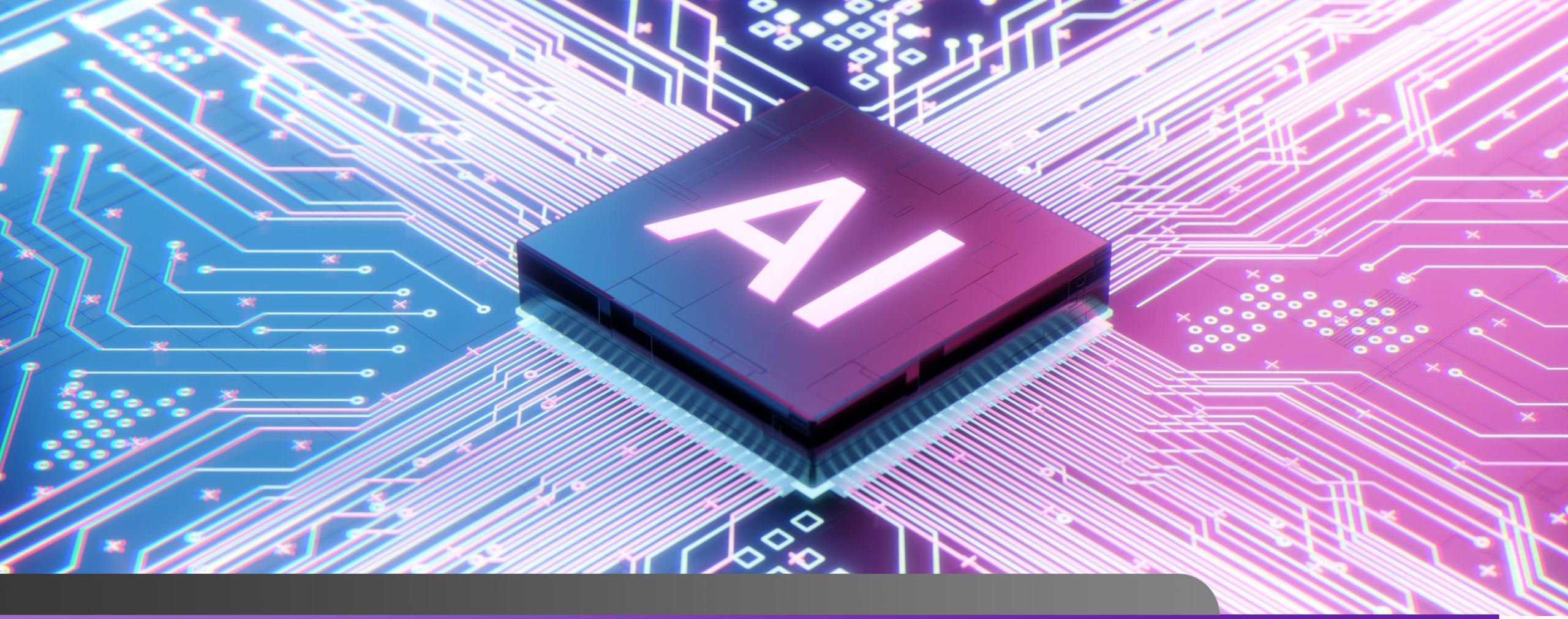


Improving Rail Safety and Transportation with Real-World AI Applications

Larry Jordan | Wi-Tronix, LLC | President and CEO

WI-TRONIX

Overview

November 2, 2023

- Introducing Wi-Tronix
- AI Primer
- AI Applications in Safety and Transportation
- Crossing Inspection using AI
- Trespasser Hotspot Detection using AI
- Safety Critical Voice Radio Communications Improvements using AI

Who we are

Wi-Tronix, LLC is a leading provider of remote monitoring, video analytics, and predictive diagnostic solutions for high-value mobile assets specializing in rail.

We utilize both edge computing and cloud-based SaaS services to provide real-time data aggregation and analytics to enable operational efficiency.

At Wi-Tronix, it's simple. We strive to integrate technology to enable businesses to improve the operational efficiency, safety, service reliability, and sustainability of the world's transportation systems.

Inspired by technology, motivated by safety

Founded in 2004

Led by founders

160+ employees

Based in suburban Chicago

14,000+ rail vehicles

Platform agnostic monitoring & analytics

Integrating data on diverse fleets & data sources

60+ customers 4,000+ users

4,000+ users across freight, passenger, and light rail markets in the US, Canada, Mexico, and Australia

Siemens investment

2017 investment capital for growth and international outreach

Innovators at our core

Leadership team with 100+ years of rail industry expertise

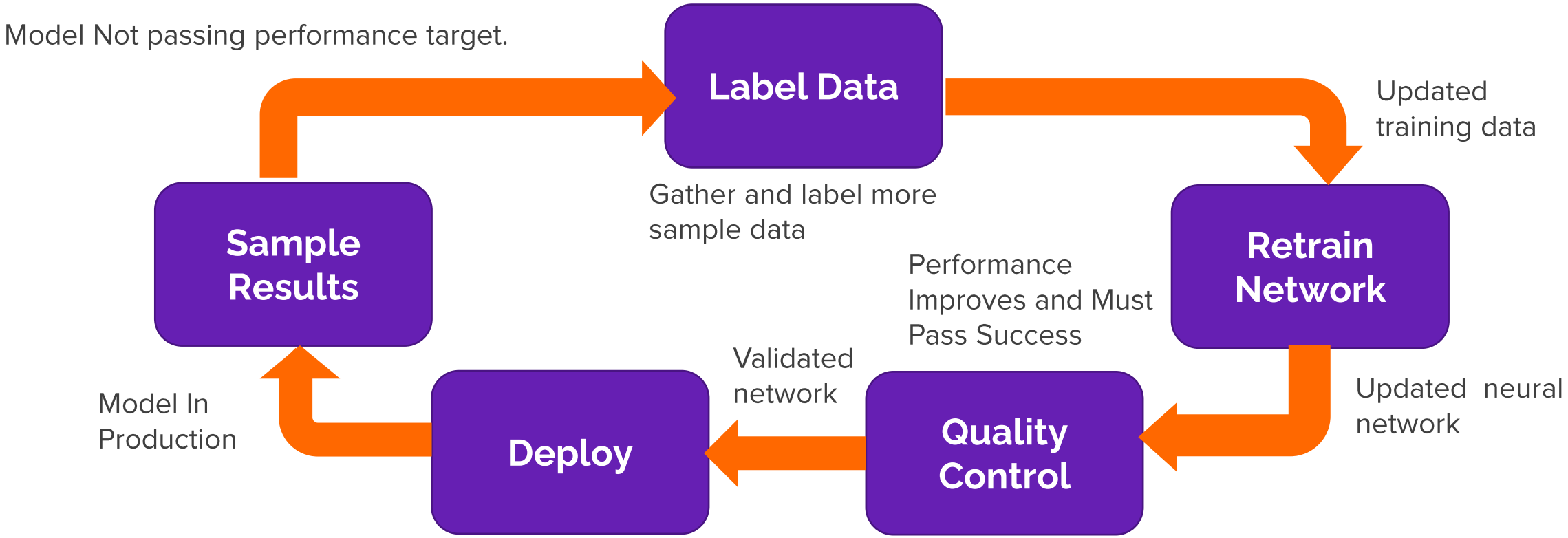
Any significantly advanced technology is indistinguishable from magic.

Arthur C. Clarke

Artificial Intelligence: The Magic

- Artificial intelligence (AI) is intelligence demonstrated by machines, as opposed to the natural intelligence displayed by animals and humans.
- Artificial Neural Networks or Deep Neural Networks are inspired by the biological neural networks of human and animal brains.
- Deep Neural Networks combined with modern sensors create the ability to See, Hear, Feel and Smell

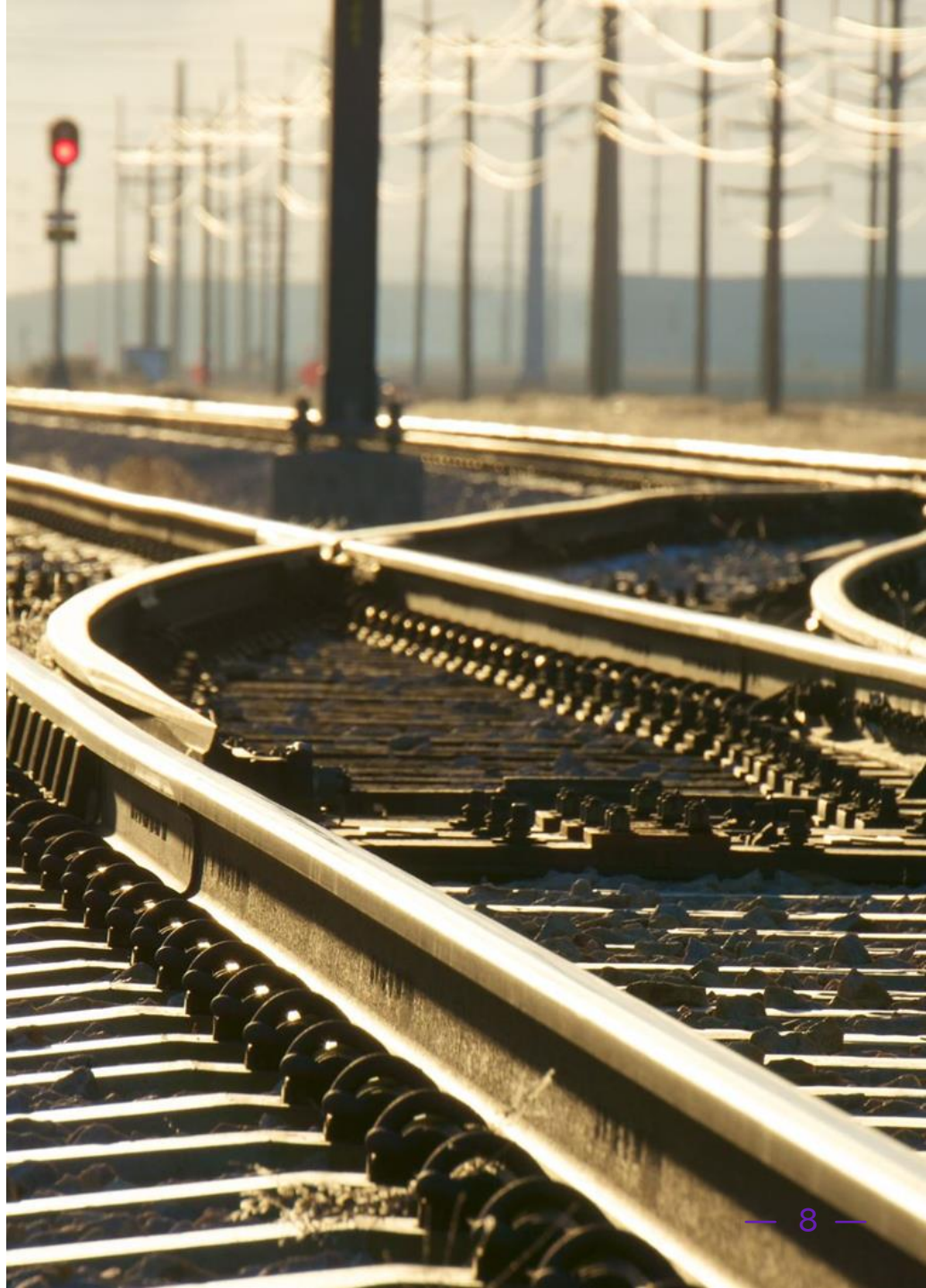
Typical AI model training loop



Iteration speed is critical to quick learning!

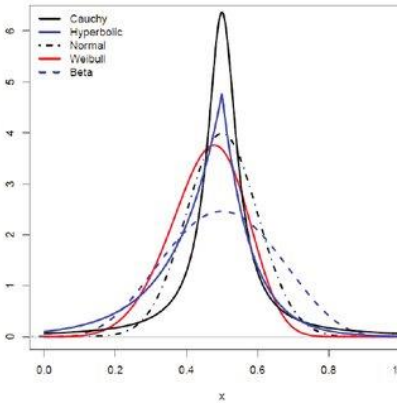
AI-enabled transport applications - rail

- Inspection of vehicle and mobile equipment
- Inspection of infrastructure
  - Track and ballast
  - Crossing gates and light
- Monitor operator performance
  - Mobile Device Detection
  - Alertness Detection
- Determine hazards
  - Near-miss Detection
  - Intruder Detection
  - Passenger Aggression Detection



Obstacles to conquer

- Artificial intelligence is generally probabilistic as opposed to deterministic
  - Many industries have a tradition of “deterministic” safety



- Established regulation is centered around human operations
  - Industry and regulators need to team to shift to performance-based regulation to enable innovative technology such as artificial intelligence

- Human error is more tolerated by society than machine error
  - Litigious environment requires AI based systems to have performance significantly higher than humans
  - Tesla’s objective is performance 10x better than the average human driver
  - Human performance levels may not be well understood

AI-powered crossing inspection

Improving public safety while reducing inspection costs

Reviewing the numbers: National statistics

US Railroad System

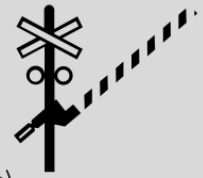
732
Railroads

143,804
Route miles of track

204,315
At-Grade Railroad Crossings
(Public, Private, and Pedestrian)

Nationwide Public At-Grade Crossings

Active
56%
(with gates, bells, and/or flashing lights)



Passive
44%
(with signs/markings, but not active warning devices)

9
People or vehicles are hit by a train daily

96%
Of rail-related fatalities over past 10 years are due to railroad grade crossing and trespassing incidents

Source: https://railroads.dot.gov/sites/fra.dot.gov/files/201911/Grade%20Crossing%20Resource%20Guide%20022015.pdf

The problem

- Fatalities at grade crossings and from trespasser incidents are increasing over last 5 years – not declining as desired
- Successful development & deployment of trespassing solutions also remains flat
  - Limited pockets of success
  - Sustainability has not been achieved

➢ *Need a new approach with today's technology to solve this!*

5-year Grade Crossing Trends

Fatalities

258 (2018) → 273 (2022) — 5.8% ↑

5-year Trespassing Trends

Fatalities

499 (2018) → 675 (2022) — 35% ↑

The solution:

Majority of rail vehicles have forward facing cameras

99.99% of captured camera imagery gets thrown away…

How can we use it for improving public safety?

➢ *Detect exceptions and take action!*

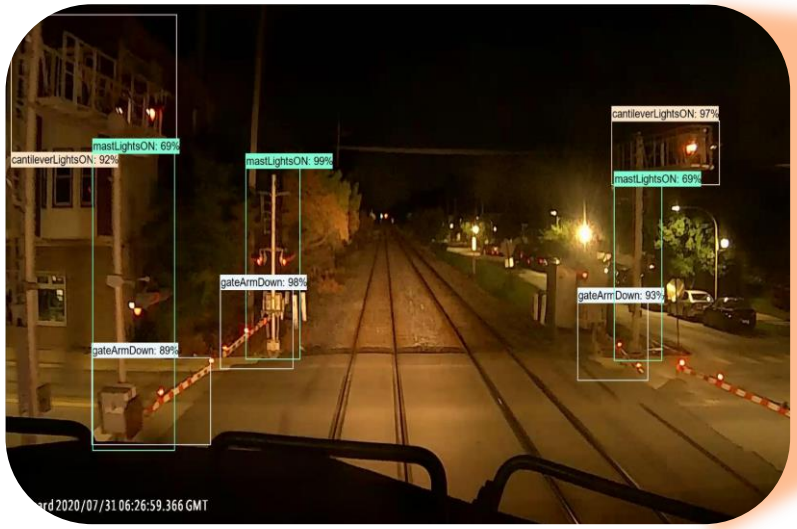
Utilize onboard cameras with AI to identify and improve grade crossing and trespasser problems

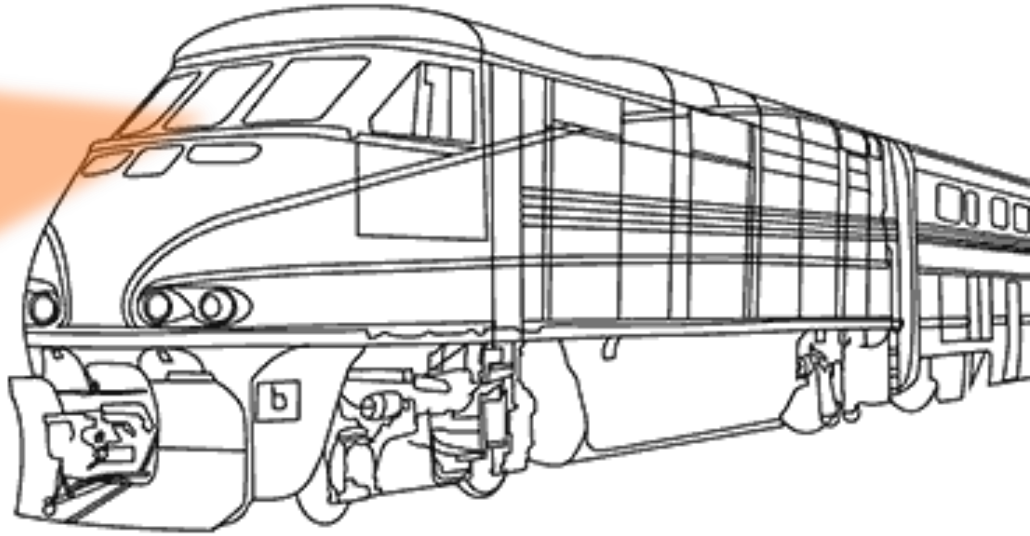
AI-powered crossing verification: What can be automated?

Goals:

- Gate arm status [CFR 234.223, CFR 234.255]
- Mast and Cantilever light flasher status [CFR 234.217, CFR 234.253]
- Detect gate arm misalignment [CFR 234.223, CFR 234.255]
- Warning system activation verification [CFR 234.225, 234.257]
- Commercial power availability verification

Front-facing imagery + AI to verify crossing





Outcome: Automated Crossing Verification

Assessing warning times

Additional visibility to crossing objects via long range cameras

Standard outward camera:

Long range camera:

- *Start activation: 20 seconds before*
- *Gates down: 5 sec before train arrives*

Wi-Tronix rail crossing assist

An innovative, AI-based vehicle platform approach for remote monitoring of crossings

- ✓ Lower lifecycle cost: Platform approach allows for continuous innovation to solves for multiple problems today and in the future
- ✓ Enhanced safety and 30% faster response to gate arm malfunction reports
- ✓ Reduced investment: No sensors at crossing
- ✓ Reduce operational cost by using AI and on-demand video to confirm proper operation of the crossing


Outward 2022/07/07 00:08:49.097 GMT

AI-powered trespasser detection

Front-end AI-enabled cameras will guide future decisions related to infrastructure, and safety education and enforcement

Grant: $1,648,000 | Awarded to Brightline and Wi-Tronix by the Consolidated Rail Infrastructure and Safety Improvements (CRISI) program

- Step 1: Install HD forward-facing cameras throughout Brightline's fleet (21 locomotives)
- Step 2: Capture video data to develop/train AI model
- Step 3: Identify unsafe behaviors on Brightline's corridor; Brightline to identify areas in need for additional community outreach, law enforcement presence, or engineering projects

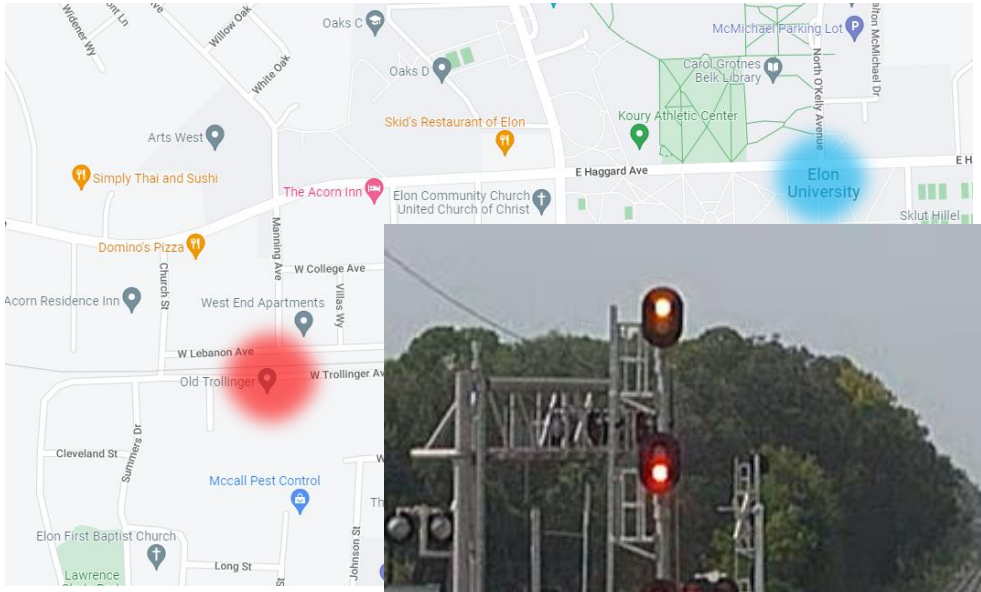
Trespasser hotspot detection

What:

- Solution that utilizes artificial intelligence (AI) to collect trespasser hotspots and trespasser behavior

Benefits:

- Focus investments on high-risk areas
- Enables railroads to perform targeted public awareness and educational campaigns
- Enables law enforcement personnel to perform efficient policing of public safety actions



Trespassing hot spot

Proximity to public areas (school, library, church, etc.)


Outward 2023/01/06 09:30:46.214 GMT


East Palestine, Ohio
February 3, 2023

Introducing RAIL Radio View

Safety critical voice radio communications improvements using AI

Defining the problem

- Limited visibility on crew compliance with radio announcements for reporting emergencies to dispatch
- Lack of visibility into whether dispatchers promptly attend to emergency calls
- When no message is received from the defect detector, or if the message is unclear or not understandable, the crew is required to immediately **reduce speed/stop** and contact the train dispatcher

- No visibility to determine whether the crew is following the above rule, leading to potential safety concerns

- Failure to properly protect shoving movements can be fatal
- Railroads have limited to no visibility to crew radio communication during shoving movement

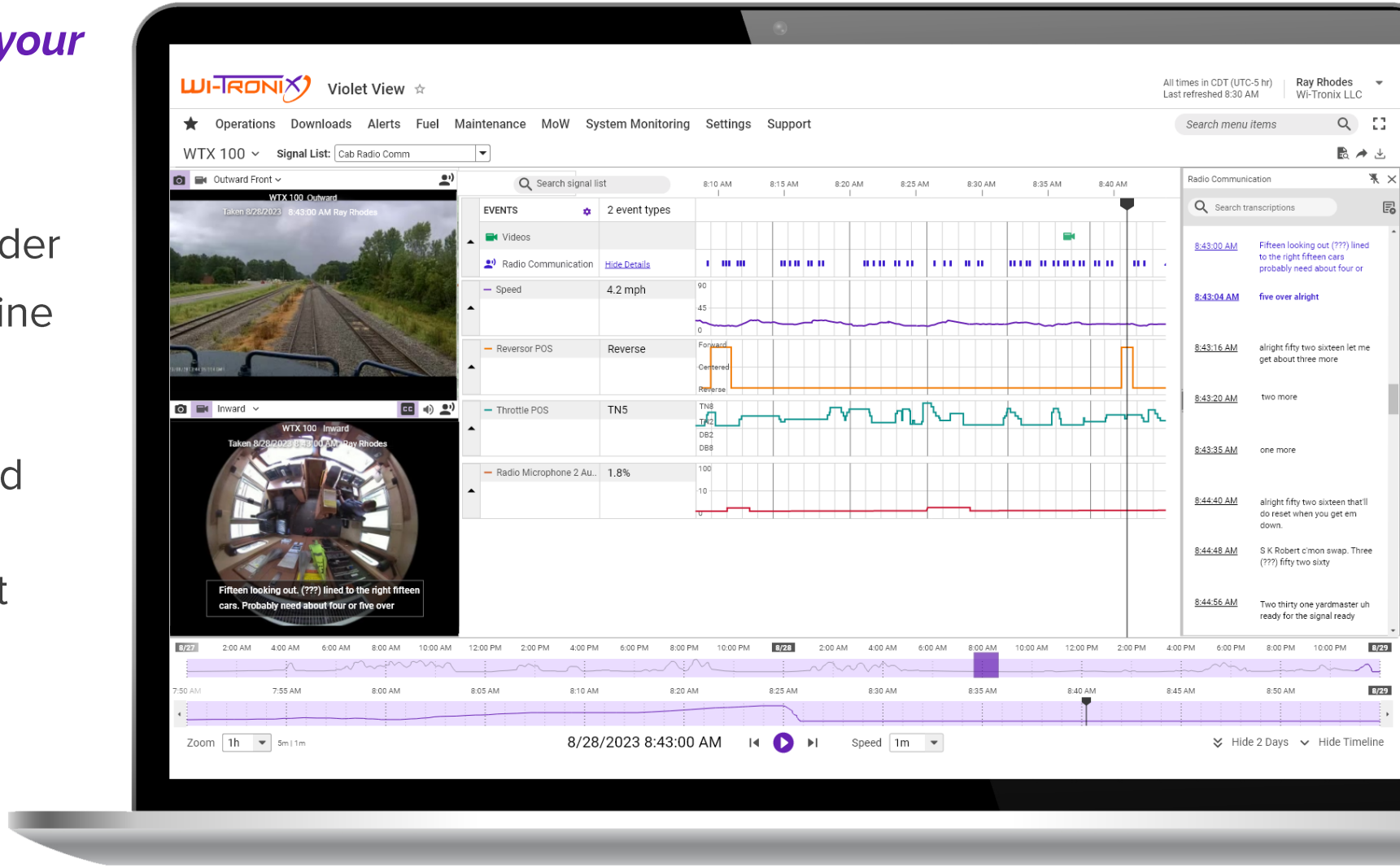
➢ *How do we provide visibility to radio communication?*

➢ *How do others address this?*

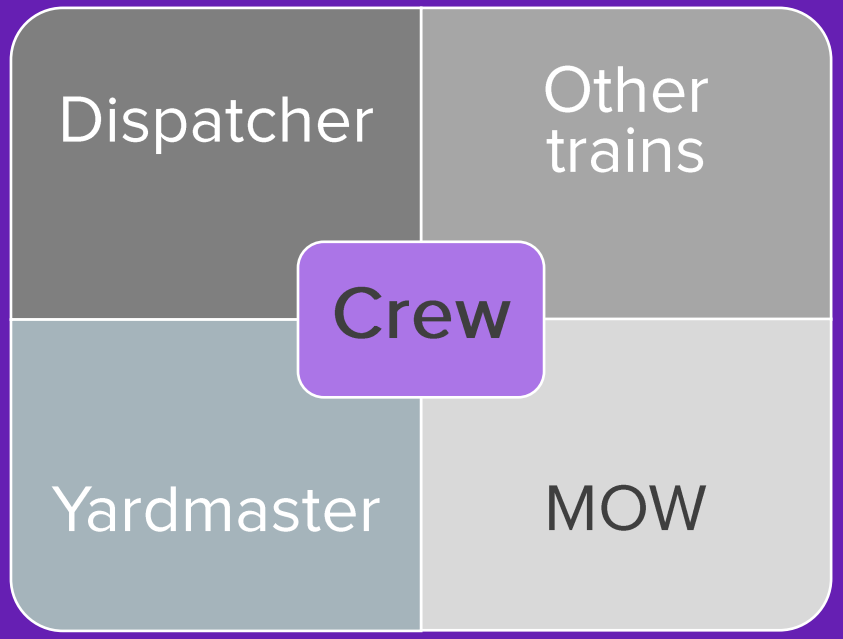
RAIL Radio View

One-click audio transcription access adding another level to your immersive experience

- ✓ **Record** cab audio and transcription in the event recorder
- ✓ **See** transcriptions on the timeline in Violet View (online event recorder player)
- ✓ **View** closed captions on inward camera view
- ✓ **Search** key words from the last 48 hours

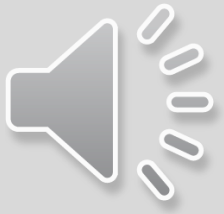


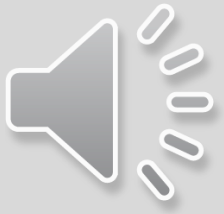
What is recorded?

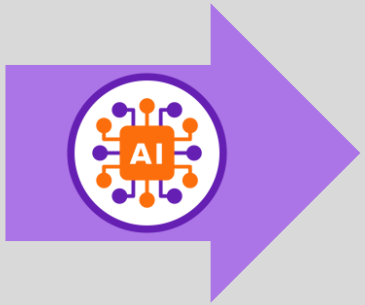


Enable in-depth incident and low-cost operational testing verification of **critical communication** in the following scenarios:

Audio to AI Transcription Defect Detector







C.S.X. Equipment defect detector. Milepost 1.0.1 Track 2

CSX Equipment Defect Detector Milepost 1.0.1 Track 2. No defect. No defects total axle six eight ten of transmission

Audio to AI Transcription example

*The Audio clip you're about to hear was recorded from the unit installed in the field with Violet.

that second motor, see what's going on with it if it's clean or if it's got a traction motor cut out. All right, I'll give it a look as soon as we get up there. All right. Dispatcher asked you about that DEP. It shows it's dead, but I guess you told him it was running. It shows running. It's showing loading right now. Good enough. Southbound look good? Yeah, cold hoppers look good. You'll have a good evening. Thank you, too.

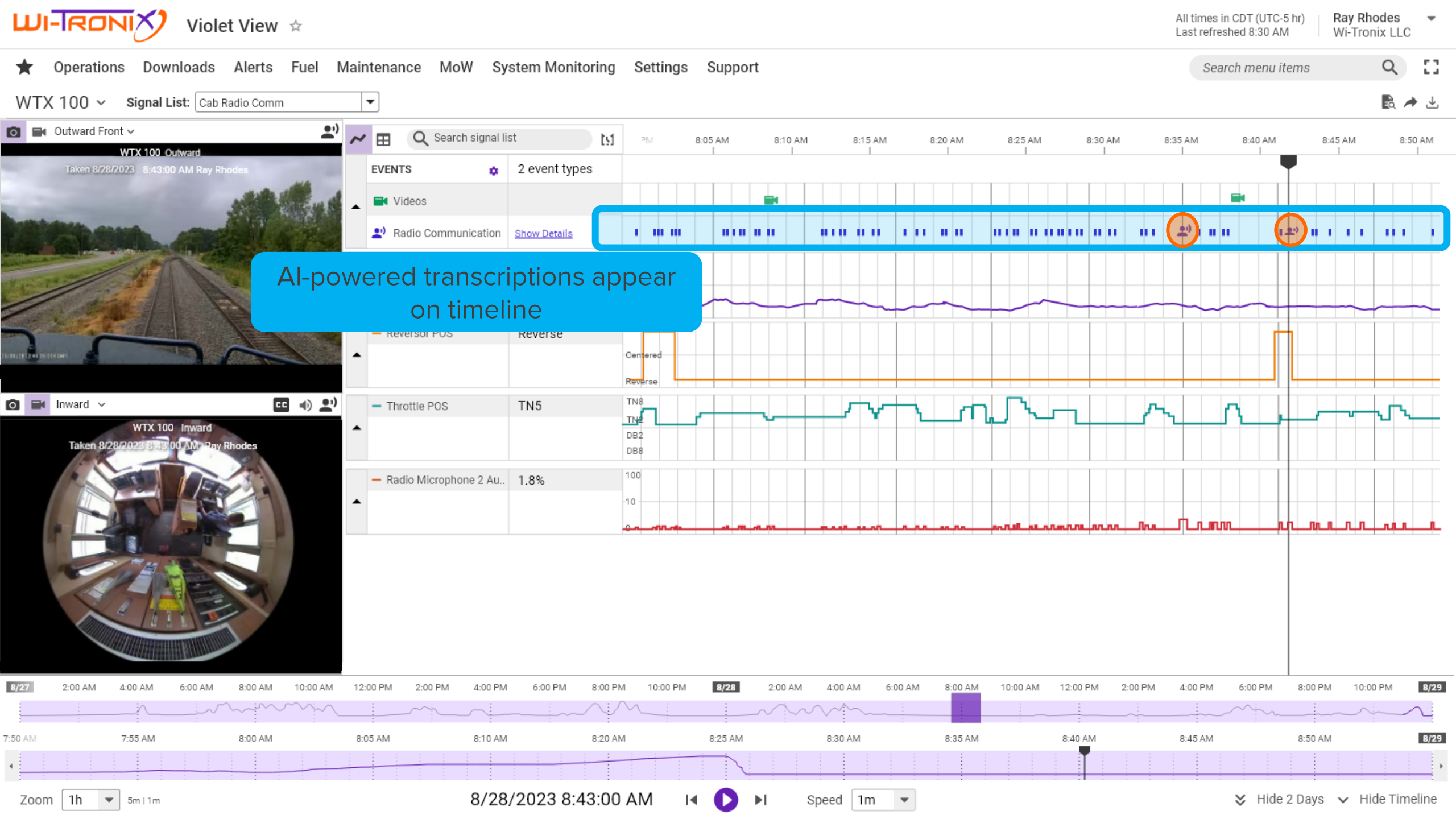
*Please note: transcription above is transcribed by AI

Audio to AI Transcription of Train to yard master example

*The Audio clip you're about to hear was recorded from the unit installed in the field with Violet.

I agree, just a fly. I'll do it for you. Greg, you want this light number? You can give it to me. 05406. 05406. Alright. 231, north.

*Please note: transcription above is transcribed by AI


Violet View
All times in CDT (UTC-5 hr)
Last refreshed 8:30 AM
Ray Rhodes
Wi-Tronix LLC
Operations
Downloads
Alerts
Fuel
Maintenance
MoW
System Monitoring
Settings
Support
Search menu items
WTX 100
Signal List:
Cab Radio Comm
Outward Front
WTX 100 Outward
Taken 8/28/2023 8:43:00 AM Ray Rhodes
Inward
WTX 100 Inward
Taken 8/28/2023 8:43:00 AM Ray Rhodes
Search signal list
EVENTS
2 event types
Videos
Radio Communication
Show Details
AI-powered transcriptions appear on timeline
Reverser POS
Reverse
Centered
Reverse
Throttle POS
TN5
TN8
TN2
DB2
DB8
Radio Microphone 2 Au..
1.8%
100
10
0
8:05 AM
8:10 AM
8:15 AM
8:20 AM
8:25 AM
8:30 AM
8:35 AM
8:40 AM
8:45 AM
8:50 AM
8/27
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/28
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/29
7:50 AM
7:55 AM
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8:05 AM
8:10 AM
8:20 AM
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8/29
Zoom
1h
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8/28/2023 8:43:00 AM
Speed
1m
Hide 2 Days
Hide Timeline


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Fifteen looking out. (???) lined to the right fifteen cars. Probably need about four or five over
Search signal list
EVENTS
2 event types
Videos
Radio Communication
Show Details
Speed
4.2 mph
Reversor POS
Reverse
Forward
Centered
Reverse
Throttle POS
TN5
DB2
DB8
Radio Microphone 2 Au..
1.8%
Inward camera view with closed captions
8/27
8/28
8/29
Zoom
1h
5m | 1m
8/28/2023 8:43:00 AM
Speed
1m
Hide 2 Days
Hide Timeline


Violet View
All times in CDT (UTC-5 hr)
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Wi-Tronix LLC
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WTX 100 Inward
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Search signal list
EVENTS
2 event types
Videos
Radio Communication
Show Details
Transcription view:
Select “show details”
90
45
0
Forward
Centered
Reverse
Throttle POS
TN5
TN8
TN2
DB2
DB8
Radio Microphone 2 Au..
1.8%
100
10
0
8:05 AM
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8:15 AM
8:20 AM
8:25 AM
8:30 AM
8:35 AM
8:40 AM
8:45 AM
8:50 AM
8/27
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/28
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/29
7:50 AM
7:55 AM
8:00 AM
8:05 AM
8:10 AM
8:20 AM
8:25 AM
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8:50 AM
8/29
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1h
5m | 1m
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1m
Hide 2 Days
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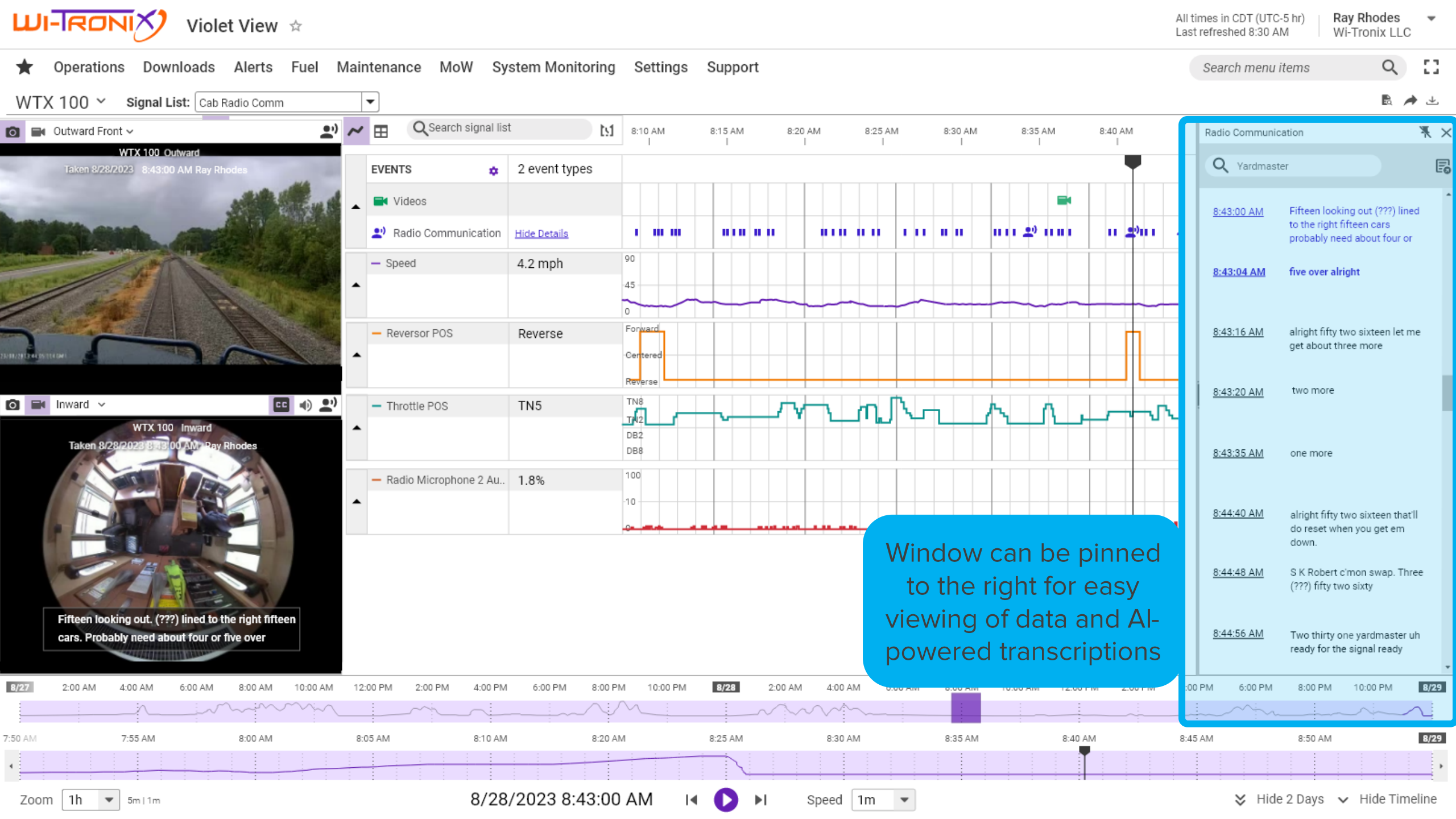
Radio Communication
Hide Details
Speed
4.2 mph
Reversor POS
Reverse
Forward
Centered
Reverse
Throttle POS
TN5
Radio Microphone 2 Au..
1.8%
Radio Communication
Search transcriptions
8:43:00 AM
Fifteen looking out (???) lined to the right fifteen cars probably need about four or
8:43:04 AM
five over alright
8:43:16 AM
alright fifty two sixteen let me get about three more
Window appears to show previous 48 hours of transcriptions
Zoom
1h
5m | 1m
8/28/2023 8:43:00 AM
Speed
1m
Hide 2 Days
Hide Timeline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8:10 AM
8:15 AM
8:20 AM
8:25 AM
8:30 AM
8:35 AM
8:40 AM
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Hide Details
Speed
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90
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Reverse
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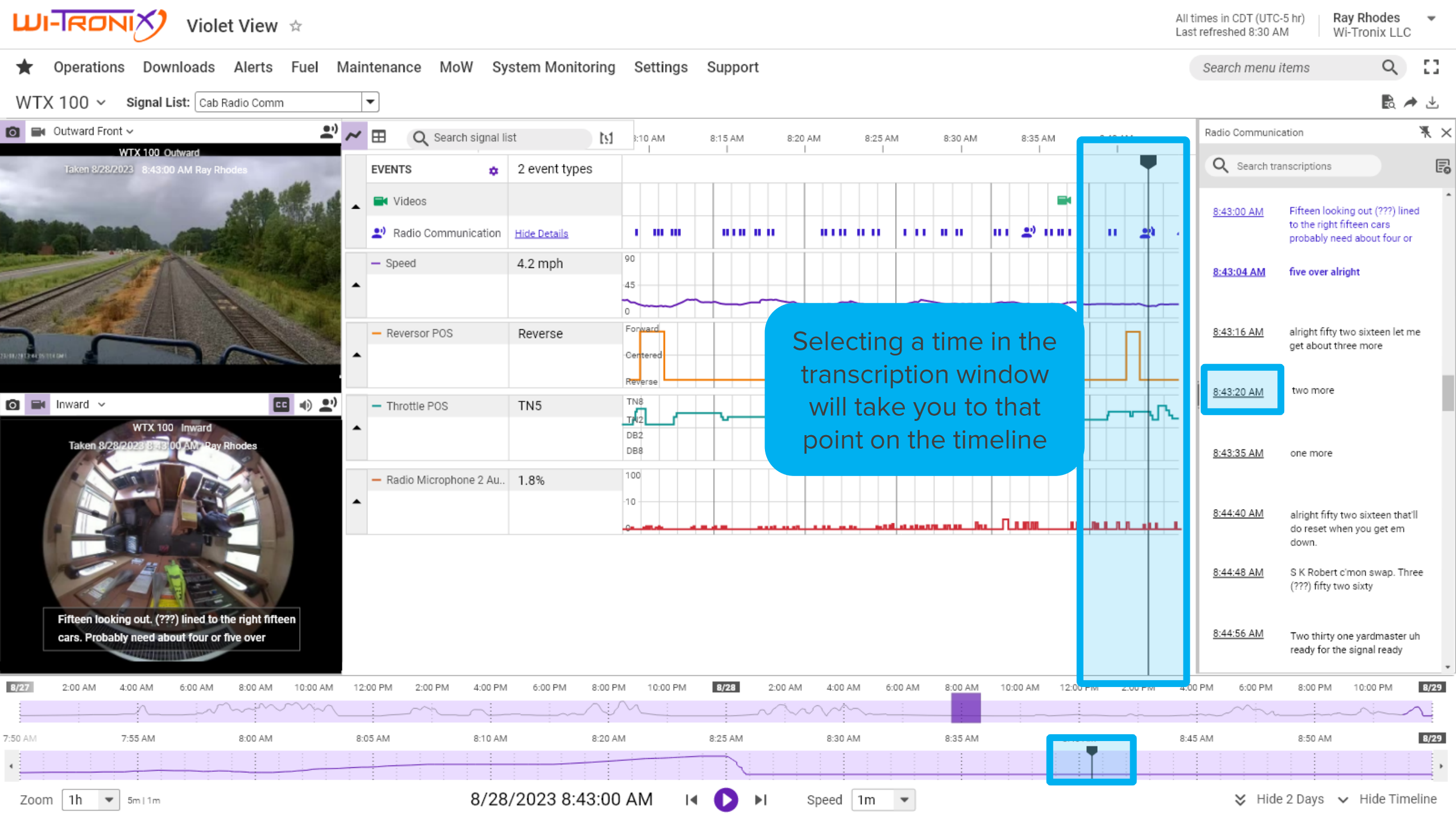
Centered
Reverse
Throttle POS
TN5
TN8
TN2
DB2
DB8
Radio Microphone 2 Au..
1.8%
100
10
Radio Communication
Yardmaster
8:43:00 AM
Fifteen looking out (???) lined to the right fifteen cars probably need about four or
8:43:04 AM
five over alright
8:43:16 AM
alright fifty two sixteen let me get about three more
8:43:20 AM
two more
8:43:35 AM
one more
8:44:40 AM
alright fifty two sixteen that'll do reset when you get em down.
8:44:48 AM
S K Robert c'mon swap. Three (???) fifty two sixty
8:44:56 AM
Two thirty one yardmaster uh ready for the signal ready
Window can be pinned to the right for easy viewing of data and AI-powered transcriptions
8/27
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/28
2:00 AM
4:00 AM
6:00 PM
8:00 PM
10:00 PM
8/29
7:50 AM
7:55 AM
8:00 AM
8:05 AM
8:10 AM
8:20 AM
8:25 AM
8:30 AM
8:35 AM
8:40 AM
8:45 AM
8:50 AM
8/29
Zoom
1h
5m | 1m
8/28/2023 8:43:00 AM
Speed
1m
Hide 2 Days
Hide Timeline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TN5
TN8
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DB8
Radio Microphone 2 Au..
1.8%
100
10
Selecting a time in the transcription window will take you to that point on the timeline
Radio Communication
Search transcriptions
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10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/28
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/29
7:50 AM
7:55 AM
8:00 AM
8:05 AM
8:10 AM
8:20 AM
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45
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Reverse
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Centered
Reverse
Throttle POS
TN5
TN8
TN2
DB2
DB8
Radio Microphone 2 Au..
1.8%
100
10
Easily search for key words
Radio Communication
Yardmaster
8:43:00 AM
Fifteen looking out (???) lined to the right fifteen cars probably need about four or
8:43:04 AM
five over alright
8:43:16 AM
alright fifty two sixteen let me get about three more
8:43:20 AM
two more
8:43:35 AM
one more
8:44:40 AM
alright fifty two sixteen that'll do reset when you get em down.
8:44:48 AM
S K Robert c'mon swap. Three (???) fifty two sixty
thirty one yardmaster uh
Search results highlighted
8/27
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/28
2:00 AM
4:00 AM
6:00 AM
10:00 PM
8/29
7:50 AM
7:55 AM
8:00 AM
8:05 AM
8:10 AM
8:20 AM
8:25 AM
8:30 AM
8:35 AM
8:40 AM
8:45 AM
8:50 AM
8/29
Zoom
1h
5m | 1m
8/28/2023 8:43:00 AM
Speed
1m
Hide 2 Days
Hide Timeline


Violet View
All times in CDT (UTC-5 hr)
Last refreshed 8:30 AM
Ray Rhodes
Wi-Tronix LLC
Operations
Downloads
Alerts
Fuel
Maintenance
MoW
System Monitoring
Settings
Support
Search menu items
WTX 100
Signal List:
Cab Radio Comm
Outward Front
WTX 100 Outward
Taken 8/28/2023 8:43:00 AM Ray Rhodes
Inward
WTX 100 Inward
Taken 8/28/2023 8:43:00 AM Ray Rhodes
Fifteen looking out. (???) lined to the right fifteen cars. Probably need about four or five over
Search signal list
8:10 AM
8:15 AM
8:20 AM
8:25 AM
8:30 AM
8:35 AM
8:40 AM
EVENTS
2 event types
Videos
Radio Communication
Hide Details
Speed
4.2 mph
90
45
0
Reversor POS
Reverse
Forward
Centered
Reverse
Throttle POS
TN5
TN8
TN2
DB2
DB8
Radio Microphone 2 Au..
1.8%
100
10
0
Arrows allow for easy navigation of all search results
Radio Communication
8:43:04 AM
five over alright
8:43:16 AM
alright fifty two sixteen let me get about three more
8:43:20 AM
two more
8:43:35 AM
one more
8:44:40 AM
alright fifty two sixteen that'll do reset when you get em down.
8:44:48 AM
S K Robert c'mon swap. Three (???) fifty two sixty
8:44:56 AM
Two thirty one yardmaster uh ready for the signal ready
8/27
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/28
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/29
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7:55 AM
8:00 AM
8:05 AM
8:10 AM
8:20 AM
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Reverse
Forward
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Reverse
Throttle POS
TN5
TN8
TN2
DB2
DB8
Radio Microphone 2 Au..
1.8%
100
10
0
Export button allows for export of transcriptions to use for additional analysis
Radio Communication
8:43:04 AM five over alright
8:43:16 AM alright fifty two sixteen let me get about three more
8:43:20 AM two more
8:43:35 AM one more
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4:00 PM
6:00 PM
8:00 PM
10:00 PM
8/29
7:50 AM
7:55 AM
8:00 AM
8:05 AM
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8:20 AM
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1m
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What else can we do with transcriptions from radio?

- *What if AI could process the transcriptions to understand what was said (or not said) in the dialog?*
- *What if AI can automatically process this dialog to detect exceptions?*

Potential AI Automated alerts from transcriptions:

- Proper radio communication around Emergency rail incidents
- Proper response to defect detector events
- Proper radio communication during shoving movements

Rail Safety can be transformed with real world AI-powered solutions!

AI is not magic. A robust training program is required. Just as human education can be costly, AI training can also be costly.

Clear system performance criteria is required to properly implement and deploy AI enabled solutions.

AI is a tool that can improve rail safety in areas that were previously considered unsolvable.

AI is an element of an overall solutions and solutions always need to be outcome focused.

thank you

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