

NYCDOT Contract No. 84105MBTR001

NYCDOT Adaptive Signal Control

Phase II

Status at the End of Phase I

By the end of Phase I,

- 1) The Adaptive Control Decision Support System (ACDSS) will have been developed, installed onto a self-contained PC¹, and delivered to NYCDOT. It will have the ability to communicate with TRANSSUITE TCS through a mutually agreed web services based protocol²;
- 2) The network for the selected section of Route 9A (34th Street to Houston Street, both directions) will have been coded and integrated into the Adaptive Control Decision Support System. The alternative network (Boston Road, from Pelham Parkway to Gun Hill Road, both directions) will have been coded and delivered, but without actual incorporation into the Decision System;
- 3) The simulator required (AIMSUN) will be incorporated into the ACDSS, but the NYCDOT license fee is incorporated into Phase II. Phase I included a royalty-free restricted license to NYCDOT for its use of the KLD algorithm at the two sites [of Phase I] and for the use of the underlying concept by its personnel at other locations within NYC. The license is extended in Phase II, as cited in the "Deliverables" section of this document;
- 4) A series of test cases will have been run on the ACDSS, using a separate "instance" of AIMSUN to generate virtual traffic conditions on Route 9A, in a set of nine scenarios (base condition, demand deviations of $\pm 10\%$ and -20% demand deviation, sudden influx of demand from special event (2 variations), incident within corridor, inclement weather conditions causing 10% capacity reduction);
- 5) Documentation on the control policy and algorithm will be provided;

Phase I will be delivered by mid-August, 2008.

Due to the realities of equipment installation (detectors, controllers, related acceptance tests, integration into a communication system), note that the Phase I

¹ This specification has been changed to a rack-mounted machine with some capability for expansion to control additional arterials as described in Phase II, herein. The cost of the rack-mounted expandable machine is incorporated into the Phase II cost.

² This is contingent upon action by TransCore.

ACDSS will not be tested in a real-world environment, nor refined based upon that testing and reality. Rather, this is the subject of Phase II.

Scope of Phase II

The purpose of Phase II is to (1) integrate the self-contained ACDSS to the TRANSSUITE system via the cited web services based protocols, (2) test the reliability and accuracy of the information being sent and received, with respect to the need and with respect to minimum phase lengths for ped crossings, (3) refine the algorithm, forecasting, and/or detector placements based upon field tests and simulations, (4) conduct before and after field evaluations, based upon RTMS detector information and (if available) travel times based upon E-ZPass readers, (5) document the refined ACDSS, results, and findings, (6) provide training to NYCDOT personnel in the use of the ACDSS, as implemented on the provided computer and as interfaced with TRANSSUITE via the web, (7) provide support to NYCDOT in demonstrating the tool and application, at the November 2008 ITS World Congress and/or at the NYCDOT booth at that conference, (8) as part of the training and "hands on" activity for NYCDOT personnel, develop and implement an application at a set of 8 intersections on Staten Island, contiguous to the College of Staten Island, (9) prepare the ACDSS for use within an environment in which the control algorithm, forecasting, and web services based interfacing is being used to autonomously control "N" arterials or subsystems and the option exists via drop-down menu to select one of the "N" arterials or subsystems for interactive control with the simulator capability designed in Phase I.

The duration of Phase II would be 12 months from the Notice to Proceed (NTP).

As part of Phase II, a limited-use license for KLD-proprietary API's, DLL's, and IMPOST algorithm (enhanced version) and ACDSS system will be granted to NYCDOT for use by its personnel on the two proof-of-concept arterials and any other NYC arterials done in-house by NYCDOT personnel.

Phase II Task Definitions

The responsibilities of KLD and GPI are defined in the task definitions below. Additional work is required by TransCore, by NYCDOT, and perhaps the detector supplier and/or installation contractor. These are not included in the task definitions or related costing.

Task 6³: Link the ACDSS to TRANSSUITE via the Web Services Based Protocols

The Phase I activity is to define the interface, implement it, and test it in terms of transferring sample data. It is assumed that this can and will be completed by July 30, 2008.

Given installation, testing, and acceptance of the TRANSSUITE system, the ASTC controllers, and the RTMS detectors, the actual transfer of information from and to hardware at the relevant intersections in the Route 9A Corridor cannot be a Phase I activity.

Rather, Task 6 is the activity in which the ACDSS will be linked to the actual hardware through TRANSSUITE, and the web services based interface tested and checked. Information obtained on signal timing and detector readings will be used in the ACDSS as applied to the Route 9A segment used in this project. Information on signal timing recommendations will be transferred to the web services based repository awaiting release (cursor click on approval link, on ACDSS GUI) but the actual transfer of this information to field equipment will not be done until after Task 7 is completed.

Task 7: Test the Reliability & Accuracy of Computed and Transmitted Information

This task is the responsibility of GPI, so that the data transfer protocols (and the values transferred) are independently assessed and verified.

In Phase I, KLD specified the transfer format after agreement with TransCore that it should be web services based, that the ACDSS would be able to receive existing signal timing information and (on a time period equal to the cycle basis) measurements of count, occupancy, maximum occupancy, and speed by lane from the RTMS detectors in the subject corridor, by invoking relevant interfaces of the web services provided by TransCore. KLD in turn would be able to transfer signal timing recommendations in a suitable format for transmittal to TRANSSUITE, upon action by NYCDOT personnel to release the settings. As of late June 2008, this format is not finalized.

The focus of this task is to develop tests to ensure that the data is received and sent in the agreed format, and that there are validation procedures to ensure that all signal settings uploaded from ACDSS to the web services interface contain no settings in conflict with phase minima by intersection approach, as specified by NYCDOT.

Task 8: Refine the Algorithm, Forecasting, and/or Detector Placement

³ Tasks 1-5 are used in Phase I, so this task numbering begins with Task 6 to avoid confusion.

The receipt of actual data from the RTMS detectors via TRANSSUITE is expected to trigger the need for a detailed review of the data being received, the summaries and the forecasts from that data, and some experimentation with the duration of the period over which data is aggregated (present plans are from 1-2 cycle lengths).

Should problems arise with the location of one or more of the RTMS detectors, they will have to be relocated by NYCDOT during the time of this Task 8.

During this refinement period, the objective that shall be kept in mind is the ability to deliver effective adaptive control in a relatively detector-sparse environment (15-20 detectors for control of Route 9A between Houston and 34th Streets, inclusive).

By the mid-point of this Task 8, the GPI/KLD team and NYCDOT personnel will work closely together for the purpose of selecting suitable periods and actually implementing control of the ASTC's in the Corridor, initially in off-peak periods and then in varied periods.

During this Task 8, it is expected that the involvement and knowledge of NYCDOT personnel will grow to the point that they could operate the system in later months.

Task 9: Conduct Before-After Field Studies

This Task 9 as written is contingent upon the placement of E-ZPass readers both immediately north and immediately south of the Route 9A segment under study, and preferably at one or more intermediate points. Data from these readers is assumed to be made available to GPI and KLD in electronic form, such that the northbound and southbound travel times (between pairs of readers, and cumulatively) for individual vehicles are made available, preferably with vehicle classification⁴, time-stamped by date and time of day.

Should this data not be available, then a modified plan for before-after studies shall be prepared for NYCDOT review and approval, within the funds budgeted for this task.

Based upon the data provided and the knowledge of whether control was being exercised or not and the traffic volumes as estimated by RTMS counts, GPI shall analyze the effectiveness of the adaptive control, discuss it with KLD to assure that all relevant factors were considered, and prepare a technical memorandum for NYCDOT on the findings.

Task 10: Test Case on Staten Island, with NYCDOT Involvement

⁴ Individual E-ZPass ID's are neither necessary nor desired in the records provided.

In order to fully prepare NYCDOT personnel for future applications of the ACDSS and its elements to their full capability, it is vital that at least two NYCDOT personnel with appropriate experience, skill, and motivation be made available for full involvement in this task. KLD will initially take the lead in using the methodology to locate detectors, code networks, and prepare the ACDSS at the eight designated intersections near the College of Staten Island. It is expected that as the task progresses, the KLD will move from undertaking the details of the task to guiding NYCDOT in the execution of the task. This will provide an essential in-depth training experience for the NYCDOT personnel, and enable future independent use of the ACDSS system.

Notwithstanding this intent, the results of this Task 10 will be completed to the point that NYCDOT can implement control at the subject intersections cited in this Task 10, if NYCDOT installs the necessary hardware and communications to effectuate the adaptive control. KLD will undertake this implementation of the ACDSS for the Staten Island site (designated above) by its own staff if necessary (i.e. if NYCDOT personnel are not available for the training as planned within this Task), using the person-hours that it would have spent on the training activity within this Task.

The training and implementation exercise of this Task 10 is to be a set of eight intersections on Staten Island, contiguous to the College of Staten Island and serving the access/egress needs of the College.

The entire process of defining the network in AIMSUN and in the control policy, of setting up the display screen layout and GUI, of specifying the RTMS detector locations, and otherwise providing a working system shall be executed for the cited intersections (treated as a system). However, unless a second AIMSUN license and computer are obtained by NYCDOT, the system would have to be installed on the same computer as the Route 9A system.

Task 11: Provide Training to NYCDOT Personnel

In addition to the training-by-involvement described in Tasks 8 and 10, there will be a two-day intensive session for up to 10 NYCDOT personnel, held at a location chosen by NYCDOT (logically, the TMC), with an executive overview of up to 1.5 hours at the beginning of the session. This executive overview may include more senior NYCDOT managers, or may be given separately to them, at NYCDOT's choice.

Materials for this session will be prepared in advance, partly within this Task 11 and partly within Task 14. The actual session shall be held in late November 2008 or early December 2008, when it is more likely that NYCDOT personnel will be available.

Task 12: Prepare the ACDSS for Use on Multiple Concurrent Sites

Task 12 is to prepare the ACDSS for use within an environment in which the control algorithm, forecasting, and web services based interfacing is being used to autonomously control "N" arterials or subsystems and the option exists via drop-down menu to select one of the "N" arterials or subsystems for interactive control with the simulator capability designed in Phase I.

Part of Task 12 will be the determination of "N", expressed in terms of distinct facilities and/or total intersections. The goal is to assure a scalable, cost-effective tool for NYCDOT to use with its own staff.

Task 13: Provide Support to NYCDOT in Demonstrations

NYCDOT anticipates that the ACDSS will be part of its demonstrations at the ITS World Congress, held in NYC in November of 2008. The project team will support the preparation of relevant computer displays, animations, and operations.

Task 14: Document Results

KLD will be responsible for project documentation, in terms of a final report that includes a description of the algorithm, the system concept and its implementation, the results (see Task 9, GPI), and lessons learned. The GPI/KLD Team will work with NYCDOT to publicize and publish the results of the undertaking, subject to the approval of NYCDOT.

As part of Phase II, A limited-use license for KLD-proprietary API's, DLL's, and IMPOST algorithm will be granted to NYCDOT for use by its personnel on the two proof-of-concept arterials and any other NYC arterials done in-house by NYCDOT personnel.

Deliverables

Refer to Table 1.

Refer in particular to Notes 1 and 4 in Table 1, namely

- Note 1: KLD will provide a limited-use license for KLD-proprietary API's, DLL's, and IMPOST algorithm will be granted to NYCDOT for use by its personnel on the two proof-of-concept arterials and any other NYC arterials done in-house by NYCDOT personnel. See Note 4.
- Note 4: The IMPOST algorithm was initially developed and implemented under NYSERDA funding, for which NYSERDA is to be acknowledged and credited. Under the terms of that funding program, the license resides with KLD Associates, Inc. The limited-use license cited in Note 1 includes the initial algorithm, plus proprietary extensions.

The overall structure of the ACDSS will be provided to NYCDOT, for its use as cited, within this license. The web services interface will be an open architecture, mutually agreed amongst KLD, TransCore, and NYCDOT; it will be made available to NYCDOT in detail. The ACDSS is a *decision support system*, and incorporates a control algorithm as a "plug-in", presently the IMPOST+ algorithm developed under NYSERDA/KLD funding. The ACDSS elements will be made available to NYCDOT as cited, as will the use of the IMPOST+ algorithm, as implemented. In the eventuality that KLD Associates Inc. ceases to exist, without its intellectual property assigned to another firm in the transportation business, the source code for all elements will become available to NYCDOT on the same restricted use/restricted distribution basis as the other elements under the initial restricted/limited use license⁵.

Schedule

Refer to Table 2. This table reflects the preferred timing of the several tasks, to make maximum use of the results in November of 2008, at the ITS World Congress. It is nonetheless noted that this timing depends upon the availability of installed/tested/working hardware and communications, as well as the data interface. Accordingly, the overall Phase II work effort has a 12-month period of performance from the date of the notice to proceed (NTP). Should NYCDOT notify GPI/KLD of unavailable elements for a specific Phase II task, or vice-versa, then either (a) that task and those dependent upon it will be shifted, and/or (b) an alternate plan prepared by GPI/KLD and approved by NYCDOT will be implemented.

Staffing and Budget

Refer to attached 4T1 forms for GPI and KLD.

The KLD budget includes the cost of the NYCDOT AIMSUN license, with expansion to five concurrent "instances" (i.e. cases, or scenarios) being run.

The KLD budget also includes a rack-mounted computer capable of expansion for future NYCDOT control of additional arterials or subsystems. Because of the future expansion potential of this machine (up to 4 quad-core CPU's; only 2 included at this time) and the high-end graphic card needed, the cost of the included rack-mounted computer is as stated, in order for future scalability⁶.

⁵ Note for instance, that the IMPOST+ software exists due to NYSERDA/KLD funding but becomes available under this contingency, as does the product of KLD IR&D efforts directly related to the ACDSS or its support.

⁶ At this writing, there is a technical problem with the rack-mounted specification: vendors may not be able to provide the needed high-end graphics card in the rack configuration; the alternative is a stand-alone machine (the original specification) with the needed card, and a 40% decrease in computer cost.

The GPI budget includes the purchase of eight (8) RTMS detectors for use in Task 10.
This does not include testing or installation.

Table 1: Phase II Deliverables

Task	Deliverables	Primary Responsibility
6	Once it is established that the web services based communication approach enables flawless transfer of relevant data, KLD is responsible for receiving it, using it in the ACDSS, and demonstrating its use to NYCDOT. Likewise, KLD is responsible for delivering the recommended signal settings to the web services based interface or to the point at which they can be transferred to that interface upon the action of a NYCDOT system operator.	KLD
7	GPI will verify that the data as transmitted meets the requirements of Task 7 as described herein.	GPI
8	KLD will involve designated NYCDOT personnel in this task to assure a transfer of operational knowledge. See Note 3.	KLD
9	GPI will acquire data from NYCDOT in electronic format, analyze it, and report on the before-after conditions in a technical memorandum.	GPI
10	KLD will involve designated NYCDOT personnel in this task to assure a transfer of operational knowledge. See Notes 3 and 5.	KLD
11	KLD will deliver a two-day training course in late November 2008 or early December, including an executive overview, as specified in the Task 11 description.	KLD
12	KLD will adapt the ACDSS to concurrent use on multiple arterials or subsystems in the autonomous mode, allowing one to be selected for interactive control using simulation displays.	KLD
13	Support for the NYCDOT demonstration(s) related to this undertaking, at the November 2008 ITS World Congress.	KLD
14	KLD will prepare and deliver to GPI a final report as specified in Task 13, and GPI will deliver the same to NYCDOT. Also, see Notes 1 and 4.	KLD
Note 1	KLD will provide a limited-use license for KLD-proprietary API's, DLL's, and IMPOST algorithm and ACDSS system will be granted to NYCDOT for use by its personnel on the two proof-of-concept arterials and any other NYC arterials done in-house by NYCDOT personnel. See Note 4.	
Note 2	KLD will obtain and transfer to NYCDOT a license for one copy of AIMSUN, for installation on the deliverable PC that contains the ACDSS.	
Note 3	As part of the process in Tasks 6, 8, 10, 11, and 12, NYCDOT personnel are expected to become proficient in the use of the ACDSS for the test arterials and for any additional arterials done in-house by NYCDOT personnel (see Note 1). <i>It is the responsibility of NYCDOT to designate two or more of its personnel for this purpose, and to assure their availability (and continuity on the project) for this purpose.</i>	
Note	The IMPOST algorithm was initially developed and implemented under NYSERDA funding, for which NYSERDA is to be acknowledged and credited. Under the terms of	

4	that funding program, the license resides with KLD Associates, Inc. The limited-use license cited in Note 1 includes the initial algorithm, plus proprietary extensions.
Note 5	Should NYCDOT personnel not be available for the planned training within Task 10, KLD will nonetheless deliver the ACDSS implementation for the Staten Island intersections cited in Task 10, using the person-hours that it would have devoted to the training activity within Task 10.

Table 2: Phase II Schedule

	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
Phase I						
Phase II						
Task 6: Link the AODS to TransSuite via the Web Services Based Protocols						
Task 7: Test the Quality & Accuracy of Computed and Transmitted Information		Provide Info	Begin Control	Major Control	After	
Task 8: Refine the Algorithm, Forecasting, and/or Detect or Placement				Before		
Task 9: Conduct Before-After Field Studies						
Task 10: Training and Implementation Test Case on Staten Island						
Task 11: Provide Training to NYCDOT Personnel						
Task 12: Prepare the AODS for Use on Multiple Concurrent Sites						
Task 13: Provide Support to NYCDOT in Demonstrations						
Task 14: Document Results						

★ = ITS World Congress

Note: The above timing depends upon the availability of installed/tested/working hardware and communications, as well as the data interface. Accordingly, the overall Phase II work effort has a 12-month period of performance from the date of the notice to proceed (NTP). Should NYCDOT notify GPI/KLD of unavailable elements for a specific Phase II task, or vice-versa, then either (a) that task and those dependent upon it will be shifted, and/or (b) an alternate plan prepared by GPI/KLD and approved by NYCDOT will be implemented.