

L02

Application Layer Overview

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<https://www.youtube.com/watch?v=tl2evqsQj4o>

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Resources Acknowledgement

Chapter 2 Application Layer

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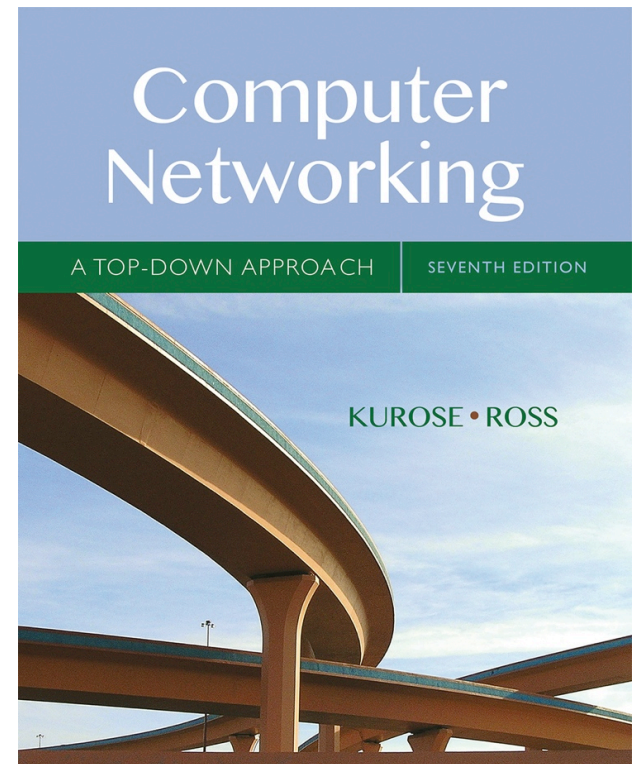
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Computer Networking: A Top Down Approach

7th edition

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Application Layer 2-1

Application Evolution in Network

- 1980s
 - Text based Email, File xfer, Remote login, Newsgroup
- 1990s
 - Web surfing, web search, e-commerce
 - Killer Applications
 - P2P file sharing, instant messaging
- 2000s
 - Voice and Video applications (Skype),
 - Rich multimedia Apps, User generated video contents
- 2010s
 - Social computing apps, Video Streaming (NetFlix)
 - Multi-player games (SecondLife, WarCraft, ...)
 - Mobile Apps

Chapter 2: Application Layer

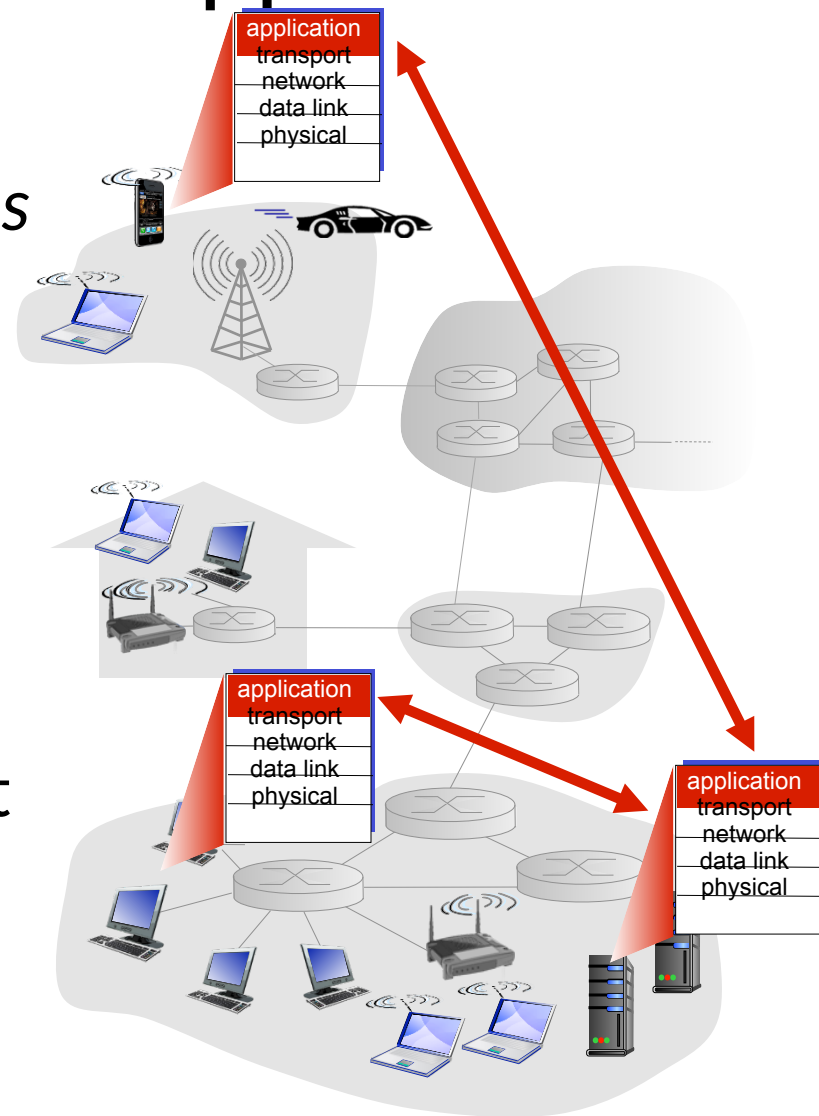
- Goals:
 - Conceptual, implementation aspects of network application protocols
 - Transport-layer service models
 - Client-server paradigm
 - Peer-to-peer paradigm
 - Content Distribution Networks
 - Learn about protocols by examining popular application-level protocols
 - HTTP
 - SMTP / POP3 / IMAP
 - DNS
 - Creating network applications
 - Socket API

Some network apps

- e-mail
- web
- text messaging
- remote login
- P2P file sharing
- multi-user network games
- streaming stored video (YouTube, Hulu, Netflix)
- voice over IP (e.g., Skype)
- real-time video conferencing
- social networking
- search
- ...
- ...

Creating a network app

- write programs that:
- run on (different) *end systems*
- communicate over network
- e.g., web server software communicates with browser software
- no need to write software for network-core devices
- network-core devices do not run user applications
- applications on end systems allows for rapid app development, propagation

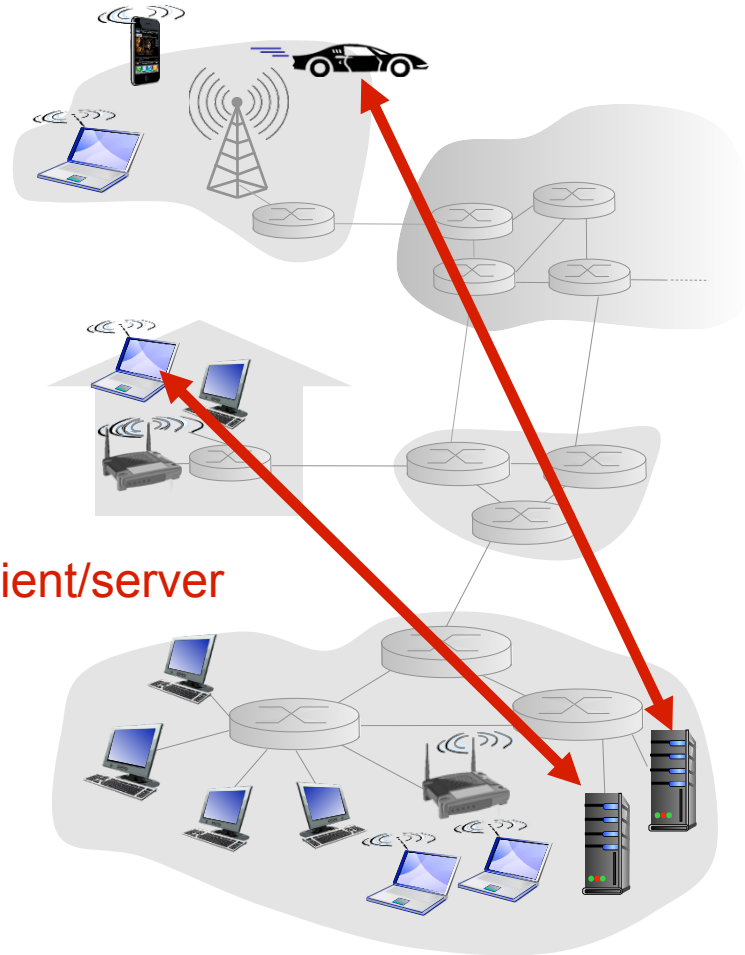


Application architectures

- possible structure of applications:
- client-server
- peer-to-peer (P2P)

Client-server architecture

server:



Server

- always-on host
- permanent IP address
- data centers for scaling

Clients:

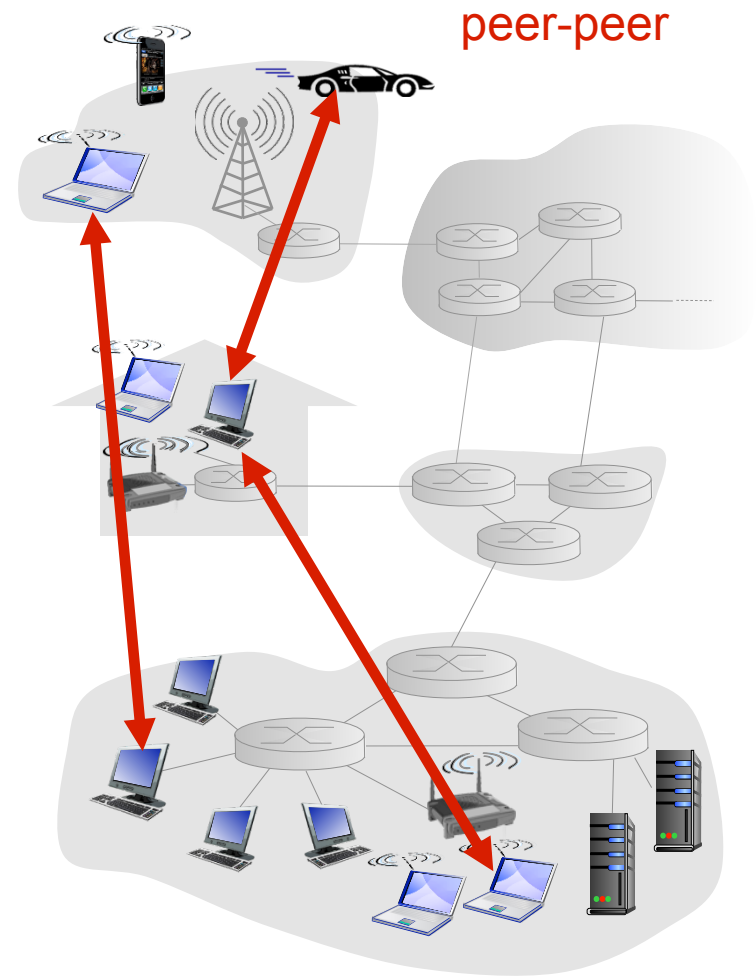
- communicate with server
- may be intermittently connected
- may have dynamic IP addresses
- do not communicate directly with each other

Application Architecture Paradigm

- Client-Server architecture
 - Client initiates requests to server
 - Clients do not talk to each other
 - Server examples
 - Web server, FTP Server, Mail server,
 - Applications typically provided by service provider
 - Gmail, Yahoo
 - Google, Bing
 - Facebook, Instagram, LinkedIn
 - Amazon, EBay, Flipkart
 - Netflix, Redbox, Amazon prime
 - WhatsApp, Skype
 - Hosted in data centers

P2P architecture

- No always-on server
- Arbitrary end systems directly communicate
- Peers request service from other peers, provide service in return to other peers
 - *Self scalability* – new peers bring new service capacity, as well as new service demands
- Peers are intermittently connected and change IP addresses
 - complex management



Application Architecture Paradigm

- Peer-to-peer architecture
 - No reliance on dedicated servers
 - Direct communication between pairs of hosts
 - Could be via intermittent hosts
 - Peers (desktop, PC, smartphones etc) not owned by service provider
 - Self scalable
 - Each peer adds service capacity to the system
 - Application examples
 - BitTorrent
 - Skype

Peer to Peer Architecture

- Challenges to future applications
 - Asymmetric access to end user (ADSL)
 - P2P video will have issues
 - Security
 - Being distributed in nature, how to secure them
 - Incentives to users
 - How to convince new users to join

App-layer protocol defines

- 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 &
- Open protocols:
 - Defined in RFCs
 - Allows for interoperability
 - e.g., HTTP, SMTP
 - Proprietary protocols:
 - Skype,
 - WhatsApp

What transport service does an app need?

- **Data integrity**
 - Some apps (e.g., file xfer, web transactions) require 100% reliable data transfer
 - Other apps (e.g., audio) can tolerate some loss
- **Timing**
 - Some apps (e.g., Internet telephony, interactive games) require low delay to be “effective”
- **Throughput**
 - Some apps need minimum amount of throughput to be “effective” (e.g., multimedia)
 - Other apps (“elastic apps”) make use of whatever throughput they get
- **Security**
 - Confidentiality,
 - Integrity, ...
 - Authentication

Transport service requirements: common apps

application	data loss	throughput	time sensitive
file transfer	no loss	elastic	no
e-mail	no loss	elastic	no
Web documents	no loss	elastic	no
real-time audio/video	loss-tolerant	audio: 5kbps-1Mbps video:100kbps-5Mbp	yes, 100's msec
stored audio/video	loss-tolerant	s same as above	yes, few secs yes, 100's msec
interactive games	loss-tolerant	few kbps up	yes and no
text messaging	no loss	elastic	

Internet transport protocols services

TCP service:

- *Reliable transport* between sending and receiving process
- *Flow control*: sender won't overwhelm receiver
- *Congestion control*: throttle sender when network overloaded
- *Does not provide*: timing, minimum throughput guarantee, security
- *Connection-oriented*: setup required between client and server processes

UDP service:

- *Unreliable data transfer* between sending and receiving process
- *Does not provide*: reliability,
- flow control, congestion control, timing,
- throughput guarantee, security
- Q: why bother? Why is there a UDP?

Application layer protocols

- Applications/processes communication
 - via sockets
- Structure of communication
 - What are various fields
 - When to send messages
 - What kind of messages
- Application layer protocol defines
 - Type of messages :
 - send, receive
 - Syntax of various message types
 - Fields of messages
 - Semantics of fields
 - Rules for determining when to send msg

Application layer protocols

- Example applications
- Web Application
 - Components
 - Web browser, server, HTML Page, HTTP
 - HTTP
 - Application layer protocol
- Email applications
 - Components
 - Mail server, mail client, SMTP, POP3, IMAP
 - SMTP, POP3, IMAP4
 - Application layer protocols

Internet apps: application, transport protocols

application	application layer protocol	underlying transport protocol
e-mail	SMTP [RFC 2821]	TCP
remote terminal access	Telnet [RFC 854]	TCP
Web	HTTP [RFC 2616]	TCP
file transfer	FTP [RFC 959]	TCP
streaming multimedia	HTTP (e.g., YouTube), RTP [RFC 1889]	TCP or UDP
Internet telephony	SIP(RFC 3261), RTP, proprietary (e.g., Skype)	TCP or UDP

Exercise 01

- List three applications that are
 - Time sensitive
 - Time insensitive
- List three applications that can
 - Tolerate some data loss
 - Can't tolerate any data loss
- Research on when TCP provides reliable service, why do we need UDP protocol at transport layer.

Summary

- Application architecture
 - Client-Server
 - Peer to Peer
- Service requirements from Transport layer
- Examples of application layer protocols