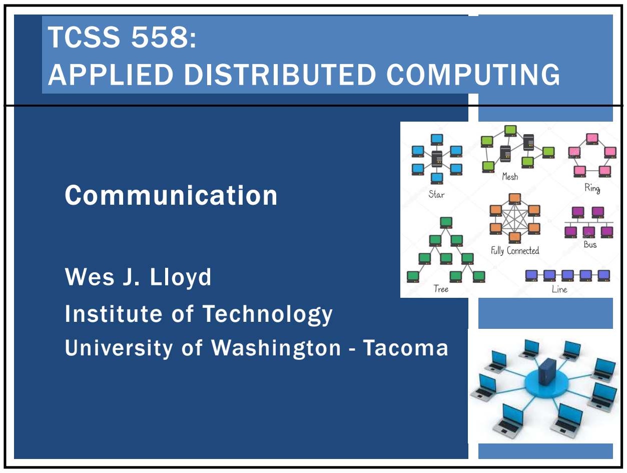
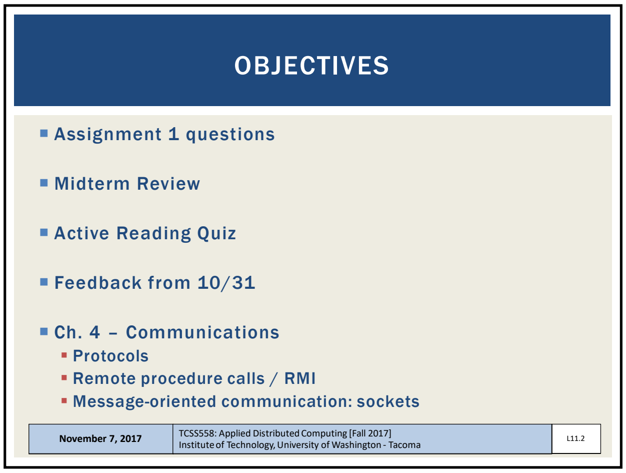


TCSS 558: APPLIED DISTRIBUTED COMPUTING

Communication

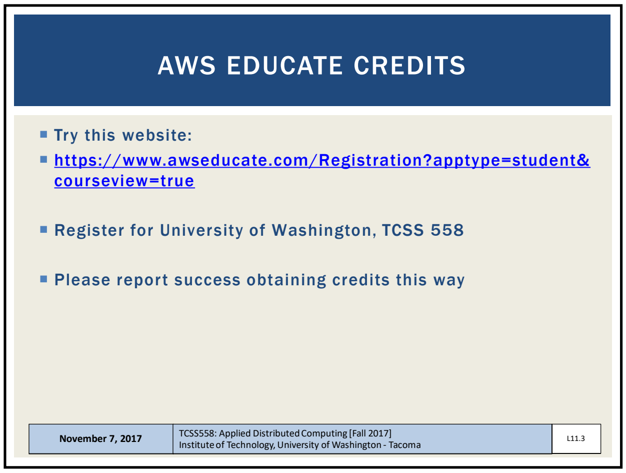
Wes J. Lloyd
Institute of Technology
University of Washington - Tacoma

Star
Mesh
Ring
Fully Connected
Bus
Tree
Line



OBJECTIVES

- Assignment 1 questions
- Midterm Review
- Active Reading Quiz
- Feedback from 10/31
- Ch. 4 – Communications
  - Protocols
  - Remote procedure calls / RMI
  - Message-oriented communication: sockets



AWS EDUCATE CREDITS

- Try this website:
- https://www.awseducate.com/Registration?apptype=student&courseview=true
- Register for University of Washington, TCSS 558
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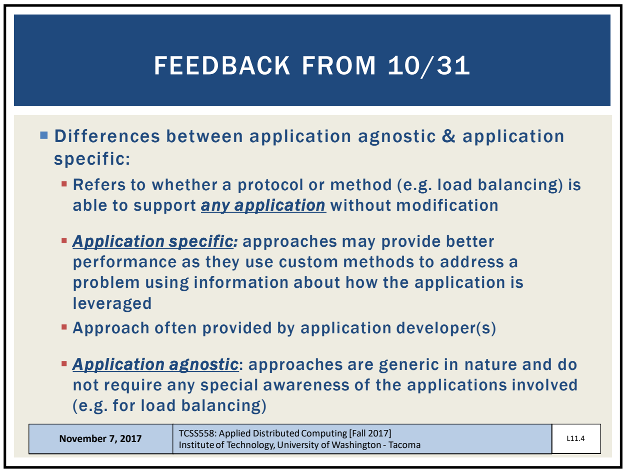
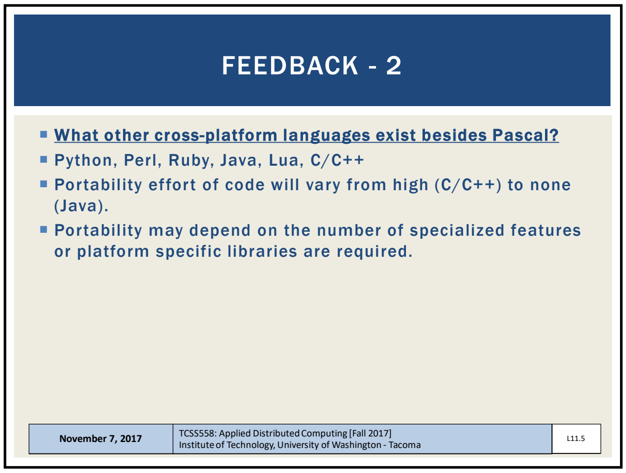


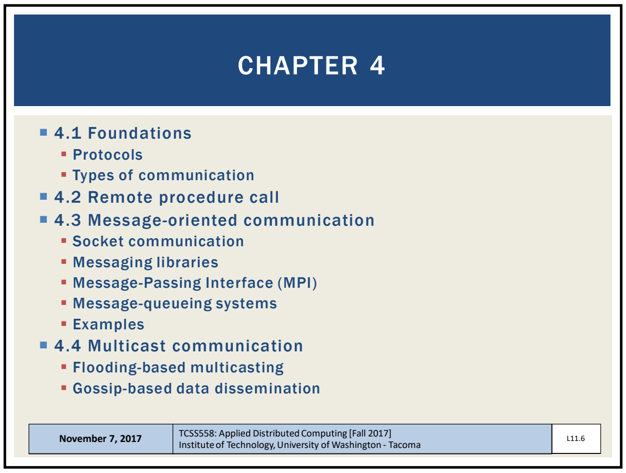
FEEDBACK FROM 10/31

- Differences between application agnostic & application specific:
  - Refers to whether a protocol or method (e.g. load balancing) is able to support ***any application*** without modification
  - ***Application specific:*** approaches may provide better performance as they use custom methods to address a problem using information about how the application is leveraged
  - Approach often provided by application developer(s)
  - ***Application agnostic***: approaches are generic in nature and do not require any special awareness of the applications involved (e.g. for load balancing)



FEEDBACK - 2

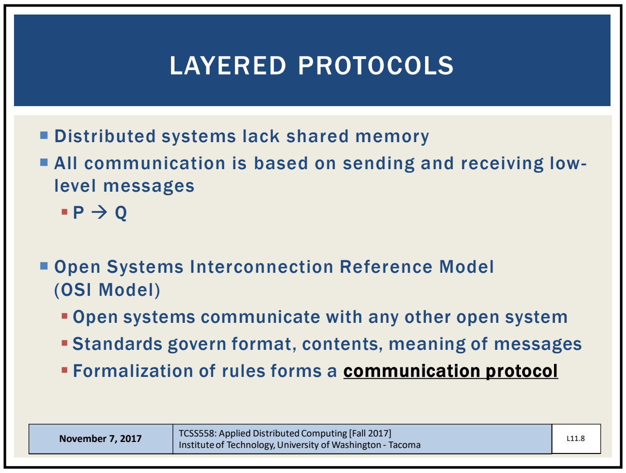
- **What other cross-platform languages exist besides Pascal?**
- Python, Perl, Ruby, Java, Lua, C/C++
- Portability effort of code will vary from high (C/C++) to none (Java).
- Portability may depend on the number of specialized features or platform specific libraries are required.



CHAPTER 4

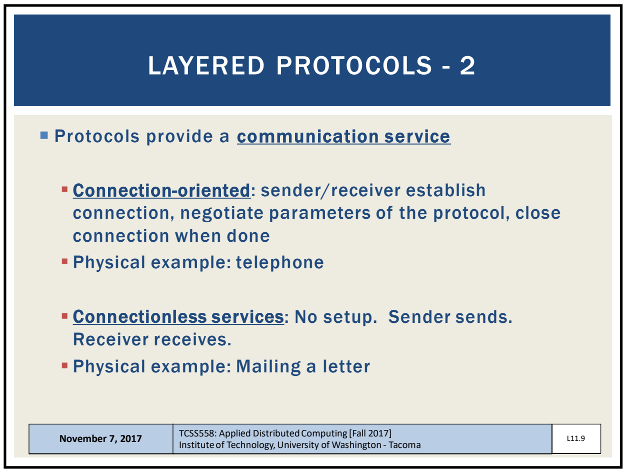
- 4.1 Foundations
  - Protocols
  - Types of communication
- 4.2 Remote procedure call
- 4.3 Message-oriented communication
  - Socket communication
  - Messaging libraries
  - Message-Passing Interface (MPI)
  - Message-queueing systems
  - Examples
- 4.4 Multicast communication
  - Flooding-based multicasting
  - Gossip-based data dissemination

CH. 4.1: FOUNDATIONS



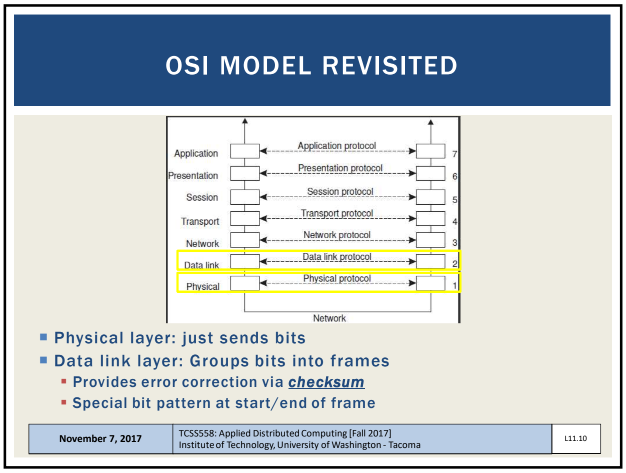
LAYERED PROTOCOLS

- Distributed systems lack shared memory
- All communication is based on sending and receiving low-level messages
  - P → Q
- Open Systems Interconnection Reference Model (OSI Model)
  - Open systems communicate with any other open system
  - Standards govern format, contents, meaning of messages
  - Formalization of rules forms a **communication protocol**



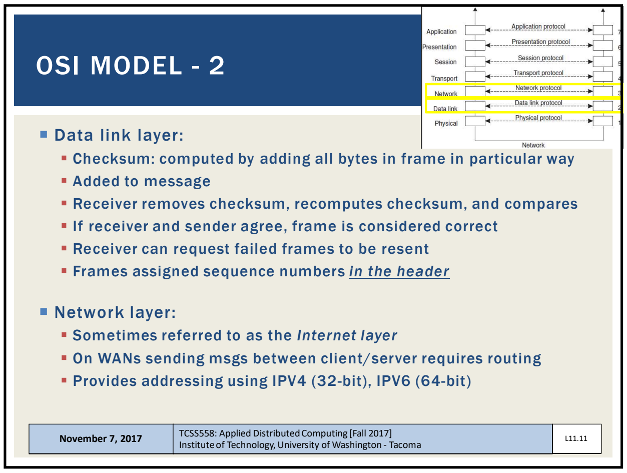
LAYERED PROTOCOLS - 2

- Protocols provide a **communication service**
  - **Connection-oriented**: sender/receiver establish connection, negotiate parameters of the protocol, close connection when done
  - Physical example: telephone
  - **Connectionless services**: No setup. Sender sends. Receiver receives.
  - Physical example: Mailing a letter



OSI MODEL REVISITED

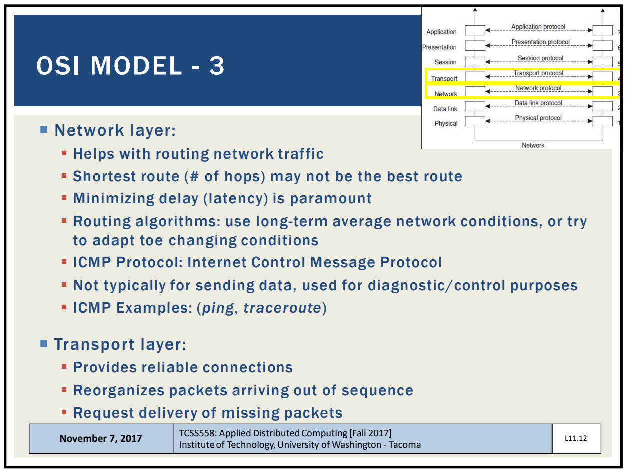
- Physical layer: just sends bits
- Data link layer: Groups bits into frames
  - Provides error correction via ***checksum***
  - Special bit pattern at start/end of frame



OSI MODEL - 2

Application
Application protocol
Presentation
Presentation protocol
Session
Session protocol
Transport
Transport protocol
Network
Network protocol
Data link
Data link protocol
Physical
Physical protocol
Network

- Data link layer:
  - Checksum: computed by adding all bytes in frame in particular way
  - Added to message
  - Receiver removes checksum, recomputes checksum, and compares
  - If receiver and sender agree, frame is considered correct
  - Receiver can request failed frames to be resent
  - Frames assigned sequence numbers ***in the header***
- Network layer:
  - Sometimes referred to as the *Internet layer*
  - On WANs sending msgs between client/server requires routing
  - Provides addressing using IPV4 (32-bit), IPV6 (64-bit)

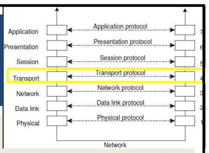


OSI MODEL - 3

Application
Application protocol
Presentation
Presentation protocol
Session
Session protocol
Transport
Transport protocol
Network
Network protocol
Data link
Data link protocol
Physical
Physical protocol
Network

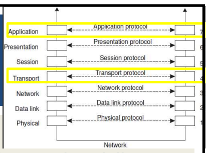
- Network layer:
  - Helps with routing network traffic
  - Shortest route (# of hops) may not be the best route
  - Minimizing delay (latency) is paramount
  - Routing algorithms: use long-term average network conditions, or try to adapt toe changing conditions
  - ICMP Protocol: Internet Control Message Protocol
  - Not typically for sending data, used for diagnostic/control purposes
  - ICMP Examples: (*ping*, *traceroute*)
- Transport layer:
  - Provides reliable connections
  - Reorganizes packets arriving out of sequence
  - Request delivery of missing packets

OSI MODEL - 4



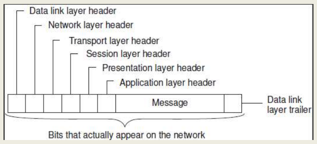
- Transport layer:
  1. Breaks application layer protocol messages into pieces to transmit
  2. Assigns messages sequence numbers
  3. Sends all messages
- Transport layer provides an infallible "message pipe"
  - Put messages in
  - Always come out undamaged, in correct order
- Transport layer protocols:
  - TCP: Transmission Control Protocol (connection-oriented)
  - UDP: Universal Datagram Protocol (connectionless)

OSI MODEL - 5



- Other transport protocols
  - Real-time transport protocol (RTP): real-time data, no data delivery guarantee
  - Streaming Control Transmission Protocol SCTP): alternative to TCP
- Higher-level protocols
  - Session layer: rarely used
  - Presentation layer: meaning of the bits;
  - Application layer: protocols that don't fit into other layers
    - Many protocols: FTP, SFTP, HTTP, etc. etc.

OSI MODEL - 2

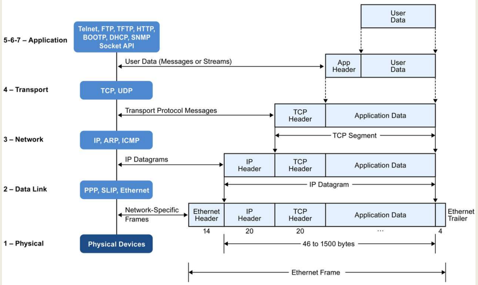


- OSI layers contribute overhead bits to the message
- Layers append data to front (and maybe end) of the message
- Receiving end strips off layers as the message goes up the OSI model stack:

  physical → data-link → network → transport → application

PROTOCOL STACK

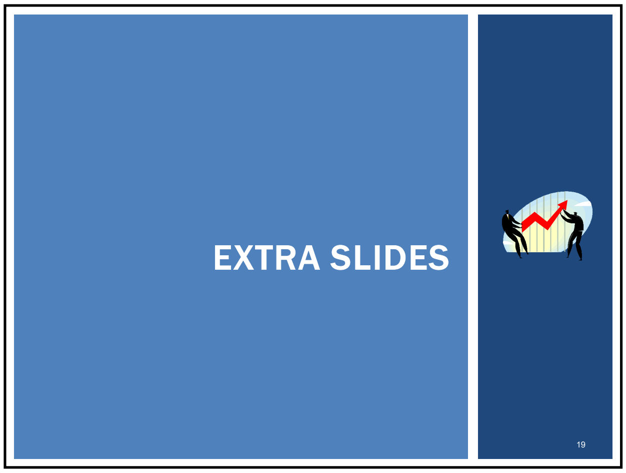
- Collection of layers used for communication from OSI model



MIDDLEWARE PROTOCOLS

- Communication frameworks/libraries
- Reused by multiple applications
- Provided needed functions apps build and depend on
- Example:
  - Authentication protocols: supports granting users and processes access to authorized resources
  - General, application-independent in nature
  - Doesn't fit as an "application specific" protocol
  - Considered as a "Middleware protocol"

QUESTIONS



EXTRA SLIDES