

Week 2: The Application Layer

CSCI 4431/6431 Computer Networks

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Today

- Where the course is going, and why
- **Chapter 1:** worksheet and network layering
- **Chapter 2:** network apps and choosing a transport
- **Chapter 2:** the Web and HTTP
- Worksheet and quiz

Housekeeping

- Student Info form — if you haven't
- Discord server — ask questions here
- Everything lives at <https://go.gwu.edu/csnetworks>
- **Install Wireshark before next week** — Lab 1 is a Wireshark lab

How the semester runs

- Most weeks: lecture + a worksheet/activity + a short quiz
- **Quizzes are graded A/B/F.** If you are in class you get at least a B!
- Two protocol projects, two labs, a midterm, a final
- Full details in the **syllabus**

Projects

- Project 1: Application Layer Protocol Development
 - Define your own application layer protocol
 - Focus is on protocol specification and coordination between group implementations
- Project 2: Transport Layer Protocol
 - Implement a lower layer transport protocol
 - Individual or partner

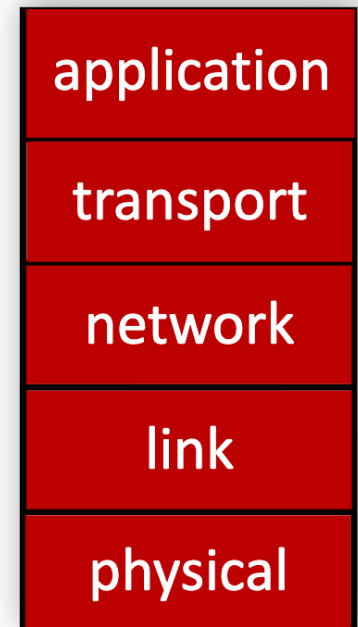
Chapter 1 - Slides 70 - 77

- Why layering?
- The layered Internet protocol stack
- Services, layering, and encapsulation

Slides: https://gaia.cs.umass.edu/kurose_ross/ppt-9e/Chapter_1_v9.0.pptx

The Protocol Stack

- ***application***: supporting network applications
 - HTTP, IMAP, SMTP, DNS
- ***transport***: process-process data transfer
 - TCP, UDP
- ***network***: routing of datagrams from source to destination
 - IP, routing protocols
- ***link***: data transfer between neighboring network elements
 - Ethernet, 802.11 (WiFi), PPP
- ***physical***: bits “on the wire”



The stack *is* the course schedule

- **application** — Chapter 2 ← *we start today*
- **transport** — Chapter 3 = weeks 4-5
- **network** — Chapters 4 and 5 = weeks 8-11
- **link** — Chapter 6 = week 12
- **physical / wireless** — Chapter 7 = week 13
- **security** — Chapter 8 = week 15 and throughout

We will work **top-down**. Everything below today is a black box.

Chapter 1 Worksheet

Where did you get stuck trying to solve it?

Chapter 2

The Application Layer

Chapter 2 - Slides 2 - 11

- Network apps; client-server and peer-to-peer
- Processes, sockets, addressing
- What an application-layer protocol defines

Slides: https://gaia.cs.umass.edu/kurose_ross/ppt-9e/Chapter_2_v9.0.pptx

Application Protocols (slide 11)

- **Types of messages** exchanged
 - e.g., request, response
- **Message syntax:**
 - what fields in messages & how fields are delineated
- **Message semantics**
 - meaning of information in fields
- **Rules** for when and how processes send & respond to messages

Discussion: Pick the Transport

Pick the transport

Let's fill in and choose TCP or UDP — and why.

Application	Loss?	Tput?	Timing?	Protocol?
Live video call				
Bank login				
Competitive FPS				
OS update download				
IoT temp sensor				

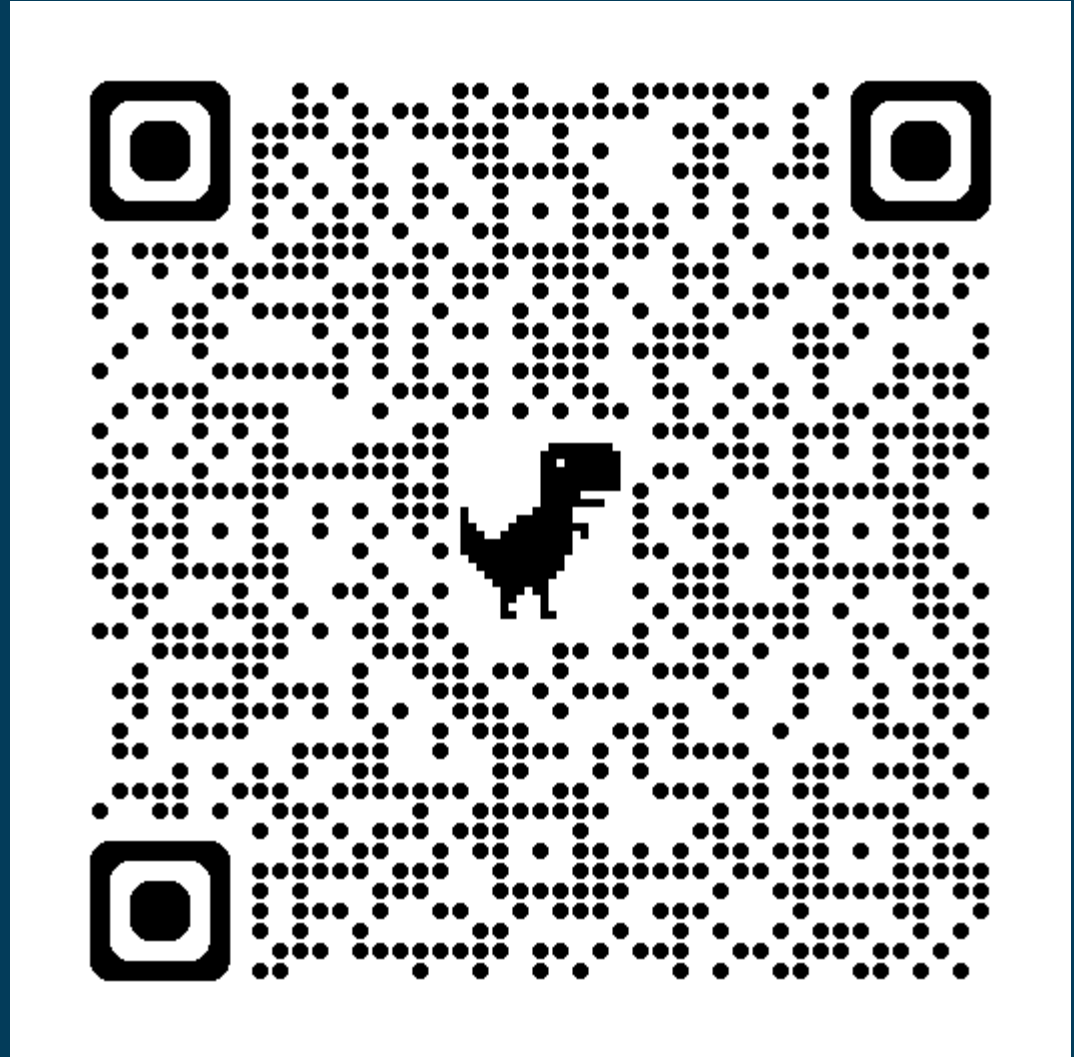
Application	Loss?	Tput?	Timing?	Protocol?
DNS lookup				

Chapter 2 - Slides 12 - 17

- What transport service does an app need?
- TCP and UDP services
- Application → transport protocol
- Securing TCP with TLS

Break (~4:30pm)

- Vint Cerf on the Internet's layered architecture
 - 6 minute video
 - Fill out Student Info form if you didn't already do so!



Chapter 2 - Slides 18 - 30

- Web and HTTP; HTTP is **stateless**
- Non-persistent vs. persistent connections
- HTTP request and response messages
- Status codes

Demo: talk to a web server by hand

```
nc -c -v gaia.cs.umass.edu 80
```

then type, and hit return twice:

```
GET /kurose_ross/interactive/index.php HTTP/1.1  
Host: gaia.cs.umass.edu
```

(Windows: `ncat -C gaia.cs.umass.edu 80`)

Chapter 2 Worksheet

Activity: HTTP response time & message anatomy

Worksheet

- Work with a partner
- Two questions: **HTTP performance** and **interpreting a protocol**
- Handout and slides: <https://go.gwu.edu/csnetworks>
- Turn in at the end of class
- Ask Esma and me for help!

Quiz

Two questions. 10 minutes.

- One similar to **Chapter 1** worksheet question
- One similar to **today's** worksheet question

Chapter 2 - Slides 32 - 36

- **We will skip these - review slides/video to learn more about how the web works!**
 - Maintaining user/server state: **cookies**

Chapter 2 - Slides 49 - 53

- HTTP/2 and head-of-line blocking
- HTTP/2 → HTTP/3

HTTP/3 moves this onto QUIC, which is a **transport** problem. Back to it in Chapter 3.

Wrap up and Homework

- Watch these videos and do the assignment:
 - 2.4 DNS
 - 2.7 Socket Programming
 - Classroom 50 - Chapter 2 Assignment
 - Install: wireshark, git and gh client, python 3
- These are optional but interesting and useful:
 - 2.2 The Web and HTTP, part 1 and part 2
 - 2.3 E-mail, SMTP, IMAP
 - 2.5 Peer to Peer Networks
 - 2.6 Video Streaming and CDNs
 - Supplemental: Web Tracking, Cookies, GDPR

Next week

- **Lab 1: Wireshark and Socket Programming**
 - I will be away, Esma will lead class
 - Hands-on lab and overview of

Chapter 2 Resources

- Textbook Slides
- Practice Problems
- Videos (Full playlist):
 - 2.1 Principles of Network Applications
 - 2.2 The Web and HTTP, part 1 and part 2
 - 2.3 E-mail, SMTP, IMAP
 - 2.4 The Domain Name System
 - 2.5 Peer to Peer Networks
 - 2.6 Video Streaming and CDNs
 - 2.7 Socket Programming
 - 2.7 Supplemental: Web Tracking, Cookies, GDPR