



Project Results

# M2MGrids

Enabling novel opportunities in cyber-physical ecosystems

## EXECUTIVE SUMMARY

The ITEA project M2MGrids focused on developing enablers to create a dynamic cyber-physical information business ecosystem that connects the physical world with the business processes of companies in real-time.

## PROJECT ORIGINS

A critical grand challenge of cyber-physical systems is related to vertical silo type development in M2M industries that hinders the development of smartness and interoperability for cyber-physical systems. Therefore, a shift from use of vertical towards more horizontal capabilities, and from offline data analysis towards online operation based on more smart autonomic information has been targeted. The specific R&D focus on the selected business cases dealing with energy flexibility and smart mobility required horizontal capabilities and architectures for enabling smartness and interoperability.

The project developed a horizontal M2MGrids architecture framework, with a set of novel horizontal capabilities related to information models, algorithmic operation, stream processing, communication overlays, security, and specific capabilities of horizontal platforms enabling embedded products to be part of the cyber-world. These novel capabilities were evaluated in use cases of the specific markets, such as the energy sector (residential energy consumption monitoring and optimisation, and energy-sensitive household appliances) and mobility sector (wearables, sports and wellness).

## TECHNOLOGY APPLIED

The proposed solutions demonstrated the key elements of the visionary M2MGrids use case story, related to future energy flexibility and smart mobility in emergency situations. The energy flexibility part of the demonstration included an



*M2MGrids achievements have opened significant novel opportunities and business impacts in energy flexibility, smart mobility and horizontal businesses in the context of cyber-physical systems*

evaluation of the World-Wide Streams (WWS) horizontal service platform developed by Nokia Bell Labs. In the demonstration, WWS acted as a key horizontal enabler for the energy flexibility service for balancing the power level and reduction of the peak loads in the distribution grid. The flexibility service operated with a number of essential capabilities: DSO network state monitoring and congestion detection (Technolution, TargetHolding, Alliander), balancing and local energy market service (Empower), scheduling of resources for aggregator services use (Gacad), external aggregator of simulated energy resources of Electric Vehicles (EVs), buildings and local distribution grid (VTT), energy flexibility interface (EFI) with household resources (TNO), EFI capable Gateway for white goods (Arçelik, KoçSistem), and EFI based operation with EVs (Eteration).

The smart mobility part of the demonstration included an evaluation of the virtual CPS communication hub (realised by VTT), which

enables mobile embedded products and services of multiple stakeholders to horizontally interact and exchange information in a controlled and secure way. This CPS hub facilitated interaction between resources like a smart watch (Polar), small size air quality monitoring sensor (Imec), wearable platform for health monitoring & analysis service (Bittium), street lamp (Valopaa), animal tracking products (Tracker), 3D camera (Sony), crime announcement service (LiveU), and Safax authorisation service (TU/e). In addition, the CPS hub was the key enabler of the interaction with Nokia WWS, energy market service (Empower), external aggregation of simulated energy resources of EVs, buildings and local distribution grid (VTT).

## MAKING THE DIFFERENCE

M2MGrids has created significant impact in energy, mobility and horizontal businesses in terms of technical R&D, dissemination, standardisation and exploitation in the form of novel products and services by several companies.

The Nokia WWS platform is now being deployed with energy business partners and Arcelik was first to introduce new automated demand/response compatible household appliance products. In addition to contributing to energy flexibility interface (EFI) standardisation in CEN/CENELEC, EFI and OneM2M capable gateway for households, the project results facilitated Bluetooth standardisation for long range, mesh networking, and 6lowPan over LE for expanding Bluetooth towards IoT as well as the next generation IoT platform of Nokia, the reference design of a miniaturised sensor node, a horizontal wearable reference design with RTOS (real-time operating system), Safax authorisation service, CPS communication hub and a complex event processing engine for big data.

Among the partners to have exploited the project's results are e.g. the Finnish companies Bittium, whose wearable platform for health monitoring enables the customisation of unique, purpose built products, and Tracker, whose low-power development platform will enable the development of new products, applications and services such as monitoring, tracking or control assets or environment. In the Netherlands, Imec has taken

advantage of the project's work by producing an Air Quality Monitoring Platform that provides real-time monitoring/accessing of the sensing data along with data storage in the cloud. Technolution has developed a sensor prototype for energy sensing, which shows clear market potential and interest from multiple distribution system operators faced with the challenges of the energy transition.

Turkish partner KoçSistem exploited the results to enable energy management of adaptive demand-supply household and industry devices while Eteration, another Turkish partner, developed a Complex Event Processor that manages real-time events within big data according to the execution plans and can run in embedded gateways and high scale cloud environments. Israeli partner LiveU is now developing services for the consumers and the security authorities on the back of M2MGrids and, in so doing, opening significant market opportunities, having won a tender for the 2020 Olympic games with the Japanese police department and collaborating with Associated Press on a new live video exchange newsgathering platform: AP Live Community, an app based on M2M.

## MAJOR PROJECT OUTCOMES

### Dissemination

- 56 publications (e.g. Frontiers in ICT, ACM SIGCOMM, SIGMOD, SCAMAT, & DEBS, SSCI, PODS, SPASH/REBLS, Systems, IEEE SSCI, IEEE/WIC/ACM, IEEE GIIS, ISAMI, ICISS, ANAC)
- Several presentations, posters and demonstrations in conferences and customer events (e.g. EPIA, ACM DEBS, DBDBM, Erlang, QTWorld summit, Flexcon, CoreDemo, ACAN)

### Exploitation (so far)

- New products, e.g. small size air quality monitoring sensor and network, smart electric car dashboard, energy sensor, WWS for Cloud streaming products, smart watch/wearable reference design/platform, smart watch with wireless beacon for smart lighting, T-IDE development platform for embedded systems, EFI and MQTT gateway for energy management system, event processing for cloud native services, transparency service for access control, mechanism selection in complex negotiation, crime announcement application, scalable CEP engine
- New services, e.g. EFI supported gateway for white goods, smart grid gateway service for grid devices, animal position data sharing, automatic animal alarm, safety feature for hunters, Safax authorisation service
- New systems: Safax authorisation service, CPS communication hub, Bittium Medical analysis cloud, Tracker 2020 century product platform, electricity request nowcasting, policy alignment service, authentication and authorisation system

### Standardisation & Patents

- Energy flexibility interface (EFI) standardisation in CEN/CENELEC
- Bluetooth standardisation long range, mesh networking, and 6lowPan over LE for expanding Bluetooth towards IoT
- Application of a large number of standards from such forums as e.g. IETF, W3C, OMG, OneM2M, ETSI, ISO/IEC, IoTa, IIC, and ITU
- More than 10 patent applications

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## M2MGrids 13011

### Partners

*Belgium*  
Nokia  
SoftKinetic  
Spikes

*Israel*  
LiveU  
Starhome

*Finland*  
Aidon  
Bittium Wireless  
Empower IM  
Polar Electro  
Tracker  
Valopaa  
VTT Technical Research Centre of Finland

*Netherlands*  
Alliander  
Delft University of Technology  
Eindhoven University of Technology  
Imec  
Neroa  
Target Holding  
Technolution  
TNO

*Portugal*  
Evoleo Technologies  
ISEP/IPP-GECAD  
ISQ

*Turkey*  
Arçelik  
Eteration  
KoçSistem  
Phaymobile  
Vektor Telekom

**Project start**  
November 2014

**Project end**  
May 2018

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