LANCOM Techpaper
Performance comparison Wi-Fi 6

The wireless LAN standard Wi-Fi 6 is becoming more and more established on the market. On the one hand, an increasing number of manufacturers are including Wi-Fi 6-capable access points in their portfolios, while, on the other hand, the number of compatible end devices such as laptops and smartphones is also increasing. But what performance can you realistically expect in everyday working life? Based on tests, this techpaper provides sound answers to this question.

With regard to the access points, the Wi-Fi 6 access points LANCOM LX-6400, LX-6402, and LW-600 were compared with comparable products available on the market in terms of throughput and signal strength. With regard to the end devices, Wi-Fi 5- and Wi-Fi 6-capable laptops were used. The test took place in an office wing to ensure realistic and representative results for a business environment.

Test setup

For the tests a distinction is made between 2-stream and 4-stream access points. The table lists the used devices in the two categories:

2-stream access point	4-stream access point
LANCOM LW-600 (LCOS LX 5.30.0001)	LANCOM LX-6400 (LCOS LX 5.30.0001)
Aruba AP-505 (FW v8.6.0.2_73853)	LANCOM LX-6402 (LCOS LX 5.30.0001)
Aruba Instant On AP22 (FW v2.1.1)	Cisco Meraki MR45 (MR 27.5)
	Aruba AP-534 (FW v8.6.0.6_77124)

As end devices, Lenovo laptops based on Windows 10 and the Apple MacBook Pro 13" with macOS 10.15.7 were used. The drivers used were up-to-date at the time of testing (week 44 / 2020).

The laptops are distributed over several offices (see figure 1 on page 2). They are permanently installed in their respective positions and connected via power supply units in order to exclude any change of location and any influences from energy-saving mechanisms.

Laptop	Wi-Fi module	Position
Lenovo 80EW	Intel AX-200, Wi-Fi 6, 2 streams	6: A, B, C, D, F, G
Lenovo 80EW	Intel 7260, Wi-Fi 5, 2 streams	1: E
Apple MacBook Pro 13"	Broadcom BCM43602, Wi-Fi 5, 3 streams	3: C, E, G

The measurements were performed on a total of three channels, one in the 2.4 GHz band with 20 MHz channel width and the other two in the 5 GHz band with 80 MHz channel width each.

Frequency band	Channel	Channel width	Allowed transmission power
2.4 GHz	6	20 MHz	100 mW (20 dBm)
5 GHz	52	80 MHz	200 mW (23 dBm)
5 GHz	100	80 MHz	1000 mW (30 dBm)

For each test step the performance against a single client was evaluated. In this way, maximum performance was available to each client, and it was ensured that the environment was as free of interference as possible, with a base load from other networks, particularly in the 2.4 GHz band.

Throughput measurement

The throughput measurement was carried out with iPerf v2.0.12, which measured the TCP data throughput between two computers. In the test setup, a server in the LAN of the access point was connected to the respective Wi-Fi device. Data could be sent from the server via the access point to the terminal device in the download direction as well as from the terminal device to the server in the LAN in the

Figure 1: Distribution of clients in the office wing and the position of the access point

upload direction.

The measurement duration was 60 seconds each, 6 runs were started one after the other per client. To achieve a high throughput, 5 parallel TCP streams were started in each case. At the end the median value of these 6 runs was used for comparison. The measured values obtained correlated very well with the values that can be reproduced in practice on a Wi-Fi connection. This is related to the traffic structure of iPerf compared to an HTTP download.

Results

The results show the signal strength at the client in percent and the median values of the throughputs in Mbps for downstream (DS) and upstream (US) direction. In general, the better the signal level at the client, the better the performance of the access point in the direction of the client should be. With increasing distance between access point and clients, a lower signal strength is expected. In addition to the distance, obstacles such as cabinets or walls also have an impact, as they can additionally weaken the signal.

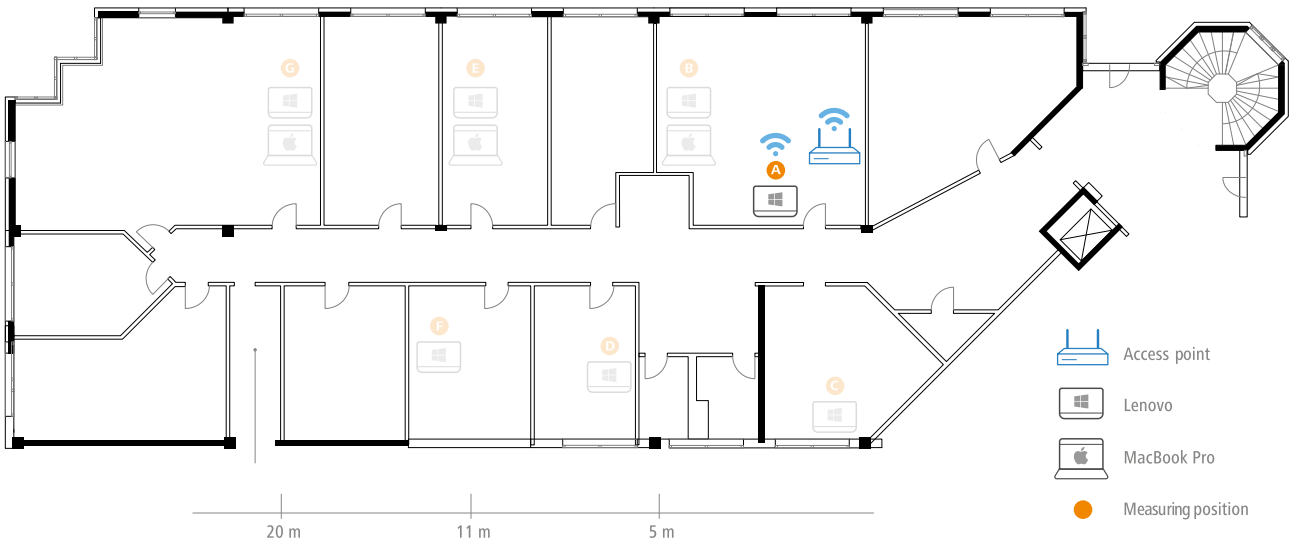
Conclusion

The results provide an orientation as to which throughputs are realistic against end devices with Wi-Fi 5 and Wi-Fi 6 over different distances. It is shown that common end devices can make good use of the performance advantage of 4-streamers compared to 2-streamers in practice.

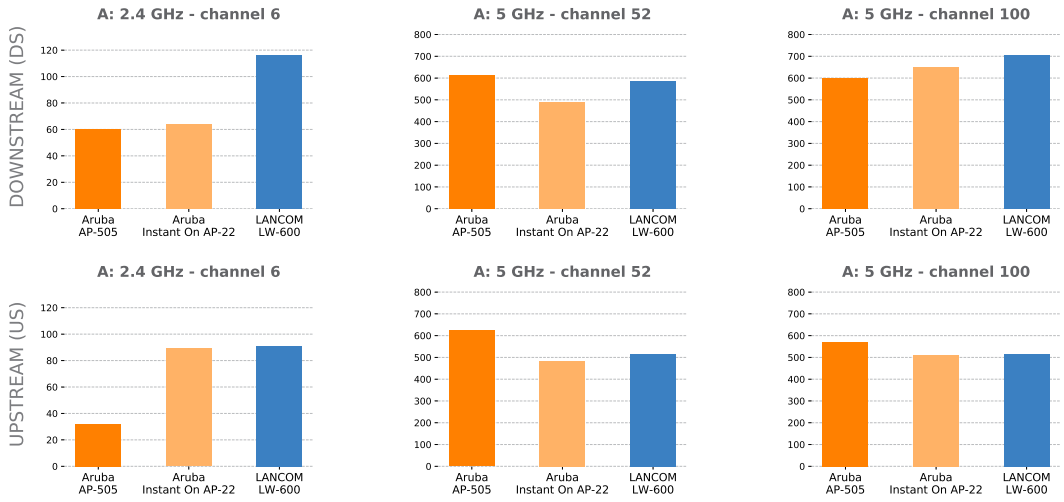
Throughput comparison of all access points involved

2-stream access point	Summarized data throughput (Mbps)	Number of measurements	Averaged data throughput per device (Mbps)
LANCOM LW-600	15,200	60	253
Aruba AP-505	13,353	60	223
Aruba Instant On AP22	12,621	60	210
4-stream access point	**Summarized data throughput (Mbps)**	**Number of measurements**	**Averaged data throughput per device (Mbps)**
LANCOM LX-6402	21,549	60	359
LANCOM LX-6400	20,305	60	338
Aruba AP-534	20,289	60	338
Cisco Meraki MR45	18,090	60	302

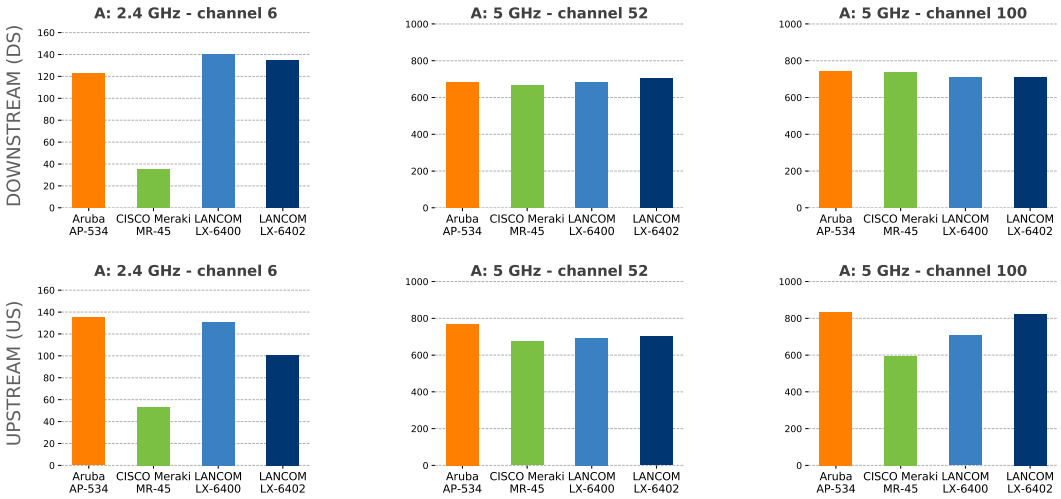
Measuring position A (approx. 4 m distance)



Client: Lenovo 80EW with Wi-Fi 6, 2 streams

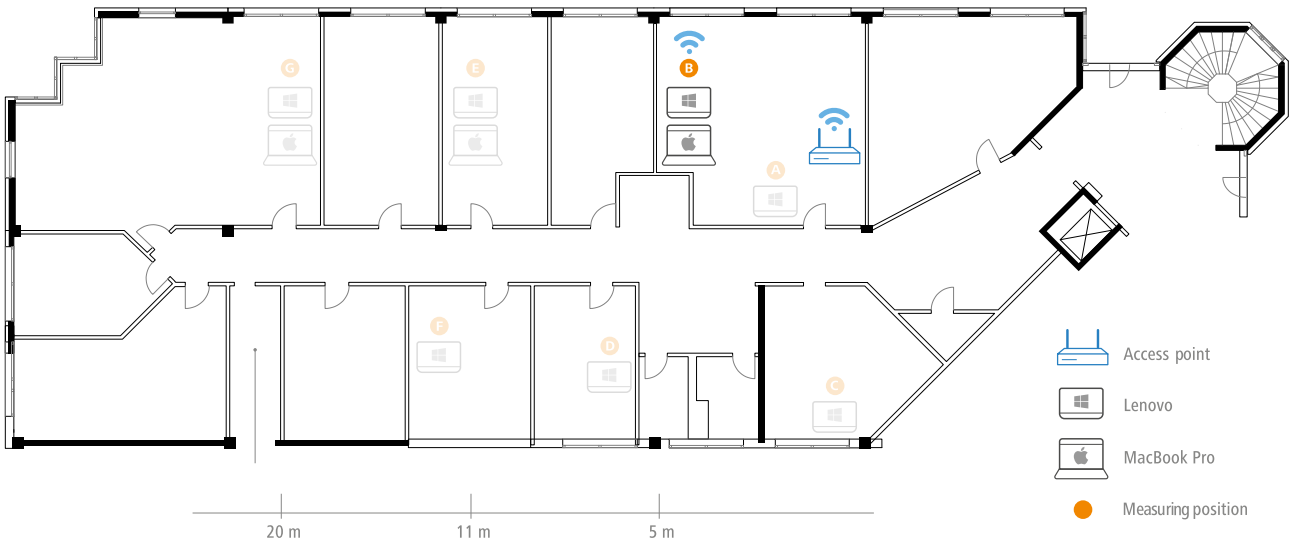


2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	95 / 116 / 91	92 / 585 / 516	91 / 704 / 516
Aruba AP-505	88 / 60 / 32	91 / 612 / 624	92 / 598 / 571
Aruba Instant On AP22	95 / 64 / 89	97 / 488 / 484	91 / 649 / 510

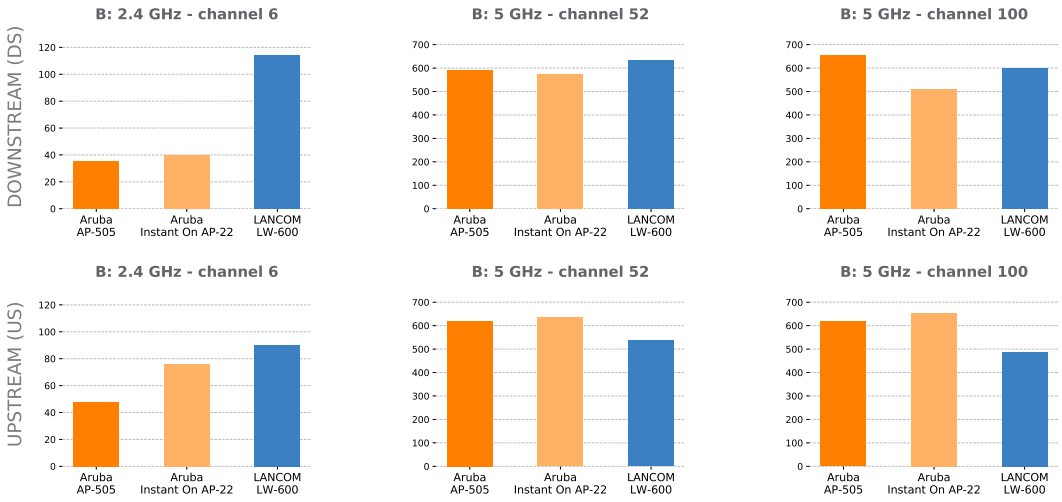


4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	89 / 140 / 131	91 / 681 / 695	96 / 710 / 707
LANCOM LX-6402	93 / 135 / 101	91 / 706 / 701	95 / 712 / 824
Cisco Meraki MR45	96 / 35 / 53	93 / 666 / 674	97 / 736 / 593
Aruba AP-534	91 / 123 / 135	93 / 680 / 768	92 / 740 / 834

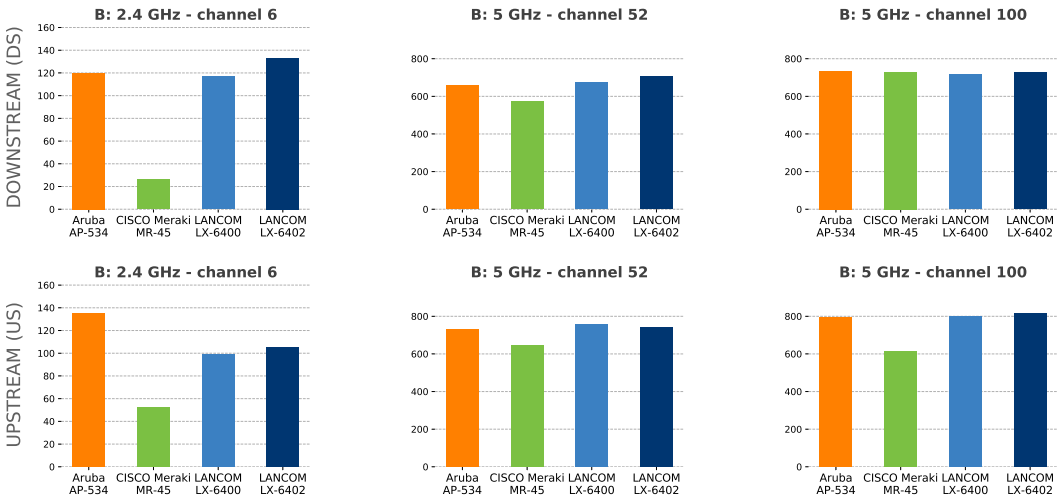
Measuring position B (approx. 5 m distance)



Client: Lenovo 80EW with Wi-Fi 6, 2 streams

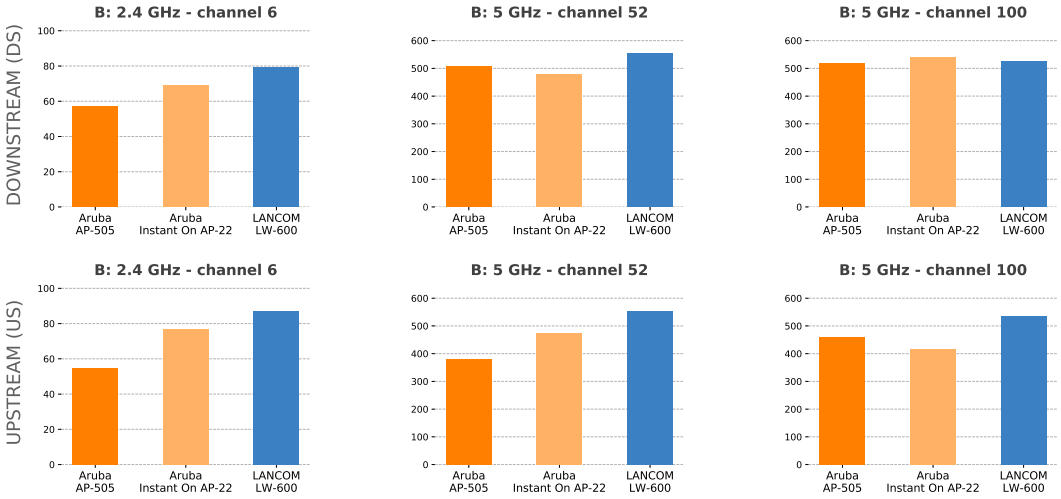


2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	93 / 114 / 90	91 / 634 / 536	91 / 601 / 488
Aruba AP-505	89 / 35 / 48	87 / 590 / 621	89 / 654 / 617
Aruba Instant On AP22	93 / 40 / 76	95 / 574 / 634	90 / 509 / 654

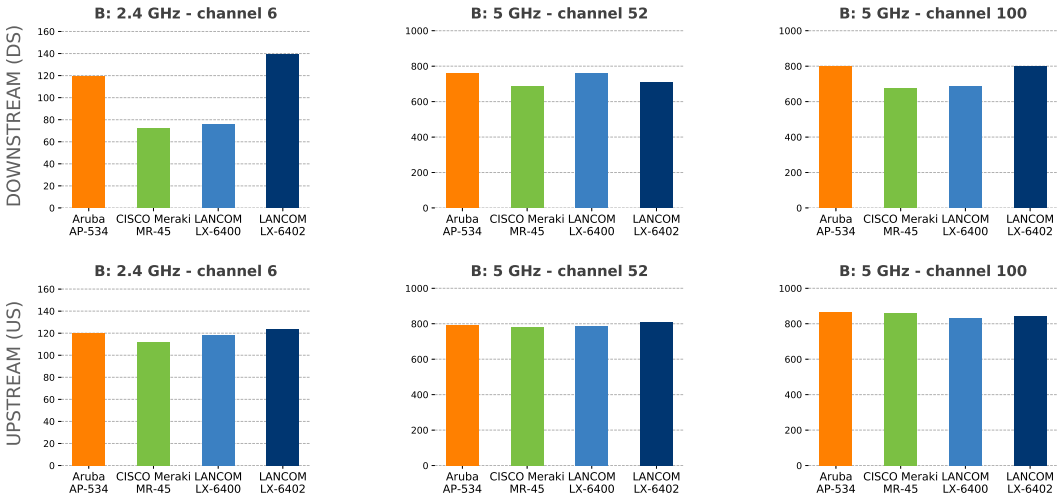


4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	88 / 117 / 99	91 / 675 / 756	97 / 716 / 800
LANCOM LX-6402	93 / 133 / 105	95 / 705 / 741	97 / 727 / 815
Cisco Meraki MR45	91 / 26 / 52	89 / 572 / 647	92 / 729 / 615
Aruba AP-534	89 / 120 / 135	93 / 659 / 733	95 / 735 / 797

Client: MacBook Pro with Wi-Fi 5, 3 streams



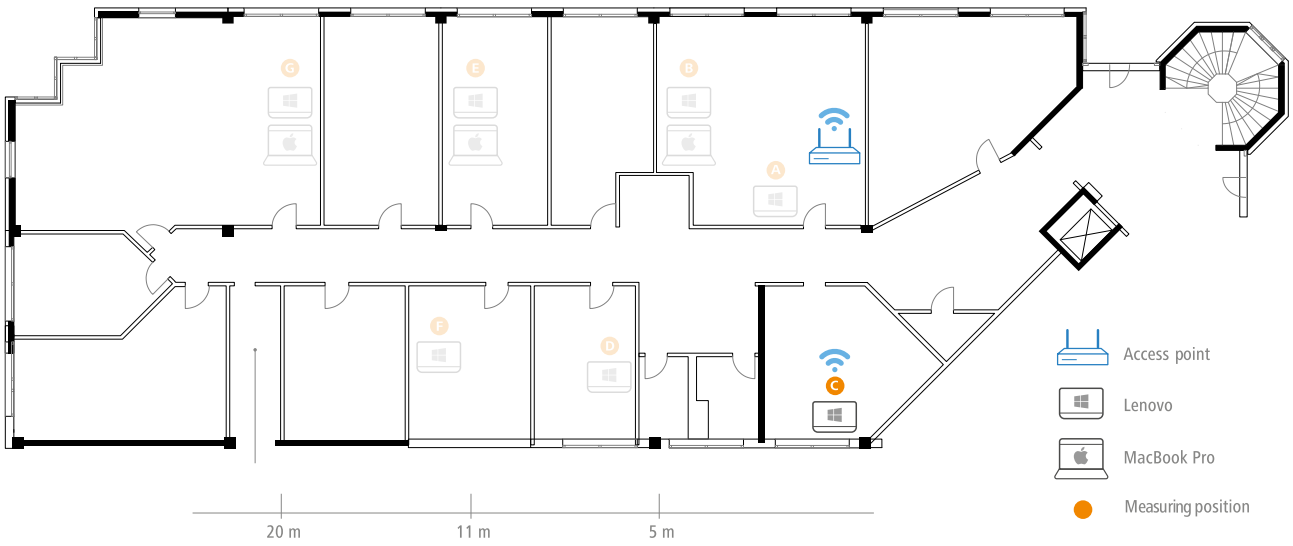
2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	79 / 79 / 87	77 / 552 / 553	78 / 525 / 536
Aruba AP-505	74 / 57 / 55	72 / 507 / 380	77 / 518 / 460
Aruba Instant On AP22	81 / 69 / 77	81 / 478 / 473	76 / 539 / 416



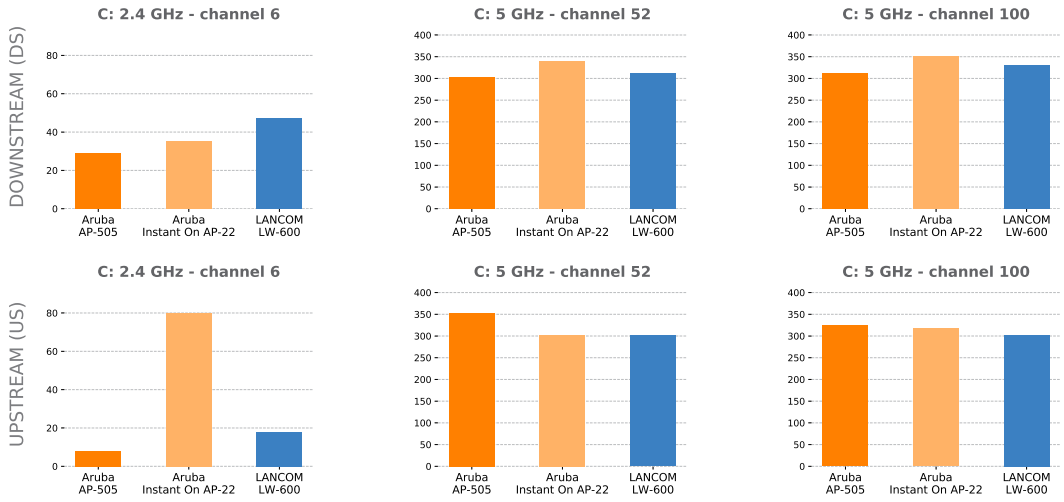
4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	80 / 76 / 118	76 / 761 / 786	80 / 686 / 831
LANCOM LX-6402	75 / 139 / 124	76 / 706 / 811	80 / 801 /842
Cisco Meraki MR45	76 / 72 / 112	75 / 686 / 780	77 / 674 / 861
Aruba AP-534	77 / 119 / 120	74 / 759 / 793	76 / 800 / 865

LANCOM Systems

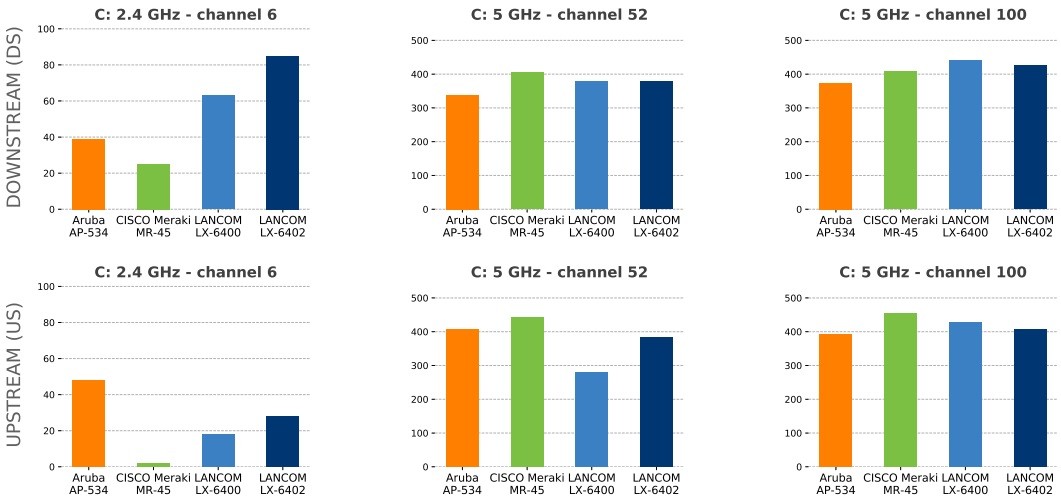
Measuring position C (approx. 7 m distance)



Client: Lenovo 80EW with Wi-Fi 6, 2 streams

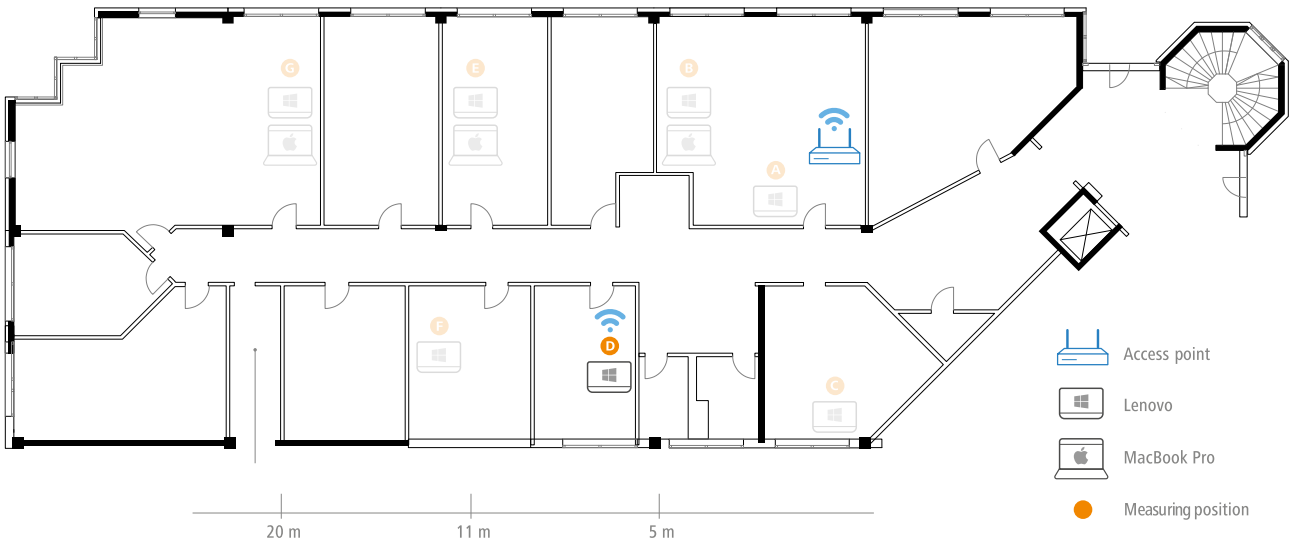


2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	85 / 47 / 18	83 / 312 / 301	83 / 331 / 302
Aruba AP-505	82 / 29 / 8	80 / 302 / 353	83 / 312 / 324
Aruba Instant On AP22	87 / 35 / 80	87 / 340 / 303	82 / 352 / 317

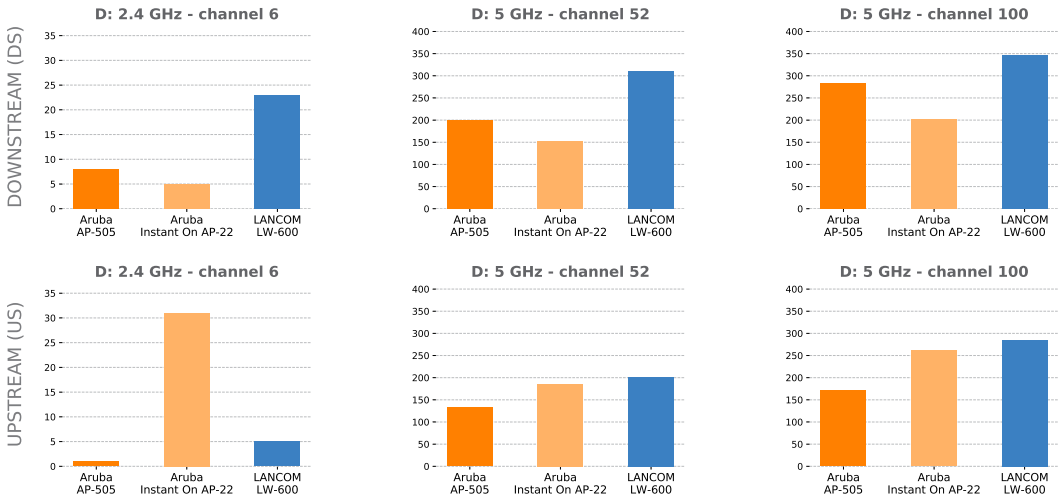


4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	82 / 63 / 18	81 / 379 / 280	87 / 441 / 429
LANCOM LX-6402	83 / 85 / 28	82 / 378 / 383	86 / 426 / 407
Cisco Meraki MR45	83 / 25 / 2	82 / 405 / 444	86 / 408 / 454
Aruba AP-534	80 / 39 / 48	85 / 338 / 408	84 / 374 / 392

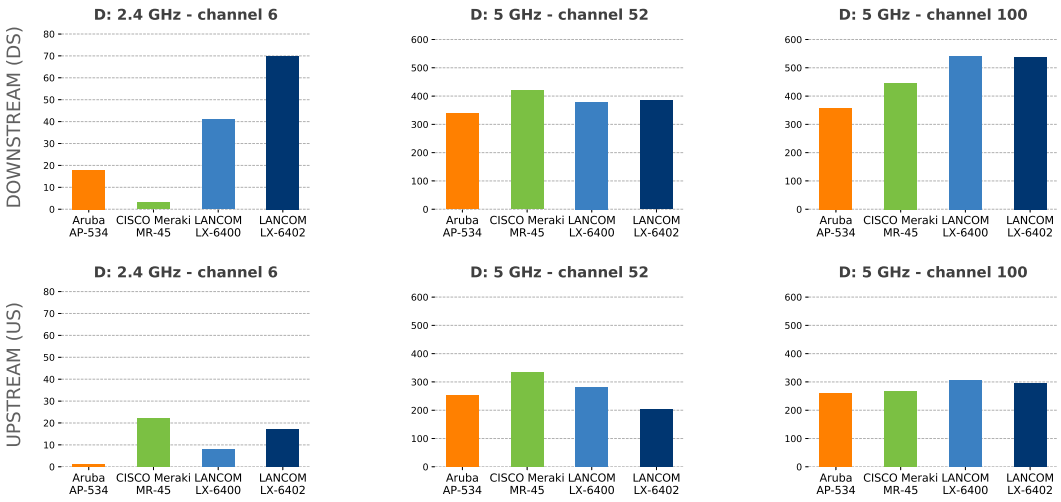
Measuring position D (approx. 10 m distance)



Client: Lenovo 80EW with Wi-Fi 6, 2 streams

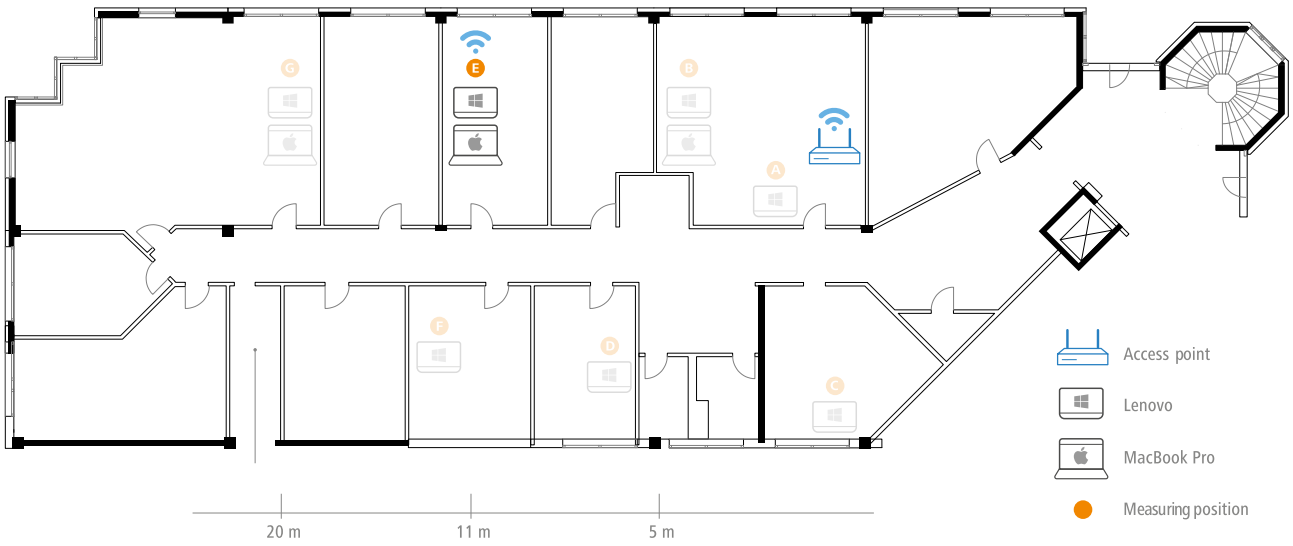


2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	78 / 23 / 5	80 / 311 / 201	75 / 346 / 285
Aruba AP-505	62 / 8 / 1	57 / 199 / 133	65 / 284 / 171
Aruba Instant On AP22	82 / 5 / 31	78 / 152 / 186	72 / 202 / 261

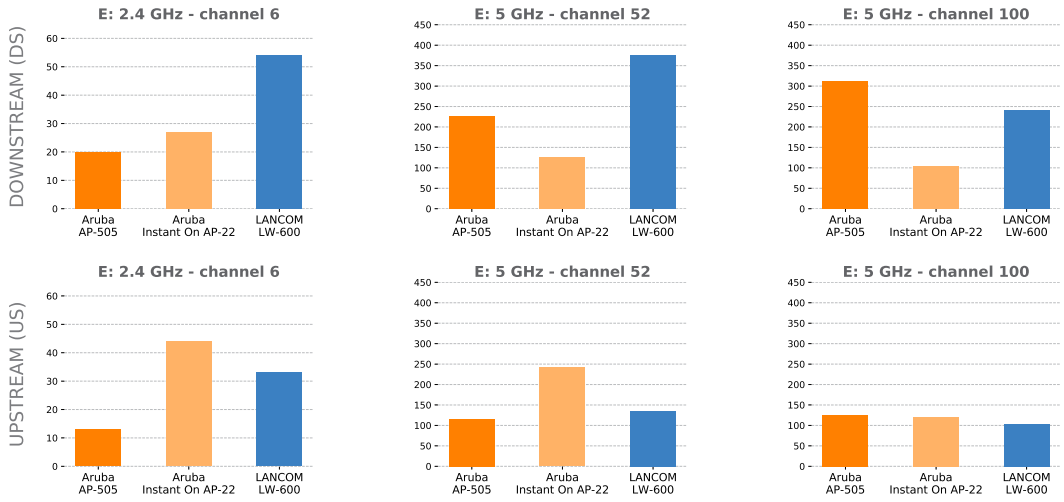


4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	75 / 41 / 8	72 / 379 / 280	83 / 542 / 306
LANCOM LX-6402	82 / 70 / 17	70 / 385 / 205	82 / 538 / 294
Cisco Meraki MR45	80 / 3 / 22	70 / 419 / 335	81 / 446 / 366
Aruba AP-534	70 / 18 / 1	72 / 338 / 251	75 / 358 / 259

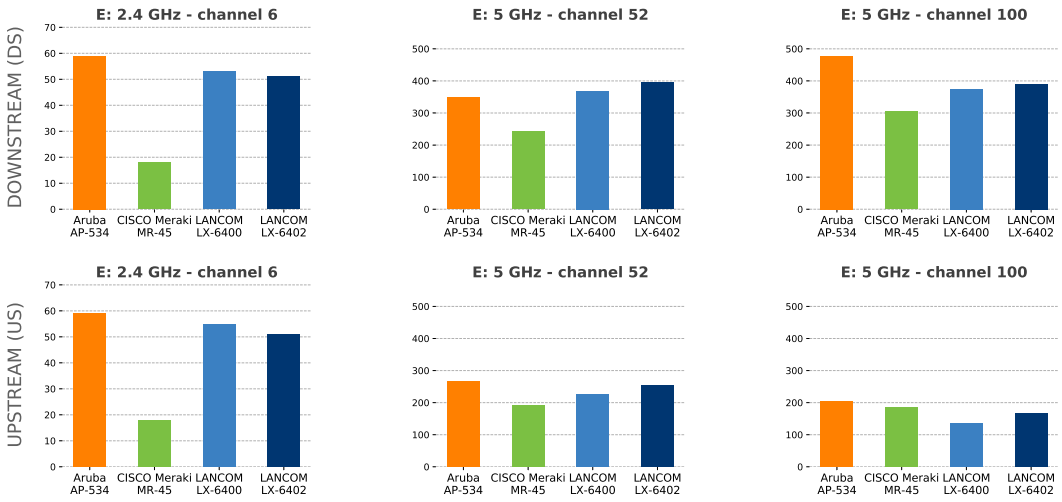
Measuring position E (approx. 11 m distance)



Client: Lenovo 80EW with Wi-Fi 5, 2 streams



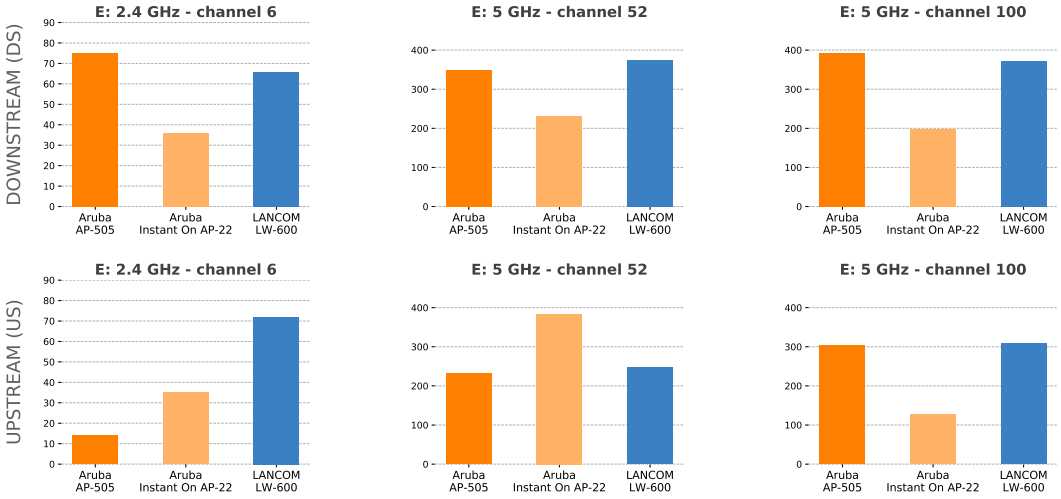
2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	83 / 54 / 33	99* / 375 / 136	99* / 242 / 103
Aruba AP-505	80 / 20 / 13	80 / 226 / 115	99* / 313 / 126
Aruba Instant On AP22	99* / 27 / 44	99* / 127 / 242	99* / 104 / 121



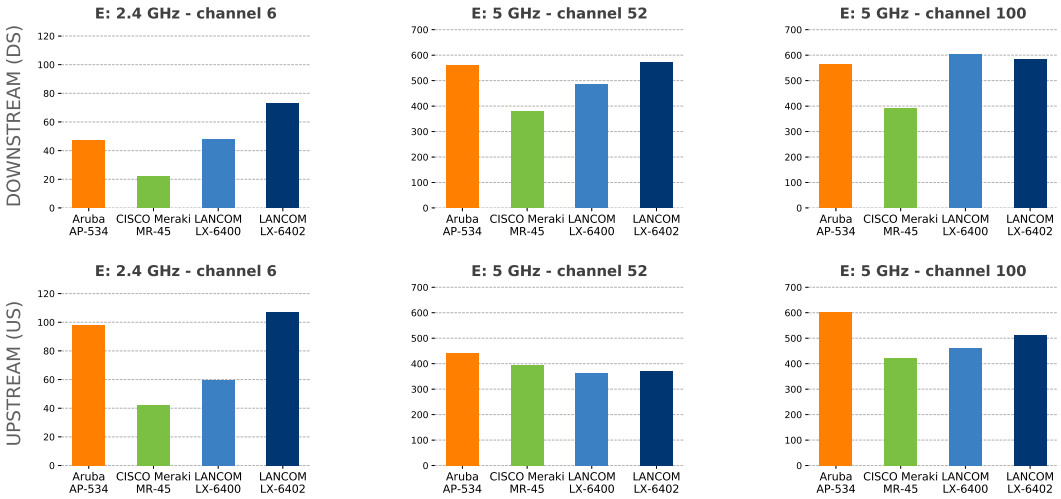
4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	81 / 53 / 55	99* / 368 / 227	99* / 375 / 136
LANCOM LX-6402	81 / 51 / 51	99* / 395 / 255	99* / 390 / 167
Cisco Meraki MR45	76 / 5 / 18	99* / 242 / 193	99* / 305 / 184
Aruba AP-534	99* / 47 / 59	99* / 348 / 266	99* / 478 / 205

* Probably a measurement error, since the value is far above the other values.

Client: MacBook Pro with Wi-Fi 5, 3 Streams

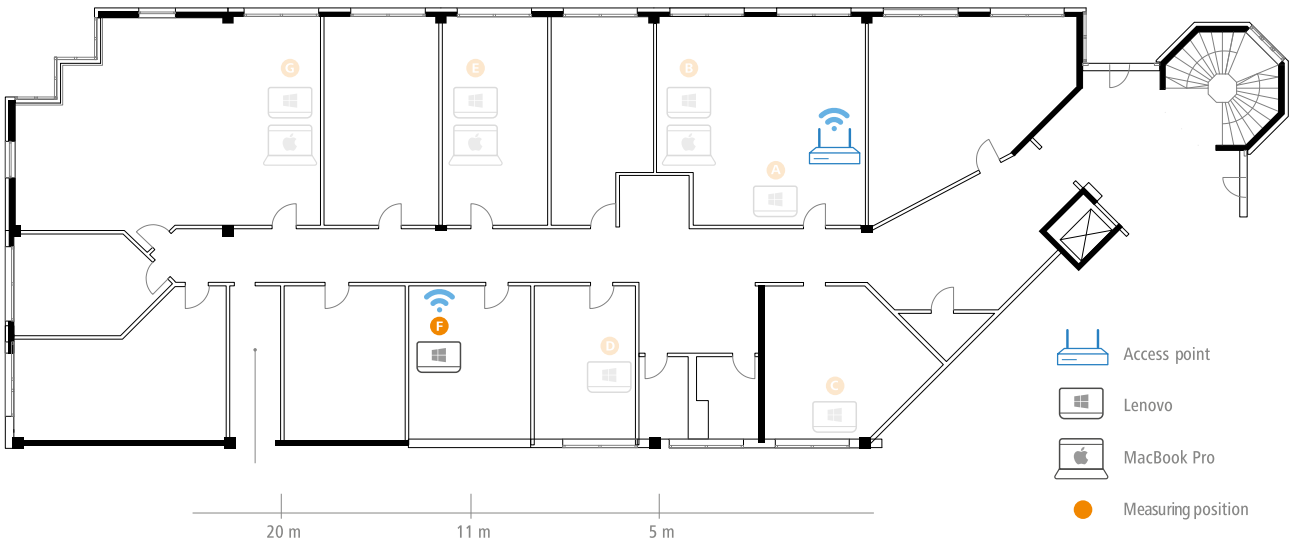


2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	76 / 66 / 72	71 / 375 / 247	72 / 371 / 309
Aruba AP-505	68 / 75 / 14	66 / 348 / 232	71 / 392 / 304
Aruba Instant On AP22	73 / 36 / 35	73 / 232 / 384	70 / 197 / 126

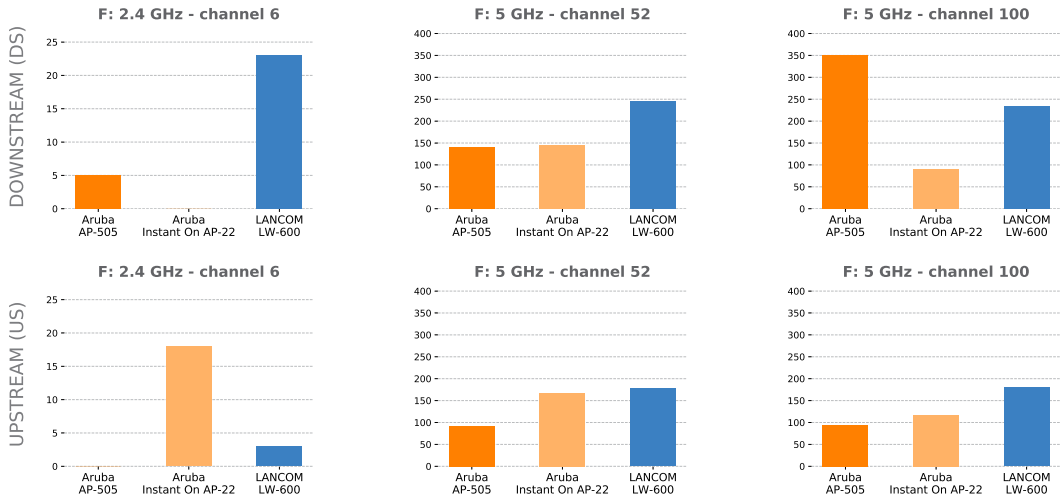


4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	73 / 48 / 60	70 / 486 / 365	77 / 601 / 460
LANCOM LX-6402	81 / 73 / 107	72 / 571 / 373	76 / 585 / 511
Cisco Meraki MR45	72 / 22 / 42	69 / 380 / 394	72 / 390 / 422
Aruba AP-534	71 / 47 / 98	77 / 561 / 441	80 / 563 / 602

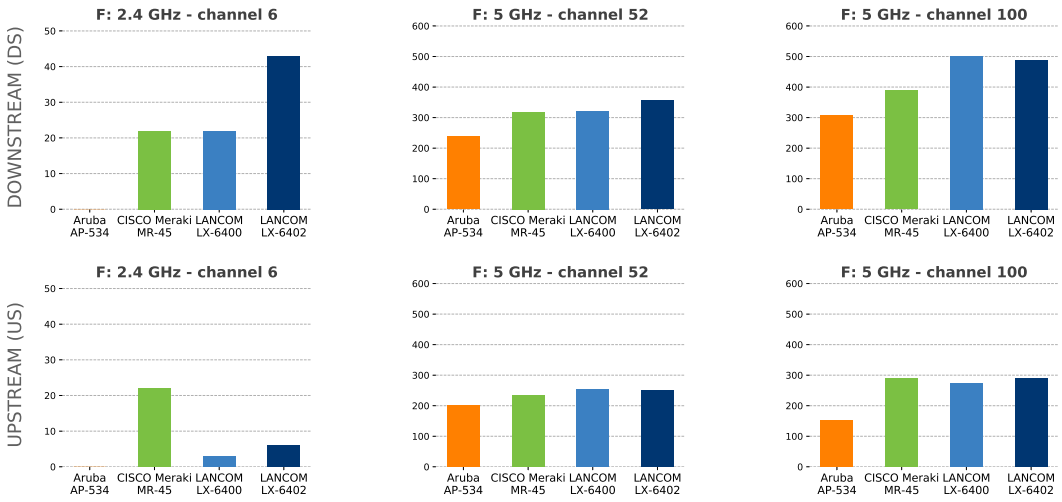
Measuring position F (approx. 13 m distance)



Client: Lenovo 80EW with Wi-Fi 6, 2 streams

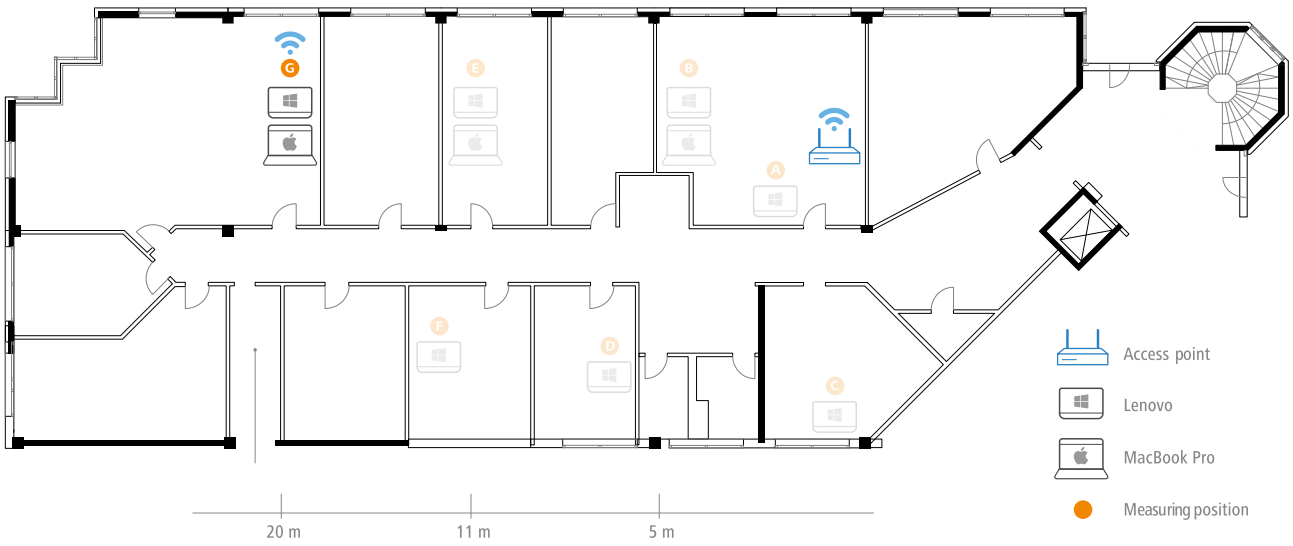


2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	72 / 23 / 3	53 / 245 / 178	62 / 235 / 180
Aruba AP-505	46 / 5 / 0	51 / 140 / 92	62 / 350 / 94
Aruba Instant On AP22	62 / 0 / 18	55 / 146 / 168	72 / 91 / 117

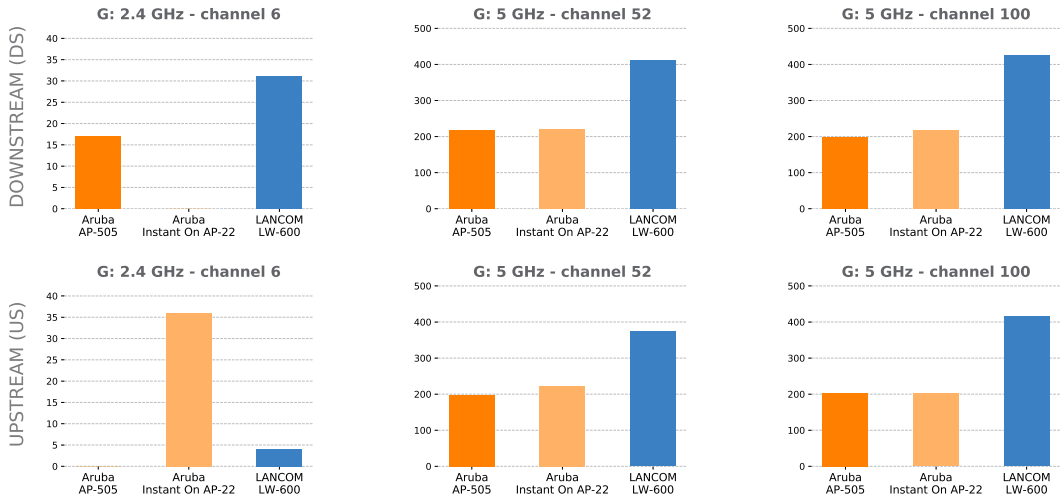


4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	70 / 22 / 3	57 / 322 / 253	82 / 502 / 274
LANCOM LX-6402	78 / 43 / 6	75 / 356 / 249	82 / 488 / 291
Cisco Meraki MR45	70 / 22 / 22	70 / 318 / 235	75 / 389 / 289
Aruba AP-534	53 / 0 / 0	62 / 239 / 202	72 / 307 / 152

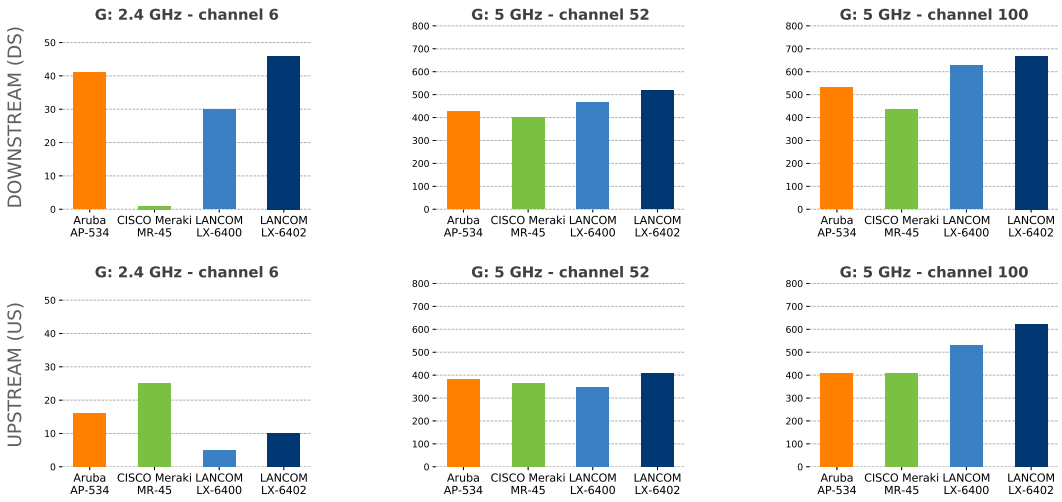
Measuring position G (approx. 20 m distance)



Client: Lenovo 80EW with Wi-Fi 6, 2 streams

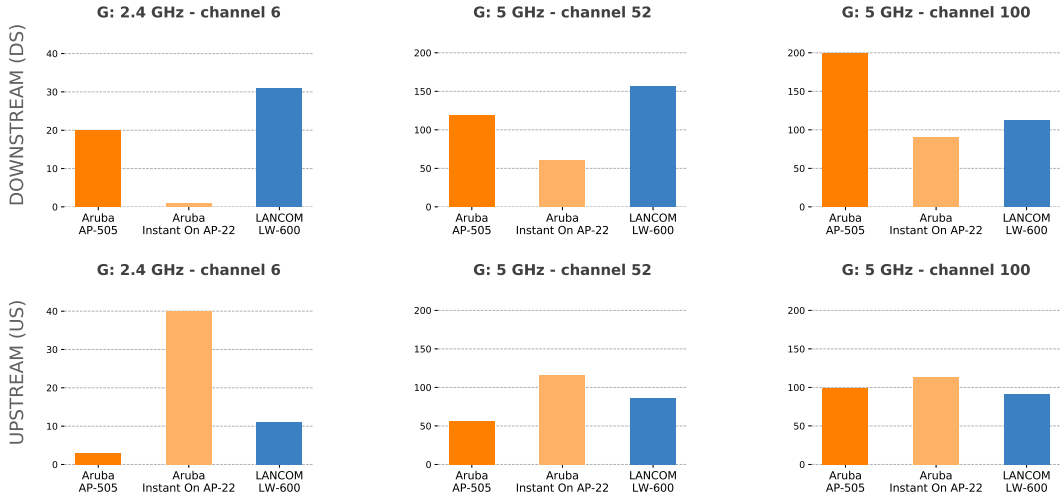


2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	78 / 31 / 4	81 / 411 / 374	81 / 425 / 415
Aruba AP-505	72 / 17 / 0	62 / 217 / 198	75 / 199 / 203
Aruba Instant On AP22	81 / 0 / 36	72 / 220 / 223	81 / 218 / 202

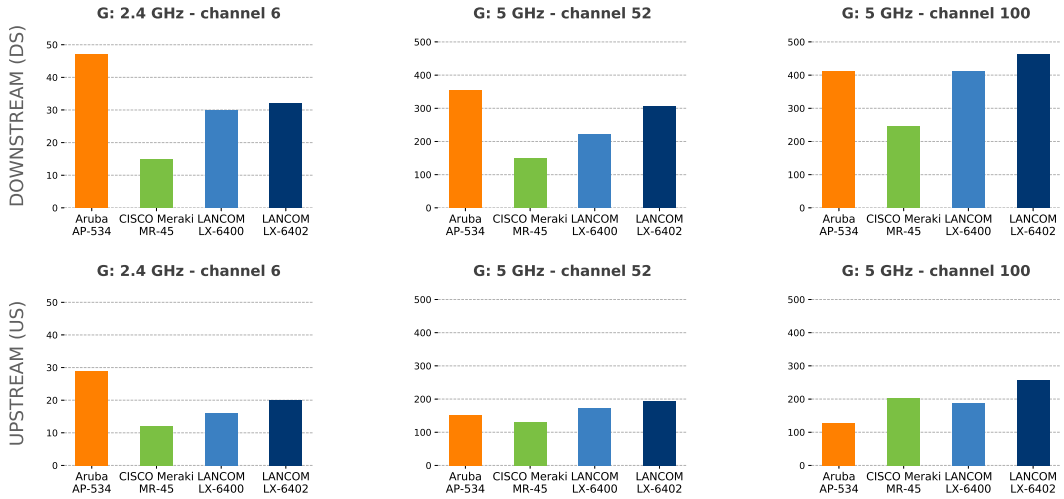


4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	67 / 30 / 5	81 / 466 / 346	88 / 627 / 532
LANCOM LX-6402	82 / 46 / 10	83 / 518 / 407	90 / 669 / 621
Cisco Meraki MR45	70 / 1 / 25	80 / 401 / 366	82 / 434 / 408
Aruba AP-534	80 / 41 / 16	62 / 427 / 380	75 / 531 / 407

Client: MacBook Pro with Wi-Fi 5. 3 Streams



2-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LW-600	69 / 31 / 11	66 / 157 / 86	66 / 112 / 91
Aruba AP-505	66 / 20 / 3	60 / 119 / 57	66 / 199 / 99
Aruba Instant On AP22	71 / 1 / 40	67 / 60 / 116	70 / 90 / 113



4-stream access point	2.4 GHz, channel 6 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 52 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)	5 GHz, channel 100 Signal strength (%) / Downstream (Mbps) / Upstream (Mbps)
LANCOM LX-6400	68 / 30 / 16	69 / 220 / 174	72 / 411 / 187
LANCOM LX-6402	70 / 32 / 20	60 / 306 / 194	73 / 462 / 258
Cisco Meraki MR45	66 / 15 / 12	64 / 150 / 132	67 / 247 / 202
Aruba AP-534	66 / 47 / 29	66 / 353 / 153	71 / 412 / 127