SHAPING A CONNECTED DIGITAL FUTURE
Visions, Challenges, Opportunities for Organizations and People in a Smart World

- PLATFORMS TO GROW INNOVATION -

www.huawei.com

Stockholm, 12.11.2012

Dr. David Soldani

Head of Central Research Institute

Huawei European Research Centre

Munich, Germany

Global Forum
Shaping the future 2012

http://www.items.fr/spip.php

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Contents

- **The Huawei European Research Centre**

- **Future Technologies and Platforms**

- **Conclusions**

Huawei Research and Development – Global organizations
- *Continuous innovation investment*

Major R&D investments

- **USD 3.76 billion** in 2011 (YoY incr. of **34.2%**)
- **70,000+ (46%) R&D employees** (as of June 2012)
- 15 R&D Centers in 29 locations worldwide, of which **10 in Europe**
- 25 Joint Innovation Centers
- 45 training centers worldwide.
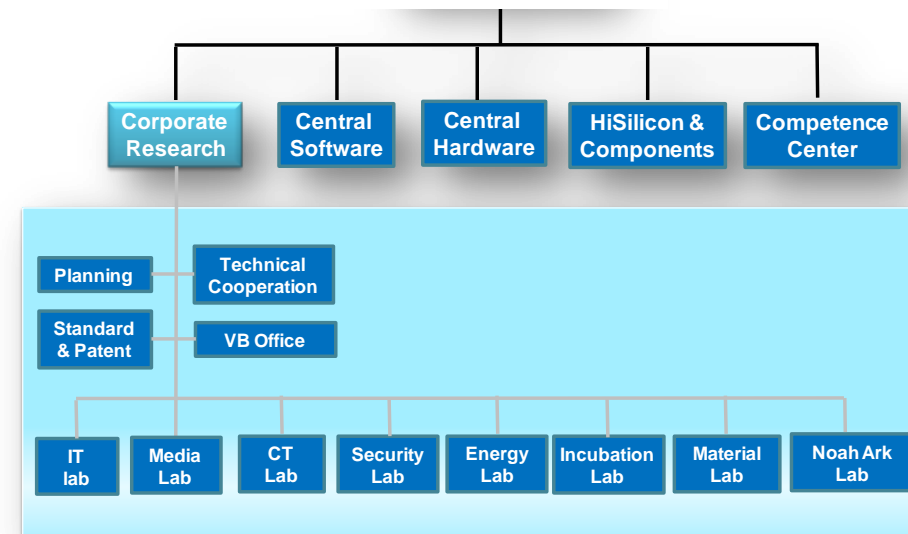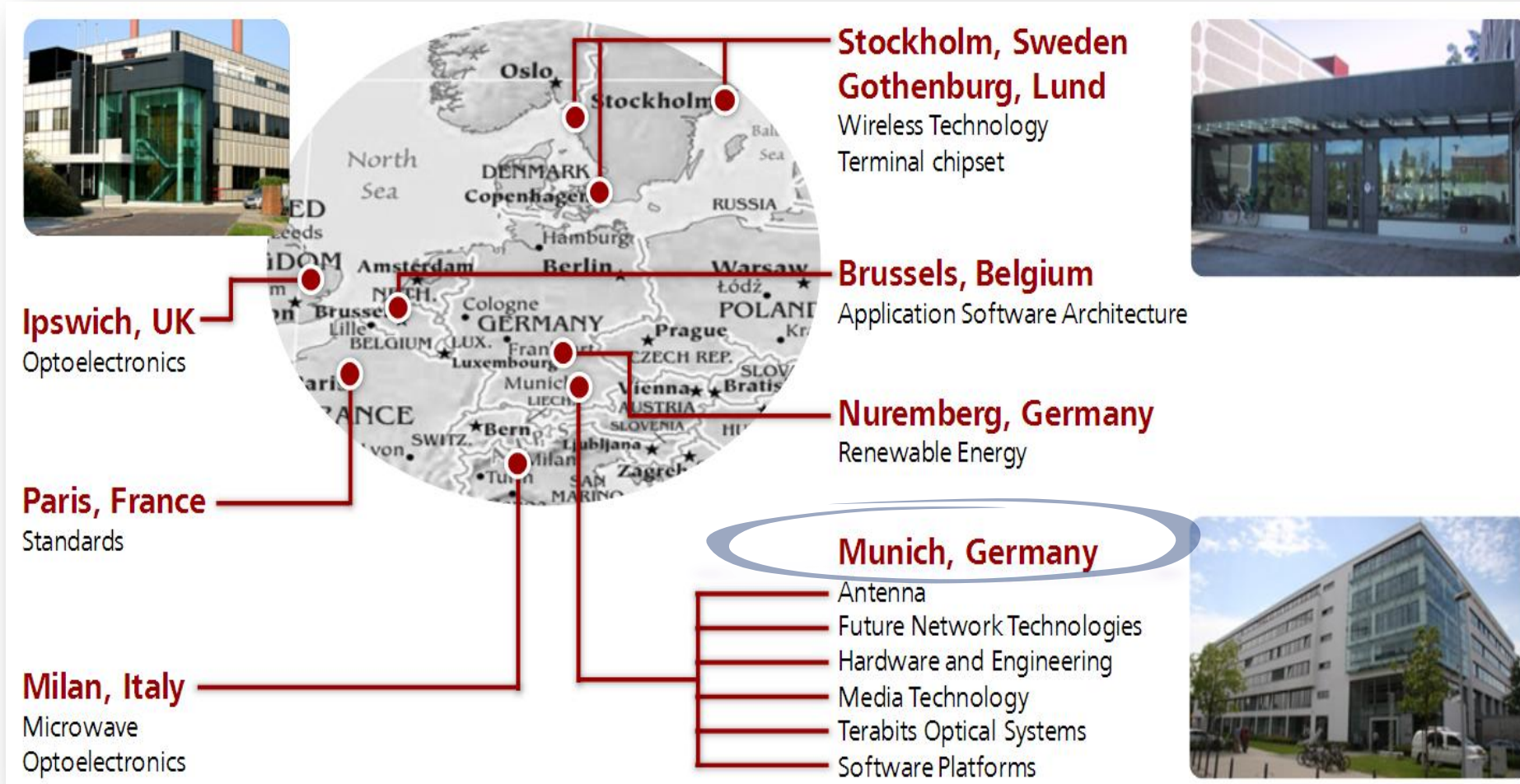- 26,539 granted patents, 90%+ invention patents

% of revenue R&D spending

Year	Value
2007	9.4%
2008	9.1%
2009	9.7%
2010	9.7%
2011	11.6%
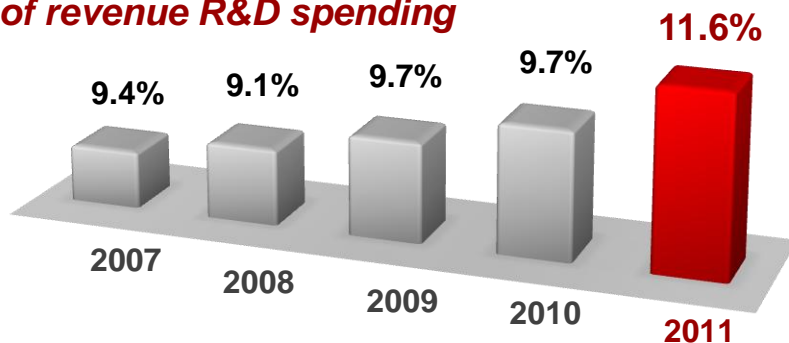
R&D focus

- Huawei's innovation engine
- Navigating the company's future through innovation

2012 Lab

- Corporate Research
- Central Software
- Central Hardware
- HiSilicon & Components
- Competence Center

Planning — Technical Cooperation
Standard & Patent — VB Office

IT lab | Media Lab | CT Lab | Security Lab | Energy Lab | Incubation Lab | Material Lab | Noah Ark Lab

Huawei research in Europe
- Locations

Stockholm, Sweden
Gothenburg, Lund
Wireless Technology
Terminal chipset

Brussels, Belgium
Application Software Architecture

Nuremberg, Germany
Renewable Energy

Munich, Germany
- Antenna
- Future Network Technologies
- Hardware and Engineering
- Media Technology
- Terabits Optical Systems
- Software Platforms

Ipswich, UK
Optoelectronics

Paris, France
Standards

Milan, Italy
Microwave
Optoelectronics

Assembling strong expertise derived from a diversified and multicultural environment and excellence in specific technology fields

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Huawei research in Europe
- Growing investments

Date	Event
Jun 2012	**Total People exceeds 750+**
Jan 2012	Establishment of UK Branch
Sept 2011	Establishment of Nuremberg Branch
Jun 2011	Total People reaches 550
Apr 2010	Total people reaches 350
Apr 2009	Establishment of Belgium Branch
Mar 2009	Establishment of Gothenburg branch
Dec 2008	Major Movement from Bonn to Munich
Jun 2008	Establishment of Milan Branch
Mar 2008	Establishment of Bonn Centre
Dec 2007	Total People in Sweden 50+
2000	Establishment in Stockholm

Total R&D CAGR: 24%

137M€
114M€
71M€

2008 2009 2010 2011 2012 (Plan)

Collaboration CAGR: 40%

14M€
12M€
6M€

2006 2007 2008 2009 2010 2011 2012 (Plan)

Towards a world-leading research centre for innovative technologies and platforms enabling the development of world-class products and solutions

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Technology and research achievements in Europe

Wireless
- Radio-Frequency: Multi-band and multi-standard RRU/ RFU/ Filter; High efficiency Wideband PA
- Chipset: RF front-end; 2G/3G/4G software defined radio RFIC for terminal; 28nm digital ASIC for baseband
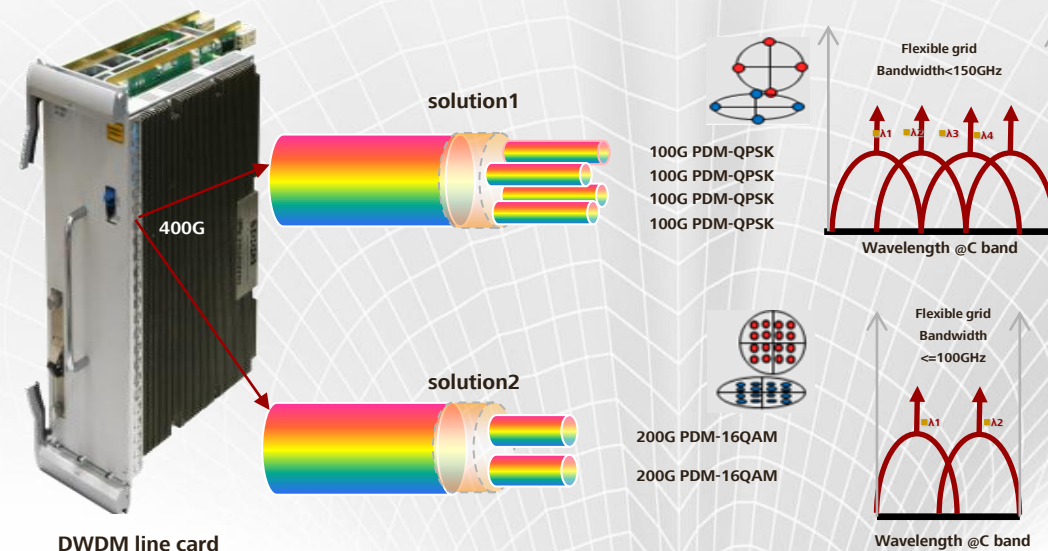- Research on the **5G** architecture
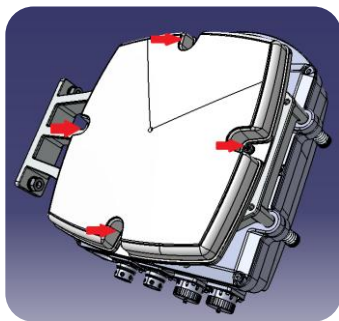
4G Mobile backhauling
- MIMO Line of Sight Point-to-Point microwave product for Gigabits transmission over long hops
- Ultra High Capacity millimeter-wave product (80 GHz), up to **2.5 Gbit/s** with first on the market high spectrum efficiency 64 QAM modulation
- GaAs high performance microwave components

High Speed Optical Systems
- Designed and made to product 100 Gbit/s optical system
- Designed, prototyped and field trial for 400 Gbit/s
- First internal demonstrations of **1 Terabit/s** optical transceiver

Central Software Research
- Embedded **Virtualization**
- Base Platform architecture for CT Cloud

400G

solution1

Flexible grid
Bandwidth<150GHz

100G PDM-QPSK
100G PDM-QPSK
100G PDM-QPSK
100G PDM-QPSK

λ1 λ2 λ3 λ4

Wavelength @C band

solution2

Flexible grid
Bandwidth
<=100GHz

200G PDM-16QAM
200G PDM-16QAM

λ1 λ2

Wavelength @C band

DWDM line card

Participation in EC Funded projects

- Already active in **10** Projects: **ARAGORN , FARAMIR, BONE, DICONET, CHRON, CONSERN, TREND, ULOOP , FI PPP – SmartAgriFood (SAF), and METIS**

- **Looking at Horizon 2020**
  - Huawei supporting the EU priorities on future global challenges
  - Huawei to legitimately contribute to EU S&T policymaking process
  - Huawei as a considerable EU employer

EU-China Innovation Cooperation

- **EU-China Summit**
  - Successful agreement, Brussels – Sept 20th

- **EU-China Seminar**
  - DG R&D and MOST, Beijing – Nov 14th

- **Open-China ICT Dialogue**
 - DG CONNECT and MIIT, Beijing – Nov 15-16th

Key industry player

- **DIGITALEUROPE**
  ✓ Speech on H2020, Brussels - Sep 24th
  ✓ **Member of R&D Working Group**
- **Net!Works**
  - Towards H2020, Brussels – Nov 13th
  ✓ **Member of R&D working Group**
- **Cloud Expert Group**
  ✓ Active participation

- **Direct communication**
  ✓ Telecom Italia
  - Telefonica TID
  - FT/Orange R&D
  - …
- **ETNO**
  ✓ **Huawei / Observer**
  ✓ **FT-ETNO Summit 2012**
  ✓ **Member of RESI** (Research & Innovation Working Group)

Direct dialog with EC/MEP

- **Direct communication**
  ✓ DG CONNECT
- **CONNECT Advisory Forum for ICT Research and Innovation (CAF)**
  ✓ Showed interest to join on Oct 26th

- **Huawei R&D White Paper to EC / MEP**
  - November 2012 (planned)

- **Speech on Huawei R&D at EP (EC/MEP)**
  - December 2012 (planned)

Participation in Standards and regulatory bodies

- **Participation to all major standards developing organizations in media technologies**
  - ITU-T, WRC, ITU-R, ETSI/3GPP, ISO/IEC, IETF…

- **Contribution to a large number of recent standards on <u>Media Technologies</u>**
  - More than 100 contributions to ITU-T (Study Groups 12 and 16), 3GPP SA4 and ISO/IEC JTC1/SC29/WG11 (MPEG)
  - **Strong involvement in the development of the following standards:**
    - **ITU-T**: G.711.0, G.711.1, G.718, G.718 Annex B, G.720.1, G.729 Appendix IV, G.729.1 Annexes C, D, E, F, G.722 Annexes B,C,D and G.711.1 Annexes D, E, F
    - **ISO/IEC MPEG**: Unified Speech and Audio Coding (ISO/IEC 23003-3), Compact Descriptors for Visual Search (CDVS)
    - **3GPP**: Enhanced Voice Services, Mobile 3D Video

- **Huawei experts hold several Chairman, Rapporteur and Editor positions in ITU-T, MPEG and 3GPP**
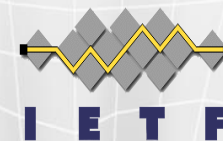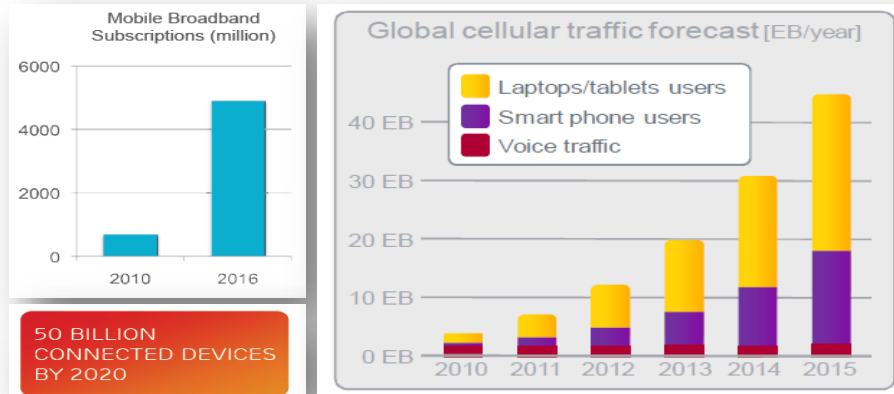
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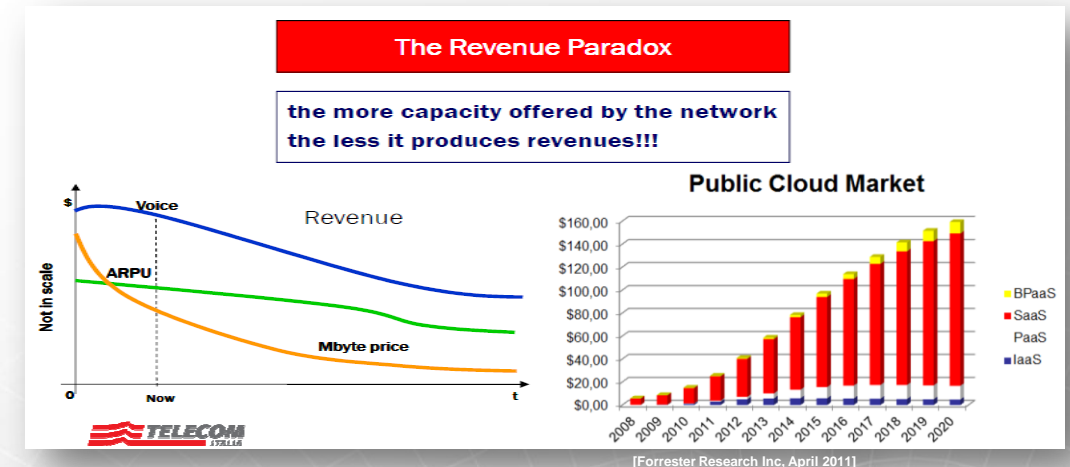
- **Conclusions**

Main challenges of the future

- Forecasts indicate a traffic growth of 500 - 1000x until 2020
- **The world is going mobile**

Mobile Broadband Subscriptions (million)

50 BILLION CONNECTED DEVICES BY 2020

Global cellular traffic forecast [EB/year]
- Laptops/tablets users
- Smart phone users
- Voice traffic

- **Internet economic model** is the main driver

The Revenue Paradox

the more capacity offered by the network the less it produces revenues!!!

Public Cloud Market

- BPaaS
- SaaS
- PaaS
- IaaS

[Forrester Research Inc, April 2011]

- Huge infrastructure investments with **uncertain return** (ROI)

The Best Network Paradox
(http://netparadox.com/)

The best network just moves bits and the best network is the hardest one to make money running

- **Reduced OPEX**
- **New network deployment possibilities**
- **Market / regulations / perceptions**

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Stakeholders' view on H2020 and beyond

- **The Internet** as such and related business models - based on content - **will not change**, probably
- **Uplink traffic** will be one of the main issues (carrier opportunity)
- **Consolidation of operators** (MNO, VNO and Cables) and **horizontal cooperation** (including network sharing)
- Carrier business model: high termination fee with **unlimited voice, data and SMS**

William E Kennard
US Ambassador to the EU

"Internet will not change!"

Vittorio Colao
Chief Executive, *Vodafone Group*

Carsten Schloter
CEO, *Swisscom*

"Carriers must stop blaming OTT to damage their market!"

Franco Bernabè
Executive Chairman and CEO, *Telecom Italia*

Neelie Kroes
Vice President of the European Commission Digital Agenda Commissioner

"What kind of governance to give to Internet must be discussed !"

Application scenario for <u>video</u> beyond 2020

- **New video formats and codec**
  - › UHDTV (Ultra High Definition TV; 7680 x 4320)
  - › New standard HEVC (Joint ITU-T/ISO)
    - » 1920 x 1080, 60 fps → 15 Mbit/s (half the bitrate of H.264/AVC)
    - » 7680 x 4320, 120 fps → **up to 800 Mbit/s**
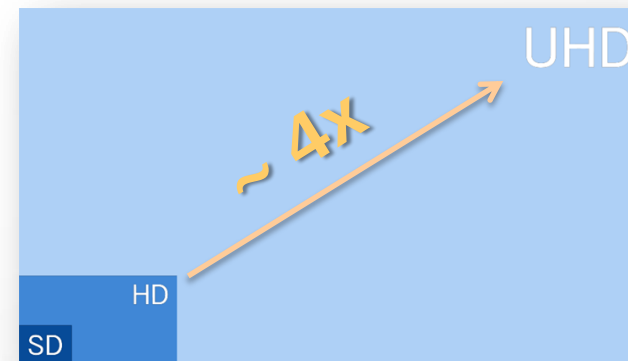
www.futuretimeline.net/21stcentury/2020.htm

- **Transition to 3D and interactive video services**
  - › Immersive service
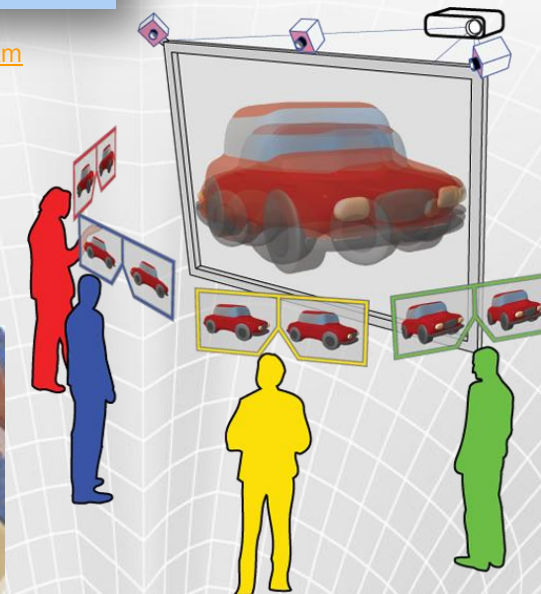   - » High Resolution Panoramas
    - » 3D video content with more than 2 views (e.g. lenticular displays with 8 views)
  - › Interactive content
    - » Select your viewpoint

- **Augmented Reality**
  - › Gaming, advertisement, localization, orientation
  - › Latency

→ **Huge data rate will be required**

http://www.imvis-eu.org/
(EU FP7 funded project)

www.metaio.com   Page 12

Application scenario for <u>audio</u> beyond 2020

- **New 3D audio formats for UHDTV**
  - › 22.2 multichannel audio format: **around 1.5 Mbit/s**
  - › HOA: a generic 3D audio format
    - » 4th order microphone (25 audio signals)
  - › Interactive content
    - » Select your viewpoint
- **Audio/video communication**
  - › High-quality speech and audio codec for conversational application (3GPP EVS)
    - » Very high quality: Hi-Fi up to 128 kbit/s
    - » Operators expects a mouth-to-ear delay below 200 ms with LTE (**less than 35 ms for codec**)
    - » But real comfortable communication would requires a total delay **< 150 ms**
    - » Packet loss rate expected to be **less than 1%**
  - › Video conferencing
    - » Immersive human interaction becomes very crucial
    - » Roundtrip latency must be very low **< 100 ms**
    - » Channel must provide graceful degradation of the service to ensure high QoE
- **Social network**
  - › Sharing media with your social network
    - » Nowadays we have Smartphone with Full HD camera…
    - » …but they will be replace by stereo-camera or even camera array
    - » …and multi-microphone recording

➡ **Large uplink bandwidth**

www.mhacoustics.com

Huawei audio lab with 22.2 channels system

Looking at H2020 and beyond: network and services vision

Site Capacity
50Gbps

Site Capacity
100Gbps

Macro

Micro

100 Tbps

Tera-Cell

Peak Rate **5Gbps**

50 Billion Things

**Hyper Connectivity to
Everyone and Everything**

CCN/UID

Browser, Chat,....
File, Streaming....
Security....
Content
Strategy, Policy....
TCP, P2P, Broadcast ...
Fiber, Copper, Radio

Virtualization

Any applications (OTT)

Decouple

VM | VM | VM

Computing Virtualization

Physical Computing Pool
（Anyx86H/W）

Virtual Network | Virtual Network | Virtual Network

Network Virtualization

Physical Capacity Pool
（Any Network H/W）

Any location

NetAPI

Open Connectivity

- **Multi-tenancy**
- **Elasticity / Openness / NaaS**
- **Content / Information Centric**

Network and services evolution
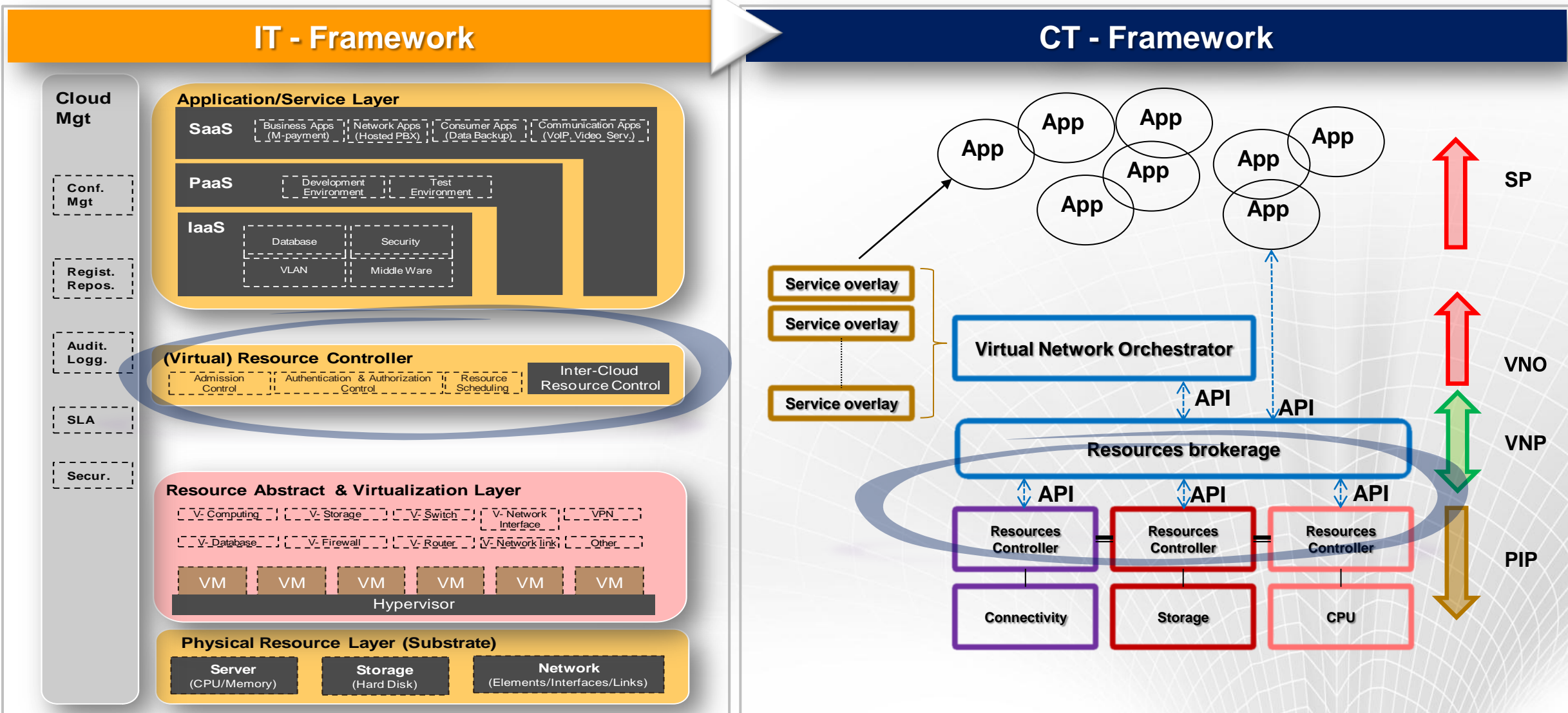
The new technical problems to resolve

Architectures
- Interface and building blocks (logical elements), end to end (including terminals)

Cloud Networking
- Protocols for carrier grade cloud interoperability
- Cloud federation for greater resilience and elasticity
- Autonomic elastic connectivity
- Optimization of virtual resource usage dealing with scale and heterogeneity
- Multidimensional, dynamic and large scale resource scheduling
- Portability

Security
- Vulnerabilities in architecture, characteristics and core-technologies
- Methods for security controls, including Cyber Security

Information Centric Networking
- Active objects (containing both code and data) in information-centric networks
- Multi-site clouds exploitation (optimal placement of applications in a network of clouds)
- Network adaptation to applications data paths, end to end (including terminals)
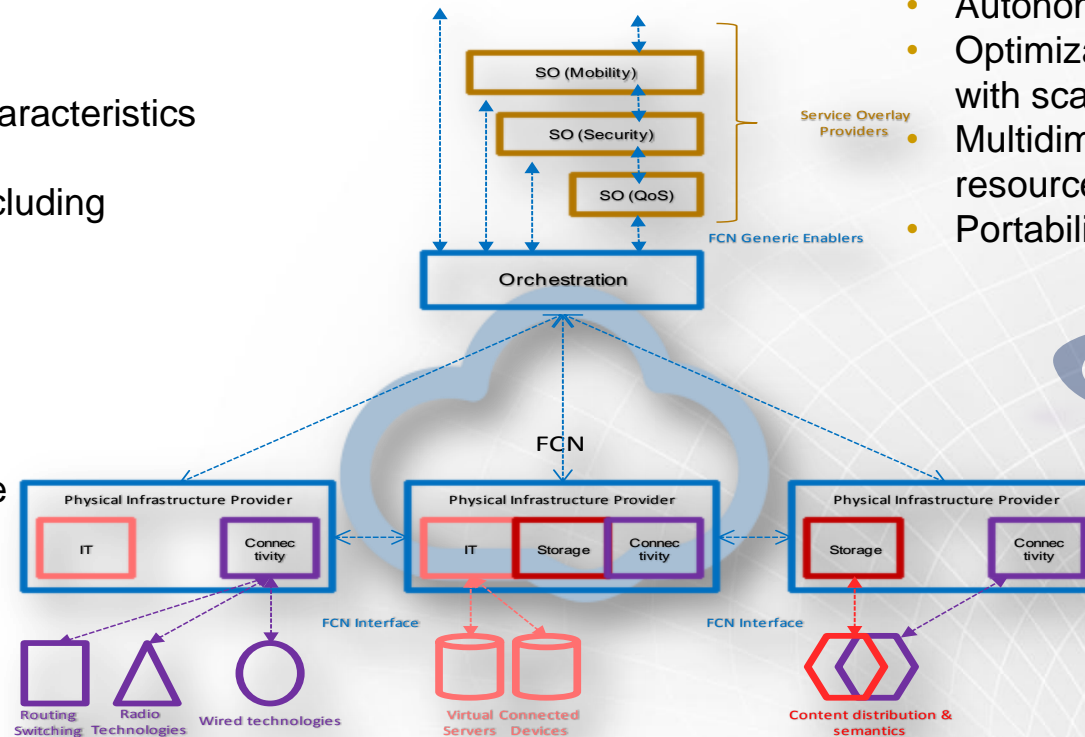
Software Defined Networking
- Resource description languages
- Architecture of metadata to describe all IT and CT components
- Network and mobility operating systems
- Algorithms for efficient embeddings
- Network as a Service (NaaS)

SO (Mobility)

SO (Security)

SO (QoS)

Service Overlay Providers

FCN Generic Enablers

Orchestration

FCN

Physical Infrastructure Provider

IT   Connectivity

Physical Infrastructure Provider

IT   Storage   Connectivity

Physical Infrastructure Provider

Storage   Connectivity

FCN Interface

FCN Interface

Routing Switching   Radio Technologies   Wired technologies

Virtual Connected Servers   Devices

Content distribution & semantics

Future Networks Security – Process

Investigation of Future Networks specific vulnerabilities			Solutions for Future Networks security	
Reference Architecture Components and Vulnerabilities	**Essential FN Characteristics Vulnerabilities**	**Core-Technologies Vulnerabilities**	**Standard methods for security controls**	**Technologies for vulnerability factors reduction**
■ Service customer ■ Future network specific infrastructures ■ Supporting (IT) infrastructure ■ Ex: 	■ On-demand self-service ■ Ubiquitous network access ■ Resources pooling ■ Rapid elasticity in resource management ■ Measured services for flexible business models ■ Etc.	• Resource description language • Software defined networking • Cloud networking • Virtualization • Information centric networking • Autonomic management • Etc.	■ Audit ■ Certification ■ Continuous security monitoring ■ Security as a service ■ Etc.	■ Key management procedures ■ Enhanced cryptography ■ Identity management ■ Authentication ■ Authorization ■ Auditing ■ Etc.

Future Networks: call for papers and speakers

- **IEEE Communications Magazine**
  - › Special Issue on Future Carrier Networks
    - » Full Paper Submission Deadline: **30 Nov 2012**
    - » Decisions Notification: 28 Feb 2013
    - » Final Manuscripts Due: 31 Apr 2013
    - » Publication of Special Issue: June 2013 (tentative)
- **IEEE ICC 2013**
  - › Panels on **Future Carrier Networks** and **IoT**
    - » 9-13 June

IEEE COMMUNICATIONS SOCIETY

Guest Editors

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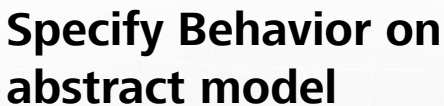E-mail: david.soldani@huawei.com

Dr. Roberto Saracco
Trento Node Director
EIT ICTLABS
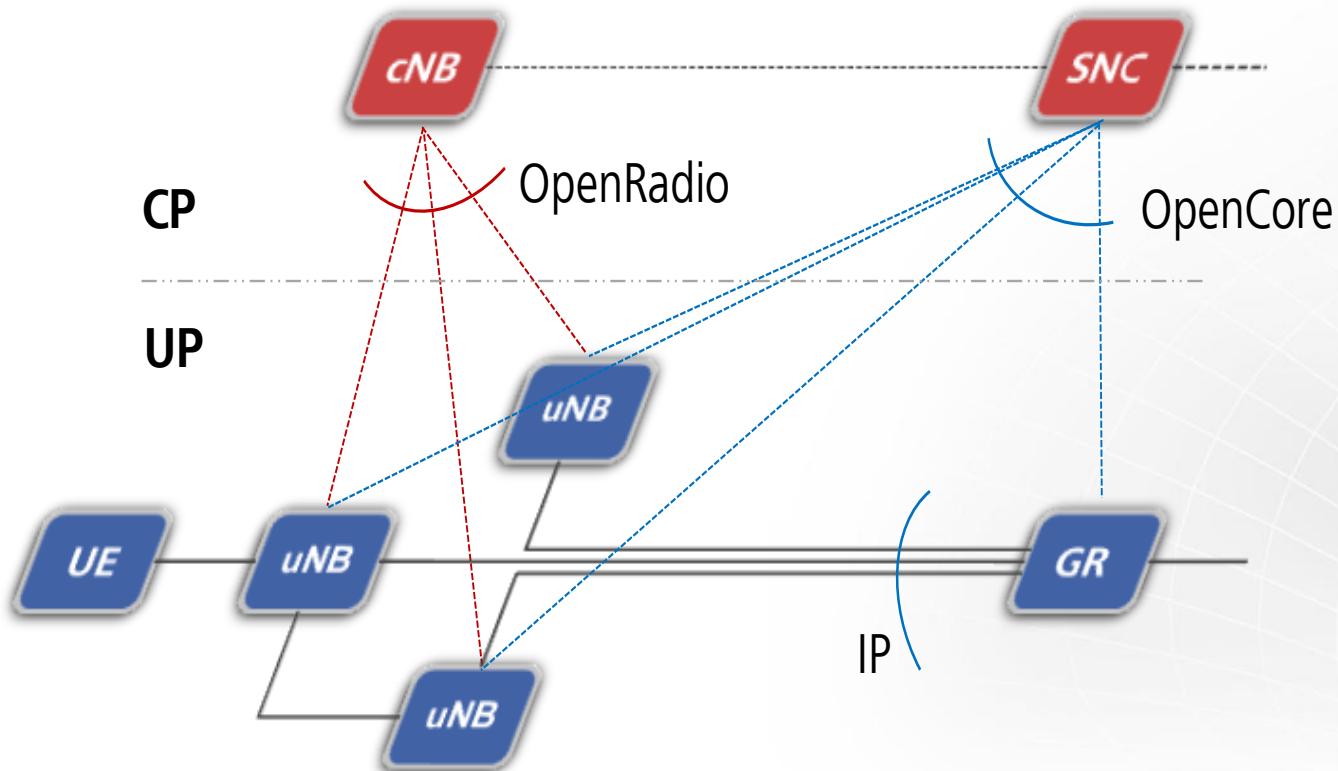v. Sommarive 18, 38123, Trento, Italy
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Roberto Saracco

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INDUSTRY FORUM & EXHIBITION
2013
9-13 JUNE · BUDAPEST, HUNGARY

Panel Sessions Co-Chairs

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Munich, Germany

Peter Rost,
Research Scientist at NEC Labs Europe
Heidelberg, Germany

David Soldani   Peter Rost

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...with Architectural Innovation (Network IT-lization)

Example

Business Requirements

Control Program $

Control Program $

Control Program $

Specify Behavior on abstract model

Abstract Network Model

Network Virtualization

Map abstract model to global view

Global Network View

Network OS

Map global view to physical switches

Physical Network

OpenFlow?

G/U/L   Line Card   IP/Eth MPLS
PON   Line Card   IP/Eth MPLS
DSL
Line Card   IP/Eth MPLS
Microwave

LAN SW

Gateway Product   IP/ETH

RNC/BRAS GGSN/EPC FW/...
PE Router

Core Router

Security Product   IP/Eth

DC Router

FW/NAT IPS/... LB/WOC...
IP/Eth

DC Switch

IP   IMS

IP   App (Server)

IP   Storage

IP ASON   IP ASON   IP ASON   IP ASON

WDM   WDM   WDM   WDM

HUAWEI

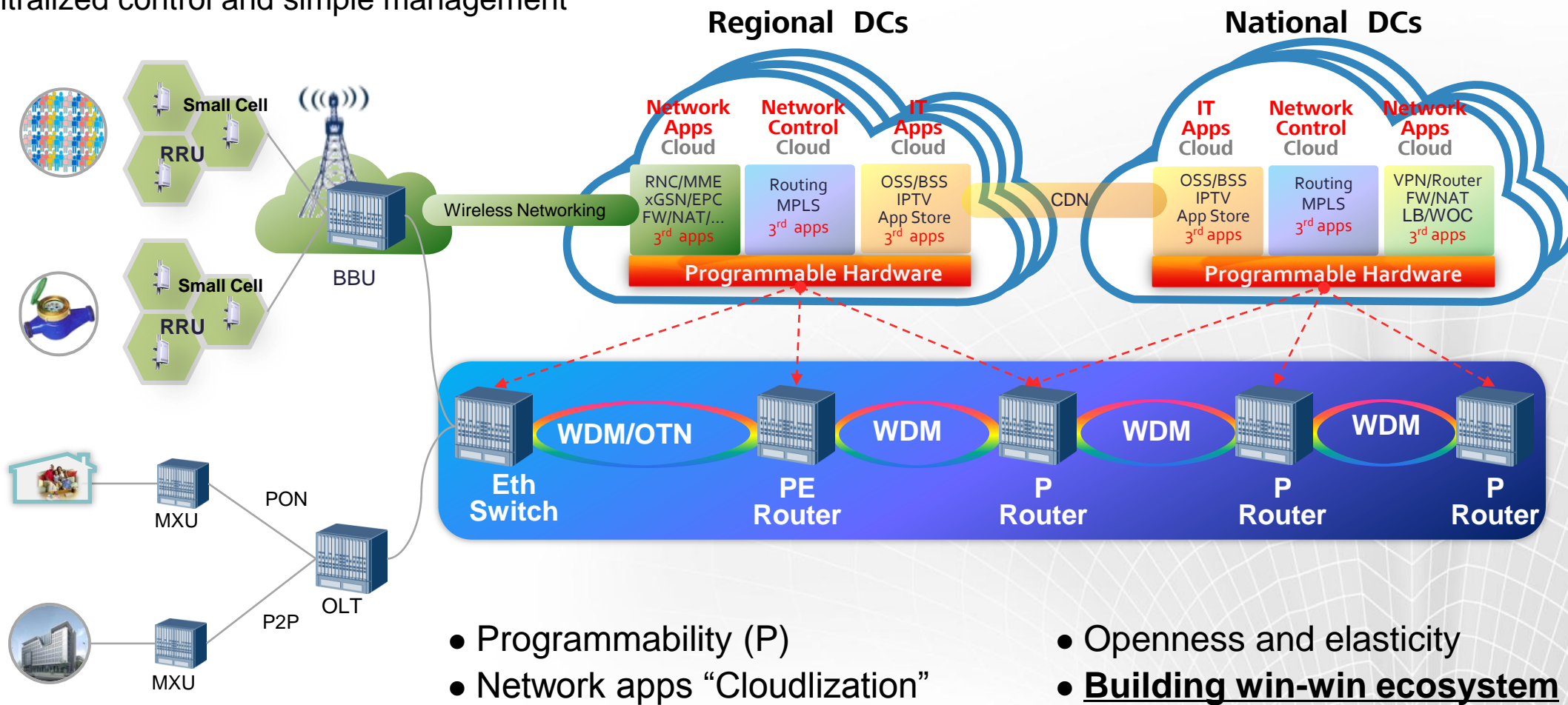# Wireless Software defined network Architecture (WiSA)

- CP and DP separation
- Centralized Control-plane
- Programmable network and open capabilities
- Flexible network virtualization
- Backhaul-constrained radio coordination
- User Identity (UID) enabled ultra flat network
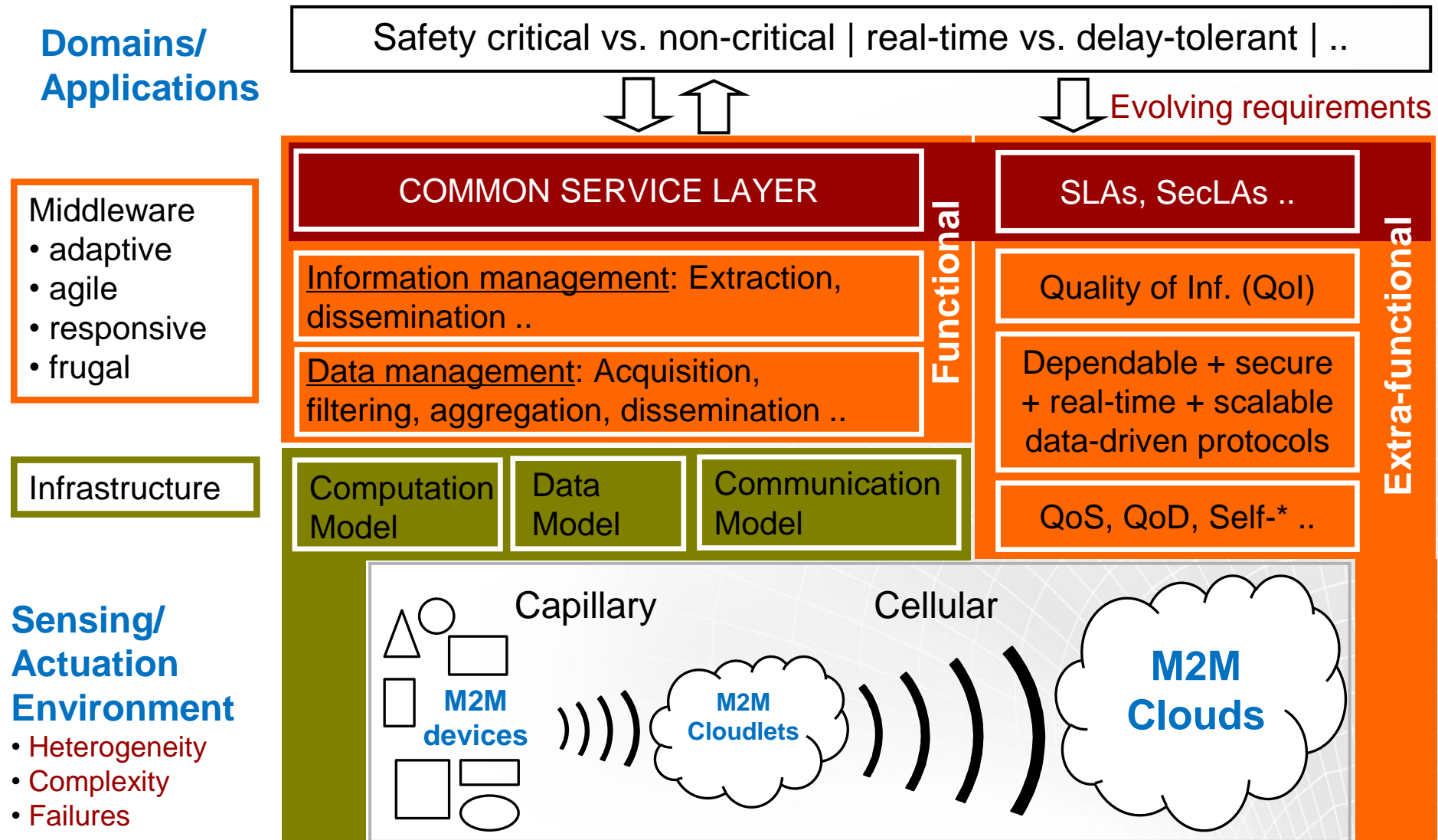
SoftCOM enables Software Defined Network

- Decoupling of forward & control planes
- Centralized control and simple management

- Programmability (P)
- Network apps "Cloudlization"

- Openness and elasticity
- **Building win-win ecosystem**

Cross-Domain M2M Middleware: Architecture

Example

Domains/ Applications

Safety critical vs. non-critical | real-time vs. delay-tolerant | ..

Evolving requirements

COMMON SERVICE LAYER

SLAs, SecLAs ..

Middleware
- adaptive
- agile
- responsive
- frugal

Information management: Extraction, dissemination ..

Data management: Acquisition, filtering, aggregation, dissemination ..

Functional

Quality of Inf. (QoI)

Dependable + secure + real-time + scalable data-driven protocols

Extra-functional

Infrastructure

Computation Model

Data Model

Communication Model

QoS, QoD, Self-* ..

Sensing/ Actuation Environment
- Heterogeneity
- Complexity
- Failures

Capillary

Cellular

M2M devices

M2M Cloudlets

M2M Clouds

[A. Khelil, "Towards an Universal M2M Platform", Nov. 2012]

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Conclusions

The **Huawei European Research Centre** we will be one of the main attractive platforms for carrying out research and innovation in Europe

There will be **new platforms bridging IT and CT resources** and a **light regulation framework** among players (ITU – Revised ITRs) for some essential services, where reliability, quality, security and privacy are required

High speed access to ICT resources along with quality, security and reliability will be the carriers' main value proposition and the most viable way to go in Europe

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Thank you

www.huawei.com