HEAVY HAUL 4.0

THE FUTURE OF HEAVY HAUL FREIGHT TRANSPORTATION

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INTERNATIONAL HEAVY HAUL ASSOCIATION

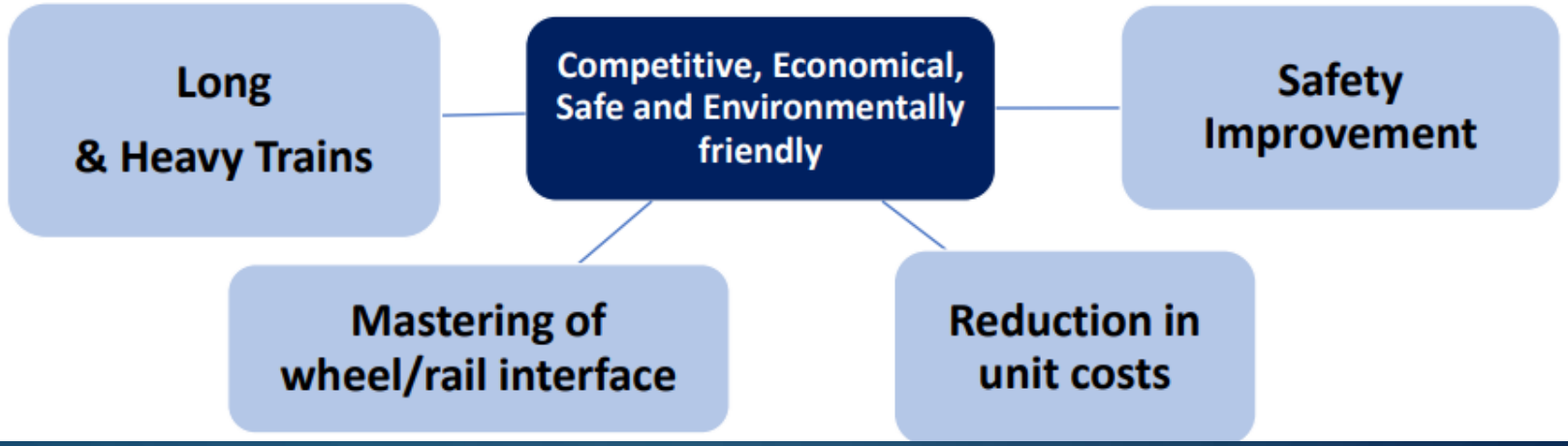
AGENDA

- **Mandate of the International Heavy Haul Association**
- Technology benchmarking around the world
- The challenges for heavy haul
- What is Industry 4.0?
- The digital railway of the future
- Headwinds
- Benefits
- Conclusion

International Heavy Haul Association (IHHA) – over 40 Year History

IHHA has 10 member Heavy Haul countries: Russia, South Africa, China, United State of America, India, **Brazil**, Sweden, Norway, Australia, Canada

IHHA Vision: Excellence in Heavy Haul Railway Operations



CARRYING MORE UNITS IN A TRAIN REDUCES OPERATING COSTS. HEAVY TRAINS WILL BECOME LONGER (40,000 TONS), WITH AXLE LOADS TO 45 METRIC TONNES (50 TONS)

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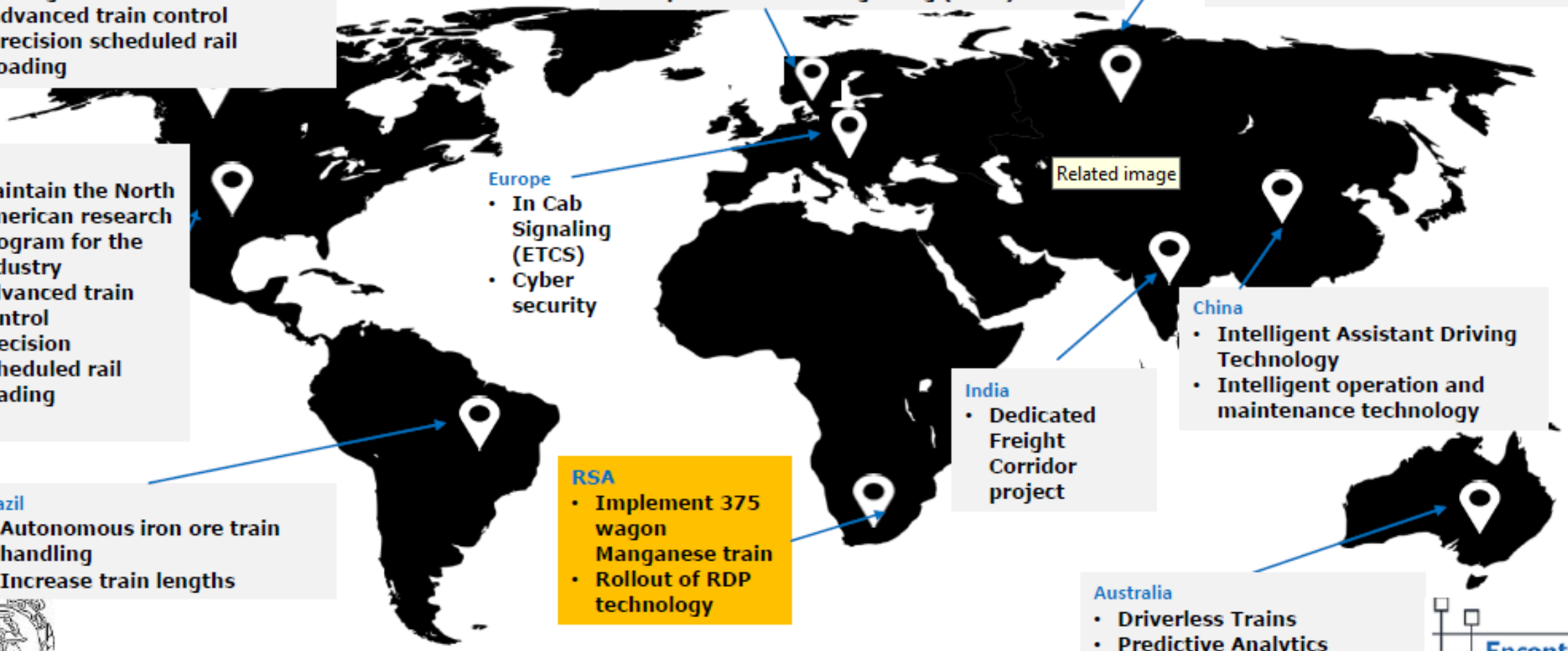

Canada
- Automated air brake inspections
- Trip plan optimization and yard management
- Advanced train control
- Precision scheduled rail roading

Sweden - Norway
- Upgrade Axel load
- Implement In Cab Signaling (ETCS)

Russia
- Improvement of traction efficiency
- Increase axle load
- In Cab Signaling (Moving Block)
- Increase train lengths

USA
- Maintain the North American research program for the industry
- Advanced train control
- Precision scheduled rail roading

Europe
- In Cab Signaling (ETCS)
- Cyber security

China
- Intelligent Assistant Driving Technology
- Intelligent operation and maintenance technology

India
- Dedicated Freight Corridor project

Brazil
- Autonomous iron ore train handling
- Increase train lengths

RSA
- Implement 375 wagon Manganese train
- Rollout of RDP technology

Australia
- Driverless Trains
- Predictive Analytics Algorithms

Encontro Ferroviário

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HEAVY HAUL GLOBAL CHALLENGES

Deriving more value from already deployed assets and technology

Improving operations efficiency & customer experience

Navigating the train in the 4th Industrial Revolution

Providing new rail capacity in a cost effective manner

Safety, Safety, Safety - Continue to Strive for Zero Derailments, Zero injuries

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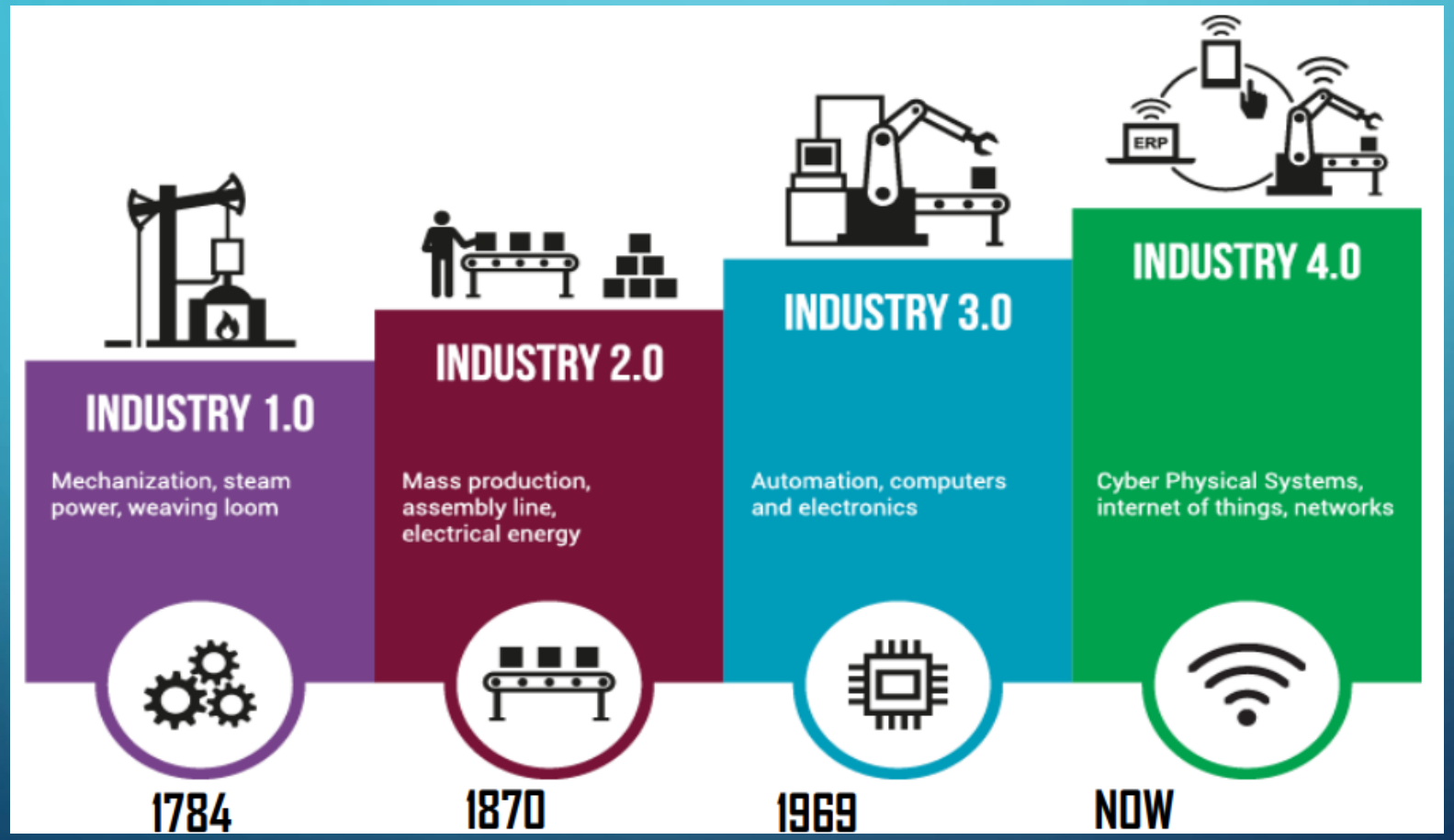
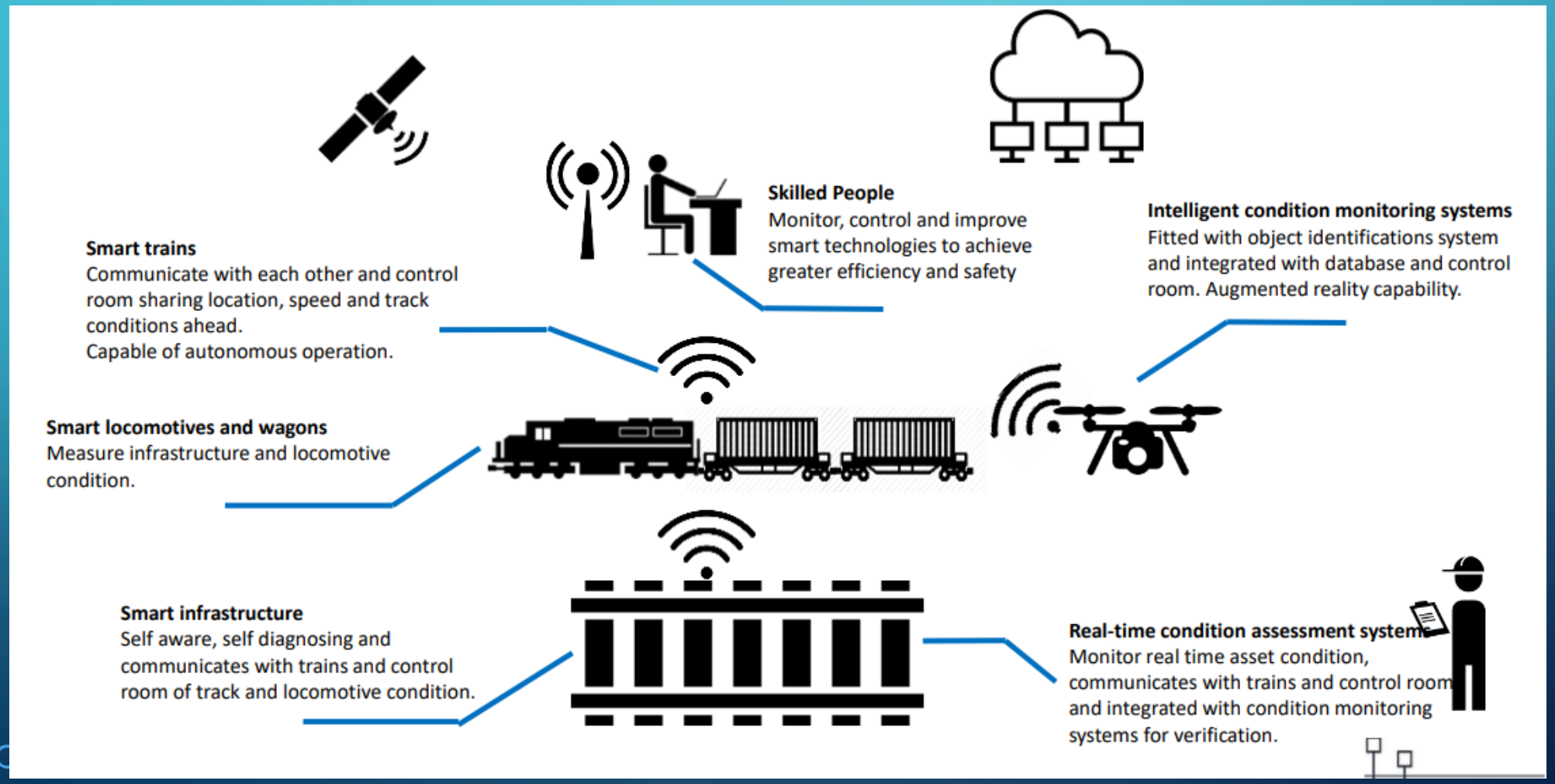
WHAT IS INDUSTRY4.0 ?



RAIL 4.0


Skilled People
Monitor, control and improve smart technologies to achieve greater efficiency and safety
Intelligent condition monitoring systems
Fitted with object identifications system and integrated with database and control room. Augmented reality capability.
Smart trains
Communicate with each other and control room sharing location, speed and track conditions ahead.
Capable of autonomous operation.
Smart locomotives and wagons
Measure infrastructure and locomotive condition.
Smart infrastructure
Self aware, self diagnosing and communicates with trains and control room of track and locomotive condition.
Real-time condition assessment system
Monitor real time asset condition, communicates with trains and control room and integrated with condition monitoring systems for verification.

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FREIGHT RAILWAYS 4.0

2020-2030

- Safety is engineered in
- Network centric precision railroading
- Precise shipment delivery projections on the web
- Block chain integrated supply chain
- Autonomous trains
- Vehicle/track as a system
- Proactively predict asset condition
- Artificial intelligence learning drives continuous improvement
- Employees want to learn new skills and must be kept “in the loop” on automated systems
- Railway widely seen as sustainable, cybersecure and socially responsible choice.

COMMUNICATIONS-BASED TRAIN CONTROL IS THE BUILDING BLOCK FOR AUTONOMOUS TRAINS AND HOLDS THE KEY TO CAPACITY IMPROVEMENTS

With a true virtual moving block, train spacing can be set by braking distance algorithms.

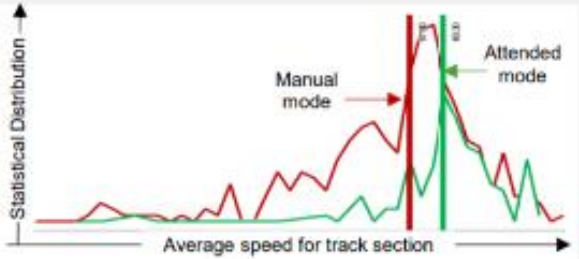
… and they can be set tighter with ECP braking and further improvements in braking effectiveness.

… But will communications-based train control permit much more frequent, shorter trains?

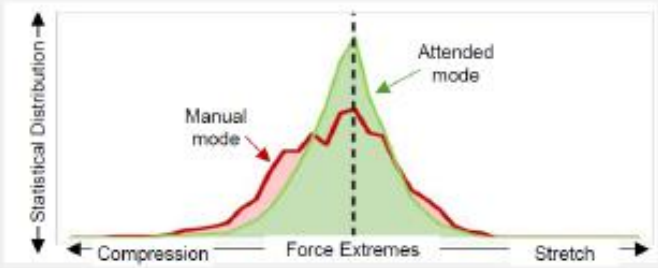
RIO TINTO AUTONOMOUS UNMANNED TRAINS ARE ON THE LEADING EDGE OF HEAVY HAUL OPERATIONS

Reduced variability, increased speed

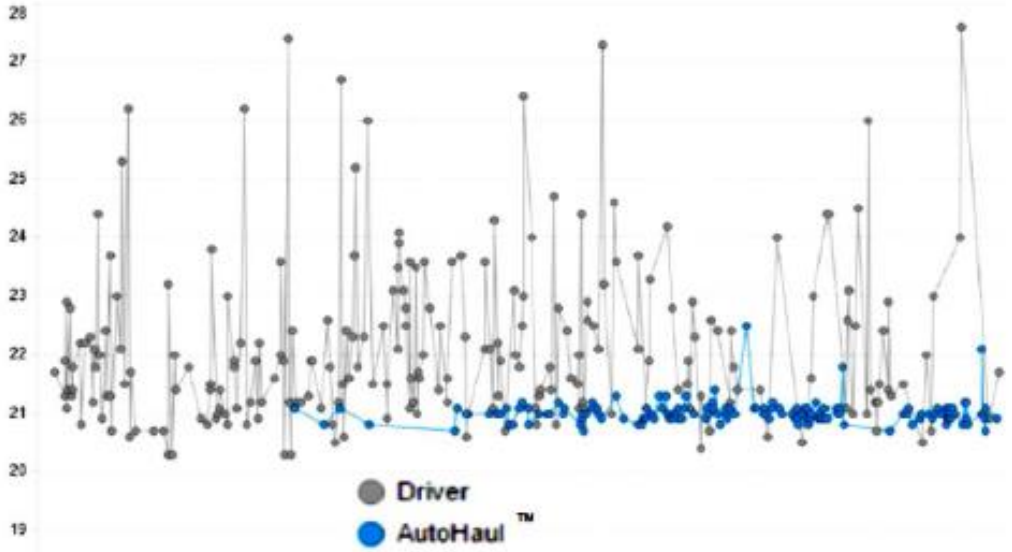
– Computerised driving improves cycle times



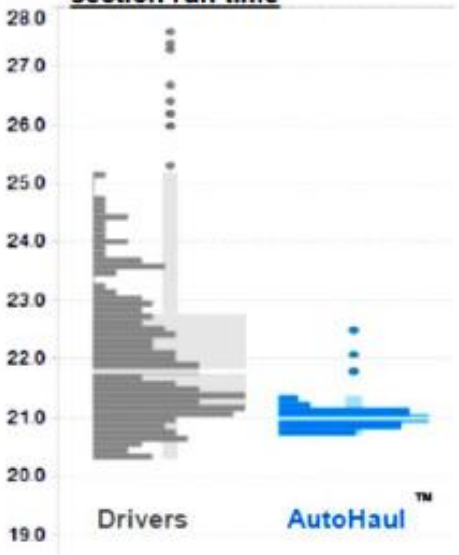
Reduced in-train forces will benefit maintenance



Section run time – individual trains



Histograms of section run time

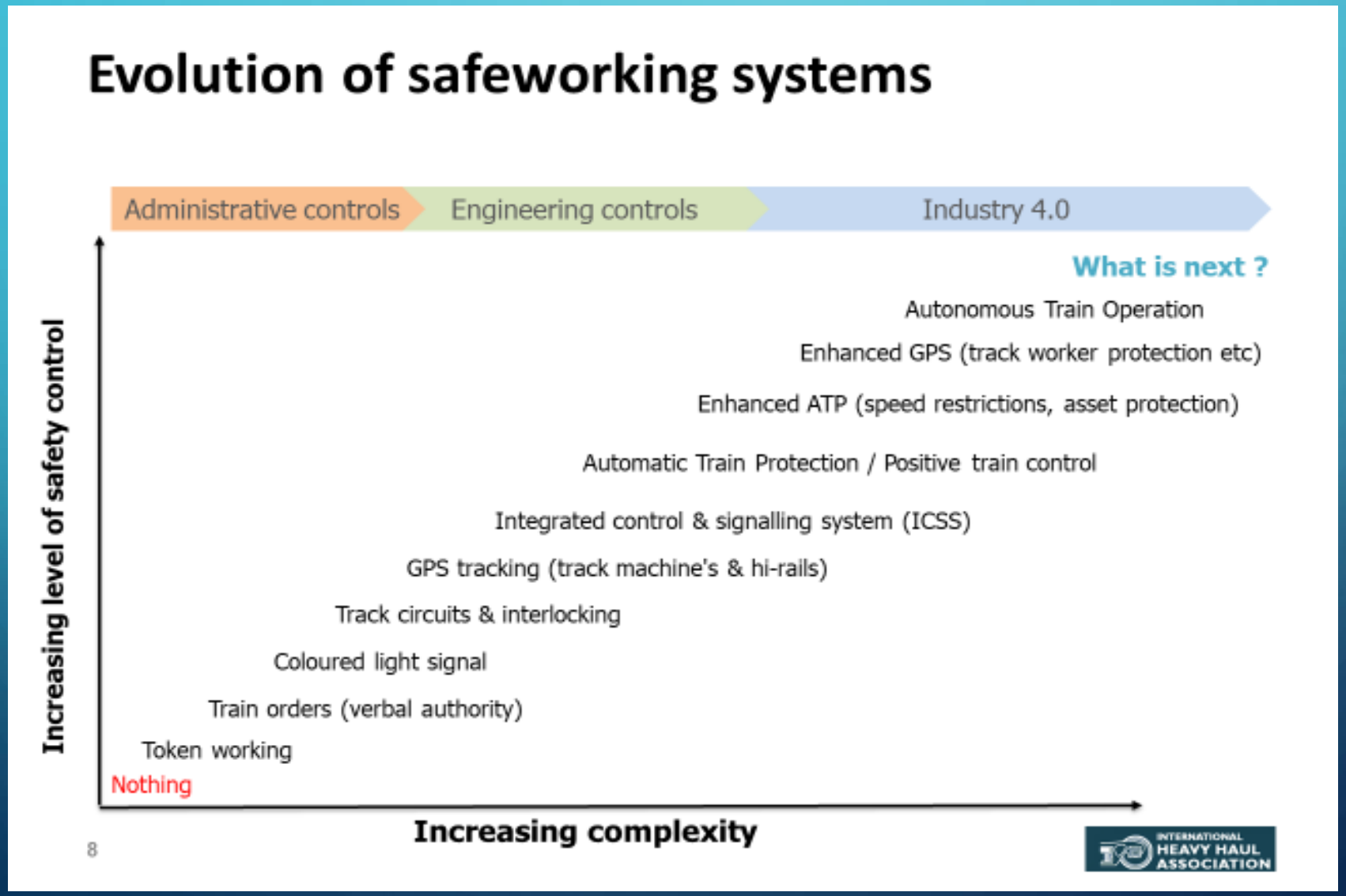


Source: Presentation by Rio Tinto IHHA Conference 2019

WHAT WILL THE HEAVY HAUL RAILWAY OF THE FUTURE LOOK LIKE? INFORMATION AND TRAIN CONTROL

- Information flows will be real time and integrated to be Network Centric
- Data streams will integrate ports, customer facilities, connecting railways, loading/unloading and customer demands
- Trains will be launched by computers, with trip plans that balance demand and supply with reliable pathways to minimize variance.
- Trains will be dispatched by algorithms that optimize trip plans and pacing in real time, with discrete monitoring of all stages of the cycle, overseen by people
- Trains will be controlled by communications based control systems operating in virtual moving blocks with tighter headways driven by advanced braking.
- Unloading will be a continuous operation with no stop and start
- Yard operations will be remote-controlled

OPERATIONS SAFETY IN THE DIGITAL ERA WILL HAVE ENGINEERED-IN SAFETY CONTROLS



FUTURE VISION FOR MAINTENANCE OF ROLLING STOCK AND INFRASTRUCTURE

FUTURE

PREDICTIVE MAINTENANCE
PROACTIVE

TODAY

Periodic preventative maintenance

- Unacceptable levels of unplanned maintenance
- Infrastructure & Rolling stock vulnerable to external factors
- Systems not fully integrated, and utilized
- Failure modes that cannot be detected
- Slow speed maintenance capacity

Right action, at right time, at right location

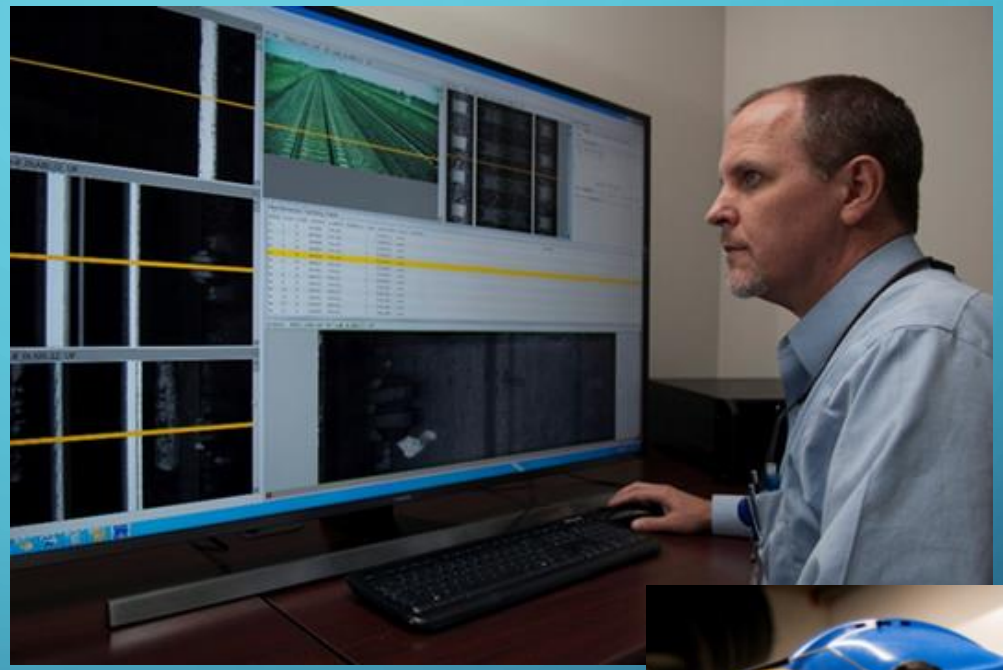
- High Speed mechanization equipment with short maintenance windows
- Minimum unplanned interruptions
- Resilient infrastructure and rolling stock
- Real time condition assessment – Remote monitoring

WHAT WILL THE HEAVY HAUL RAILWAY OF THE FUTURE LOOK LIKE? TRACK AND STRUCTURES

- Rail will be proactively preventively ground based upon measurement of optimal wheel/rail profile matching and the depth and extent of RCF
- Track geometry and ballast condition will be monitored and trended with proactive asset management plans that rarely require a speed restriction
- Track and turnouts will have minimum discontinuities and robust designs in all operations bottleneck locations
- Track inspections will be done by reviewing potential issues detected by wayside systems, onboard monitors, special inspection vehicles and machine vision systems. Repair crews will be dispatched to the specific location of the potential defect.
- Unmanned UAV drones will drive bridge inspections, track obstruction inspections and some elements of track inspections
- Rail steels will have greater fatigue resistance at lower temperatures
- Rail neutral temperature will be continuously monitored and corrected
- Broken rails will be detected remotely
- Track will be jointless and constructed with longer rails with few welds

FUTURE TRACK AND ROLLING STOCK INSPECTIONS WILL BE PERFORMED BY SENSOR-ASSISTED DISPLAYS AND LOGIC

Office-based track inspector accessing digital imaging and onboard sensor displays



Technician is sent to exact location of potential track or wagon defect to perform repairs

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HEADWINDS

- Autonomous trucks
- Low emission highway vehicles
- Skills shortages
- Man-machine interface
- Communications limitations
- Cybersecurity

BUILDING BLOCKS OF THE DIGITAL RAILWAY

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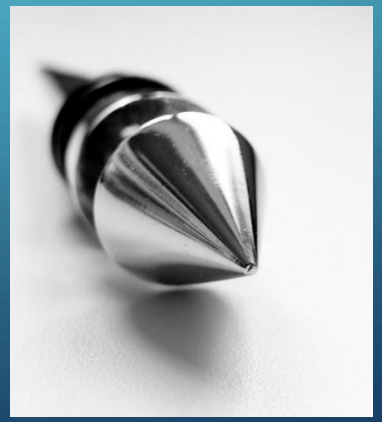
BENEFITS OF HEAVY HAUL 4.0

- Capacity and throughput lift
- Lower service variance
- Lower stress state
- Predictive, preventive maintenance regime
- Integrated supply chains
- Improved asset utilization
- Lower costs



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CONCLUDING REMARKS

- The world's best freight railways have adopted similar business practices and technologies to improve their key performance indicators.
- These practices have evolved over the past 2 decades, and continue to develop to deploy longer and heavier trains.
- High capacity communications and true moving blocks with communications-based train control are keys to improved throughput.
- Automated train operations ~~will~~ must progress.
- Automated train operations must be built on a solid foundation of supporting IT and comms. infrastructure.
- Inspections will be led by inspection technologies that direct crews to validate and correct.
- A digital railway needs new processes; it is not simply a digitized version of an analog railway.
- It must combine the best of human skills and artificial machine intelligence to run autonomously, with human oversight and management of variances.

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