The Next Generation of Transit Signal Priority: Cloud Computing and the TSP-as-a-Service Model

September 20, 2017
TSP Conceptual Overview

Extend green signal time at beginning or end of signal phase

Best suited for:
- Intersections with less cross traffic and fewer turn signals—allowing for greater adjustment to the traffic signal pattern
- Streets with predictable bus travel times (e.g., dedicated bus lanes), so that ETAs can be estimated accurately

Source: NYCDOT Transit Signal Priority in NYC Report, 2017
The Need for TSP

Over past several years, declining bus ridership has been a consistent national trend.

One major factor cited is increased travel time and worsening travel time reliability.

TSP is one of several solutions in the toolbox to improve bus speeds and gain back riders.
Typical Approach:
Siloed Traffic and Transit Systems

Priority Granting
Data logging & analysis

Priority Request
Data logging & analysis
Typical Communications Architecture: Vehicle-to-Roadside Model

- IR emitters require line-of-sight
- Typically only consider local conditions
- Better range with 802.11 radio, but interference can be an issue

**Infrared (IR)**
- Same method emergency vehicles use for preemption, requires line-of-sight
- TriMet (Opticom IR)

**Location-Aware Radio-Based**
- Better range than IR
- AC Transit, SFMTA (Opticom GPS proprietary radio)
- LA Metro, RTA (Custom wireless roadside infrastructure)
Conceptual Benefits of the Cloud Computing Approach

- IT expertise
- Scalability
- A common platform
- Easy app deployment and update
Key Technologies Supporting a Cloud-Based Model

**IP-based devices**

- IP 172.16.254.1
- IP 172.12.128.2

**Cellular networks**
Ever-Increasing Reliability of Cellular
A Comic Interlude

Credit: XKCD (https://xkcd.com/1865/)
TSP-as-a-Service Inputs

Traffic Agency ATMS
- Signal system info
- Location of signals
- Comms methods
- Priority action taken

Isolated Signal
- Signal info
- Location
- Comms methods
- Priority action taken

Transit Agency
- Bus routes
- Schedules/headways

Core functions:
- Identify appropriate signals to pass priority request to
- Convert request to standard NTCIP
- Send NTCIP priority request to signals/ATMS as appropriate
- Data aggregation and analysis

Bus
- Bus ID info
- Location, heading, speed
- Priority request
- Other status info (e.g., percent full)
TSP-as-a-Service Outputs

Traffic Agency ATMS
- ATMS-specific NCTIP 1211 priority requests

Isolated Signal
- Signal-specific NCTIP 1211 priority request

TSPaaS Cloud
- Data feeds (via public API)

Transit Agency
- Priority action taken
- Data analytics

Bus

Third Parties
LA Metro’s Next-Gen Concept:

Core Vision Elements

1. Cloud-based platform for standardized signal system interfaces
2. Cloud-based analytics platform
3. Maintain support for legacy equipment and communications infrastructure
4. Support for multiple signal system designs
5. Commercial cellular networks for next-generation bus communication
6. Adopt NTCIP 1211 messaging standards
7. Implementation of Mobile Gateway Router
Next-Gen Concept: On-Bus Elements

- 802.11 to Legacy CSP
- DSRC to CV signal
- Cellular to BSPaaS cloud

802.11/DSRC Radio
Cellular/Data Radio
CAD/AVL
DTRP
MGR

Other on-board systems
Next-Gen Concept: Signal/TMC Elements

Centralized Signal System
- Signal Controller
- ATMS
- TMC
- To BSPaaS cloud
- DTGP may reside at signal controller or ATMS

Isolated Signal
- Signal Controller
- To BSPaaS cloud

CV-Equipped Signal
- Field Comm.
- DSRC Radio
- Switch
- PC
- Signal Controller
- DTGP
- DSRC to bus

Wi-Fi Legacy Corridor Signal
- 802.11 Radio
- Terminal Server
- Signal Controller
- DTGP
- 802.11 Wi-Fi to CSP WLAN

Cellular to BSPaaS cloud
Next-Gen Concept: Information Flow Diagram

- Location
- Heading
- Speed
- Status info

NTCIP 1211 / ATMS standard priority request

Action taken

Analyzed data

Bus priority information: location, heading, speed, status info

Commercial Cellular/Data Radio Network

Bus (on Next-Gen Corridor)
Benefits

- Increased availability of TSP and signal performance data to operators
- Increased potential for TSP expansion to new corridors
- New capabilities to actively manage TSP operations and rules
- Reduced network and hardware management responsibilities (hosted solution using commercial communications networks)
- Increased automation of data collection and analytics functions, reducing the need for manual data analysis functions
Other Impacts and Potential Issues

- Increased need for collaboration between transit agency and local traffic agencies on coordinating operations
- Need to develop inter-agency agreements on data security practices and requirements
- Data sharing between agencies and with external users will require standardized data formatting
- Increased need to focus on cyber-security issues
Other Relevant Industry and Agency Initiatives to Note

Centralized TSP “Gatekeeper” to receive and distribute TSP requests

Software-based centralized priority control manager with “many-to-many” config support and cellular V2C communications

MaxConnect web service with API for 3rd party signal data access

Centralized TSP system with NTCIP translation support and transport of requests to field

Centralized priority server with commercial cellular V2C communications
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