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for a world in motion™

Telecom Networks - Vision 2020
LCU 2013

Our vision: Mobile networks are able to deliver one Gigabyte of personalized data per user per day profitably

Key requirements for networks towards 2020…

Support up to 1000 times more capacity

Reduce latency to milliseconds

Flatten total energy consumption

Reinvent Telcos for the cloud

…for profitability and a quantum leap in flexibility

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The thirst for mobile data will continue to grow exponentially

3D, high- and ultra-high definition screens

Video integrated everywhere

Digital universe continues to grow exponentially

Everything from and on the cloud
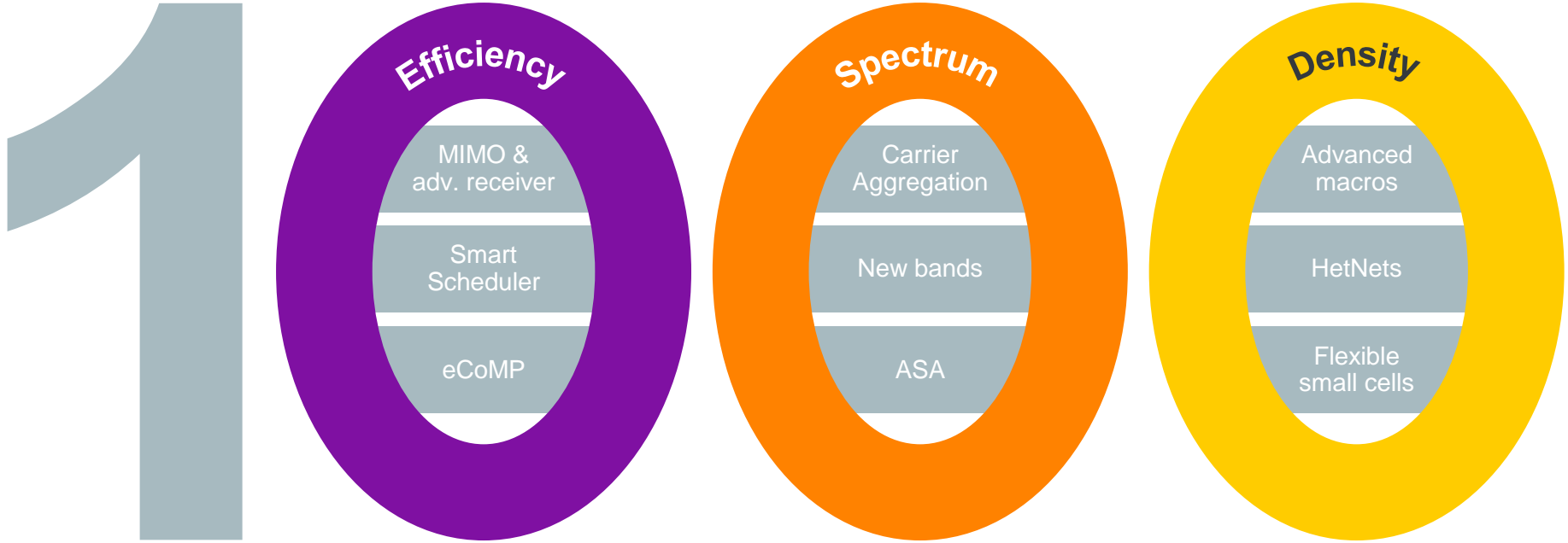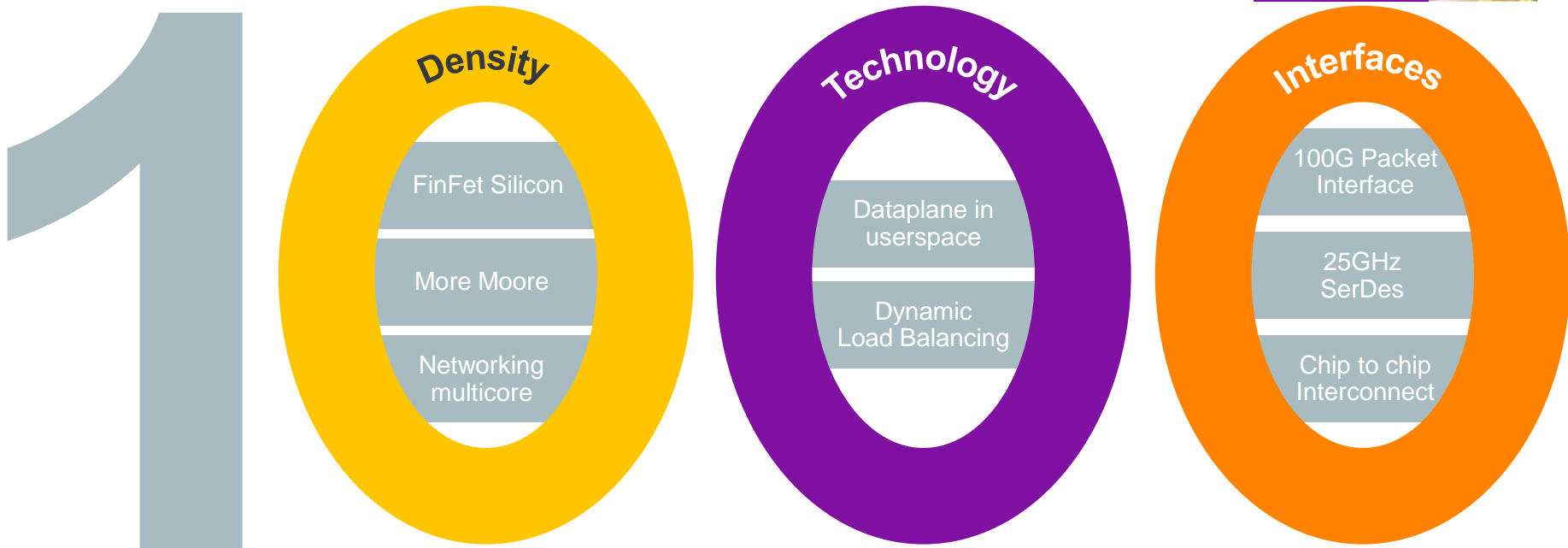
Billions of connected objects

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Paving the way to support up to…

1000 ... times more capacity in radio

Efficiency
- MIMO & adv. receiver
- Smart Scheduler
- eCoMP

Spectrum
- Carrier Aggregation
- New bands
- ASA

Density
- Advanced macros
- HetNets
- Flexible small cells

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Creating connections to support

1000

... times more capacity in core

Density
- FinFet Silicon
- More Moore
- Networking multicore

Technology
- Dataplane in userspace
- Dynamic Load Balancing

Interfaces
- 100G Packet Interface
- 25GHz SerDes
- Chip to chip Interconnect

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Era for dense 3D technologies emerging

Support up to 1000 times more capacity

Density

- FinFet Silicon
- More Moore
- Networking multicore
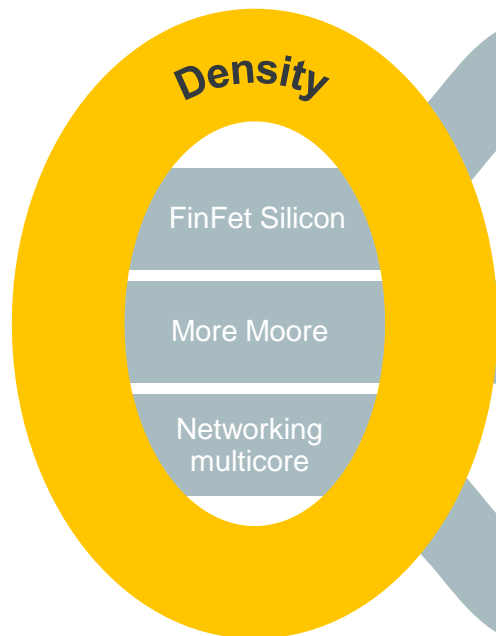
True 3D Transistor Build - Leakage current Minimization

Gate S D
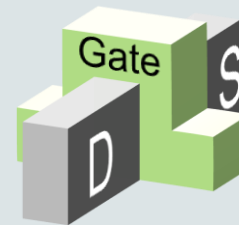
No foreseeable end to Moore's law

2011	2013	2015+
22nm	14nm	10nm 7nm

More cores, more memory, more programmable HW acceleration

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Technology advancement in SW engineering

Technology

Dataplane in userspace

Dynamic Load Balancing

Optimal scalability and efficiency with least number of computing cycles

Amdahl's law

$$T(n) = T(1)\left(B + \frac{1}{n}(1 - B)\right)$$

Scalability to any number of resources

| 65% | 65% | 65% | 65% |

Scheduler

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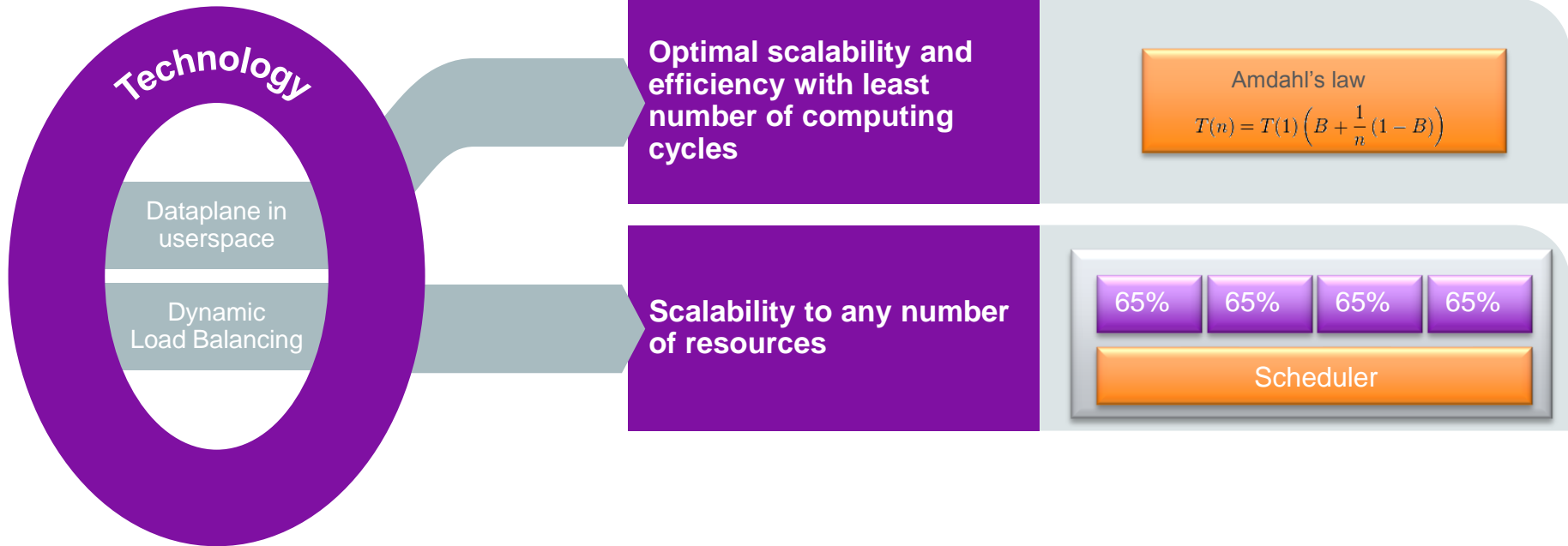
Ever increasing need for bandwidth

Interfaces

- 100G Packet Interface
- 25GHz SerDes
- Chip to chip Interconnect
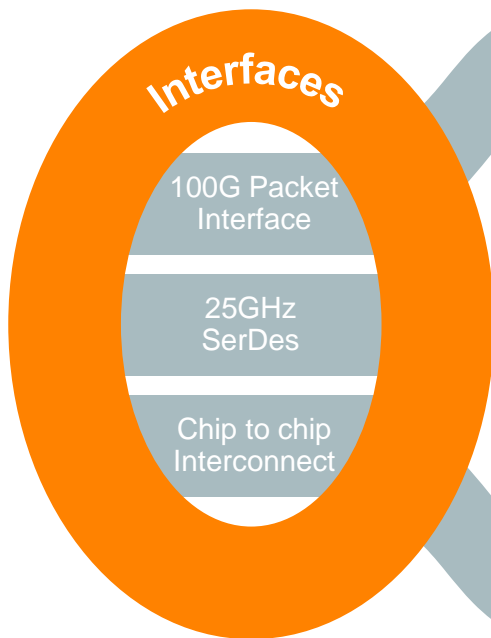
Up to 100Gbit/s and beyond

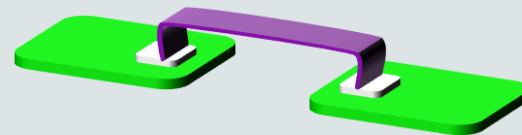**Least amount of connections in high speed interfaces**

Serializer

De-serializer

Controlled transmission line conditions for line drivers and loads
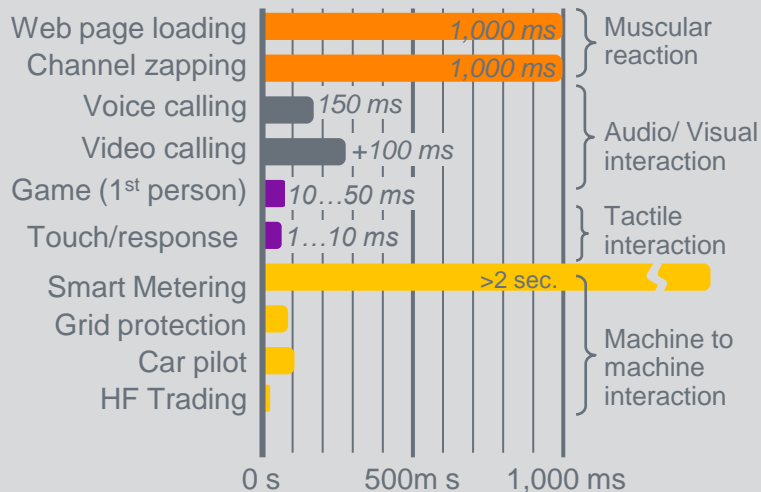
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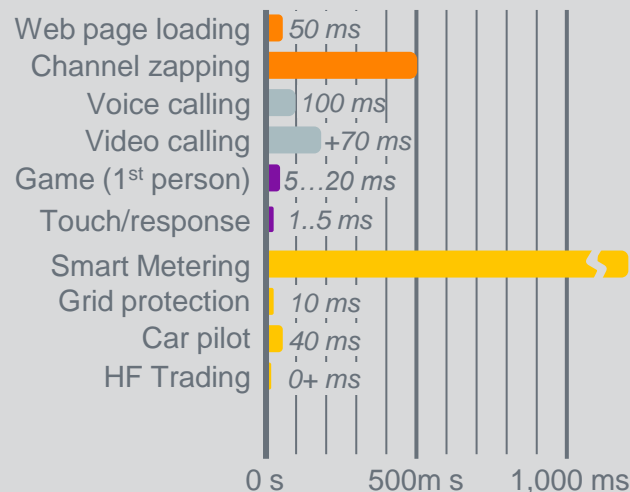# Future real-time applications will demand network latency of single digit milliseconds

E2e latency requirements expected by users

Application	Latency	Category
Web page loading	1,000 ms	Muscular reaction
Channel zapping	1,000 ms	
Voice calling	150 ms	Audio/ Visual interaction
Video calling	+100 ms	
Game (1st person)	10…50 ms	Tactile interaction
Touch/response	1…10 ms	
Smart Metering	>2 sec.	Machine to machine interaction
Grid protection		
Car pilot		
HF Trading		

0 s   500m s   1,000 ms

Network latency requirements

Application	Latency
Web page loading	50 ms
Channel zapping	
Voice calling	100 ms
Video calling	+70 ms
Game (1st person)	5…20 ms
Touch/response	1..5 ms
Smart Metering	
Grid protection	10 ms
Car pilot	40 ms
HF Trading	0+ ms

0 s   500m s   1,000 ms

Network capabilities will constrain application's implementation options, but finally applications will have some minimum requirements ….
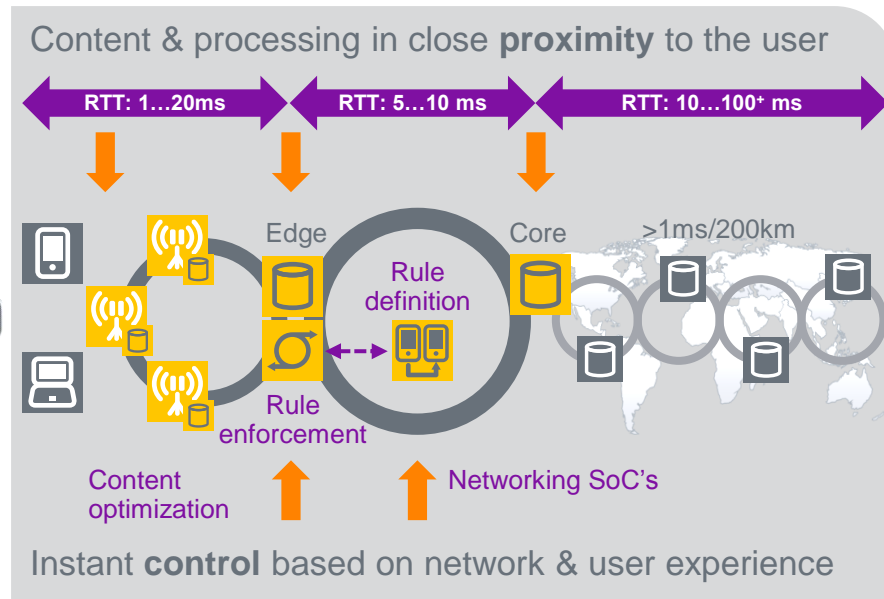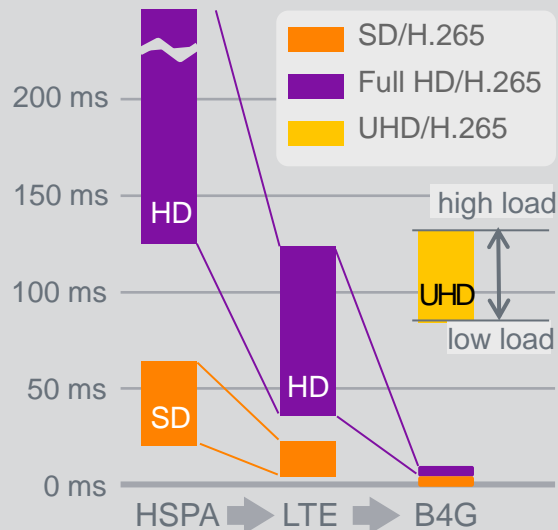
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Reduce latency to milliseconds
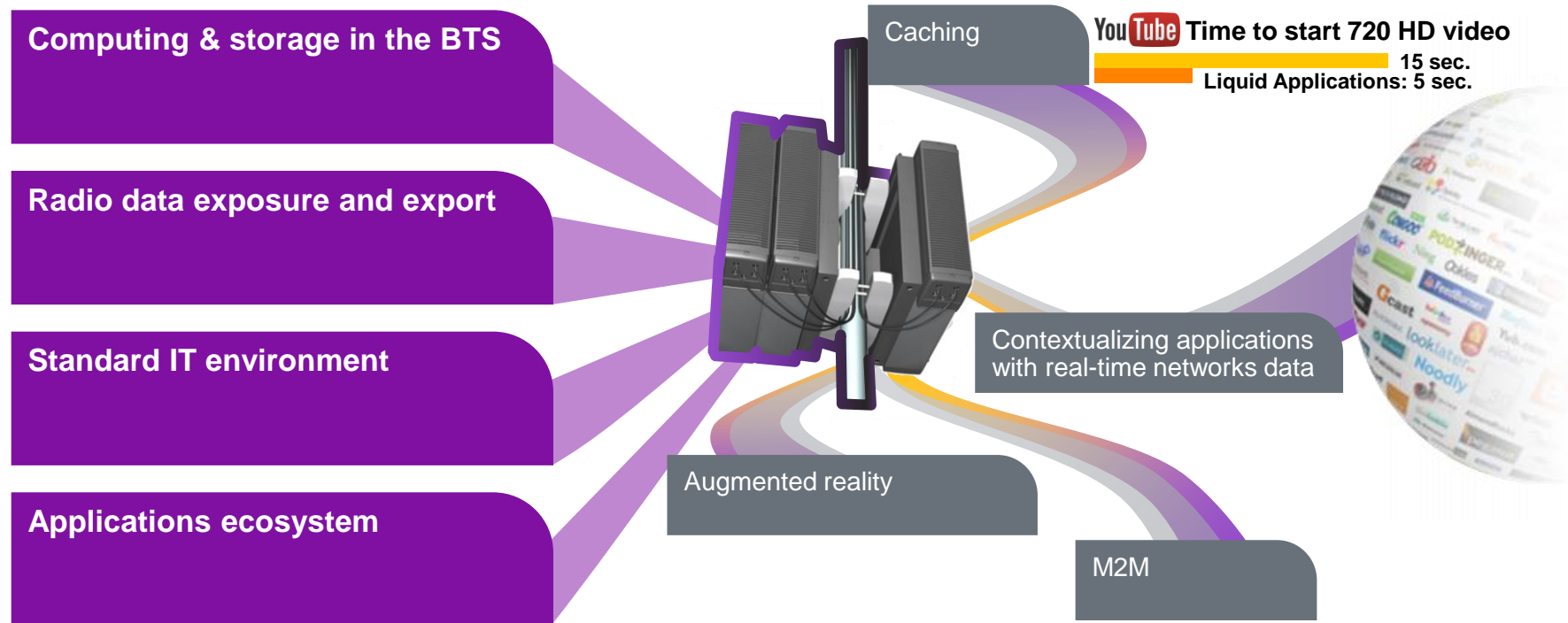## - Bandwidth, Proximity, Control

Sufficient **bandwidth** for media-rich, delay-sensitive applications

Average time to load a video frame

- SD/H.265
- Full HD/H.265
- UHD/H.265

200 ms
150 ms
100 ms
50 ms
0 ms

HD
SD
HD
UHD
high load
low load

HSPA → LTE → B4G

Bandwidth
Proximity
Control

Content & processing in close **proximity** to the user

RTT: 1…20ms   RTT: 5…10 ms   RTT: 10…100+ ms

Edge   Core   >1ms/200km

Rule definition

Rule enforcement

Content optimization   Networking SoC's

Instant **control** based on network & user experience

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Edge services for a wealth of rich low latency applications

Computing & storage in the BTS

Radio data exposure and export

Standard IT environment

Applications ecosystem

Caching

You **Tube** **Time to start 720 HD video**

15 sec.
Liquid Applications: 5 sec.

Contextualizing applications with real-time networks data

Augmented reality

M2M

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Cloud, SDN and NFV

Cloud Computing

- Programmable, SW-defined datacenter
- Decoupling of HW and SW
- Business Agility
- IaaS, PaaS and SaaS*
- Fast and growing open source ecosystem
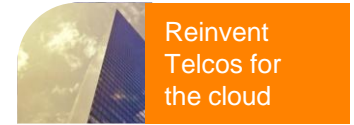- Open source

Software Defined Networking

- Network abstraction
- Decoupling of control and data planes
- Centralized control, overlay networks
- Programmable and open API
- Support for variety of platforms
- Open source
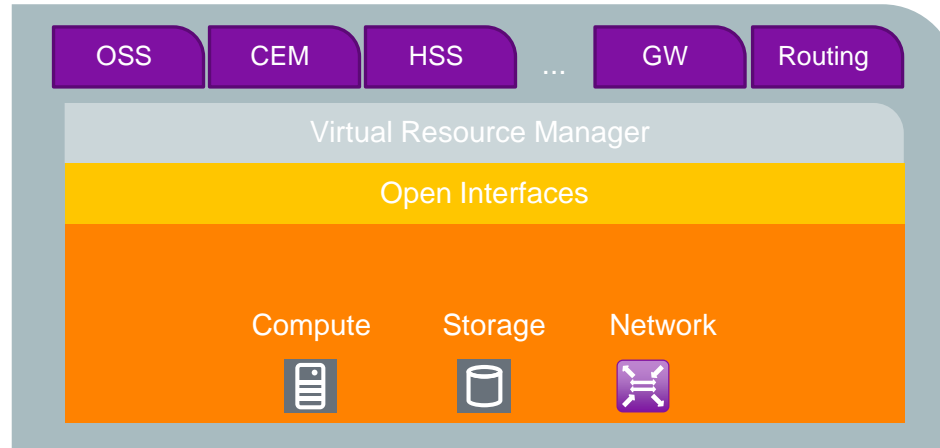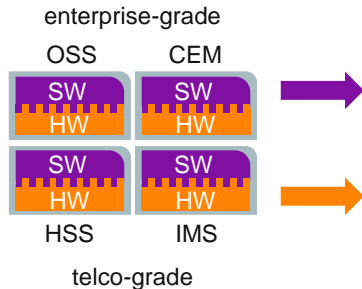
Network Functions Virtualization

- Network Functions running on standard IT hardware
- Decoupling of HW and SW
- Use of IT virtualization technology
- Higher degree of automation and flexibility
- ETSI ISG

*) IaaS, PaaS and SaaS: Infrastructure-, Platform-and Software-as-a-Service
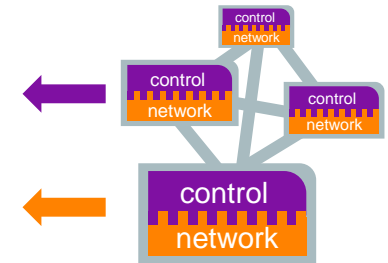
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Leveraging cloud computing paradigms to create a software defined, programmable infrastructure

Cloud principle
decoupling SW and HW

enterprise-grade

OSS | CEM
SW | SW
HW | HW

SW | SW
HW | HW
HSS | IMS

telco-grade

| OSS | CEM | HSS | ... | GW | Routing |

Virtual Resource Manager

Open Interfaces

Compute   Storage   Network

SDN principle
decoupling control and network

control network

control network

control network

control network

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# A combination of measures is needed to reduce network energy consumption

Energy efficiency by new silicon technology and optimised processing

High resource utilization will be a key contributor to increased energy efficiency
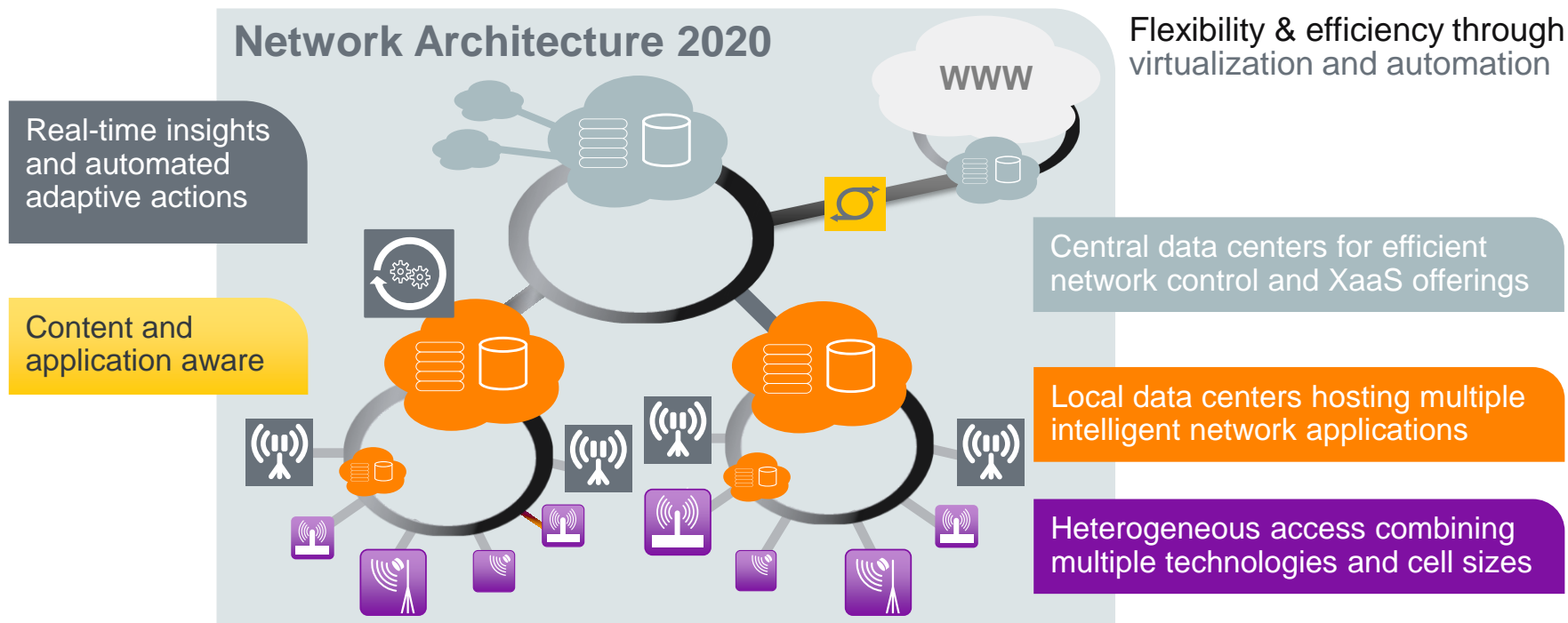
Energy efficiency comes with network modernization – phase out of legacy technologies needed

Energy efficiency can beat Traffic Growth
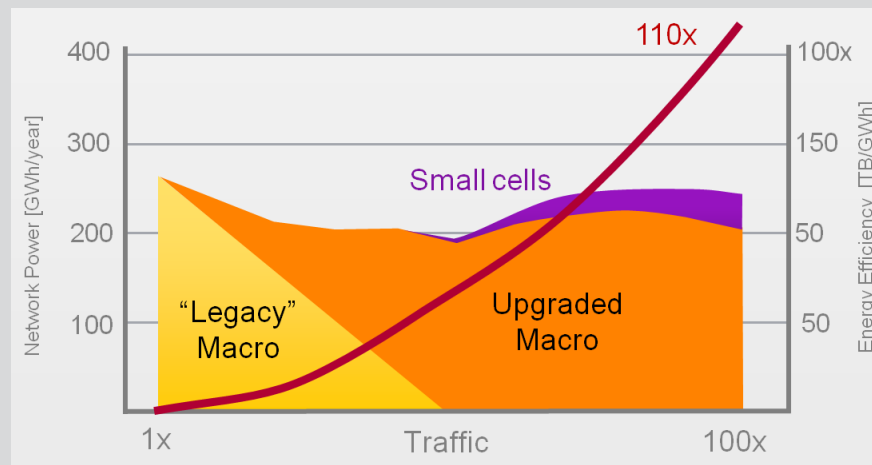
Source: NSN analysis, example radio access deployment scenario with 20k Macro sites, 30m subscribers, 200MB/month/user initial traffic. 5 years equipment lifetime and rollout of key technology improvements & small cells.

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Networks need to undergo a fundamental transformation

Network Architecture 2020

WWW

Flexibility & efficiency through virtualization and automation

Real-time insights and automated adaptive actions

Content and application aware

Central data centers for efficient network control and XaaS offerings

Local data centers hosting multiple intelligent network applications

Heterogeneous access combining multiple technologies and cell sizes

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Remain profitable and achieve a strong competitive positioning

Support up to 1000 times more capacity | to support the growing demand

Reduce latency to milliseconds | to enable real-time user experience

Reinvent Telcos for the cloud | to get the required lean agility

Flatten total energy consumption | for improved efficiency and sustainability

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We are future ready to bring our vision to reality

1GB of personalized data per user per day profitably

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