How the Internet Works

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IS117

What is the Internet?

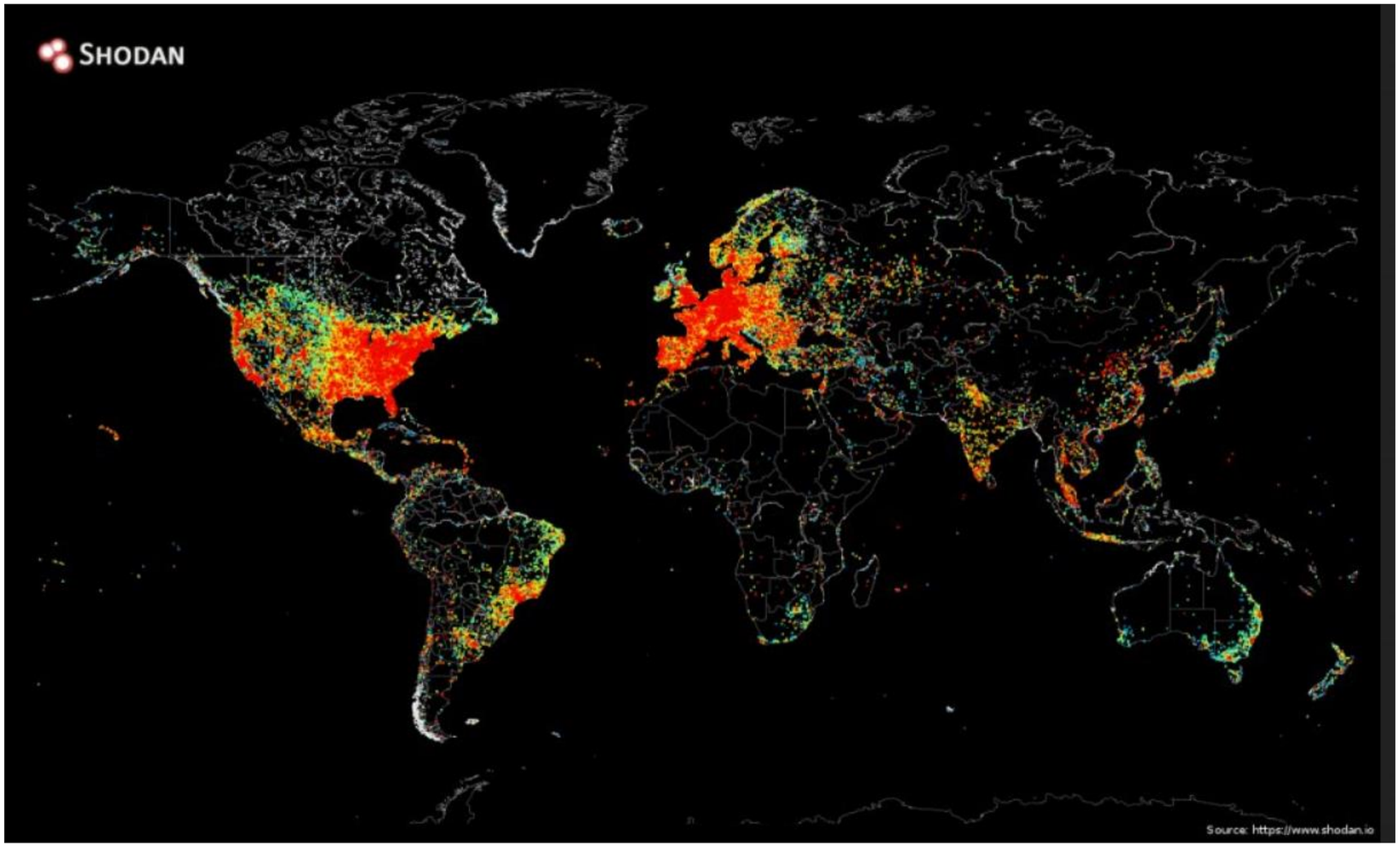
FORMAL DEFINITION:

"The Internet, a loosely-organized international collaboration of autonomous, interconnected networks, supports host-to-host communication through voluntary adherence to open protocols and procedures defined by Internet Standards [1]."

MY DEFINITION:

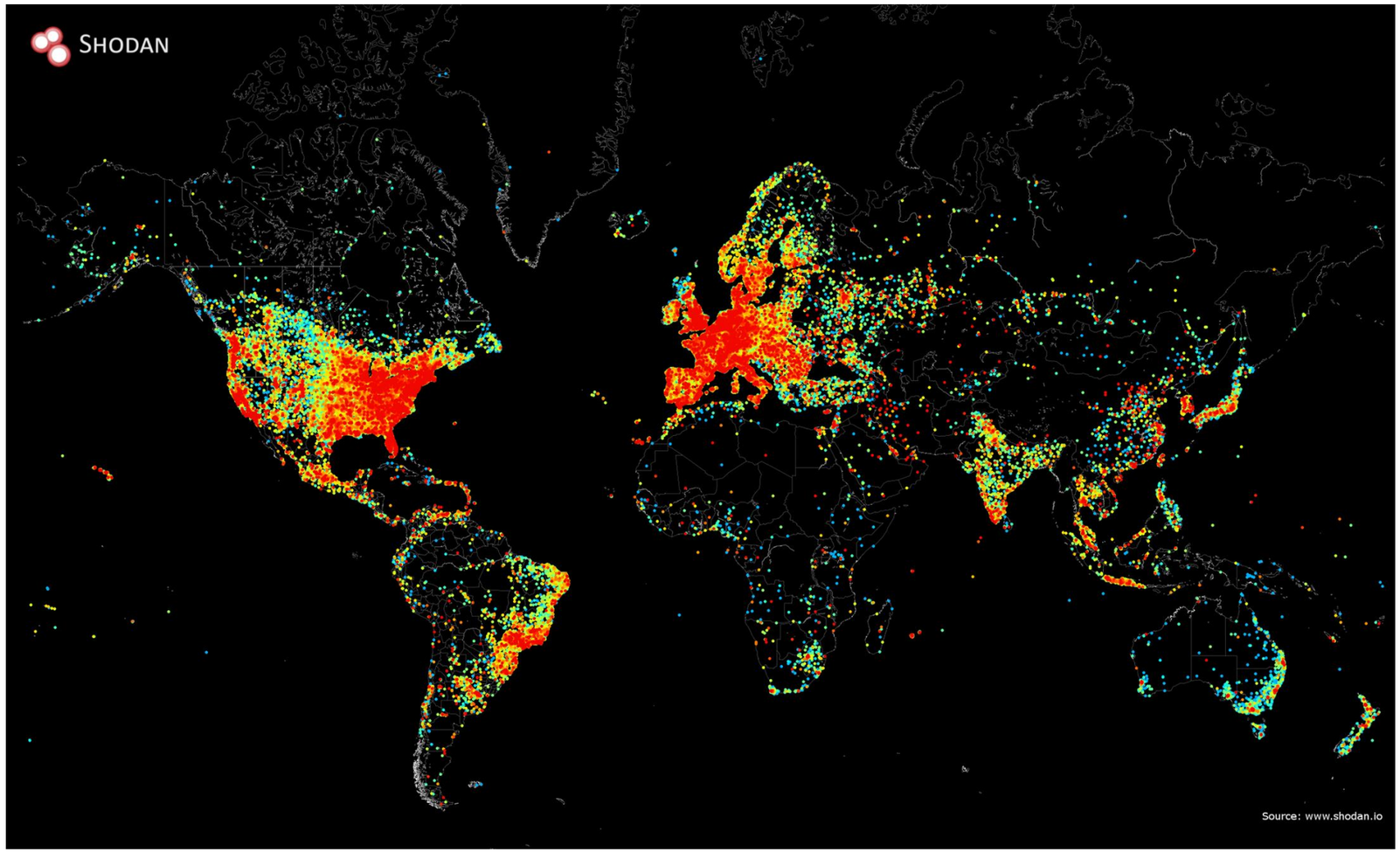
A collection of multiple different pieces of computer and non-computer equipment talking to one another by means of a communications network either wired or wireless.

Where is the Internet Used?



2014 [2]

Where is the Internet Used?

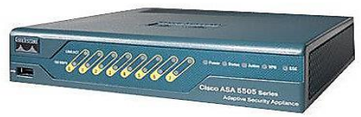


2016 [3]

Types of Connections

- Dial-up
- Broadband:
  - DSL
  - Cable
  - Fiber optic (FIOS)
- Wireless (WiFi)
- Mobile:
  - 3G
  - 4G
  - 5G (soon)

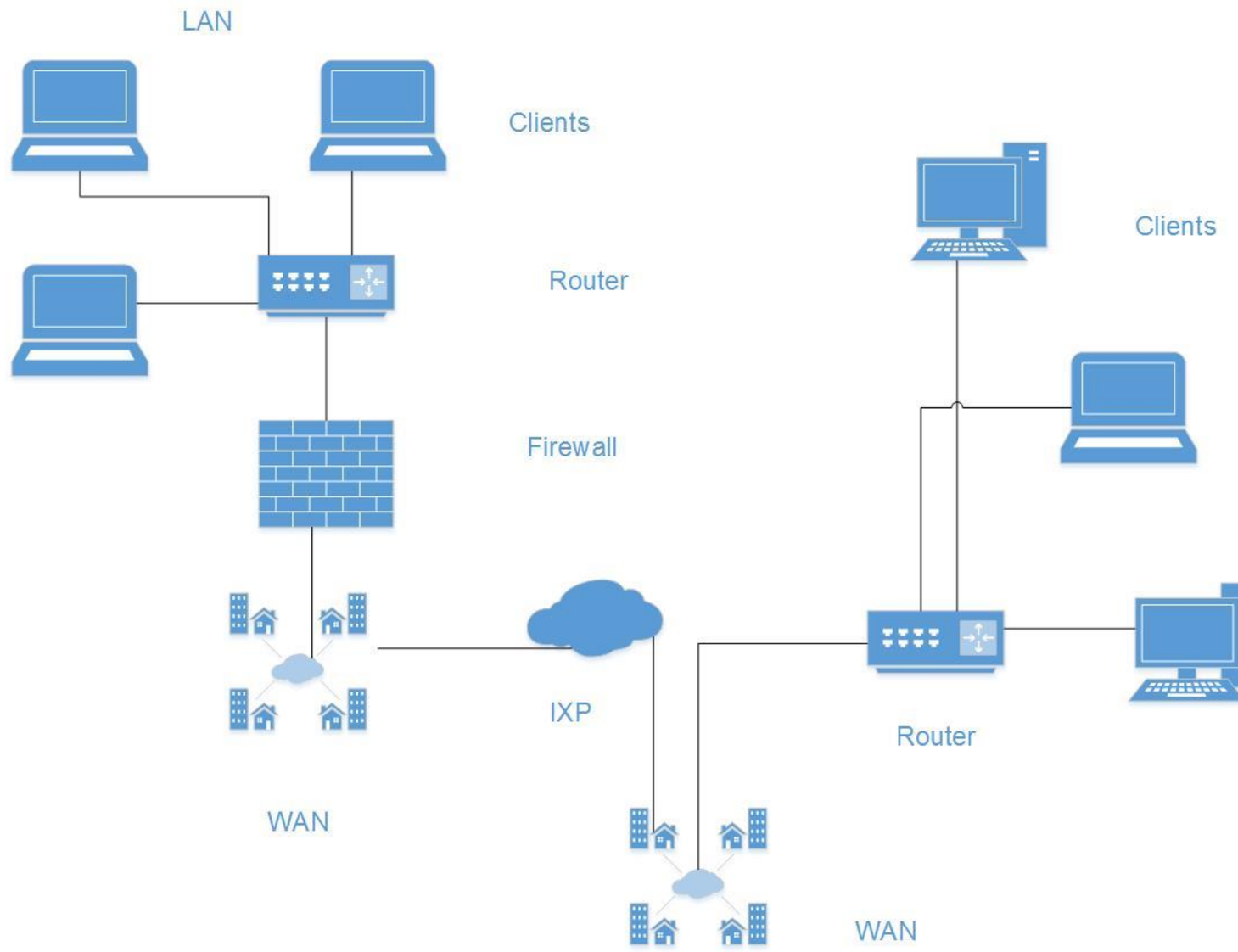
Internet Equipment

Modem 	Router 
Switch 	Firewall 

Internet Equipment

Cable 	NIC 
Access Point 	Repeater 

Internet Architecture



Internet Architecture

- **Client** – uses web browser to request pages from an internet server
- **LAN** – Local Area Network connects computers close to one another
- **WAN –** Wide Area Network connects two or more LANS together
- **IXP –** Internet Exchange Point to connect WANs together
- **ISP –** Internet Service Provider owns WANs and leases access to users

How an Internet Message is sent

1. Data being sent is divided into packets (Max size = 64K, 65535 bytes)
2. Packet has a header with some technical information and a FROM address, TO address and the actual data. Each header is 60 bytes
3. Packets divided in to multiple parts contain the order of the packet
4. Packets move on the Internet along different paths each taking different times
5. Packets are reordered
6. Received packets are acknowledged back to the sender
7. Sender resends packets that do not acknowledge

IP Header

IPv4 Header Format

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	Version				IHL				DSCP						ECN		Total Length															
4	32	Identification																Flags			Fragment Offset											
8	64	Time To Live								Protocol								Header Checksum															
12	96	Source IP Address																															
16	128	Destination IP Address																															
20	160	Options (if IHL > 5)																															
24	192																																
28	224																																
32	256																																

See http://www.informit.com/articles/article.aspx?p=130895

Commands to see the Internet Working

Command	Meaning
IPConfig /all	Your local connection /all shows MAC address, etc.
IP4.ME	Website to find public IP address
Ping 127.0.0.1	Local “loop back test.” Local machine test
Ping njit.edu –n 20	Send 20 test packets to NJIT.edu Notice the IP Address of the website (128.235.251.25). Also notice no response
Ping nytimes.com	Send test packets to NYTIMES.COM
Tracert nytimes.com	Up to 30 hops traced. When successful, note that the final IP address is the same as the target.
Nslookup nytimes.com	See servers used for DNS lookup.
Netstat -an	See open ports used by your machine
https://www.iplocation.net/	Shows geographic location of a website host
https://whois.icann.org/en	Domain name registration
https://www.verizon.com/speedtest/	Internet upload/download speed

Ping Results

C:\>ping nytimes.com

Pinging nytimes.com [151.101.1.164] with 32 bytes of data:
Reply from 151.101.1.164: bytes=32 time=18ms TTL=57
Reply from 151.101.1.164: bytes=32 time=15ms TTL=57
Reply from 151.101.1.164: bytes=32 time=14ms TTL=57
Reply from 151.101.1.164: bytes=32 time=14ms TTL=57

Ping statistics for 151.101.1.164:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 14ms, Maximum = 18ms, Average = 15ms

Tracert nytimes.com

C:\>tracert nytimes.com

Tracing route to nytimes.com [151.101.1.164]
over a maximum of 30 hops:

1	<1 ms	<1 ms	<1 ms	Linksys17821-2g [192.168.1.1]
2	9 ms	13 ms	13 ms	10.240.160.93
3	12 ms	9 ms	9 ms	ubr201-ge1-0-1.cmts.mhwhnj.cv.net [67.59.232.246]
4	19 ms	11 ms	10 ms	ool-4353f416.dyn.optonline.net [67.83.244.22]
5	23 ms	14 ms	11 ms	64.15.7.71
6	16 ms	29 ms	15 ms	64.15.3.250
7	14 ms	14 ms	18 ms	199.27.73.94
8	21 ms	12 ms	23 ms	151.101.1.164

Trace complete.
NOTE: use traceroute domainname on Mac/Linux

Tracert www.google.co.uk

C:\>tracert www.google.co.uk

Tracing route to www.google.co.uk [216.58.201.99]
over a maximum of 30 hops:

1	2 ms	1 ms	1 ms	Linksys17821-2g [192.168.1.1]
2	12 ms	12 ms	11 ms	10.240.160.93
3	13 ms	9 ms	11 ms	ubr201-ge3-0-1.cmts.mhwhnj.cv.net [67.59.232.254]
4	22 ms	12 ms	12 ms	ool-4353f412.dyn.optonline.net [67.83.244.18]
5	15 ms	12 ms	15 ms	67.59.251.70
6	12 ms	11 ms	23 ms	64.15.0.68
7	15 ms	12 ms	16 ms	72.14.223.70
8	13 ms	22 ms	13 ms	108.170.248.98
9	16 ms	16 ms	12 ms	108.170.226.123
10	89 ms	89 ms	96 ms	72.14.235.23
11	101 ms	118 ms	139 ms	209.85.251.176
12	100 ms	116 ms	98 ms	108.170.235.144
13	114 ms	119 ms	120 ms	216.239.46.48
14	115 ms	113 ms	119 ms	108.170.245.33
15	116 ms	115 ms	119 ms	108.170.238.235
16	115 ms	120 ms	117 ms	prg03s02-in-f3.1e100.net [216.58.201.99]

Trace complete.

Tracert baidu.com

```
C:\>tracert baidu.com
Tracing route to baidu.com [123.125.114.144]
over a maximum of 30 hops:
  1    <1 ms    <1 ms    <1 ms  Linksys17821-2g [192.168.1.1]
  2    18 ms    13 ms     8 ms  10.240.160.93
  3    10 ms     9 ms    12 ms  67.59.232.252
  4    15 ms    12 ms    21 ms  ool-4353f412.dyn.optonline.net [67.83.244.18]
  5    11 ms    11 ms    14 ms  67.59.239.235
  6    19 ms    14 ms    12 ms  64.15.2.74
  7    14 ms    15 ms    13 ms  lag-102.ear1.Newark1.Level3.net [4.35.20.29]
  8    79 ms    79 ms    82 ms  ae-1-9.edge2.SanJose3.Level3.net [4.69.209.181]
  9   352 ms   423 ms   358 ms  CHINA-UNICO.edge2.SanJose3.Level3.net [4.53.211.142]
 10   323 ms   326 ms   335 ms  219.158.117.1
 11   346 ms   351 ms   367 ms  219.158.16.77
 12   362 ms   355 ms   360 ms  219.158.18.69
 13     *        *      349 ms  202.96.12.62
 14   349 ms   360 ms   359 ms  61.51.115.114
 15   337 ms   351 ms   359 ms  202.106.43.66
 16     *        *        *     Request timed out.
 17     *        *        *     Request timed out.
 18   333 ms   331 ms   326 ms  123.125.114.144

Trace complete.
```

Contributions

- We use the Internet with many clients – desktops, laptops, tablets, phones
- Increase of use via Internet of Things (IoT)
- Transmission done over cable, fiber, airwaves
- We take it for granted, but NJ is one of the most wired areas of the world

References

1. Internet Activities Board, "The Internet Standards Process" - RFC1310, RFC Editor, March 1992.
2. http://www.businessinsider.com/this-world-map-shows-every-device-connected-to-the-internet-2014-9
3. https://www.inverse.com/article/19357-internet-map-of-every-connected-device

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