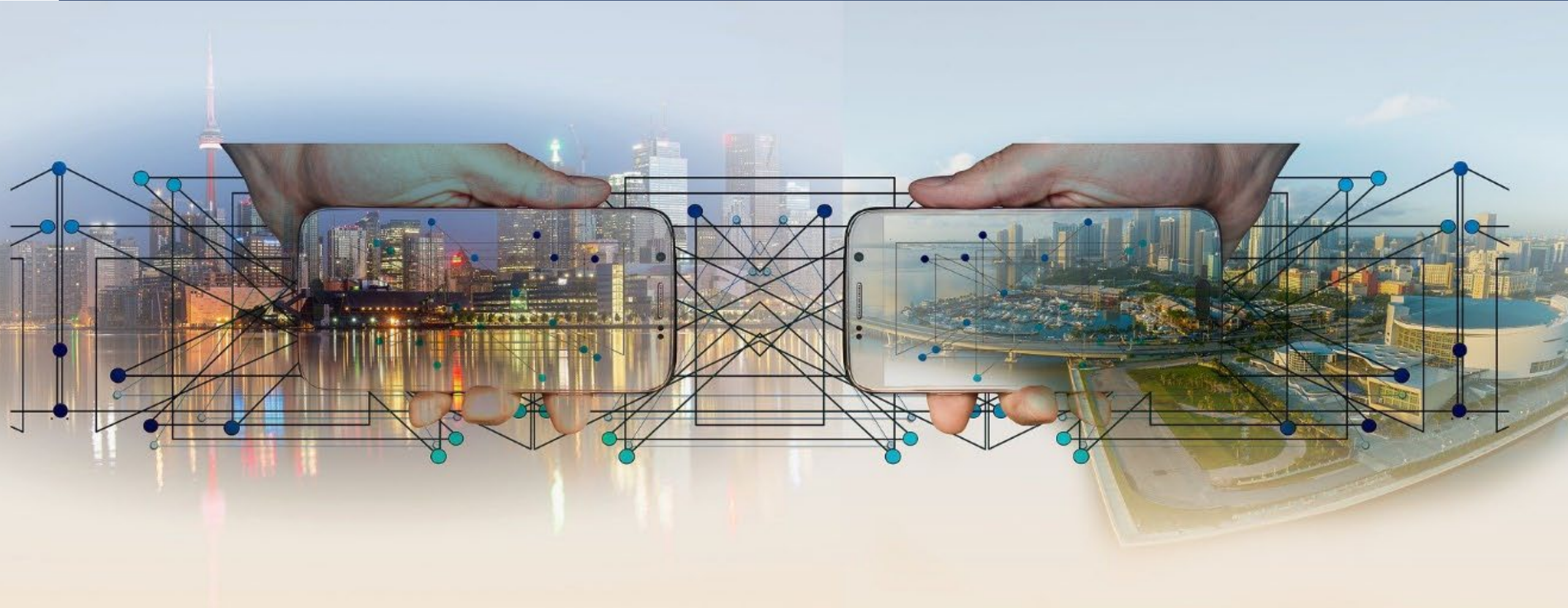


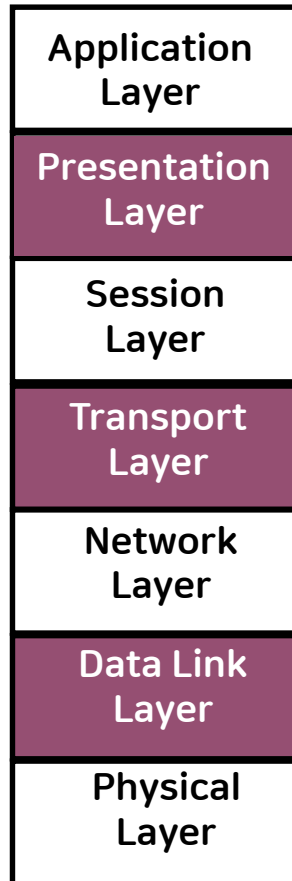
Lecture Note 2

Review of Computer Network Fundamentals



OSI Reference Model & TCP/IP Protocol Stack

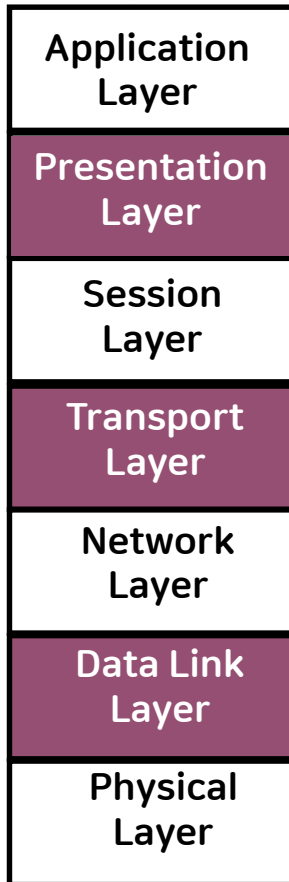
Application



OSI Reference Model & TCP/IP Protocol Stack

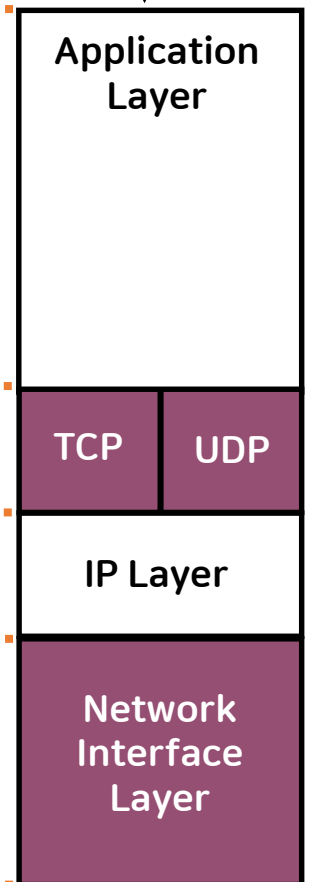
OSI 7 Layers

Application
↕

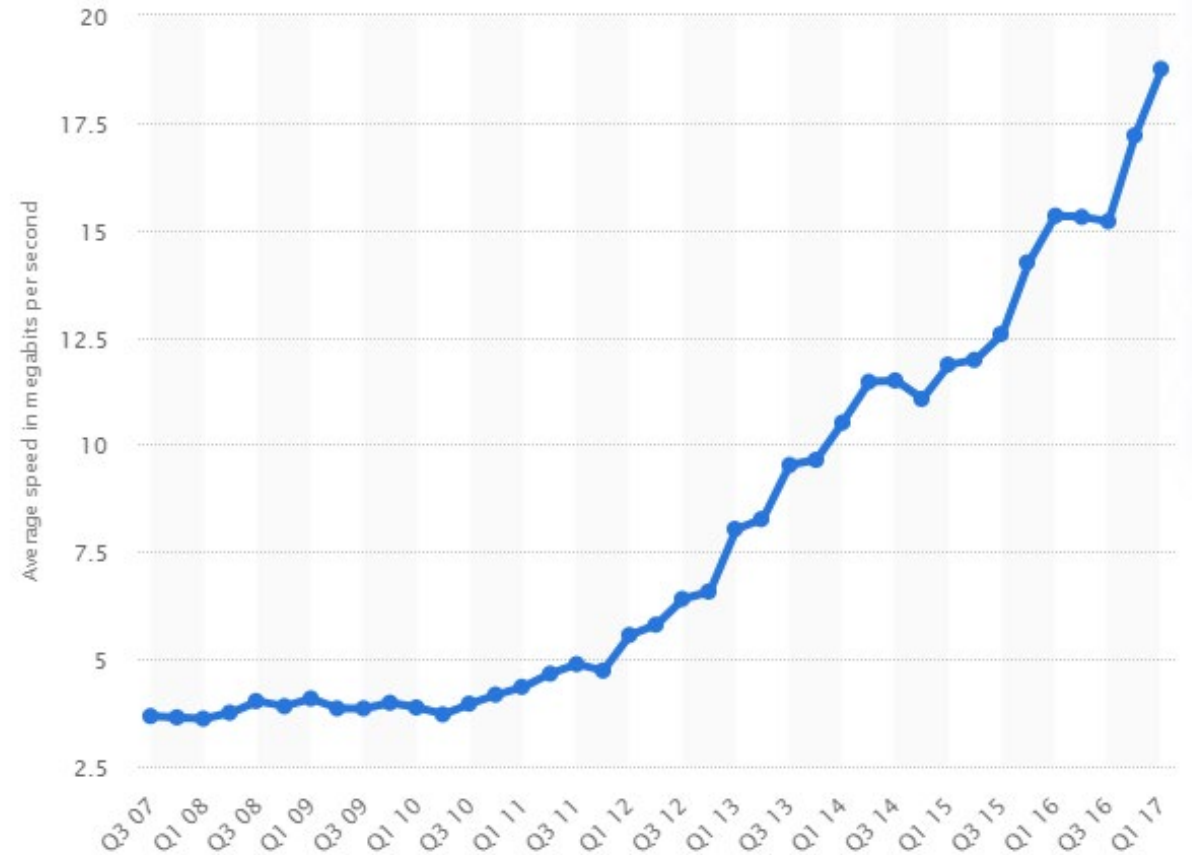
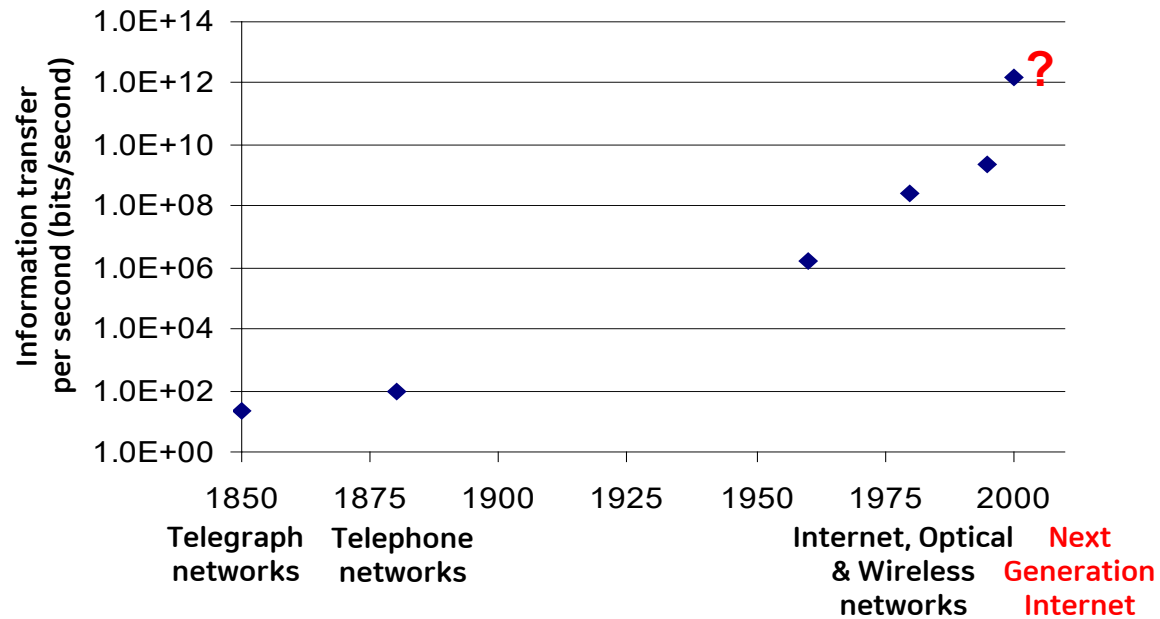


TCP/IP Protocol

Application
↕



Network Architecture Evolution



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[Source] <https://www.statista.com/statistics/616210/average-internet-connection-speed-in-the-us/>
<https://ourworldindata.org/internet>

Classification of interconnected processors by scale.

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

Metric Units

Exp.	Explicit	Prefix	Exp.	Explicit	Prefix
10^{-3}	0.001	milli	10^3	1,000	Kilo
10^{-6}	0.000001	micro	10^6	1,000,000	Mega
10^{-9}	0.000000001	nano	10^9	1,000,000,000	Giga
10^{-12}	0.0000000000001	pico	10^{12}	1,000,000,000,000	Tera
10^{-15}	0.0000000000000001	femto	10^{15}	1,000,000,000,000,000	Peta
10^{-18}	0.0000000000000000001	atto	10^{18}	1,000,000,000,000,000,000	Exa
10^{-21}	0.00000000000000000000001	zepto	10^{21}	1,000,000,000,000,000,000,000	Zetta
10^{-24}	0.0000000000000000000000001	yocto	10^{24}	1,000,000,000,000,000,000,000,000	Yotta

The principal metric prefixes.

IP Addresses

- An IP Packet can be sent to
 - A single workstation (**unicast**)
 - Efficient for data between pairs of addresses
 - A specific list of workstations (**multicast**)
 - Efficient for specific groups, but must specify all individual workstations IP addresses
 - All stations on a network (**broadcast**)
 - Efficient for large (unknown) group – use special broadcast IP address.
- IP addresses have a special broadcast address
- Class .vs. Classless Addressing.
- Internet Assigned Numbers Authority (IANA)

IP Address Ranges, Or “Classes”

From:	To:	Description
1.x.x.x	126.x.x.x	Class A license
127.x.x.x	127.x.x.x	Loop back
128.x.x.x	191.x.x.x	Class B license (172.16 thru 31. 0. 0 reserved for private addresses)
192.x.x.x	223.x.x.x	Class C license (192. 168. x. 0 reserved for private addresses)
224.0.0.0	224.0.0.255	Multicast: Reserved Link Local Addresses
224.0.1.0	238.255.255.255	Multicast: Globally Scoped Addresses
239.0.0.0	239.255.255.255	Multicast: Limited Scope Addresses
240.x.x.x	255.255.255.254	Experimental
255.255.255.255		Broadcast

IP Addressing and Subnetting

"Anding" a Binary Subnet Mask

100010010010110101101000	10101100
--------------------------	----------

111111111111111111111111	00000000
--------------------------	----------

100010010010110101101000	00000000
--------------------------	----------

subnet ID = (137.45.104.0)

Recap: Network Classes

- IANA (Internet Assigned Numbers Authority)
 - Class A
 - IP address := <8bits>.<24bits>
 - 16 Million hosts in a class A network domain
 - Class B
 - IP address = <16bits>.<16bits>
 - 65534 hosts in a class B network domain
 - Class C
 - IP address = <24bits>.<8bits>
 - 256 hosts in a class C network domain
- Waste of Address Range~!



Note on Classful vs. Classless

- Note that, in classful subnetting, we lose quite a few blocks of addresses.
- RFC 1519 (Classless Inter-Domain Routing = CIDR) was introduced in 1993 to deal with rapid depletion of IP address space due to “Classful Fragmentation”
- Problem:
 - Given the entire internet was “classful” in 1993, how to transition to classless methods?
 - What exactly is the impact to internet protocols (in all the millions of devices and hosts) of such a change?

Routeable and Nonrouteable Addresses

- Nonrouteable Address [RFC 1918]
 - Internet Router ignore the following addresses.
 - 10.0.0.0 – 10.255.255.255
 - 172.16.0.0 – 172.31.255.255
 - 192.168.0.0 – 192.168.255.255
 - Millions of networks can exist with the same nonrouteable address.
 - “Intranet” : Internal Internet
 - NAT (Network Address Translation) router
 - Side benefit : “Security”



VLSM (Variable Length Subnet Masking)

- Can support variable length of subnet id in a single domain
- How?
 - Decide the necessary number of bits for a host id first
 - Then, get the number of bits for a subnet id

VLSM: Sample Question

- **[Given] IP Addr 192.3.4.0/24**

- AtlantaHQ: 58 hosts
- PerthHQ: 26 hosts
- SydneyHQ: 10 hosts
- CorpusHQ: 10 hosts
- WAN1: 2 IP addresses
- WAN2: 2 IP addresses
- WAN3: 2 IP addresses

→ Give a subnet address, an address range, a broadcast address, and a network prefix

Reference: Cisco Network Fundamental course

Standards

- New technologies very costly and risky
- Standards allow players to share risk and benefits of a new market
 - Reduced cost of entry
 - Interoperability and network effect
 - Compete on innovation
 - Completing the value chain
 - Chips, systems, equipment vendors, service providers
- Example
 - 802.11 wireless LAN products

Standards Bodies

- Internet Engineering Task Force
 - Internet standards development
 - Request for Comments (RFCs): www.ietf.org
- International Telecommunications Union
 - International telecom standards
- IEEE 802 Committee
 - Local area and metropolitan area network standards
 - https://en.wikipedia.org/wiki/IEEE_802
- Industry Organizations
 - MPLS Forum, WiFi Alliance, World Wide Web Consortium