APTA Track Circuit Monitoring Tool Applications

A Software Based Monitoring Tool for Secondary Train Tracking and Evaluation.

A System to recognize Loss Of Shunt conditions

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APTA STANDARDS DEVELOPMENT PROGRAM
RECOMMENDED PRACTICE
American Public Transportation Association
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APTA [Insert name of Task Force]
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MMM DD, YYYY: Public Comment & Technical Oversight Committee(s) Approval
MMM DD, YYYY: APTA Rail CEO Committee Approval
MMM DD, YYYY: Policy & Planning Authorization
(Note: All the italicized text above is purely for use during the development phase)

Recommended Practices for a Software Based Track Circuit Monitoring (TCM) Tool

Abstract: The Recommended Practices offers guidelines necessary to integrate a software based tool to monitor track circuit occupancies and identify abnormal operation of track circuits

Project Initiative

- Address NTSB Recommended Practice # R-09-6 and R-09-7
  - *R-09-6: Urgent to WMATA – Enhance safety redundancy by evaluating track occupancy and automatically generate alerts.*
  - *R-09-7: Urgent to FTA – Advise all transit operators with systems that can monitor train movement. Add redundancy by evaluating track occupancy data on a real time basis to automatically generate alerts and speed restrictions to prevent train collisions.*

Background and Challenge

To maintain safety and reliability:

- Requires technologically experienced labor force
- Maintenance employees should be empowered with the ability *to stop train movements or implement appropriate speed restrictions to prevent collisions.*
  (Red text is QUOTE from NTSB R-09-6 Urgent)
- Technical and safety responsibilities can be challenging
- Immediate information availability **is critical** to assure safe and reliable operation and making operational decisions

TCM Objectives

Provide a Practical and Cost Effective Solution to Transit Agencies for Secondary Train Tracking and Evaluation

- Provide enhanced algorithms to monitor integrity of track circuit indications and train progressions
- Categorize abnormal events in notifications, warning, and safety critical alerts
- Initiates Stop of train movements or appropriate Speed restrictions to prevent collisions. [*QUOTE from NTSB R-09-6*]
- Enabling long-term perspective for improved asset management
- Improve Track Circuit reliability and transportation safety

TCM Product History

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES
NATIONAL ACADEMY OF SCIENCES

APTA AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

metro

Track Circuit Monitoring tool source code sections and algorithms made available by WMATA *(special thanks to Tim Shoppa for his support in implementing the tool at CTA)*

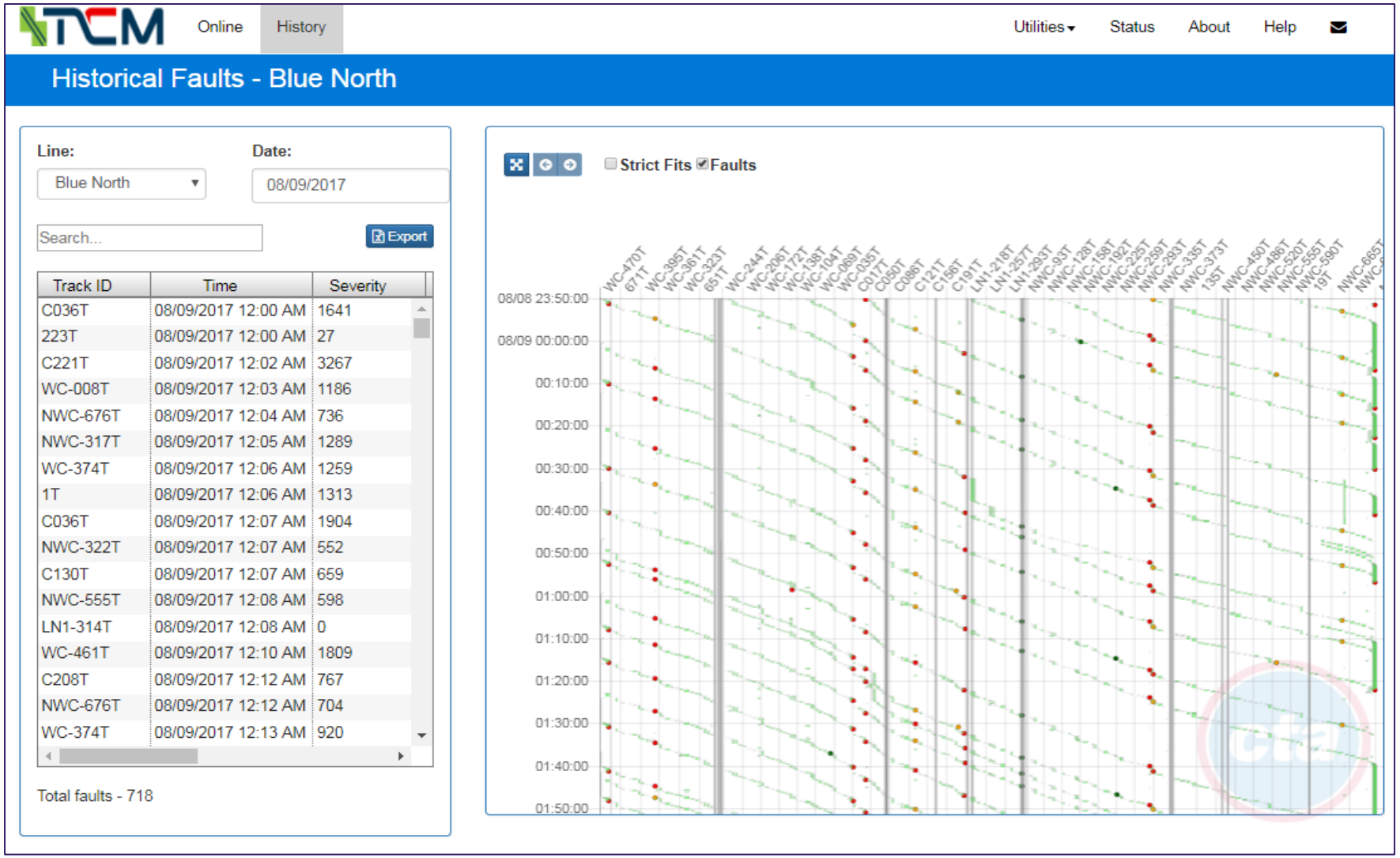
cta

Pilot installation and Systems integration support provided by Chicago Transit Authority

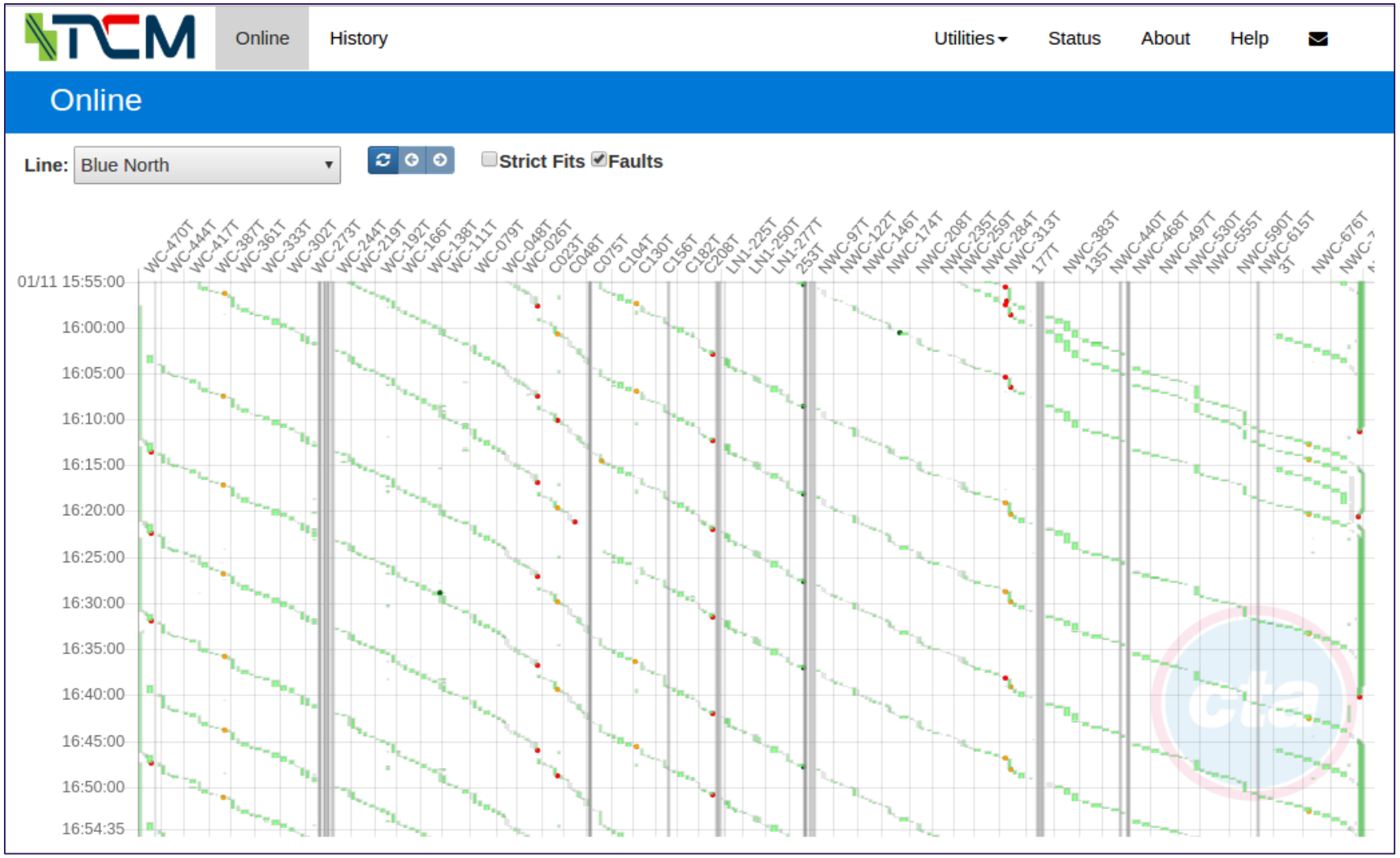
marta

Track Circuit Monitoring system based on TCM product deployment in a 2-phase staged approach

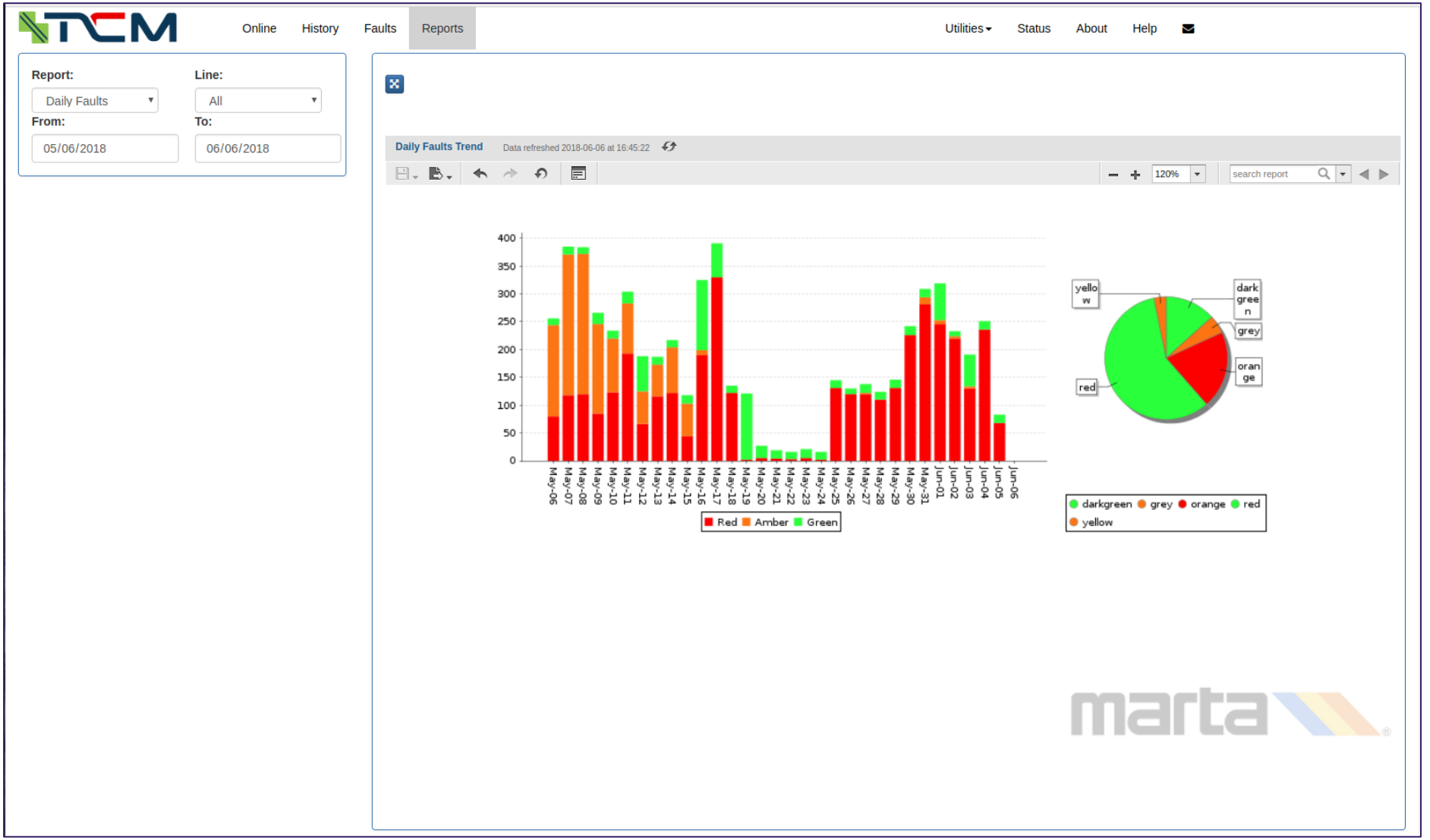
TCM Tool – Alert Overview



TCM Tool – Track Charts



TCM Tool – Reports



TCM Tool – Reports

TCM helps identifying System problems

Potential to detect occupancy failures in Train Monitoring and Control Systems, regardless, if ATC system or other infrastructure systems failure. Examples include:

Failures to detect train occupancy:

- Circuits out of Adjustment
- Corrugated Rail
- Damaged Bonds
- Broken rail clamps
- Loose connectors
- Rusty Rail
- Short circuits protected by LOS timer

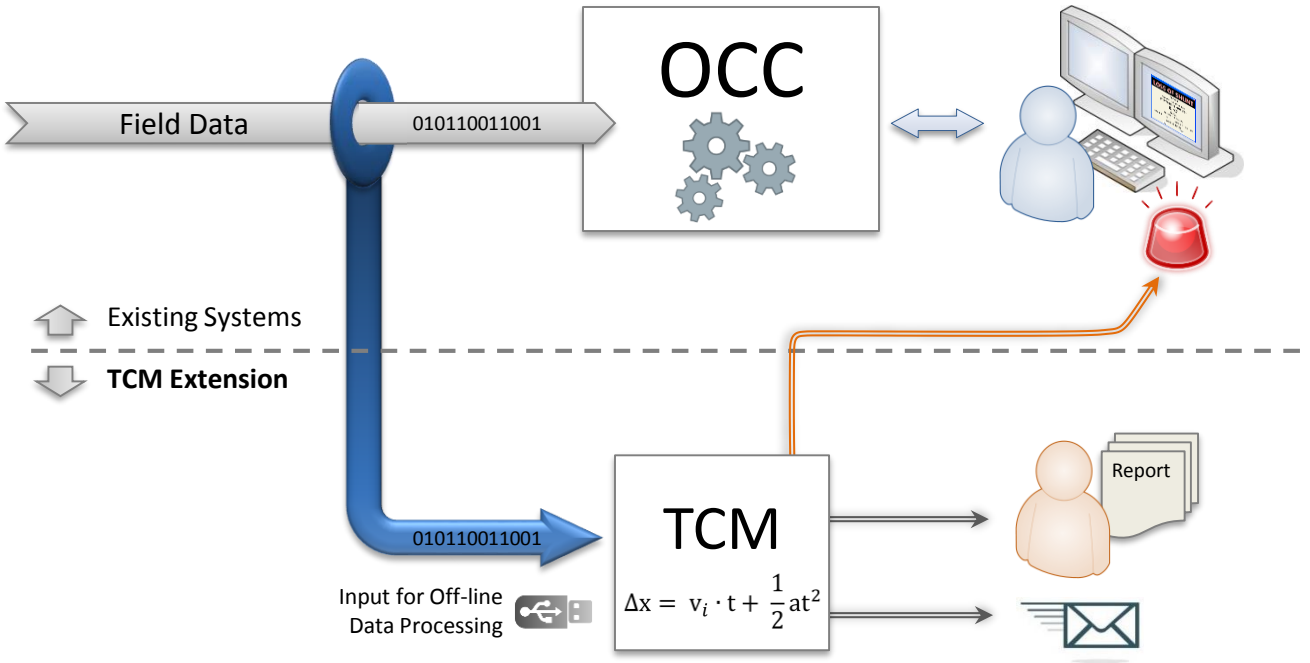
False occupancy:

- Circuits out of Adjustment
- Damaged Bonds
- Broken rail
- Traction Power Imbalance
- Dissimilar Rail
- Autumn leaves

The TCM Tool has been found to be a significant asset in the analysis, detection, and identification of track circuit and systems anomalies, improving the reliability and safety of Train Monitoring and Control Systems.

Systems Concept and Program Approach

Provide a secondary train tracking evaluation based on track occupancy data on a real time basis



The Track Circuit Monitoring Tool utilizes track circuit status information and analyzes this information – in real time – to detect irregular operation and potentially unsafe conditions. TCM separates and alerts only those conditions, creating potentially unsafe conditions and affecting the reliability and safety of rail systems.

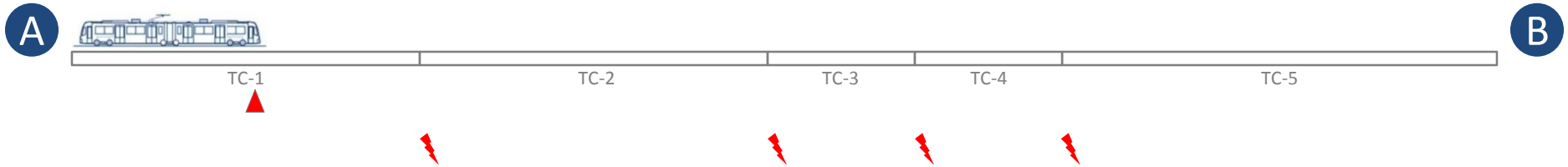
TCM Algorithms

1. Determine actual train location based on the laws of physics
2. Calculate severity of abnormal track circuit behavior
3. Alerts and reports findings (based on configurable parameters)

→ Improves timely reaction to potentially safety critical incidents

Illustration

Train progression monitoring and verification with TCM

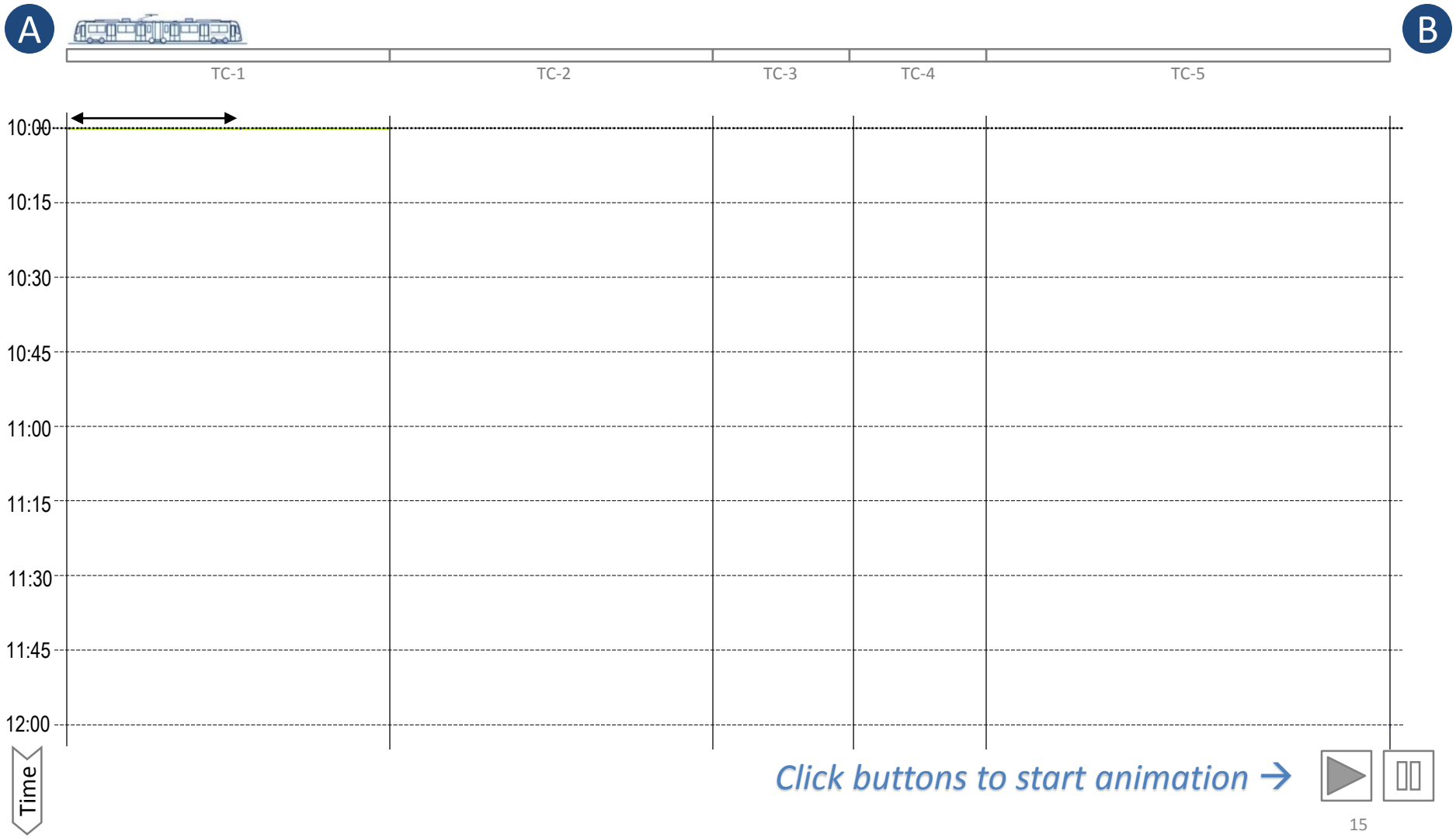


Calculation of Train Progression = $f\{L_{train}, +a, -a, v_{max}, L_{TC}, TC_{\infty}\}$

(based on Laws of Physics)

- Validates Track Circuit indications based on physical constraints of Train Performance Data, Train Consist, Alignment data, and Laws of Physics
- Determines Severity of Inconsistencies and issues Alerts
- Provides Archive Functionality to enable Historic Analysis of Incidents

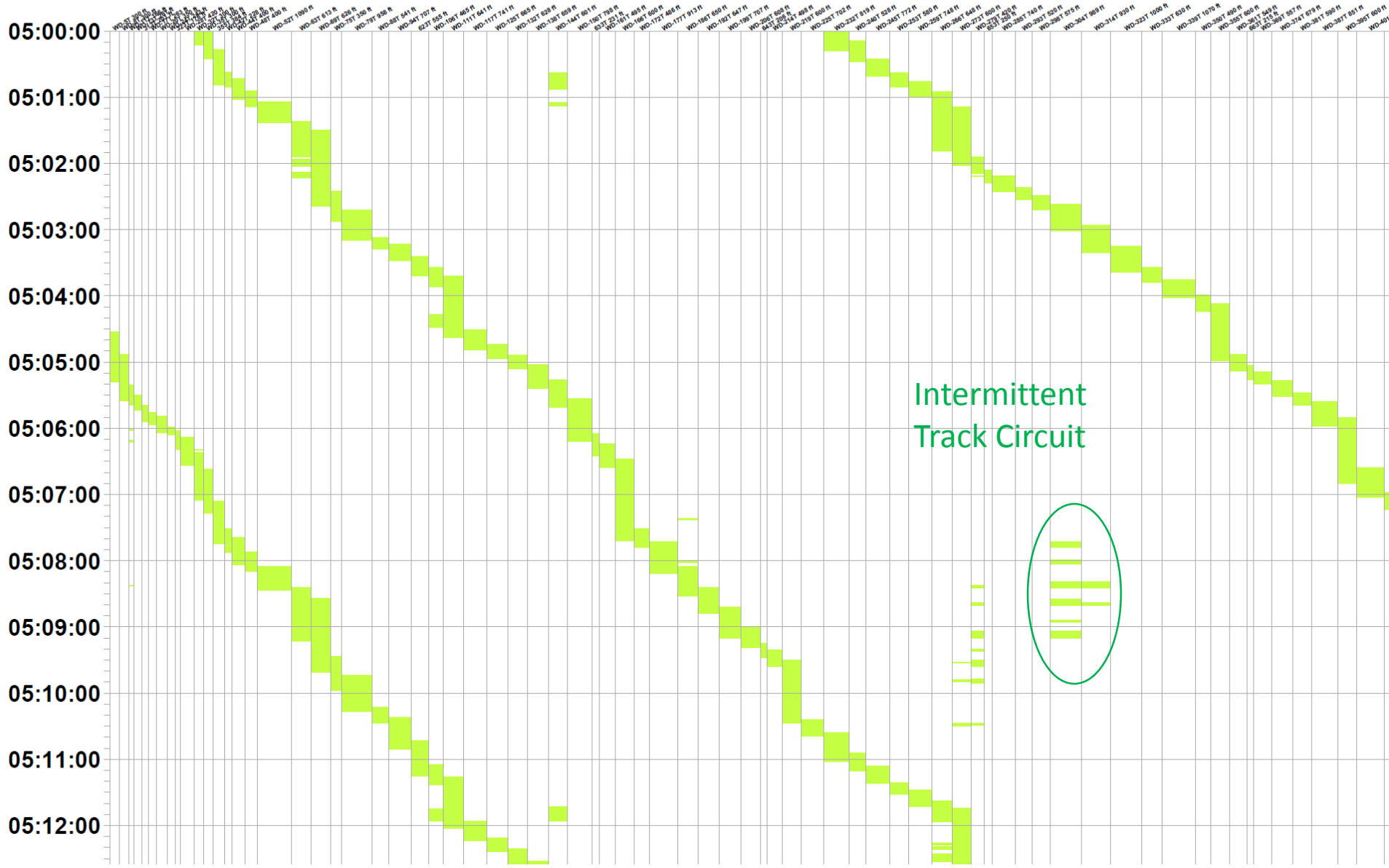
TCM Evaluation in Track Occupancy Chart



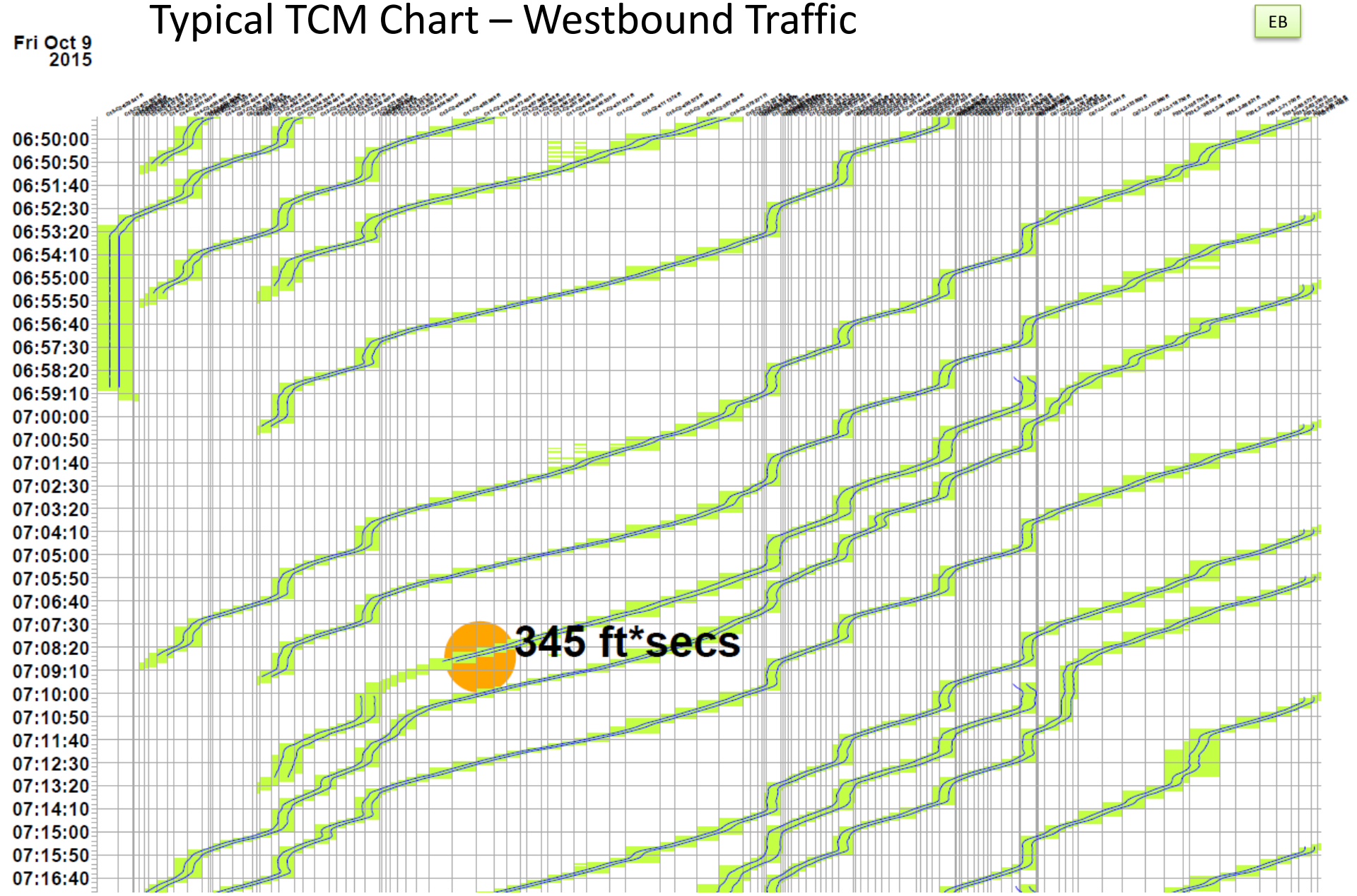
Click buttons to start animation →

Fri Oct 2
2015

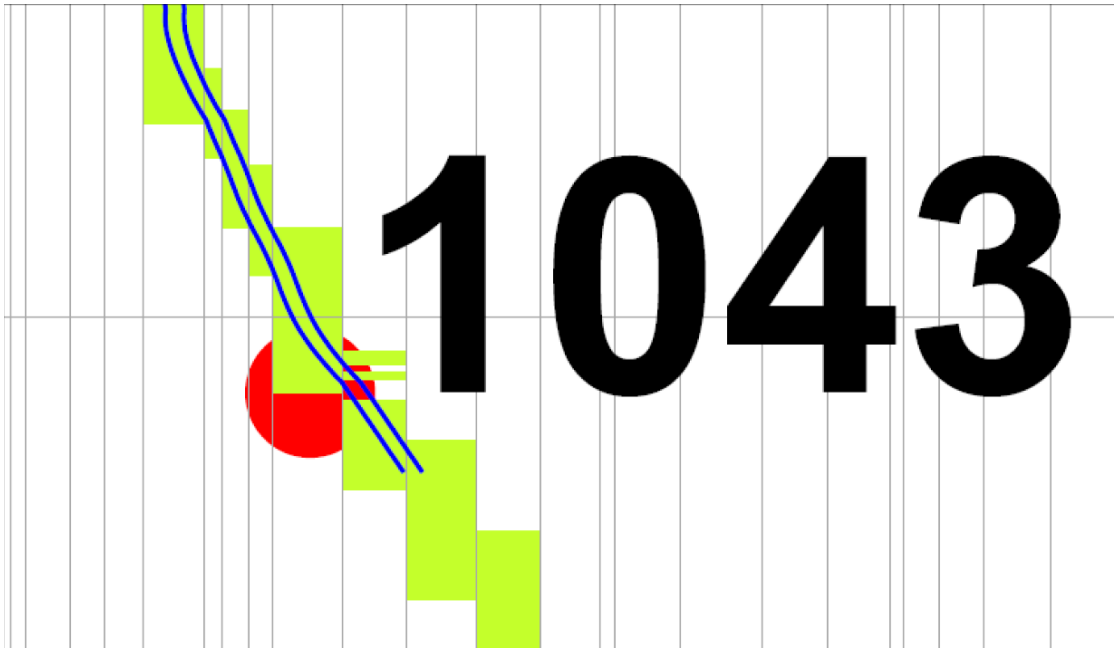
CTA Data: Blue Line Track Occupancy Chart

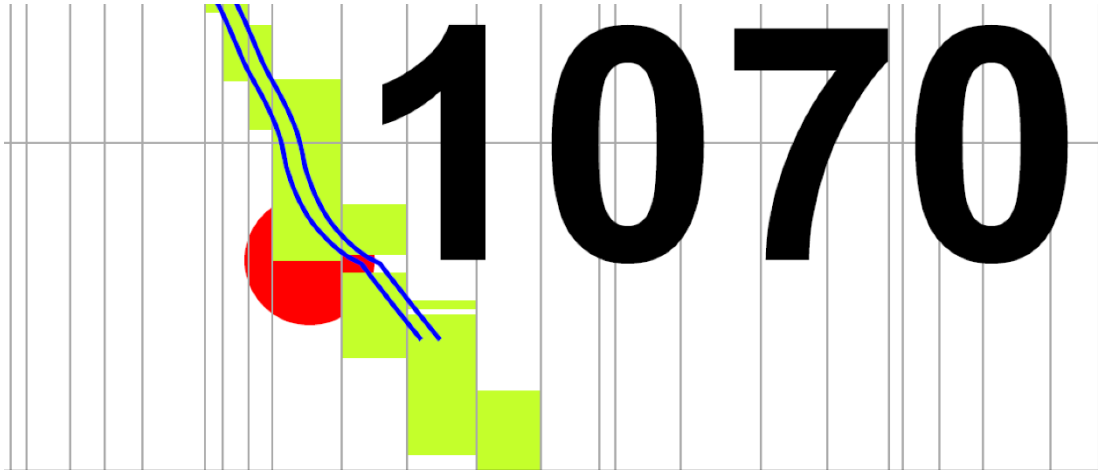


Typical TCM Chart – Westbound Traffic

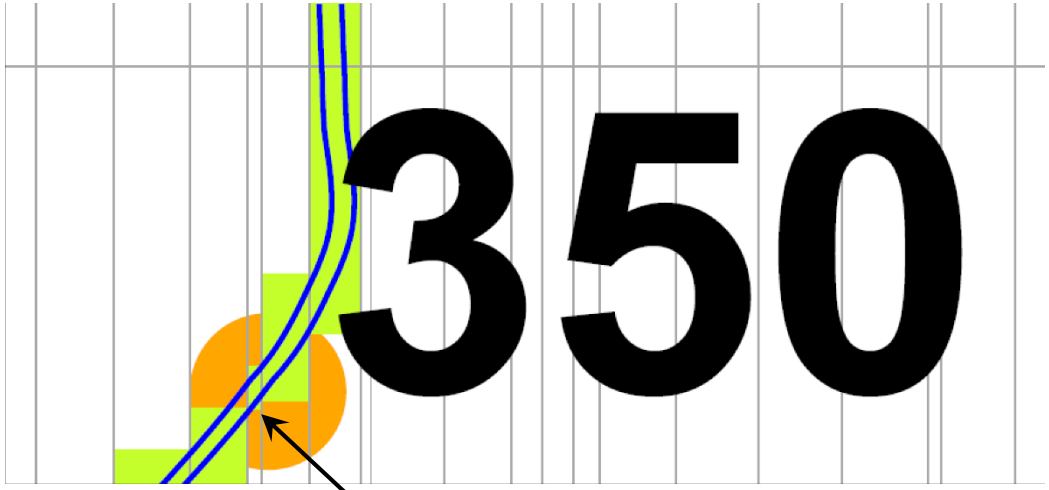


CTA Data: July 18, 2017

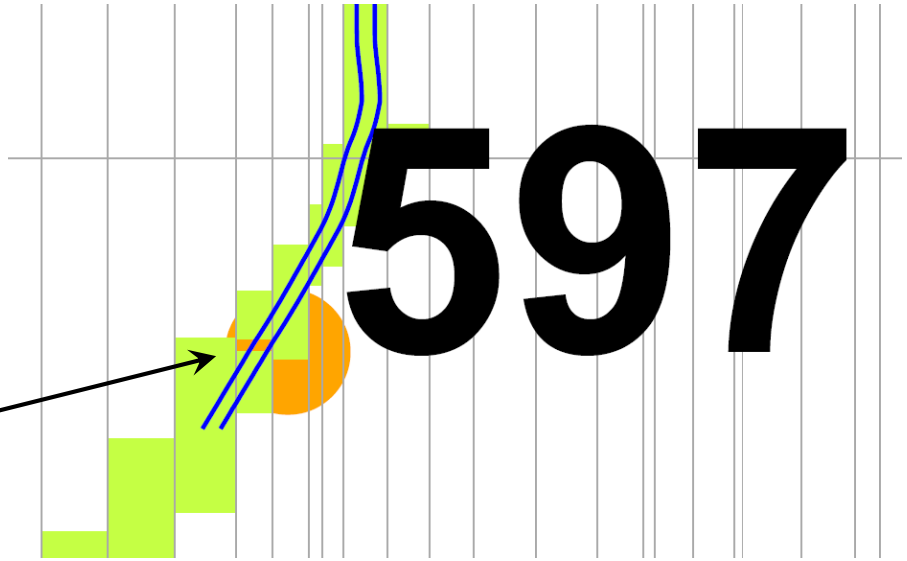




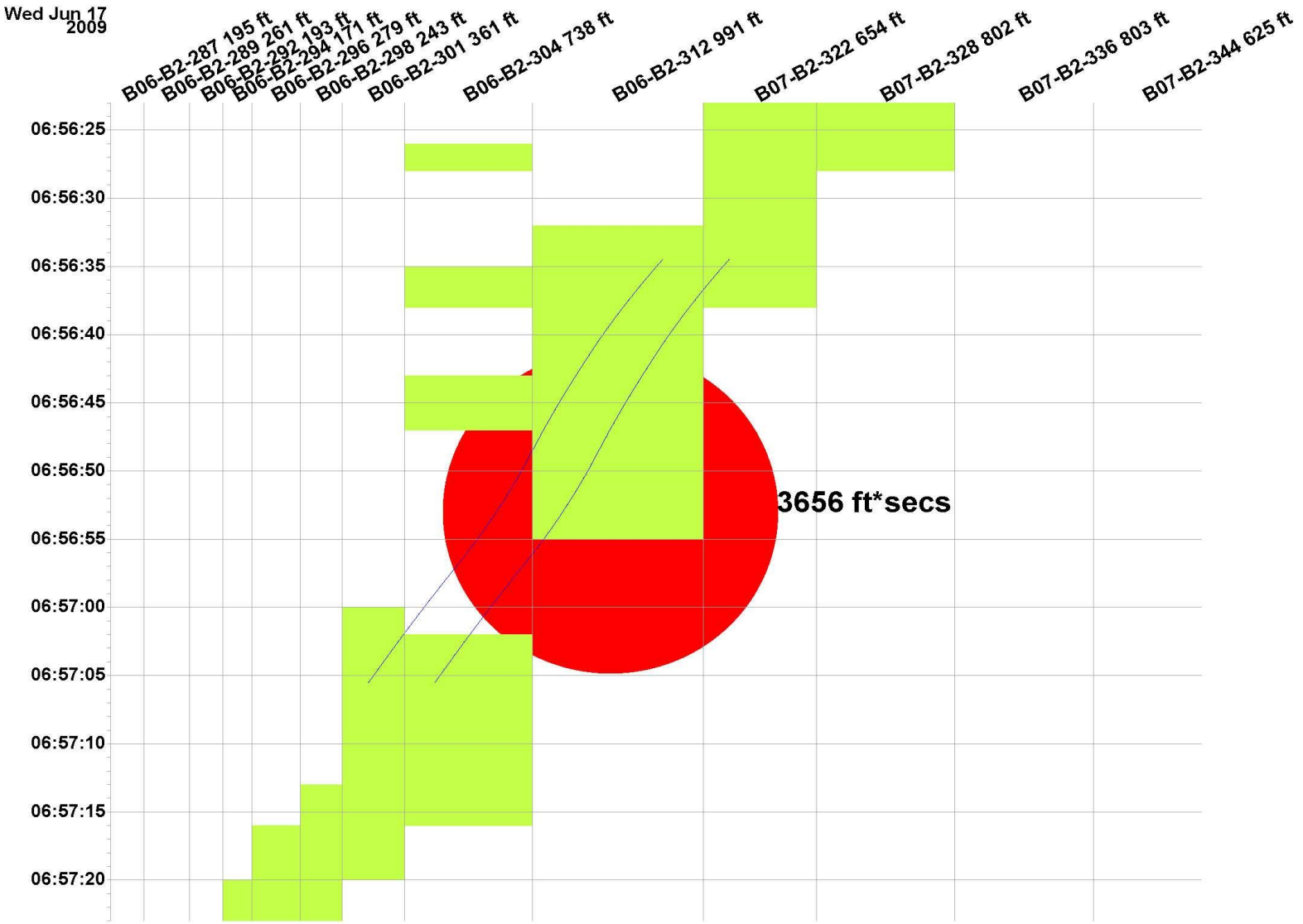
CTA Data: July 18, 2017

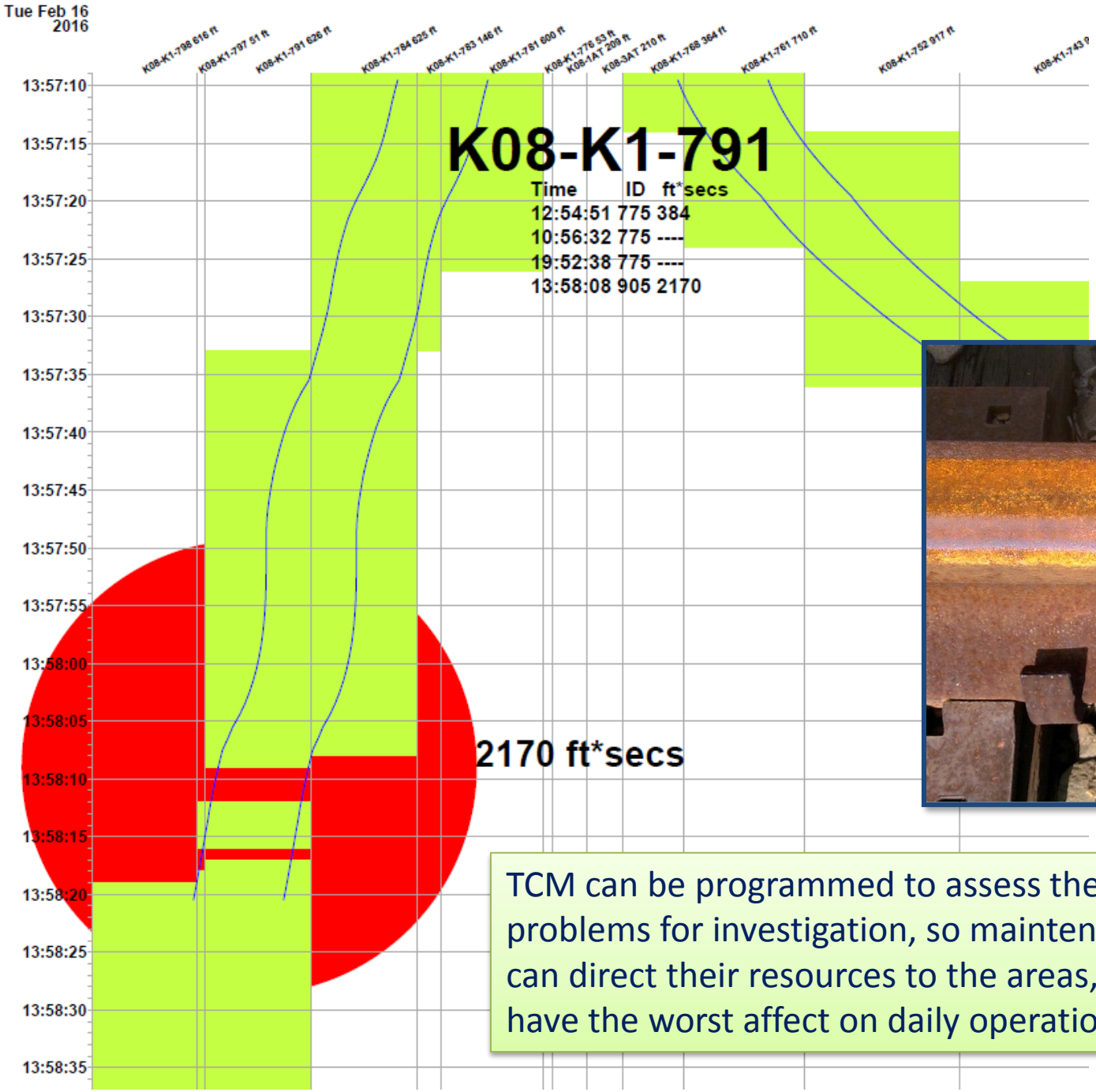


Insufficient overlap



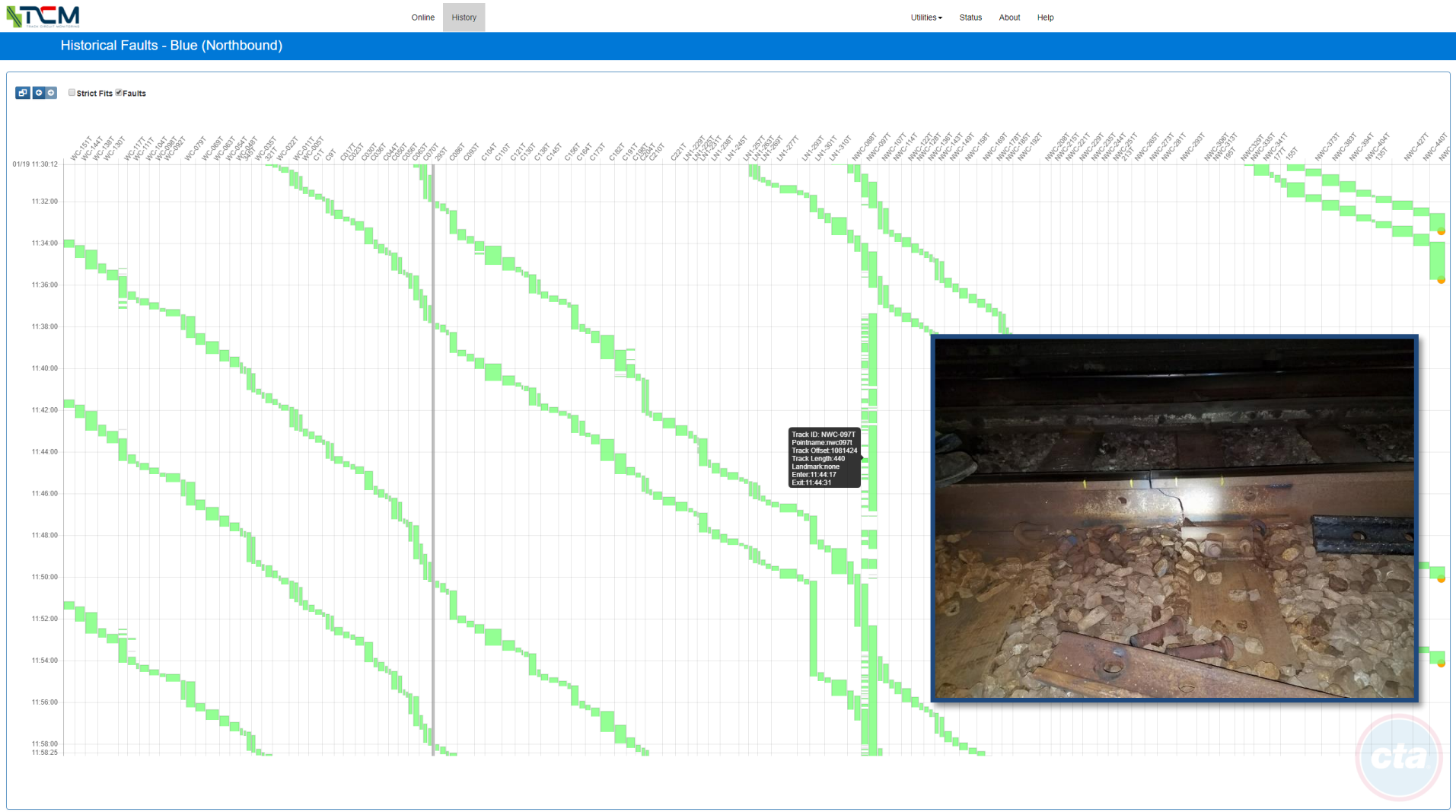
TC pickup under Train


Wed Jun 17
2009
B06-B2-287 195 ft
B06-B2-289 261 ft
B06-B2-292 193 ft
B06-B2-294 171 ft
B06-B2-296 279 ft
B06-B2-298 243 ft
B06-B2-301 361 ft
B06-B2-304 738 ft
B06-B2-312 991 ft
B07-B2-322 654 ft
B07-B2-328 802 ft
B07-B2-336 803 ft
B07-B2-344 625 ft
06:56:25
06:56:30
06:56:35
06:56:40
06:56:45
06:56:50
06:56:55
06:57:00
06:57:05
06:57:10
06:57:15
06:57:20
3656 ft*secs



TCM can be programmed to assess the most severe problems for investigation, so maintenance managers can direct their resources to the areas, most likely to have the worst affect on daily operations.

Broken Rail Events (CTA)

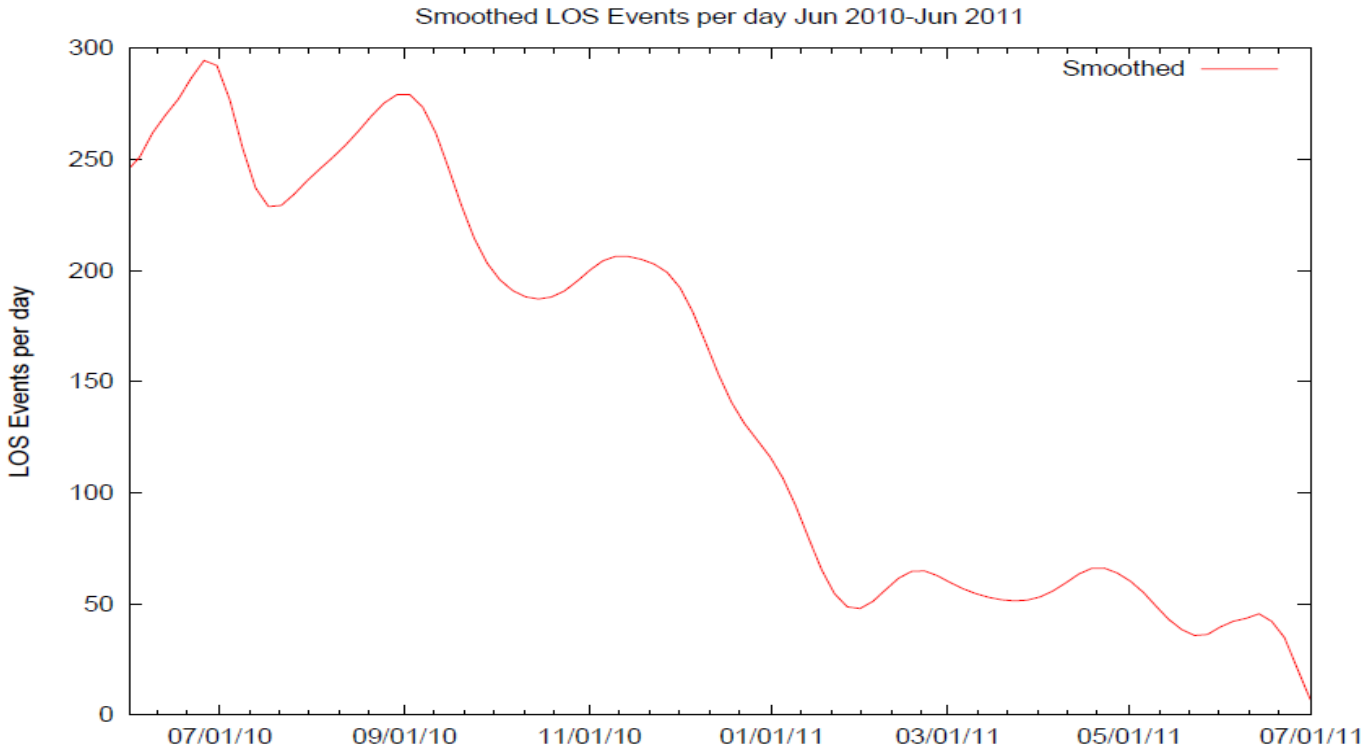


Benefits for Wayside Signaling Maintenance

- Automated daily reports on tracking anomalies and irregularities
- Early detection of track circuit malfunction or deterioration
- Maintenance prioritization for faster response to reoccurring problems
- Improved asset reliability and subsequently more reliable service
- Extended useful lifetime of assets

WMATA Performance Data

LOS = Loss Of Shunt



- As the tool was refined and the review process between Engineering and Maintenance was applied, the number of alarm events continuously fell from a high of almost 300 per day to about 10 per day over the period July 2010 to July 2011.

Closing Comments

Most issues affecting the safety of a system are caused by a series of errors, oversights, omissions and poor communication, potentially compromising the integrity of key components of rail transportation infrastructure which can culminate in tragic consequences[1].

The TCM tool helps in identifying the risk for track circuit failure.

It alerts operations, maintenance, an engineering organizations to a potential threat in the shortest possible time.

1) modified quote from LinkedIn

QUESTIONS !?

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