A1 Telekom Austria Group
@
Intel® Network Builders Summit
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Dr. Wolfgang Fleischer
A1 Group – Group Technology & Future Services
Head of Technology Strategy and Network Innovation
Vienna – Austria

NFV Core Network

Core Network NFV Status in A1 Group

Operator	Current	Comment	
A1 Belarus	100%	Achieved Jan 2017	Migration within 9 months; very successful
A1 Austria	90%	Achieved in 2017	Due to commercial issues
A1 Bulgaria	50%	Since YE 2018	Waiting for other operators to lead successful implementations
A1 Slovenia	60%	Achieved in 2019	Taking the lead for implementation; issues with Cloud Management Environment
A1 Croatia	50%	Achieved Q1-2109	Waiting for issues to be resolved
VIP Mobile (SRB)	50%	Achieved Q2-2019	Waiting for issues to be resolved
A1 North Macedonia	0		Waiting for other OpCos to finish their migration successfully

Core Network: EPC (SGSN/MME, GGSN/P-GW&S-GW), HLR/HSS, PCRF, MSS, IMS, TAS

Issues with moving towards NFV

- NFV Silos
  - VNF & Cloud Environments (HW & VIM) coupled
- Capacity
  - Cloud Environments performance does not follow Moore's law (although HW does)
  - Multiple vendors for vEPC as a consequence
- OpenStack
  - Complex solution
  - No knowledge internally (i.p. Architects)
  - Knowledge @ vendors also weak
  - More than 6 weeks for establishing Cloud Environment with help of vendor
  - Cloud environments instable, release upgrade go way beyond 4 hour night shifts
- Future OSS
  - EMSs are still around; tied to VNFM; ➔ vendor specific solutions
  - EMS solutions not suited for automation ➔ external automation (expensive RPA) instead of internal automation
- Orchestration
  - No product for end2end orchestration
  - No effective NFV Orchestration
    - ETSI / MANO does not cover all
    - ONAP too complex ?
  - Containers & kubernetes to the rescue ?
- Readiness
  - Some vendors are still not ready; other vendors are ready and are already starting to move to SBA
  - Implement while delivering
  - VNF landscape still patchwork

Our OpenStack Experiment

- Set-up
  - 5 people; typical operator folks; prior programming experience; no knowledge about OpenStack
  - 10% of their time only for OpenStack
  - No prior OpenStack experience
  - „free“ laptops
    - No company security measures
    - Work only in the Internet, not in company NW
    - Responsibility of the people
    - Rebuild from scratch if necessary
- Learnings
  - Biggest Hurdles
    - LINUX knowledge
    - Certain LINUX distribution work better than others (w/o being able to explain why)
    - Network (still broken)
  - 6 weeks to be able to install and configure OpenStack
  - Multi-component installations just running in lab environment
  - OpenStack Architect is missing
    - Operators cannot express to vendors what they need
  - OpenStack not the sole tool, it comes immediately with a larger tool environment
  - Each vendor defines his own environment

intel experience what's inside
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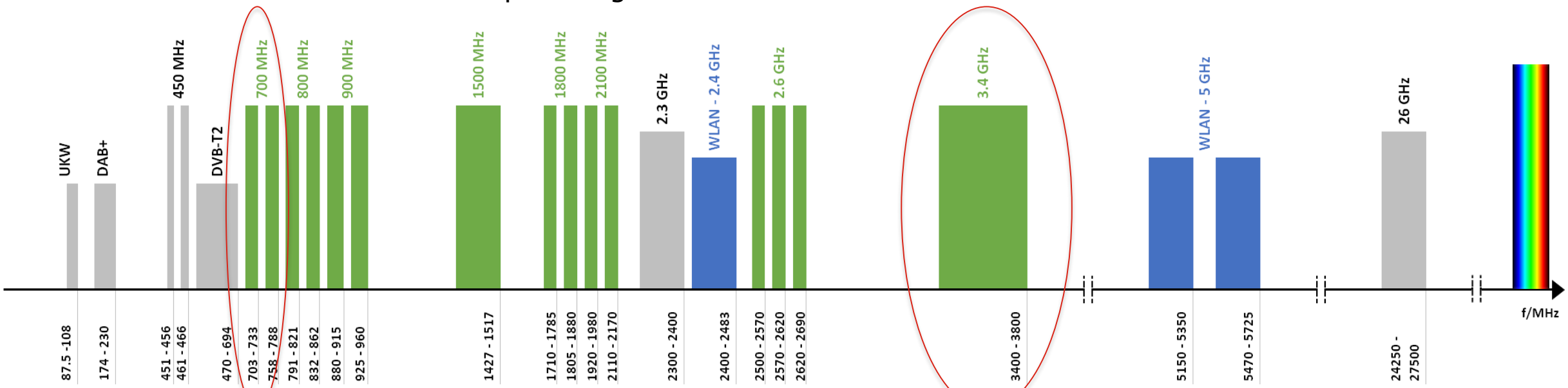
5G Roll-Out

Spectrum bands for 5G

700MHz (Digital Dividend 2)
2nd 5G band in European region

3.500MHz
1st 5G band in European region



< 1GHz
Coverage, good propagation characteristic, little capacity

> 1GHz
Capacity
Smaller cells
More spectrum available

Frequency Range 1 Sub 6GHz

Frequency Range 2 mmWave

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5G spectrum deployment

Frequency Band	Today	Tomorrow	Near Future	Far Future
26-28 GHz	n/a	**5G**	**5G**	**5G**
3500 MHz	n/a	**5G**	**5G**	**5G**
2600 MHz	LTE	LTE	LTE / 5G	LTE / 5G
2100 MHz	UMTS / LTE	UMTS / LTE	LTE / 5G	LTE / 5G
1800 MHz	GSM / LTE	GSM / LTE	GSM / LTE / 5G	LTE / 5G
900 MHz	GSM / UMTS / LTE	GSM / UMTS / LTE	GPRS / UMTS / LTE	LTE / 5G
800 MHz	LTE	LTE ←→ 5G	LTE ←→ 5G	LTE ←→ 5G
700 MHz	n/a	**5G**	**5G**	**5G**

5G roll-out (Expected)

Country	2019	2020	2021	2022	2023
A1 Hrvatska		**In Progress**	**In Progress**	**Capacity**	**Capacity**
A1 Austria	In Progress	**In Progress**	**In Progress**	**Capacity**	**Capacity**
A1 Slovenia		**In Progress**	**In Progress**	**Capacity**	**Capacity**
A1 Bulgaria			**In Progress**	**In Progress**	**Capacity**
A1 Belarus	n/a				
Vip mobile			**In Progress**	**In Progress**	**Capacity**
A1 Macedonia			**In Progress**	**In Progress**	**Capacity**

prospective

actual

Fat letters = commercial

Radio Topics

- NSA vs. SA
  - NSA „on the safe side"; watch out for vendor lock-in: radio – core; radio – radio; missing features, e.g. network slicing; 5G core: does it exist? Is it SBA based? Etc.
  - SA better when you are late (2021); heavy dependency on 5G Core – SBA readiness is relevant
- Coverage Layer
  - Heavily depends on existing assets and acquirable assets
  - For best performance – nationwide identical (at least for smaller countries in Europe)
  - LTE for NSA: 800, 900, 1800, 2100, 2600 are possible depending on your own assets
  - 5G for SA: 700, 800 – all other frequencies require a swap of the existing technology (which might be desired from you)
- 3.5 GHz appears problematic – due to propagation characteristics
- What assets to retire? 2G – 3G – 4G? And when?
  - A1 Group: 3G → 2G voice → 2G GPRS – timing still not fixed

Network Slicing
Airport Vienna

A1 Pre5G Campus Airport Vienna

Characteristics:

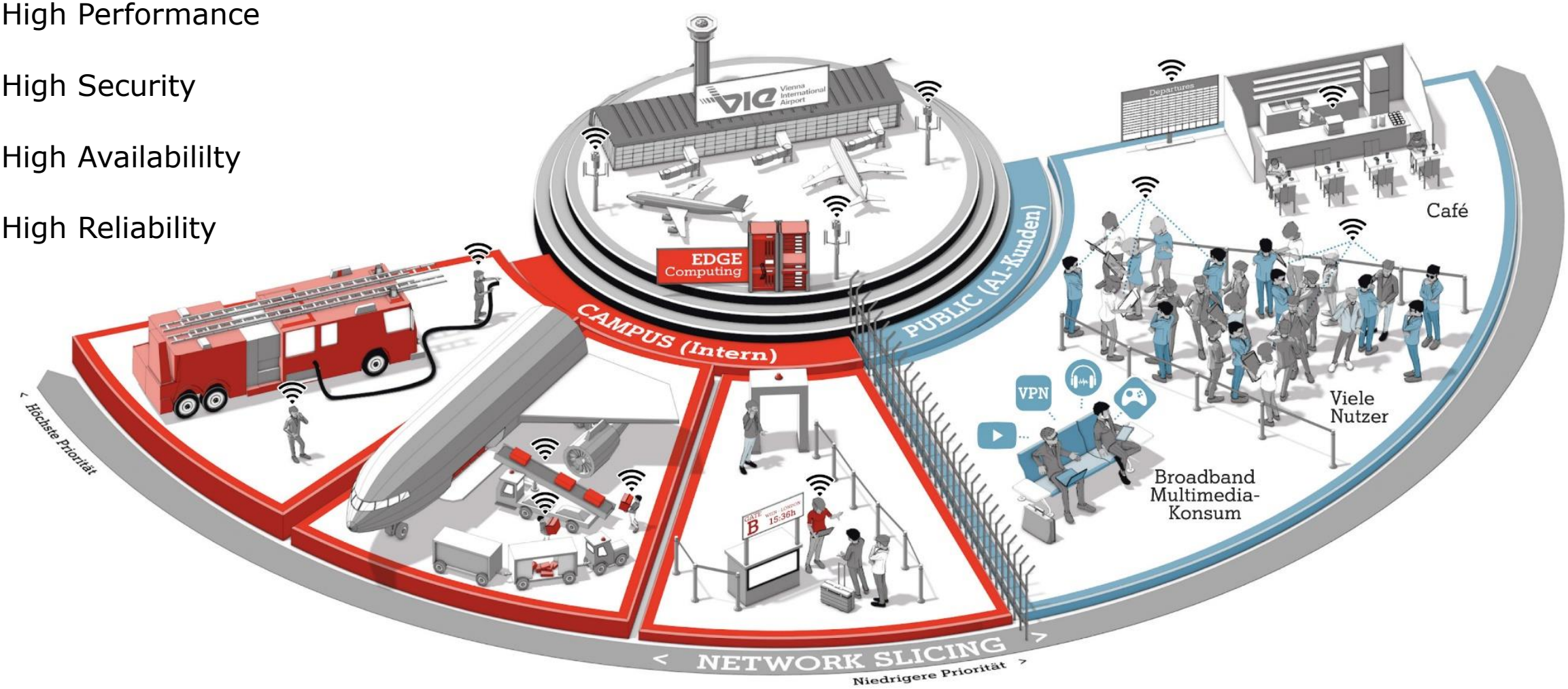
- **First Pre5G „Campus“** Company Mobile Network in Austria
- **Security**: Campus network is physically and logically separated from the public network. All data transferred are encrypted.

Technical Features:

- **Network Slicing**: User and Applications can be prioritized, reduced latency
- **Edge Computing**: all traffic remains within the Campus
- **Small Cells**: Fast and reliable data connectivity (compared to WLAN)

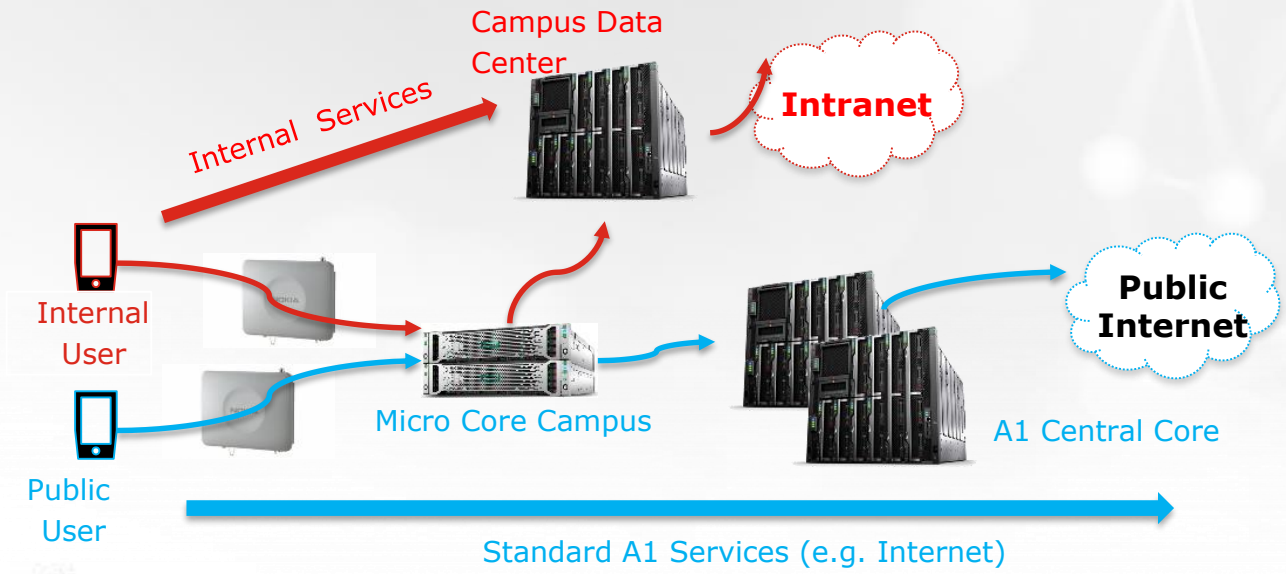
Advantages of Network Slicing for Airport Vienna

- High Performance
- High Security
- High Availabililty
- High Reliability



Building the A1 Pre5G Campus

- Small Cells on light masts
- Autonomous operations due to dedicated HW on Campus location
- Fix allocation of Resource by Network Slicing



Examples of 5G Projects with A1 Customers

„NW Slicing" Campus LTE

Requirements:
- E2E SLA
- Autonomous NW
- Local Data BO

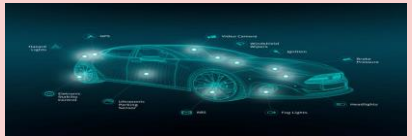
5G „Playgrounds"

Requirements:
- Early 5G Testing
- uRLLC/NW Slicing
- GHz Interference

BVLOS
(Beyond Visual Line of Sight)

Requirements:
- Reliable Location
- Command&Control
- Ultra Broadband

V2X Automotive



Requirements:
- uRLLC
- Precise Location
- Dynamic Map

Smart Grids Time Sync

Requirements:
- uRLLC
- Sync Time Stamp
- 5G2Grid Interface

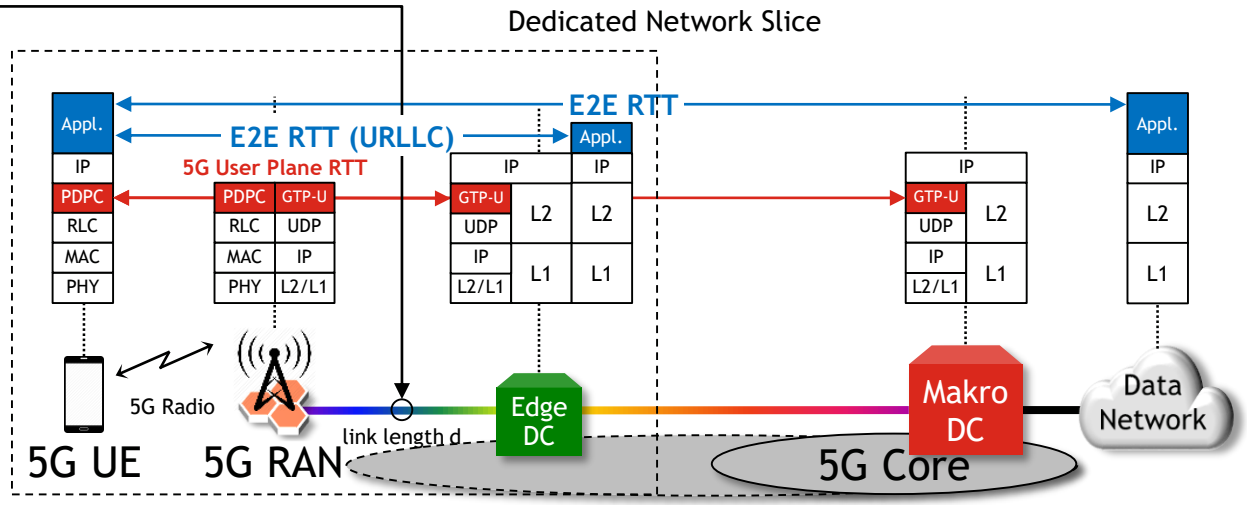
Learnings from Actual 5G Use Cases

Round Trip Time in a Mobile Network

RTT increases with the distance between RAN and Core!

Length d of physical link [km]		1	10	25	50	75	100	300	500	1.000
5G User Plane RTT [ms]		1,11	1,2	1,35	1,6	1,9	2,1	3,6	6,1	11,1
Target E2E RTT	10 ms	8,89	8,8	8,65	8,4	8,1	7,9	5,9	3,9	-1,1
	5 ms	3,89	3,8	3,65	3,4	3,1	2,9	1,4	0,9	-6,1
	4 ms	2,89	2,8	2,65	2,4	2,1	1,9	0,4	-0,1	-7,1
	3 ms	1,89	1,8	1,65	1,4	1,1	0,9	-0,6	-1,1	-8,1
	2 ms	0,89	0,8	0,65	0,4	0,1	-0,1	-1,6	-2,1	-9,1
	1 ms	-0,11	-0,2	-0,35	-0,6	-0,9	-1,1	-2,6	-3,1	-10,1

Budget left for Application incl. TCP/UDP



- Target **E2E RTT ≤2 ms will be feasible** with initial 5G New Radio in 3GPP Rel. 15, and placing Network Functionalities and content closer to the end user in NFV/SDN based distributed Edge Data Centers.
- Network Slicing shall be used to guarantee the required SLA/QoS performance and reliability for URLLC services and isolation from other (non-critical) network traffic.

- 5G use cases targeting an **E2E RTT ≤1 ms (e.g. tactile internet) will need further improvements** of
  - the 5G Radio interface latency in 3GPP R16+ by shortening the Scalable Transmission Time Interval (TTI) down to 100 µs (per direction) as stated by TU Dresden[1] or Qualcomm[2].
  - existing network protocols (TCP/IP was developed in the 1970's!) towards Next Generation Protocols (NGP)[3] for the connected society of the 21st century
  - processing delay in network endpoints and intermittent transport nodes, switches etc.

[1] http://5glab.de/wp-content/uploads/20160929_5gsummit_fettweis_wirelesstrack.pdf
[2] https://www.qualcomm.com/documents/making-5g-nr-reality
[3] http://www.etsi.org/technologies-clusters/technologies/next-generation-protocols

intel experience what's inside
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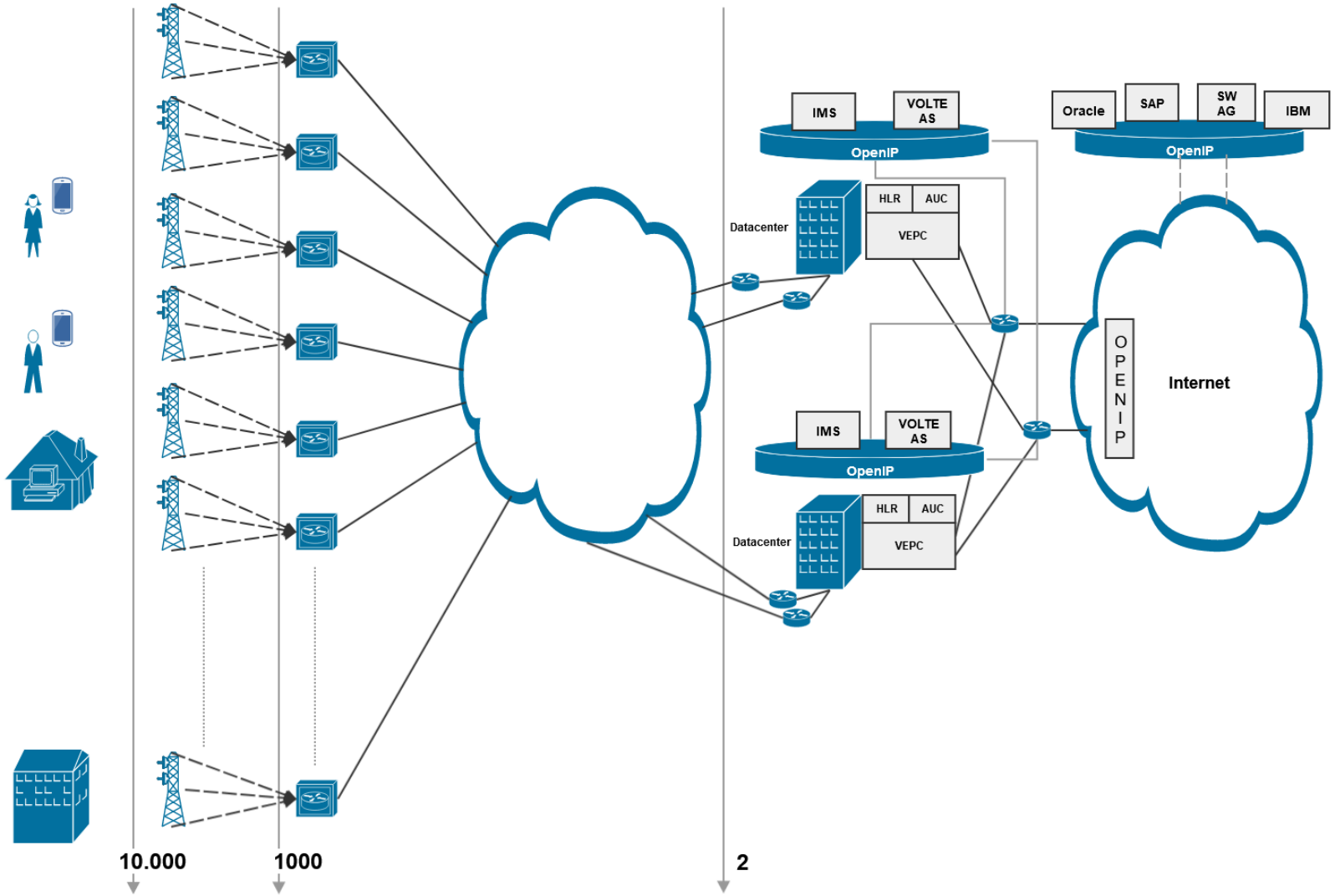

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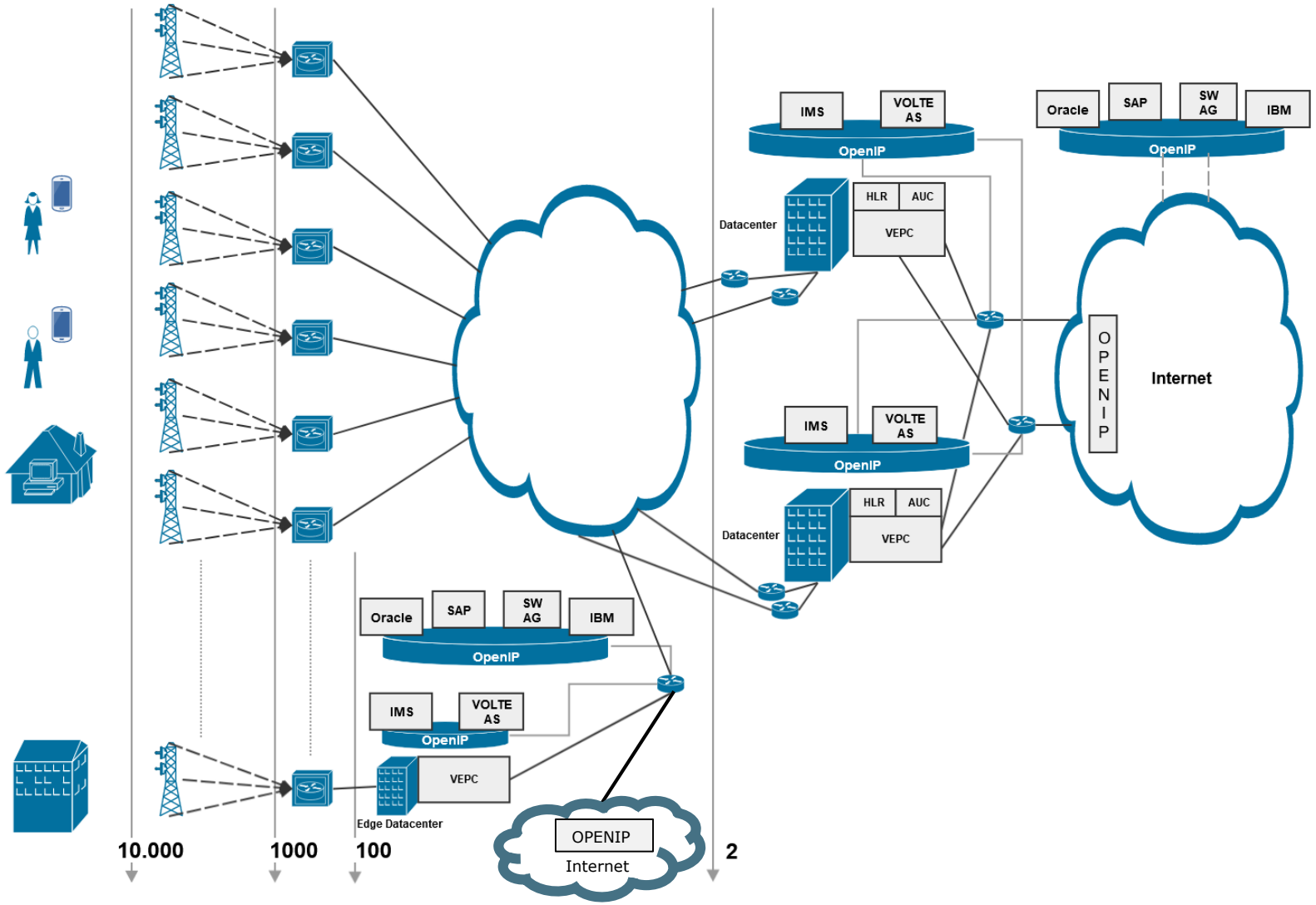
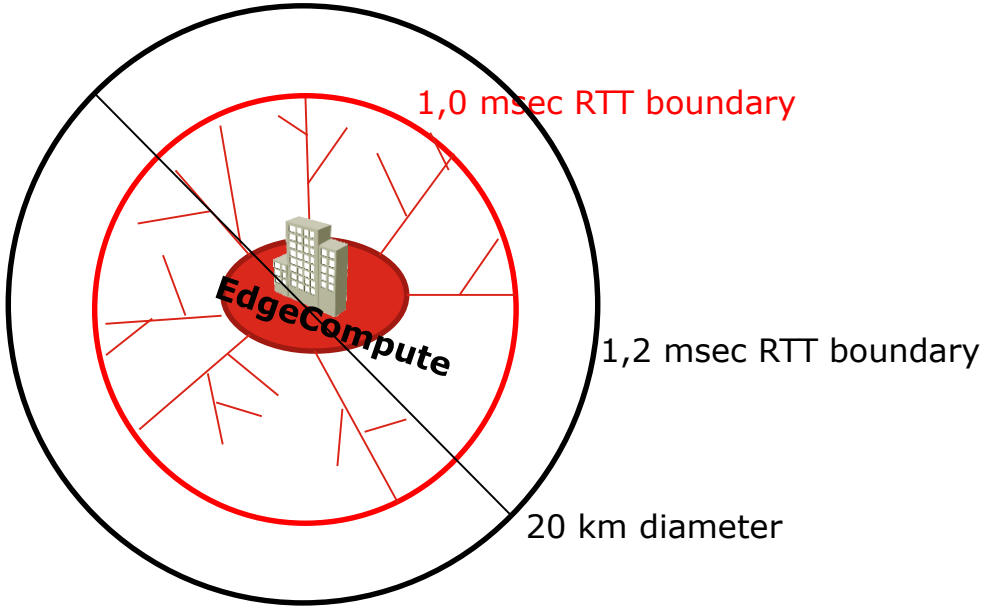
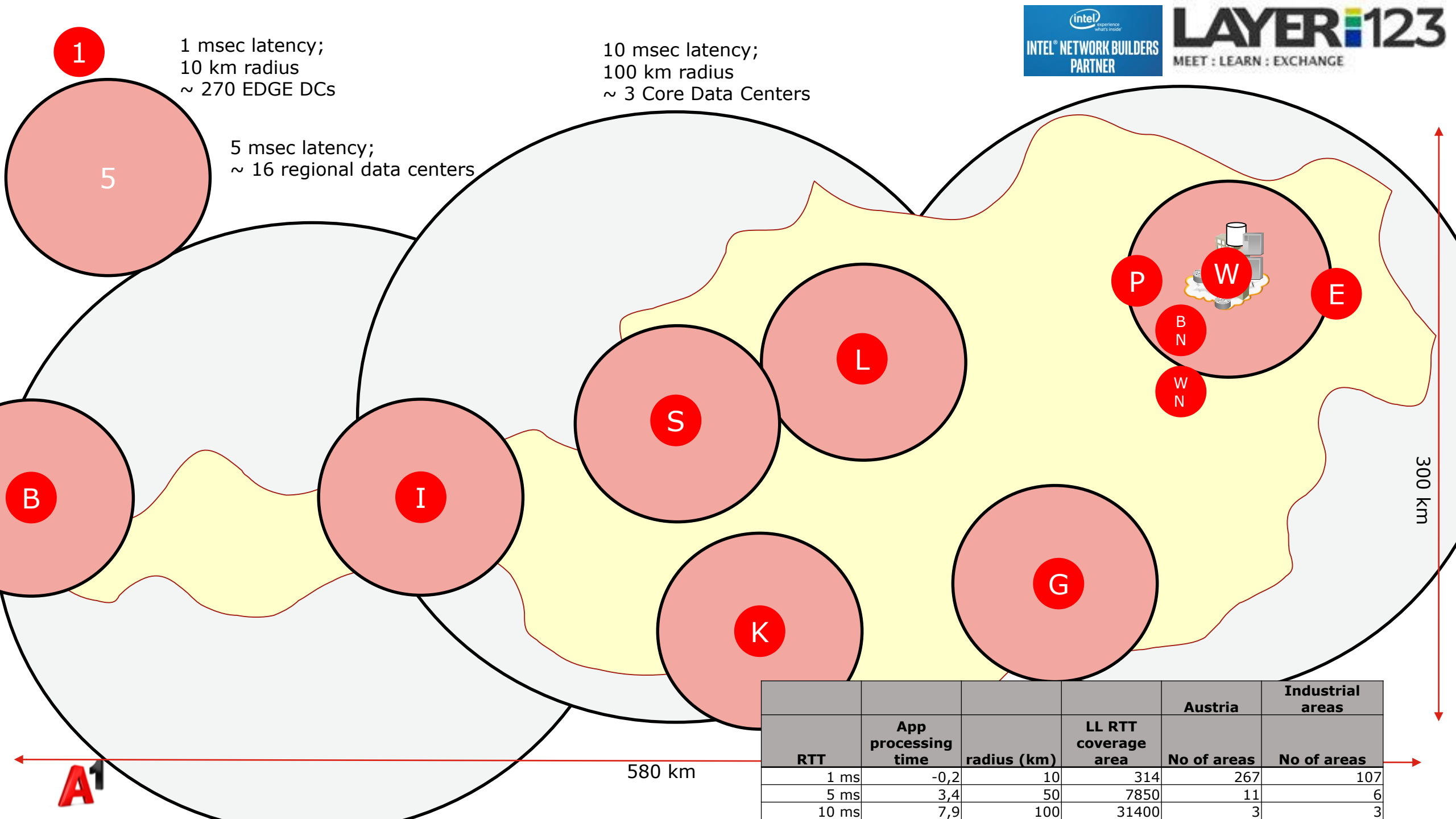




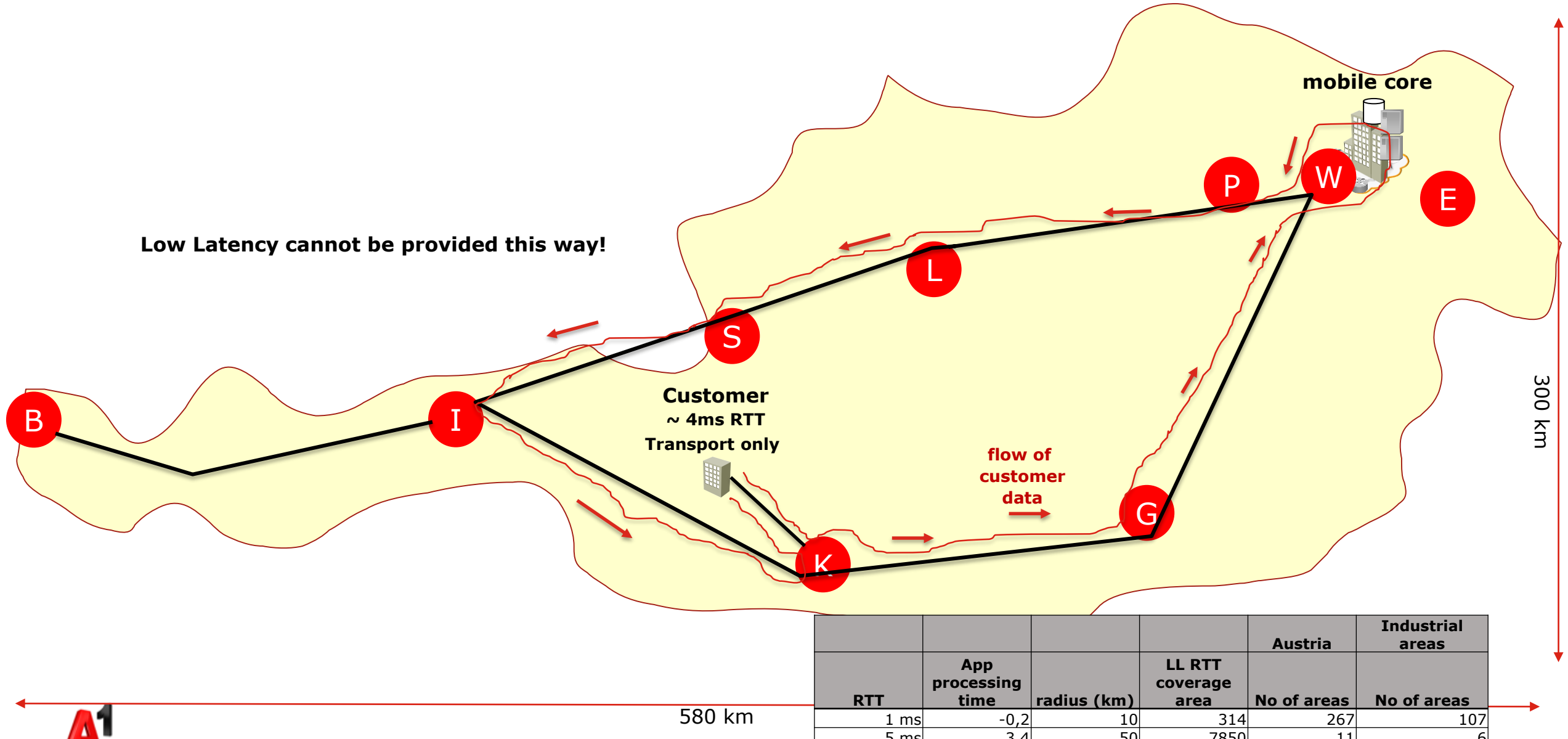
Note: each path within a circle needs to be shorter than the desired low latency



				Austria	Industrial areas
RTT	App processing time	radius (km)	LL RTT coverage area	No of areas	No of areas
1 ms	-0,2	10	314	267	107
5 ms	3,4	50	7850	11	6
10 ms	7,9	100	31400	3	3

1

1 msec latency;
10 km radius;
~ 100 Edge DCs



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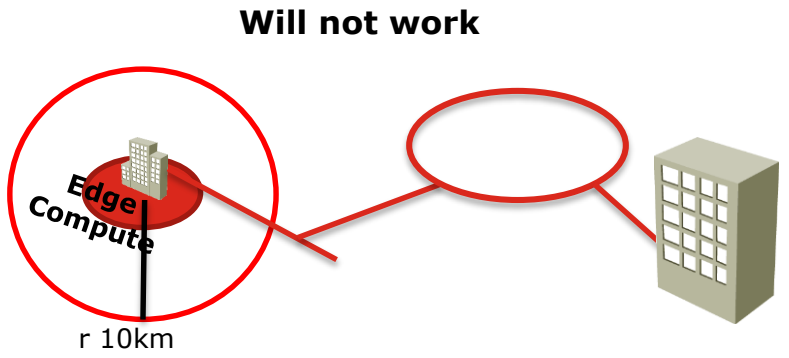
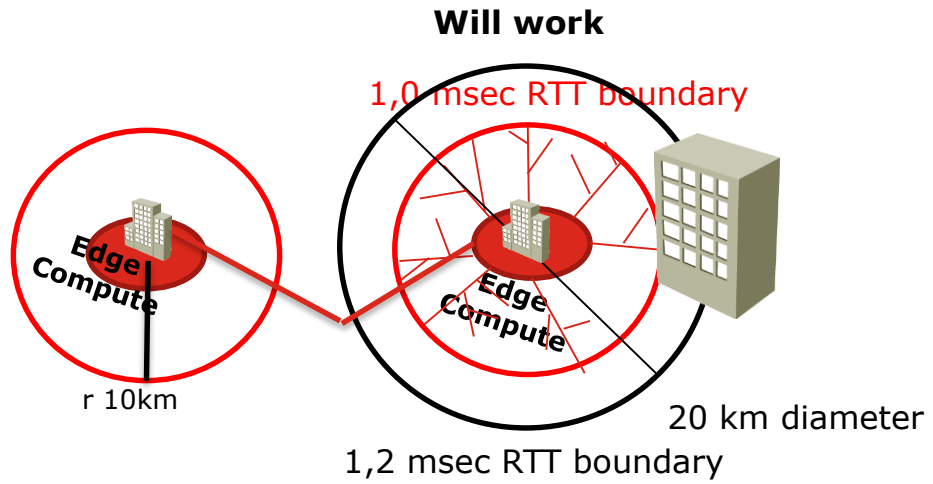
Concrete Customer Use Case

- An industry partner runs a robotics plant. Robots move freely. For various reasons they learned that robots cannot be only self controlled, but they also need to be controlled from sensors external to the robot. Only around 1 msec RTT for the command – response loop will the robot stop accurately enough to avoid any risk of damages.

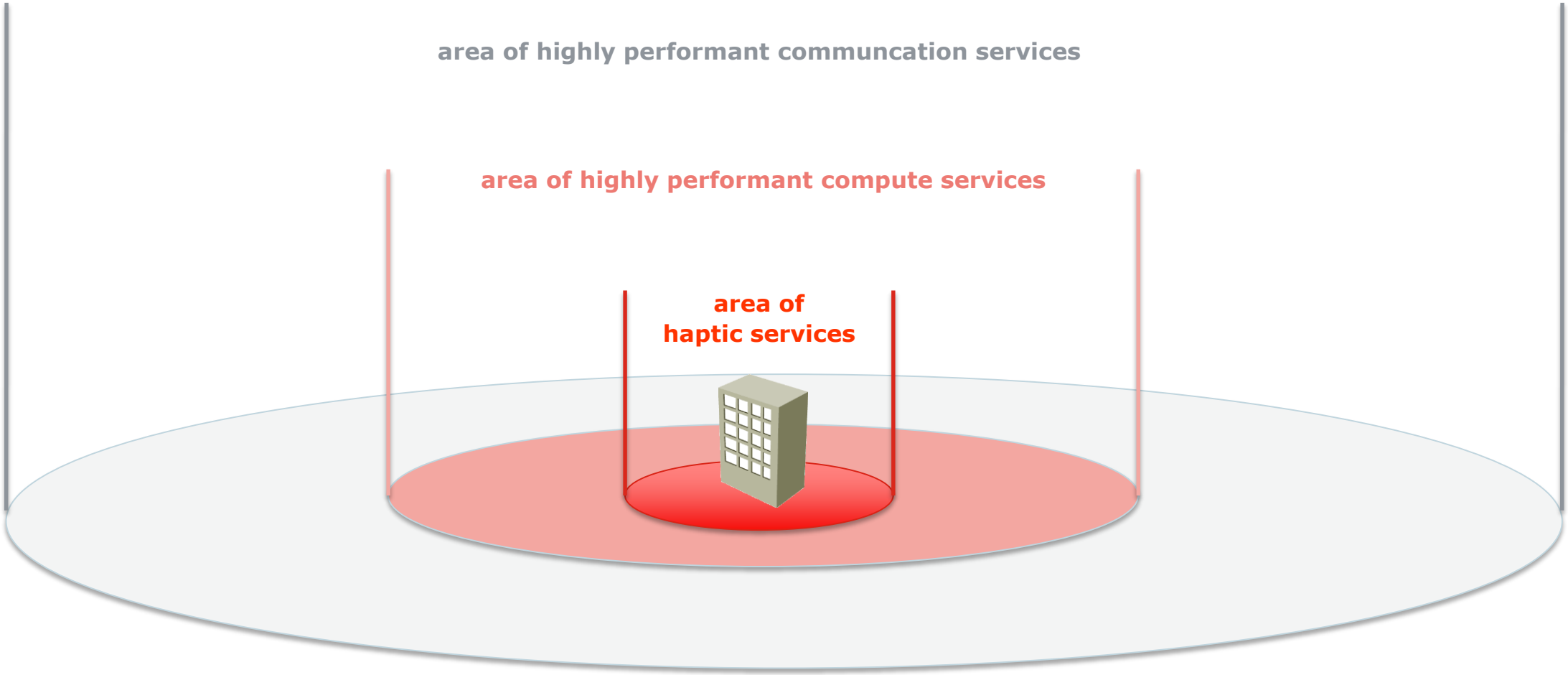
➔ Any IT application providing the control of the robot will need to be located on a compute within a 10 km radius of the robot‘s deployment location.

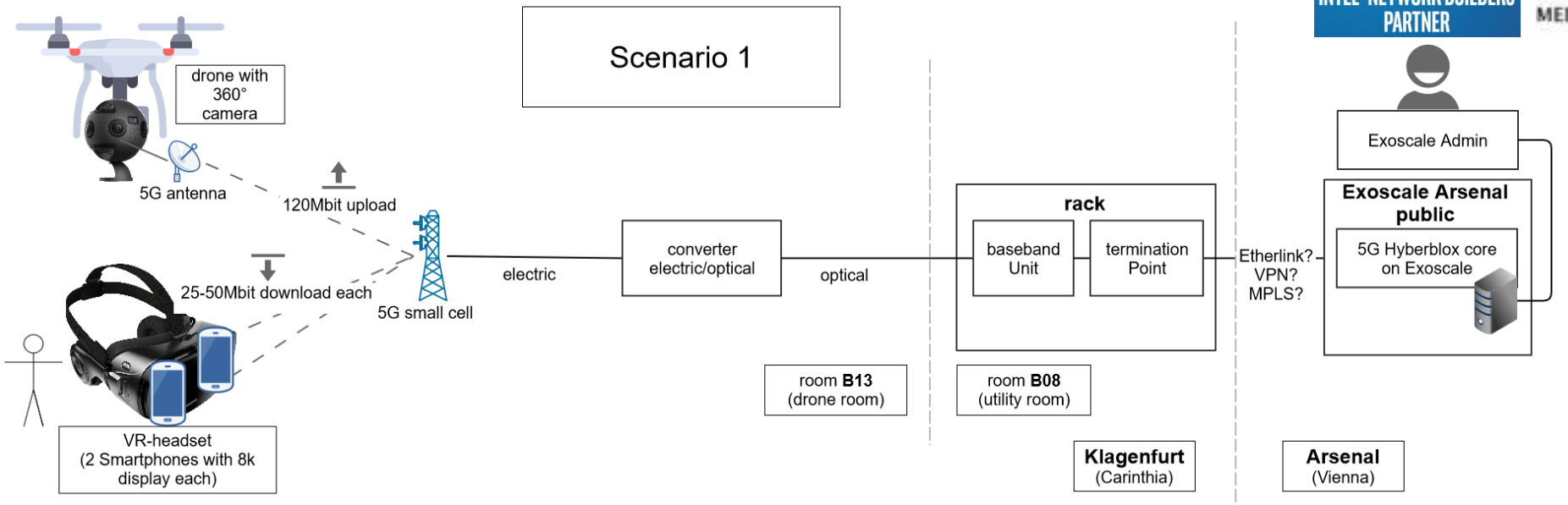
➔ Value for the customer: less waste, safer operations of the plant, no cabling, faster setup times, time to market, flexibility

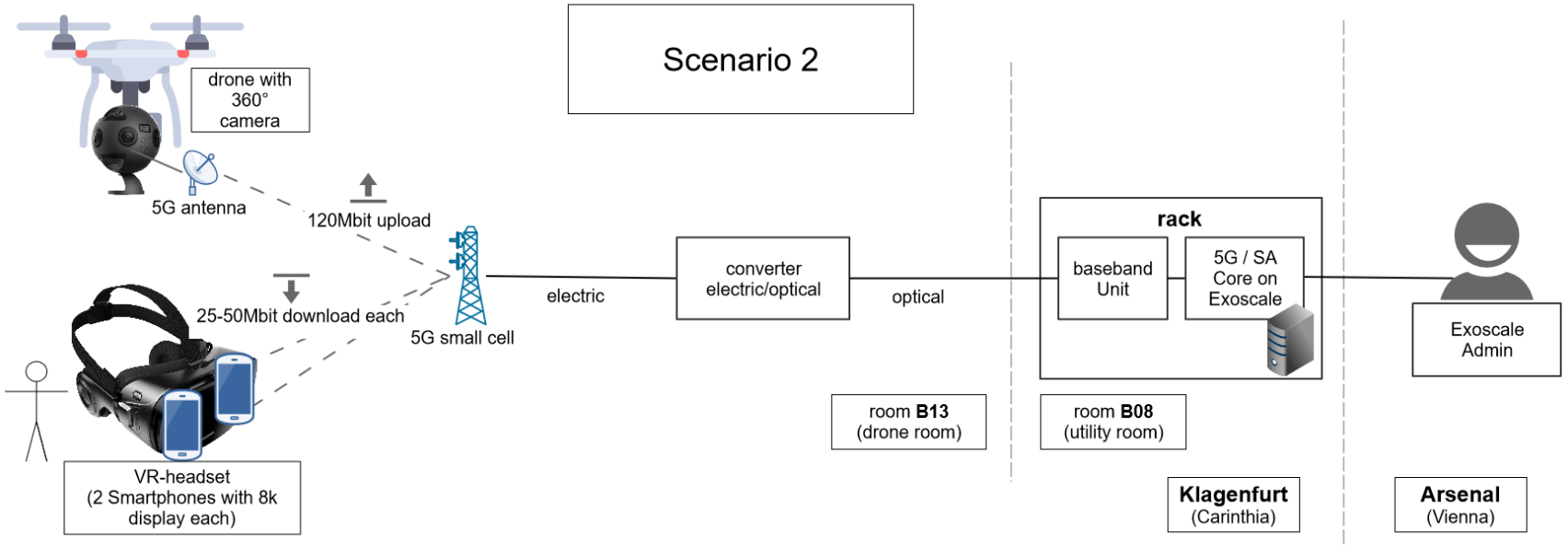




Not at accurate scale!




Scenario 1
drone with 360° camera
5G antenna
120Mbit upload
25-50Mbit download each
5G small cell
VR-headset (2 Smartphones with 8k display each)
electric
converter electric/optical
optical
rack
baseband Unit
termination Point
Etherlink? VPN? MPLS?
Exoscale Admin
Exoscale Arsenal public
5G Hyberblox core on Exoscale
room B13 (drone room)
room B08 (utility room)
Klagenfurt (Carinthia)
Arsenal (Vienna)


Scenario 2
drone with 360° camera
5G antenna
120Mbit upload
25-50Mbit download each
5G small cell
VR-headset (2 Smartphones with 8k display each)
electric
converter electric/optical
optical
rack
baseband Unit
5G / SA Core on Exoscale
Exoscale Admin
room B13 (drone room)
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Klagenfurt (Carinthia)
Arsenal (Vienna)

Summary

- NFV
  - 5G SBA & container will replace NFV
  - NFV never fully embraced by all vendors
- 5G
  - Roll-out fully underway
  - main issues are band availability and auctions
  - NSA as an intermittent step remains an issue
- Network Slicing
  - Works already with 4G
  - A1 Austria realized NW Slicing solution with Vienna Airport
- 5G Learnings
  - Low latency networks
  - 5G Core Networks
  - Network Slicing works automatic with new SW

Thanks a lot for your attention!

Backup Slides

Mobile Edge Computing (MEC)