Next Generation Bus Signal Priority

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Los Angeles County Metropolitan Transportation Authority
(LA Metro)

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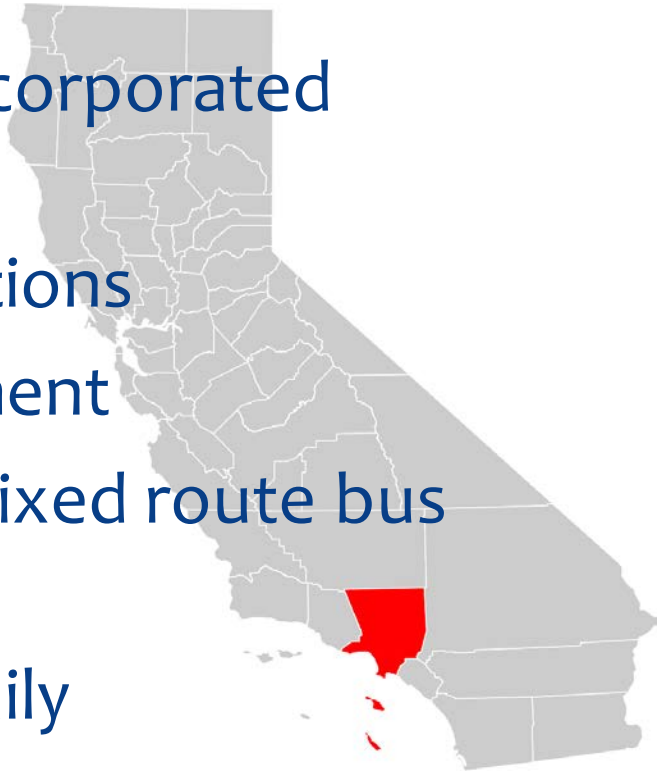
Program Background

Los Angeles Region

* 4,083 square miles
* 88 incorporated cities and unincorporated County areas
* Over 10,000 signalized intersections
* Diverse traffic control environment
* Other municipalities providing fixed route bus service
* Nearly 3,000 buses in service daily



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Pilot Demonstration

* Crenshaw Boulevard
  * Smart-Bus and Wireless Communications
  * $4.3 Million
  * 10.5 miles
  * 51 signal priority equipped intersections
* Partners
  * Cities of Los Angeles, Gardena, Hawthorne, Inglewood, County of Los Angeles

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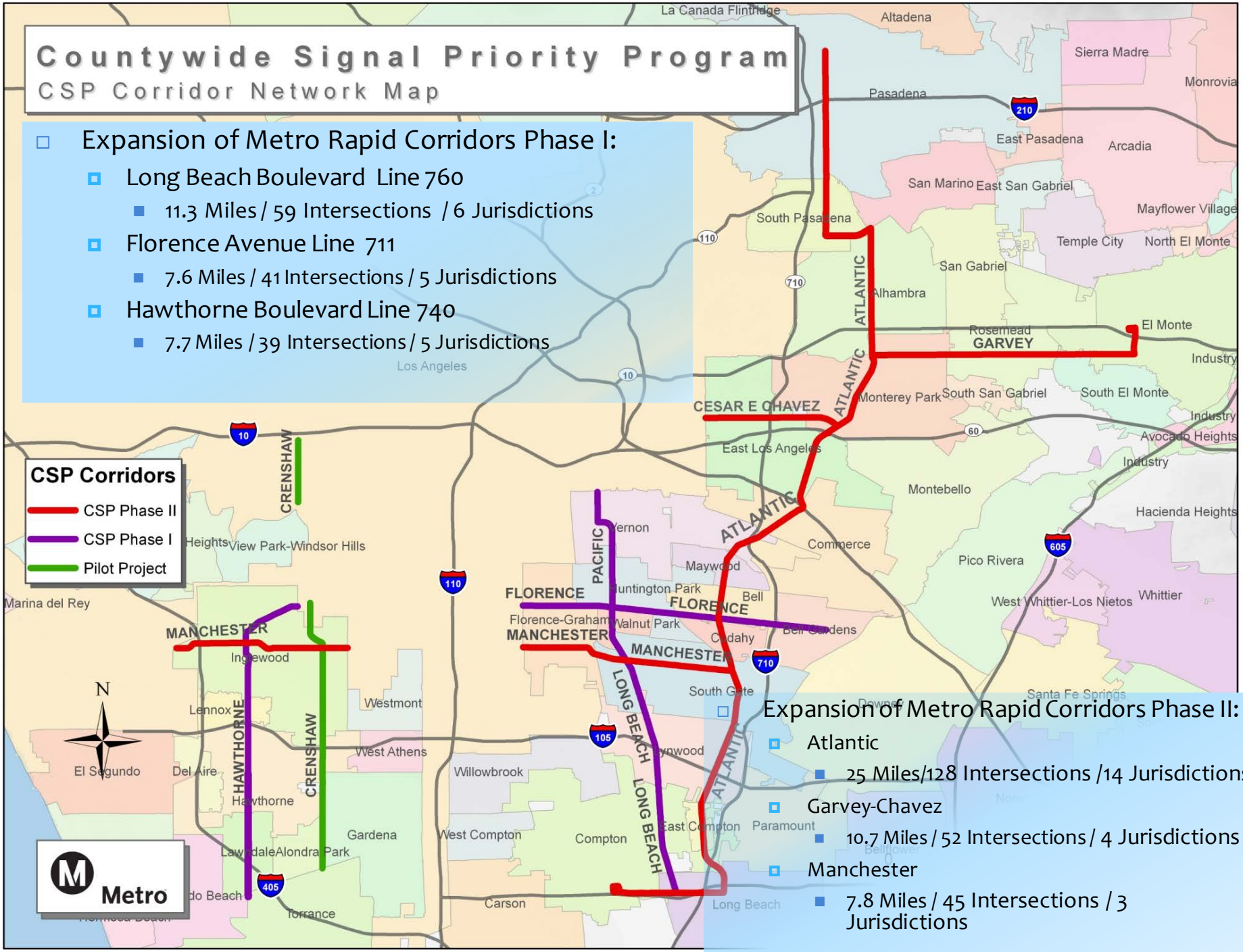
Countywide Signal Priority Program
CSP Corridor Network Map
Expansion of Metro Rapid Corridors Phase I:
Long Beach Boulevard Line 760
11.3 Miles / 59 Intersections / 6 Jurisdictions
Florence Avenue Line 711
7.6 Miles / 41 Intersections / 5 Jurisdictions
Hawthorne Boulevard Line 740
7.7 Miles / 39 Intersections / 5 Jurisdictions
CSP Corridors
CSP Phase II
CSP Phase I
Pilot Project
Expansion of Metro Rapid Corridors Phase II:
Atlantic
25 Miles/128 Intersections /14 Jurisdictions
Garvey-Chavez
10.7 Miles / 52 Intersections / 4 Jurisdictions
Manchester
7.8 Miles / 45 Intersections / 3 Jurisdictions
Metro
N
La Canada Flintridge
Altadena
Sierra Madre
Monrovia
Pasadena
East Pasadena
Arcadia
San Marino
East San Gabriel
Mayflower Village
South Pasadena
Temple City
North El Monte
San Gabriel
Alhambra
Rosemead
El Monte
Industry
Los Angeles
Monterey Park
South San Gabriel
South El Monte
East Los Angeles
Avocado Heights
Montebello
Hacienda Heights
Commerce
Pico Rivera
Whittier
West Whittier-Los Nietos
Marina del Rey
Heights
View Park-Windsor Hills
Vernon
Maywood
Huntington Park
Bell
Florence-Graham
Walnut Park
Cudahy
Bell Gardens
Inglewood
Lennox
Westmont
South Gate
Santa Fe Springs
El Segundo
Del Aire
West Athens
Willowbrook
Hawthorne
Gardena
West Compton
Compton
East Compton
Paramount
Lawndale
Alondra Park
Carson
Long Beach
Torrance
CRENSHAW
PACIFIC
ATLANTIC
FLORENCE
MANCHESTER
HAWTHORNE
LONG BEACH
GARVEY
CESAR E CHAVEZ
10
110
105
405
710
605
60

CSP Expansion

* Foothill Transit (Line 187)
  * 42 intersections
  * 5 partners (Azusa, Arcadia, Duarte, Monrovia, Pasadena)
* Torrance Transit (Route 3)
  * 80 intersections
  * 5 partners (County of LA, Long Beach, Carson, City of LA, Torrance)

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CSP Expansion

* Culver City Bus (Systemwide)
  * 103 intersections
* Gardena Transit - GTrans (Line 1)
  * 26 intersections
* Metro Rapid (Line 740)
  * 25 intersections in Pasadena
  * Conversion from loop and transponder to wireless

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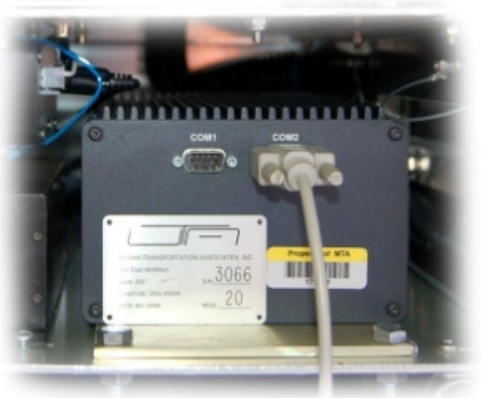
Current CSP Architecture and Technology

“Smart Bus” Approach

* On-Bus Hardware
  * On-Board Computer
    * Automated
    * Real-time vehicle location information (GPS)
    * Wireless radio transmitting priority request
      * 2.4Ghz spread spectrum



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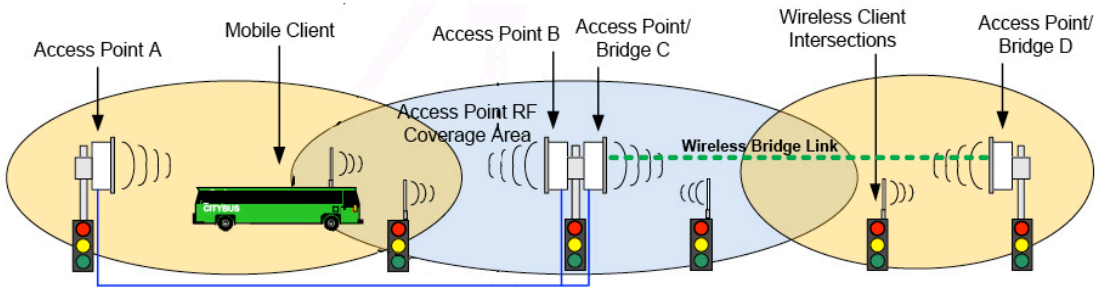
Wireless Communications

* Communication Infrastructure
  * IEEE 802.11b (Wi-Fi) Wireless local area network (WLAN)
    * Access Points
    * Bridges
    * Clients



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Traffic Signal Interface

* Signal Control Hardware
  * 170E, 170ATC/HC11, 2070, ASC/2, ASC/3
* Signal Firmware
  * BiTran/McCain, Econolite, LA County (LACO-4), City of LA 2070, D4 (future)

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Traffic Signal Timing Modifications

* Green Extension
  * Typically 8-10 seconds
  * Up to 10 percent of the cycle time
  * Typically not on back-to-back cycles
* Early Green
  * Typically 8-10 seconds

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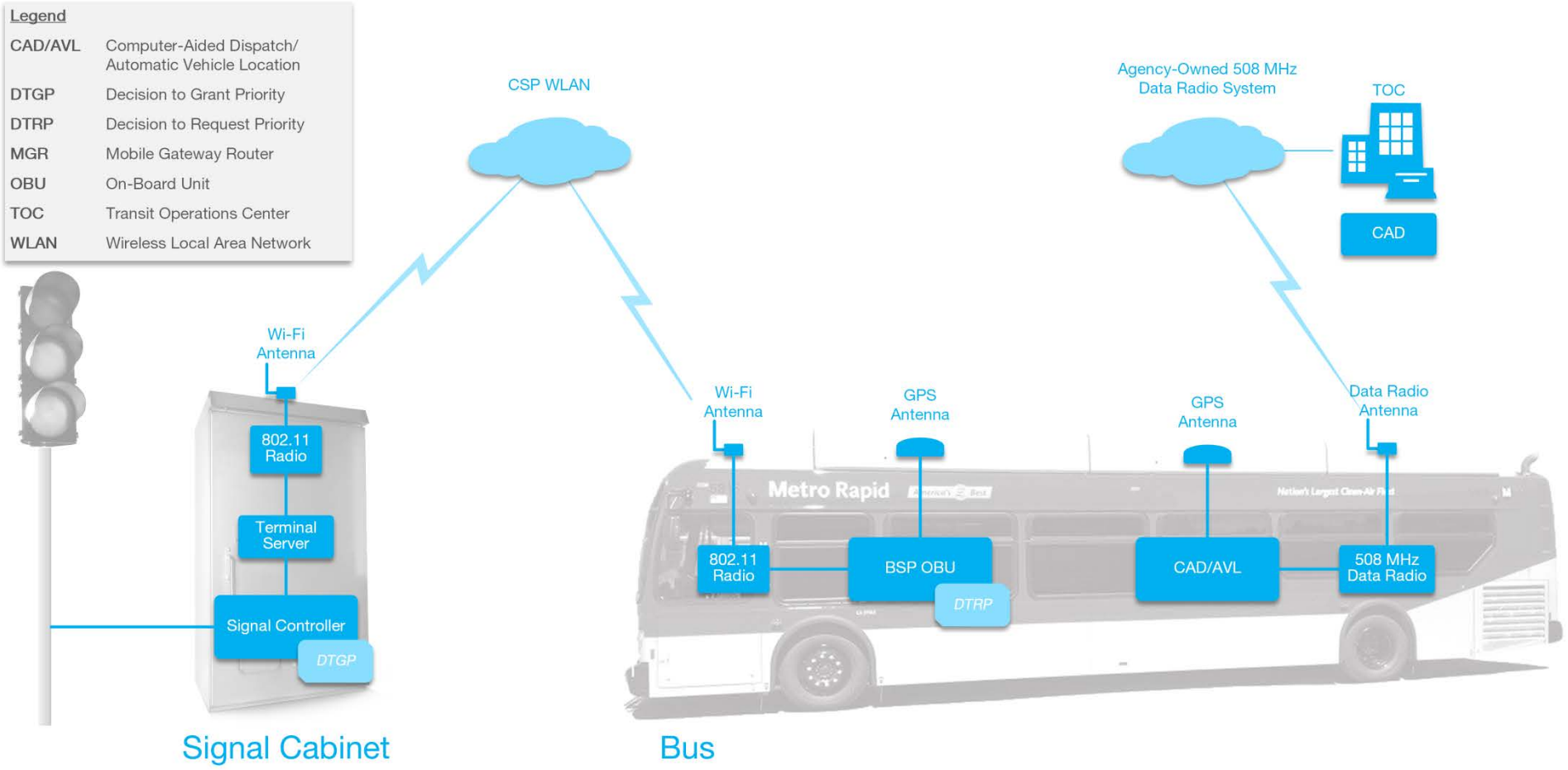
CSP System Architecture



Why Next Generation technologies?

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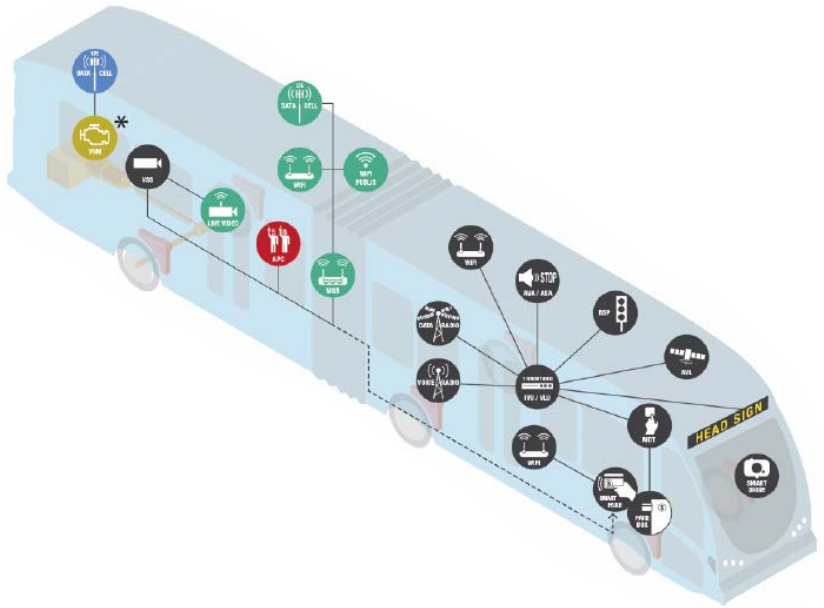
Upgrades to Metro Buses

* Metro's Advanced Transportation Management System (ATMS) Update
  * includes integration of transit signal priority
* Metro's Bus and Rail Fleet Systems Strategic Plan
  * Mobile Gateway Router



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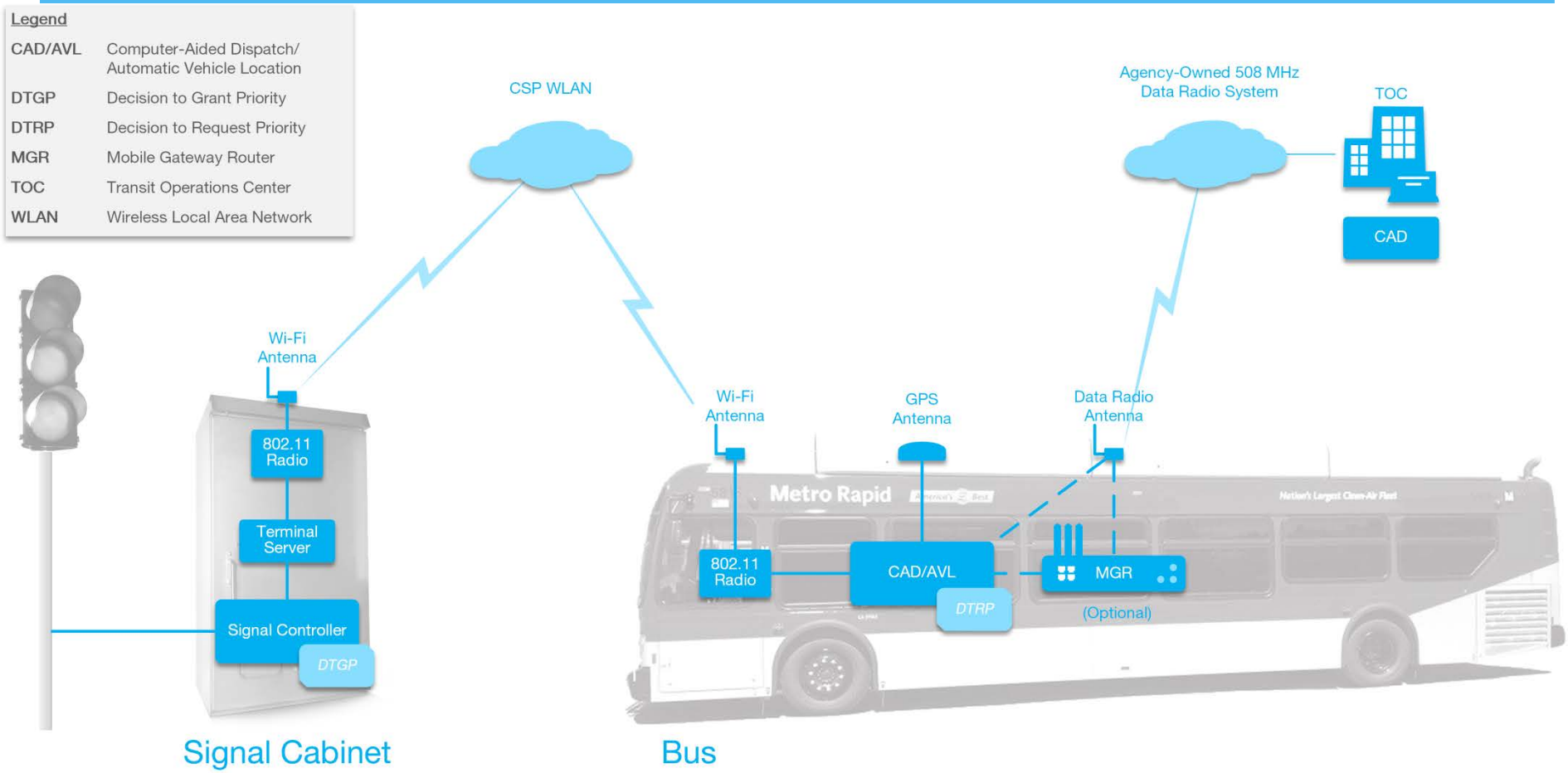
CSP System Revised Architecture



Upgrades to CSP Network and Monitoring

* Migrate Central BSP Network to the Cloud
  * Phase 1 – Existing Network Improvements – Clean-up
  * Phase 2 – Cloud Infrastructure Setup – BSP Database
  * Phase 3 – Cloud Reporting Implementation – Remote Client Access for Metro, Torrance Transit, and Culver CityBus; Reporting Web Server
  * Phase 4 – BSP Web Service – Receive Request/DTGP Data
* Enhance the Cloud Reporting Software

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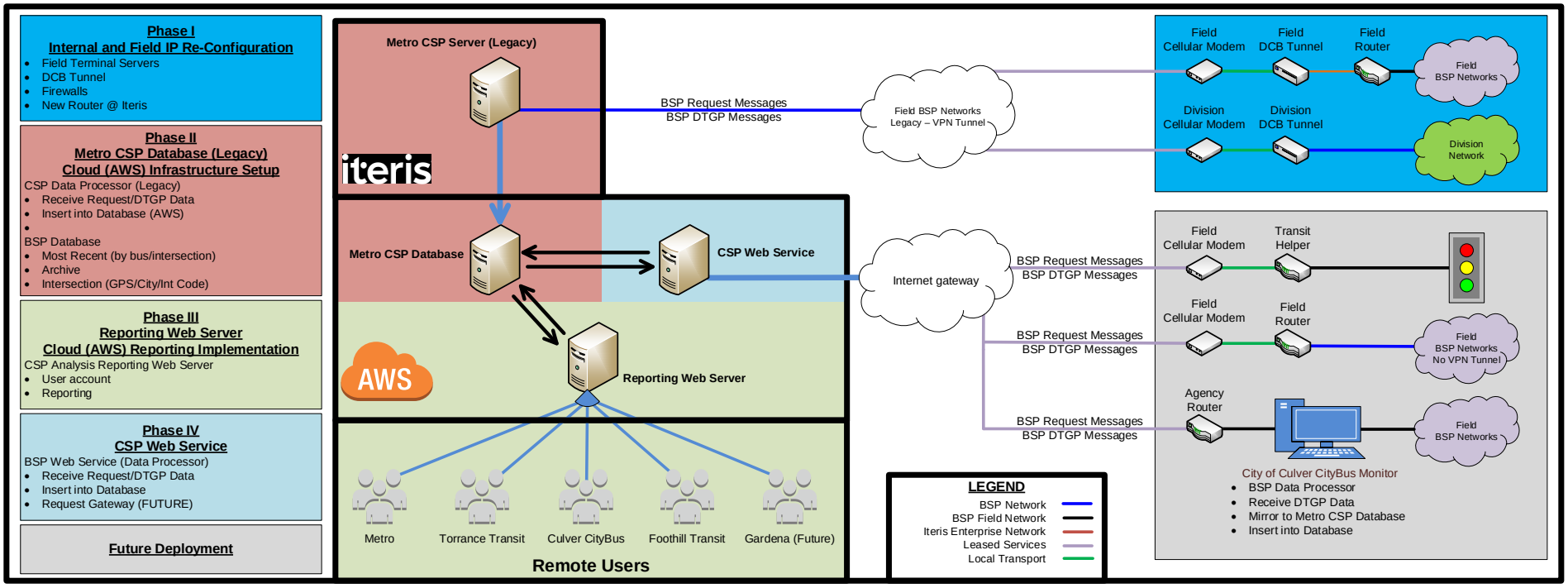
New Central BSP Network



Next Generation BSP Study

* Original CSP architecture was developed and deployed over 15 years ago.
  * What other types of signal priority is being deployed nationwide?
  * Evaluate existing CSP approach
  * Evaluate new technologies that have advanced in the past few years
  * How we should evolve signal priority in the region?

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Nationwide Evaluation of Current BSP Practices

* TriMet – Portland, OR
* AC Transit – East Bay, CA
* King County Metro – Seattle, WA
* Regional Transportation Authority (RTA) – Chicago, IL
* Metropolitan Transportation Authority (MTA) – New York, NY
* Los Angeles Department of Transportation (LADOT) – Los Angeles, CA

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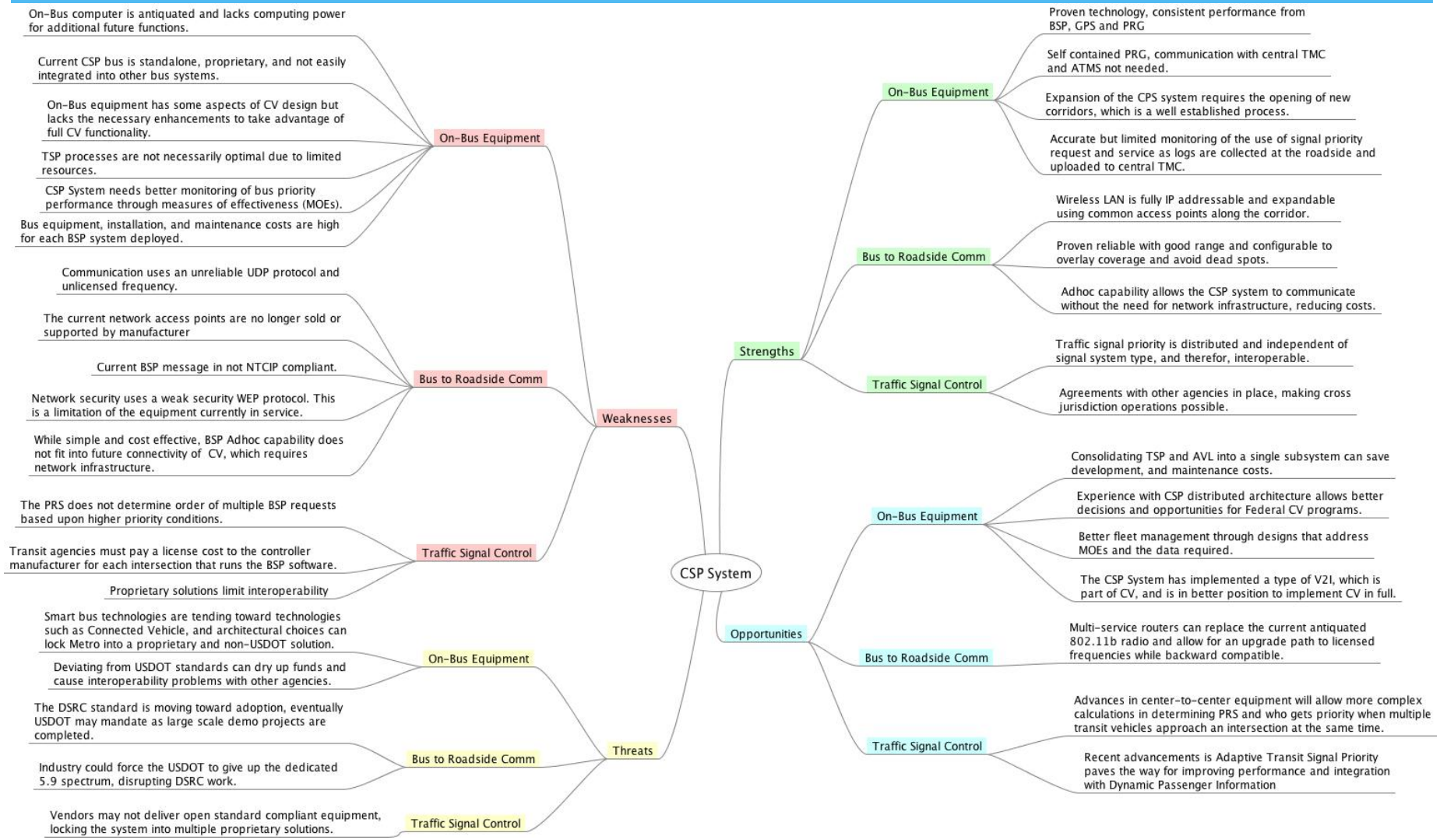
Nationwide Evaluation of Current BSP Practices

	National Comparables					Local	
Attributes	**TriMet (Portland)**	**AC Transit (East Bay)**	**King County Metro (Seattle)**	**RTA (Chicago)**	**MTA (New York)**	**LADOT (City of Los Angeles)**	**Metro CSP (Los Angeles County)**
System Design							
BSP Architecture:	Distributed, on-bus/intersection hybrid	Distributed, on-bus priority request	Distributed, off-vehicle priority logic	Distributed, on-bus priority request	Centralized, TMC priority request	Centralized, TMC priority request	Distributed, on-bus priority request
Wireless Comm. Technology:	Proprietary (Opticom IR)	Proprietary (Opticom GPS 2.4 GHz)	Licensed WiFi (4.9 GHz Public Safety)	Unlicensed WiFi (5 GHz)	Commercial cellular (Verizon 3G/4G)	N/A (Presence Detection Loops)	Unlicensed WiFi (2.4 GHz)
Size/Scope of Deployment:	7 corridors 275 intersections	3 corridors 270 intersections	6 corridors 192 intersections	(In construction)	10 corridors 474 intersections	9 corridors 654 intersections	7 corridors 400 intersections
Year First Deployed:	2000	2015	2005	2017 (planned)	2010	2000	2002
Capabilities							
Priority Treatments:	• Early green • Green extend	• Early green • Green extend • Phase call	• Early green • Green extend • Phase call	• Early green • Green extend • Phase call	• Early green • Green extend • Phase call	• Early green • Green extend • Phase call	• Early green • Green extend
Monitoring Capabilities	Controllers log BSP requests	Central CMS logs and reports on BSP requests	Controllers log BSP requests	Controllers log BSP requests and status	Central system logs BSP requests and status	Central TPM server logs BSP requests active signal control status	Controllers log BSP requests and action taken (early green/green extend)
Measured Benefits	• 5-12% reduction in travel time	*Not yet collected*	• 25-34% reduction in travel time* • 35% reduction in travel time variability*	*Not yet collected*	14-18% reduction in travel time	• 8% reduction in travel time • 12% reduction in intersection delay	• 4-8% reduction in travel time • 14% reduction in intersection delay

Existing CSP Assessment
SWOT Analysis



Existing CSP Assessment Strengths

* Proven technologies
* Wireless LAN is fully IP addressable and expandable
* Signal Priority is distributed and independent of signal system type
* Agreements with other agencies, and architecture is used county-wide.

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Existing CSP Assessment Weaknesses

* Pilot system was deployed over 15 years ago
* Aging CSP technologies and equipment (on-bus)
* Monitoring of performance through MOE's
* BSP message is not NTCIP compliant
* Proprietary solutions limit interoperability

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Existing CSP Assessment Opportunities

* Consolidating TSP and AVL in to single system
  * Metro is upgrading its ATMS to incorporate TSP
* Implementation of CV technologies
* Upgrade equipment on-bus (i.e. routers)
  * Metro completed its Bus/Rail Strategic Plan and includes the roll-out of mobile gateway routers
* Center-to-center equipment

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Existing CSP Assessment Threats

* DSRC as a standard
* What is going to happen with DSRC?
* Vendors may not deliver open standard complaint equipment, locking the system into multiple proprietary solutions

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Concept Exploration

* Goals:
  * Reliability, speed, and value of bus service
* Needs:
  * Cost effective
  * Rapidly deployable
  * Scalable
  * Adaptable and functional with traffic signal control and transit system management
  * Advanced priority functions
  * Performance measurement and data analysis
  * Standardized communications and messages
  * Not dependent on a particular vendor

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Concept Exploration

* Vehicle-to-Infrastructure (V2I) Connected Vehicle
* Vehicle-to-Infrastructure (V2I) Cellular to Isolated Signal
* Vehicle-to-Center (V2C) Cellular to Centralized TMC
* Center-to-Center (C2C) Fully Centralized TOC and TMC
* BSP-as-a-Service (BSPaaS) Cloud Application

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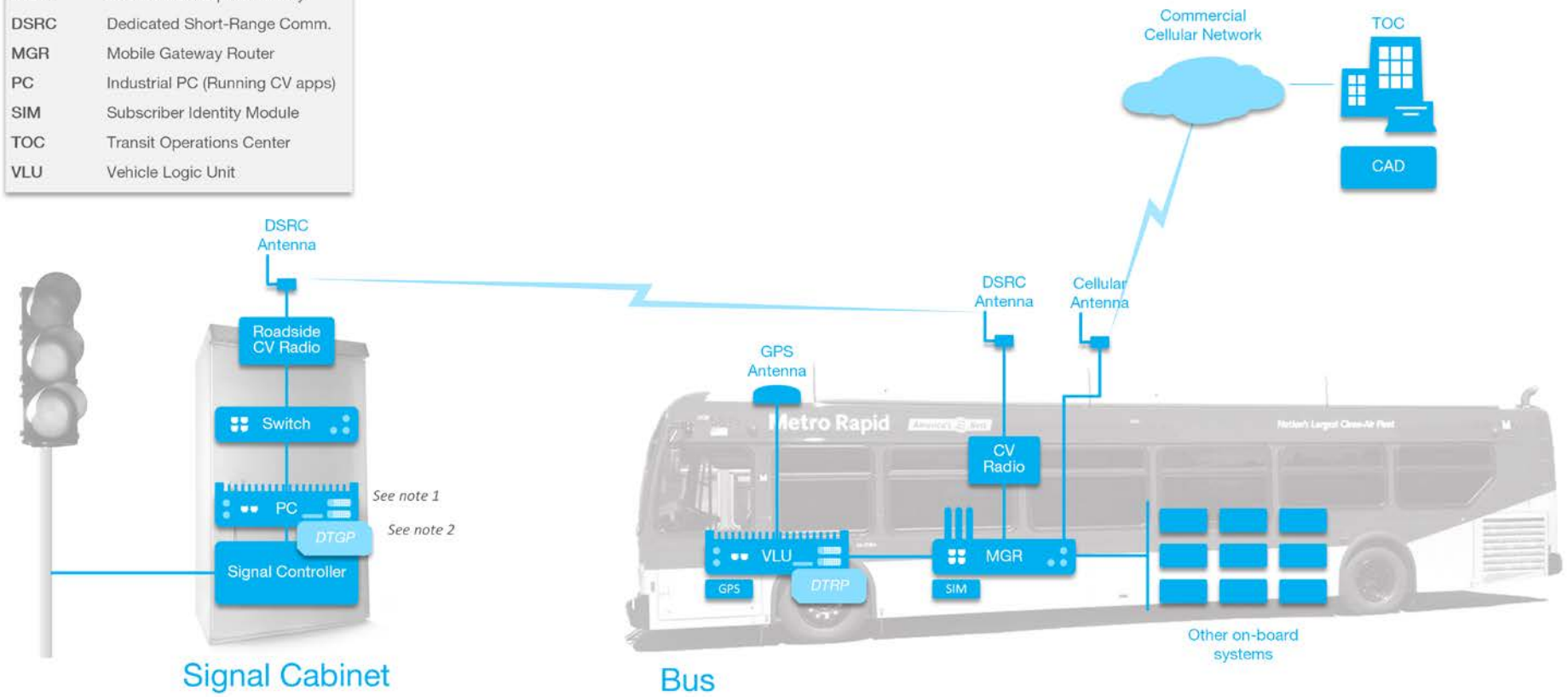
Vehicle-to-Infrastructure (V2I) Connected Vehicle

Legend	
CAD/AVL	Computer-Aided Dispatch/ Automatic Vehicle Location
DTGP	Decision to Grant Priority
DTRP	Decision to Request Priority
DSRC	Dedicated Short-Range Comm.
MGR	Mobile Gateway Router
PC	Industrial PC (Running CV apps)
SIM	Subscriber Identity Module
TOC	Transit Operations Center
VLU	Vehicle Logic Unit

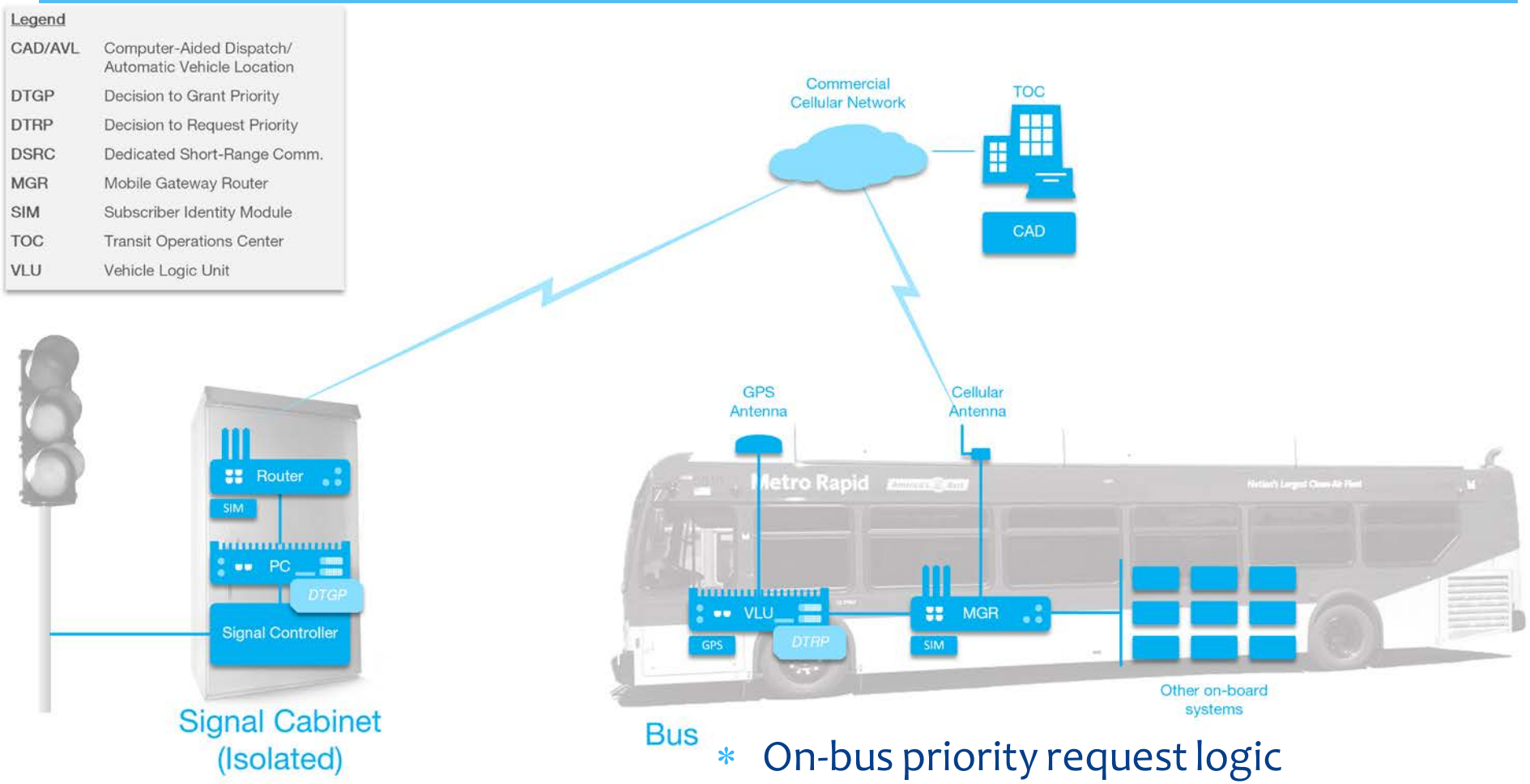
* On-bus priority request logic
* Intersection-based priority granting logic



1. Local intersection PC is required only if controller is not an Advanced Traffic Controller (ATC). If traffic agency has upgraded to ATC the BSP application and DTGP can reside on the controller.

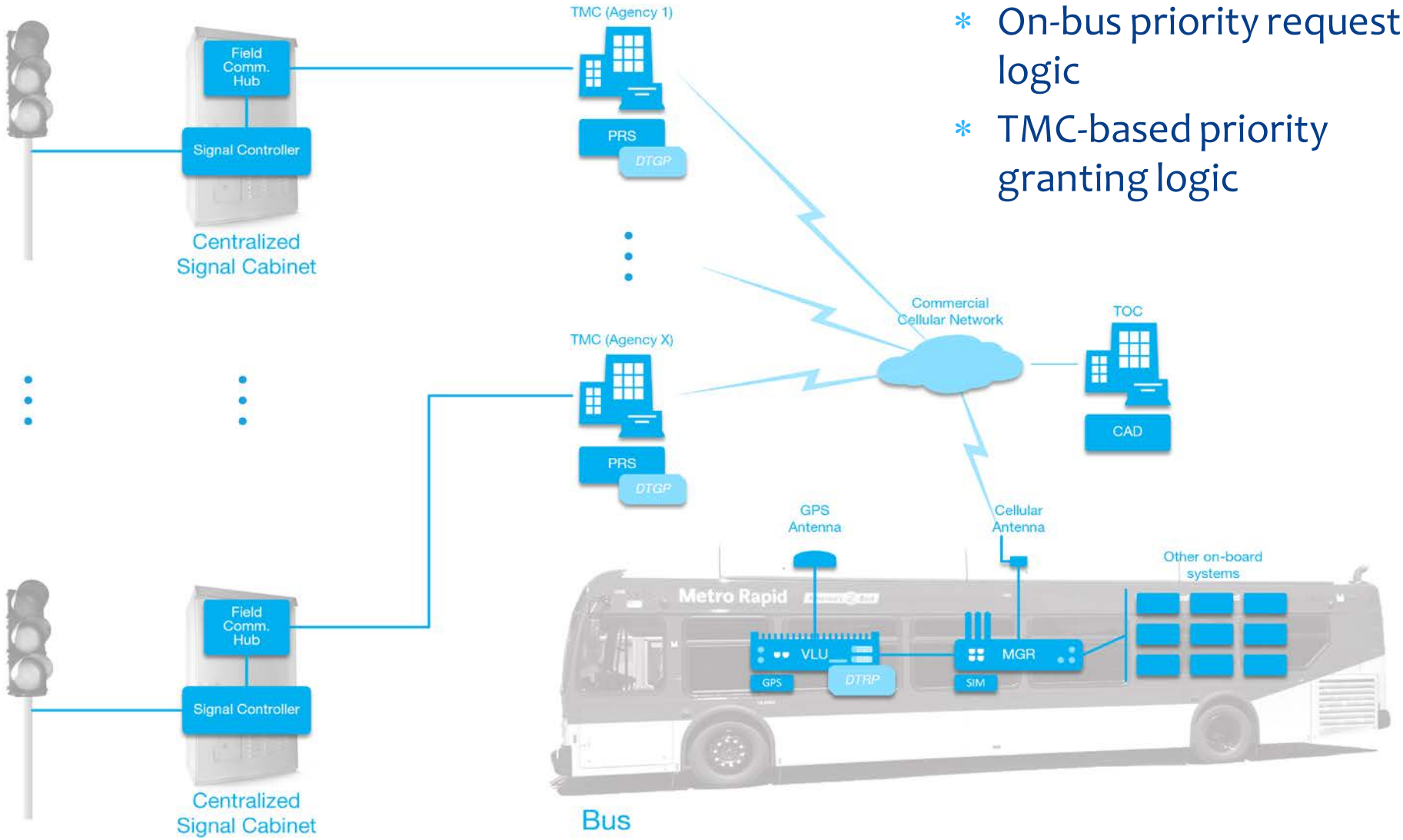
2. DTGP functionality may reside on either PC or controller, depending on architecture.

Vehicle-to-Infrastructure (V2I) Cellular to Isolated Signal



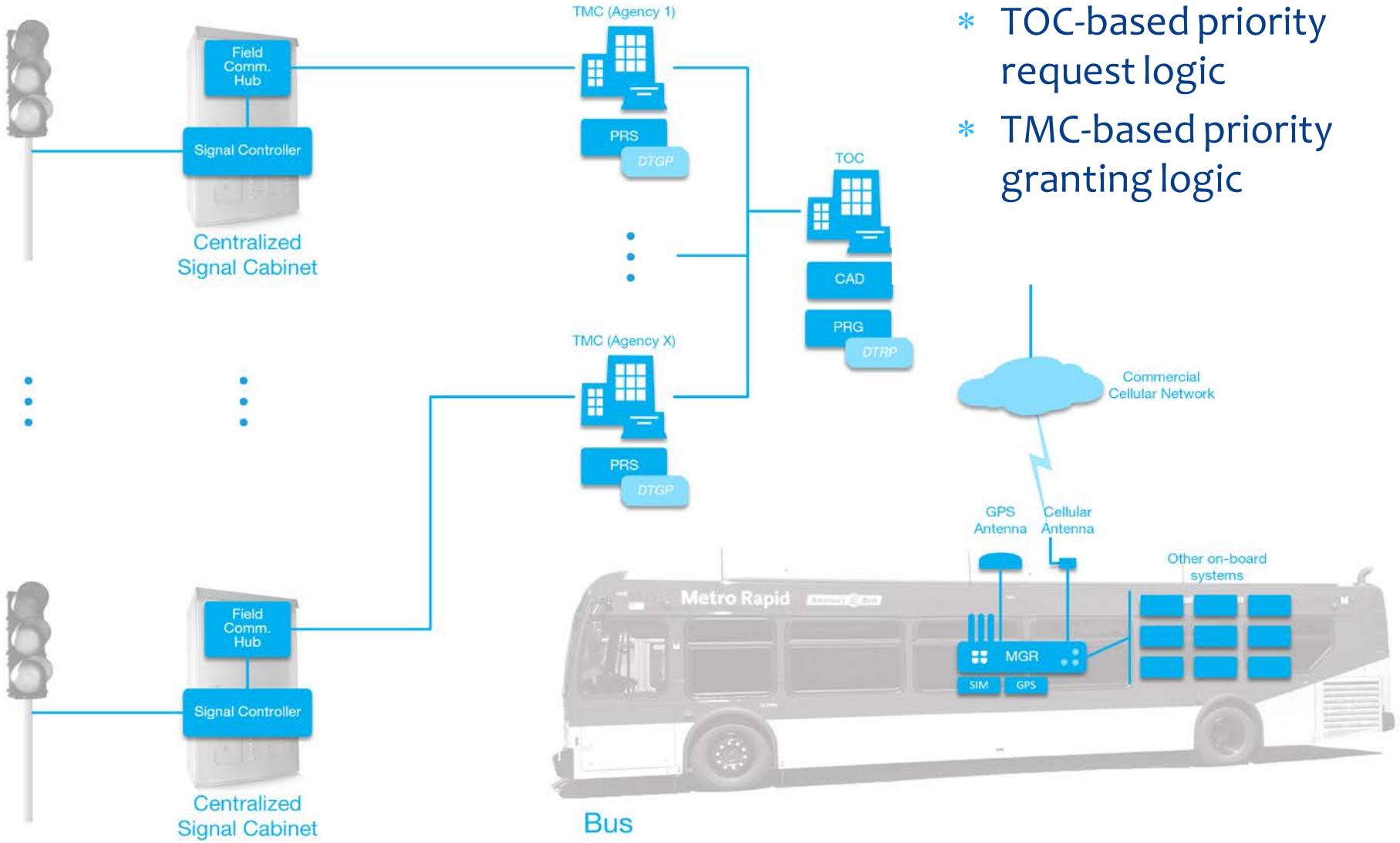
- On-bus priority request logic
- Intersection-based priority granting logic

Vehicle-to-Center (V2C) Cellular to Centralized TMC



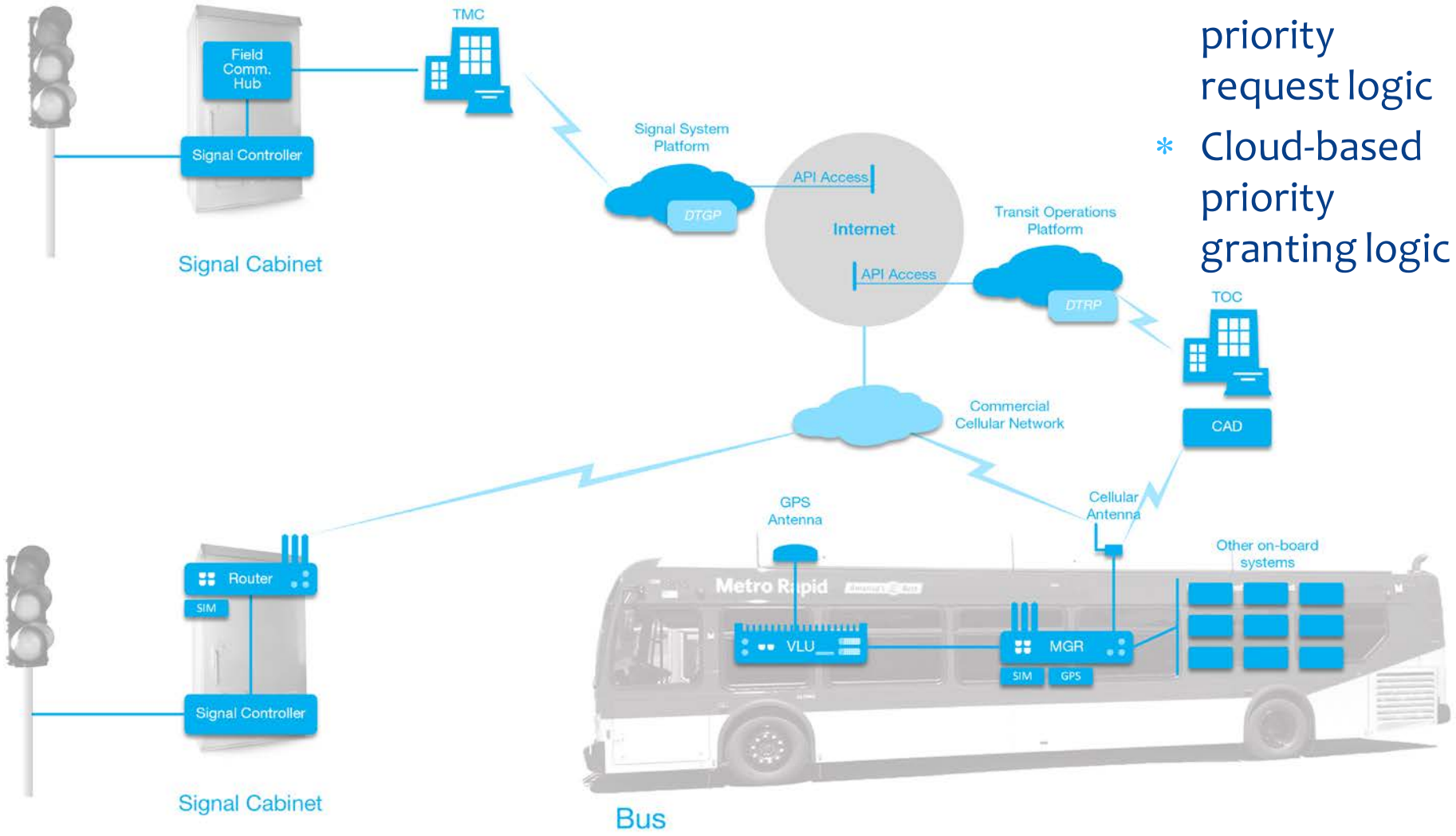
- On-bus priority request logic
- TMC-based priority granting logic

Center-to-Center (C2C) Fully Centralized TOC and TMC



* TOC-based priority request logic
* TMC-based priority granting logic

BSP-as-a-Service (BSPaaS) Cloud Application



* Cloud-based priority request logic
* Cloud-based priority granting logic

Next Gen BSP Evaluation Summary

Concept	Priority Request Logic Location	Priority Granting Logic Location	Support for Advanced Priority Functions	Maturity of Technology	Compatibility with Existing System	Cost Effectiveness	Maintain-ability	Expansion Potential		**Overall Assessment (Near-Term)**	**Overall Assessment (Long-Term)**
								Fleet	Signal Systems		
1. V2I Connected Vehicle			◕	◔	◔	◔	◔	◔	◑	◔	◕
2. V2I Cellular to Isolated Signal			◔	◔	◑	◑	◑	◕	●	○	○
3. V2C Cellular to Centralized TMC			◔	◕	○	◕	◕	◕	○	◑	◑
4. C2C Centralized TOC and TMC			●	◕	○	◕	○	●	○	○	○
5. BSP-as-a-Service Cloud-Native			●	◔	○	●	●	●	●	◔	●

Ratings key:

○ 1 (low) ◔ 2 (low-mid) ◑ 3 (medium) ◕ 4 (mid-high) ● 5 (high)

How should CSP evolve in the LA Region?

* Operate, maintain, and improve on the existing CSP system
* Consider Piloting V2I Connected Vehicle Concept
  * Deploy pilot on a small municipal operator/line
* Assess Readiness and Pilot for BSP-as-a-Service
  * Prepare industry white paper
  * Full deployment may take years on Metro Rapid service, therefore, small pilot may be more desirable to test out architecture

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Thank You!

Questions?

Contact

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