Emerging Water Technology Symposium: Information Technology Trends and the Water Industry

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EWTS
Emerging Water Technology Symposium

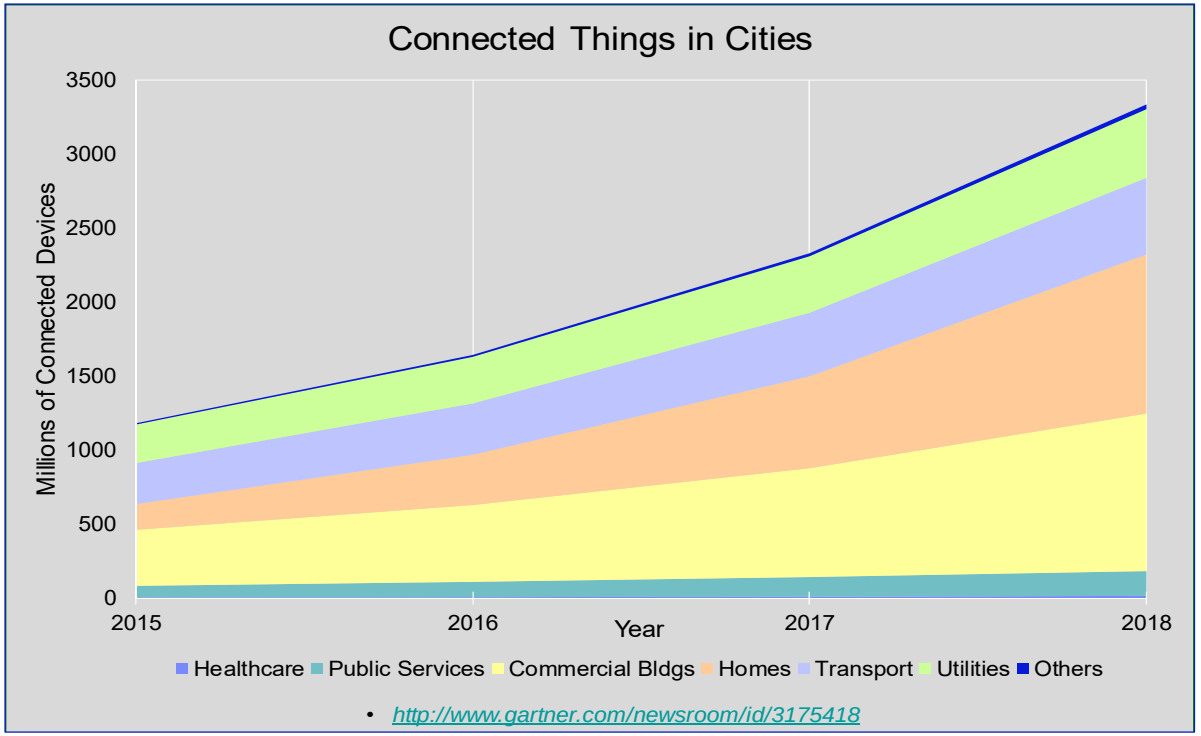
Alliance for Water Efficiency

Introduction

- This presentation identifies some technology trends that are transforming (or will transform) society and the economy.
- The water industry will experience these trends, just like any other industry.
- The presentation identifies some potential impacts on the water industry, both good and bad, and the implications of these.

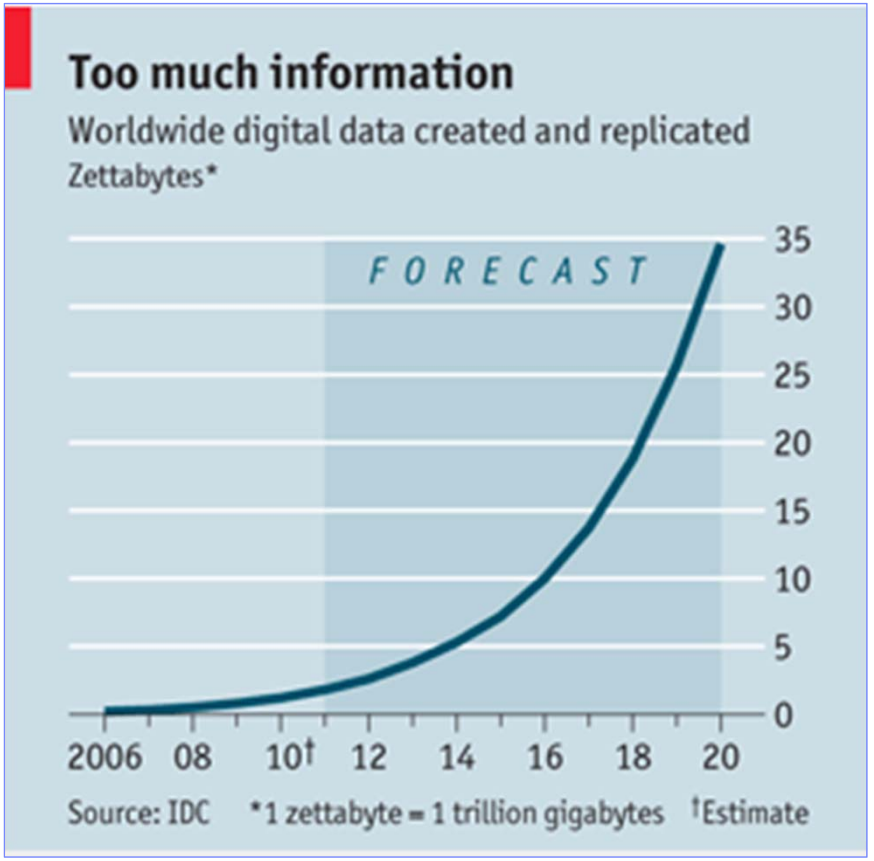
Technology Trend 1: The Internet of Things (IOT) is growing fastest in cities – with water utilities heavily involved!

- The fastest growth in the IOT will be in cities.
- Gartner projects 3.3 billion devices in cities by 2018, mainly in:
  - Commercial buildings (~32%);
  - Homes (which they include as part of smarter cities ~32%);
  - **Utility infrastructures (~14%)**
    - **Meters**
    - **System instrumentation and sensing.**
  - Transportation infrastructures (~14%)



Technology Trend 2: Big Data. Water won't escape the deluge…

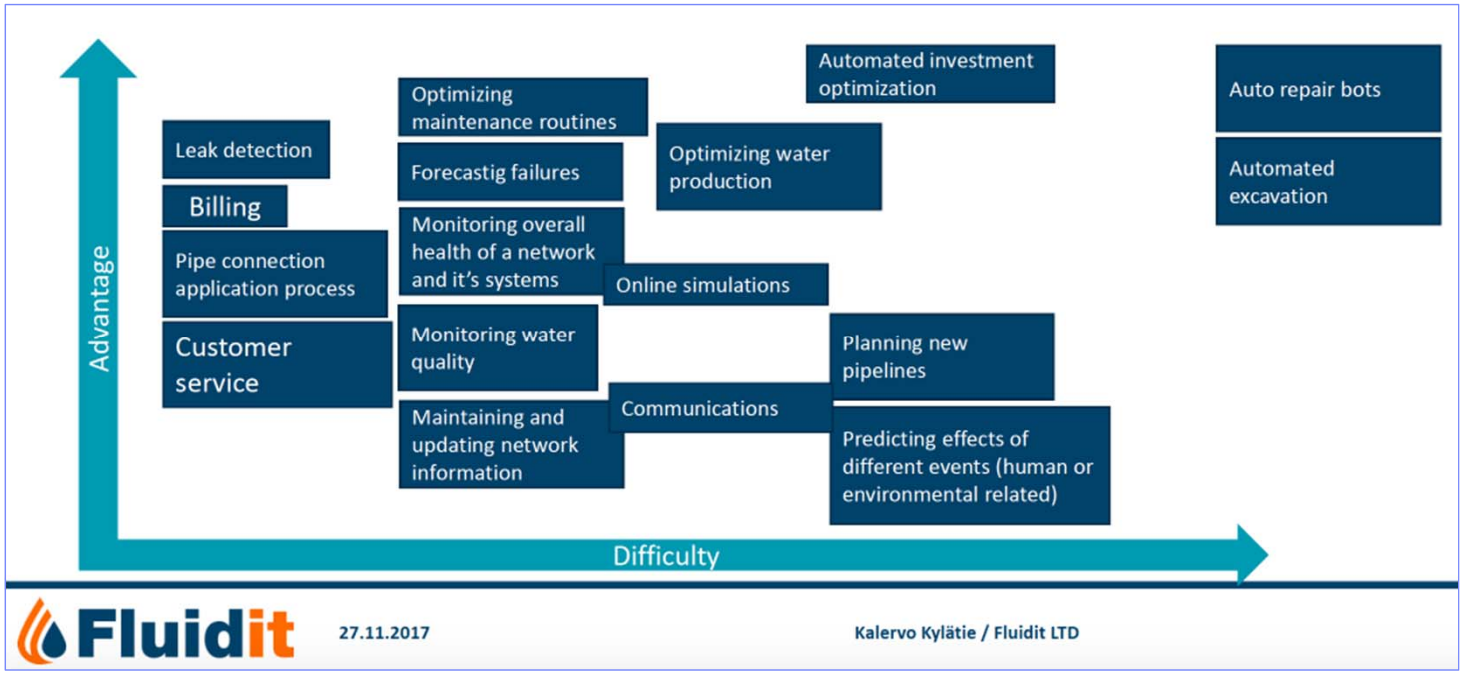
- "Utilities and industrial water users are beginning to understand that there is a big picture here... It is a vision of the digital utility which brings together all the different parts of this world of data collection, processing and automation which promises to deliver significant efficiencies with a high return on investment."
- https://www.globalwaterintel.com/water-industry-gets-smart-on-big-data



https://www.economist.com/node/18226961

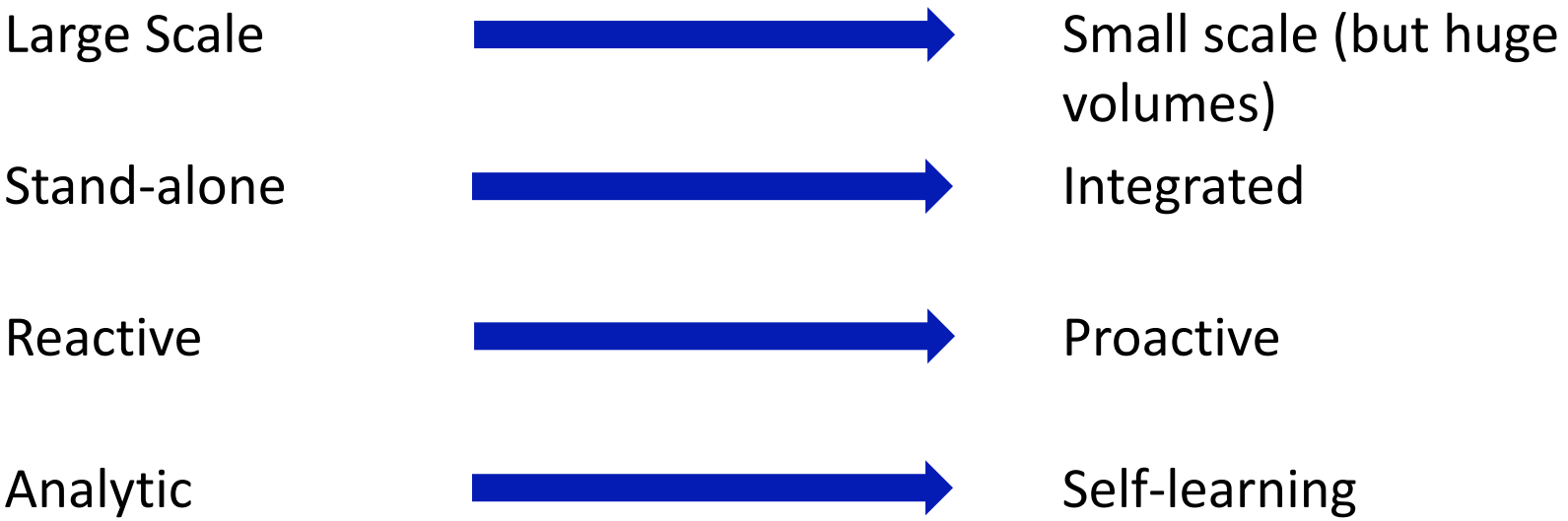
Technology Trend 3: Artificial Intelligence (AI) also offers huge opportunities for cities – with water utilities again heavily involved.

- AI will play an increasing role in making use of the data from the IOT.
  - System optimization (pump optimization, energy management)
  - Combined systems (demand response with water pumping);
  - Detection of emergent patterns (meter drift, NRW trends);
  - Predictive maintenance (pipes most at risk of failing next year).

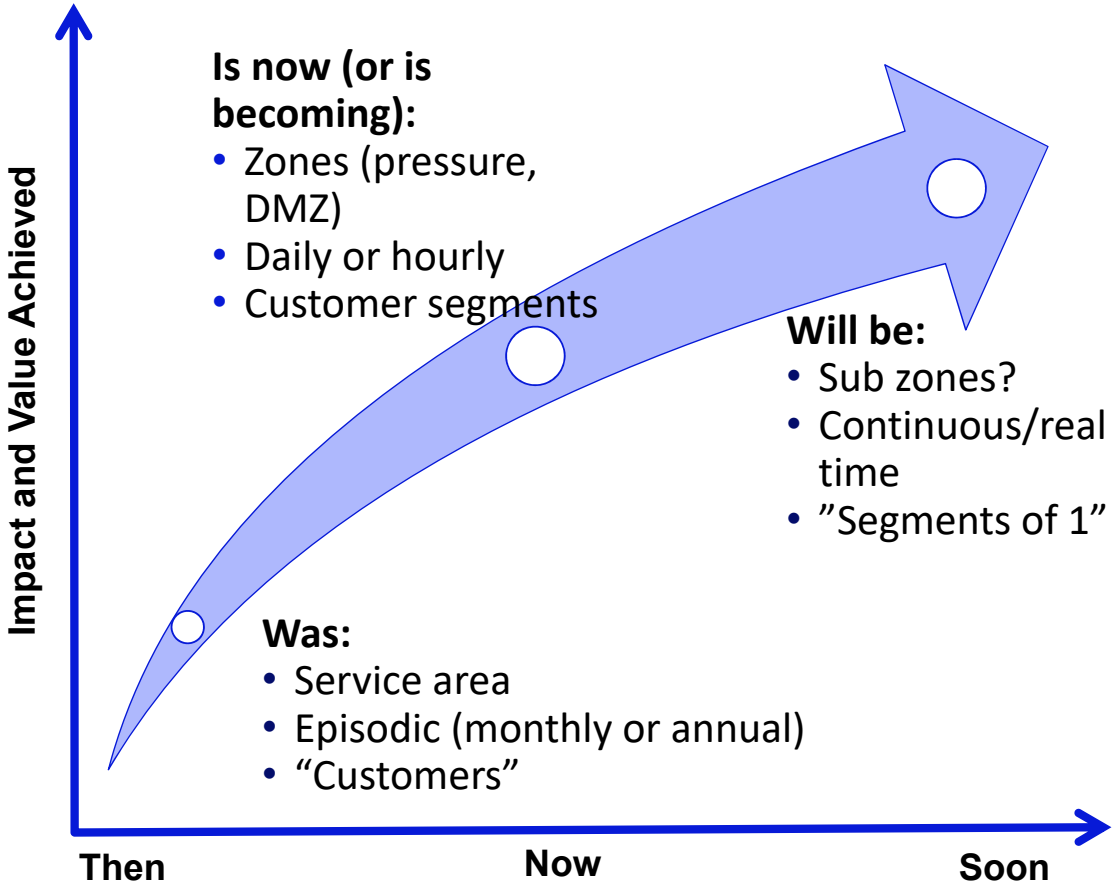


- Sometimes AI will come from combining existing data and models in new ways. Sometimes it will come from new technologies such as deep learning and cognitive computing.

So what? Four huge transformations in how information will be used



Large scale - small scale: “big data” should really be called “small data”!



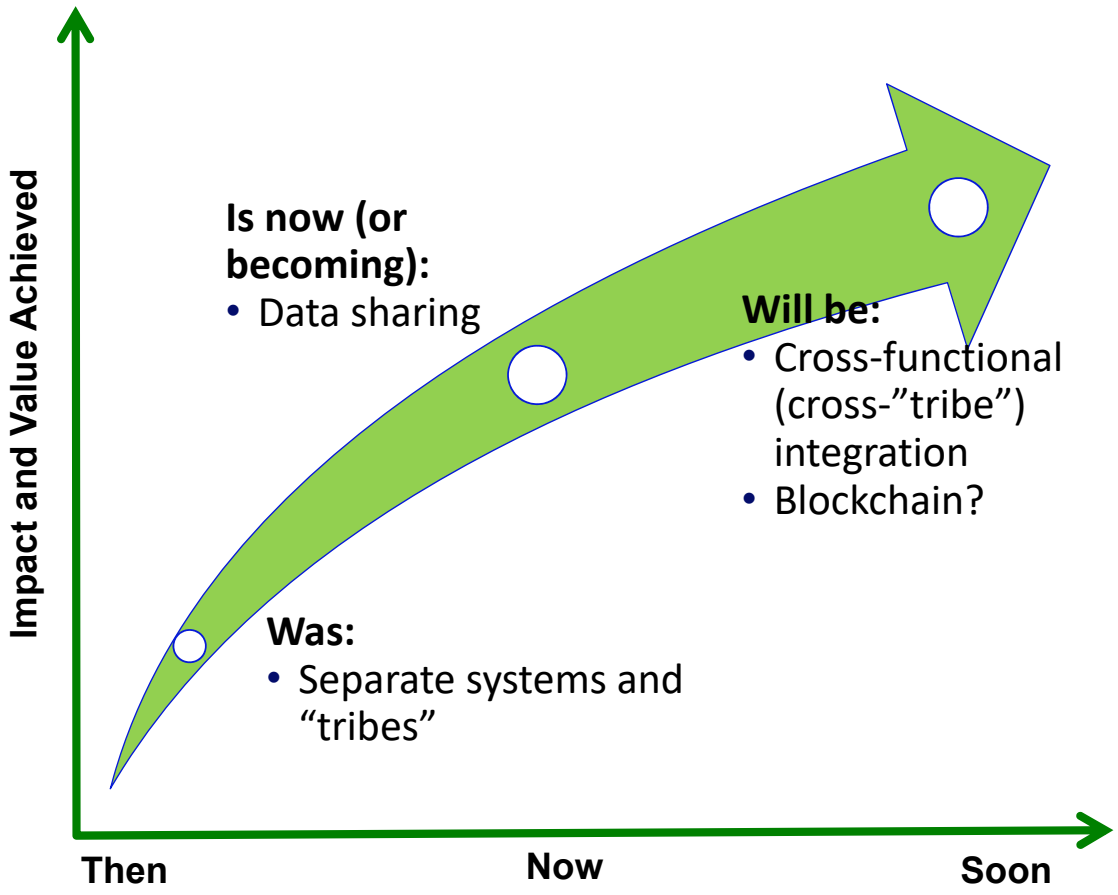
Will be (for example):

- Precise leak alerts – with multiple data sources offering triangulation.
- Rolling or daily water balances for each DMZ or pressure zone.
- Revenue maximization (especially when conserving water).
- Agricultural water management – groundwater usage and withdrawals.

Big data and small data – Thames Water

- Large UK water company, covers (>15 million customers – ~25% of UK population).
- Goal – reduce sewage system blockages, and resulting floods and pollution.
- Focused for the first time on individual manholes rather than postcode-level analysis:
  - Analysed 4 years of data for each of 1.6 million manholes.
- Pollution risk calculated from data mining and decision-tree based modelling.
  - Predicted 20% of pollution incidents per year would arise from 0.06% of manholes.
- Predictions borne out by observation. Thames was then able to target interventions and achieve 15% reduction in pollution incidents.

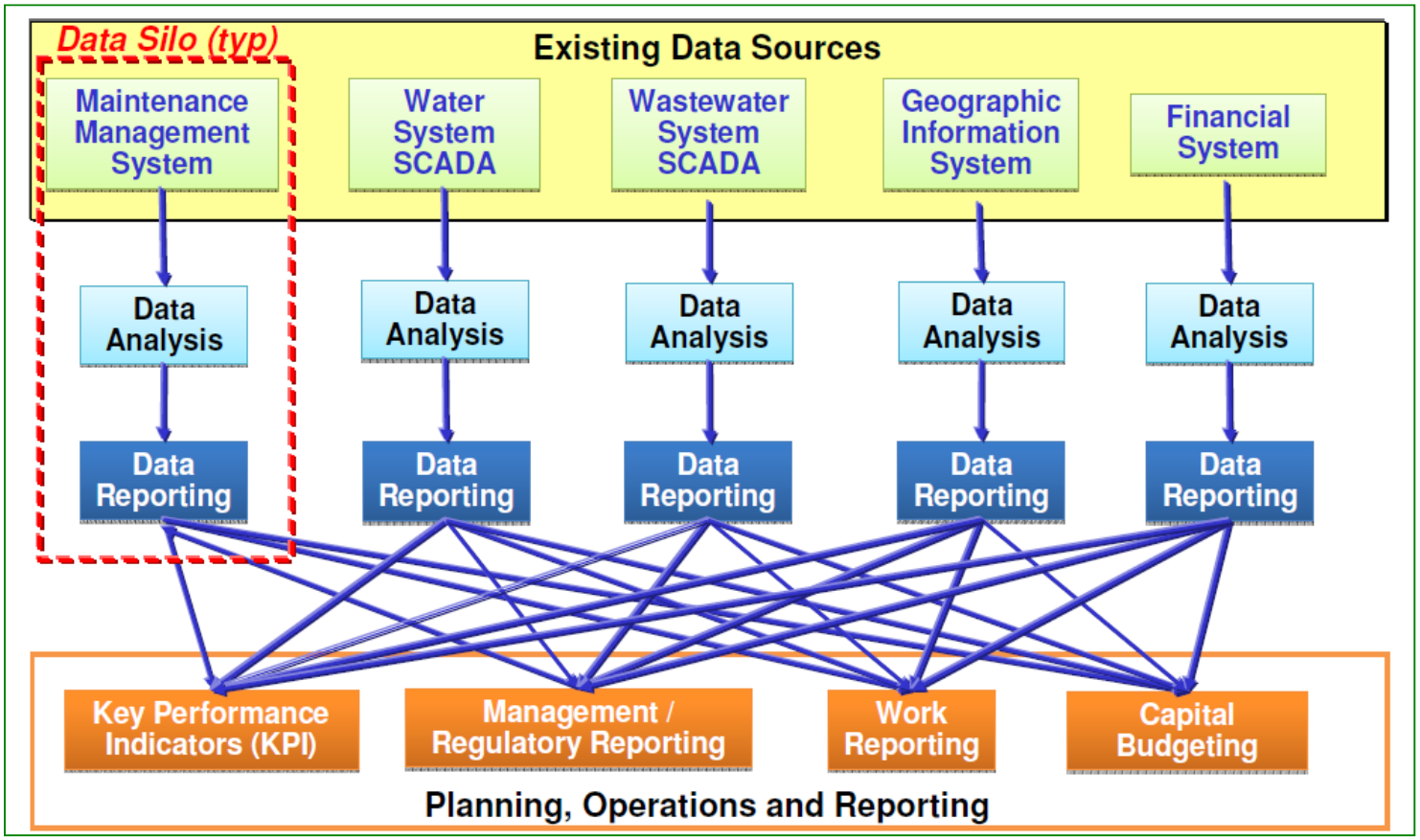
From stand-alone to integrated – the connected and seamless water utility



Will be (for example):

- Integrated view of operations spanning operators, planners, maintainer, customer service and finance:
  - Continuous comparison of hydraulic model and SCADA.
  - Use of AMI data-points for system control – not just for billing.
- Integration with others, for example:
  - Energy utilities, for demand response;
  - Welfare departments, for customer payment issues.
- Water trading - connecting buyers and sellers.

The effect of the “tribes” and their data silos



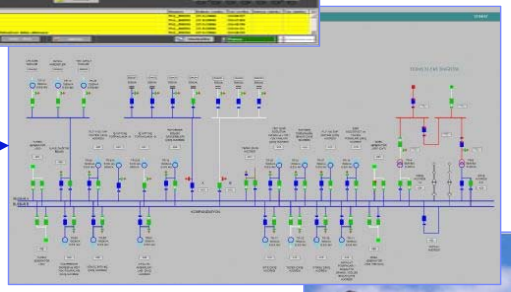
Graphic: IBM

Integration example – consequences of a major water main break…

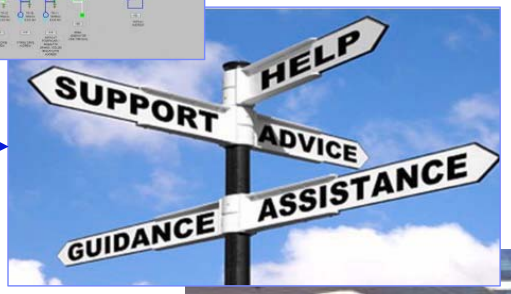
Water system

With thanks to TaKaDu

Road/rail systems



Electricity system



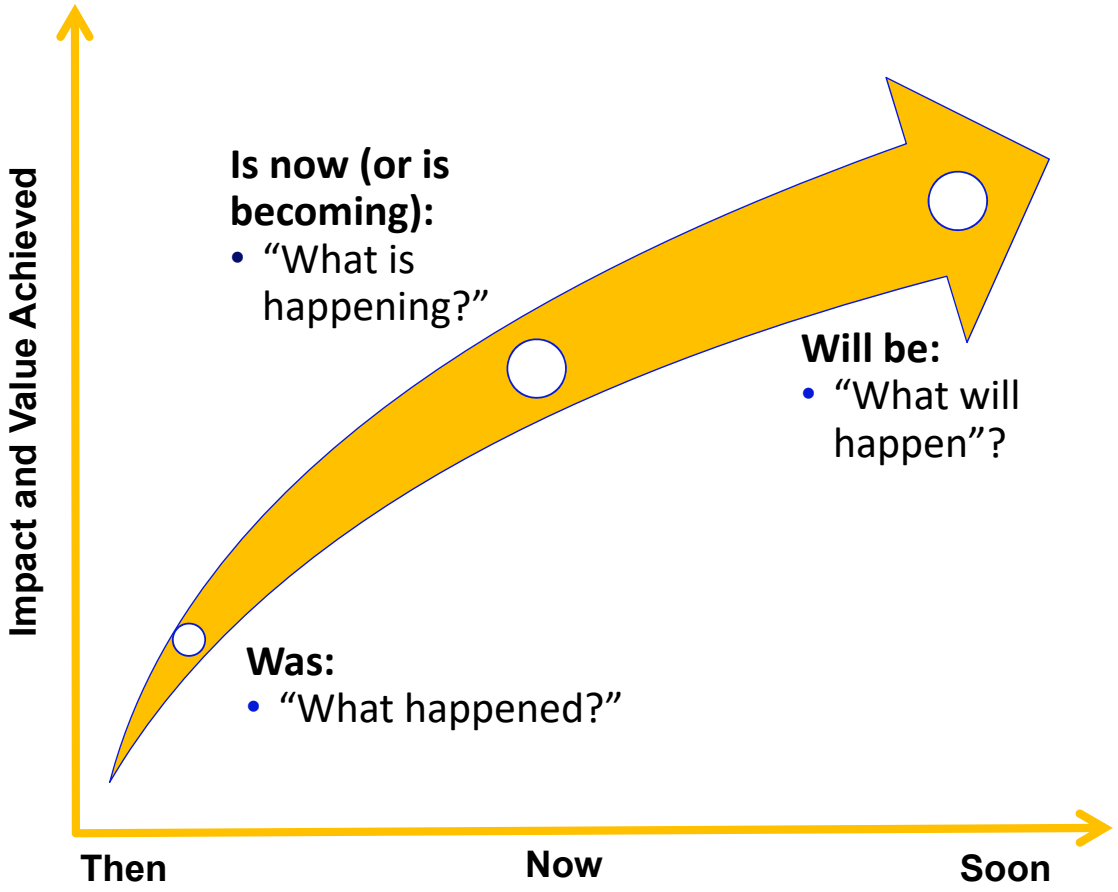
Welfare/ public health

Emergency management

Integration of:

- Acoustic data
- Customer reports/call center
- Analytics
- Asset management and work ticketing
- …

From reactive to proactive – managing ahead, not managing in the rear view mirror

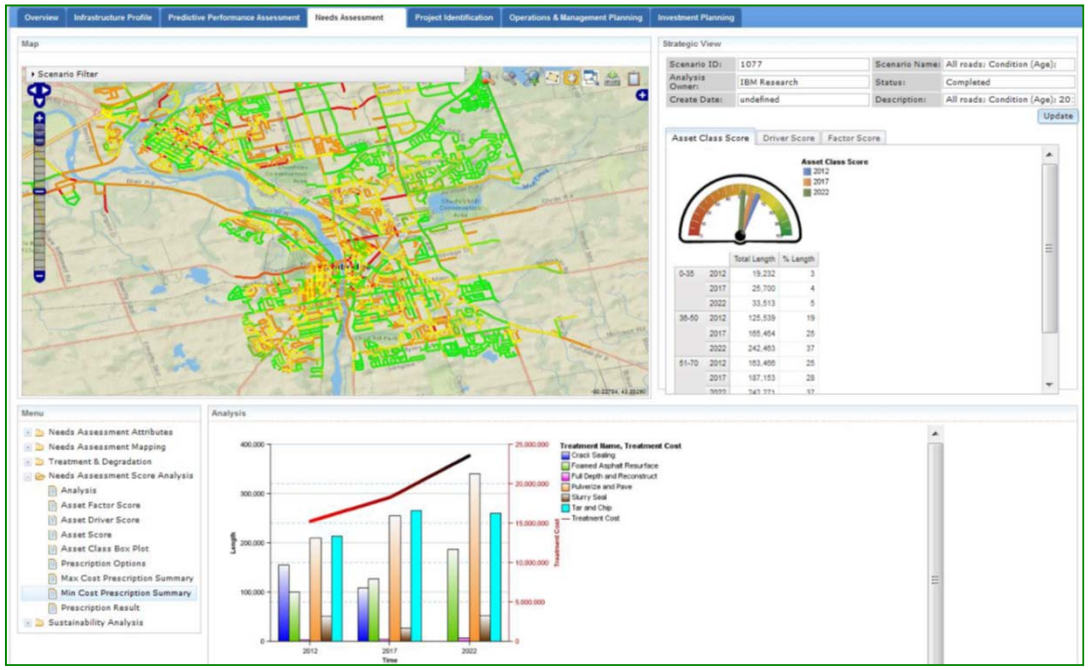


Will be (for example):

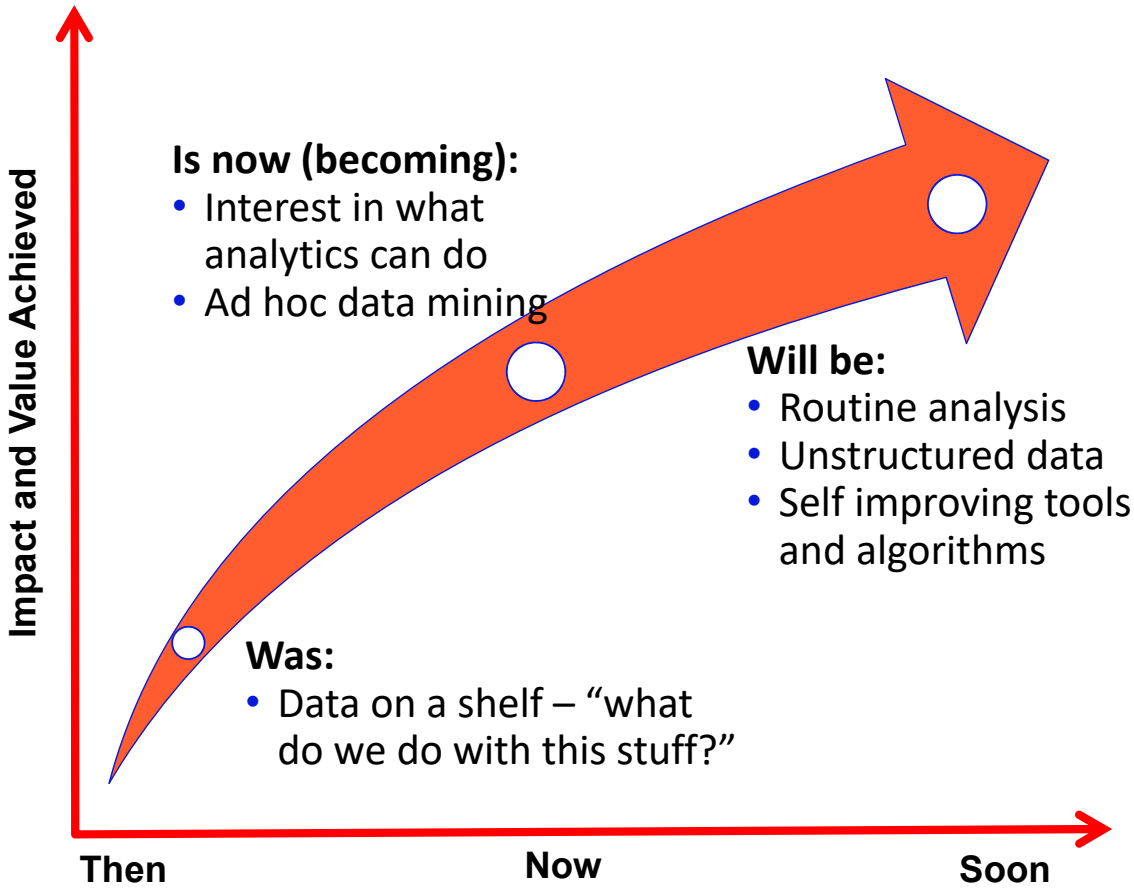
- Predictive maintenance – which pipes or pumps or valves will fail next year?
  - Capital planning and budgeting.
  - Capital efficiency.
- Groundwater management – in the light of drought predictions, predicted crop withdrawals.
- Water quality and pollution management – for example in hot climates.
- Revenue prediction, for example, which customers may have trouble paying?

Prediction – capital budgeting based on what will break next year in Cambridge, Ontario

- Budgeting for water, sewer and road renewal expense based on predicted remaining in-service life.
- Uses service histories and sophisticated clustering and forecasting, to find patterns of physical asset characteristics and operational circumstances.
- Linked to a scoring methodology to identify replacement priorities and also prescribed maintenance or replacement needs.
- Spatial distribution of expenditure also monitored.



The advent of AI – analytics with self-learning.



Will be (for example):

- Incorporation of structured and unstructured data.
- Self learning and continuously improving versions of many analytic tasks:
  - Pump optimization
  - Predictive maintenance
  - Source water availability
  - Water quality issues
- Detection of patterns and issues that would escape a human being.
- Skills replacement – automated "water system advisor".

AI in an engineered environment – Woodside Energy

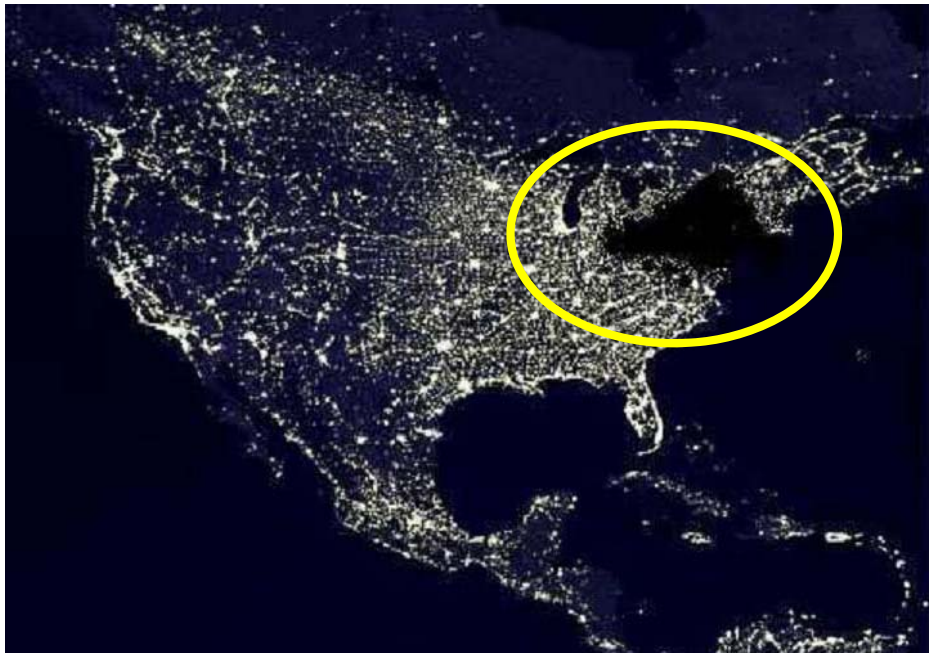
- Large natural gas platform operator in Australia.
- Uses AI (cognitive computing) to ingest 38000 documents embracing 30 years of knowledge – text, plans, performance data, notes…
  - Integrates with weather, tidal, other data.
- Allows employees to ask queries about engineering issues in natural language – for example, “what is the maximum weight the helipad can support?”
- Frequently comes up with diagnoses and solutions that humans had not seen.
- Gets better the more it is used.
- Is in effect an “engineering advisor” for the platform.

But the future is not risk free

- Three key areas of risk that may be *emergent* (you don't know they are there until they happen!):
  - Cascading failures
  - Privacy
  - Cyber security

Cascading system-of-systems failures.

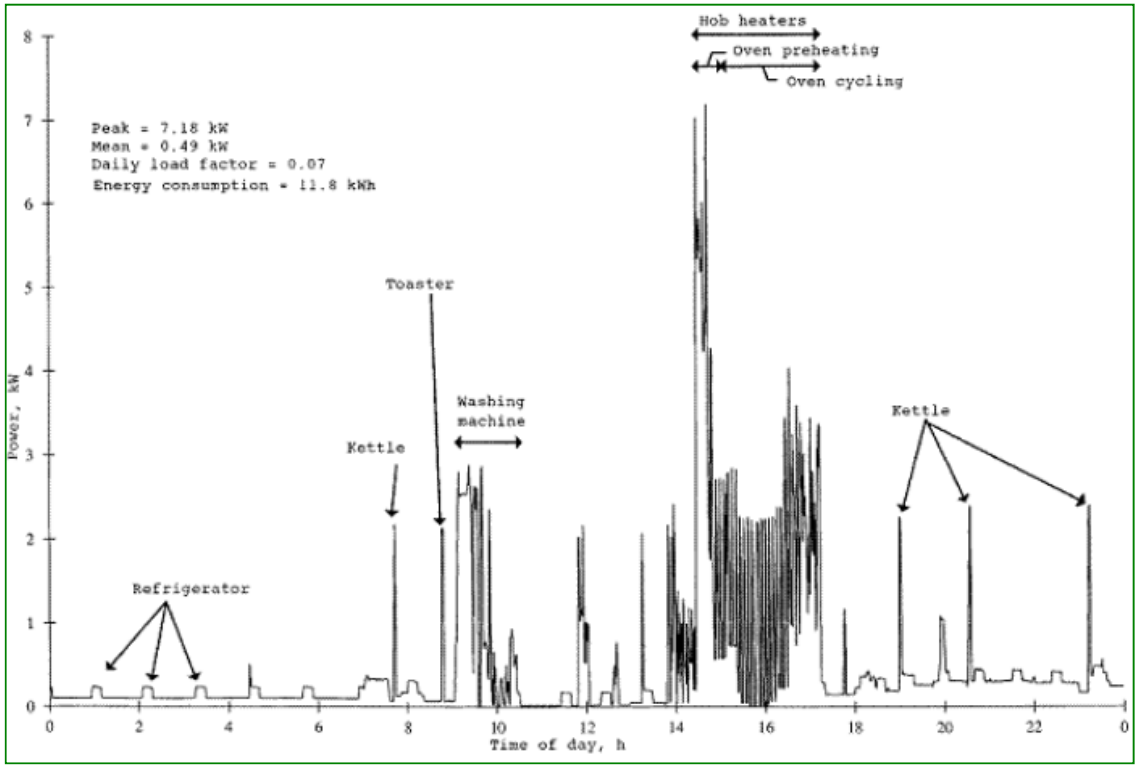
- Example: cascading failures of the energy grid in NE USA/SE Canada in 2003.
  - Unpruned tree foliage hit a power-line and made it trip. Resulting overload shifted to other lines, in turn shutting down 500 generating units suddenly bereft of demand.
  - Software bug in an alarm system meant operators unaware of fault for over an hour.
  - Cellphone, Amtrak and some water systems also affected – "boil water" notices required.



- Aside from the alarm, most systems and components were operating ***as intended***. No single person or organization understood all the linkages that existed.

Emergent privacy threats

- Individuals' data collected by "smart systems" can have significant privacy implications.
- Energy, water:
  - Lifestyle – for example, when asleep or awake, appliances purchased…
  - Who's at home?
  - (Worse when coupled with connected home devices)
- Transportation:
  - Location by time of day, travel patterns, travel times
- Privacy risks can be emergent – otherwise innocuous data items, when put together, are a problem.



Example is from an energy meter – but water meters and flow management systems are becoming increasingly sophisticated at identifying water-using appliances too.

https://www.nist.gov/cyberframework/draft-version-11

Cyber threats

- Cyber-criminals *love* interconnected systems – they can surf around an entire organization doing damage or stealing data.
  - How about an entire city?
- Warning signs:
  - Recent attack on a water agency in the US – begin with SCADA and PLCs, then surfed through link to billing data and stole 200,000 credit card numbers.
  - Numerous examples of cyber-attacks on city systems: metro controls, police data, traffic signals, water agencies, tornado alarms. What else was linked…?

Thank you!