

# Networks and Routing

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# OSI Model

- Layer 1 - Physical
  - T1, 100BASE-TX, RS-232, 802.11n
- Layer 2 - Data Link
  - 802.3, Frame Relay, PPP, LocalTalk
- Layer 3 - Network
  - IP, IPSec, BGP
- Layer 4 - Transport
  - TCP, UDP
- Layer 5 - Session
  - Sockets, TCP establishment
- Layer 6 - Presentation / Encoding
  - SSL, TLS, ASCII
- Layer 7 - Application
  - HTTP, FTP, DNS, AFP



# IPv4

- 32-bit space - 4,294,967,296 addresses
- Represented as a set of four, eight bit sets of integers
  - 199.96.82.94
- Currently being phased out in favor of IPv6.

# IPv6

- 128 bit address
- $2^{128} = 340,282,366,920,938,463,463,374,607,431,768,211,456$
- Represented as eight 16-bit groups
  - 2607:ff50:0:9:a548:a548:a548:a548
- Common allocations
  - /64 - home networks - smallest allocation, 18 quintillion addresses
  - /56 or /48 - businesses, allowing assignment of /64 per division or other use.



# CIDR

## IPv4 CIDR Chart

## RIPE NCC

IP Addresses	Bits	Prefix	Subnet Mask
1	0	/32	255.255.255.255
2	1	/31	255.255.255.254
4	2	/30	255.255.255.252
8	3	/29	255.255.255.248
16	4	/28	255.255.255.240
32	5	/27	255.255.255.224
64	6	/26	255.255.255.192
128	7	/25	255.255.255.128
256	8	/24	255.255.255.0
512	9	/23	255.255.254.0
1 K	10	/22	255.255.252.0
2 K	11	/21	255.255.248.0
4 K	12	/20	255.255.240.0
8 K	13	/19	255.255.224.0
16 K	14	/18	255.255.192.0
32 K	15	/17	255.255.128.0
64 K	16	/16	255.255.0.0
128 K	17	/15	255.254.0.0
256 K	18	/14	255.252.0.0
512 K	19	/13	255.248.0.0
1 M	20	/12	255.240.0.0
2 M	21	/11	255.224.0.0
4 M	22	/10	255.192.0.0
8 M	23	/9	255.128.0.0
16 M	24	/8	255.0.0.0
32 M	25	/7	254.0.0.0
64 M	26	/6	252.0.0.0
128 M	27	/5	248.0.0.0
256 M	28	/4	240.0.0.0
512 M	29	/3	224.0.0.0
1024 M	30	/2	192.0.0.0
2048 M	31	/1	128.0.0.0
4096 M	32	/0	0.0.0.0

K = 1,024 • M = 1,048,576

Contact Registration Services:  
hostmaster@ripe.net • lir-help@ripe.net

[www.ripe.net](http://www.ripe.net)

## IPv6 Chart

Prefix	/48s	/56s	/64s	Bits
/24	16M	4G	1T	104
/25	8M	2G	512G	103
/26	4M	1G	256G	102
/27	2M	512M	128G	101
/28	1M	256M	64G	100
/29	512K	128M	32G	99
/30	256K	64M	16G	98
/31	128K	32M	8G	97
/32	64K	16M	4G	96
/33	32K	8M	2G	95
/34	16K	4M	1G	94
/35	8K	2M	512M	93
/36	4K	1M	256M	92
/37	2K	512K	128M	91
/38	1K	256K	64M	90
/39	512	128K	32M	89
/40	256	64K	16M	88
/41	128	32K	8M	87
/42	64	16K	4M	86
/43	32	8K	1M	85
/44	16	4K	1M	84
/45	8	2K	512K	83
/46	4	1K	256K	82
/47	2	512	128K	81
/48	1	256	64K	80
/49		128	32K	79
/50		64	16K	78
/51		32	8K	77
/52		16	4K	76
/53		8	2K	75
/54		4	1K	74
/55		2	512	73
/56		1	256	72
/57			128	71
/58			64	70
/59			32	69
/60			16	68
/61			8	67
/62			4	66
/63			2	65
/64			1	64

K = 1,024 • M = 1,048,576 • G = 1,073,741,824 • T = 1,099,511,627,776

## RIPE NCC

# Hardware



# Router / Firewall

- Stands between LAN and Internet.
- Routes packets between networks.
- Generally runs DHCP, IPv4 NAT, and DNS.
- Firewall blocks incoming connections
  - Especially important with IPv6!
- Some offer multiple WAN links or VPN.





# NAT

- Created to combat IPv4 exhaustion
  - One globally routable IP address
  - Many locally routable IP addresses
- IPv4
  - Used in almost all environments, and some ISPs are implementing on a carrier level.
- IPv6
  - Does not exist, all addresses globally routable.

# Port Forwarding

- One IPv4 address with services on multiple machines behind it.
- Example:
  - External 199.96.82.12, LAN 10.0.0.1/24
  - Forward 199.96.82.12:80 to 10.0.0.251:80
  - Forward 199.96.82.12:64292 to 10.0.0.3:3389



# Switches

- Link network devices to a common network.
- Most are layer 2 switches, functional at the data link level.
- Smart and managed switches can perform functions at the per-port or per MAC address level.
- Some switches feature Power over Ethernet to power VoIP phones and other devices.



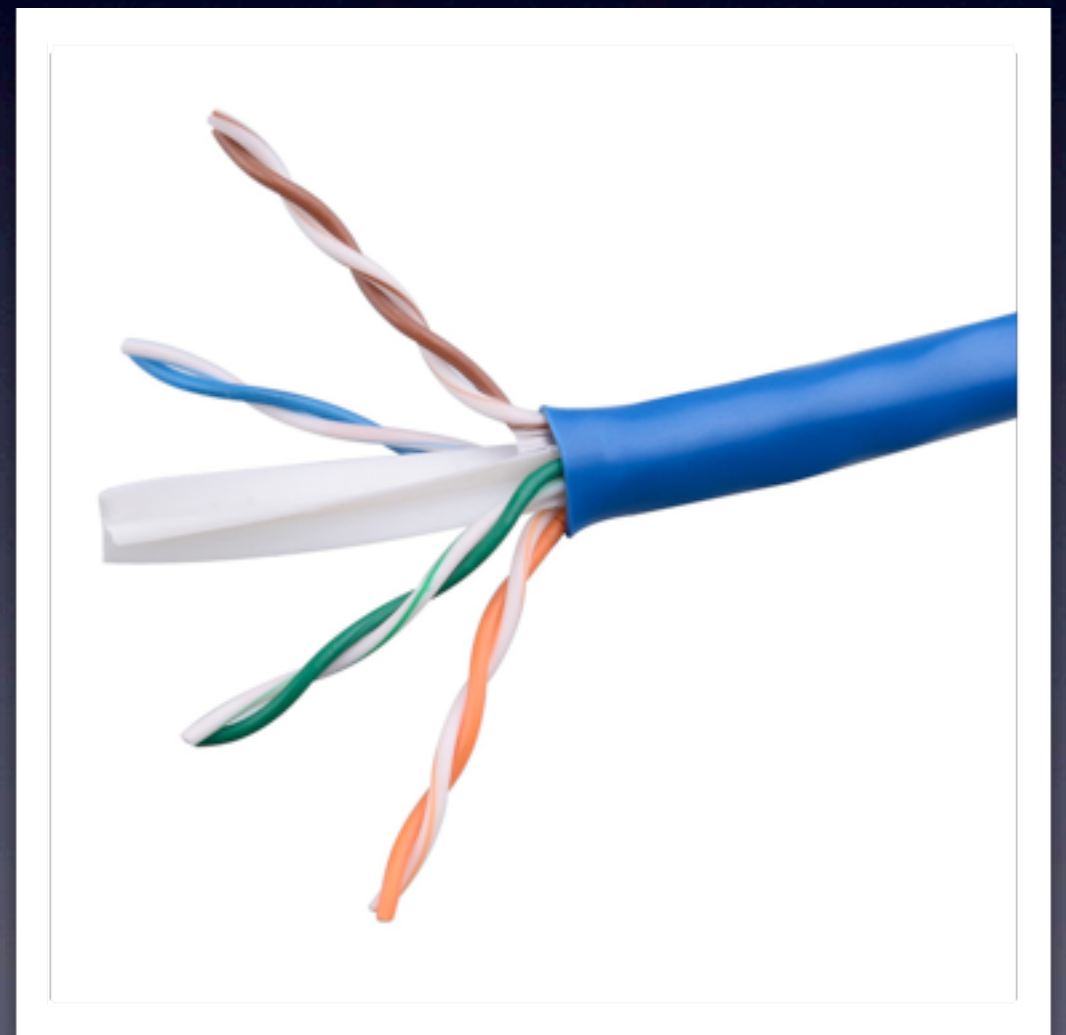
# Spanning Tree Protocol





# Twisted Pair Cable

- Four twisted pairs, one jacket
- Current types under T568B
  - Category 5e
  - Category 6(a)
- Options
  - Plenum
  - Shielding
  - Stranded or Solid



# Connecting Twisted Pair Cable

- Patch panels
- Keystone jacks
- 110 punch down tool
- Crimping cable
  - **Never!** (except in emergencies)





# “Making” Patch Cables

- Easy as 1-2-3!
  1. Go to [monoprice.com](http://monoprice.com), navigate to Cat6 cables.
  2. Pick your favorite color.
  3. Order 100 of them.
- Watch out for CCA patch cables!
- Test some with a Fluke tester.

# Cable Verification

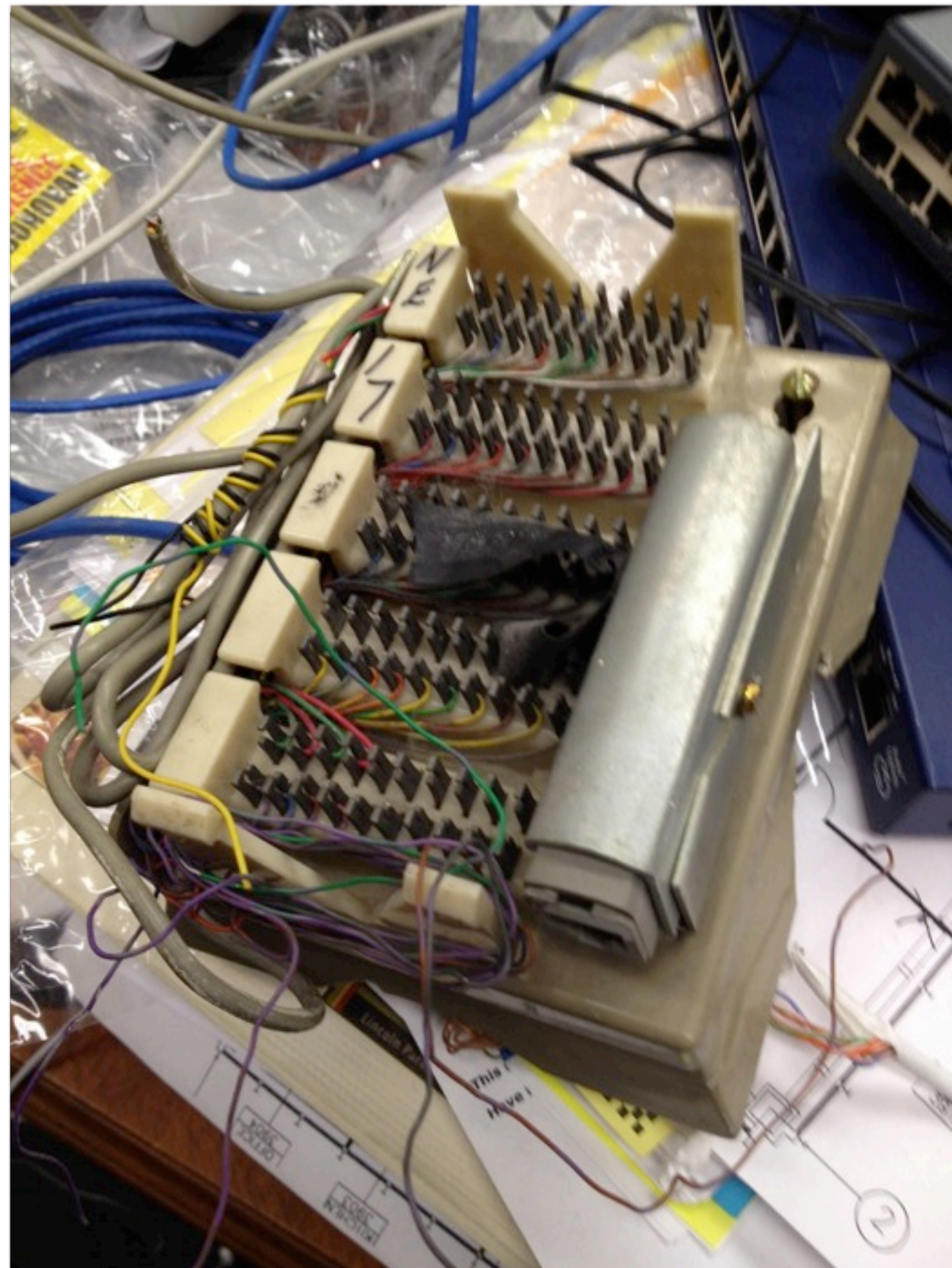
- Qualifies wiring to specification and performance.
- Easily finds faulty wiring
- Distance to fault
- Fluke Networks is the golden standard.



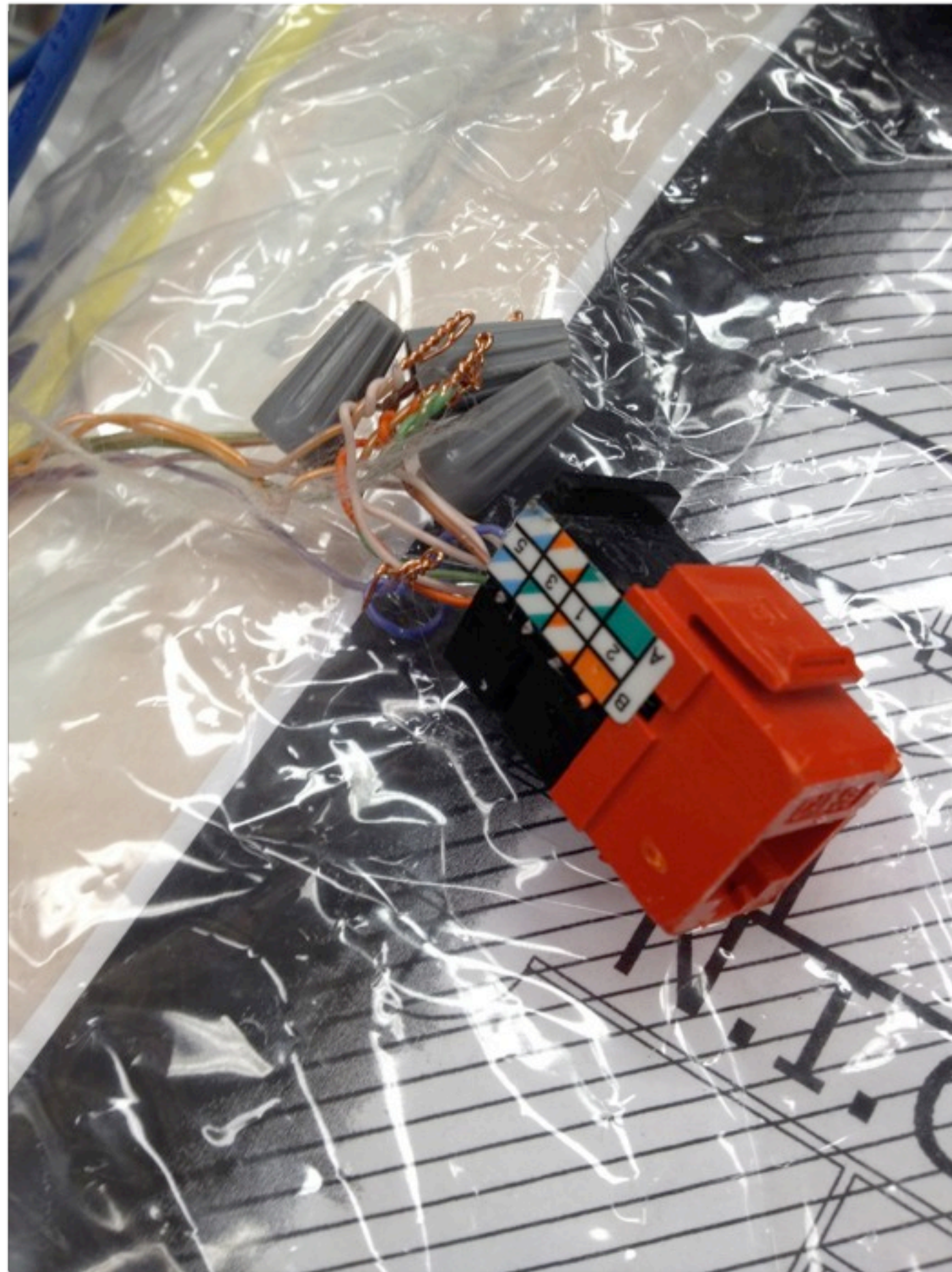


















# Wireless Access Points

- Current standards:
  - 802.11n
  - 802.11ac
- Large setups greatly benefit from a wireless controller.
- Overprovision!





# Others

- 802.1x
- RADIUS
- SNMP
- BGP
- 6to4
- NTP
- VLANs
- DNS
- PXE
- NetBoot
- SIP
- Bonjour

# Conclusion

- IPv6
- Overprovision everything!
- A good network is a great investment!



# Questions?

@keeleysam  
AFP548.com