M2M Service Architecture:

Delivering M2M Services Over Heterogeneous Networks

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Chonggang Wang
InterDigtial Communications
Chonggang.Wang@InterDigital.com

Agenda

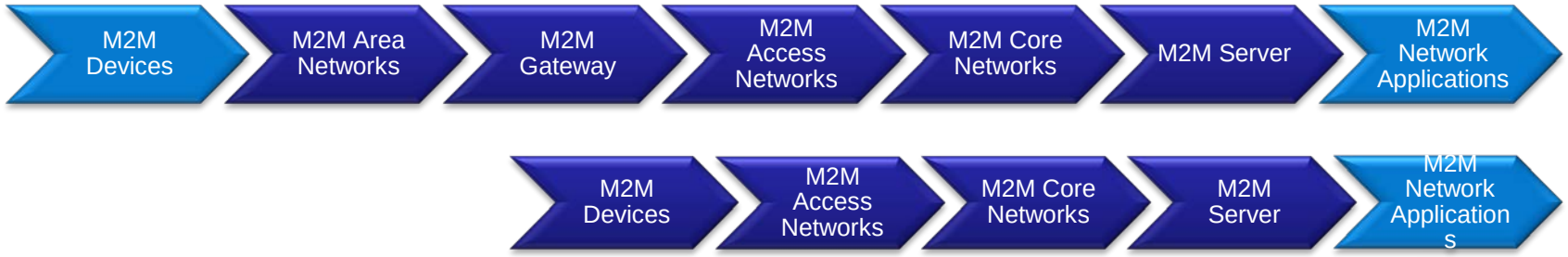
- M2M Overview
- M2M Protocol Stack
- M2M Service Architecture
- CoAP Protocol
- M2M Evolution to IoT

M2M Overview - Definition

- Machine-to-Machine (M2M) is about communication among devices (such as a sensor or meter) without (or only limited) human intervention to capture/retrieve an event or status (such as temperature, inventory level, etc.), which is relayed through a network (wireless, wired or hybrid) to an application (software program), that translates the captured event into meaningful information (for example, items need to be restocked).
  - a huge amount of resource-constrained or powerful devices
  - autonomous device operation and management
  - seamless domain inter-operability
  - energy efficiency
  - self-organization

Source: Wikipedia

M2M Overview – General Network Architecture



- M2M Area Networks – IEEE 802.15.4, etc
  - Consists of resource-constrained devices (sensors and actuators)
- M2M Gateway – Converged GW
  - Connects area networks to M2M core networks via M2M access networks
- M2M Access Networks – xDSL/Cable, 3G/LTE, PLC
  - Connects M2M GW to M2M core
- M2M Core Networks – IPv4/v6
  - Connects to M2M Sever
- M2M Server
  - Connects to applications and/or backend database

M2M Overview - Enabling Technologies

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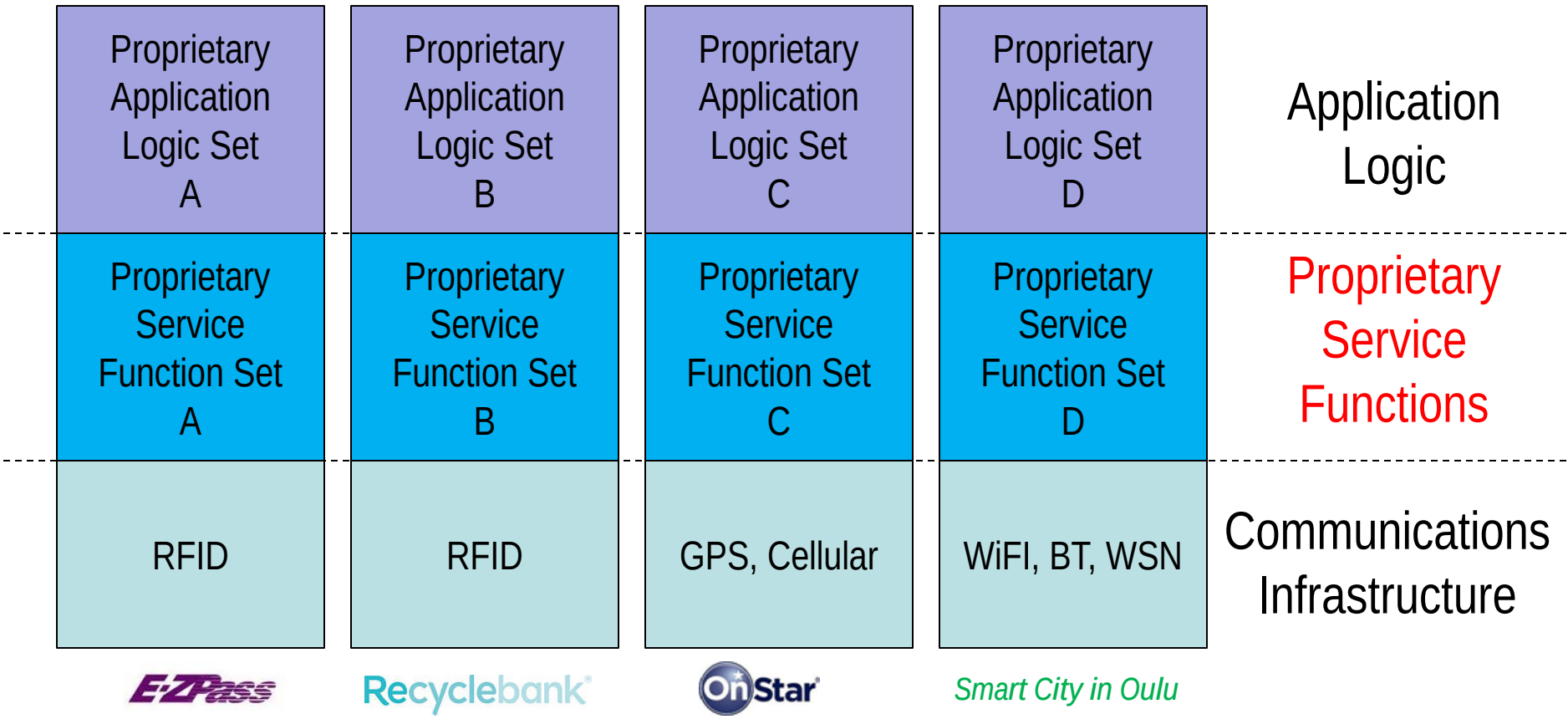
M2M Overview – Some Deployments



Vertical and Proprietary Solution

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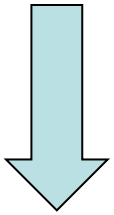
M2M Overview – Characteristics and Challenges

- Huge Number of M2M Devices
  - device management, system optimization
- Diverse M2M Applications and Use Cases
  - Different traffic model: event-based, query-based, continuous streaming
  - Different performance requirements: delay, lifetime, security, energy-efficiency
- Heterogeneous Communications Technologies
  - Wireless: Capillary vs Cellular; Short-range vs Long-range
  - Wired: PLC, Ethernet, xDSL, Fiber
- Different M2M Actors
  - device manufacturers, network providers, service providers, application providers, & system integrators



Horizontal M2M solutions are required to be standardized.

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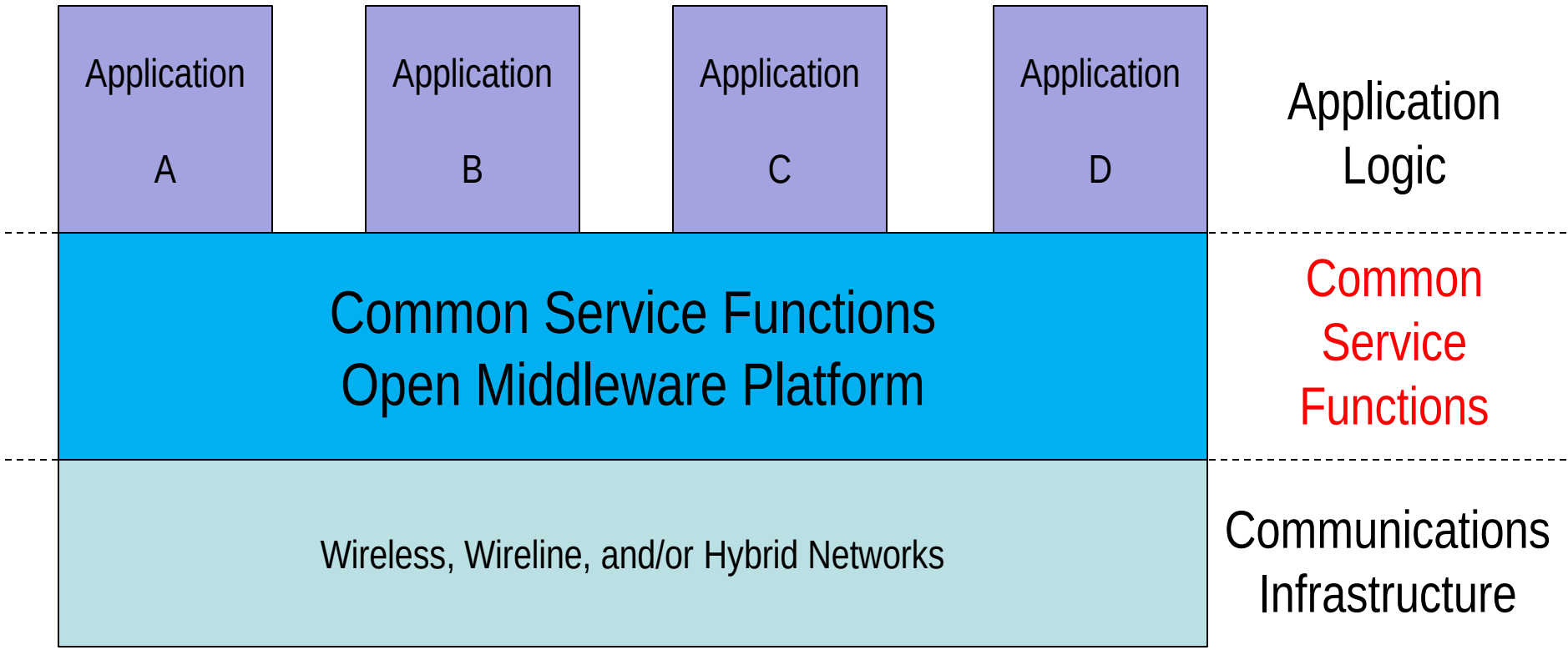
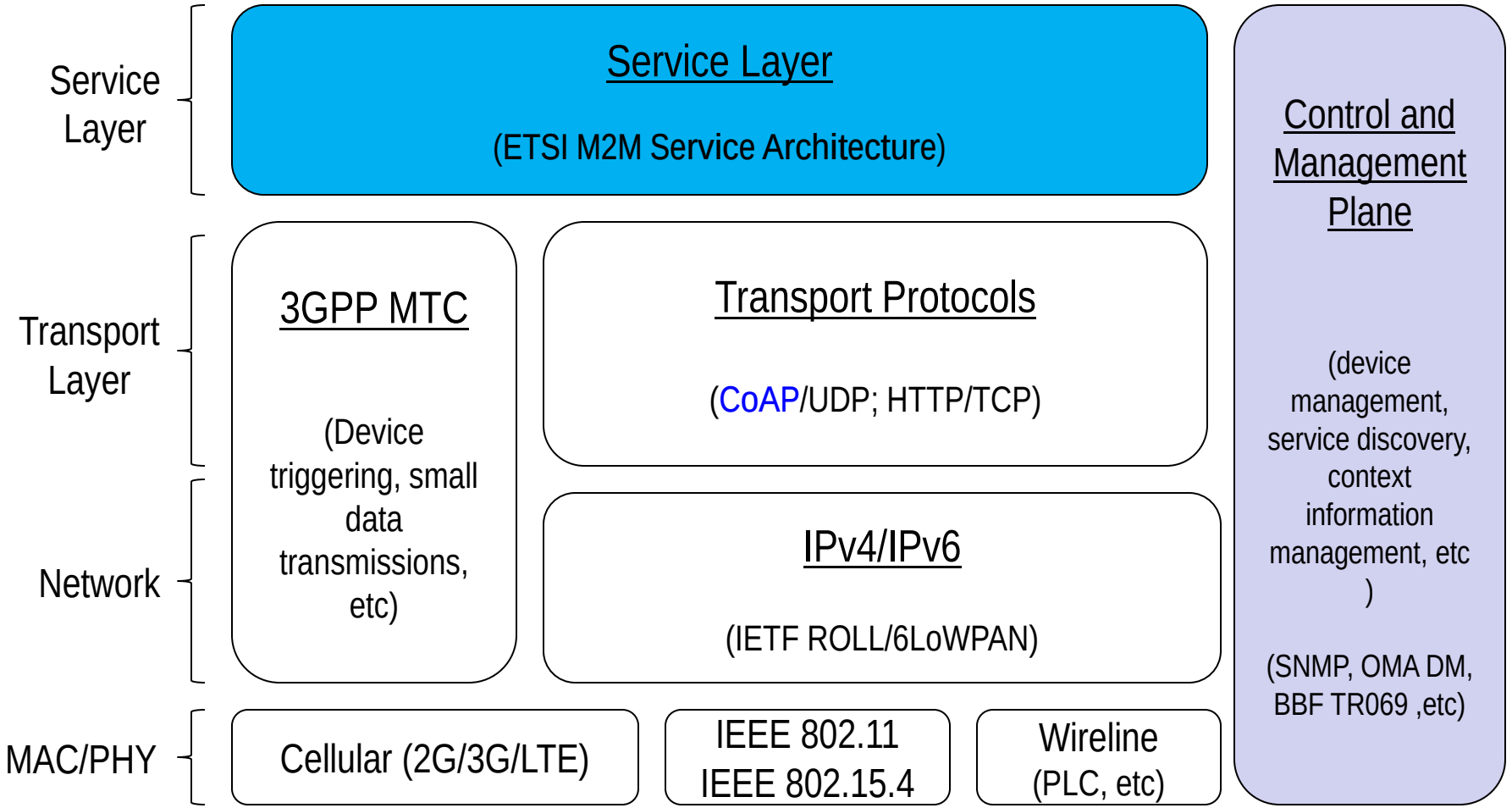
M2M Overview – Horizontal Solutions



Horizontal solution means network & application-agnostic, but aware. This is the first step and a key enabler towards the Internet-of-Things (IoT)

M2M Protocol Stack



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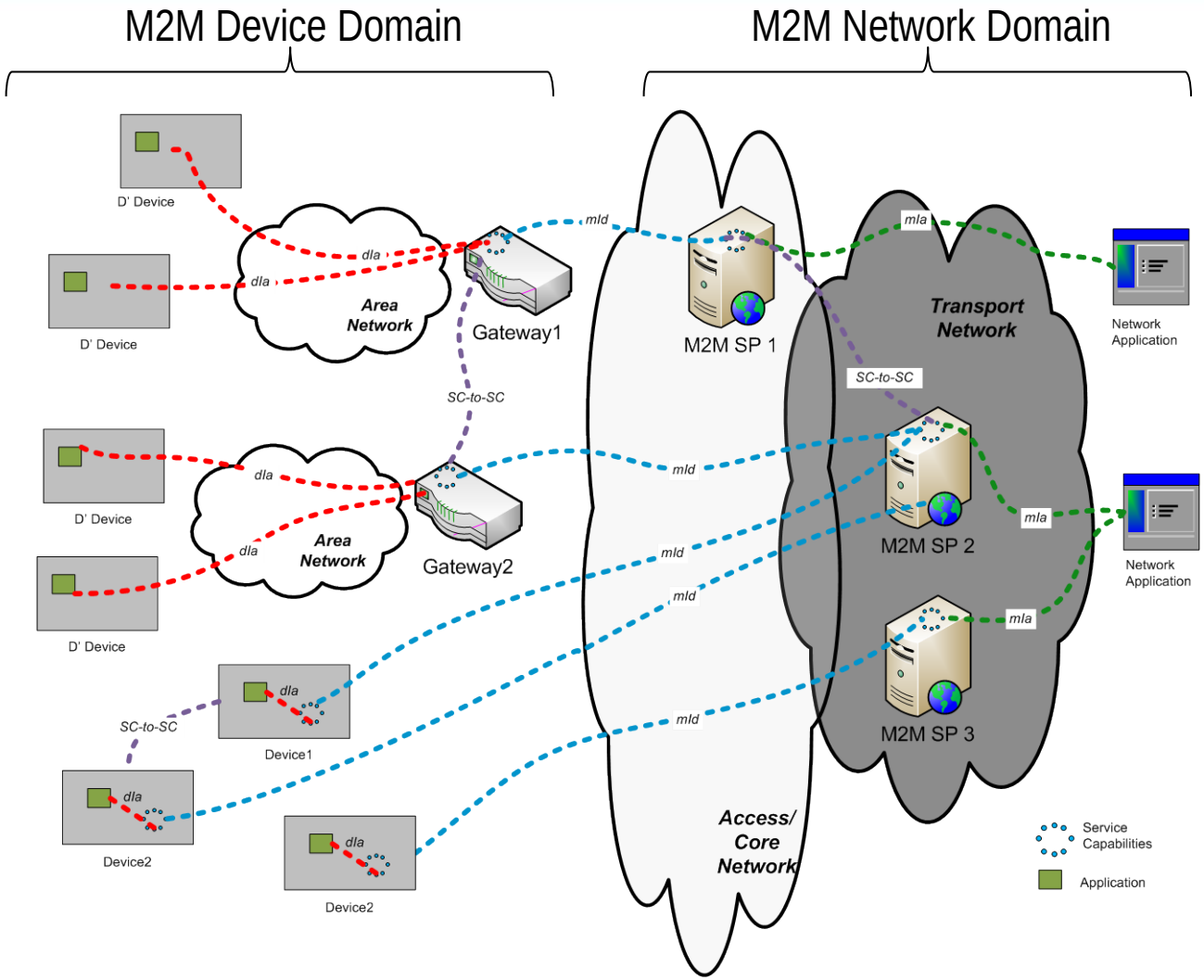
ETSI M2M Service Architecture



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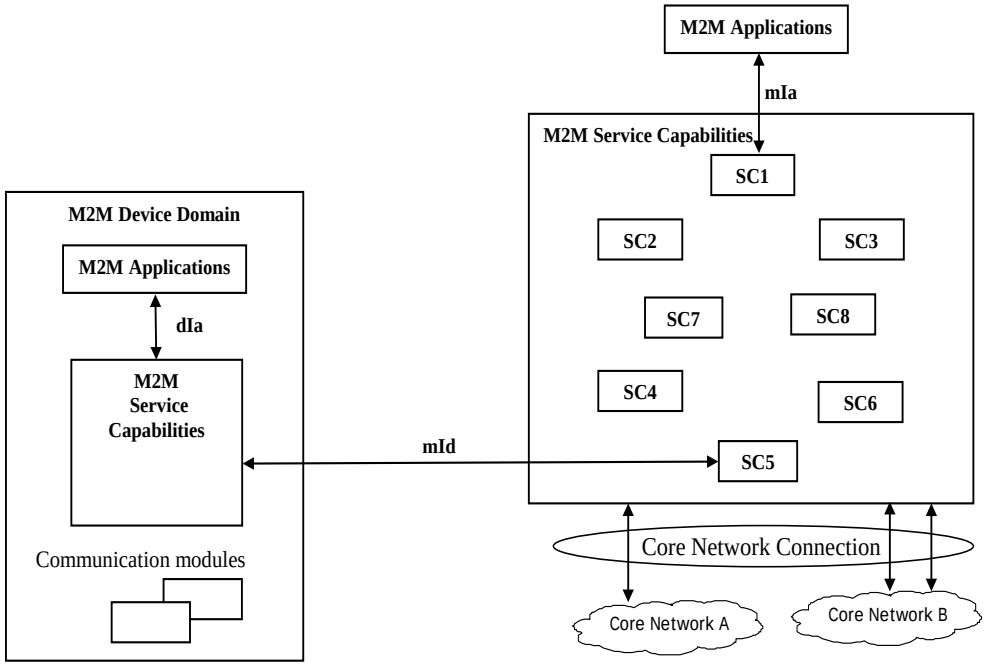
ETSI M2M Service Architecture – Service Capabilities



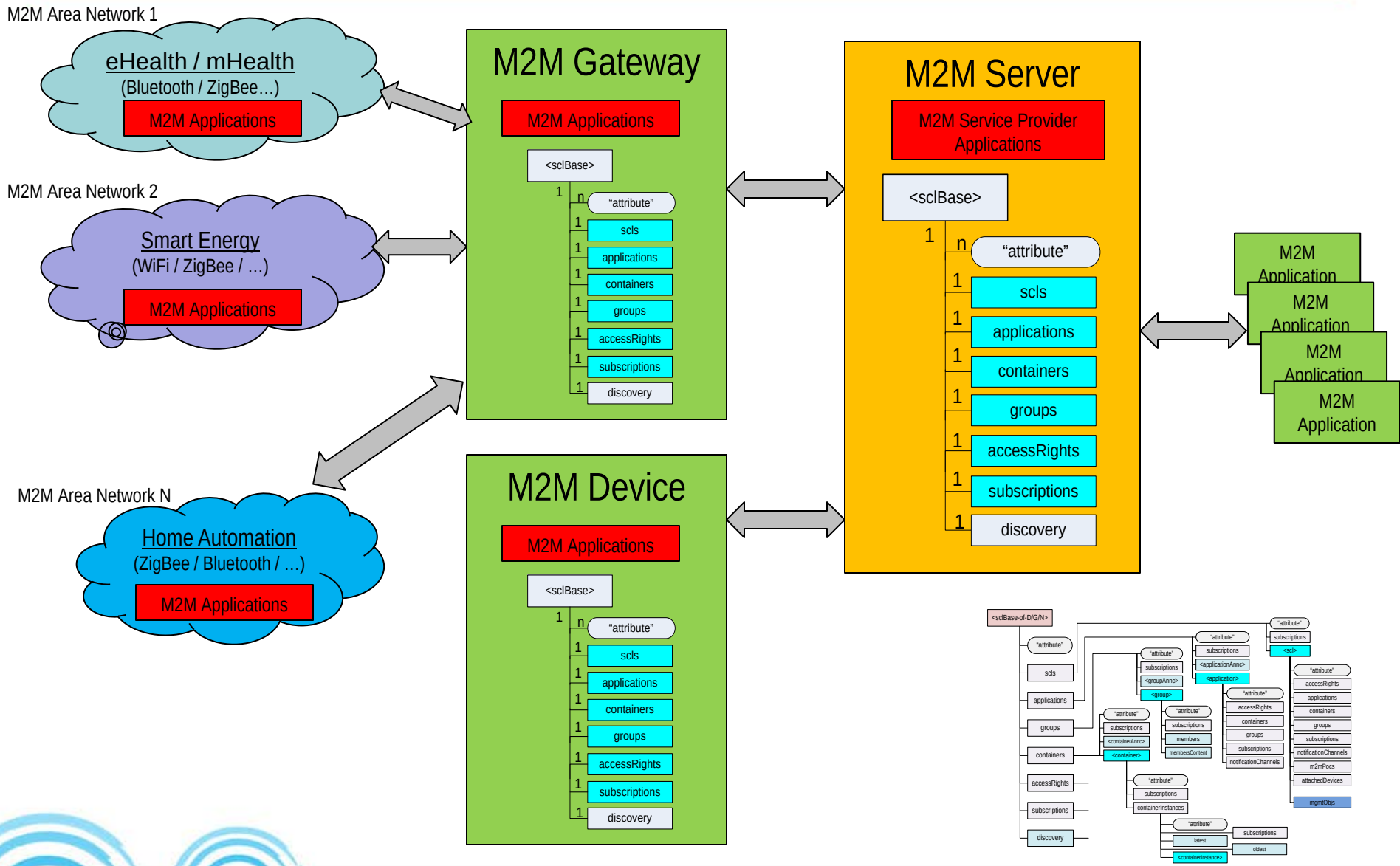
The list of M2M Service Capabilities (SC) are:

- Application Enablement (**xAE)**
- Generic Communication (**xGC**)
- Reachability, Addressing and Repository (**xRAR**)
- Communication Selection (**xCS**)
- Remote Entity Management (**xREM**)
- SECurity (**xSEC**)
- History and Data Retention (**xHDR**)
- Transaction Management (**xTM**)
- Compensation Broker (**xCB**)
- Telco Operator Exposure (**xTOE**)
- Interworking Proxy (**xIP**)

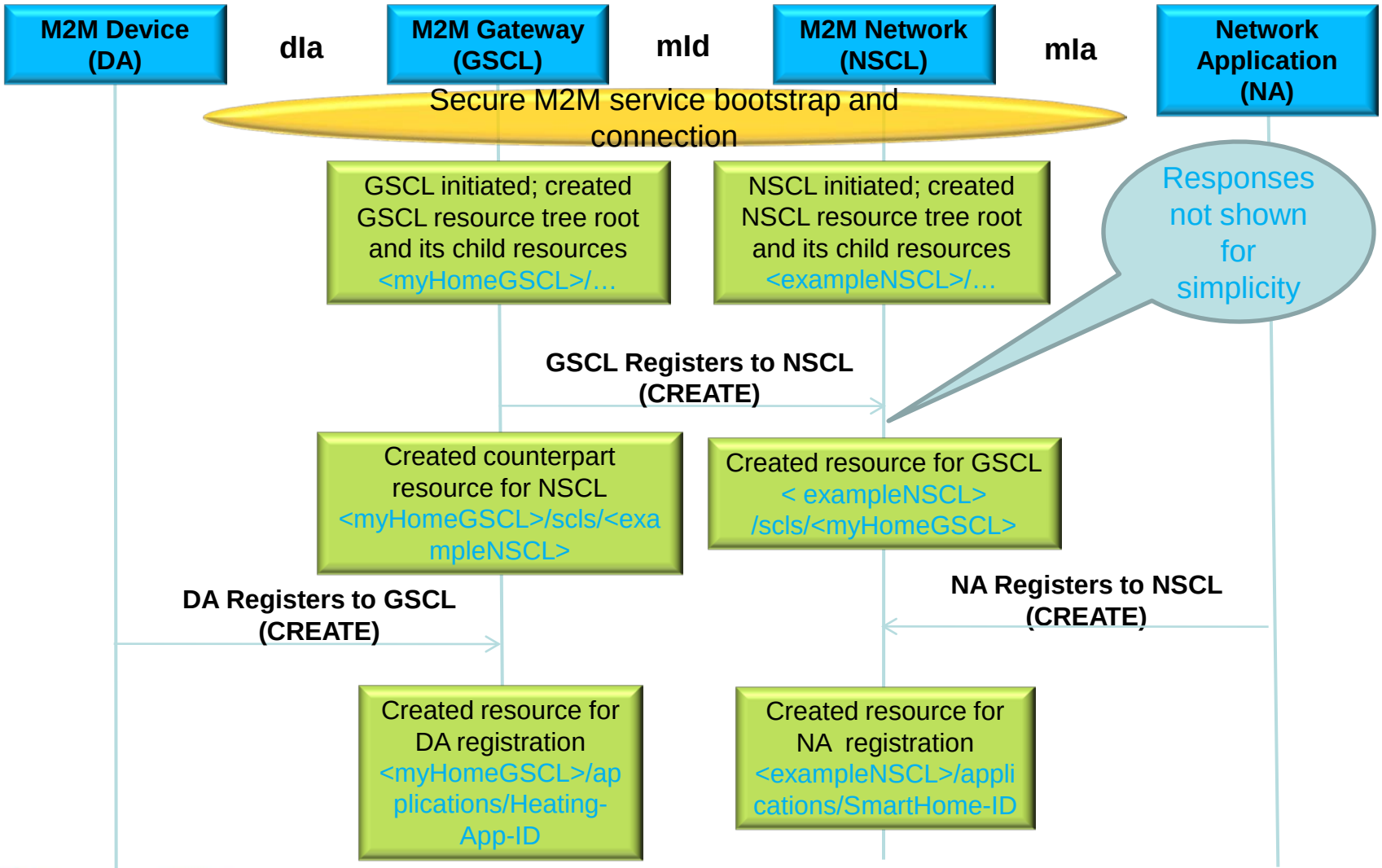
where x is:

- N for Network, consists of the complete ETSI M2M core network infrastructure communication with gateways and devices.
- G for Gateway, is an ETSI M2M device specialized to directly manage M2M area networks of ETSI M2M devices; the gateway directly communicates with an ETSI M2M core network.
- D for Device, is an ETSI M2M device than can directly communicate to an ETSI M2M core network or to an ETSI M2M gateway.

ETSI M2M Service Architecture – Resource Tree



ETSI M2M Service Architecture – Service and Application Registration



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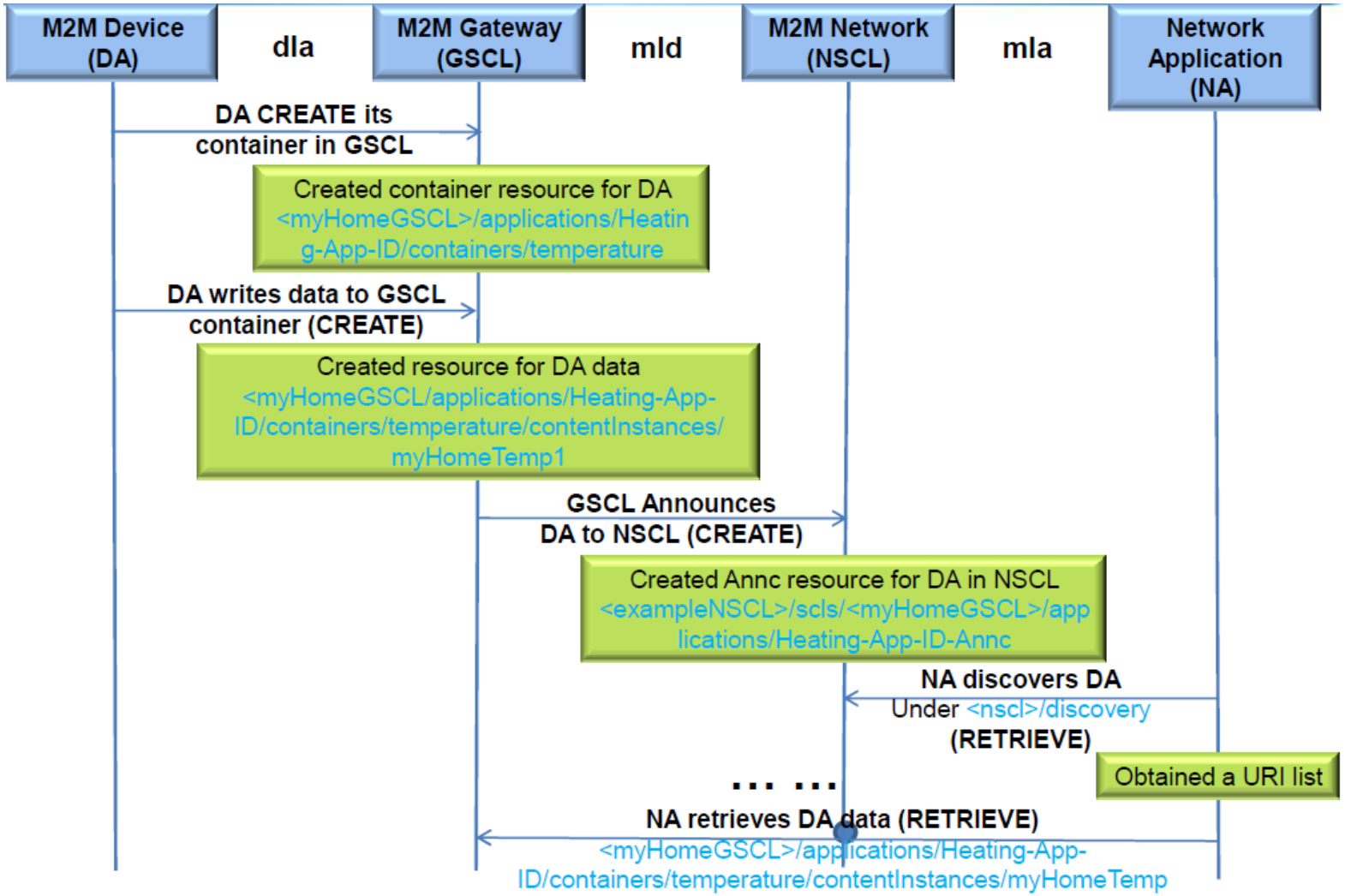
ETSI M2M Service Architecture – Resource Announcement/Discovery



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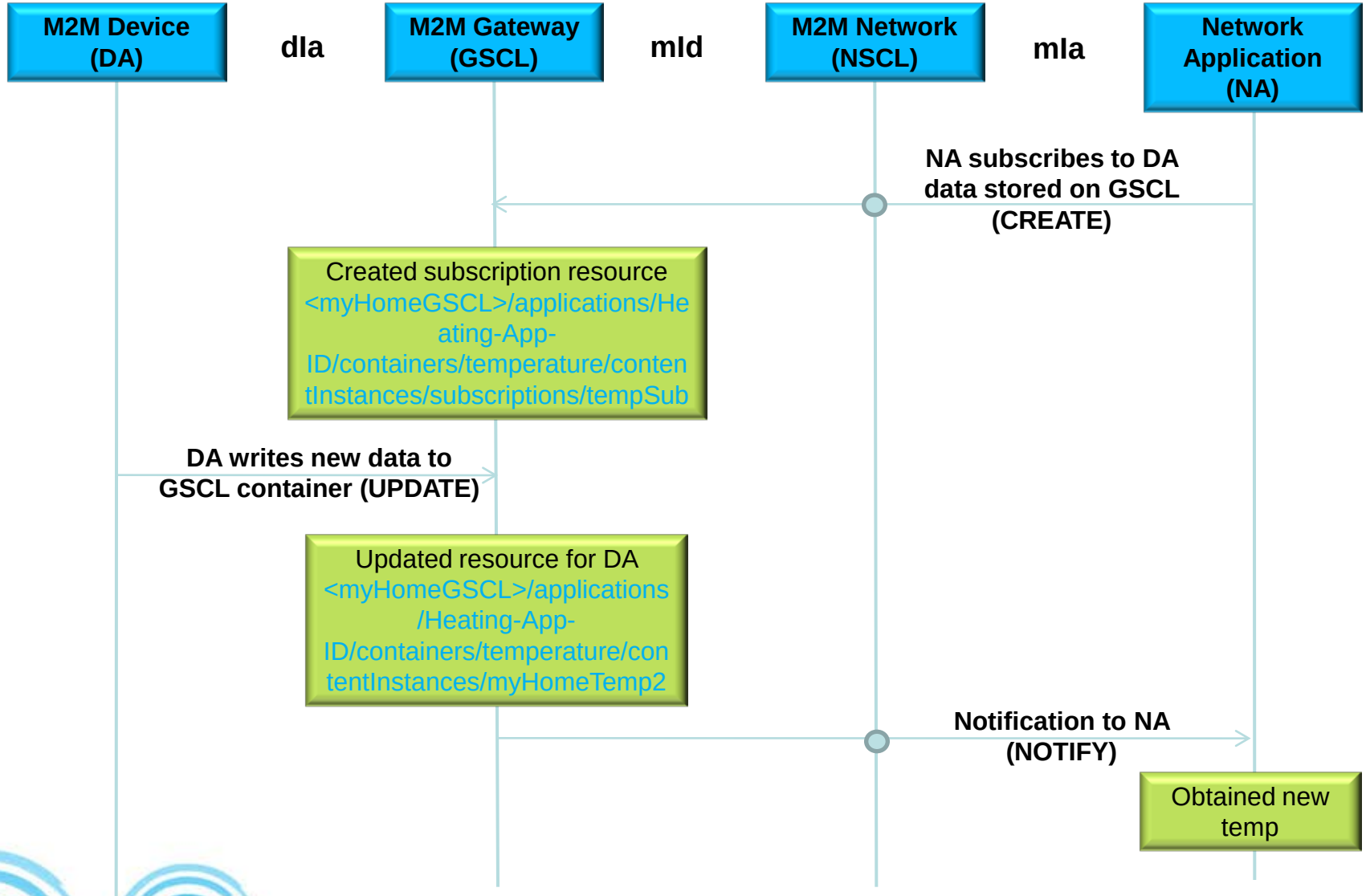
ETSI M2M Service Architecture – Resource Subscription/Notification



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ETSI M2M Service Architecture – HTTP and CoAP Binding

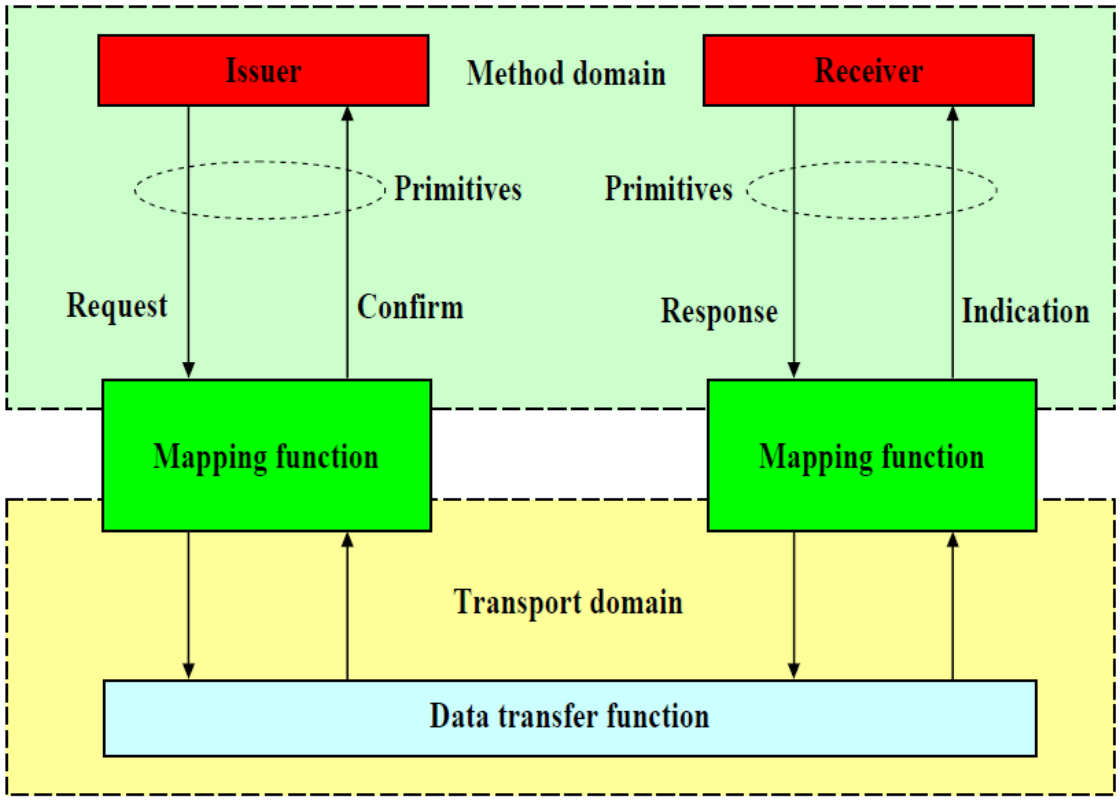
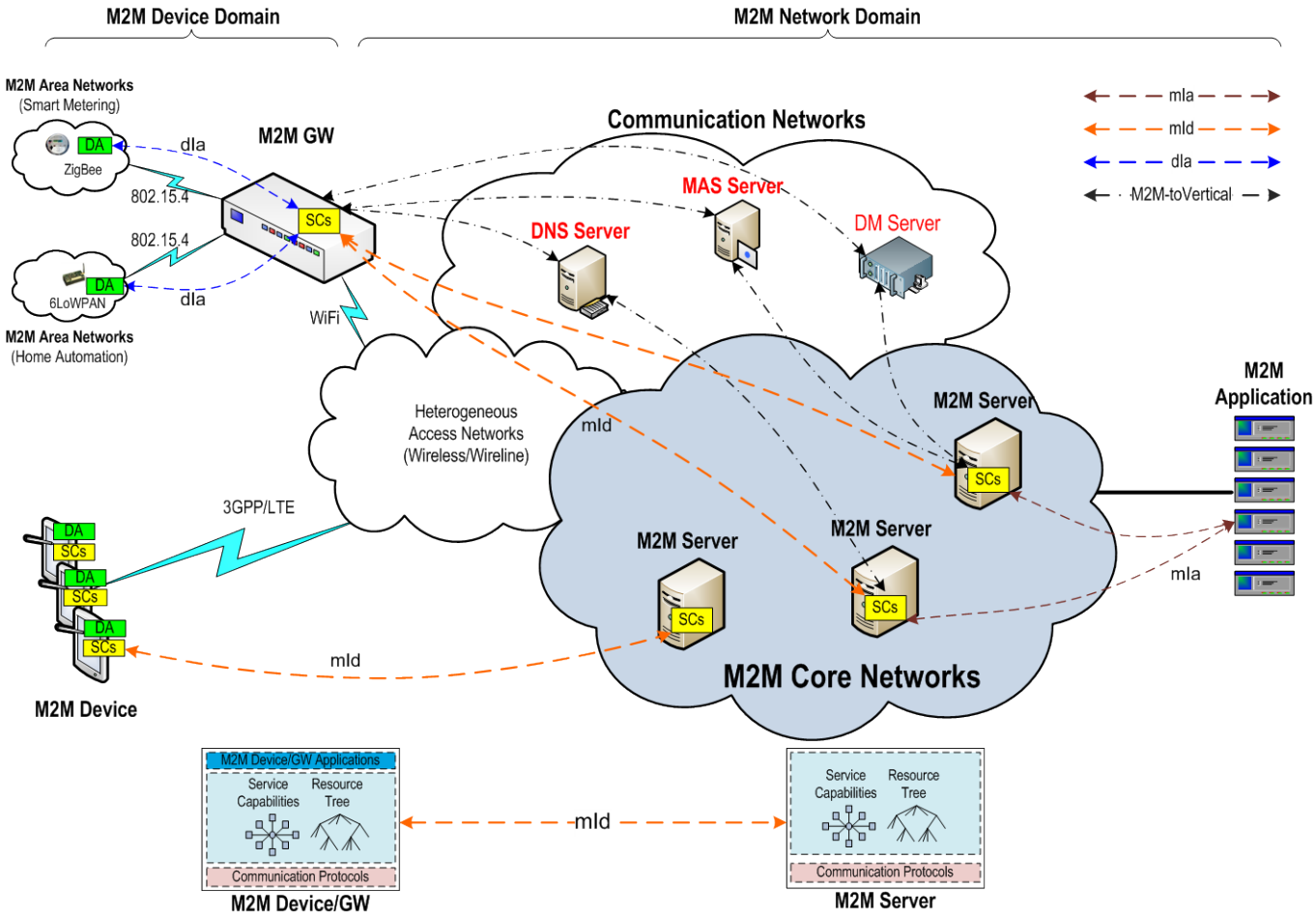


Illustration of ETSI M2M Primitive Binding to Transport Layer Protocols

- Binding to HTTP and CoAP is easy due to ETSI M2M RESTful approach
- Normative mapping defined for both HTTP and CoAP
- Primitives represent the resource operation in the Method domain

ETSI M2M Service Architecture – Leveraging Verticals



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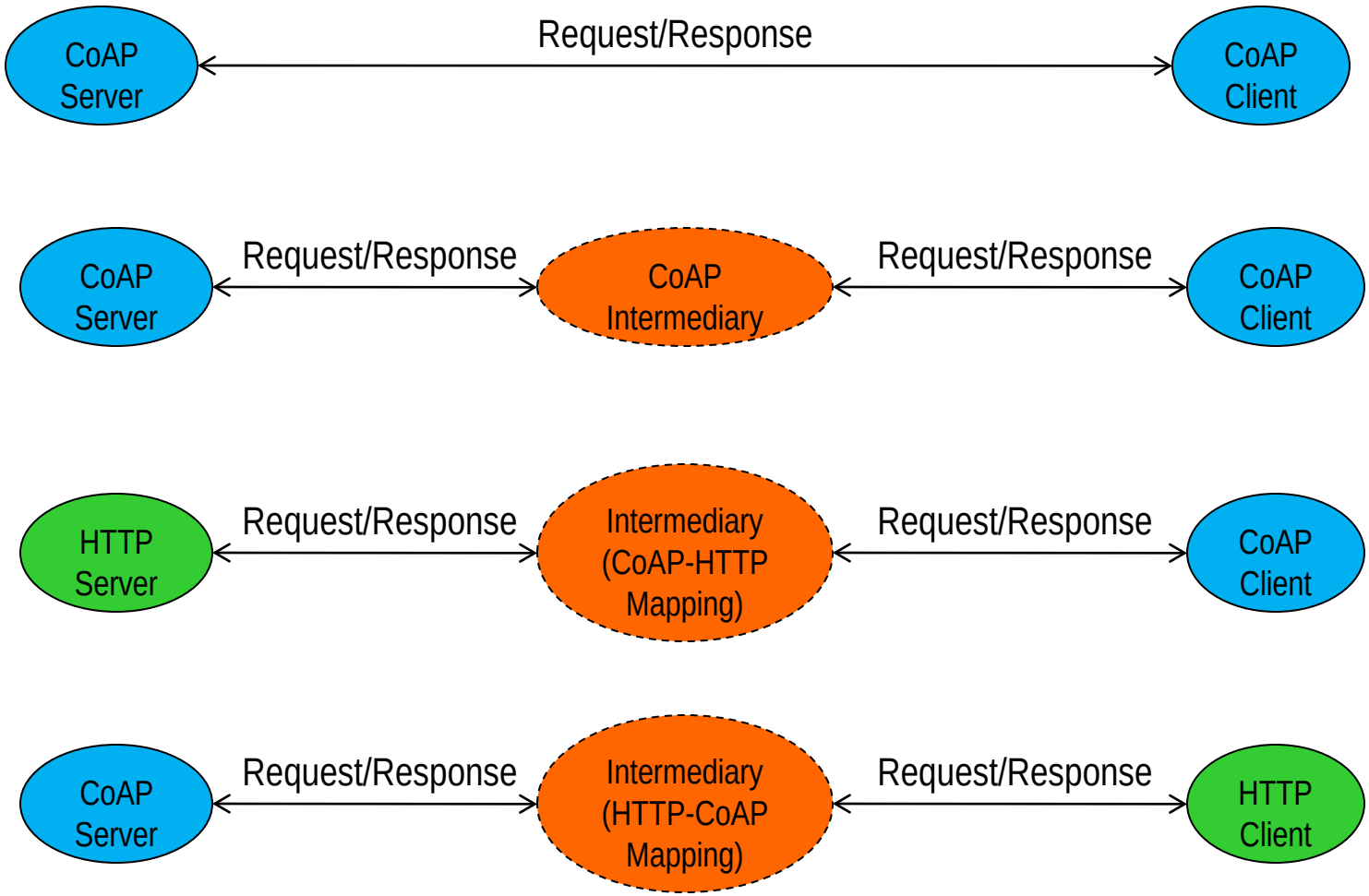
CoAP – Constrained IP Networks

- A constrained IP network is a network which consists of devices. Both the network and devices have the following unique features, in contrast to general IP networks.
  - Limited packet sizes
  - High degree of packet loss
  - A number of low-duty cycling devices with severe limits on throughput, available device power, device RAM, and affordable complexity.
  - An example: low-power wireless personal area networks (LoWPANs)
- Application-related resources in a constrained IP network include:
  - Sensors (e.g. temperature sensors, light switches, power meters, etc)
  - Actuators (e.g. light switches, heating controllers, door locks)
  - Combinations of values or other information
- Common operations to/within constrained IP networks:
  - Monitor sensors
  - Control actuators
  - Manage devices

CoAP – Representative State Transfer (REST)

- REST is a style of software architecture for distributed hypermedia systems such as WWW.
- Six Constrains of REST
  - Client-Server : a uniform interface to connect clients and servers
  - Stateless: servers keep no state for previous client requests
  - Cacheable: clients are able to cache responses from servers
  - Layered System: clients do not recognize intermediate servers or end servers
  - Code on Demand: servers can alter/customize the client's functionality, for example, by executing some compiled components (Java Applets, JavaScript) at the clients
  - Uniform Interface:
    - Identification (Representations) of Resources: such as URI in web-based REST systems (HTTP)
    - Manipulation of Resources thru These Representations (by clients under permission approved)
    - Self-Descriptive Messages: enough info is contained in each message
    - Hypermedia as the Engine of Application State: the client accesses related sources
- Key Goals:
  - Scalability of component interactions
  - Generality of interfaces
  - Independent deployment of components
  - Intermediary components to reduce latency, enforce security and encapsulates legacy systems

CoAP – Client / Server Model



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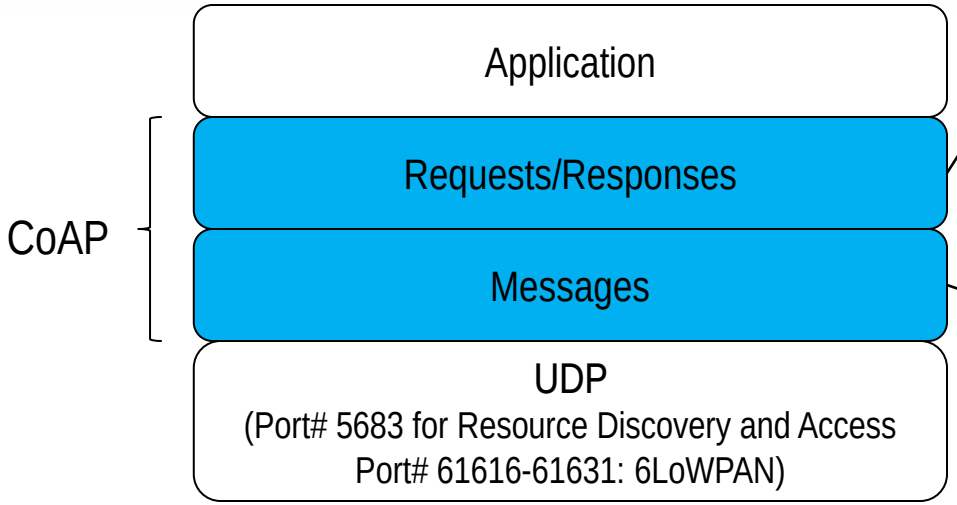
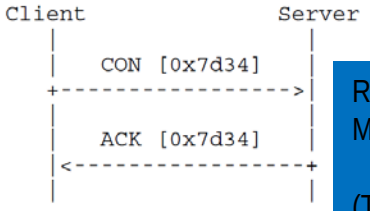
CoAP – Protocol Stack & Message Model



Request: confirmable and non-confirmable (GET/PUT/POST/DELETE)
Response: piggybacked, separate, non-confirmable

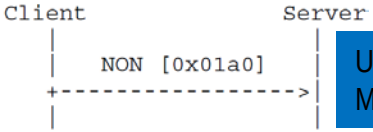
4 Types: Confirmable (CON), Non-Confirmable (NON), Acknowledgement (ACK), Reset (RST)

Each message has a "Message ID"; Each request message has an addition "Token" for response-request matching purpose

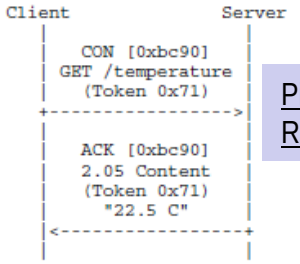


Reliable Msg Delivery

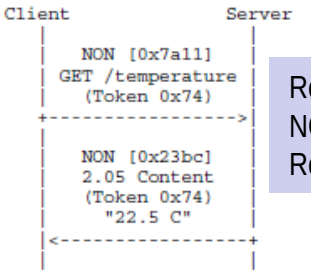
(Timer-based Re-transmission)



Unreliable Msg Delivery

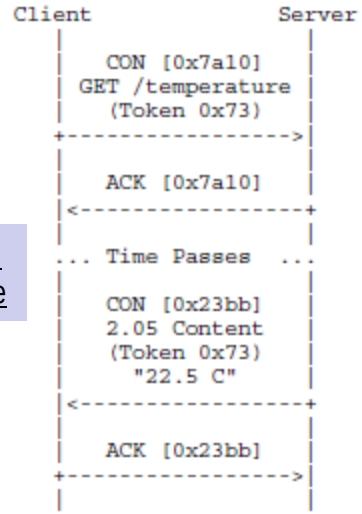


Piggybacked Response



Response for NON-type Request

Separate Response



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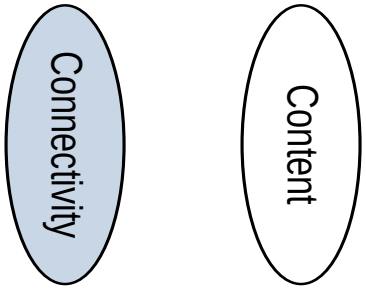
InterDigital's M2M Evolution into IoT

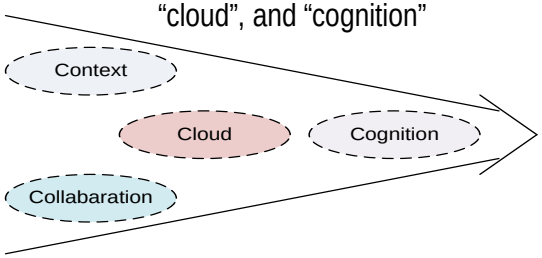
Current M2M

• Focuses on communications (i.e. how information is transmitted from one machine to another)



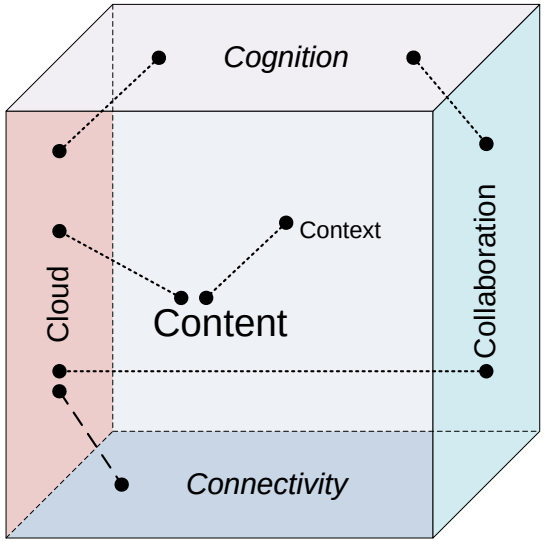
Evolution

• Effectively integrate "connectivity" and "content" with "context", "collaboration", "cloud", and "cognition"



Future IoT Cube

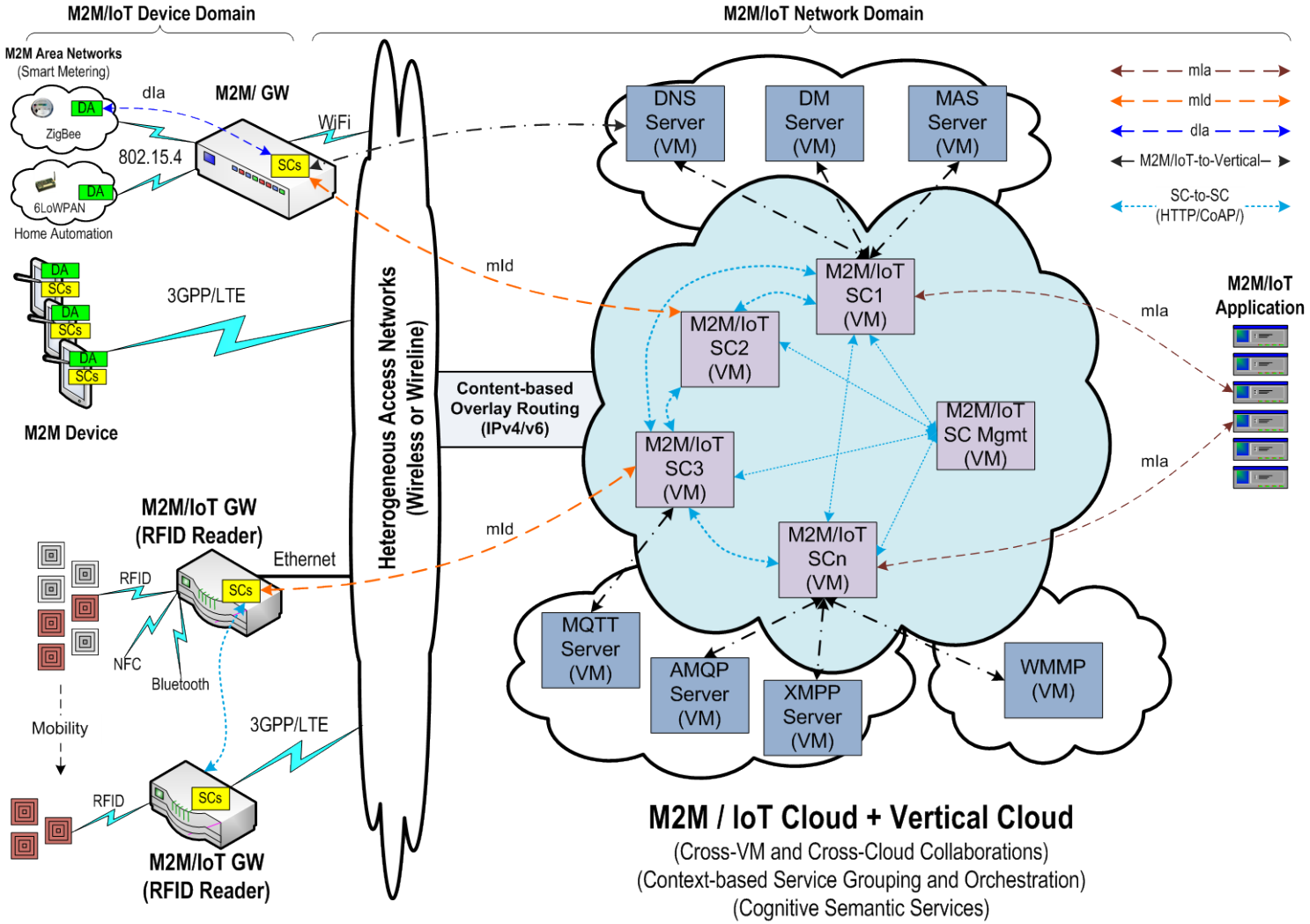
• A global network infrastructure, linking physical and virtual objects through the exploitation of data processing and communication capabilities



A world-wide network of interconnected objects that enables object identification, semantic data processing, and service discovery via C^6

- Connectivity: provide connection for mobile and constrained objects
- Content: massive data produced from things
- Cloud: cloud service and cloud content storage
- Context: context-aware design to improve performance
- Collaboration: cooperative comm., inter-things, service sharing
- Cognition: mine knowledge from massive data and provide autonomous system adjustment for improvements

M2M Evolution to IoT – Architecture



M2M Evolution to IoT Prototype Development

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Thank You!

With an eye on the future, InterDigital invites fellow global market participants in the ecosystem to collaborate on integrating our advanced technologies into products and services for field testing and commercial deployment.

Paul.Russell@InterDigital.com

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