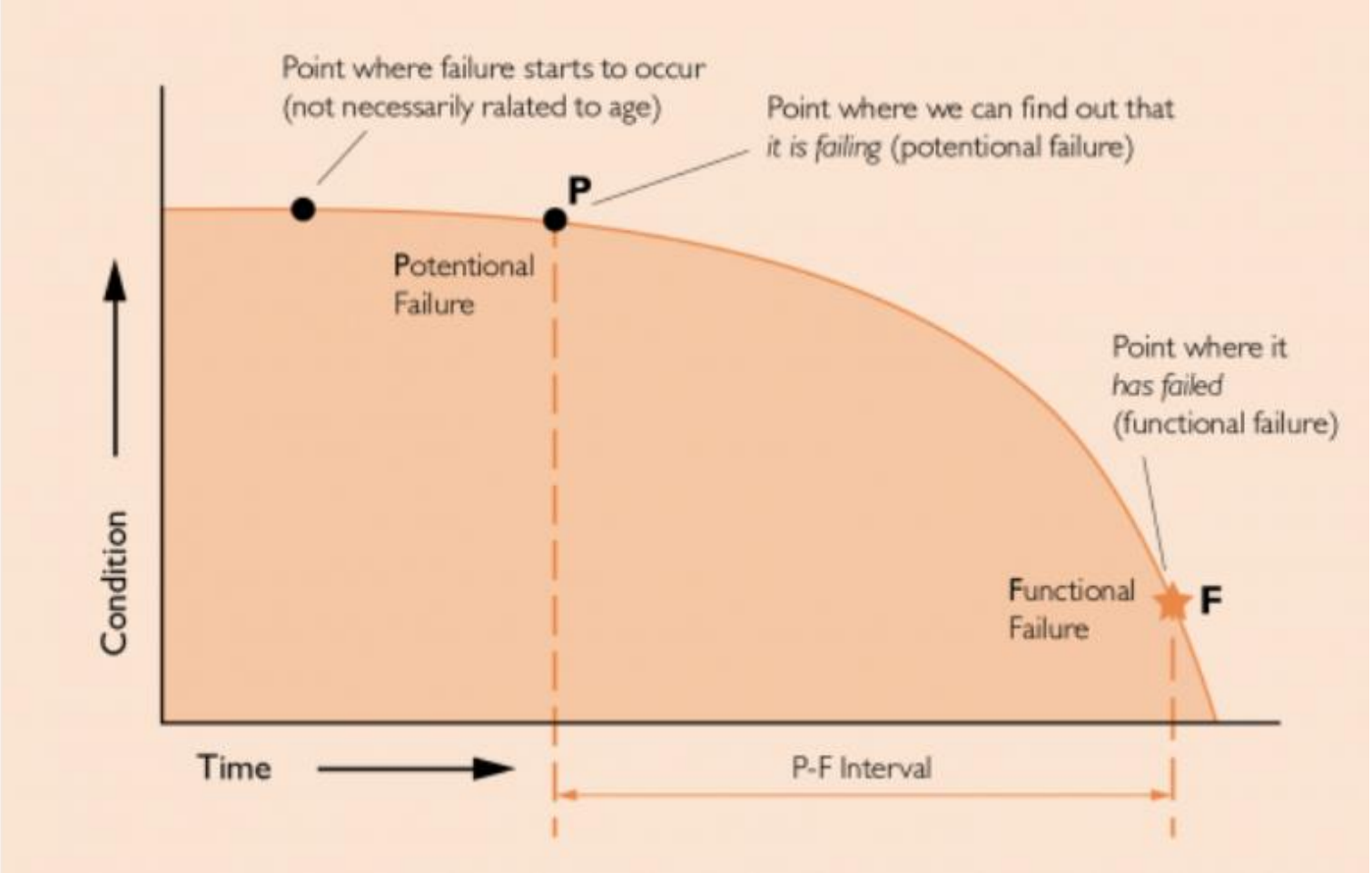
RSAC Wayside Detector Overview

3/27/23

Lawrence Biess

Performance To Failure

A map for improved safety and reliability

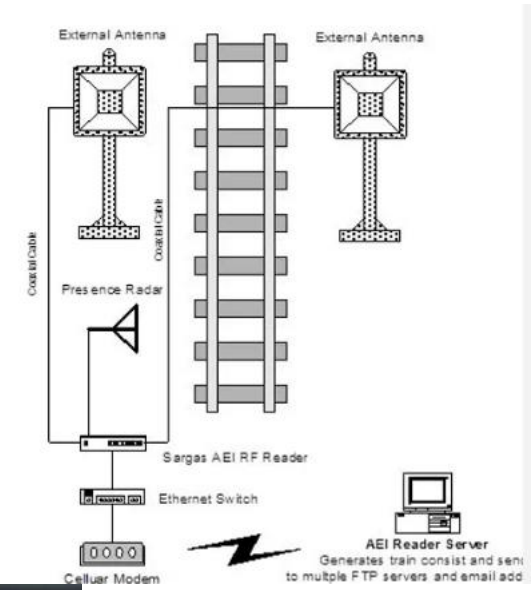


All components have a finite life. Understanding how a component performs over time can present opportunities to prevent failures and shift to data-driven repair/maintenance activities.

Detector Types

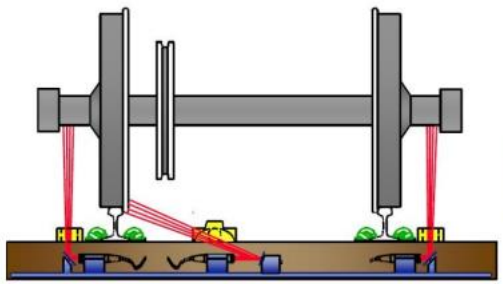
- Equipment Identification
- Dragging Equipment and High-Wide (Clearance)
- Thermal (wheel, bearing, traction motor)
- Acoustic (bearing, traction motor)
- Force (Rail impact, rail lateral)
- Laser Optical (wheel shape, position, angle, component thickness)
- Imaging (train, wheel, brake disc, pantograph)

Automatic Equipment Identification Tags and Readers



High Wide Detector

Hot Bearing and Wheel, Dragging Equipment



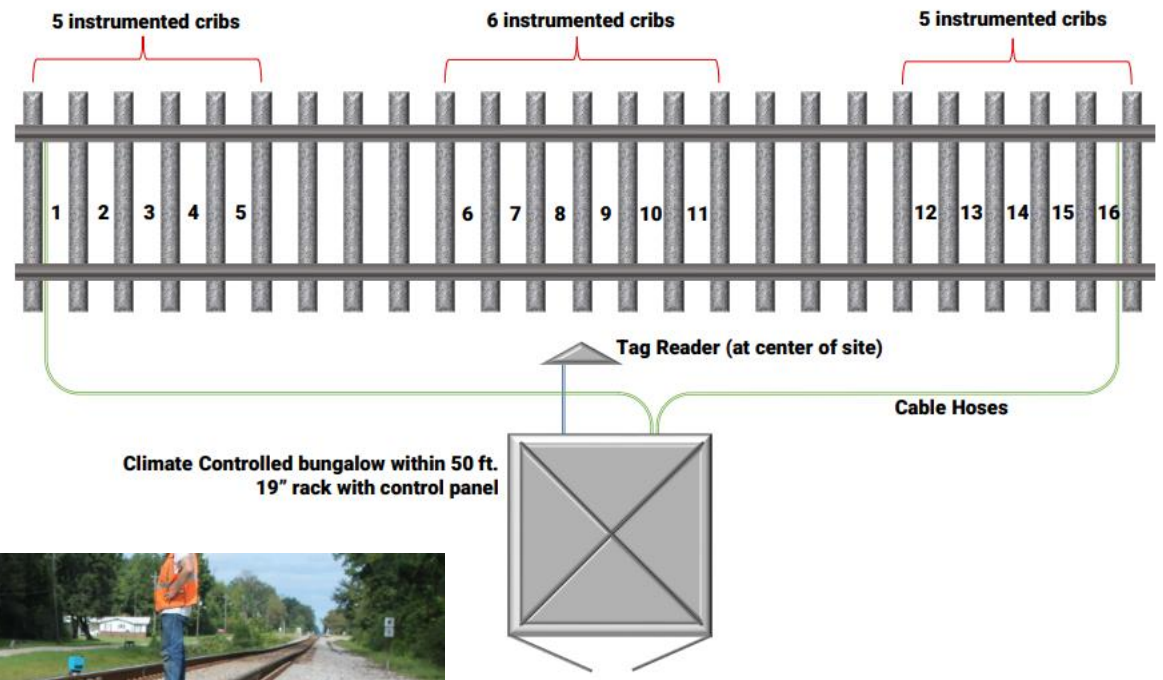
Hot Box/Hot Wheel detection

Hot Box/Hot Wheel detector

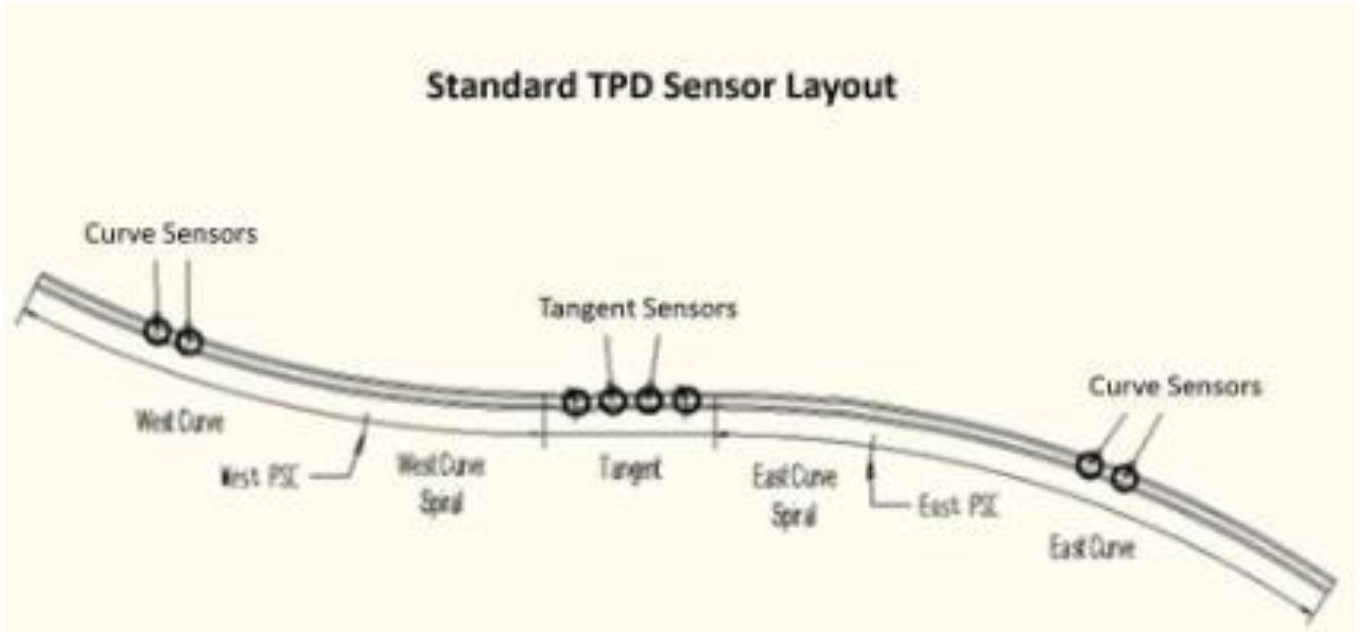
Wayside monitoring system/detectors

Acoustic Detector

Rail Force Detector (also known as Wheel Impact Load Detector or WILD)

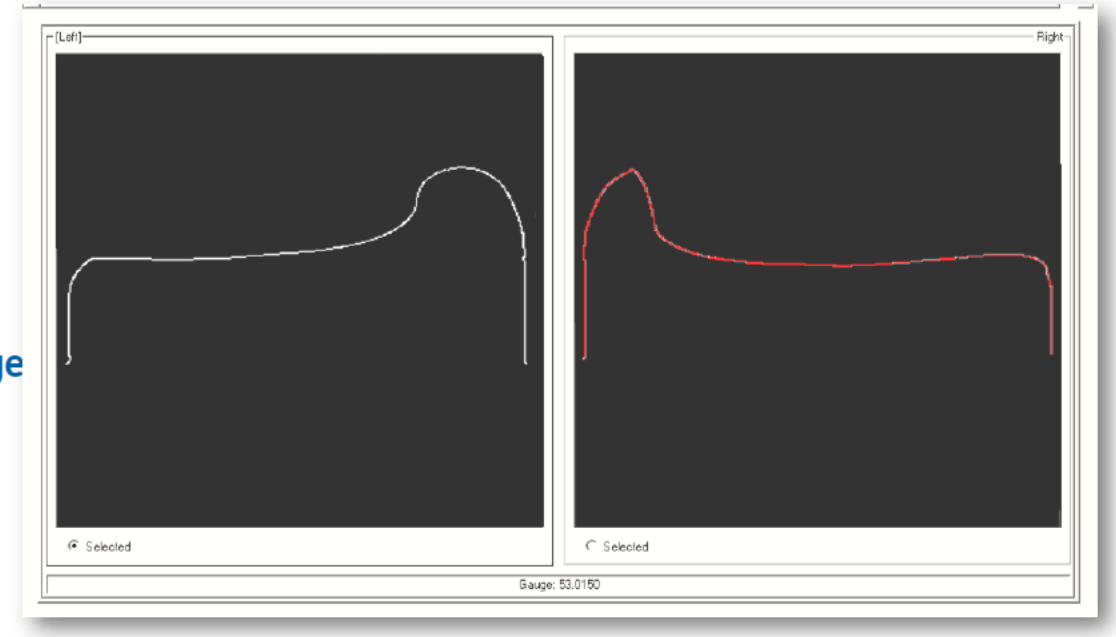


Force Based Truck Performance Detector (TPD)

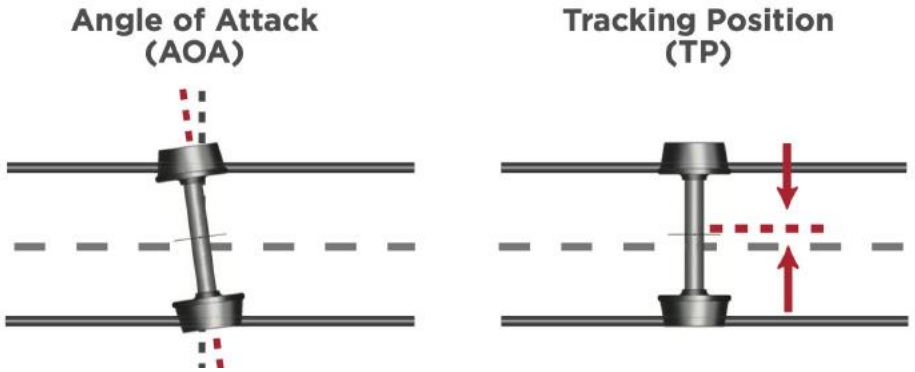


Laser Optical Wheel Profile Detector

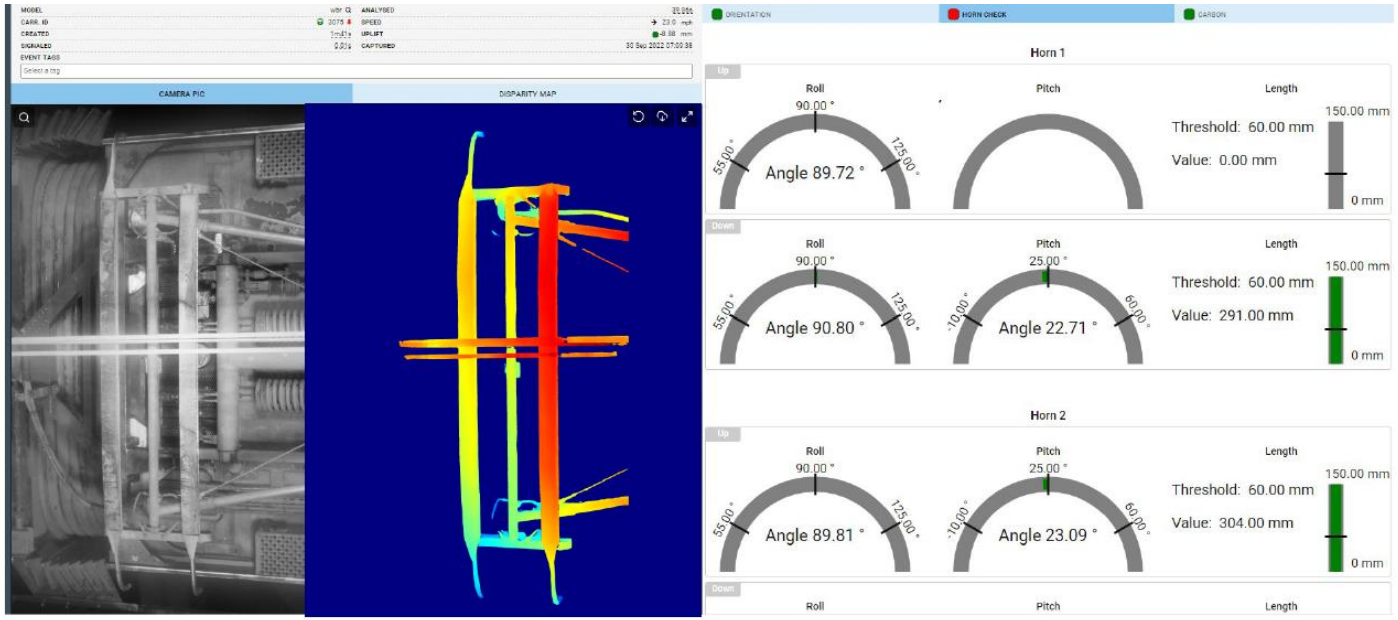
- Wheel Profile
- Flange Height
- Flange Width
- Hollow Tread
- Rim Thickness/Diameter
- Back-to-Back/Inner Gauge
- Flange Angle/(qR)
- Tread Rollover
- Wheel Width
- Diameter

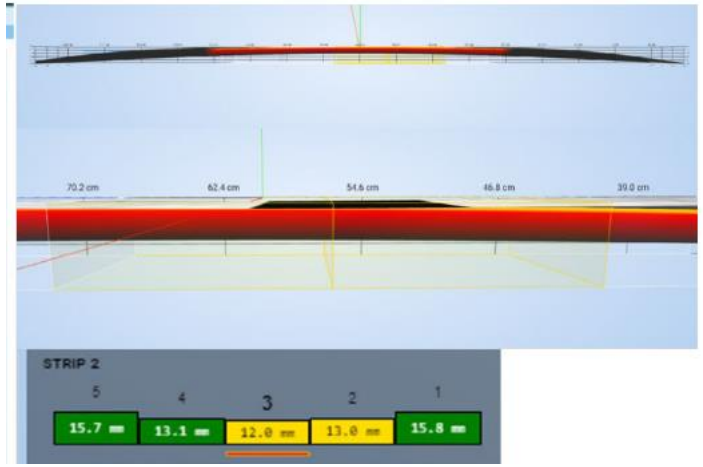


Laser Optical Truck Geometry Detector

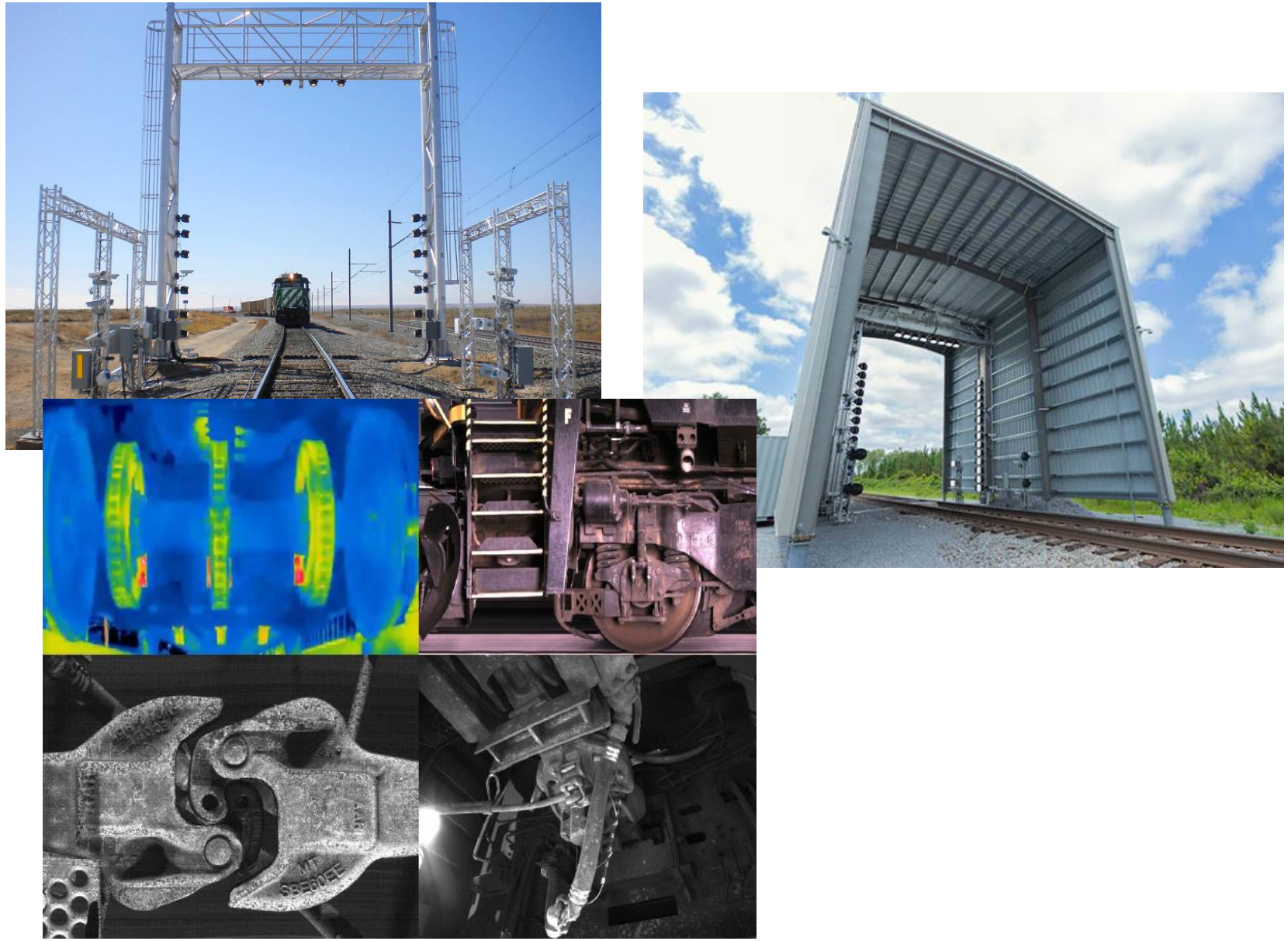


Laser Optical Measurement





Imaging Systems



Bearing Trending

- Hot Bearing Detectors are made by a variety of manufacturers
- Not all of them have AEI
- Typically, they "talk" to crews and deliver a radio message after a train is passed.
- If they detect a defect, the detector will radio message the crew the axle and side.
- Equipment handling rules for roads vary, but generally require that the crew stop and walk both sides of a train and +/- 10 axles and use a piece of wax or "temple stick" to find the hot bearing.
- Hot bearing detectors are set at different temperatures, typically 170 degrees above ambient, or 115 degrees side to side differential will make a Hot Bearing Detector "talk.
- To trend, the hot bearing detector data needs to be collected and matched with AEI data to get equipment, axle, and side information.

Challenges to for Trending: Enriching Data, Accurate Comparisons

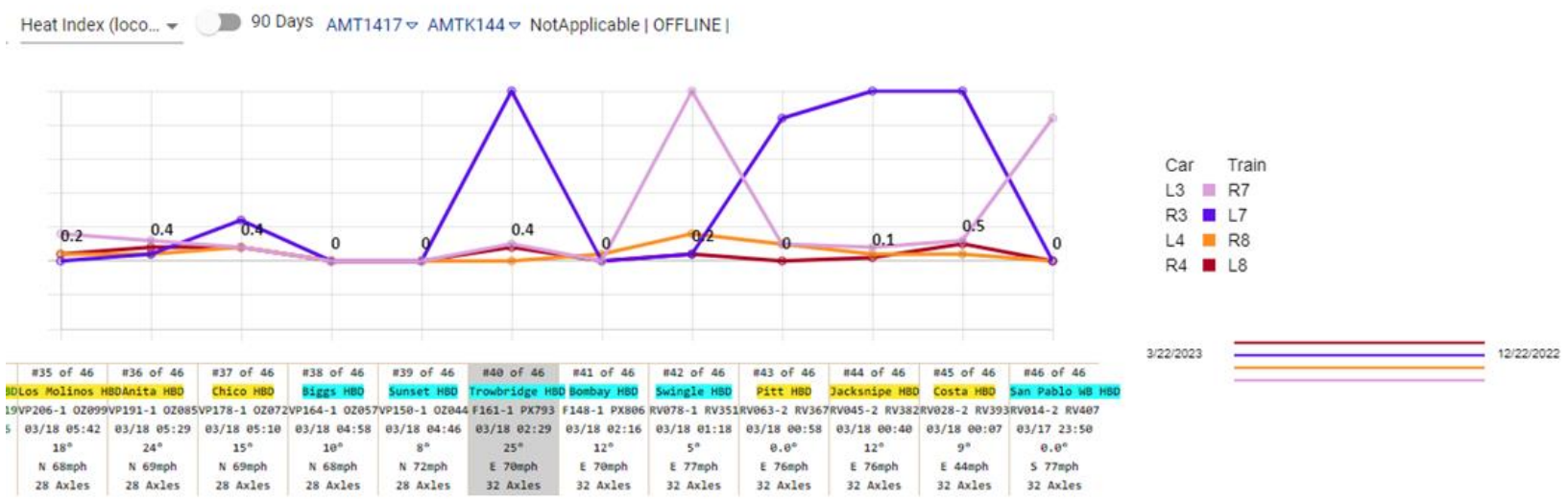
- Over the past 15 years, work has been done to make Hot Bearing Detectors "smart" by adding field technology and communications to acquire data.
- AEI information is added to the Hot Bearing Detector data in the back office to get asset-specific identification (car, side, axle)
- Trending with absolute temp is problematic. Train handling, ambient air temp, train speeds, detector site characteristics, sun, wind, solar, all of these can cause ambient temps and ambient temps to vary site to site, making trending problematic.
- A means of creating a quantitative value, based in temp, but normalized or otherwise statistically consistent between sites is needed.

Quartile Analysis

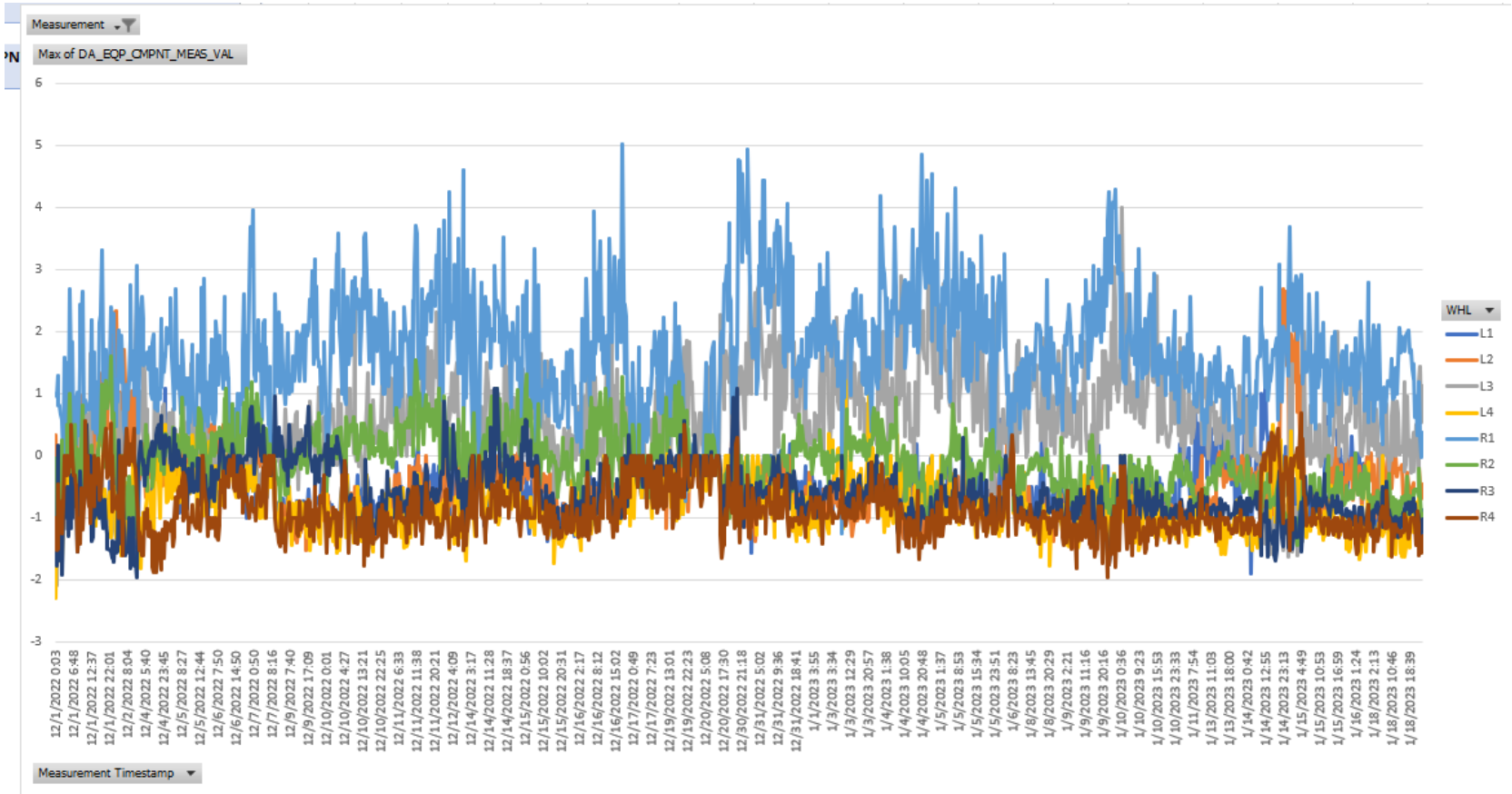
- Roads pull in absolute temps from each train pass at an HBD.
- These temps are put into 4 quartiles
- First Q1
- Second Q2
- Third Q3
- Fourth Q4
- The difference between the third quartile value, and first quartile value, is a delta to calculate K. So, Q3 – Q1 = a step increase (K).
- A "K" is the number of step increases above Q3. Trend systems begin tracking bearings with K above 2.5 as "warm"

AMTK 0144 Flagged by Host Road, High Temperature

Details	Alert ID	Alert Name	Alert Indicator	Train ID	Popup Sent	Equipment ID	Position	Detector Type	Control Point	Track Number	CIRC7	Detector Name	Alert History ID	Pattern Number
Details	HBD85603	Locomotive Axle Bearing Problem Critical	0	AMT14 17	2023-03-18 02:30:54	AMTK 144	1 R	HBD	F161	1	PX793	Trowbridge HBD	147063950	856



AMTK 33024 Flagged by Host Road, Trend



Alerts and Responses: Prioritization

- Wayside Data can be combined and processed to provide insight into equipment condition which can be used to identify:
  - Conditions requiring clear corrective action
  - Conditions requiring further inspection to determine corrective action

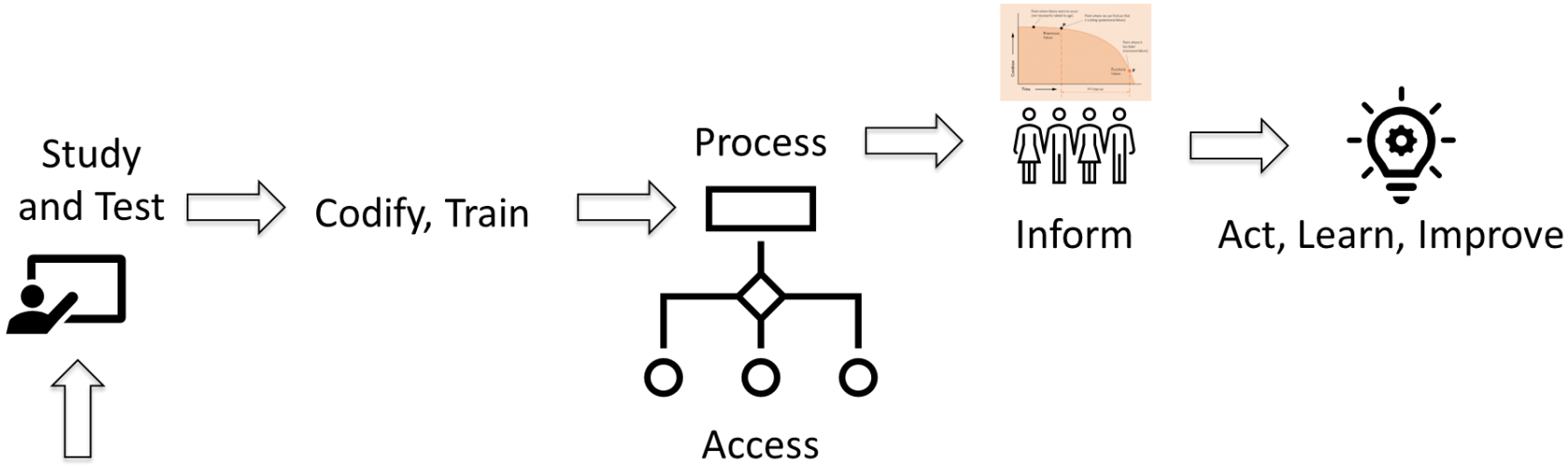
- Alerts can be categorized to minimize line of road interruptions
  - Level 1: Stop train and inspect now, possible slow order or equipment setout
  - Level 2: Slow train and monitor, repair at next available inspection point
  - Level 3: Repair at next available/nearest facility/track
  - Level 4: Plan for inspection and repair, next scheduled maintenance.

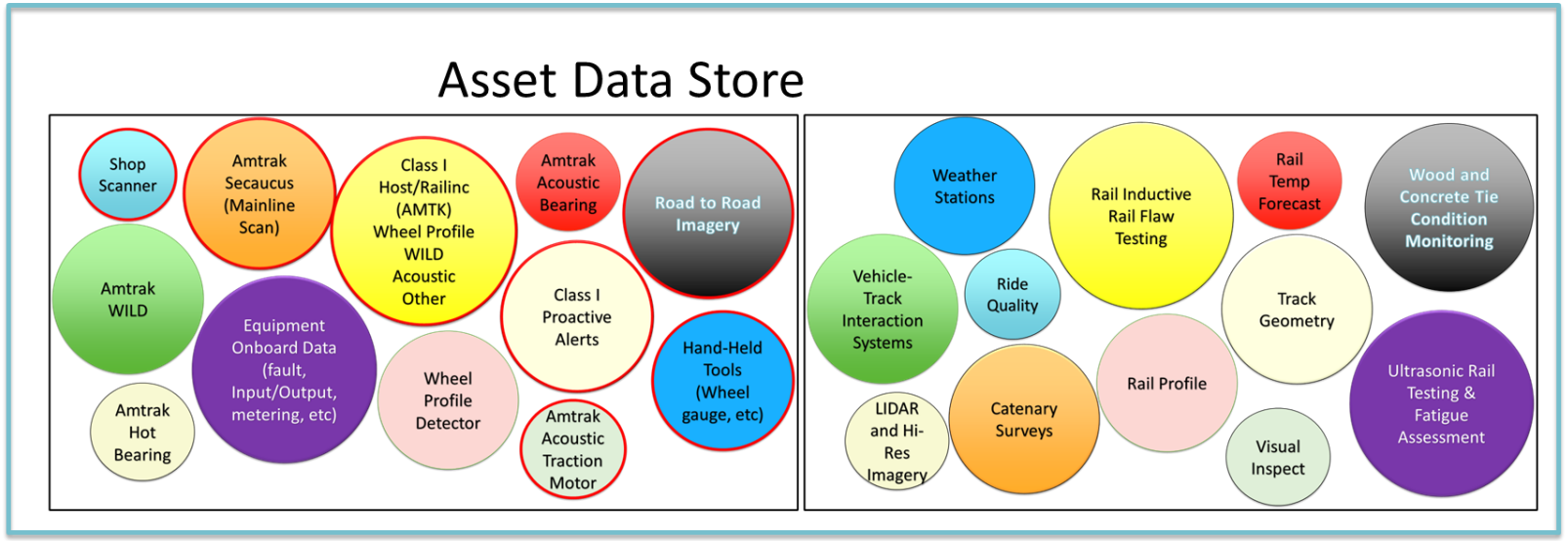
- Ideally, repairs and inspections would occur at the L3 and L4 levels to prevent line of road failures and delays.

Level 1 and 2 Alerts

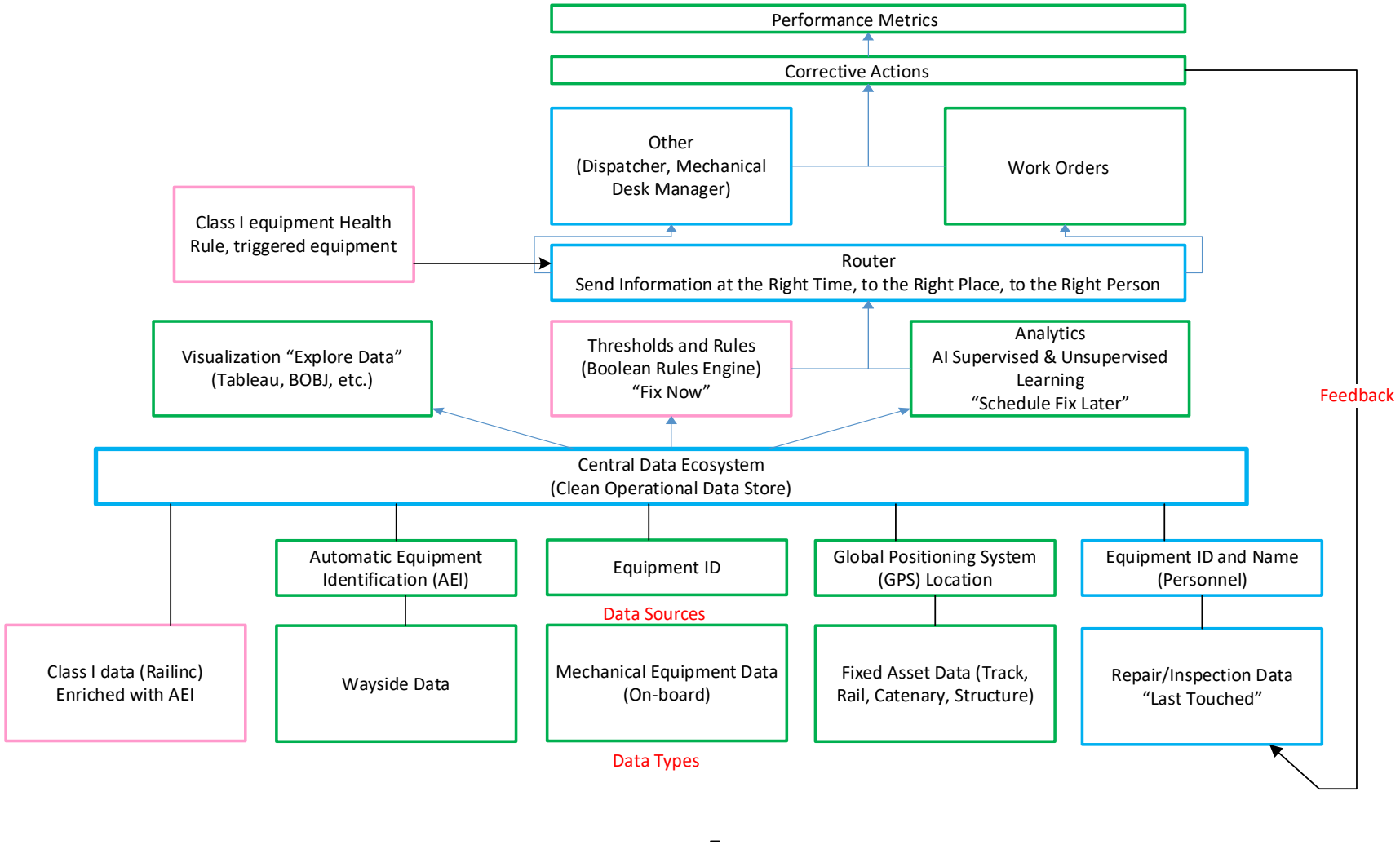
- Ideally these alerts are provided to both the Mechanical Desk and Dispatcher at the same time.
- Dispatcher receives train handling instructions
- Mechanical gets more detail on the nature of the alert symptoms, and actions that need to be taken to address/fix.
- “Detector” or “Tech Desks” are sometimes used to evaluate data, detector performance, and validate alerts.
- Sometimes line of road actions (apply/release brakes) can clear an issue (stuck brakes/dragging brakes).

Combining Data and Creating Information and Strong Processes





A deeper "module" view of an Asset Condition Monitoring System



Recent Industry Activities

- Technology Driven Train Inspection (AAR) to evaluate the current location of wayside detectors to create "inspection corridors"
- Machine Learning (using past failures to evaluate preceding data and developing "agents" that are trained by subject matter experts to predict failures.
- Newer locomotives are software-driven: Acquiring the input and output data to evaluate performance.
- Combining Mechanical and Engineering Data (wheel and rail as a system)
- Vision systems and vision-based inspection algorithms
- Road to road benchmarking
  - Inspection best practices
  - Policy
  - Staffing
  - Notification

What does the Data Driven Future look like, feel like?