ENERGY ICT MICROGRID

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Contents

I Microgrid Overview

1.1 Definition

- A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid.

- A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.

(Source: DoE OE Microgrid R&D Initiative, 2011)

1.2 Key Attributes

▸ Grouping interconnected loads and distributed energy resources

▸ Can operate in both island mode or grid-connected

▸ Can connect and disconnect from the grid

▸ Acts as a single controllable entity to the grid

(Source: DoE OE Microgrid R&D Initiative, 2011)

1.3 Ownership Model

- Utility model – the distribution utility owns and manages the microgrid to reduce customer costs and provide special services (e.g. high power quality and reliability) to customers on the system.
- Landlord model – a single landlord installs a microgrid on-site and provides power and/or heat to tenants under a contractual lease agreement.
- Co-op model – multiple individuals or firms cooperatively own and manage a microgrid to serve their own electric and/or heating needs. Customers voluntarily join the microgrid and are served under contract.
- Customer-generator model – a single individual or firm owns and manages the system, serving the electric and/or heating needs of itself and its neighbors. Neighbors voluntarily join the microgrid and are served under contract.
- District Heating model – an independent firm owns and manages the microgrid and sells power and heat to multiple customers. Customers voluntarily join the microgrid and are served under contract.

1.4 Market Analysis
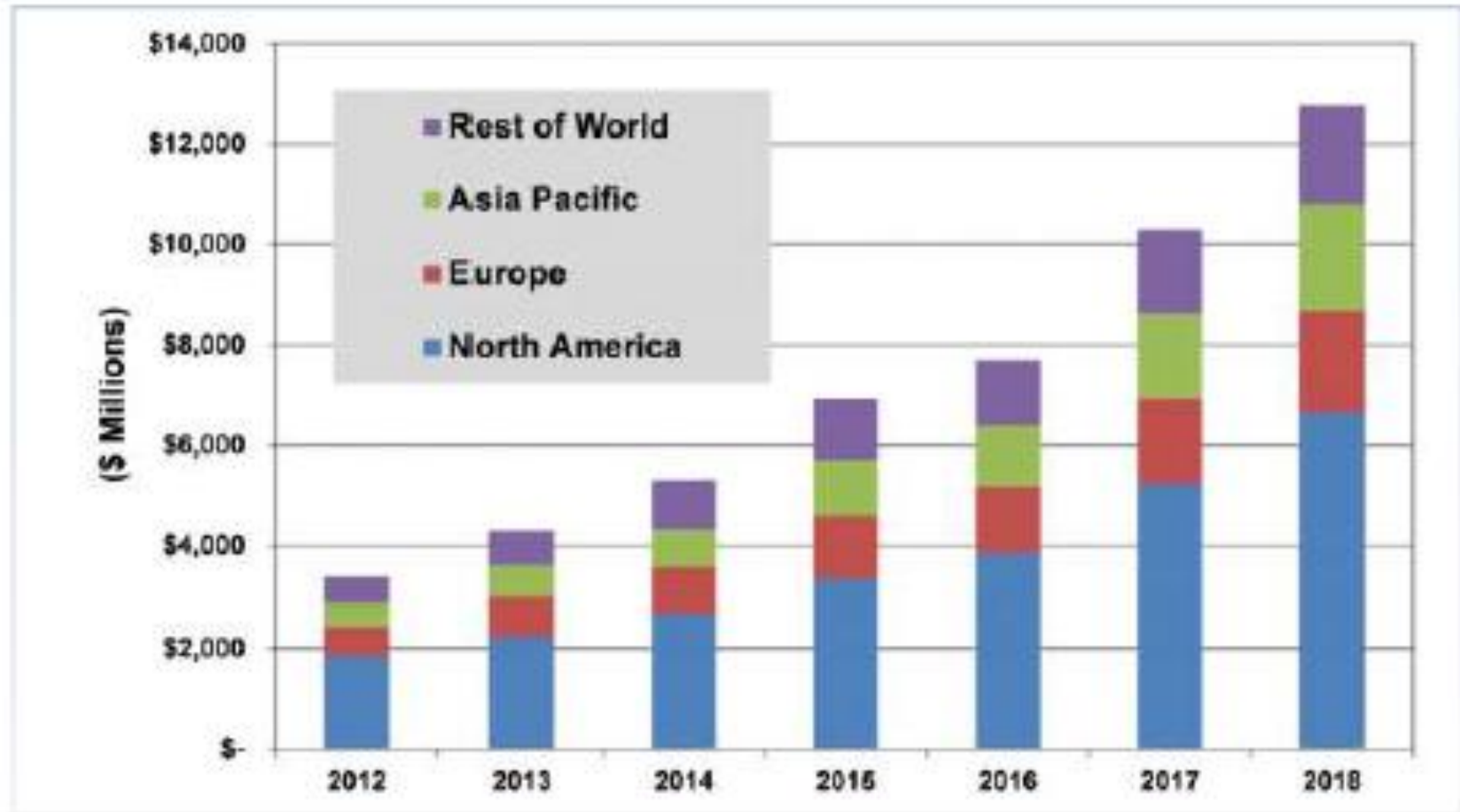
(Source : Pike Research)

1.5 Ancillary Microgrid Services

Centralized Control Goal (System Automation)	Constraints
Demand Response	Dynamically orchestrate the shedding and adding of load and generation. Dynamically orchestrate the connection of power generation and storage devices.
Distributed Generation	Control and optimize the generation of power based on cost of energy, reliability and environmental constraints.
Energy Storage	Control and optimize the storage of energy based on cost of energy, reliability and environmental constraints.
Energy Metering	Measure, aggregate, analyze and publish energy usage.
Energy Forecasting	Analyze and predict consumption, price, generation and failure risk. Generate system and power profile optimization programs.
Energy Market Trading	Perform price monitoring, negotiation and settlement.
System Monitoring	Analyze cyber security, information flow, information quality, business processes and topology. Generate reports and programs to optimize system performance and provide control center visualization.

# 1.6 Roadmap to Evolving to the Dynamic Microgrid
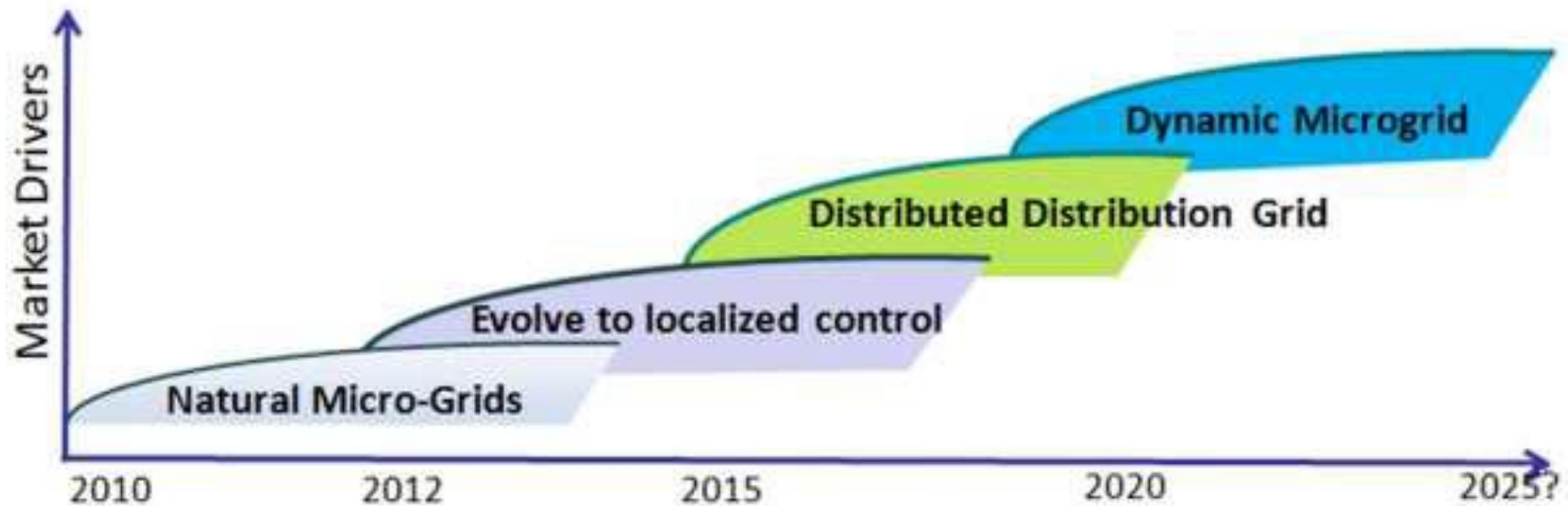
Ⅱ FISENY (EU)

2.1 FISENY Overview

- **FISENY: Future Internet for Smart ENergY**
- **Microgrid Functional Architecture Description**
- Simens, Siemens AG, Grenoble INP, Iberdrola S.A., Orange Labs, Synelixis, Thales (2011)
- Based on the use cases described in the scenario evaluation in D3.1 this document describes the use case drill-down with the help of the Smart Grid Architecture Model (SGAM) and the detailed analysis for the functional, information, communication and component layer including the functional key building blocks, the interfaces and data models. → **Microgrid ICT Requirements**
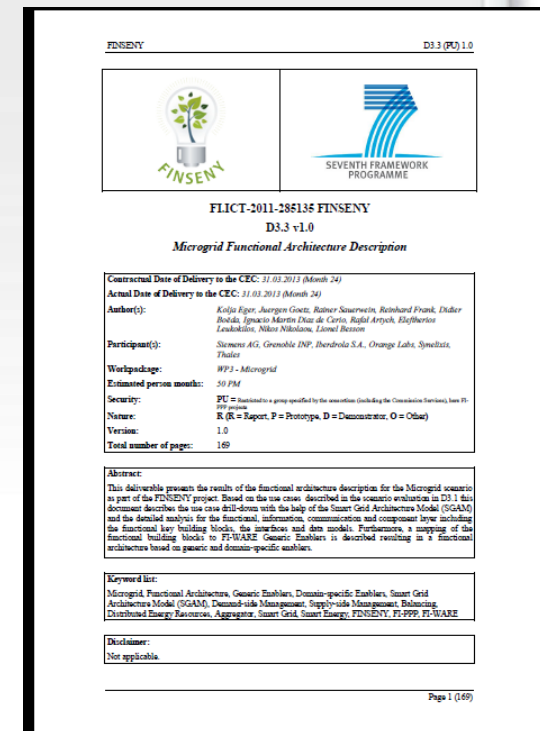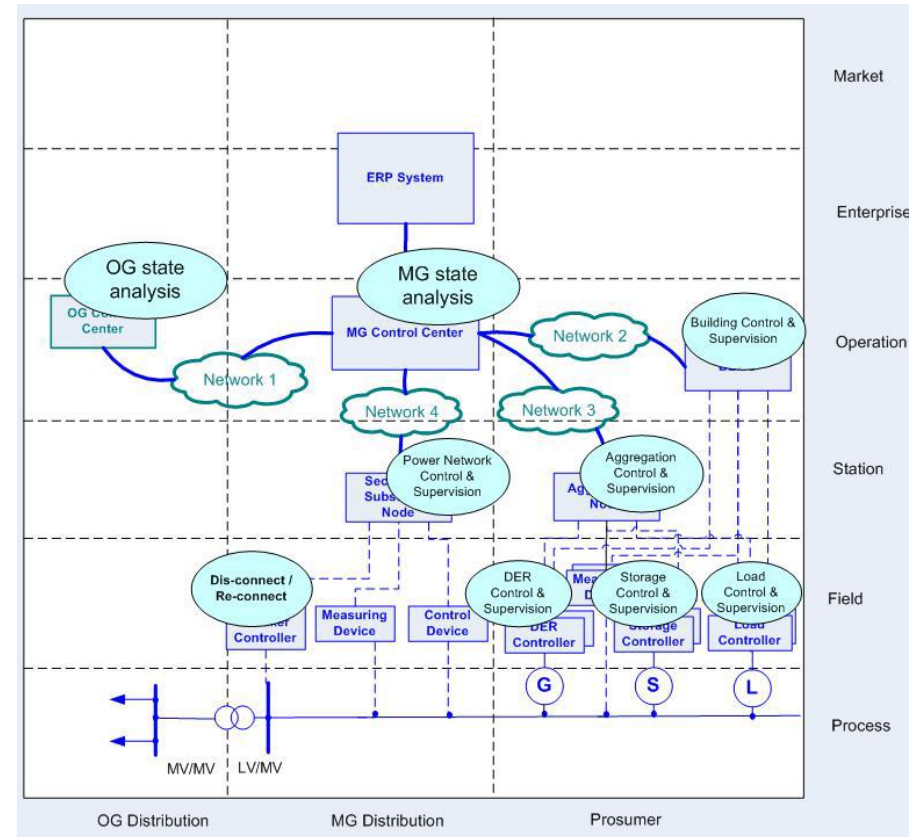
2.2 Drill-down on SGAM Layers
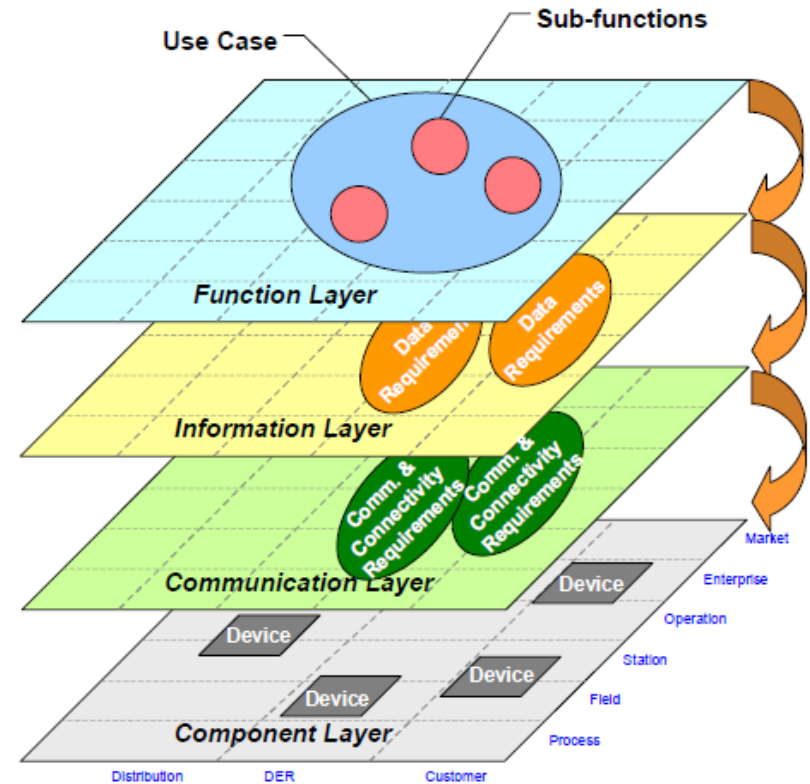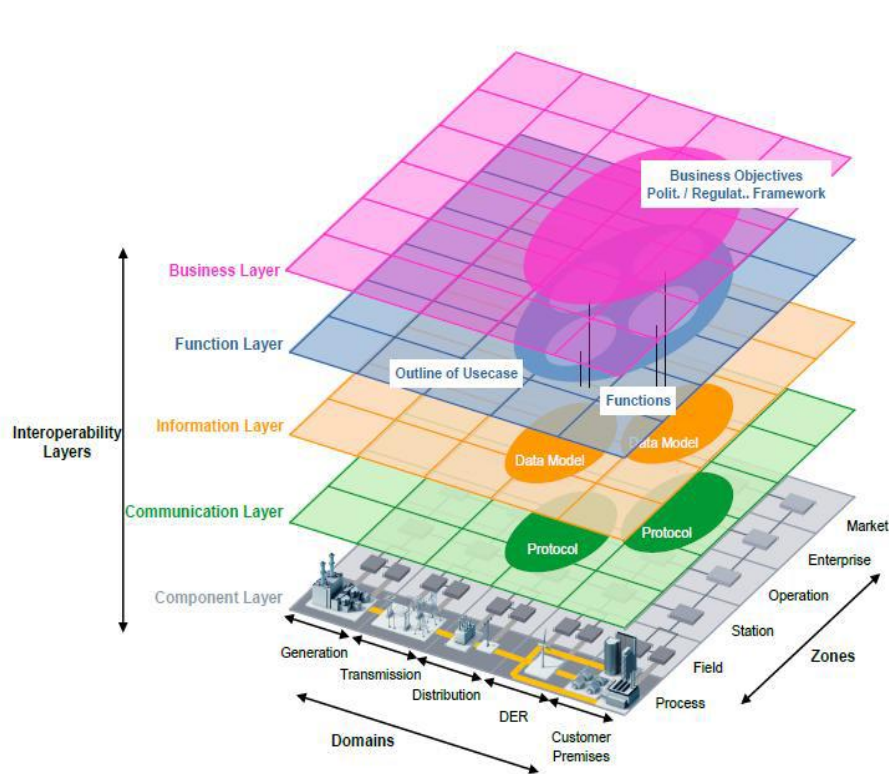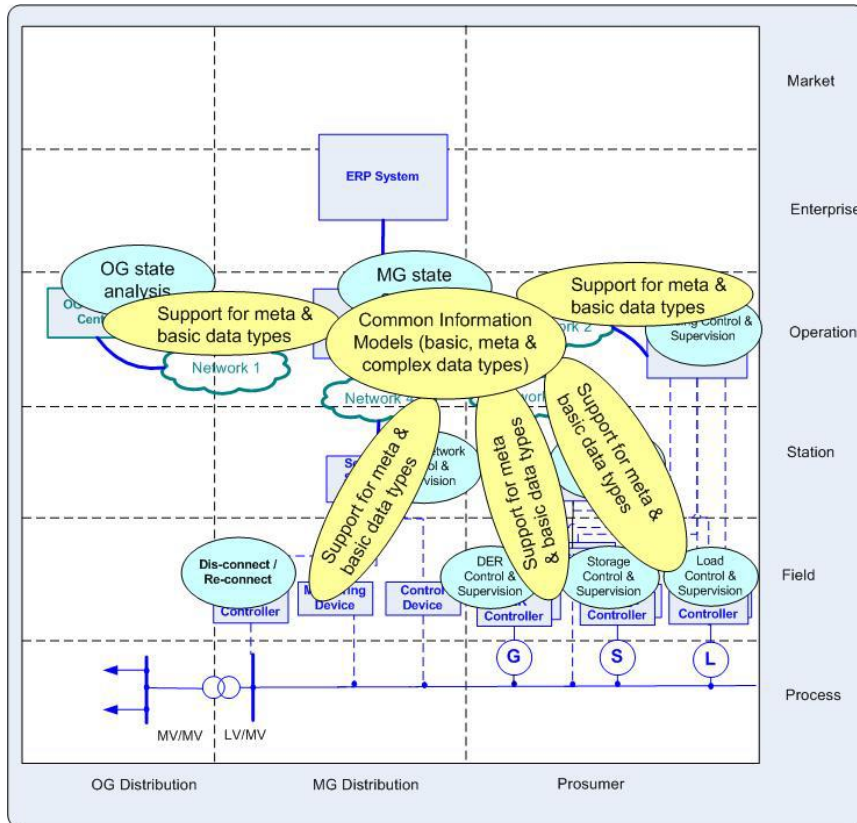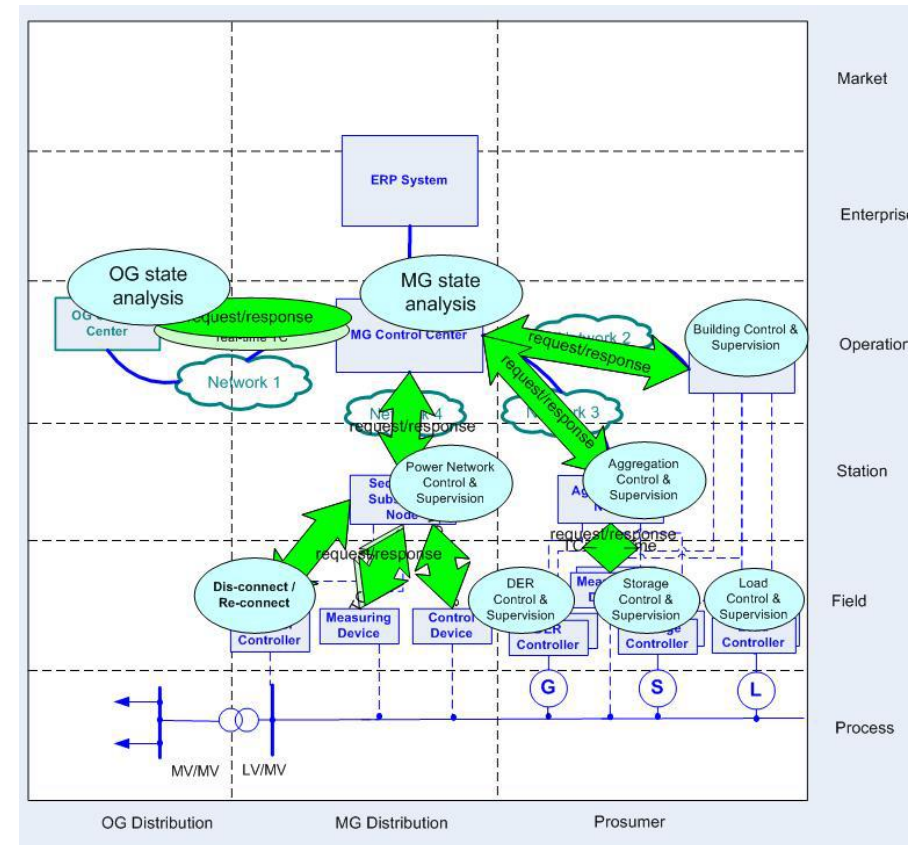
2.2 Drill-down on SGAM Layers
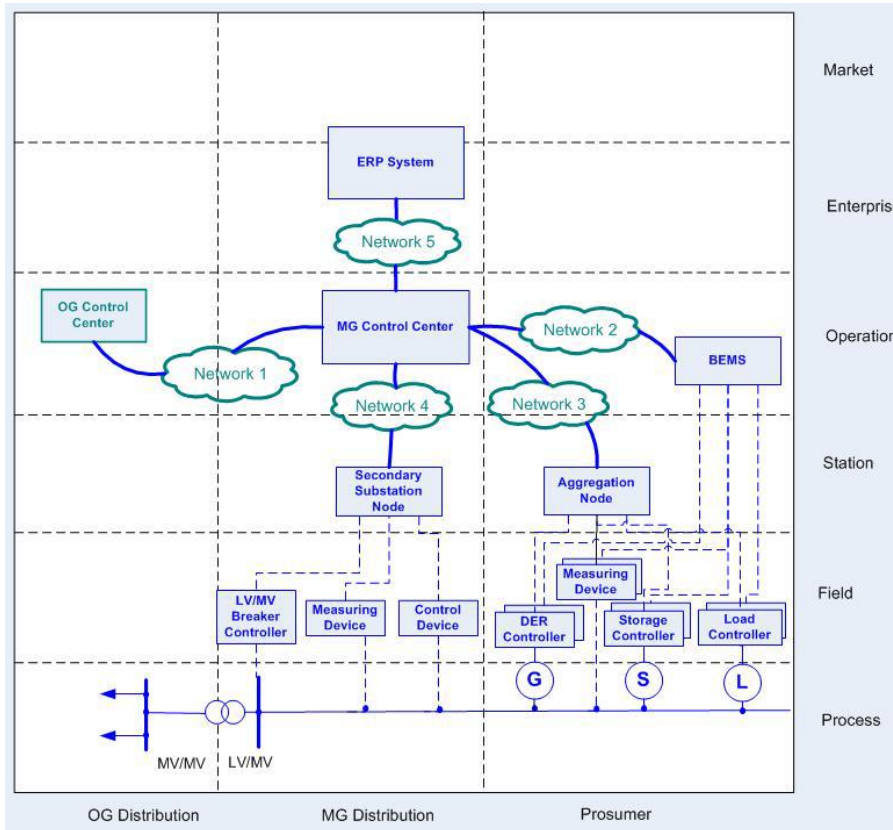
Component Layer

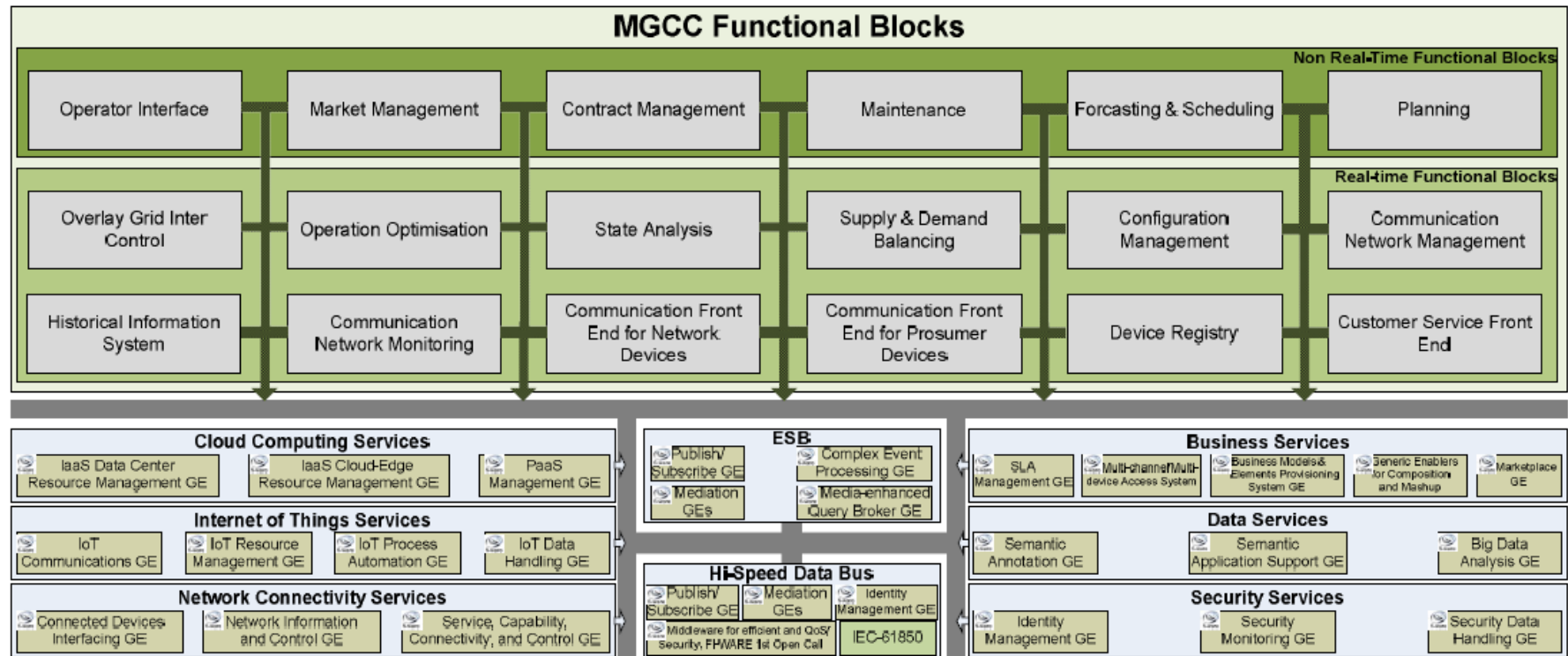Functional Layer

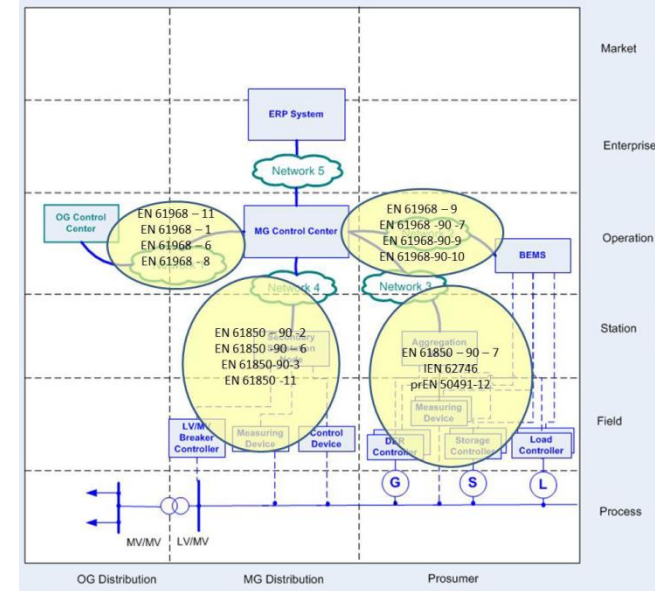# 2.2 Drill-down on SGAM Layers

Information Layer

Communication Layer

2.3 Key Functional Building Blocks

2.4 Information & Data Model
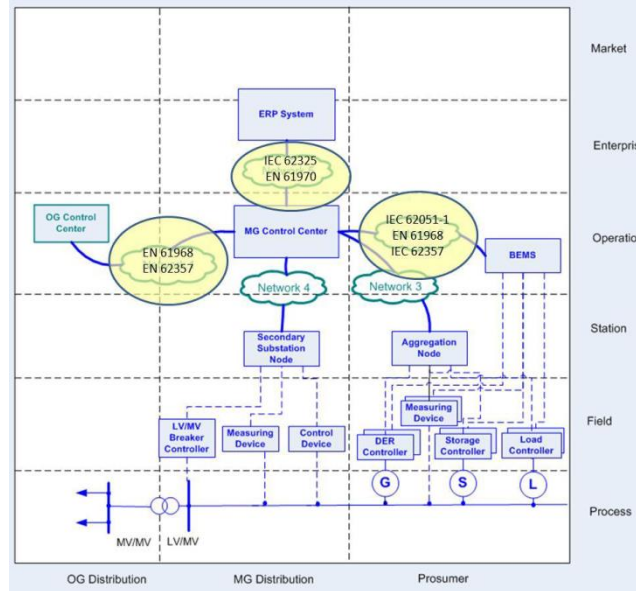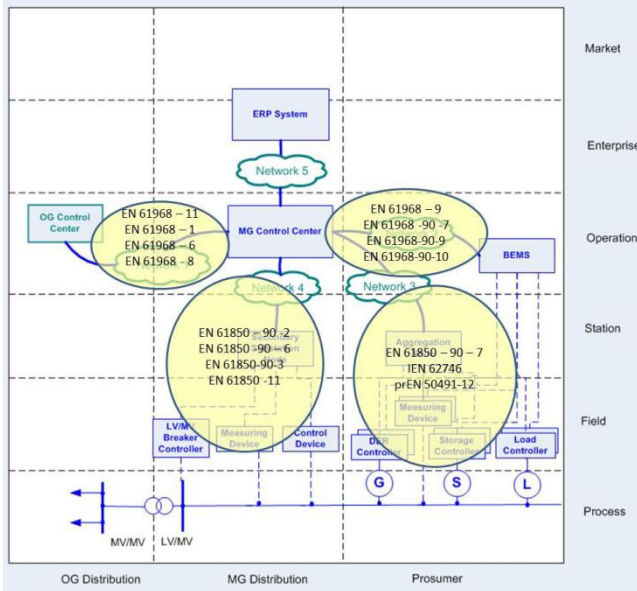
Ⅲ Advanced Microgrid (US)

3.1 Advanced MG Overview

- Sandia National Laboratory
- Advanced Microgrid Integration and Interoperability (2014)
- Microgrid Cyber Security Reference Architecture (2013)
- Advanced microgrid have been identified as being a necessary part of the modern electrical grid through a two DOE microgrid workshops, the National Institute of Standards and Technology, Smart Grid Interoperability Panel and other related sources.
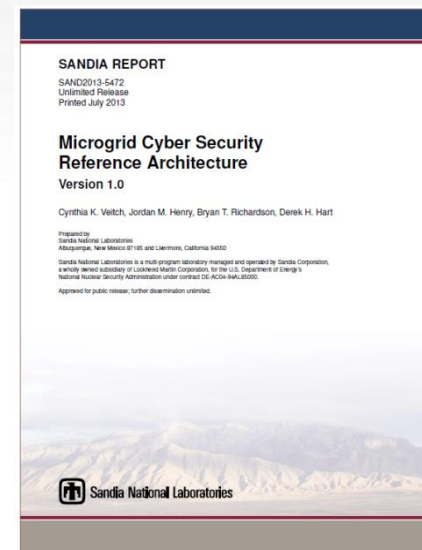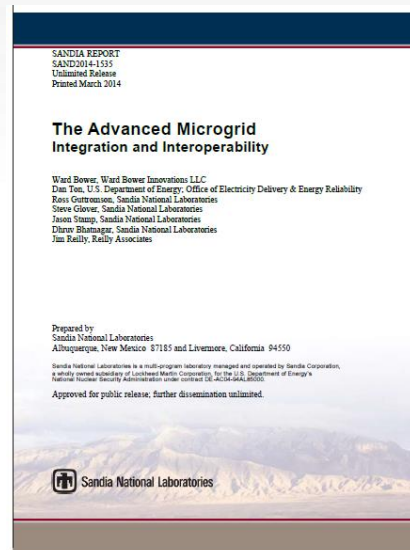
3.2 Contributing Elements

Table 1.   Important Advanced Microgrid Contributing Elements

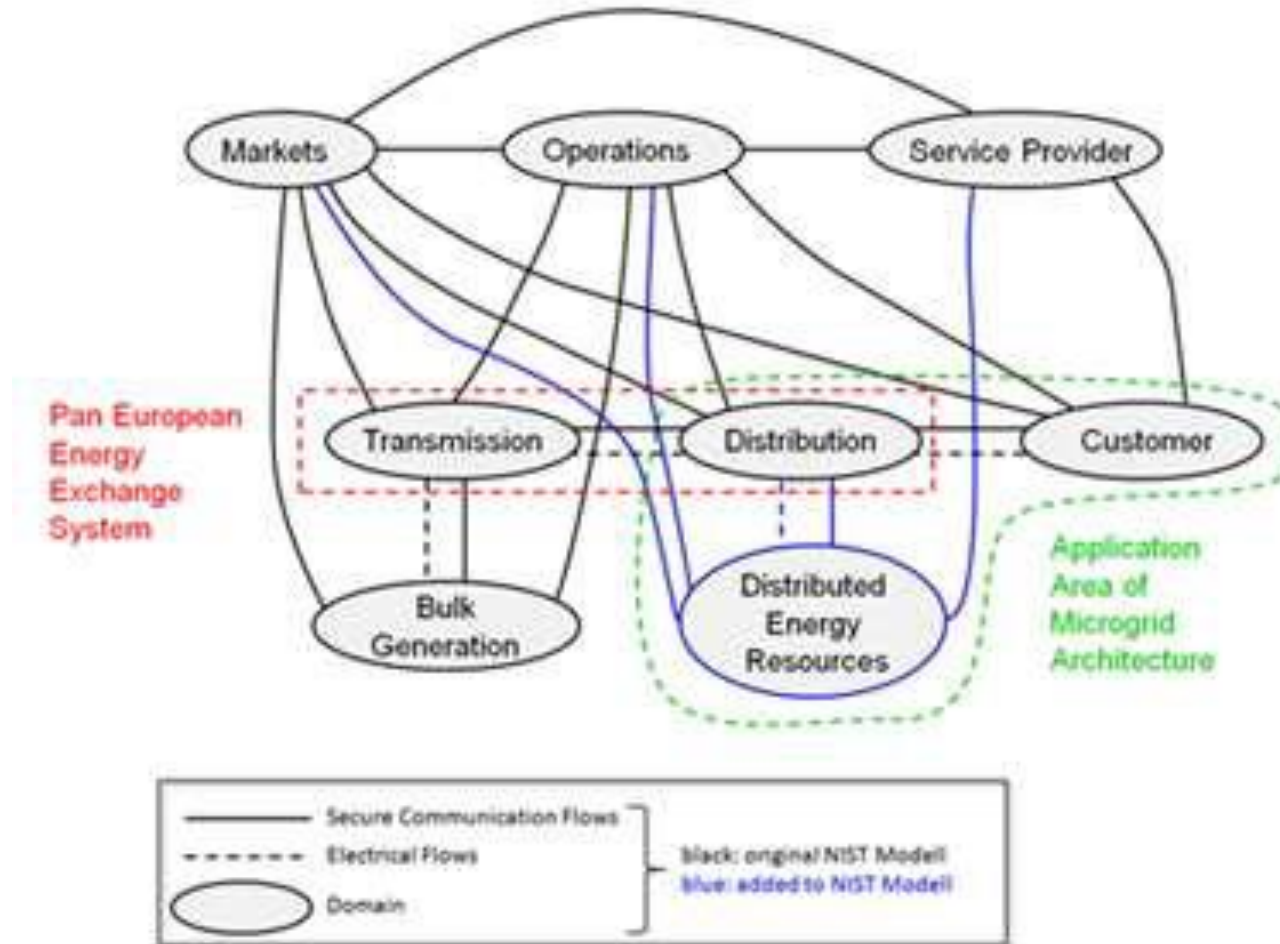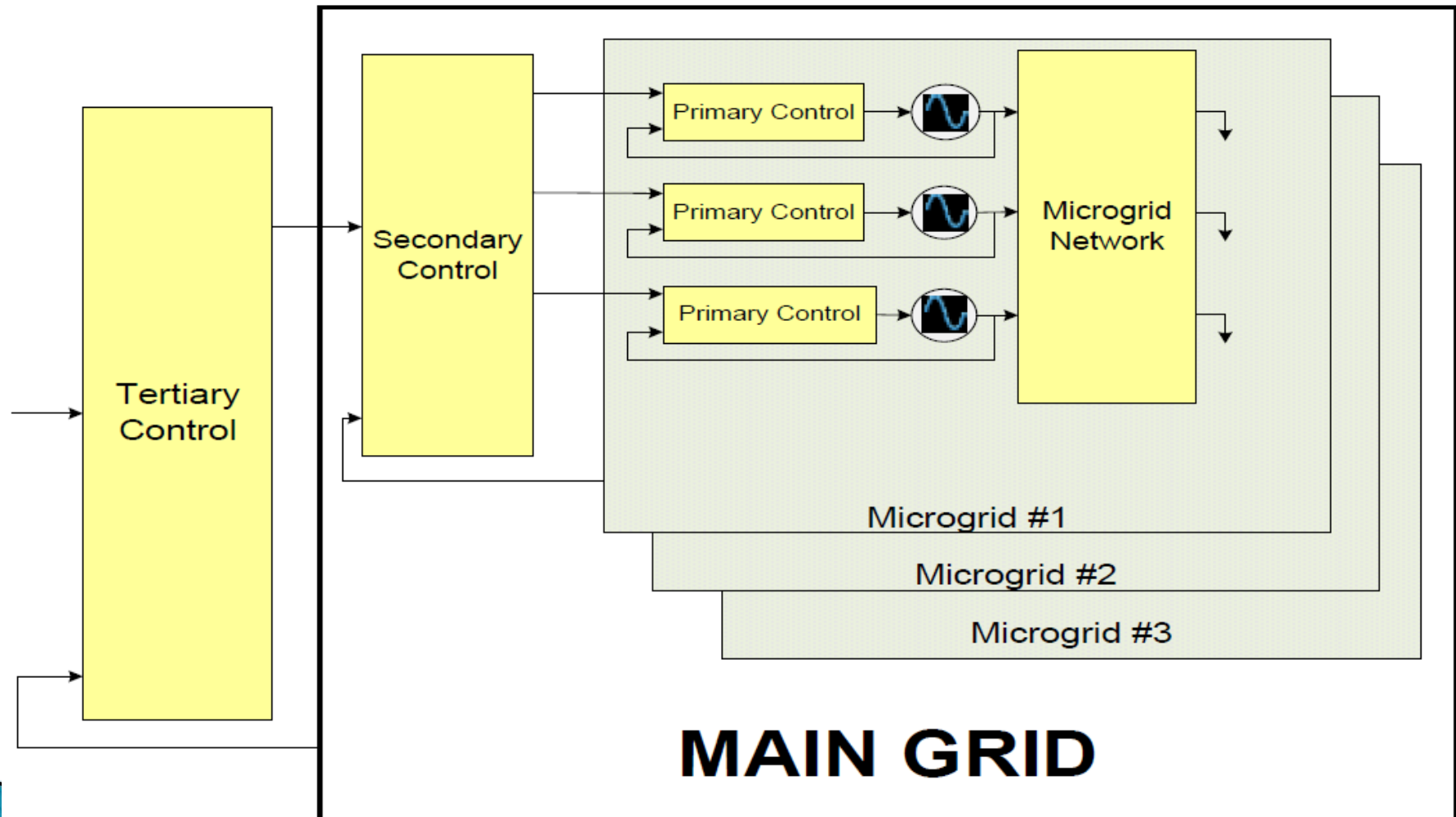| Name	Type	Element Description
Area EPS	System	The EPS that normally supplies the microgrid through their PCC.
EMS	System	EMS acting at the interface between loads and the microgrid. It communicates with smart devices and to the outside with the microgrid control center. It aggregates the services of the smart devices and provides further services to the microgrid. Furthermore, it can implement some level of intelligence to fulfill the services.
Grid Control Center	System	Control center from which the grid is operated. All required supervision and control functions are carried out here.
Market Operator (MO)	System	The system that procures energy and ancillary services and ensures reliability for the area EPS. The MO may be part of the area EPS or may be a separate entity.
Microgrid Control Center	System	The control system comprising different microgrid operator subsystems that ensures the control & management tasks of the microgrid and the aggregation of supply and demand.
Microgrid Controller	System	A control system able to dispatch the microgrid assets, e.g., opening/closing switches, changing control reference points, changing generation/consumption levels, etc. Other than the microgrid functions specifically referenced below, this use case does not specify the objective of any of the microgrid controller functions. This use case does not specify how the control signals are transferred or implemented in the microgrid assets.
Consumer	Person/ Org	A consumer of electricity, e.g., a private house, business building, large industrial/manufacturing industry or transportation system. The consumer acts as a customer. The consumer may operate smart appliances (an electric load with some intelligence to control it) that are flexible in demand.
DER Owner	Person/ Org	The distributed energy resource (DER) owner (or DG owner) operates a DER (or DG) that is connected to the microgrid.
Service Provider	Person/ Org	The service provider provides different kinds of services to the microgrid operator to support him in the operation of the microgrid, e.g., weather forecasts or energy market analysis.
Storage Owner	Person/ Org	Provider of storage capacity for storing and delivering energy.
Aggregator	Org	Market participant that purchases/sells electricity products on behalf of two or more consumers/generators/DERs. In a small microgrid, the microgrid operator could act also as aggregator. In a large microgrid, the aggregator might be a legal entity and the microgrid operator contracts with this entity.
Grid Operator	Org	The grid operator is the operator of the grid to which the microgrid has a connection point. The term "grid operations" refers to the undertakings of operating, building, maintaining, and planning electric power transmission and distribution (T&D) networks.
Microgrid Operator	Org	The microgrid operator acts as system operator in the microgrid and is responsible for operating, maintaining, and, if necessary, developing the microgrid's distribution system. In some use cases, e.g., running the microgrid in an islanding mode, the microgrid should take over the roles of the energy retailer and/or the aggregator to ensure system stability.
Retailer	Org	Entity selling electrical energy to consumers. Could also be a grid user who has a grid connection and access contract with the transmission system operator or distribution system operator (DSO)
DER Unit	Device	DER including DG (small photovoltaics [PV], wind, etc.) connected to the microgrid. The device provides some degree of intelligence to facilitate monitoring and control.
Network Smart	Device	An intelligent electrical device in the microgrid that can be supervised and controlled (e.g., sensors, circuit breakers, or switches)
Storage Unit	Device	A storage unit provides an electricity reserve to the microgrid. The device provides some degree of intelligence to facilitate monitoring and control.

Table basics provided by James Reilly, Lead, NIST Smart Grid Interoperability Panel, Subgroup C - microgrids
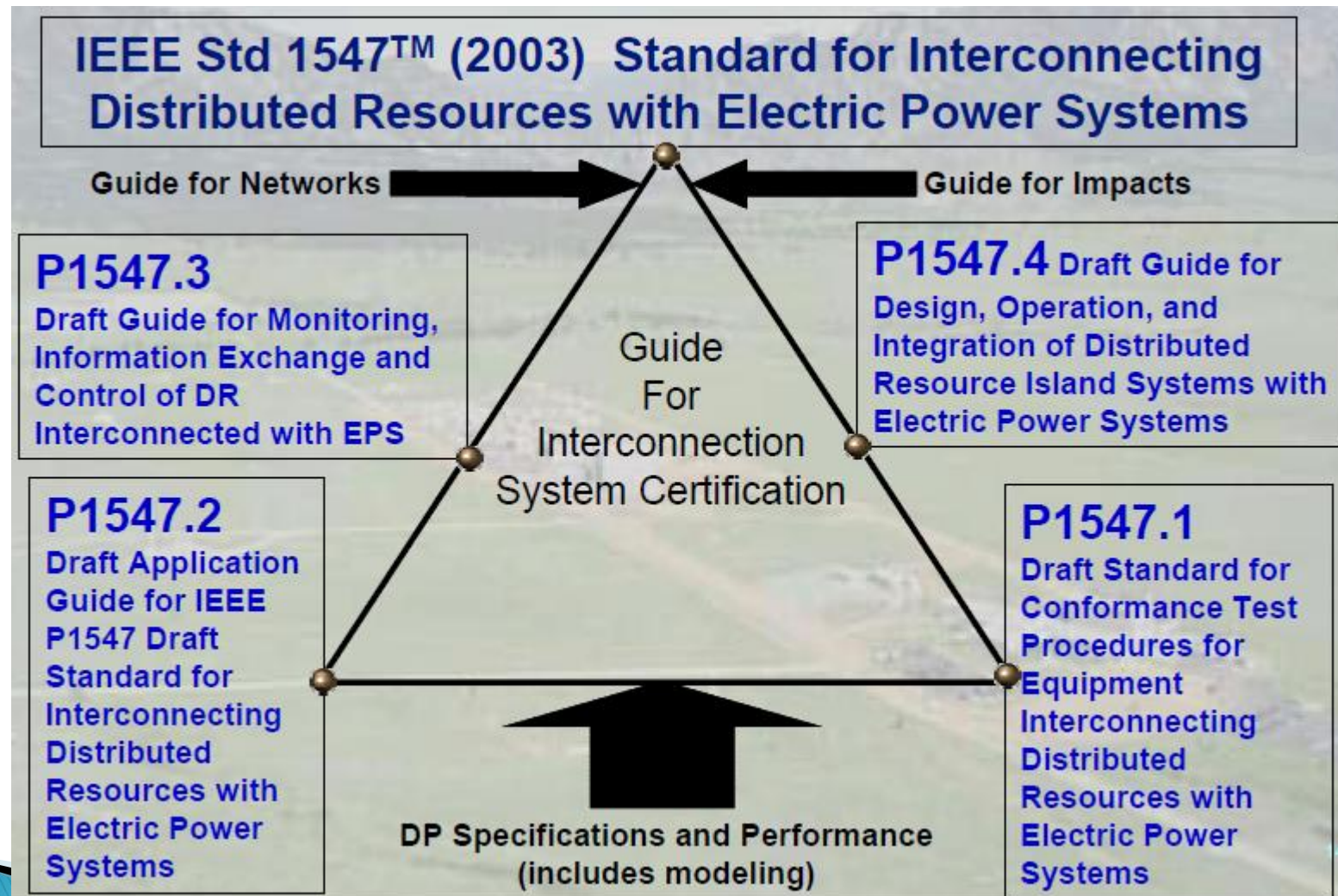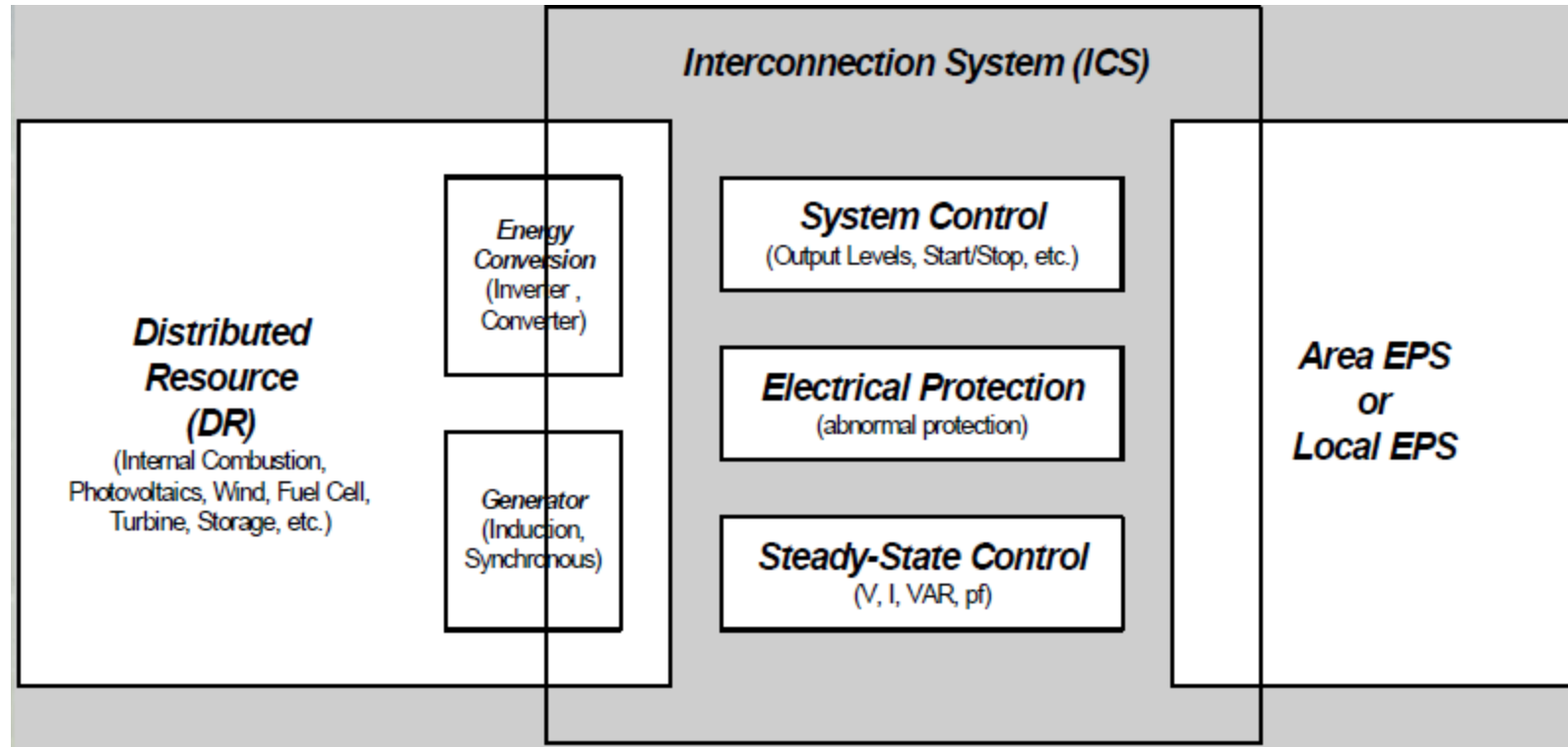
3.3 System Architecture

3.4 Hierarchical Control Levels in Networked Microgrids

3.5 Key Functional Building Blocks

IEEE Std 1547™ (2003) Standard for Interconnecting Distributed Resources with Electric Power Systems

Guide for Networks → ← Guide for Impacts

P1547.3
Draft Guide for Monitoring, Information Exchange and Control of DR Interconnected with EPS

P1547.4 Draft Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems

Guide For Interconnection System Certification

P1547.2
Draft Application Guide for IEEE P1547 Draft Standard for Interconnecting Distributed Resources with Electric Power Systems

P1547.1
Draft Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems

DP Specifications and Performance (includes modeling)

3.6 Interconnection System(ICS)

3.7 Information Exchange Reference Diagram

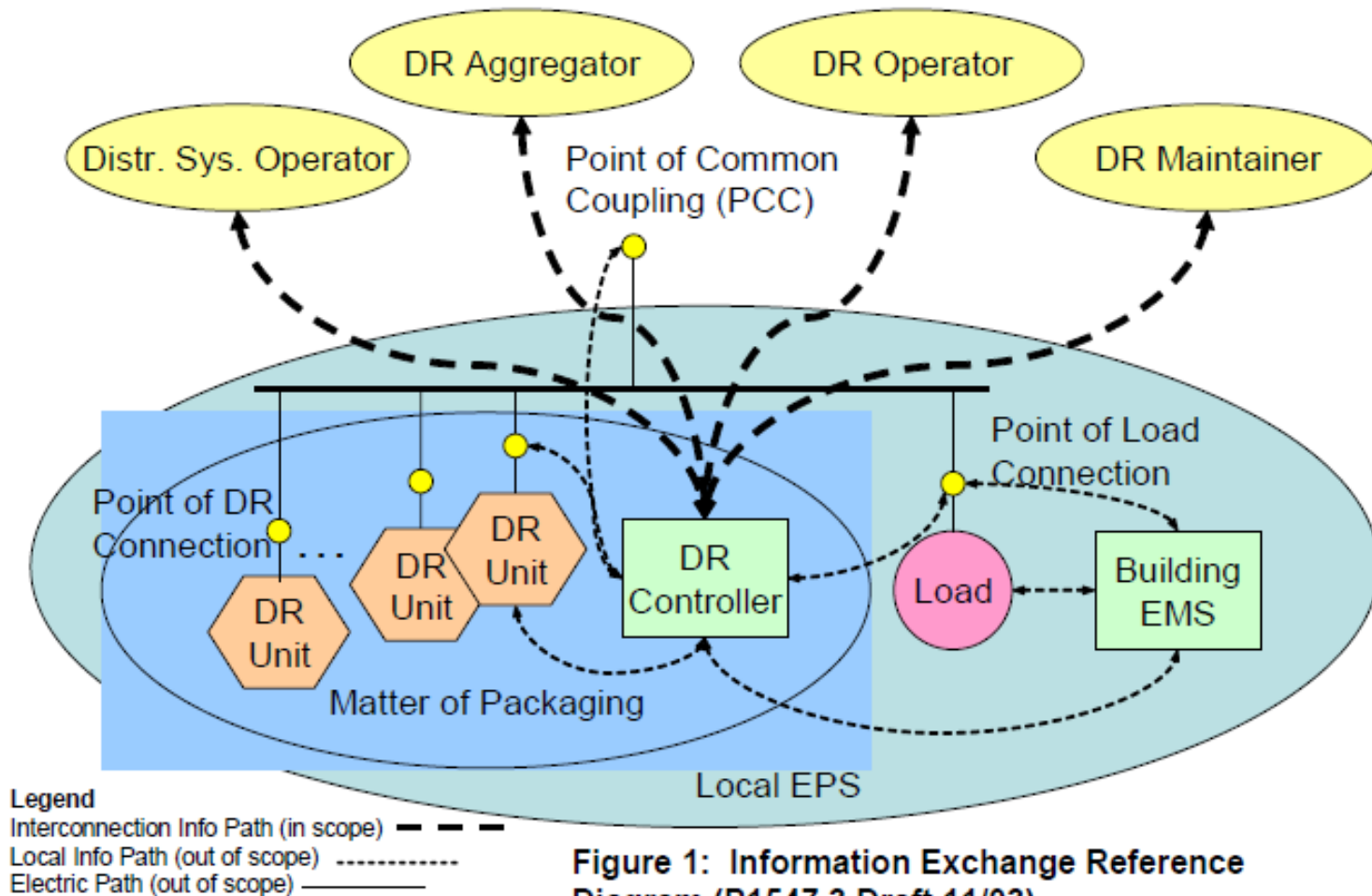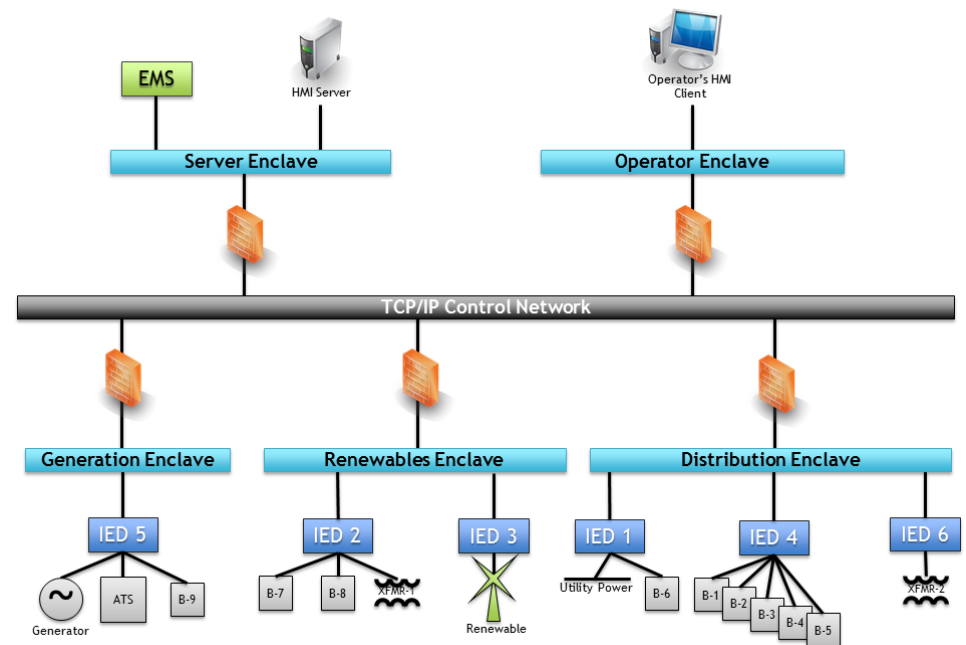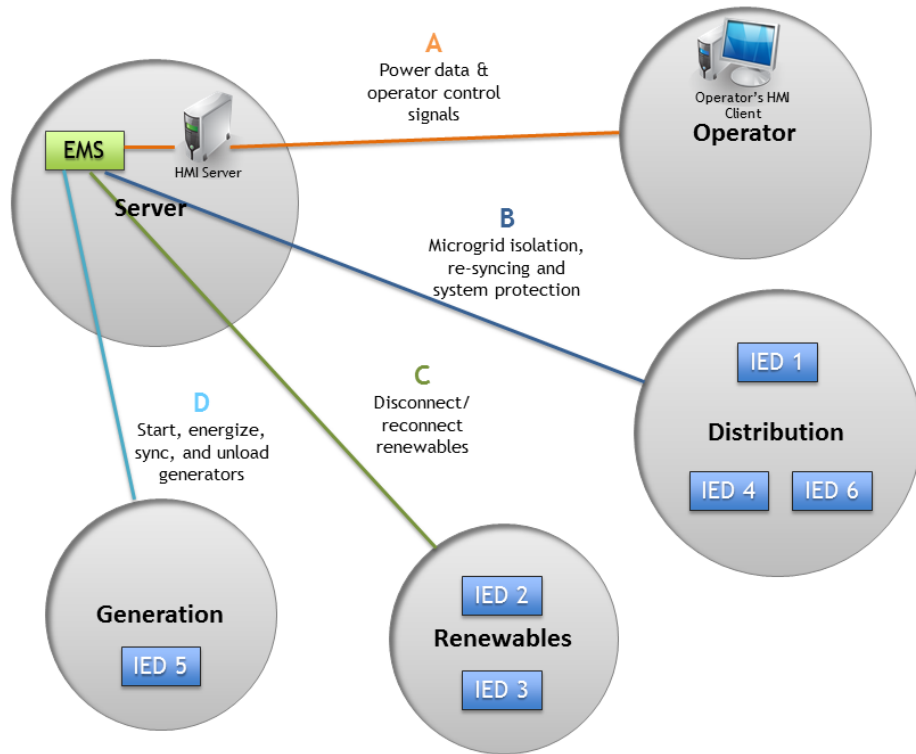Figure 1: Information Exchange Reference Diagram (P1547.3 Draft 11/03)

3.8 Network Segmentation

Questions?

Thank you!