ITU Kaleidoscope 2013
Building Sustainable Communities

Design and implementation of virtualized ICT resource management system for carrier network services toward cloud computing era

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Contents

1. Background & Motivation
2. Contribution
3. Requirements for virtualized ICT resource management
4. Carrier network service architecture design
5. Implementation for mobile network service
6. Conclusion

Background and motivation

- High flexibility in provisioning, control, and management is indispensable to satisfy new type demands of customers in cloud computing era
  - e.g. Speed to market, service elasticity for traffic demands, cooperation of NW and IT resources
- Network carriers face to reduce OPEX/CAPEX while ensuring variety, reliability, availability, and management flexibility with shared ICT resource
  - Disaster-tolerant network services
- Advanced technology in ICT resource virtualization
  - Virtualization middleware, cloud computing in IT
  - Software-defined networking/OpenFlow in NW

Approach

- ***Management Engine:***
  Redesigned software component-based management system + Virtualized NW/IT resources for carrier network service
  - Virtualized ICT resource information modeling for cooperation of NW and IT resources
  - Decoupling the functionality from the entity of the physical ICT resources
  - Software defined networking
  - Matured IT virtualization technologies

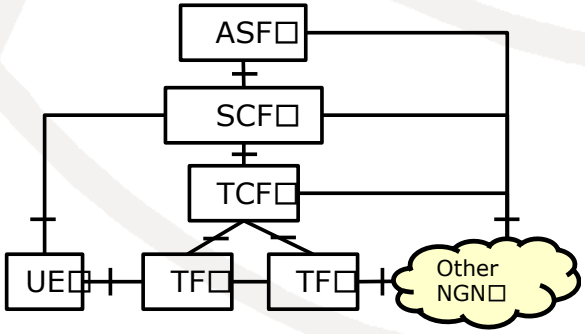
Contributions

- A virtualized ICT resource information model is designed to take advantage of ICT virtualization technology in carrier network service
- Designing a modular/layered management system architecture for virtualized ICT resource
- Flexible service cooperation to ensure dynamic resource accommodation between services with virtual ICT resources is demonstrated
- Future standardization and improvement issues in the virtual ICT resource management field are summarized

Existing network service architecture: NGN and Internet

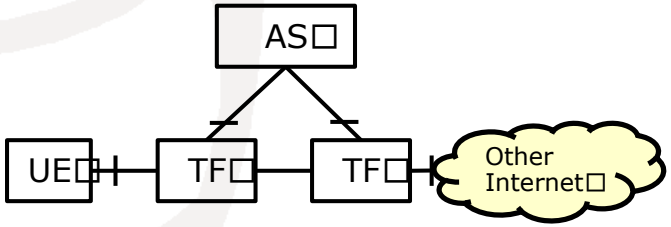
- Application service functions and network functions are separately managed
- Cooperation functions between application service and ICT resource are limited
  - Poor support for global optimization

NGN



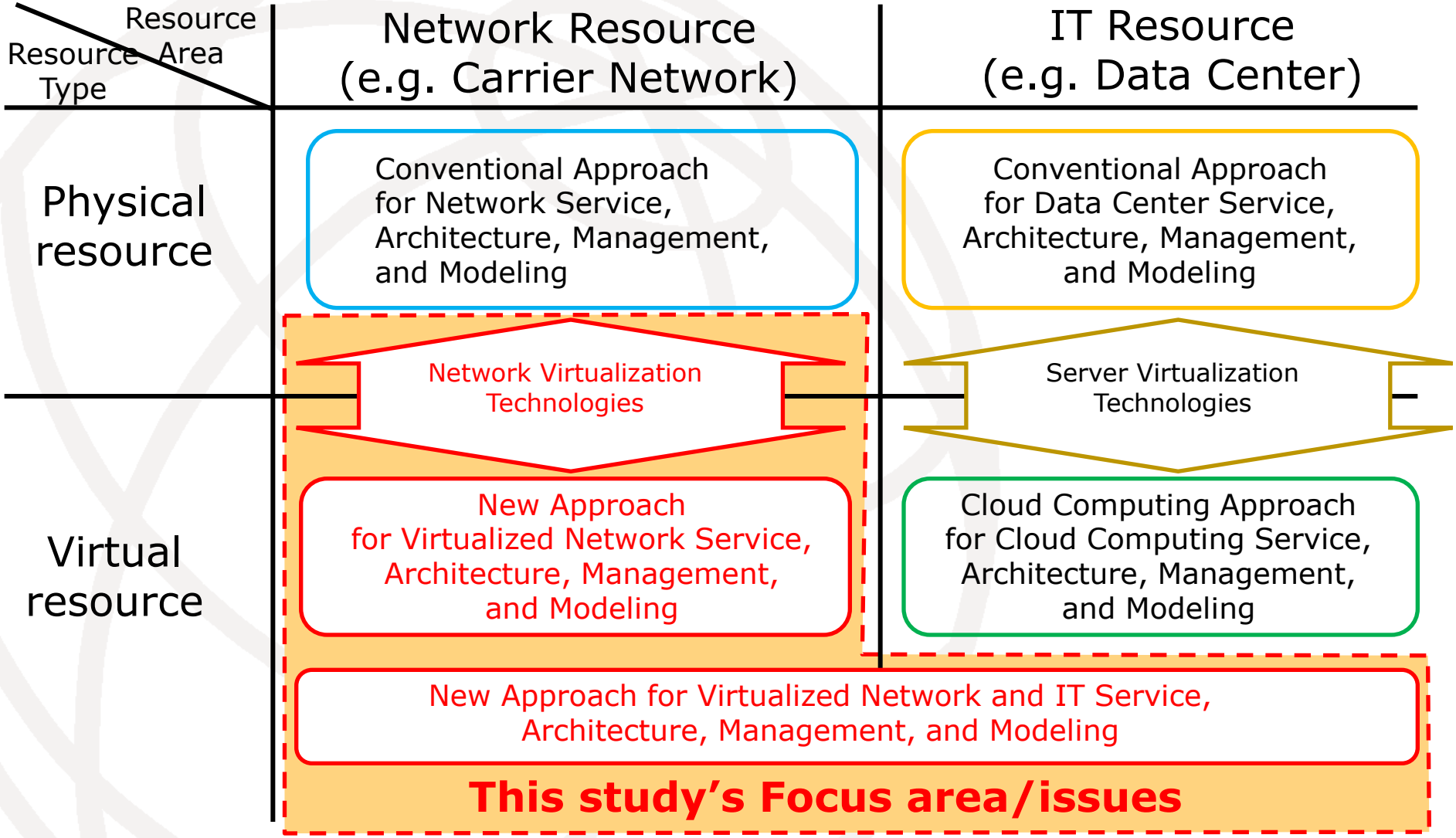
UE: User Equipment
ASF: Application Support Functions
SCF: Service Control Functions
TCF: Transport Control Functions
TF: Transport Functions

Internet



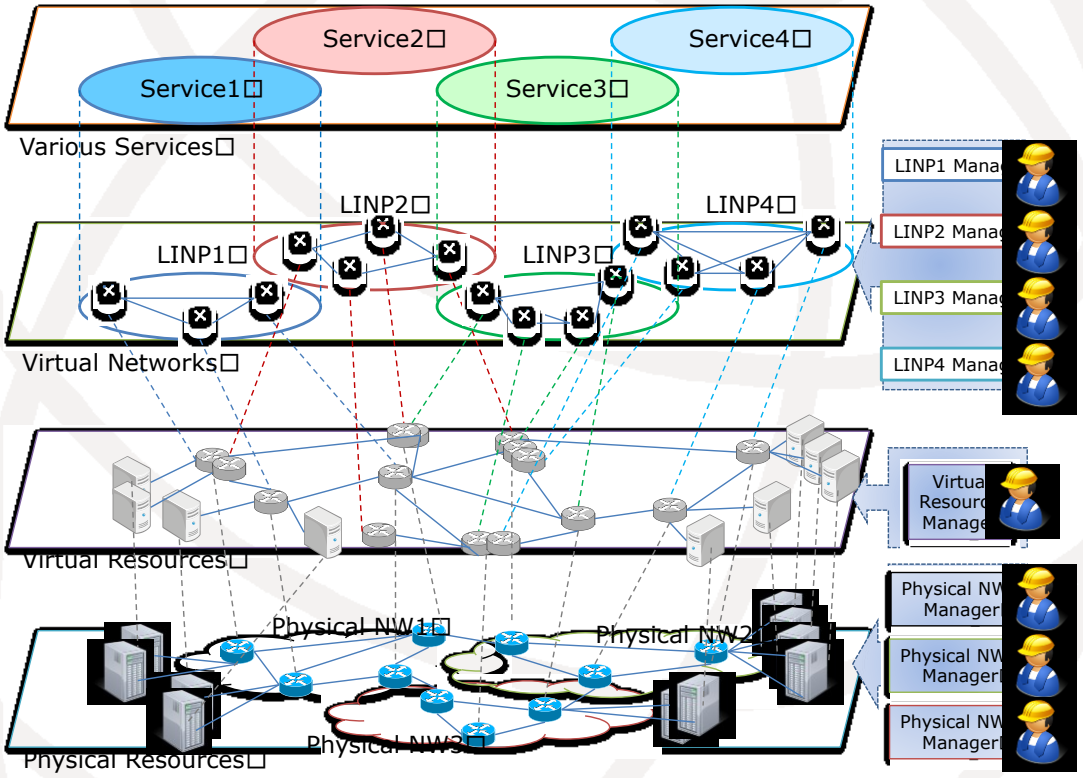
UE: User Equipment
AS: Application Servers
TF: Transport Functions

Approach portfolio of virtualized resource management



ITU-T Y.3011: NW virtualization for future NW

- Various services run over logical isolated network partition (LINP) using shared virtualized network resource



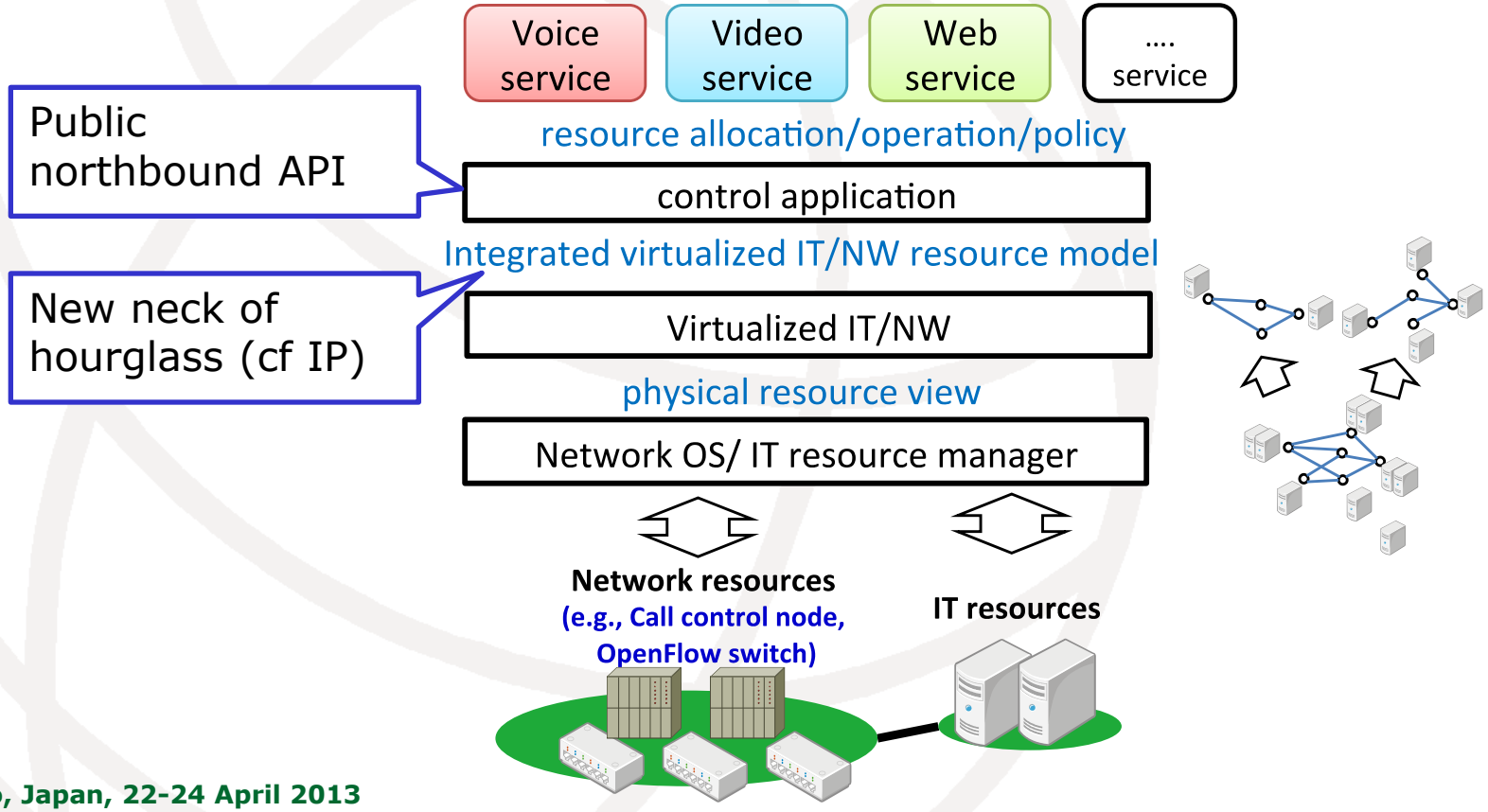
- Four main issues
  - Coexistence of multiple NW
  - Simplified access to resources
  - Flexibility in provisioning
  - Evolvability

Requirements of virtualized ICT management for carrier network

- Virtualized ICT resource information model
  - Extended/integrated resource information model for virtualized NW and IT resource
    - cf cloud technologies for virtualized IT resources, ITU-T Y.3011 for virtualized NW resources
- Additional requirements to ITU-T Y.3011
  - Multi-tenant support
  - Cooperation control and resource provisioning for virtualized ICT resource
  - Traceability and mapping relationship information between virtualized and physical resources

Concept design of the proposed network architecture

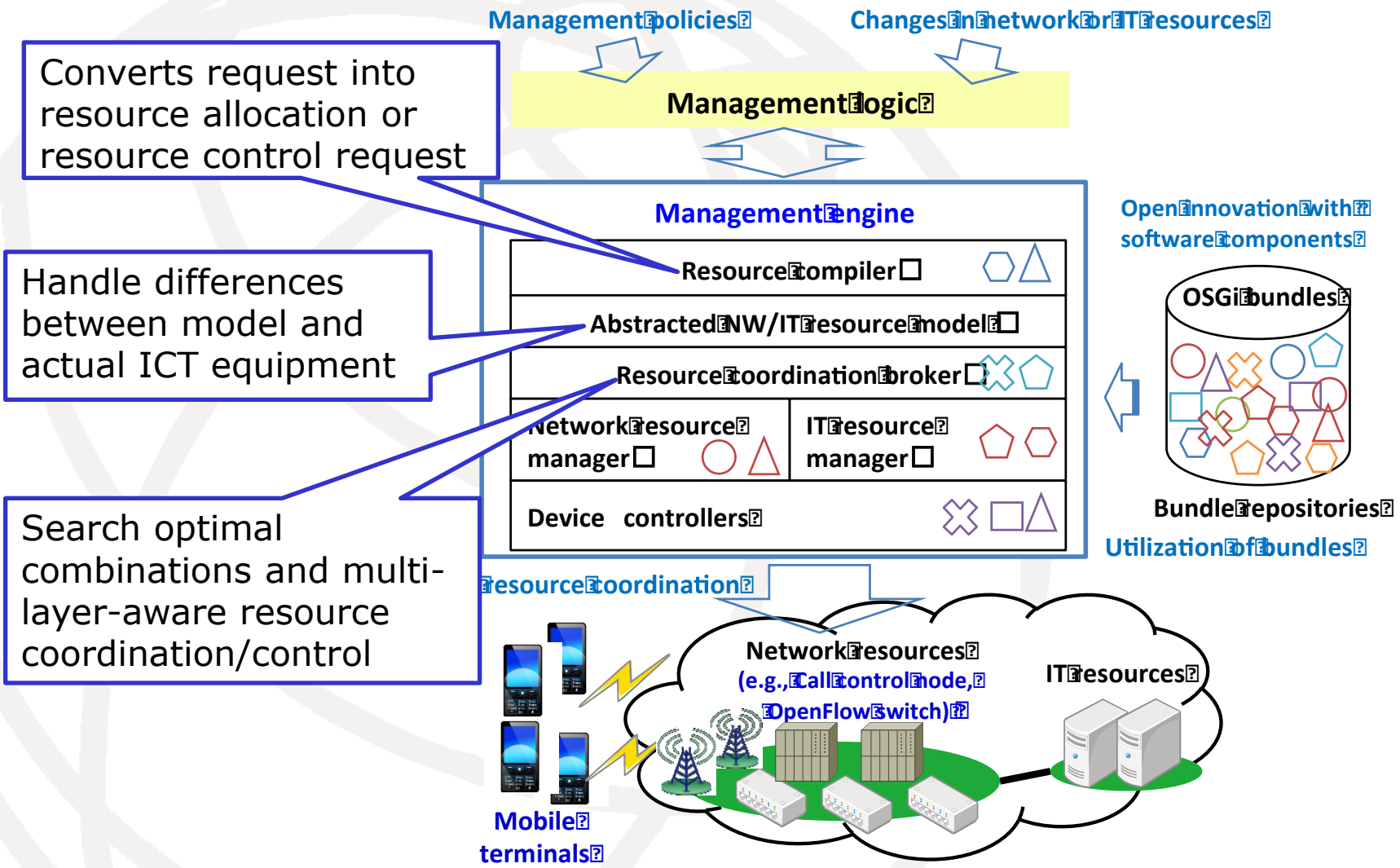
- Encourages flexible network service operations and dynamic service reconfigurability for service providers and carrier operators



Management system design

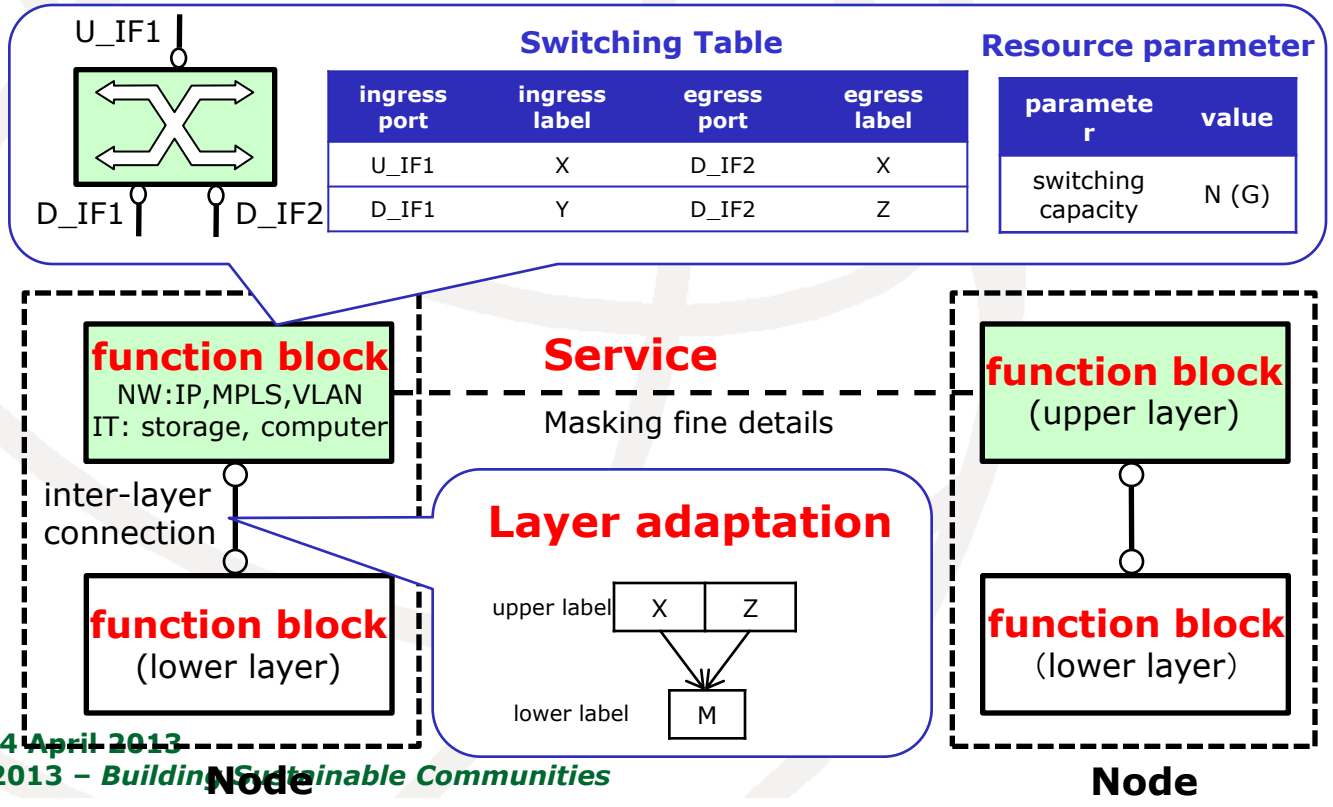
- Layering/modularizing architecture
  - For long-term evolution and rapid development
- Utilizing software component technologies
- Leveraging software-defined networking technologies
  - Decoupling systems functionality from physical resource entities with programmability and ICT resource virtualization
  - Using function-aware ICT resource abstraction model and model-based control

Architecture overview of Management Engine



Function-aware virtualized ICT resource information model

- Unified information model based on ITU-T G.805, TM Forum SID, and NDL for ICT resources
  - Allows multi-layer-capable & ICT coordination processing
  - Consists of function block, layer adaptation, and service

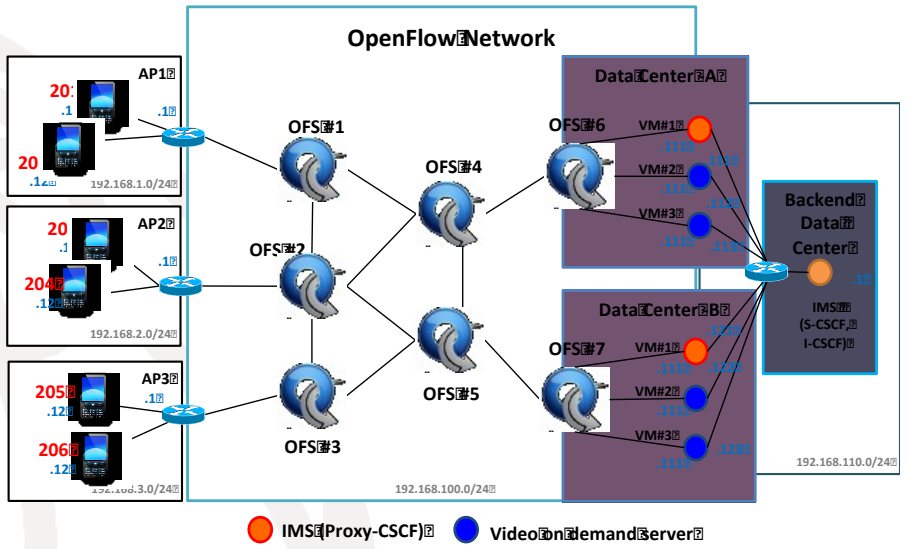


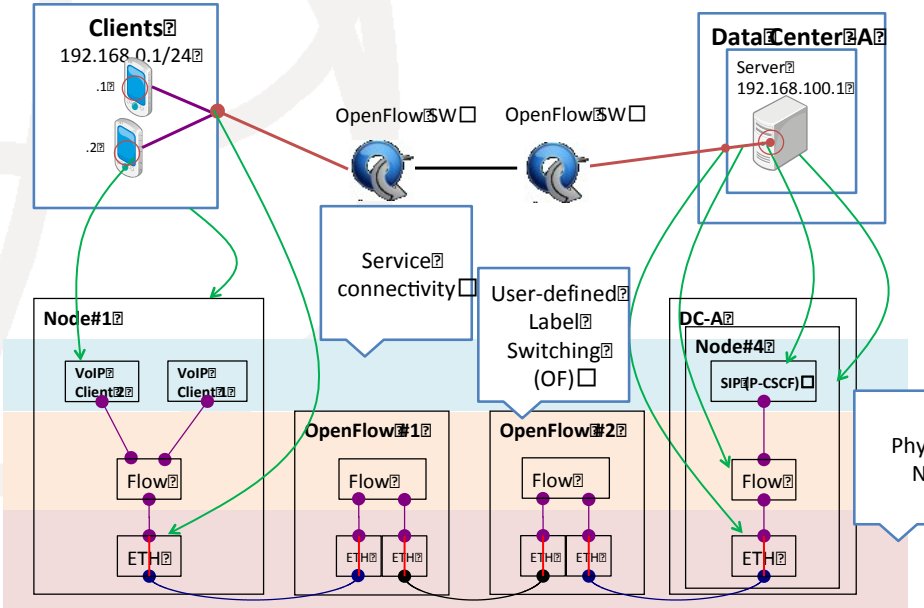
Architecture implementation for mobile network services

- Voice and Video service run on prototype network designed by referencing architecture of 3GPP LTE
  - IMS with dynamic scale-out/scale-down extension for voice
  - Flash over HTTP for video
- Management Engine dynamically controls both OpenFlow network and virtualized IT resources

Configuration and its information modeling

- Physical configuration
  - Two DC, Three APs:P-CSCF of IMS and HTTP video server on three VM
  - One backend DC: {S,I}-CSCF of IMS
  - OpenFlow network
- Information modeling
  - Layer-4-level path as minimum elements of NW virtualization view
  - Underlying resources are systematically configured

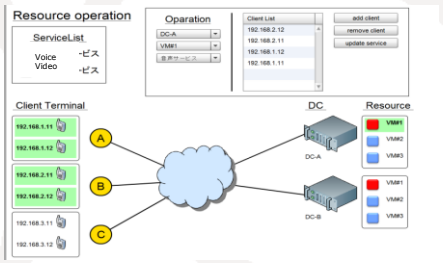




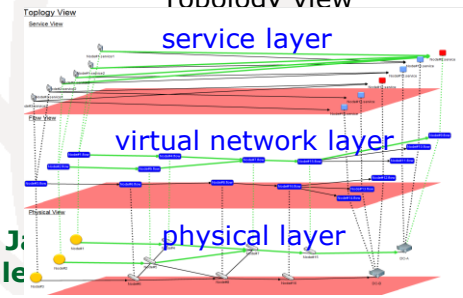
Management Engine Implementation

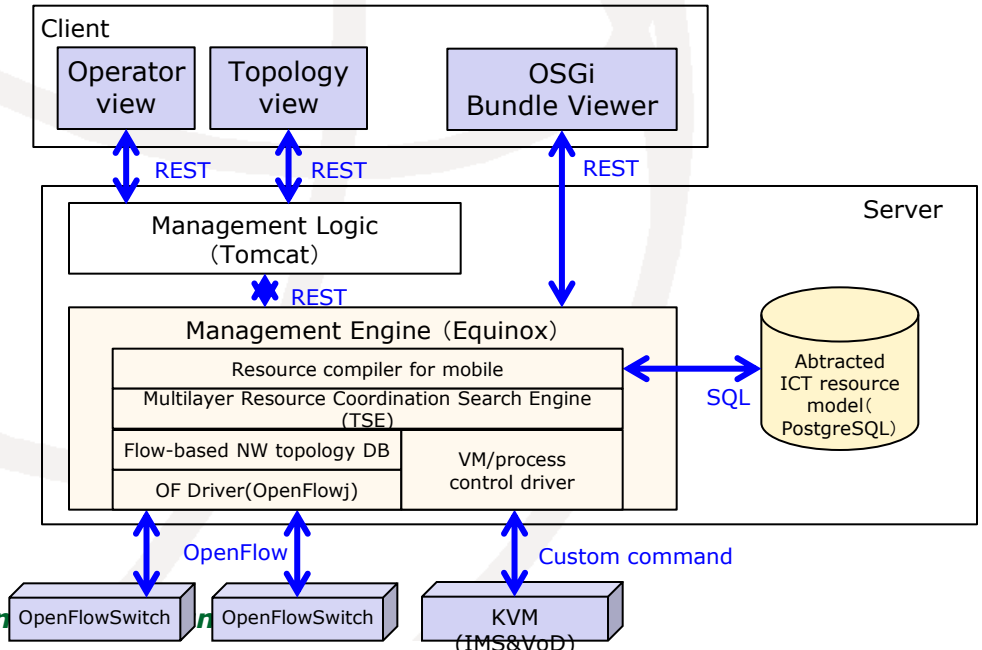
- All modules are developed as OSGi bundles
- ICT-tightly-coupled resource coordination and function assignments are performed with multi-layer resource coordination search engine
- OpenFlow driver controls layer-3/4 flow as label switching on OpenFlow switch

Service operator's view



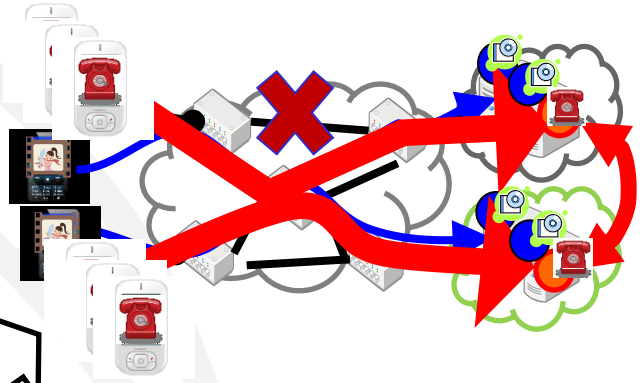
Topology view

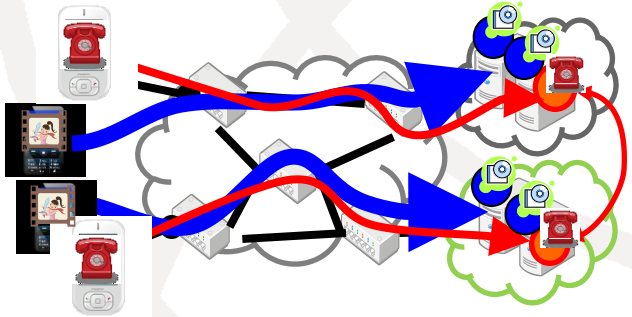




Operation strategy policy

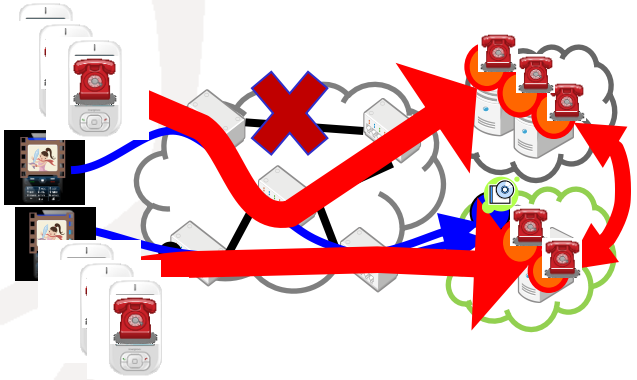
Strategy 1: Simple management
- Maximize the performance of video-on-demand service
- Resource allocation for QoS guaranteed voice service





NW link failures and burst demand for voice service

Switch policy strategy to Strategy 2

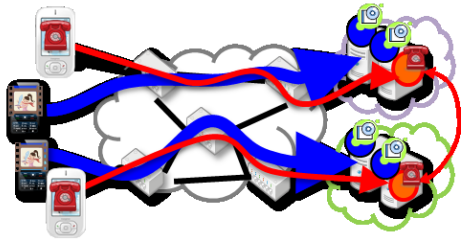


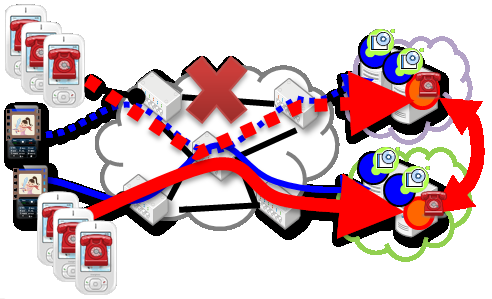
Strategy 2: Intelligent management
- Preferential NW and IT resource allocation for voice service
- Scale-down of Video on-demand service

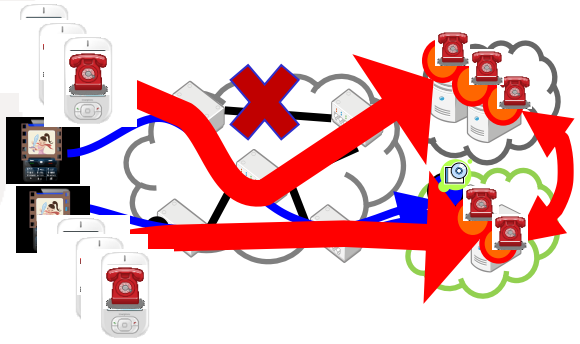
Voice service Video-on-demand service

Demonstration scenario: disaster scenario

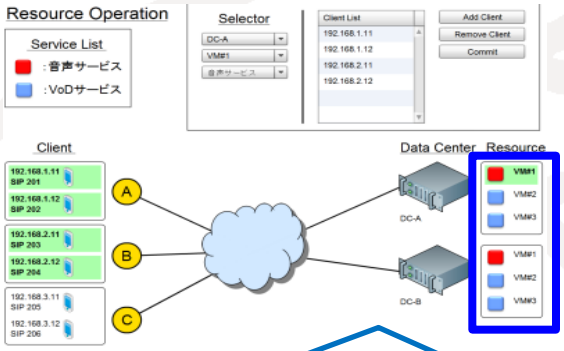
1. Normal state: Strategy #1
2. Network problems due to a major earthquake
   - link failure occurs and burst emergency call demands for voice service
3. Enforcement for voice service with network restorations
   - Strategy changeover from #1 to #2.



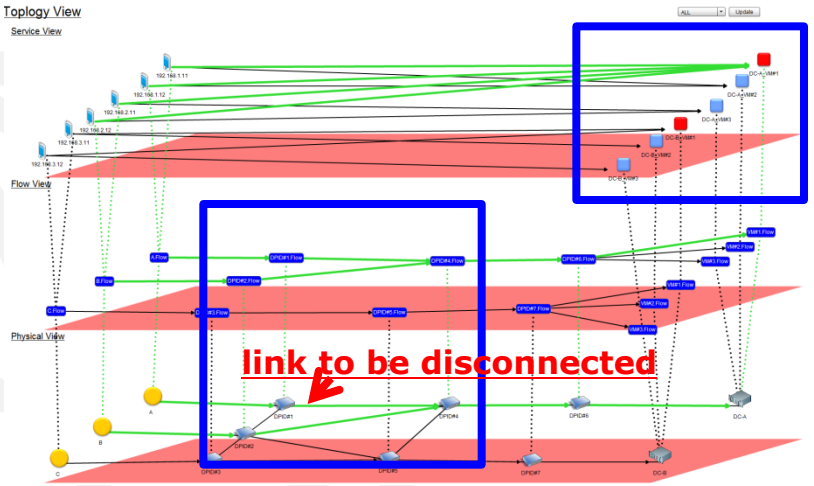




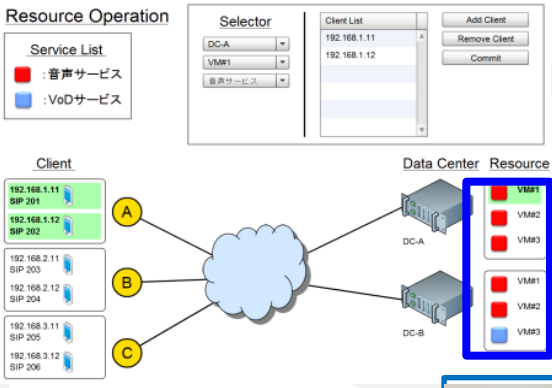
Demonstration



Voice service (R-CSCF)
Video-on-demand service

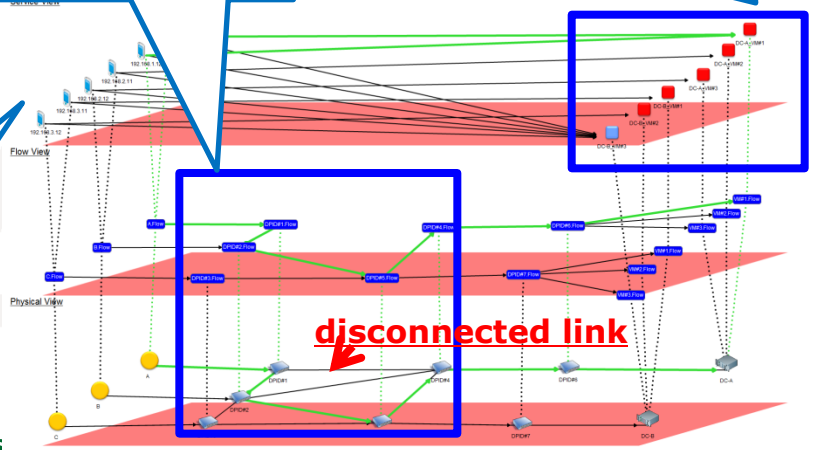


Strategy changeover from #1 to #2
Configuration is changed in one minute



path restoration
& enhancement
for voice service

scale-out of voice service
scale-down of video service



Future research area and standardization issues

- Unified abstracted ICT resource information model
  - Realizes carrier-grade network control and management from physical entity to the service level for
- Standardized API for virtualized ICT resource control and provisioning
  - Lowers entry barrier for new service creation
  - Refers API of cloud middleware and DMTF
- Operational policy description language
  - enables arbitration of resource allocation among service and automatic service management

Conclusion

- "Management Engine", a virtualized ICT resource management system for carrier network services is designed and implemented
  - Function-aware virtualized ICT information model
  - Demonstration shows its flexibility and capability
- Future work
  - Standardizing a virtualized ICT resource information model