Towards Future Networks -
the importance of early standardization

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Future networks: New architecture != new services

- New architecture becomes necessary when balance among important issue varies
  - **Line cost** versus **Node cost**: Optical fiber reduced line cost: we can simplify node by sending more complicated (text-based) control messages
  - **Storage cost**: Hard-disk cost is still decreasing

- New service emerges when new end-user device emerges
  - Personal Computer $\rightarrow$ internet
  - Mobile phone $\rightarrow$ made everything personal
  - Bigger computer (Data center) $\rightarrow$ cloud (GFLOPS history)
  - Cheap sensors $\rightarrow$ M2M
### Examples of networking concept:

<table>
<thead>
<tr>
<th></th>
<th>PSTN (telephony)</th>
<th>IP (Internet)</th>
<th>Data Centric Network</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time</strong></td>
<td>1930’s -</td>
<td>1980’s -</td>
<td>2020’s -</td>
</tr>
<tr>
<td><strong>Usage</strong></td>
<td>Voice communication</td>
<td>WEB</td>
<td>M2M</td>
</tr>
<tr>
<td><strong>Type of Communication</strong></td>
<td>Human to Human</td>
<td>Human to Machine</td>
<td>Machine to Machine</td>
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<td><strong>Infrastructure</strong></td>
<td>Circuit switching</td>
<td>Packet switching</td>
<td>Object distribution</td>
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<tr>
<td><strong>Strength</strong></td>
<td>QoS</td>
<td>Connectivity</td>
<td>Mobility</td>
</tr>
<tr>
<td><strong>Weakness</strong></td>
<td>Efficiency</td>
<td>Reliability, QoS, Mobility</td>
<td>Delay</td>
</tr>
<tr>
<td><strong>Mechanism</strong></td>
<td>Sender specifies terminal ID (phone number) and set-up end-to-end circuit passage.</td>
<td>Sender specifies terminal location (IP address) and send out packet flows.</td>
<td>Sender registers an object with an ID attached, and receiver specifies the ID to retrieve it.</td>
</tr>
</tbody>
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Backcast/forecast in standardization

- Historically, standardization target already existed in the market (backcast)
- Modern standardization is done to develop market (forecast)
- Future Networks: ?
  - Danger: History of standardization is filled with unused standards, in particular in ICT area...

Timing is almost everything. When should we standardize what?
ITU-T status in field of FN standardization

- ITU-T SG13 (Future Networks) leads this activity since 2009
- ITU-T Y.3001 Title: “Future Networks: Objectives and Design Goals”
- Specifies 4 objectives and 12 Design Goals of Future Networks.
- 4 top level documents already published
Four FN Objectives

- **Environment awareness**
  - FNs should be environmental friendly.

- **Service awareness**
  - FNs should provide services that are customized with the appropriate functions to meet the needs of applications and users.

- **Data awareness**
  - FNs should have architecture that is optimized to handling enormous amount of data in a distributed environment.

- **Social-economic awareness**
  - FNs should have social-economic incentives to reduce barriers to entry for the various participants of telecommunication sector.
12 - Design Goals

1. FNs should accommodate a wide variety of traffic and support diversified services \textit{(Service Diversity)}

2. FNs should have flexibility to support and sustain new services derived from future user demands \textit{(Functional Flexibility)}

3. FNs should support virtualization so that a single resource can be used concurrently by multiple virtual resources. FNs should support isolation and abstraction \textit{(Virtualization of resources)}

4. FNs should have mechanisms for retrieving data in a timely manner regardless of its location \textit{(Data Access)}

5. FNs should have device, system, and network level technologies to improve power efficiency and to satisfy customer’s requests with minimum traffic \textit{(Energy Consumption)}

6. FNs should facilitate and accelerate provision of convergent facilities in differing areas such as towns or the countryside, developed or developing countries \textit{(Service Universalization)}
12 - Design Goals (Cont.)

7. FNs should be designed to provide sustainable competition environment to various participants in ecosystem of ICT by providing proper economic incentives (Economic Incentives)

8. FNs should be able to operate, maintain and provision efficiently the increasing number of services and entities (Network Management)

9. FNs should be designed and implemented to provide mobility that facilitates high levels of reliability, availability and quality of service in an environment where a huge number of nodes can dynamically move across the heterogeneous networks (Mobility)

10. FNs should provide sufficient performance by optimizing capacity of network equipments based on service requirement and user demand (Optimization)

11. FNs should provide a new identification structure that can effectively support mobility and data access in a scalable manner (Identification)

12. FNs should support extremely high-reliability services (Reliability and Security)
ITU-T Future networks activity timeline (Roadmap)

2009-2012
2011 2012

2013-2016

Service awareness
Y.301x

Virtualization of Resources
Network Management
Functional Flexibility
Service Diversity
Mobility
Reliability and Security

Y.3011
Y.FNvirtreq
Architecture
Y.AMNSA
Requirement and Architecture

Data awareness
Y.303x

Data Access
Identification

Y.3031
Y.FNDAN
Requirement and Architecture
Y.FNdconfig

Environmental awareness
Y.302x

Energy Consumption
Optimization

Y.3021

Social and economic awareness
Y.304x

Economic Incentives
Service Universalization

Y.Fnsocioeco
(Y.3041??)

Software Defined Networking
Y.3100-

Y.FNSDN
Requirement and Architecture

Q14

Q15

Q16

Conceptual document phase
Detail document phase

Approved or Initiated
Future plan
Candidate technologies for achieving the design goals:

- Network Virtualization (Virtualization of Resources)
  - Enables creation of logically isolated network partitions over shared physical network infrastructures so that multiple heterogeneous virtual networks can simultaneously coexist over the shared infrastructures; it allows the aggregation of multiple resources and makes the aggregated resources appear as a single resource

- SDN (Software Defined Networking)

- Data/Content-oriented Networking (Data Access)

- Energy-saving of Networks (Energy Consumption)
  - Forward traffic with less power
  - Control device/system operation for traffic dynamics
  - Satisfy customer requests with minimum traffic

- In-system Network Management (Network Management)

- Distributed Mobile Networking (Mobility)

- Network Optimization (Optimization)
  - Device / System / Network level optimization (Path optimization, Network topology optimization, Accommodation point optimization)

- DTN (Delay-tolerant networking)
  - To provide robustness even in presence of link/network disconnections (e.g, Automobile, train, ships, airplane, …)

- …
Concept of network virtualization
(LINP: Logically Isolated Network Partition)

- Network virtualization is required to be capable of providing multiple virtual infrastructures those are isolated each other.
- The virtualized infrastructures may be created over the single physical infrastructure.
- Each virtual network is isolated each other and is programmable to satisfy the user’s demand on the functionality and amount.
- User’s demand is conveyed to LINP manager which is required to coordinate infrastructures so that appropriate network resource is provided to the user.
Identification Framework for FNs

- High-level requirements for identifiers
  - unique in given scope
  - unambiguous for the given category
  - some persistent IDs and some temporary IDs
  - recommended to have ID structure helpful for mapping between IDs of different categories
  - both static and dynamic mapping should be possible between IDs of different categories
  - flexible structure for future enhancement
  - security friendly structure

- Identification Framework
  - Logically connects communication objects to physical networks
  - Includes node IDs, data IDs, user IDs, service IDs and location IDs in its scope
  - Includes four components:
    - ID Discovery Service
    - ID Spaces
    - ID Mapping Registries and
    - ID Mapping Service
Y.FN socio-economic

Is this technology good for society?
Economically reasonable?

When a technology is given, this “guide”:

- Lists and describes methods to assess socio-economic effect of the technology
- Analyze potential tussles among parties
- Helps design/select appropriate technology for Future Networks

Some interfaces/mechanisms are too integrated, and difficult to improve because too many parties are involved
Outline

Future Networks: a Programmable Network?

- Standardisation in ITU-T
- Standardisation in ETSI
- Standardisation in 3GPP
- Standardisation in ISO IEC JTC1
- Standardization in ONF
  - OpenFlow
- Standardisation in IETF
  - SDN overall architecture?

Vision and collaboration is important

Network for/of Individual
Network for/of Society
Network for/on Earth

Cleaner slate design approach

2015~2020

Future Networks
Questions on FN standardization

- To design FN, wider collaboration than traditional ICT framework is necessary!
  - Today’s promising areas are all interdisciplinary ones between ICT and other industries (Cloud: computer, smart grid: power, IoT: health, vehicle, etc.)
  - **ICT has become an infrastructure of every industry, so we need to learn their needs to design future networks** (We can’t design smart grid ready network without understanding power industry’s requirements)

- Do we have enough options?
  - Are R&D/industry proposals mature enough?

- Is the emerging market clear enough?
  - Can we expect enough participation from industries so early? *(ITU-T is contribution driven - no progress without contribution!)*
    
    Diferent SDOs, Research Communities (FP7/Horizont 2020, ...) and Forums are invited to contribute.

- If we specify standards, do market respect our specifications?
Thank you!