Buildings of the Future
Innovation at Siemens Building Technologies
Duke Energy Academy at Purdue University
June 23, 2015
Agenda

• Dave Hopping Introduction
• Why are buildings important
• Present state of buildings
• Future state of buildings
• Q & A
David Hopping - Introduction

President
Siemens Building Technologies
Americas

Roots: Muncie, Indiana

Education: Purdue University – Electrical Engineering

Experience: 30 Years Building Experience

Passion: Energy Efficiency & Sustainability
Urbanization

- 2007: for the first time in history, more people live in cities than in rural areas.
- Today 280 million people live in megacities (> 10 million residents)
- 2030: 60 % of the world’s population will live in cities.

Demographic Change

- Average life expectancy: increase to 72 years in 2025 from 46.6 years in 1950.
- World population will grow from more than 6 billion now to 8 billion by 2025.
- 95% of the global population growth is taking place in developing countries.
Megatrends shape our future

### Climate Change

- The average global surface temperature has increased by 0.76° C compared to the 18th century.
- 11 of the 12 years between 1994 and 2005 rank among the 12 warmest since weather observations began.
- Greenhouse gas emissions are increasing.

### Globalization

- From 1950 to 2004, the volume of global trade has increased 27.5-fold.
- The number of global players has grown from 17,000 in 1980 to over 70,000 today.
- Ocean freight has increased over the past four decades from less than 6,000 billion ton-miles to over 27,500 billion ton-miles a year.
Today’s Smart City Solutions:

**Intelligent Infrastructure**

Across the world, infrastructure systems are coming under increasing pressure due to urbanization, globalization and climate change. The scale of the challenge calls for a new, more intelligent approach to infrastructure.

**Challenges**

**More traffic**

The demand for travel within urban areas is expected to triple by 2050.¹

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**More fluctuating power**

The share of renewables will rise to 31% of global electricity generation.²

How will grids cope with this fluctuating supply?

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**Rising energy costs**

Energy accounts for 40% of a building’s operation costs. Businesses must increase energy efficiency in order to remain competitive.
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Intelligent Infrastructure
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Challenges

More traffic
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Solutions

In the fast lane
On the Jerusalem-Tel Aviv highway, it takes only 12 min in the fast lane to travel a 12km stretch that used to take up to an hour. A dynamic toll based on real-time traffic volumes ensures a guaranteed speed of 70km/h.

Future grids
By using smart grid technologies, the integration of renewables results in 25 to 40% lower investment costs compared to traditional grid expansions.3

Virtual power
In Munich, a virtual power plant combines energy from distributed sources, including renewables, using data on demand and weather forecasts.

The combination of data and engineering is a key enabler for maximizing the capacity and efficiency of infrastructure.

All aboard!
Paris' metro line 1, the city's oldest and busiest line, can carry an additional 70,000 passengers at peak time since converting to a driverless system.

Smart and cool
Since optimizing its building automation and energy efficiency, Taipei 101 is among the world's tallest green buildings, consuming 30% less energy than average buildings, saving US$ 700,000 annually.

Virtual power plant

$700,000
annual savings
Global Impact of Buildings

Buildings consume 41% of energy worldwide.
Global Impact of Buildings

Buildings produce 21% of CO₂

- 21% Buildings
- 22% Forestry
- 18% Agriculture/Waste
- 14% Transport
- 13% Buildings Power
- 11% Industry 1)
- 14% Industry 2)
- 8% Buildings 2)

1) Indirect emissions from primary energy usage
2) Direct emissions from primary energy usage
Global Impact of Buildings

New York City:
• 400 million sq.ft. of office space
• 50 lbs CO$_2$ / year/sq.ft.
• Total: 10 million tons CO$_2$ / year

Today’s Average USA household:
• 30 ton CO$_2$ / year

How it started?
1 Kg of wood
= 1.8 kg of CO$_2$

Early rural USA household
• 0.1-1 ton CO$_2$ / year
Building Lifecycle Costs

- Energy typically one of the highest operating costs
- Rising prices can have tremendous impact on bottom line
- Impacts core business as budget/investments are prioritized

**POST-BUILT ENERGY CONSUMPTION = 32% OF TOTAL LIFECYCLE COSTS!**
More Stats:

WORLDWIDE, BUILDINGS ACCOUNT FOR...

17% fresh water withdrawals
25% wood harvest
33% CO₂ emissions
40% material and energy use
45% in China
Buildings Today…

Integration/Optimization:
We integrate and optimize a whole array of equipments, systems, and sub-systems to provide best in class energy efficiency solutions.
Smart and Sustainable:

- More sustainable
- Monitored and rated for performance
- Interconnected to the Smart Grid
- Leverage on-site generation and energy storage technologies
- Continuously commissioned
- Participate in new business models like utility initiated demand response
Evolution of Buildings
Digitalization at Siemens Building Technologies

Basic
- 27X7 operation
- Remote Monitoring
- Data Storage and Archival
- Alarm Management

Today
- Fault Detection & Diagnostics
- Remote service
- Web based solutions
- Continuous monitoring

Tomorrow
- Performance Prediction
- & Prognostics
- Performance Analytics
- Big Data Analytics
- IOT
Megatrends
How digitalization is transforming our world

Worldwide data volume doubles every two years. By 2020, it will have grown to 40 zettabytes – that’s a 50-fold increase within ten years.

Worldwide revenue of the IT and communications industries reached a record €4.1 trillion in 2014.

Revenue from apps alone amounted to US$72 billion in 2013 and will more than double by 2017.

Digitalization boosts GDP – a 10% increase in the digitalization level of a country leads to a 0.75% rise in per capita GDP.
Buildings of the Future: Innovation Opportunities

Internet of Things (IOT)

BT owns a rich and diverse portfolio of IP related to IOT technology. This is the opportune moment to commercialize our IP portfolio to derive business gain in smart building space.

Big Data Analytics:

Big Data Analytics to extract knowledge and insights for our enterprise business who owns multiple buildings is a key focus.

Building As a Tree:

How can we apply Artificial Photosynthesis to make building act like a tree? We are collaborating with academia and Siemens Corporate Technology in pursuit of this game-changing technology development and commercialization.
IOT for Smart City:

- **Garbage collectors**: only pick up trash from bins that need to be emptied.
- **Data servers**: use the information they receive to compile an overall picture of the city.
- **Smartphone users**: can use a Smart City app to notify officials about necessary street repairs, and the app allows tourists to receive location-specific tips.
- **About 10,000 sensors**: fastened to building walls, street lamps and utility poles, or inserted into street pavement, measure light, noise levels, traffic volume and traffic jams.
- **Taxis, buses, and police cars**: constantly register their location and transmit measurements from their surroundings.
- **Gardens and parks**: use the technology to regulate their lights, save energy and control how much watering is done.
- **Trouble spots**: are automatically reported to the appropriate city authorities.

**Pervasive**  **Ubiquitous**  **Low-cost**  **Edge-computing**  **Connectivity**
IOT for Smart Buildings:

Building that thinks, acts, and knows needs of its occupants and systems and optimizes resources

Equipment IOT network:
All equipments even building glass panels can transmit their performance data such as flow, pressure, leakage, crack, vibration etc. IOT can be embedded into building envelope as well.

Comfort/health IOT network:
Thousands of tiny IOT senses building environment, air quality, light levels and transmits real-data to a data center that uses cloud to provide high-end solutions utilizing data analytics.

Occupants IOT network:
All occupants shall be able to communicate their surrounding data, T, RH, air quality, light, sound automatically via mobile platform along with occupant’s position.

Environment IOT network:
Environment data such as soil moisture, solar radiation, water quality, wind velocity, street lighting, parking environment are also monitored.

Cloud Platform:
Cloud platform collects all data either via high-speed internet or via wireless, uses a series of high-end computing tools, and converts data into knowledge and insights for creating value-added solutions.
Data Analytics for future cities

2060

How do you solve infrastructure problems before they pose a threat? Whether it's roads, power plants or public buildings, Lumumba Ewesa has an overview of his city's infrastructures, all of which are networked with radio sensors that recognize potential damage in advance and notify him in good time. His team then uses miniature drones to assess situations and plan responses. After that, replacement parts are individually manufactured using 3-D printing.
Big Data Analytics for Smart City Service and Inspection:

City of Chicago:
• Big focus on data. Installed city-wide network of Environment IOT.
• City has Chief Data Officer Position
• Owns hundreds of buildings
• Responsible for providing service to thousands of buildings
• Home of Blackhawks - Stanley cup champion - 3/6

Siemens Building Technologies:
• A major player in Chicago market
• Provides solutions & services to many City buildings.
• Some of the key facilities:
  • O'Hare airport
  • John Hancock
  • United Center
  • University of Chicago
  • Northwestern University

Siemens BT, as a founding member of Cityworks, is collaborating with UI Labs, City of Chicago, and other corporate and academic partners on launching a Pilot Project on Smart City Service using Big Data Analytics
An Overview of City Smart Service and Inspection

IOT and Multiple Systems

Data Management Platform

Raw Data Stream

Support heterogeneous protocols

Data Stream

Data Analytics and Machine Learning Platform

Classifier Clusters

Neural Network

Genetic Algorithm

Decision and Deployment Business Service

Raw Data Stream

Results/Output

Results/Output

Results/Output

Good Performers

• Continue monitoring
• Cluster and profile
• Trend patterns
• Keep learning

Poor Performers

• Apply FDD
• Apply Predictive Analytics
Building As A Tree- Open Innovation Collaboration Opportunity

- JCAP- Collaboration between Caltech and UC Berkeley. Funded by DOE.
- Goal is to produce bio-fuel from sunlight, water, and CO₂

**Artificial Photosynthesis**

Siemens Board is funding Corporate Technology to find means to convert CO₂ to Bio-fuel.

BT’s goal is to use building envelope as a platform and using artificial photo-synthesis to convert ambient CO₂ to bi-fuel and free O₂ to atmosphere.

Exploring collaboration between JCAP, Siemens- CT, and Siemens- BT
Summary

Buildings are important

Use of Data in Buildings IOT

Buildings Future – Smart, Sustainable, and Alive