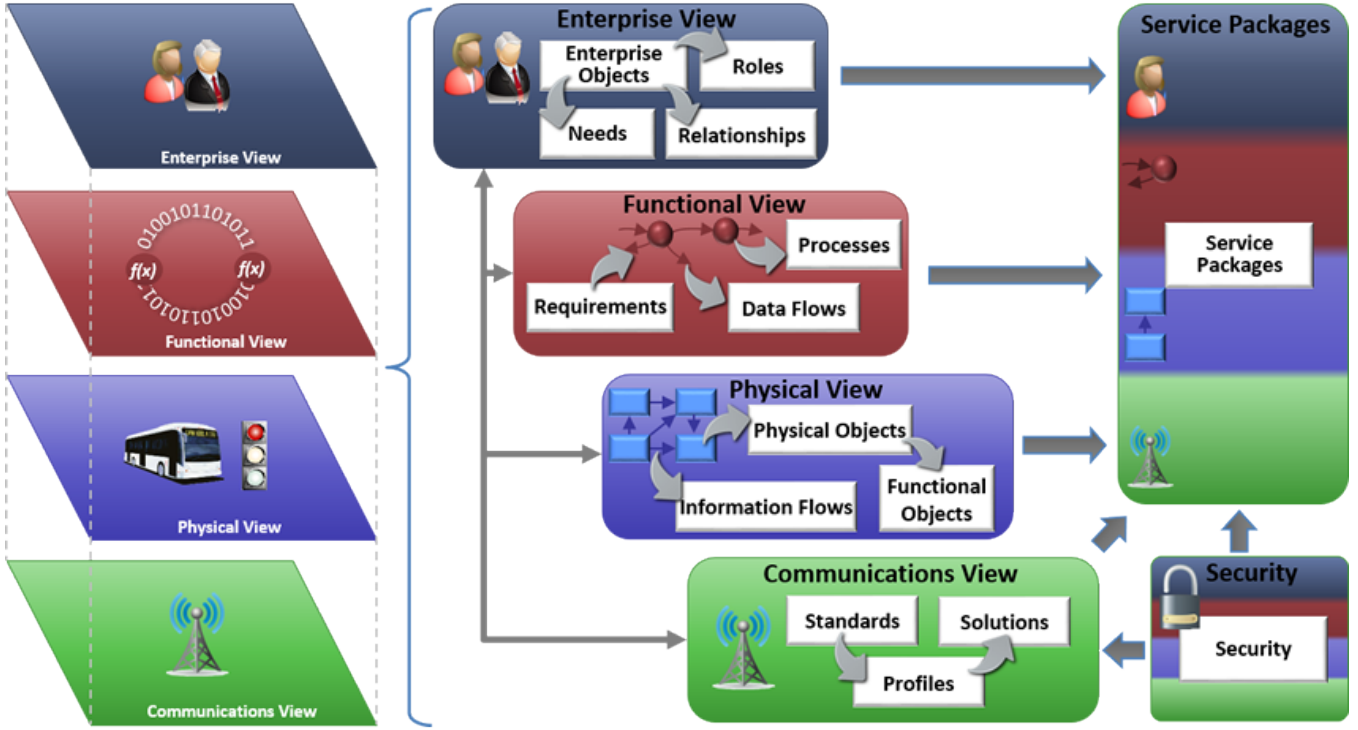
Architecture for Automation update

July 27, 2020

Agenda

- ARC-IT use in ITS Planning and Projects
- Support for Advanced Technologies
- Enhancements to Support Automation

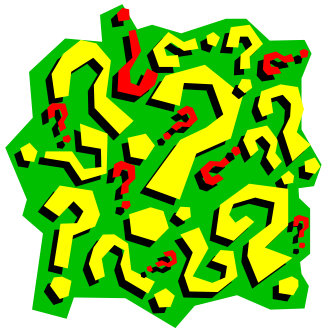
ARC-IT use in ITS Planning



What is ARC-IT?

Why Do We Need a National ITS Reference Architecture?

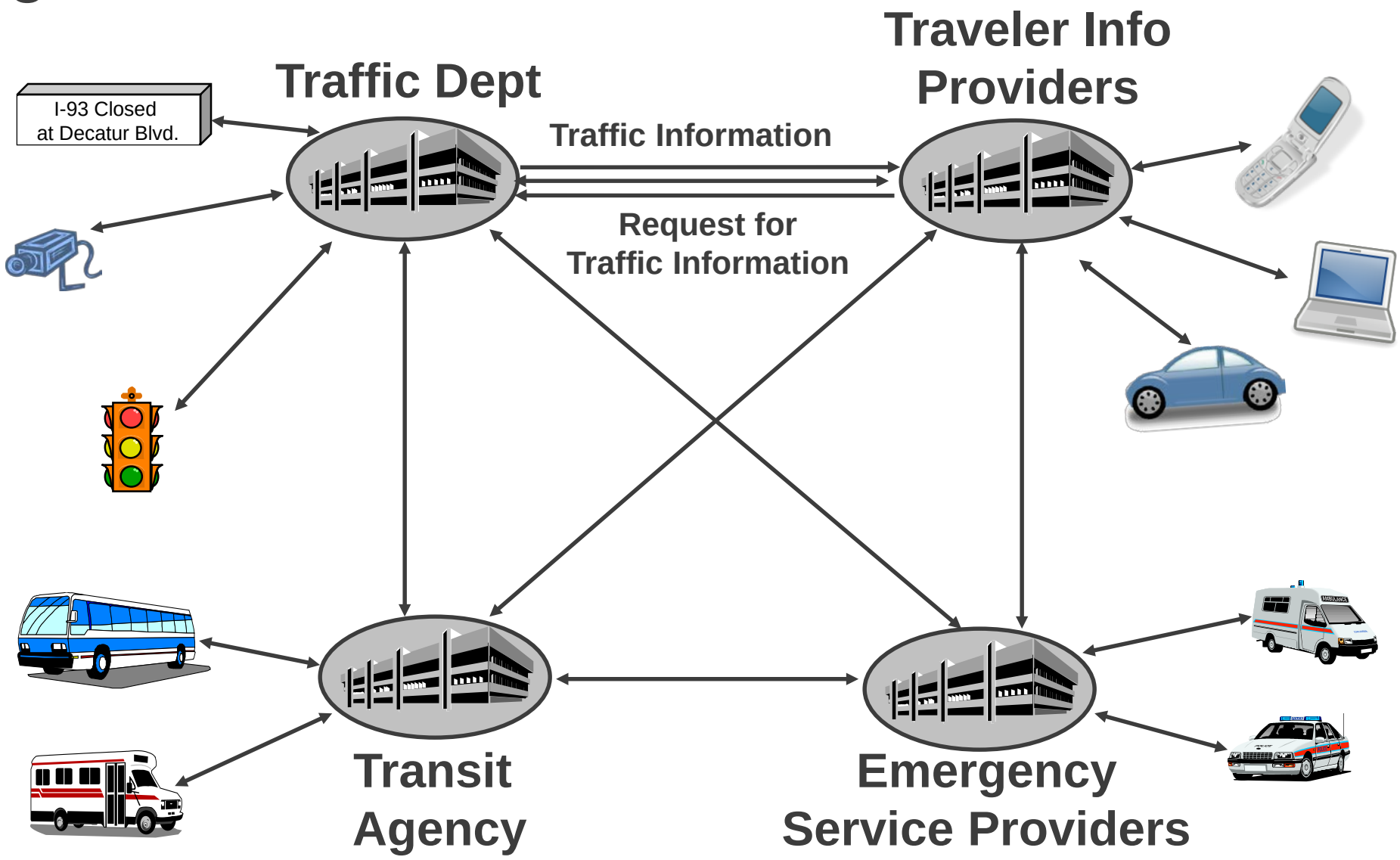
- Provide a national “vision” for ITS
- Guide sound ITS planning and investments at the state and local level
- Support systems engineering analysis for projects deploying ITS
- Identify and scope the needs for standardized interfaces



System Architecture for ITS

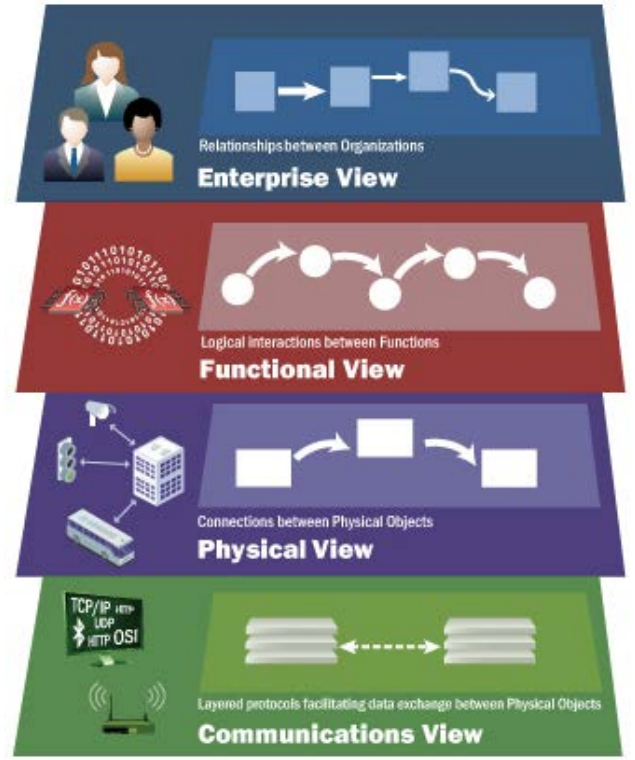
- Provides a framework for developing integrated transportation systems
- Identifies:
  - Organizations
  - Systems operated
  - Functions performed, services provided
  - Communications required
  - Information exchanged
- WITHOUT getting into specific technologies, picking winners/losers
  - Technology Neutral is key

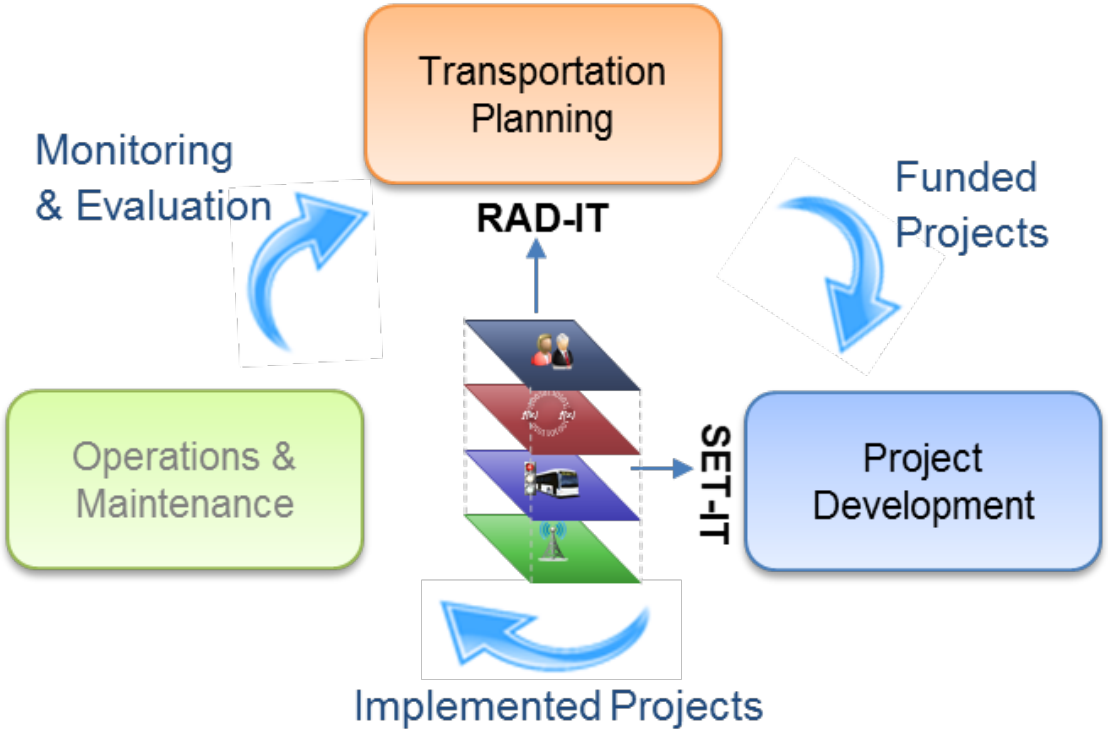
ITS Architectures Provide a Framework for Integration



ARC-IT – the National ITS Reference Architecture is a “Living Document”

- Provides a common framework for planning, defining, and integrating ITS
- Continually evolving & growing

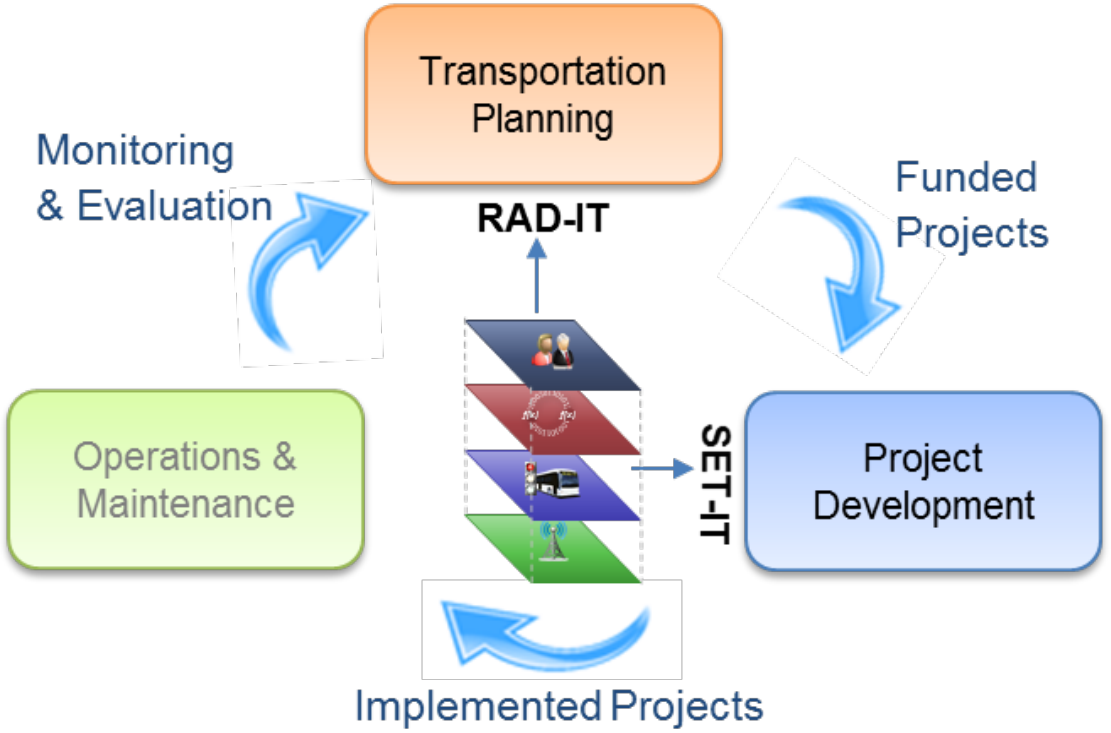




ARC-IT & Transportation Planning

ARC-IT & Planning

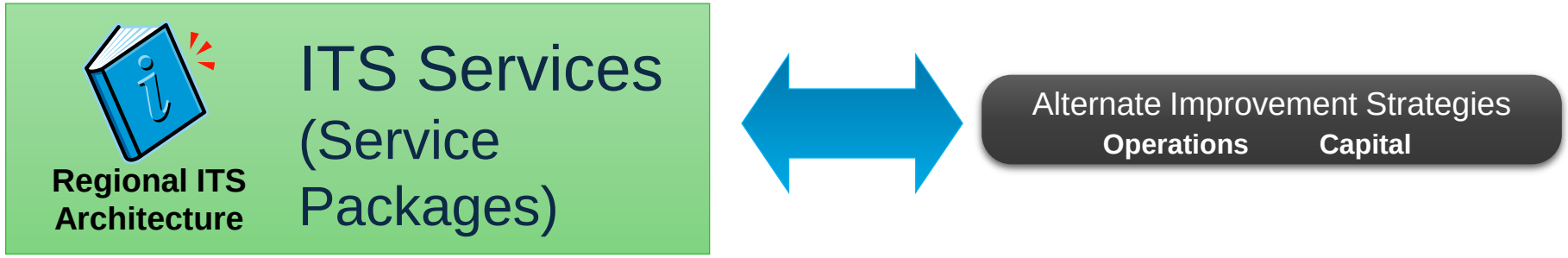
- Technology-based systems can pose real challenges for transportation planning.
  - 2 yr device/app turnover vs 20-30 year capital planning cycles
- Regional ITS architectures -- plan for technology application and integration to support more effective planning for operations
  - Provides context for ITS projects so that each project can build a piece of the envisioned transportation system
- With the architecture, each project will be on the path to fulfilling the larger objectives set forth in the long range transportation plan



Using the Architecture in Transportation Planning

- Architecture represents a consensus vision of Operations and Planning stakeholders for deployment of ITS systems
- Addresses both short range projects and long range strategies

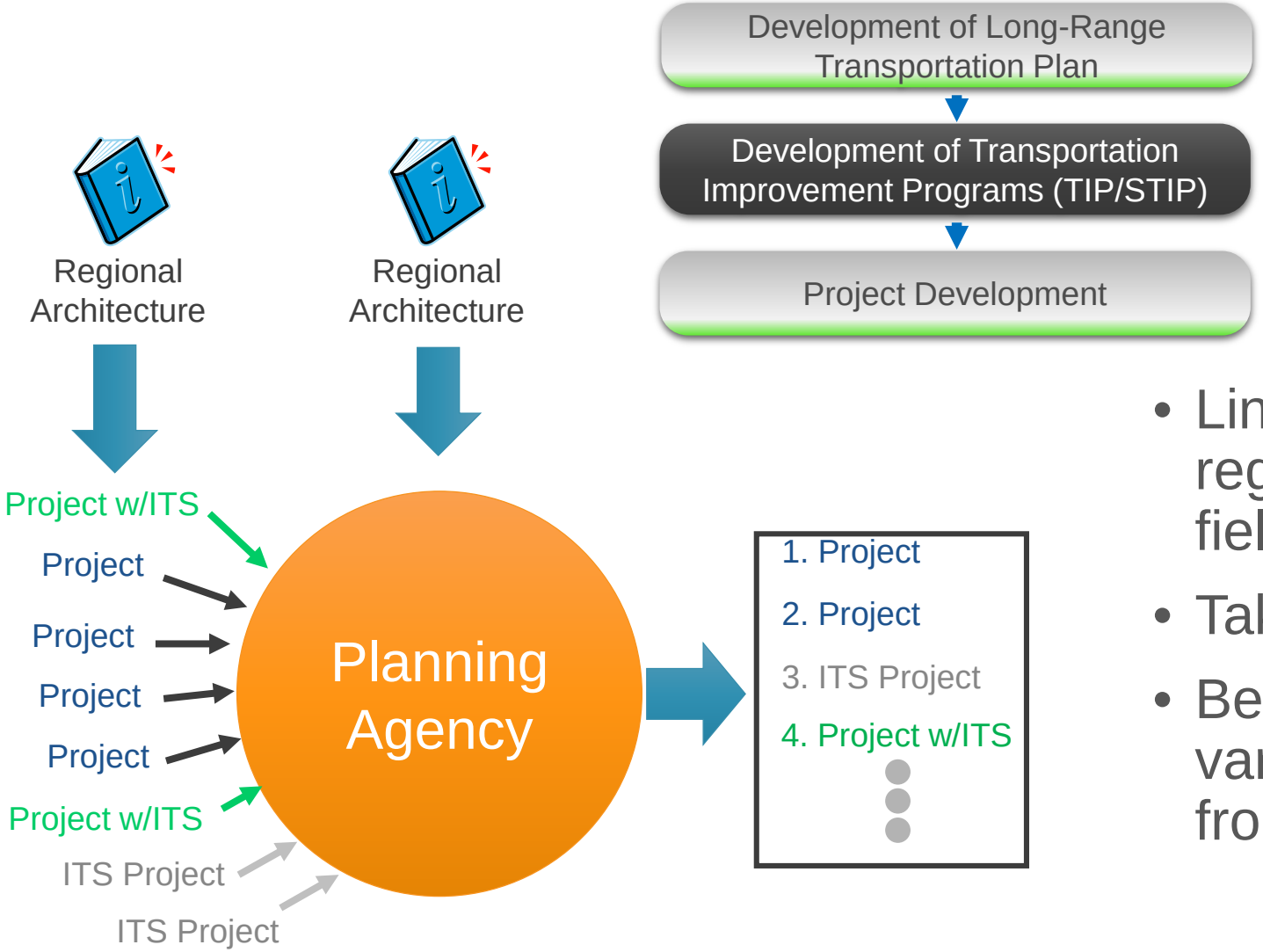
- Architecture services can point to operational strategies
- Operational strategies from the LRTP can be mapped to architecture services



Benefits of Architecture Use

- Link objectives and needs of the region with ITS deployed in the field
- Take a regional view
- Begin coordination of projects of various organizations by defining from the same reference point
- Interfaces – those integration opportunities are related to standards being developed that will lead to interoperable systems cooperating and preserving investment

Architecture Use in Programming/Budgeting



- Link objectives and needs of the region with ITS deployed in the field
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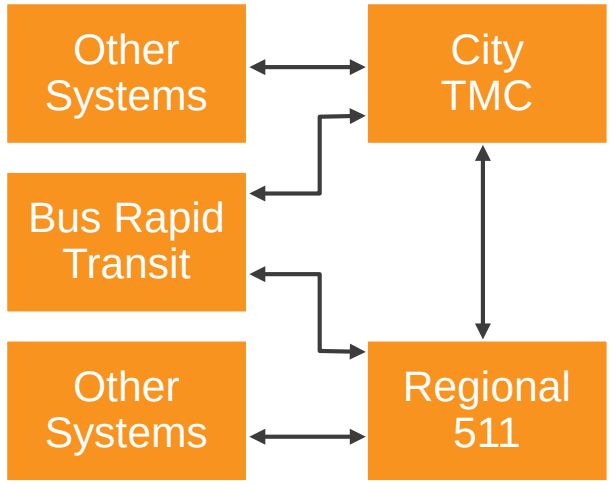
ARC-IT use in ITS Project Development

Architecture Provides a Regional Context for Planned Projects

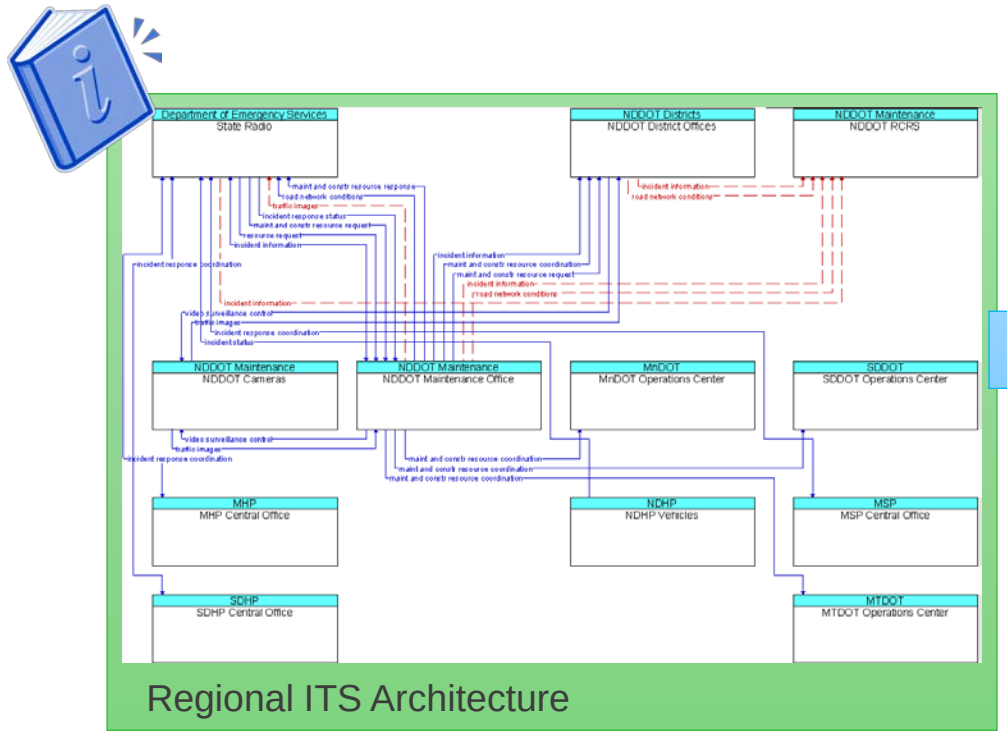
Regional Architecture



Transportation Improvement Program

Agency	Number	Project	Funding
City	C11-321	City TMC	$400K
CTrans	T12-023	Bus Rapid Transit Ph1	$1.4M
DOT	D11-843	Regional 511 Ph2	$600K

Use to Identify Projects & Look for Opportunities



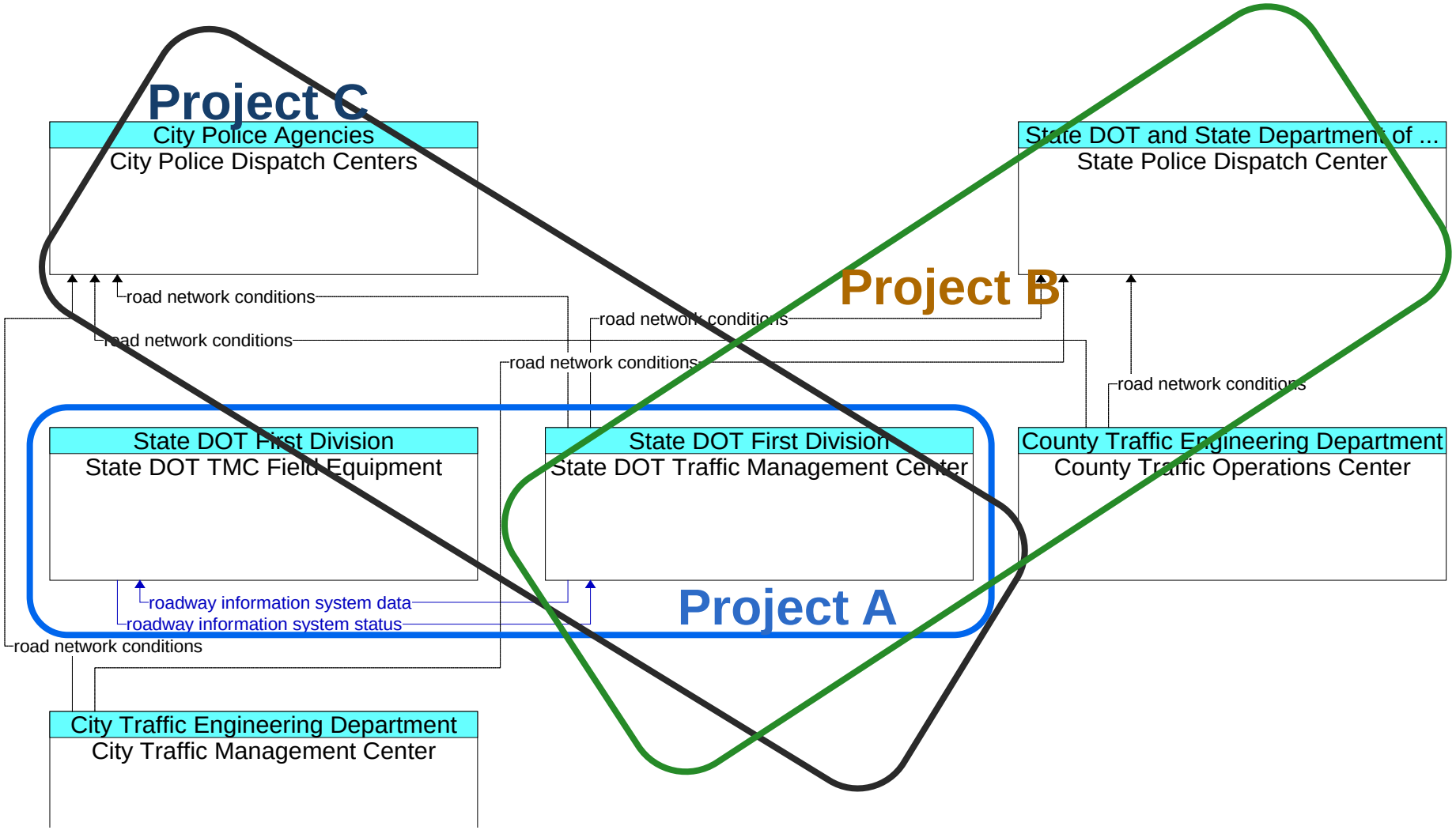
Regional ITS Architecture

Integration Opportunities

ITS Project

Project Identification from Architecture

Identify Projects



Use to Plan Project Details

Scope Projects

ITS Architecture

1. Region description
2. Stakeholder identification
3. ITS elements
4. ITS services
5. Operational concept
6. Functional requirements
7. Interfaces / Information flows
8. Standards identification
9. Project sequencing
10. Agreements
11. Maintenance plan

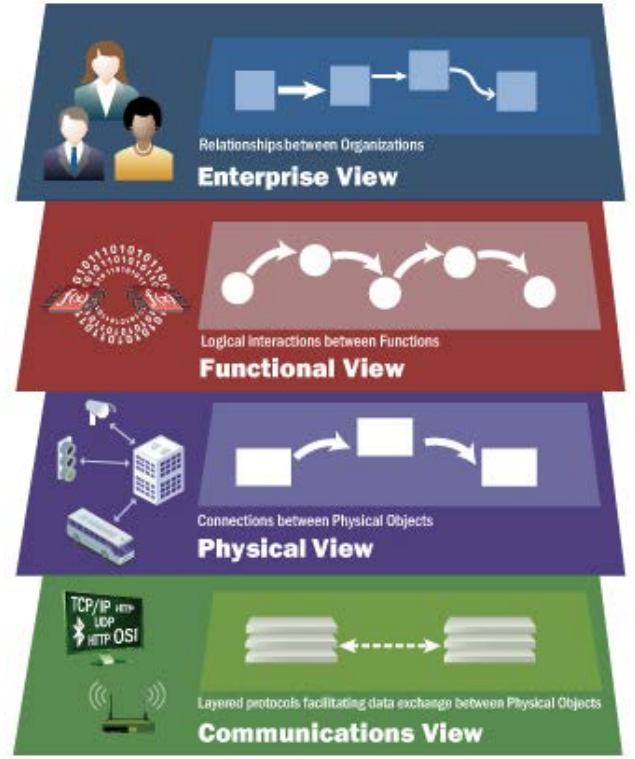
Project Scoping

- Project Description
- Stakeholders involved
- Stakeholder roles & responsibilities
- Potential partners
- Elements involved
- Integration opportunities
- Dependencies
- Budget estimate

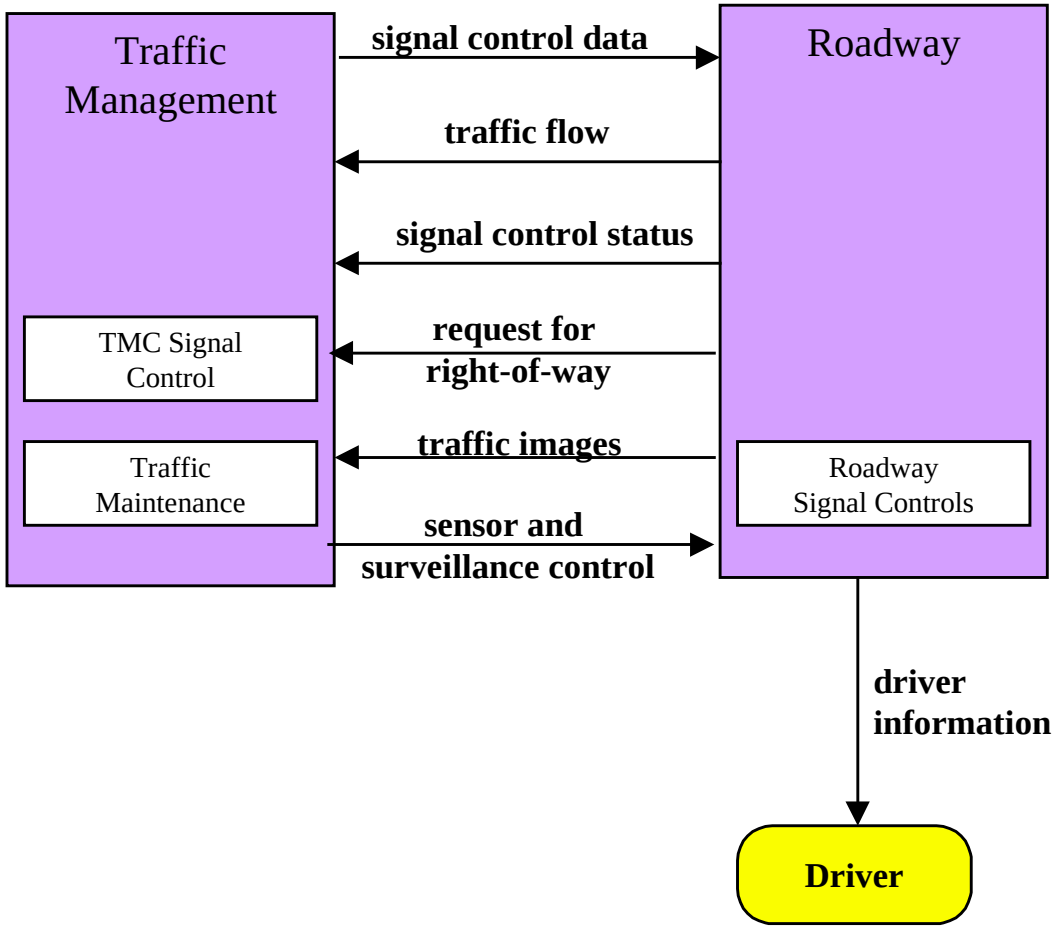
ARC-IT & Advancing Technologies

Support for Advanced Technologies

- Begun in 1993 with a 20 year time horizon
- Some concepts take a long time to get from the architecture to the roadway



Adaptive Signal Control

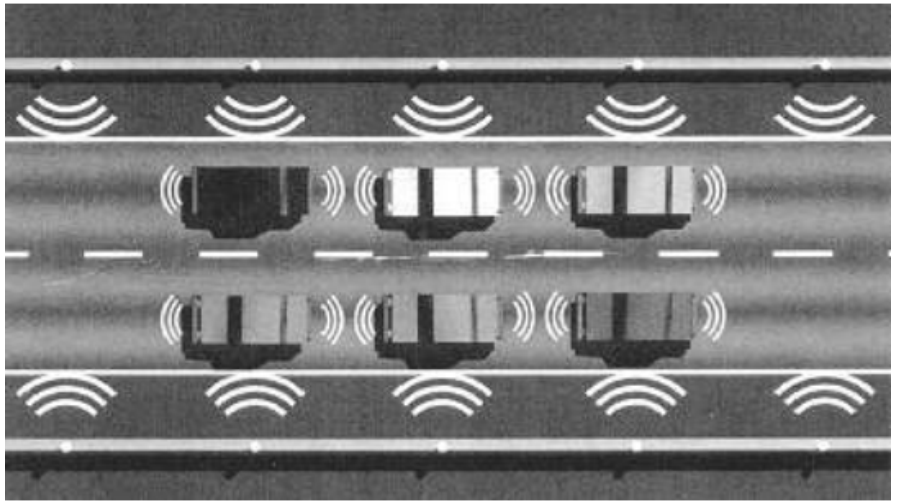


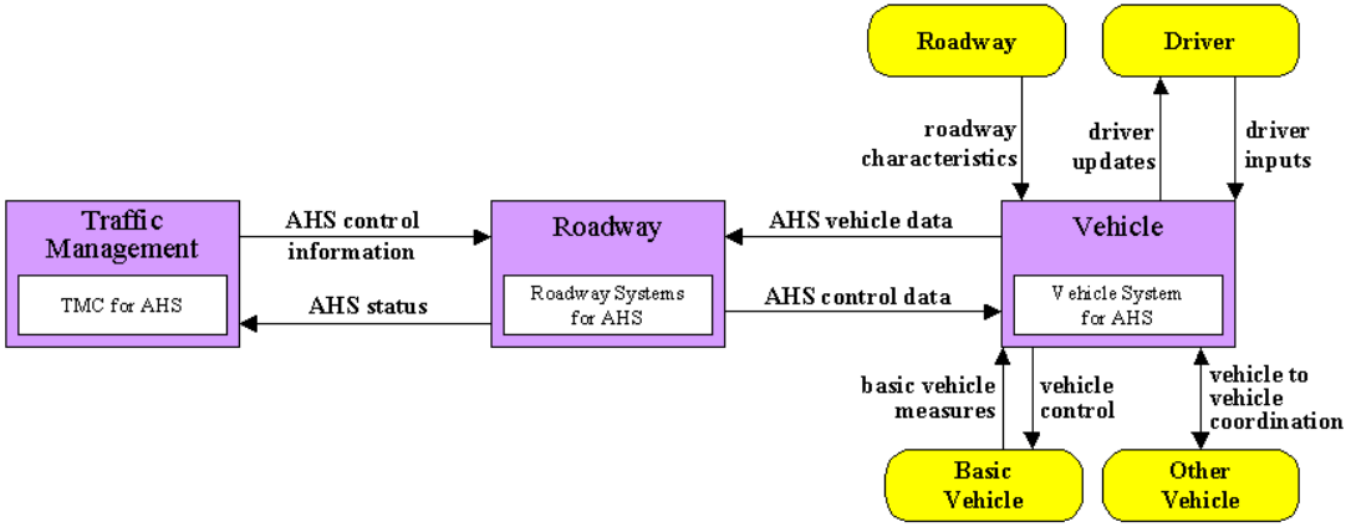
- "real-time traffic adaptive control" envisioned as part of the original ITS Program Plan in 1993
- Part of version 1 of the National ITS Architecture
  - ATMS03 Traffic Control includes basic signals as well as traffic responsive or adaptive controls
  - Included in standards, on-going research, early deployments
  - Finally coming into their own in 2010s

Intelligent Highways

"In an automated highway system, the car will be guided by the road rather than by the driver. Sensors and communication devices will link the road and the vehicle to maximize driving performance. Driver error will be reduced and ultimately, with full implementation, eliminated."

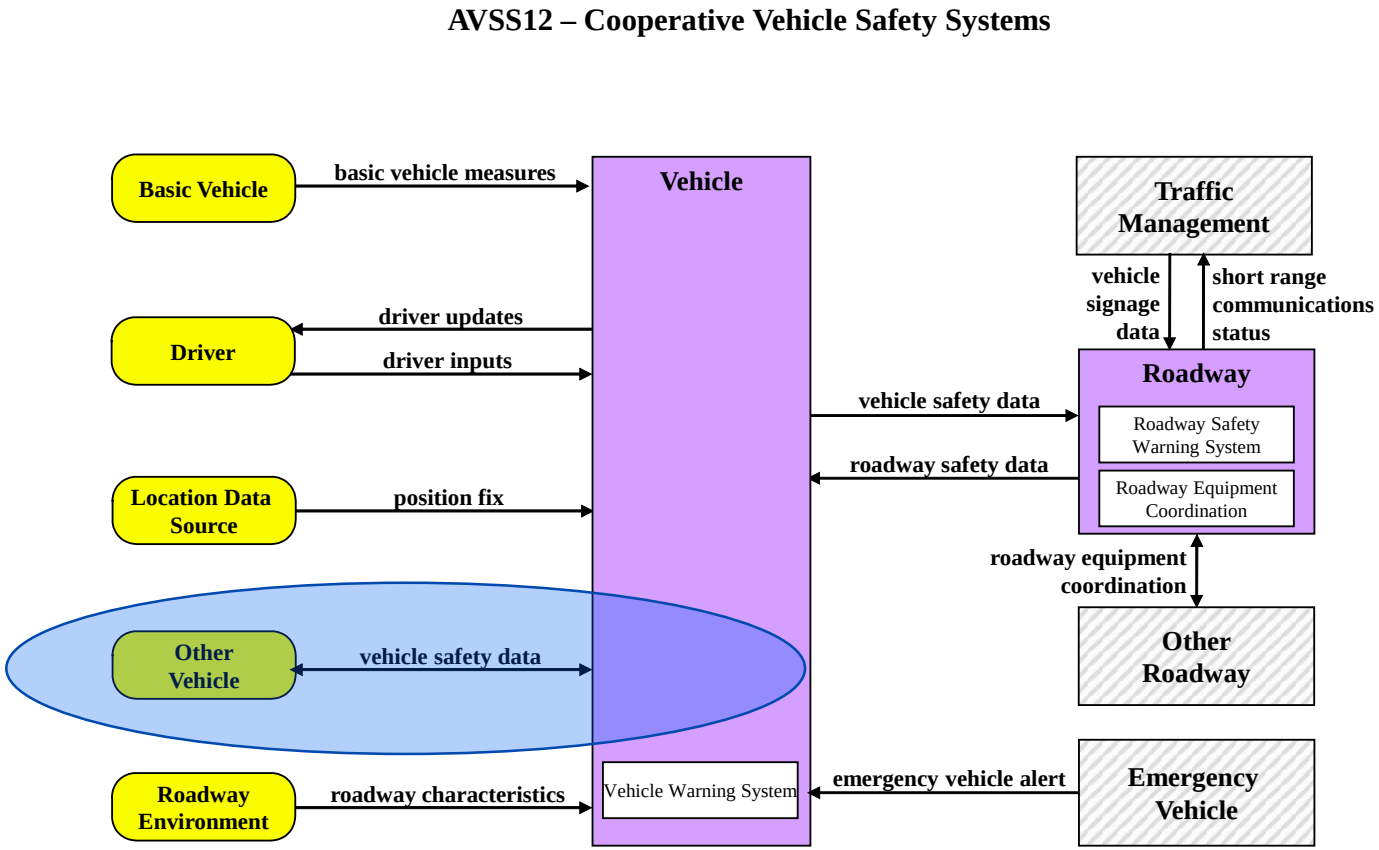
-- Public Roads, Summer 1994





AVSS11 – Automated Highway System

V2V Collision Avoidance

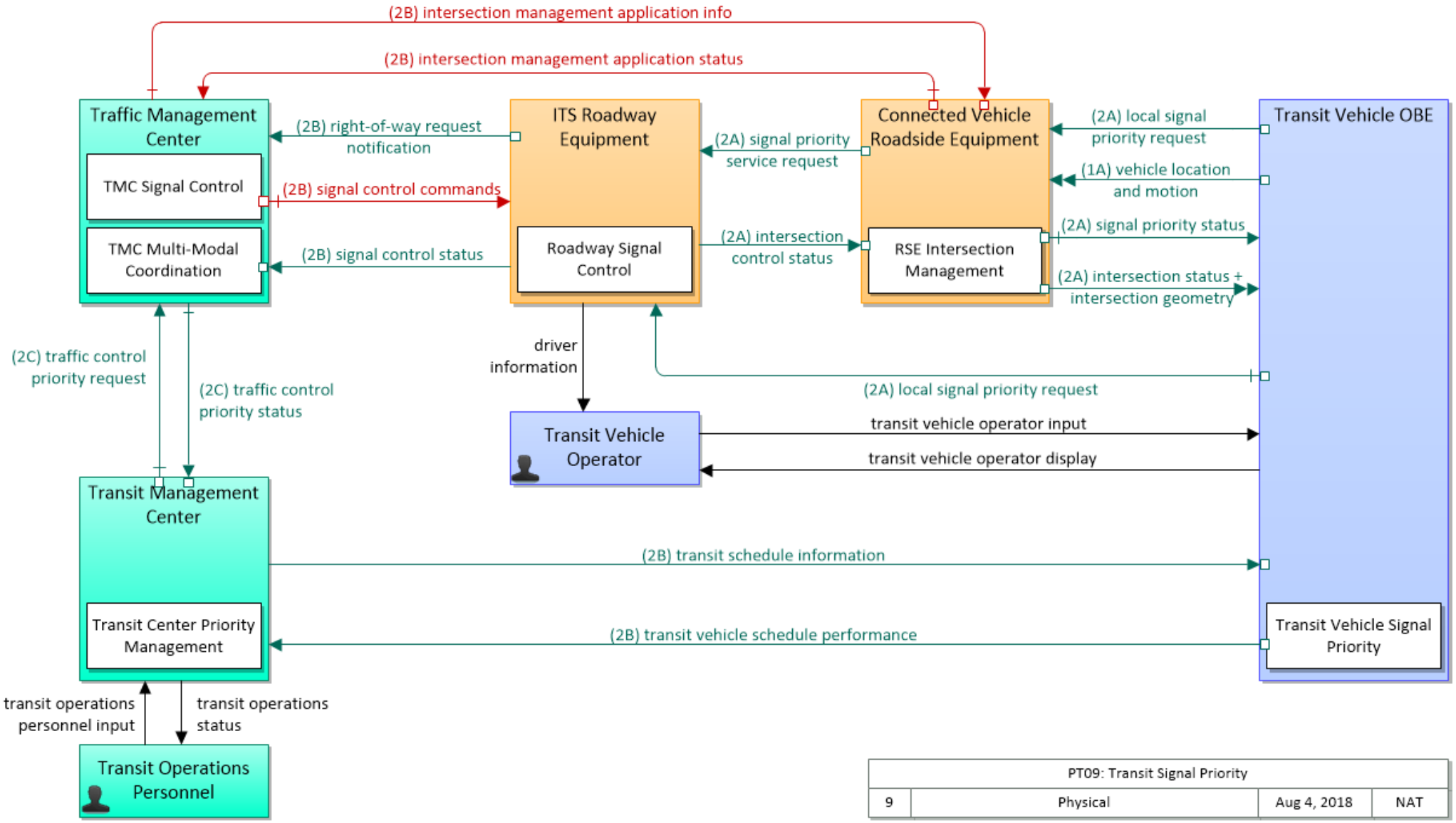


- Introduced with the VII program - 2003
- Included in National ITS Architecture v6, 2007
- Discussions lead to ideas, captured in services, functions, interfaces to be realized much later
- Evolves with the CV/AV programs
- As the industry has learned the architecture has grown, standards developed, tests run, many lessons learned

Vehicle Connectivity

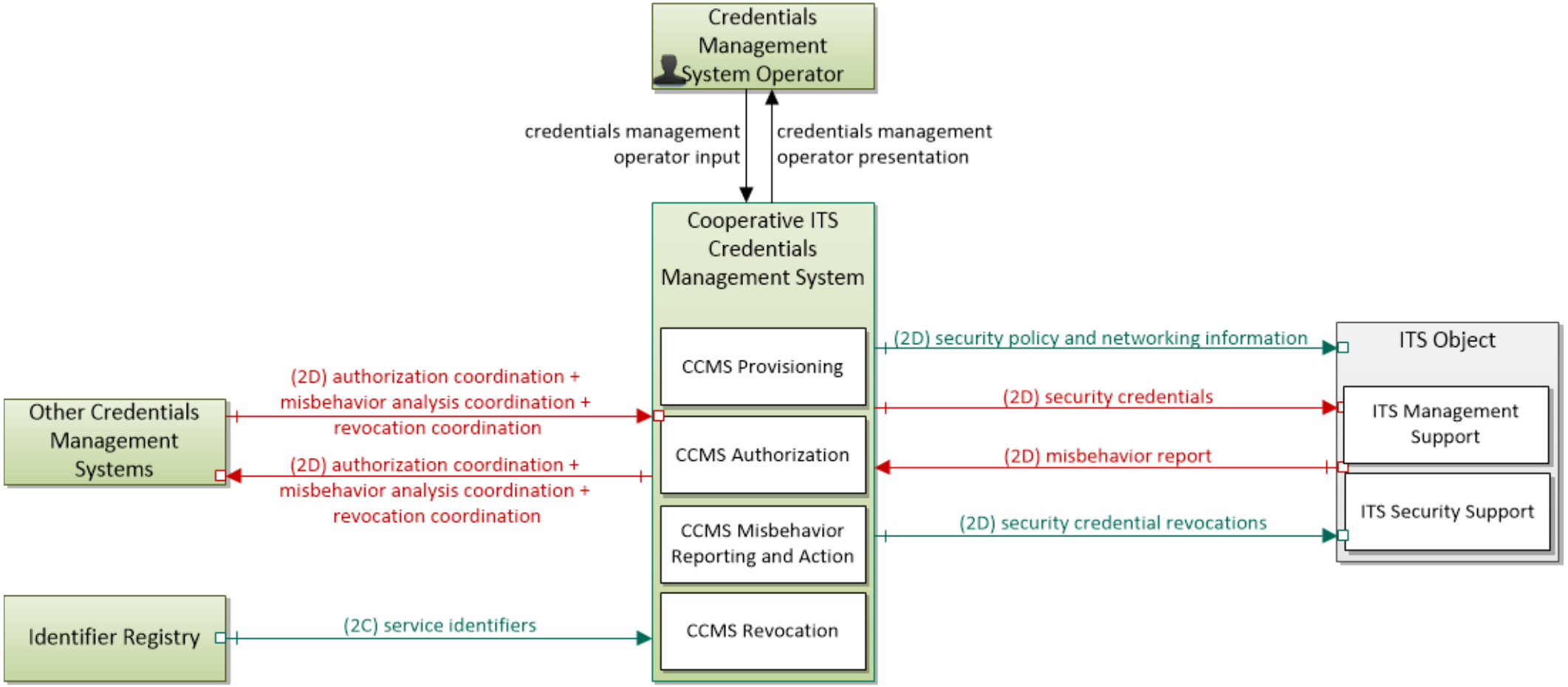
- Once the cars start talking to each other, what else can they talk to? What else can they do
- VII → CV → CVRIA → CAV & ARC-IT
- From the early Vehicle to Roadway connections in 1993
  - Route Guidance
  - Automated Highway
- VII-inspired traveler messages in mid-2000s
  - In-vehicle signing
- Connected Vehicle research initiatives in the 2010s
  - SPaT, connected transit, fleet operations
- Today's architecture includes dozens of services enabled by Vehicle-to-Vehicle, Vehicle-to-Infrastructure, Vehicle-to-everything

Roadside Connectivity



PT09: Transit Signal Priority			
9	Physical	Aug 4, 2018	NAT

Cooperative Trust Enablement



SU08: Security and Credentials Management			
8	Physical	May 9, 2019	NAT

What’s the Point?

- ARC-IT has always tried to stay years ahead of deployment
- Planning has a long life cycle
- Projects have a shorter life cycle, but in the project case, we facilitate replication, early deployment and common understanding

ARC-IT Enhancements to Support Automation

Architecture for Automation: A4A

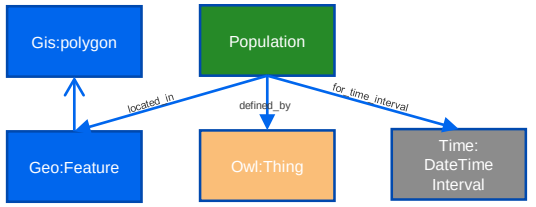
- Just a name
- Really, A4A is the sum of all changes to ARC-IT that support vehicle automation. It is not a new product, though it may spur some new products
- Timeframe from 2020, version 9.0 onward
- Many of the enhancements described here were inspired by discussions at the National Dialogues on Highway Automation

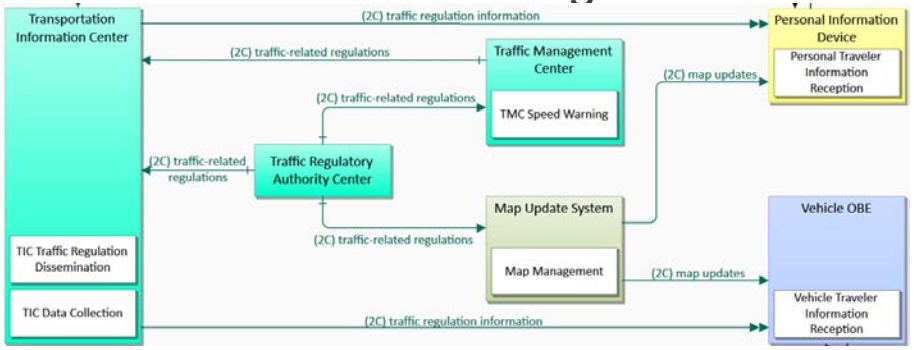
Sampling of A4A Content

- Considering the roadway environment
  - What infrastructure characteristics are needed to support AV?
  - How does the Locate/Sense/Predict/Plan paradigm impact the roadway operator?
- Asset management?
  - Can we make work zone items, such as barrels and vests, more visible to AV?
- Deep dive into interfaces
  - Wherever possible, data exchanges should follow well-know standards
  - Help implementers avoid proprietary lock-in

Sampling of A4A Content cont'd

- Information Viewpoint
  - Who owns what data?
  - What about data privacy (including secondary exchange)?
  - How is data governed? Who has the right to do what with "your" data? How is this administered and policed?
  - What are the minimum data requirements for services?
  - Wherever possible, data and metadata should be defined and stored in standardized formats
- Rules-of-the-Road
  - There should be a (possibly commercial) mechanism for disseminating road rules



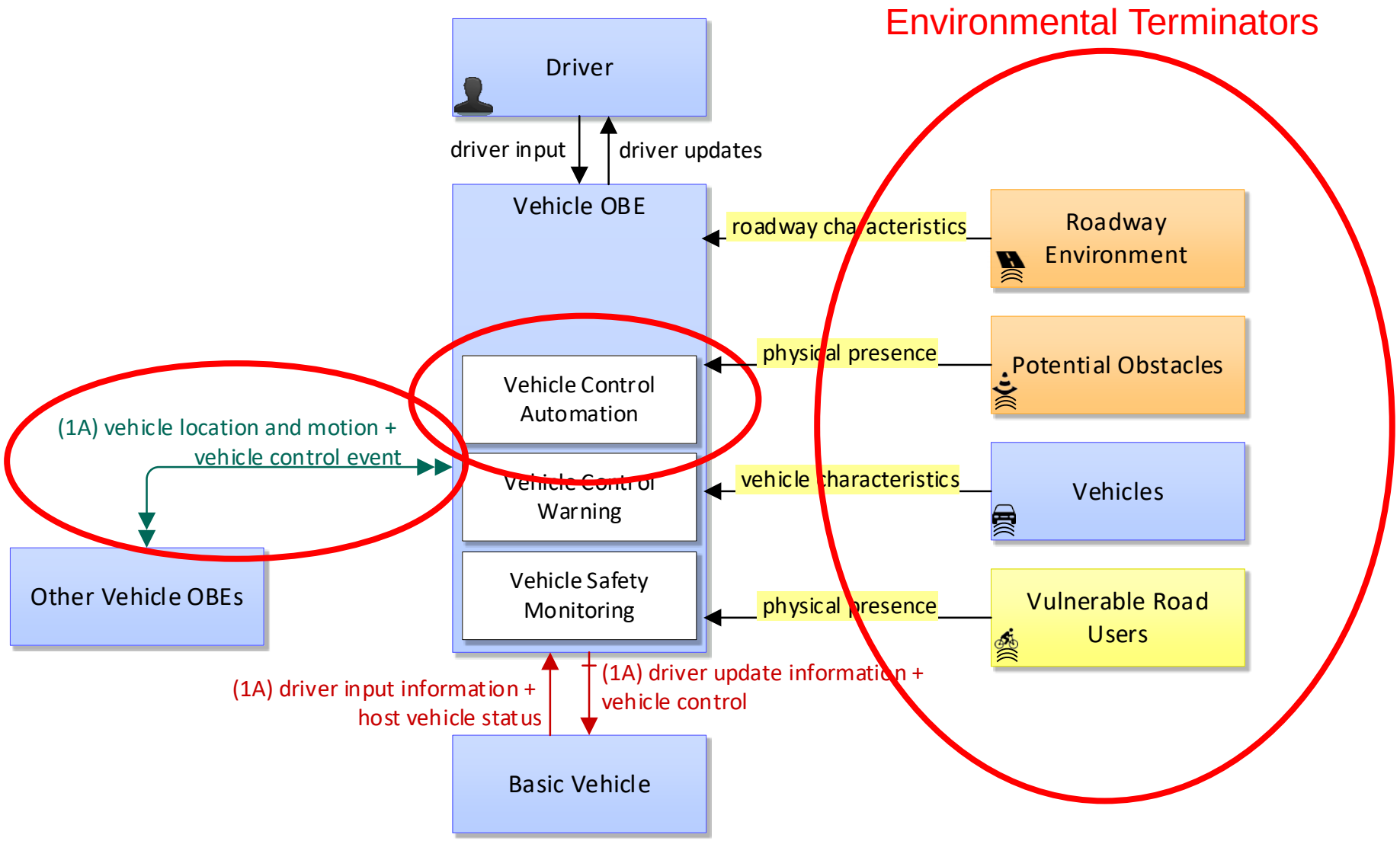


Sampling of A4A Content cont’d

- Service revisions, starting with commercial vehicle operations and public transportation
- Organizational readiness
  - What kind of data do infrastructure operators need to collect to support AV?
  - How will AVs interact with people and devices in and around the roadway

A4A: V2V Roadway Environment

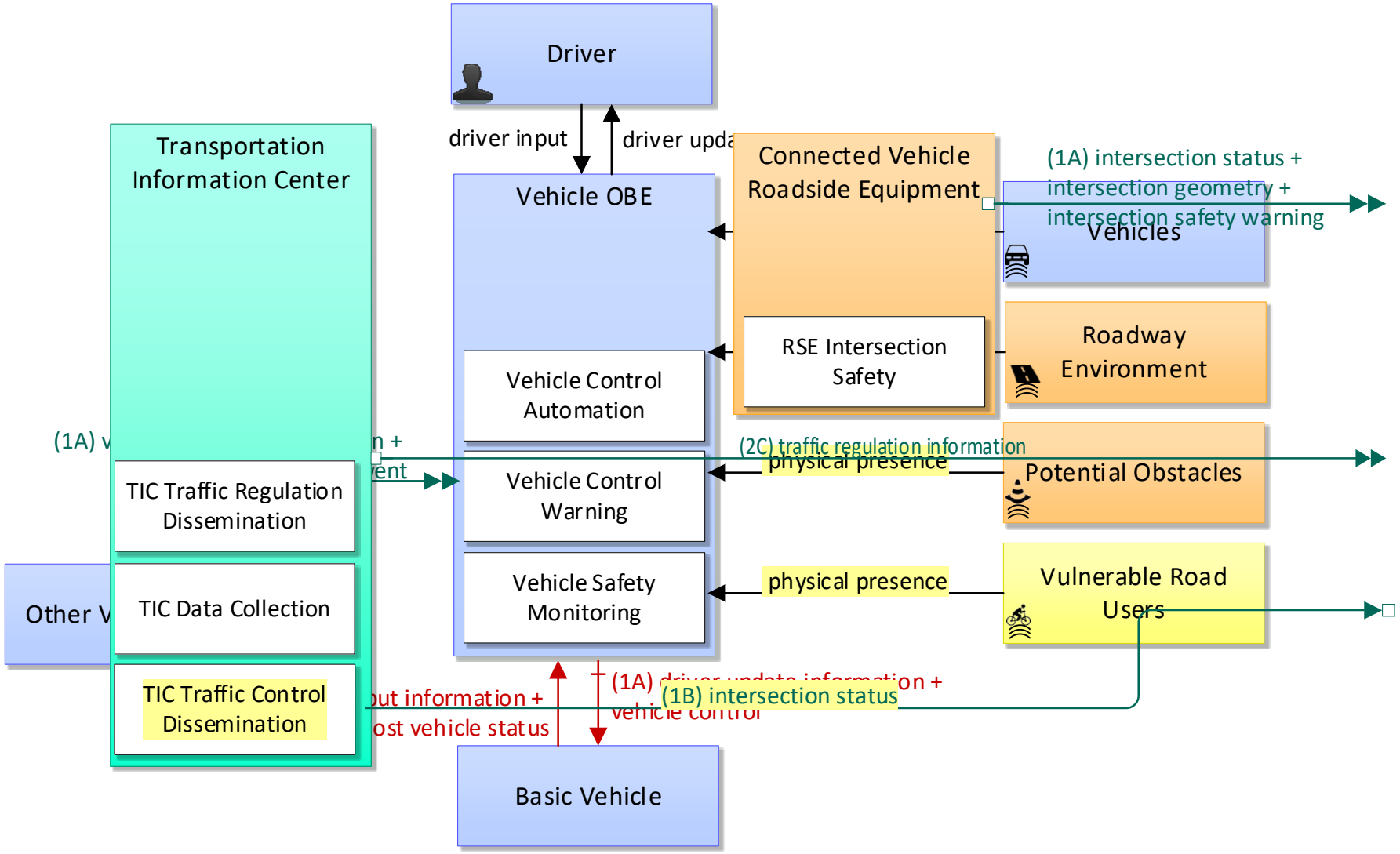
Doing this now 9.0



A4A: What about Infrastructure?

Doing this now

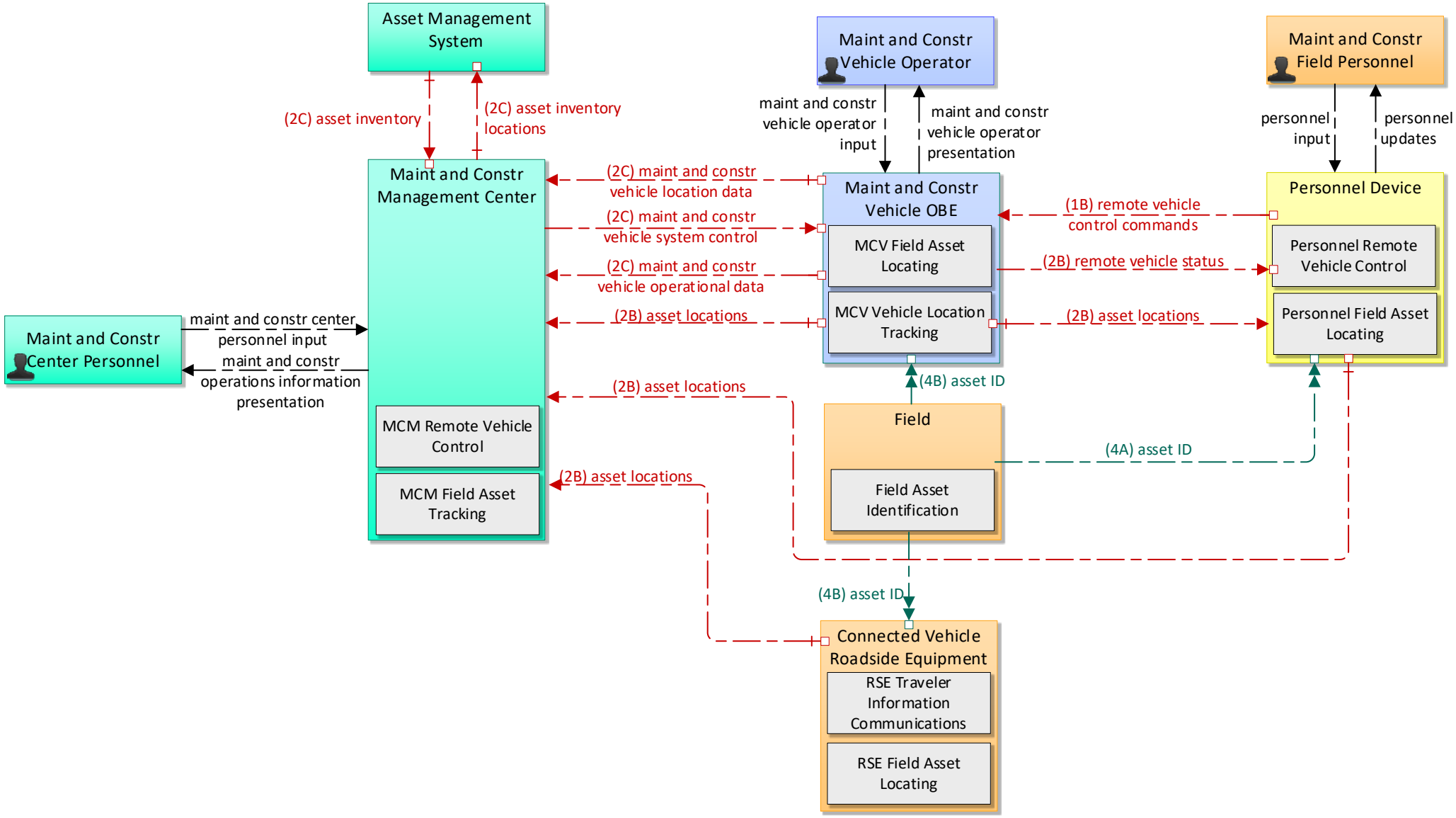
9.0



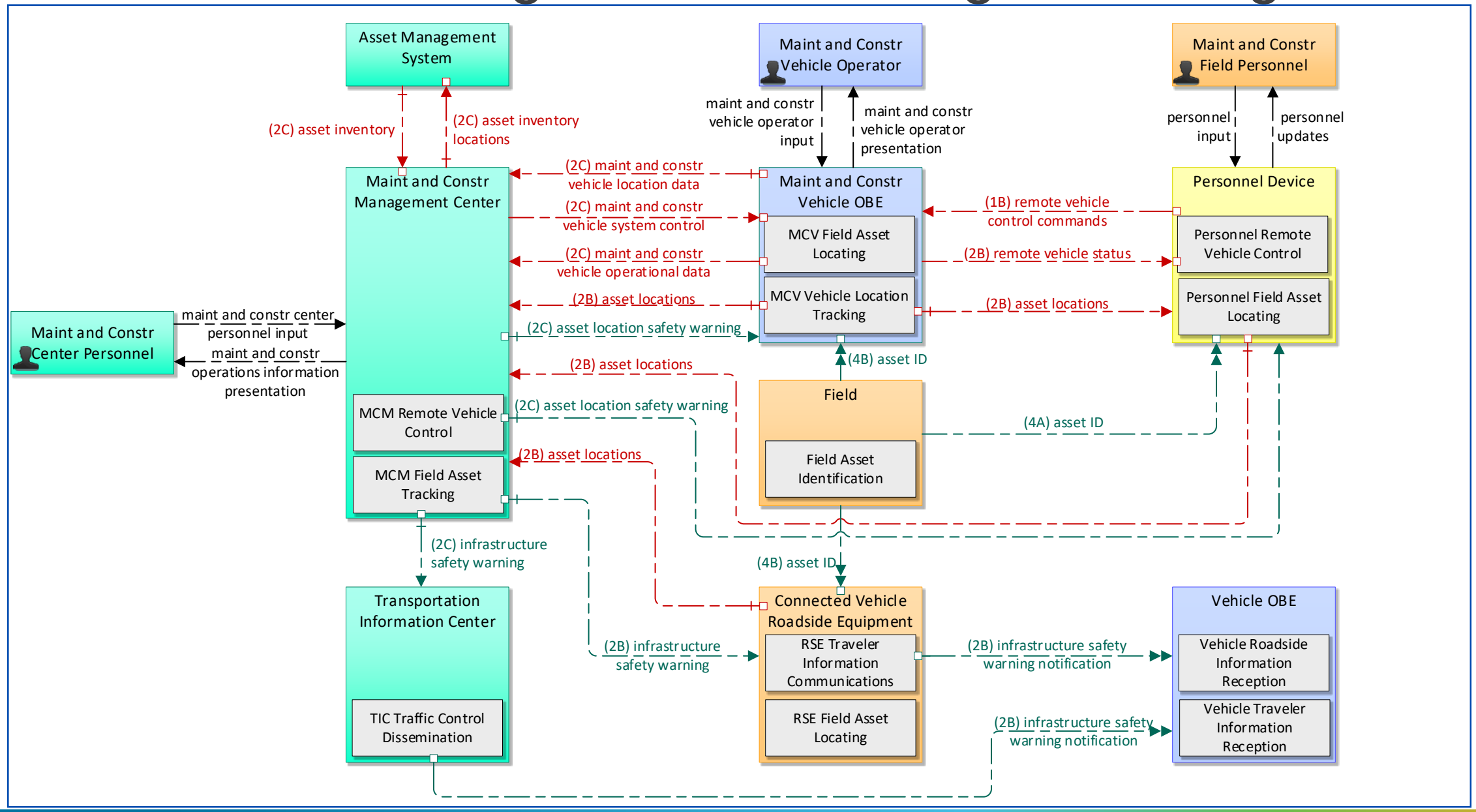
A4A: Asset Tracking

- Can we make work zone items more visible to the AV?
- Basic flow of events with variations:
  1) Tag field assets
  2) Maintain a database of field asset tag and tagged asset characteristics
  3) Periodically scan field asset locations
     1) With handheld scanner, by field personnel, OR
     2) With vehicle-based scanner (likely remotely piloted), OR
     3) With an RSE placed in the work zone
  4) Correlate scanned locations with asset characteristics
  5) Distribute asset footprint and relevant characteristics to vehicles
     1) Through wide-area wireless, significantly before vehicle enters work zone
     2) Through short-range communications, just before vehicle enters work zone

A4A: Asset Tracking Service Package: Getting the Data



A4A: Asset Tracking Service Package: Sharing the Data

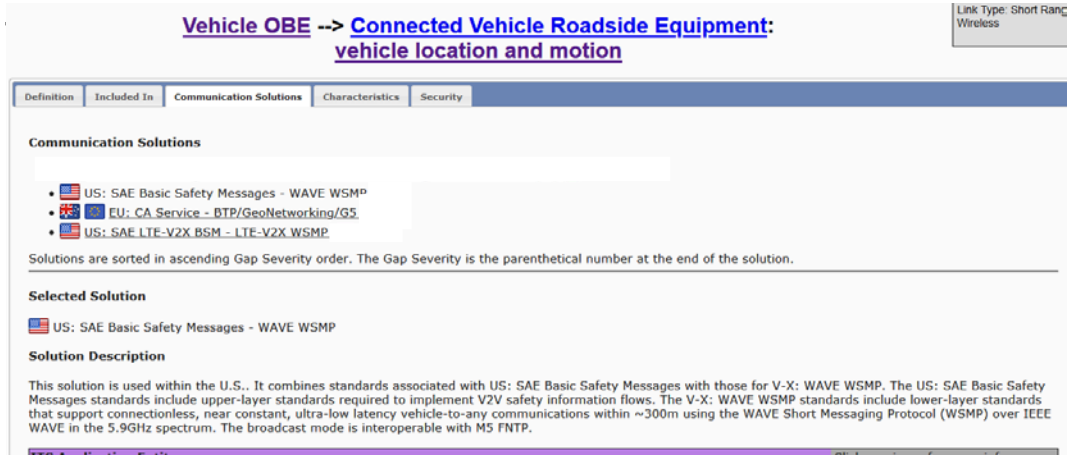


A4A: What about Interfaces?

Doing this now

9.0

- Interfaces should follow standards as much as possible; preferably open or easily available standards
- ARC-IT's approach is to borrow from the work performed by Harmonization Task Group 7
  - Communications model substantially more detailed
  - Allows an assessment of a standard or set of standard's applicability to a given information flow triple (e.g., information exchange)
  - Also conceived as a multi-region

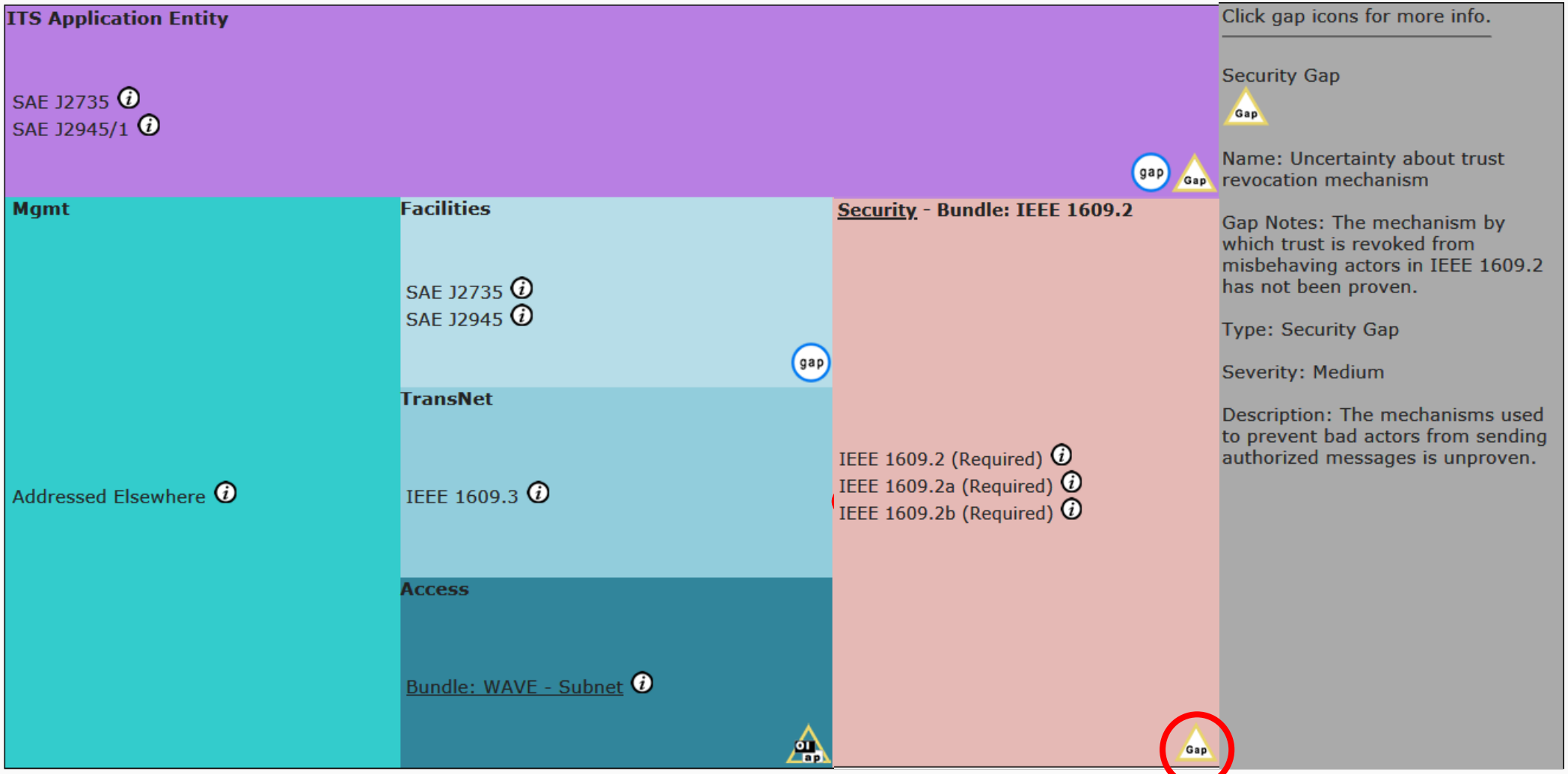


A4A: Interfaces Detail

US: SAE Basic Safety Messages - WAVE WSMP

Solution Description

This solution is used within the U.S.. It combines standards associated with US: SAE Basic Safety Messages with those for V-X: WAVE WSMP. The US: SAE Basic Safety Messages standards include upper-layer standards required to implement V2V safety information flows. The V-X: WAVE WSMP standards include lower-layer standards that support connectionless, near constant, ultra-low latency vehicle-to-any communications within ~300m using the WAVE Short Messaging Protocol (WSMP) over IEEE WAVE in the 5.9GHz spectrum. The broadcast mode is interoperable with M5 FNTP.



Note that some layers might have alternatives, in which case all of the gap icons associated with every alternative may be shown on the diagram, but the solution severity calculations (and resulting ordering of solutions) includes only the issues associated with the default (i.e., best, least severe) alternative.

A4A: Interfaces in Tools

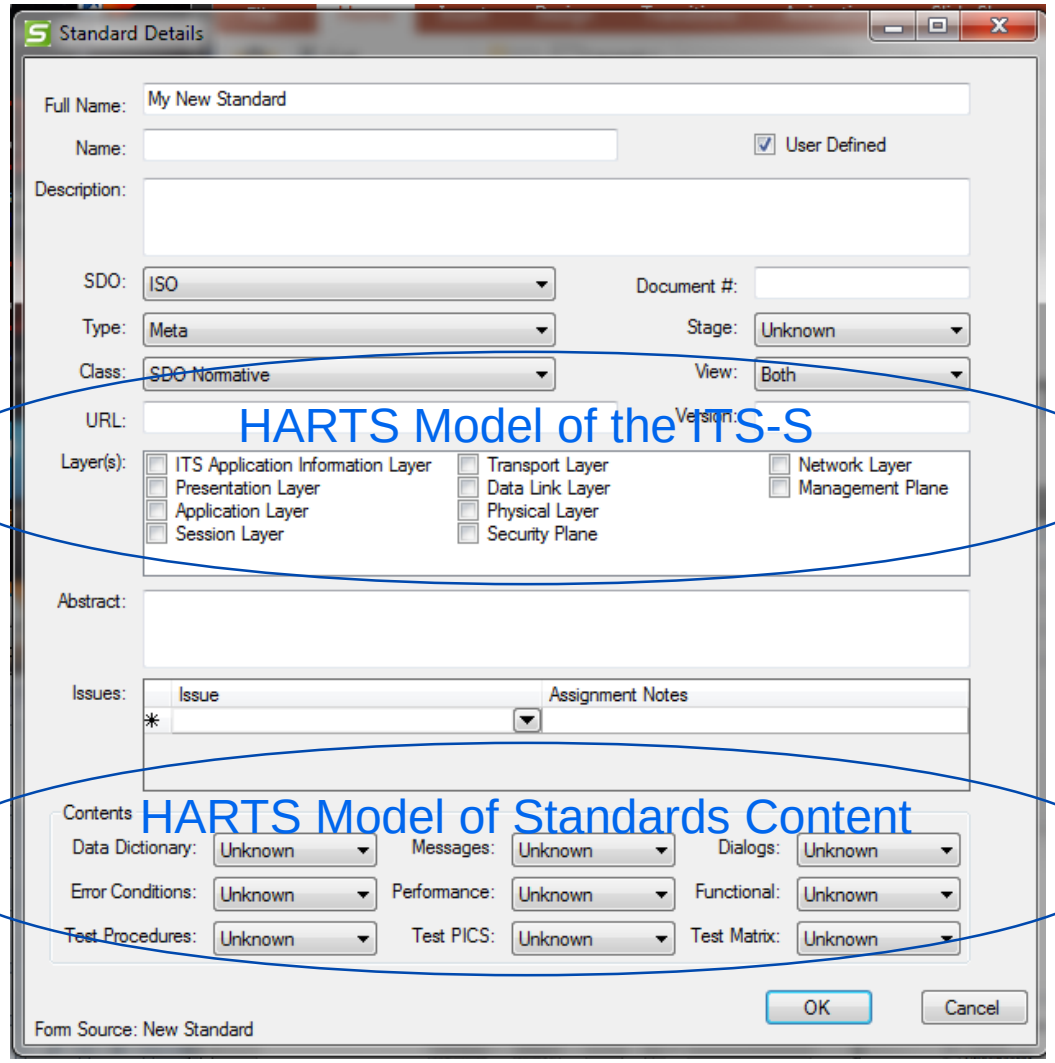
- Both regional and project architectures benefit by an enhanced understanding of
  - Relevant communications and data standards
  - Issues surrounding the applicability of those standards
- Both tools (RAD-IT and SET-IT) will come with the most applicable solutions we can identify
- SET-IT will allow the user to extend the architecture
  - Define new standards
  - Define new solutions
  - Apply those solutions to existing and user-defined content

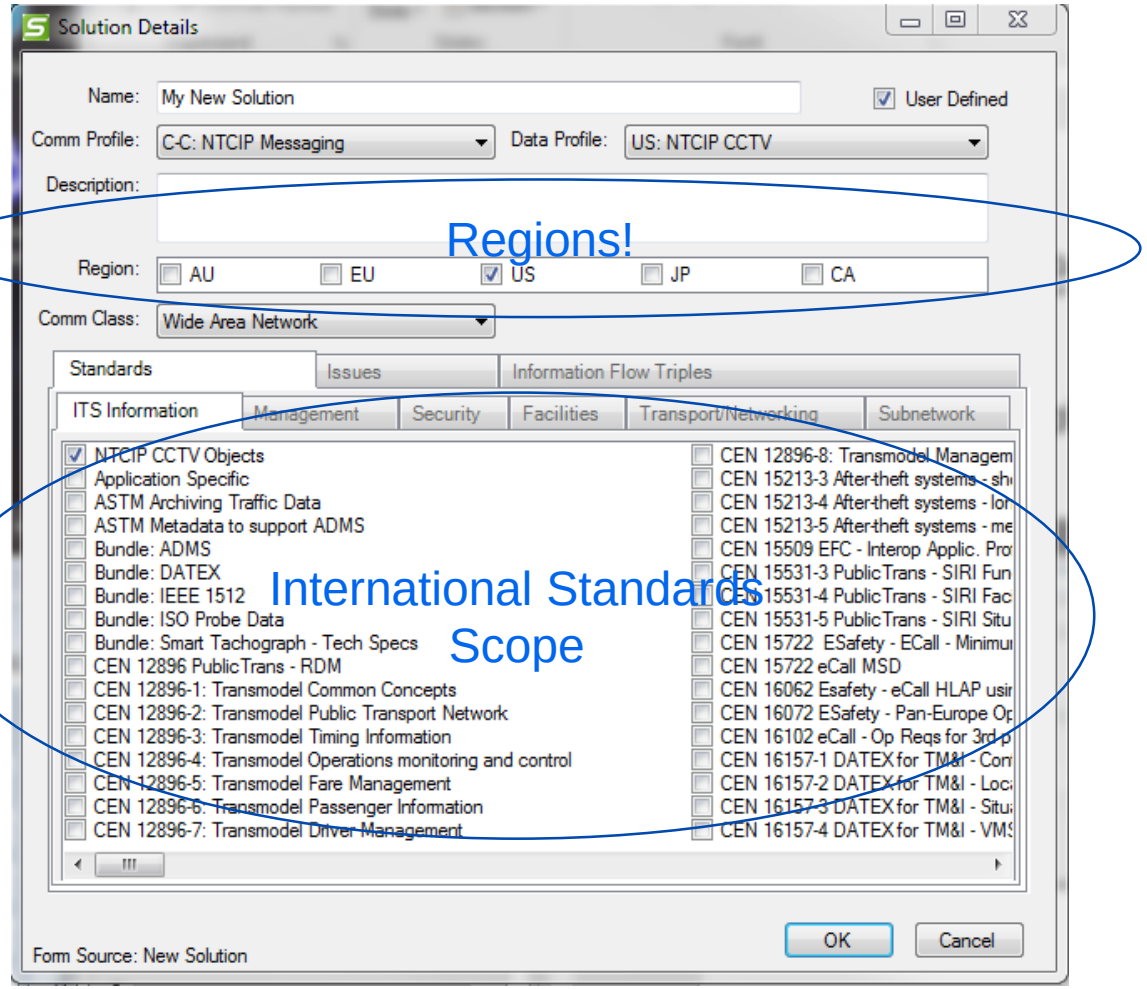
A4A: What about Interfaces: ????

- Enable regional architects to make informed decisions about the readiness of available technology to support services
  - "How ready is this interface?"
  - "How ready is this service package?"
- Provide more precise standards information to project implementers
  - Facilitate the implementation of interfaces that follow well-known, openly available standards
  - Help implementers avoid proprietary vendor lock-in
- Communications solution content for all service for North America
- Communication solution content for 44 services for EU (Day 1, Support, some public transport)

A4A: Interfaces in Tools

Doing this now and later 9.0+





A4A: Support the Development of an Information Viewpoint

- How an Information Viewpoint might satisfy stakeholder concerns.
- Just the viewpoint definition and correspondence rules
- Provide mechanisms for specifying various data characteristics
  - Data ownership: who owns what data should be clear
  - Rights management: who can do what with data?
  - Privacy concerns: related to data

A4A: Information Viewpoint: More questions

- Are there penalties for bad behavior? Who decides? We certainly don’t, but can we do anything to facilitate identification of misbehavior?
- What are some options for data governance
- Is it practical to consider minimum data requirements at the service package level?

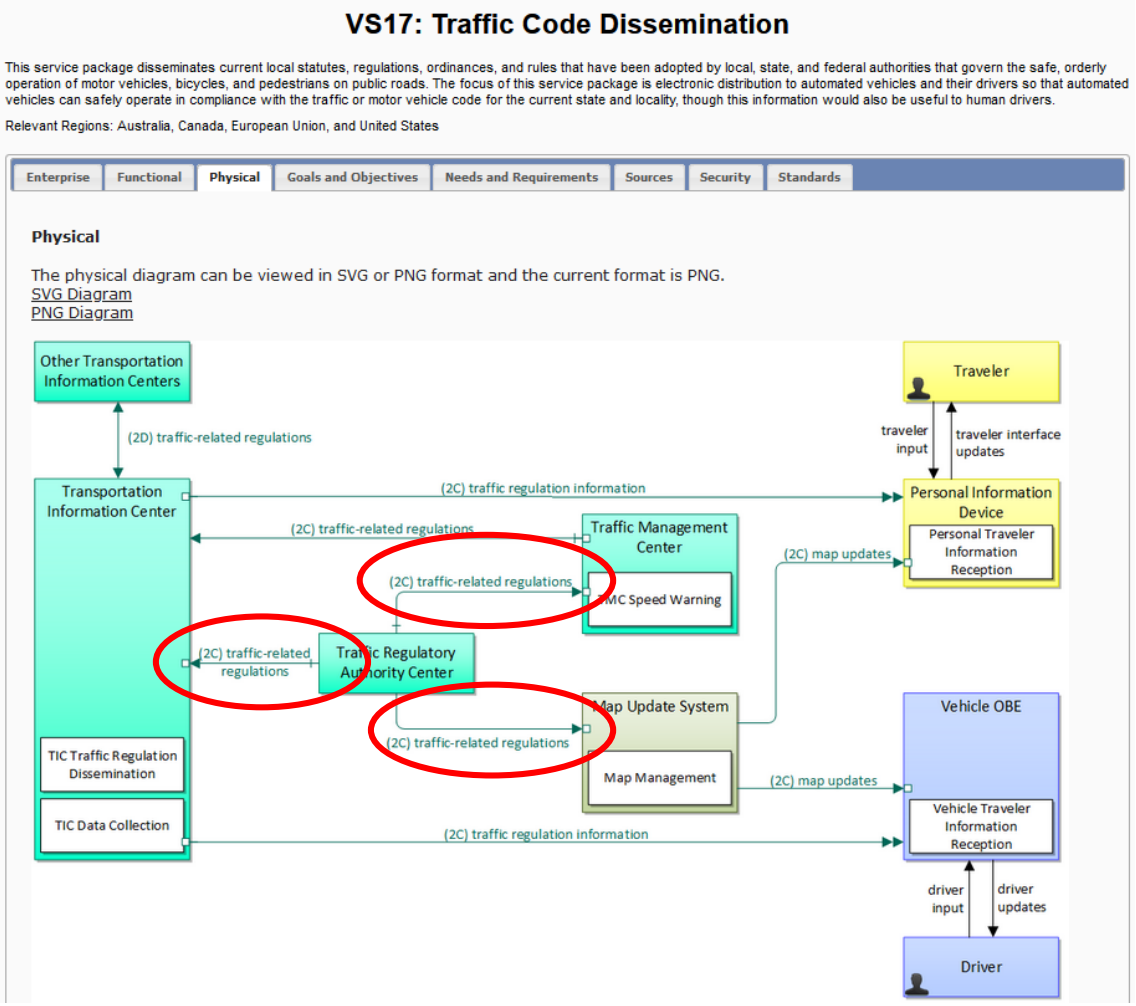
- Strategic approach to work with a loose consortium of international participants to share the work, including the W3C, ISO/IEC JTC1

A4A: Rules of the Road

Doing this later

9.1+

- ARC-IT recognizes this as VS17: Traffic Code Dissemination
- Initial efforts focus on the interface from the Traffic Regulatory Authority Center



A4A Rules of the Road concerns

- There are commercial efforts to make this happen
  - What about authentication?
  - Have these been adopted?
  - Are these based on open definitions, and regardless, do they meet requirements?
- Leaning on work being done in the United Kingdom to lead the development of roles and responsibilities

A4A: AV-Specific Service Revisions

- Enable all of the Public Transport services to utilize AV
- Enable Commercial Vehicle Operations services to utilize AV
- AV dedicated lanes service (based on PT10 (Intermittent Bus Lanes) and TM22 (Dynamic Lane Management and Shoulder Use)
- Could IOOs affect the AV by leveraging ODDs?
  - The communication of geo-fenced restrictions from TMC to ADS or regular vehicle for that matter, like encompassed in Low Emissions Zones, needs to consider more factors than we do today, maybe.

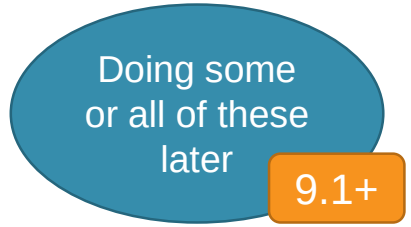
A4A: Organizational Readiness

- IOOs emphasized the need to understand what the requirements were *on them* to “be ready for” automation.
- Consider that every ITS service package could have a set of minimal requirements for its installation, operation and maintenance.
  - Installation requirements are things like necessary communications infrastructure in the deployment area, access to power, acceptable regulatory constraints and the like.
  - Operation and maintenance requirements are really requirements on the capabilities of the organizations filling the ‘operates’ and ‘maintains’ roles.

A4A: Organizational Readiness Approach

- This is where CMM and TSM&O fit in. Someone could define:
  - Organizational capabilities relevant to ITS, much of which we can see in TSM&O but we were exploring other sources, as the existing models have gaps
  - The maturity level necessary for each capability that is nominally required for operating and maintaining that service.
- Since project and regional architectures define services that would be implemented, we could then associate the stakeholder operating the service in the architecture with the required organizational capabilities.

New AV-Centric Services



- Consider an application where drones are used to collect data over major highways
- Consider an application monitoring the status of AVs, with the goal being to identify and minimize the impact of 0 occupancy vehicles
- How will AVs interact with law enforcement, emergency vehicles and other first responders? What about response to hand signals? What about eye contact and more human interactions? Consider also the need to establish a law enforcement interaction plan, and whether this should be 1:1 or 1:N or N:N (company: government). This might be more than a single service, and might imply changes to flows or even new characteristics associated with flows
- Consider a highly accurate lane keeping application to avoid lane rutting caused by AVs all following the same path with high precision
- Consider if PS13 (Evacuation and Reentry Management) needs any changes, or we need a new service to deal with all the people that are no longer independently mobile because they rely on AVs or simply ride-hailing services for their personal mobility
- TI06 (Dynamic Ridesharing and Shared Use Transportation) ostensibly includes ride-hailing, but if OEMs start deploying AVs and operating their own ride-hailing services, do we want to show this a little differently? Its not really public transit, its private, independently contracted ride hailing. The TIC definition as-is does not really equate to Uber or Lyft, so if we do intend to show this, we would need to expand the definition.
- Consider a new service to support last mile freight consolidation

A4A: Timing

- Initial 9.0 material to be released late summer 2020
- Subsequent versions follow roughly yearly
  - 9.1 ~ 2021
  - 9.2 ~ 2022

Questions?

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