How Can Organizations Use Big Data to Achieve Sustainability Objectives?

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Big Data Creates A Challenge – And an Opportunity
A Profound Explosion In The Data The World Produces

"We have for the first time an economy based on a key resource [Information] that is not only renewable, but self-generating. Running out of it is not a problem, but drowning in it is" -- John Naisbitt

25 Zettabytes worth of data will exist by 2020

Volume – Data at Rest

30 Billion RFID sensors and counting

Velocity – Data in Motion

80% of the world's data is unstructured

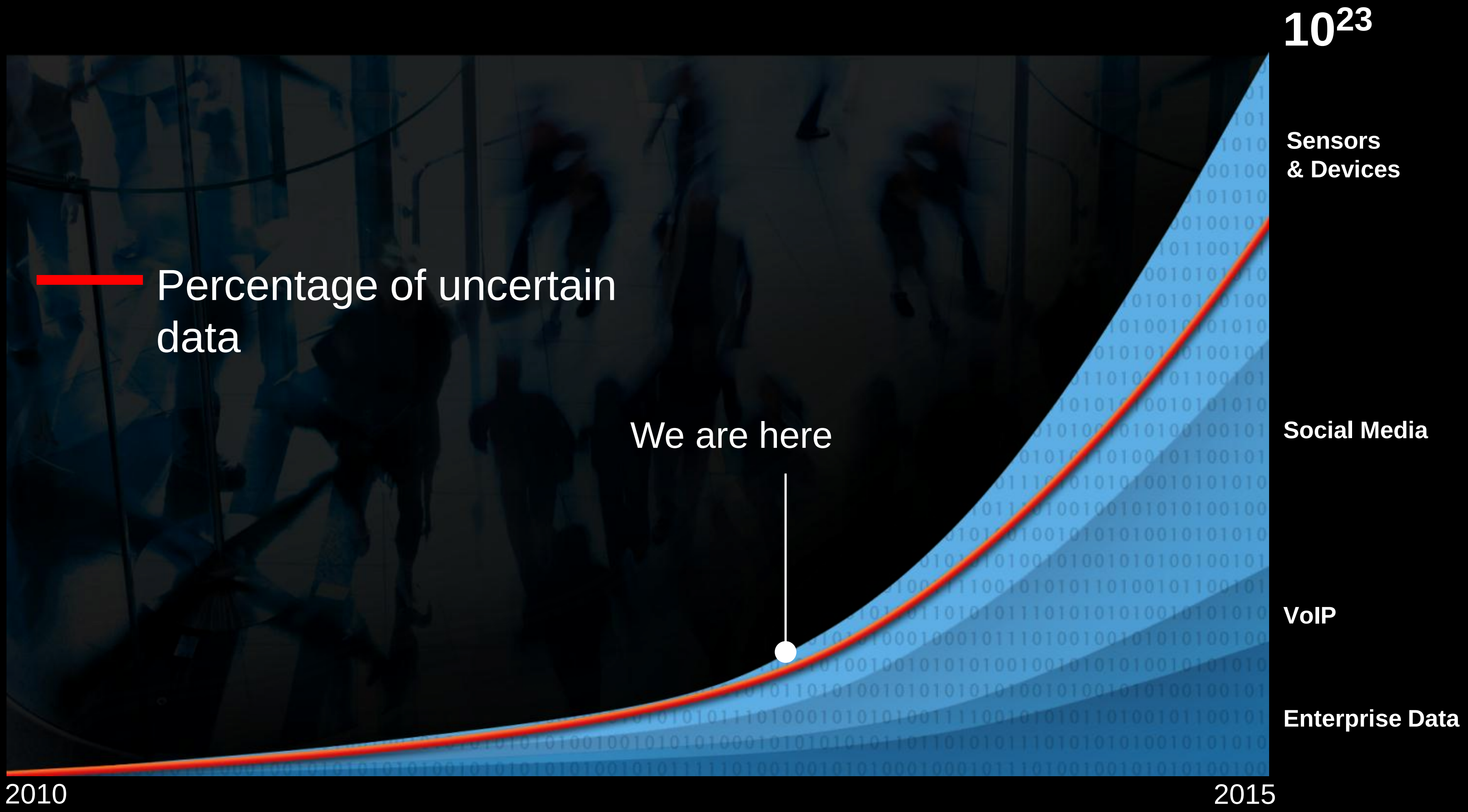
Variety – Data in Many Forms

1 in 3 business leaders don't trust the information they use to make decisions

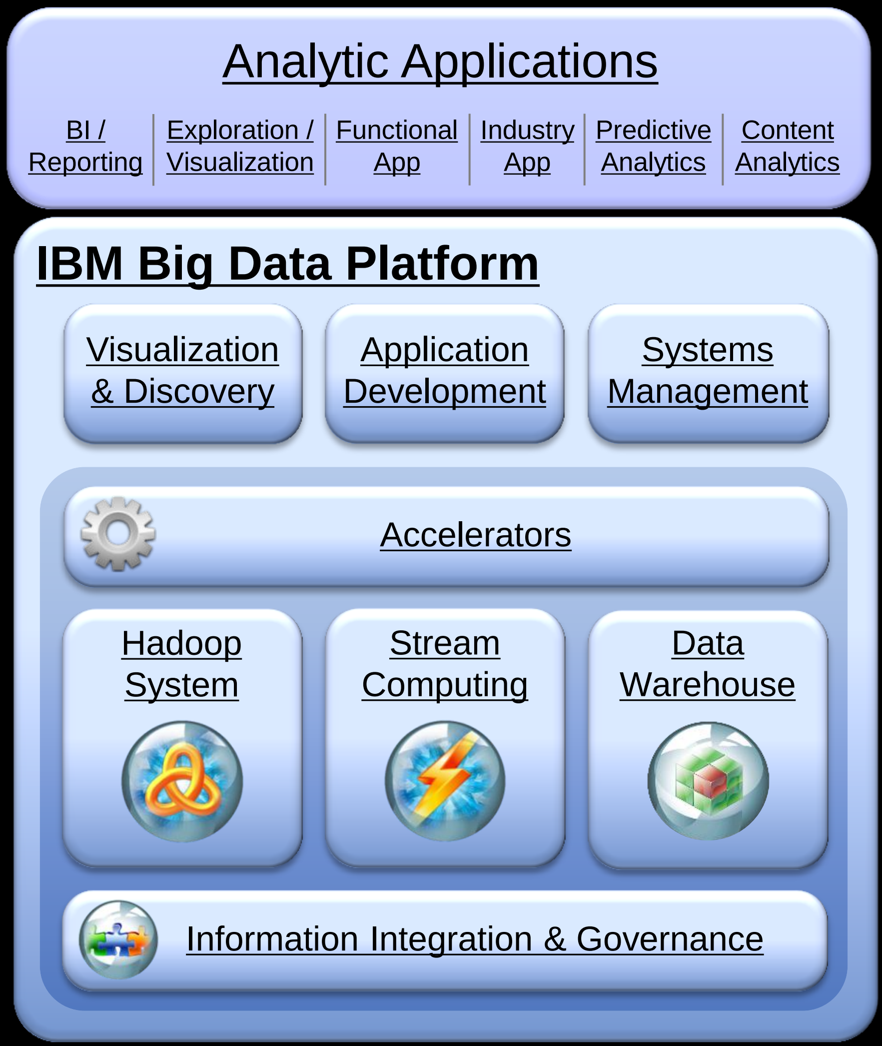
Veracity – Data in Doubt

The Mega Trends

Big data: This is just the beginning



IBM Big Data Platform

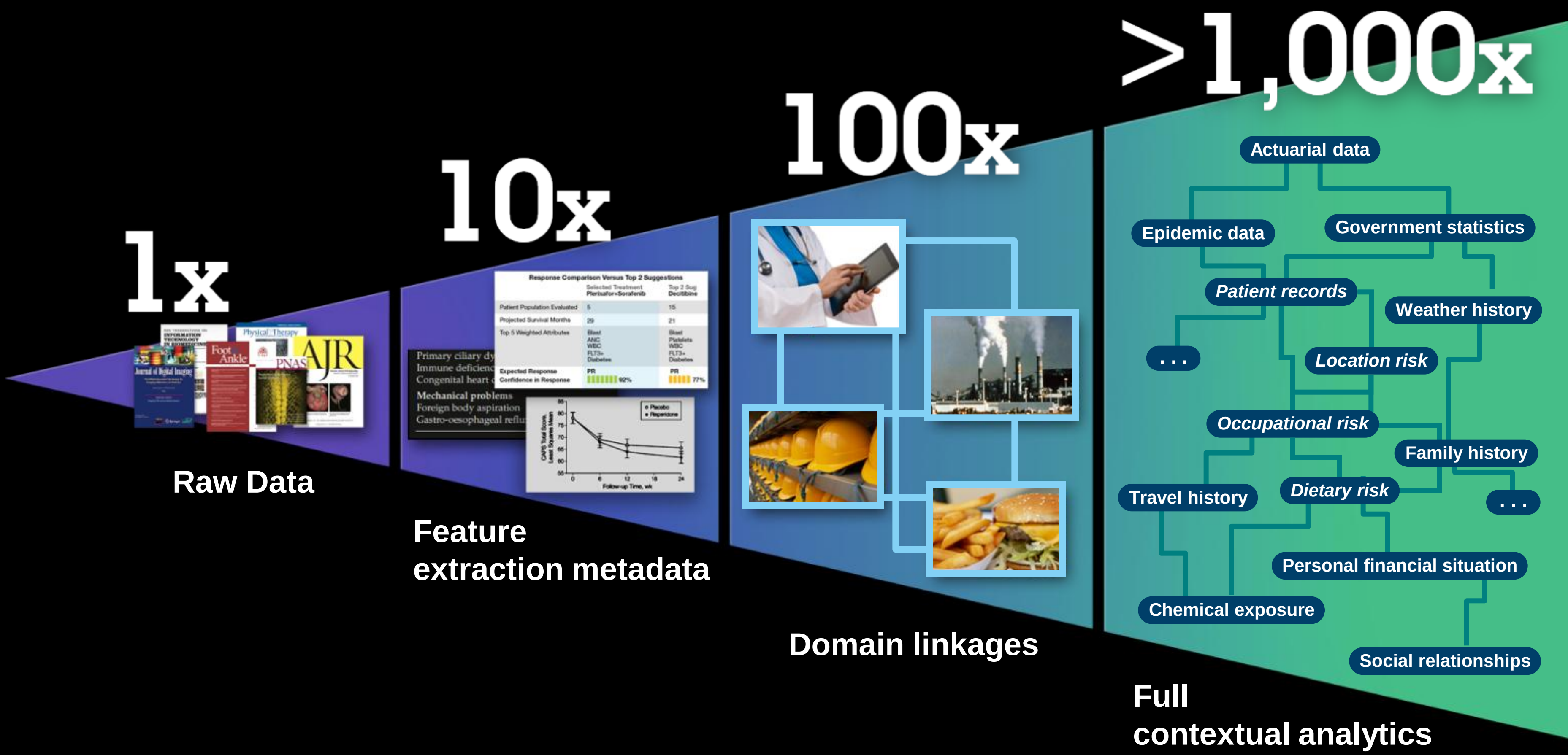


Pacific Northwest SMART GRID

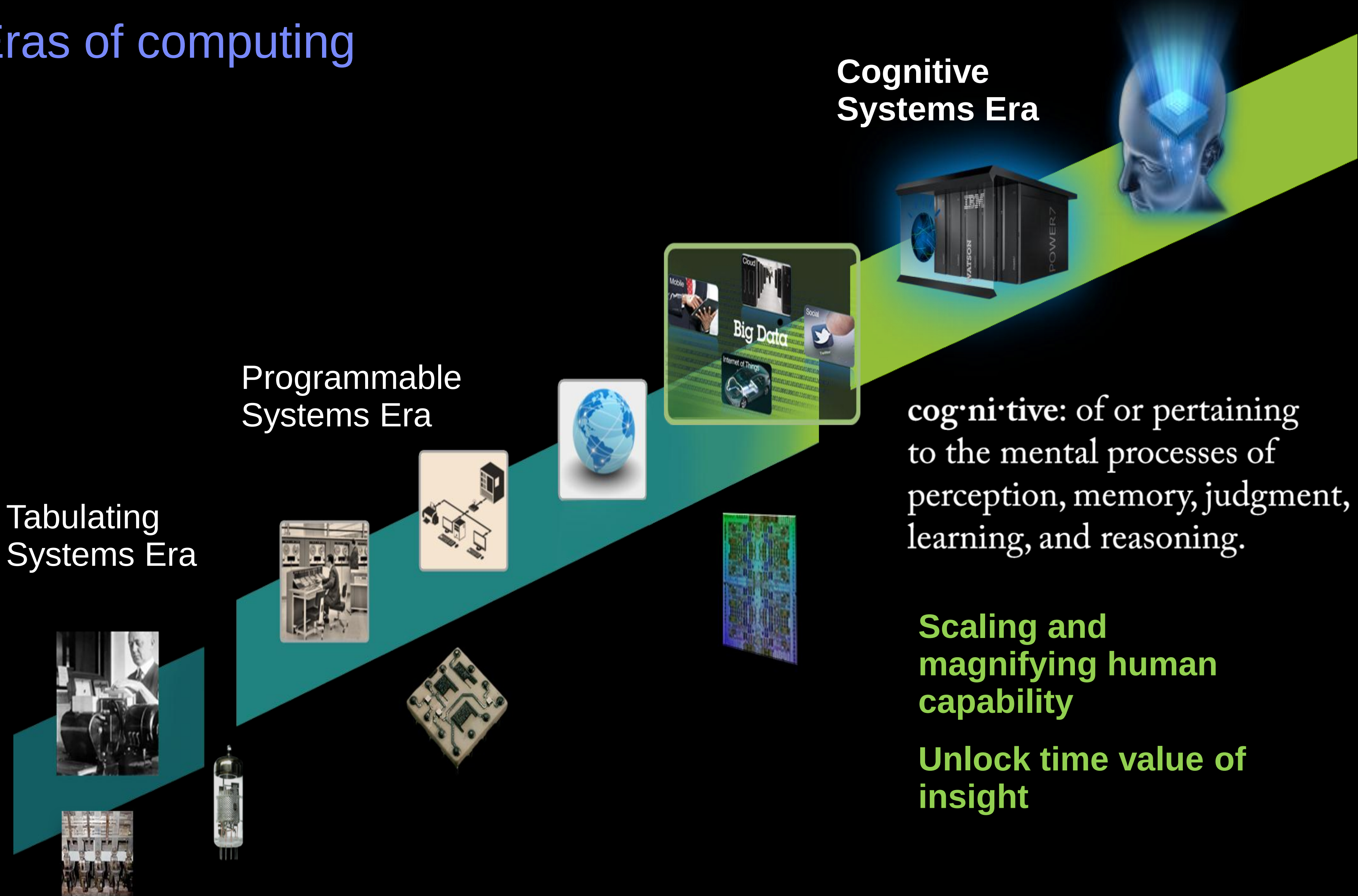
To support its smart grid demonstration project, the U. S. DOE's Battelle needed an infrastructure that facilitates two-way data flow and is capable of continuously processing large amounts of data to gain insight into:

- price fluctuations
- energy consumption profiles
- risk
- fraud detection
- grid health

Analytics and the Context Multiplier Effect



Eras of computing



cog·ni·tive: of or pertaining to the mental processes of perception, memory, judgment, learning, and reasoning.

Scaling and magnifying human capability

Unlock time value of insight

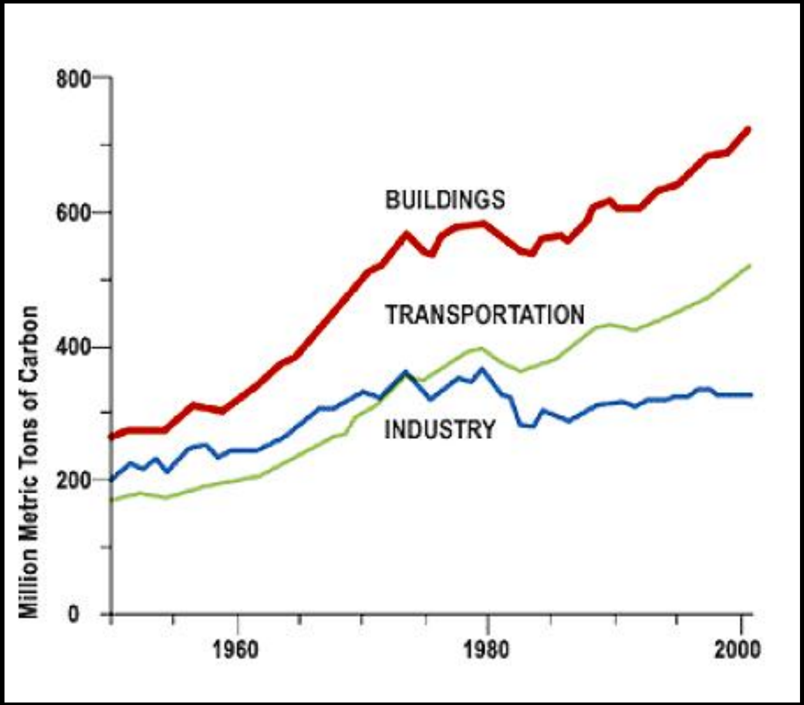
Building Energy Consumption in the U.S.

The building sector has:

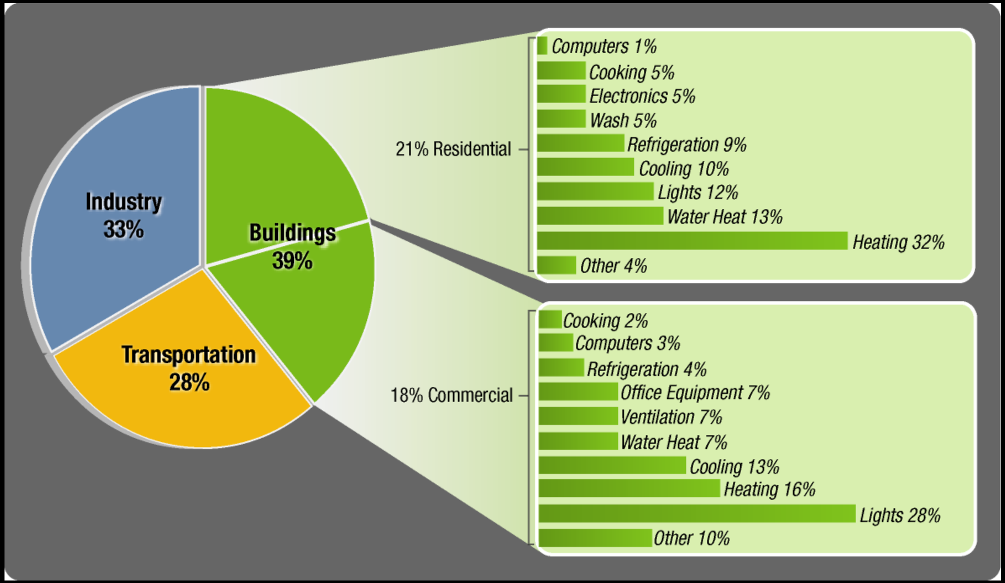
- *Largest Energy Use*
- *Fastest Growth Rate*

Buildings consume 40% of total U.S. energy

- *71% of electricity*
- *54% of natural gas*
- *12% of all potable water (15T gal/yr)*



No Single End Use Dominates



Source: EPA Report to Congress, August 2, 2007; National Academy of Sciences, National Academy of Engineers and the National Research Council report *America's Energy Future: Technology and Transformation*.

General Service Administration Building Analytics - GSAlink

Challenge

- Reduce energy and mechanical operations costs
- Refine building operations to meet President Obama's mandate to make buildings 30% more energy efficient by 2015
- General Service Administration manages 354 million square feet of real estate in 8,603 buildings

Solution - GSAlink

- A building analytics system designed, built, and operated by IBM and comprised of:
  - IBM TRIRIGA
  - Skyfoundry SkySpark
  - Tridium Niagara
- GSAlink is integrated with GSA's Building Automation Systems, smart meter system, business intelligence system, and a GSA Region's computerized maintenance management system

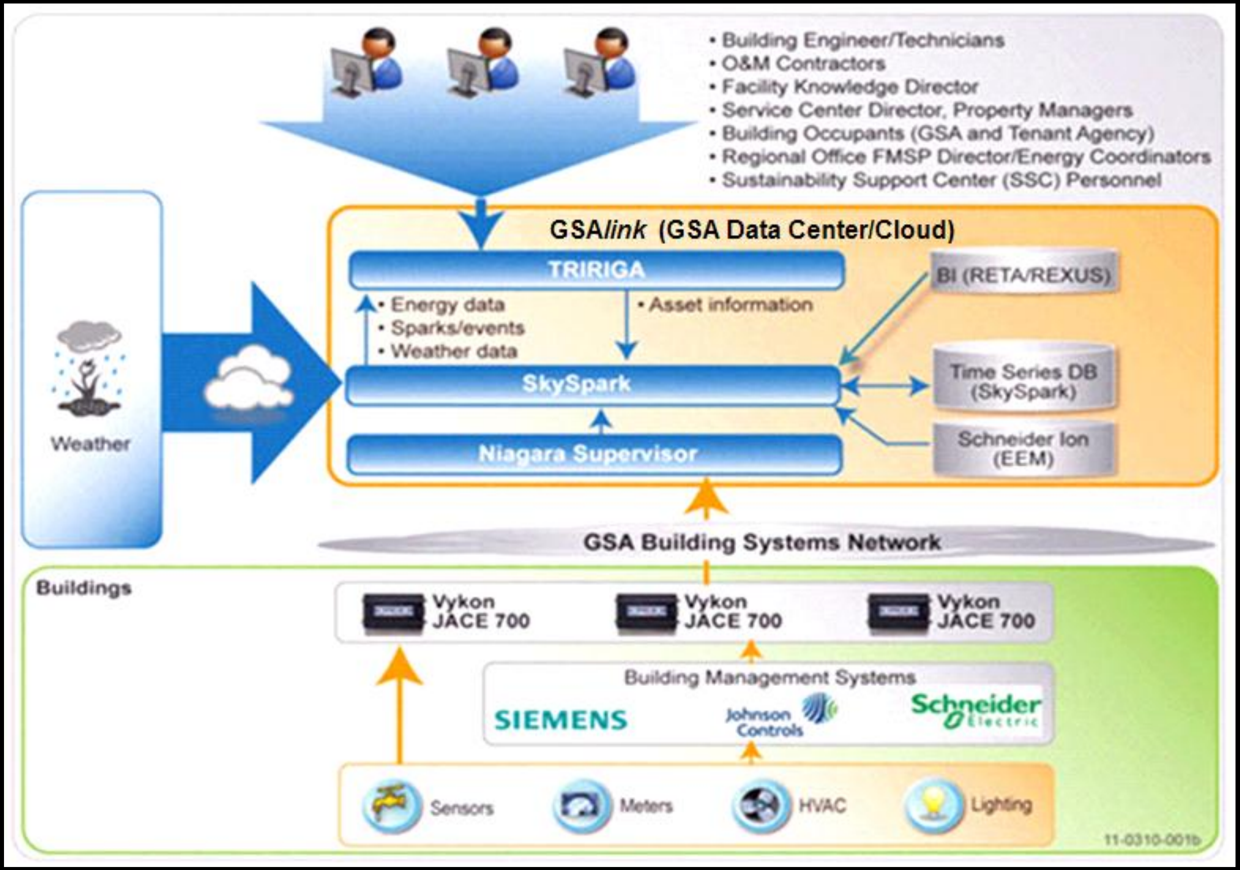
Customer Value

- GSAlink collects and analyzes building sensor data to gain intelligence and provide insights that were previously unavailable, enabling building management teams to reduce energy consumption and optimize facility operations

Status

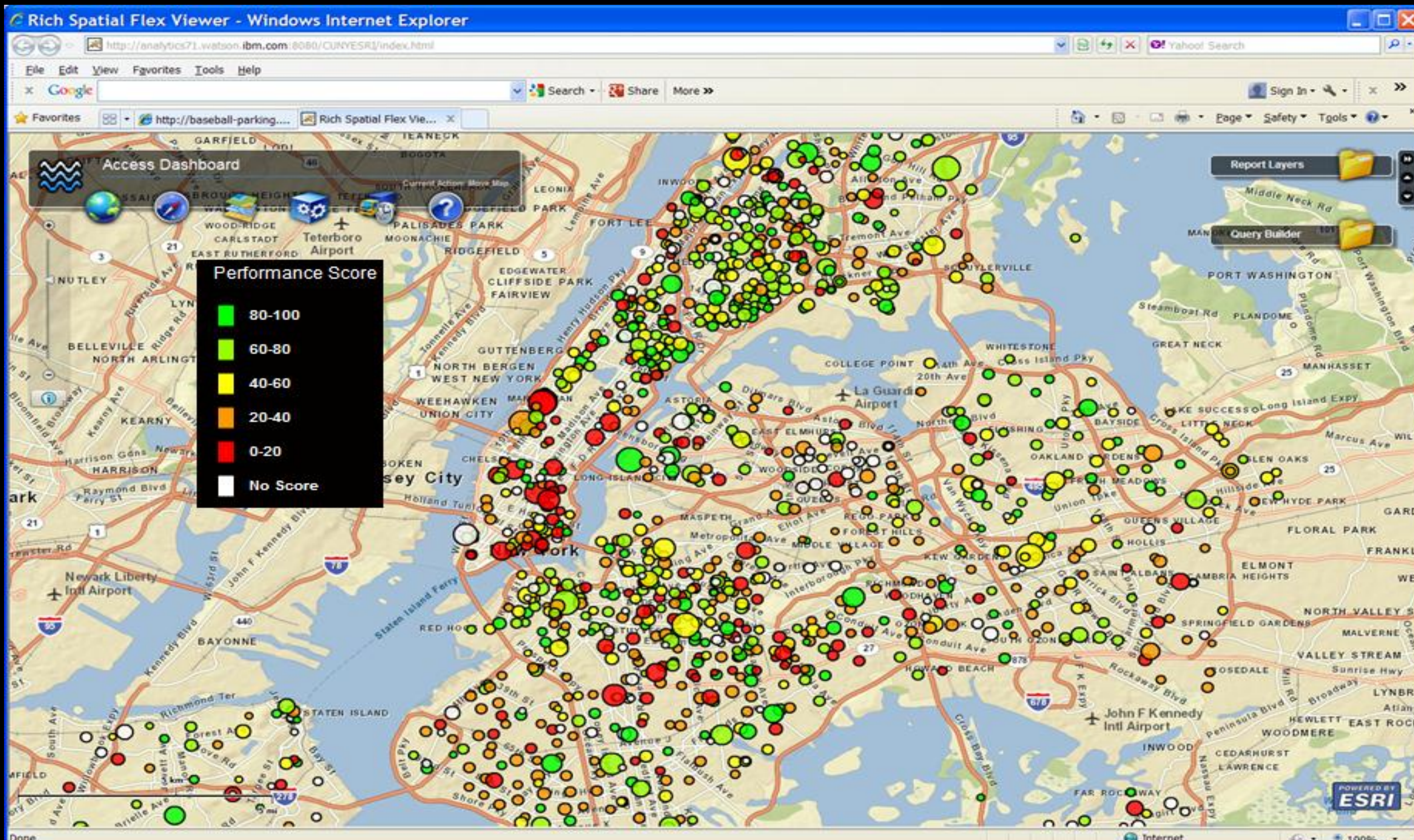
- 55 buildings (~33M square feet of building space) are currently integrated and live on GSAlink
- GSA is realizing substantial energy and mechanical opex savings by taking action on the operating faults that GSAlink is detecting

GSAlink System Overview



- Flexible, non-intrusive, scalable, and configurable
- Diverse building data points extracted
- Building managers monitor building system performance using automated analytics that identify operating faults
- Cost values assigned to operating faults drive decision making based on largest savings opportunities

Energy Performance Score for 1,200 K-12 Public School Buildings in New York City comprising 150 million sq ft



Simulating the energy saving impact of increased roof insulation for a building

Heat Transfer Model - i-BEE (IBM Building Energy and Emission analytics) Dashboard - Windows Internet Explorer

http://analytics39.watson.ibm.com/BldgEnergy/cgi-bin/cognos.cgi?b_action=xts.run&m=portal/cc.xts&m_tab=i27FBE840E90F423D88248555A

File Edit View Favorites Tools Help

Favorites | Heat Transfer Model - i-BEE (IBM Building En...

i-BEE (IBM Building Energy and Emission analytics) Dashboard — CUNY User Log Off Launch

Energy Performance Assessment | Statistical Model | **Heat Transfer Model** | Forecasting | Whole Building Energy Simulation (EnergyPlus) | Optimization

Individual Buiding Thermal Properties | Building Comparison of Thermal Properties | **Simulation with Thermal Properties**

Individual Building Sensitivity Analysis

NYC Department of Education — Select Building: SAM — Select Year: 2009

Sensitivity Model Description

By updating the thermal parameters after enhancing insulation of the building envelop (through retrofitting projects), the annual energy consumption would be changed accordingly. This view gives some qualification of the saving impact on its annual consumption.

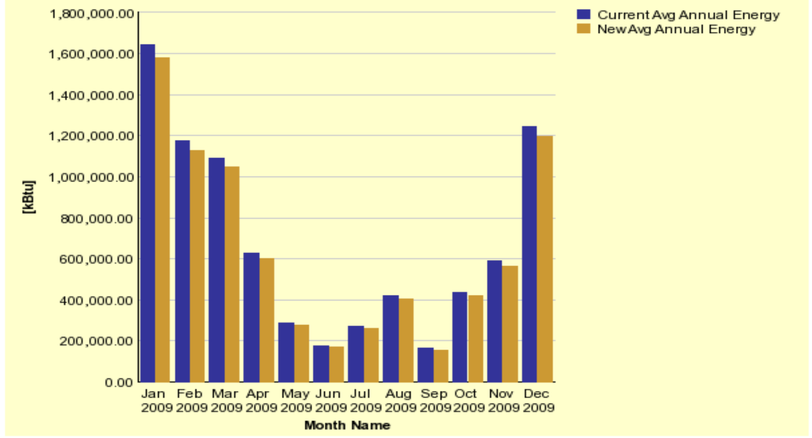
Thermal Parameters of Building (What If Analysis)

Building Properties	Unit	Current Values	New Adjusted Values
R wall	[(ft2*F*h)/Btu]	6.50	6.50
R roof	[(ft2*F*h)/Btu]	16.88	40
U win	[Btu/(ft2*F*h)]	0.72	0.72
M inf	[ft3/(min*ft2)]	0.26	0.26

Set Points	Unit	Current Values	New Adjusted Values
Cooling SP	Fahrenheit	65	65
Heating SP	Fahrenheit	65	65

Enter adjusted values and press Submit Button — Submit

Energy Consumption Difference

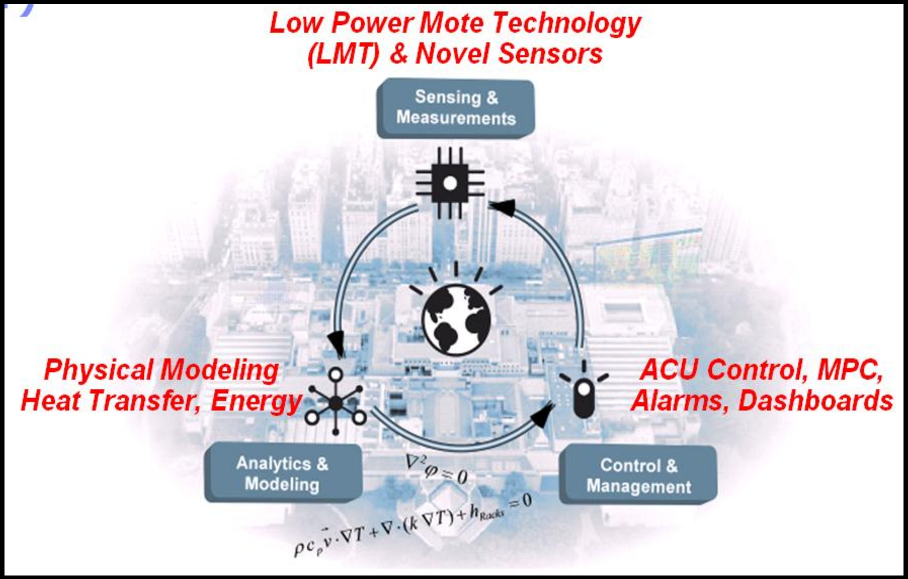


Energy Consumption Difference

	Jan 2009	Feb 2009	Mar 2009	Apr 2009	May 2009	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Oct 2009	Nov 2009	Dec 2009	Total Year
Current [kBtu]	1,642,545	1,175,710	1,092,691	628,281	285,322	175,913	272,691	419,209	163,023	434,803	587,571	1,246,722	**8,124,482**
Estimated [kBtu]	1,576,679	1,128,564	1,048,874	603,087	273,880	168,859	261,756	402,399	156,486	417,368	564,010	1,196,728	**7,798,690**
Energy Savings [kBtu]	-65,866	-47,146	-43,817	-25,194	-11,441	-7,054	-10,935	-16,810	-6,537	-17,436	-23,562	-49,994	**-325,792**

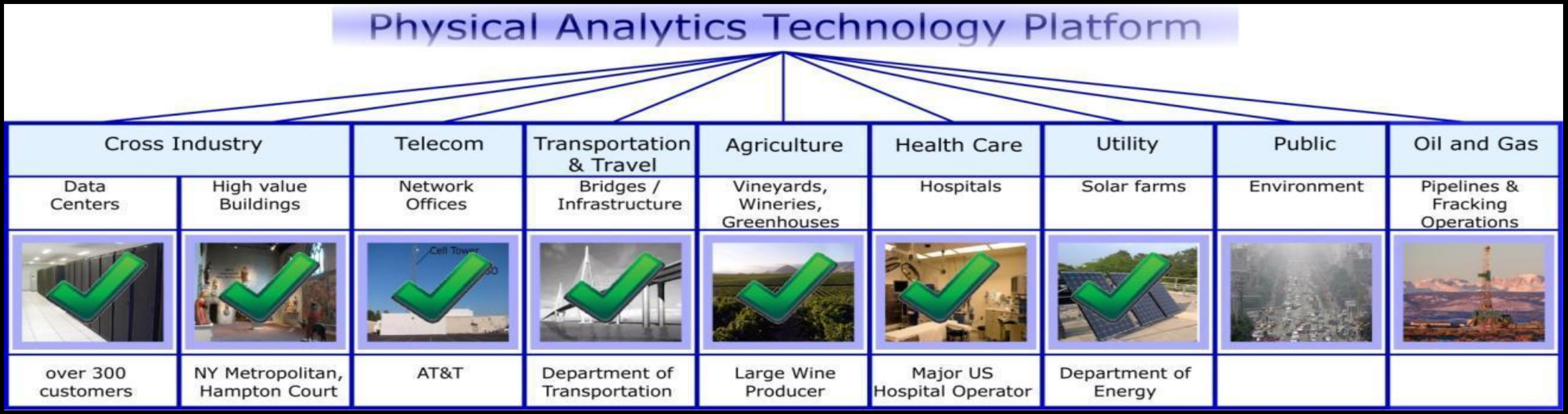
Internet | 100%

What is Physical Analytics?



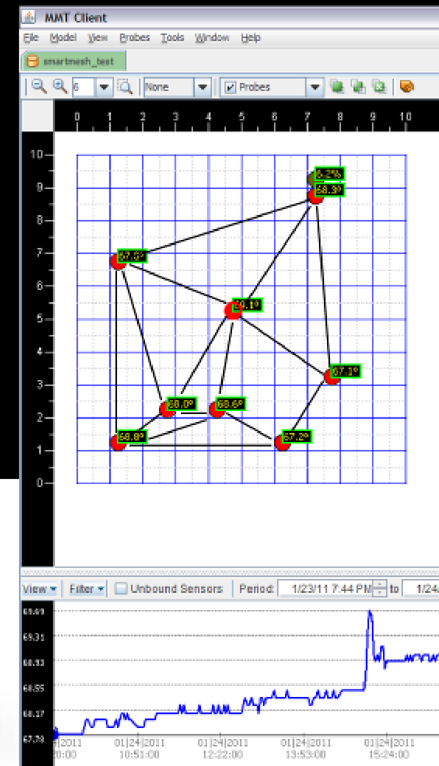
A set of critical technology components for rapid development and deployment of "smarter planet applications"

- High resolution & real-time sensing systems
- Physical modeling
- Management and optimal control



Physical Analytics Example Asset: Low-Power Mote Technology (LMT)

- **LMT—a general wireless data gathering and control technology**
- **World's lowest power consumption**
  - 5 to 7 year lifetime with two AA batteries
  - Forms mesh network, highly reliable, robust and scalable
- **Very flexible and modular design**
- **Only technology with localization capabilities**
  - **down to 1-2 feet**
- **Environmental sensing:**
  - Temperature and Humidity
  - Dew point
  - Pressure, Air flow
  - Particulates
  - Carbon dioxide
  - Presence and Occupancy
  - Corrosion and Air quality
  - Smell
  - Door positions
  - Assets, Location
  - ……



Applying Physical Analytics to Agriculture

Customer

- Large wine producer

Objectives

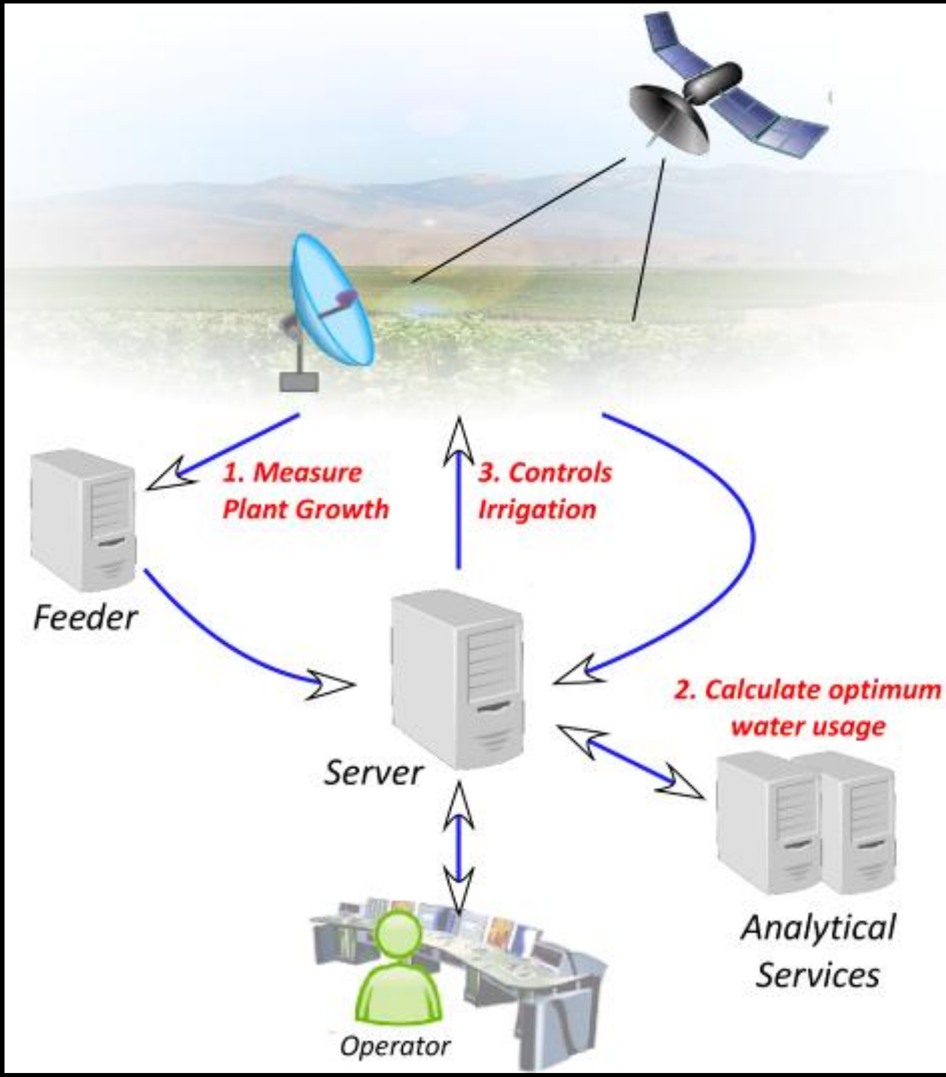
- Reduce intra-field variability to increase crop yield
- Reduce water / fertilizer usage
- Increase operational efficiency

Solution

- Satellite images are analyzed to determine canopy size of wines
- Soil moisture measurements using mote sensors
- Canopy temperature measurements
- Analytics to calculate optimum water usage
- Control a differential irrigation / fertilization system

Analytical Components

- Soil Moisture Modeling
- Image Processing



Applying Physical Analytics in Hospitals / HealthCare Settings

Customer

- Major Operator of Hospitals

Objectives

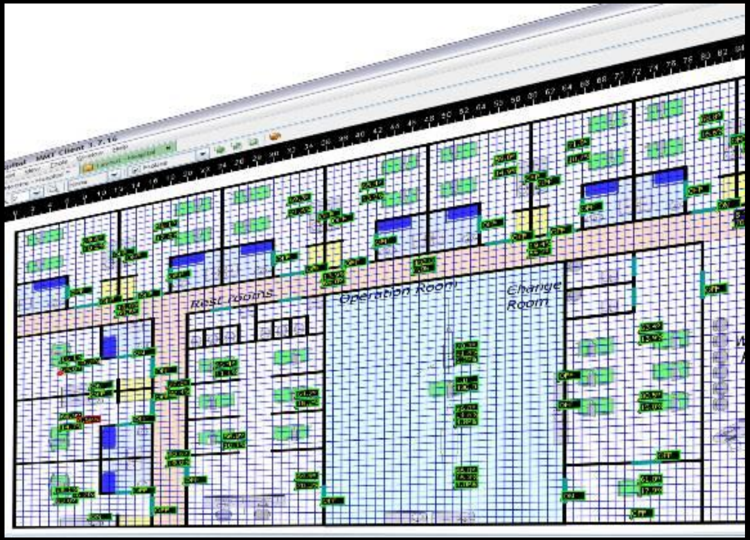
- Quality of Care, Clinical Hygiene
- Patient Comfort

Solution

- Dense wireless mesh network (LMT) in 80 patients rooms; motes include
  - Integrated RFID reader
  - Presence sensors
  - Volatile organic compound sensors
  - Temperature, AQ, Humidity sensors
- Personnel wear RFID badges
- System tracks each person, monitors hand sanitizers and other environmental conditions

Analytical Components

- Sensor Analytics
- Probabilistic Analysis



Example for a Hospital Floor (25k square feet), which includes

- patient and isolation rooms
- operation, preparation and walkup rooms
- nurse stations
- waiting rooms and reception area

The need for progress in the way we manage water is clear

6x

Increase in global water usage since the 1900s; twice the rate of human population growth.

1.1 billion

The number of people that do not have access to safe water according to The World Bank.

45%

Up to 45% of water is lost due to leaks in an aging water infrastructure around the world.

10,855

Estimated liters of water it takes to make a pair of jeans.

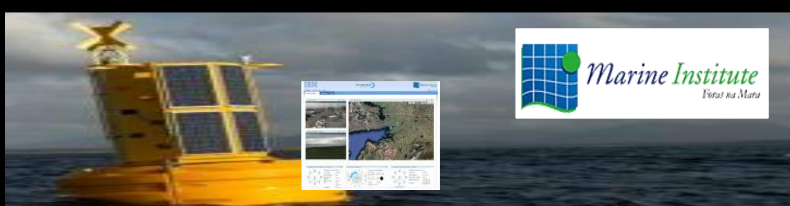
2/3

Two thirds of the world's population is projected to face water scarcity by 2025, according to the United Nations..

Examples of smarter water management innovation from IBM

Smarter Flood Management: In Rio de Janeiro, IBM is using high-resolution hydro-meteorological modeling for operational short-term forecasting to improve prediction of flooding events.

Smarter Levee Management and Flood Control: In the Netherlands, IBM is working with partners to build smarter levees and flood management solutions that enable authorities to monitor infrastructure and changing flood conditions and utilize advanced decision tools to help prevent avoidable flooding incidents as well as enable better emergency response to unavoidable flooding events.



Smarter Bay Management: Paving the way for smarter environmental management and development of Galway Bay, IBM and the Marine Institute of Ireland have deployed a real-time advanced analytics platform to monitor wave conditions, marine life, and pollution levels in and around Galway Bay.

Smarter Water Use and Energy Efficiency: IBM itself has realized dramatic economic and sustainability benefits implementing advanced water management systems. Using Green Sigma^{TM} methodologies, IBM has implemented a smarter water management solution in IBM Burlington's Semiconductor Fab that allowed us to realize $3 million in cost savings and reduce water consumption by 27% while increasing production.

IBM's own sustainability leadership and experience
Recognition of Results – A Sampling from 2012 - 2013

- Climate Leadership Award (second year in a row), Supply Chain Leadership (2013)
- Climate Leadership Award (inaugural year), Organizational Leadership (2012)
- Gold Medal, World Environment Center (2012)
- #1 Ranking of World's Greenest Companies, Newsweek (2012)
- EU Code of Conduct (CoC) for Data Center Energy Efficiency, Corporate Level Participant of the Year (2012)
- Industrial Energy Technology Conference (IETC) Energy Award, Canada (2012)
- Golden Peacock Environment Management Award, India (2012)
- The Chambers Ireland President's Awards for Corporate Social Responsibility for Excellence in Marketplace for its Integrated Supply Chain Social and Environmental Management System, Ireland (2012)
- The International Union for Conservation of Nature prize for sustainability, the Netherlands (2012)
- Singapore Environmental Achievement Award, Singapore (2012)
- White House Champion of Change Award for Leadership in Corporate Sustainability (2012)

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