

# 智慧整合感控系統概論

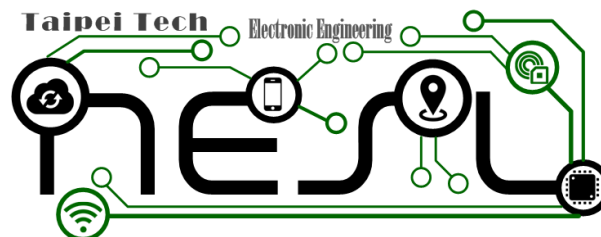
## Introduction to Cyber-Physical Systems

### 物聯網架構實作 (M2M Architecture Implementation)

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# 學習目標

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## Resource-Based M2M Communications

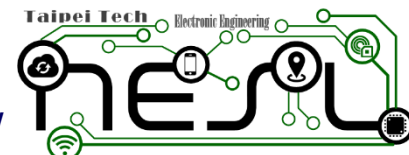


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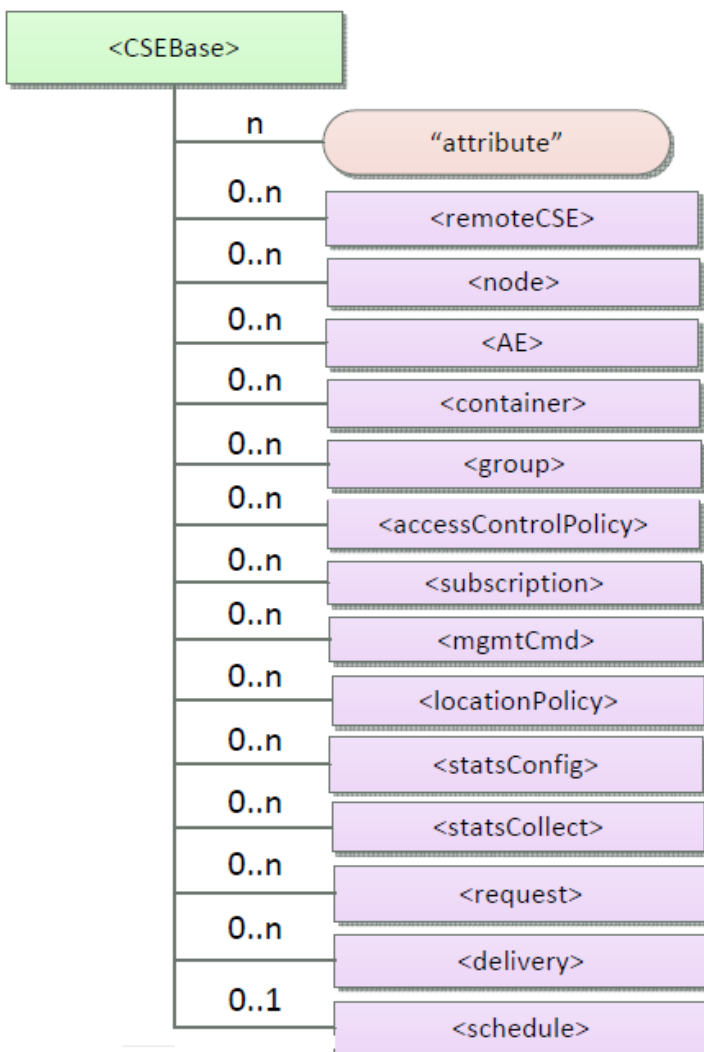
# Resource-based Information Model

- ❖ All entities in the oneM2M System, such as AEs, CSEs, data, etc. are represented as resources.
- ❖ A resource structure is specified as a representation of such resources. Such resources are uniquely addressable via a Uniform Resource Identifier (URI).
- ❖ A given Resource is of one of the defined Resource Types.
- ❖ The Resource Type determines the semantics of the information in the Resource

# Properties of Resources

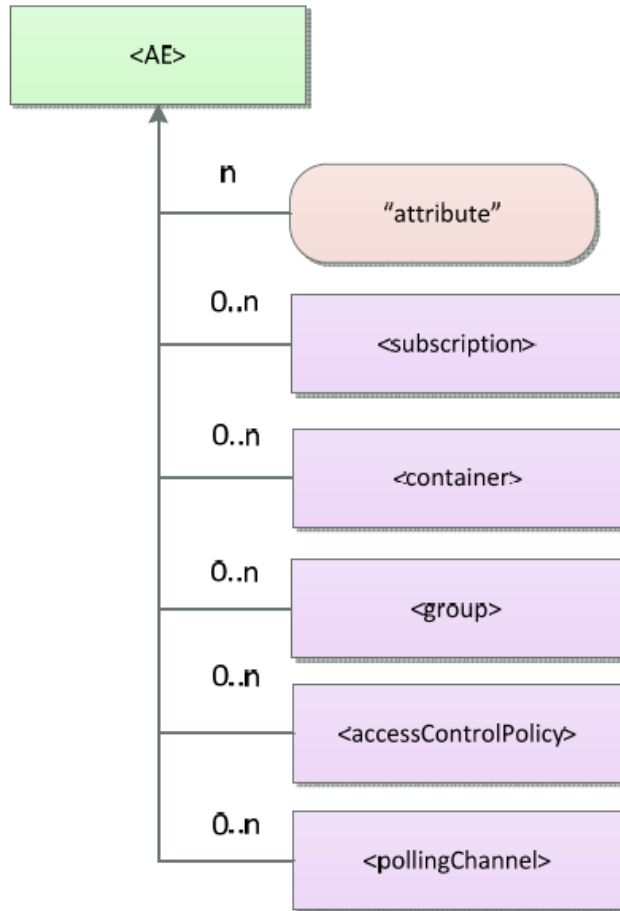
- ❖ Resources can be Created, Read, Updated or Deleted to manipulate the information.
- ❖ Resources are organized in a tree-like structure and connected by links.
- ❖ Addressing all resources and associated attributes through unique URI.
  - Structured URI based on the chain of child-parent relationship
  - Flat URI made of a unique identifier addressable via the base root

# oneM2M Resource Structure (1)



Resource Type	Description
CSEBase	The structural root for all the resources that are residing on a CSE
remoteCSE	Represents a remote CSE registered on the registrar CSE identified by the CSEBase resource
node	Represents specific Node information
AE	Stores information about the AE. It is created as a result of successful registration of an AE with the registrar CSE
container	Shares data instances among entities. Used as a mediator that takes care of buffering the data to exchange "data" between AEs and/or CSEs.
group	Stores information about resources of the same type that need to be addressed as a Group
accessControlPolicy	It controls "who" is allowed to do "what" and the context in which it can be used for accessing resources
subscription	represents the subscription information related to a resource.

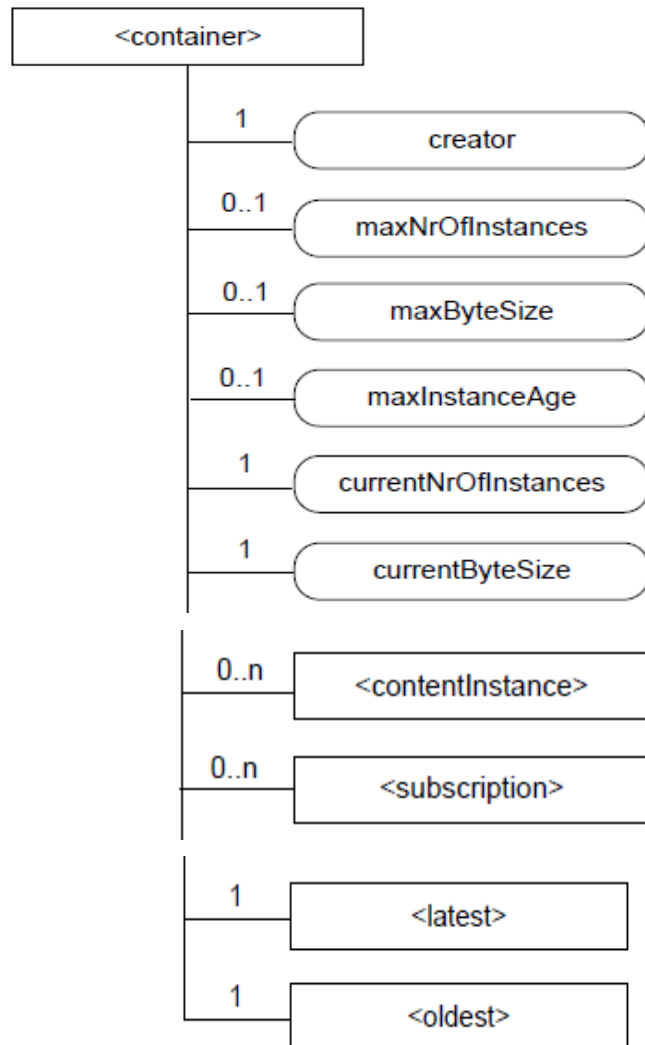
# oneM2M Resource Structure (2)



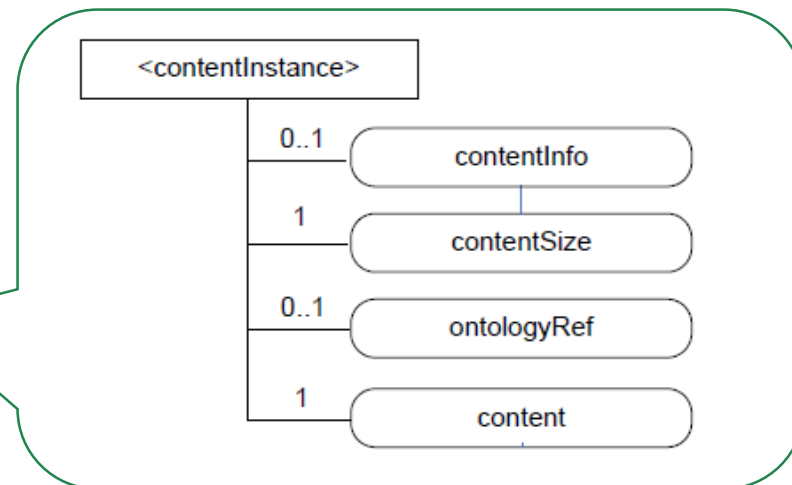
Resource Type (Cont.)	Description
mgmtCmd	Management Command resource represents a method to execute management procedures required by existing management protocols.
locationPolicy	Includes information to obtain and manage geographical location. It is only referenced within a container, the contentInstances of the container provide location information
statsconfig	Stores configuration of statistics for applications
StatsCollect	Defines triggers for the IN-CSE to collect statistics for applications
request	Expresses/access context of an issued Request
delivery	Forwards requests from CSE to CSE
schedule	Contains scheduling information for delivery of messages
pollingChannel	Represent a channel that can be used for a request-unreachable entity

Details in “Table 9.6.1.1-1 Resource Types” of oneM2M-TS0001

# oneM2M Resource Structure (3)



**Container & ContentInstance**  
where the actual data is stored!



# Resource Categories

## ❖ oneM2M identifies three categories of resources:

- Normal resources
  - include the complete set of representations of data which constitutes the base of the information to be managed.
- Virtual resources
  - used to trigger processing and/or retrieve results, but they do not have a permanent representation in a CSE.
- Announced resources
  - a resource at a remote CSE that is linked to the original resource that has been announced, and it maintains some of the characteristics of the original resource.



# Virtual Resource or Attribute

- ❖ Virtual resource or a virtual attribute is used to trigger processing and/or retrieve results, but they do not have a permanent representation in a CSE, for example:
  - FanOutPoint:
    - virtual resource is used for addressing bulk operations to all the resources that belong to a group.
  - Latest/Oldest:
    - virtual resources are pointers to the actual latest and oldest Content Instance in a Container.

# Resource Addressing

- ❖ The address of a resource is a string that uniquely identifies the targeted resource within the scope of a request.
- ❖ Requests can have 3 different scopes:
  - CSE-relative
    - the request is originated within the same CSE as the targeted resource.
  - SP-relative
    - the request is originated within the same M2M Service Provider domain as the targeted resource, but at different CSE.

# Resource Addressing (cont'd)

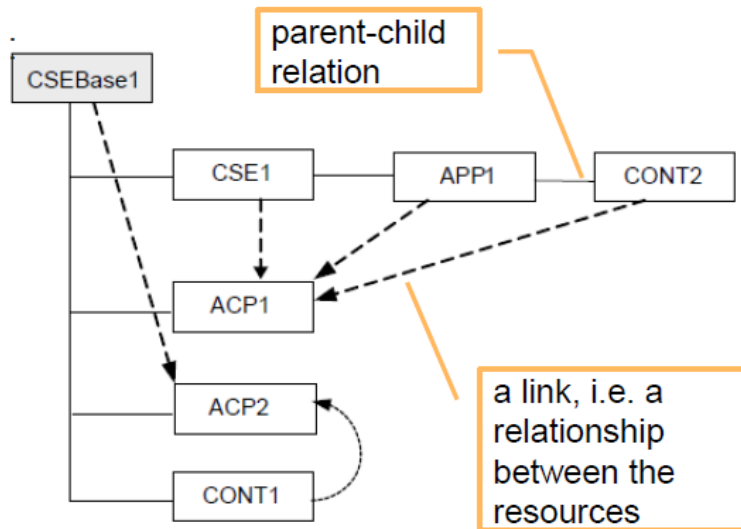
- Absolute
  - the request is originated within an M2M Service Provider domain, but the target resource resides in a different M2M Service Provider domain.
- ❖ Two different methods for addressing a resource:
  - Hierarchical URI (structured)
  - Non-Hierarchical URI (non-structured)
- ❖ Each addressing method can have three variants depending on the scope of the request:

# Resource Addressing (cont'd)

	CSE-relative	SP-relative	Absolute
<b>Hierarchical</b>	streetX/houseY/roomZ/temp123	/MN-CSE-02/ streetX/houseY/roomZ/ temp123	//m2m.com/MN-CSE-02/ streetX/houseY/roomZ/ temp123
<b>Non-Hierarchical</b>	temp123	/MN-CSE-02/temp123	//m2m.com//MN-CSE-02/ tempe123

# Relationship between Resources

## ❖ Two types of relationships: parent-child and link



Source: oneM2M TS-0001

Origin Resource type	Destination Resource type	Relationship type
Any (e.g. AE, container)	Access Control Policy	Link (access Control Policy ID)
CSEBase or remoteCSE	node	Link (nodeLink)
node	CSEBase or remoteCSE	Link (hosted CSE Link or CSEBase)
a child resource of any resource type	a parent resource of any resource type	Link (parent-ID)
a parent resource of any resource type	a child resource of any resource type	Parent-Child
mgmtObj	mgmtObj	Link (mgmtLink)

# Normal Resource Types (1)

1. Access Control Policy
2. Content Instance
3. AE
4. Container
5. CSE Base
6. Delivery
7. Event Config
8. Exec Instance
9. Group
10. Location Policy
11. Latest (virtual)
12. Fan Out Point (virtual)
13. mgmtCmd
14. mgmtObj
15. M2m Service Subscription Profile
16. Node
17. Oldest (virtual)
18. Polling Channel
19. Polling Channel URI (virtual)
20. Remote CSE

# Normal Resource Types (2)

21. Request

22. Schedule

23. Service Subscribed Node

24. Service Subscribed App Rule

25. Stats Collect

26. Stats Config

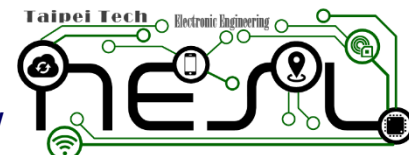
27. Subscription



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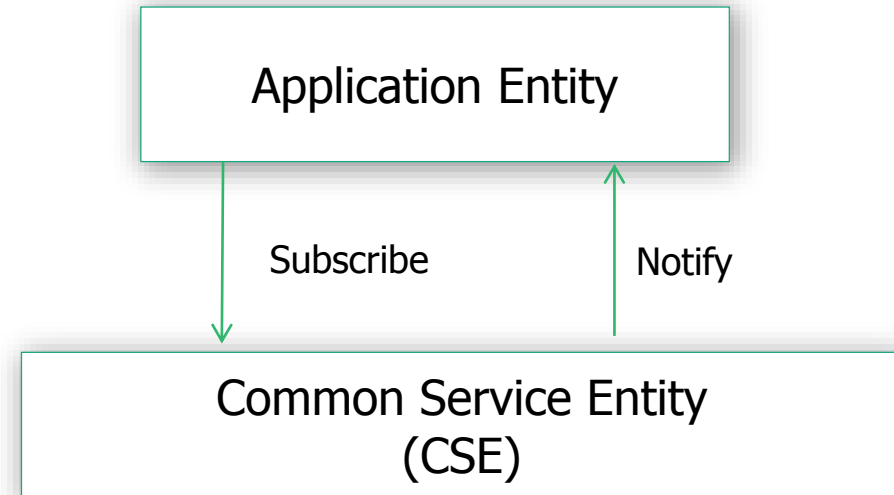
# Resource Type Specializations

## ❖ Used by Communication Management and Delivery Handling or Device Management CSFs

- |                             |                       |
|-----------------------------|-----------------------|
| 1. ActiveCmdhPolicy         | 11. cmdhNwAccessRule  |
| 2. Area Network Device Info | 12. cmdhPolicy        |
| 3. Area Network Info        | 13. Device Capability |
| 4. Battery                  | 14. Device info       |
| 5. cmdhBuffer               | 15. Event Log         |
| 6. cmdhDefaults             | 16. Firmware          |
| 7. cmdhEcDefParamValues     | 17. Memory            |
| 8. cmdhDefEcValue           | 18. Reboot            |
| 9. cmdhLimits               | 19. Software          |
| 10. cmdhNetworkAccessRules  |                       |



- ❖ Data is often provided in irregular intervals.
- ❖ To alleviate the need for constant polling, a subscribe/notify mechanism is used.
- ❖ Notifications can be twofold:
  - Synchronous (long polling)
  - Asynchronous (server capable client)



# M2M End to End Communication High Level Overview

- ❖ For a simple end to end example consider the following scenario:
- ❖ A Device application, for example a SmartMetering Sensor is connected to a local M2M gateway.
- ❖ A Network Application, e.g. a SmartMeter GUI is connected to a IN-CSE for visualizing sensor data.

Network Application on  
Infrastructure Node  
e.g. Visualization GUI

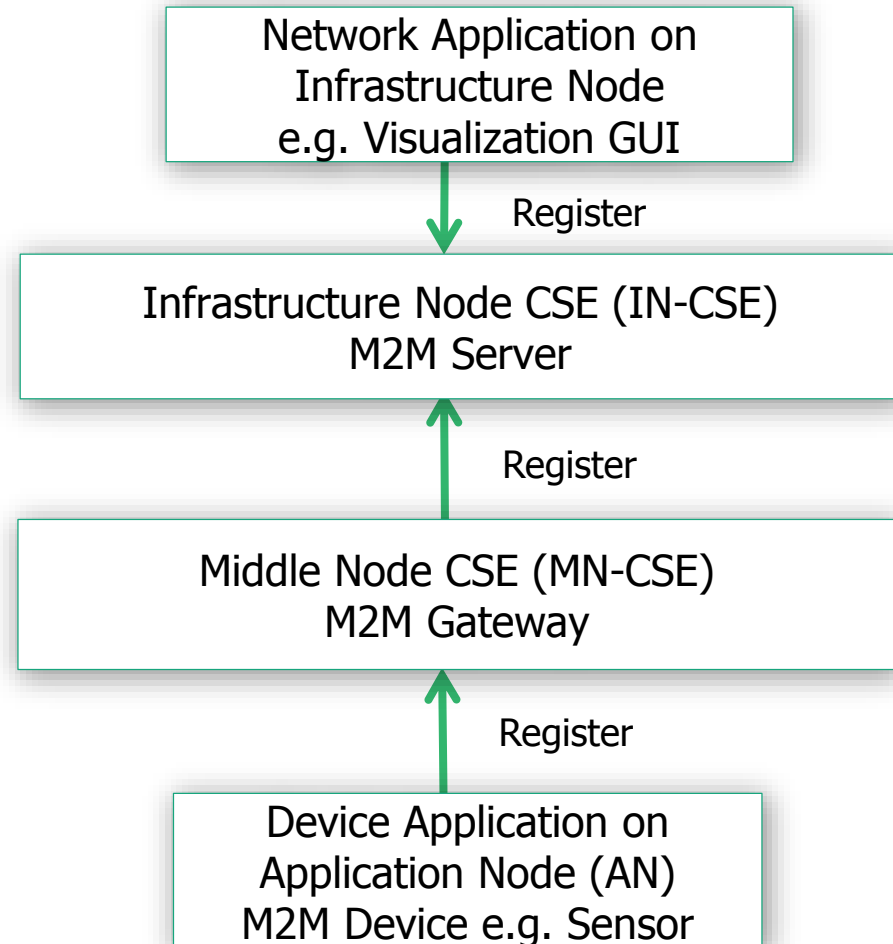
Infrastructure Node CSE (IN-CSE)  
M2M Server

Middle Node CSE (MN-CSE)  
M2M Gateway

Device Application on  
Application Node (AN)  
M2M Device e.g. Sensor

## ❖ Registration Phase

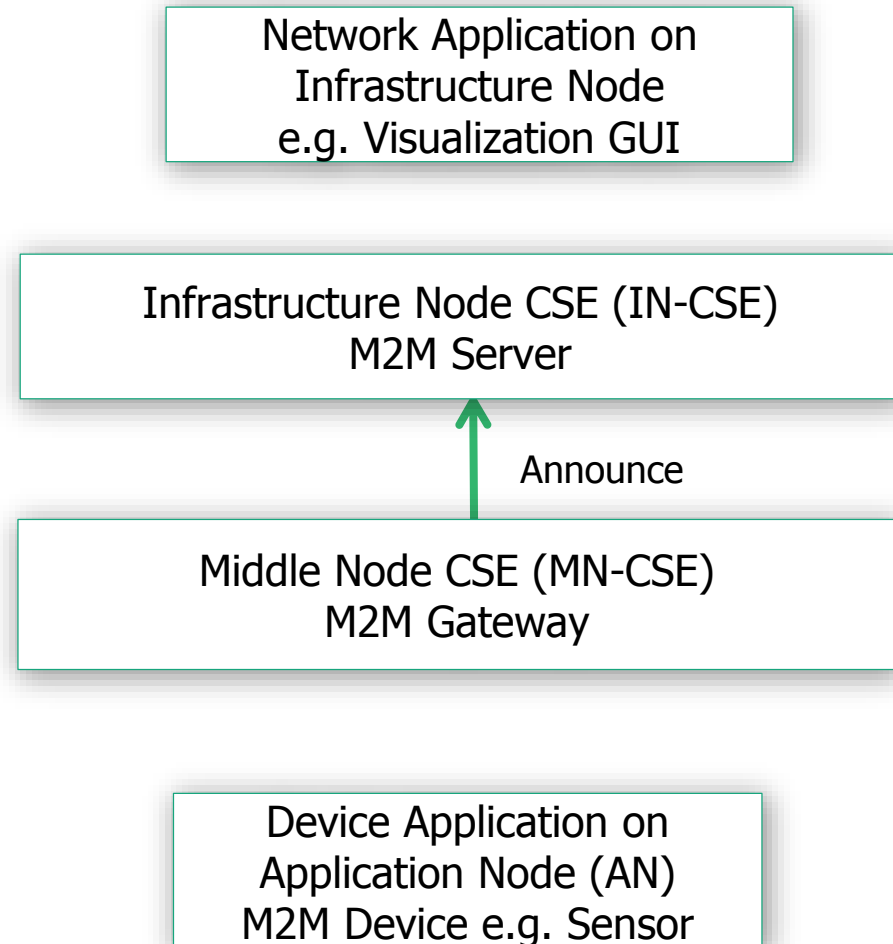
- NA and DA register at their respective local CSEs.
- The MN-CSE registers at the IN-CSE



# M2M End to End Communication High Level Overview

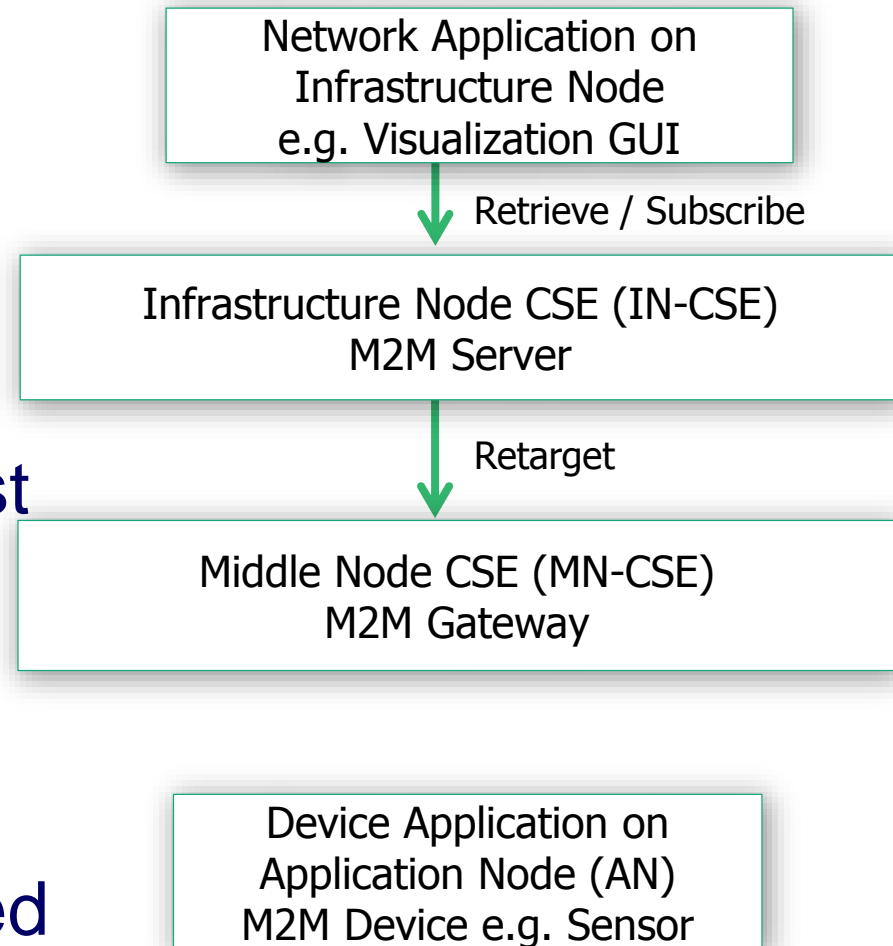
## ❖ Announcement

- MN-CSE announces local applications towards the IN-CSE.



# M2M End to End Communication High Level Overview

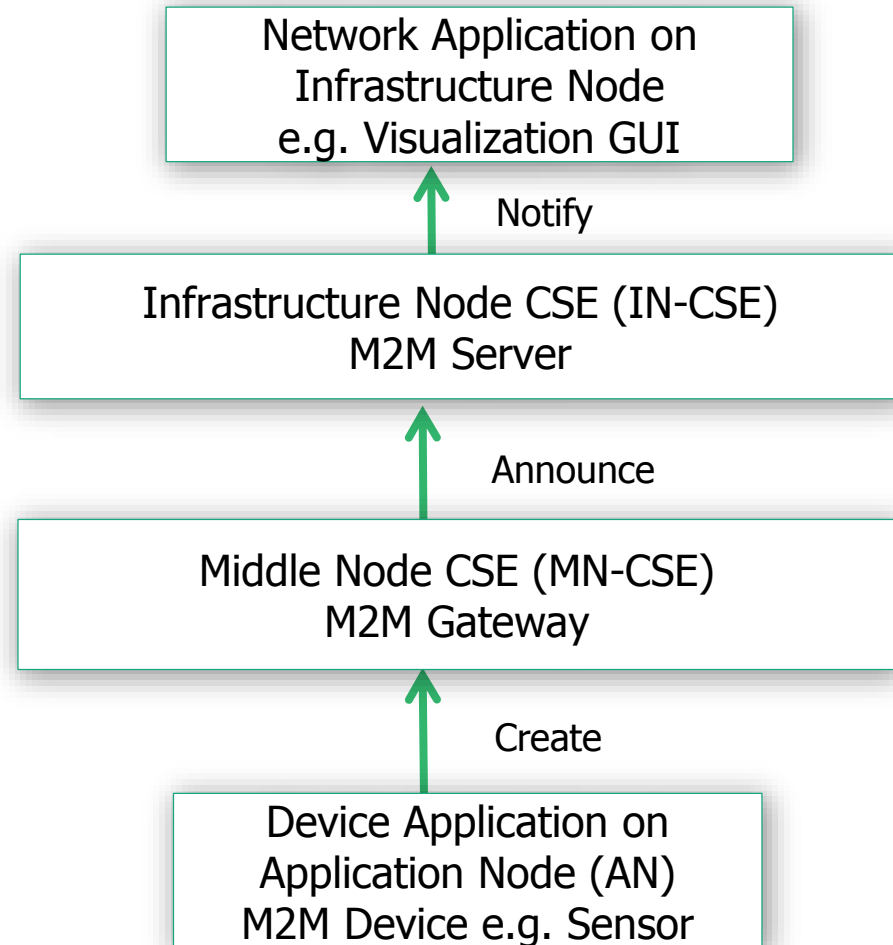
- ❖ The NA retrieves information on existing applications  
-> receives information about the sensor DA
- ❖ If necessary, the request is retargeted by the IN-CSE to the MN-CSE
- ❖ Subsequently, the NA subscribes to the DA's data in order to be notified when new data arrives.



Source: Tutorial from FOKUS

# M2M End to End Communication High Level Overview

- ❖ Periodically, the sensor DA pushes metering data to the local gateway.
- ❖ This is done by creating a „contentInstance“
- ❖ The incoming data is announced towards the IN-CSE.
- ❖ The NA is notified about the incoming data.



# M2M Service Subscription (1)

- ❖ An M2M Service is the marketable service offered to M2M users, e.g. device management, data exchange, etc.
- ❖ M2M Service Subscription establishes a link between
  - One or more AEs;
  - One or more M2M Nodes,
  - One or more roles associated with an M2M Service Subscription as well as subscriber defined groups (used for access control policies).

# M2M Service Subscription (2)

- ❖ In each M2M Service, one or multiple M2M Service role(s) shall be defined by the M2M Service Provider.
- ❖ An M2M Service subscription role is defined as a set of privileges pertaining to a resource types which are associated with M2M Service.
- ❖ The M2M Subscriber subscribes as one or multiple roles within the M2M Services, depending upon which role(s) the M2M Subscribers are interested in.



# M2M Service Subscription (3)

- ❖ An M2M Service Subscription shall be used for the following purposes:
  - Serve as a basis for authorization for resource operations.
  - Serve as the basis for charging.
  - Identify which Nodes are part of this M2M Service Subscription.

# General Communication Flow

- ❖ The general flow is based on the use of Request and Response messages.
- ❖ The message applies to communications such as:
  - between an AE and a CSE (Mca reference point); and
  - among CSEs (Mcc reference point).
- ❖ Such communications can be initiated either by the AEs or by the CSEs depending upon the operation in the Request message.

# Request

- ❖ The Request from an Originator to a Receiver includes the following parameters:
  - **ri:** Request Identifier.
  - **to:** URI of the target resource for the operation.
  - **fr:** Identifier representing the Originator.
  - **cn:** resource content to be transferred.
  - **role:** optional, required when role based access control is applied (associated text and procedure TBD).
  - **op:** operation to be executed: Create (C), Retrieve (R), Update (U), Delete (D), Notify (N)

# Types of Requests

## ❖ Four Classic REST Operations:

1. **CREATE:** Create child resources.
2. **RETRIEVE:** Read the content of the resource.
3. **UPDATE:** Write the content of the resource.
4. **DELETE:** Delete the resource.

# Types of Requests

## ❖ Two Extended Operations:

1. **NOTIFY**: indicate a change of a resource for a subscription. Variant of RETRIEVE/UPDATE.
2. **EXECUTE**: for executing a management command/task which is represented by a resource, corresponding to an UPDATE method without payload data.

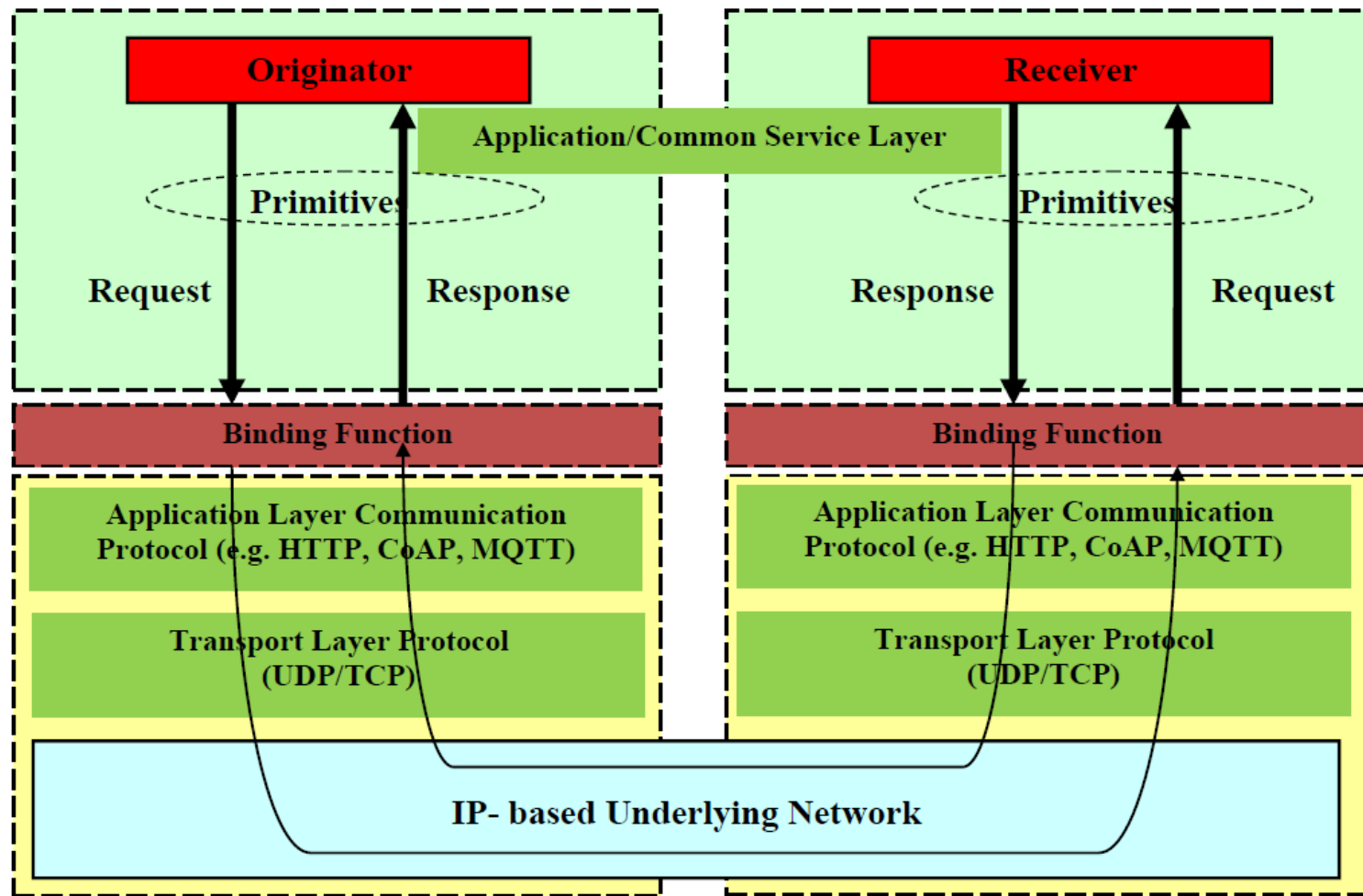
# Response

- ❖ The Response from a Receiver to the Originator includes the following parameters:
  - **rs:** response code: This parameter indicates whether the operation was successful, unsuccessful or is an acknowledgement
  - **ri:** Request Identifier. The ri in the Response shall match the ri in the corresponding Request.
  - **cn:** (conditional) resource content.

# Primitive Mapping

- ❖ Primitives are service layer messages transmitted over the Mca and Mcc reference points
- ❖ Primitives are data structures that a specific procedure requests or answers in both originator and receiver entities.
- ❖ A primitive shall consist of:
  - control part
  - optional content part: user data
- ❖ Designed for Scalability, Extensibility and Efficiency

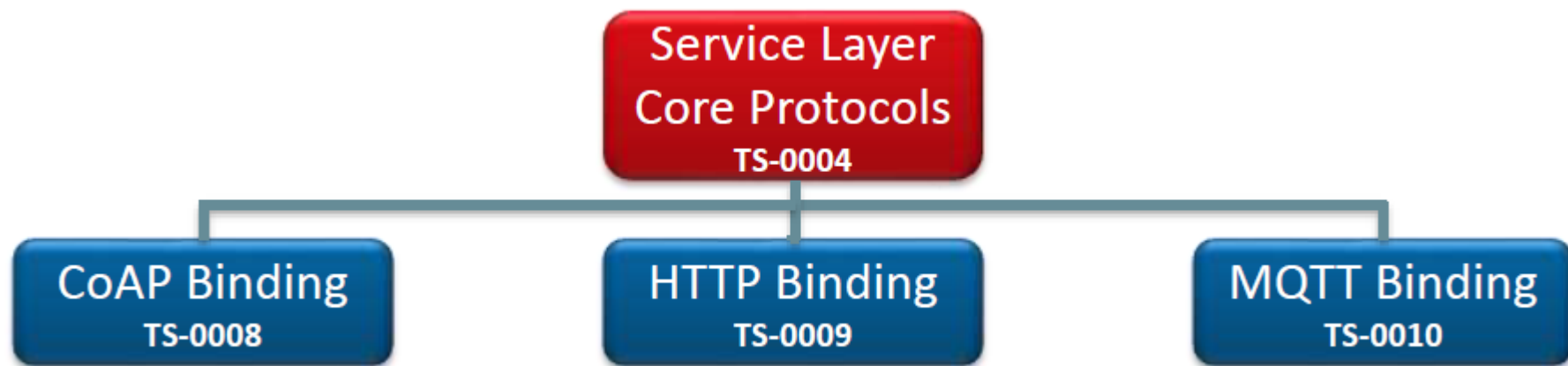
# Primitive Mapping



Source: oneM2M TS-0004



# Protocol Binding



# <xxx Resource> Primitives

- ❖ xxxCreateRequest
  - xxxCreateResponse
- ❖ xxxRetrieveRequest
  - xxxRetrieveResponse
- ❖ xxxUpdateRequest
  - xxxUpdateResponse
- ❖ xxxDeleteRequest
  - xxxDeleteResponse
- ❖ xxxNotifyRequest
  - xxxNotifyResponse

# HTTP Binding for Primitives

**Table 6.2.1-1: HTTP Method Mapping**

oneM2M Operation	HTTP Method
Create	POST
Retrieve	GET
Update	PUT
Delete	DELETE
Notify	POST

Source: TS-0009-HTTP\_Protocol\_Binding

# 總結

- ❖ Lastly, the architectural ideas of resource-based M2M communications are explained. Under this architecture, M2M resources are represented as a data model of tree structure.
- ❖ We explain this tree structure and the general communication flow used to manipulate this resource tree.
- ❖ Finally, protocol binding that maps interface primitives to protocol messages is explained.