Concept of Operations Document Template

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# Introduction

## Scope

## References

[1] Guide to the Preparation of Operational Concept Documents (ANSI/AIAA G-043A-2012)

[2] Systems and Software Engineering – Life Cycle Processes – Requirements Engineering (IEEE 291487:2011)

## Acronyms

## System Definition & Assumptions

# Existing Signalling System and Operations

## System Overview

Describe the existing legacy signalling system currently in service. This will provide the context for the new CBTC system intended to be deployed.

### Central Control

### Trackside

### Vehicle

### Data Communication

### External Interfaces

#### Passenger Information and Announcement System (PIS/PAS)

#### SCADA

#### Tunnel Ventilation Doors

#### Level Crossing

## Operational Overview

Describe the operations of the current legacy system. The Transit Agency may keep the same operation or modify them in light of new CBTC capabilities.

### Mainline Operations

Describe the pattern of operation during:

1. Morning peak
2. Evening peak
3. After morning peak
4. After evening peak
5. Nighttime. There may be no operations but maintenance activities might be occurring
6. Special events (sporting, concert, major conventions etc.)
7. Weekend
8. Failure scenarios

### Yard Operations

Describe the internal yard/depot operations. How do trains move around?

#### Launching into Service

#### Taking Trains out of Service

#### Internal Yard Operations

### Key Operational Procedures

Identify key operational procedures such as:

1. Fire at a station
2. Stranded train due to a mechanical failure
3. Overcrowding at a station

## Support Environment

### Diagnostics

How are problems identified if at all?

Do maintenance personnel need to go to the location to investigate the problem or is there a mechanism in place to identify and localize the problem before personnel travel to investigate.

### Maintenance

#### Work Zones

How are work zones established to protect maintenance crew working at trackside.

#### Work Cars

How are work cars utilized?

How are they tracked?

List the various types of work cars in the fleet and their basic characteristics such as length and purpose.

Are they permitted to operate during normal operational hours along with passenger trains?

Are they shared between lines if there are multiple lines?

### Training

How are agency personnel trained?

Is training conducted in a class room setting?

Are students trained using simulators or is training conducted on live equipment or both?

# Justification for New CBTC System

## Operational Need

This section attempts to answer the question of what is required by the transit agency that the current signalling system does not provide.

This is simply the justification for transitioning from a conventionally signalled system to a CBTC signalled system. This section should:

1. Briefly summarize the aspects of a CBTC system that will benefit the transit agency.
2. Summarize the deficiencies or limitations of the current conventional signalling system that make it unable to address current or future needs such as ridership or maintenance expectations; and
3. Provide justification for CBTC system.
   * What problem is this CBTC system going to address for the transit agency.
   * If the CBTC system improves current operations, describe the rationale behind the decision to modify the existing system such as reduce headway, increase passenger throughput, to reduce maintenance costs or increase automation.
   * Explain which CBTC functions are important for the Transit Agency.

## Description of Desired Changes

This section summarizes the CBTC capabilities that will benefit the Transit Agency such as:

1. Capability changes. Description of the CBTC functions and features to be added, old conventional signalling capabilities that will be deleted and or modified to allow the new CBTC system to meets its objectives.
2. Interface changes. How will existing external subsystems interface with the new CBTC system?
3. Personnel changes. Description of changes in personnel caused by the new CBTC system: Old positions removed, new positions added and other positions repurposed.
4. Operational changes. Description of changes to the Transit Agency’s operational policies, procedures, rule book caused by the new CBTC system.
5. Support changes. Description of changes in the support requirements due to the new CBTC system such as maintenance/diagnostic approach, training or information technology.
6. Other changes. Description of other changes that will impact the Transit Agency not captured above.

## Priorities of Desired Changes

## Desired Changes Considered but not Included

Capabilities that were considered but not included along with a justification.

# Proposed CBTC Operating Environment

## System Users

This section of the document describes the intended CBTC operation from the end user vantage point. It identifies the users of the system and their priorities which will be translated into CBTC system capabilities in the next chapter.

This portion of the ConOps is the main focus for the entire document, as it is intended to outline the landscape of the system, and provide a clear working image for each stakeholder.

This is accomplished by using a mind map of users and their priorities.



Figure 1 - Mind map of a typical CBTC system with users and their priorities

From the mind map, describe each operator/user and what their priorities and needs are and why?

### Operators

#### Central Control Operator

#### Yard Operator

### Maintenance Personnel

#### Trackside Maintenance Personnel

#### Vehicle Maintenance Personnel

### Train Drivers

### IT Personnel (DCS)

### Instructors

### Passengers

### Emergency First Responders

## Operations

In this section, describe the expected operations for the CBTC system broken out by mainline and yard operations.

### Mainline Operations

#### Normal Operations

Describe the normal patterns of operation using graphics.

#### Terminal Stations

How are turn backs performed?

### Yard/Depot Operation

#### Launching Trains into Service

How will the trains be launched into service?

Where will the train localize and be placed into a controlled mode?

Will trains “wake up” in the storage lane and proceed automatically to the launch point?

#### Taking Trains out of Service

How will trains be taken out of service?

Is there a disembarkation point where the crews can exit the trains?

#### Operations within the Yard/Depot

How will trains move about in the depot, automatic or manual

### Degraded Operations

#### Failed Trains

How will the operator recover a failed train with passengers on board in the middle of the track?

#### Subsystem Failures

How will the system respond to the various subsystem (central, wayside and on-board) failures that can occur in a CBTC system?

#### Closed Station

#### Misalignment at Station

What is the reaction of the train if it misaligns at a station platform.

#### Work Zones

How will work zones be implemented? By procedure or is it expected the CBTC system will implement a work zone and protect the maintenance crews?

## Support Concept and Environment

Talk about how training will be performed, how maintenance will be performed, how IT will monitor the system. These are people who support the front line personnel and users such as the Central Control Operators, Train Drivers and Passengers.

### Maintenance

### Training

### Network

# Proposed CBTC System Overview

The intent of this section is to provide an overview of the CBTC system, rather than a detailed description of system architecture, functions and other characteristics. The system overview is written from the perspective(s) of the Transit Agency personnel using the CBTC system defined in section 4 above. This section should include details of the CBTC system scope, CBTC boundaries (both physical and operational), CBTC states and modes, capabilities and external interfaces.

## System Scope

What is the primary use of the CBTC system within the context of the Transit Agency’s operational environment?

## System Goals and Objectives

Describe why the Transit Agency needs this system. What are the expectations of the system?

* + - Availability
    - Reliability
    - Maintainability – reduced equipment to maintain, less trackside equipment
    - Performance – headway or pphpd (People Per Hour Per Direction)
    - Increased automation
    - Safety

## Systems Architecture

This section expands the green CBTC circle from Figure 1.

Early in the development of the ConOps, the CBTC architecture may not be known (each supplier has their own architecture) but there should be a basic concept of what the CBTC architecture may look like. This should be shown graphically as well as a brief description.



Figure 2 - The green CBTC circle in the mind map is expanded to show the CBTC architecture



Figure 3 - Typical CBTC architecture

## System Capabilities

The intention of this section is not to define requirements but a narrative with graphics to understand what kind of system capabilities will address the end user’s needs and possible changes to the operating environment due to a new signalling system.

In this section, broad CBTC system capabilities are extracted from the user mind map defined in chapter 4. Each capability is further divided into smaller topics where proper details can be provided.

This section is also concerned with adaptations expected from the operating environment. Although the intent is for the CBTC system to adapt to the operating environment as much as possible but in order to take advantage of certain CBTC capabilities, the operating environment may need to change as well.



Figure 4 – User needs and priorities are broken down into CBTC system capabilities that will address the user’s needs

### Central Control

#### Operational Failure Recovery

#### User Interface

#### Reports

#### Regulation

#### Cutover Strategy

#### Yard Operator

##### Launching Trains into and Out of Service

### Simulators

#### Trackside Simulator

#### Central Simulator

#### Vehicle Simulator

#### Training Material

### Network

#### Network Security

#### Reliability

### Trains

#### Train Modes

#### Train Status/Alarms

#### Train & Platform Doors

#### Train Performance Characteristics

### Maintenance

#### Reliability

#### Maintainability

#### Trackside Maintenance

##### Special Tools

##### Work Zone Protection

##### Work Cars

#### Vehicle Maintenance

##### Special Tools

### Emergency Response

### Redundancy

#### Central

#### Trackside

#### Vehicle

#### Network

### Diagnostics

#### Central

#### Trackside

#### Vehicle

#### Network

### Passenger Information and Announcement System (PIS/PAS)

#### Platform PIS/PAS

#### Train PISPAS

## Operating Environment Modifications

Although the intent is for the CBTC system to adapt to the operating environment as much as possible but in order to take advantage of certain CBTC capabilities, the operating environment may need to change as well.

This section is also concerned with adaptations expected from the operating environment if any.



Figure 5 – Modifications to the operating environment that may emanate from the CBTC system to take advantage of new CBTC capabilities

### Diagnostics

A complete new diagnostics approach will be taken due to new equipment

### Work Car Operating Procedures

New procedure for operating work cars depending on if the work cars are equipped with CBTC equipment or not.

## System Interfaces and Boundaries

This section defines all of the external interfaces to the CBTC system. Each external interface describes how the CBTC system will behave with it.



Figure 6 - Define external interfaces

### Rolling Stock

#### TOD

#### Propulsion

#### Braking

#### TCMS

#### Doors

### Platform Doors

### Passenger Information and Announcement System

### SCADA

### Tunnel Vent Doors

### Switch Machines

## System States and Modes

There are two parts to this section. The first is the CBTC system level modes and the second are the train modes of operations.

### System Level Modes of Operation

#### Normal Mode

#### Fallback Mode

#### Self-Regulating Mode

#### Back Up Control Centre

### Train Modes

#### Automatic Mode

#### Protected Manual Mode

#### Manual Mode

#### Cut-out Mode

## Impact

This section summarizes the impact on the Transit Agency personnel arising from the implementation of the CBTC solution. Its purpose is to provide advance notice to all parts of the organization which may need to take action in response to the implementation of the CBTC system.

It should also identify impacts to the operational, and support environments as well.

Impacs may include the following:

* Operational impacts, including procedures, interfaces with other systems, and the source and handling of information;
* Organizational impacts, including changes to responsibilities, addition or elimination of responsibilities or positions, the need for training or retraining; and changes in number, skill levels, position identifiers, or location of personnel in various modes of operation; and
* Impacts during the development effort, including meetings/discussions regarding the new CBTC system, development or modification of common information, training, parallel operation of the CBTC with the legacy signalled existing system, impacts during testing and other activities needed to aid or monitor development. In the beginning, it should be noted that some of this information may not be available during preparation of the ConOps and therefore speculation should be avoided.

# Operational Scenarios

This section should describe key operational scenarios expected of the new CBTC system. It should be written in a narrative form with graphics to describe the scenario properly.

## Implementing and Lifting Work Zones

Describe how a work zone would be implemented then lifted, by the CBTC system, once the work crews complete their work.

## Launching Trains into Service

## Taking Trains Out of Service

## Recovering Failed or Stranded Train

## Emergency Protocols

## Turn Backs at Terminal Stations

# Analysis of the Proposed System

Summarize the advantages and disadvantages of the proposed system