ITU-T
STUDY GROUP 13

Future networks including cloud computing, mobile and next-generation networks

Dr Leo Lehmann,
SG13 Chairman, 2015-2016

All about networks

1956 2016
CCITT / ITU-T

IMT-2020

85
GAPS

ICN/CCN

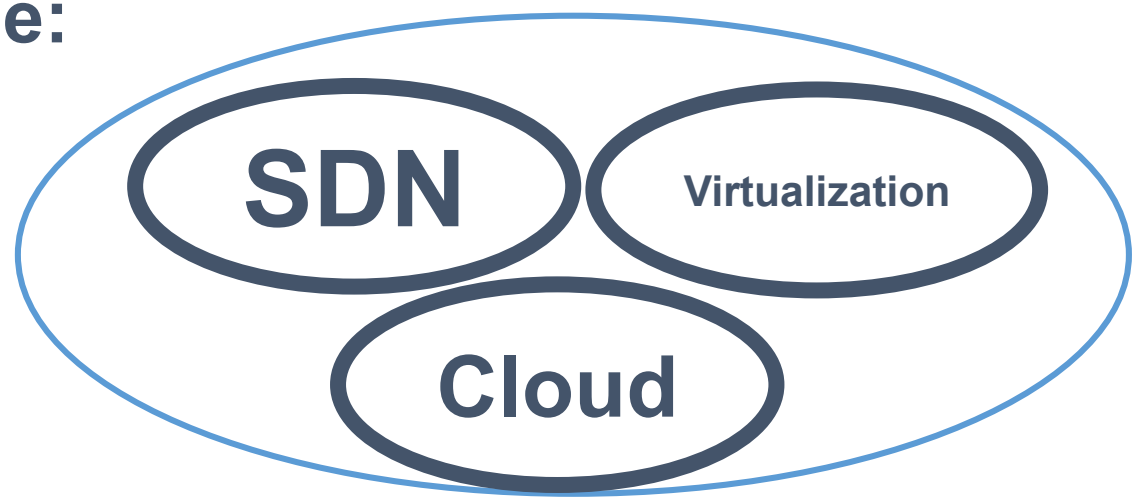
SOFTWARIZATION

5G
WIRELINE

SLICING

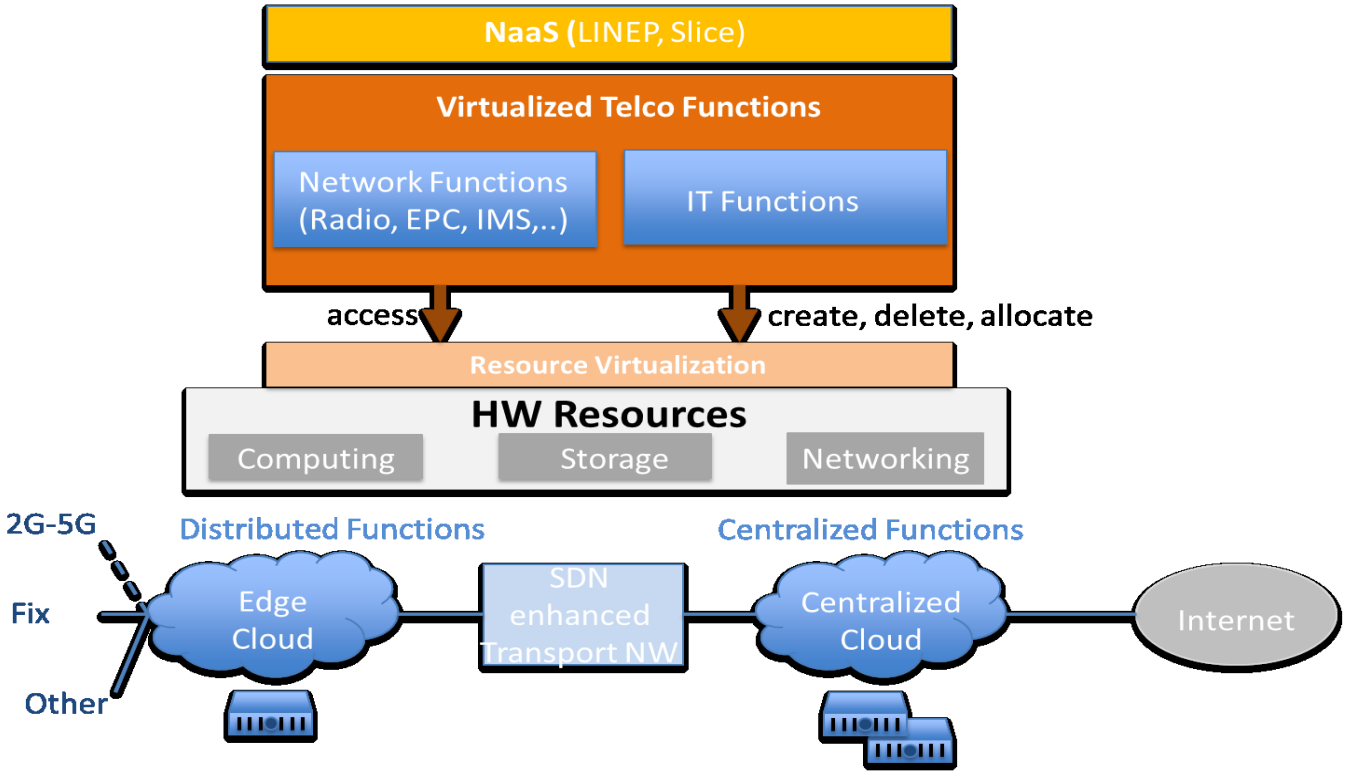
FRONT/BACK
HAUL

Base:



IoT

12/2015: transferred to SG20



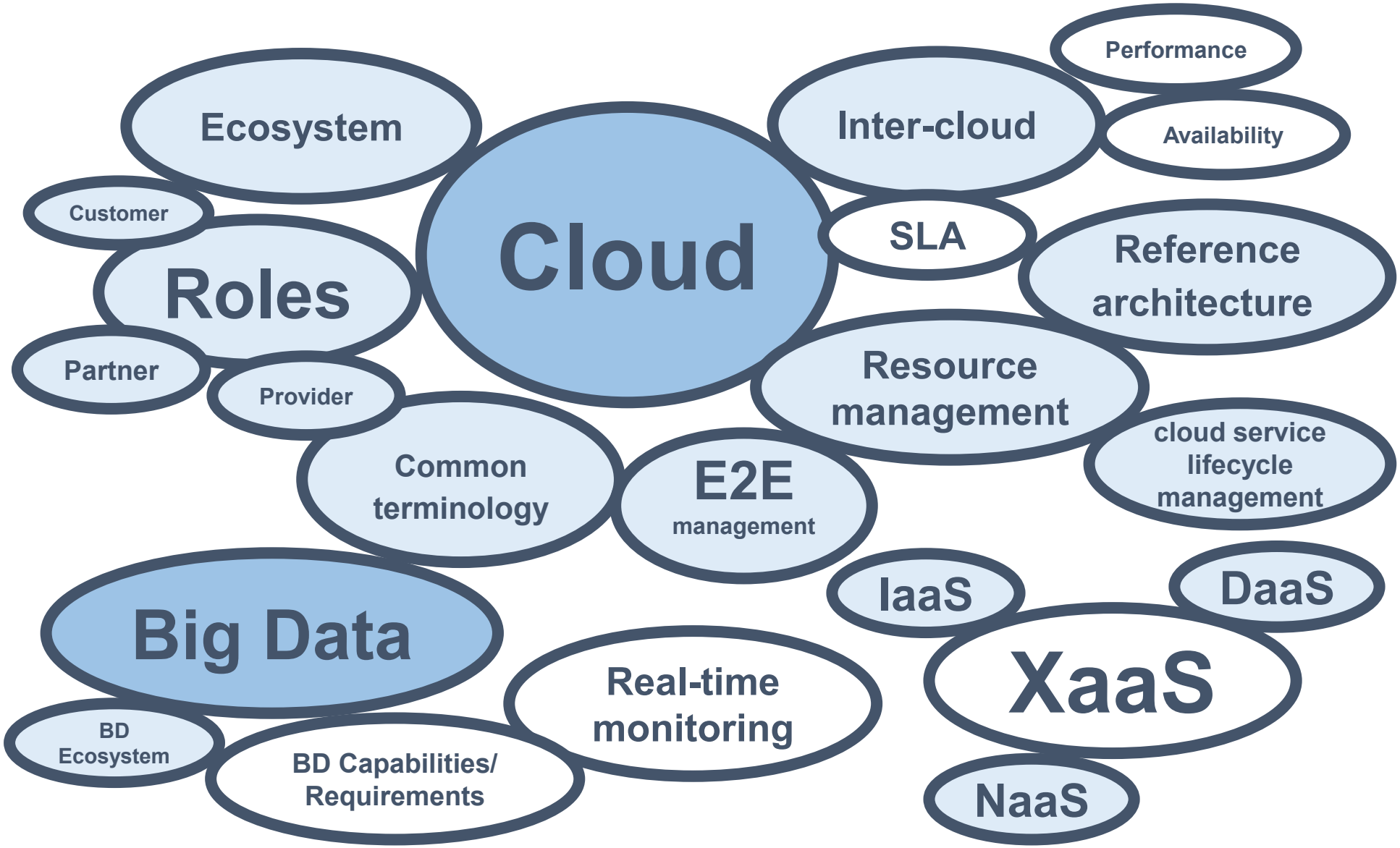
IMT-2020 First Results in NSP

Definition of IMT-2020 Roadmap

Spring 2017:

- **IMT-2020 Network Requirements**
- **Framework of IMT-2020 Network Architecture**
- **Softwarization General Requirements**

Cloud computing/Big data

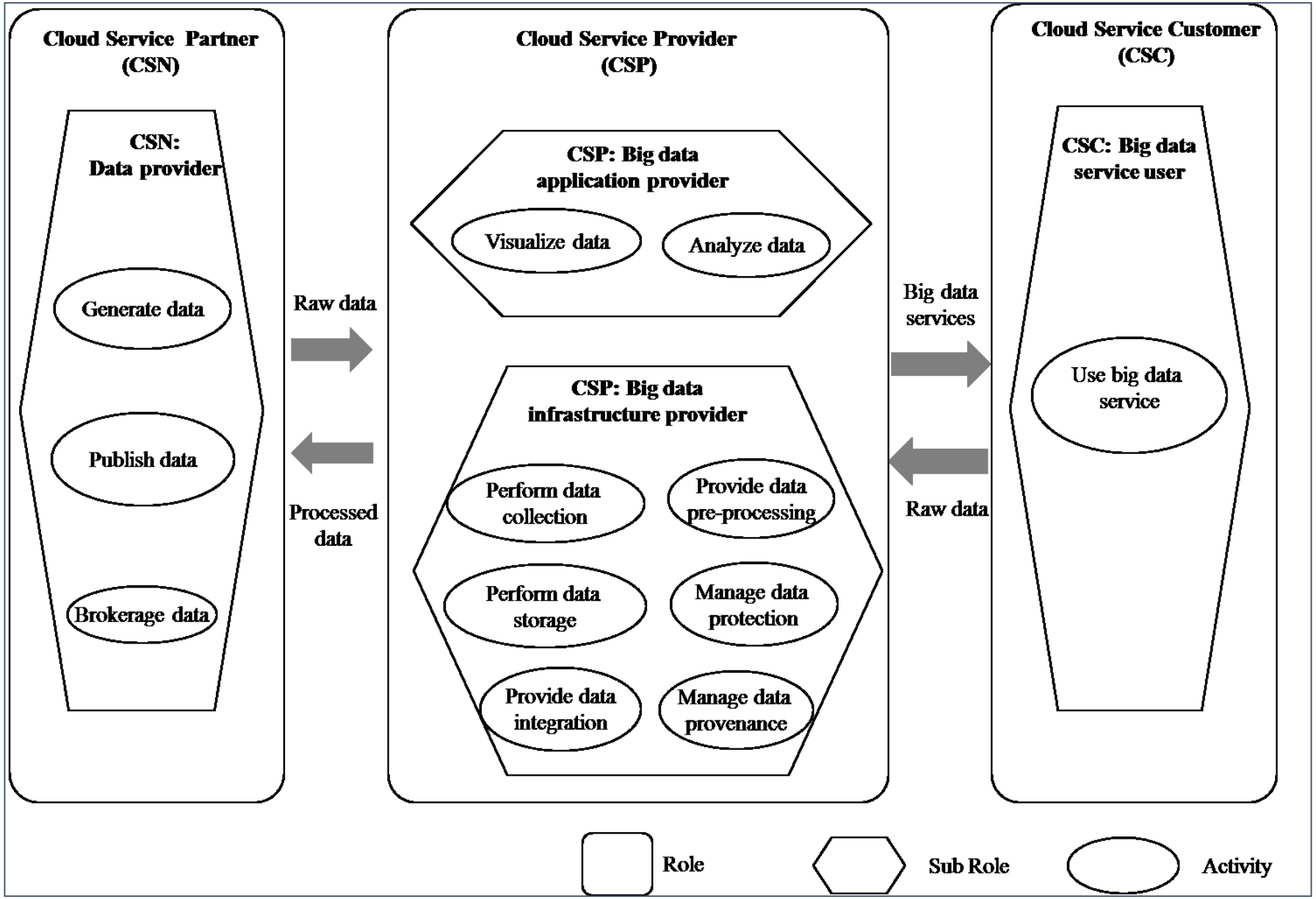


Context Cloud Computing - Big Data

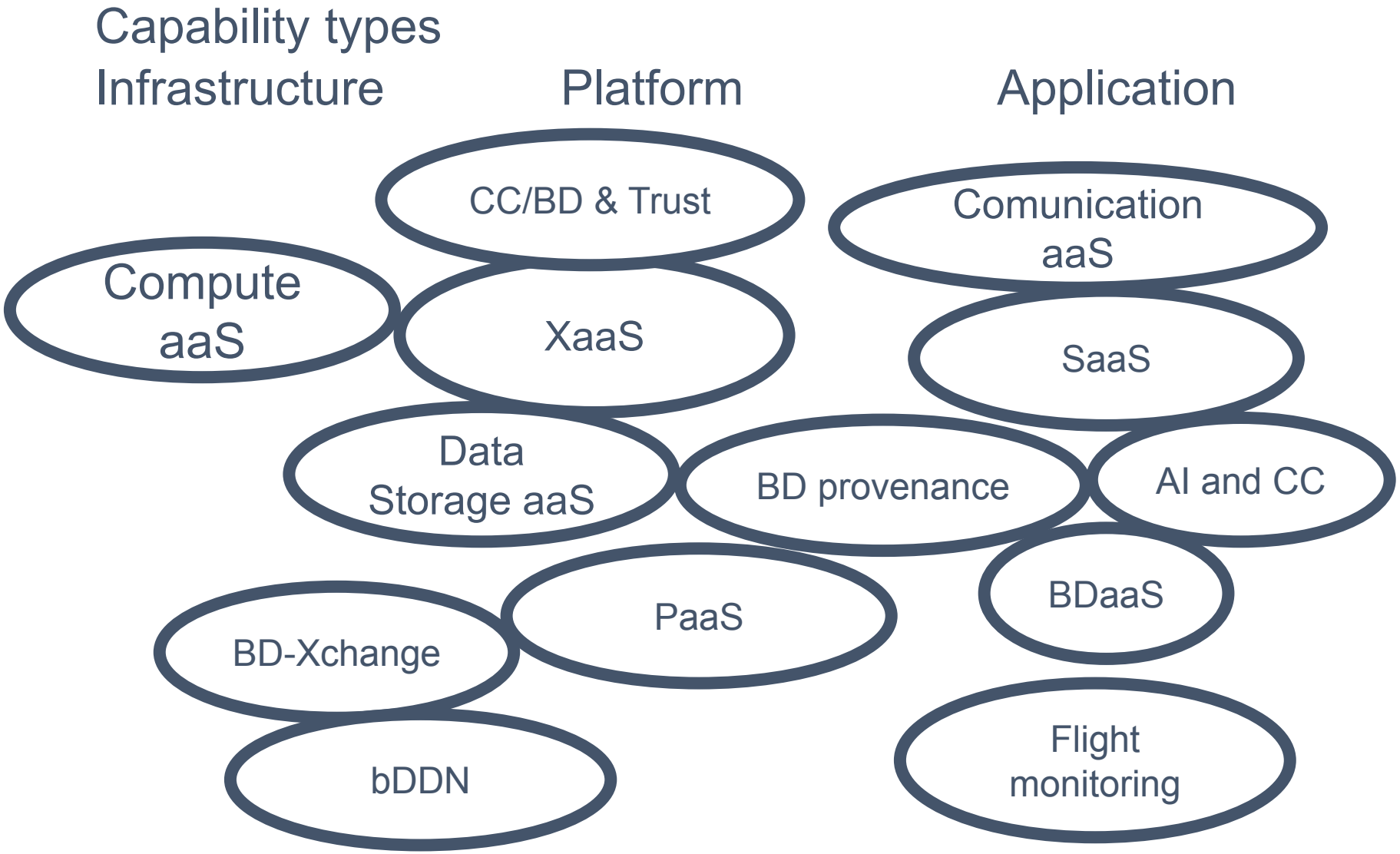
Volume

Variety

Velocity



Cloud computing/Big Data – what's next



Trust in ICT

Achievements

Technical Report “Trust provisioning for future ICT infrastructures and services”

Draft Rec Y.trusted-env on basic principles of trusted environment creation

Draft Rec Y.CCTIC on concepts for trusted inter-cloud

What’s Next?

Requirements, capabilities and service scenarios for trust provisioning

Architectural framework for trustworthy telecommunication networks

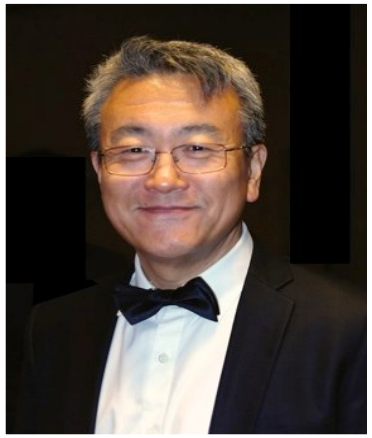
Technical solutions for trust provisioning

Trust provisioning in Big Data analytics

Inter Cloud Trust Management

Thank You!

Dr Leo Lehmann
SG13 Chairman, 2015-2016
Leo.Lehmann@ties.itu.int



Dr Chaesub LEE
SG13 Chairman, 2009-2014

Additional Slides

Future networks including cloud computing, mobile and next-generation networks

"A collection of networks, end user equipment, information, and human resources which can be used to access valuable information, communicate with each other, work, learn, receive entertainment from it, at any time and from any place, with affordable cost on a global scale."

G.101 "Global Information Infrastructure terminology: Terms and definitions" (03/2000)

SG13 today – more in depth

- New ideas from research arms

  u-learning, WPT, trust in networks, real-time flight monitoring

- Enhancements to the existing networks

  NGNe, FPBN, PTDN, DPI

- Mobile communications

  MM, FMC (N-screen), multiconnection, IMT-advanced, 5G basics via FG

- Cloud computing

  ecosystem, players, inter-cloud, XaaS, resource management, big data

- Networks of the future

  FN, SUN, SDN, service-, data-, env/socio-ec aware networking, self-managed net

- Assistance and solutions for developing countries – technical papers

- Definitions, Emergency communications

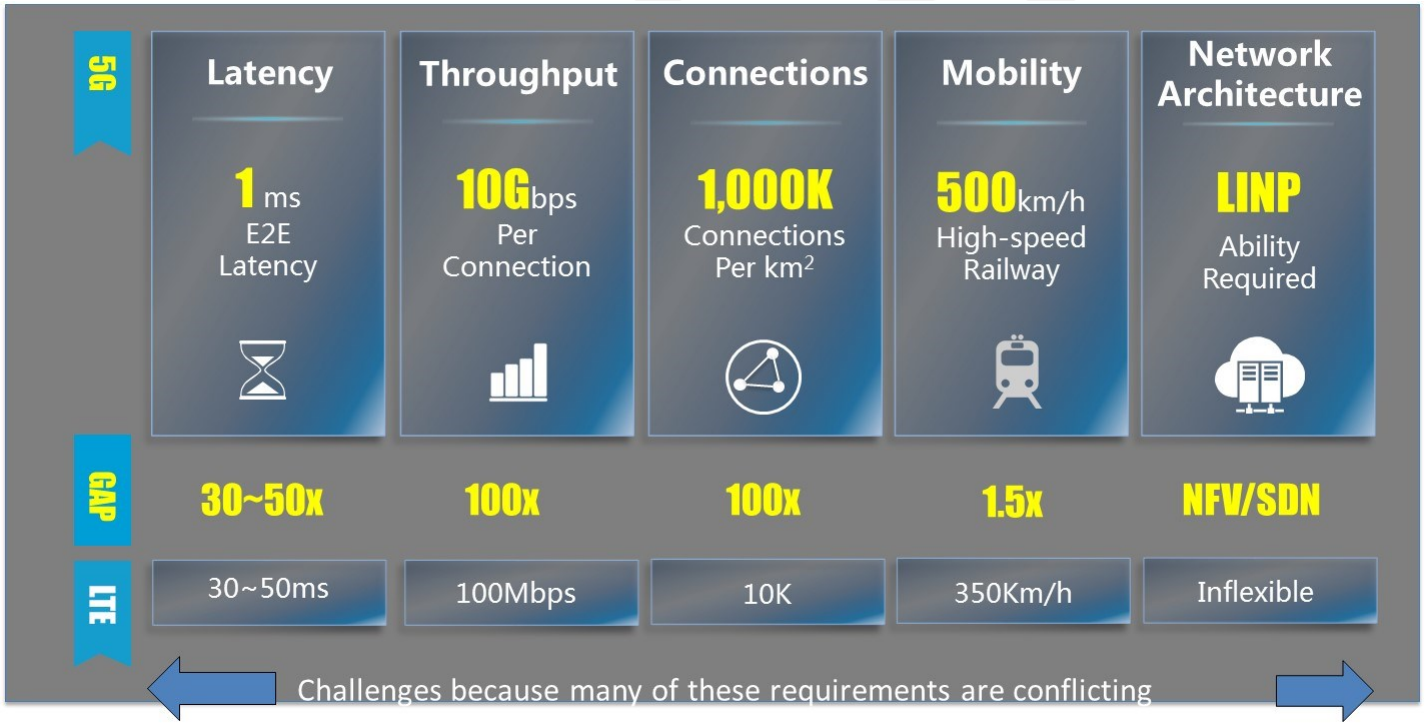
5G: From hardware to software

HW world

Dedicated appliances +
Dedicated wire/radio

SW world

Virtual functions +
virtual links
on generic server /
storage / network pool



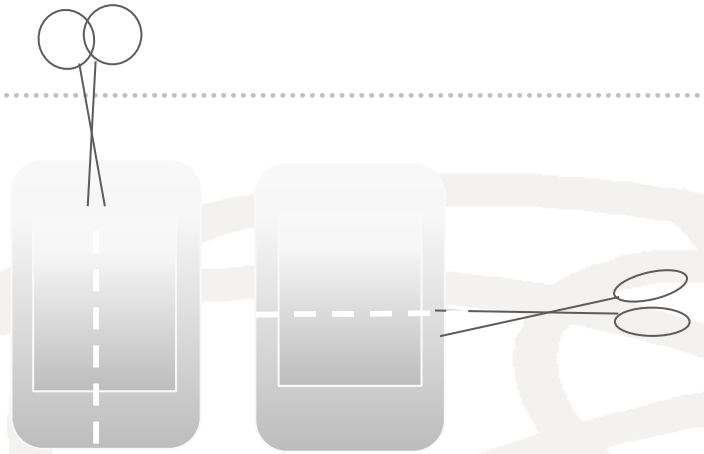
Key wireline standardization issues

- ***Fronthaul*** – Fronthaul ties CRAN to Antennas, major downstream effects.
  - Is it sliced, where, how.
- ***Backhaul/IDC*** – latency, jitter, loss at packet layer, flexible data paths
- ***NFV*** – concept needs to be made broader. Cover some of DSP and all of MEC
- ***MEC*** – ETSI approach ridged. Any F any CPU + RAT (merge into NFV?)
- ***Orchestration*** – does not exist yet. Understand AT&T to build in-house
  - Danger of orchestration/mgmt duplication (virtual/physical)
- ***Softwarization*** – high level programming model, profiles, scripts, end to end
- ***OA&M*** – need “cloud like” approach. Continuous test/repair not just report.

Major Drivers for the 5G wireline architecture

- *End to end virtualization* – obvious operational savings for "tidal" effects
- *Cloud RAN* – opex/capex savings, CoMP, CA, cell edge interference, migration, performance.
- *Mobile Edge Computing* – operators low delay advantage over the OTTs.
- *Fixed Mobile Convergence* – access side also looking for virtualization savings too… can they be combined?
- *Slicing* – differences between RAT's/CORES etc rather than a one size fits all allows ultra low delay etc. RATS.
- *SDN and Orchestration* – hard to implement all of above with distributed protocols and too complex for manual operation.
- *NFV* – use of general purpose compute as much as possible (but not everywhere) 4G vEPC, 5G-PacketCore$_{[slice]}$, … MEC + some of RAT
- *Better operations/mgmt*, more Cloud-Style, auto problem detect/fix etc.

Slicing



Platform/
Applications

Slice

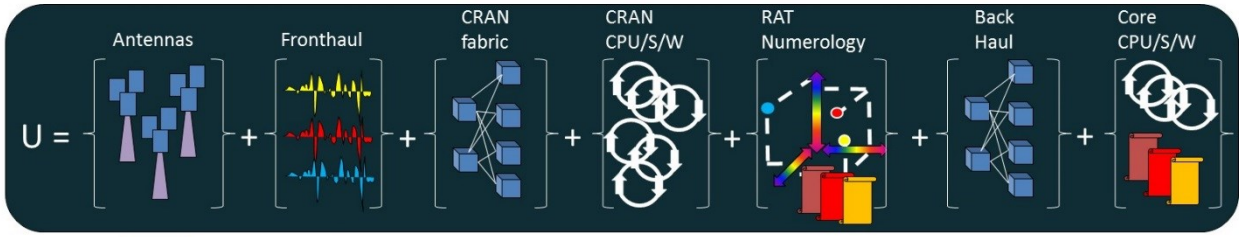
Infrastructure

Horizontal Extension

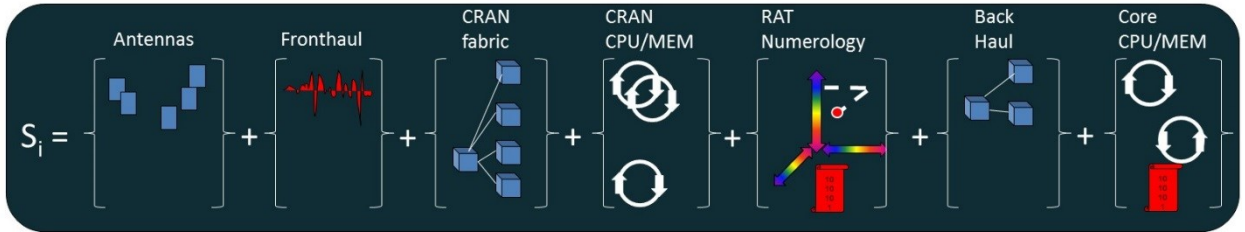
Vertical
Extension

UE-Slicing
Horizontal or
Vertical

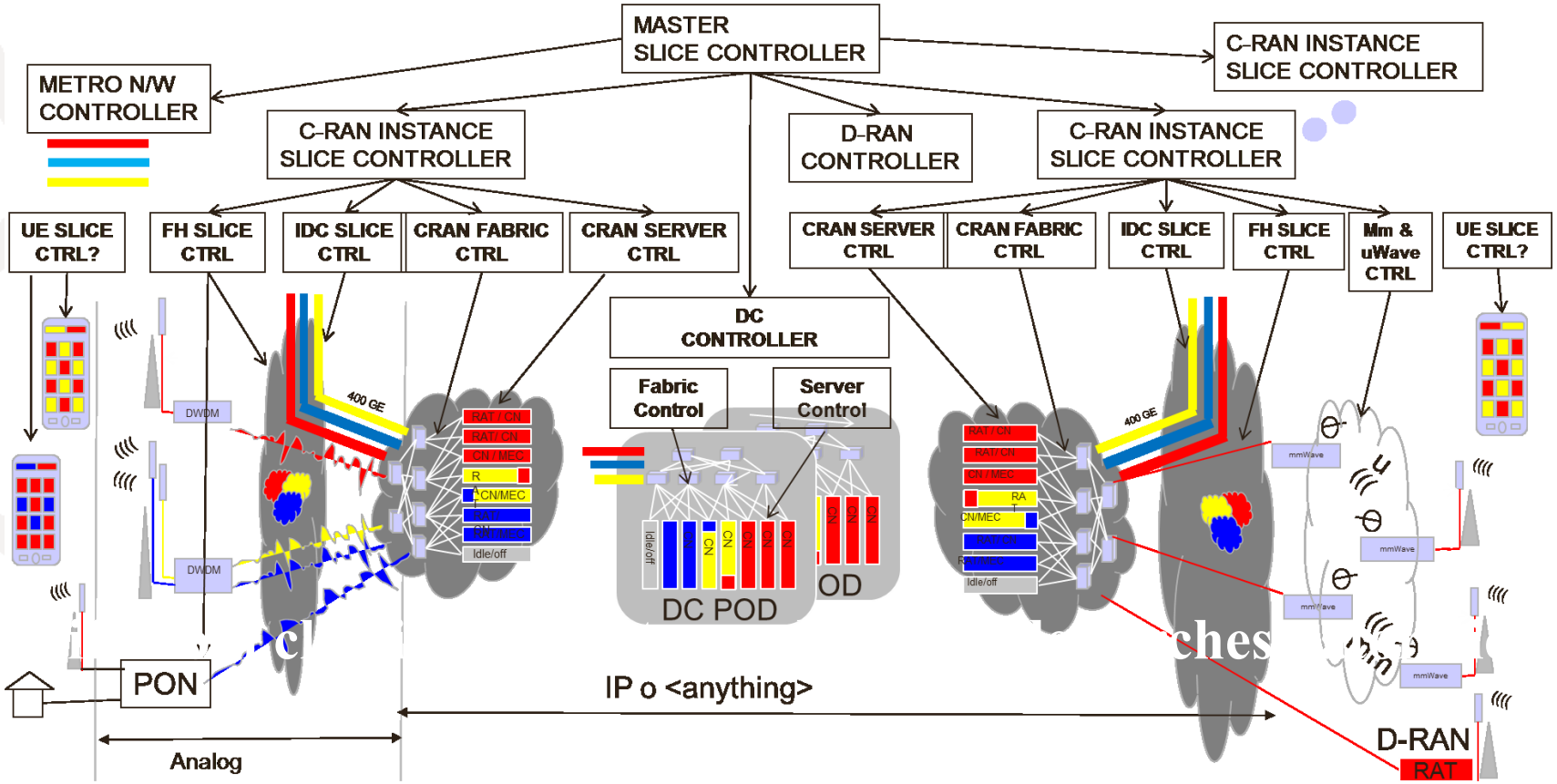
Example: 5G concept of end to end slice



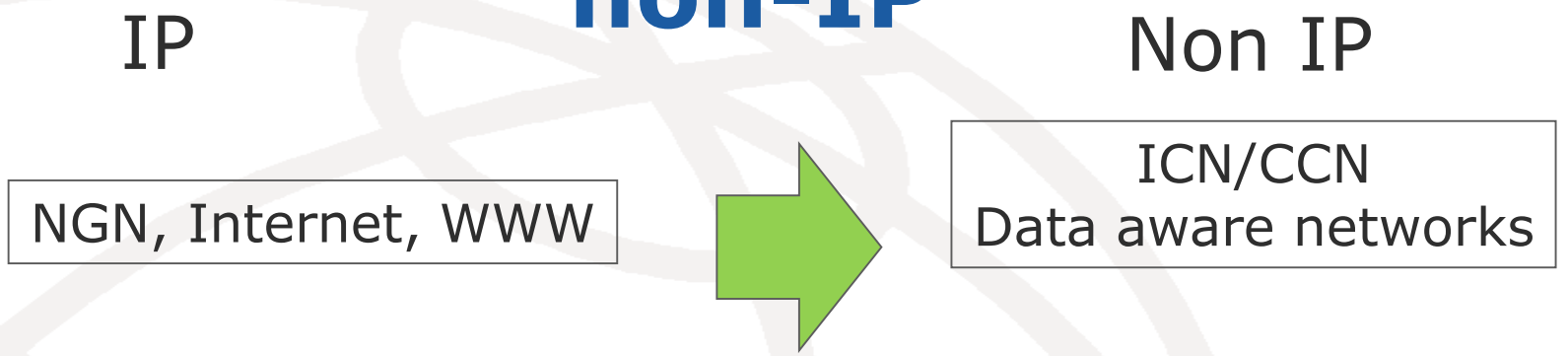
If U is the set of all resource sets { Antennas, Fronthaul , ..} then
Slice S_i is a set of resource subsets taken from resource sets { Antennas, Fronthaul .. }



IMT-2020 Hierarchical Orchestration



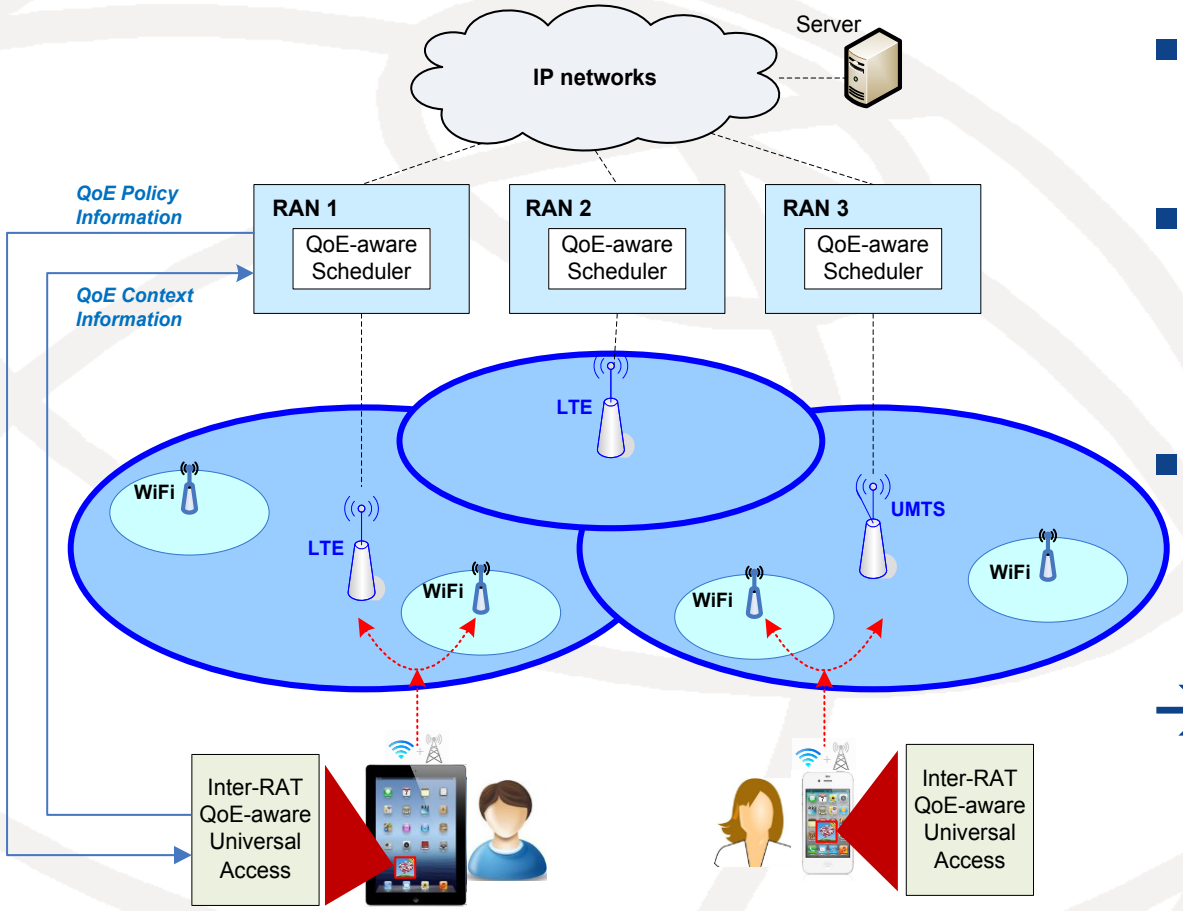
From IP-based networks to non-IP



This shift is expected to contribute to

- Flexible network function implementation/ operation
- Opex / capex reduction
- Faster business cycle, rapid adaptation to demand, increased resource usage, …

NW becomes more complicated



- Multi-RAT for better QoE
- Applications / virtual servers wanders
- Various reqs on mobility, security, …

→ Underlying NW must be flexible

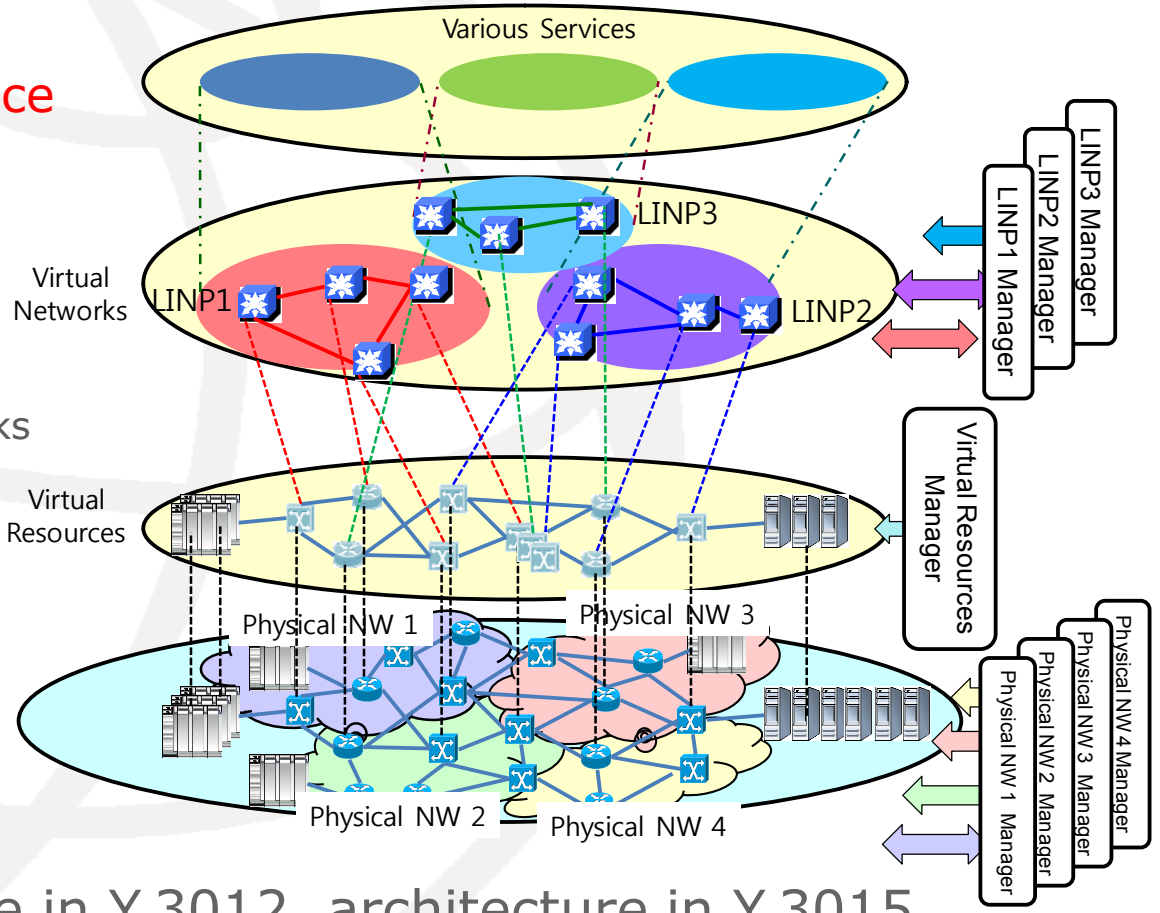
An example of more complicated network architecture:
QoE enhancement in a multi-RAT environment

ITU-R M.2320-0 (11/2014)

Y.3011: Network Virtualization for FNs

- Definition of "network virtualization":
  - A technology that enables the creation of logically isolated network partitions over shared physical networks so that heterogeneous collection of multiple virtual networks can simultaneously coexist over the shared networks. This includes the aggregation of multiple resources in a provider and appearing as a single resource.

- Motivation
  - Key technology for Service Awareness of FNs
    - Diverse services
    - Heterogeneous network architectures
- Problem spaces & design goals
  - Coexistence of multiple networks
  - Simplified access to resources
  - Flexibility in provisioning
  - Evolvability
  - Design goals
    - Isolation, network abstraction, topology awareness and quick reconfigurability, performance, programmability, management, mobility, wireless



Detailed requirements are in Y.3012, architecture in Y.3015

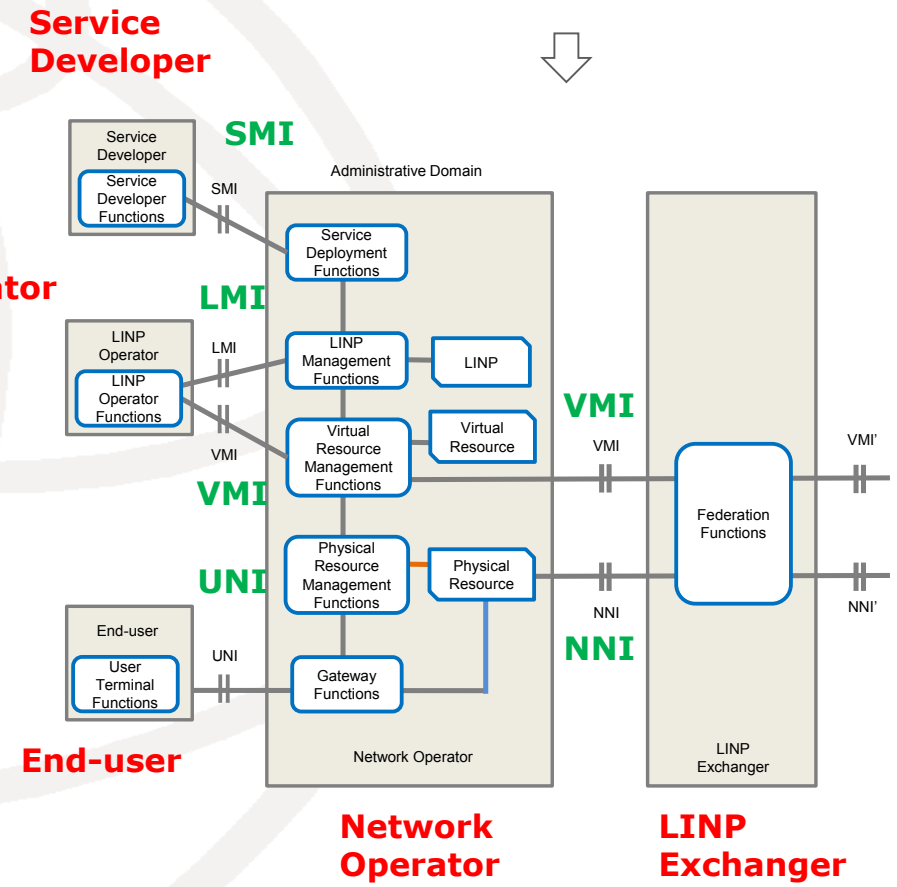
Y.3015: Functional architecture of Network Virtualization for FNs

Functional architecture that realizes:

- Isolation of virtual networks ("Logically Isolated Network Partition")
- Programmability on LINPs

1. Overview of Functional Architecture
2. User Roles
3. Reference Points
4. Functions
   - Management
     - Abstraction of Physical Resources
     - Allocation of Physical/Virtual Resources to LINPs
     - Coordination of Resources
   - Operations
     - LINP Activation
     - Service Deployment & Activation
   - Service Development
   - LINP Federation
   - Authentication & Authorization

Overview of Functional Architecture



Calculation of network energy consumption

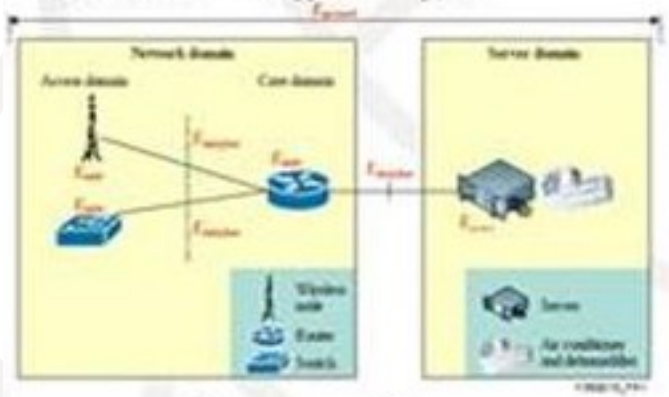
$$E_{network} = \sum_i E_{node,i} + \sum_j E_{server,j} + E_{environment}$$

For further details see alsoc Y.3022

node,i : in case of a switch

$$E_{switch} = \sum_0^T \left(P_{common} + \sum_i P_{Module i} \right)$$

$$P_{common} = P_{buffer} + P_{fan}$$



node,j : in case of a router

$$E_{router} = E_{common} + \sum_i E_{interface i}$$

$$E_{common} = \sum_0^T P_{common}$$

$$P_{common} = P_{chassis} + \sum_j P_{routing engine,j} + \sum_k P_{power\ supply\ unit\ k} + \sum_l P_{linecard\ l}$$

$$E_{interface,j} = \sum_0^T P_{interface,j}(\rho, l, s, c)$$

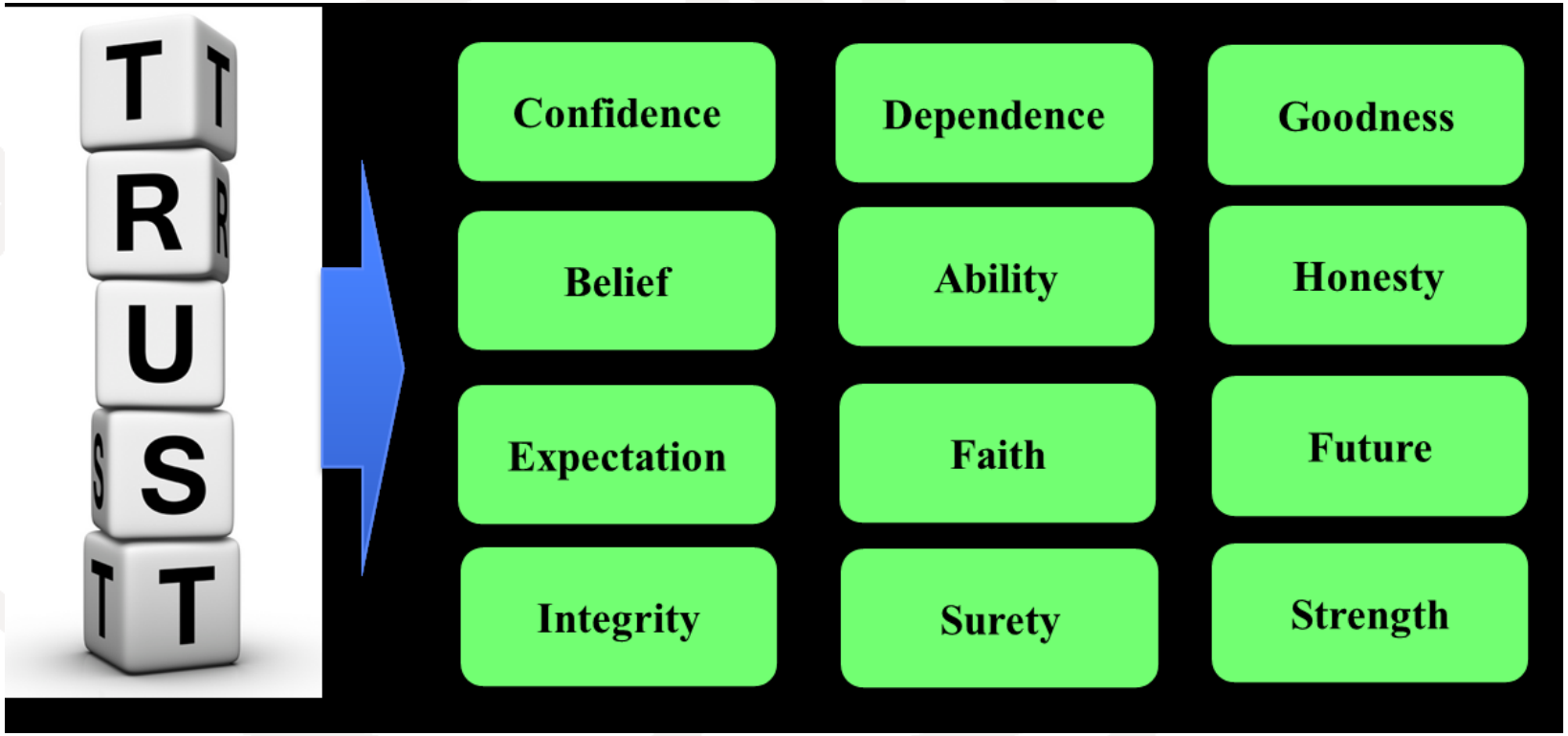
$$P_{interface,j} = P_{HP,j} + P_{PT,j} = \left(E_{HP} \times \frac{\rho \times R_j}{l} \right) + (E_{PT} \times \rho \times R_j)$$

$$E_{server} = \sum_0^T P_{server} = \sum_0^T \left\{ P_{common} + \sum_i P_{interface,i} + (P_{environment}) \right\}.$$

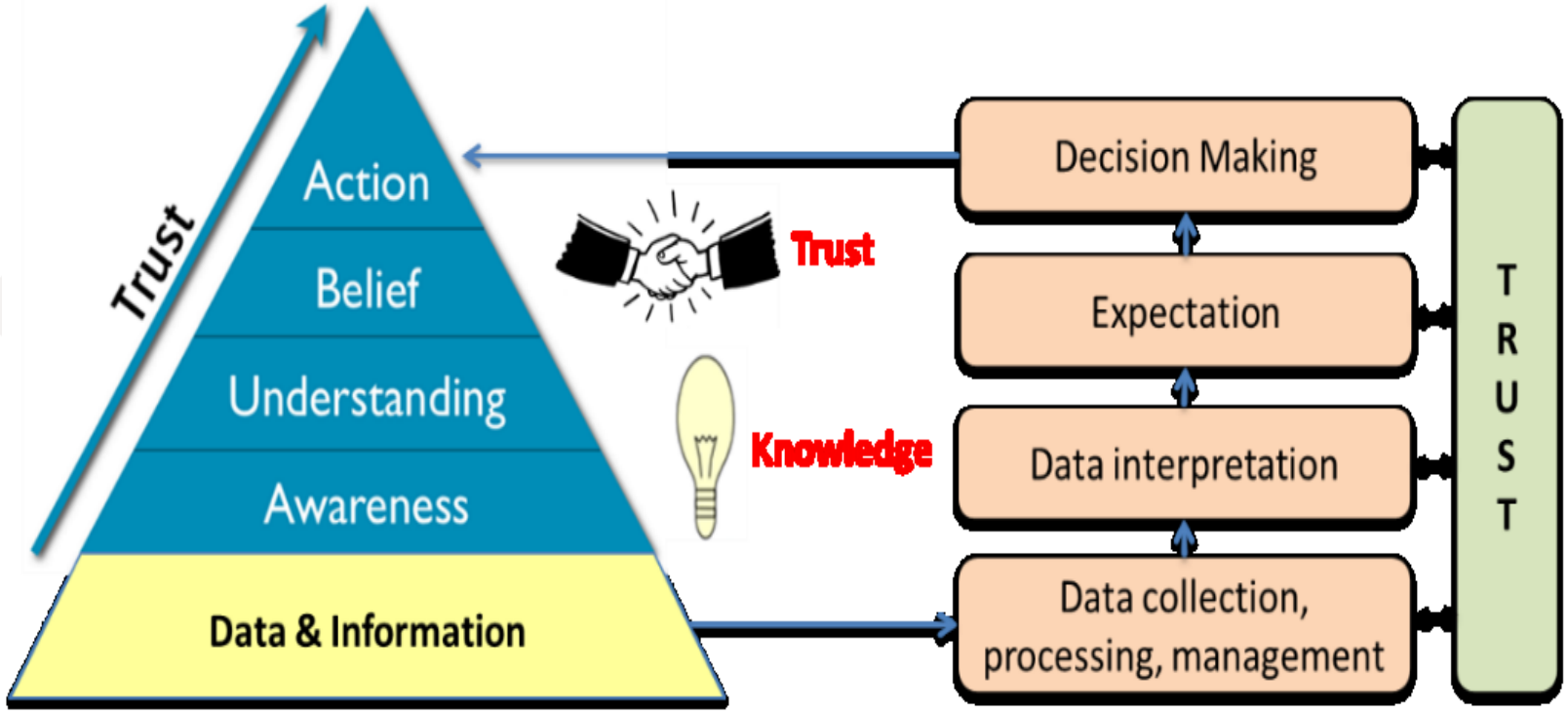
$$P_{environment} = P_{chiller} + P_{delumid}.$$

$$\sum_i P_{interface i} = (P_{server_{Peak}} - P_{server_{Idle}}) \times u_{server}$$

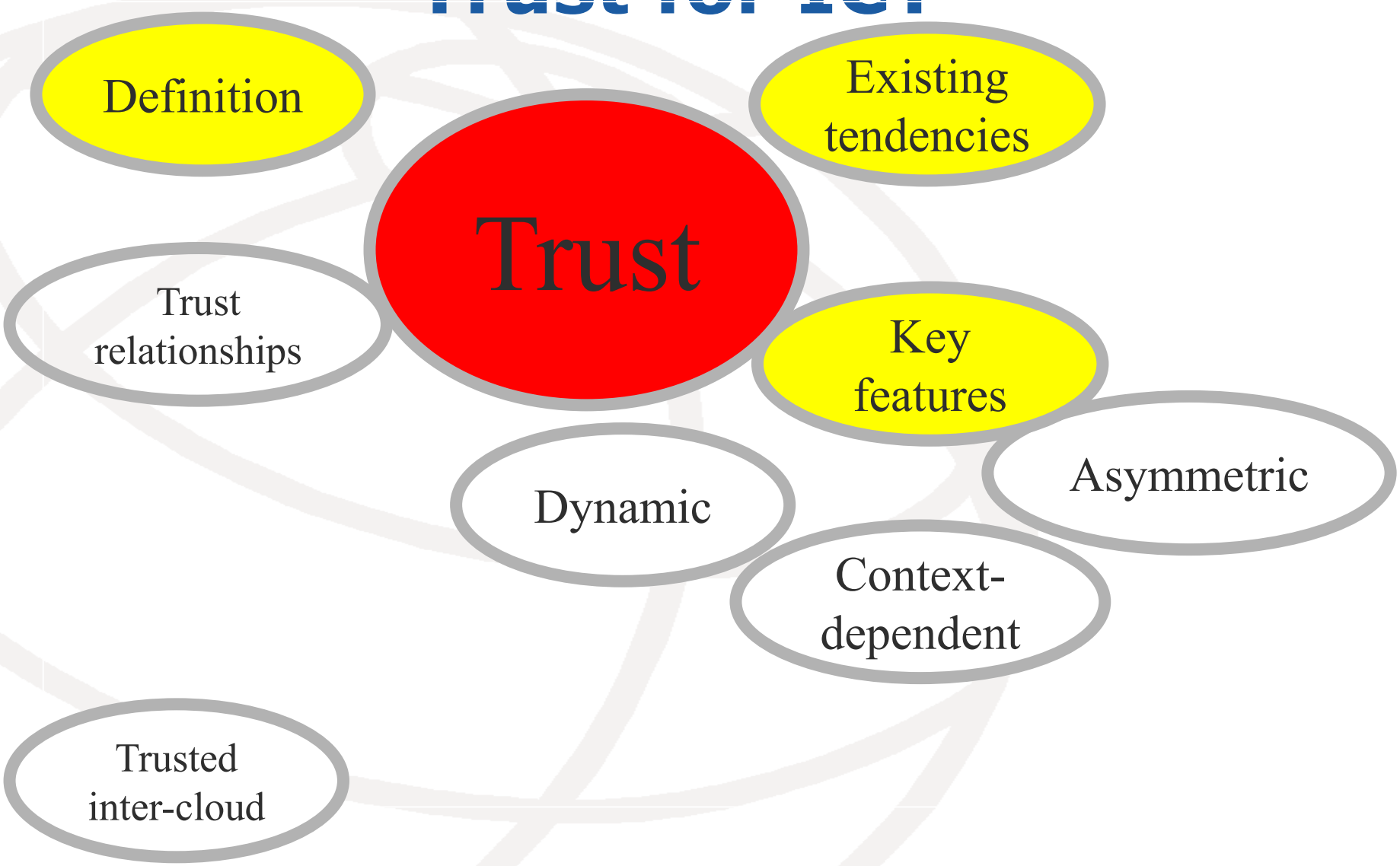
Reliance on others



Knowledge and trust



Trust for ICT



ITU

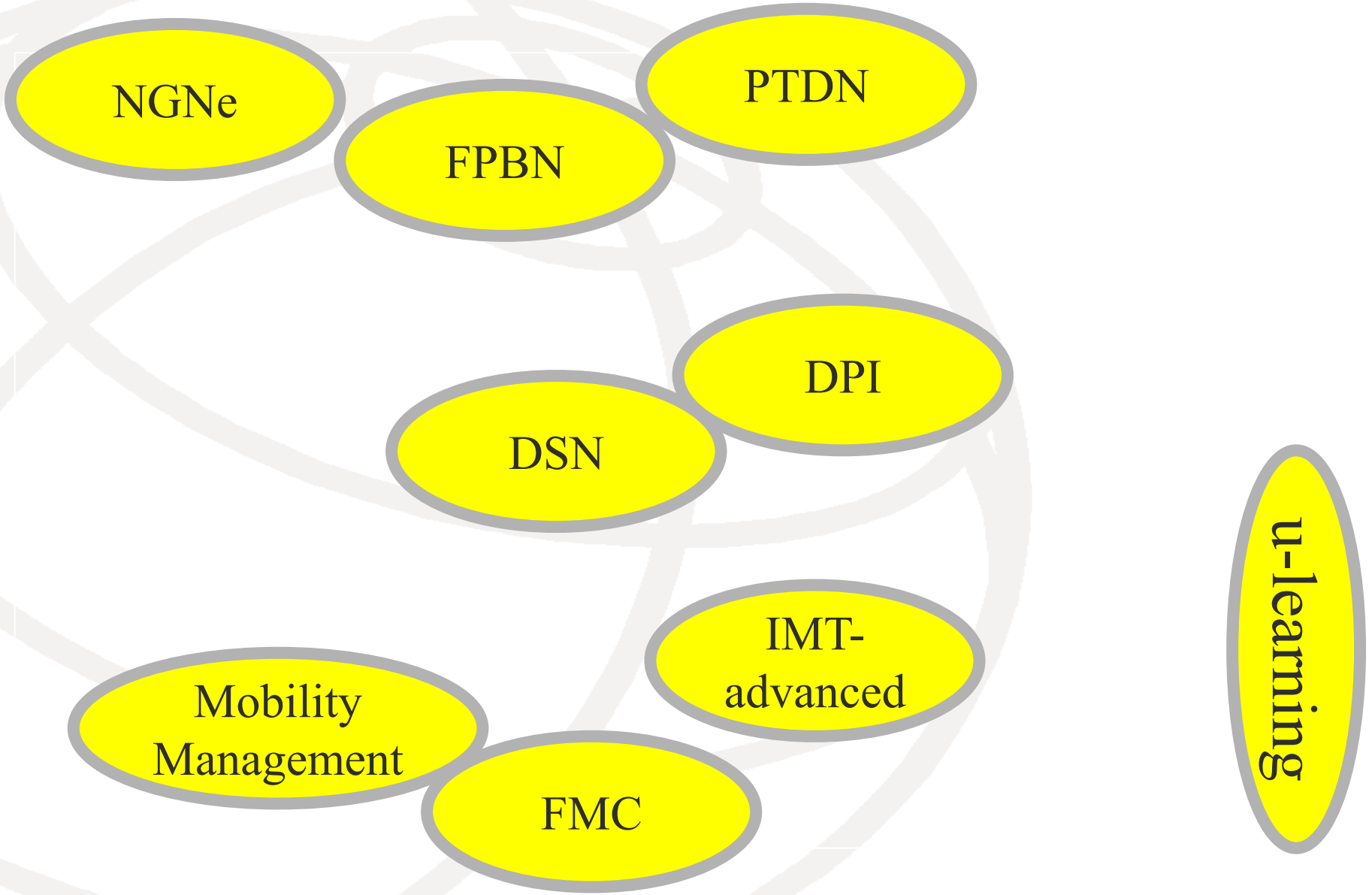
Stands for

I

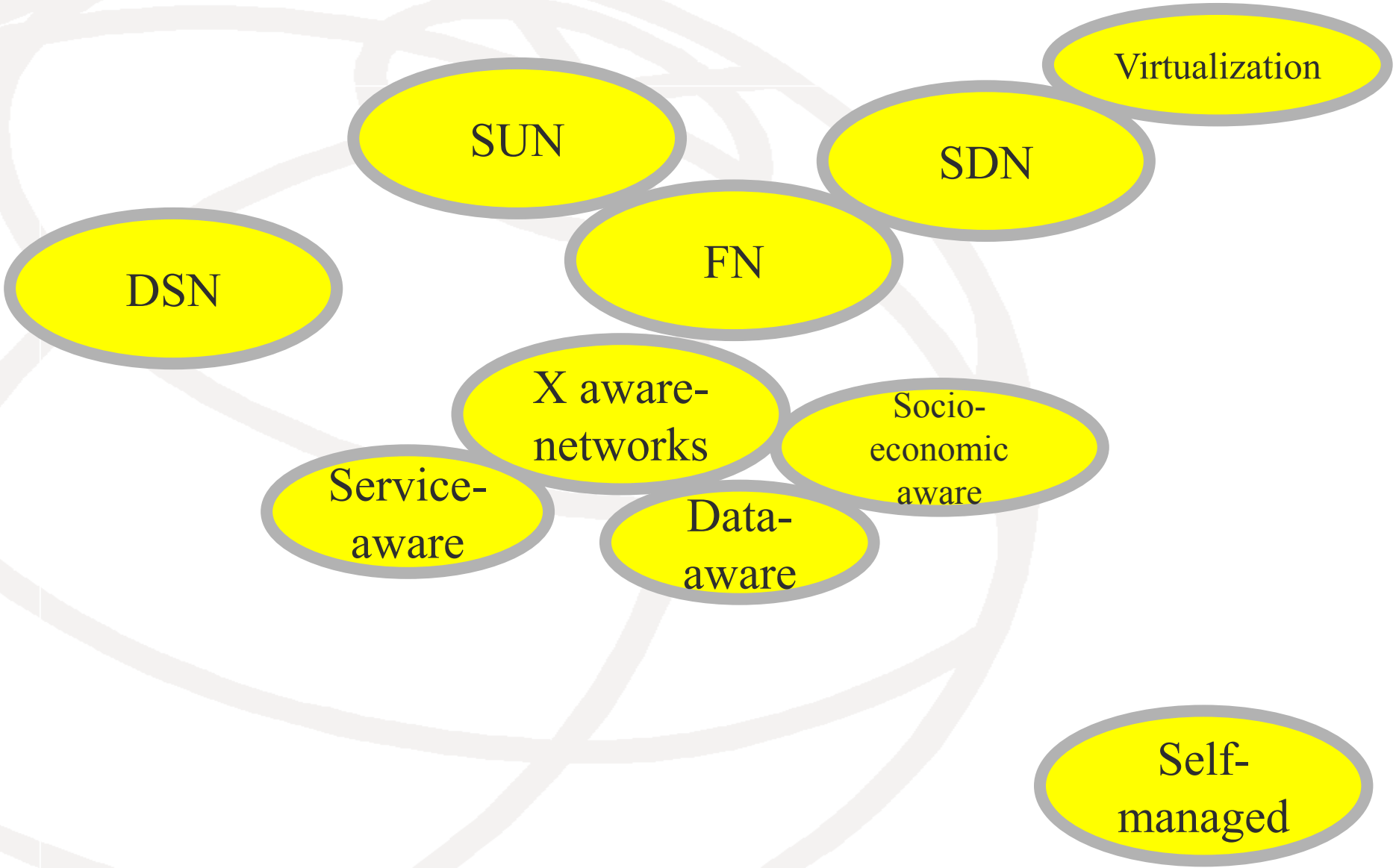
Trust

You

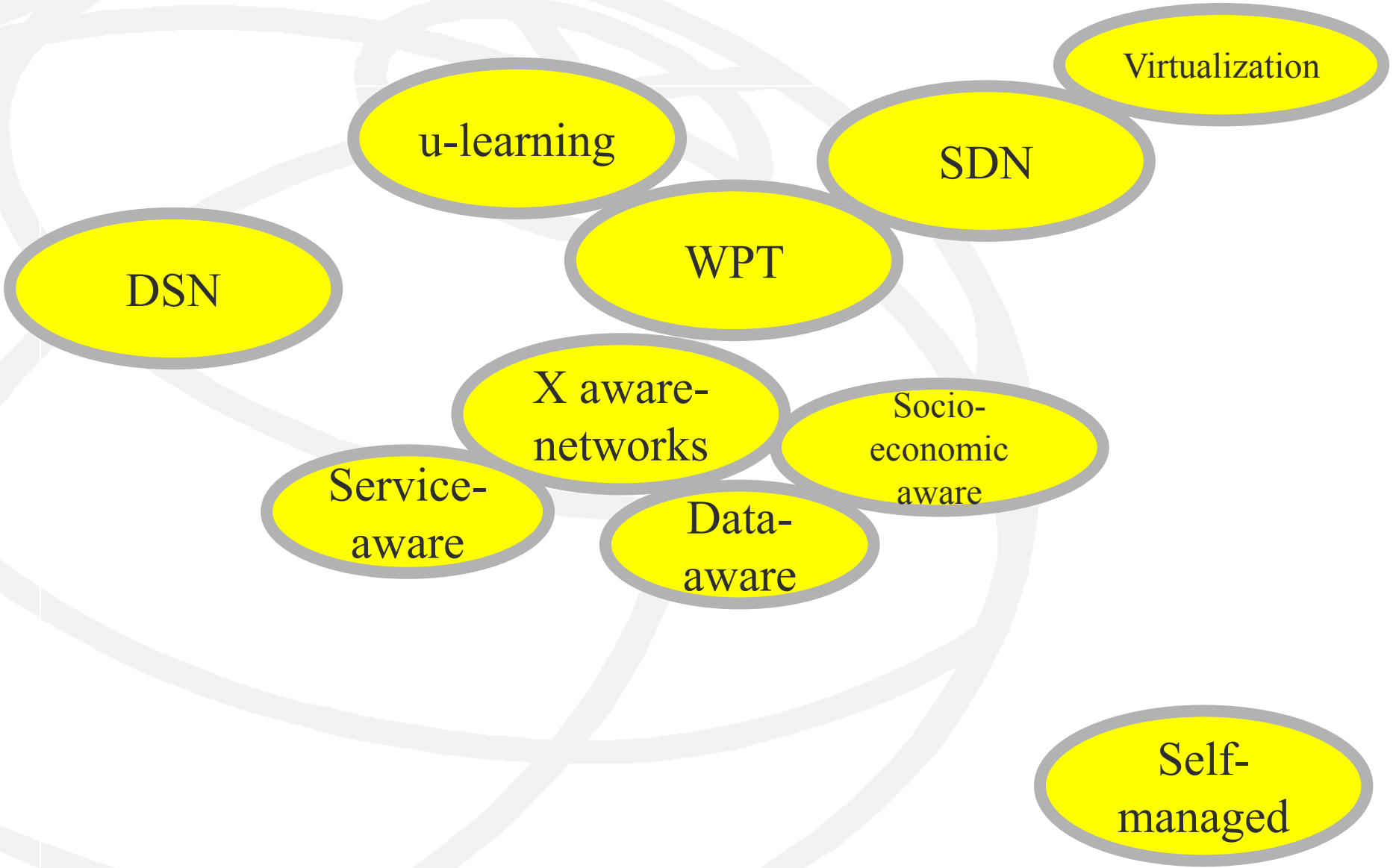
SG13 today - enhancements



SG13 today – future networks



SG13 today – new ideas



Finally, SG13 today

- New ideas from research arms

- Enhancements to the existing networks
- Mobile communications (network aspects)
- Cloud computing
- Networks of the future

- Assistance and solutions for developing countries

Cloud Computing: Definition (ITU-T Y.3500)

"paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand"

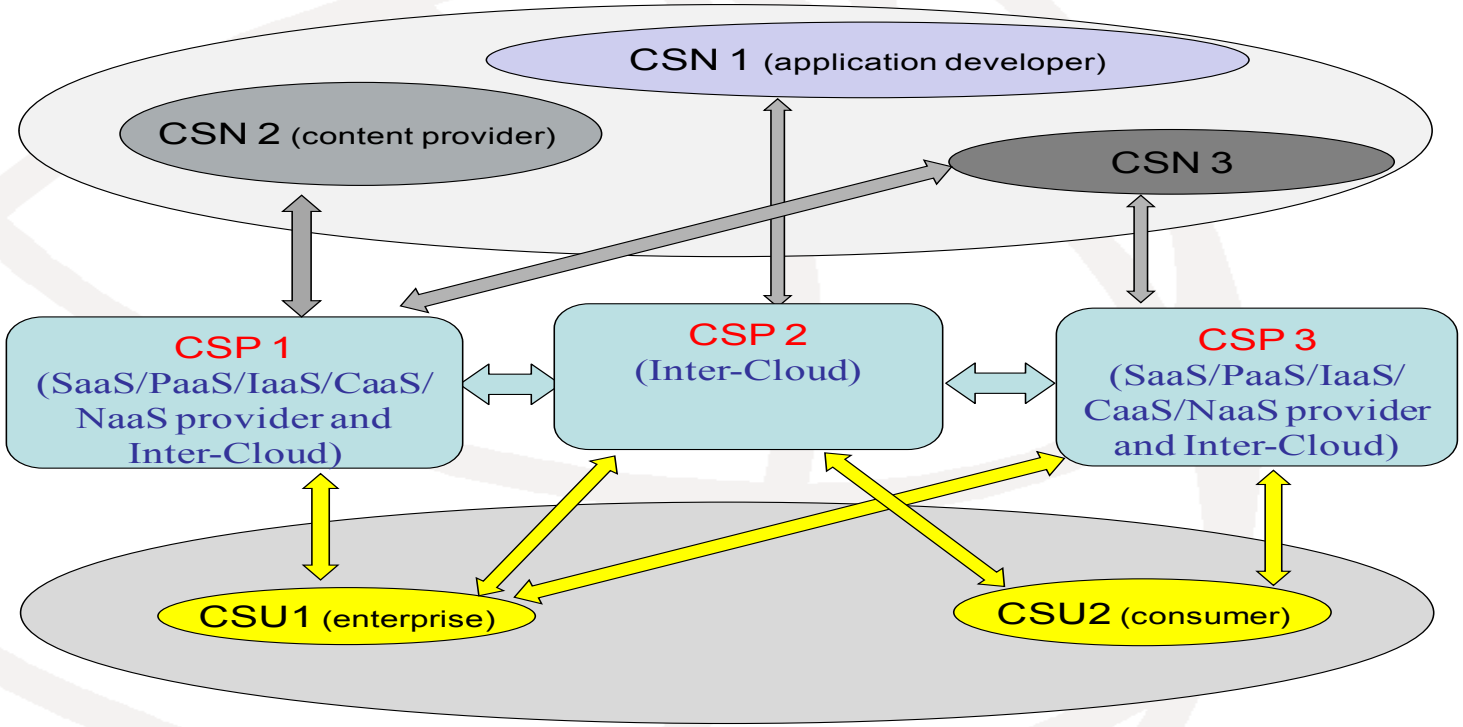
NOTE – Examples of resources include servers, operating systems, networks, software, applications, and storage equipment.

[Source: ISO/IEC 17788 | Recommendation ITU-T Y.3500 "Information technology - Cloud computing - Overview and vocabulary", approved on 13 August 2014]

Cloud Ecosystem

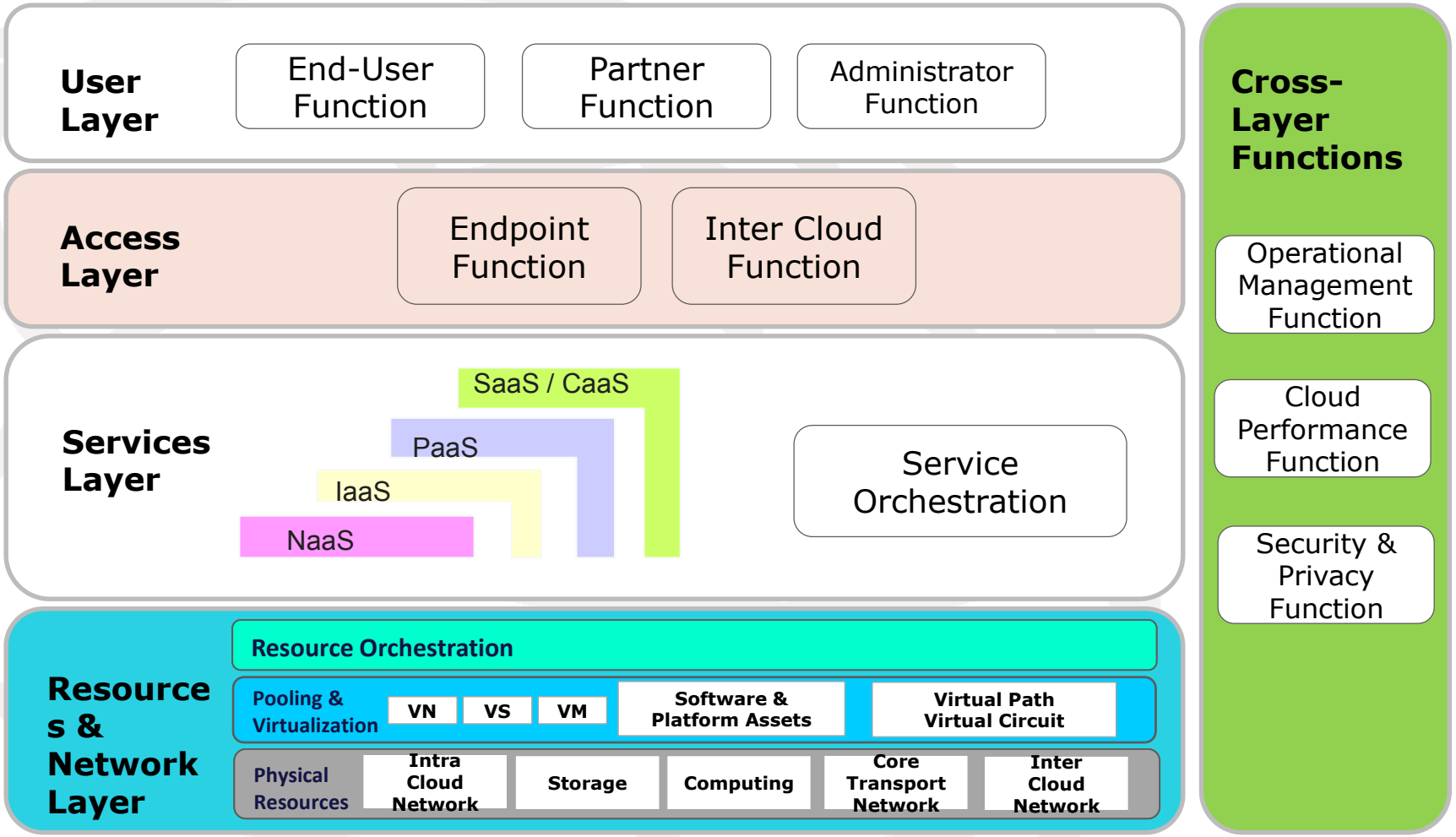
actors playing different roles

- Service Provider
- Service User
- Service Partner

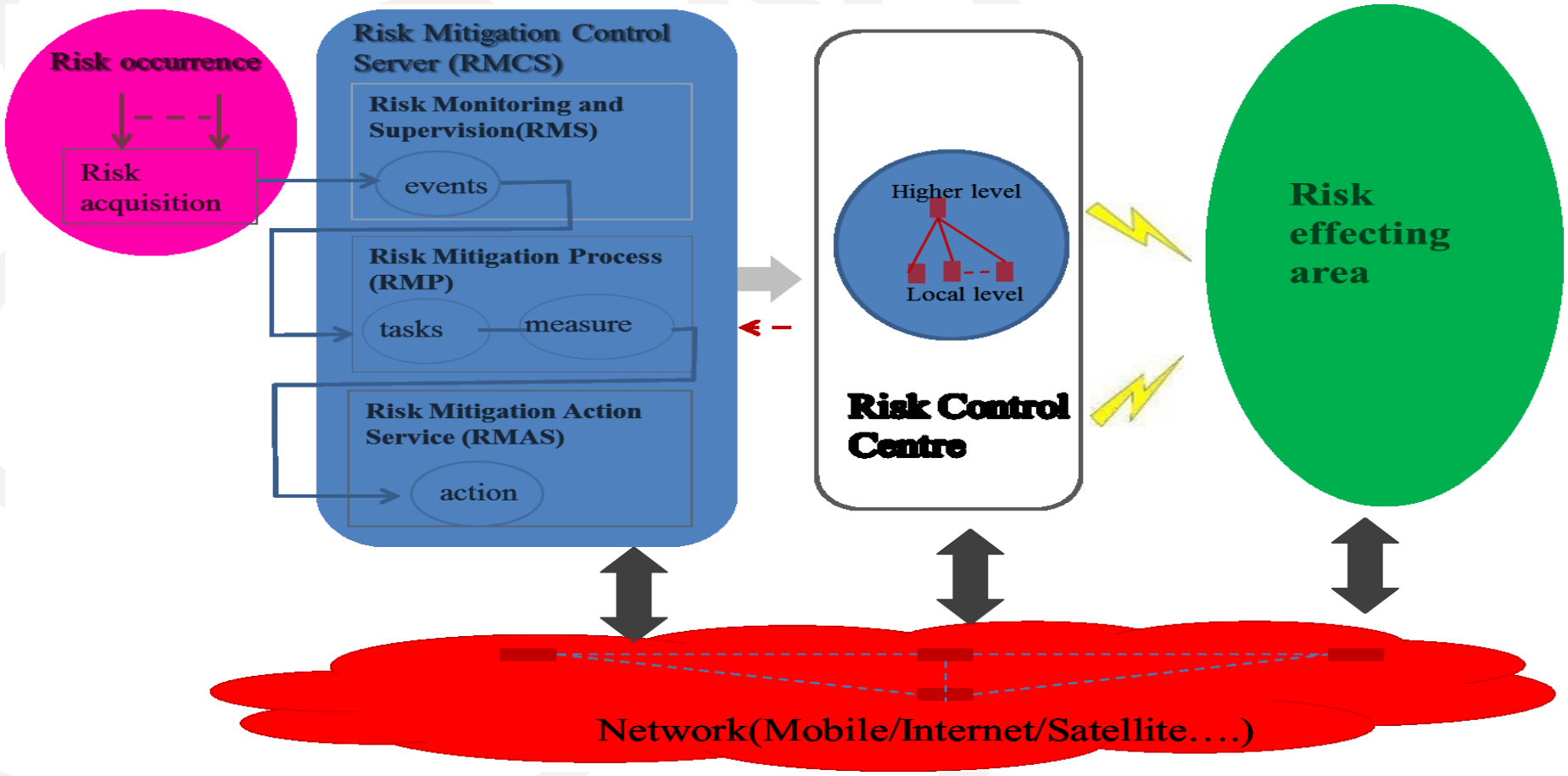


Cloud Functional Architecture

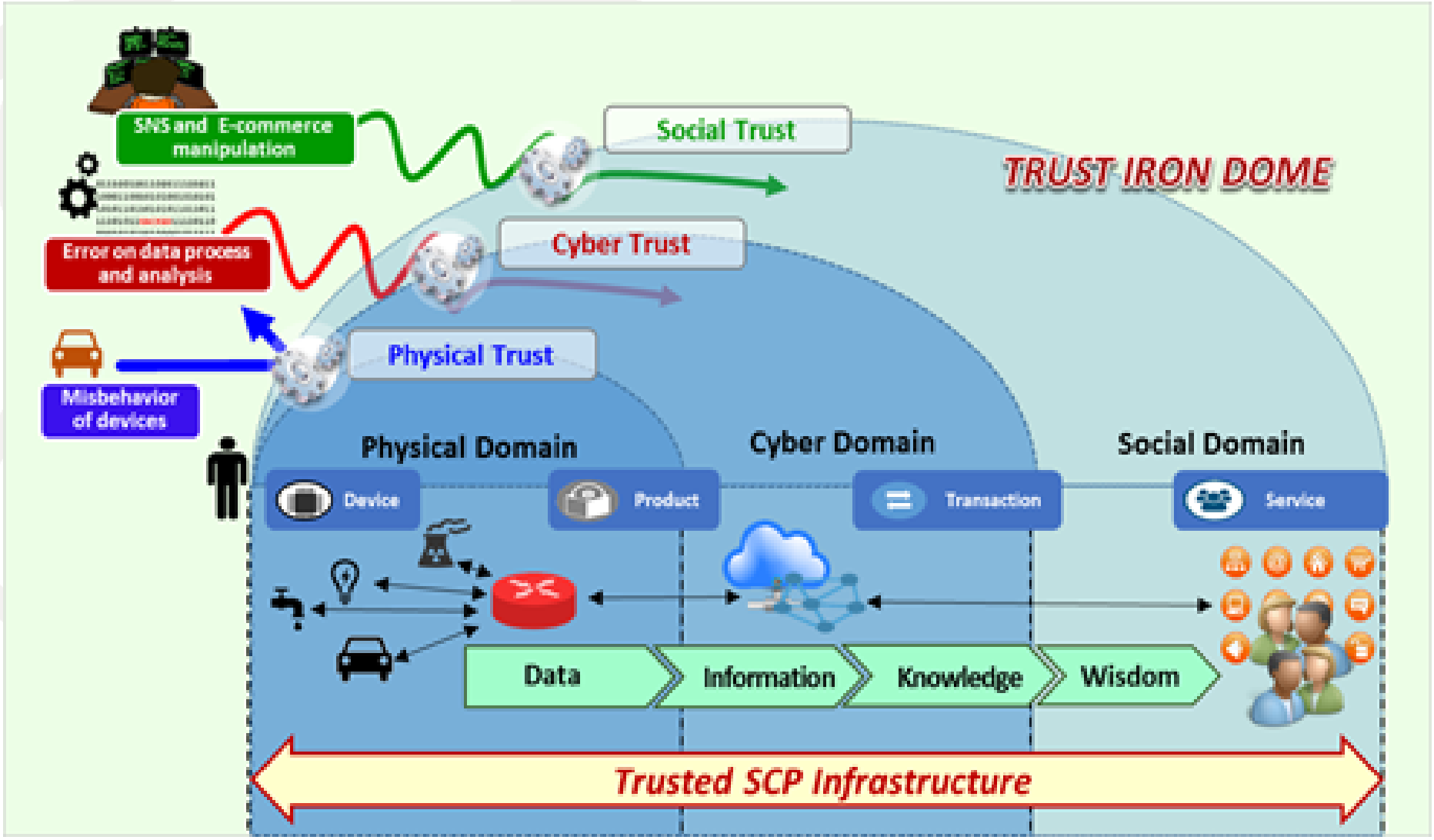
First Cloud ICT Architecture



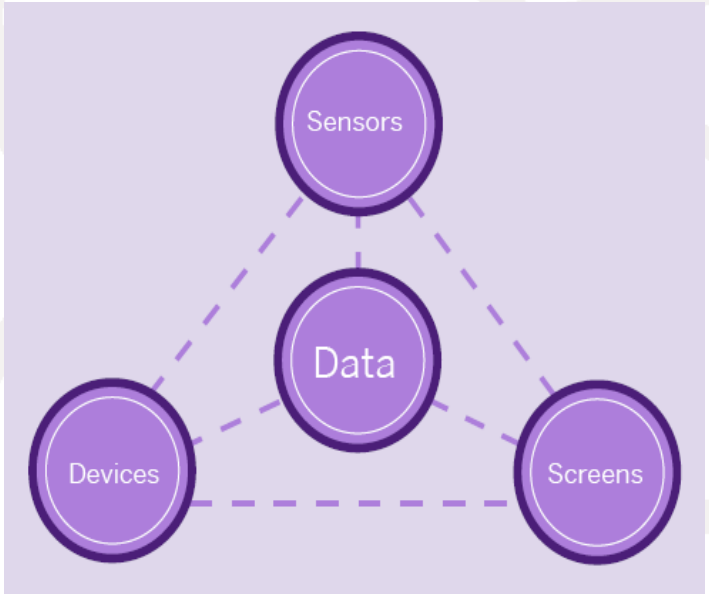
Conceptual model of risk mitigation service



Trust in ICT


SNS and E-commerce manipulation
Social Trust
TRUST IRON DOME
Error on data process and analysis
Cyber Trust
Physical Trust
Misbehavior of devices
Physical Domain
Cyber Domain
Social Domain
Device
Product
Transaction
Service
Data
Information
Knowledge
Wisdom
Trusted SCP Infrastructure

Future ICT



Enhancements of networking/ service scope/capabilities

- ✓ Extension of **service**
- ✓ Extension of **network**
- ✓ Extension of end-user

Consider Trust as a Key Component for Future ICT Infrastructure

- **Key Design Principles**
- Interactions and relationships among Social/Cyber/Physical worlds
- Trustable intelligent services based on data convergence and mining
- Trustworthy environment for correct operations
- Enhanced security and privacy

Study Group 13 Mandate

- **Per Res.2: Future networks including CC, mobile and NGNs**

- **Mission**:

✓studies relating to the requirements, architectures, capabilities and mechanisms of **future networks**;

✓studies relating to service awareness, data awareness, environmental awareness and socio-economic awareness of **future networks**.

- **Responsibility:**

✓studies relating to cloud computing technologies such as virtualization, resource management, reliability and security

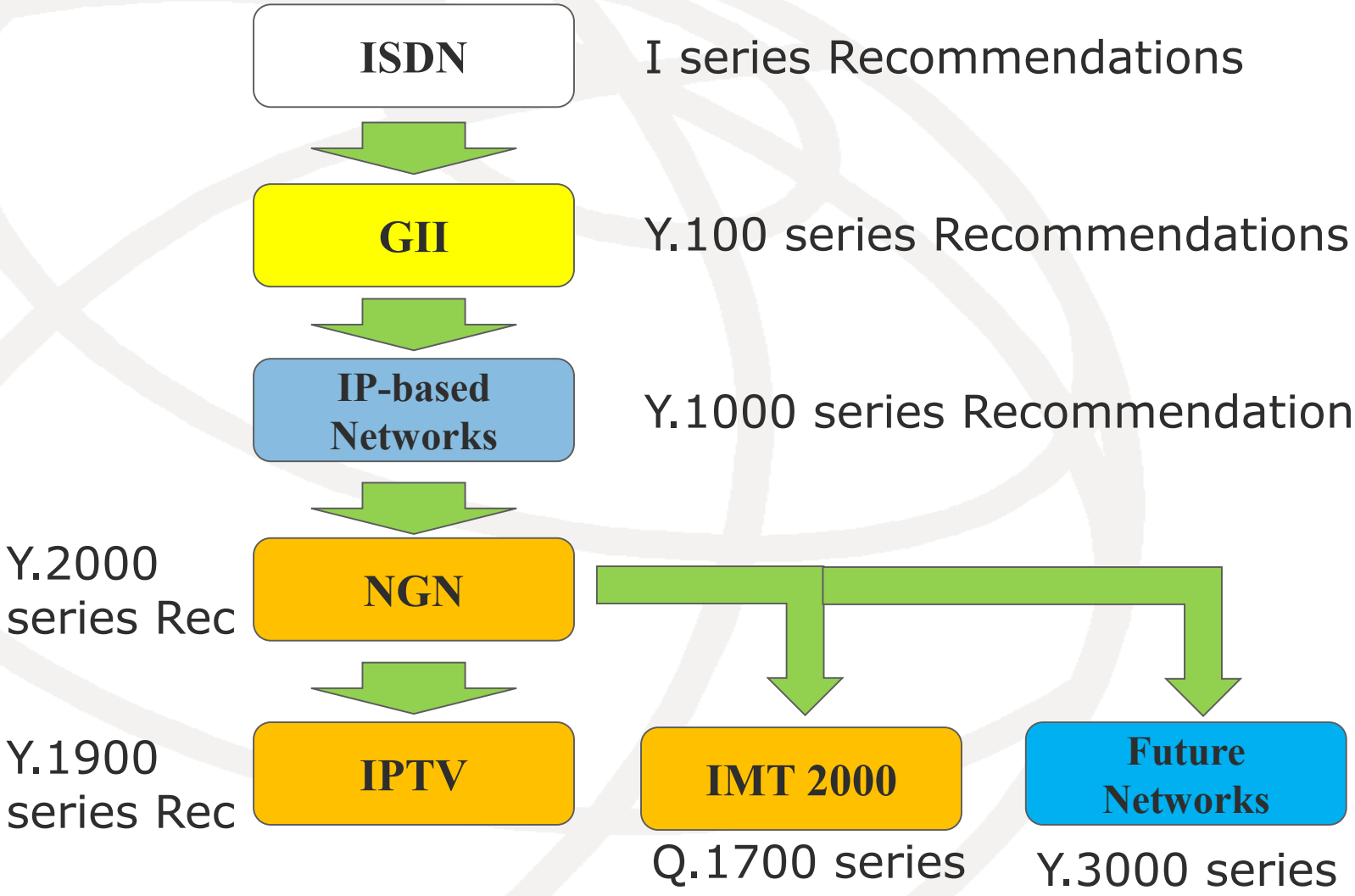
✓studies relating to network aspects of mobile telecommunication networks, including IMT and IMT-Advanced, wireless Internet, mobility management, mobile multimedia network functions, internetworking and enhancements to existing ITU-T Recommendations on IMT

✓studies relating to NGN/IPTV enhancements, including requirements, capabilities, architectures and implementation scenarios, deployment models, and coordination across study groups.

→**WTSA 2012 added a mission for SDN by Resolution 77**

→**TSAG 06/2015 entrusted IoT studies to SG20**

History of studies in SG13



Study Group 13 Overview

SG13 - Future networks including cloud computing, mobile and next-generation networks

- Lead SG on:
  - future networks
  - mobility management and NGN
  - cloud computing
  - Software-Defined Networking
- Participants: ~200 delegates from 37 countries
- Around 230 contributions

Study Group 13 Overview (2)

1/13	Service scenarios, deployment models and migration issues based on convergence services
2/13*	Requirements for NGN evolution (NGN-e) and its capabilities including support of IoT and use of software-defined networking
3/13*	Functional architecture for NGN evolution (NGN-e) including support of IoT and use of software-defined networking
4/13	Identification of evolving IMT systems and beyond
5/13	Applying IMS, IMT and other new technologies in developing country mobile telecom networks
6/13	Requirements and mechanisms for network QoS enablement (including support for software-defined networking)
7/13	Deep packet inspection in support of service/application awareness in evolving networks
9/13	Mobility management (including support for software-defined networking)
10/13	Coordination and management for multiple access technologies (Multi-connection)
11/13*	Evolution of user centric networking, services, and interworking with networks of the future including Software-Defined Networking
12/13	Distributed service networking
13/13	Requirements, mechanisms and frameworks for packet data network evolution
14/13	Software-Defined Networking and Service-aware networking of future networks
15/13	Data-aware networking in future networks
16/13	Environmental and socio-economic sustainability in future networks and early realization of FN
17/13	Requirements, ecosystem, and general capabilities for cloud computing and big data
18/13	Cloud functional architecture, infrastructure and networking
19/13	End-to-end Cloud computing management and security

* Per TSAG June 2015 meeting decision, IoT portion of the work of this Question is being performed in the new SG20

Focus Group on IMT-2020

- Established on 1 May 2015, runs till Dec 2016
- Looks after the network aspects of IMT-2020
- Reports to SG13
- Had 7 meetings and planned one more
- Delivered the Gap Analysis Report identifying the network standardization requirements for the "non-radio" '5G' of International Mobile Telecommunications (IMT) for 2020 and beyond
- Complements the work in ITU-R on IMT-2020
- Currently working on the technical reports on network architecture and network softwarization techniques

SG13 Regional Group for Africa

The main objective: encourage national authorities and operators from countries in Africa to work together and better contribute to ITU-T SG 13 activities in general and to **Cloud Computing (CC)** in particular **in line with SG 13 mandate**.

Terms of Reference:

a) To encourage participation in the SG 13 and to report SG 13's outcomes and deliverables.
b) To establish an electronic forum on CC implementation challenges incl. regulatory issues.
c) To establish training needs on current hot topics and future networks in Africa and coordinate the organization of technical tutorials in the region on such topics with SG 13.
d) To encourage African countries to the development of new/revised ITU-T Recommendations on CC and future networks.
e) To disseminate relevant information provided by ITU-T on current hot topics and future networks standards and document relevant use cases of CC architectures and services including emerging mobile services.
f, g) To provide the focal points identified on hot topics issues and future networks in African countries and to collaborate with African Telecommunication Union (ATU).
h) Act as a liaison body between administrations, operators, regulators and ITU-T in matters relating to CC and future networks.
i) Continent priorities are set to: CC, IMT-2020 (non-radio aspects), Big Data and Trust in ICT

JCA-SDN

- JCA-SDN "Joint Coordination Activity on Software-Defined Networking":
  - Created by TSAG in June 2013
  - Since June 2015 JCA-SDN reports its progress to SG13
  - Maintaines the SDN standardization roadmap
  - Lifetime extended until the end of 2017

JRG-CCM

- JRM-CCM "Joint Rapporteur Group on Cloud Computing Management":
  - Composed of Qs 5/2, 7/2 and 19/13
  - Develops the Recommendations on Cloud Computing Management
  - Managed by co-Rapporteurs from each SG involved
  - Reports to its parent groups, SGs 2 and13
  - Had 2 Recommendations approved on cloud computing management (M.3070/Y.3521, Y.3522)

Results in brief: 2013 – 2016

- **WP1**
- Two SG13 Recommendations on **e-health** Y.2065, Y.2075 Service and capability requirements and framework for **e-health** monitoring services, approved and consented respectively
- Twelve more Rec on **IoT** developed
- One Rec on functional requirements of mobile **IPTV**
- Two (new and revised) Recs on **emergency** communication
- One Rec on **smart farming**
- One Rec on Next Generation Network **evolution**

Results in brief: 2013 – 2016 (2)

- **WP2**
- Y.2771, Framework for **Deep Packet Inspection**
- Y.2772, Mechanisms for the network elements with support of deep packet inspection
- Y.2773, Performance models and metrics for deep packet inspection◇
- Y.3500, Cloud computing - Overview and Vocabulary*
- Y.3502, Cloud computing - Reference architecture*
- Y.3503, Requirements for Desktop as a Service
- Y.3504, Functional architecture for desktop as a service
- Y.3512, Cloud computing - Functional requirements of Network as a Service
- Y.3513, Cloud Computing - Functional requirements of Infrastructure as a Service
- Y.3520, revised, Cloud computing framework for end to end resource management
- Y.3521/M.3070, Overview of end-to-end cloud computing management
- Rec on **big data** - Y.3600: Requirements and capabilities for cloud computing based big data and its standardization roadmap in Supplement 40
- 11 Recs on **cloud computing**, including the latest mentioned above (three Recs were revised)

* Common text with ISO/IEC/JTC1 SC38/WG3

◇ Determined

Results in brief: 2013 – 2016 (3)

- **WP3**
- Three Recommendations on **SDN** Y.3300, Framework of Software-Defined Networking, Y.3320, Requirements for applying formal methods to SDN, Y.3321, Requirements and capability framework for NICE implementation making use of SDN technologies, approved. Four more, Y.3301, Functional requirements of SDN, Y.3302, Functional architecture of SDN, Y.3322, Functional architecture for NICE implementation making use of SDN, and Y.3323, Requirements of Soft network Architecture for Mobile, consented
- 13 Recs on **Future Networks**
- One Rec on **home network**
- 3 Recs on **smart grid**

Workshops

SG13 organized

- Algiers, Algeria, 8 September 2013 “ITU Workshop on Standardization on IMT, M2M, IoT, Cloud Computing and SDN”

- Tunis, Tunisia, 28 April 2014 “2nd SG13 Regional Workshop for Africa on "Future Networks: Cloud Computing, Energy Saving, Security & Virtualization"

- Geneva, 14 November 2014 “ITU Workshop on "Cloud Computing Standards - Today and the Future”

Workshops (2)

SG13 organized

- Livingstone, Zambia, 23 – 24 February 2015 "Third SG13 Regional Workshop for Africa on "ITU-T Standardization Challenges for Developing Countries Working for a Connected Africa"
- Geneva, 24 April 2015 "ITU workshop on Future Trust and Knowledge Infrastructure, Phase 1"
- Accra, Ghana, 14 – 15 March 2016 "The fourth SG13 Regional Workshop for Africa on Future Networks for a better future for Africa: IMT-2020, Cloud Computing and Big Data"
- Geneva, 1 July 2016 "ITU workshop on Future Trust and Knowledge Infrastructure, Phase 2"

Workshops (3)

SG13 participated and contributed to

- ITU Workshop on "Internet of Things – Trends and Challenges in Standardization", Geneva, 18 February 2014

- ITU Workshop on Software Defined Networking (SDN) Standardization Landscape, Geneva, 4 June 2013

- ITU Workshop on Big Data, Geneva, 17 June 2014

Planned Workshop

- *"ITU-T Standardization Work on Future Networks: Towards a Better Future for Africa"* 3 – 4 April 2017, Egypt.

Management Team

Committed to Connecting the World

Chair	***Leo Lehmann succeed Chaesub Lee***	***(Switzerland) (Korea, Rep. of)***
Vice-Chairs:	***Simon Bugaba***	***(Uganda)***
	Mohammed Al Ramsi	***(UAE)***
	Jamil Chawki	***(France)***
	Rim Belhassine-Cherif (succeed Slaheddine Maaref)	***(Tunisia)***
	Hui-Lan Lu	***(USA)***
	Hyoung Jun Kim	***(Korea, Rep. of)***
	Yoshinori Goto	***(Japan)***
	Ahmed Raghy	***(Egypt)***
	Konstantin Trofimov	***(Russia)***
	Heyuan Xu	***(China)***
TSB	***Tatiana Kurakova***	
	Lara Al-Mnini and AnaMaria Meshkurti (succeed Svetlana Kagermazova and Gabrielle Regan)	

Statistics

- 163 Rapporteurs meetings held
- 1337 contributions received (plus about the same amount for the interim meetings)
- 7 SG meetings held
- Max/Min/Average SG participants: 194/139/164
- 11 WP meetings held

Statistics (2)

- 87 New/Revised Recommendations
- 10 Supplements
- 19 Questions assigned by WTSA-12
- 11 revised Questions during study period
- 13 Questions proposed for next period

SG13 "Future networks including cloud computing, mobile and next-generation networks",

its Chairman Leo Lehmann and Counsellor Tatiana Kurakova

are thankful to you for your attention