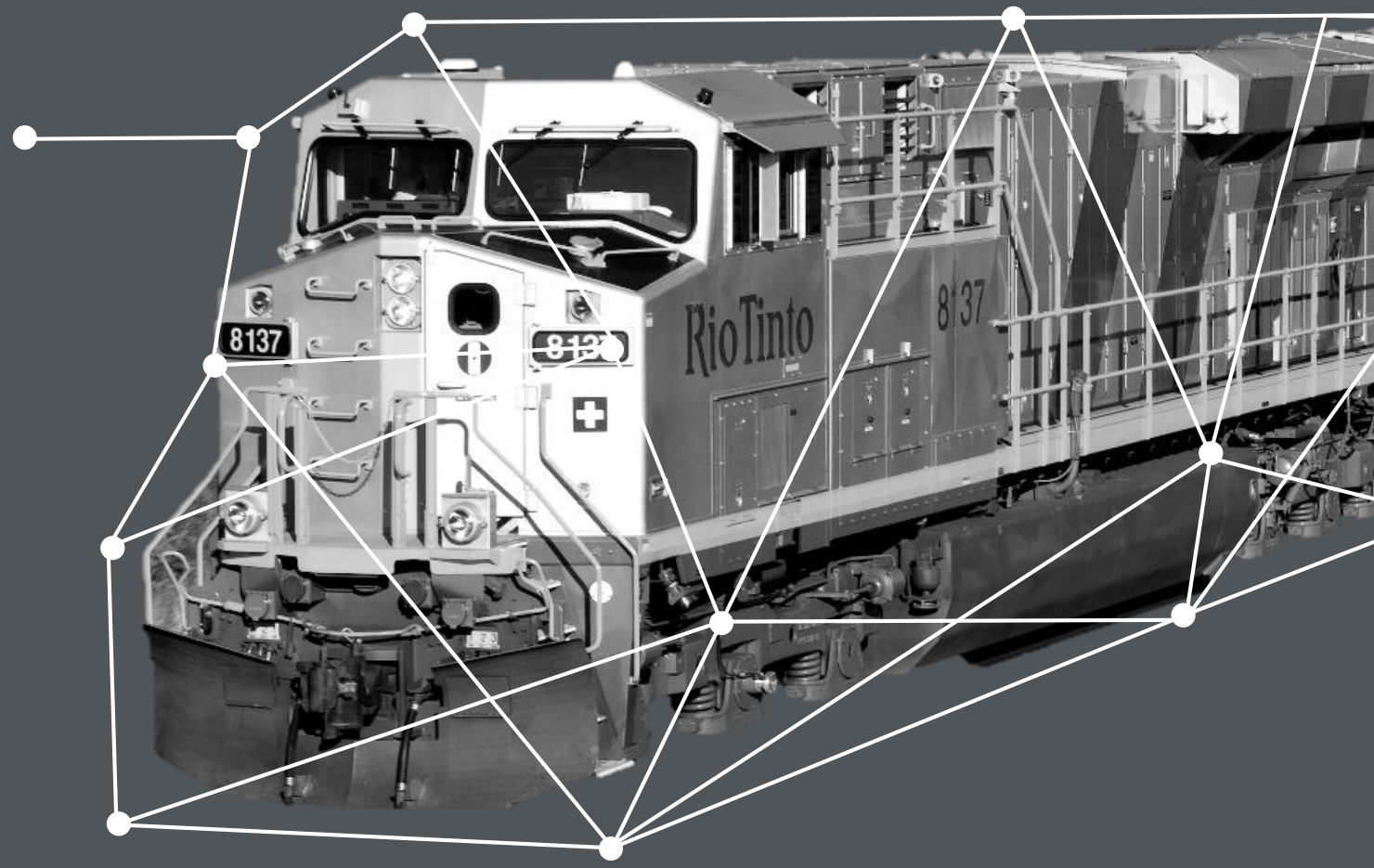
FULLY AUTONOMOUS TRAIN CONTROL

FOR MAINLINE RAIL SYSTEMS



Ansaldo STS

A Hitachi Group Company

Rio Tinto granted accreditation for AutoHaul®

1st long-distance driverless Heavy Haul Railway in the world

18 May 2018

Rio Tinto granted accreditation by Australia's Office of the National Rail Safety Regulator approving the autonomous operation of trains at the group's iron ore business in Western Australia.

The AutoHaul® project continues to progress and is on schedule to be completed by the end of 2018.

Rio Tinto will take a phased approach to deploying autonomous trains across the network in the lead up to full commissioning.

A true milestone for the global Railway Industry

RioTinto

Rio Tinto achieves delivery of iron ore with world's largest robot

13 July 2018

Rio Tinto has achieved a significant milestone with the first delivery of iron ore by an autonomous train in the Pilbara, Western Australia.

The autonomous train, consisting of three locomotives and carrying around 28,000 tonnes of iron ore, travelled over 280 kilometres from Rio Tinto's mining operations in Tom Price to the port of Cape Lambert on 10 July.

It was monitored remotely by operators from Rio Tinto's Operations Centre in Perth more than 1,500 kilometres away.

The inaugural journey is a significant milestone for Rio Tinto's AutoHaul™ programme and follows regulatory approval in May.

AutoHaul™ is on schedule to complete by the end of the year, unlocking significant safety and productivity gains for the business, as well as optimising the company's iron ore system by providing more flexibility and reducing bottlenecks.

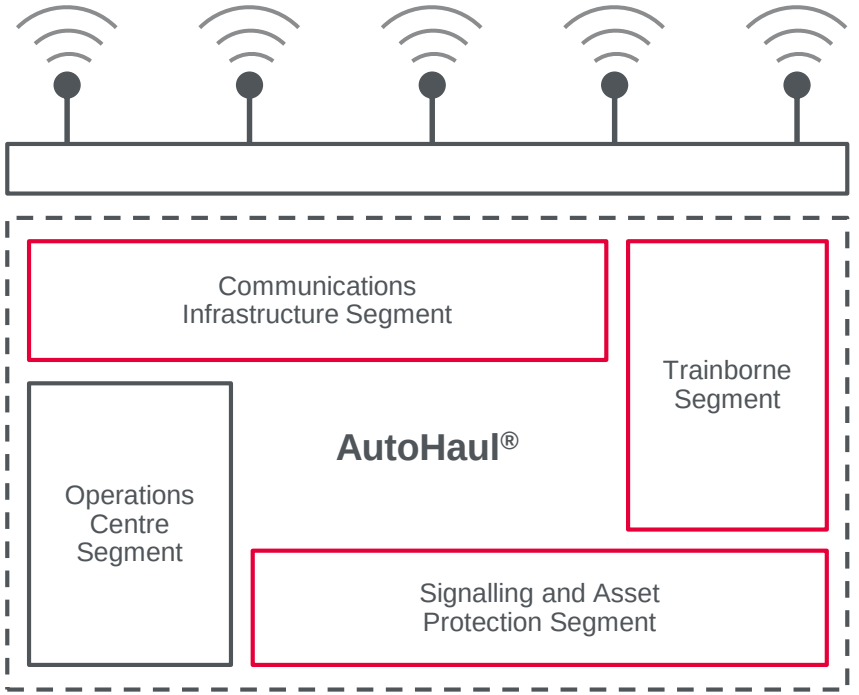
Rio Tinto Iron Ore managing director Rail, Port & Core Services Ivan Vella said **"This safe first delivery of ore by an autonomous train is a key milestone for the AutoHaul™ program which will deliver the world's first autonomous, rail network."**

"This programme shows our absolute commitment to improving safety and productivity, as well as enabling greater flexibility across our operations."

Managing Director
Rail, Ports & Services
Rio Tinto
Ivan Vella

What is AutoHaul®?

1st long-distance driverless Heavy Haul Railway in the world



Project Scope

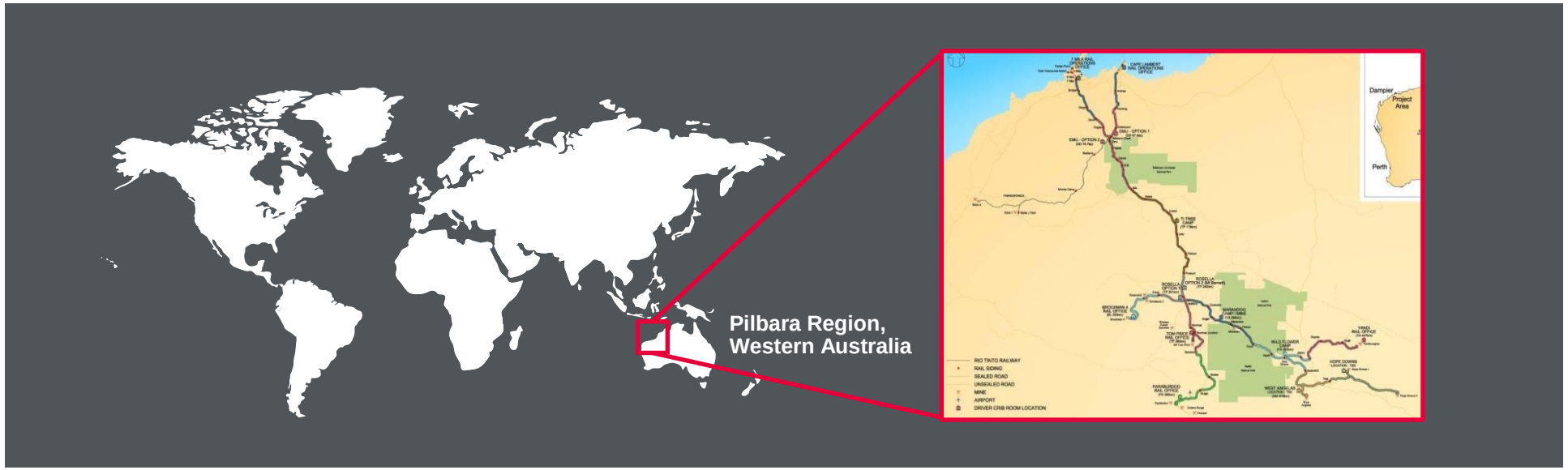
Automatic Train Operation (ATO) system to automatically drive trains on remote 1,500km main line

On Board, Office, and Wayside systems to control, monitor and ensure the safe movement of driverless trains

Key part of Rio Tinto – Ansaldo STS Framework Agreement (RAFA) to support iron ore mining expansion in the Pilbara, Western Australia

Where is AutoHaul® applied?

AutoHaul® – World's first long-distance driverless Heavy Haul Railway



Rio Tinto moves iron ore from mine to port via its

1,700km rail line

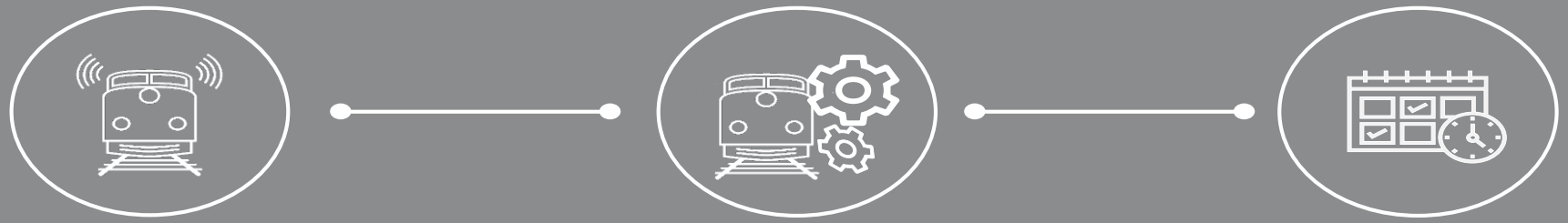
Each train has

3 locos **+ 240** wagons

is **2.5km** long

and weighs **28,000** tonnes

AutoHaul® Efficiencies Achieved to Date



More than 750,000km in fully driverless mode completed safely and successfully

Over 11 million km in ETCS L2 mode completed safely and successfully

Six percent speed improvement

Removal of driver change-over saving 1hr/journey cycle

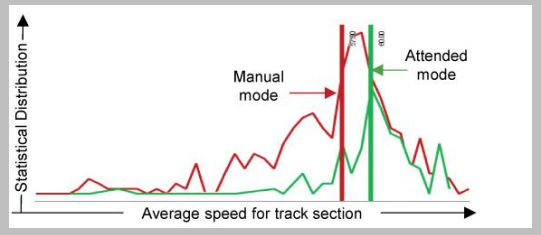
AutoHaul®'s Benefits for the Customer

Value over Volume

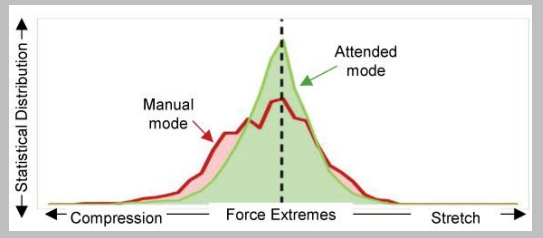
Continuous flow → Schedule real-time → No human interaction

by means of a flexible, sustainable, fully automated Railway compliant to the highest safety standards and the highest productivity (driverless operation and trip optimised)

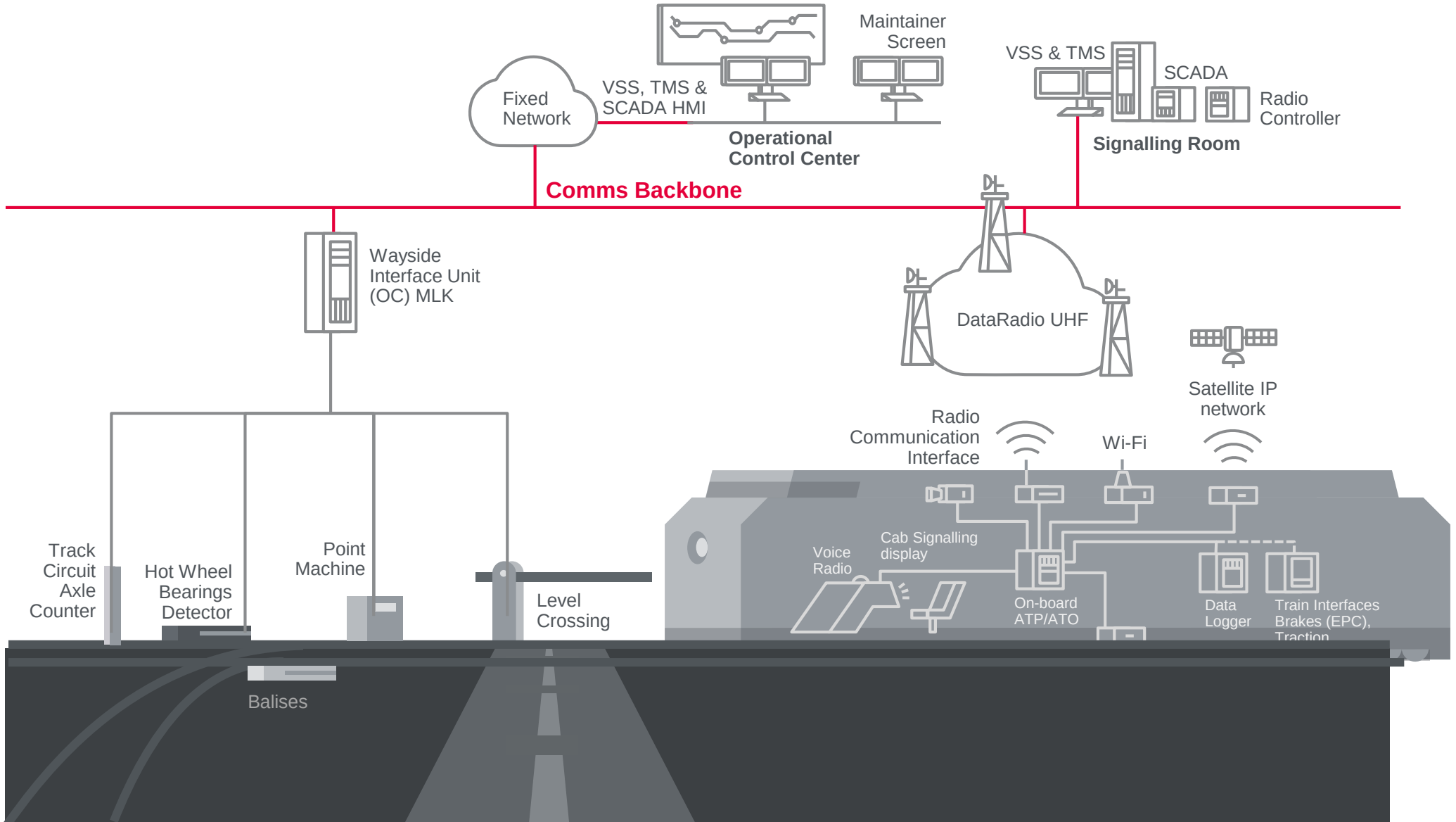
1 Shifts



2 Efficiency



AutoHaul® System at a Glance



AutoHaul® ATO Strategy & Implementation

Four Modes of Operation

1

Passive

Drivers run the train, which is protected by the ATP system

2

Driver Assist

Advises Driver of optimal driving commands to apply

3

Attended

Automatic running with a supervising driver on board

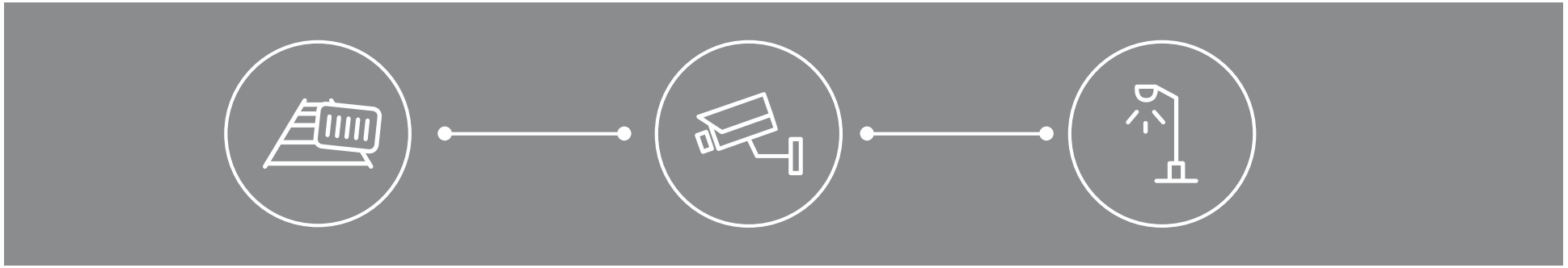
Initially designed as a “transport” mode for staff, it has become a key part of the deployment and acceptance approach

4

Driverless

Unmanned

AutoHaul® Level Crossing & Asset Protection



Obstruction Detection System (ODS)

Laser based system detects objects within level crossing boundaries

Closed-Circuit TV (CCTV)

Provides surveillance coverage of each end of level crossing

Records vision via Digital Video Recorder (DVR)

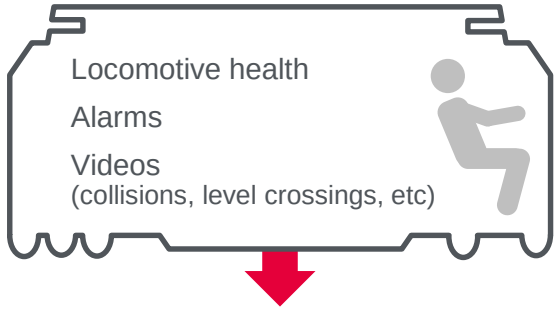
Enables remote retrieval/viewing by authorised Operation Centre (OC) personnel

Street Lighting

Provides consistent lighting for level crossing

Turns on each time crossing operates, is obstructed or when staff view live feed from CCTV

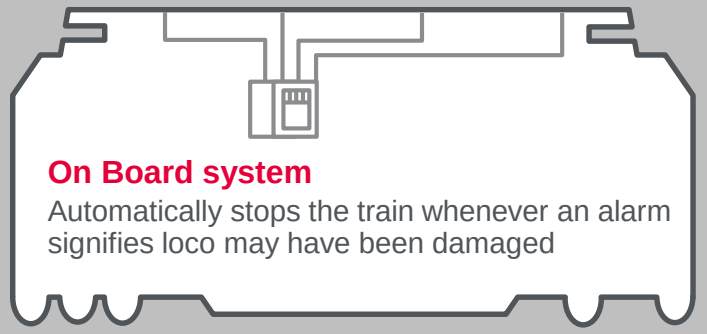
AutoHaul® Remote Loco Monitoring



Monitoring activities previously performed by the driver while on board the train…

Now managed via:

Rolling Stock Asset Health Evaluator
Remotely monitors On Board status of assigned trains throughout their journey and Processes all On Board alarms



On Board system
Automatically stops the train whenever an alarm signifies loco may have been damaged

INSPIRATION OF THE YEAR GLOBAL AWARD 2018

31 October 2018

Ansaldo STS Australia Pty. Ltd
Freight Business Unit

Ansaldo STS successfully delivered into commercial service the world's first fully autonomous long-distance heavy haul rail operation for key client Rio Tinto

Has been selected for

Inspiration of the Year Global Award 2018
"Japan, Korea and Oceania Region" 2nd Prize

Porting AutoHaul® to Freight: North America

PTC provides Authorities and TSRs, but not the following:

Signalling System

Vital Safety Server acting as Office Center

Integrated Vital Possession Management

Integrated Level crossings and Level crossing obstruction detection and protection

Integrated Asset Protection devices

Virtual & Moving Block

Onboard

ATO

Collision Detection

Motion sensors

Video Monitoring

Operations Centre

Remote locomotive health monitoring

Video monitoring

ATO Mission Start/Stop

Porting AutoHaul® to Freight: Europe, Africa, Asia

ETCS provides Authorities and TSRs, but does not currently the following:

Signalling System

Integrated Vital Possession Management

Integrated Level crossings and Level crossing obstruction detection and protection

Integrated Asset Protection devices

Virtual & Moving Block

Onboard

ATO

Collision Detection

Motion sensors

Video Monitoring

Operations Centre

Remote locomotive health monitoring

Video monitoring

ATO Mission Start/Stop

Beyond AutoHaul® - Roy Hill Project (WA)

Signalling and communications system that has equipped a 350km remote privately owned heavy haul iron ore railway for future autonomous operation

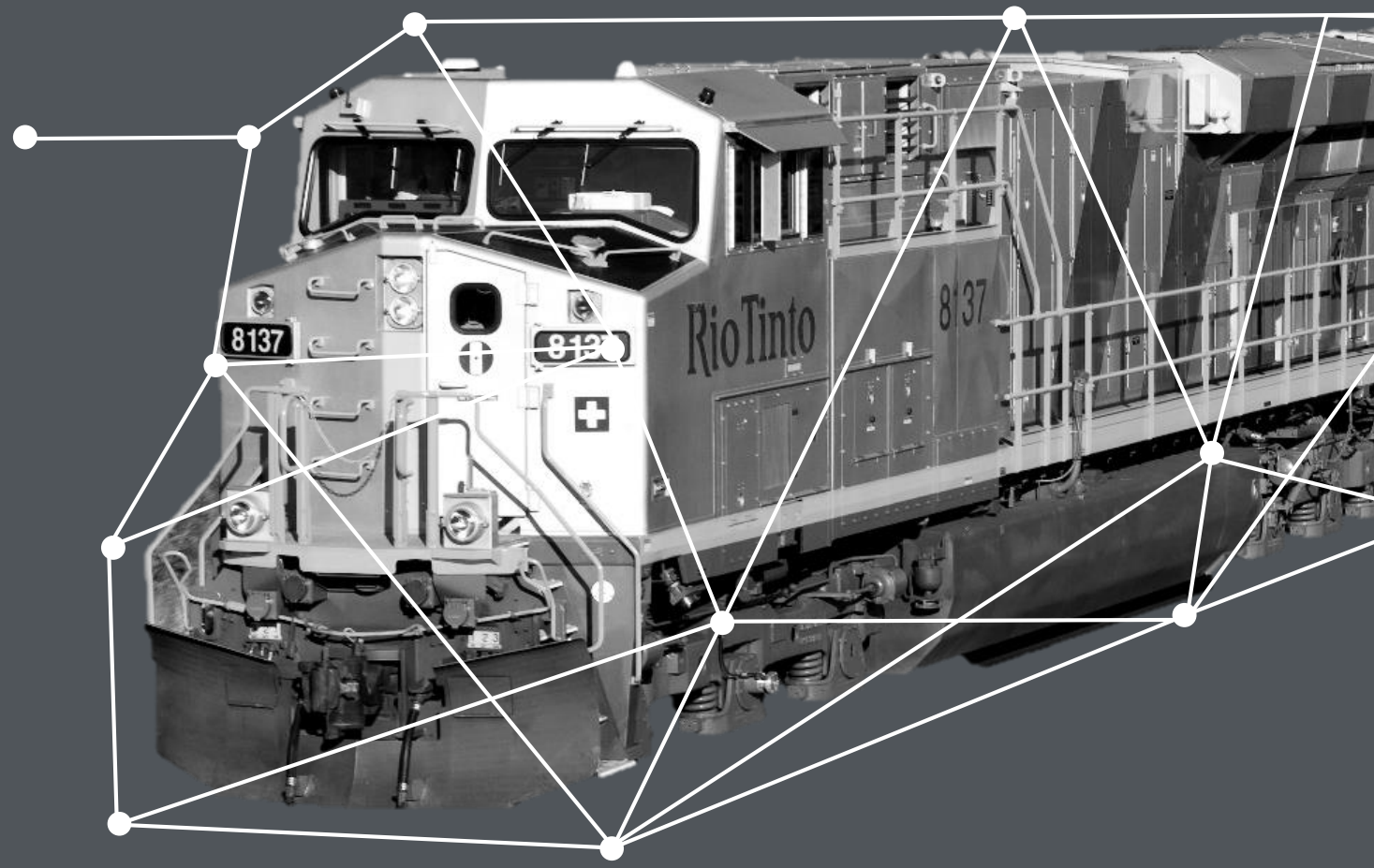
Beyond AutoHaul® - Roy Hill Project (WA)

A Series of Technical Firsts

- Communication Based Signaling on TETRA IP radio systems in Australia
- Communications Based Signaling (CBS) using SIL4 GPS Localisation
- Train and Hi-Rail with Driver Assist system at SIL2
- SIL4 Moving Block on Freight System

FULLY AUTONOMOUS TRAIN CONTROL

FOR MAINLINE RAIL SYSTEMS



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