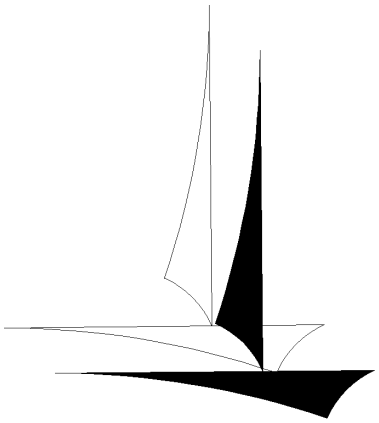
Assessment of City of Minneapolis Traffic Signal Management and Operations Program



Minneapolis

City of Lakes

By

National Transportation Operations Coalition
Traffic Signal Action Team

In Association with
AASHTO, ITE, ITS America, APWA, FHWA and
University of Maryland

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NATIONAL TRANSPORTATION OPERATIONS COALITION (NTOC)
Partnership of traditional transportation professionals and non-traditional stakeholders, who are convened to identify, promote, and/or implement activities that will advance operations and management strategies and improve the nations transportation system. The NTOC is leading the effort to advance transportation operations on a national scale, through information sharing and outreach to state and local government practitioners and decision-makers, and through a number of associated subcommittees activities focused on issue specific areas related to transportation operations.

TRAFFIC SIGNAL ACTION TEAM
The Traffic Signal Action Team is a partnership of experts in the field of traffic signal system design, implementation and operations who are providing assistance to other professionals. The first task undertaken by this team was the development of a self-assessment tool.

Executive Summary

Traffic signals are an important part of today's transportation infrastructure. They function to safely assign right of way to competing flows of vehicles at locations where roadways cross each other. Their level of complexity varies with respect to their position within the roadway network. In general those used to control locations with high demand for vehicle flow are the most complex.

These systems, even considering the sophistication of current technology, are not an "install and forget" proposition. Changes in land use, weather, the roadway network itself, incidents, planned events all contribute to changing patterns, volumes and demands for service at each signalized intersection.

An active concerted effort is required to ensure that they are kept operating at peak efficiency. Failure to do so can result in potentially severe negative impacts such as:

- Increased crash frequency and severity
- Increased travel times resulting in increased fuel usage and reduced air quality
- Negative economic impact to commercial carriers and public transit
- Traffic diversion to side streets and neighborhoods
- Citizen complaints

In recent years the City of Minneapolis has endured significant reductions in their traffic signal management and operations program. The impacts of some of these changes have led to major portions of the City traffic management system being rendered inoperative or less than fully functional. These reductions have had a noticeable negative impact on the City's ability to promptly and effectively deal with traffic congestion. The reductions have also eliminated the ability for city personnel to actually measure and report on the negative impacts. To respond to this situation the city of Minneapolis requested an independent review of their arterial traffic signal operations program to attempt to help reconstruct the program to improve traffic conditions. The National Transportation Operations Coalition (NTOC) Traffic Signal Action Team responded to this request and has produced the following assessment of the current city program.

The request was originally made by the city to the Federal Highway Administration (FHWA) Minnesota Division office that, working with FHWA's National Resource Center, requested assistance from the National Transportation Operations Coalition, Traffic Signal Action Team. This Coalition includes experts from the Institute of Transportation Engineers, American Association of State Highway and Transportation Officials (AASHTO), ITS America, Association of Metropolitan Planning Officials (AMPO), American Public Transportation Association (APTA), FHWA, the University of Maryland and others.

The assessment was performed on February 19 and 20, 2004 using the first draft of an assessment tool. Goals for the effort were two-fold: first, to assess the condition of the

current city program and second, to gain feedback to improve the self-assessment tool. Both city personnel and the assessment team found the effort very helpful. The team brought information of programs undertaken at other locations. The city also provided the team with extremely useful guidance needed to improve the assessment program.

Overall we conclude that the city is working hard to keep the most basic system elements operating as efficiently as possible given the constraints placed upon them. We would therefore would award them an A grade for effort. However, the overall outcome from that effort can only be evaluated around a D to perhaps a C minus due to the lack of a coherent program to better focus the effort and to provide adequate funding to increase the level of effort applied to managing and improving conditions.

As a result of this assessment effort the National Transportation Operations Coalition, Traffic Signal Action Team would like to offer the following five summary findings and recommendations. This is followed by detailed descriptions.

	Finding	**Recommendation**
1	No Measure of System Health or Performance	Adopt and Implement a Performance Based Approach
2	Current Approach is Reactive	Adopt and Implement a Proactive Approach
3	A Good Foundation Exists	Improve Funding Situation
4	Inadequate Personnel Levels	Increase Personnel Levels
5	Regional Focus is Limited and Opportunity Exists	Build Regional Program

Finding 1: No Measure of System Health or Performance
Due to funding and personnel shortfalls, as well as the primary focus in the region on construction-based remedies, there are no routinely quantified baselines for knowing how well the system is serving travelers needs.

Recommendation 1: Adopt and Implement a Performance Based Approach
The region and the City should institute a program of frequent planned system performance measurement. This could take the form of a report card. This report card could include measurements such as travel times and travel time variability. It should also include reporting how well the systems components are maintained and their operational status.

The region and the City should institute a program to review and revise as necessary the traffic signal timing or other operational improvements for critical corridors. It is recommended that each individual signal be reviewed and updated at least every three years. The program should also consider setting reasonable thresholds that might trigger

more frequent reviews in response to changes in regional or local travel conditions as developments occur and roadway construction occurs.

Several of the existing city systems and programs collect significant amounts of raw data that could be used in such an assessment. This data is filed and archived but little else is done with it. This data could and should be used in assessing agency performance.

Performance measures should also include keeping measurements of how much of the system is in operation at given point in time as well as how long it takes to make repairs.

Performance measurements can also be used to focus limited resources on those things or areas to gain the greatest benefit. Periodic reports based on operations performance measures to establish and reinforce these practices can be shared with leaders and the public.

Finding 2: Current Approach is Reactive

Currently changes in signal operation are rarely made and then only in response to public complaints. Repairs sometimes can't be completed quickly due to lack of personnel time and shortages of some specialized materials.

Likewise, police and traffic control agents are frequently used to manually assist signal operations. This is a low-tech, inefficient and costly way to provide signalized traffic control.

Recommendation 2: Adopt and Implement a Proactive Approach

The City should move operation of the system from one that is only capable of reacting to one that can anticipate and accommodate changes quickly.

More signal system work should be included in construction plans. Capital construction projects are very well funded when compared to operations. A closer relationship with construction projects could result in more signal systems work (installation, hardware/software upgrades, updated timing) being included in the construction project to better ensure effective transitions between construction and operations services.

The region and the City should also begin planning for the obsolescence of their current systems.

Construction and roadway maintenance projects (in house, contractor, utilities) should be required to ensure and provide resources for placing traffic signal systems (detectors, cameras, etc) back into working order following construction. The SCOOT traffic adaptive signal system has been out of operation for many months due to a construction project since the work to configure the numerous sensors rested on a short-handed operations crew. Consideration could also be given to reconfiguring the system to better handle detectors placed out of service for any reason. It is a bad sign that this entire system can be rendered inoperable due to a single isolated failure.

Another potential proactive approach would be to undertake an assessment of all of the signals in the system. This assessment program would focus on determining an appropriate course of action for each. Actions could include signal retiming, physical modifications to improve traffic flow or other techniques to maximize signal efficiency. Much of these actions would apply to the more heavily traveled routes so these should be given a high priority. However, significant improvements can be obtained through a review of the basic timing settings at other locations.

For those signals at less traveled intersections the assessment should include consideration of removing the signal. It is quite possible that motorists would be served by another form of right of way assignment such as a four-way stop or a traffic circle. This would also reduce the operational costs to the City.

Proactive operation also means having predetermined plans of action ready to respond to situations as they develop. There is evidence that some of these already exist but have not been used due to lack of personnel and expertise needed to put them into effect. However, it should be noted that few of the plans are linked to or coordinated with events/situations that may be reported by other regional systems.

Finding 3: A Good Foundation Exists

The city system has a reasonably good foundation. Much of the existing basic hardware (signal heads, signal poles, controllers) appears to be maintained and in operation. A slow response to operational problems has been and is an issue. Some malfunctioning signals have been left in a flashing mode or four-way stop control to minimize weekend overtime costs. Some very specialized replacement parts, and one model of traffic signal controller are often in short supply. With insufficient resources to repair all failed detectors, priority has been properly assigned to the repair of the most critical intersection control detectors, while postponing indefinitely the repairs to failed system detectors for monitoring speeds and volumes. Overall city personnel are to be commended for at least maintaining a basic level of functionality. However, it is clear that this is a very fluid and tenuous situation, which cannot be continued indefinitely.

An excellent example of this good foundation is the SCOOT adaptive traffic control system that has been installed in a part of the central business district. This system is a good well-proven system to help manage the irregular traffic flows that can occur there. In previous years it had been operated to produce significant impact travel times.

Recommendation 3. Improve Funding Situation

Provide sufficient funding to reverse system deterioration before the cost to deal with the situation inflates dramatically. Protect, preserve and use the considerable investment that has been made in the program through more active operation of the system. Funding is also needed to repair and maintain key system components such as the system detectors. Funding levels need to reflect the true costs of active system operation and the impacts of inflation.

Finding 4: Inadequate Personnel Levels

The current personnel has preformed in a heroic sprit by with keeping the traffic signal system operational in recent years. This cannot continue indefinitely. The Institute of Transportation Engineers, the Transportation Research Board and others recommend that systems of this size typically require more personnel for efficient operation than are currently employed in Minneapolis. This is a significant problem to the future viability of the City system.

There are some key parts of the system that could greatly improve traffic operations/flow flow if personnel with time and training could put them back into full operation. The prime example of this is the SCOOT system that has been installed at great expense in a portion of downtown Minneapolis. It has been out of operation for many months due to construction projects. These projects have restored the affected system hardware but no personnel time has been available to restart the system. And at this time there is no date set as to when this might occur.

The city has also installed at great expense a central traffic signal management system. Currently an operator is dedicated to monitor this system only until 2:00 PM each weekday. Engineering personnel are also available to assist in system operation and monitoring on an as needed basis until 4:00 PM. This leaves the system relatively unattended during the afternoon commute hours. There is also no coverage for many planned events where an operator could make a significant difference in traffic flow. If another agency such as MNDOT or emergency management or homeland security forces or police/traffic control agents need help from the city traffic management outside of these hours they are lacking someone to make operations changes except for a dedicated employee's volunteering during off-duty time.

There also are other routine but essential functions such as signal retiming that are not being done on a regular basis due to lack of personnel and resources.

Recommendation 4: Increase Personnel Levels

The personnel levels should be increased. At the very minimum they should be increased sufficiently to implement the previous recommendations. For signal maintenance, three to five personnel should be added. This would be an increase from the six positions currently funded for signal maintenance activities. The other existing positions should be increased to full FTEs.

In the area of signal operations, staffing should be increased by at least three so that operators are available to cover peak traffic periods as well as to handle events and incident response. This increase will also provide the personnel needed to ensure that signal timings are kept current. These people will also be key to preparation of performance reporting. Additionally, hours can be offset to cover peak period travel periods.

These increased personnel levels should be regularly reassessed against measurements of system performance. Likewise to address emergency situations, greater efficiencies should be explored with other city departments and public agencies.

Finding 5: Regional Focus Is Limited and Opportunity Exists

The city operates the current system as an island unto itself. There are no connections of any significance between the Minneapolis systems and that of neighboring agencies and the Minnesota DOT. The City does communicate with and coordinate one signal system in Edina. In the future there will be communication and coordination with two MnDOT signals. Regional opportunities exist with several adjacent cities, Hennepin County and Metro Transit's LRT line.

During the timeframe of the original Minnesota Guidestar program there was considerable discussion and some momentum for regional operations. However, due to changes in funding and personnel they were never fully realized. It may be appropriate to take a look back on that program and apply the lessons learned since then.

Recommendation 5: Build Regional Program

The city should begin to work with the other regional transportation system operators to develop a plan for regional operations. Transportation systems are by their nature regional systems. Customers traveling on the system desire and deserve a safe, reliable and predictable trip. One that is safe from physical and mental harm, has consistent service, and is predictable in terms of travel time. The public does not know or care who is actually responsible.

Regional collaboration in system operation and investments has the potential to provide significant operational improvements for a much lower life cycle cost. Consider the power that could be gained from sharing resources, personnel and systems. Consider the amount of inefficiency if every agency in the region has to purchase, support and maintain separate individual yet duplicate systems.

The regional partnership should consider developing a detailed concept of operations to define exactly how the overall transportation system will be operated. This effort should be an extension of the Regional ITS Architecture development work. It could include tabletop exercises by the stakeholders to work through how to handle operational scenarios.

Potential benefits from a regional approach can include sharing resources such as personnel and specialized materials, improved incident response, and improved traffic flow across jurisdictional boundaries.

The region should consider a funding program to support this regional approach. This has been very successfully done in different manners by other regions. We think the Twin Cities could also achieve similar success.

Overall Bottom Line:

The huge public investment made in these traffic signal systems has been and will be wasted if there are insufficient adequately trained personnel, partnerships and funding to operate and manage them. The traveling public deserves better service for their investment.

Introduction

In March 2003 a new director of public works came to the City of Minneapolis. The new director then undertook an effort to assess the condition of the organization. At the same time others in the transportation profession were working to assess existing conditions and promote improved operations of the overall transportation system nationwide. The group that shouldered this effort was given the National Transportation Operations Coalition (NTOC) masthead.

The city made a request to the Federal Highway Administration (FHWA) for help in making an assessment of their existing situation. The FHWA Minnesota Division fielded the request and subsequently engaged experts from the NTOC and the FHWA National Resource center. This team of experts was then tasked with making a review of the City operation and to prepare this report.

Fortunately the timing of the Minneapolis request and the work efforts of the NTOC coincided. The NTOC had just completed the first draft of a self-assessment tool and was looking for test sites. The Minneapolis Department of Public Works agreed to be the pilot for the assessment in return for getting a thorough review of their operation.

In reading this report it is important to recognize that the development of this self-assessment tool is still very much in its early stages. For example you will see a very early scoring scheme in the draft assessment tool presented in the appendix. We also need to stress that the primary purpose of this tool is for organizations to assess their own operation and therefore somewhat subjective.

The NTOC assessment team met with city personnel on February 19 and 20 in City of Minneapolis offices. The team also met with members of the Minnesota Department of Transportation to seek their view of the city program. The team was working to arrange meetings with Hennepin County to seek their view of the city, but the meeting was cancelled due to inclement weather and scheduling needs.

City Organizational Structure

The Department of Public Works is responsible for system operation, system maintenance, traffic signal design and traffic signal construction. The focus of this study is the Traffic Engineering Section of the Traffic and Parking Division of the Department of Public Works. The new traffic engineer/manager traffic policy position (new to the organization) is currently vacant.

There are also a few other vacant engineering positions within the organization due to retirements and budget reductions. The current organizational structure is shown in Figure 1. Returning retirees and temporary employees fill some of these vacancies at this time.

In interviews with personnel it was noted that there is only a single Traffic Systems Operator that works the morning shift. There is no system operational coverage after 2:00 PM each day and no coverage for weekend or off peak events. It is our opinion that this personnel function needs to be filled. But we would also like to note that this is a prime example of where a regional approach could help fill the gaps.

Traffic signal personnel are divided into two areas, operations and maintenance.

Signal Operations (Office Positions)
With the current personnel levels there are only two people responsible for operating the signal systems. Their workload includes not only day to day operations, until 2:00 PM but signal retiming, providing management and quality control for contracted signal timing work, responding to citizen signal operations complaints and to responding to legal inquires on signal timing and operations. Given the size of the system there should be at least five people in this group as follows:

- Engineering Supervisor. This position would also be responsible for performance monitoring and reporting.
- Traffic System Operators. (2 People) There should be a morning operator and an afternoon/evening operator. These people while working system operations can also provide assistance to the signal timing and performance monitoring work.
- Signal Timing Engineers. (2 People) There should be two engineers here. They could be responsible for the signal timing management for half the signals in the system. They would be expected to actually perform signal timing and performance monitoring work. This would also include management and quality control of contractor provided signal timing.

Signal Maintenance (Field Positions)
The current maintenance personnel are spread thin, handling maintenance, design and construction of the traffic signal system. As currently constituted there is insufficient personnel to barely handle the maintenance. This assessment only addresses personnel

needed for the maintenance task and makes no attempt to suggest any personnel level for the construction work.

The ITE "Traffic Control System Operations[1]" manual estimates that an agency should have one traffic signal maintenance technician for every 31 traffic signals in the system. This estimate is based upon time-per-technician-per-signal estimates and from public agency experts. Given this estimate the city of Minneapolis would require a staff of 25 technicians to maintain the 800 signals within the city. The National Cooperative Highway Research Program Synthesis 245[2] suggests a range of 38 to 43 signals per technician, which for Minneapolis would require between 18 and 21 technicians.

Additional tasks performed by the traffic signal personnel include many that are not traditionally recognized for their significant workload impacts. None of them represent insignificant time commitments; some of these individual tasks could easily consume the attention of a one or more full time positions. Some of these tasks are related to asset management. These tasks include the following:

- Utility location information and field marking
- Signal Structure Condition Ratings
- Maintenance Database (creation and management)
- Creation and maintenance of As-Built drawings
- Traffic Counts (classification, speed, turning movements, tube)
- Construction Inspection
- Controller database updates (operational information such as timing)
- Signal Design
- Maintenance and operations of telecommunications systems to field devices
- Handling signal operational complaints from the public

Not included in the above would be time needed to implement and manage an performance based approach to operations as discussed in Recommendation 3. In the beginning of this program it should be expected that considerable time would be spent.

The result is that the maintenance personnel should be increased by at least three to five technicians.

[1] Traffic Control System Operations: Installation, Management and *Maintenance*, Institute of Transportation Engineers, Washington, D.C., 2000
[2] Kraft, Walter H., *NCHRP Synthesis 245, Traffic Signal Control Systems Maintenance Management Practices*, Washington, D.C., National Academy Press, 1997.

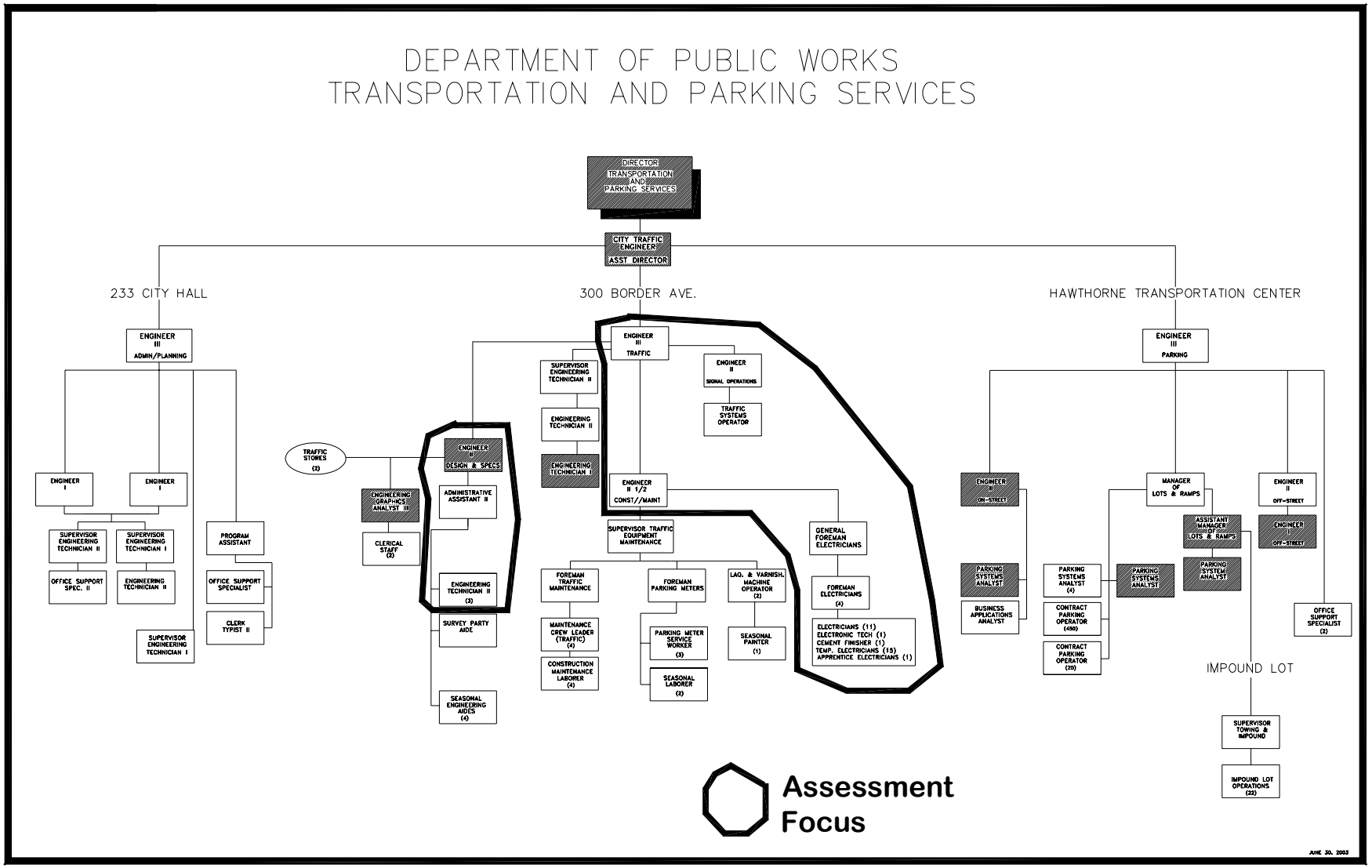

Figure 1 Organization Chart, Transportation and Parking Services Division

Survey Instrument

Survey Creation

A team of transportation professionals representing FHWA, ITE, AASHTO, ITS America, APWA, FHWA and the University of Maryland created the draft self-assessment document. The team members include practicing traffic engineering professionals with extensive local government experience and traffic signal design and installation experience.

Minneapolis Responses

The following sections are a presentation of the survey and a discussion of the City response to each question. The response and ensuing discussion are clearly noted.

Section 1 - Management

Traffic signals are one of the transportation industry's most visible points of service to the traveling public. They are tools to automate the safe assignment of right of way among conflicting traffic movements to reduce or eliminate the need for full-time manual traffic control at a given location. While a traffic signal can eliminate the need for manual control of the right of way, it does not eliminate human involvement, intervention, or intelligence in service delivery – and the customer understands this even though they do not know the underlying technologies or how engineers are involved. The issues addressed in this section include management actions.

Management plan for traffic signal operations

- ☐ Does your agency have a documented signal system concept of operations?
  - ***Response:*** *The meaning of the question is unclear but in general there is no overall documentation of operational policy. No policy exists for removal of unwarranted signals.*
- ☐ Does your agency conduct field measures or floating car studies on established "control" or benchmark sections of signalized corridors at least once per year for:
  - ○ delay-per-vehicle-per-intersection
  - ○ stops-per-vehicle-per-section
  - ○ travel time per section
  - ○ delay-per-pedestrian-per-intersection
    - ***Response:*** *There was a "baseline" floating car study performed about two years ago for a portion of the signals in the downtown area. There has been no follow-up of that work. Historically this type of performance measurement has not been done. There are plans to do some study of the impacts of lane closures. There is also an uncompleted section in a draft business plan that proposes to monitor system performance.*
- ☐ Does the agency conduct, document, and graph routine signal system health and diagnostics monitoring by date for:

- Number of working detectors
- Number of controllers "online" through functioning communications
  - ***Response:*** *This information is collected but isn't analyzed, summarized or reported in any form. It is noted that many of the existing systems are operating in a "recall" mode due to budget cuts.*

☐ Does your traffic signal operations personnel meet monthly with special event organizers, permits officers, law enforcement, and emergency service providers to coordinate on upcoming events or closures?
- ***Response:*** *Yes. They meet more frequently. However, these are traffic operations personnel and not signal operations personnel.*

☐ Does your agency include provisions in your contractor specifications or utility permits for prohibiting closures during peak periods or heavier traffic flows?
- ***Response****: Yes, monitoring and enforcement is addressing and improving this issue. However, compliance is a problem.*

Clear visions and goals exist for proactive traffic operations

☐ Does your agency have a policy regarding closures during peak periods or heavy traffic flows?
- ***Response:*** *Yes but lack of personnel and funding has limited the ability to adequately implement it. Likewise, a signal source is needed to improve coordination between the administering/monitoring and the enforcement.*

Committing adequate resources to traffic operations

☐ Does the agency have a policy for sensors/detectors destroyed or disabled by roadway maintenance or permitted utility activities to be replaced as part of the maintenance project or utility work?
- ***Response:*** *Yes, for roadway maintenance activities. For utility and some construction work this is problematic since it is sometimes difficult to identify the party responsible*

☐ Does your agency schedule a traffic signal engineer and technician to oversee operations during peak periods of travel outside normal business hours?
- ***Response:*** *Only for the morning peak period. There is no coverage after 2:00 PM on weekdays or anytime nights, holidays and weekends. There is a limited ability for calling in an operator during significant emergencies.*

Communication with the customer regarding signal operations

☐ Do you provide real-time traveler information on utility or work zone closures, signal outages, excessive delays, crashes, or other condition reporting?
- ***Response:*** *Yes they have a website showing areas of long term utility work zone closures but nothing beyond that. This should be coordinated and linked to the Minnesota DOT 511 system.*

Cooperation and integration with other service providers

☐ Do you and your regional stakeholder agencies publish a single number for the public to call for signal complaints and behind the scenes dispatch the work item to the appropriate agency?

- ***Response:*** *Not at this time. They are working toward a "311" complaint system for the City only but this program is still several years from operation.*

☐ Have you and your regional stakeholders prepared a regional concept of operations including regional high-level signal timing standards?

- ***Response****: No.*

☐ Do you have regional congestion stakeholder monthly meetings for coordinating upcoming events affecting multi-jurisdictional signal operations?

- ***Response:*** *They meet frequently on an ad hoc basis. There is no formal schedule of meetings.*

☐ Do you and your stakeholder jurisdictions share responsibilities, rotate duties, or have pool funded contracts for regional support during off-hours responses involving signal equipment failures or plan adjustments?

- ***Response****: No.*

Developing the agency's workforce for signal operations

☐ Are technical training programs available and encouraged as appropriate from equipment suppliers, software suppliers, and in engineering areas?

- ***Response:*** *Yes but more is needed. Attendance unfortunately is limited by available budget.*

General Discussion of Questions and Responses*: At this time, mainly due to personnel and budget shortfalls, little is being done to actively manage the traffic signal systems in Minneapolis. Also since little has been done to quantitatively assess current conditions there is no way to tell how much more efficiently the system could be managed. Neither is there a way to quantify a level of investment required to reach various efficiency points.*

Section 2 - Coordinated Traffic Signal Operations

Traffic signal coordination is one of the most important aspects of traffic signal control. Traffic signal coordination ensures that motorists are able to travel through multiple intersections without stopping. The issues addressed in this section include the timing, interconnection and operation of coordinated systems.

☐ Is the need for retiming signals on a system-wide basis reviewed every three years?

- ***Response:*** *This isn't done on a systematic basis. There is currently work underway to retime signals in the Central Business District (CBD) area. This program addresses timing at 180 intersections. Prior to this the last timing work in the CBD was done in 1993. They would like to do these updates every three or four years but don't have sufficient personnel or funding for such a program. For the CBD intersections retimed recently they report a preliminary 25% reduction in delay and a 10% reduction in stops. These are significant improvements but the long time between retiming is a factor.*

- ☐ Is new system-wide timing developed within one year after the need has been identified?
    - ***Response:*** *No because there is no reliable funding stream to support this. There is some work done in very isolated areas in response to land development but it is very minor. The funds for this come from the General Fund on a 5-year planning horizon.*
- ☐ Does the process of developing new system-wide timing include the use of traffic signal optimization software (for example - Synchro, TRANSYT or Passer II), simulation of optimized timing, field installation, observation and fine-tuning?
    - ***Response:*** *Current staff members have very limited experience with running these programs. There has been very little field fine-tuning by staff. The consultant doing the CBD timing work has not done this on an extensive basis because it is an interim plan to be followed up by additional data collection and another retiming effort. They do fine tuning by simply making minor adjustments to the timings based upon the Time Space Diagram produced by the timing optimization software. They are currently using the Synchro software.*
- ☐ In addition to the normal AM Peak, Off Peak and PM Peak plans, do the timing plans used in your coordinated systems include timing for weekends and holidays?
    - ***Response:*** *They do have some special Sunday morning programs for areas near some churches. They also have a library of 9 plans for the CBD; one is for inclement weather, Metrodome incoming and outgoing, an exit plan for the Target Center area, holiday parade plan besides the normal AM, PM and off-peak plans. These plans were originally developed when the Super Bowl was held in Minneapolis. The plans were developed using the "seat of the pants" method. They did have personnel on hand to operate the system during football games but it was discontinued due to budget shortfalls.*
- ☐ Do you have incident plans for special events, roadway construction, inclement weather and accidents?
    - ***Response:*** *Yes see previous question. However, at this time they are unsure just how to implement those plans due to lack of personnel and funding.*
- ☐ Does your criterion for interconnecting (coordinating) signals consider traffic flow characteristics? (In other words, do you interconnect signals separated by less than a predefined distance (say 1,000 feet) and ignore all signals with a greater separation without regard to traffic platoon characteristics?)
    - ***Response****: Currently 720 out of 800 signals are connected to their systems. However, not all of them run in a coordinated mode because they won't benefit from coordination. Of all the signals on the system 80 wouldn't benefit.*
- ☐ Do you coordinate signal timings across jurisdictional boundaries?
    - ***Response:*** *Yes but limited. The City is working on one signal in Edina and will work with two MnDOT signals at TH 55. There are also significant distance gaps between the City's and other systems. There are also*

challenges with incompatible systems and equipment different cycle lengths and timing parameters.

- ☐ Does your agency have a cross jurisdictional agreement (formally or informally) with neighboring jurisdictions regarding signal timing and operation?
  - ***Response:*** *No, except for the one signal in Edina, on block outside of Minneapolis.*
- ☐ Do you use either traffic responsive or adaptive control in areas with unpredictable traffic demand (e.g. in the vicinity of major shopping centers, universities, recreational centers, etc.)?
  - ***Response:*** *Their current system is capable of running traffic responsive plan selection (TRPS) but that feature is not being used due to detector failures. They have a TRPS library but it is not up to date. It was developed using a seat-of-the-pants method. Some (56) signals in the CBD are connected to an adaptive control system and they have funding to expand it to the University area. They also want to expand it in the downtown area and replace existing electromechanical signal controllers. The adaptive system was actively operated until 3 years ago when roadway and building construction removed some of the system detectors. Those detectors have been replaced but there has not been enough personnel time to perform a recalibration needed to get the system back in operation.*

General Discussion of Questions and Responses*: City personnel felt that the questions in this section are good and not too stretched. If an agency was doing a good job they should have good solid positive answers to them. The questions need to have a little more emphasis on evaluation or measuring effectiveness. The NTOC should consider measuring the response with a sliding scale.*

The City currently operates the traffic signals at the terminals of the freeway ramps. They have unimplemented plans to communicate with MNDOT for response to incidents. At this time there is very little real time communications with operators in the MNDOT operations center. Given that there are no City operators dedicated for duty after 2:00 PM significantly reduces any possible opportunities for this to occur. MnDOT has appropriate city phone numbers and can call on an as-needed basis.

Section 3 - Signal Timing Updates at Individual Intersections

Reviewing and updating the timing and operational aspects of individual signalized intersections on a regular basis is extremely important, especially where traffic volumes and/or adjacent land uses have occurred since the last review. This is important for all signalized intersections, regardless of whether they are isolated or coordinated, and regardless of whether the coordination is provided by a central system or a smaller, more localized system comprised of even a few intersections. The issues addressed in this section include review and update of the phasing sequence, detectors, displays, timing

parameters (settings), and other related operational aspects of individual signalized intersections within a jurisdiction.

- ☐ Does your agency have a process that effectively triggers systematic reviews of individual signalized intersections, such as 1) an implemented policy to review and update as needed the timing of all individual signalized intersections at least once every _____ years; and/or 2) monitoring traffic volumes, crash history, and land use changes to identify signal timing update needs?
    - ***Response****: There is no policy to do this on a regular basis. They do however look at crash history when they can but it is not done in any systematic way. They get monthly crash history reports and look at the top ten locations. They typically handle this in a reactive manner, i.e. wait for the phone to ring. In the last year, the City has been reviewing monthly reports and flagging abnormally recurrent crash types at a given intersection, then developing recommendations to rectify the situation including signal timing changes if necessary.*
- ☐ Is there an inventory of approved signal phasing and timing settings for each intersection that includes systematic updating of the records whenever any change is approved and implemented?
    - ***Response:*** *They have this information on file, most of it in electronic form via their signal system master. Some of these timing records have not been updated in the last five years. They do yearly maintenance on each signal but don't keep track of the "door open" alarm switch at central or keep a work log at the intersection. Other than that there is no systematic updates. They noted that the majority of the signal technicians' time is devoted to repair work vs. preventive maintenance work.*

      The have also had to cut back on emergency repair hours and services. The reduction of their maintenance forces from11 or 12 down to 7 has had a major impact.
- ☐ Does the timing review utilize all available sources of pertinent information (volumes, field observations during peak and off-peak times, records of citizen complaints, etc.) to determine needed timing revisions?
    - ***Response****: This is not done now as a regular program task. Some work done in response to customer complaints.*
- ☐ Does the review include consideration of need for changes to both of the following: 1) settings that affect each approach's green time (initial green, vehicle extension, maximum green, etc.); and 2) a calculation of the required yellow change interval, red clearance interval, and pedestrian clearance intervals for all phases, taking into account any physical changes (road widenings, etc.) that may have occurred since the last review?
    - ***Response****: This is not done now as a regular program task.*
- ☐ Are revisions to individual intersection timing settings normally developed and implemented within two weeks after the need has been identified?
    - ***Response****: This is not done now as a regular program task.*

- ☐ Does the individual intersection review include an assessment of need for coordination with adjacent signals?
  - ***Response**: This is not done now as a regular program task.*
- ☐ Does the review include an assessment of whether the intersection needs to be put onto or removed from late-night flashing operation in accordance with applicable policies?
  - ***Response**: This is not done now as a regular program task. There are currently no signals operating in a late-night flashing mode.*
- ☐ Does the review include an assessment of whether a change in type of control (pretimed vs. semi-actuated vs. fully-actuated) is needed?
  - ***Response**: This is not done now as a regular program task.*
- ☐ Does the review include an assessment of the need for a change in left turn control modes (permissive only vs. protected-permissive vs. protected only and left turn phase sequence (leading vs. lagging vs. "lead-lag" vs. "split-phase") for all left turn movements at the intersection?
  - ***Response**: Yes. This is done when scenarios are analyzed for operational improvements. However, the City does not regularly or continually address these signal operations needs on a systematic manner.*
- ☐ Does the review include a check of the operational status and effectiveness of all signal equipment at the intersection, including vehicle and pedestrian detectors and signal displays (vehicular and pedestrian signal heads)?
  - ***Response**: This is not done now as a regular program task.*
- ☐ Does the review include consideration of need for other operational changes, such as adding or eliminating vehicular or pedestrian phases, re-striping to re-align or increase the number of lanes, changing the lane-use assignments, improving signing, etc.?
  - ***Response**: This is not done now as a regular program task*
- ☐ Does the review include consideration for removal of unwarranted signals?
  - ***Response:** This is not done now as a regular program task. However, as part of new corridor construction and upon request, such removal needs are examined.*

***General Discussion of Questions and Responses**: These questions appear to have raised a lot of issues that they have not yet considered. They think that many of them are great ideas, however the lack of adequate staffing and recent personnel turn over prohibit these sorts of operational parameters from being considered.*

Many of the discussion items are however, reviewed as part of reconstruction projects but not on a predetermined regular basis.

It is clear from the answers to the questions and the discussion that the City personnel can barely keep up with the most basic of needs. This is made worse by instability of the funding stream.

Section 4 - Specialized Traffic Signal Operations

All agencies responsible for traffic signal operations must consider and manage many unique operations that require frequent study and adjustments. The issues contained in this section address these unique situations.

- ☐ Does your agency have the means to identify, examine, and adjust, as needed those traffic signals in close proximity to railroad-highway grade crossings in order to prevent vehicles being trapped on the tracks due to traffic signal operations?
    - ***Response****: They are doing emergency vehicle preemption but haven't done a detailed review of rail crossings. There are very few railroad crossings in the City.*
- ☐ Does your agency have fail-safe mechanisms in place to prevent wrong way moments during reversible lane situations?
    - ***Response****: There are no reversible roadways in the City.*
- ☐ Are special procedures in place to ensure that light rail vehicles sharing the roadway are provided signals that are not confusing to motorists or pedestrians?
    - ***Response****: There is a new light rail line being constructed in the City. They hope that these issues have been resolved as a part of the system design. They are planning to monitor the systems once the LRT is in operation. However the amount of time available to devote to this is limited by personnel availability.*
- ☐ School zones require special attention. Does your agency routinely install and maintain appropriate flashing lights in school zones during school operating hours?
    - ***Response****: There are no school zone flashers in the city. There are some flashers at several bikeway crossings and other political sensitive pedestrian crossings. School and park zone crossings were to be studied about five years ago but the effort has never been funded.*
- ☐ Does your agency have the capability and policies in place to adapt its signal systems to aid in emergency situations requiring evacuations, to allow passage of military convoys, to accommodate traffic diverted from freeways due to accidents or closure, and to handle extraordinary volumes of temporary traffic following events such as football games, concerts, and other special events?
    - ***Response****: There are none for emergency situations. They are starting to do some work with MNDOT using the DynaSmart program to assess traffic diversion. This work has not developed or implemented any plans yet.*

      The city police and traffic control agents do some manual control at intersections on an ad hoc basis the benefit is questioned by some. At times this manual control can work against the traffic signal systems and efficient flow.

City personnel were not involved in a recent emergency management workshop.

MNDOT has asked the city for help in response to incidents but the city's ability to assist was hampered by staffing constraints.

- ☐ Does your agency have procedures in place to respond to increases or decreases in pedestrian movements?
  - ***Response**: There are no personnel currently available for this. They are attempting to add a pedestrian coordinator to their organization.*
- ☐ Freeway ramp meters can greatly improve the efficiency of freeway flow. But they can also disrupt the flow on arterial streets due backups on ramps. Does your agency have procedures in place to monitor the operation of freeway ramp meters to prevent ramp overflow?
  - ***Response**: At this time there are no signal hardware connections between the ramp meters and the traffic signals at the ramp terminals. The City manages the ramp terminal signals and MNDOT manages the ramp meter systems. As a result of the recent legislatively mandated ramp meter study and resulting changes in metering strategies traffic conditions on adjacent arterials have improved.*
- ☐ If your agency allows signal control priority by buses and emergency vehicles, is there a procedure in place to measure its impact and effectiveness in order to make adjustments as needed?
  - ***Response**: They have both systems. Only 25% of the signals have this equipment. They have attempted to do signal control priority for buses but didn't get good results and have dropped the operation. Only the fire departments are equipped for this. They do only minor monitoring of these systems. They don't get any complaints about its operation nor assess impacts of its operation.*

    The city has completed the installation of pre-emptive equipment at more than 125 intersections as part of multiple ISTEA Projects for Transit Priority. The intent was to utilize emitter preemption capabilities to achieve transit priority. An evaluation was completed for the signals on the Lake Street Corridor. The evaluation, for the most part, determined that there was no decrease in bus travel times. Reasons for possible failure include:
    1. *Emitter detection calibration cannot accommodate signals at such close spacings (350' in some areas). This led to priority calls on signals 700 feet away when the bus was still two signals away from the called intersection. This led to time-outs prior to bus arrival.*
    2. *Due to pedestrian clearances, buses had little opportunity to obtain time for increased greens, early or extended.*
    3. *Most bus stops along the corridor are near side. With a variable delay time for passenger boarding and exiting the priority aspect waivers. Also note that there is a stop at practically every*

intersection (signalized or not) in this corridor, so approach times are not constant and impossible to measure.

4. *The low priority emitter was triggering high priority calls at signals outside Minneapolis that don't have the capability to decipher the difference.*

☐ Does your agency's signal priority system match that of adjacent jurisdictions?

- ***Response**: Yes. (They suggest rewording the question as it is unclear what is being asked.)*

***General Discussion of Questions and Responses**: Again a lot of the problems noted here are traced to inadequate staffing and funding.*

The staff also discussed frustration with the implementation of traffic signal systems along the new light rail line. Their frustration centers on failure of the systems designers and contractors to provide a system that functions properly. The systems designers and contractors are further taxing City personnel to sort out and correct problems in this system that should have been resolved.

City personnel also noted that trials of bus transit signal priority were not successful and the systems were subsequently turned off. Neither were there any attempts to ascertain why it was not successful.

Section 5 - Detection Systems

A robust detection system is needed in order for traffic signal systems to be able to respond to changes in traffic conditions. Detection systems also provide information that is used to determine how well control systems are performing and to calculate new traffic signal timing plans. Rate the quality of your agency's data collection for traffic signal operations.

☐ Does your agency routinely collect information about traffic flows and movements using manual counts or temporary sensors (road tubes)?

- ***Response**: They are collecting data via their central computer but are not using the data for traffic analysis. They do over 600 tube counts annually for their State Aid requirements. They have one person to do manual counts if needed. They are simply filling a file cabinet with the data. The primary use of the information is to respond to citizen complaints or signal justification reports for construction projects.*

☐ Does your agency collect information about traffic flows and movements with a surveillance system of detectors?

- ***Response**: Tube counts only but not in any systematic way. They will use some of the "system loops" but only from the 10% that are operational.*

- ☐ Does your agency maintain an inventory of its detector stations, including the number and types of detectors?
    - ***Response**: They have extensive as-built drawings and some hand written notes that have not yet been put into as-built drawings but no systematic database of this information. It all appears to be very ad hoc.*
- ☐ Does your agency maintain an inventory or schematic of the communications between sensors and roadside collection units?
    - ***Response**: Yes but this is not a good question. This implies the connection between individual detectors and an adjacent traffic signal controller. This connection is typically a hardwire connection of some sort.*
- ☐ Is the operating condition of your agency's detection system (sensors) monitored in "real-time" (i.e., faults are detected within 15 minutes)?
    - ***Response**: They could do it in real-time and if they did they couldn't keep up with it. They simply don't have the personnel to keep track of this. If they really need to know they can dig into the central control systems and manually find out.*
- ☐ Does your agency have a policy or established procedures to ensure that faults or problems with the detection system are remedied in a timely fashion?
    - ***Response**: This hasn't been a high priority due to staffing constraints. They have the ability and personnel that can repair detectors but not enough funding to do the work. It can take years before repairs are done.*
- ☐ Is data collected by your agency's detection system available to a transportation management center (or other similar central location) for monitoring or processing?
    - ***Response**: It is only available to the City no one else. The Minnesota Guidestar project was originally conceived as the regional mechanism for data sharing. The system was installed about 5 years ago and due to technical difficulties and other events it has not been used to full potential. More recently MnDOT has adopted a newer incident management software package that is sold under the CARS trade name. This system is an improvement but is not configured to share detailed vehicle volume data or traffic signal operational parameters.*

      There have also been concerns from MnDOT about the lack of commitment from local agencies to share data. Some of this appears to have resulted from the lack of city resources to actively participate in those programs.

      The University of Iowa was trying to harvest the data and produce a publicly available map of congestion.

***General Discussion of Questions and Responses**: Detection problems have been a big issue for the city. They are doing their best to maintain the minimum necessary for the most rudimentary operation. Their biggest problem is the condition of the pavements in which the loops are installed and construction projects cutting them. They recognize the*

quality control and inspection during installation are key factors to the lifespan of a detector. Their biggest problem is being resource constrained. They think that they can do better and understand the importance but are doing the best they can given existing constraints.

They use video detection for the adaptive control system, but on other applications video detection is not cost effective. The do not plan any more installations.

Their communications system has been very reliable. Approximately 6 out of 720 intersections have communications systems problems.

They shut down their signal system master control computer approximately once a month for database maintenance.

They still have 225 electromechanical (Model EF-20) controllers that demand considerable regular maintenance care. Parts for these units are very specialized and in short supply. The majority of these units are in the CBD area adjacent to their SCOOT traffic adaptive system.

View from Regional Partner

The team met with the MNDOT operations personnel to solicit their views on the City program. In general they praised the City program. They stated that they felt the city traffic staff was doing very well with little resources, yet the resources ultimately constrained the service outcomes.

They view the city personnel as overworked and under funded. They are also concerned that the city has lost a lot of really good staff members lately. They feel that this has had a significant negative impact to the program. They are also concerned with the length of time taken by the city to make repairs.

MNDOT has been presenting a lot of training courses for their own personnel and offered to include city personnel in the program. They feel that this is a win-win situation that will help everyone.

MNDOT is working to develop a benchmarking tool to decide which corridors to retime. The city may be able to make use of this when complete.

MNDOT sees an urgent need to do more interjurisdictional work. There has been some work on this at the MPO level but it is still in the early stages. They recently completed construction of a new operations control room and have noticed a significant improvement in their freeway operation. This new center houses MNDOT operations, highway patrol, emergency management and answers cell phone generated 911 calls.

Summary

The Traffic Management program in Minneapolis is to be commended for working hard to keep their system operating in a most rudimentary fashion. We think that both city personnel and the NTOC Traffic Signal Action Team learned a lot from the exercise. We hope that the findings and recommendations detailed in the document are acted on and result in an improved level of service for the system users in the greater Twin Cities area.

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Appendix A: Self Assessment Agenda

Minneapolis Signal System Review & NTOC Self Assessment

February 19 – 20, 2004
Draft Agenda

Purpose: The purpose of this meeting is 1) to assist the City of Minneapolis, MN with a peer review of their signal system operations utilizing a peer panel of experienced transportation officials presently collaborating on the National Transportation Operations Coalition (NTOC). 2) The panel seeks to utilize the discussions with the City of Minneapolis officials for evaluating the national signal operations self-assessment presently being developed.

Thursday, February 19

8:00 am – 8:15 am	Introductions & agenda/schedule revisions (if needed)
8:15 am – 8:45 am	Background of NTOC & signal operations self-assessment
8:45 am – 9:30 am	Tour of City signal system operations
9:30 am – 10:00 am	Break
10:00 am – 11:00 am	Discussion of regional mobility, identification of stakeholders, special conditions
11:00 am – 12:00 am	Discussion/Assessment of Detection Systems
1200: am – 1:00 pm	Lunch
1:00 pm – 2:30 pm	Discussion/Assessment of Signal Timing Updates
2:30 pm – 3:00 pm	Break
3:00 pm – 5:00 pm	Discussion/Assessment of Coordinated Traffic Signal Operations

Friday, February 20

8:00 am – 9:00 am	Discussion/Assessment of Specialized Operations (eg, RR, school)
9:00 am – 10:00 am	Discussion/Assessment of Management Activities
10:00 am – 10:15 am	Break
10:15 am – 11:00 am	Discussion of Assessment Scoring Methods/Interpretation
11:00 am – 12:00 am	Discussion of City Signal Operations opportunities
12:00 am – 1:00 pm	Lunch
1:00 pm – 2:00 pm	Closeout discussion with Public Works Director
2:00 pm	Adjourn

Other possible discussions

A. Discussion of signing & markings
B. Signal Operations Self Assessment for Executive Leadership
C. Available Training
D.

Appendix B: Draft Self Assessment

Traffic Signal Operations Self-Assessment
National Transportation Operations Coalition - Signal Benchmarking Action Team

This self-assessment questionnaire tool has been designed to help signal managers assess their signal systems operational performance. A simple scoring mechanism has been designed to help the manager and agency gauge their practice against a model program.

Scoring for Traffic Signal Self-Assessment

There are five sections in this questionnaire. Sections are weighted base on the relevance and significance reviewed by the National Transportation Operations Coalition - Signal Benchmarking Action Team. Questions in each section are weighted equally requiring a "yes" or "no" response. The weight of each section and the scoring mechanism is listed and summarized in table below.

Section	Weight	Percentage Point per Section (Number of "yes" responses to total number of questions) {example}	Possible Points (Weight x Percentage point per section) {example}
Management	25	1 {10/14}	25 {21.67}
Coordinated Traffic Signal Operations	25	1 {7/9}	25 {22.50}
Signal Timing Update at Isolated Intersections	25	1 {9/11}	25 {21.67}
Specialized Traffic Signal Operations	10	1 {7/9}	10 {6.67}
Detection Systems	15	1 {6/7}	15 {9.0}
Total	100		100 {81.51}

Example Scoring: 25x(52/60)+25x(9/10)+25x(13/15)+10x(4/6)+15x(3/5) = 81.51

Agencies scoring a "total possible points" of 80 or higher are considered in the "Green" zone, which means the agency is generally managing and operating the traffic signal systems in a manner that deserves applauding.

Agencies with a total of 60 – 79 are considered to be in the "Yellow" zone. This means good practice is being exercised, but there appears to room for improvement. These agencies are encouraged to continue their good practices and are welcome to contact their FHWA Division Office and/or FHWA's National Resource Center for tools and assistance that are available to them.

Agencies scoring 60 or below are considered to be in the "Red" zone. Cautionary measures should be taken by these agencies. Better practice should be considered to improve the traffic signal operations. These agencies are encouraged to contact their FHWA Division office or professional associations such as the Institute of Transportation Engineers for assistance and guidance.

All agencies completing this questionnaire are invited and encouraged to return their questionnaire to _____ and enclose a copy of the agencies operating manual or procedures guide to the Action Team for educational reference and sharing as appropriate.

A "Certificate of Good Practice" will be sent to agencies in the "Green" zone in recognition of their participation and efforts. Agencies in the "Green" zone will also be invited to become a mentoring agency to other agencies seeking input and guidance.

Please place a check mark beside each question that positively applies to your agency. Then total the check marks and compare them to the scoring table above to determine your agency's assessment score .

Section 1 - Management

Traffic signals are one of the transportation industry's most visible points of service to the traveling public. They are tools to automate the safe assignment of right of way among conflicting traffic movements to reduce or eliminate the need for full-time manual traffic control at a given location. While a traffic signal can eliminate the need for manual control of the right of way, it does not eliminate human involvement, intervention, or intelligence in service delivery – and the customer understands this even though they do not know the underlying technologies or how engineers are involved. The issues addressed in this section include management actions.

Management plan for traffic signal operations

- ☐ Does your agency have a documented signal system concept of operations?
- ☐ Does your agency conduct field measures or floating car studies on established "control" or benchmark sections of signalized corridors at least once per year for:
  - ○ delay-per-vehicle-per-intersection
  - ○ stops-per-vehicle-per-section
  - ○ travel time per section
  - ○ delay-per-pedestrian-per-intersection
- ☐ Does the agency conduct, document, and graph routine signal system health and diagnostics monitoring by date for:
  - ○ Number of working detectors
  - ○ Number of controllers "online" through functioning communications

- ☐ Does your traffic signal operations personnel meet monthly with special event organizers, permits officers, law enforcement, and emergency service providers to coordinate on upcoming events or closures?
- ☐ Does your agency include provisions in your contractor specifications or utility permits for prohibiting closures during peak periods or heavier traffic flows?

Clear visions and goals exist for proactive traffic operations

- ☐ Does your agency have a policy regarding closures during peak periods or heavy traffic flows?

Committing adequate resources to traffic operations

- ☐ Does the agency have a policy for sensors/detectors destroyed or disabled by roadway maintenance or permitted utility activities to be replaced as part of the maintenance project or utility work?
- ☐ Does your agency schedule a traffic signal engineer and technician to oversee operations during peak periods of travel outside normal business hours?

Communication with the customer regarding signal operations

- ☐ Do you provide real-time traveler information on utility or workzone closures, signal outages, excessive delays, crashes, or other condition reporting?

Cooperation and integration with other service providers

- ☐ Do you and your regional stakeholder agencies publish a single number for the public to call for signal complaints and behind the scenes dispatch the work item to the appropriate agency?
- ☐ Have you and your regional stakeholders prepared a regional concept of operations including regional high-level signal timing standards?
- ☐ Do you have regional congestion stakeholder monthly meetings for coordinating upcoming events affecting multi-jurisdictional signal operations?
- ☐ Do you and your stakeholder jurisdictions share responsibilities, rotate duties, or have pool funded contracts for regional support during off-hours responses involving signal equipment failures or plan adjustments?

Developing the agency's workforce for signal operations

- ☐ Are technical training programs available and encouraged as appropriate from equipment suppliers, software suppliers, and in engineering areas?

Section 2 - Coordinated Traffic Signal Operations

Traffic signal coordination is one of the most important aspects of traffic signal control. Traffic signal coordination ensures that motorists are able to travel through multiple intersections without stopping. The issues addressed in this section include the timing, interconnection and operation of coordinated systems.

- ✓ Is the need for retiming signals on a system-wide basis reviewed every three years?
- ✓ Is new system-wide timing developed within one year after the need has been identified?
- ✓ Does the process of developing new system-wide timing include the use of traffic signal optimization software (for example - Synchro, Transyt or Passer II), simulation of optimized timing, field installation, observation and fine-tuning?
- ✓ In addition to the normal AM Peak, Off Peak and PM Peak plans, do the timing plans used in your coordinated systems include timing for weekends and holidays?
- ✓ Do you have incident plans for special events, roadway construction, inclement weather and accidents?
- ✓ Does your criterion for interconnecting (coordinating) signals consider traffic flow characteristics? (In other words, do you interconnect signals separated by less than a predefined distance (say 1,000 feet) and ignore all signals with a greater separation without regard to traffic platoon characteristics?)
- ✓ Do you coordinate signal timings across jurisdictional boundaries?
- ✓ Does your agency have a cross jurisdictional agreement (formally or informally) with neighboring jurisdictions regarding signal timing and operation?
- ✓ Do you use either traffic responsive or adaptive control in areas with unpredictable traffic demand (e.g. in the vicinity of major shopping centers, universities, recreational centers, etc.)?

Section 3 - Signal Timing Updates at Individual Intersections

Reviewing and updating the timing and operational aspects of individual signalized intersections on a regular basis is extremely important, especially where traffic volumes and/or adjacent land uses have occurred since the last review. This is important for all signalized intersections, regardless of whether they are isolated or coordinated, and regardless of whether the coordination is provided by a central system or a smaller, more localized system comprised of even a few intersections. The issues addressed in this section include review and update of the phasing sequence, detectors, displays, timing parameters (settings), and other related operational aspects of individual signalized intersections within a jurisdiction.

- ✓ Does your agency have a process that effectively triggers systematic reviews of individual signalized intersections, such as 1) an implemented policy to review and update as needed the timing of all individual signalized intersections at least once every _____ years; and/or 2) monitoring traffic volumes, crash history, and land use changes to identify signal timing update needs?
- ✓ Is there an inventory of approved signal phasing and timing settings for each intersection that includes systematic updating of the records whenever any change is approved and implemented?

- ✓ Does the timing review utilize all available sources of pertinent information (volumes, field observations during peak and off-peak times, records of citizen complaints, etc.) to determine needed timing revisions?
- ✓ Does the review include consideration of need for changes to both of the following: 1) settings that affect each approach's green time (initial green, vehicle extension, maximum green, etc.); and 2) a calculation of the required yellow change interval, red clearance interval, and pedestrian clearance intervals for all phases, taking into account any physical changes (road widenings, etc.) that may have occurred since the last review?
- ✓ Are revisions to individual intersection timing settings normally developed and implemented within two weeks after the need has been identified?
- ✓ Does the individual intersection review include an assessment of need for coordination with adjacent signals?
- ✓ Does the review include an assessment of whether the intersection needs to be put onto or removed from late-night flashing operation in accordance with applicable policies?
- ✓ Does the review include an assessment of whether a change in type of control (pretimed vs. semi-actuated vs. fully-actuated) is needed?
- ✓ Does the review include an assessment of the need for a change in left turn control modes (permissive only vs. protected-permissive vs. protected only and left turn phase sequence (leading vs. lagging vs. "lead-lag" vs. "split-phase") for all left turn movements at the intersection?
- ✓ Does the review include a check of the operational status and effectiveness of all signal equipment at the intersection, including vehicle and pedestrian detectors and signal displays (vehicular and pedestrian signal heads)?
- ✓ Does the review include consideration of need for other operational changes, such as adding or eliminating vehicular or pedestrian phases, re-striping to re-align or increase the number of lanes, changing the lane-use assignments, improving signing, etc.?

Section 4 - Specialized Traffic Signal Operations

All agencies responsible for traffic signal operations must consider and manage many unique operations that require frequent study and adjustments. The issues contained in this section address these unique situations.

- ✓ Does your agency have the means to identify, examine, and adjust as needed those traffic signals in close proximity to railroad-highway grade crossings in order to prevent vehicles being trapped on the tracks due to traffic signal operations?
- ✓ Does your agency have fail-safe mechanisms in place to prevent wrong way moments during reversible lane situations?
- ✓ Are special procedures in place to ensure that light rail vehicles sharing the roadway are provided signals that are not confusing to motorists or pedestrians?

- ✓ School zones require special attention. Does your agency routinely install and maintain appropriate flashing lights in school zones during school operating hours?
- ✓ Does your agency have the capability and policies in place to adapt its signal systems to aid in emergency situations requiring evacuations, to allow passage of military convoys, to accommodate traffic diverted from freeways due to accidents or closure, and to handle extraordinary volumes of temporary traffic following events such as football games, concerts, and other special events?
- ✓ Does your agency have procedures in place to respond to increases or decreases in pedestrian movements?
- ✓ Freeway ramp meters can greatly improve the efficiency of freeway flow. But they can also disrupt the flow on arterial streets due backups on ramps. Does your agency have procedures in place to monitor the operation of freeway ramp meters to prevent ramp overflow?
- ✓ If your agency allows signal control priority by buses and emergency vehicles, is there a procedure in place to measure its impact and effectiveness in order to make adjustments as needed?
- ✓ Does your agency's signal priority system match that of adjacent jurisdictions?

Section 5 - Detection Systems

A robust detection system is needed in order for traffic signal systems to be able to respond to changes in traffic conditions. Detection systems also provide information that is used to determine how well control systems are performing and to calculate new traffic signal timing plans. Rate the quality of your agency's data collection for traffic signal operations.

- ✓ Does your agency routinely collect information about traffic flows and movements using manual counts or temporary sensors (road tubes)?
- ✓ Does your agency collect information about traffic flows and movements with a surveillance system of detectors?
- ✓ Does your agency maintain an inventory of its detector stations, including the number and types of detectors?
- ✓ Does your agency maintain an inventory or schematic of the communications between sensors and roadside collection units?
- ✓ Is the operating condition of your agency's detection system (sensors) monitored in "real-time" (i.e., faults are detected within 15 minutes)?
- ✓ Does your agency have a policy or established procedures to ensure that faults or problems with the detection system are remedied in a timely fashion?
- ✓ Is data collected by your agency's detection system available to a transportation management center (or other similar central location) for monitoring or processing?

Thank you for completing this questionnaire. We hope it has helped your agency assess the operation of its traffic signal system operations. Should you have any questions about this form, or wish to offer suggestions for improvement, please contact _____.