



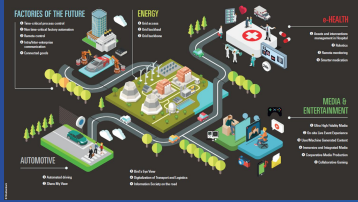
No 5G without Network Virtualization

Pål Grønsund, Telenor Research

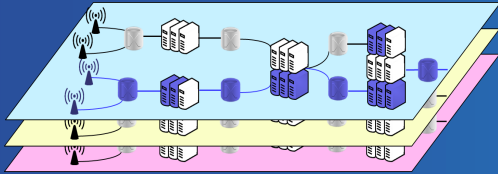
Mobil Agenda, Lysaker, Norway, 14.Nov 2017



3 key takeaways



5G is about empowering the verticals, hence, there will be a stronger focus on Verticals and B2B



Network Virtualization is a prerequisite for 5G



Introducing Network Virtualization is a journey that must start today preparing for 5G

FACTORIES OF THE FUTURE

- 1 Time-critical process control
- 2 Non time-critical factory automation
- 3 Remote control
- 4 Intra/Inter-enterprise communication
- 5 Connected goods

ENERGY

- 1 Grid access
- 2 Grid backhaul
- 3 Grid backbone

e-HEALTH

- 1 Assets and interventions management in Hospital
- 2 Robotics
- 3 Remote monitoring
- 4 Smarter medication

MEDIA & ENTERTAINMENT

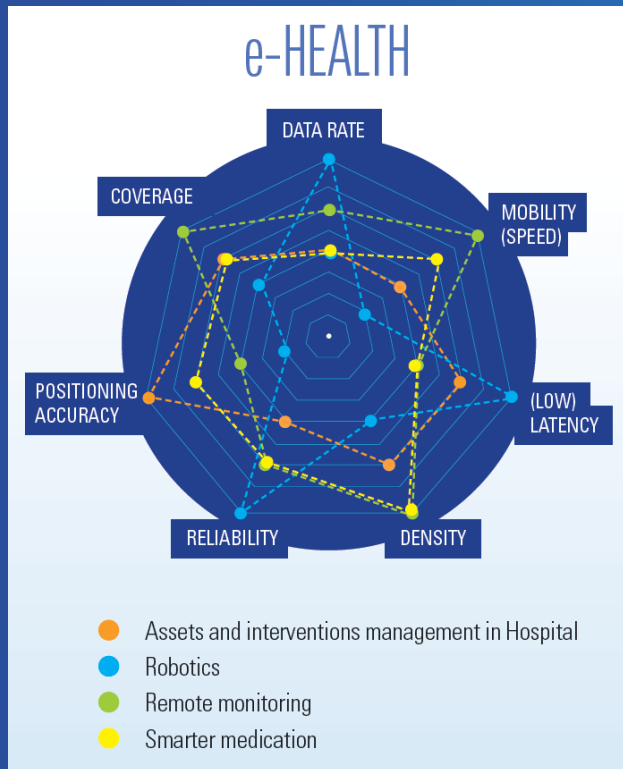
- 1 Ultra High Fidelity Media
- 2 On-site Live Event Experience
- 3 User/Machine Generated Content
- 4 Immersive and Integrated Media
- 5 Cooperative Media Production
- 6 Collaborative Gaming

AUTOMOTIVE

- 1 Automated driving
- 2 Share My View

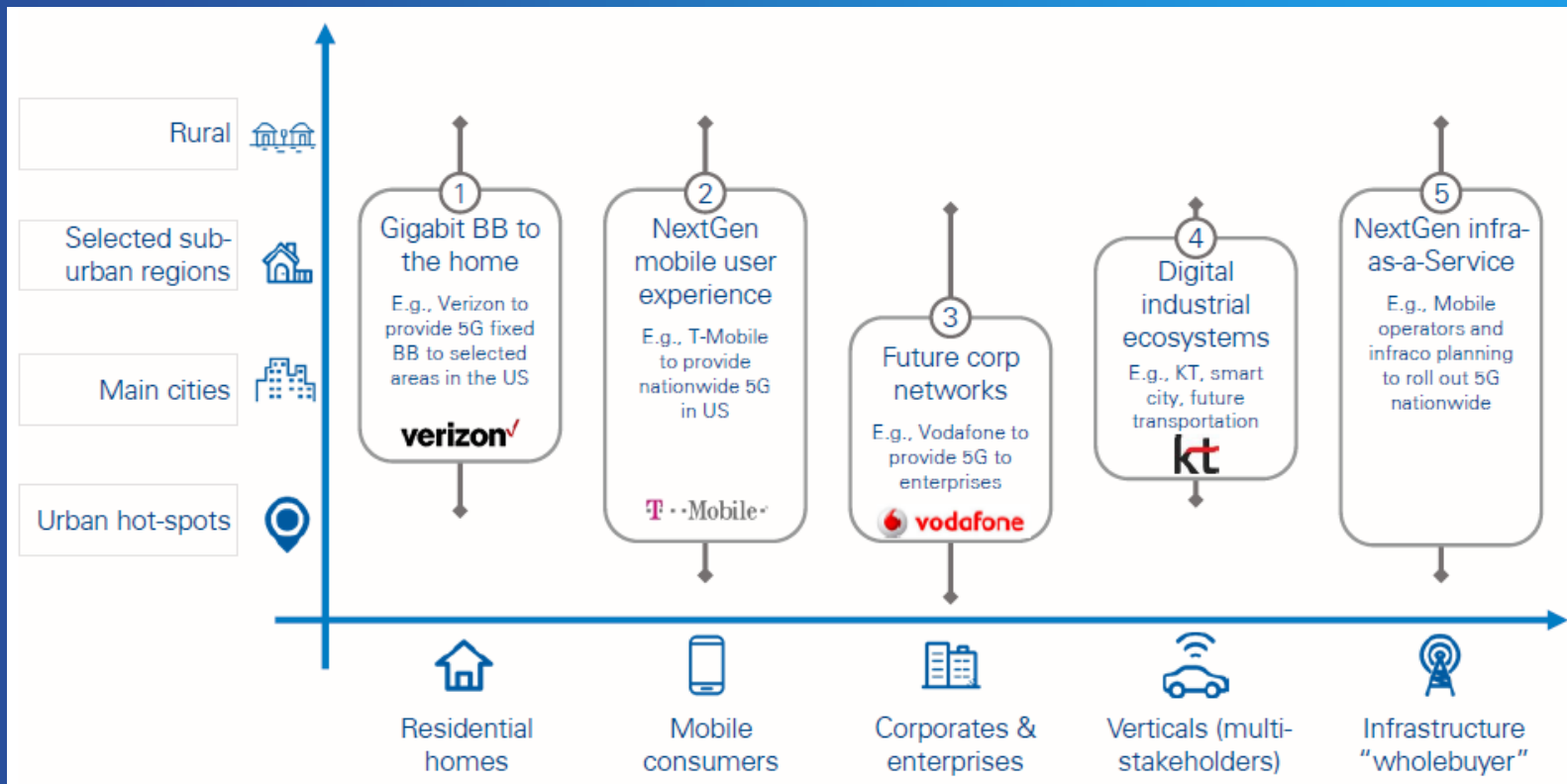
- 3 Bird's Eye View
- 4 Digitalization of Transport and Logistics
- 5 Information Society on the road

Different verticals and use cases have different requirements



Source: 5G Infrastructure Association:
Vision White Paper, February 2015

Operators have different motivation for 5G deployment

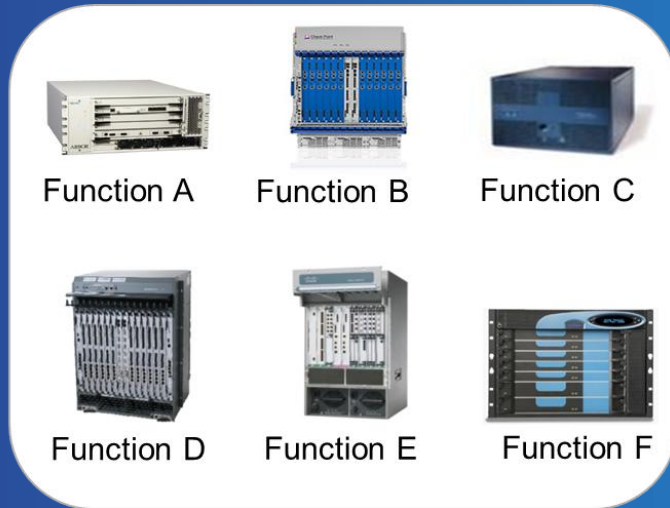


Source: Arthur D. Little, 5G Deployment models are crystallizing, Jun 2017

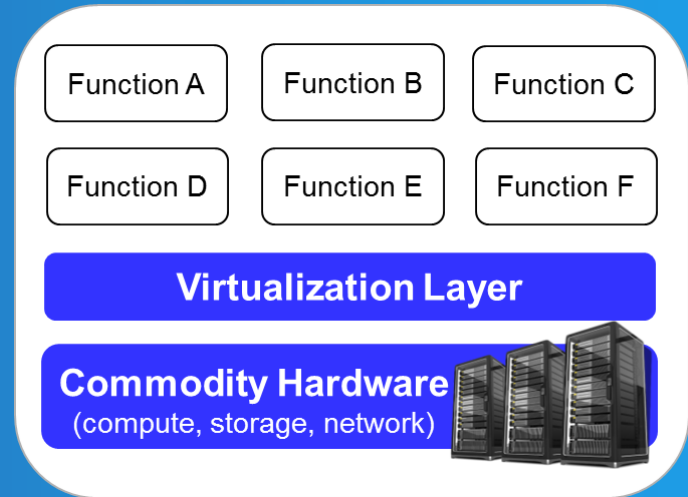
**Network Virtualization is a prerequisite
for 5G**

Network Function Virtualization (NFV) decouples network functions from hardware so they can run in software

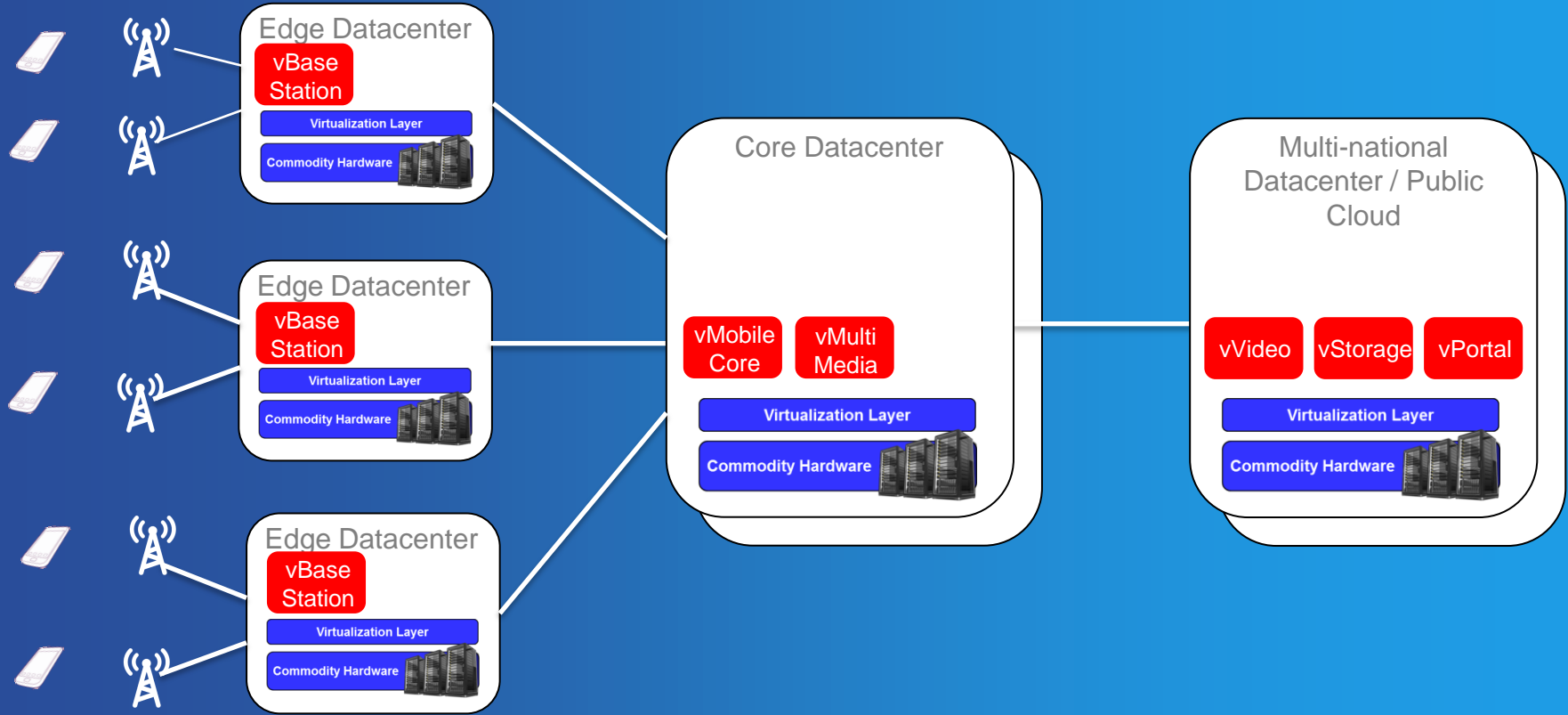
Classical Network Function approach



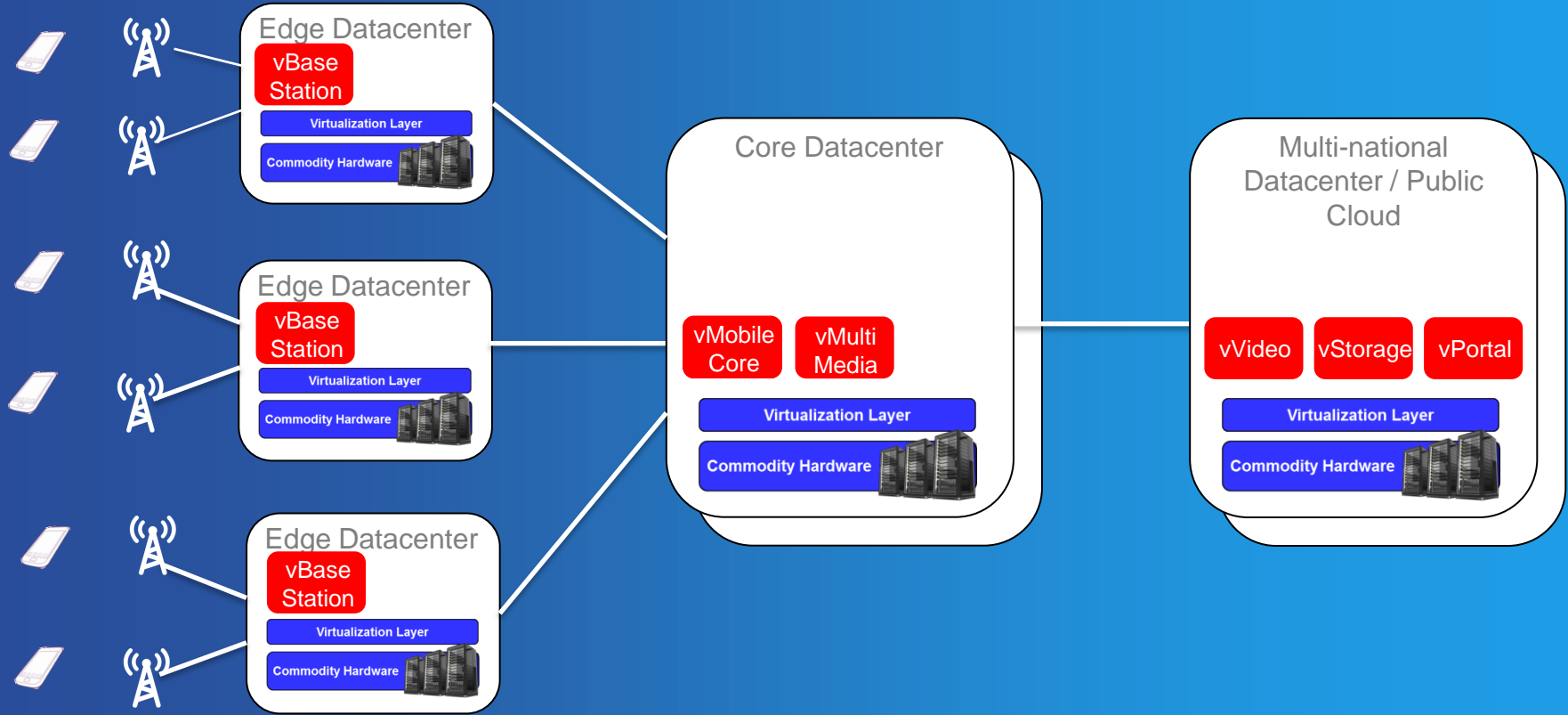
NFV



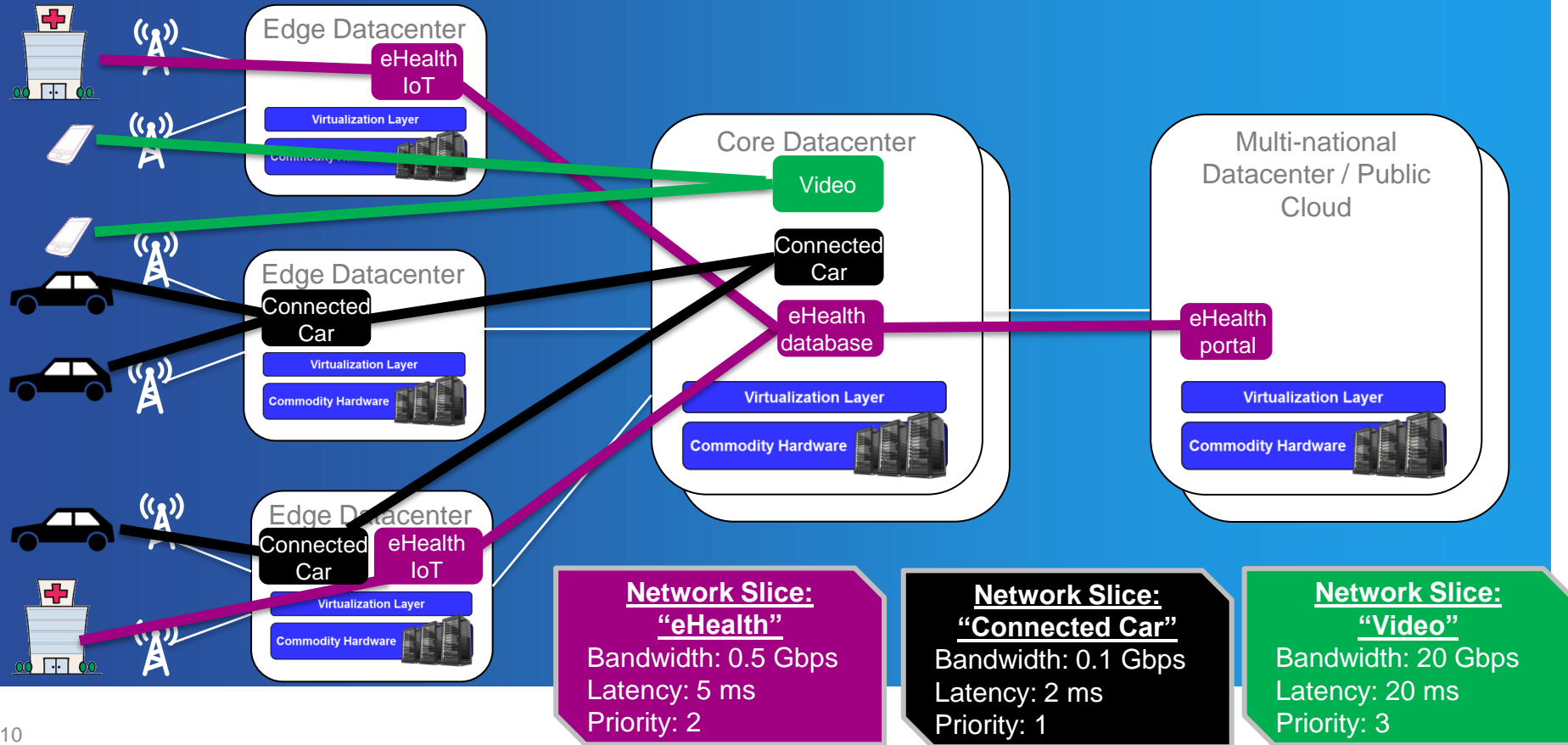
Network Virtualization is the basis for the Telenor Hybrid Cloud



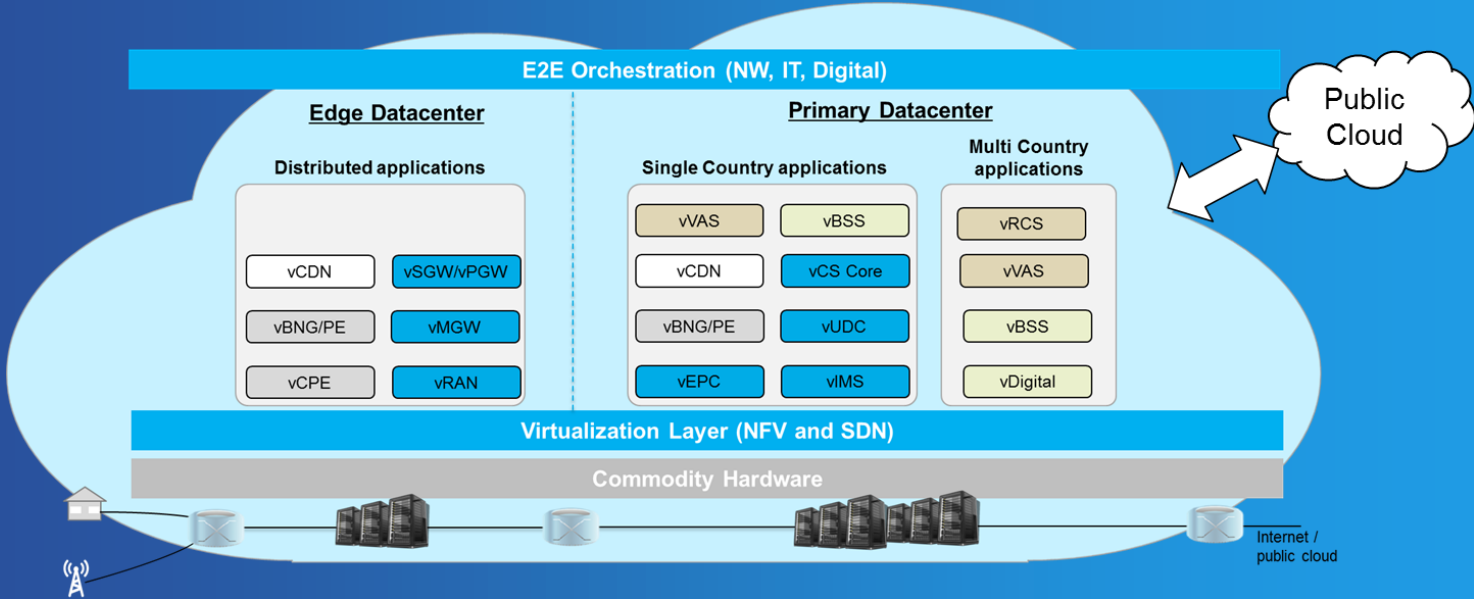
Applications can be migrated and replicated



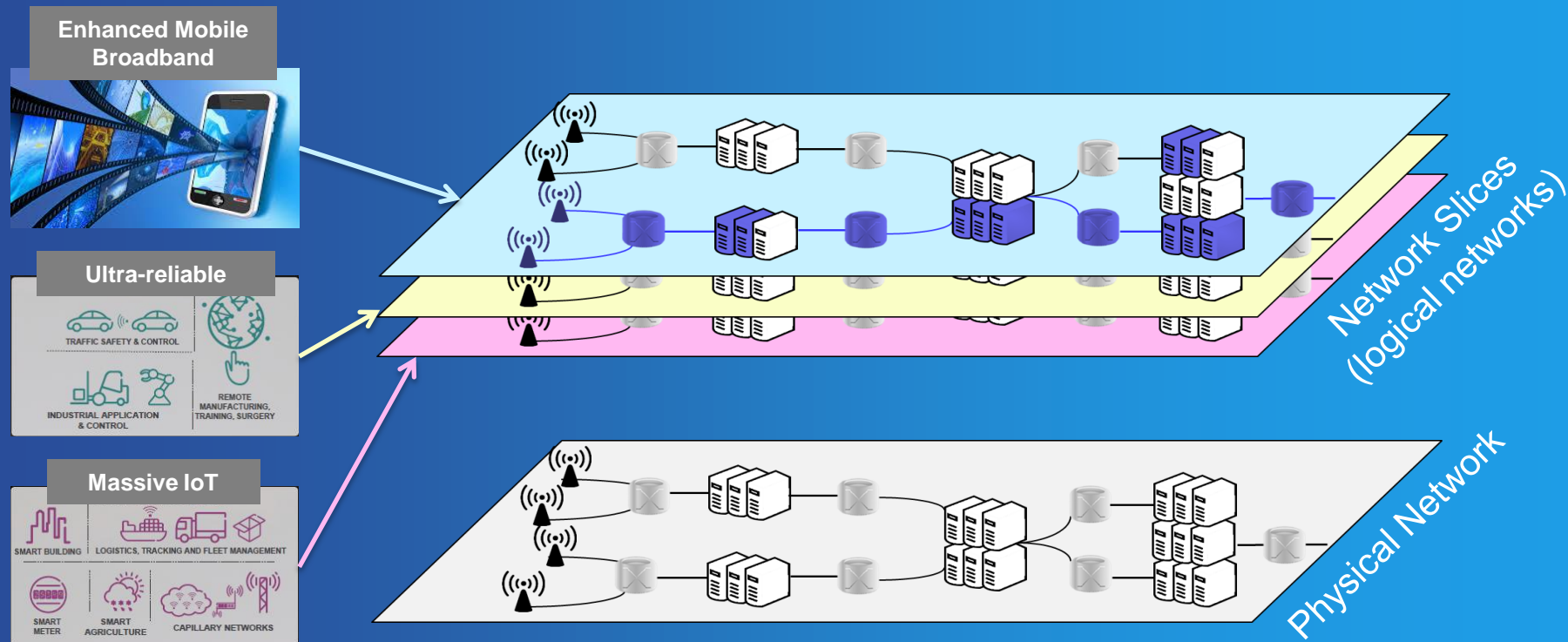
A **Network Slice** is a logical network tailored to different functional and performance requirements



E2E Orchestration will be critical for 5G to automate the management of networks and network slices



5G will be a toolbox for operators, with Network Slicing enabling a diverse set of use cases on the shared physical network



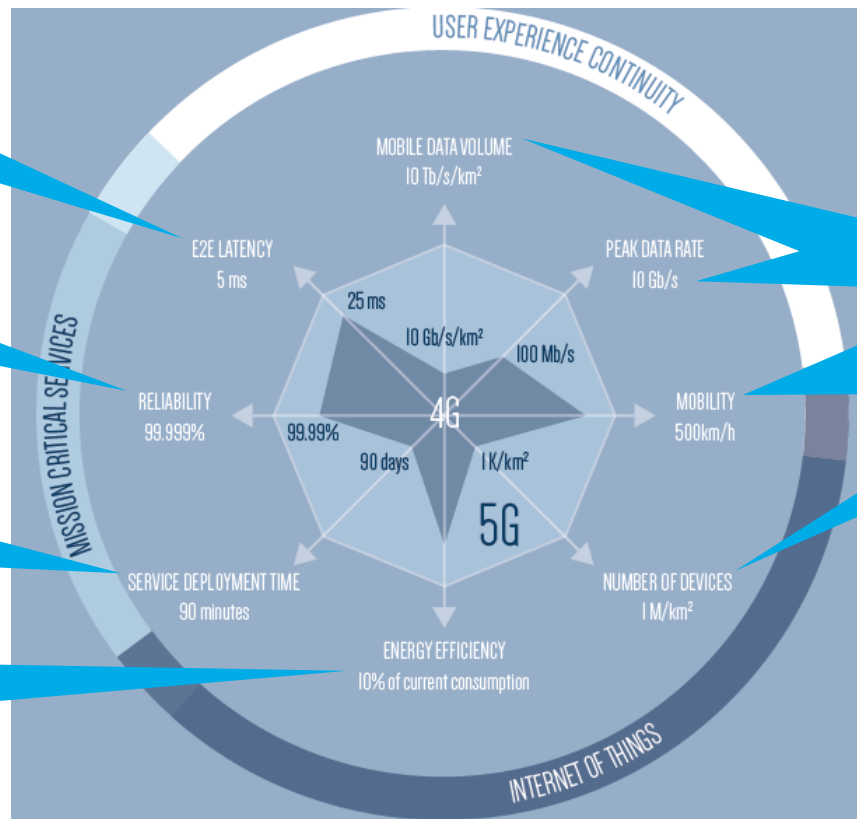
Network virtualization is needed to achieve the 5G KPIs

“speed of light” demands hosting applications closer to customers (in edge)

Network slices (i.e. logical networks) will have different reliability requirements

Fast deployment of services require automation, hence, network virtualization

Energy optimization by smart utilization and sharing of infrastructure

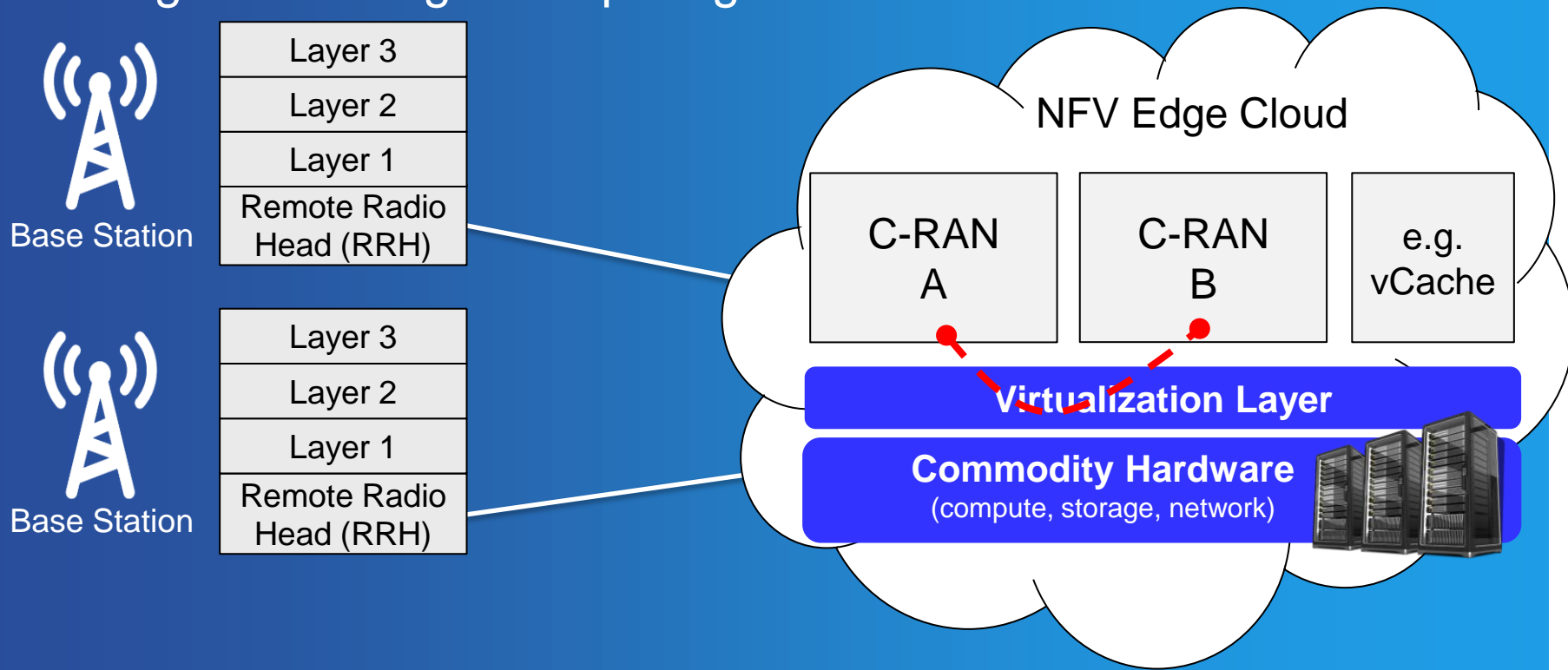


Tailoring of services require flexibility enabled by network virtualization

Source: 5G Infrastructure Association:
Vision White Paper, February 2015

Network Virtualization enabling new
network architectures for 5G

Cloud-RAN can increase performance and cost efficiency, enabling Mobile Edge Computing



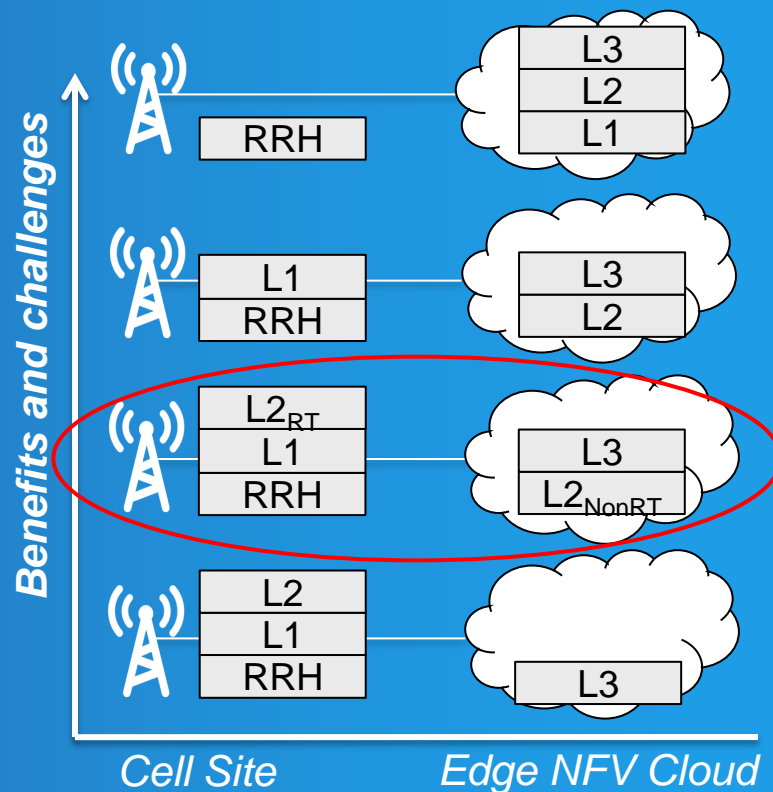
Cloud-RAN can increase performance and cost efficiency, enabling Mobile Edge Computing

Benefits

- Spectral efficiency (SON, COMP)
- Resource utilization & energy consumption
- Management and operation
- Faster time-to-market
- Enables edge computing and services

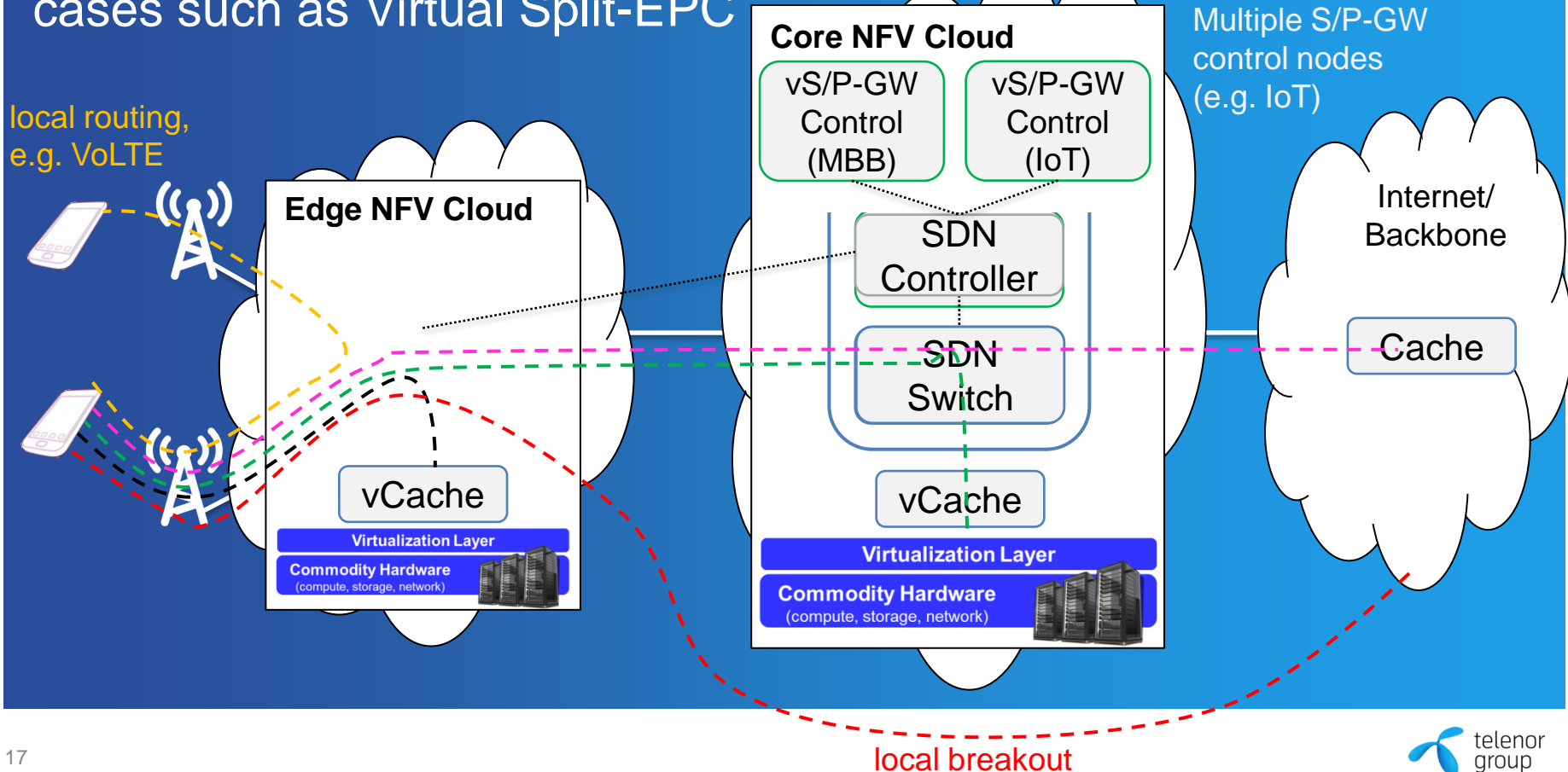
Challenges

- Fronthaul capacity and latency
- Performance of virtual resources (e.g. compute)
- OpenRAN interface between vBBU and RRH



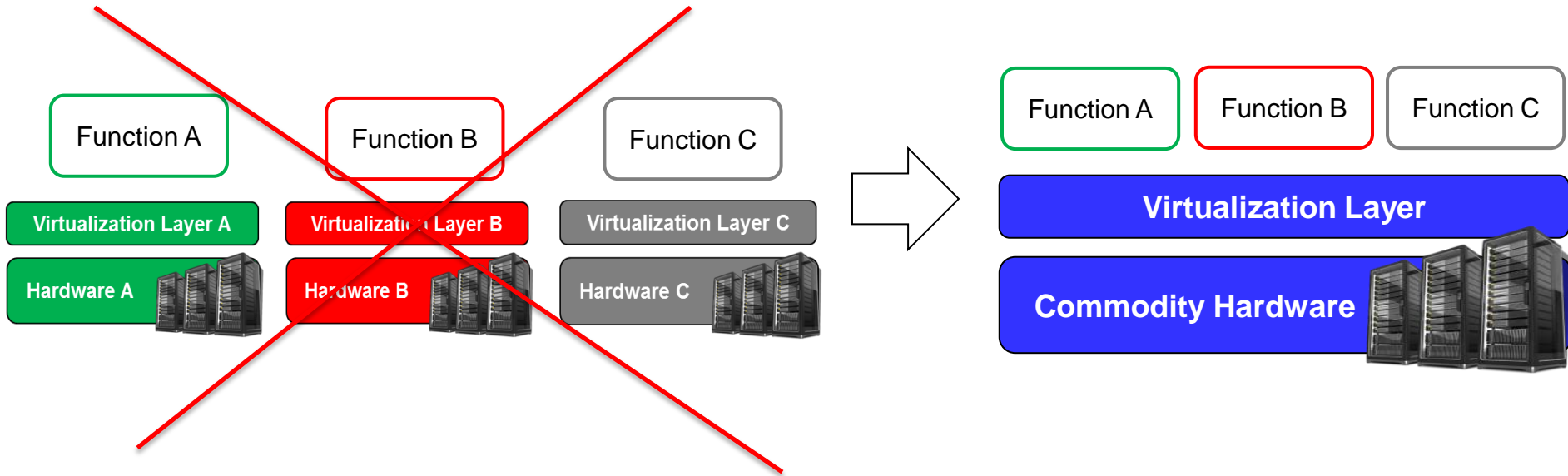
Network Virtualization enables new opportunities with use cases such as Virtual Split-EPC

local routing,
e.g. VoLTE



Network Virtualization is a journey that must start with 4G while preparing for 5G

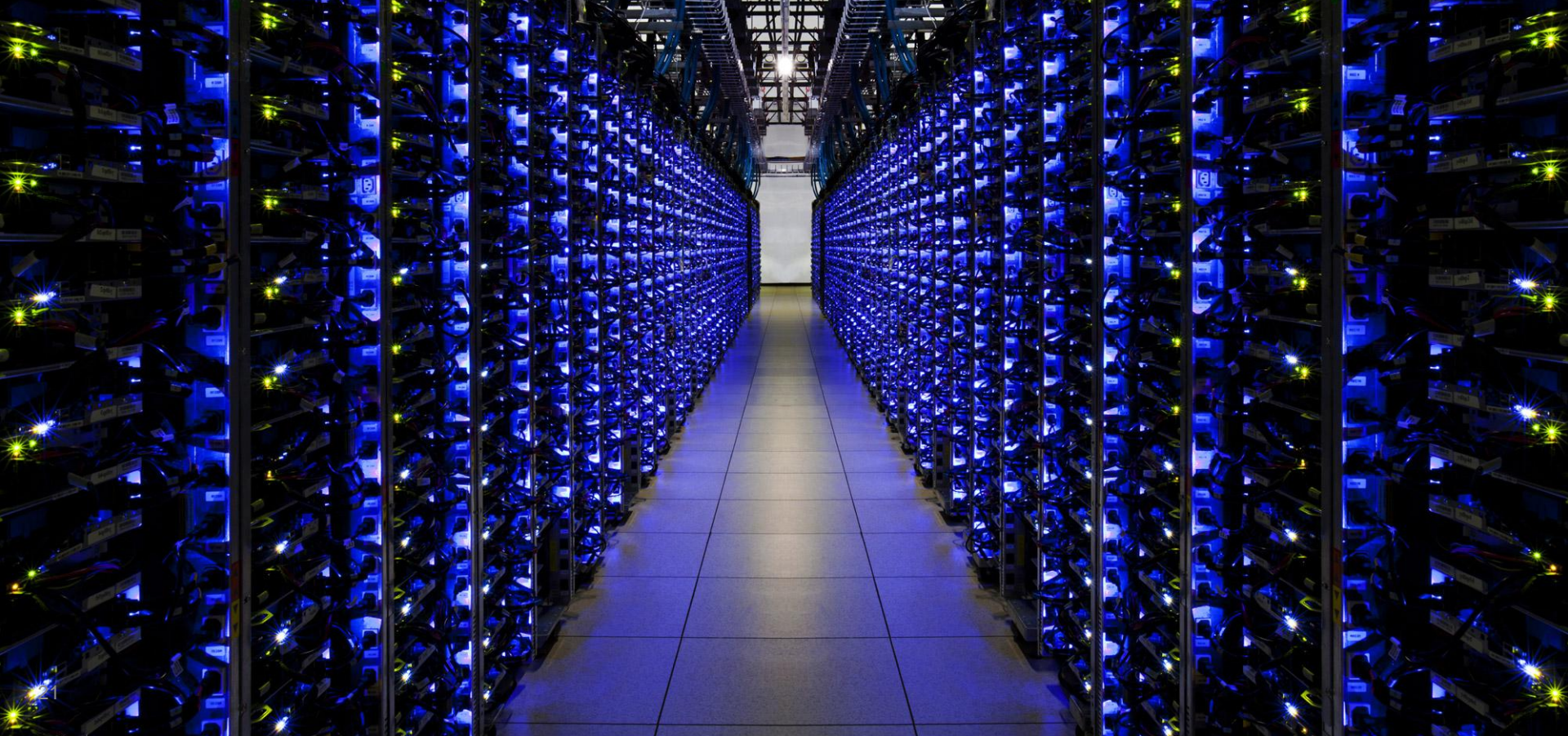
Soon suppliers will only provide **Virtual** Network Functions (VNFs), hence, Network Virtualization and the Cloud platform must be ready



Introducing Network Virtualization does not happen over night



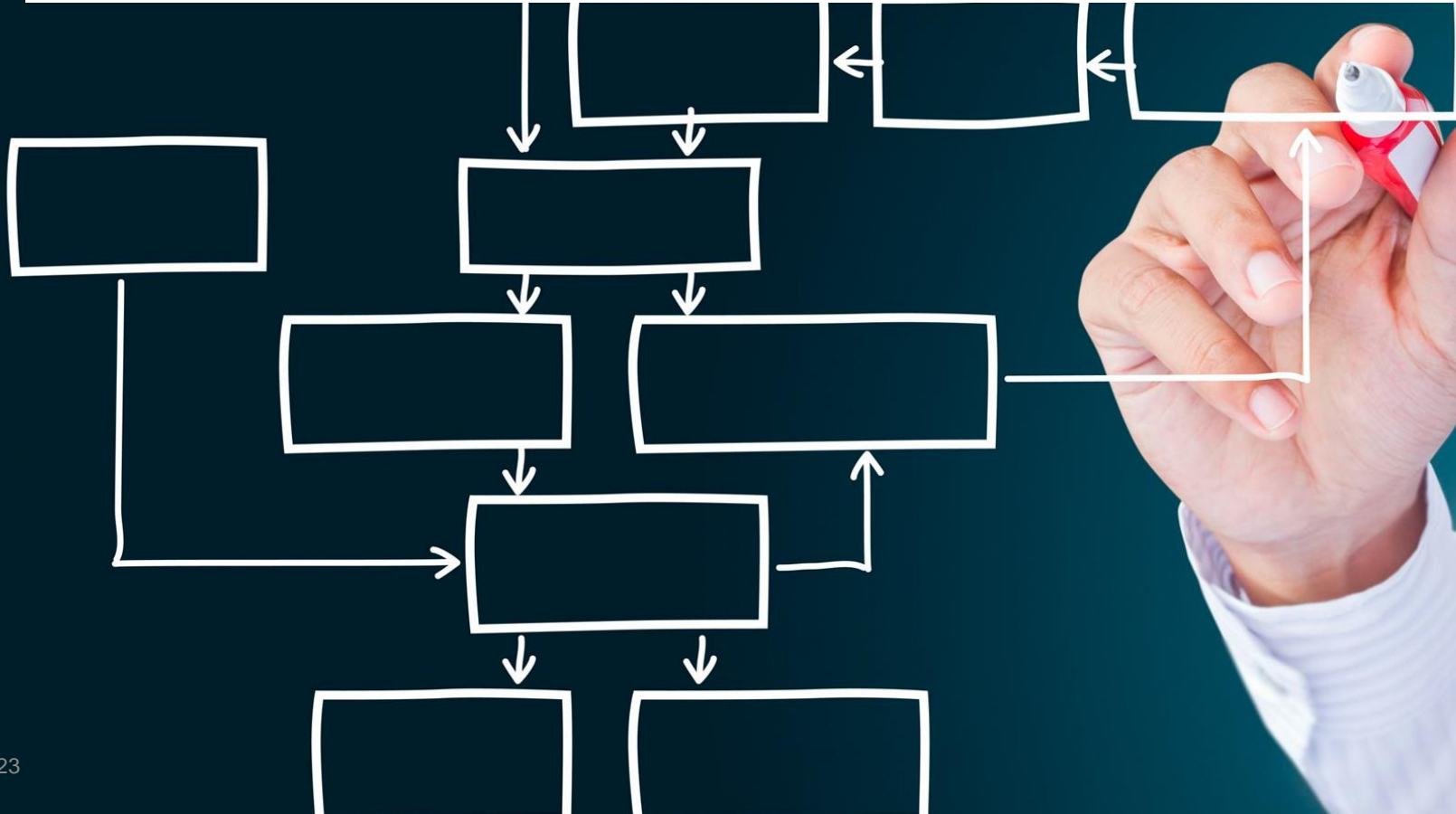
Technology changes with Network Virtualization, e.g. shared commodity hardware, networking, automation, security, Cloud



Services and Commercial challenges, e.g. multi-vendor integration, split-of-responsibility, pricing



Organizational changes, e.g. common infrastructure, SLAs, standardization, skills



Regulatory challenges, e.g. net-neutrality, differentiation, national autonomy, customer data, common service delivery and operations



The **Business Impact** of 5G will be more
focused on **Verticals and B2B**

Almost all industries are being Digitized, Telenor can provide major value for many of these Verticals

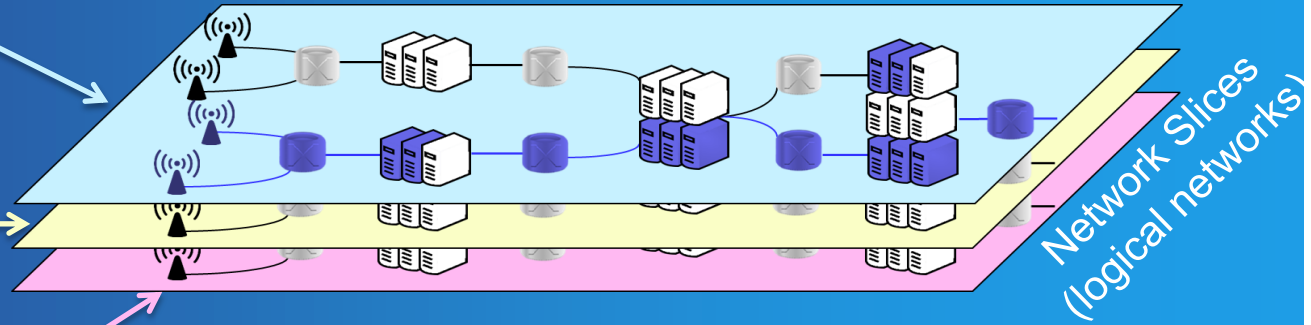
Transportation



Public Safety

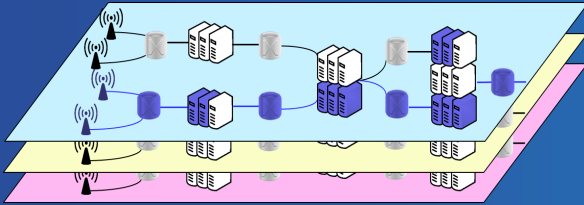


Shipping



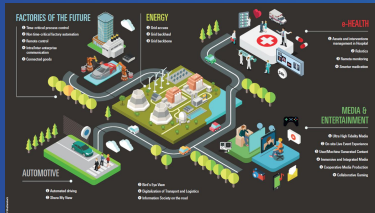
Summary and Key Takeaways

Key takeaways



Network Virtualization is a prerequisite for 5G

Introducing Network Virtualization is a journey that must start with 4G when preparing for 5G



5G is about empowering the verticals, hence, 5G will be more focused on B2B

Pål Grønsund (pal.gronsund@telenor.com)
Telenor Research