In order to illustrate the challenges of deploying the xhaul architecture, a dimensioning exercise was performed for a 10x10 Km metro with 8000 5G small cell ANs, covering 65% of area, and delivering 1Tbps to Apps.

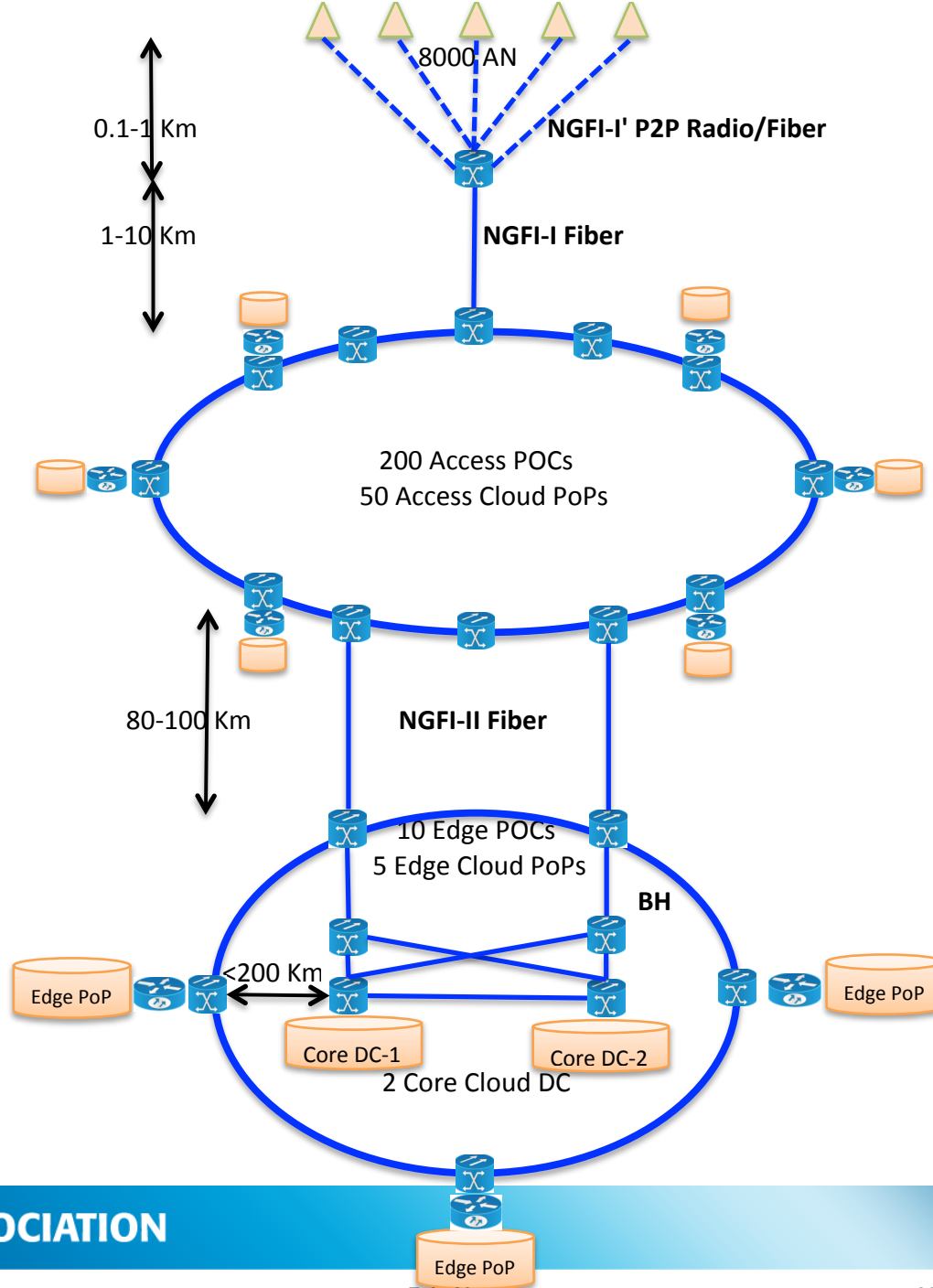Even with moderate assumptions, the results were difficult to deploy.

-Peak of only 5Gbps was used instead of 20 Gbps.
-eCPRI was considered instead of native CPRI .
-Aggressive NGMN peak-to-average throughput algorithm was used
-Advanced 20 Core server was taken into account for H/w requirements

And some useful terms,

- **POC**: Point of Concentration, or OTN for handling Optical L0/L1/L2, or OTN+IP for L0/L1/L2/L3.

- **PoP**: Point of Presence or NFV Infrastructure where a VNF can be spawned to handle L4/L7. A VNF could be a vBBU on Access Cloud, or a UPF on Edge Cloud.

- **DC:** Data Centre with a full blown Telco Cloud handling user plane and control plane virtual functions of EPC/NGC, PCC, and Applications

| Dimensioning with 3-Tier Transport | | | | |
|---|---|---|---|---|
| | Tbps | | | |
| Peak AN traffic | 0.005 | | | |
| I/O | 0.005 | | | |
| AN | 0.01 | Number of AN | Per AN traffic | Per AN h/w |
| O/P | 0.01 | 8000 | 5 Gbps peak | AAU |
| AN per Access POC | 40 | | | |
| Per NGFI-I link | 0.4 | *NGFI-I without being split would mean the capacity had to be maintained for peak of each AN located 100m next to each other, but connected to DU upto 10Km far* | | |
| I/O per Access POC | 0.4 | | | |
| I/O Per Access PoP | 1.6 | No. of Access POCs | No. of Access PoPs | Servers per PoP |
| O/P Per Access PoP | 0.8 | 200 | 50 | 540 |
| Access PoPs per Edge POC | 5 | DU+CU+UPF | | |
| Per NGFI-II link | 0.4 | *Based on the conservative algorithm of the NGMN, smoothening the peaks and average, and reducing the NGFI-II transport load by 10 folds* | | |
| I/O per Edge POC | 0.4 | | | |
| I/O per Edge PoP | 0.8 | No. of Edge POCs | No. of Edge PoPs | Servers per PoP |
| O/P per Edge PoP | 0.4 | 10 | 5 | 270 |
| Edge PoPs per Core POC | 2.5 | CU+AMF+SMF+UPF+PCC | | |
| Per Backhaul link | 1 | | | |
| I/O per Core POC | 1 | | | |
| I/O per Core DC | 1 | | | |
| O/P per Core DC | 0.5 | No. of Core POCs | No. of Core DC | Servers per DC |
| Total Core DC | 2 | 2 | 2 | 350 |
| Total to Apps -> | 1 | AMF+SMF+UPF+PCC | | |

| Dimensioning with 4-Tier Transport and CUPS | | | | |
|---|---|---|---|---|
| | Tbps | | | |
| Peak AN traffic | 0.005 | | | |
| I/O | 0.005 | | | |
| AN | 0.01 | Number of AN | Per AN traffic | Per AN h/w |
| O/P | 0.01 | 8000 | 5 Gbps peak | AAU |
| AN per Muxponder | 40 | | | |
| | | *The Muxponder smoothens the peaks and average, and reduces both the NGFI-I transport load and Access Cloud server requirements by 10 folds* | | |
| Per NGFI-I link | 0.04 | | | |
| | | | | |
| I/O per Access POC | 0.04 | | | |
| I/O Per Access PoP | 0.16 | No. of Access POCs | No. of Access PoPs | Servers per PoP |
| O/P Per Access PoP | 0.08 | 200 | 50 | 50 |
| Access PoPs per Edge POC | 5 | DU+CU+UPF | | |
| | | | | |
| Per NGFI-II link | 0.4 | *Statistical multiplexing gain moved to NGFI-I* | | |
| | | | | |
| I/O per Edge POC | 0.4 | | | |
| I/O per Edge PoP | 0.8 | No. of Edge POCs | No. of Edge PoPs | Servers per PoP |
| O/P per Edge PoP | 0.4 | 10 | 5 | 135 |
| Edge PoPs per Core POC | 2.5 | CU+UPF | | |
| | | | | |
| Per Backhaul link | 1 | | | |
| | | | | |
| I/O per Core POC | 1 | | | |
| I/O per Core DC | 1 | | | |
| O/P per Core DC | 0.5 | No. of Core POCs | No. of Core DC | Servers per DC |
| Total Core DC | 2 | 2 | 2 | 350 |
| Total to Apps -> | 1 | AMF+SMF+UPF+PCC | | |

0.1-1 Km

8000 AN

**NGFI-I' P2P Radio/Fiber**

1-10 Km

**NGFI-I Fiber**

200 Access POCs
50 Access Cloud PoPs

80-100 Km

**NGFI-II Fiber**

10 Edge POCs
5 Edge Cloud PoPs

**BH**

Edge PoP

<200 Km

Edge PoP

Core DC-1

Core DC-2

2 Core Cloud DC

Edge PoP

| Applications | Access Node | | Access Cloud | | Edge Cloud | | Core Cloud |
|---|---|---|---|---|---|---|---|
| mMTC | RU | | DU | | CU | | AMF+SMF+UPF |
| | | NGFI-I | | NGFI-II | | Backhaul | |
| eMBB | RU | | DU | | CU+UPF | | AMF+SMF |
| | | 100 µs | | 1 ms | | 10 ms | |
| uRLCC | RU | | DU+CU+UPF | | | | AMF+SMF |
| | | < 10 Km | | ~ 80-100 Km | | < 200 Km | |
| 4G LTE | RU | | DU | | CU | | EPC |
| POC | N*4000 | | N*100 | | N*5 | | N |

*Without any concern about latency or transport capacity the UPF stays in Core with high capacity to support massive IoT apps server load*

*Without much concern about latency, UPF need not move to load Access Cloud, but to save backhaul capacity it must move to Edge Cloud with UHD cached*

*UPF moves closer for under 1ms latency requirement, and app such as V2X can also be spwan at Access Cloud*

*Without much concern about latency, CU can stay at Edge Cloud instead of loading Access Cloud, and without CUPS, the EPC remains in Core Cloud*

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