Smart Energy

Mihail Botez  Product Sales Specialist, IoT
Edward Agostinho  Consulting Systems Engineer, IoT
Utility Industry Megatrends

Changing customer expectations resulting from the digitization of services allowing anytime, anywhere personalized services

Rise of social networks the ability to quickly form communities of interest and communicate instantaneously with a billion people globally via text, video and/or voice

Pervasive connectivity and computing is unlocking a sea change in productivity gains for businesses, disrupting existing businesses and creating new opportunities for agile firms

Expansion of energy markets for distributed energy resources enabling greater adoption and increased transactions

Financial innovation that is enabling a wide range of customers to amortize initial capital costs of DER to align with benefit cash flows and make a stronger value proposition

Energy technology advancements for power system and distributed energy technologies are accelerating at exponential rates while also converging to enable breakthroughs on business models and system performance
Global Policy Driving Decentralization

USA
43 States have NEM policies & 3.3 GWs of Solar PV installed thru 2012. Installed prices for PV systems fell 27% in 2012. White House targets 122 GW of CHP.

Europe
Germany’s Energiewende: from nuclear to renewable and distributed energy. Volkswagen launched natural gas engine residential CHP unit. Solar PV reached retail parity in Germany, Spain and Italy.

Japan
Ene.farm Sm. Comm. & Residential fuel cell program gaining market traction. Solar PV & battery storage subsidies driving adoption.

China
Launched new policy to encourage distributed energy resources up to 6MW in size and allow surplus to be sold openly.

Brazil

Australia
Australian solar PV market currently at 2.5GW, will likely grow to 6GW~10GW by 2017. Rooftop solar PV is reducing overall electricity demand by 3%.
Transformation: Doing Both

**INNOVATION**
- Engage customers with new technology and process enabled services
- Create new business lines to profit from expansion of customer adoption of DER

**UTILITIES**
- Integrate mobility and workforce automation to enhance operations
- Add connectivity and Intelligence to enable new business opportunities

**CORE**
- Improve Grid Infrastructure and Reliably to Support Increasing Demand / Variability
- Expanded Capacity and New Power Systems Technology

**GROWING**
- 21st Century Utilities

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What’s on Your Mind?

ALIGN MARKETS and regulation to public policy

ASSET OPTIMIZATION...improving reliability and utilization

WORKFORCE PRODUCTIVITY...safety, new skills, knowledge transfer

INVESTMENT PROTECTION...business and technology architecture alignment

SECURITY, SECURITY, SECURITY
A Modernized Grid Is Part of the Internet of Things

But, What Is the Internet of Things?

"The Internet of Things is the intelligent connectivity of physical devices driving massive gains in efficiency, business growth and quality of life."
Cisco Calls It the Internet of Everything (IoE)

People
Connecting People in More Relevant, Valuable Ways

Process
Delivering the Right Information to the Right Person (or Machine) at the Right Time

Data
Leveraging Data into More Useful Information for Decision Making

Things
Physical Devices and Objects Connected to the Internet and Each Other for Intelligent Decision Making

Networked Connection of People, Process, Data, Things
What Will it Take?
Operational Technology Network Transformation

From Basic Connectivity...  
...to a Critical Part of the Enterprise Infrastructure

From Proprietary Standards...  
...to Open Standards

From Disparate IT and OT Networks...  
...to Converged, Secure, and Collaborative Operations
Cisco Connected Energy Networks
Key Components

Solutions
Core foundation of the network: routing, switching, security

Architecture
The role of the network as a critical element in grid modernization, delivering business and technology architectures

Services
The role services and partners play for delivering customer value at every point in the emerging energy value network
Utility Solutions & Architectures
Cisco Internet of Things Portfolio

Manufacturing | Mining | Energy-Utity | Oil and Gas | Transportation | City | Defense | SP/M2M

Plantwide Ethernet, Intelligent Transportation, Smart Cities, S&C Refinery, Smart Connected Vehicle, Smart Grid

Plant Switching | Plant Routing | Field Network | Embedded Networks | Physical Security

IE 2000, IE 3000, CGS 1000, CGS 2500

IE 3000

CGS 1000

CGS 2500

CGR 2010

CGR 1000

IR500 DA Gateway

1552 Rugged Wireless

819H M2M ISR Gateway Router

5915 Embedded Services Router

3200 ESS2000

Video Surveillance Manager and IP Cameras

Physical Access Manager

IPICS

Network Management and IoT Security

Fog Computing

Data Center/Virtualization
Building an IoT Ecosystem

VTERTICALS

Manufacturing
Mining
Energy-Utity
Oil and Gas
Transportation
City
Defense
SP/M2M

INDUSTRY PARTNERS

INDUSTRY PARTNERS

IoT ENABLERS

RUGGEDIZED PRODUCTS

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CISCO’S APPROACH TO IoT

“Customer-In” Approach
- Understanding of key business care abouts and pain points
- Relevance to LOB leaders / CXOs

Products/Technologies
- Best-in-class ruggedized products
- Smart solutions for verticals
- IoT architectures

Strategic Partnerships
- Industry partners
- Vertical software / service partners
- Service providers

VERTICALS

Building an IoT Ecosystem

VTERTICALS

Manufacturing
Mining
Energy-Utity
Oil and Gas
Transportation
City
Defense
SP/M2M

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GridBlocks™ Reference Model

- Describes the power delivery chain
- Architectures detail networking each of the eleven tiers in this model
- Results in a complete end-to-end architecture for converged power delivery chain communications
- Framework for:
  - Integrating legacy devices
  - Using existing products in new ways
  - Integrating new ecosystem partners
  - Developing new products and services
- Provides a platform for innovation
Cisco GridBlocks™ Architecture
Systematic Approach to Grid Modernization

Reference Model

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“The ability to leverage our infrastructure with Cisco's telecommunications ability is a great stepping stone into smart grid. We'll be able to leverage it for years to come.”

Gary Murphy
Chief Project Officer,
Smart Metering Program
Electric Grid Market Transition

Multiple Energy Sources
Unpredictable Voltage Levels
Human Intervention Too Slow

Government Regulation
Central Operations
Not Scalable

CENTRALIZED Analytics, Control, and Protection Applications

Business Application No. 1
Business Application No. 2
Business Application No. 3

Network No.1
Network No.2
Network No.3

Device No.1
Device No.2
Device No.3

DISTRIBUTED Analytics, Control, and Protection Applications

Business Application No. 1
Business Application No. 2
Business Application No. 3

Converged IP based Network

Device No.1
Device No.2
Device No.3
High Level View of a Utility Network

**DATA/CONTROL CENTER**
- Redundant MPLS PE
- Connected to optical backbone

**OPTICAL/ MPLS CORE**
- DWDM with ROADM and long haul
- MPLS P routers

**REGIONAL AGGREGATION**
- Aggregation at transmission sub
- Other aggregation at other regional POPs
- Connection to optical backbone

**TRANSMISSION AND DISTRIBUTION SUBSTATIONS**
- Requiring substation hardened products
- Providing NERC/CIP compliance
- Advanced network services
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Leased (T1, T3, OC-N, Carrier Ethernet)

Private Wireless (Microwave, LTE)
High Level View of a Utility Network

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FAN

FAN Aggregation

Leased (T1, T3, OC-N, Carrier Ethernet)

Private Fiber

Private Wireless (Microwave, LTE)

Esp
High Level View of a Utility Network

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- Advanced network services

WAN

Leased (T1, T3, OC-N, Carrier Ethernet)

Private Fiber

Private Wireless (Microwave, LTE)

SP Private Line or Ethernet Service

Multiservice

CE Router

Substation

IEDs

ESP

CE

FAN Aggregation
System Scope
Cisco Route, Switch, and Compute Product Portfolio

Substation LAN
- CGS-2k
- IE-2000U

Substation WAN Edge
- CGR 2010
- ASR 903

Core Network
- ASR 903
- ASR 9000
- CRS

Data Center and Control Center
- ASA CX
- ISR G2
- ASR 1000
- Nexus 1000V
- Nexus 2000-5000
- Nexus 7000
- UCS Blade Servers
- Fabric Interconnect & Extenders
- UCS Rack Servers

Network Management
- Prime Carrier Management
- Prime Infrastructure
- Prime Data Center

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System Overview
Teleprotection refers to the use of communication to improve performance of protection schemes:
- Permissive, blocking, direct-trip, differential etc.

Protection requirements: deterministic + reliability + speed

- Relay system operation time is measured in cycles (one cycle = 16.67 ms in a 60 Hz system)
- Communication network latency typically expected to be 4-16 ms
- Relay attachment circuits (interfaces): C37.94, E1/T1, X.21, E&M, RS422, and recently Ethernet
Use Case: Inter-Substation Protection

FEATURES:

- Circuit emulation for traditional teleprotection with legacy interfaces: X.21, RS232, E&M, T1/E1, C37.94
- EoMPLS for IEC61850 teleprotection
- Firewall for management interfaces
MPLS Transport for TDM, Serial, and Ethernet Interfaces

1. Channel bank
   - Teleprotection Relay
   - T1/E1
   - STM-1/OC3
   - STM-4/OC12

2. SCADA RTU
   - RS232
   - VRF
   - TCP Raw-Socket over MPLS VPN

3. Station bus
   - IEC 61850 relay
   - Ethernet GE, 10GE

4. Station bus
   - Multiservice bus
   - IEC 61850 IED
   - Ethernet GE, 10GE
   - VFI
   - VPLS

5. Station bus
   - Multiservice bus
   - IEC 61850 IED
   - Ethernet GE, 10GE
   - VRF
   - L3 MPLS VPN

- Channel bank
- Teleprotection Relay
- SCADA Master
- Front end processor
- Station bus
- IEC 61850 relay
- Station bus
- Multiservice bus
- IEC 61850 IED
- Station bus
- Multiservice bus
- IEC 61850 IED

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Network Management
- Prime Carrier Management
- Prime Infrastructure
- Prime Data Center

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Substation Network Tier

Utility Private MPLS/IP WAN

Substation Network

Electronic Security Perimeter (ESP)

Serial, C37.94, E&M

Legacy RTU

Legacy Teleprotection Relay

Comm Processor

Bay Controller

RTU

PMU

PDC

IEC 61850 Station Bus

Protection Relay

Defined Physical Boundary (DBP)

Multiservice Bus

Physical Security

Workforce Enablement

Hardwired I/O

PT CT Breaker Sensor

IEC 61850 Process Bus

Breaker IED

Security Router or Appliance

IP WAN

HMI

Distributed Controller

ITU
High Level View of a Utility Network

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- Requiring substation hardened products
- Providing NERC/CIP compliance
- Advanced network services

FAN

- FAN Aggregation
- Leased (T1, T3, OC-N, Carrier Ethernet)
- Private Fiber
- Private Wireless (Microwave, LTE)
- CE Router
- Substation
- IEDs
- IP
- Multiservice
- MPLS PE
- Multiservice
Cisco Field Area Network Portfolio

- CGR 1000 Series with IOX
- IPv6 RF Mesh and PLC SDK
- IPv6 Endpoint SDK
- Cisco 819H Series
- Cisco IR 500 DA Gateway
- CG-NMS
- CG Device Manager

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Multi-Service Field Area Networks
Last Mile Communications Networks (IoE)
Unified FAN Architecture

- Flexibility in Network Design: Coverage, Capacity, and Latency
- Media Agnostic Network Services
- Tiered Architecture: Separation of Communication and Applications
- Scalability and Interoperability
- Ease of Use to Reduce Total Cost of Ownership
- Security and Compliances

Network Management and Security
- Certificate Authority
- Intrusion Prevention
- Access Control
- Directory Services
- Network Management and Security

Multiple Head-End
- CG-NMS
- SIEM
- Access Control
- Directory Services
- Third-Party CGE DA Devices--SDK

Single Converged
- MDM
- CIS
- Historian
- Data Center, Enterprise Apps

Evolution of FAN
- EVSE Mgmt.
- DER
- Dist. Planning
- IWC
- FLISR
- SCADA
- AMI/Smart Metering
- Reliability Improvement
- Energy Savings
- Asset Management
- Operational Efficiency
- Distributed Solar
- EV Charging Station
- C&I Services
Fog Computing

Traditional Computing Model
(Terminal/Mainframe, Client-Server, Web)

- Data Center/Cloud
- Speed of Light
- Latency-Critical
- Responsiveness Required
- Resiliency
- Security
- Data Grows Faster Than Bandwidth
- Assumes Infinite, Bandwidth, 0 Delay
- Endpoint

IoT Computing Model

- Data Center/Cloud
- Assumes Limited Bandwidth, Variable Delay, and Intermittent Connectivity
- Fog
- Assumes Limited Bandwidth, Variable Delay, and Intermittent Connectivity
- Device

Data Grows Faster Than Bandwidth

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Underlying Security Principles

Access Control
- User and device identity
- Authentication, authorization, and accounting

Data Confidentiality and Data Privacy
- Network segmentation
- Security connectivity and encryption (VPN)

Threat Detection and Mitigation
- Security zones and firewall
- Intrusion prevention

Device and Platform Integrity
- Device hardening
- Configuration assurance
Connected Grid Security Architecture

- Certificate-based identities, user names, and passwords
- Role-based access control
- 802.1x-based access control for meters, routers, grid devices
- Link-layer encryption in RF mesh
- Group-based key generation and management (mesh)
- Network-layer encryption for WAN backhaul (IPSec)

Security Services
- Directory Services
- AAA Server
- Certificate Authority
- Intrusion Prevention

AMI Head-End
- NMS
- HES
- SIEM

Public or Private WAN
- FAN Aggregation Layer Within Substation Automation Network
- Mobile Workforce

Neighborhood Area Network (RF Mesh)
- Field Area Router (FAR)
- CGR 1000 Series

Smart Meters

Secure Device Identity via Digital Certificates
Strong User Identities with Role-Based Access
Time-Stamped logs, Correlation at SIEM
Separation of AMI vs. Non-AMI Traffic, Segmentation

Secure Encryption Keys
Network-Layer Encryption (IPSec)
Link-Layer Encryption (AES-128)
Safety and Security Portfolio

PHYSICAL SECURITY INFORMATION MANAGERS (PSIM)

- Video Surveillance
  - Video Surveillance Manager
- Unified Incident Communications
  - IPICS
- IP Cameras
  - Standard Definition and High Definition IP Cameras
- Access Control
  - Physical Access Manager

END-TO-END:
- Medianet Enable IP Network
- Virtualization
- Security
- Management

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Questions
Thank you.
Additional - Case Studies
FAN / AMI Case Study

**CHALLENGE**
- Legislation challenged Massachusetts utilities to provide AMI and dynamic pricing for customers to achieve 5% energy savings
- Goal to establish meter network, data collection and management system, theft detection solutions

**SOLUTION**
- Itron as supplier of smart metering system and meter data management, collection engine and reporting software
- Cisco for Field Area Network solution with IR 500 providing DA communications
- Itron OpenWay® platform over a multi-application communication network powered by Cisco

**RESULTS**
- 14,500 meter endpoints installed by end of 2013; “zero-touch” deployment
- Proven operation of multiple applications simultaneously over IPv6
- Remote and secure technology upgradability over the air; network load balancing and monitoring

“We have been very pleased with the results of the early field trial. We look forward to working with Itron and Cisco on the next phase of implementing our smart grid pilot program.”

Cherri Warren, Vice President, Asset Management National Grid

Press Release, January 2013
FAN / AMI Case Study

**CHALLENGE**
- Deploy two million smart meters by the end of 2012 with installation starting in Summer 2011
- Establish meter network, data collection & management system, theft detection solutions
- Integrate with existing BC Hydro applications

**SOLUTION**
- Itron as supplier of smart metering system and Meter Data Management System (MDMS)
- Cisco for Field Area Network solution
- Itron OpenWay® platform over a multi-application communication network powered by Cisco

**RESULTS**
- $70M in savings to BC Hydro expected the first three years
- $500M net benefit to customers over long term

“*The Itron–Cisco partnership was a compelling factor why we decided to go with Itron. The partnership is really a game changer. The ability to leverage our infrastructure with Cisco’s telecommunications ability is a great stepping stone into smart grid. We’ll be able to leverage it for years to come.*”

Gary Murphy
Chief Project Officer
Smart Metering Program
Architecture Design and Deployment

CHALLENGE
- Develop architectural design to meet both present and future needs
- Modernize existing systems providing SCADA and telephony services for the high voltage substations

SOLUTION
- Services developed a highly modular, flexible, converged architecture built on a single standard (IEC 61850)
- Deployed access and distribution layer networks based on Cisco Connected Grid switches

RESULTS
- Modular approach will drive cost savings, will enable phased implementation of substations and provided tools to support business case
- Reduced costs and improved security with highly available LAN infrastructure within new major substations

“Cisco Services’ has recently worked with Ausgrid to understand the requirements for electricity substations today and as we move towards a more complex and integrated future environment. Their work is assisting us to transform the electricity network into a smarter grid. We highly value their ongoing partnership and commitment to our company and the industry.”

Adrian Clark,
Chief Technology Officer
Ausgrid
Substation Visualization and Design Tool

**CHALLENGE**
- Complexity of automating large scale digital substation deployment
- Difficulty for Electrical Engineer to visualize the communication network and track changes in the substation
- IEC 61850 standard compliance validation from IED vendors

**SOLUTION**
- Visualize communication network in context of CIM Mode (Energy Delivery Network) and the IEC 61850 (Protection Schema)
- Enable engineers to discover, design, model, and test the Substation LAN before and after the deployment

**RESULTS**
- Reduce deployment errors
- Help create standard deployment plan and efficiently test and monitoring each system upon activation
- Reduce time and cost for deployment and on-going maintenance

“Cisco’s Visualization and Design Tool helps validate and keep track of configuration changes, which meet our operational needs very well.”

Lu Hong, Automation Dept., Director, State Grid Corporation of China
Incident Response Management

CHALLENGE
- Integrate 50+ different radio channels across three state region
- Modernize existing systems with flexible IP Dispatch to improve coordination with the field workforce.
- Meet regulation banning cell phone in commercial truck fleet

SOLUTION
- Standards-based centralized, converged architecture using Cisco IPICS, Land Mobile Radio gateways, and ISR routers
- Support IP Dispatch operations with Cisco IPICS

RESULTS
- Increased productivity with new centralized dispatch operations
- Reduced costs with flexible infrastructure across field and incident management operations

“Cisco IPICS enabled unified incident management for the PSNC gas business, allowing us to centralize dispatch operations across three states and 50 different radio channels.”

Oscie Brown, General Manager
SCANA Services, Inc.
Grid4EU Demo Project

**CHALLENGE**
- Implement Active Control and Demand Response of DER (i.e. generators, controllable loads and storage) to increase MV network hosting capacity of renewable generation
- Help the MV Distribution network to become more flexible with advanced network operation and energy management capabilities
- Demonstrate advanced solutions under real operating conditions and on large scale

**SOLUTION**
- Realizing an advanced control system communicating with the renewable generators, HV/MV substations, MV/LV substations and storage facility.
- Implementing an “always on” and standard-based communication solution, Using IEC 61850 standard; wireless and wired communication technologies and Power Line Communication system

**RESULTS**
- Pilot communications network across 200+ substations for study purposes
- Understanding of applicability and costs of conventional 11-kV grid reinforcement techniques
- New communications network blueprint for WPD
FAN / AMI Case Study

CHALLENGE
- Design and build private network pilot to monitor grid to support modernization studies
- Meet all security policies and requirements
- Create blueprint for future grid intervention techniques

SOLUTION
- Design and deploy IP network using IEEE 802.16e WiMAX access and backhaul technologies
- Built on Cisco Connected Grid CGR2010 and CGS2520 routers, Airspan iBridge, and Airspan Airsynergy devices

RESULTS
- Pilot communications network across 200+ substations for study purposes
- Understanding of applicability and costs of conventional 11-kV grid reinforcement techniques
- New communications network blueprint for WPD
Workforce Enablement Solution

**CHALLENGE**
- Need a way to consolidate wireless coverage and 2-way radio coverage
- Need to move away from dedicated desktop appliance using dedicated wiring

**SOLUTION**
- Cisco IPICS
- Cisco network

**RESULTS**
- Allows any employee anywhere with an IP device (phone, laptop, desktop) to communicate on the radio system.
- Provides service call connectivity – service clerk can communicate with field personnel who are helping customers
- Enables communications with agencies such as outside utility company or emergency services

“Cisco is the logical choice for us since our network was already a Cisco enabled network and one that we have a lot of experience with. The IPICS product plugged directly in and was an extension of the system we have already put into place for both our workforce and for both our customers.”

Ron Beck,
Network Engineer
Central Lincoln People’s Utility District
Substation and Security Case Study

CHALLENGE
- Protect people and property at remote sites
- Simplify IT management and minimize operational costs

SOLUTION
- Centralized management of physical security systems using Cisco video surveillance and Cisco Physical access control
- Unified network for all substation voice, video and data applications with Cisco Connected Grid switches and routers

RESULTS
- Accelerated incident detection through centralized monitoring
- Standardized on single network platform for office and substations
- Investment recovered through travel avoidance

“Cisco Video Surveillance and Cisco Physical Access Manager have both simplified and improved physical security at our wind farms.”

Keske Toyofuku, Keske Toyofuku, VP and CIO
First Wind
Interconnecting the Substations

CHALLENGE
- Migration from Legacy Network to IP Based Network
- Mission-critical network reliability
- Reduce power consumption

SOLUTION
- Cisco Connected Grid Switches for harsh environments (IEC 61850-3 and IEEE 1613 compliance)
- REP for fast convergence
- Centralized management: corporate and substation network

RESULTS
- Cost Reduction using standard-based products (Total 660 units of CGS2520)
- Network Innovation: power consumption: 20% down, bandwidth: 500% up, operational efficiency: priceless!
Thank you.