

Communication-Based Signaling (CBS): Vital PTC

AREMA S&C Technical Conference

May 22, 2007

Bill Petit

www.billpetit.com



Topics

◆ Update Industry on Communication-Based Signaling (CBS) Activities

- Activities to define interoperable radio-based vital train control system based on signaling principles
- AREMA Committee 37 Manual Parts on Interoperability
 - ◆ Background
 - ◆ Proposed Manual Parts and Status
 - ◆ Basic System Architecture
 - ◆ Operational Goals leading to this architecture
- Supplier Initiative to demonstrate interoperability and compliance with Manual Parts

Background

- ◆ Roundtable discussions at 2005 AREMA C&S show generated request for interoperability guidelines for radio-based cab signal systems
- ◆ Assigned to Committee 37-3

Preliminary Meeting

- ◆ Assignees invited AREMA members to explore potential of defining interoperability.
 - Suppliers who have demonstrated desire for safety-critical (vital) radio-based signal systems with aspect display onboard
 - ◆ Alstom (Atlas), GETS (ITCS), Safetran (vTc), US&S (AKRR CAS).
 - Was there any hope of achieving consensus on architecture and interoperability?

Preliminary Meeting

- ◆ Assignees invited AREMA members to explore potential of defining interoperability.
 - Suppliers who have demonstrated desire for safety-critical (vital) radio-based signal systems with aspect display onboard
 - ◆ Alstom (Atlas), GETS (ITCS), Safetran (vTc), US&S (AKRR CAS).
 - Was there any hope of achieving consensus on architecture and interoperability?
 - AMAZINGLY, YES

Preliminary Meeting

- ◆ Assignees invited AREMA members to explore potential of defining interoperability.
 - Suppliers who have demonstrated desire for safety-critical (vital) radio-based signal systems with aspect display onboard
 - ◆ Alstom (Atlas), GETS (ITCS), Safetran (vTc), US&S (AKRR CAS).
 - Was there any hope of achieving consensus on architecture and interoperability?
 - GETS, Safetran and US&S decided to actively support development of manual parts

Group Members

◆ Safetran

- Jim Hoelscher (Staff Engineer), Bill Petit (VP Technology)

◆ GETS

- Jeff Baker (Product Mgr Adv Train Control), Daryl Seck (Product Mgr)

◆ US&S

- Chinnarao Mokkalapati (Chief Technologist), Denny Pascoe (Chief Technologist)

Group Recommendations

- ◆ Develop recommended practices for interoperability of communication based signaling systems based on signaling philosophy and practices consistent with other sections of the AREMA manual.
- ◆ Allows an opportunity for existing projects to integrate with an interoperable vital signal system
- ◆ Committee 37 approved plan to develop a series of proposed manual parts related to CBS at Spring 2006 meeting.

Proposed Manual Parts

- ◆ CBS.2 CBS System Requirements
- ◆ CBS.3 CBS System Design Guidelines
- ◆ CBS.4 CBS System Interoperability Requirements
- ◆ CBS.5 CBS Infrastructure Database

Section CBS.2

- ◆ CBS.2.1 Recommended Functional Requirements of a CBS System.
 - Define the recommended system functional requirements.
- ◆ CBS.2.2 Recommended RAMS, Environmental and Other Requirements for Signaling Systems Using CBS Architecture.
 - Define the recommended reliability, availability, maintainability, and safety (RAMS), environmental, electromagnetic compatibility, and quality assurance requirements.

Section CBS.3

- ◆ CBS.3.1 Recommended Design Guidelines for a CBS System
 - Define the recommended system architecture and interfaces based on conventional signaling principles.

Section CBS.4

◆ CBS.4.1 Recommended Communications Protocols for a CBS system

- Define the recommended system communication protocol (based on ATCS addressing and datagram)

◆ CBS.4.2 Recommended Communications Messages for a CBS System

- Define the recommended standard messages for communications between CBS subsystems

Section CBS.5

- ◆ CBS.5.1 Recommended Onboard Database Guidelines for a CBS system
 - Define the recommended structure and content of the onboard database

Status

- ◆ Drafts of the proposed new manual parts were developed.
- ◆ Provided to Committee 37 for full review (all committee members) at the Fall 2006 meeting.
- ◆ Initial comments collected at Spring 2007 meeting
- ◆ Manual Parts assigned to committee members to lead review at Fall 2007 meeting
- ◆ Committee also approved sharing drafts with AAR committees working on interoperability



Basic System Architecture

What is CBS?

Defined Communications Based Signaling as 'a radio based cab signal system'.

- Operate the same as a conventional Cab Signal System with enforcement. Onboard aspect display instead of wayside signals
- "Virtual" Block Occupancies used instead of physical track circuits.
- Train location determination done by on-board equipment (Definition of how to indicate a block is occupied, not how position is determined).
- Communication, including cab signal aspect transmission from wayside to trains, via a digital data communications network.

What is CBS?

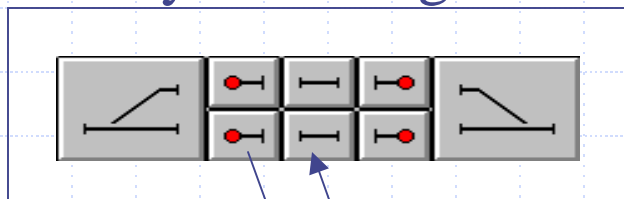
- ◆ CAD operation (i.e dispatching) is the same as in conventional CTC system.
- ◆ Signal Logic Processor (SLP) does all the vital logic and sends controls to wayside appliances and signal aspect info to the On Board Logic Processor (OBLP).
- ◆ OBLP provides signal aspect and speed limit info to train operators, and performs vital overspeed protection and signal enforcement.
- ◆ SLP also processes Bulletins received from CAD via Form Translator, and communicates them to various OBLPs.
- ◆ Interlocking logic is done in SLP or locally at the wayside.
- ◆ Communication follows ATCS protocols over a wide variety of transmission media

Existing cTc Territory

Control Office

Controls and Indications

Wayside Bungalow



CBS in existing
Dark Territory



Control Office

Controls and Indications

Proceed Aspect

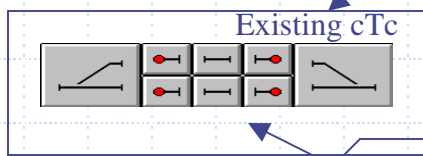
Occupying Block 123



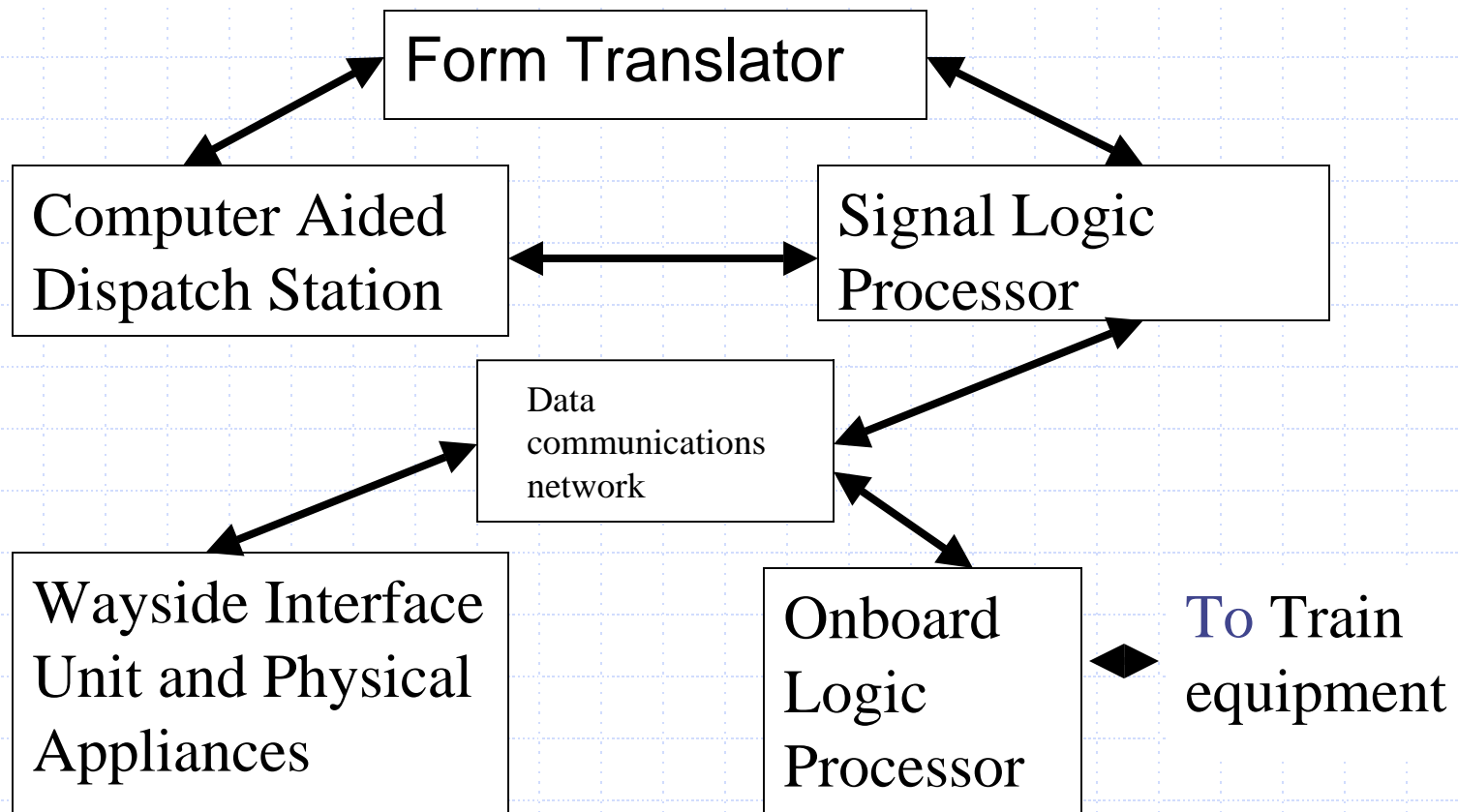
CBS overlaid on
cTc




Control Office
Controls and Indications



Defined CBS Architecture





Basic System Operational Goals

Key Goals and Benefits of CBS System

(Highlights Only – See paper for complete list)

- Improve Safety
- Reduce Cost
- Interoperability
- Based on Signaling Principles and Existing Vital Platforms
 - ◆ Each RR defines their own operating scenarios through application logic
 - ◆ Regulatory Acceptance
 - ◆ Not dependent on underlying method of operation for safety – allows change in method of operation
- Common, well known method of operation across entire territory

Enhanced Safety Features

- ◆ Continuous overspeed protection
- ◆ Safe movement of trains throughout the territory
 - Route protection based on signaling principles
 - Vital monitoring of all wayside appliances
 - In-cab display reduces wayside signal reliance due to weather, etc
- ◆ Secure communication between different subsystems
- ◆ Reduced train collisions
- ◆ Protection of roadway workers
- ◆ Reduces human error from movement authorities / train orders / track warrants
- ◆ Incorporate other wayside elements into signal protection system

Reduced System Costs

Reduced Equipment Costs and Reduced Labor to Operate, Install, Maintain and Test

- Cost-effective upgrade of currently non-signaled territory to radio-based cTc operation.
- Cost-effective upgrade of wayside signal systems to onboard displays with enforcement.
- ◆ Ability for shorter virtual blocks allows better following moves, improved throughput
- ◆ Enhanced Number of cab signal aspects allows better movement control and throughput.

Interoperability

- ◆ Industry association (AREMA) defined and maintained
 - Defines interfaces between equipment and basic system architecture, not form or fit.
- ◆ Developed jointly by multiple suppliers, consultants, users and regulatory representatives through Industry committee
- ◆ Availability from multiple suppliers
- ◆ Open Interface – no barriers to entry
- ◆ Based on existing open ATCS protocols (upper layers, not physical or network specific)
- ◆ Open system with multiple users leads to stable operation and increased functionality
- ◆ Maintains cost competition from multiple suppliers

Use of Signaling Principles and Existing Vital Platforms

- ◆ Operations controlled by each railroad
 - Application Logic is written by each railroad according to their own preferences.
 - Minimizes training and rule changes
- ◆ Not dependent on underlying method of operation for safety
 - Change underlying method of operation
 - Pathway to replacement of wayside systems as they become life expired

Use of Signaling Principles and Existing Vital Platforms

◆ Regulatory Acceptance

- Ability to qualify under 49CFR part 236, including subpart H
 - ◆ Based on proven and accepted signaling principles
 - ◆ Based on proven and accepted safety-critical platforms
 - ◆ Use of existing principles reduces HF issues
- Builds on existing knowledge base of S&C employees
- Familiarity of concepts



Planned Interoperability Demo

Interoperability Demo Goals

- ◆ Note that this is independent of AREMA
- ◆ Verify interoperability MP's and overall system operation
- ◆ GETS, Safetran and US&S have jointly agreed to support a lab interoperability demo.
 - Each company will modify their own products to demonstrate interoperability
 - 3rd party will be used to develop interoperability simulation and testing
- ◆ AAR/FRA have expressed interest in funding lab demo

Interoperability Demo

◆ 3rd party work products

- Vehicle Simulator (allows speed control of locomotive)
- Central Office Simulator– Displays operation of overall system
- Communications Hub – simulates communication architecture



Questions / Comments ?

Bill.Petit@ieee.org