INSTITUTO DE INVESTIGACIONES ELECTRICAS

Smart Grid Related Technology Development in Mexico. The IIE Case

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Electrical Research Institute (IIE)

US-Mexico Smart Grid Conference

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IIE - Smart Grid R&D activities

- The Electrical Research Institute (IIE) has been working in some Smart Grid R&D activities:
  - IEC 61850 Profile for Distribution Substations
  - Advance Metering Infrastructure
  - Home Energy Management Systems
  - Photovoltaic inverter
  - Distribution Operation Modeling and Analysis (On-line Simulator for decision support)
  - Semantic Interoperability

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IEC 61850 Profile for Distribution Substations

- The IEC 61850 Profile definition for Substation Automation System (SAS) functions for Distribution networks:
  - Protections, control and measurements
  - One-Line diagrams
  - Communication architecture and protocols
  - Logical Nodes
  - Common Data Classes (CDC)
  - Substation Configuration Language (SCL)

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Advance Metering Infrastructure

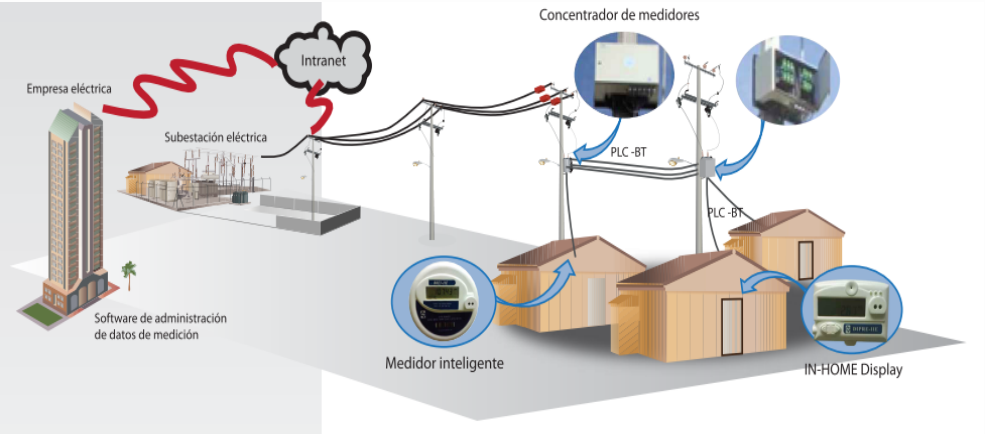
Integral Energy Metering System (SIM-IV)

SIM-IV, an Advanced Metering Infrastructure and energy loss detection system, is one of the smart grid key components.

SIM-IV principal goal is to help electrical utilities run better. It integrates the equipment and functions to measure electrical energy in order to obtain information required for billing, CRM/CIS, energy loss detection and power grid control of failures, among other utility's important functions. It can be easily customized, minimizing risks of obsolescence, given its modular and scalable architecture.

SIM-IV main elements:

- Metering concentrator.
- Electronic smart meters for energy metering at customer premises or at pole distribution level, with remote connect / disconnect service and netting.
- Pre-pay smart meter.
- In-Home Display.
- Meter Data Management System (MDMS).



SIM-IV technology has been transferred to a national manufacturer.

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Advance Metering Infrastructure

Integral Energy Metering System (SIM-IV)

SIM-IV is a helpful tool for:

<u>System operation</u>
- Increased meter reading accuracy.
- Energy theft.
- Power grid fault detection.
- Outage management.

<u>Customer service</u>
- Billing accuracy.
- Service restoration.
- Incorporation of smart appliances to the smart grid concept.

<u>Economic benefits.</u>
- Reduction or energy theft.
- Reduction of power grid equipment maintenance costs.
- faster restoration and shorter outages.

Electronic meters comply with International and National standards

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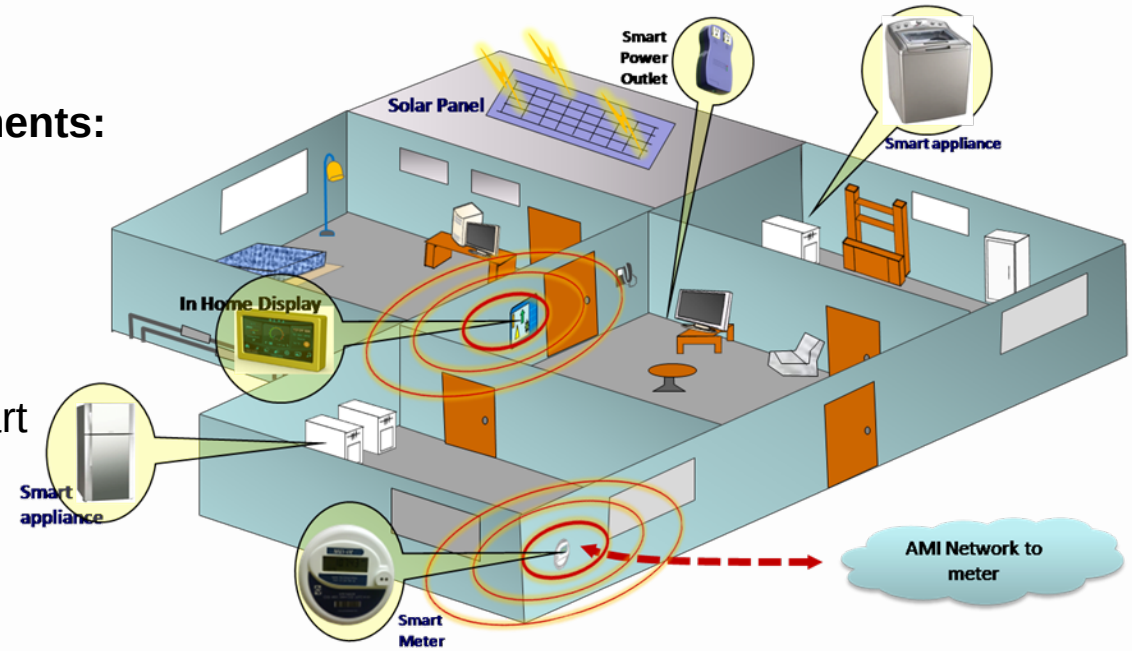
Home Energy Management System

Home Energy Management Systems (HEMS) provide the final consumers with information about energy consumption and its cost in real time or in defined time intervals. HEMS also include functions that enable the consumer to better manage their amount of energy consumption and its time of use.

The IIE is working on developing a HEMS in partnership with a national appliance manufacturer, in order to incorporate smart appliances to the Smart Grid concept.

The HEMS under development includes the following main elements:

- In-Home Display.
- Smart appliances:
  - ✓ Washer
  - ✓ Refrigerator
- Smart power outlet for non-smart appliances.
- Smart meter.
- Home Area Network.



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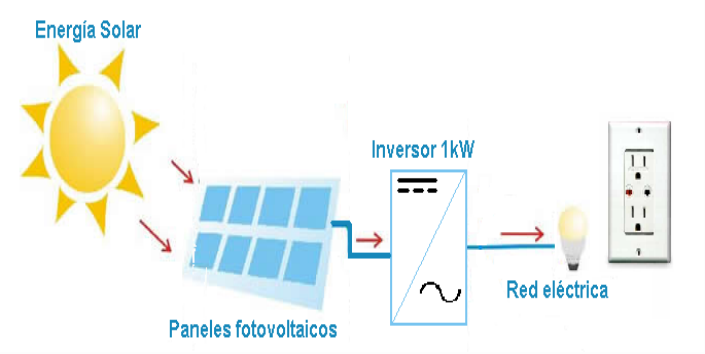
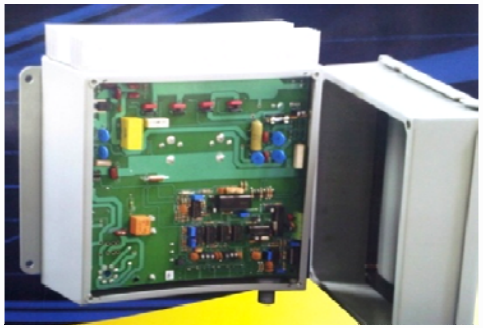
Photovoltaic inverter

The IIE is working to develop inverters for photovoltaic systems connected to the grid, which help to reduce dependence on energy from fossil fuels, thus contributing to reducing emissions. Additionally, contributes to the development of the national industry in the field of clean energy.



The IIE has developed a 1 KW photovoltaic inverter, addressed to high electricity consumption customers, with the main following features:

- 127 VAC and 220 VAC .
- Automatic start and stop under continues operation.
- Protection for over-voltage and over-current transients.
- EMI filtering of power line current.
- Transformer and transformer less operation.
- Islanding protection.
- Power grid energy netting.



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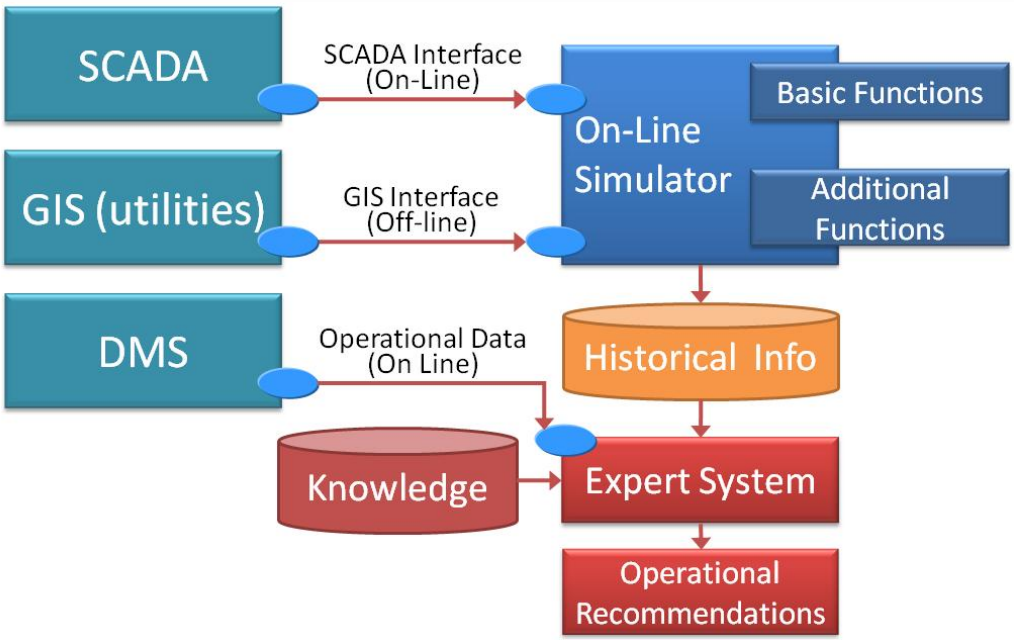
Distribution Operation Modeling and Analysis

- The On-Line Simulator is an engineering tool that allows studies of behavior and short-term prediction with updated on-line information in order to establish normal and contingency operation plans, optimal restoration strategies supported by calculation of indices and objective functions.

- Automatic verification of safety and operational levels (voltage profile, load profile, loss minimization, among others).



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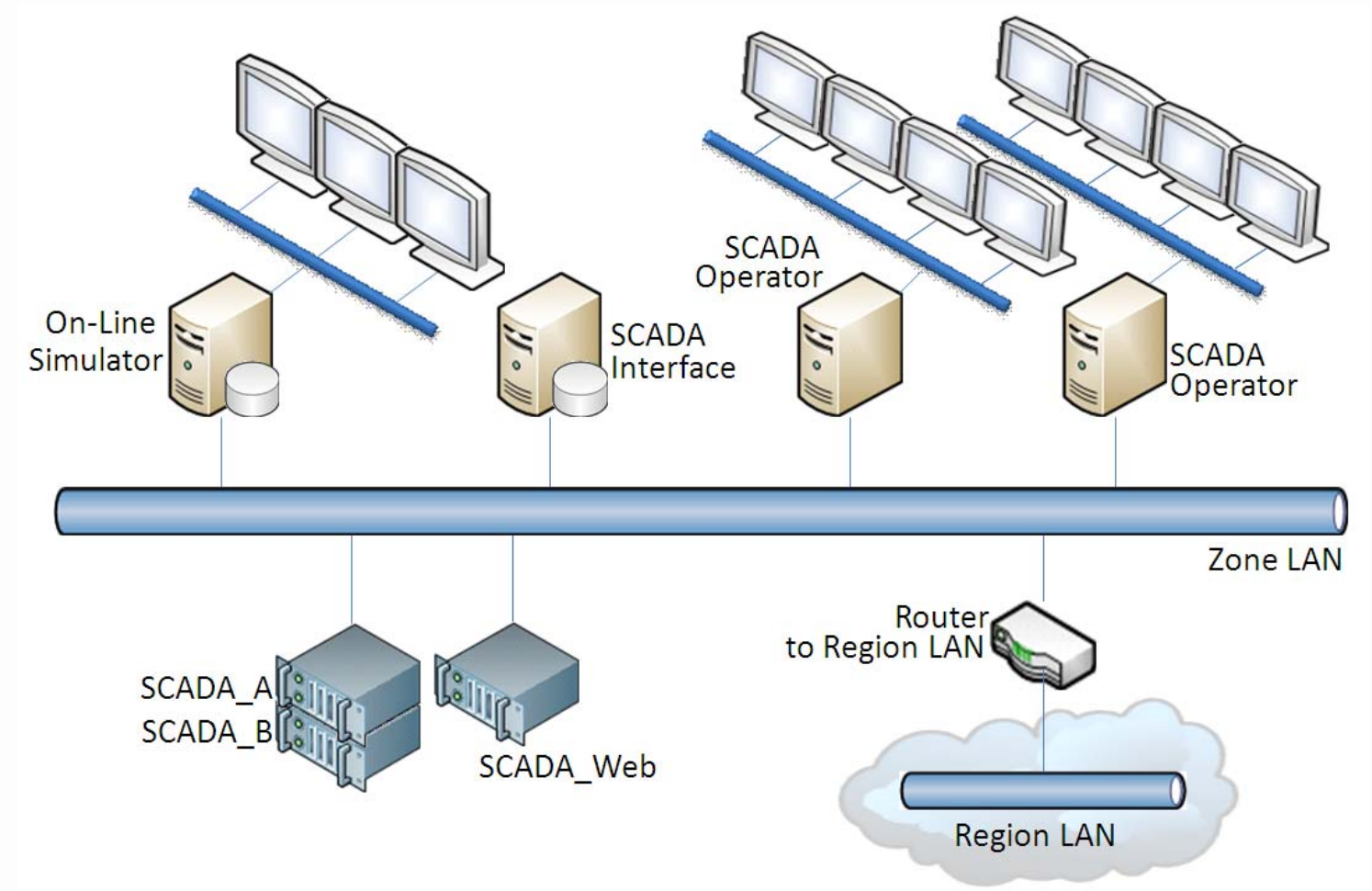
Distribution Operation Modeling and Analysis



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Semantic Interoperability

- In the Smart Grid context, the Smart Distribution Power Network (SEDI by its Spanish acronym) is a project for a more efficient, secure and reliable distribution network.
- SEDI includes the definition of how to improve or obtain: power quality, response time to failures, automatic detection and self-healing, flexibility to integrate distributed generation and storage, among others.
- One of the main goals of SEDI Project is to reach the semantic interoperability of legacy systems.

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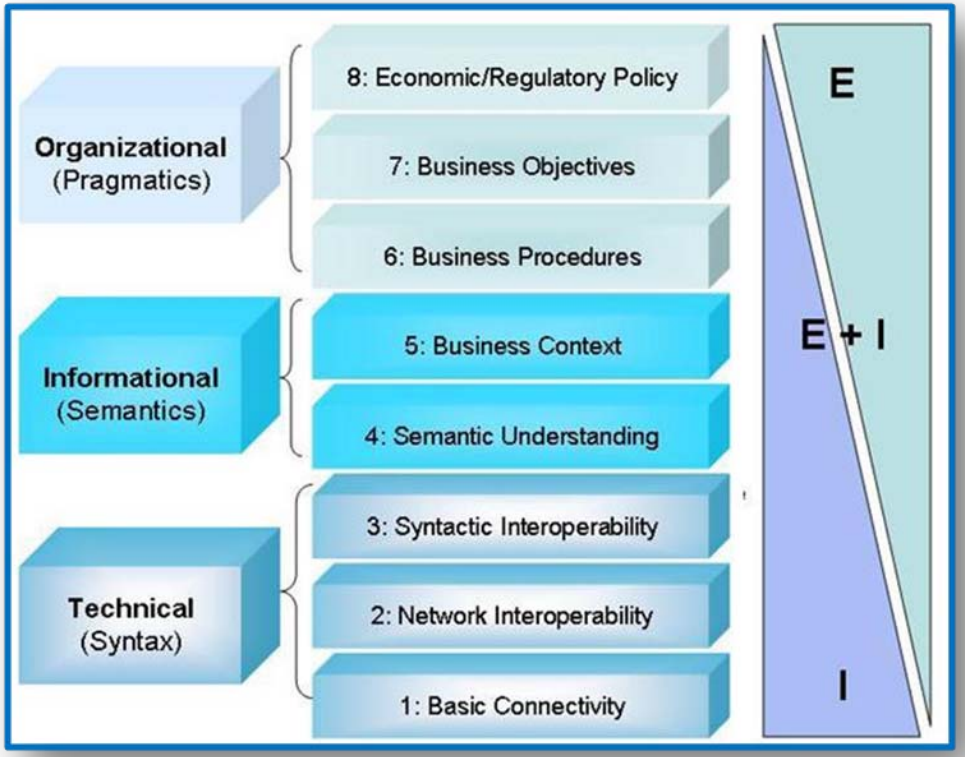
Semantic interoperability

- SEDI Project uses the GridWise Architecture Council - Interoperability Layered Categories.
- The Informational Interoperability Category (Semantics) is based on CIM definition.
- Common Information Model (CIM) is defined in IEC 61968 and IEC 61970.



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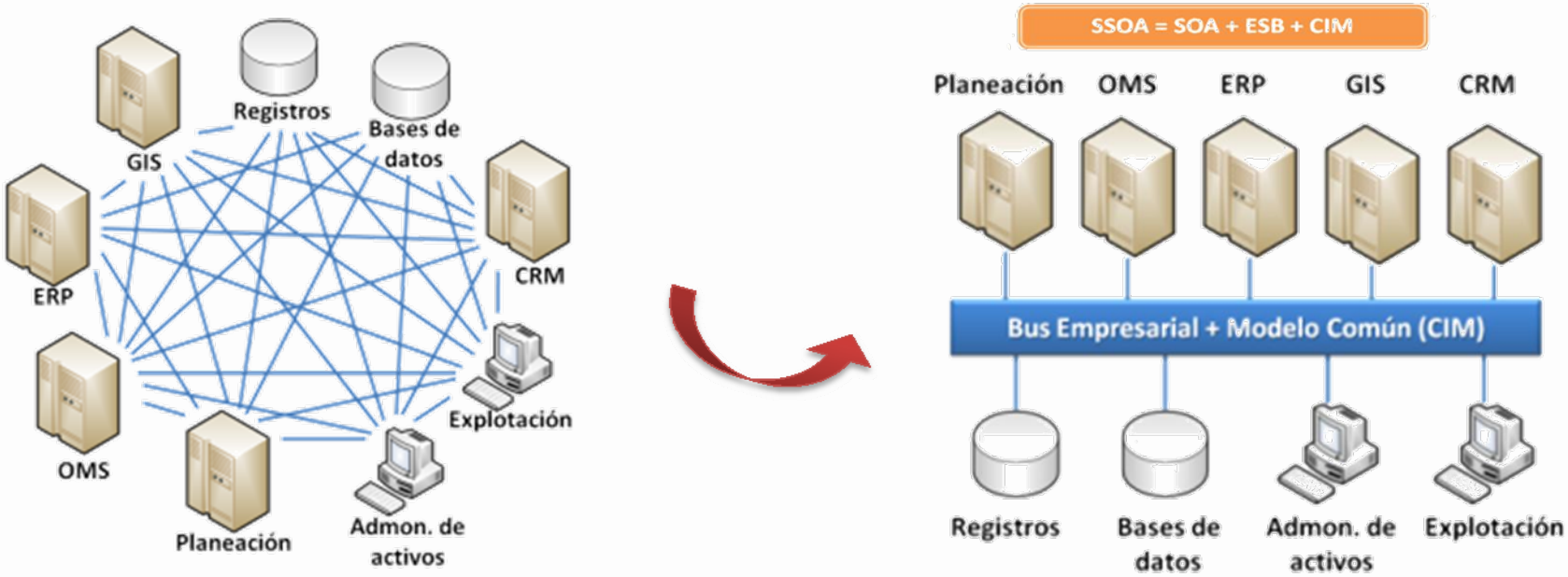
Semantic interoperability

- The goal is replace point-to-point interfaces, using a Semantic Service Oriented Architecture (SSOA) including an Enterprise Service Bus (ESB) and a Common Information Model (CIM)



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Semantic Model - Results

- IIE is developing the Semantic Model and CIM Instances for Distribution Network. The obtained results include:
  - The topological model of Distribution Network (georeferenced) from 135 kV up to 13.8 kV.
  - The one-line diagrams for Distribution Substations.
  - The electrical and physical models of the electrical elements (electrical assets) and integrated devices (such as telecontroled devices).
  - SCADA data acquired in real time.
  - Historical data of Distribution Substations.
  - Important customers (VIP) that are connected to the Distribution Network in MV.
  - Operational data (failures and maintenance).
  - Historical data of power quality events (Sags and Swells).

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