



# Open Transit Priority Systems

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**AECOM**

February 18, 2016

# Agenda

- Transit Signal Priority Overview
- Project Overview
- Specification Development
- Virtual Test Tool
- Next Steps
- Questions



# Transit Signal Priority (TSP) Overview

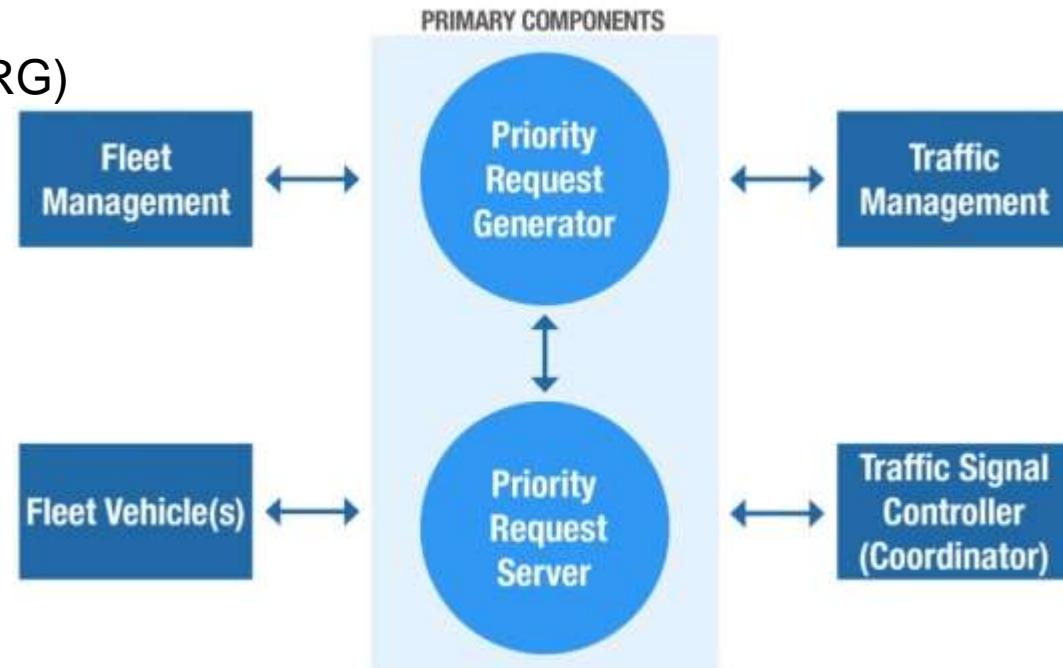
- Goal: Reduce traffic signal delay, improve transit schedule adherence and transit reliability
- Active Priority:
  - Detect the approaching transit vehicle in real-time
  - Temporarily adjust the traffic signals to benefit the transit vehicle
  - Return to normal signal operation when the transit vehicle clears the signalized intersection
- Active Conditional Priority:
  - TSP is only granted when certain “conditions” are met
  - Most common condition is schedule adherence

# TSP Overview

- National Transportation Communications for ITS Protocol (NTCIP)
- AASHTO, ITE, and NEMA, Office of the Assistant Secretary
- A goal is to develop standards for the transportation industry (Interchangeability and interoperability)

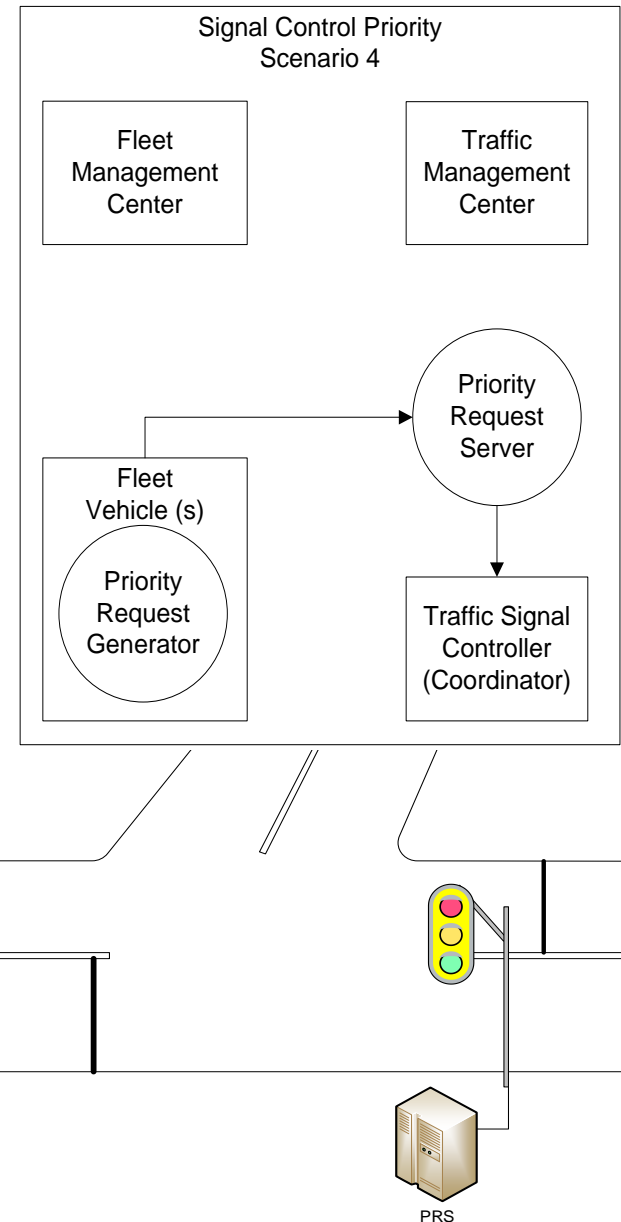
## Signal Priority Control:

- Priority Request Generator (PRG)
- Priority Request Server (PRS)



# TSP Overview

- NTCIP Scenario 4
- PRG on Transit Vehicle
- PRS on Roadside
- PRS Communicates with the Traffic Signal Controller



# Project Overview

- Client: Regional Transportation Authority (RTA)
  - Pace Suburban Bus
  - Chicago Transit Authority
  - Chicago Department of Transportation (CDOT)
  - Illinois Department of Transportation (IDOT)
  - FHWA
- Physical requirements:
  - Two transit CAD/AVL systems
  - 161 km of roadway over 400 signalized intersections
- AECOM and IBI Group are the main consultant team
- Goal is to develop a “**Regional TSP System**”
  - Competitive procurement of system components
  - Interoperability between various vendors
  - Do not limit future development



pace



# Project Overview

- Work Plan (Systems Engineering Approach):
  - User Needs
  - Functional Requirements
  - Communication Protocol Standard Development
  - PRS Specification
  - PRG (CAD/AVL) Specification
  - Virtual Test Tool
  - Procurement Support
  - Implementation Support

# Specification Development

- **User Needs** – gathered through a workshop process
- **Functional Requirements** – translated User Needs into functional requirements
- Organized Functional Requirements into **five (5) TSP Subsystems**:
  - Priority Request Generator (PRG) – 23 requirements
  - Priority Request Server (PRS) – 27 requirements
  - TSP Protocols (PRO) – 23 requirements
  - Communications (COM) – 7 requirements
  - TSP Central Software (SOFT) – 18 requirements



# Specification Development

- NTCIP 1211/1212, Object Definitions for Signal Control and Prioritization:
  - **Determine the Need for Priority:** Determine whether a vehicle is in need of priority according to series of user-defined criteria (e.g. lateness, passenger loading)
  - **Estimate Arrival Time:** Produce an estimate of the vehicles time for service desired at the signalized intersection
  - **Communicate:** Communicate the vehicle's request for priority and its time of service desired to the PRS
  - **Event Log:** Produce a log of all priority requests

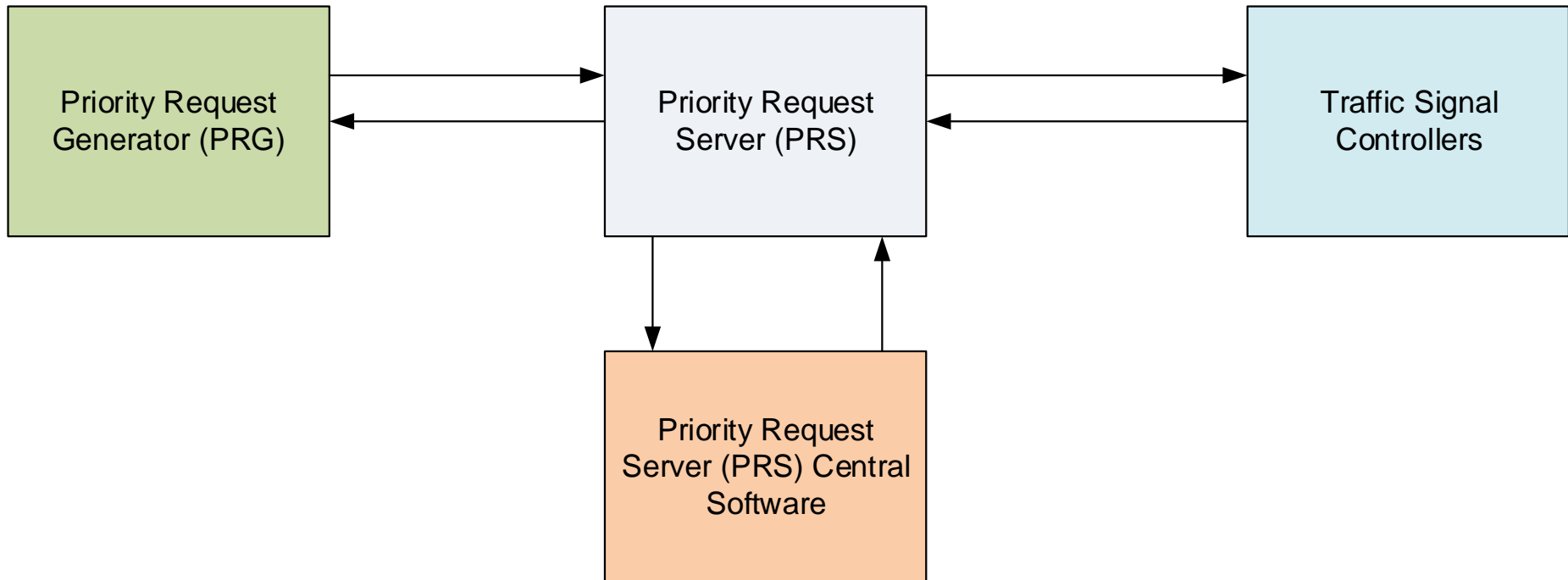
# Specification Development

- Connected Vehicle:
  - **Communicate and exchange information** among ITS devices, vehicles, and operation centres
  - Vehicle manufacturers are early adopters – vehicle braking
  - FHWA could mandate that all new vehicles use standard
  - Aspects are being developed, with **limited messaging regarding TSP**

# Specification Development

- Proposed Solution:
  - **NTCIP** using extended MIBS to meet functional requirements
  - Standardized Communication (**Connected Vehicle Framework**):
    - Frequency: 5 GHz, many vendors, staff knowledge
    - Technology: MIMO (multiple input/output) radios, line of sight
    - Protocol: 802.11n minimum, allows newer protocols

# Published Pace PRS Specification



# Published PRS Specification

Object Id	Name
1.3.6.1.4.1.1206.4.2.11.2.5	prgPriorityCancel_chi
1.3.6.1.4.1.1206.4.2.11.2.6	prgPriorityClear_chi
1.3.6.1.4.1.1206.4.2.11.2.1	prgPriorityRequest_chi
1.3.6.1.4.1.1206.4.2.11.2.4	prgPriorityStatusBuffer_chi
1.3.6.1.4.1.1206.4.2.11.2.3	prgPriorityStatusControl_chi
1.3.6.1.4.1.1206.4.2.11.2.2	prgPriorityUpdate_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.4	priorityRequestAgencyID_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.2	priorityRequestID
1.3.6.1.4.1.1206.4.2.11.1.1.1.12	priorityRequestIntersectionID_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.13	priorityRequestRouteID_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.14	priorityRequestRunNumber_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.15	priorityRequestScheduleLateness_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.17	priorityRequestStatusInPRS
1.3.6.1.4.1.1206.4.2.11.1.1.1.1	PriorityRequestTableEntryNumber
1.3.6.1.4.1.1206.4.2.11.1.1.1.8	priorityRequestTimeOfEstimatedDeparture
1.3.6.1.4.1.1206.4.2.11.1.1.1.7	priorityRequestTimeOfServiceDesired
1.3.6.1.4.1.1206.4.2.11.1.1.1.9	priorityRequestTSPPhaseRequired_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.6	priorityRequestVehicleClassLevel
1.3.6.1.4.1.1206.4.2.11.1.1.1.5	priorityRequestVehicleClassType
1.3.6.1.4.1.1206.4.2.11.1.1.1.3	priorityRequestVehicleID_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.10	priorityRequestVehicleLatitude_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.11	priorityRequestVehicleLongitude_chi
1.3.6.1.4.1.1206.4.2.11.1.1.1.16	priorityRequestVehicleOccupancy_chi

# Virtual Test Tools

- Test **PRG-PRS interface functions** through transmission of SNMP GET and SET requests, and the reception and limited processing of SNMP responses
- Development using the C# and the Microsoft .NET Framework
- Mix of NTCIP, SNMP and TCP/IP communication class libraries
- Windows Graphical User Interface (GUI)

VirtualPRG - PRS Testing Tool - (version 1.2.0.0 - Tuesday, Apr 14, 2015)

Priority Request Generator List

Request Id	Vehicle id	Agency id	Vehicle Class Type	Vehicle Class Level	Status in Server	Last Request Message Time Stamp	Desired Time of Service	Time of Expected Departure	Required TSP Phase	Latitude	Longitude	Intersection Id	Route Id	Run Number	Schedule Lateness	Vehicle Occupancy
1	DACIA	CTA	4	6		04132015 10:38:08	7777	200	3	445	789	ASA	150	14	200	10
1	DAC	CTA	4	6	activeProcessing	04142015 14:54:10	200	200	3	445	789	ASA	150	14	200	10

Create New Priority Request | Update Priority Request | Request Priority Status Buffer | Cancel Priority Request | Clear Priority Request | Delete Request from Database

# Virtual Test Tools

- Virtual PRG and Virtual PRS tools to help vendors to test their PRG and PRS and **ensure compatibility** with the communication standard
- Virtual PRG allows the user to **submit requests** for priority with transit vehicle details
- Virtual PRS allows the user to **receive priority requests** from different PRGs, prioritize the requests and **communicate** the service request **to the traffic signal controller**
- Enable to **simulate real-life conditions**
  - TSP triggered by lateness
  - Buses receives traffic controller status responses (TSP calls in process, TSP call canceled, flash mode, etc.)

# Virtual Test Tool – PRG

	Description ▲	Vehicle ID ▼	Agency ID ▼	Vehicle Class Type ▼	Vehicle Class Level ▼	Desired Time of Service	Time of Estimated	Required TSP Phase	Lat	
▶1	PRS Profile 1	DACIA	CTA	4	(All) 1 3 4	6	200	200	3	445
2	PRS Profile 2	FIAT	CTA	4		6	333	444	5	666
3	PRS Profile 3	ACD	PACE	1		3	100	100	1	200
4	PRS Profile 4	AXD	PACE	3		4	200	200	0	100

	Description ▲	Vehicle ID ▼	Agency ID ▼	Vehicle Class Type ▼	Vehicle Class Level ▼	Desired Time of Service	Time of Estimated	Required TSP Phase	Lat	
▶1	PRS Profile 1	DACIA	CTA	4	(All) 1 3 4	6	200	200	3	445
2	PRS Profile 2	FIAT	CTA	4		6	333	444	5	666

	Description ▲	Vehicle ID ▼	Agency ID ▼	Vehicle Class Type ▼	Vehicle Class Level ▼	Desired Time of Service	Time of Estimated	Required TSP Phase	Lat	
▶1	PRS Profile 1	DACIA	CTA	4	(All) DACIA FIAT	6	200	200	3	445



# Virtual Test Tool – PRG

PRG VirtualPRG - PRS Testing Tool - [version 1.3.1.0 - Friday, June 12, 2015]

### Priority Request Generator List

Request ID	Vehicle ID	Agency ID	Vehicle Class Type	Vehicle Class Level	Status in Server	Last Request Message Time Stamp	Desired Time of Service	Time of Estimated Departure	Required TSP Phase	Latitude	Longitude	Intersection ID	Route ID	Run Number	Schedule Lateness	Vehicle Occupancy
1	DACIA	CTA	4	6	closedCancelled	06122015 09:41:36	200	200	3	445	789	ASA	150	14	200	10
1	FIAT	CTA	4	6	readyQueued	06122015 09:41:39	333	444	5	666	777	ASA	150	14	300	10
1	ACD	PACE	1	3	readyQueued	06122015 09:41:42	100	100	1	20000	10098	ASA	12	2	100	20
1	AXD	PACE	3	4	readyQueued	06122015 09:41:45	200	200	0	10000	10030	564	20	2	20	15
2	DACIA	CTA	4	6	readyQueued	06122015 09:42:42	200	200	3	445	789	ASA	150	14	200	10

Create New Priority Request
Update Priority Request
Request Priority Status Buffer
Cancel Priority Request
Clear Priority Request
Delete Request from Database

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[06122015 09:41:36] > Sending Priority Request message for Request ID [1], Agency ID [CTA], Vehicle ID [DACIA], Vehicle Class Type [4], Vehicle Class Level [6], Status in Server [null]
[06122015 09:41:36] > Priority Request message successfully processed by PRS
[06122015 09:41:39] > Sending Priority Request message for Request ID [1], Agency ID [CTA], Vehicle ID [FIAT ], Vehicle Class Type [4], Vehicle Class Level [6], Status in Server [null]
[06122015 09:41:39] > Priority Request message successfully processed by PRS
[06122015 09:41:42] > Sending Priority Request message for Request ID [1], Agency ID [PACE], Vehicle ID [ACD ], Vehicle Class Type [1], Vehicle Class Level [3], Status in Server [null]
[06122015 09:41:42] > Priority Request message successfully processed by PRS
[06122015 09:41:45] > Sending Priority Request message for Request ID [1], Agency ID [PACE], Vehicle ID [AXD ], Vehicle Class Type [3], Vehicle Class Level [4], Status in Server [null]
[06122015 09:41:45] > Priority Request message successfully processed by PRS
[06122015 09:41:48] > Sending Priority Status Control Request message for Request ID [1], Agency ID [CTA], Vehicle ID [DACIA ], Vehicle Class Type [4], Vehicle Class Level [6], Status in Server [null]
[06122015 09:41:48] > Priority Status Control Request message successfully processed by PRS
[06122015 09:41:48] > Sending Priority Status Buffer Request message for Request ID [1], Agency ID [CTA], Vehicle ID [DACIA ], Vehicle Class Type [4], Vehicle Class Level [6], Status in Server [null]
[06122015 09:41:48] > Priority Status Buffer Request message successfully processed by PRS
[06122015 09:41:48] > Priority Request Status Buffer content Request ID [1], Agency ID [CTA], Vehicle ID [DACIA ], Vehicle Class Type [4], Vehicle Class Level [6], Status in Server [ReadyQueued]
[06122015 09:41:49] > Sending Priority Status Control Request message for Request ID [1], Agency ID [CTA], Vehicle ID [FIAT ], Vehicle Class Type [4], Vehicle Class Level [6], Status in Server [null]
[06122015 09:41:49] > Priority Status Control Request message successfully processed by PRS
[06122015 09:41:49] > Sending Priority Status Buffer Request message for Request ID [1], Agency ID [CTA], Vehicle ID [FIAT ], Vehicle Class Type [4], Vehicle Class L
    
```

Save
Clear

# Next Steps

- PRS Vendor Response and Selection
  - PRG Vendor Development Underway
  - Testing with Virtual Test Tool
  - Implementation, field testing (CTA in Summer 2016), and Operation
- 
- Goal is to develop an “Open Regional TSP System”
    - Moving Closer.....

# Questions?



# Thank you!

An aerial night view of a city skyline, likely Chicago, with numerous skyscrapers illuminated with various lights. The city extends to the horizon, with a body of water visible on the left side.

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