NTCIP Signal Control Prioritization Working Paper:
Concept of Operations

1.0 Overview

This working paper summarizes and describes the concept of operations for signal control prioritization. The purpose of the concept of operations document is to establish descriptions of priority operations from which the system requirements, data objects, alternative system architectures, and standards test procedures can be developed. In general traffic signal priority can be given to vehicles from a variety of fleets including transit vehicles (buses and light rail), emergency vehicles (fire, ambulances, and police), and rail vehicles (heavy rail). Realistically, priority can be given to any and all vehicles – however, the level of priority may be different across and within different fleets.

Figure 1 depicts a Level 0 Data Flow Diagram (Context Diagram) for the priority scenario. This diagram will serve as the basis for the discussion of the concepts of operations. The two basic processes identified in Figure 1 are the Priority Request Generator and the Signal Timing process. The Priority Request Generator accepts Criteria from the Fleet Operations Management System and Vehicle Information from any fleet vehicle and determines the content of the Priority Request message that is sent to the Signal Timing process. The Signal Timing Process accepts Signal Timing Parameters from a Traffic Management System and Status information from the operating Traffic Signal(s) to provide the desired level of signal timing priority. The Fleet Operations Management Systems and the Traffic Management System have the ability to share

![Figure 1. Signal Priority Context Diagram.](image-url)
information through the Data Exchange process. Each process provides Status, or Feedback, information to each of the information sources.

This working paper is organized into the three sections. Section 2.0 provides operational concept descriptions of existing and current priority systems. These descriptions are intended to provide a baseline for existing practices and are presented within the framework of the Signal Priority Context Diagram. Section 2.0 is divided into three primary areas: 2.1 transit signal priority, 2.2 emergency vehicle priority, and 2.3 railroad priority. Section 2.4 describes other applications of signal priority. Section 3.0 provides a speculative projection of future priority systems based on current trends, practices, and agency desires. This section is intended to address potential requirements that future system designs will place on signal priority standards.

Section 4.0 presents a series of typical (generic) scenarios that will be used as the basis for the development of a class model and interaction diagrams that will be used in the development of the NTCIP SCP standard. The typical scenarios will be used to identify the fundamental classes (objects) that are needed to describe signal prioritization. Classes are made up of attributes and operations that characterize signal prioritization. Classes may have relationships to other classes and groups of classes may be combined into packages (such as the traffic management system package). Interaction diagrams describe the interaction of objects (through message passing) to realize behaviors. Each operational scenario should be describable within the class diagram model through an interaction diagram. Interaction diagrams provide a mechanism for exercising the class model to ensure that a valid object model has been developed. Details of the class model and interaction diagrams are provided in a separate working paper.

Discussion of Components of the DFD

**Processes** – Processes are the active logical components of the system. Processes accept data from the flows and generate data for flows.

**Priority Request Generator** – The process of deciding if, when, and how a vehicle can request priority timing from the signal timing logic. The process might include factors such as priority level, frequency of requests, multiple requests, etc.

**Signal Timing** – The process of deciding how to time the traffic signals. This includes preemption, priority, free, coordination, transition (short way, long way, hold, dwell, etc.). This process may include consideration for prevailing traffic conditions.
Data Exchange – The data exchange process provides a mechanism (e.g. translation) between management centers (center-to-center communications).

Terminators – Sources and Sinks for information. These generally represent other entities (actors) that interface to the principle process of the priority system.

Traffic Management – The ATMS component that provides traffic management functions including monitoring signal operations, area-wide control (time-of-day, manual traffic responsive), incident detection and management, etc.

Traffic Signal – The equipment used to display signals to vehicle operators.

Fleet Operations Management – The operations management system for different fleets of vehicles, e.g. transit management system, and includes information management and control capabilities for the respective fleet.

Fleet Vehicle – The vehicle that desires priority treatment within a system.

Data Flows – the basic data elements that are passed between processes and between processes and terminators.

Signal Timing Parameters – All data (parameters) required for operation of a traffic signal controller. (The TS 3.5 ASC Standard should be the basis).

Status (Signal Timing) – The current state of the signal timing process in providing the requested priority within the set of signal timing logic and parameters.

Priority Timing – The actual signal timing that is implemented. This is what the vehicles actually see.

Status (Traffic Signal) – The state of the actual traffic signals as presented to the vehicles.

Priority Request – The request from the Priority Request Generator to the signal timing process asking for priority timing. Information in this request might include the priority level, the time service is required, the class of vehicle, and the desired length of service.

Feedback – This is information from the Signal Timing process back to the request generator about the status of the priority request. The information might include the ability of the Signal Timing process to satisfy the request, when the request can be served, etc.
Criteria – This is the set of criteria by which the priority request generator decides whether to request priority at a signal. Criteria might include factors such as permission based on class or identification of vehicles, frequency of priority requests, time-of-day, transit schedule (by route) etc.

Status (Priority Request Generator) – Status of each priority request that is returned to the Fleet Operations Management and contains information necessary for generating reports, tracking requests, etc.

Vehicle Information – Information about a specific vehicles that will be used by the Priority Request Generator and includes information such as passenger count, vehicle characteristics.

Request Status (Priority Request Generator) – Information from the Request Generator to the Fleet Vehicle reflecting the status of a request for priority. Information might include the time to service, acceptance or denial of a request, etc.

Vehicles (Potential Priority Users)

1. Transit
   1.1. Buses
   1.2. Light Rail
   1.3. Commuter Rail (Tom)
2. Maintenance Vehicles (Mike)
3. Trucks (Tom Urbanik)
4. Emergency Vehicles
   4.1. Fire
   4.2. Police
   4.3. Ambulances
5. Freight Rail
2.0 Operational Descriptions of Existing Systems

2.1 Transit Signal Priority

2.1.1 UTCS Bus Priority System – (L. Head)

2.1.2 King County Metro Bus Priority System – (R. Atherley)

2.1.3 Cermak Road – (G. Duncan)

2.1.4 Montgomery County, MD. – (G. Duncan)

2.1.5 Portland LRT Priority System (Willie Rotich)

2.1.6 Tasman (Paul Olson)

2.1.7 LA TSP (Sean Skekan)

2.1.8 LA Blue Line (Warren Tighe, Sean Skekan)

2.1.9 Imagine (LACO MTA) (G. Duncan, K. Balke)

2.1.10 SLC LRT ATMS (L. Head)

2.1.11 Typical transit priority in existing traffic signal controllers (least common denominator)

2.2 Emergency Vehicle Priority (Mike Roman, Dale Thomson)

2.3 Railroad Priority (Tom Urbanik)

3.0 Operational Descriptions of Future Priority Systems

4.0 Typical Operational Scenarios

Notes: We may end up moving all of Sections 2 and 3 to an appendix and trying to keep the content of the working paper to a short (10-15 pp) document that supports the generic concept of operations.
Work Item 0: Draft Work Plan 12.31.99
Work Item 1: Draft Use Cases 12.31.99
Work Item 2: Draft Terminology 12.31.99
Work Item 3: Revise/Consolidate Use Cases 1.31.00
Work Item 4: Draft Operational Scenarios 2.14.00
Meeting 2: Review Operational Scenarios 3.2-3.00
    Brainstorm Class Definitions
    Houston TransStar
White Paper: Operational Concepts 4.15.00
White Paper: Terminology 3.30.00

Work Item 5: Select Consultant 3.30.00
Work Item 6: Identify Class Definitions 5.30.00
Work Item 7: Compare with Existing Standards 6.30.00
Meeting 3: Review Class Definitions (Seattle) 7.11-12.00
    (Tentative)
White Paper: Class Definitions (Model) 8.30.00
White Paper: Comparison with Existing STD

Work Item 8: Draft Class (Object) Model 9.15.00
Work Item 9: Draft Standard 11.30.00
    (College Station, TX)
Draft Standard 12.31.00