
CERN

Wi-Fi Service Enhancement at CERN

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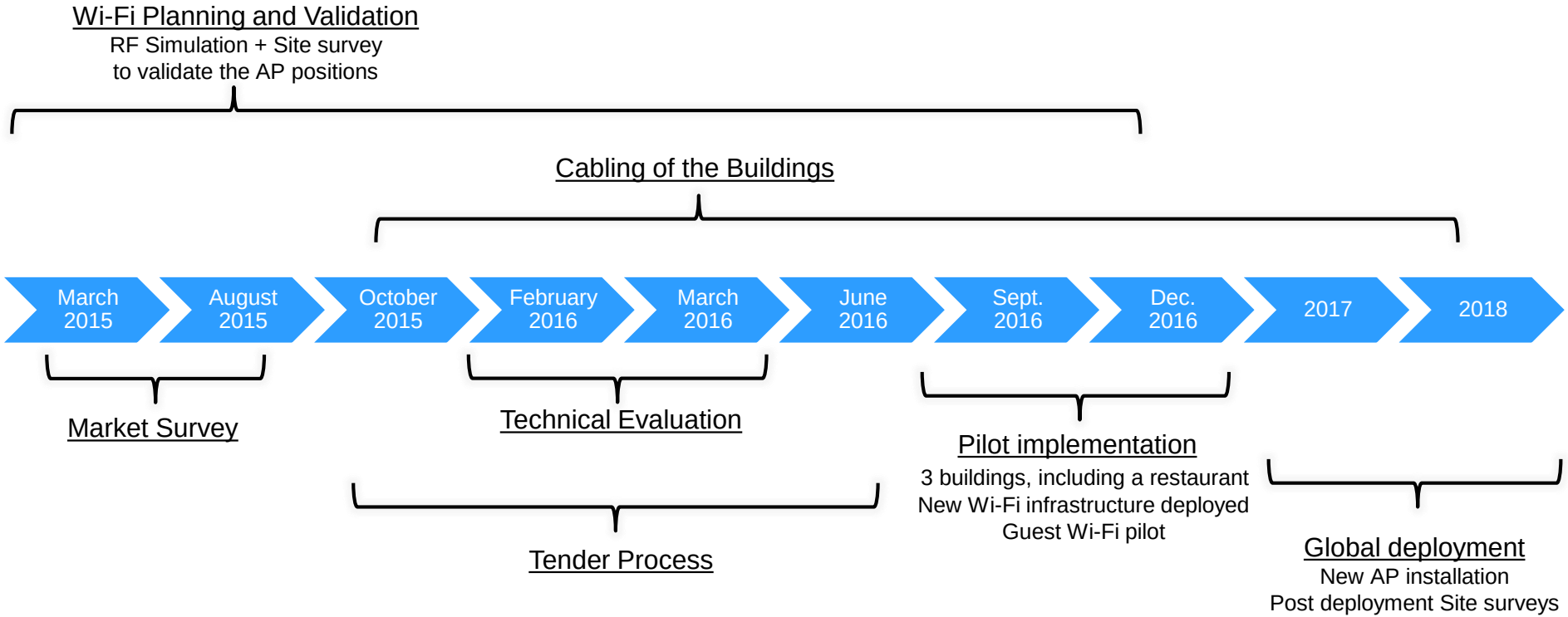
Agenda

- Project organisation
- Technical evaluations
- New Wi-Fi network infrastructure design
- Next steps

Project organization



Technical evaluation : Market Survey

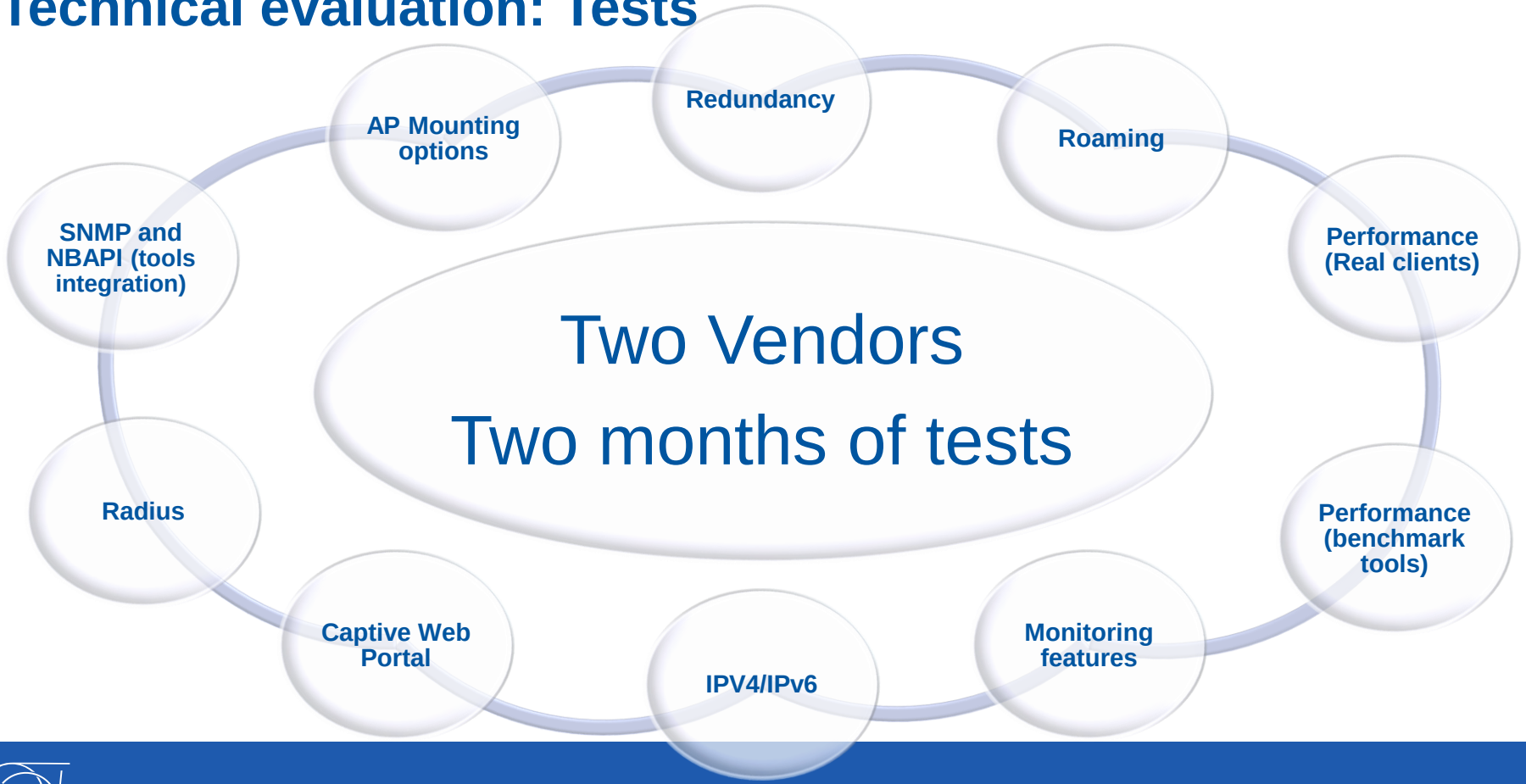
- Market survey showed that Controller Based solutions were:

  ✓ Suitable for all our needs

  ✓ Mature enough to provide a good level of support

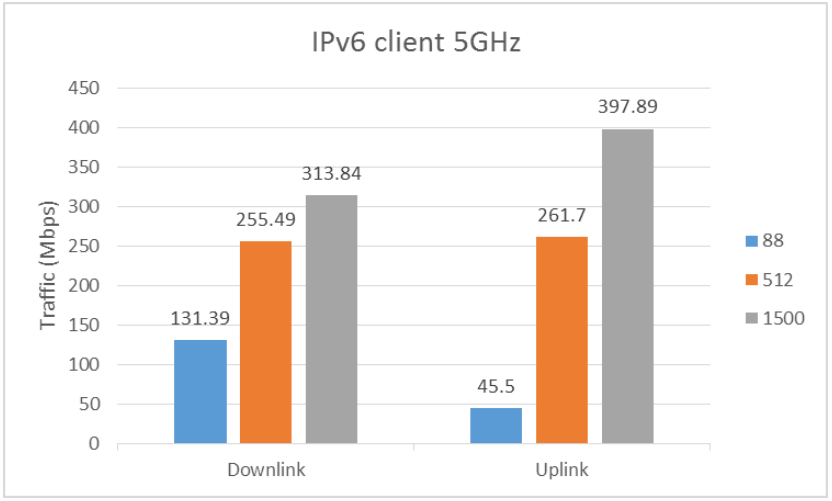
  ✓ Scalable enough to match our campus size

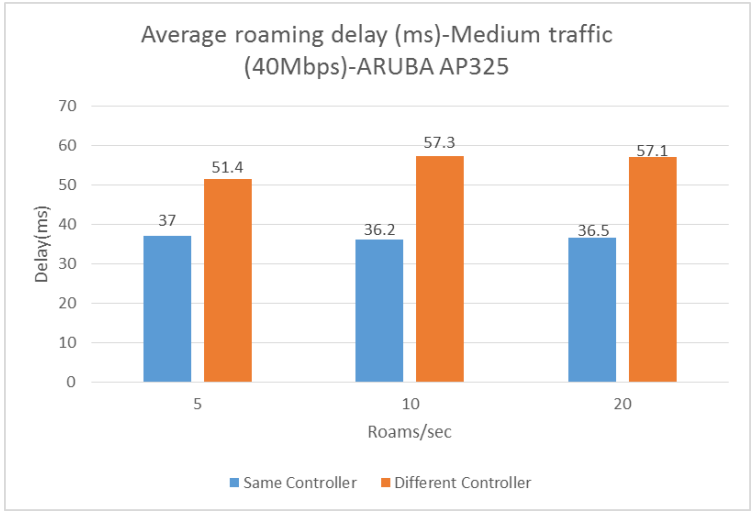
Technical evaluation: Tests



Technical evaluation: Tests

- We used a traffic generator (Wi-Fi Client simulator) to do some advanced tests (benchmark IPv4/IPv6, roaming, etc…)





What performance can we expect ?

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Theory

866 Mbps
1300 Mbps
1733 Mbps
2340 Mbps
3466 Mbps

What performance can we expect ?

Theory

802.11ac

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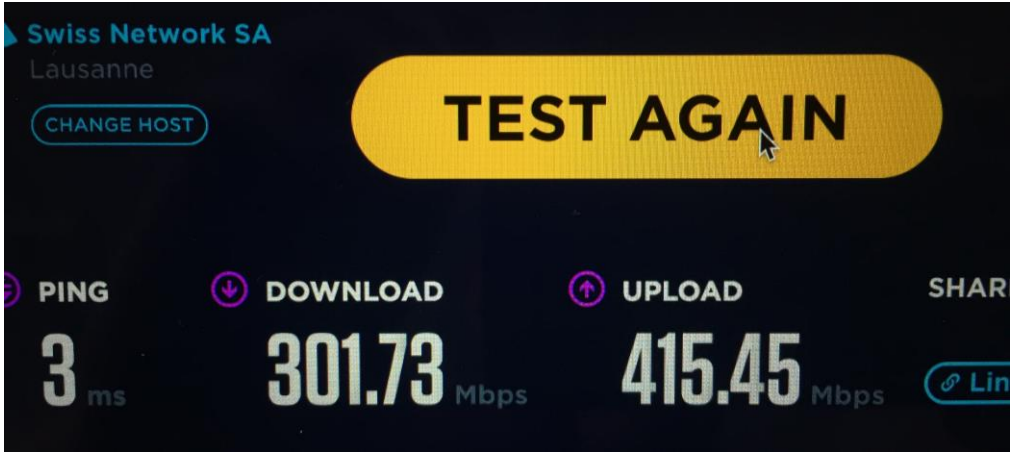
1300 Mbps
1733 Mbps
2340 Mbps
3466 Mbps

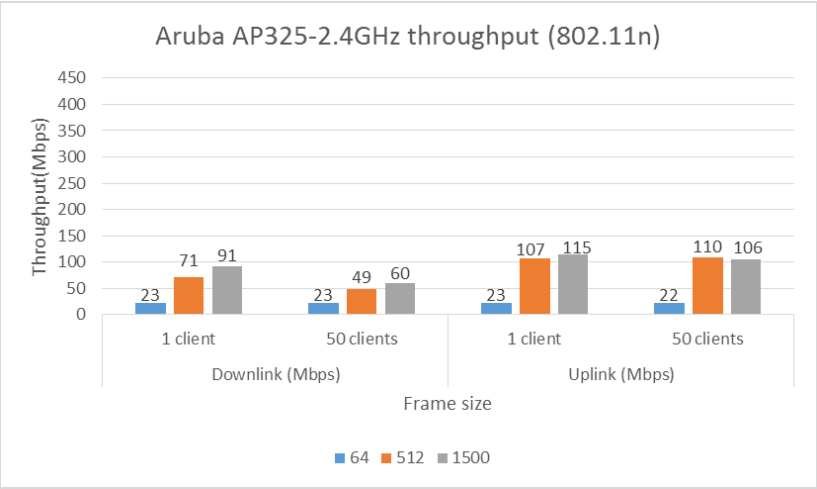
802.11ac reality today

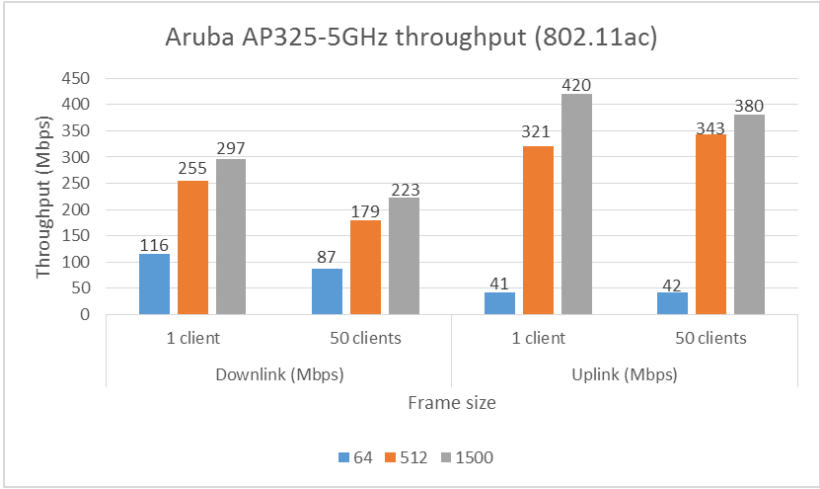


Technical evaluation: expected performances (real traffic throughput)?

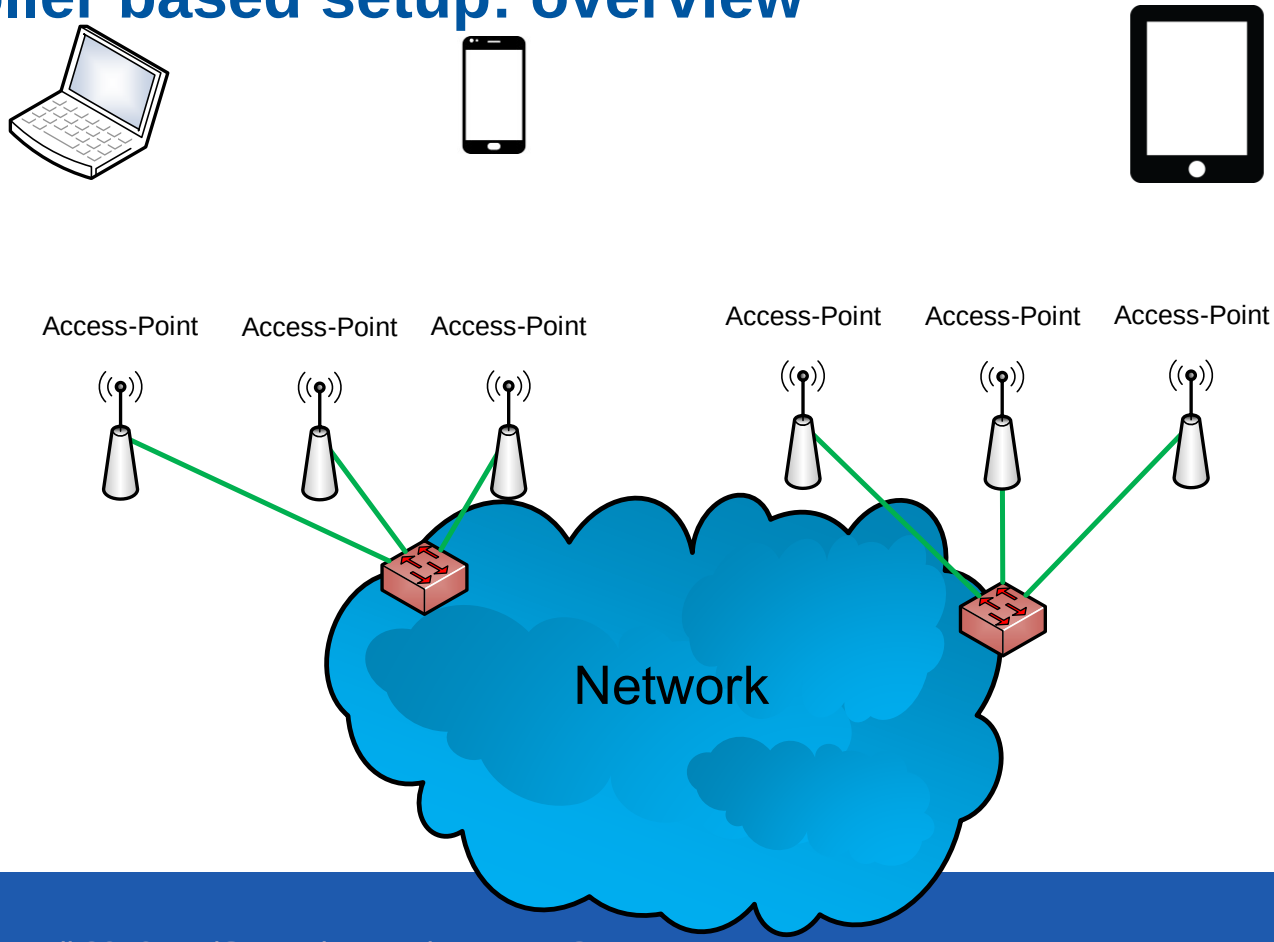
- 100-150 Mbps for a Smartphone (2015+)
- 200-300 Mbps for a laptop (up to 400Mbps with the latest models)

Performance depends on the client and not, as today, on the Wi-Fi infrastructure.





Controller based setup: overview



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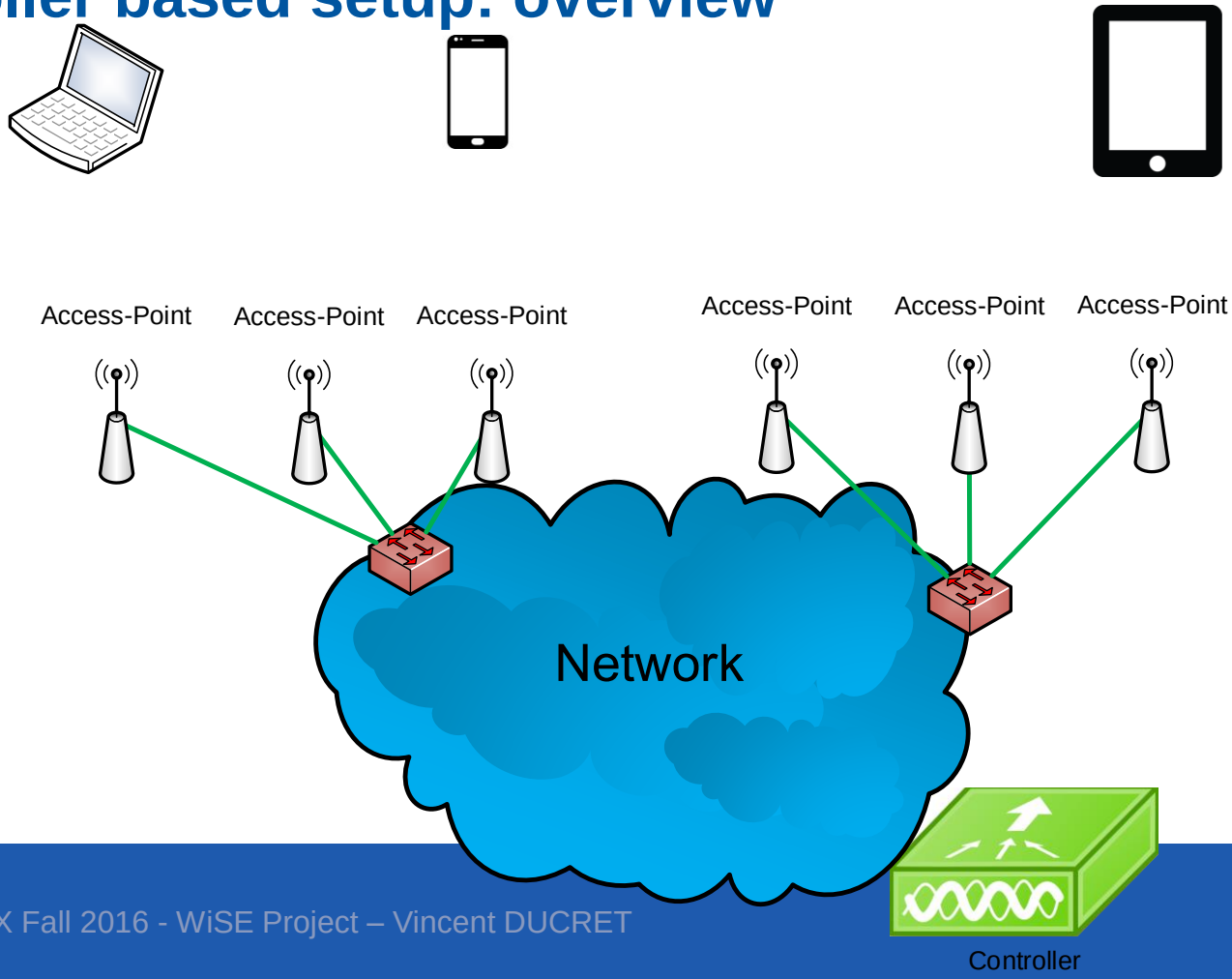

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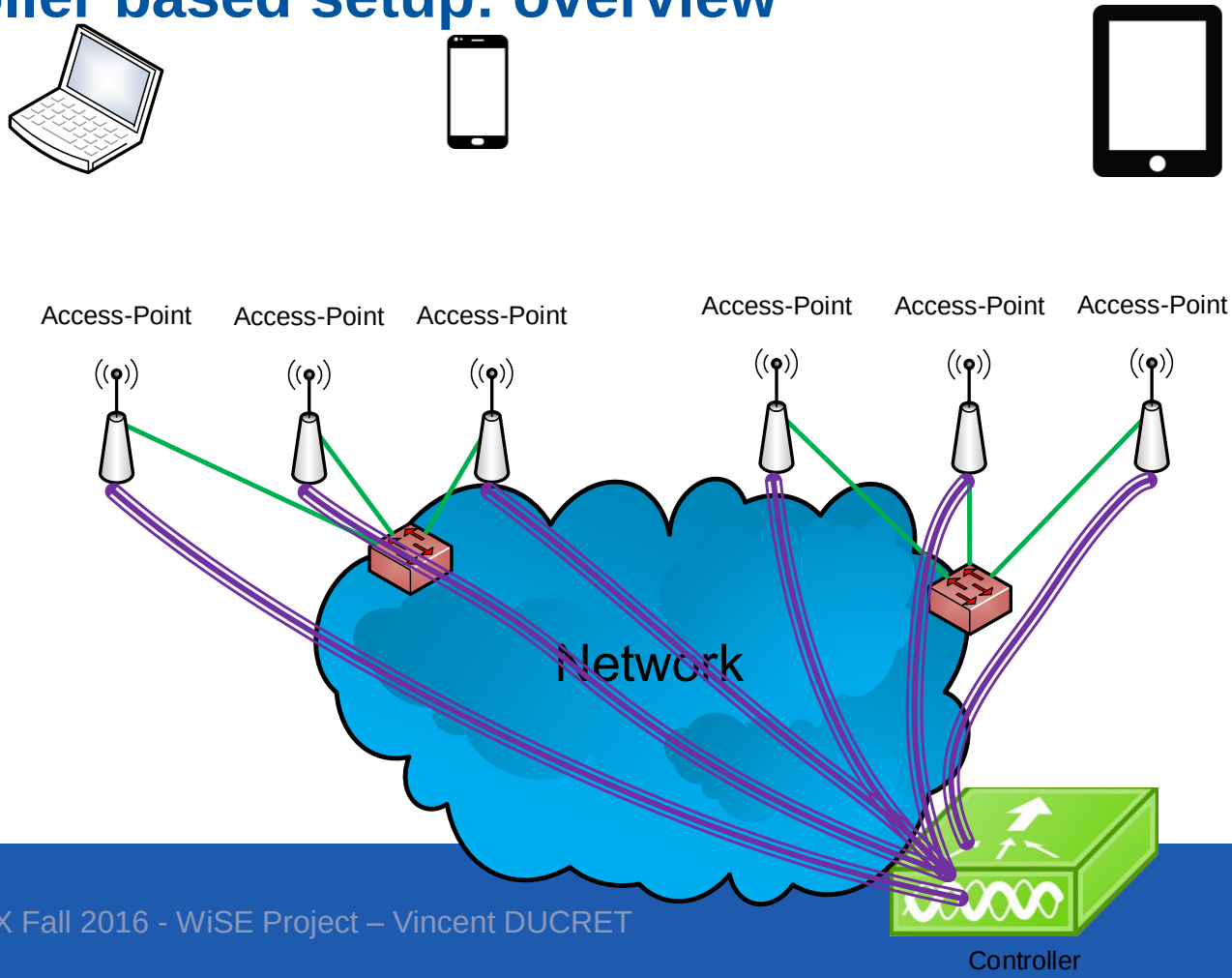

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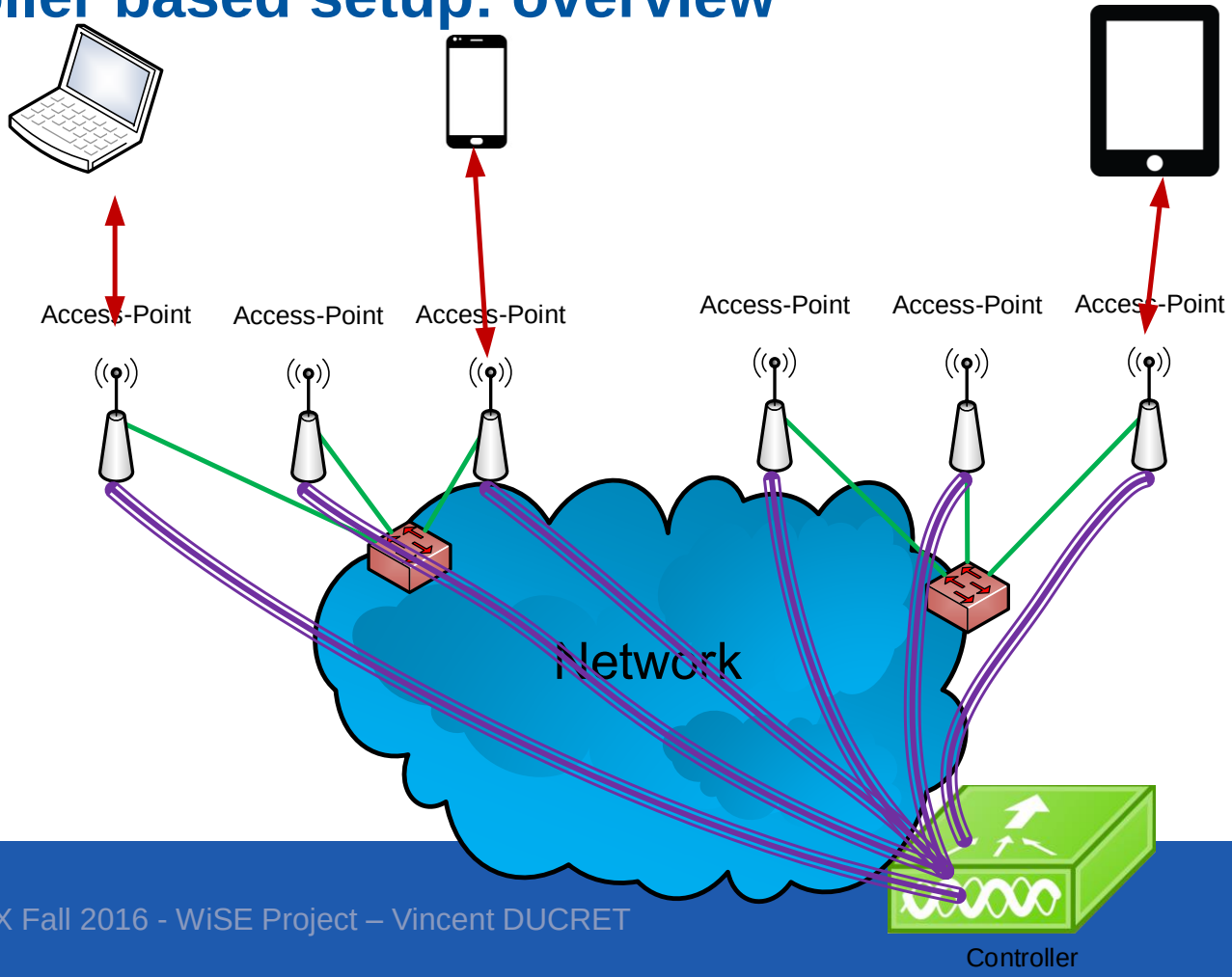
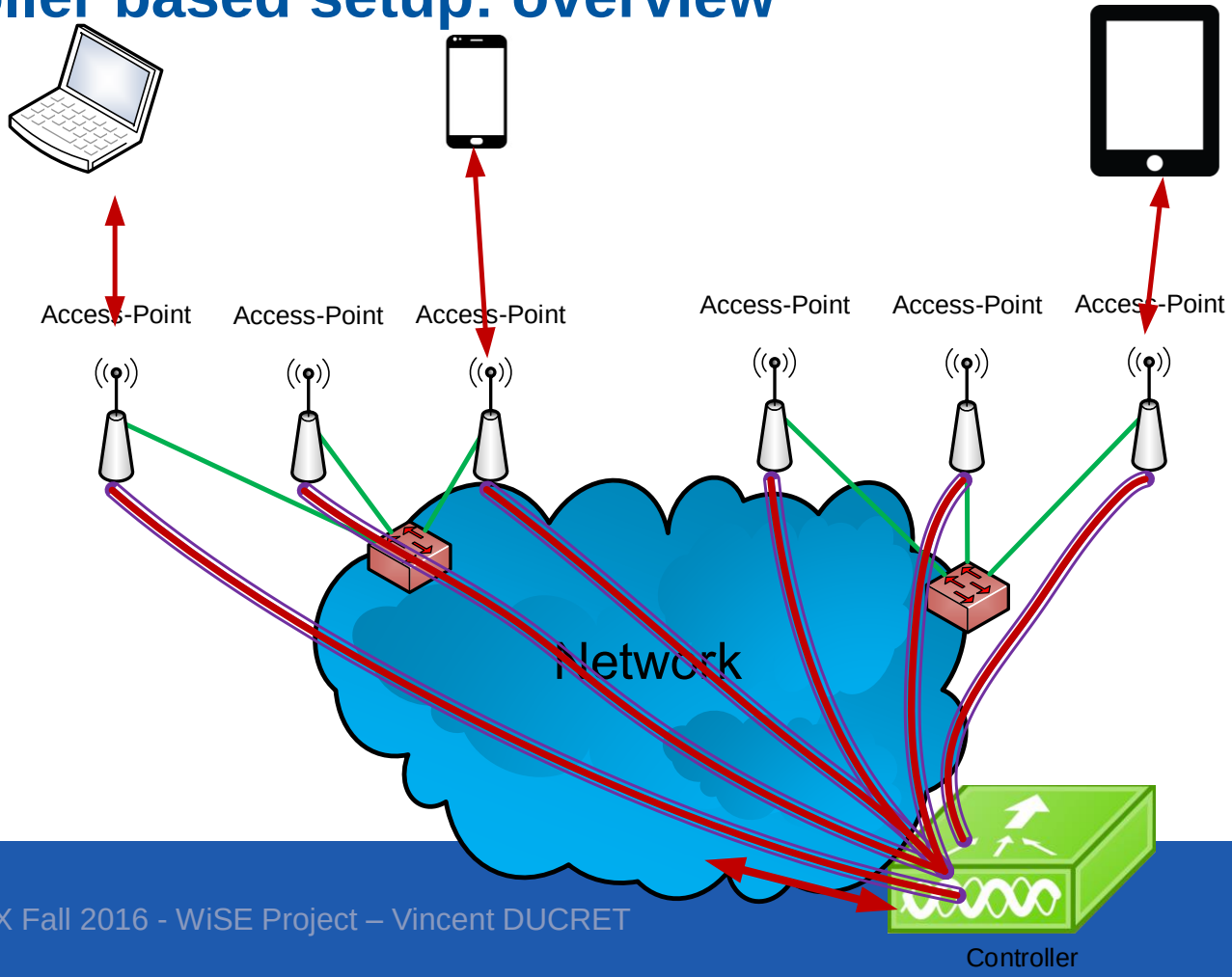
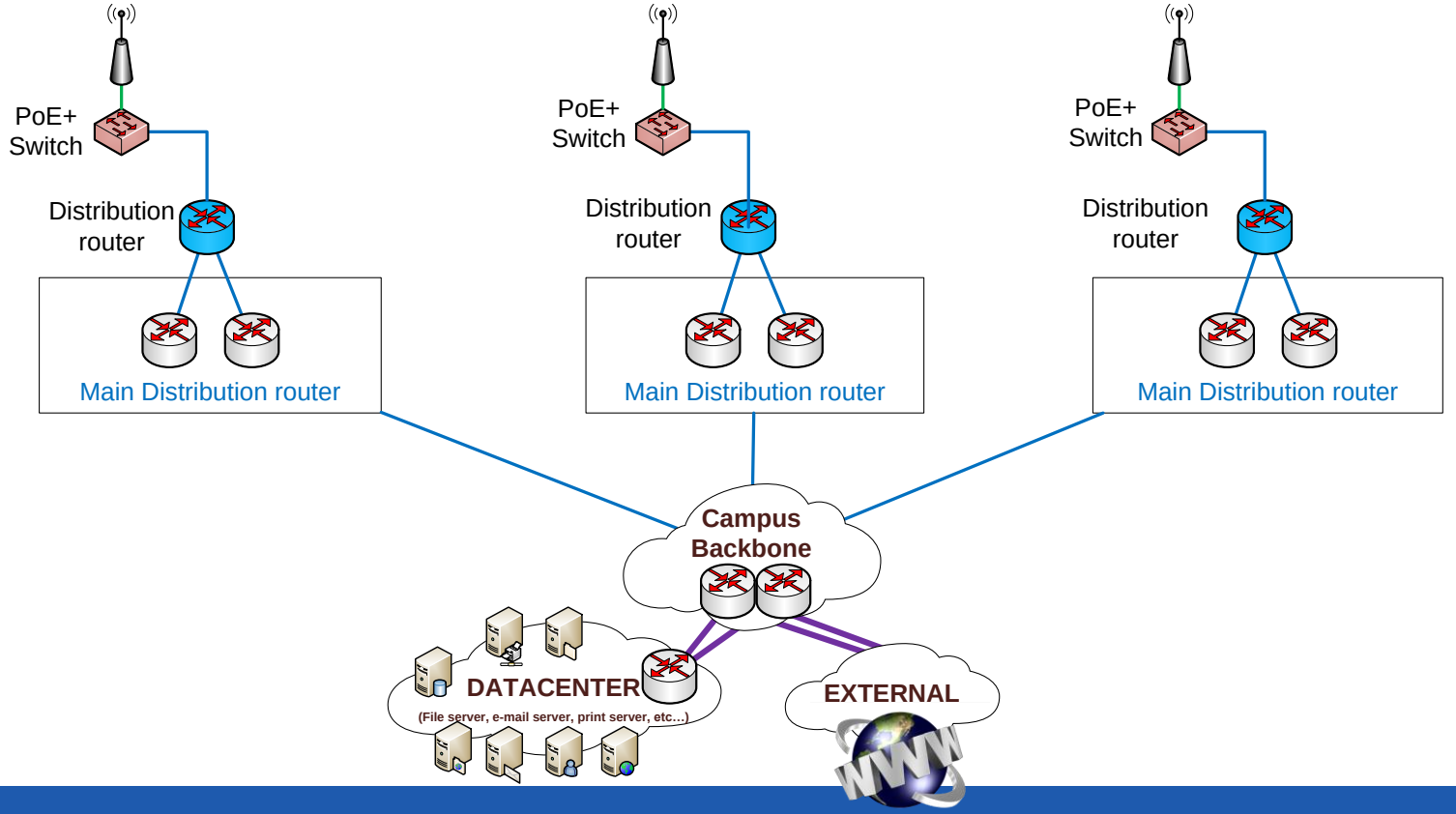


Controller based setup: overview



New Wi-Fi infrastructure design



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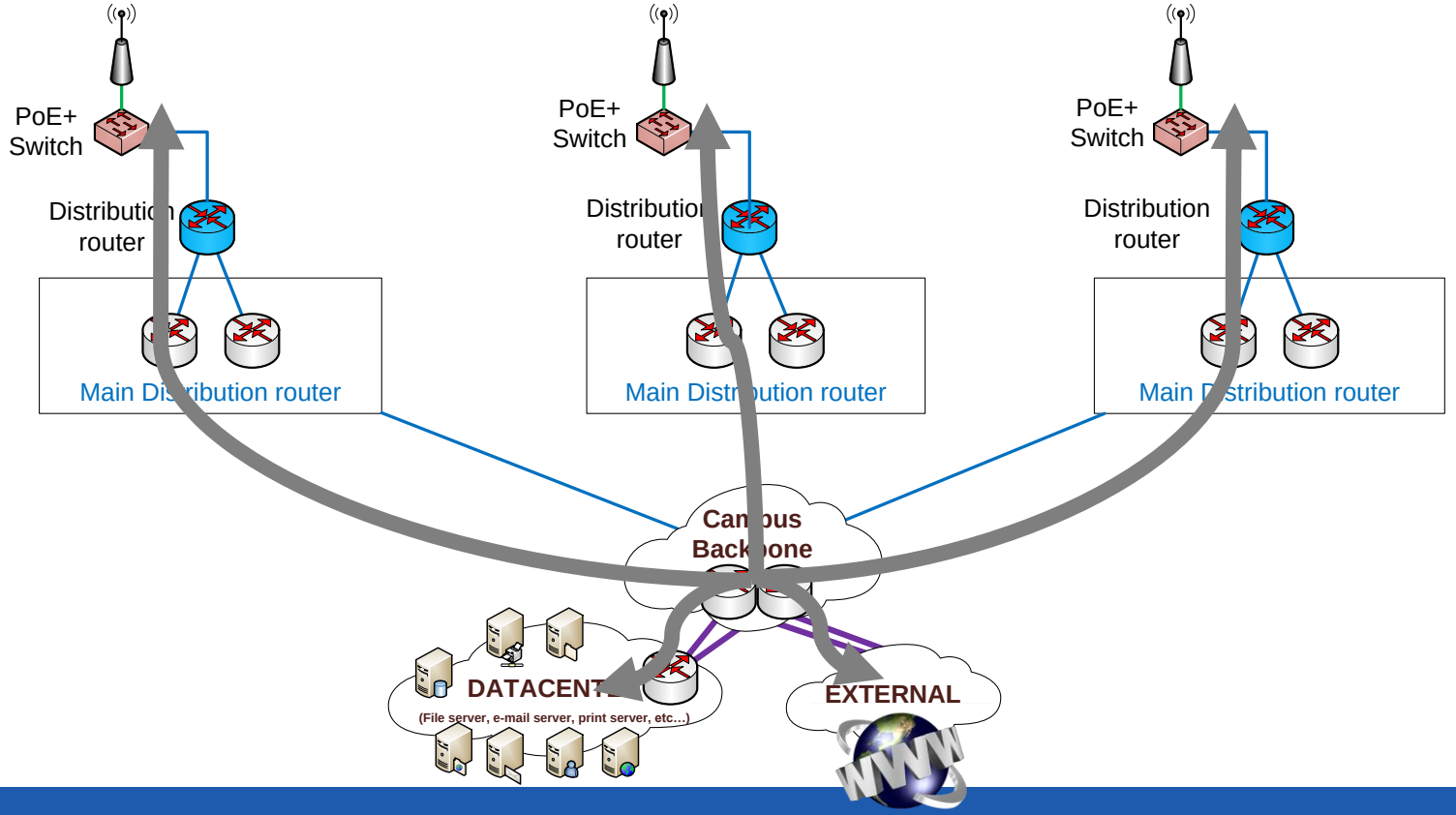

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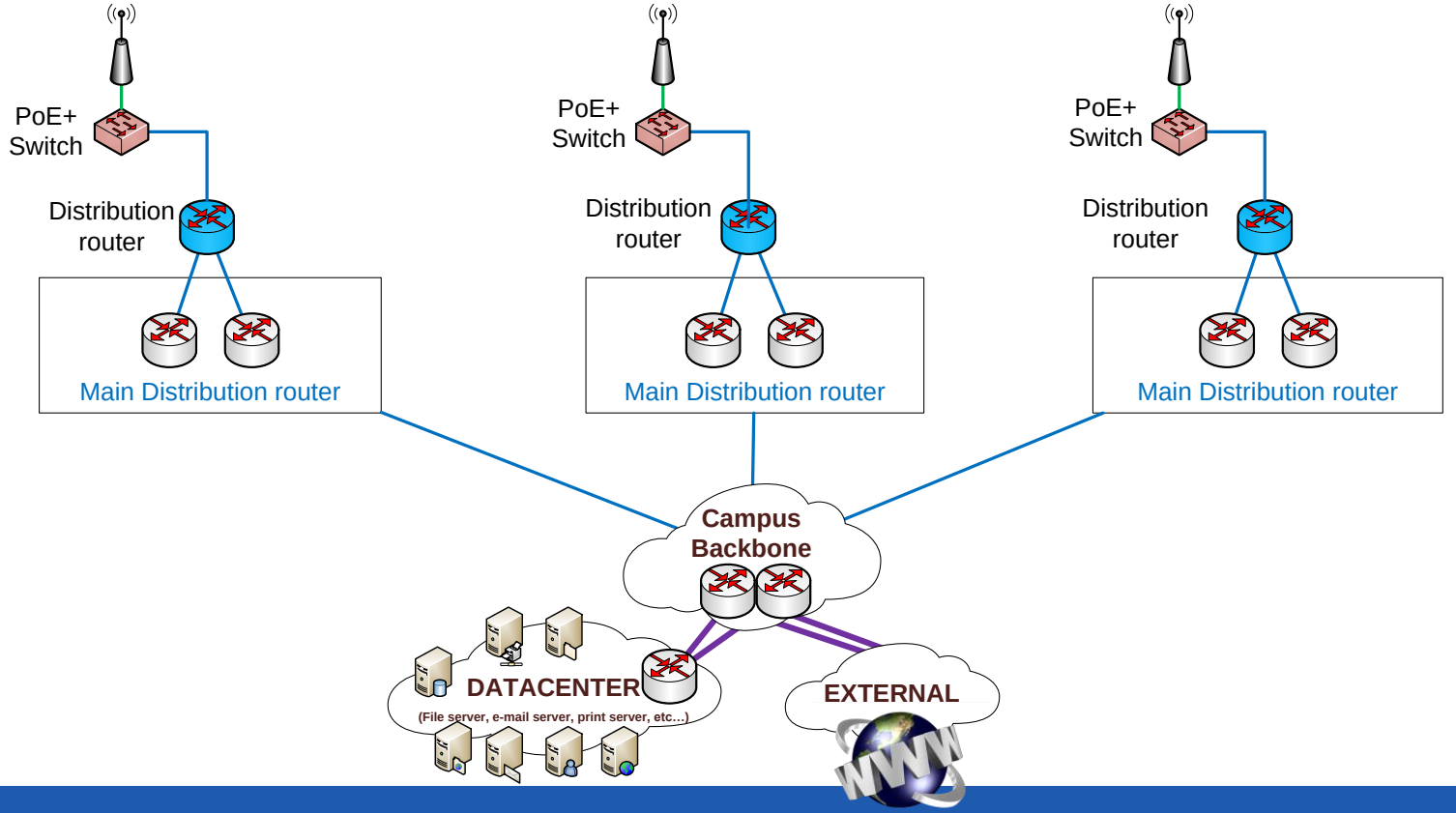

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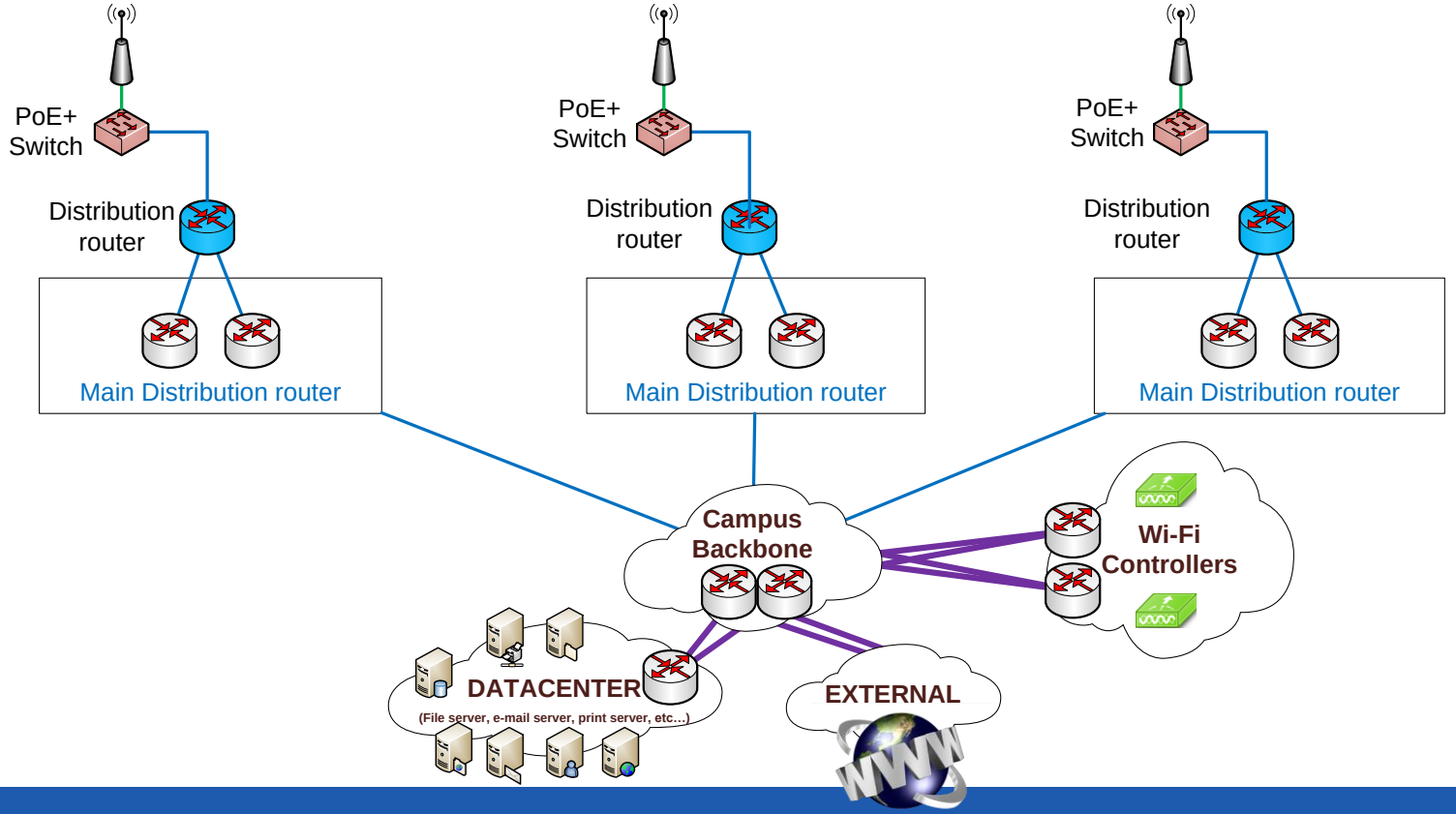

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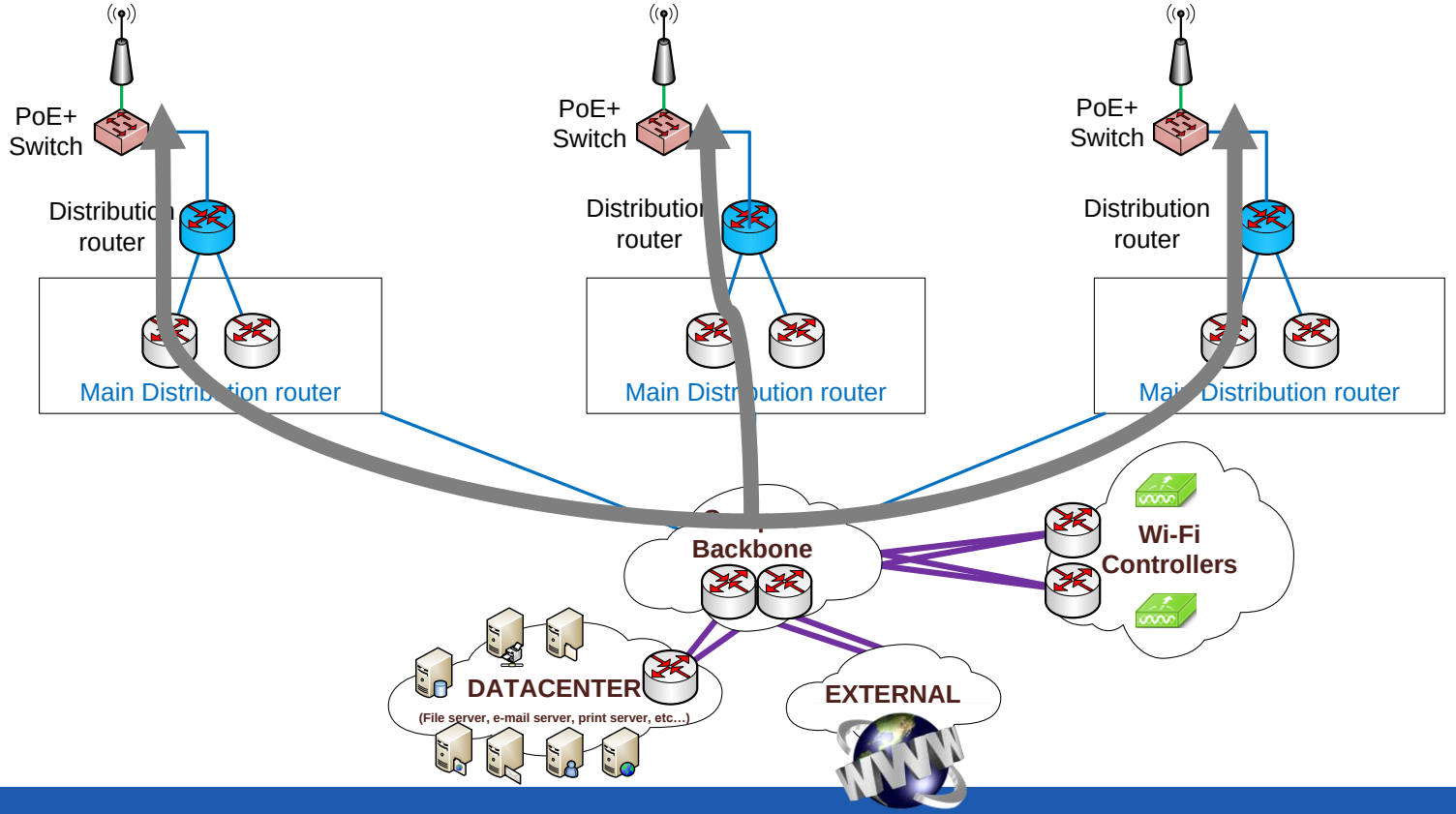

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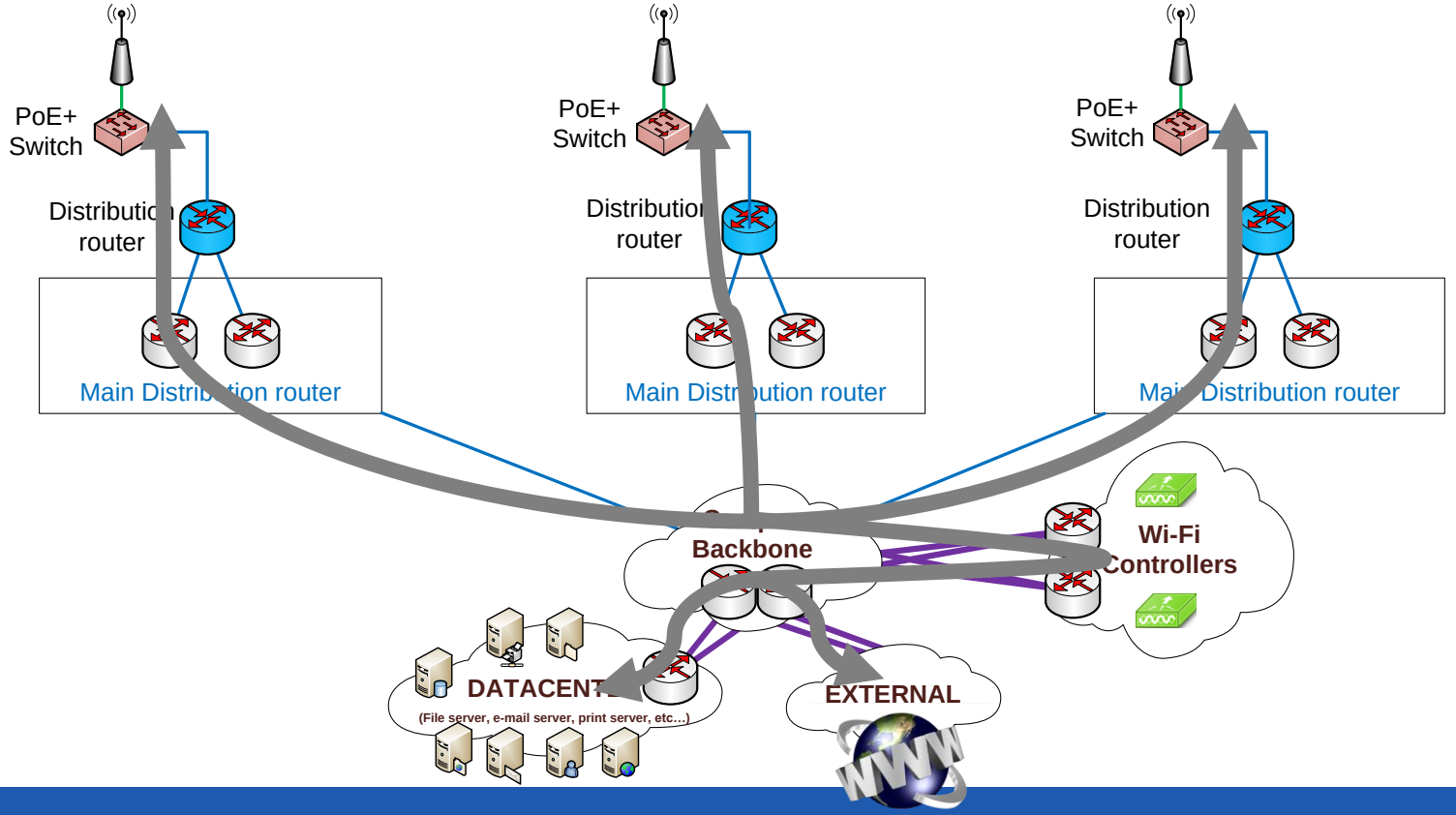
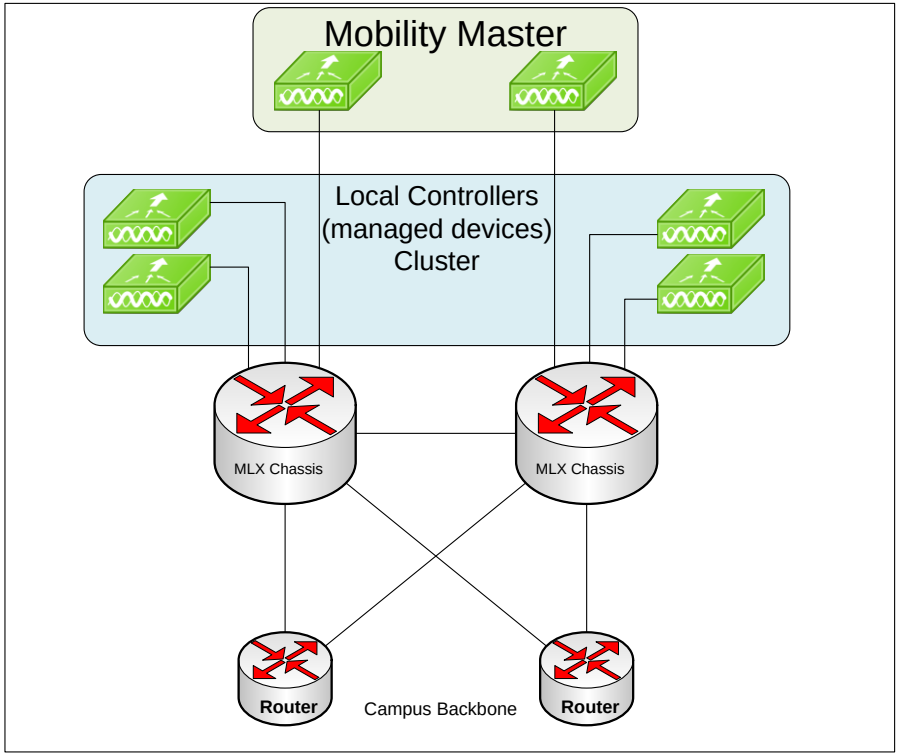


Controller setup

- Fully redundant
- Scalable
- Central point of configuration
- Central point of monitoring, providing global overview of the Wi-Fi environment



User mobility today

A.A.A.A

Building A

IP Subnet A

Building B

IP Subnet B

Building C

IP Subnet C

Building D

IP Subnet D for 1st floor
IP Subnet E for 2nd floor

User mobility today

B.B.B.B

Building A

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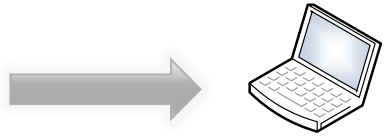
- A client's IP address depends on its physical location

User mobility today



C.C.C.C

Building A

IP Subnet A

Building B

IP Subnet B

Building C

IP Subnet C

Building D

IP Subnet D for 1st floor
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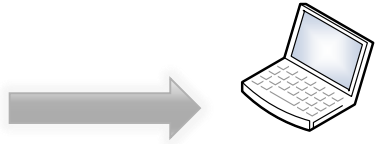
- A client's IP address depends on its physical location
- Clients need to change IP address when moving across the coverage area
  ➔ disconnection/freeze

User mobility today



D.D.D.D
or E.E.E.E

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IP Subnet D for 1st floor
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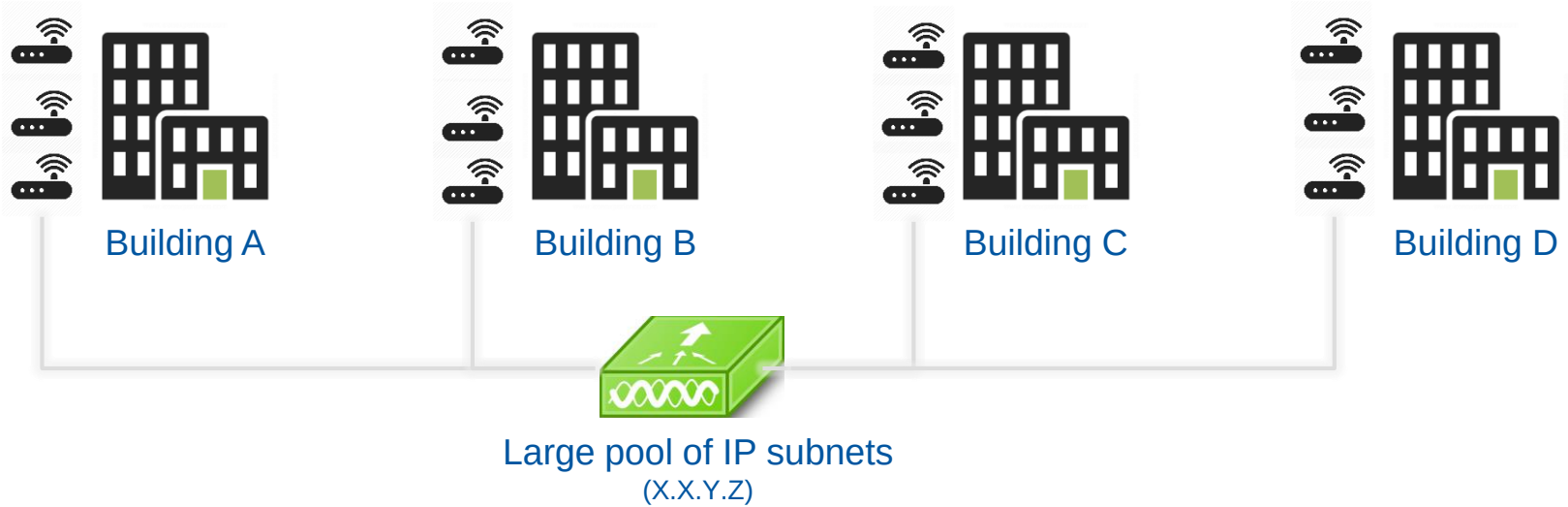
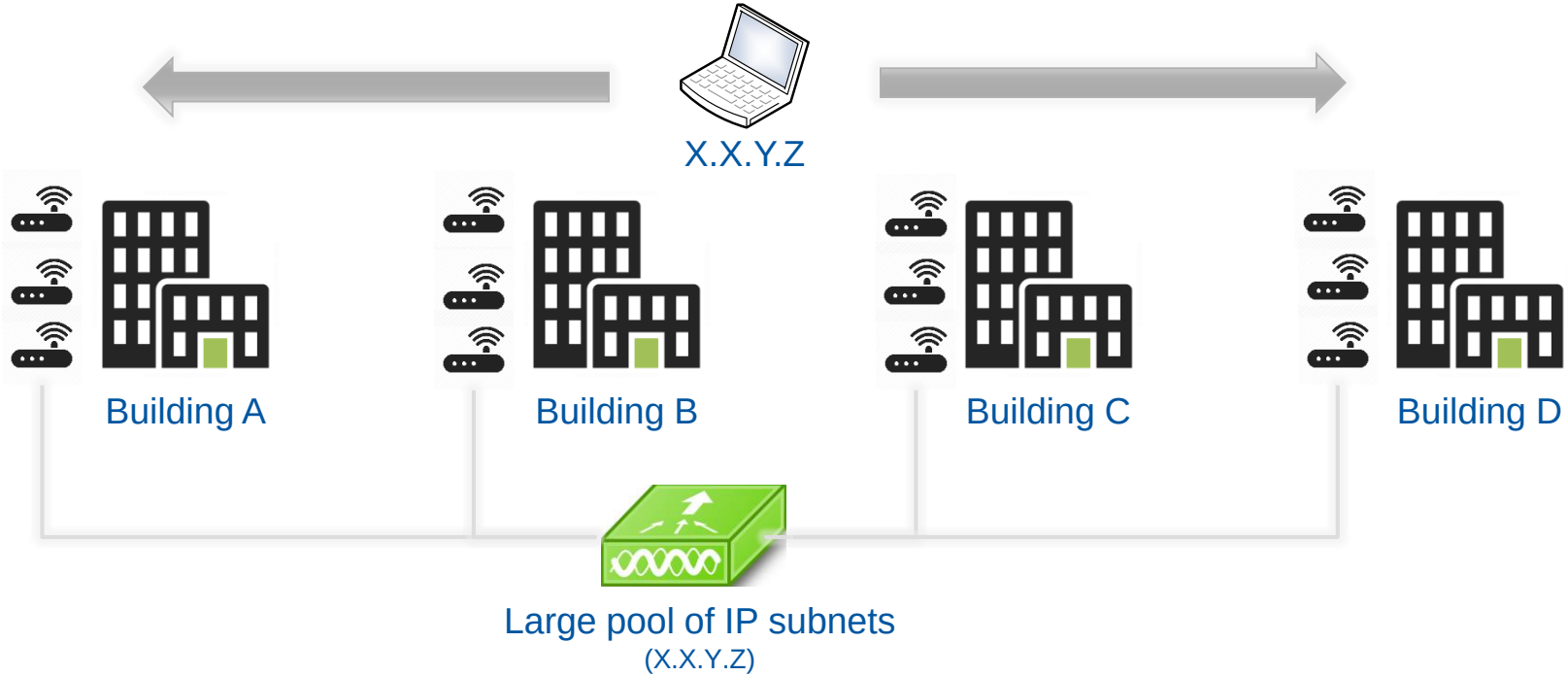
User mobility tomorrow



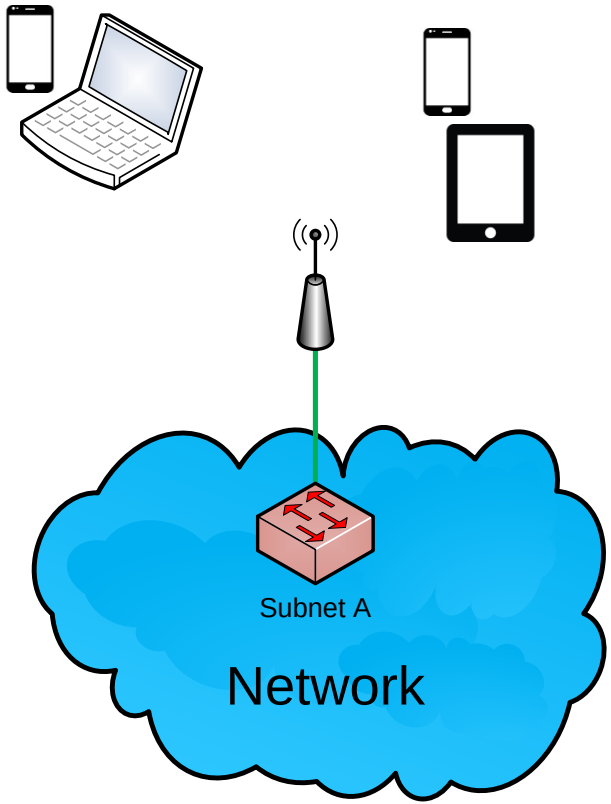
User mobility tomorrow



- A client's IP address is INDEPENDENT of its physical location
- Clients can keep the same IP address when moving across the coverage area

Current issue: Guest Wi-Fi

- With the current setup, Wi-Fi users are directly connected to the CERN network. There is no way to isolate traffic from Guest users.



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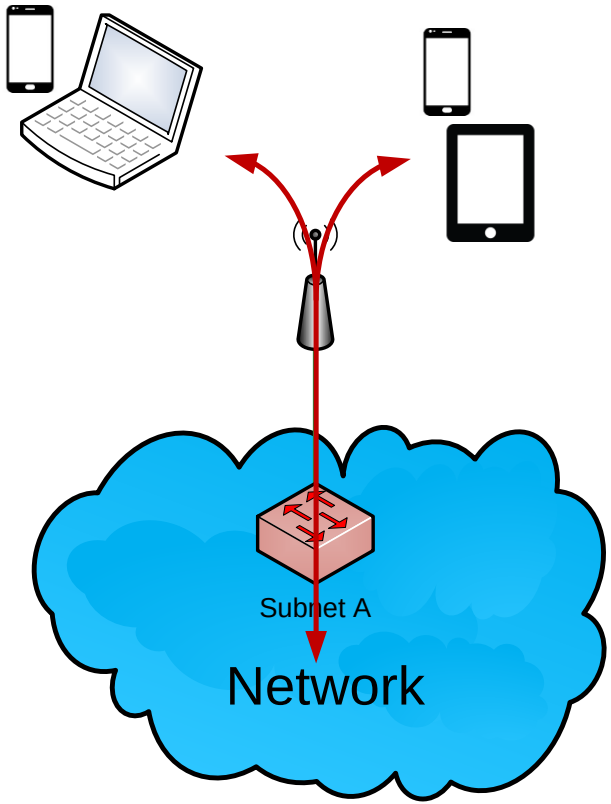
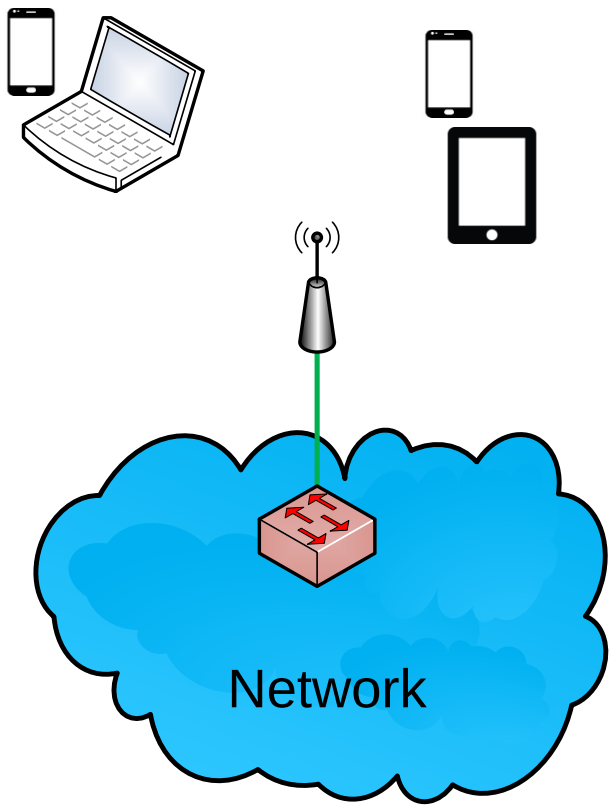


Guest Wi-Fi with the new solution

- Controllers centralize the traffic
- Guests are redirected to a self-registration portal which sends an access code via SMS.

  => No need for CERN approver.
- Guest traffic is isolated (internet access only)



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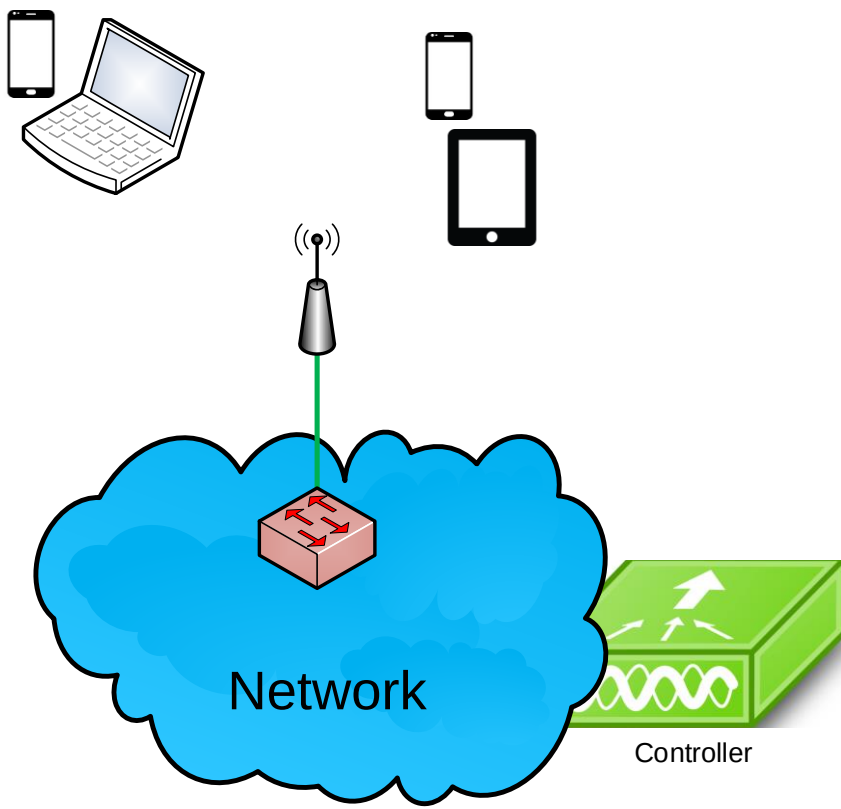

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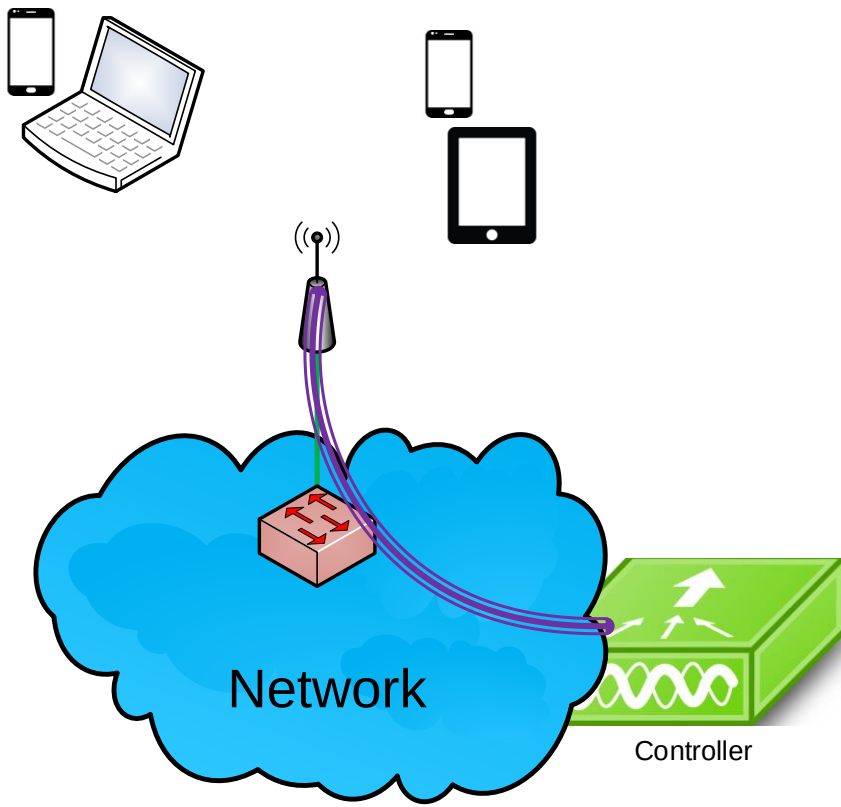

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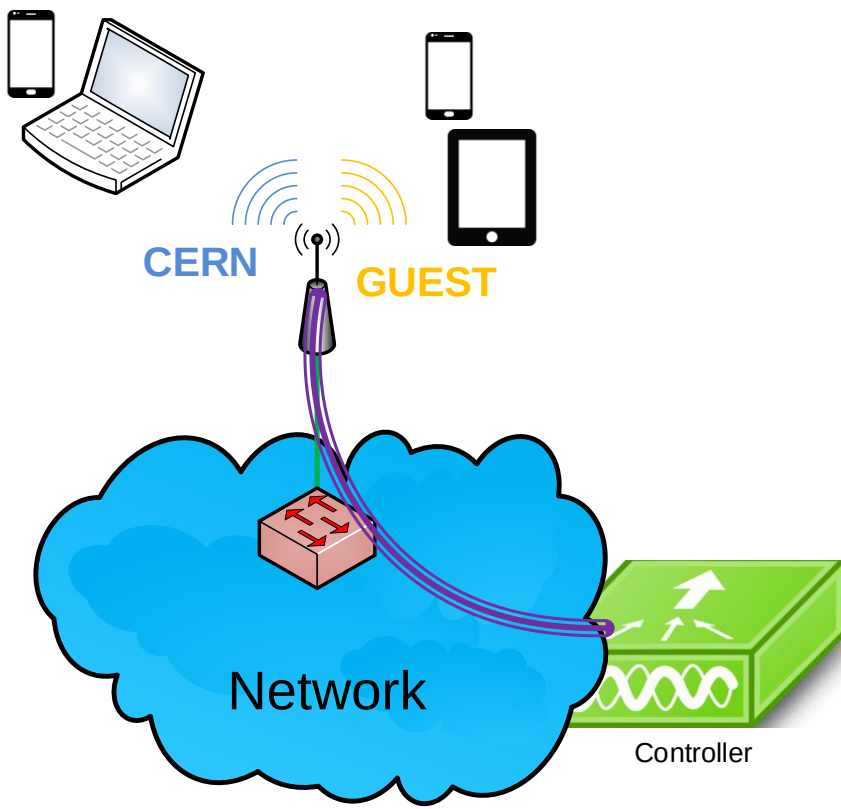

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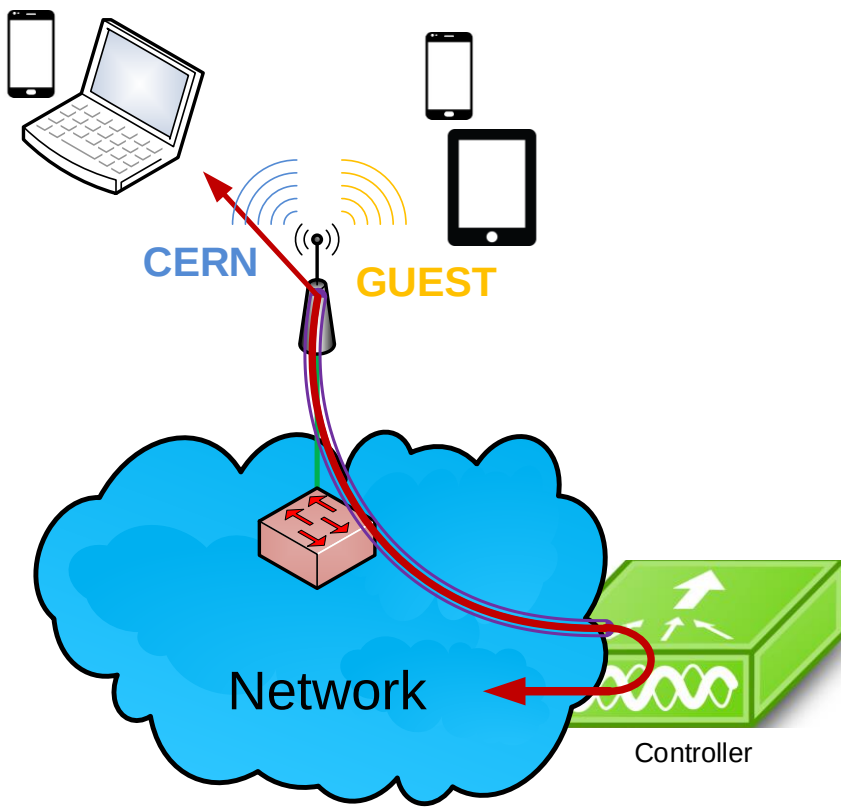

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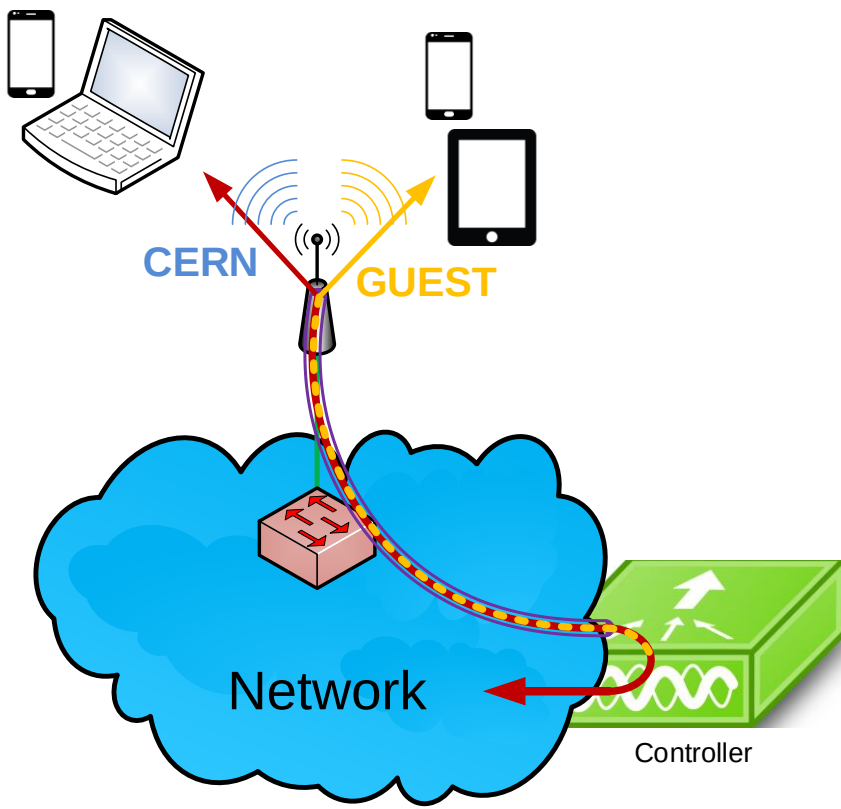

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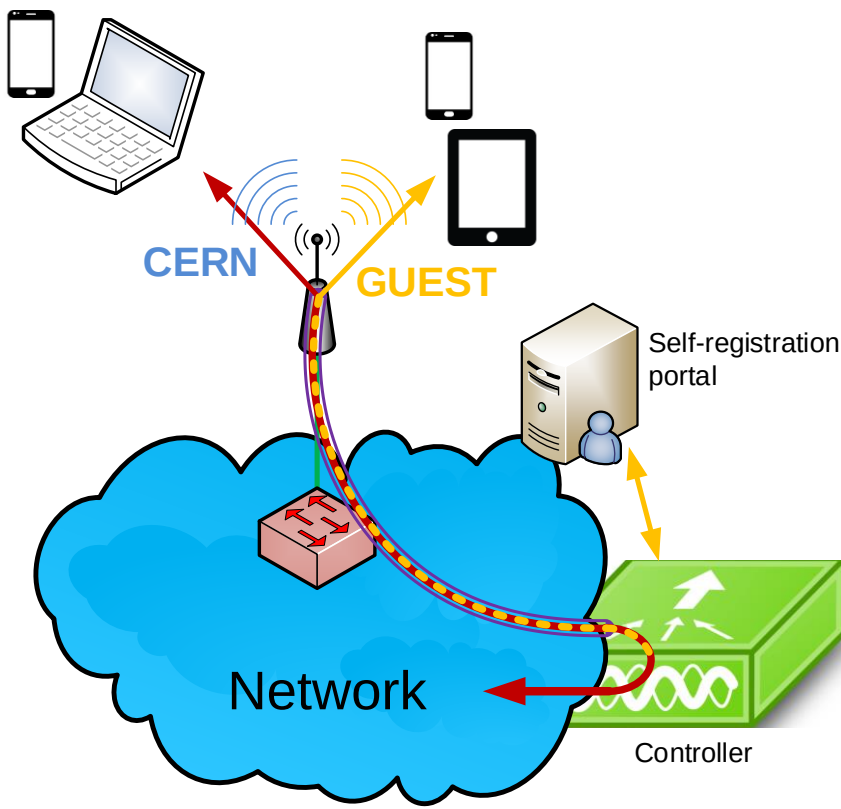

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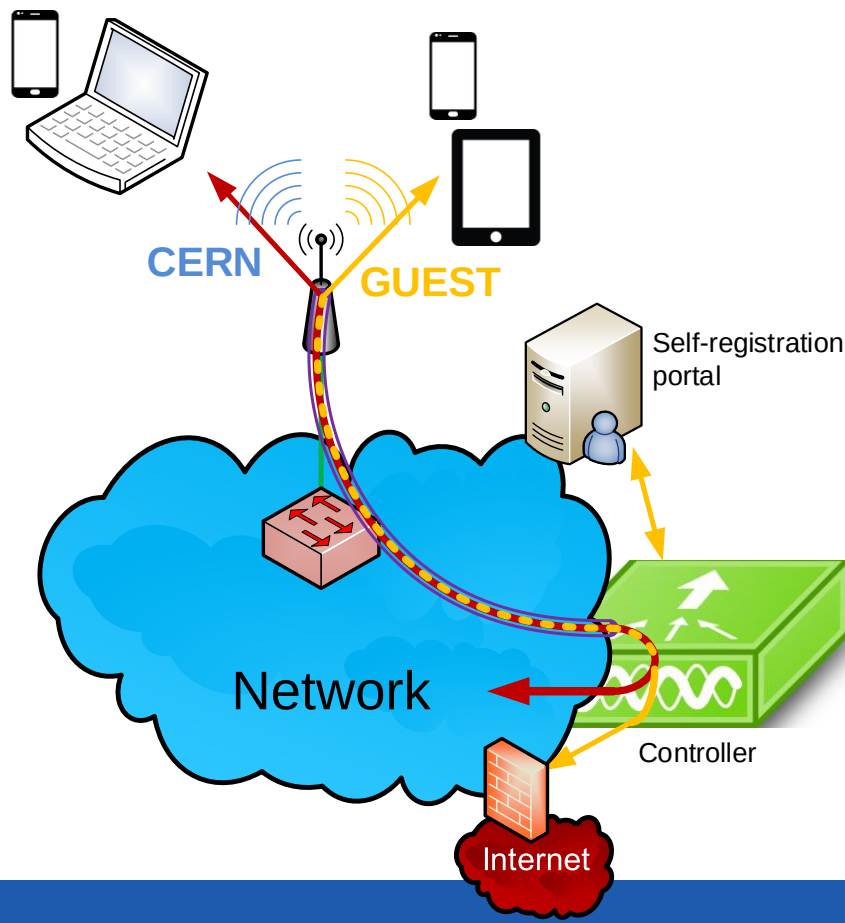
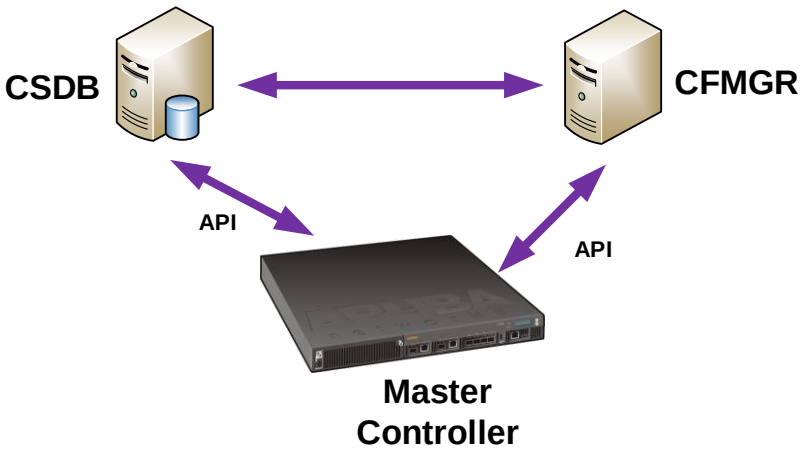
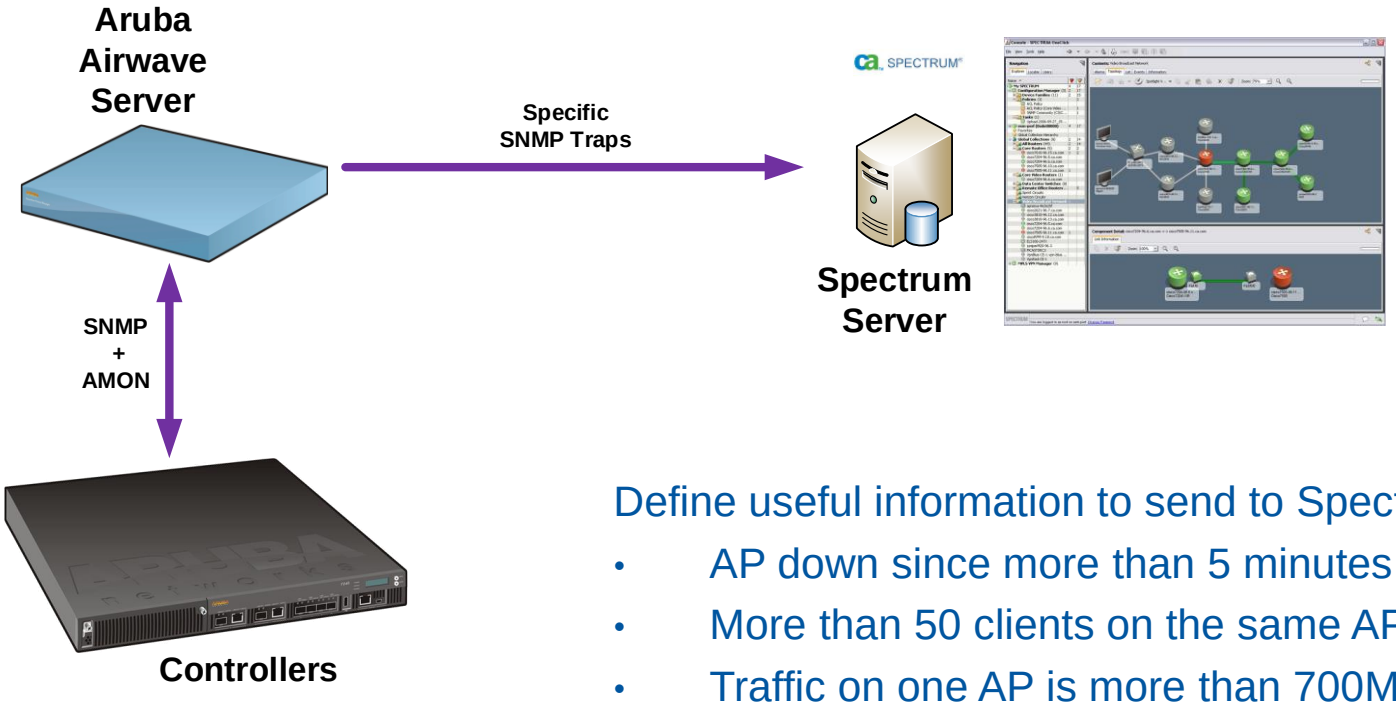


Configuration automation via CSDB/CFMGR

- CSDB has the list of all Access-Points (mac address, location, etc…)
- CFMGR extracts the information from CSDB, and pushes the appropriate configuration to the Master controller (via API)
- CSDB can query the master controller API to check any mismatch



Monitoring with Spectrum



Define useful information to send to Spectrum:

- AP down since more than 5 minutes
- More than 50 clients on the same AP
- Traffic on one AP is more than 700Mbps
- Etc…

Next steps

- Pilot implementation on-going
  - Controllers installed
  - API tests for deployment/configuration automation are underway
  - Guest Wi-Fi interface being tested
- Deployment in the Pilot buildings: November 2016
- Global deployment: from mid-January 2017
  - 55+ buildings are cabled and waiting

Questions?

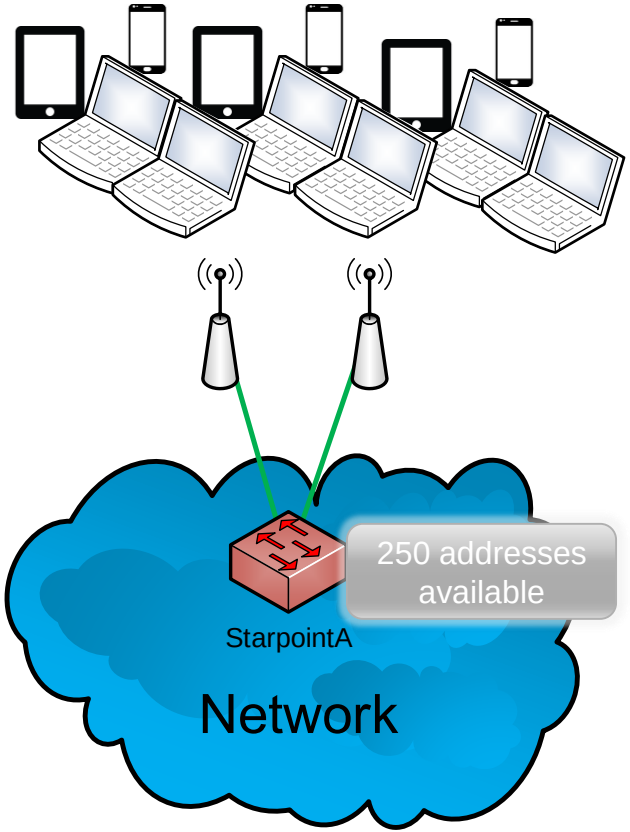
Spare slides

Controller based solution: RF management

- Controller has the full view of all the APs
- AP RF settings (Channel/power) are dynamically assigned by the controller
- Enhanced Steering features:
  - Band steering to move client to 5GHz band when possible
  - Client steering to move the Client to the best available AP (best signal level)
  - Load balancing of client among AP
  - Prevent sticky client
- Based on probes analysis, standards (802.11r, 802.11k, 802.11v), and some proprietary algorithms

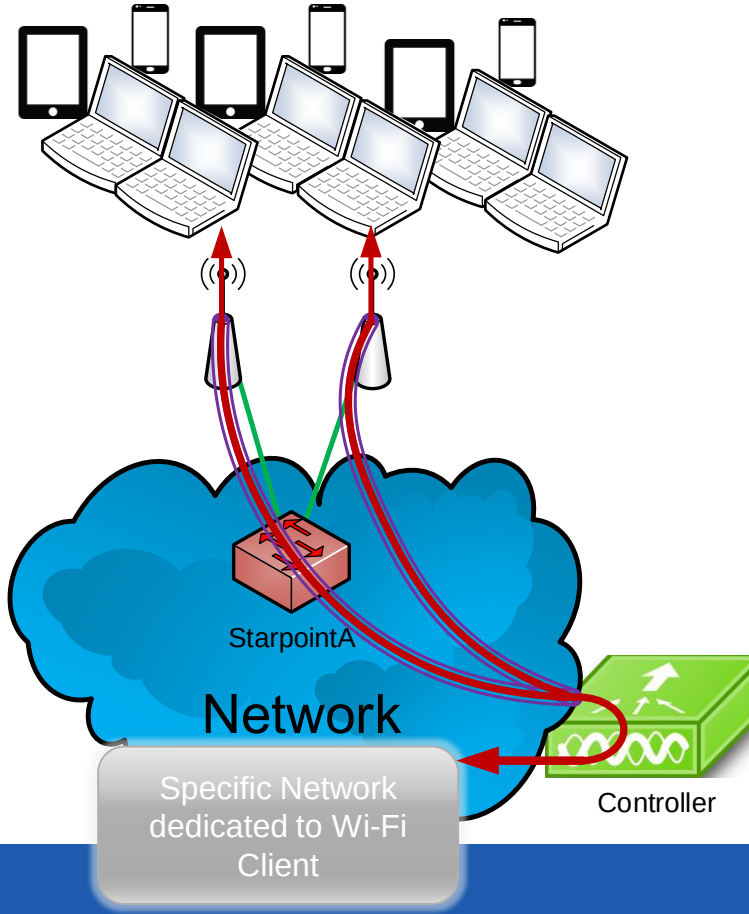
Current issue: IP address management

- Today: a specific IP range is reserved for Wi-Fi users in each location
- Problem if too many people connect at the same place:
  - Big event at the Main auditorium
  - Many people in Restaurant at lunch time

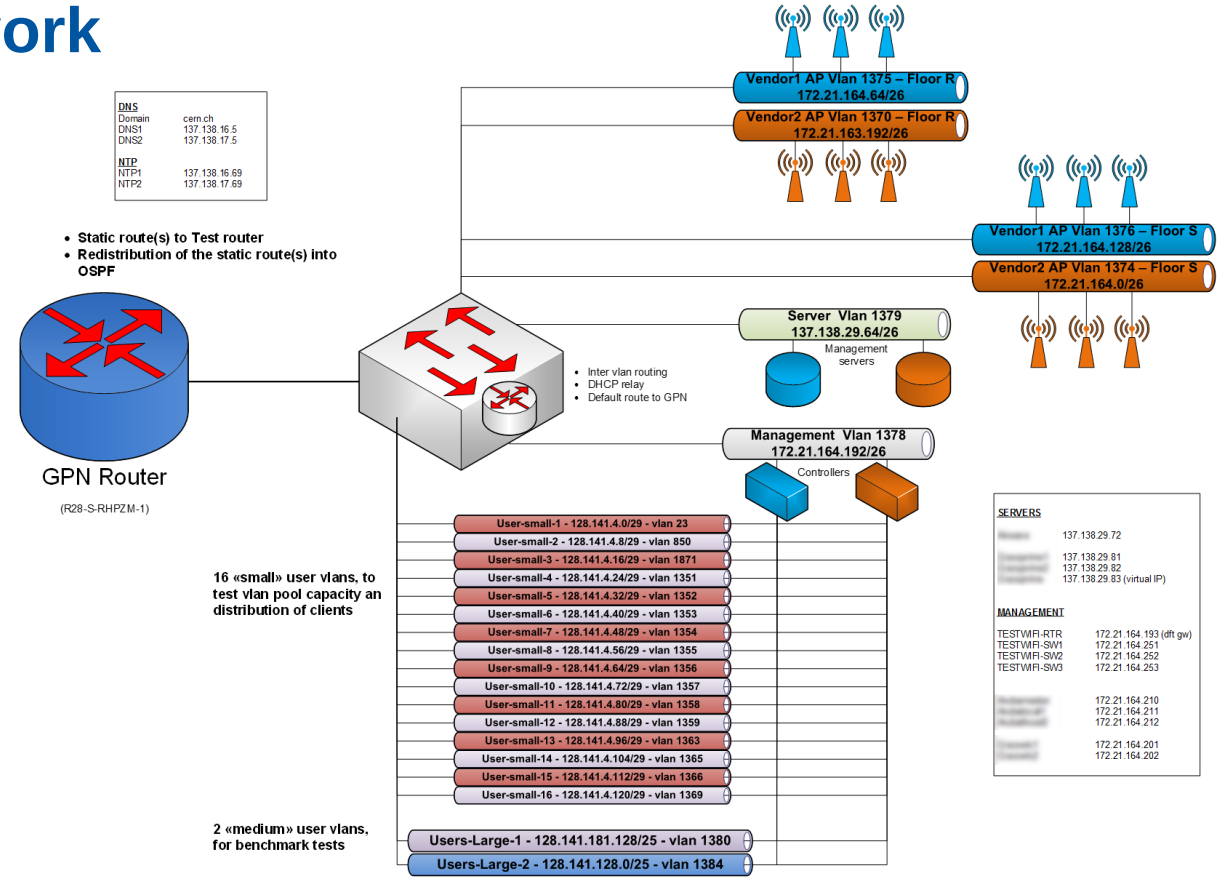


IP address management with the new solution

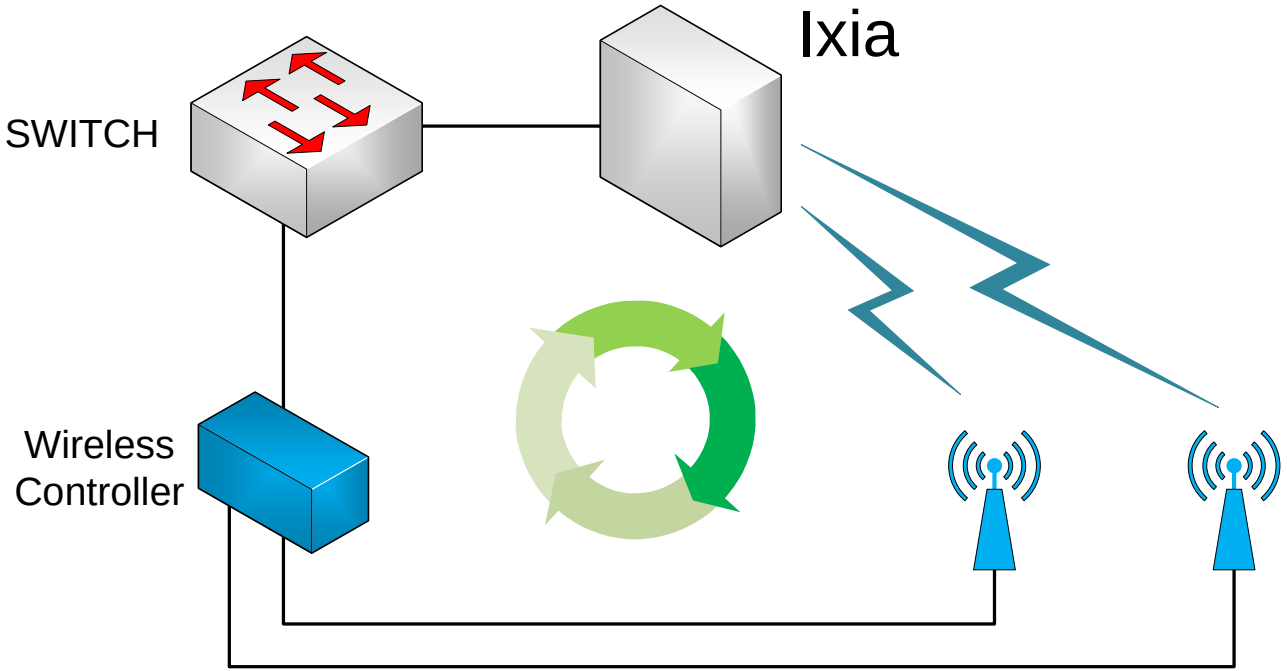
- With the controller, IP addresses are no longer linked to the location
- All Wi-Fi clients use a single large pool of IP addresses



Test network



Ixia devices - principle



Controller hardware

- Model 7240
- Supports up to 2000 Access-Points
- Supports up to 40 Gbps of traffic
- Redundant and scalable cluster design

Access-Points models

- 802.11ac Wave1 or Wave2 (more user density support)
- Indoor and outdoor, with integrated or external antennas

Indoor

AP-325

AP-324

Offices, meeting rooms, restaurant, etc…
(802.11ac Wave2 – MU-MIMO)

AP-205

Corridors, technical areas, etc…
(802.11ac Wave1)

Outdoor

AP-274
(802.11ac Wave1)

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
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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

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
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
24	4	BPSK 1/2	26	28.9	54	60	117	130	234	260	0
25	4	QPSK 1/2	52	57.8	108	120	234	260	468	520	1
26	4	QPSK 3/4	78	86.7	162	180	351	390	702	780	2
27	4	16-QAM 1/2	104	115.6	216	240	468	520	936	1040	3
28	4	16-QAM 3/4	156	173.3	324	360	702	780	1404	1560	4
29	4	64-QAM 2/3	208	231.1	432	480	936	1040	1872	2080	5
30	4	64-QAM 3/4	234	260	486	540	1053	1170	2106	2340	6
31	4	64-QAM 5/6	260	288.9	540	600	1170	1300	2340	2600	7
	4	256-QAM 3/4	312	346.7	648	720	1404	1560	2808	3120	8
	4	256-QAM 5/6	n/a	n/a	720	800	1560	1733.3	3120	3466.7	9