Slides to accompany
the presentation of
Steven R. Ditmeyer

at the
National Transportation Safety Board’s
Positive Train Control Forum
February 27, 2013
Locomotive Cab Displays

Coordinated displays of relevant information to train crews in both graphical and textual formats:

- Train position and speed
- Current movement authority
- Current and upcoming route profile
- Train consist, with special handling instructions
- In-train forces
- Actual and recommended throttle and brake settings
- Locomotive and car health
- Set-out and pick-up instructions
ARES Locomotive Cab Display
ARES Locomotive Cab Display

ARES COMMUNICATION CHANNEL 25

CREW IDENTIFICATION
ENGINEER  R. BURNS
CONDUCTOR  E. MUMFORD
BRAKEMAN  J. WAUER
BRAKEMAN  E. SCHULTZ

REAR OF TRAIN MONITOR IDENT 83368

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ARES COMM CHANNEL | VERIFY CREW | RTM IDENT | IDLE | POWER UP | UPDATE EFF/FUEL | SUMMARY
## ARES Locomotive Cab Display

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**PREVIOUS PAGE** | **NEXT PAGE** | **WORK LIST** | **SUMMARY**
Track Forces Terminals

- Provide the interface for communications to and from roadway workers
- Can be laptop computers or PDAs
- Enable crews to determine future track occupancy and to request “track and time” from dispatcher
- Display current movement authority
- Enable crews to place slow orders and to transmit administrative data
- Should greatly improve productivity of roadway workers by eliminating uncertainty of track availability
Locomotive Health Monitoring Systems

• Provide real-time and historical internal health monitoring data for engines, electrical systems, dynamic and air brake systems, hydraulic systems, exhaust systems, fuel tanks
• Transmit health data to locomotive cab, and over the data link to the control center, locomotive scheduling center, and locomotive shops
• Include event recorders
• Allow collection of health data for maintenance-based decision making
• Improve reliability, availability, and utilization rate of locomotives
Work Order Reporting

- Instructions sent from control center to train crews to set out and pick up loaded and empty cars en route.
- On-board train consist updated automatically based on crew acknowledgement of work order completed.
- Train consists in control center and central computer data bases also updated in real time.
- Location of set-outs automatically recorded.
- Customers can be automatically notified of impending or actual car placement.
- Important for establishing “custody chain” of shipments.
Tracking Hazmat and Other Shipments

- AEI confirms the locos and cars on each train and sends it to operating data system.
- DGPS receiver determines location of the loco to within 1-2 meters and speed to within 1-2 km/hr and data radio transmits it back to dispatchers and operating data system.
- Work order reporting system confirms set-outs and pick-ups and sends them to operating data system.
- Data in train location, train consist, work order reporting, and waybill data bases can be merged to *precisely* locate *every* car/shipment.
- Authorized parties (at railroad, shipper, and appropriate local/state/federal government agencies) can inquire about precise car/shipment location.
How ARES PTC Permitted More Efficient Train Meets

Accurate projections of train location reveal opportunities to reduce meet/pass delays.
How ARES PTC Permitted More Efficient Train Passes

The ability to operate with short headways can reduce meet/pass delays.

With Greater Headway

With Less Headway
How the ARES PTC Control Center Helped Dispatchers

- Reduced dispatchers’ *communication load*
- Improved dispatchers’ *communication efficiency and speed*
- Increased dispatchers’ *communication precision*
- Radically changed dispatchers’ *communication focus:*
  - Traffic planning and problem solving replaced information gathering and movement authorization as dispatchers’ primary tasks
PTC Positioning

• Multiple inputs on train position are integrated:
  – DGPS
  – Odometer
  – Switch position indicators
  – Digital track map in control center and on-board computers

• Train and roadway worker position is sent over the data link to the control center; movement authorities are sent over the data link from the control center to trains and roadway workers

• Track centers are 4 m apart, which requires 1-2 m positioning accuracy (i.e., DGPS)

• Accurate positioning also needed at clearance points at switches
Global Positioning System

GPS Nominal Constellation:

• 24 satellites in 6 orbital planes
• 4 satellites in each plane
• Altitude 20,200 km
• Inclination 55 degrees
The Global Positioning System

Measurements of code-phase arrival times from at least four satellites are used to estimate four quantities: position in three dimensions (X, Y, Z) and GPS time (T).
Differential GPS

Measured: x y z
Delta: x y z
True: x y z

Measured: x y z
Delta: x y z
True: x y z

Corrections applied after survey
Nationwide Differential GPS

- GPS satellite constellation provides 10 m accuracy
- NDGPS is an augmentation of GPS providing 1-to-2 meter positioning accuracy
- NDGPS monitors GPS integrity; users receive warning of GPS degradation within 5 seconds
- Currently operational with single coverage over 90% of continental US and double coverage over 45%
- NDGPS signals available to anyone with proper receiver; no user fee
- Managed and monitored 24/7 at USCG Navigation Center, Alexandria, VA
Nationwide Differential GPS

• Uses decommissioned USAF Ground Wave Emergency Network (GWEN) sites to send out correction signals
• International standard (RTCM 104) developed by US Coast Guard; used in 40 countries
• Joint project with FRA, USCG, FHWA, OST, USACE, TVA, states, and others
• Date for Full Operational Capability with double coverage uncertain due to funding limitations
• High-Accuracy DGPS (HA-DGPS) developed and tested by FHWA and USCG at Hagerstown, MD site: 10-20 cm accuracy
Converted GWEN to NDGPS

Appleton, WA

Reference & Integrity Antennas
Two sets of each

NDGPS Equipment Shelter

There is a similar shelter for the 25KW generator
Nationwide Differential GPS Coverage

Source: 2010 Federal Radionavigation Plan
Worldwide DGPS Coverage