Addressing Unique Smart Grid Challenges with Converged Gateways

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Where are we heading?

Vision: Enable seamless integration of advanced networks with multiple air interfaces that intelligently connect people and things across a myriad of wide-, local- and personal area networks.

- **Dependable connections** for everyone, everything, everywhere
- **Ultra-broadband**, low latency, high capacity, and reliable coverage for limitless applications
- **QoS flexibility**, balancing high throughput with low power, low cost, and small size
- **Security and privacy**, preventing misuse, tampering, malware, and other unauthorized access
- **Making it work together**, transparent, seamless, and without interference
What are the challenges?

- Trillions of connections, which includes low cost M2M Devices (sensors)
  - We don’t want to congest the access and core networks with signaling to and from all these connections
  - We want to be able to identify and address all devices (both individually and in groups). Addressing schemes have to be able to support all these devices.
- These connections have varied characteristics (delay tolerance, duty cycle, RAT capability, etc) making it difficult to find a “one-size-fits-all” solution for access network and core network operation
- A larger number of connections will require autonomous operation - maintenance and configuration should be “human” free
- Leveraging unreliable unlicensed bands and emerging spectrums (e.g. TVWS)
- Unique security considerations: physical attacks to unmanned devices, compromised (malicious or not) device behavior
- Some of these connections will be constrained in terms of power & storage – requiring targeted solutions for security, end-to-end reachability, etc.
Who’s doing what?

- Standards are being developed to address these challenges
M2M Ecosystem

Application Providers

Service Providers

Network Operators

System Integrators

Devices

Assets

Medical
Mobile
Transportation
Consumer
Industrial

Usage-based Insurance
Remote Service
Fleet Management
Traffic Management Portal

Application

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ETSI M2M Architecture Allows Cellular & Non-Cellular Networks to Interconnect

**Standard APIs, access, security & device management features**

**Intelligent Pipe** provides the bridge, enables Operator to monetize using Service Platform and APIs

- **Service APIs to 3rd-Party M2M Applications**
- **Service Provider NW** to interact with and manage M2M devices
- **Proxy for Service Provider NW** to interact with and manage M2M devices
- **Provides local services**

**M2M Devices & Capillary Networks**
- WLAN, WPAN (ZigBee, 6LowPAN, Bluetooth, Zwave, etc.), Wireline, SmartPhones, PDAs, etc.

**M2M Gateway**
- Enables cellular & non-cellular M2M devices to communicate through operator network

**M2M Server**
- M2M Service Platform, offering Service Capabilities to Application Providers

**Cellular Core Network**

**IP Network**
ETSI Architecture Allows Service Providers to Capitalize on M2M Growth

Proprietary Vertical Applications ...

Horizontal (based on common Layer)
Applications share common infrastructure, environments and network elements

- Current M2M solutions are fragmented

- Need for security & manageability anytime, anywhere

- Ensure interoperable networks and services

- Optimized architecture to address M2M service requirements and network traffic load

- ETSI M2M links with other SDOs such as 3GPP, OMA, ZigBee, IETF, CEN, CENELEC, NIST, and many others

ETSI is providing a standardized mechanism that will enable MNOs and other service providers to provide standardized M2M services to Application Providers
ETSI M2M Services Capabilities provide functions that are to be shared by different applications.

The list of current SCs are:
- Application Enablement
- Generic Communication
- Reachability, Addressing, and Repository
- Remote Entity Management
- Security
- History and Data Retention
- Transaction Management
- Compensation Brokerage
- Telco Operator Exposure
- Interworking Proxy

Detailed specifications & use cases are available at ETSI Collaborative Portal Web Site.
Smart Grid Topology utilizing ETSI M2M Architecture
SE2.0 Messages are encapsulated in ETSI M2M Service Layer Messages as they travel end to end through the network
Smart Energy 2.0 integrated within ETSI M2M Architecture

SE2.0 Devices interfacing to ETSI M2M GWs

SE2.0 Gateway w/ ETSI M2M Services

SE2.0 Network Applications

SE2.0 Network

ETSI M2M Servers support SE2.0 applications
ETSI M2M ZigBee SE 2.0 Device and Gateway Stacks

M2M Device ZigBee IP Stack

- Application Code Instrumented with calls to ETSI M2M API & ZigBee Profile API
- ZigBee IP Stack/Profile with updates to support ETSI M2M Services
- ETSI M2M Application Services Layer
- ZigBee IP Stack + Profile
- Baseband Backhaul Access Protocol Layer
- New ETSI M2M / ZigBee Interface

M2M GW Stack with ZigBee IP Interface
ETSI M2M WiFi SE 2.0 Device and Gateway Stacks

**Key:**
- Application Code Instrumented with calls to ETSI M2M API & SE2.0 Profile API
- SE2.0 Stack/Profile for WiFi with updates to support ETSI M2M Services
- ETSI M2M Application Services Layer
- SE2.0 Stack for WiFi
- Baseband Backhaul Access Protocol Layer
- New ETSI M2M / SE2.0 Interface

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**M2M Device SE 2.0 IP WiFi Stack**

- **Device Application**
  - ETSI M2M D’ App Layer
    - HTTP or CoAP
    - TCP or UDP
    - IPv4/IPv6
    - 802.11 MAC
    - 802.11 PHY

- **GW Application**
  - ETSI M2M GW App Layer
    - HTTP or CoAP
    - TCP or UDP
    - IPv4/IPv6
    - 802.11 MAC
    - 802.11 PHY

**Note:**
- Smart Energy 2.0 Profile
- Baseband Access Protocol (3GPP, DSL, …)
M2M Converged Gateway is Key

- Moving M2M Network Intelligence to the edge
- Reduces control and data traffic over the network
- Makes network scalable
• The Converged Gateway, seen as an “ETSI M2M Gateway” provides:
  – A tool that extends the reach of an M2M service provider – extend into capillary networks in a home/enterprise
  – Hierarchical integration of M2M Service Capabilities, allowing the functionality to reside closer to the involved entities while at the same time enabling optimizations in both network signaling load and data storage
  – Proxying for Network Service Capabilities and Network applications
  – Potential advanced features
    • Bandwidth and Spectrum Management
    • Enhanced Security (e.g. Security scalability, Platform validation, and Trusted Environment)
    • Media Mobility
Benefits of a Converged Gateway – At Service Layer (2 of 4)

• Real Gains…
  – Reduced Access/Core Network Signaling Load
    • Device and network registration information needs to be stored in a repository, typically located in the M2M server/core. This information can be mirrored, shared, and/or coordinated with the gateway → alleviating network signaling load
  – Efficient Management of Underlying Devices
    • Management of M2M Area Network devices by a gateway allows:
      – More efficient scheduling of management of individual devices,
      – “Bulk” management of similar devices, reducing signaling in M2M area network and access/core networks
      – Protocol translation if M2M Area Network management protocol is different from management protocol on the network side
  – Legacy device support
    • Gateways will allow ETSI compliant service layer to interact with legacy devices through an interworking unit
• Real Gains…
  – Security
    • Gateway permits group authentication, authorization, and registration, of M2M Area Network devices
    • Provides first level of “filter”ing to prevent interaction with access and core network
  – Network Selection
    • Gateway will allow selection of the optimum access network for communication to a network application. Similarly gateway will allow selection of optimum M2M Area Network parameters for communication to M2M devices
Benefits of a Converged Gateway – At Service Layer (4 of 4)

• Real Gains…
  – Device History Tracking
    • Gateway is best located to store device history for potential tracking purposes. Information can also be used to monitor device compliance to agreed profiles and to generate fault management reports.
  – Service Provider - User Experience
    • Gateway allows efficient bulk transfer through multicast and broadcast
    • Gateway will cache M2M device data for potential querying by network application. Gateway can synchronize the availability of the cached data from multiple sources → removing burden from device
    • Gateway can manage inter-M2M Area Network communication reducing network traffic over access/core networks
    • Gateway can provide user plane protocol conversion to allow M2M service to extend to constrained devices
    • Network applications can be accessed locally, bypassing need to go through M2M Server/Core
Benefits of a Converged Gateway – What’s Next?

• Converged Gateway is in a unique position as the link between the “internal” home/enterprise capillary networks and the external access/core/transport networks.

• It has access to information that can be used to provide a number of advanced services.
  - Self Organization
    • Gateway can provide M2M devices with operating parameters (bandwidth, transmission parameters, etc) → plug-n-play
  - Bandwidth aggregation
    • Gateway can provide aggregation of traffic to M2M devices across multiple wireless networks, enabled by the use of cognitive radio techniques and innovative network protocols combined with deep packet inspection → increased reliability and per-device throughput
Benefits of a Converged Gateway – What’s Next?

- It has access to information that can be used to provide a number of advanced services.
  - Interference management
    - Gateway can make use of whitespace through interaction with the TVWS (TV white space) database
    - Gateway will assign operating channels to M2M Area Networks with a focus to reducing interference
      → increases reliability and system throughput
  - Enhanced Security Features
    - Secure and trusted environment: an environment which can be trusted to perform security sensitive operations
    - Platform validation: an ability for a device to measure its “own health” and report the results to the Gateway / Core Network
    - Delegation and load balancing of traditional network-based security and device management features by using network edge components such as the M2M or Converged Gateway
Thank You for your time!
Technology Overview
(Backup Material)
Fusion Technologies Part of the Solution of Future Networks

Terminals

- User Interface
- Applications
- Connection Manager Application
- Smart Connection Manager
- Media Mobility
- Terminal Mobility (MIH)
- Bandwidth Management
- Dynamic Spectrum Management
- IP Layer
- Advanced Air Interface
- LTE Platform
- WLAN
- WPAN

Networks

- Smart Networks
- Services Enablement
- Media Mobility
- M2M
- Connectivity, Mobility, Bandwidth Management
- Bandwidth Management
- Dynamic Spectrum Management
- IP Layer
- Advanced Air Interface
- WLAN
- WPAN
- LTE Platform

Laptop, Netbook, iPad, Smart Phone, TV

Femtocell, Access Point, Home Gateway, Set Top Box, Server, Routers

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InterDigital M2M Technology Map

**Terminals**
- User Interface
- Applications
- UcanConnect
- Connection Manager
- Terminal Mobility (MIH)
- Media Mobility
- Security
- Bandwidth Management
- Smart Access Manager
- Dynamic Spectrum Management

**Networks**
- Smart Networks
- M2M Gateway & Servers
- Media Mobility
- Radio Resource Management
- Security
- Bandwidth Management
- Dynamic Spectrum Management
- IP Layer

**Cellular**
- Femtocell, Access Point, Home Gateway, Set Top Box, Laptop, Smartphones

**WLAN**

**WPAN**

**Applications**

**User Interface**

**Sensor Devices**
Enabling the Operator’s Intelligent Pipe for M2M Services

1. Subscribe/Register for alert indicating energy consumption exceeding threshold
2. Request meter reading
3. Wake up sleeping sensor nodes, request readings
4. Send meter readings
5. Send meter readings
6. Send alert
7. Adjust Thermostat

Capabilities applicable to Smart Grid, Smart Metering, Security, Appliance Control, Asset Tracking....
1. User gets multimedia call (voice and video) on phone via cellular
2. User moves to location with weaker cellular signal/high interference
3. Video is now offloaded via WLAN to phone
4. Noticing proximity to TV, user moves the media session to TV
5. As TV location has marginal coverage on both Cellular & WLAN, system aggregates video across Cellular & WLAN

- Applications: Media Sharing, Collaboration, Multimedia Calls
- Home Network
  - Media Mobility
  - Bandwidth Aggregation
  - Differentiated QoS/DPI
  - Bandwidth Segregation
- Femtocell
- WLAN

- Voice
- High-def Video
Bandwidth Management Solution Highlights

• IP layer solution to load balance traffic over multiple network connections
  – Networks of same access type, or across heterogeneous networks
  – Bandwidth allocation based on policies (operator, user) and/or network conditions

• Key features:
  – Packet inspection to determine application flow type, QoS requirements
  – Programmable policy engine
  – Bandwidth segregation: allocation of different application flows to different networks, based on policies and/or network performance
  – Bandwidth aggregation: simultaneous distribution of application flow over multiple network connections
  – Bandwidth mobility: seamless movement of application flows across network connections, based on network conditions
Bandwidth Management Solution – Key Benefits

• Bandwidth multiplying technology enabling richer, seamless multimedia experience
  – Access to increased bandwidth
  – Increased access options, flexibility in network selection
  – Allocation of right bandwidth to right application at right time
  – Operator-controllable offloading of traffic from licensed -> unlicensed spectrum
  – Load sharing, load balancing among multiple network connections
  – Reliable, interference-robust support of high data rate applications
Network architecture flattens

To the users, the network disappears

Media is network agnostic

Media moves seamlessly, between devices and over networks

Media is context-optimized for network bandwidth, device capability, power, cost, etc.