ITU Arab Regional Forum on NGN
(Rabat, Morocco, 5-6 March 2014)

An overview of key achievements and relevant ongoing studies in ITU-T standardization activities on NGN

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Outline

- Introduction to ITU-T standardization activities on Next Generation Networks
- Some key achievements of ITU-T NGN standardization (only some areas !)
- Ongoing work
  - Focus on some emerging and hot areas for NGN evolution
- Some useful links and references for ITU-T NGN standards

NOTE – this presentation mainly focuses on the work conducted by ITU-T Study Group 13 (leading study group on NGN since the start of ITU-T NGN standardization) and has not by any means the intention to provide exhaustive coverage of the ITU-T activities which have had/have relationship with NGN (globally, most of ITU-T study groups – in line with their specific mandate and competences - have had/have relationship with NGN standards developments)

Introduction to ITU-T standardization activities on Next Generation Networks

Some key milestones and actions in ITU-T standardization of NGN

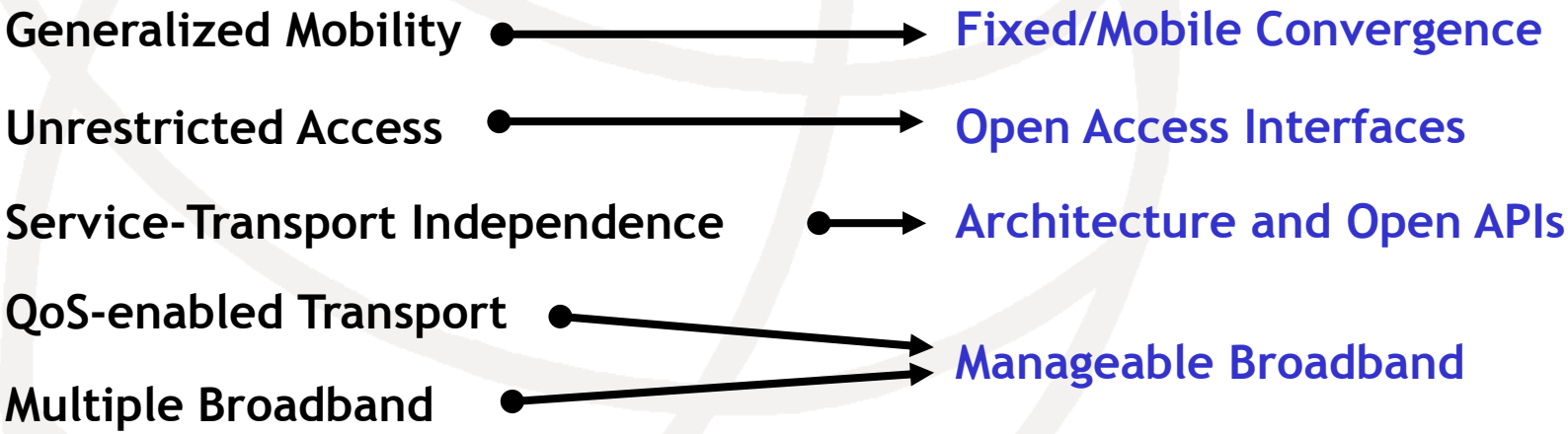
- NGN studies started with the first ITU-T NGN workshop in July 2003
- …
- NGN Focus Group formed in May 2004, then Study Group 13 established by WTSA-04 as the Leading SG for NGN studies
- **JCA-NGN (Joint Coordination Activity), NGN GSI(Global Standards Initiative) started in 2006 – main involved ITU-T study groups: SG2, SG11, SG13**
- … first basic Recommendations
- Coordination with ITU-D (migration to NGN) and ITU-R
- Collaboration & coordination with other international and regional SDOs (3GPP/3GPP2, IETF, ETSI TISPAN, ATIS NGN, CJK & ASTAP, others – including with "common IMS" effort within 3GPP)
- Other ITU-T SGs gradually involved: SG3, SG9, SG12, SG15, SG16, SG17, (SG19)
- **ITU-T NGN Release 1 practically completed in Jan 2008** (but of Release approach finally abandoned)
- … a lot of new areas of development in NGN
- **JCA-NGN and NGN GSI ended in July 2012**
- **NGN evolution (NGNe) agreed in SG13 for ITU-T 2013-2016 study period (as enhancements to NGN, hopefully an evolutionary path in parallel/towards Future Networks)**

NGN definition and basic features

Definition of NGN (Rec. Y.2001)

A NGN is a packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

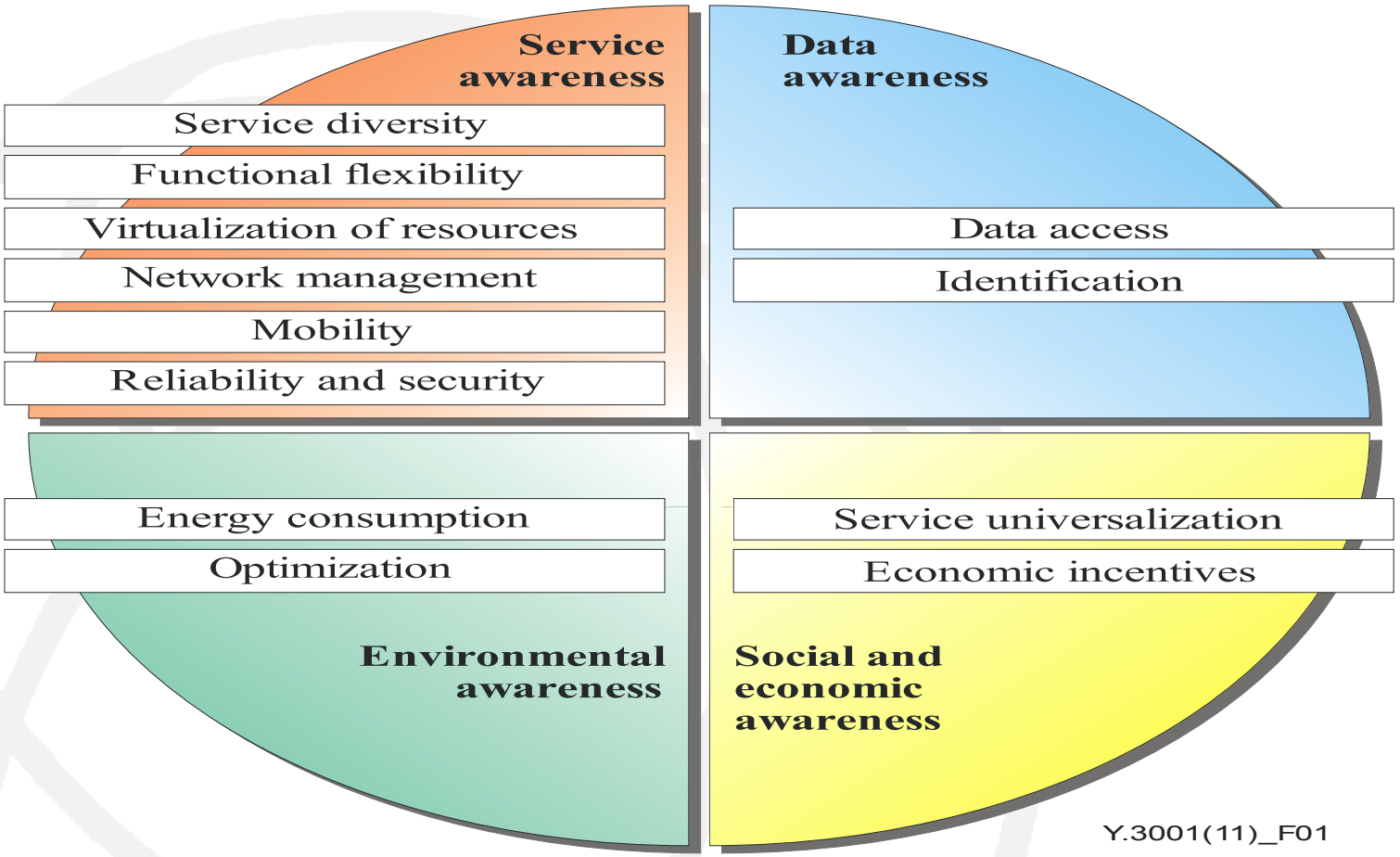
Target Standards areas



NGN Architecture: objectives and core component

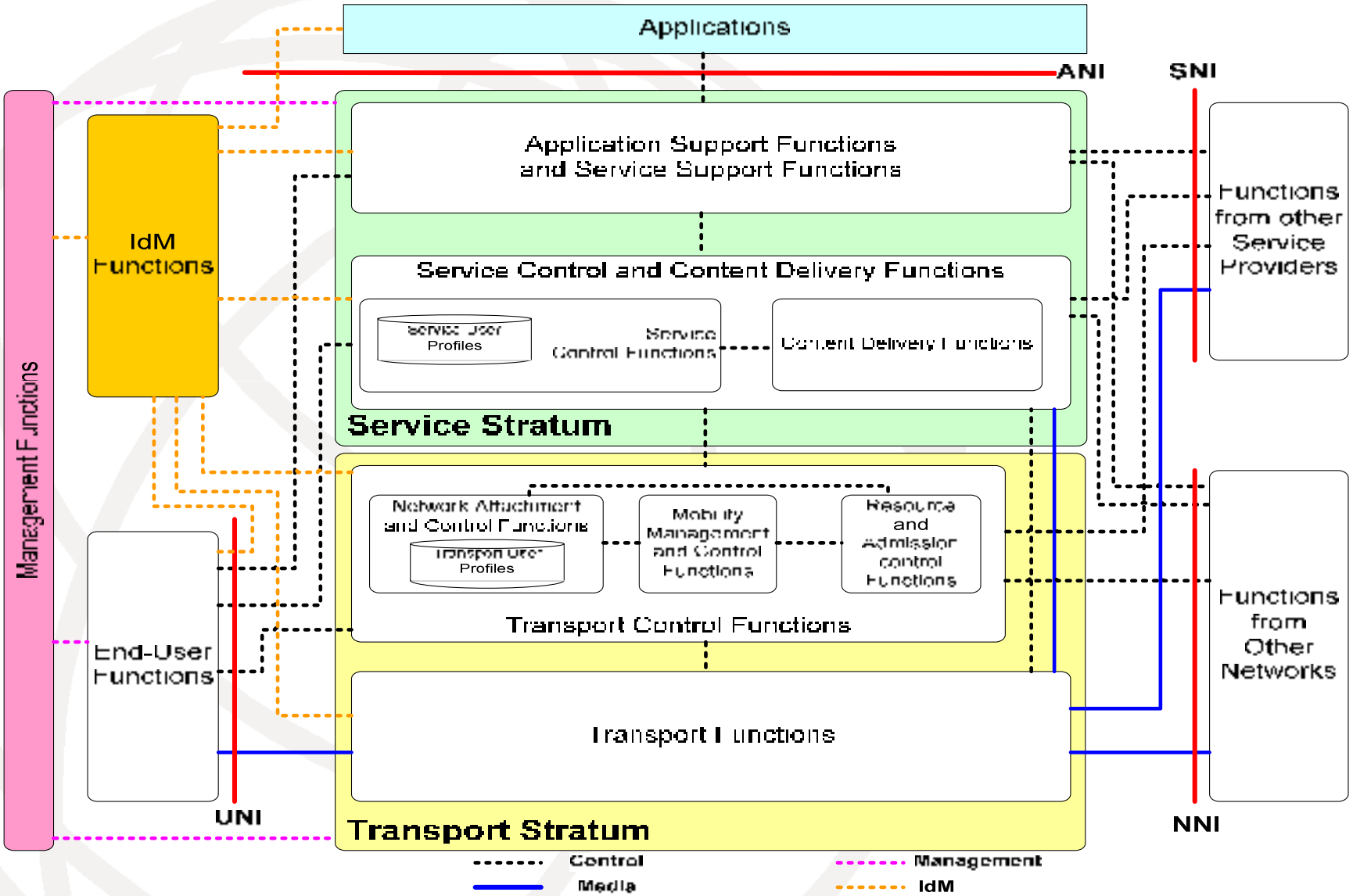
- **NGN Architecture objectives**
  - Support of a comprehensive set of services over a unifying IP layer network (converged network)
  - Support by Transport stratum of a multiplicity of access networks and a variety of mobile and fixed terminal types
  - Independent service provisioning (separable from transport stratum)
  - Distributed and open control, with enhanced security and protection
  - *Openness to application service development building on NGN capabilities*
  - *Integration with services and capabilities to of other networks (Internet)*
  - *Scalable and flexible to support a variety of emerging services, business models and emerging technologies*
  - *Possibly, an evolutionary path towards Future Networks objectives*
- **IMS was agreed as a core component of NGN Architecture**
  - IP Multimedia Service component
  - Extended 3GPP IMS capabilities usable by NGN (common IMS), but not only
  - Y.2012 “NGN Rel.1 FRA”, Y.2021 “IMS for NGNs”

Towards Future Networks

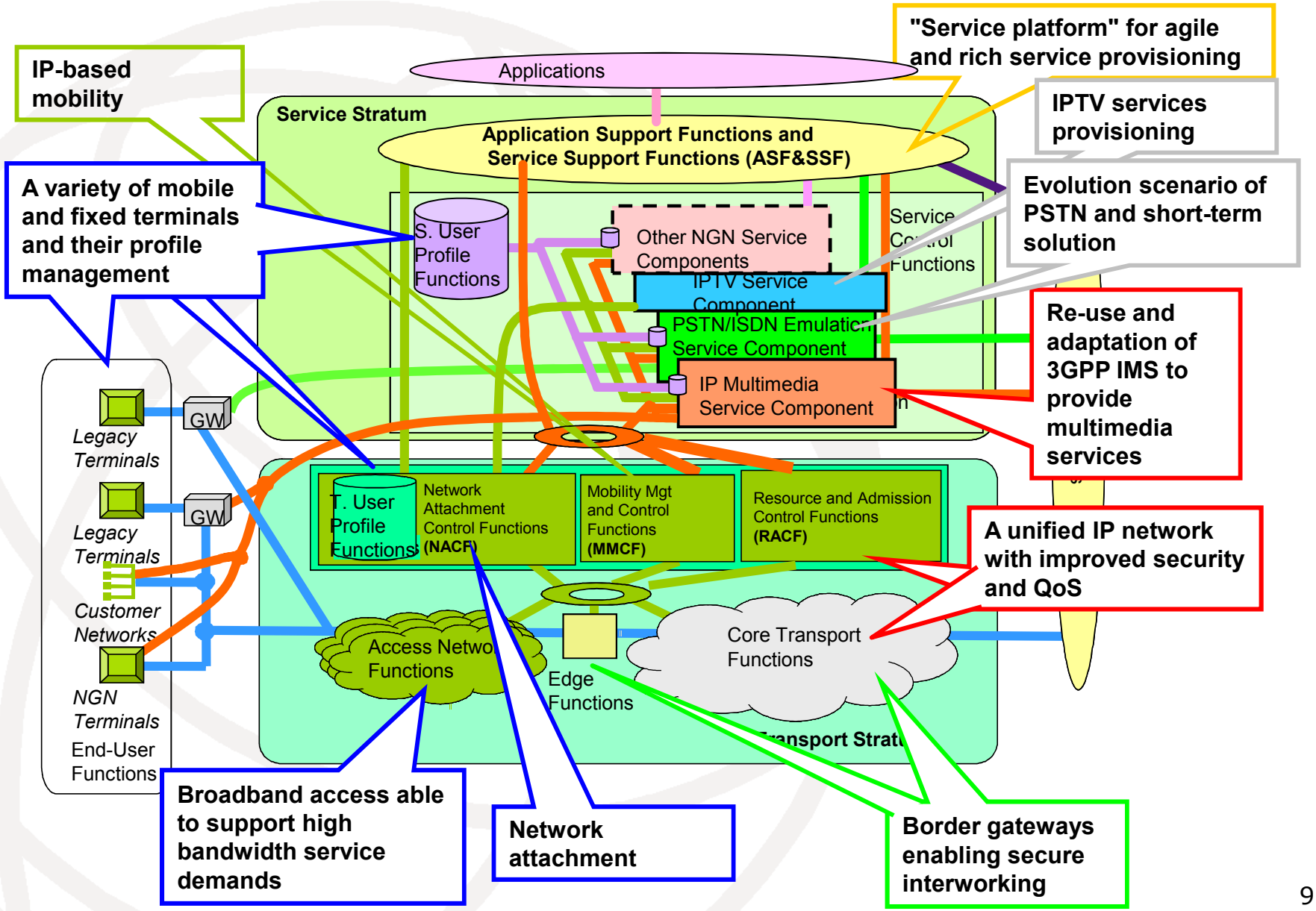


The 4 objectives and 12 design goals of Future Networks (FNs) -
Source: ITU-T Rec. Y.3001 "Future networks: Objectives and design goals"

NGN functional reference architecture [Y.2012, 04/2010]



"NGN components" (functional view) [Y.2012 4/2010]



Notes to Y.2012 04/2010 (1/2)

Additional functional features of Y.2012 2010 compared to Y.2012 2006:

- Introduction of the SNI reference point in the NGN architecture;
- Support for mobility in the transport stratum via the introduction of the MMCF component in the NGN architecture and related functional entities [ITU-T Y.2018];
- Introduction of content delivery functions and related functional entities;
- Introduction of new functional entities in the ASF&SSF that can be used for the support of IPTV services;
- Details of CPN gateway functions and related functional entities;
- Introduction of identity management functions and related functional entities in the NGN architecture; a new appendix shows an example illustration of IdM in NGN;
- Introduction of a new annex regarding the support of IPTV services in NGN. This annex provides the mapping between functions and functional blocks defined in [ITU-T Y.1910] and NGN functions and functional entities defined in this Recommendation;
- Introduction of functional entities regarding forwarding in the transport functions,. This Recommendation describes the use of these functional entities for the support of multicast in the NGN transport stratum and its relationship with [ITU-T Y.2017];
- Addition of the management of performance measurement (MPM) in the management functions. MPM functions are described in [ITU-T Y.2173].

Notes to Y.2012 04/2010 (2/2)

- UNI, NNI, ANI and SNI should be understood as general NGN reference points that can be mapped to specific physical interfaces depending on the particular physical implementations.
- The instantiation of the NGN reference points is useful to clarify the specific role of the NGN reference points in terms of service offering and the physical implementation entailed.
- The NGN-UNI deals with the functional aspect only and should not make any pre-decision about an ownership domain.
- Some functional groups, such as RACF, NACF, MMCF, CDF and SCF, can optionally be distributed and instantiated over different NGN provider domains. The functional groups in service and transport stratum can optionally be distributed between a "visited network" and a "home network" (NGN terminology [ITU-T Y.2091]) .
- User profiles in both service and transport stratum are shown as separate functional databases. Depending on the business model, these two databases can be co-located.
- Other functional databases required for the support of NGN services (such as DNS) are not illustrated.

Requirements and Capabilities of NGN

- **Y.2201 "High level requirements and capabilities to support NGN Release 1 service objectives" - approved in April 07**
  - Only network capabilities (no user equipment capabilities)
- **Y.2201 Rev1 "Requirements and capabilities for ITU-T NGN" - approved in Sept 09**
  - Includes user related and service-specific requirements
- **A number of specific Recommendations have been also developed covering the various capability areas and related requirements (including Security and IdM, QoS, Mobility and FMC, Accounting & Charging, Interconnection etc.)**

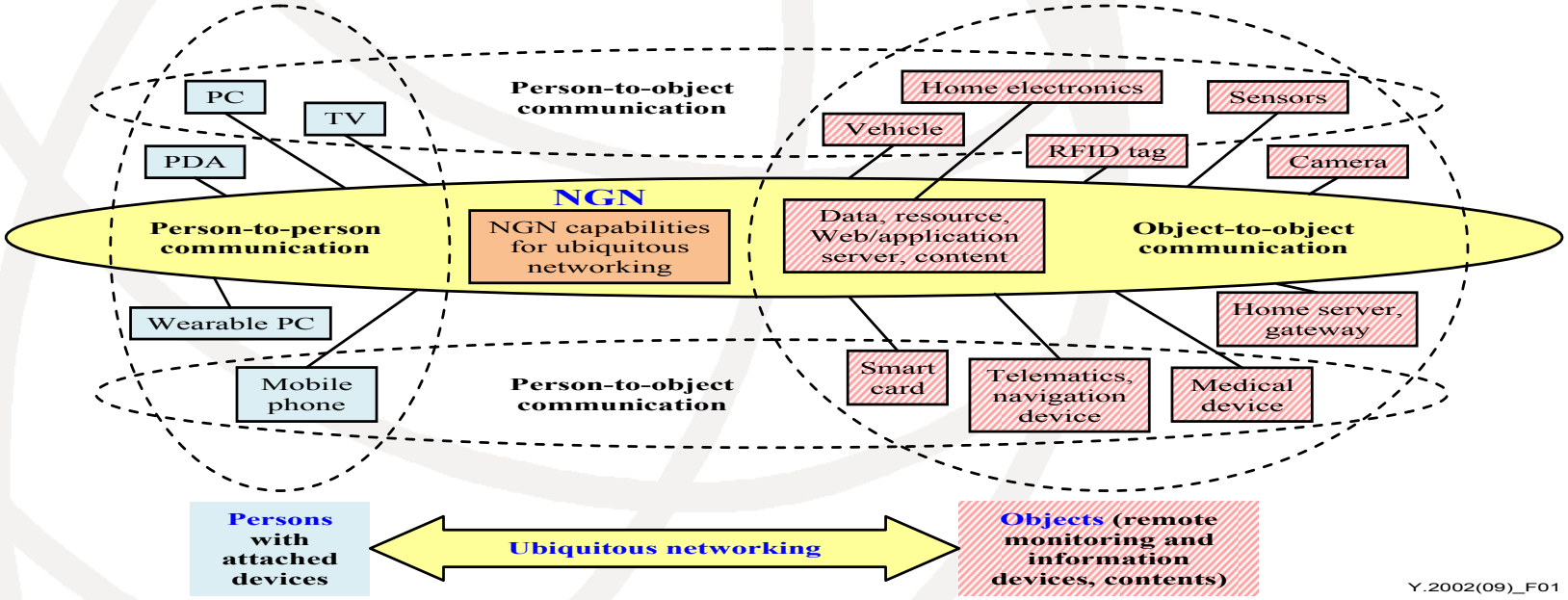
NOTE: each specific NGN realisation may support an arbitrary set of services, thus requiring the implementation of an arbitrary set of capabilities ("component oriented" view of services)

Some key achievements of ITU-T NGN standardization

"Ubiquitous networking" support in NGN

- Y.2002 Overview of ubiquitous networking and its support in NGN [Oct 09]
- Definition of "ubiquitous networking" [Y.2002]
  - Ability for persons and/or devices to access services and communicate while minimizing technical restrictions regarding where, when and how these services are accessed, in the context of the service(s) subscribed to.

    NOTE- although technical restrictions to access services and communicate may be minimized, other constraints such as regulatory, national, provider and environmental constraints may impose further restrictions.
- "Any Time, Any Where, Any Device, Any Service, Any Network" operations
- Human-to-Human, Human-to-Machine, Machine-to-Machine communications



Y.2002(09)_F01

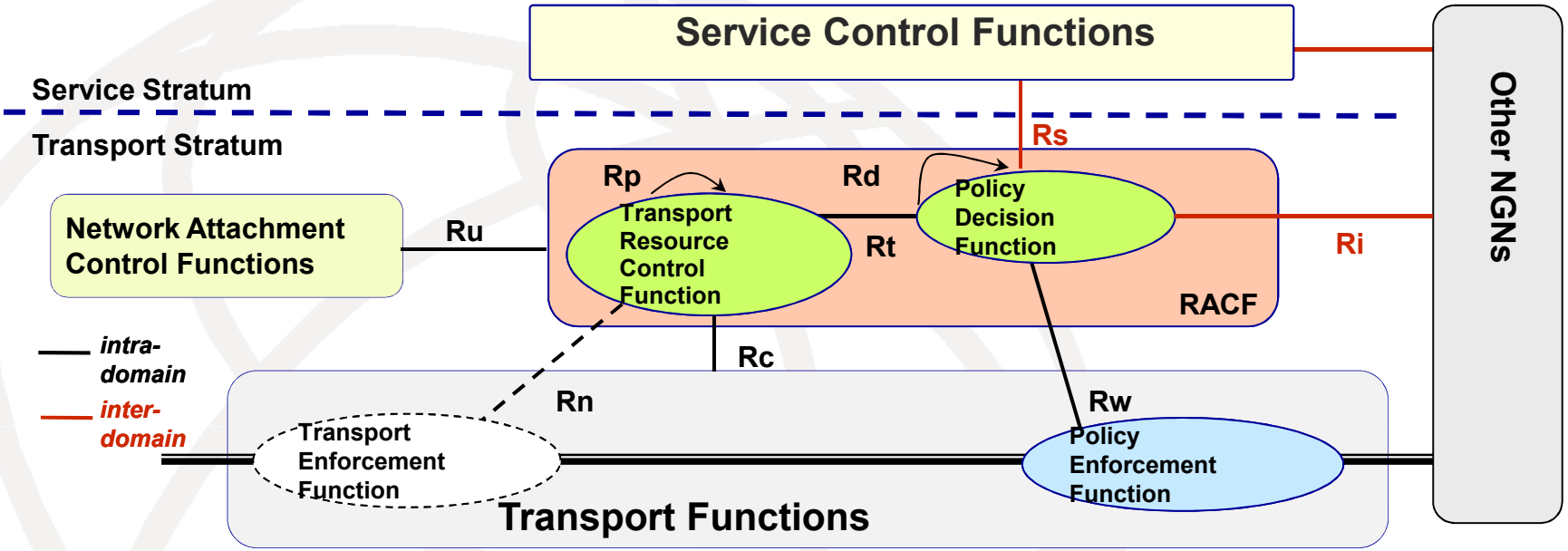
Main motivations for QoS and Security in NGN

Basic packet transport lacks inbuilt support for hard Security and Quality of Service

While

- Applications have diverse bandwidth and performance needs
- User devices have improving but varied capabilities
- Different access technologies are in use
- Multiple providers and walled gardens are involved end-to-end
- Networks and communications are vulnerable, while some actors are malicious or non-trustworthy

Resource and Admission Control Functions (RACF) [Y.2111]

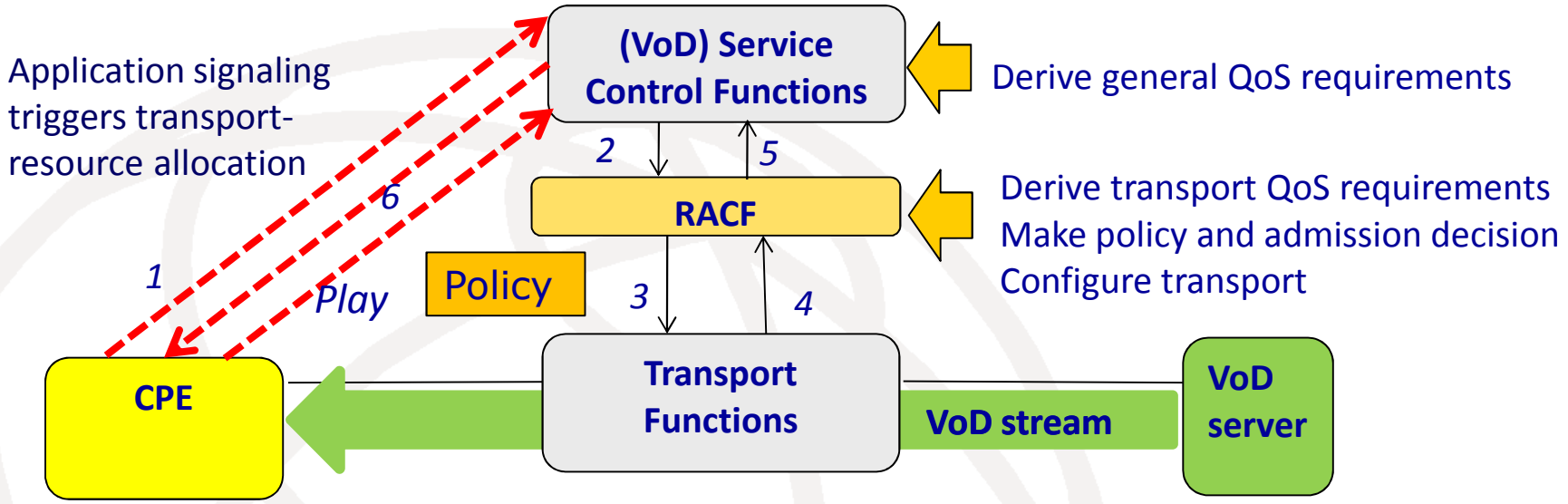


- Policy Decision Function
  service facing, transport independent
- Transport Resource Control Function
  service independent, transport dependent, network-segment specific
- Policy Enforcement Function
  typically part of border transport elements

RACF augments native transport QoS support

- Preempting transport congestion at the *service control layer*
- Protecting ongoing premium traffic

How RACF works – example with Unicast



Key achievements in QoS for NGN

Y.2111: *Resource and admission control functions in next generation networks*

Y.2121: *Requirements for the support of flow-state-aware transport technology in NGN*

Y.2122: *Flow aggregate information exchange functions in NGN*

Y.2171: *Admission control priority levels in Next Generation Networks*

Y.2172: *Service restoration priority levels in Next Generation Networks*

Y.2173: *Management of performance measurement for NGN*

Q.3300 to Q.3314: various Recommendations on resource control protocols

Security in NGN

Key Security objectives

- To address security dimensions
- To address security features required for secure domain interconnection

Key achievements in Security for NGN

Y.2701: *Security requirements for NGN release 1*

Y.2702: *Authentication and authorization requirements for NGN release 1*

Y.2703: *The application of AAA service in NGN*

Y.2704: *Security mechanisms and procedures for NGN*

Y.2705: *Minimum security requirements for the interconnection of the Emergency Telecommunications Service (ETS)*

Y.2720: *NGN identity management framework*

Y.2721: *NGN identity management requirements and use cases*

Y.2722: *NGN identity management mechanisms*

Y.2723: *Support for OAuth in next generation networks*

Y.2724: *Framework for supporting OAuth and OpenID in next generation networks*

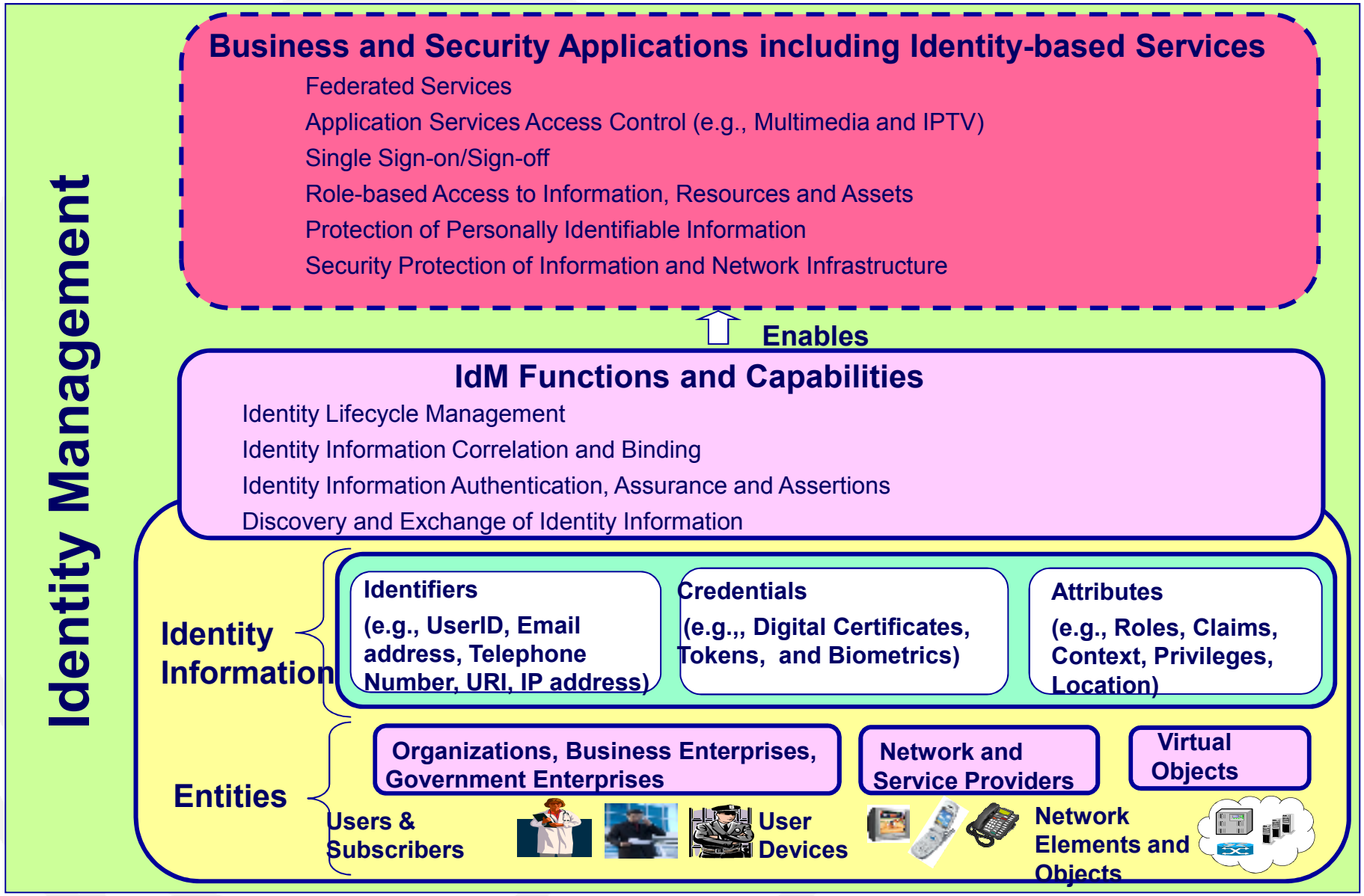
Y.2740: *Security requirements for mobile remote financial transactions in next generation networks*

Y.2741: *Architecture of secure mobile financial transactions in next generation networks*

Y.2760: *Mobility security framework in NGN*

Y.2770: *Requirements for deep packet inspection in next generation networks*

NGN IdM framework [Y.2720]

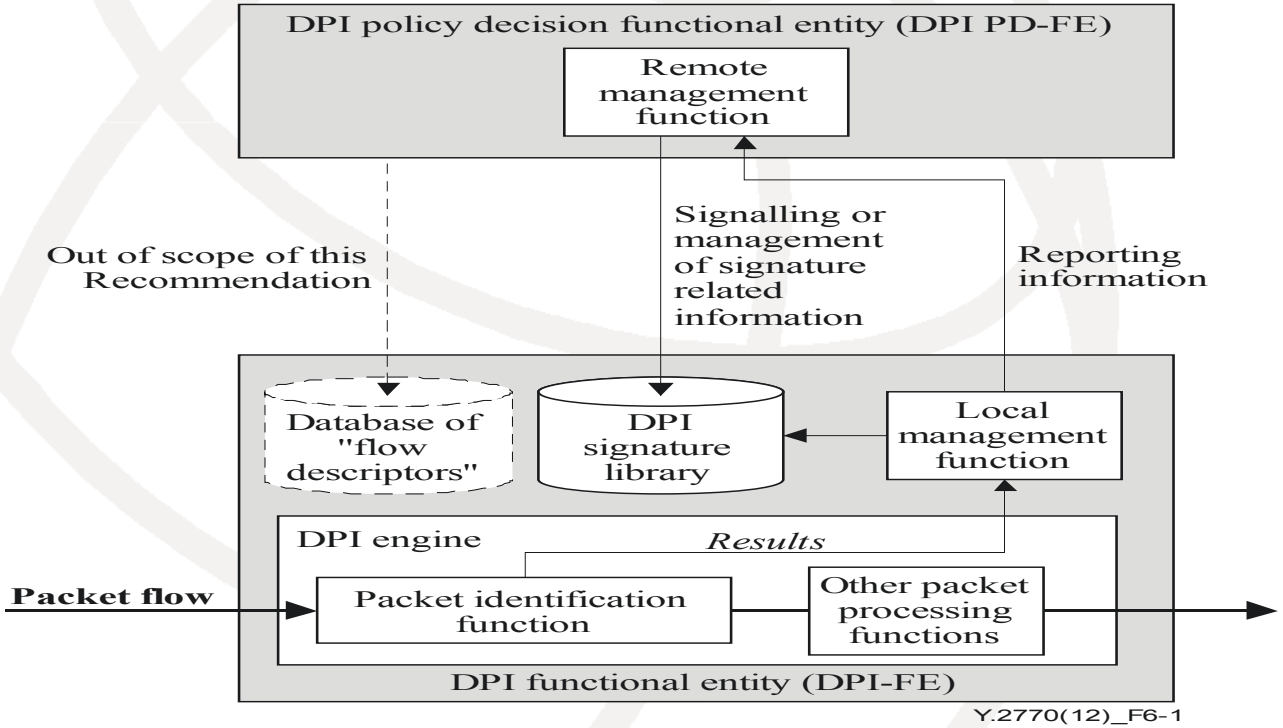


Deep Packet Inspection – Requirements [Y.2770]

		Packet-based network type	
		NGN	non-NGN
Packet bearer technology	IP	Applicable	Possibly applicable
	non-IP	Possibly applicable	Possibly applicable

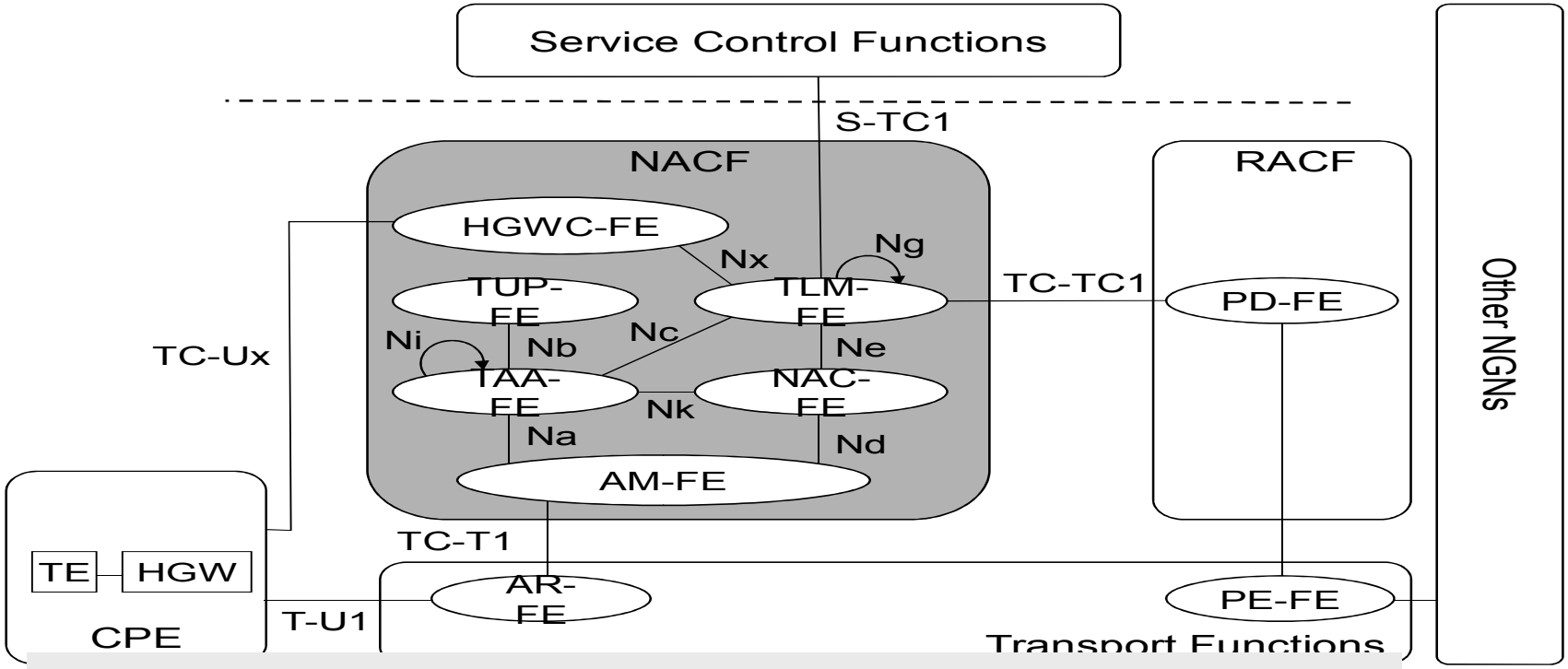
Y.2770(12)_F1-1

Applicability of Y.2770



DPI signature management within scope of example DPI funct. entity architecture

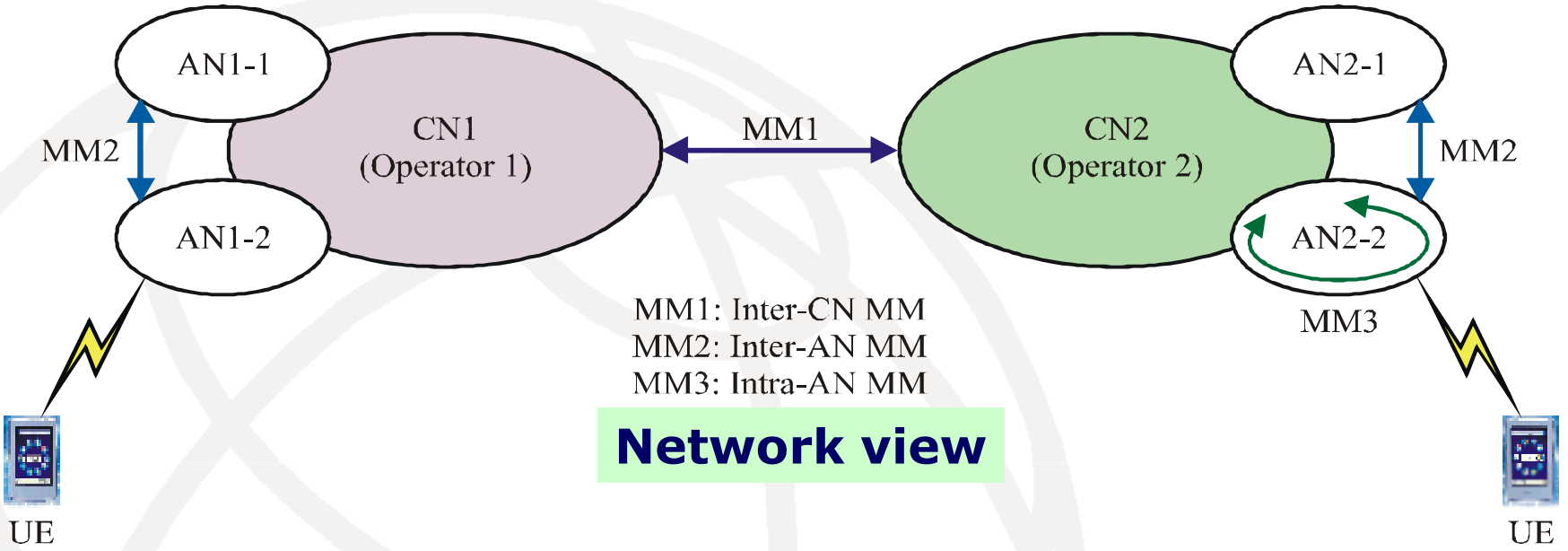
Network Attachment Control Functions functional architecture [Y.2014]



NAC-FE (Network Access Control Functional Entity)
AM-FE (Access Management Functional Entity)
TLM-FE (Transport Location Management Functional Entity)
TAA-FE (Transport Authentication and Authorization Functional Entity)
TUP-FE (Transport User Profile Functional Entity)
HGWC-FE (Home GateWay Configuration Functional Entity)
AR-FE (Access Relay Functional Entity)

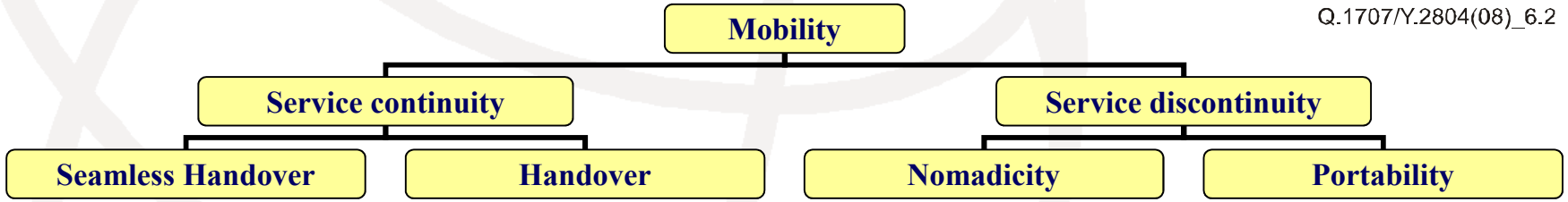
NACF protocol specifications are contained in Q.3220 to Q.3230

Mobility dimensions



MM1: Inter-CN MM
MM2: Inter-AN MM
MM3: Intra-AN MM

Network view



Q.1707/Y.2804(08)_6.2

Y.2801/Q.1706

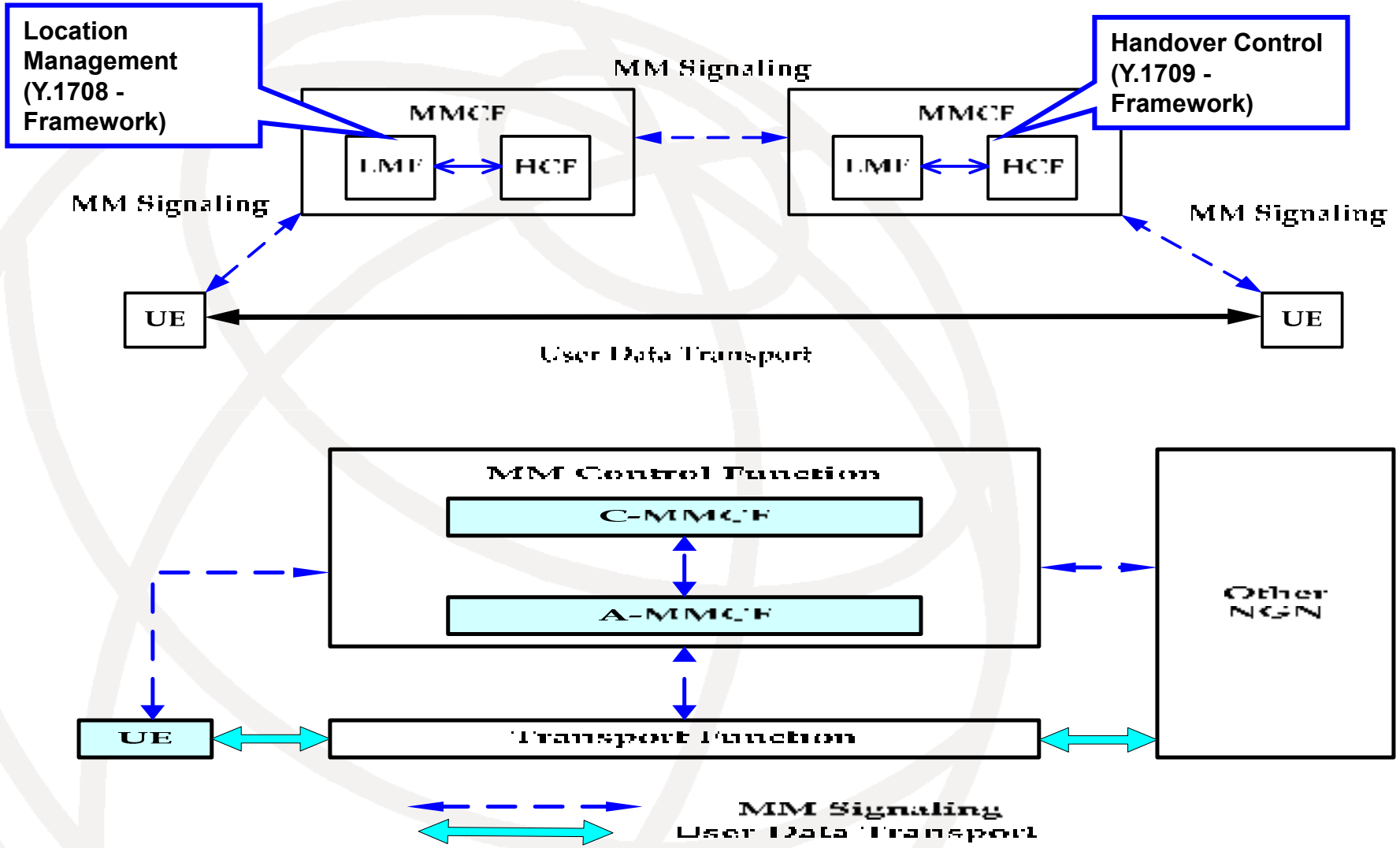
Quality of Service view

Mobility: from Nomadism to Service continuity

- **NGN Release 1 required support of "Nomadism" [Y.2201]**
  - **"The ability to change network access point on moving, without maintaining service continuity"**
  - To be supported between networks and within a network
  - NOTE: support for service continuity is not excluded (where specs exist)
- **Two types of mobility [Y.2201, Q.1706]**
  - **Personal Mobility: the user moves (between terminals)**
  - **Terminal (Device) Mobility: the device moves (with its binded user)**
- **No new interfaces defined for Release 1 Mobility**

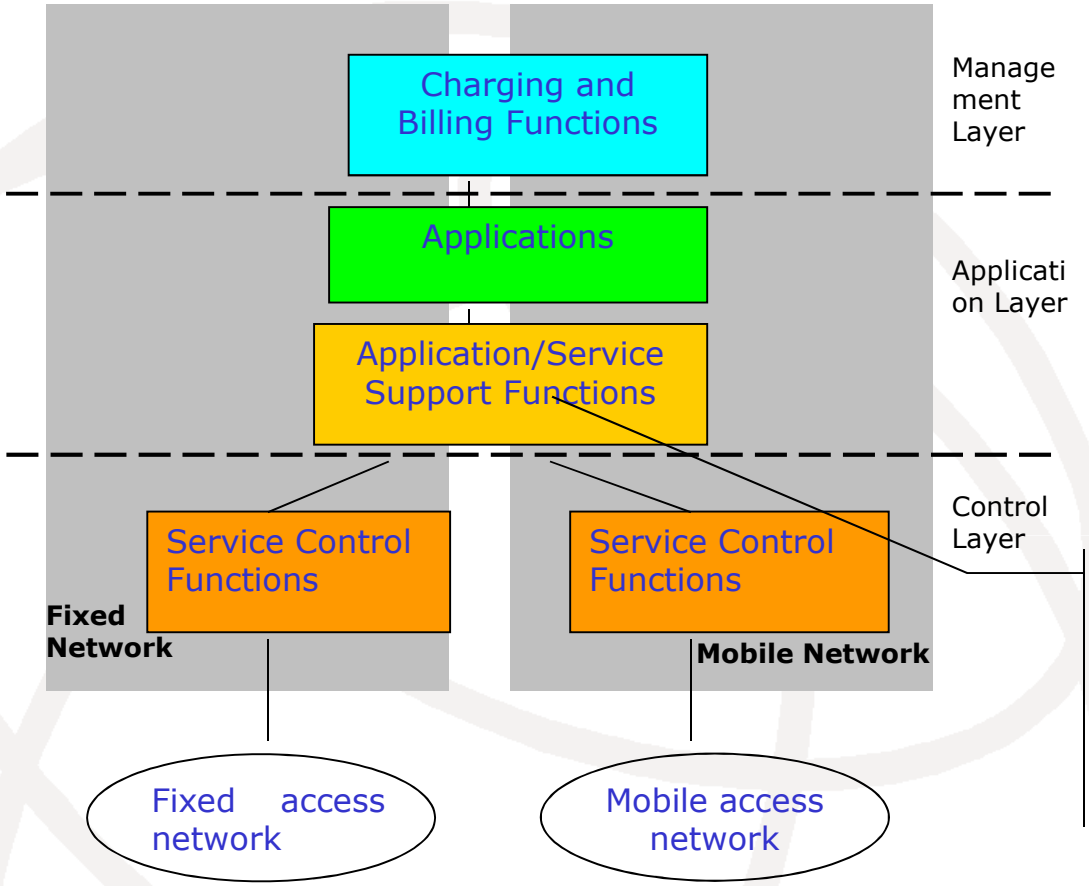
- **Service continuity as step 2 of Mobility [Y.2201 Rev.1]**
  - **NGN support of service continuity is recommended in Intra-AN and Inter-AN scenarios for personal and terminal mobility**
    - **Implementation levels may vary (depending on conditions such as access technology restrictions and Provider's service level support)**
    - **For voice services, service continuity required for terminal mobility**
  - **NGN is recommended to allow adaptation for service continuity when users' reqts and network conditions mismatch (e.g. (re)negotiation of network QoS and terminal parameters (codec))**

Mobility Management functional architecture – [Y.2804/Q.1707]



Functional architecture-level view of MMCF in NGN

Fixed Mobile Convergence (FMC)



Convergence may be happen at different functional levels

This is an example of convergence in Application/Service Support Functions

Key achievements:

Y.2802/Q.1762: FMC characteristics, requirements, capabilities, scenarios

Y.2803/Q.1763: FMC service using legacy PSTN/ISDN as fixed Access Network for mobile users

Y.2808: FMC with a common IMS session control domain

Achievements in Mobility and FMC for NGN

Y.2801/Q.1706: ***Mobility management requirements for NGN***

Y.2802/Q.1762: ***Fixed-mobile convergence general requirements***

Y.2803/Q.1763: ***FMC service using legacy PSTN or ISDN as the fixed access network for mobile network users***

Y.2804/Q.1707: ***Generic framework of mobility management for next generation networks***

Y.2805/Q.1708: ***Framework of location management for NGN***

Y.2806/Q.1709: ***Framework of handover control for NGN***

Y.2807: ***MPLS-based mobility capabilities in NGN***

Y.2808: ***Fixed mobile convergence with a common IMS session control domain***

Y.2809: ***Framework of mobility management in the service stratum for next generation networks***

Y.2810: ***Mobility management framework for IP multicast communications in next generation networks***

Y.2811: ***Framework of the mobile virtual private network service in next generation networks***

Y.2812: ***Mobility management for interworking between WiMAX and UMTS***

Y.2251: Multi-connection requirements

Y.2252: Identification and configuration of resources for multi-connection

Y.2253: Capabilities of multi-connection to support streaming services

Y.2254: Capabilities of multi-connection to support enhanced multimedia telephony services

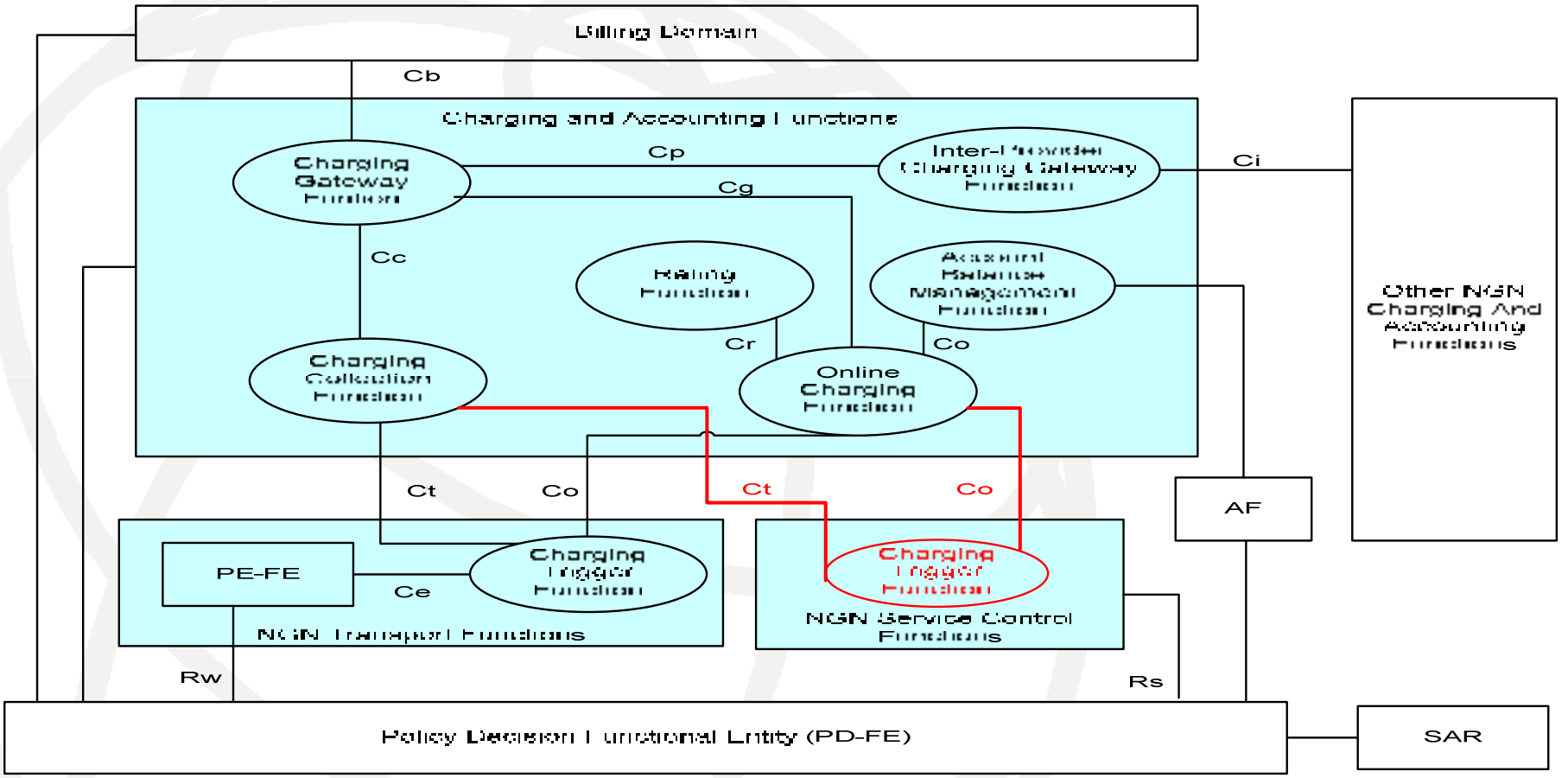
Requirements of NGN Accounting & Charging [Y.2233 Rev1]

- Secure, reliable, scalable and seamless A&C operations
- A&C architecture with open-standard interfaces
- Different interfaces and protocols
- Policy control Elements and A&C Elements
- A&C functionalities for both unicast and multicast based services
- Different charging policies (e.g. fixed rate, usage based)
- Per-user offline charging and online charging
- Service level and transport level charging
- Per-service and per-medium charging
- Per-QoS level charging (incl. network resource usage based)
- Appropriate charging arrangement models
- Coordination with Resource Control functions (RACF)
- Flow-based charging
- 3rd party charging, real-time modification of accounting policies, dynamic rating, customer account hierarchy

NOTE – A new work item approved at Feb 2014 WP1/13 meeting aims to identify scenarios and functional requirements for **«Free Data» service** in NGN evolution (« Free » means here « at no cost for the users of the service »).

Service Providers' rationale for this new work item: the current technical solutions (charging and other, incl. provisioning operations) do not scale for the implementation of this service.

NGN policy-enabled
Accounting & Charging capabilities [Y.2233 Rev.1]



Policy enablement based on multiple attributes

- Access specific characteristics, bearer QoS, service type, time, user subscription info etc.

PSTN/ISDN and the Migration to NGN: preserving the existing services

In evolution path to NGN, NGN shall support:

- legacy terminal equipment (e.g. PSTN/ISDN phones)
- PSTN/ISDN-like capabilities

PSTN/ISDN Emulation

- From the end user perspective, the NGN "appears" supporting the same types of services offered by the existing PSTN/ISDN
- Legacy terminals are enabled to continue to use existing telecommunication services while connected to NGN
- Implemented via adaptation to an IP infrastructure

PSTN/ISDN Simulation

- NGN terminals in an NGN network are enabled to use PSTN/ISDN-like service capabilities
- But legacy terminals with terminal adaptations may be used too
- Implemented over IP-based control infrastructure (e.g. using SIP)

Standards achievements in Migration to NGN

Scenarios for PSTN/ISDN evolution to NGN [Y.2261]

- Aspects to consider about migration
- Call Server (SoftSwitch) based core network evolution: 3 scenarios (start from Local Exchanges, start from Transit Exchanges, One-step)
- IMS-based core network evolution: One-step scenario
- Access network evolution: xDSL access network scenario

Generalities on PSTN/ISDN Emulation and Simulation [Y.2262]

- Adaptation functions for legacy user equipment at UNI user/network side

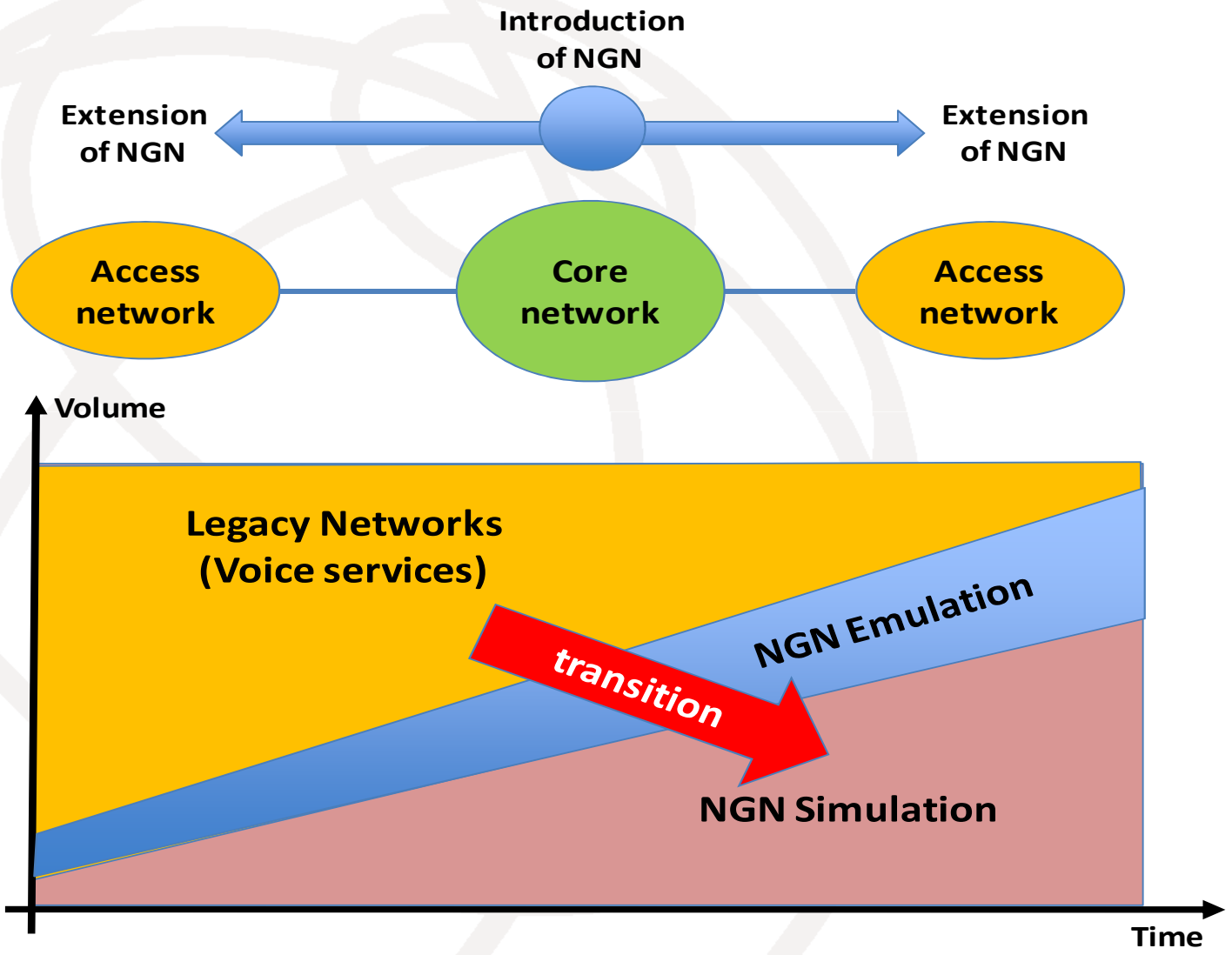
PSTN/ISDN Emulation

- 2 approaches for emulation: Call Server based [Y.2271], IMS based
- PSTN/ISDN Emulation architecture [Y.2031]– «Emulation service component » in NGN

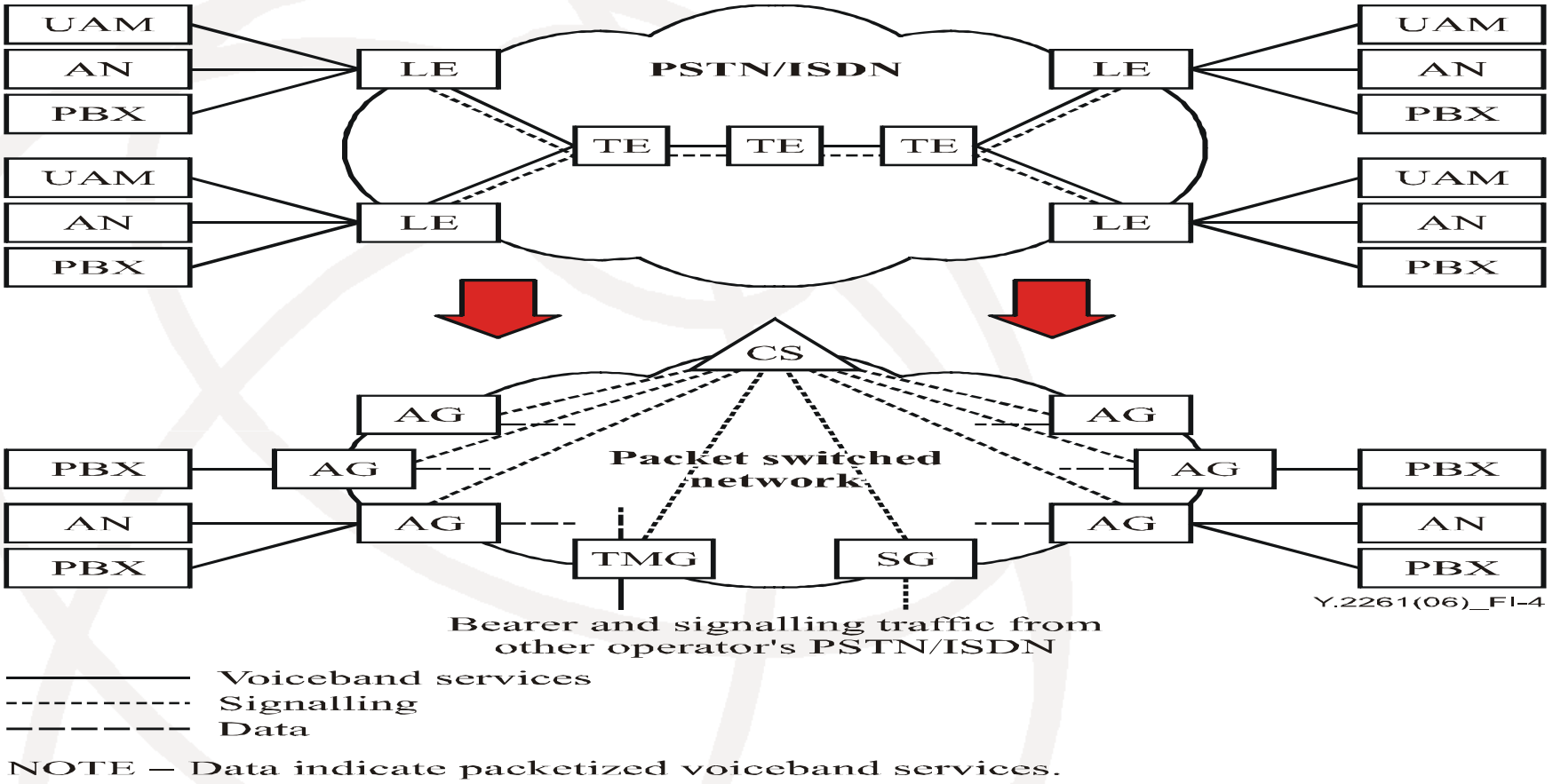
PSTN/ISDN Simulation

- PSTN/ISDN simulation services rely on IMS capabilities (3GPP MMTel)
- Requirements in [Y.2211], OIP/OIR protocol specification in [Q.3614]

General view of migration scenarios to NGN



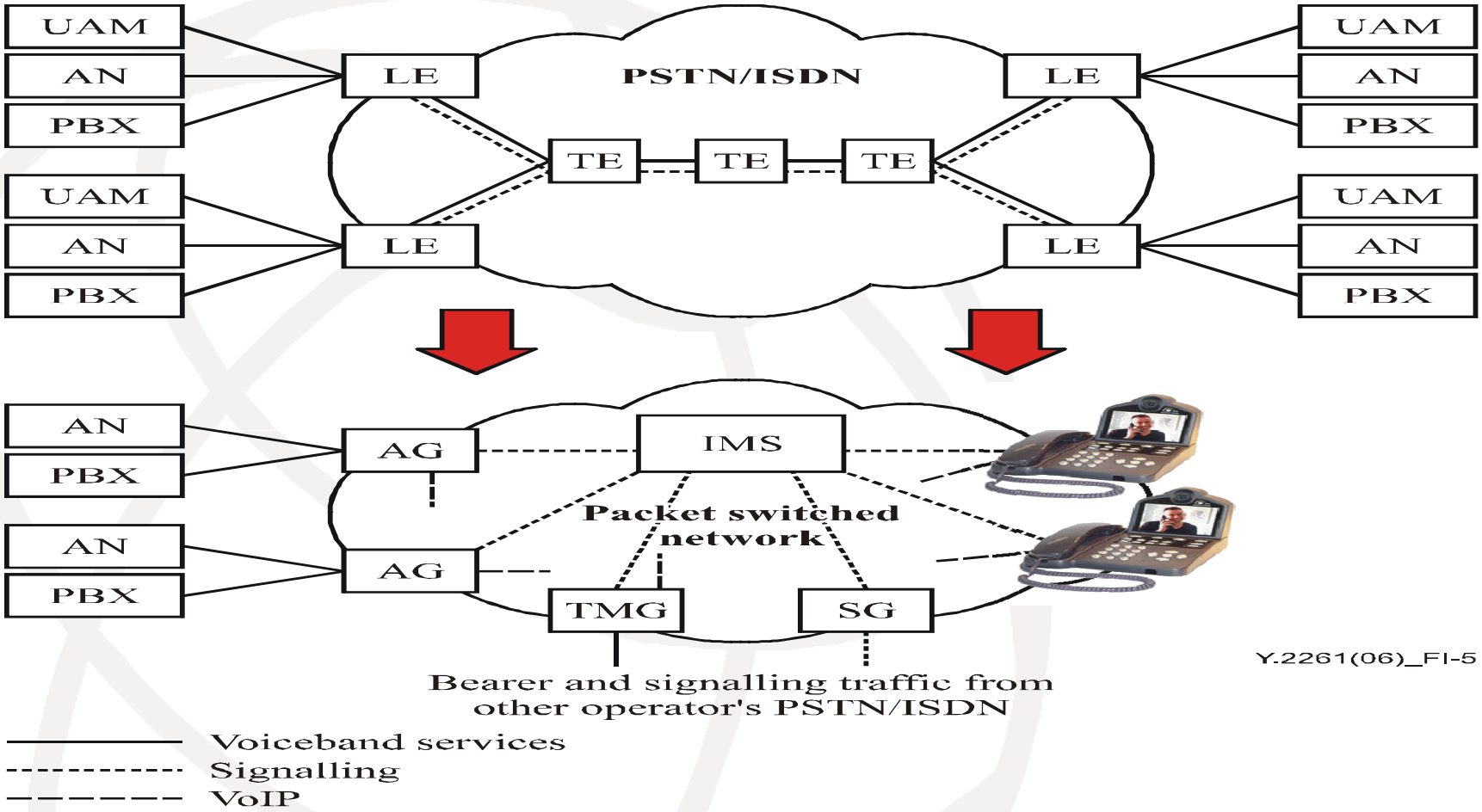
PSTN/ISDN evolution scenarios to NGN [Y.2261]: CS-based core network evolution



"One-step" scenario

- PSTN/ISDN is replaced with PSN in one step. LEs are replaced by AGs and their functions divided between AGs and CS

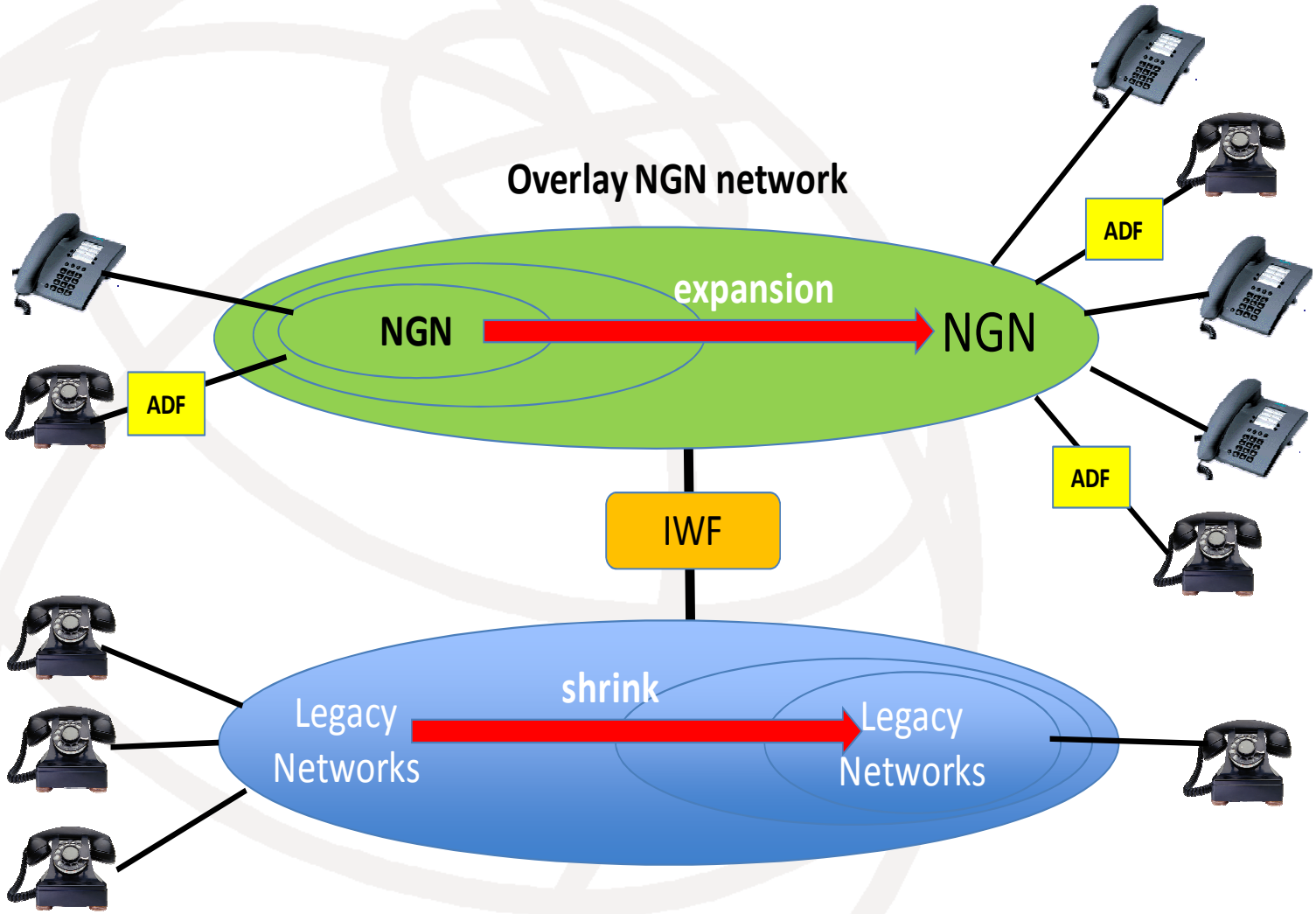
PSTN/ISDN evolution scenarios to NGN [Y.2261]: IMS-based core network evolution



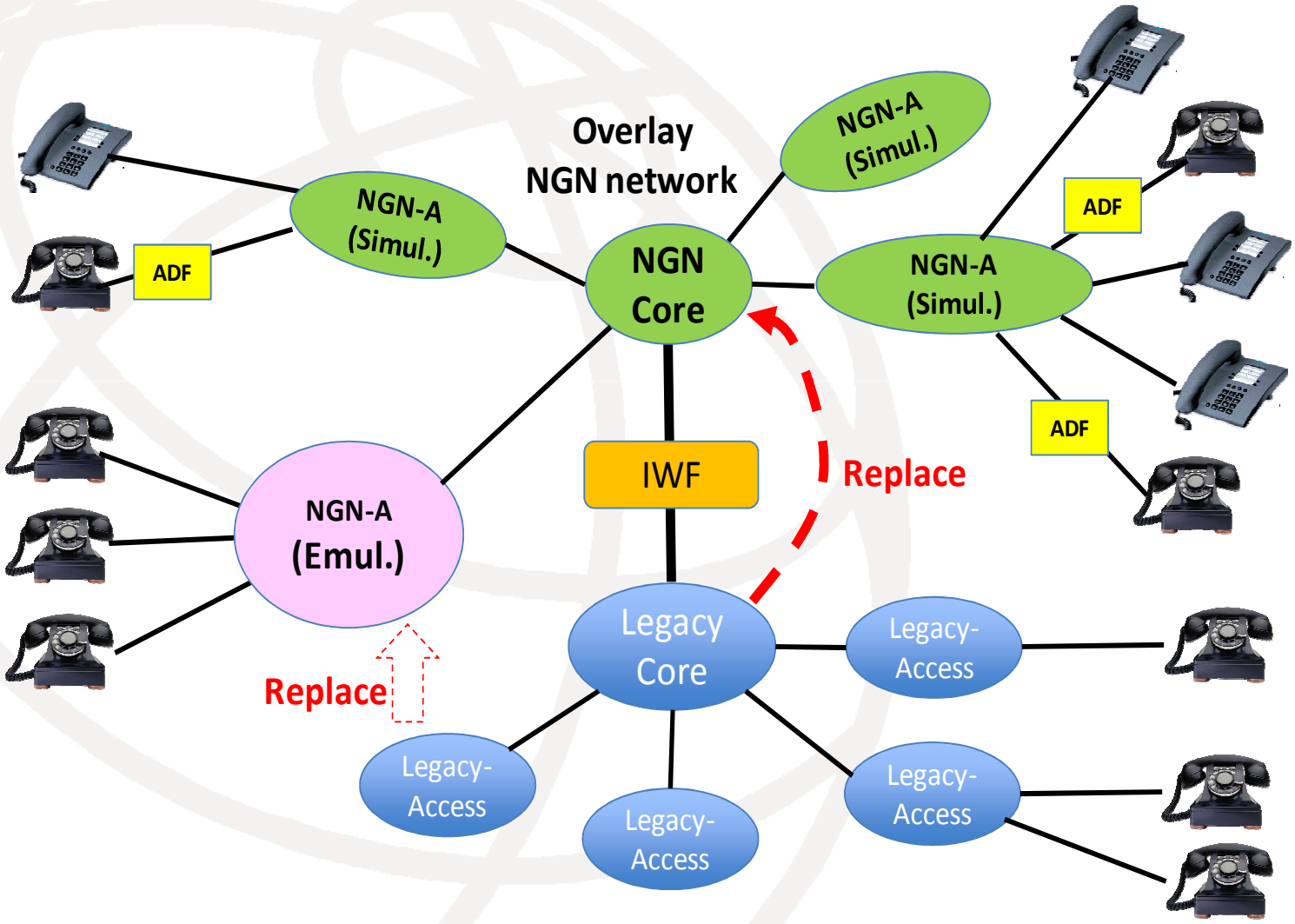
"One-step" scenario

- PSTN/ISDN evolves directly to a PSN based on IMS core network architecture. End-users access using NGN user equipment or legacy user equipment connected via AG

"Overlay" migration scenario



"Replacement" migration scenario



PSTN/ISDN Emulation architecture [Y.2031] – a specific Emulation Service component (PES) in NGN

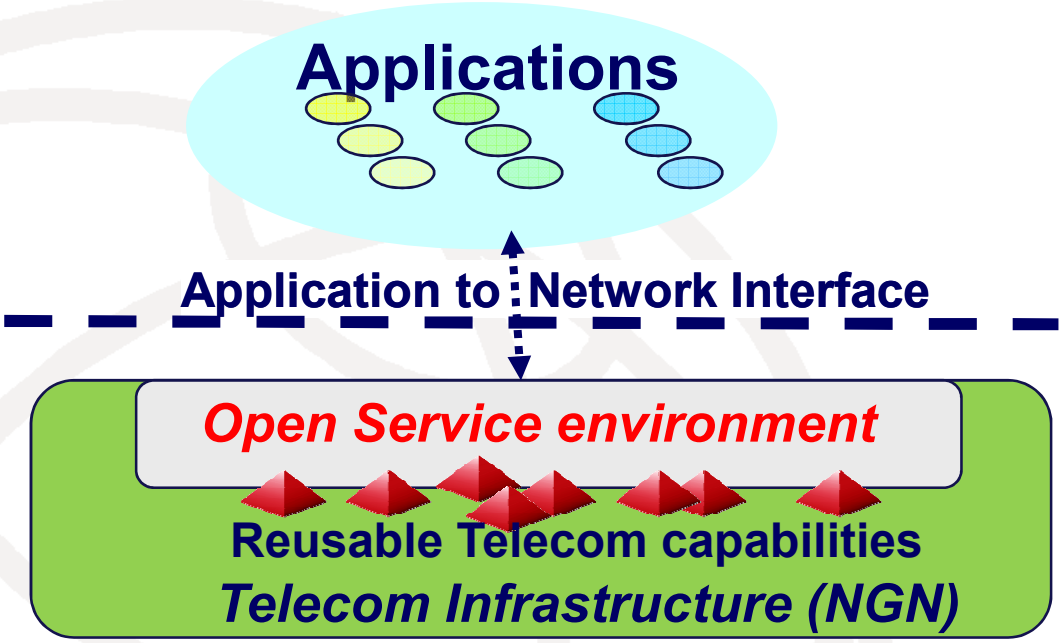
CS-based PES

- Depending on the network configuration, a CS may be functionally deployed as
  - Access call server
  - Breakout call server
  - IMS call server
  - Gateway call server
  - Routing call server
- Y.2031 provides mapping correspondence between CS-based PES functional entities and NGN functional entities

IMS-based PES

- The functional architecture of the IMS-PES is based on the IMS architecture
- Y.2031 provides mapping correspondence between IMS-based PES functional entities and NGN functional entities

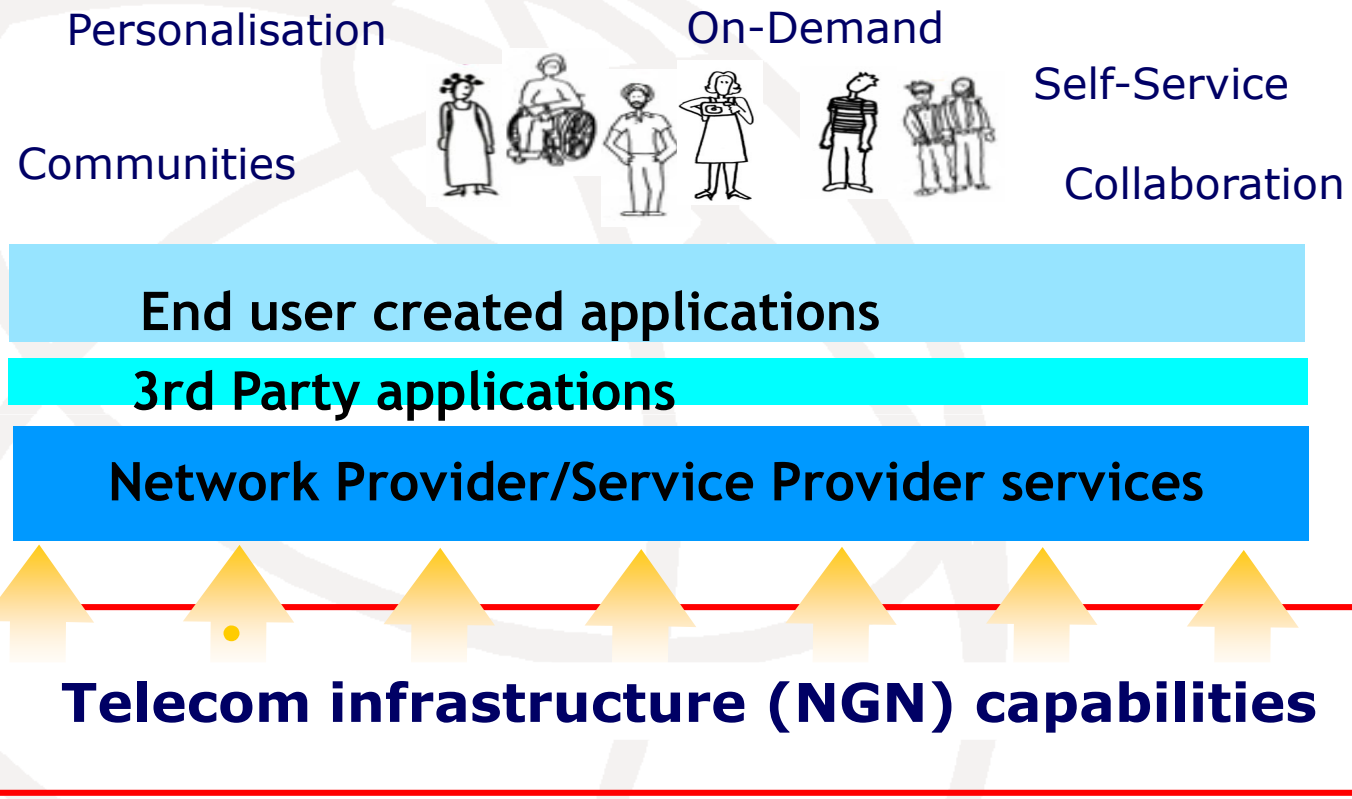
Open service environment for Telecom Infrastructure



- **Reusable Telecom capabilities for reduced service development costs**
  - Applying the development approach from IT industry to telecoms
- **Open service environment** for flexible and agile service creation, execution, management and deployment
  - "Rapid change" is key for satisfying the changing customer needs
  - New business opportunities via an environment integrating applications and telecom infrastructure

Telecom "Service Delivery Platform" (SDP) (with Apps Store)
[nowadays technically moving into private clouds]

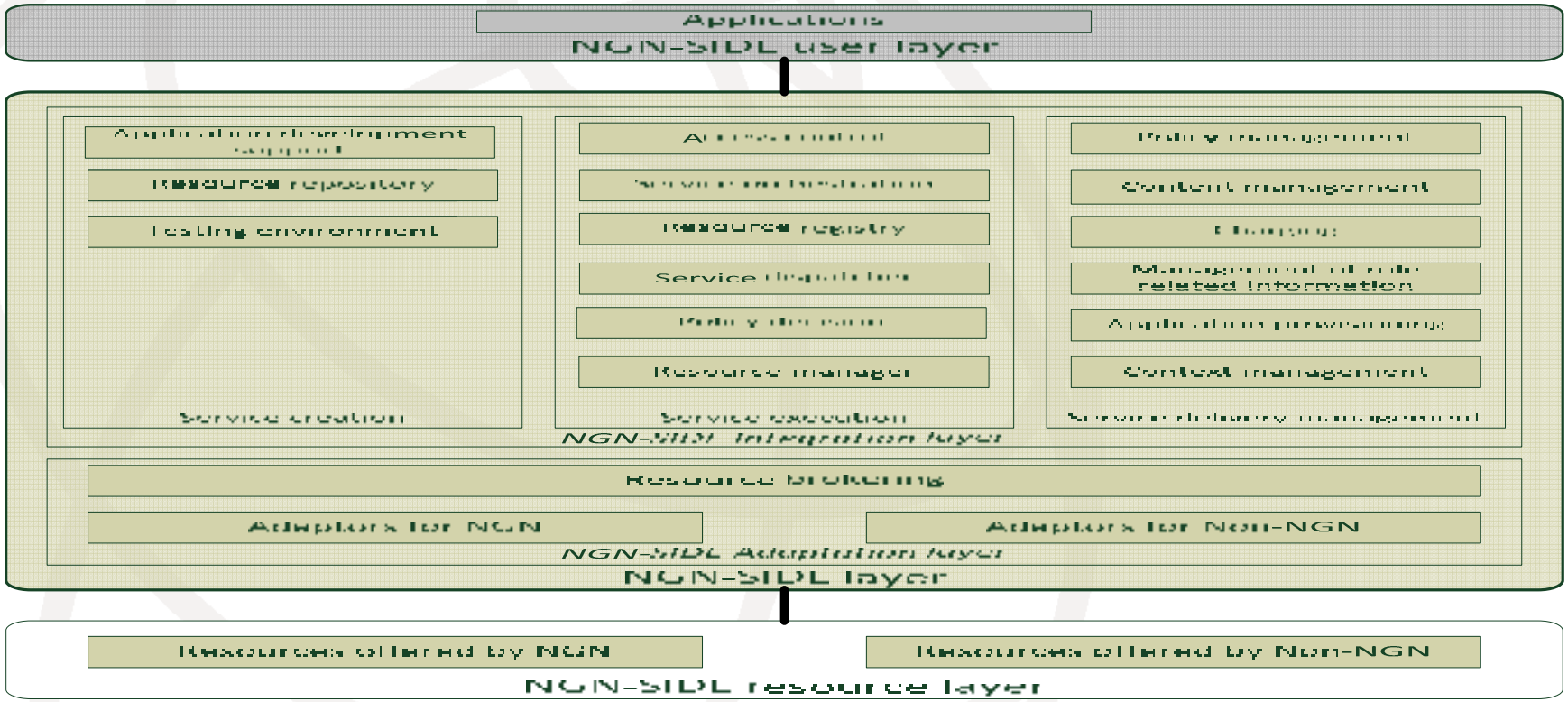
Increasing the business opportunities via a Telecom SDP ecosystem



The big challenge to this approach comes from the Internet giant players and OTT providers - they already have their own SDP: the Web (and can easily and quickly create new services)

Telecom SDP in NGN: NGN-SIDE

Y.2240 "Requirements and capabilities for NGN Service Integration and Delivery Environment (NGN-SIDE)" and Y.2025 "Functional architecture of NGN-SIDE (extending previous initial effort on OSE [Y.2234])



NGN-SIDE provides an open environment in NGN, with integration of resources from different domains, including Telecom domain (e.g. Fixed and Mobile Networks), Internet domain, Broadcasting domain, Content Provider domain

User Services to be supported by NGN

From NGN Release 1 objectives (Y Sup.Rel1 Scope)

- PSTN/ISDN Emulation services, PSTN/ISDN Simulation services [Y.2211]
- Multimedia services
- Data communication services (including VPNs [Y.2215])
- Public Interest Services
- Internet access not precluded

To NGN Release 2 objectives (Y Sup.Rel2 Scope)

- IPTV services (with/without IMS) [Y.1901, Y.1910, Y.2019 (based on Y.1910)]
- Managed Delivery Services [Y.2212]
- NID related services (services using tag-based identification [Y.2213], Ubiquitous Sensor Network services [Y.2221])
- Additional multimedia services (CMRT [Y.2214])
- Visual surveillance services
- Multimedia communication centre services [Y.2216]

And many other services later (with no Release linkage)

- ….
- **other IoT/M2M applications using NGN ? Augmented Reality using NGN ? Cloud Services using NGN ? Advanced Mobile Services using NGN ?**
- **Pros and cons of NGN, definitive technical limitations of NGN ?**

NOTE – NGN standardization approach doesn't require the definition (specification) of a service unless legal and regulatory requirements exist for it

Ongoing work - focus on some emerging and hot areas for NGN evolution

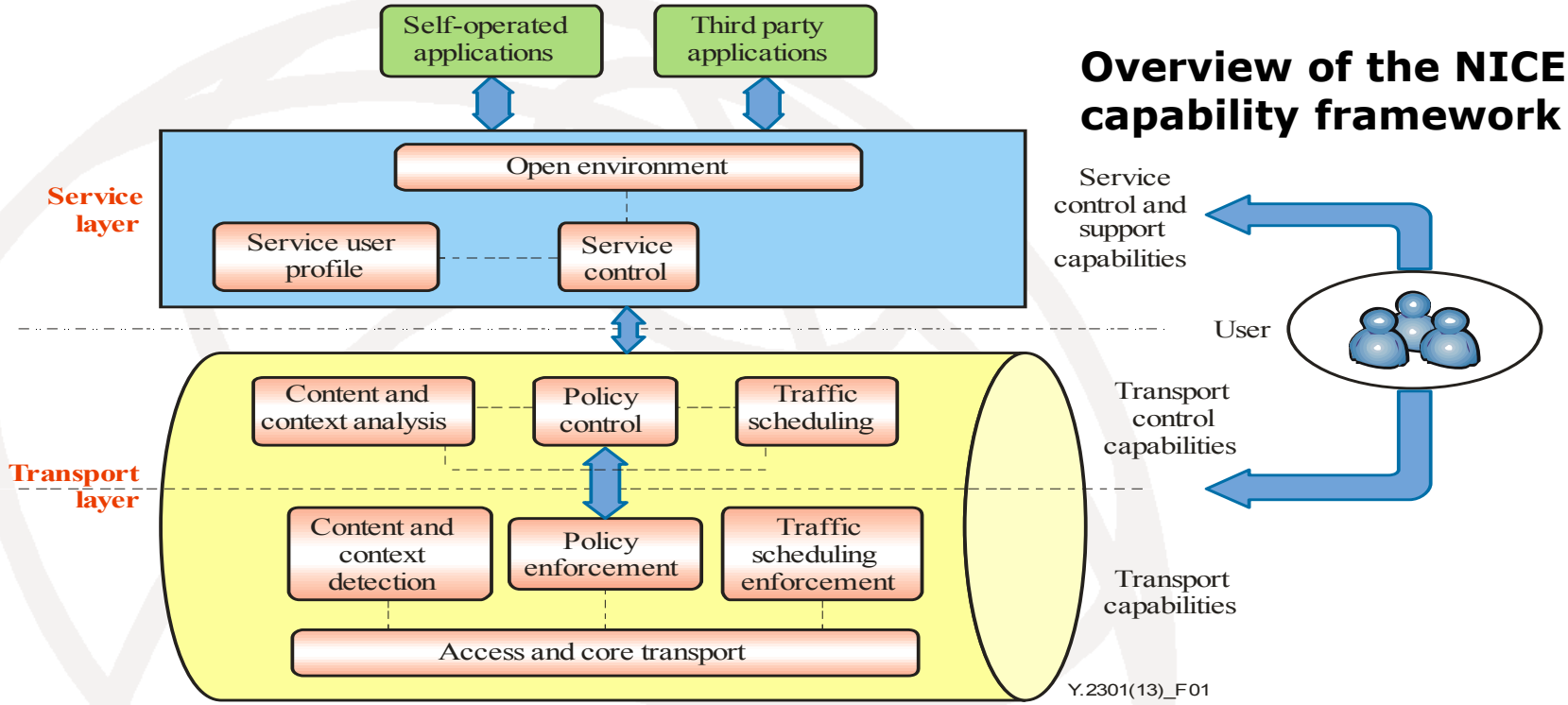
An "umbrella" Recommendation documenting NGN evolution (NGNe) phase by phase – work in progress

- **ITU-T Draft Rec. Y. NGNe1 "Overview of NGN evolution phase 1"**
- **Scope:** general overview of NGN evolution phase 1 in terms of overall requirements and capability framework.
- NOTE - Since NGN evolution is a non-stop long-term work, NGN evolution relevant Recommendations will be developed phase by phase.

- **Capabilities in NGN evolution phase 1 provide support for:**
  - Network Intelligence enhancements (based on NICE work)
  - Integration of Software Defined Networking (SDN) technology
  - Integration of Network Functions Virtualization (NFV) technology
  - Internet of Things applications

  NOTE 1 - Some other capabilities with urgent demand and reflecting the needs of the industry may be included along the progress of this document.
- NOTE 2 – This Rec. is intended to keep alignment with relevant Recs as appropriate or to assist the development of specific Recs in the future.

NICE [Y.2301, Y.NICE-Arch]: enhancing the NGN with network intelligence capabilities for service provisioning



Overview of the NICE capability framework

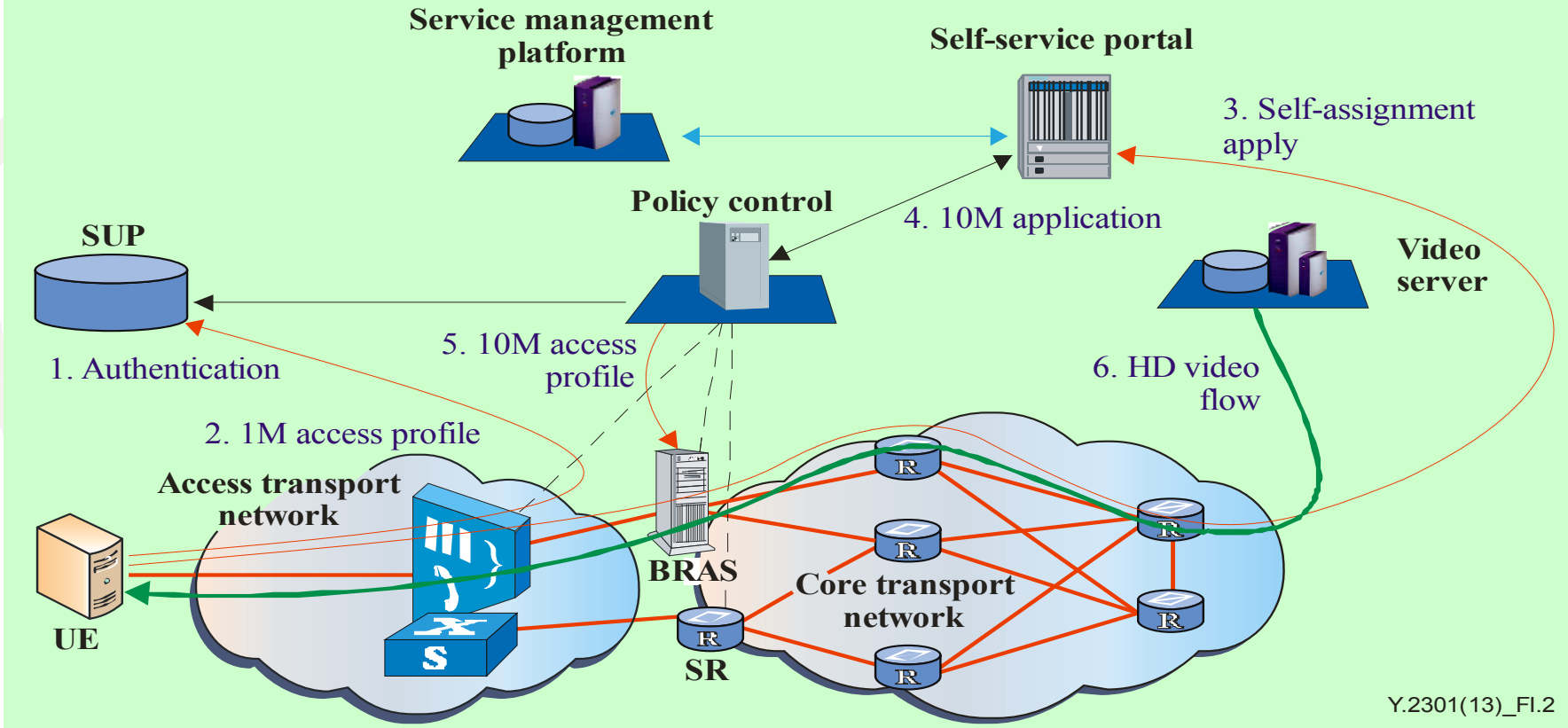
- **NICE capabilities** enable operators to assign and dynamically adjust specific network resources based on the requirements, as well as supporting interfaces for users and applications enabling on-demand resource and service provision

NICE is required to support the following features:

1)awareness features: user, application and network awareness with content and context analysis;
2)on-demand provision features: user self-assignment of service subscription and network resources, user on-demand service of quality assurance;
3)optimization features: traffic management based on intelligent traffic scheduling;
4)openness features: invocation of the above features by third-party application providers;
5)cooperation features: network coordination between policy control capabilities of different access networks.

Example use cases for NICE (1/2)

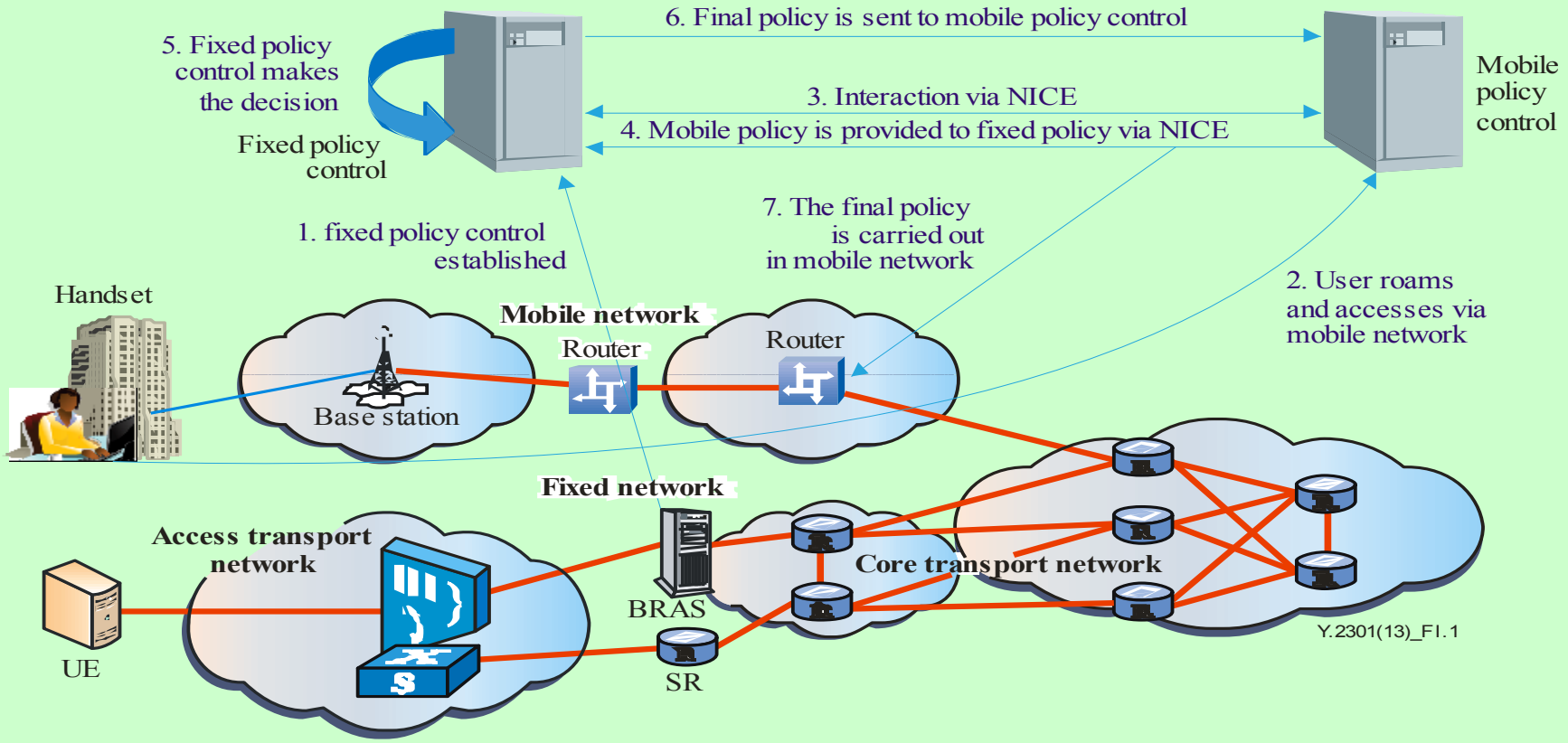
Use case of on-demand provision feature: user self-service access bandwidth assignment



A user subscribes to a fixed broadband network with 1 Mb/s data rate. His/her user profile is authenticated in the SUP. The user would like to have a high definition (HD) video on-demand service which requires 10 Mb/s data rate. In current situation, the user has to subscribe to a new service pack which requires manual operation and takes a lot of time. With NICE capabilities, the user can log onto a self-service portal and apply for a higher bandwidth automatically without further manual care.

Example use cases for NICE (2/2)

Use case of cooperation feature: unified user profile and charging case between fixed and mobile network



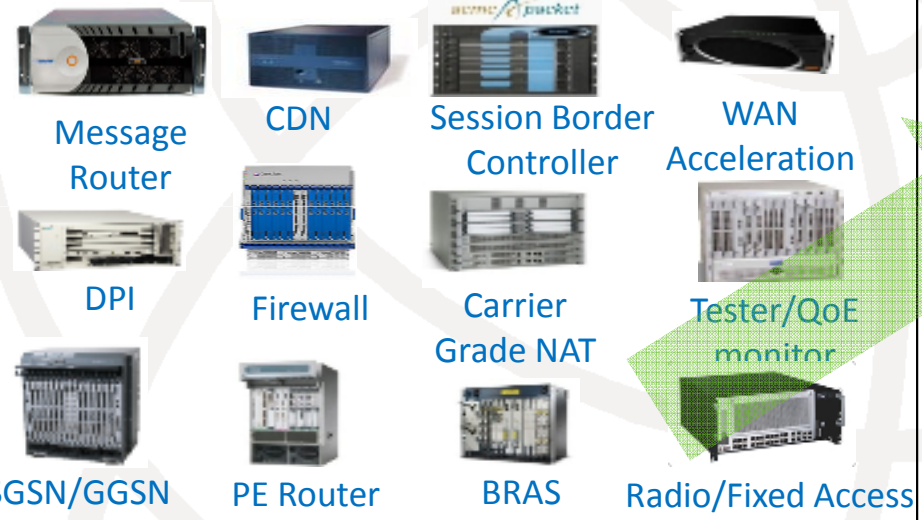
In traditional networks, when a user switches the network connection between mobile network and fixed network, policies (including charging rules, services, bandwidth, etc.) may change causing severe inconvenience.

With NICE capabilities, when the user roams between mobile and fixed network, the same policies can apply all the time.

Network Functions Virtualisation (NFV)

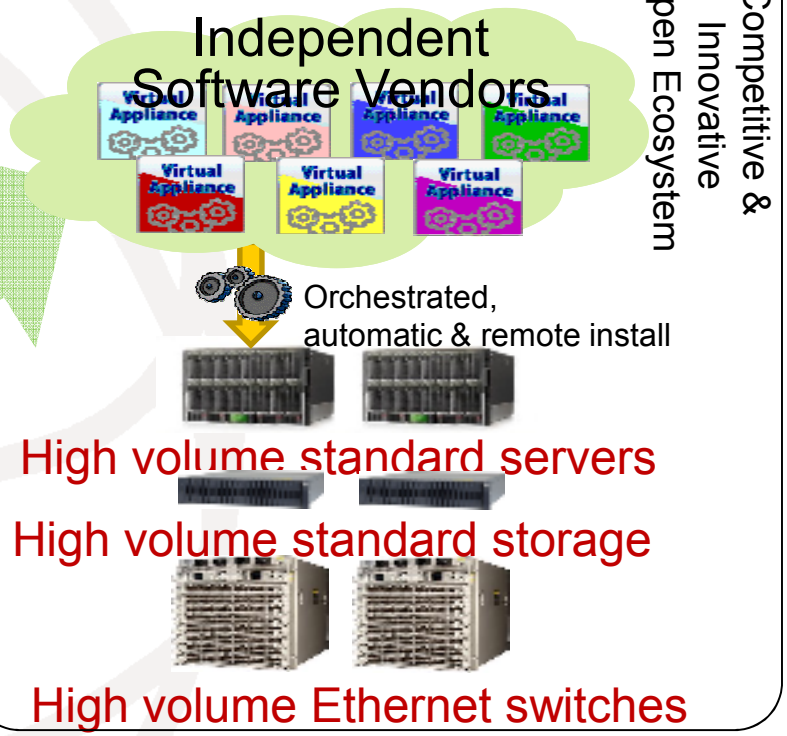
NFV is about implementing network functions in software (running today on proprietary hardware), leveraging (high volume) standard equipment and IT virtualization

Classical Network Appliance Approach



- Fragmented, purpose-built hardware
- Physical install per appliance per site
- Hardware development large barrier to entry for new vendors, constraining innovation & competition

Network Functions Virtualisation Approach

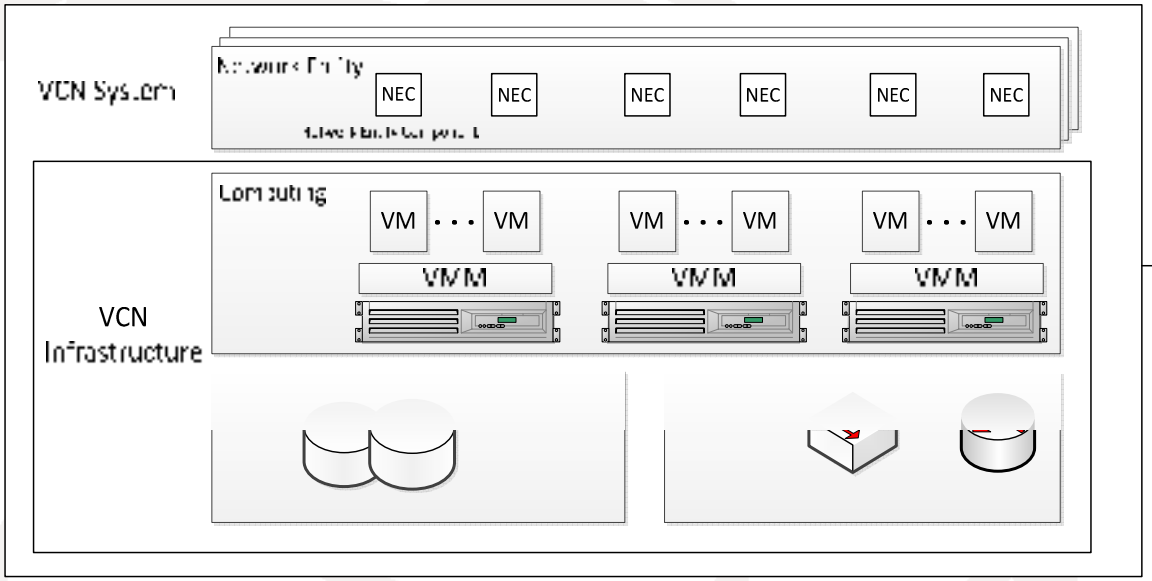


NFV is expected to be disruptive for telecom industry over next 2-5 years. A trend for all telecom networks, applicable to NGN.

Applying the NFV concept to NGN:

ITU-T draft Rec. Y.NGNe-VCN-Reqts "Requirements of Virtualization of Control Network (VCN) entities for NGN evolution" – work in progress

VCN system overview

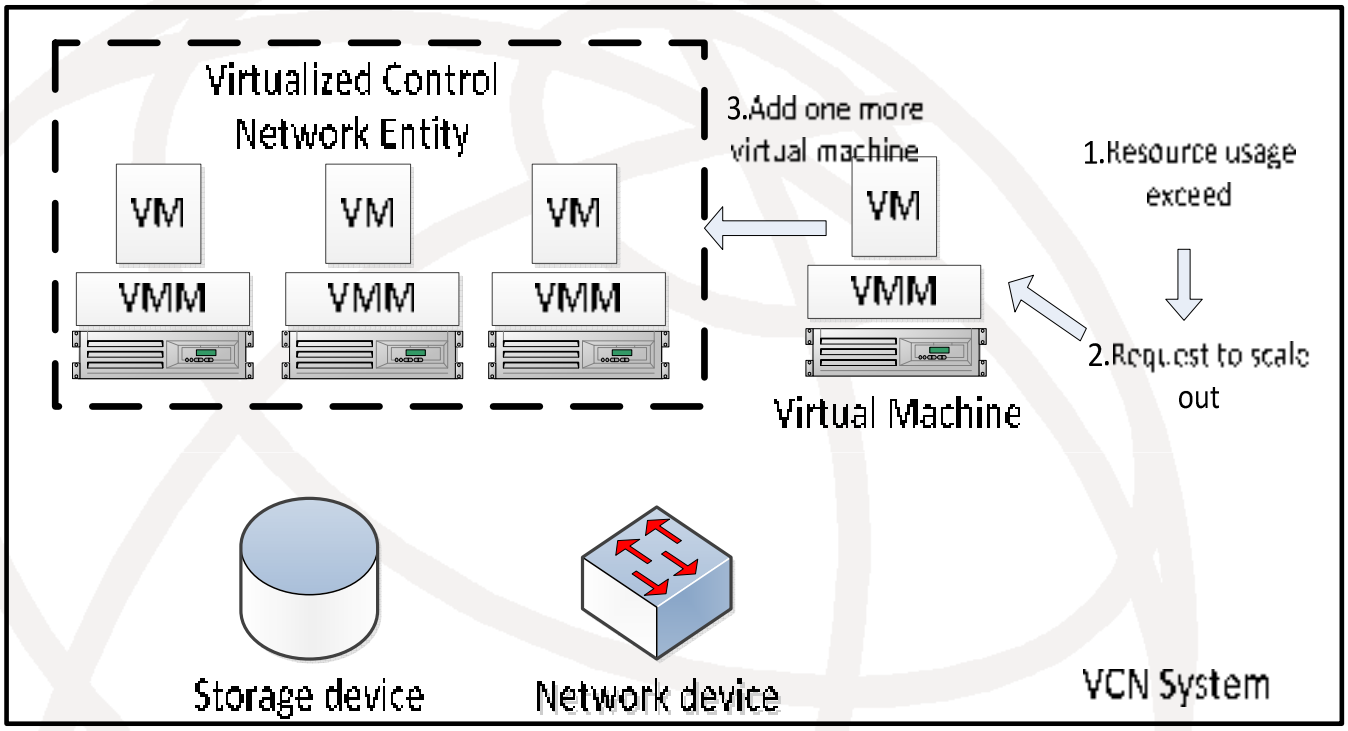


First target of virtualization: control network entities

The application of virtualization techniques in NGN evolution will enable deployment of **virtualized network entities** (implementation of network entities in virtualized hardware/software environment)

- Abstraction of underlying hardware gives **elasticity, scalability, automation**
- **Significant CAPEX/OPEX benefits (TCO)**, leveraging economies of scale
- **Application field spanning all domains (fixed and mobile networks)**
- Aiming to transform the way network operators architect and operate their networks – though change will be incremental
- First tests show feasibility and cost-effective performances

Example use case for virtualization of network entities: virtual resource management (Automatic Scale Out)



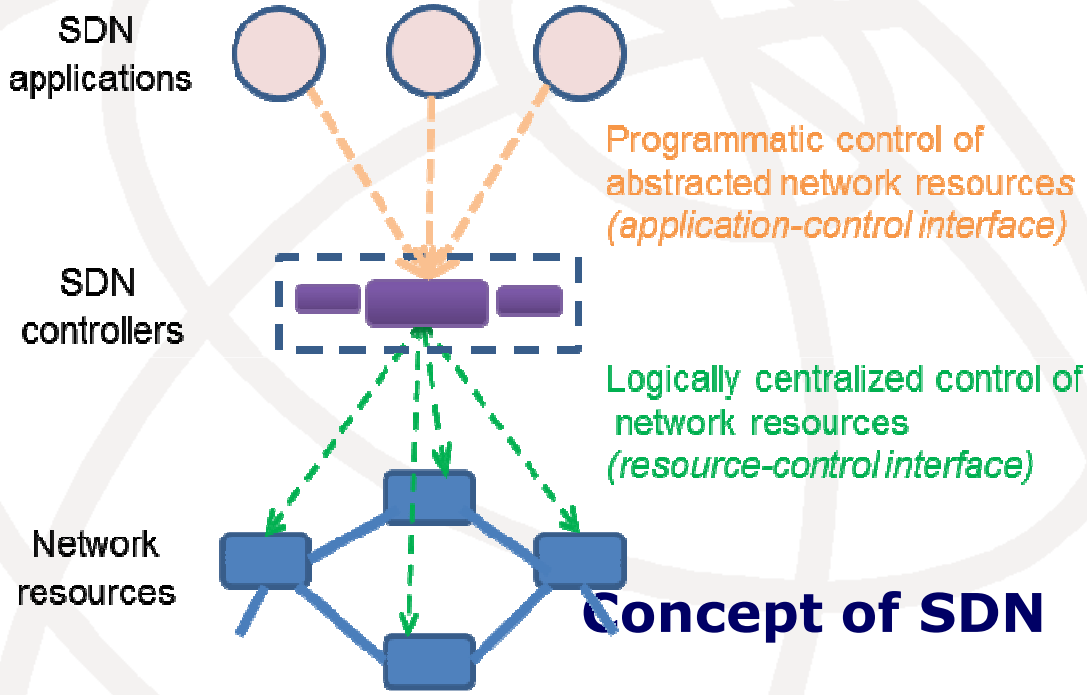
Similar virtual resource management scenarios include Automatic Scale In, On-Demand Scale Out and On-Demand Scale In

Other use cases discussed in Y.NGNe-VCN-Reqts:

- Deployment (e.g. Auto-deployment of network entities)
- Network Management and operations (e.g. High reliability via VM regeneration; Hardware replacement without service interruption)

Software-defined networking (SDN)

SDN is a set of techniques enabling to directly program, orchestrate, control and manage network resources, which facilitates design, delivery and operation of network services in a dynamic and scalable manner.



Concept of SDN

SDN objectives

- *Faster network business cycle*
- *Acceleration of innovation*
- *Rapid adaptation to demand*
- *Increase in resource availability and usage efficiency*
- ***Customization of network resources** including **service-aware networking***

•Basic SDN capabilities

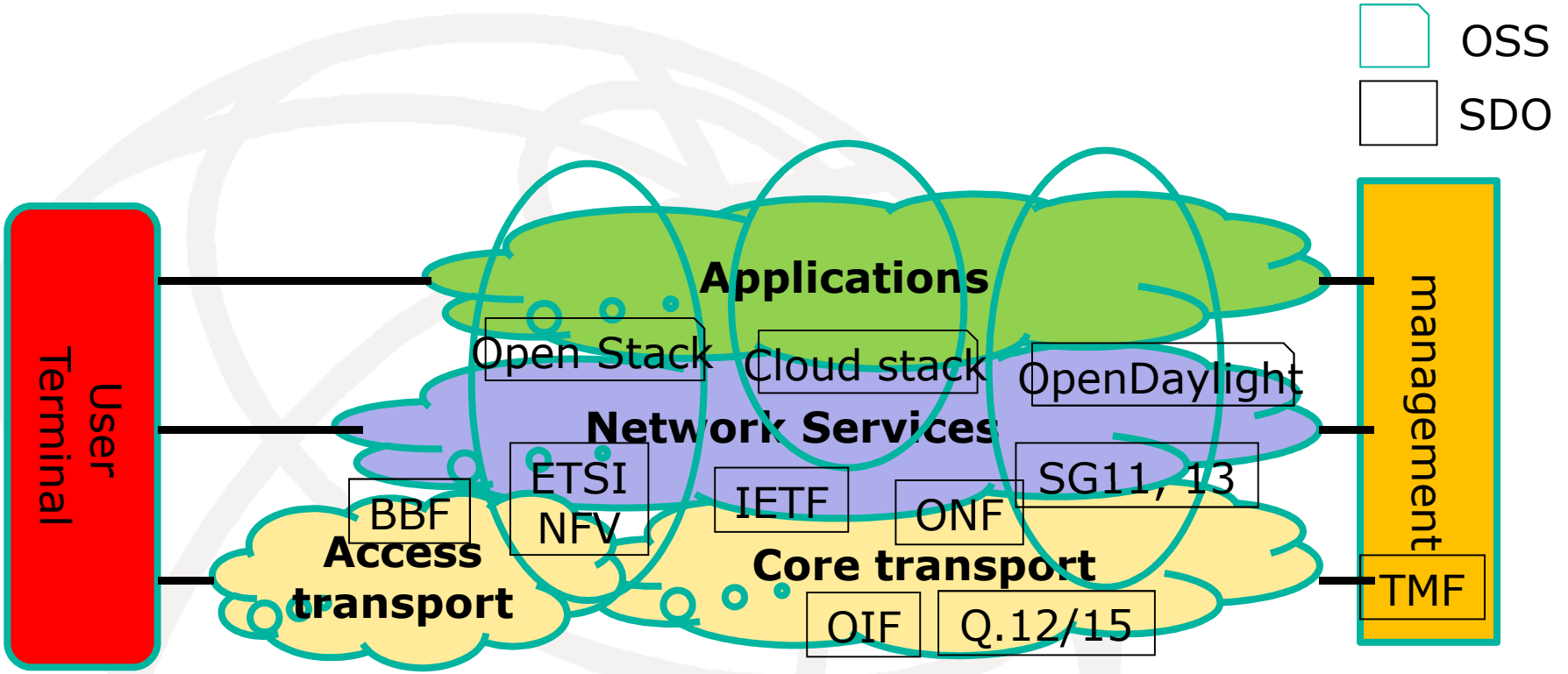
- *Programmability (customized behavior of network resources)*
- *Resource abstraction (easy management and control of network resources)*

SDN and NFV can be complementary:

SDN applications may require virtual partitioning of network element's resources for programmability or may require virtually aggregated resources from multiple network elements to satisfy their requirements.

Then, Virtualization techniques can provide an appropriate solution because they include partition and aggregation of network elements, as well as an integrated interface to such virtualized network resources.

ITU-T SDN standardization (SDN for carrier networks)

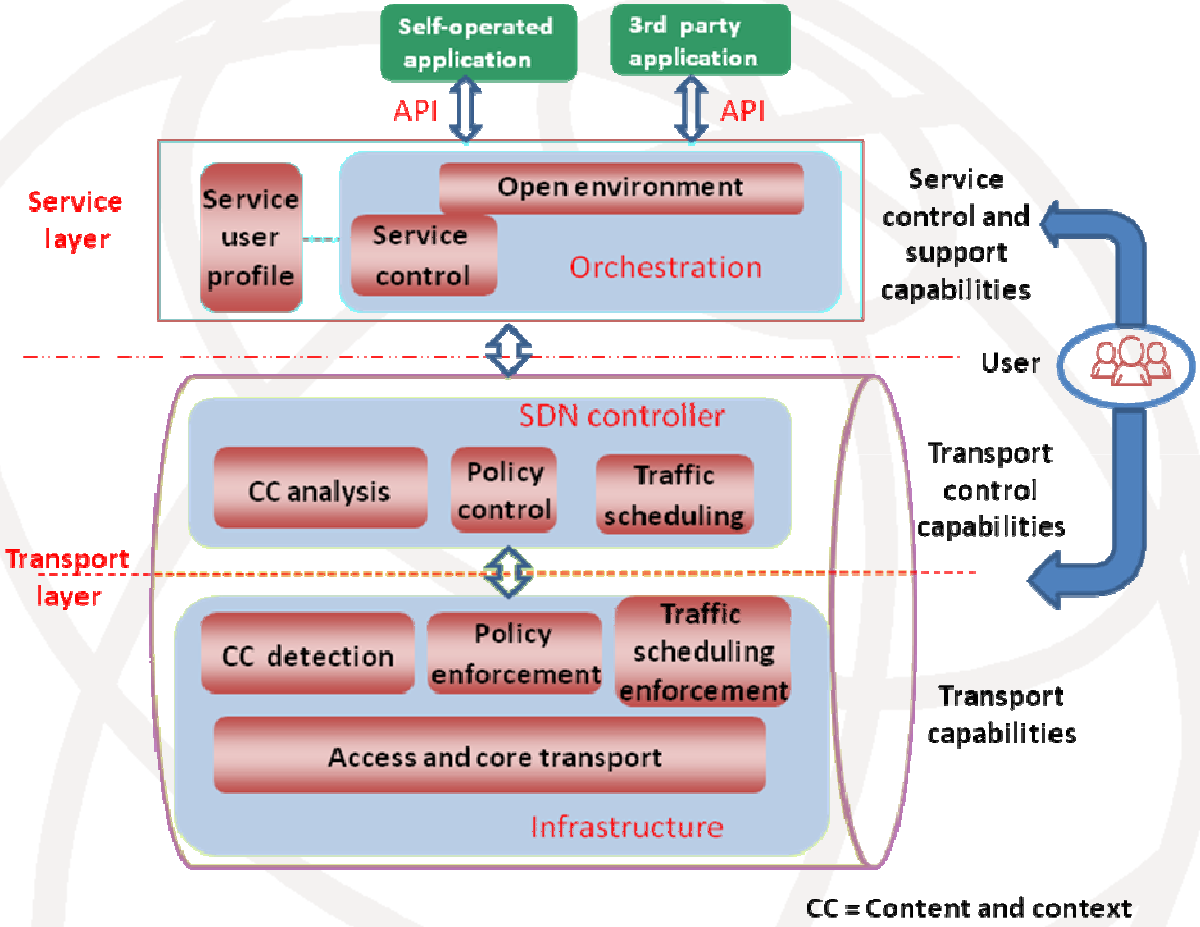


Current ITU-T work on SDN

- JCA-SDN
- Future Networks use SDN and Network Virtualization [Y.3001, 3011, 3012]
- iSCP (independent Scalable Control Plane) for control/data separation [Y.2621, 2622]
- "Framework of SDN" - consented as [Y.3300] in Feb 2014
- Other SDN related work, incl. SDN signalling and **application of SDN to NGN**

Applying SDN to NGN

Y.S-NICE-reqts "Requirements and capability framework for NICE implementation using SDN technologies" – work in progress



Overview of the S-NICE capability framework

Software defined NICE (S-NICE) is a specific implementation of NICE making usage of SDN technologies.

S-NICE supports the intelligent features of NICE, but in the S-NICE framework some NICE capabilities have a different implementation approach and some enhancements.

Internet of Things (IoT)

IoT is defined in ITU-T Rec. Y.2060 "Overview of Internet of Things" as:

A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies.

NOTE 1 - Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

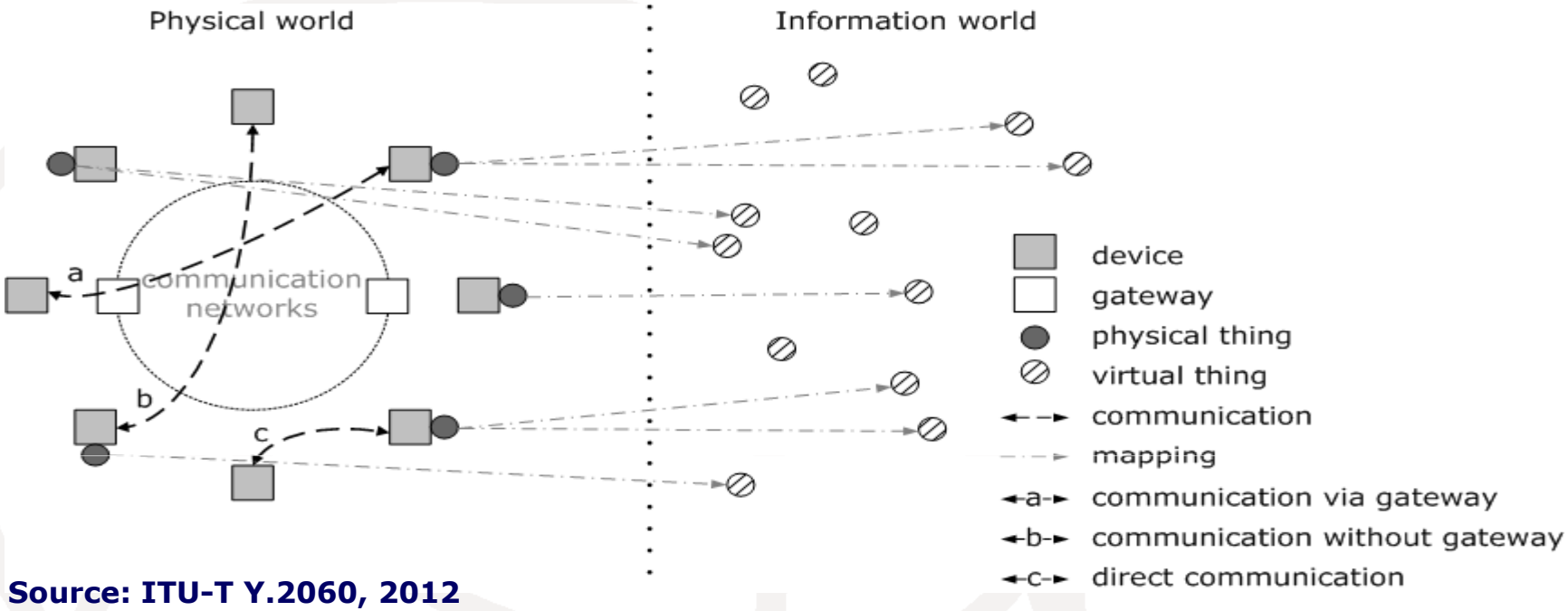
NOTE2 - In a broad perspective, the IoT can be perceived as a vision with technological and societal implications.

IoT is expected to integrate leading technologies such as:

- Advanced Machine2Machine
- Autonomic Networking
- Data Mining and Data Reasoning (BIG DATA)
- Cloud Computing
- Service Delivery Platforms

with technologies for advanced sensing and actuation

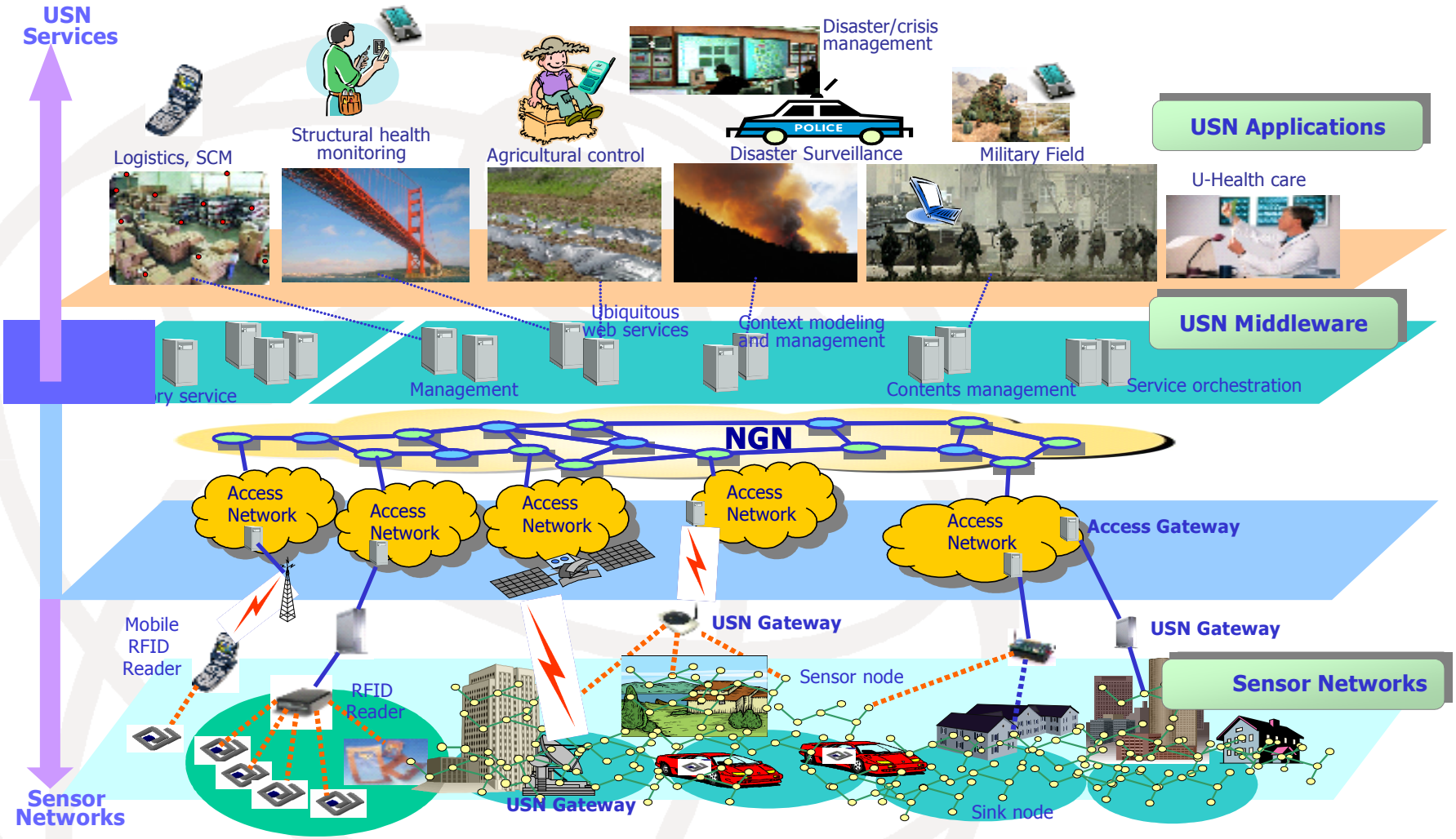
High level view of things and networks



Source: ITU-T Y.2060, 2012

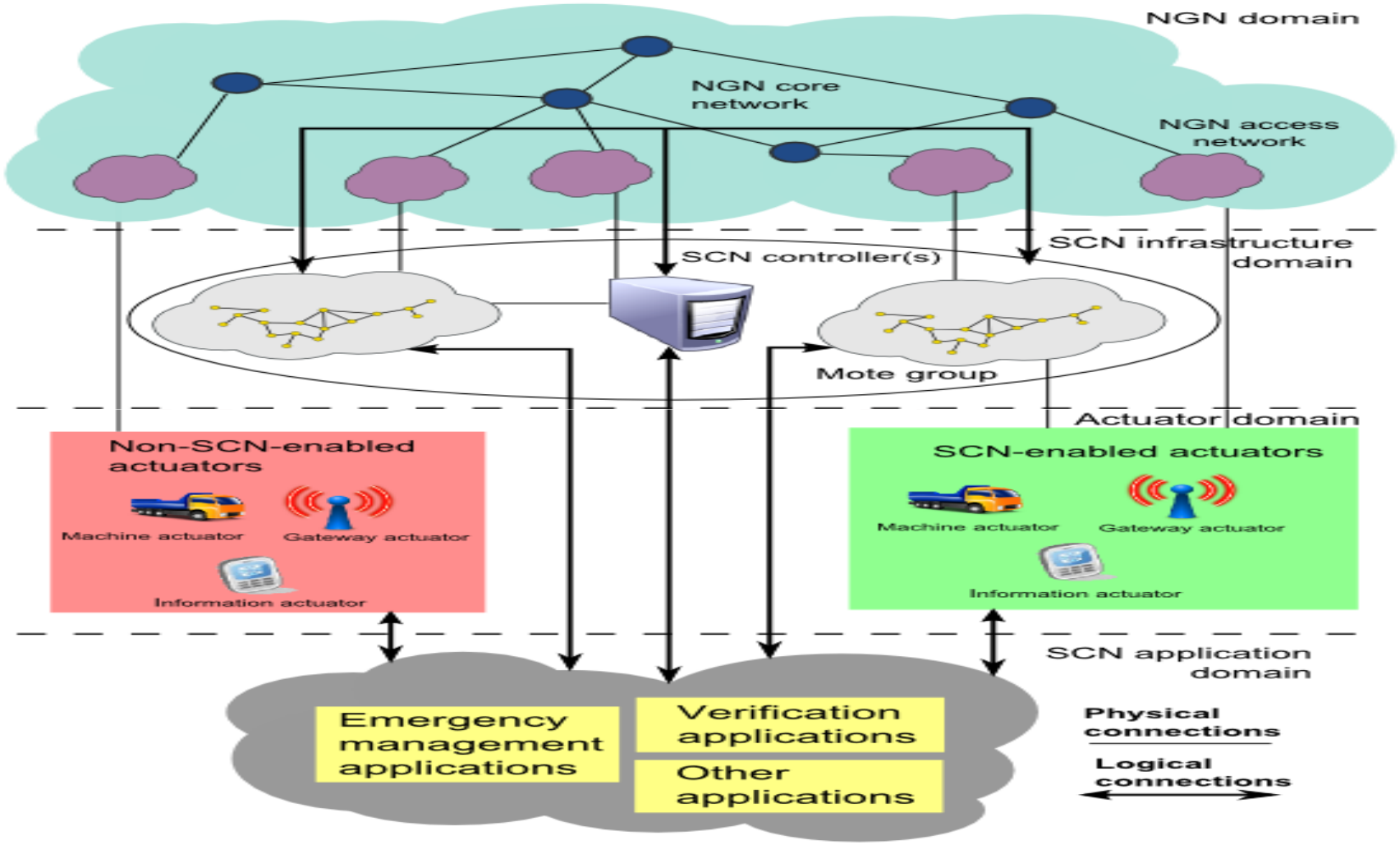
Physical and Virtual Thing: a physical thing may be represented in the info world via one or more virtual thing, but a virtual thing can also exist without associated physical thing. All types of exchanges (P-P, P-V, V-V) are possible.
Device: In the Internet of Things, a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing
Communication networks: may be realized via existing networks (IP based networks) and/or evolving network such as NGN

Examples of NGN support of IoT applications: USN apps



Source: Y.2221 - Requirements for support of Ubiquitous Sensor Networks (USN) applications over NGN

Examples of NGN support of IoT applications: Sensor Control Networks applications



Source: Y.2222 - Sensor Control Networks and related applications in NGN environment

Some useful links and references for ITU-T NGN standards

Useful Links

- **ITU-T**
  - http://www.itu.int/en/ITU-T/Pages/default.aspx
- **ITU-T SG11 "Protocols and test specifications"**
  - http://www.itu.int/en/ITU-T/studygroups/2013-2016/11/Pages/default.aspx
- **ITU-T SG 13 "Future Networks including cloud computing, mobile and next-generation networks"**
  - http://www.itu.int/en/ITU-T/studygroups/2013-2016/13/Pages/default.aspx
- **ITU-T Recommendations**
  - http://www.itu.int/en/ITU-T/publications/Pages/recs.aspx

NGN Recommendations: NGN relevant Y-series (SG13)

Y.2000-Y.2999: Next Generation Networks

Frameworks and functional architecture models	**Y.2000-Y.2099**
Quality of service and performance	**Y.2100-Y.2199**
Service aspects: Service capabilities and service architecture	**Y.2200-Y.2249**
Service aspects: Interoperability of services and networks in NGN	**Y.2250-Y.2299**
Enhancements to NGN	**Y.2300-Y.2399**
Network management	**Y.2400-Y.2499**
Packet-based networks	**Y.2600-Y.2699**
Security	**Y.2700-Y.2799**
Generalized mobility	**Y.2800-Y.2899**

NOTE – 21 over 24 Y Supplements also deal with NGN

NGN Recommendations: NGN relevant Q-series (SG11)

Q.3000-Q.3999: Signalling requirements and protocols for NGN

General [empty]	Q.3000-Q.3029
Network signalling and control functional architecture	Q.3030-Q.3099
Network data organization within the NGN [empty]	Q.3100-Q.3129
Bearer control signalling	Q.3130-Q.3179
Signalling and control requirements and protocols to support attachment in NGN environments	Q.3200-Q.3249
Resource control protocols	Q.3300-Q.3369
Service and session control protocols	Q.3400-Q.3499
Service and session control protocols – supplementary services	Q.3600-Q.3649
NGN applications [empty]	Q.3700-Q.3849
Testing for NGNs	Q.3900-Q.3999

Q Suppl. 54: Signalling requirements at the interface between SUP-FE and I/S-CSC-FE
Q Suppl. 55: Signalling requirements at the interface between AS-FE and S-CSC-FE
Q Suppl. 56: Organization of NGN service user data
Q Suppl. 58: Organization of NGN transport user data

Thanks for your attention

Marco Carugi

Marco Carugi works as consultant on telecommunication technologies and associated standardization, currently engaged with China Unicom on requirements and architectures for advanced services and networks.
Marco began his career in Solvay as telecommunication system engineer, worked for 7 years in France Telecom/Orange Labs as research engineer on Broadband Data Services and Network Technologies and then for 8 years in Nortel CTO organization as Senior Advisor on NGN and emerging services. More recently, he has worked for 3 years in ZTE R&D division, Technology Strategy department, as Senior Expert on future service and network technologies and associated standardization.
Marco participates actively since 17 years in several standard development organizations, and has held numerous leadership positions, including ITU-T SG13 vice-chair, Rapporteur for ITU-T Q.3/13 in last three study periods, Rapporteur in ITU-T NGN Focus Group, Cloud Ecosystem working group chair in ITU-T Focus Group on Cloud Computing, OIF Board member, IETF Provider Provisioned VPN working group co-chair. Currently, he is Rapporteur for Q.2/13 (Requirements for NGN evolution (NGN-e) and its capabilities including support of IoT and SDN) inside ITU-T SG13 (Future networks including cloud computing, mobile and NGN). NGN evolution, SDP, SDN, Cloud Computing and IoT/M2M are technical areas in which he is involved at present.
In ITU-T, as Rapporteur for Q.2/13, he is currently participating in the Internet of Things Global Standards Initiative (IoT-GSI) where he leads the development of technical specifications on requirements, capabilities and services. He also acts as vice-chair of the ITU-T Focus Group on M2M Service Layer and co-chair of its working group dealing with requirements and architectural framework of the M2M Service Layer.
Marco has led the development of numerous standards specifications and published in technical journals and conference proceedings.
Marco holds an Electronic Engineering degree in Telecommunications from the University of Pisa in Italy, a M.S. in Engineering and Management of Telecommunication Networks from the National Institute of Telecommunications (INT) in France and a Master in International Business Development from the ESSEC Business School in Paris.