Talk at University of Cape Town Mini-Symposium
„The Internet of Things, Machine to Machine Communication and Smart Cities“, September 5, 2013

Smart Communication Platforms for Prototyping Smart City Applications

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DAAD unifi University Future Internet

Fraunhofer FOKUS

About the Speaker

Prof. Dr. Ing. habil Thomas Magedanz

Thomas Magedanz (PhD) is professor in the electrical engineering and computer sciences faculty at the Technical University of Berlin, Germany, leading the chair for next generation networks (Architektur der Vermittlungsknoten – AV) supervising Master and PhD Students

In addition, he is director of the "NGNI" division at the Fraunhofer Institute FOKUS, which provides toolkits for NGN/IMS as well as Next Generation of Fixed and Mobile Networks /EPC test and development tools for global operators and vendors. Prof. Magedanz is one of the founding members of FOKUS (1988) and member of the management team.

Furthermore he is principal consulant of Direct Link Consult e. V., a FOKUS Consulting spin off focussing on professional services, strategic studies and technology coaching.

Prof. Magedanz is a globally recognised technology expert, based on his 18 years of practical experiences gained by managing various research and development projects in the various fields of today's convergence landscape (namely IT, telecoms, internet and entertainment).

He acts often as invited tutorial speaker at major telecom conferences and workshops around the world.

Prof. Magedanz is senior member of the IEEE, editorial board member of several journals, and the author of more than 200 technical papers/articles. He is the author of two books on IN standards and IN evolution.

Agenda

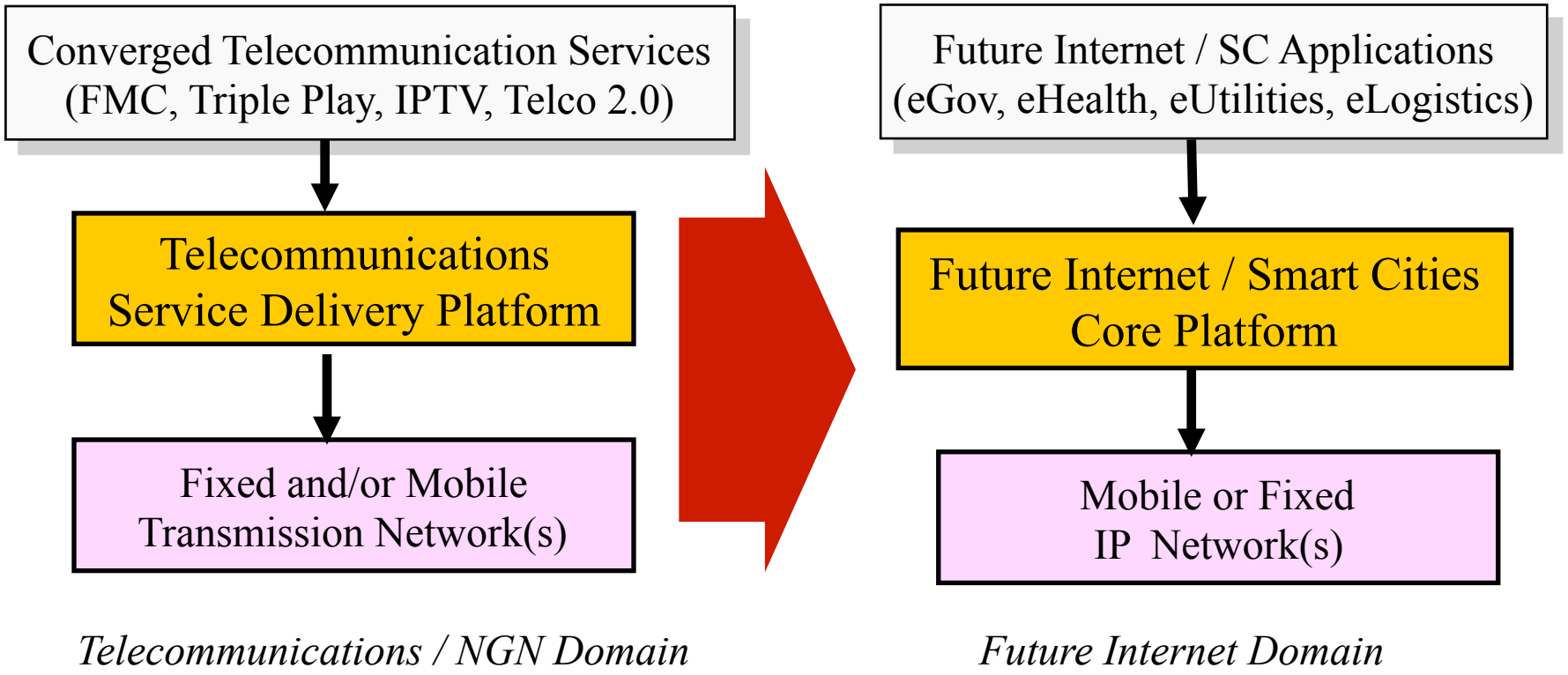
- Smart Cities as Future Internet Show Case
- Smart City communication infrastructures requirements
- *The Role of IP Multimedia Subsystem, Machine Type Communication, Evolved Packet Core and related Open APIs within emerging Smart City SDPs*
- FOKUS Toolkits and practical examples
- Summary
- *Q&A*

Main Messages of the Talk

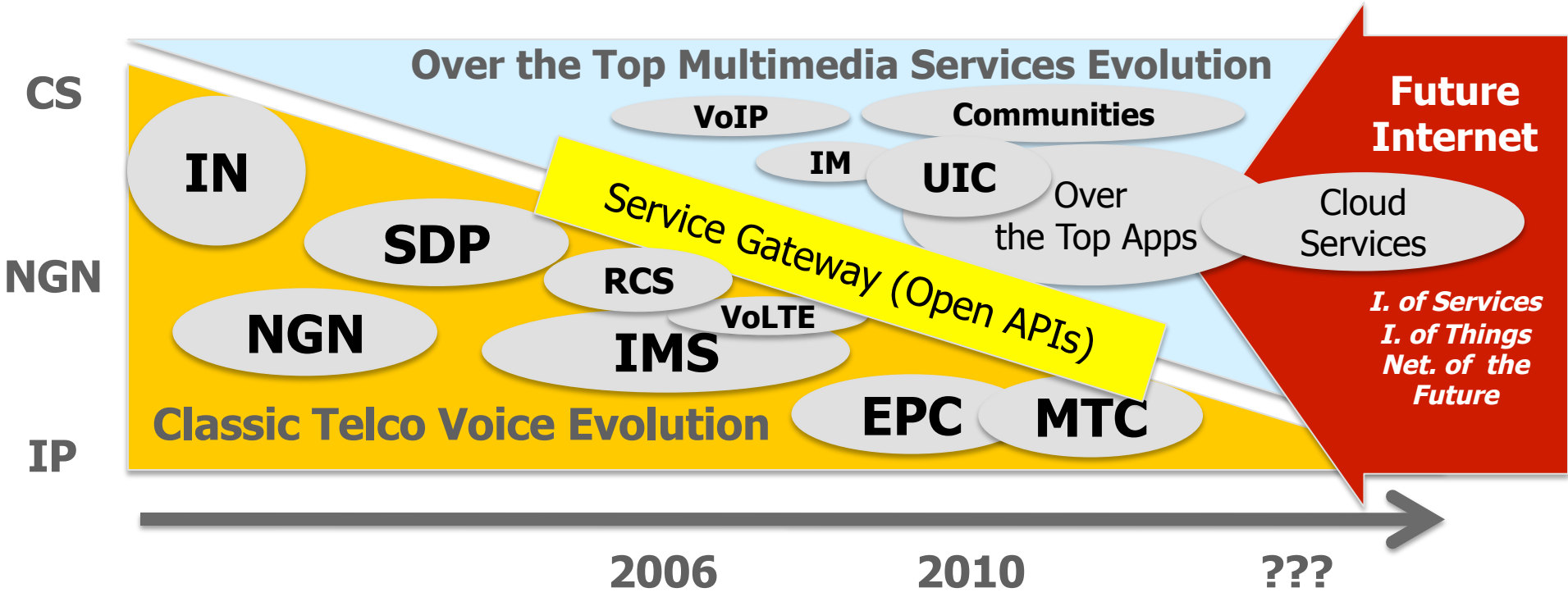
- **Convergence** of fixed and mobile networks plus internet technologies was the driver for **Next Generation Network (NGN)**
- IMS (plus an SDP) is the common control platform of the NGN today
- Over the top (OTT) services challenge operators and IMS platforms
- Future Internet (FI) is a hot research topic and equates to emerging Smart City (SC) ICT platforms and applications
- Smart Cities relate to the domains of Internet of Things (➔ M2M) and Internet of Services (➔ SDP)
- Smart Cities are driving **even more convergence** of networks and control platforms
- Evolved Packet Core (EPC) and Machine Type Communication (MTC) platforms are becoming key pillars around IP Multimedia System (IMS) in the context of emerging Smart City ICT platforms
- Nevertheless Open APIs will abstract from the specifics of the platforms
- FOKUS tools and testbeds are designed to prototype Smart City ICT

A déjà vu - From NGN towards SDPs for Future Internet / Smart Cities

Main Idea: A Core Platform provides reusable capabilities (➔ Enablers) for multiple applications hiding the details of underlying technologies

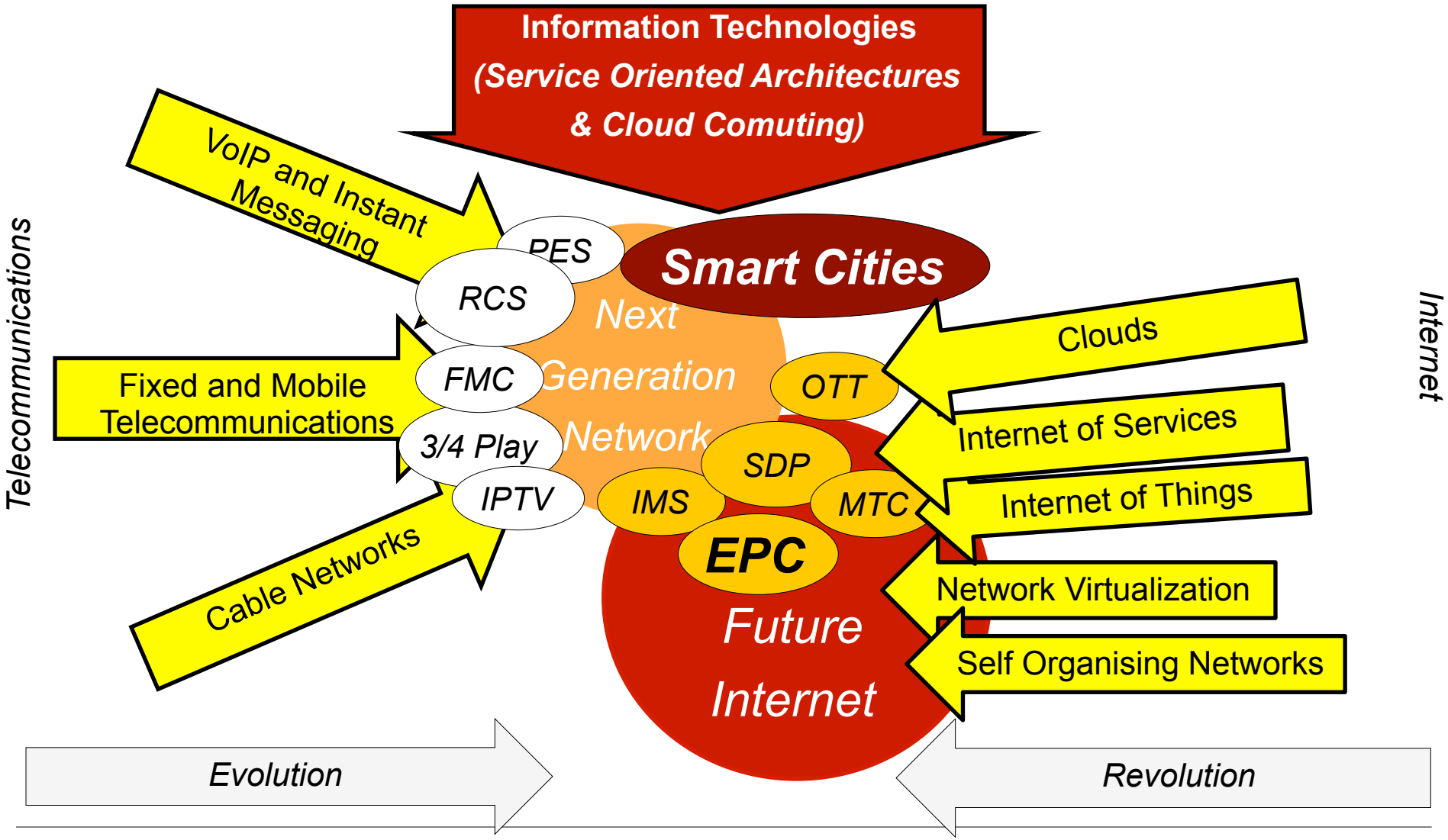


OTT vs. Telco Networks & Platforms – APIs/IMS/EPC/MTC as last resort??



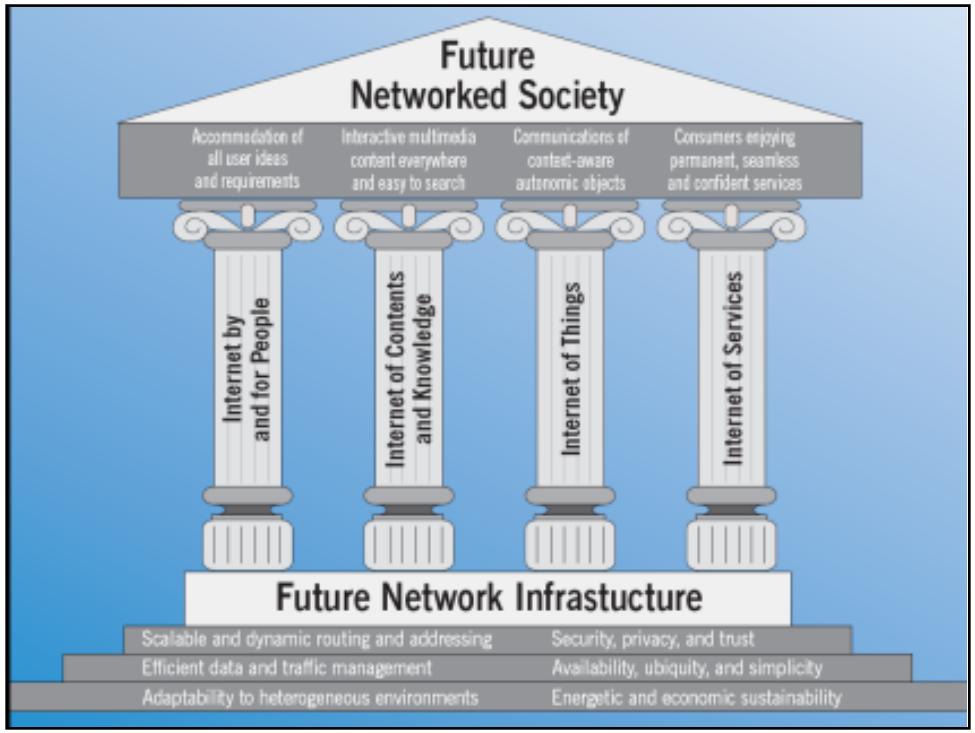
- ✓ All IP Networks will pave the road for Over the Top (OTT) Application
- ✓ Evolved telecom platforms may provide revenue potentials via Service Gateways (APIs) on top VoIP/RCS (IMS), Maschine Type Communication (MTC) and Smart Bit pipe approaches (EPC)
- ✓ *RCS will have to compete with Unified Communications (UIC) in OTT area*

NGN2FI Evolution is a Challenge



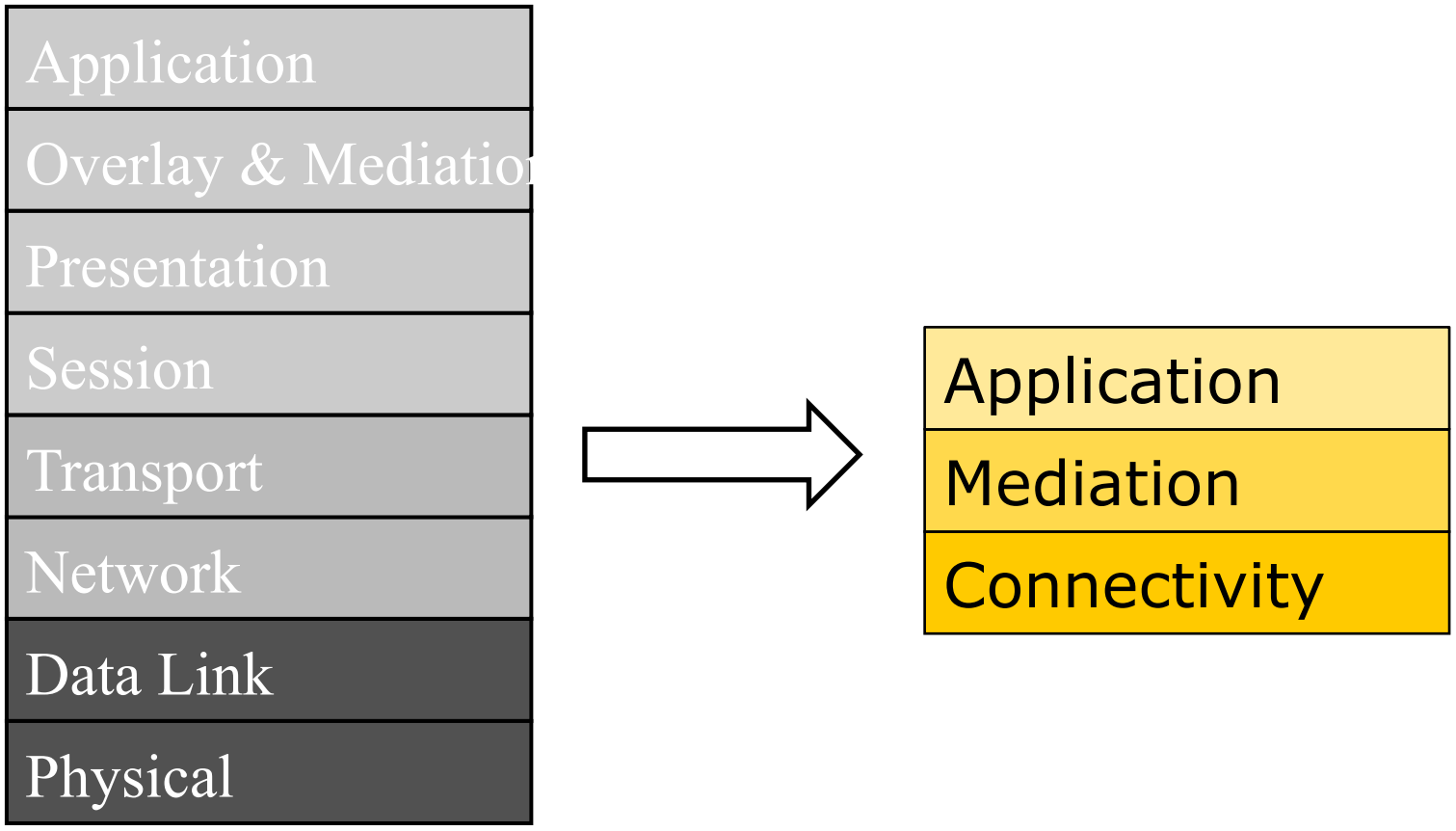
Dimensions of the Future Internet

- Future Internet Pillars
  - Network of the future
  - Internet of Content
  - ***Internet of Things***
  - ***Internet of Services***
- Infrastructure Foundation:
  - Network infrastructure / substrate that supports the pillars
  - Shall support capacity requirements of Future Internet



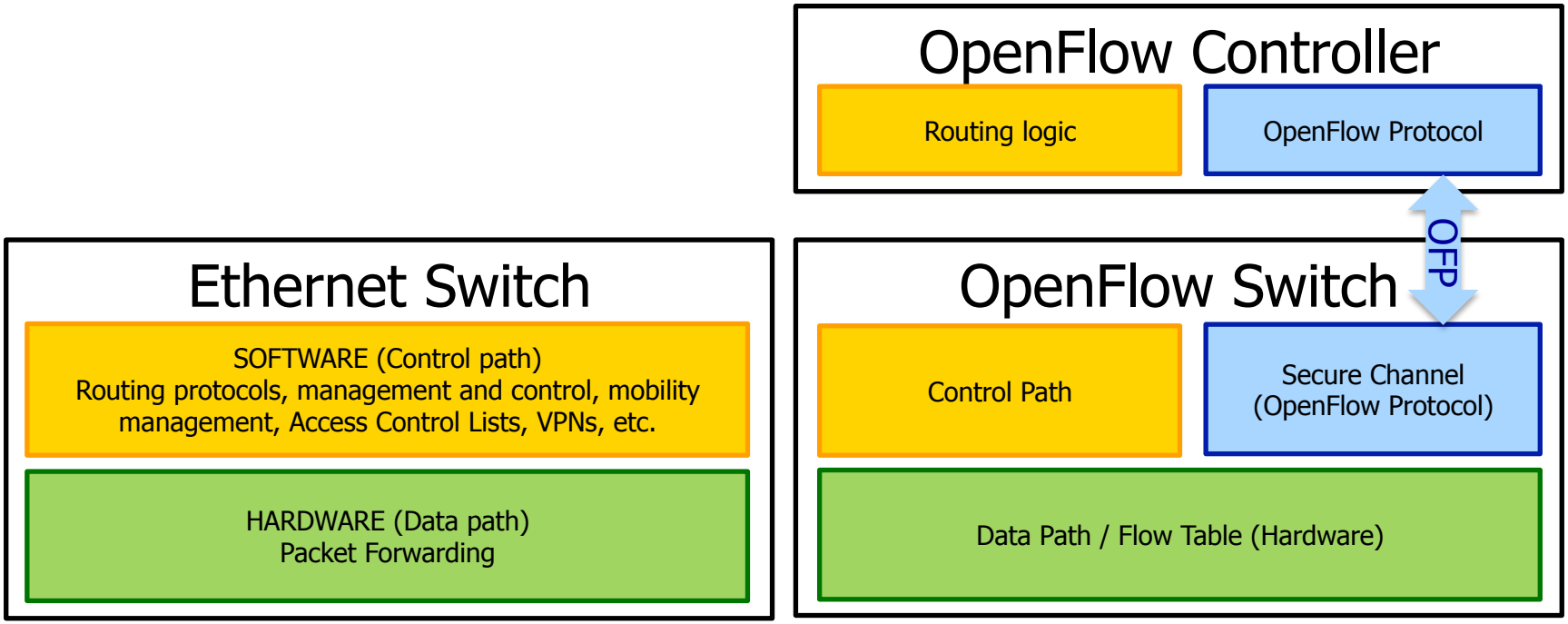
Future Internet, The Cross-ETP Vision Document, Version 1.0, 2009

FI = Towards a Thinner Protocol Stack

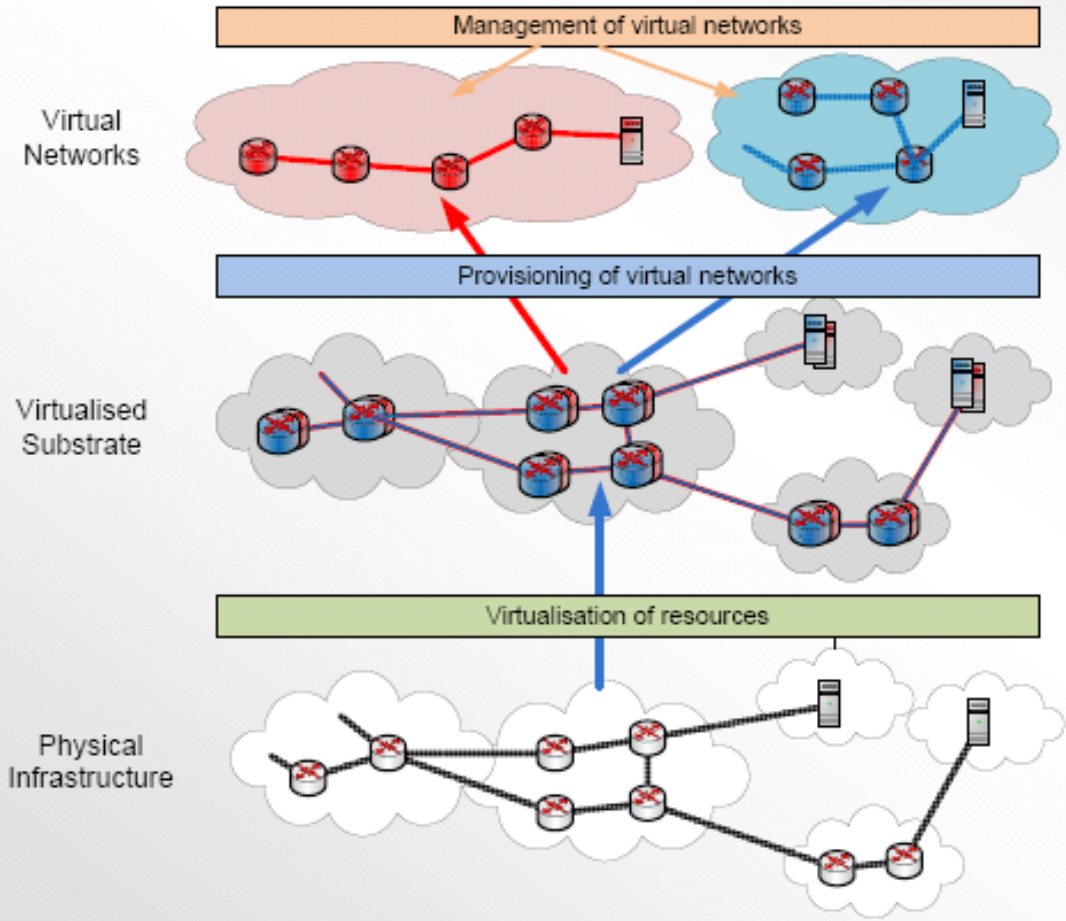


Switch Evolution towards Software-Defined-Networks (SDN)

- Ethernet Switch Architecture
- OpenFlow Switch Architecture and OpenFlow Controller interaction



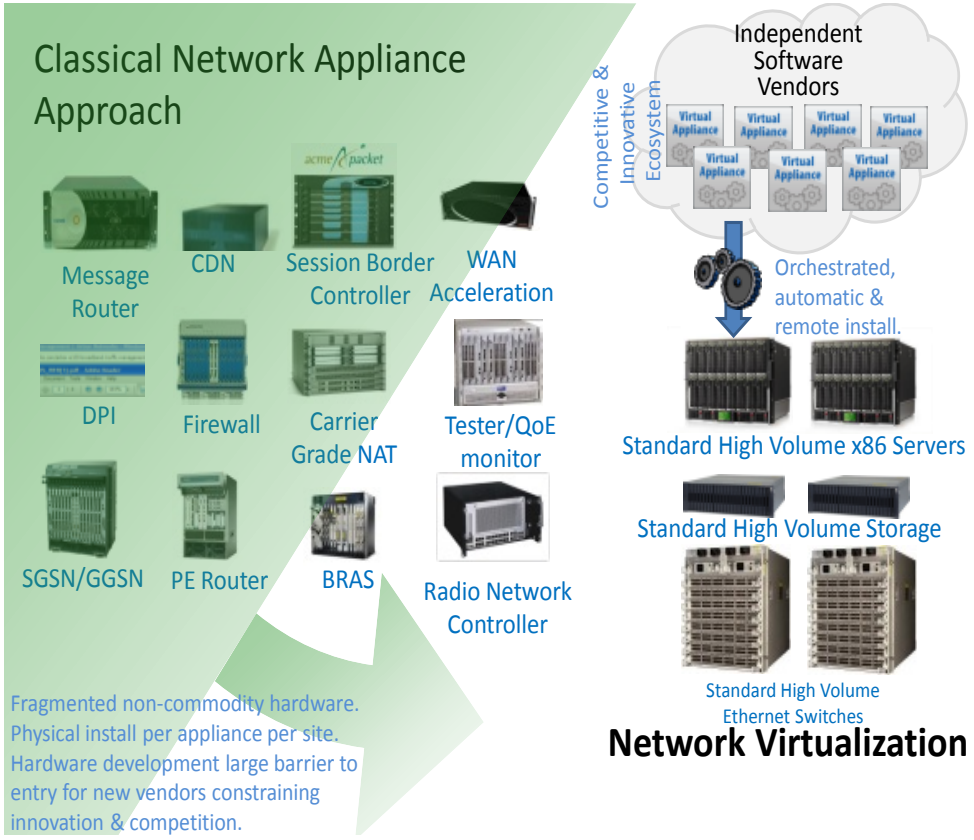
Decoupling Networks from Infrastructure



Source: EURESCOM Project P1956

What is Network Functions Virtualization (NFV)

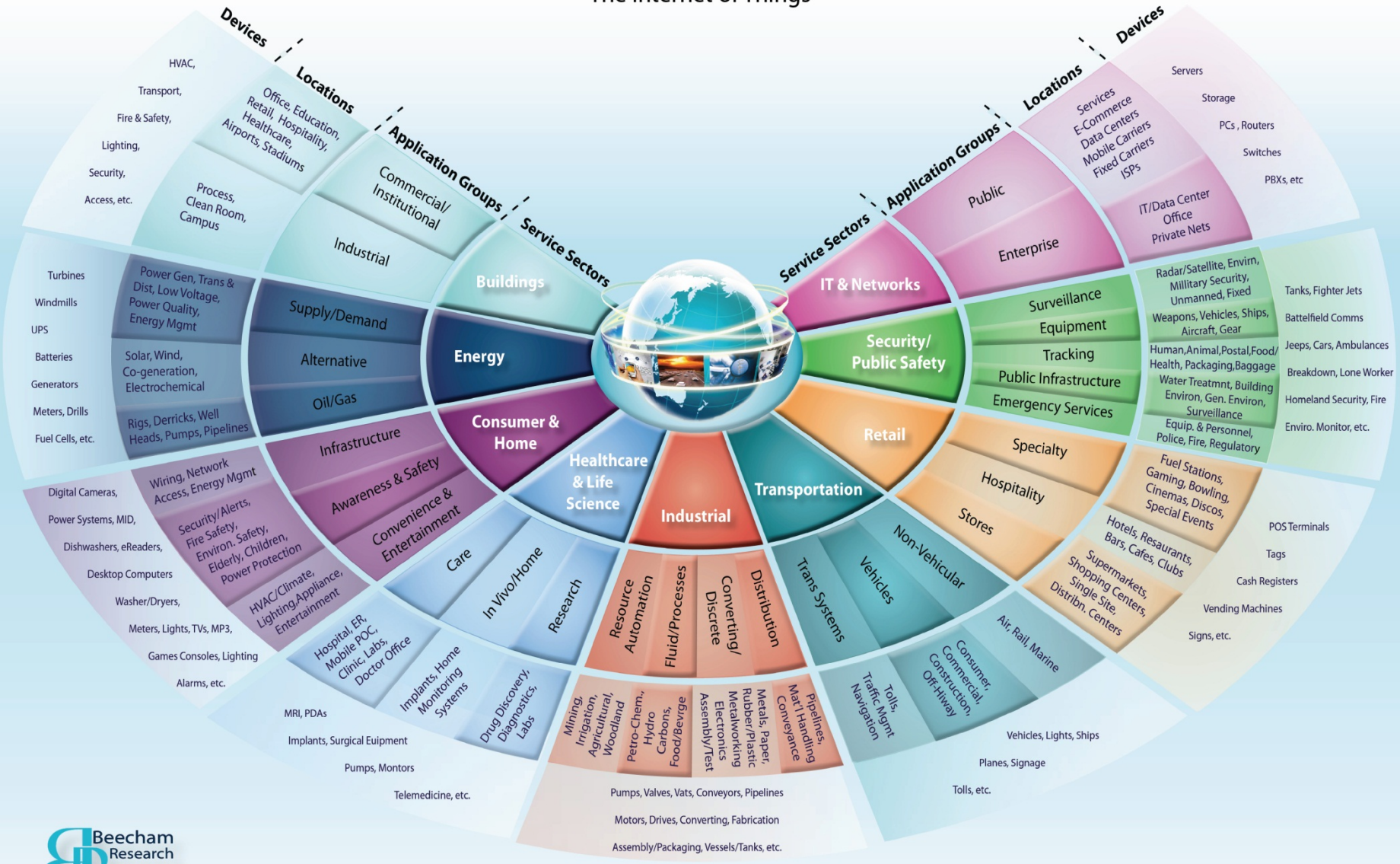
- Network Functions Virtualization (NFV) is a novel paradigm that presumes that the network functions:
  - Are implemented only as software (programs)
  - Can run on top of common servers
- NFV implies that network functions:
  - Can be moved as required
  - Do not require special equipment



© NFV White Paper presented at "SDN and OpenFlow World Congress", Darmstadt Oct 22-24, 2012

M2M World of Connected Services

The Internet of Things



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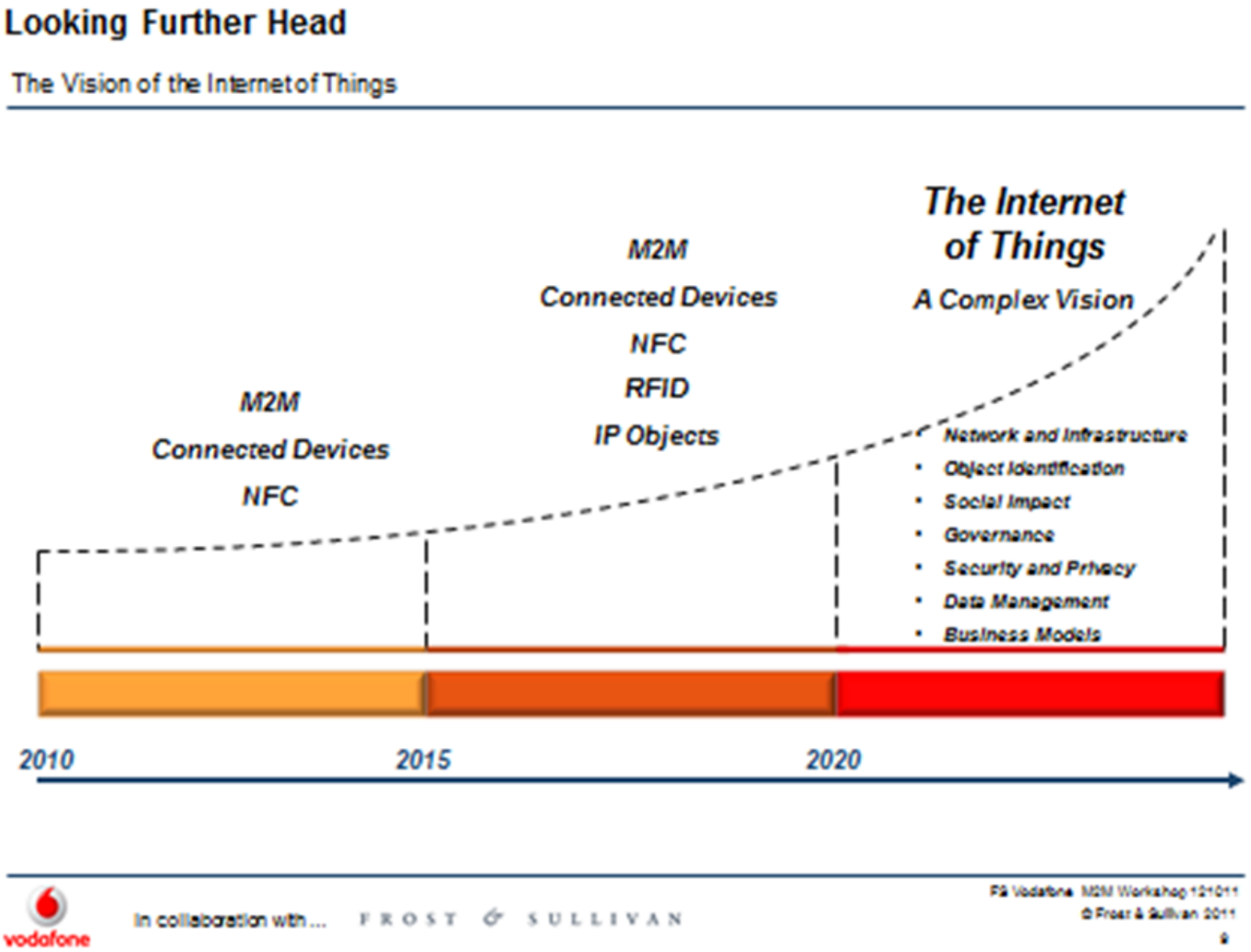
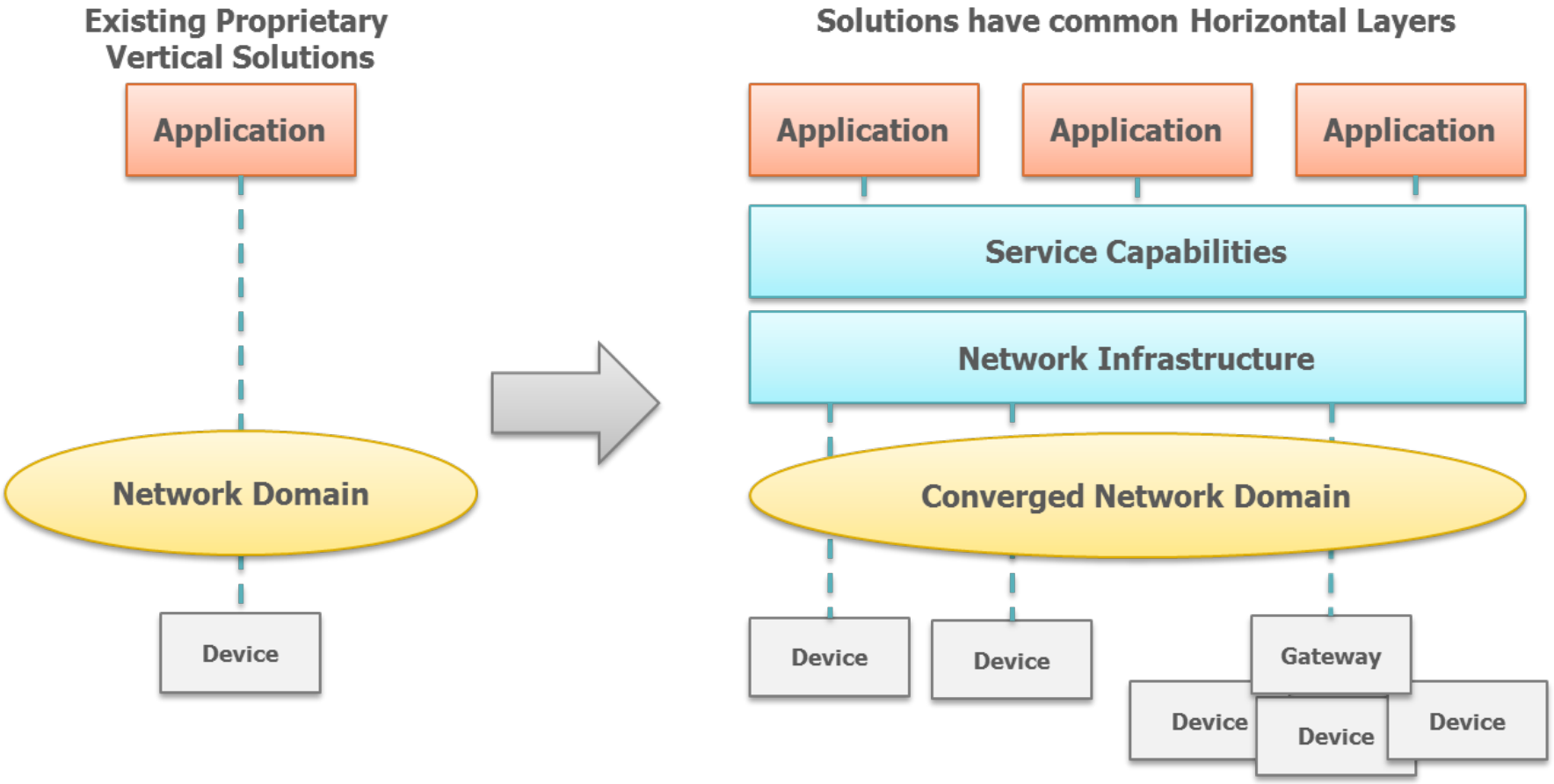
The Internet of Things



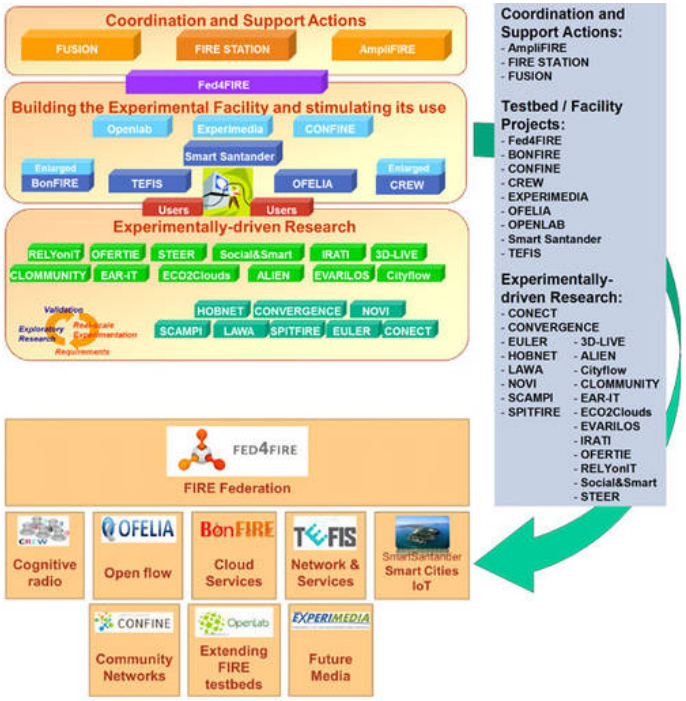
Source: Frost& Sullivan, Presentation: M2M Technologies Overview; 2011

Stop the Silo Mindset - Horizontal Approach for M2M

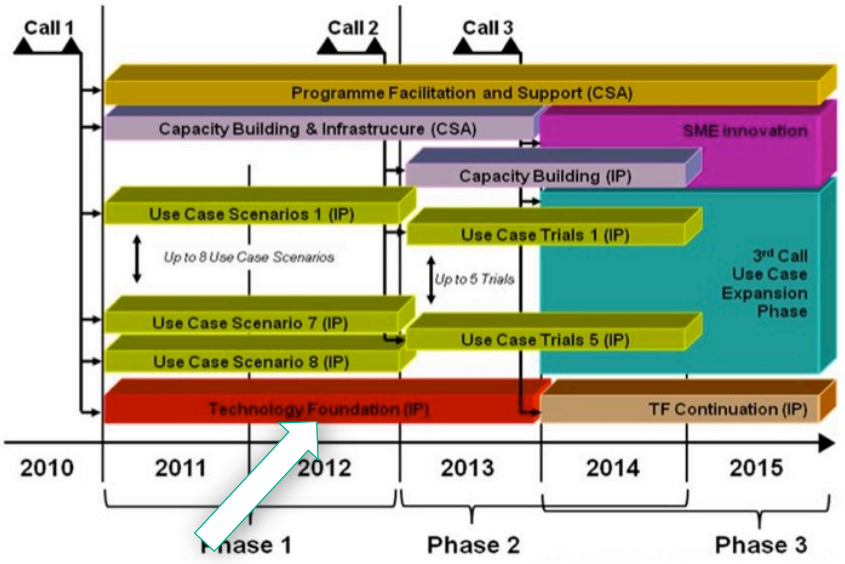


Europe's key Initiatives for Future Internet Research FIRE and the FI-PPP

- Europe's **Future Internet Research and Experimentation Initiative (FIRE)**
- Europe's **Future Internet Public Private Partnership Programme (FI-PPP)**



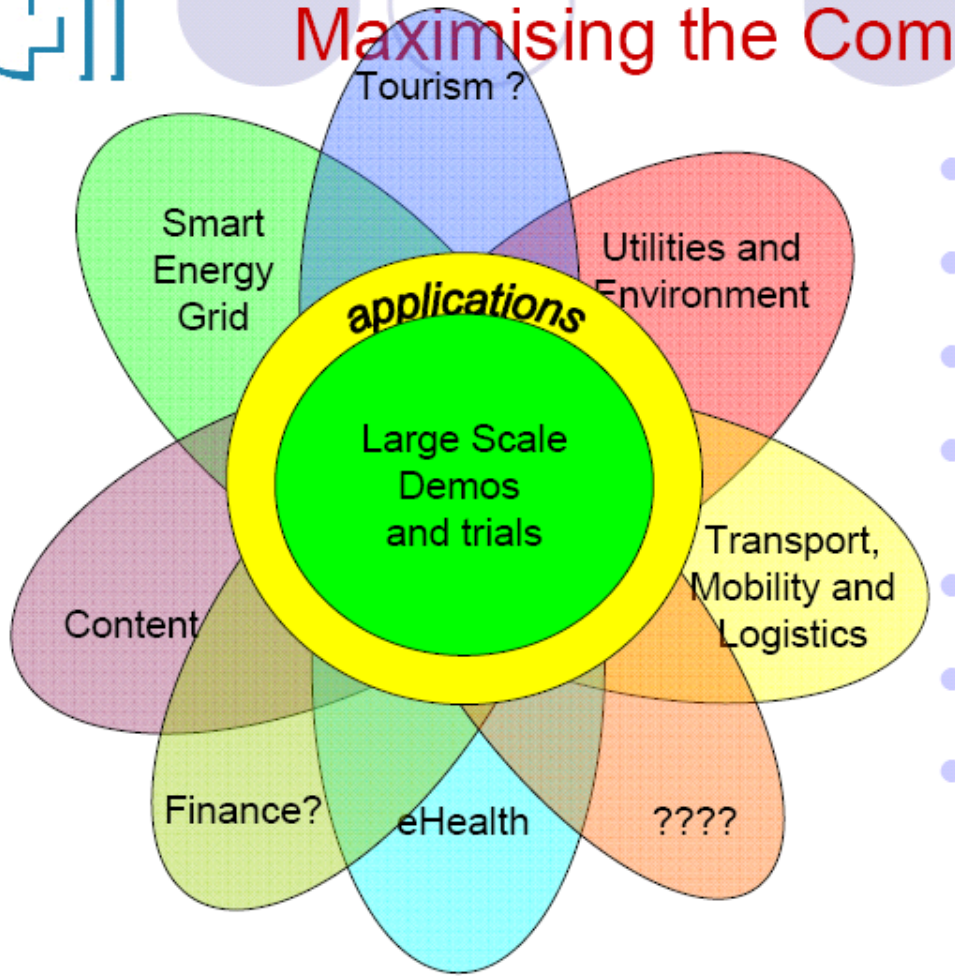
FIRE



Future Internet Core Platform

FI-PPP

The Notion of Enablers within the European Future Internet Initiative



- Examine the basic enablers in each area
- Determine the common enablers
- Determine the enhanced enablers
- Work out how to provide a core platform that supports the enablers
- Build it and show the world
- Use it in large scale trials and tests
- Use existing advanced infrastructures to test future Internet function

EU FI PPP Facts

FACTS & FIGURES

2x € 300 million

INVESTMENT BY THE EUROPEAN COMMISSION & PROGRAMME PARTICIPANTS

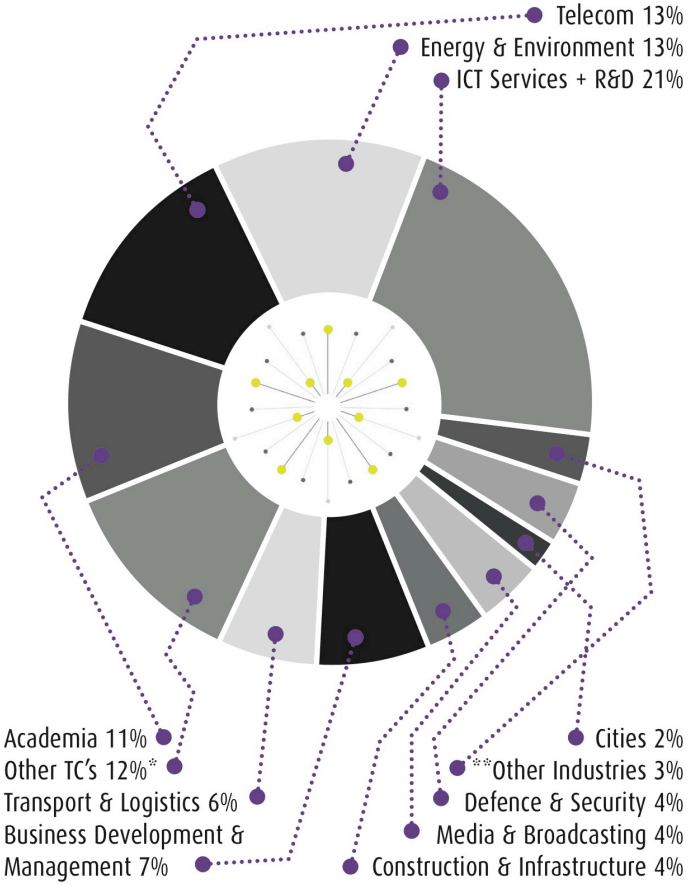
158 PARTNER ORGANIZATIONS AND COMPANIES

68% INDUSTRY SHARE IN THE PROGRAMME

18 ACADEMIC INSTITUTIONS

23

COUNTRIES REPRESENTED (2 FROM OUTSIDE EUROPE)



INDUSTRIES REPRESENTED IN THE FI PPP PROGRAMME

* Other Technology Companies, such as artificial intelligence, marine, aerial and satellite R&D, or automobile and other hardware manufacturing. ** E.g. Banks, retail stores, agriculture and food producing industries. Note: Figures are based on the number of participating organisations and approximate, since there are stakeholders with notable overlap in industries.

FI-WARE: Collaborating with Usage Area Projects

Outsmart: making public infrastructure in urban areas more intelligent and efficient

Envirofi: environmental data in the public domain

Fi-content: networked media including gaming

Finest: increasing efficiency in international logistics value-chains

Finseny: Reaping the benefits of electricity management at community level

Safety: Making cities saber

SmartAgriFood: Making the food value chain smarter

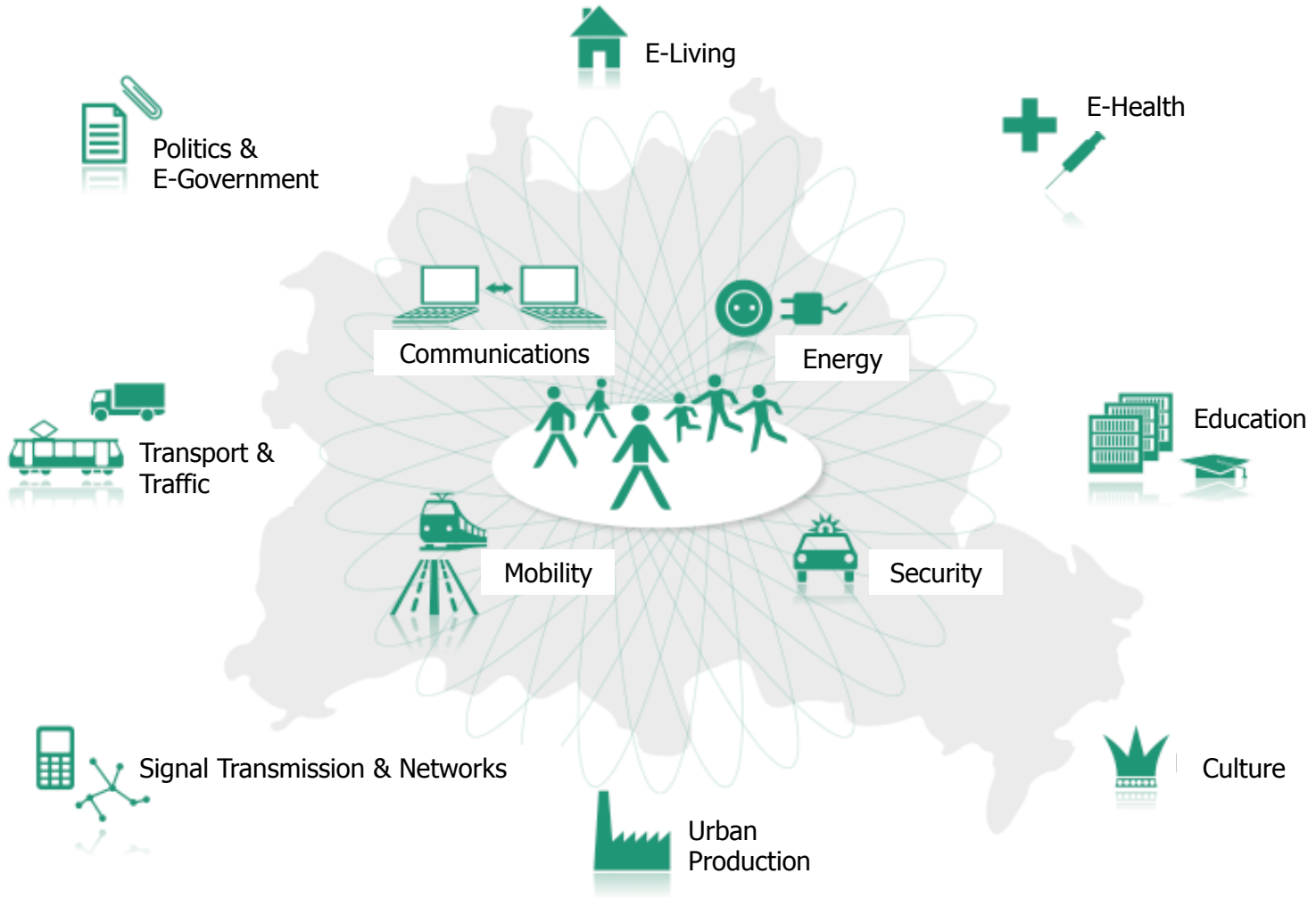
Instant Mobility: using FI in personal mobility

Future Internet vs. Smart Cities

- Future Internet is "a socio-technical system comprising Internet-accessible information and services, coupled to the physi- cal environment and human behavior, and supporting smart applications of societal importance"
- FI can transform a Smart City into an open innovation platform supporting vertical domain of business applications built upon horizontal enabling technologies.
- FI pillars for a Smart City environment:
  - The Internet of Things (IoS): defined as a global network infrastructure based on standard and interoperable communication protocols where physical and virtual "things" are seamlessly integrated into the information network
  - The Internet of Services (IoS): flexible, open and standardized enablers that facili- tate the harmonization of various applications into interoperable services as well as the use of semantics for the understanding, combination and processing of data and information from different service provides, sources and formats.
  - The Internet of People (IoP): envisaged as people becoming part of ubiquitous intelligent networks having the potential to seamlessly connect, interact and ex- change information about themselves and their social context and environment.

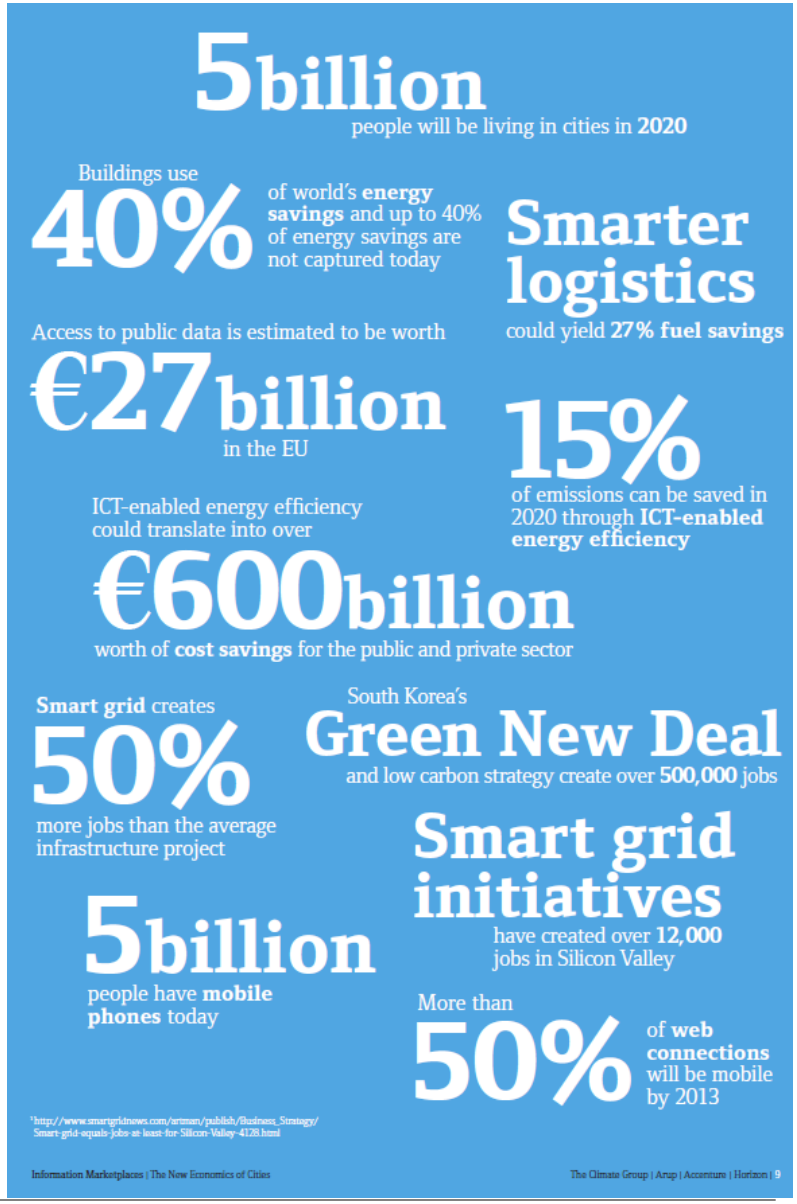
Future Internet … to make our cities smart

A Smart City is a huge Future Internet Show Case



Smart Cities: The Facts

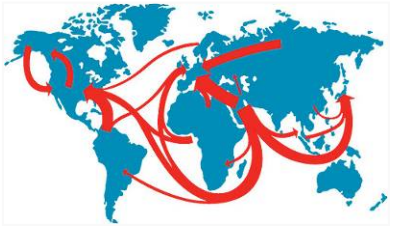
- 50% of the world's population already lives in cities and trends suggest that over 60% will live in cities by 2030
- 50% of global GDP is generated in the largest 600 cities
- There are 484 cities worldwide with populations in excess of one million
- There are 780,000 municipalities and states that are charged with the same functions as cities
- A UN report suggests that 40,000 new cities will need to be built worldwide by 2050
- The global private & public ICT market is $1580bn per annum; public sector market $423bn with $179bn of that local & regional government
- The global ICT market is 15% software and around 85% services and hardware
- Total estimated global budget for improving city ICT- $35-55bn
- Total ICT public sector city market circa $5bn software, $30bn services/hardware
- USA largest market +$12bn, Europe +$5bn, China +$3bn, Japan +$3bn, India +$1bn



Challenges for Future Cities – Global Megatrends until 2050

Demographic Change

Urban Development



Globalization

Energy and Resources

Environment

Health

Mobility

Dialog and Participation

Work & Life

Smart Cities

- The Smart City can be defined as the integration of technology into a strategic approach to sustainability, citizen well-being, and economic development. Any adequate model for the smart city must be multi-dimensional, encompassing different aspects of "smartness" and stressing the importance of integration and interaction across multiple domains.
- "Smart Cities" are environments of open and user driven innovation for experimenting and validating Future Internet-enabled services.
- Smart Cities Technology links to FI, the Internet of Things, and M2M.

As cities are defined as 'systems of systems', there is no **one** Smart Cities market:
-There are Smart Cities segments, ecosystems, and subsystems

Smart Cities – Forecast by Pike Research

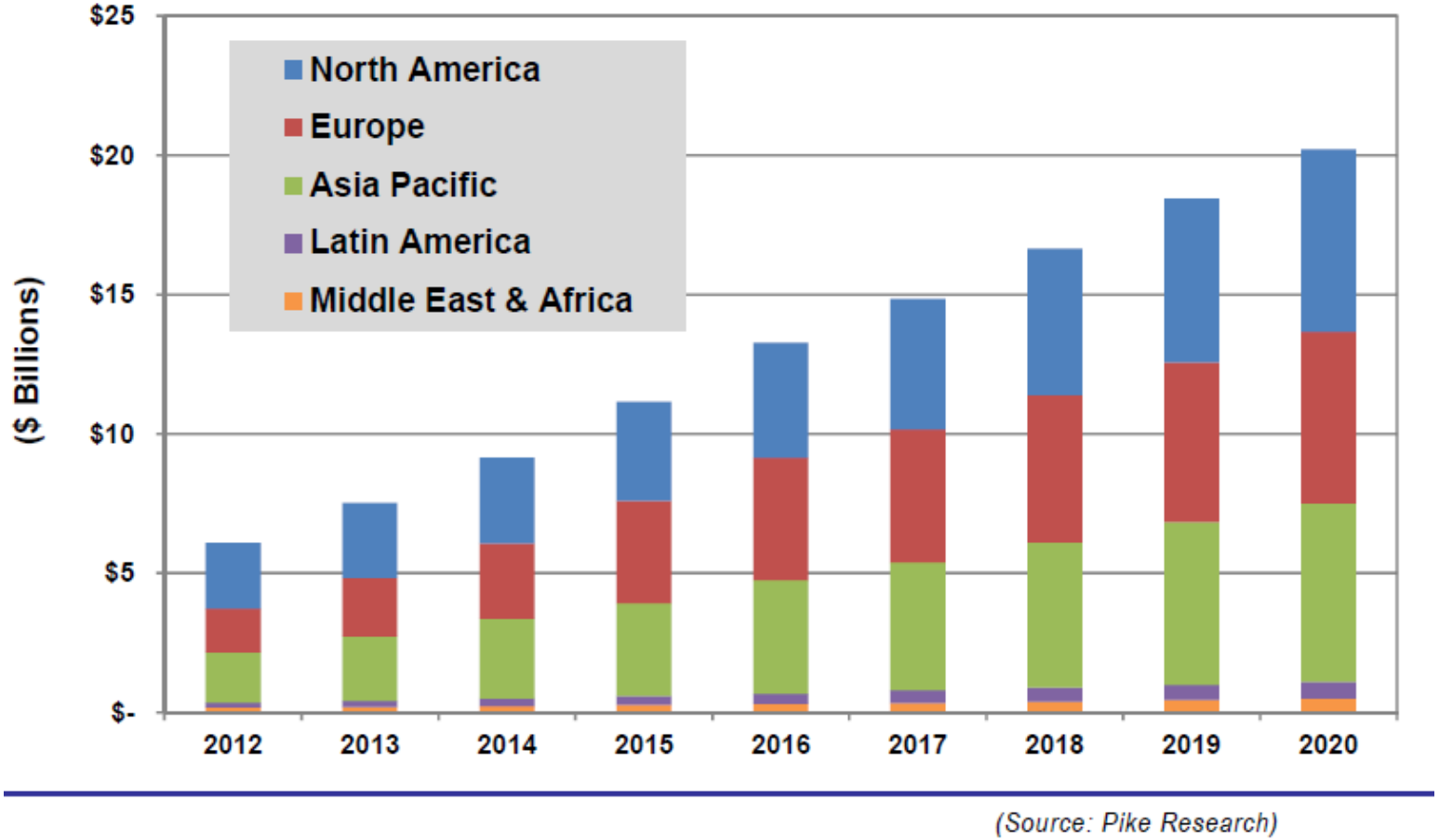
- Between 2010 and 2050, the number of people living in cities will increase from 3.6 billion to 6.3 billion. By 2025, there will be 37 megacities with populations of over 10 million; 22 of those cities will be in Asia.

- By 2020, the smart city technology market will be worth $20.2 billion annually, compared to$ 6.1 billion in 2012. This represents a compound annual growth rate (CAGR) of 16.2%.

- Pike Research analyzes the market in terms of the five "industries" that are core to the development of smart cities: smart energy, smart water, smart transportation, smart buildings,and smart government. The fastest-growing of these industries will be smart transportation,with a CAGR of 19.5% between 2012 and 2020. By 2020, the smart transportation marketrelated to smart cities will be worth $5.5 billion annually.

[Source: Pike Research:"Smart Cities Infrastructure, Information, and Communication Technologies for Energy, Transportation, Buildings, and Government: City and Supplier Profiles, Market Analysis and forecast, 2013]

Smart City Technology Annual Revenue by Region, World Markets: 2012-2020



(Source: Pike Research)

Agenda

- Smart Cities as Future Internet Show Case
- Smart City communication infrastructures requirements
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- FOKUS Toolkits and practical examples
- Summary
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Smart City Vision – Information and Communication is Key

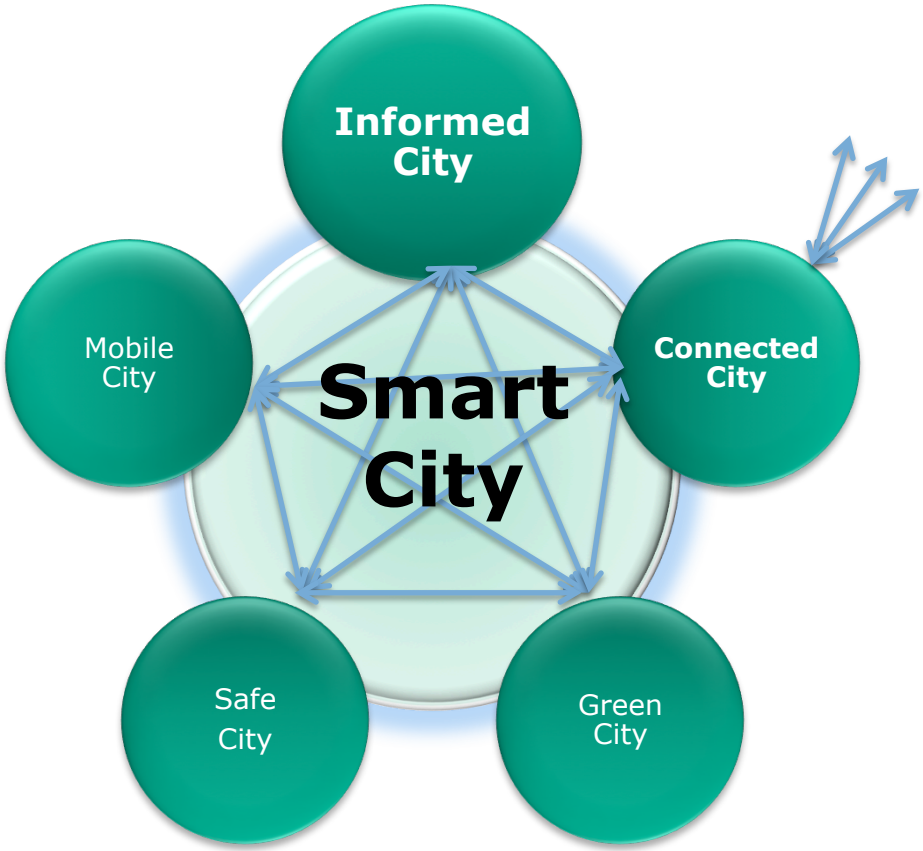
- City as **service provider**

  for citizens, enterprises, institutions, and tourists

- Smartness via

  Always Best Informed and Inter-Connected Urban Actors (Machines, Systems and People)

  Information at any need, at any place, at any device, at any time, at any preference

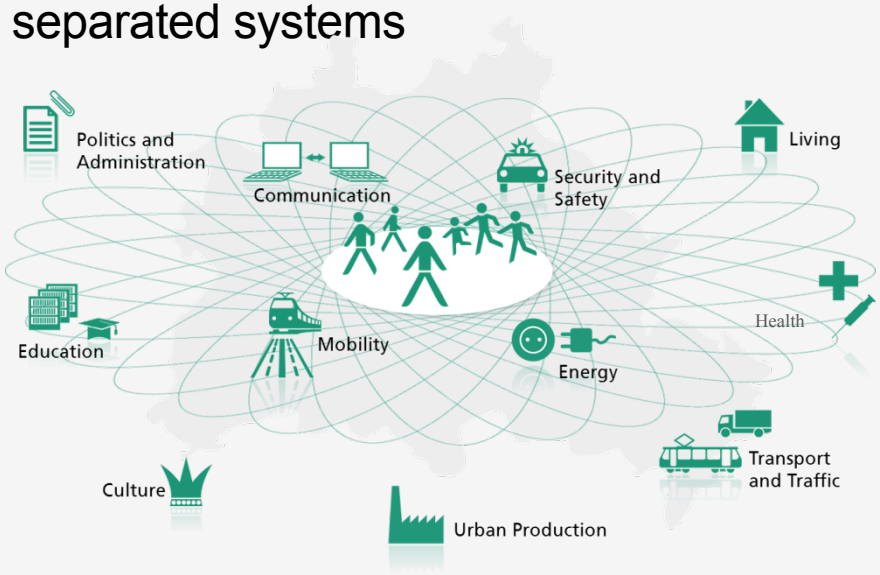


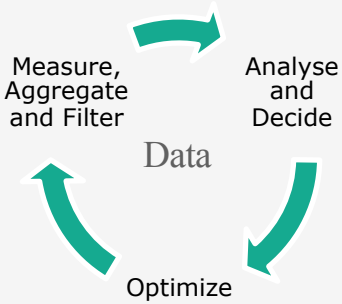
Smart Cities require a common service and network Infrastructure

City is a system of systems

Set of separate technical systems → Integrated systems

Effectivity and efficiency results from optimized integration / federation of separated systems



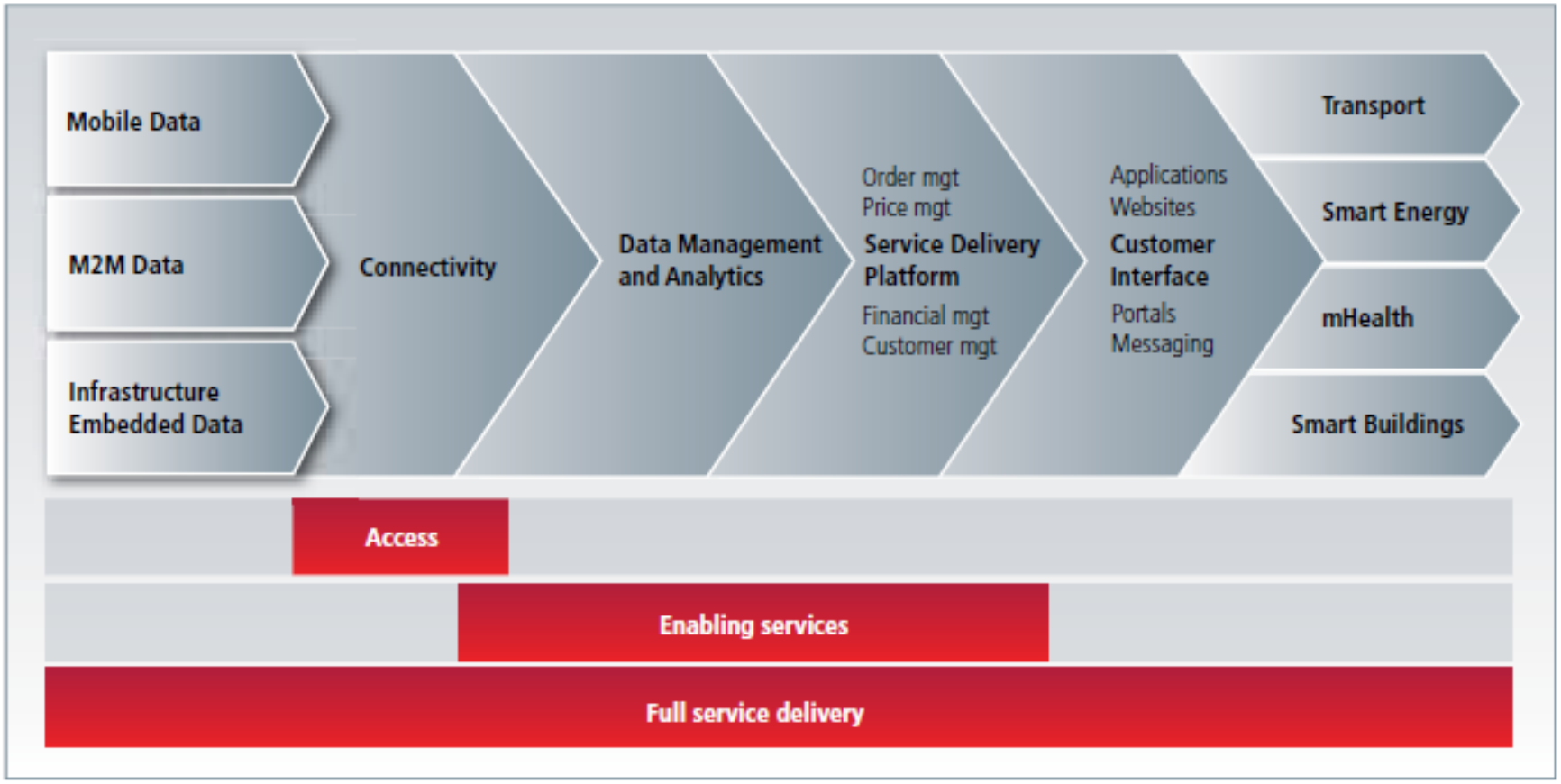


Fraunhofer FOKUS

as Enabler and Integrator for ICT-based Solutions

- FOKUS Smart Cities Portal, Sept. 2011
- acatech Position Paper: „Smart Cities“, Jan. 2011.
- Münchener Kreis Smart Cities Conference in Berlin, July 2010

The Smart Cities Value Chain

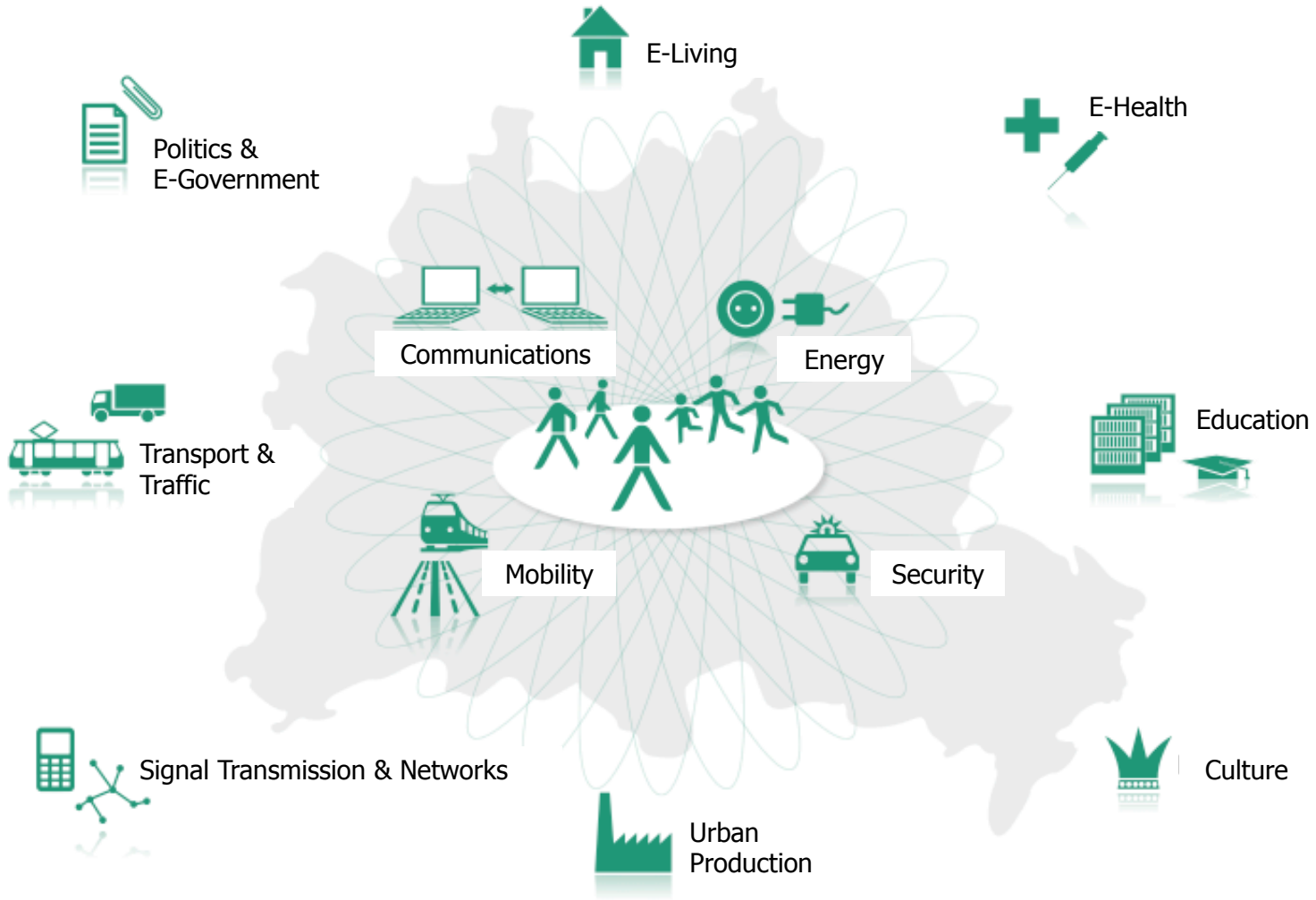


Source: Accenture

Future Internet … to make our cities smart

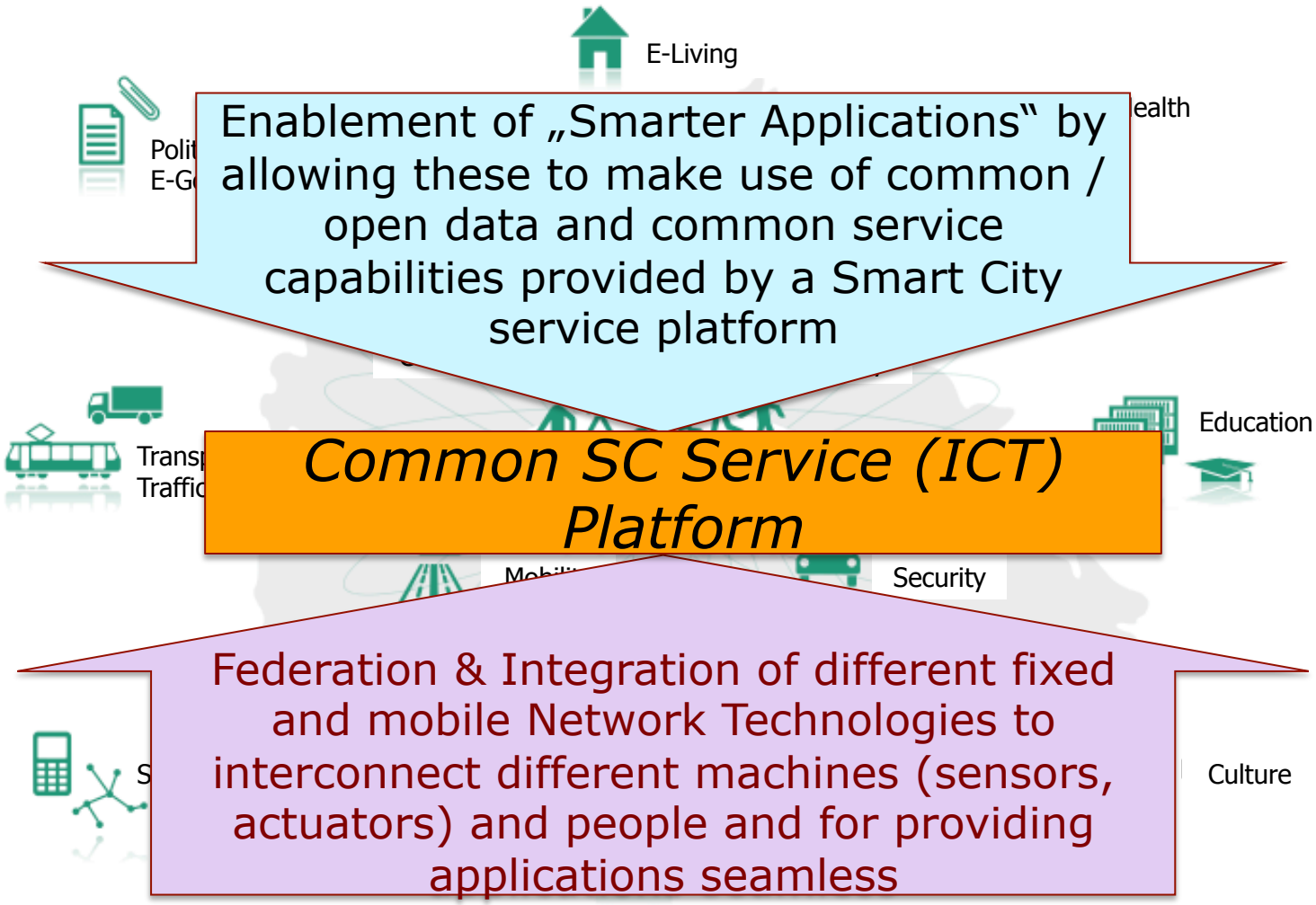
A Smart City is a huge Future Internet Show Case

Fraunhofer SMART CITIES



A Smart City relies on Integration & Federation of Systems

Convergence will lead to a Common SC Service (ICT) Platform



Smart City Enablement Requirements

- Different communication patterns need to be supported for different service domains:
  - session-based human-to-human & M2M communication
  - one-to-one, multicast, broadcast and group communication
  - resource-based pull/push communication between sensors & actuators

- Generic Smart City platform needs to support many service verticals and application scenarios
- Smart Cities require federation between heterogeneous platforms
- Smart City communication platforms acts as a convergence & orchestration point for networks, services and data
- Different principles for OTT & Telecom core networks need to be supported
- A set of common requirements as QoS, security, charging, device & entity management needs to be shared to across many service domains.

Functional Requirements for a Smart City Platform
Communication Enablers & Sectors

	Enabling Services	Business / Collaboration	Leisure time communication	E-Health	Utilities	Facility Management	E-Energy	Logistics
Machine-2-machine	Retrieve data			X	X	X	X	X
	Control devices			X	X	X	X	X
	Send data			X	X	X	X	X
Human-2-human	A/V Call	X	X	X	X	X		
	A/V conference	X		X	X	X		
	Messaging / File transfer	X	X	X	X	X		
	Presence	X	X			X		X
	Location	X	X	X	X	X	X	X
	Address Book	X				X		
Overarching enablers	QoS	X	X	X	X	X		
	Device/ entity mgmt	X	X	X	X	X	X	X
	Security	X	X	X	X	X	X	X

Example Use Case: In-Depth Analysis Facility Management

Facility Management		Video surveillance	Utility Metering	Condition monitoring (temp., humidity, etc.)	Automation (light, air conditioning, etc.)	Alarm system monitoring
Machine-2-machine	Retrieve data	X	X	X	X	X
	Control devices				X	X
	Send data				X	X
Human-2-human	A/V Call	X				X
	A/V conference					X
	Messaging / File transfer		X			
	Presence	X				X
	Location	X	X	X	X	X
	Address Book	X		X		
Overarching enablers	QoS	X		X	X	X
	Device/ entity mgmt	X	X		X	X
	Security	X	X	X	X	X

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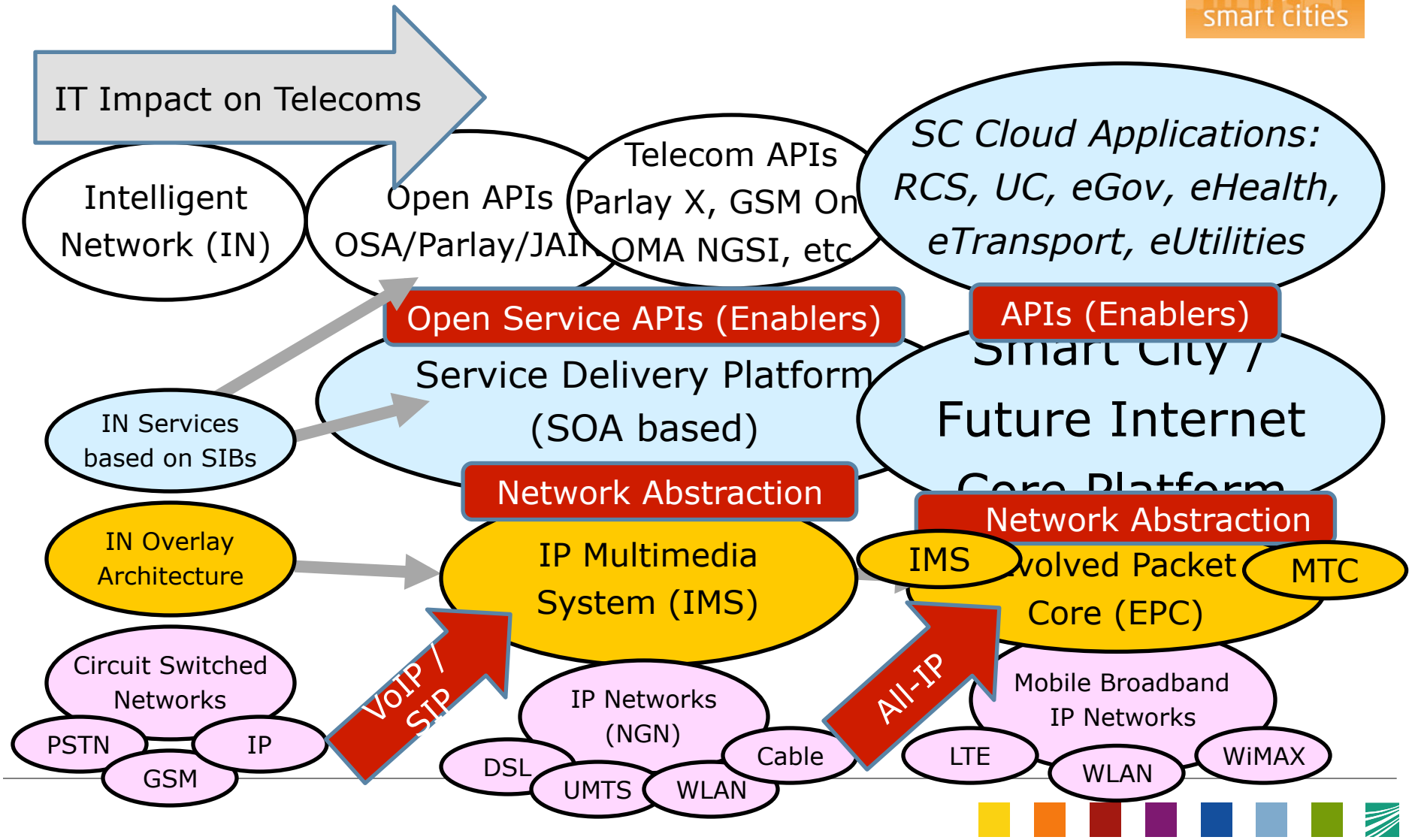
Evolution of Telecommunication Platforms toward Smart Communications



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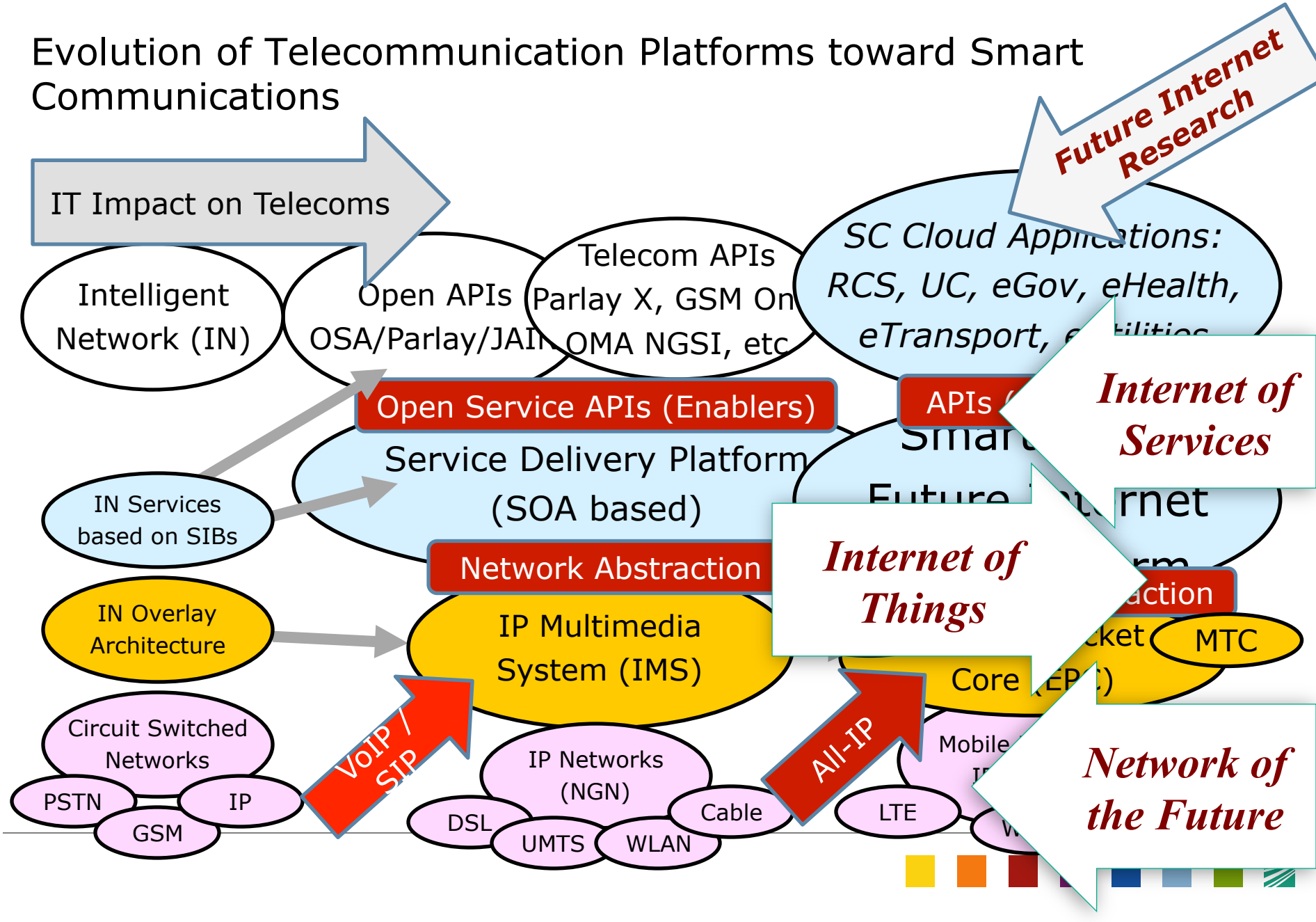
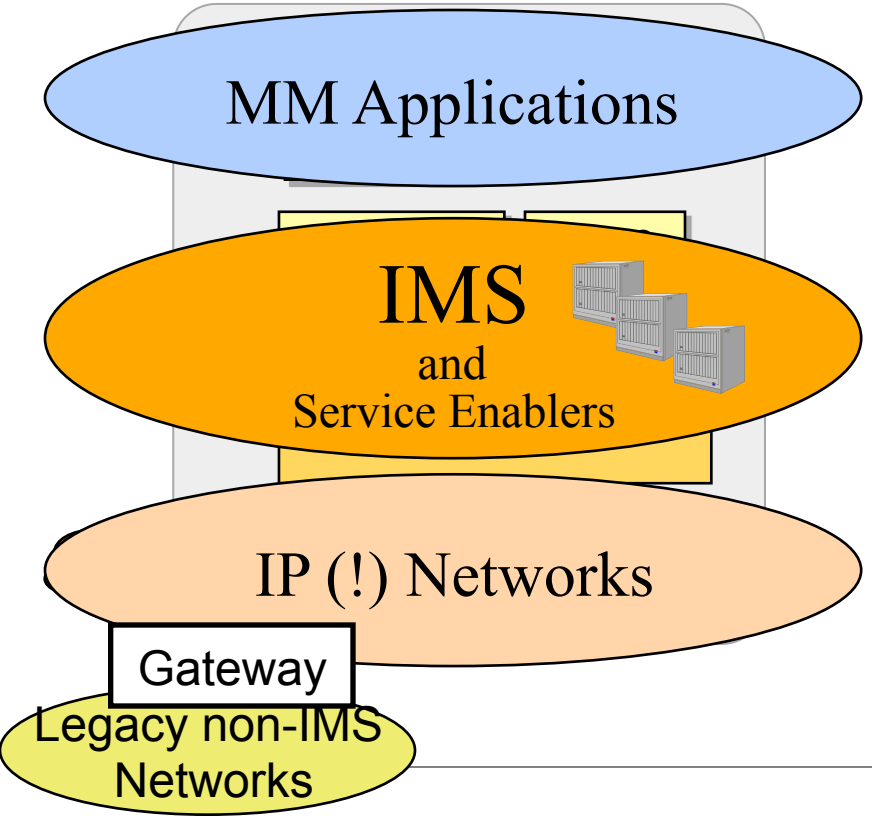


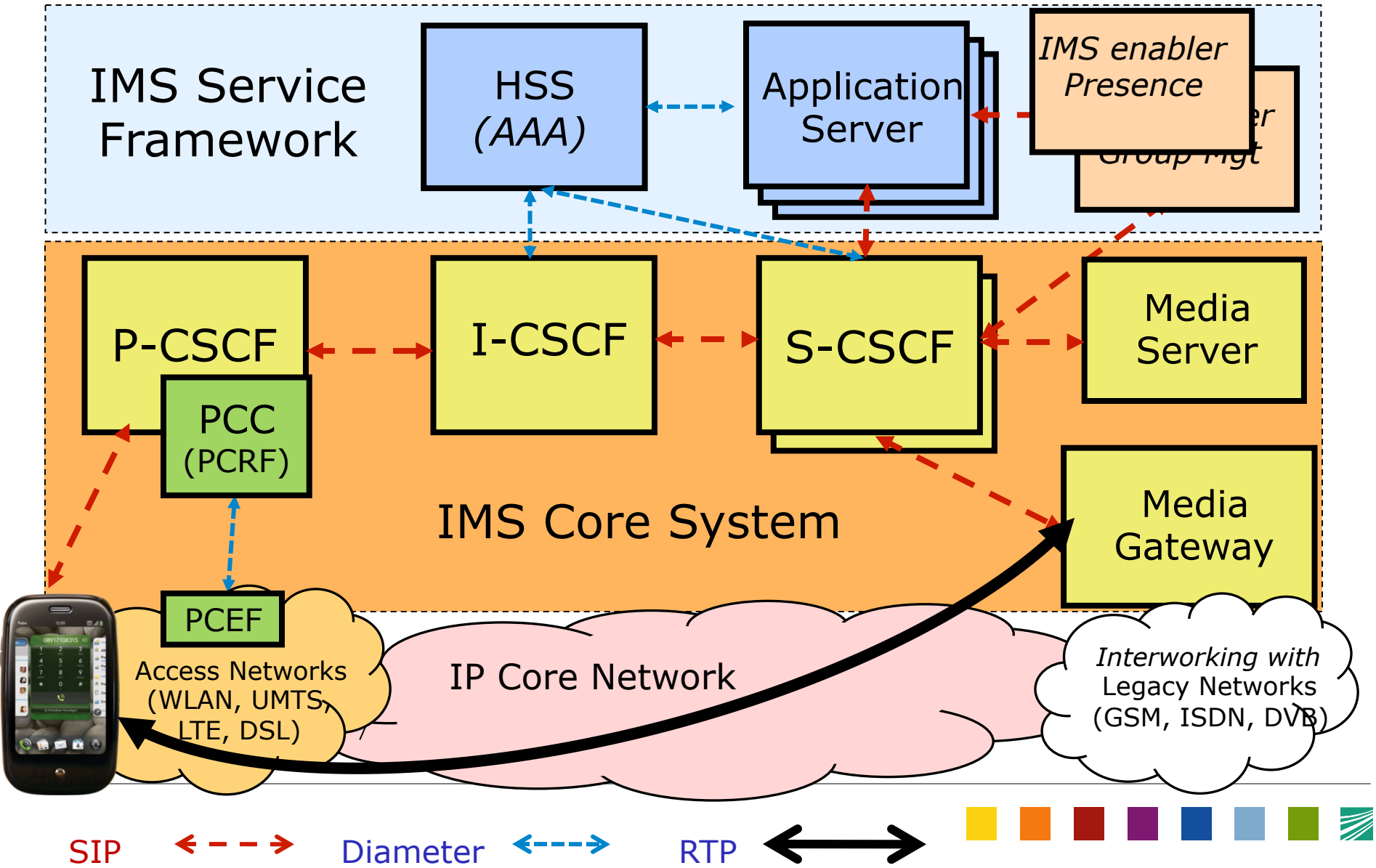
IMS Architecture Principles

- IMS does NOT standardise specific services, but enablers
- BUT supports inherently multimedia over IP, VoIP, IM, presence (SIP)
- IMS enables the flexibility in providing IP-based applications !!



- Horizontal Architecture defining a "docking station" for applications
- Defines service enabler capabilities
- Build on existing IETF and telco SDP standards
- Provides compared to standard internet
- Better security, Service based QoS, flexible charging and single sign on

3GPP IMS Architecture: IMS Core and Application Layer



IMS Road Map

IMS Deployment Roadmap

2005	2006	2007	2008	2009	2010	2011	2012	2013-2014

IMS Reaches Trial Stage
The bulk of HSS, CSCF, BGCF, PSTN gateways, and application sever (mainly voice app server) equipment move from lab testing to field trials, some moving to services by the end of 2007

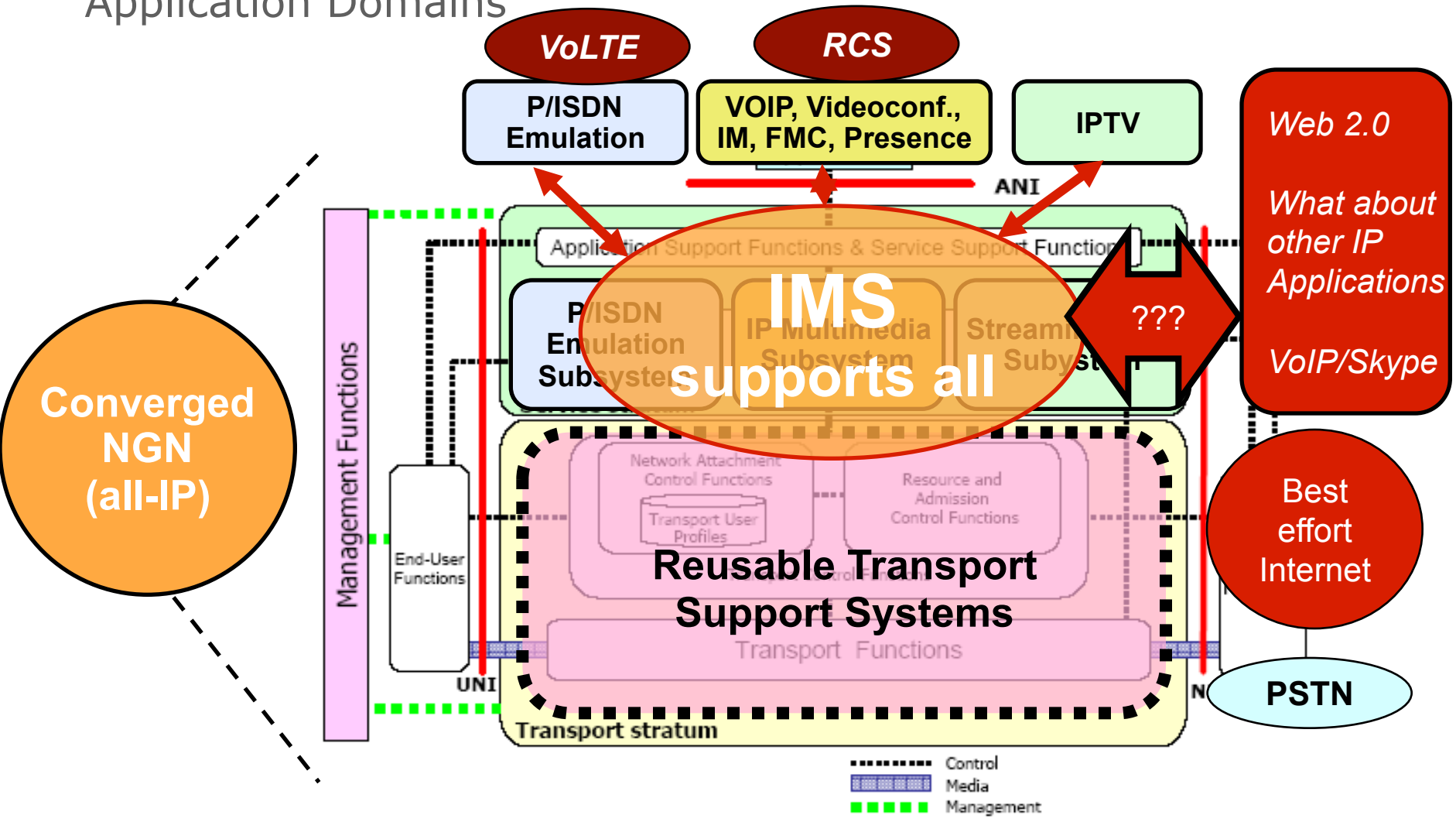
IMS Networks Emerge
IMS deployments consist of an HSS and a CSCF to support fixed-line VoIP services deployed by both large incumbents expanding out of their home turf, and mobile operators jumping into the fixed line business

IMS Deployments Ramp Up
Large fixed-line incumbents continue to migrate their infrastructure from PSTN to TISPAN. Mobile operators begin to deploy IMS with the adoption of RCS in 2010 and the migration of their mobile infrastructure to LTE, with massive IMS deployments expected in 2012.

Source: Infonetics

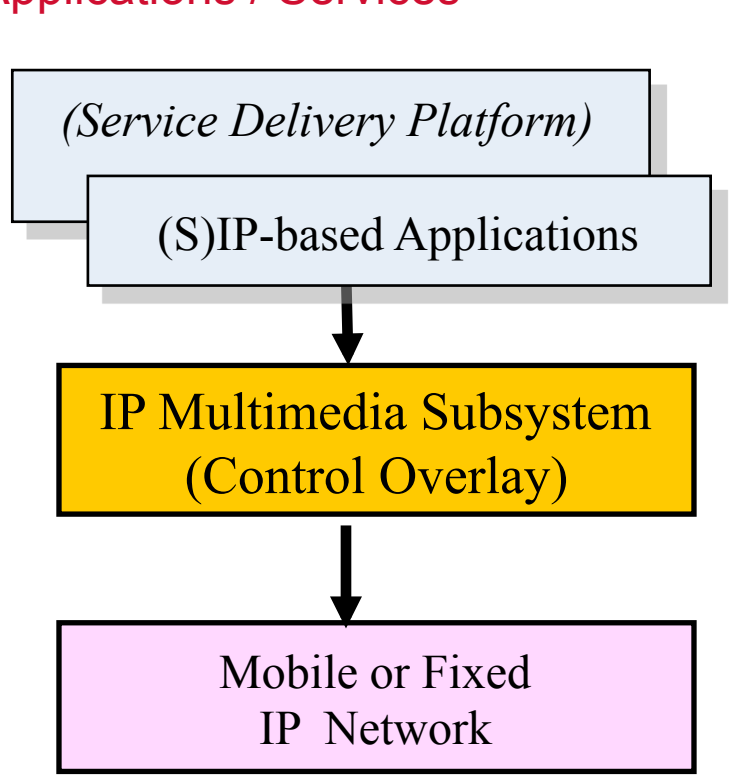
Industry expects IMS deployment to ramp up, driven by PSTN migration from fixed line operators and migration to LTE together with RCS adoption from operators

IMS is the common control platform within the NGN for many Application Domains

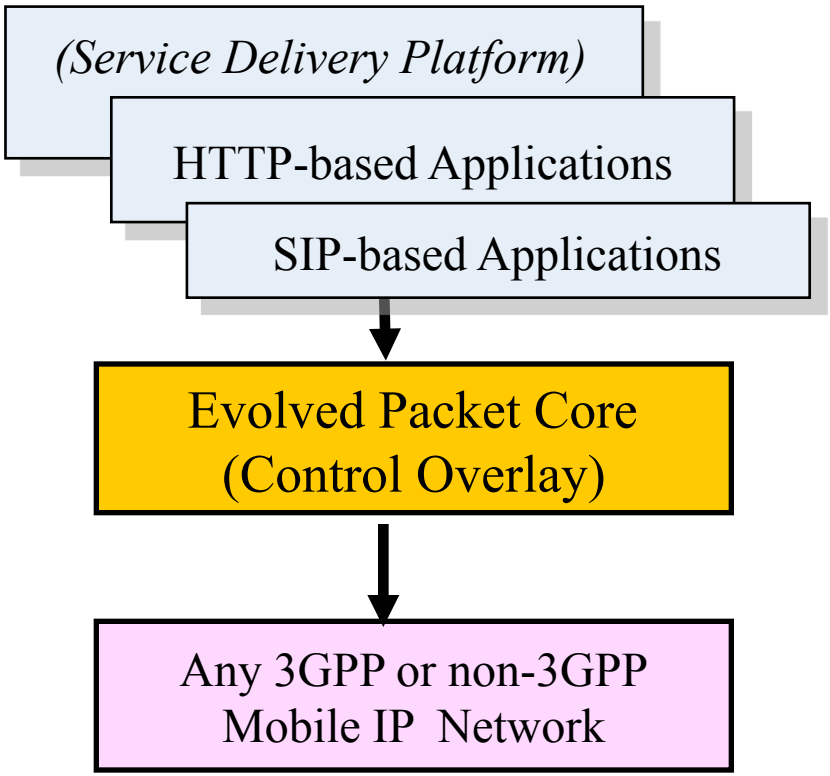


IMS Concept Evolution toward EPC

Main Idea: Common Control Overlay Architecture abstracts from underlying IP network technology and provides common platform capabilities for any IP-based Applications / Services

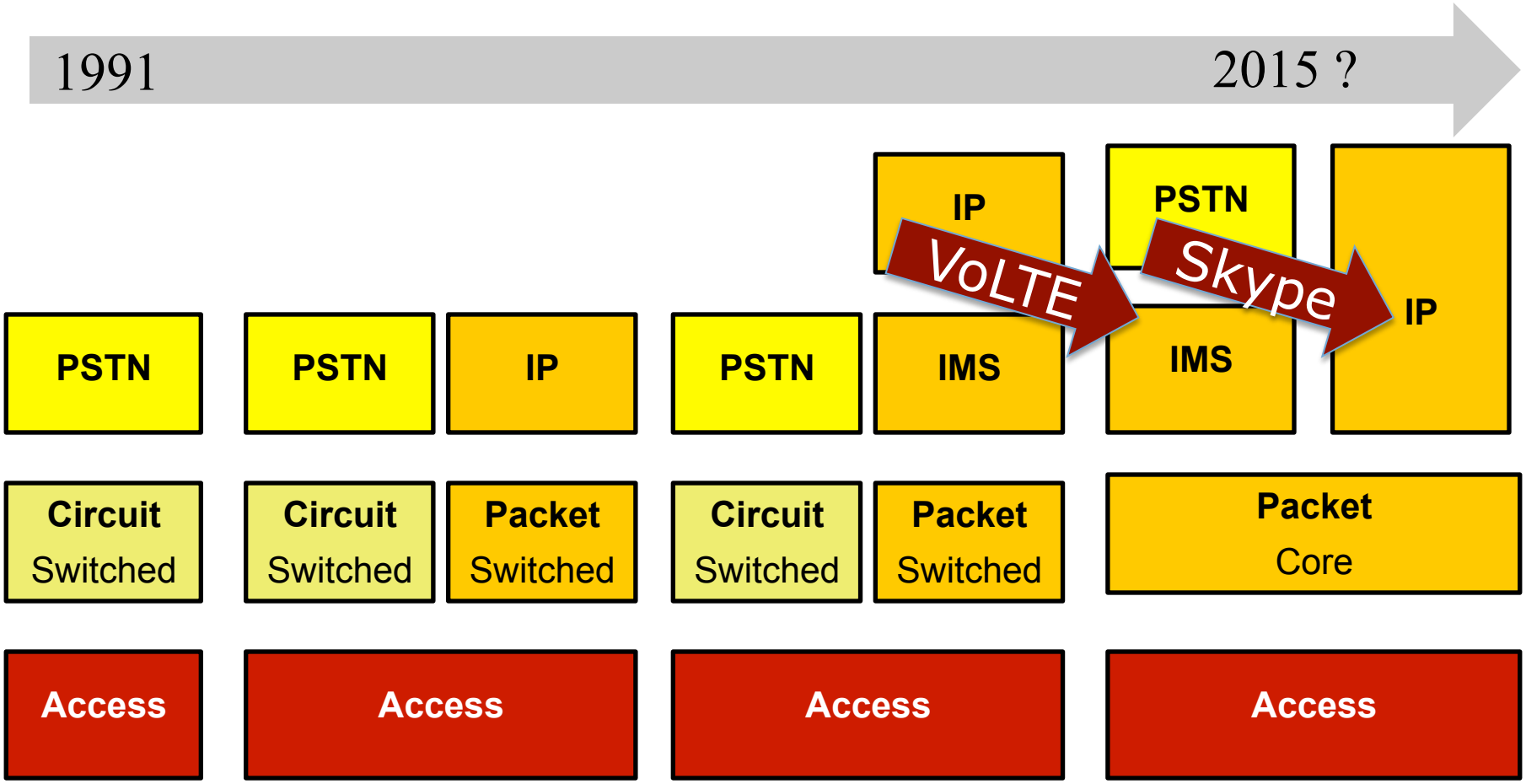


Packet Switched Telco Domain (NGN)

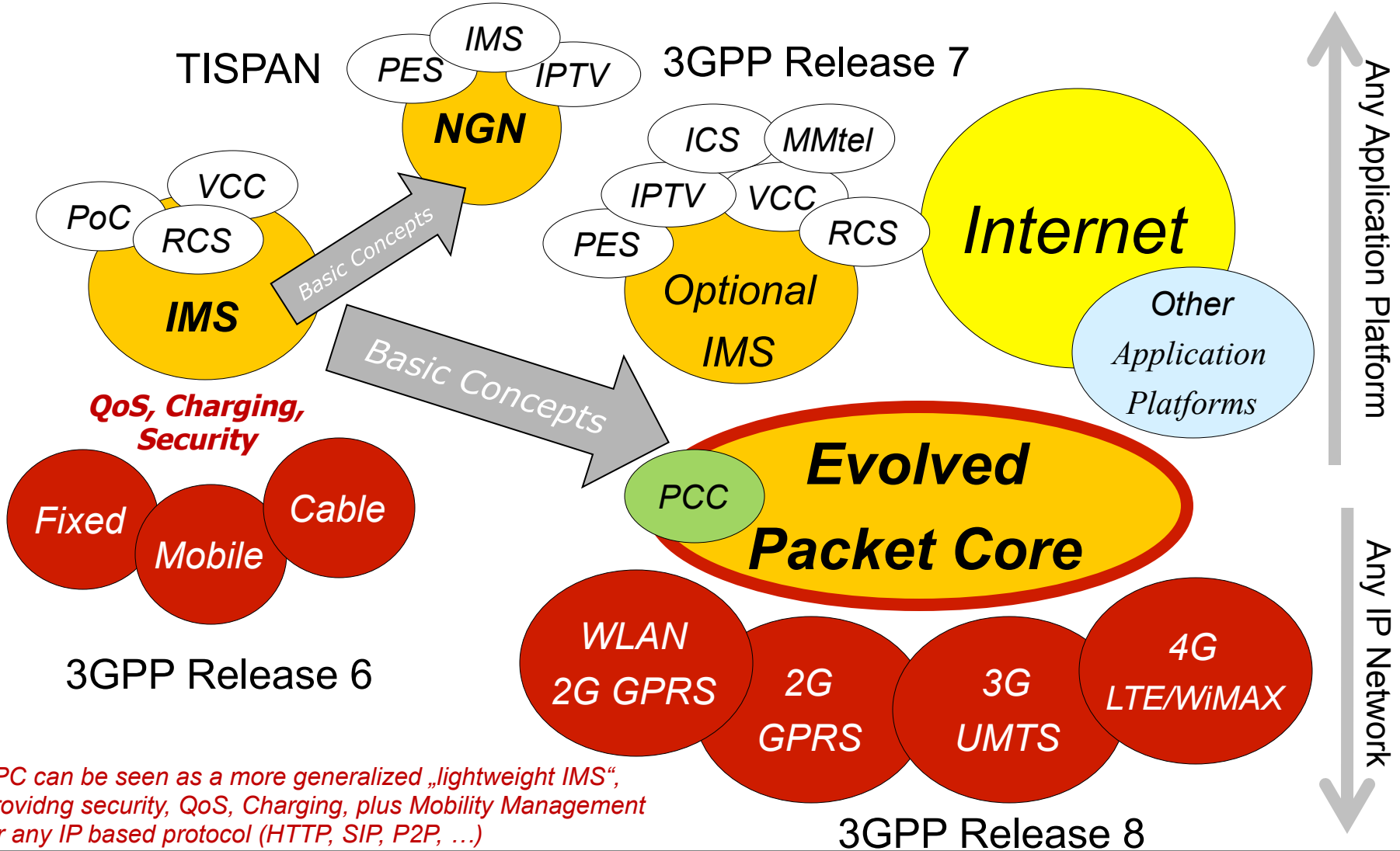


Mobile Packet Switched Telco Domain

Mobile Network Architecture Evolution



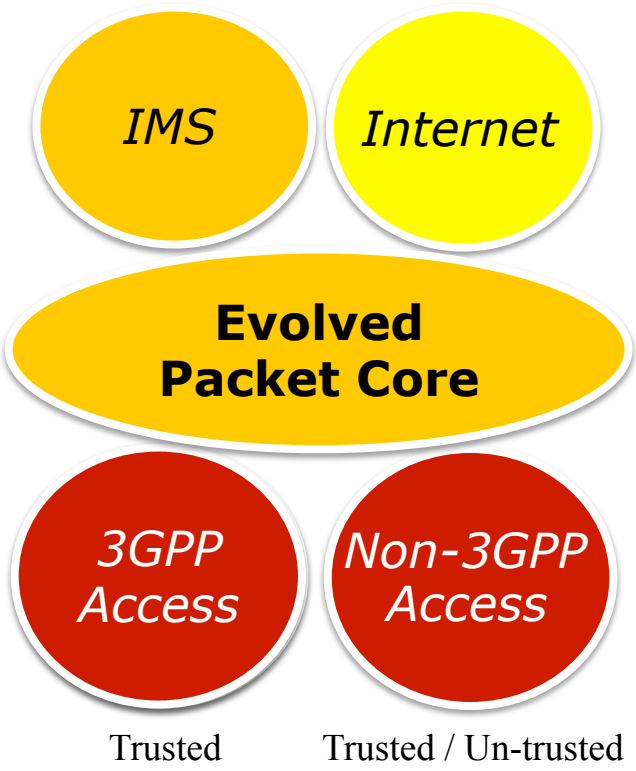
Concept Reuse: From IMS for NGN to EPC for all-IP



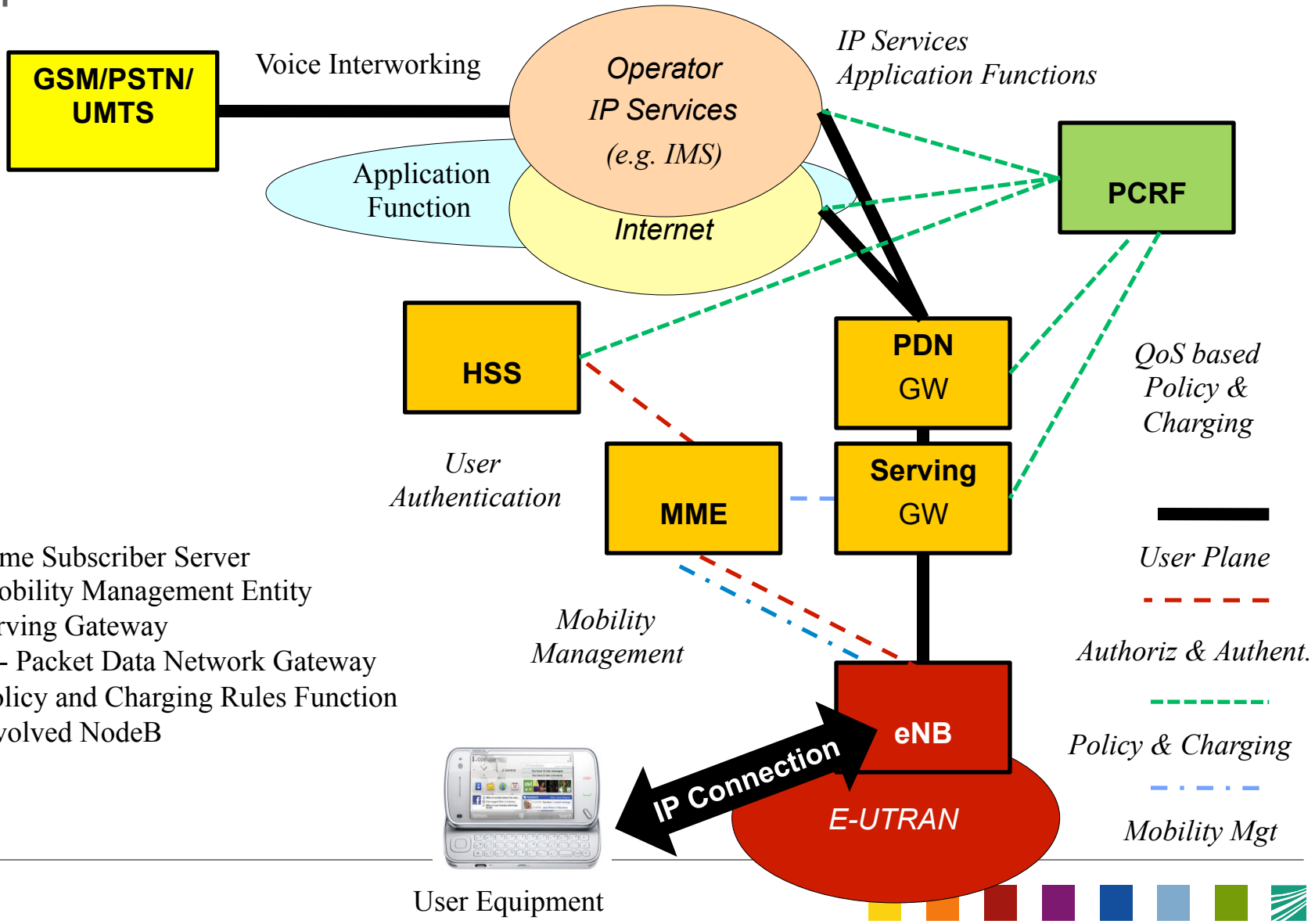
EPC can be seen as a more generalized „lightweight IMS“, Providng security, QoS, Charging, plus Mobility Management for any IP based protocol (HTTP, SIP, P2P, …)

3GPP Evolved Packet Core (EPC)

- The EPC is a multi-access core network architecture based on the Internet Protocol (IP) common for:
  - 3GPP access networks (LTE-A, LTE, HSPA+, UMTS, GPRS)
  - Non-3GPP access networks
    - Trusted networks (cdma2000, WiMAX)
    - Un-trusted networks (WiFi)
- EPC provides **connectivity** to IP service domains
  - IMS
  - Internet or other (M2M, Cloud, P2P etc.)
- The enhanced IP connectivity features include:
  - Authentication and authorization
  - Secure communication
  - Transparent mobility management
  - Connectivity management support
  - Policy based QoS and charging

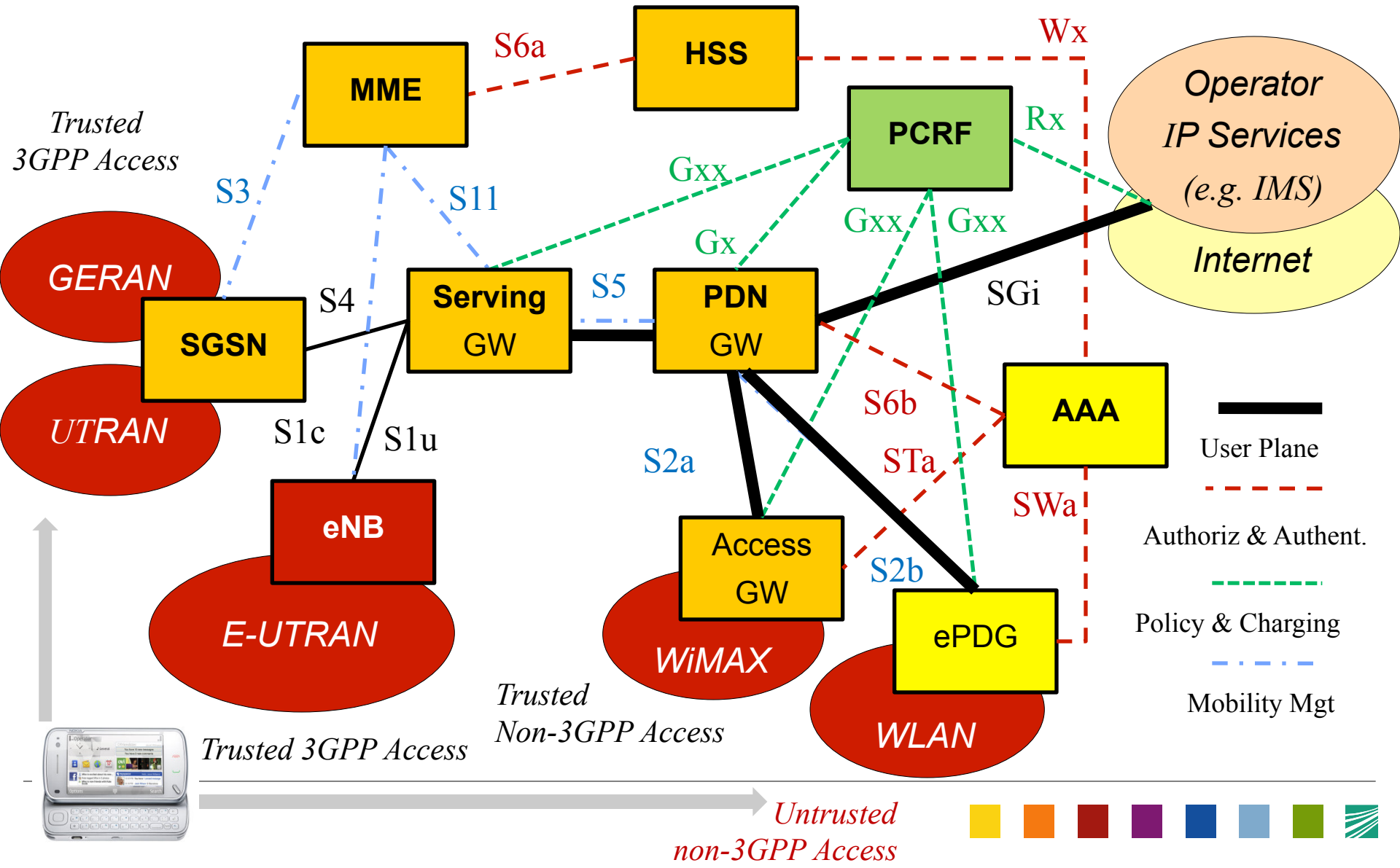


Simplified EPC Architecture



HSS - Home Subscriber Server
MME - Mobility Management Entity
SGW - Serving Gateway
PDN GW - Packet Data Network Gateway
PCRF - Policy and Charging Rules Function
eNB – Evolved NodeB

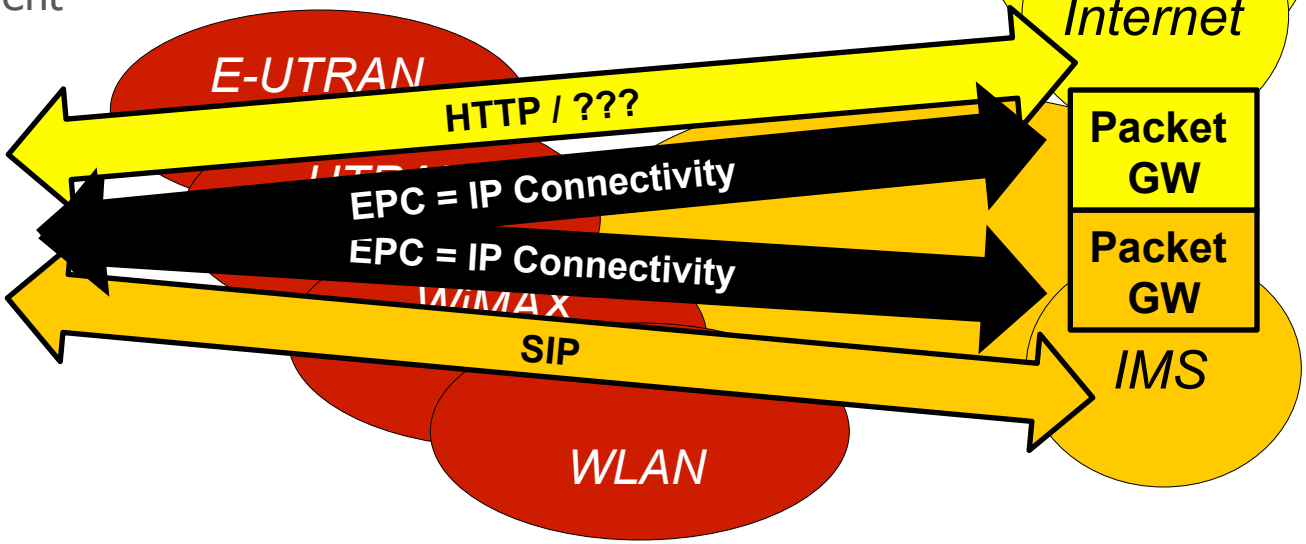
Full EPC Architecture



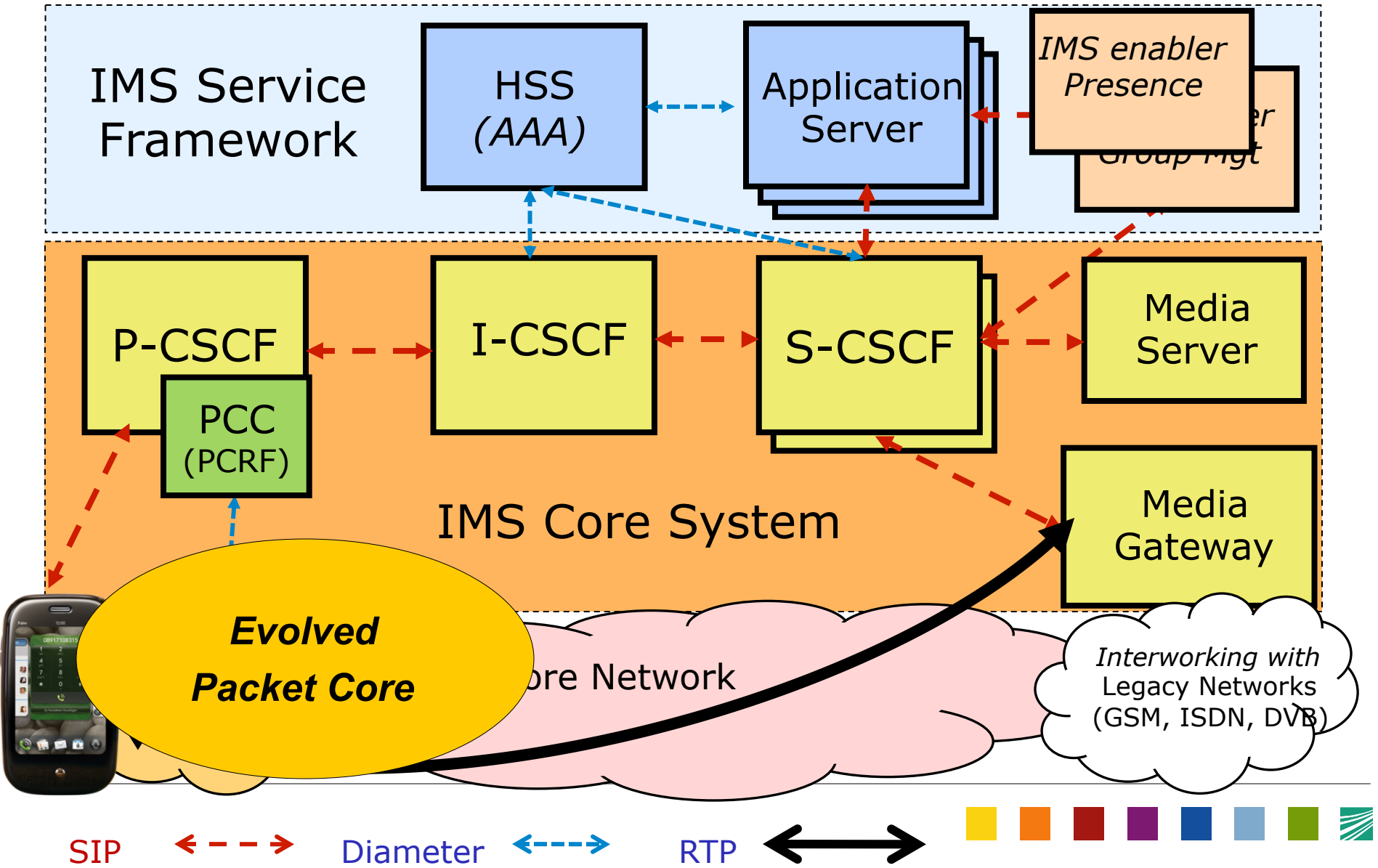
EPC Capabilities = Seamless IP Connectivity (= ABC)

- The EPC allows multiple access networks to be connected in a controlled way (secure, QoS, seamless) to either
  - the operator IP cloud (e.g. IMS or any intranet)
  - the internet or others
- Note that the EPC provides controlled IP connectivity, in regard to
  - User authentication and authorization
  - Quality of Service and related Charging
  - Mobility Management

User Equipment
may be connected to several IP service domains in parallel



3GPP IMS Architecture: IMS Core and Application Layer



M2M Segments

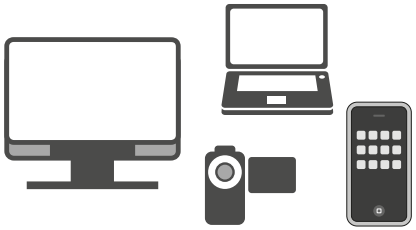
Automotive

Security

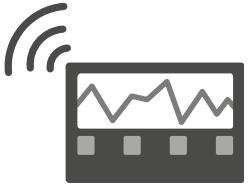
Tracking & Tracing

Payment

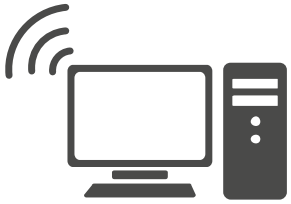
Healthcare



Consumer Electronics



Metering



Remote Maintenance and Control

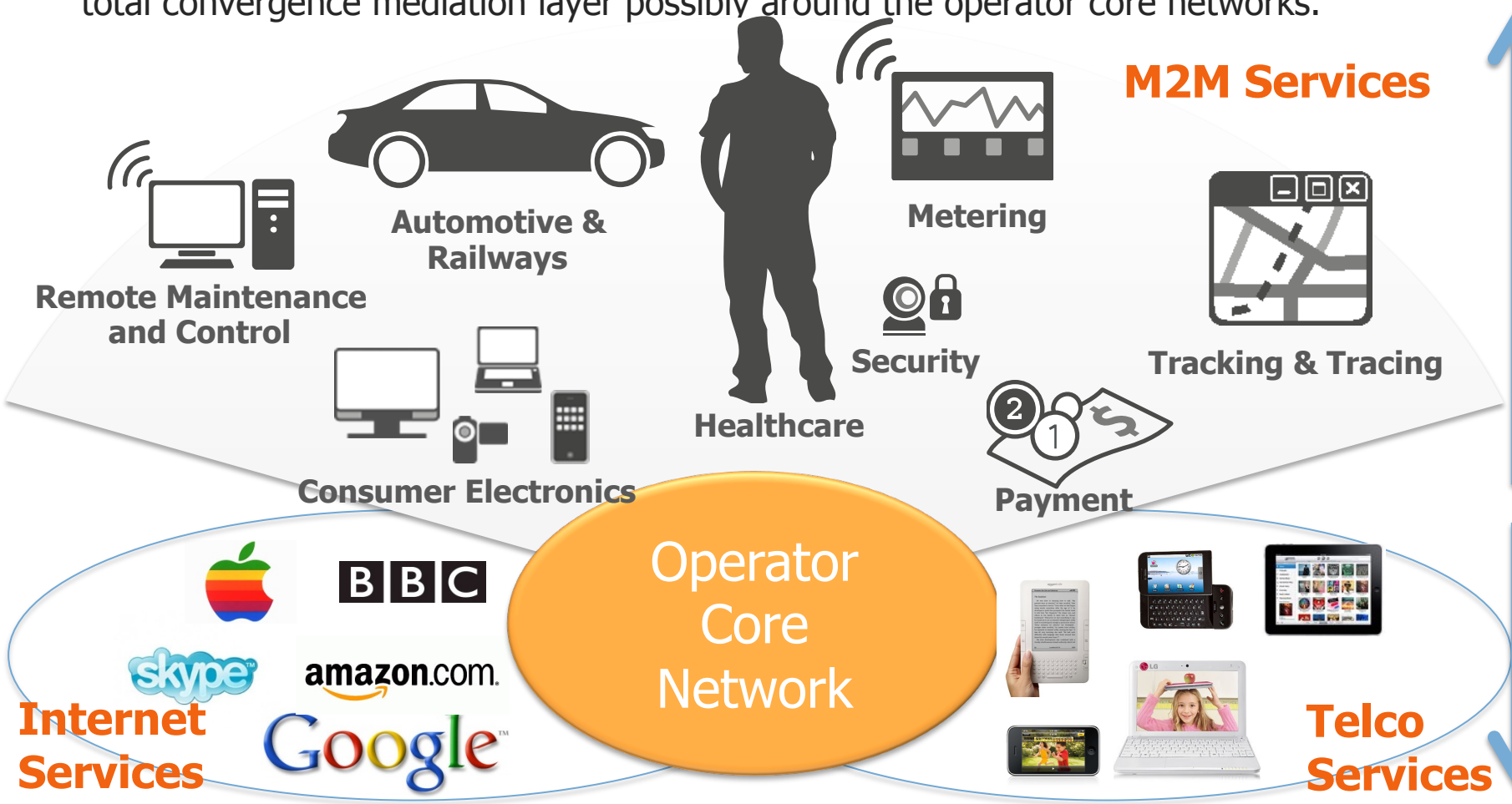
M2M – Fraunhofer FOKUS Positioning

MACHINE	-- TO --	MACHINE

Communication terminal independent of human interaction
- Acting automatically or on remote request
- Managed remotely
- Mobile and fixed terminals
- Monitoring device (sensor)
- Actuator device (e.g. switch)
- Associated order of magnitude: trillion = 10^{12}
	Network facilitating the M2M communication
	- Access & core network, backhaul, application server
	- Enabling connectivity (AAA & security, session manage-ment, QoS, charging, mobility management)
	- Supporting the data traffic of terminals (e.g. for direct and infrastructure communication)
	- Supporting the signaling of terminals
		Core network (or terminal) automating the services
		- Sensor data aggregation, processing and presentation
		- Data caching and interpretation
		- Real-time communication
		- Automatic decision, processing, control followed by communication with other machines through:
		  - Instructions
		  - Notifications

M2M – Total Convergence of Communication

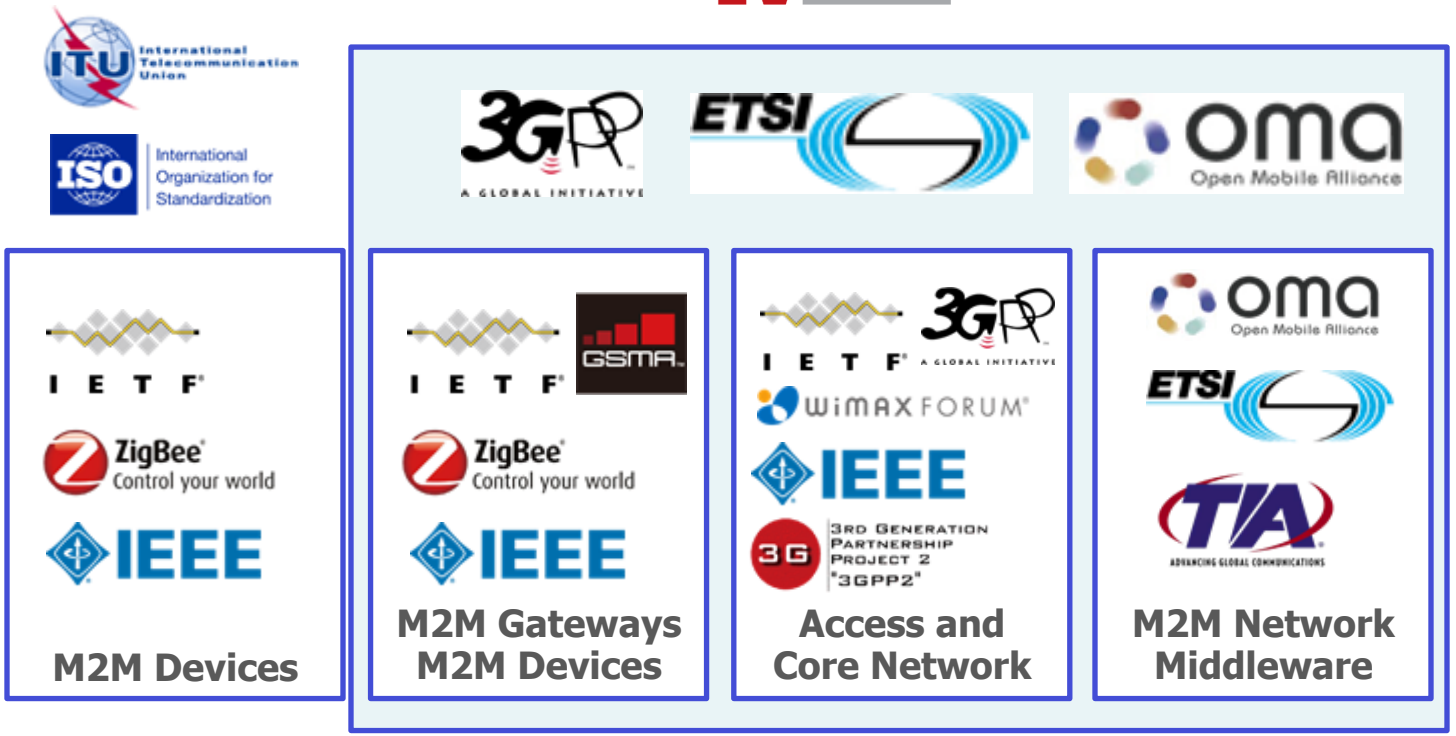
The telecommunication industry and other business branches are currently merging into a total convergence mediation layer possibly around the operator core networks.



MTC Standard Landscape

- MTC standards address in general only one part of the M2M communication
- ETSI, OMA & 3GPP standards together develop a complete network oriented M2M communication architecture
- oneM2M is about to take off

NEW: oneM2M



ETSI TC M2M Introduction

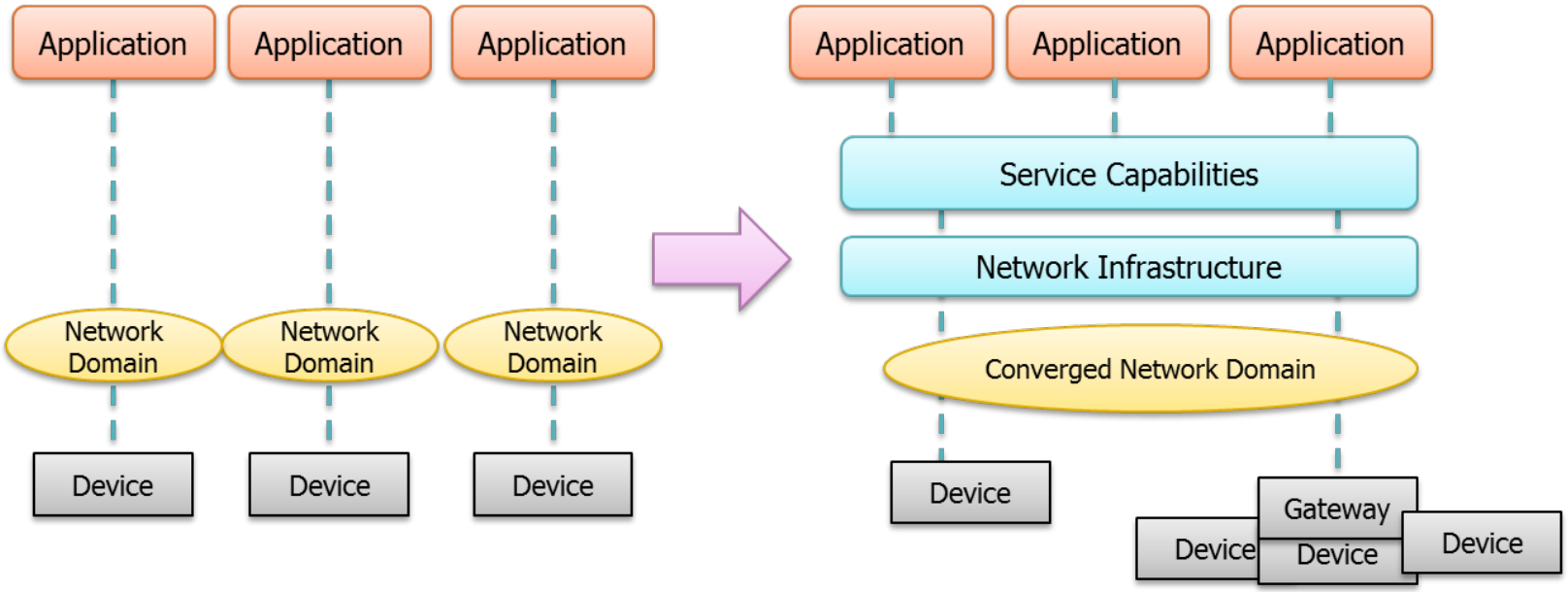
Standard need	Benefit	SDOs
Access network optimization	Reduce connectivity costs, match ARPU targets	3GPP, 3GPP2, etc.
Horizontal service platforms and related API	Faster development and deployment of applications	oneM2M member SDOs, etc.
Device lifecycle management	Cost efficient software and application management	BBF, OMA, ETSI, UPnP etc.
Data models (vertical specific)	Application level interoprability	ZigBee, DLMS, Continua etc
Device & module	Certification and interoperability, reduce costs	GSMA, etc.

ETSI scope

Source: ETSI TC M2M Tutorial Draft

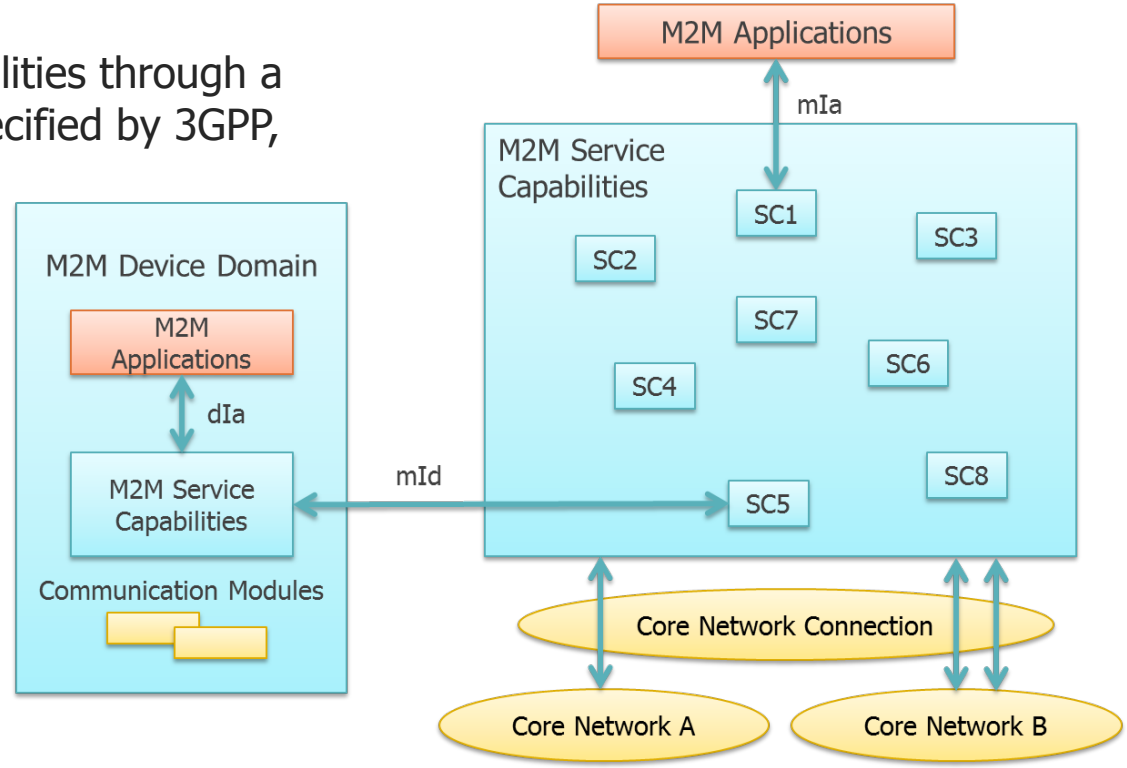
M2M Services & Applications

- Today
  - SMS based.
  - Vertical isolated systems.
  - INTRAnet of Things
- Future
  - Global horizontal approach.
  - INTERnet of Things.



Functional Architecture Framework

- **Service Capabilities (SC):** provide functions that are shared between different M2M applications
  - Can use core network capabilities through a set of exposed interfaces specified by 3GPP, TISPAN, 3GPP2
  - SC can involve other SCs (to be further studied)
  - SC can interface with CNs
- Three interfaces are defined:
  - dIa, mIa, mId



M2M Functional Architecture Framework

- mIa allows an application to access the M2M Service Capabilities in the Networks and Applications Domain
- mId allows an M2M Device or M2M Gateway to communicate with the M2M Service Capabilities in the Network and Applications Domain. mId uses core network connectivity functions as an underlying layer
- dIa allows an application residing in an M2M Device to access the different M2M Service Capabilities in the same M2M Device or in an M2M Gateway; and allows an application residing in an M2M Gateway to access the different M2M Service Capabilities in the same M2M Gateway

ETSI M2M Service Capabilities

- A set of standardized Service Capabilities (SC) is defined in M2M Core and M2M Device/Gateway, to provide functions that are to be shared by different M2M Applications

- M2M Service Capabilities:
  - provide recommendations of logical grouping of functions
  - expose functionalities through a set of open interfaces
  - use Core Network functionalities
  - simplified, optimized application development and deployment through hiding of network specificities from applications
  - can interface to one or several Core Networks

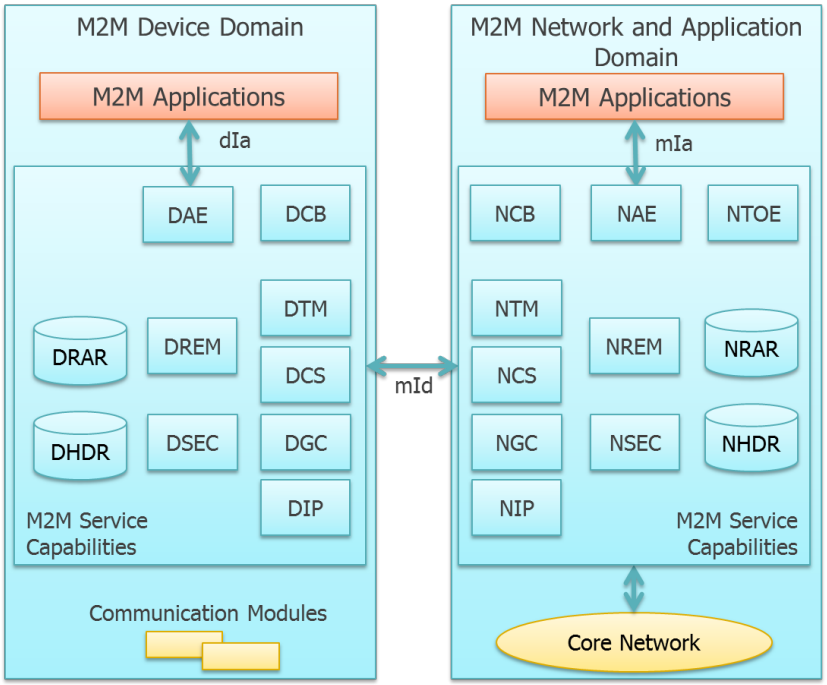
- **M2M SCs provide recommendations of logical grouping of functions**
- **M2M SCs do not mandate an implementation**

Not all M2M SCs are foreseen to be instantiated in the different parts of the system.

Only external interfaces are mandated and are required for compliance.

Service Capabilities

1. Application Enablement (xAE);
2. Generic Communication (xGC);
3. Reachability, Addressing and Repository (xRAR);
4. Communication Selection (xCS);
5. Remote Entity Management (xREM);
6. SECurity (xSEC);
7. History and Data Retention (xHDR);
8. Transaction Management (xTM);
9. Telco Operator Exposure (xTOE);
10. Interworking Proxy (xIP).
11. Compensation Broker (xCB);



where x stands for: N for Network, G for Gateway, D for Device

oneM2M – New Global Organization for M2M Standardisation

- oneM2M will develop technical specifications
  - for a common M2M Service Layer
  - to ensure the global functionality of M2M
- Allow a range of industries to take advantage of M2M technology
- Connect the myriad of devices in the field with M2M application servers worldwide
- Attract and actively involve organizations from M2M-related business domains such as: telematics and intelligent transportation, healthcare, utilities, industrial automation, smart homes, etc.

www.onem2m.org

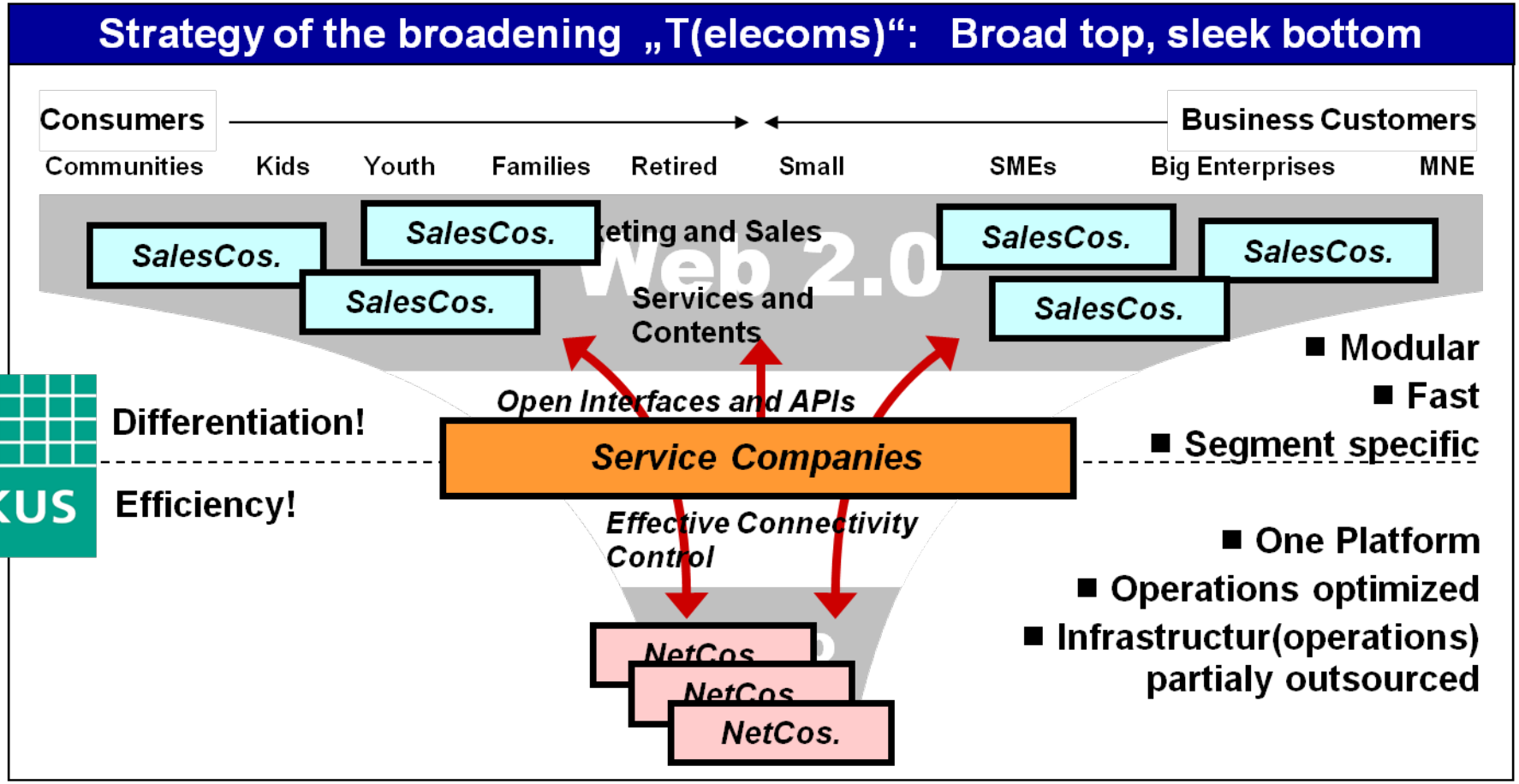
The SDOs Behind oneM2M

Founding SDOs (Partner 1 type)

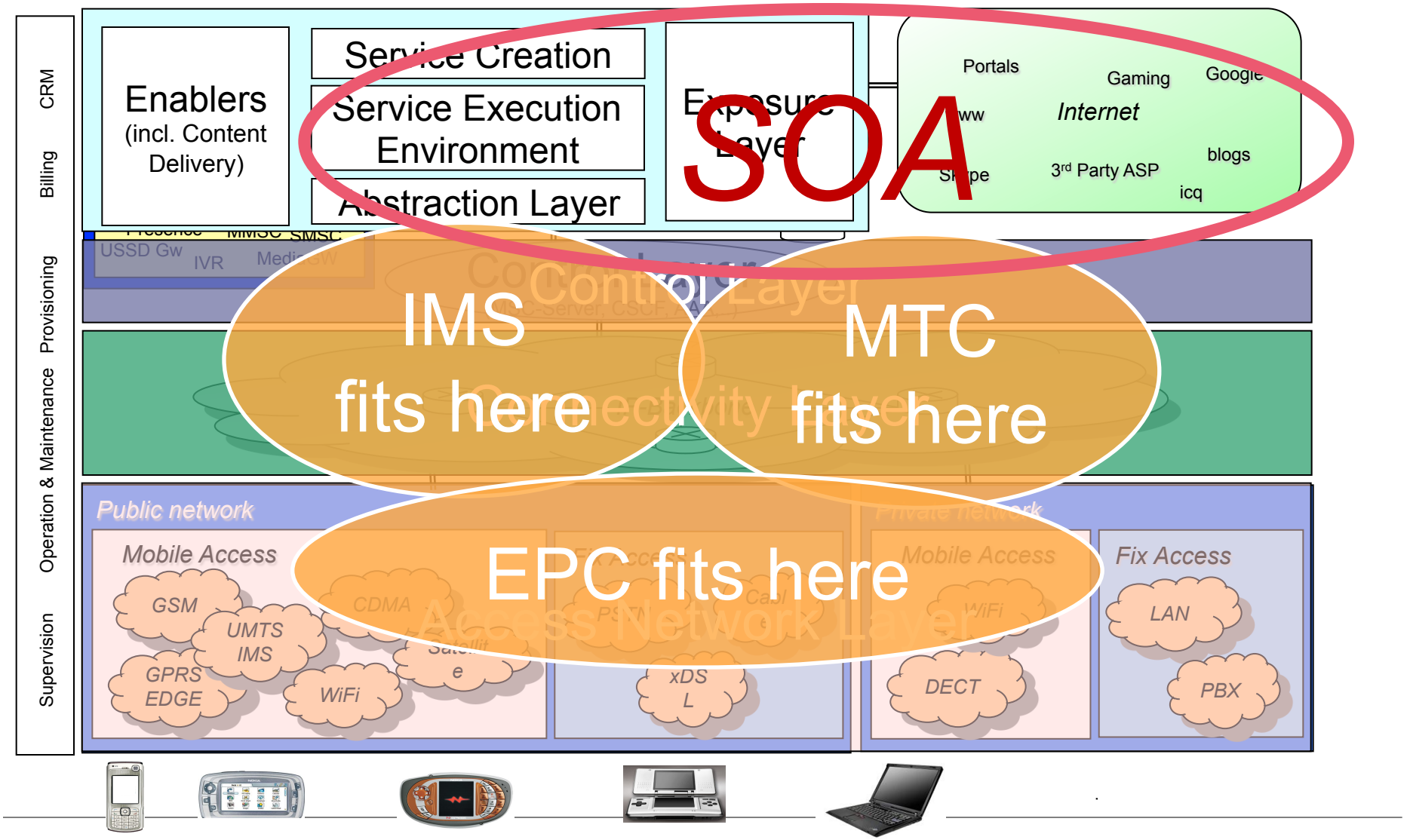
Joined since the foundation (Partner 2 type)

ARIB: Association of Radio Industries and Businesses
TTC: Telecommunication Technology Committee of Japan
ATIS: Alliance for Telecommunications Industry Solutions
TIA: Telecommunications Industry Association of the USA
CCSA: China Communications Standards Association
ETSI: European Telecommunications Standards Institute
TTA: Telecommunications Technology Association of Korea
OMA: Open Mobile Alliance

Increasing Service Diversity requires Abstractions & Partnering



IMS, MTC and EPC Positioning within an SDP Environment



Towards APIs / Enablers in the Smart City (SC) Context …

SC Application Providers and Services

(Universal Coms, eLogistics, eUtilities, eEnergy, eHealth, eGov...)

- Re-use what is publicly available
- Create recognised user interfaces

Import of SC APIs

Export Of SC Enablers

- Resell available capabilities
- Enable value added services

Service Brokering

SC Enablers provided by SC Core Platform

(RCS, information access, QoS, Charging, Identity Mgt., Security, M2M)

Network Abstraction

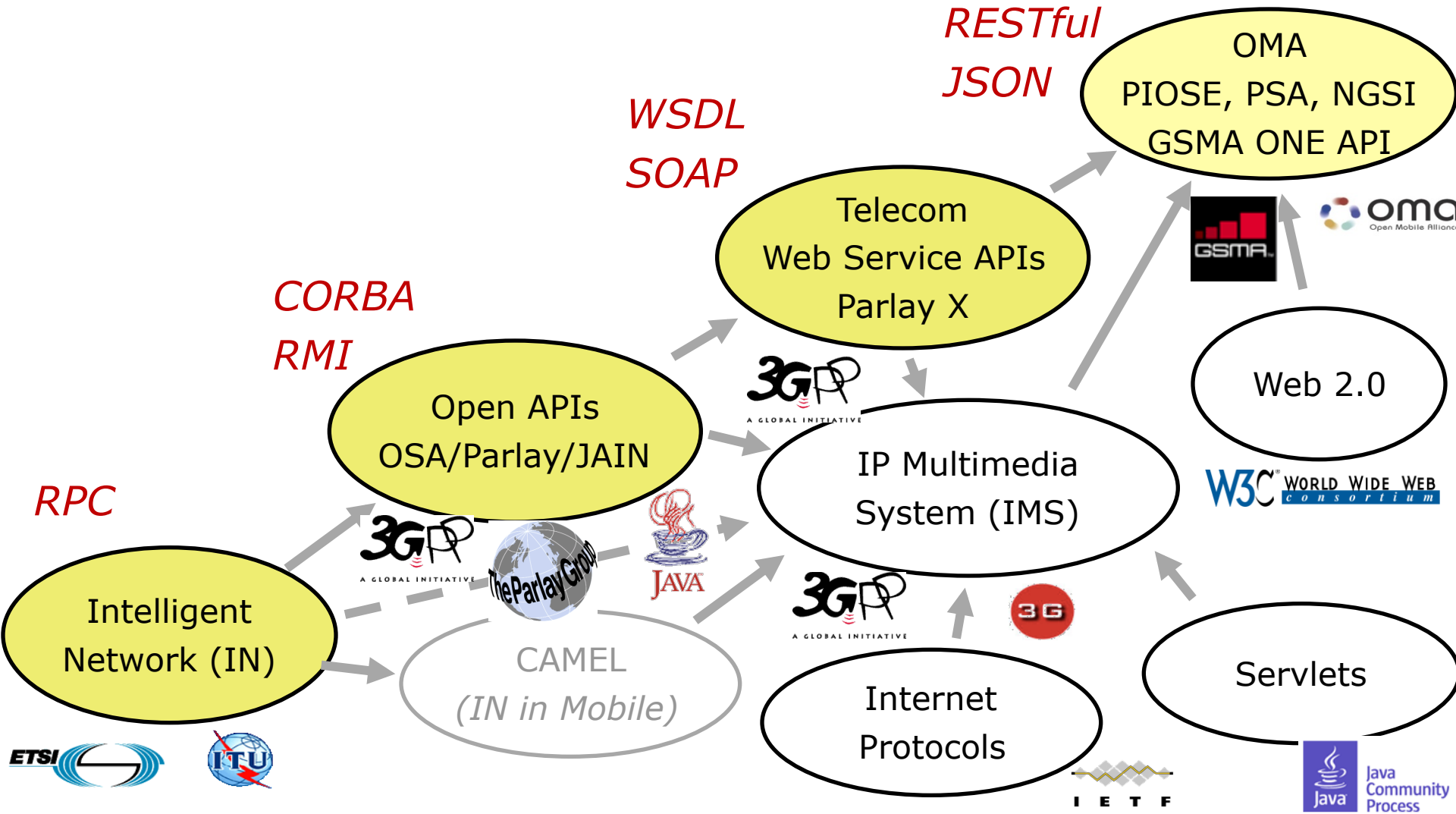
IMS + MTC + Evolved Packet Core

Sensor Networks

Mobile IP Network

Fixed IP Network

Evolution of Network API Concepts in Telecommunications



Agenda

- Smart Cities as Future Internet Show Case
- Smart City communication infrastructures requirements
- *The Role of IP Multimedia Subsystem, Machine Type Communication, Evolved Packet Core and related Open APIs within emerging Smart City SDPs*
- FOKUS Toolkits and practical examples
- Summary
- *Q&A*

Fraunhofer FOKUS

Smart City ICT

Tools & Testbeds

Smart Communications Playground

Fraunhofer FOKUS

osims

Fraunhofer FOKUS

open mtc

Fraunhofer FOKUS

open epc

Fraunhofer FOKUS

FUSECO playground

FUTURE SEAMLESS COMMUNICATION

www.fokus.fraunhofer.de/go/ngni

Research Agenda of Fraunhofer:

Smart City Vision

Environment

Cities that produce **almost no more CO_2-Emissions**.

Energy

Cities that are greatly **energy-efficient**.

Resources

Cities that are profoundly **resource-efficient**.

Quality of life

Cities that provide the **best life quality** for all residents.

Vision
»Morgenstadt«
Fraunhofer

Society

Cities that **represent a post-fossil society.**

Smart City

Cities that **intelligently interlink** all its potentials and city systems.

Climate Change

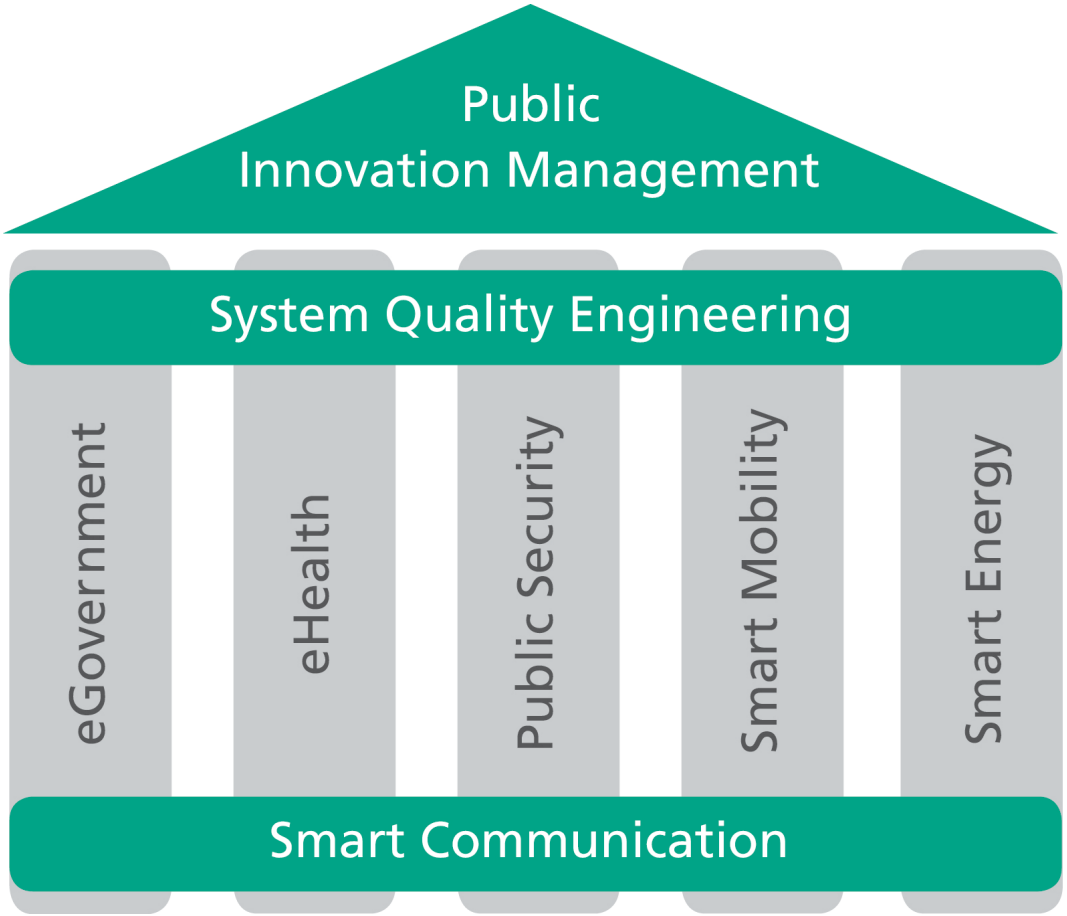
Cities that can easily adapt to the **effects of climate change**.

E-Mobility

Cities that offer a **medium** for the **change towards electromobility**.

Quelle: www.pig.dk

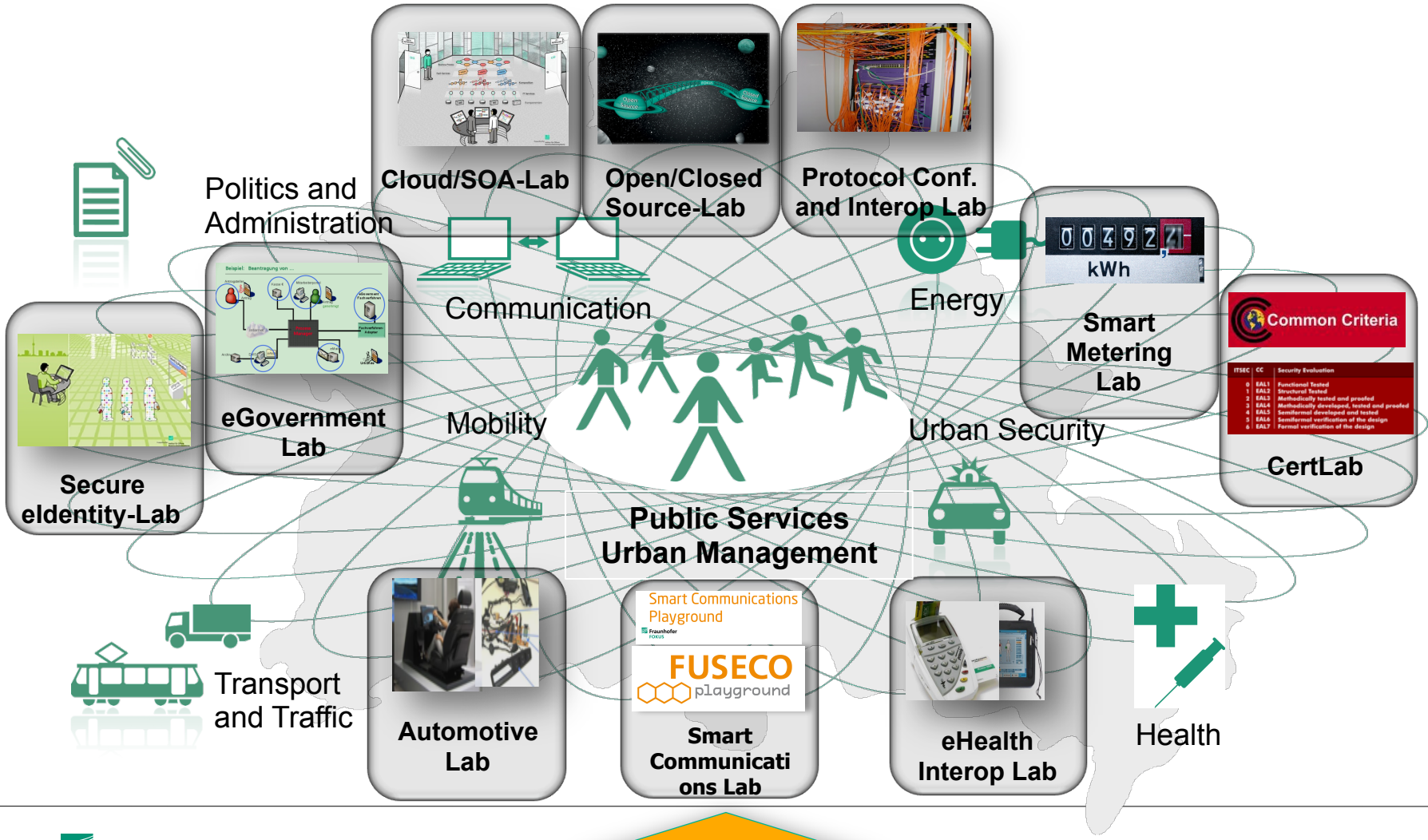
Fraunhofer FOKUS – Activity Domains



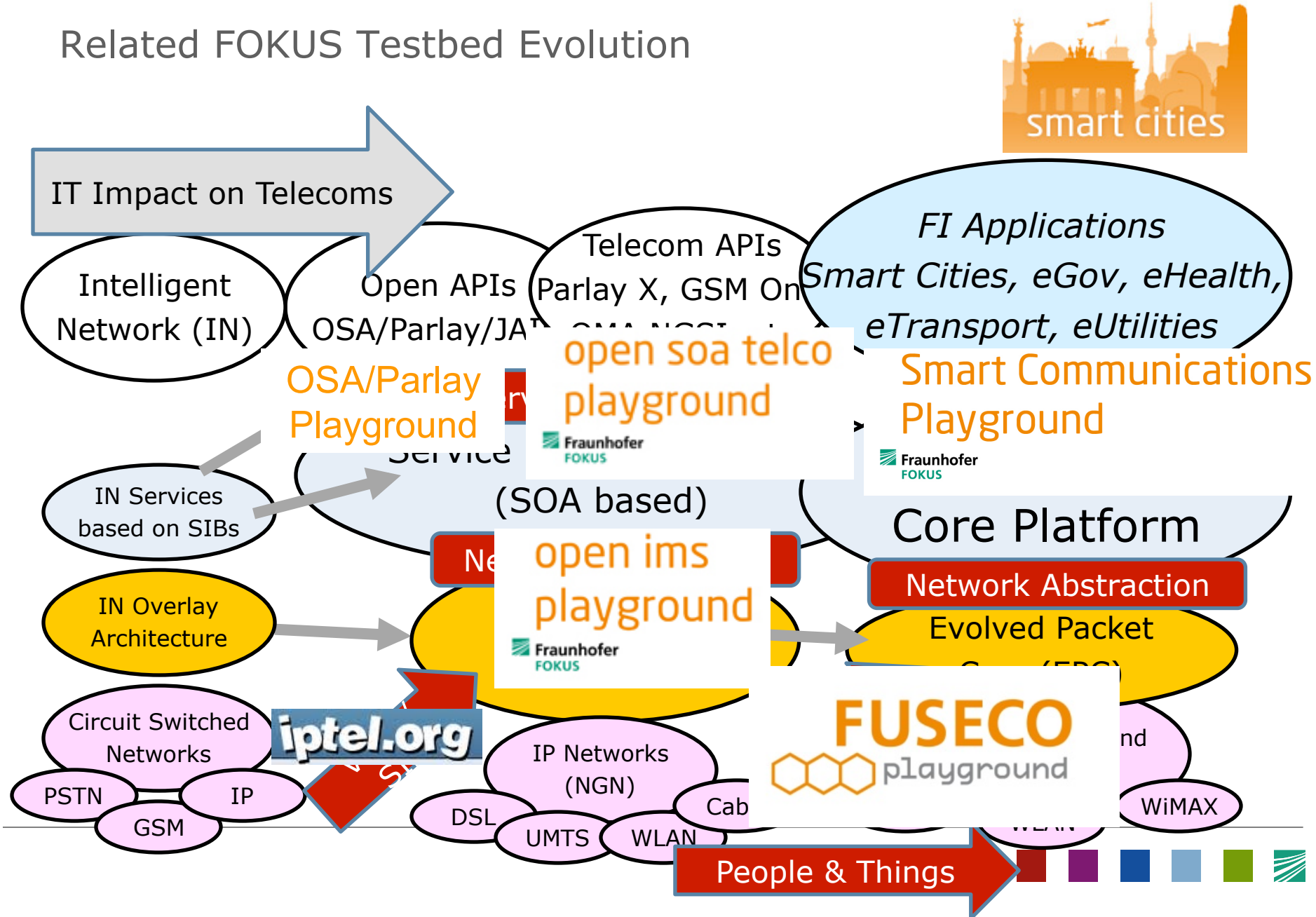
- Interoperability
- Critical Infrastructure
- Identity Management
- Virtualization
- Process Orientation
- Linking Legislation and Technology
- Business Analytics/Big Data

Solutions made by FOKUS

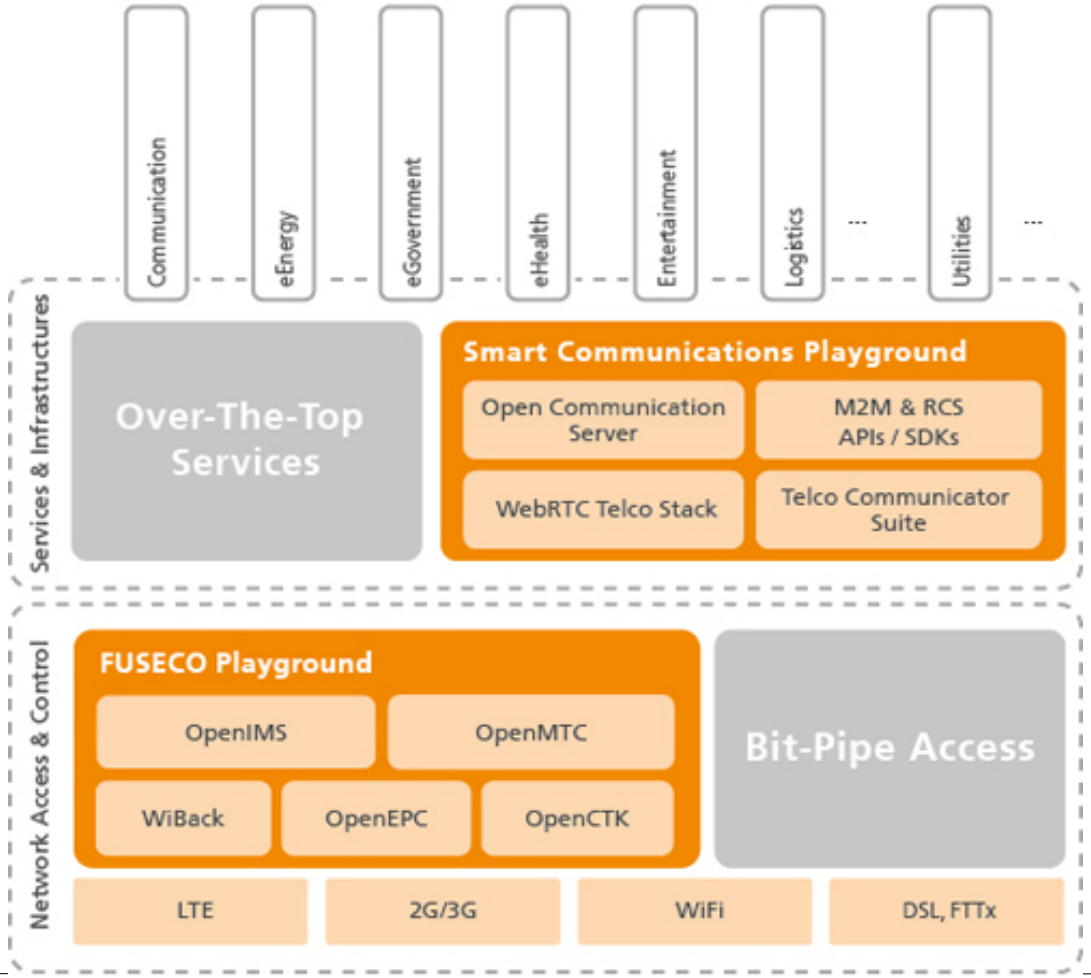
FOKUS labs on ICT in Smart Cities



Related FOKUS Testbed Evolution



Fraunhofer Testbeds / Playgrounds



Smart Communications Playground

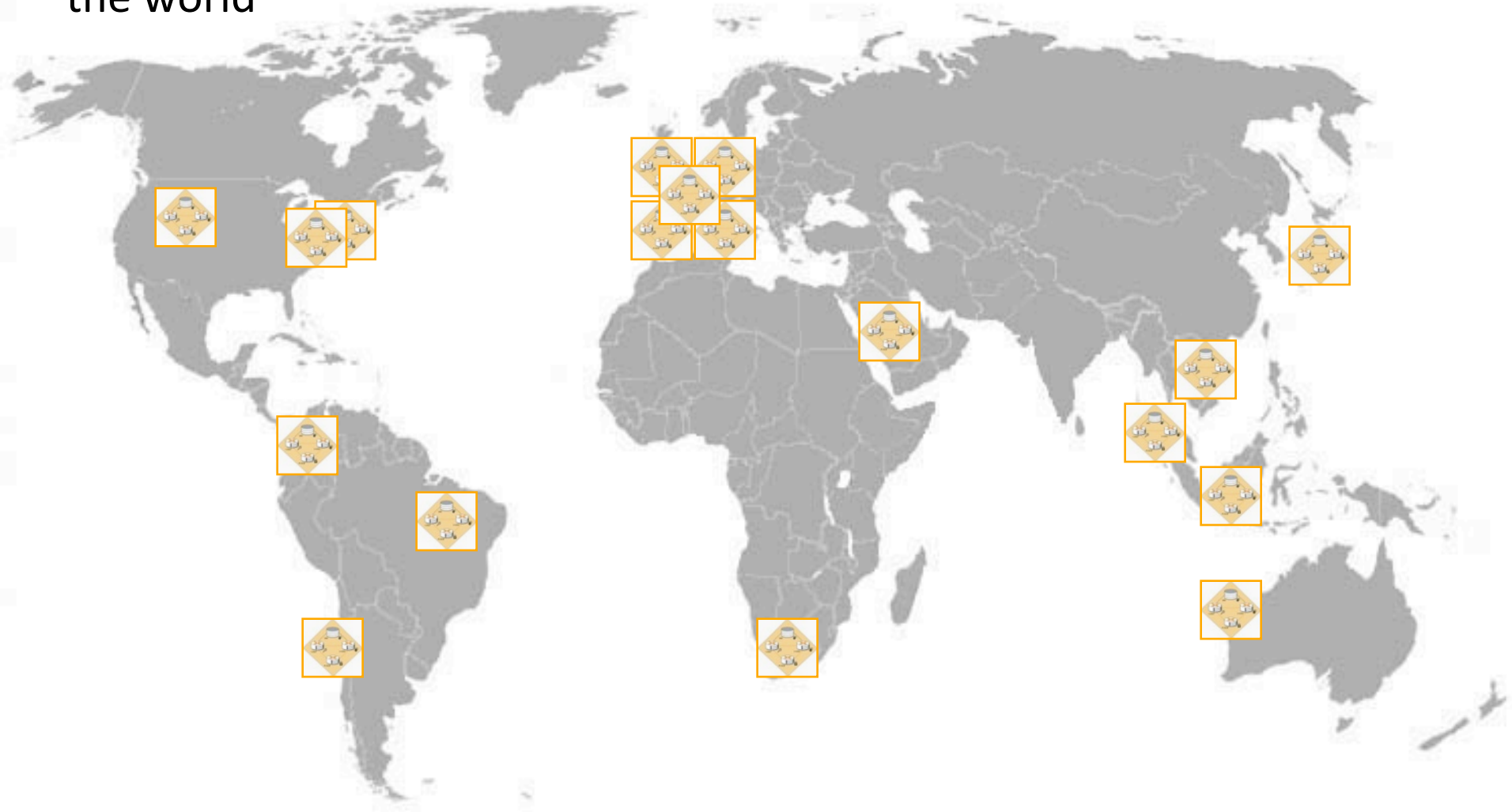
Fraunhofer FOKUS

www.SC-playground.org

FUSECO playground

www.FUSECO-Playground.org

Commercial FOKUS NGN/IMS/EPC/SOA Testbed Deployments around the world



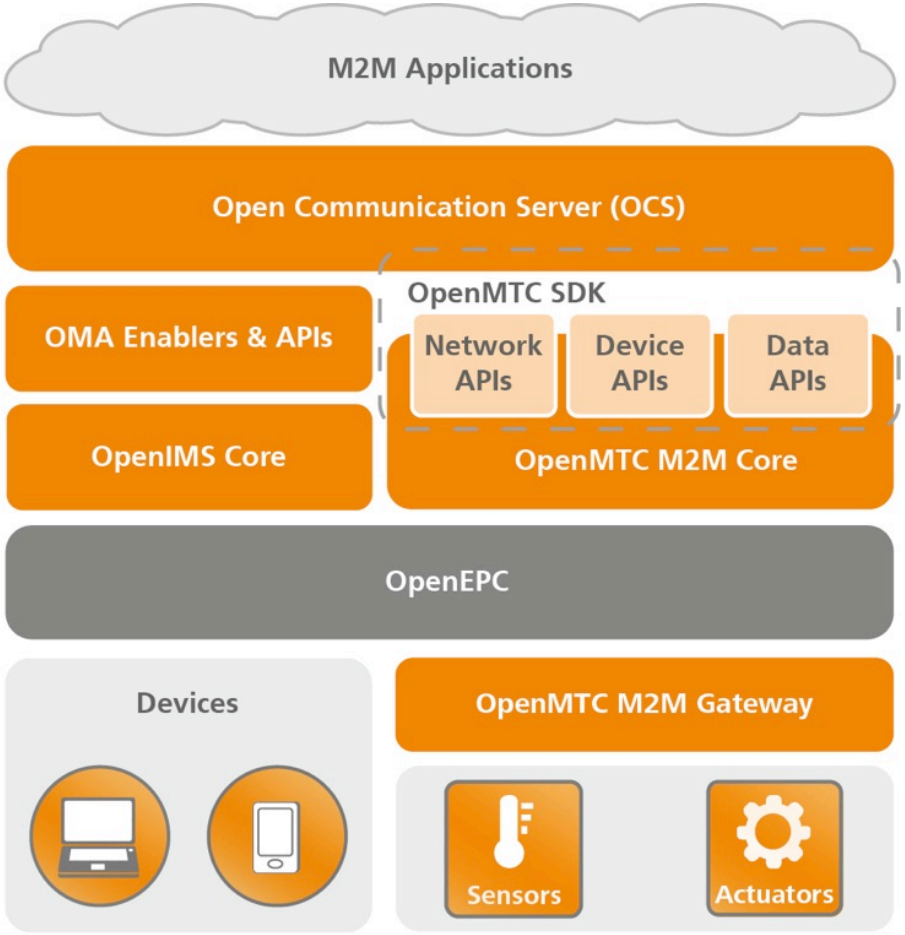
FOKUS Smart Communication Research

A Generic Smart Communication Architecture

Smart Communications Playground

Fraunhofer FOKUS

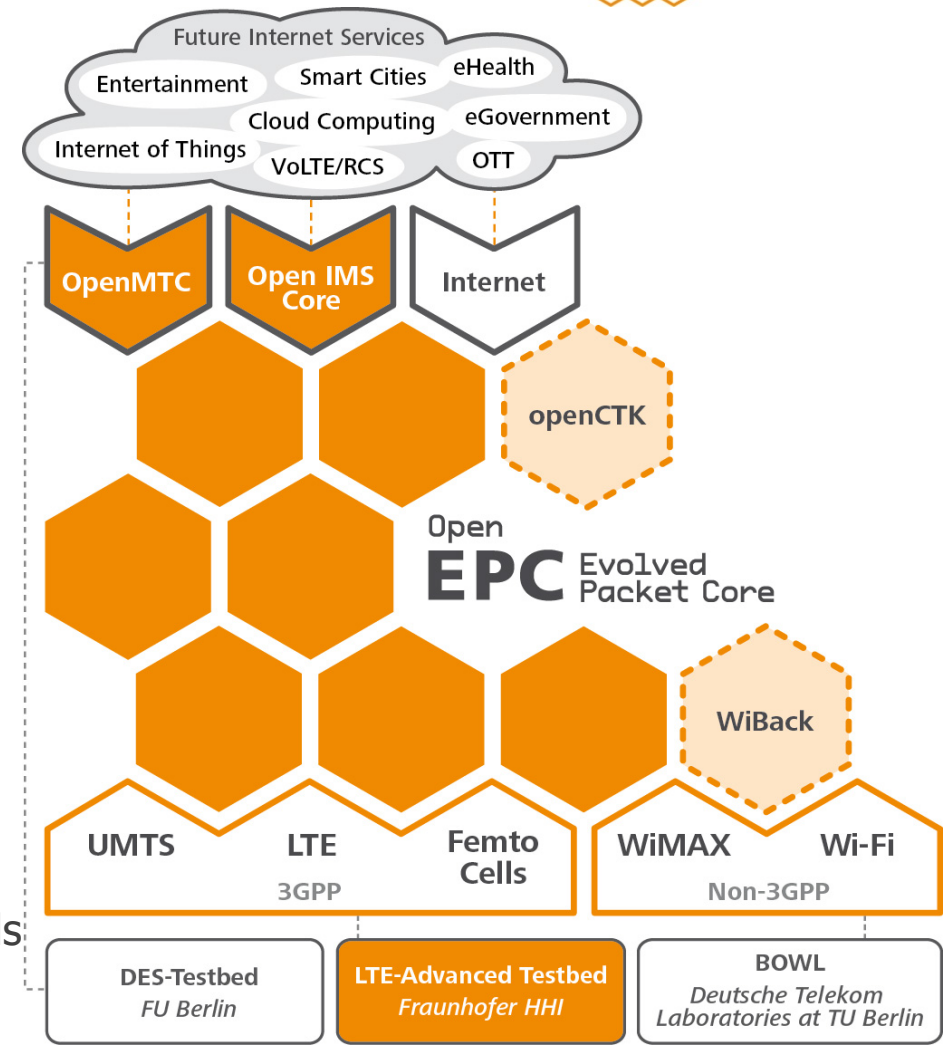
- Connecting Smart City objects across application domains
- Enabling the Internet of Things by using M2M gateways and network middleware to communicate efficiently
- Enabling multimedia communication services by integrating Telecoms APIs and platforms.
- Enable rapid application development using M2M and H2H network APIs and software development kits (SDK)
- Enable cross domain data analytics and fusion to serve the need of Smart Cities



Future Seamless Communication (FUSECO) Playground

FUSECO playground

- State of the art testbed infrastructure as a cooperation of Berlin's Next Generation Mobile Network expertise for
  - **Open IMS** for H2H communications
  - **OPenMTC** for M2M communications
  - **OpenEPC** for seamless access
  - Various access network technologies
- Enabling to prototype application support for
  - handover optimization across heterogeneous networks
  - support for Always Best Connected (ABC)
  - subscriber profile based service personalization
  - QoS provisioning and related charging
  - controlled access to IMS-based services
  - controlled access to Internet/Mobile Clouds
- More information:

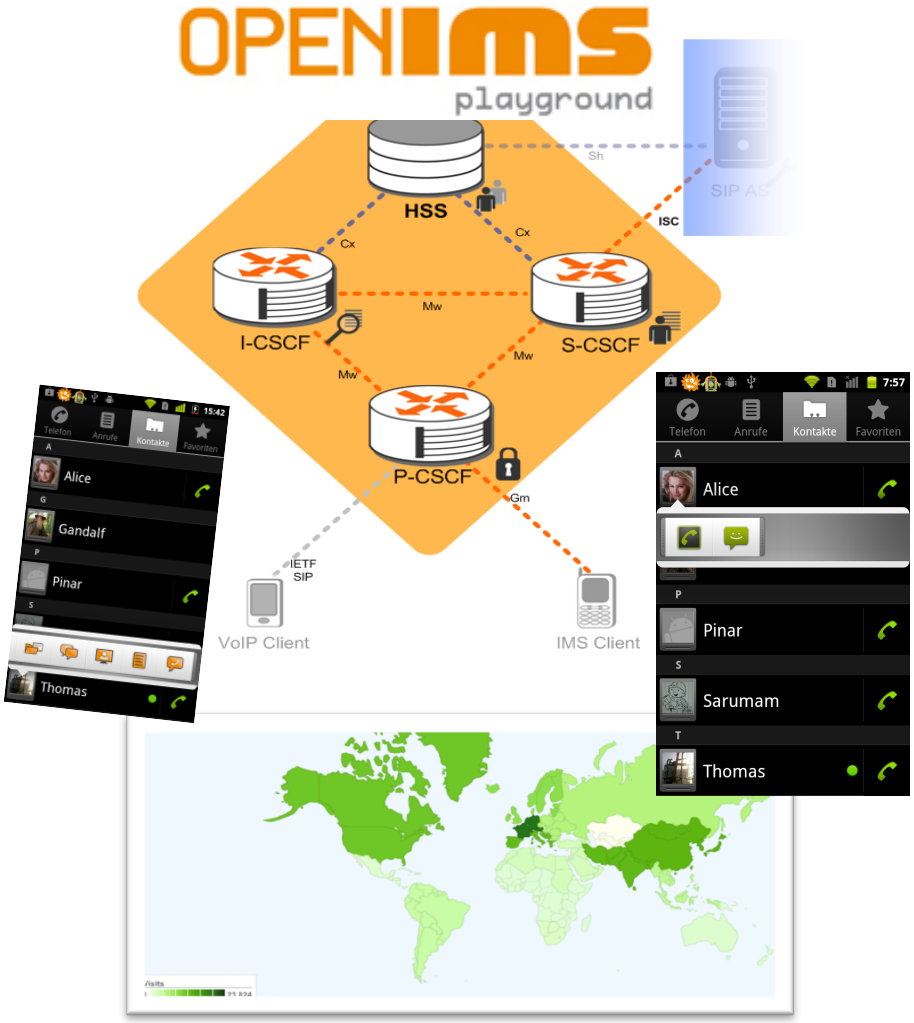


Open Source IMS Core System

- Global reference for IMS test-beds
- In November 2006 the FOKUS ***Open Source IMS (OSIMS) Core*** System - the core of the **Open IMS playground** - has been officially released to the general public via the BerliOS Open Source portal

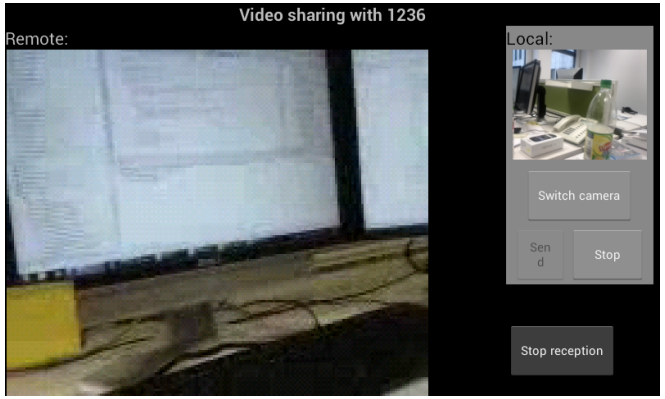
  www.openimscore.org
- OSIMS allows industry and academic institutions to setup own testbeds (with or without FOKUS support and components)
- Since then OSIMS has been downloaded many thousand times from all over the world

  See also **www.open-ims.org**



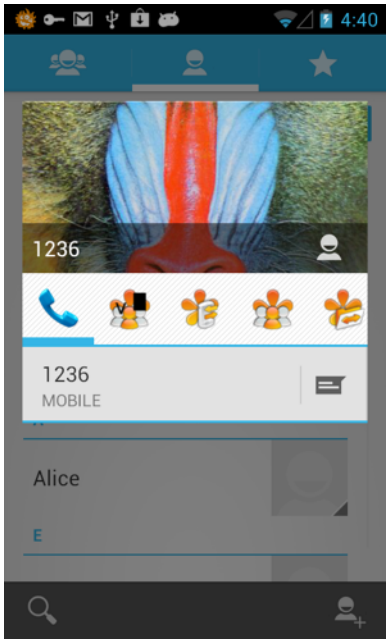
Note: IMS Client shown is MyMonster – see www.opensoaplayground.org/tcs

Telco Communicator Suite
Android Communication Client



- The software stems
  - Extended RCS Stack from Orange Labs for VoLTE
  - Compliant to GSMA RCSe specification
  - Client/Server API allows easy integration with Android native application

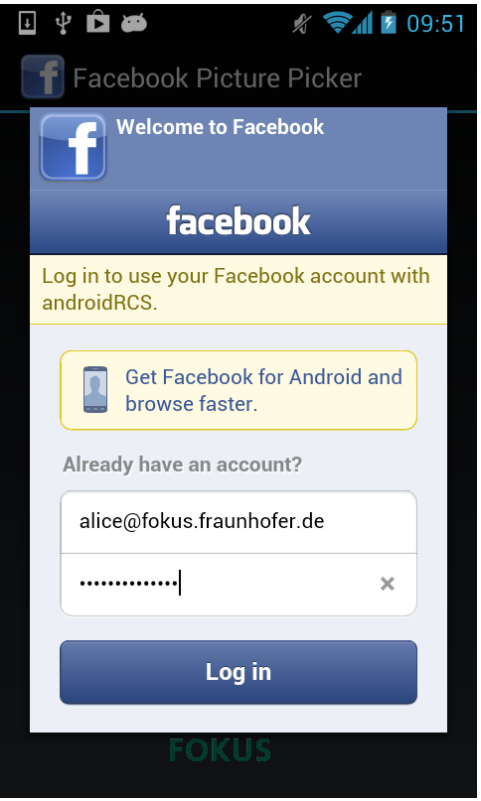
- Supported RCS/VoLTE key features:
  - Enhanced native address book with supported service capabilities and presence info
  - Messaging
    - File Transfer
    - 1-1 chat
    - Adhoc group chat
    - Location
  - Rich Call with multimedia content sharing
    - Image Sharing
    - Video Sharing
    - Video/Audio VoIP

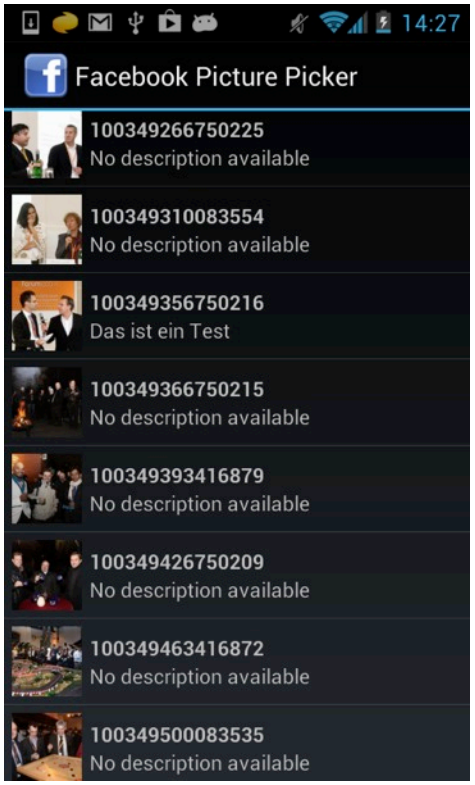


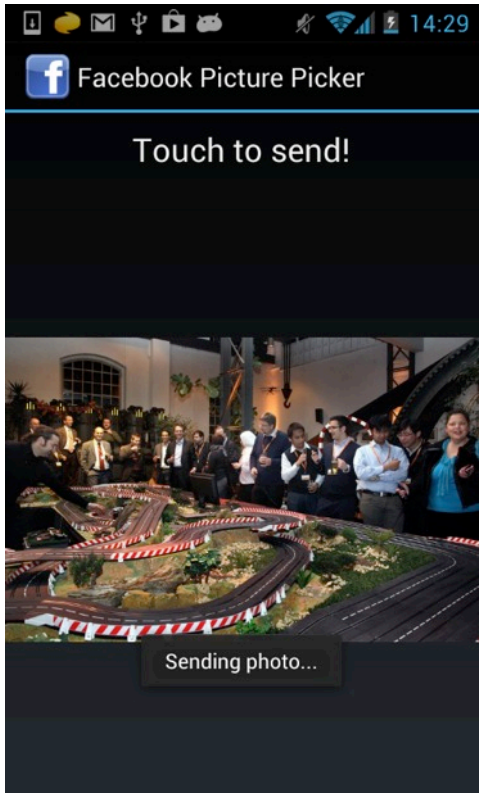
see www.sc-playground.org/tcs for more information

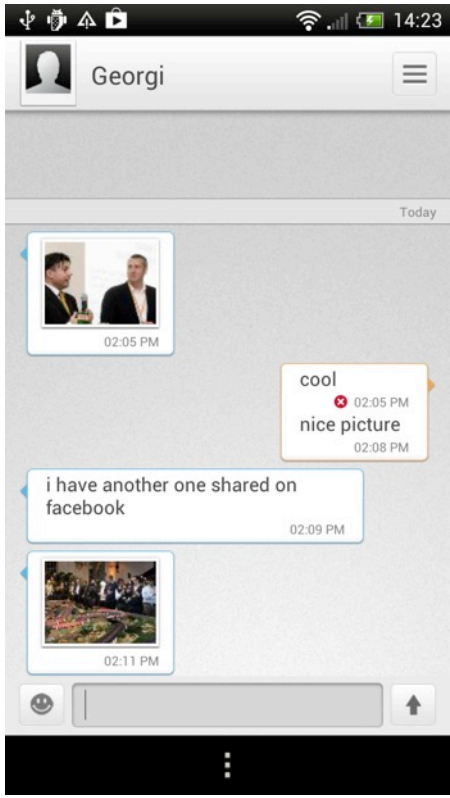
FOKUS joyn App for Deutsche Telekom
Extending RCS for Facebook Image sharing

- App uses Deutsche Telekom RCS network gateway to provide mobile image sharing for Facebook images
- Extends Facebook network with mobile operator RCS network









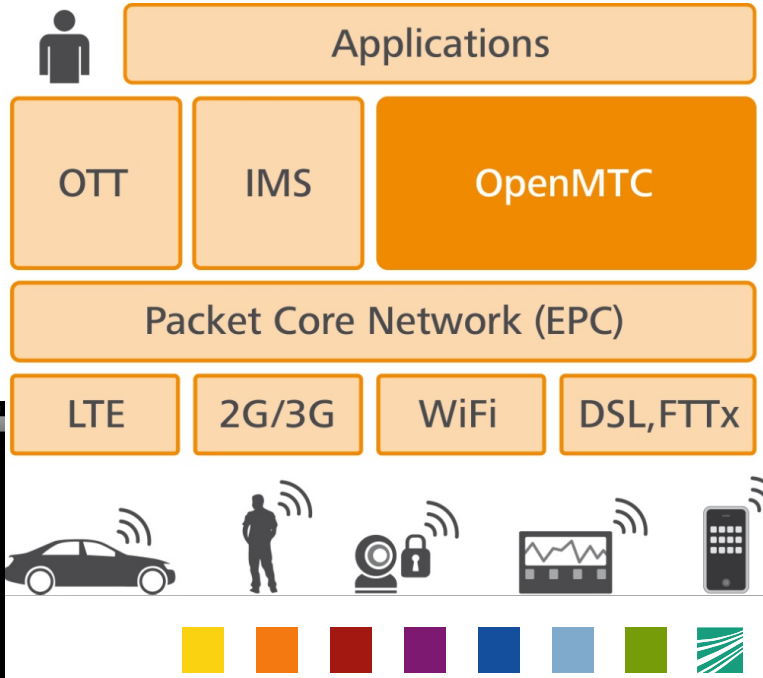
Fraunhofer FOKUS

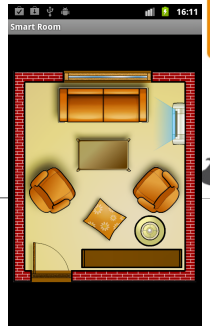
Introducing the FOKUS OpenMTC Platform

open mtc
Fraunhofer FOKUS

- Based on the success of the Open IMS Core and OpenEPC Fraunhofer FOKUS has developed a **NON-OPEN SOURCE** Machine Type Communication platform, enabling academia and industry to:
  - integrate various machine devices with operator networks
  - integrate various application platforms and services

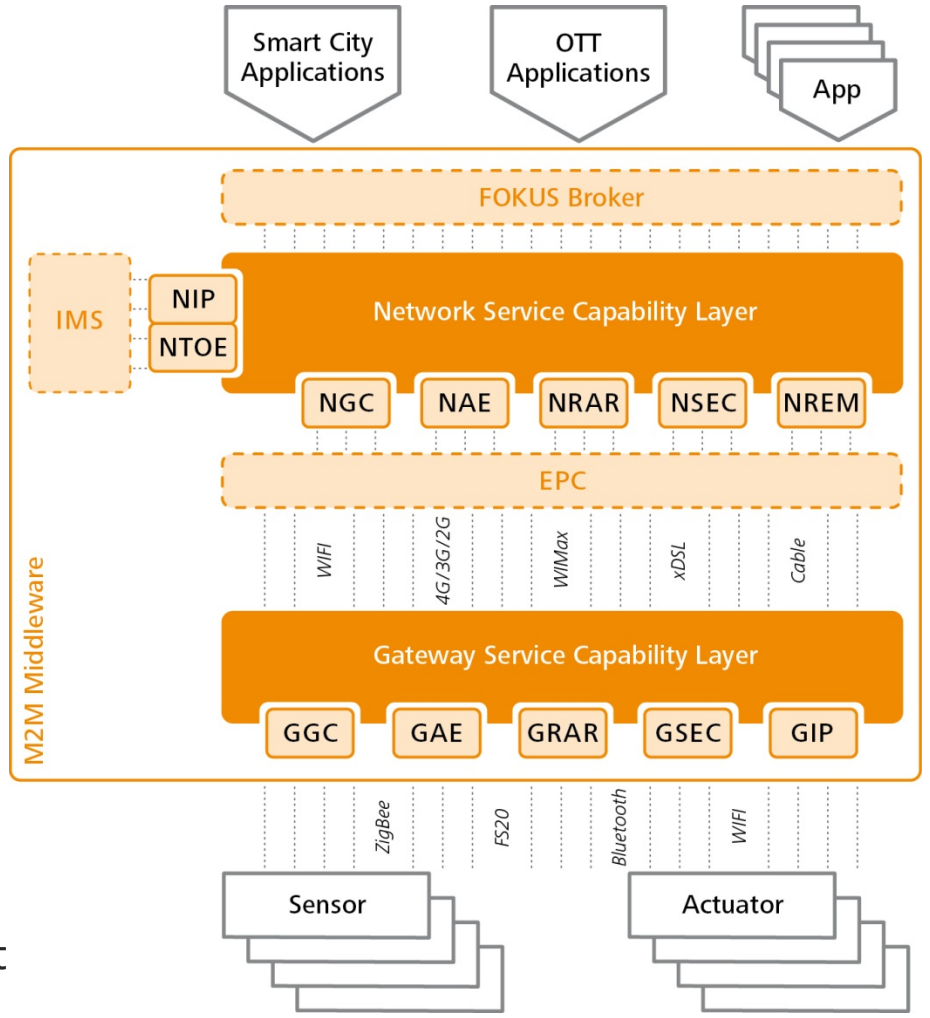
  into a single local testbed, thus lowering own development costs
- OpenMTC is an intermediary layer between multiple service platforms, the operator network, and devices
- This platform can be used to perform R&D the fields of machine type communication
- OpenMTC implemented features are aligned with ETSI M2M specifications:
  - Adaptable to different M2M scenarios (e.g. automotive)
  - Extensible to specific research needs
  - Configurable
  - Performant
  - For more see wwww.open-MTC.org



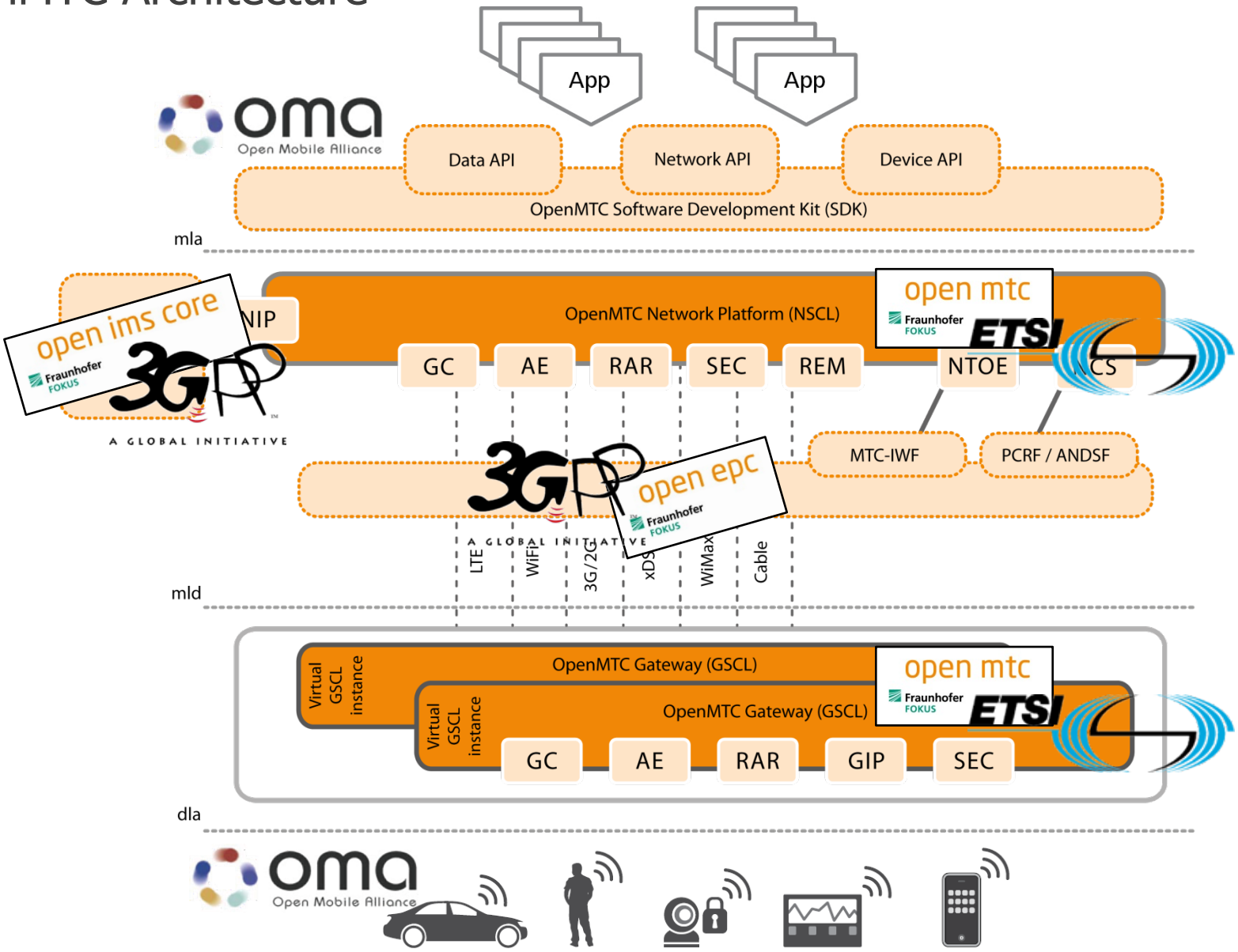


OpenMTC Architecture – Release 1

- OpenMTC consists of the two main components
  - Network Service Capability Layer (NSCL)
  - Gateway Service Capability Layer (GSCL)
- Both SCLs contain several modules
  - e.g. NGC: Network generic communication, GSEC: Gateway security, etc.
  - Some of them are optional
- OpenMTC allows interworking with
  - OpenEPC (Evolved Packet Core)
  - OpenIMS (IP Multimedia Subsystem)
  - FOKUS Service Broker
- OpenMTC supports:
  - Various sensors and actuators (e.g. ZigBee, FS20 devices)
  - Multiple Access networks (e.g. fixed, mobile, xDSL, 3G, etc.)
  - Various Applications (e.g. Smart Cities, Smart Home, etc.)

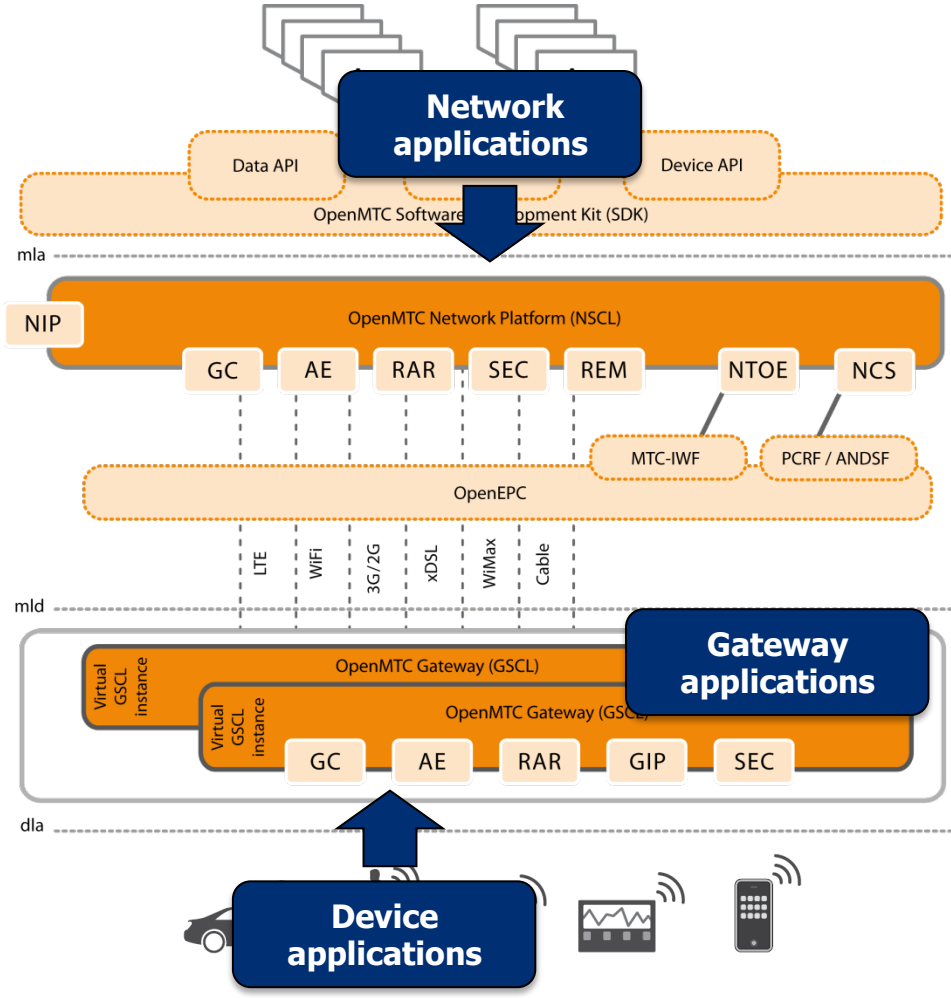


OpenMTC Architecture



OpenMTC Application Enablement

- Exposes functionalities implemented in the service layers (N/GSCL) via the reference points
  - mIa
  - dIa
- Single contact point for
  - Network Applications (NA)
  - Gateway Applications (GA)
  - Device Applications (DA)
- Performs routing between applications and capabilities in the N/GSCL
- Routing is defined as the mechanism by which a specific request is sent to a particular capability



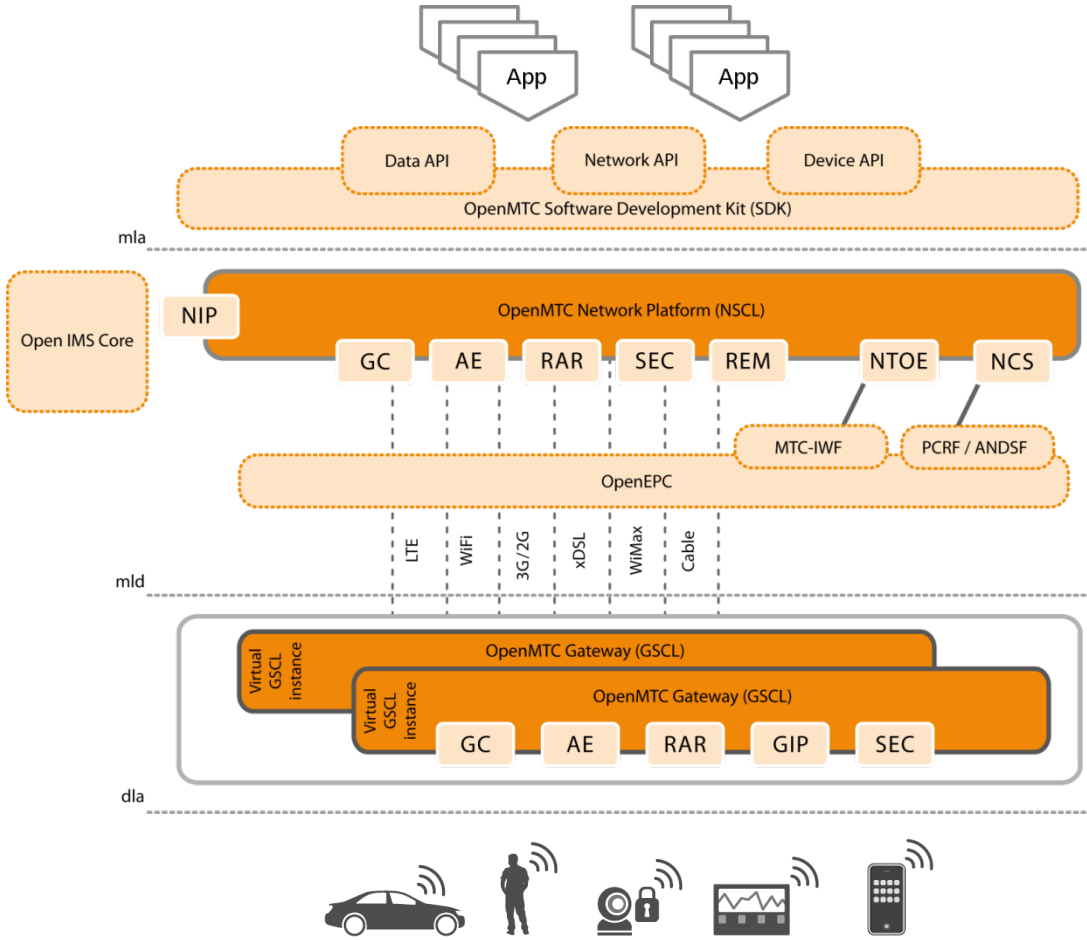
Integration and Interworking on all layers

Supporting Interoperability

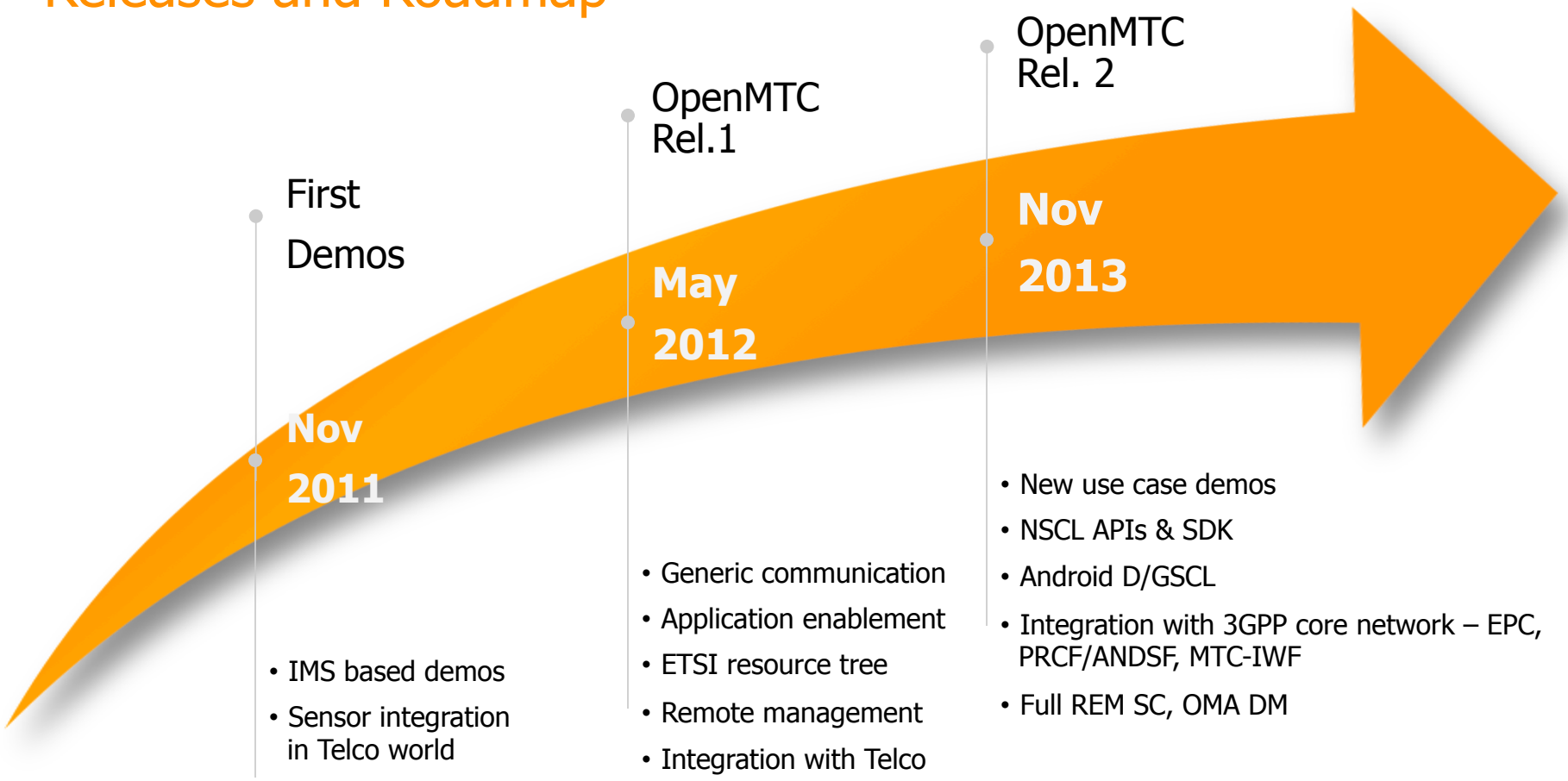
Heterogeneous Application Integration

Heterogeneous System / Platform Integration

Heterogeneous Device Integration

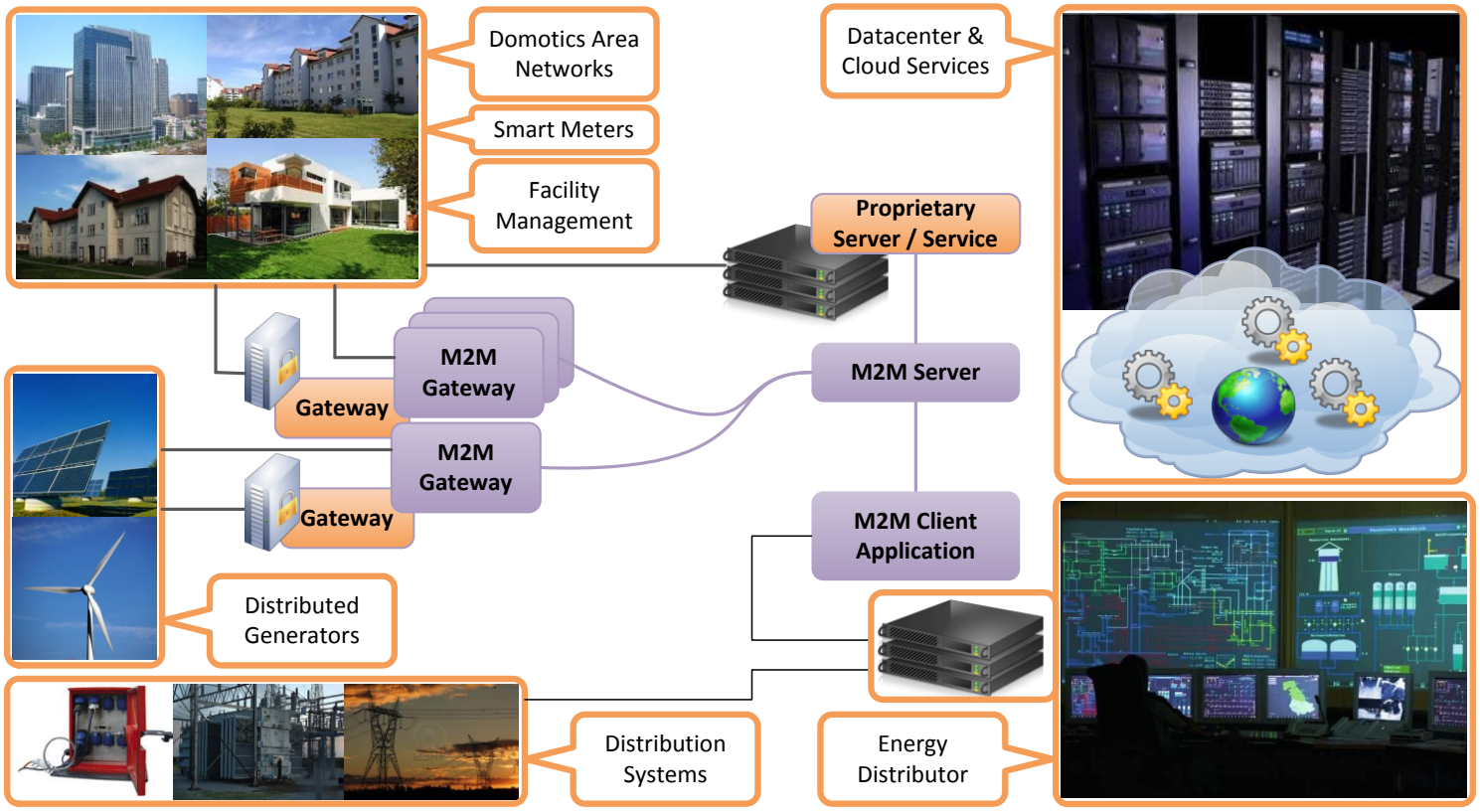


OpenMTC
Releases and Roadmap



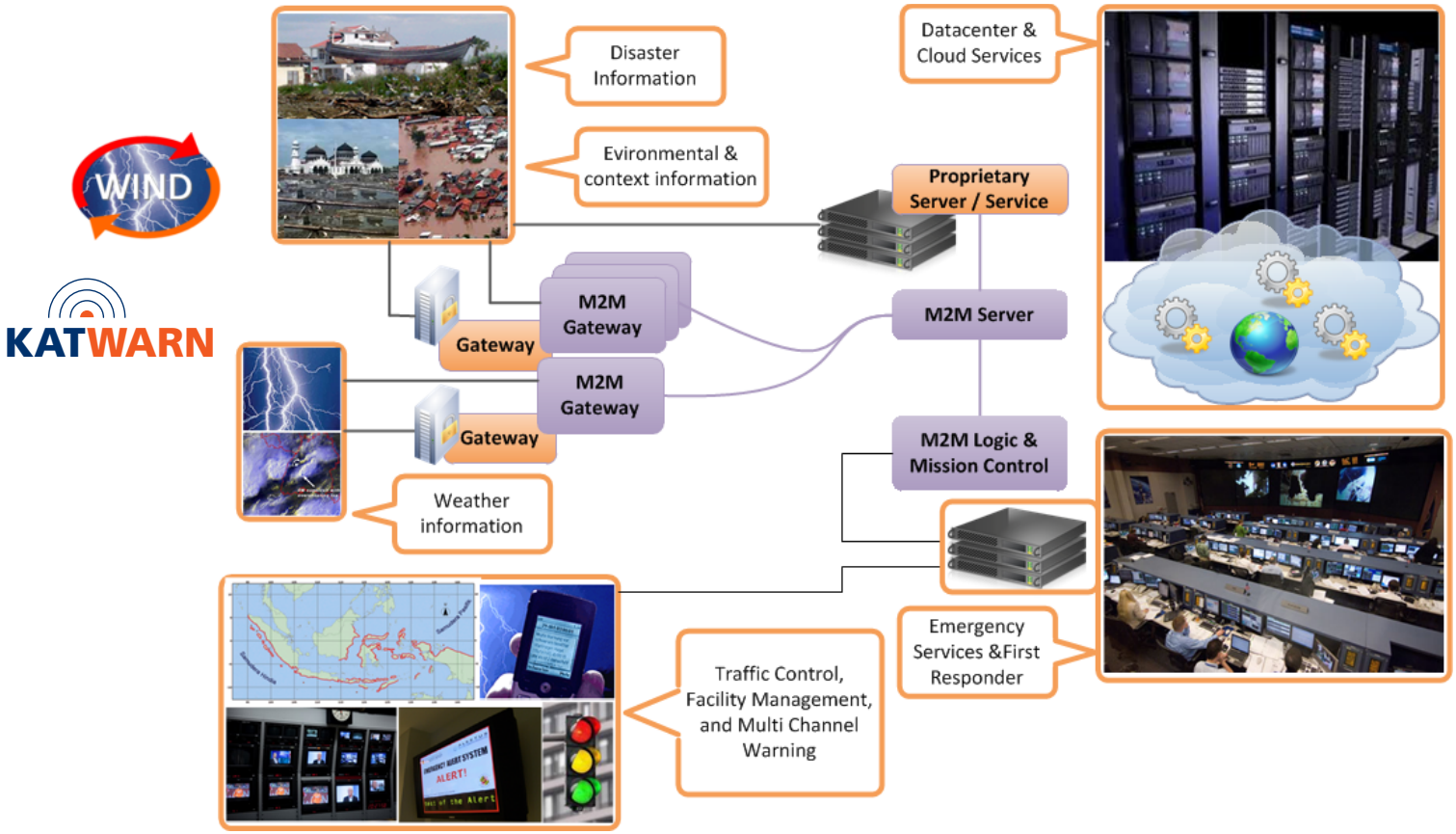
Smart City Services for Facilities and Campuses

- OpenMTC hides heterogeneity across a wider facility infrastructure (i.e. sensor and actor networks), communications (i.e. wireline or wireless, fixed or mobile), and services (i.e. M2M or proprietary) enabling data fusion and joint control.



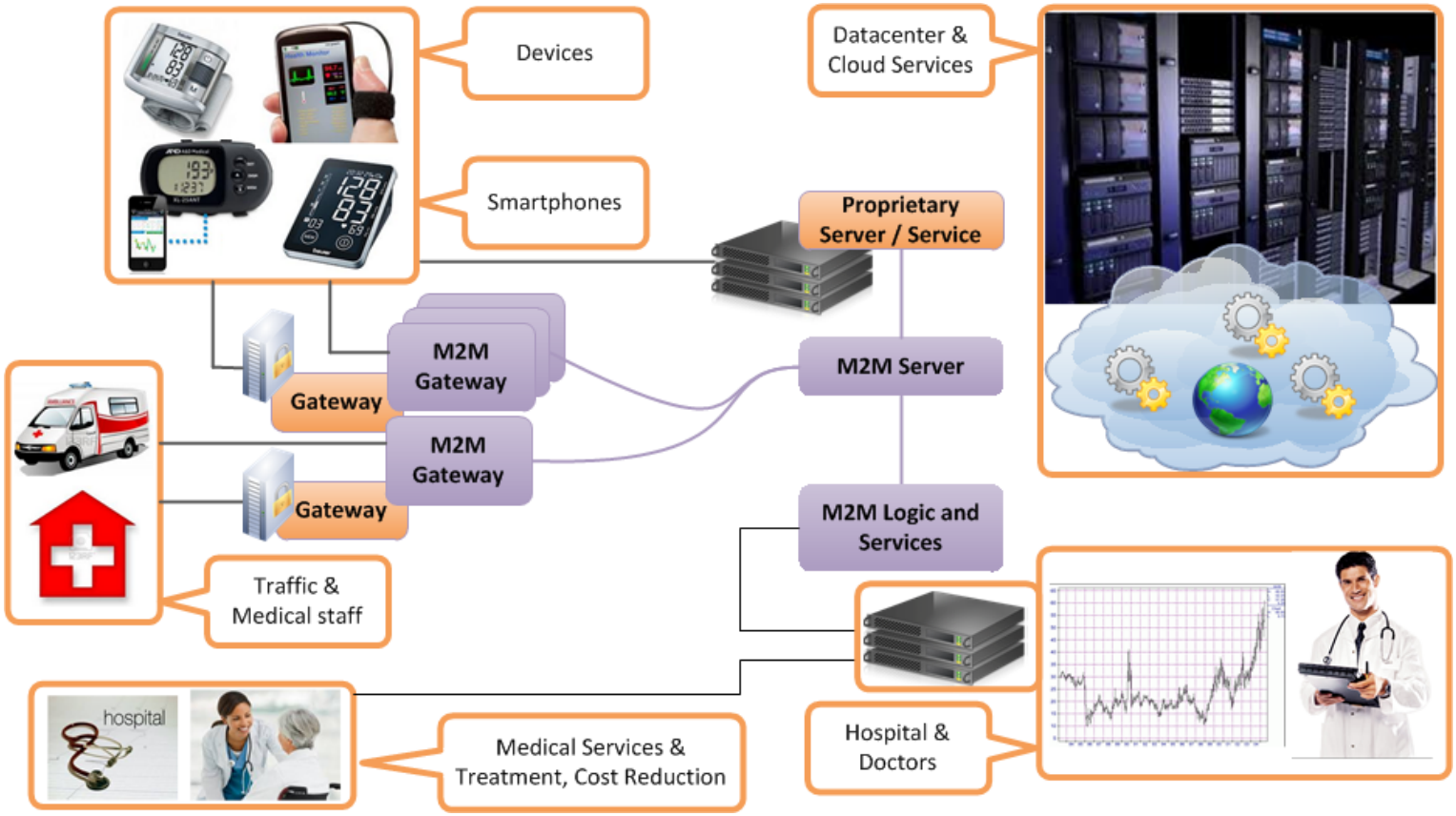
Smart City Services for Early Warning and Emergency Management

- OpenMTC aggregates sensor information and environmental warnings, implements application logic and policies, and can automate counter-measures (e.g. multi-channel hazard warning, facility management, and traffic control) via dedicated application logic.



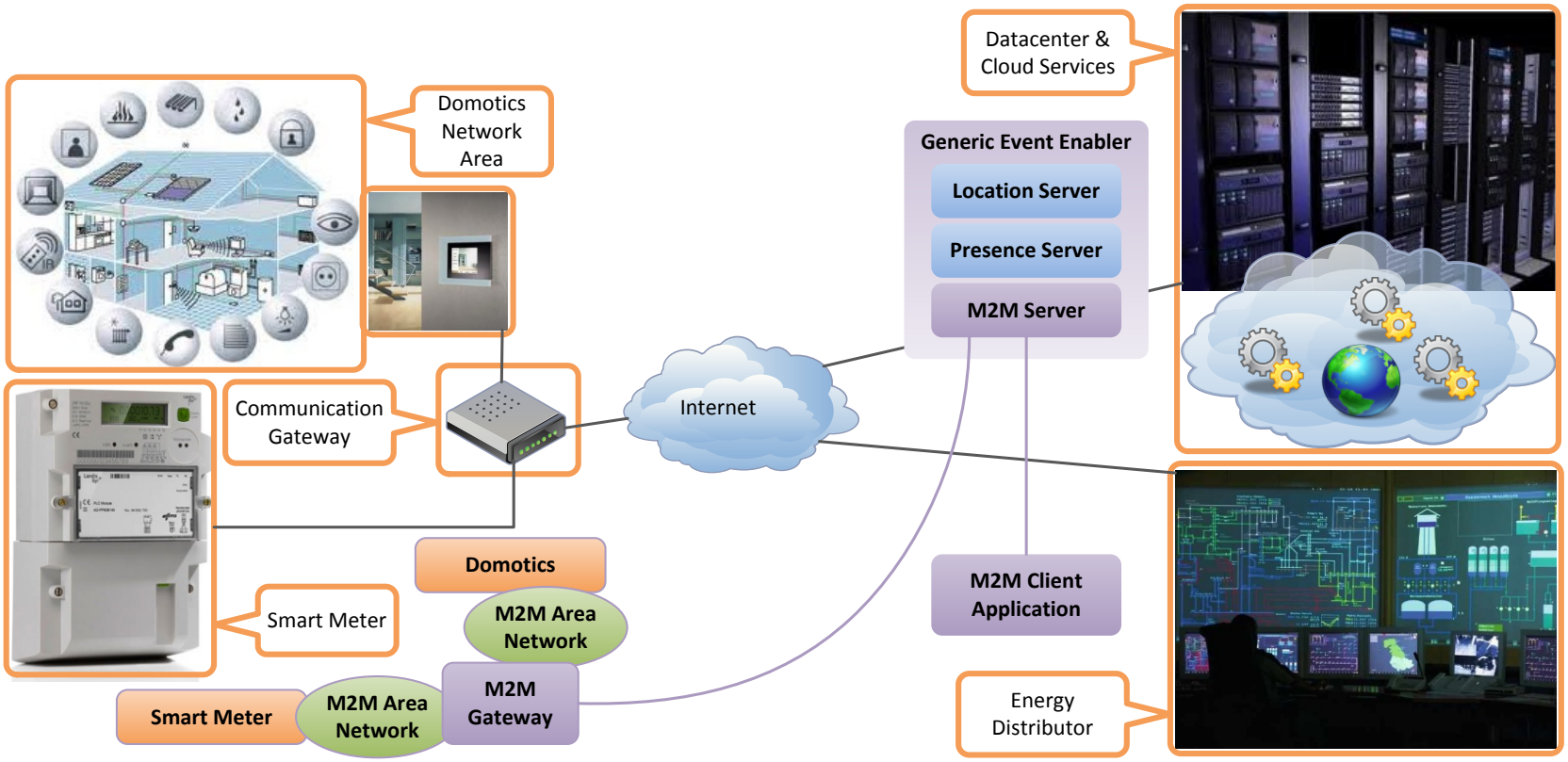
Smart City Services for eHealth and Support of Elderly People

- OpenMTC supports various eHealth devices and can communicate health information to hospitals and first responders. In conjunction with traffic & location information and data about medical staff occupancy, critical time savings and cost reduction can be achieved.



Smart City Services for End Customer Domotics and Smart Metering

- OpenMTC provides a unified API to M2M client applications while hiding heterogeneity of end-customer premises equipment (i.e. domotics and smart meter) and the communication links between customer premises and M2M service center.



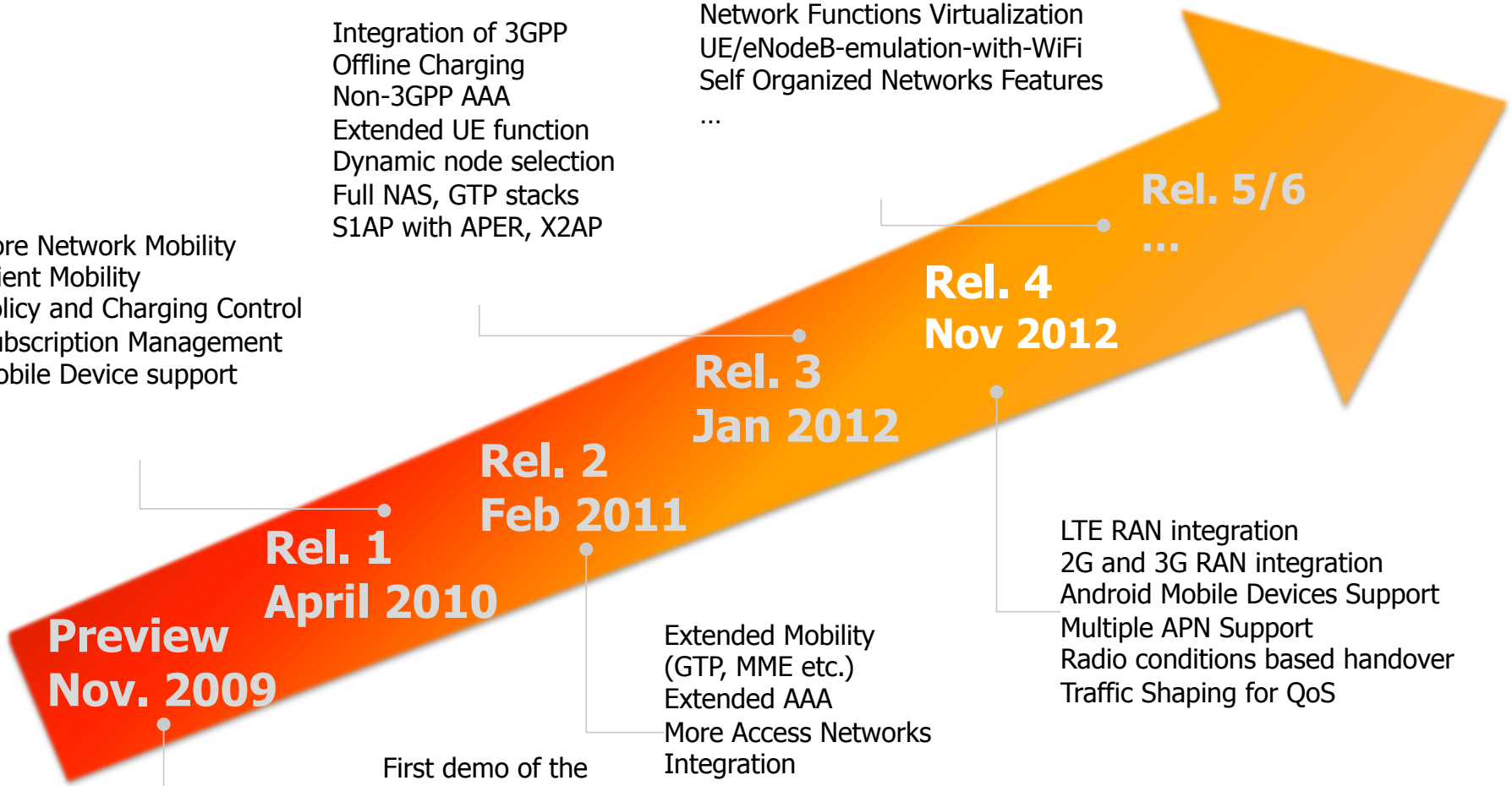
What is FOKUS OpenEPC Platform?

open epc
Fraunhofer FOKUS

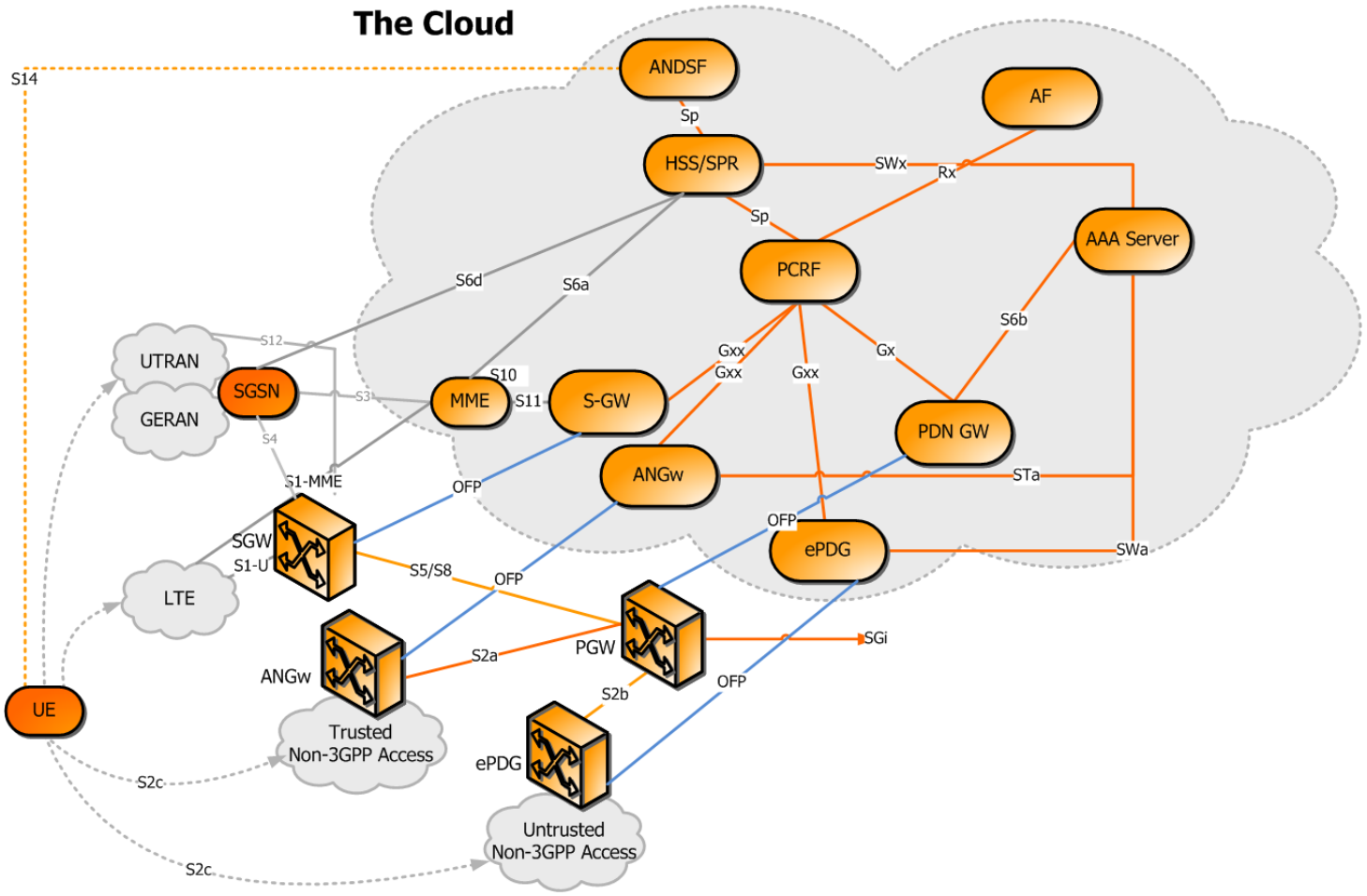
- Future massive broadband communications will be realized through multi-access support (LTE, 3G, 2G, WiFi, fixed networks …) and multi-application domains (OTT, IMS, P2P, M2M, Cloud, …)
- Fraunhofer FOKUS is developing the **NON-OPEN SOURCE** OpenEPC, enabling:
  - integrate various network technologies and
  - integrate various application platforms

  into a single local testbed, thus lowering own development costs
- This platform can be used to perform R&D in the fields of QoS, Charging, Mobility, Security, Management, Monitoring
- OpenEPC represents a software implementation of the 3GPP EPC standard addressing academia and industry R&D:
  - Configurable to different deployments
  - Customizable to the various testbed requirements
  - Extensible to specific research needs
  - Reliable & highly performant
  - Based on 3GPP standards
- More information: www.OpenEPC.net

OpenEPC Roadmap



OpenEPC with OpenFlow – Clean Infrastructure/Cloud Split



- EPC Control, Mobility and all signaling can be cloudified
- But the User Data Plane stays in the infrastructure → maximum performance

Fraunhofer FOKUS Toolkits and Technology Evolution Path

open ims core

Fraunhofer FOKUS

Converged **Session control** for SIP multimedia services on top of IP networks

Evolution from Session Management to plain IP connectivity

Evolution towards flexible deploy- and mgmt

Evolution of core network functionality

open SDN core

Fraunhofer FOKUS

Network component orchestration and management; Adaptable **distributed control** platform; **Programmable switches**

open epc

Fraunhofer FOKUS

IP Connectivity, Charging, Security, QoS Control, Mobility, Heterogeneous Access Network support

open 5G core

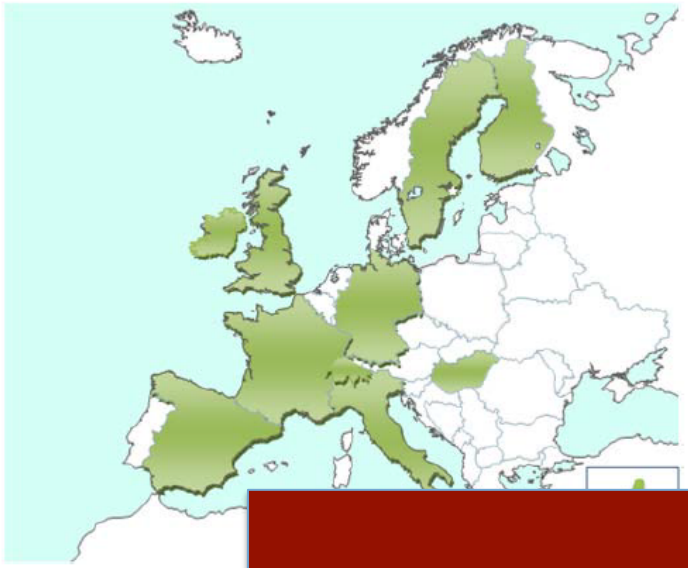
Fraunhofer FOKUS

Towards **5G Core Evolution,** 5G RAN support, **SDN data path concepts**, Flatter architecture

FI-WARE – a collaboration effort between operators and IT providers with good participation from Academia

- *The FI-WARE project will introduce a generic and extendible ICT platform for Future Internet services.*
- *The platform – also referred to as the "Future Internet Core Platform" or "FI-WARE" – aims to meet the demands of key market stakeholders across many different sectors, strengthen the innovation-enabling capabilities in Europe and overall ensure the long-term success of European companies in a highly dynamic market environment.*

fi-ware



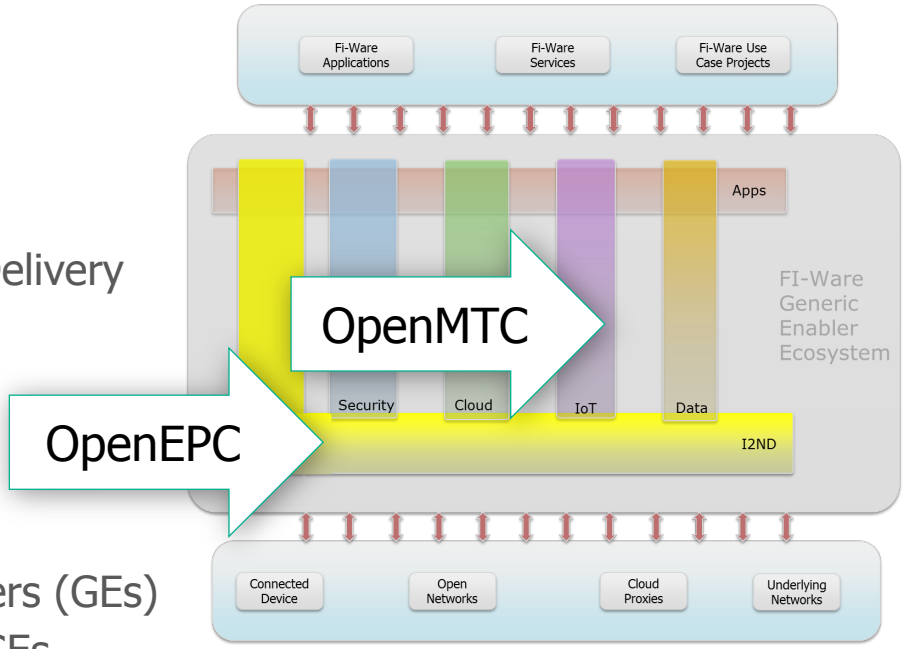
THALES, Telefonica, SAP, NEC, ERICSSON, technicolor, TELECOM ITALIA, IBM, Nokia Siemens Networks, SIEMENS, orange, Atos Origin, intel, T, ENGINEERING, Alcatel·Lucent, POLITÉCNICA, Fraunhofer FOKUS, INRIA, UNIVERSITÄT DUISBURG ESSEN, UNIVERSITY OF SURREY

http://www.fi-ware.eu
http://forge.fi-ware.eu/plugins/mediawiki/wiki/fiware/index.php/Welcome_to_the_FI-WARE_Wiki

FI-PPP FI-WARE

FI PPP Key Platform Project makes use of OpenXXX Tools

- FI-WARE project is providing the design and the first prototypes of the European Future Internet
- Generic platform covers the following areas / topics (referred to "chapters")
  - Data/Context Management
  - Internet of Things Service Enablement
  - Cloud Hosting
  - Security
  - Applications/Services Ecosystem and Delivery Framework
  - Interface to Networks and Devices



- FIWARE aims at
  - Identifying and defining generic enablers (GEs)
  - Providing an API specification for the GEs
  - Showing that GEs can be realized

Agenda

- Smart Cities as Future Internet Show Case
- Smart City communication infrastructures requirements
- The Role of IP Multimedia Subsystem, Machine Type Communication, Evolved Packet Core and related Open APIs within emerging Smart City SDPs
- FOKUS Toolkits and practical examples
- Summary
- *Q&A*

UNIFI Mission

- **UNIFI** – **UNI**versities for **F**uture **I**nternet
- **UNIFI** is an initiative of the Chair of **Next Generation Networks (AV) at the Technische Universität Berlin** aiming at building sustainable teaching and research infrastructures in the areas of Future Internet through global collaboration among academic institutions.
- The initiative intends to reach its goals via enablement and empowerment of all stakeholders of academia:
- the creation and development of high quality curricula, integration and exchange of teaching personnel, students, postgraduates and researchers among the partner universities
- the creation of Competence Centers for a sustainable development and bundling of local expertise
- the creation and development of an open, general purpose, and sustainable large-scale shared Next Generation Networks Infrastructures & Future Internet Technology Experimentation and Research Facility via federation of interoperable local testbeds.
- the creation and operation of an International Multilateral Academic Network as a communication hub and motor for intercultural understanding in the international FI academic community

DAAD Project University Future Internet

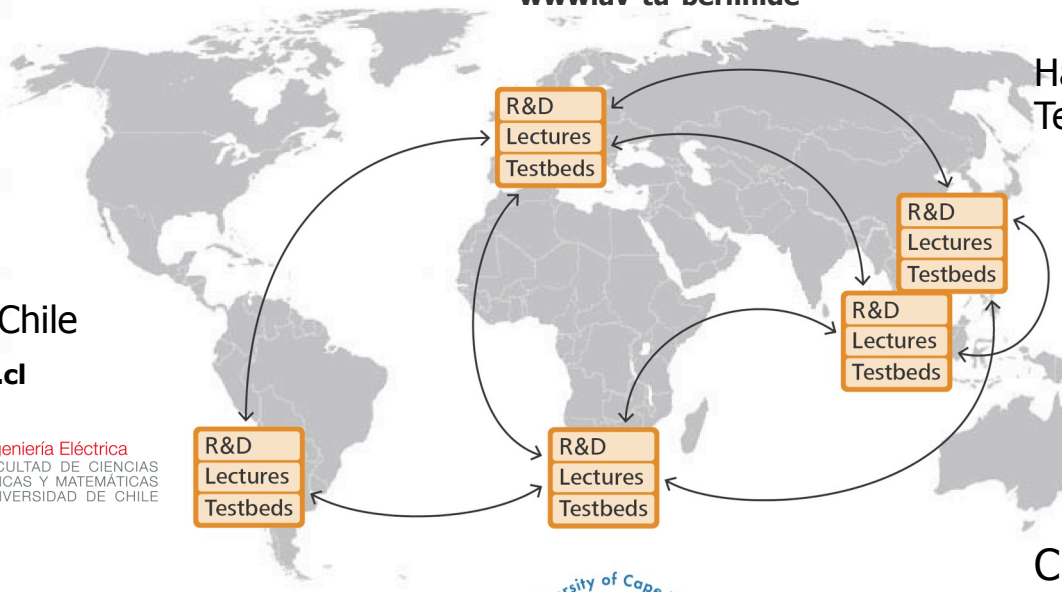
Unifying Education and Testbeds around the Globe

DAAD unifi University Future Internet

TU Berlin

AV Next Generation Networks

www.av-tu-berlin.de



SET

Hanoi University of Science and Technology

en.hustech.edu.vn

Universidad de Chile

www.uchile.cl

fcfm Ingeniería Eléctrica
FACULTAD DE CIENCIAS FÍSICAS Y MATEMÁTICAS UNIVERSIDAD DE CHILE

Department of Electrical Engineering

Chulalongkorn University

www.chula.ac.th

University of Cape Town

www.uct.ac.za

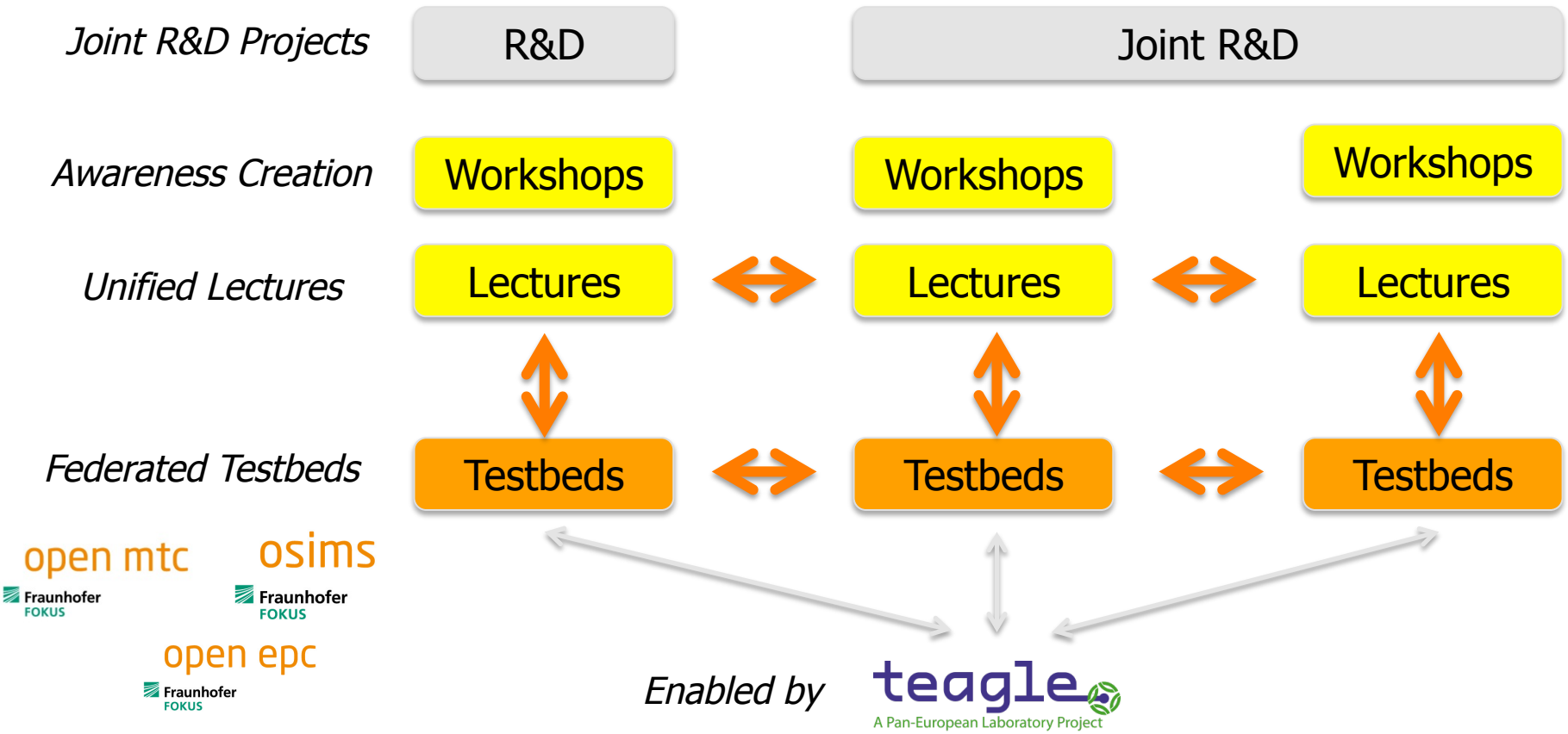
Enabled by teagle
A Pan-European Laboratory Project

www.daad-unifi.org

DAAD Project University Future Internet

Unifying Education and Testbeds around the Globe

DAAD unifi University Future Internet



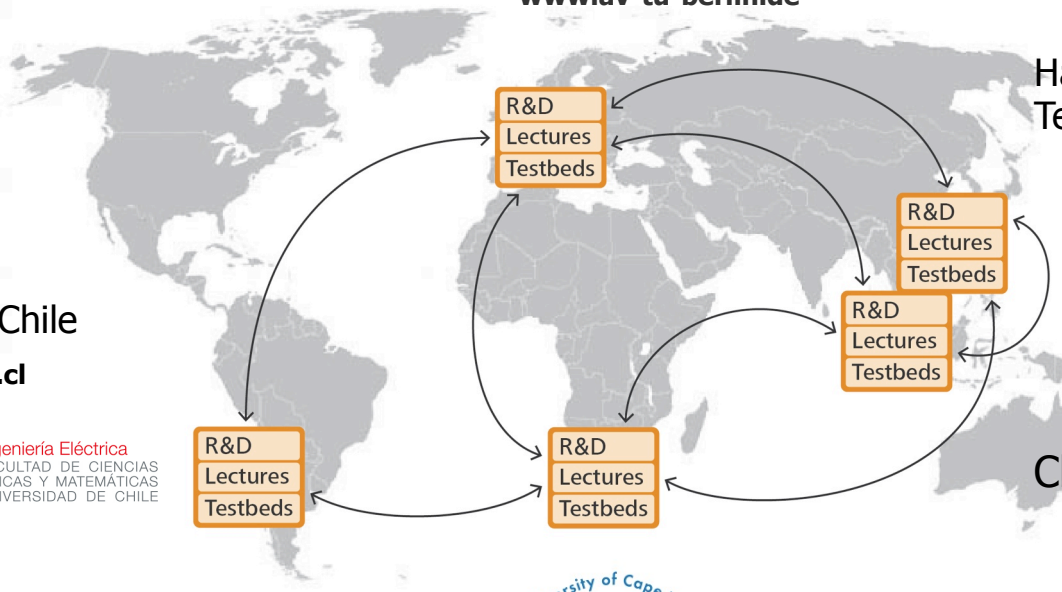
IT Telkom as Partner in DAAD UNIFI

Unifying Education and Testbeds around the Globe

DAAD unifi University Future Internet

AV Next Generation Networks

www.av-tu-berlin.de



Hanoi University of Science and Technology

en.hustech.edu.vn

Universidad de Chile

www.uchile.cl

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Chulalongkorn University

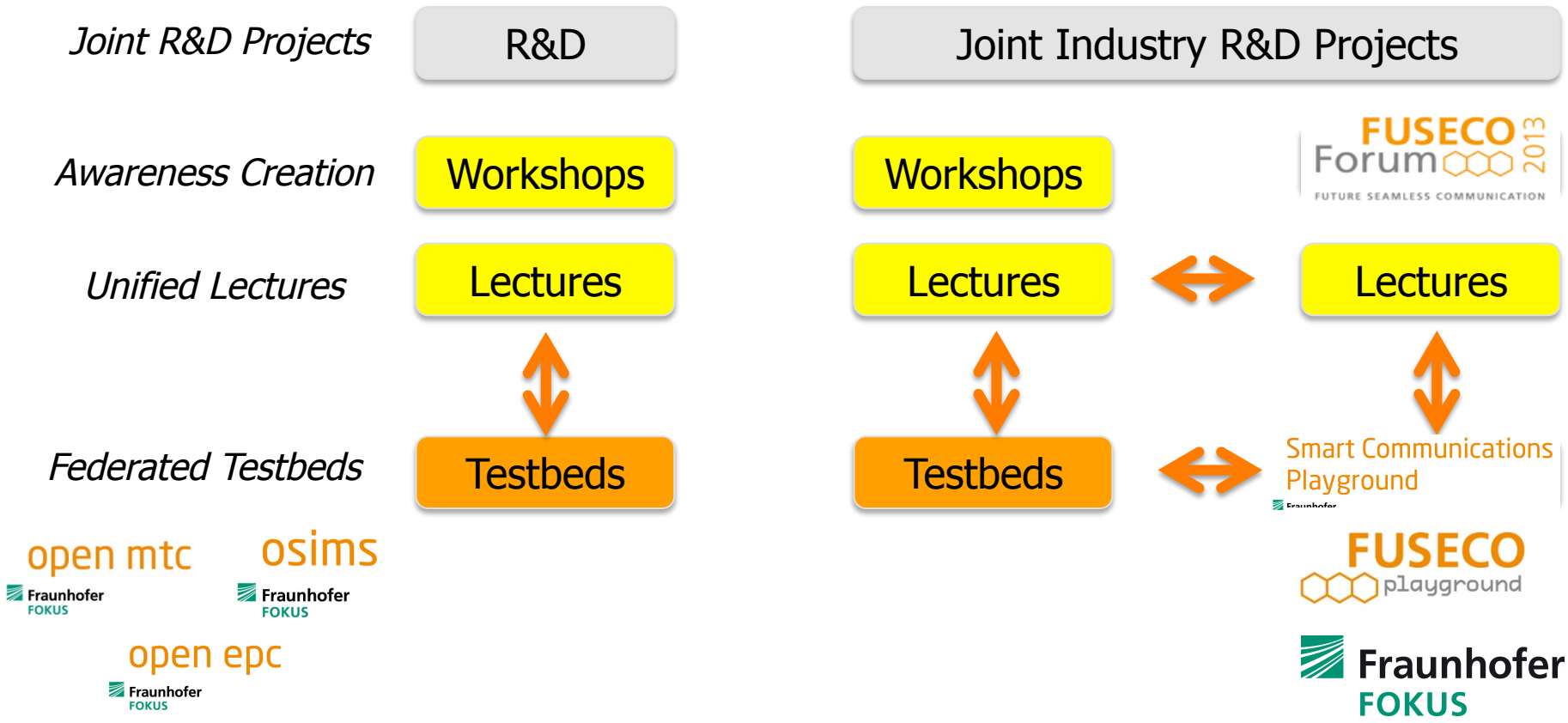
www.chula.ac.th

University of Cape Town

www.uct.ac.za

Beyond DAAD UNIFI

Unifying Testbeds and Education for Local Industry



Current Research

TRESCIMO | Testbeds for Reliable Smart City Machine-to-Machine Communication

- **Context:** FP7 FIRE STREP: EU/SA collaboration
- **Motivation:** Urbanization issues in South Africa
- **Goal:** Reliable Smart City Communication Platform
- **Approach:**
  - Smart Technologies
    - CSIR: Smart Platform
    - i2CAT: Smart City Platform
    - Fraunhofer/TUB: OpenMTC / FITeagle
  - Smart Sensors
    - Eskom: Utility Load Manager
    - AirBase: Smart City Air Pollution Wireless Sensors
  - Evaluation
    - Pilots: San Vicenç dels Horts and Johannesburg
    - Testbeds: TUB and University of Cape Town
- **Web:** http://trescimo.eu

Motivation | Smart Cities

- Cities are the engine for future economic growth: 65% of the GDP in 600 global cities in 2025 [McKinsey]
- Cities take up a mere 2% of the world's land mass, but account for 80% of the world's energy consumption, 70% of the world's greenhouse gas emissions, 60% of our water consumption [UN]
- Urbanization will significantly increase [UN], growing world population: 9.3 billion in 2050, growing % of people live in urban areas (> 50% in 2035 Africa).
- In Africa: from 412 million now => 870 million in 2035

Smarter and **greener** cities are needed to address challenges (resources, infrastructure, sustainable, liveable, economical, social, environmental). ICT allows cities/people to make better decisions (smarter) and become greener (better usage of available resources).

Approach | Main Roles

EURESCOM — Project Management.

Technische Universität Berlin — OpenMTC developments. Testbed interconnection.

Fraunhofer FOKUS — OpenMTC developments.

AirBase — Smart device developments. Testbed setup.

i2cat Fundació — Experimentation and evaluation.

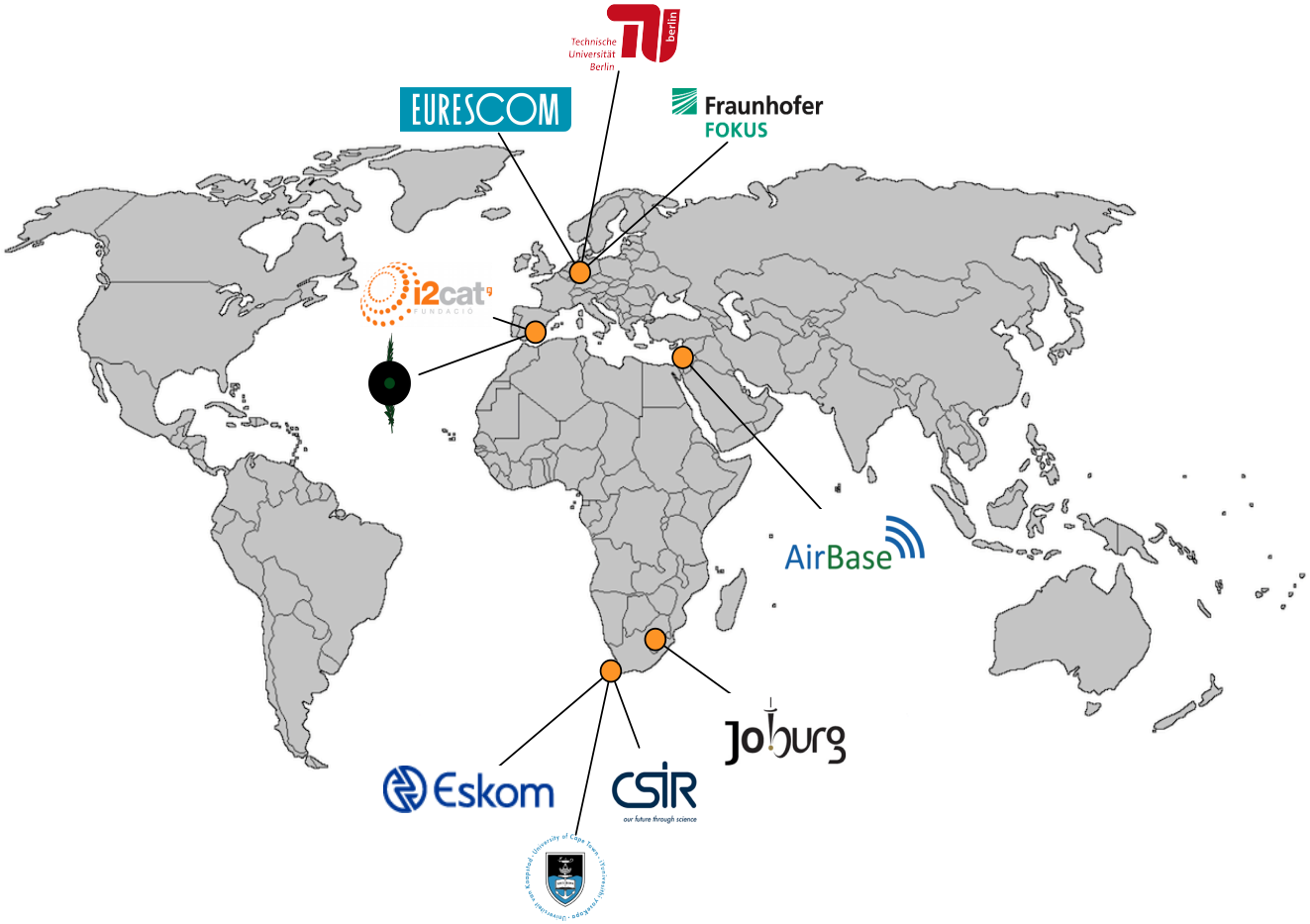
Scenarios and requirements. Smart City platform developments. — CSIR our future through science

Testbed setup. — University of Cape Town · iYunivesithi yaseKapa · Universiteit van Kaapstad

Smart device developments. Testbed setup. — Eskom

These partners **are not** funded by the EC.

Approach | Collaboration between Europe and South Africa



4th FOKUS „Future Seamless Communication“ Forum (FFF)
Berlin, Germany, November 28-29, 2013

FUSECO Forum 2013
FUTURE SEAMLESS COMMUNICATION

- **Theme: „Smart Communications Platforms for Seamless Smart City Applications – Fixed and Mobile Next Generation Networks Evolution towards virtualized network control and service platforms and Seamless Cloud-based H2H and M2M Applications“**
- FUSECO FORUM is the successor of the famous FOKUS IMS Workshop series (2004-09)
  - FFF 2010 attracted 150 experts from 21 nations
  - FFF 2011 was attended by around 200 experts from 30 nations
  - FFF 2012 was attended again by around 200 experts from 30 nations
- See **www.fuseco-forum.org**

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- *Q&A*

Fraunhofer FOKUS

Smart City ICT
Tools & Testbeds

Questions

Fraunhofer SMART CITIES

Useful Links

- Fraunhofer FOKUS NGNI Competence Center: www.fokus.fraunhofer.de/go/ngni
- TU Berlin Chair for Next Generation Networks: www.av.tu-berlin.de
- Open IMS Core Project: www.openimscore.org
- Open IMS Playground: www.open-ims.org
- Open MTC Project: www.open-mtc.org
- Open EPC Project: www.openEPC.net
- Smart Communications Playgorund: www.sc-playground.org
- Future Seamless Communication Playground: www.fuseco-playground.org
- NGN to Future Internet evolution Lab: www.ngn2fi.org
- Future Internet testbed tool FITeagle: www.fire-teagle.org
- Future Internet PPP: http://www.fi-ppp.eu

Contact

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TUB Chair Next Generation Networks / Director FOKUS NGNI Division

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