Lecture 1: Preparation for Learning Edge Networks

XG, VS Code, GitHub, JSON, AI, and 5G Toolbox

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COP 4610 Operating Systems
https://xinliulab.github.io/FSU-CIS4930-CIS5930-Future-Edge-Networks/

Meet Your Instructor

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Research Area:
AI-driven edge networks and transformative IoT applications

Hobby: *Not Working*
Started at FSU in Fall 2024
Click here to visit my homepage

Mobile has made a leap every ~10 years

Mobile voice communication

1G

1980s

Analog voice

AMPS, NMT, TACS

Efficient voice to reach billions

2G

1990s

Digital voice

D-AMPS, GSM, IS-95 (CDMA)

Focus shifts to mobile data

3G

2000s

Wireless Internet

CDMA2000/EV-DO WCDMA/HSPA+,

Mobile broadband and emerging expansion

4G

2010s

Mobile broadband

LTE, LTE Advanced, Gigabit LTE

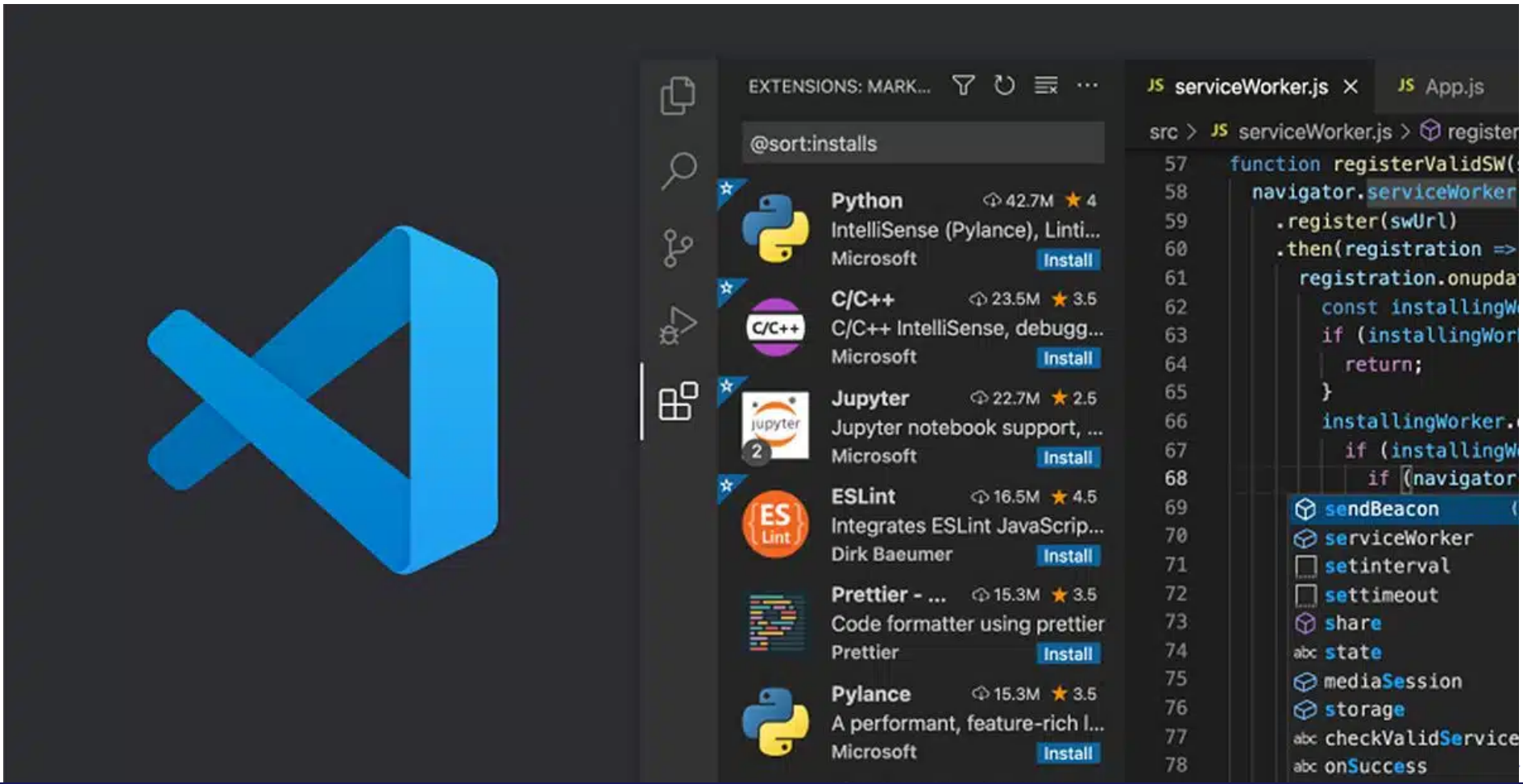
A unified future-proof platform

2020s

Wireless Edge

5G New Radio (NR)

The Best IDE in the World: Visual Studio Code



Become a VS Code Master in 1 Second

Just remember one thing:

`Ctrl + Shift + P`

This shortcut opens the Command Palette — your gateway to: *Extensions, settings, themes, terminal, and everything else.*

“Professor… I don’t want to install all that stuff.”

GitHub Resources

No problem!
We use **GitHub Codespaces!**
No installs. No setup. Just code in your browser.

We will use GitHub in three key ways:

- **GitHub Codespaces** — Write and run code directly in your browser. No local setup needed.
- **GitHub Classroom** — Submit your programming assignments.
- **Code Version Control** — Learn how to use GitHub to manage your code, especially when collaborating in a team.

We Use JSON for Assignment Answers

- JSON (JavaScript Object Notation) is a lightweight, structured data format based on **key–value pairs**.
- It's simple, human-readable, and widely used in modern software systems (e.g., APIs, configs, logs).
- In the AI and cloud era, JSON has become a **de facto standard**.
- For assignments, JSON lets us automatically parse your answers and process them programmatically.

What does JSON look like?

What does JSON look like?

- JSON is a structured data format based on **key–value pairs**.
- JSON supports **nesting** — values can be strings, numbers, lists, or even other JSON objects.

Example JSON Format

```
{
  "student_id": "FSU12345",
  "answers": {
    "Q1": "B",
    "Q2": "D"
  }
}
```

My View on AI

Can we use **ChatGPT, Copilot, Gemini, etc.**
to help with assignments?

Absolutely — I strongly encourage it!

Use It!

- You're welcome to use AI tools to brainstorm, generate code, or write explanations.
- You can even include notes like "This answer was inspired by GitHub Copilot" — that's fine.
- I want you to learn how to use AI productively, just like in real-world engineering.

But Outsmart It.

- My job is to make sure assignments are designed so that AI won't give you perfect answers easily.
- Your real skill is not in typing a prompt — it's in understanding, adapting, and improving what AI gives you.

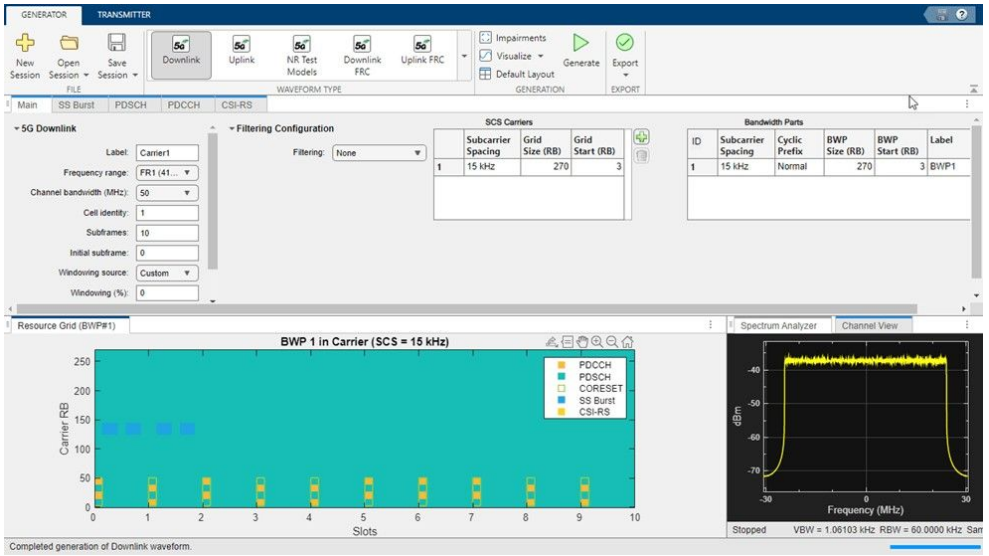
AI is welcome. Lazy copying is not.

MATLAB 5G Toolbox

Do we still need to build 5G from scratch?

Not really.

MATLAB already gives you
a solid 5G NR toolbox.



What Is 5G Toolbox?

- A MATLAB add-on to **model, simulate, analyze, and test** 5G communications systems.
- Built-in workflows for:
  - **Waveform generation**
  - **Link-level simulation**
  - **Golden reference design verification**
  - **System-level simulation**
- More details here

Waveforms in Minutes

- Generate uplink and downlink waveforms with:
  - **subcarrier spacing**, **bandwidth parts**, **frame numerology**
- Wireless Waveform Generator app:
  - **NR Test Models (NR-TM)**
  - **Downlink Fixed Reference Channels (FRC)**
  - For **FR1** and **FR2**

Channels and Signals You Will See in Real 5G

- Physical channels:
  - Uplink/downlink shared channels
  - Control and broadcast channels
- Synchronization and reference signals:
  - PSS, SSS
  - DM-RS (demodulation, timing, sync)
  - Phase tracking, CSI-related reference signals
  - SRS (sounding reference signal)
  - PRACH (random access)

Link-Level Simulation: The Classic Pipeline

- End-to-end link simulation:
  - transmitter $\rightarrow$ channel $\rightarrow$ receiver
- Standard channel models:
  - **CDL** and **TDL** channel models
- Metrics you can compute:
  - BER, BLER, throughput
- Receiver building blocks:
  - channel/timing estimation, synchronization, equalization

Coding and Procedures Are Included

- Channel coding components:
  - **LDPC** and **Polar** coding subcomponents
- Initial access procedures:
  - cell search and selection
  - decode **MIB** and **SIB1**
  - construct SS bursts and sync using DM-RS

System-Level Simulation: Multi-Node, Scheduling

- Multi-node simulations at the system level
- Example: **PUSCH scheduling** under different MAC strategies
- Great for understanding:
  - RAN behaviors, resource allocation, and performance tradeoffs

The Part I Really Want You to Use

It is open MATLAB source code.

Read it like a textbook.

Why This Matters

- You can access features as **customizable MATLAB source code**.
- Treat it as a **golden reference** for design verification.
- If you dissect the implementation step by step (with the help of your GPT teacher),
  - you will understand how 5G NR really works.
  - **you will become a 5G (6G) engineer faster**.

Takeaways

- We are living in the **AI era**.
- With AI, the distance between you and “top talent” is much smaller than you think.
- Knowledge is no longer the bottleneck. **Curiosity is.**
- Your advantage is the ability to **ask good questions** and **analyze what you get**.