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Wireless performance
(in the LAN environment)

SIG-PMV meeting, SWITCH, Zurich - 03.11.2016

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Rapid overview of Wireless performance issues

Wireless LAN consideration, not WAN

CWNP – CWNP, CWDP etc

Background…. The growth of demand via WiFi connectivity

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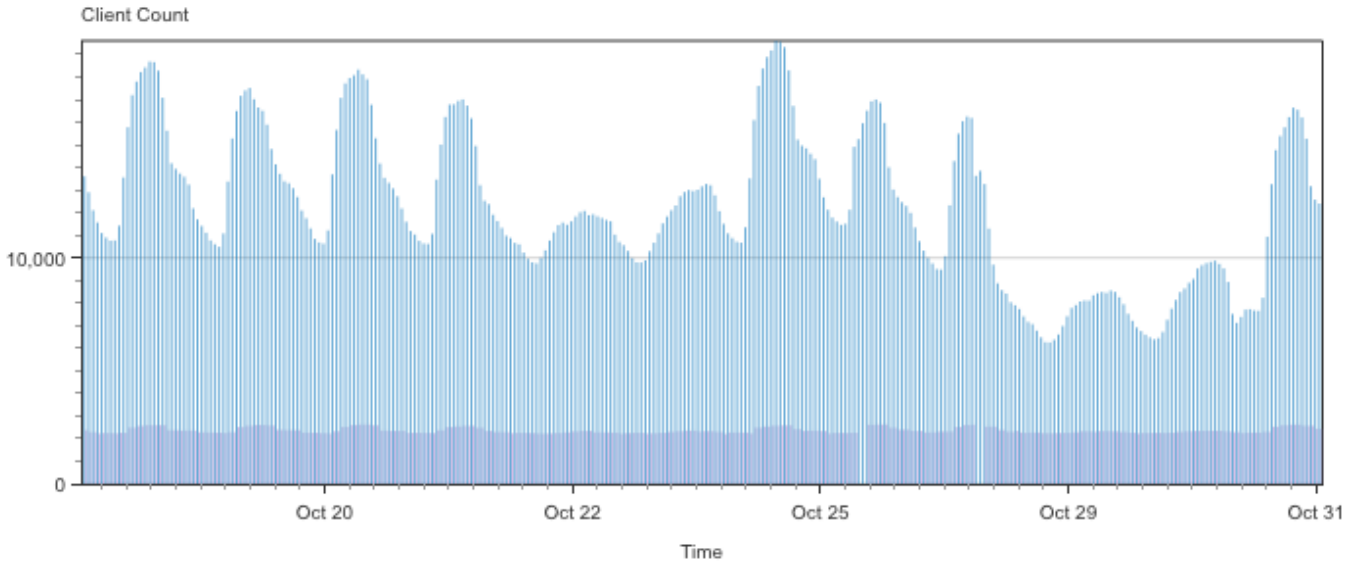
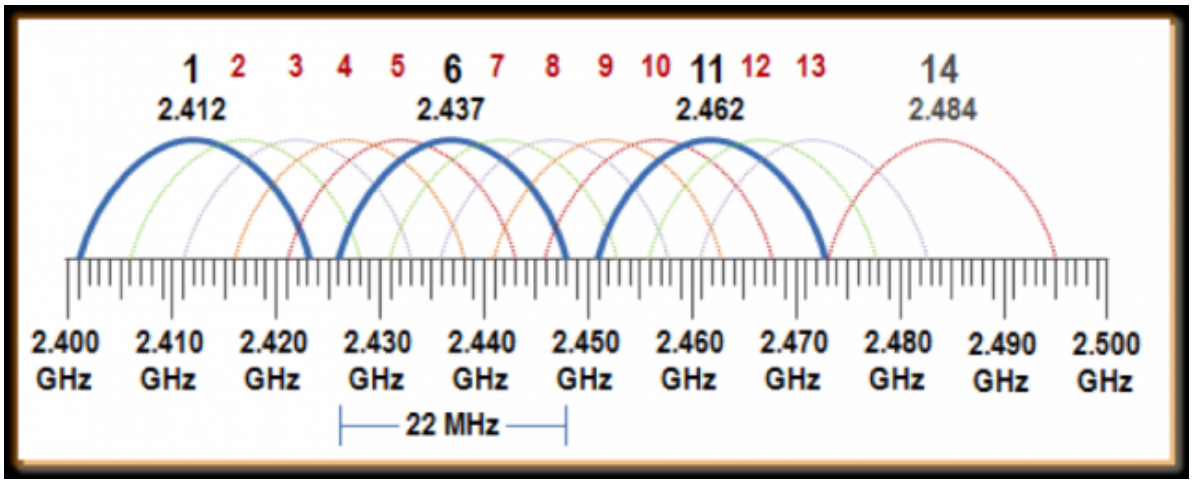
eduPERT Vilnius TNC (2010)

(Task Leader : Alessandra Scicchitano)



$$$$ being spent



http://boundless.aerohive.com/experts/wi-fi-back-to-basics--24-ghz-channel-planning.html

Wireless signal propagation

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WiFi outside the Oslo School of Architecture and Design

http://www.yourban.no/2011/02/22/immaterials-light-painting-wifi/

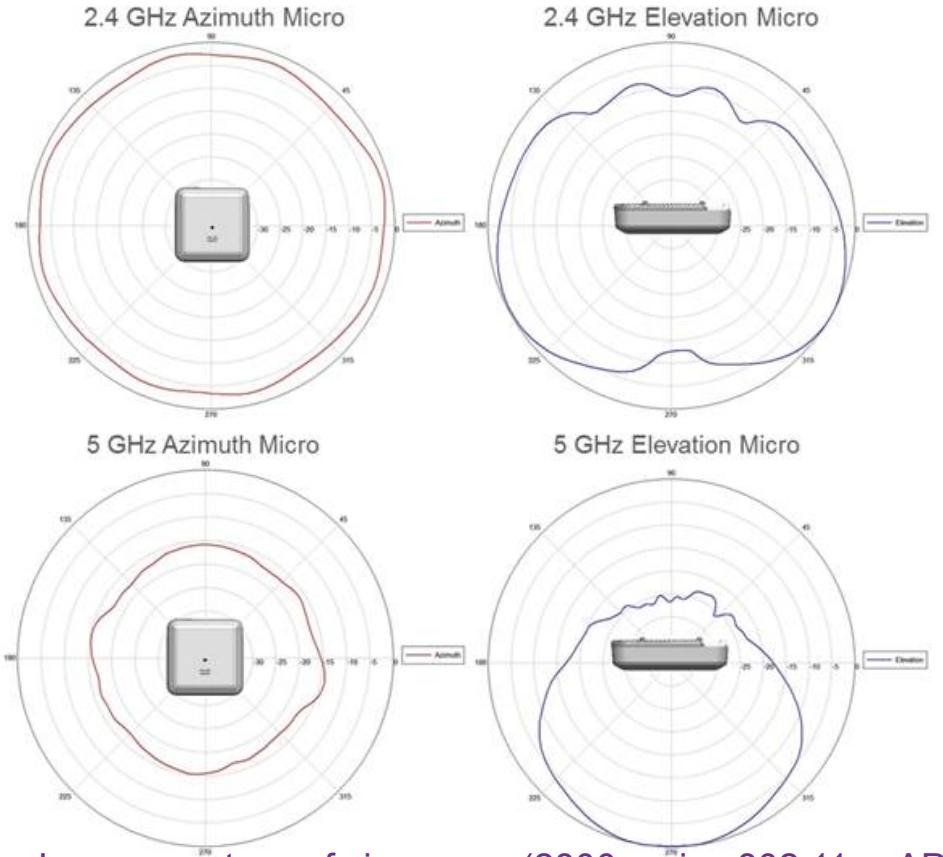

Image courtesy of cisco.com (2800 series 802.11ac AP)

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Layer 1/layer 2 issues abound - unlike wired…

Absorption – attenuation by materials signal passes through (1/8 to ½ or more!)

Reflection, Refraction, Scattering and diffraction – RF signal propagation is altered by interaction with objects

Free Space Path Loss – open space attenuation (as signal spreads out)

Gain – signal amplification

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RF interference – narrowband/wideband/allband

Cordless phones, microwaves, video camera, baby monitors, DECT etc

….bluetooth….

Multipath

…bad for older kit but needed for 11n/ac!

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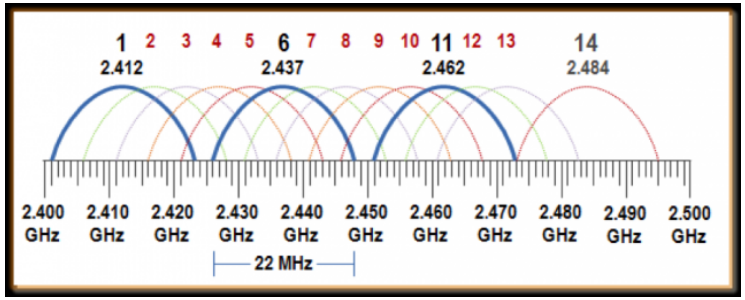
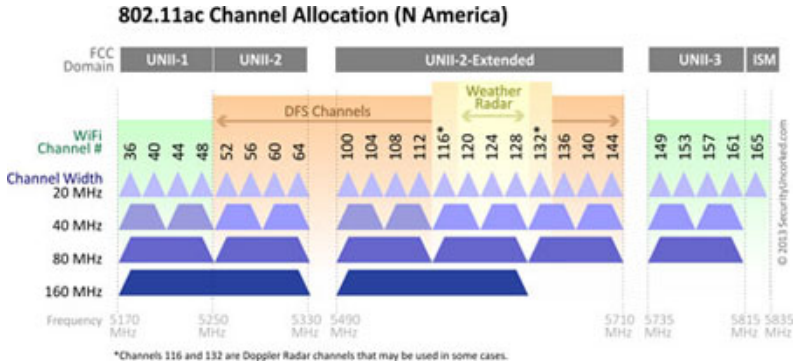
Adjacent channel interference

image of channels

25MHz separation – only 3 for 2.4GHz

in 5GHz ‘nonoverlapping’ (20MHz separation)





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analogy

https://commons.wikimedia.org/wiki/File%3AM60_motorway%2C_Denton.jpg

Layer 2 retransmissions

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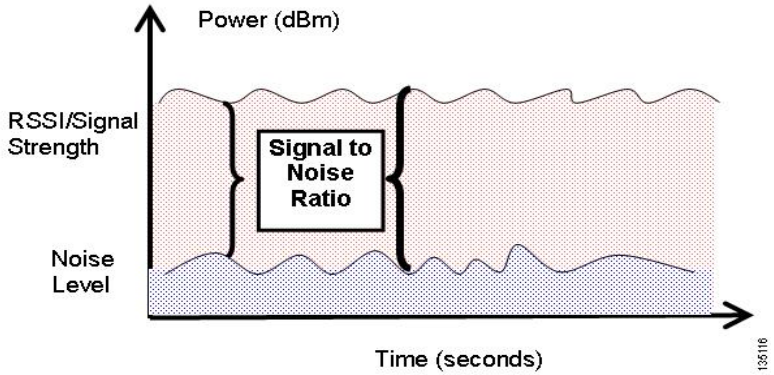
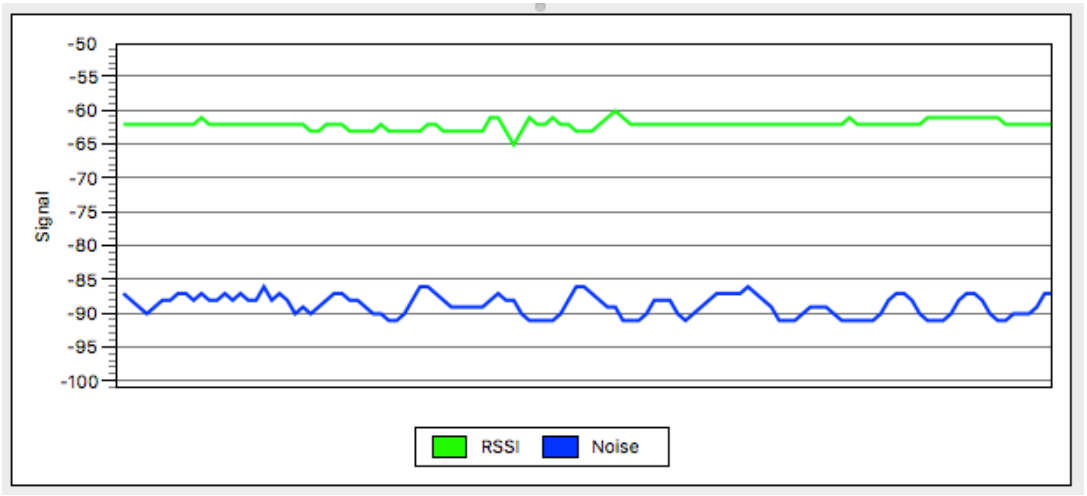


From cisco.com

Signal to Noise ratio (SnR)



From my Mac

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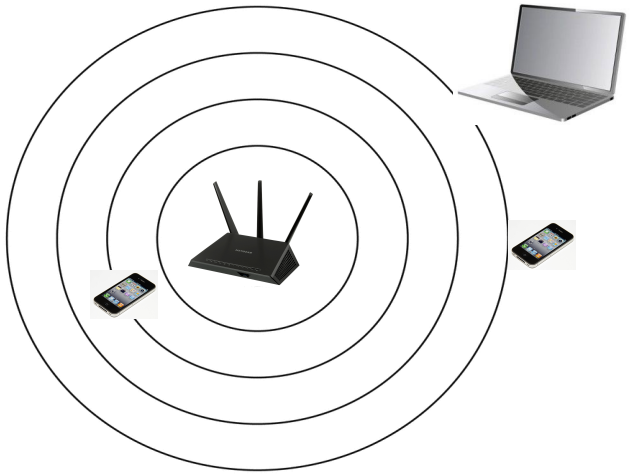
Mismatched power

Client can hear AP (at 100mW), AP cannot hear client (at 20mW)



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Near/Far

Low power client at distance from AP not heard if high powered clients are closer (which raise the noise floor)

Analogy – crowded bar

Layer 2 retransmissions

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https://commons.wikimedia.org/wiki/File:WP10_in_Pittsburgh_27.jpg

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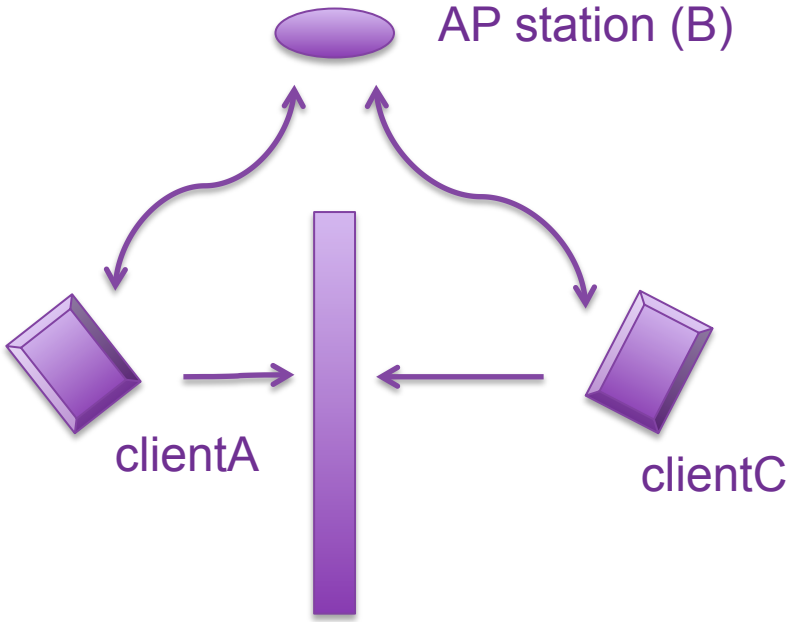
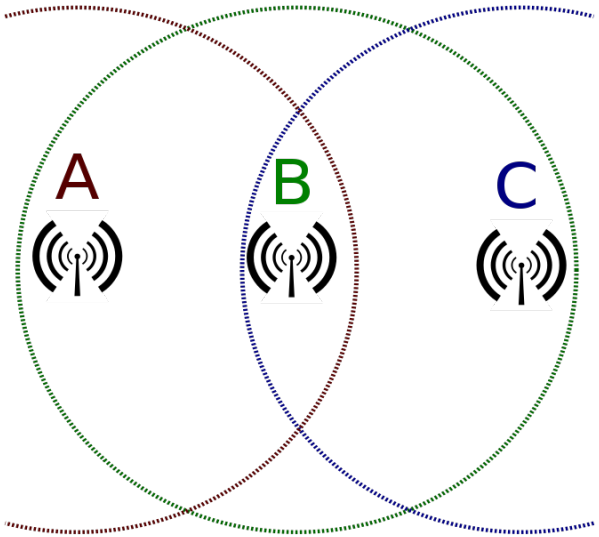
Hidden node





https://en.wikipedia.org/wiki/Hidden_node_problem#/media/File:Wifi_hidden_station_problem.svg

Layer 2 retransmissions

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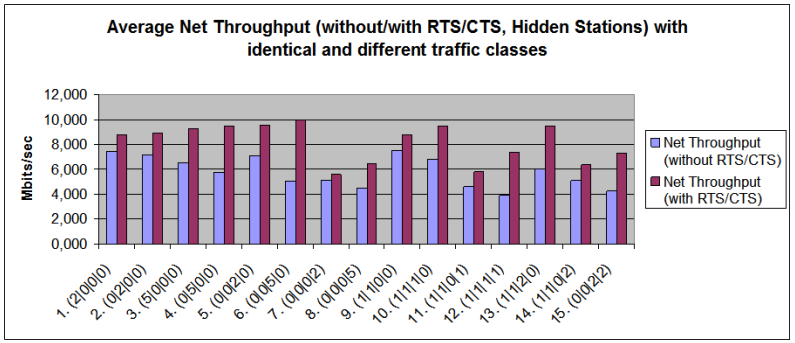

https://commons.wikimedia.org/wiki/File:StateLibQld_1_210610_Customer_service_counter_inside_the_new_Commonwealth_Bank,_Brisbane,_1953.jpg

https://commons.wikimedia.org/wiki/File:RTS_CTS_benchmark.png

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Dynamic rate switching (DRS) – Modulation and Coding Schemes (MCS)

MCS : Index

802.11n											802.11ac
HT MCS Index	Spatial Streams	Modulation & Coding	Data Rate GI = 800ns 20MHz	Data Rate SGI = 400ns 20MHz	Data Rate GI = 800ns 40MHz	Data Rate SGI = 400ns 40MHz	Data Rate GI = 800ns 80MHz	Data Rate SGI = 400ns 80MHz	Data Rate GI = 800ns 160MHz	Data Rate SGI = 400ns 160MHz	VHT MCS Index
0	1	BPSK 1/2	6.5	7.2	13.5	15	29.3	32.5	58.5	65	0
1	1	QPSK 1/2	13	14.4	27	30	58.5	65	117	130	1
2	1	QPSK 3/4	19.5	21.7	40.5	45	87.8	97.5	175.5	195	2
3	1	16-QAM 1/2	26	28.9	54	60	117	130	234	260	3
4	1	16-QAM 3/4	39	43.3	81	90	175.5	195	351	390	4
5	1	64-QAM 2/3	52	57.8	108	120	234	260	468	520	5
6	1	64-QAM 3/4	58.5	65	121.5	135	263.3	292.5	526.5	585	6
7	1	64-QAM 5/6	65	72.2	135	150	292.5	325	585	650	7
	1	256-QAM 3/4	78	86.7	162	180	351	390	702	780	8
	1	256-QAM 5/6	n/a	n/a	180	200	390	433.3	780	866.7	9
8	2	BPSK 1/2	13	14.4	27	30	58.5	65	117	130	0
9	2	QPSK 1/2	26	28.9	54	60	117	130	234	260	1
10	2	QPSK 3/4	39	43.3	81	90	175.5	195	351	390	2
11	2	16-QAM 1/2	52	57.8	108	120	234	260	468	520	3
12	2	16-QAM 3/4	78	86.7	162	180	351	390	702	780	4
13	2	64-QAM 2/3	104	115.6	216	240	468	520	936	1040	5
14	2	64-QAM 3/4	117	130.3	243	270	526.5	585	1053	1170	6
15	2	64-QAM 5/6	130	144.4	270	300	585	650	1170	1300	7
	2	256-QAM 3/4	156	173.3	324	360	702	780	1404	1560	8
	2	256-QAM 5/6	n/a	n/a	360	400	780	866.7	1560	1733.3	9
16	3	BPSK 1/2	19.5	21.7	40.5	45	87.8	97.5	175.5	195	0
17	3	QPSK 1/2	39	43.3	81	90	175.5	195	351	390	1
18	3	QPSK 3/4	58.5	65	121.5	135	263.3	292.5	526.5	585	2
19	3	16-QAM 1/2	78	86.7	162	180	351	390	702	780	3
20	3	16-QAM 3/4	117	130	243	270	526.5	585	1053	1170	4
21	3	64-QAM 2/3	156	173.3	324	360	702	780	1404	1560	5
22	3	64-QAM 3/4	175.5	195	364.5	405	n/a	n/a	1579.5	1755	6
23	3	64-QAM 5/6	195	216.7	405	450	877.5	975	1755	1950	7
	3	256-QAM 3/4	234	260	486	540	1053	1170	2106	2340	8
	3	256-QAM 5/6	260	288.9	540	600	1170	1300	n/a	n/a	9

Also, MCS Value Achieved by Clients at Various Signal to Noise Ratio Levels (SNR)
http://www.wlanpros.com/wp-content/uploads/2015/06/Revolution-Wi-FI-MCS-to-SNR-Single-Page.pdf

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Roaming

Moving from one AP to another – can be fast…needs to be fast for some applications (eg < 150ms for VoWiFi)

802.11k (RRM and neighbour reports to move AP)
802.11r faster secure handoffs

Coverage considerations

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Co-channel interference

Really should be called “Co-channel co-operation”!

It’s a fundamental part of WiFi – same channel, CSMA/CA mechanism

Its better to have APs on same channel than adjacent *if* some agreement needs to be made (e.g. with 3rd party)

….and it all relies on the wired network

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Wi-Fi can be ‘perfect’ but still relies on the wired network it uses to transit client/control data!

If you’ve got issues there then that just compounds the wireless domain (L1/L2) issues – the WiFi is using the wired for user data transit AND control plane etc

What about dealing with Loss? (eduPERT angle…)

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WiFi is an environment with loss (due to interference etc etc). What about just *accepting* that and dealing with it?

Different TCP algorithms:

Westwood, Forward, new Reno, TCP BBR etc
(forget Vegas, SACK, Tahoe.….)

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Monitoring/validation etc

- WiFiMon – crowd sourced monitoring
- UNINETT – Trådløs probe (WiFi probe)

- PerfSONAR - have wireless nodes talking to wired target(s) – MADDash matrix

- APs in monitor mode/'CleanAir' et al

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Final thoughts (PMV)

"System One and System Two" Daniel Kahneman

- emotional/intuitive/instinctive (heart) versus research/ analysis (head) – think 'possible outcomes of your actions'

"The brightest flashes in the world of thought are incomplete until they have been proven to have their counterparts in the world of fact" - John Tyndall

- All research [and other activities] must have 2 phases – information gathering and verification

Thank you!

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