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EH Powered IoT

Monitoring Trains and Track

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IoT Characteristics

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- Sensor, Microprocessor, Transmitter
- **Self Powered** - Energy Harvester (no batteries)
- **Wireless** Data Transmission to Cloud Server
- Information/Alarms anywhere over the internet
- Mobile Platform (to make it a little more difficult)

When will see this ?

INNOVATE UK

ENERGYMAN

WARNS

EU FP7/H2020 SME INST

WiBRATE

WARNTRAK

Live Monitoring on Trains

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- Axle Bearings

- Traction Motors

- Wheels

- Track

- Gearboxes

- Cows

Perpetuum WSN Features

- Totally Autonomous WSN (no wires or batteries)
- 32 WSN's per 4 car train transmitting to 1 Data Concentrator (powered) with GPRS link to Cloud Server
  - ✓ Vibration & Temperature Sensors
    - Early Identification of Failure
  - ✓ Wireless Communication
    - No Wires
  - ✓ Vibration Energy Harvester
    - No batteries
  - ✓ Robust design for harsh environments
  - ✓ Fast to fit
    - Trains fitted overnight

Installation

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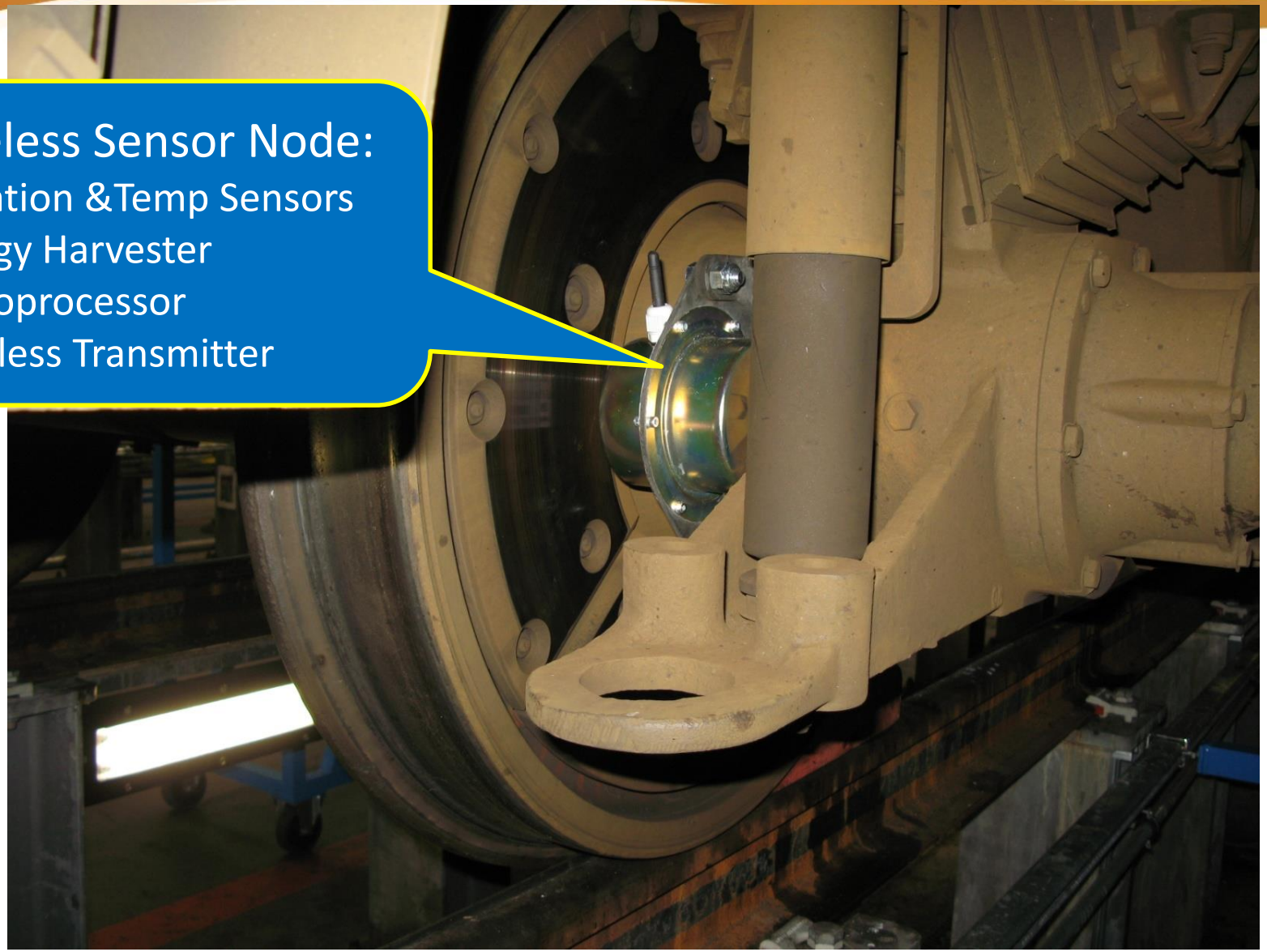

Wireless Sensor Node:

- Vibration &Temp Sensors
- Energy Harvester
- Microprocessor
- Wireless Transmitter

Communications

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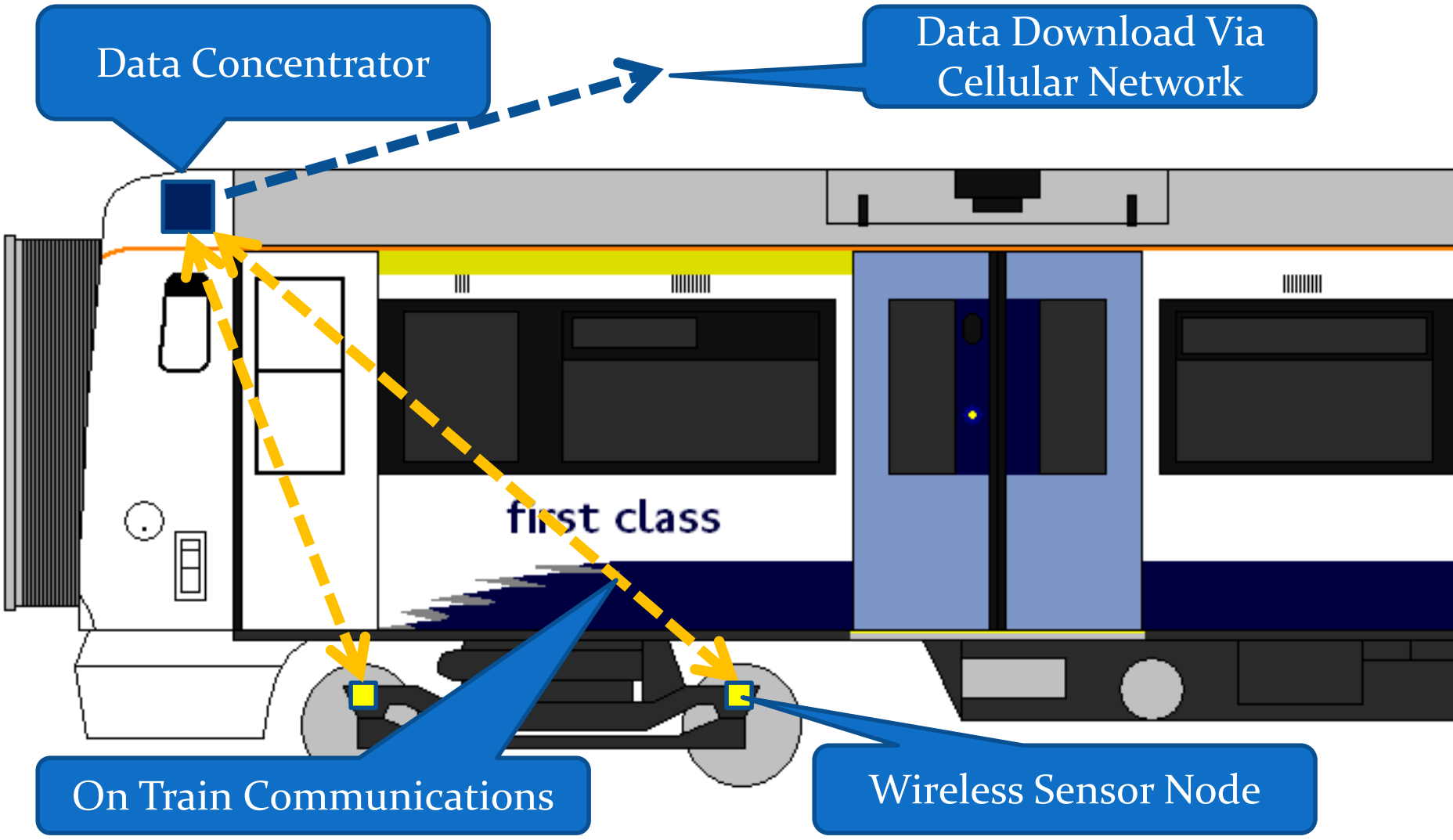

Bearing Failure !

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Simple to Use

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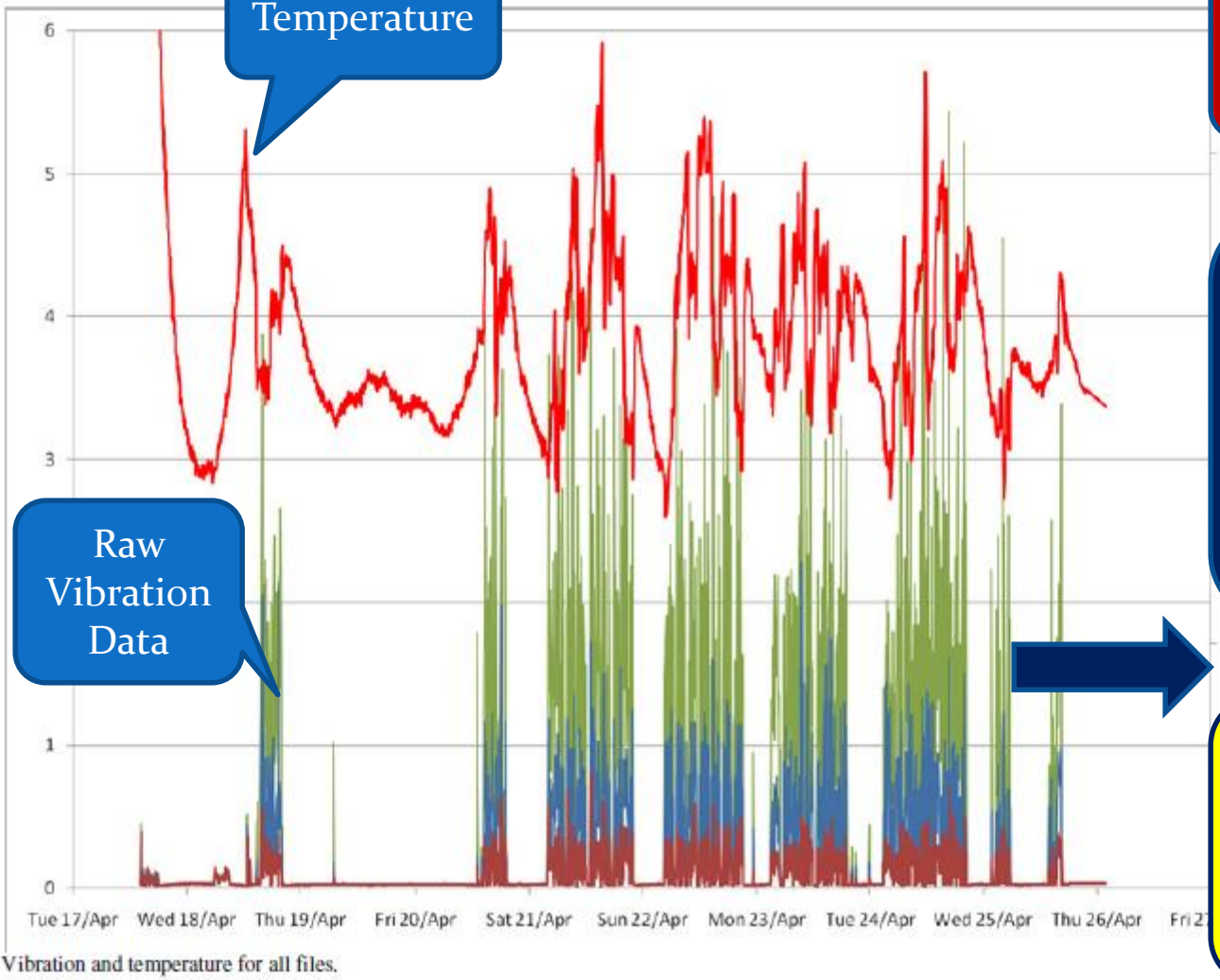

Vibration and temperature for all files.

Input:
Complex & noisy 3D Vibration data

Perpetuum's Algorithms:
Reduce background noise, Look for Vibration signatures of bearing & wheel damage

Output:
Simple numerical rating of wear: Bearing/Wheel Health Index (BHI/WHI)

Vibration Data

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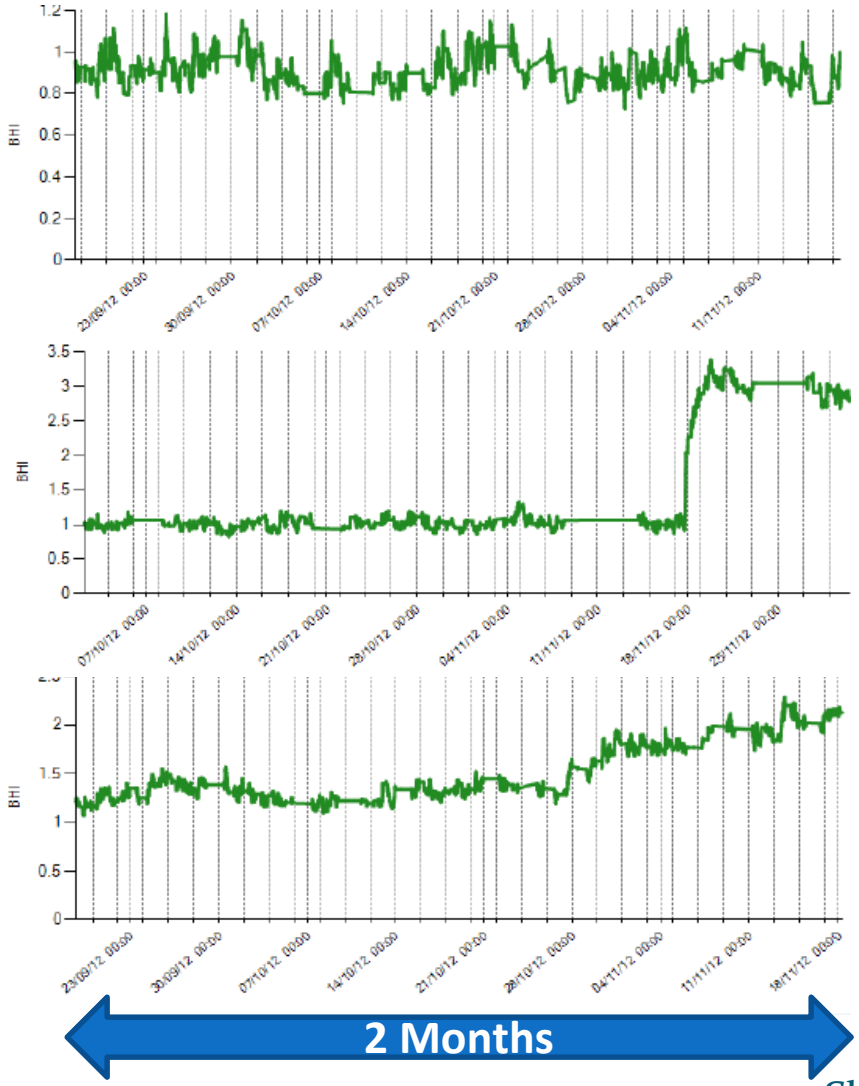
Good Bearing

Onset of Flat

Degrading Bearing



Correlation of Damage to BHI

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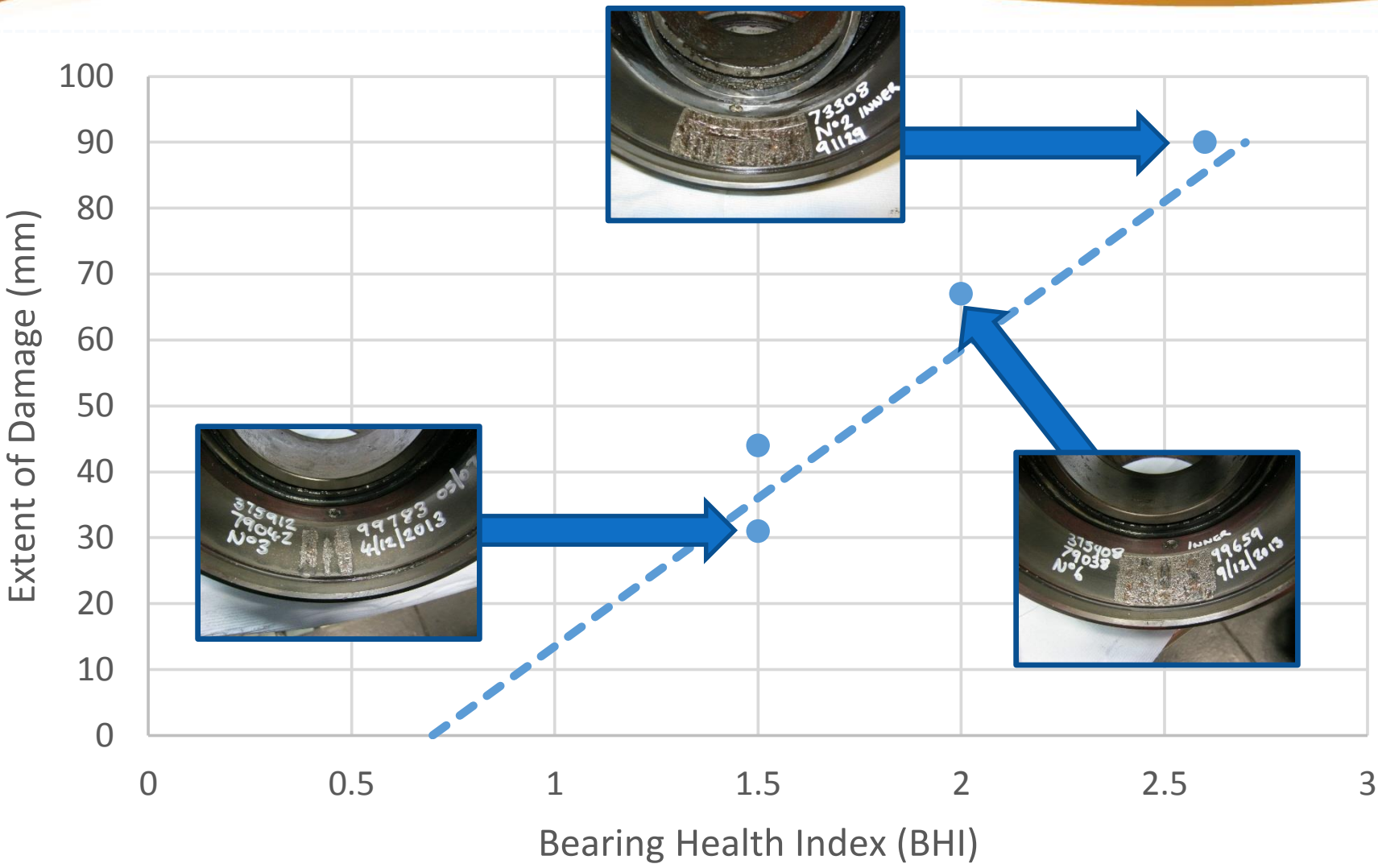

Subsurface Damage Revealed

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0.6 mm Cut

Initial inspection shows minimal damage

Surface removal reveals hidden damage

Business Case

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- Extend service interval
  - Maintain on need not on mileage
  - Reduce number of major overhauls in franchise period
- Improves asset utilisation
  - Fleet being monitored while earning revenue
- Improves efficiency of maintenance operations
  - Allows potential failure to be identified in advance & maintenance planned
- Reduces damage by enabling early intervention
  - Wheel sets, shock damage etc
- Avoids in service breakdown
  - Penalty charges , cost of repair & recovery
- Improved Reliability and Safety

No Wasteful Bearing Changes

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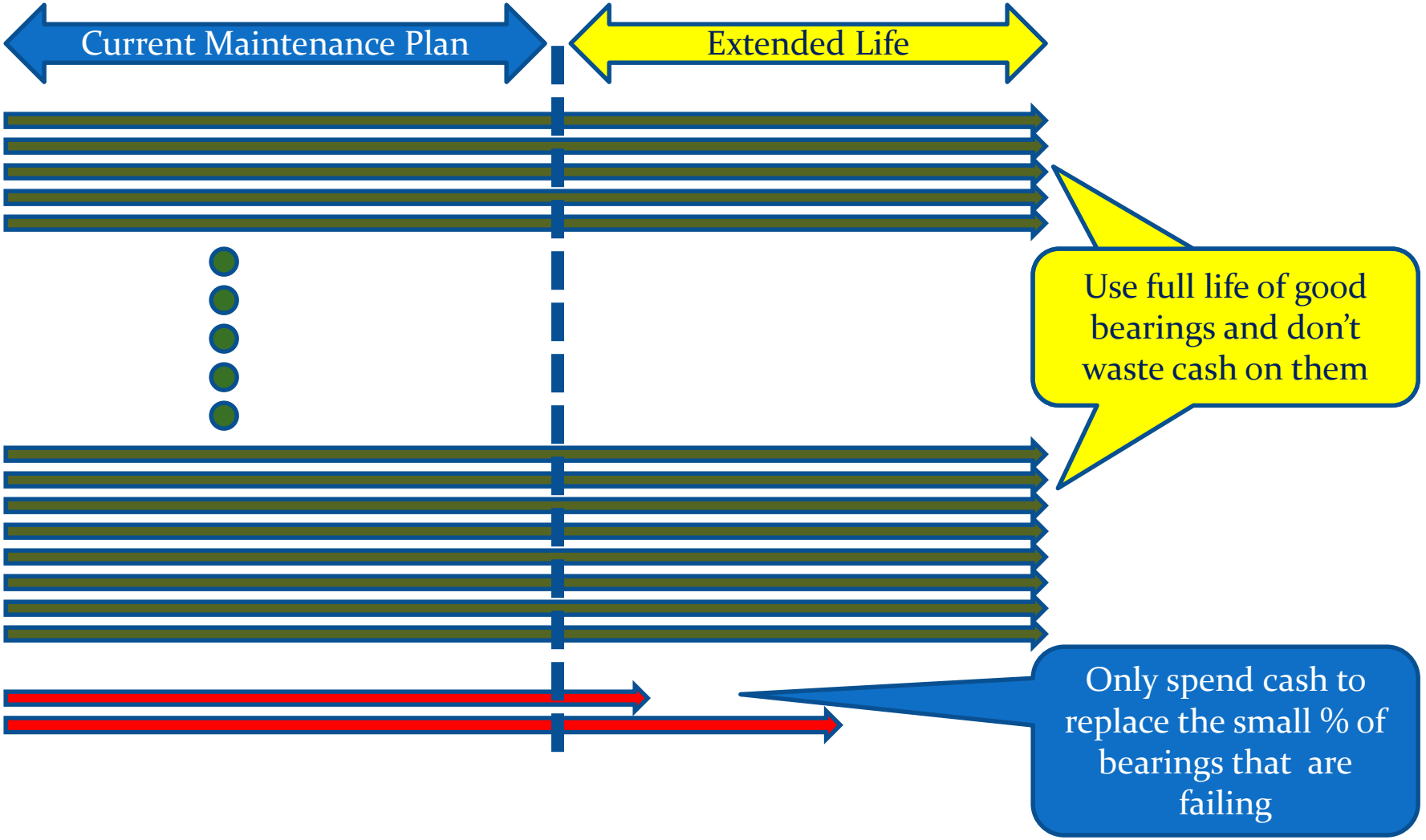

Gearbox Monitoring

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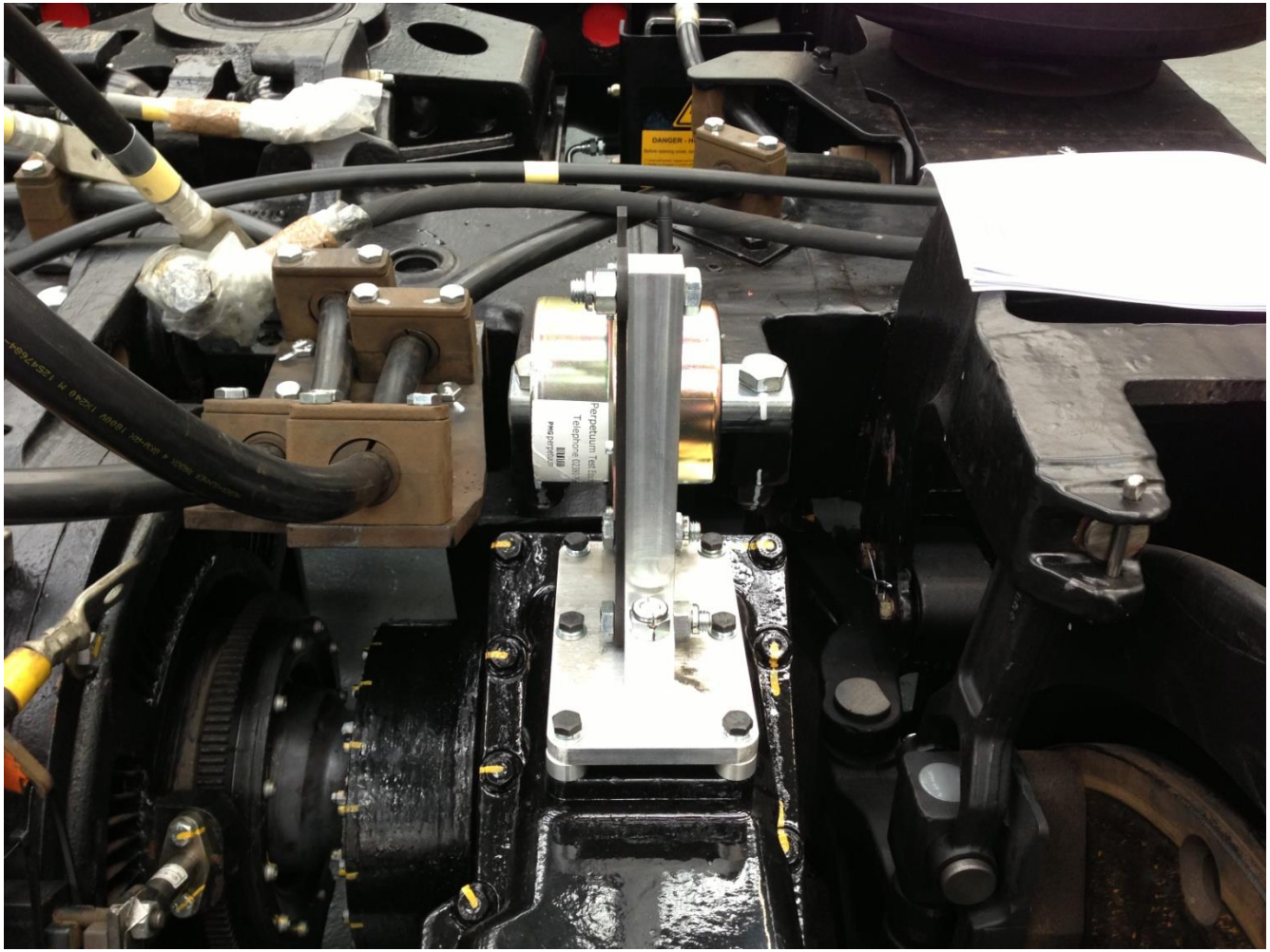

Going beyond rolling stock …

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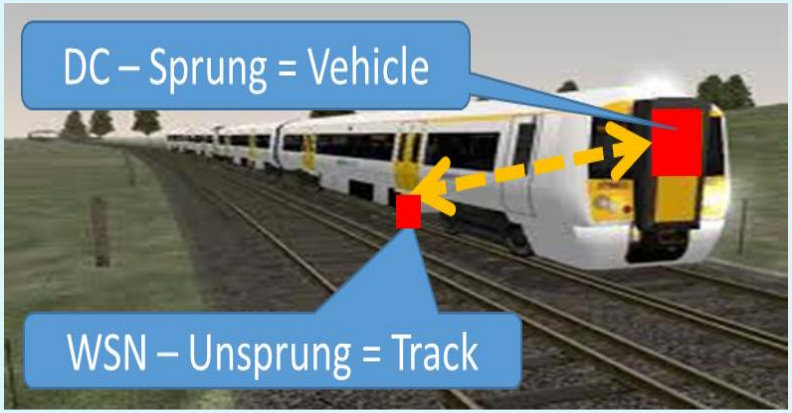
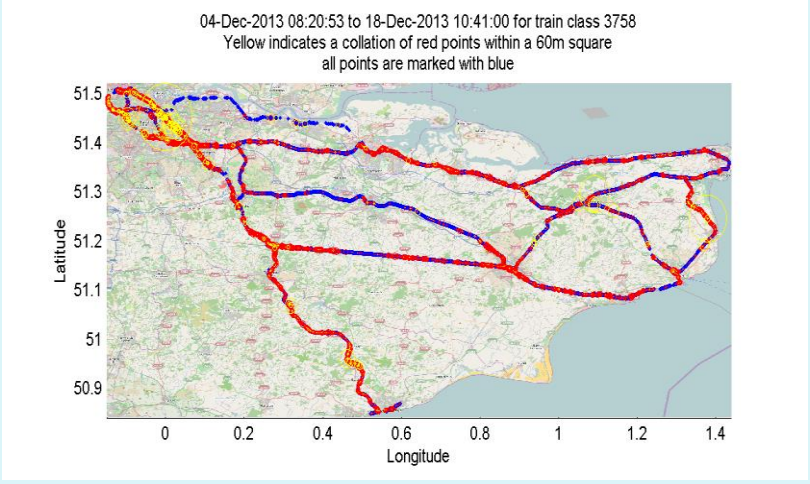
- Original bearing solution led to wheel solution
- Now investigating track solution
- > 5 000 sensors already monitor Kent network daily in real-time
- Location tagged data using GPS





- Sprung & Unsprung measurements
- “Noisy” wheels easily removed
- Vertical shock & vibration at wheel/rail (+/- 0.025Grms)
- Also lateral and longitudinal forces

WARNTRAK Track Monitoring

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- Vibration sensors measure the interaction of the rolling stock and the track
- The Perpetuum Data Concentrator has GPS capability which enables vibration levels to be correlated with track position
- This enables the system to identify locations where there are faults developing
- Maintenance teams can then predict the priority areas for maintenance resulting in improvements in safety, reliability and cost
- Examples:
  - Increasing vibration that leads to a track break
  - Increased vibration associated with poor track bed
  - Degradation of quality of points over time

Poor Bed Identified, Remedied

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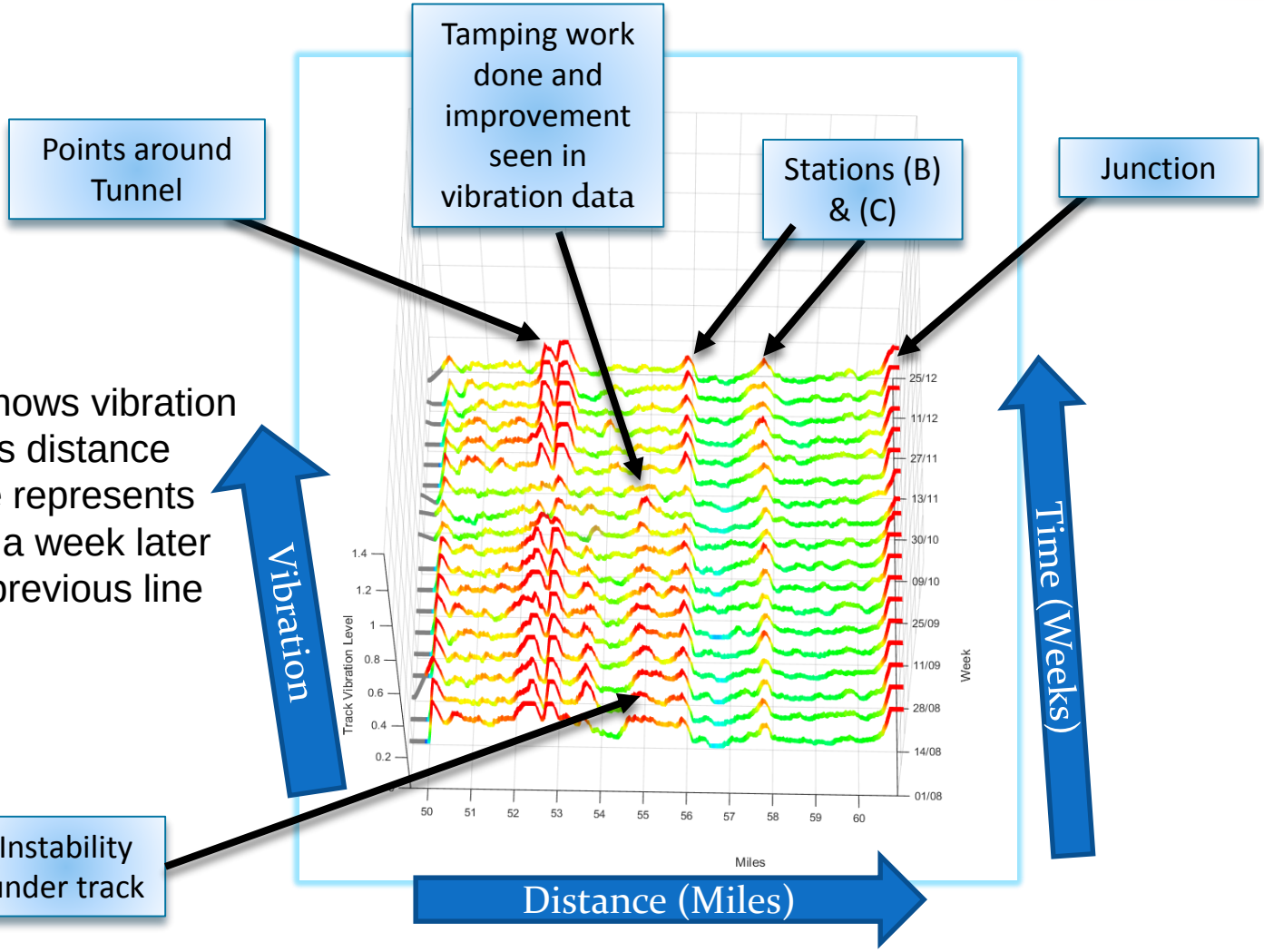
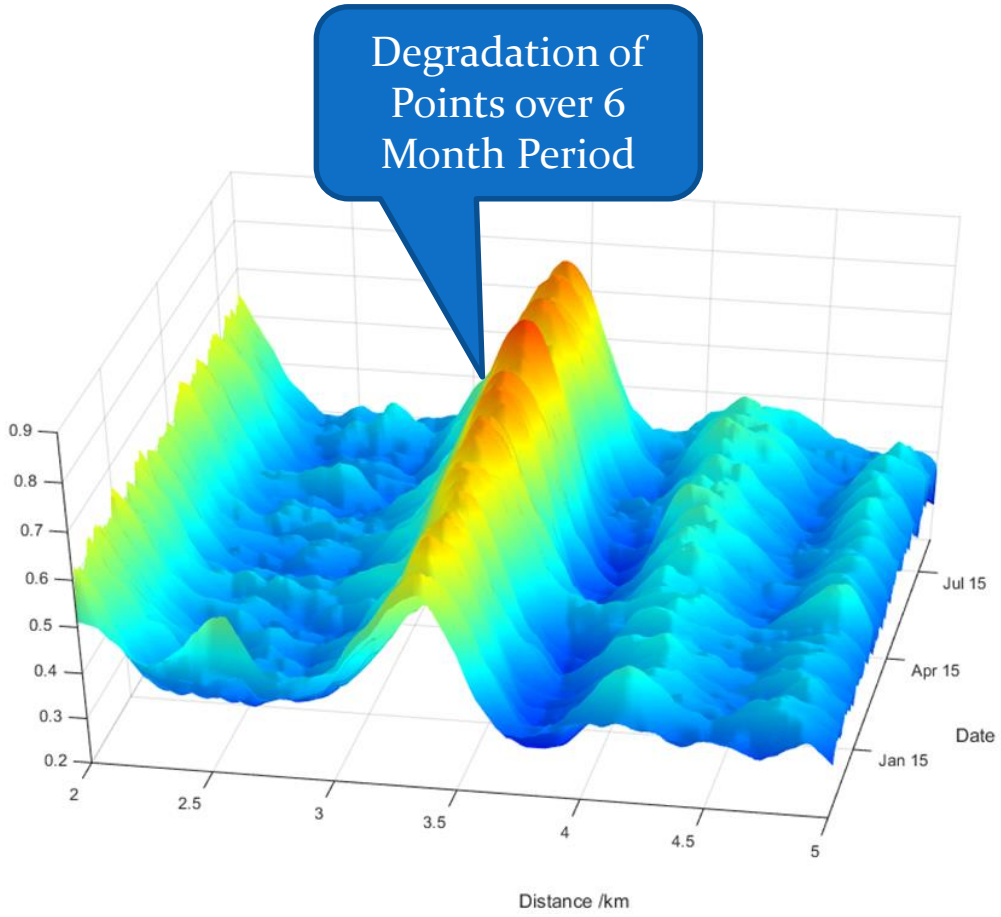
Each line shows vibration levels vs distance
Each line represents data from a week later than the previous line



Degradation of Points



Future: Fully Monitored Train

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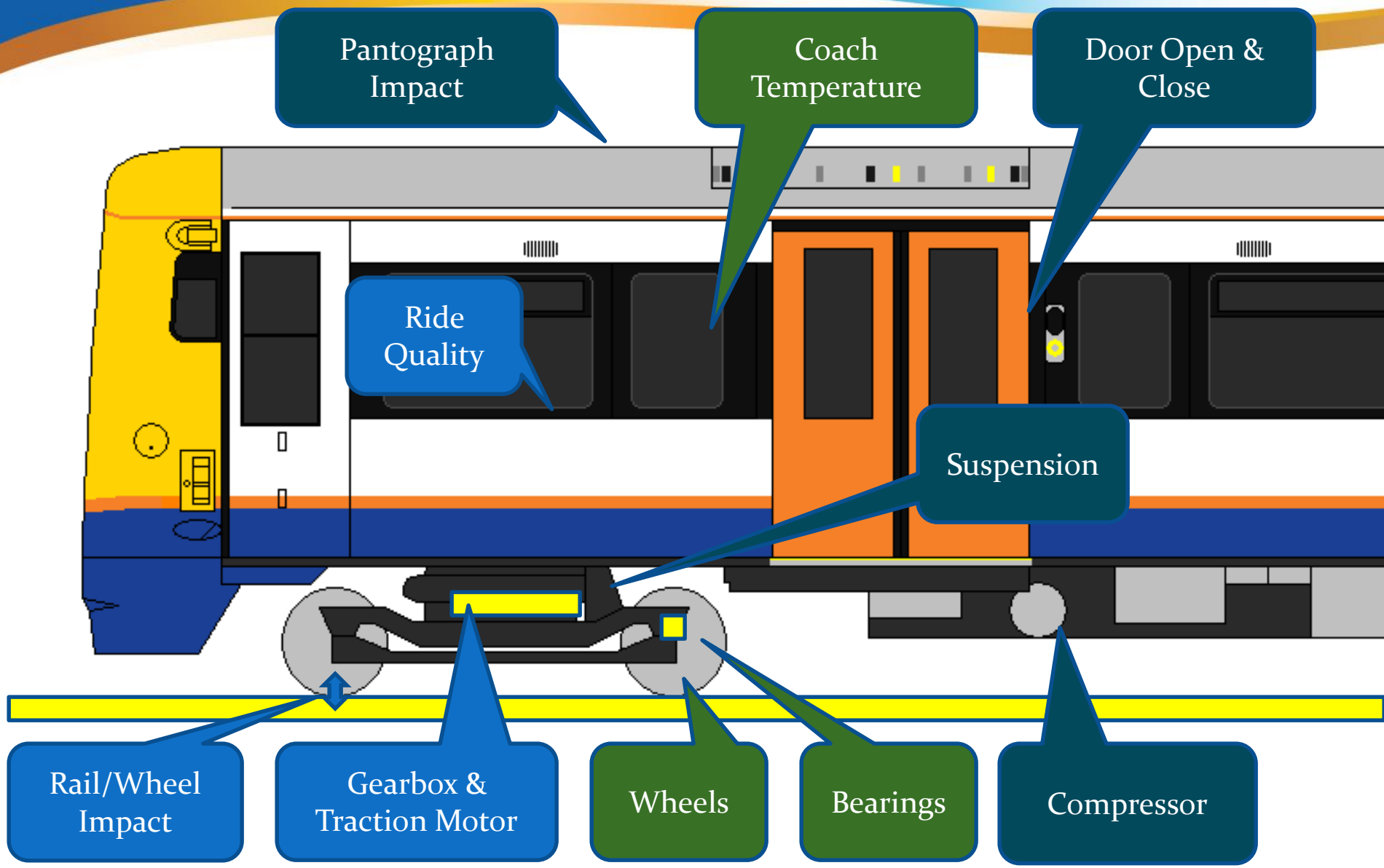

IoT–Improving Quality of Life

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Checking the bearings on the 12.37 to Brighton

Summary – EH Powered IoT

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EH Powered Wireless > Competitive Installation

- Wireless Condition Monitoring
  - Adopt new maintenance methodology
  - Enhanced Safety from real time data
  - Improve Reliability
  - Reduce Maintenance Costs
- Fast to Fit & Easy to Use with clear actionable information
- Early Warning
  - See bearing degradation 2-3 months ahead
  - Wheel issues before further damage
  - Reduce unnecessary speed restrictions
- Powerful Evolution Path
  - Gearboxes, Traction Motors, Track condition, Cows

Cow on track – Train in Field

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