Telecom Network Virtualization

September 3, 2010

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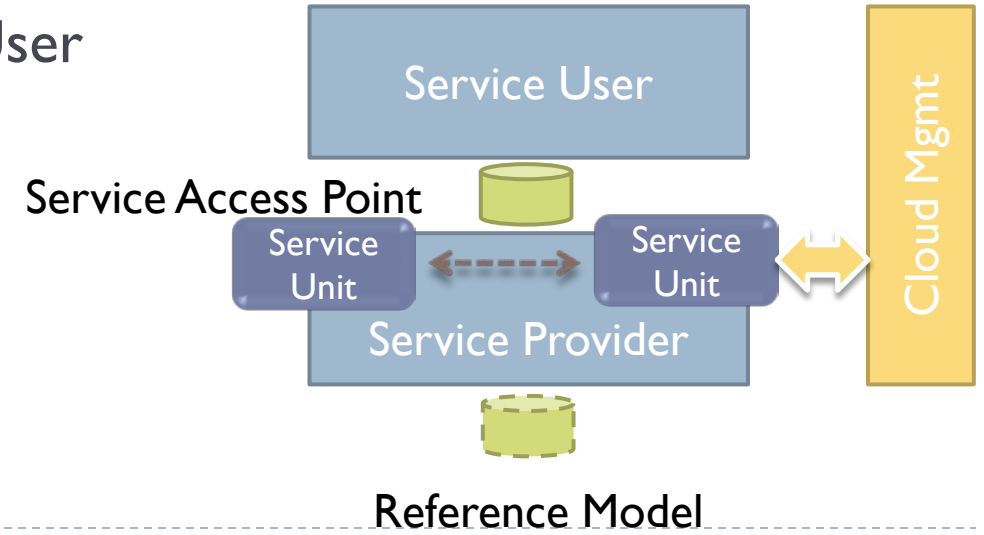
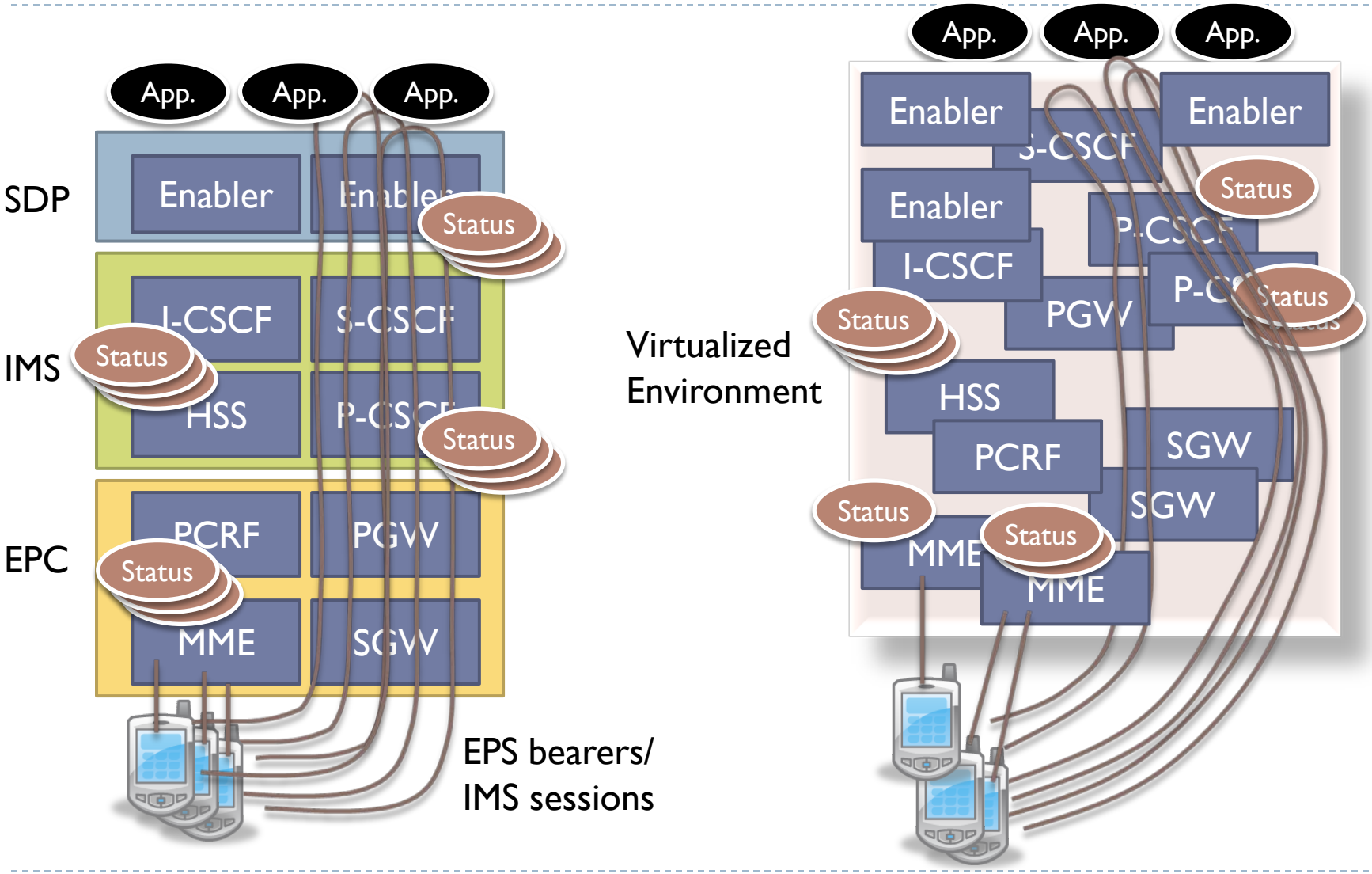
Motivation

- Tapping into Cloud Computing technology
  - to scale telecom services on demand and
  - to improve reliability and availability
  - to efficiently use infrastructure

- "Service mobility" in virtualized environment
  - Transparent to Service User
  - Does not affect existing protocol or interface

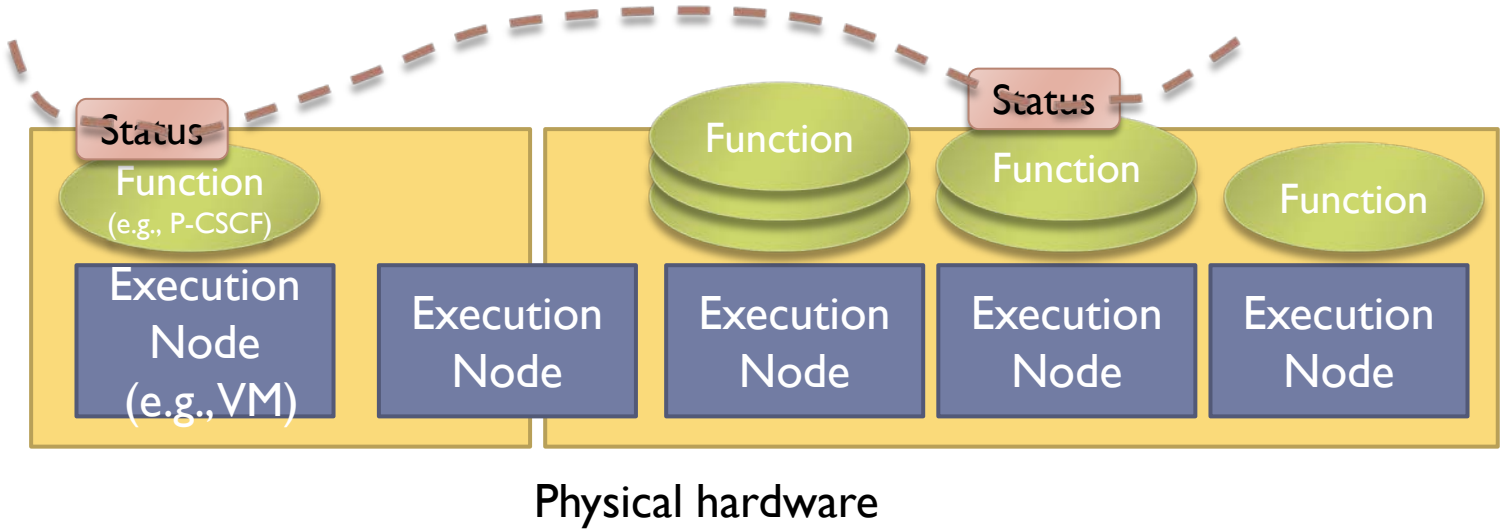


Virtualized Telecom Network



Components

- Execution Node
- Functional Entity (Service)
- Session and Status



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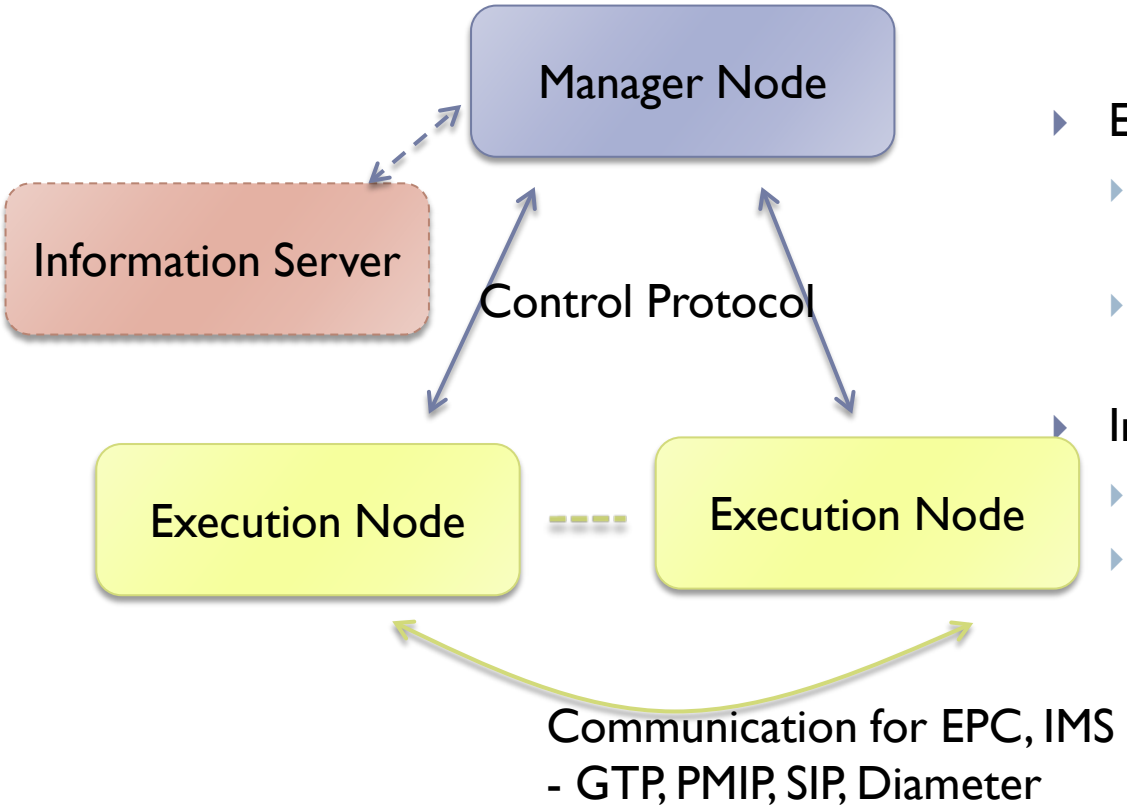
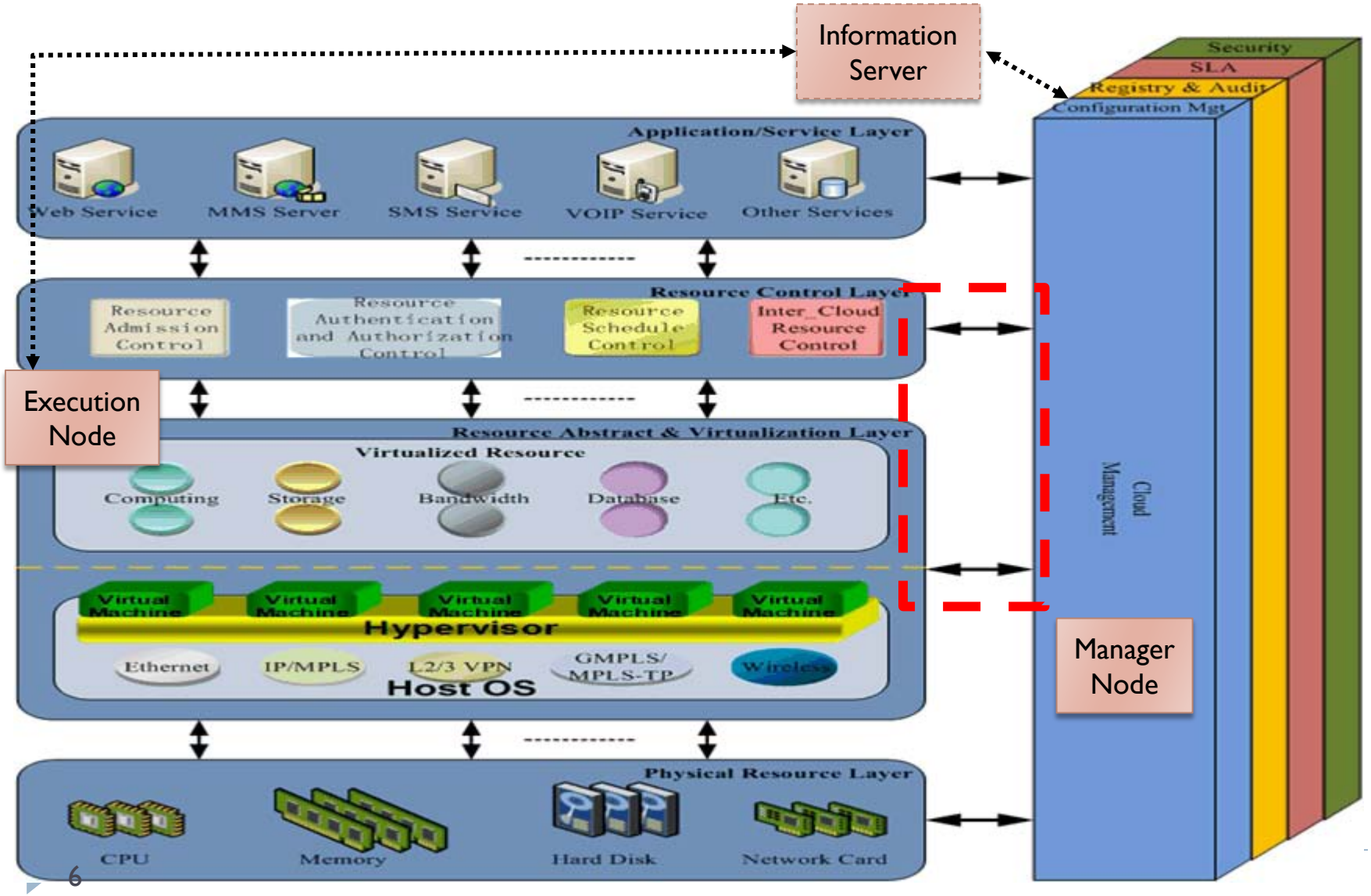
Roles and relationship between components



- Manager Node
  - Control node for Execution Nodes
  - Two ways:
    - centralized Manager
    - Manager-less (Peer-to-peer)
- Execution Node
  - Physical or virtual machines on which some functions (software) are running.
  - In IMS, for example, CSCF and HSS are candidates of functions.
- Information Server
  - DHCP, DNS, etc.
  - Used for discovery and assignment of Execution Node to a session (e.g., P-CSCF at a UE's registration)

Targeted interfaces and protocols



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IETF Work

- Control protocol for service/function movement
  - Protocol between the Manager Node and Execution Nodes
- Description protocol for functions, sessions
  - Capability to describe:
    - Functional entity (e.g., HSS, PCRF)
    - Location (relationship between physical entity and virtual entity)
    - Session (relationship between active instance and virtual entity)

Protocol Example

Node Information Example

Preconfigured Information

- IP address (v4/v6)
- Port
- Node ID
- Installed Functionality
- Capabilities

Runtime Information

- CPU
- Memory
- Storage
- Network usage
- Running Status

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Preconfigured Information (1/2)

- Manager Node
  - IP address and port
    - Used for Execution Nodes to access Manager Node
  - Capacity
    - e.g., the maximum number of Execution Nodes and UEs
  - …

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Preconfigured Information (2/2)

- Execution Node
  - Node ID
    - It is also possible for Manager Node to generate Node ID when a new Execution Node registers
  - IP address and port of Manager Node
  - Capability
    - OS, H/W architecture (32bit/64bit)
  - Name of functional entities installed on this node
    - New software could be dynamically downloaded and installed by Manager Node

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Run-time Information (1/2)

- Node Information
  - Related to Execution Node
- Parameters
  - Node ID
    - Unique ID of Node
  - CPU
    - Processing capability
    - Current / Average Load
  - Memory
    - Available/Total Size
  - Storage
    - Available/Total Size
  - Network
    - Bandwidth
    - Current / Average Usage
  - Boot Time
  - Functions
    - Currently Running Functions
      - Details of functions are described in Function Information
    - Executable Functions

Run-time Information (2/2)

- Function Information
  - Related to Function running on Execution Node
  - In IMS, for instance, this is information for CSCFs and HSS.
- Parameters (in the case of IMS nodes)
  - Function ID
    - Unique ID for each function
  - Function Name
    - Name of the function such as P-CSCF, S-CSCF, HSS
  - CPU Usage
    - Current / Average Load
  - Memory Usage
    - Current / Average / Required Size
  - Storage
    - Current / Average / Required Size
  - Network
    - Current / Average Usage
  - Boot Time
  - Running Status
    - Starting, Running, Terminating
  - Function dependent Information
    - The number of Registered UEs
    - The number of active sessions
    - The number of processing SIP messages
    - The number of failure of sending SIP messages
    - The number of retransmit of SIP messages
    - The average time for processing SIP message
    - Processing Status
  - IMS specific performance measurement information (e.g., 3GPP 32.409)

Protocol Specification Example

Virtual Node Maintenance Protocol

- Registration
- Deregistration
- Keep-Alive
- Status Update

Function / Service Control Protocol

- GET
- ADD
- DELETE
- MOVE
- COPY

Session / Status Control Protocol

- MOVE_SESSION

Session / Status Description Protocol

- IPv4/IPv6 address
- URI
- Number of sessions
- Ratio of sessions

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Virtual Node Maintenance Protocol

- Registration and Deregistration of Execution Node
  - Each Execution Node registers with Manager Node
    - With Node Information
- Keep-Alive
  - Each Execution Node sends keep alive message to Manager Node
    - With Node Information
    - With Function Information
  - In case that Manager Node cannot get keep alive from a Execution Node, the Manager Node deregisters the Execution Node
- Status Update
  - When functions and processing status of functions are changed, Execution Node sends status update message to Manager Node
    - With Node Information
    - With changed Function Information

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Function / Service Control Protocol (1/3)

- GET Information
  - Instruction to obtain specific information from a Execution Node
  - Params
    - Node ID
    - Function ID or any
    - Required Params or Any
- ADD function
  - Instruction to run a new function on the Execution Node
  - Request Params
    - Node ID
    - Function Name and Function ID generated by Manager Node
    - Configurations required for the function
      - FQDN or IP address and ports of HSS and other CSCF
  - Return Params
    - Node ID
    - Function ID
    - Result Code
    - Running Status
  - Action: Some Function takes time to boot up, thus after getting ready, the Execution Node sends Status update message to the Manager Node

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Function / Service Control Protocol (2/3)

- DELETE function
  - Instruction to terminate a running function on the Execution Node
  - Request Params
    - Node ID
    - Function ID
  - Return Params
    - Node ID
    - Function ID
    - Result Code
    - Running Status
  - Action
    - Some Function takes time to terminate, thus after the termination, the Execution Node sends Status update message to the Manager Node

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Function / Service Control Protocol (3/3)

- MOVE function
  - Combination of ADD and DELETE, but internal status of function is also passed to a new node
  - Request Params
    - Src Node ID and Dst Node ID
    - Function ID
  - Return Params
    - Node ID
    - Function ID
    - Result Code
    - Running Status
- COPY function
  - Similar with ADD, but internal status of function is also passed to a new node
  - Request Params
    - Src Node ID and Dst Node ID
    - Function ID
  - Return Params
    - Node ID
    - Function ID
    - Result Code
    - Running Status

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Session/Status Control Protocol

- MOVE_SESSION
  - Move sessions to another Execution Node
    - Request Params
      - Function ID
      - IP address and port of src Execution Node
      - IP address and port of dst Execution Node
      - With Target Session/Status Information
    - Return Params
      - Function ID
      - Result Code
      - Processing Status
    - Action
      - After the movement is complete, Execution Node sends Status Update message to Manager Node

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Session/Status Description Protocol

- Description to specify a group of sessions to control
- In the case of IMS:
  - SIP URI (IMPU) of UEs
    - with regular expression
    - E.g. Sip: kddi_22***@kddi.com
  - Contact address of UEs
    - with regular expression or netmask
    - E.g. 210.223.5.0/24
  - Ratio
    - Indicate the ratio of the target UEs
    - UEs can be selected at random
    - E.g. 35%
  - The number of UEs
    - Indicate the number of the target UEs
    - UEs can be selected at random
    - E.g. 1000