FNI 421- Mobile Computing

Dr. Soha Nabil Hussein

01 - Introduction

Agenda

- Course Information
- Introduction to Mobile Computing
  - Global Market
  - What is mobile computing?
  - Common Terminologies
  - History of Mobile Computing
- Version Control
  - Decentralized Version Control Systems: GitHub

Course Information

- This course introduces the fundamental concepts of mobile computing, including mobile platforms, application development, wireless networks, mobile operating systems, and the challenges of mobility.
- You will gain practical experience building mobile applications and understanding the theoretical principles underlying mobile computing.

Parts of the lecture

- Part 1: Foundation of Mobile Computing
- Part 2: Practical Tools and Technologies in Mobile Computing

Course Core Topics - Foundations of Mobile Computing

1. Mobile Computing Introduction
2. Mobile Computing Architecture
3. Cellular Networks and GSM
4. Emerging Technologies (Bluetooth, RFID and NFC)
5. Short Message Service (SMS)
6. General Packet Radio Service (GPRS)
7. Wireless Application Protocol (WAP)
8. Logical mobility
9. Bluetooth, NFC, RFID
10. Wireless Sensor Networks

Course Additional Topics - Practical Tools and Technologies

- **As time allows** we will try to talk about these practical tools and technologies:
  - Version of Control
  - Build Automation
  - Java Virtual Machine
  - Android Framework Layers
  - Design Patterns in Android
  - Android and Databases
  - Android and Threads
  - Android and Cloud
  - Android and Testing
  - Android and Security
  - Android and IoT

Lecture

- Come to the lecture with your computer.
- We will often use polls during class.
- Lecture participation (graded for your yearly work - free points)
- We will have a couple of quick quizzes in class (graded).
- Office Hours: Sunday 11:30 am - 12:30 pm, Wednesday 9:30 am - 10:30 am
- Email: sohaDOThusseinATcisDOTasuDOTedueg, do not email unless there is something urgent. Try TA and/or come to the office hours.

Lab

- You will work and deliver your work on GitHub.
- You will learn Android, and probably Flutter too.
- There will be a final project you'll do and present.

Grading

- Final Exam: 50%
- Year work: 10%
- Quiz: 5%
- Midterm: 15 %
- Project: 20%
- Total: 100%

How to Succeed in this Course

- You should aim for learning at your best.
- True success is how good you have become after taking the class.
- *"Difficulty of part of the deal"* - myself!
- *"There is no education like adversity" – Benjamin Disraeli*
- *"Practice makes Perfect" - Roger Ascham*
- Recipe: Come to class, go to the lab, do your homework at your best, and combine that with a healthy dose of motivation.

Introduction to Mobile Computing

Global Market

Mobile Applications Market

Market size value in 2024	**USD 281.52 billion**
Revenue forecast in 2030	**USD 626.39 billion**
Growth rate	**CAGR of 14.3% from 2024 to 2030**
Actual data	**2017 - 2023**

Mobile Phones Market

Market size value in 2024	**USD 469 billion**
Revenue forecast in 2030	**USD 972.2 billion**
Growth rate	**CAGR of 7.5% from 2023 to 2032**
Actual data	**2019 - 2021**

How much do you think you'll earn in 10 years?

Based on: https://www.grandviewresearch.com/industry-analysis/mobile-application-market

Global Market

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How much do you think you'll earn in 10 years?

Have you now changed your mind?

What is Mobile Computing?

Mobile computing is the process of distributed computation on diversified mobile devices and hybrid networks interconnected by mobile communication protocols.

Mobile Hardware / Mobile Software

Mobile computing refers to the use of different mobile devices, like smartphones, tablets, or laptops, to perform tasks or computations. These devices can connect to various networks, like Wi-Fi or cellular, using special communication methods. It allows you to work, access information, and communicate from almost anywhere, without needing to be tied to a specific location or device.

- Hardware
  - Network
  - Devices
  - Sensors
- Software
  - Mobile Applications
  - Mobile protocols
  - Algorithms for network design
  - Database

History of Generations of Mobile Communications

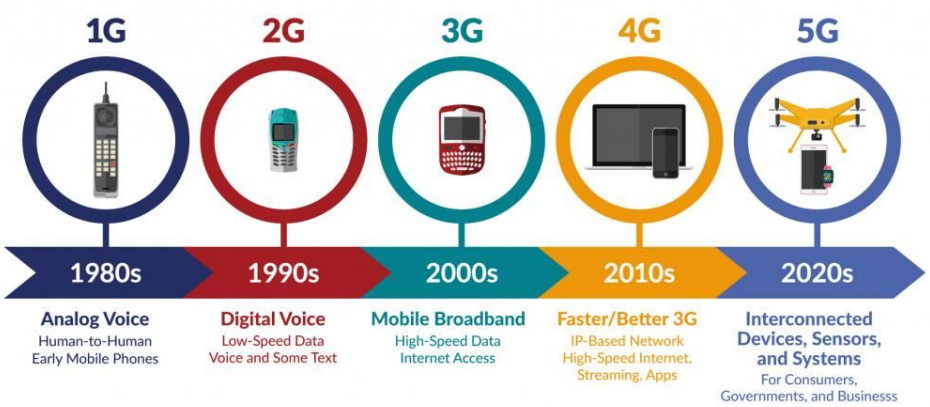

Image from: https://allixo.com/wp-content/uploads/2023/09/Cellgenerationslayedout.png

Terminologies

- Signal
- Frequency
- Bandwidth
- Latency
- Speed

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Is a wave that transfer the data. Two types of signals:

1. An analog wave which is a continuous signal
2. A digital wave which is a discrete signal

Both digital and analogue signals weaken as they travel, so they may need to be amplified along their route.

But digital signals are considered better, can you guess why?

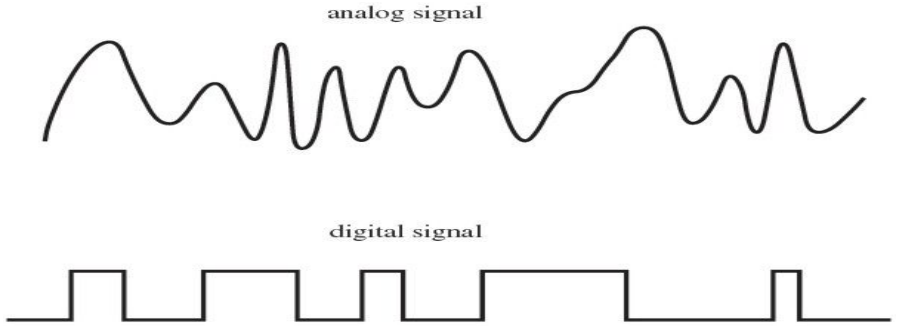

Image from: https://digestiblenotes.com/images/physics/signals.jpg

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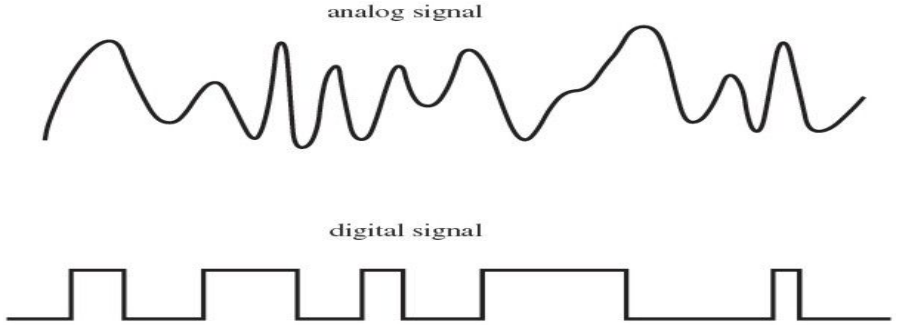
But digital signals are considered better, can you guess why?

- **With digital signals, noise is far less of a problem because a noisy digital signal is still quite clear what is meant to be shown (in other words, even when the digital signal is slightly distorted, it is still easy to see whether its value is a 1 or a 0.**
- **The other benefit of digital signals is that they are processed far better by laptops as they are digital too**



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Terminologies

- Signal
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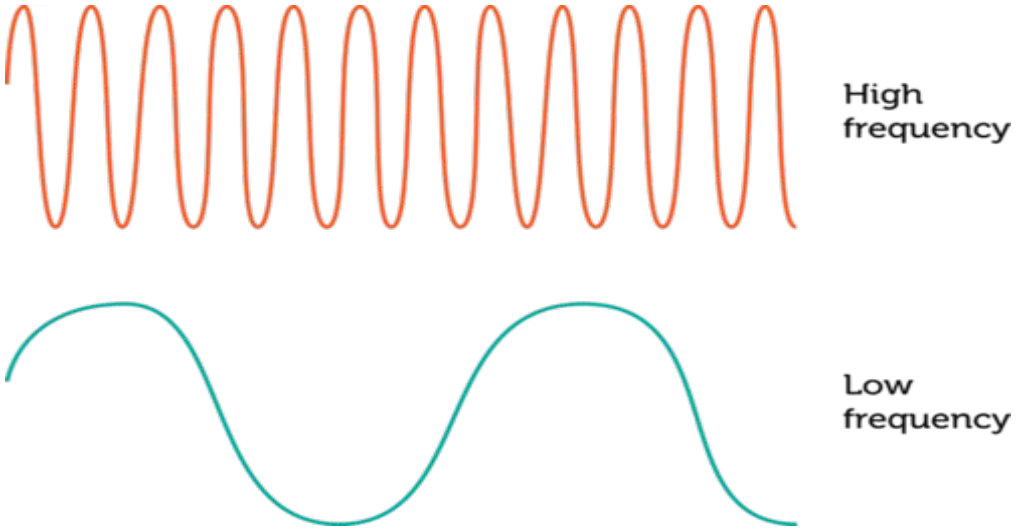
- Is the number of occurrences of a repeating event (cycle) per unit of time
- most often measured in *hertz* (symbol: Hz)



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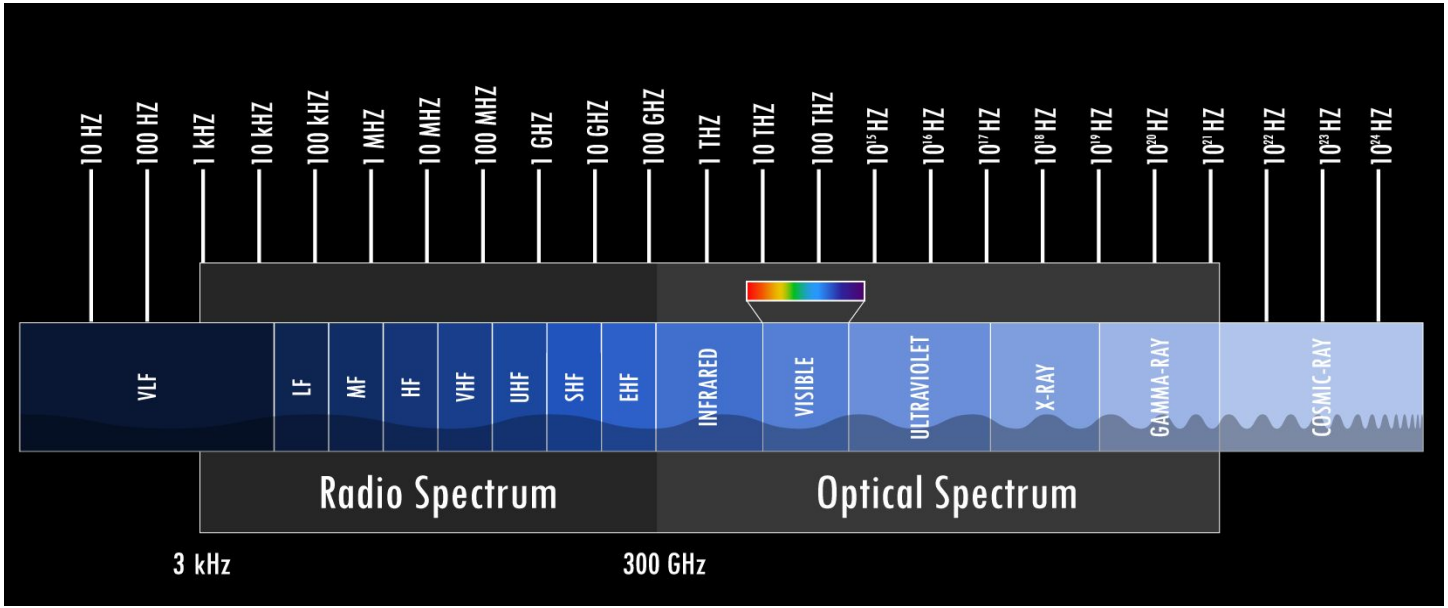

Image from: https://www.nasa.gov/wp-content/uploads/2015/05/spectrum_graphic_web_updated.png?resize=1200,516

Terminologies

- Signal
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Fun Fact

- The audible frequency range for humans is typically given as being between about 20 Hz and 20,000 Hz (20 kHz), though the high frequency limit usually reduces with age.
- Other species have different hearing ranges. For example, some dog breeds can perceive vibrations up to 60 KHz.

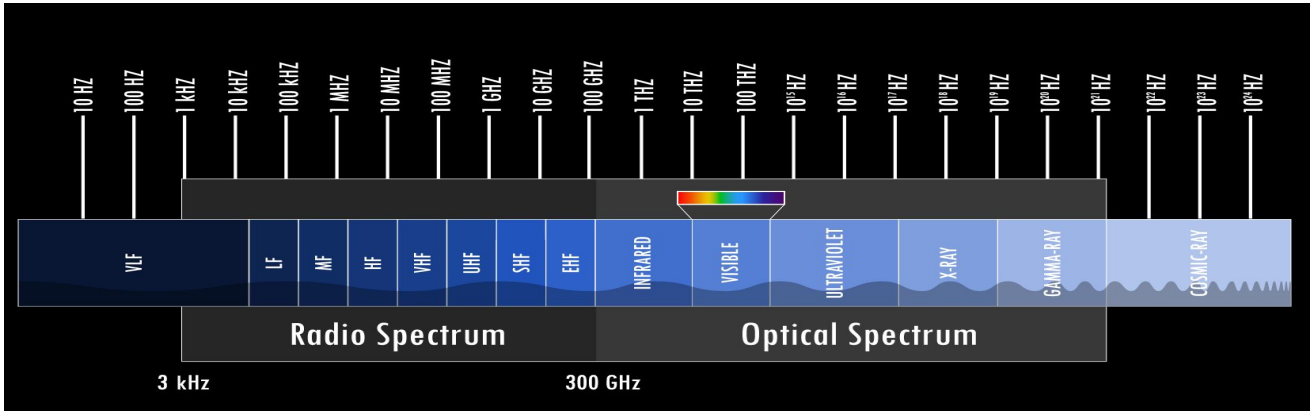

Image from: https://www.nasa.gov/wp-content/uploads/2015/05/spectrum_graphic_web_updated.png?resize=1200,516

Signal: A signal is like a wave that carries data from one place to another. There are two main types of signals:

1. **Analog signal**: This is a smooth, continuous wave, like a radio signal.
2. **Digital signal**: This is a series of separate, clear points, like the ones and zeros in a computer.

Both types of signals get weaker as they travel, so they sometimes need to be boosted along the way. However, digital signals are better for two main reasons:

- **Less affected by noise**: Even if there's some distortion, a digital signal still makes it easy to tell whether it's a "1" or a "0."
- **Better processing**: Computers and laptops work with digital signals because they are digital devices, so it's easier for them to handle.

Frequency refers to how often something repeats in a certain amount of time. For example, if something happens once every second, it has a frequency of 1 cycle per second, or 1 **hertz (Hz)**.

Fun fact:
- Humans can usually hear sounds in the frequency range between **20 Hz** (low sounds) and **20,000 Hz (20 kHz)** (high sounds). However, as people get older, they may not hear the highest frequencies as well.
- Other animals, like some dogs, can hear even higher frequencies—up to **60,000 Hz (60 kHz)**!

Terminologies

- Signal
- Frequency
- Latency
- Bandwidth
- Speed

In general latency is the time delay between a user action and the response from the system.

In networking, latency measures the time it takes for data to travel from the source (sender) to the destination (receiver) and back.

It is usually measured in milliseconds (ms) and is sometimes called ping or lag in certain contexts, such as online gaming.

In Mobile Networks:

- Low latency means faster response times, enabling smoother experiences in real-time applications like video calls, online gaming, and virtual reality.
- High latency results in noticeable delays, such as in voice or video communication where there might be a gap between speaking and hearing the response.

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```
ping -c 10 google.com
```

Terminologies

- Signal
- Frequency
- Latency
- Bandwidth
- Speed

- Is the maximum rate of data transfer across a given path

Image from: https://www.lifewire.com/thmb/5SqaDry976mUZV7bgiqbgfokxRI=/750x0/filters:no_upscale():max_bytes(150000):strip_icc():format(webp)/what-is-bandwidth-26258091-957d0a321cbe4b09b05b4b211b7e7e6b.png

Terminologies

- Signal
- Frequency
- Latency
- Bandwidth
- Speed

So what is the network speed then?

- Bandwidth is the maximum capacity of a network connection.
- Speed is the actual data transfer rate experienced during use.

Terminologies

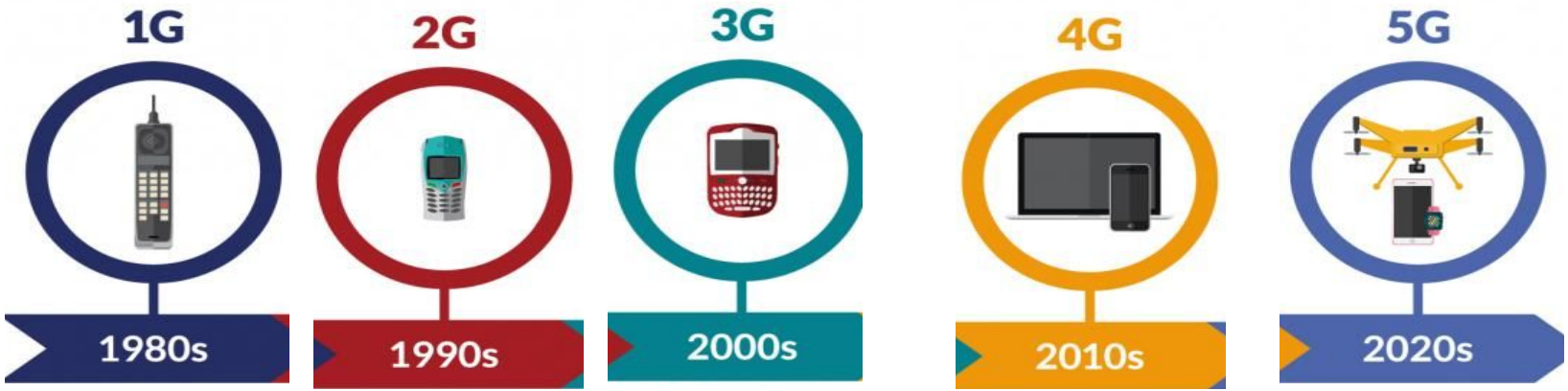
- Wave
- Frequency
- Latency
- Bandwidth
- Speed

So what is the **network speed** then?

- Bandwidth is the maximum capacity of a network connection.
- Speed is the actual data transfer rate experienced during use.

- In essence, network can have
  - **High Bandwidth but Low Speed:** You might have a high-bandwidth connection (e.g., 1 Gbps), but if the network is congested, has high latency, or experiences packet loss, the actual speed of data transfer might be lower than the bandwidth.
  - **Low Bandwidth and Speed:** Conversely, a connection with lower bandwidth (e.g., 10 Mbps) will have a lower maximum speed, but if the network is not congested and has low latency, you might achieve speeds close to the bandwidth limit.

- test your internet actual data transfer rate https://www.speedtest.net/
  or run speedtest



Technolog					
Main Use Case					
Frequency					
Bandwidth (speed)					
Application Examples					

Image from: https://mark-kalin.com/wp-content/uploads/2021/06/Picture1.png.webp

Latency is the delay between doing something and seeing the result. For example, if you click a button, the time it takes for the system to respond is the latency.

In networking, **latency** refers to the time it takes for data to travel from your device to another device (like a server) and back. It's measured in **milliseconds (ms)** and is sometimes called **ping** or **lag**, especially in online gaming.

In **mobile networks**:
- **Low latency** means fast responses, which makes things like video calls, online games, or virtual reality smoother and more real-time.
- **High latency** causes delays, so in a video call, you might notice a delay between someone speaking and hearing their response.

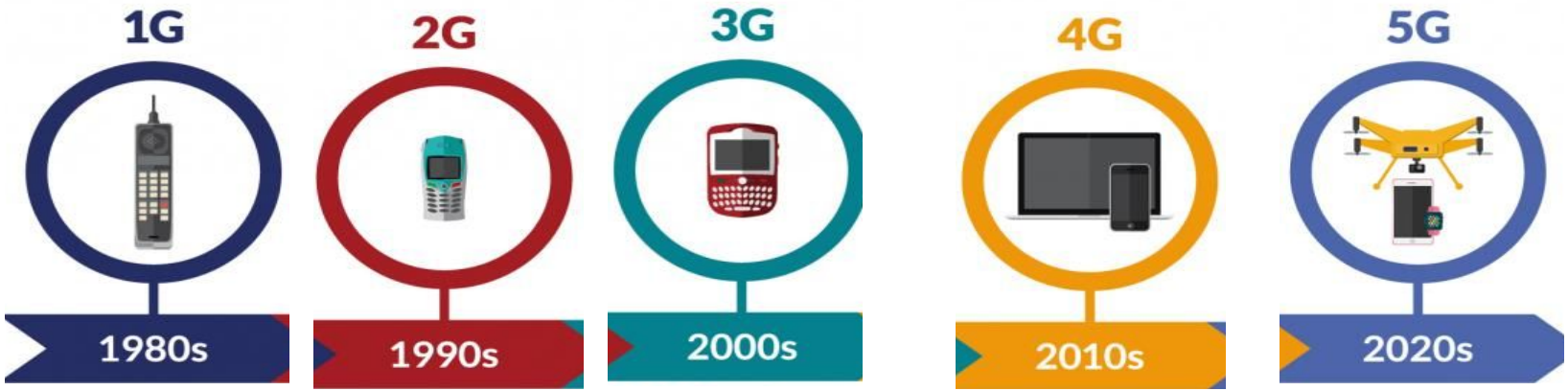
The command `ping -c 10 google.com` tests the latency between your device and Google's server.

Network speed is how fast data moves from one place to another over the internet, but there are two key terms to understand:

- **Bandwidth**: This is the maximum amount of data a network can handle at once, like how wide a highway is.
- **Speed**: This is the actual rate at which data is transferred while you're using the network, like how fast cars are moving on that highway.

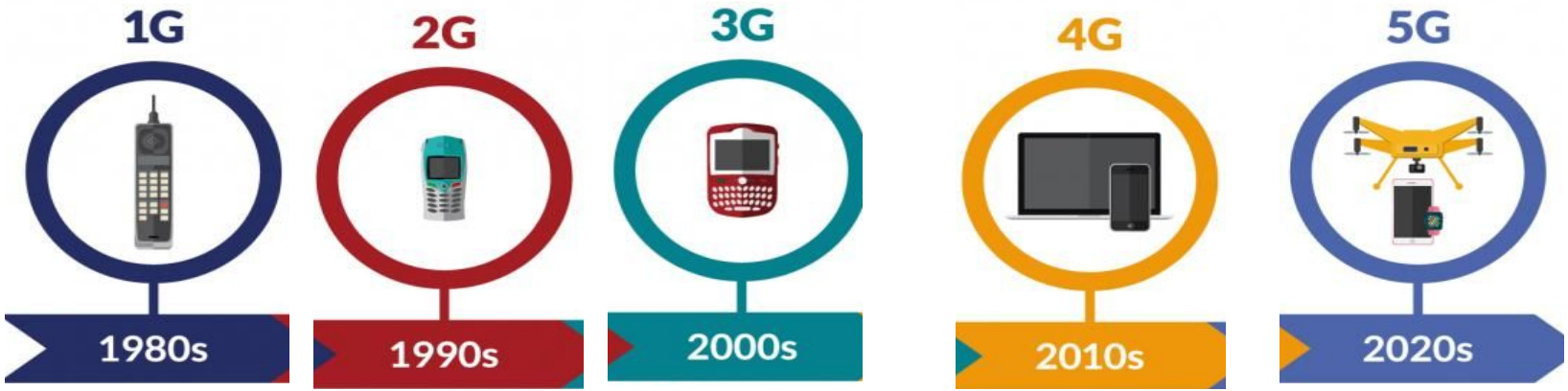
You can have:
- **High bandwidth but low speed**: Even if the highway is wide, if there's traffic (like congestion, high latency, or packet loss), the cars (data) move slowly.
- **Low bandwidth and speed**: If the highway is narrow, fewer cars can move, but if there's no traffic, they can still move smoothly up to the road's limit.

You can check your actual internet speed by visiting **speedtest.net** or running the **speedtest** command.



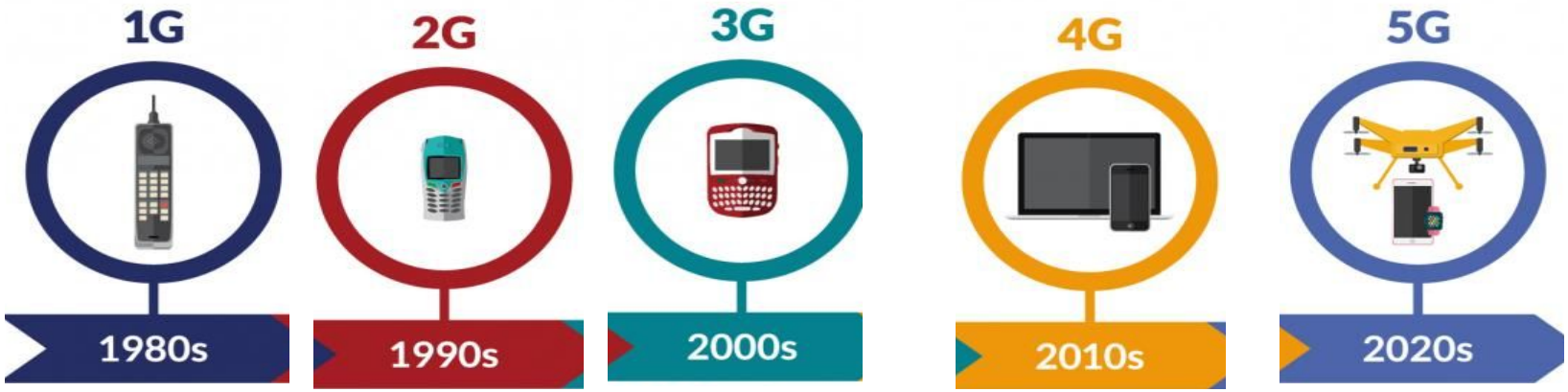
Technolog	Analog				
Main Use Case	Voice only				
Frequency	800 MHz				
Bandwidth (speed)	30 kHz (2.4 kbps)				
Application Examples	Basic voice calls				

Image from: https://mark-kalin.com/wp-content/uploads/2021/06/Picture1.png.webp



Technolog	Analog	Digital			
Main Use Case	Voice only	Voice and basic text messaging			
Frequency	800 MHz	<=1900 MHz			
Bandwidth (speed)	30 kHz (2.4 kbps)	200 kHz (to 64 kbps)			
Application Examples	Basic voice calls	SMS, MMS, early mobile internet			

Image from: https://mark-kalin.com/wp-content/uploads/2021/06/Picture1.png.webp



Technolog	Analog	Digital	Digital		
Main Use Case	Voice only	Voice and basic text messaging	Voice, text, and mobile internet		
Frequency	800 MHz	<=1900 MHz	<= 2100 MHz		
Bandwidth (speed)	30 kHz (2.4 kbps)	200 kHz (to 64 kbps)	<=20 MHz (to 2 Mbps)		
Application Examples	Basic voice calls	SMS, MMS, early mobile internet	Mobile internet browsing, video streaming		

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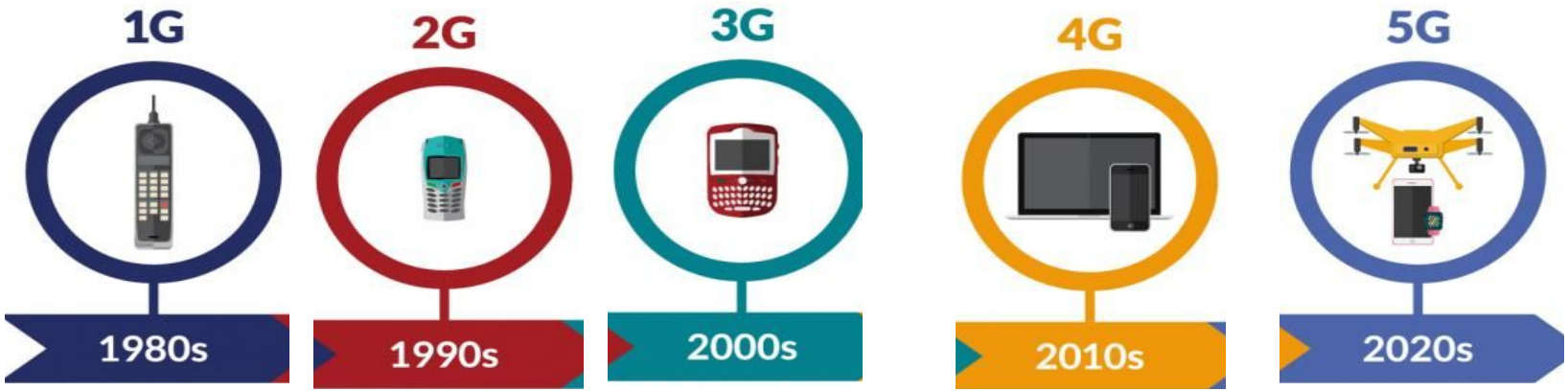
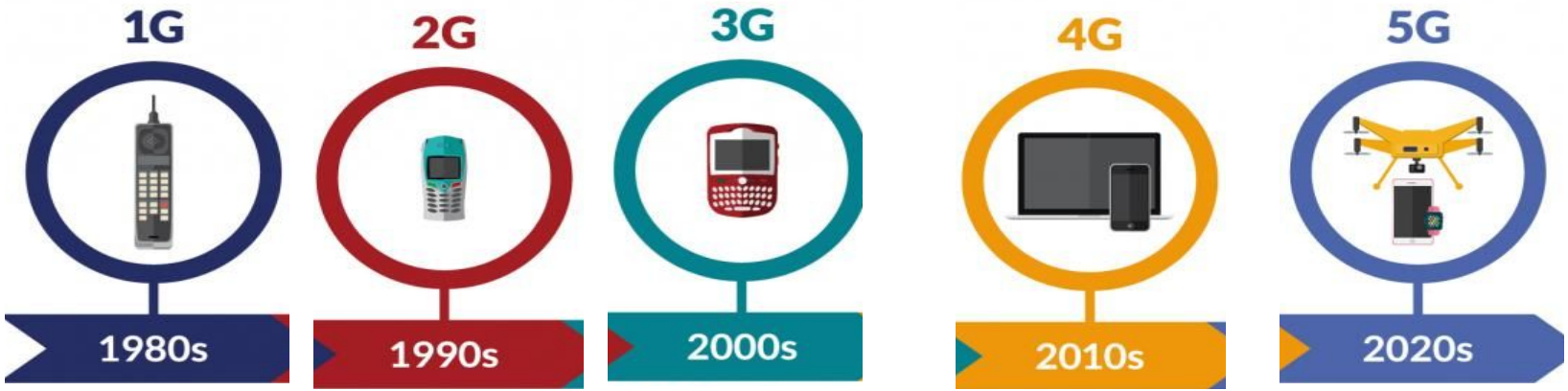


Technolog	Analog	Digital	Digital	Digital	
Main Use Case	Voice only	Voice and basic text messaging	Voice, text, and mobile internet	High-speed internet, HD video	
Frequency	800 MHz	<=1900 MHz	<= 2100 MHz	~ 2.6 GHz	
Bandwidth (speed)	30 kHz (2.4 kbps)	200 kHz (to 64 kbps)	<=20 MHz (to 2 Mbps)	<= 100 MHz (to 1 Gbps)	
Application Examples	Basic voice calls	SMS, MMS, early mobile internet	Mobile internet browsing, video streaming	Streaming media, video calls, fast web access	

Image from: https://mark-kalin.com/wp-content/uploads/2021/06/Picture1.png.webp



Technolog	Analog	Digital	Digital	Digital	Digital
Main Use Case	Voice only	Voice and basic text messaging	Voice, text, and mobile internet	High-speed internet, HD video	Ultra-fast internet, IoT, AR/VR
Frequency	800 MHz	<=1900 MHz	<= 2100 MHz	~ 2.6 GHz	100 GHz
Bandwidth (speed)	30 kHz (2.4 kbps)	200 kHz (to 64 kbps)	<=20 MHz (to 2 Mbps)	<= 100 MHz (to 1 Gbps)	<=1 GHz (to 10 Gbps)
Application Examples	Basic voice calls	SMS, MMS, early mobile internet	Mobile internet browsing, video streaming	Streaming media, video calls, fast web access	Autonomous vehicles, smart cities, AR/VR

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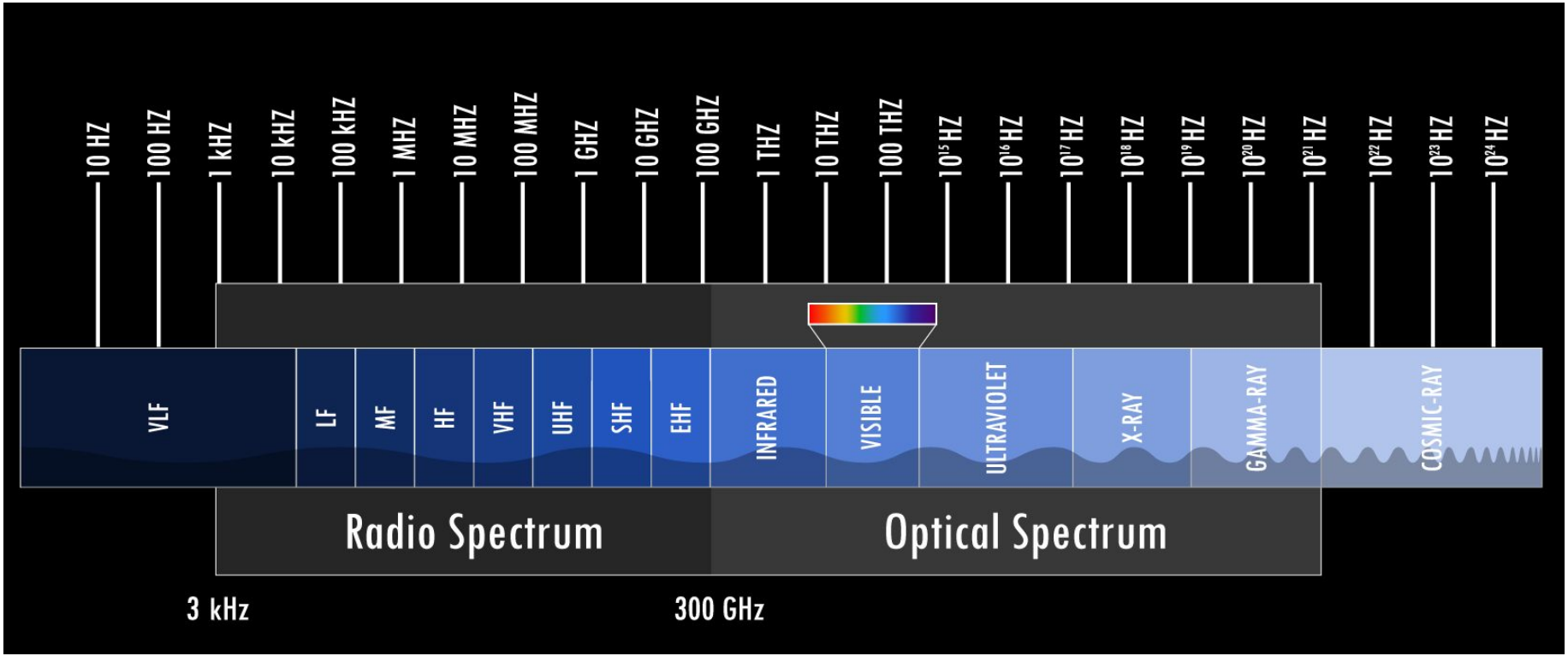
Terminologies



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Version Control Systems

What is a Version Control System?

- A Version Control System (VCS) is a tool that helps manage and track changes to files over time.

- It allows multiple people to work on a project collaboratively, maintaining a history of changes and providing mechanisms to merge, revert, and track modifications.

Key Features of Version Control

- Track Changes
- Collaboration
- Branching and Merging
- Reversion
- Backup and Recovery

Distributed Version Control Systems - GIT

- Every developer has a full copy of the project's history, including all branches and versions.
- Example: GitHub, GitLab
- Pros: Offline work is possible, faster operations, no single point of failure.
- Cons: More complex setup and usage.

Essential Concepts in Version Control

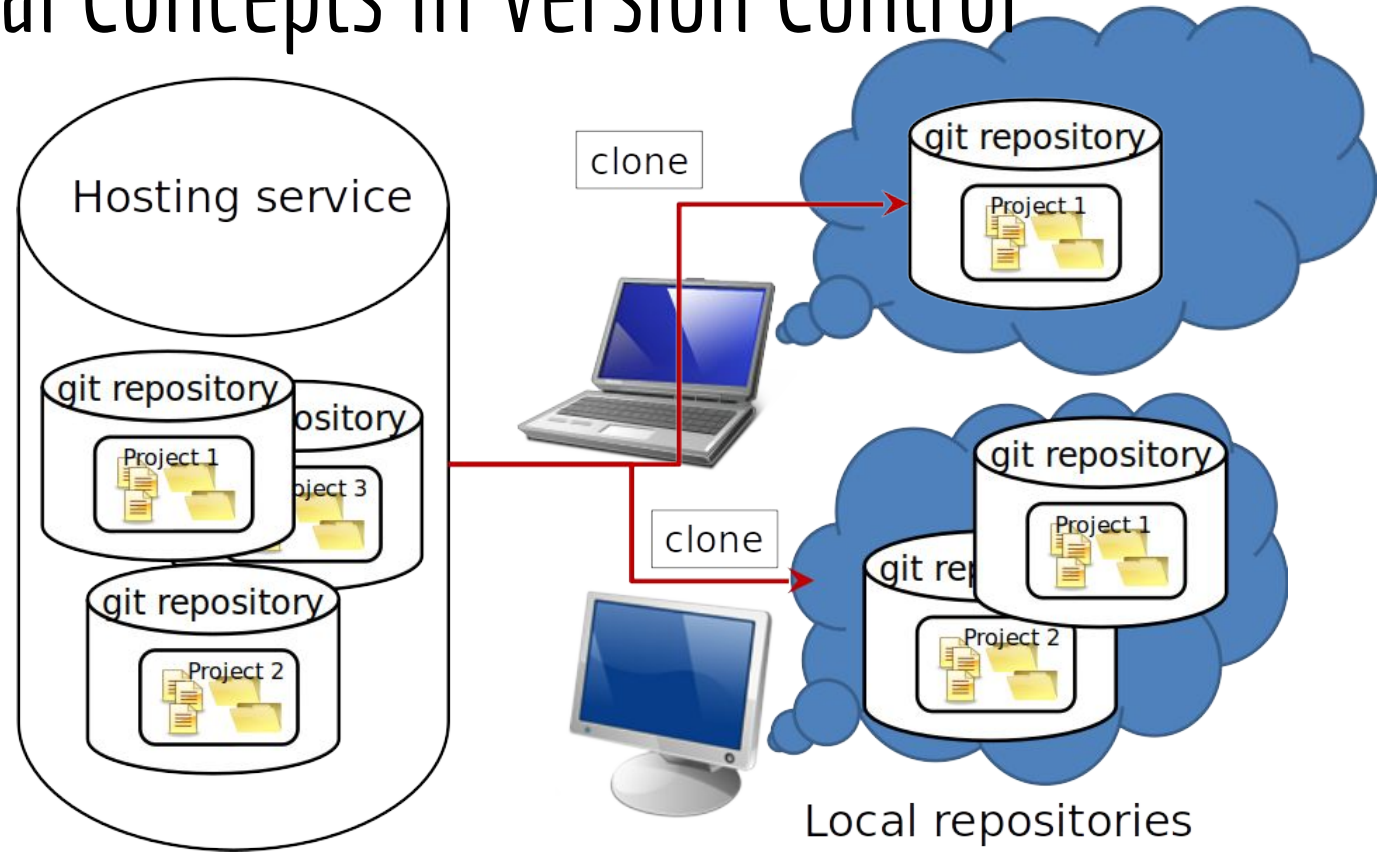


Image from: https://github.com/gjbex/Version-control-with-git/blob/master/version_control_git.pptx

Version Control Terms: Repository

- A repository (or "repo") is the main storage space where the entire history of a project is stored, including all files, their changes, and metadata.
- Repositories can be **local** (stored on your machine) or **remote** (stored on a server like GitHub or GitLab).
- Commands: git clone, git fork

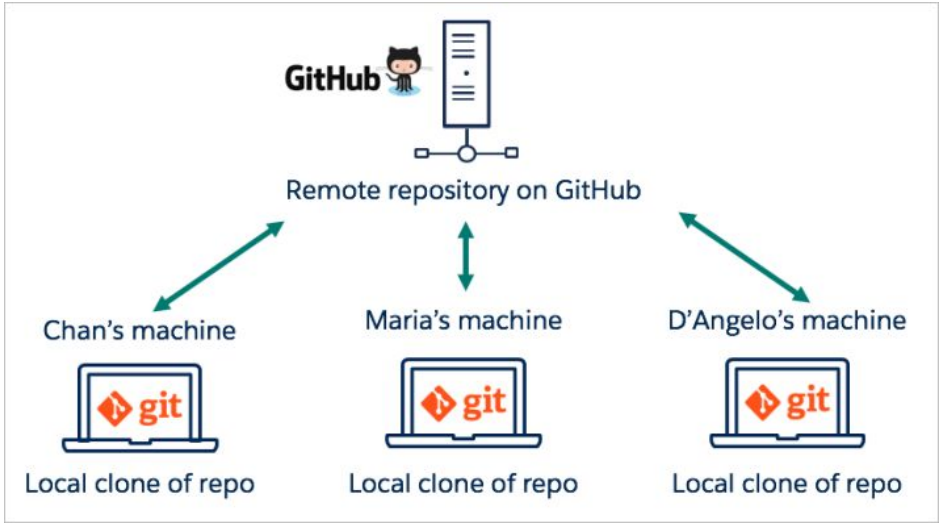


Image from: https://sfdctechie.wordpress.com/2019/12/27/how-to-add-a-salesforce-dx-project-to-source-control-step-by-step-guide/

Version Control Terms: Branch

- Each repo (local or remote) can have multiple branches
- Branch allows developers to create a separate context for development, leaving the main codebase unaffected.
- Each local branch tracks a remote branch.
- Main Branch: is the default branch for any repository
- We need to merge branches, and sometimes solve conflicts.
- Commands: git branch, git checkout, git merge

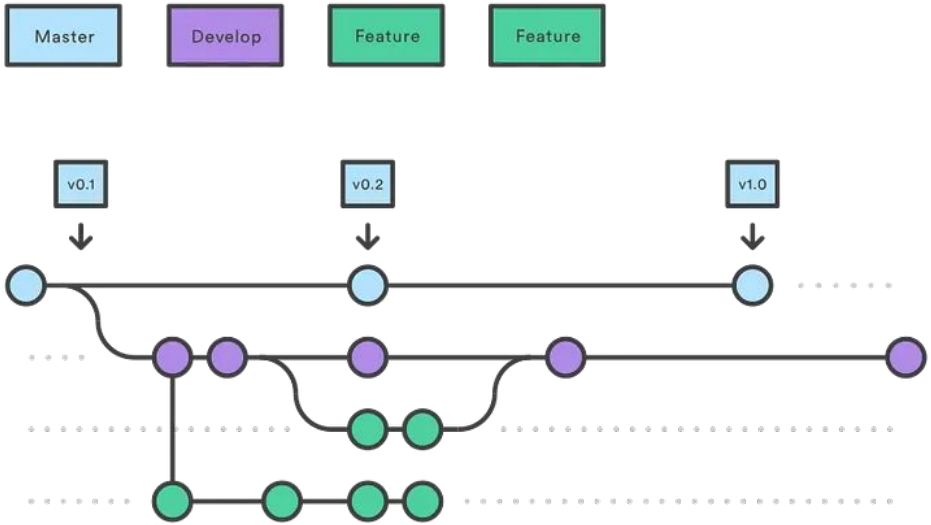
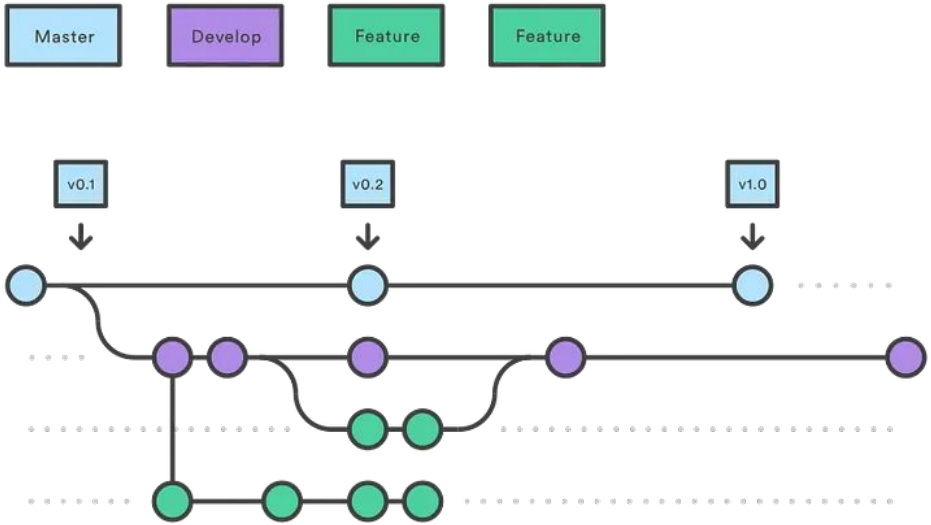


Image from: https://miro.medium.com/v2/resize:fit:720/format:webp/1*L0jHGLTJwZO5CTtpsn-dKA.png

Version Control Terms: Commit

- A **commit** is a snapshot of changes made to the files in the repository at a specific point in time.
- It represents a state of the project and contains metadata such as the author, date, and commit message describing the change.
- Commits form the backbone of the project's history, allowing developers to traverse back and forth through the project's evolution.
- Commands: git commit



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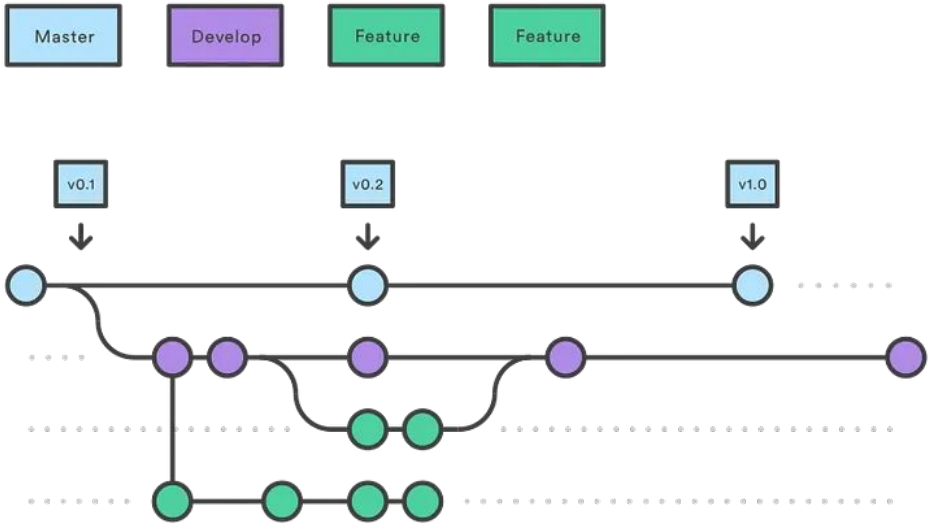
Version Control Terms: pull/push

- **Pull**: Retrieves updates from a remote repository and merges them into your local copy. This ensures your local project is up-to-date.
- **Push**: Sends your local changes to the remote repository, making them available to others.
- Commands: git push, git pull



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Frequent GitHub Workflow

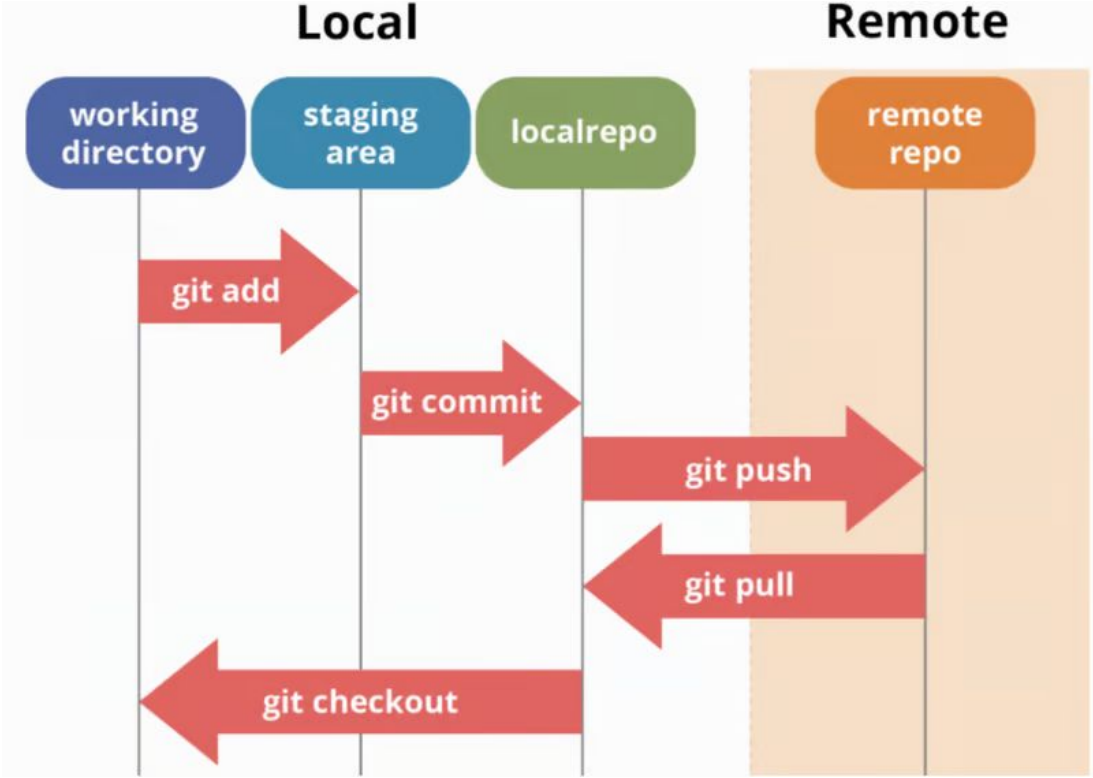

Image from: https://dev.to/mollynem/git-github--workflow-fundamentals-5496

Files in Your GitHub Repo

What to Push:

- Source Code
- Configuration files, pom.xml, or a Dockerfile
- Documentation: README.md
- Assets: special images, fonts
- Tests: unit tests for your application

What NOT to Push:

- Sensitive Information
- Build Artifacts: log files, binaries.
- Dependencies
- Personal Configuration

We use .gitignore to specify excluded files/folders from adding them to your repo.

Time to Learn Using Git

- Use https://learngitbranching.js.org/ to make a repository state as in the left figure.
- Commands that you can use are:
  - git commit
  - git merge
  - git branch <branch name>

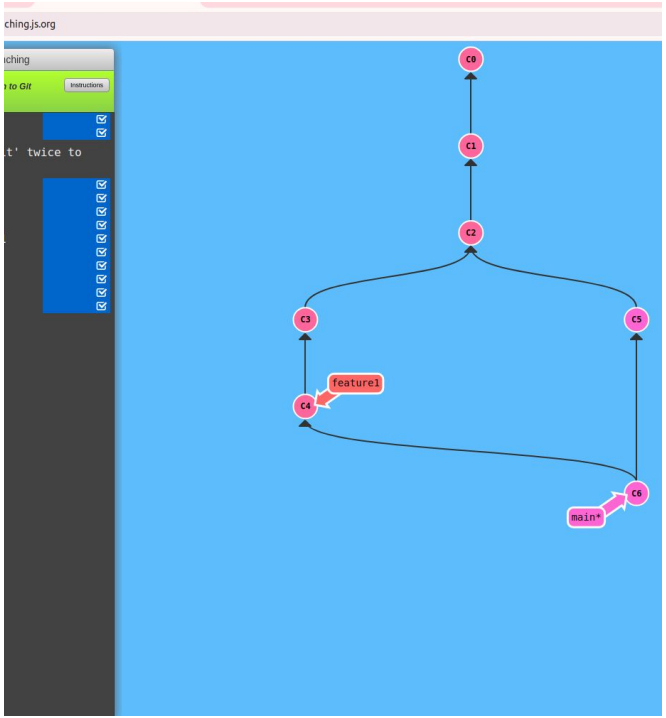

Image from:https://learngitbranching.js.org/

What's Next Until We Meet

- Read the slides.
- Make a GitHub account.
- Play with Git essentials:

  https://learngitbranching.js.org/