IT601 – System and Network Administration

Grid Computing Approach

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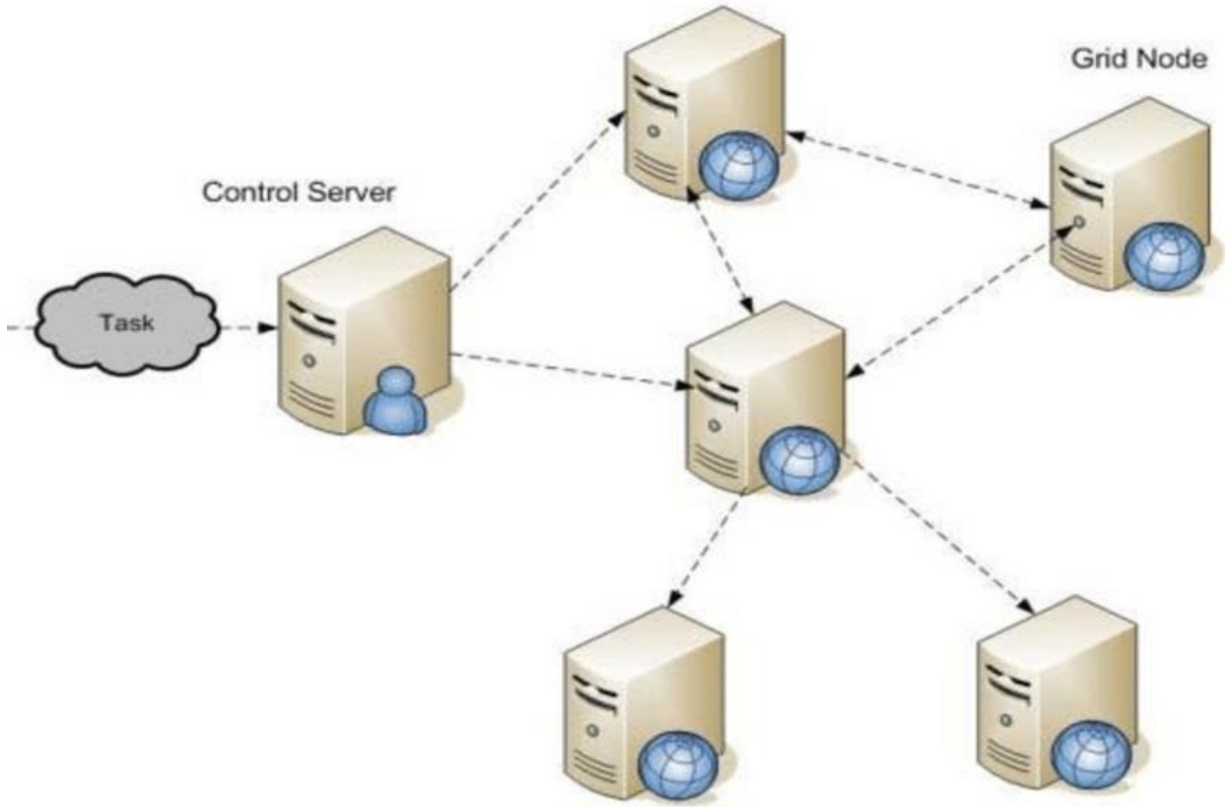
Grid computing

- Grid computing takes many similar machines and manages them as a single unit.
- To use the grid, a customer specifies how many machines are needed and which software package to run
  - The grid management system allocates the right number of machines, installs the software on them, and runs the software.
  - When the computation is done, the results are uploaded to a repository and the software is de-installed.



- scheduling algorithm
- grids are very controlled systems. All allocations are done though the grid management and scheduling system

Grid computing – Key Components and Benefits

- Key Components

- Grid computing is more efficient than virtualization because it eliminates the virtualization overhead, which is typically a 5 to 10 percent reduction in performance.

- Grids are easier to manage because what is done for one machine is done for all machines. They are fungible units i.e each one can substitute for the others. If one machine dies, the scheduler can replace it with another machine in the grid

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Blade Server Approach

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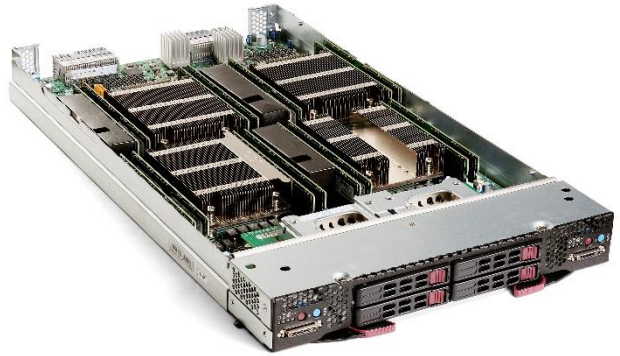
Blade servers

- There is a lot of overhead in installing individual machines.
  - Each machine needs to be racked, connected to power, networked, and so on. Blade servers reduce this overhead by providing many servers in one chassis.

- A blade server has many individual slots that take motherboards, called blades, that contain either a computer or storage.
  - Each blade can be installed quickly and easily because you simply slide a card into a slot.
  - There are no cables to connect; the blade's connector conveys power, networking, and I/O connectivity.
  - Additional capacity is added by installing more blades, or replacing older blades with newer, higher-capacity models.



- blade systems is that they are software configurable

- Blade systems are most cost-effective

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Cloud Computing Approach

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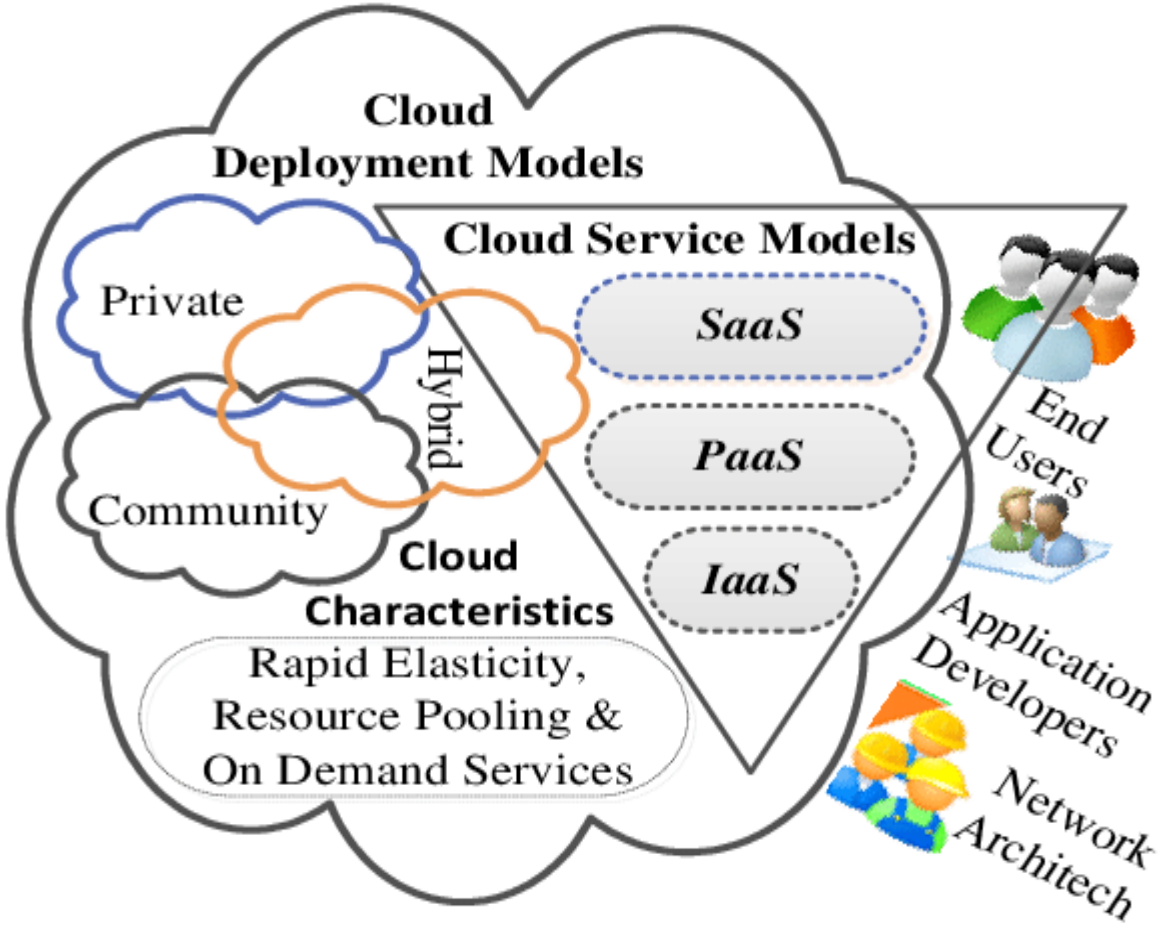
Cloud-based compute services

- Another strategy is to not own any machines at all, but rather to rent capacity on someone else's system.
  - Such cloud-based computing lets you benefit from the economies of scale that large warehouse-size datacenters can provide, without the expense or expertise to run them.
  - Examples of cloud-based compute services include Amazon AWS, Microsoft Azure, and Google Compute Engine



Cloud Definitions - Consumers

- When a typical consumer uses the term the cloud, they meancputting their data on a web-based platform.
  - The primary benefit is that this data becomes accessible from anywhere.
  - For example, consumers might havecall their music stored in the cloud; as a result their music can be played on any
  - device that has Internet access.

Cloud Definitions - Business

- Typically business people think of the cloud as some kind of rented computing infrastructure that is elastic.
  - That is, they can allocate one or thousands of machines; use them for a day, week, or year; and give them back when they are done.
  - They like the fact that this infrastructure is a payas- you-go and on-demand system.
  - The on-demand nature is the most exciting because they won't have to deal with IT departments that could take months to deliver a single new machine, or simply reject their request. Now with a credit card, they have a partner that always says yes.

Cloud Definitions – IT Professionals

- When all the hype is removed (and there is a lot of hype), cloud computing comes down to someone else maintaining hardware and networks so that customers can focus on higher-level abstractions such as the operating system and applications.
  - It requires software that is built differently and new operational methods.
  - IT professionals shift from being the experts in how to install and set up computers to being the experts who understand the full stack and become valued for their architectural expertise, especially regarding how the underlying infrastructure affects performance and reliability of the application, and how to improve both.

Cloud Computing's Cost Benefits

- Cloud-based compute services take that strategy to a larger scale than most companies can achieve on their own, which enables these smaller companies take advantage of these economics.

- Adoption of cloud computing is also driven by another cost: opportunity cost. Opportunity cost is the revenue lost due to missed opportunities. If a company sees an opportunity but the competition beats them to it, that could be millions of potential dollars lost.

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SAS Approach

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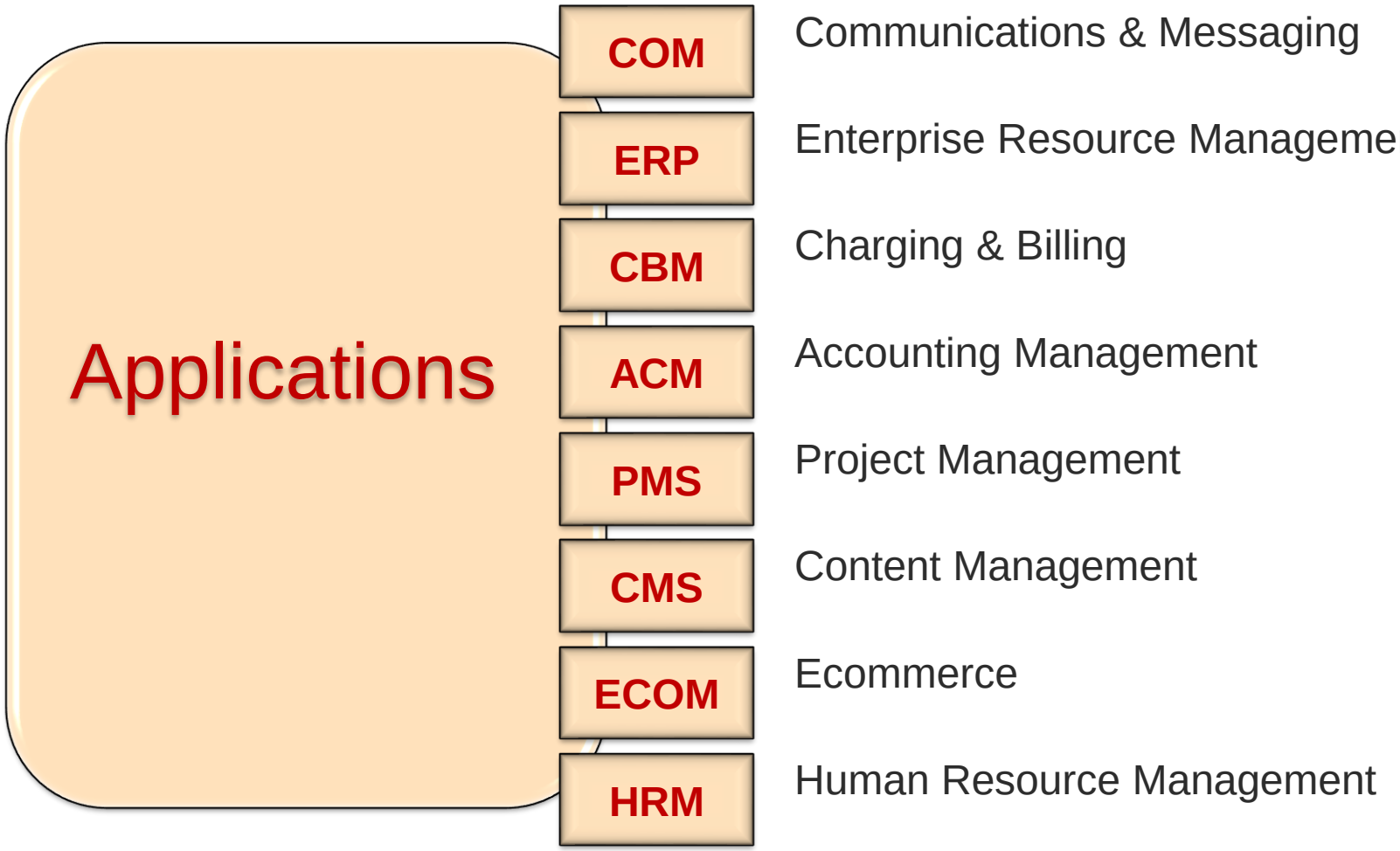
Software as a service (SaaS)

- Software as a service (SaaS) means using web-based applications. Many small companies have no servers at all. They are able to meet all their application needs with web-based offerings.



Software as a service (SaaS)

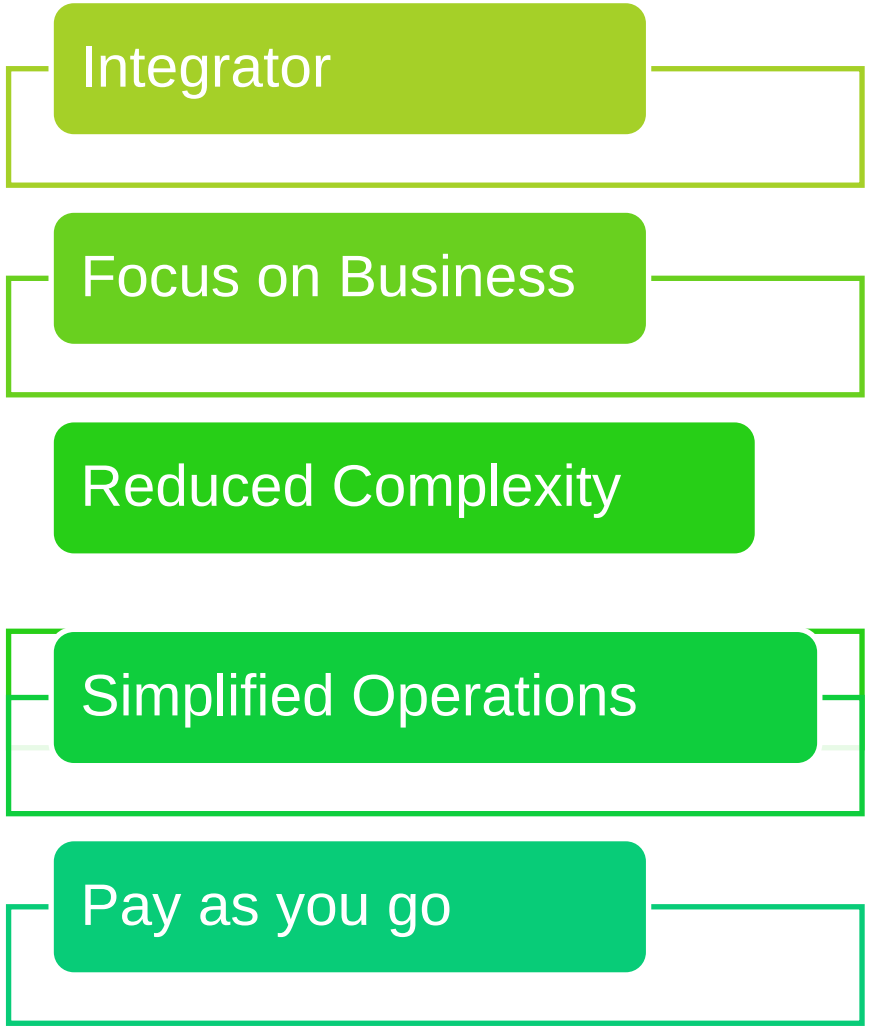
- Organizations host their web site using a hosting service, they use a web-based payroll provider, they share files using Dropbox, they use Salesforce for customer relationship management and sales process management, and they use Google Apps for Work for word processing, spreadsheets, and presentations.

- If they use Chromebooks, iPads, or other fixed-configuration webbrowsing devices, they don’t need traditional computers and can eliminate a lot of the traditional enterprise IT infrastructure that most companies require.

- This strategy was impossible until the early 2010s. Since then, ubiquitous fast Internet connections, HTML5’s ability to create interactive applications, and better security features have made this possible.

Software as a service (SaaS): Impact

- When a company adopts such a strategy, the role of the IT department becomes that of an IT coordinator and integrator.
- Rather than running clients and services, someone is needed to coordinate vendor relationships, introduce new products into the company, provide training, and be the first stop for support before the provider is contacted directly.
- Technical work becomes focused on high-level roles such as software development for integrating the tools, plus low-level roles such as device support and repair management.



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Server Appliance Approach

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Server appliances:

- An **appliance** is a device designed specifically for a particular task.

- **Examples**
  - Toasters make toast.
  - Blenders blend.

- **General Purpose Vs. Specialized**
  - We could build servers using general-purpose hardware with specific software packages
  - However, there are significant benefits in using a device designed to do one task very well.

Server appliances

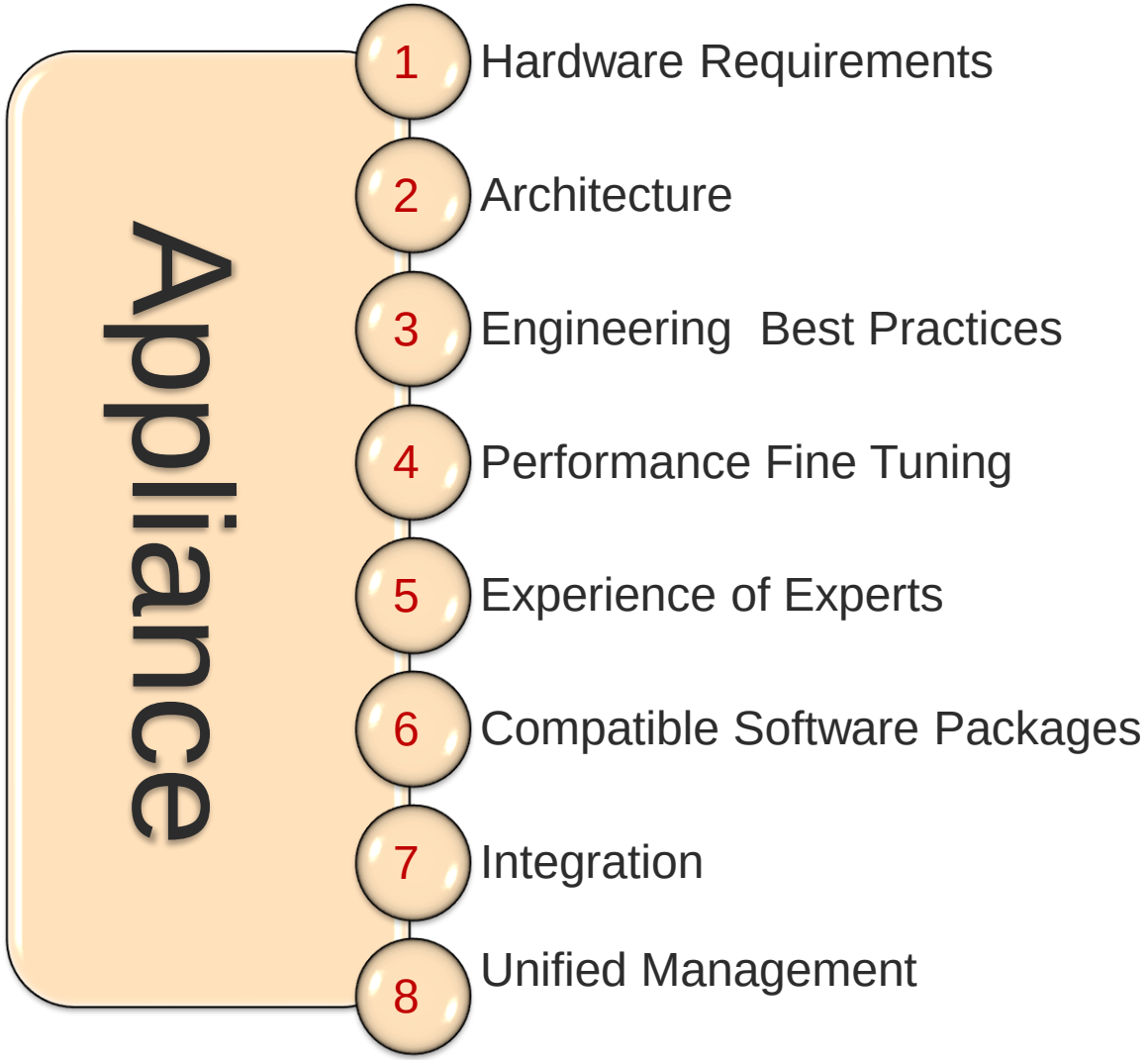
- **The computing area also has appliances:**
  - File server appliances,
  - Web server appliances,
  - Email appliances,
  - DNS/DHCP appliances,
  - and so on.

- **The first appliance was the dedicated network router.**
  - Is it feasible to spend all that money on a device that just sits there and pushes packets when we can easily add extra interfaces to our VAX and do the same thing?”

- **Common Opinion**
  - Some people have point of view that a box dedicated to doing a single task, and doing it well, was in many cases more valuable than a general-purpose computer that could do many tasks.
  - It allows you could reboot the VAX without taking down the network for everyone else.

Server appliance consolidates

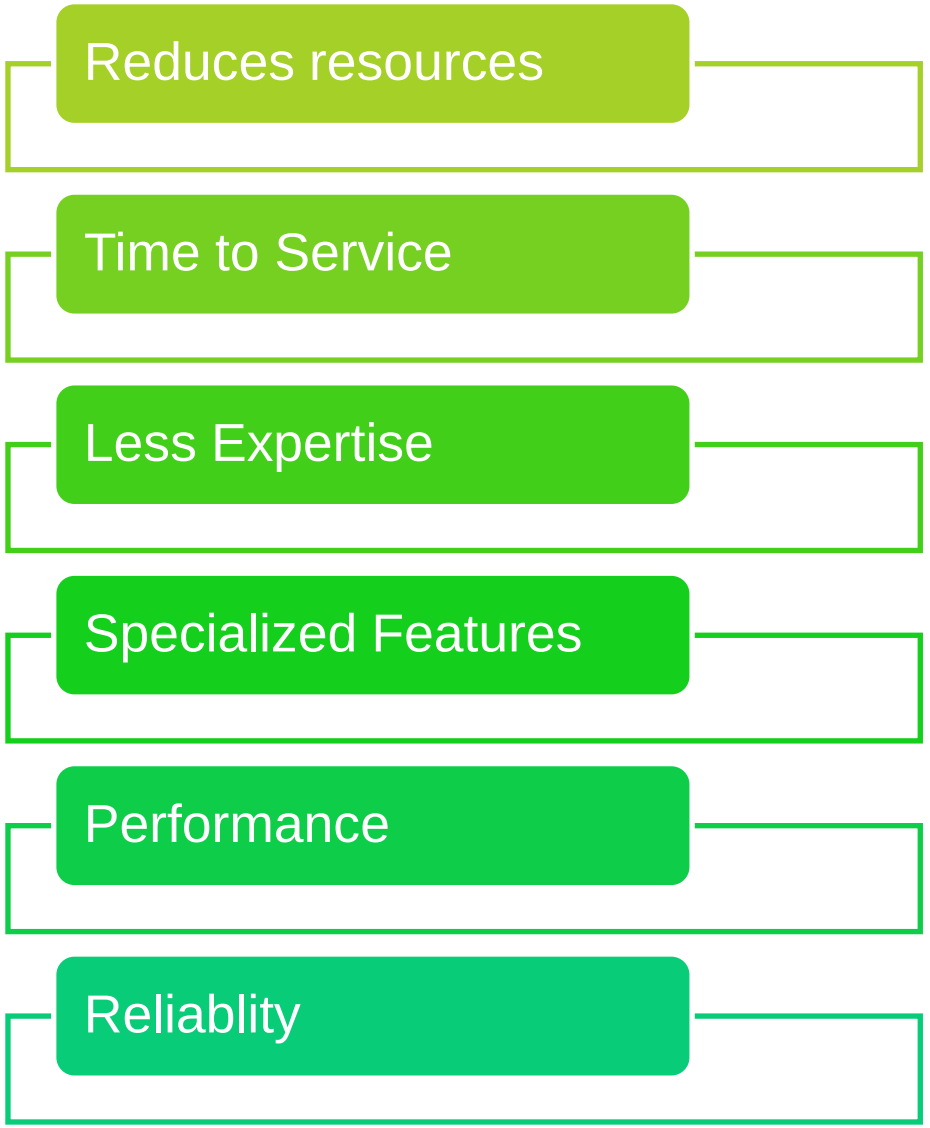
- **A server appliance brings lot of things together in one box.**
  - Architecting a server is difficult.
  - The physical hardware for a server has all the requirements
  - The system engineering and performance tuning that only a highly experienced expert can do.
  - The software required to provide a service often involves assembling various packages, gluing them together, and providing a single, unified administration system for it all.



- **It's a lot of work! Appliances do all this for you right out of the box.**

Server appliances - Benefits

- Although a senior SA can engineer a system dedicated to file service or email out of a general-purpose server, purchasing an appliance can free the SA to focus on other tasks.
- Every appliance purchased results in one less system to engineer from scratch, plus access to vendor support in case of an outage.
- Appliances also let organizations without that particular expertise gain access to well-designed systems.
- The other benefit of appliances is that they often have features that can't be found elsewhere.
- Competition drives the vendors to add new features, increase performance, and improve reliability.
- For example, NetApp Filers have tunable file system snapshots that allow end users to "cd back in time," thus eliminating many requests for file restores.



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Server Selection Aspects

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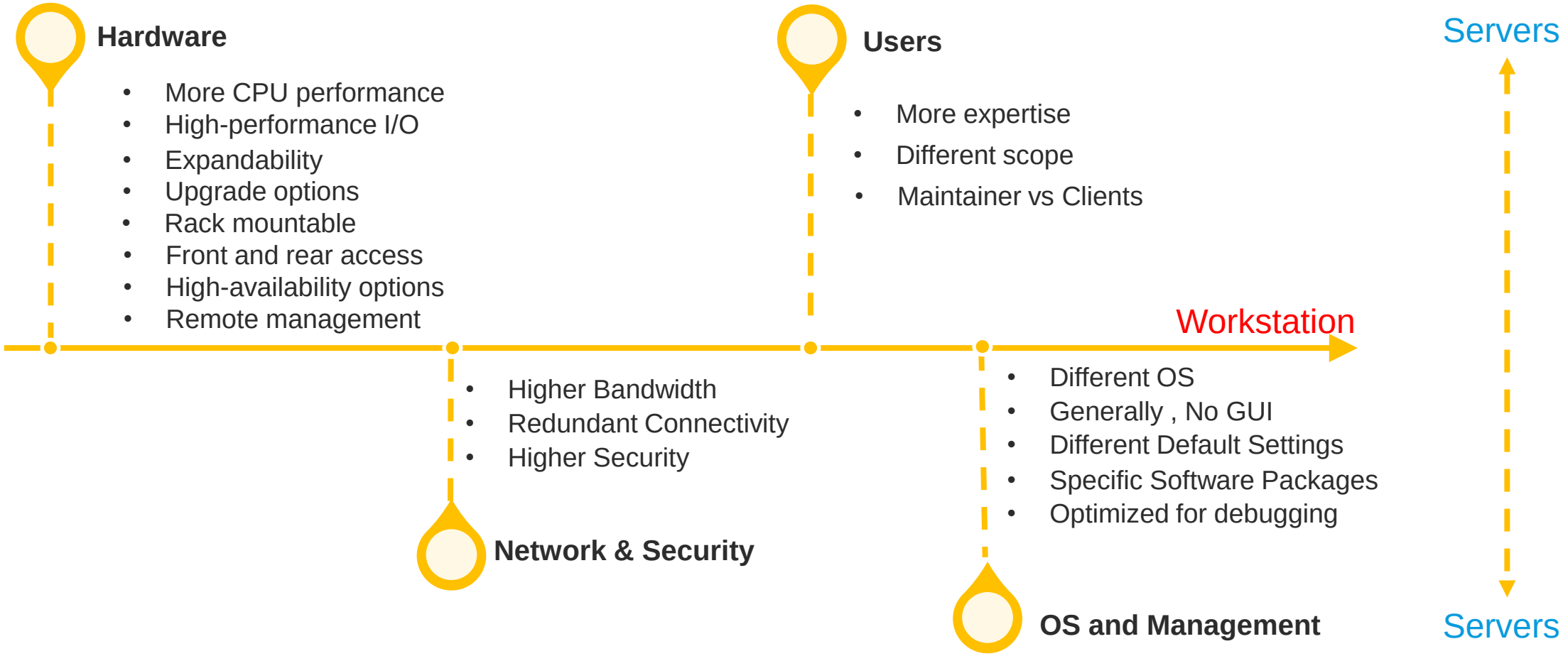
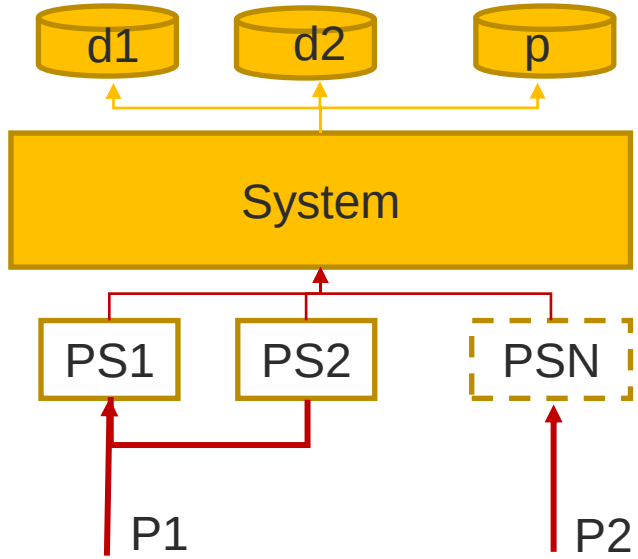
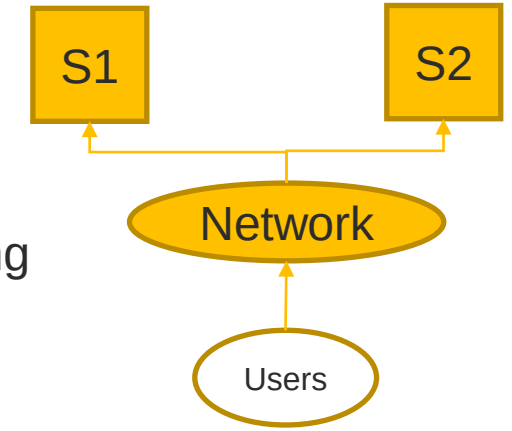
The Differences



Server Reliability

- **Levels of Redundancy**
  - N+0, N+1,…, N+r
  - Identify Redundant Units, Power Supplies, CPUs, Hard disks etc
- **Data Integrity**
  - ❑ Ensure data is available and valid in future
  - ❑ RAID , Service Failure Vs Component failure
  - ❑ Non-RAID Approaches,
    - Redundant Systems vs Redundant Components
    - Distributed systems e.g Google's GFS, Hadoop's HDFS, Cassandra
    - Backups
- **Hot-Swap Components**
  - the ability to add, remove, and replace a component while the system is running
  - Not All components are hot swapable
- **Servers Should Be in Computer Rooms**



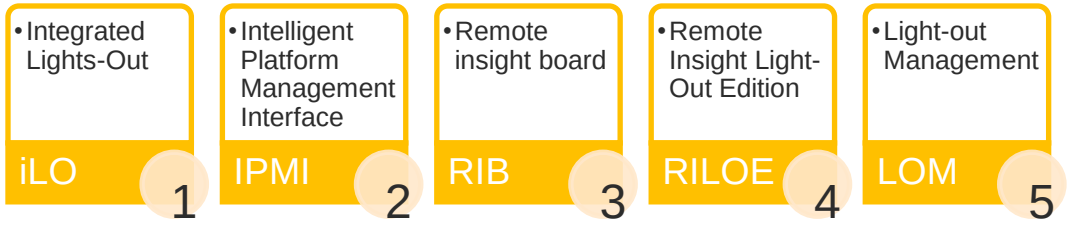


Remotely Managing Servers

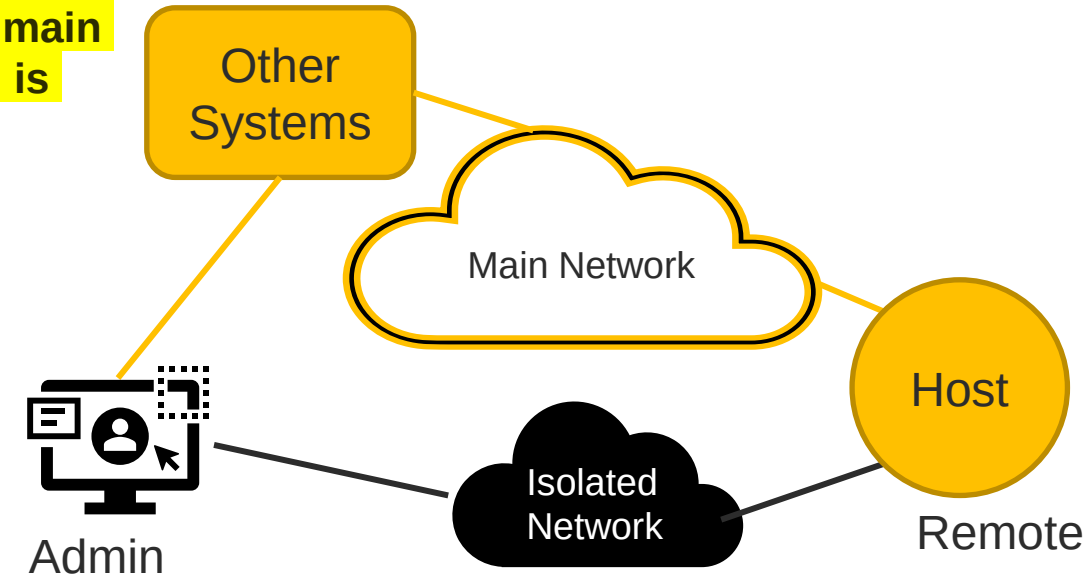
- Do all system administration tasks involving the machine from a remote location, except physical labor such as adding and removing physical hardware.
    - Ability to remotely access the machine's console and, optionally, have remote control of the power switch.
    - Ability to operate a system's console when the machine is in a bad state or otherwise disconnected from the network. e.g. Accessing a basic BIOS configuration, CTRL-ALT-DEL keys
- Saves time and cost
- Need to consider security aspects
- **Two Types of Remote management techniques**
    - Integrated Out-of-Band Management
    - Non-integrated Out-of-Band Management

Integrated Out-of-Band Management

- **Integrated Out-of-Band Management**
  - Modern servers have remote management capabilities built-in. Such systems are generically called out-of-band (OOB) management and have an Ethernet port as an interface.
- **OOB interface requires an IP Address, and remote system console is accessed via browser or client.**
  - Remote access via a browser has limited functionalities as compared to clients.



- **The remote management systems must be isolated from the main network and must be accessible even when the main system is down or powered off**
- **Security Aspects**
  - OOB interface is equivalent to physical access to the machine
  - Built-in systems have been found to suffer from traditional security holes, such as buffer overruns
  - Don't assume that a password on the OOB interface and using SSL is sufficient protection
  - Put OOB interfaces on a dedicated protected network, use a web proxy, authentication and authorization

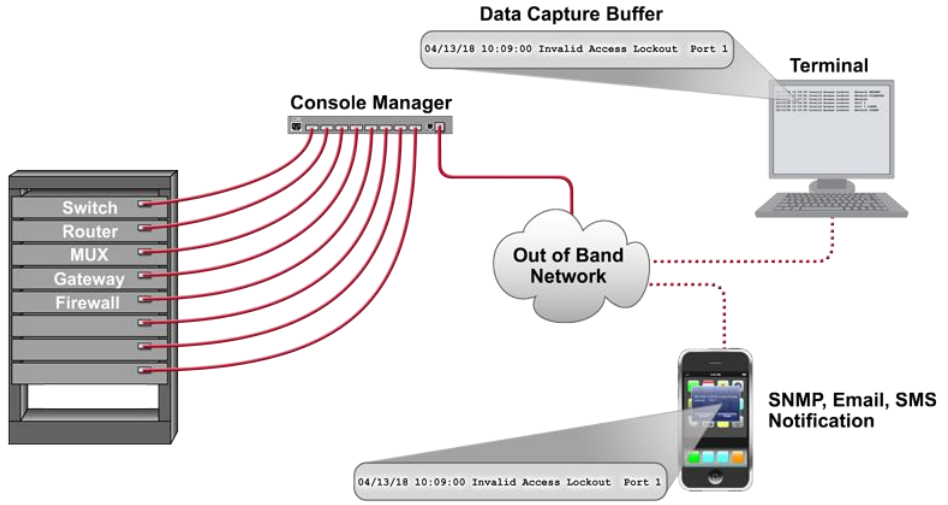


Non-integrated Out-of-Band Management

- The built in OOB has some limitations in terms of remote power cycling and console access. Third party tools can address these issues.
  - **Remote Power Cycle**
    - Switched power distribution unit (PDU) provide the remote power cycling. A PDU is the fancy name for a power strip

  - **Remote Console with IP-KVM**
    - Keyboard, video screen, and mouse (KVM) switch is a device that allows many machines share a single.
    - An IPKVM switch provides the remote console access.
    - An IP-KVM is a KVM switch that can be accessed remotely. This eliminates the need for any monitors, keyboards, or mice in the computer room. You simply run a client on your workstation that connects to the IP-KVM.

  - **Remote Console with Serial Consoles**
    - Network equipment, appliances, and older servers have serial consoles. They have no video, keyboard, or mouse connector.
    - In the old days one would attach a physical VT-100 terminal to the serial console port of each device
    - In the 1990s it became popular to replace physical terminals with a terminal console concentrator.
    - Also, serial console concentrators usually have the option to require authentication—for example, using RADIUS or TACACS—before allowing someone to connect to a console.



Separate Administrative Networks

- **It is common for servers to have a separate NIC that is connected to a dedicated administrative network. Separating administrative traffic from normal service traffic has a number of benefits.**
  - For servers, the primary benefit is often to isolate disruptive traffic.
  - Backups, for example, consume a large amount of bandwidth and can interfere with normal service traffic.
    - Sometimes servers have a dedicated backup interface that uses a high-speed network dedicated to backups.

- **Characteristics of administrative networks**

Stable & Static	Strict Security	Dedicated	Separation	Simplicity	Availability
• Should be more stable • More static • Service Networks are more dynamic	• More Restrictive firewall rules • Serves more critical systems	• Only for administrative purpose	• Should be separated from other service network	• Simple Engineering • No VLANs • Simple Topology	• Should be always available • Immune to outages

Maintenance Contracts and Spare parts

- **Vendor SLA**
  - There is a variety of maintenance contract options, with different service level agreements (SLAs).
    - Replacement for a bad part with a 4-hour response time, a 12-hour response time, or next-day options.
      - Sometimes the options include 24/7 response, but other times just specify some number of business day
    - Other options include having the customer purchase a kit of spare parts and receive replacements after a spare part gets used.
      - Usually, the installation of the replacement part is by organization itself, though vendors offer onsite repairs for a higher price. Sometimes the service offerings vary by country or region, depending on where the vendor has local presence.

- **Response time**
  - Response Start
  - Fast Response Vs Cost
  - Plan for redundancy

- **Critical Servers**
  - Lowest level maintenance contract
  - Redundant Server
  - Maintenance contract with warranties
    - Vendors to maintain spares in same city

- **Non-Critical Servers**
  - Default maintenance contract
  - Flexible Response time
  - Low cost maintenance contract

Maintenance contracts and spare parts

- **Spare Parts**
  - In house repair department vs maintenance contract
    - Cost
    - Trainings, Certifications on the hardware
    - Maintaining inventory of spares
  - Self-Support Plans
    - Repair kit with maintenance contract
      - Homogeneous Infrastructure to allow sharable spares
      - No Licenses
      - Cold Spares
      - Suitable for High End Servers

Maintenance contracts and spare parts

➢ **Tracking Service Contracts**

- **Machines not covered in maintenance contract**
  - Discovered during outage
  - Generally , coordinating with sales staff of vendor will add to maintenance contract

- **Improvement Strategies**

  ❑ Service contracts with 10% additional price
    - allows adding new machines as added
    - vendors can easily extend maintenance contract

  ❑ Ensure each machine is purchased with maintenance contract
    - Avoid situations where vendor can agree to add new machines into existing maintenance contracts

  ❑ Tract expiry of the initial maintenance contract that came with purchase
    ❑ Remove dismantled machines
    ❑ Add new machines

Maintenance contracts and spare parts

- **Cross-Shipping**

  - A type of shipping in which vendors requires the faulty units to be received before shipping replacement unit.
    - Alternate approach may be that vendor ship the replacement immediately and faulty unit is sent back afterwards.
    - Vendors use it to avoid unnecessary replacements

  - Cross shipping should be part of maintenance contract.

Selecting vendors with server experience

- Some vendors have years of experience designing servers, and it shows
- They build hardware with the common server-related features, as well as include little extras that one can learn only from years of market experience.
- Servers from inexperienced vendors may lead to .
  - Issues to integrate with enterprise systems such as authentical systems
  - Management of the device is manual and cumbersome, lacking the ability to manage many servers at once, and with no kind of remote management
  - No maintenance contracts or degraded maintenance contracts
  - Low quality technical support
  - Issues in replacement of parts
- Select vendors that are known for building reliable hardware. Some vendors cut corners by using consumer-grade parts; others use premium-quality parts.

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Services

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Service

- **Services are the applications that customers need and use.**
- **Different components that make an application work includes**
  - the software,
  - the hardware,
  - and the operations that bring it all together.
- **A service may have direct customers,**
  - such as a web-based application,
  - or it may be invisible to most people, such as a database that is used by other services.
- **The fundamental purpose of System Administration is to provide services**
  - Computers and software are useful only when they are actively providing a service, not sitting in a box.
  - Services do not run themselves; it is a human process to create a service as well as to maintain it.
  - A good service meets customer requirements, is reliable, and is maintainable.
- **A service begins life as a set of requirements.**
  - Customers and stakeholders have needs, and the service is created to fulfill them.
  - These requirements are used to create the technical design.
  - The service is deployed and launched.
  - Launching a service is more complex than one would expect.

- **The launch of a service is not the end of this process, but it is really just the beginning.**
- Services usually run much longer than it takes to create them.
- A running service requires maintenance and upkeep.
  - As demand grows it is scaled to handle the larger workload.
  - Requirements change over time, and new software releases must be deployed to fix bugs and add features.
  - systems fail, disaster planning is part of any service. This includes basics such as data backups and more advanced practices such as service relocation.

- Services need to be supported.
  - They must be monitored, so that problems are detected and fixed.
  - There needs to be a team that handles alerts from the monitoring system as well as end-user reports of problems.
  - For many services, the customers can request moves, adds, changes, and deletes.
  - There needs to be a mechanism for them to do so, and a team that is responsible for handling those requests.

Types of Services

- **Generally, the computing environment and processes depends on the type of services being offered.**
  - Homes and very small offices typically have a few services; often they simply rely on their ISP for foundational services.
  - Larger organizations have a rich environment of services: from the applications that run the company, to the foundational services and infrastructure on which they depend.
  - A large organization's fundamental services are run like an in-house ISP.
- **Services can be categorized into following categories**

Foundational services	Basic services	Primary Applications	Back Office Systems
▪ Create the platform that other services rely on.	▪ User-visible applications that most people have come to expect in an organization.	▪ Applications generally drive business functions	▪ include the databases and other behind-the-scenes
▪ DNS, DHCP, directory services, network access (WAN and LAN), and Internet gateways	▪ Examples include printing, email, file storage, chat/IM, and VoIP/phone service.	▪ Examples are payroll, inventory management, enterprise resource planning (ERP), supply chain management, and so on	▪ services that support applications
▪ While they are generally invisible to users, failures are highly visible because they affect many services.	▪ Because of their visibility and pervasiveness, people have developed expectations that these services will be reliable and always available.		

- Together they form the company's critical path The company cannot function without them.

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Service Requirements

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Service Requirements Process and their Types

- **The determination of requirements for a services follows two steps.**

  1 – Kick off Meetings , 2 – Written Requirements

  1 - Starting with a Kick-Off Meeting

  - Creating and launching a new service cannot be done alone.
  - Good to start with requirements gathering via email, IM, teleconference, and video chat.
    - Nevertheless, it is critical to start out with a face-to-face meeting; the kick-off meeting
      - A kick-off meeting should have all the stakeholders present
    - Stakeholders are all the key people affected by or involved in the project

  - **What to expect from Kick off Meeting?**
    - agreement on the goal of the new service and the problem being solved
    - A timeline for completion
    - an approximate budget
    - It is no possible to resolve all these issues.
      - Mark them open.
      - Delegate each unresolved issue to a participant who will be accountable for its resolution.

  - **Benefits of Kick off Meeting?**
    - Introduce stakeholders and their roles
    - Improves collaboration
    - Resolves the issues faces in emails, IM e.t.c.

Service Reequipments and their Types

2 - Gathering Written Requirements

- The next step is gathering requirements.

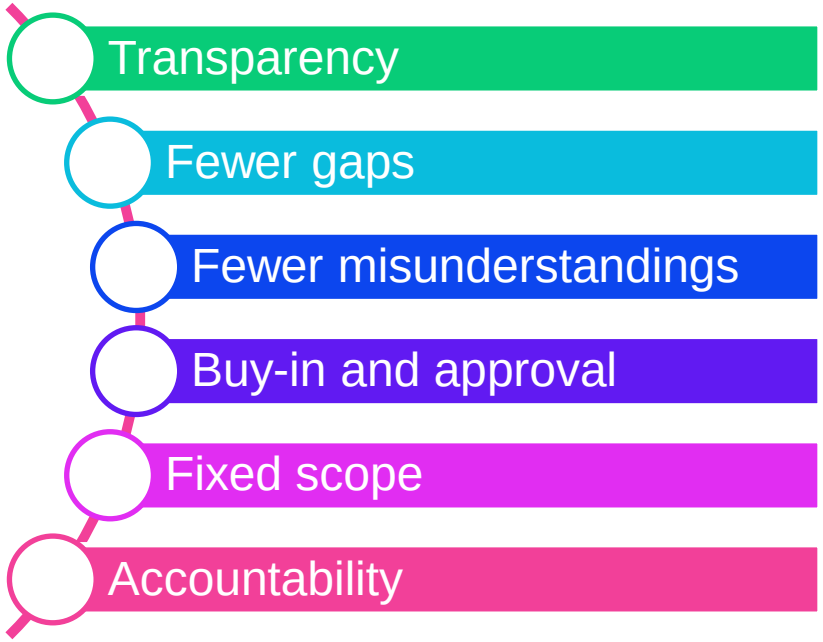
- **Goal of Requirements**
  - Requirements are a list of what the service will be able to do. Requirements should list desired functionality, features, and capabilities. Focus on the end goal: what the system will enable people to achieve.

- **Serve as checklist for other steps**
  - The list of requirements guides all the other steps: design, engineering, implementation, testing, and so on.
  - It avoids confusion and finger-pointing.
  - It sets expectations with customers. It can even be a checklist that lets you know when you are done.
  - Avoid boiling the ocean.
    - Some requested features will be too difficult or expensive to implement.
    - Some may not be appropriate for this service to provide but may be better suited to a different service.
    - Some may be required by too few people to be worth implementing, at least in the initial release.
    - Some requirements may have external dependencies on other groups, projects, or services.
    - Make sure to flag each of these external dependencies and have a plan for what to do if the external dependency is not delivered on time.

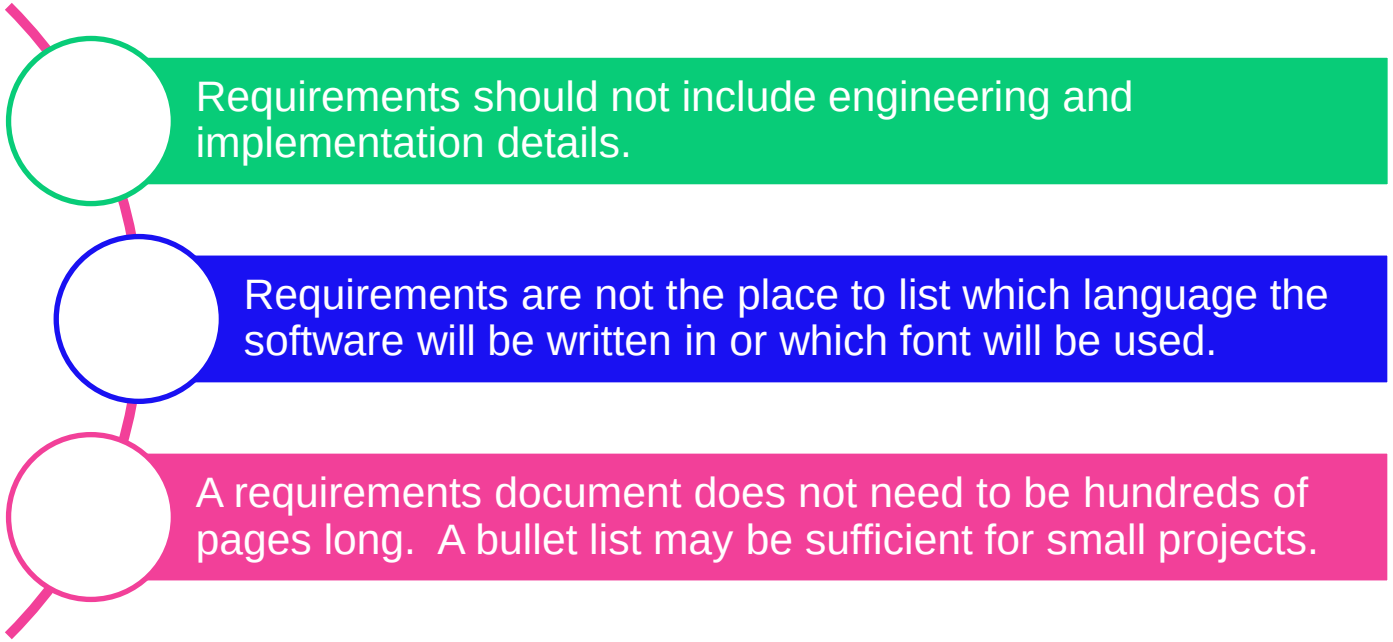
2 - Gathering Written Requirements

- **Requirements are written down. They are not simply agreed to in a verbal discussion, tracked on a dry-erase board in your office, or kept in your head.**
  - Writing them down in a shared requirements document has many benefits:

- **Benefits**



- **What to avoid**



2 - Gathering Written Requirements

- **Guidelines**
  - **Define terminology early in the document. Getting agreement to the ontology that will be used is very important.**
    - ❑ Ontology is the system of terms and definitions that define the system and its parts.
    - ❑ Often during a heated debate, one realizes that everyone is using the same words but meaning different things.
    - ❑ Pausing to get agreement on terminology helps everyone see eye-to-eye.
    - ❑ At that point we often realize we were closer to agreement than we had previously realized.
  - **Annotate the importance of each requirement.**
    - ❑ Marking each as “must have,” “desired,” or “optional/nice to have” communicates intent.
    - ❑ It gives the system designers flexibility and helps implementors prioritize work when deadlines are looming, and features must be cut.

Types of Requirements

- **The requirements can be classified into following types**

Customers

Scope, Schedule, and Resources

Operations

Open Architecture

1 - Customer Requirements

A - Describing Features

B - Questions to Ask

C - Service Level Agreements

D- Handling Difficult Requests

A - Describing Features

- **Record the "what," not the "how."**
  - The requirements should focus on the list of features, stated from the perspective of what the customer should be able to accomplish using business terms, not technical terms.
  - **Example**

    It is better to record a requirement such as "the user should be able to send email" than "there should be a button on the left that the user clicks to send email." The latter assumes a lot about the interface. Why should the designers be required to include a button even though they have a better idea?

- **Do not proscribe particular technology**

B - Questions to Ask

- **Ask how, why, where, and when, as if you are a journalist conducting an interview.**
- **Example Questions**
  - How do customers intend to use the new service?
  - Why do they need each feature?
  - Where, when, and how will the system be accessed?
  - How critical is the service to them, and which levels of availability and support do they need for service?
- **Determine how large the customer base for this service will be and what sort of performance they will expect from it.**
- **Another way to record requirements is through use cases that tell a story. As long as the story can be completed by the final design, the use case is sufficiently covered.**
  - In Agile methodology, the format is “As a <type of user>, I want <some goal> so that <some reason>.”
  - Examples

    For example, one might specify: “As a payroll clerk, I want to be able to enter future payroll adjustments so that I don’t need to do them all on the day they take effect.”

    Another example: “As a user, I want to indicate which folders should not be backed up so that my backup drive isn’t filled up with things I don’t need saved.”

C - Service Level Agreements

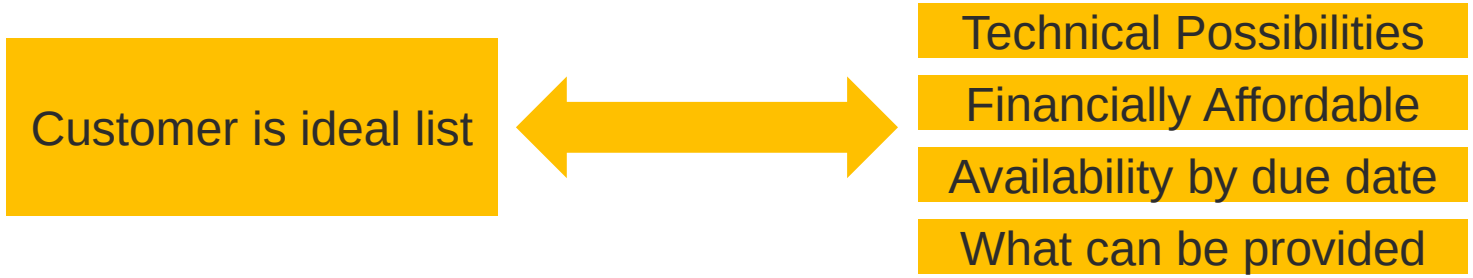
- **The requirements document should include the service level agreement (SLA), or at least some general specifications that can be used to build an SLA.**
  - What SLA Should Incudes.

Enumerate Services	Categories Problems	Escalation Process	Penalties	Resources	Customer Needs	Future Needs
It should enumerate the services with the level of support.	Categorizes problems by severity and commits to response times for each category.	Defines an escalation process to increases the severity of non-resolved problems.	Specifies penalties if the service provider fails to meet a given standard of service.	A tool to plan the resources for project.	Document the customers' needs and set realistic goals for the SA team in terms of features, availability, performance, and support.	Document future needs and capacity so that all parties understand the growth plans, and their approximate costs.

- The SLA is always discussed in detail and agreed on by both parties.
- The SLA creation process is a forum for the SAs to understand the customers' expectations and to set them appropriately, so that the customers understand what is and isn't possible and why.
- The SLA is a document that the SA team can refer to during the engineering process to make sure that they meet customers' and their own expectations and to help keep them on track.

D - Handling Difficult Requests

- **Requirements gathering is a collaborative process.**
- **The ultimate goal is to find the middle ground.**



- **Your job is to educate as much as it is to record features.**
  - Don't become upset when a customer asks for something technically unreasonable; if the customer knew technology as well as you do, the customer would be an SA.
  - Try to understand the end goal and see how that can be achieved instead.
    - Rather than say "no," focus on the need, not the technology.

- **Examples**
  - A feature that will take years to develop is not reasonable for a system that must be deployed next month.
  - A feature that will cost $1 million is not reasonable for a project with a budget that's in the thousands of dollars.
  - A small company with only one or two SAs will not get 24/7 support, no matter how much the company wants that.

IT601 – System and Network Administration

Services – Requirement Gathering

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2 - Scope, Schedule, and Resources

- **A project plan generally has three elements.**

- If a project is at risk of not making its deadline, one or more of these will have to change. Features will need to be dropped, the deadline will need to be extended, or the budget will need to be increased.

- **Flexible Vs Inflexible Features**
  - For example, if the project needs to be complete in time for the Eid shopping season, the schedule is inflexible; so the features and/or budget needs to be flexible. If the budget is inflexible, it must be possible to remove features or extend the schedule.
  - If the project is to send humans to the moon and safely return them, the features are inflexible; a one-way trip is not an option. In this case, either the budget or the schedule must be flexible.

  - **Management Buy-in is important**
    - management to decide as to which of these elements are flexible and which are inflexible at the start of the project.
    - The buy-in process helps communicate priorities to all stakeholders, prevents a lot of confusion all around, and helps focus people on the right priorities.
    - It also has the benefit of discovering early on if management is unwilling to be flexible in any of the three areas.

3 - Operational Requirements

Operational requirements are the things that make a system maintainable. These are the features required if we are to have a system that is reliable, scalable, and secure. The features are often invisible to the customers; yet reliability is the most visible aspect of a service.

A - System Observability

B - Remote and Central Management

C - Scaling Capacity

D - Software Upgrades

E - Environment Fit

F - Support Model

G - Service Requests

H - Disaster Recovery

A - System Observability

- **System Observability means the ability of a manageable system that we can see what it is doing.**
  - The system must provide enough visibility and introspection to debug it when there are problems, optimize it when it is slow, and detect when resources are low before they become a problem.
  - There should be situational awareness to reason about it, predict its future behavior, and do capacity planning.
  - A system may runs itself, or that a company's goal may be to build a system that it doesn't need maintenance.
    - It should be their goal, but until it is achieved vendors must build observable systems.
- **A system which is not observable, we cannot manage it, fix it, or scale it**
- **Basic Tools of Visibility**
  - **System Logging**
    - The most basic kind of visibility is logging. All parts of the system should log events, transitions, and operations.
    - Logging should be adjustable to provide more detail when debugging. The level of detail may include logging every API call or function call.
  - **System Monitoring**
    - Ability to monitor not just the system 's up or down, but also internal resources, timing, bandwidth, disk space usage and requests delays.
    - The system is up or down information cannot prevent outages; you can only respond to them. There should be warnings if too late to prevent an outage.
    - The new system should integrate into existing monitoring systems, dashboards, trouble-ticket systems, and other appropriate visibility tools.

B - Remote and Central Management

- **Services should be remotely managed. If you have to be on the console of a machine to do rudimentary maintenance and configuration, each task will be more time consuming.**
  - This is also an indication that automating management tasks may not be possible.
- **Two basic reasons for remote servers**
  - **Specialized Premises**
    Servers are generally located in machine rooms where power and cooling can be managed more effectively. Remote management permits servers to be located anywhere. It is less expensive to rent colocation space elsewhere than to build a computer room in your office. It is often also more reliable.
  - **Geographic Redundancy**
    Services that are replicated in many places must be manageable in a centralized fashion. Remote management opens up the possibility of deploying instances of the service around the world. Configuration changes and upgrades should not require manually updating each instance.
- **Consider high latency over long-distance connections**
  - Protocols may time out. User interfaces may work but can be unusably slow. This is not a limit of the technology, but rather bad software engineering. Plenty of APIs and user interfaces work well over high-latency links—and so should management tools.

C - Scaling Capacity

- **If a service is successful, more people will want to use it. Over time it will need to scale to handle more users, more transactions, or more capacity.**

- **There are two ways services generally scale.**
  - **Scale-up**
    means getting a bigger system. To process more requests, more users, or more disk space, the main system is replaced with one that is bigger and faster.
    - For example, to scale up a web server so that it can process more requests per second, you might replace the computer with one that has a faster CPU and I/O system.
  - **Scale-out**
    means the system is expanded by adding more replicas.
    - For example, a web-based service is often made up of web servers behind a load balancer. Scaling out means adding more redundant web servers (replicas). Each web server scales out the system to handle more requests per second.

D - Software Upgrades

- **A system must have a reasonable way to upgrades.**
  - The software
  - The firmware

- **Two types of upgrades.**
  - Interruption Free
  - With Interruption

- **Ideally, it should be possible to test a new software release outside of production and upgrade the service without interrupting it.**

- **new software releases**
  - Software is never done. There will always be the need for new software releases, even if every feature is complete and every bug is fixed.
  - New security holes are discovered constantly, and may not even be in the vendor's code but in a library or framework it used.
  - More importantly, software is malleable and vendors should be providing new features and improvements over time. There's always room for improvement.

D - Software Upgrades

- **Upgrades should be a Process**
  - Upgrade processes should exist and be automatable.
  - The process should integrate into the organization's software patching automation.
  - It should not involve walking to each desktop machine for a manual update.
  - Roll out the upgrade slowly
    - It should be possible to upgrade some clients, but not all, so that we can mitigate risk by rolling out the upgrade slowly.
    - If all clients have to be upgraded simultaneously, then there is no way to test the upgrade.
    - As number of clients grows, the concept of upgrading clients at the same time becomes more and more inconceivable.
- **Test environment**
  - The more people depend on a service, the more visible a failed upgrade will be.
  - Ensure to make it possible to deploy the service to a test environment for the purpose of both testing the upgrade process and testing the new release itself.
- **Production assurance test (PAT) or user acceptance test (UAT)**
  - PAT and UAT environments are run at production standard, but upgraded ahead of the main production environment.
  - Select volunteers who use PAT or UAT environment, rather than the production environment, at all times, to ensure that when an upgrade is rolled out in that environment, it is really used and production tested.

E - Environment Fitness

- **The better a service fits into the existing IT environment, the easier it is to adopt it in your environment. Integration issues are reduced, and less training or skill development is required.**
  - For example, if you use ActiveDirectory, then using a product that interfaces with it will be easier than using a product that has its own directory service. If the service runs on an operating system with which the team is unfamiliar, using it will require not just additional training, but entirely new procedures that have to be developed for tasks such as data backups, account creation, and configuration.
- **For a small project, it is reasonable to make it an operational requirement that the service fit into the existing OS infrastructure, directory service, and so on. Larger projects require more flexibility.**
  - For example, a large SAP ERP deployment is a self-contained environment unto itself. Therefore it is more acceptable that it may introduce a new operating system to your environment. Most likely it will have its own system administration team.

- **Environmental Factors**

▪ Operating system ▪ Backup/restore facilities ▪ Monitoring system ▪ Network equipment vendor and routing protocols ▪ Security auditing systems	▪ Trouble-ticket systems ▪ Dashboards and consoles ▪ Network directory services ▪ DNS and other name services ▪ Printing systems

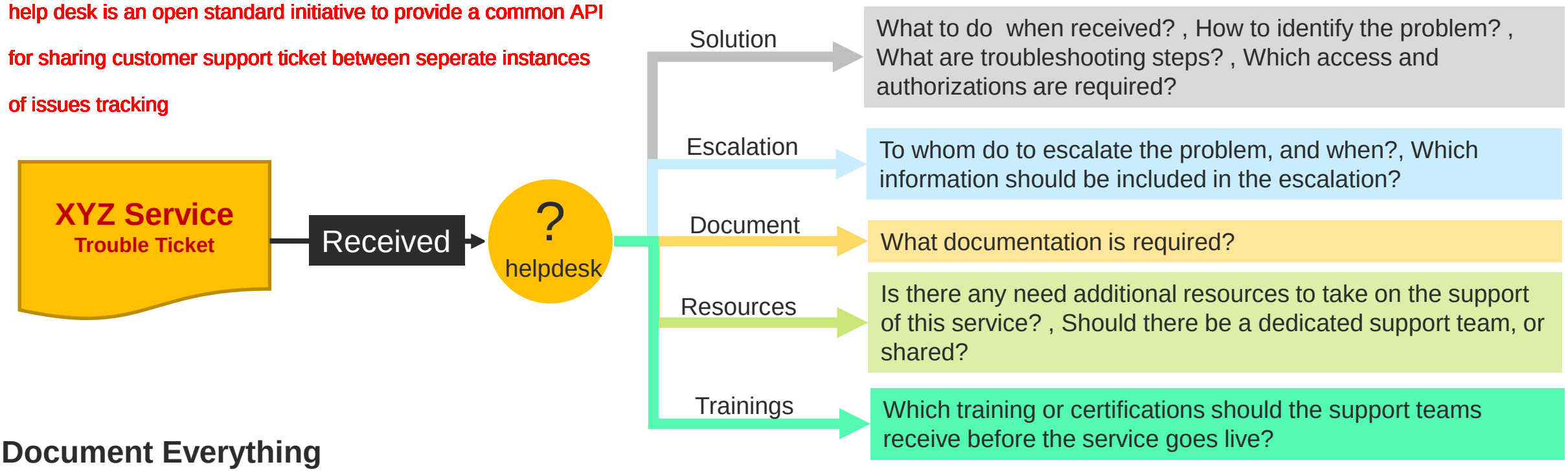
F - Support Model

- **A key component in the success of a new service is support processes.**
  - This aspect is often forgotten or neglected by the engineers, who are intent on developing the technical solution.
- **Problems arise as service goes into production**
  - When they have problems with it, they will raise tickets or call the helpdesk.
  - If the helpdesk does not know about the new service, the users of the service will receive very poor support, and will have a bad impression of the service, no matter how well it has been implemented.

help desk is an open standard initiative to provide a common API

for sharing customer support ticket between seperate instances

of issues tracking



- **Document Everything**
  - The project plan will need to include time and budget resources to implement the answers to these questions. Documentation may need to be written, new staff hired, training completed, helpdesk operations updated, monitoring systems expanded, and so on.

G - Service Requests

- **Most services will include standard service requests that people can raise.**
  - Depending on the service, these may be access or authorization requests, data changes, configuration changes, resource requests, and so on.
- **A checklist for building requirements might look like this:**

Checklist	
	• What should people be able to request?
	• How do people raise these requests?
	• Which changes need to be made to the service request system to support these new service requests?
	• Which approvals are required for each of these service requests?
	• Who will process the requests?
	• Which access and authorizations will that team need?
	• Which runbooks does that team need to correctly service the requests?
	• To what extent can, or should, these requests be self-service or fully automated?

- **The answers to these questions will provide some new requirements.**
  - For example, depending on whether the requests should be self-service or automated, there are API requirements that need to be taken into consideration. The requirements and dependencies on other systems, such as the service request system, also need to be documented, agreed to, signed-off on, budgeted, and planned.

G - Disaster Recovery

- **Failures cannot be eliminated.**
  - Hardware fails, buildings lose power, Internet access gets cut, and so on.
  - Assuming everything will always function perfectly is irrational. Instead, we need to prepare for failures so that we know how to recover from them.

- The most basic disaster recovery requirement is that there must be a way to perform backups and restores. This includes total system restores, as well as the ability to restore an individual file or customer data point.

- The most common data restore requirement is for something that was deleted by accident. As a result, the operational requirement of restoring individual data points has been implemented in most systems, often with no SA intervention required.

- It can be useful to be able to separately back up the system configuration and the user data. Configuration files that are human-readable are preferable to large binary blobs. Being human-readable makes these files easy to store in source code repositories, makes it easy to produce historical diff listings, and so on.

4 – Architectural Requirements

- **A new service should be built around an architecture that uses open standards and open protocols.**

- **Open Vs Closed Service Architectures**

  - **Open Architecture**

    - Protocols, file formats, and APIs that are publicly documented so that others can write to those standards and make interoperable products without having to worry about royalties or patent restrictions.

    - Any service with an open architecture can be more easily integrated with other services that follow the same standards.

  - **Closed Architecture**

    - uses standards, protocols, APIs, and file formats that are owned by one company, are controlled by that one company, and do not interoperate with other products.

    - Other products are prevented from using the standard because the standard is not publicly documented, because it requires licensing, or because the vendor forbids it.

    - Vendors use proprietary protocols when they are covering new territory or are attempting to maintain market share by preventing the creation of a level playing field.

- **What is difference between a Protocol Versus a Product?**

4 – Architectural Requirements

- **Standard Vs Extended Products**
  - That's not very customer oriented
- **Benefits Of deploying open products**
  - Promotes Competition
  - Multi-Vendor Environment
  - Interoperability
  - More Choices and Freedom
  - Easier Support
  - don't require gateways to the rest of the world.
- **A better way is to select protocols based on open standards, permitting users and operations to select their own software.**
  - Open protocols and file formats typically change only in upwardly compatible ways and are widely supported, giving you the maximum product choices and maximum chance of obtaining reliable, interoperable products.
  - Such as Internet Engineering Task Force (IETF) and Institute of Electrical and Electronic Engineers (IEEE) Standards.

IT601 – System and Network Administration

<End>

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IT601 – System and Network Administration

Service Planning and Design

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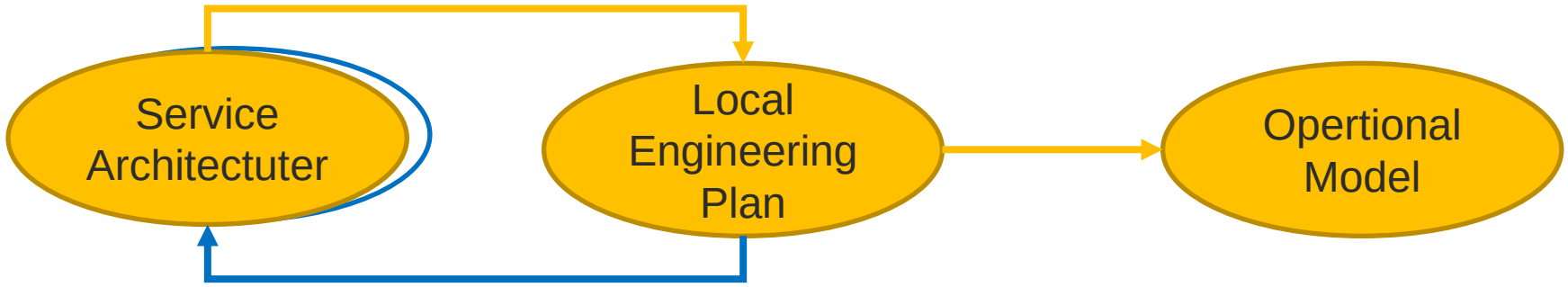
Designing a Service

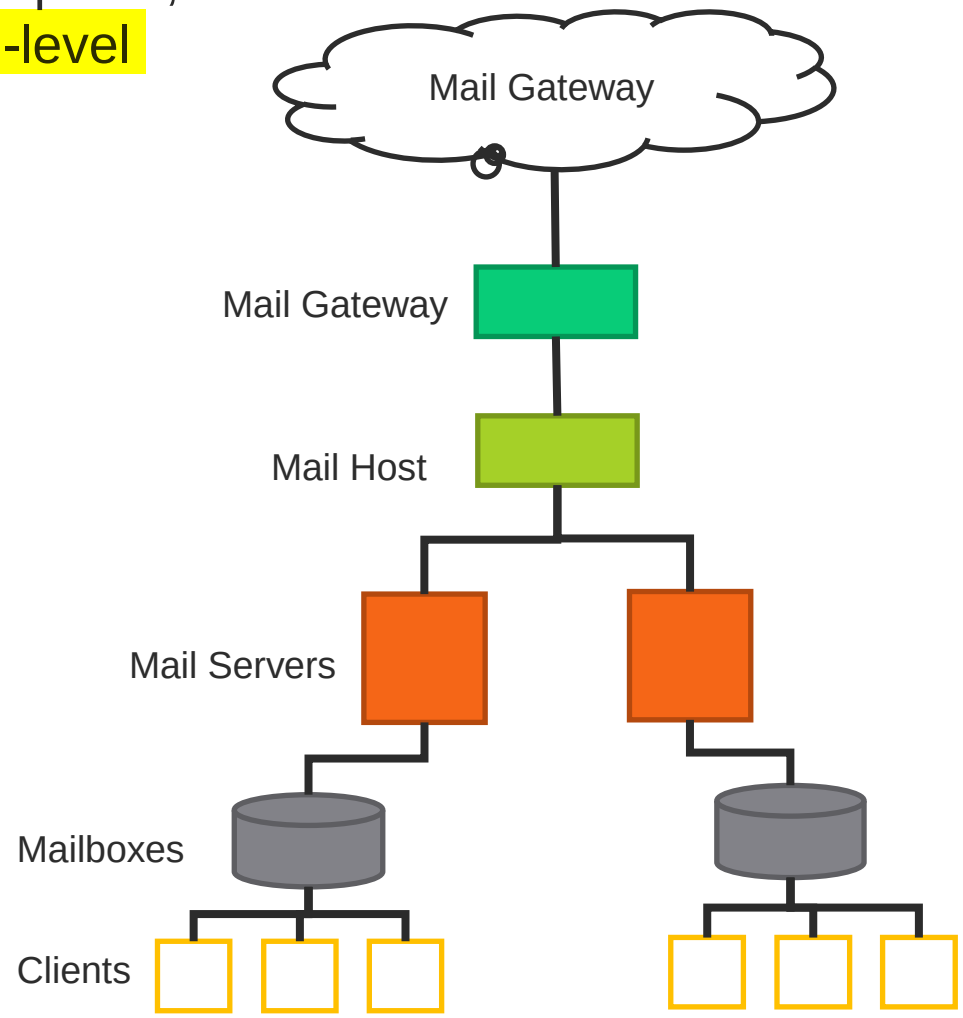
- **Service engineering involves designing how a product will be configured and used in your environment. With a simple service, it is a matter of installing the software.**
- **But most services are not simple. In such a case, we must design the service architecture and local engineering plans.**
- **The service design includes the following plans. All these must be defined and documented.**
  - The service architecture
  - The local engineering plans
  - The operational model or support model



Service Architecture

- The service architecture is the high-level design. It describes how the parts will work together, which resources are required, and so on. Service Architecture is also known as High-level description

- It Includes:
  - Service Type
  - Sites and Clusters
  - Type of Machines, Technologies, Topologies and Storage, Networks
  - IP addressing Design



Local Engineering Plan

Local Engineering Plan is also known as Low Level Design description

It Includes:

- Specific Component Levels Plan
- Product Ordering and Product Codes
- Cable, Mounting Brackets and Connectors their types
- Detailed IP addressing Hirerachy

Operational Plan

Operational Plan is lso known as Service Support Plan.

It Includes:

- Operational level agreement (OLA)
- The service level agreement (SLA) for the service
- Tho supports the various components of the service

Guidelines for Service Designing

- Simplicity
- Vendor-Certified Designs
- Dependency Engineering
- Decoupling Hostname from Service Name
- Support

Simple Designs

- When engineering a service, your foremost consideration should be simplicity. Strive to create the simplest solution that satisfies all the requirements.
- **Simple Services**

Maintenance	Expansion	Integration
▪ Easiest to maintain	▪ Easiest to expand	▪ Easiest to integrate with other systems

- **Complex Services**

Confusion	Mistakes	Usage	Slower	Costly
▪ Leads to confusion	▪ Prone to mistakes	▪ Difficult to use	▪ Makes everything slower	▪ More expensive in setup cost and maintenance costs.

- During the engineering phase, create multiple design proposals. Consider each of them for its simplicity, manageability, cost, and so on. Revise, revise, revise.
- Good engineering is not about having the ability to create perfection in the first draft, but rather about being able to iterate over many revisions, improving each one until we have the design we want.

Use Vendor-Certified Designs

- **Vendors of IT products have the engineering guidelines.**
  - They proscribes minimum CPU, RAM, and disk requirements.
  - They also publish certified engineering designs or vendor best practices.
  - There may be separate engineering recommendations for use with up to one dozen, one hundred, or one thousand users.

- **Vendor designs are**

  best practice engineering designs | Real-world experience | labs and real world Tested | Stress Tested

- **Trust vendor designs but verify them**
  - Straying too far from the vendor's recommendations will result in the loss of support.

- **But even with the use of the certified engineering design exactly, some local decisions are part of local engineering design such as;**

  hardware vendor | model number | specific configurations, | IP addresses | network switch connections | deployment racks | Optional parameters

Dependencies

- **The reliability of a service is greatly influenced by its dependencies.**
  - A system is never more reliable than the most unreliable system it has a hard dependency on.

- **The larger and more complex a system becomes, the more dependencies it has.**
  - These dependencies can be managed during the engineering process in ways that greatly improve the resulting system's reliability

- **Primary Dependencies**
  - Primary reliability refers to the core system reliability.
  - SAs do not have much control over reliability of software itself especially for 3rd party products.
  - Sas can control are their decisions about the hardware it runs on.
  - Generally, enterprise software tends to be written assuming the hardware will never fail thus for SAs, the options are reliability features such as mirrored boot disks, ECC RAM, dual NICs etc.

External Dependencies

- **SAs can control many of the external dependencies that influence a service's reliability.**
- **Know what those dependencies are. A dependency matrix is a list of which subsystems depend on other subsystems.**
  - Usually the dependency matrix resembles a tree diagram, with each level relying on services in the levels below, and no cross-dependencies.
  - Used to find high-risk
  - Useful for operational tasks such as basic debugging as well as disaster planning
- **Types of External Dependencies**
  - **Hard dependency**

    The dependent service will fail if the other service fails or is unavailable
  - **Soft dependency**

    does not directly cause a failure, though it may reduce performance
  - **Graceful degradation**

    if that server is unavailable, the application may work around it by using cached data, disabling a specific feature, or requiring the data to be manually entered
- Improve the reliability by identifying hard dependencies and either eliminate them or reengineer them to be soft dependencies

Dependency Alignment

Another trick in which use system administrator through this trick manage of failure domain

- **Another engineering trick is to realign dependencies into smaller failure domains.**
- **A failure domain is all the services, locations, and users that are adversely affected when a particular component fails or is taken out of service.**
- **Good engineering requires taking the time to think through how we can shrink failure domains, or divide large failure domains into smaller, isolated failure domains.**

Hardware Failure Domains	Service Failure Domains	Location Failure Domains
• Make Redundant domains including power strips, CPUs, and storage and VPN devices	• Align all dependencies on same machine • All startup scripts should be on the same machine • Rack aligned dependenies	Make sites self dependent

Decoupling Hostname from Service Name

- **Decouple the purpose of the machine from the name of the machine.**
- **A better choice is to design your systems to use aliases for the service name**
- **do not hardcode services to IP addresses**

Support

- **During planning and engineering phase, consider how service will be supported during its lifetime.**
- **Support includes**
  - **Technical aspects**
    detecting problems, patching, upgrading, performing backups, and scaling the service
  - **People and processes**
    identifying and training the support groups, developing mechanisms for customers to report problems and submit requests, and providing documentation for the customers and the support teams.

- **Support planning aspects can be divided into followings**

Monitoring	**Support Model**	**Service Request Model**	**Documentation**

Monitoring

- **It isn't a service if it isn't monitored.**
- **A service should be monitored for availability problems, performance, and capacity-planning.**
- **The helpdesk, or front-line support group, must be automatically alerted to problems with the service.**
- **The SA group should monitor the service on an ongoing basis from a capacity-planning standpoint.**
- **Followings must be defined and developed**

what to monitor and what events to trigger notifications.	the process for adding new components into the monitoring system as the system is scaled up or upgraded.	how component are removed from the monitoring system.	Automation needs to be developed, and the processes need to be clearly defined and documented

Support Model

- **The support model needs to specify who supports the various components of the service, and what the OLAs and SLAs for each component are.**

- **The OLA and SLA for the service need to consider the OLAs and SLAs of the constituent parts, as well as the design of the service itself.**
  - In small or midsize company, many of these roles will be performed by the same people, who all know each other.
  - In large companies, there will be different teams supporting each component, they won't all know each other, and the processes and communication paths may not be clear

Service Request Model

- **The local engineering plan should also include a service request model (SRM).**

  - The SRM defines
  - which requests users can make relating to this service,
  - who can make those requests,
  - how they make those requests,
  - which approvals are required
  - who acts on the requests
  - which change control policies apply
  - which SLA is used for turning around those requests.

- **Work with the vendor and stakeholders to define which tasks are required, document them, and then practice them in a test environment.**

- **Try to estimate the volume of requests of each type and understand from the stakeholders what would trigger a request of each type and what kind of turnaround time they would expect on each request.**

Documentation

- **As part of support planning, operational procedures must be defined.**
- **These are different for every service, but generally include**
  - backups and restores,
  - Business continuity or disaster recovery plans,
  - tasks related to onboarding new users
  - Disconnecting users who are leaving
  - performing periodic tasks
  - Anything else required to keep the service running.
- **For each routine task, there must be a runbook that details how the task should be performed. Define the runbooks by performing each task in a test environment.**

IT601 – System and Network Administration

Primary Services

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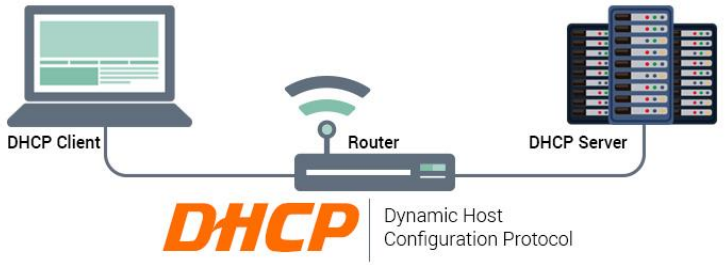
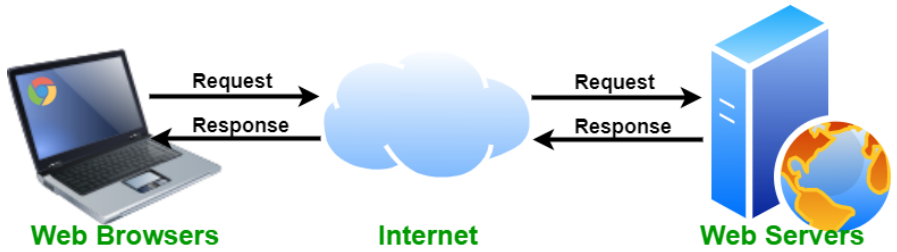
Primary Services

- There are several common services used in almost all IT deployments.

  - DHCP Service
  - DNS Service
  - NTP Service
  - Web Service
  - File Sharing Service
  - SSH Server





IT601 – System and Network Administration

DHCP Service

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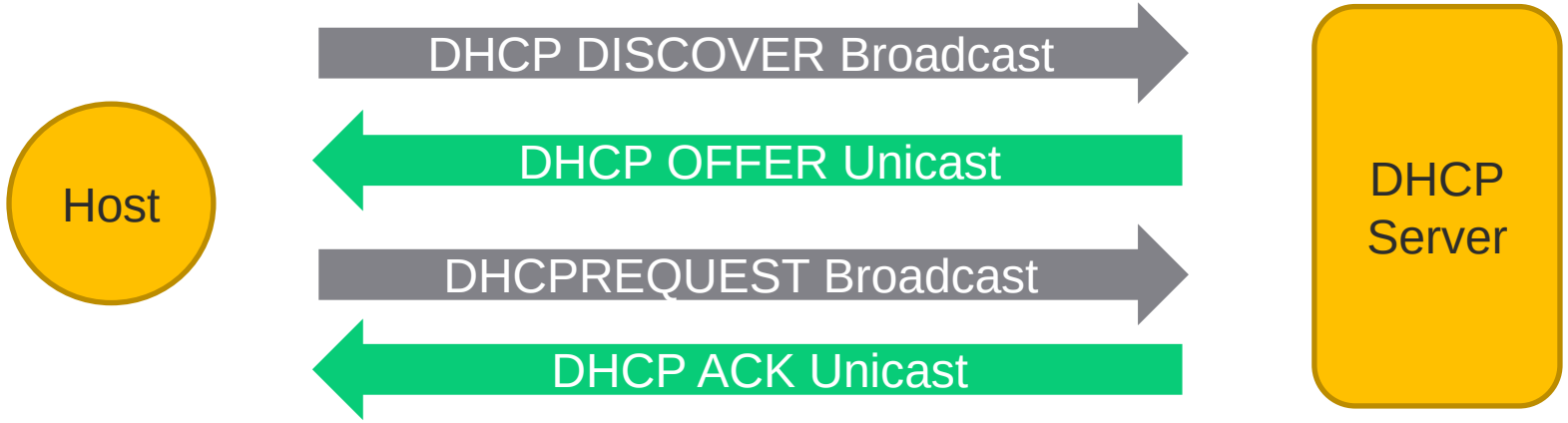
DHCP Service

- The Dynamic Host Configuration Protocol (DHCP) is a network service that enables host computers to be automatically assigned settings from a server as opposed to manually configuring each network host.
  - It was initial defined in RFC 2131 and later on it was superseded by RFC 1541.
- Its Components are DHCP Client, DHCP Relay Agent and DHCP Server

1 - DHCP Client

- A DHCP client is an Internet host using DHCP to obtain configuration parameters such as an IP address.
- The basic steps that occur when a DHCP client requests an IP address from a DHCP server are as below.



- The client, Host A, sends a DHCPDISCOVER broadcast message to locate a DHCP server. A DHCP server offers configuration parameters such as an IP address, a MAC address, a domain name, and a lease for the IP address to the client in a DHCPOFFER unicast message

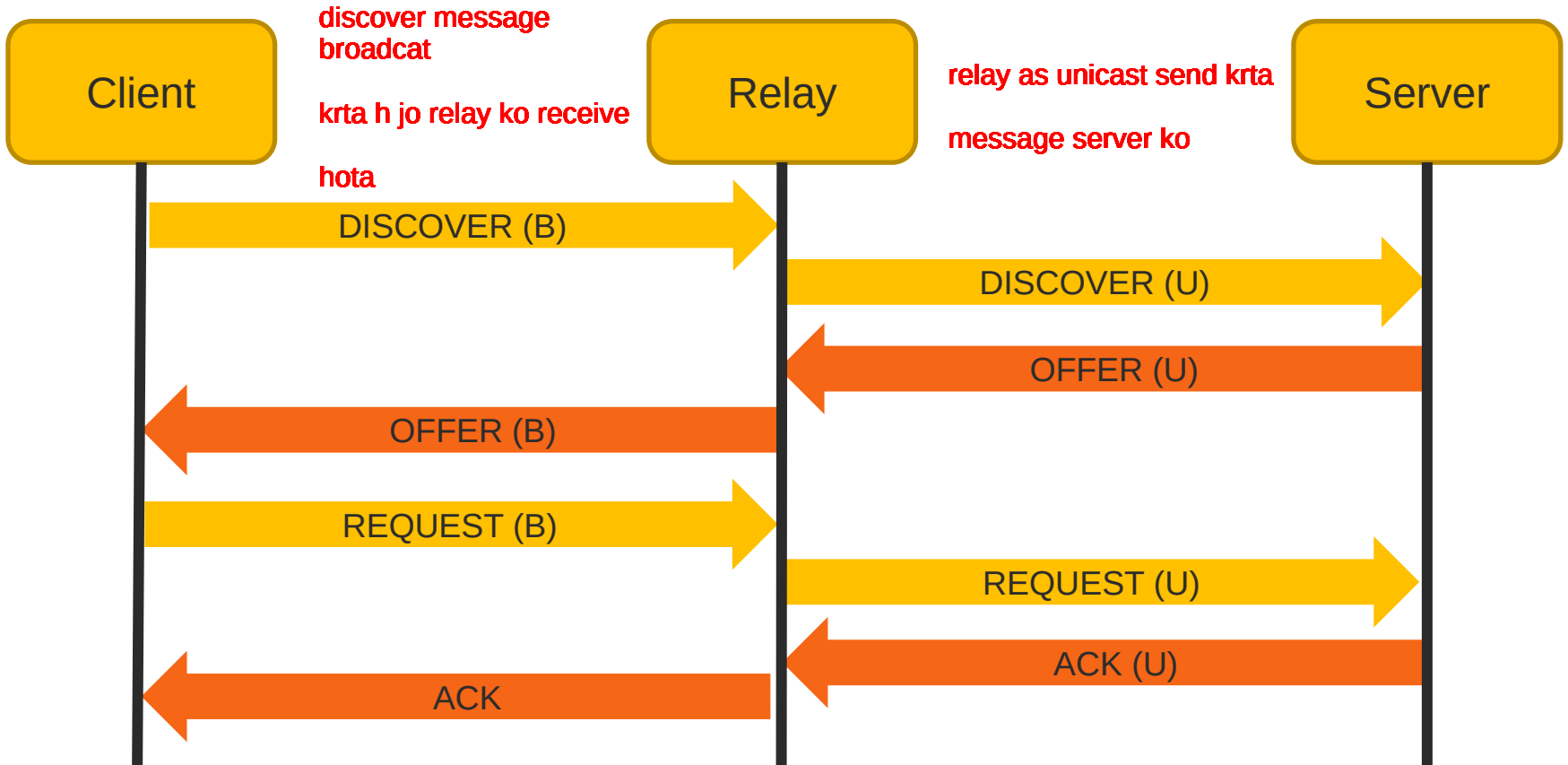
DHCP Client Options

The DHCP client provides flexibility by allowing the following options to be configured for a DHCP client:

- Option 12—This option specifies the name of the client. The name may or may not be qualified with the local domain.
- Option 51—This option is used in a client request (DHCPDISCOVER or DHCPREQUEST) to allow the client to request a lease time for the IP address.
- Option 55—This option allows the DHCP client to request certain options from the DHCP server.
- Option 60—This option allows the user to configure the vendor class identifier string to use in the DHCP interaction.
- Option 61—This option is used by DHCP clients to specify their unique identifier. DHCP servers use this value to index their database of address bindings. This value is expected to be unique for all clients in an administrative domain.
- Option 120—This option is used to specify a 32-bit (binary) IPv4 address to be used by the Session Initiation Protocol (SIP) client to locate a SIP server.
- Option 121—This option is used to configure classless static routes by specifying classless network destinations; that is, each routing table entry includes a subnet mask. Upto ten classless static routes are supported using option 121 on the DHCP client.
- Option 125—This option is used by DHCP clients and servers to exchange vendor-specific information

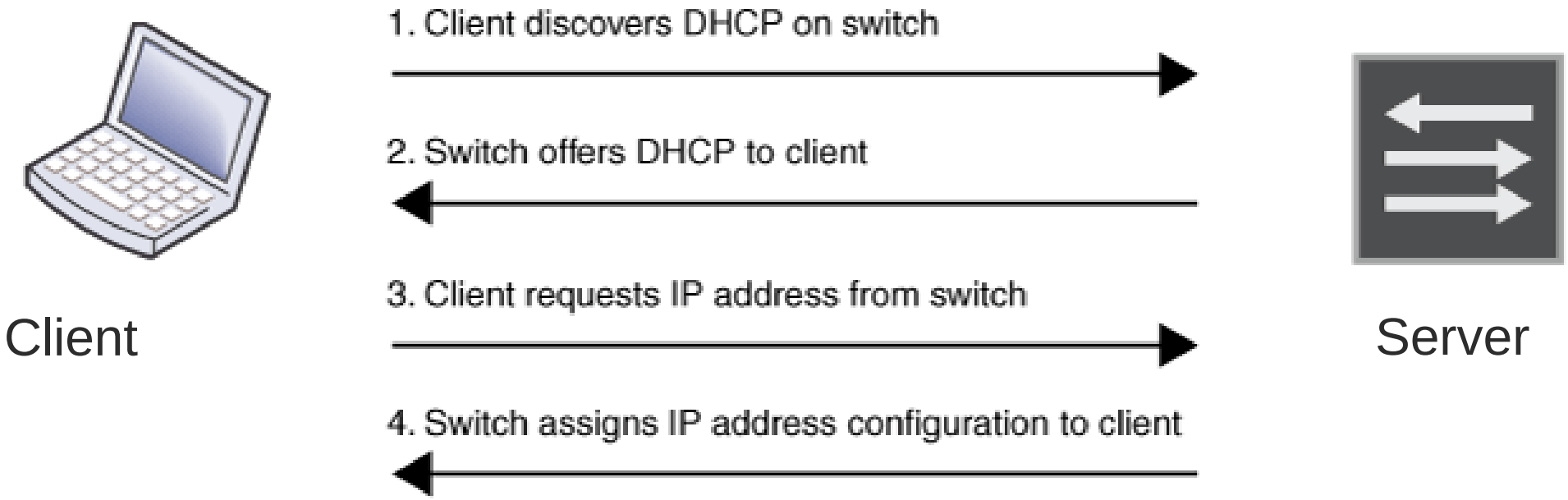
DHCP Relay Agent

- The function of the DHCP relay agent is to forward the DHCP messages to other subnets so that the DHCP server does not have to be on the same subnet as the DHCP clients.
- The DHCP relay agent transfers DHCP messages from the DHCP clients located on a subnet without a DHCP server, to other subnets.



DHCP Service

- Computers configured to be DHCP clients have no control over the settings they receive from the DHCP server, and the configuration is transparent to the computer's user.



DHCP Service

- The most common settings provided by a DHCP server to DHCP clients include:

- A DHCP server can also supply configuration properties such as:

- The advantage of using DHCP is that any changes to the network, such as a change in the DNS server address, only need to be changed at the DHCP server, and all network hosts will be reconfigured the next time their DHCP clients poll the DHCP server.

- As an added advantage, it is also easier to integrate new computers into the network, as there is no need to check for the availability of an IP address. Conflicts in IP address allocation are also reduced.

DHCP Service

- A DHCP server can provide configuration settings using the following methods:

Manual allocation (MAC address)

1 - Identify the unique hardware address of each network card

2 - Supplies a constant configuration each time the DHCP client makes a request to the DHCP server

3 - ensures that a particular address is assigned automatically to that network card, based on its MAC address

Dynamic allocation (address pool)

1 - The DHCP server assigns an IP address from a pool of addresses for a period of time

2 - clients receive their configuration properties dynamically and on a “first come, first served” basis

3 - Server Releases the address to address pool after client is no more on networks or lease time expires

4 - After this period, client must renegotiate the lease with the server to maintain use of the address.

Automatic allocation

1 - the DHCP automatically assigns an IP address permanently to a device, selecting it from a pool of available addresses.

2 - Usually, DHCP is used to assign a temporary address to a client, but a DHCP server can allow an infinite lease time.

Configuring DHCP Server on Linux

1. Install DHCP Server

- sudo apt install isc-dhcp-server

2. Configure the DHCP Server

- Backup Original Configuration file
  sudo mv /etc/dhcp/dhcpd.conf{,.backup}
- Create and edit the new configuration file
  sudo nano /etc/dhcp/dhcpd.conf
- Assigning Random IP Addresses from a pool

```
# a simple /etc/dhcp/dhcpd.conf
default-lease-time 600;
max-lease-time 7200;
authoritative;

subnet 192.168.1.0 netmask 255.255.255.0 {
 range 192.168.1.100 192.168.1.200;
 option routers 192.168.1.254;
 option domain-name-servers 192.168.1.1, 192.168.1.2;
#option domain-name "mydomain.example";
}
```

Assigning Static IP Address to a client

Assigning Static IP Address to a client

get the MAC Address of a client

ip a

```
[21:13:42] $ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: enp6s0f0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc fq_codel state DOWN group defaul
t qlen 1000
    link/ether 00:90:f5:b2:bd:cd brd ff:ff:ff:ff:ff:ff
3: wlp5s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000
    link/ether e0:91:53:31:af:ab brd ff:ff:ff:ff:ff:ff
    inet 192.168.1.218/24 brd 192.168.1.255 scope global dynamic noprefixroute wlp5s0
       valid_lft 83879sec preferred_lft 83879sec
    inet6 fe80::edb7:8f6:3d9e:8ee9/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
```

Verifying the DHCP Server

```
host archmachine {
hardware ethernet e0:91:53:31:af:ab;
fixed-address 192.168.1.20;
}
```

3. Bind the DHCP Server to an interface

4. Restart the DHCP Server sudo systemctl restart isc-dhcp-server.service

5. Check the status of the DHCP Server sudo systemctl status isc-dhcp-server.service

```
LinuxForDevices> systemctl status isc-dhcp-server.service
● isc-dhcp-server.service - ISC DHCP IPv4 server
     Loaded: loaded (/lib/systemd/system/isc-dhcp-server.service; enabled; vendor preset: enabl>
     Active: active (running) since Fri 2020-09-18 16:50:50 UTC; 26s ago
       Docs: man:dhcpd(8)
   Main PID: 18083 (dhcpd)
      Tasks: 4 (limit: 2282)
     Memory: 4.5M
     CGroup: /system.slice/isc-dhcp-server.service
             └─18083 dhcpd -user dhcpd -group dhcpd -f -4 -pf /run/dhcp-server/dhcpd.pid -cf /e>

Sep 18 16:50:50 localhost dhcpd[18083]: ** Ignoring requests on docker0.  If this is not what
Sep 18 16:50:50 localhost dhcpd[18083]:    you want, please write a subnet declaration
Sep 18 16:50:50 localhost dhcpd[18083]:    in your dhcpd.conf file for the network segment
Sep 18 16:50:50 localhost dhcpd[18083]:    to which interface docker0 is attached. **
Sep 18 16:50:50 localhost dhcpd[18083]:
Sep 18 16:50:50 localhost dhcpd[18083]: Listening on LPF/eth0/[redacted]/24
Sep 18 16:50:50 localhost dhcpd[18083]: Sending on   LPF/eth0/[redacted]/24
Sep 18 16:50:50 localhost dhcpd[18083]: Sending on   Socket/fallback/fallback-net
Sep 18 16:50:50 localhost sh[18083]: Sending on   Socket/fallback/fallback-net
Sep 18 16:50:50 localhost dhcpd[18083]: Server starting service.
lines 1-20/20 (END)
```

Best Practices for DHCP Administration

- Following a few DHCP best practices will keep your network running at it's best.
  - **Have an appropriate amount of established IP addresses.**
    - Get a good idea of the number of IP addresses that are going to need to have IP addresses assigned.
    - Remember that in today's networks, we're talking about more than just computers.
    - Other devices that may be requesting IP addresses are VoIP phones and mobile devices, just to name a few.
    - On top of all that, your DHCP scope should leave room for future growth as well.
  - **Avoid overlapping static addresses.**
    - While you can use DHCP server settings to assign static reservations to most devices, there will still be some devices on your network that need to keep the same IP address via manual configuration.
    - When creating your DHCP scope, be sure to understand any IP addresses that are already being used with manual configurations.
    - You can do a network scan or refer to your network map to see what IP addresses are already being used.
  - **DHCP security best practices**

    You need to make sure that you are not allowing unwelcome devices to infiltrate your network. There are a few things to do to prevent this. Here's a list of DHCP security best practices:
    - Keep your business networks and guest networks separate.
    - If you are using a managed switch, be sure to disable unused ports.
    - Generate alerts from your DHCP server when an unrecognized device sends a DHCP request.

IT601 – System and Network Administration

Web Service

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Web Server and Web Services

A web service makes an application (s) or content available to the users over the internet using internet browsers.

- Running a web server is more than just installing Apache or IIS and providing content.

1 - Open Standards

- The web is based on open standards, which are developed by an international committee, not a single corporation.
- You can use them without paying royalty or licensing fees.
- Web standards are defined by the World Wide Web Consortium (W3C), and the underlying Internet protocols are defined by the Internet Engineering Task Force (IETF).

2 - Benefits

- The benefit of web-based applications is that one browser can access many web applications. The web browser is a universal client.
- Cost , No transfer of software product, Universal availability

3 - Usage

- Web applications and small web servers are also present in firmware in many devices, such as small routers and switches, smart drive arrays, and network components.

Types of Web Servers

There are four basic web server types:

Static web server

1. Serves only documents that don't change or change only rarely.
2. The documents are read from disk and are not altered by the web server.

CGI servers

1. Common Gateway Interface (CGI) is interface specification to enables servers to execute an external program, typically to process.
2. CGI servers generate pages dynamically.
3. Dynamic page generation uses more CPU and memory than reading from disk.

Database-driven web sites

1. Generate each web page from database.
2. Each page is generated by reading information from a database and filling that information into a template.

Multimedia servers

1. Content includes media files, such as video or audio.
2. Have high performance requirements for CPU, memory, storage, and network.

Multiple Web Servers on One Host

Small Vs Large sites

Small Sites	Large Sites
1. Small sites may want to start with a single web server that is used for all applications.	1. Large sites that load-balance web services across multiple machines often want all the machines to be identical clones of each other, rather than having N machines dedicated to one application and M machines dedicated to another.
2. The amount of traffic that each application receives does not justify the cost and overhead of additional machines.	2. Identical clones are easier to manage.
	3. There are many ways to host multiple web services on the same machine.

Multiple Web service Problems

Single Port

1. HTTP-based services usually listen for requests on TCP ports 80 (unencrypted) and 443 (encrypted via SSL, often called HTTPS).
2. Multiple services cannot share a port. That is, only one process can be listening to port 80 at a time.

Multiple IP Addresses

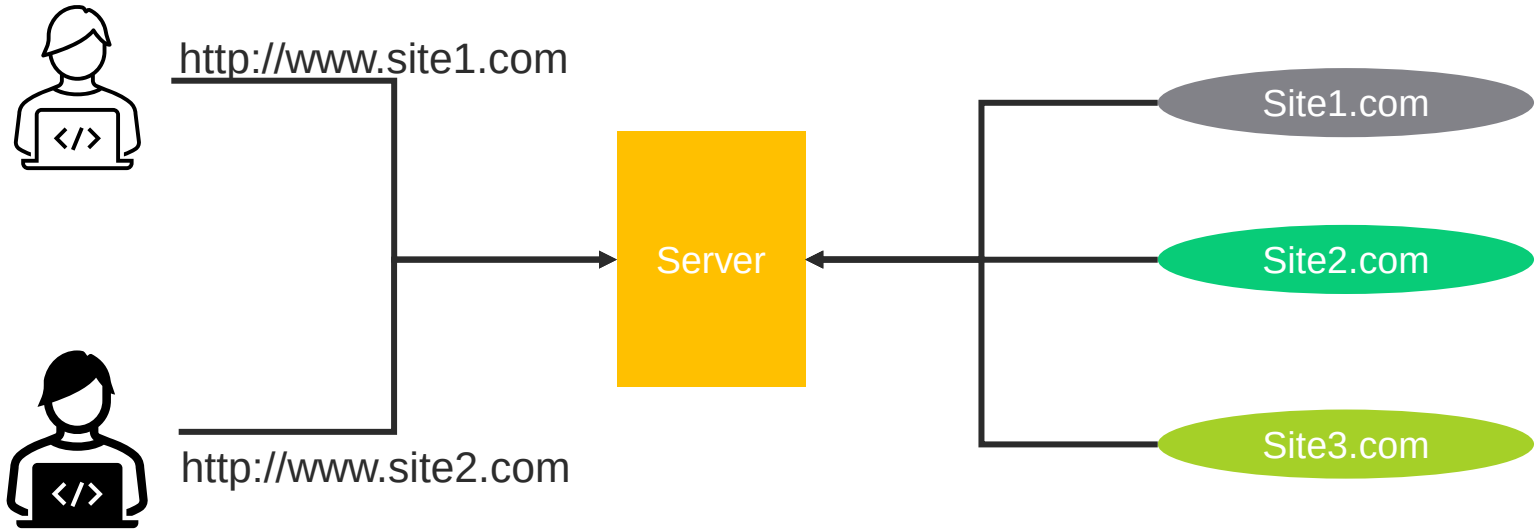
1. The easiest way to resolve this is to configure multiple IP addresses on a machine. A less attractive option is to use different ports for each server, with URLs that list the port, such as http://myservice:8000.
2. Configuring multiple IP addresses on a machine does not scale well. This scheme is complex and not well supported in some OSs. Also, IPv4 addresses are scarce. URLs containing the port information look unprofessional.

Scalable Techniques for Multi Services

There are two techniques for permitting many services to share the same port on the same IP address. Both techniques provide a scalable solution with a professional look.

1 - Virtual hosting

- The first technique is called virtual hosting. Originally one machine could host only one domain.



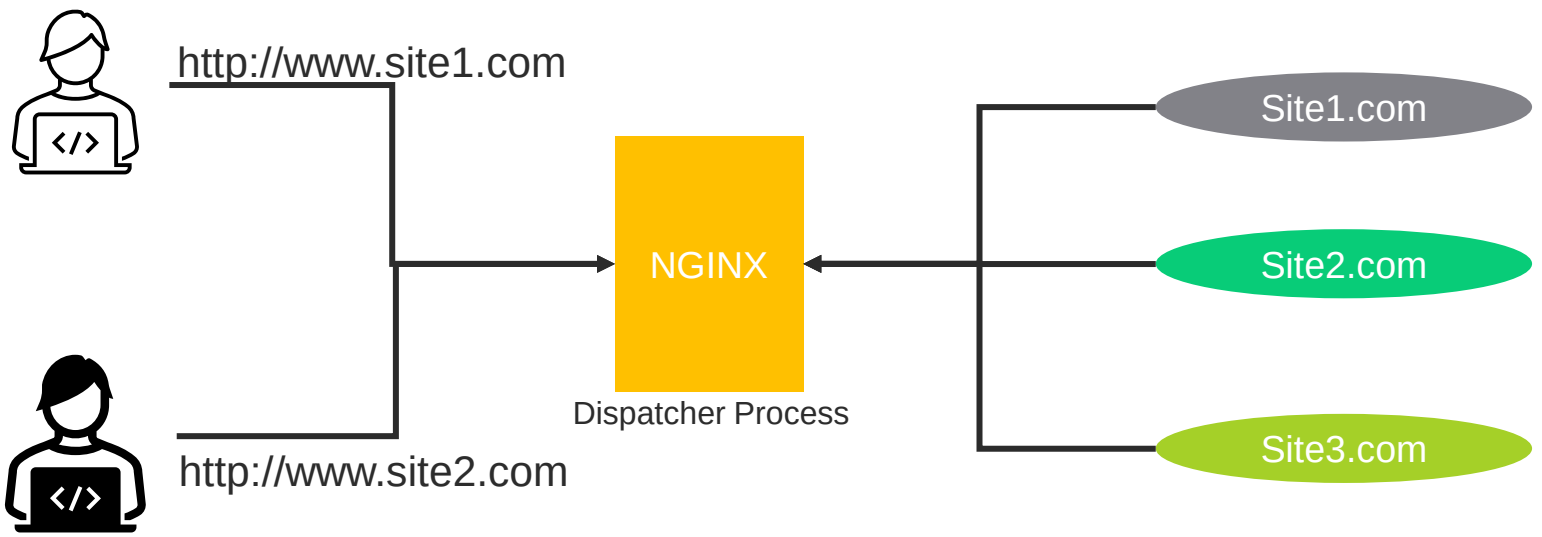

```
<VirtualHost *:80>
   ServerAdmin admin@site1.com
   ServerName site1.com
   ServerAlias www.site1.com
   DocumentRoot /var/www/ site1.com/html
</VirtualHost>

<VirtualHost *:80>
   ServerAdmin admin@site2.com
   ServerName site2.com
   ServerAlias www.site2.com
   DocumentRoot /var/www/site2.com/html
</VirtualHost>
```

- Virtual hosting permits one system to listen for incoming HTTP and HTTPS connections but serve different web pages depending on which domain the request is for.
- This required a change to the HTTP protocol, but it is supported by all web browsers.

2 - Dispatcher

- The second technique is to use one process as a dispatcher for many individual services. A single process listens for connections and forwards them to the proper service.




```
http {
  index index.html;

  server {
    server_name www.site1.com;
    root /var/www/site1.com/htdocs;
  }

  server {
    server_name www.site2.com;
    root /var/www/site2.com/htdocs;
  }
}
```

- Nginx is often used to listen for incoming HTTP and HTTPS connections, determine which domain they are intended for, and forward the request as appropriate.
  - The individual services listen on different ports such as 8000, 8001 etc , but this is hidden from the users.
  - This has another benefit in that Nginx can decrypt SSL connections so that the individual services must process only the simpler HTTP protocol. SSl connection ko sigle process manage kr rha hota
  - It also isolates all cryptographic issues to one place, where they can be managed separately.

HTTPS and Multiple Servers

- **Catch-22 Problem** This is general problem

  Serving multiple domains on the same IP address is more complex for HTTPS (encrypted) connections due to a Catch-22 in how HTTPS works. Each domain has its own SSL certificate. The software needs to know which SSL certificate to use to decrypt the request, but the intended domain is in the encrypted portion of the request.

- **Techniques to Address Catch 22**

Share Certificate	Server name indication
1. An early solution to this Catch-22 was to permit one certificate to apply to multiple domains. 2. These multidomain certs are called subject alternative name (SAN) certificates. 3. All but the oldest, most broken web browsers support it. Since there is one certificate, the expiration data and other information are the same for all domains, which isn't usually a problem. 4. However, the certificate must be reissued to add and remove domains, which is inconvenient.	1. A newer technique is called server name indication (SNI). different certificate use for different domain 2. This allows for the use of multiple unique certificates on the same machine, as would be expected. In order for SNI to function, the client must first submit the intended domain in an unencrypted form. To decrypt the session, the server can choose which certificate to apply. 3. The desired domain must match the unencrypted request and is nevertheless provided in the encrypted part for security reasons. Sadly, SNI requires a modification to the SSL protocol, therefore it is incompatible with older hardware. These gadgets have, however, largely vanished.

SLA for Web Services

- **A web service needs an SLA.**
- **Generally, web as a 24/7 critical service, but the SLA of an individual web service might be quite different.**
  - Most internal web services will have the same SLA as other office services, such as printing or storage.
- **Ideally, as with any SLA, the service level should be set by collaborating with the customer community.**

1 - Resist setting any SLA that does not allow for periodic maintenance, unless the service is built out on redundant infrastructure.

2 - If the service is provided by a single host or a shared web host and is required to be available around the clock, it is time to discuss increasing the redundancy of the service.

3 - Metrics that are part of a web SLA should include the latency for a certain level of QPS.

- For example , how long should a typical query take when the system is under a particular load? Latency is usually measured as the time between receipt of the first byte of the request and sending of the last byte of the answer.

Web Service Monitoring

- **Why monitoring web services?**
  - How well it is scaling?
  - Which areas need improvement?
  - Whether the service is meeting your SLA?

jb tk SLA ni ho ga hm kisi bhi application ko hm service ni khain gy

jb tk application monitor ni hoti un ko bhi hm services ni keh skty

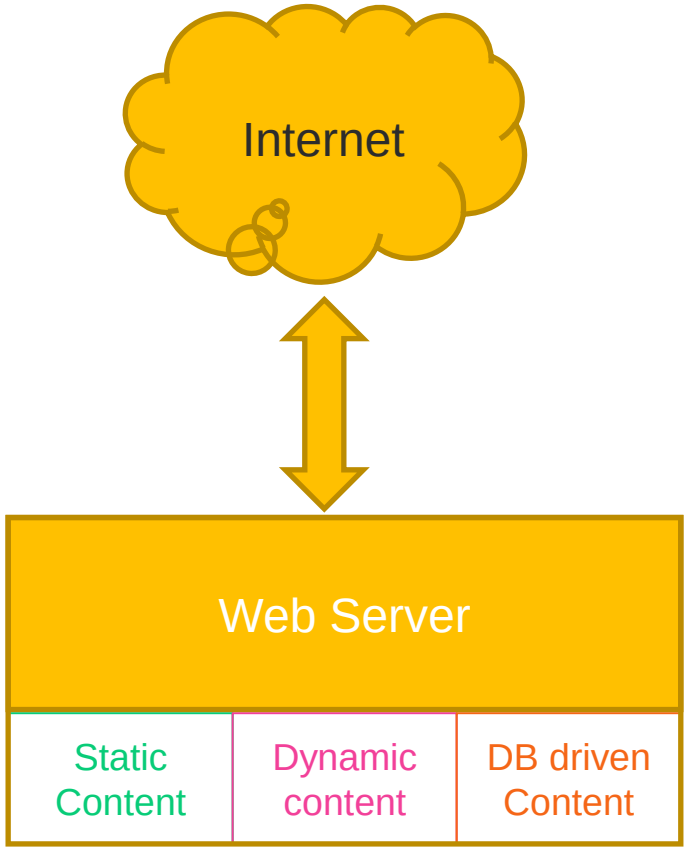
so monitoring is very important for web service

- **Be specific about which web-specific elements to your monitoring.**
  - Web server errors are most often related to problems with the site's content and are often valuable for the web development team.
  - Certain errors or patterns of repeating errors can be an indication of customer problems with the site's scripts. Other errors may indicate an intrusion attempt. Such scenarios are worth investigating further.
- **Typically, web servers allow logging of the browser client type and of the URL of the page containing the link followed to your site (the referring URL).**
- **Web servers may have server-specific information that would be useful as well, such as data on active threads and per-thread memory usage.**
- **Become familiar with any special support for extended monitoring available on your web server platform.**

Scaling for Web Services

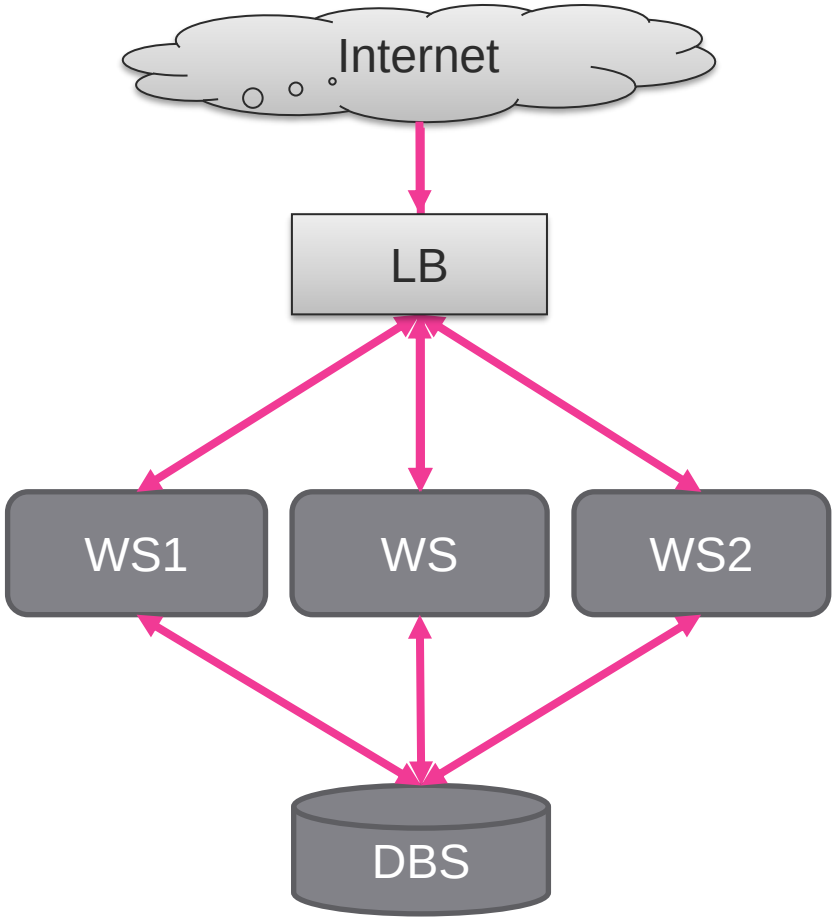
"Scaling is the only problem on the Internet. Everything else is a subproblem."

- **slashdot effect** web service is over load
  - The Slashdot effect, also known as slashdotting, occurs when a popular website links to a smaller website, causing a massive increase in traffic.
  - If the web server is successful, it will get overloaded by requests. You may have heard of the Slashdot effect.
- **Single machine web server Scaling**
  - A small organization with basic needs can improve a web server's performance by simply upgrading the CPU, disks, memory, and network connection.
- **Multi machine web server Scaling**
  - For multiple machines, there are two main types of scaling are horizontal and vertical. They get their names from web architecture diagrams.
    - When drawing a representation of the web service cluster, the machines added for horizontal scaling tend to be in the same row, or level.
    - For vertical scaling, they are in groups arranged vertically, as they follow a request flowing through different subsystems.



Horizontal Scaling

- **In horizontal scaling, a web server or web service resource is replicated and the load is divided among the replicated resources.**
- **Example**
  - Consider two web servers with the same content, each getting approximately half the requests.
  - The typical solution is to use a device called a load balancer. A load balancer sits between the web browser and the servers.
  - The browser connects to the IP address of the load balancer, which forwards the request transparently to one of the replicated servers.
  - The load balancer tracks which servers are down and stops directing traffic to a host until it returns to service.
  - Other refinements, such as routing requests to the least-busy server, can be implemented as well
- **Load balancers are often general-purpose protocol and traffic shapers, routing not only HTTP but also other protocol requests, as required.**
  - This allows much more flexibility in creating a web services architecture. Almost anything can be load balanced, and this approach can be an excellent way to improve both performance and reliability.



Vertical Scaling

- **Separates out the various kinds of subservices, rather than duplicating a whole machine.**
  - **It allows you to create an architecture with finer granularity, so that you can put more resources at the most intensively used stages of page creation.**
  - **It also keeps different types of requests from competing for resources on the same system.**
- **Examples**
  - Consider the single web server case , split the different types of content onto separate machines, and change the web pages to refer to those other machines for that content.
  - Using an application to complete a brief survey on a video clip after it has been viewed is one example of a website with numerous huge video clips. It is inefficient to try to write numerous minor database changes while reading huge video files from the same disc.
  - OS may have caching algorithms that are automatically tuned for one or the other but perform badly when both happen. In this case, all the video clips might be put on a separate web server, perhaps one with a storage array customized for retrieving large files. The rest of the web site would remain on the original server. Now that the large video clips are on a separate server, the original server can handle many more requests.
- **As you might guess, horizontal and vertical scaling can be combined. The video survey web site might need to add another video clip server before it would need to scale the survey form application.**

How to choose a Scaling Method

- A site may need horizontal or vertical scaling or some combination of both.

1 - Classify the various components

- Classify the various components that are used in conjunction with your web server according to the resources they use most heavily.

How to choose a Scaling Method

2 - Identify Interfering Components

- Then look at which components compete with one another and whether one component interferes with the function of other components.

  - A site may include static files, CGI programs, and a database.
  - Static files can range from comparatively small documents to large multimedia files.
  - CGI programs can be memory-intensive or CPU-intensive processes and can produce large amounts of output.
  - Databases usually require the lion’s share of system resources.
  - In some cases, such as the video survey site, you might choose to move part of the service to another server.

How to choose a Scaling Method

3 - Use Diagnostics

- Use system diagnostics and logs to see which kinds of resources are being used by these components.

  - Consider an IS department web server that is also being used to create graphs of system logs.

  - This can be a very CPU-intensive process, so the graphing scripts and the log data can be moved to another machine, leaving the other scripts and data in place.

How to choose a Scaling Method

4 - Decide All or Gradual Upgrades

Web Service Security

Importance of Web server security

- Implementing security measures is a vital part of providing web services.
- Security is a problem because people you don't know are accessing your server.
- Some sites believe that security is not an issue for them, since they do not have confidential documents or access to financial information or similar sensitive data.
- However, the use of the web server itself and the bandwidth it can access are, in fact, a valuable commodity.

The Uses of Web Server Attacks

- Intruders often break into hosts to use them for money-making purposes, and sometimes they do so simply for entertainment
- Intruders usually do not deface or alter a web site, since doing so would lead to their discovery. Instead, they simply use the site's resources.
- **Common uses of hijacked sites and bandwidth**
  - Distribution of pirated software
  - Generating advertising email
  - Launching automated systems to try to compromise other systems
  - Competing with other intruders to see who can run the largest farm of machines

Why to Secure Internal Websites?

Internal web services should be secured as well. Although you may trust employees of your organization, there are still several reasons to practice good web security internally:

- Stopping virus transmission keep system secure to avoid virus
- Protecting privileged information that requires authentication. protect sensitive information
- Protect from visitors—temps, contractors, vendors, speakers, interviewees limit access for temp,contractor
- Protect Network resources such as WIFI protect wifi and network
- Security and reliability go hand-in-hand such avoiding DOS avoid DOS attack

Secure Connections and Certificates

- **Usually web sites are accessed using unencrypted, plaintext communication.**
  - The privacy and authenticity of the transmission can be protected by using HTTP over Secure Sockets Layer (SSL) to encrypt the web traffic. SSL 4.0 is also known as Transport Layer Security (TLS) 1.0. Confusingly, SSL 2.0 and 3.0 predate TLS 1.0.
  - Use encryption to prevent casual eavesdropping on our customers' web sessions even if they are connecting via a wireless network in a public place, such as a coffeeshop. URLs using https:// instead of http:// are using SSL encryption.
- **Implementing HTTPS on a web server is relatively simple, depending on the web server software being deployed. Properly managing the cryptographic certificates is not so easy.**
  - The private key of certificate must be kept secret. If it is leaked to outsiders, they can use it to pretend to be your site.
  - One role of the web system administrator is to maintain a repository, or key escrow, of certificates for disaster-recovery purposes. Treat this data the same way as you manage other important secrets, such as root or administrator passwords.
- **Places to store private keys**

  Private keys must be secret, but the web server needs to read the private key to use it. There are a number of ways to solve this issue:

Isolated storage	Encrypted storage	Network-accessible key repository	Protected file

Self-Signed-Certificates

- **A cryptographic certificate is created by the web system administrator using software that comes with the encryption package; OpenSSL is one popular system.**
- **The certificate at that point is "self-signed," which means that when someone connects to the web server using HTTPS, the communication will be encrypted, but the client that connects has no way to know that it has connected to the right machine.**
  - Anyone can generate a certificate for any domain. It is easy to trick a web client into connecting to a "man in the middle" attacker instead of to the real server; the client won't know the difference. This is why most web browsers, when connecting to such a web site, display a warning stating that a self-signed certificate is in use.
    - The solution to this dilemma is to use an externally signed cryptographic certificate from a registered certification authority (CA).
    - The public half of the self-signed certificate is encrypted and sent to a trusted CA, which signs it and returns the signed certificate.
    - The certificate now contains information that clients can use to verify that the certificate has been certified by a higher authority.
    - When it connects to the web site, a client reads the signed certificate and knows that the site's certificate can be trusted because the CA says that it can be trusted.

Protecting the Web Server Application

- **A variety of malicious efforts can be directed against the web server itself in an attempt to get login access to the machine or administrative access to the service.**

- **Any vulnerabilities present in the operating system can be addressed by standard security methods.**

- **Web-specific vulnerabilities can be in multiple layers of the web server implementation such as**

  - The HTTP server
  - modules or plug-ins that extend the server
  - web development frameworks running as programs on the server.

  This last category is distinct from generic applications on the server, as the web development framework is serving as a system software layer for the web server.

- **The best way to stay up-to-date on web server security at those layers is through vendor support.**

  - The various HTTP servers, modules, and web development environments often have active mailing lists or discussion groups and almost always have an announcements-only list for broadcasting security exploits, as well as available upgrades.

Protecting the Content

- **Some web-intrusion attempts are directed toward gaining access to the content or service rather than to the server..**
  - There are many types of web content security exploits, and new ones are always being invented.
- **SAs should educate themselves on current exploits via Internet security resources.**
  - The knowledge allows properly evaluate a server for complex threats is a significant undertaking.
  - Fortunately, open source and commercial packages to assist you are available.

Software Vulnerabilities

- largest threat is security vulnerabilities frameworks used.
- The code may be perfect, but an old framework may have security vulnerabilities.
- Most of security incidents are not due to the newest security threats, but old unfixed vulnerabilities.

Directory Traversal

- A technique generally used to obtain data.
- Data may be useful itself or used to enable method of direct intrusion.
- Efficient with servers generating auto indexes.
- Modern servers don't allow to traverse root directory, but old servers are vulnerable.
- common variation of directory traversal uses a CGI query

Form-Field Corruption

- DB fields may appear in form or contents.
- A legitimate web form can be copied and altered to gain access to data or services.
- form validations strictly may prevent it but newer methods are always coming.

SQL Injection

- A variant of form-field corruption is SQL injection.
- Intruders can even perform entire SQL queries, updates, and deletions.
- Some database systems
- include debugging options that permit running arbitrary commands on the
- operating system.

Application Security

- The efforts of malicious people can be rendered less likely to succeed by following good security practices when developing applications.
- The following are some of the fundamental practices to use when writing web code or extending server capabilities.

Limit the Potential Damage

- the best protections is to limit the amount of damage an intruder can do.
- Store Contents and programs on well protected servers and copy to web server on need.
- If web server is defaced by intruder, it can quickly be reimaged.
- Another technique is to isolate the webserver to its own network, disallow connections to internal hosts.
- Backups, logging and installations must be from internal hosts

Validate Input

- Validate the input to interactive web apps so as to maximize security.
- Input should be checked for length, to prevent buffer overflows where executable commands could be deposited into memory.
- Disallow using quotes or escape characters.
- It is better to validate input by inclusion than by exclusion.
- adopt programming paradigms that do not reinterpret or reparse data for you

Automate Data Access

- Access to DBs should be specific.
- If a web application needs to read data, allow with read only access.
- If your DB supports stored precompiled queries, use them instead of executing SQL input.
- preparation function of DB should be used to convert potentially executable input into a form.

Use Permissions and Privileges

- Set permissions to local sever for authentication methods.
- Apply the least-privilege security principle to web servers and web applications

Use Logging

- Logging is an important protection of last resort.
- After an intrusion attempt, detailed logs will permit more complete diagnostics and recovery.
- Logs should be stored on other machines or in nonstandard places to make them difficult to tamper with.
- Another way of storing logs in a nonstandard place is to use network logging

Content Management

The software that allow you to upload your content on this system can be in txt form or in pdf form or video or audio any kind of content you can edit it

- **Providing a content-management system (CMS) empowers users to perform self-service updates of the web content.**
  - A CMS lets you create privileged accounts for those users who are permitted to perform these updates, often in some kind of controlled manner.

- **It is not a good idea for an SA to be directly involved with content updates. Assuming this responsibility not only adds to the usually lengthy to-do list of the SA, but also creates a bottleneck between the creators of the content and the publishing process.**
  - Form a web council makes to attach domains of responsibility for web site content much easier, because the primary "voices" from each group are already working with the webmaster or the SA who is being a temporary webmaster.
  - The web council is the natural owner of the change control process.

- **This process should have a specific policy on updates. Ideally, the policy should distinguish three types of alterations that might have different processes associated with them:**
    - Update: Adding new material or replacing one version of a document with a newer one
    - Change: Altering the structure of the site, such as adding a new directory or redirecting links
    - Fix: Correcting document contents or site behavior that does not meet the standards

Web Server Packages

- There are several web server package available for Linux and windows. The commonly used packages are…

Apache HTTP

- second most popular web server software.
- It's an open-source project that uses HTTP protocol.
- operates across various OSs, including Windows and Linux.
- Best features of Apache is its customizability.
- comprised of several modules.
- Key Features for Apache: IPv6, Session tracking, FTP and HTTP/2,Customizable modules

NGINX

- Most highly used
- NGINX is compatible with both Linux and Windows.
- most famous for its high-performance features.
- designed to handle multiple connections simultaneously.
- NGINX is less customizable. You can't disable some of its modules,

Microsoft IIS

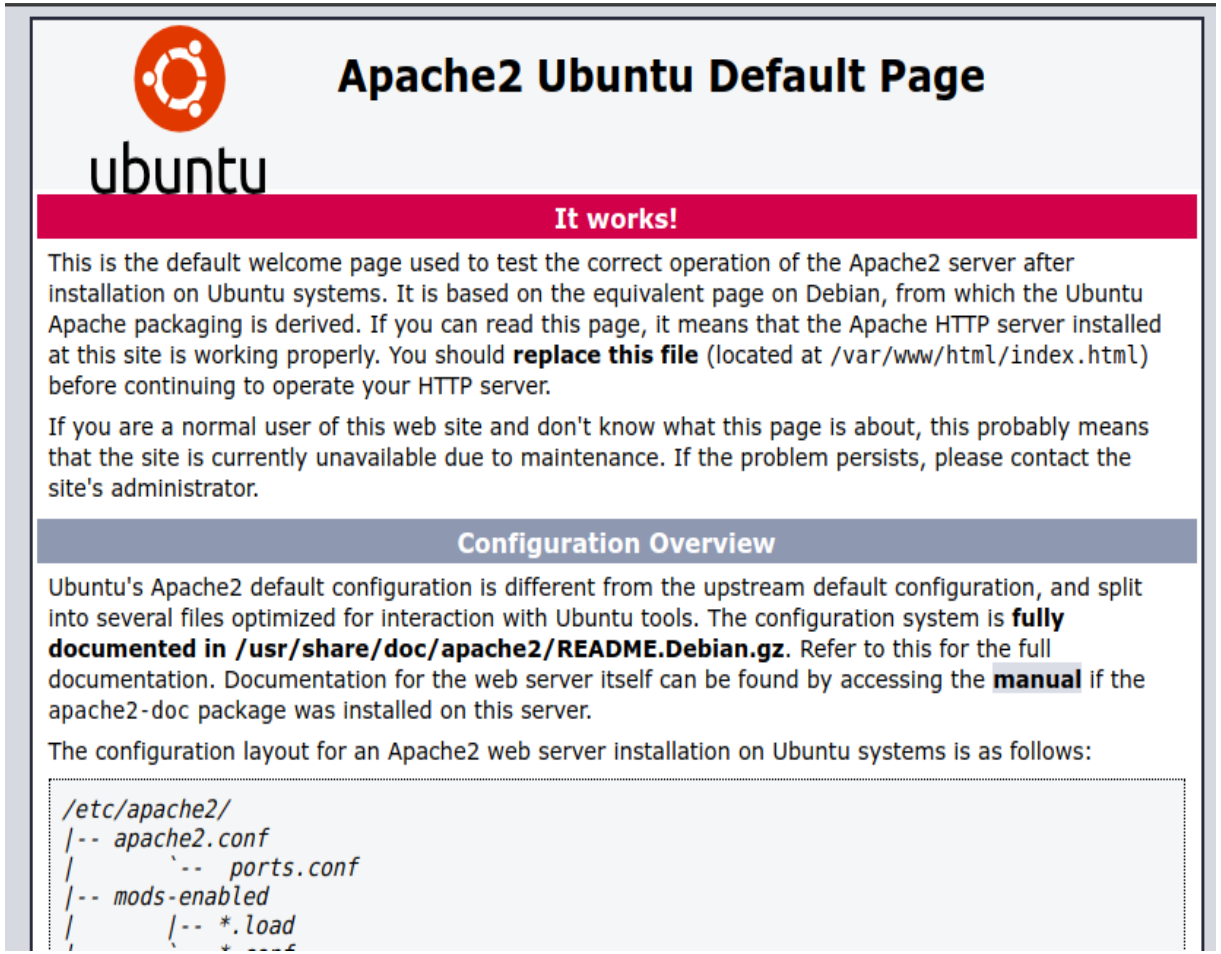
- an excellent server software option that's specifically designed for Windows.
- includes many native Windows security features, such as Azure Active Directory
- it has integrated website and server management tools.
- native support for dynamic ASP.NET applications, spanning CSS, JavaScript, and HTML

Apache Tomcat

- Best web server software options for Java applications.
- uses multiple Java specifications in an open-source environment.
- Tomcat comes from the same company as Apache.
- Key Features for Tomcat: Customizable modules, Multiple Java technologies, including Jakarta WebSocket, Performance-enhanced data processing, Open-source design

Installing Apache Package

- **Install apache2 Package**
  - sudo apt update
  - sudo apt install apache2
- **By default, Apache comes with a basic site**
  - Web Content : /var/www/html
  - Configurations :
    - /etc/apache/apache2.conf
    - /etc/apache/ ports.conf
    - /etc/apache/mods-enabled
    - /mods-available
    - /sites-enabled
    - /sites-available
    - /conf-available
- **Operational Commands**
  - systemctl <*start*|*restart*|*reload*|*stop*> apache
  - a2ensite <config-name>
  - a2dissite <config-name>
  - a2dismod <module-name>
  - a2enmod <module-name>
  - apachectl <options>



Apache Modules

- **Active Apache modules**

  apache2ctl -t -D DUMP_MODULES

  apache2ctl -M

- **Commonly used Apache modules**
  - Mod_security
  - Mod_rewrite
  - Mod_deflate
  - Mod_cache
  - Mod_proxy
  - Mod_ssl

Mod_security

- Deals with the security of your server.

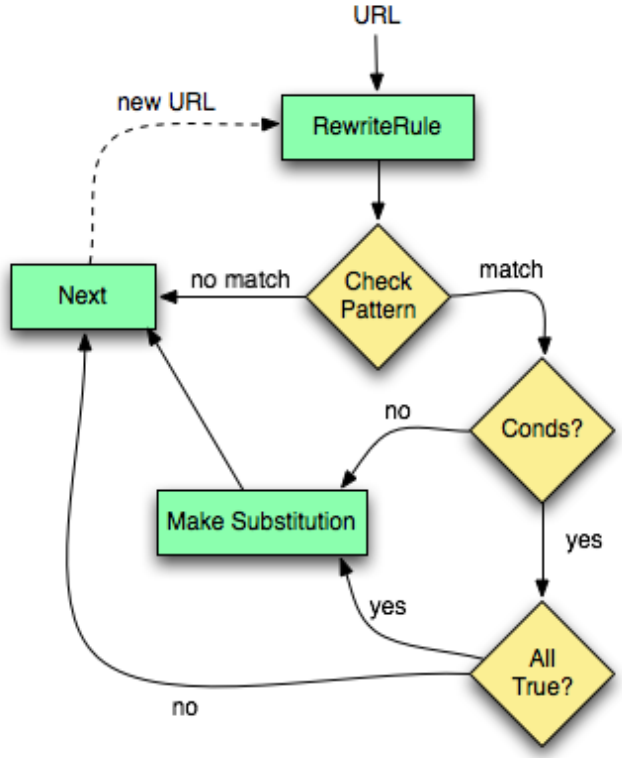
  - It can protect the server from various attacks.
  - It uses the regular expressions and rule sets to block the attacks.
  - It works as a firewall.
  - It could work either embedded or as a reverse proxy.

- A reverse proxy is a proxy server that accesses the servers on behalf of a client. They retrieve the resources from the servers and return to the client as they from the proxy server and not from the original server.

- It is very efficient in blocking SQL injection attacks. When a SQL injection attack is completed, it will return a 406 error.

mod_rewrite

- The mod_rewrite is also popular in the web hosting industry.
  - It is used to rewrite the URLs and so that the redirection can be achieved.
  - The module has a rewrite engine which will rewrite a requested URL based on a PCRE regular expression parser.



- The mod_rewrite uses unlimited rules. Each rule can have unlimited attached rule conditions which enables the rewriting based on server and environment variables, HTTP headers, etc.

- example of a rule for redirecting a url that starts with ‘http’ to ‘https’ is given below.

```
RewriteEngine On

RewriteCond %{HTTPS} off

RewriteRule ^(.*)$ https://%{HTTP_HOST}%{REQUEST_URI} [L,R=301]
```

- https://httpd.apache.org/docs/2.4/mod/mod_rewrite.html

mod_deflate

- This module is used to compress the output from the webserver before sending to the client. It reduces the size of the output file, so that the client can download it faster.
  - The following directive will enable the compression for documents in the container where it is placed.

```
SetOutputFilter DEFLATE
```

  - If Apache is being used as a reverse proxy and you need to process the content which passes through the proxy, you can use the mod_deflate for decompressing purpose as well.
  - However, it is rarely used and the common use of mod_deflate is to compress the web server output. The mod_deflate uses a combination of LZ77 algorithm and Huffman coding.
  - This ensures no data is lost while compressing the files. If the output file size is less than 120 bytes (approximately), then the output file will be larger after being processed by the mod_deflate.
  - This happens because this module does not have a lower bound for the file size. The mod_gzip is similar to mod_deflate.

mod_cache

- The mod_cache is the Apache module that is used for content caching.

  - Web caching is a way to improve the performance of the server.

  - The commonly requested content will be stored in an easy to access locations so that the client can access the data faster and client does not need to retrieve the data every time when the request is demanded.

  - We can create caching rules for making caching effective. However, highly dynamic content will be served to the client normally from the server.

  - There are many other methods also used by Apache for the purpose of web caching and one of them is using mod_file_cache module.

mod_proxy

- **This is an optional Apache module.**
  - This module implements a proxy, gateway for Apache server.
  - It supports many commonly used protocols and many load balancing algorithms.

- **To enable this feature, a set of modules will need to be loaded onto the server. This include the following.**

1) mod_proxy
2) mod_proxy_balancer
3) One or more proxy scheme, or protocol, module

mod_ssl

- Mod_ssl also is an optional module of the Apache.
- It is used in Apache version 1.3 and version 2.
- It enables encryption via the Secured Sockets Layer (SSL) and Transport Layer Security (TLS) with the help of Open-Source SSL/TLS toolkit OpenSSL.
- Its original version was created for Apache version 3 in 1998.
- The intention of this module is to provide SSL v3 and TLS v1.x support for the Apache server. The SSL v2 is no longer supported.

.htaccess

- **The .htaccess file in Apache is a tool that allows configurations at the directory and subdirectory level.**

- **Using .htaccess enables you to configure website permissions without altering server configuration files.**

- **Enabling .htaccess**
  - sudo vi /var/www/my_website.com/.htaccess
  - sudo vi /user/safe_location/.htpasswd

- **Common Uses**
  - Manage IP Addresses
  - Block Visitors by Referrer
  - Redirect Traffic
  - Set a 404 Page

.htaccess Usage

➢ Enable authentication:

```
AuthUserFile /user/safe_location/.htpasswd
AuthGroupFile /dev/null
AuthName "Please Enter Password"
AuthType Basic
Require valid-user
```

➢ Redirect Traffic

```
Redirect301/Other_Website.com/index.html/My_Website.com/index.html
```

➢ Allow. Deny IP Addresses

```
order deny, allow
deny from 192.168.0.54
allow from 192.168.0
```

➢ Block Visitors by Referrer

```
RewriteEngine on
# Options +FollowSymlinks
RewriteCond %{HTTP_REFERER} blockeddomain\.com [NC]
RewriteRule .* - [F]
```

➢ Set a 404 Page

```
ErrorDocument 404 /404.html
```

Minimal Basic Configuration

- **Listen:**
  - Used to bind Apache to specific IP addresses and/or ports. HTTP server, by default, runs on port 80 for production.
  - For testing, you could choose a port number between 1024 to 65535, which is not used by an existing application (you can run command "netstat" to check the existing connections). We shall run the Apache at port 8000.

```
# Listen: Allows you to bind Apache to specific IP addresses and/or ports.

Listen 8000
```

- **ServerName:**
  - Set to your DNS hostname, or IP address (to find out your IP address, run command "ipconfig"), or your computer name, or "localhost" followed by the port number chosen above.

```
# ServerName gives the name and port that the server uses to identify itself.
# If your host doesn't have a registered DNS name, enter its IP address here.

ServerName YourHostNameOrIPAddres:8000
```

Minimal Basic Configuration

- **ServerRoot:**
  - The Apache installed directory "<APACHE_HOME>", e.g.,

```
# ServerRoot: The top of the directory tree under which the server's
# configuration, error, and log files are kept.
# Assume that Apache HTTP server is installed in “/Project/apache2“


ServerRoot “/Project/apache2"
```

Note : use Unix-style forward slash (/) as the directory separator, instead of Windows-style backward slash (\) in the configuration file.

Configuration options

- **DocumentRoot:**
  - It specifies document root directory or home directory of the server. It is set to <APACHE_HOME>\htdocs by default.

```
# DocumentRoot: The directory out of which you will serve your documents.
DocumentRoot “/Porject/apache2/htdocs"

# Access Control for the document base directory
<Directory "/Porject/apache2/htdocs">
    # Show directory listing, and allow symbolic links
    Options Indexes FollowSymLinks

    # Cannot override with .htaccess files.
    AllowOverride None

    # Controls who can get stuff from this server.
    Order allow,deny
    Allow from all
</Directory>
```

Caution: You MUST do a global search on "htdocs", before modifying the document root directory.

IT601 – System and Network Administration

Web Service

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Web Server and Web Services

A web service makes an application (s) or content available to the users over the internet using internet browsers.

- Running a web server is more than just installing Apache or IIS and providing content.

1 - Open Standards

- The web is based on open standards, which are developed by an international committee, not a single corporation.
- You can use them without paying royalty or licensing fees.
- Web standards are defined by the World Wide Web Consortium (W3C), and the underlying Internet protocols are defined by the Internet Engineering Task Force (IETF).

2 - Benefits

- The benefit of web-based applications is that one browser can access many web applications. The web browser is a universal client.
- Cost , No transfer of software product, Universal availability

3 - Usage

- Web applications and small web servers are also present in firmware in many devices, such as small routers and switches, smart drive arrays, and network components.

Types of Web Servers

There are four basic web server types:

Static web server

1. Serves only documents that don't change or change only rarely.
2. The documents are read from disk and are not altered by the web server.

CGI servers

1. Common Gateway Interface (CGI) is interface specification to enables servers to execute an external program, typically to process.
2. CGI servers generate pages dynamically.
3. Dynamic page generation uses more CPU and memory than reading from disk.

Database-driven web sites

1. Generate each web page from database.
2. Each page is generated by reading information from a database and filling that information into a template.

Multimedia servers

1. Content includes media files, such as video or audio.
2. Have high performance requirements for CPU, memory, storage, and network.

Multiple Web Servers on One Host

Small Vs Large sites

Small Sites	Large Sites
1. Small sites may want to start with a single web server that is used for all applications. 2. The amount of traffic that each application receives does not justify the cost and overhead of additional machines.	1. Large sites that load-balance web services across multiple machines often want all the machines to be identical clones of each other, rather than having N machines dedicated to one application and M machines dedicated to another. 2. Identical clones are easier to manage. 3. There are many ways to host multiple web services on the same machine.

Multiple Web service Problems

Single Port

1. HTTP-based services usually listen for requests on TCP ports 80 (unencrypted) and 443 (encrypted via SSL, often called HTTPS).
2. Multiple services cannot share a port. That is, only one process can be listening to port 80 at a time.

Multiple IP Addresses

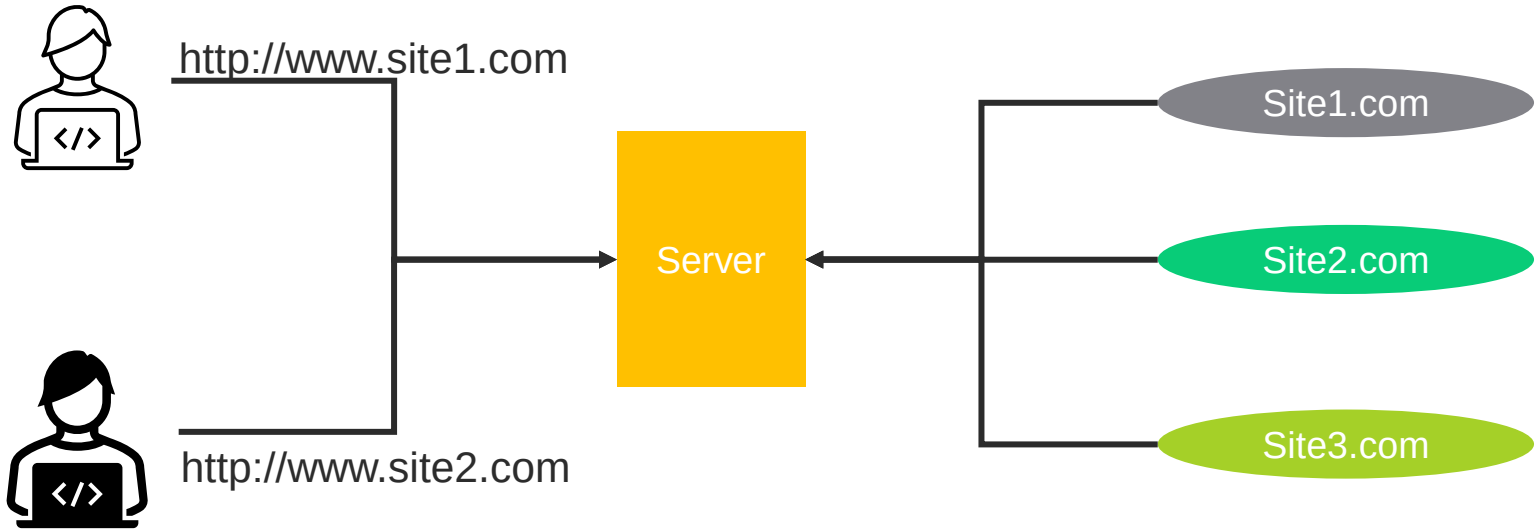
1. The easiest way to resolve this is to configure multiple IP addresses on a machine. A less attractive option is to use different ports for each server, with URLs that list the port, such as http://myservice:8000.
2. Configuring multiple IP addresses on a machine does not scale well. This scheme is complex and not well supported in some OSs. Also, IPv4 addresses are scarce. URLs containing the port information look unprofessional.

Scalable Techniques for Multi Services

There are two techniques for permitting many services to share the same port on the same IP address. Both techniques provide a scalable solution with a professional look.

1 - Virtual hosting

- The first technique is called virtual hosting. Originally one machine could host only one domain.



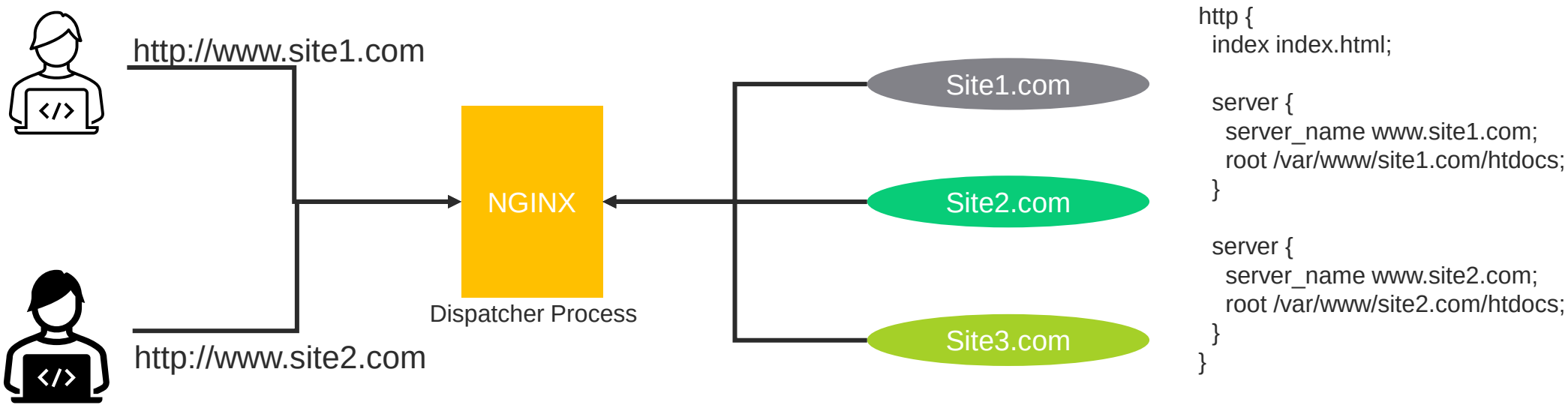

```
<VirtualHost *:80>
   ServerAdmin admin@site1.com
   ServerName site1.com
   ServerAlias www.site1.com
   DocumentRoot /var/www/ site1.com/html
</VirtualHost>

<VirtualHost *:80>
   ServerAdmin admin@site2.com
   ServerName site2.com
   ServerAlias www.site2.com
   DocumentRoot /var/www/site2.com/html
</VirtualHost>
```

- Virtual hosting permits one system to listen for incoming HTTP and HTTPS connections but serve different web pages depending on which domain the request is for.
- This required a change to the HTTP protocol, but it is supported by all web browsers.

2 - Dispatcher

- The second technique is to use one process as a dispatcher for many individual services. A single process listens for connections and forwards them to the proper service.




```
http {
  index index.html;

  server {
    server_name www.site1.com;
    root /var/www/site1.com/htdocs;
  }

  server {
    server_name www.site2.com;
    root /var/www/site2.com/htdocs;
  }
}
```

- Nginx is often used to listen for incoming HTTP and HTTPS connections, determine which domain they are intended for, and forward the request as appropriate.
  - The individual services listen on different ports such as 8000, 8001 etc , but this is hidden from the users.
  - This has another benefit in that Nginx can decrypt SSL connections so that the individual services must process only the simpler HTTP protocol.
  - It also isolates all cryptographic issues to one place, where they can be managed separately.

HTTPS and Multiple Servers

Catch-22 Problem

Serving multiple domains on the same IP address is more complex for HTTPS (encrypted) connections due to a Catch-22 in how HTTPS works. Each domain has its own SSL certificate. The software needs to know which SSL certificate to use to decrypt the request, but the intended domain is in the encrypted portion of the request.

Techniques to Address Catch 22

Share Certificate

1. An early solution to this Catch-22 was to permit one certificate to apply to multiple domains.
2. These multidomain certs are called subject alternative name (SAN) certificates.
3. All but the oldest, most broken web browsers support it. Since there is one certificate, the expiration data and other information are the same for all domains, which isn't usually a problem.
4. However, the certificate must be reissued to add and remove domains, which is inconvenient.

Server name indication

1. A newer technique is called server name indication (SNI).
2. This allows for the use of multiple unique certificates on the same machine, as would be expected. In order for SNI to function, the client must first submit the intended domain in an unencrypted form. To decrypt the session, the server can choose which certificate to apply.
3. The desired domain must match the unencrypted request and is nevertheless provided in the encrypted part for security reasons. Sadly, SNI requires a modification to the SSL protocol, therefore it is incompatible with older hardware. These gadgets have, however, largely vanished.

SLA for Web Services

- **A web service needs an SLA.**
- **Generally, web as a 24/7 critical service, but the SLA of an individual web service might be quite different.**
  - Most internal web services will have the same SLA as other office services, such as printing or storage.
- **Ideally, as with any SLA, the service level should be set by collaborating with the customer community.**

  1 - Resist setting any SLA that does not allow for periodic maintenance, unless the service is built out on redundant infrastructure.

  2 - If the service is provided by a single host or a shared web host and is required to be available around the clock, it is time to discuss increasing the redundancy of the service.

  3 - Metrics that are part of a web SLA should include the latency for a certain level of QPS.

  - For example , how long should a typical query take when the system is under a particular load? Latency is usually measured as the time between receipt of the first byte of the request and sending of the last byte of the answer.

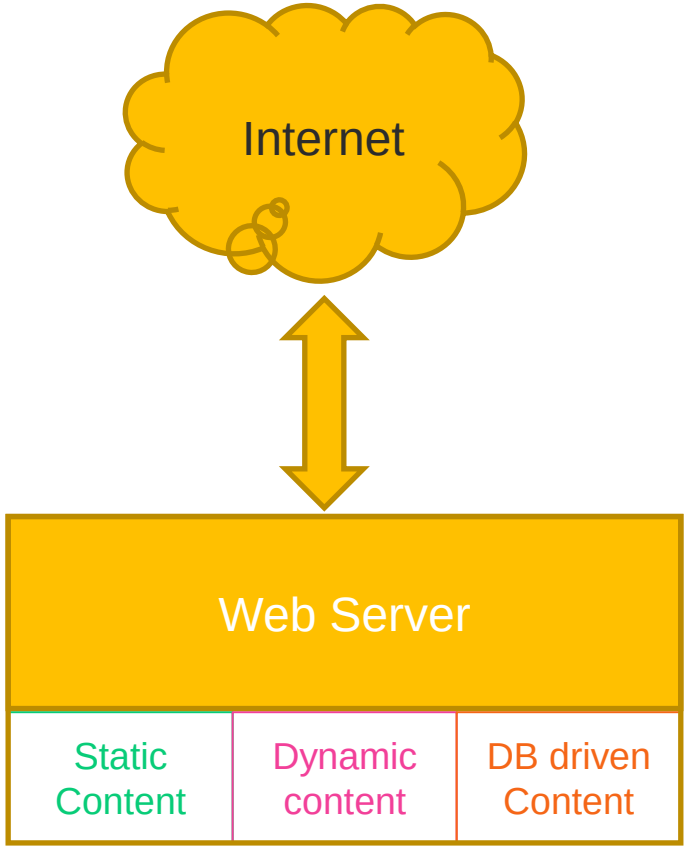
Web Service Monitoring

- **Why monitoring web services?**
  - How well it is scaling?
  - Which areas need improvement?
  - Whether the service is meeting your SLA?
- **Be specific about which web-specific elements to your monitoring.**
  - Web server errors are most often related to problems with the site's content and are often valuable for the web development team.
  - Certain errors or patterns of repeating errors can be an indication of customer problems with the site's scripts. Other errors may indicate an intrusion attempt. Such scenarios are worth investigating further.
- **Typically, web servers allow logging of the browser client type and of the URL of the page containing the link followed to your site (the referring URL).**
- **Web servers may have server-specific information that would be useful as well, such as data on active threads and per-thread memory usage.**
- **Become familiar with any special support for extended monitoring available on your web server platform.**

Scaling for Web Services

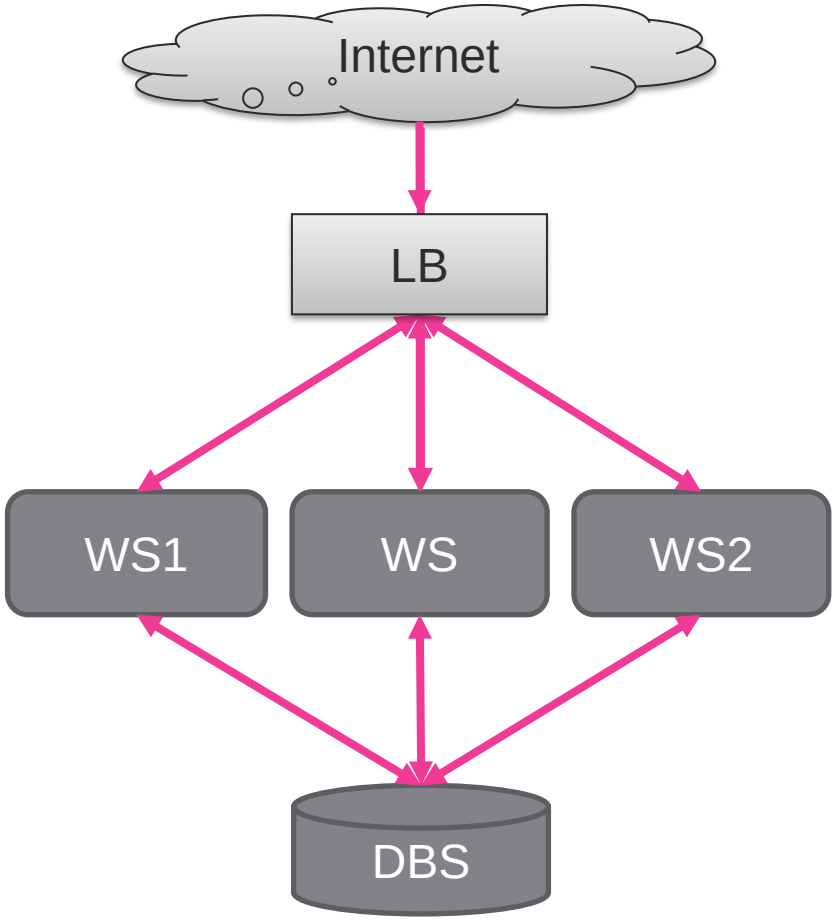
“Scaling is the only problem on the Internet. Everything else is a subproblem.”

- **slashdot effect**
  - The Slashdot effect, also known as slashdotting, occurs when a popular website links to a smaller website, causing a massive increase in traffic.
  - If the web server is successful, it will get overloaded by requests. You may have heard of the Slashdot effect.
- **Single machine web server Scaling**
  - A small organization with basic needs can improve a web server’s performance by simply upgrading the CPU, disks, memory, and network connection.
- **Multi machine web server Scaling**
  - For multiple machines, there are two main types of scaling are horizontal and vertical. They get their names from web architecture diagrams.
    - When drawing a representation of the web service cluster, the machines added for horizontal scaling tend to be in the same row, or level.
    - For vertical scaling, they are in groups arranged vertically, as they follow a request flowing through different subsystems.



Horizontal Scaling

- **In horizontal scaling, a web server or web service resource is replicated and the load is divided among the replicated resources.**
- **Example**
  - Consider two web servers with the same content, each getting approximately half the requests.
  - The typical solution is to use a device called a load balancer. A load balancer sits between the web browser and the servers.
  - The browser connects to the IP address of the load balancer, which forwards the request transparently to one of the replicated servers.
  - The load balancer tracks which servers are down and stops directing traffic to a host until it returns to service.
  - Other refinements, such as routing requests to the least-busy server, can be implemented as well
- **Load balancers are often general-purpose protocol and traffic shapers, routing not only HTTP but also other protocol requests, as required.**
  - This allows much more flexibility in creating a web services architecture. Almost anything can be load balanced, and this approach can be an excellent way to improve both performance and reliability.



Vertical Scaling

- **Separates out the various kinds of subservices, rather than duplicating a whole machine.**
  - **It allows you to create an architecture with finer granularity, so that you can put more resources at the most intensively used stages of page creation.**
  - **It also keeps different types of requests from competing for resources on the same system.**
- **Examples**
  - Consider the single web server case , split the different types of content onto separate machines, and change the web pages to refer to those other machines for that content.
  - Using an application to complete a brief survey on a video clip after it has been viewed is one example of a website with numerous huge video clips. It is inefficient to try to write numerous minor database changes while reading huge video files from the same disc.
  - OS may have caching algorithms that are automatically tuned for one or the other but perform badly when both happen. In this case, all the video clips might be put on a separate web server, perhaps one with a storage array customized for retrieving large files. The rest of the web site would remain on the original server. Now that the large video clips are on a separate server, the original server can handle many more requests.
- **As you might guess, horizontal and vertical scaling can be combined. The video survey web site might need to add another video clip server before it would need to scale the survey form application.**

How to choose a Scaling Method

- A site may need horizontal or vertical scaling or some combination of both.

1 - Classify the various components

- Classify the various components that are used in conjunction with your web server according to the resources they use most heavily.

How to choose a Scaling Method

2 - Identify Interfering Components

- Then look at which components compete with one another and whether one component interferes with the function of other components.

  - A site may include static files, CGI programs, and a database.
  - Static files can range from comparatively small documents to large multimedia files.
  - CGI programs can be memory-intensive or CPU-intensive processes and can produce large amounts of output.
  - Databases usually require the lion’s share of system resources.
  - In some cases, such as the video survey site, you might choose to move part of the service to another server.

How to choose a Scaling Method

3 - Use Diagnostics

- Use system diagnostics and logs to see which kinds of resources are being used by these components.

  - Consider an IS department web server that is also being used to create graphs of system logs.

  - This can be a very CPU-intensive process, so the graphing scripts and the log data can be moved to another machine, leaving the other scripts and data in place.

How to choose a Scaling Method

4 - Decide All or Gradual Upgrades

Web Service Security

Importance of Web server security

- Implementing security measures is a vital part of providing web services.
- Security is a problem because people you don't know are accessing your server.
- Some sites believe that security is not an issue for them, since they do not have confidential documents or access to financial information or similar sensitive data.
- However, the use of the web server itself and the bandwidth it can access are, in fact, a valuable commodity.

The Uses of Web Server Attacks

- Intruders often break into hosts to use them for money-making purposes, and sometimes they do so simply for entertainment
- Intruders usually do not deface or alter a web site, since doing so would lead to their discovery. Instead, they simply use the site's resources.
- **Common uses of hijacked sites and bandwidth**
  - Distribution of pirated software
  - Generating advertising email
  - Launching automated systems to try to compromise other systems
  - Competing with other intruders to see who can run the largest farm of machines

Why to Secure Internal Websites?

Internal web services should be secured as well. Although you may trust employees of your organization, there are still several reasons to practice good web security internally:

- Stopping virus transmission
- Protecting privileged information that requires authentication.
- Protect from visitors—temps, contractors, vendors, speakers, interviewees
- Protect Network resources such as WIFI
- Security and reliability go hand-in-hand such avoiding DOS

Secure Connections and Certificates

- **Usually web sites are accessed using unencrypted, plaintext communication.**
  - The privacy and authenticity of the transmission can be protected by using HTTP over Secure Sockets Layer (SSL) to encrypt the web traffic. SSL 4.0 is also known as Transport Layer Security (TLS) 1.0. Confusingly, SSL 2.0 and 3.0 predate TLS 1.0.
  - Use encryption to prevent casual eavesdropping on our customers' web sessions even if they are connecting via a wireless network in a public place, such as a coffeeshop. URLs using https:// instead of http:// are using SSL encryption.
- **Implementing HTTPS on a web server is relatively simple, depending on the web server software being deployed. Properly managing the cryptographic certificates is not so easy.**
  - The private key of certificate must be kept secret. If it is leaked to outsiders, they can use it to pretend to be your site.
  - One role of the web system administrator is to maintain a repository, or key escrow, of certificates for disaster-recovery purposes. Treat this data the same way as you manage other important secrets, such as root or administrator passwords.
- **Places to store private keys**

  Private keys must be secret, but the web server needs to read the private key to use it. There are a number of ways to solve this issue:

Isolated storage	Encrypted storage	Network-accessible key repository	Protected file

Self-Signed-Certificates

- **A cryptographic certificate is created by the web system administrator using software that comes with the encryption package; OpenSSL is one popular system.**
- **The certificate at that point is "self-signed," which means that when someone connects to the web server using HTTPS, the communication will be encrypted, but the client that connects has no way to know that it has connected to the right machine.**
  - Anyone can generate a certificate for any domain. It is easy to trick a web client into connecting to a "man in the middle" attacker instead of to the real server; the client won't know the difference. This is why most web browsers, when connecting to such a web site, display a warning stating that a self-signed certificate is in use.
    - The solution to this dilemma is to use an externally signed cryptographic certificate from a registered certification authority (CA).
    - The public half of the self-signed certificate is encrypted and sent to a trusted CA, which signs it and returns the signed certificate.
    - The certificate now contains information that clients can use to verify that the certificate has been certified by a higher authority.
    - When it connects to the web site, a client reads the signed certificate and knows that the site's certificate can be trusted because the CA says that it can be trusted.

Protecting the Web Server Application

- **A variety of malicious efforts can be directed against the web server itself in an attempt to get login access to the machine or administrative access to the service.**

- **Any vulnerabilities present in the operating system can be addressed by standard security methods.**

- **Web-specific vulnerabilities can be in multiple layers of the web server implementation such as**

  - The HTTP server
  - modules or plug-ins that extend the server
  - web development frameworks running as programs on the server.

  This last category is distinct from generic applications on the server, as the web development framework is serving as a system software layer for the web server.

- **The best way to stay up-to-date on web server security at those layers is through vendor support.**

  - The various HTTP servers, modules, and web development environments often have active mailing lists or discussion groups and almost always have an announcements-only list for broadcasting security exploits, as well as available upgrades.

Protecting the Content

- **Some web-intrusion attempts are directed toward gaining access to the content or service rather than to the server..**
  - There are many types of web content security exploits, and new ones are always being invented.
- **SAs should educate themselves on current exploits via Internet security resources.**
  - The knowledge allows properly evaluate a server for complex threats is a significant undertaking.
  - Fortunately, open source and commercial packages to assist you are available.

Software Vulnerabilities

- largest threat is security vulnerabilities frameworks used.
- The code may be perfect, but an old framework may have security vulnerabilities.
- Most of security incidents are not due to the newest security threats, but old unfixed vulnerabilities.

Directory Traversal

- A technique generally used to obtain data.
- Data may be useful itself or used to enable method of direct intrusion.
- Efficient with servers generating auto indexes.
- Modern servers don't allow to traverse root directory, but old servers are vulnerable.
- common variation of directory traversal uses a CGI query

Form-Field Corruption

- DB fields may appear in form or contents.
- A legitimate web form can be copied and altered to gain access to data or services.
- form validations strictly may prevent it but newer methods are always coming.

SQL Injection

- A variant of form-field corruption is SQL injection.
- Intruders can even perform entire SQL queries, updates, and deletions.
- Some database systems
- include debugging options that permit running arbitrary commands on the
- operating system.

Application Security

- The efforts of malicious people can be rendered less likely to succeed by following good security practices when developing applications.
- The following are some of the fundamental practices to use when writing web code or extending server capabilities.

Limit the Potential Damage

- the best protections is to limit the amount of damage an intruder can do.
- Store Contents and programs on well protected servers and copy to web server on need.
- If web server is defaced by intruder, it can quickly be reimaged.
- Another technique is to isolate the webserver to its own network, disallow connections to internal hosts.
- Backups, logging and installations must be from internal hosts

Validate Input

- Validate the input to interactive web apps so as to maximize security.
- Input should be checked for length, to prevent buffer overflows where executable commands could be deposited into memory.
- Disallow using quotes or escape characters.
- It is better to validate input by inclusion than by exclusion.
- adopt programming paradigms that do not reinterpret or reparse data for you

Automate Data Access

- Access to DBs should be specific.
- If a web application needs to read data, allow with read only access.
- If your DB supports stored precompiled queries, use them instead of executing SQL input.
- preparation function of DB should be used to convert potentially executable input into a form.

Use Permissions and Privileges

- Set permissions to local sever for authentication methods.
- Apply the least-privilege security principle to web servers and web applications

Use Logging

- Logging is an important protection of last resort.
- After an intrusion attempt, detailed logs will permit more complete diagnostics and recovery.
- Logs should be stored on other machines or in nonstandard places to make them difficult to tamper with.
- Another way of storing logs in a nonstandard place is to use network logging

Content Management

- **Providing a content-management system (CMS) empowers users to perform self-service updates of the web content.**
  - A CMS lets you create privileged accounts for those users who are permitted to perform these updates, often in some kind of controlled manner.

- **It is not a good idea for an SA to be directly involved with content updates. Assuming this responsibility not only adds to the usually lengthy to-do list of the SA, but also creates a bottleneck between the creators of the content and the publishing process.**
  - Form a web council makes to attach domains of responsibility for web site content much easier, because the primary "voices" from each group are already working with the webmaster or the SA who is being a temporary webmaster.
  - The web council is the natural owner of the change control process.

- **This process should have a specific policy on updates. Ideally, the policy should distinguish three types of alterations that might have different processes associated with them:**
    - Update: Adding new material or replacing one version of a document with a newer one
    - Change: Altering the structure of the site, such as adding a new directory or redirecting links
    - Fix: Correcting document contents or site behavior that does not meet the standards

Web Server Packages

- There are several web server package available for Linux and windows. The commonly used packages are…

Apache HTTP

- second most popular web server software.
- It's an open-source project that uses HTTP protocol.
- operates across various OSs, including Windows and Linux.
- Best features of Apache is its customizability.
- comprised of several modules.
- Key Features for Apache: IPv6, Session tracking, FTP and HTTP/2,Customizable modules

NGINX

- Most highly used
- NGINX is compatible with both Linux and Windows.
- most famous for its high-performance features.
- designed to handle multiple connections simultaneously.
- NGINX is less customizable. You can't disable some of its modules,

Microsoft IIS

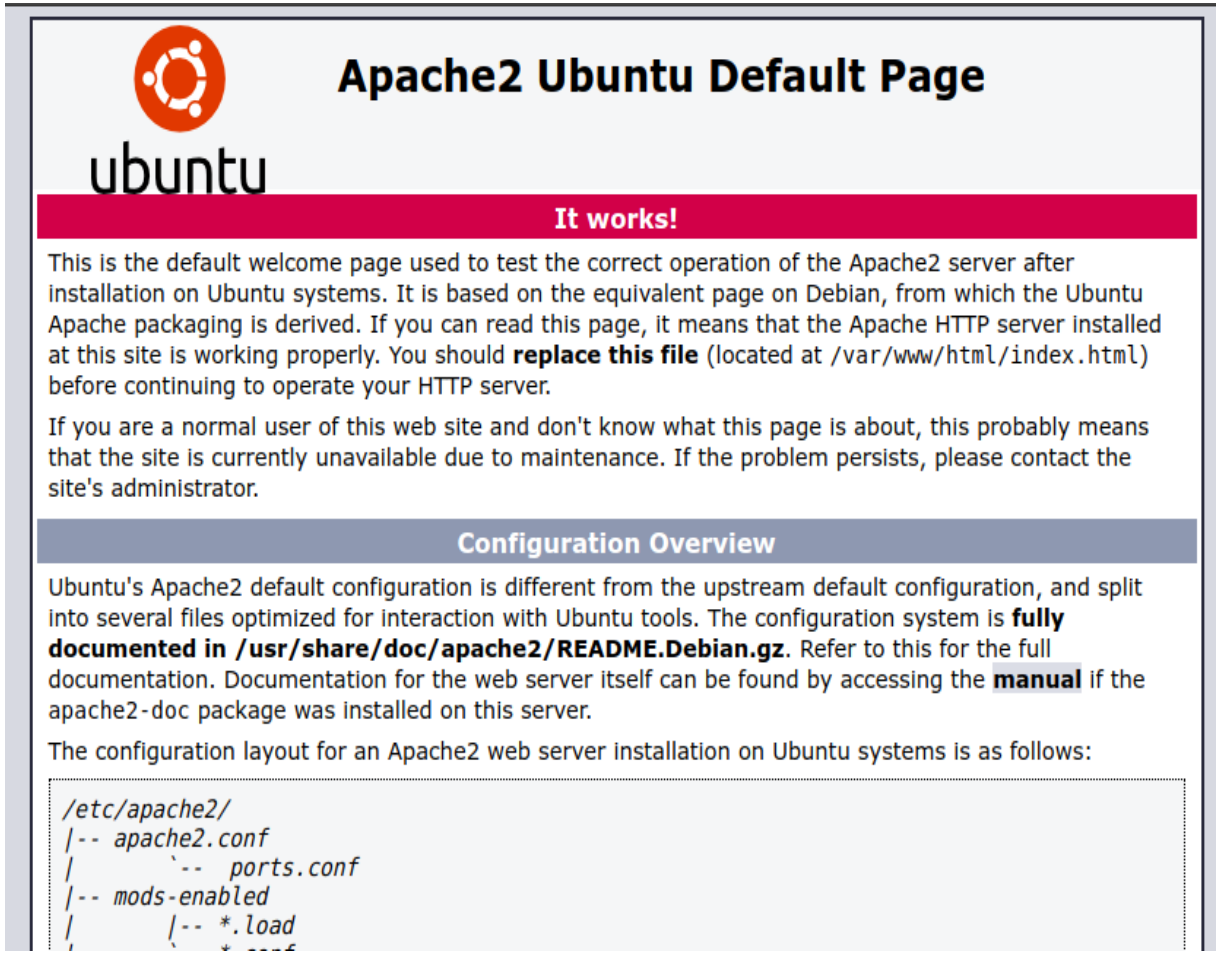
- an excellent server software option that's specifically designed for Windows.
- includes many native Windows security features, such as Azure Active Directory
- it has integrated website and server management tools.
- native support for dynamic ASP.NET applications, spanning CSS, JavaScript, and HTML

Apache Tomcat

- Best web server software options for Java applications.
- uses multiple Java specifications in an open-source environment.
- Tomcat comes from the same company as Apache.
- Key Features for Tomcat: Customizable modules, Multiple Java technologies, including Jakarta WebSocket, Performance-enhanced data processing, Open-source design

Installing Apache Package

- **Install apache2 Package**
  - sudo apt update
  - sudo apt install apache2
- **By default, Apache comes with a basic site**
  - Web Content : /var/www/html
  - Configurations :
    - /etc/apache/apache2.conf
    - /etc/apache/ ports.conf
    - /etc/apache/mods-enabled
    - /mods-available
    - /sites-enabled
    - /sites-available
    - /conf-available
- **Operational Commands**
  - systemctl <*start*|*restart*|*reload*|*stop*> apache
  - a2ensite <config-name>
  - a2dissite <config-name>
  - a2dismod <module-name>
  - a2enmod <module-name>
  - apachectl <options>



Apache Modules

- **Active Apache modules**

  apache2ctl -t -D DUMP_MODULES

  apache2ctl -M

- **Commonly used Apache modules**
  - Mod_security
  - Mod_rewrite
  - Mod_deflate
  - Mod_cache
  - Mod_proxy
  - Mod_ssl

Mod_security

- Deals with the security of your server.

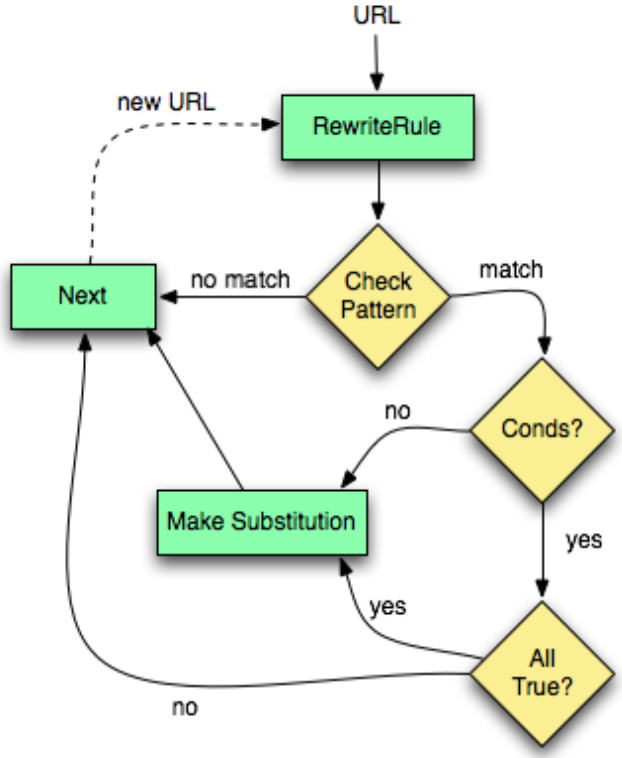
  - It can protect the server from various attacks.
  - It uses the regular expressions and rule sets to block the attacks.
  - It works as a firewall.
  - It could work either embedded or as a reverse proxy.

- A reverse proxy is a proxy server that accesses the servers on behalf of a client. They retrieve the resources from the servers and return to the client as they from the proxy server and not from the original server.

- It is very efficient in blocking SQL injection attacks. When a SQL injection attack is completed, it will return a 406 error.

mod_rewrite

- The mod_rewrite is also popular in the web hosting industry.
  - It is used to rewrite the URLs and so that the redirection can be achieved.
  - The module has a rewrite engine which will rewrite a requested URL based on a PCRE regular expression parser.



- The mod_rewrite uses unlimited rules. Each rule can have unlimited attached rule conditions which enables the rewriting based on server and environment variables, HTTP headers, etc.

- example of a rule for redirecting a url that starts with ‘http’ to ‘https’ is given below.

```
RewriteEngine On

RewriteCond %{HTTPS} off

RewriteRule ^(.*)$ https://%{HTTP_HOST}%{REQUEST_URI} [L,R=301]
```

- https://httpd.apache.org/docs/2.4/mod/mod_rewrite.html

mod_deflate

- This module is used to compress the output from the webserver before sending to the client. It reduces the size of the output file, so that the client can download it faster.
  - The following directive will enable the compression for documents in the container where it is placed.

```
SetOutputFilter DEFLATE
```

  - If Apache is being used as a reverse proxy and you need to process the content which passes through the proxy, you can use the mod_deflate for decompressing purpose as well.
  - However, it is rarely used and the common use of mod_deflate is to compress the web server output. The mod_deflate uses a combination of LZ77 algorithm and Huffman coding.
  - This ensures no data is lost while compressing the files. If the output file size is less than 120 bytes (approximately), then the output file will be larger after being processed by the mod_deflate.
  - This happens because this module does not have a lower bound for the file size. The mod_gzip is similar to mod_deflate.

mod_cache

- The mod_cache is the Apache module that is used for content caching.

  - Web caching is a way to improve the performance of the server.
  - The commonly requested content will be stored in an easy to access locations so that the client can access the data faster and client does not need to retrieve the data every time when the request is demanded.
  - We can create caching rules for making caching effective. However, highly dynamic content will be served to the client normally from the server.
  - There are many other methods also used by Apache for the purpose of web caching and one of them is using mod_file_cache module.

mod_proxy

- **This is an optional Apache module.**
  - This module implements a proxy, gateway for Apache server.
  - It supports many commonly used protocols and many load balancing algorithms.

- **To enable this feature, a set of modules will need to be loaded onto the server. This include the following.**

1) mod_proxy
2) mod_proxy_balancer
3) One or more proxy scheme, or protocol, module

mod_ssl

- Mod_ssl also is an optional module of the Apache.
- It is used in Apache version 1.3 and version 2.
- It enables encryption via the Secured Sockets Layer (SSL) and Transport Layer Security (TLS) with the help of Open-Source SSL/TLS toolkit OpenSSL.
- Its original version was created for Apache version 3 in 1998.
- The intention of this module is to provide SSL v3 and TLS v1.x support for the Apache server. The SSL v2 is no longer supported.

.htaccess

- **The .htaccess file in Apache is a tool that allows configurations at the directory and subdirectory level.**

- **Using .htaccess enables you to configure website permissions without altering server configuration files.**

- **Enabling .htaccess**
  - sudo vi /var/www/my_website.com/.htaccess
  - sudo vi /user/safe_location/.htpasswd

- **Common Uses**
  - Manage IP Addresses
  - Block Visitors by Referrer
  - Redirect Traffic
  - Set a 404 Page

.htaccess Usage

➢ Enable authentication:

```
AuthUserFile /user/safe_location/.htpasswd
AuthGroupFile /dev/null
AuthName "Please Enter Password"
AuthType Basic
Require valid-user
```

➢ Redirect Traffic

```
Redirect301/Other_Website.com/index.html/My_Website.com/index.html
```

➢ Allow. Deny IP Addresses

```
order deny, allow
deny from 192.168.0.54
allow from 192.168.0
```

➢ Block Visitors by Referrer

```
RewriteEngine on
# Options +FollowSymlinks
RewriteCond %{HTTP_REFERER} blockeddomain\.com [NC]
RewriteRule .* - [F]
```

➢ Set a 404 Page

```
ErrorDocument 404 /404.html
```

Minimal Basic Configuration

- **Listen:**
  - Used to bind Apache to specific IP addresses and/or ports. HTTP server, by default, runs on port 80 for production.
  - For testing, you could choose a port number between 1024 to 65535, which is not used by an existing application (you can run command "netstat" to check the existing connections). We shall run the Apache at port 8000.

```
# Listen: Allows you to bind Apache to specific IP addresses and/or ports.

Listen 8000
```

- **ServerName:**
  - Set to your DNS hostname, or IP address (to find out your IP address, run command "ipconfig"), or your computer name, or "localhost" followed by the port number chosen above.

```
# ServerName gives the name and port that the server uses to identify itself.
# If your host doesn't have a registered DNS name, enter its IP address here.

ServerName YourHostNameOrIPAddres:8000
```

Minimal Basic Configuration

- **ServerRoot:**
  - The Apache installed directory "<APACHE_HOME>", e.g.,

```
# ServerRoot: The top of the directory tree under which the server's
# configuration, error, and log files are kept.
# Assume that Apache HTTP server is installed in “/Project/apache2“


ServerRoot “/Project/apache2"
```

Note : use Unix-style forward slash (/) as the directory separator, instead of Windows-style backward slash (\) in the configuration file.

Configuration options

- **DocumentRoot:**
  - It specifies document root directory or home directory of the server. It is set to <APACHE_HOME>\htdocs by default.

```
# DocumentRoot: The directory out of which you will serve your documents.
DocumentRoot “/Porject/apache2/htdocs"

# Access Control for the document base directory
<Directory "/Porject/apache2/htdocs">
    # Show directory listing, and allow symbolic links
    Options Indexes FollowSymLinks

    # Cannot override with .htaccess files.
    AllowOverride None

    # Controls who can get stuff from this server.
    Order allow,deny
    Allow from all
</Directory>
```

Caution: You MUST do a global search on "htdocs", before modifying the document root directory.

IT601 – System and Network Administration

IAM and Directory Services

Arif Husen

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Virtual University of Pakistan

Identity and Access Management

- An IAM framework often includes a variety of solutions, tools, processes, policies, and technologies.
  - to ensure the right individuals have the right access to organization assets
  - to help security teams manage and monitor the user lifecycle
  - to protect organization assets from both internal and external threats.

Components of an IAM

- The components of an IAM framework are based on the following principles:

Identification or Authentication

- Confirming or denying the identity of the user attempting to access an asset.
- Single sign on (SSO) is a form of authentication.

Authorization

- Controlling what a user is able to do once they are operating within an enterprise asset.
- Role-based access controls (RBAC) are an example of an authorization approach.

Administration and Management

- Provisioning and managing throughout the user account lifecycle.
- Includes setup to deactivation, administration and management of requirements related to compliance and regulation and access to different computing environments and architectures.

Monitoring and Auditing

- Observing, tracking, managing, and reporting on a user's activities.
- The types of data and metrics that are often monitored or audited include password resets, uncorrelated accounts, number of accounts and associated roles and entitlements across applications and systems, login failures, uncorrelated privileged accounts, separation-of-duty violations, non-human identities and associated access.

Security and Protection

- Protecting enterprise assets (corporate devices, systems, data, networks, or software applications) from threats, such as breaches and damage due to unauthorized access by external threat actors, as well as insiders, such as disgruntled employees.

Identity and Access Management

services

- Lightweight Directory Access Protocol (LDAP) Service
- Kerberos Authentication Service
- Radius Authentication Service
- TACACS Authentication Service

IT601 – System and Network Administration

Lightweight Directory Access Protocol (LDAP) Service

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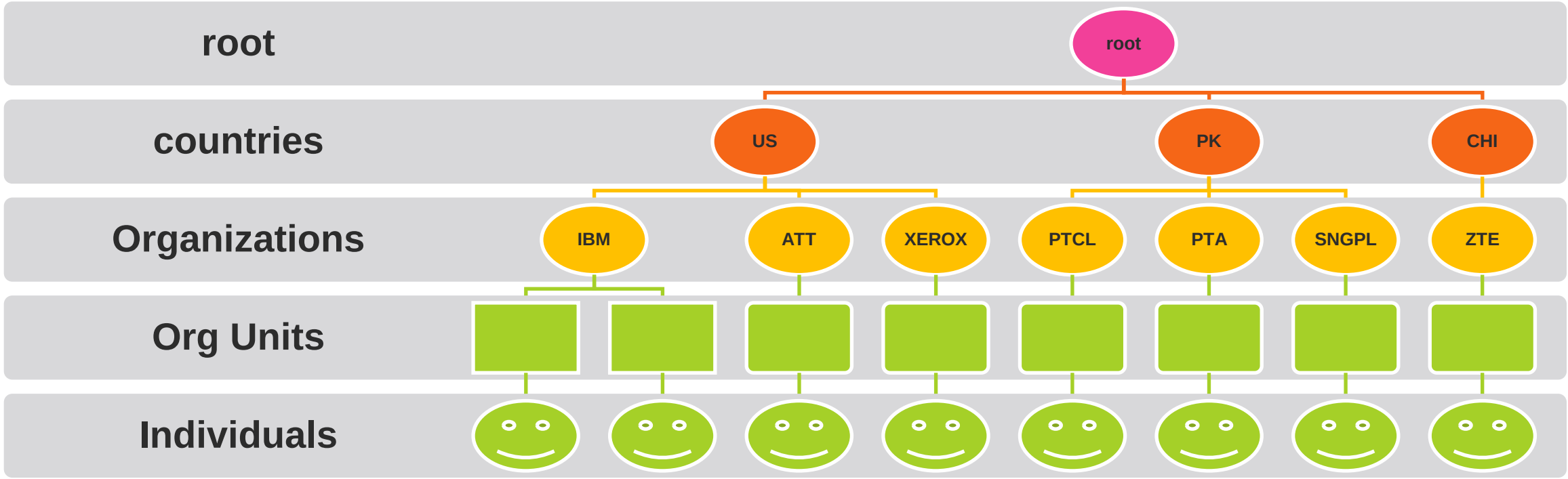
Background and Motivation

- Increased reliance on networked computers
- Need in information
  - Functionality
    - To store data in the LDAP directory and authenticate users to access the directory.
    - Provide the communication language that applications require to send and receive information from directory services
  - Ease-of-Use
    - A directory tells the user where in the network something is located.
    - provide a central place for authentication, meaning it stores usernames and passwords.
    - LDAP can then be used in different applications or services to validate users with a plugin.
  - Administration (Application specific dirs)
  - Clear and consistent organization
  - Integrity
  - Confidentiality

X.500 Standard

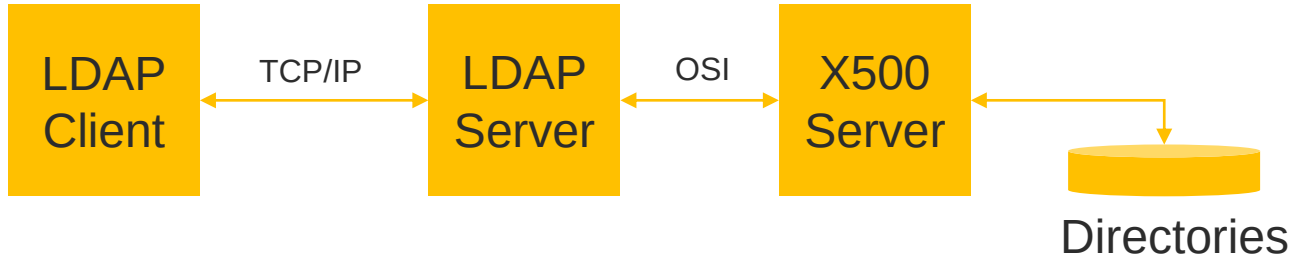
uses

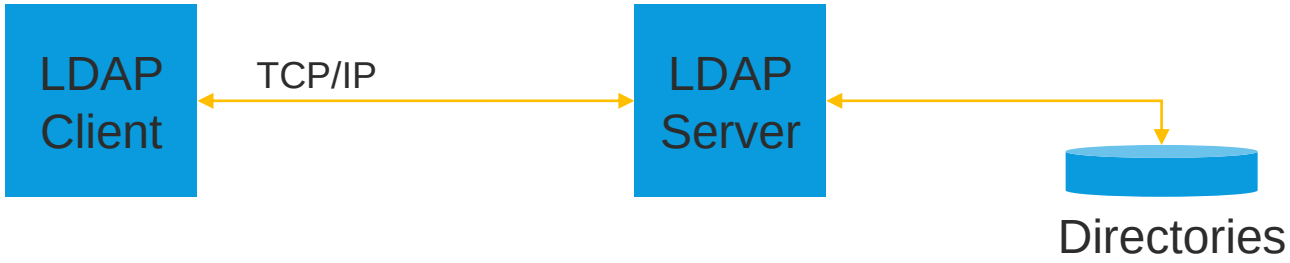
- Organizes directory entries into a hierarchical namespace
- Powerful search capabilities
- Often used for interfacing incompatible directory services
- Used DAP for c/s communication
- DAP (App. Layer) requires ENTIRE OSI stack to operate
- Too heavy for small environments



What is LDAP?

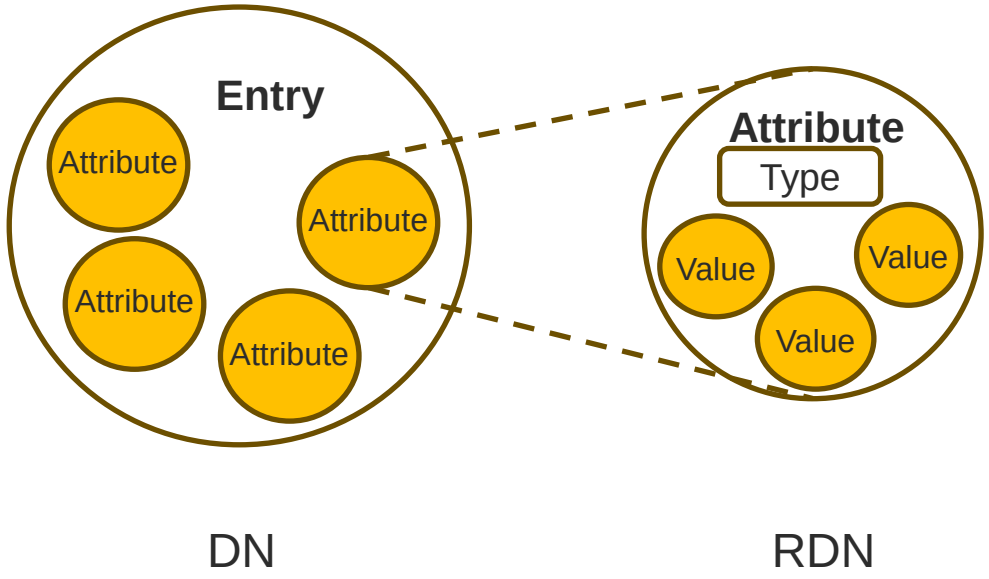
- Lightweight Directory Access Protocol
- Used to access and update information in a directory built on the X.500 model
- Specification defines the content of messages between the client and the server
- Includes operations to establish and disconnect a session from the server
- Lightweight alternative to DAP
- Uses TCP/IP instead of OSI stack
- Simplifies certain functions and omits others…
- Uses strings rather than DAP's ASN.1 (Abstract Syntax Notation One) notation to represent data.





LDAP Conventions

- **Information**
  - How information is stored in ldap directory
- **Naming**
  - How information is organized and identified.
- **Functional / Operations**
  - Describes what operations can be performed on the information stored in an LDAP directory.
- **Security**
  - Describes how the information can be protected from unauthorized access.

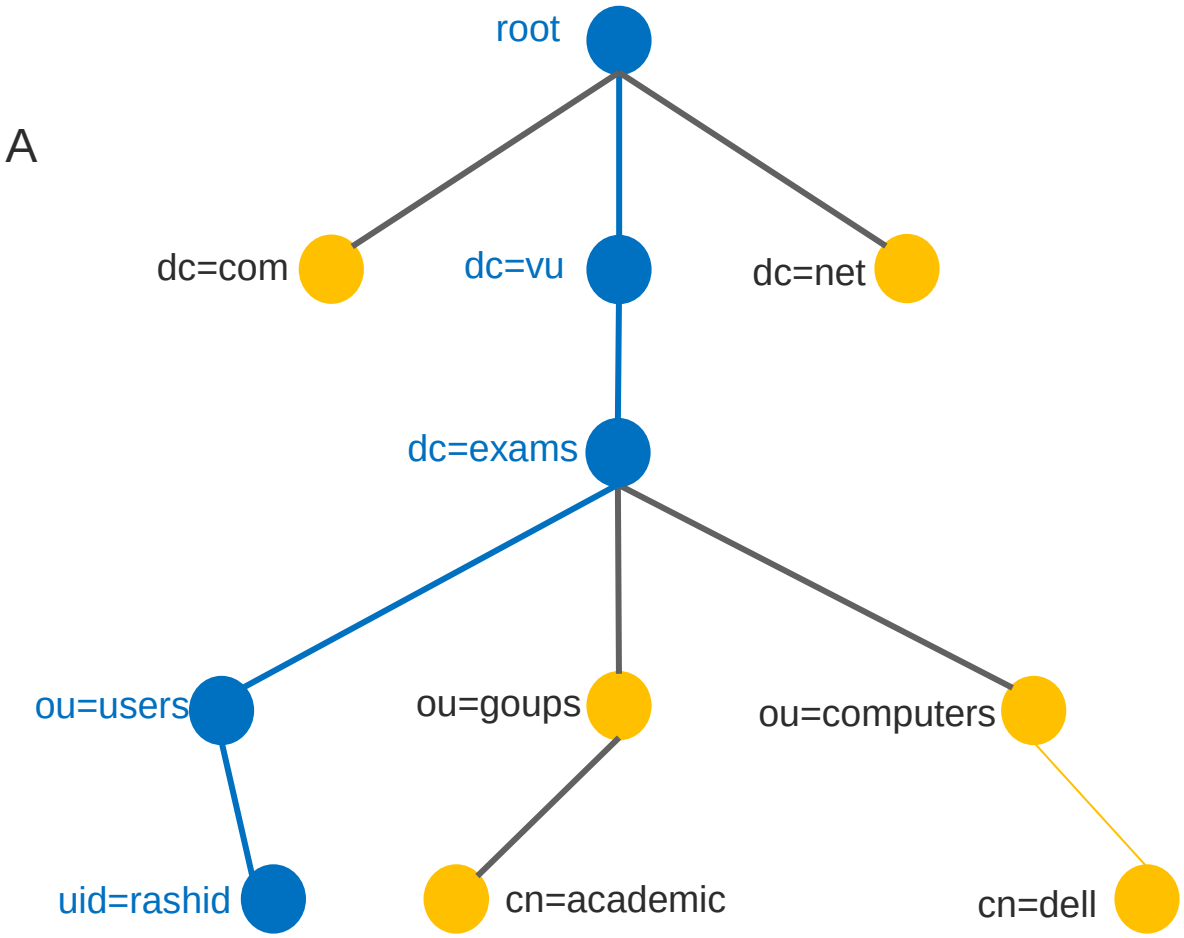


DN RDN

LDAP Information Structure

- LDAP uses a DIT (Directory Information Tree) based on X.500 which help present information in the hierarchical tree format.
  - Each node in the LDAP tree is called an entry and is uniquely identified by its Distinguished Name (DN)
  - RFC4514 provides the description of the DN format. A DN corresponding to an entry is highlighted in the diagram and represented by:
    - “ui=rashid,ou=users,dc=exams,dc=vu”

      dc stands for Domain Component
      cn stands for Common Name



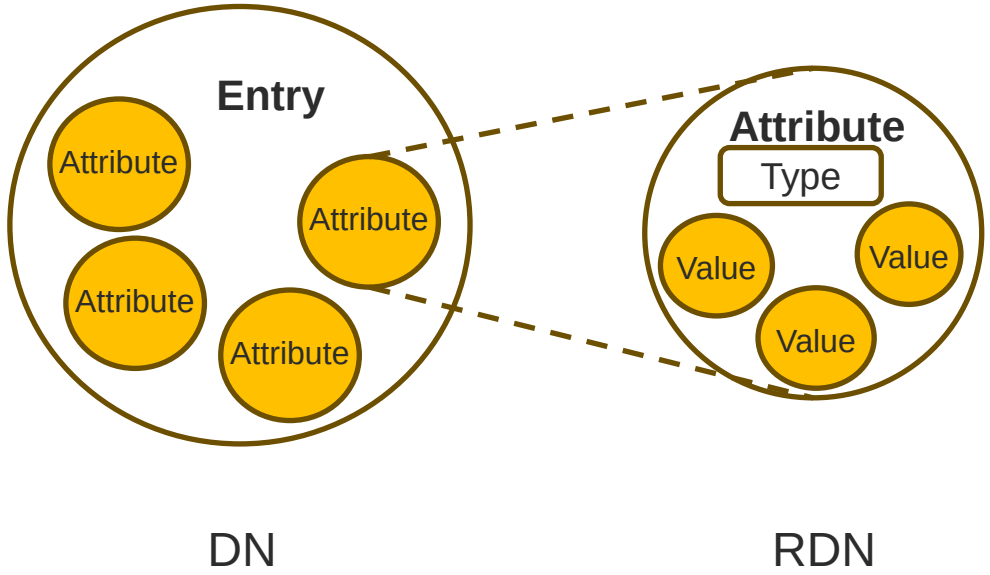
- Objectclasses define the attribute structure of an LDAP entry.
- Both ObjectClasses and Attributes are defined within schemas

Schema

- Defines what object classes allowed
- Where they are stored
- What attributes they have (objectClass)
- Which attributes are optional (objectClass)
- Type/syntax of each attribute (objectClass)

LDAP Information Structure

- An entry consists of a set of attributes, each attribute has a name or type and one or more values.
  - Entry
    - Each entry consists of several attributes
    - Each entry represents Distinguished Name (DN)
    - DN uniquely identifies an entry in the directory
  - Attributes
    - Each attribute has a type and set of values
  - Relative Distinguished Name (RDN) is an attribute that will make the entry unique in its hierarchy when combined with its parent's Distinguished Name



LDPA Abbreviations

- O stands for organization
- OU stands for Organizational unit
- SN stands for Surname
- Givenname stands for First Name
- UID stands for Userid
- Mail stands for Email address
- C stands for country
- L stands for location
- St stands for Status

Entries Using LDIF Format

- Entries can be represented in a human-readable format by using the LDIF format as in example below.

```
dn: uid=rashid,ou=academics,dc=exams,dc=vu
objectClass: top
objectClass: person
objectClass: orgnizationalPerson
objectClass: inetOrgPerson
objectClass: posixAccount
objectClass: shadowAccount
objectClass: nfsAccount
cn: Arif Rashid
sn: arifhrashid
givenName:Rashid
uid: arifhrashid
uidNumber: 3000
gidNumber: 500
homeDirectory: /home/arifhrashid
....
```

Client and Server Interaction

- Client starts an LDAP session by connecting to an LDAP Server
- The default TCP port is 389
- Bind to the server through an authentication process
- Client then sends an operation request to the server
- The Server sends responses in return
- Interaction involves three phases

Client establishes session with server (BIND)

- Hostname/IP and port number
- Security
  - User-id/password-based authentication
  - Anonymous connection - default access rights
  - Encryption/Kerberos also supported

Client performs operations

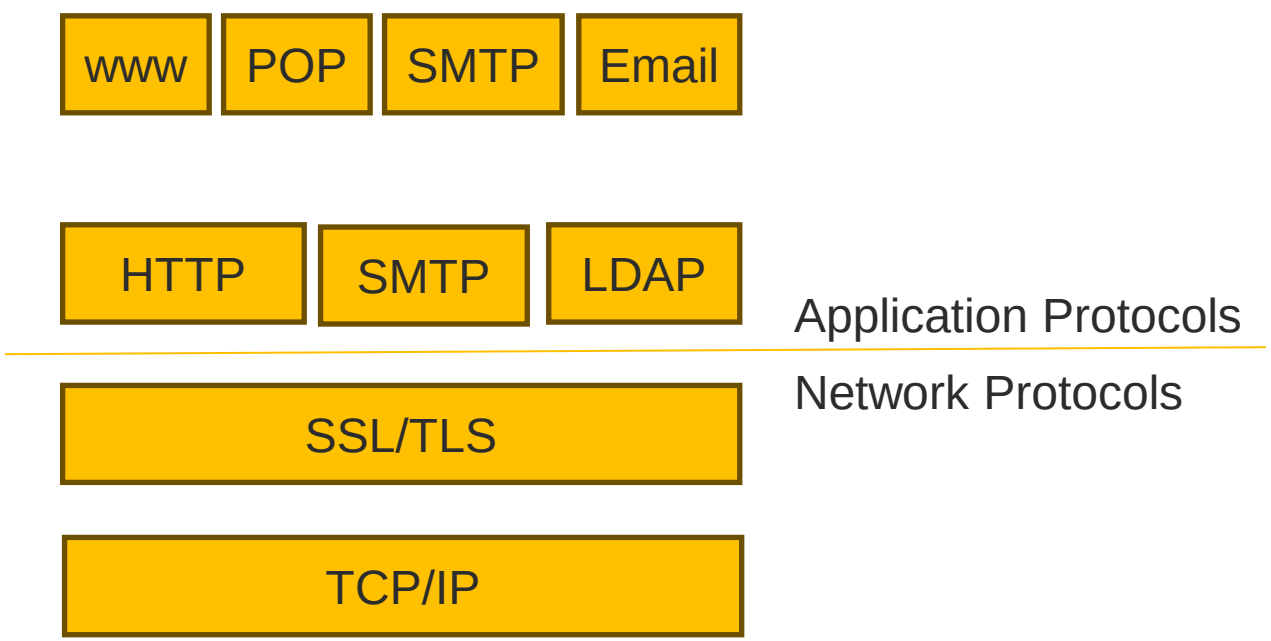
- Read/Update/Search
- SELECT X,Y,Z
- FROM PART_OF_DIRECTORY

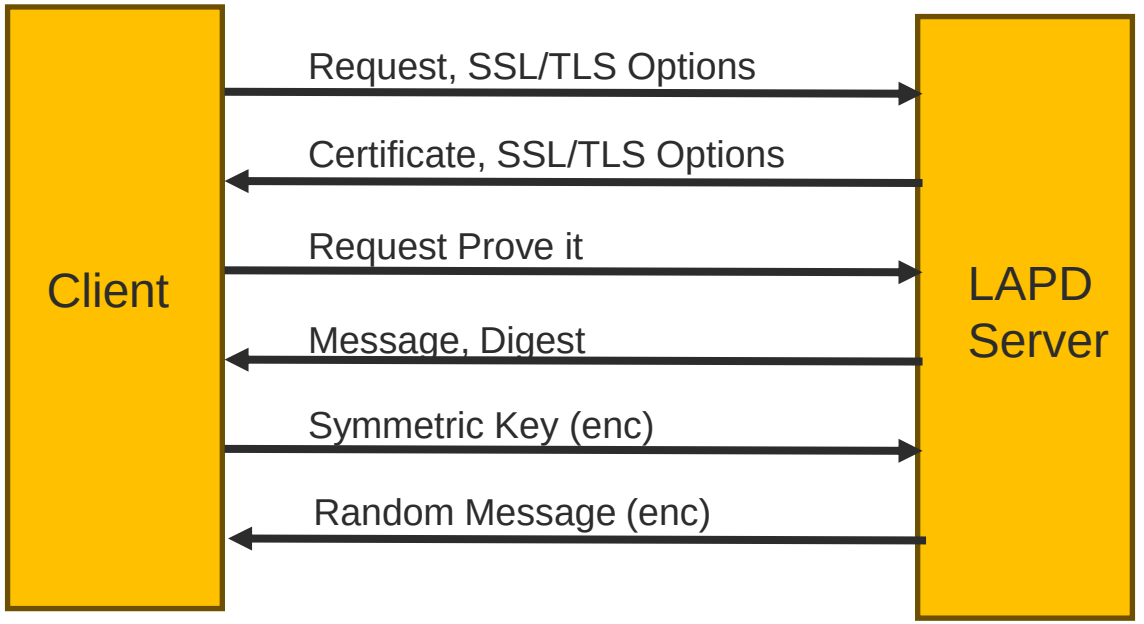
Client ends the session (UNBIND)

Client can ABANDON the session

LDAP Security

- **LDAP using Simple Authentication and Security Layer (SASL)With SSL/TLS**





LDAP Operations

- **Three types of LDAP Operations are Authentication, Query and Update**

Search

Search Directory for matching directory entries

Compare

Compare directory entry to a set of attributes

Add

Add a new directory entry

Modify

Updates a particular directory

Delete

Removes a specific directory entry

Rename

Renames or modify the DN

Bind

Start a session with an LDAP Server

Unbind

Ends a session with LDAP server

Abandon

Ends a session with LDAP server

Extended

Extended Operations

LDAP Common Commands

- **ldapbind**
  - Used to authenticate to a directory server.
  - Also used to find out if the server is running.
  - **Usage**

    ldapbind [options]

  - **Scenario**

To authenticates user arifhrashid to the directory server ldap.vusna.com located at port 389, using the password mypassword.

```
ldapbind -h ldap.vusna.com -p 389 -D "cn=arifhrashid" -w mypassword
```

LDAP Common Commands

➢ ldapsearch

Used to search for specific entries in a directory. It opens a connection to a directory, authenticates the user performing the operation, searches for the specified entry, and prints the result in a format that the user specifies.

- **Usage**

  ldapsearch [options] filter [attributes]

- **Scenario**

  Searche the directory server ldap.vusna.com, located at port 389. The scope of the search (-s) is base, and the part of the directory searched is the base DN (-b) designated. The search filter "objectclass=*" means that values for all of the entry's object classes are returned. No attributes are returned because they have not been requested. Assume anonymous authentication.

```
ldapsearch -h ldap.vusna.com -p 389 -s base -b "ou=people,dc=vu,dc=com“  "objectclass=*"
```

LDAP Common Commands

- **ldapadd**

  Used to add entries to the directory. It opens a connection to the directory and authenticates the user. Then it opens the LDIF file supplied as an argument and adds, in succession, each entry in the file.

  - **Usage**

    ldapadd [options] [-f LDIF-filename]

  - **Scenario**

    A user arifhrashid authenticates to the directory ldap.vusna.com, located at port 389. Open the file arifhrashid.ldif and adds its contents to the directory. For example, add the entry uid=arifhrashid,cn=exams,cn=vu,dc=com and its object classes and attributes.

```
ldapadd -h ldap.vusna.com -p 389 -D "cn=arifhrashid" -w mypassword -f arifhrashid.ldif
```

LDAP Common Commands

- **ldapdelete**

  Used to remove leaf entries from a directory. It opens a connection to a directory server and authenticates the user. Then it deletes specified entries.

  - **Usage**

    ldapdelete [options] "entry DN"

  - **Scenario**

    Authenticates user arifhrashid to the directory ldap.vusna.com, using the password mypassword. Then deletes the entry uid=arifhrashid,ou=academics,ou=people,dc=vu,dc=com.

```
ldapdelete -h ldap.vusna.com -p 389 -D "cn=arifhrashid" -w mypassword \
"uid=arifhrashid,ou=academics,ou=people,dc=vu,dc=com"
```

LDAP Common Commands

- **ldapmodify**
  - Used to modify existing entries. It opens a connection to the directory and authenticates the user. Then it opens the LDIF file supplied as an argument and modifies the LDAP entries specified by the file.
  - It uses a modified form of an LDIF file. Within the file itself, you use the attribute changetype to specify the type of change.
  - Four types of changes are possible:
    - add--adds a new entry
    - modify--changes an existing entry, that is, it adds, deletes, or replaces attributes of the entry
    - delete--deletes an existing entry
    - modrdn--modifies the RDN of an existing entry
  - **Usage**

    ldapmodify [options] [-f LDIF-filename]
  - **Scenario**

    A user arifhrashid authenticates to the directory ldpa.vusna.com, located at port 389and open the file arifhrashid.ldif and modifies the directory entries specified by the file. The file might, for example, change the telephone number attribute of entry uid= arifhrashid,cn=exams,cn=vu,dc=com.

```
ldapmodify -h ldpa.vusna.com -p 389 -D "cn=arifhrashid" -w mypassword -f arifhrashid.ldif
```

ldapmoddn

- It is used to:
  - change the RDN of an entry
  - move an entry or subtree to another location in the directory

- **Usage**

  ldapmoddn [options] -b "current DN" -R "new RDN" -N "new Parent"

- **Scenario**

  To authenticates user arifhrashid to the directory ldap.vusna.com, using the password mypassword. Then assign to the entry uid= arifhrashid,ou=exams,ou=people,dc=vu,dc=com a new parent entry, ou=academics,ou=people,dc=vu,dc=com.

```
ldapmoddn -h ldap.vusna.com -p 389 -D "cn= arifhrashid " -w mypassword \
-b " uid= arifhrashid,ou=exams,ou=people,dc=vu,dc=com " \
-N " ou=academics,ou=people,dc=vu,dc=com"
```

LDAP Security

- **Current LDAP version supports**
  - Clear text passwords
  - KERBEROS version 4 authentication

- **Other authentication methods possible**

- **SASL support added in version 3**
  - Simple Authentication and Security Layer (SASL) is a framework for authentication and data security in Internet protocols.

  - It decouples authentication mechanisms from application protocols, in theory allowing any authentication mechanism supported by SASL to be used in any application protocol that uses SASL.
  - Kerberos deemed stronger than SASL…

LDAP Security

- **Security based on the BIND model**
- **Clear text -> ver 1**
- **Kerberos -> ver 1,2,3 (depr)**
- **SASL -> ver 3**
  - Simple Authentication and Security Layer
  - uses one of many authentication methods
- **Proposal for Transport Layer Security**
  - Based on SSL v3 from Netscape

LDAP Security

- **No Authentication**

- **Basic Authentication**
  - DN and password provided
  - Clear-text or Base 64 encoded

- **SASL (RFC 2222)**
  - Parameters: DN, mechanism, credentials
  - Provides cross protocol authentication calls
  - Encryption can be optionally negotiated
  - ldap_sasl_bind() (ver3 call)
  - Ldap://<ldap_server>/?supportedsaslmechanisms

LDAP Implementations

- **C Library API**
  - LDAPv2 - RFC 1823 ‘The LDAP API’
  - LDAPv3 – In Internet Draft stage

- **Java JNDI**

- **LDAP v3 uses the UTF-8 encoding of the Unicode character set.**

- **HTTP to LDAP gateway**

- **LDAP to X.500 gateway – ldapd**

Version 2 v/s Version 3

- **Referrals**
  - A server that does not store the requested data can refer the client to another server.
- **Security**
  - Extensible authentication using Simple Authentication and Security Layer (SASL)
- **Internationalization**
  - UTF-8 support for international characters.
- **Extensibility**
  - New object types and operations can be dynamically defined and schema published in a standard manner.

Common Uses Cases of LDAP

- Centralized User Management
- Centralized Authentication Servers
- Identity and Access Management (IAM) Solution

Installation and Configuration

- **Step 1: Set hostname for the Ubuntu server**
- **Step 2: Install OpenLDAP Server**

```
sudo apt update
sudo apt -y install slapd ldap-utils
```

Verify installation with command slapcat to output SLAPD database contents.

- **Step 3: Add base dn for Users and Groups**
  - Add a base DN for users and groups. Create a file named basedn.ldif and the file by running the command ldapadd
- **Step 4: Add User Accounts and Groups**
  - Generate a password for the user account to add.
  - Create ldif file for adding users.
  - When done with edit, add account by running ldapadd command.
  - Create ldif file for groups and add groups with command ldapadd

Install LDAP Account Manager

➢ **Step 5: Install LDAP Account Manager**

- Install Apache Web server & PHP

```
sudo apt -y install apache2 php php-cgi libapache2-mod-php php-mbstring php-common php-pear
```

- Then enable php-cgi PHP extension.

```
sudo a2enconf php*-cgi
sudo systemctl reload apache2
```

- Step 3: Install LDAP Account Manager

```
sudo apt -y install ldap-account-manager
```

```
sudo vim /etc/apache2/conf-enabled/ldap-account-manager.conf
```

- comment the line Require all granted and add subnet(s) allowed to access LDAP Account Manager administration interface.

IT601 – System and Network Administration

DNS Service

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DNS Service

- **Domain Name Service (DNS) is an Internet service that maps IP addresses and fully qualified domain names (FQDN) to one another.**
- **DNS service alleviates the need to remember IP addresses. Computers that run DNS are called name servers.**
- **Ubuntu is shipped with BIND (Berkley Internet Naming Daemon), the most common program used for maintaining a name server on Linux.**
- **Fully Qualified Domain Name (FQDN)**

DNS Terminology and Components

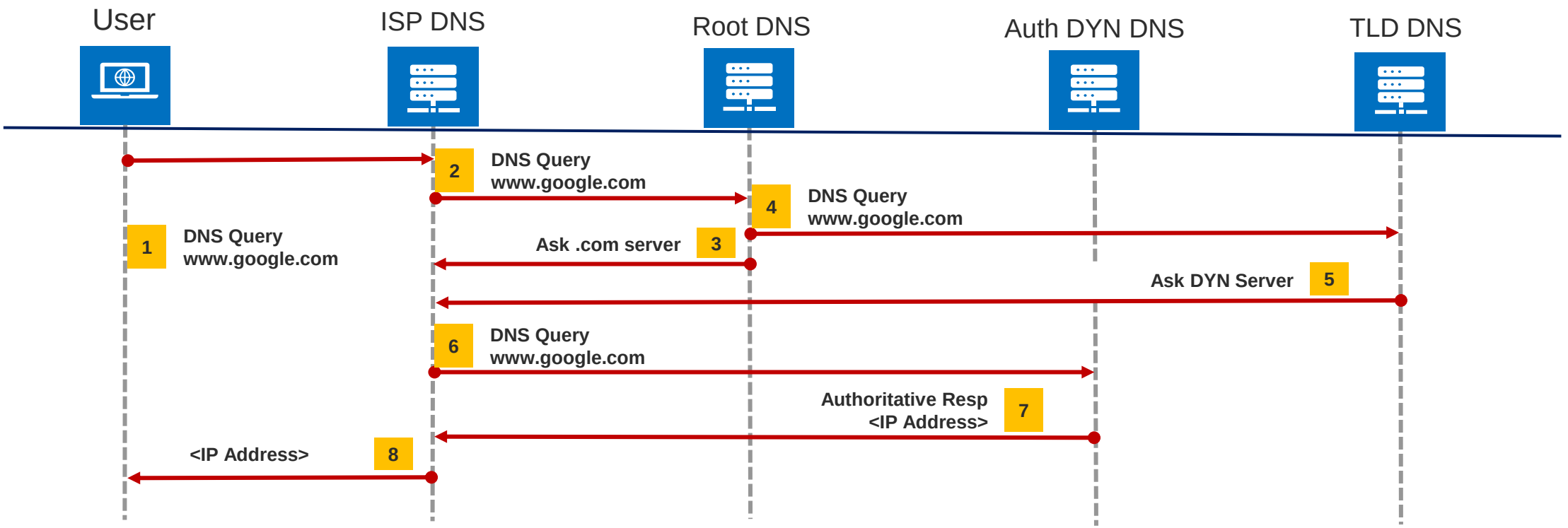
- **DNS Terminology**
  - Domain Name System
  - Domain Name
  - IP Address
  - Top-Level Domain
  - Hosts
  - Subdomain
  - Fully Qualified Domain Name
  - Name Server
  - Zone File
  - Records

DNS Components

- Root Servers
- TLD Servers
- Domain-Level Name Servers
- Resolving Name Server
- Zone Files

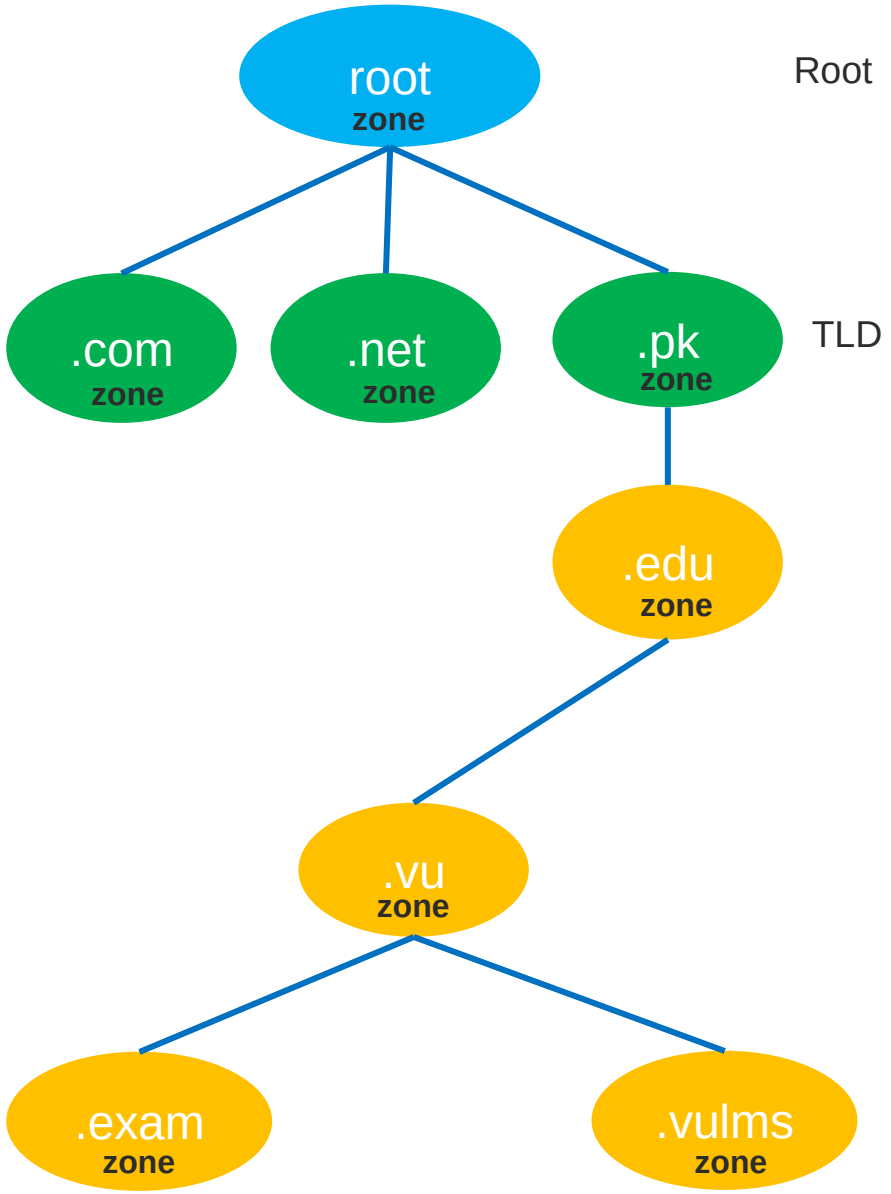
DNS Resolution

- DNS resolution is completed in several steps.



DNS ZONE

- The DNS is broken up into many different zones. These zones differentiate between distinctly managed areas in the DNS namespace.
- A DNS zone is a portion of the DNS namespace that is managed by a specific organization or administrator. A DNS zone is an administrative space which allows for more granular control of DNS components, such as authoritative nameservers.
- The domain name space is a hierarchical tree, with the DNS root domain at the top. A DNS zone starts at a domain within the tree and can also extend down into subdomains so that multiple subdomains can be managed by one entity.
- Don't associate a DNS zone with a domain name or a single DNS server. In fact, a DNS zone can contain multiple subdomains and multiple zones can exist on the same server. DNS zones are not necessarily physically separated from one another, zones are strictly used for delegating control.
- All of the information for a zone is stored in what's called a DNS zone file, which is the key to understanding how a DNS zone operates



DNS Record Types

1 SOA

- Admin Email
- Last Update
- Refresh Rate

2 A and AAAA

- A is an address record.
- Shows the IP address of hostname or domain
- AAAA record, just like A record, point to the IPv6 address for a domain

3 CNAME

- CNAME or "canonical name“ is a record that points a domain name (an alias) to another domain.
- The subdomain ng.example.com can point to example.com using CNAME. Here example.com points to the actual IP address using an A record.

4 MX

- A mail exchange (MX) record, is a DNS record type that shows where emails for a domain should be routed to.
- An MX record makes it possible to direct emails to a mail server.

5 NS

- A nameserver (NS) record specifies the authoritative DNS server for a domain.
- The NS record helps point to where internet applications like a web browser can find the IP address for a domain name.

6 PTR

- A pointer (PTR) record provides a domain name for reverse lookup.
- It's the opposite of an A record as it provides the domain name linked to an IP address instead of the IP address for a domain.

7 CAA

- The CAA record is a type of DNS record used to provide additional confirmation for the Certification Authority (CA) when validating an SSL certificate.

8 TXT

- TXT stands for "text," and this record type lets the owner of a domain store text values in the DNS.
- Several services use this record to verify ownership of a domain

9 SRV

- Using this DNS record type, it's possible to store the IP address and port for specific services

10 CERT

- This record type stores public keys certificates.

11 DCHID

- This DNS record type stores information related to dynamic host configuration protocol (DHCP).

12 DNAME

- DNAME is "delegation name.“
- It works very similarly to CNAME.
- It points all the subdomains for the alias to the canonical domain name.

SOA Records

- **The Start of Authority (SOA) record is a mandatory record in all zone files.**
- **It must be the first real record in a file (although $ORIGIN or $TTL specifications may appear above).**
- **It is also one of the most complex to understand.**
- **Example**

```
domain.com.    IN      SOA     ns1.domain.com.      admin.domain.com. (
                       12083   ; serial number
                       3h      ; refresh interval
                       30m     ; retry interval
                       3w      ; expiry period
                       1h      ; negative TTL
                       )
```

A and AAAA Records

- **Both of these records map a host to an IP address.**
- **The "A" record is used to map a host to an IPv4 IP address, while "AAAA" records are used to map a host to an IPv6 address.**
- **The general format of these records is this:**

host	IN	A	IPv4_address
host	IN	AAAA	IPv6_address
ns1	IN	A	111.222.111.222

ns1.domain.com.	IN	A	111.222.111.222
www	IN	A	222.222.222.222
domain.com.	IN	A	222.222.222.222
@	IN	A	222.222.222.222
*	IN	A	222.222.222.222

CNAME Records

- **CNAME records define an alias for canonical name for your server (one defined by an A or AAAA record).**
- **For instance, we could have an A name record defining the “server1” host and then use the “www” as an alias for this host:**

```
server1    IN  A      111.111.111.111
www        IN  CNAME  server1
```

- **Be aware that these aliases come with some performance losses because they require an additional query to the server.**
- **Most of the time, the same result could be achieved by using additional A or AAAA records.**
- **One case when a CNAME is recommended is to provide an alias for a resource outside of the current zone.**

MX Records

- **MX records are used to define the mail exchanges that are used for the domain. This helps email messages arrive at your mail server correctly.**
- **Unlike many other record types, mail records generally don't map a host to something, because they apply to the entire zone. As such, they usually look like this:**

```
IN  MX  10   mail.domain.com.
```

- **Example**

The MX record should generally point to a host defined by an A or AAAA record, and not one defined by a CNAME. So, let's say that we have two mail servers. There would have to be records that look something like this:

```
IN      MX    10    mail1.domain.com.
IN      MX    50    mail2.domain.com.
mail1   IN    A     111.111.111.111
mail2   IN    A     222.222.222.222
```

```
IN      MX    10      mail1
IN      MX    50      mail2
mail1   IN    A       111.111.111.111
mail2   IN    A       222.222.222.222
```

NS Records

- **NS record type defines the name servers that are used for this zone.**

  Question : if the zone file resides on the name server, why does it need to reference itself?". Part of what makes DNS so successful is its multiple levels of caching.

  - One reason for defining name servers within the zone file is that the zone file may be actually being served from a cached copy on another name server.

- **Like the MX records, these are zone-wide parameters, so they do not take hosts either. In general, they look like this:**

```
IN  NS    ns1.domain.com.
IN  NS    ns2.domain.com.
```

- You should have at least two name servers defined in each zone file in order to operate correctly if there is a problem with one server.
- Most DNS server software considers a zone file to be invalid if there is only a single name server.
- As always, include the mapping for the hosts with A or AAAA records:

```
IN  NS    ns1.domain.com.
IN  NS    ns2.domain.com.
ns1    IN  A    111.222.111.111
ns2    IN  A    123.211.111.233
```

- **There are quite a few other record types you can use, but these are probably the most common types that you will come across.**

PTR Records

- **The PTR records are used define a name associated with an IP address.**
- **PTR records are the inverse of an A or AAAA record.**
- **PTR records are unique in that they begin at the .arpa root and are delegated to the owners of the IP addresses.**
- **The Regional Internet Registries (RIRs) manage the IP address delegation to organization and service providers.**
- **The Regional Internet Registries include APNIC, ARIN, RIPE NCC, LACNIC, and AFRINIC.**
- **Example of a PTR record for 111.222.333.444 would look like:**

  - 444.333.222.111.in-addr.arpa. 33692 IN PTR host.example.com.

- **Example of a PTR record for an IPv6 address shows the nibble format of the reverse of Google's IPv6 DNS Server 2001:4860:4860::8888.**

8.8.8.8.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.6.8.4.0.6.8.4.1.0.0.2.ip6.arpa. 86400IN PTR google-public-dns-a.google.com.

PTR Records

- **The command line tool dig with the -x flag can be used to look up the reverse DNS name of an IP address.**

- **An example of a dig command. The +short is appended to reduce the output to the reverse DNS name.**

  dig -x 8.8.4.4 +short

  - The output for the dig command above will be the domain name in the PTR record for the IP address: google-public-dns-b.google.com.

- **Servers on the Internet use PTR records to place domain names within log entries, make informed spam handling decisions, and display easy-to-read details about other devices.**

- **Most commonly-used email servers will look up the PTR record of an IP address it receives email from.**

- **If the source IP address does not have a PTR record associated with it, the emails being sent may be treated as spam and rejected.**

- **It is not important that the FQDN in the PTR matches the domain name of the email being sent. What is important is that there is a valid PTR record with a corresponding and matching forward A record.**

CAA Records

- **CAA records are used to specify which Certificate Authorities (CAs) are allowed to issue SSL/TLS certificates for your domain.**
  - As of September 8, 2017 all CAs are required to check for these records before issuing a certificate. If no record is present, any CA may issue a certificate.
  - Otherwise, only the specified CAs may issue certificates. CAA records can be applied to single hosts, or entire domains.
- **An example CAA record**

```
example.com.        IN        CAA        0 issue "letsencrypt.org"
```

  - The host, IN, and record type (CAA) are common DNS fields. The CAA-specific information above is the 0 issue "letsencrypt.org" portion. It is made up of three parts: flags (0), tags (issue), and values ("letsencrypt.org").
  - Flags are an integer which indicates how a CA should handle tags it doesn't understand. If the flag is 0, the record will be ignored. If 1, the CA must refuse to issue the certificate.
  - Tags are strings that denote the purpose of a CAA record. Currently they can be issue to authorize a CA to create certificates for a specific hostname, issuewild to authorize wildcard certificates, or iodef to define a URL where CAs can report policy violations.
  - Values are a string associated with the record's tag. For issue and issuewild this will typically be the domain of the CA you're granting the permission to. For iodef this may be the URL of a contact form, or a mailto: link for email feedback.
- **You may use dig to fetch CAA records using the following options:**

```
dig example.com type257
```

Addressing

1-6 ADDRESSING

- Four levels of addresses are used in an internet employing the TCP/IP protocols:

Physical

- Used on Physical and Data link Layer
- Examples are MAC Address…

Logical

- Used on Network Layer
- Examples are IP and IPX addresses

Port

- Used on Transport Layer
- Examples are TCP/UDP Addresses

Specific

- Used on Application Layer
- Examples are Socket Addresses etc.

Physical Address

associated

- Physical addresses are imprinted on the NIC. Most local-area networks (Ethernet) use a 48-bit (6-byte) physical address written as 12 hexadecimal digits; every byte (2 hexadecimal digits) is separated by a colon.

Example:

07:01:02:01:2C:4B

A 6-byte (12 hexadecimal digits) physical address.

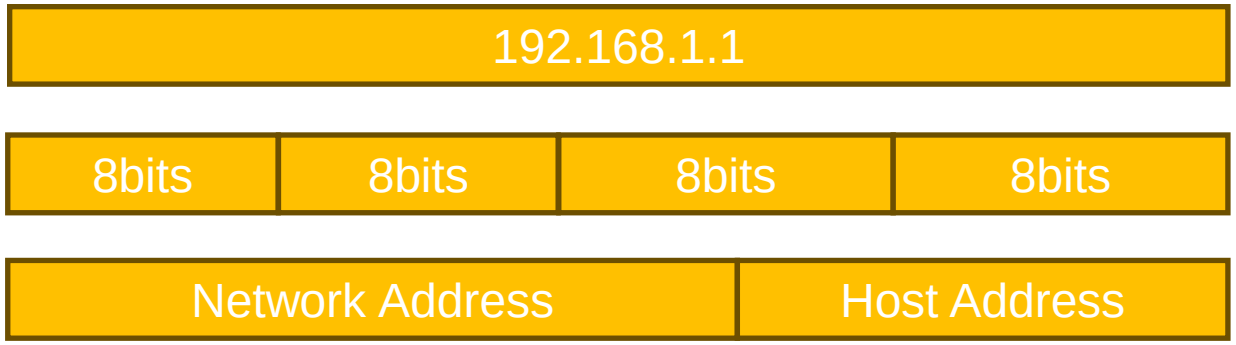
- known also as the MAC address
- Is the address of a node as defined by its LAN or WAN
- It is included in the frame used by data link layer

- The physical addresses in the datagram may change from hop to hop.

Logical Address

- IP addresses are necessary for universal communications that are independent of physical network.
- No two host address on the internet can have the same IP address
- IP addresses in the Internet are 32-bit address that uniquely define a host.
- The physical addresses will change from hop to hop, but the logical addresses usually remain the same.
- IPv4 Addresses

- Dotted decimal notation



IP Addressing

- Network Mask is used to identify the network and host addresses

11000000	10101000	00000001	00000001	11111111	11111111	11111111	00000000
192	168	1	1	255	255	255	0

192.168.1.1/24

192.168.1.1 mask 255.255.255.0

Classes of Network Addresses

Class	1st octet	Network Mask
Class A Network	0 - 127	/8
Class B Network	128 - 191	/16
Class C Network	192 - 223	/24
Class D Network	224 - 239	-
Class E Network	240 - 255	-

Special IP address	0.0.0.0/8	addresses used to communicate with the local network
	127.0.0.0/8	Loopback Addresses
	169.254.0.0/16	Link-local Addresses

Public and Private Addresses

Private IP Address

- Used with LAN
- Not Recognized over internet
- Assigned by Sas
- No Cost

- Class A : 10.0.0.0 to 10.255.255.255
- Class B : 172.16.0.0 to 172.31.255.255
- Class C : 192.168.0.0 to 192.168.255.255

Public IP Address

- Used in Public Network
- Recognized on Internet
- Assigned by IANA
- Unique Globally
- Not Free

- Class A: 1.0.0.0 To 9.255.55.255
  - 11.0.0.0 To 126.255.255.255
- Class B : 128.0.0.0 To 172.15.255.255
  - 172.32.0.0 To 191.255.255.255
- Class C : 192.0.0.0 To 192.167.255.255
  - 192.169.0.0 To 223.255.255.255

Unicast Vs Multicast Addresses

- A unicast address represents a single device in the network.
- A multicast address represents a group of devices in the network.
- A broadcast address represents all devices in the network.

IP multicast address range	Description	Routable
224.0.0.0 to 224.0.0.255	Local subnetwork	No
224.0.1.0 to 224.0.1.255	Internetwork control	Yes
224.0.2.0 to 224.0.255.255	AD-HOC block 1	Yes
224.1.0.0 to 224.1.255.255	Reserved	
224.3.0.0 to 224.4.255.255	AD-HOC block 2	Yes
225.0.0.0 to 231.255.255.255	Reserved	
232.0.0.0 to 232.255.255.255	Source-specific multicast	Yes
233.0.0.0 to 233.251.255.255	GLOP addressing	Yes
233.252.0.0 to 233.255.255.255	AD-HOC block 3	Yes
234.0.0.0 to 234.255.255.255	Unicast-prefix-based	Yes
235.0.0.0 to 238.255.255.255	Reserved	
239.0.0.0 to 239.255.255.255	Administratively scoped	Yes

Fixed and Variable Length Subnet Masking

- **In subnetting, a large network is logically or physically divided into multiple small networks or "subnets."**
  - subnetting a large network is to address network congestion and its negative impact on speed and productivity.
  - Subnetting also improves efficiency due to the way an address space is utilized in a small network.
  - The divisions between subnets allow organizations to enforce access controls, which improves network security, and helps contain security incidents.

- **Fixed vs. Variable Length Masking**
  - For subnetting an IP address for a network, one of two approaches can be used: VLSM or Fixed Length Subnet Mask (FLSM). These methods differ in three keyways:
    - FLSM creates subnets of the same size and an equal number of host identifiers, while VLSM creates subnets with varying sizes with a variable number of hosts.
    - FLSM is a better choice for private IP addresses, while VLSM is more suitable for public IP addresses.
    - FLSM tends to use more IP addresses than are necessary, which leads to wastage. In VLSM, wastage is minimum because it uses a given IP address range more efficiently.

IPv6 Addresses

- **128 bits (or 16 bytes) long: four times as long as its predecessor.**
- **2^128 : about 340 billion billion billion billion different addresses**
- **Colon hexadecimal notation:**
  - addresses are written using 32 hexadecimal digits.
  - digits are arranged into 8 groups of four to improve the readability.
  - Groups are separated by colons

    2001:0718:1c01:0016:020d:56ff:fe77:52a3

- **IPv6 Zero Suppression**
  - To simplify the representation of IPv6 addresses, a contiguous sequence of 16-bit blocks set to 0 in the colon hexadecimal format can be compressed to "::", known as double-colon.
    - link-local address : FE80:0:0:0:2AA:FF:FE9A:4CA2 -> FE80::2AA:FF:FE9A:4CA2.
    - multicast address : FF02:0:0:0:0:0:0:2 -> FF02::2
    - loopback address : 0:0:0:0:0:0:0:1 -> ::1
  - Zero compression can only be used once in a given address.

IPv6 Prefixes

- **The prefix is the part of the address that indicates the bits that have fixed values or are the bits of the subnet prefix.**

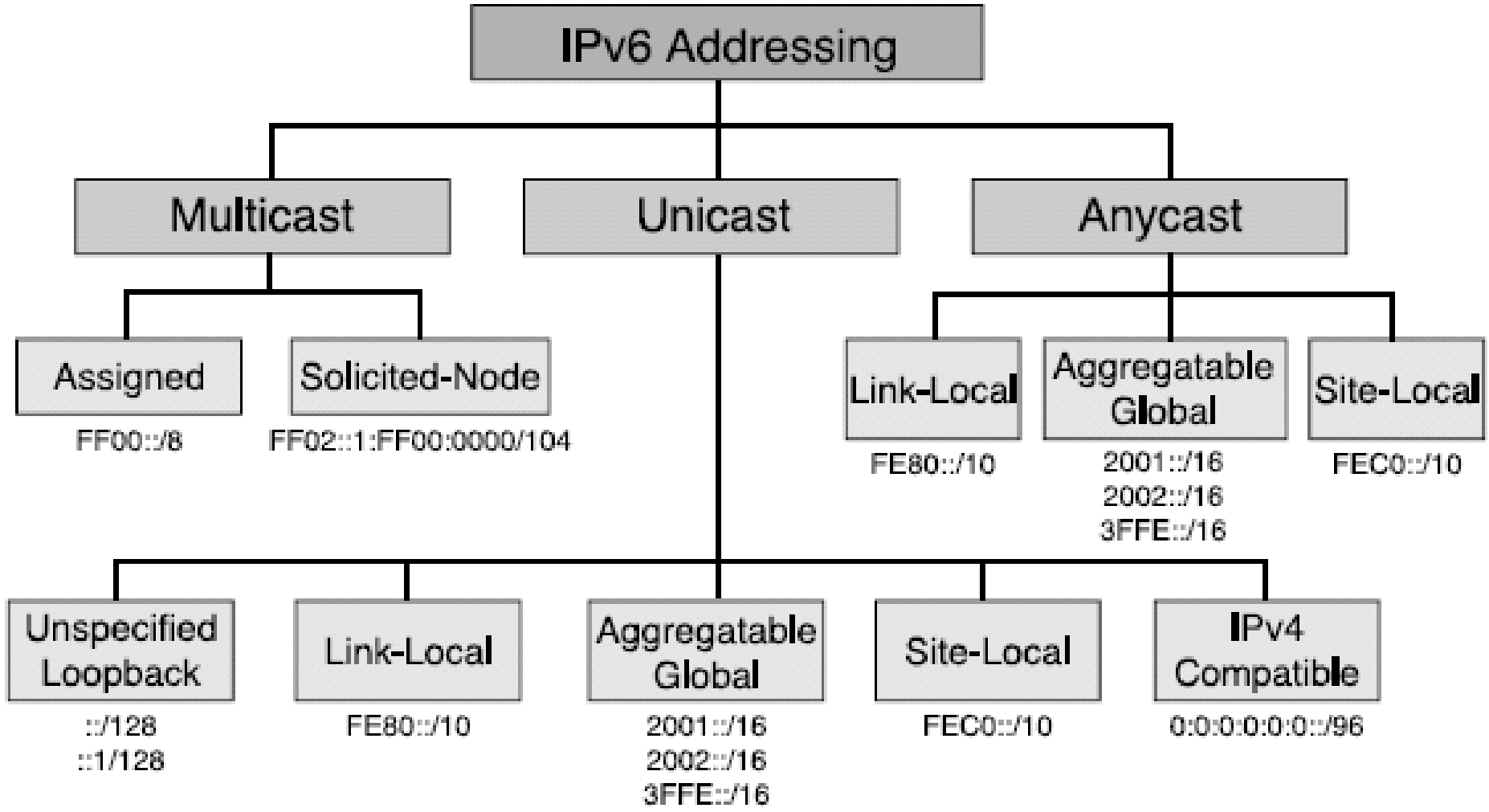
- **An IPv6 prefix is written in address/prefix-length notation.**
  - For example, 21DA:D3::/48 and 21DA:D3:0:2F3B::/64 are IPv6 address prefixes.

- **IPv6 Address Categories**

  - IPv6 have three types of addresses

    - Unicast : Transmission from source to single host
    - Multicast : Transmission from source to group (of hosts) address
    - Anycast : Transmission from source to single address of host where host has multiple ipv6 addresses

IPv6 Address Types



Port addresses

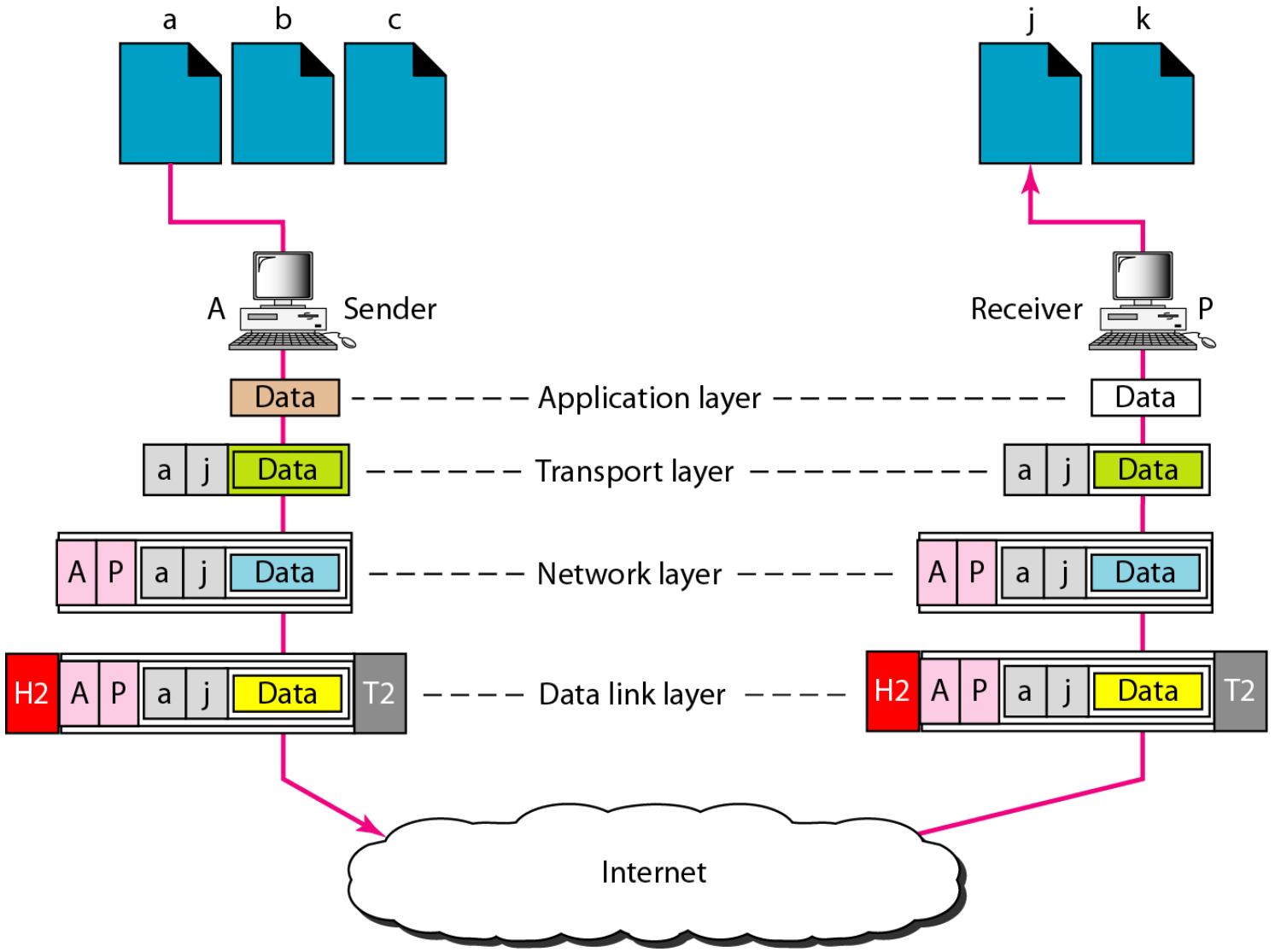
Port address is a 16-bit address represented by one decimal number ranged from (0-65535) to choose a process among multiple processes on the destination host.

- Destination port number is needed for delivery.
- Source port number is needed for receiving a reply as an acknowledgments.

In TCP/IP , a 16-bit port address represented as one single number. Example: 753

The physical addresses change from hop to hop, but the logical and port addresses usually remain the same.

Port addresses



IT601 – System and Network Administration

Networks

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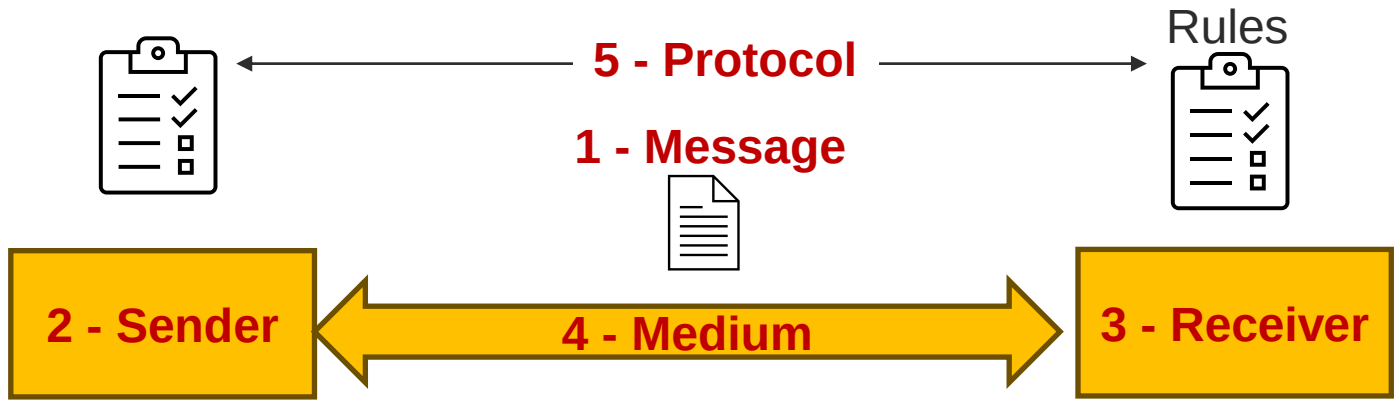
Data communications

- Data communications are used to exchange data between two devices via some form of transmission medium such as a wire cable or wireless.

1. Delivery → Correct destination
2. Accuracy → Accurate data
3. Timelines → Real-time transmission
4. Jitter → Uneven delay

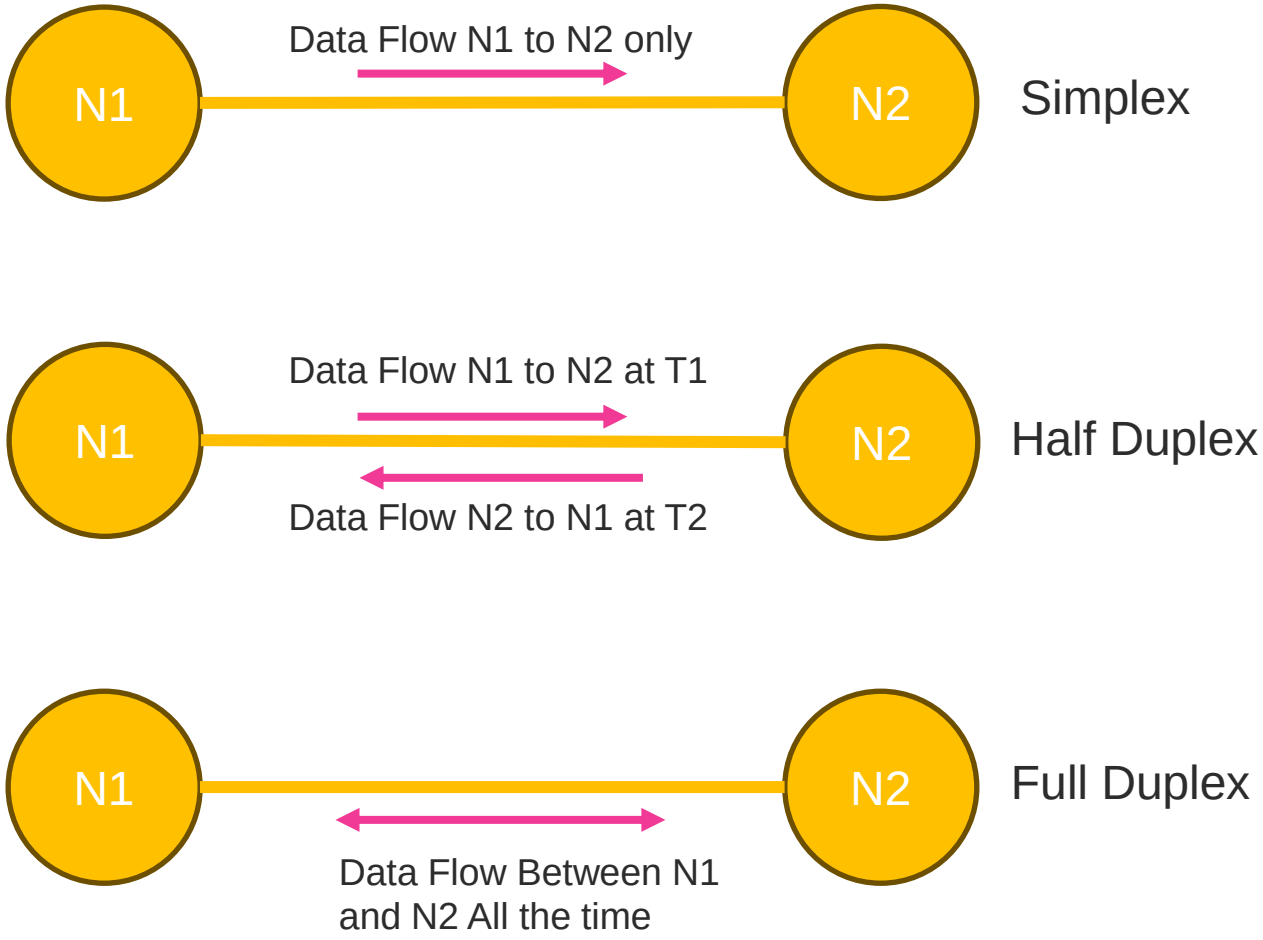
Five components of data communication

- Message
- Sender
- Receiver
- Medium
- Protocol



Data types and flows

- **Data Types**
  - Text
  - Numbers
  - Images
  - Audio
  - Video
- **Data flow**
  - Simplex
  - Half-duplex
  - Full-duplex

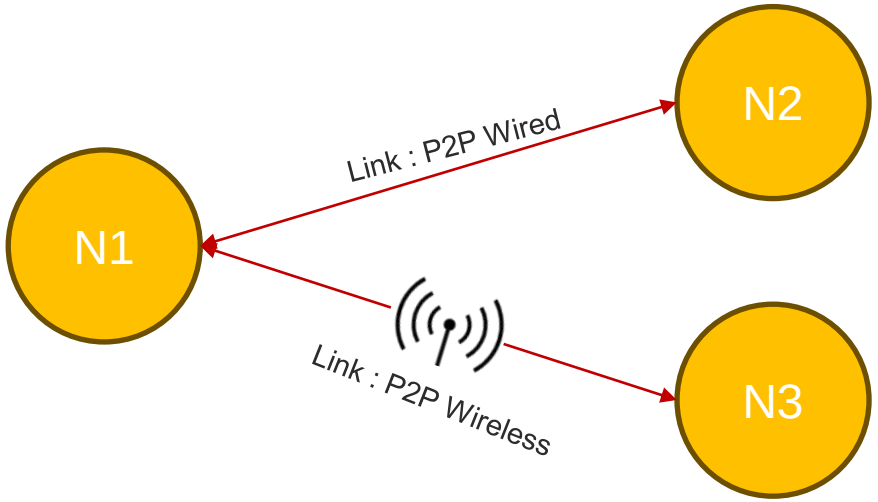


1-2 NETWORKS

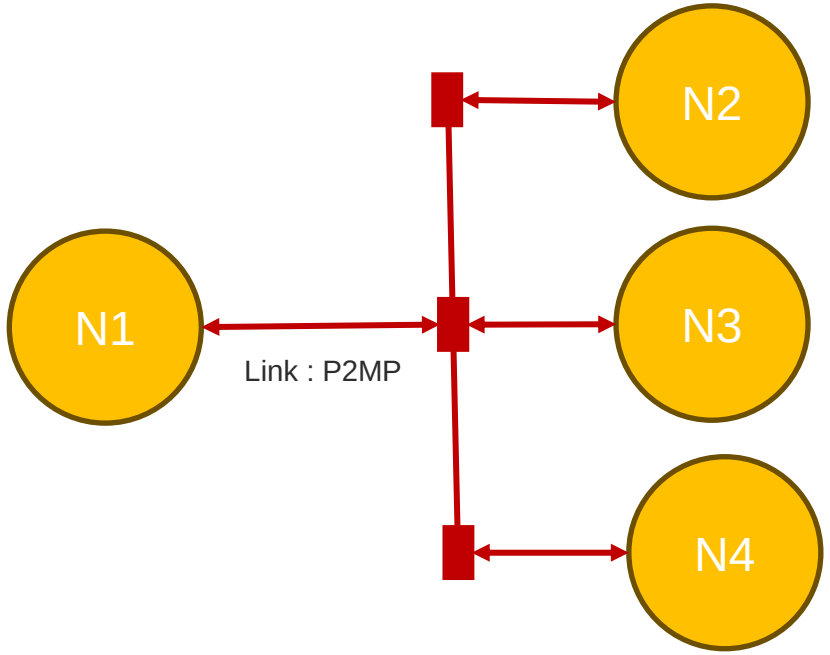
- A network is a set of devices (nodes) connected by communication links.
  - A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network.

Types of connections

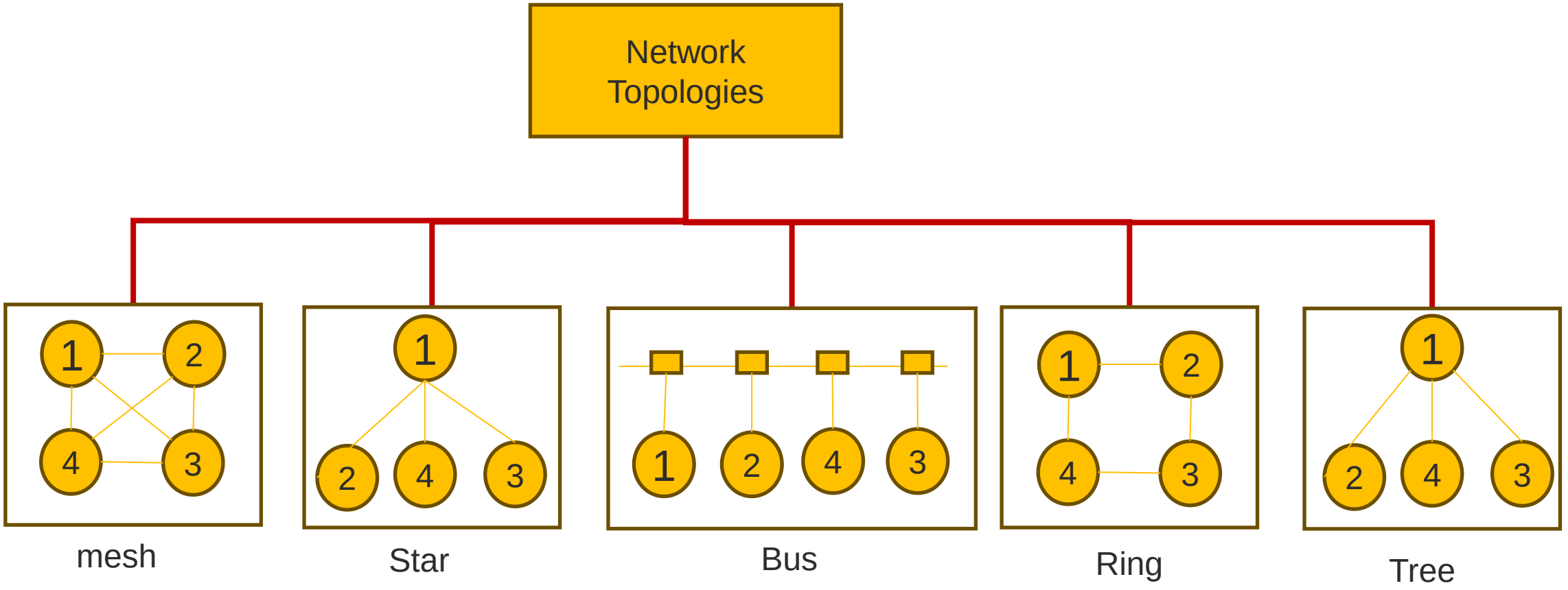
- Point to point
  - A dedicated link is provided between two devices



- Multipoint
  - More than two specific devices share a single link



Physical Topologies

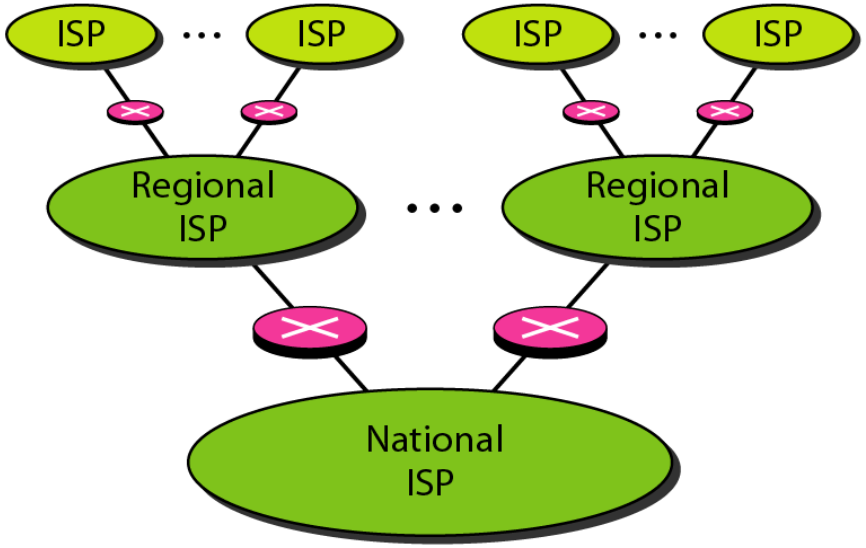


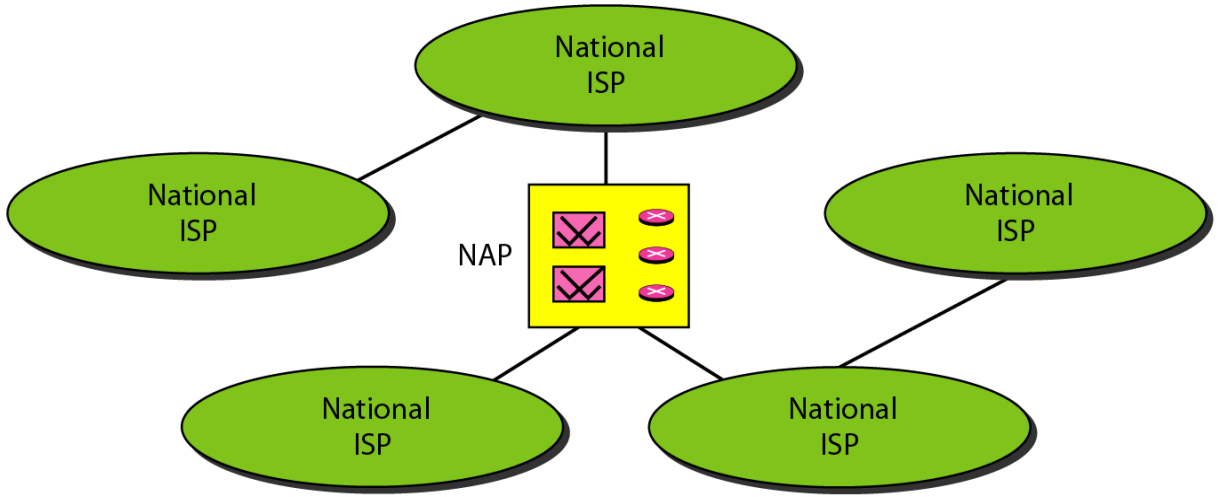
Categories of Networks

- Local Area Network (LAN)
- Wireless Local Area Network (WLAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)
- Virtual Private Networks
  - L3 VPN
  - L2 VPN

1-3 THE INTERNET

- The Internet has changed many aspects of our daily lives.
- It has affected the way we do business as well as the way we spend our leisure time.
- The Internet is a communication system that has brought a wealth of information to our fingertips and organized it for our use.





1-4 PROTOCOLS AND STANDARDS

- Protocol is synonymous with rule. Standards are agreed-upon rules.

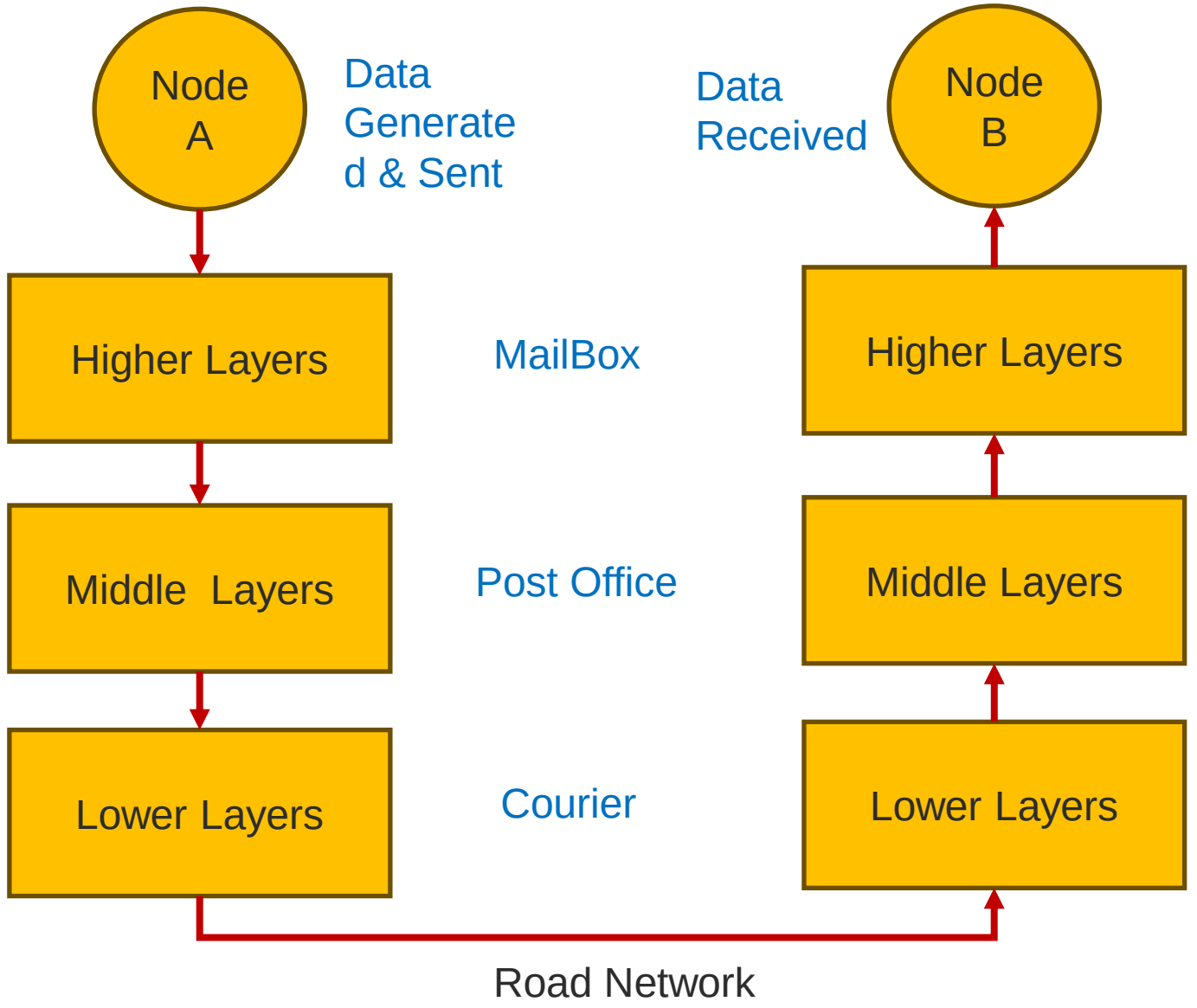
  - Protocols
    - Syntax → format of the data
    - Semantics → meaning of each section
    - Timing → when data should be sent and how fast.
  - Standards
    - De facto → by fact (not approved as a standard)
    - De jure → by Law (approved)
  - Standards Organizations
    - International Organization for Standardization (ISO)
    - International Telecommunication Union - Telecommunication Standards (ITU-T)
    - American National Standards Institute (ANSI)
    - Institute of Electrical and Electronics Engineers (IEEE)
    - Electronic Industries Association (EIA)

LAYERED TASKS

- A network model is a layered architecture
  - Task broken into subtasks
  - Implemented separately in layers in stack
  - Functions need in both systems
  - Peer layers communicate

peer to peer communication

- Protocol:
  - A set of rules that governs data communication
  - It represents an agreement between the communicating devices



LAYERED TASKS

- A network model is a layered architecture
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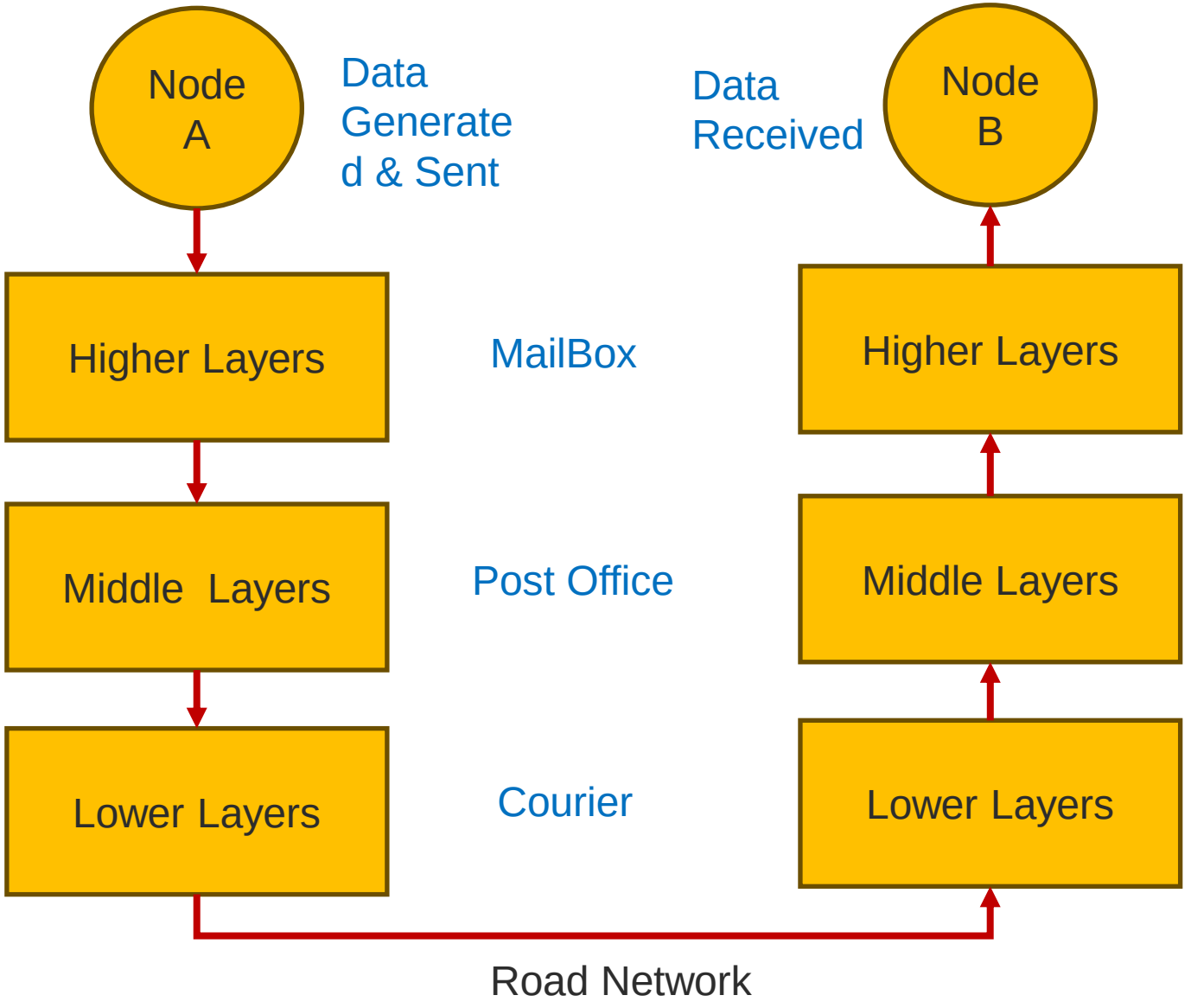

IT601 – System and Network Administration

OSI Model

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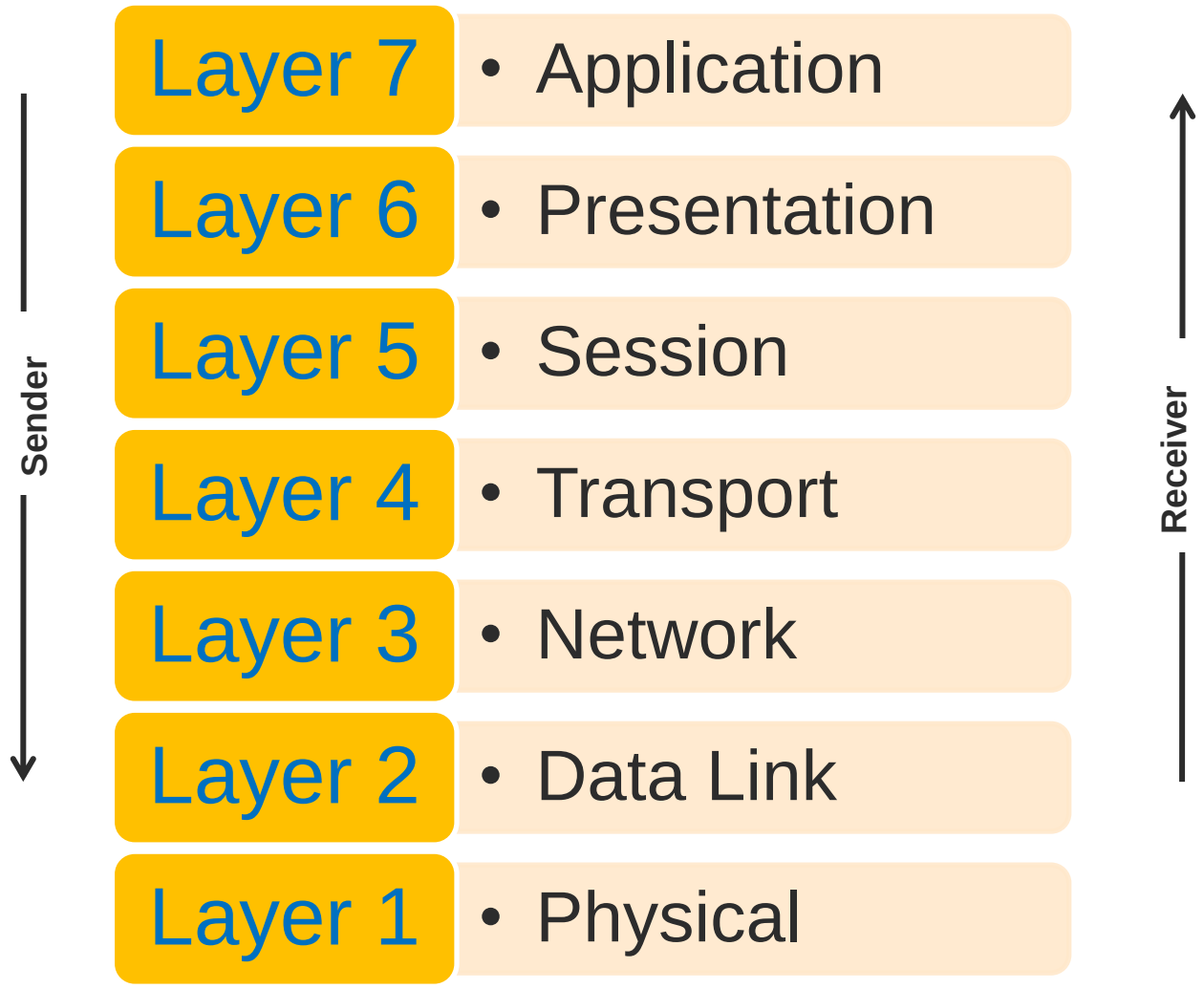
THE OSI MODEL

- Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards.

- An ISO is the Open Systems Interconnection (OSI) model is the standard that covers all aspects of network communications from ISO. It was first introduced in the late 1970s.

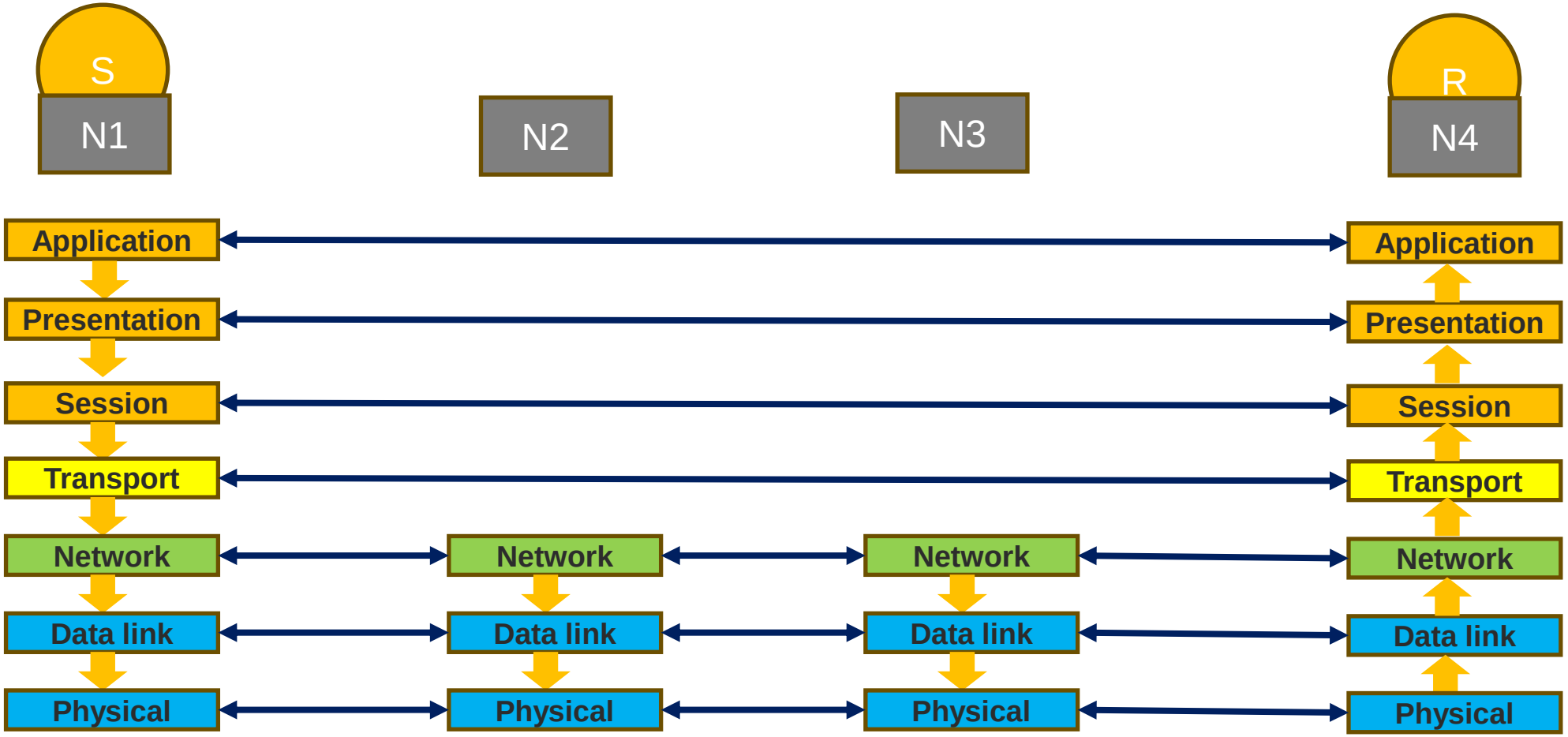
- Layered Architecture
  - A layered model
  - Each layer performs a subset of the required communication functions
  - Each layer relies on the next lower layer to perform more primitive functions
  - Each layer provides services to the next higher layer
  - Changes in one layer should not require changes in other layers
  - The processes on each machine at a given layer are called peer-to-peer process



PEER – TO – PEER PROCESS

- Communication must move downward through the layers on the sending device, over the communication channel, and upward to the receiving device
- Each layer in the sending device adds its own information to the message it receives from the layer just above it and passes the whole package to the layer just below it
- At the receiving device, the message is unwrapped layer by layer, with each process receiving and removing the data meant for it
- The passing of the data and network information down through the layers of the sending device and backup through the layers of the receiving device is made possible by *interface* between each pair of adjacent layers
- Interface defines what information and services a layer must provide for the layer above it.

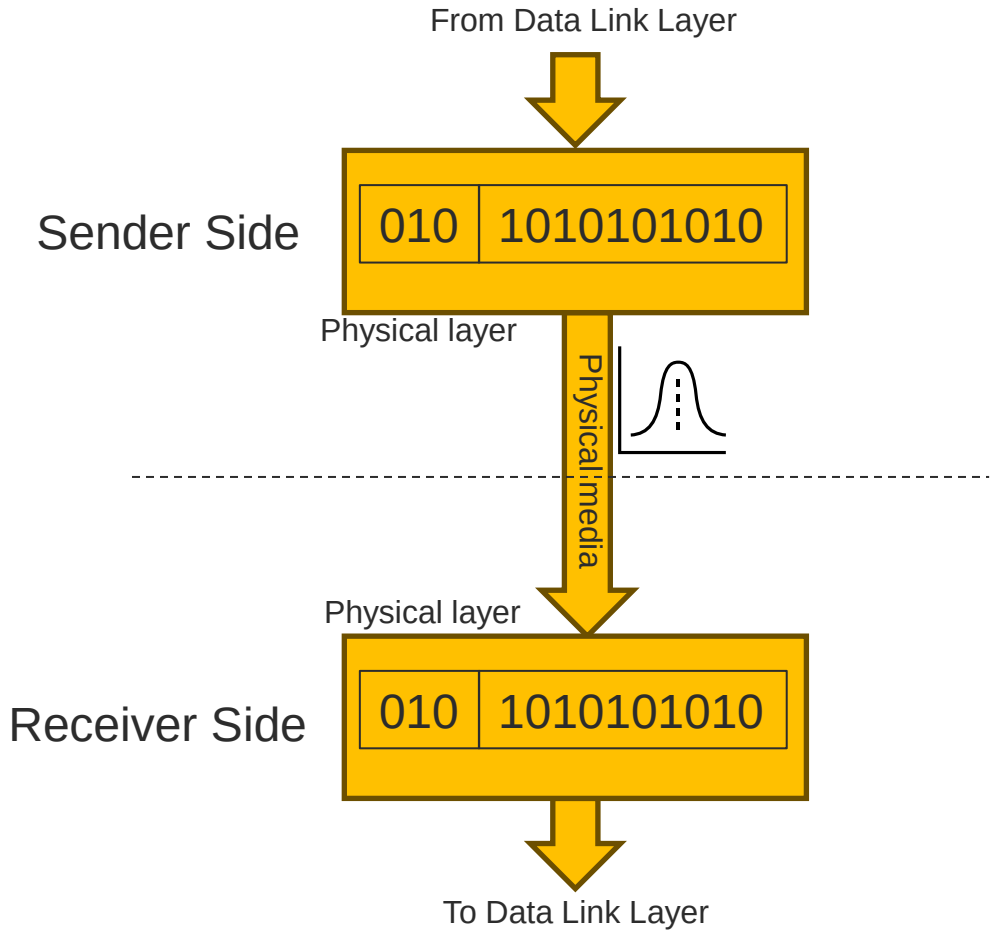
The interaction between layers in the OSI model



Physical Layer

- **The physical layer is responsible for movements of individual bits from one hop (node) to the next.**

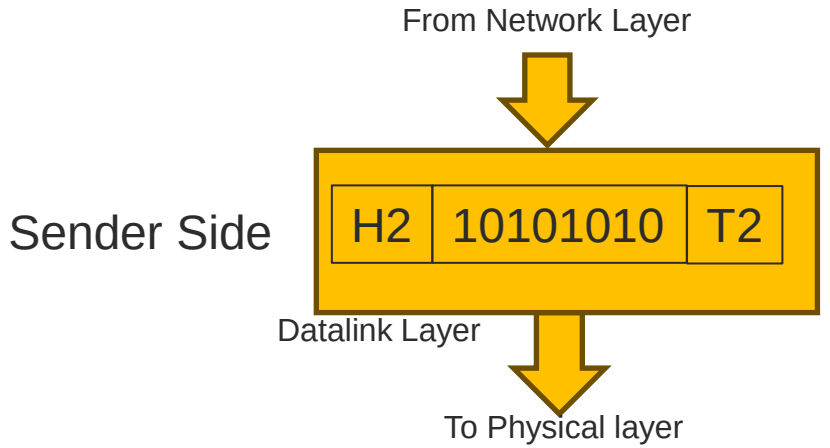
- Function
  - Physical characteristics of interfaces and media
  - Representation of bits
  - Data rate
  - Synchronization of bits
  - Line configuration (point-to-point or multipoint)
  - Physical topology (mesh, star, ring or bus)
  - Transmission mode (simplex, half-duplex or duplex)

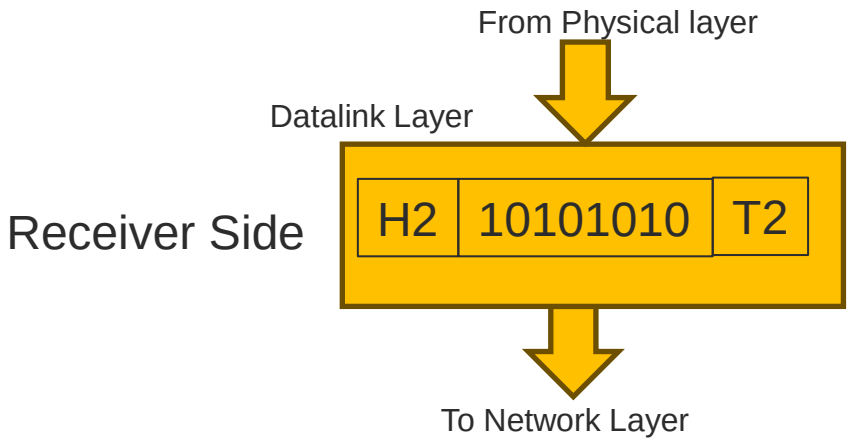


Data Link Layer

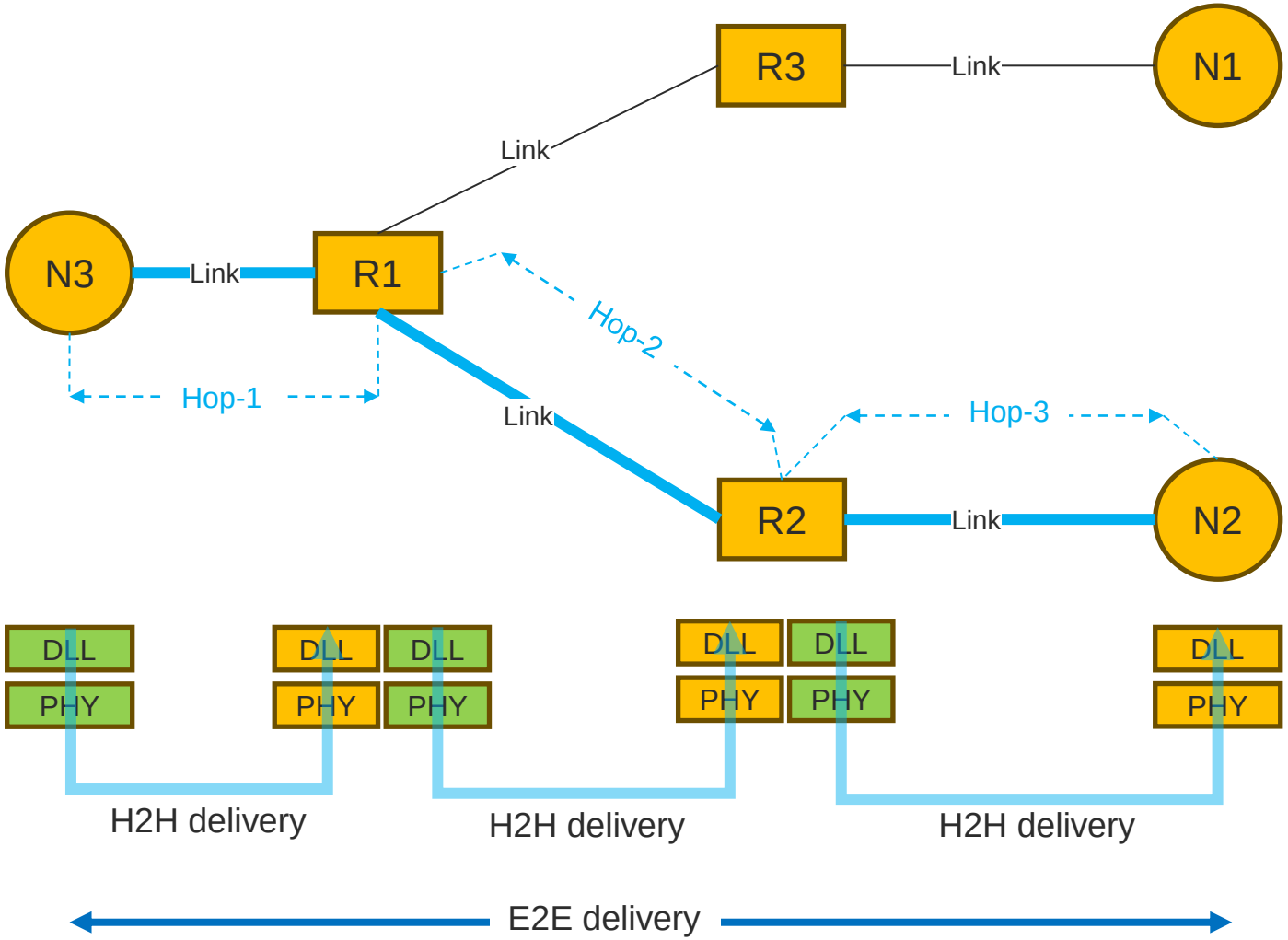
- **The data link layer is responsible for moving frames from one hop (node) to the next.**

  - Functions
    - Framing
    - Physical addressing
    - Flow control
    - Error control
    - Access control



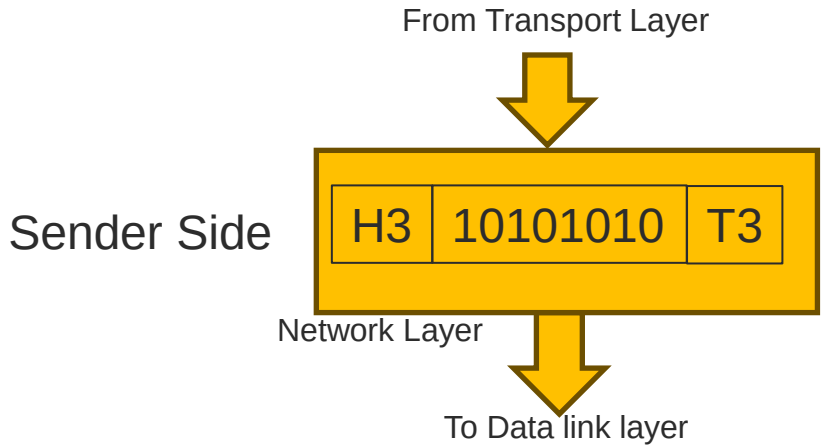


Hop-to-hop delivery

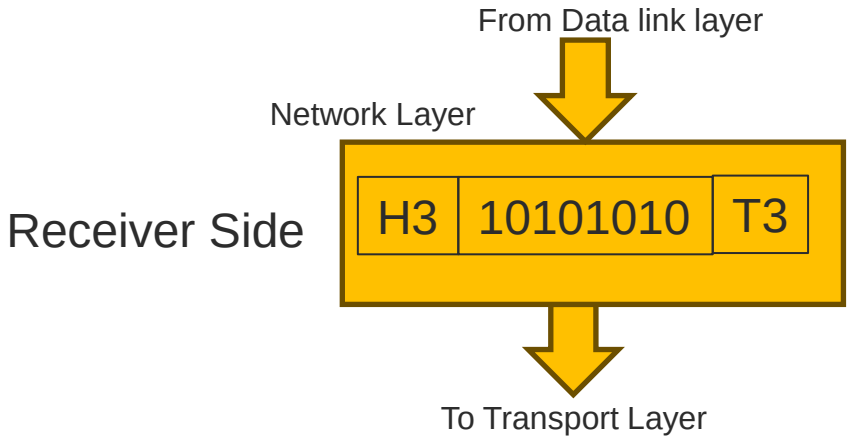


Network Layer

The network layer is responsible for the delivery of individual packets from the source host to the destination host.



- Source-to-destination delivery
- Responsible from the delivery of packets from the original source to the final destination
- Functions
  - Logical addressing
  - routing

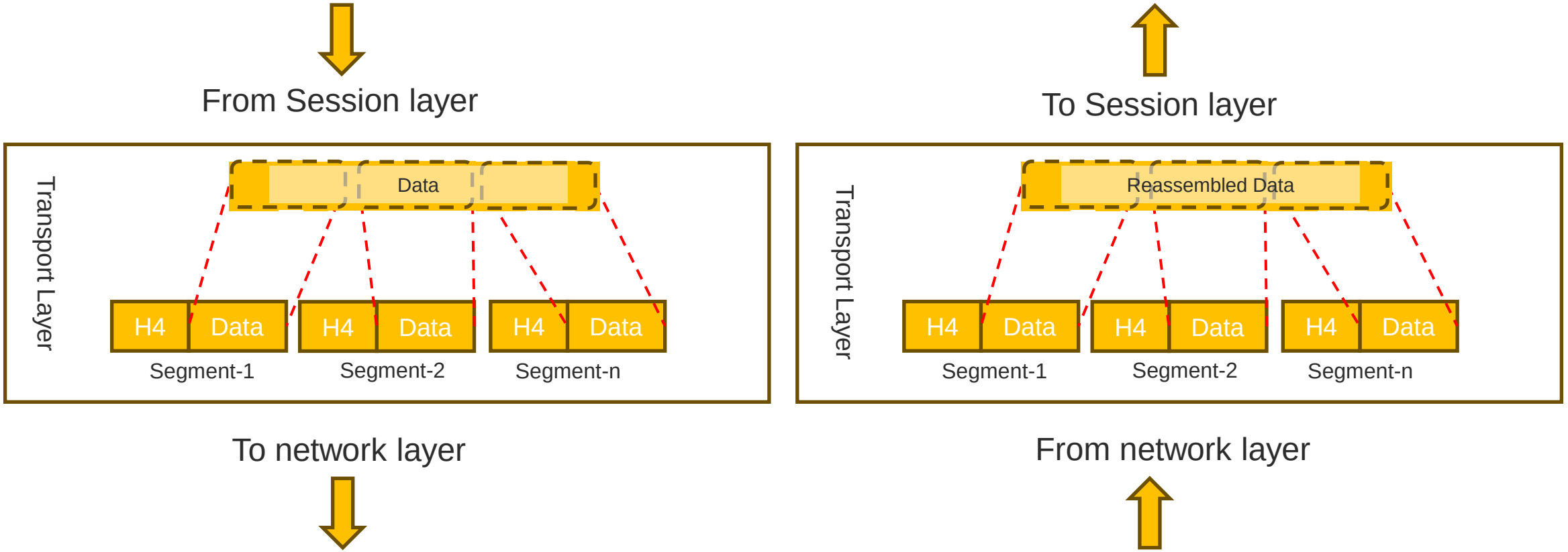


Transport Layer

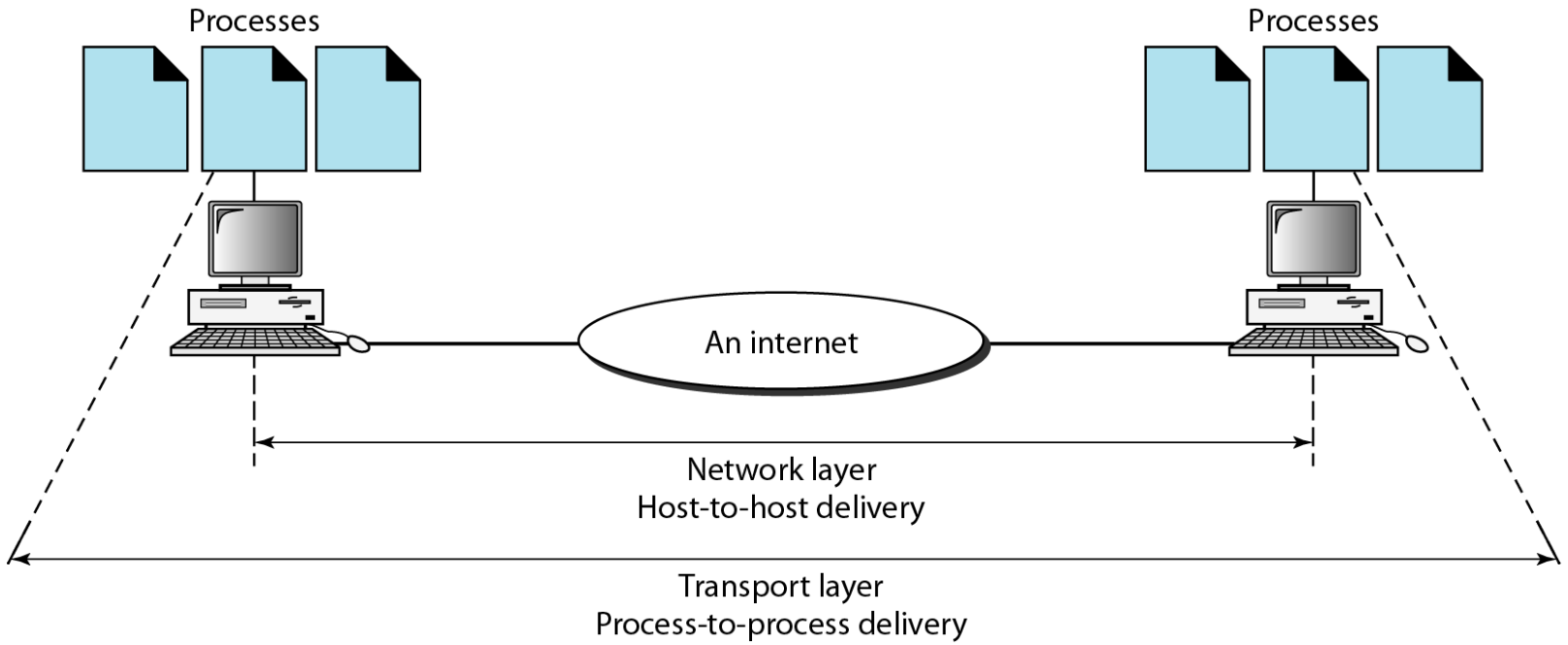
- **The transport layer is responsible for the delivery of a message from one process to another.**
  - Process-to- process delivery
  - Functions
    - Port addressing
    - Segmentation and reassembly
    - Connection control (Connection-oriented or connection-less)
    - Flow control
    - Error control

Transport layer

- Segmentation and reassembly



Reliable process-to-process delivery of a message

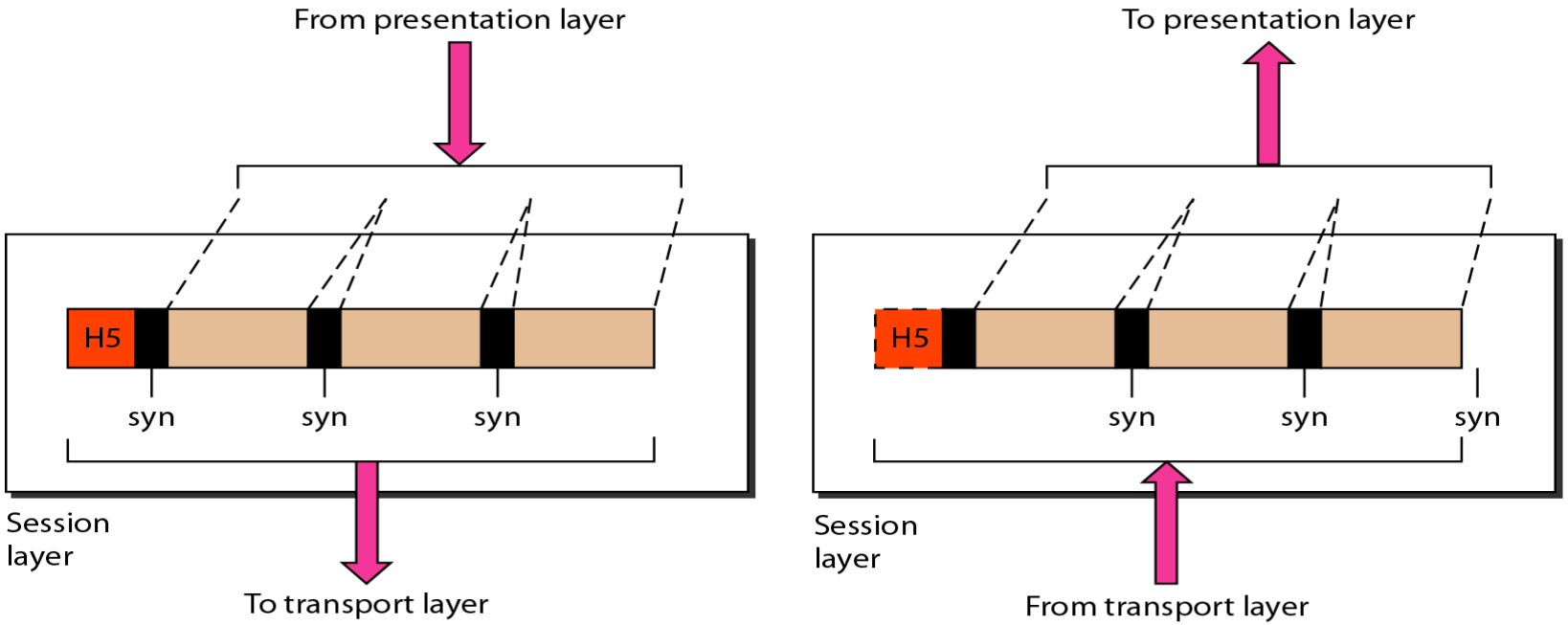


Session Layer

- **The session layer is responsible for dialog control and synchronization.**

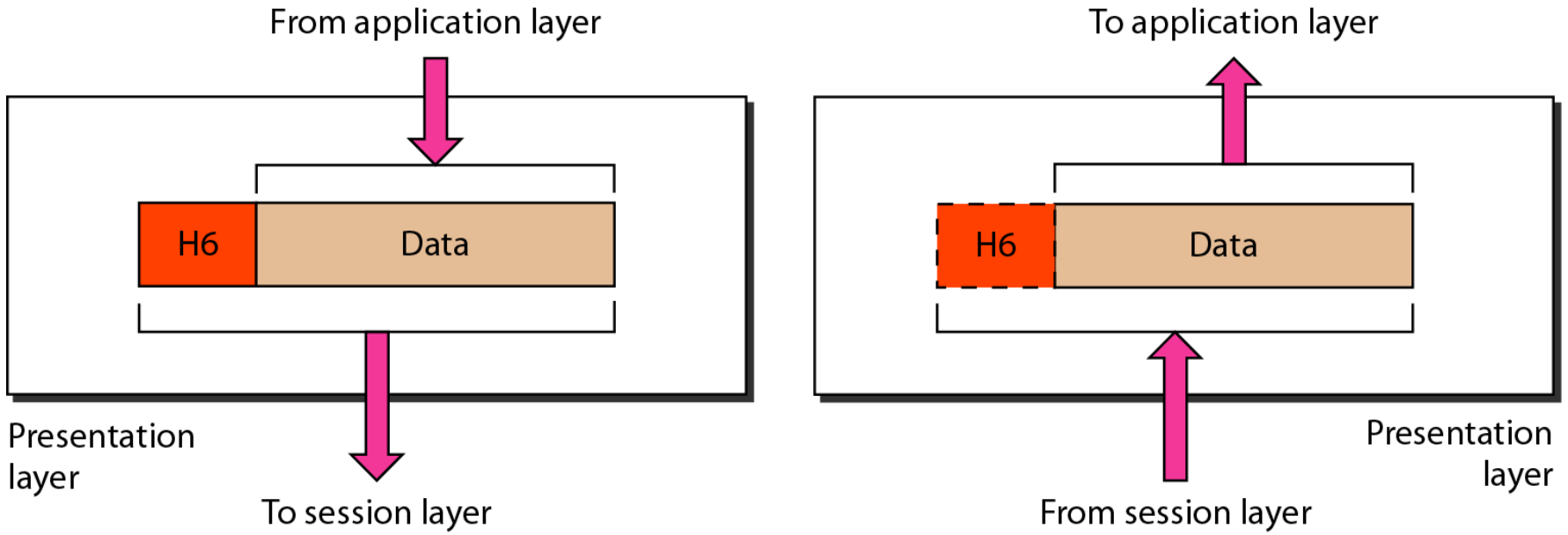
- **It establishes, maintains and synchronize the interaction between communicating system**
- **Function**
  - **Dialog control**
  - **Synchronization (checkpoints)**

Synchronization



Presentation Layer

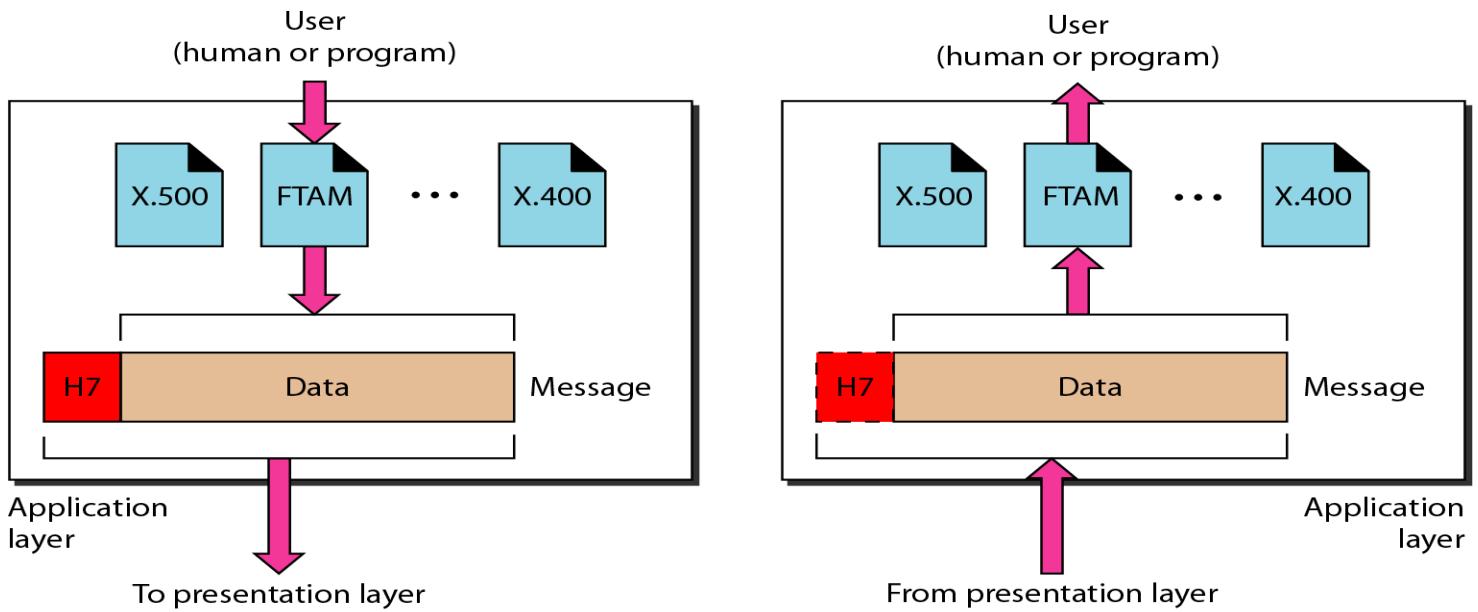
- **The presentation layer is responsible for translation, compression, and encryption.**
  - **Concerned with the syntax and semantics of the information exchanged between two system**
  - **Functions**
    - **Translation** (EBCDIC-coded text file → ASCII-coded file)
    - **Encryption and Decryption**
    - **Compression**



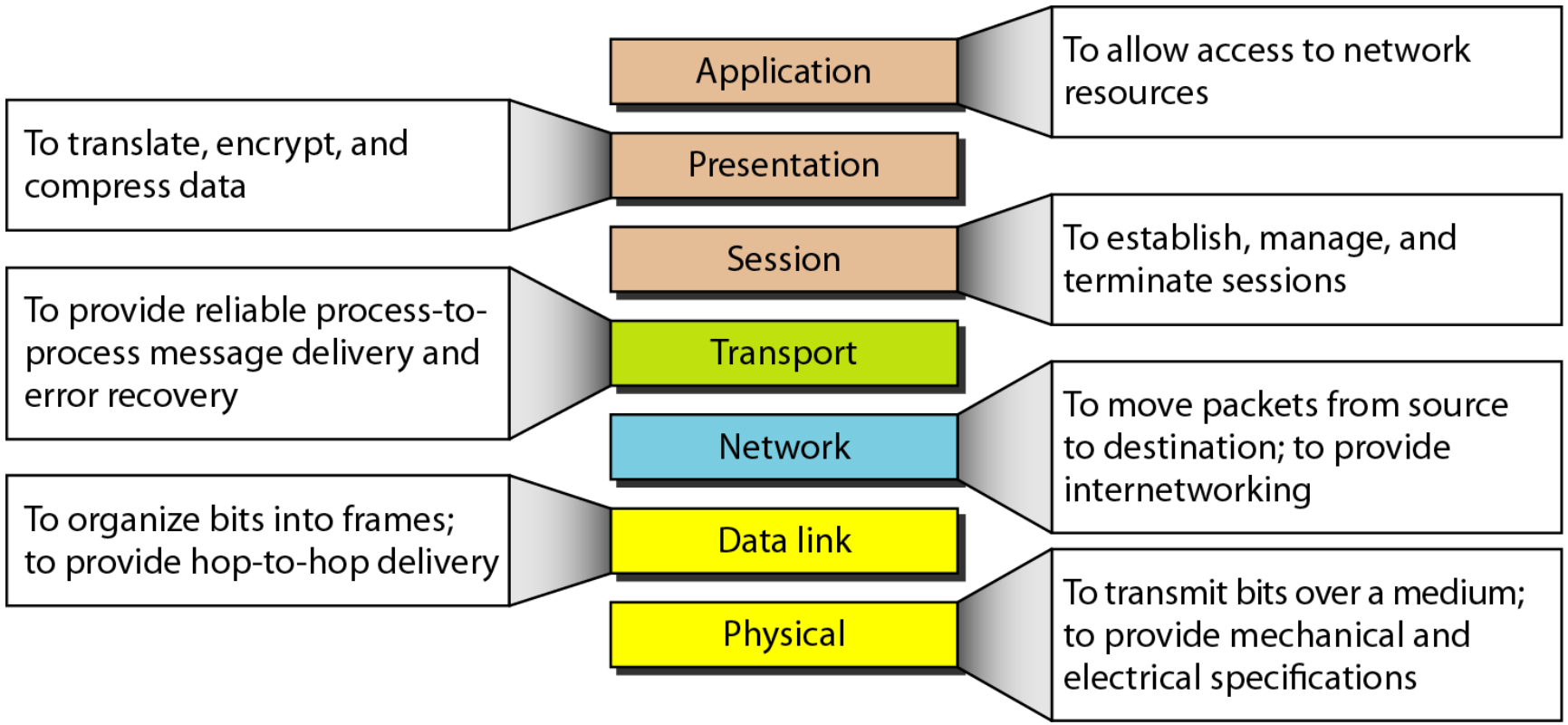
Application Layer

The application layer is responsible for providing services to the user.

- Functions
  - Network virtual terminal (Remote log-in)
  - File transfer and access
  - Mail services
  - Directory services (Distributed Database)
  - Accessing the World Wide Web



Summary of layers



Summary of layers

Sender

OSI Model			
	Data unit	**Layer**	**Function**
User support layers	Data	7. Application	Network process to application
		6. Presentation	Data representation and encryption
		5. Session	Inter-host communication
User⇔ Network	Segment	4. Transport	End-to-end connections and reliability
Network support layers	Packet	3. Network	Path determination and logical addressing
	Frame	2. Data Link	Physical addressing
	Bit	1. Physical	Media, signal and binary transmission

Receiver

IT601 – System and Network Administration

TCP/IP Model

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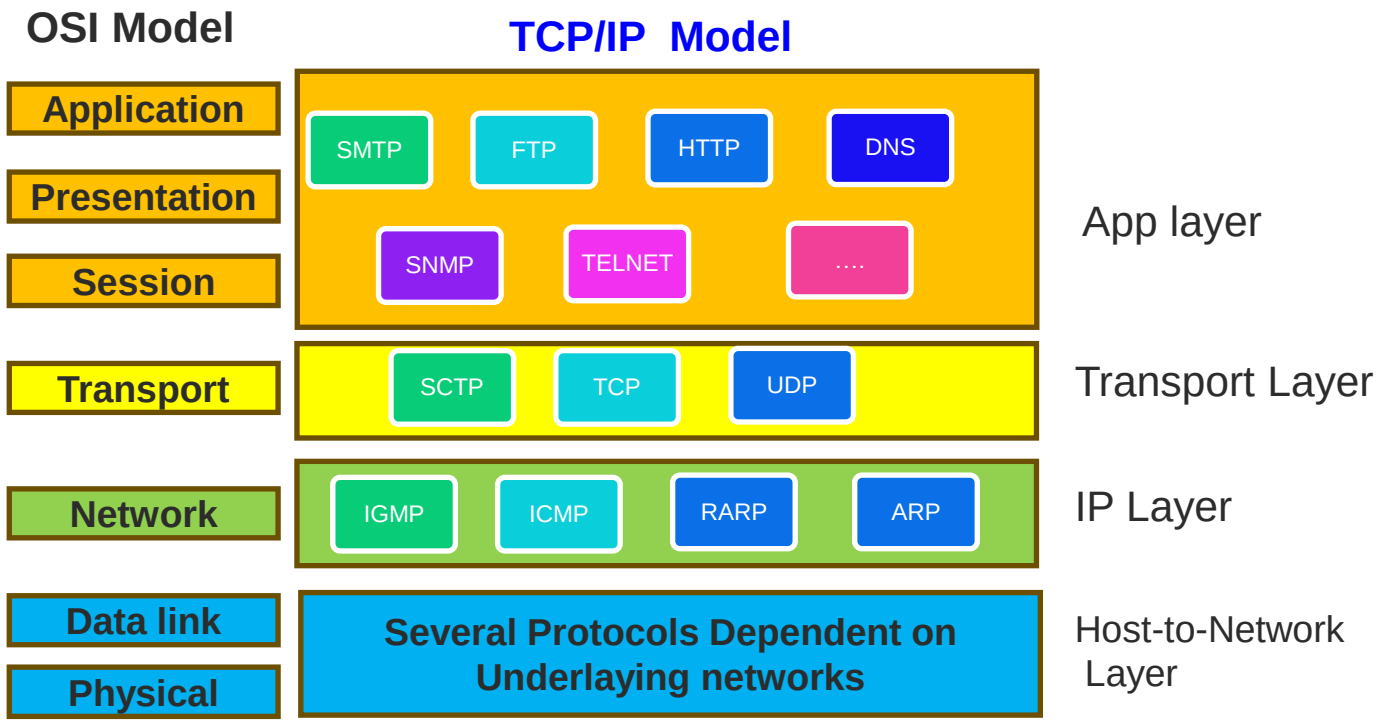
TCP/IP PROTOCOL SUITE

- The layers in the TCP/IP protocol suite do not exactly match those in the OSI model. The original TCP/IP protocol suite was defined as having four layers:
  - User Datagram Protocol (UDP)
  - Transmission Control Protocol (TCP)
  - Stream Control Transmission Protocol (SCTP)
- However, when TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application.

- **Internet Layer**
  - TCP/IP support the IP (unreliable).
  - IP is a host-to-host protocol.
  - Supporting protocols:
    - Address Resolution Protocol (ARP)
    - Reverse Address Resolution Protocol (RARP)
    - Internet Control Massage Protocol (ICMP)
    - Internet Group Massage Protocol (IGMP)
- **Transport Layer**
  - Process-to-process protocol.
    - host-to-network
    - Internet
    - Transport
    - application.



IT601 – System and Network Administration

Collision and Broadcast Domains

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Virtual University of Pakistan

Collision and Broadcast Domains

- **Collision Domains**

  In a group of devices or nodes, only one node can transmit at a given time due shared medium.

- **Broadcast Domains**

  - In data link layers perspectives, The collection of nodes in a given broadcast domain.

    Examples are :
    - VLANs
    - Isolated Networks

  - In network layer perspectives, The collection of nodes having IP address from a distinct network address specified with mask.

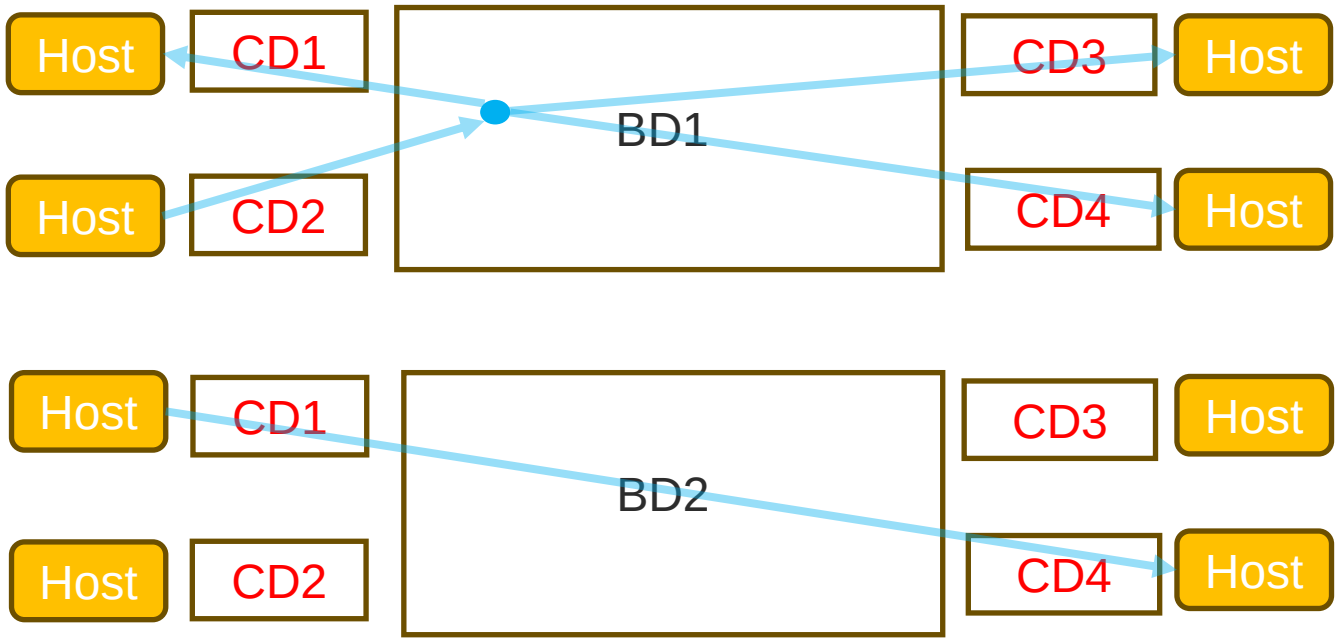
    - 192.168.1.0/24

Broadcast and Collision Domains

- **Hub, Bridge, Switch and Router**

- **Broadcast Domain**
  - All hosts can listen

- **Collision Domain**
  - Only one host can send at t time.

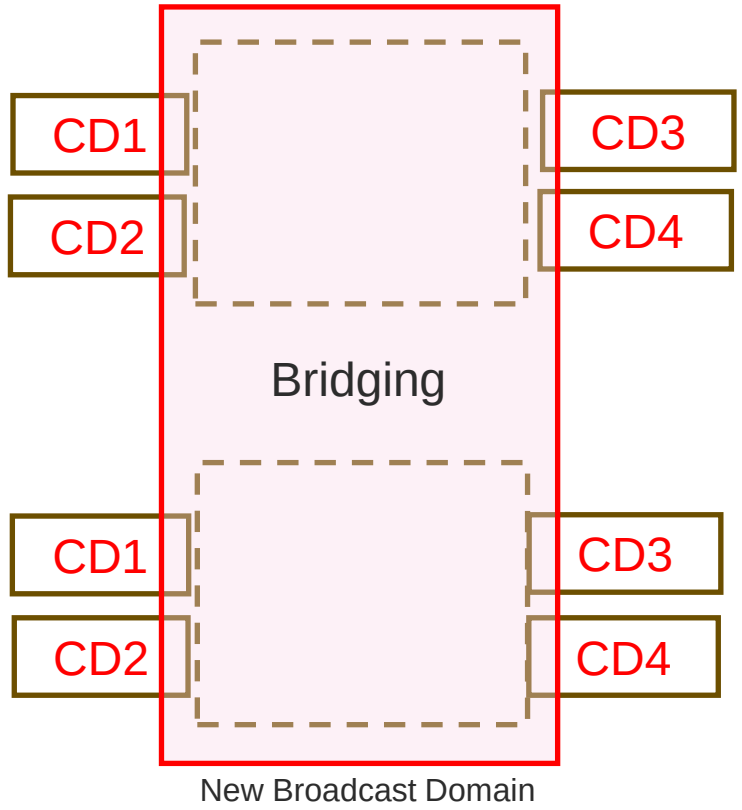


Bridging

- **Bridging**

Joining of the separate networks in a way that both becomes one. Generally, works at data link layer

- Existing BDs Merged
- No Effect on CDs
- Operates at Datalink Layer

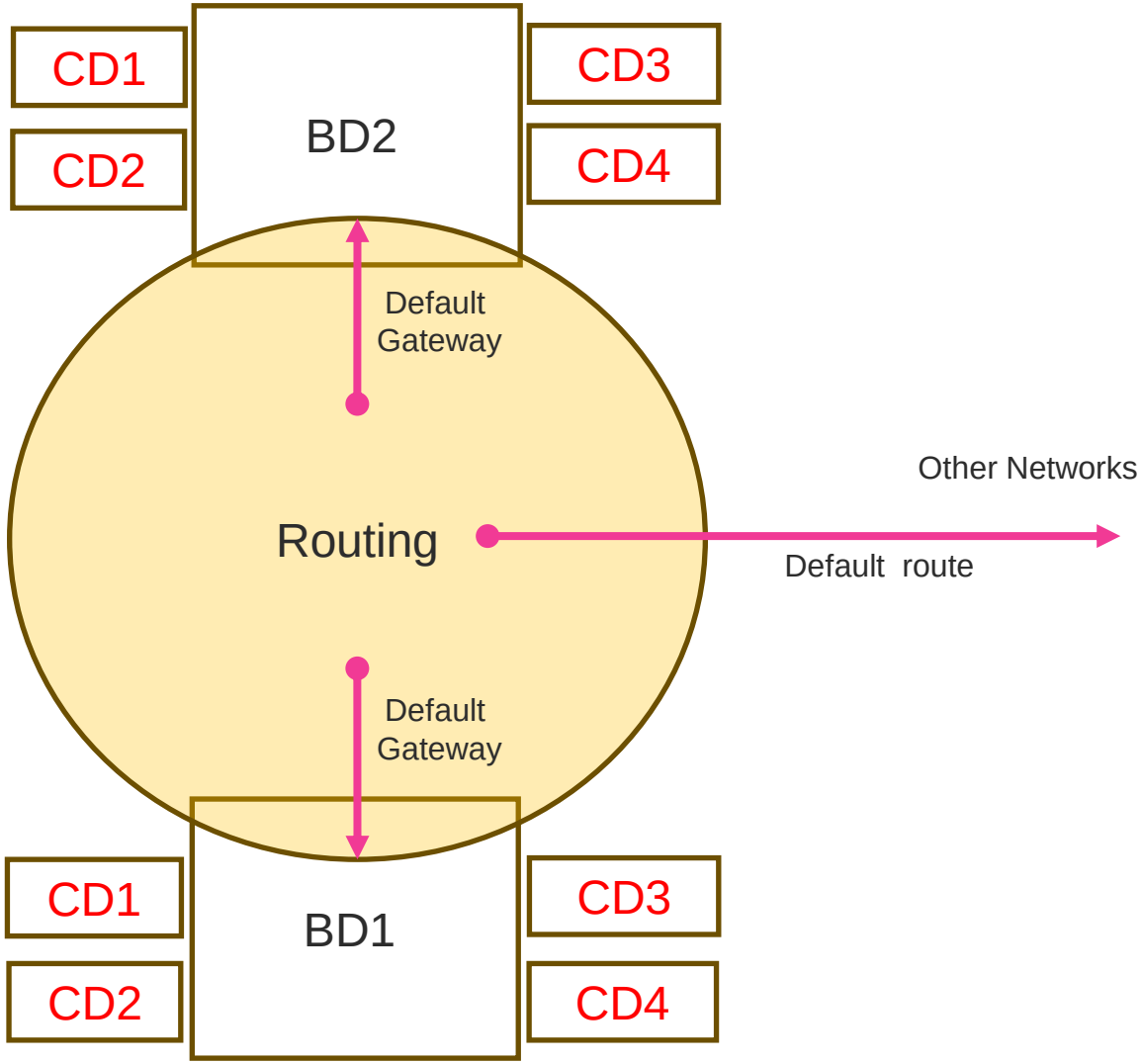


- **Switching**

Joining of the separate networks in a way that both becomes one.

Routing

- **Routing**
  - Joining of networks without loosing their separation
  - Communications between disconnected networks
  - Operates at Network Layer
  - Default route, Default gateway, minimal cost link, shortest path, topology



IT601 – System and Network Administration

Virtual Private Networking

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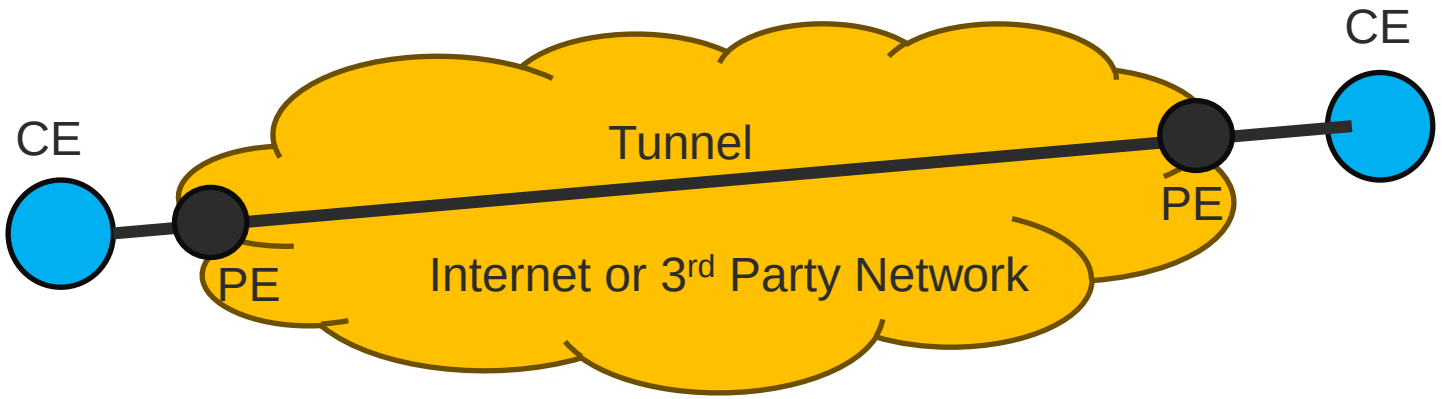
Department of Computer Science and Information Technology,

Virtual University of Pakistan

Virtual Private Networking

- **Layer 2 VPNs**
  - Extends networks at datalink layer
  - Can Carry STP, VLAN and other L2 Control packets
  - More Secure than L3VPN , More Control



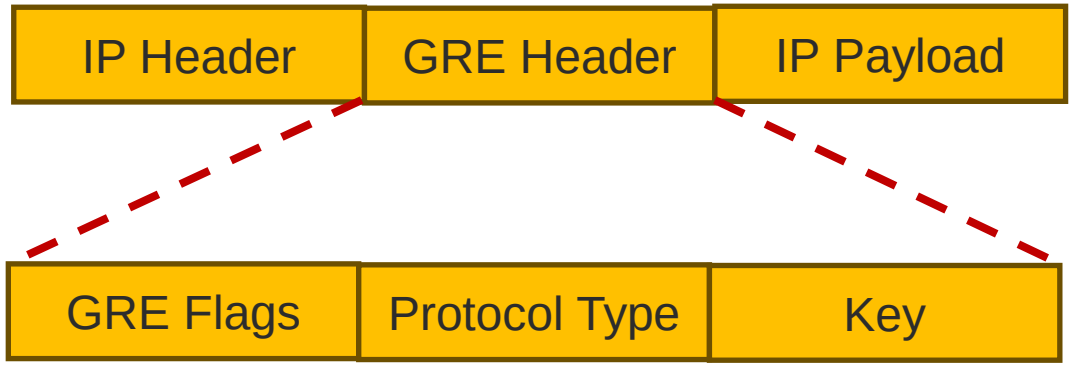
- **Layer 3 VPNs**
  - Extends networks at network layer
  - Can Carry STP, VLAN and other L2 Control packets
  - Encryption or Without Encryption
  - MP2MP

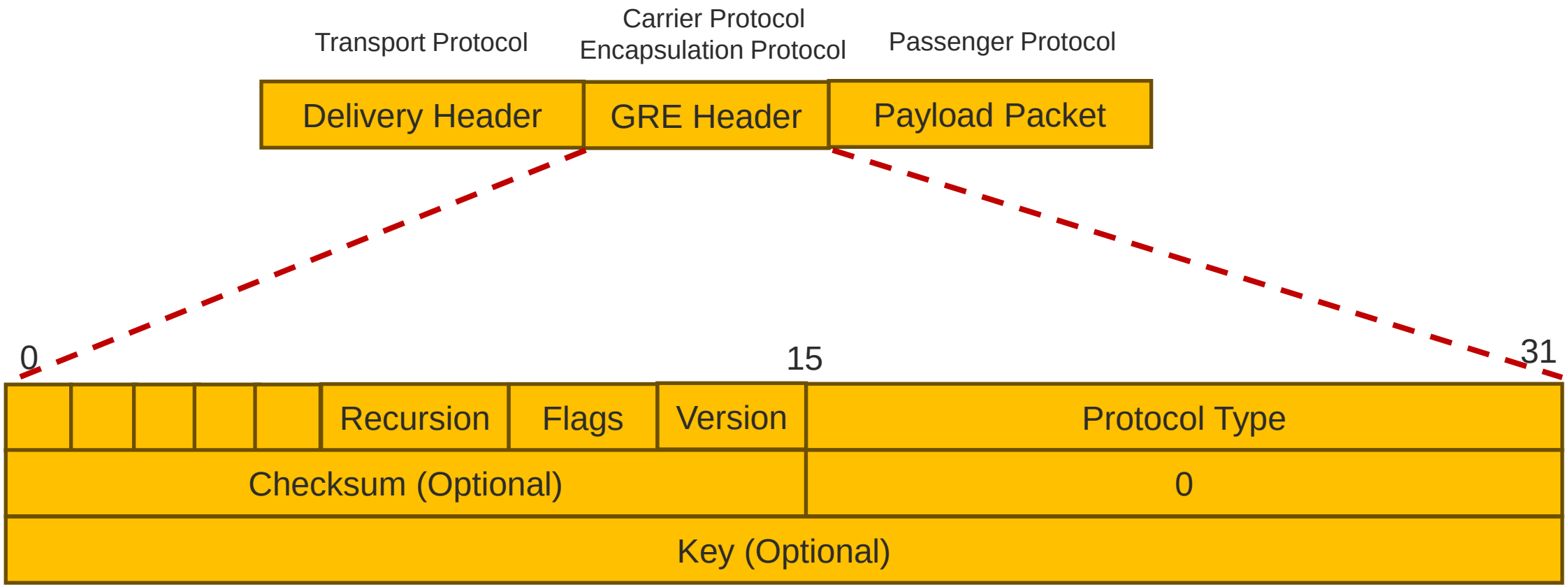
Tunneling Protocols

- Generic Routing Encapsulation
- Internet Protocol Security
- Ip-in-IP
- SSH
- Point-to-Point Tunneling Protocol
- Secure Socket Tunneling Protocol
- Layer 2 Tunneling Protocol
- Virtual Extensible Local Area Network

Generic Routing Encapsulation (GRE)

- Generic Routing Encapsulation is a method of encapsulation of IP packets in a GRE header that hides the original IP packet.
  - A new header named delivery header is added above the GRE header which contains the new source and destination address.
  - GRE header act as a new IP header with a Delivery header containing a new source and destination address.
  - Only routers between which GRE is configured can decrypt and encrypt the GRE header.
  - The original IP packet enters a router, travels in encrypted form, and emerges out of another GRE-configured router as the original IP packet as they have traveled through a tunnel.



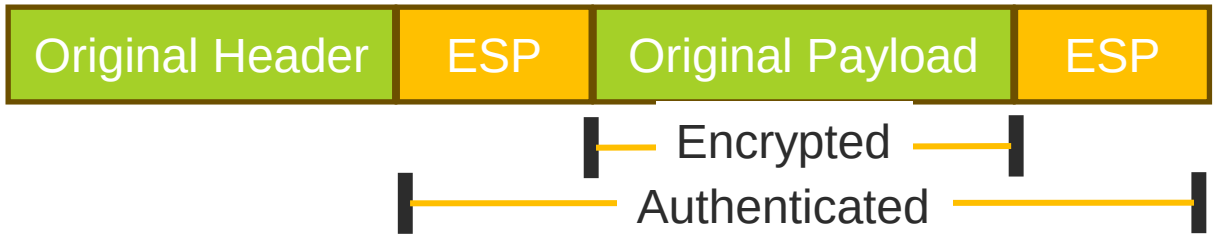

Transport Protocol
Carrier Protocol
Encapsulation Protocol
Passenger Protocol
Delivery Header
GRE Header
Payload Packet
0
15
31
Recursion
Flags
Version
Protocol Type
Checksum (Optional)
0
Key (Optional)

IP security

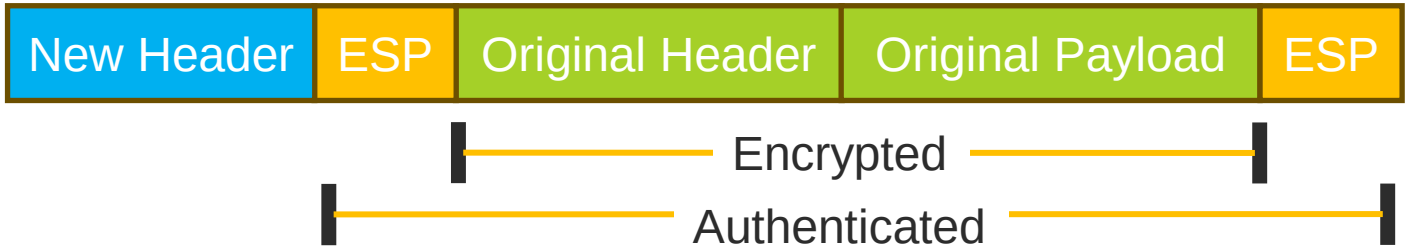
- IP security (IPSec) is an Internet Engineering Task Force (IETF) standard suite of protocols between 2 communication points across the IP network that provide data authentication, integrity, and confidentiality. It also defines the encrypted, decrypted, and authenticated packets.
- The protocols needed for secure key exchange and key management are defined in it.
- The AH (Authentication Header) protocol provides a mechanism for authentication only. AH provides data integrity, data origin authentication, and an optional replay protection service.
- The ESP (Ecapsulating Security Payload) protocol provides data confidentiality (encryption) and authentication (data integrity, data origin authentication, and replay protection). ESP can be used with confidentiality only, authentication only, or both confidentiality and authentication.

IP Packet W/o ESP

IP Packet With ESP Transport

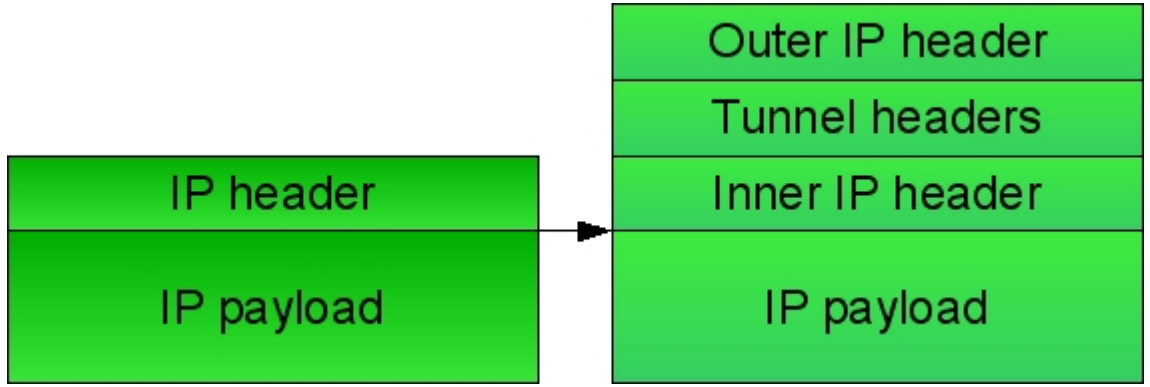


IP Packet With ESP Tunnel



IP-in-IP

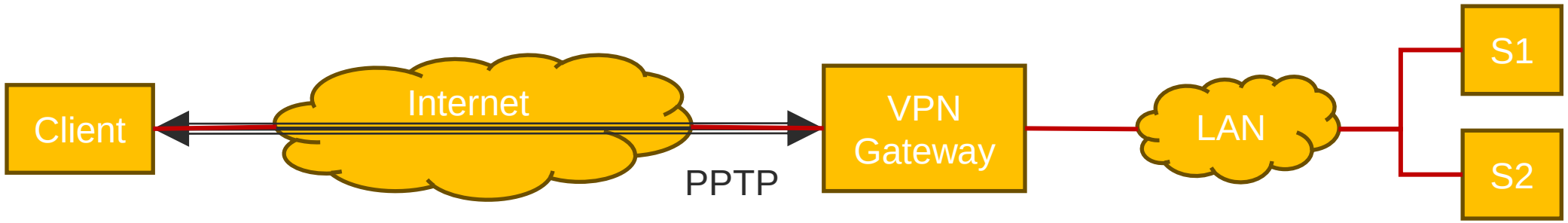
IP-in-IP is a Tunneling Protocol for encapsulating IP packets inside another IP packet.



Point-to-Point Tunneling Protocol (PPTP)

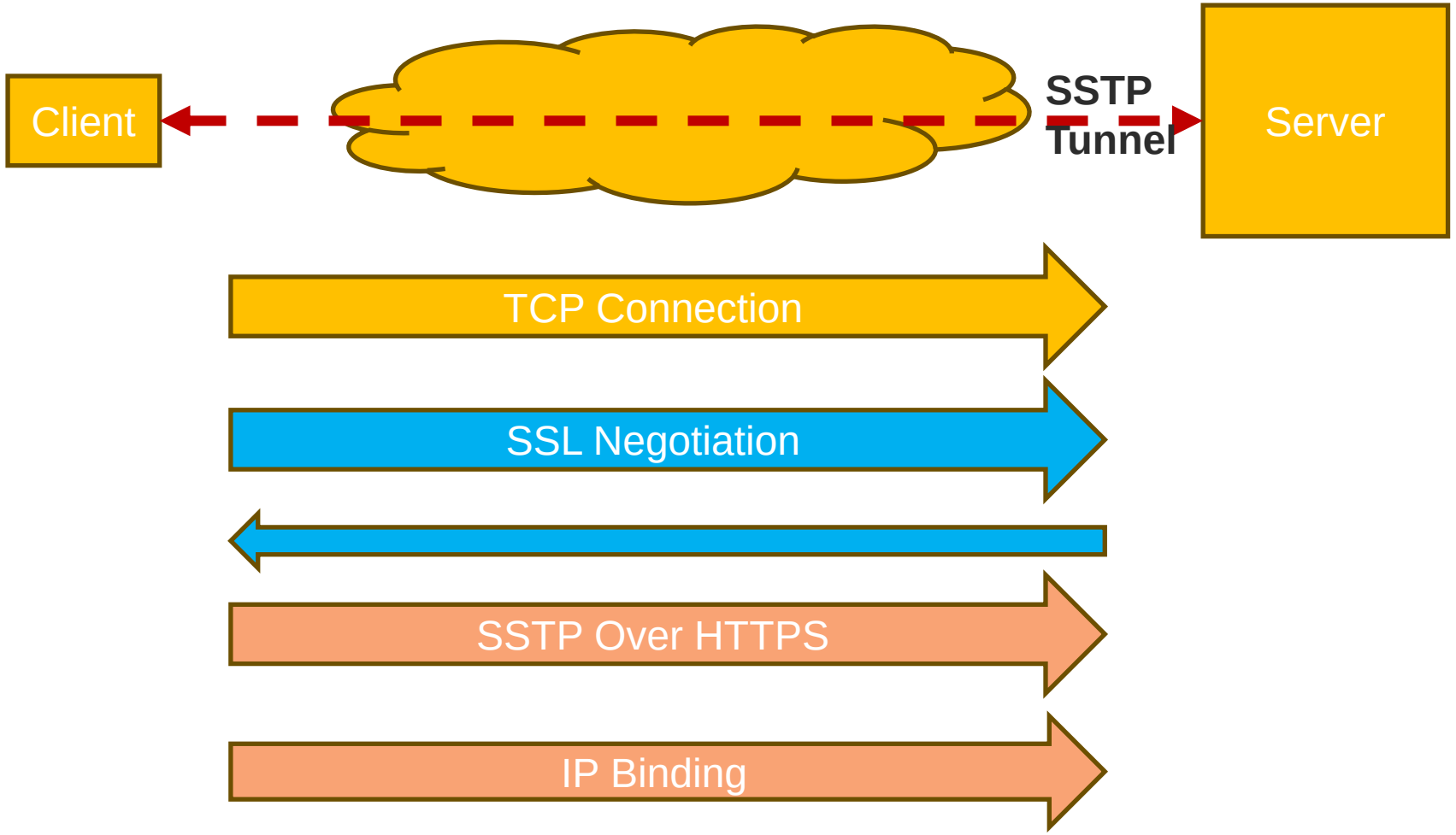
- PPTP or Point-to-Point Tunneling Protocol generates a tunnel and confines the data packet. Point-to-Point Protocol (PPP) is used to encrypt the data between the connection.

- PPTP is one of the most widely used VPN protocols and has been in use since the early release of Windows. PPTP is also used on Mac and Linux apart from Windows.



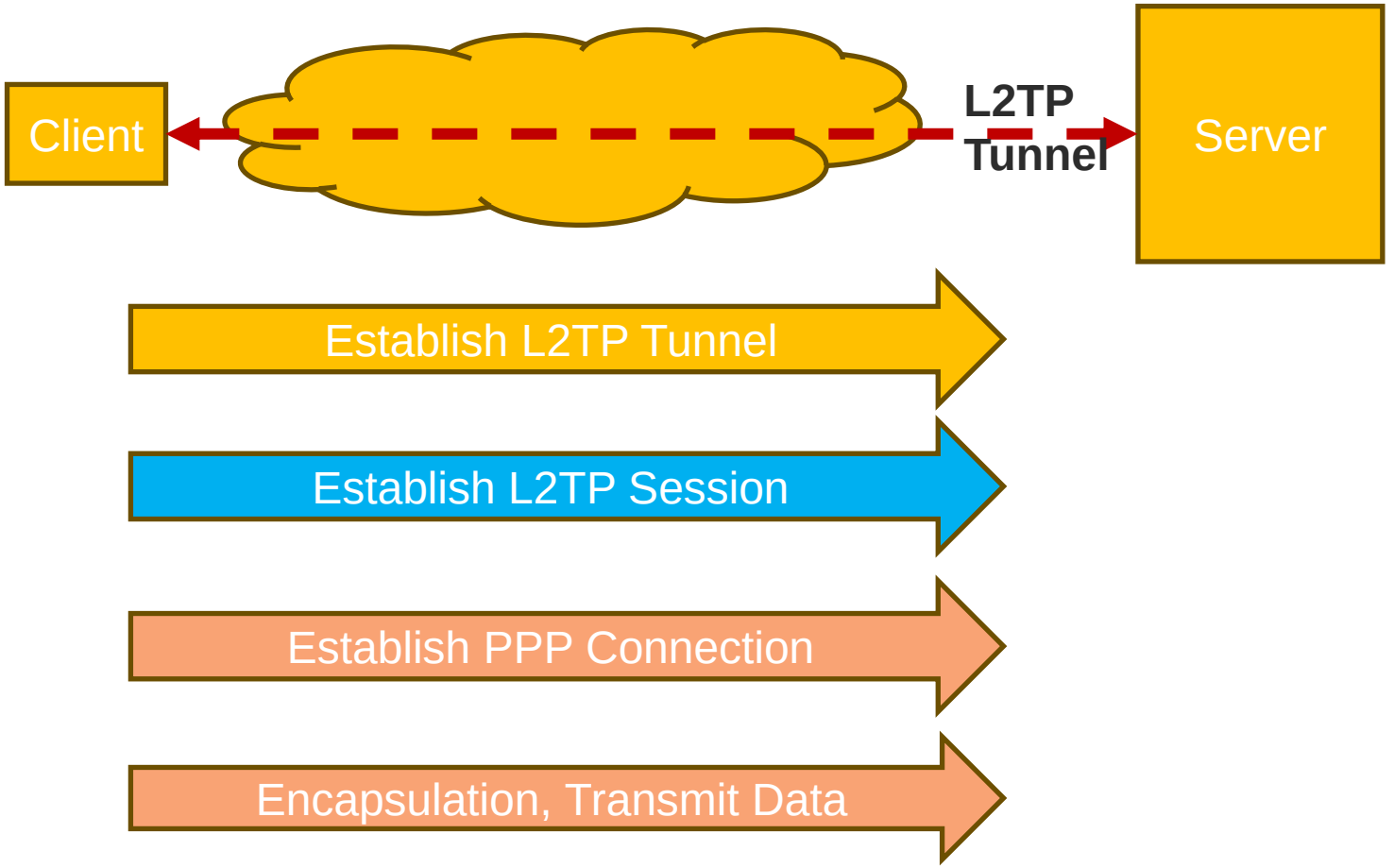
6. Secure Socket Tunneling Protocol (SSTP)

A VPN protocol developed by Microsoft that uses SSL to secure the connection, but only available for Windows.



7. Layer 2 Tunneling Protocol (L2TP)

- L2TP stands for Layer 2 Tunneling Protocol, published in 2000 as proposed standard RFC 2661.
- It is a computer networking protocol that was designed to support VPN connections used by an Internet service provider (ISP) to enable VPN operation over the Internet.
- L2TP combines the best features of two other tunneling protocols- PPTP(Point-to-Point Tunneling Protocol) from Microsoft and L2F(Layer 2 Forwarding) from Cisco Systems.

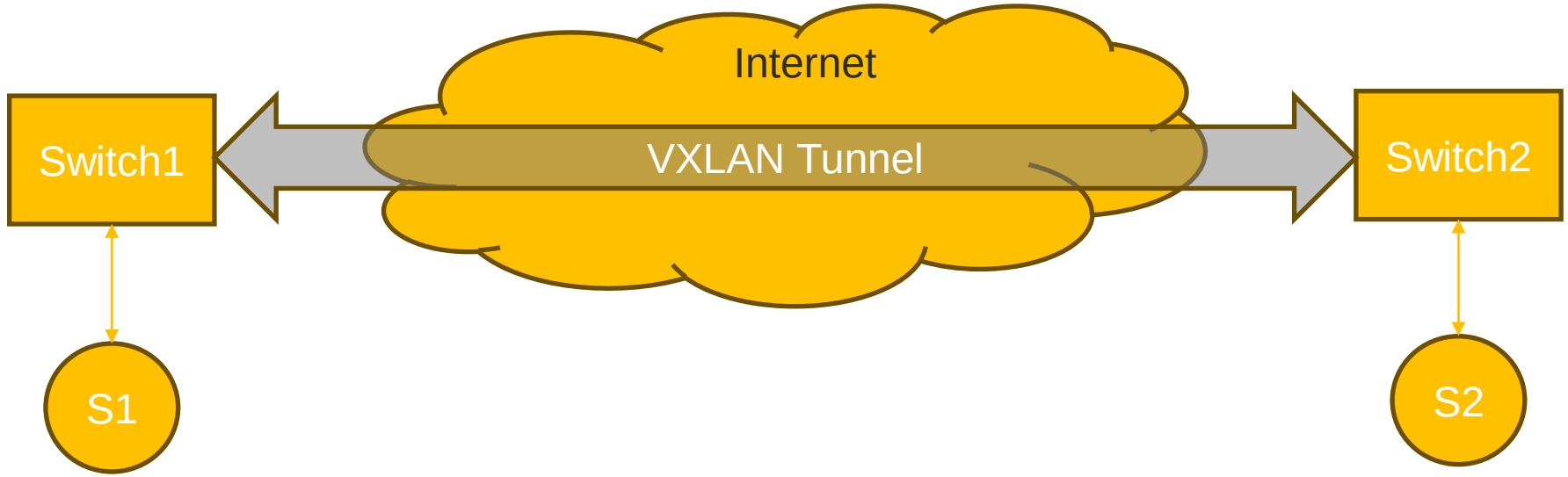


- sudo apt-get install xl2tpd openswan ppp

8. Virtual Extensible Local Area Network (VXLAN)

Virtual Extensible Local Area Network is short called VXLAN.

It is a network virtualization technology that stretches layer 2 connections over layer 3 networks by encapsulating Ethernet frames in a VXLAN packet which includes IP addresses to address the scalability problem in a more extensible manner.



IT601 – System and Network Administration

Network Address Translation

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Introduction

- To access the Internet, one public IP address is needed, but we can use a private IP address in our private network.
  - The idea of NAT is to allow multiple devices to access the Internet through a single public address. To achieve this, the translation of a private IP address to a public IP address is required.
- Network Address Translation (NAT) is a process in which one or more local IP address is translated into one or more Global IP address and vice versa in order to provide Internet access to the local hosts.
  - Also, it does the translation of port numbers i.e. masks the port number of the host with another port number, in the packet that will be routed to the destination.
  - It then makes the corresponding entries of IP address and port number in the NAT table. NAT generally operates on a router or firewall.

Network Address Translation (NAT) working

- Generally, the border router is configured for NAT i.e the router which has one interface in the local (inside) network and one interface in the global (outside) network.
- When a packet traverse outside the local (inside) network, then NAT converts that local (private) IP address to a global (public) IP address.
- When a packet enters the local network, the global (public) IP address is converted to a local (private) IP address.
- If NAT runs out of addresses, i.e., no address is left in the pool configured then the packets will be dropped and an Internet Control Message Protocol (ICMP) host unreachable packet to the destination is sent.

Masking Port Numbers

- Consider, in a network, two hosts A and B are connected. Now, both of them request for the same destination, on the same port number, say 1000, on the host side, at the same time.

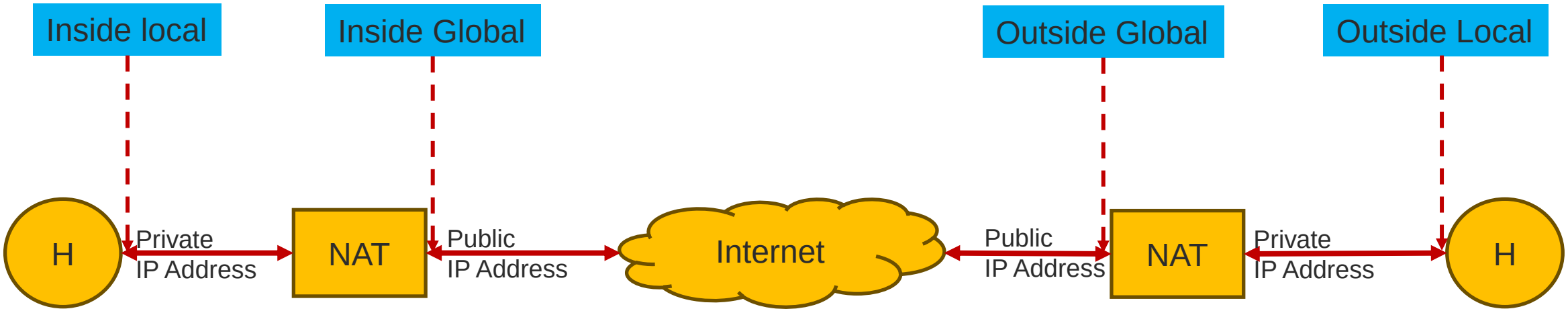
- If NAT does only translation of IP addresses, then when their packets will arrive at the NAT, both of their IP addresses would be masked by the public IP address of the network and sent to the destination.

- Destination will send replies to the public IP address of the router. Thus, on receiving a reply, it will be unclear to NAT as to which reply belongs to which host (because source port numbers for both A and B are the same).

- Hence, to avoid such a problem, NAT masks the source port number as well and makes an entry in the NAT table.

NAT inside and outside addresses

Inside refers to the addresses which must be translated. Outside refers to the addresses which are not in control of an organization. These are the network Addresses in which the translation of the addresses will be done.



Network Address Translation (NAT) Types

- There are three types of NAT

Static NAT

- In this, a single unregistered (Private) IP address is mapped with a legally registered (Public) IP address i.e one-to-one mapping between local and global addresses.
- This is generally used for Web hosting. These are not used in organizations as there are many devices that will need Internet access and to provide Internet access, a public IP address is needed.

Dynamic NAT

- In this type of NAT, an unregistered IP address is translated into a registered (Public) IP address from a pool of public IP addresses.
- If the IP address of the pool is not free, then the packet will be dropped as only a fixed number of private IP addresses can be translated to public addresses.

Port Address Translation (PAT)

- Also known as NAT overload. In this, many local (private) IP addresses can be translated to a single registered IP address.
- Port numbers are used to distinguish the traffic i.e., which traffic belongs to which IP address.
- This is most frequently used as it is cost-effective as thousands of users can be connected to the Internet by using only one real global (public) IP address.

Advantages/Disadvantages of NAT

- **Advantages of NAT –**
  - NAT conserves legally registered IP addresses.
  - It provides privacy as the device's IP address, sending and receiving the traffic, will be hidden.
  - Eliminates address renumbering when a network evolves.

- **Disadvantage of NAT –**
  - Translation results in switching path delays.
  - Certain applications will not function while NAT is enabled.
  - Complicates tunneling protocols such as IPsec.
  - Also, the router being a network layer device, should not tamper with port numbers(transport layer) but it has to do so because of NAT.

Common Uses of NAT

- Wireless Routers or Access Points
- Virtual Machines
- Container Hosts

IT601 – System and Network Administration

IP Tables

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Introduction to IP tables

- All modern operating systems come equipped with a firewall – a software application that regulates network traffic to a computer.
- Firewalls create a barrier between a trusted network (like an office network) and an untrusted one (like the internet).
- Firewalls work by defining rules that govern which traffic is allowed, and which is blocked. The utility firewall developed for Linux systems is iptables.

Working Principles of IP Tables

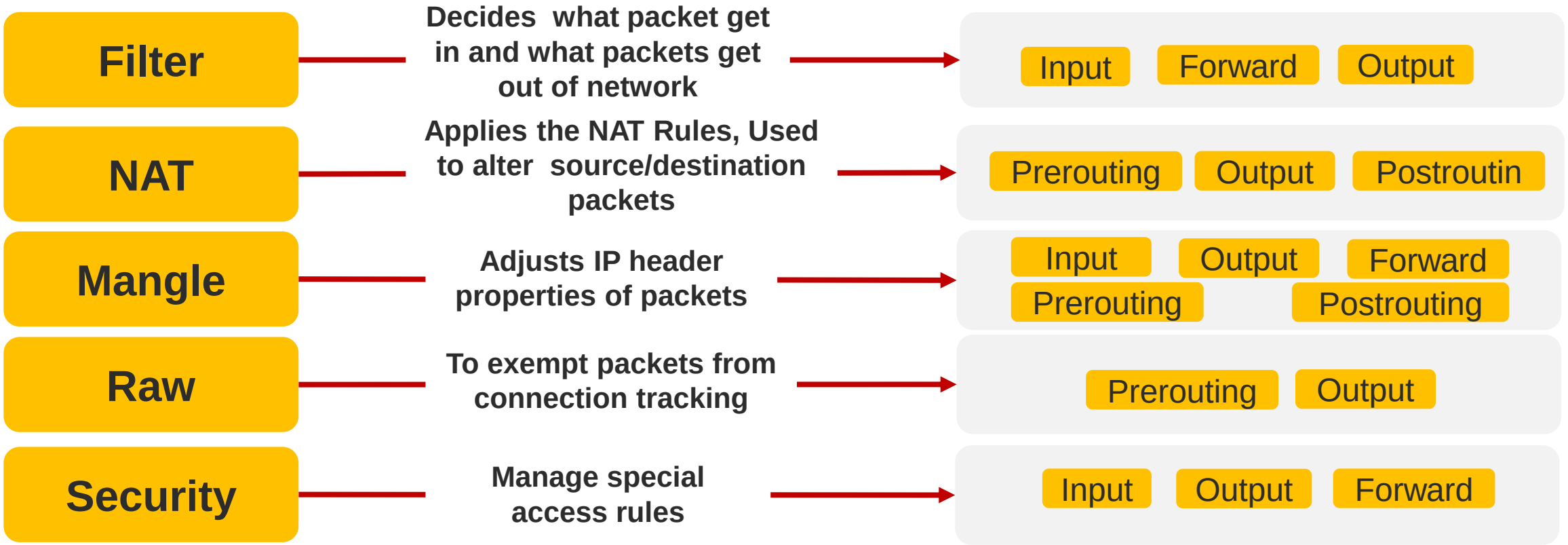
- Network traffic is made up of packets. Data is broken up into smaller pieces (called packets), sent over a network, then put back together. Iptables identifies the packets received and then uses a set of rules to decide what to do with them.

- Iptables filters packets based on:

Tables	Chains	Rules	Targets
• Tables are files that join similar actions. • A table consists of several chains	• A chain is a string of rules. • When a packet is received, iptables finds the appropriate table, then runs it through the chain of rules until it finds a match.	• A rule is a statement that tells the system what to do with a packet. • Rules can block one type of packet or forward another type of packet. • The outcome, where a packet is sent, is called a target.	• A target is a decision of what to do with a packet. • Typically, this is to accept it, drop it, or reject it (which sends an error back to the sender).

Tables and Chains

- Linux firewall iptables has four default tables.



Chains

Targets

- A target is what happens after a packet matches a rule criteria. Non-terminating targets keep matching the packets against rules in a chain even when the packet matches a rule.
- With terminating targets, a packet is evaluated immediately and is not matched against another chain. The terminating targets in Linux iptables are:
- Four Targets are defined.

Accept

accepts the packets to come through the iptables firewall

Drop

the dropped package is not matched against any further chain

does not generate an error

Return

sends the packet back to the originating chain

Reject

rejects a packet

Generates an error to the connecting device

Installation and Status

- Install IP Tables
  - sudo apt-get update
  - sudo apt-get install iptables

- Check the status of current iptables configuration
  - sudo iptables -L -v

Here, the -L option is used to list all the rules, and -v is for showing the info in a more detailed format. Below is the example output:

```
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target     prot opt in out   source destination

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target     prot opt in out   source destination

Chain OUTPUT (policy ACCEPT 0 packets, 0 bytes)
pkts bytes target     prot opt in out   source destination
```

Defining Chain Rules

- A rule can be inserted with following command
  - sudo iptables -A <chain> -i <interface> -p <protocol (tcp/udp) > -s <source> --dport <port no.> -j <target>

- **-i (interface)**
  - The network interface whose traffic you want to filter, such as eth0, lo, ppp0, etc.
- **-p (protocol)**
  - The network protocol where your filtering process takes place. It can be either tcp, udp, udplite, icmp, sctp, icmpv6, and so on. Alternatively, you can type all to choose every protocol.
- **-s (source)**
  - The address from which traffic comes from. You can add a hostname or IP address.
- **–dport (destination port)**
  - the destination port number of a protocol, such as 22 (SSH), 443 (https), etc.
- **-j (target)**
  - the target name (ACCEPT, DROP, RETURN). You need to insert this every time you make a new rule.

Allow traffic on localhost

- To allow traffic on localhost, type this command:
  - sudo iptables -A INPUT -i lo -j ACCEPT
- Use lo or loopback interface. It is utilized for all communications on the localhost.
- The command above will make sure that the connections between a database and a web application on the same machine are working properly.

Enabling Connections on HTTP, SSH, and SSL Port

- **Allow SSH Traffic**
  - sudo iptables -A INPUT -p tcp --dport 22 -j ACCEPT
- **Allow HTTP Traffic**
  - sudo iptables -A INPUT -p tcp --dport 80 -j ACCEPT
- **Allow HTTPS Traffic**
  - sudo iptables -A INPUT -p tcp --dport 443 -j ACCEPT
- **Check Status of IP Tables**

  sudo iptables -L -v

Filtering Packets Based on Source

- **Allow packets from 192.168.1.3**

  sudo iptables -A INPUT -s 192.168.1.3 -j ACCEPT

- **Deny packets from 192.168.1.3**

  sudo iptables -A INPUT -s 192.168.1.3 -j DROP

- **Deny packets from a range of IP addresses**

  sudo iptables -A INPUT -m iprange --src-range 192.168.1.100-192.168.1.200 -j DROP

- **Dropping all Other Traffic**

  sudo iptables -A INPUT -j DROP

Deleting Rules

- **remove all rules and start with a clean slate**
  - sudo iptables -F
- **delete a specific rule**
  - sudo iptables -L --line-numbers
- **delete a specific rule from specific chain**
  - sudo iptables -D INPUT 3

Persisting Changes

- **Save Rules to file**
  - sudo iptables-save > /etc/iptables/rules.v4
  - sudo iptables-save > /etc/iptables/rules.v6
- **Restore rules from file**
  - sudo iptables-restore < /etc/iptables/rules.v4
  - sudo iptables-restore < /etc/iptables/rules.v6
- **Enable Auto Save**
  - sudo apt-get install iptables-persistent

IT601 – System and Network Administration

Simple Network Management Protocol

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Simple Network Management Protocol

- SNMP is a framework that provides facilities for managing and monitoring network resources on the Internet.
- Components of SNMP:

Agent

SNMP agent is software that runs on a piece of network equipment (host, router, printer, or others) and that maintains information about its configuration and current state in a database

Manager

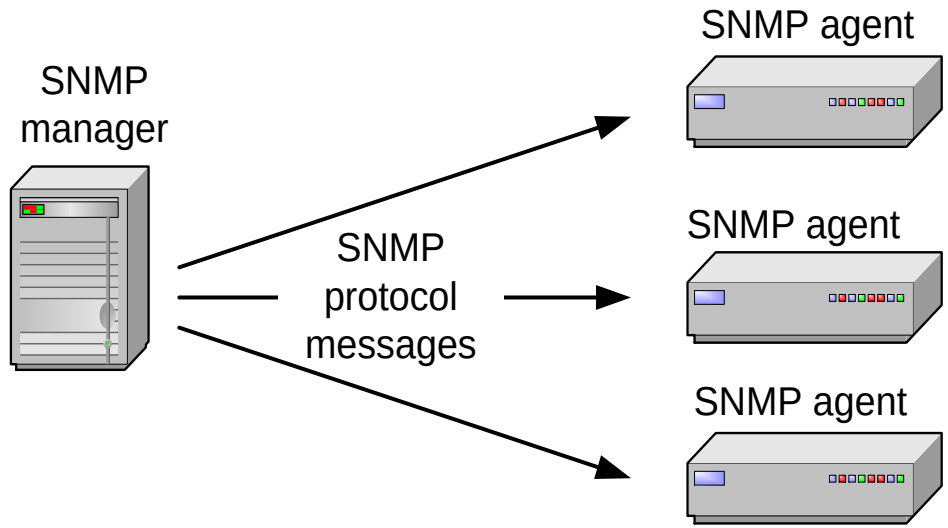
An **SNMP manager** is an application program that contacts an SNMP agent to query or modify the database at the agent.

MIB

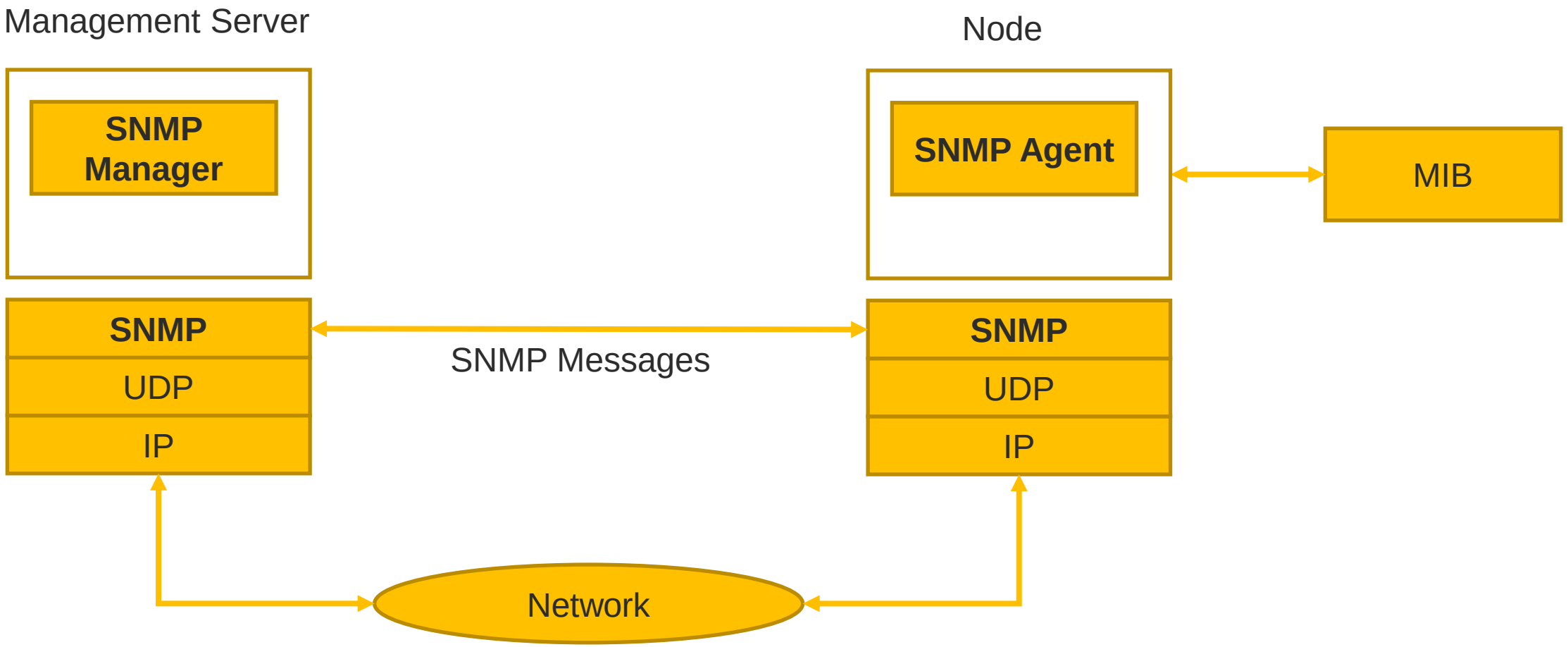
Information in the database is described by **Management Information Bases (MIBs)**

Protocol

SNMP protocol is the application layer protocol used by SNMP agents and managers to send and receive data.



Interactions in SNMP



ASN.1 Notation

- Abstract Syntax Notation One (ASN.1) is a standard interface description language for defining data structures that can be serialized and deserialized in a cross-platform way.
- It is broadly used in telecommunications and computer networking, and especially in cryptography

- ASN.1 is a data type declaration notation. It does not define how to manipulate a variable of such a type.
  - Manipulation of variables is defined in other languages such as SDL (Specification and Description Language) for executable modeling or TTCN-3 (Testing and Test Control Notation) for conformance testing.
  - Both these languages natively support ASN.1 declarations. It is possible to import an ASN.1 module and declare a variable of any of the ASN.1 types declared in the module.

```
DemoProtocol DEFINITIONS ::= BEGIN

    DemoQ ::= SEQUENCE {
        trackingNumber INTEGER,
        question       IA5String
    }

    DemoA ::= SEQUENCE {
        questionNumber INTEGER,
        answer         BOOLEAN
    }

END
```

- ASN.1 is a joint standard of the International Telecommunication Union Telecommunication Standardization Sector (IT`U-T) in ITU-T Study Group 17 and ISO/IEC

MIBS

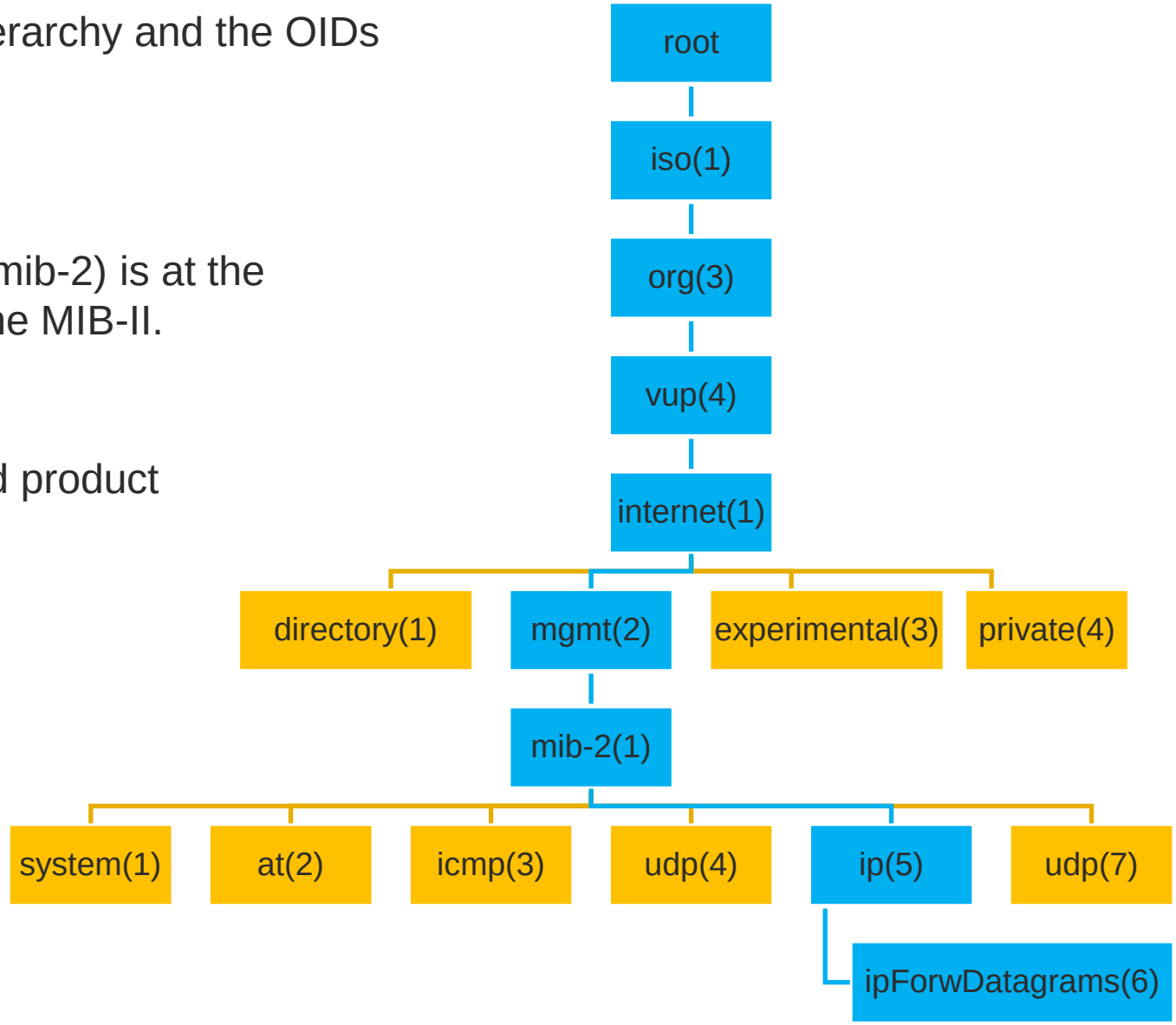
- A MIB specifies the managed objects
- MIB is a text file that describes managed objects using the syntax of ASN.1 (Abstract Syntax Notation 1)
- ASN.1 is a formal language for describing data and its properties
- In Linux, MIB files are in the directory */usr/share/snmp/mibs*
  - *Multiple MIB files*
  - *MIB-II (defined in RFC 1213) defines the managed objects of TCP/IP networks*

Managed Objects

- Each managed object is assigned an object identifier (OID)
- The OID is specified in a MIB file.
- An OID can be represented as a sequence of integers separated by decimal points or by a text string:
  - Example:
    1.3.6.1.2.1.4.6.
    iso.org.dod.internet.mgmt.mib-2.ip.ipForwDatagrams
- When an SNMP manager requests an object, it sends the OID to the SNMP agent.

Organization of managed objects

- Managed objects are organized in a tree-like hierarchy and the OIDs reflect the structure of the hierarchy.
- Each OID represents a node in the tree.
- The OID 1.3.6.1.2.1 (iso.org.dod.internet.mgmt.mib-2) is at the top of the hierarchy for all managed objects of the MIB-II.
- Manufacturers of networking equipment can add product specific objects to the hierarchy.



Definition of managed objects in a MIB

- Specification of ipForwDatagrams in MIB-II.

ipForwDatagrams OBJECT-TYPE

SYNTAX Counter
ACCESS read-only
STATUS mandatory
DESCRIPTION

"The number of input datagrams for which this entity was not their final IP destination, as a result of which an attempt was made to find a route to forward them to that final destination. In entities which do not act as IP Gateways, this counter will include only those packets which were Source-Routed via this entity, and the Source- Route option processing was successful."

::= { ip 6 }

SNMP Messages

- SNMP manager and an SNMP agent communicate using the SNMP protocol
  - Generally: Manager sends queries and agent responds
  - Exception: Traps are initiated by agent.

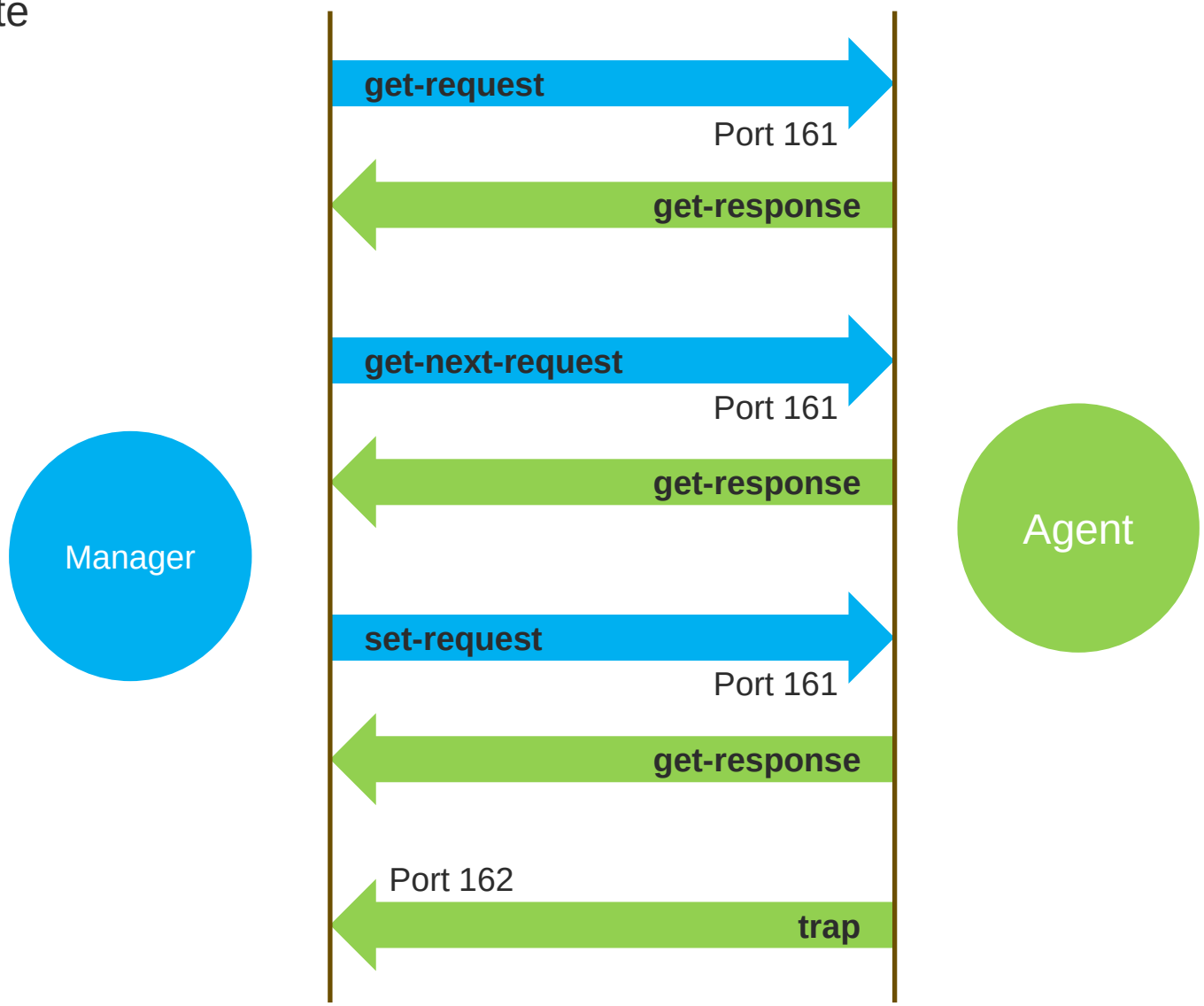
Get-request. Requests the values of one or more objects

Get-next-request. Requests the value of the next object, according to a lexicographical ordering of OIDs.

Set-request. A request to modify the value of one or more objects

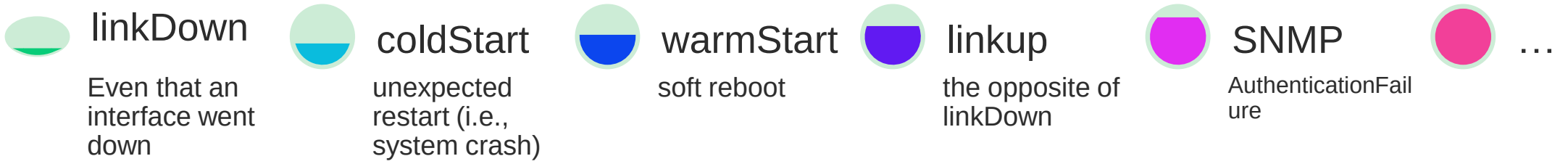
Get-response. Sent by SNMP agent in response to a *get-request, get-next-request, or set-request* message.

Trap. An SNMP trap is a notification sent by an SNMP agent to an SNMP manager, which is triggered by certain events at the agent.



Traps

- Traps are messages that asynchronously sent by an agent to a manager
- Traps are triggered by an event
- Examples of Defined traps are



SNMP Versions

- Three versions are in use today:

SNMPv1

1990

SNMPv2c

- 1996
- Adds “GetBulk” function and some new types
- Adds RMON (remote monitoring) capability

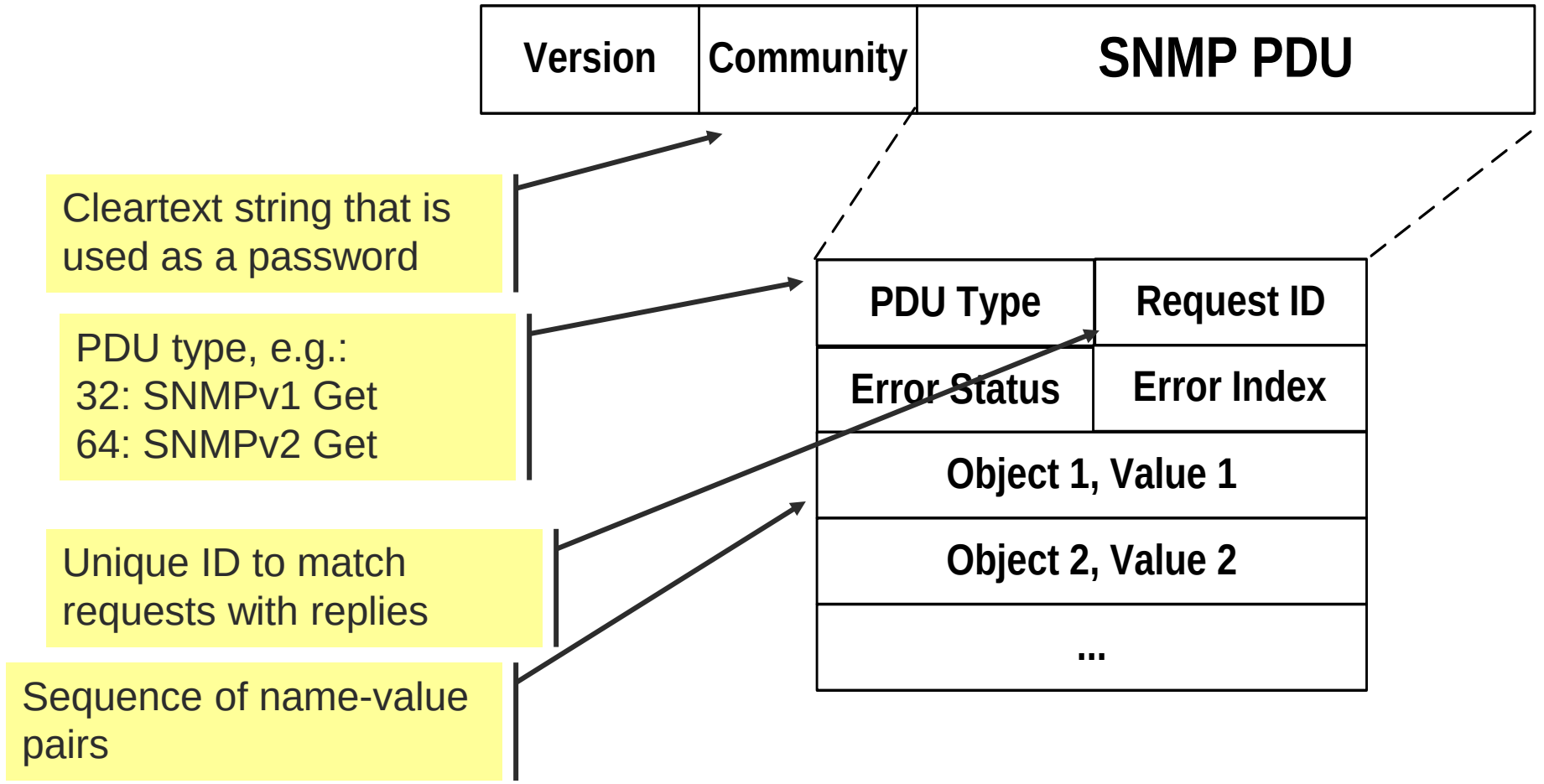
SNMPv3

- 2002
- SNMPv3 started from SNMPv1 (and not SNMPv2c)
- Addresses security

- All versions are still used today
- Many SNMP agents and managers support all three versions of the protocol.

Format of SNMP Packets

- SNMPv1 Get/Set messages:



SNMP Security

- SNMPv1 uses plain text community strings for authentication as plain text without encryption

- SNMPv2 was supposed to fix security problems, but effort de-railed (The “c” in SNMPv2c stands for “community”).

- SNMPv3 has numerous security features:

  - Ensure that a packet has not been tampered with (**integrity**),
  - Ensures that a message is from a valid source (**authentication**)
  - Ensures that a message cannot be read by unauthorized (**privacy**).

SNMP Security

- Security model of SNMPv3 has two components:

  1.Instead of granting access rights to a community, SNMPv3 grants access to users.

  2. Access can be restricted to sections of the MIB (V*ersion-based Access Control Module* (VACM). Access rights can be limited

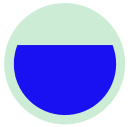
  - by specifying a range of valid IP addresses for a user or community,
  - or by specifying the part of the MIB tree that can be accessed.

Security levels in SNMPv2

- SNMP has three security levels:

noAuthNoPriv

Authentication with matching a user name



authNoPriv

Authentication with MD5 or SHA message digests

authPriv

Authentication with MD5 or SHA message digests, and encryption with DES encryption

- Compare this to SNMPv1 and SNMPv2c:
  - SNMPv1, SNMPv2: Authentication with matching a community string.

IT601 – System and Network Administration

Email Services

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Email Service

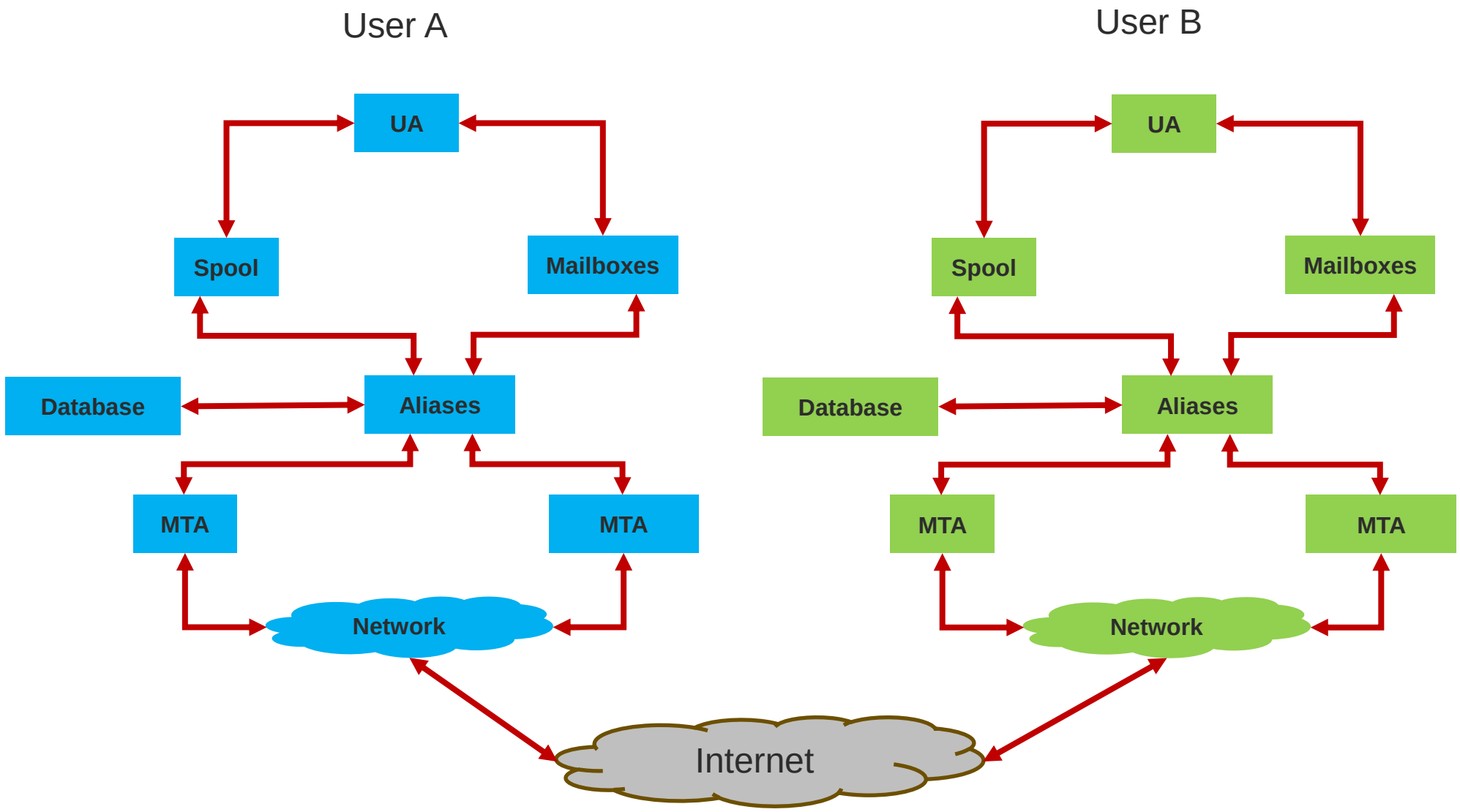
- Email (electronic mail) is a way to send and receive messages across the Internet. It's similar to traditional mail, but it also has some key differences.
- Elements of Email

Addresses	Delivery	Time
• Traditional mail service uses postal addresses that consists of name, house no, street address, city, state and country. • Sender postal address • Receiver postal address • Different formats	• Traditional mail is sent as sealed envelope and dropped in local mailbox. • Sender -> sMailbox -> rMailbox -> Receiver • User physical transport means and involves the courier services	• Takes time to reach destination.

• Email address use a standard format.
  • Standard format consist of username and email server address joined by @.
  • Uses passwords or other authentication mechanisms
	• Email is sent from sender device to sender mailbox on providers premises.
	• Mailboxes implements IMAP or POP3 to retrieve emails.
	• senderDevice ->sSMTP ->rSMTP
	• Transmission is encrypted
		• Instantly delivered to receiver

Email Architecture

- **Components**
  - Email Client
  - Email Server
  - Mailboxes
  - MTA
  - Spool
  - Network
- **Protocols**
  - SMTP
  - SSL/TLS
  - IMAP
  - POP3
  - IP



Email Service Components

- Normally a program which is used to send and receive mail
- Examples are Outlook, Thunderbird etc.
- Should support Email Operations

Email Client

- This file contains mails that are to be sent.
- User agent appends outgoing mails in this file using SMTP.
- MTA extracts pending mail from spool file for their delivery.
- E-mail allows one name, an alias, to represent several different e-mail addresses.
- It is known as mailing list, Whenever user have to sent a message, system checks recipient's name against alias database.

Spool

- responsible for transfer of mail from one system to another.
- To send a mail, a system must have client MTA and system MTA.
- The delivery from MTA to another MTA is done by SMTP Protocol

MTA

- it is used as a blanket term for both mail transfer agents (MTA) and mail delivery agents (MDA), each of which perform a slightly different function

Mail Server

- A local file to collect mails.
- Delivered mails are in this file.
- To use e-mail system Users must have a mailbox .
- Access to mailbox is only to owner of mailbox.

Mailbox

MTA used IP networks to deliver email.

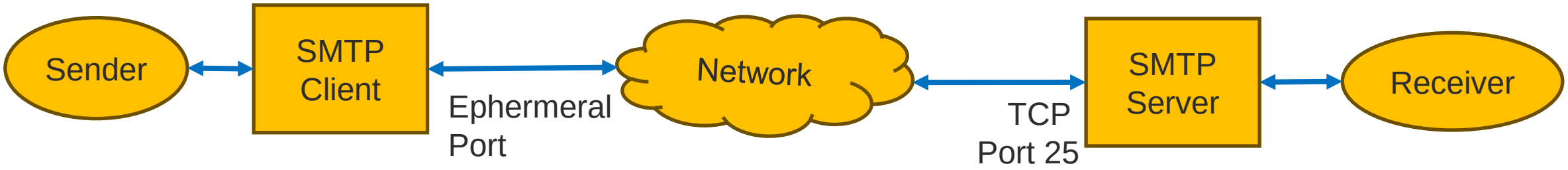
Network

Email Service Protocols

SMTP	POP	IMAP	SSL/TLS	IP
• SMTP stands for Simple Mail Transfer Protocol. • SMTP is the principal email protocol that is responsible for the transfer of emails between email clients and email servers.	• POP stands for Post Office Protocol. • Email clients use the POP protocol support in the server to download the emails. • This is primarily a one-way protocol and does not sync back the emails to the server.	• IMAP stands for Internet Message Access Protocol. • IMAP Protocol is used to sync the emails in the server with the email clients. • It allows two-way sync of emails between the server and the email client, while the emails are stored on the server.	• SSL/TLS certificates are used to authenticate and encrypt emails	• IP protocol is underlyaing network protocols

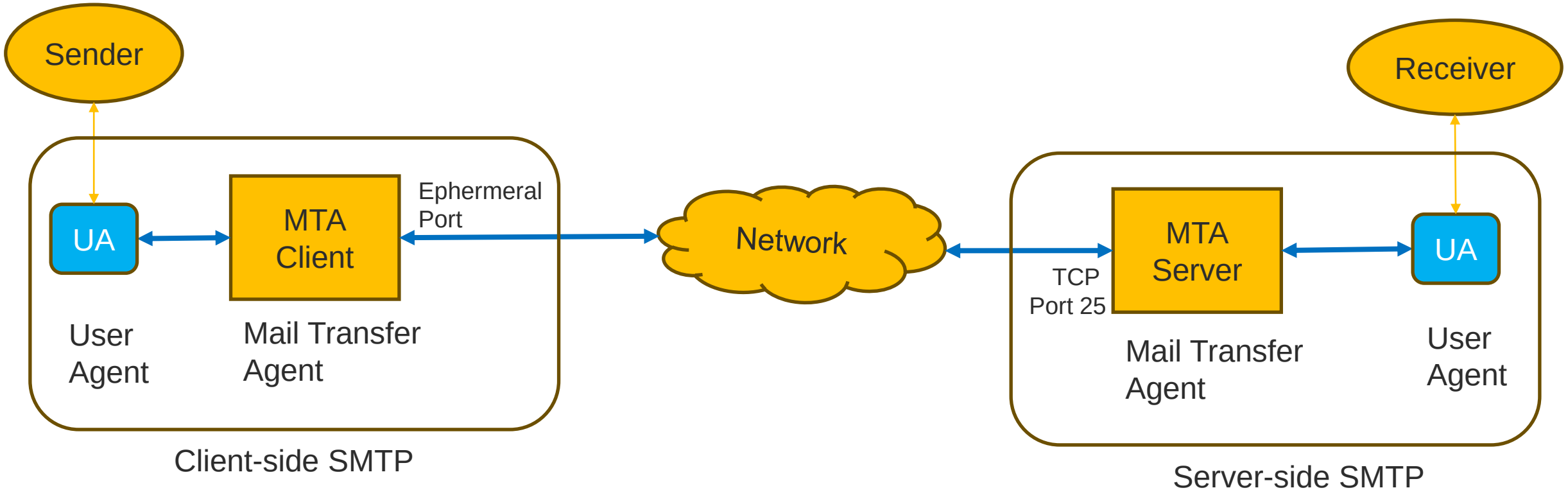
SMTP Protocol

- It developed in 1982 in rfc0821 by Jon Postel
- Basic Purpose: To transfer mail reliably and efficiently
- Basic Architecture



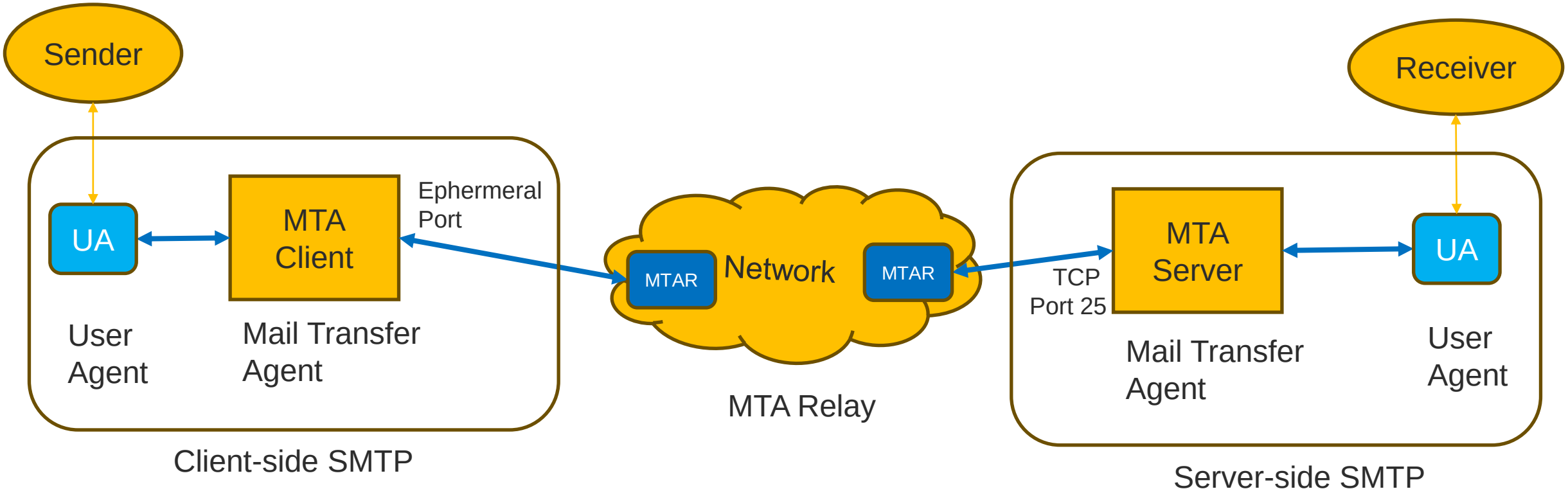
SMTP : UA and MTA

- **SMTP clients and servers have two main components**
  - User Agents – Prepares the message, encloses it in an envelope. (Eudora for example)
  - Mail Transfer Agent – Transfers the mail across the internet
- **These components are required on both sides.**



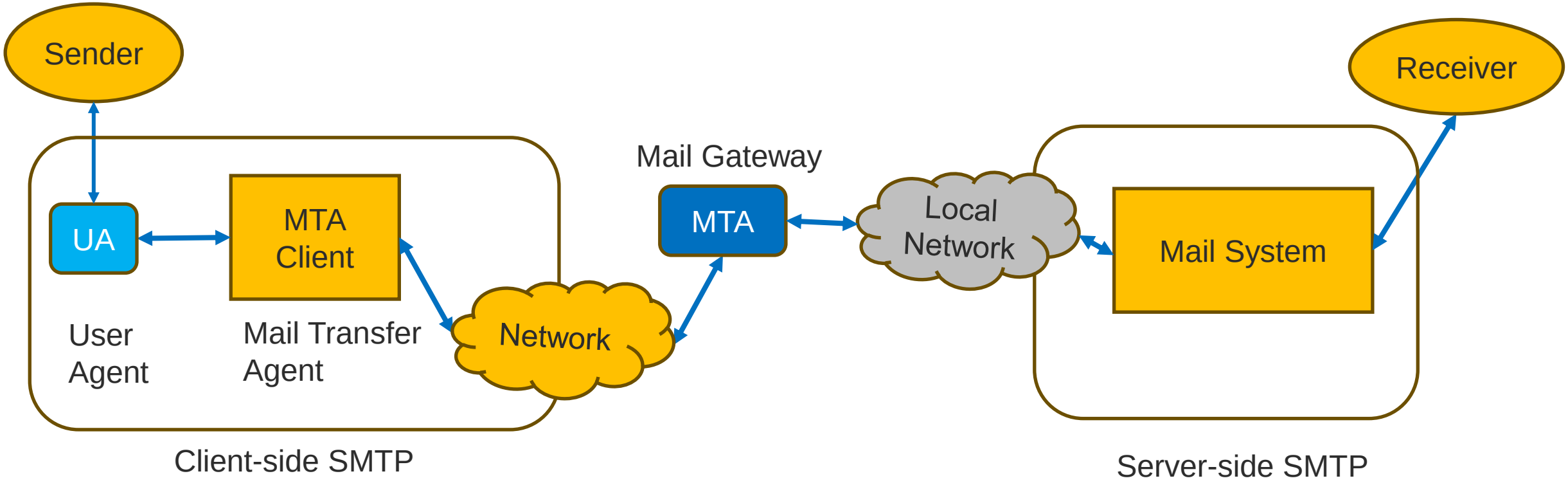
SMTP Relaying

- **SMTP also allows the use of Relays allowing other MTAs to relay the mail**



SMTP Gateway

- **Mail Gateways are used to relay mail prepared by a protocol other then SMTP and convert it to SMTP**



Email Structure

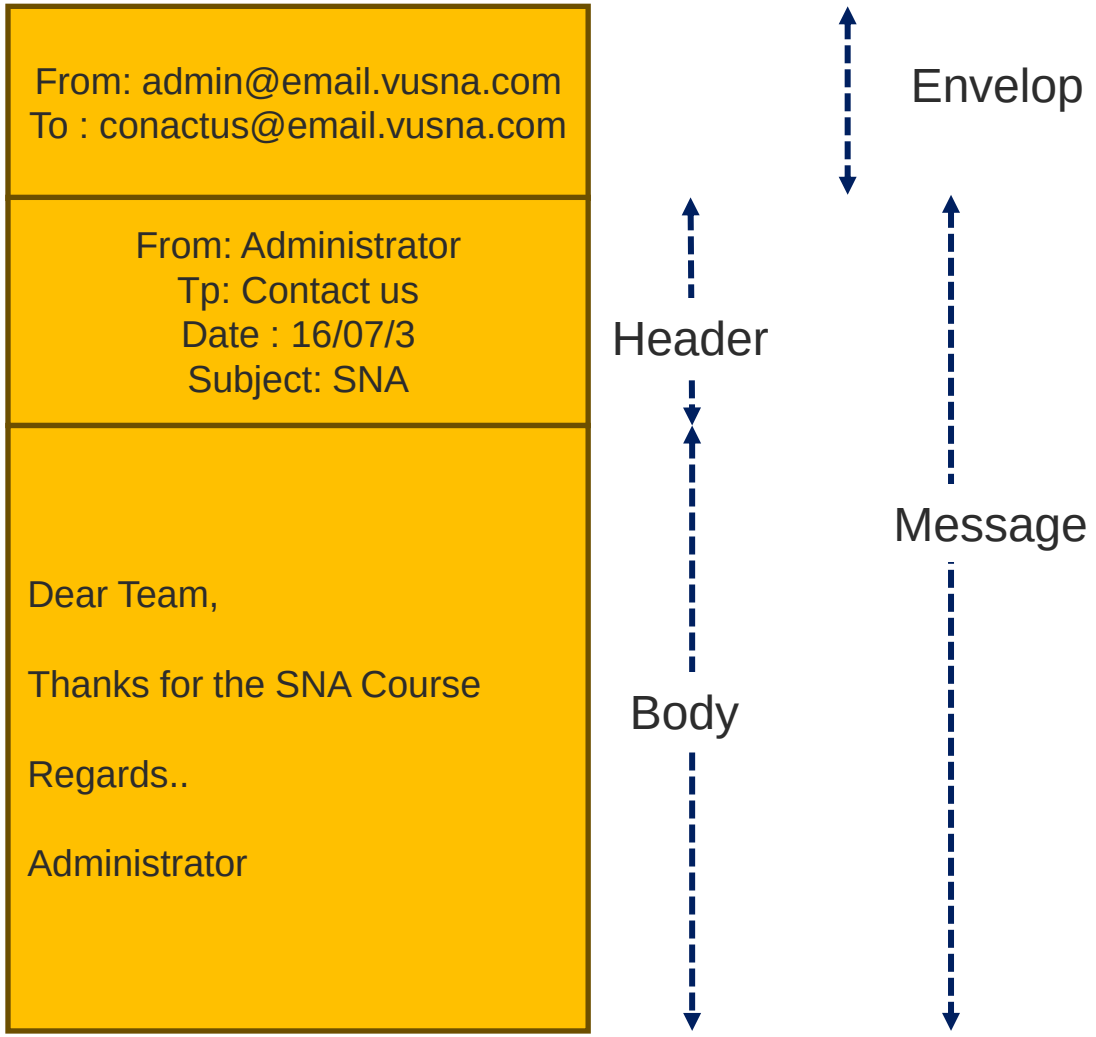
- Mail is a text file

Envelope –

- sender address
- receiver address
- other information

Message –

- Mail Header – defines the sender, the receiver, the subject of the message, and some other information
- Mail Body – Contains the actual information in the message



Email Delivery Example

POP Mailbox

POP mail route

Receiver Mailbox

```
Return-Path: <admin@email.vusna.com>
Delivered-To: admin@email.vusna.com

Received: by email.vusna.com (Postfix, from userid 62)
        id 17FBD328DE; Wed,  16 July 2023 11:27:02
Received: from email.vusna.com
        (email.vusna.com [192.168.19.9])
        by email.vusna.com (Postfix) with ESMTP id
        5F41832893 for <admin@email.vusna.com>; Wed,  16    July 2023
        11:27:01
Received: by email.vusna.com (Postfix, from userid  62)id 47509456C;
Wed,  5 Nov 2003 11:27:01
Received: from email.vusna.com(email.vusna.com     [192.168.19.9])by
email.vusna.com (Postfix)          with SMTP id 7C2943D79 for <admin@
email.vusna.com>; Wed,  16 July 2023 11:26:34
Message-Id: <30031105162634.3C2943D79@ email.vusna.com>
Date: Wed,  5 Nov 2003 11:26:34
From: admin@email.vusna.com
To: admin@email.vusna.com: ;

MIME-Version: 1.0

Welcome to IT601P course.
```

How SMTP works (A-PDU's)

- The Essentials Commands are

HELO

DNS of Sender host

Identifies the domain name of the sending host to SMTP

MAIL FROM

Sender Email Address

RCPT TO

Receiver Email Address

DATA

Message Body

QUIT

Close

How SMTP works (A-PDU's)

- The Additional Commands are

RSET
Reset

VRFY
Verify Name

NOOP
No operation

Used for testing purpose

TURN
The roles of server and client to be reversed in a session

EXPN
Mailing list

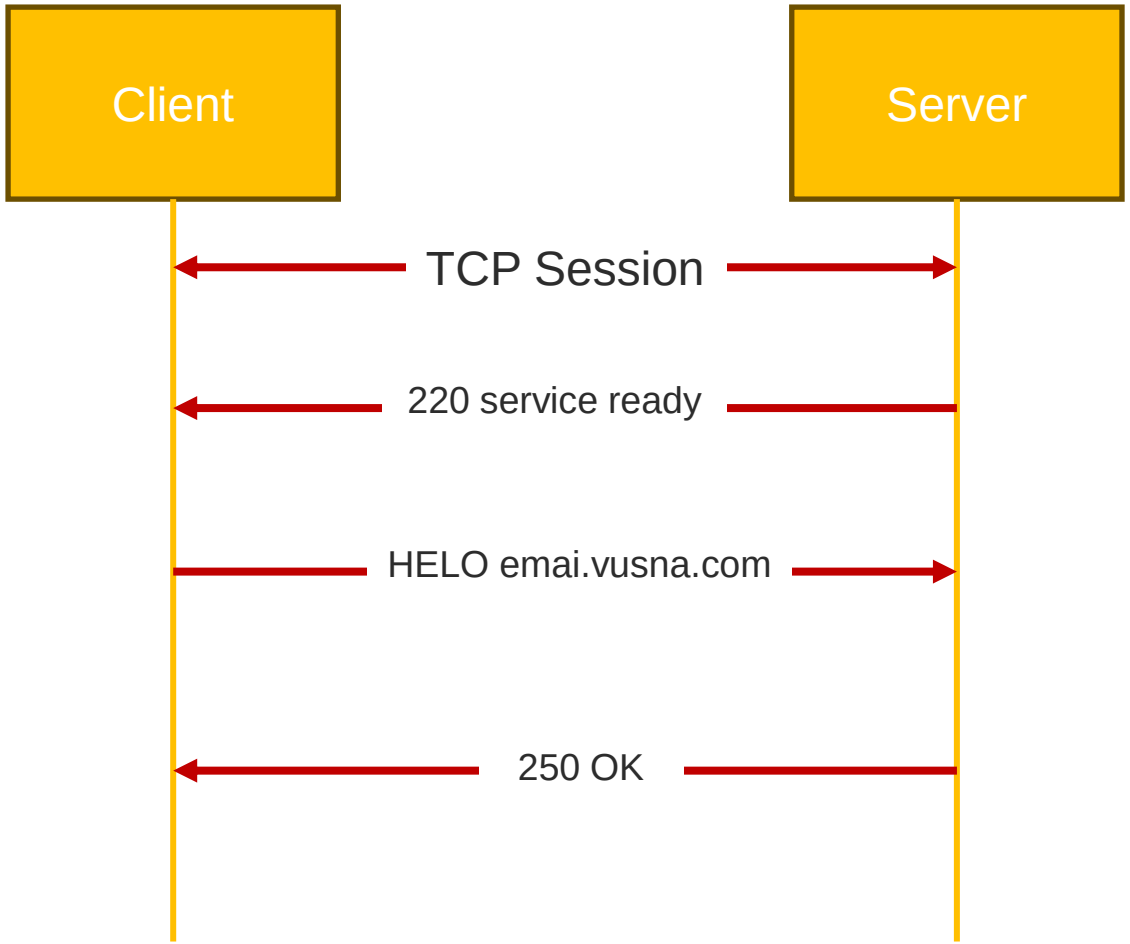
HELP
Command Name

Status Codes

The Server responds with a 3 digit code that may be followed by text info

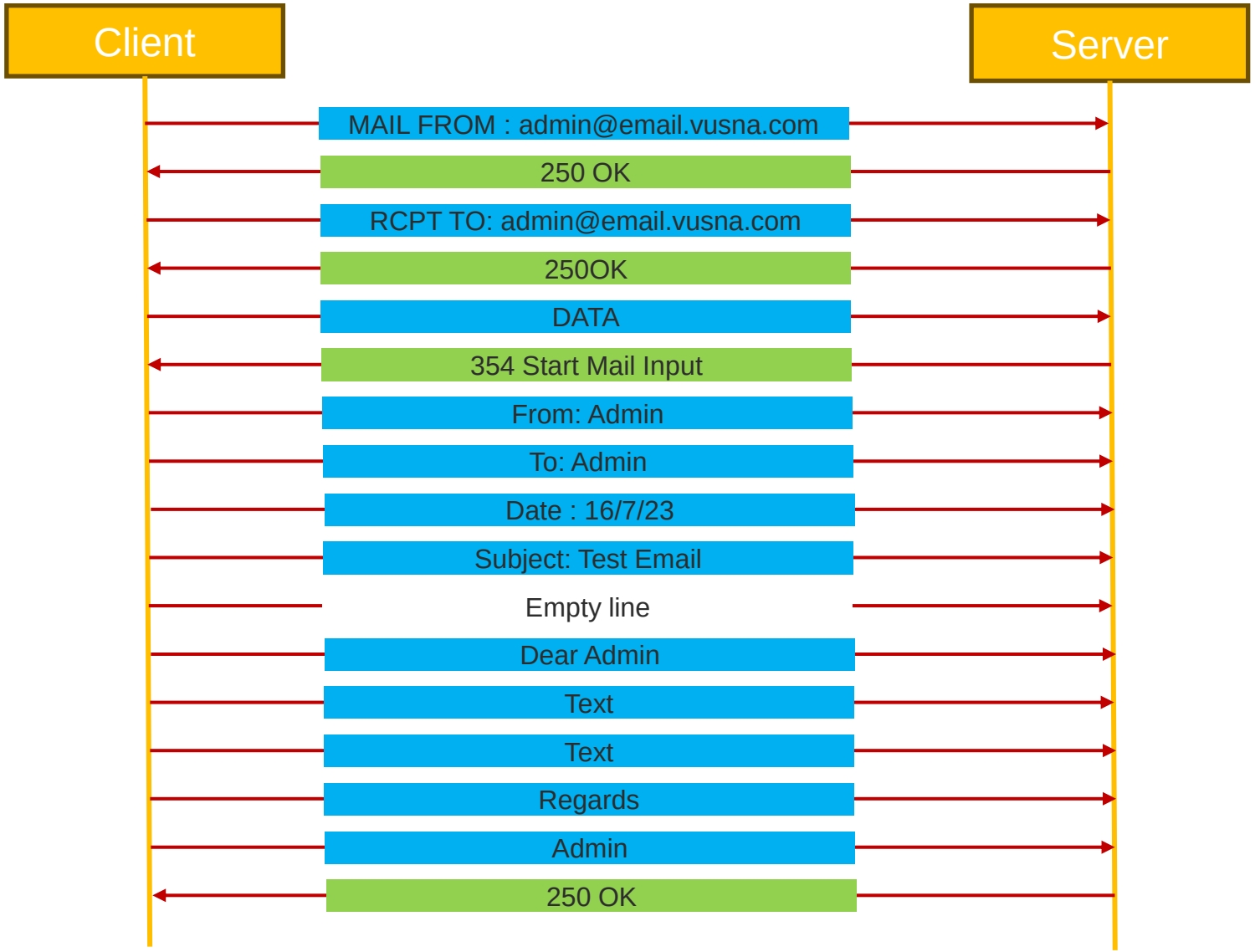
2## - Success
3## - Command can be accepted with more information
4## - Command was rejected, but error condition is temporary
5## - Command rejected, Bad User!

SMTP MTA Connection Establishment

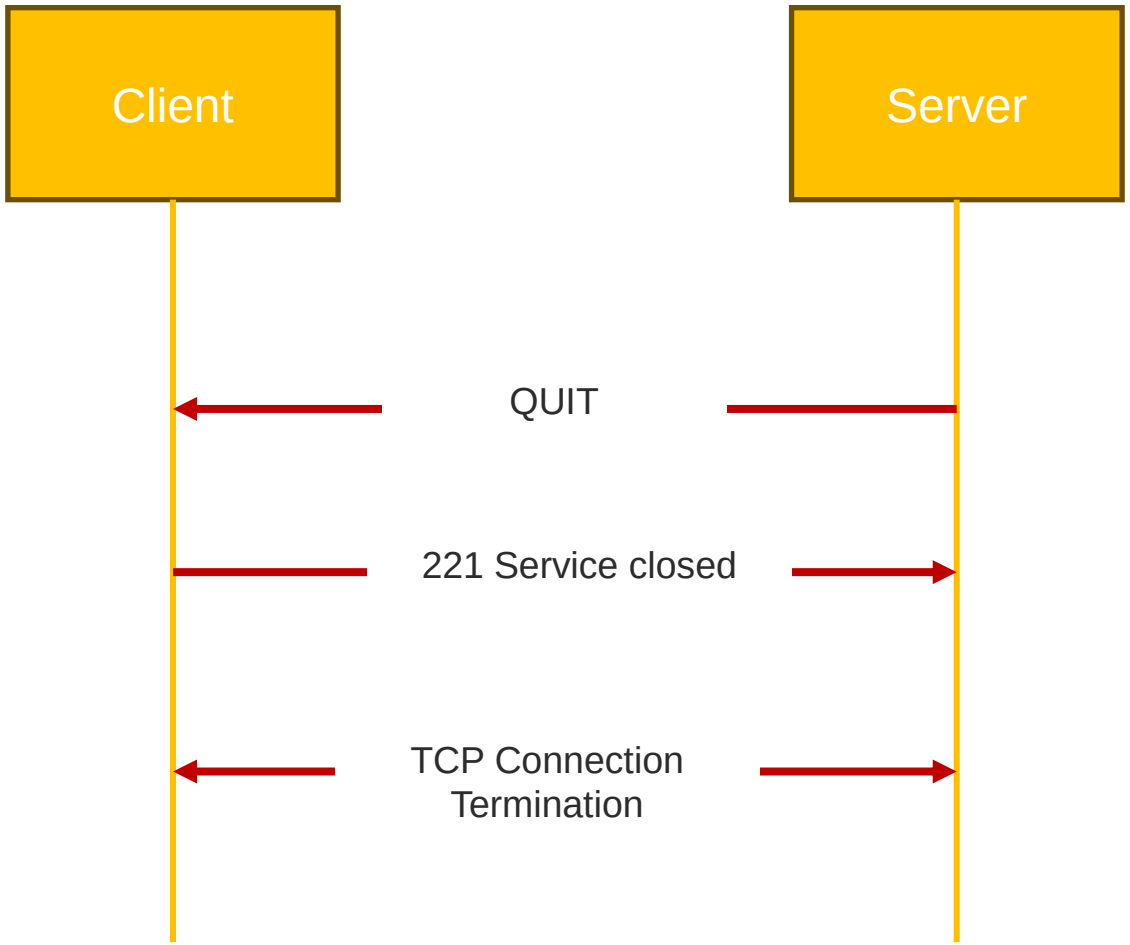


Message Progress

- Email sending sequences are are followed.



Connection Termination



Problems with SMTP

- No security
  - Authentication
  - Encryption
- Possible Solutions:
  - VRFY command
  - Signature
- Only uses Non Virtual Terminal (NVT) 7 bit ASCII format
- Emails can easibly forged

Extensions to SMTP

- MIME – Multipurpose Internet Mail Extensions
  - Transforms non-ASCII data to NVT (Network Virtual Terminal) ASCII data
    - Text
    - Application
    - Image
    - Audio
    - Video

MIME Headers

- Goes between the Email Header and Body
  - MIME-Version: 1.1
  - Content-Type
  - Content-Transfer-Encoding
  - Content-Id
  - Content-Description

MIME Headers

- Content-Type – Type of data used in the body of the message
  - Text – plain, unformatted text; HTML
  - Multipart – Body contains multiple independent parts
  - Message – The body is whole mail message, part of a message, or a pointer to a message

MIME Headers

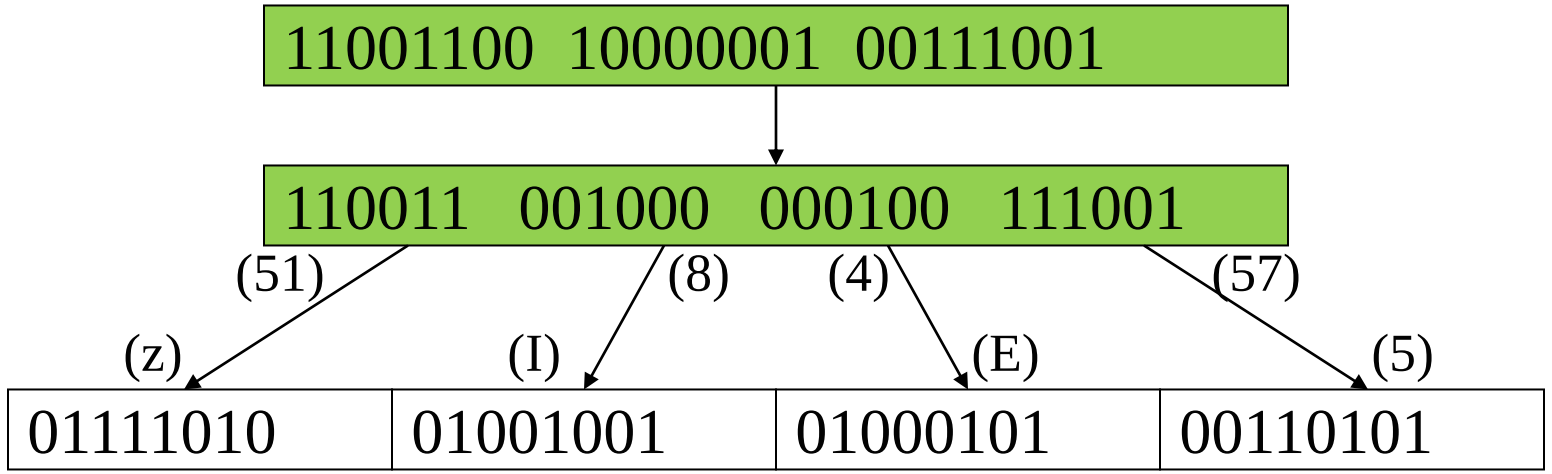
- Image – The message is a stationary e.g image (JPEG or GIF)
- Video – The message is an animation e.g Mpeg
- Audio – The message is 8 kHz standard e.g audio data
- Application – The message is a type of data not previously defined

MIME Headers

- Content-Transfer-Encoding – The method used to encode the messages
  - 7 bit – no encoding needed
  - 8 bit – Non-ASCII, short lines
  - Binary – Non-ASCII, unlimited length lines
  - Base64 – 6 bit blocks encoded into 8-bit ASCII
  - Quoted-printable – send non-ASCII characters as 3 ASCII characters, =##, ## is the hex representation of the byte

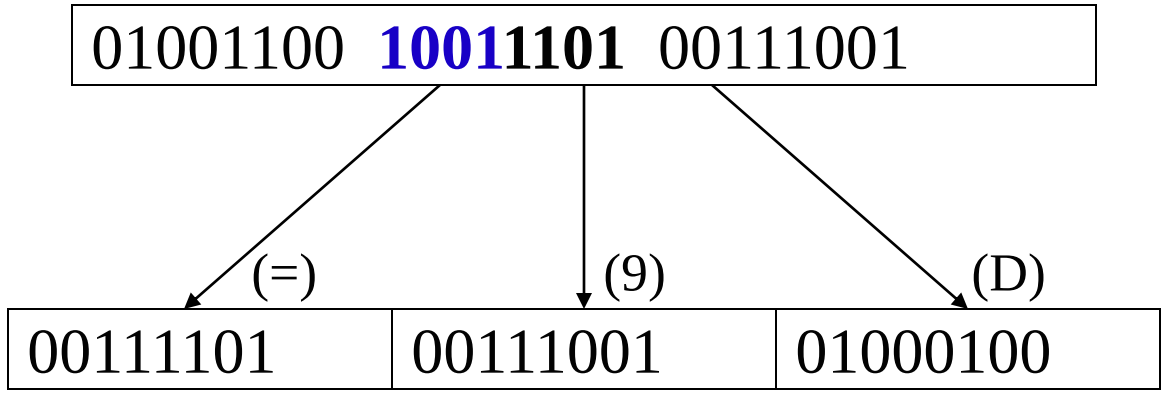
Base64 Encoding

- Divides binary data into 24 bit blocks
- Each block is then divided into 6 bit chunks
- Each 6-bit section is interpreted as one character causes 25% overhead



Quoted-Printable Encoding

- Used when the data has a small non-ASCII portion
- Non-ASCII characters are sent as 3 characters
- First is ‘=‘, second and third are the hex representation of the byte



MIME Headers

- The following headers are defined in MIME:

MIME-Version

MIME 1.0

Content-Type

Contains media type
And its subtype

Content-Transfer-Encoding

Base64
quoted-printable
7bit/8bit – no enc

Content-ID

identify body parts

Content-Disposition

how to present a message or a body part

Content-Description

Description of content

Content-Base

Special header

Content-Location

Special header

Example Multipart, Encoded MIME Message

From: admin@email.vusna.com
To: admin@email.vusna.com
Subject: Test Message
MIME-Version: 1.0
Content-Type: multipart/mixed; boundary=17

- 17
Content-Type: text/enriched; charset="us-ascii"
Content-Transfer-Encoding: 8bit
Content-Description: Greetings
Welcome to IT601P

- 17
Content-Type: application/octet-stream
Content-Transfer-Encoding: base64
Content-Description: Spec sheet saved as MS Word file
- 17 -

Mail Transfer Agents

- MTAs do the actual mail transfers
- MTAs are not meant to be directly accessed by users.
- MMDF
- SENDMAIL

Mail Access Protocols

- The MTAs place the email in the user’s mailbox
- The Mail Access Protocols are used by the users to retrieve the email from the mailbox
  - POP3
  - IMAP4

Post Office Protocol v3

- Simple
- Allows the user to obtain a list of their Emails
- Users can retrieve their emails
- Users can either delete or keep the email on their system
- Minimizes server resources

Internet Mail Access Protocol v4

- Has more features then POP3
- User can check the email header before downloading
- Emails can be accessed from any location
- Can search the email for a specific string of characters before downloading
- User can download parts of an email
- User can create, delete, or rename mailboxes on a server

Linux Packages for Email Service

- Postfix
- Courier-imap
- Dovecot
- E.t.c

Postfix

- It is Wietse Venema's mail server that started life at IBM research as an alternative to the widely-used Sendmail program. Now at Google, Wietse continues to support Postfix.

- Postfix attempts to be fast, easy to administer, and secure. The outside has a definite Sendmail-ish flavor, but the inside is completely different.

    - apt update
    - apt install postfix

Postfix Configuration Types

No configuration

- The installation process will not configure any parameters.

Internet Site

- Use Postfix for sending emails to other MTAs and receiving email from other MTAs.

Internet with smart host

- Uses postfix to receive email from other MTAs but using another smart host to relay emails to the recipient.

Satellite system

- Uses smart host for sending and receiving email.

Local only

- Uses emails are transmitted only between local user accounts.

Authentication

- **Configure mailbox location**

```
sudo postconf -e 'home_mailbox = Maildir/'
```

- **SMTP authentication**

SMTP-AUTH allows a client to identify itself through the Simple Authentication and Security Layer (SASL) authentication mechanism, using Transport Layer Security (TLS) to encrypt the authentication process. Once it has been authenticated, the SMTP server will allow the client to relay mail.

- **Configure SMTP authentication**

```
sudo postconf -e 'smtpd_sasl_type = dovecot'
sudo postconf -e 'smtpd_sasl_path = private/auth'
sudo postconf -e 'smtpd_sasl_local_domain ='
sudo postconf -e 'smtpd_sasl_security_options = noanonymous,noplaintext'
sudo postconf -e 'smtpd_sasl_tls_security_options = noanonymous'
sudo postconf -e 'broken_sasl_auth_clients = yes'
sudo postconf -e 'smtpd_sasl_auth_enable = yes'
sudo postconf -e 'smtpd_recipient_restrictions = \
permit_sasl_authenticated,permit_mynetworks,reject_unauth_destination'
```

TLS

- **Configure TLS**
  - Obtain a digital certificate for TLS. MUAs connecting to your mail server via TLS will need to recognize the certificate used for TLS. This can either be done using a certificate from Let's Encrypt, from a commercial CA or with a self-signed certificate that users manually install/accept.
  - For MTA-to-MTA, TLS certificates are never validated without prior agreement from the affected organizations.
  - For MTA-to-MTA TLS, there is no reason not to use a self-signed certificate unless local policy requires it. See our guide on security certificates for details about generating digital certificates and setting up your own Certificate Authority (CA).
  - Once you have a certificate, configure Postfix to provide TLS encryption for both incoming and outgoing mail:

```
sudo postconf -e 'smtp_tls_security_level = may'
sudo postconf -e 'smtpd_tls_security_level = may'
sudo postconf -e 'smtp_tls_note_starttls_offer = yes'
sudo postconf -e 'smtpd_tls_key_file = /etc/ssl/private/server.key'
sudo postconf -e 'smtpd_tls_cert_file = /etc/ssl/certs/server.crt'
sudo postconf -e 'smtpd_tls_loglevel = 1'
sudo postconf -e 'smtpd_tls_received_header = yes'
sudo postconf -e 'myhostname = mail.example.com'
```

SASL

Postfix supports SMTP-AUTH as defined in RFC2554. It is based on SASL. However it is still necessary to set up SASL authentication before you can use SMTP-AUTH.

Configure SASL

Postfix supports two SASL implementations: Cyrus SASL and Dovecot SASL.

To enable Dovecot SASL the dovecot-core package will need to be installed:

```
sudo apt install dovecot-core
```

Configure SASL

Next, edit /etc/dovecot/conf.d/10-master.conf and change the following:

```
service auth {
unix_listener auth-userdb {
    #mode = 0600
    #user =
    #group =
  }

  # Postfix smtp-auth
  unix_listener /var/spool/postfix/private/auth {
    mode = 0660
    user = postfix
    group = postfix
  }
 }
```

auth_mechanisms = plain login

sudo systemctl restart dovecot.service

IT601 – System and Network Administration

Database Services

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Database Services

- **Database is essential to any web-based application for saving records and user data. A database is an organized collection of data so that it can be easily accessed. To manage these databases, Database Management Systems (DBMS) are used.**

- **Types of DBMS**

  In general, there are two common types of databases:
  - Non-Relational
  - Relational

- **Non-Relational Database Management System (Non-RDBMS)**
  - In Non-RDBMS, data is stored in key-value pairs. For example:

    ```
    Customers = [ {id: 1, name=furqan, age=40}, {id=2,name=aisha,age=22}]
    ```

  - Commonly used Non-RDBMS: MongoDB, Amazon DynamoDB, Redis, ES etc.

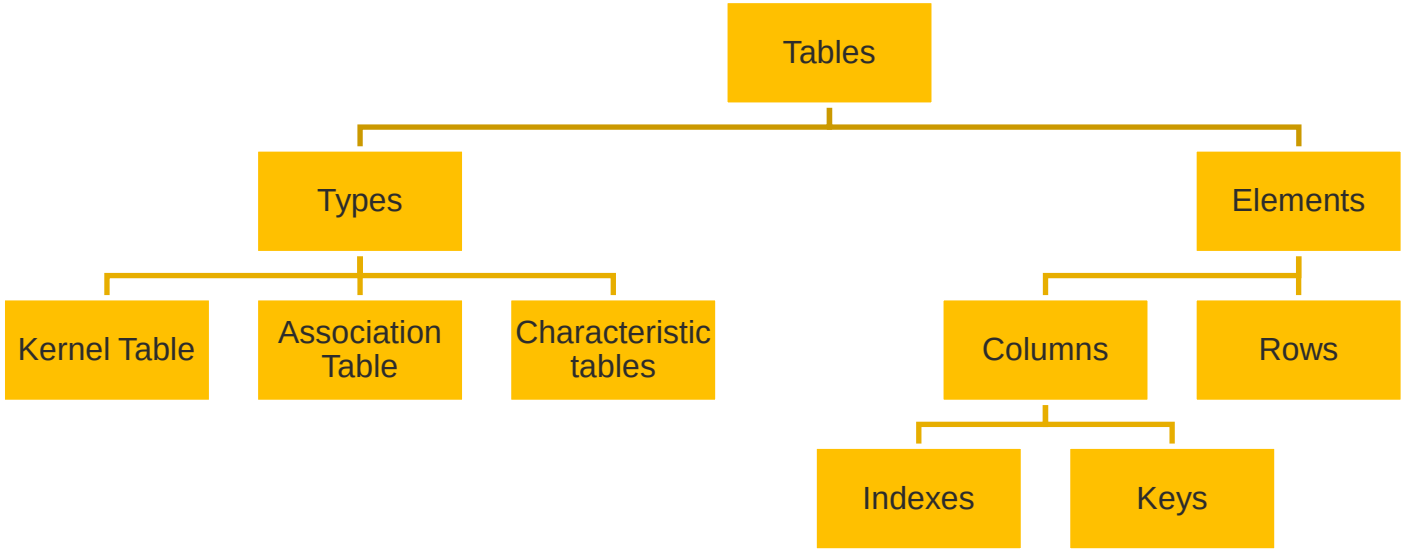
- **In RDBMS, data is stored in tabular format. For example,**

ID	Name	Age
1	Furqan	40
2	Aisha	22

  - Commonly used RDBMS: MySQL, PostgreSQL, MSSQL, Oracle etc.

Elements of Relational Databases

- Relational databases are based on the relational model.
  - The relational model is a group of rules set forth by E. F. Codd based on mathematical principles (relational algebra), and it defines how database management systems should function.
  - The basic structures of a relational database (as defined by the relational model) are tables, columns (or fields), rows (or records), and keys.



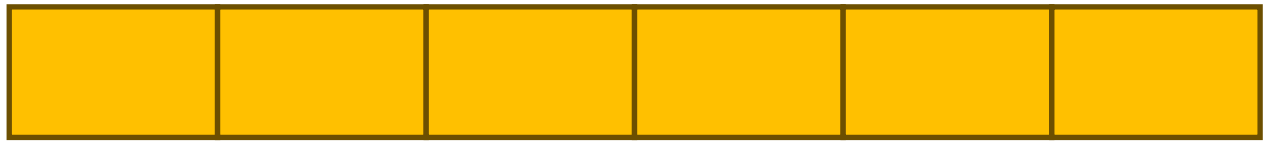
Types of Tables

Tables are generally grouped into three types:

Kernel tables	Association tables	Characteristic tables
• Tables that are independent entities. Kernel tables often represent or model things that exist in the real world. • Some example kernel tables are customers, vendors, employees, parts, goods, and equipment.	• Tables that represent a relationship among entities. • For example, an order represents an association between a customer and goods.	• Tables whose purpose is to qualify or describe some other entity. • Characteristic only have meaning in relation to the entity they describe. • For example, order-lines might describe orders; without an order, an order-line is useless.

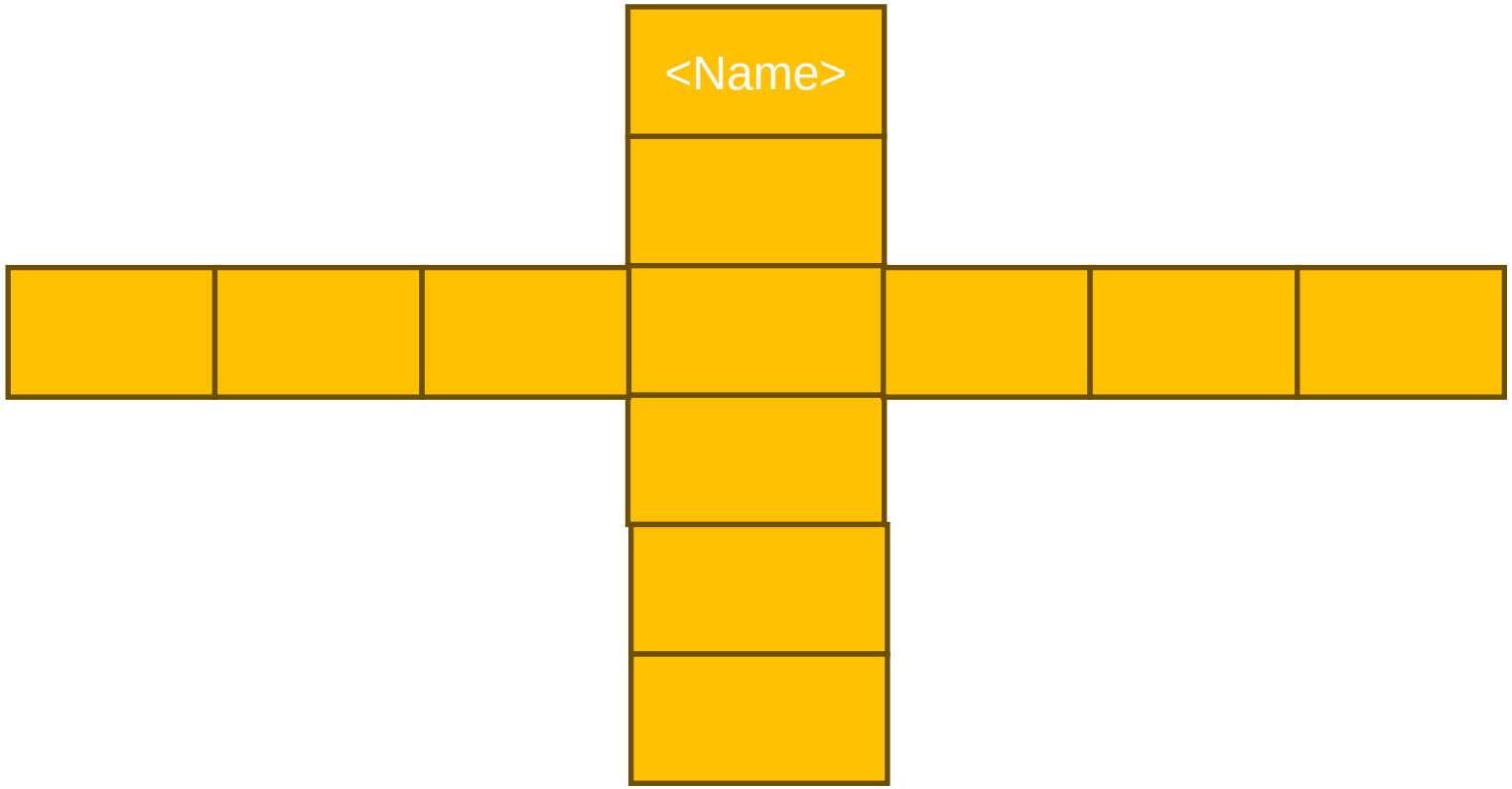
Elements of Tabe : Row

- A row is a single occurrence of the data contained in a table; each row is treated as a single unit. In the Customer table image in Tables, there are four rows, and each row contains information about an individual customer.



Elements of Tabe : Column

- Rows are organized as a set of columns (or fields). All rows in a table comprise the same set of columns. In the Customer table image in Tables, the columns are Cust Number, Name, and Street.



Elements of Tabe : Keys

- **Keys identify a unique row**

Primary key

- A primary key is a column (or group of columns) whose value uniquely identifies each row in a table. Because the key value is always unique, you can use it to detect and prevent duplicate rows.
- A good primary key has the following characteristics:

❑ mandatory
❑ unique
❑ stable
❑ short

Foreign Key

- A foreign key is a column value in one table that is required to match the column value of the primary key in another table.
- If the foreign key value is not null, then the primary key value in the referenced table must exist.
- It is this relationship of a column in one table to a column in another table that provides the relational database with its ability to join tables.

Elements of Tabe : Indexes

- An index in a database operates like the index tab on a file folder. It points out one identifying column, such as a customer's name, that makes it easier and quicker to find the information you want.
  - A single column can be used to define a simple index, or a combination of columns to define a composite or compound index.
  - To decide which columns to use, you first need to determine how the data in the table is accessed.
  - If users frequently look up customers by last name, then the last name is a good choice for an index. It is typical to base indexes on primary keys

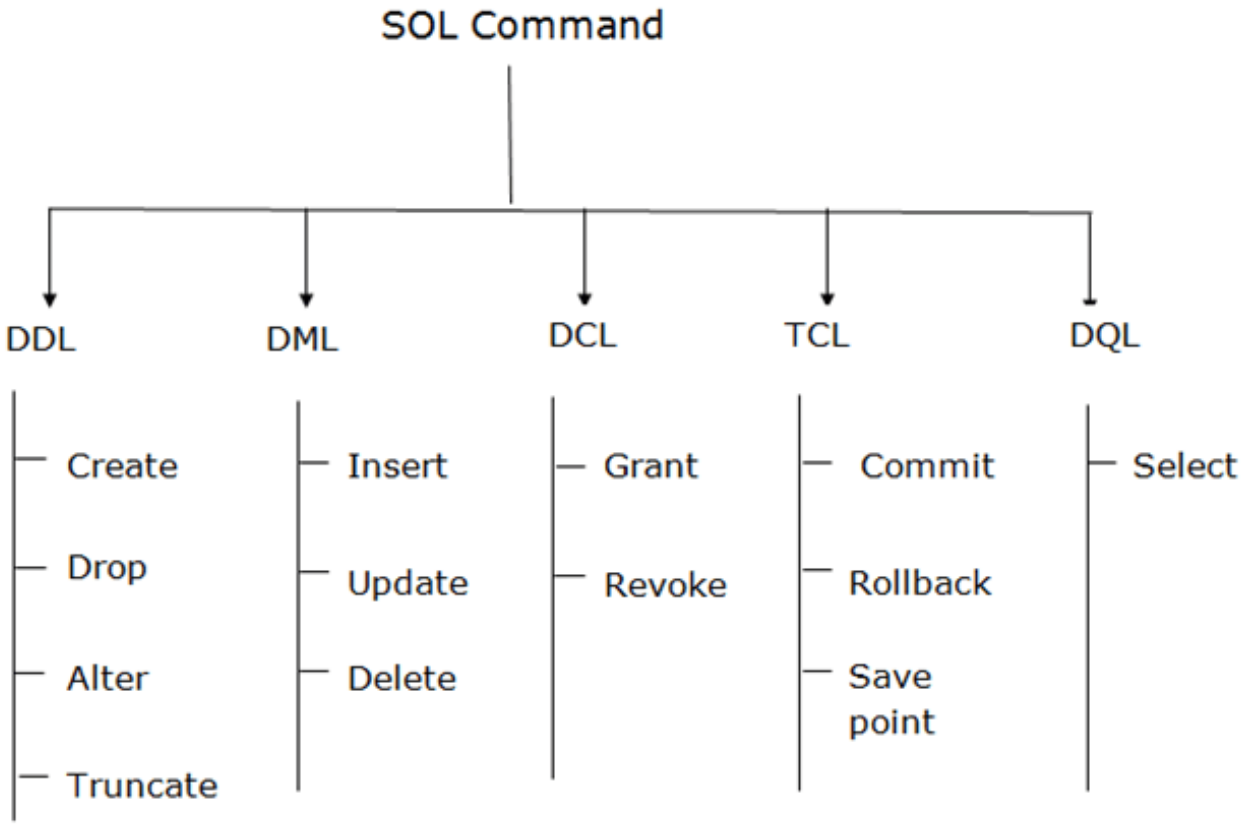
Database Schema

- **A database schema defines how data is organized within a relational database.**
  - It covers logical constraints such as, table names, fields, data types, and the relationships between these entities.
- **Schemas commonly use visual representations to communicate the architecture of the database, becoming the foundation for an organization's data management discipline.**
- **Types of database schemas**

Conceptual schema	Logical schema	Physical schema
• It provides a big-picture view of what the system will contain, how it will be organized, and which business rules are involved. • Conceptual models are usually created as part of the process of gathering initial project requirements.	• It is less abstract, compared to conceptual schemas. • It clearly define schema objects with information, such as table names, field names, entity relationships, and integrity constraints.	• It provide the technical information that the logical database schema type lacks in addition to the contextual information, such as table names, field names, entity relationships, et cetera.

Strcutured Query Language

- **Structured Query Language (SQL) is a standard query language that is used to work with relational databases.**
  - The SQL is used to perform several operations.
  - SQL queries are general divided into 5 classes
    - Data Definition Language (DDL)
    - Data Manipulation Language (DML)
    - Data Control Language(DCL)
    - Transaction Control Language(TCL)
    - Data Query Language (DQL)



- **Example : SELECT first_name, last_name FROM Customers;**

- SQL is generally used with relational databases, however there is no standard way of using non-relational databases

MYSQL

- MySQL is a very popular open-source relational database management system (RDBMS).

  - MySQL is a relational database management system
  - MySQL is open-source
  - MySQL is free
  - MySQL is ideal for both small and large applications
  - MySQL is very fast, reliable, scalable, and easy to use
  - MySQL is cross-platform
  - MySQL is compliant with the ANSI SQL standard
  - MySQL was first released in 1995
  - MySQL is developed, distributed, and supported by Oracle Corporation
  - MySQL is named after co-founder Monty Widenius's daughter: My

- Applications

  - Huge websites like Facebook, Twitter, Airbnb, Booking.com, Uber, GitHub, YouTube, etc.
  - Content Management Systems like WordPress, Drupal, Joomla!, Contao, etc.
  - A very large number of web developers around the world

Common RDBMS

- MySQL,
- Microsoft SQL Server
- Oracle
- Microsoft Access.

Installing MYSQL Server

- **Installation MySQL Service**

```
sudo apt update
```

```
sudo apt install mysql-server
```

```
mysql --version
```

- **Secure MySQL Service**

```
sudo mysql_secure_installation
```

  - **Add a Dedicated MySQL User**

```
sudo mysql
```

```
mysql> CREATE USER ‘<username>’@’<hostname>' IDENTIFIED WITH authentication_plugin BY 'password';
```

```
mysql> CREATE USER ‘<username>’@’<hostname>' IDENTIFIED BY 'password';
```

Installing MYSQL Server

- **Grant Privileges to Secure MySQL**

```
mysql> GRANT PRIVILEGE ON database.table TO 'username'@'host';
```

```
GRANT CREATE, ALTER, DROP, INSERT, UPDATE, DELETE, SELECT, REFERENCES, RELOAD
on *.* TO ‘username'@'localhost' WITH GRANT OPTION;
```

```
FLUSH PRIVILEGES;
```

- **Managing MySQL Service**

```
systemctl status mysql.service
```

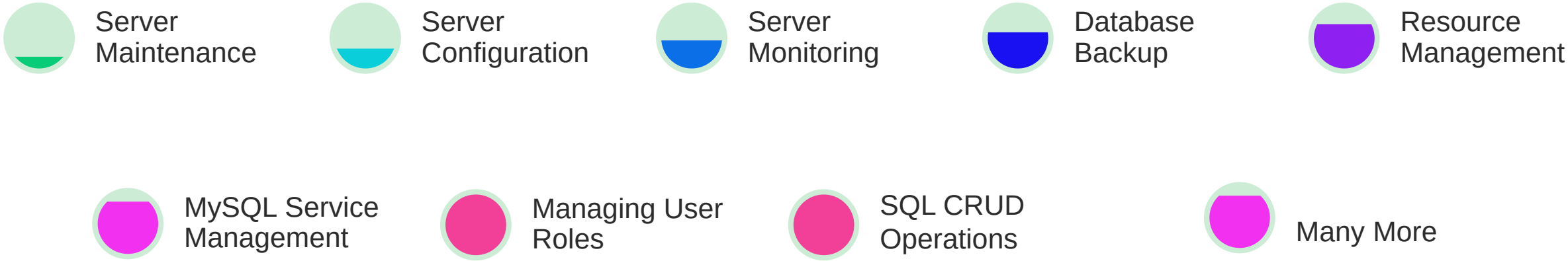
```
systemctl start|restart|enable mysql.service
```

- **Log in to your MySQL Server**

```
sudo mysql -u root
```

Use of mysqladmin

- mysqladmin package used by Database Administrators to easily perform basic tasks in MySQL.
- It has several valuable tools which can be used for

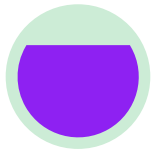


Common Tasks Performed with mysqladmin

- mysqladmin has a controlled set of procedures and workflow. It can perform Database operations and queries with the help of standard and easy-to-use Structured Query Language (SQL).
  - It assigns users permissions to work on the Database Server Management and Maintenance activities.
  - Here are some of the important tasks that can be performed with mysqladmin.

Monitor MySQL Server processes

Create and drop Databases in MySQL Server

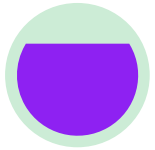


Flush information logs, statistics, status variables, and tables

Reload/reset MySQL privileges

Kill running queries

Start and stop the server with backups



Start and stop replicas

Check server configuration and status

Benefits of mysqladmin

- Below are some of the advantages of mysqladmin.

  - Provides defined and improved structure of settings vital for the performance of the MySQL Server.
  - Visualize the flow by displaying a graphical representation, making it easy for users to read, interpret, and fine-tune the settings of the MySQL Server.
  - Takes care of Security Risk Management, hence you can feel super safe working around your data.
  - Easily import and export data files from the MySQL Server depending on the limited file size.
  - It maintains User Accounts, their Passwords, and is also capable of locking or unlocking users whenever needed.
  - It provides open-source flexibility and secure transactional support with high scalability and continuous uptime.

Administering MYSQL with mysqladmin

Create a new Database.	**create db_name**
Delete a Database.	drop db_name
Check the status of all MySQL Server variables.	extended-status
Flush all information in the host cache.	flush-hosts
Flush all tables.	refresh
Set a new password.	password new_password
Stop the server.	shutdown
Display the server variables.	variables
Change the MySQL Root Password	mysqladmin -u root password [New_Password]
Change the MySQL Root Password	mysqladmin -u root -pOld_Password password 'New_Password'
see if your MySQL server is up and running.	mysqladmin -u root -pPassword ping
Check MySQL Server Uptime	mysqladmin -u root -pPassword status
check the version of the MySQL server	mysqladmin -u root -pPassword version
Check the Status of a MySQL Server	mysqladmin -u root -pPassword status
Extended Status of a MySQL Server	mysqladmin -u root -pPassword extended-status
Check MySQL Server Variables	mysqladmin -u root -pPassword variables
Check the MySQL Process List	mysqladmin -u root -pPassword processlist
kill the MySQL client process	mysqladmin -u root -pPassword kill 195003

phpmyadmin

- Phpmyadmin is an Web based alternative to mysqlamin. Its main features are
  - Security
    - It has some built-in security features, but it may not be as robust as Debian.
  - Stability
    - It is generally stable but may not be as reliable as Debian.
  - Compatibility
    - It may require additional steps to install and configure PHPMyAdmin on a separate system.
  - Familiarity
    - It may require some learning if not familiar with Ubuntu.

Installaing PHPMYADMIN

- Update APT Repositories

```
sudo apt update
```

- Install PHP Support

```
sudo apt install phpmyadmin php-mbstring php-zip php-gd php-json php-curl
```

- Install phpMyAdmin

```
sudo apt install phpMyAdmin
```

```
phpenmod mbstring
```

- Restart Web service

```
sudo systemctl restart apache2
```

- Access via Web Interface http://<hostname>/phpmyadmin

Non-Relational Databases

- Relational Databases are not suitable for large data, unstructured or semistrucutre data
  - NoSQL databases are non-relational databases and addresses above issues

- There are four major types of NoSQL Databases

Document databases	Key-value stores	Column stores	Graph databases
• Store data as semi-structured documents, such as JSON or XML, and can be queried using document-oriented query languages	• Store data as key-value pairs, and are optimized for simple and fast read/write operations.	• These databases store data as column families, which are sets of columns that are treated as a single entity. • Optimized for fast and efficient querying of large amounts of data.	• Store data as nodes and edges, and are designed to handle complex relationships between data.

Key Characteristics of NoSQL

- Key Characteristics of NoSQL databases are

Dynamic schema

- Do not have a fixed schema and can accommodate changing data structures without the need for migrations or schema alterations.

Horizontal scalability

- Designed to scale out by adding more nodes to a database cluster, making them well-suited for handling large amounts of data and high levels of traffic.

Document-based

- Some NoSQL Dbs, such as MongoDB, use a document-based data model, where data is stored in semi-structured format, such as JSON or BSON.

Key-value-based

- NoSQL based Redis, use a key-value data model, where data is stored as a collection of key-value pairs.

Column-based

- Some NoSQL databases, such as Cassandra, use a column-based data model, where data is organized into columns instead of rows.

Distributed and high availability

- NoSQL databases are often designed to be highly available and to automatically handle node failures and data replication across multiple nodes in a database cluster.

Flexibility

- NoSQL databases allow developers to store and retrieve data in a flexible and dynamic manner, with support for multiple data types and changing data structures

Performance

- NoSQL databases are optimized for high performance and can handle a high volume of reads and writes, making them suitable for big data and real-time applications.

Merits/Demerits

- NoSQL has the following Benefits

High scalability

- Use sharding for horizontal scaling
- Vertical Scaling Complex
- MongoDB, Cassandra are examples of horizontal scaling DBs.
- Handle a huge amount of data, as the data grows it scale itself to handle that data in an efficient manner

Flexibility

- Designed to handle unstructured or semi-structured data, which means that they can accommodate dynamic changes to the data model.
- This makes it suitable for applications that need to handle changing data requirements.

High availability

- Auto replication feature in NoSQL databases makes it highly available because in case of any failure data replicates itself to the previous consistent state.

Performance

- Designed to handle large amounts of data and traffic, which means that they can offer improved performance compared to traditional relational databases.

Cost-effectiveness

- More cost-effective than traditional relational databases, as they are typically less complex and do not require expensive hardware or software.

Agility

- Ideal for agile development.

Merits/Demerits

- NoSQL has the following demerits

No standardization	**No ACID compliance**	**Narrow focus**
No complex queries	**Not Mature**	**Complex Management**

Applications of NoSQL Databases

- NoSQL databases are often used in applications where there is a high volume of data that needs to be processed and analyzed in real-time, such as social media analytics, e-commerce, and gaming.
- They can also be used for other applications, such as content management systems, document management, and customer relationship management.
- NoSQL databases may not be suitable for all applications, as they may not provide the same level of data consistency and transactional guarantees as traditional relational databases.
- It is important to carefully evaluate the specific needs of an application when choosing a database management system.

Available NoSQL Databases

- **Following are commonly available NoSQL based databases.**

Graph Databases	Key value store	Tabular	Document-based
➢Amazon Neptune ➢ Neo4j	➢Memcached ➢Redis ➢Coherence	• Hbase • Big Table • Accumulo	• MongoDB • CouchDB • Cloudant • Elasticsearch ?

Elasticsearch

- **To some people known as "an index," "a search engine," "an analytics database," "a big data solution," "it's quick and scalable," or "it's like Google."**
  - All of above are correct, which is part of Elasticsearch's appeal.

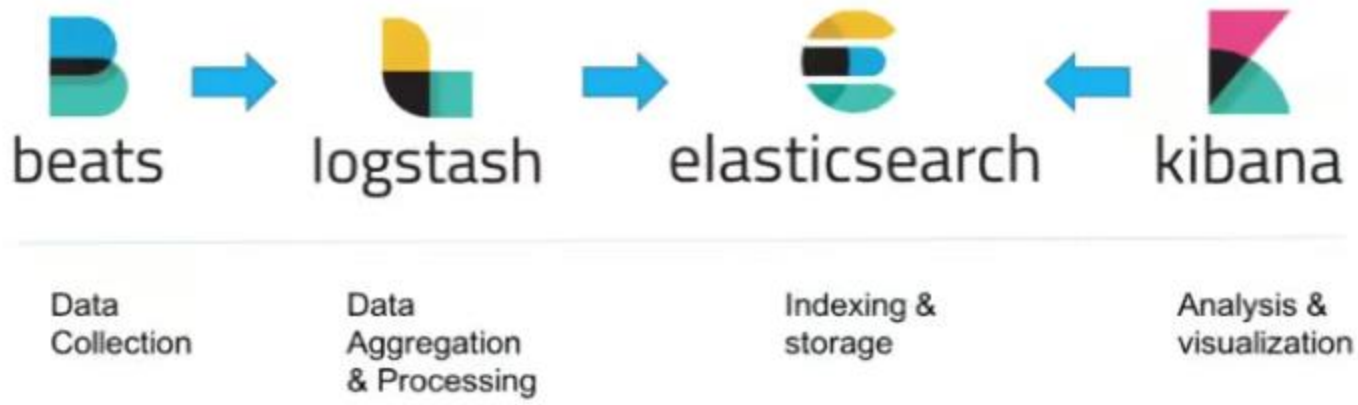
- **Elasticsearch is a distributed, free and open search and analytics engine for all types of data, including textual, numerical, geospatial, structured, and unstructured.**
  - Elasticsearch is built on Apache Lucene and was first released in 2010 by Elasticsearch N.V. (now known as Elastic).

- **It is known for its simple REST APIs, distributed nature, speed, and scalability, Elasticsearch is the central component of the Elastic Stack, a set of free and open tools for data ingestion, enrichment, storage, analysis, and visualization.**
  - Commonly referred to as the ELK Stack (after Elasticsearch, Logstash, and Kibana), the Elastic Stack now includes a rich collection of lightweight shipping agents known as Beats for sending data to Elasticsearch.

Operations of ES

- Raw data flows into Elasticsearch from a variety of sources, including logs, system metrics, and web applications.
    - Data ingestion is the process by which this raw data is parsed, normalized, and enriched before it is indexed in Elasticsearch.

- Once indexed in Elasticsearch, users can run complex queries against their data and use aggregations to retrieve complex summaries of their data.



Elasticsearch index

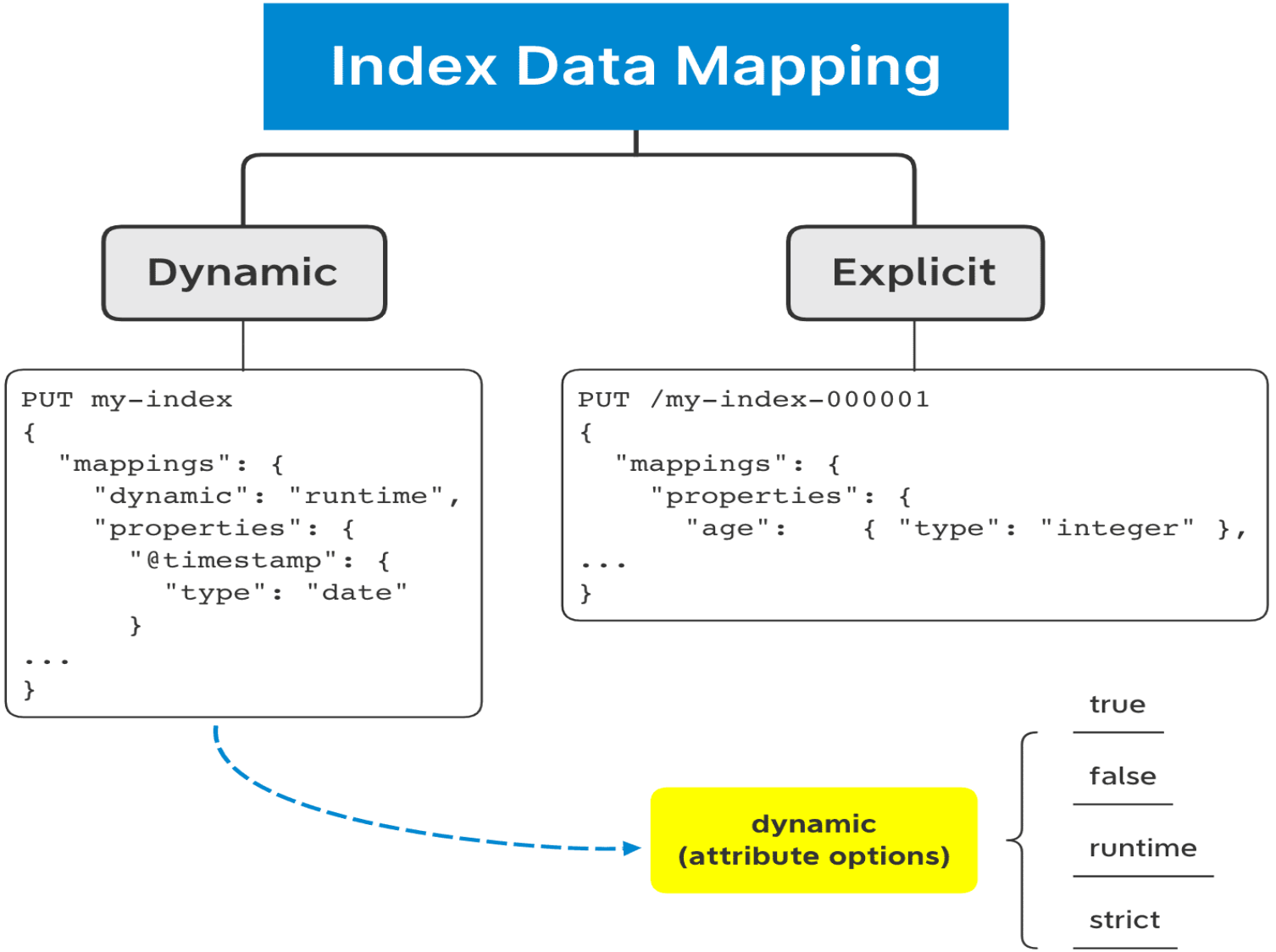
- **An Elasticsearch index is a collection of documents that are related to each other. Elasticsearch stores data as JSON documents.**
  - Each document correlates a set of keys (names of fields or properties) with their corresponding values (strings, numbers, Booleans, dates, arrays of values, geolocations, or other types of data).

- **Elasticsearch uses a data structure called an inverted index, which is designed to allow very fast full-text searches. An inverted index lists every unique word that appears in any document and identifies all of the documents each word occurs in.**

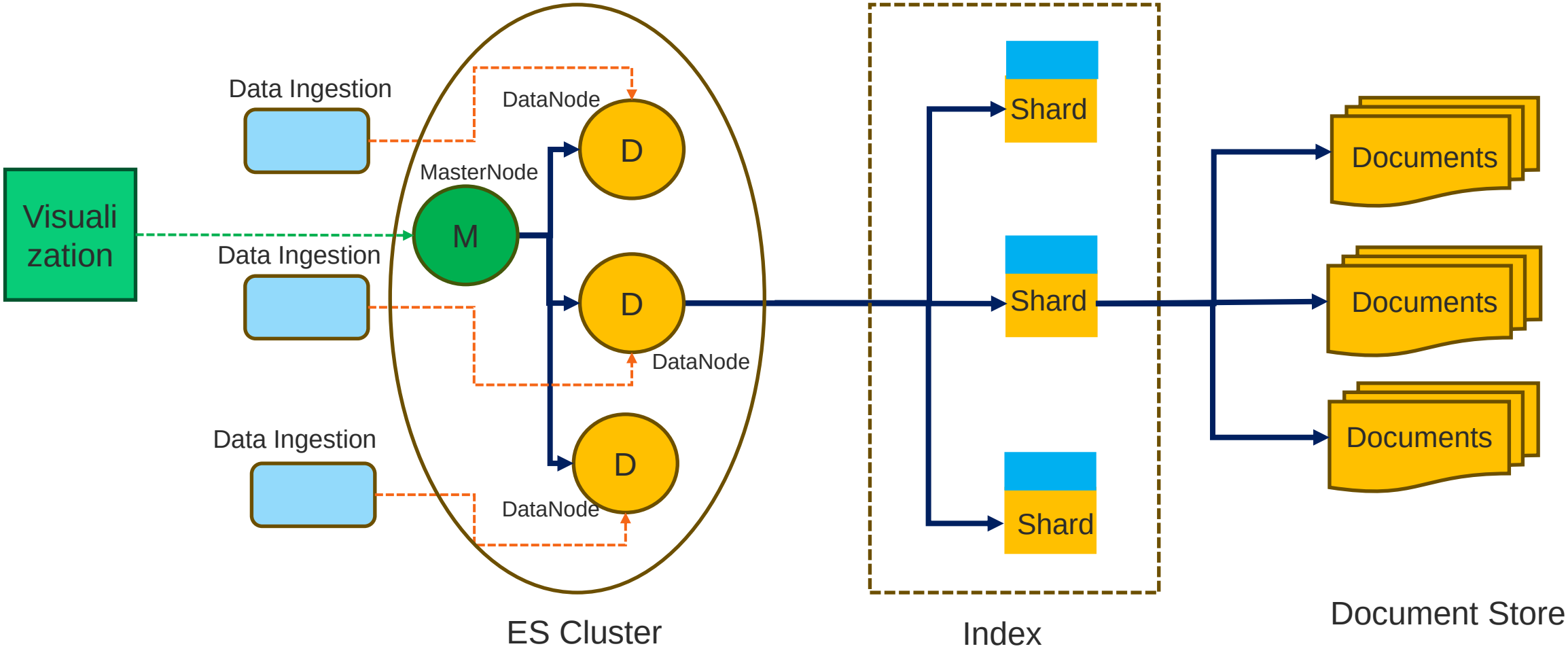
  - An inverted index is a mapping of each specific ‘word' (token) to the list of documents (locations) containing that word, allowing users to easily find documents containing given keywords. Index data is contained in one or more partitions, also defined as shards. Elasticsearch also automatically distributes and allocates shards to cluster nodes.

- **During the indexing process, Elasticsearch stores documents and builds an inverted index to make the document data searchable in near real-time. Indexing is initiated with the index API, through which you can add or update a JSON document in a specific index.**

Elasticsearch index



Architecture of Elasticsearch



Basic Terms in ES

- Some basic terminology related to ES are

JVM

- JVM allows running java programs on specified servers.

Shard

- Shards, on the other hand, are the "Apache Lucene" application itself that provides indexing of data within nodes.

Index

- Each record in ElasticSearch consists of JSON documents. Elasticsearch indexes is a collection of JSONson documents. In short, each index is a kind of database.

Segment

- The Lucene index is split into parts, which are smaller directories. A segment is a subset of the Lucene index.

Mapping

- Mapping is the method of specifying how a document and the fields contained inside it will be stored and indexed. Each index has a single mapping form that defines how the text is indexed.

Node

- Any single instance (elasticsearch installed machine) is defined as Node.

Document

- In Elasticsearch a document represents a basic unit of information that can be indexed.

Replica

- Elasticsearch sends a copy of each data to other machines, thus preventing data loss if one of the machines is down. Theise replicated machines or shards are defined as Replica.

Cluster

- A cluster in Elasticsearch is a set of nodes with the same cluster namecluster .name attribute. As nodes join or exit a cluster, the cluster reorganizes itself to spread data equally over the available nodes.

Type

- In Elasticsearch, a type represents a class of related documents and is identified by a name such as customer or product.

Why use Elasticsearch?

- **Elasticsearch is fast.**
  - built on top of Lucene which excels at full-text search.
  - a near real-time search platform, Lowest Latency, typicaly 1s
    - A requirements for time-sensitive use cases such as security analytics and infrastructure monitoring
- **Elasticsearch is distributed by nature.**
  - The documents stored in Elasticsearch are distributed across different containers known as shards
  - Shards are duplicated to provide redundant copies of the data in case of hardware failure
  - scale out to hundreds (or even thousands) of servers and handle petabytes of data.
- **A wide set of features**
  - In addition to its speed, scalability, and resiliency, it has a number of powerful built-in features such as data rollups and index lifecycle management.
- **Simplified data ingest, visualization, and reporting**
  - Integration with Beats and Logstash makes it easy to process data before indexing into Elasticsearch.
  - Kibana provides real-time visualization of Elasticsearch data as well as UIs for quickly accessing application performance monitoring (APM), logs, and infrastructure metrics data.

ES Applications

- Application search
- Website search
- Infrastructure metrics and container monitoring
- Application performance monitoring
- Enterprise search
- Geospatial data analysis and visualization
- Security analytics
- Logging and log analytics
- Business analytics

ES Node Roles

➢ **The main Node roles of ES are as follows**

Master

- A node that has the master role, which makes it eligible to be elected as the master node, which controls the cluster.

Remote_cluster_client

- A node that has the remote_cluster_client role, which makes it eligible to act as a remote client.

ml

- Allows to use machine learning features, there must be at least one machine learning node in your cluster.

Ingest

- Ingest nodes are able to apply an ingest pipeline to a document in order to transform and enrich the document before indexing.
- With a heavy ingest load, it makes sense to use dedicated ingest nodes and to not include the ingest role from nodes that have the master or data roles.

Data

- Data nodes hold data and perform data related operations such as CRUD, search, and aggregations. A node with the data role can fill any of the specialised data node roles.

- Data_content
- Data_hot
- Data_warm
- Data_cold
- Data_frozen

Transform

- Used to transform data, there must be at least one transform node in your cluster.

Data Ingestion

- **Data ingestion refers to the tools & processes used to collect data from various sources and move it to a target site, either in batches or in real-time.**
  - The data ingestion layer is critical to your downstream data science, BI, and analytics systems which depend on timely, complete, and accurate data.
- **ES provides following tools for data ingestion**

Elastic Beats	Logstash	Language clients	Kibana Dev Tools
• Elastic Beats are a set of lightweight data shippers that allow to conveniently send data to Elasticsearch Service.	• Powerful and flexible tool to read, process, and ship data of any kind	• Python, ruby etc	

Elasticbeats

Filebeat	▪ Used to read, preprocess and ship data from sources that come in the form of log files. ▪ Filebeat further supports a number of other data sources including TCP/UDP, containers, Redis, and Syslog. ▪ Large No. of module ease collection and parsing of log formats for applications such as Apache, MySQL, and Kafka.
Metricbeat	▪ Collects and preprocesses system and service metrics. ▪ System metrics include information about running processes, as well as CPU / memory / disk / network utilization numbers. ▪ Can collect data from many different services including Kafka, Palo Alto Networks, Redis, and many more.
Packetbeat	•Collects and preprocesses live networking data, therefore enabling application monitoring, as well as security and network performance analytics. •Among others, Packetbeat supports the following protocols: DHCP, DNS, HTTP, MongoDB, NFS, and TLS.

Elasticbeats

Winlogbeat

- is all about capturing event logs from Windows operating systems, including application events, hardware events, and security and system events.
- The vast information available from the Windows event log is of much interest for many use cases.

Auditbeat

- detects changes to critical files and collects events from the Linux Audit Framework.
- Different modules ease its deployment, which is mostly used in the security analytics use cases.

Heartbeat

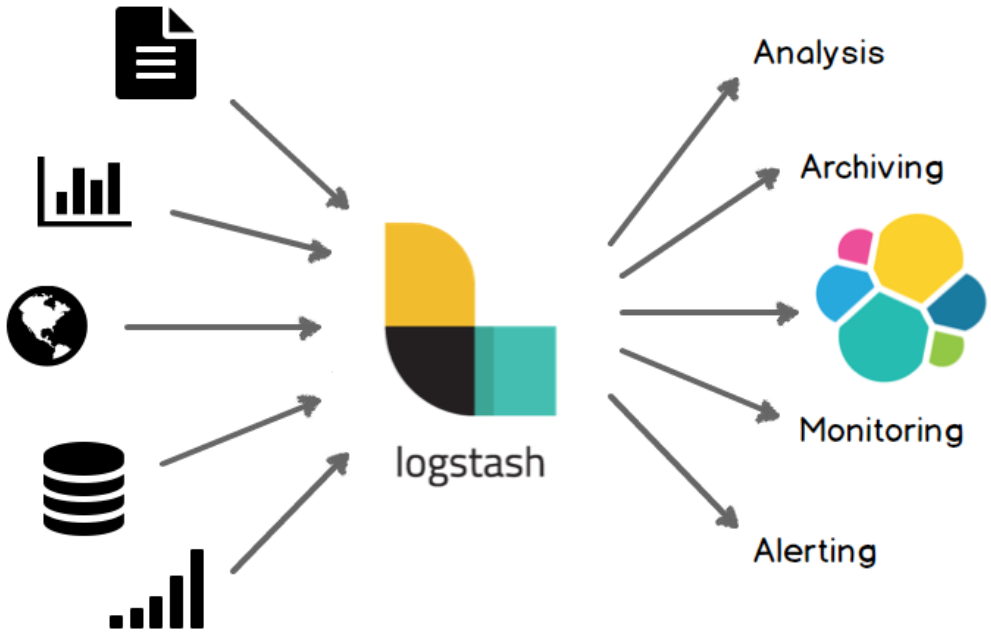
- uses probing to monitor the availability of systems and services.
- Heartbeat is useful in a number of scenarios such as infrastructure monitoring and security analytics. ICMP, TCP, and HTTP are supported protocols.

Functionbeat

- collects logs and metrics from within a serverless environment such as AWS Lambda.

Logstash

- Logstash is a powerful and flexible tool to read, process, and ship data of any kind.
  - Logstash provides several capabilities that are not currently available or too costly to perform with Beats, such as enriching documents by performing lookups against external data sources.
- However, this functionality and flexibility of Logstash comes at a price. Also, hardware requirements for Logstash are significantly higher than for Beats.
  - Logstash should generally not be deployed on low-resource devices. Logstash is therefore used as an alternative to Beats, should the functionality of the latter be insufficient for a specific use case.

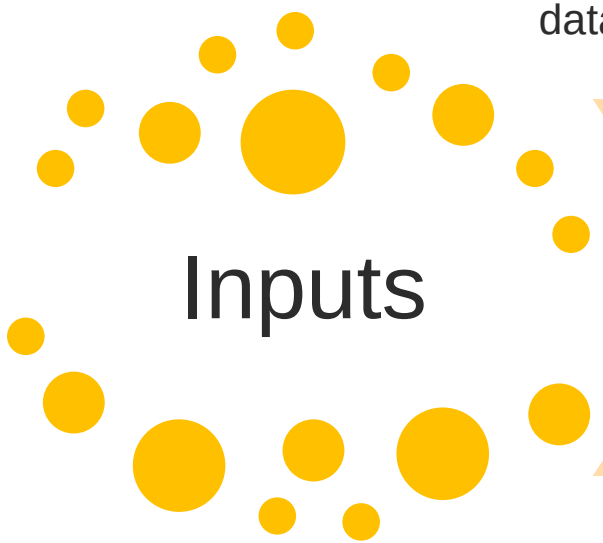


- A common architectural pattern is to combine Beats and Logstash: use Beats to collect data and use Logstash to perform any data processing that Beats are not capable of doing.

Logstash Pipeline

- **Logstash works by executing event processing pipelines, whereby each pipeline consists of at least one of each of the following:**

- Process and enrich the data in various ways.
- Filters can parse CSV, JSON, key/value pairs, delimited unstructured data, and complex unstructured data on the basis of regular expressions (grok filters).



Inputs

Filters

Outputs

- Read from data sources such as files, http, imap, jdbc, kafka, syslog, tcp, and udp.

- Enrich data by performing DNS lookups, adding geoinformation about IP addresses, or by performing lookups against a custom dictionary or an Elasticsearch index.

- Additional filters allow for diverse transformations of the data, for example, to rename, remove, copy data fields and values (mutate filter).

- write the parsed and enriched data to data sinks and are the final stage of the Logstash processing pipeline.

- While many output plugins are available, here we focus on ingestion into Elasticsearch Service using the Elasticsearch output.

Logstash Example Pipeline

input

```
input {
  rss {
    url => "/blog/feed"
    interval => 120
  }
}
```

Transformations

```
filter {
  mutate {
    rename => [ "message", "blog_html" ]
    copy => { "blog_html" => "blog_text" }
    copy => { "published" => "@timestamp" }
  }
  mutate {
    gsub => [
      "blog_text", "<.*?>", "",
      "blog_text", "[\n\t]", " "
    ]
    remove_field => [ "published", "author" ]
  }
}
```

Output

```
output {
  stdout {
    codec => dots
  }
  elasticsearch {
    hosts => [ "https://<your-elsaticsearch-url>" ]
    index => "elastic_blog"
    user => "elastic"
    password => "<your-elasticsearch-
password>"
  }
}
```

Installing ES on Linux Server

- Refer to LAB Session, Week 15.

IT601 – System and Network Administration

IT Operations & Support Process

Arif Husen

Department of Computer Science and Information Technology,

Virtual University of Pakistan

Contents

- Introduction to Help Desk
- Development and Operations (DevOps)

Introduction to Help Desk

- **Helpdesk is the primary mechanism to provide customer support**
  - A helpdesk is a place, real or virtual, where people can get answers to their computing questions, report problems, and request new services.
    - It may be a physical desk that people walk to, or it may be a virtual helpdesk that people access electronically.

- **Significance of Helpdesk**
  - Nothing is more important than it for ITOps.
  - It is the face of an organization. The HD staff is the first impression on customers and maintain relationship, good or bad, with them.
  - The HD fix the issues , part of living with computers and are the heroes. Customers call in an emergency.
  - A good helpdesk reflects well on your organization. The typical customer sees only the customer support portion of your organization and often assumes that this is your entire organization.
  - Customers have no idea which back-office operations and infrastructure duties are also performed. In short, a helpdesk is for helping the customers.
  - Don’t forget the help in helpdesk.

Introduction to Help Desk

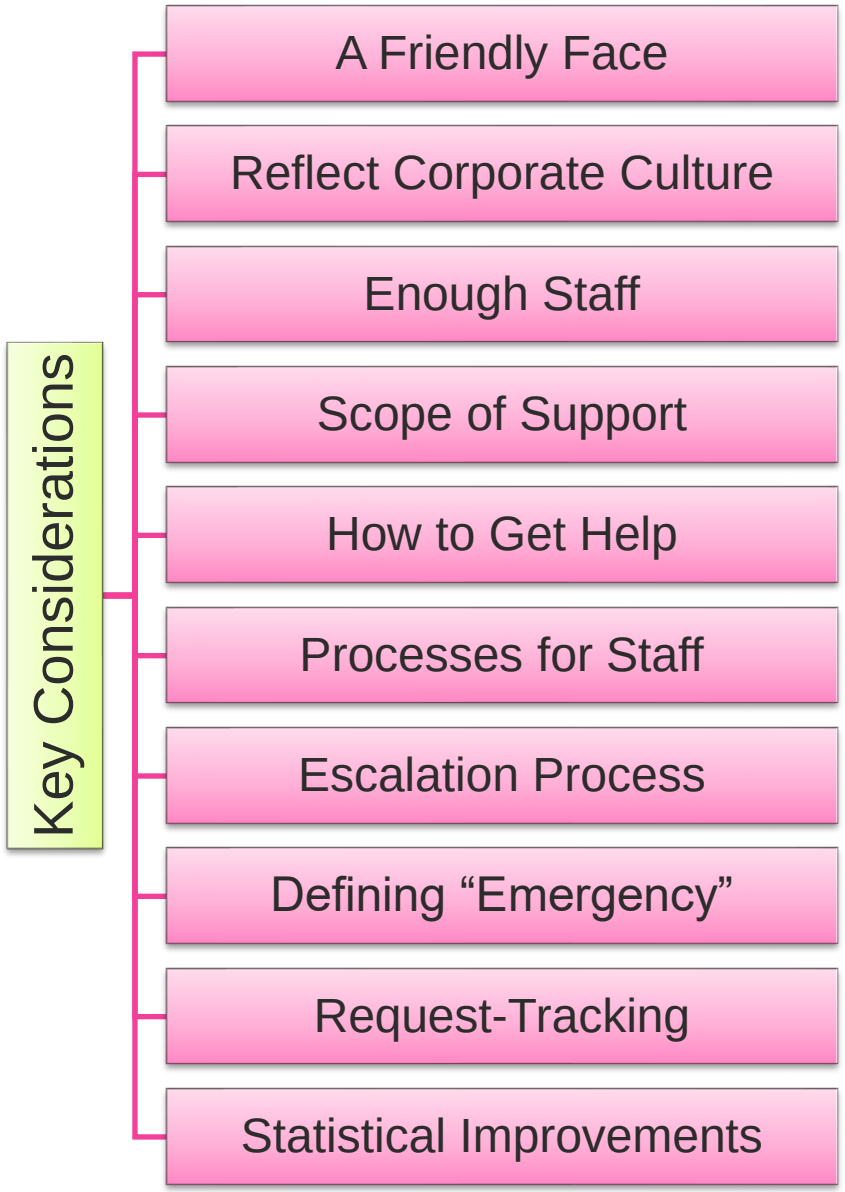
- **Is a Helpdesk really required?**
  - Every organization has a helpdesk.
    - It may be physical like walk-up counter
    - Virtual like by phone or email.
    - Sometimes unofficial.
  - Small orgnizations may not have formal helpdesk, but still leads to issues.
  - Large orgnizations needs anyhow a formal helpdesk
    - Developing a formal helpdesk should be part of that organizational planning
  - Symptoms of lacking formal helpdesk
    - Communication Problems
    - SAs unable to complete Project Tasks
    - Continuous SAs Interuuptions

Source : https://klik.solutions/managed-it-services/it-help-desk-services/

Introduction to Help Desk

- The transition from ad hoc to formal helpdesk can be uncomfortable to customers.
  - SAs should expect this push-back and do their best to ease the transition.
  - Communicating the new helpdesk procedures clearly is important.
- Helpdesks do not need to be purely physical locations but instead can be virtual.
  - Problems can be reported and replies returned via email.
  - Telephone, text-based, and audio chat systems can also be used.
  - Self-help systems are also popular but should not be considered a replacement for systems that involve human interaction.
    - These systems can reduce the workload of helpdesk attendants but cannot provide interactive debugging or resolve workflow issues that require real-time interaction.
    - There should be a phone number to call to report that the self-help system is down.
- A simple repository of documentation for customers on such topics as how to get help or request service activation and solutions to common problems.

Key Consierations for Helpdesk



Friendly Face

- **A helpdesk should have a friendly face.**
  - For a physical helpdesk, the interior design should be pleasant and welcoming.
    - A web-based virtual helpdesk is equally welcoming, Use a design based on soothing colors and readable fonts with the most selected items at the top left of the first page.
- **The faces of the staff should be welcoming and friendly, as should their personalities.**
  - When hiring HD staff, A key factor is that some people have personalities that are suited for customer service; others don't.
- **The roll or supervisor is key factor.**
  - The tone set by the staff will reflect that set by the supervisor.
    - A supervisor who yells at the staff will find staff yelling at customers.
  - A good-natured supervisor who can laugh and is always friendly will attract similar staff, who will reflect such an attitude with customers.
  - It is easier to build a reputation for being friendly initially than to restore a bad reputation.

  - The supervisor should be the friendly person you want your staff to be. Be a role model.

Reflect Corporate Culture

- **The look and feel of your helpdesk of an organization reflects its corporate culture.**
  - A helpdesk doesn't garner respect in a company when people working at the helpdesk buck the corporate culture.
    - A company that is very strict and formal may reflect this with strict dress codes and ways of conducting business, but the people at the helpdesk wear logo T-shirts and jeans, and a visitor hears a video game being played in the background.
    - A little asking around will find that the helpdesk has a reputation of being a bunch of slackers, no matter how hard they work or how high the quality of the service they provide.
  - The opposite can also happen.

- **Spend time to consider the culture and "look" of your helpdesk as compared to that of the customers they serve. Try to evolve to a culture that suits the customers served.**

HelpDesk Staff

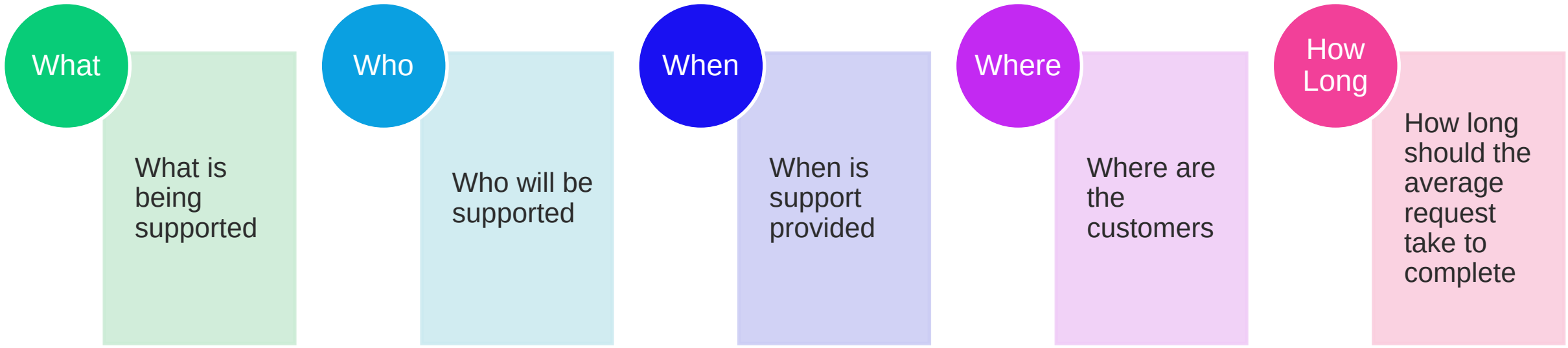
- **A helpdesk can be helpful only if it has enough people to serve customers in a timely manner.**
  - Otherwise, people will look elsewhere for their support.
- **Metrics for Sizing Helpdesk Staff**

Customer to HD Staff (CHS) Ratio	Call Volume Ratio (CVR)
▪ Universities often have 1000s of students per HD Staff. Corporates may have a higher ratio or a lower ratio.	▪ It is better to focus on callvolume ratios and time-to-call completion.
▪ An indirect metric	▪ A Direct Metric
▪ In a commercial computer science research dept., the ratio is often 40:1, with same skill level of the first-tier SAs and second-tier SSs.	▪ The rate at which customers receive busy signals or wait to receive a response, minutes required to resolve issues excluding time spent in “customer wait,”
▪ E-commerce sites usually have a separate and depending on the services being offered, the ratio can be 10,000:1 or 1,000,000:1.	▪ Managing resources based on call volume also presents a more diverse set ofpotential solutions.
▪ Ratios are a no-win situation. Management will always push to have a higher ratio; customers for lower ratio.	▪ It is required to have appropriate metrics to make decisions about improving processes.
▪ The the ratio can be increased by providing less service to the customers, which usually costs the organization.	▪ Metrics can reveal good candidates for new automation, documentation, ortraining for both SAs and customers.
	▪ Metrics can reveal which processes are more effective, which are used heavily, or which are not used at all.

Scope of Support

- A helpdesk should have a policy defining the scope of support. This document explains what an SA group is and isn't responsible for.

- The components of scope are what, who, where, when, and how long



- SAs should have a writen the scope-of-support policy.
  - What is in scope and what is out of scope

Specify How to Get Help

- **The companion to the scope-of-support document is a document that specifies how to get help: by phone, email, a ticket system, and so on.**
  - Certain types of requests may be directed to certain departments, or a unified helpdesk might be the single point of contact that forwards requests as appropriate to individual departments.

- **An image or document specifying how to get help should appear on default Windows background wallpaper images:**
  - “CompanyName IT helpdesk: [phone number] [email address] [web site].”

- **If customers have not been given clear directions on the proper way to get help, they will contact SAs directly, interrupting them at inappropriate times, and making it impossible to get larger projects done.**

Define Processes for Staff

- **Helpdesk staff should have well-defined processes to follow.**
  - In a smaller environment, this is not as important, because the processes are more ad hoc or are undocumented because they are being used by the people who built them.
  - However, for a large organization, the processes must be well documented.
- **Very large helpdesks should use scripts as part of their training. Every service supported has an associated flow of dialogue to follow to support that service.**
- **Some Scripts required identify verifications**
  - The script for a request to reset a password would, for security reasons, require callers to prove who they are, possibly by knowing a unique piece of personal information, before a new password would be set.

Establish an Escalation Process

- **Escalation is a process by which an issue is moved from the current staff person to someone with more expertise.**
  - The first line of operators should be able to handle 80 percent to 90 percent of all calls and escalate the remaining calls to a second tier of support.
  - The people at this second tier may have more experience, more training, and, possibly, other responsibilities.
  - Larger organizations can have four or more tiers; the higher tiers may include the people who built or currently maintain the service in question.
- **The escalation process is also what customers use when they are dissatisfied with the support they are receiving.**
  - Large numbers of calls being escalated to the second tier is a warning sign of a larger, systemic problem.
  - Usually, it indicates that the first-tier staff people need more training or do not have the tools to do their job properly.
  - If large numbers of calls are escalated to management, there may be systemic problems with the support the helpdesk is providing.

Define “Emergency” in Writing

- **Often, SAs are overloaded because every customer claims to have an emergency that requires immediate attention.**

  SAs may feel that customers are using this claim to boss them around, which decreases morale and increases stress levels.

- **Having a written policy empowers SAs to know when to push back and gives them a document to point to when they need it.**

  - If the customer still disagrees with this assessment, the SA can pass the issue up to someone in management, who can make the decision.
  - This lets the SA focus on technical duties and lets management focus on setting priorities and providing resources.

- **Every company should be able to define what constitutes an emergency.**
  - At a factory, an emergency is anything that stops the assembly line.
  - At a web-based service or ISP, an emergency might be anything that will prevent the service from meeting an SLA.

Use Request-Tracking Software

- **Every helpdesk needs some kind of software to help it manage requests.**
  - The alternative is a collection of notes written on scraps of paper. Although it is simple in the beginning and sufficient for environments with one or two SAs, a system based on notes on paper doesn't scale.
  - Requests get lost, and management has no ability to oversee the process to better allocate resources.
- **Those are the first qualities that you need in helpdesk software. As a helpdesk grows, software can help in other areas.**
- **Features of Helpdesk Software**
  - Helpdesk software should permit some kind of priority to be assigned to tickets.
  - Another important aspect of helpdesk software is that it collects logs about which kinds of requests are made and by whom.
  - Helpdesk software should also automate the collection of data on customer satisfaction.
  - It is critical that helpdesk software match the workflow of the people who use it.
  - Choosing helpdesk software is not an easy process. Most software will need a lot of customizing for your environment.

Statistical Improvements

- **Many sophisticated statistics can be gathered about a helpdesk.**
  - For example, you can monitor the rate of escalations to determine where more training is needed.
- **when dealing with upper management for budgeting and planning purposes, historical statistics become much more valuable.**
  - You can make a better case for your budget if you can show multiyear trends of customer growth, call volume, types of calls, technologies used, services provided, and customer satisfaction.
  - When you are asked to support a new technology or service, you can use past data to predict what the support costs may be.
- **The value of statistics increases as the organization grows, because the management becomes less directly involved in the work being done.**
  - As an organization grows, statistics are easier to collect, and it becomes more important that they be collected.

After-Hours and 24/7 Coverage

- **As computers become critical to an ever-expanding list of business processes, customers are asking for 24/7 coverage more often.**
  - Although a full three-shift staff may be required in some organizations, some very simple ways to provide 24/7 coverage are not as expensive.
- **Options**
  - Set up a voicemail box that alerts a pager when new messages arrive. The pager can be rotated among various staff members.
  - Have all managers of the customer groups know the home phone number of the helpdesk's supervisor, who then takes responsibility for calling SAs in turn until one is found.
- **No matter how SAs are contacted after hours, the person must be compensated.**
  - Some organizations have a salary incentive for oncall time, equivalent to a fraction of the employee's salary and time and a half if the person is called.
  - Other organizations issue compensation time either officially or unofficially.

Better Advertising for the Helpdesk

- **Defining your policies and providing announcements online is nice, but rarely will anyone seek them out.**
- **Options are**
  - Publish on Website
  - Email to customers esp. new policies
  - Workshops

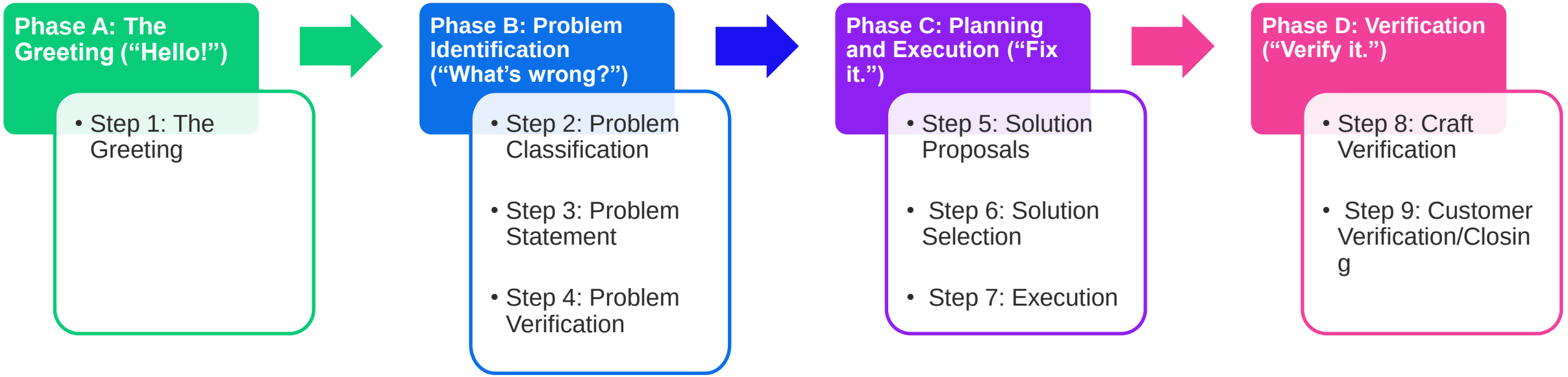
Multiple Helpdesks

- **When an organization grows, it may make sense to have two separate helpdesks:**
  - One for requesting new services.
  - Second for reporting problems that arise after the service has been successfully enabled.
  - A third group deals with installing the new service, especially if it requires physical work.

- **This third group may be an internal helpdesk that installers all over the organization can call to escalate installation problems. It is not uncommon, though, for this third group to be the second tier of one of the other helpdesks.**

Processing for processing customer requests

- **The method for processing these customer requests has nine steps, which can be grouped into four phases:**

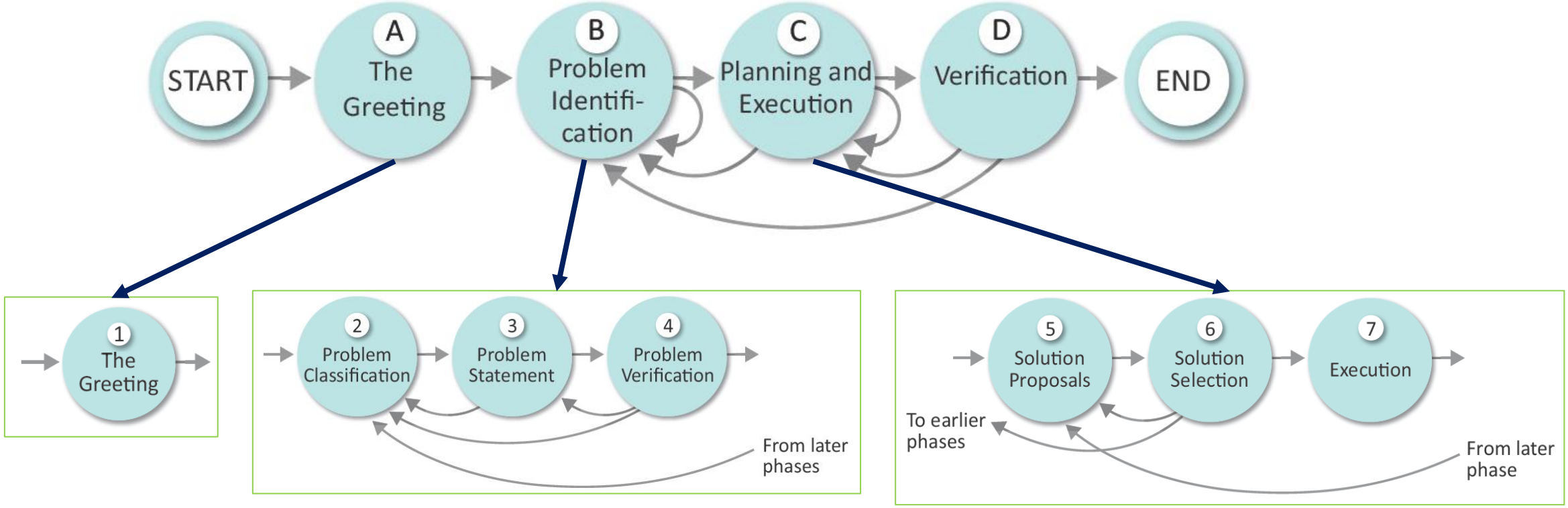


- **This method gives structure to what is, for newer SAs, a more haphazard process.**
  - It helps SAs solve problems more efficiently by keeping them focused and helps them avoid mistakes. It introduces a common set of terminology that, when used by the entire SA team, increases the ability to communicate within the group.

Problem Solving Process

- **Problem Solving Process consist of four phases**

A. Reporting the problem
B. Identifying the problem
C. Planning and executing a solution
D. Verifying that the problem resolution is complete



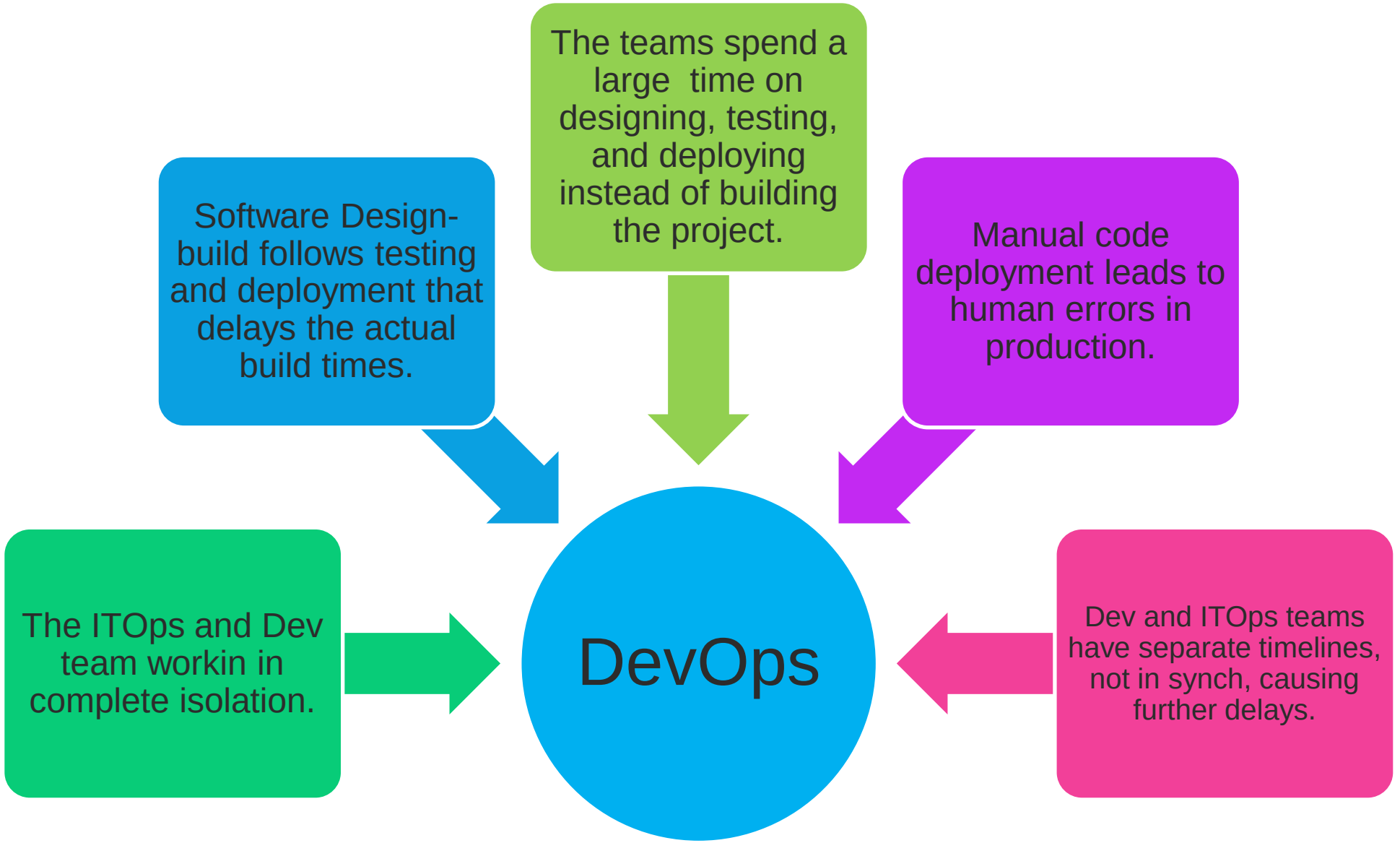
Development and Operations Together

- **Large organizations often have software development teams and IT operations team.**
  - System and Network Administration is part of IT operations
- **Some problems reported to system administrators or tasks requires the collaboration with software development team**
  - Thus development and Operations are not standalone they are strongly coupled
- **The collaboration of software development and IT operations is also applicable even if organizations donot have in house software development/ IT operations teams (Outsouricing Model)**
  - Thus development and Operations are not standalone they are strongly coupled
- **DevOps is a model which allows agile collaboration between administratively independent software development and IT operations teams.**

DevOps

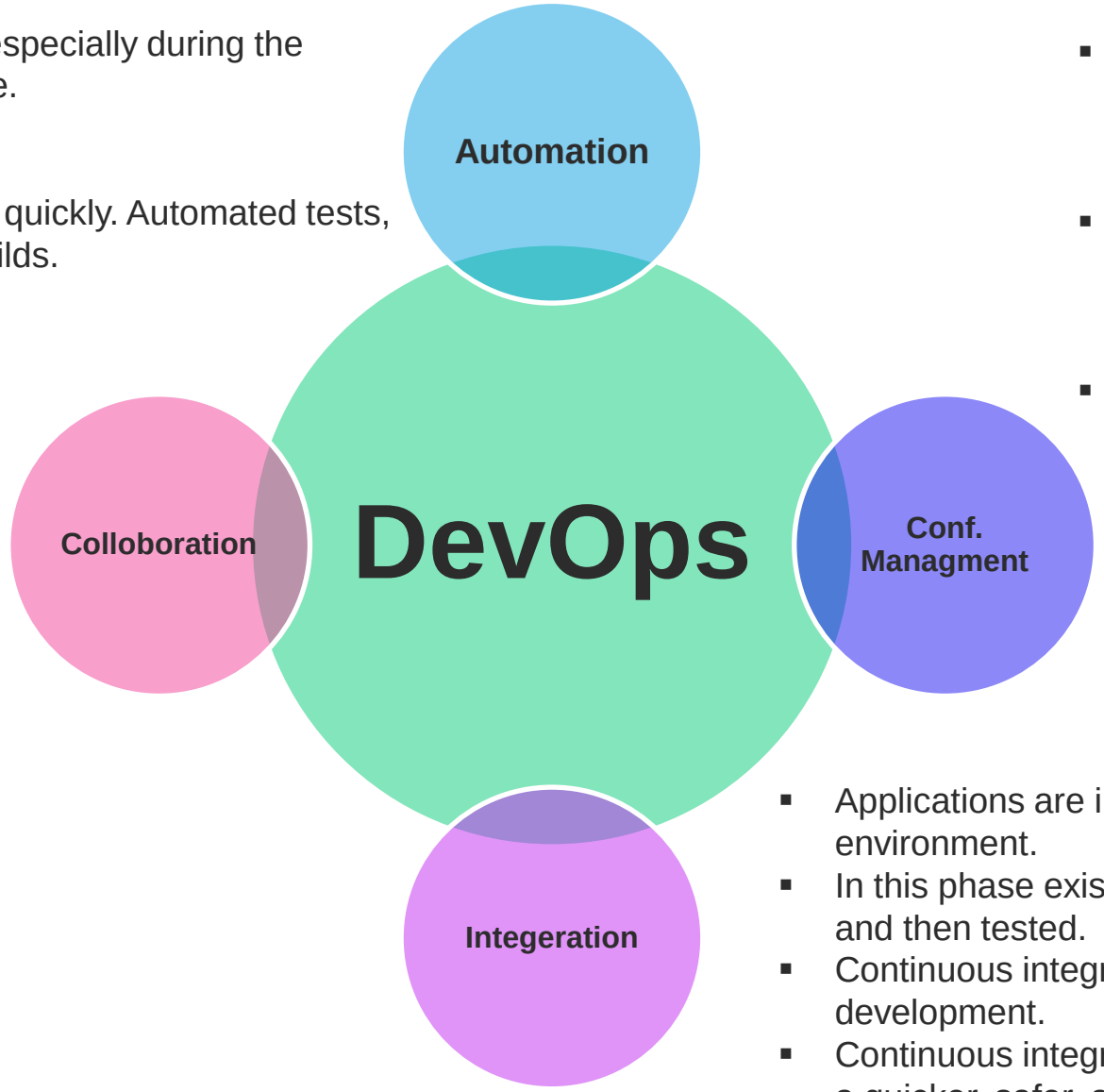
- **The DevOps is a mixture of two words, one is software Development, and second is Operations.**
  - It allows to jointly handle the entire application lifecycle, from development to testing, deployment, and operations.
  - DevOps helps to reduce the disconnection between software developers, quality assurance (QA) engineers, and system administrators.

The Need of DevOps



Features of DevOps

- Reduces time consumption, especially during the testing and deployment phase.
- Increases Productivity
- SW Releases are quicker.
- Catching bugs and their fixed quickly. Automated tests, cloud-based services, and builds.



- It ensures the Apps to interact with only those resources that are concerned with the environment in which it runs.
- The conf files are not created where the external configuration to the application is separated from the source code.
- The conf file can be written during deployment, or they can be loaded at the run time, depending on the environment in which it is running.

- The Dev and ITOps team collaborates that improves the cultural model.
- Improves productivity, accountability and ownership.
- Share responsibilities and work closely in sync, making the deployment to production faster.

- Applications are integrated with other components in the environment.
- In this phase existing code is combined with new functionality and then tested.
- Continuous integration and testing enable continuous development.
- Continuous integration and delivery are implemented to deliver in a quicker, safer, and reliable manner.

Mertis and Demerits of DevOps

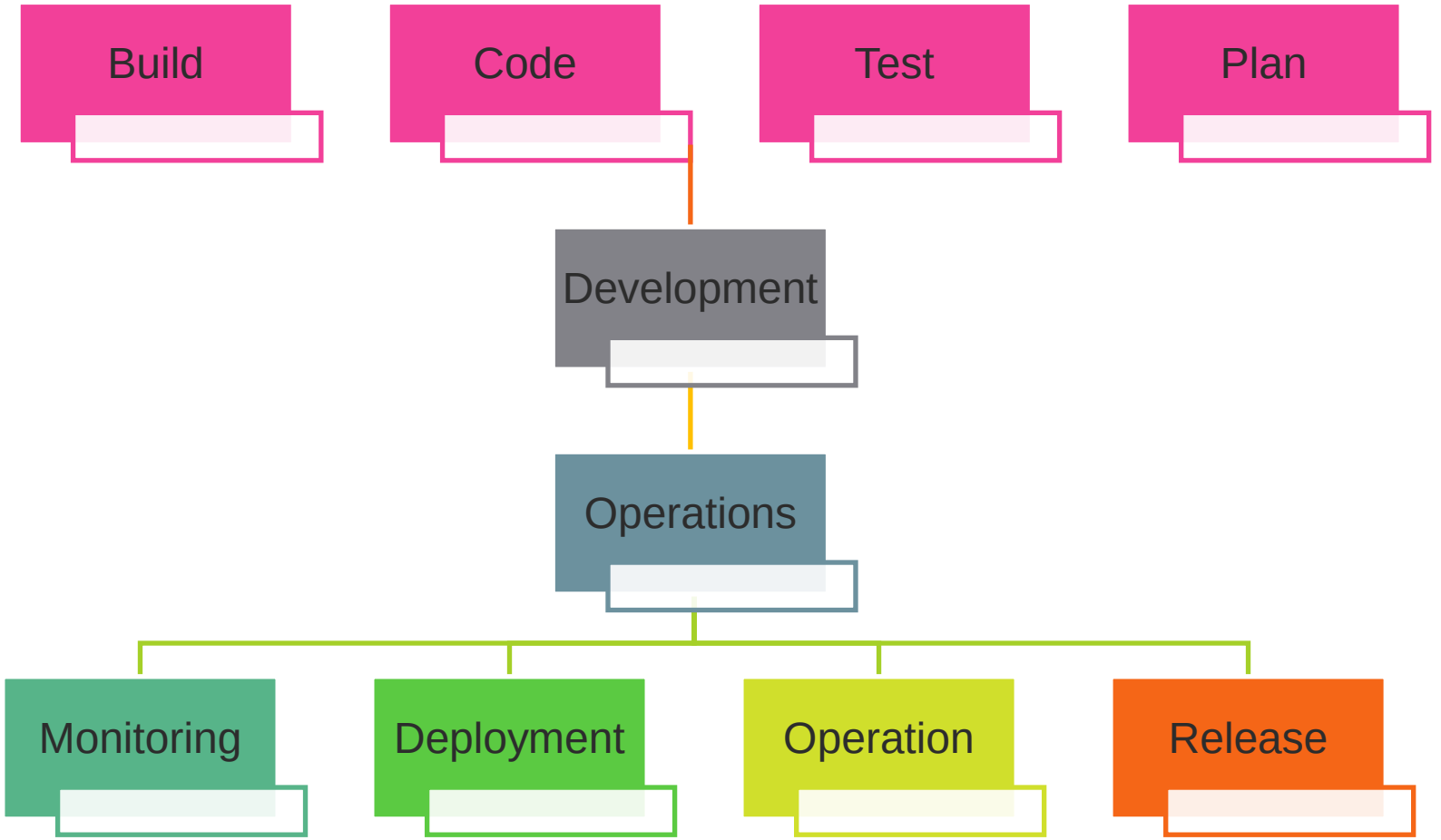
Merits

- DevOps is an excellent approach for quick development and deployment of applications.
- It responds faster to the market changes to improve business growth.
- DevOps escalate business profit by decreasing software delivery time and transportation costs.
- DevOps clears the descriptive process, which gives clarity on product development and delivery.
- It improves customer experience and satisfaction.
-
- DevOps simplifies collaboration and places all tools in the cloud for customers to access.
- DevOps means collective responsibility, which leads to better team engagement and productivity.

Demerits

- DevOps professional or expert's developers are less available.
- Developing with DevOps is so expensive.
- Adopting new DevOps technology into the industries is hard to manage in short time.
- Lack of DevOps knowledge can be a problem in the continuous integration of automation projects.

DevOps Architecture



DevOPs Components

1 - Build

- Without DevOps, the cost of the consumption of the resources was evaluated based on the pre-defined individual usage with fixed hardware allocation.

- With DevOps, the usage of cloud, sharing of resources comes into the picture, and the build is dependent upon the user's need, which is a mechanism to control the usage of resources or capacity.

2 - Coding

- Many good practices such as Git enables the code to be used, which ensures writing the code for business, helps to track changes, getting notified about the reason behind the difference in the actual and the expected output, and if necessary reverting to the original code developed.

- The code can be appropriately arranged in files, folders, etc. And they can be reused.

3 - Testing

The application will be ready for production after testing.

In the case of manual testing, it consumes more time in testing and moving the code to the output.

The testing can be automated, which decreases the time for testing so that the time to deploy the code to production can be reduced as automating the running of the scripts will remove many manual steps.

4 - Planing

- DevOps use Agile methodology to plan the development.

- With the operations and development team in sync, it helps in organizing the work to plan accordingly to increase productivity.

DevOPs Components

5 - Monitoring

- Continuous monitoring is used to identify any risk of failure. Also, it helps in tracking the system accurately so that the health of the application can be checked.

- The monitoring becomes more comfortable with services where the log data may get monitored through many third-party tools such as Splunk.

6 - Deployment

- Many systems can support the scheduler for automated deployment.

- The cloud management platform enables users to capture accurate insights and view the optimization scenario, analytics on trends by the deployment of dashboards.

7 - Operation

- DevOps changes the way traditional approach of developing and testing separately.

- The teams operate in a collaborative way where both the teams actively participate throughout the service lifecycle.

- The operation team interacts with developers, and they come up with a monitoring plan which serves the IT and business requirements.

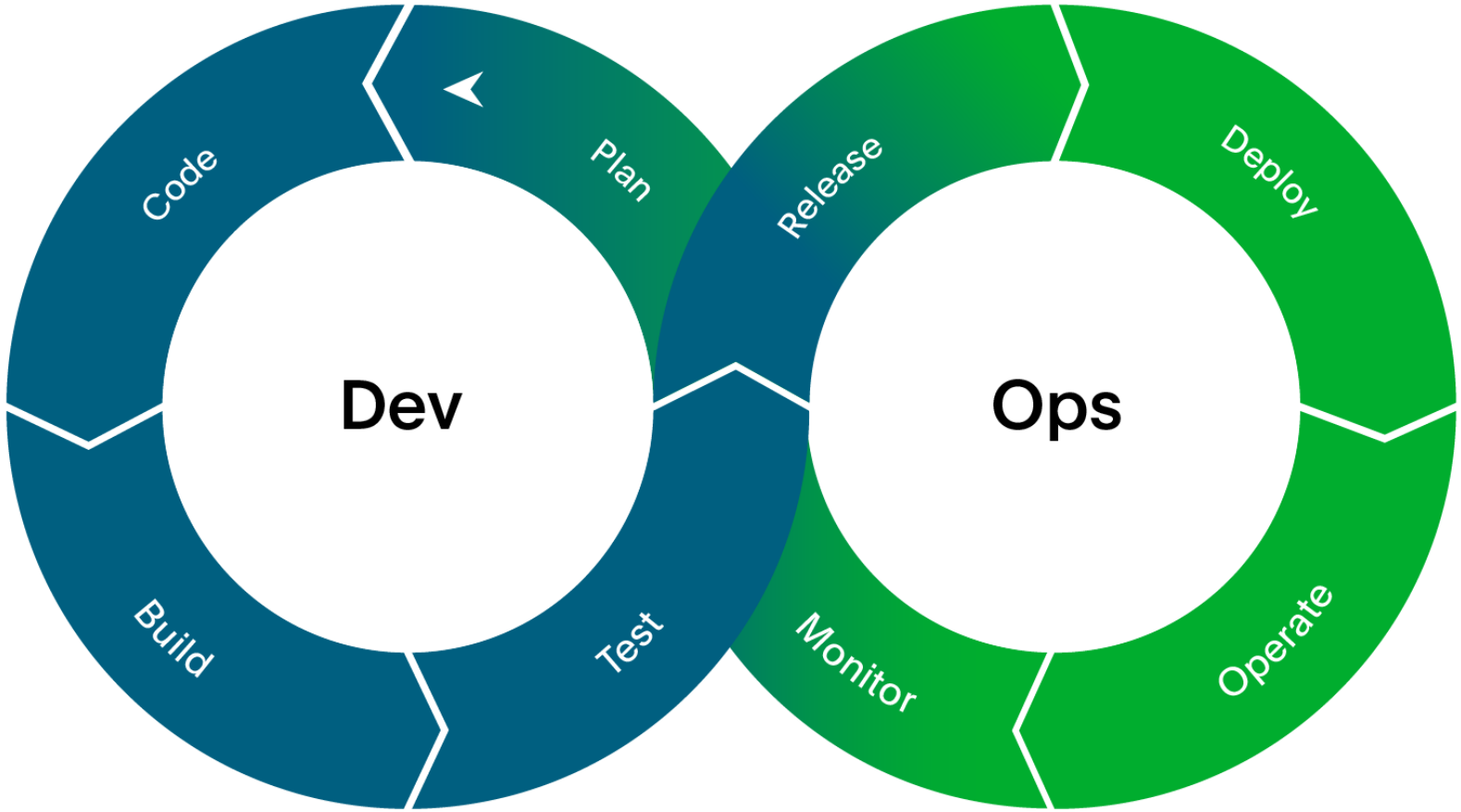
8 - Release

- Deployment to an environment can be done by automation.

- But when the deployment is made to the production environment, it is done by manual triggering. Many processes involved in release management commonly used to do the deployment in the production environment manually to lessen the impact on the customers.

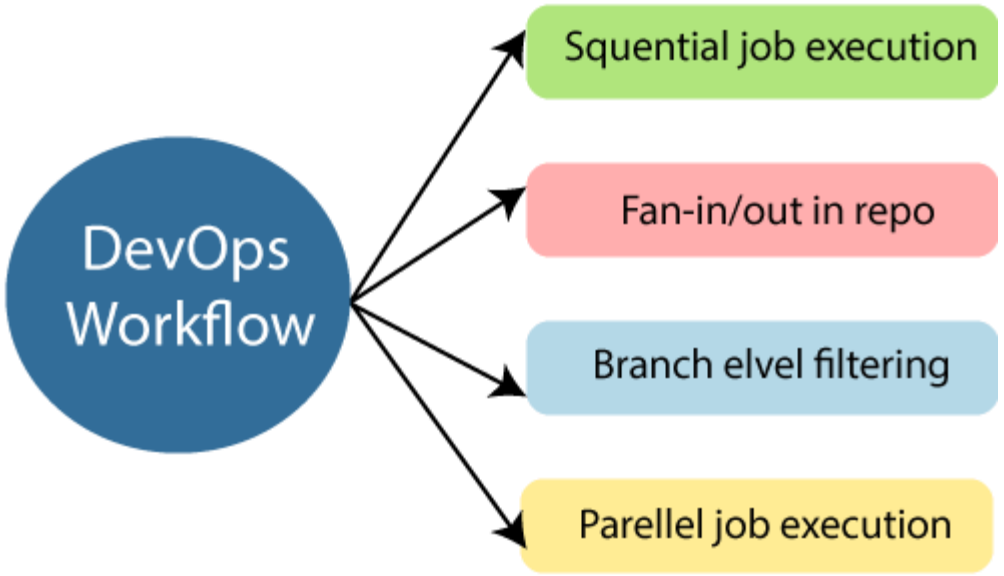
DevOps Cycle

- All components discussed reviously work in continuous model



Workflow

- DevOps workflow provides a visual overview of the sequence in which input is provided. Also, it tells about which one action is performed, and output is generated for an operations process.



- DevOps workflow allows the ability to separate and arrange the jobs which are top requested by the users. Also, it gives the ability to mirror their ideal process in the configuration jobs.

DevOps Principles

- The main principles of DevOps are Continuous delivery, automation, and fast reaction to the feedback.

End to End Responsibility

- DevOps team need to provide performance support until they become the end of life. It enhances the responsibility and the quality of the products engineered.

Continuous Improvement:

- DevOps culture focuses on continuous improvement to minimize waste. It continuously speeds up the growth of products or services offered.

Automate Everything

- Automation is an essential principle of the DevOps process. This is for software development and also for the entire infrastructure landscape.

Custom Centric Action

- DevOps team must take customer-centric for that they should continuously invest in products and services.

Monitor and test everything

- The DevOps team needs to have robust monitoring and testing procedures.

Work as one team

- In the DevOps culture role of the designers, developers, and testers are already defined. All they needed to do is work as one team with complete collaboration.

- These principles are achieved through several DevOps practices, which include frequent deployments, QA automation, continuous delivery, validating ideas as early as possible, and in-team collaboration.

DevOps Practices

- Some identified DevOps practices are:

  - Self-service configuration
  - Continuous build
  - Continuous integration
  - Continuous delivery
  - Incremental testing
  - Automated provisioning
  - Automated release management

DevOps Tools

Puppet

- Puppet is the most widely used DevOps tool.
- It allows the delivery and release of the technology changes quickly and frequently.
- It has features of versioning, automated testing, and continuous delivery.
- It enables to manage entire infrastructure as code without expanding the size of the team.

Ansible

- Ansible is a leading DevOps tool.
- Ansible is an open-source IT engine that automates application deployment, cloud provisioning, intra service orchestration, and other IT tools.
- It makes it easier for DevOps teams to scale automation and speed up productivity.
- Ansible is easy to deploy because it does not use any agents or custom security infrastructure on the client-side, and by pushing modules to the clients.
- These modules are executed locally on the client-side, and the output is pushed back to the Ansible server.

Docker

- Docker is a high-end DevOps tool that allows building, ship, and run distributed applications on multiple systems.
- It also helps to assemble the apps quickly from the components, and it is typically suitable for container management.

Nagios

- Nagios is one of the more useful tools for DevOps.
- It can determine the errors and rectify them with the help of network, infrastructure, server, and log monitoring systems.

CHEF

- A chef is a useful tool for achieving scale, speed, and consistency.
- The chef is a cloud-based system and open source technology. This technology uses Ruby encoding to develop essential building blocks such as recipes and cookbooks.
- The chef is used in infrastructure automation and helps in reducing manual and repetitive tasks for infrastructure management.
- Chef has got its convention for different building blocks, which are required to manage and automate infrastructure.

DevOps Tools

Jenkins

- Jenkins is a DevOps tool for monitoring the execution of repeated tasks.
- Jenkins is a software that allows continuous integration. Jenkins will be installed on a server where the central build will take place.
- It helps to integrate project changes more efficiently by finding the issues quickly.

Git

- Git is an open-source distributed version control system that is freely available for everyone.
- It is designed to handle minor to major projects with speed and efficiency.
- It is developed to co-ordinate the work among programmers. The version control allows you to track and work together with your team members at the same workspace.
- It is used as a critical distributed version-control for the DevOps tool.

SALTSTACK

- Stackify is a lightweight DevOps tool.
- It shows real-time error queries, logs, and more directly into the workstation.
- SALTSTACK is an ideal solution for intelligent orchestration for the software-defined data center.

Splunk

- Splunk is a tool to make machine data usable, accessible, and valuable to everyone.
- It delivers operational intelligence to DevOps teams.
- It helps companies to be more secure, productive, and competitive.

Selenium

- Selenium is a portable software testing framework for web applications.
- It provides an easy interface for developing automated tests.

IT601 – System and Network Administration

IT Operations & Support Process

Arif Husen

Department of Computer Science and Information Technology,

Virtual University of Pakistan

Contents

- Introduction to Help Desk
- Development and Operations (DevOps)

Introduction to Help Desk

- **Helpdesk is the primary mechanism to provide customer support**
  - A helpdesk is a place, real or virtual, where people can get answers to their computing questions, report problems, and request new services.
    - It may be a physical desk that people walk to, or it may be a virtual helpdesk that people access electronically.

- **Significance of Helpdesk**
  - Nothing is more important than it for ITOps.
  - It is the face of an organization. The HD staff is the first impression on customers and maintain relationship, good or bad, with them.
  - The HD fix the issues , part of living with computers and are the heroes. Customers call in an emergency.
  - A good helpdesk reflects well on your organization. The typical customer sees only the customer support portion of your organization and often assumes that this is your entire organization.
  - Customers have no idea which back-office operations and infrastructure duties are also performed. In short, a helpdesk is for helping the customers.
  - Don’t forget the help in helpdesk.

Introduction to Help Desk

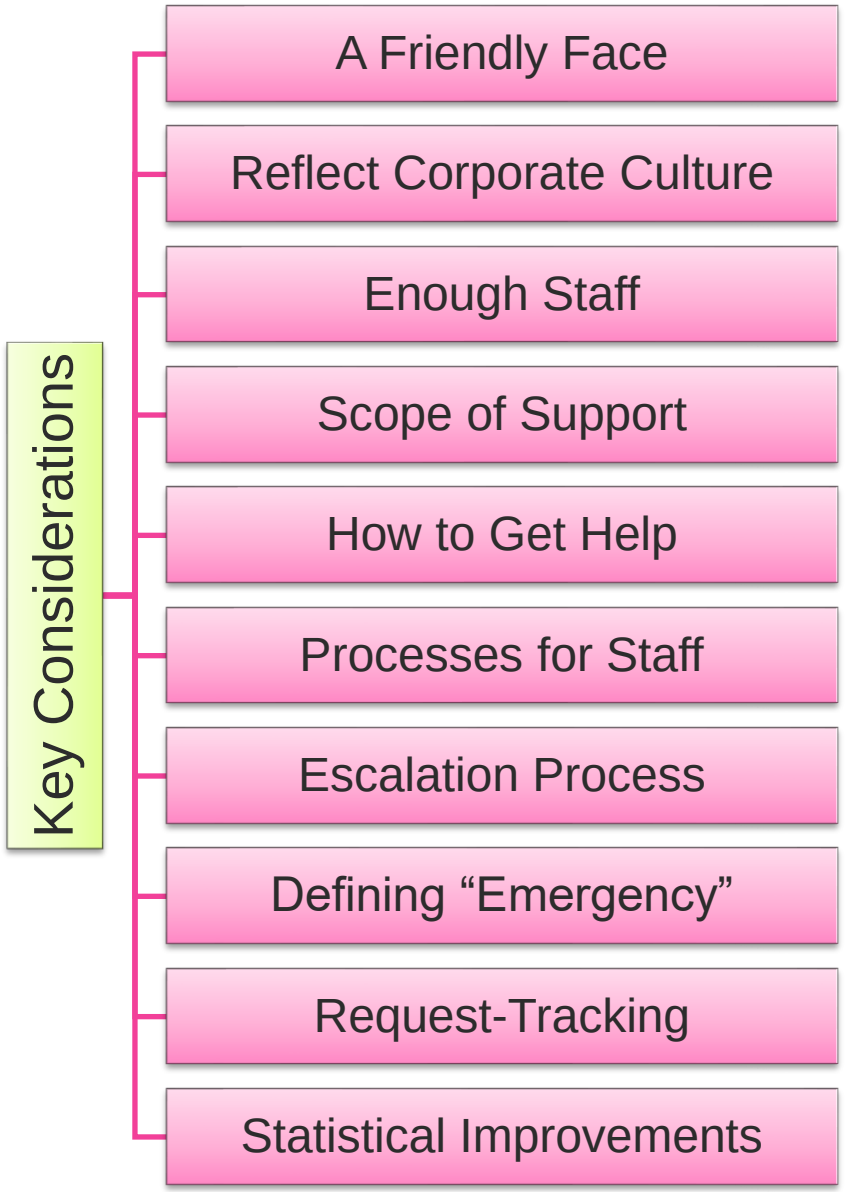
- **Is a Helpdesk really required?**
  - Every organization has a helpdesk.
    - It may be physical like walk-up counter
    - Virtual like by phone or email.
    - Sometimes unofficial.
  - Small orgnizations may not have formal helpdesk, but still leads to issues.
  - Large orgnizations needs anyhow a formal helpdesk
    - Developing a formal helpdesk should be part of that organizational planning
  - Symptoms of lacking formal helpdesk
    - Communication Problems
    - SAs unable to complete Project Tasks
    - Continuous SAs Interuuptions

Source : https://klik.solutions/managed-it-services/it-help-desk-services/

Introduction to Help Desk

- The transition from ad hoc to formal helpdesk can be uncomfortable to customers.
  - SAs should expect this push-back and do their best to ease the transition.
  - Communicating the new helpdesk procedures clearly is important.
- Helpdesks do not need to be purely physical locations but instead can be virtual.
  - Problems can be reported and replies returned via email.
  - Telephone, text-based, and audio chat systems can also be used.
  - Self-help systems are also popular but should not be considered a replacement for systems that involve human interaction.
    - These systems can reduce the workload of helpdesk attendants but cannot provide interactive debugging or resolve workflow issues that require real-time interaction.
    - There should be a phone number to call to report that the self-help system is down.
- A simple repository of documentation for customers on such topics as how to get help or request service activation and solutions to common problems.

Key Consierations for Helpdesk



Friendly Face

- **A helpdesk should have a friendly face.**
  - For a physical helpdesk, the interior design should be pleasant and welcoming.
    - A web-based virtual helpdesk is equally welcoming, Use a design based on soothing colors and readable fonts with the most selected items at the top left of the first page.
- **The faces of the staff should be welcoming and friendly, as should their personalities.**
  - When hiring HD staff, A key factor is that some people have personalities that are suited for customer service; others don't.
- **The roll or supervisor is key factor.**
  - The tone set by the staff will reflect that set by the supervisor.
    - A supervisor who yells at the staff will find staff yelling at customers.
  - A good-natured supervisor who can laugh and is always friendly will attract similar staff, who will reflect such an attitude with customers.
  - It is easier to build a reputation for being friendly initially than to restore a bad reputation.

  - The supervisor should be the friendly person you want your staff to be. Be a role model.

Reflect Corporate Culture

- **The look and feel of your helpdesk of an organization reflects its corporate culture.**
  - A helpdesk doesn't garner respect in a company when people working at the helpdesk buck the corporate culture.
    - A company that is very strict and formal may reflect this with strict dress codes and ways of conducting business, but the people at the helpdesk wear logo T-shirts and jeans, and a visitor hears a video game being played in the background.
    - A little asking around will find that the helpdesk has a reputation of being a bunch of slackers, no matter how hard they work or how high the quality of the service they provide.
  - The opposite can also happen.

- **Spend time to consider the culture and "look" of your helpdesk as compared to that of the customers they serve. Try to evolve to a culture that suits the customers served.**

HelpDesk Staff

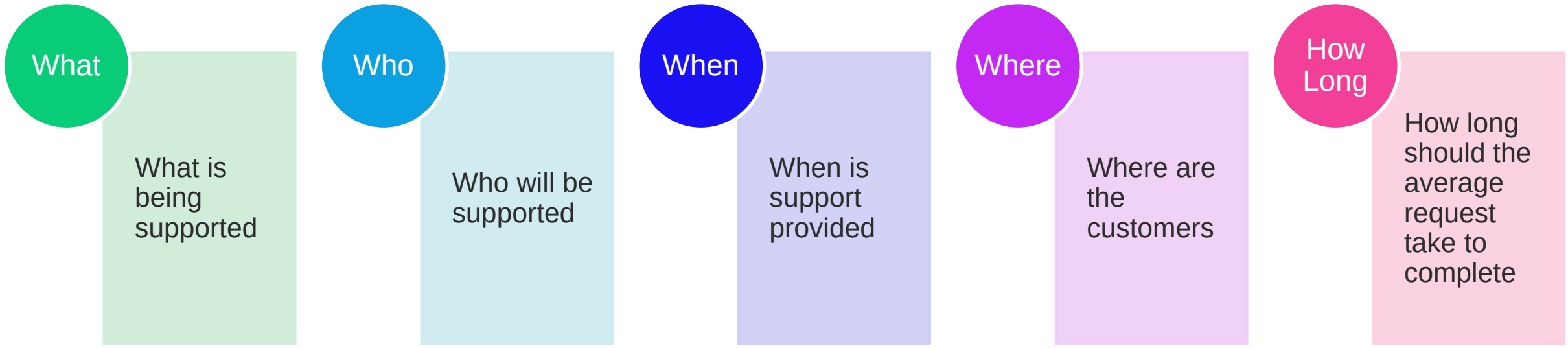
- **A helpdesk can be helpful only if it has enough people to serve customers in a timely manner.**
  - Otherwise, people will look elsewhere for their support.
- **Metrics for Sizing Helpdesk Staff**

Customer to HD Staff (CHS) Ratio	Call Volume Ratio (CVR)
▪ Universities often have 1000s of students per HD Staff. Corporates may have a higher ratio or a lower ratio.	▪ It is better to focus on callvolume ratios and time-to-call completion.
▪ An indirect metric	▪ A Direct Metric
▪ In a commercial computer science research dept., the ratio is often 40:1, with same skill level of the first-tier SAs and second-tier SSs.	▪ The rate at which customers receive busy signals or wait to receive a response, minutes required to resolve issues excluding time spent in “customer wait,”
▪ E-commerce sites usually have a separate and depending on the services being offered, the ratio can be 10,000:1 or 1,000,000:1.	▪ Managing resources based on call volume also presents a more diverse set ofpotential solutions.
▪ Ratios are a no-win situation. Management will always push to have a higher ratio; customers for lower ratio.	▪ It is required to have appropriate metrics to make decisions about improving processes.
▪ The the ratio can be increased by providing less service to the customers, which usually costs the organization.	▪ Metrics can reveal good candidates for new automation, documentation, ortraining for both SAs and customers.
	▪ Metrics can reveal which processes are more effective, which are used heavily, or which are not used at all.

Scope of Support

- A helpdesk should have a policy defining the scope of support. This document explains what an SA group is and isn't responsible for.

- The components of scope are what, who, where, when, and how long



- SAs should have a writen the scope-of-support policy.
  - What is in scope and what is out of scope

Specify How to Get Help

- **The companion to the scope-of-support document is a document that specifies how to get help: by phone, email, a ticket system, and so on.**
  - Certain types of requests may be directed to certain departments, or a unified helpdesk might be the single point of contact that forwards requests as appropriate to individual departments.

- **An image or document specifying how to get help should appear on default Windows background wallpaper images:**
  - “CompanyName IT helpdesk: [phone number] [email address] [web site].”

- **If customers have not been given clear directions on the proper way to get help, they will contact SAs directly, interrupting them at inappropriate times, and making it impossible to get larger projects done.**

Define Processes for Staff

- **Helpdesk staff should have well-defined processes to follow.**
  - In a smaller environment, this is not as important, because the processes are more ad hoc or are undocumented because they are being used by the people who built them.
  - However, for a large organization, the processes must be well documented.
- **Very large helpdesks should use scripts as part of their training. Every service supported has an associated flow of dialogue to follow to support that service.**
- **Some Scripts required identify verifications**
  - The script for a request to reset a password would, for security reasons, require callers to prove who they are, possibly by knowing a unique piece of personal information, before a new password would be set.

Establish an Escalation Process

- **Escalation is a process by which an issue is moved from the current staff person to someone with more expertise.**
  - The first line of operators should be able to handle 80 percent to 90 percent of all calls and escalate the remaining calls to a second tier of support.
  - The people at this second tier may have more experience, more training, and, possibly, other responsibilities.
  - Larger organizations can have four or more tiers; the higher tiers may include the people who built or currently maintain the service in question.
- **The escalation process is also what customers use when they are dissatisfied with the support they are receiving.**
  - Large numbers of calls being escalated to the second tier is a warning sign of a larger, systemic problem.
  - Usually, it indicates that the first-tier staff people need more training or do not have the tools to do their job properly.
  - If large numbers of calls are escalated to management, there may be systemic problems with the support the helpdesk is providing.

Define “Emergency” in Writing

- **Often, SAs are overloaded because every customer claims to have an emergency that requires immediate attention.**

  SAs may feel that customers are using this claim to boss them around, which decreases morale and increases stress levels.

- **Having a written policy empowers SAs to know when to push back and gives them a document to point to when they need it.**

  - If the customer still disagrees with this assessment, the SA can pass the issue up to someone in management, who can make the decision.
  - This lets the SA focus on technical duties and lets management focus on setting priorities and providing resources.

- **Every company should be able to define what constitutes an emergency.**
  - At a factory, an emergency is anything that stops the assembly line.
  - At a web-based service or ISP, an emergency might be anything that will prevent the service from meeting an SLA.

Use Request-Tracking Software

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  - The alternative is a collection of notes written on scraps of paper. Although it is simple in the beginning and sufficient for environments with one or two SAs, a system based on notes on paper doesn't scale.
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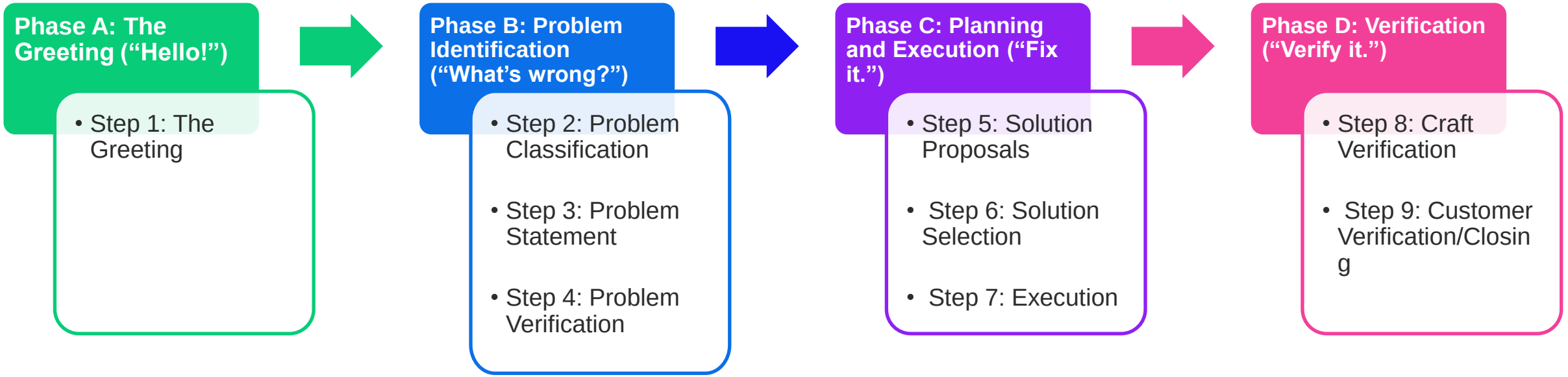
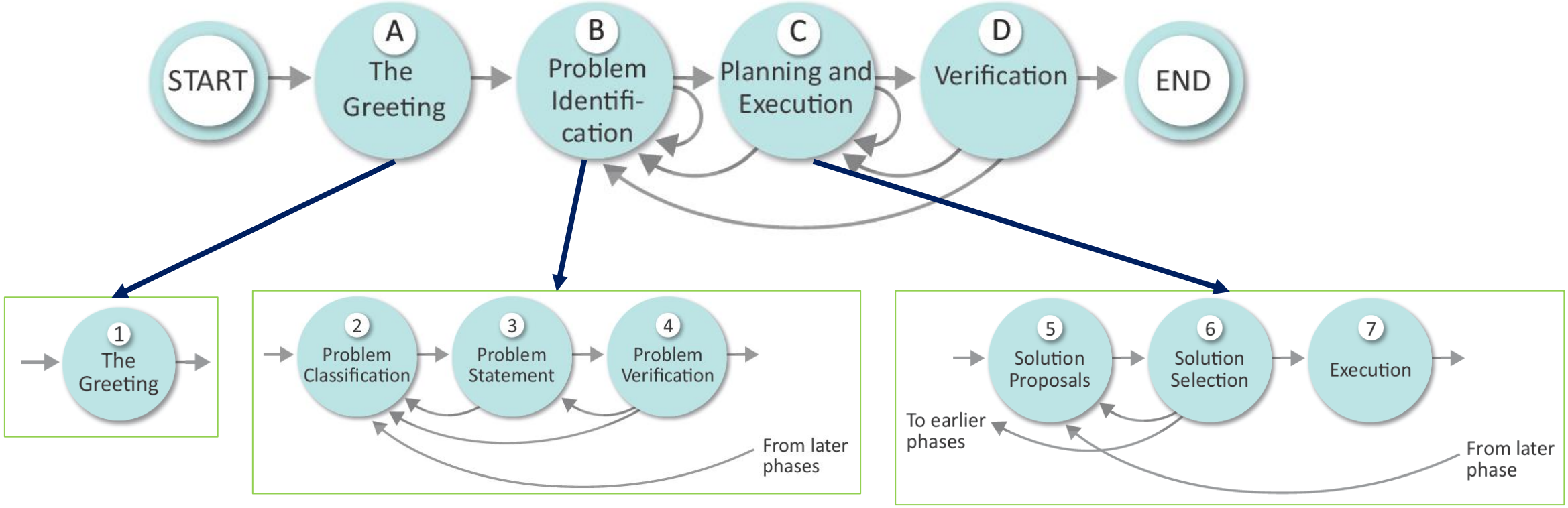


- **This method gives structure to what is, for newer SAs, a more haphazard process.**
  - It helps SAs solve problems more efficiently by keeping them focused and helps them avoid mistakes. It introduces a common set of terminology that, when used by the entire SA team, increases the ability to communicate within the group.

Problem Solving Process

- **Problem Solving Process consist of four phases**

A. Reporting the problem
B. Identifying the problem
C. Planning and executing a solution
D. Verifying that the problem resolution is complete



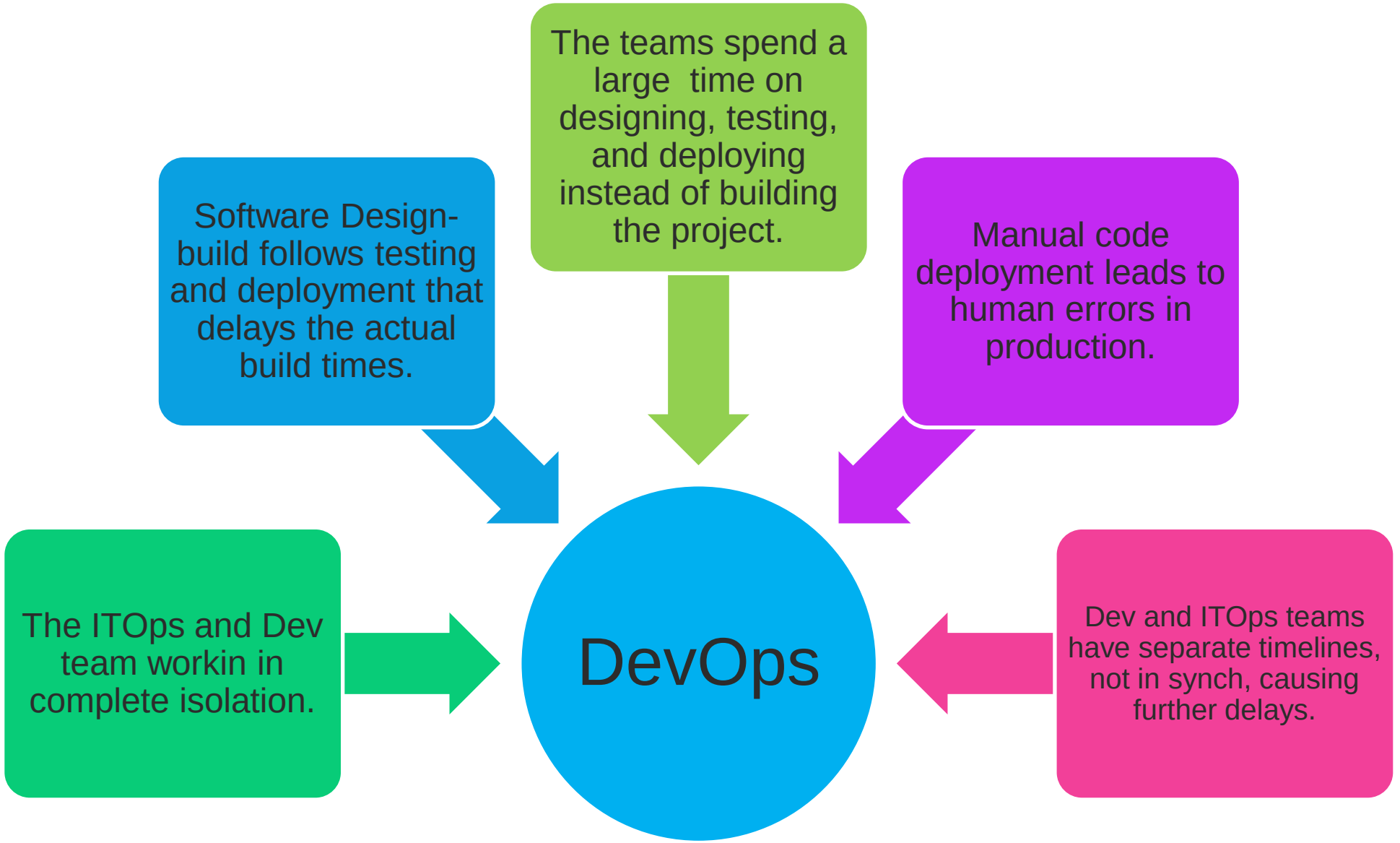
Development and Operations Together

- **Large organizations often have software development teams and IT operations team.**
  - System and Network Administration is part of IT operations
- **Some problems reported to system administrators or tasks requires the collaboration with software development team**
  - Thus development and Operations are not standalone they are strongly coupled
- **The collaboration of software development and IT operations is also applicable even if organizations donot have in house software development/ IT operations teams (Outsouricing Model)**
  - Thus development and Operations are not standalone they are strongly coupled
- **DevOps is a model which allows agile collaboration between administratively independent software development and IT operations teams.**

DevOps

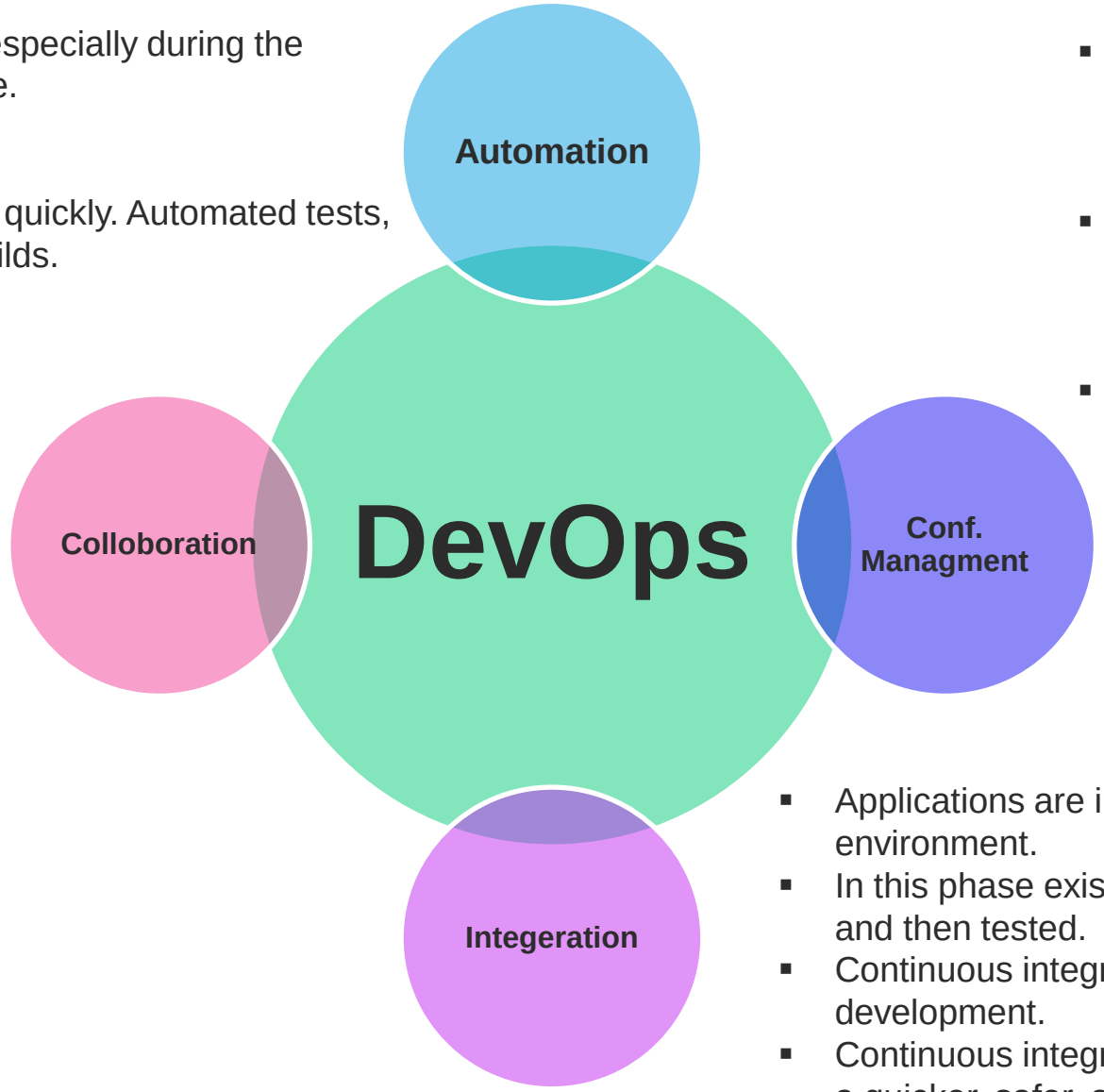
- **The DevOps is a mixture of two words, one is software Development, and second is Operations.**
  - It allows to jointly handle the entire application lifecycle, from development to testing, deployment, and operations.
  - DevOps helps to reduce the disconnection between software developers, quality assurance (QA) engineers, and system administrators.

The Need of DevOps



Features of DevOps

- Reduces time consumption, especially during the testing and deployment phase.
- Increases Productivity
- SW Releases are quicker.
- Catching bugs and their fixed quickly. Automated tests, cloud-based services, and builds.



- It ensures the Apps to interact with only those resources that are concerned with the environment in which it runs.
- The conf files are not created where the external configuration to the application is separated from the source code.
- The conf file can be written during deployment, or they can be loaded at the run time, depending on the environment in which it is running.

- The Dev and ITOps team collaborates that improves the cultural model.
- Improves productivity, accountability and ownership.
- Share responsibilities and work closely in sync, making the deployment to production faster.

- Applications are integrated with other components in the environment.
- In this phase existing code is combined with new functionality and then tested.
- Continuous integration and testing enable continuous development.
- Continuous integration and delivery are implemented to deliver in a quicker, safer, and reliable manner.

Mertis and Demerits of DevOps

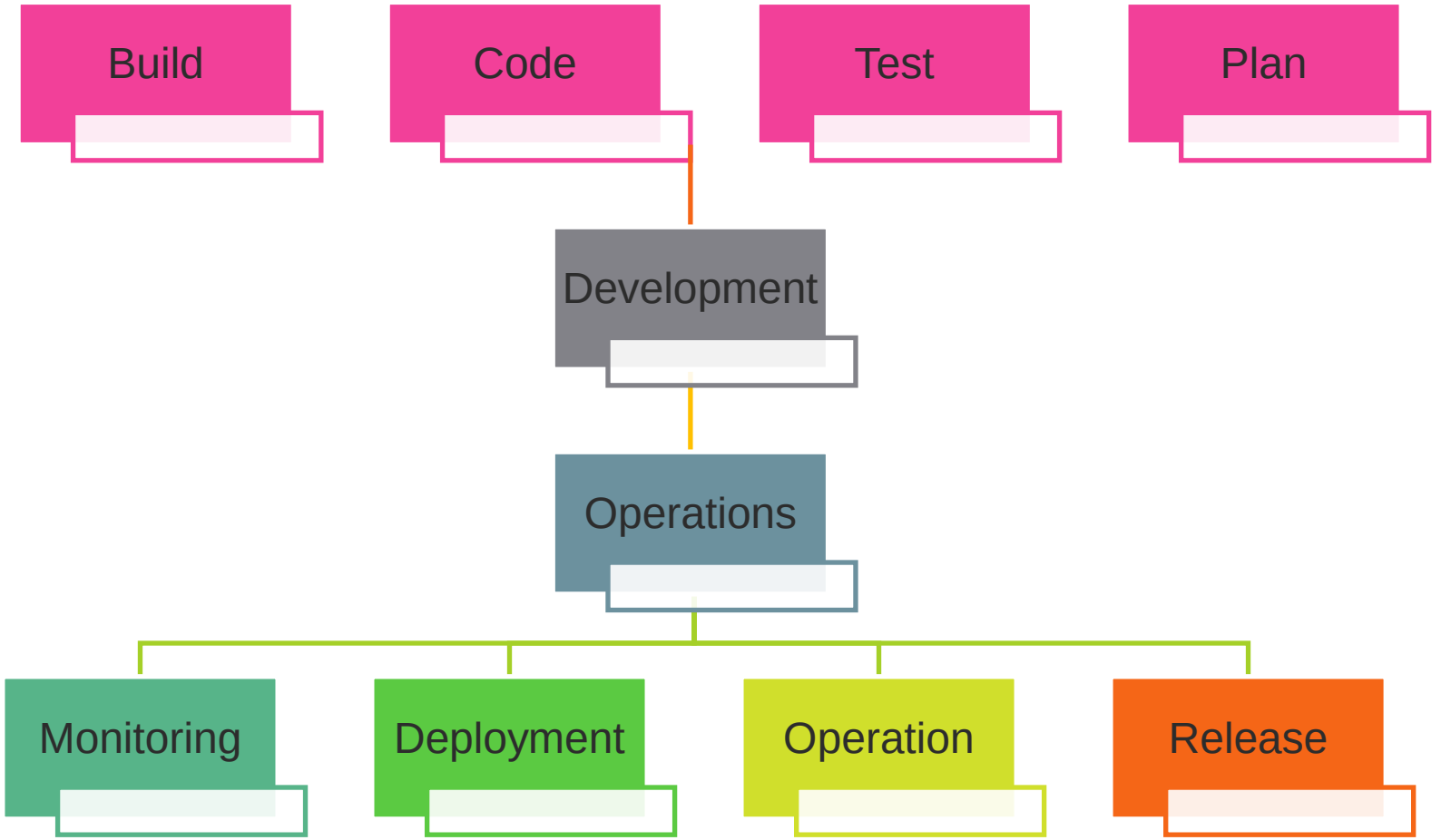
Merits

- DevOps is an excellent approach for quick development and deployment of applications.
- It responds faster to the market changes to improve business growth.
- DevOps escalate business profit by decreasing software delivery time and transportation costs.
- DevOps clears the descriptive process, which gives clarity on product development and delivery.
- It improves customer experience and satisfaction.
-
- DevOps simplifies collaboration and places all tools in the cloud for customers to access.
- DevOps means collective responsibility, which leads to better team engagement and productivity.

Demerits

- DevOps professional or expert's developers are less available.
- Developing with DevOps is so expensive.
- Adopting new DevOps technology into the industries is hard to manage in short time.
- Lack of DevOps knowledge can be a problem in the continuous integration of automation projects.

DevOps Architecture



DevOPs Components

1 - Build

- Without DevOps, the cost of the consumption of the resources was evaluated based on the pre-defined individual usage with fixed hardware allocation.

- With DevOps, the usage of cloud, sharing of resources comes into the picture, and the build is dependent upon the user's need, which is a mechanism to control the usage of resources or capacity.

2 - Coding

- Many good practices such as Git enables the code to be used, which ensures writing the code for business, helps to track changes, getting notified about the reason behind the difference in the actual and the expected output, and if necessary reverting to the original code developed.

- The code can be appropriately arranged in files, folders, etc. And they can be reused.

3 - Testing

The application will be ready for production after testing.

In the case of manual testing, it consumes more time in testing and moving the code to the output.

The testing can be automated, which decreases the time for testing so that the time to deploy the code to production can be reduced as automating the running of the scripts will remove many manual steps.

4 - Planing

- DevOps use Agile methodology to plan the development.

- With the operations and development team in sync, it helps in organizing the work to plan accordingly to increase productivity.

DevOPs Components

5 - Monitoring

- Continuous monitoring is used to identify any risk of failure. Also, it helps in tracking the system accurately so that the health of the application can be checked.

- The monitoring becomes more comfortable with services where the log data may get monitored through many third-party tools such as Splunk.

6 - Deployment

- Many systems can support the scheduler for automated deployment.

- The cloud management platform enables users to capture accurate insights and view the optimization scenario, analytics on trends by the deployment of dashboards.

7 - Operation

- DevOps changes the way traditional approach of developing and testing separately.

- The teams operate in a collaborative way where both the teams actively participate throughout the service lifecycle.

- The operation team interacts with developers, and they come up with a monitoring plan which serves the IT and business requirements.

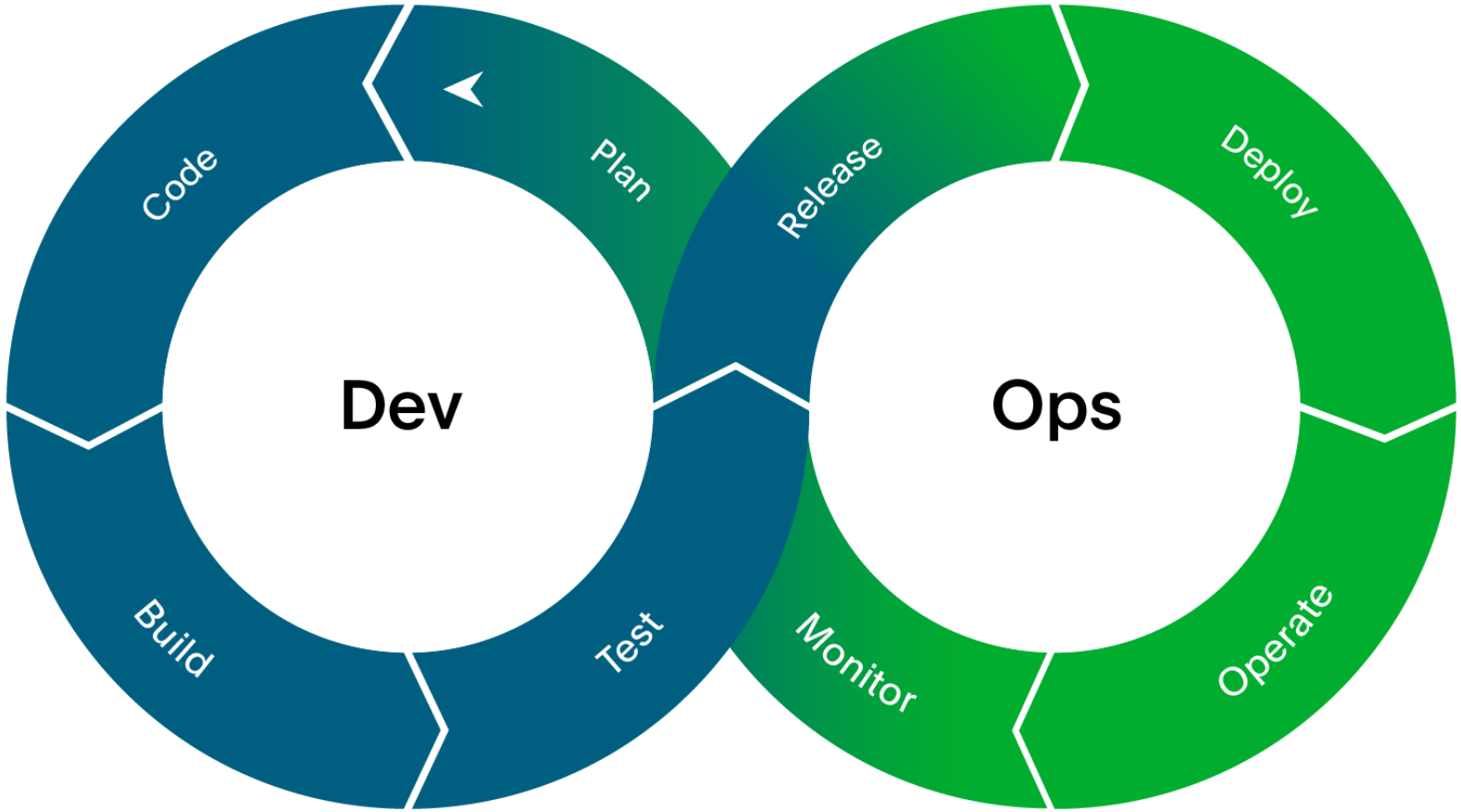
8 - Release

- Deployment to an environment can be done by automation.

- But when the deployment is made to the production environment, it is done by manual triggering. Many processes involved in release management commonly used to do the deployment in the production environment manually to lessen the impact on the customers.

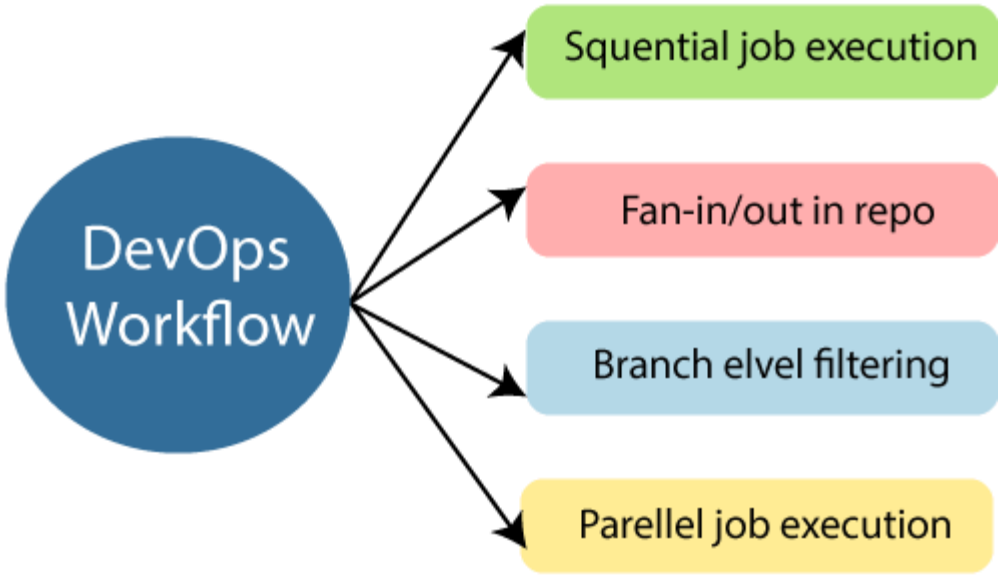
DevOps Cycle

- All components discussed reviously work in continuous model



Workflow

- DevOps workflow provides a visual overview of the sequence in which input is provided. Also, it tells about which one action is performed, and output is generated for an operations process.



- DevOps workflow allows the ability to separate and arrange the jobs which are top requested by the users. Also, it gives the ability to mirror their ideal process in the configuration jobs.

DevOps Principles

- The main principles of DevOps are Continuous delivery, automation, and fast reaction to the feedback.

End to End Responsibility

- DevOps team need to provide performance support until they become the end of life. It enhances the responsibility and the quality of the products engineered.

Continuous Improvement:

- DevOps culture focuses on continuous improvement to minimize waste. It continuously speeds up the growth of products or services offered.

Automate Everything

- Automation is an essential principle of the DevOps process. This is for software development and also for the entire infrastructure landscape.

Custom Centric Action

- DevOps team must take customer-centric for that they should continuously invest in products and services.

Monitor and test everything

- The DevOps team needs to have robust monitoring and testing procedures.

Work as one team

- In the DevOps culture role of the designers, developers, and testers are already defined. All they needed to do is work as one team with complete collaboration.

- These principles are achieved through several DevOps practices, which include frequent deployments, QA automation, continuous delivery, validating ideas as early as possible, and in-team collaboration.

DevOps Practices

- Some identified DevOps practices are:

  - Self-service configuration
  - Continuous build
  - Continuous integration
  - Continuous delivery
  - Incremental testing
  - Automated provisioning
  - Automated release management

DevOps Tools

Puppet

- Puppet is the most widely used DevOps tool.
- It allows the delivery and release of the technology changes quickly and frequently.
- It has features of versioning, automated testing, and continuous delivery.
- It enables to manage entire infrastructure as code without expanding the size of the team.

Ansible

- Ansible is a leading DevOps tool.
- Ansible is an open-source IT engine that automates application deployment, cloud provisioning, intra service orchestration, and other IT tools.
- It makes it easier for DevOps teams to scale automation and speed up productivity.
- Ansible is easy to deploy because it does not use any agents or custom security infrastructure on the client-side, and by pushing modules to the clients.
- These modules are executed locally on the client-side, and the output is pushed back to the Ansible server.

Docker

- Docker is a high-end DevOps tool that allows building, ship, and run distributed applications on multiple systems.
- It also helps to assemble the apps quickly from the components, and it is typically suitable for container management.

Nagios

- Nagios is one of the more useful tools for DevOps.
- It can determine the errors and rectify them with the help of network, infrastructure, server, and log monitoring systems.

CHEF

- A chef is a useful tool for achieving scale, speed, and consistency.
- The chef is a cloud-based system and open source technology. This technology uses Ruby encoding to develop essential building blocks such as recipes and cookbooks.
- The chef is used in infrastructure automation and helps in reducing manual and repetitive tasks for infrastructure management.
- Chef has got its convention for different building blocks, which are required to manage and automate infrastructure.

DevOps Tools

Jenkins

- Jenkins is a DevOps tool for monitoring the execution of repeated tasks.
- Jenkins is a software that allows continuous integration. Jenkins will be installed on a server where the central build will take place.
- It helps to integrate project changes more efficiently by finding the issues quickly.

Git

- Git is an open-source distributed version control system that is freely available for everyone.
- It is designed to handle minor to major projects with speed and efficiency.
- It is developed to co-ordinate the work among programmers. The version control allows you to track and work together with your team members at the same workspace.
- It is used as a critical distributed version-control for the DevOps tool.

SALTSTACK

- Stackify is a lightweight DevOps tool.
- It shows real-time error queries, logs, and more directly into the workstation.
- SALTSTACK is an ideal solution for intelligent orchestration for the software-defined data center.

Splunk

- Splunk is a tool to make machine data usable, accessible, and valuable to everyone.
- It delivers operational intelligence to DevOps teams.
- It helps companies to be more secure, productive, and competitive.

Selenium

- Selenium is a portable software testing framework for web applications.
- It provides an easy interface for developing automated tests.

IT601 – System and Network Administration

IT Operations & Support Process

Arif Husen

Department of Computer Science and Information Technology,

Virtual University of Pakistan

Contents

- Introduction to Help Desk
- Development and Operations (DevOps)

Introduction to Help Desk

- **Helpdesk is the primary mechanism to provide customer support**
  - A helpdesk is a place, real or virtual, where people can get answers to their computing questions, report problems, and request new services.
    - It may be a physical desk that people walk to, or it may be a virtual helpdesk that people access electronically.

- **Significance of Helpdesk**
  - Nothing is more important than it for ITOps.
  - It is the face of an organization. The HD staff is the first impression on customers and maintain relationship, good or bad, with them.
  - The HD fix the issues , part of living with computers and are the heroes. Customers call in an emergency.
  - A good helpdesk reflects well on your organization. The typical customer sees only the customer support portion of your organization and often assumes that this is your entire organization.
  - Customers have no idea which back-office operations and infrastructure duties are also performed. In short, a helpdesk is for helping the customers.
  - Don’t forget the help in helpdesk.

Introduction to Help Desk

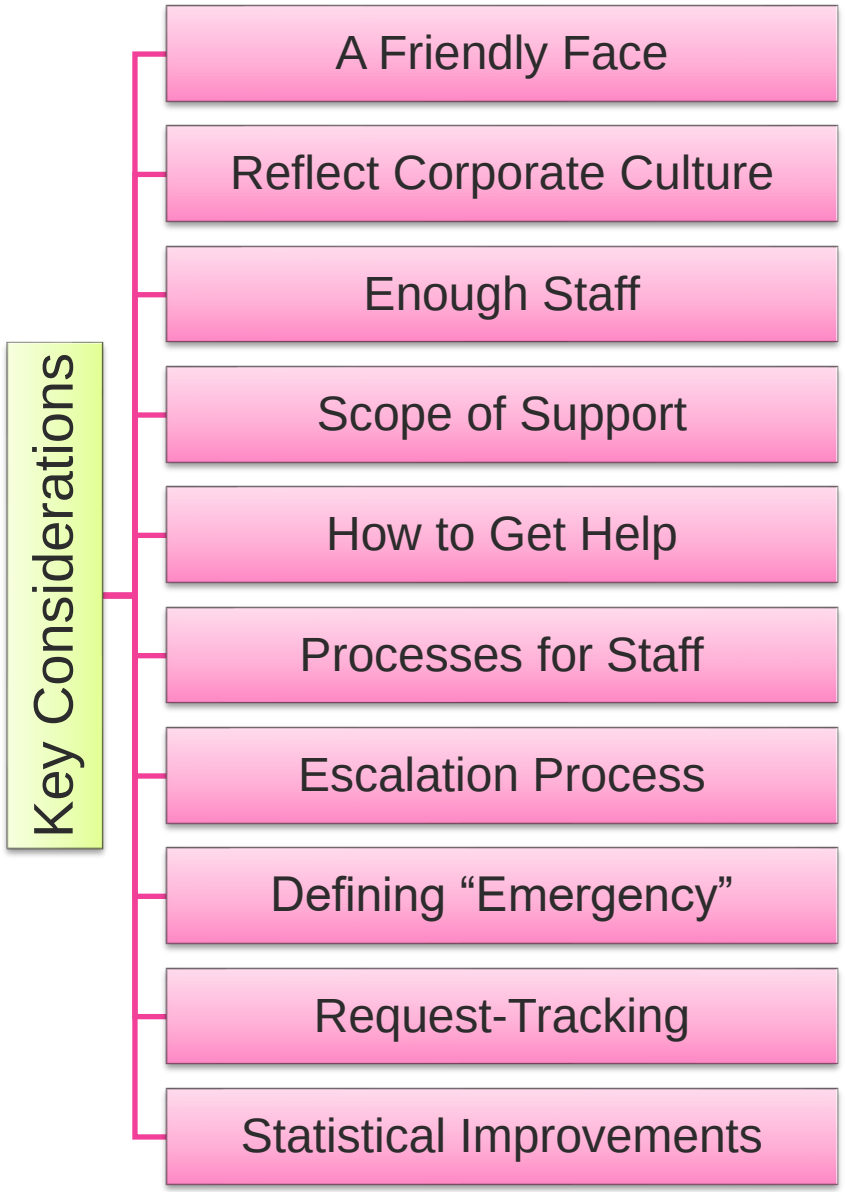
- **Is a Helpdesk really required?**
  - Every organization has a helpdesk.
    - It may be physical like walk-up counter
    - Virtual like by phone or email.
    - Sometimes unofficial.
  - Small orgnizations may not have formal helpdesk, but still leads to issues.
  - Large orgnizations needs anyhow a formal helpdesk
    - Developing a formal helpdesk should be part of that organizational planning
  - Symptoms of lacking formal helpdesk
    - Communication Problems
    - SAs unable to complete Project Tasks
    - Continuous SAs Interuuptions

Source : https://klik.solutions/managed-it-services/it-help-desk-services/

Introduction to Help Desk

- The transition from ad hoc to formal helpdesk can be uncomfortable to customers.
  - SAs should expect this push-back and do their best to ease the transition.
  - Communicating the new helpdesk procedures clearly is important.
- Helpdesks do not need to be purely physical locations but instead can be virtual.
  - Problems can be reported and replies returned via email.
  - Telephone, text-based, and audio chat systems can also be used.
  - Self-help systems are also popular but should not be considered a replacement for systems that involve human interaction.
    - These systems can reduce the workload of helpdesk attendants but cannot provide interactive debugging or resolve workflow issues that require real-time interaction.
    - There should be a phone number to call to report that the self-help system is down.
- A simple repository of documentation for customers on such topics as how to get help or request service activation and solutions to common problems.

Key Consierations for Helpdesk



Friendly Face

- **A helpdesk should have a friendly face.**
  - For a physical helpdesk, the interior design should be pleasant and welcoming.
    - A web-based virtual helpdesk is equally welcoming, Use a design based on soothing colors and readable fonts with the most selected items at the top left of the first page.
- **The faces of the staff should be welcoming and friendly, as should their personalities.**
  - When hiring HD staff, A key factor is that some people have personalities that are suited for customer service; others don't.
- **The roll or supervisor is key factor.**
  - The tone set by the staff will reflect that set by the supervisor.
    - A supervisor who yells at the staff will find staff yelling at customers.
  - A good-natured supervisor who can laugh and is always friendly will attract similar staff, who will reflect such an attitude with customers.
  - It is easier to build a reputation for being friendly initially than to restore a bad reputation.

  - The supervisor should be the friendly person you want your staff to be. Be a role model.

Reflect Corporate Culture

- **The look and feel of your helpdesk of an organization reflects its corporate culture.**
  - A helpdesk doesn't garner respect in a company when people working at the helpdesk buck the corporate culture.
    - A company that is very strict and formal may reflect this with strict dress codes and ways of conducting business, but the people at the helpdesk wear logo T-shirts and jeans, and a visitor hears a video game being played in the background.
    - A little asking around will find that the helpdesk has a reputation of being a bunch of slackers, no matter how hard they work or how high the quality of the service they provide.
  - The opposite can also happen.

- **Spend time to consider the culture and "look" of your helpdesk as compared to that of the customers they serve. Try to evolve to a culture that suits the customers served.**

HelpDesk Staff

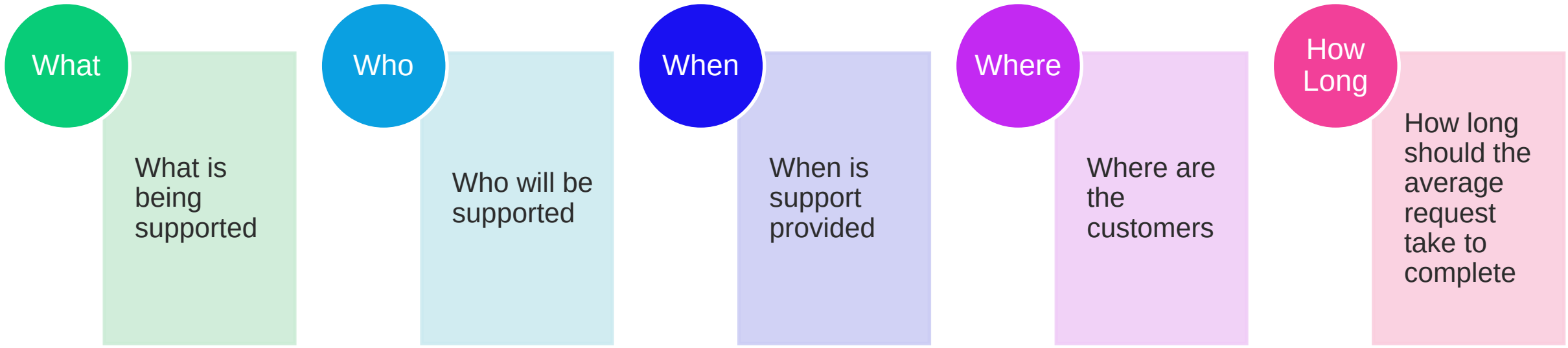
- **A helpdesk can be helpful only if it has enough people to serve customers in a timely manner.**
  - Otherwise, people will look elsewhere for their support.
- **Metrics for Sizing Helpdesk Staff**

Customer to HD Staff (CHS) Ratio	Call Volume Ratio (CVR)
▪ Universities often have 1000s of students per HD Staff. Corporates may have a higher ratio or a lower ratio.	▪ It is better to focus on callvolume ratios and time-to-call completion.
▪ An indirect metric	▪ A Direct Metric
▪ In a commercial computer science research dept., the ratio is often 40:1, with same skill level of the first-tier SAs and second-tier SSs.	▪ The rate at which customers receive busy signals or wait to receive a response, minutes required to resolve issues excluding time spent in “customer wait,”
▪ E-commerce sites usually have a separate and depending on the services being offered, the ratio can be 10,000:1 or 1,000,000:1.	▪ Managing resources based on call volume also presents a more diverse set ofpotential solutions.
▪ Ratios are a no-win situation. Management will always push to have a higher ratio; customers for lower ratio.	▪ It is required to have appropriate metrics to make decisions about improving processes.
▪ The the ratio can be increased by providing less service to the customers, which usually costs the organization.	▪ Metrics can reveal good candidates for new automation, documentation, ortraining for both SAs and customers.
	▪ Metrics can reveal which processes are more effective, which are used heavily, or which are not used at all.

Scope of Support

- A helpdesk should have a policy defining the scope of support. This document explains what an SA group is and isn't responsible for.

- The components of scope are what, who, where, when, and how long



- SAs should have a writen the scope-of-support policy.
  - What is in scope and what is out of scope

Specify How to Get Help

- **The companion to the scope-of-support document is a document that specifies how to get help: by phone, email, a ticket system, and so on.**
  - Certain types of requests may be directed to certain departments, or a unified helpdesk might be the single point of contact that forwards requests as appropriate to individual departments.

- **An image or document specifying how to get help should appear on default Windows background wallpaper images:**
  - “CompanyName IT helpdesk: [phone number] [email address] [web site].”

- **If customers have not been given clear directions on the proper way to get help, they will contact SAs directly, interrupting them at inappropriate times, and making it impossible to get larger projects done.**

Define Processes for Staff

- **Helpdesk staff should have well-defined processes to follow.**
  - In a smaller environment, this is not as important, because the processes are more ad hoc or are undocumented because they are being used by the people who built them.
  - However, for a large organization, the processes must be well documented.
- **Very large helpdesks should use scripts as part of their training. Every service supported has an associated flow of dialogue to follow to support that service.**
- **Some Scripts required identify verifications**
  - The script for a request to reset a password would, for security reasons, require callers to prove who they are, possibly by knowing a unique piece of personal information, before a new password would be set.

Establish an Escalation Process

- **Escalation is a process by which an issue is moved from the current staff person to someone with more expertise.**
  - The first line of operators should be able to handle 80 percent to 90 percent of all calls and escalate the remaining calls to a second tier of support.
  - The people at this second tier may have more experience, more training, and, possibly, other responsibilities.
  - Larger organizations can have four or more tiers; the higher tiers may include the people who built or currently maintain the service in question.
- **The escalation process is also what customers use when they are dissatisfied with the support they are receiving.**
  - Large numbers of calls being escalated to the second tier is a warning sign of a larger, systemic problem.
  - Usually, it indicates that the first-tier staff people need more training or do not have the tools to do their job properly.
  - If large numbers of calls are escalated to management, there may be systemic problems with the support the helpdesk is providing.

Define “Emergency” in Writing

- **Often, SAs are overloaded because every customer claims to have an emergency that requires immediate attention.**

  SAs may feel that customers are using this claim to boss them around, which decreases morale and increases stress levels.

- **Having a written policy empowers SAs to know when to push back and gives them a document to point to when they need it.**

  - If the customer still disagrees with this assessment, the SA can pass the issue up to someone in management, who can make the decision.
  - This lets the SA focus on technical duties and lets management focus on setting priorities and providing resources.

- **Every company should be able to define what constitutes an emergency.**
  - At a factory, an emergency is anything that stops the assembly line.
  - At a web-based service or ISP, an emergency might be anything that will prevent the service from meeting an SLA.

Use Request-Tracking Software

- **Every helpdesk needs some kind of software to help it manage requests.**
  - The alternative is a collection of notes written on scraps of paper. Although it is simple in the beginning and sufficient for environments with one or two SAs, a system based on notes on paper doesn't scale.
  - Requests get lost, and management has no ability to oversee the process to better allocate resources.
- **Those are the first qualities that you need in helpdesk software. As a helpdesk grows, software can help in other areas.**
- **Features of Helpdesk Software**
  - Helpdesk software should permit some kind of priority to be assigned to tickets.
  - Another important aspect of helpdesk software is that it collects logs about which kinds of requests are made and by whom.
  - Helpdesk software should also automate the collection of data on customer satisfaction.
  - It is critical that helpdesk software match the workflow of the people who use it.
  - Choosing helpdesk software is not an easy process. Most software will need a lot of customizing for your environment.

Statistical Improvements

- **Many sophisticated statistics can be gathered about a helpdesk.**
  - For example, you can monitor the rate of escalations to determine where more training is needed.
- **when dealing with upper management for budgeting and planning purposes, historical statistics become much more valuable.**
  - You can make a better case for your budget if you can show multiyear trends of customer growth, call volume, types of calls, technologies used, services provided, and customer satisfaction.
  - When you are asked to support a new technology or service, you can use past data to predict what the support costs may be.
- **The value of statistics increases as the organization grows, because the management becomes less directly involved in the work being done.**
  - As an organization grows, statistics are easier to collect, and it becomes more important that they be collected.

After-Hours and 24/7 Coverage

- **As computers become critical to an ever-expanding list of business processes, customers are asking for 24/7 coverage more often.**
  - Although a full three-shift staff may be required in some organizations, some very simple ways to provide 24/7 coverage are not as expensive.
- **Options**
  - Set up a voicemail box that alerts a pager when new messages arrive. The pager can be rotated among various staff members.
  - Have all managers of the customer groups know the home phone number of the helpdesk's supervisor, who then takes responsibility for calling SAs in turn until one is found.
- **No matter how SAs are contacted after hours, the person must be compensated.**
  - Some organizations have a salary incentive for oncall time, equivalent to a fraction of the employee's salary and time and a half if the person is called.
  - Other organizations issue compensation time either officially or unofficially.

Better Advertising for the Helpdesk

- **Defining your policies and providing announcements online is nice, but rarely will anyone seek them out.**
- **Options are**
  - Publish on Website
  - Email to customers esp. new policies
  - Workshops

Multiple Helpdesks

- **When an organization grows, it may make sense to have two separate helpdesks:**
  - One for requesting new services.
  - Second for reporting problems that arise after the service has been successfully enabled.
  - A third group deals with installing the new service, especially if it requires physical work.

- **This third group may be an internal helpdesk that installers all over the organization can call to escalate installation problems. It is not uncommon, though, for this third group to be the second tier of one of the other helpdesks.**

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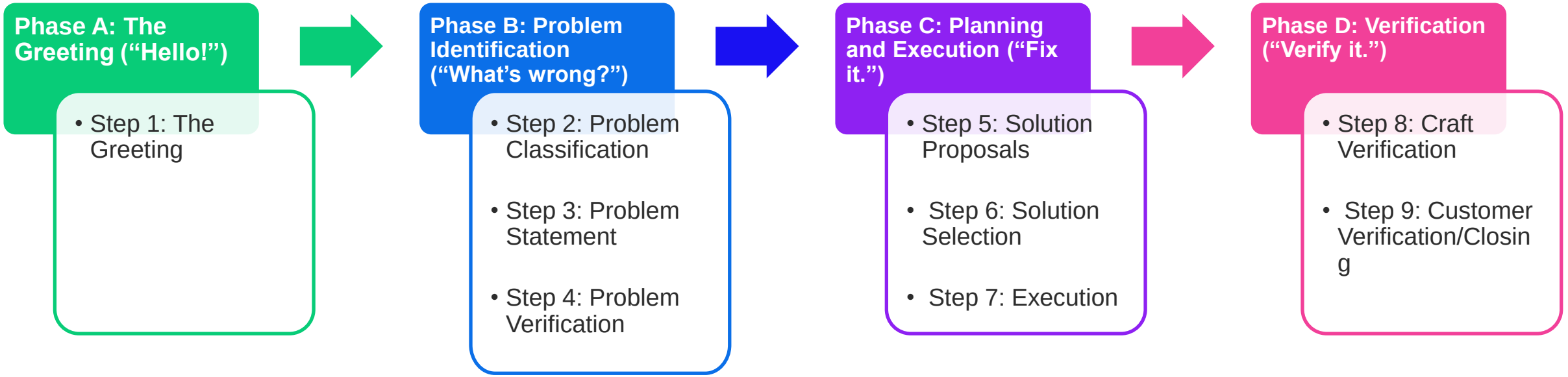

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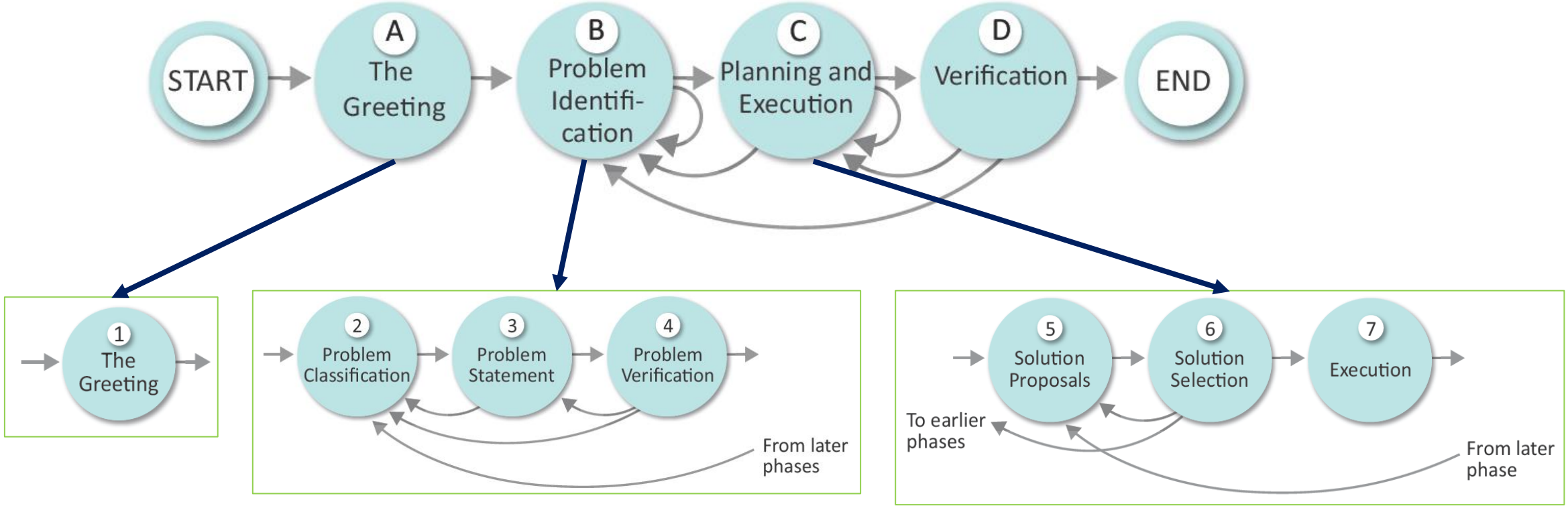

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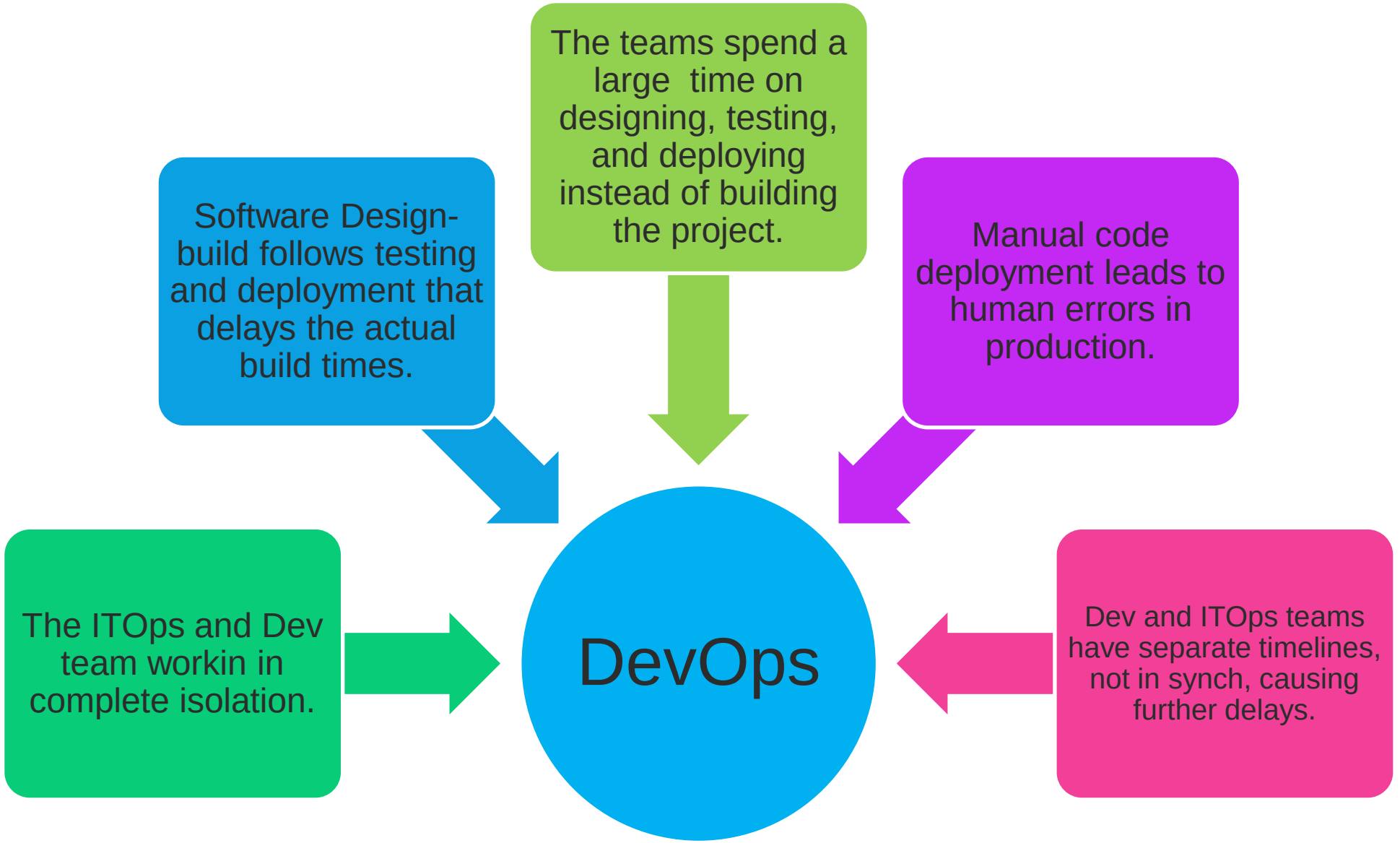

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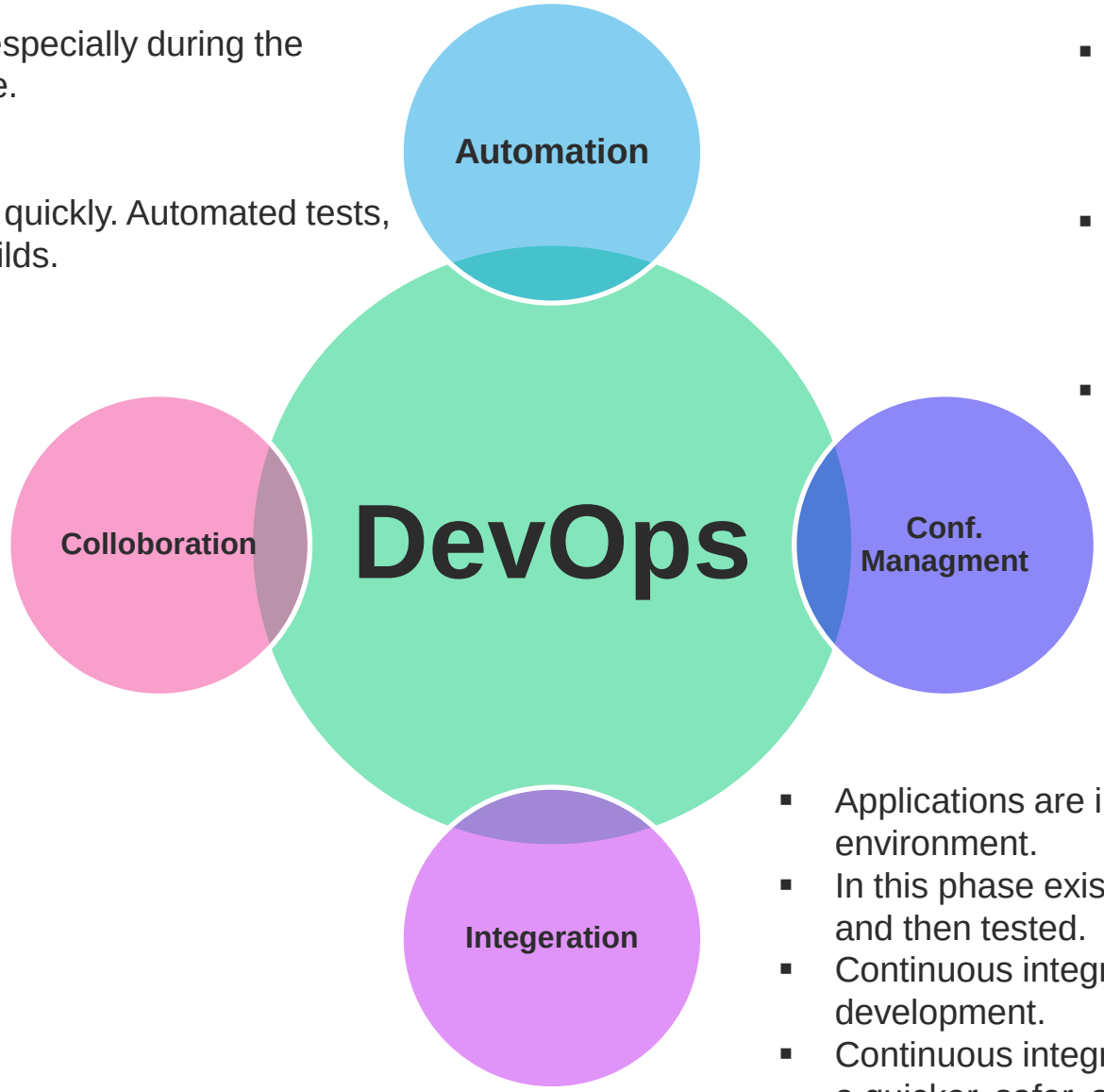
- Reduces time consumption, especially during the testing and deployment phase.
- Increases Productivity
- SW Releases are quicker.
- Catching bugs and their fixed quickly. Automated tests, cloud-based services, and builds.



- It ensures the Apps to interact with only those resources that are concerned with the environment in which it runs.
- The conf files are not created where the external configuration to the application is separated from the source code.
- The conf file can be written during deployment, or they can be loaded at the run time, depending on the environment in which it is running.

- The Dev and ITOps team collaborates that improves the cultural model.
- Improves productivity, accountability and ownership.
- Share responsibilities and work closely in sync, making the deployment to production faster.

- Applications are integrated with other components in the environment.
- In this phase existing code is combined with new functionality and then tested.
- Continuous integration and testing enable continuous development.
- Continuous integration and delivery are implemented to deliver in a quicker, safer, and reliable manner.

Mertis and Demerits of DevOps

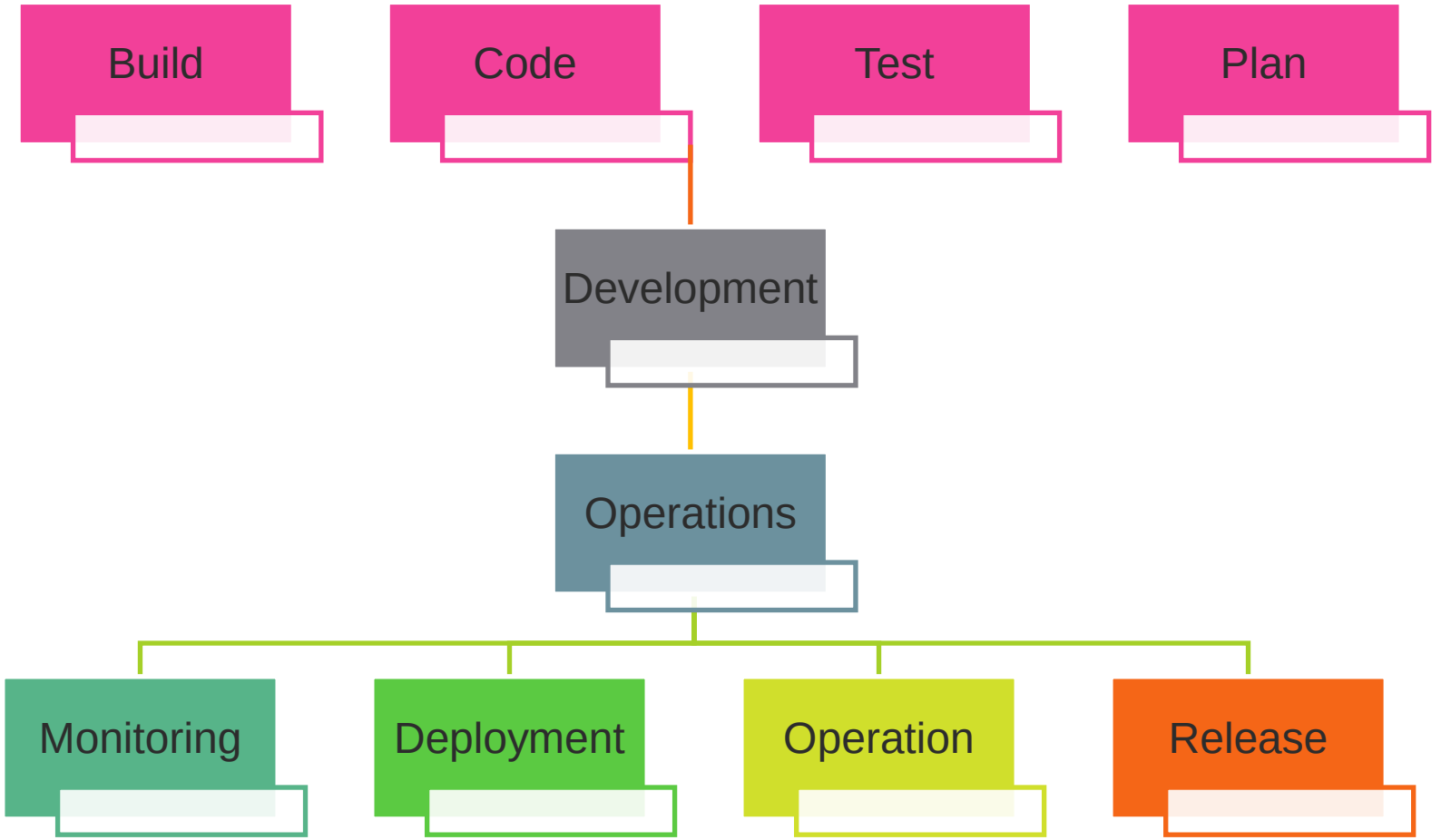
Merits

- DevOps is an excellent approach for quick development and deployment of applications.
- It responds faster to the market changes to improve business growth.
- DevOps escalate business profit by decreasing software delivery time and transportation costs.
- DevOps clears the descriptive process, which gives clarity on product development and delivery.
- It improves customer experience and satisfaction.
-
- DevOps simplifies collaboration and places all tools in the cloud for customers to access.
- DevOps means collective responsibility, which leads to better team engagement and productivity.

Demerits

- DevOps professional or expert's developers are less available.
- Developing with DevOps is so expensive.
- Adopting new DevOps technology into the industries is hard to manage in short time.
- Lack of DevOps knowledge can be a problem in the continuous integration of automation projects.

DevOps Architecture



DevOPs Components

1 - Build

- Without DevOps, the cost of the consumption of the resources was evaluated based on the pre-defined individual usage with fixed hardware allocation.

- With DevOps, the usage of cloud, sharing of resources comes into the picture, and the build is dependent upon the user's need, which is a mechanism to control the usage of resources or capacity.

2 - Coding

- Many good practices such as Git enables the code to be used, which ensures writing the code for business, helps to track changes, getting notified about the reason behind the difference in the actual and the expected output, and if necessary reverting to the original code developed.

- The code can be appropriately arranged in files, folders, etc. And they can be reused.

3 - Testing

The application will be ready for production after testing.

In the case of manual testing, it consumes more time in testing and moving the code to the output.

The testing can be automated, which decreases the time for testing so that the time to deploy the code to production can be reduced as automating the running of the scripts will remove many manual steps.

4 - Planing

- DevOps use Agile methodology to plan the development.

- With the operations and development team in sync, it helps in organizing the work to plan accordingly to increase productivity.

DevOPs Components

5 - Monitoring

- Continuous monitoring is used to identify any risk of failure. Also, it helps in tracking the system accurately so that the health of the application can be checked.

- The monitoring becomes more comfortable with services where the log data may get monitored through many third-party tools such as Splunk.

6 - Deployment

- Many systems can support the scheduler for automated deployment.

- The cloud management platform enables users to capture accurate insights and view the optimization scenario, analytics on trends by the deployment of dashboards.

7 - Operation

- DevOps changes the way traditional approach of developing and testing separately.

- The teams operate in a collaborative way where both the teams actively participate throughout the service lifecycle.

- The operation team interacts with developers, and they come up with a monitoring plan which serves the IT and business requirements.

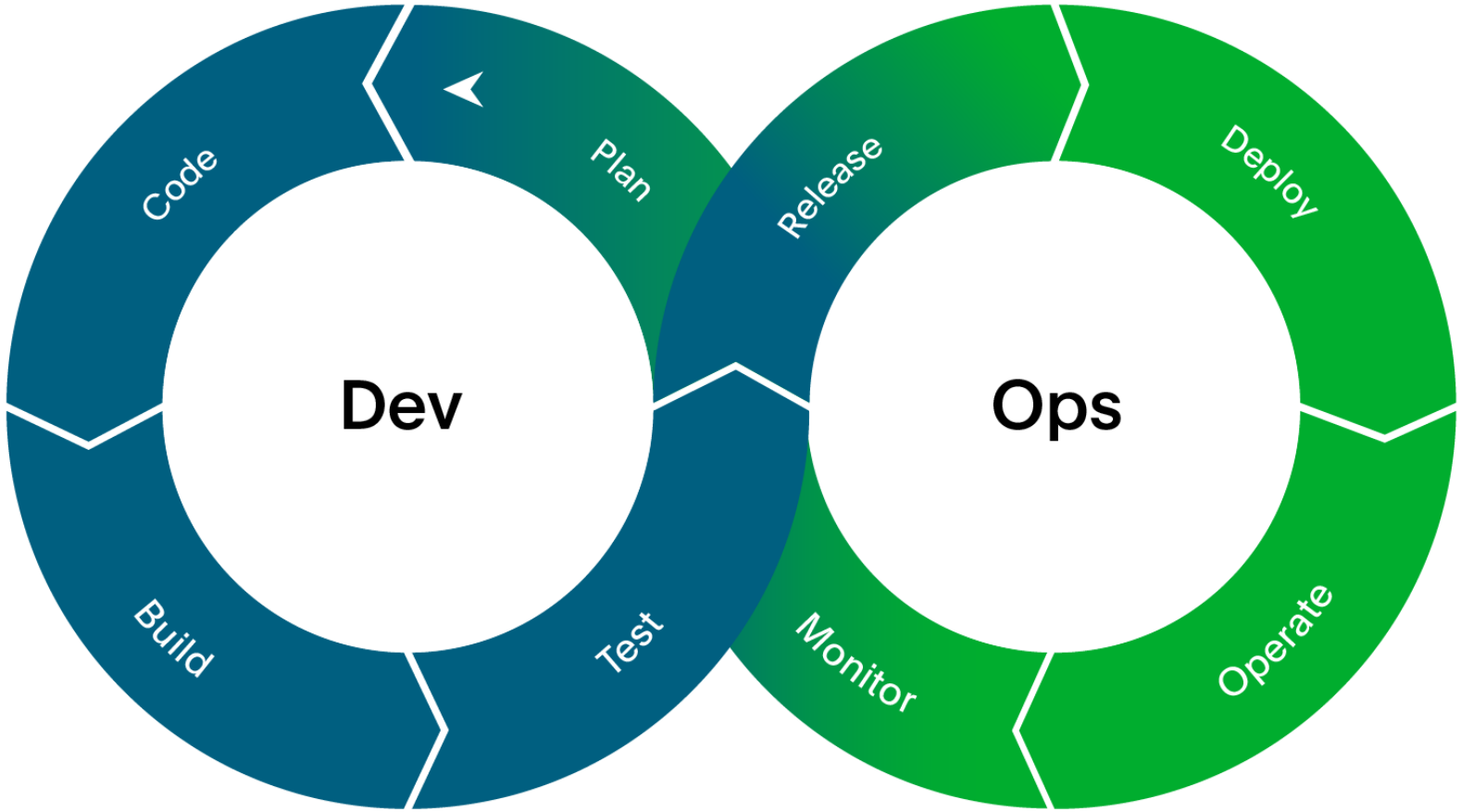
8 - Release

- Deployment to an environment can be done by automation.

- But when the deployment is made to the production environment, it is done by manual triggering. Many processes involved in release management commonly used to do the deployment in the production environment manually to lessen the impact on the customers.

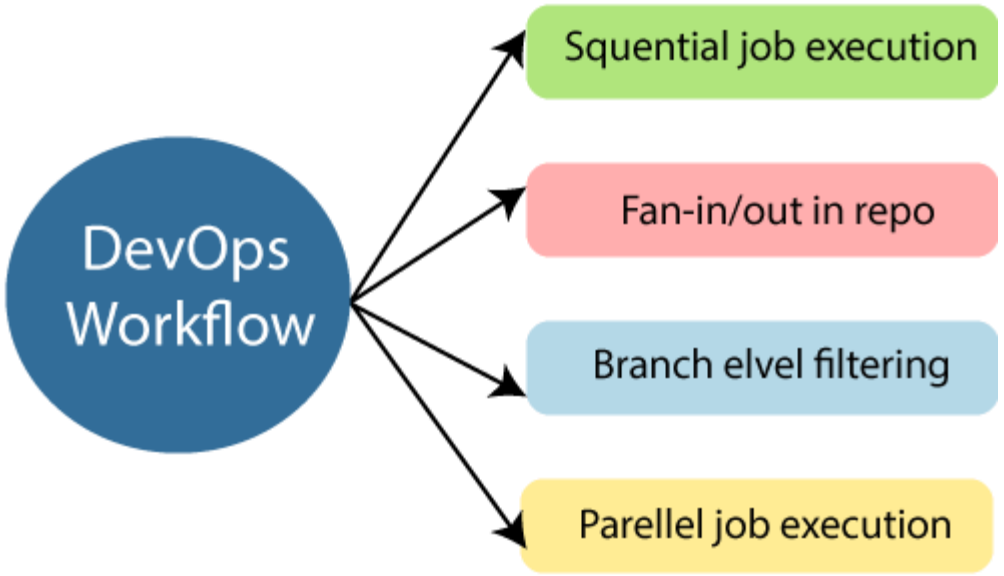
DevOps Cycle

- All components discussed reviously work in continuous model



Workflow

- DevOps workflow provides a visual overview of the sequence in which input is provided. Also, it tells about which one action is performed, and output is generated for an operations process.



- DevOps workflow allows the ability to separate and arrange the jobs which are top requested by the users. Also, it gives the ability to mirror their ideal process in the configuration jobs.

DevOps Principles

- The main principles of DevOps are Continuous delivery, automation, and fast reaction to the feedback.

End to End Responsibility

- DevOps team need to provide performance support until they become the end of life. It enhances the responsibility and the quality of the products engineered.

Continuous Improvement:

- DevOps culture focuses on continuous improvement to minimize waste. It continuously speeds up the growth of products or services offered.

Automate Everything

- Automation is an essential principle of the DevOps process. This is for software development and also for the entire infrastructure landscape.

Custom Centric Action

- DevOps team must take customer-centric for that they should continuously invest in products and services.

Monitor and test everything

- The DevOps team needs to have robust monitoring and testing procedures.

Work as one team

- In the DevOps culture role of the designers, developers, and testers are already defined. All they needed to do is work as one team with complete collaboration.

- These principles are achieved through several DevOps practices, which include frequent deployments, QA automation, continuous delivery, validating ideas as early as possible, and in-team collaboration.

DevOps Practices

- Some identified DevOps practices are:

  - Self-service configuration
  - Continuous build
  - Continuous integration
  - Continuous delivery
  - Incremental testing
  - Automated provisioning
  - Automated release management

DevOps Tools

Puppet

- Puppet is the most widely used DevOps tool.
- It allows the delivery and release of the technology changes quickly and frequently.
- It has features of versioning, automated testing, and continuous delivery.
- It enables to manage entire infrastructure as code without expanding the size of the team.

Ansible

- Ansible is a leading DevOps tool.
- Ansible is an open-source IT engine that automates application deployment, cloud provisioning, intra service orchestration, and other IT tools.
- It makes it easier for DevOps teams to scale automation and speed up productivity.
- Ansible is easy to deploy because it does not use any agents or custom security infrastructure on the client-side, and by pushing modules to the clients.
- These modules are executed locally on the client-side, and the output is pushed back to the Ansible server.

Docker

- Docker is a high-end DevOps tool that allows building, ship, and run distributed applications on multiple systems.
- It also helps to assemble the apps quickly from the components, and it is typically suitable for container management.

Nagios

- Nagios is one of the more useful tools for DevOps.
- It can determine the errors and rectify them with the help of network, infrastructure, server, and log monitoring systems.

CHEF

- A chef is a useful tool for achieving scale, speed, and consistency.
- The chef is a cloud-based system and open source technology. This technology uses Ruby encoding to develop essential building blocks such as recipes and cookbooks.
- The chef is used in infrastructure automation and helps in reducing manual and repetitive tasks for infrastructure management.
- Chef has got its convention for different building blocks, which are required to manage and automate infrastructure.

DevOps Tools

Jenkins

- Jenkins is a DevOps tool for monitoring the execution of repeated tasks.
- Jenkins is a software that allows continuous integration. Jenkins will be installed on a server where the central build will take place.
- It helps to integrate project changes more efficiently by finding the issues quickly.

Git

- Git is an open-source distributed version control system that is freely available for everyone.
- It is designed to handle minor to major projects with speed and efficiency.
- It is developed to co-ordinate the work among programmers. The version control allows you to track and work together with your team members at the same workspace.
- It is used as a critical distributed version-control for the DevOps tool.

SALTSTACK

- Stackify is a lightweight DevOps tool.
- It shows real-time error queries, logs, and more directly into the workstation.
- SALTSTACK is an ideal solution for intelligent orchestration for the software-defined data center.

Splunk

- Splunk is a tool to make machine data usable, accessible, and valuable to everyone.
- It delivers operational intelligence to DevOps teams.
- It helps companies to be more secure, productive, and competitive.

Selenium

- Selenium is a portable software testing framework for web applications.
- It provides an easy interface for developing automated tests.

IT601 – System and Network Administration

IT Operations & Support Process

Arif Husen

Department of Computer Science and Information Technology,

Virtual University of Pakistan

Contents

- Introduction to Help Desk
- Development and Operations (DevOps)

Introduction to Help Desk

- **Helpdesk is the primary mechanism to provide customer support**
  - A helpdesk is a place, real or virtual, where people can get answers to their computing questions, report problems, and request new services.
    - It may be a physical desk that people walk to, or it may be a virtual helpdesk that people access electronically.

- **Significance of Helpdesk**
  - Nothing is more important than it for ITOps.
  - It is the face of an organization. The HD staff is the first impression on customers and maintain relationship, good or bad, with them.
  - The HD fix the issues , part of living with computers and are the heroes. Customers call in an emergency.
  - A good helpdesk reflects well on your organization. The typical customer sees only the customer support portion of your organization and often assumes that this is your entire organization.
  - Customers have no idea which back-office operations and infrastructure duties are also performed. In short, a helpdesk is for helping the customers.
  - Don’t forget the help in helpdesk.

Introduction to Help Desk

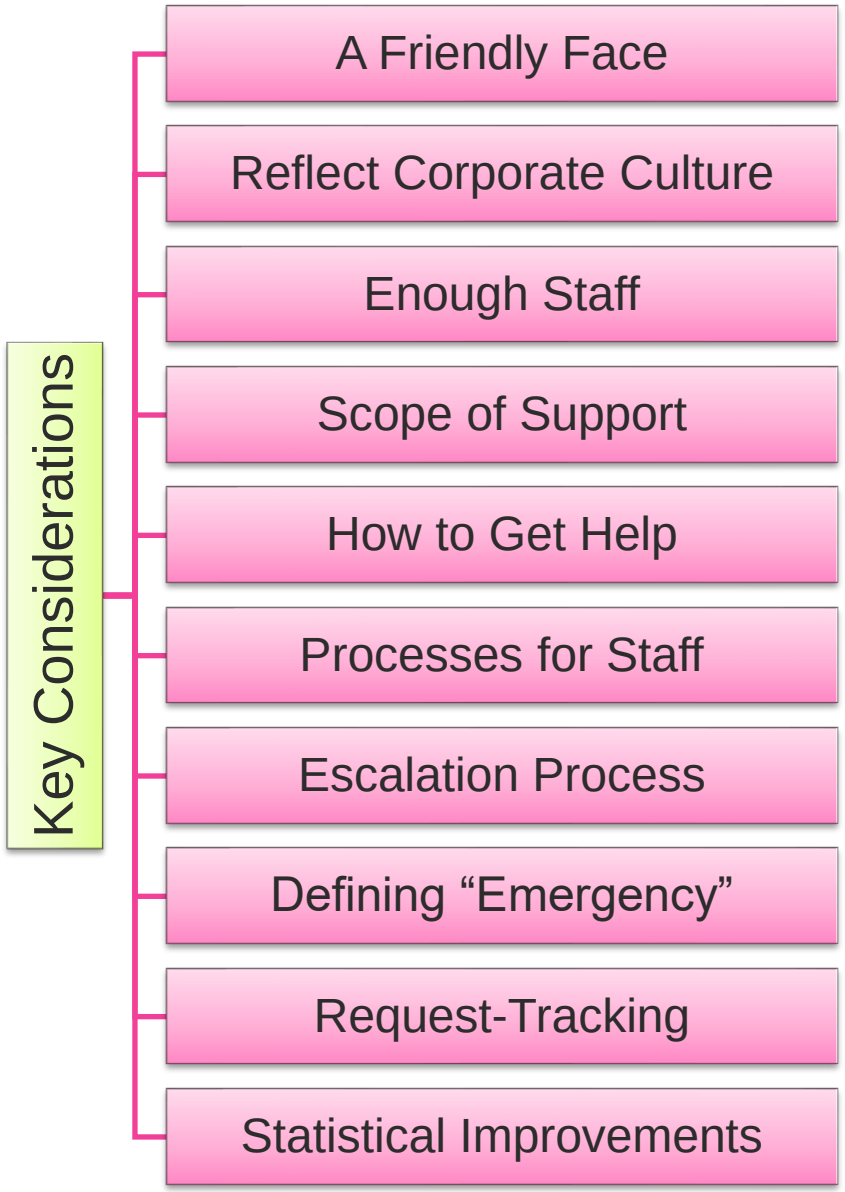
- **Is a Helpdesk really required?**
  - Every organization has a helpdesk.
    - It may be physical like walk-up counter
    - Virtual like by phone or email.
    - Sometimes unofficial.
  - Small orgnizations may not have formal helpdesk, but still leads to issues.
  - Large orgnizations needs anyhow a formal helpdesk
    - Developing a formal helpdesk should be part of that organizational planning
  - Symptoms of lacking formal helpdesk
    - Communication Problems
    - SAs unable to complete Project Tasks
    - Continuous SAs Interuuptions

Source : https://klik.solutions/managed-it-services/it-help-desk-services/

Introduction to Help Desk

- The transition from ad hoc to formal helpdesk can be uncomfortable to customers.
  - SAs should expect this push-back and do their best to ease the transition.
  - Communicating the new helpdesk procedures clearly is important.
- Helpdesks do not need to be purely physical locations but instead can be virtual.
  - Problems can be reported and replies returned via email.
  - Telephone, text-based, and audio chat systems can also be used.
  - Self-help systems are also popular but should not be considered a replacement for systems that involve human interaction.
    - These systems can reduce the workload of helpdesk attendants but cannot provide interactive debugging or resolve workflow issues that require real-time interaction.
    - There should be a phone number to call to report that the self-help system is down.
- A simple repository of documentation for customers on such topics as how to get help or request service activation and solutions to common problems.

Key Consierations for Helpdesk



Friendly Face

- **A helpdesk should have a friendly face.**
  - For a physical helpdesk, the interior design should be pleasant and welcoming.
    - A web-based virtual helpdesk is equally welcoming, Use a design based on soothing colors and readable fonts with the most selected items at the top left of the first page.
- **The faces of the staff should be welcoming and friendly, as should their personalities.**
  - When hiring HD staff, A key factor is that some people have personalities that are suited for customer service; others don't.
- **The roll or supervisor is key factor.**
  - The tone set by the staff will reflect that set by the supervisor.
    - A supervisor who yells at the staff will find staff yelling at customers.
  - A good-natured supervisor who can laugh and is always friendly will attract similar staff, who will reflect such an attitude with customers.
  - It is easier to build a reputation for being friendly initially than to restore a bad reputation.

  - The supervisor should be the friendly person you want your staff to be. Be a role model.

Reflect Corporate Culture

- **The look and feel of your helpdesk of an organization reflects its corporate culture.**
  - A helpdesk doesn't garner respect in a company when people working at the helpdesk buck the corporate culture.
    - A company that is very strict and formal may reflect this with strict dress codes and ways of conducting business, but the people at the helpdesk wear logo T-shirts and jeans, and a visitor hears a video game being played in the background.
    - A little asking around will find that the helpdesk has a reputation of being a bunch of slackers, no matter how hard they work or how high the quality of the service they provide.
  - The opposite can also happen.

- **Spend time to consider the culture and "look" of your helpdesk as compared to that of the customers they serve. Try to evolve to a culture that suits the customers served.**

HelpDesk Staff

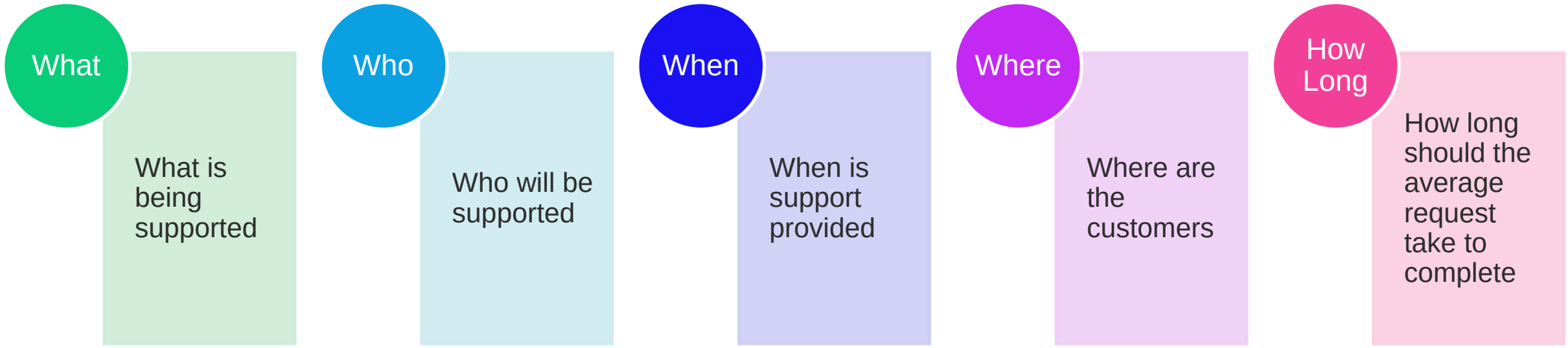
- **A helpdesk can be helpful only if it has enough people to serve customers in a timely manner.**
  - Otherwise, people will look elsewhere for their support.
- **Metrics for Sizing Helpdesk Staff**

Customer to HD Staff (CHS) Ratio	Call Volume Ratio (CVR)
▪ Universities often have 1000s of students per HD Staff. Corporates may have a higher ratio or a lower ratio.	▪ It is better to focus on callvolume ratios and time-to-call completion.
▪ An indirect metric	▪ A Direct Metric
▪ In a commercial computer science research dept., the ratio is often 40:1, with same skill level of the first-tier SAs and second-tier SSs.	▪ The rate at which customers receive busy signals or wait to receive a response, minutes required to resolve issues excluding time spent in “customer wait,”
▪ E-commerce sites usually have a separate and depending on the services being offered, the ratio can be 10,000:1 or 1,000,000:1.	▪ Managing resources based on call volume also presents a more diverse set ofpotential solutions.
▪ Ratios are a no-win situation. Management will always push to have a higher ratio; customers for lower ratio.	▪ It is required to have appropriate metrics to make decisions about improving processes.
▪ The the ratio can be increased by providing less service to the customers, which usually costs the organization.	▪ Metrics can reveal good candidates for new automation, documentation, ortraining for both SAs and customers.
	▪ Metrics can reveal which processes are more effective, which are used heavily, or which are not used at all.

Scope of Support

- A helpdesk should have a policy defining the scope of support. This document explains what an SA group is and isn't responsible for.

- The components of scope are what, who, where, when, and how long



- SAs should have a writen the scope-of-support policy.
  - What is in scope and what is out of scope

Specify How to Get Help

- **The companion to the scope-of-support document is a document that specifies how to get help: by phone, email, a ticket system, and so on.**
  - Certain types of requests may be directed to certain departments, or a unified helpdesk might be the single point of contact that forwards requests as appropriate to individual departments.

- **An image or document specifying how to get help should appear on default Windows background wallpaper images:**
  - “CompanyName IT helpdesk: [phone number] [email address] [web site].”

- **If customers have not been given clear directions on the proper way to get help, they will contact SAs directly, interrupting them at inappropriate times, and making it impossible to get larger projects done.**

Define Processes for Staff

- **Helpdesk staff should have well-defined processes to follow.**
  - In a smaller environment, this is not as important, because the processes are more ad hoc or are undocumented because they are being used by the people who built them.
  - However, for a large organization, the processes must be well documented.
- **Very large helpdesks should use scripts as part of their training. Every service supported has an associated flow of dialogue to follow to support that service.**
- **Some Scripts required identify verifications**
  - The script for a request to reset a password would, for security reasons, require callers to prove who they are, possibly by knowing a unique piece of personal information, before a new password would be set.

Establish an Escalation Process

- **Escalation is a process by which an issue is moved from the current staff person to someone with more expertise.**
  - The first line of operators should be able to handle 80 percent to 90 percent of all calls and escalate the remaining calls to a second tier of support.
  - The people at this second tier may have more experience, more training, and, possibly, other responsibilities.
  - Larger organizations can have four or more tiers; the higher tiers may include the people who built or currently maintain the service in question.
- **The escalation process is also what customers use when they are dissatisfied with the support they are receiving.**
  - Large numbers of calls being escalated to the second tier is a warning sign of a larger, systemic problem.
  - Usually, it indicates that the first-tier staff people need more training or do not have the tools to do their job properly.
  - If large numbers of calls are escalated to management, there may be systemic problems with the support the helpdesk is providing.

Define “Emergency” in Writing

- **Often, SAs are overloaded because every customer claims to have an emergency that requires immediate attention.**

  SAs may feel that customers are using this claim to boss them around, which decreases morale and increases stress levels.

- **Having a written policy empowers SAs to know when to push back and gives them a document to point to when they need it.**

  - If the customer still disagrees with this assessment, the SA can pass the issue up to someone in management, who can make the decision.
  - This lets the SA focus on technical duties and lets management focus on setting priorities and providing resources.

- **Every company should be able to define what constitutes an emergency.**
  - At a factory, an emergency is anything that stops the assembly line.
  - At a web-based service or ISP, an emergency might be anything that will prevent the service from meeting an SLA.

Use Request-Tracking Software

- **Every helpdesk needs some kind of software to help it manage requests.**
  - The alternative is a collection of notes written on scraps of paper. Although it is simple in the beginning and sufficient for environments with one or two SAs, a system based on notes on paper doesn't scale.
  - Requests get lost, and management has no ability to oversee the process to better allocate resources.
- **Those are the first qualities that you need in helpdesk software. As a helpdesk grows, software can help in other areas.**
- **Features of Helpdesk Software**
  - Helpdesk software should permit some kind of priority to be assigned to tickets.
  - Another important aspect of helpdesk software is that it collects logs about which kinds of requests are made and by whom.
  - Helpdesk software should also automate the collection of data on customer satisfaction.
  - It is critical that helpdesk software match the workflow of the people who use it.
  - Choosing helpdesk software is not an easy process. Most software will need a lot of customizing for your environment.

Statistical Improvements

- **Many sophisticated statistics can be gathered about a helpdesk.**
  - For example, you can monitor the rate of escalations to determine where more training is needed.
- **when dealing with upper management for budgeting and planning purposes, historical statistics become much more valuable.**
  - You can make a better case for your budget if you can show multiyear trends of customer growth, call volume, types of calls, technologies used, services provided, and customer satisfaction.
  - When you are asked to support a new technology or service, you can use past data to predict what the support costs may be.
- **The value of statistics increases as the organization grows, because the management becomes less directly involved in the work being done.**
  - As an organization grows, statistics are easier to collect, and it becomes more important that they be collected.

After-Hours and 24/7 Coverage

- **As computers become critical to an ever-expanding list of business processes, customers are asking for 24/7 coverage more often.**
  - Although a full three-shift staff may be required in some organizations, some very simple ways to provide 24/7 coverage are not as expensive.
- **Options**
  - Set up a voicemail box that alerts a pager when new messages arrive. The pager can be rotated among various staff members.
  - Have all managers of the customer groups know the home phone number of the helpdesk's supervisor, who then takes responsibility for calling SAs in turn until one is found.
- **No matter how SAs are contacted after hours, the person must be compensated.**
  - Some organizations have a salary incentive for oncall time, equivalent to a fraction of the employee's salary and time and a half if the person is called.
  - Other organizations issue compensation time either officially or unofficially.

Better Advertising for the Helpdesk

- **Defining your policies and providing announcements online is nice, but rarely will anyone seek them out.**
- **Options are**
  - Publish on Website
  - Email to customers esp. new policies
  - Workshops

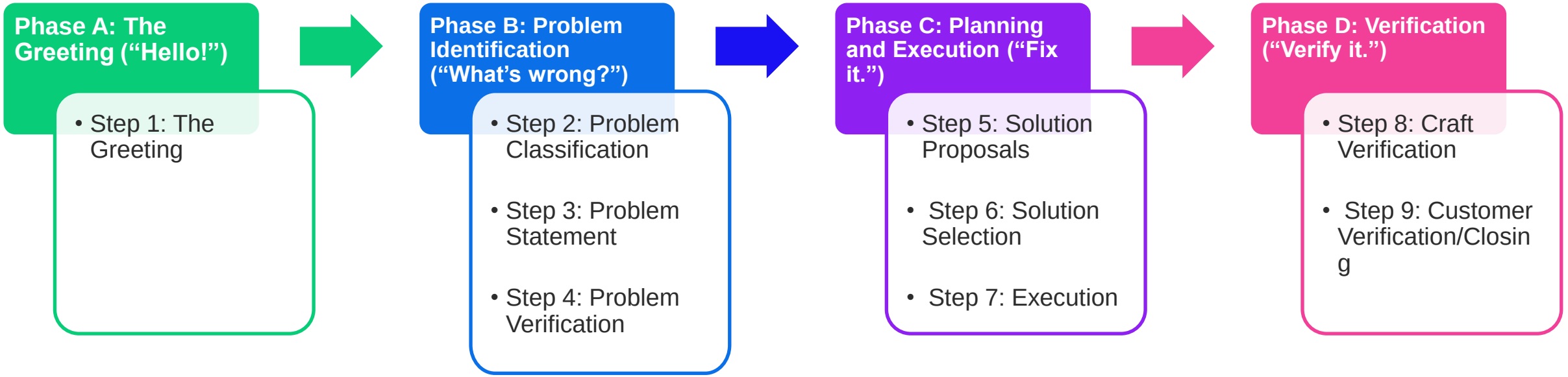
Multiple Helpdesks

- **When an organization grows, it may make sense to have two separate helpdesks:**
  - One for requesting new services.
  - Second for reporting problems that arise after the service has been successfully enabled.
  - A third group deals with installing the new service, especially if it requires physical work.

- **This third group may be an internal helpdesk that installers all over the organization can call to escalate installation problems. It is not uncommon, though, for this third group to be the second tier of one of the other helpdesks.**

Processing for processing customer requests

- **The method for processing these customer requests has nine steps, which can be grouped into four phases:**

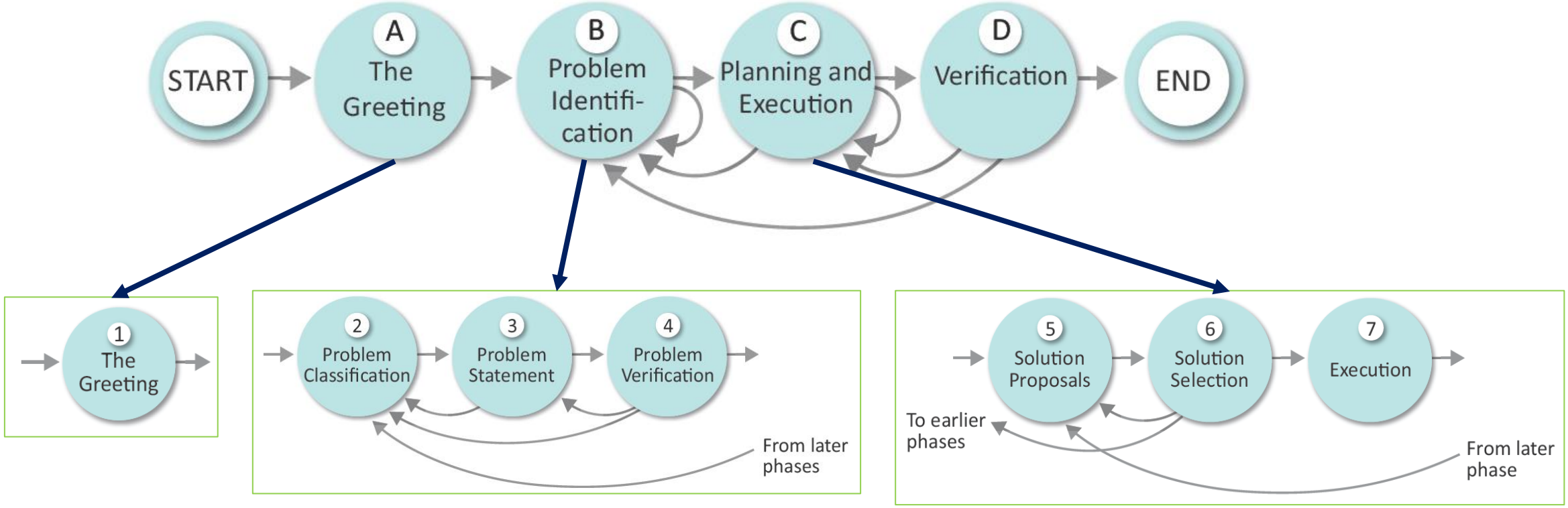


- **This method gives structure to what is, for newer SAs, a more haphazard process.**
  - It helps SAs solve problems more efficiently by keeping them focused and helps them avoid mistakes. It introduces a common set of terminology that, when used by the entire SA team, increases the ability to communicate within the group.

Problem Solving Process

- **Problem Solving Process consist of four phases**

A. Reporting the problem
B. Identifying the problem
C. Planning and executing a solution
D. Verifying that the problem resolution is complete



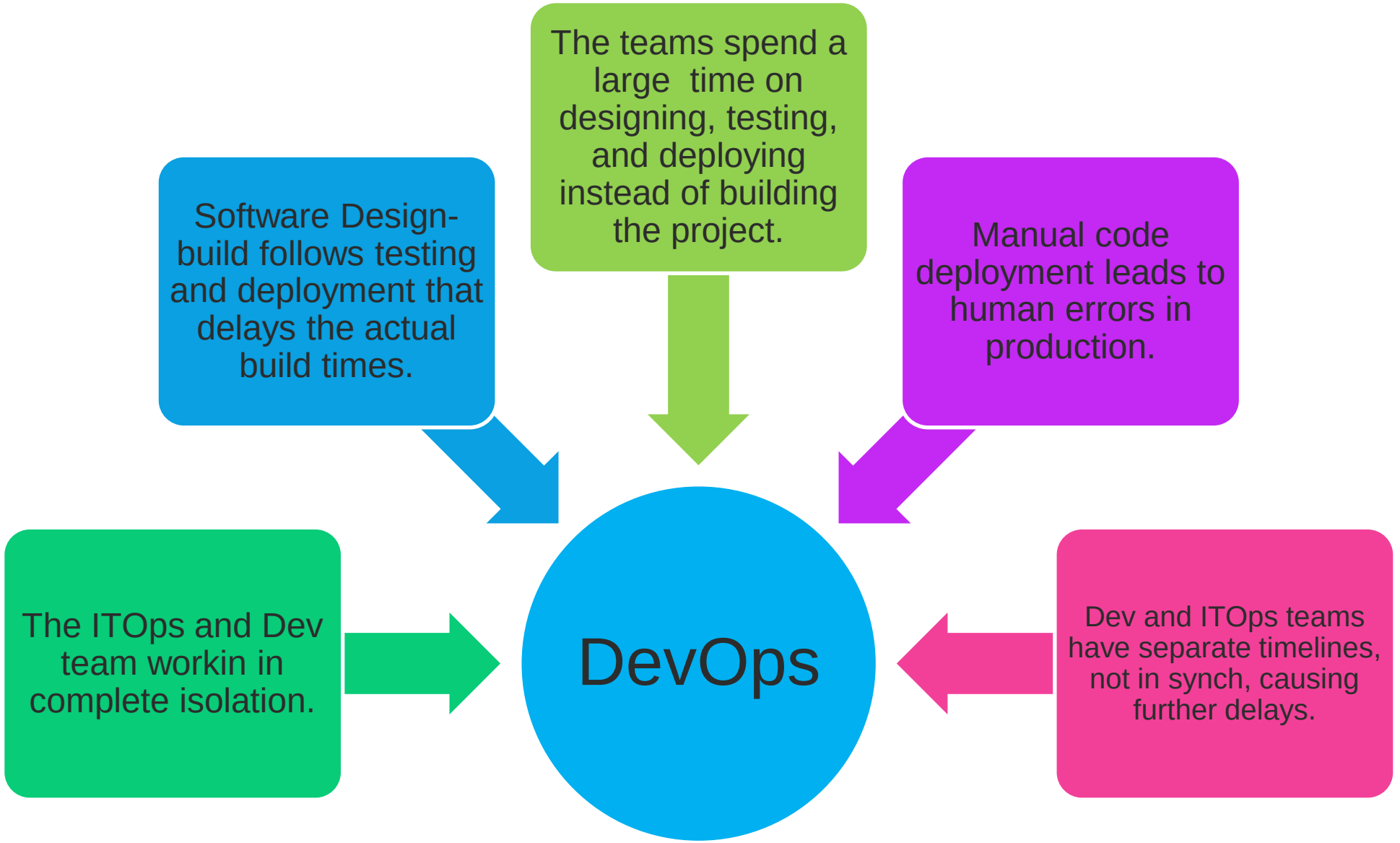
Development and Operations Together

- **Large organizations often have software development teams and IT operations team.**
  - System and Network Administration is part of IT operations
- **Some problems reported to system administrators or tasks requires the collaboration with software development team**
  - Thus development and Operations are not standalone they are strongly coupled
- **The collaboration of software development and IT operations is also applicable even if organizations donot have in house software development/ IT operations teams (Outsouricing Model)**
  - Thus development and Operations are not standalone they are strongly coupled
- **DevOps is a model which allows agile collaboration between administratively independent software development and IT operations teams.**

DevOps

- **The DevOps is a mixture of two words, one is software Development, and second is Operations.**
  - It allows to jointly handle the entire application lifecycle, from development to testing, deployment, and operations.
  - DevOps helps to reduce the disconnection between software developers, quality assurance (QA) engineers, and system administrators.

The Need of DevOps



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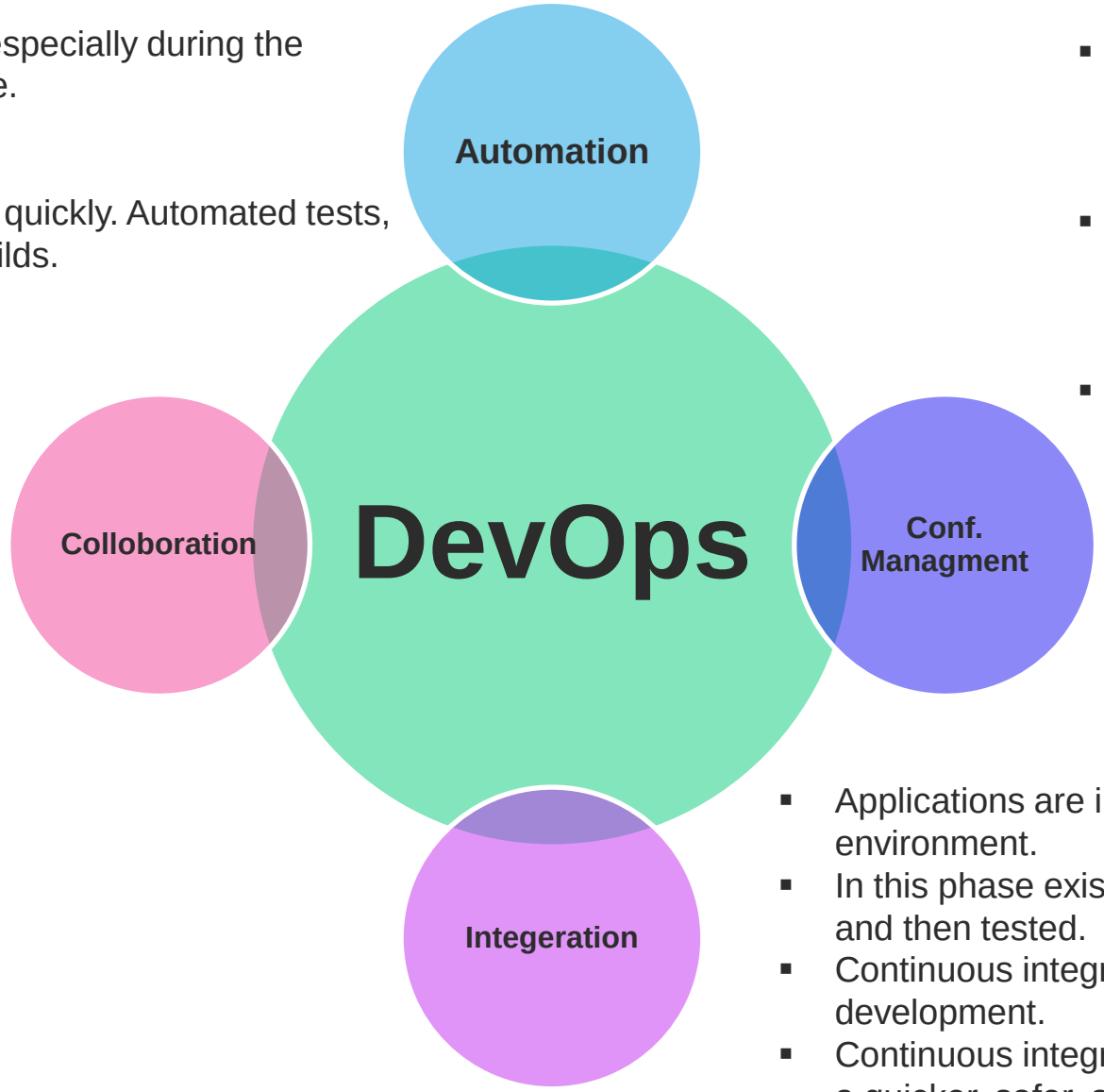

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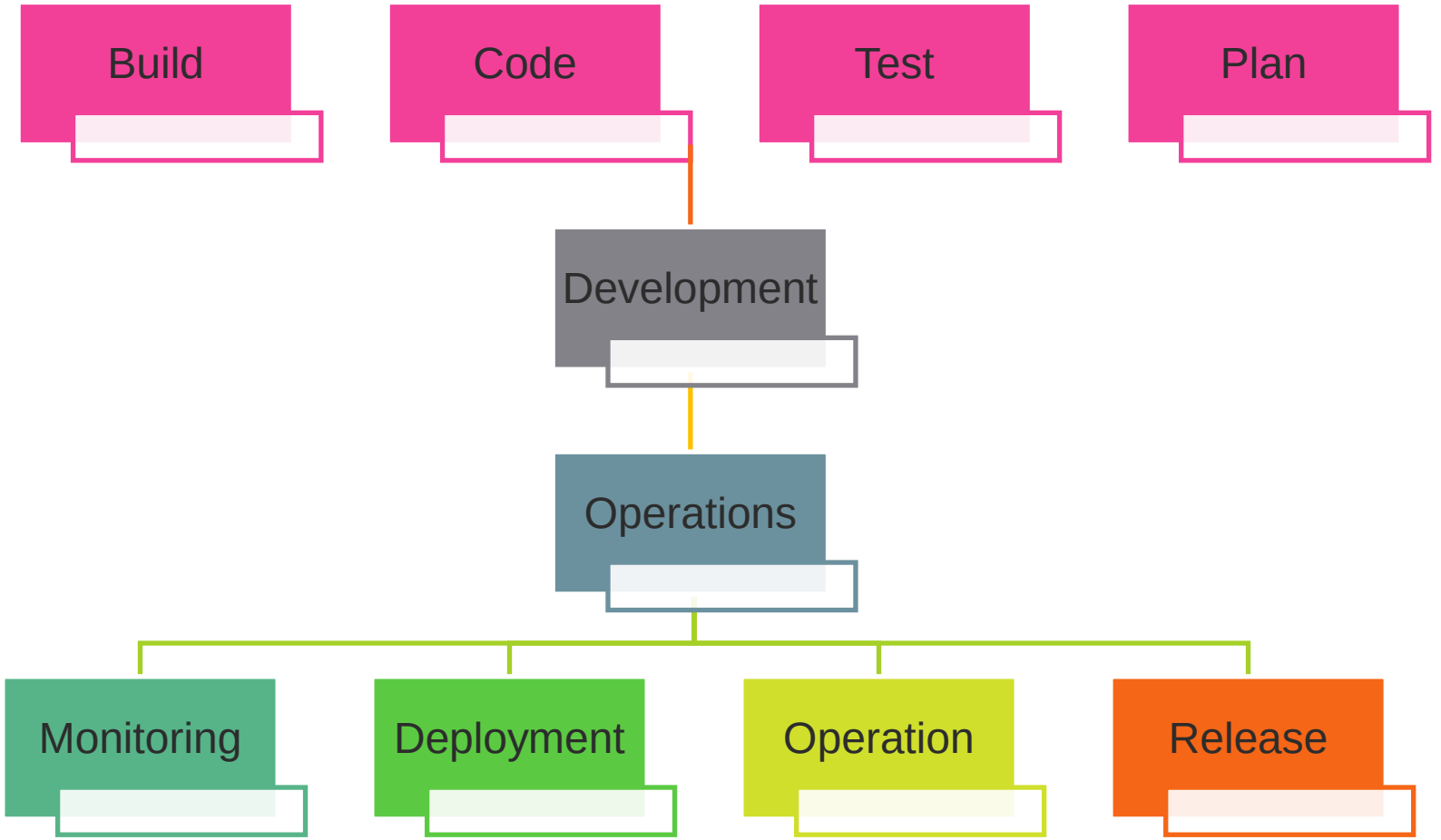

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- With DevOps, the usage of cloud, sharing of resources comes into the picture, and the build is dependent upon the user's need, which is a mechanism to control the usage of resources or capacity.

2 - Coding

- Many good practices such as Git enables the code to be used, which ensures writing the code for business, helps to track changes, getting notified about the reason behind the difference in the actual and the expected output, and if necessary reverting to the original code developed.

- The code can be appropriately arranged in files, folders, etc. And they can be reused.

3 - Testing

The application will be ready for production after testing.

In the case of manual testing, it consumes more time in testing and moving the code to the output.

The testing can be automated, which decreases the time for testing so that the time to deploy the code to production can be reduced as automating the running of the scripts will remove many manual steps.

4 - Planing

- DevOps use Agile methodology to plan the development.

- With the operations and development team in sync, it helps in organizing the work to plan accordingly to increase productivity.

DevOPs Components

5 - Monitoring

- Continuous monitoring is used to identify any risk of failure. Also, it helps in tracking the system accurately so that the health of the application can be checked.

- The monitoring becomes more comfortable with services where the log data may get monitored through many third-party tools such as Splunk.

6 - Deployment

- Many systems can support the scheduler for automated deployment.

- The cloud management platform enables users to capture accurate insights and view the optimization scenario, analytics on trends by the deployment of dashboards.

7 - Operation

- DevOps changes the way traditional approach of developing and testing separately.

- The teams operate in a collaborative way where both the teams actively participate throughout the service lifecycle.

- The operation team interacts with developers, and they come up with a monitoring plan which serves the IT and business requirements.

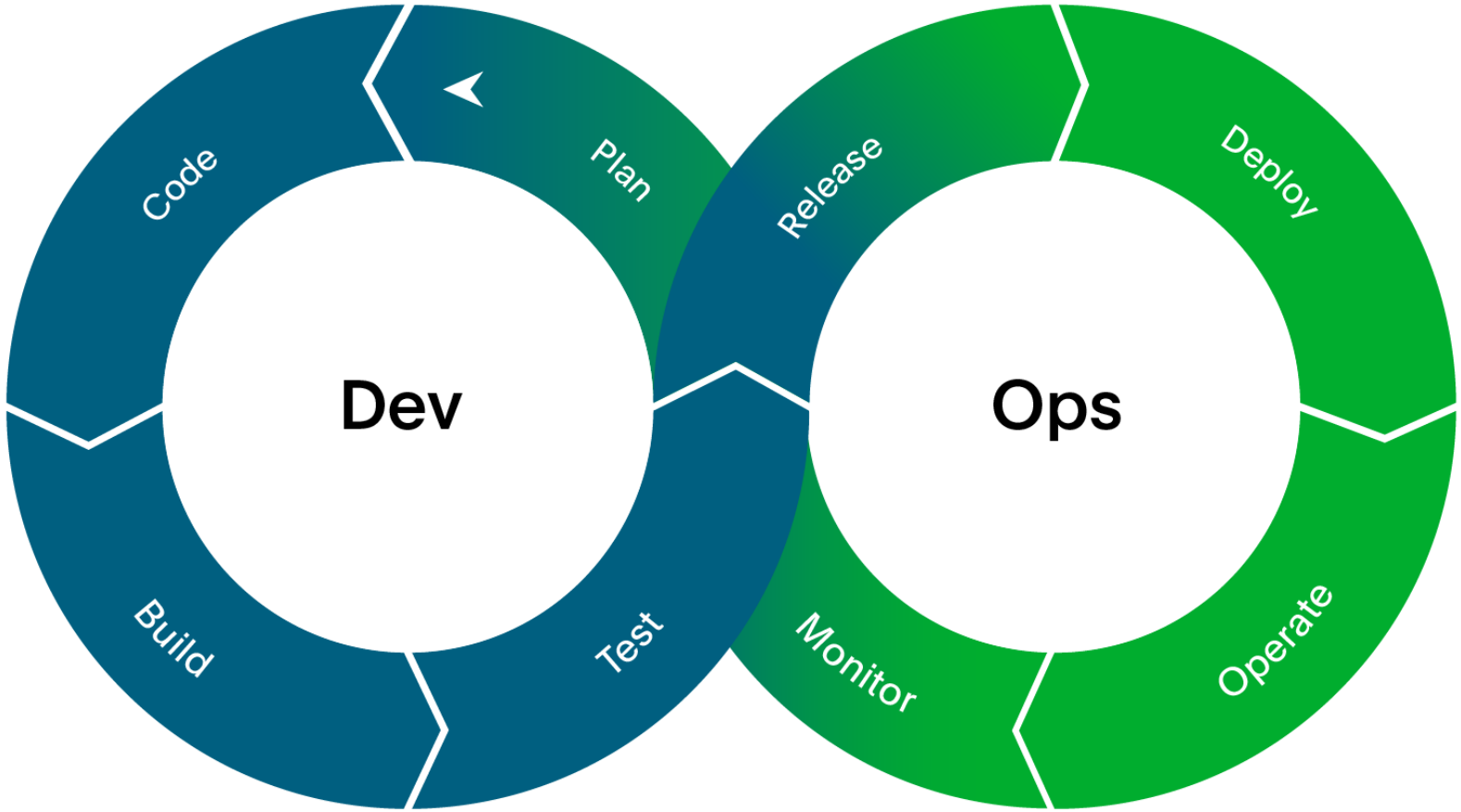
8 - Release

- Deployment to an environment can be done by automation.

- But when the deployment is made to the production environment, it is done by manual triggering. Many processes involved in release management commonly used to do the deployment in the production environment manually to lessen the impact on the customers.

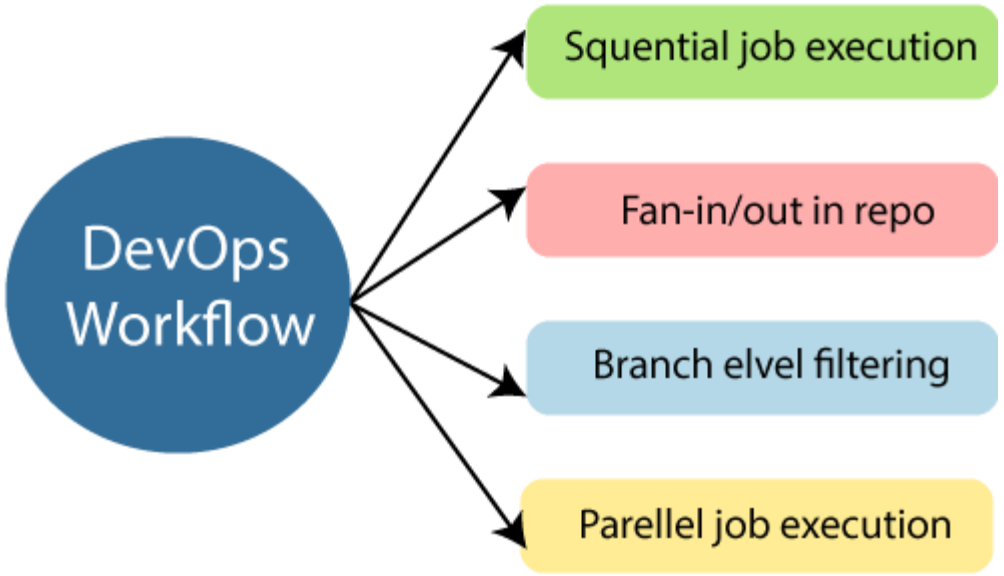
DevOps Cycle

- All components discussed reviously work in continuous model



Workflow

- DevOps workflow provides a visual overview of the sequence in which input is provided. Also, it tells about which one action is performed, and output is generated for an operations process.



- DevOps workflow allows the ability to separate and arrange the jobs which are top requested by the users. Also, it gives the ability to mirror their ideal process in the configuration jobs.

DevOps Principles

- The main principles of DevOps are Continuous delivery, automation, and fast reaction to the feedback.

End to End Responsibility

- DevOps team need to provide performance support until they become the end of life. It enhances the responsibility and the quality of the products engineered.

Continuous Improvement:

- DevOps culture focuses on continuous improvement to minimize waste. It continuously speeds up the growth of products or services offered.

Automate Everything

- Automation is an essential principle of the DevOps process. This is for software development and also for the entire infrastructure landscape.

Custom Centric Action

- DevOps team must take customer-centric for that they should continuously invest in products and services.

Monitor and test everything

- The DevOps team needs to have robust monitoring and testing procedures.

Work as one team

- In the DevOps culture role of the designers, developers, and testers are already defined. All they needed to do is work as one team with complete collaboration.

- These principles are achieved through several DevOps practices, which include frequent deployments, QA automation, continuous delivery, validating ideas as early as possible, and in-team collaboration.

DevOps Practices

- Some identified DevOps practices are:

  - Self-service configuration
  - Continuous build
  - Continuous integration
  - Continuous delivery
  - Incremental testing
  - Automated provisioning
  - Automated release management

DevOps Tools

Puppet

- Puppet is the most widely used DevOps tool.
- It allows the delivery and release of the technology changes quickly and frequently.
- It has features of versioning, automated testing, and continuous delivery.
- It enables to manage entire infrastructure as code without expanding the size of the team.

Ansible

- Ansible is a leading DevOps tool.
- Ansible is an open-source IT engine that automates application deployment, cloud provisioning, intra service orchestration, and other IT tools.
- It makes it easier for DevOps teams to scale automation and speed up productivity.
- Ansible is easy to deploy because it does not use any agents or custom security infrastructure on the client-side, and by pushing modules to the clients.
- These modules are executed locally on the client-side, and the output is pushed back to the Ansible server.

Docker

- Docker is a high-end DevOps tool that allows building, ship, and run distributed applications on multiple systems.
- It also helps to assemble the apps quickly from the components, and it is typically suitable for container management.

Nagios

- Nagios is one of the more useful tools for DevOps.
- It can determine the errors and rectify them with the help of network, infrastructure, server, and log monitoring systems.

CHEF

- A chef is a useful tool for achieving scale, speed, and consistency.
- The chef is a cloud-based system and open source technology. This technology uses Ruby encoding to develop essential building blocks such as recipes and cookbooks.
- The chef is used in infrastructure automation and helps in reducing manual and repetitive tasks for infrastructure management.
- Chef has got its convention for different building blocks, which are required to manage and automate infrastructure.

DevOps Tools

Jenkins

- Jenkins is a DevOps tool for monitoring the execution of repeated tasks.
- Jenkins is a software that allows continuous integration. Jenkins will be installed on a server where the central build will take place.
- It helps to integrate project changes more efficiently by finding the issues quickly.

Git

- Git is an open-source distributed version control system that is freely available for everyone.
- It is designed to handle minor to major projects with speed and efficiency.
- It is developed to co-ordinate the work among programmers. The version control allows you to track and work together with your team members at the same workspace.
- It is used as a critical distributed version-control for the DevOps tool.

SALTSTACK

- Stackify is a lightweight DevOps tool.
- It shows real-time error queries, logs, and more directly into the workstation.
- SALTSTACK is an ideal solution for intelligent orchestration for the software-defined data center.

Splunk

- Splunk is a tool to make machine data usable, accessible, and valuable to everyone.
- It delivers operational intelligence to DevOps teams.
- It helps companies to be more secure, productive, and competitive.

Selenium

- Selenium is a portable software testing framework for web applications.
- It provides an easy interface for developing automated tests.

IT601 – System and Network Administration

IT Operations & Support Process

Arif Husen

Department of Computer Science and Information Technology,

Virtual University of Pakistan

Contents

- Introduction to Help Desk
- Development and Operations (DevOps)

Introduction to Help Desk

- **Helpdesk is the primary mechanism to provide customer support**
  - A helpdesk is a place, real or virtual, where people can get answers to their computing questions, report problems, and request new services.
    - It may be a physical desk that people walk to, or it may be a virtual helpdesk that people access electronically.

- **Significance of Helpdesk**
  - Nothing is more important than it for ITOps.
  - It is the face of an organization. The HD staff is the first impression on customers and maintain relationship, good or bad, with them.
  - The HD fix the issues , part of living with computers and are the heroes. Customers call in an emergency.
  - A good helpdesk reflects well on your organization. The typical customer sees only the customer support portion of your organization and often assumes that this is your entire organization.
  - Customers have no idea which back-office operations and infrastructure duties are also performed. In short, a helpdesk is for helping the customers.
  - Don’t forget the help in helpdesk.

Introduction to Help Desk

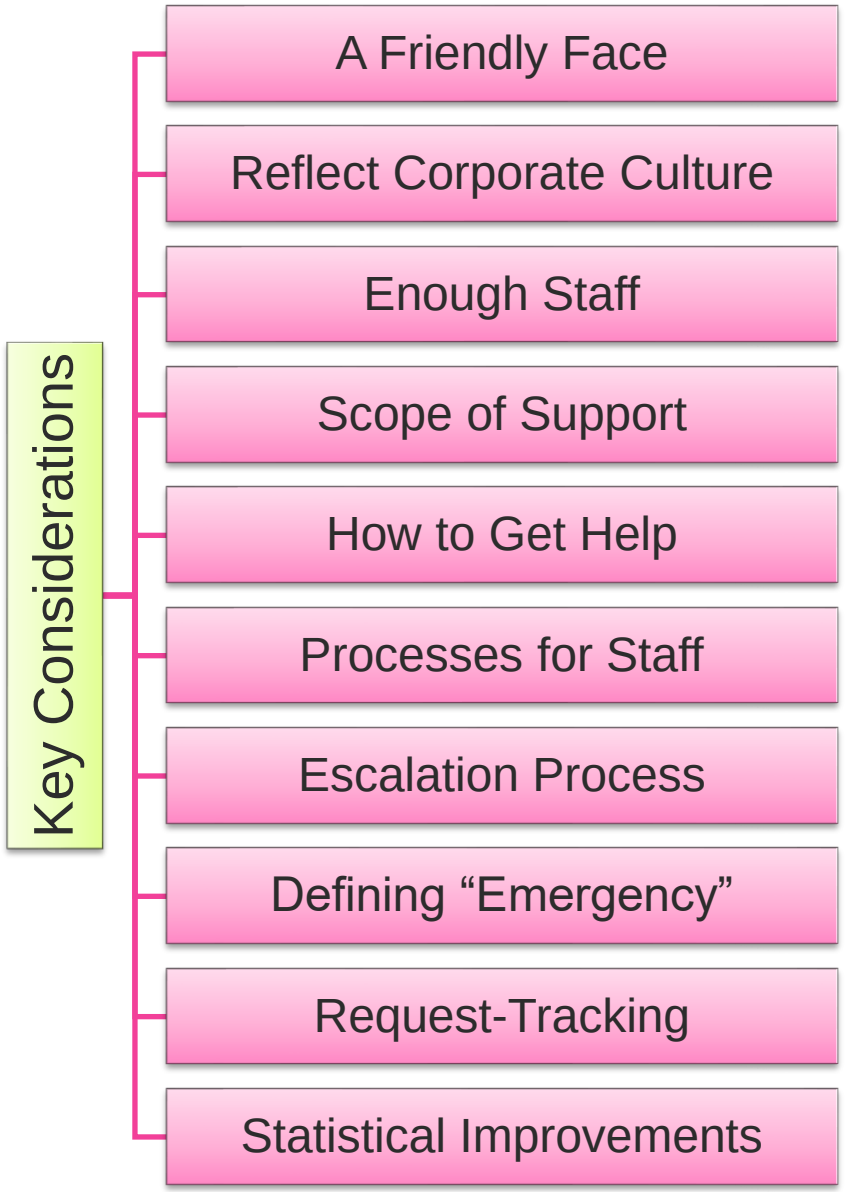
- **Is a Helpdesk really required?**
  - Every organization has a helpdesk.
    - It may be physical like walk-up counter
    - Virtual like by phone or email.
    - Sometimes unofficial.
  - Small orgnizations may not have formal helpdesk, but still leads to issues.
  - Large orgnizations needs anyhow a formal helpdesk
    - Developing a formal helpdesk should be part of that organizational planning
  - Symptoms of lacking formal helpdesk
    - Communication Problems
    - SAs unable to complete Project Tasks
    - Continuous SAs Interuuptions

Source : https://klik.solutions/managed-it-services/it-help-desk-services/

Introduction to Help Desk

- The transition from ad hoc to formal helpdesk can be uncomfortable to customers.
  - SAs should expect this push-back and do their best to ease the transition.
  - Communicating the new helpdesk procedures clearly is important.
- Helpdesks do not need to be purely physical locations but instead can be virtual.
  - Problems can be reported and replies returned via email.
  - Telephone, text-based, and audio chat systems can also be used.
  - Self-help systems are also popular but should not be considered a replacement for systems that involve human interaction.
    - These systems can reduce the workload of helpdesk attendants but cannot provide interactive debugging or resolve workflow issues that require real-time interaction.
    - There should be a phone number to call to report that the self-help system is down.
- A simple repository of documentation for customers on such topics as how to get help or request service activation and solutions to common problems.

Key Consierations for Helpdesk



Friendly Face

- **A helpdesk should have a friendly face.**
  - For a physical helpdesk, the interior design should be pleasant and welcoming.
    - A web-based virtual helpdesk is equally welcoming, Use a design based on soothing colors and readable fonts with the most selected items at the top left of the first page.
- **The faces of the staff should be welcoming and friendly, as should their personalities.**
  - When hiring HD staff, A key factor is that some people have personalities that are suited for customer service; others don't.
- **The roll or supervisor is key factor.**
  - The tone set by the staff will reflect that set by the supervisor.
    - A supervisor who yells at the staff will find staff yelling at customers.
  - A good-natured supervisor who can laugh and is always friendly will attract similar staff, who will reflect such an attitude with customers.
  - It is easier to build a reputation for being friendly initially than to restore a bad reputation.

  - The supervisor should be the friendly person you want your staff to be. Be a role model.

Reflect Corporate Culture

- **The look and feel of your helpdesk of an organization reflects its corporate culture.**
  - A helpdesk doesn't garner respect in a company when people working at the helpdesk buck the corporate culture.
    - A company that is very strict and formal may reflect this with strict dress codes and ways of conducting business, but the people at the helpdesk wear logo T-shirts and jeans, and a visitor hears a video game being played in the background.
    - A little asking around will find that the helpdesk has a reputation of being a bunch of slackers, no matter how hard they work or how high the quality of the service they provide.
  - The opposite can also happen.

- **Spend time to consider the culture and "look" of your helpdesk as compared to that of the customers they serve. Try to evolve to a culture that suits the customers served.**

HelpDesk Staff

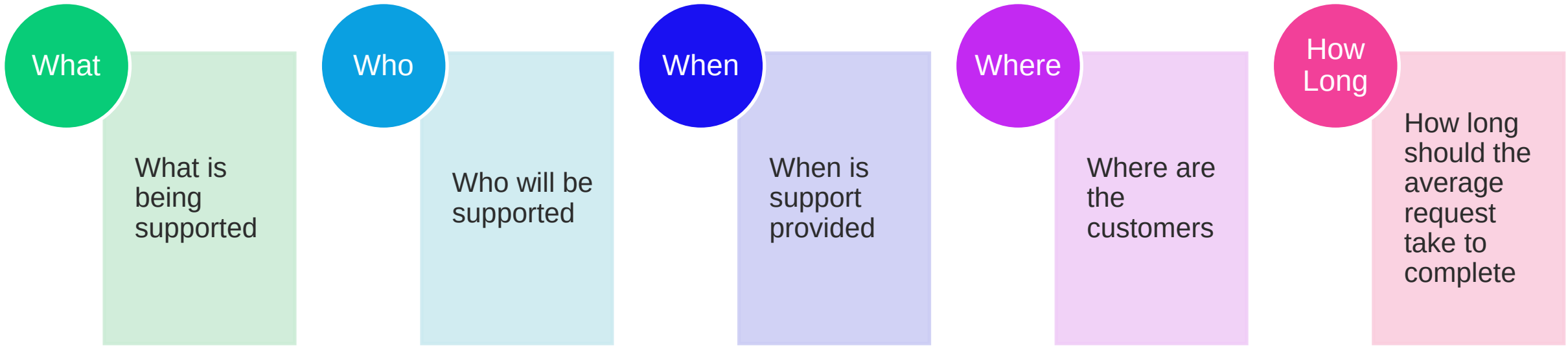
- **A helpdesk can be helpful only if it has enough people to serve customers in a timely manner.**
  - Otherwise, people will look elsewhere for their support.
- **Metrics for Sizing Helpdesk Staff**

Customer to HD Staff (CHS) Ratio	Call Volume Ratio (CVR)
▪ Universities often have 1000s of students per HD Staff. Corporates may have a higher ratio or a lower ratio.	▪ It is better to focus on callvolume ratios and time-to-call completion.
▪ An indirect metric	▪ A Direct Metric
▪ In a commercial computer science research dept., the ratio is often 40:1, with same skill level of the first-tier SAs and second-tier SSs.	▪ The rate at which customers receive busy signals or wait to receive a response, minutes required to resolve issues excluding time spent in “customer wait,”
▪ E-commerce sites usually have a separate and depending on the services being offered, the ratio can be 10,000:1 or 1,000,000:1.	▪ Managing resources based on call volume also presents a more diverse set ofpotential solutions.
▪ Ratios are a no-win situation. Management will always push to have a higher ratio; customers for lower ratio.	▪ It is required to have appropriate metrics to make decisions about improving processes.
▪ The the ratio can be increased by providing less service to the customers, which usually costs the organization.	▪ Metrics can reveal good candidates for new automation, documentation, ortraining for both SAs and customers.
	▪ Metrics can reveal which processes are more effective, which are used heavily, or which are not used at all.

Scope of Support

- A helpdesk should have a policy defining the scope of support. This document explains what an SA group is and isn't responsible for.

- The components of scope are what, who, where, when, and how long



- SAs should have a writen the scope-of-support policy.
  - What is in scope and what is out of scope

Specify How to Get Help

- **The companion to the scope-of-support document is a document that specifies how to get help: by phone, email, a ticket system, and so on.**
  - Certain types of requests may be directed to certain departments, or a unified helpdesk might be the single point of contact that forwards requests as appropriate to individual departments.

- **An image or document specifying how to get help should appear on default Windows background wallpaper images:**
  - “CompanyName IT helpdesk: [phone number] [email address] [web site].”

- **If customers have not been given clear directions on the proper way to get help, they will contact SAs directly, interrupting them at inappropriate times, and making it impossible to get larger projects done.**

Define Processes for Staff

- **Helpdesk staff should have well-defined processes to follow.**
  - In a smaller environment, this is not as important, because the processes are more ad hoc or are undocumented because they are being used by the people who built them.
  - However, for a large organization, the processes must be well documented.
- **Very large helpdesks should use scripts as part of their training. Every service supported has an associated flow of dialogue to follow to support that service.**
- **Some Scripts required identify verifications**
  - The script for a request to reset a password would, for security reasons, require callers to prove who they are, possibly by knowing a unique piece of personal information, before a new password would be set.

Establish an Escalation Process

- **Escalation is a process by which an issue is moved from the current staff person to someone with more expertise.**
  - The first line of operators should be able to handle 80 percent to 90 percent of all calls and escalate the remaining calls to a second tier of support.
  - The people at this second tier may have more experience, more training, and, possibly, other responsibilities.
  - Larger organizations can have four or more tiers; the higher tiers may include the people who built or currently maintain the service in question.
- **The escalation process is also what customers use when they are dissatisfied with the support they are receiving.**
  - Large numbers of calls being escalated to the second tier is a warning sign of a larger, systemic problem.
  - Usually, it indicates that the first-tier staff people need more training or do not have the tools to do their job properly.
  - If large numbers of calls are escalated to management, there may be systemic problems with the support the helpdesk is providing.

Define “Emergency” in Writing

- **Often, SAs are overloaded because every customer claims to have an emergency that requires immediate attention.**

  SAs may feel that customers are using this claim to boss them around, which decreases morale and increases stress levels.

- **Having a written policy empowers SAs to know when to push back and gives them a document to point to when they need it.**

  - If the customer still disagrees with this assessment, the SA can pass the issue up to someone in management, who can make the decision.
  - This lets the SA focus on technical duties and lets management focus on setting priorities and providing resources.

- **Every company should be able to define what constitutes an emergency.**
  - At a factory, an emergency is anything that stops the assembly line.
  - At a web-based service or ISP, an emergency might be anything that will prevent the service from meeting an SLA.

Use Request-Tracking Software

- **Every helpdesk needs some kind of software to help it manage requests.**
  - The alternative is a collection of notes written on scraps of paper. Although it is simple in the beginning and sufficient for environments with one or two SAs, a system based on notes on paper doesn't scale.
  - Requests get lost, and management has no ability to oversee the process to better allocate resources.
- **Those are the first qualities that you need in helpdesk software. As a helpdesk grows, software can help in other areas.**
- **Features of Helpdesk Software**
  - Helpdesk software should permit some kind of priority to be assigned to tickets.
  - Another important aspect of helpdesk software is that it collects logs about which kinds of requests are made and by whom.
  - Helpdesk software should also automate the collection of data on customer satisfaction.
  - It is critical that helpdesk software match the workflow of the people who use it.
  - Choosing helpdesk software is not an easy process. Most software will need a lot of customizing for your environment.

Statistical Improvements

- **Many sophisticated statistics can be gathered about a helpdesk.**
  - For example, you can monitor the rate of escalations to determine where more training is needed.
- **when dealing with upper management for budgeting and planning purposes, historical statistics become much more valuable.**
  - You can make a better case for your budget if you can show multiyear trends of customer growth, call volume, types of calls, technologies used, services provided, and customer satisfaction.
  - When you are asked to support a new technology or service, you can use past data to predict what the support costs may be.
- **The value of statistics increases as the organization grows, because the management becomes less directly involved in the work being done.**
  - As an organization grows, statistics are easier to collect, and it becomes more important that they be collected.

After-Hours and 24/7 Coverage

- **As computers become critical to an ever-expanding list of business processes, customers are asking for 24/7 coverage more often.**
  - Although a full three-shift staff may be required in some organizations, some very simple ways to provide 24/7 coverage are not as expensive.
- **Options**
  - Set up a voicemail box that alerts a pager when new messages arrive. The pager can be rotated among various staff members.
  - Have all managers of the customer groups know the home phone number of the helpdesk's supervisor, who then takes responsibility for calling SAs in turn until one is found.
- **No matter how SAs are contacted after hours, the person must be compensated.**
  - Some organizations have a salary incentive for oncall time, equivalent to a fraction of the employee's salary and time and a half if the person is called.
  - Other organizations issue compensation time either officially or unofficially.

Better Advertising for the Helpdesk

- **Defining your policies and providing announcements online is nice, but rarely will anyone seek them out.**
- **Options are**
  - Publish on Website
  - Email to customers esp. new policies
  - Workshops

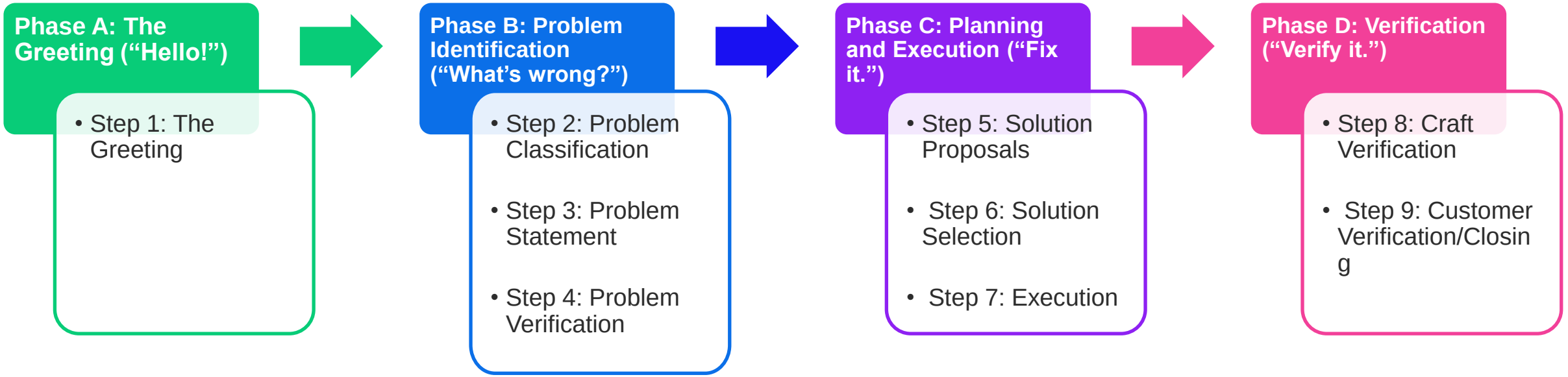
Multiple Helpdesks

- **When an organization grows, it may make sense to have two separate helpdesks:**
  - One for requesting new services.
  - Second for reporting problems that arise after the service has been successfully enabled.
  - A third group deals with installing the new service, especially if it requires physical work.

- **This third group may be an internal helpdesk that installers all over the organization can call to escalate installation problems. It is not uncommon, though, for this third group to be the second tier of one of the other helpdesks.**

Processing for processing customer requests

- **The method for processing these customer requests has nine steps, which can be grouped into four phases:**

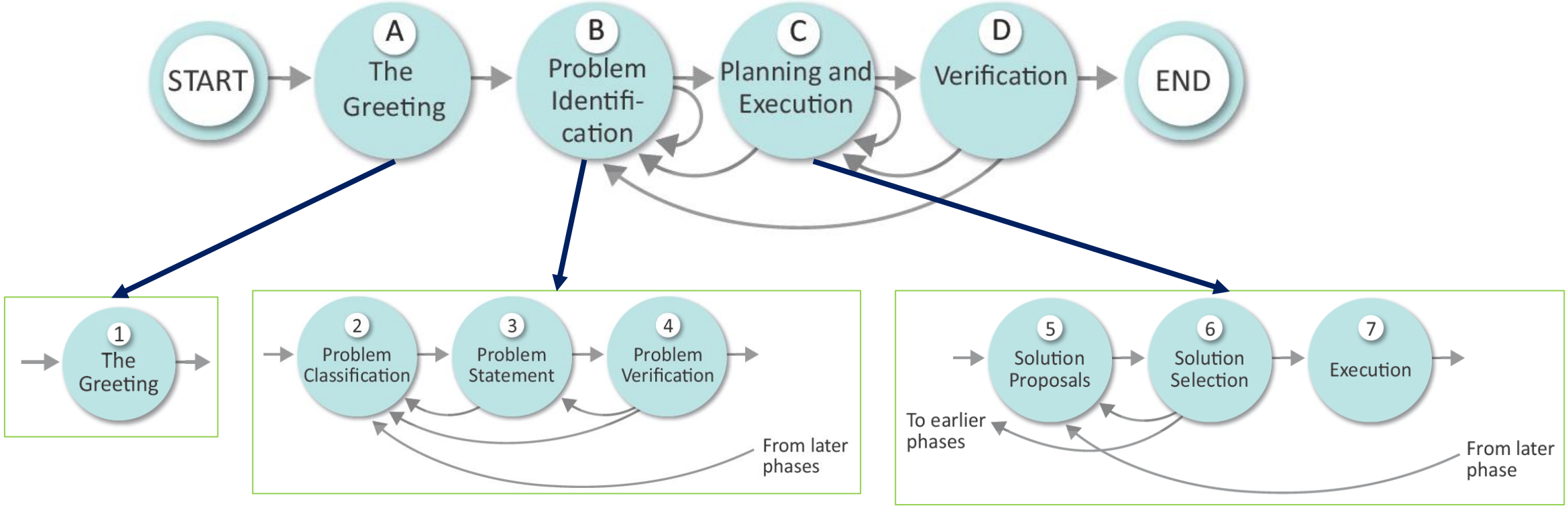


- **This method gives structure to what is, for newer SAs, a more haphazard process.**
  - It helps SAs solve problems more efficiently by keeping them focused and helps them avoid mistakes. It introduces a common set of terminology that, when used by the entire SA team, increases the ability to communicate within the group.

Problem Solving Process

- **Problem Solving Process consist of four phases**

A. Reporting the problem
B. Identifying the problem
C. Planning and executing a solution
D. Verifying that the problem resolution is complete



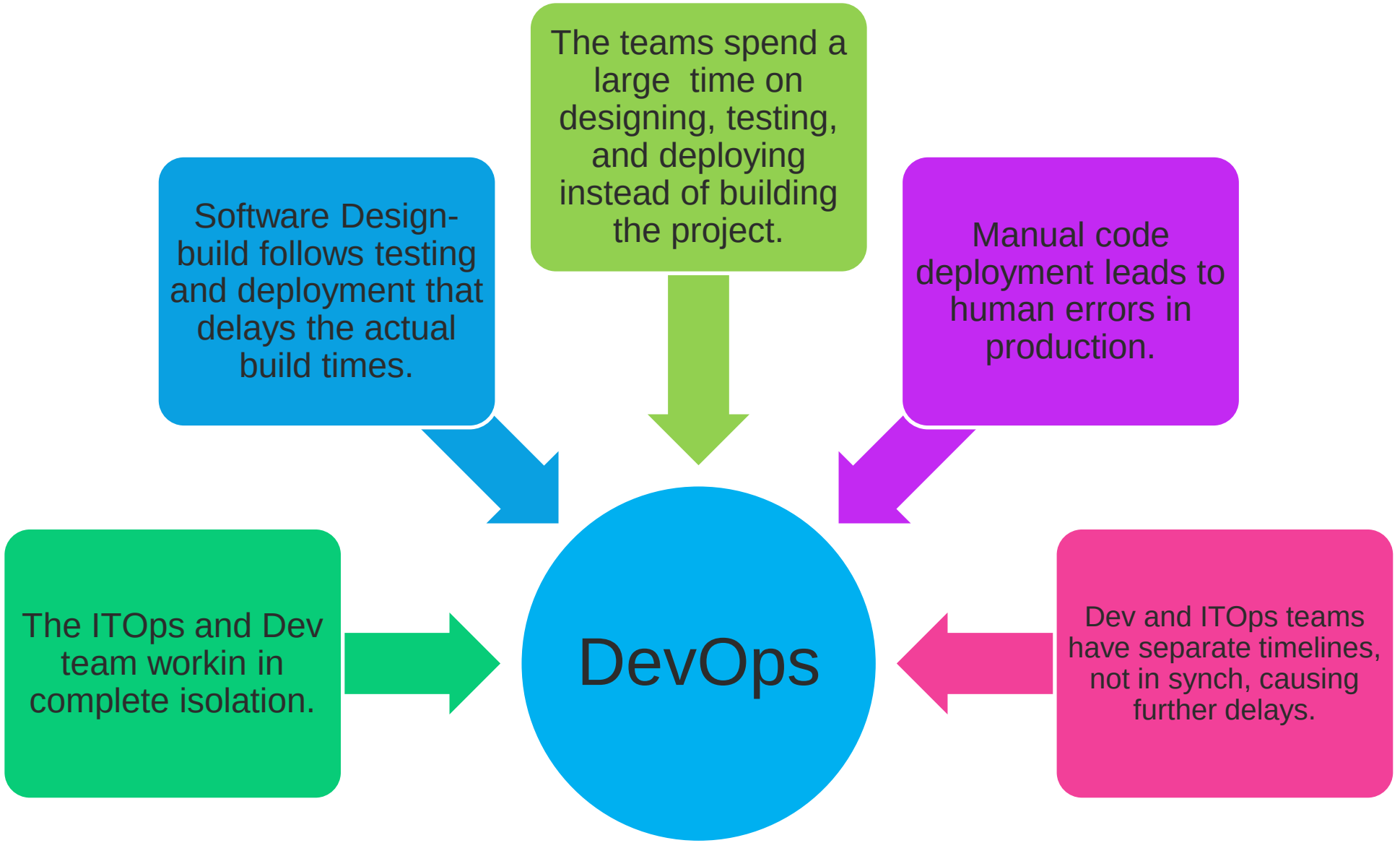
Development and Operations Together

- **Large organizations often have software development teams and IT operations team.**
  - System and Network Administration is part of IT operations
- **Some problems reported to system administrators or tasks requires the collaboration with software development team**
  - Thus development and Operations are not standalone they are strongly coupled
- **The collaboration of software development and IT operations is also applicable even if organizations donot have in house software development/ IT operations teams (Outsouricing Model)**
  - Thus development and Operations are not standalone they are strongly coupled
- **DevOps is a model which allows agile collaboration between administratively independent software development and IT operations teams.**

DevOps

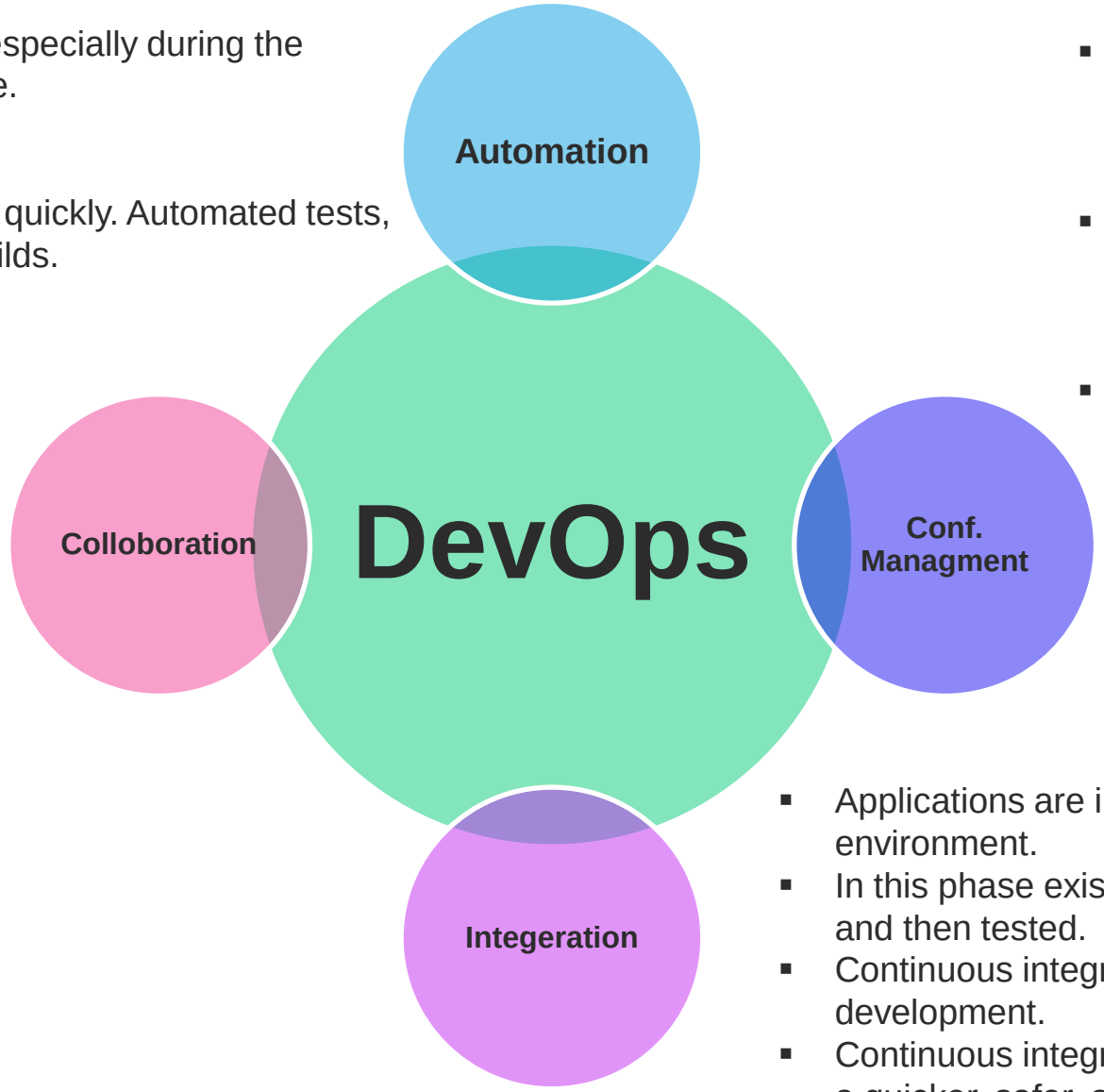
- **The DevOps is a mixture of two words, one is software Development, and second is Operations.**
  - It allows to jointly handle the entire application lifecycle, from development to testing, deployment, and operations.
  - DevOps helps to reduce the disconnection between software developers, quality assurance (QA) engineers, and system administrators.

The Need of DevOps



Features of DevOps

- Reduces time consumption, especially during the testing and deployment phase.
- Increases Productivity
- SW Releases are quicker.
- Catching bugs and their fixed quickly. Automated tests, cloud-based services, and builds.



- It ensures the Apps to interact with only those resources that are concerned with the environment in which it runs.
- The conf files are not created where the external configuration to the application is separated from the source code.
- The conf file can be written during deployment, or they can be loaded at the run time, depending on the environment in which it is running.

- The Dev and ITOps team collaborates that improves the cultural model.
- Improves productivity, accountability and ownership.
- Share responsibilities and work closely in sync, making the deployment to production faster.

- Applications are integrated with other components in the environment.
- In this phase existing code is combined with new functionality and then tested.
- Continuous integration and testing enable continuous development.
- Continuous integration and delivery are implemented to deliver in a quicker, safer, and reliable manner.

Mertis and Demerits of DevOps

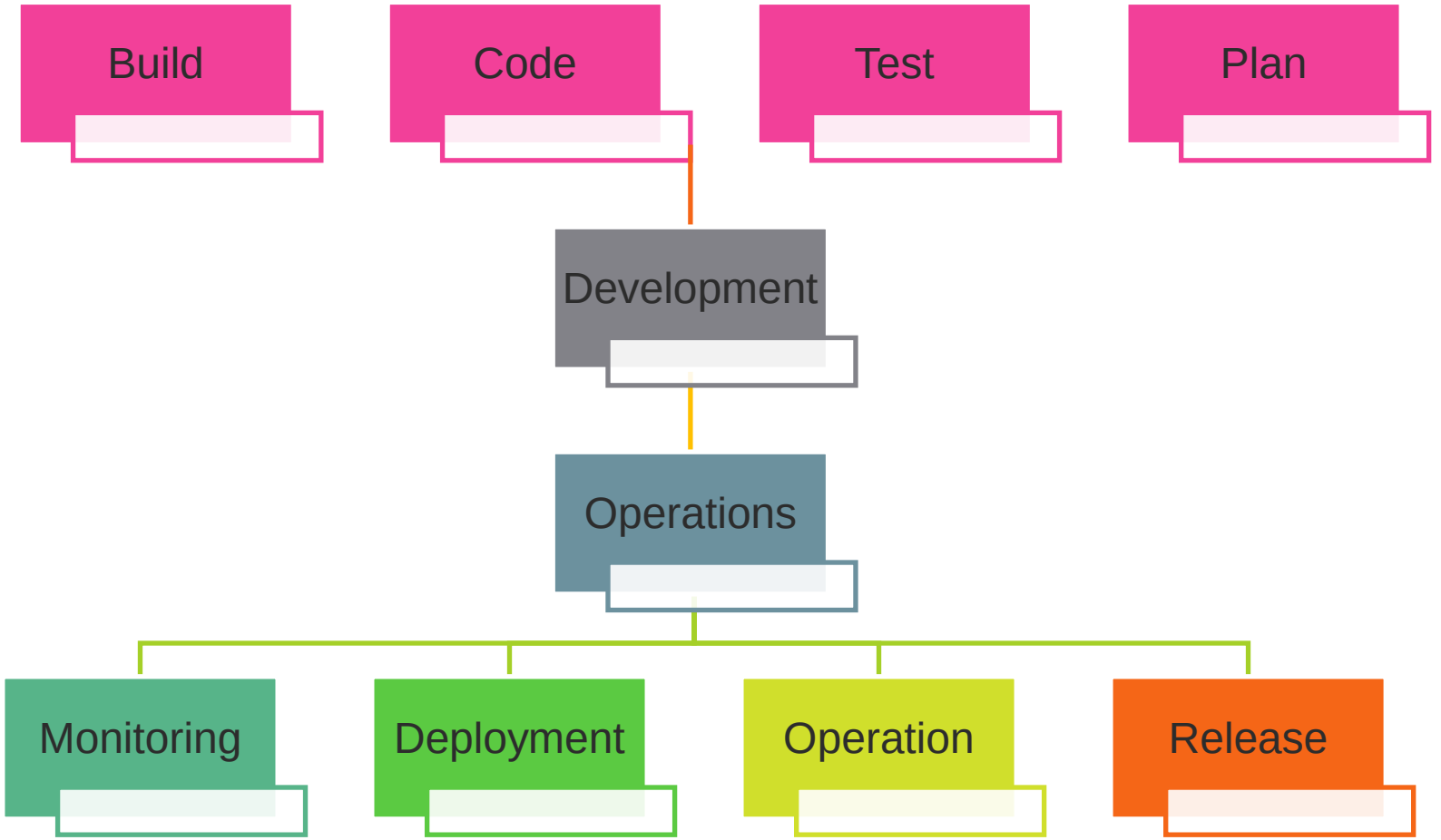
Merits

- DevOps is an excellent approach for quick development and deployment of applications.
- It responds faster to the market changes to improve business growth.
- DevOps escalate business profit by decreasing software delivery time and transportation costs.
- DevOps clears the descriptive process, which gives clarity on product development and delivery.
- It improves customer experience and satisfaction.
-
- DevOps simplifies collaboration and places all tools in the cloud for customers to access.
- DevOps means collective responsibility, which leads to better team engagement and productivity.

Demerits

- DevOps professional or expert's developers are less available.
- Developing with DevOps is so expensive.
- Adopting new DevOps technology into the industries is hard to manage in short time.
- Lack of DevOps knowledge can be a problem in the continuous integration of automation projects.

DevOps Architecture



DevOPs Components

1 - Build

- Without DevOps, the cost of the consumption of the resources was evaluated based on the pre-defined individual usage with fixed hardware allocation.

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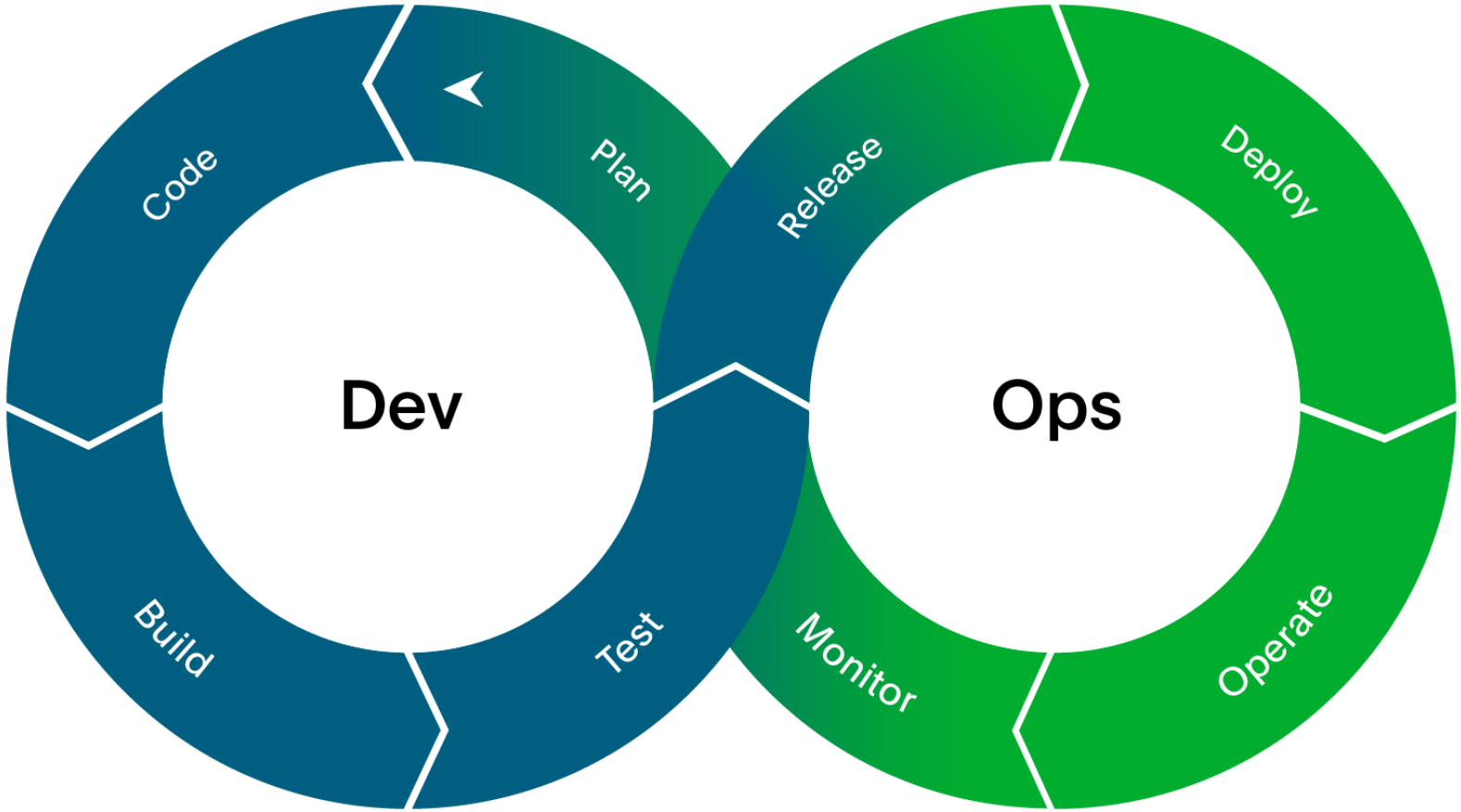
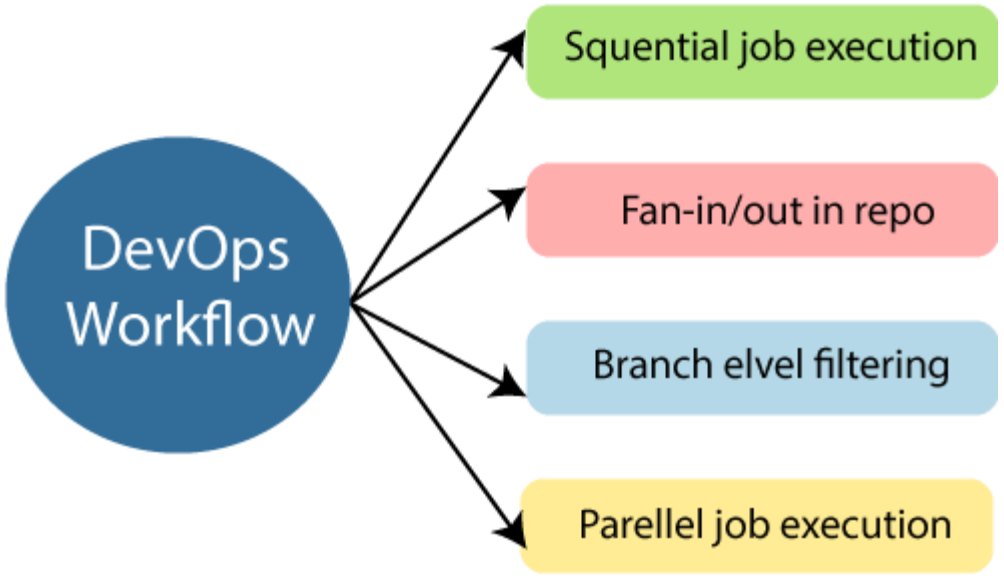


Workflow

- DevOps workflow provides a visual overview of the sequence in which input is provided. Also, it tells about which one action is performed, and output is generated for an operations process.



- DevOps workflow allows the ability to separate and arrange the jobs which are top requested by the users. Also, it gives the ability to mirror their ideal process in the configuration jobs.

DevOps Principles

- The main principles of DevOps are Continuous delivery, automation, and fast reaction to the feedback.

End to End Responsibility

- DevOps team need to provide performance support until they become the end of life. It enhances the responsibility and the quality of the products engineered.

Continuous Improvement:

- DevOps culture focuses on continuous improvement to minimize waste. It continuously speeds up the growth of products or services offered.

Automate Everything

- Automation is an essential principle of the DevOps process. This is for software development and also for the entire infrastructure landscape.

Custom Centric Action

- DevOps team must take customer-centric for that they should continuously invest in products and services.

Monitor and test everything

- The DevOps team needs to have robust monitoring and testing procedures.

Work as one team

- In the DevOps culture role of the designers, developers, and testers are already defined. All they needed to do is work as one team with complete collaboration.

- These principles are achieved through several DevOps practices, which include frequent deployments, QA automation, continuous delivery, validating ideas as early as possible, and in-team collaboration.

DevOps Practices

- Some identified DevOps practices are:

  - Self-service configuration
  - Continuous build
  - Continuous integration
  - Continuous delivery
  - Incremental testing
  - Automated provisioning
  - Automated release management

DevOps Tools

Puppet

- Puppet is the most widely used DevOps tool.
- It allows the delivery and release of the technology changes quickly and frequently.
- It has features of versioning, automated testing, and continuous delivery.
- It enables to manage entire infrastructure as code without expanding the size of the team.

Ansible

- Ansible is a leading DevOps tool.
- Ansible is an open-source IT engine that automates application deployment, cloud provisioning, intra service orchestration, and other IT tools.
- It makes it easier for DevOps teams to scale automation and speed up productivity.
- Ansible is easy to deploy because it does not use any agents or custom security infrastructure on the client-side, and by pushing modules to the clients.
- These modules are executed locally on the client-side, and the output is pushed back to the Ansible server.

Docker

- Docker is a high-end DevOps tool that allows building, ship, and run distributed applications on multiple systems.
- It also helps to assemble the apps quickly from the components, and it is typically suitable for container management.

Nagios

- Nagios is one of the more useful tools for DevOps.
- It can determine the errors and rectify them with the help of network, infrastructure, server, and log monitoring systems.

CHEF

- A chef is a useful tool for achieving scale, speed, and consistency.
- The chef is a cloud-based system and open source technology. This technology uses Ruby encoding to develop essential building blocks such as recipes and cookbooks.
- The chef is used in infrastructure automation and helps in reducing manual and repetitive tasks for infrastructure management.
- Chef has got its convention for different building blocks, which are required to manage and automate infrastructure.

DevOps Tools

Jenkins

- Jenkins is a DevOps tool for monitoring the execution of repeated tasks.
- Jenkins is a software that allows continuous integration. Jenkins will be installed on a server where the central build will take place.
- It helps to integrate project changes more efficiently by finding the issues quickly.

Git

- Git is an open-source distributed version control system that is freely available for everyone.
- It is designed to handle minor to major projects with speed and efficiency.
- It is developed to co-ordinate the work among programmers. The version control allows you to track and work together with your team members at the same workspace.
- It is used as a critical distributed version-control for the DevOps tool.

SALTSTACK

- Stackify is a lightweight DevOps tool.
- It shows real-time error queries, logs, and more directly into the workstation.
- SALTSTACK is an ideal solution for intelligent orchestration for the software-defined data center.

Splunk

- Splunk is a tool to make machine data usable, accessible, and valuable to everyone.
- It delivers operational intelligence to DevOps teams.
- It helps companies to be more secure, productive, and competitive.

Selenium

- Selenium is a portable software testing framework for web applications.
- It provides an easy interface for developing automated tests.