

# Network

E155

# Sources

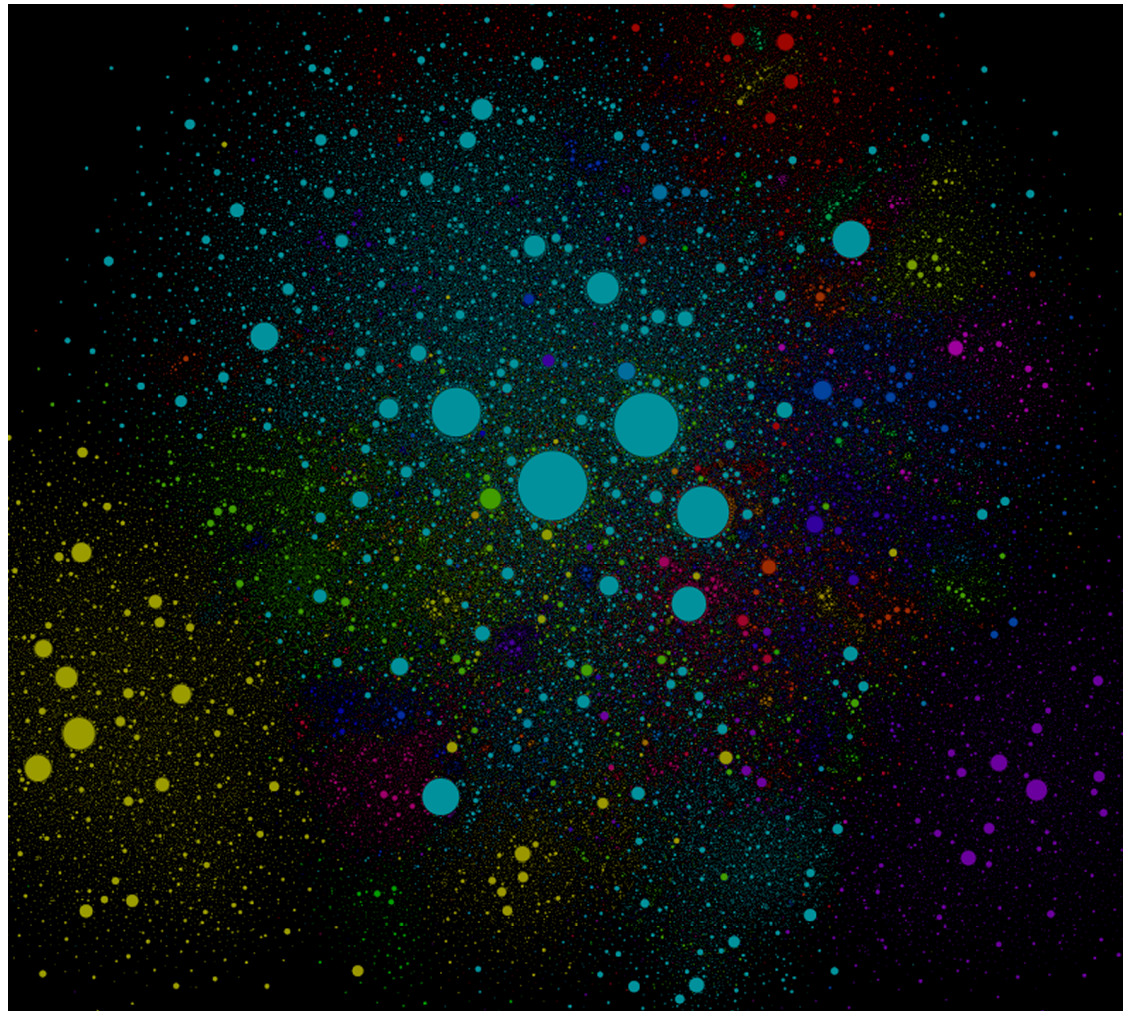
- Harris and Harris 2<sup>nd</sup> Edition Chapter 8
- <http://standards.ieee.org/about/get/802/802.3.html>
- <http://standards.ieee.org/about/get/802/802.11.html>
- [http://en.wikipedia.org/wiki/OSI\\_model](http://en.wikipedia.org/wiki/OSI_model)

# Internet

- Transmission Control Protocol and Internet Protocol (TCP/IP)
- Physically Ethernet cable or wireless wi-fi

# How Big is the Internet?

- <http://internet-map.net/>



# Internet Users

<b>WORLD INTERNET USAGE AND POPULATION STATISTICS</b>						
<b>June 30, 2012</b>						
<b>World Regions</b>	<b>Population ( 2012 Est.)</b>	<b>Internet Users Dec. 31, 2000</b>	<b>Internet Users Latest Data</b>	<b>Penetration (% Population)</b>	<b>Growth 2000-2012</b>	<b>Users % of Table</b>
<a href="#"><u>Africa</u></a>	1,073,380,925	4,514,400	<b>167,335,676</b>	15.6 %	3,606.7 %	7.0 %
<a href="#"><u>Asia</u></a>	3,922,066,987	114,304,000	<b>1,076,681,059</b>	27.5 %	841.9 %	44.8 %
<a href="#"><u>Europe</u></a>	820,918,446	105,096,093	<b>518,512,109</b>	63.2 %	393.4 %	21.5 %
<a href="#"><u>Middle East</u></a>	223,608,203	3,284,800	<b>90,000,455</b>	40.2 %	2,639.9 %	3.7 %
<a href="#"><u>North America</u></a>	348,280,154	108,096,800	<b>273,785,413</b>	78.6 %	153.3 %	11.4 %
<a href="#"><u>Latin America / Caribbean</u></a>	593,688,638	18,068,919	<b>254,915,745</b>	42.9 %	1,310.8 %	10.6 %
<a href="#"><u>Oceania / Australia</u></a>	35,903,569	7,620,480	<b>24,287,919</b>	67.6 %	218.7 %	1.0 %
<b><a href="#"><u>WORLD TOTAL</u></a></b>	<b>7,017,846,922</b>	<b>360,985,492</b>	<b>2,405,518,376</b>	<b>34.3 %</b>	<b>566.4 %</b>	<b>100.0 %</b>

NOTES: (1) Internet Usage and World Population Statistics are for June 30, 2012. (2) CLICK on each world region name for detailed regional usage information. (3) Demographic (Population) numbers are based on data from the [US Census Bureau](#) and local census agencies. (4) Internet usage information comes from data published by [Nielsen Online](#), by the [International Telecommunications Union](#), by [GfK](#), local ICT Regulators and other reliable sources. (5) For definitions, disclaimers, navigation help and methodology, please refer to the [Site Surfing Guide](#). (6) Information in this site may be cited, giving the due credit to [www.internetworldstats.com](http://www.internetworldstats.com). Copyright © 2001 - 2012, Miniwatts Marketing Group. All rights reserved worldwide.

<http://www.internetworldstats.com/stats.htm>

# Internet Users

<b>WORLD INTERNET USAGE AND POPULATION STATISTICS</b>						
<b>December 31, 2013</b>						
<b>World Regions</b>	<b>Population ( 2014 Est.)</b>	<b>Internet Users Dec. 31, 2000</b>	<b>Internet Users Latest Data</b>	<b>Penetration (% Population)</b>	<b>Growth 2000-2014</b>	<b>Users % of Table</b>
<a href="#"><u>Africa</u></a>	1,125,721,038	4,514,400	<b>240,146,482</b>	21.3 %	5,219.6 %	8.6 %
<a href="#"><u>Asia</u></a>	3,996,408,007	114,304,000	<b>1,265,143,702</b>	31.7 %	1,006.8 %	45.1 %
<a href="#"><u>Europe</u></a>	825,802,657	105,096,093	<b>566,261,317</b>	68.6 %	438.8 %	20.2 %
<a href="#"><u>Middle East</u></a>	231,062,860	3,284,800	<b>103,829,614</b>	44.9 %	3,060.9 %	3.7 %
<a href="#"><u>North America</u></a>	353,860,227	108,096,800	<b>300,287,577</b>	84.9 %	177.8 %	10.7 %
<a href="#"><u>Latin America / Caribbean</u></a>	612,279,181	18,068,919	<b>302,006,016</b>	49.3 %	1,571.4 %	10.8 %
<a href="#"><u>Oceania / Australia</u></a>	36,724,649	7,620,480	<b>24,804,226</b>	67.5 %	225.5 %	0.9 %
<b><a href="#"><u>WORLD TOTAL</u></a></b>	<b>7,181,858,619</b>	<b>360,985,492</b>	<b>2,802,478,934</b>	<b>39.0 %</b>	<b>676.3 %</b>	<b>100.0 %</b>

NOTES: (1) Internet Usage and World Population Statistics are for December 31, 2013. (2) CLICK on each world region name for detailed regional usage information. (3) Demographic (Population) numbers are based on data from the [US Census Bureau](#) and local census agencies. (4) Internet usage information comes from data published by [Nielsen Online](#), by the [International Telecommunications Union](#), by [GfK](#), local ICT Regulators and other reliable sources. (5) For definitions, disclaimers, navigation help and methodology, please refer to the [Site Surfing Guide](#). (6) Information in this site may be cited, giving the due credit to [www.internetworldstats.com](#). Copyright © 2001 - 2014, Miniwatts Marketing Group. All rights reserved worldwide.

# Ethernet

- IEEE 802.3 standard
- Xerox Palo Alto Research Center (PARC) 1974
- 10 Mb/s originally
- Now also 100 Mb/s and 1 Gb/s
- Category 5 cables
- 10 Gbit on fiber optic cables

# Wi-Fi

- IEEE 802.11 standard
- 2.4 and 5 GHz bands
  - Unlicensed
  - Can transmit at low power



# Wi-Fi Speeds

---

<b>Protocol</b>	<b>Release</b>	<b>Frequency Band (GHz)</b>	<b>Data Rate (Mb/s)</b>	<b>Range (m)</b>
802.11	1997	2.4	1-2	20-100
802.11a	1999	5	6-54	35-120
802.11b	1999	2.4	5.5-11	35-140
802.11g	2003	2.4	6-54	38-140
802.11n	2009	2.4/5	7.2-150	70-250
802.11ac	2013	5	87.6-866.7	35-115
802.11ad	Draft 2012	60	6912	???

# On Standards

- Designed by committee
- Very specific
- Many contributors
  - 802.3: 6 pages of names
  - 802.11: 4 pages of names

# A look at the Standards

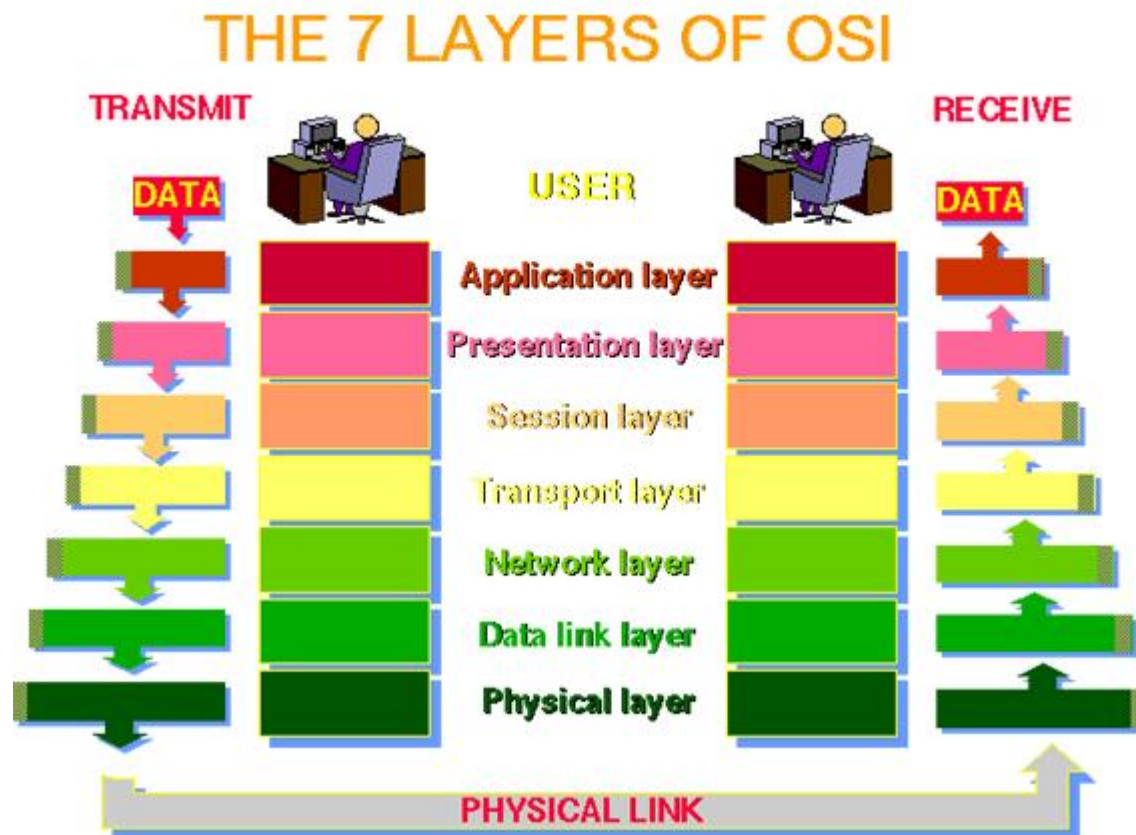
- 802.3:
  - 53 pages of ToC
  - Section 1-5 are 596, 789, 315, 584 and 613 pages
  - Now there's also a section 6...
- 802.11: 55 pages of ToC
  - 55 pages of ToC
  - 2695 pages of content

# OSI Standard

- ISO/IEC 7498-1
- Open Systems Interconnection
- Abstraction layers

# OSI model

- Specifies 7 layers of network communication



[http://www.petri.co.il/osi\\_concepts.htm](http://www.petri.co.il/osi_concepts.htm)

# 1. Physical Layer

- Operates on bits
- IEEE 802.3
- IEEE 802.11
- USB
- Bluetooth
- DSL
- RS-232, RS-449, IEEE 802.16, IEEE 1394, etc.

## 2. Data Link Layer

- Means to transfer data between entities
- IEEE 802.3
- IEEE 802.2
- PPP
- LLC
- Many more...

# 3. Network Layer

- IP
  - IPv4 (127.0.0.1)
  - IPv6 (0:0:0:0:0:0:0:1) (::1 for short)
- AppleTalk
- IPsec
- Many more...



# 4. Transport Layer

- TCP
- UDP
- SCTP
- Others...

# 5. Session Layer

- TLS/SSL
- SOCKS
- RTP
- PPTP
- Others...

# 6. Presentation Layer

- MIME
- XDR

# 7. Application Layer

- HTTP
- DNS
- SMTP
- Telnet
- DHCP
- Others...

# TCP Segment Header

Offsets	Octet	0							1							2							3										
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Source port														Destination port																	
4	32	Sequence number																															
8	64	Acknowledgment number (if ACK set)																															
12	96	Data offset	Reserved	N	C	E	U	A	P	R	S	F	Window Size																				
			0	0	0	S	W	C	R	C	S	S	Y	I																			
							R	E	G	K	H	T	N	N																			
16	128	Checksum														Urgent pointer (if URG set)																	
20	160	Options (if Data Offset > 5, padded at the end with "0" bytes if necessary)																															
...	...	...																															

[http://en.wikipedia.org/wiki/Transmission\\_Control\\_Protocol](http://en.wikipedia.org/wiki/Transmission_Control_Protocol)

# Recommendation

- Use something you know
- SPI-to-Ethernet Module <\$20
- MRF24WG0MA/MB
  - 802.11b/g
  - Product from Microchip
  - Datasheet

# Peripheral Speeds

Protocol	Throughput
SPI	Variable
USB	1.5 Mb/s to 5 Gb/s
PCI	133 MB/s to 533 MB/s
PCIe	250 MB/s to 16 GB/s
Ethernet	10 Mb/s to 10 Gb/s
Wi-Fi	1 Mb/s to 866.7 Mb/s