atmosphere'19

AB207 – Outdoor WiFi Network Design Fundamentals

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aruba
a Hewlett Packard Enterprise company

Agenda

- Family Products
- Outdoor Coverage Basics
- Performance Examples
- Design and Best Practices
- Warehouses
- How We Do Competitive
- Q&A

"Complexity is your enemy. Any fool can make something complicated. It is hard to keep things **simple**"

Sir Richard Charles Nicholas Branson

Family Photo

Aruba’s Outdoor, Industrial, and
Point to Point Gig Solutions

Aruba’s Outdoor and Industrial Portfolio (11ac Wave 2)

FLAGSHIP

AP-370 Series
- 4x4:4 @ 5Ghz
- 2x2:2 @ 2.4Ghz
- 1G Eth and SFP
- BLE (loc and console)
- POE or AC Power

AP-375
- Integrated Omni

AP-377
- Integrated Directional

AP-374
- Connectorized

VALUE

AP-360 Series
- 4x4:4 @ 5Ghz
- 2x2:2 @ 2.4Ghz
- 1G Eth and SFP
- BLE (loc and console)
- POE Only

AP-365
- Integrated Omni

AP-367
- Integrated Directional

INDUSTRIAL

AP-318 Series
- 4x4:4 @ 5Ghz
- 2x2:2 @ 2.4Ghz
- 1G Eth and SFP
- BLE (loc and console)
- POE Only

AP-318
- Connectorized

60GHz PtP

AP-387 Series
- 60Ghz 11ad
- 2x2:2 @ 5Ghz
- 1G Ethernet
- BLE (loc and console)
- POE Only

AP-387
- Integrated Directional

Outdoor Coverage Basics

How far, how much?

“How Far”?

A number of factors come in to play when determining ‘how far’ an outdoor AP will cover

- Line of sight to the client, are there people, vehicles, trees, buildings or obstacles in the way
  - https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.833-9-201609-I!!PDF-E.pdf
  - https://lra.le.ac.uk/bitstream/2381/31383/1/2014ADEGOKEASPhD.pdf
- What type and number of clients
- AP power, antenna, directionality, regulatory, wall or pole mount, etc

Overlapping coverage and interference

- Channel re-use, adjacent/co-channel interference, etc all apply and must be considered, as well as neighboring interference from nearby locations. Free space can make it more challenging

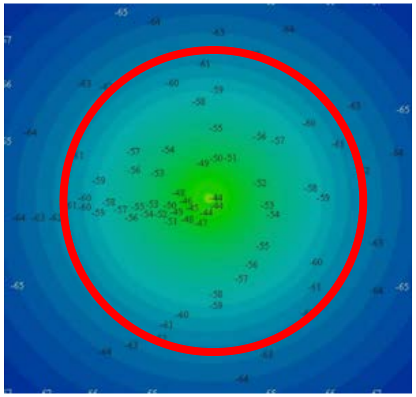
The Human Factor

- As outdoor has fewer APs per given area, and are covering much larger areas, the orientation of the human holding the client device matters for attenuation, higher up is generally better
- For large client density areas, overhead AP installation is required or the pathloss through a crowd will be too great and range will be greatly decreased
- In less client dense area where the client devices are more spread out and crowd densities are less, it’s not as much of an issue

AP-375 - General Design Guidance

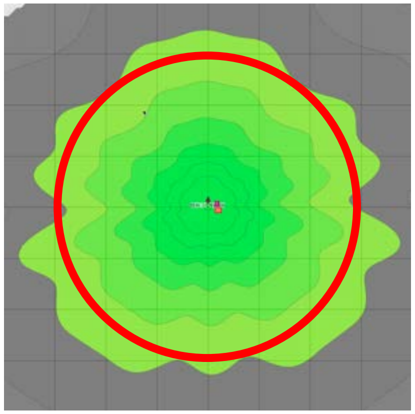
AP-375

- Can be thought to reliably produce a 150-200m radius of outdoor coverage (line of sight, barring any trees, buildings, etc).
- If no overlap is required, can be planned with spacing of ~300-400m
- Mounting height ideally should be at approx 4-6m above ground. Viable anywhere from 3m up to 30m (Ideal is 10-12m generally)
- Flat, long wall mounting locations can cause issue with outside RF penetrating indoors, causing client issues, if long wall mounting, look at AP-377 firing out



Pole Mount versus Wall Mount

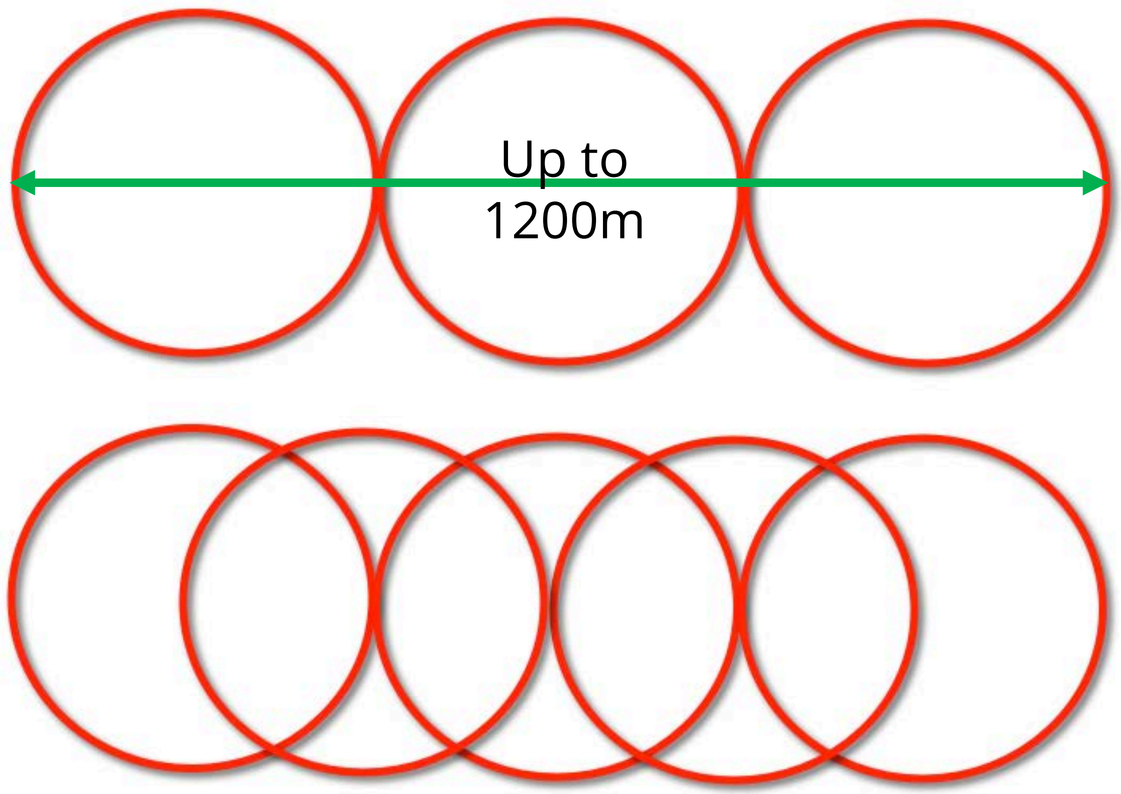
- Pole mounts should use the AP-270-MNT-V1
- Wall mounts should use the AP-270-MNT-V2



Ceiling Mounts

- If the ceiling is parallel to the ground, the AP-270-MNT-H2 can be used
- If the ceiling is parallel or sloped relative to ground, the AP-270-MNT-H1 can be used

AP-275/375 - General Design Guidance



Top-Down views of AP coverage

No Overlap

- Three APs would cover up to ~1200m distance
- Larger separation for better channel separation and lower ACI/CCI
- If one AP fails, there will be a gap

100% Overlap

- Would take five APs to cover the same distance
- One AP can fail and still have 100% coverage
- Higher AP density results in higher ACI/CCI to account for

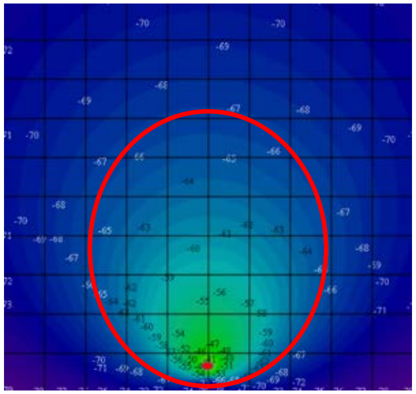
AP-377 - General Design Guidance

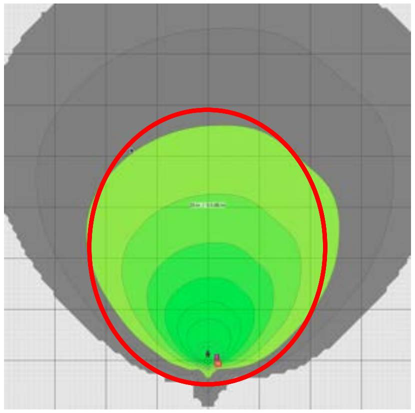
General Guidance

- Is a directional AP (80deg x 80deg)
- Relative to heading, the perpendicular coverage (sides) are approx 50-75m wide on each side, whereas the parallel coverage can cover out to 250-300m to a client
- If no side to side overlap is required, they can be planned along a wall with spacing of ~100-150m
- Mounting height ideally should be at or below 10m above ground aimed straight out parallel to the ground. For every 5m above 10m, downtilt the AP 5 degrees should be applied
- Best for wall mounting to minimize interior RF penetration

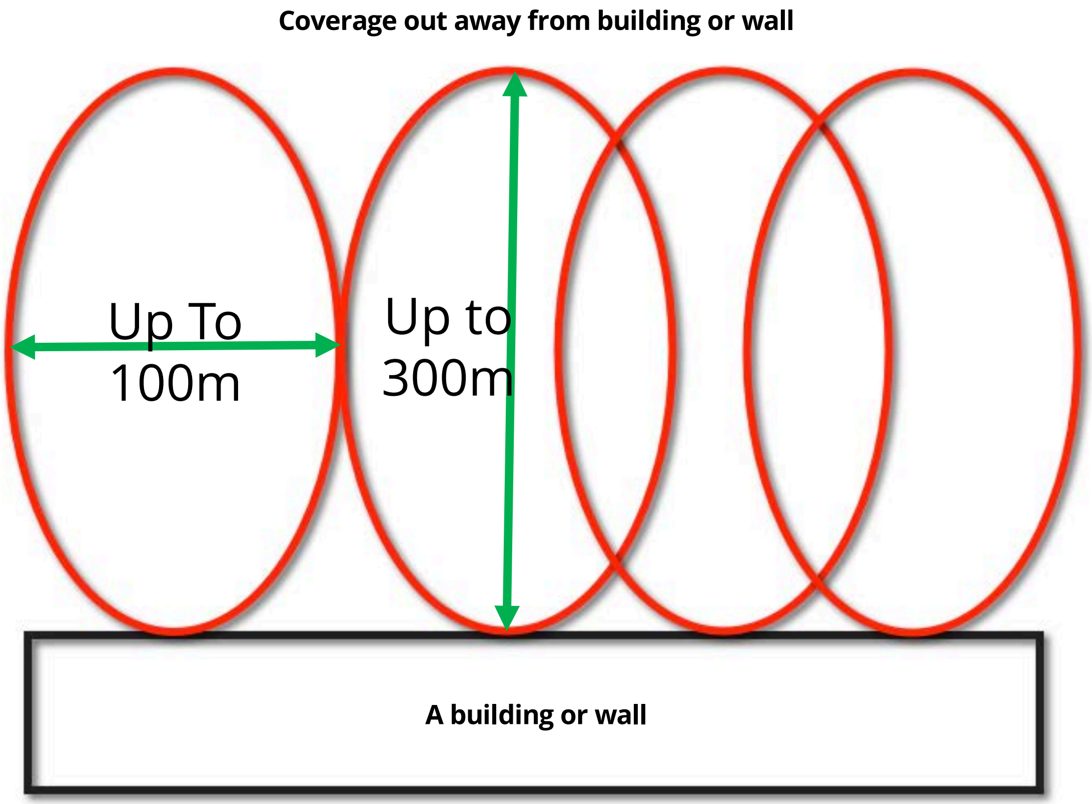
Mounts

- Pole or wall mounts below 10m should use the AP-270-MNT-H2
- Pole or wall mounts above 10m should use the AP-270-MNT-H1
- AP-377s can be used in Very High Density (VHD) deployments as a dual-band client access AP (read the High Density VRD for more)





AP-377 - General Design Guidance



Top-Down views of AP coverage

No Overlap

- Three APs would cover up to ~100-wide, and out to ~300m away
- Better separation for better channel separation and lower ACI/CCI
- If one AP fails, there will be a gap

100% Overlap

- Overall distance out doesn't change based on AP density
- One AP can fail and still have 100% coverage
- Higher AP density results in higher ACI/CCI to account for

AP-374 - General Design Guidance

General Guidance

- The AP-374 is a connectorized unit, with N-Male connectors (the AP-374 is (2) x 2.4Ghz/(4) x 5Ghz)
- These APs have no antennas, the antennas to be used will be determined by the design requirements
- Supports the use of Omni-directional antennas, as well as directional antennas. The common use case for this is 2.4GHz omni antennas for client access (ANT-XxX-2005) and a directional antenna for mesh backhaul.
- There is more design and planning work required for the use of AP-374s. Scope accordingly

Mounts

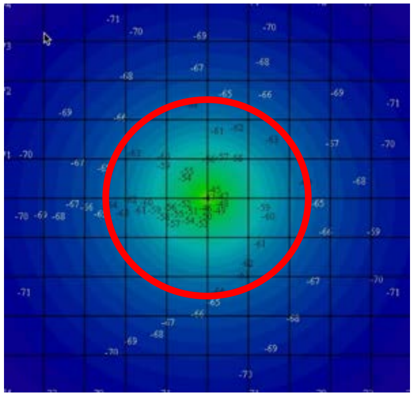
- In most all cases, the AP-270-MNT-V1 or AP-270-MNT-V2 would be used
- No weatherization is required on the connectors for the AP-274/374
- Cables 2m and shorter **DO NOT** require lightning arrestors
- Cables longer than 2m **DO** require lightning arrestors (AP-LAR-1)

- **Other Information**
  - 2x2 and 4x4 antennas can be used on the AP-374. If using 2x2, use ANT0 and ANT1, and put a 50-ohm terminator on ANT2/3.

AP-365 - General Design Guidance

AP-365

- In general, the AP-365 can be though of to reliably produce a 100-125m radius of outdoor coverage (line of sight, barring any trees, buildings, etc).
- If no overlap is required, AP-365s can be planned with spacing of ~200-250m
- If the plan is to deploy in a courtyard or campus with trees, this distance should be halved (depending on the tree density)
- Mounting height ideally should be at approx 4-6m above ground. The AP-365 is viable anywhere from 3m and below 20m.

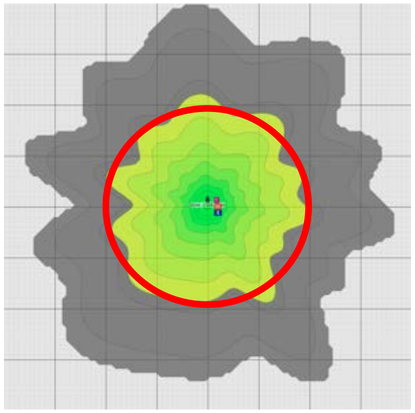


Pole Mount versus Wall Mount

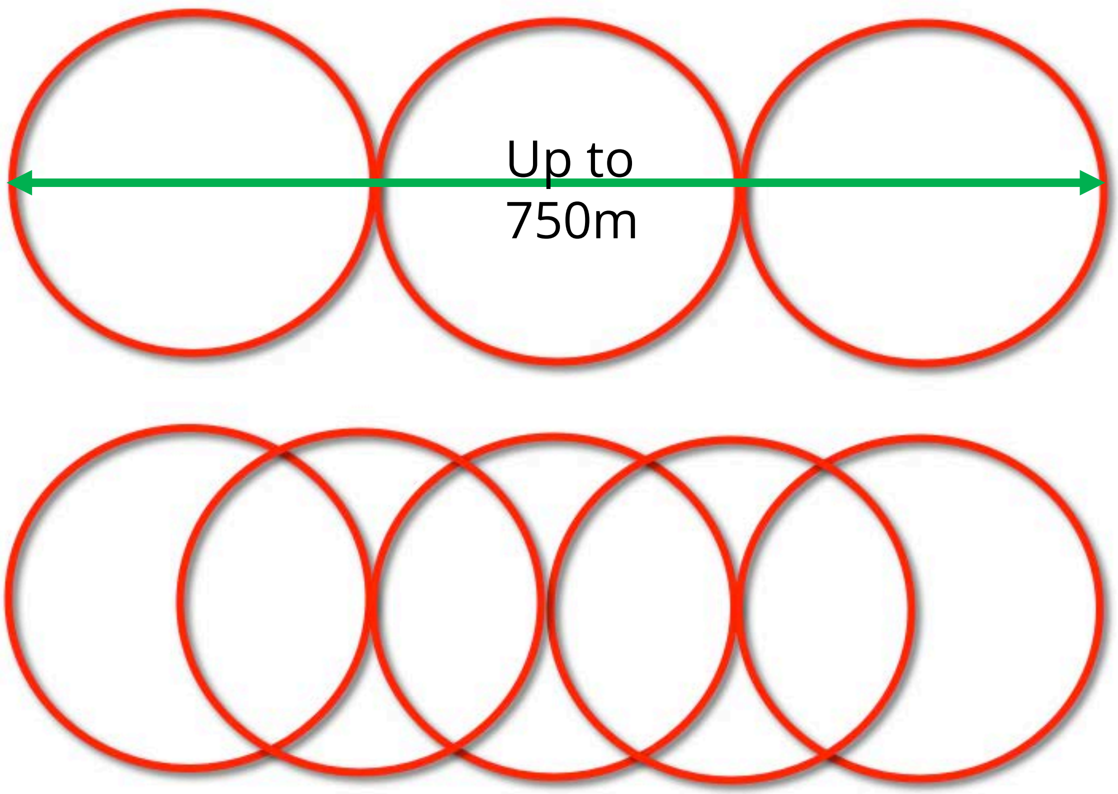
- Pole mounts should use the AP-270-MNT-V1
- Wall mounted AP-365s should use the AP-270-MNT-V2

Ceiling Mounts

- If the ceiling is parallel to the ground, the AP-270-MNT-H2 can be used
- If the ceiling is parallel or sloped relative to ground, the AP-270-MNT-H1 can be used



AP-365 - General Design Guidance



Top-Down views of AP coverage

No Overlap

- Three APs would cover up to 600m distance
- Better separation for better channel separation and lower ACI/CCI
- If one AP fails, there will be a gap

100% Overlap

- Would take five APs to cover the same distance
- One AP can fail and still have 100% coverage
- Higher AP density results in higher ACI/CCI to account for

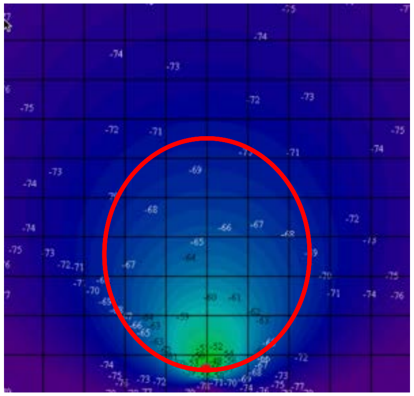
AP-367 - General Design Guidance

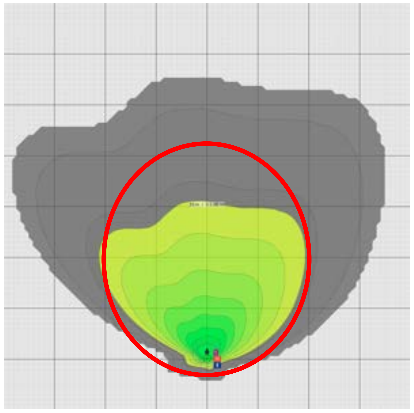
General Guidance

- Is a directional AP (90deg x 90deg)
- Relative to heading, the perpendicular coverage (sides) of the AP-367 are approx 30-40m wide on each side, whereas the parallel coverage can cover out to 200m to a client
- If no side to side overlap is required, they can be planned along a wall with spacing of ~60-75m
- Mounting height ideally should be at or below 7.5m above ground aimed straight out parallel to the ground. For every 5m above 7.5m, downtilt the AP ~5 degrees
- AP-367 can also be used with ceiling mounts (AP-270-MNT-H1/H2) for a tighter downtilt omni application

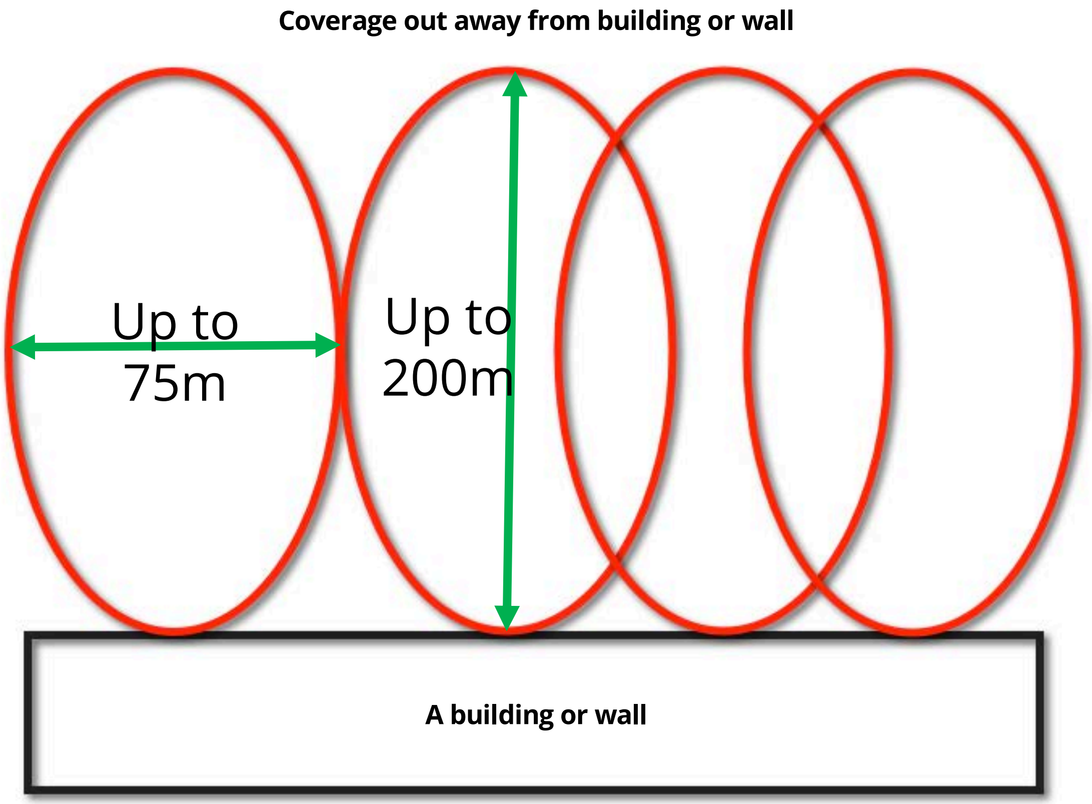
Mounts

- Pole or wall mounts below 7.5m should use the AP-270-MNT-H2
- Pole or wall mounts above 7.5m should use the AP-270-MNT-H1





AP-367 - General Design Guidance



Top-Down views of AP coverage

No Overlap

- Three APs would cover up to ~75m wide, and out to ~200m away
- Better separation for better channel separation and lower ACI/CCI
- If one AP fails, there will be a gap

100% Overlap

- Overall distance out doesn't change based on AP density
- One AP can fail and still have 100% coverage
- Higher AP density results in higher ACI/CCI to account for

Performance Examples

Real-world performance captures

Testing Methodologies

There are two main types of testing done within Technical Marketing

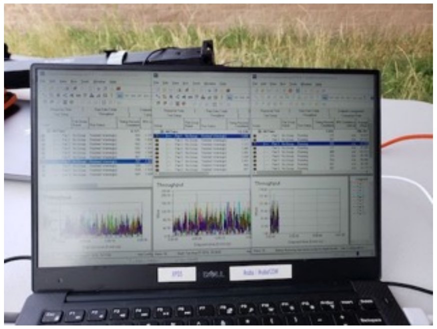
Idealized Testing – Testing done where additional work is done to ensure maximum performance between the client and AP. Generally this is done per ‘system’ (AP and client(s)). Idealized testing will give the higher performance and give the results of expected highest value, but is extremely time and labor intensive which does not lend itself well to competitive testing due to the variability. This could include things like

a) Adjust AP channel and power to find highest performing results
b) Adjusting orientation, height, or angle of the client device to maximize performance
c) Tuning the environment to maximize traits like multi-path, reflectivity, etc

Standardized Testing – Testing done where minimal physical characteristics except the System Under Test (SUT). While this would include changing out APs that are being tested, it also means that client number, type, position, locations, orientations, and AP heights, antenna headings, etc should all remain constant from product to product to give as close to an ‘Apples to Apple’ comparison as possible, changing as little as possible between the SUT. However, without any client or AP tuning, lower performance results are generally seen. However, these results are much closer to predicting real world application results.

For this testing, the ‘Standardized Testing’ model was used.

Test Site Images



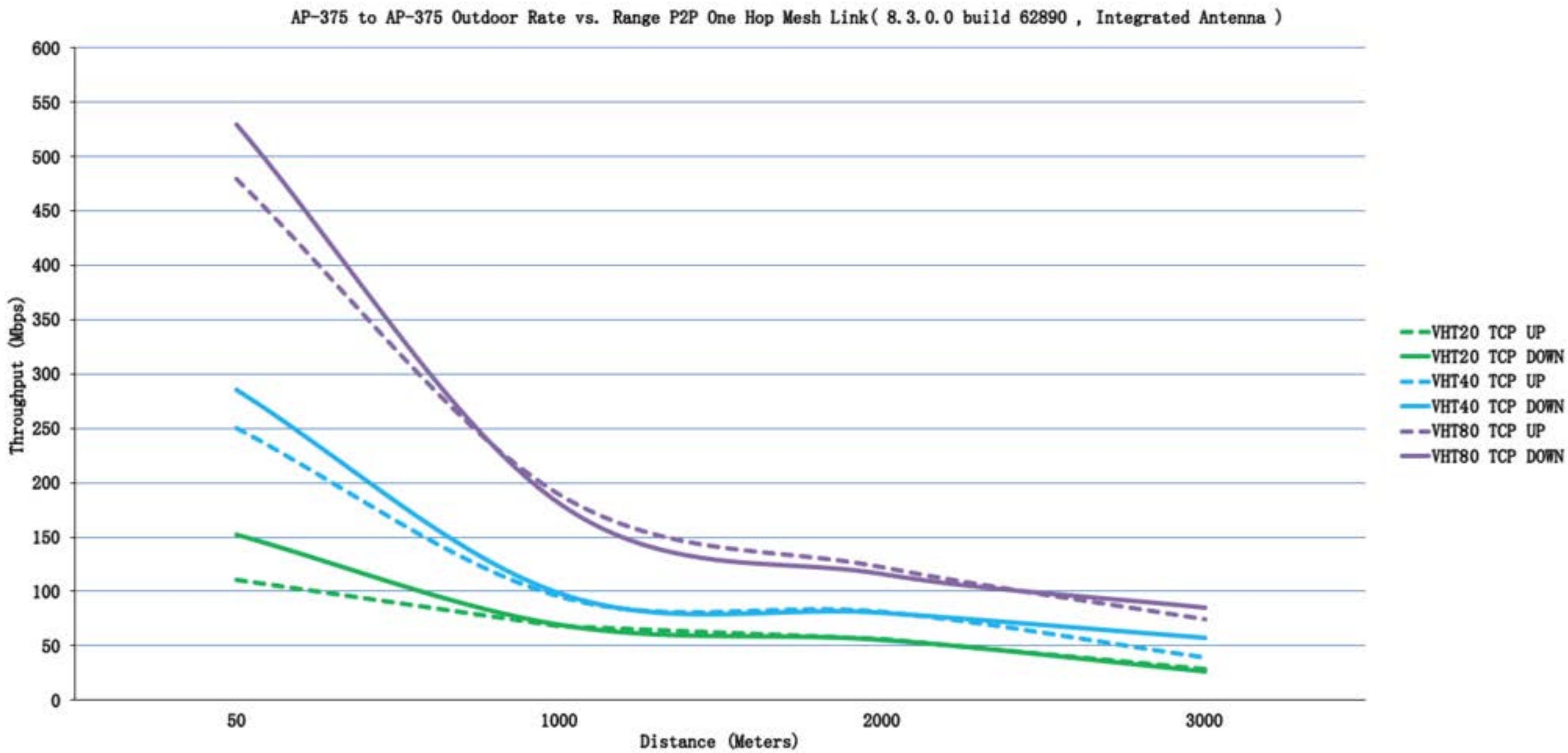
Aruba AP-365

	10m	25m	50m	75m	100m	125m	150m	175m	200m
Galaxy 2x2	358	367	403		294				5
Dell 2x2	328	417	333		177				63
MacBookPro 3x3	475	472	443		243				8

Aruba AP-375

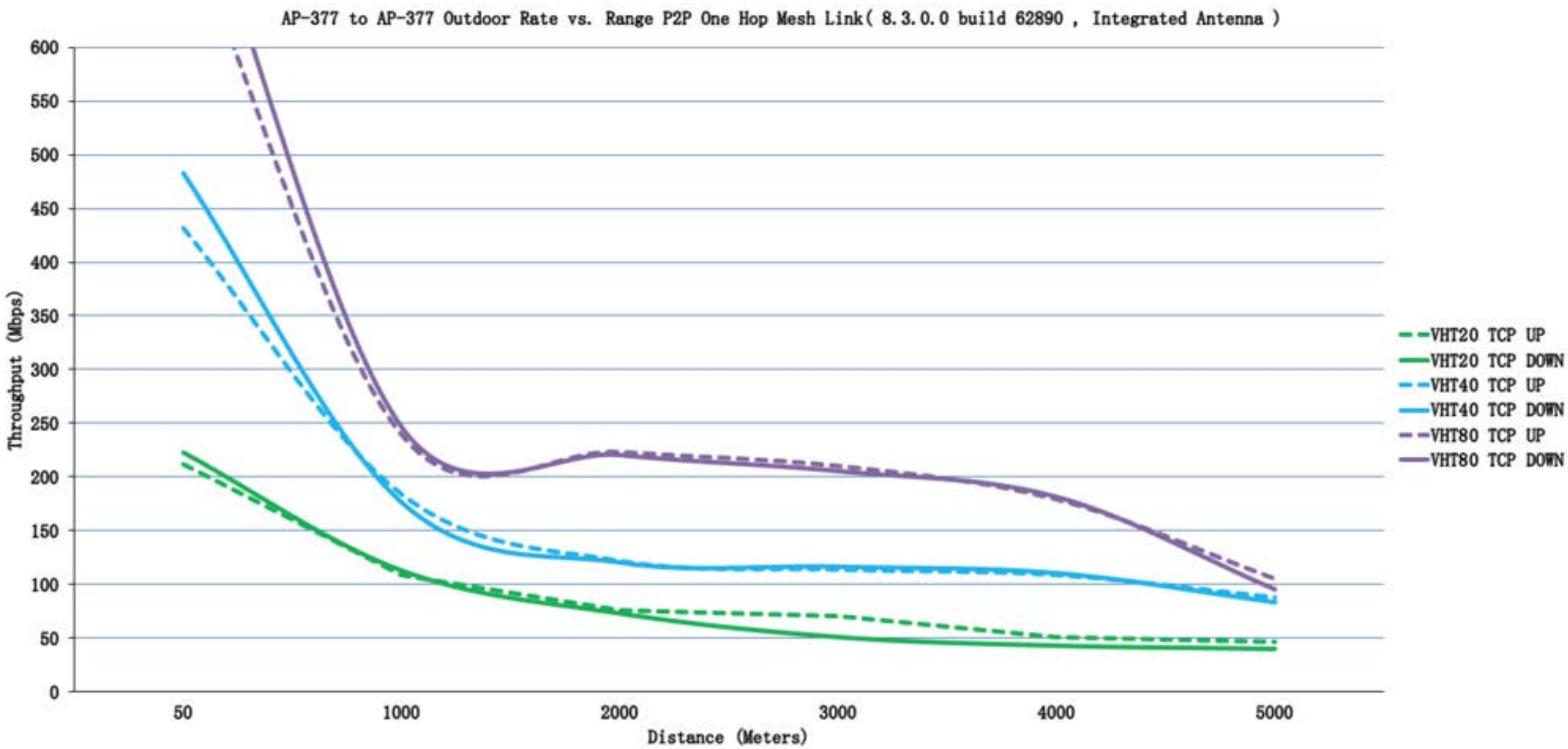
	10m	25m	50m	75m	100m	125m	150m	175m	200m
Galaxy 2x2	339	296	282		201				58
Dell 2x2	397	441	345		215				59
MacBookPro 3x3	506	502	406		191				63

Mesh: AP-375 to AP-375



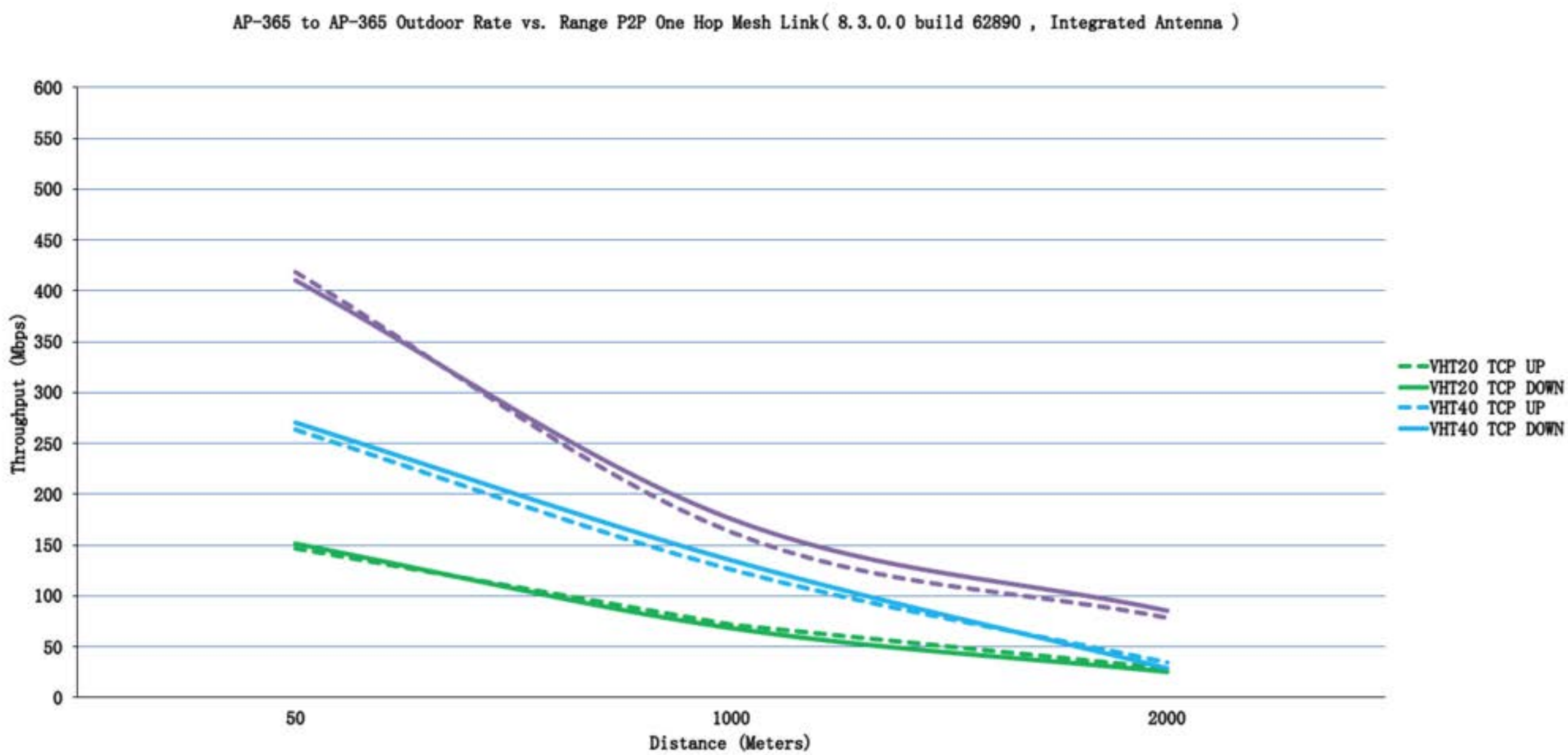
Note: All results captured are US FCC UNI3 at Max EIRP for each AP model tested

Mesh: AP-377 to AP-377



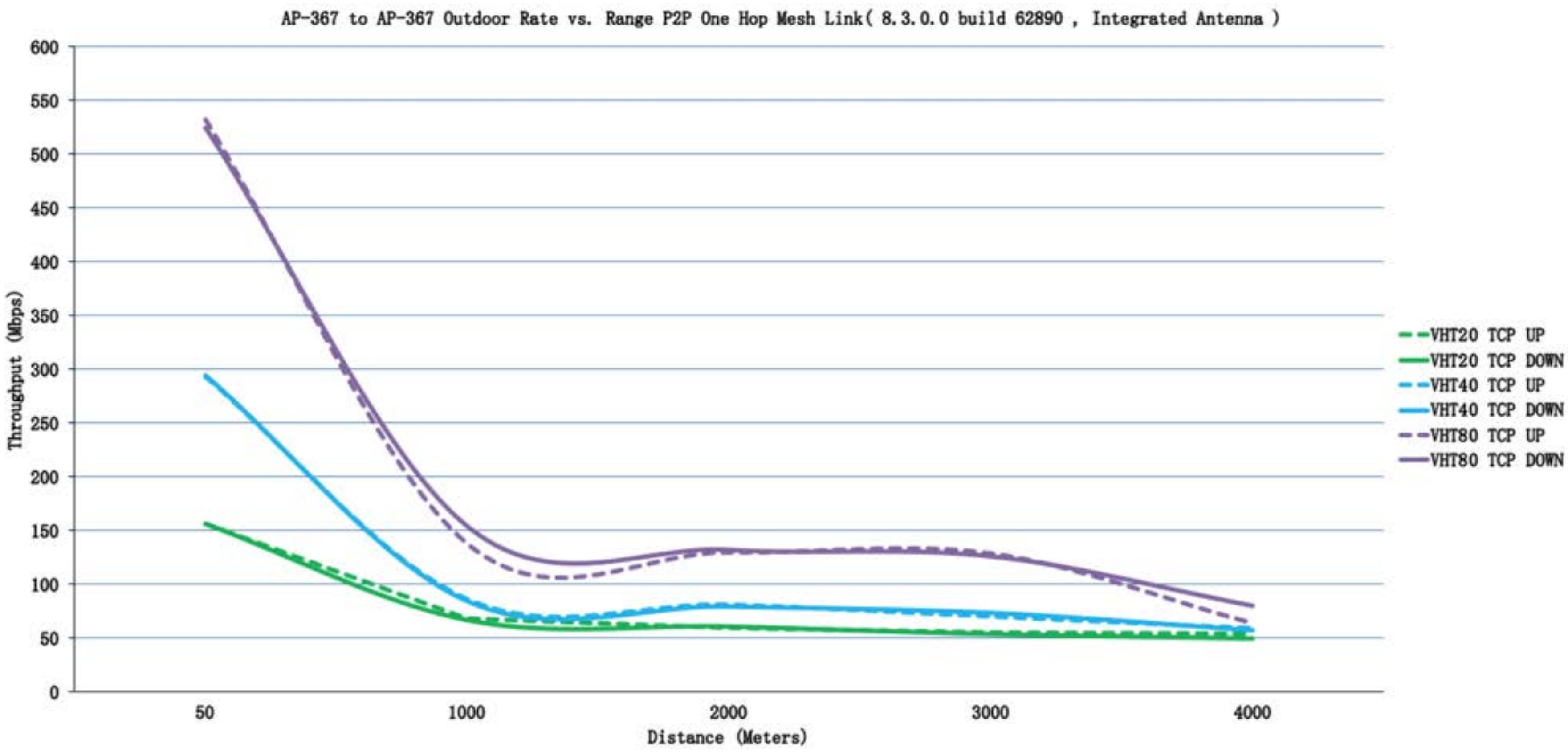
Note: All results captured are US FCC UNI3 at Max EIRP for each AP model tested

Mesh: AP-365 to AP-365



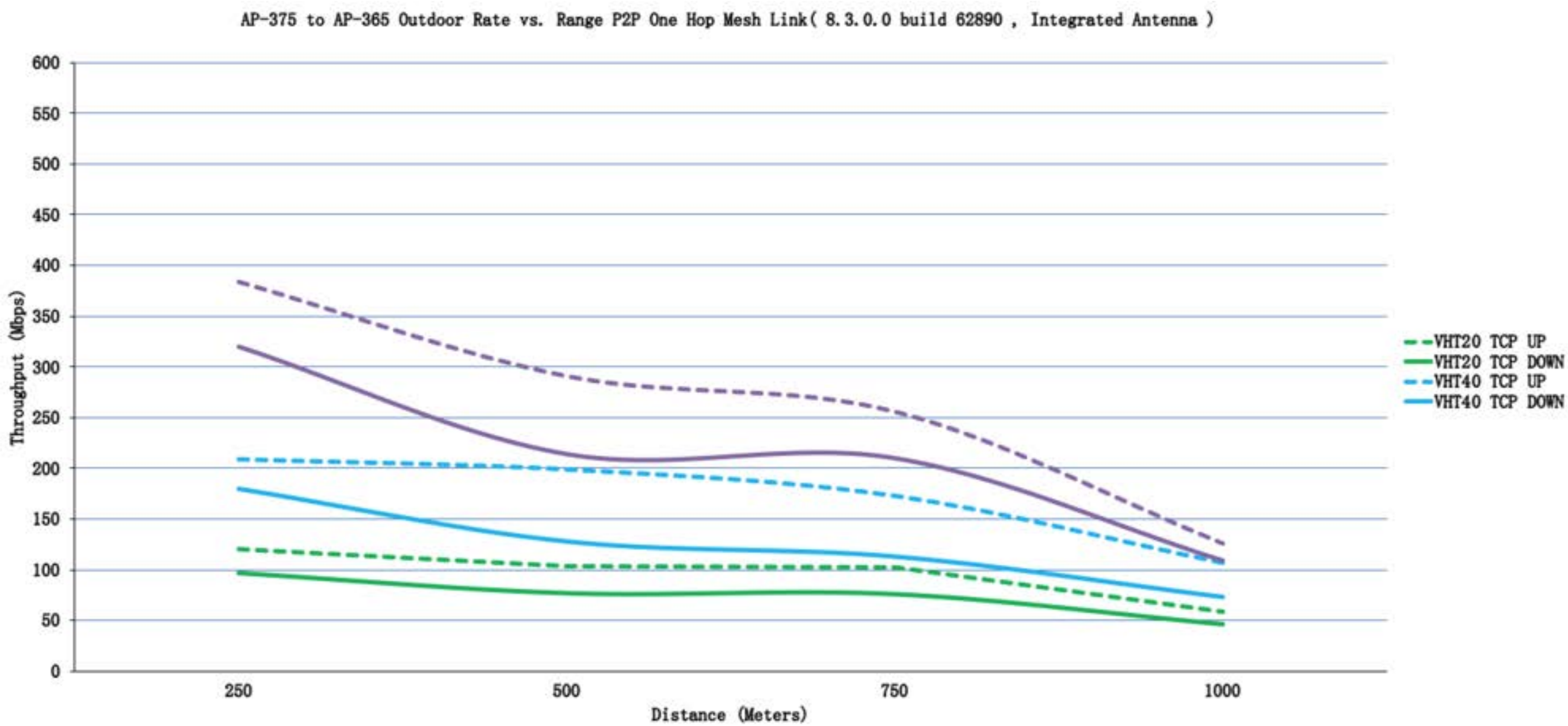
Note: All results captured are US FCC UNI3 at Max EIRP for each AP model tested

Mesh: AP-367 to AP-367



Note: All results captured are US FCC UNI3 at Max EIRP for each AP model tested

Mesh: AP-375 to AP-365



Note: All results captured are US FCC UNI3 at Max EIRP for each AP model tested

Warehouses

Bringing the Outdoors, In

A Space All Its Own - Warehouses

What makes warehouses so difficult to design to?

- Share many of the same considerations in regards to large coverage areas
- Have large, tall obstacles to accommodate
- Coverage per AP is much larger (3-8k sq ft per AP)
- More challenging mounting locations, cable planning, and obstacles
- The larger spaces and longer distances make regular indoor APs inadequate
- Connectorized APs add additional hardware and labor costs, and increase risk

Other factors to account for:

- How large is the warehouse
- How tall are the ceilings
- How tall are the rack
- What is the client density
- Is there any locationing or wayfinding
- What is stored on the shelves
- How much does the layout change
- How much do the contents change
- Is outdoor a component of the design
- ***What are the client types***

AP Placement Topology

There are two main options with regard to AP placement, and each has pros and cons (and sometimes it's not an option)

Ceiling – ideal placement is on the ceiling. It allows for 'cellularized' coverage along the floor while minimizing large amounts of RF propagation across the warehouse (especially in 2.4Ghz), provides best adjacent aisle coverage to support a staggered AP placement, and the least change of impairment from equipment and products when being moved. Ceiling mount is also more flexible for large warehouses.

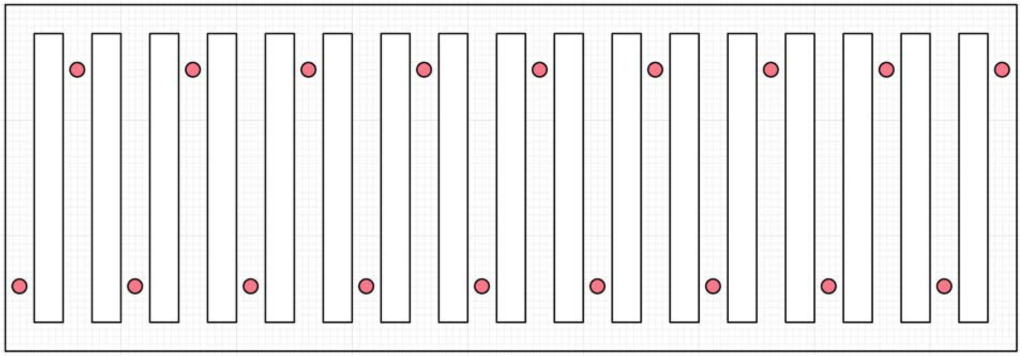
Wall – Generally used in some designs to provide coverage down the entire aisle and can be used in cases where the ceiling is unavailable. The intent would be to light up the entire aisle, but can lead to cross wall RF pollution and shadowing when equipment and pallets are pulled out, blocking the RF for clients.

Staggered Placement – when ceiling mounted, a stagger provides for an every other aisle arrangement to provide coverage in adjacent aisles where there is not an AP next to it. For wall placement, APs are installed on opposite walls covering every other aisle.

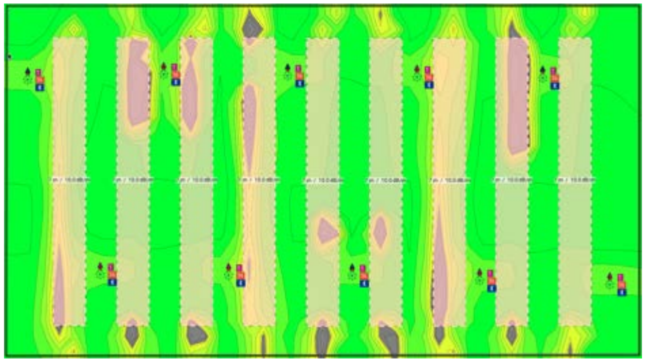
Note: It's always advised to use tools like Ekahau for placement planning and visualization

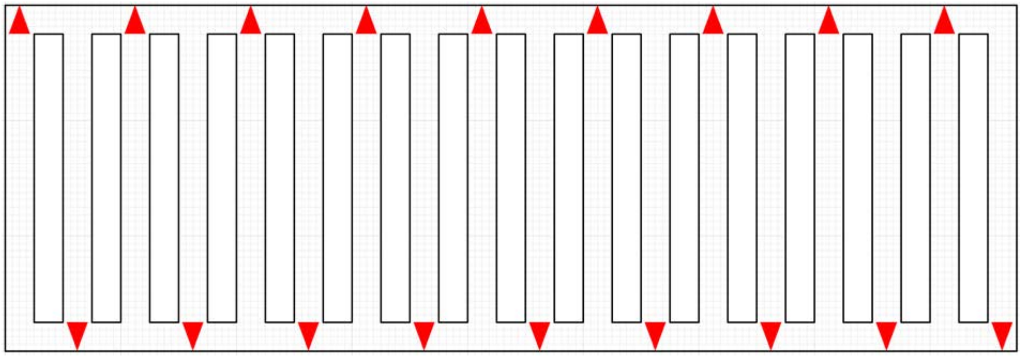
Ceiling versus Wall

There are two main options with regard to AP placement, and each has pros and cons (and sometimes it's not an option).

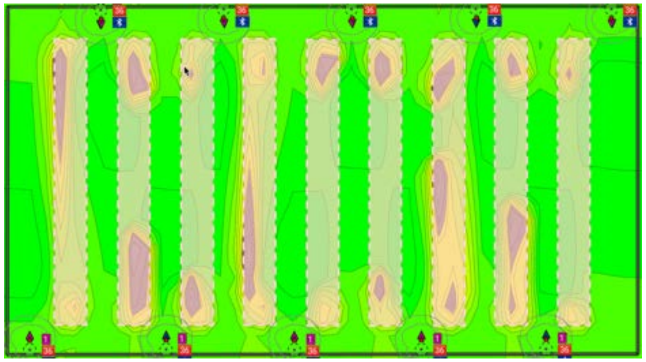


_AP-365_
10m AGL



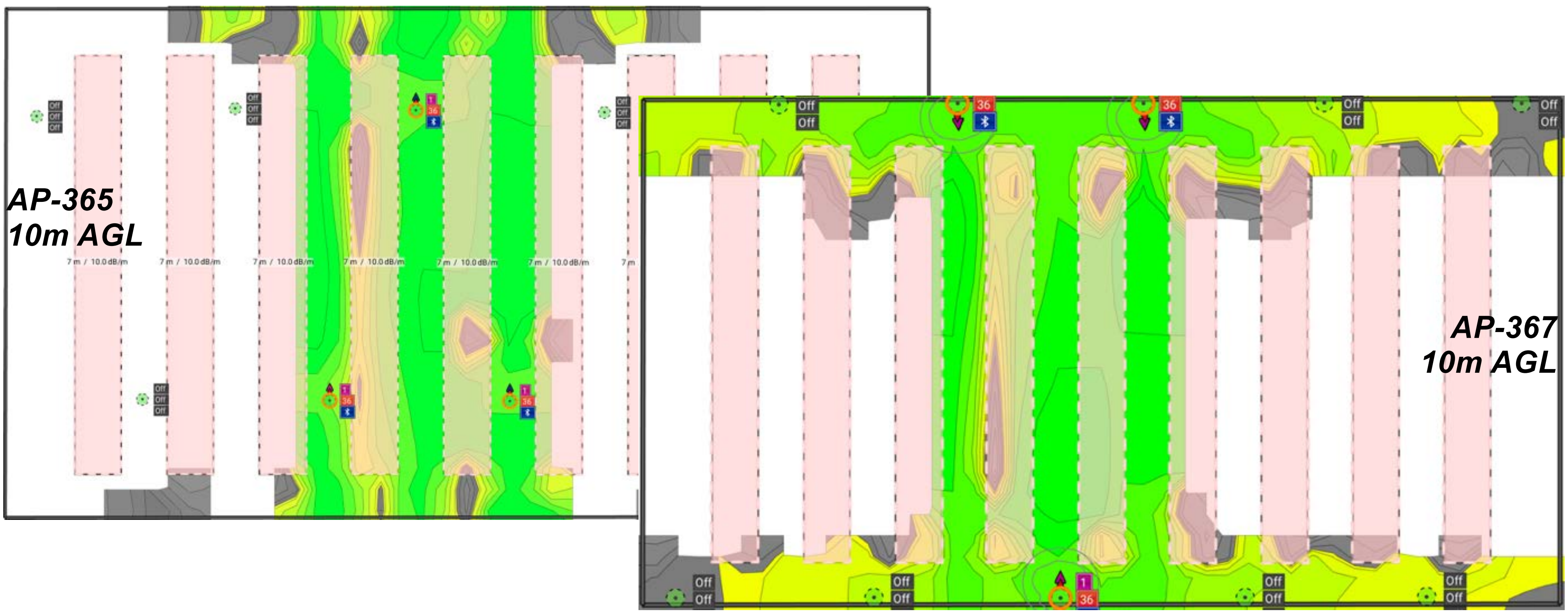


_AP-367_
10m AGL



Comparison of 3 AP Coverage

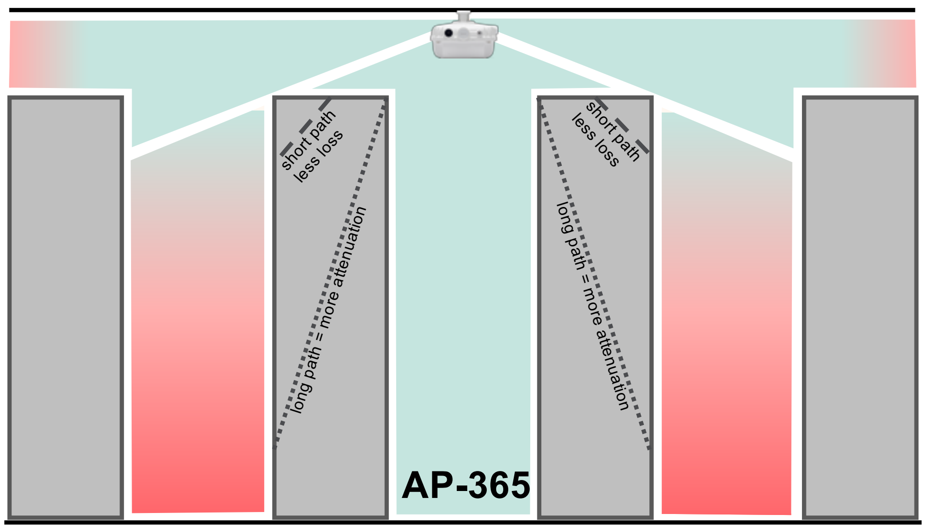
When comparing the propagation of wall versus ceiling mounted for the center three APs, note that the wall mounted AP-367 bleed along the walls much worse than the ceiling mounted AP-365

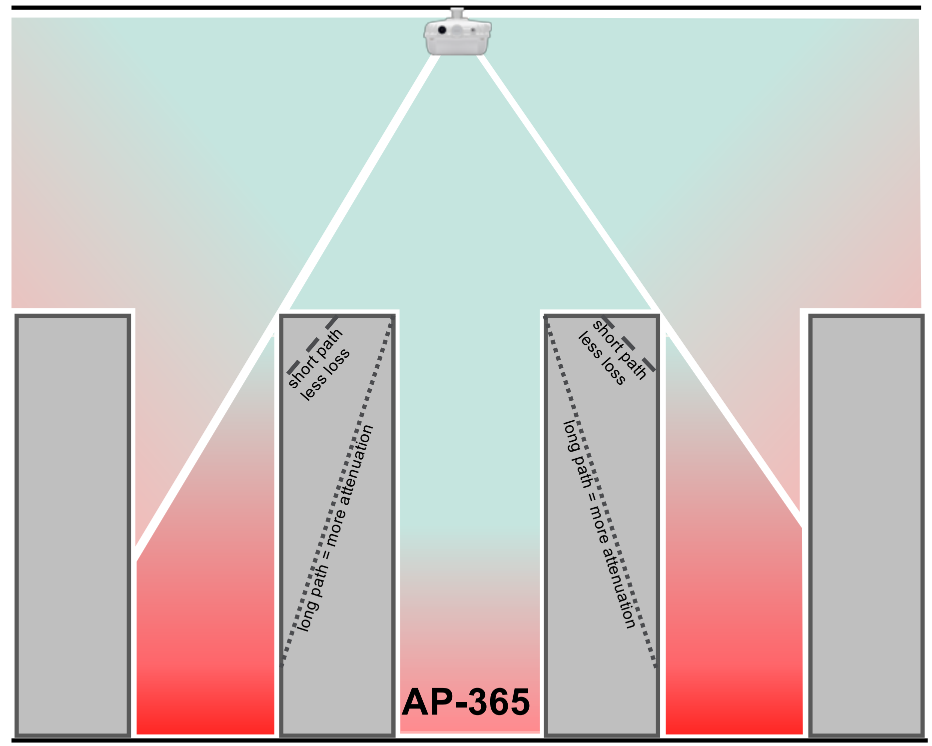


AP Height – Antenna Patterns and Path Loss

The first aspect of AP height is that as the AP gets higher, path loss increases. Depending on the AP and the antenna pattern and AP or antenna selected. When omnis get higher, SNR decreases under the AP.

Below, the AP-365 is closer to the floor so signal under the AP is stronger. On the right, because the AP-365 is further away, SNR at the ground is lower, which will create roaming issues with the client.





AP Height – Antenna Patterns and Path Loss (survey data)

On the left, the heatmap shows coverage from AP-365s @ 10m AGL and an signal under the AP of -53. On the right are the same APs but at 25m AGL and shows a signal under the AP OF -63. Additionally, it's clear from the overall heatmap that overall SNR dropped. This is due to omni APs directing their RF to the side, not down.

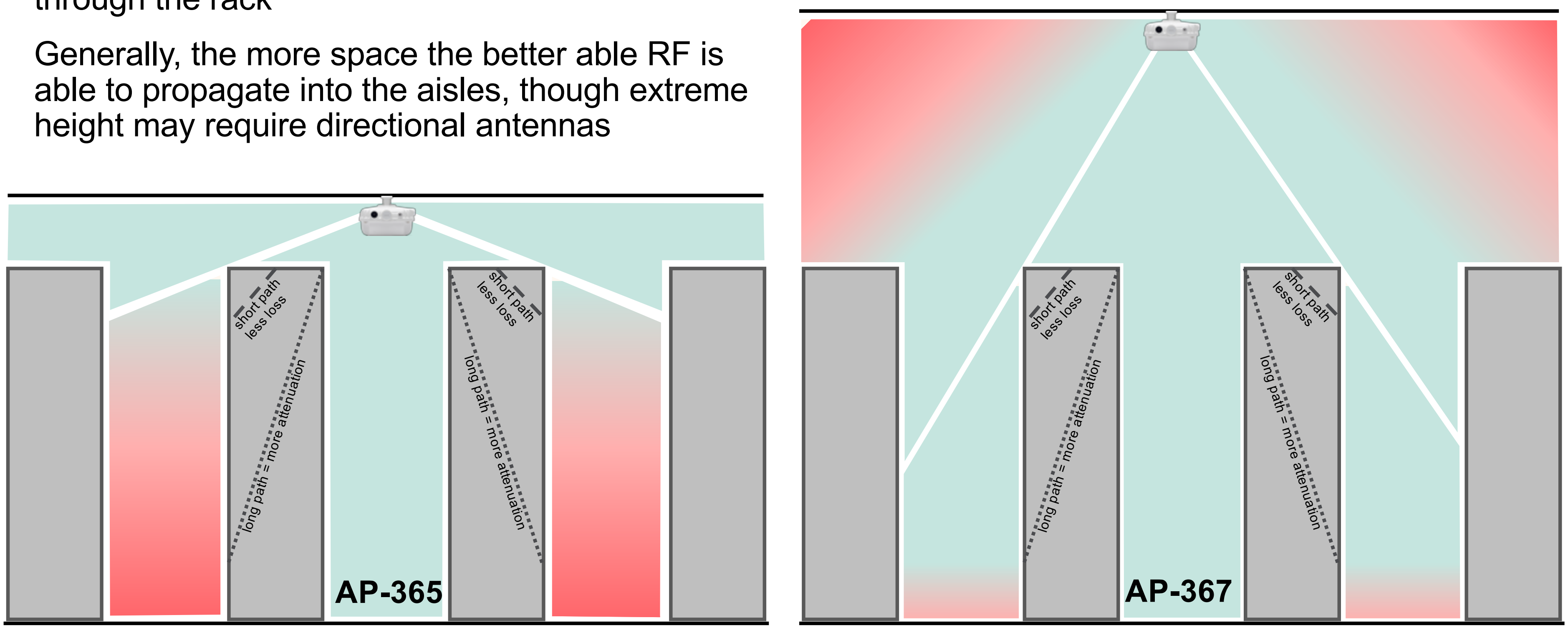
AP-365 10m AGL

AP-365 25m AGL

AP Height - Spacing Between AP and Top of Racks

Additionally, the space between the AP and the top of the rack dictates the geometry of pathloss through the rack

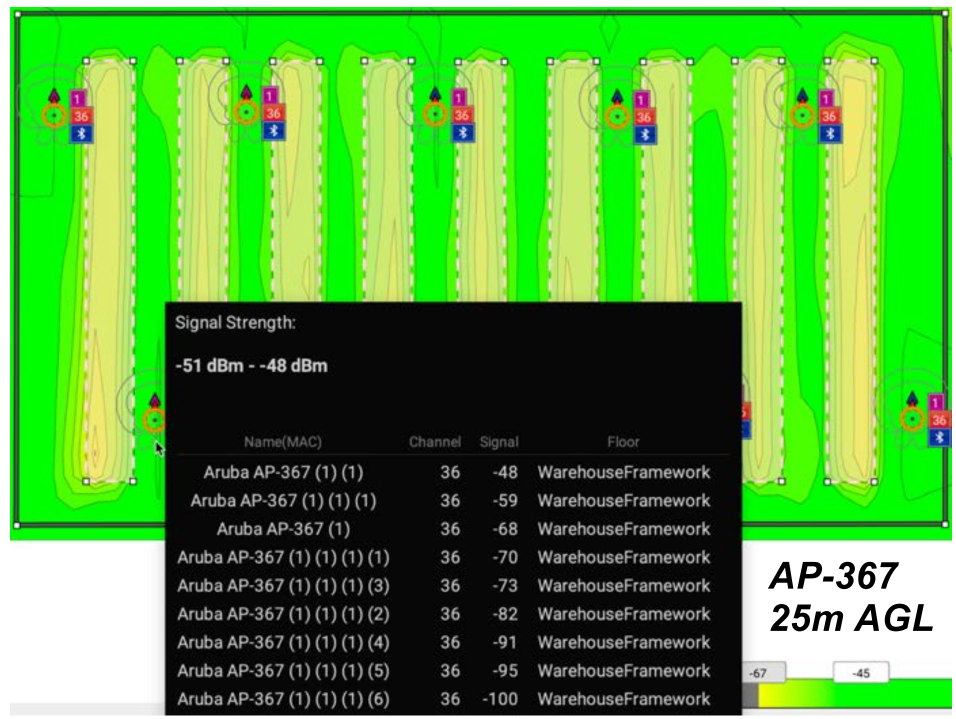
Generally, the more space the better able RF is able to propagate into the aisles, though extreme height may require directional antennas



AP Height – High Ceilings Using Directional APs

For high ceilings (25m), using AP-367s with directional antennas pushes most of the RF to the ground, providing clients stronger SNR. This will prevent the clients from entering their roam thresholds until needed.

AP-365 25m AGL



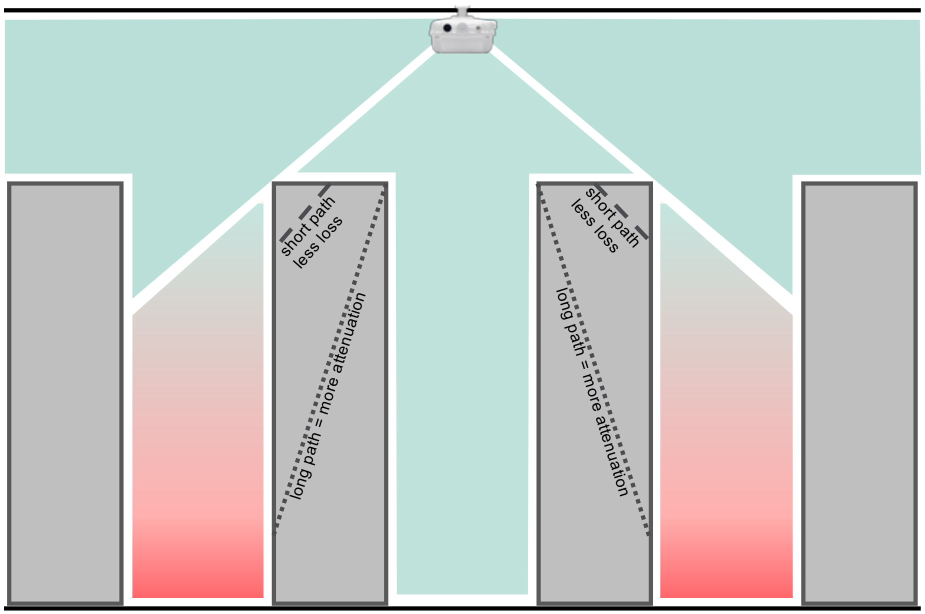
AP-367 25m AGL

AP Height - Shelving and RF Path Loss

The largest obstacle to warehouse planning is the shelving. They act as large RF barriers with varying degrees of attenuation of RF from aisle to aisle

How tall the racks are, in relation to the ceiling height and AP placement must be accounted for. This provides the minimum bit of information in determining how the RF propagates between and over the shelves into the aisles

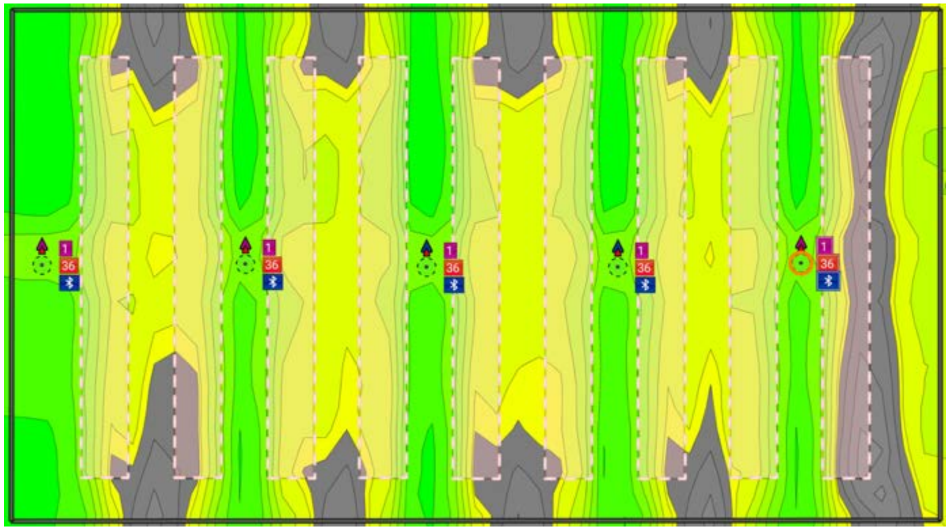
- RF propagation from the AP directly over an aisle will properly cover the aisle, but adjacent aisles will attenuate the RF as it travels through the rack and materials
- The more material and the larger amount of rack space passed through, the higher the loss
- Amount of attenuation is dictated by materials stored and rack configuration
- The more spacing across aisles between APs increases the chance that the aisles between the APs won't have enough RF



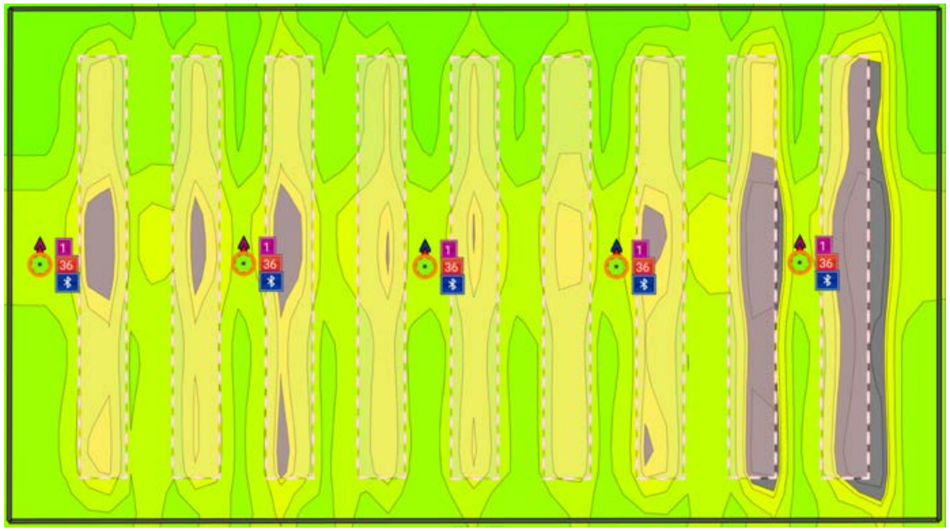
What Happens When Aisles are Skipped

When the assumption is made that enough RF can pass through each shelf, and a design is create that skips every other aisle, due to the 3-dimensional nature of path loss through the shelf can result in severe coverage gaps. Additionally, there’s no secondary coverage should an AP fail.

Below shows a simple warehouse design where every other aisle is left without an AP. The left shows the APs 10m AGL, the right shows APs at 20m AGL. And while the higher APs get more coverage in to the empty aisles, the height results in an overall lowering of SNR across the entire floor, even under the AP.



AP-365 @ 10m AGL



AP-365 @ 20m AGL

Using Indoor APs or Connectorized APs to Save Cost

Often there may be pressure or a desire to use indoor APs to save money. However, the lower overall transmit power of indoor APs limits the coverage effectiveness in some cases.

Use of connectorized APs with external antennas can address some issues be shaping the RF, the added hardware cost and labor to install, along with the added risk of cabling issues makes connectorized indoor APs more costly with lower overall effectiveness.

Below is a comparison of the costs associated with using the AP-36x family with the H1/H2 mount versus an indoor connectorized AP with external antenna(s)

	AP-304	AP-314	AP-36x
AP cost	$695	$995	$1295
Mount	$25 (MNT-W1)	$25 (MNT-W1)	$65 (MNT-H2)
Antenna	$365 (3x3)	$450 (4x4)	--
Antenna Mount	$105	$105	--
Labor Time*	$200 (1hr per mount)	$200 (1hr per mount)	$100 (1hr per mount)
Total Cost	$1390	$1775	$1460

** Labor time and cost assume $50/hr labor and $150/hr lift rental cost*

High Power APs, What About AP and Client Link Budget?

Some older recommendations will note that ‘Link Budget’ between clients and AP should be established by setting AP power similar to the client power. However, as the tables show to the right, with MIMO APs and the use of TxBF and MRC, that even when the AP is at or near max power, the link budget is still maintained between the AP and client. So there’s often not a need to significantly drop AP power.

From the table, however, it can be seen that when looking at the totality of RF metrics, even when the AP is at a much higher power than the client, the combination of TxBF and MRC provides for a balanced link budget in all but the most extreme cases.

Downlink 4 dBi AP Antenna				**Downlink 4 dBi AP Antenna**		
AP tx Power per Branch	18.0	dBm		AP tx Power per Branch	18.0	dBm
4 branch power sum	6.0	dB	= 10 log(# of chains)	2 branch power sum	3.0	dB
antenna gain AP	4	dBi		antenna gain AP	4	dBi
Cable losses	0	dB	Enter as positive number	Cable losses	0	dB
Net AP EIRP	**28**	**dBm**	<-- **This is what is entered in the controller**	**Net AP EIRP**	**25.0**	**dBm**
Client Rx antenna gain	0	dBi		Client Rx antenna gain	0	dBi
Client 1 Chain MRC	0	dBi		Client 1 Chain MRC	0	dBi
Client Rx noise floor	-94	dBm		Client Rx noise floor	-94	dBm
total downlink path loss	**122**	**dB**		**total downlink path loss**	**119.0**	**dB**

Uplink 4 dBi AP Antenna				**Uplink 4 dBi AP Antenna**		
Client tx Power per Branch	**14**	**dBm**		Client tx Power per Branch	**14**	**dBm**
1 branch power sum	0	dB	= 10 log(# of chains)	1 branch power sum	0	dB
antenna gain client	0	dBi		antenna gain client	0	dBi
Net Client EIRP	**14**	**dBm**		**Net Client EIRP**	**14**	**dBm**
AP Rx antenna gain	4	dBi		AP Rx antenna gain	4	dBi
AP 4 Chain MRC	6.0	dBi		AP 2 Chain MRC	3.0	dBi
AP Cable losses	0.0	dB		AP Cable losses	0.0	dB
AP Rx noise floor	-99	dBm		AP Rx noise floor	-99	dBm
total uplink path loss	**123**	**dB**		**total uplink path loss**	**120.0**	**dB**
		4x4 AP				*2x2 AP*

Aruba Warehouse General Recommendations

From the concepts outlined previously, Aruba recommends the following guidelines for warehouses:

- Use AP-365 and AP-367 with the industrial AP mounts for ease of install, security, and simplicity
- Use of AP-365 for lower ceiling heights (30-40ft and under), and AP-367 for higher ceilings
- Always at least one AP per aisle (length of aisles may necessitate more than one AP per aisle, space APs accordingly based on design guidelines)
- Maximize separation between the AP and the top of the racks
- Create 'cellularized' coverage from the ceilings. Wall mounting should be used as little as possible, unless absolutely unavoidable. Goal is to minimize wide-scale RF propagation across the entire deployment

Design guidelines for same-aisle AP spacing:

- AP-365 – separation of 100-150m between APs on the same aisle
- AP-367 –
  - separation of 50-75m between APs on the same aisle when installed at 30-40ft high
  - separation of 75-125m between APs on the same aisle when installed over 40ft high

Exceptions for Warehouse General Recommendations

The general assumptions are based around large industrial warehouses. However, there are and can always be exceptions to some of the recommendations, based on the uniqueness of different facilities

- Warehouses where the racks are more narrow, where AP to rack height separation is larger, and/or when the materials stored are not large attenuators of RF, or where racks are fairly open all the time (clothes, some paper goods, etc) can allow for larger margins between AP spacing, skipping every other aisle for AP placement, etc.
- Open storage, or palletized storage sometimes follow the same rules, but these usually have larger aisles, and are not stacked as tall vertically, and are more forgiving to RF propagation based on the common arrangements of the stacks

As with all deployments of this kind, it’s CRITICAL that tools like Ekahau Site Survey be used to model, change, analyze and validate AP placement and RF propagation. Ekahau supports the creation of ‘RF Attenuation Areas’ (used in the heatmaps above) that can model the type of attenuation seen in warehouses.

How We Do Competitive

How does Aruba compare?

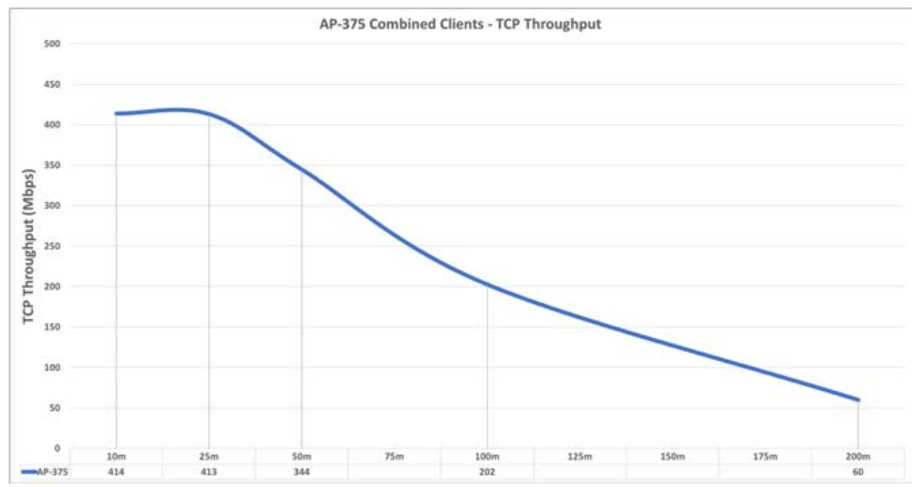
What is 3-Client Averaging?

To simplify competitive analysis, the three individual client results are average at each test point

Essentially the “Client Average = (Client1+Client2+Client3)/3”

This 3-Client Averaging allows for generalizing about client performance in a more simple visualization, while maintaining the average trending over distance

AP-375 - 3 Individual Clients



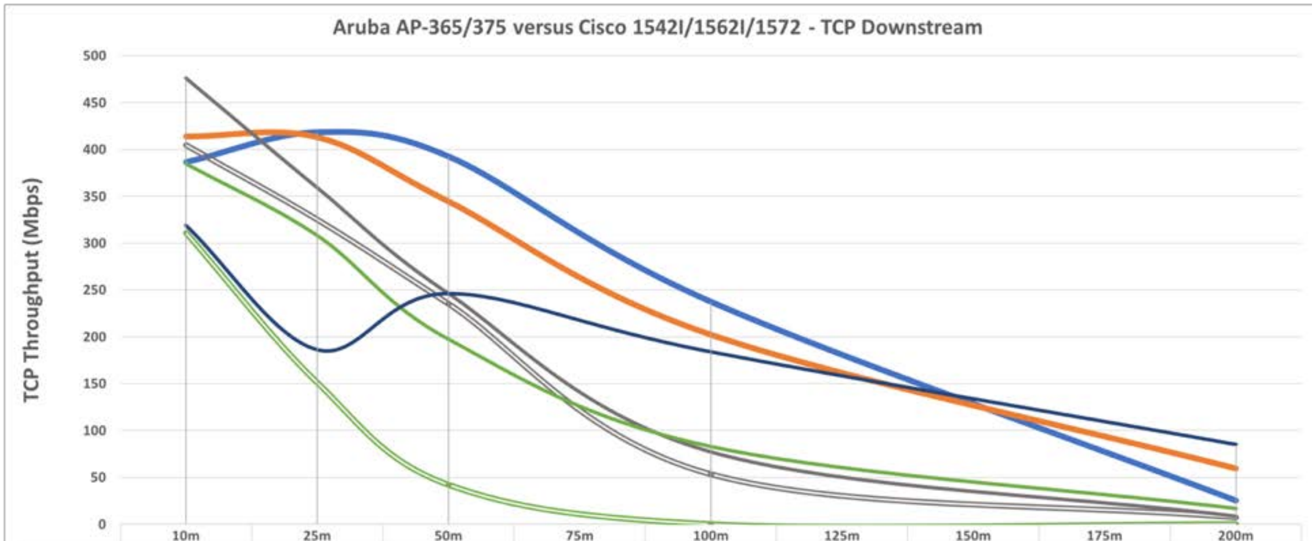
AP-375 - 3-Client Average

Aruba Omnis versus Cisco Omnis

3-Client Averaging Results, 5Ghz VHT80 Ch149

All Aruba Omnis versus All Cisco Omnis

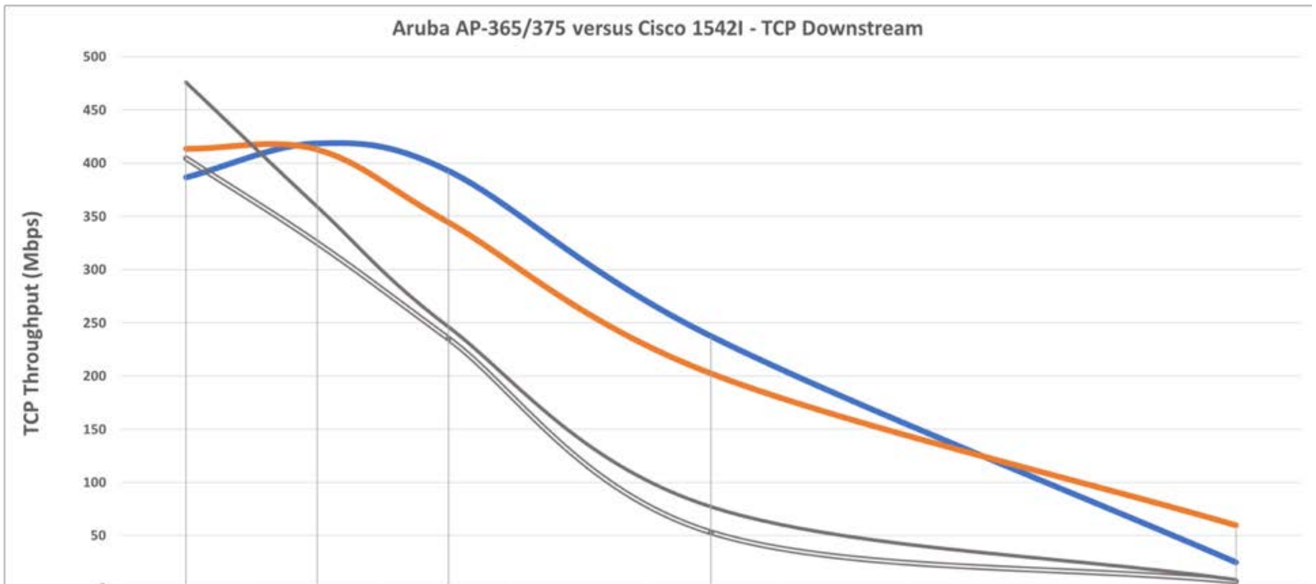
A bit noisy, due to the two plots for each 1542I and 1562I to account for orientation differences. However, the general trend shows the AP-365 and AP-375 outperforming all Cisco AP except at the 200m mark, where the higher gain 1572E 8dBi antennas give an edge



	10m	25m	50m	75m	100m	125m	150m	175m	200m
AP365	387	419	393		238				25
AP375	414	413	344		202				60
1542I-Front	476	359	246		77				8
1542I-Side	405	325	235		53				7
1562I-Front	311	151	42		0				0
1562I-Side	385	308	198		83				17
1572E	319	186	246		184				85

All Aruba Omnis versus 1542I

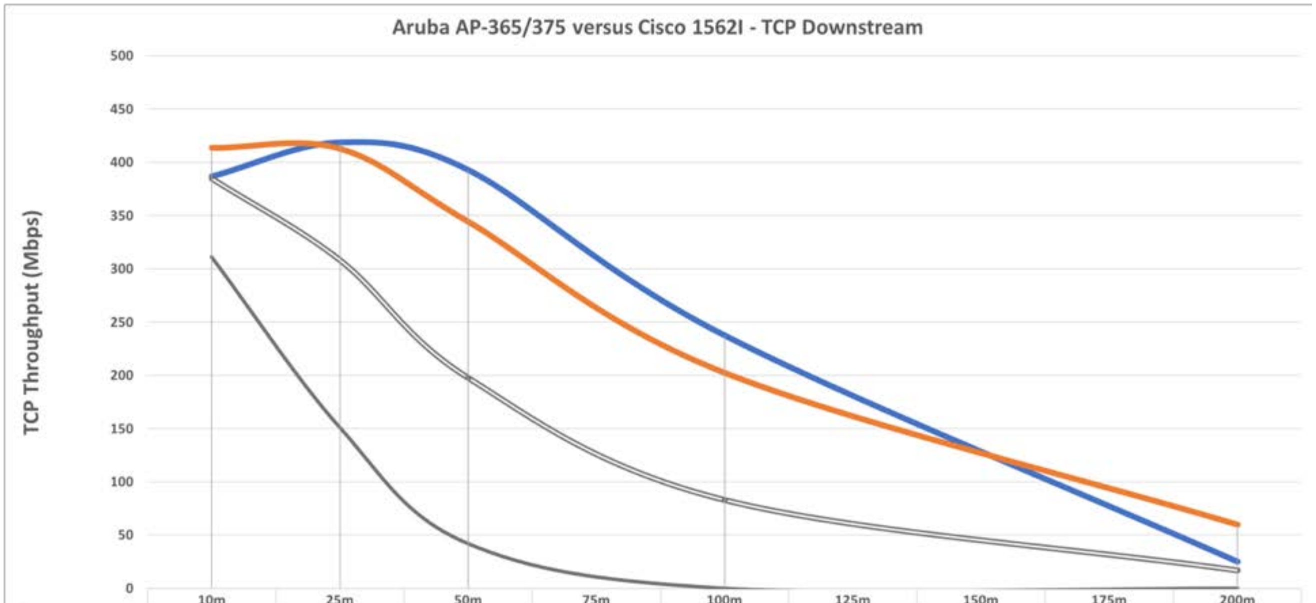
There really is no comparison here, the 1542I is handily outperformed by both Aruba AP models



	10m	25m	50m	75m	100m	125m	150m	175m	200m
AP365	387	419	393		238				25
AP375	414	413	344		202				60
1542I-Front	476	359	246		77				8
1542I-Side	405	325	235		53				7

All Aruba Omnis versus 1562I

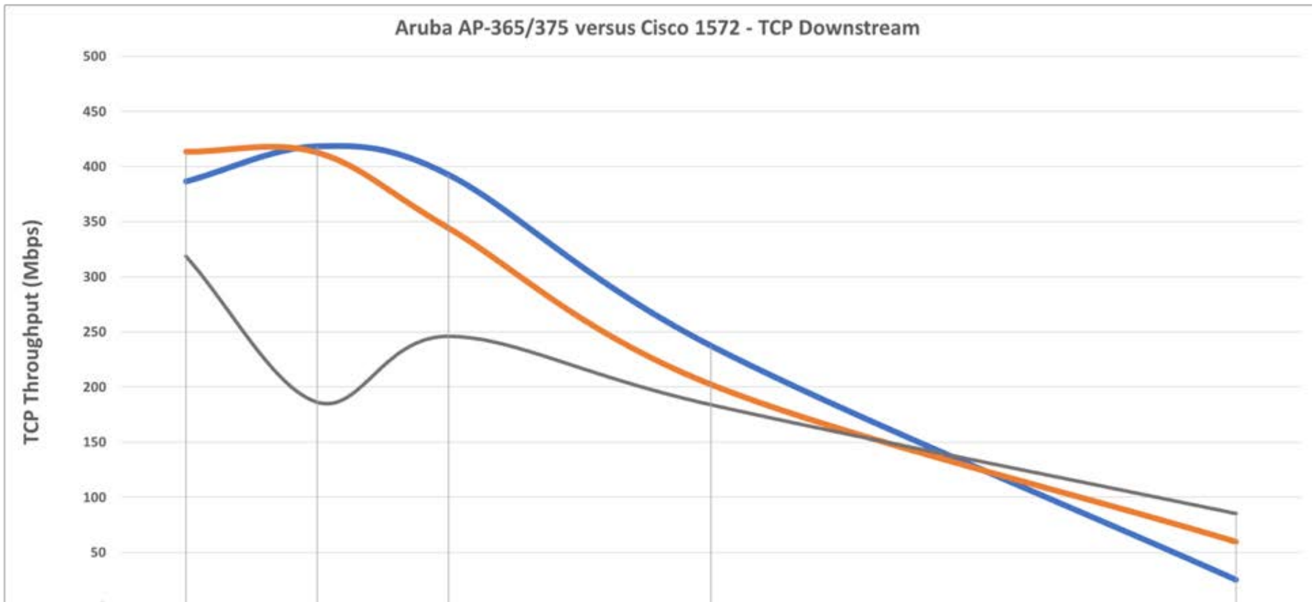
The stark difference in the two orientations of the 1562I come in to sharp focus here, as the ‘forward’ orientation is just unusable



	10m	25m	50m	75m	100m	125m	150m	175m	200m
AP365	387	419	393		238				25
AP375	414	413	344		202				60
1562I (Forward)	311	151	42		0				0
1562I (Side)	385	308	198		83				17

All Aruba Omnis versus 1572E+8dBi Omnis

Even with a 3dBi edge on the antenna gain, the 1572E is handily outperformed except at the 200m distance



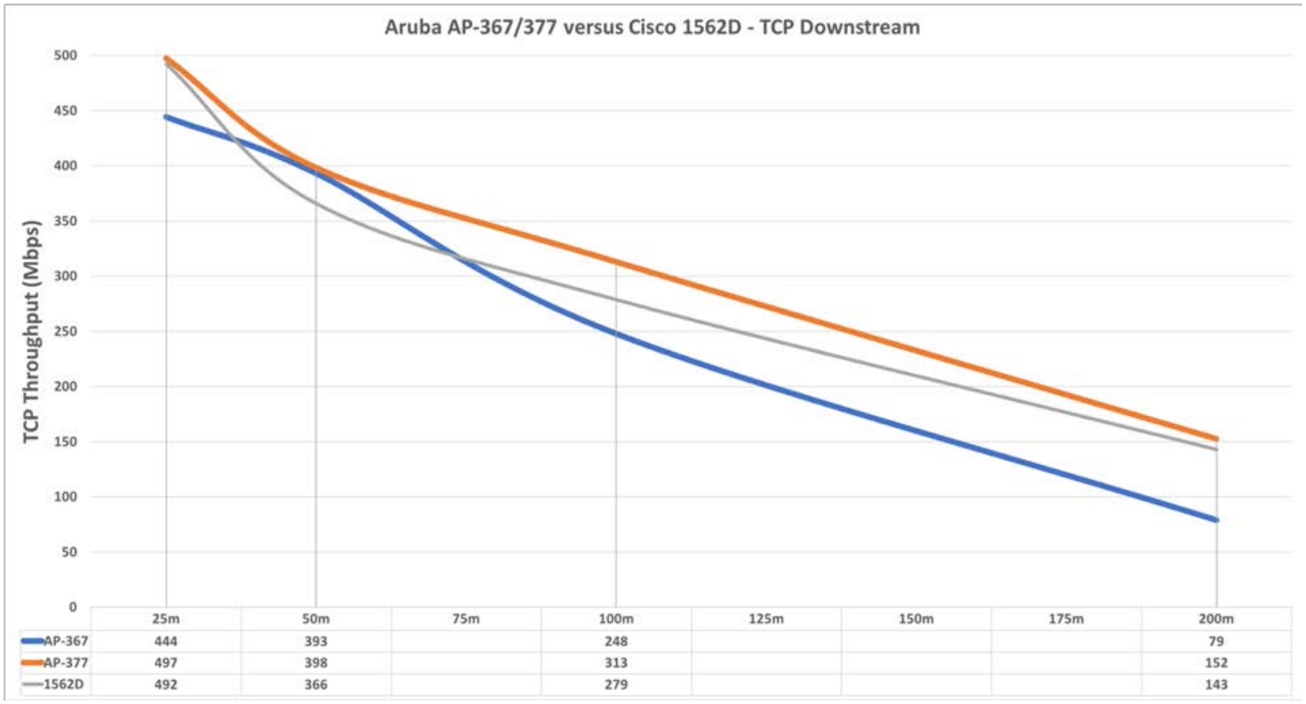
	10m	25m	50m	75m	100m	125m	150m	175m	200m
AP365	387	419	393		238				25
AP375	414	413	344		202				60
1542I-Front	319	186	246		184				85

Aruba Directional versus Cisco Directional

3-Client Averaging Results, 5Ghz VHT80 Ch149

All Aruba Omnis versus 1562D

Very even performance between all three models, with the Cisco 1562D right in between the AP-367 and AP-377

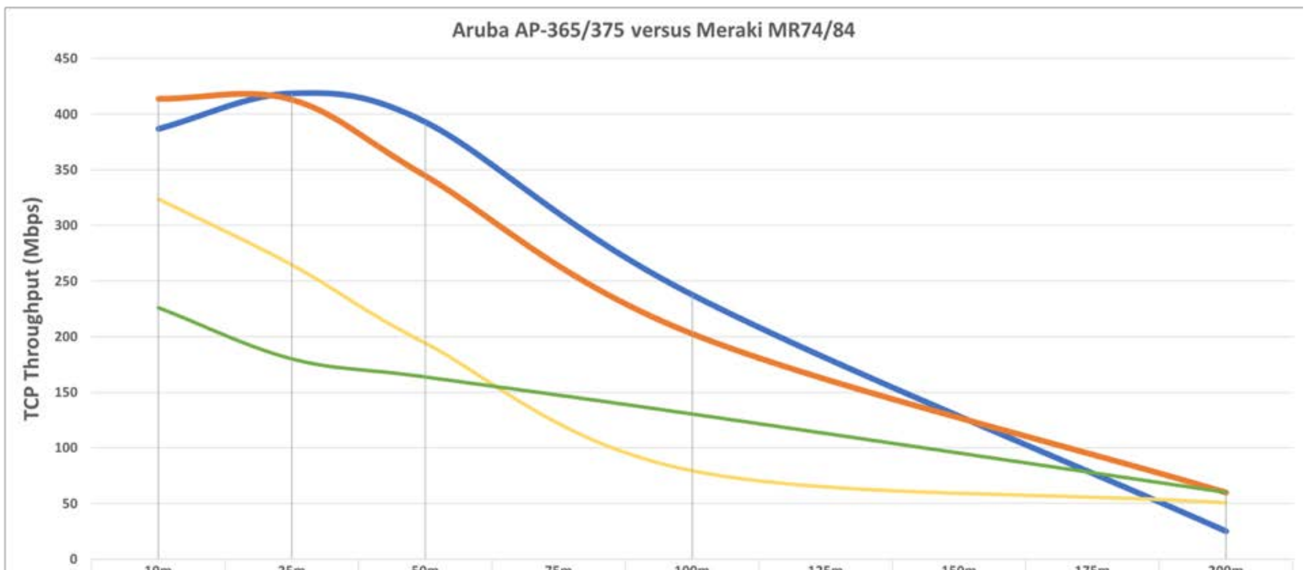


Aruba Omnis versus Meraki Omnis

3-Client Averaging Results, 5Ghz VHT80 Ch149

All Aruba Omnis versus Meraki MR74 and MR84

Both Meraki models are easily out performed by both Aruba models. Additionally, the MR74 seems to outperform the MR84 at close range



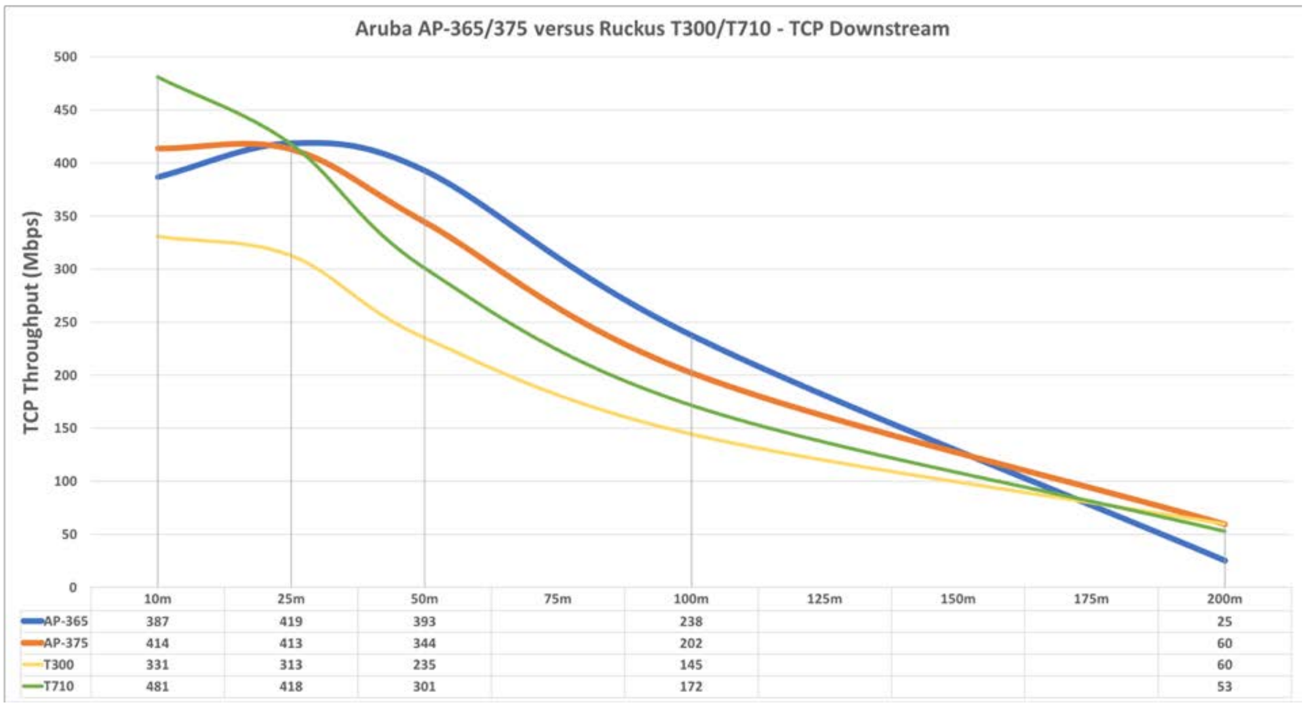
	10m	25m	50m	75m	100m	125m	150m	175m	200m
AP-365	387	419	393		238				25
AP-375	414	413	344		202				60
AP74	324	265	194		80				51
AP84	226	180	164		131				60

Aruba Omnis versus Ruckus Omnis

3-Client Averaging Results, 5Ghz VHT80 Ch149

All Aruba Omnis versus Ruckus T300 and T710

The T710 has a good showing with very high throughput at the 10m mark, and matches Aruba at the 25m mark, but then drops lower at 100m to catch up at 200m. The T300 is outperformed across the board until 200m, which is outside the AP-365's design guidance



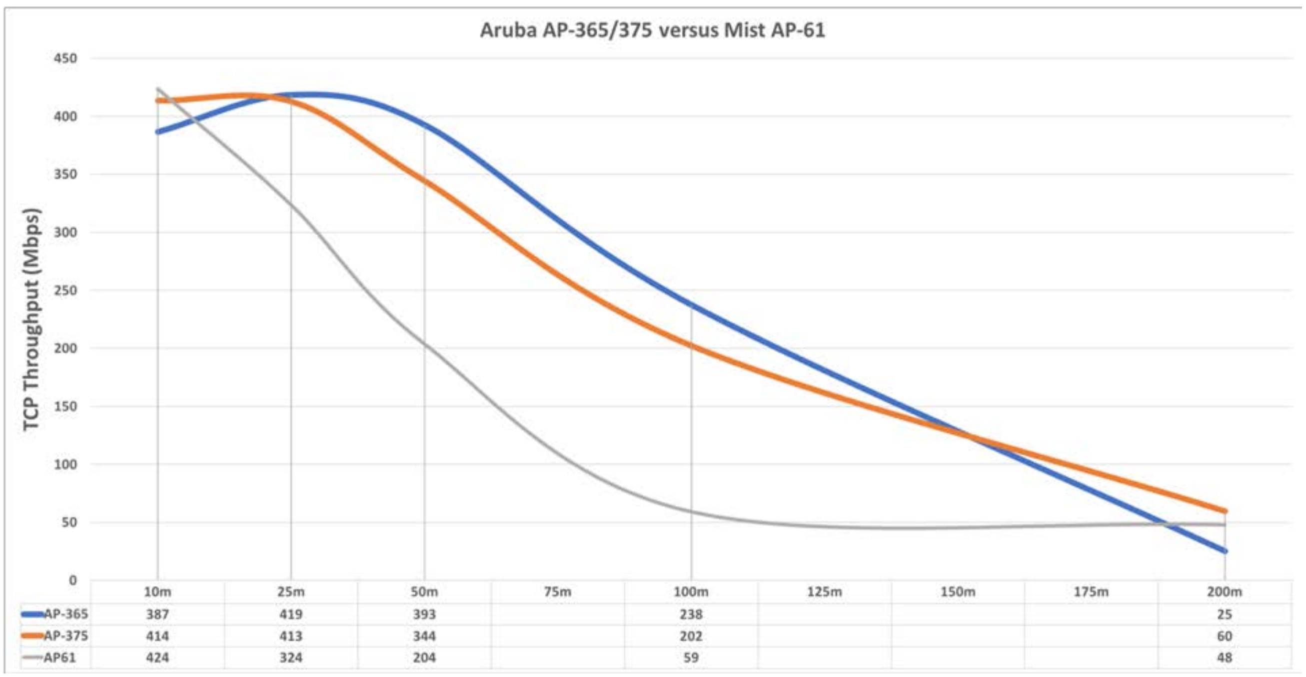
	10m	25m	50m	75m	100m	125m	150m	175m	200m
AP-365	387	419	393		238				25
AP-375	414	413	344		202				60
T300	331	313	235		145				60
T710	481	418	301		172				53

Aruba Omnis versus Mist Omnis

3-Client Averaging Results, 5Ghz VHT80 Ch149

All Aruba Omnis versus Mist AP61

The Mist AP61 seems to fall significantly short in the most useable ranges of coverage (between 10m and 200m) when compared to the AP-365 and AP-377. The Mist outdoor AP is generally a very poor performer.



Designs and Best Practices

#GoodWiFi and #BadWiFi

atmosphere'19

Best Practices for Survey on Outdoor Service or Mesh

- **Know the environment, validate line of sight**
- **Know who owns what (mounting infrastructure, power, assets, operations, etc)**
- **Physical Site Survey**
  - Survey both 2.4and 5Ghz at the client level, as well as 5Ghz at the portal and point locations
  - Take pictures of all mounting locations, client coverage areas, etc
  - Use Google Earth to build KMZs that show coverage areas, building names/locations, etc
  - Use the 3D Outdoor Planner for ‘Soft Planning”, as well as any other planning tools available (Ekahau, VisualRF, etc)
- **Read through Ch 10 on the “Outdoor MIMO VRD” for more specific guidelines**

Examples of Bad Installs (#BadFi)

- AP-275 installed upside down
- Most of the RF is going up into the air
- The mount arm being upside down means it will collect rainwater, not shed it
- The bottom of the AP-275 has a water-proof goretex pressure vent on it. That will be underwater and will degrade over time to the point water will get into the chassis.
- The vented solar shield cannot shed water either, and will likely collect in there. If it freezes, may crack the solar shield as well.

Examples of Bad Installs (cont'd)

- The example on the left has the antenna aiming straight at the post, blocking the signal!
- The example on the right has the antenna aimed at the sky instead of the ground where clients are.

Examples of Bad Installs (cont'd)

- Most cabling companies do not have experience with low-loss RF cable such as LMR or Heliax
- <u>ANY</u> bend exceeding the bend radius or damage to the geometry of a coaxial cable reduces its performance and increases loss.

Examples of Bad Installs (cont'd)

- AP installed directly over the racks
- Antenna are oriented incorrectly, or wrong antennas were possibly chosen, hard to tell the intent here

- How much RF is getting past that I-beam? A pendant mount would be an easy solution here

@dammitjacob

@cleartosend

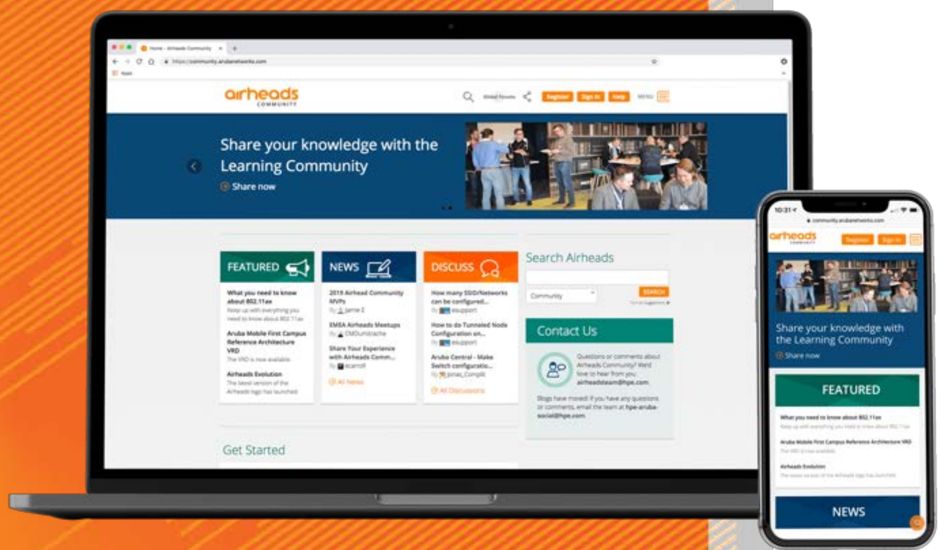
Examples of Bad Installs (cont'd)

- If you've flown and walked down the jet bridge, you've seen AP-228s at the end
- This one apparently fell, either knocked off or a fastener failed, possibly insecure mount
- Good news, the gland is over the cable so it didn't fall, this is first I've seen with the gland actually installed
- Bad news, that connector will have to be replaced

@theTrebel

Q&A

Who wants to go first?



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