

Leading the digital transformation of the rail industry

March 1, 2018



We are GE Transportation. We move the world.



Locomotives



Mining



Marine



Manufacturing



Digital Solutions



Drilling



**Stationary
Power**



Services



An aerial photograph of a freight train traveling through a dry, open landscape. The train is led by a blue locomotive with the number 2024 on its front. It is pulling a long line of cargo cars, including several brown flatcars and a few blue and white boxcars. The terrain is arid with sparse, dry vegetation. A blue sign with the number 27 is visible on the right side of the tracks. The text "The rail transportation industry faces unprecedented challenges" is overlaid in white on the left side of the image.

The rail transportation industry
faces unprecedented challenges



Trucking
innovation

Coal declines
continue

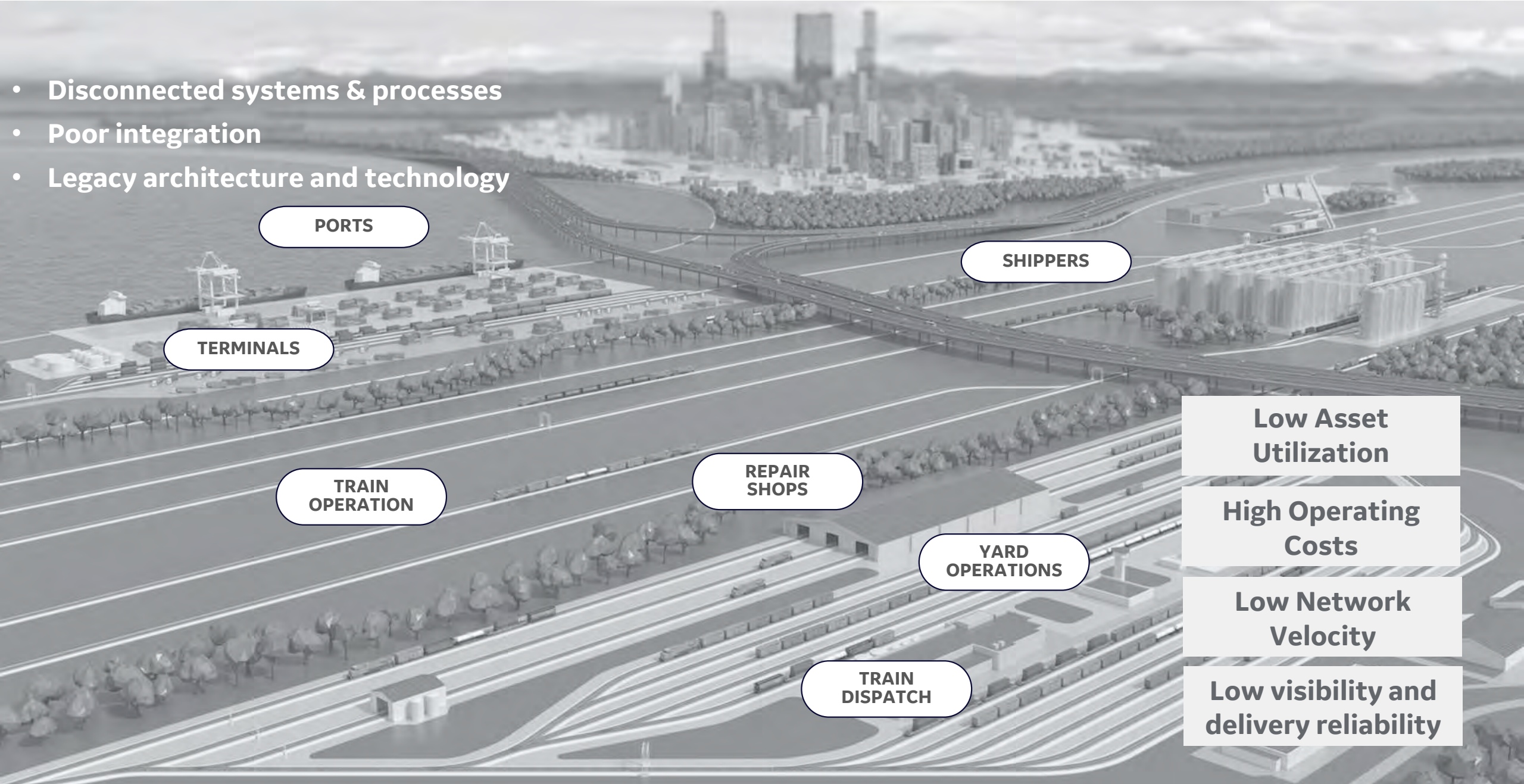
Tightening
supply chains

Aging workforce,
institutionalization
of knowledge

Evolving customer expectations



- **Disconnected systems & processes**
- **Poor integration**
- **Legacy architecture and technology**



PORTS

SHIPPERS

TERMINALS

**TRAIN
OPERATION**

**REPAIR
SHOPS**

**YARD
OPERATIONS**

**TRAIN
DISPATCH**

**Low Asset
Utilization**

**High Operating
Costs**

**Low Network
Velocity**

**Low visibility and
delivery reliability**





North America

~500,000 Unexpected
Train delays a year

20+ HOURS terminal dwell

~20 miles per hour
average train speed

\$10B

Yearly fuel costs

India

91% Op Ratio

104 # of Accidents in 2016

~24 km per hour average
train speed

\$2.5B

Yearly diesel costs

Brazil

11.6 Accidents per
million train km

~12 km per hour average
train speed

\$1.0B

Yearly diesel costs

Sub-Saharan Africa

11 days Freight wagon
(dwell)

~20 km per hour
average train speed

\$2.3B

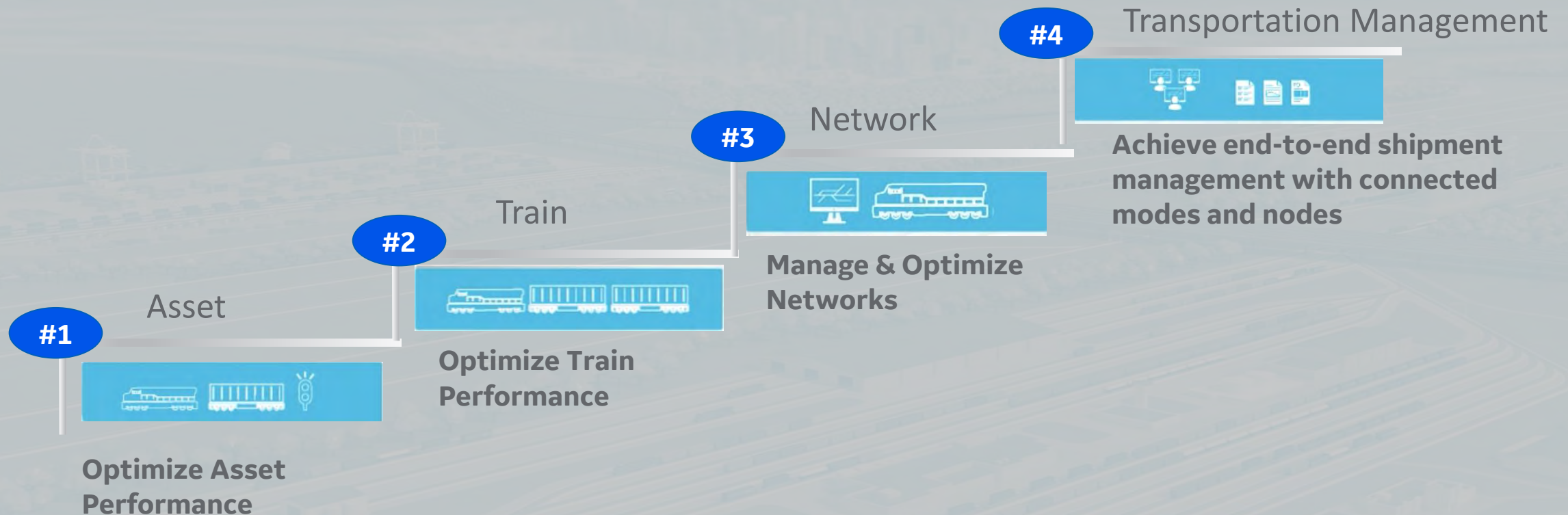
Yearly fuel costs



Digital solutions: driving the transformation



The components of transformation



Many of the Pieces Available Now

Installed base Highlights

- 17,000 locomotives monitored
- 20,000 LOCOTROL systems
- 10K GoLINC Edge Devices
- 10,000 Trip Optimizer Systems
- 500+ short lines on TMS system
- 70 Terminals, 20 Million Lifts/year

#2

Train Performance Optimization

- LOCOTROL Distributed Power
- Yard & Road RCL
- Trip Optimizer

#1

Asset Performance Management (APM)

- APM: Locomotives
- APM: Railcar
- APM: Track/Wayside
- ServiceMax

#3

Network Optimization

- Precision Dispatch
- Movement Planner
- Yard Planner Systems
- Smart Intermodal & Auto Ramp Management

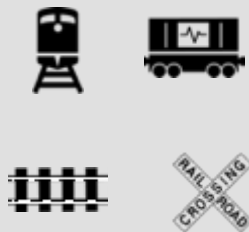
#4

Transportation Management

- Railroad TMS
- Shipper TMS

Examples of Digital Solutions

APM



- Enterprise asset management
- **25%** reduction in failures

▲ Reliability



Train Performance



- Smart cruise control for trains
- **10%** ↑ fuel eff., ~900K gallons fuel saved per week; 9000 units IB
- Vale Mozambique – 1st implementation In Africa

▲ Fuel Efficiency



Network Optimization



- Real-time line-of-road planning
- 2 Class 1 + 1 Int'l installs
- 10-15% ↑ in velocity

▲ Velocity



Transport Logistics



- Unlocks power of big data at one of the world's largest ports
- Delivers fast, data-driven insights
- Improves cargo visibility, increases efficiency

▲ Visibility, Productivity



Network Optimization

#4

Transportation
Management

#1

Asset Performance
Management

#2

Train Performance
Optimization

#3

Network
Optimization

- Precision Dispatch
- Movement Planner
- Yard Planner Systems**
- Smart Intermodal & Auto Ramp Management

The opportunity for rail yards



The rail yard of today

- Typical workstation



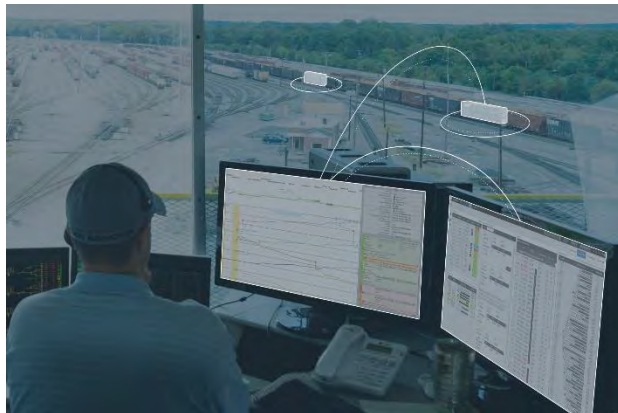
- Selected automation
- Minimal decision support
- Localized planning and execution
- Minimal real-time asset tracking
- Ad-hoc network considerations



The rail yard of the future: objectives

Anticipate & prevent problems

- Predictive maintenance
- Proactive decision-making
- Informed recommendations



Enhance network productivity

- Automation (as much as possible)
- Remote control
- Optimizing asset utilization



Develop new opportunities

- Multidisciplinary, team-based planning
- Improved customer experience



The high-level yard of the future roadmap

• **TODAY**

Consistent Data & Control

• **SHORT TERM**

Proactive Network Planning

• **LONG TERM**

Autonomous Yards

• **LONGER TERM**

Decentralize Yard Activities

Everything is...



VISIBLE

SMART

AUTONOMOUS

CONNECTED

SUPPORTING INPUTS

HUMANS AND THE VETERAN KNOWLEDGE BASE

As automation and AI are introduced, the role of humans shift from reactive to strategic. Veterans will play an important advisory role to a data-empowered strategic team.

DATA INSIGHTS AND COLLABORATIVE HUBS

Sensors, data, analytics, and new predictive tools will support multi-disciplinary teams, working together on bigger problems. The workforce will likely shift into central planning environments.

POLICY CHANGES AND LABOR RELATIONS

To level the competitive playing field and defend against under-regulated emerging technologies, a consistent effort will be required, to enable labor and technology changes.

CARRIER AND MODE PARTNERSHIPS

The walls between "us" and "them" need to be torn down within today's connected world. Share data and compete as a uniform, customer-centered shipping experience.



Hump yard planner system



Decision support for hump yard operations

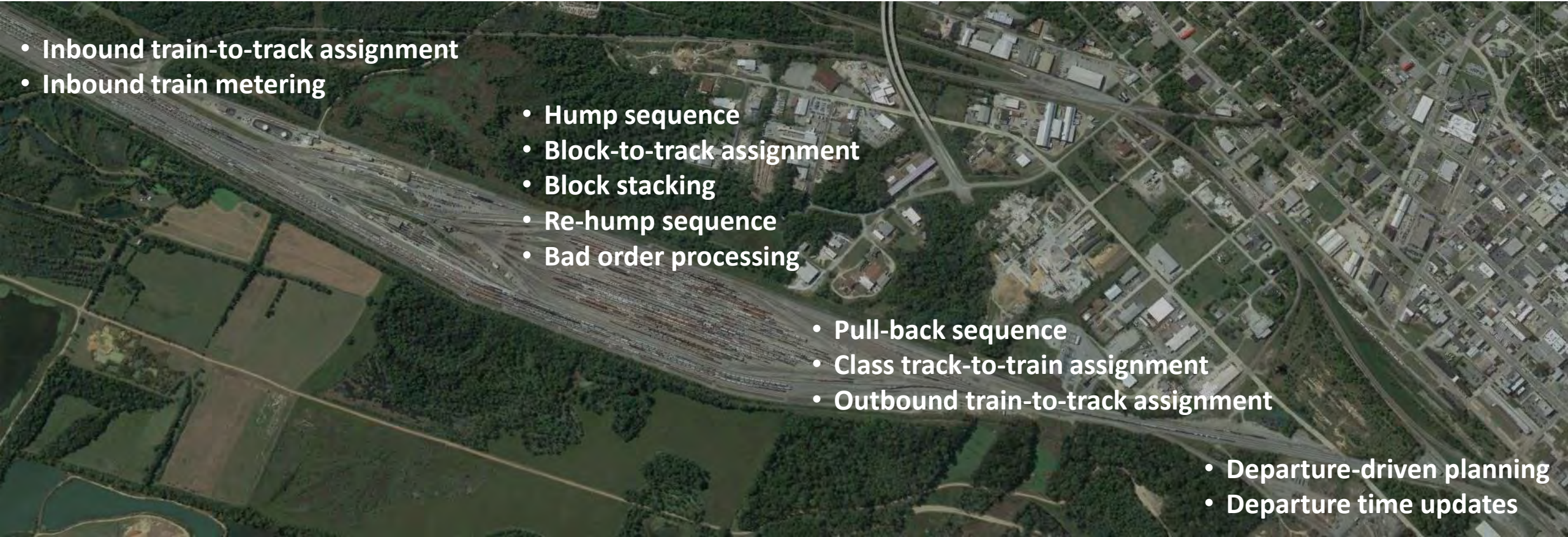
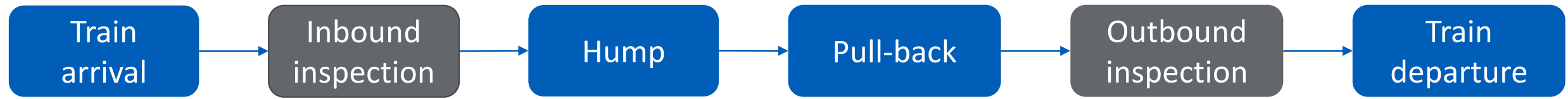


Image source: Google Earth



Three cool things our engineering team has done

There are many more...

Class Scoring

Planning insights

Clear UI



Class scoring

- The planning algorithm is driven by outbound demand
- Cars are evaluated against each other
 - Desired standing order
 - Target outbound train
 - The train's departure direction
- An integer value is created to represent the demand
- This allows cars to be easily compared with each other

MWAY	1	124	50	hated
B12	1	130	60	49.02
D20	1	31	49	49.01
K34	4	540	193	01.01



Planning insights

Plan generated at 10/11 11:51 AM

Hump Insights

#	Car	Class Code	To Track	Insight
▶ 145	SOU 88643	CLNC	CT03	New CLN Track
▶ 135	NS 295140	NIXONP	CT11	New Track
▶ 121	SOU 65737	LINWOP	CT11	New B/O Track
▼ 117	AOK 29278	VLDTAP	CT35	Shiftable Car

Is AOK 29278 a Shiftable centerbeam? Yes No

Class Code	AP	RT	CT	FT	LT	OT
VLDTAP	44	33	22	78	0	0

Relevant Tracks

▶ CT35 VLDTAP

▶ 110	FLOX 983451	HALCHAT	CT17	New Track
▶ 87	NOKL 822493	ALBANP	CT27	New Track
▶ 82	NS 120100	JACVLF	CT23	Shiftable Car
▶ 81	NS 120099	JACVLF	CT10	Shiftable Car
▶ 71	ABS 83018	JACVLP	CT23	Train Building
▶ 65	NS 111222	JACVLP	CT04	Train Building
▶ 64	NS 111220	JACVLF	CT23	Train Building

- Goal: Let users know that planner is going to do something that may not be intuitive
- Also for user input that will affect decisions
- Eliminate the “flying blind” feeling



Clear UI

Plan generated at 10/12 10:38 AM

Approaching Trains

Train	Arrival	Cars	Consist	A Dir	Status	Landing Trk	Destination
198 09	11:19 AM	47	A S	S	LATE	RT01	
119 10	11:51 AM	56	A N	N	ON TIME	RT06	
363 11	12:13 PM	84	A N	N	ON TIME	TF01	
356 11	5:29 PM	195	P S	S	ON TIME		
152 11	6:59 PM	153	P S	S	ON TIME		
191 10	7:14 PM	103	P N	N	EARLY		
M77 10	8:37 PM	67	A N	N	LATE		
139 11	9:44 PM	116	P N	N	ON TIME		

Receiving Yard 824 cars, 358 loaded, 466 empty, 59380 tons, 45417 ft

Track	Train	Track Content	Available
TF01			10500
RT01			9800
RT02	191 09		2557
RT03	373 10	G02	1534
RT04	175 09		1784
RT05	377 10		7607
RT06	GM98 10 336 10		1510
RT07	G08 10 932 08	P2LUT SPARKUT	4264
RT08	330 10		3931

Inbound & Hump Task List

Filter

Start Time	Source	Crew
10:38 AM	RT06	GM01

Duration 77 minutes

Cars	Tons	Feet
148	12004	8291

End Time 11:55 AM

Inbound train 198 09 from South to RT01 at 11:19 AM
Inbound train 119 10 from North to RT06 at 11:51 AM

Start Time	Source	Crew
12:05 PM	RT03	GM61

Duration 78 minutes

Cars	Tons	Feet
150	8380	8266

End Time 1:23 PM

Pullback Task List

Filter

Start Time	Crew	Lead	Destination	OB Train
10:38 AM	GM02	PBW	FT02	357 11

Duration 34 minutes

Source	Class	Last Car #	Cars	Tons	Feet
CT36	HALCIRR	CIRR 2013	14	1631	807

End Time 11:12 AM

- Pullback task is in progress.
- Activity is going to end soon. Extend end time if necessary.
- 3 ALBANGFs, 1 HALCIRR on CT23 not planned to make train.



Wrap-up



Our vision: integrate across solutions

Port & Supply
Chain
Visibility

Edge Devices,
Cloud
Connectivity

Transportation
Management

Train
Handling &
Automation

Yard &
Network
Optimization

Asset
Performance
Management

- **Interoperability**
- **Visibility**
- **Optimization**
- **Common architecture, data foundations & UX**



For more information:



<https://www.getransportation.com/digital-solutions>

Read the GE Transportation white paper:
“Transportation’s Evolution: A Promising Future”
<http://www.getransportation.com/whitepaper>

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