

A decorative graphic on the left side of the slide, consisting of a network of white lines and circles on a blue gradient background, resembling a circuit board or a neural network.

COMPE 560: COMPUTER NETWORKS

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GOALS FOR TODAY'S CLASS

- Key concepts in data networking
 - Protocols
 - Layering
 - Resource allocation
 - Naming
- But before we begin....

LEARNING THE MATERIAL: STRATEGIES

- The course involves a **LOT of reading**
- Be sure to be **at par with the class** so that you do not have too much catching up to do before an exam
- Follow and use my **slides as a guideline** of what to focus on in a chapter
- **Attend class lectures** – I will almost always tell you what is going to show up on an exam – all you need to do is pay attention
- **Pile up on the easy points** – OPNET, class participation
- Very detailed Syllabus – stay with me

A decorative graphic on the left side of the slide, consisting of a network of light blue lines and circles of varying sizes, resembling a circuit board or a data network topology. The lines are vertical and horizontal, with some diagonal connections, and the circles are placed at various points along these lines.

OKAY, SO LET'S GET
STARTED... WITH A
CRASH COURSE IN
DATA NETWORKING

WHAT IS A NETWORK ??

- A **network** is a combination of hardware and software that sends data from one location to another.
- The hardware consists of the physical equipment that carries signals from one point in the network to another.
- The software consists of instructions that make the services that we expect from a network possible.
- NETWORKS versus COMMUNICATION !!!

KEY CONCEPTS IN NETWORKING

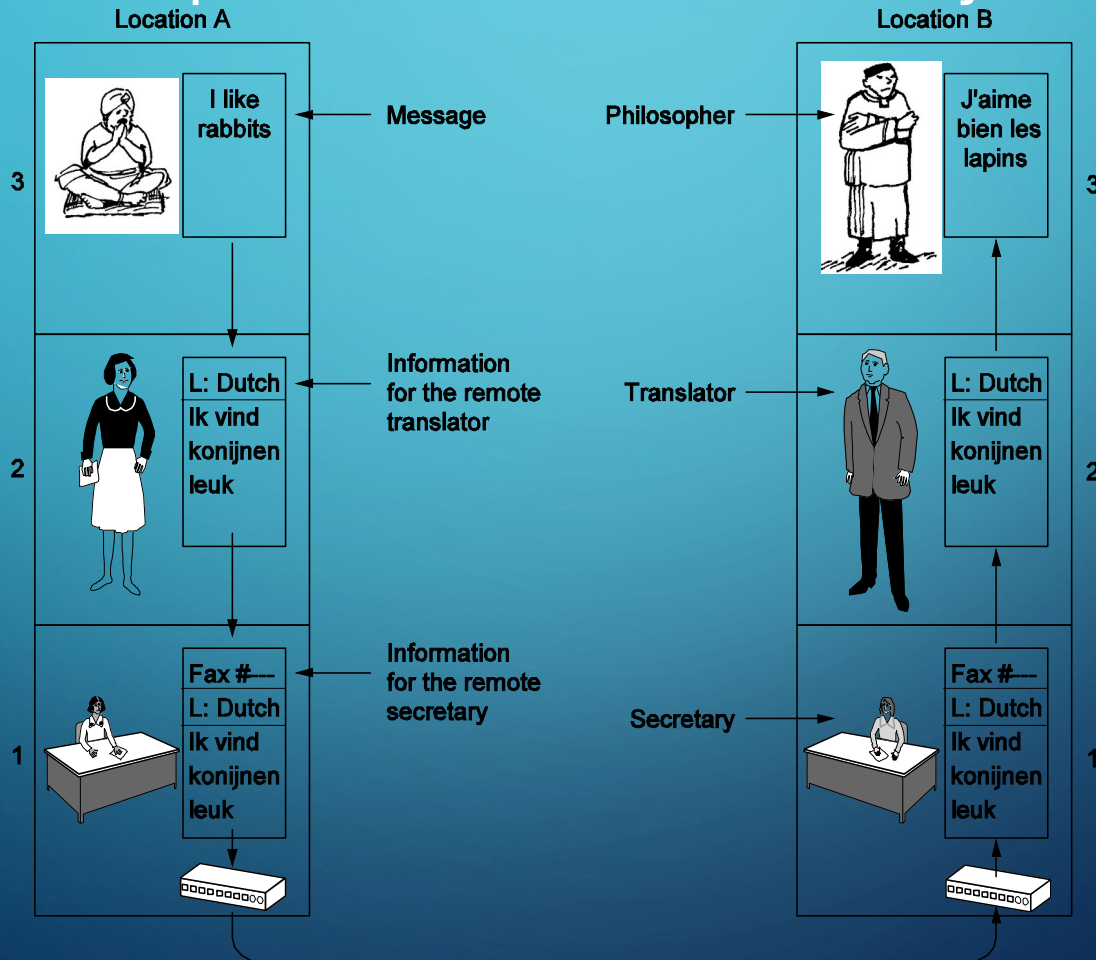
- Layering
 - Standing on the shoulders of giants
 - A key to managing complexity
- Protocols
 - Speaking the same language
 - Syntax and semantics
- Resource allocation
 - Dividing scarce resources among competing parties
 - Memory, link bandwidth, wireless spectrum, paths, ...
 - Distributed vs. centralized algorithms
- Naming
 - What to call computers, services, protocols, ...

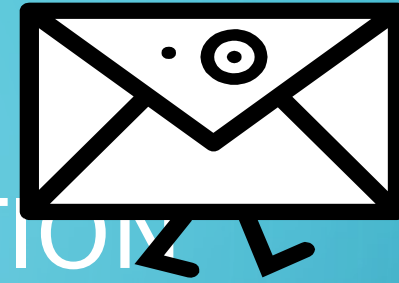
LAYERING: A MODULAR APPROACH

- Sub-divide the problem
 - Each layer relies on **services** from layer below
 - Each layer exports services to layer above
- **Interface** between layers defines interaction
 - Hides implementation details (**protocols**)
 - Layers can change without disturbing other layers

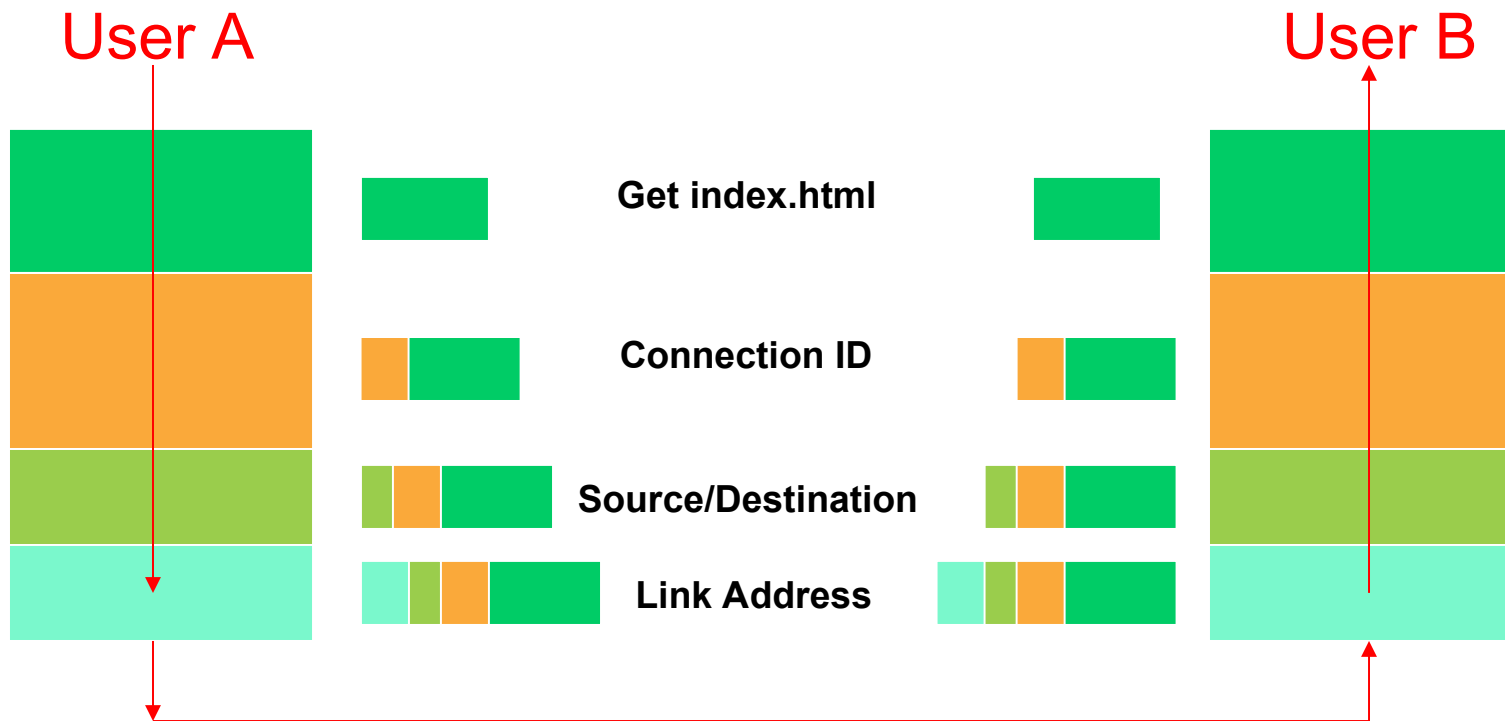
PROTOCOL HIERARCHIES : LAYERS, SERVICE, INTERFACE

- The philosopher-translator-secretary architecture.





LAYER ENCAPSULATION



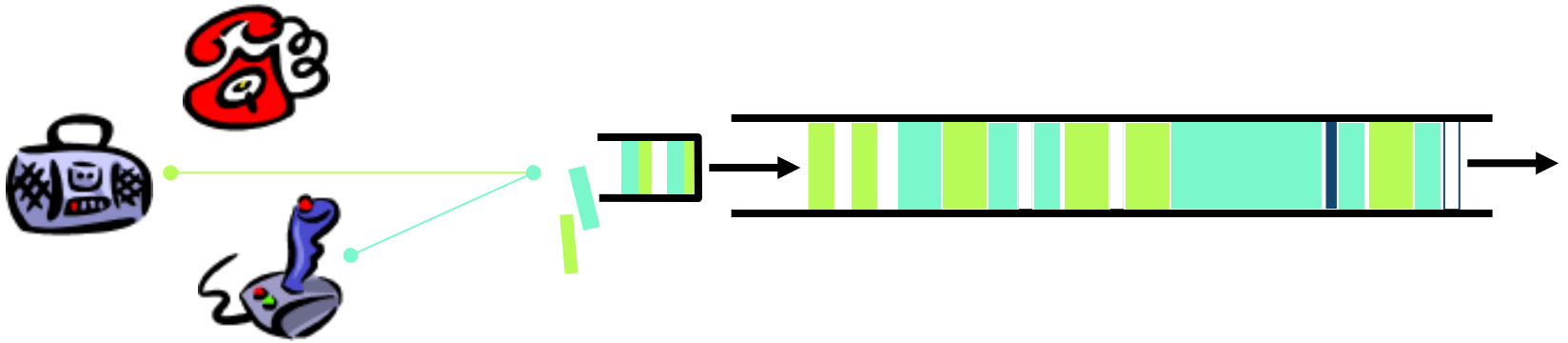
IS LAYERING HARMFUL?

- Layer N may duplicate lower level functionality
 - E.g., error recovery to retransmit lost data
- Layers may need same information
 - E.g., timestamps, maximum transmission unit size
- Strict adherence to layering may hurt performance
 - E.g., hiding details about what is really going on
- Some layers are not always cleanly separated
 - Inter-layer dependencies for performance reasons
 - Some dependencies in standards (header checksums)
- Headers start to get really big
 - Sometimes more header bytes than actual content

PROTOCOL STANDARDIZATION

- Communicating hosts speaking the same protocol
 - Standardization to enable multiple implementations
 - Or, the same folks have to write all the software
- Standardization: Internet Engineering Task Force
 - Based on working groups that focus on specific issues
 - Produces “Request For Comments” (RFCs)
 - Promoted to standards via rough consensus and running code
 - E.g., RFC 1945 on “HyperText Transfer Protocol - HTTP/1.0”
 - IETF Web site is <http://www.ietf.org>
- De facto standards: same folks writing the code
 - P2P file sharing, Skype, <your protocol here>...

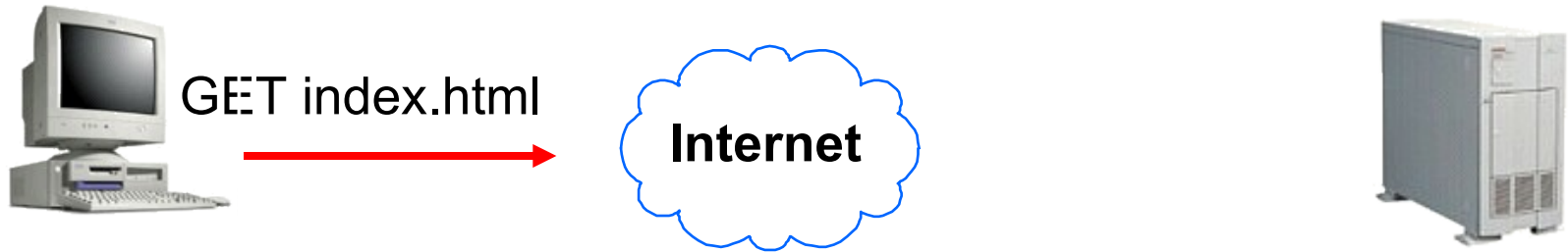
RESOURCE ALLOCATION: QUEUES



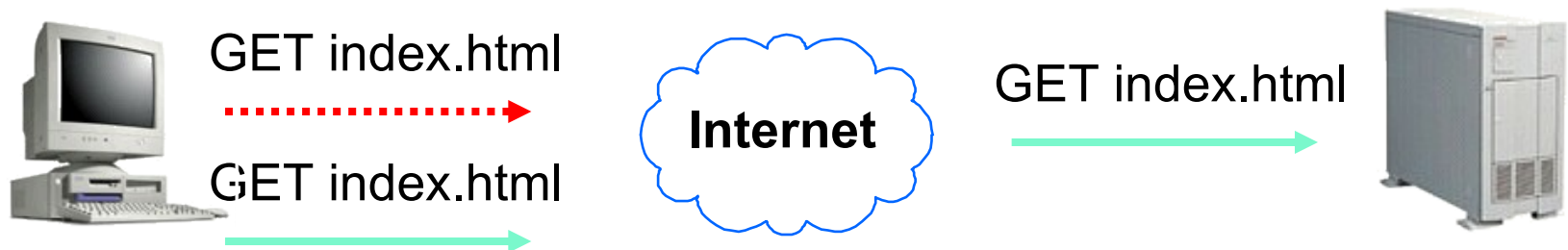
- Sharing access to limited resources
 - E.g., a link with fixed service rate
- Simplest case: first-in-first out queue
 - Serve packets in the order they arrive
 - When busy, store arriving packets in a buffer
 - Drop packets when the queue is full

WHAT IF THE DATA GETS DROPPED?

Problem: Lost Data



Solution: Timeout and Retransmit



WHAT IF THE DATA IS OUT OF ORDER?

Problem: Out of Order



ml



inde



x.ht



GET



GET x.htinde ml

Solution: Add Sequence Numbers



ml 4



inde 2



x.ht 3



GET 1



GET index.html

HIGHLIGHTS FROM CHAPTER 1

- Client-Server Model vs P-2-P network
- Applications of a computer network, usage of Internet
- PAN vs LAN vs WAN vs MAN
- Store-n-forward/Packet Switch vs Circuit Switch
- Connection oriented vs Connectionless
- Layers – functionalities of each layer
- Service vs Interface vs Protocols
- Topics to Read up on : **ARPANET**, **Internet Architecture**, **Ethernet**, **P-2-P Networks**