How the Internet of Things is going to change Condition Monitoring of Rail Assets

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What is the Internet of Things?

“The interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data.”

Today’s Presentation:
- A model for applying the idea of IoT to condition monitoring of rail assets
- What are the advantages of this model over traditional rail condition monitoring
- An example implementation of these principles in the Pantograph Collision Detection System developed by ART.
### Key Areas of an IoT Model for Condition Monitoring in Rail

<table>
<thead>
<tr>
<th>Area</th>
<th>Description</th>
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<tbody>
<tr>
<td>Low cost field devices</td>
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<tr>
<td>Collection of data via the Internet</td>
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<tr>
<td>Aggregation, analysis and storage of data in a cloud environment</td>
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<tr>
<td>Meaningful access to data through visualisation tools and Application Programming Interfaces</td>
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**Australian Rail Technology**
## New Vs Old

<table>
<thead>
<tr>
<th>Data Collection Hardware Cost</th>
<th>Data Collection</th>
<th>Data Aggregation</th>
<th>Data Usage</th>
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<tbody>
<tr>
<td><strong>Traditional Condition Monitoring</strong></td>
<td>Expensive hardware, high installation costs, high ongoing maintenance.</td>
<td>Infrequent data collection.</td>
<td>Manual collection processes or operators internal network.</td>
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<tr>
<td><strong>IoT Based Condition Monitoring</strong></td>
<td>Small, low-cost, easy to install, minimal ongoing maintenance</td>
<td>Continuous data collection of the monitored system.</td>
<td>Via the public Internet often through use of a cellular data network.</td>
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Data Collection: Low Cost Field Devices

Challenges in deploying field devices:

- Power for the device
- Communication with the device
- Physical size and weight of the device
- Computational capability of the device

Mobile Phones

- High speed, low cost mobile internet
- Advancement of low cost, low power hardware for computing, MEMS sensors, GNSS receivers, etc.
Data Storage and Analysis: Cloud Computing

Challenges in aggregating field data:

- Cybersecurity
- Upfront and ongoing costs for server hardware
- Scalability
- Reliability

Cloud Computing

- Lower costs
- Extended developer tool kits
- Outsourcing of specialised capabilities
Data Access and Use: GUIs and APIs

GUI: Graphical User Interface

API: Application Programming Interface

DATA
Implementation of the IoT Model for Monitoring of Overhead Wire
Current method typical of traditional condition monitoring systems
- Purpose built rolling stock vehicle
- Expensive to procure and maintain
- Infrequent data on the assets being monitored
- Return on investment takes much longer
New Method

– Inexpensive, self-powered hardware with mobile data connection
– Cloud computing platform for data aggregation, analysis and storage
– Both data presentation tools and open APIs for customers to access their data
Field devices

PCDS
- Inexpensive, self-powered hardware with mobile data connection
- Extensible architecture allowing new sensors and power technologies to be added to expand capability
The PCDS is made up of 4 smaller devices:
- 1 Data Unit
- 1 Accelerometer Pair
- 2 Solar Power Units

Each device is “smart” and monitors itself and reports to the data unit.

Each device communicates over a standardized bus providing multi-drop communications and “multi-feed” power supplies.
Accelerometer Pair

- 2x 3 axis High G Accelerometers
- Integrated raw data analysis
- Integrated communications and diagnostics
- GNSS System
- Wireless communications (GSM, 3G)
- Data storage (Flash)
- Wake-up accelerometer
- Bus communications support
Solar Power Unit

- 5W solar panel
- Battery for energy storage
- Solar charging circuitry
- Built in diagnostics, battery and solar health monitoring
Field devices

Current PCDS System

- Solar Power Unit
- Solar Power Unit
- Comms and Data Logging Unit
- Accelerometer Pair
- Additional Sensors
- Additional Power Units
- Server side services leverage AWS
- AWS provides extensive set of high quality services to allow rapid and low cost development of solutions
- Utilises security best practices
- Can be deployed to almost any region in the world for high availability as well as high performance
- Single platform to monitor and manage all field devices
Server side architecture

For some details on implementations refer to the paper
- Data access through RESTful API’s
- Standardised and versioned data schemas to allow for easy integration with 3rd party systems
- Field device drivers interact with the standard API allowing 3rd party field devices to be easily integrated into the platform
- Workflow integration can be achieved via API hooks
- Integration with Enterprise Asset Management systems allows the customer to use standard interfaces and procedures with no need for additional training
- API hooks allow integration with 3rd party analysis and aggregation packages, the aggregation can occur pre and post analysis allowing both platforms strengths to be leveraged
Expand capabilities of current hardware from shock detection to include OHW stagger, ride quality monitoring, OHW sag monitoring, video capture and many more.

Bigger picture we have built a platform that can be used to deploy any manner of IoT devices, including third party equipment not originally intended for IoT applications.
- Lower device cost = more devices = more data
- With all assets being monitored operators will be able to adopt predictive, as-required maintenance strategies.
- Increased network reliability as the risk of unknown and hidden failures trends to zero.
- Deeper insights into the health of the network can be obtained by analyzing diverse datasets and combining them in ways that previously would have been impractical
Thankyou for your time