Empowered by Innovation NEC

How to deal with a thousand nodes: M2M communication over cellular networks

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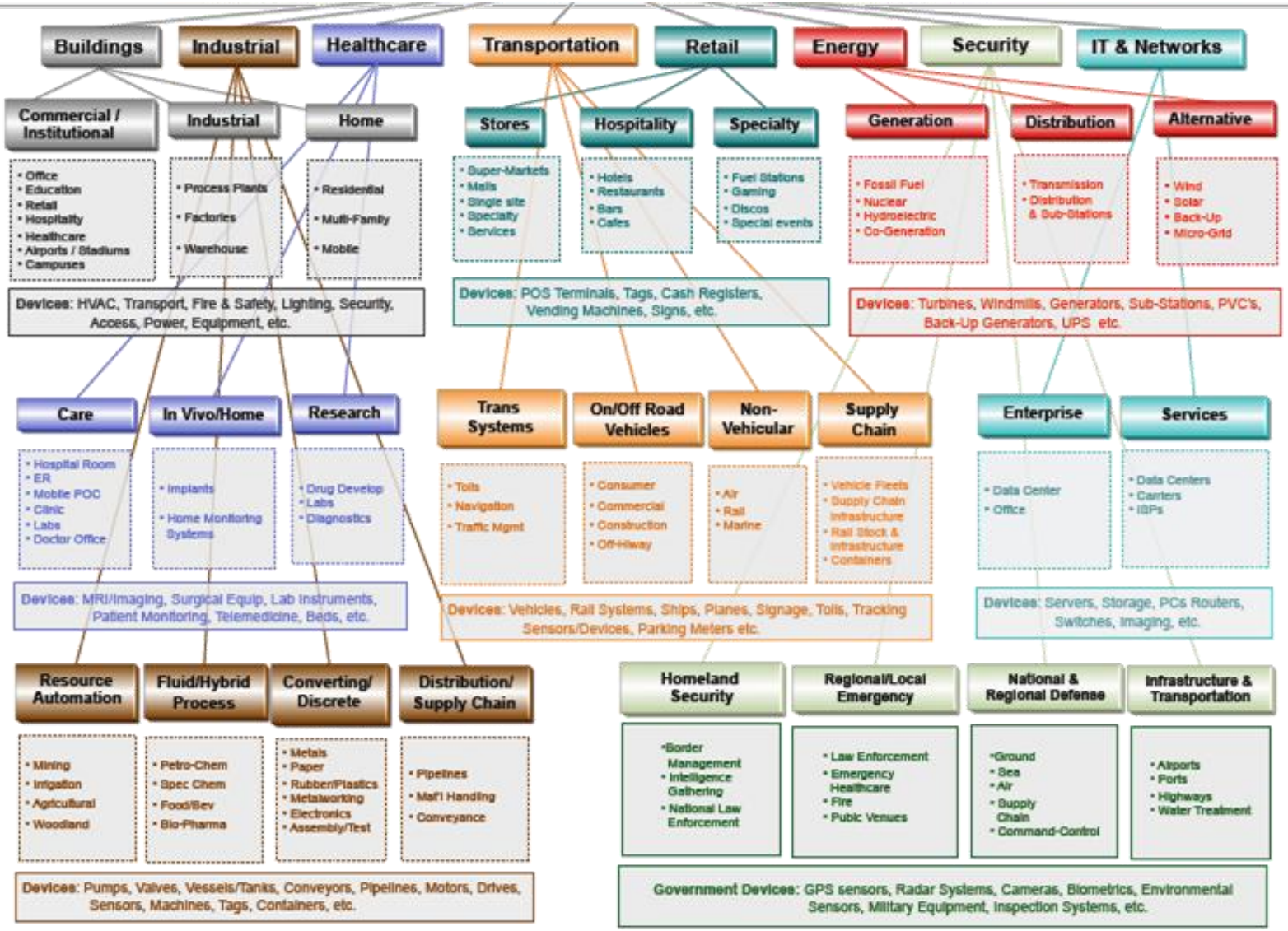
Outline

- Introduction to M2M communications
  - The M2M use case landscape
  - Properties and requirements
- Challenges for mobile cellular networks
  - Architecture
  - Challenges on RAN and core network
- Current efforts in standardization
  - ETSI: end-to-end framework for M2M
  - 3GPP: Keep the operators into the value chain
  - IEEE: Optimize the radio access
- Conclusion and outlook

The M2M use case landscape

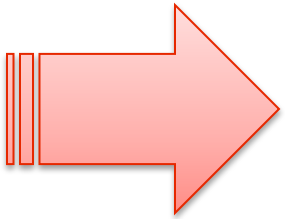


Source: Harbor Research, Inc.

What is the issue?

- Cellular mobile networks are designed for human communication
  - Interactive communication between humans (voice, video)
  - Data communication involving humans (web browsing, file downloads, etc).
  - Communication is connection-centric

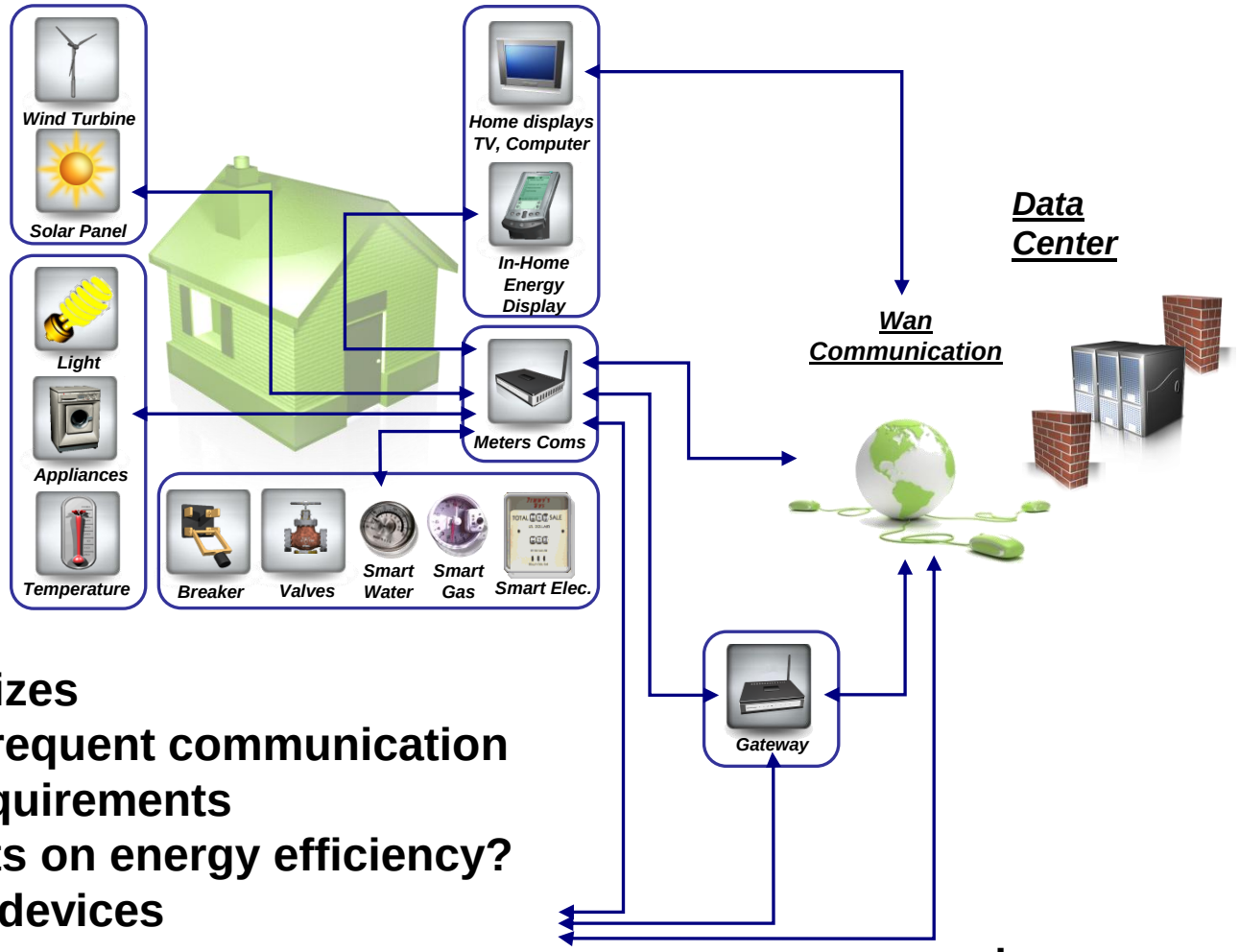
- Cellular mobile networks are optimized for traffic characteristics of human-based communication applications
  - Communication with a certain length (sessions) and data volume
  - Communication with a certain interaction frequency and patterns (talk-listen, download-reading, etc.)



But: M2M communication is different

Example: Smart Grid/Smart Metering

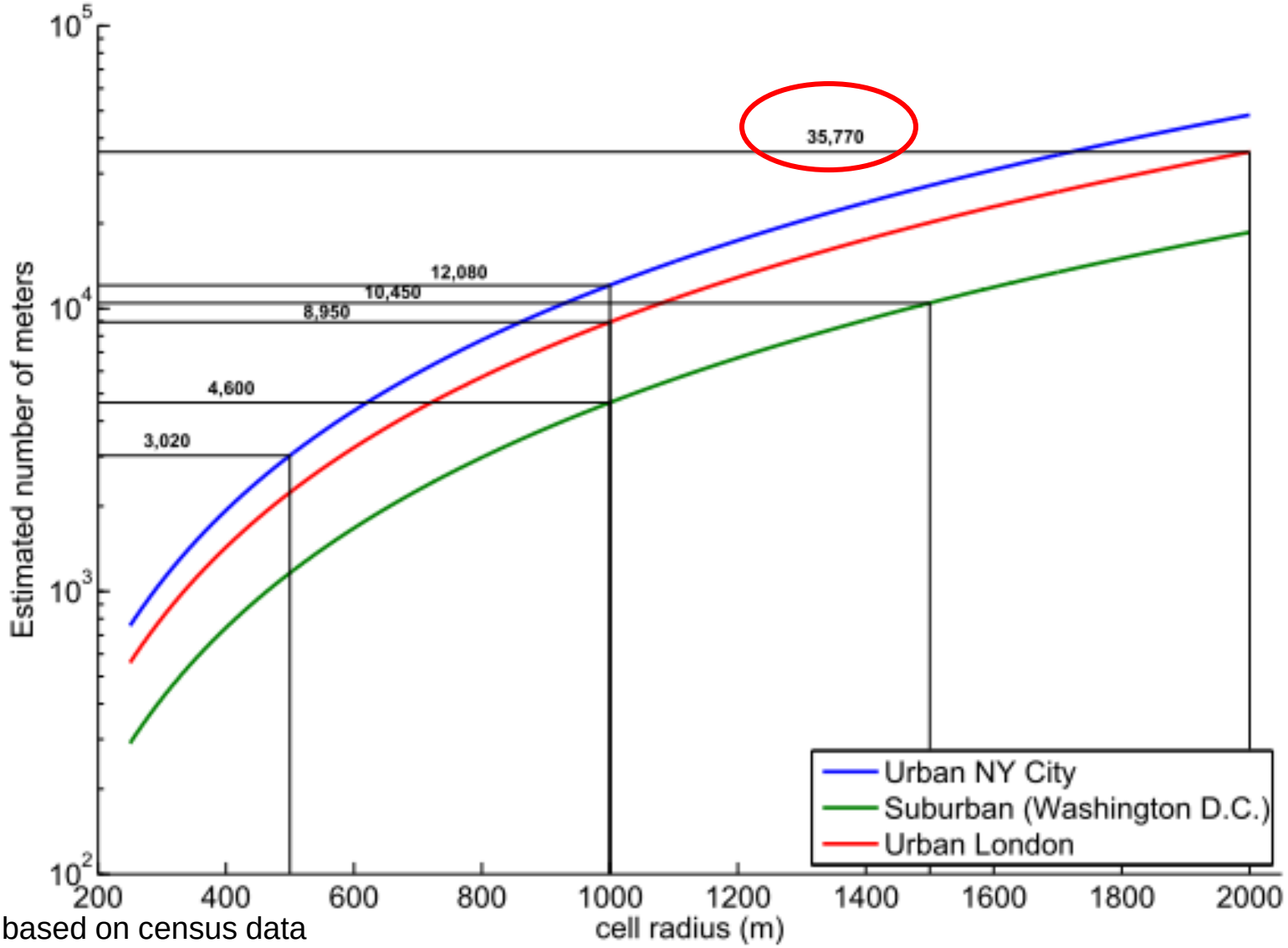
- Control and reading of metering/infrastructure



Small message sizes
Low to medium frequent communication
Relaxed delay requirements
High requirements on energy efficiency?
Large number of devices
“Alarm” scenarios

Image source: ETSI

Example scenario: smart meters per single cell



Estimation based on census data

One smart meter assumed per household

Example: Intelligent Transport Systems

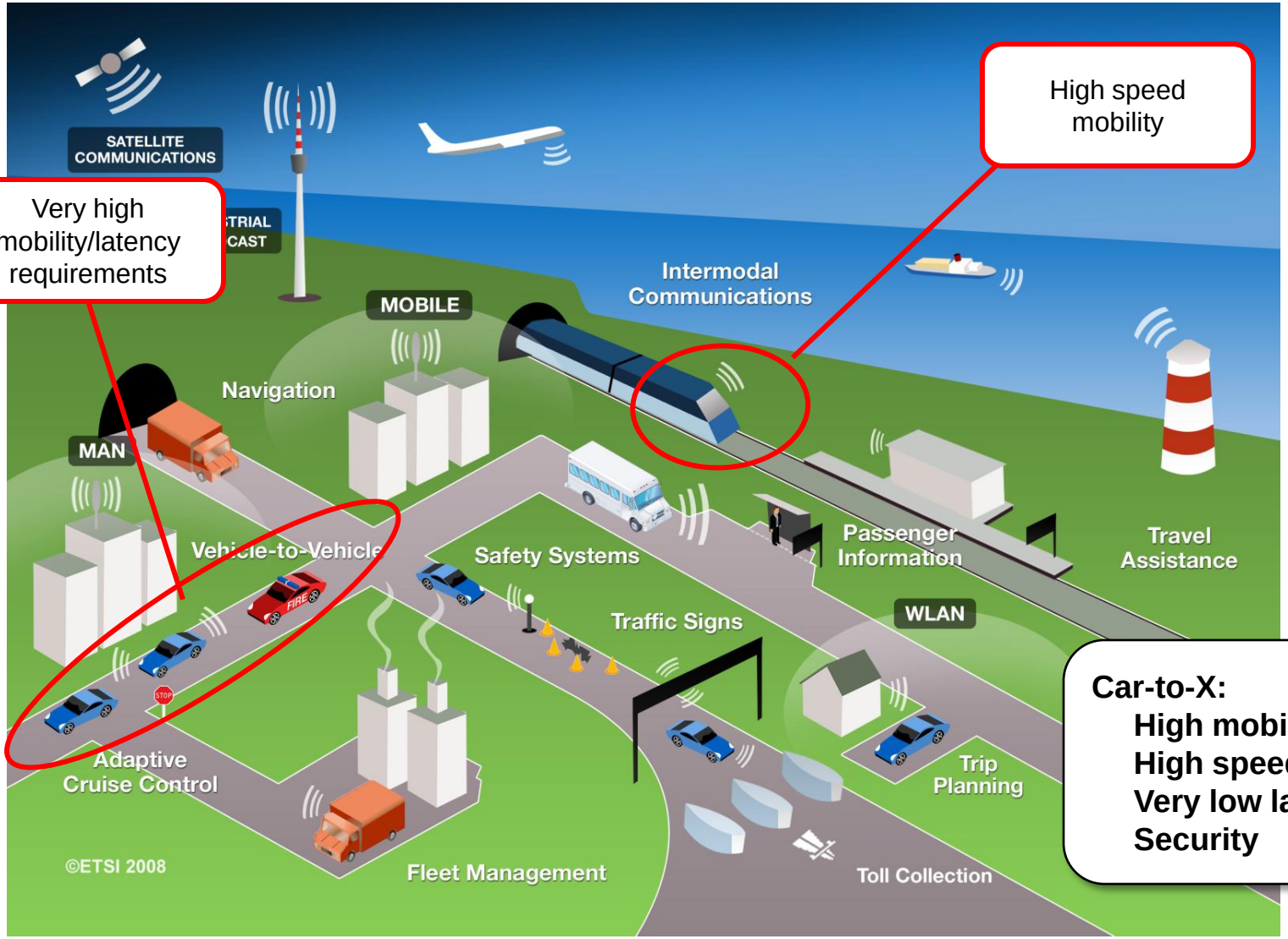


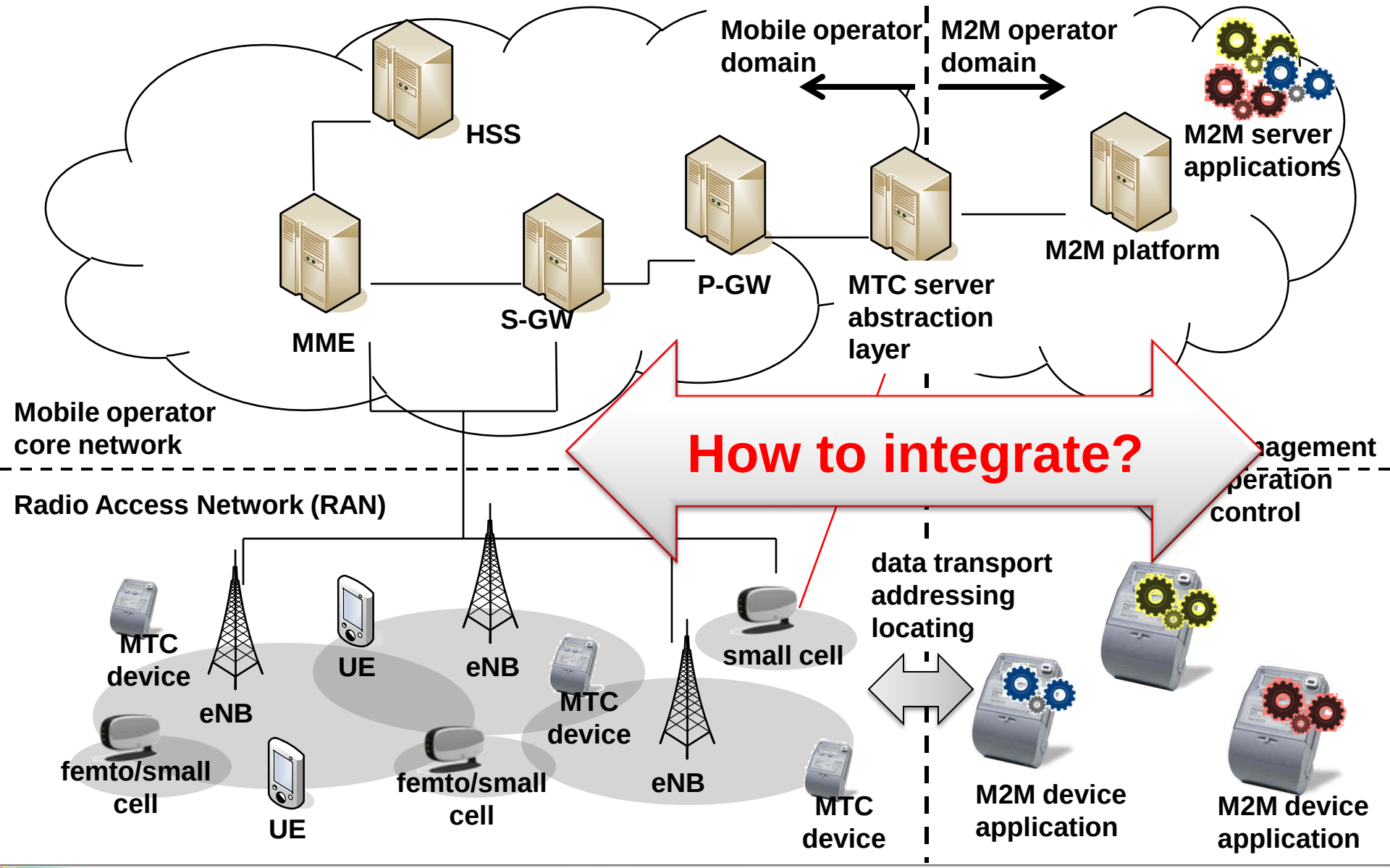
Image source: ETSI

Properties and requirements of M2M applications

	Smart meters	eHealth	ITS	Surveillance
Mobility	none	Pedestrian /vehicular	Vehicular	none
Message size	Small (few kB)	Medium?	Medium	large
Traffic pattern	Regular	Regular/irregular	Regular/irregular	Regular
Device density	Very high (up to ten thousands per cell)	Medium	High	low
Latency requirements	low (up to hours)	Medium (seconds)	Very high (few milliseconds)	Medium (< 200ms)
Power efficiency requirements	High (battery powered meters)	High (battery power devices)	Low	low
Reliability	High	High	High	medium
Security requirements	High	Very high	Very high	medium

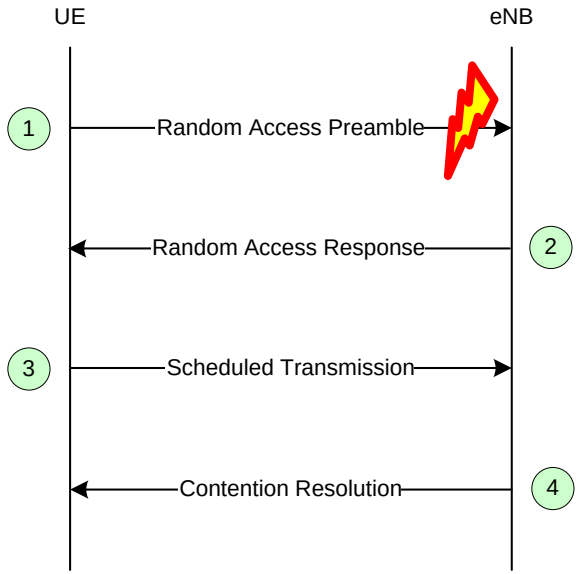
Diverse and challenging requirements for today's mobile networks
Requirements and traffic patterns are not clear today!

Cellular M2M architecture

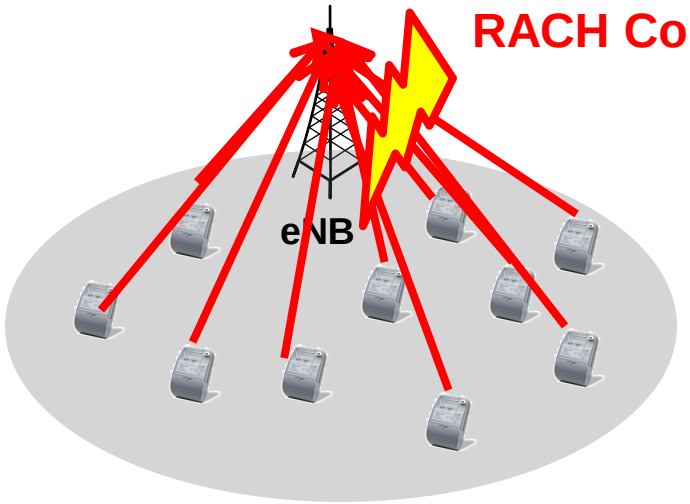


Challenges for radio access

- Many devices
- Long idle intervals
- Small message transmission
- Uplink is bottleneck
- Energy efficiency
- Human communication must not be affected!

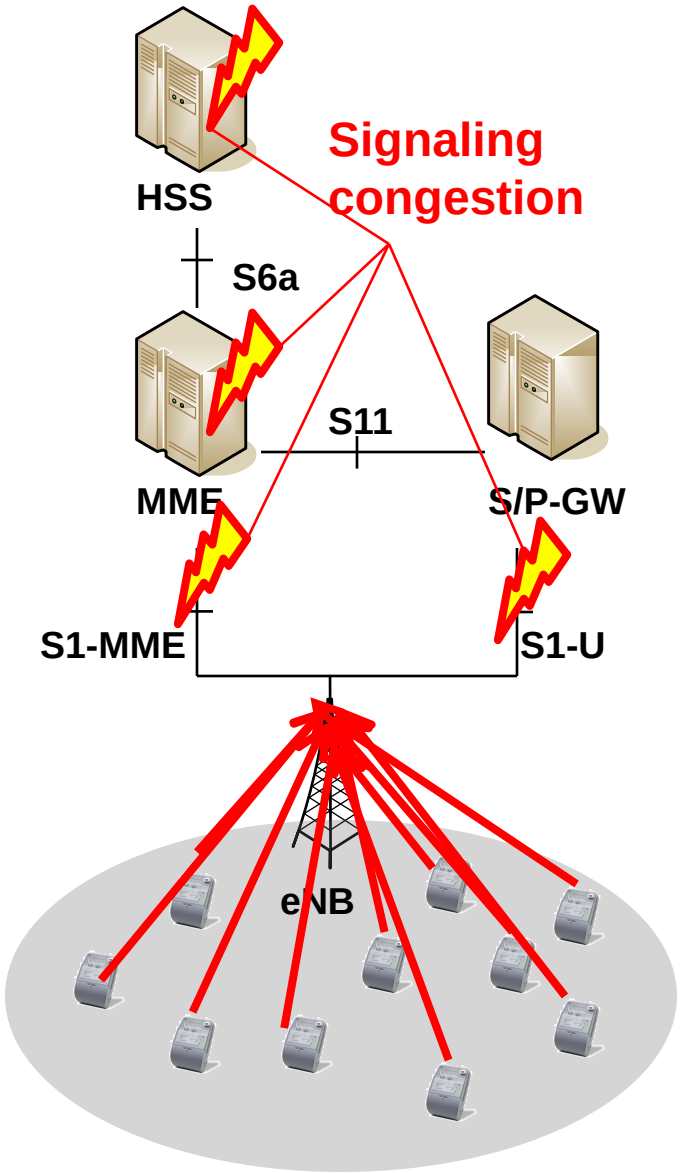


Random access procedure in LTE for attachment, uplink bandwidth requests



- Proposed solutions:
  - Dedicated RACH
  - Time backoff classes
  - Slotted access
  - Group coordination
  - Access barring
  - Randomization

Challenges for non-access stratum



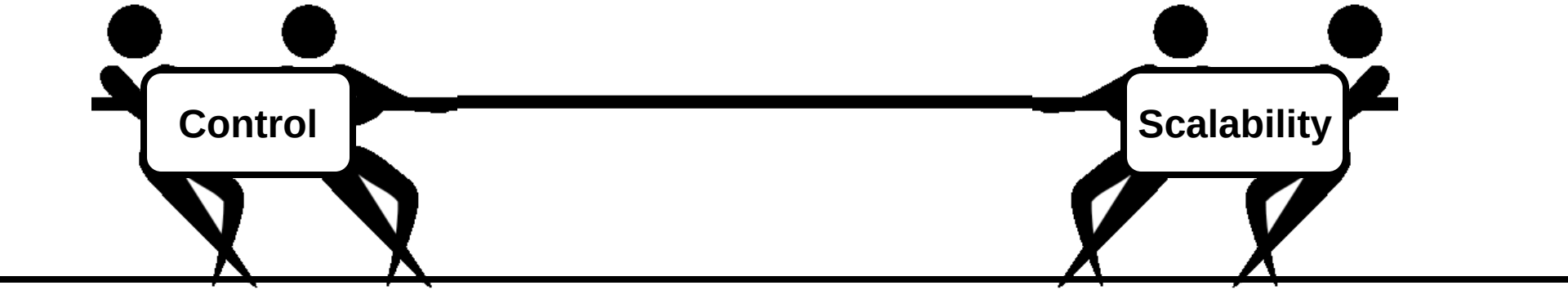
- Each data transmission from idle mode requires a bearer setup
  - Complex procedure with several CN entities involved
  - Large overhead for small message sizes
  - May lead to signaling congestion and high computational load

- Proposed solutions:
  - Signaling aggregation
  - Signaling rejection/differentiation
  - Signaling reduction for MTC device classes

Trade-off between control and scalability

Security
Charging
QoS
Management
Monitoring
Scheduled access

Large device numbers
Low latency
Low power consumption
Small burst transmission
Low cost
Low overhead

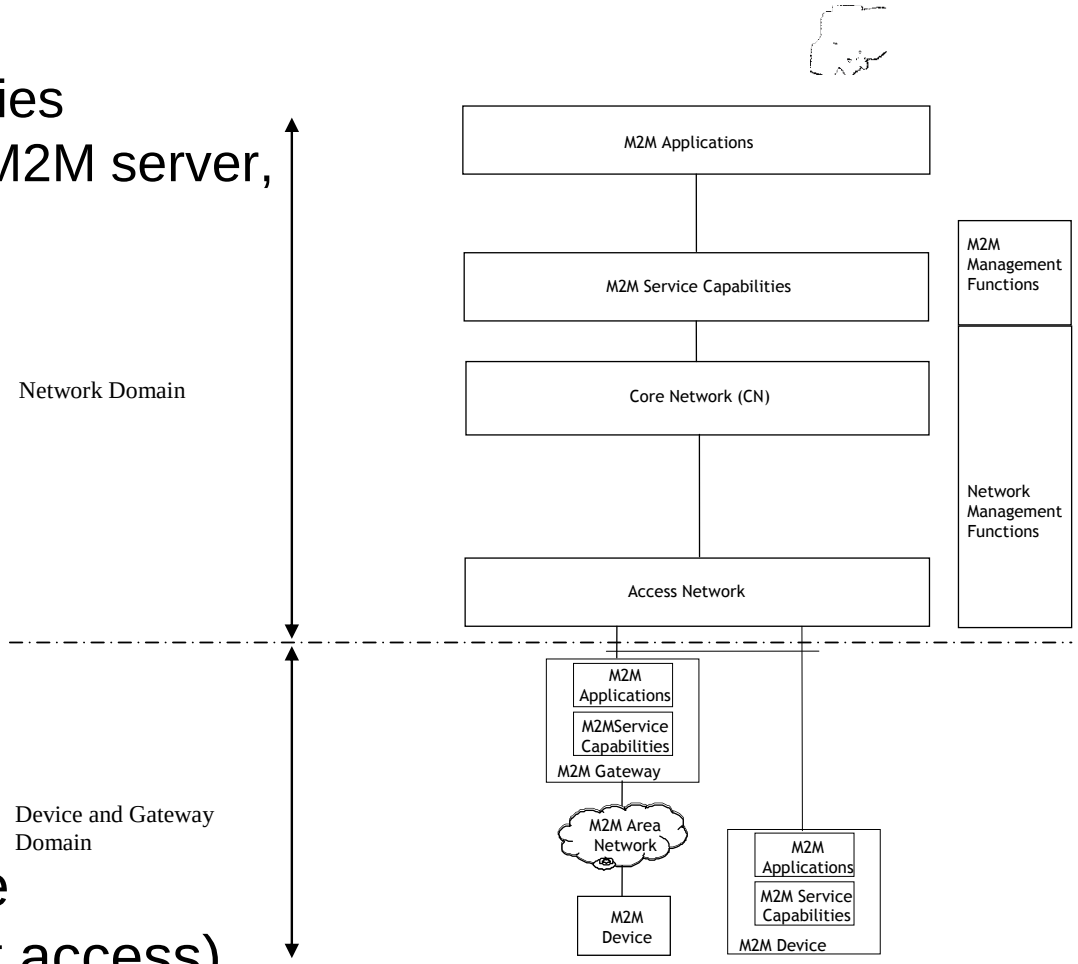


Diverse and partially contradicting requirements
Balancing mobile and M2M operator needs

Is it sufficient to modify existing technologies?

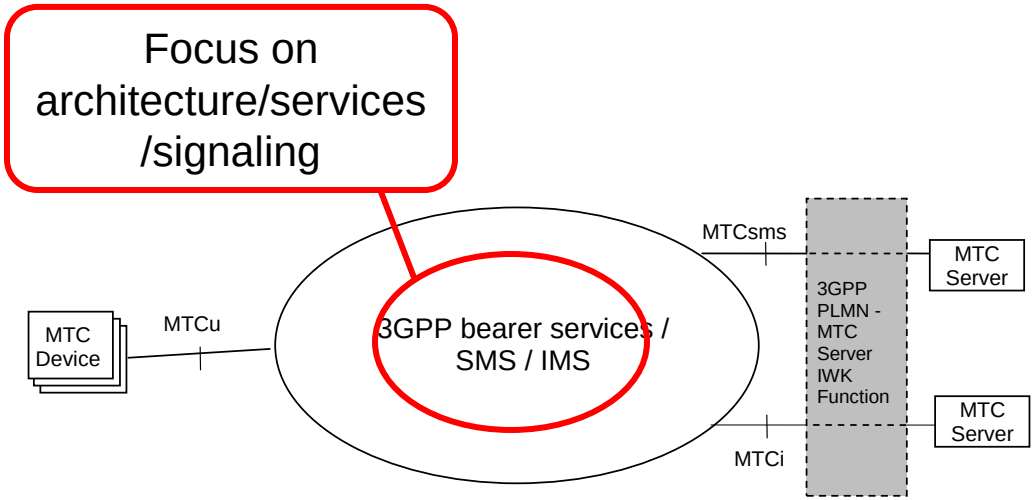
Activities in standards: ETSI

- ETSI develops an end-to-end framework for M2M
- Architecture highlights
  - Generic service capabilities for M2M applications in M2M server, gateway and devices
  - M2M identification and addressing scheme
  - Framework for security and service bootstrap
  - Resource management framework
- Independent of transport network
- Interaction with MNO core network functions (but not access)

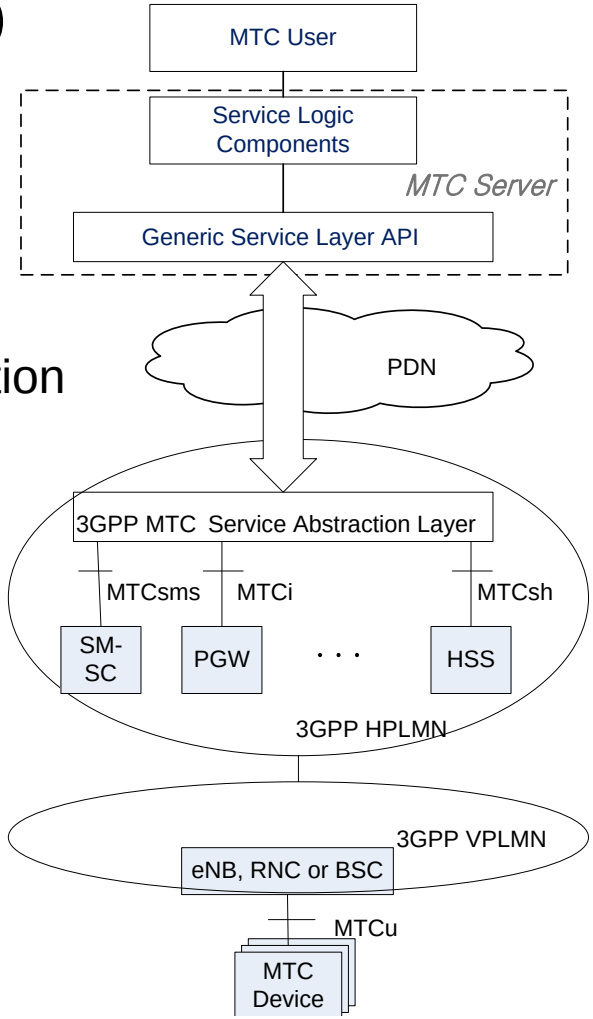


Activities in standards: 3GPP

- Two work items: network improvements for MTC (NIMTC, Rel. 10) and system improvements for MTC (SIMTC, Rel. 11)
- Current focus on architecture (MTC server), control plane, services, features: TR 23.888
- Study on RAN improvements finished in Sept.
  - TR 37.868, section on RAN overload control
  - Extended Access Barring (EAB) selected as solution



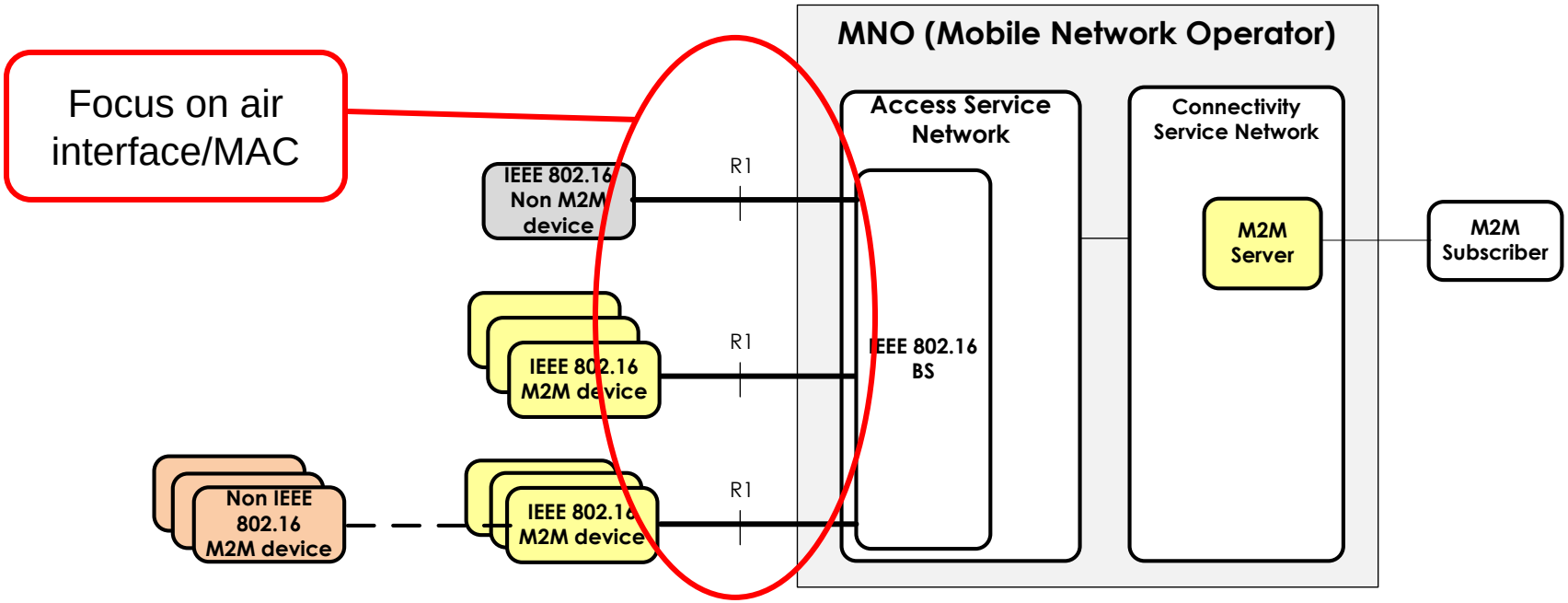
3GPP MTC architecture



3GPP MTC service abstraction

Activities in standards: IEEE 802.16p

- IEEE 802.16p: started in Sept. 2009
- Extension of 802.16e (WiMAX) and 802.16m (WiMAX 2.0)
- MAC and minimal OFDMA PHY enhancements
- Current status: enhancements for network entry, group control, multicast, mobility, dedicated random access resources
- Letter ballot in Nov. 2011, publish 2012



802.16p M2M service reference system architecture

Conclusion and Outlook

- M2M is an enabler of the **Internet of Things.**
- M2M is **challenging** for today's and future cellular networks:
  - Interworking between M2M operator and mobile operator.
  - Diverse traffic characteristics and requirements on QoS, energy efficiency, …

- **Efforts in Standards**: "Fix" existing systems by adding as much as necessary, as less as possible.

- **Research needs to think beyond this approach**
  - M2M applications imply novel network performance metrics
  - Flexible MAC, low-overhead protocols, virtualization, energy efficiency, hierarchical networks, …
  - **First step: M2M traffic models for popular use cases (e.g. smart meters)!**
  - Talk to **industries and users** of M2M communications.

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