Systems and Information for Smart Cities

AMCIS 2014
Savannah, GA
August 8, 2014

Ken Geisler
Vice President, Strategy
Smart Grid Division North America
Siemens Infrastructure & Cities Sector
Siemens is a Globally Integrated Technology Company

**Global**
- Operating in 190 countries
- $100 billion sales in fiscal 2013
- 362,000 employees
- $5.7 billion in R&D expenditures
- 29,800 R&D employees
- 290 manufacturing sites

**U.S.**
- Siemens’ largest country market
- $24.3 billion sales in fiscal 2013
- 53,000 employees
- $1.4 billion in R&D expenditures
- 6,300 R&D employees
- 130 manufacturing sites
## Siemens Business Sectors

### Energy
- Divisions
  - Fossil Power Generation
  - Wind Power
  - Solar & Hydro
  - Oil & Gas
  - Energy Service
  - Power Transmission

### Healthcare
- Divisions
  - Imaging & Therapy Systems
  - Clinical Products
  - Diagnostics
  - Customer Solutions

### Industry
- Divisions
  - Industry Automation
  - Drive Technologies
  - Customer Services

### Infrastructure & Cities
- Divisions
  - Rail Systems
  - Mobility and Logistics
  - Low and Medium Voltage
  - Smart Grid
  - Building Technologies
# Siemens Infrastructure and Cities Sector

**Infrastructure & Cities**  
Dr. R. Busch

<table>
<thead>
<tr>
<th>Rail Systems</th>
<th>Mobility and Logistics</th>
<th>Low and Medium Voltage</th>
<th>Smart Grid</th>
<th>Building Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Speed and Commuter Rail</td>
<td>Rail Automation Complete Transportation and e-Vehicle Infrastructure Logistics</td>
<td>Low Voltage Medium Voltage</td>
<td>Energy Automation Rail Electrification Services</td>
<td>Building Automation Fire Safety and Security Control Products and Systems</td>
</tr>
</tbody>
</table>

**Rail Systems**  
- High Speed and Commuter Rail  
- Metro, Coaches and Light Rail  
- Locomotives and Components  
- Customer Services and Transportation Solutions

**Mobility and Logistics**  
- Rail Automation Complete Transportation and e-Vehicle Infrastructure Logistics

**Low and Medium Voltage**

**Smart Grid**

- Energy Automation Rail Electrification Services

**Building Technologies**

- Building Automation  
- Fire Safety and Security  
- Control Products and Systems  
- Infrastructure Logistics

**Building Technologies**

- Infrastructure Logistics
Siemens Smart Grid Division - OT/IT systems for grid operators, utilities, cities and consumers

Modernization For Operational Efficiencies
- Improve reliability and efficiency of T&D grids
- Maximize the use of existing equipment
- Optimize production and transmission
- Enable electricity markets

Cleaner Power
- Connect wind farms and solar panels to the grid
- Improve electric railroad transportation
- Enable large scale infrastructure for electric cars

Responsible Consumption
- Use meter information to analyze consumer behavior
- Use meter information to analyze grid behavior
- Innovate in distributed resource management
Cities and the Energy Grid - Evolution

1900
Thomas Edison develops the first electric systems

1950
Rural Electrification and continued Industrialization

1980
Grids are required to power the sprawling growth of suburbanization

2020
“Re-urbanization” of cities is changing the way we work and live and has the potential to bring awareness, education, and responsibility to energy use

"Re-urbanization" of cities is changing the way we work and live and has the potential to bring awareness, education, and responsibility to energy use

© Siemens AG 2013 All rights reserved.
Why do energy grids need to change?

Increasing Energy Demand

By 2030, power consumption will grow to roughly 33,000 TWh - a 63 percent leap!

Security Concerns & Regulation

7 Million people without power during 2012 Hurricane Sandy and billions in damage

Renewable Energy Adoption

In 2011, renewable sources of energy accounted for about 9.3% of total U.S. energy consumption and 12.7% of electricity generation

Aging Infrastructure & Electrical Loss

Today, in the U.S. power grid: 70% of transformers and 60% of switchgear are over 25 years old

Source: US Energy Information Administration, Institute for Energy Research
Weather patterns are becoming more extreme, mostly due to climate change. ... resilient grids!

- Climate change leads to higher temperatures, rising sea levels and more rainfall
- Increasing number of extreme weather events
- Increasing urbanization and settlement patterns lead to higher damages
- 2012: US$ 160 bn damage worldwide (67% in USA)

Figure 1: Number of recorded disasters
Source: EMDAT-CRED, Brussels
Why Resilience? USA, New York City 2012

- Hurricane Sandy was second costliest in US history
- More than 8 million people without power
- US$ 50 bn in damage
- NYSE down for two days – prior 2 day stretch was in 1888
- 2/3 of storm surge damage exceeded 500 year FEMA* demarcation

*Federal Emergency Management Administration: 2/3 of storm surge damage exceeded 500 year FEMA demarcation in New York City
Why Resilience?
Disasters hit developed & developing nations

- **Hurricane Sandy, 2012:** $50bn in damages, 2\textsuperscript{nd} costliest in US history
- **USA Droughts, 2011 & 2012:** $28bn in damages
- **Japan Tsunami, 2011:** $210bn damages, geopolitical consequences
- **UK Winter Snow Storms, 2010/2011:** Cost the UK economy $1.5bn per day, total $20bn
- **Haiti Earthquake, 2010:** 220,000 deaths, >300,000 injuries, 1.5m people homeless
- **Europe Heat Wave, 2003:** 66,720 deaths across Italy, France, Spain, Germany, Portugal
Decentralization of energy grid generation and design

From centralized, unidirectional grid …

… to distributed energy and bidirectional energy balancing
The State of the Utility Market

Key Challenges identified by sampling of 527 IOU/Muni/Coops

- Old Infrastructure: 48%
- Current Regulatory Model: 32%
- Aging Workforce: 31%
- Distributed Generation: 30%
- Flat Demand Growth: 28%
- Smart Grid Deployment: 23%
- Grid Reliability: 21%
- Coal Plant Retirements: 17%
- Renewable Portfolio Standards: 17%
- Energy Efficiency Mandates: 16%
- Emission Standards: 12%
- Cybersecurity: 11%

Key Value Propositions

- Resilience
- Sustainability
- Efficiency
- Reliability

Integrated Resilient Grid Solutions

**Integrated Distributed Resources**
- Market Systems Interface
  - MMS
- Energy Balancing & Demand Response
  - DERM/DRM

**Grid Modernization**
- Planning and Asset Optimization
  - PAO
- Control Center
  - EMS/DMS/OMS
- Substation Automation

**Informed Consumption**
- Customer Care Management
  - CRMS
- Consumer Information Management
  - MDMS/AMI

**Balancing of Resource Capacity for Reliability and Economics**
- Industrial
- Commercial
- Residential
  - Wind
  - Solar
  - Batteries

**Grid Reliability and Resilience**
- Recloser
- Switch
- Capacitor Bank
- DER

**Bi-Directional Management of Customer Energy Information**
- Intelligent Field Devices
  - (i.e. Meters)
Decentralized Energy-District designs enhance resilience…

- Apply resilience planning as a guiding principle for future infrastructure investments ("Inside-out" distributed design)
- Resilience built on Reliability, Efficiency and Sustainability
- Develop a strategy for prioritizing necessary upgrades, investing in new generation assets and allowing the electrical delivery grid to fail in predictable layers of demand priority

**Energy District Structure**

- **Level 1**: Critical infrastructure - Resilient Microgrid
- **Level 2**: Sustainable Energy Districts
- **Level 3**: Efficiency through Automation
- **Level 4**: Utility General Reliability

**Resilience Plan**

- **Level 1 Resilience**: Most critical areas for self-sustaining power infrastructure
- **Level 2 Sustainability**: Self-healing reliability
- **Level 3 General Reliability**: Least critical areas for self-sustaining power infrastructure

© Siemens AG 2013 All rights reserved.
Defining Layers of Infrastructure Criticality

1. Resilience
   - Renewable energy sources and other distributed generation enable complete independence from the grid under selected or extreme conditions. Area demand response is able to manage capacity and variation.
   - Infrastructure of Hospitals, Water, Transportation, Military Bases, Public Safety...

2. Sustainability
   - Distributed renewable and traditional energy sources enable significant energy demand to be met while approaching grid independence. Eco-districts where off-set is green. Area demand response to manage capacity.
   - Airports, rail systems, marine ports, university campuses, etc.

3. Efficiency
   - System designed with redundant feed paths and switchable connection points
   - Developed automation, monitoring, and control of feeder equipment
   - Control Center applications for Distribution Management and efficiency

4. Reliability
   - Utility reliability measures address outage duration and frequency averages
   - Maintenance and expansion is driven by the current rate structure
   - System design supports an “average” level of reliability for all customers
City infrastructure with sustainable and resilient energy districts

Navy Pier – Tourist District
Northwestern University Hospital
Union Station (Train Transit)
Midway Airport
Soldier Field (da Bears)
Water Tower & Water Intake
Lincoln Park Zoo
Residential Area

Energy Required
Demand Priority
Reliability
Efficiency
Sustainability
Resilience

Level 1
Level 2
Level 3
Level 4

© Siemens AG 2013 All rights reserved.
Creating a Plan for Resilient Energy Transformation

Grid Modernization

- Micro-Grids, Eco-districts, Critical Infrastructure Zones
- Delivery Efficiency & Partial Sustainability
- Intelligent & Automated Equipment
- Self-Healing Capability
- General Reliability
- “Always On” Mentality
- Consumer Production
- Net Metering
- Feed-in Tariff, Demand Offset
- Integrated Demand Response & Variable Resources
- Large Scale Deployment & Economic Participation of Renewable Resources

Informed Consumption

- Integration Of Supply Incentives
- Automation Investment
- Focus on Efficiency
- Information Access

Greening the Grid

- Micro-Grids, Eco-districts, Critical Infrastructure Zones
- Delivery Efficiency & Partial Sustainability
- Intelligent & Automated Equipment
- Self-Healing Capability
- General Reliability
- “Always On” Mentality
- Consumer Production
- Net Metering
- Feed-in Tariff, Demand Offset
- Integrated Demand Response & Variable Resources
- Large Scale Deployment & Economic Participation of Renewable Resources

Informed Consumption

- Integration Of Supply Incentives
- Automation Investment
- Focus on Efficiency
- Information Access

Greening the Grid

- Micro-Grids, Eco-districts, Critical Infrastructure Zones
- Delivery Efficiency & Partial Sustainability
- Intelligent & Automated Equipment
- Self-Healing Capability
- General Reliability
- “Always On” Mentality
- Consumer Production
- Net Metering
- Feed-in Tariff, Demand Offset
- Integrated Demand Response & Variable Resources
- Large Scale Deployment & Economic Participation of Renewable Resources
Enabling Resilient Cities
Focus on Energy, Transport, Water, Safety

Information & Telecommunication Networks

Transport
- Passengers
- Emergency services
- Logistics, incl. food, waste, materials.

Energy
- Generation
- Transmission
- Distribution

Water
- Potable supply & distribution
- Waste water

Buildings
- Residential
- Commercial
- Public / Institutional

Security & Physical Protection
Grid Automation (Efficiency)
Hawaiian Electric Company, East Oahu, USA

- Automation of 46kV sub-transmission system
- To address overload & reliability issues in East Oahu
- New transformers installed to shift load from north to south corridor
- Automated high-load distribution circuits to feed sections of East Oahu
- Creates intelligent hierarchical control system
- Substations & devices become intelligent agents supervised by the control center, providing robust contingency situations, maintenance switching, fault isolation & restoration
University of Genoa, Savona Italy (Sustainability)

- The Smart Polygeneration Microgrid has been developed for University of Genova, precisely in its campus in Savona.
- The system is a microgrid (with its own grid) connected to the national grid by a MV connection.
- Although the size (in terms of nominal power) is not huge, the system is complex and there are many generation, storage and load units to be managed.

**Power Generation:**
- 2 cogenerative GTs
- 1 PV plant
- 3 cogenerative CSPs

**Loads**
- 4 LV electric Boxes
- 3 Thermal Loads
- 3 Charging Units for Electric Vehicles

**Storage:**
- 1 Electrochemical Energy storage
- 3 thermal storages

**Thermal generation**
- 2 Boilers
- 1 Electrical Chiller
- 1 Absorption Chiller
- Cogenerative heat from GTs and CSPs

DEMS is a SW tool which is able to optimize the management of electrical and thermal energy flows in a Smart Grid/Microgrid.

**Planning Functionalities:**
- Weather, Generation and Load Forecast
- Economically optimized Unit Commitment

**Online Functionalities:**
- Monitoring of every unit and of the exchange with the grid
- Manual and automatic control of each controllable unit

**Possibility to interact with DSO**
- Possibility to provide primary reserve service
Resilience
Revealed by Hurricane Sandy

Co-Op City, Bronx, NYC

- 14,000 apartments
- 35 high-rise buildings
- 40MW steam turbine generator, plus CHP
- Operates on a micro grid
- Retained power for 60,000 residents
The Transportation Network
Pilot project in Harris County, Texas, in response to Hurricane Ike

Traffic lights & vehicles communicate in real time

Data from smart phones in vehicles are aggregated to produce real-time estimates of numbers of vehicles on the road, & their speeds

Data mapped in a database accessible to drivers via smartphone

During evacuation, allows drivers to choose route with shortest travel time

Traffic lights can detect emergency vehicles & turn green to facilitate rapid response
Communications-Based Train Control
Metro lines - São Paulo, New York, Paris, Beijing

- Railway signaling system using telecommunications between train & track equipment for traffic management
- Position of train known more accurately
- Safer & more efficient way to manage railway traffic
- Enables improved time intervals between trains, & therefore increased passenger capacity on the line
- Technology allows ‘driverless trains’
- More energy-efficient than traditional signaling equipment, reducing draw on the grid
Transport Coordination Centre
London 2012 Olympics, UK

- Transport Coordination Centre for the London Olympics 2012
- Active sharing of information & coordinated responses to incidents
- Multi-modal transport providers & other key stakeholders
- Supported the 2012 Games additional spectator movement, whilst enabling London & the UK to maintain free flow of people
- Estimated passenger time savings due to TCC intervention on a single event at Bank Station, were quantified at £85,538
Real-time Levée Monitoring System
Livedijk, Netherlands

- EU Urban Flood project
- Internet-based early warning system issues warnings if there is threat of flood or breaks in dikes
- Sensors buried in dike measure water height/pressure, moisture, temperature
- Data transferred to via internet to connected server
- System evaluates data & issues early warning
- Seasonal & daily weather phenomena are integrated within the evaluation
- Livedijk at Eemshaven is first coastal levée that can be monitored online
Water System Improvement Program (WSIP)
San Francisco, USA

- 6 major earthquakes in California the last 100 years
- San Francisco undertaking a $4.6 billion comprehensive program to upgrade the water system by 2016
- Broad range of projects covering all aspects of the water system – from dams, reservoirs, pipelines, & tunnels to treatment facilities & pump stations
- The aim is to ensure that should a large seismic event occur, the system can remain relatively intact & continue to deliver water to 2.4 million people
- The project includes projects that harden the infrastructure, add redundancy to the system & increase monitoring & automation
Decentralized wastewater treatment manages wastewater flexibly
Shenzhen, China

- The Food Chain Reactor (FCR) solution for urban wastewater management combines conventional treatment methods with biological treatment provided by the roots of 2,000-3,000 plant species, thereby treating water to high quality standards.

- This is a decentralized approach, which manages wastewater on a neighborhood scale using small, odor free facilities.

- The decentralized approach helps to avoid the risk of sewer overflows and burst pipes during severe weather.
Building Mass Notification Systems coordinate human reactions to hazards

Alberta, Canada

- Mass Notification Systems (MNS) deliver targeted messages to advise building occupants during a crisis.
- Messages are disseminated through multiple redundant channels, including voice systems, LED signage and local area networks.
- The system can contact people en masse inside and outside of the building, and directly via personal devices such as cell phones.
- Systems inform occupants about what action they should take, therefore coordinating movement to facilitate safe and efficient response.
3D simulation of human behavior enables advanced evacuation planning
London, UK

- The behavior of building occupants during an emergency can be modeled prior to an event, using advanced 3D simulation software.
- The software enables movement through a building or space to be forecast up to ten times faster than real time with relative accuracy, including places where blockages may occur.
- This tool improves human preparedness, coordination and response. With a faster than real time reaction, this technology also helps to gain valuable time in a situation where every second counts.
Holistic system design secures information flows and communications
Geneva, Switzerland

- The Safe Host SA data center in Geneva, Switzerland, incorporates a range of data center infrastructure services that promote service reliability and data security.
- Built-in solutions protect against power supply interruptions, security and fire safety threats and ensure that servers operate at the correct temperature to protect customer data from changes in environmental conditions.
- Features of the data center include a central management system, over 800 smoke detectors, fire control panels, nitrogen based extinguishing solutions and video surveillance at all major entrances.
Integrated Operations Center
Rio de Janeiro, Brazil

- State-of-the-art intelligent operations center
- Real-time data feeds monitor weather, traffic, police, medical services
- Operators anticipate problems & take instant action to reduce their impact
- Coordinates 30 municipal & state departments, plus private utility & transportation companies
- Weather & flood forecasting predicts emergencies 2 days ahead
- Alerts distributed direct to mobile phones
### Metropolitan security reference

**Emergency Management Project HELS (Hamburger Einsatzleitsystem)**

#### Facts and figures
- 1400 incidents/h
- 450K Police missions p.a.
- 185K Rescue missions p.a.
- 95K Patient transport p.a.
- 30K Fire mission

#### Challenges
- 4 public authorities (police, fire brigade, rescue services, patient transport ambulance) should collaborate with only one C&CC-system (first time in GER)

#### Siemens solutions
- Incident Mgmt. System (ELS Web)
- HiPath 4000 RTC platform
- Cross redundancy through distributed DB (two locations)
- Preparation for digital radio communication
- Existing individual developed systems have to be replaced

#### Customer benefits
- Improved collaboration between public authorities
- Renewal of existing C&CC architecture, optimized coordination flows (i.e. effort plans, authority overlaps for bigger efforts) and cost savings (one system only)
- Integration of digital radio communication
- Additional redundancy through distributed architecture
Modern emergency management scenarios require highly integrated, effective, quick response time solutions to manage emergencies.

### Siemens solutions
- **Call Flow Management** module for collecting and managing emergency / event data
- **Real Time Tracking** module for keeping in touch with field forces
- **Geographical Information System (GIS)** module for retrieving detailed geographic information
- **Mobile CC112** module for gathering and for the distribution of information on field

### Challenges
Modern emergency management scenarios require highly integrated, effective, quick response time solutions to manage emergencies.

### Facts and figures
- Rollout in 73 towns (control centers)
- 500 central and local offices
- 2,500 radio localized vehicles
- 8,000 vehicles for patrol services

### Customer benefits
- A single framework to manage every emergency management need
- An encapsulation of the different components to easily focus the customer requirements
- All functionalities integrated in one system to have high "end-user" acceptance
### Facts and figures

- One nation wide TETRAPOL network
  - Based on 26 regional networks
  - More than 50 different organizations
  - More than 50 control centers,
    - 750 base stations,
    - finally 40,000 terminals

### Challenges

- Complex network capable of connecting all security organizations in Switzerland for seamless interworking
- Protection of communication against eavesdropping
- High availability

### Siemens solutions

- Radio Network Management System (incl. switches e.g.)
- Tactical Working Position
- Voice Dispatch Systems
- Data communication software
- Automatic vehicle localization system
- Application integration

### Customer benefits

- Radio Network Management System (incl. switches e.g.)
- Tactical Working Position
- Voice Dispatch Systems
- Data communication software
- Automatic vehicle localization system
- Application integration
Community Enabling Technologies

Information & Telecommunication Networks

Transport
- Passengers
- Emergency services
- Logistics, incl. food, waste, material

Energy
- Generation
- Transmission
- Distribution

Buildings
- Residential
- Commercial
- Public / Institutional

Security & Physical Protection

© Siemens AG 2013 All rights reserved.
Systems and Information for Smart Cities

AMCIS 2014
Savannah, GA
August 8, 2014

Ken Geisler
Vice President, Strategy
Smart Grid Division North America
Siemens Infrastructure & Cities Sector