

Path to 5G

Impact & Challenges for Operator
Network

Vodafone



GNE&D/TTE

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5G | Key enabler for new business

5G capabilities will enable...

...Extreme Mobile Broadband

- Speed & capacity > 1Gbps
- 10's Mbps for cell edge user
- Wide area and indoor coverage



...Massive IoT

- Billions of connected devices
- Long life and very low cost
- Wide area and very deep coverage



...New Industry verticals

- Ultra-high reliability
- Very low latency
- Variable coverage requirements



New opportunities

Consumer



Wearables



Smart Home



Aug. reality



Virtual reality



Visual experience



Holo

Enterprise



Automotive



Smart Energy



Smart City



Healthcare



Logistics



Smart Factory



What is 5G?

- For the end-user:



Accessing any application, everywhere at any time

- For the MNO:



=1ms+10Gbps+99,9999%+
1Mdev/Km²+10years+Security



1	Spectrum
2	Site Design
3	Transport – Site
4	Transport – Access
5	Transport – Core
6	Transport - SDN
7	Telco Data Centers
8	Cloud-RAN
9	MEC
10	Core NW Virtualisation & 5G Core
11	NW Slicing



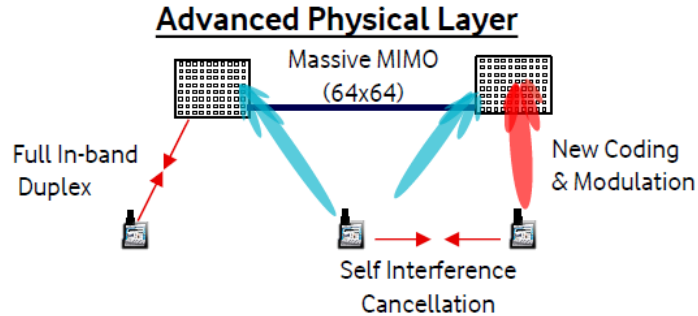
Spectrum | regulation adaptation needed

Range	Band	Mode	Typical MHz	4G/4G Evo	Initial 5G NR Deployments
<1GHz	700	FDD	2x10	✓	✓
	800	FDD	2x10	✓	✓
	900	FDD	2x10	✓	✓
1GHz - 2.6GHz	1400	SDL	1x20	✓	✗
	1800	FDD	2x20	✓	✗
	2100	FDD	2x15	✓	✗
	2300	TDD	1x20	✓	✗
	2600	FDD	2x20	✓	✗
	2600	TDD	1x20	✓	✗
3.5GHz	3500	TDD	1x 50 -100	✗	✓
	3700	TDD	1x50-100	✗	✓

- Enough Spectrum (>100MHz)
 - Spectrum Sharing?
- Contiguous spectrum
 - Defragment
- Low band for coverage
 - 700MHz
- High band for capacity
 - 3,5GHz, even higher @full deployment
- Increased number of sites
 - Accelerate licensing
 - EMF relaxation

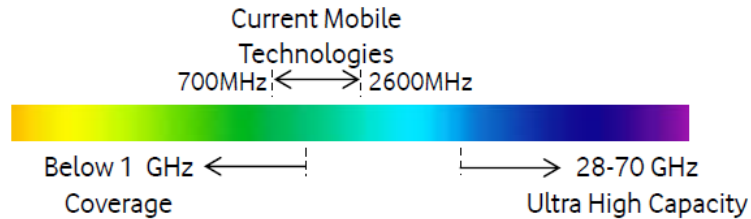


Radio | new bands, radio, architecture & SDN

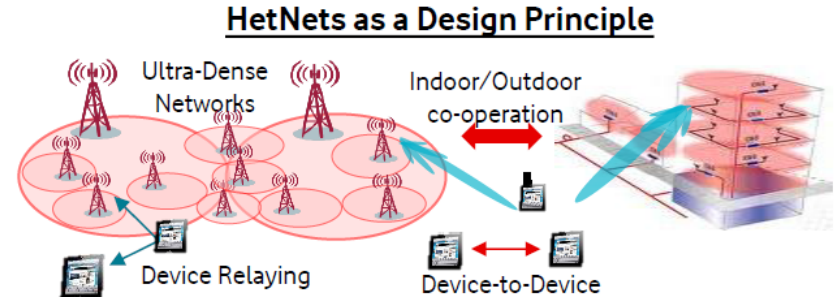


Higher speed/capacity, Lower Latency

Maximizing Spectrum Opportunities

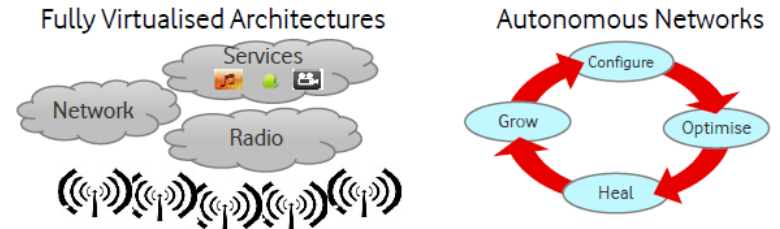


Leverage all spectrum licenced/unlicensed



Fully flexible connectivity & coverage

Software Defined Architecture



Reducing costs & time to market



Transport | need to standardize & rationalize requirements

Gigabit Capacity

- Video & Convergence
- Enterprise Broadband
- MIMO & CA
- Evolved DRAN
- C-RAN
- FrontHaul Capacity



Resilience

- Life critical applications
- Real time applications
- Six nines availability



Security

- Millions of devices connected
- Device to device comm
- Business critical



Time/Phase Sync

- LTE-TDD
- Inter-eNB CoMP
- EMBMS
- Cell Site coordination
- eICIC-HetNet



Time Sync

Ultra Low Latency

- Life critical applications
- Real time applications
- Virtual Reality



SDN/NFV

- Cloud ready Core sites
- Connectivity automation & network slicing
- Flexible orchestration
- Edge Computing





Network Slicing

- NB-IoT → millions of devices
- Dynamically assign network resources
- Network differentiation per service



Transport Capacity | How to meet requirements



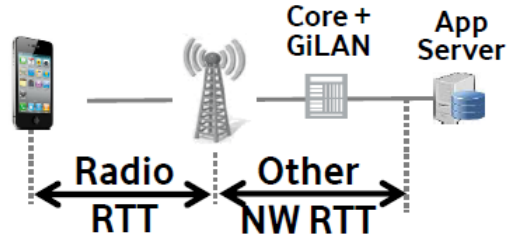
Technology	Max Speed (Gbps)	Latency per hop (ms)
Fibre	1 - 10+	<0.05
E-Band Microwave	2 - 10	<0.2
Multi Band Link	1.5 - 4	0.25
Normal IP Microwave	0.5+	0.25

- Accelerate fiberization
 - Focus on Aggregation
- Wireless technologies where fiber not feasible or viable
 - Eband
 - Multi Band Links

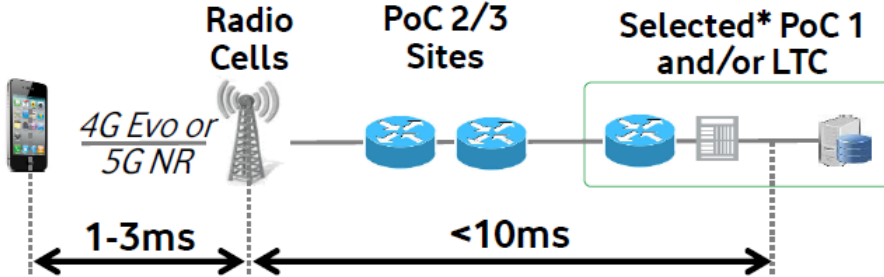


Transport Latency | mainly about architecture

* Prioritise based on business needs

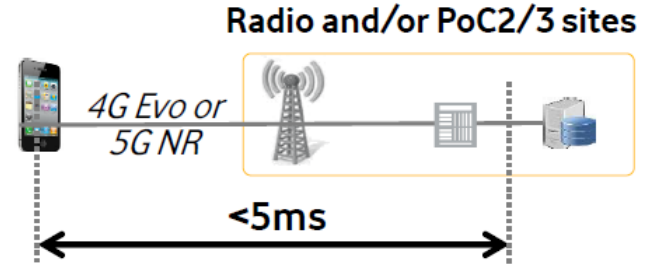


Low Latency (LL) Apps



Ultra Low Latency (ULL) Apps

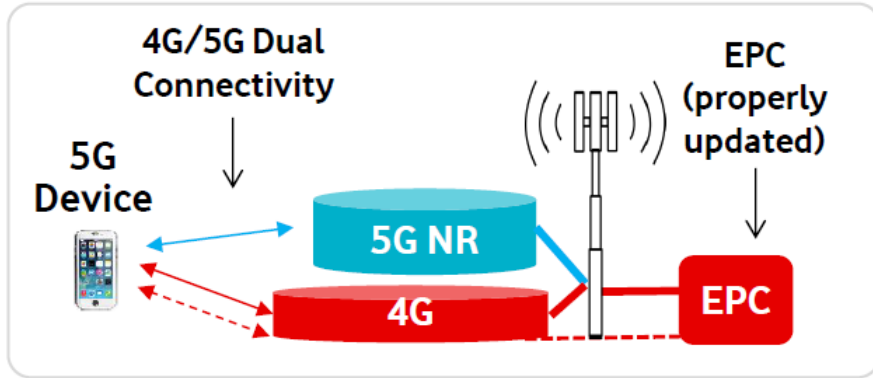
<5ms RTT - business case driven



Core | phased evolution to NGCN

Step 1 Non Stand-alone Operation with 4G Anchor

Initial 5G Deployments

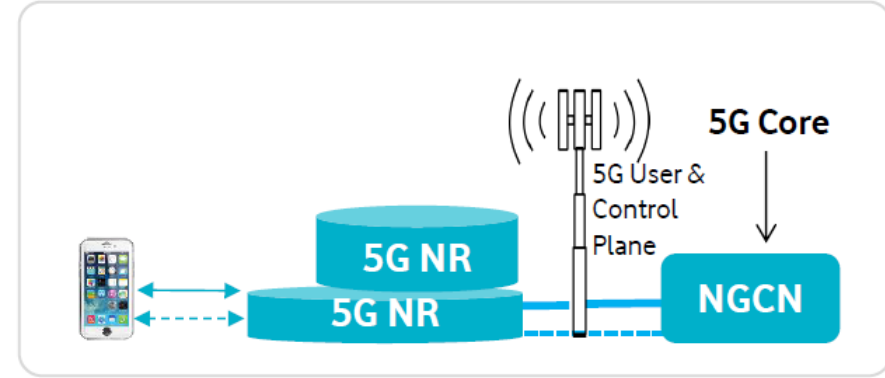


- The 5G Radio is “anchored” to the underlying 4G network
- Updated EPC will support initial 5G devices and applications
- Evolution includes ability to handle peak speed >2Gbps

↔ User plane
↔ Control Plane

Step 2 Stand-Alone Operation with NGCN

Future 5G Evolution



- 1st NGCN standards in 2018; Service Based Architecture enables full 5G capabilities and flexibility
- NGCN migration timing and traffic transfer model under study
- Use of NGCN to manage 4G packet traffic also under study



Slicing & SDN | Enablers for service differentiation, low latency & reduced Time To Market

Key benefits of SDN

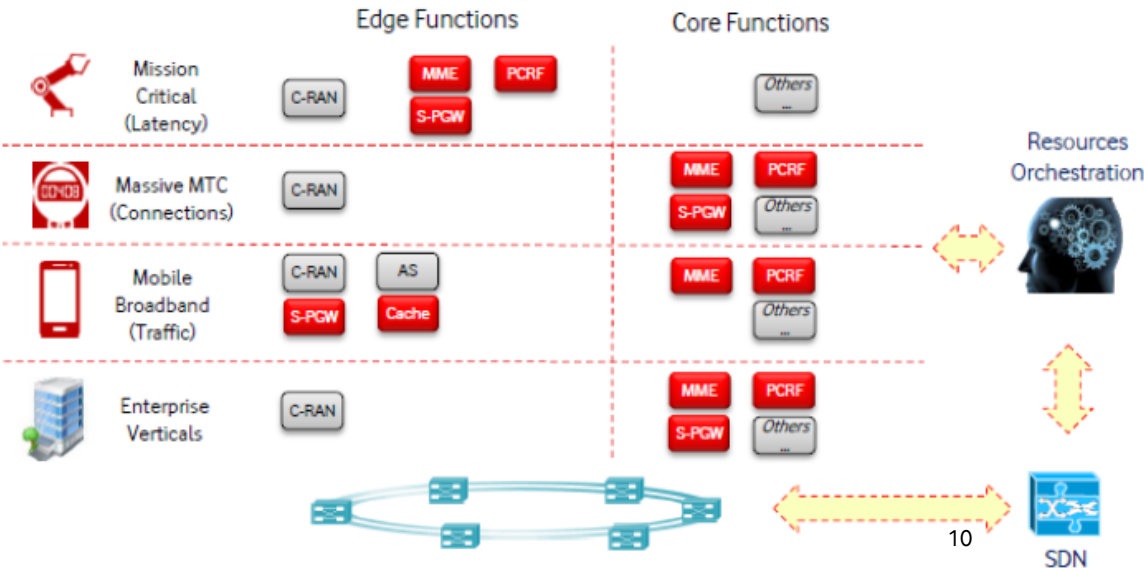
- NW automation, simplified provisioning
- Dynamic resource allocation
- Automatic restoration & protection
- Faster time to market, reduced operational costs

- NW slicing: Specialized network slices to match specific requirements

- Slice definition / selection function under definition by 3GPP

- Key network components (SDN, Cloud-RAN, MEC, IP Backhaul) enablers to implement slices

- Hierarchical QoS & SDN key enablers for MBH



Take away

- Standardization is essential
 - Service & Requirements
- Regulatory adaptations
 - New bands
 - EMF
 - Collocation
- 5G is about complete network transformation
 - Significant investment
 - Changes in the architecture, topology & technology
 - Access & Transport the most impacted domains
- Step-by-step approach



New business model





Thank you