



W I - F I R O A M I N G T E S T

NanoPing vs. a Single Wi-Fi Network

Latency of a live 7 Mbit/s video stream from a laptop carried through a 30 m lab with three access points, measured against a 100 ms budget: NanoPing over all three Wi-Fi networks at once, against each network on its own.

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The single-network results are estimated from the same run: from how each network treated the packets NanoPing sent over it. NanoPing gave each network only part of the stream, so they are a lower bound on what one network carrying the whole stream would have suffered.

Executive summary

A laptop was carried through a lab of several rooms, about 30 m end to end, while it sent a live video stream at 7 Mbit/s and 30 frames per second for 60 seconds. Three access points cover the lab, one at each end and one in the middle, and none of them reaches all of it. The laptop was connected to all three at once, through three Wi-Fi adapters, and NanoPing carried the stream over the three networks together. The receiving application has a 100 ms budget: a packet that arrives later, or never, spoils its frame.

NanoPing kept every packet within the budget; the slowest took 91 ms. The same run shows what each network would have done had it carried the video alone: each would have broken the budget as the laptop moved away from its access point - AP A 12 times, AP B 3 times and AP C 5 times in the minute - and AP C alone would have spoiled 208 of the 1,800 frames.

ONE 60-SECOND WALK	● NANOPING	■ AP A ALONE	◆ AP B ALONE	▲ AP C ALONE
Times over the 100 ms budget	✓ 0	12	3	5
Time over the budget	✓ 0.0 s	5.8 s	0.5 s	8.1 s
Frames late or lost (of 1,800)	✓ 0	119	8	208
99 of 100 packets arrive within	✓ 49 ms	177 ms	50 ms	941 ms
Slowest packet	✓ 91 ms	580 ms	208 ms	1,137 ms

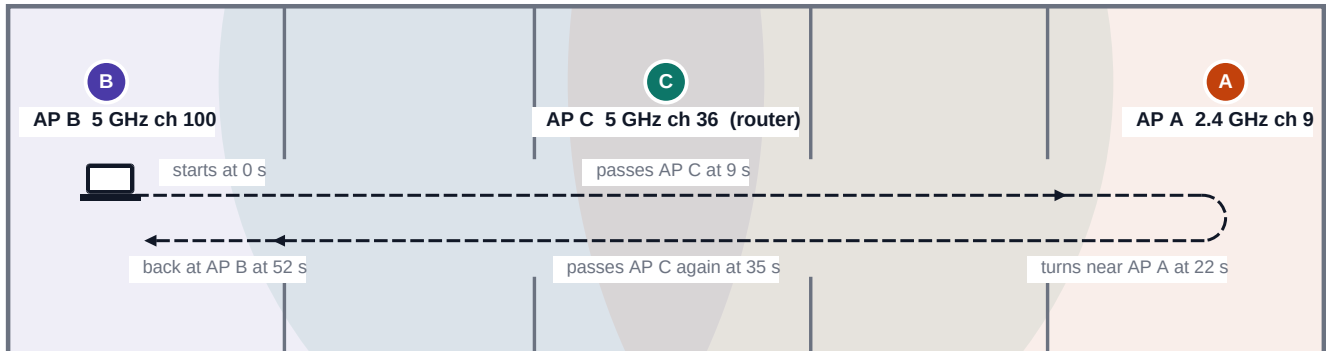
One walk; a check marks the best. A network alone is judged from the packets NanoPing sent over it: a 100 ms window counts against it if one of them arrived after 100 ms or never, or if the adapter was not associated, and breaks less than 0.5 s apart count as one time. Latency is one-way: the application's for NanoPing, the network's own transit for each network alone, which flatters the networks. One frame at 31.0 s is left out of NanoPing's figures: NanoPing delivered its 19 packets, but the receiving test program did not record them.

TEST SETUP

How the test was run

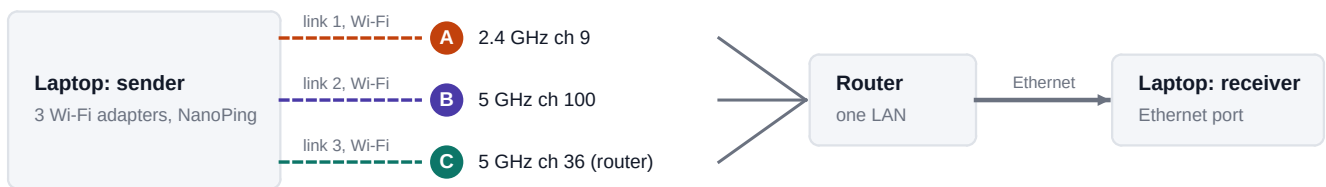
One laptop was both ends of the stream. It sent the video over three Wi-Fi networks at once and received it back over Ethernet, through the router all three access points hang off. It was carried from one end of the lab to the other and back during the 60 seconds of video.

THE LAB FROM ABOVE, ABOUT 30 M END TO END (SCHEMATIC)



Not to scale. The laptop is carried along the dashed line; the shaded circles show roughly how far each access point reaches.

HOW EVERY PACKET TRAVELS



THE STREAM

- 30 frames per second at 7 Mbit/s: each second one 113,750-byte I-frame and 29 P-frames of 26,250 bytes, 43,980 UDP packets in all. Every packet carries its send time, and sender and receiver share the laptop's clock, so each packet's one-way latency is exact.

THE NETWORKS

- Three access points on three channels, so the links do not share airtime: AP A on 2.4 GHz channel 9, AP B on 5 GHz channel 100 and AP C, the router's own radio, on 5 GHz channel 36.
- NanoPing (plumr 46.0.0) uses all three at once, one link per adapter, with a 100 ms timeout and no jitter buffer. A monitor read each adapter's signal and link rate every 100 ms.

WHAT IS MEASURED

- ✓ The 100 ms budget: a packet is usable if it arrives within 100 ms of being sent. A frame is late or lost if any of its packets is.
- ✓ One network alone: every packet NanoPing sent over a network, probes included, shows what that network did at that moment. Had the network carried the whole stream, a frame sent then would have fared the same.

RESULTS

One network at a time against the 100 ms budget

As the laptop moved, each network faded in turn. On its own, each would have broken the budget while the laptop was far from its access point. NanoPing moved the video to the networks that were good at that moment.

TIMES OVER THE 100 MS BUDGET		TIME OVER THE BUDGET		FRAMES LATE OR LOST, OF 1,800	
● NanoPing	0	● NanoPing	0.0 s	● NanoPing	0
■ AP A alone	12	■ AP A alone	5.8 s	■ AP A alone	119
◆ AP B alone	3	◆ AP B alone	0.5 s	◆ AP B alone	8
▲ AP C alone	5	▲ AP C alone	8.1 s	▲ AP C alone	208

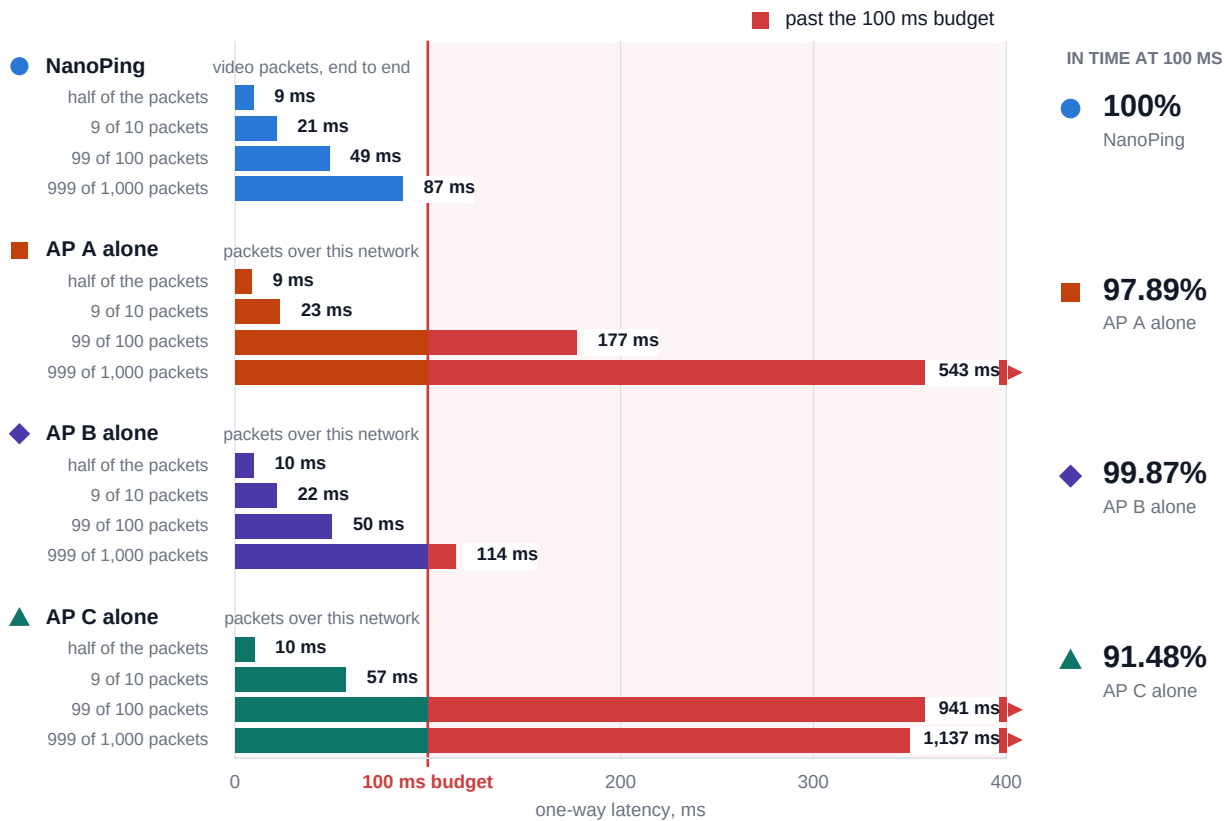


Top: each network's signal strength at the laptop, half-second means. Middle: the share of each second's video packets NanoPing sent over each network. Bottom: the 100 ms windows in which a network alone would have been over budget. The weak spots never lined up: in none of the 600 windows were all three over budget at once.

RESULTS

Packet latency: NanoPing against each network

The application waits 100 ms for each packet. NanoPing's packets arrived in a narrow band well inside the budget; each network alone had a long tail past it.



Each bar runs from 0 to the latency within which that share of packets had arrived; red where it crosses the budget. NanoPing: every video packet, application to application; 999 of 1,000 within 87 ms. Each network alone: every packet NanoPing sent over it, its transit only. AP C needed 941 ms for 99 of 100.

HOW NANOPING STAYED IN TIME

- ✓ It steered around the weak spots. In the seconds each network alone would have been over budget, NanoPing sent it only a small share of the video: AP A 2%, AP B 0% and AP C 0%.
- ✓ It repaired across networks. The individual networks lost 108 of the packets sent over them and delivered another 2,429 after the budget. NanoPing resent 1,251 packets and sent 7,943 repair packets over the others, so none of this reached the video.
- ✓ There was no handover to wait for. Each adapter kept its own access point, and NanoPing used whichever networks were good at the moment.

PACKETS NANOPING SENT OVER EACH NETWORK

	PACKETS	LATE	LOST	LOWEST LINK RATE
AP A alone	26,325	554	2	6 Mbit/s
AP B alone	31,761	42	0	8.6 Mbit/s
AP C alone	22,765	1,833	106	6 Mbit/s

Video, repair and probe packets over the 60 seconds. Late: arrived after 100 ms. Lowest link rate: the adapter's slowest uplink rate in the minute; carrying the whole 7 Mbit/s stream at that rate, a network would have fared worse than the figures here, so they are a floor.

Conclusion

Carried through a 30 m lab that no single access point covers, a laptop sent 60 seconds of live 7 Mbit/s video. Over NanoPing, using all three networks at once, every packet arrived within the 100 ms budget: 99 of 100 within 49 ms and the slowest in 91 ms.

On its own, each network would have broken the budget 12 times, 3 times and 5 times in the same minute. Even the best, AP B, would have spoiled 8 frames, and AP C 208. These are a floor: each network alone would have had to carry the whole stream, not the share NanoPing gave it.

The same laptop, the same walk and the same minute. One network at a time broke the budget; the three together, under NanoPing, did not.