IoT and Big Data

BNSF Railway

Sunny Bajaj
BNSF at a Glance

32,500 mi of track
28 States/ 3 Canadian Provinces
1600 trains/ day
8000 Locomotives
13,000 Bridges
89 Tunnels
25,700 Grade Crossings
10m Carloads Shipped in 2014
Internet of Things

Wayside Detectors
Why Wayside Detection?

• Improve **Safety, Availability, Reliability and Velocity** of rolling stock
• Augment manual inspections
• Reduce train delays associated with setouts
• Proactively identify “Bad Actors”
Detector Types

5 Types of Technologies

13 Types of Detector Systems

2000+ Individual Detectors

Infrared Technology
Excessive friction in wheels and bearings generates elevated temperatures that indicate a defect that, if not addressed, can result in catastrophic failure.

Acoustic Sensors
Harnessing sounds of a target component as it operates under load and speed can provide early warnings about defects in a component that may not be visible, like a crack or an internal defect.

Force Detectors
It is normal for railcars to impart stable and balanced forces to the rail, but excessive impact forces or imbalanced forces in curves or straightaways indicate issues that may result in component damage or derailment.

Vision Cameras
Recording images of components operating at track speed is proving an effective and modern way to spot defects that are hard to identify while a car is sitting in a yard.

Laser Technology
Measuring position of components can provide useful information. Most recently, this information is being used to plan maintenance for locomotive wheels that require attention and to monitor freight-car braking capabilities.
Detector Examples

• **Acoustic Bearing Detector (ABD)** – acoustic systems used to evaluate sounds generated by specific bearing component defects

• **Hot Box Detector (HBD)** – evaluates bearing temperature history for statistical outliers; brake issues, burned off journals

• **Cracked Wheel/Axle Detector (CWAD)** – Rail mounted sensors capable of detecting the difference between tones generated by normal vs. flawed wheels and axles
The Results

300% reduction in Mechanical-caused reportable train derailments

* Since 2000, normalized by train miles
Internet of Things

The Connectivity
The Connectivity
Establishing a Big Data Platform... and Exploring the Possibilities...
Big Data Platform – Any Data, Any Where, Any Time

Analytics
WEKA, R, etc.

Data
Hadoop

Optimized for Analytics

Optimized for Operations

Sources
Mechanical Detectors
Engr. Geo Cars
Weather
Drones
Asset Mgmt
Industry Data

Video & Audio
Structured Data
Internet & Log Data
Real-Time Streams

Standard Reporting
Predictive & Prescriptive Analytics
Discovery
Visualization
### Potential Business Applications...

<table>
<thead>
<tr>
<th>Business Case</th>
<th>Analysis</th>
<th>Platform</th>
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<tbody>
<tr>
<td>What is the impact of weather on Detector readings?</td>
<td>Map weather patterns and history to BNSF Network. Use Detector data to run predictive models.</td>
<td>Hadoop, IOC,</td>
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<td>DB2, SAS/R/SPSS</td>
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<td>What is the correlation between Track Quality and Truck/wheel condition?</td>
<td>Use Geo/Detector Car &amp; Mech. Sensor data to determine correlations</td>
<td>Hadoop, IOC,</td>
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<td>DB2, SAP, SAS/R/SPSS</td>
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<tr>
<td>Can we predict engineering track defects in advance?</td>
<td>Combine Geo-Car EAM and drones data to predict engineering track defects in advance</td>
<td>Hadoop, GIS,</td>
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<td></td>
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<td>Teradata, SAS/R/SPSS</td>
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