



GE Transportation

LOCOTROL + Remote Monitoring

*E-Mobility in Indian Railways
Session III:
Emerging technologies for Rolling stock
New Delhi: 04th Sep'18*



Our solutions enable a

Digitally Connected Transportation Ecosystem

ASSETS

OPERATIONS

NETWORKS

VISIBILITY

APM

Collision Avoidance

OPM



MINE

Port Optimizer



PORT

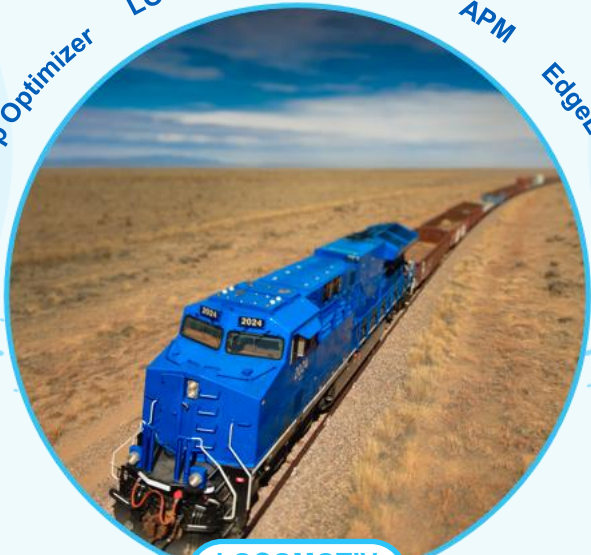
Trip Optimizer

LOCOTROL

GoLINC

APM

EdgeLINC



LOCOMOTIVE

Smart Intermodal

Yard Planner



YARD & TERMINAL

Smart Automotive



NETWORK

Movement Planner

Dispatch

TMS



SHIPPER

TMS



RECEIVER

GE Transportation Digital Solutions portfolio



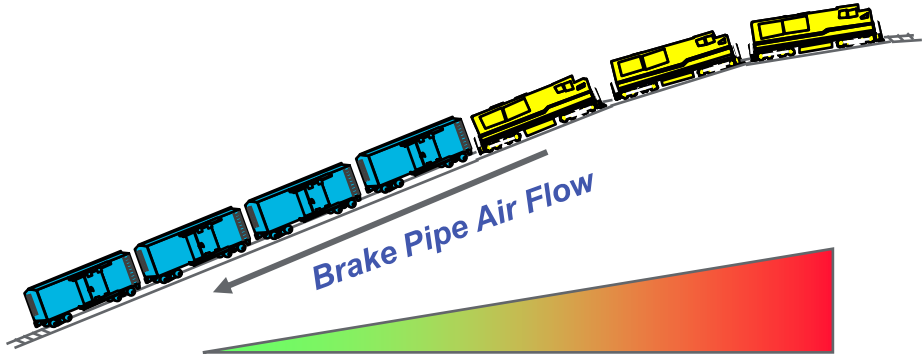
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LOCOTROL Distributed Power (DP)



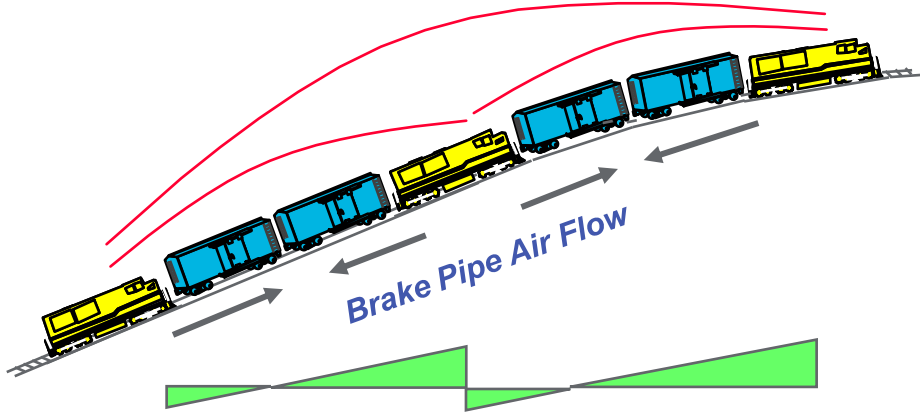
LOCOTROL Distributed Power (DP) ... what is it?

Conventional Train



Draw Bar Force highest behind Trail locomotive

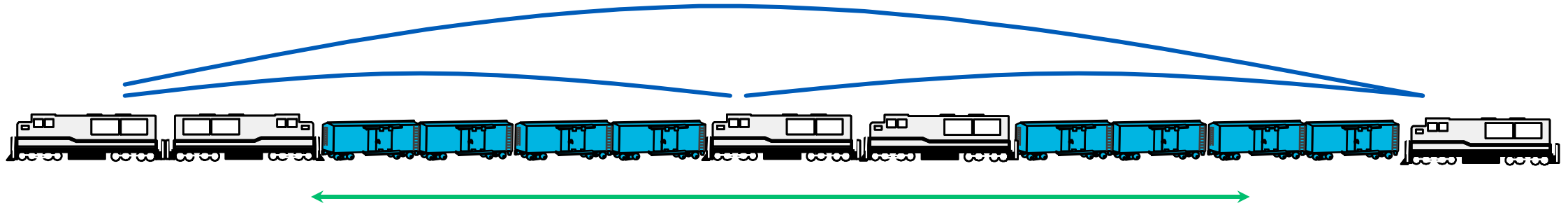
LOCOTROL[®] Distributed Power Train



Draw Bar Forces reduced when locomotive power and braking is distributed throughout the train



LOCOTROL ... how it works?



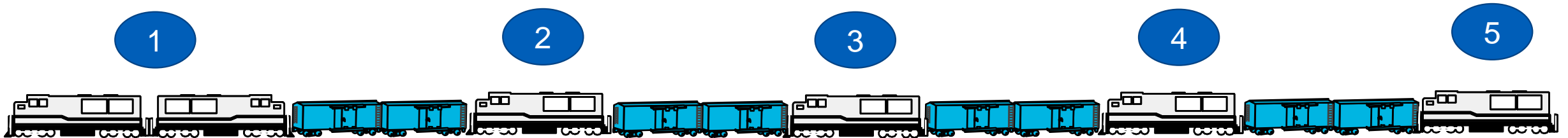
Two Forms of Communication Between the Lead and Remote

- Radio Link (Both Directions)
 - Full Remote Control & Status
- Brake Pipe
 - Remote senses brake pipe reduction and goes to Idle if in Comm Loss

Safety maintained during communication loss



LOCOTROL DP ... performance capabilities

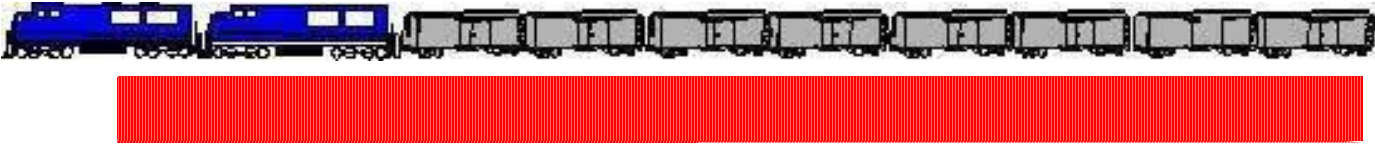


- ✓ LOCOTROL DP can operate 5 loco consists in the same train = 1 Lead + 4 Remote (unmanned) consists
 - LOCOTROL DP can put the Remote consists in Idle (i.e. Throttle Idle) when the Remote consist's tractive power is not required (ex. on flat geographic terrain) and then power up the Remote consist when required (ex. going up a hill) to help conserve fuel.
- ✓ LOCOTROL DP operated on Freight Trains
 - Customers have not utilized for Passenger Trains due to potential for high intrain forces
- ✓ LOCOTROL DP can operate with different loco types (Siemens, Alstom, Bombardier) in the same train
- ✓ LOCOTROL DP designed to International Standards
 - Communication Protocol – American Association of Railroads (AAR) LSI specification v4.2
 - Mechanical- AAR S-9101
 - Environmental – EN50155, AAR S-9401
 - Safety – MIL-STD-882, CFR 229, CFR 236, AREMA, IEEE 1483, CENELEC, ARP 4761 + GEIA-STD-0010 (Aerospace)

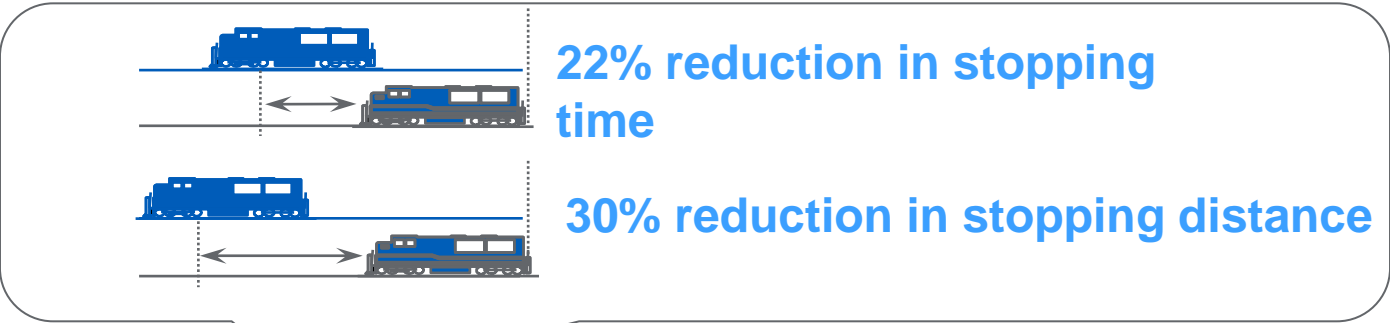


LOCOTROL DP ... Benefits

Conventional Train



Brake Pipe: Air Exhaust - 185M/sec Propagation



LOCOTROL® DP Train



Brake Pipe : Radio commanded Air Exhaust 2 places - 370M/sec Propagation



LOCOTROL DP ... equipment applications

Locomotive Types

- Diesel Electrics
 - GE
 - EMD
 - ALCO
 - English Electric
 - USSR/German 232
- Electrics
 - Alstom
 - Siemens
 - Bombardier
 - Toshiba
 - CNR
 - CSR / ZELC
 - Hitachi
 - ASEA
 - Adtranz

Air Brake Types

- Pneumatic Manifold I/F
 - 26 L (NYAB, WABCO)
 - PBL 2 (French)
 - 28 LAV-1 Vacuum+Air
 - 28 LV-1 Vacuum
 - EP-85 (D&M)
- Electric Air Brake I/F
 - EPIC 3102, II, Fastbrake (WABCO)
 - CCB I, II, 1.5, 2-IR (NYAB)
 - Faiveley
 - D5 (Knorr Bremse)
 - HSM (Knorr Bremse)
 - DK1 (MOR – future)

Radio Types

- Motorola (VHF, UHF)
- ICOM/SRI (UHF, VHF)
- CARS (China)
- GSMR Network (China)

- VHF ~ 140-150 MHz
- UHF ~ 450-470 MHz
- CARS ~ 827 MHz
- GSMR ~ 920 MHz

- Up to 8 freq. per system
 - 25 KHz channel
 - 12.5 KHz channel

Variety of Proven Applications, Experience Around the World



LOCOTROL DP ... customer success stories!

BHP, Australia



World's Longest, Heaviest Train Ever...

- 7.3 km long
- 99,732 tons, 682 ore cars
- **8 AC6000 Diesel-Electric locos**

Transnet, South Africa



World's 1st Mixed Electric & Diesel DP Train

- 4,024 m long train
- 41,000 tons, 342 ore cars
- 5 Alstom 9E 50kVA 50 Hz Electric locos
- 6 Class 34-500 Diesel-Electric locos
- **Alstom 9E electric + Toshiba 15E electric + GE Class 43 diesel-electric + GE Class 44 diesel-electric locos operate in the same DP train**

Daqin Line, China



China's Longest, Heaviest Coal Train Ever

- 20,000 tons, 208 coal cars
- **Alstom (HXD2) + Siemens (HXD1) + SS4G electric locos operate in the same DP train**
- 655 km in distance
- LOCOTOROL DP comm with Digital Radios + GSMR



19,000 DP systems deployed with 8 loco manufacturers On Both Electric & Diesel Locomotives
+30 customers in 17 countries



Remote Monitoring



Expert On Alert: monitoring & predicting asset performance

CONDITION MONITORING

ONBOARD
(SENSORS)



MANAGED ANALYTIC SERVICES

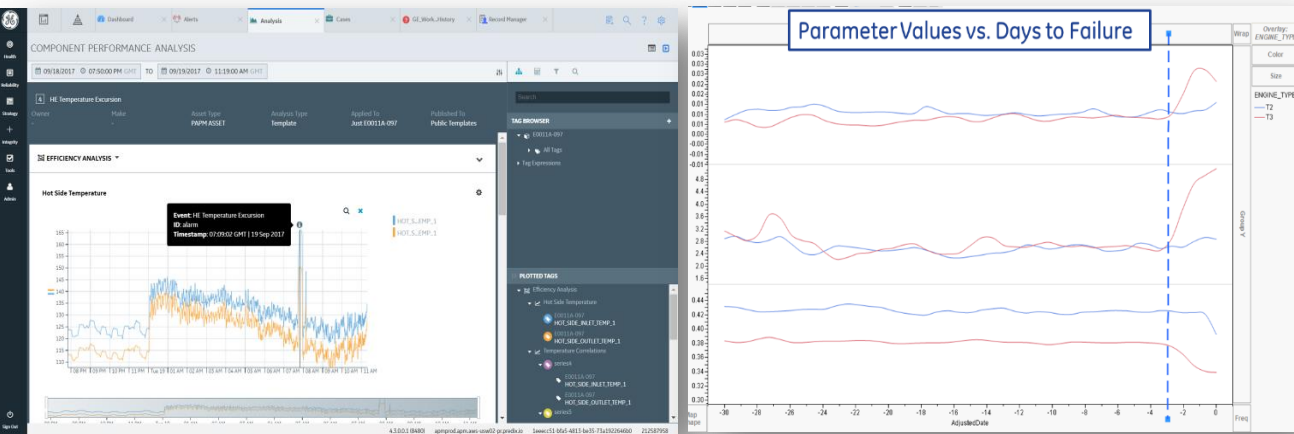
EXPERT
(BACKOFFICE)



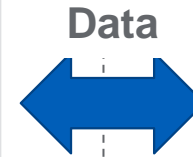
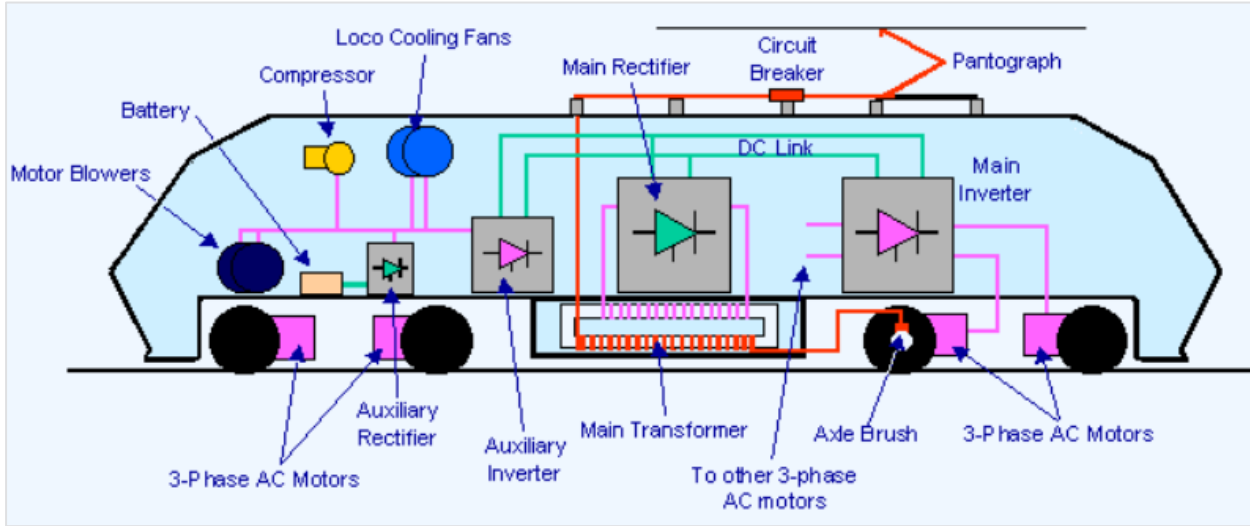
INSTALLED BASE & KEY FACTS

- ✓ 17K+ locomotives under monitor
- ✓ Deployed at 25+ railroads... 4 monitoring centers across the globe
- ✓ Over 1M messages processed
- ✓ ~250 alerts and repair advisories generated per day
- ✓ Platform scalable to GE & Non-GE assets
- ✓ **OUTCOME: 25% reduction in line of road failures**

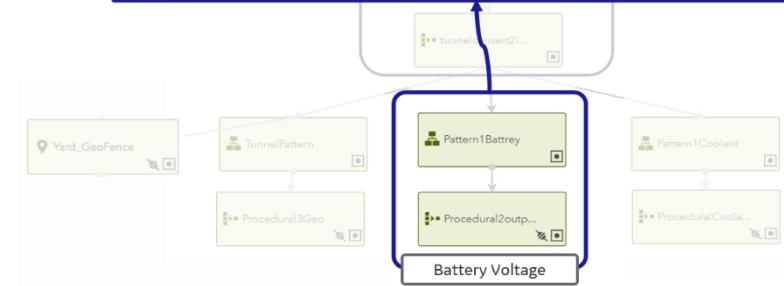
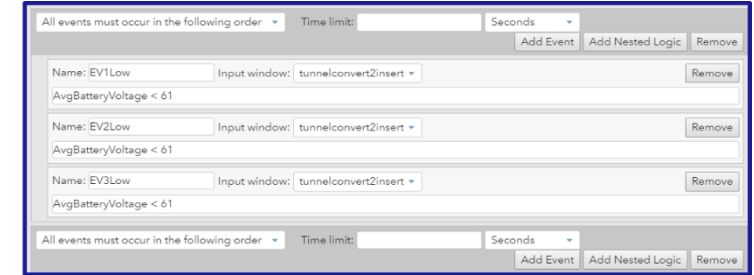
RELIABILITY ANALYTICS



Reliability analytics packages For Electric Locomotives Onboard



Rule and data logic: Battery voltage



Analytics Coverage based on onboard data availability

- ✓ AC/DC Drive Electrical
- ✓ Frequency Converters
- ✓ Motors
- ✓ Cooling Systems
- ✓ Battery
- ✓ Power Supply/Transformer
- ✓ Air Compressor

Outcomes and Benefits

- ① Advantage of Predictive Maintenance
- ② Better Maintenance Planning
- ③ Faster detection from real-time data
- ④ Reduce unplanned downtime



