Network Centric Railroading Utilizing Intelligent Railroad Systems

Steven R. Ditmeyer
DOT Faculty Chair
Industrial College of the Armed Forces

10th International Command and Control Research and Technology Symposium
McLean, Virginia
June 15, 2005

Network Centric Railroading

Use digital data communications, sensors, and computers on railroads to:

- Improve safety and security
- Raise effective capacity
- Improve asset utilization
- Improve customer satisfaction
- Measure and control costs
- Reduce energy consumption and emissions
- Increase economic viability and profits
- ***"Manage the unexpected"***

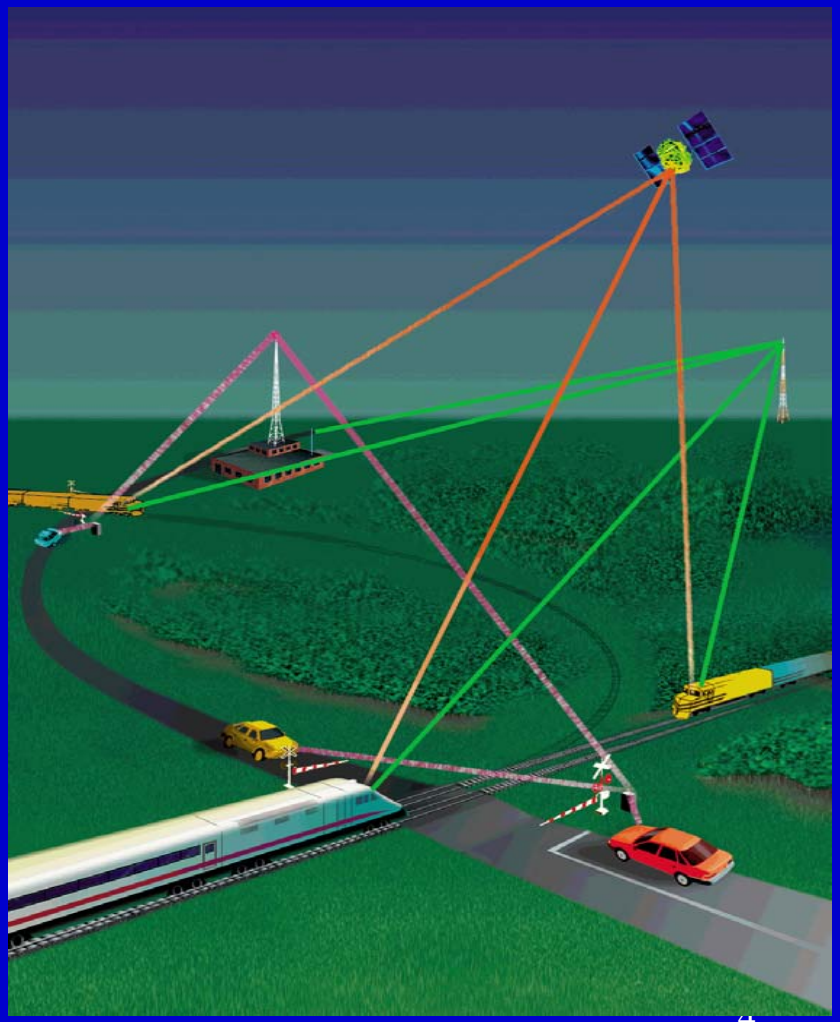
Intelligent Railroad Systems

- Apply the same technologies used in:
  - Intelligent Transportation Systems
  - The National Airspace System
  - Maritime vessel tracking systems
  - Parcel delivery services
  - Emergency response services
  - Military command and control
- Use the technologies to enhance security through:
  - ***Prevention*** of incidents -- ***Detection*** of incidents
  - ***Notification*** of incidents -- ***Recovery*** from incidents

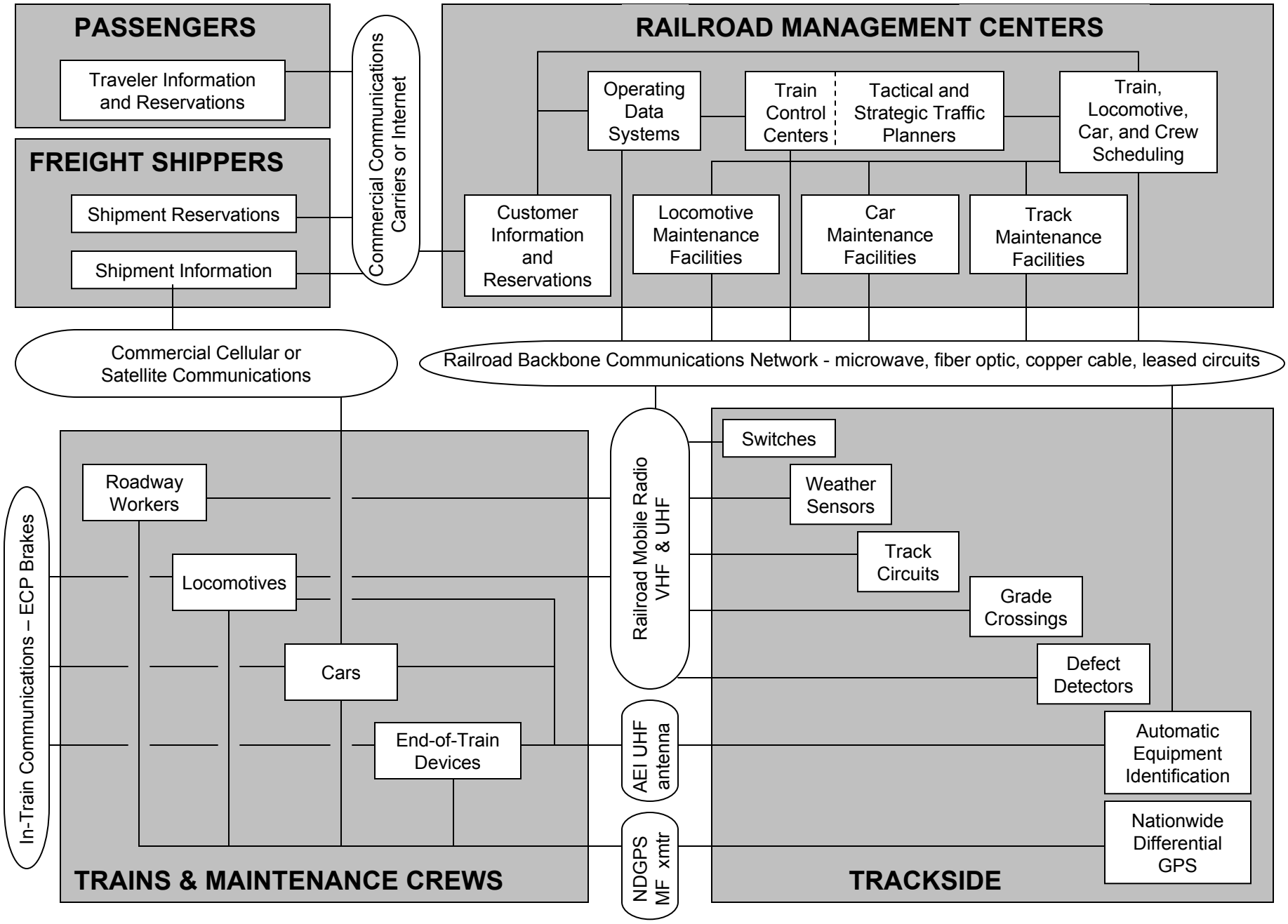
"Continuous, real-time information;
no more snapshots"

The Principal Intelligent Railroad Systems

- Digital data communications
- Positive Train Control
- Nationwide DGPS
- Electronically-controlled pneumatic brakes
- Automatic equipment identification
- Intelligent grade crossings



NETWORK CENTRIC RAILROADING



System Security

- Must be designed into Intelligent Railroad Systems before deployment
- Data regarding trains, cars, crews, and shipments must be kept confidential
- Authentication of data will insure that the content is genuine, unaltered, and complete
- Unwarranted extraction of information from communications net must be prevented
- Encrypt data to keep it out of wrong hands

Positive Train Control

- Provides safety benefits by:
  - Preventing collisions
  - Preventing overspeed accidents
  - Protecting roadway workers
- Provides enhanced security through:
  - Monitoring location and speed of all trains
  - Monitoring all switches, bridges, tunnels, etc.
  - Only authorized persons controlling trains
  - On-board enforcement of all movement authorities
  - Remote intervention capability

Positive Train Control Components

- Along the wayside
  - Digital data radios and backbone comm net
  - Wayside interface units at switches and detectors
- On locomotives and maintenance vehicles
  - On-board computer with digital maps
  - Positioning system
  - Throttle-brake interface
  - Integrated displays
- At the control center
  - Dispatching computer with displays

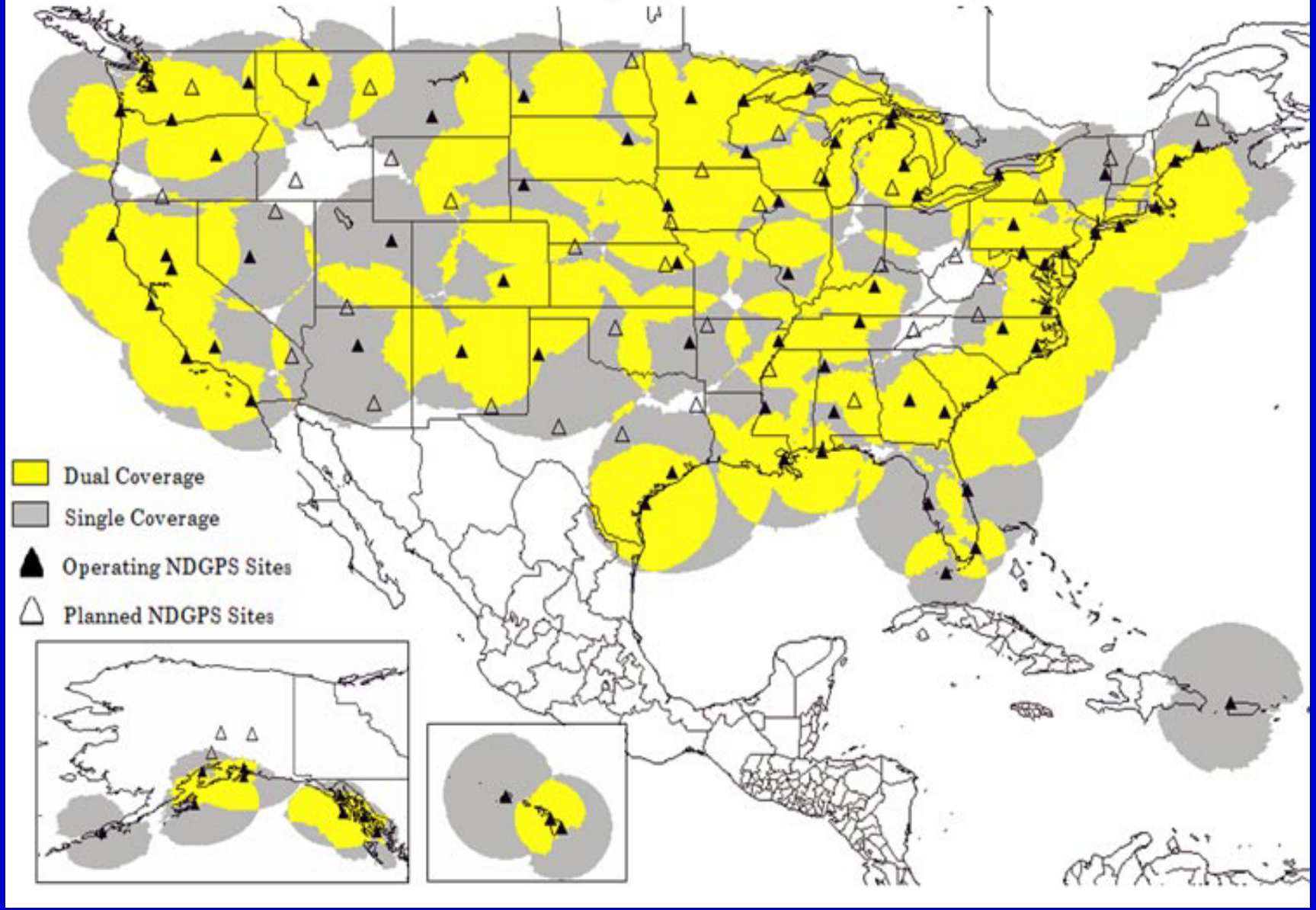
PTC Positioning

- Train positioning integrates multiple inputs:
  - Augmented GPS
  - Odometer
  - Switch position indicators
  - Digital track map in on-board computer
- System design copes with GPS signal loss in tunnels
- Position sent by data link to control center
- Track centers are 4 m apart, which requires 1-2 m accuracy (i.e., NDGPS)
- Accurate positioning also needed at clearance points at switches

Nationwide Differential GPS

- Augmented GPS: 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 60%
- Signals available to anyone with proper receiver; no user fee
- Managed and monitored 24/7 at US Coast Guard Navigation Center, Alexandria, VA

NDGPS Coverage (03 NOVEMBER 2004)

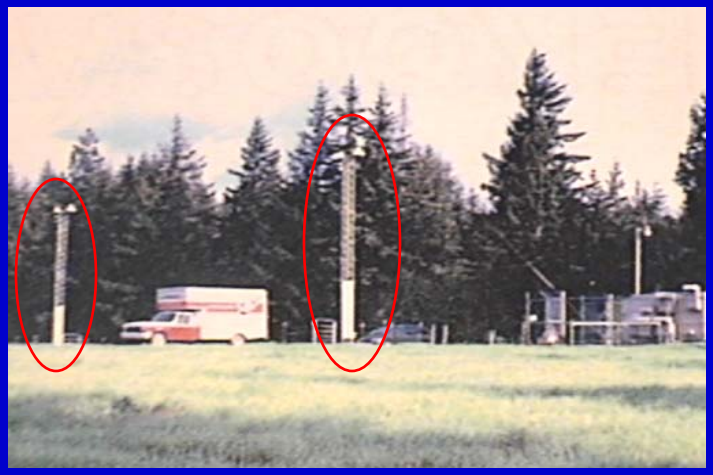


Nationwide Differential GPS

- In US, uses decommissioned USAF Ground Wave Emergency Network (GWEN) sites
- International standard (RTCM 104) developed by USCG; 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 NDGPS (HA-NDGPS) developed and tested by FHWA and USCG at Hagerstown, MD site: 10-20 cm accuracy

Converted GWEN to NDGPS

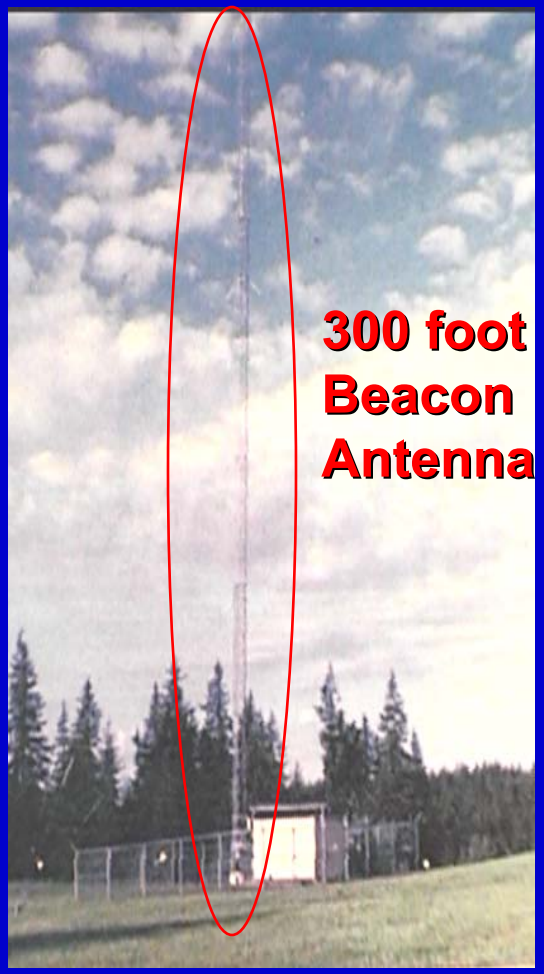
Appleton, WA



Reference & Integrity Antennas
Two sets of each

DGPS Equipment Shelter

There is a similar shelter for the 25KW generator

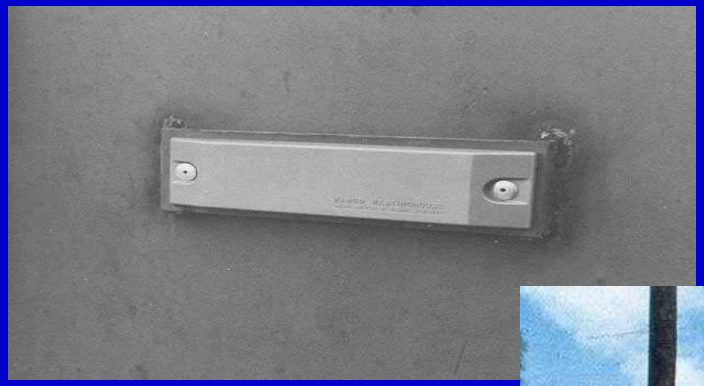


300 foot Beacon Antenna

Automatic Equipment Identification

- Two passive AEI (ie., RFID) tags installed on each freight car and locomotive since 1995; AAR Interchange Rule, no Federal involvement
- Readers at track-side interrogate tags at 900 MHz radio frequency; they require periodic "tuning" to maintain 100% read rate
- Tags respond with vehicle initial and number
- Can be integrated with wayside equipment sensors to identify specific cars with problems
- Active tags with read-write capability also available; require periodic battery replacement

AEI Tag and Reader



AEI Tags for Containers and Trailers

- ISO has adopted same tag for containers as a voluntary standard
- (Railroad AEI standard actually based on draft ISO container tag standard)
- ATA has adopted same tag for truck trailers and chassis as a voluntary standard
- It would be ideal if container and trailer tagging standards became mandatory as with rail cars

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
- Location of set-outs automatically recorded
- Train consists in central computers also updated in real time
- 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
- NDGPS receiver determines location of the loco to within 1-2 meters and speed to within 1-2 km/hr
- Data radio transmits train location and speed info back to dispatchers and operating data system
- Work order reporting system confirms set-outs and pick-ups
- 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 and shipper) can inquire about precise car/shipment location

Crew Registration and Time-Keeping Systems

- Use passwords, card keys, or biometrics to identify crew members authorized to operate trains
- Movement authority issued only when designated crew is on board and logged in
- On and off duty times, and terminal departure and arrival times, automatically sent to operating data system for payroll accuracy
- Data link necessary to carry this out

Emergency Notification Systems

- Automated reporting of rail incidents
- Notification of all involved organizations
- Coordination and control of organizations involved
- Information services for media and passengers
- Registration and analysis of performance
- Faster resolution of problems and resumption of service

Other Intelligent Railroad Systems

- Knowledge display interfaces
- Crew alertness monitoring systems
- Track forces terminals
- Wayside equipment sensors
- Wayside track sensors
- Locomotive health monitoring systems
- Energy management systems
- Vehicle-borne track monitoring sensors
- Car on-board component sensors
- Car on-board commodity sensors
- Intelligent weather systems
- Tactical traffic planners
- Strategic traffic planners
- Train, locomotive, car, and crew scheduling systems
- Yield management systems
- Travelers' advisory systems

Impediments to Implementation of Network Centric Railroading

- Magnitude of costs; competition for capital
- Pressure by the investment community to deliver near-term on investments
- Shortage of capital due to mergers and post-merger problems
- Time to implement – 7 to 10 years
- Lack of trained staff
- Fear of liabilities
- Interoperability issues come into play
- Fear of change, institutional and individual

More Impediments to Implementation of Network Centric Railroading

- Unwilling to view existing systems as sunk costs
- Uncertainty about customer response to improved service
- Railroads discount “soft” efficiency benefits heavily, count only “hard” labor and fuel savings
- Some RRs try to minimize cost of subsystems and not optimize total system
- RRs are implementing independent, not integrated systems
- Some RRs want PTC based on existing operating rule books, not on new paradigm

Still More Impediments to Implementation of Network Centric Railroading

- Signaling community tied to legacy systems
- RR budgeting often calls for each department to justify its own projects
- RRs not organized for implementing NCR; telecomm and signaling report to different VPs
- New information means information flows must be changed
- Uncertainty about FRA regulations; process is slow, it's taken over 7 years for PTC rule
- Proposed separation of RRs into infrastructure and operating companies

Yet Even More Impediments to Implementation of Network Centric Railroading

- RRs concerned about DoD control of GPS
- RR managers are used to managing downsizing and cost-cutting, not growth
- RRs want off-the-shelf systems, but won't give suppliers the commitment to enable them to put systems on-the-shelf
- RRs on record saying business benefits of PTC are less than the costs, that current operations are so good there is little room for improvement

Summary

- Network Centric Railroading is an integrated "system of systems"
- The US economy is growing; state highway departments say railroads need to carry more freight
- The Graniteville, SC chlorine accident has spooked communities throughout the nation; collisions continue to occur
- Railroad security continues to be a front-page story, "Where are the hazmat shipments?"
- Railroads need more profits
- Railroad safety, security, efficiency, and profitability are all achievable with Network Centric Railroading and intelligent railroad systems

Questions ?

Steve Ditmeyer
Department of Transportation Faculty Chair
Industrial College of the Armed Forces
Eisenhower Hall
Fort Lesley J. McNair
Washington, DC 20319

Phone: 202-685-4375
Email: ditmeyers@ndu.edu