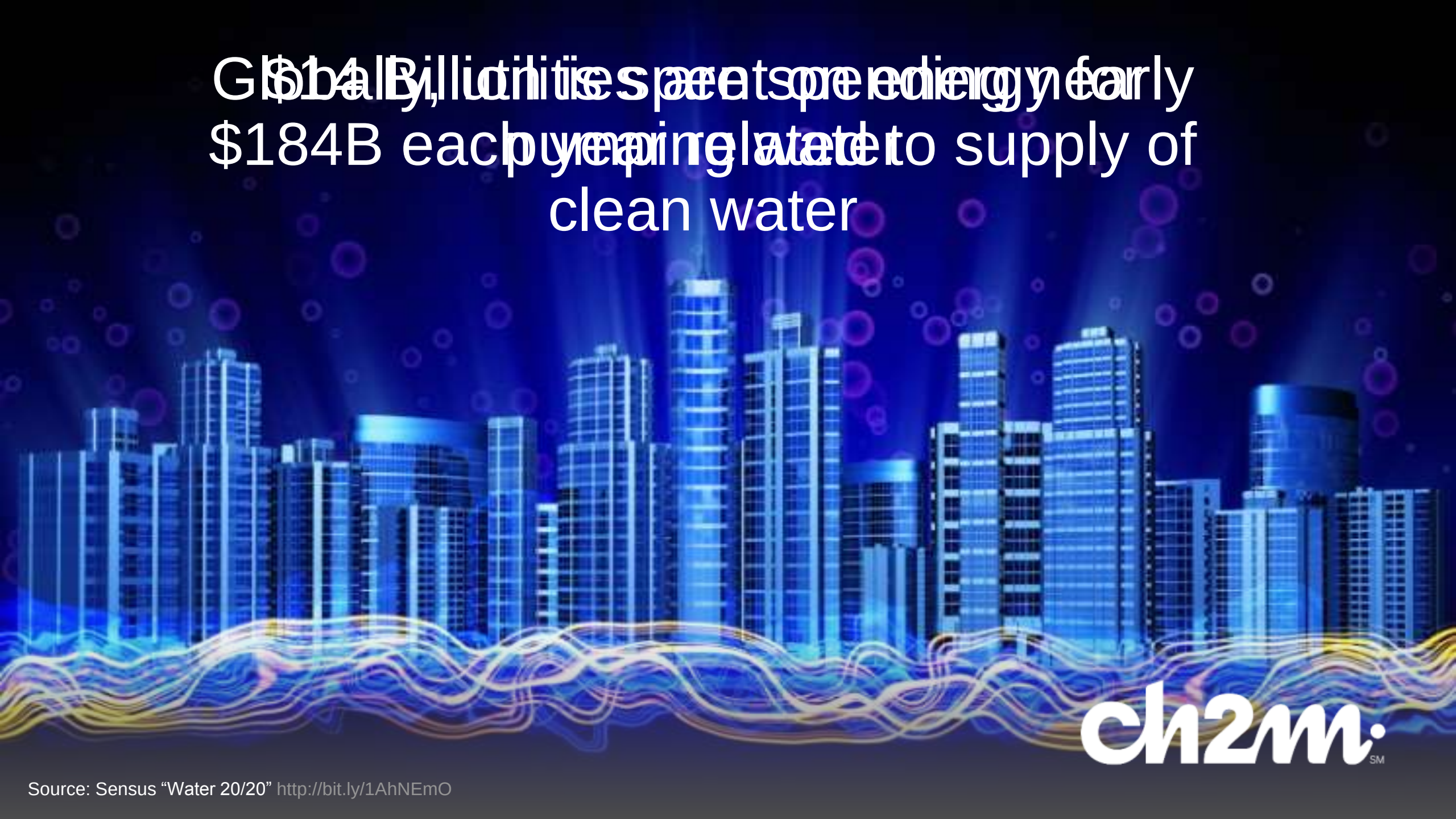
Smart Grid for Distribution System Water Quality Management

Making Water Systems Smarter Using M2M: the Internet of Things

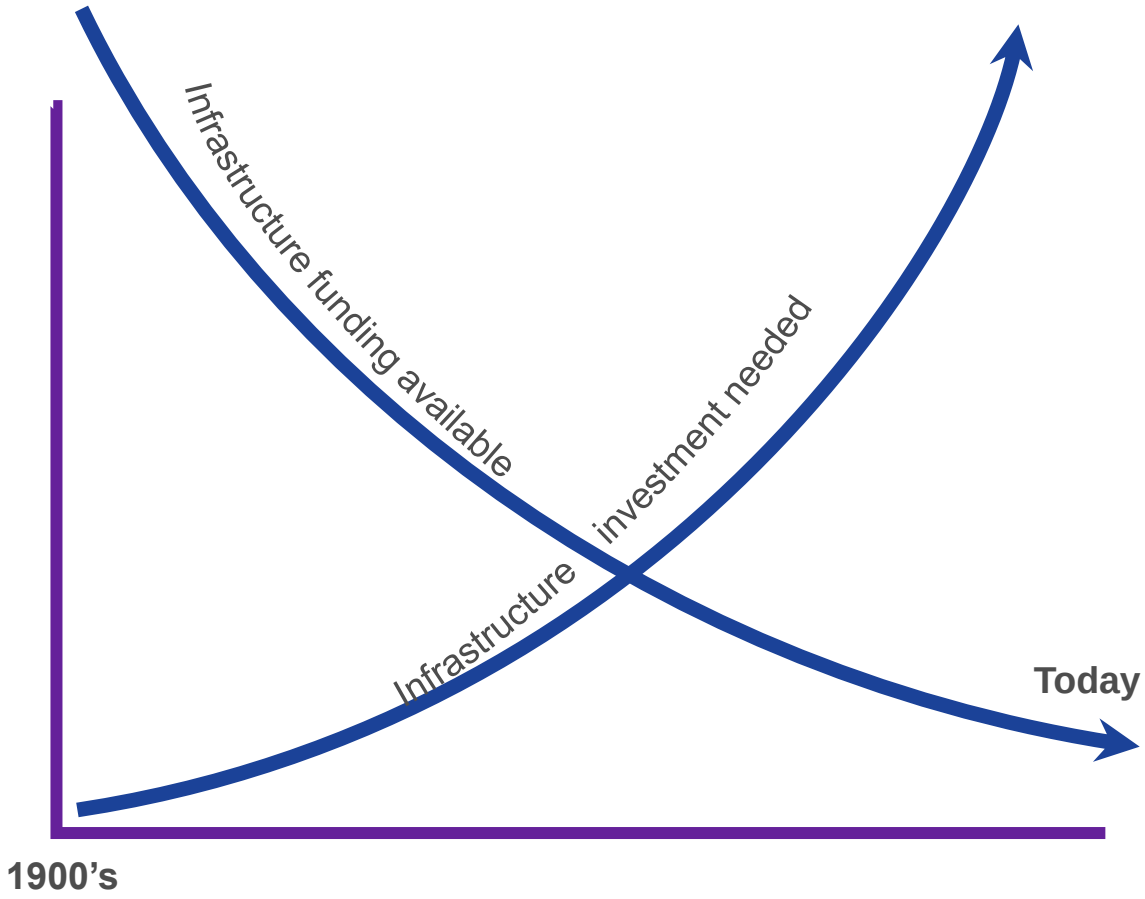
Mike Karl

Intelligent Water Solutions



Source: Sensus “Water 20/20” http://bit.ly/1AhNEmO

Within the next decade, approximately 1.8 billion people worldwide will be living in areas of absolute water scarcity



Top Concerns

Security

Workforce

Infrastructure

Water Source

Obsolete Technology

Economic Sustainability

Regulatory Compliance

The Value of Smart Grid for Utilities

Rapid deployment and lower capital costs

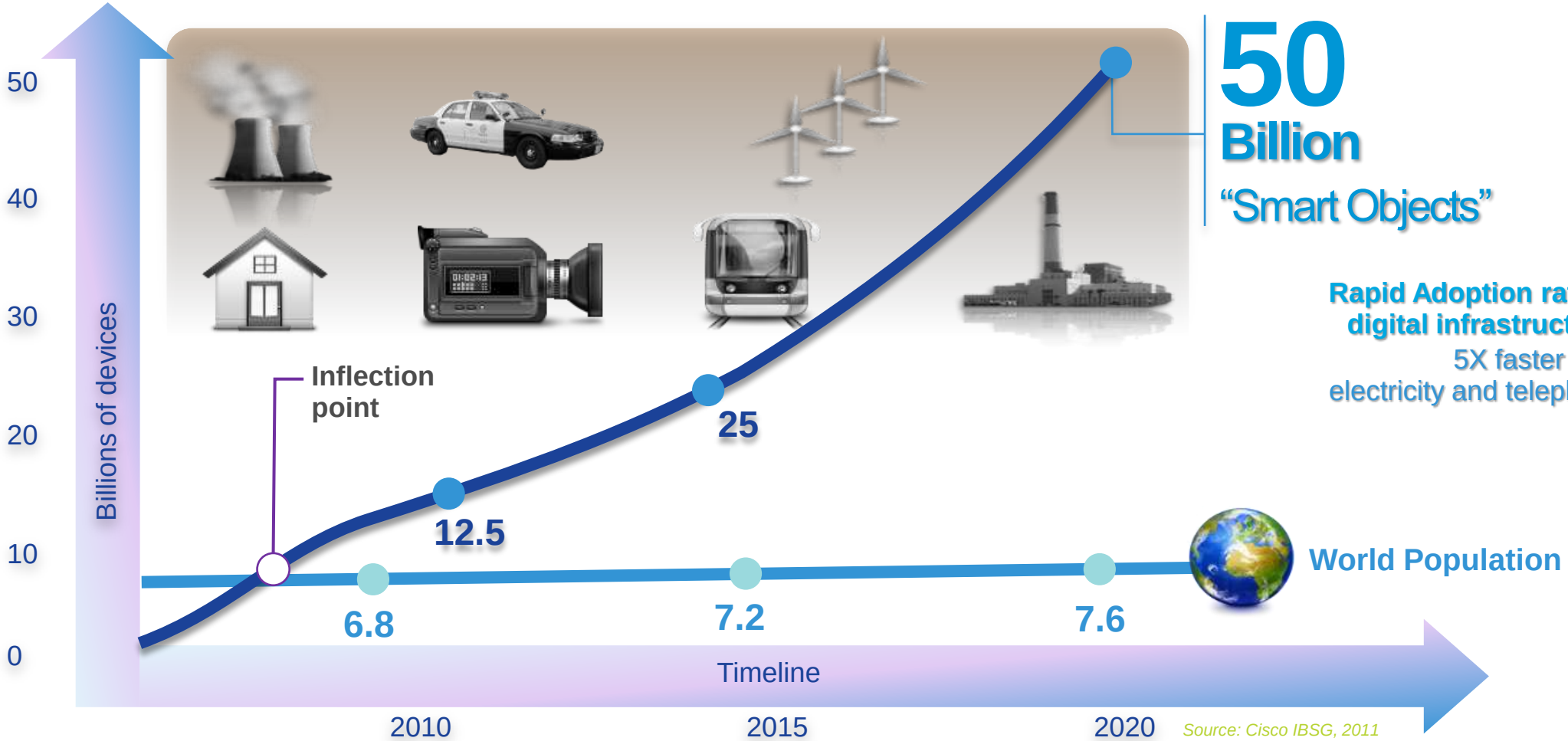
Lower cost of providing essential services

Increase in reliability of operating assets – improve lifecycle costs

Improved service levels AND increase regulatory compliance

Lower cost of related infrastructure for wiring, telecom, SCADA, CMMS

Smart Grid drivers: Internet of Everything is projected to increase from 10 billion to 50 billion objects by 2020



Smart Grid Drivers

- By 2020, the IoE will provide a $19 trillion benefits to cities worldwide (CISCO)
- The Public Sector will benefit from one third of that value
- New providers are entering the market weekly offering systems and widgets
- Something that just produces more data or does not help improve your operations is not **Smart**

Big changes are coming and utilities need to be prepared

Smart technologies can be leveraged to save an impressive $12.5B.

Reducing leaks by 5%, and reducing 10% of pipe bursts can save up to **$4.6B**

Streamlined water quality monitoring: Smart Water Network can save **$600M** annually of up to 70% of water quality monitoring

Employing dynamic asset management tools can result in 15% saving of Capital Expenditures, or up to **$5.2B**

Implementing Smart Utility Framework that provides critical data, via remote operations, utilities can save **$2.1B** or up to 20% of labor/vehicle

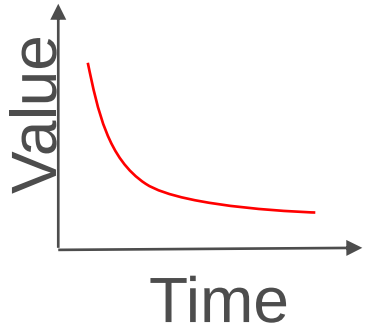
Globally, utilities are spending nearly $184B each year related to supply of clean water.

$14 Billion is spent on energy for pumping water

Sensus
Water 20/20
http://bit.ly/1AhNEmO

What can the data provide that is different?

- The Value of Now
  - There is certain information whose value decays exponentially over time. Need to perform real-time analytics on data to provide real-time intelligence

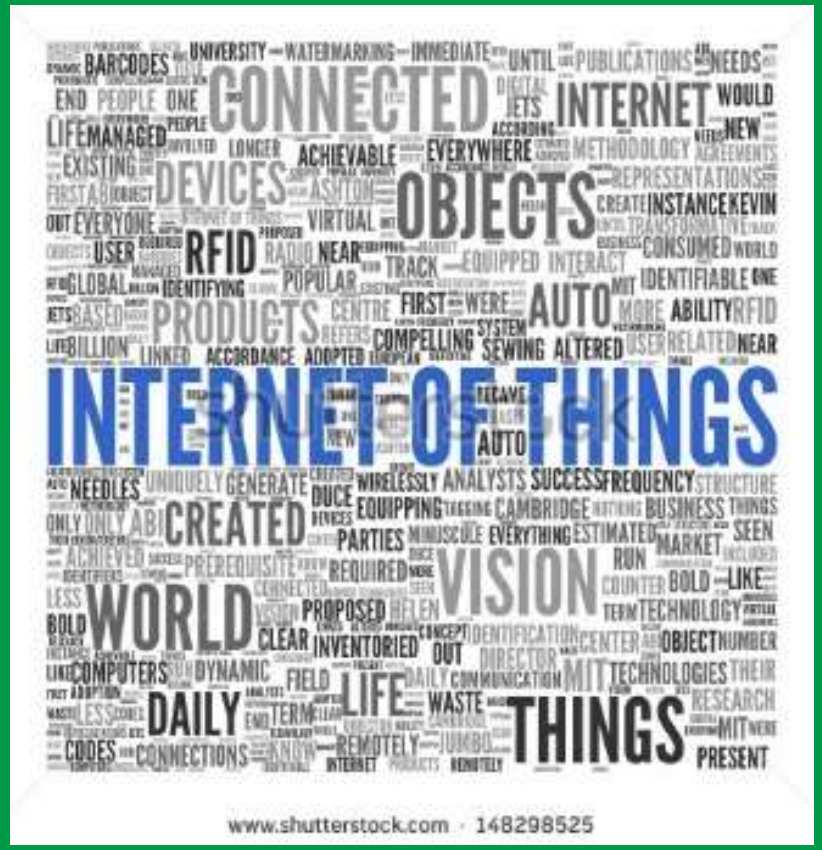


- Enabling the Edge
  - Resources on the perimeter of the distribution/collection system (aka the *edge*) often lack the ability to provide/generate real-time or consume real-time information. By enabling these resources, value can be achieved.

Topics:

- Internet of Things & M2M
- What makes something smart?
- Case studies & applications
- CH2M approach
- The future

Making Water Systems Smarter Using M2M: the Internet of Things

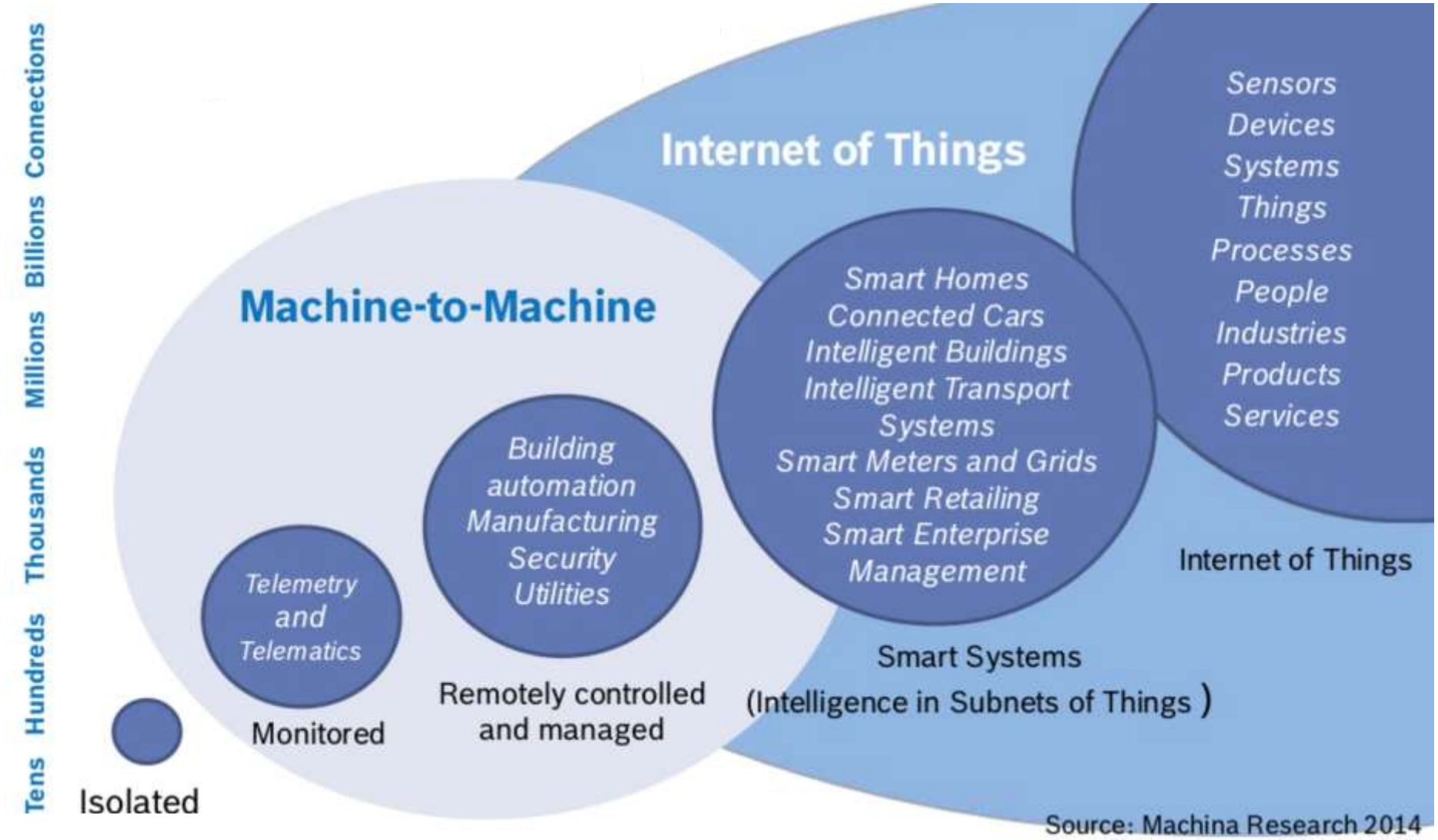


Internet of Things is all about:

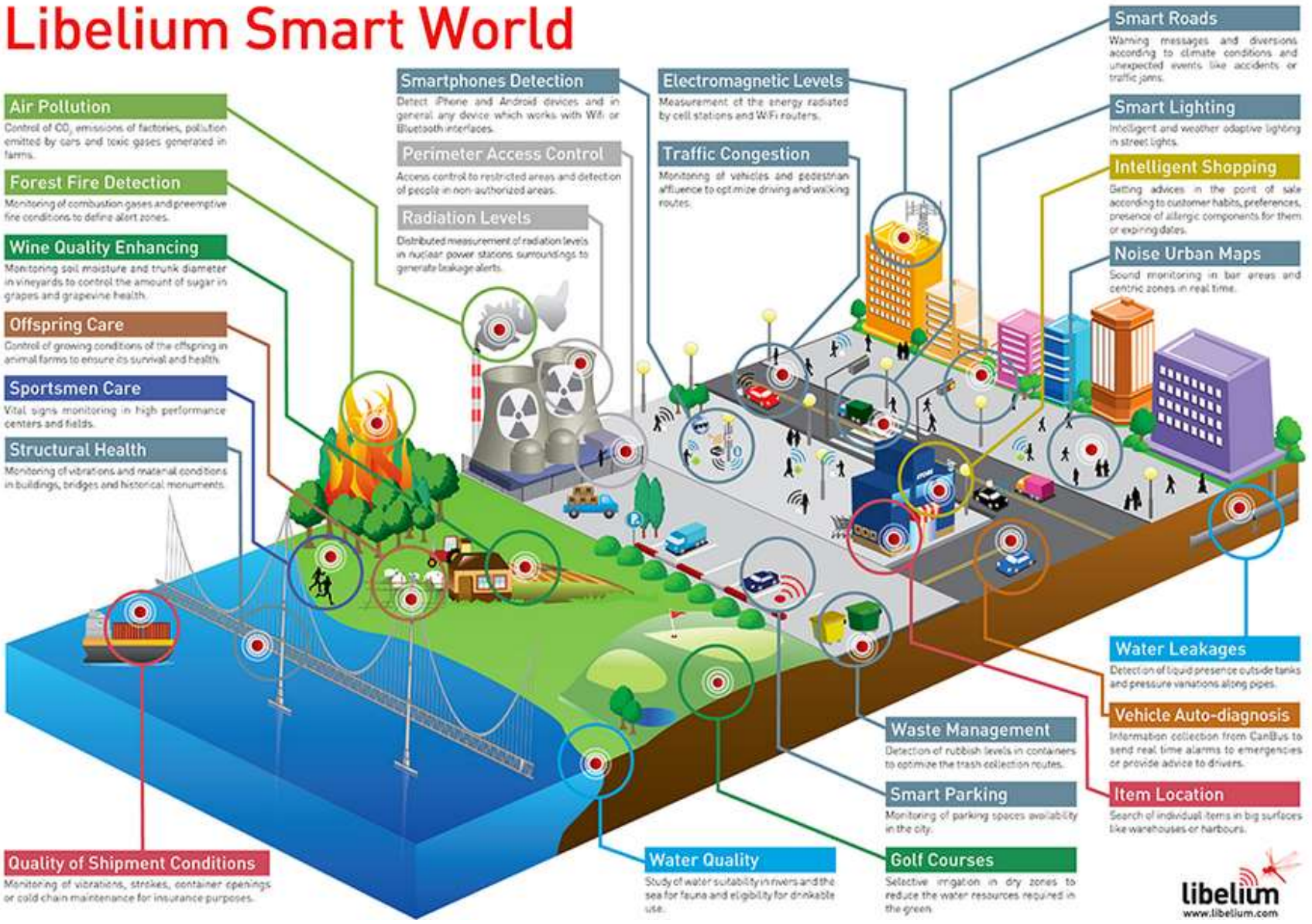
- Helping Humans
- Big Data and Analytics
- Opportunity

Enabled by integrating multiple functions into one piece of hardware at a valuable price.

The Internet of Things (also called Machine to Machine) has arrived and is rapidly growing



Future = Everything connected



Wide-ranging applications are already in use

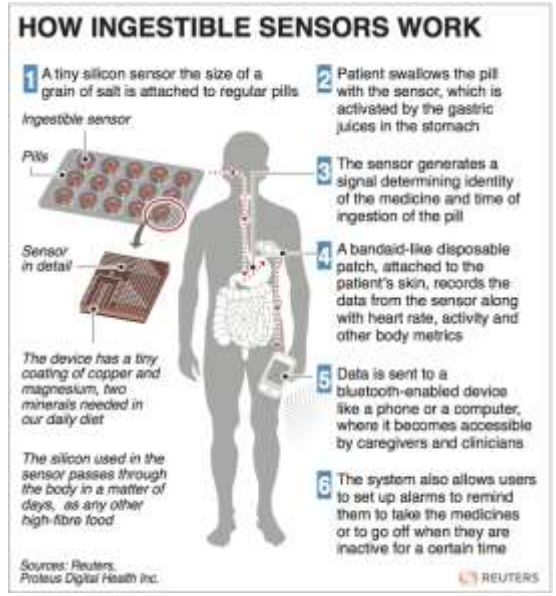
NEST – just bought by Google

Baby Monitor

Digital Pill

Home Systems

NEST
Google



Wide-ranging applications are already in use

Libelium
(71 sensors)

Trunk Diameter
Libelium

Dispatch Compass
Centeron

WZZARD
B+B SMARTWORX
ENABLING CONNECTED INTELLIGENCE

Waspmote Smart Water Sensors

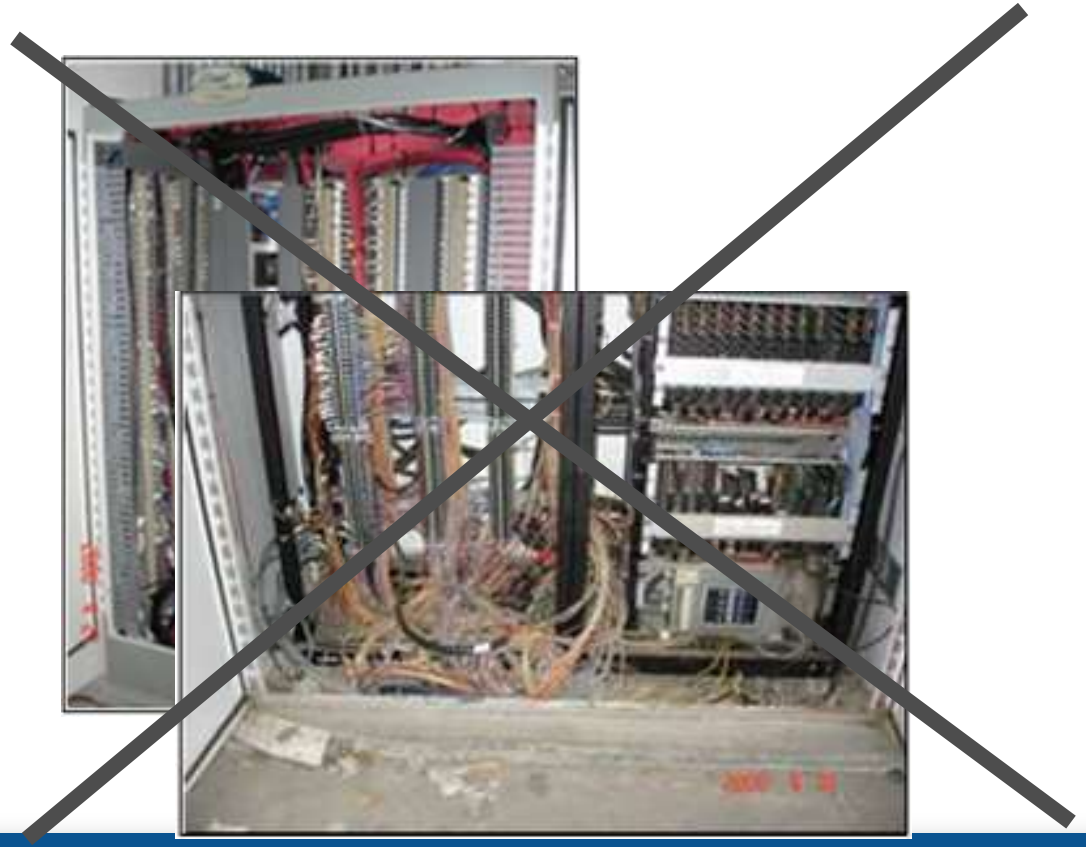
Smart Water

Turbidity

Model	Product(s)	Total
WWATER	Waspmote Smart Water Sensor Board, Supports 6 Sensors at Once	US$273.50
9332	Dissolved Ions Sensor: F- (Fluoride), BNC Interface	US$207.20
9329	Oxidation Reduction Potential (ORP) Sensor, BNC Interface	US$74.59
9328	pH Sensor, BNC Interface, 0-14pH	US$28.18
9327	Dissolved Oxygen Sensor, BNC Interface, 0-20mg/L, 0-100psig	US$563.58
9326	Conductivity Sensor for Liquid, Two Electrodes, 100Hz-100kHz	US$54.70
WWIFI-SMA2	Waspmote Main Board with 802.11b/g WiFi Module, 2 dBi Antenna	US$244.00

Sub-Total: US$1,445.75

Moving from Hard Wired PLCs and Conduit to M2M Technologies



Like this,… but smaller.

Devices that provides processing, memory, sensor interface, power, and communications capability.

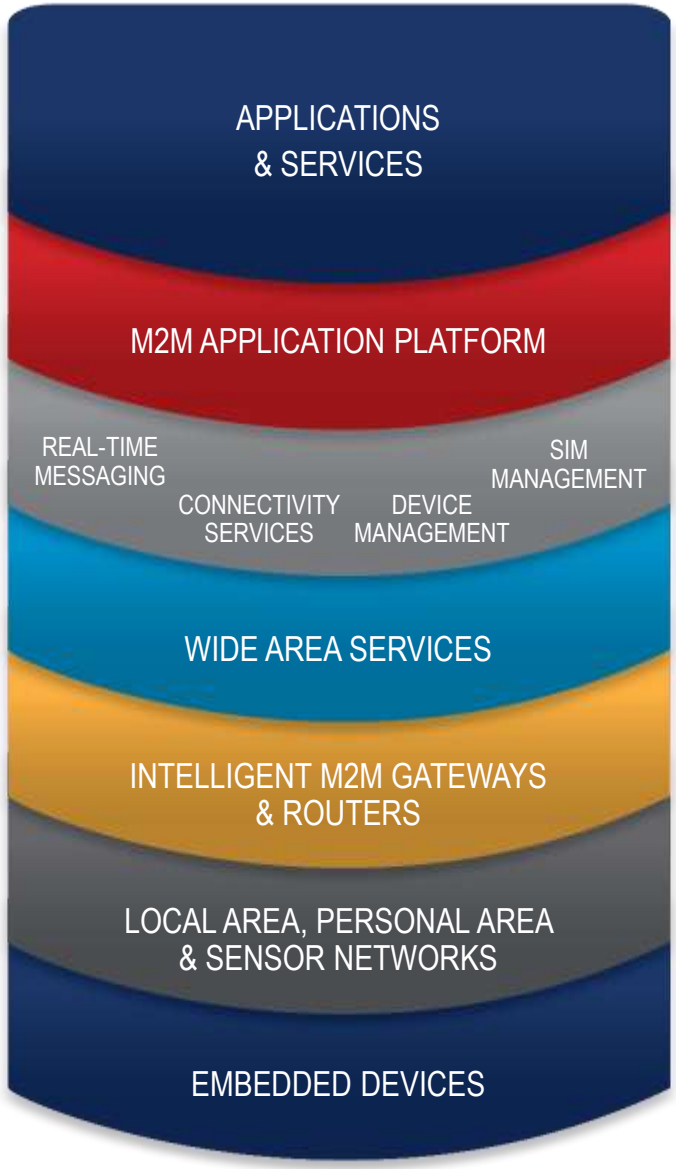
What types of Machine to Machine (M2M) Technologies are available?

- Generally refers to devices connected wirelessly such as:
  - Cellular
  - WiFi
  - Bluetooth
  - Zigbee
  - Wireless Hart
- Often connected to a Cloud for data transfer
- Power Options
  - Solar
  - Battery
  - Powered

What technology is required to make M2M systems work?

Micro Electro-Mechanical Systems (MEMS):

- affordable MEMS, a semiconductor manufacturing technology that incorporates active elements into microelectronics devices
  - accelerometers,
  - pressure sensors,
  - RF antennas,
  - switches,
  - sensors,
  - actuators



What technology is required to make M2M systems work?

Energy-Harvesting:

- IoT devices require a source of power
- placing a battery in each one is not always practical or environmentally sound
- New technologies harvest energy from novel sources such as vibrations, temperature gradients, and radio frequencies

Identification Tags and Wireless Networks:

- objects and devices identify themselves using RFID (Radio Frequency Identification) tags
- connect to the network wirelessly.
- various standards proposed for wireless network

What technology is required to make M2M systems work?

Infinite Internet Addresses:

- current internet protocol standard, IPv4, has ‘only’ 4.3 billion addresses,
- insufficient for the quantity of devices joining the IoT.
- latest version, IPv6, solves the problem definitively.

Cloud Computing:

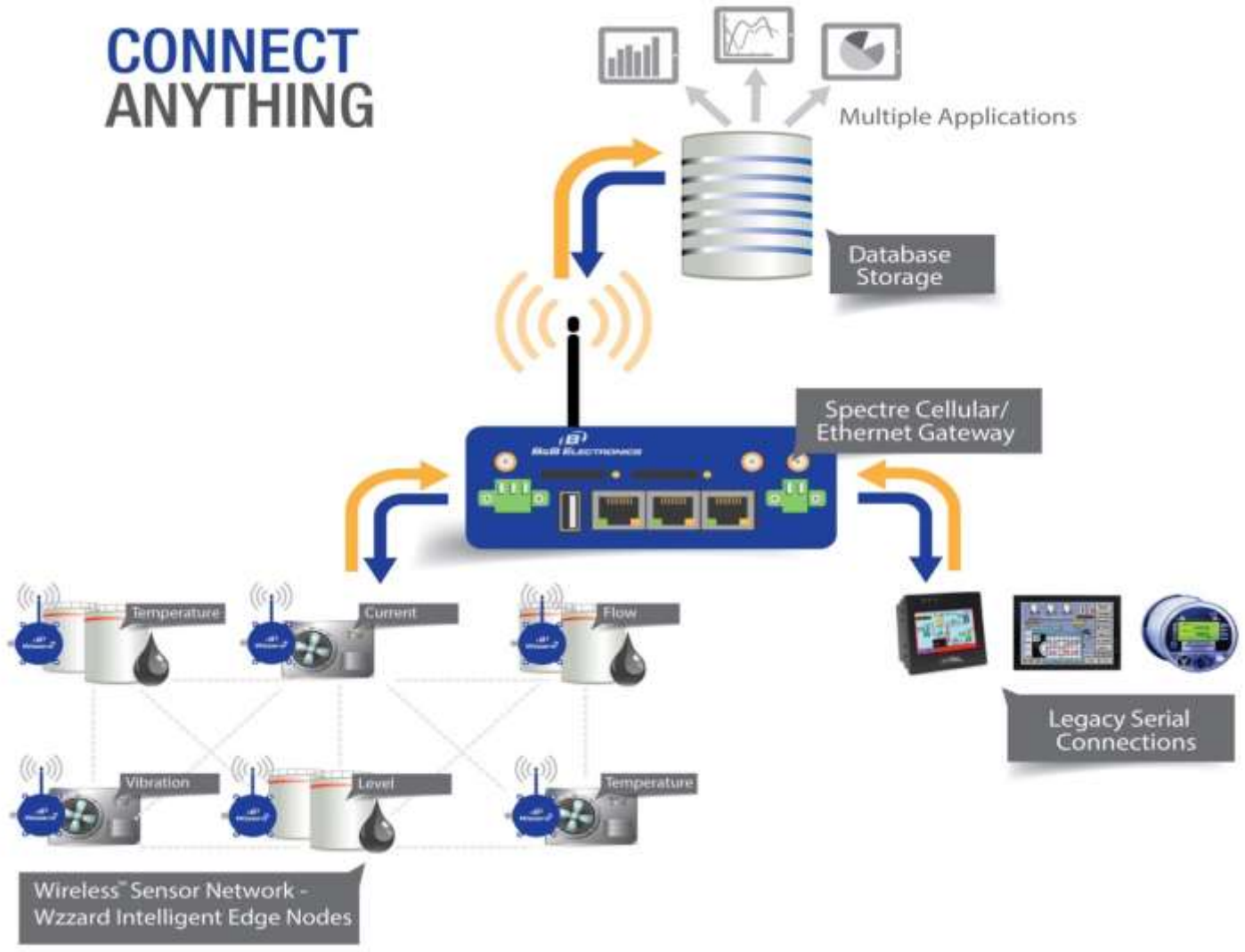
- devices with relatively limited computer power must access and run sophisticated programs.
- accomplished via cloud computing
- hosts applications and stores data for connected devices

What technology is required to make M2M systems work?

Big Data:

- massive amount of data generated
- track, manage, and extract useful information
- use of data sets so large and complex that they are difficult to process using standard database tools and computing power.

Reference System Architecture



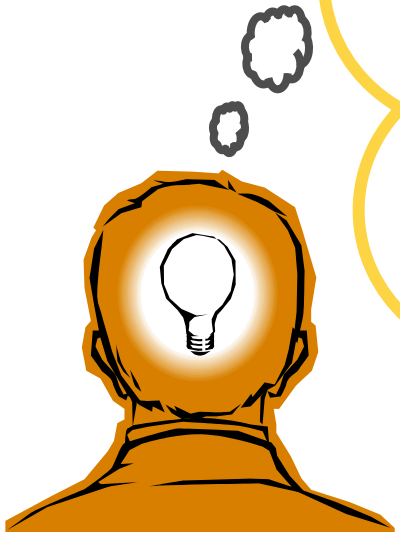
What makes something smart?

A Smart City uses information and communications technology to enhance its livability, workability and sustainability

- Collect information about itself through sensors, other devices and existing systems
- Communicate data using wired or wireless networks
- Crunch data to understand what's happening now and what's likely to happen next

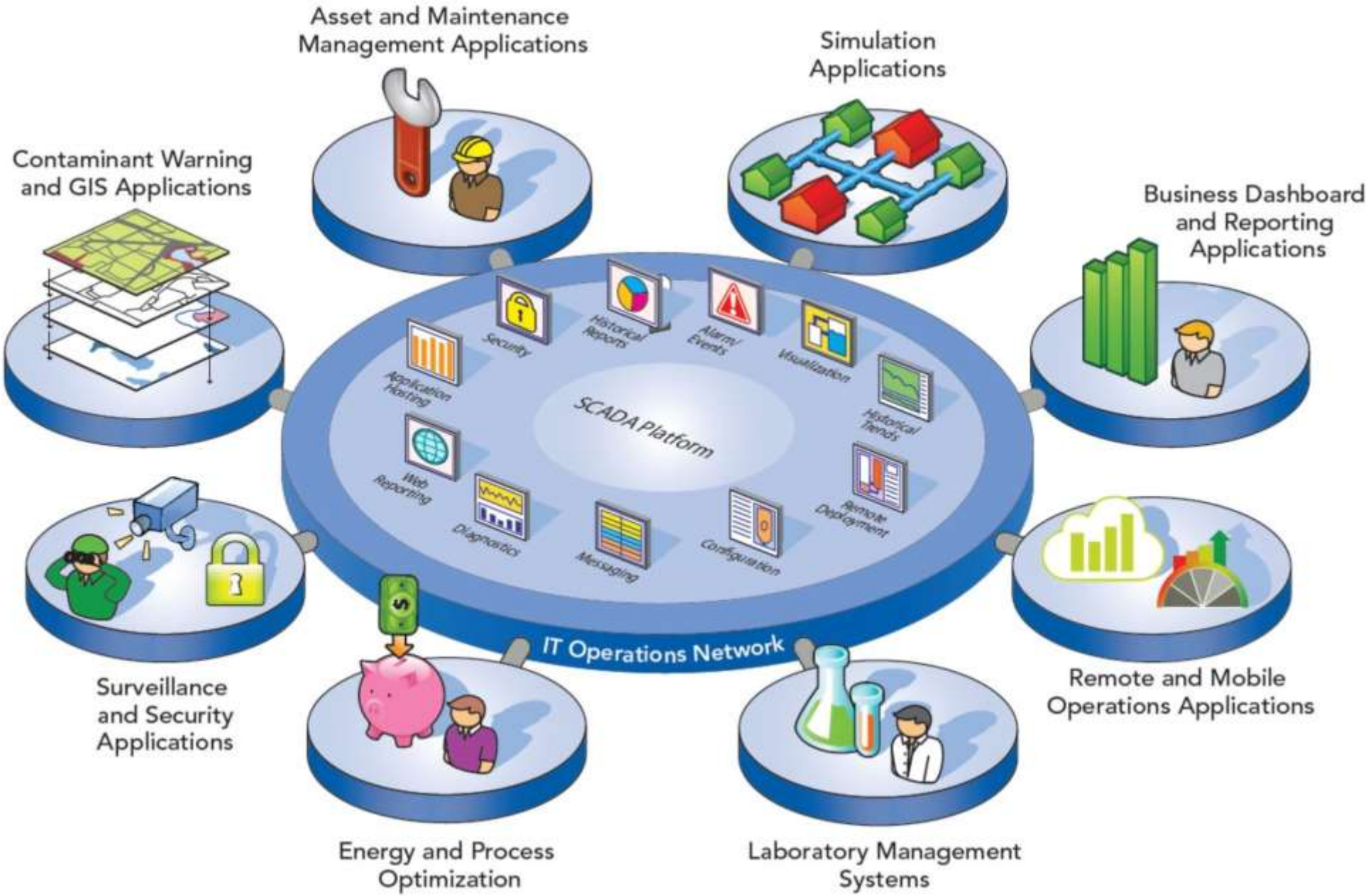
Smart Cities Council

To quote Martin Luther King, I have a Dream…



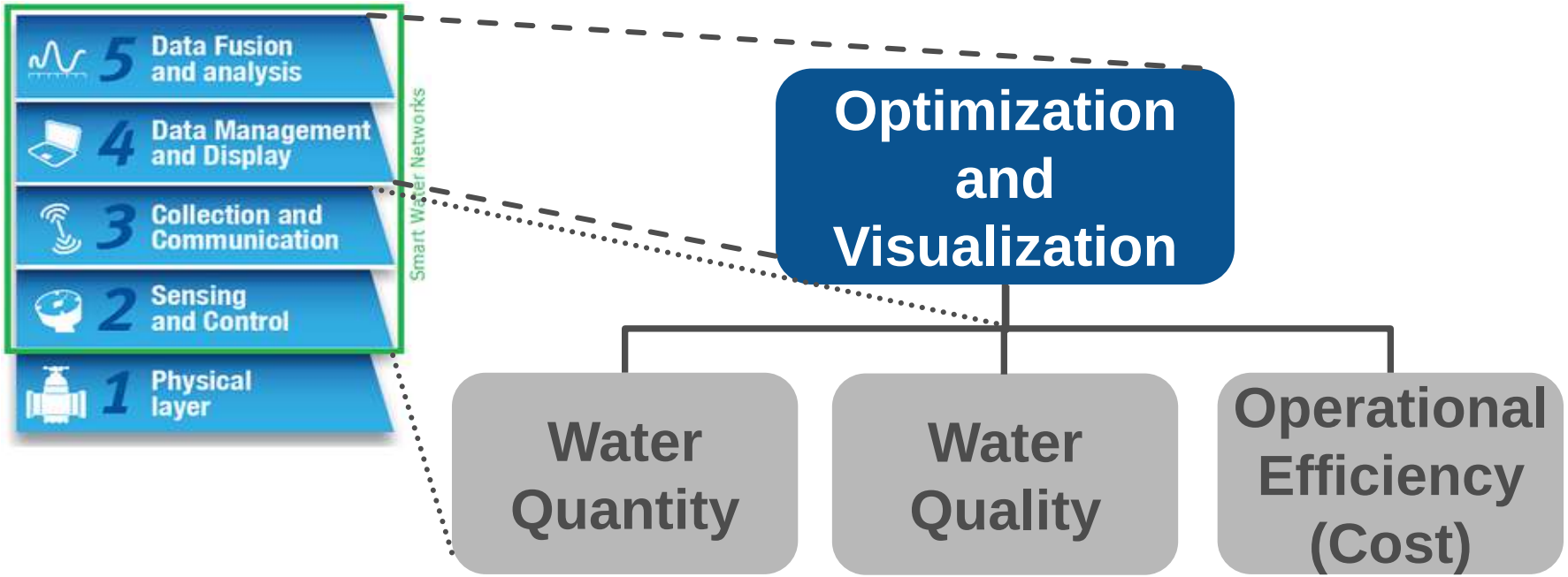
- ✓ Increase Efficiency in Power and Labor Use
- ✓ Decrease Non-Revenue Water
- ✓ Decrease Operational Costs
- ✓ Improve Capital Planning Approach
- ✓ Improve System Knowledge
- ✓ Improve Water Quality
- ✓ Maintain Regulatory Compliance

Not just Smart, Brilliant Network…



How does Smart Grid apply to distribution systems?

Processes and technologies used to optimize the combination of **quality**, **quantity** and **cost** for water system management

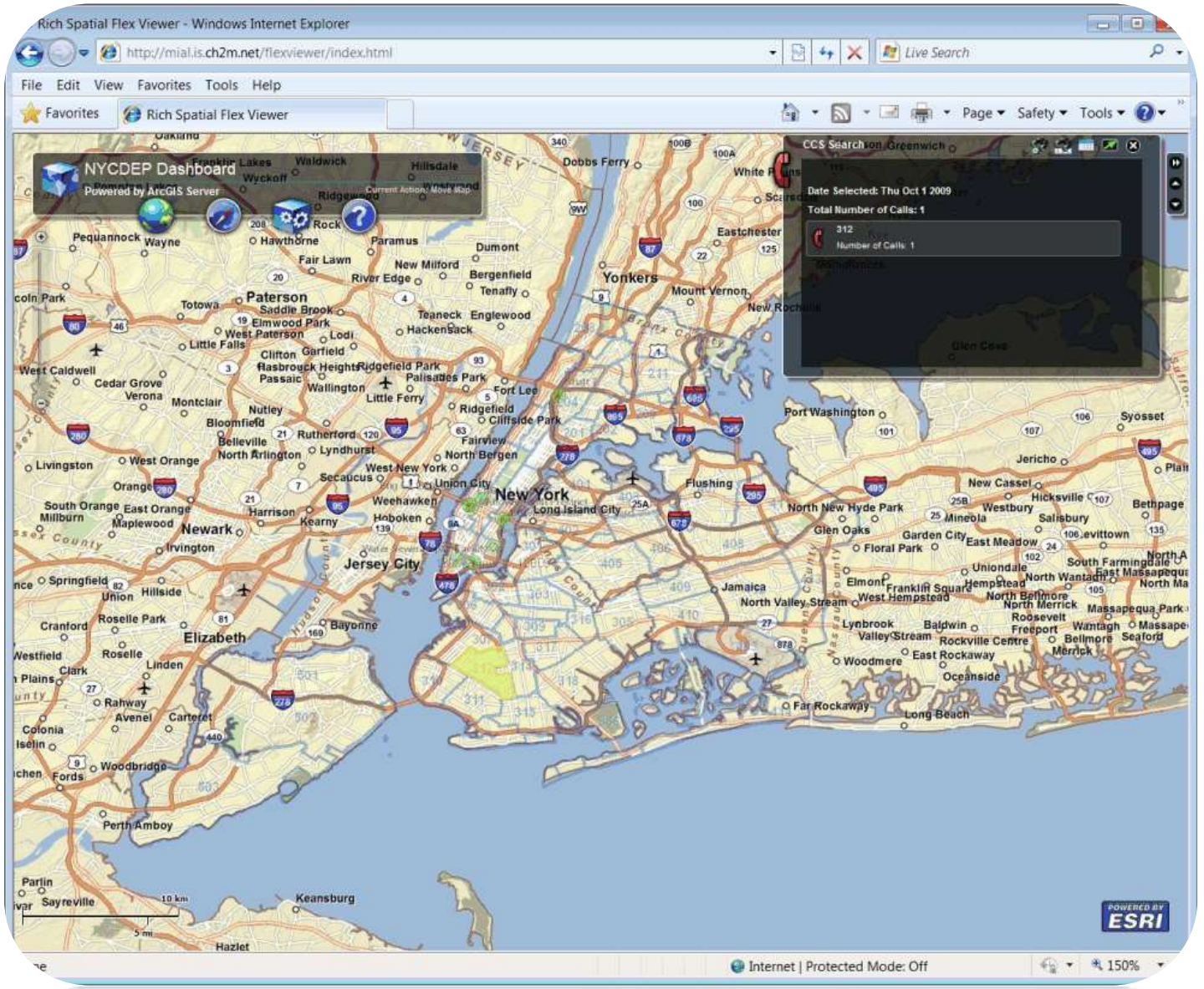


Components of distribution system Smart Grid

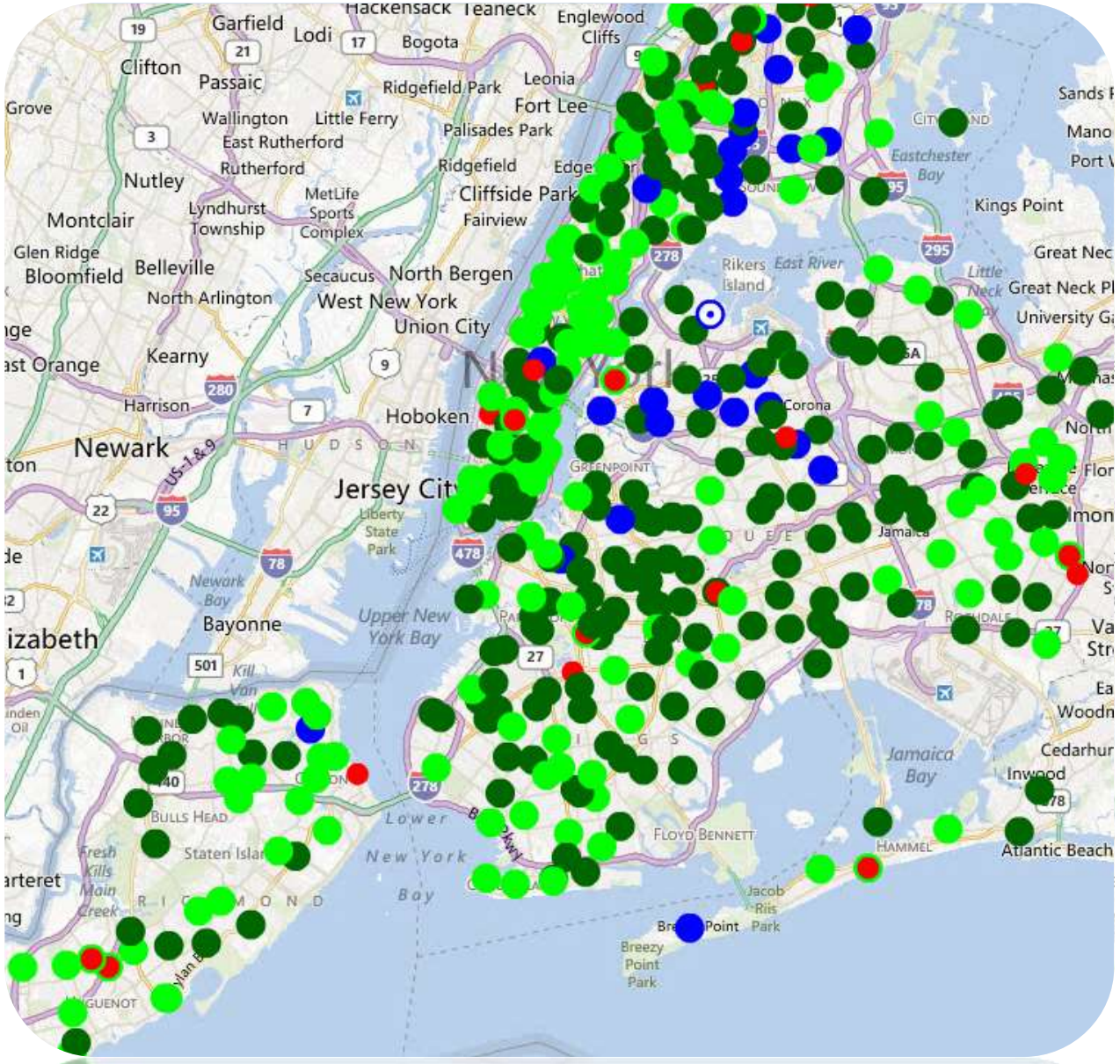
- Integrated information platform
- Collect multiple streams of data, in real-time
- Understand inter-relationships between the data
- Develop algorithms and computer systems to analyze events as a result of inter-relationships
- Display and present data easily in a decentralized manner
- Perform analysis
- Recognize competing objectives through a multi-dimensional decision-making process

Case Studies: Optimizing Water Quality, Quantity, and Cost

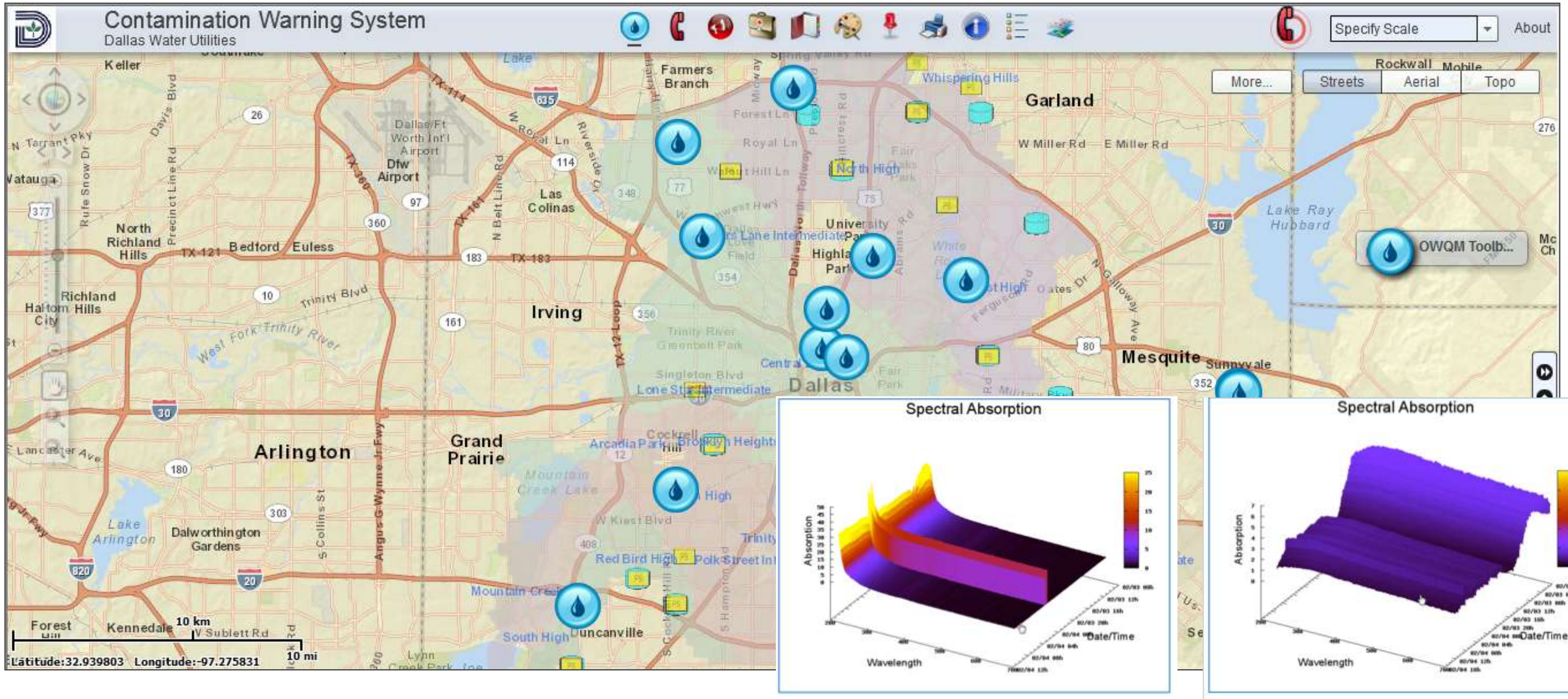
Tracking an Algal Incident in New York City's Drinking Water Based On Customer Calls Expedites Solution Implementation



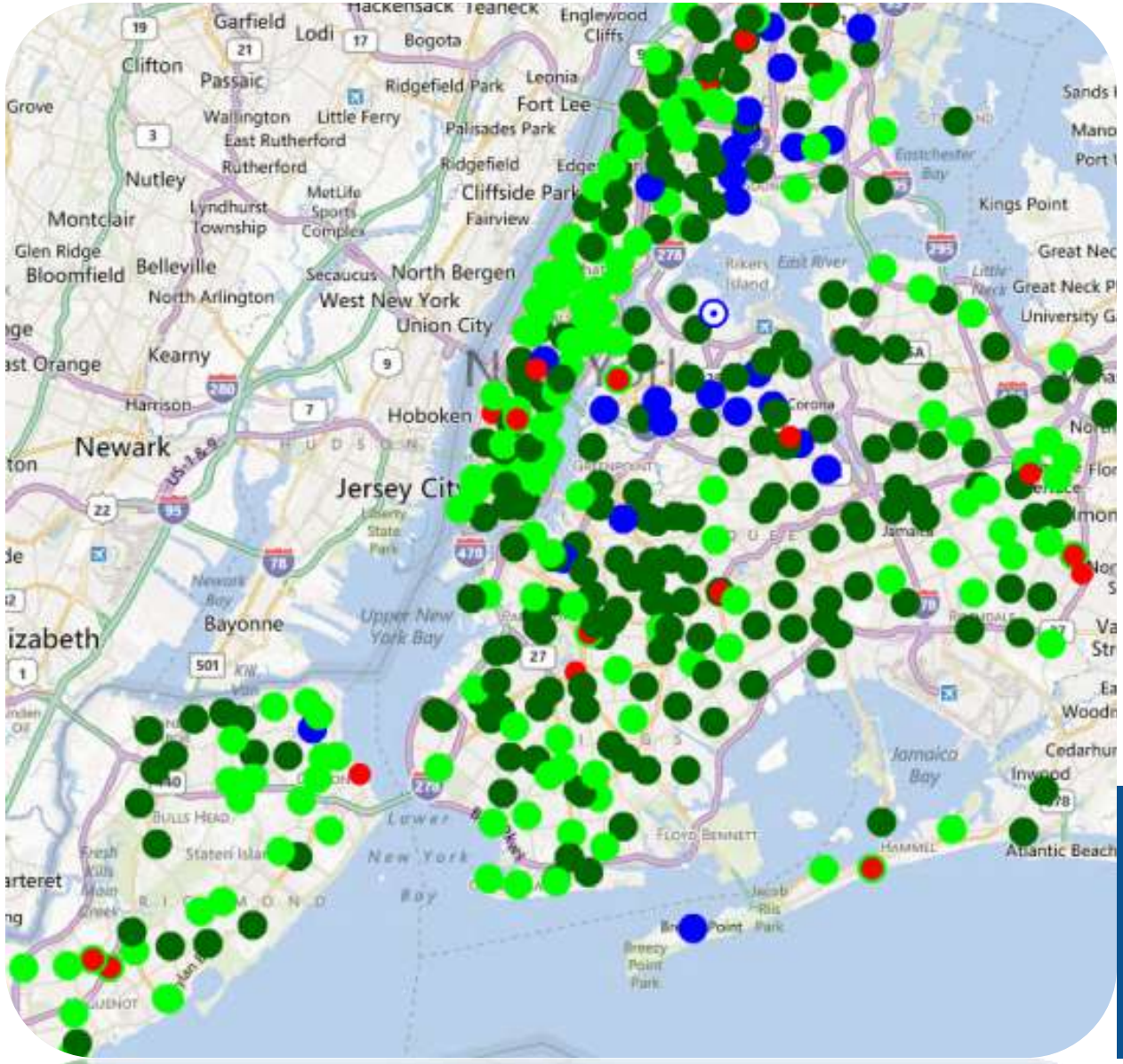
Real-time LIMS (Laboratory Information Management System) Visualization



Real-time Evaluation of System Water Quality



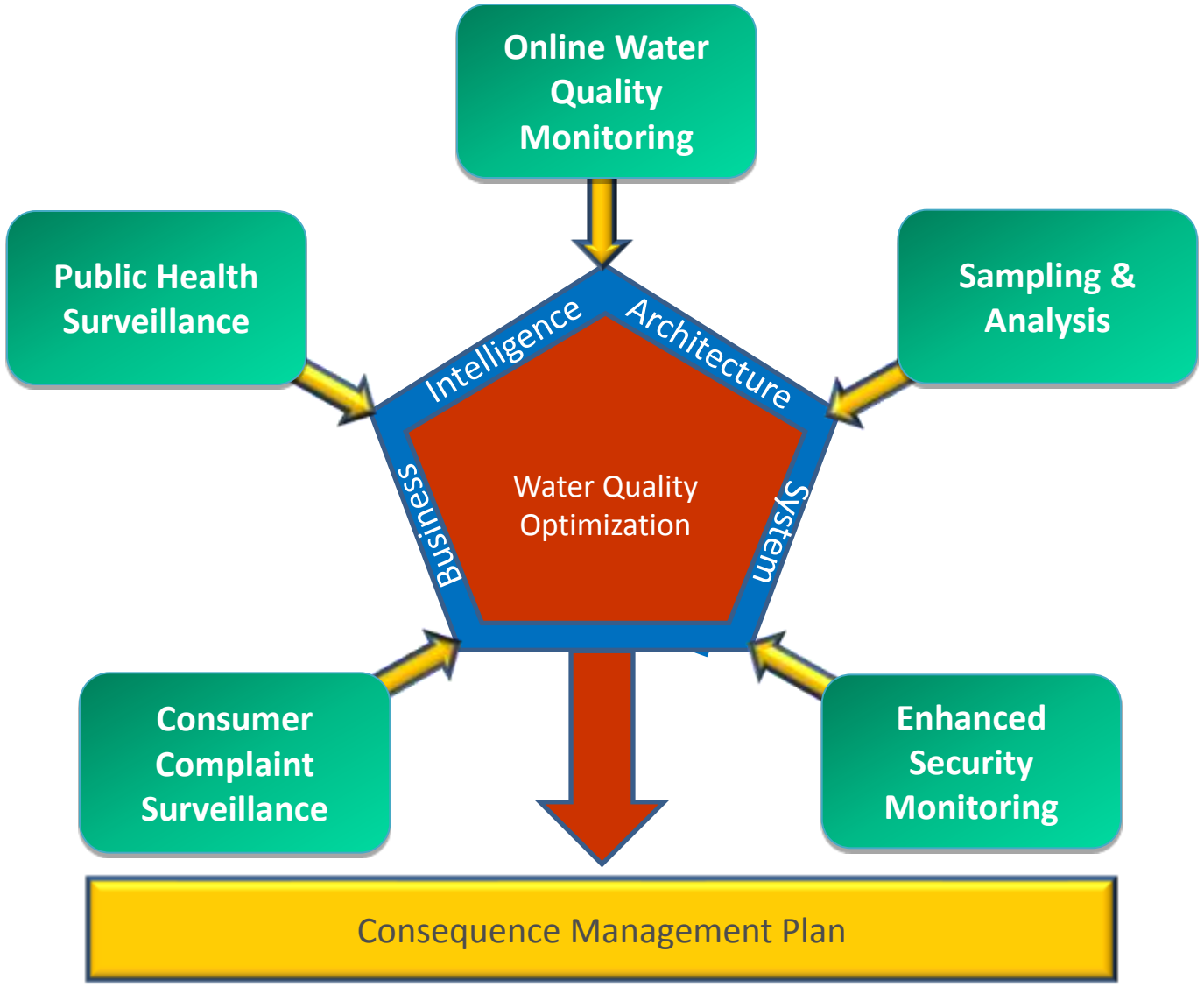
Real-time Visualization of Chlorine Levels demonstrates safe water



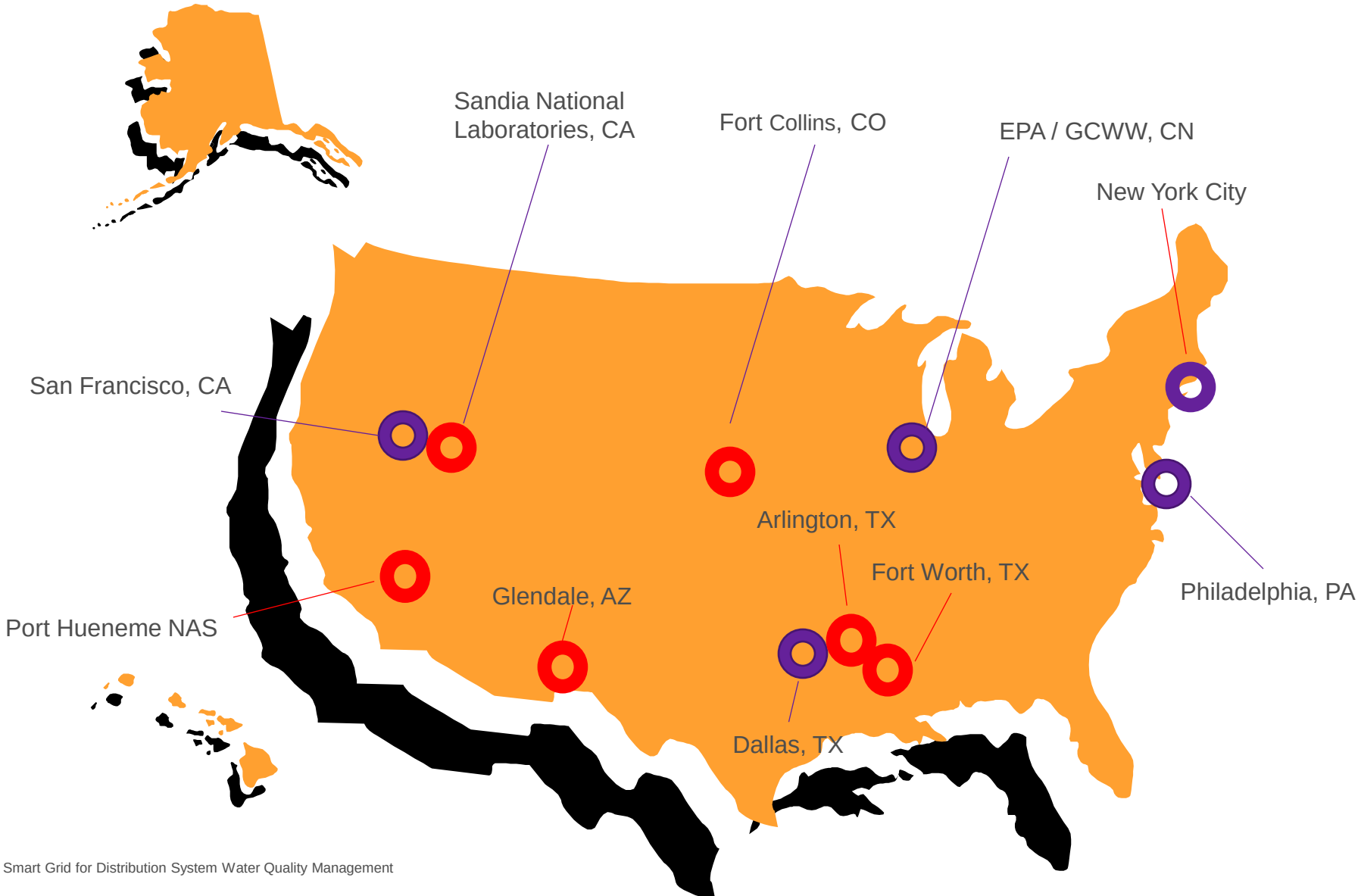
Blue=Low
Green=Good
Red=High

Water Quality Data Sources

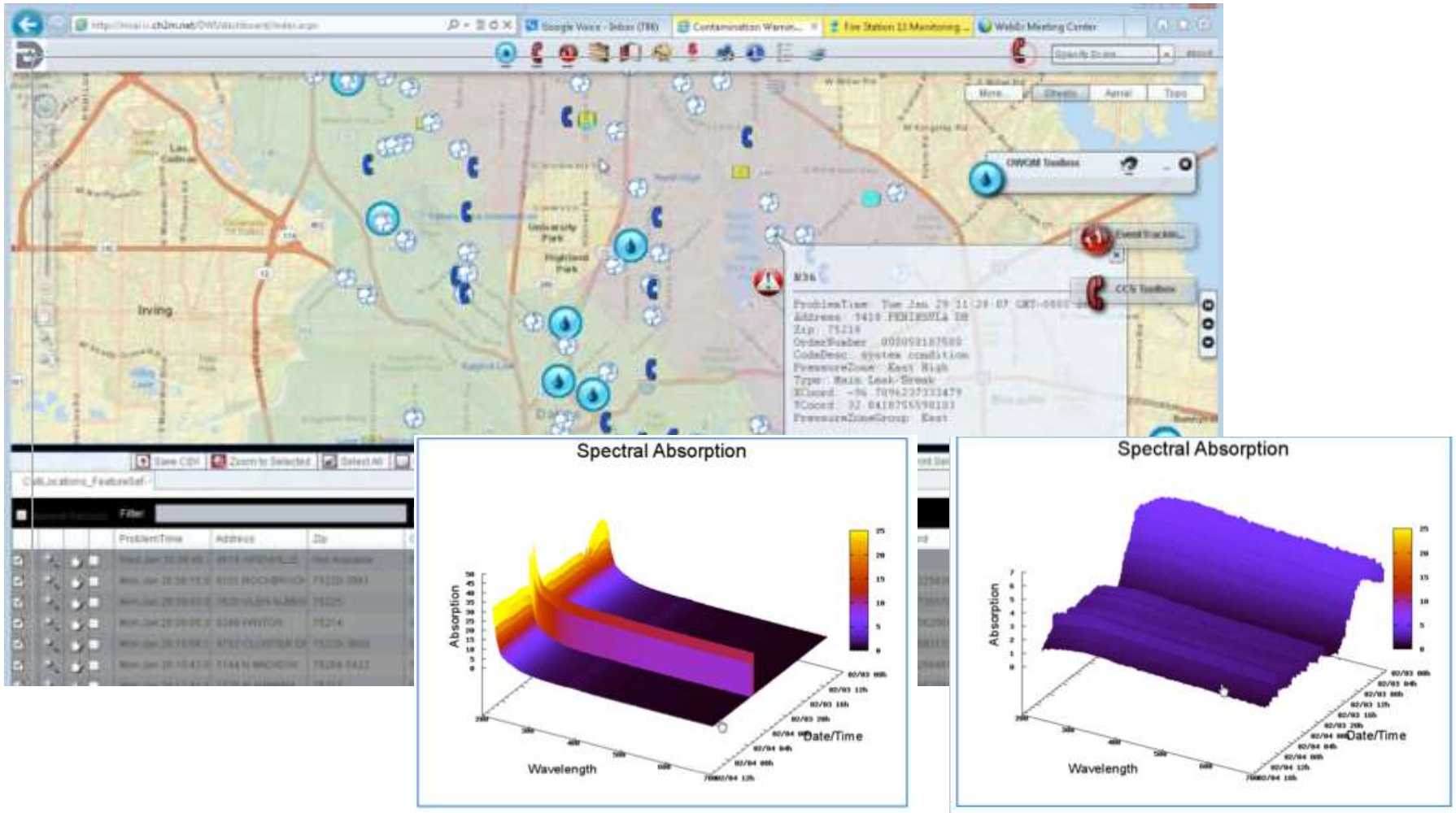
Water Quality System Architecture



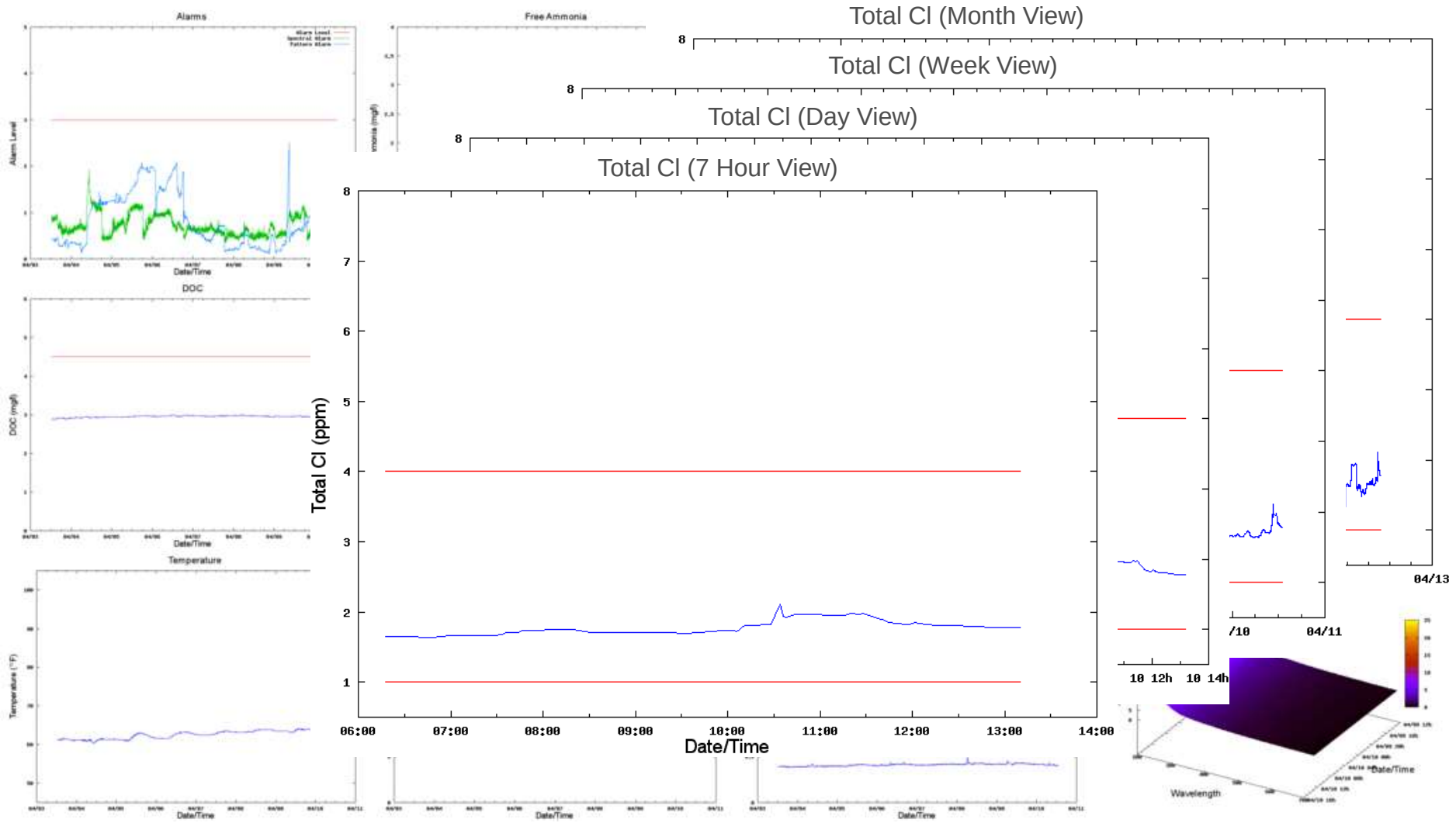
Water Quality Optimization Programs



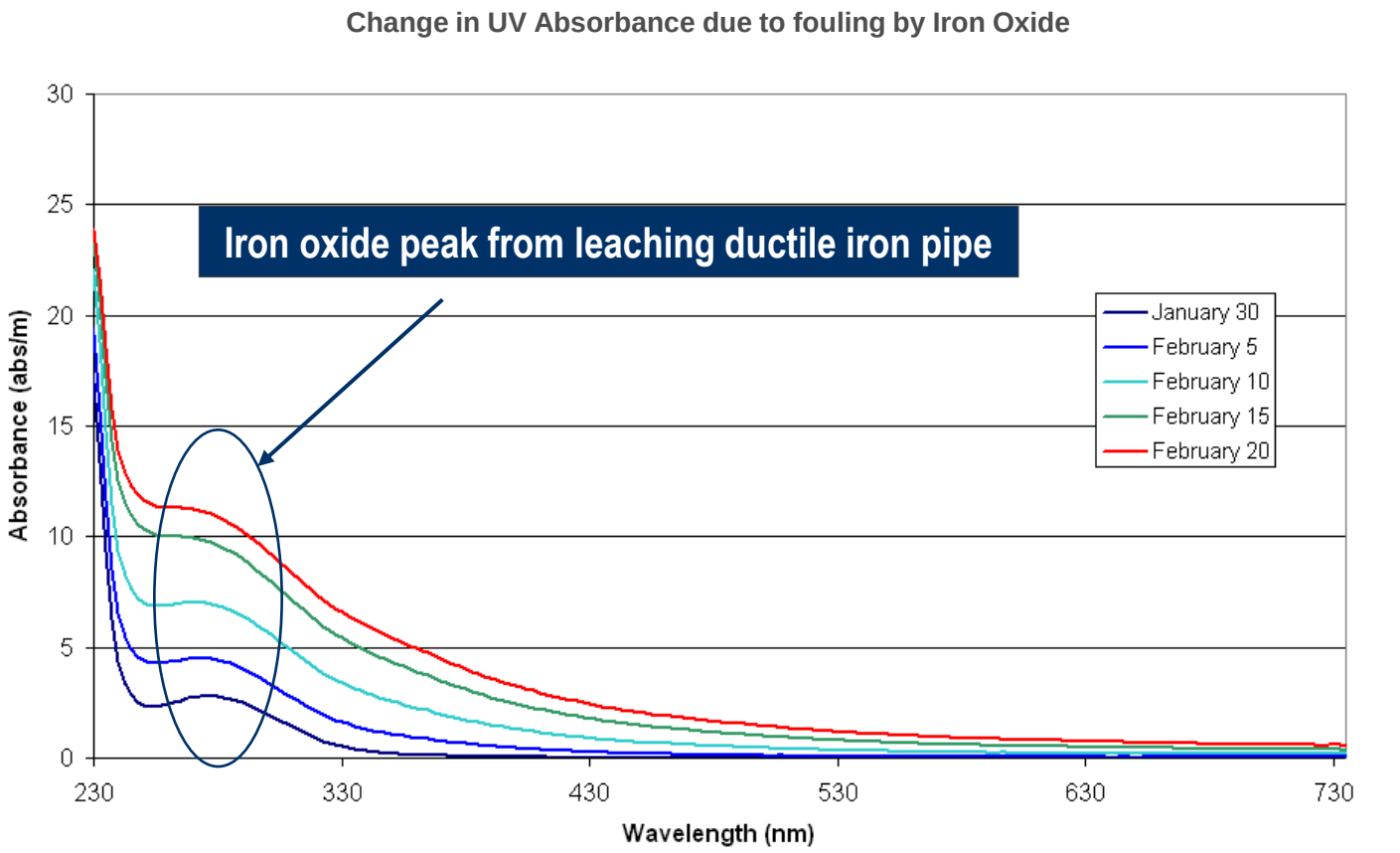
Representing Information More Efficiently



Water Quality Trending Visualization Tools

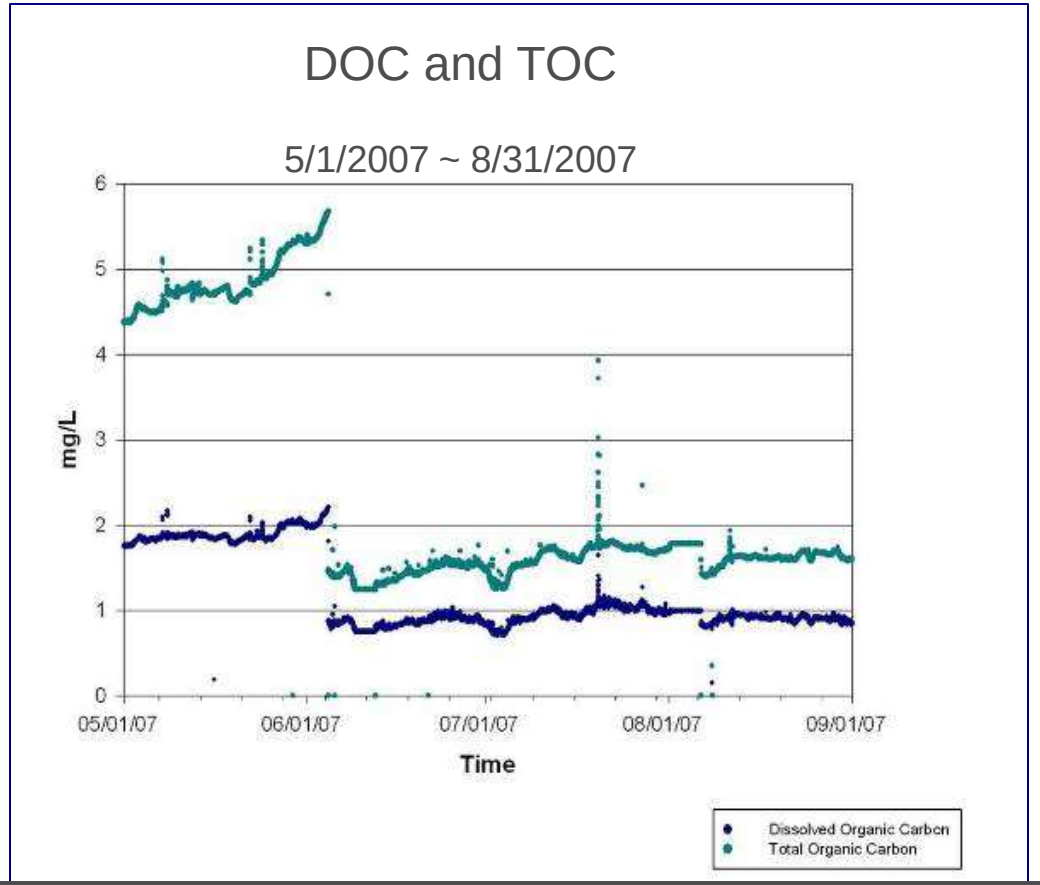


Detection of Aggressive Water



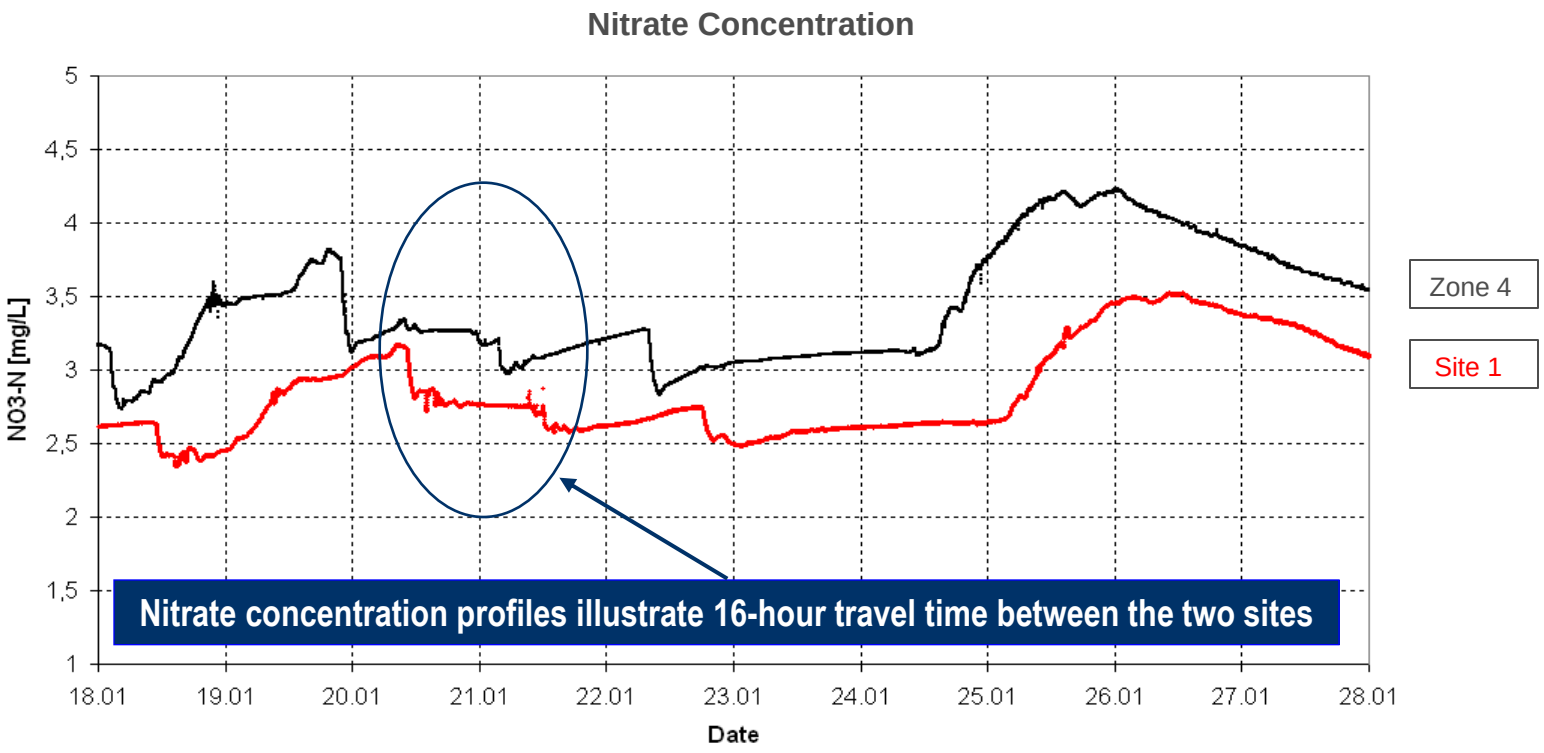
Early identification of aggressive water problem saved the utility $20M in early replacement costs

Optimizing Treatment Plant GAC Filter Performance



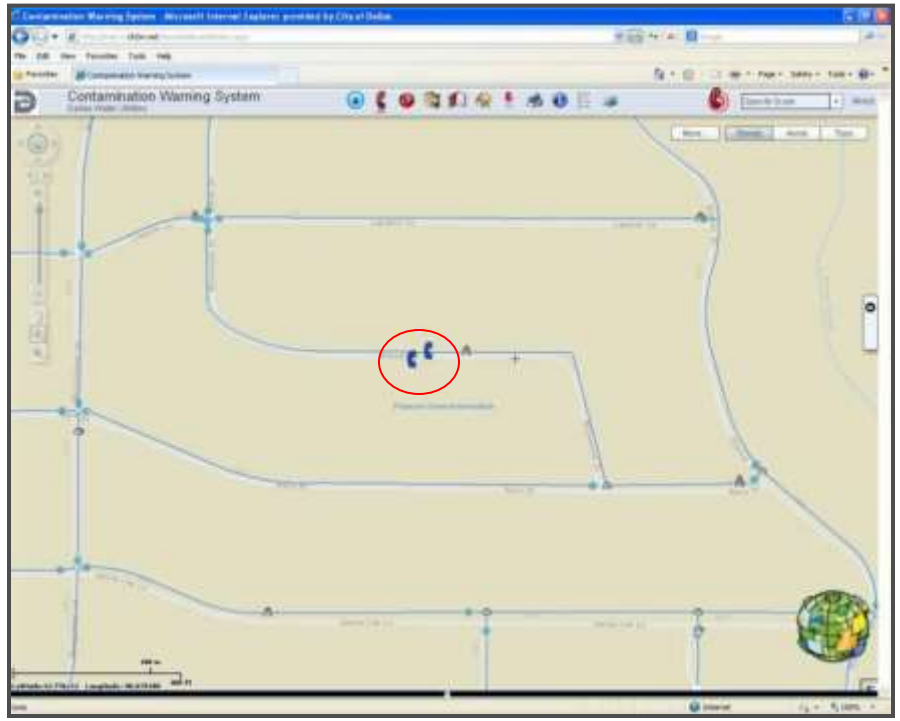
Reduced annual GAC replacement costs by $100K at each WTP

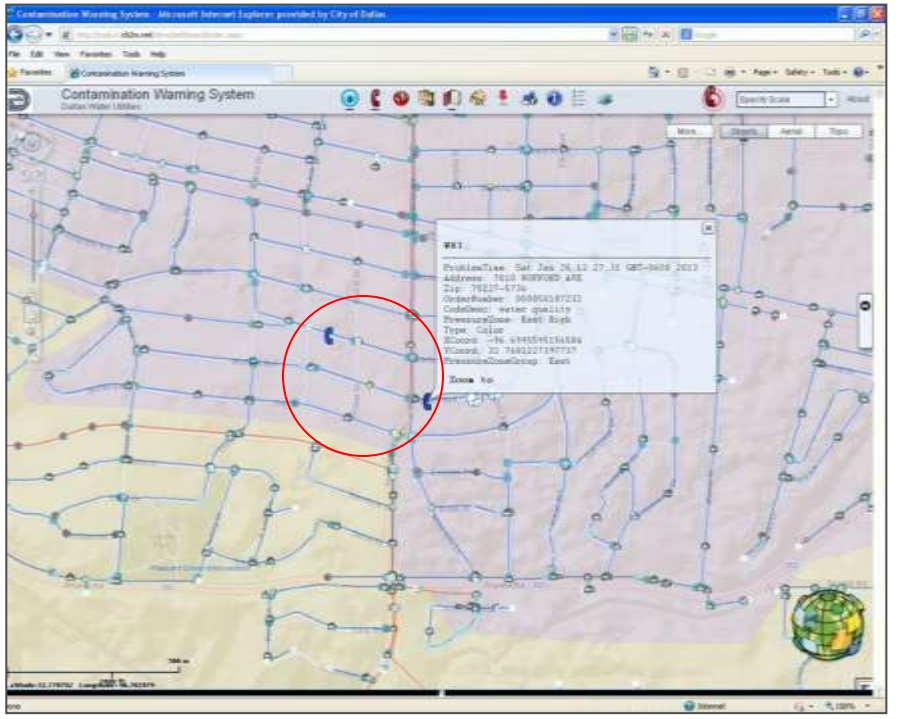
Tracking Water Age Real-Time



Verification of hydraulic model accomplished by tracking travel time between sites

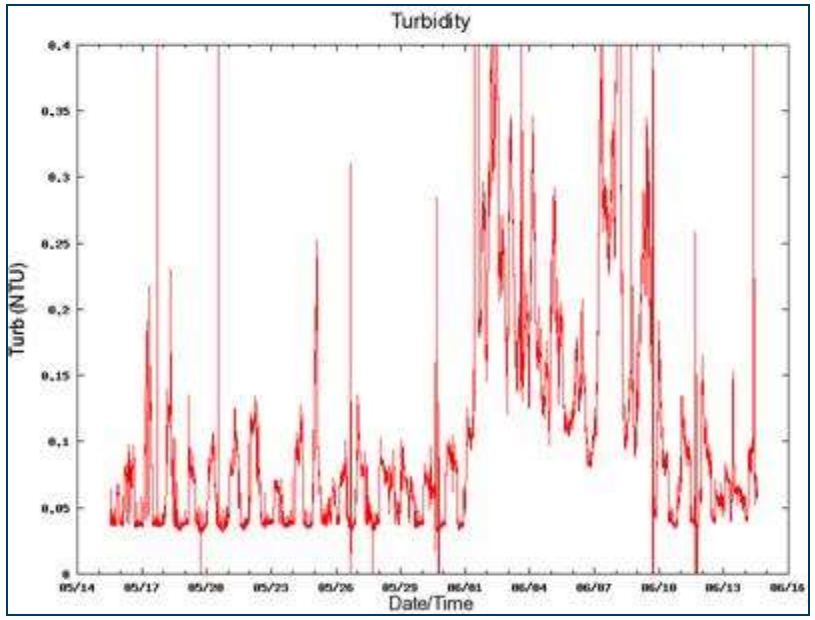
Detecting leaks through customer water quality calls

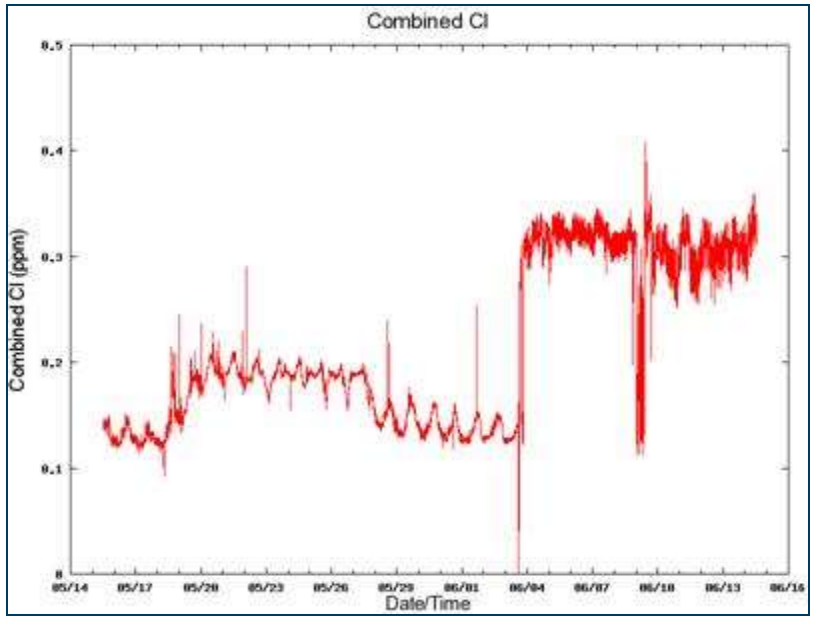




Two examples where consumer complaints were received that indicated a leak before it was detected by other means.

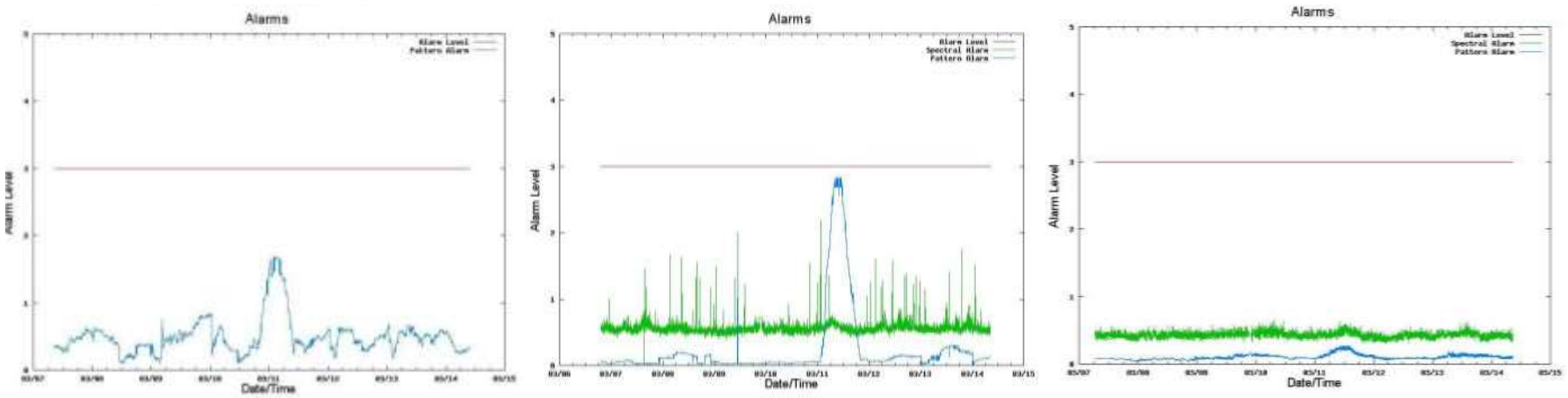
Identifying Source Water Changes





Water monitoring at inlet to a military base
shows changes in source water provided by a retail provider
when it reversed the flow in the distribution system.

Tracking Treatment Changes Through the System



Using monitoring stations to track a water quality problem through the system that originated from the WTP.

Water Quantity Sources of Data

Water Quantity

Operational Efficiency Saves $$

Smart Grid Application: Copenhagen Smart Cities Program

Municipality of Copenhagen Specific Use Cases

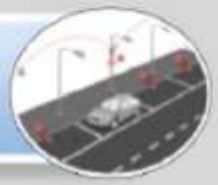
Traffic Monitoring
Congestion – bicycle tracking – incident monitoring

REGS
- Pilot Deployment Feb '14
- Scaling planned

City WiFi
- Two inner city zones
- Albertslund Municipality
- Horizon 2020

Smart Waste
Smart Waste as IoE innovation area for greater Copenhagen

Smart Parking



IoE for Health
- Video for care homes
- Location Based Services

Smart Bus Stops

Smart Municipal Buildings
- CRE
- Energy Management

IoE for Tourism
- WiFi Access for Tourists
- Location Based Services

Cloud Burst Program
- Comprehensive water defences
- Forecasting, sensing, alerting, controls

Current and Potential Partners
- Conscia
- TDC
- Global Connect
- Citelum
- IBM
- Sensity
- AGT
- Elevate Digital
- 24x7
- CH2MHILL
- Accenture

Danish Academic Partners
- DTU
- Aalborg University

PMO for IoE Program
- CLEAN
- Gate21

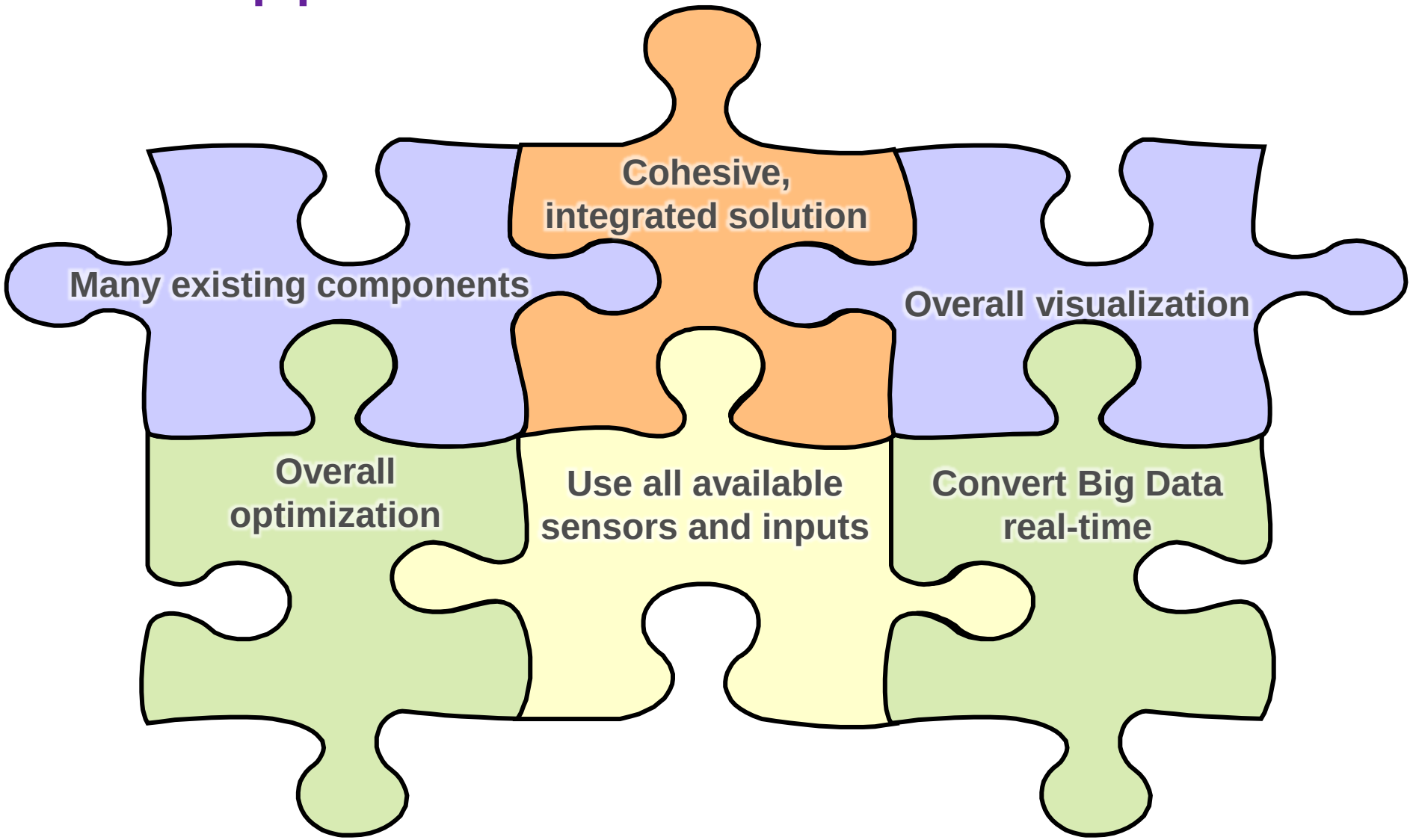
Incubator Partners
- Startup Bootcamp
- Accelerace
- SCION - DTU

City of Copenhagen – Smart City

- Problem
  - Copenhagen has recently experienced significant rain events (10-12” over 2 hours) causing 2.5 Euros ($2.84 B US) damage per event
- Solution
  - City Council approved a 1B Euro ($1.14 B US) budget
  - Create an integrated solution covering multiple technologies and service team
    - Wet weather modeling
    - Smart sensor technologies, data analytics, spatial dashboard
    - SCADA integration
    - Conventional control structures
    - Green control structures
    - Response plan
- Program Team
  - Cisco leads Smart Cities Program
  - CH2M HILL provides water and wastewater solution

CH2M Approach

CH2M Approach



CH2M Approach – Ecosystem partners

- Qualcomm – World leader in the development of cellular and wireless technology (2 year collaboration)
  - Working with technology providers to adapt their sensors with M2M wireless communications
  - Cincinnati MSD Technology Innovation Partnership
    - Developing pump station appliance
  - India KNBIR project support for Dynamic Operations Model (Smart Grid)
    - Cellular communications analysis for 300 km pipeline alignment

- s::can – Advanced water quality sensor and data analytics supplier (10 year partnership)
  - 10 advanced water quality monitoring projects
  - Multiple water and wastewater treatment applications

CH2M Approach – Ecosystem partners

- CISCO
  - Announcing global partnership for Smart Cities in April
  - CH2M HILL services from multiple groups
    - Water and wastewater system planning and design
    - Urban Planning
    - Transportation
  - Project Opportunities
    - Urban Planning – Two new cities along Mumbai Delhi Industrial Corridor
    - VA Hospital whole facility real time water quality monitoring
    - Copenhagen Cloudburst Program

The future of Smart Grid

The Future of Smart Grid

- Optimize and Balance: Quality, Quantity and Cost
  - Most focus on monitoring quantity (AMR/AMI)
    - AMI provides information beyond customer billing (i.e.; leak detection, backflow, meter tampering)
  - Use Big Data analytics to reduce costs and improve quality
- Utilize all the data coming into the utility
  - Currently less than 40% of data generated is actually used
- Understand the patterns
  - Do not overwhelm operators with data – provide information that can rapidly be converted to knowledge and action.

Thank You

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C 425-749-2020