Using AMI to Realize the Smart Grid

David G. Hart

July 2008

What is AMI?

Advanced Meter Infrastructure (AMI)

- Smart meters with two way communications
- Self configuring
- Self healing
- Offer new functionality such as:
  - Interval data
  - TOU data
  - Home automation
  - Service connect/disconnect

AMI Network

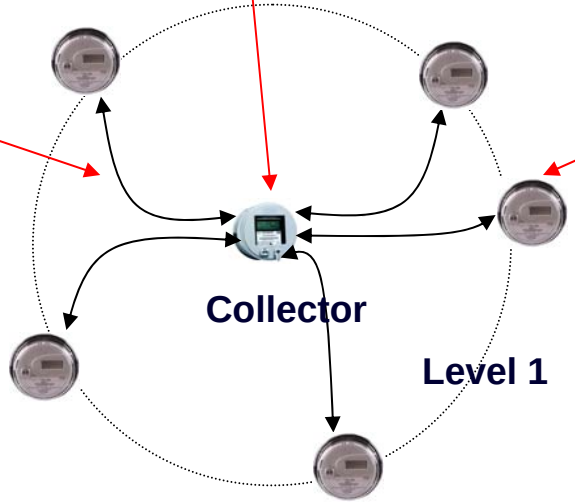
Steps

1. **Collector looks for unregistered nodes**
2. **Collector registers level 1 nodes**

A3 Meter with WAN interface is the Collector

A3 Meter or REX Meter acts as a node in the Mesh Network

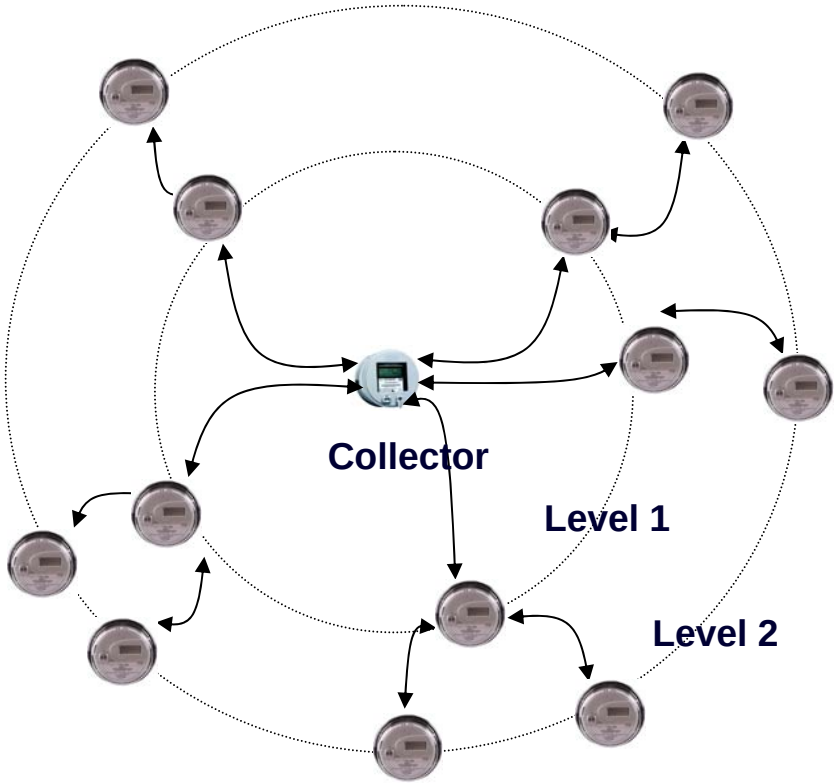
Each path is qualified !



AMI Network

Steps

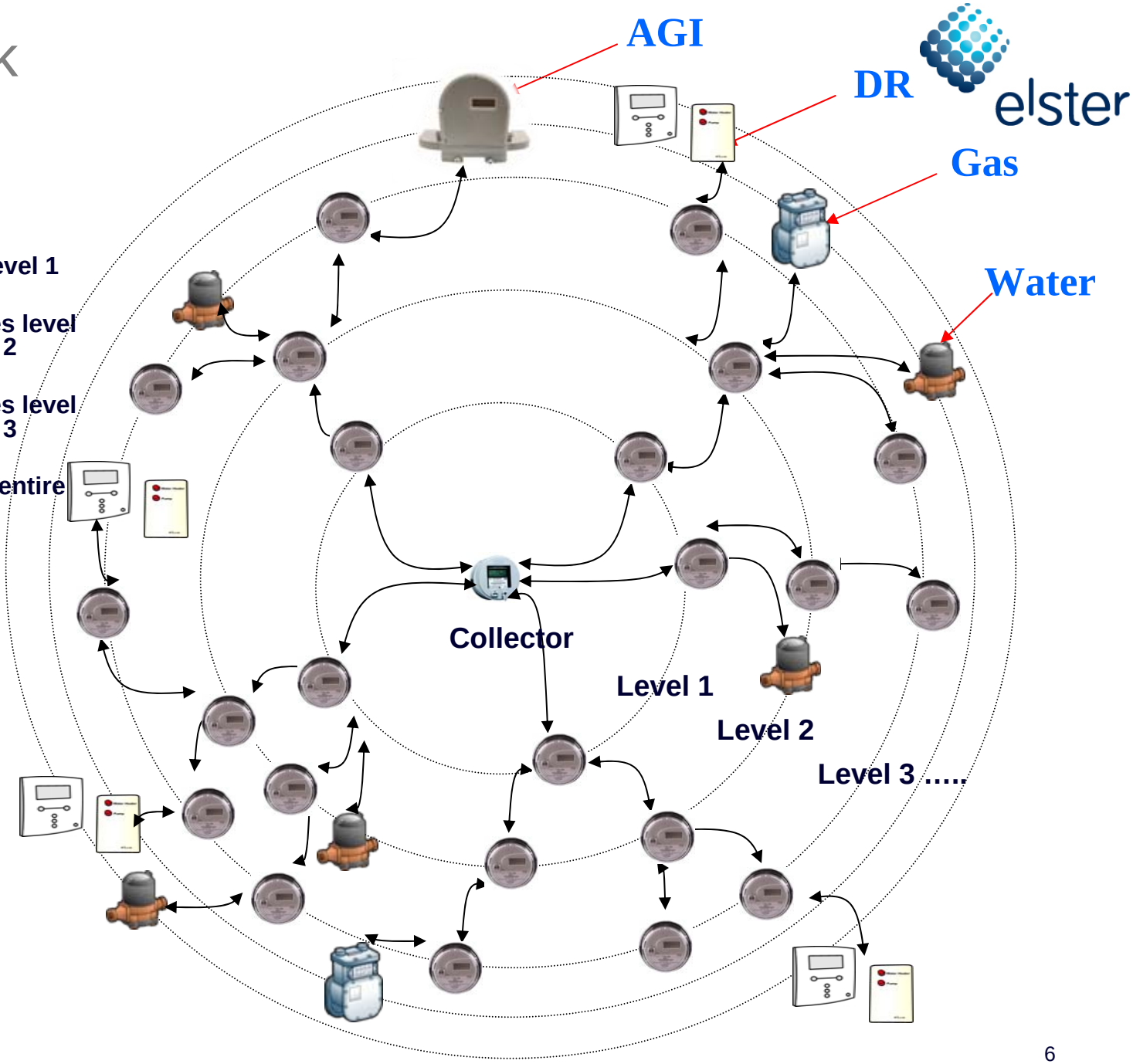
1. **Collector looks for unregistered nodes**
2. **Collector registers level 1 nodes**
3. **Collector interrogates level 1 nodes to find level 2 nodes**



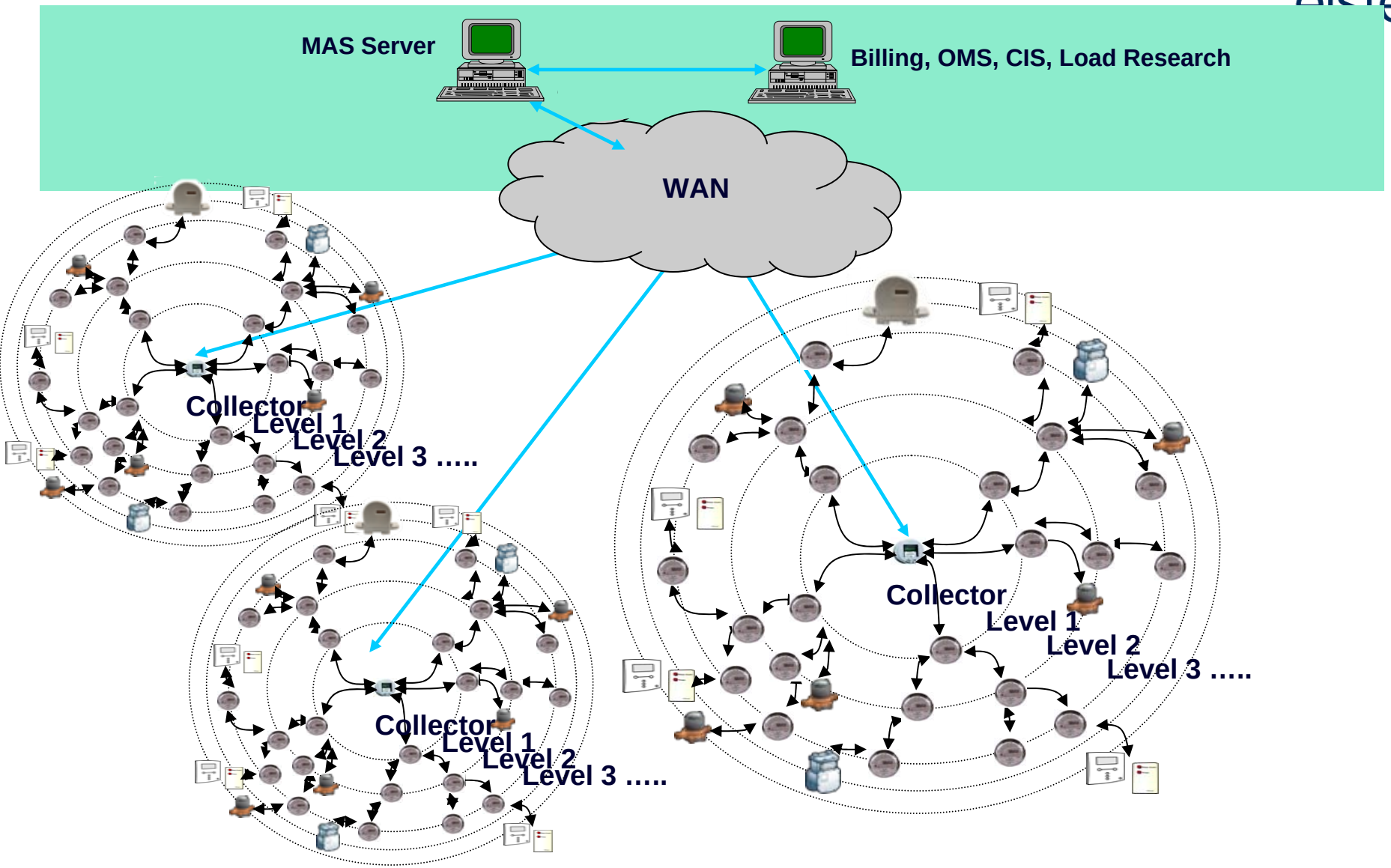
AMI Network

Steps

1. Collector looks for unregistered nodes
2. Collector registers level 1 nodes
3. Collector interrogates level 1 nodes to find level 2 nodes
4. Collector interrogates level 2 nodes to find level 3 nodes
5. Collector builds out entire network



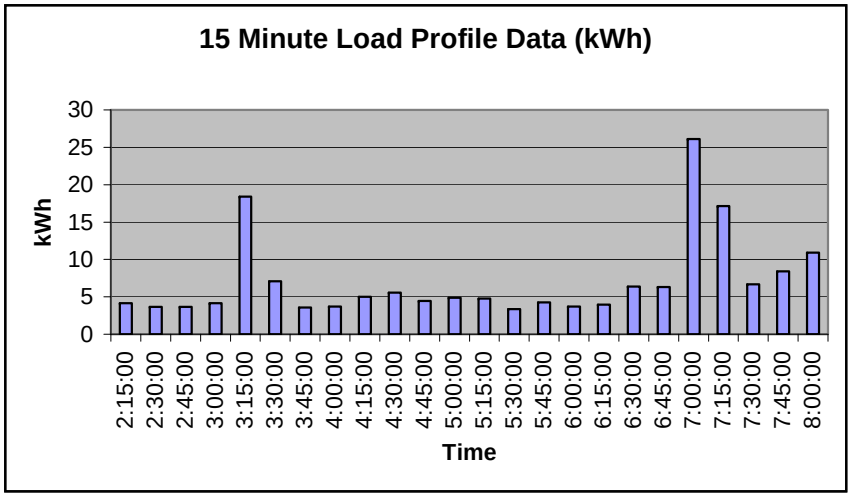
AMI Network



Meter Functionality

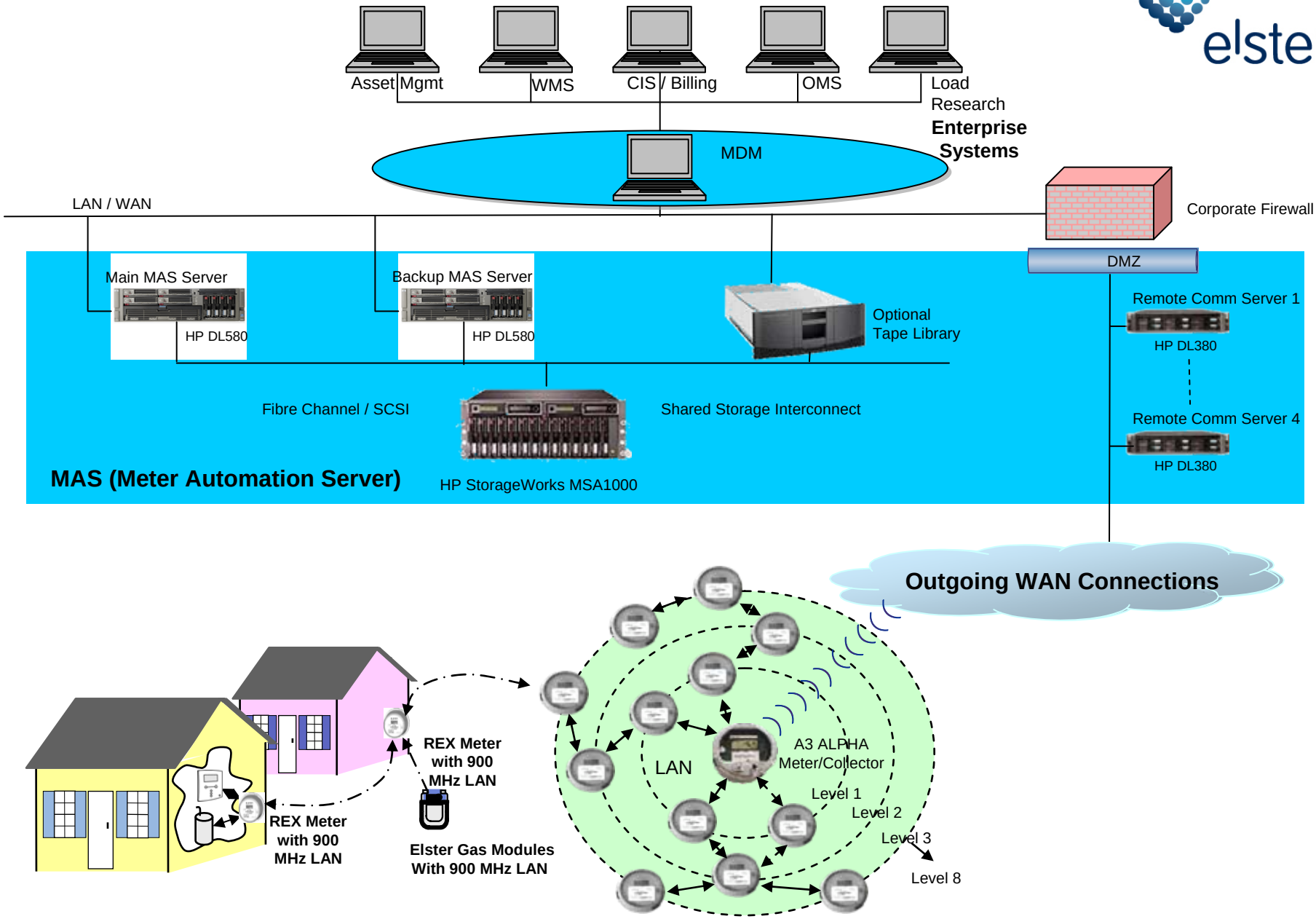
Meter calculates:

- kWh-delivered
- kWh-received
- kWh-delivered+received
- kWh-delivered-received (not available as a demand source)
- Alternate energy sources (VARh and VAh available Q4 ’08). Firmware will be upgradeable remotely
- Interval data
- Demand data



Meter Data	
Tier A kWh	1949
Tier B kWh	748
Tier C kWh	7319
Tier D kWh	718
Tier E kWh	767
Total Received kWh	0
Total kWh	11501
Max Demand 1	2.37
Max Demand 2	2.37
Voltage	242.43

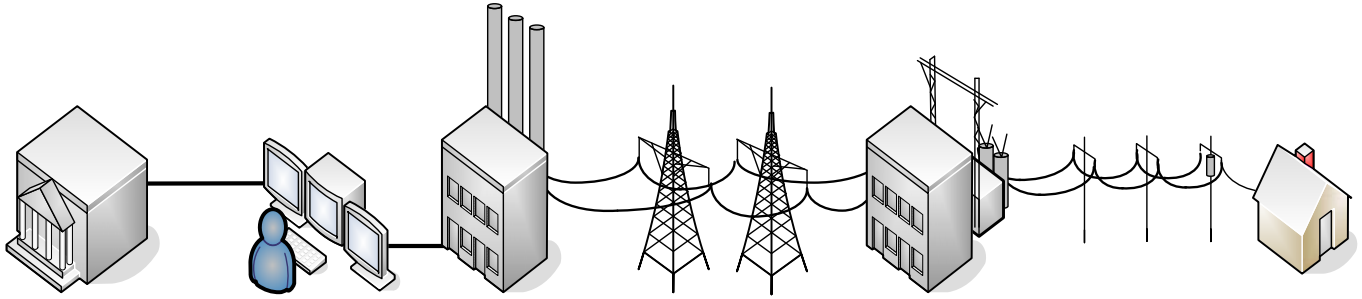
AMI - Architecture Overview



What is the Smart Grid?

Elster is a member of EPRI's IntelliGrid Program

Supporting the Power Delivery System of the Future



Uses open standards-based architecture

Integrates data communications networks and intelligent equipment

Provides the methods, tools, best practices and recommendations for specifying "intelligent" systems to promote:

- Interoperability
- Flexibility
- Expandability
- Effective security for data and system management

Content provided by EPRI, the IntelliGrid Program

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Vision of Smart Grid

- Self healing distribution power grid
- Grid free of disturbances such as sags, swells, interruptions
- Secure operation
- Accommodates a wide variety of generation options
- Optimizes Asset Utilization and O&M expenses

How does AMI help realize the smart grid?

Elster's View of the AMI and the Smart Grid

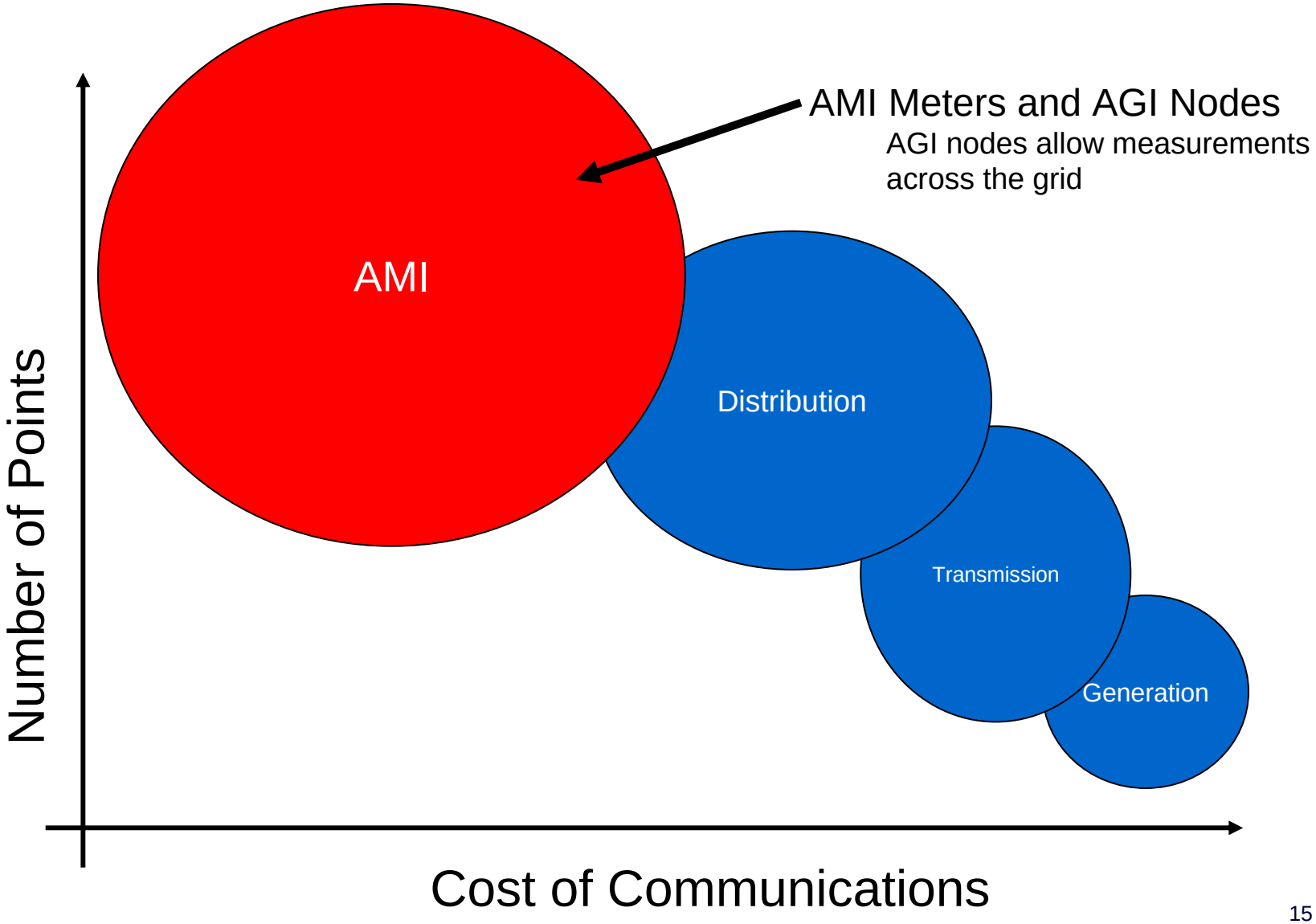
- There is no single definition of Smart Grid
  - Many define Smart Grid from 50,000 feet

- AMI is a key part of the Smart Grid but not the only part
  - Start by leveraging AMI infrastructure

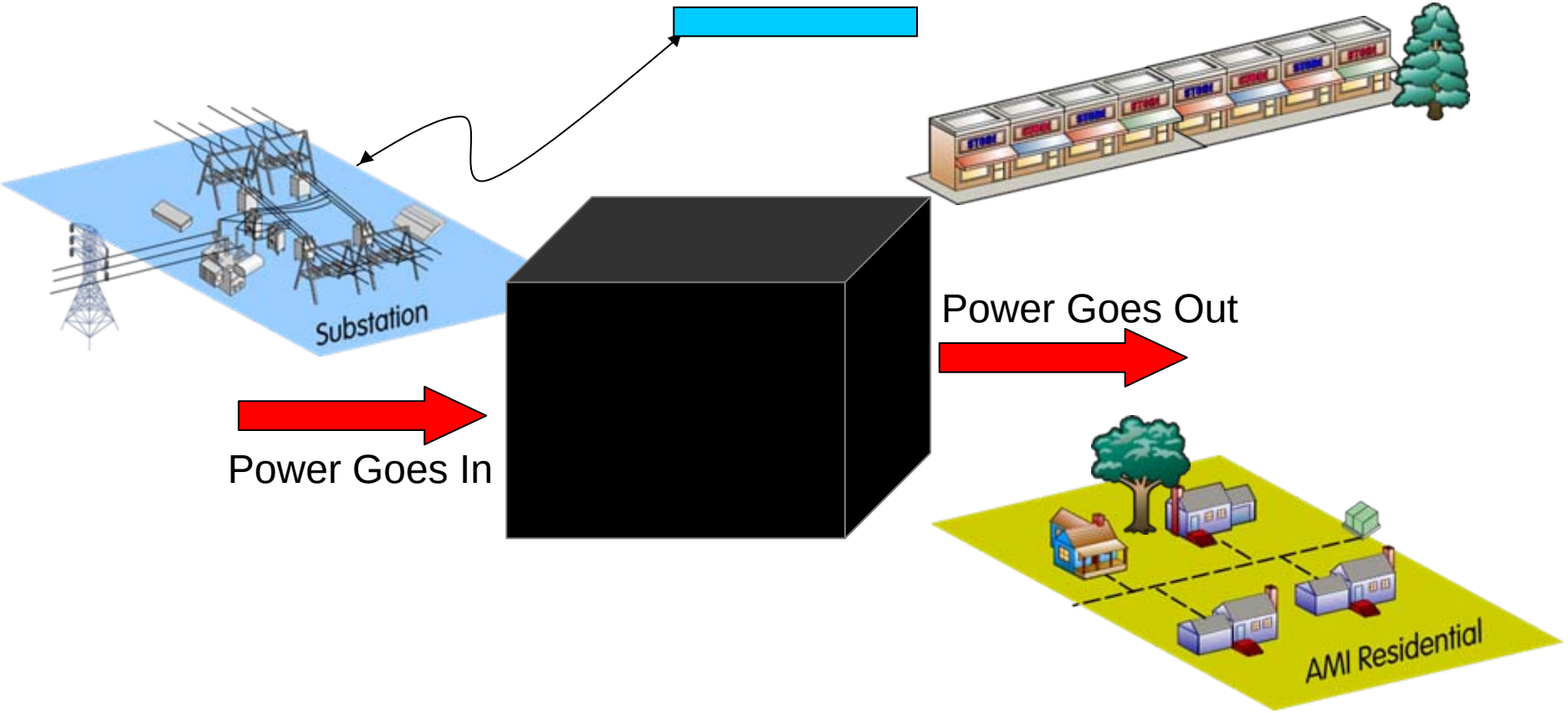
- AMI vendors need to partner with utilities and key technology partners to realize components of the smart grid

Smart Grid $\cap$ AMI = AGI

AMI Allows for more economical remote sensing

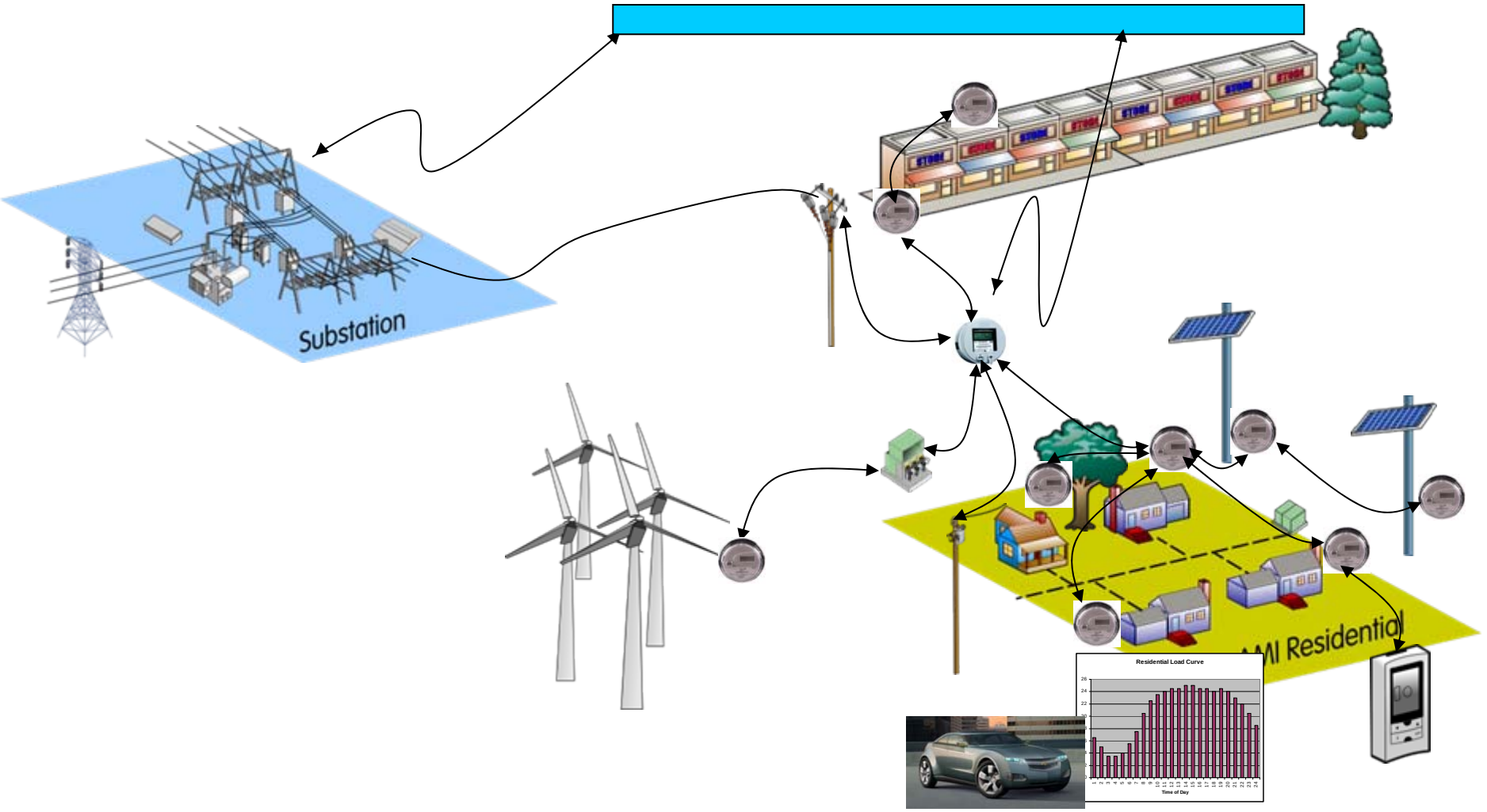


Power Grid Today



Smart Grid Tomorrow

DMS Billing O&M Planning Customer Service



- ***We should not think of AMI endpoints as traditional revenue meters but as Advanced Grid Infrastructure (AGI) nodes.***

Today an AMI device or endpoint looks like:

Tomorrow AMI endpoints will ***also*** look like:

AGI Endpoints

FieldMetrics®

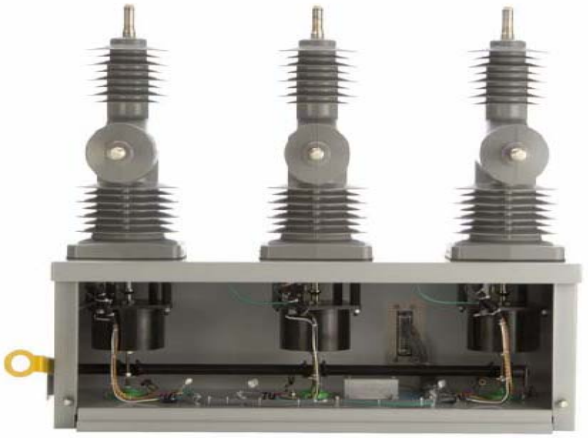
MV Overhead Line Sensor Node

LV Distribution Transformer Node

SensorLink®

Thermostat

MV Underground Line Node

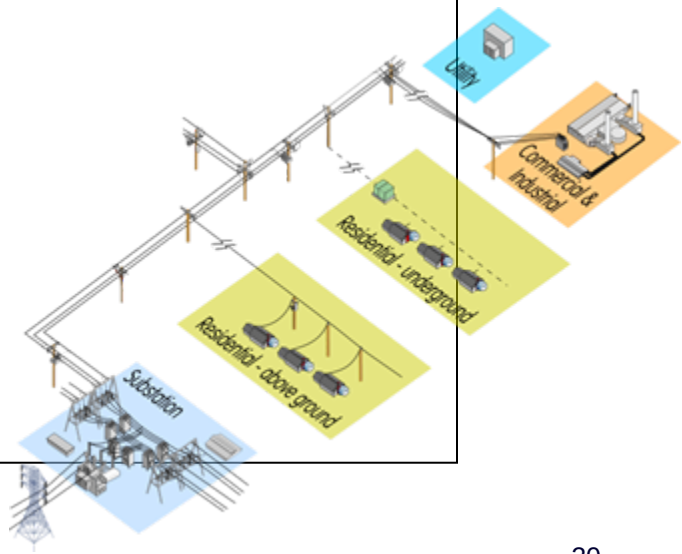


ABB

MV Recloser Node

AGI – the Benefits

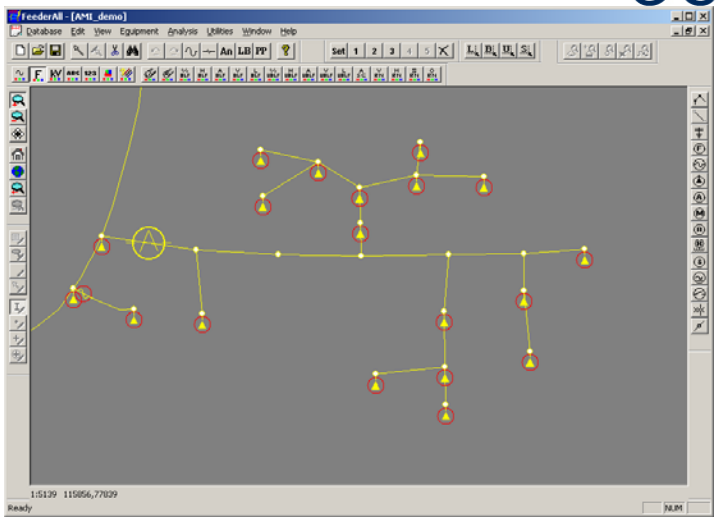
Customer Service	Operations	Planning
• **Outage Management System** – use smart meters to report outages • **Power Quality** – use smart meter voltage reporting to better understand voltage profile across system •**Customer Usage** – use smart controls to level loads and inform customer of usage (IHD)	• **Efficiency** – central Volt/Var control • **Maintenance** – Use outage indices to target areas needing maintenance • **Reduce Losses** – Tamper detection • **Reduce Losses** – Non-technical loss detection • **Load Flow** – improved data for load modeling for renewables or switch reconfiguration -	• **Loading** – use historical data to obtain better information on transformer/feeder loading

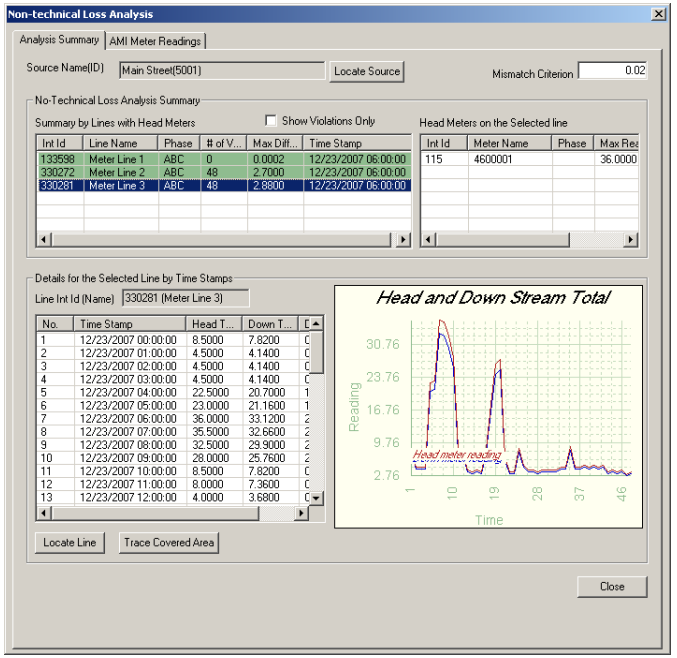


Some Examples

Pilot for Loss Detection

- Joint utility/Elster/ABB pilot to demonstrate loss detection
- ABB FeederAll allows user to model electrical network
- Head and load meters are modeled in the network
- Elster meter data is imported from files
- User initiated trace shows the loads and circuit covered by a head meter
- Dynamic trace detects head meters downstream from an upstream head meter
- Downstream head meter reading is subtracted
- Difference indicates losses





Thermostats with Load Control

- Deployed in the field
- Expands the basic Energate thermostat to provide:
  - event status information

LOAD CONTROL DEVICES

	EVENT	START	END
	THERMOSTAT	NONE	NONE
⏻	POOL PUMP	12:04	2:34
	WATER HEAT	2:00	4:00
	SWITCH 4	4:00	10:00
	ANY EVENT		

EXIT

  - energy use information

ENERGY USE TOU RATE A $$$$

NOW: 3.726 KW

TOTAL ENERGY
560 KWH

ESTIMATED COST
$ 39.20

BREAKDOWN

RATE	KWH
A:	88
B:	89
C:	383

EXIT

Conclusions

- AMI will become a key part of the smart grid
- AMI has the potential to provide significant missing measurements in distribution power system applications, providing solutions matching real-time conditions throughout the distribution network
- AMI provides the capability to:
  - verify and improve real-time per phase unbalanced load flow
  - outage and restoration notification
  - Understand load flows on the distribution grid
  - Improve planning
  - Improve maintenance
  - Inform customers of usage
  - Initiate load conservation
- If you believe the future requires more energy generation, better control and conservation are also required

Thank You !