SYSTEMS ENGINEERING
TEST PLAN

For

HENNEPIN COUNTY
CENTRAL TRAFFIC SIGNAL CONTORL
SOFTWARE

SP 027-030-040
Minn Proj. No. HSIP 2717 (156)
County Project 1546

November 2, 2020

Table of Contents

1. Introduction

1.1 Introduction

This document presents the draft test plan for Hennepin County Central Traffic Signal Control System (CTSCS) implementation as part of systems engineering requirements. System testing is an essential step in the systems engineering process to ensure that system functionalities and operations being defined, designed and integrated conform to the needs and requirements specified in the concept pf operations and system requirements document. System requirements will be verified by testing at different levels during system acceptance test period after the system is fully implemented. The test results will provide evidence to assure compliance with the system needs and requirements as well as provide guidance for corrective actions that need to be conducted to produce proper system operations.

1.2 Purpose of Document

The purpose of this document is to present a list of high level system requirements that will be verified for system testing. The document includes the description of each requirement that will be tested by the deployment team as part of the project. It serves as a basis that can be used for the testing team to perform acceptance testing. The specific test will be conducted for each requirement by the test personnel to follow when performing the system requirement verification during the test period. Testing details and results will be documented in the system requirement verification tables included in this document and also presented to determine whether a test passes or fails when the acceptance test is completed.

1.3 Scope

This test plan is to be used to verify system requirements after successful installation and integration of the CTSCS at the Hennepin County. The document addresses verification of system functionalities and operations as a result of installations and modifications to either the system hardware or software during the course of acceptance testing.

The requirements verification will focus on a total of 18 areas for the CTSCS, including graphical user interface, signal timing database management, traffic signal control interface, operator/user access, control modes, traffic adaptive control, control areas, time/data synchronization, system schedule, signal timing compliance monitoring, failure monitoring, CTSCS database, detectors, system log, reporting, automatic alerting, failure recovery, and online help.

2. Needs

This section presents a series of needs that have been identified for the Hennepin County CTSCS. These needs are described below and numbered for identification and traceability purposes.

Need	Description
Need 1:	Hennepin County needs to control any County-operated traffic signal controller that is equipped with continuous communications (e.g. Ethernet) capabilities and also supports NTCIP 1202 Actuated Signal Controller (ASC) management information base (MIB) codes, from one central system.
Need 2:	Hennepin County needs the CTSCS to be easy to use and convenient, supporting both regular operators who will work with it daily and occasional operators.
Need 3:	Hennepin County needs the CTSCS to be compatible with existing and future hardware and software environments, as well as, the Minnesota Statewide Regional ITS Architecture.
Need 4:	Hennepin County needs easy access to real-time signalized intersection information.
Need 5:	Hennepin County needs to upload and download traffic control operations to traffic signal controllers, and perform quick and full compare functions.
Need 6:	Hennepin County needs to use traffic signal optimization tools in conjunction with the CTSCS to help develop and program signal timing plans.
Need 7:	Hennepin County needs to accommodate multiple operators with various privilege levels, who may securely access the system at any time, including simultaneous use.
Need 8:	Hennepin County needs the option to allow other jurisdictions the ability to view and/or control selected signalized intersections and the ability to view and/or control signalized intersections in neighboring jurisdictions.
Need 9:	Hennepin County needs the CTSCS to support multiple control modes to meet various conditions, including time-of-day, traffic responsive, and compatibility with future adaptive control systems.
Need 10:	Hennepin County needs CTSCS data describing signalized intersections to be saved in a manner that supports secure access by others and having archiving capabilities.
Need 11:	Hennepin County needs the CTSCS to generate a variety of operations, maintenance, and performance reports in useful formats.
Need 12:	Hennepin County needs the CTSCS to operate reliably, with minimum downtime.

Need 13:	Hennepin County needs the CTSCS to be supported by the vendor through a combination of training, limited on-site visits, telephone help lines, and online help features to support operator questions about technical issues.
Need 14:	Hennepin County and partnering agencies need to access the CTSCS from various office locations throughout the metropolitan area.
Need 15:	Hennepin County staff needs to securely access the CTSCS from mobile devices, such as tablets or cell phones, although not all functionality needs to be available from mobile devices.
Need 16:	Hennepin County needs the CTSCS to support traffic signal performance measure calculations.
Need 17:	Hennepin County needs the CTSCS to allow customization and flexibility in the user interface, without requiring software code changes (e.g. the ability to select the parameters that appear when hovering the mouse over an object).
Need 18	Hennepin County needs the CTSCS to be expandable to include additional intersections in the future.
Need 19	Hennepin County Operators need to receive automated maintenance recognition and alerts including requirements for user-defined formats.
Need 20	Hennepin County Operators need to be able to remotely monitor transit signal priority (TSP) operations, and to be able to remotely upload/download TSP timing parameters from the CTSCS to the signal controllers.
Need 21	Hennepin County needs the CTSCS to interface with and operate current and future Intelligent Transportation System (ITS) devices (i.e. DMS and CCTV).

3. System Requirement Verification

This section presents the system requirements in relation to 18 areas of functionality that will be verified by testing for the CTSCS. Each requirement is described in terms of how it will address the stakeholder needs identified in the previous section. These needs are noted in parentheses following each description of the system requirements. Each requirement is numbered for reference and traceability purposes and will be tested and evaluated during the system testing phase.

Category	Descriptions	Pass/Fail	Comments
Graphical User Interface			
1.1.	Operators will want to see and work with field devices located on a map in the central control software. (Need 2)		
1.2.	Operators may be simultaneously monitoring field device operations and controlling modifications to them. (Need 2)		
1.3.	Operators will use tools and features they are familiar with (e.g. pop-up windows, dialog boxes, menu icons). (Needs 2, 3, 17)		
1.4.	Operators will customize the user interface settings to suit their preferences. (Needs 2, 17)		
1.5.	Operators will use a map in the user interface to view all field devices connected to the CTSCS and require a map displaying their locations to do so. (Needs 4, 21)		
1.6.	Operators will use screen captures and annotated text to share information with other operators or jurisdictions. (Need 4)		
1.7.	Operators will view a map displaying status of all signals controlled by their agency. (Need 4)		
1.8.	Operators will pan/zoom the map to view any of the intersections controlled by the system. (Need 4)		
1.9.	Operators will mouse over intersections to view detailed signal phase status. (Need 4)		
1.10.	As operators zoom to specific intersections or corridors, the map should present real-time intersection information. (Need 4)		
1.11.	Operators will view general signal status at higher zoom levels. (Need 4)		

Category	Descriptions	Pass/Fail	Comments
1.12.	Operators needing additional information will zoom the map to examine closer views of the intersections, where additional information will be available. (Needs 2, 4, 17)		
1.13.	Operators may quickly access their specific area using zoom, pull down menus or individual operator settings. (Need 4)		
1.14.	Operators will save their preferred map area displayed for future access. (Need 4)		
1.15.	Operators will use one CTSCS to view the status of all traffic signals controlled by the system. (Need 1)		
1.16.	Operators will have the option of viewing background satellite images overlaid on the map to understand the geometries and other physical characteristics of the intersection. (Need 4)		
1.17.	Operators will use the CTSCS map display to select one or more intersections and view information about the current demand at the intersection and signal control plan in operation, including: (Needs 4, 20)		
	• The geographic layout of the intersection(s);		
	• The location of detectors;		
	• The location of signal controllers;		
	• The current signal plan and phasing in operation;		
	• The current green, yellow, red displays to travelers (including flashing yellow arrow); and		
	• The most recent detector data recorded.		
1.18.	Operators will use the interface to place a demand on one or more detectors, effectively replicating a vehicle crossing a detector, and the system will communicate this demand to the local controller. (Need 4)		
1.19.	The creation of the graphical map display will be supported by customized graphics that are used by operators to diagram intersections. (Need 4)		
1.20.	Operators will have the option of selecting a group of intersections and be able to view the current green for all signalized intersections in the group. (Need 4)		

Category	Descriptions	Pass/Fail	Comments
1.21.	Operators will have the capability of opening multiple windows, including multiple map displays and text displays. (Need 4)		
1.22.	The operator will always be viewing the most recent data that has been received by the CTSCS from field devices during the most recent data poll. (Needs 4, 21)		
1.23.	Operators will use the map interface to view ITS devices not controlled by the CTSCS (e.g. DMS, CCTV) located at intersections, including text descriptions of their capabilities. (Need 21)		
1.24.	Operators will have the capability to view current transit signal priority operations in real-time. (Need 20)		
2. Signal Timing Database Management			
2.1.	The operator will have the ability for the CTSCS to select to download data describing traffic signal control operations from the CTSCS to the field controller, or to upload data from the field controller to CTSCS. (Need 5)		
2.2.	Operators will have the option of archiving data related to signal timing plans and other control attributes for use later or by other intersections. (Need 5)		
2.3.	When operators use a database to generate traffic control operations, the CTSCS will include safeguards to avoid unacceptable operations. (Need 5)		
2.4.	Operators will have the option to copy traffic control operations implemented at one intersection and deploy it to other intersections by menu that allows to select portion of the database (i.e. system configuration, signal timing, detectors, and etc.). (Need 5)		
2.5.	Operators will have the option to schedule upload or download of traffic control operations parameters from and to intersection controllers. (Need 5)		
2.6.	Operators will have the ability to initiate a process for Synchro to determine a new signal timing plan for one or more intersections and to incorporate the Synchro generated timing plan into the CTSCS and the intersection controllers. (Need 6)		
2.7.	Operators will have the ability to download TSP timing parameter data from the CTSCS to the field controllers, and to upload TSP		

Category	Descriptions	Pass/Fail	Comments
	timing parameter data from the field controller to the CTSCS. (Need 20)		
3.	**Traffic Signal Controller Interface**		
3.1.	Operators will execute a login process to gain access to the CTSCS, including specific access and control privileges. (Need 3)		
4.	**Operator / User Access to CTSCS**		
4.1.	Multiple operators will access and use the CTSCS simultaneously, with various levels of privileges. (Need 7)		
4.2.	Operators will execute a login process to gain access to the CTSCS, including specific access and control privileges. (Need 7)		
4.3.	Hennepin County operators will use the CTSCS to view and/or control signalized intersections in neighboring jurisdictions. (Need 8)		
5.	**Control Modes**		
5.1.	Operators will enter commands into the CTSCS to control one or more signalized intersections and the CTSCS will execute the commands. (Needs 5, 9)		
5.2.	Operators viewing information in the CTSCS will view real-time changes at the field controllers, with updates no less frequent than once per second. (Need 5)		
5.3.	In situations where a change is implemented to the signal timing plan by an operator manually adjusting the controller at the cabinet, the CTSCS will notify operators that a field change has been implemented. (Need 4)		
5.4.	The CTSCS will operate to control all connected traffic signal controllers 24 hours per day, seven days per week, regardless of whether any operators are logged in. (Needs 5, 9)		
5.5.	Operators will have the ability to control traffic signal controllers using 'manual mode.' (Needs 5, 9)		
5.6.	Operators will select to operate the CTSCS in Time-of-Day (TOD)/Day-of-Week (DOW) mode. (Needs 5, 9)		
5.7.	Operators will select to operate the CTSCS in Traffic Responsive Control Mode. (Needs 5, 9)		

Category	Descriptions	Pass/Fail	Comments
5.8.	Traffic signal controllers connected to the CTSCS will support vehicle actuated signal priority operation and the CTSCS will enable and support this. (Need 5)		
5.9.	Operators will use the CTSCS to implement flash control (red flashing lights) to any individual intersection controlled by the CTSCS. (Need 5)		
5.10.	Operators may need to control select intersections outside normal coordination with other intersections. (Need 5)		
5.11.	Operators will predefine scheduled operations for intersections based on events. (Need 5)		
5.12.	Operators will rely on functionality of the CTSCS to enable them to define a series of actions that can be applied to various signal controllers and save these actions as 'action plans' to be implemented quickly when needed. (Need 5)		
5.13.	Unless prescribed otherwise by an operator, the CTSCS will operate in a default mode that is based on TOD/DOW. (Needs 5, 9)		
5.14.	Operators will maintain a schedule for appropriate timing plans based on time of year, week and day. (Needs 5, 9)		
6. Traffic Adaptive Control			
6.1.	At some point in the future Hennepin County may utilize a traffic adaptive control strategy. The architecture of the CTSCS will enable Hennepin County to implement the adaptive control strategy at selected intersections or corridors. (Need 9)		
7. Control Areas			
7.1.	Operators will have the option to control all signal controllers in the system. (Need 1)		
7.2.	Operators or administrators will organize traffic signals into logical groups to support more efficient control of multiple intersections. (Needs 2, 17)		
7.3.	Operators will have the option to add and delete signal controllers in the system. (Need 18)		

Category	Descriptions	Pass/Fail	Comments
8. Time/Date Synchronization			
8.1.	The time/date of the CTSCS will be synchronized using a scheduled command with Universal Time automatically, without operator intervention. (Need 2)		
8.2.	The CTSCS will support system-wide clocks and local time clocks. (Need 2)		
8.3.	The CTSCS will perform checks on traffic signal controllers connected to the CTSCS to verify if the field clocks are within acceptable range of the system time. (Need 2)		
9. System Schedules			
9.1.	Operators will create and implement schedules for the control of one or more traffic signal controllers by specifying the begin/end time and date. (Need 2)		
9.2.	When creating and implementing schedules, operators will have the option to use either permanent or temporary schedules. (Need 2)		
10. Timing Plan Compliance Monitoring			
10.1.	The CTSCS will support operators by performing remote monitoring of traffic signal controllers connected to the CTSCS to determine if the actual timing parameters match the current values scheduled to be operational at the selected time, based on the database stored in the CTSCS. Operators will receive alerts if these do not match. (Need 5)		
11. Failure Monitoring			
11.1.	The CTSCS will support operators by detecting, alerting, and logging communication failures to traffic signal controllers. (Needs 4, 5, 19)		
12. CTSCS Database			
12.1.	The CTSCS will support a variety of users by maintaining a database that stores data describing traffic detected at signalized intersections and signal timing parameters executed at intersections. (Need 10)		

Category	Descriptions	Pass/Fail	Comments
13. Detectors			
13.1.	The CTSCS will accept and process detector data reported by connected traffic signal controllers, including system detectors (e.g. mid-block detectors reporting volume and occupancy) and local detectors near the intersection to support actuation, extensions, etc. (Need 1)		
13.2.	Hennepin County will use data collected and processed by the CTSCS to support the creation of measures of effectiveness (MOEs). (Needs 5, 16)		
13.3.	As Hennepin County's involvement in Connected Vehicle deployments evolves, increased functionality may be required of the CTSCS that is not known at this time. (Need 3)		
14. System Log			
14.1.	Operators will have access to a log reporting what was performed by the traffic signal controllers. (Need 10)		
14.2.	Operators viewing system logs will view the functions actually performed by the traffic signal controllers, the source of the functions, and the time they were performed, not solely what the scheduler requested. (Need 10)		
14.3.	The CTSCS will keep logs secure, unalterable, and accessible. (Need 10)		
14.4.	Operators with certain privileges will be able to view logs reporting what operators have logged into and out of the system, and activities performed by operators. (Need 7)		
15. Reporting Requirements			
15.1.	Operators will have the ability to run, view, print, and save a variety of pre-defined or operator created reports from the CTSCS user interface. (Need 11)		
15.2.	Operators will have the ability to run, view, print, and save system status reports that describe operational status of all equipment connected to the CTSCS. (Needs 11, 16)		
15.3.	Operators will have the ability to run, view, print, and save intersection operation reports on an individual intersection basis. (Needs 11, 16)		

Category	Descriptions	Pass/Fail	Comments
15.4.	Operators will have the ability to run, view, print, and save real-time split monitor reports. (Needs 11, 16)		
15.5.	Operators will have the ability to run, view, print, and save time space diagram reports. (Needs 11, 16)		
15.6.	Operators will have the ability to run, view, print, and save intersection measures of effectiveness reports. (Needs 11, 16)		
15.7.	Operators will have the ability to run, view, print, and save database reports. (Needs 11, 16)		
15.8.	Operators will have the ability to run, view, print, and save real-time communications monitoring reports, describing all requests and replies to and from the intersection. (Needs 11, 16)		
15.9.	Operators will have the ability to run, view, print, and save communications statistics reports describing statistics for communications, including failures and successes. (Needs 11, 16)		
15.10.	Operators will have the ability to run, view, print, and save pre-emption / signal priority reports. (Needs 11, 16)		
16. Automatic Alerting of Maintenance Personnel			
16.1.	The CTSCS will automatically create and send alerts to appropriate individuals or agencies by email or text message when critical problems or communications failures are detected within the system or within connections to other systems. (Needs 12, 19)		
16.2.	The CTSCS will automatically send emails to designated individuals when changes to the database are implemented. (Need 7)		
17. Failure Recovery			
17.1.	The CTSCS will monitor for failures and follow an organized procedure to shut-down and/or recover from failures. (Need 12)		
18. Online Help			
18.1.	Operators will use an online help support tool to troubleshoot technical issues. (Need 13)		