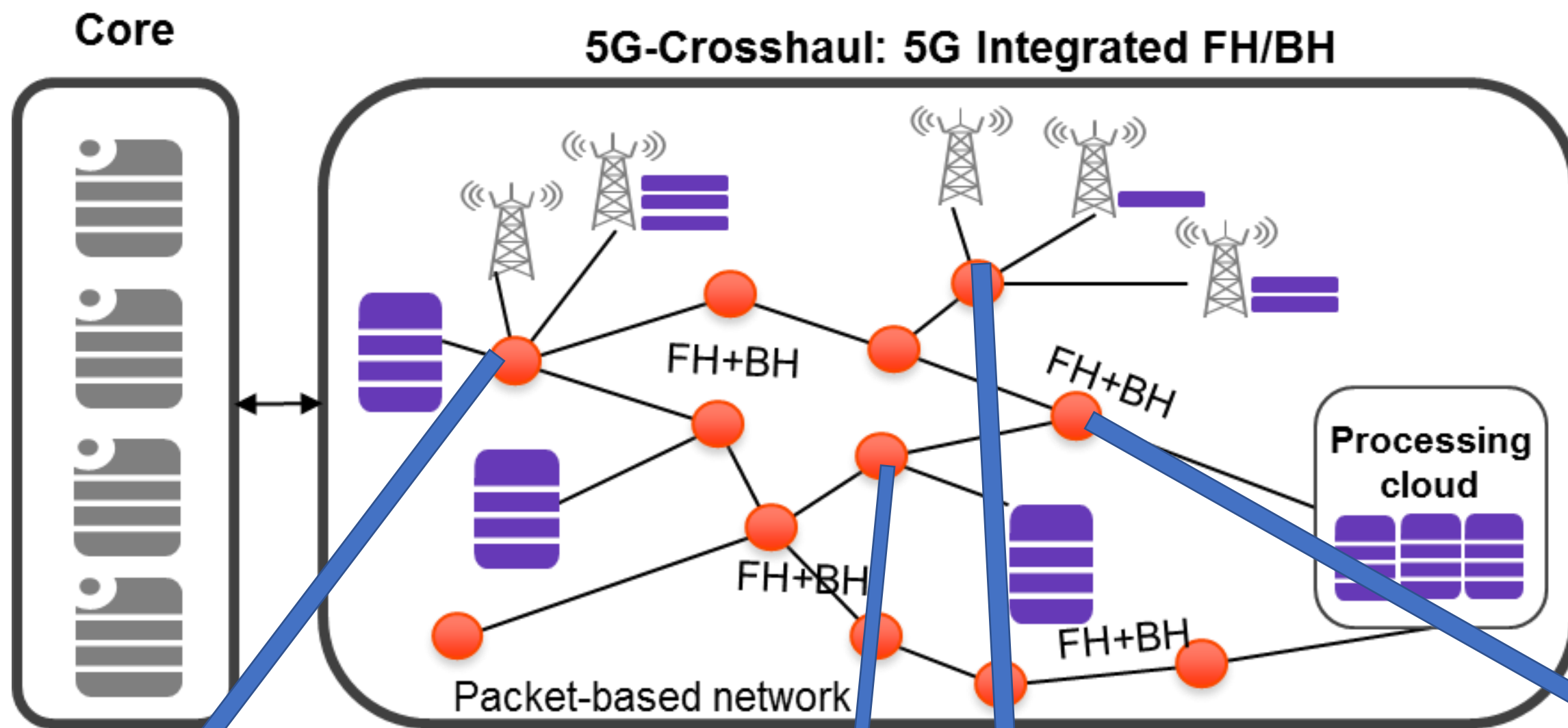


Dataplane Measurements on a Fronthaul (FH) and Backhaul (BH) integrated network



Heterogenous Dataplane

- Fibre, copper, mmWave, μ Wave, ...
- Wavelength, TDM, packet switching
- Outdoor, indoor, ...

Heterogenous traffic types

- Backhaul
- Fronthaul (different functional splits)

Circuit switch

- TDM on top of optical switch

Measurement:

Additional latency by TDM (incl. FEC): $4\mu\text{s}$
BER after FEC: $< 10^{-15}$

Outdoor MmWave

- 802.11ad based, 60GHz
- SencityMatrix V-band antenna
- gain of 38dBi
- 3dB beamwidth of 1.8°

Throughput and packet loss
185m outdoor link

| MC S | DL UDP/TCP Mbps (pkt loss %) | UL UDP/TCP Mbps (pkt loss %) | Jitter DL/UL μs |
|------|------------------------------|------------------------------|----------------------------|
| 9 | 1700/910 (0.87/0) | 1340, 1100 (1.1/0) | 24/11 |
| 8 | 1220/972 (0.23/0) | 1300, 1070 (0.69/0) | 20/12 |
| 7 | 1080/894 (0.76/0) | 1160, 966 (1.1/0) | 29/7 |
| 6 | 910/781 (1.1/0) | 986, 856 (0.65/0) | 25/11 |
| 5 | 866/760 (0.28/0) | 869, 760 (1.1/0) | 29/14 |
| 4 | 814/719 (0.34/0) | 812, 718 (0.96/0) | 13/29 |
| 3 | 705/633 (0.26/0) | 709, 633 (0.39/0) | 20/20 |

Indoor MmWave

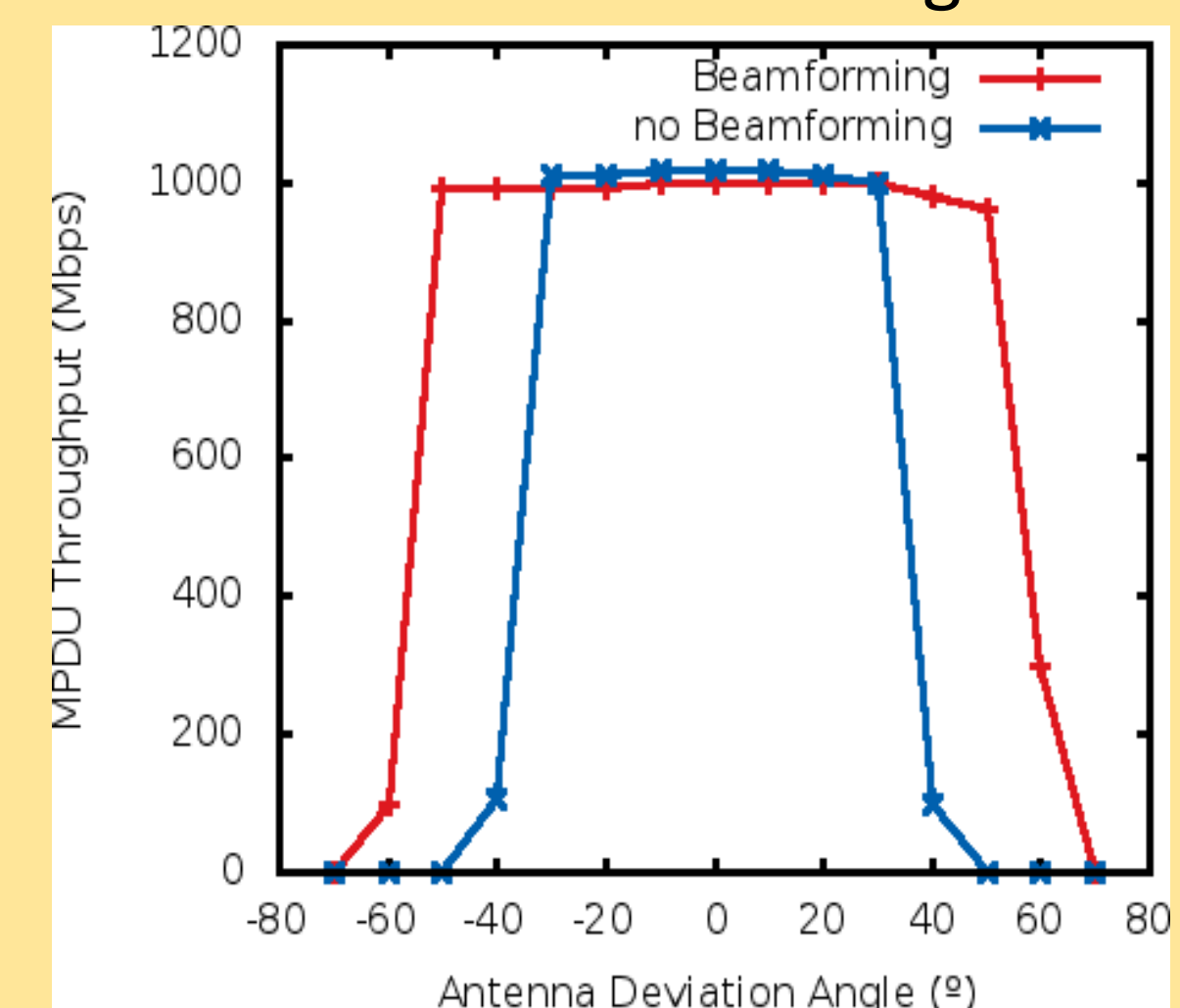
- 802.11ad based, 60GHz
- CMOS embedded antenna
- gain of 10dBi
- 2x2 MIMO
- Automatic beamforming

Throughput and achievable distance

| MCS | Achieved MPDU Throughput (Mbps) | Achieved Phy Rate (Mbps) | Max Distance (meters) |
|-----|---------------------------------|--------------------------|-----------------------|
| 7 | 1020 | 1925 | 2.6 |
| 6 | 900 | 1540 | 3.6 |
| 5 | 790 | 1251.25 | 4.8 |
| 4 | 760 | 1155 | 8.2 |
| 3 | 665 | 962.5 | 10.3 |
| 2 | 565 | 770 | 15.7 |
| 1 | 325 | 385 | 16.9 |

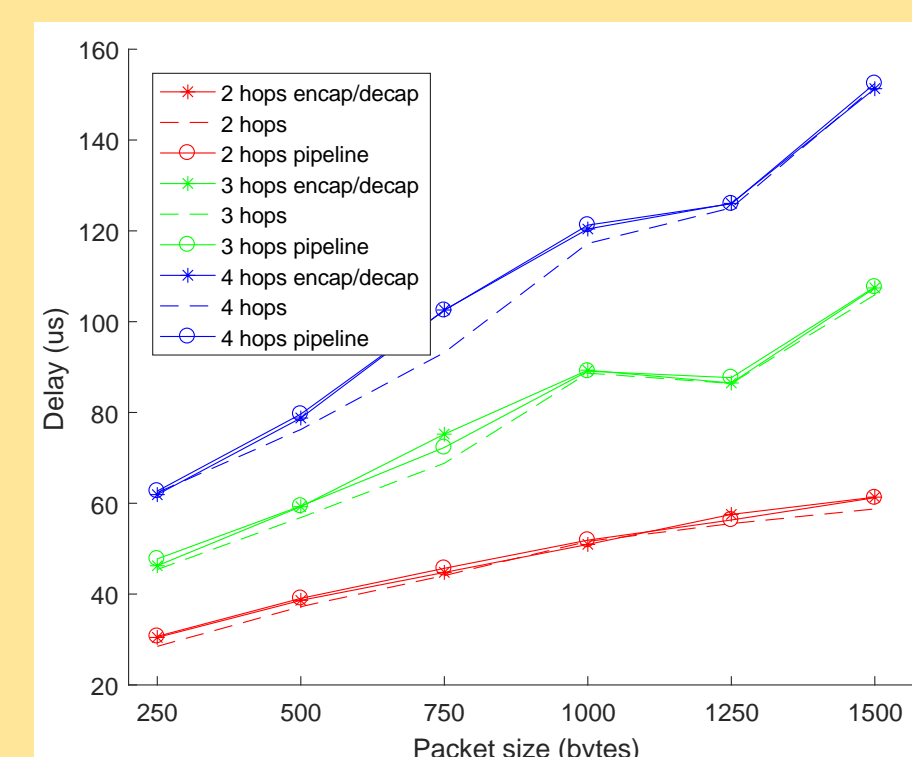
Impact of beamforming procedure:

- Throughput gains over big antenna misalignments
- Robustness showed over small and null antenna misalignments

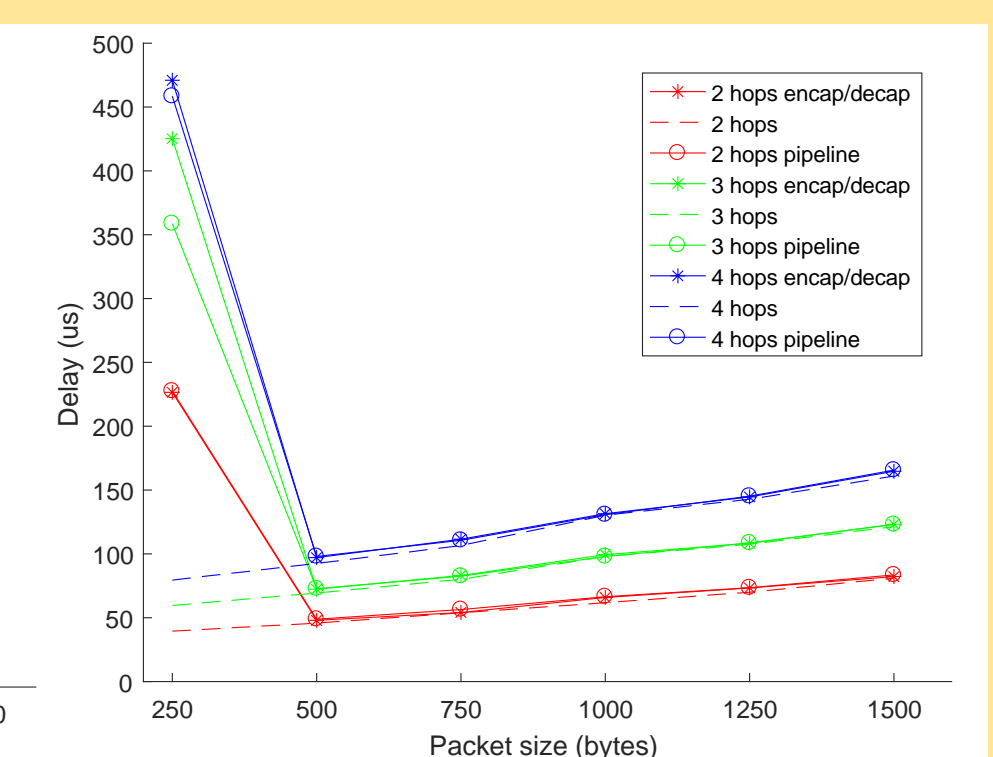
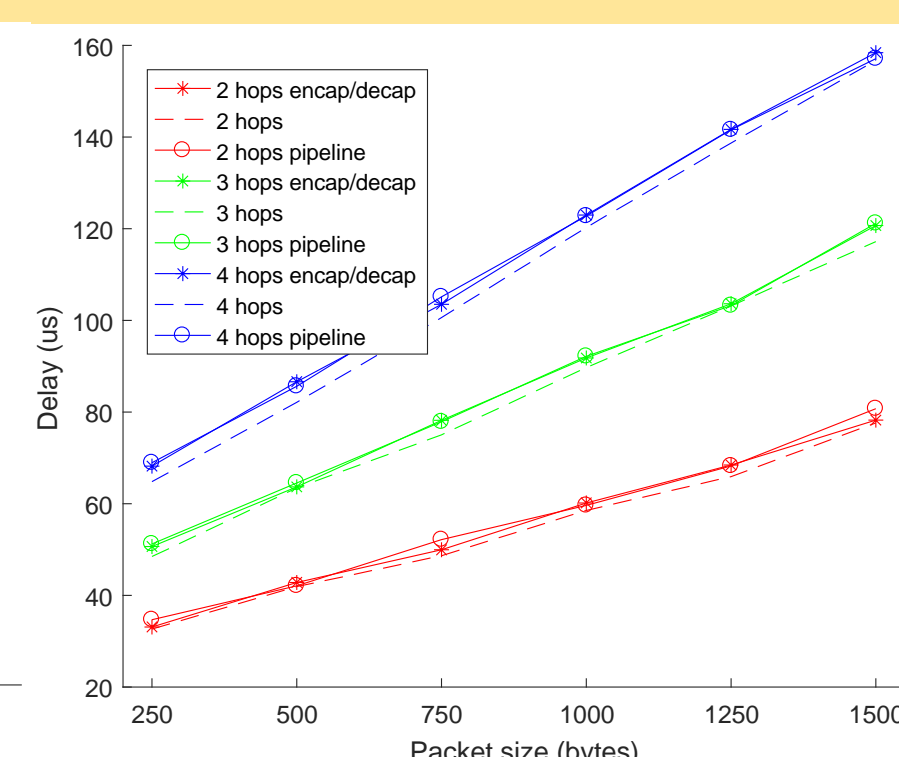


Packet switch

- Openflow switch (lagopus, DPDK based)
- Openflow pipelines
 - Pure forwarding
 - simple encapsulation/decapsulation (encap/decap)
 - Encapsulation/decapsulation, multi-tenancy support (pipeline)



Average latency



- Thomas Deiß* (Nokia, Germany), Jorge Baranda (CTTC, Spain), Luca Cominardi (Interdigital, UK), Luis Miguel Contreras Murillo (Telefonica, Spain), Jessé Gomes (HHI, Germany), Sergio González (UC3M, Spain), Paola Iovanna (Ericsson, Italy), Josep Mangues-Bafalluy (CTTC, Spain), Nuria Molner (UC3M, IMDEA Networks Institute, Spain), José Núñez-Martínez (CTTC, Spain), Antonio de la Oliva (UC3M, Spain), Stefano Stracca (Ericsson, Italy)
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- * Corresponding author email: thomas.deiss@nokia.com