Energy@home

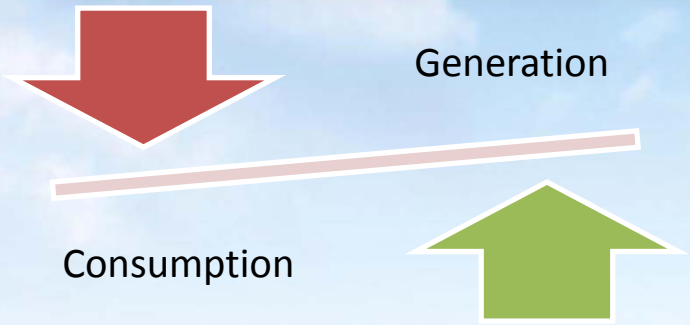
Energy@home contribution to the definition of an european ontology for smart appliances, as an enabling factor of electrical system flexibility

Summary

- How Demand Response could contribute to electrical system flexibility ?
- Energy@home association
  - Vision & governance
  - Achievements so far
  - What is next
- Technical Approach
  - Flexibility Architecture
  - Standards for Flexibility Management
  - Energy@home approach to a standard based solution
    - How SGAM could help to achieve systems interoperability
    - Data Model *(SGAM-Information Layer)*
      - Why a CIM based solution for the customer domain ?
      - Why a SEP2 based solution ?
      - Energy@home contribution for an European Smart Appliances Ontology
    - Communication Protocol *(SGAM-Communication Layer)*
  - Conclusion

How Demand Response could contribute to electrical system flexibility ?

The need of electrical system flexibility



"On an individual level, flexibility is the modification of generation injection and/or consumption patterns in reaction to an external signal (price signal or activation) in order to provide a service within the energy system" (*)

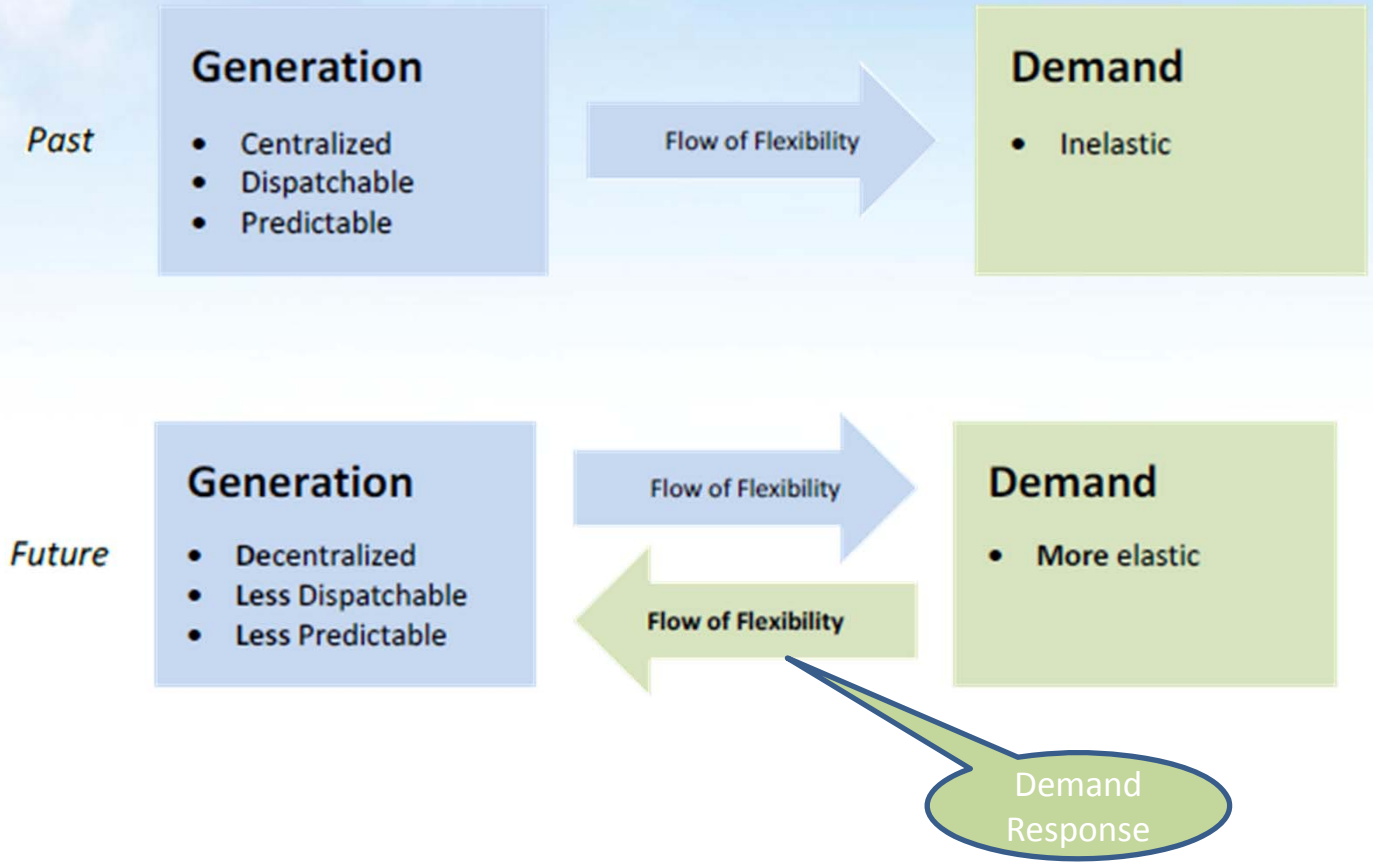
Why Grid needs more flexibility:

The European Commission's 2030 policy framework for climate and energy aims at decarbonising the energy system and implies an **enhanced need for system flexibility** in order to accommodate:

- the increasing variable renewable energy share
  - that is less predictable and more complex to plan, control, and balance
- the growth of electrification (see electric vehicles and heating pumps)
- and to mitigate the potential problems of ageing infrastructure (i.e. deferring investments)

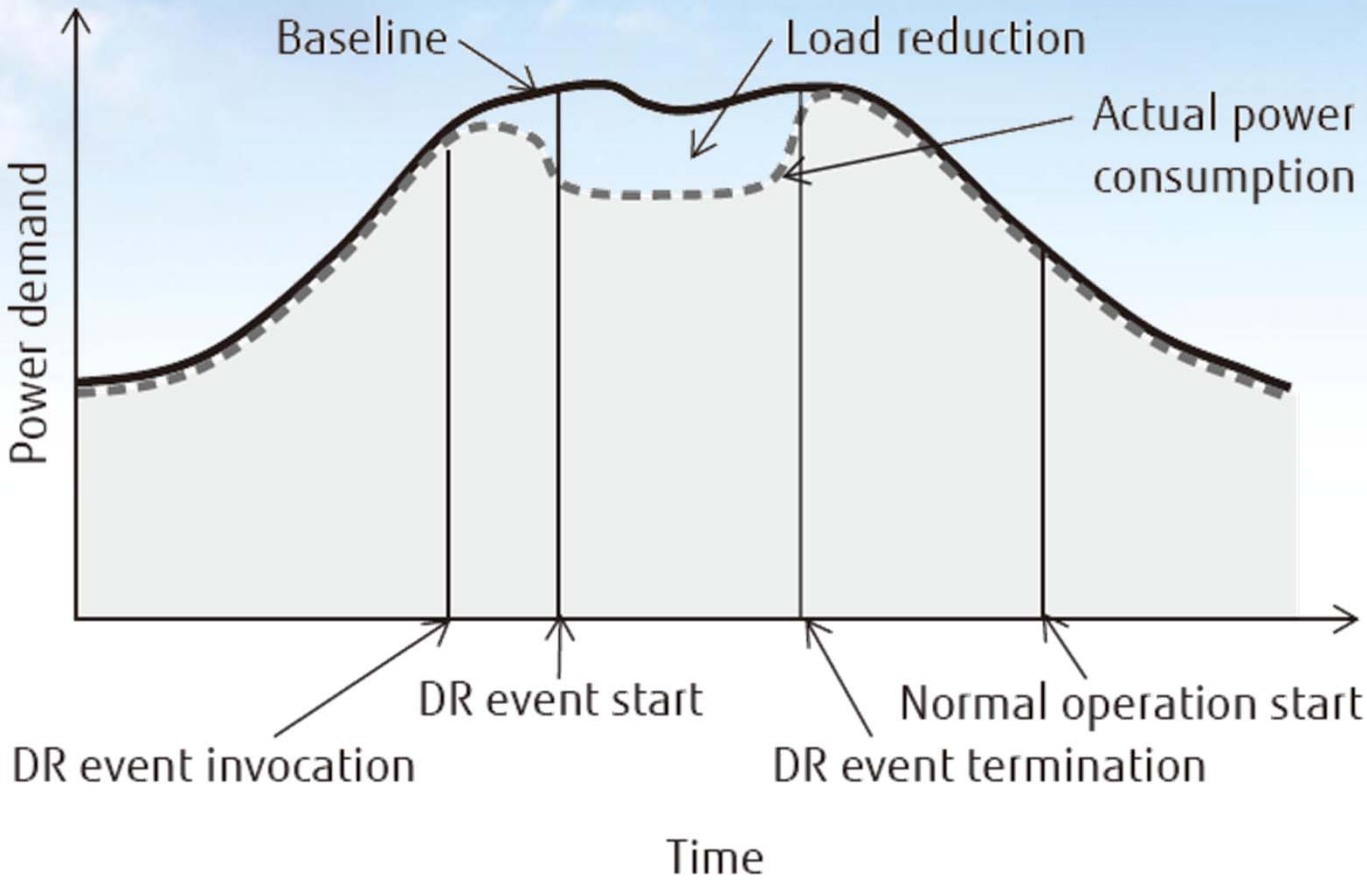
(*) Eurelectric, Jan 2014

From one to two way flow of flexibility (*)



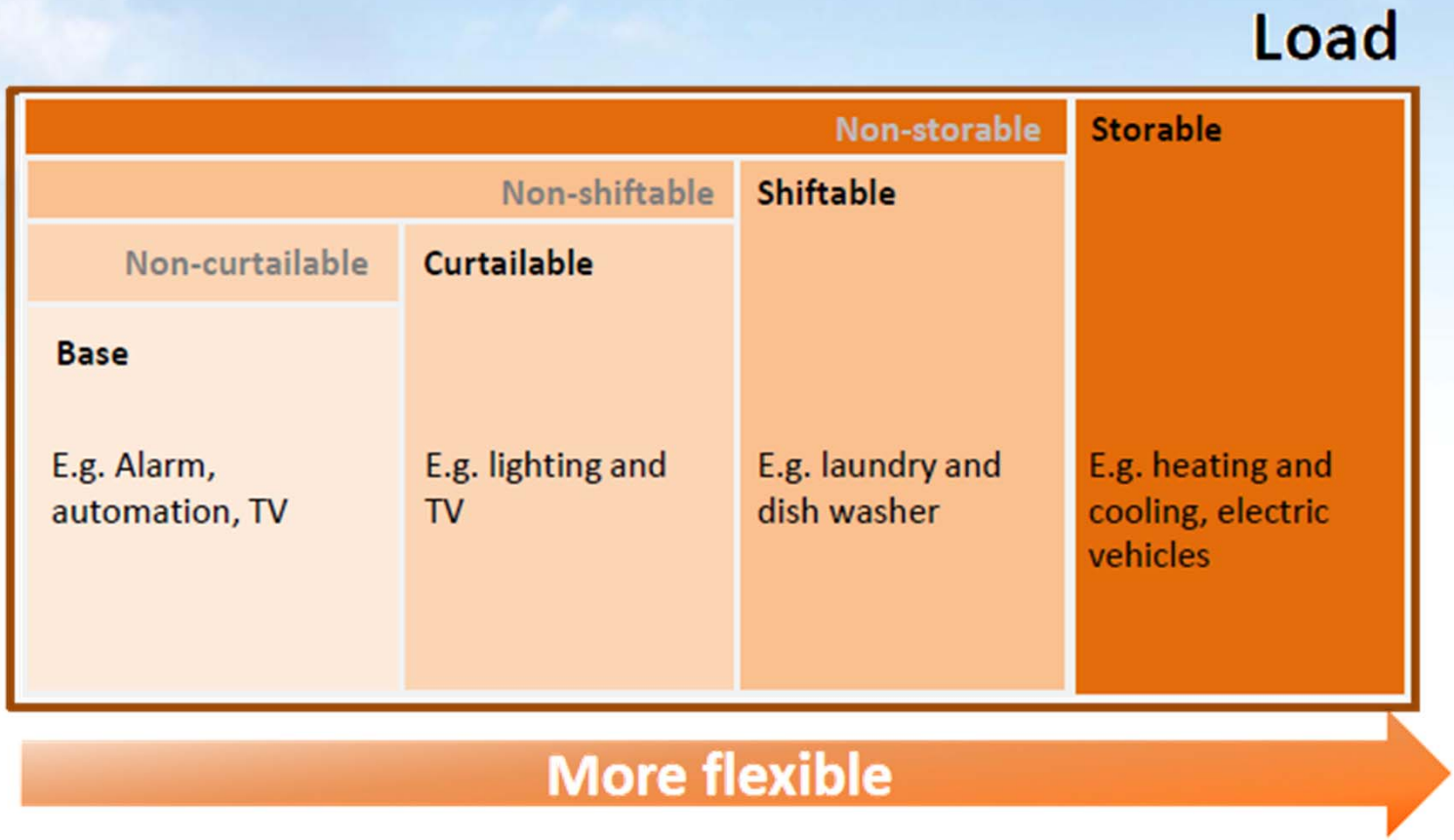
(*) Source: FP7 project Think

Impact of a real time Demand Response Event on load curve(*)



(*) Source: FUJITSU Sci. Tech. J., Vol.50 No.2

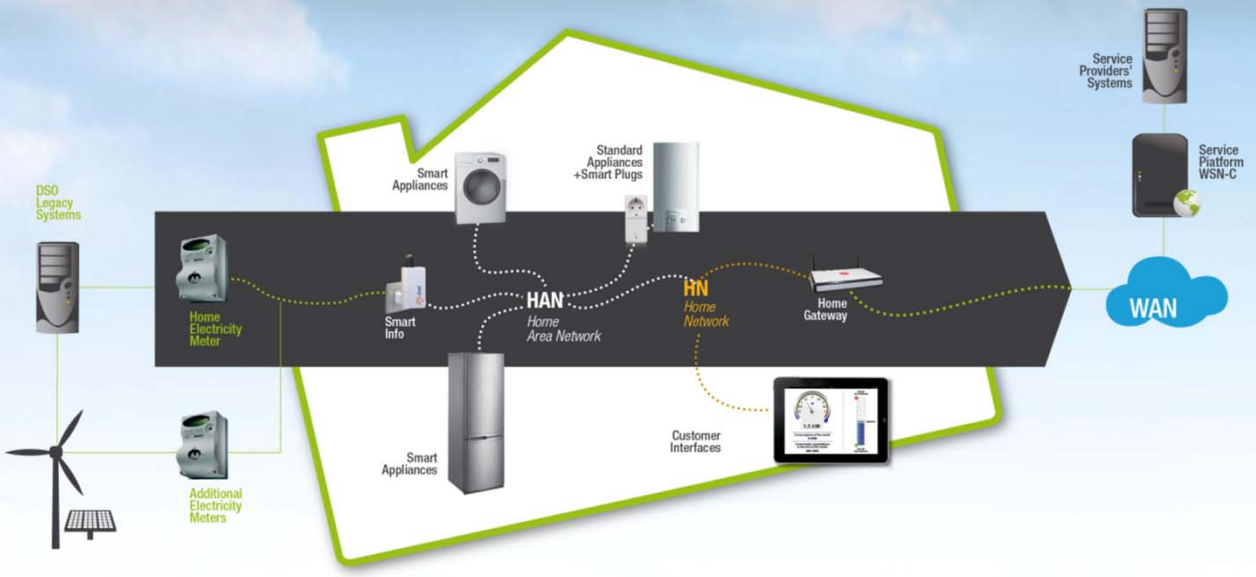
Different kind of demand side contribution to flexibility (*)



(*) Source: FP7 project Think

1. **Vision & governance**
2. Achievements so far
3. What is next

Vision: consumer's flexibility can be managed and valued



All customers have a degree of demand side flexibility

- in time, in power, in energy

Flexibility can be managed to adapt & locally optimise the demand

- Pricing (time of use, critical peak, real time), contractual power, self-consumption

Flexibility enables also Customer 2 Grid Value Added Services

- to increase grid quality and grid reliability and to reduce balancing costs

Home Energy Management can exploit the Smart Home service provisioning infrastructure

Smart Grid & Smart Appliances: Energy benefits evidence

MDA's account for ~43% of the residential electricity consumption
They can provide flexibility in the way and timing they can be used

REFRIGERATION

- Pre-cooling prior to peak
- Optimize defrost to run it during off peak

LAUNDRY

- Delay start: remote auto start for laundry cycle to off peak hours
- Dryer – short delay and/or power down heating element

CLEANING

- Delay start: remote auto start for laundry cycle to off peak hours
- Short delay and/or power down heating element

AIR COND

- Auto set from cooling to dehum
- Reduce power during peak hours
- Suggest settings

WATER HEATER

- Plan water heating based on tariff and energy availability
- Reduce power during peak hours

A set of standard Use Cases and a standard Data Model is required

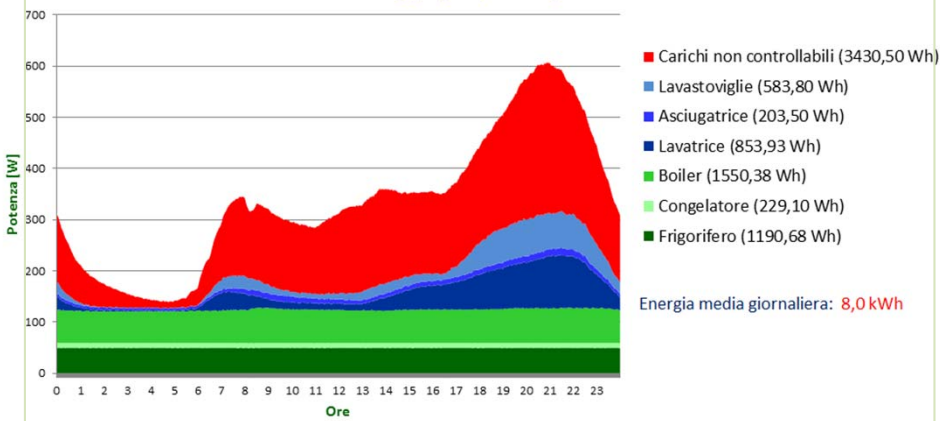
Energy@home

(courtesy of CECED Italia)

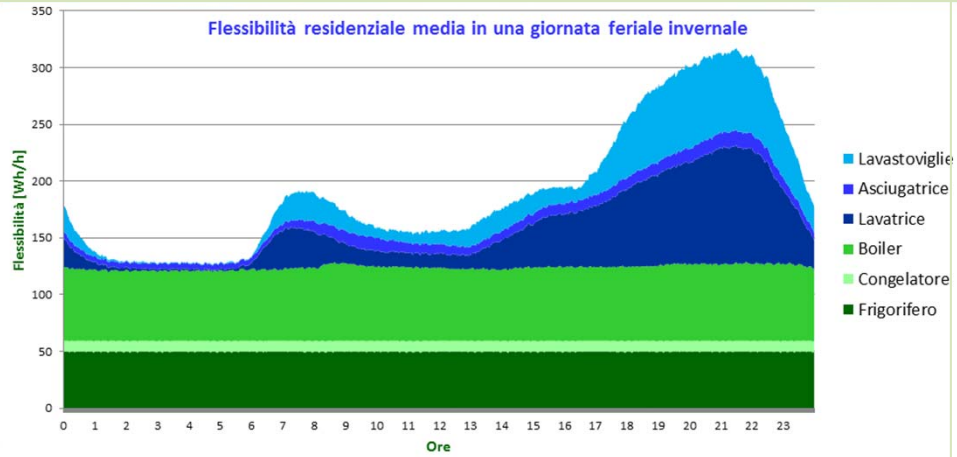
Analysis of the demand flexibility of an Italian residential customer

Bellifemine, Bella (Telecom Italia) – Gallanti, Maggiore (RSE), to appear on: L'Energia Elettrica, August 2014

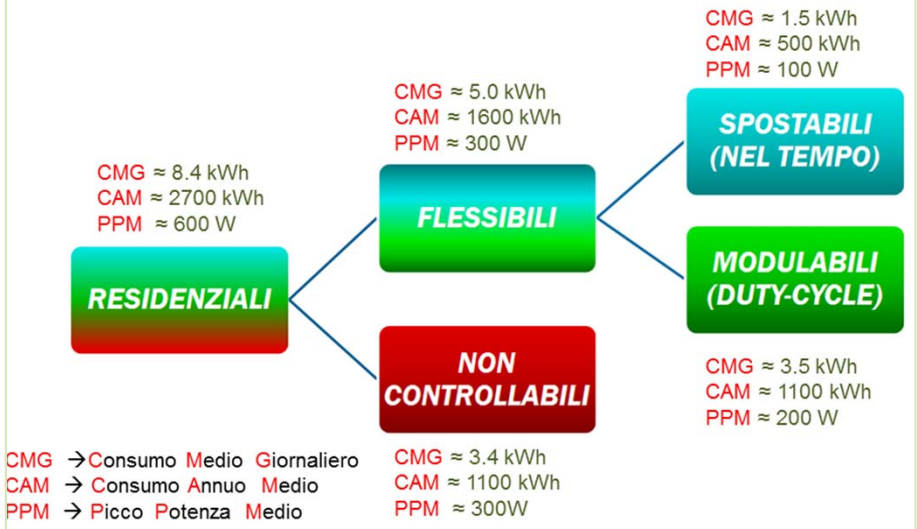
Disaggregated Load Profile (data from 1000 customers)



Demand Side Flexibility



60% of the energy demand is flexible!



What if 20 Million customers…

- 6 GW of flexibility between 19:00 and 21:00
- 2.4 GW of flexibility over all 24 hours
- 100 GWh/day of flexibility

Energy@home Association

Non-profit Association founded on July ’12.
22 members so far

Scope: demand side management & home energy efficiency, not limited to the italian market

Goal: create a market for new Value Added Services based upon device-to-device communication and demand side management

Approach:
Open and International Standard, value networking through industries, trials & regulations

Organization of the activities

Board of Directors

- Fabio Bellifemine, Telecom Italia, Director
- Sergio Brambilla, Enel D, Secretary & Treasurer
- Stefano Frattesi, Indesit Company
- Nicolas David, Electrolux
- Lorenzo Montelatici, Edison
- Davide Cabri, Whirlpool

Paola Petroni, ENEL D.
Honorary Chairman

General Assembly
(all member companies)

Working Groups

Standard
A. Ranalli,
E. Arione

Use Cases
S. Di Carlo

Policies & Regulations
E. Molinari

Reference Implementation
R. Tomasi

1. Vision & governance
2. **Achievements so far**
3. Next steps for 2014 and beyond

Main achievements so far

ZigBee Home Automation 1.2

- acknowledges Energy@home in standard, press release & public webinar
- Integrates Energy@home use cases and technical specifications
- Energy is just 1 of the services of the Smart Home

Prototype system

- Integrates 11 different devices and systems from E@h partners/off-the shelf products
- Presented at EU Utility Week, M2MForum
- Permanent demo at ISMB and Telecom Italia premises

Open Source

- ZigBee Gateway
- Sw of the client side
- Java for OSGi

Trials

- 5 trials in Europe, one is in Italy

Regulations

- acknowledged contributor to CERRE report on Smart Metering (Centre on Regulation in Europe)
- acknowledged in DCO 232 of Italian Authority on user awareness
- Contributor to Confindustria cost-benefit analysis

Energy@home *adapts and adopts* International Standards

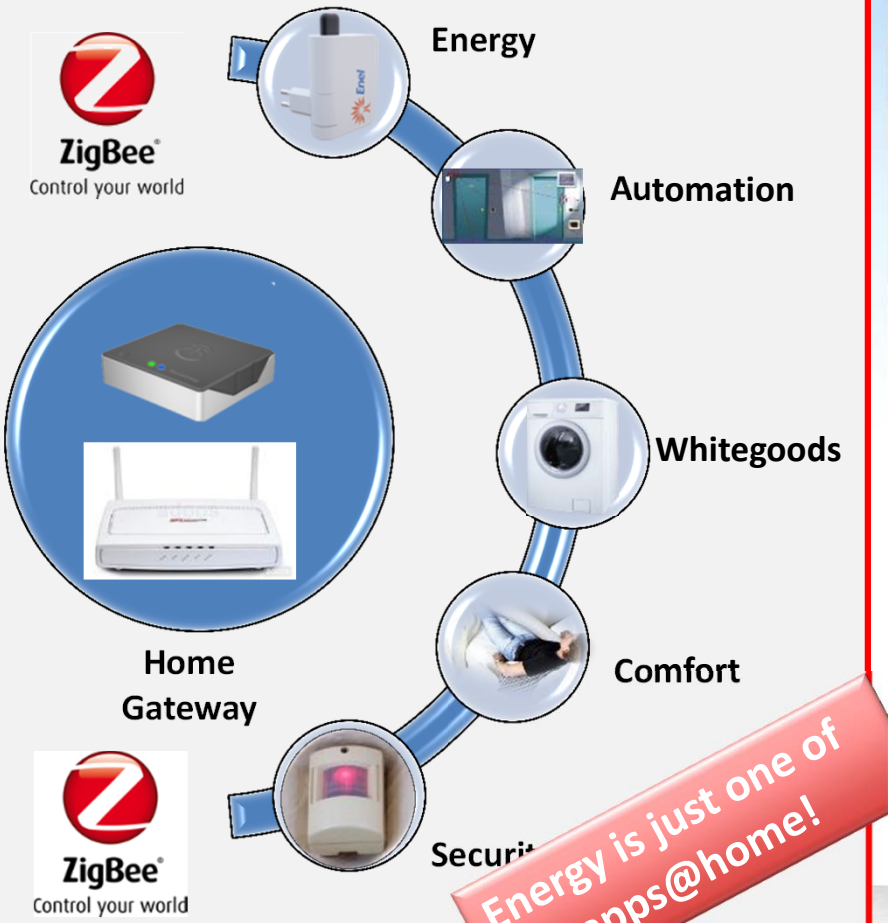
On Jul. 2011, Energy@home and ZigBee Alliance signed a collaboration agreement that brought on July 2013 to the ZigBee Home Automation 1.2 standard

ZigBee Alliance:

- 400+ member companies (40% Americas, 30% EMEA, 30% Asia)
- 800+ certified products

Market leader with most deployed low power wireless mesh standard

A plethora of services can be based upon the same service provisioning infrastructure: communication standard + home gateway + cloud



White Goods: Power Profile and Appliance Control Data Structures

Appliance Identification

- Manufacturer, Brand
- Product Type
- CECED Specification Version

Appliance Control & State

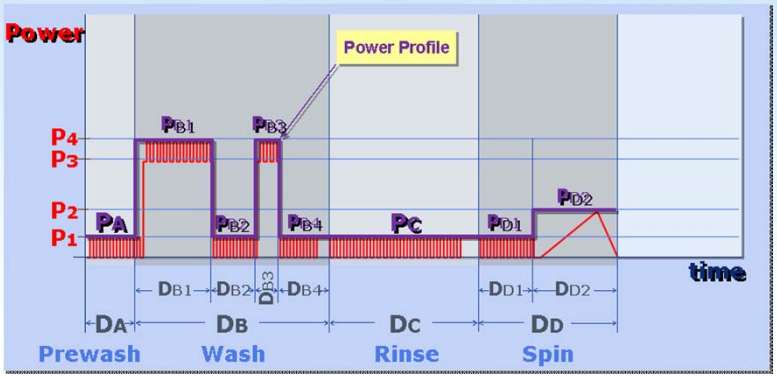
- EN50523 Signal States
- Selected Cycle and Current Phase
- Duration & Remaining Time To End
- Start and Finish Time

EN50523 Appliance Events

- Faults
- Warnings

Appliance Statistics

- Statistics about usage



Power Profile

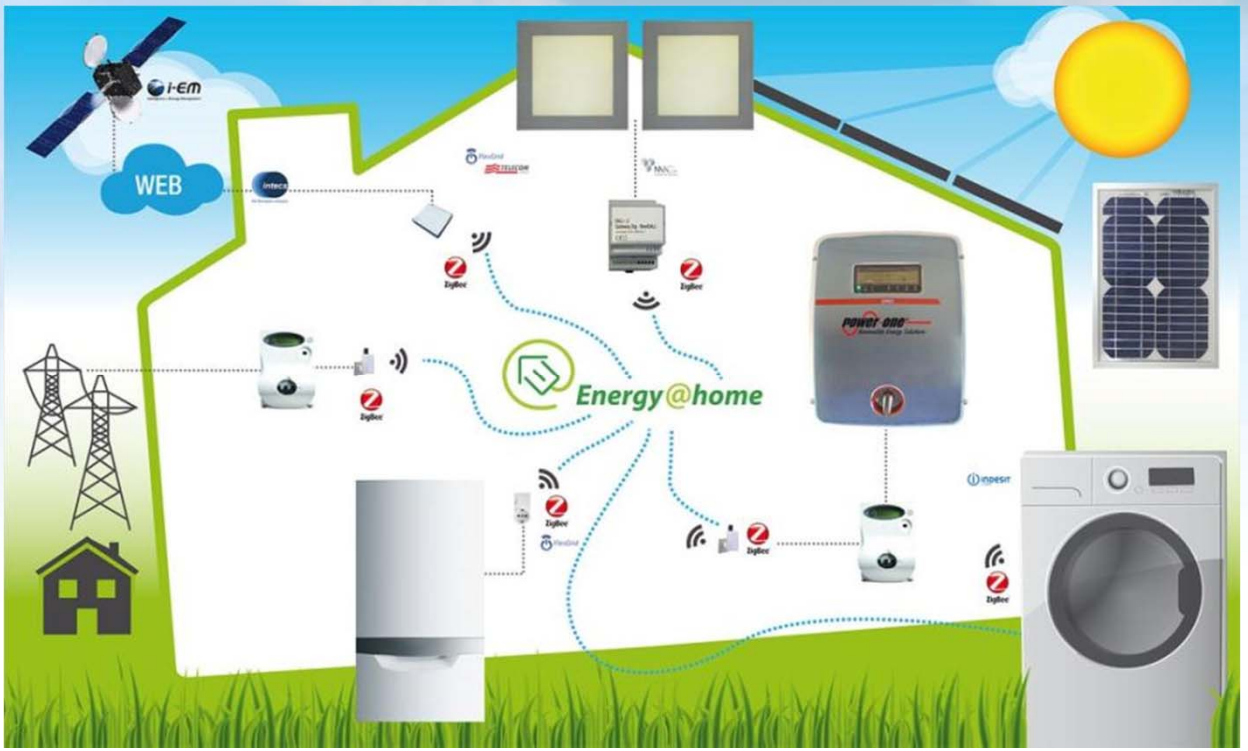
- Sequence of electrical loads activation / deactivation (Power phases); basic "uninterruptable" elements:
  - ✓ Expected duration
  - ✓ Peak Power consumption
  - ✓ Maximum activation delay
  - ✓ Expected Energy consumption
- Sequence of Power phases -> Power Profile

No more monolithic cycles

Extension of Power Profile to Cyclic Appliances is ongoing

Energy@home

Energy@home demonstrator



- Integrates devices and sub-systems from 11 different vendors
  - Gateway, smart meter, inverter, whitegood, thermostat, lights, smart plugs, temperature sensor
  - Cloud platform, gateway sw environment, PV forecast system
- Permanent demo at Telecom Italia and at ISMB premises

European Utility Week
15-17 October 2013 • Amsterdam • The Netherlands
www.european-utility-week.com

m2m FORUM 2014
since 2002 the premier M2M matchmaking event
Milano
20 Maggio 2014
XIII edizione

JEMMA Open Source Project

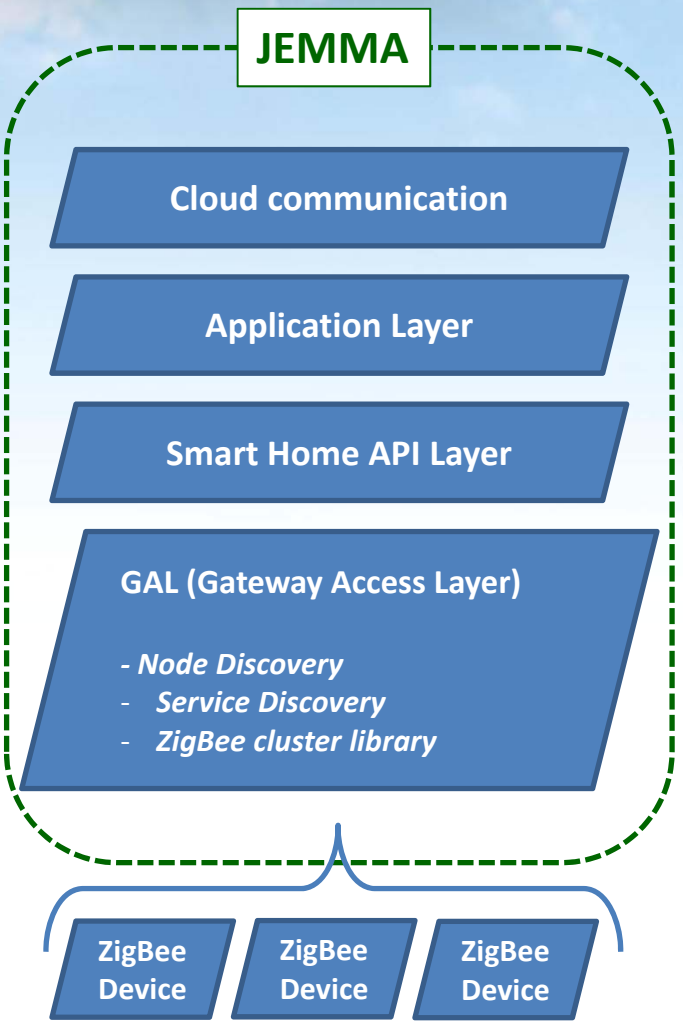
JEMMA (Java **E**nergy **M**anage**M**ent **A**pplication Framework)

Implements the Energy@home Technical Specifications and the Energy@home gateway application

Implements the ZigBee Home Automation 1.2 standard and the ZigBee Gateway Device standard

Copyright Telecom Italia, available under LGPL License

It is on github at
http://jemma.energy-home.org



Energy@home trials in UK & Netherland

Enexis Jouw Energy Moment

What: time-of-use tariffs and green energy
Size: 380 Indesit washing machines
When: August 2012 -> December 2015

Power Matching City

What: Grid imbalance reduction, smart appliances match their energy use in real time, depending on the available renewable generation
Size: 25 Indesit washing machines
When: May 2014-> December 2015

Thinking Energy in UK

What: Customer energy awareness and flexibility
Size: 25 Indesit washing machines
When: May 2013 -> Summer 2015

British Gas in UK

What: smart tariffs in 2 groups of customers (ToU vs Demand-Response)
Size: 165 Indesit washing machines
When: March 2013 -> December 2014

Energy@home

Energy@home Italian trial

56 users in Italy (20 have a PV plant)

User functionalities:

- Awareness:
  - monitoring (kWh, stand-by, €)
  - aggregated reports
  - social comparison
- Automatic scheduling
- Overload warning

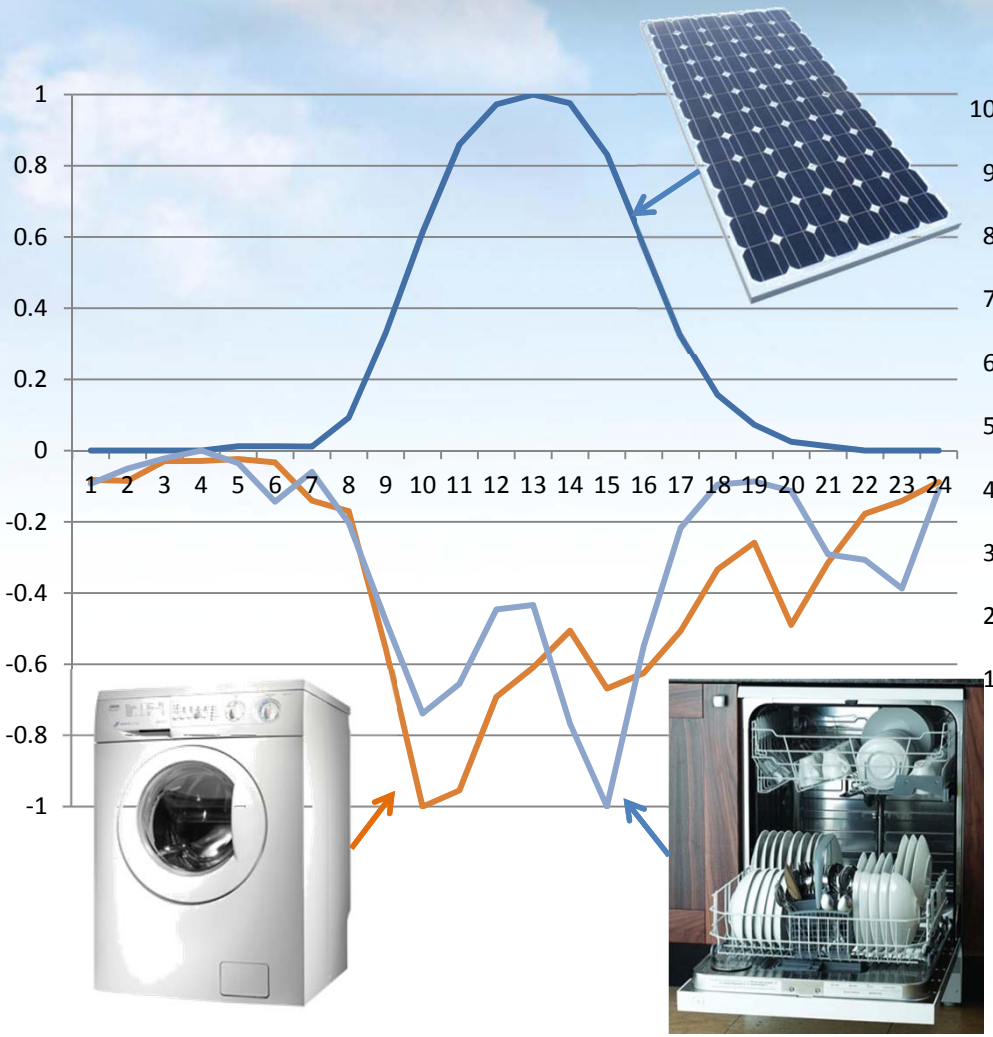
LIKE

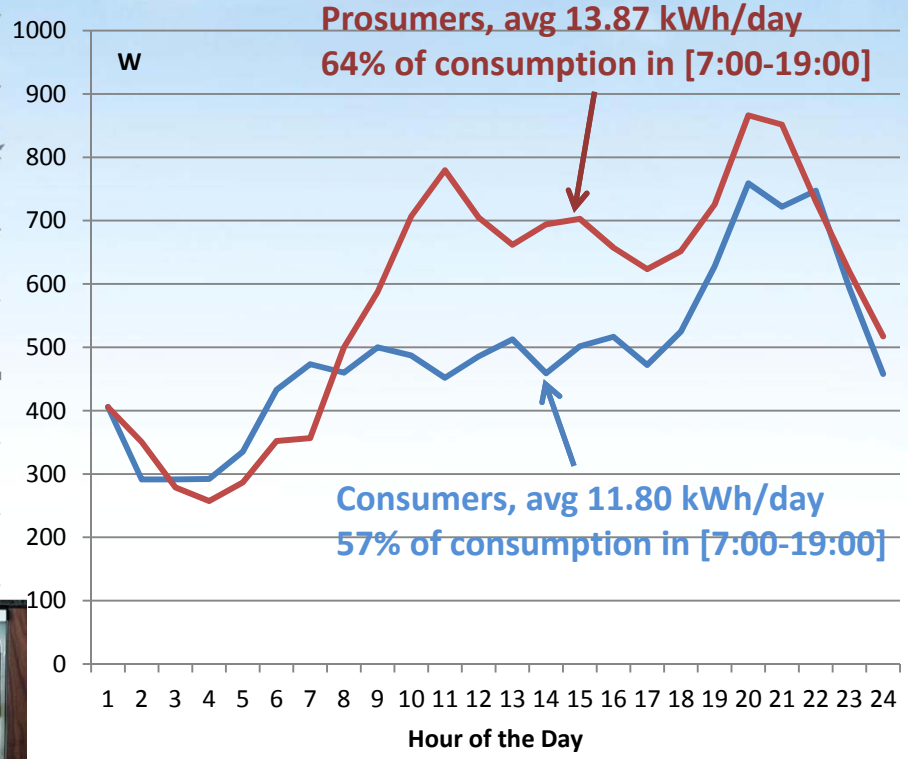
- 9% avg energy saving
  - at country level means 5.6 TWh, ~ 3 M tons CO2
- 5% energy shifted to off-peak hours
- 15% reduction stand-by consumption
- Social comparison as a benchmark
- Smart Info, Smart Appliance, Smart Gateway

DISLIKE

- Automatic decision systems are required!
- Smart Plugs
- More smart home services are expected

Prosumers synchronize main loads with the generation curve

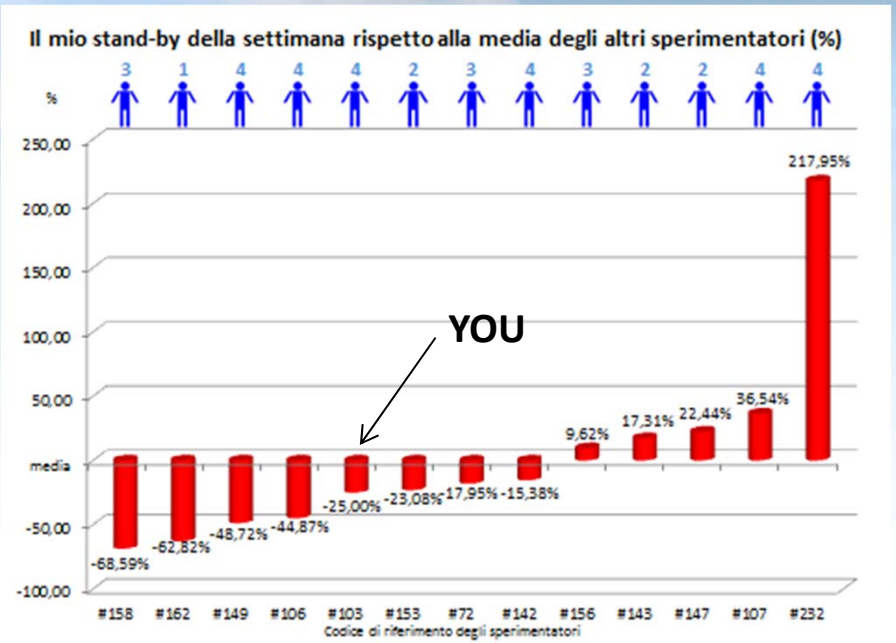




PV: data averaged over 20 users
No-PV: data averaged over 30 users

Energy@home

Analysis of Occupant Behaviour: Data & Gamification



«the verdict was very cruel to me given that **only a family with four members has consumed more than me**, […] and all the other trialists have consumed much less than me»

«**I am satisfied when seeing the other participants' consumption because I am in the middle of the ranking**, of course I would be pleased to further improve my position»

«**I am very satisfied that my fridge has the least consumption**: it is an A+ class and I bought it very recently»

«I understood that I could use the quick program of the dishwasher every 2 days and save 25€»

«I'm pleased this week I saved 3.84 KW/h in respect to last week: a small quantity but it's a good start»

«I discovered where I have a large consumption: it is the fridge!»

«Thank you for the info. I suspected stand-by consumption impacted but I had no idea how much»

Energy@home

23

Energy@home implementa una delle soluzioni riportate nel DCO 232/2014/R/eel di AEEGSI di Maggio 2014

Il DCO investiga le «opportunità tecnologiche per la messa a disposizione dei dati di consumo di energia elettrica ai clienti finali in bassa tensione»

- chiede opinioni in merito a 3 soluzioni tecnologiche:
  - A. Aumento della frequenza di acquisizione dati del normale ciclo di tele-lettura
  - B. Acquisizione dati tramite dispositivo del DSO posto in casa del cliente (Smart Info)
  - C. Acquisizione dati tramite il lampeggio led sul misuratore

I risultati del trial Energy@home sono riportati ad evidenza dei saving generabili dalla tecnologia

I prossimi passi previsti dall'Autorità prevedono:

- La formulazione degli orientamenti per la messa a disposizione dei dati, in relazione alle disposizioni contenute nel D.Lgs di recepimento della Direttiva 2012/27/UE
- La formulazione di proposte di regolazione NON tariffaria per la copertura dei costi dei dispositivi collegati al misuratore tramite la linea BT
- L'avvio di un procedimento in tema di funzionalità della «seconda generazione» di misuratori elettronici per superare il «vincolo proprietario»

1. Vision & governance
2. Achievements so far
3. **Next steps for 2014 and beyond**

Next Communication Events (planned so far)

European Utility Week
the grid & renewables | energy storage | smart metering ict & grid security | smart homes end-users & cities | smart water
4 - 6 November 2014, Amsterdam, The Netherlands
STAND 4.G20

- Common stand Energy@home, Agora and EEBus
- Common Demo: Energy Efficiency Use Case
- Shows interoperability based on data model
- Amsterdam, 4-6 Nov 2014

- ZigBee Smart Homes Day
- Venice, 17th Oct 2014
- Demonstrator + Speech

Smart Home Hackathon
Torino, 21-23 Nov 2014
in collaboration with i3P

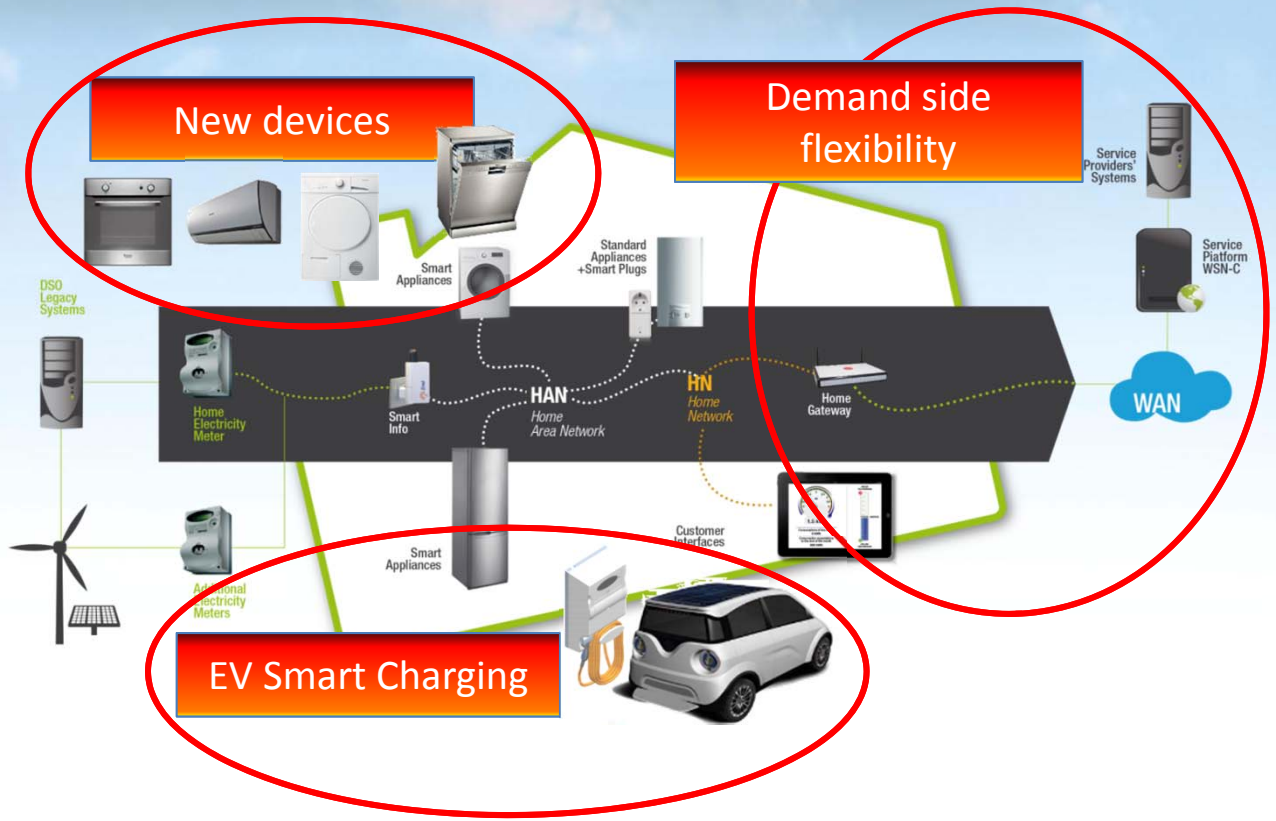
Incubatore Imprese Innovative Politecnico Torino

- Competition between startups & sw developers
- Prize for the 3 best ideas
- Requires integration with JEMMA

- Designing with Freescale
- Milan, 1st Oct 2014
- Demonstrator
- Opening Speech

Energy@home: what's next

- EU Smart Home Ontology (in collaboration with EEBus, Agora & DG Connect)



- Integration of new devices (storage, heating pumps, …) & EV Smart Charging
- Trial of Real Time Energy Pricing schemes
- Specs & Regulations for Active Demand & Demand side flexibility

The path towards FlexibilityAsAService goes through a number of incremental steps

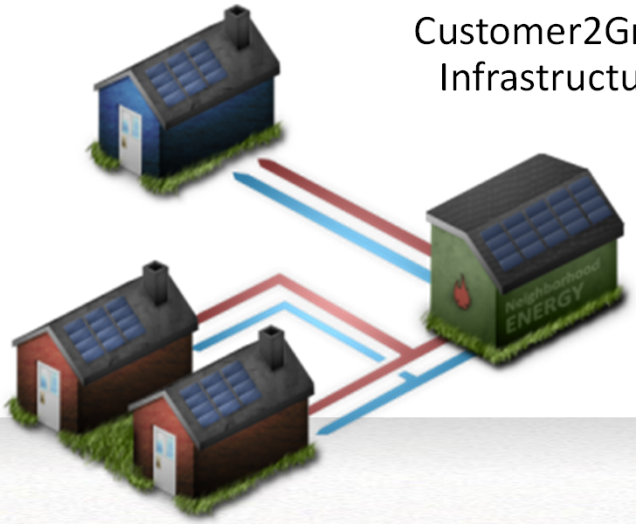
Local infrastructure

Tools for User Awareness

Tools & Methods to Drive and Motivate changes in user behaviour

Automatic system (requiring no user intervention)

Customer2Grid Infrastructure

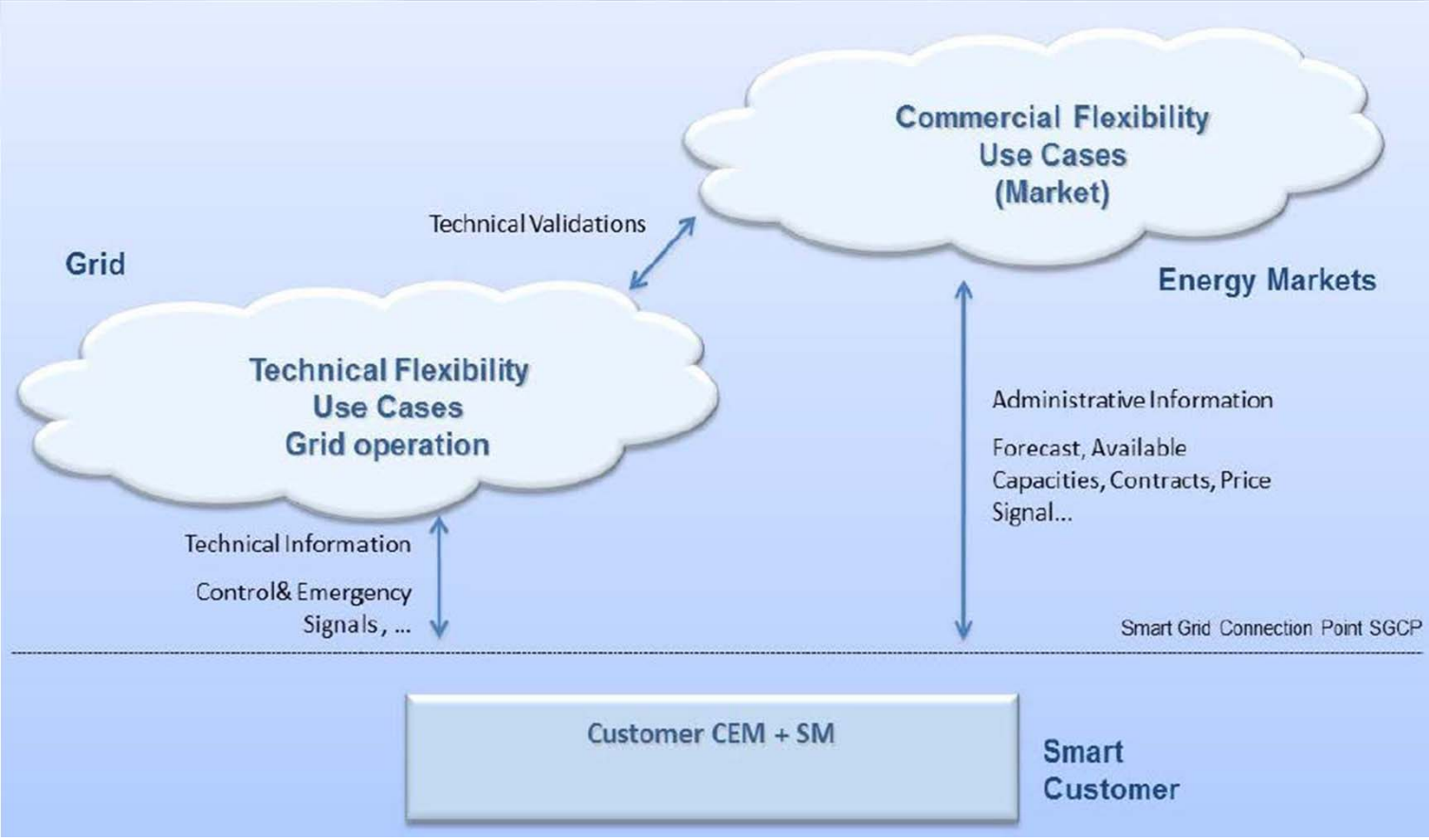


Flexibility as a service

Technical approach

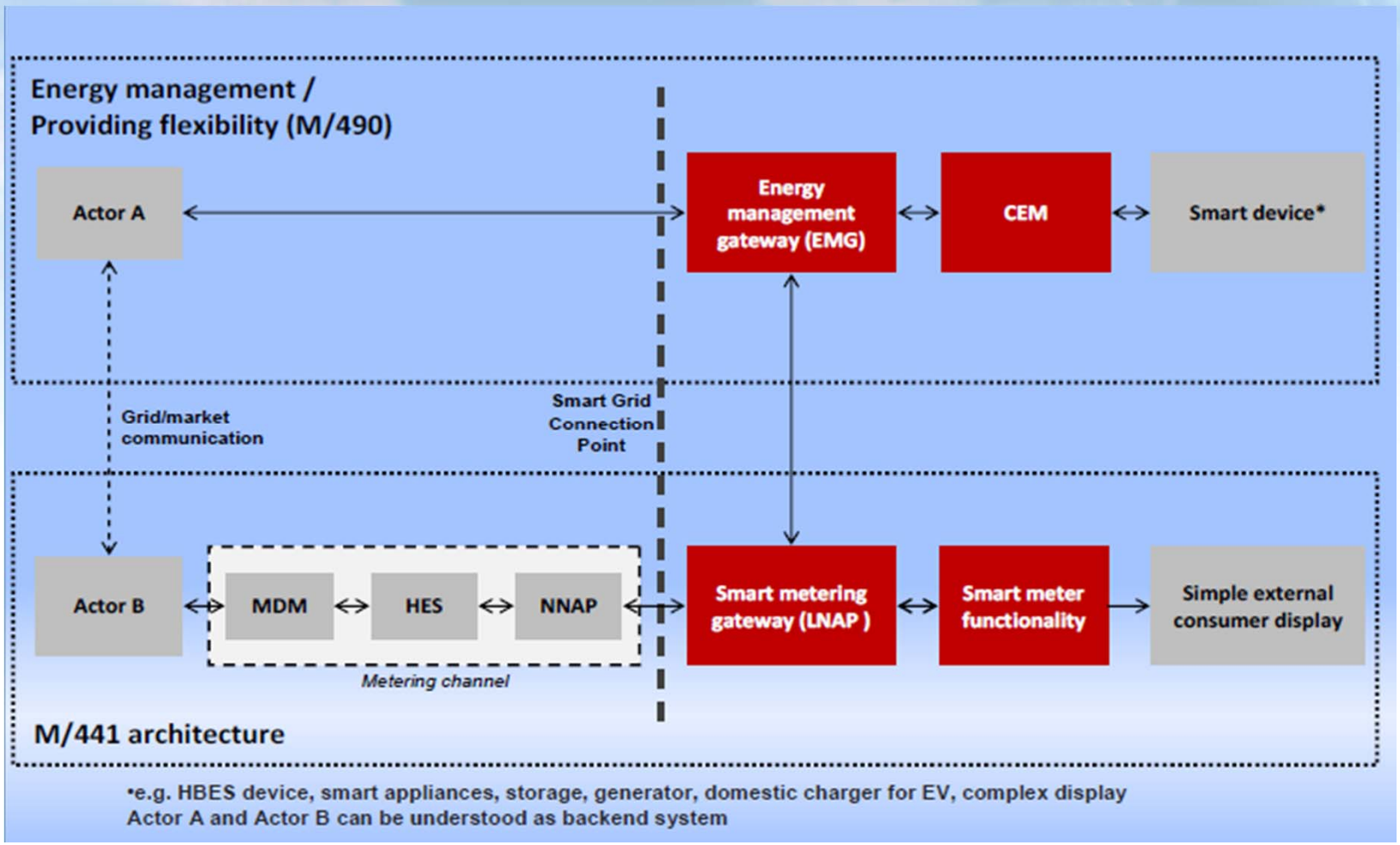
Flexibility Architecture

Commercial and technical Flexibility use cases (*)



(*) Source: Smart Grid Coordination Group for the M/490 Mandate
"Smart Grids Methodology & New Applications WG"

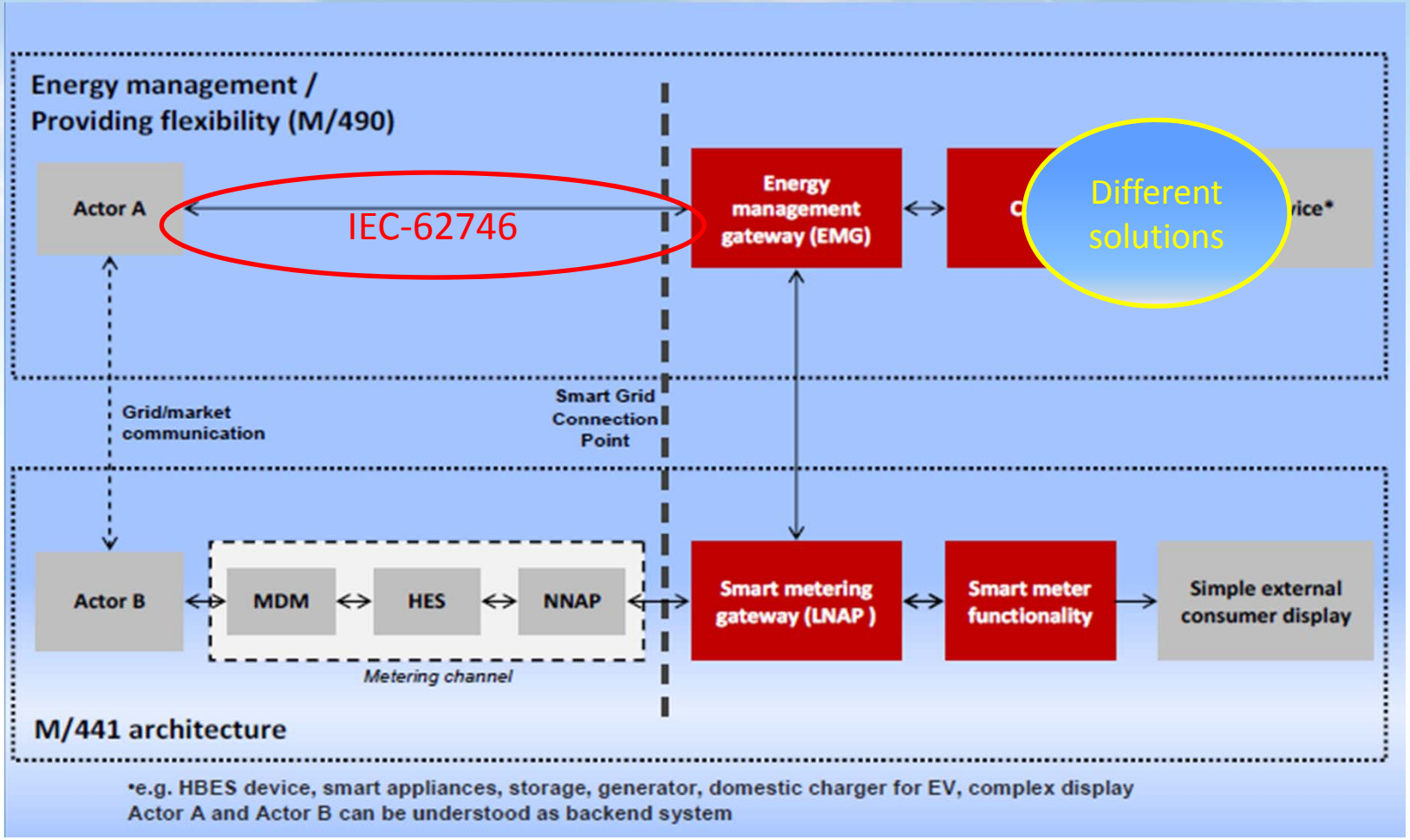
Flexibility functional architecture (*)



(*) Source: Smart Grid Coordination Group for the M/490 Mandate
"Smart Grids Methodology & New Applications WG"

Standards for Flexibility Management

Flexibility standards



Development process of IEC 62746 standard (*)

- The IEC 62746 standard for interface between “Grid” and “Active Customers” will be based on current OpenADR 2 specifications (**)
- Contemporary , the current CIM Model will be extended based on Use Cases associated with the “Grid” - ”Active Customer” interface
- The final solution will use a new version of OpenADR, based on this extended CIM Model

(*) IEC 62746-2 TR: Systems interface between customer energy management system and the power management system
(**) http://www.openadr.org

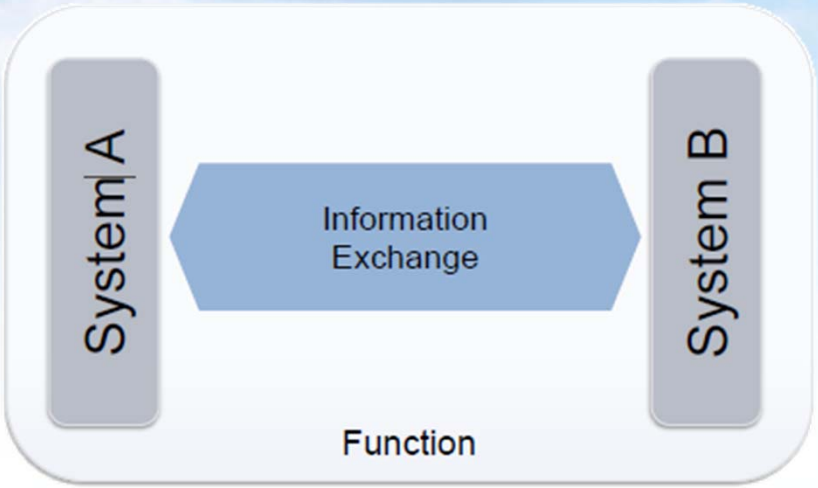
Energy@home approach for defining a standard based solution

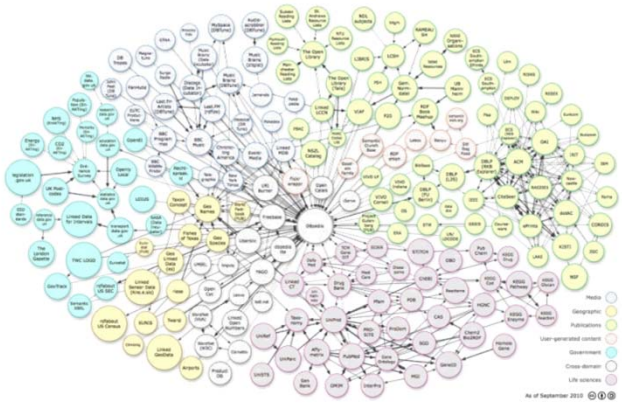
How SGAM could help to achieve systems interoperability (*)

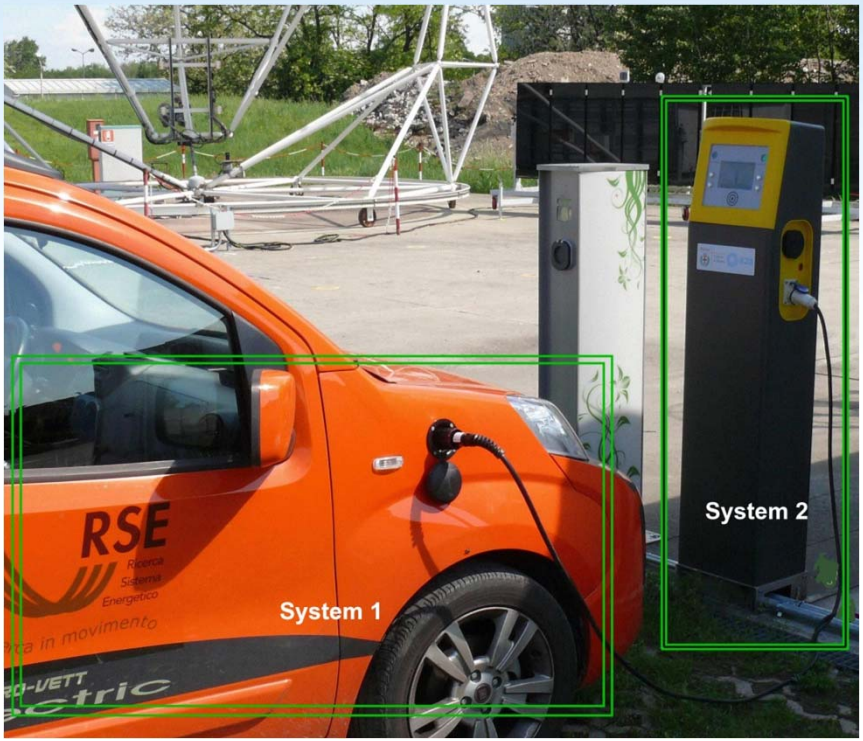
(*) For a more detailed description see previous webinar presentation :
http://www.energy-home.it/Documents/Others/Interop_DataModel_role_CEI.pdf

What is «interoperability» ?

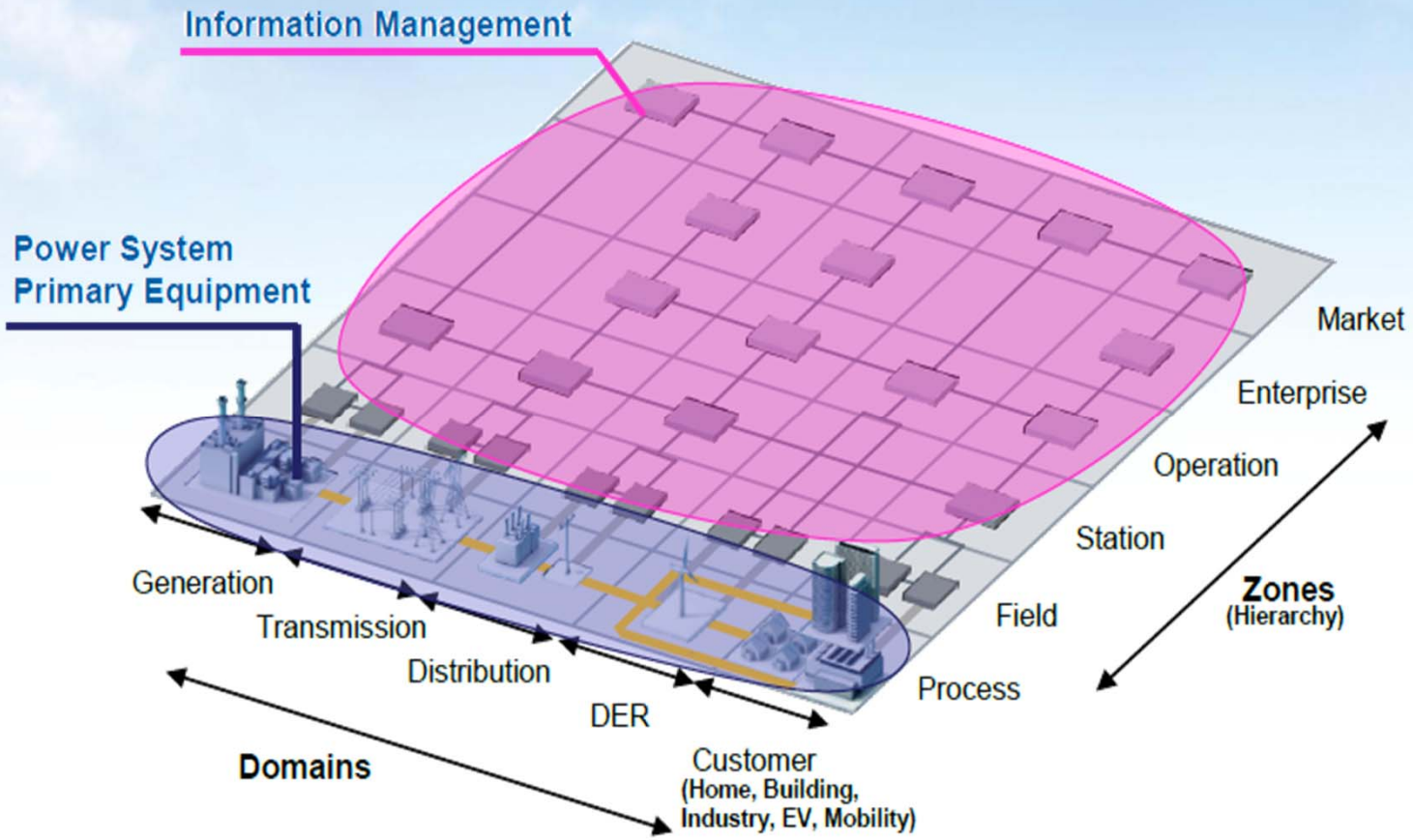
It is the ability that systems have to exchange informations and use them in order to perform required functions



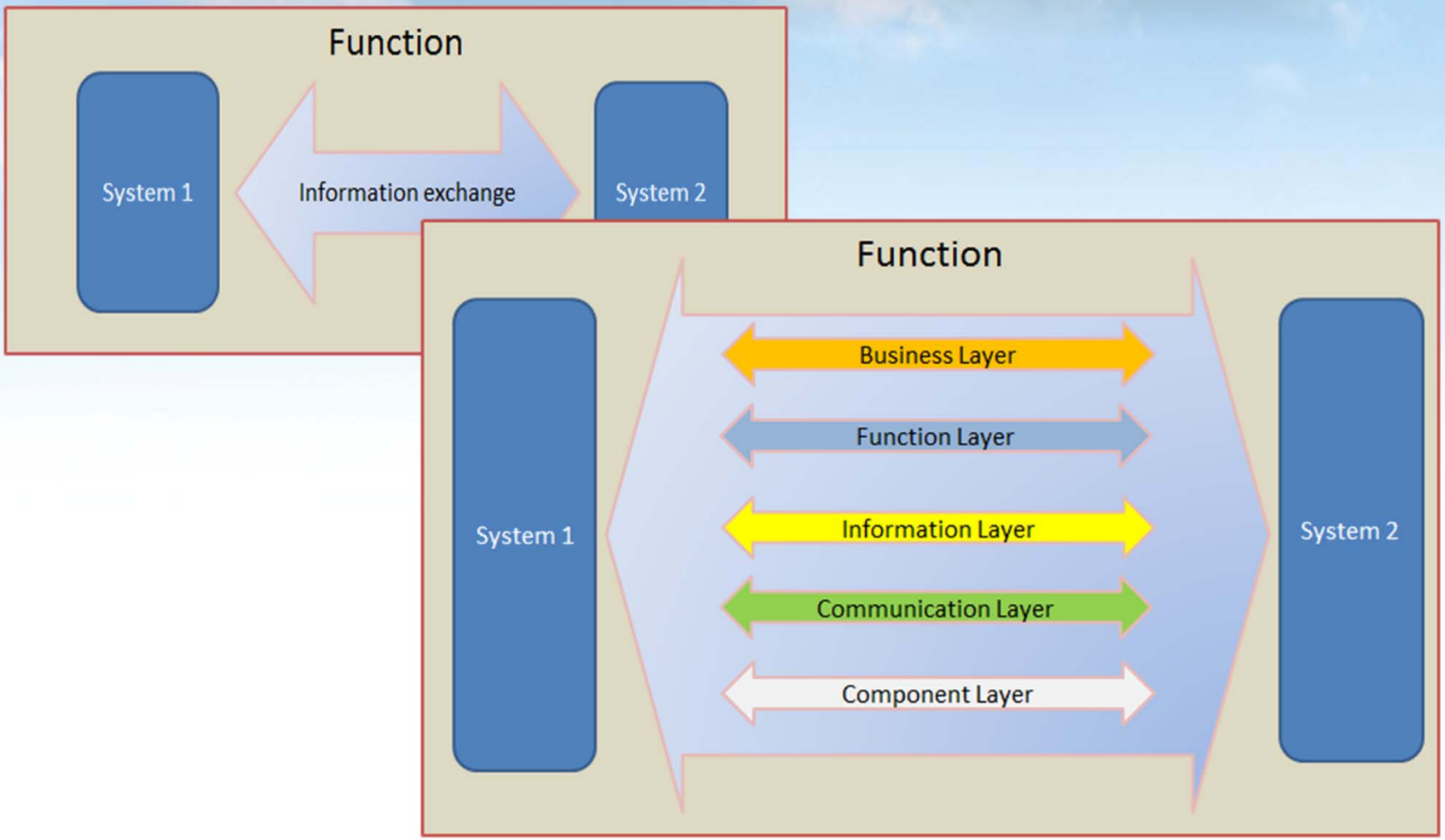




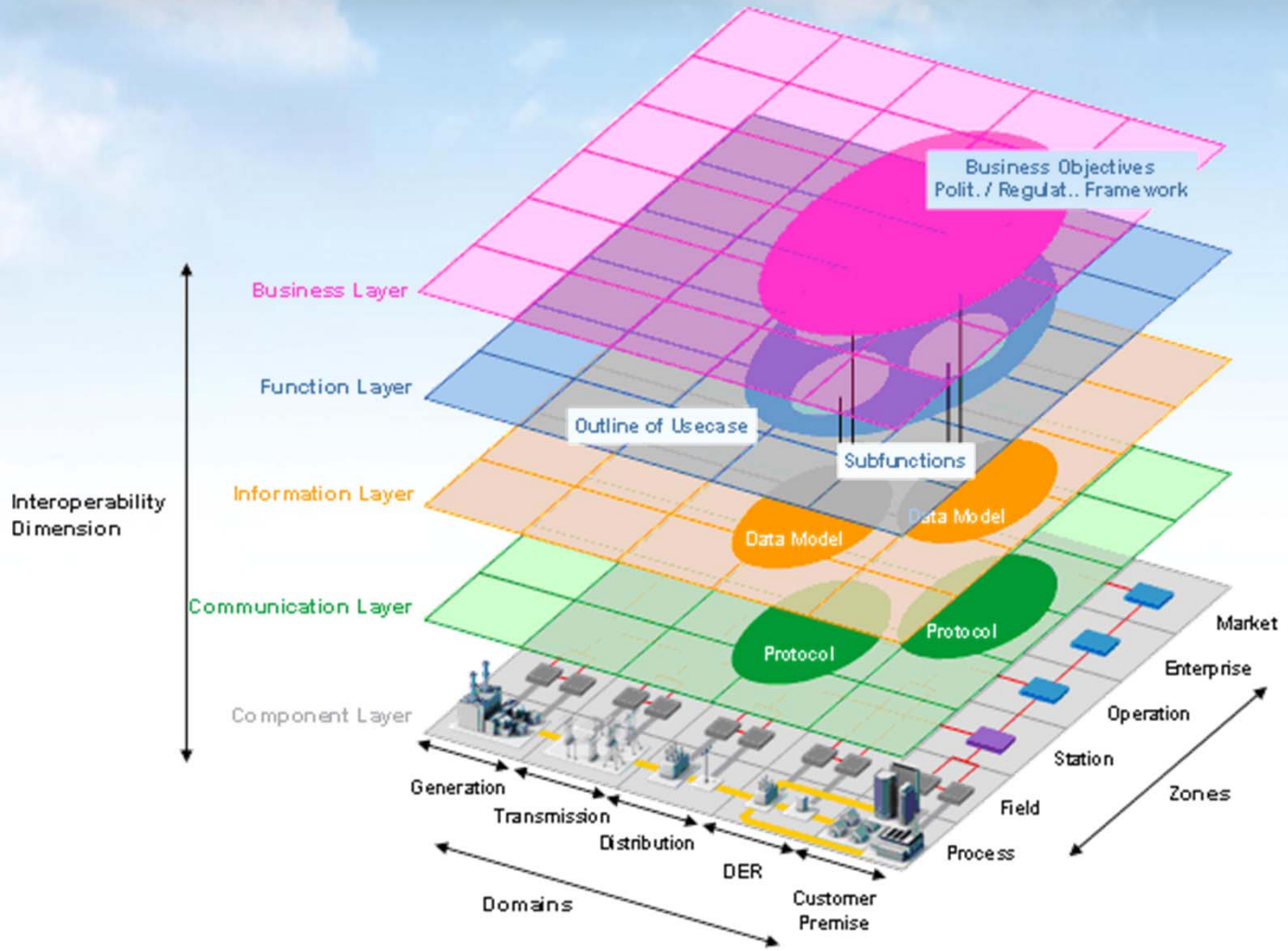
The Smart Grid Plane defined by SG-CG “Reference Architecture” WG



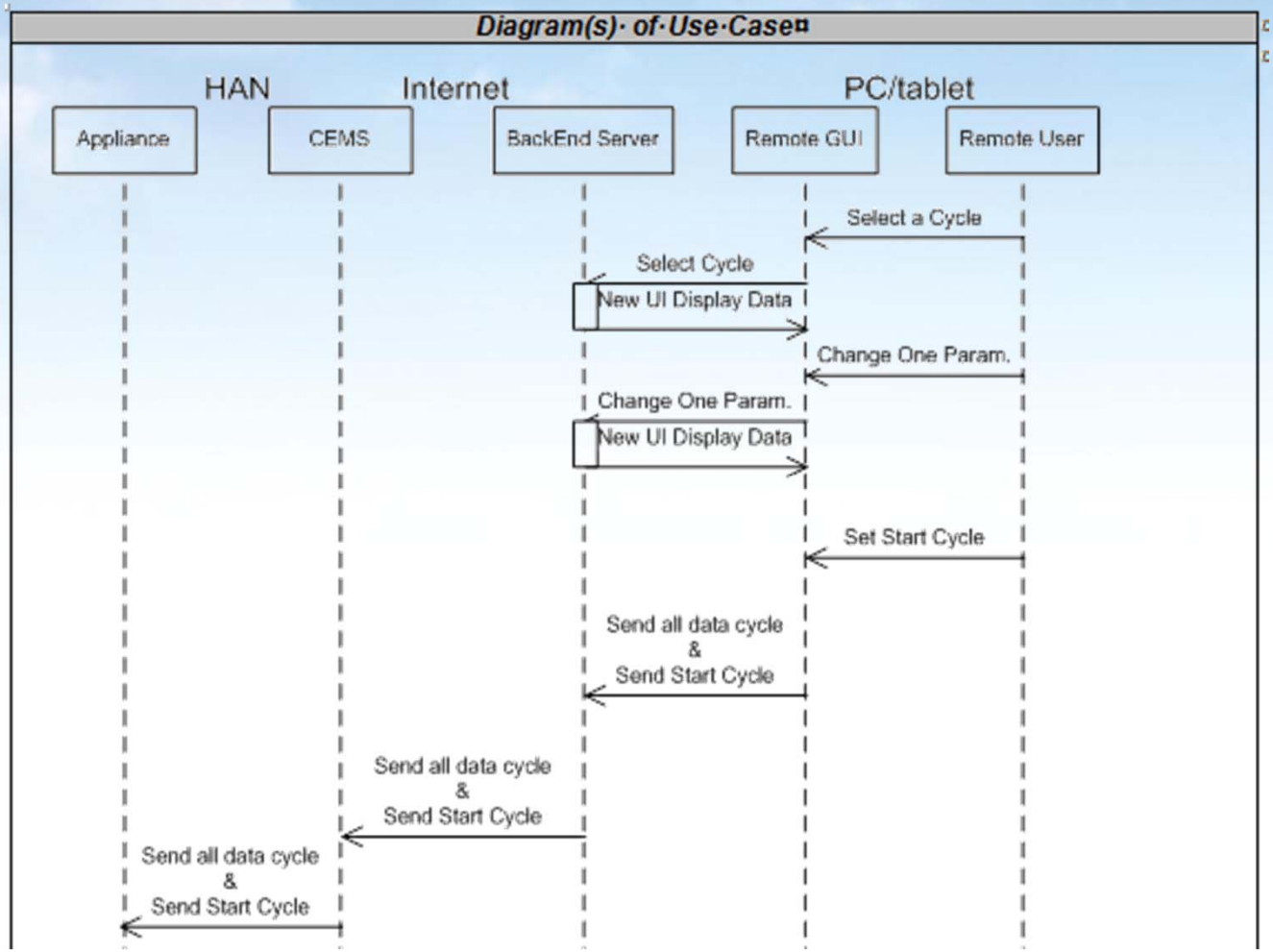
Interoperability levels



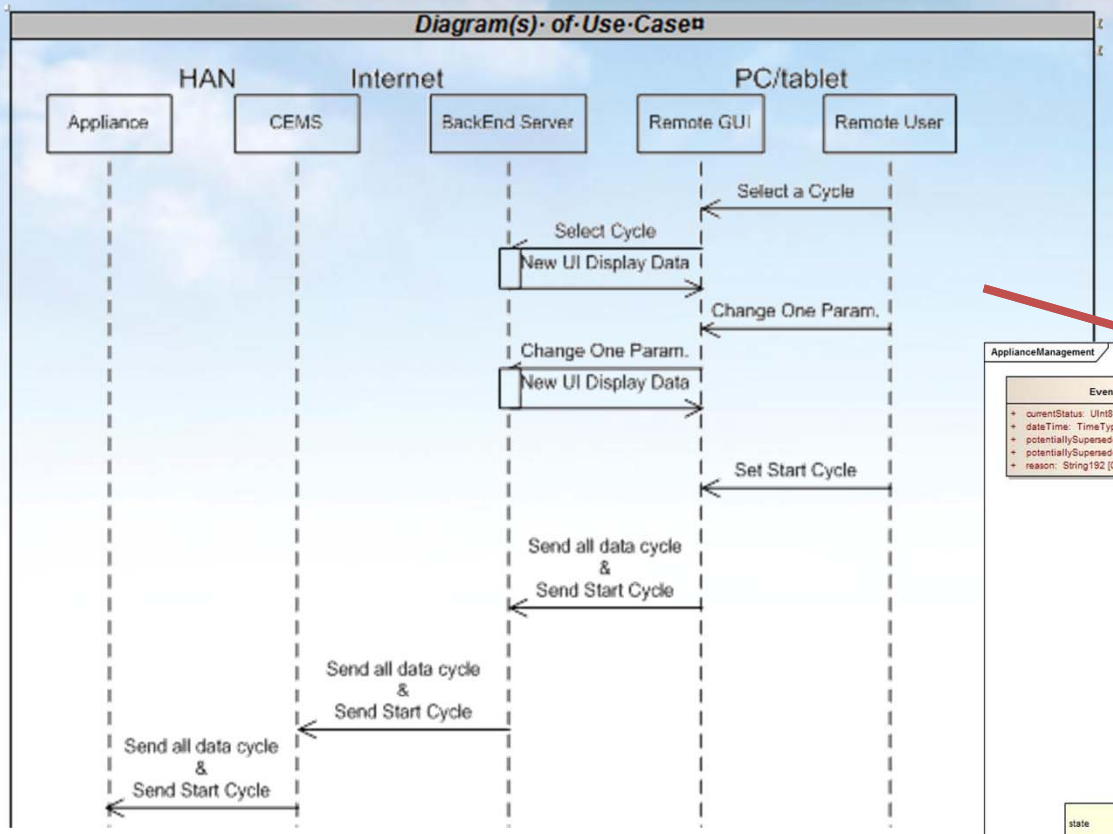
Interoperability Levels in Smart Grid Architecture Model (SGAM)

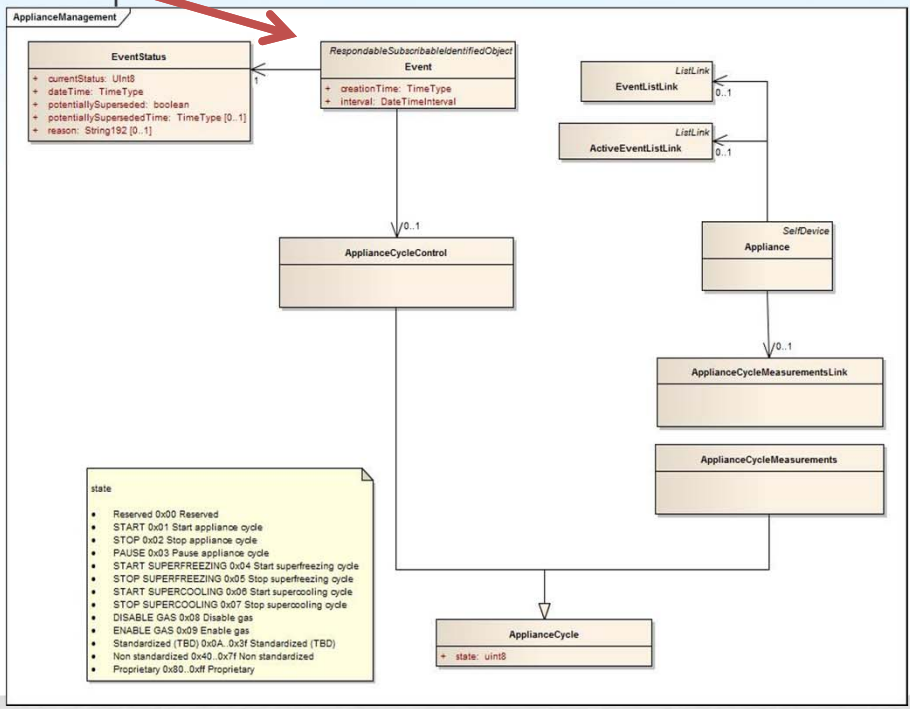


Use cases definition (SGAM Function layer)

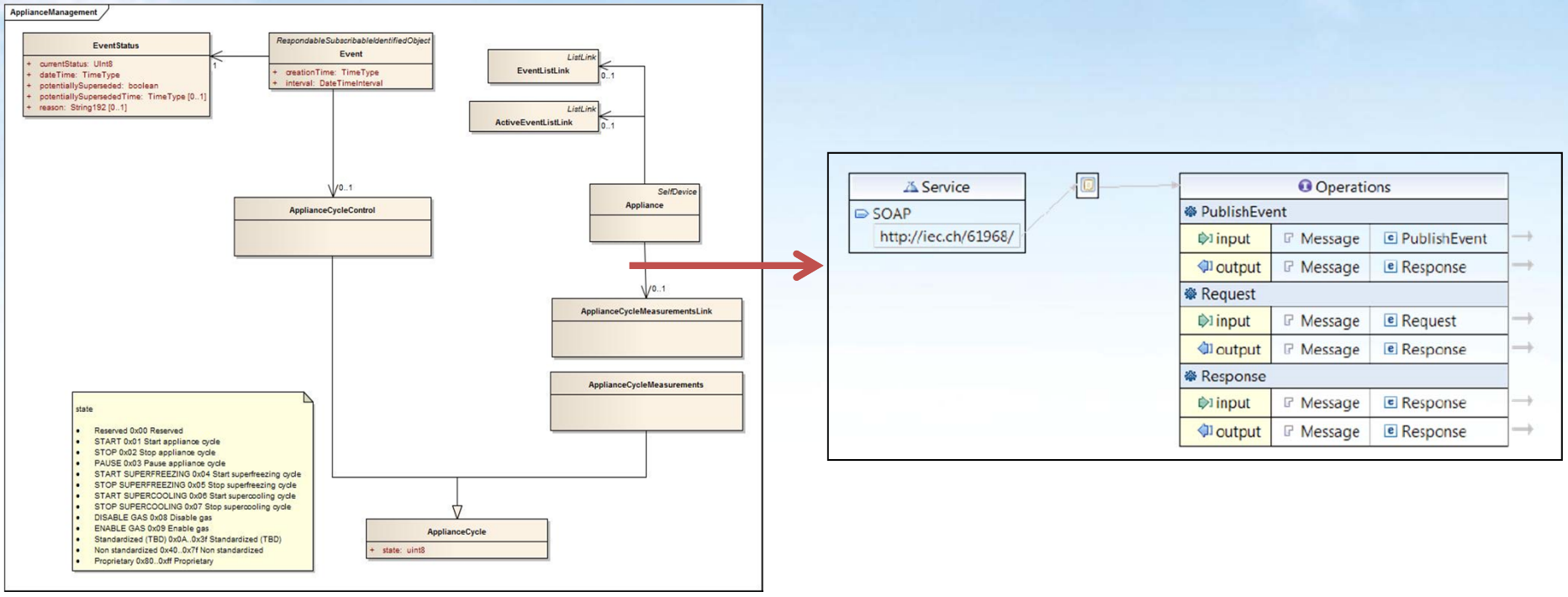


Mapping information exchange on standard Data Model
(SGAM Information layer)





Apply a communication protocol (SGAM Communication layer)



The process for the development of interoperable systems

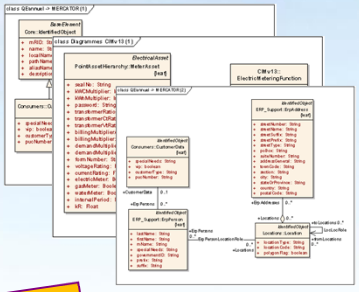
Subset, Constraints

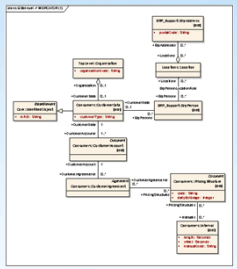
2

3

Contextual Model (Profile)

Mapping on Data Model (e.g. CIM)





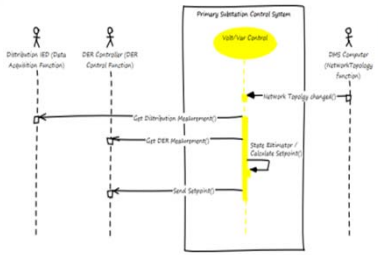
Manage XSD, OWL, RDFS by "Model Driven" technologies

4

Esempio XMLSchema

1

Analysis of the "use case" and definition of information exchange



Mapping data on standard protocol (e.g. XML Payload On Web Service)

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XML exchanged data

CEM

Smart Appliance

Data Model (SGAM-Information Layer)

Why a IEC «Common Information Model» based solution for the customer domain ?

Why a IEC “Common Information Model” based solution ?

- The IEC “Common Information Model” («**CIM»)** is a Data Model expressed by a UML Class diagram
- CIM represents the main resources for the management of the electric system
- Expressing the knowledge associated to the electrical domain, CIM represent its base ontology

Why a IEC “Common Information Model” based solution ?

- The IEC-62746 standard for the“Grid” – “Customer” interface will be based on the IEC “Common Information Model” («**CIM»)**
- The implementation of the “Customer Energy Manager” (CEM), that acts as a bridge between the Grid and the Customer domains, would be faciltated by the adoption of a common Data Model on both interfaces sides
- The US approach provide a consistent example of the application of CIM based standards in the «Grid» – «Customer» relationship
  - «SEP2» for Customer domain (IEC-61968-9 based)
  - «GreenButton» for Customer awareness (IEC-61968-9 based)
  - «OpenADR» for Demand Response (Future mapping on CIM)

Data Model (SGAM-Information Layer)

Why a SEP2(*) based solution ?

(*) SEP2 (Smart Energy Profile 2) was adopted by IEEE as P2030.5 (http://standards.ieee.org/findstds/standard/2030.5-2013.html)

Why a SEP2 based solution ?

- It’s a CIM based solution
- It’s one of the recommended standard by IEC PC118 (*)
- It’s ready to use
- It’s the natural evoultion of the Zigbee technology previously adopted by E@h

(*) IEC Project Committee 118: Smart Grid User Interface

Data Model (SGAM-Information Layer)

Energy@home contribution for the definition
of a Smart Appliances ontology

Energy@home activity on Data Modeling

- In order to cover its use cases, Energy@home is working for a SEP2 data model extension
- **The result of this data model extension was proposed to ETSI in order to contribute to the definition of an European Ontology for Smart Appliances (*) as requested by «EU - DG Connect»**
- The current collaboration with the Zigbee Alliance on the SEP2 data model extension, it's preparatory for its proposal in the context of IEEE P2030.5
- Energy@home is collaborating with EEBus Initiative for an european common approach on Smart Appliances data modeling

(*) http://ec.europa.eu/digital-agenda/en/news/workshop-smart-appliances

Communication Protocol
(SGAM-Communication Layer)

Communication Protocol
(SGAM-Communication Layer)

- The definition of a technology indipendent Data Model based on the layered SGAM approach will enable the use of different IP based technology solutions

- The current SEP2 based solution is based on RESTful architecture

Technical conclusions

- The management of the Demand Side will contribute to address the growing need of flexibility in the Electrical System
- The Demand Response functionality need the implementation of standard based interoperable systems both on Grid and Customer sides
- The interoperability, both a semantic and syntactic level, will be facilitated by the use of “Data Models” (Ontologies)
- A Customer domain ontology should consider “CIM”, as it represents the most mature grid-side ontology
- SEP2 is a CIM based ready solution recommended by IEC-PC118 for the management of the customer domain


Grazie