CHICAGO REGION’S
INTEROPERABLE
TRANSIT SIGNAL PRIORITY PROGRAM

Daryl Taavola
URS Corporation

25th Annual Transportation Research Conference
Presentation Overview

- **Background**
- **Program Update**
  - Accomplishments since May 2013
  - Adopted Regional Interoperability Standards
    - TSP Message Set
    - V-2-I Communications
    - Implementation Guidelines
- **Upcoming Activities**
Acknowledgements

- Chicago Regional Transportation Authority (RTA)
  - Kevin Stanciel, PM
  - Mark Pitstick
  - Gerry Tumbali
RTA Transit System

- 2 million trips per day
- 3rd largest system
- 6 counties
- 8 million people

Agencies
- CTA – Urban Bus & Rail
- Metra – Commuter Rail
- Pace – Suburban Bus
- RTA – Funding/Oversight
Participants and Roles

**Agencies**
- Regional Transportation Authority
- Chicago Transit Authority
- Pace Suburban Bus Company
- Illinois DOT
- City of Chicago DOT
- Local DOTs

**TSP Working Group**
All agencies listed above, plus:
- Lake County DOT
- Federal Transit Administration
- Chicago Metropolitan Agency for Planning (CMAP)
What is TSP?

What do we mean by Interoperability?
- Communication Equipment
- Message Sets
Program Goals & Objectives

1. Establish Regional TSP Standards and Implementation Guidelines
   - Operational guidelines for requesting & granting TSP
   - “Open standards” for equipment (non-proprietary)
   - Compatible technology for communications throughout the region
   - Centralized TSP system monitoring
   - Performance measures to assess effectiveness
Program Goals & Objectives (continued)

2. Implement TSP along priority corridors throughout the region
   • 5 year program (2013 – 2017)
   • ~30 Arterial Corridors
   • $40 million CMAQ grant to the RTA

3. Reduce travel times, schedule variability and fuel consumption
Legacy TSP Systems

Pace/CTA Corridor
- Cermak Road

CTA Corridor
- Western Avenue (2 segments)

Pace Corridors
- Washington Street
- Harvey Transp. Center
CTA Jeffery Jump Project

- TSP operations began in March 2014

Jeffery Jump Features

- Dedication Bus Lanes (67th to 83rd)
- Commercial Area Showcase Station (Jeffery/71st)
- Transit Signal Priority (73rd to 84th)
- Queue Jump (Jeffery/Anthony)
- Residential Area Showcase Station (100th/Patton)
- Non-Stop Service (11th to 67th)
Existing Operational Environment

- **CTA Buses**
  - Clever Devices AVL System

- **Pace Buses**
  - Trapeze TransitMaster AVL System

- **CDOT Traffic Signal Controllers**
  - Peek ATC-1000 Controllers
  - Central communications with MIST Traffic Mgmt. System
  - Communications box (C-box) with router at intersections

- **IDOT / Local DOT Traffic Signal Controllers**
  - Mix of Econolite / Eagle Controllers
  - Many closed-loop signal systems (non-centralized); dial-up communications to master controllers
  - Some County centralized communications
Reasons and Anticipated Benefits

- **Guiding Principles**
  - Utilize existing on-board AVL systems and vehicle technology to generate TSP requests
  - Utilize signal controller to accept requests if possible
  - Utilize readily available off-the-shelf communications technology
  - Create standards-based communication protocols between buses and intersections
Prior Year Accomplishments

- **Program Management Plan (PMP)**
- **Systems Engineering Management Plan (SEMP)**
- **Concept of Operations (ConOps)**
  - Centralized versus Distributed approach
Past Year Accomplishments

Communications Assessment

Technical System Requirements

Regional TSP Message Set

Regional Interoperability Standards

Implementation Guidelines

Vendor RFI

Final Regional Standards
Communications Assessment

- **Vehicle-to-Intersection Communications**

  *Wireless Technologies*
  - DSSS/FHSS (900 MHz)
  - Wi-Fi (2.4 or 5.0 GHz)
  - Public Safety (4.9 GHz)
  - Cellular (4G LTE)
  - DSRC (5.9 GHz)
# Communications Assessment

## Wireless Communications Weighted Evaluation Criteria

<table>
<thead>
<tr>
<th>Cost</th>
<th>State of the Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deployment</td>
<td>Vendor Compatibility</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Market Acceptance</td>
</tr>
<tr>
<td>Reoccurring</td>
<td>Proven Technology</td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td><strong>Ease of Installation/Operation</strong></td>
</tr>
<tr>
<td>Reliability Hardware (MTBF)</td>
<td>Maintainability</td>
</tr>
<tr>
<td>Reliability of Communication</td>
<td>Built-in TSP logic capability</td>
</tr>
<tr>
<td>Range</td>
<td>Leverage Existing Hardware</td>
</tr>
<tr>
<td>Bandwidth</td>
<td></td>
</tr>
<tr>
<td>Latency</td>
<td><strong>Future Opportunities</strong></td>
</tr>
<tr>
<td>Security</td>
<td>Consistency with national initiatives</td>
</tr>
<tr>
<td>Licensed Frequency</td>
<td>Intersection to intersection compatibility</td>
</tr>
<tr>
<td><strong>Expandability</strong></td>
<td></td>
</tr>
</tbody>
</table>
Adopted Standard for V-2-I Communications

- **Technology**
  - Wi-Fi Communications

- **Frequency**
  - 5.0 GHz Band

- **Protocol**
  - 802.11n Protocol (Minimum)
  - 802.11ac and newer acceptable
  - SNMP Version 2
    - For intersection radio health monitoring
Regional Standard for V-2-I Communications

- **Address Line-of-Site Limitations using**
  - Bi-Directional Antennas
  - MIMO (Multiple Input Multiple Output)

- **Recommend**
  - Software Upgradeable Radios
    - Accommodate future DSRC
  - Dual Radios at Roadside
    - Dependent on Backhaul design
Intersection-to-Intersection Communications

Or ....
Intersection-to-Center Communications

Or.....
Technical System Requirements

- **Priority Request Generator (PRG)**
- **Priority Request Server (PRS)**
- **TSP Protocols (PRO)**
- **TSP Communications (COM)**
- **TSP Central Software (SOFT)**

- **Requirement Types (Mandatory, Valued or Optional)**
  - Functional Requirements (F)
  - Performance Requirements (P)
  - System Requirements (S)
  - Environmental Requirements (E)
  - Non-Functional Requirements (NF)
Regional TSP Message Set

- Assessed NTCIP 1211 vs. SAE vs. TCIP Standards

- Regional TSP Message Set
  - NTCIP 1211 standard, version 1.38 as base
  - Custom parameters leverage the SAE J2735 standard, version 2009 r036
  - Transfer of data from PRG to PRS, via Simple Network Management Protocol (SNMP) Set commands
  - Abstract Syntax Notation One (ASN.1) format used
TSP Message Set - 6 Message Types

- Priority Request Message
- Priority Update Message
- Priority Status Control Message
- Priority Status Buffer Message
- Priority Cancel Message
- Priority Clear Message
**TSP Message Data Objects**

- PriorityRequestTableEntryNumber: INTEGER (1..10),
- PriorityRequestID: INTEGER (1..255),
- PriorityRequestVehicleID_chi: OCTET STRING (SIZE (6)),
- PriorityRequestVehicleClassType: INTEGER (1..10),
- PriorityRequestTimeOfServiceDesired: INTEGER (1..65535),
- PriorityRequestTimeOfEstimatedDeparture: INTEGER (1..65535),
- PriorityRequestTSPPhaseRequired_chi: INTEGER (0..16),
- PriorityRequestVehicleLatitude_chi: INTEGER (-900000000..900000001),
- PriorityRequestVehicleLongitude_chi: INTEGER (-1800000000..1800000001),
- PriorityRequestAgencyID_chi: INTEGER,
- PriorityRequestIntersectionID_chi: OCTET STRING (SIZE (7)),
- PriorityRequestRouteID_chi: OCTET STRING (SIZE (7)),
- PriorityRequestRunNumber_chi: OCTET STRING (SIZE (9)),
- PriorityRequestScheduleLateness_chi: INTEGER (0..65535),
- PriorityRequestVehicleClassLevel: INTEGER (1..10),
- PriorityRequestVehicleOccupancy_chi: INTEGER (1..255),
- PriorityRequestStatusInPRS: INTEGER
Regional TSP Message Set

• **Example Data Object**
  – The suffix “_chi” has been added to data objects new or modified from NTCIP 1211

```plaintext
priorityRequestAgencyID_chi OBJECT-TYPE
  SYNTAX INTEGER {
    cta (1),
    pace (2)
  }
  ACCESS read-only
  STATUS mandatory
  DESCRIPTION
    "This object is an enumerated value that identifies the agency requesting priority for
    logging and TSP monitoring purposes."
  DEFVAL { cta }
  ::= { PriorityRequestTableEntry_chi 10 }
```
Implementation Guidelines

• **Vehicle**
  – AVL development for Trapeze/Clever Devices
  – PRG if necessary
  – 5.0 GHz radio placement

• **Intersection**
  – External PRS for Eagle/Econolite Controllers
  – Internal PRS for Peek
  – 5.0 GHz radio placement

• **Intersection to Intersection/Center**
  – Fiber or Wireless or Vehicle-to-Garage
  – Web-based Server

• **General**
# Signal Controller Capabilities

## Figure 3-1. Summary of Econolite and Eagle Signal Controller Modifications

<table>
<thead>
<tr>
<th>Existing Controller Types</th>
<th>Compatible with NTCIP 1211?</th>
<th>Replacement Needed?</th>
<th>Controller Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Econolite ASC-2</td>
<td>No</td>
<td>Yes</td>
<td>Replace ASC-2 Controller with ASC-3 model. See modifications for ASC-3 controller below.</td>
</tr>
<tr>
<td>Econolite ASC/2S</td>
<td>No</td>
<td>Yes</td>
<td>Replace ASC/2S Controller with ASC-3 model. See modifications for ASC-3 controller below.</td>
</tr>
<tr>
<td>Econolite ASC-3</td>
<td>Yes</td>
<td>No</td>
<td>Install TSP Data Key Upgrade for ASC-3. Will require firmware upgrade for NTCIP 1211 communications or separate PRS.</td>
</tr>
<tr>
<td>Eagle M40 series</td>
<td>No</td>
<td>Yes</td>
<td>Replace M40 series controller with Eagle M52 model with NTCIP 4.52 Firmware. See notes below.</td>
</tr>
<tr>
<td>Eagle M50 series</td>
<td>Yes</td>
<td>No</td>
<td>Local Controller Firmware Upgrade to NTCIP 4.52 firmware. Requires use of Tactics at central office and separate PRS.</td>
</tr>
<tr>
<td>Peek ATC-1000</td>
<td>Yes</td>
<td>No</td>
<td>Modify how controller reacts to proposed regional TSP Message Set</td>
</tr>
<tr>
<td>Peek LMD</td>
<td>No</td>
<td>Yes</td>
<td>Replace with ATC-1000 or other approved ATC model controller</td>
</tr>
<tr>
<td>Peek 3000E</td>
<td>No</td>
<td>Yes</td>
<td>Replace with ATC-1000 or other approved ATC model controller</td>
</tr>
</tbody>
</table>
Vendor Request for Information

- **6 Responses on Draft Standards**
  - AVL Vendors
  - Signal Controllers Vendors
  - TSP Vendors

- **Confirmed on Right Path**

- **Some Corrective Actions**
Current Activities

• **Preliminary Engineering Underway**
  – CTA/CDOT (2 Corridors)
  – Pace/IDOT (6 Corridors)

• **Upcoming Procurements**
  – Detailed Design
  – Systems Integration Manager
  – PRS Developer
  – Software Development
    – AVL
    – Signal Controllers
    – Central Management
Five-Year Program

• **Annual Program of Projects (2014-2017)**
  – TSP Preliminary Engineering
  – TSP Design Engineering
  – TSP Implementation
Where?

2013 Preliminary Eng.

**CTA Corridors**
- Ashland Ave.
- Western Ave.

**Pace Corridors**
- Grand Ave.
- Roosevelt Rd.
- 95th Street
- 147th Street
- 159th Street
- Cicero Ave.
Where?

~30 TSP Corridors

- **CTA Corridors**
- **Pace Corridors**
- **CTA & Pace**
NE Illinois Vision

- TSP Corridors
- ART Corridors
- BRT Corridors
Thank You!

Daryl Taavola
URS Corporation
Phone: 612-373-6889
Email: daryl.taavola@urs.com
Questions?