IT/OT CONVERGANCE AND DIGITAL TRANSFORMATION AT SYDNEY WATER

Mike Wassell
Sydney Water
Drivers for change

The Hyper-Connected Utility
The digitally smart utility is a highly connected, agile and performant enterprise with integrated business functions and an agile and flexible IT delivery model tuned to each specific business unit.

A Single View of Operations

Connected Workforce

Connected Assets

Wholesaler

Retailer

Regulators

Shareholders
Ooops, your files have been encrypted!

What Happened to My Computer?
Your important files are encrypted. Many of your documents, photos, videos, databases and other files are no longer accessible because they have been encrypted. Maybe you are busy looking for a way to recover your files, but do not waste your time. Nobody can recover your files without our decryption service.

Can I Recover My Files?
Sure. We guarantee that you can recover all your files safely and easily. But you have not so enough time.
You can decrypt some of your files for free. Try now by clicking <Decrypt>.
But if you want to decrypt all your files, you need to pay.
You only have 3 days to submit the payment. After that the price will be doubled. Also, if you don’t pay in 7 days, you won’t be able to recover your files forever.
We will have free events for users who are so poor that they couldn’t pay in 6 months.

How Do I Pay?
Payment is accepted in Bitcoin only. For more information, click <About bitcoin>.
Please check the current price of Bitcoin and buy some bitcoins. For more information, click <How to buy bitcoins>.
And send the correct amount to the address specified in this window.
After your payment, click <Check Payment>. Best time to check: 9:00am - 11:00am GMT from Monday to Friday.

Send $300 worth of bitcoin to this address:

Copy

Contact Us

About bitcoin

How to buy bitcoins?
We are adopting a factory model for our core services

CIO
- Leadership & Direction
- Strategy and Architecture
- Program Assurance

Head of Business Engagement

Factory Model (Our Capacity to Build)

Head of Operational Technology
- Operational Tech. Solutions
  - Operational and Automation Solutions
  - Continuous OT Improvement
  - Monitoring and Control Systems
  - Operational / SMART Program Delivery

Head of Digital and Corporate Solutions
- Corporate Solutions
  - Corporate Application Development
  - Integration and Process Development
  - Business Analytics / Discovery
  - Geospatial Solution Development

Head of Enterprise Solutions
- Enterprise Solutions
  - SAP Solutions / Infra Program Delivery
  - SAP Service Delivery Design
  - EPRM Program Design and Delivery
  - EAM Program Design and Delivery

Head of Digital Infrastructure
- Digital Infrastructure
  - Corporate / Digital Infrastructure Services Development
  - Foundation Services and Delivery Platform Development

Service Support & Infra Mgt
- Application Monitoring & Lifecycle Mgt
- Integration & Process Monitoring
- Infrastructure & Network Monitoring
- Technical Service & Support
- Technical Service Contract Mgt.
- Cyber Security & User Authentication

Assurance, Compliance & Risk Mgt
- Program, Service and Solution Assurance
- Information and Technology Architecture
- Digital Audit & Risk Response Accountabilities
- Cyber Governance & Standards Mgt.
- Digital Compliance & Regulatory Assurance
- Digital Services Performance Reporting

Head of Digital Operations

Head of Assurance and Compliance

Head of Enterprise Solutions

Head of Digital and Corporate Solutions

Head of Operational Technology

Business Engagement
- Digital Business and Technology Planning
- Business Relationship and Commercial Management
- Strategic IT and Business Alignment
- Corporate and Divisional Portfolio Management
- Program Prioritisation

Operational Tech. Solutions
- Operational and Automation Solutions
- Continuous OT Improvement
- Monitoring and Control Systems
- Operational / SMART Program Delivery

Plan, Align, Decide, Prioritise

Design, Architect, Build, Enhance and Test

Accept, Operate, Monitor, Support

Assure, Protect, Comply
Digital Business Core Accountabilities

• To manage and protect Sydney Water's information assets.

• To enable and support the delivery of business and operational processes.

• To advance the transformation of Sydney Water through innovative, future proof digital solutions.
Manage & Protect

(1) People Skills and Knowledge

(2) Cyber Security Breach

(3) Sustained Asset Failure

Manage and Protect

A cyber security breach is not a question of if, but when.
Customer Hub

Proactive
in communication with customers

Predictive
in the way we manage our assets
Minimise Customer Impact

- > 140,000 property impacts avoided or minimised
- > $1M in avoided rebate costs
Proactive Communications via SMS and email

- > 80,000 customers notified of water interruptions
- > 35,000 customers kept informed on reported faults
- 40% reduction in inbound calls related to water interruptions
Real-time Voice of Customer Feedback

- Net Promoter Score lifted from baseline of 21 to 56
- Response rate consistent at 13-14%
- Real-time experience recovery
Improved Understanding of the Customer

- Improved triage and first call resolution
- Approx $400k p.a. savings in avoided non value-add work
The Customer Hub... Getting Ahead of the Incident

Preventative / Predictive Maintenance

Data Science and Analytics  
Artificial intelligence  
Machine Learning  
Smart Assets / IoT

Reactive Maintenance

Time of Incident

Long Term Infrastructure Planning

Days

Hours

Minutes

Years / Months

Duration of Customer Impact

Sydney WATER
Why IoT for Sydney Water

IoT is a key enabler for a hyper-connected utility, providing Sydney Water with near-real time asset performance analytics leading to better asset performance and customer outcomes.

- **Current State:** Customer is the Sensor for outages, leakages, overflows, burst mains etc. resulting in poor customer experience, costs, loss of productivity and environmental and regulatory impacts.

- **Now with IoT and more timely data to act upon,** Sydney Water customer outcomes can be achieved using Customer Hub to shift from a reactive to proactive state with the vision to move to predictive.

- **Future State:** Smart sensors on pipes and pressure monitoring, combined with analytics and data shared through spatial and customer hub will enable Sydney Water to pinpoint vulnerable locations, proactively notify water outages and plan optimised maintenance work schedules based on real-world asset condition rather than time.
IoT and Sydney Water

Monitoring Solution

Status Quo

SCADA (IICATS)

Customer sees and reports an issue

Future

SCADA (IICATS)

&

Internet of Things
Detect sewer blockages
IoT Use Case

Objective:
- Detect issues in the wastewater network before customers and the environment are impacted

Benefits realised:
- 21 sewer blockages detected
- High impact overflows averted with 4,700 properties upstream
- Potential alternative to preventive maintenance
- Breakdown maintenance effectiveness monitored
Detect sewer blockages

IoT Use Case

IoT sensors deployed in Liverpool
Water Pressure Monitoring

IoT Use Case

Objectives:
- Detect water pressure issues
- Provide more data points for leak detection and main break prediction

Insights:
- Detected water pressure fluctuation caused by water tanker filling
- Accurate at reasonable cost
- Water ingress led to multiple device failures
Digital Metering
IoT Use Case

Objectives of the first phase of the trial:
- Test reliability, connectivity and handling

Objectives of the next phase of the trial:
- Gain insights into how digital metering can support:
  - General water consumption reduction
  - Asset investment deferral
  - Reduction of system losses and network leakage
**IoT PoV High-level Architecture**

- **IoT Devices**
  - Sensors / Meters
  - IoT Devices

- **Network**
  - sigfox
  - LoRa
  - taggle
  - Telstra NB-IOT
  - SCADA (IICATS)

- **Broker**
  - Data Ingestion
  - Telstra IOT Platform

- **Data Storage & Processing**
  - Azure
  - Spatial Hub

- **Data Analysis and Apps**
  - Power BI
  - Configuration Database

- **ClearSCADA trial**
Key Learnings

- IoT and end-to-end solution worked well
- Immature marketplace
- No plug-and-play
- Manual device setup

- Cost of (un)reliability is critical
- Logistics of installation very complex

- Security concern ⇒ for non-mission critical monitoring activities only
Feedback provided to Suppliers
Anonymised Example for tested IoT Transmitters

Transmitters:

Cost

lower

higher

less

Technical

higher

Key:
1 Supplier A
2 Supplier B
3 Supplier C
4 Supplier D
5 Supplier E
6 Supplier F
7 Supplier G
8 Supplier H
9 Supplier I
10 Supplier J

Device cost distribution:
Next Steps

- Sewer blockage sensors
- Sewer infiltration detection
- Acoustic leak sensors
- Pressure transient monitoring
- Waterway monitoring
- Water quality monitoring
- Sewer overflow monitoring
- Sewer fibre-optics
- Digital meters
# Prioritisation Criteria

**IoT Initiatives Prioritisation Tool**

<table>
<thead>
<tr>
<th>Satisfaction of Needs</th>
<th>Use of Resources</th>
<th>Value (derived)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Alignment</td>
<td>FTE #s and Skills Required</td>
<td>Customer Impact</td>
</tr>
<tr>
<td>12.50%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Addresses Risks and Issues</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Delivers Required Capabilities</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Potential Benefits</td>
<td>Time to Implement</td>
<td>Complexity of implementation</td>
</tr>
<tr>
<td>12.50%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>50%</td>
<td>50%</td>
<td>10%</td>
</tr>
<tr>
<td>12.50%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>12.50%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

- **Value (derived):**
  - 12.50% 12.50% 12.50% 12.50% 10% 10% 10% 10% 10% 100%
<table>
<thead>
<tr>
<th>Initiative ID</th>
<th>Initiative Name</th>
<th>Description</th>
<th>Comment</th>
<th>Category</th>
<th>Requester</th>
<th>Prioritisation Points 20/03/2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>73</td>
<td>Digital/Smart Metering – select agreed zone (recommendation for Mt Pritchard)</td>
<td>may fund around 150 digital meters for 92 link to 92 Water / Recycled Water</td>
<td>M. Sramek, D. Cash, A. Stanley, B. Aiken</td>
<td>Wild card</td>
<td></td>
<td></td>
</tr>
<tr>
<td>92</td>
<td>Digital Meters for Nepean catchment</td>
<td>around 150 digital meters required, could be funded from 73 link to 73 Water / Recycled Water</td>
<td>P. Higham</td>
<td>Wild card</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>Top 100 EPA Sydney Basin overflow sites to monitor</td>
<td>similar to 65 - all points added to 55 Wastewater</td>
<td>P. Higham; G. Hurley</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>Sewer overflow level monitoring</td>
<td>similar to 55 - all points added to 55 Wastewater</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Sewer Blockage (choke) in high priority (repeat occurrence) areas</td>
<td>Wastewater</td>
<td>D. Cash; D. Tang</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Sewer Infiltration – Upper Parramatta catchment</td>
<td>similar to 61 - all points added to 56 Wastewater</td>
<td>B. McDonnel</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>Detect Inflow / Infiltration of sewers -remainder of sewers</td>
<td>similar to 56 - all points added to 56 Wastewater</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>87</td>
<td>Measurement of pressure transients / water hammer to prevent main breaks (water)</td>
<td>Water / Recycled Water</td>
<td>D. Cash</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>79</td>
<td>Water balance</td>
<td>Improving flow totalisation methodology and implementing assurance around process.</td>
<td>Water / Recycled Water</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Water quality for river systems (extension of Parramatta River trial)</td>
<td>define data set per use case eg swimming e-coil, nutrients for river health</td>
<td>similar to 57, 80 - all points added to 40 Environmental</td>
<td>R. Kerr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>Sewer leak in to Stormwater channels</td>
<td>Currently developing a low cost DO probe with SigFox/Lora for this application (150 – 200 sensors)</td>
<td>similar to 40, 60 - all points added to 40 Wastewater</td>
<td>R. Kerr; D. Cash</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Stream monitoring</td>
<td>proactive monitoring for compliance, quality, wet weather overflow abatement etc.</td>
<td>Wastewater</td>
<td>C. Port</td>
<td></td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>Leakage management</td>
<td>additional probes could improve Takadu predictions for example</td>
<td>Water / Recycled Water</td>
<td>D. Cash</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>Smart standpipes for trucks</td>
<td></td>
<td>Water / Recycled Water</td>
<td>G. Hurley</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Chlorine Monitoring - Network Chlorine Residual/TFC as feedback control to Chlorinators. Early trials done with ChionoClam. On-line Chlorine Analyser - Low cost battery units to carry out real-time Network monitoring of Free Chlorine or Chlorine Residual.</td>
<td></td>
<td>Water / Recycled Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>83</td>
<td>Valve position monitoring</td>
<td>Water / Recycled Water</td>
<td>D. Cash; D. Holland</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>Detect salt water ingress</td>
<td>Wastewater</td>
<td>D. Cash</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Artificial Intelligence
Machine Learning
Deep Learning
ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.

MACHINE LEARNING

Machine learning begins to flourish.

DEEP LEARNING

Deep learning breakthroughs drive AI boom.
Sewer CCTV Condition Assessment in Sydney Water
We collect and treat over 564 billion litres of wastewater a year from 1.9 million properties using:

25,000 km
of pipes
Current CCTV Assessment Procedure

Contractor

Manual Detection
Pipe Exploration + Manual Defect Annotation

Output DVD
Defect tags and video output stored in DVD’s and sent to Sydney Water

SWC Asset Management

Video Analysed
Sydney Water Asset Management Team validates manual annotations from the contractors

Condition Assessment
Sydney Water Asset Management team generates Work Orders depending on the defects present

AUTOMATE
Current State

- 4hrs/km to capture footage
- 18hrs/km to assess the condition of the pipes
- 3 month backlog
CCTV Coverage
2017
CCTV Coverage per year

- Inspected Pipe: 2%
- Uninspected Pipe: 98%

Legend:
- Inspected Pipe
- Uninspected Pipe
Deep Learning Sewer Defect Detection
## Sewer Defect Dataset

<table>
<thead>
<tr>
<th>Defect Class</th>
<th>No. of Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roots &gt;75% Obstruction</td>
<td>1,300</td>
</tr>
<tr>
<td>Cracks</td>
<td>2,025</td>
</tr>
<tr>
<td>Grease Deposits</td>
<td>3,025</td>
</tr>
<tr>
<td>No Defects</td>
<td>2,050</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,400</strong></td>
</tr>
</tbody>
</table>
Deep Learning Tools

- PyTorch 1.0
- fast.ai
- Amazon Web Services
Results

Model Accuracy ~93%
Sydney Water Digital 1.0

- Individual Information Systems (eg Hydra/Maximo/Peoplesoft)
- Each provided a much needed and useful service
- Little if any integration
- High Maintenance Cost
- Reliance on vertical specific Subject Matter Experts (lots of them)
- No articulated long term strategy
Sydney Water Digital 1.5

- Introduction of Automation (IICATS/Treatment Plant SCADA)
- Introduction of Enterprise Service Bus
- Cross System data transfer to a limited degree
- Introduction of Business Intelligence System
- Predominantly IT still a back-end processing function
- Clearly Articulated Strategy about Digital Future
Sydney Water Digital 2.0

• Fusion of IT/OT functions to embed Digital Business firmly in day to day Operations
• Introduction of Enterprise Resource Planning System to provide consolidated platform for entire business operations
• Introduction of Field Mobility Platform to empower field staff
• Introduction of digital technology to all aspects of front-line business (Digital Metering/IoT/Drones/Asset Maintenance)
• Introduction of Machine Learning/Artificial Intelligence platform
• Focus on Customer Outcomes as opposed to Assets with Customer Hub as a key focus for enablement of these technologies.
# Sydney Water 2.0

**Positioning Sydney Water Digital Strategy**

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Sense</th>
<th>Acquire</th>
<th>Analyse</th>
<th>Insight</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Meters</td>
<td>Digital Meters</td>
<td>Comms Network</td>
<td>MDM/ML</td>
<td>Customer/Network usage patterns</td>
<td>Reduced Usage/Leakage</td>
</tr>
<tr>
<td>IoT</td>
<td>Instruments</td>
<td>Transmitters/Comms Network</td>
<td>ML/AI/Predictive Analytics</td>
<td>How to be in front of the incident/Use of empirical data not theory/belief</td>
<td>Customer benefits/Operations Efficiency</td>
</tr>
<tr>
<td>Drones</td>
<td>Unmanned Autonomous Vehicles</td>
<td>Camera Images (Manual or Auto transfer)</td>
<td>ML/AI/Predictive Analytics</td>
<td>How to be in front of the incident/Use of empirical data not theory/belief</td>
<td>Improved Safety/Operations Efficiency/Customer Benefits</td>
</tr>
<tr>
<td>Asset Maintenance</td>
<td>Instruments</td>
<td>Transmitters/Comms Network</td>
<td>ML/AI/Predictive Analytics</td>
<td>Actual Operation/Need for maintenance/Maintenance frequency</td>
<td>Operations Efficiency/Customer Benefits</td>
</tr>
<tr>
<td>Digital Twin</td>
<td>Digital Meters/instruments</td>
<td>Manual or Auto transfer plus import planning models</td>
<td>ML/AI/Predictive Analytics</td>
<td>Improved Efficiency/How to be in front of the incident/Use of empirical data</td>
<td>Operations Efficiency/Customer Benefits</td>
</tr>
</tbody>
</table>
Summary

- IT/OT now a fully merged group as Digital Business
- Customer Hub now covers all of Sydney
- SCADA systems still the core part of our system operations
- IoT is a key enabler of our proactive and predictive vision
- AI can provide predictive analytics to change the way your business operates
- AI+SCADA+IoT - our industry has a unique opportunity with large data collection
- Digital Transformation will help change the way we service customers, enabling us to become a customer centric hyper-connected water utility
- Digital Business is now a core part of Sydney Water operations

Digital enablement must be cognisant of cyber-security risks – failsafe fallback strategies that are regularly tested