



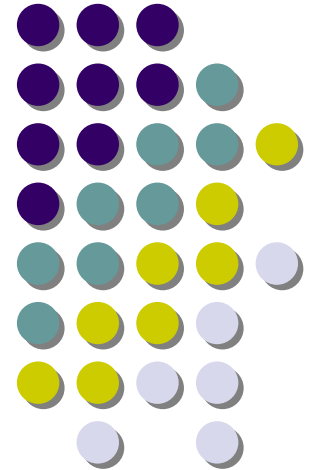
# New York State Department of Transportation

## Using ITS Standards for Deployment: Identification, Specification, and Testing Version 2.0 (Day 2 - Technical)

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Last Updated: June 6, 2008



# Module 7: ITS Standards Framework for New York State



# Module 7 – New York State ITS Standards Framework Learning Objectives

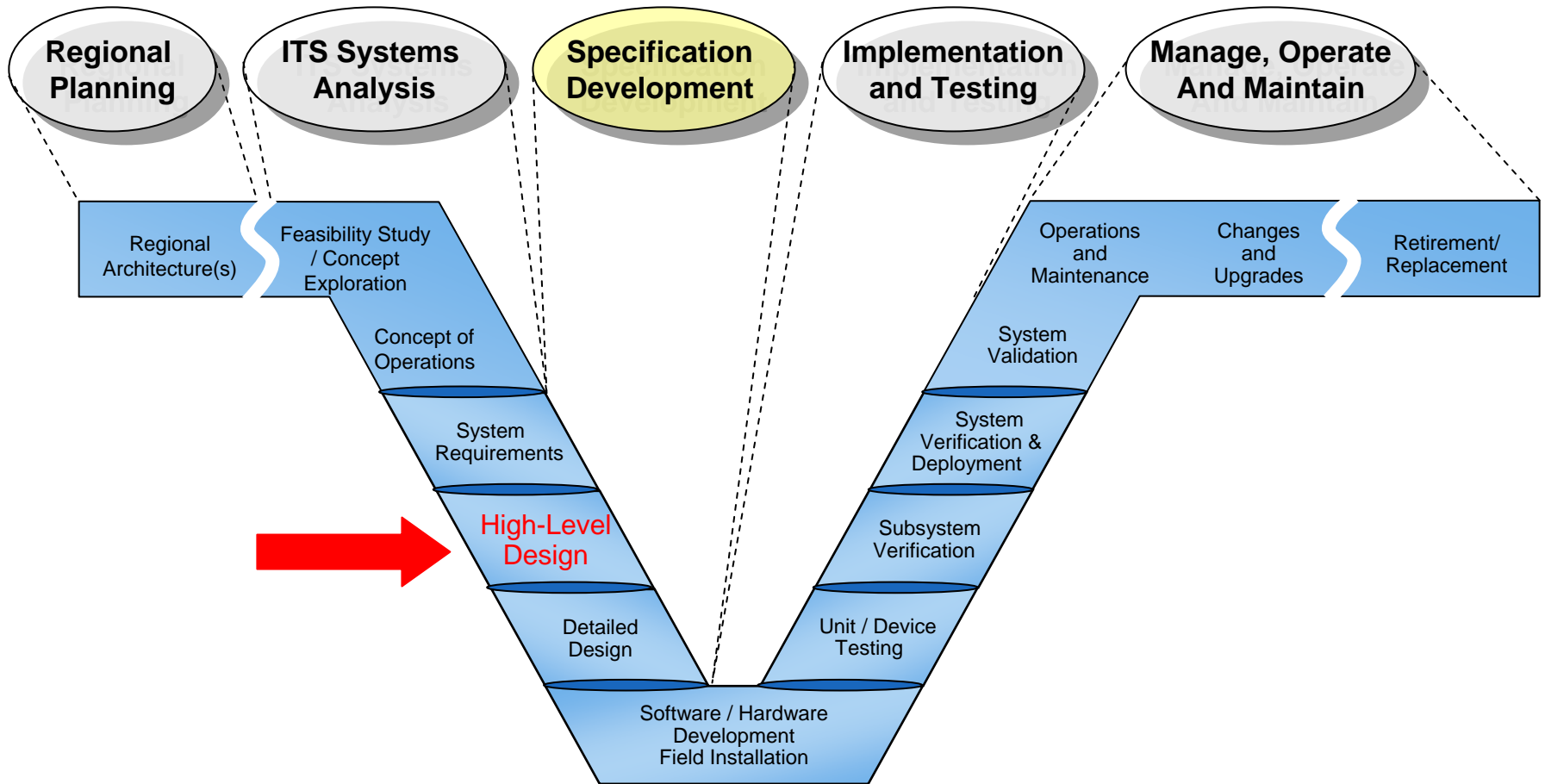


- What is it?
- How it supports ITS Standards Identification
- How it support Alternatives Analysis
- Relation to the National ITS Architecture Communications Layer
- Relation to National ITS Architecture Flows



# Module 7.1: NYS ITS Standards Framework

# Specification Development (High Level Design)



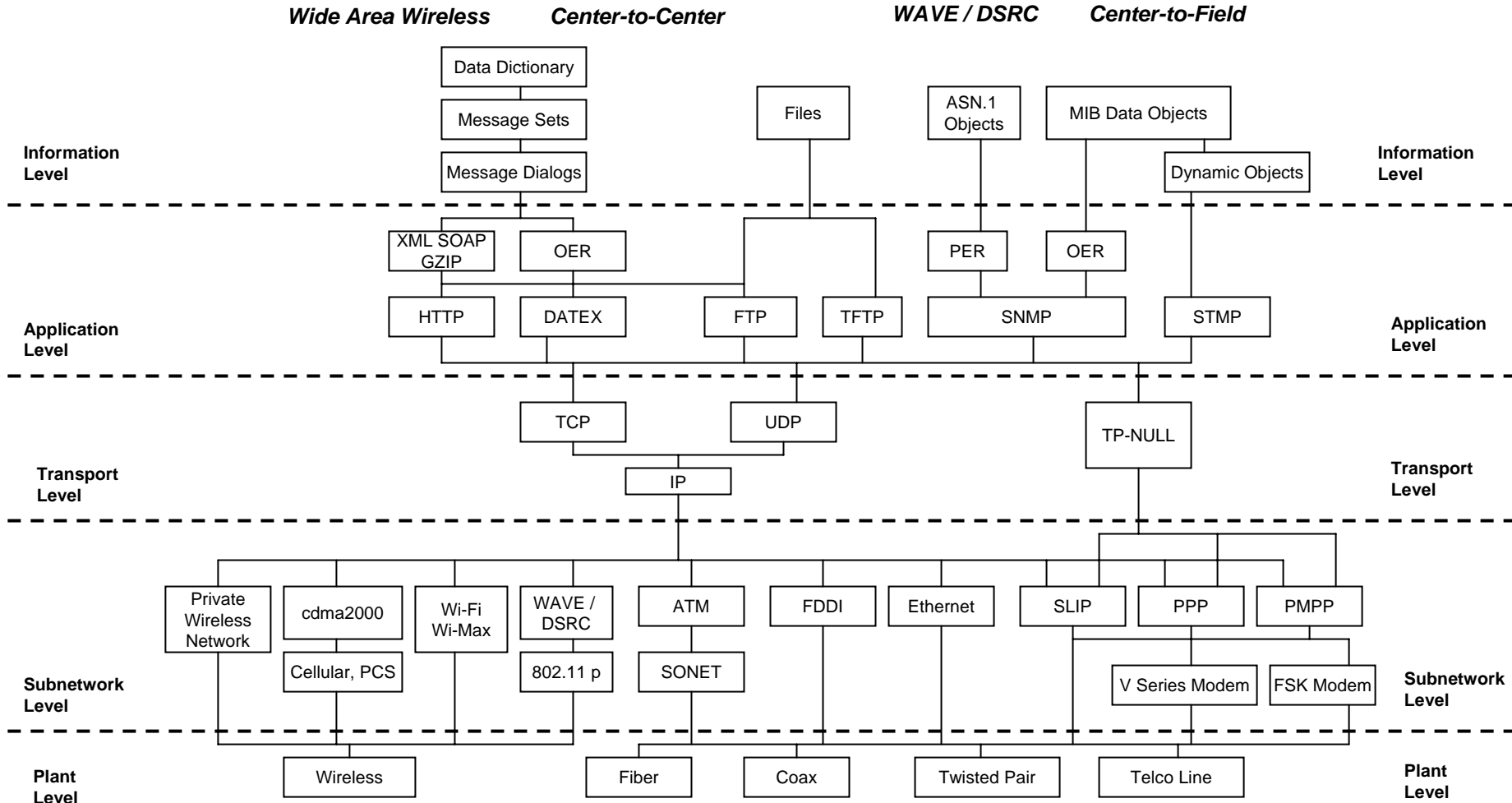
# New York State ITS Standards Framework

## - Identification and Use



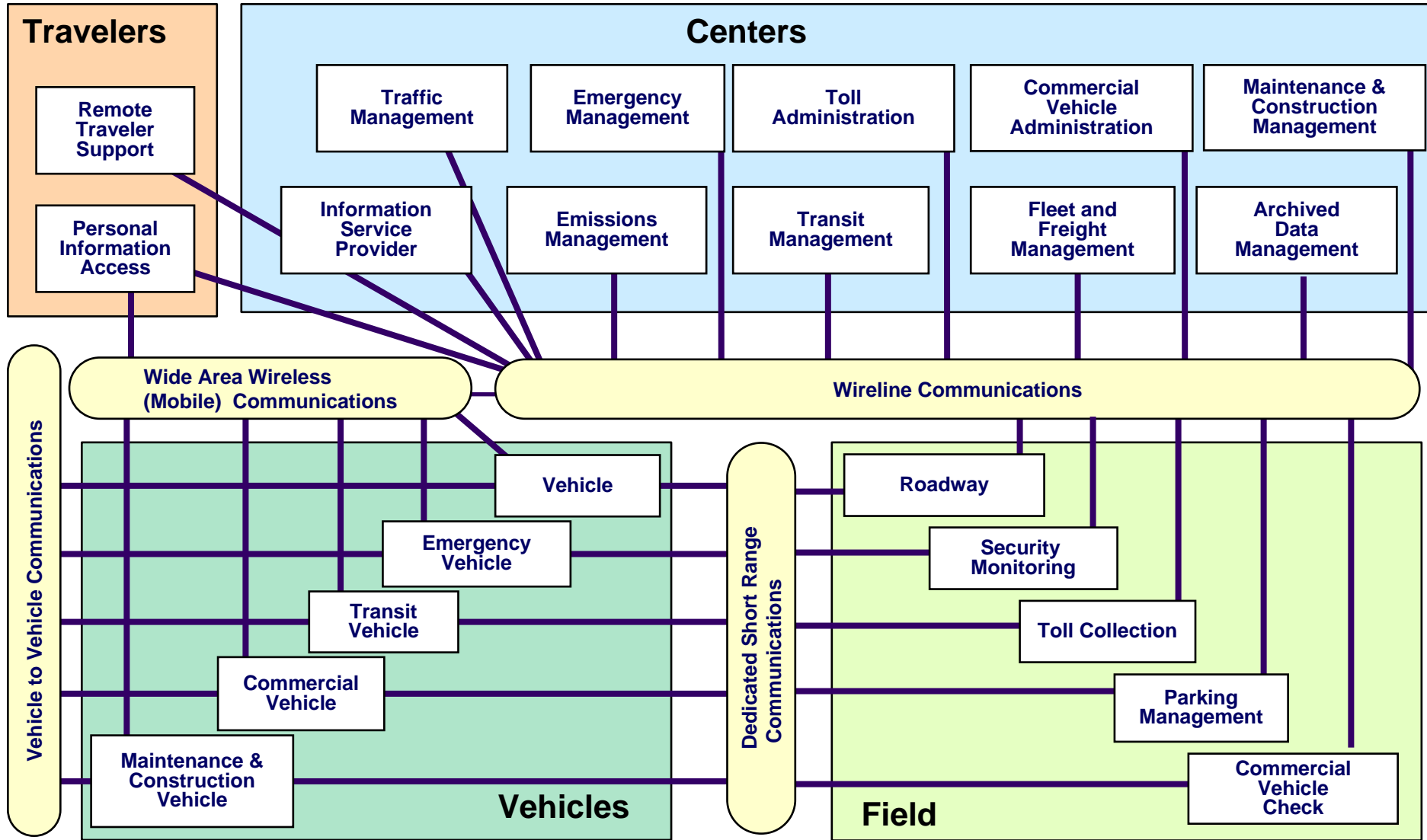
- Based on NTCIP Standards Framework
  - Added non-NTCIP Standards to support standards for WAVE/DSRC and Wide-Area Wireless ITS Applications
- Organized into 5 Levels
  - **Information Level** – Information Content
  - **Application Level** – Information Encoding and Transport
  - **Transport** – TCP/IP “Glue” between communications applications (software) and the network infrastructure
  - **Subnetwork** – Lower level routing and telephony standards
  - **Plant** – The Communications Media
- Mapped to National ITS Architecture
  - Communications Layer
  - ITS Architecture Flows

# ITS Standards Framework



# National ITS Architecture v 6.0 Physical Architecture

## - Focus on Subsystems

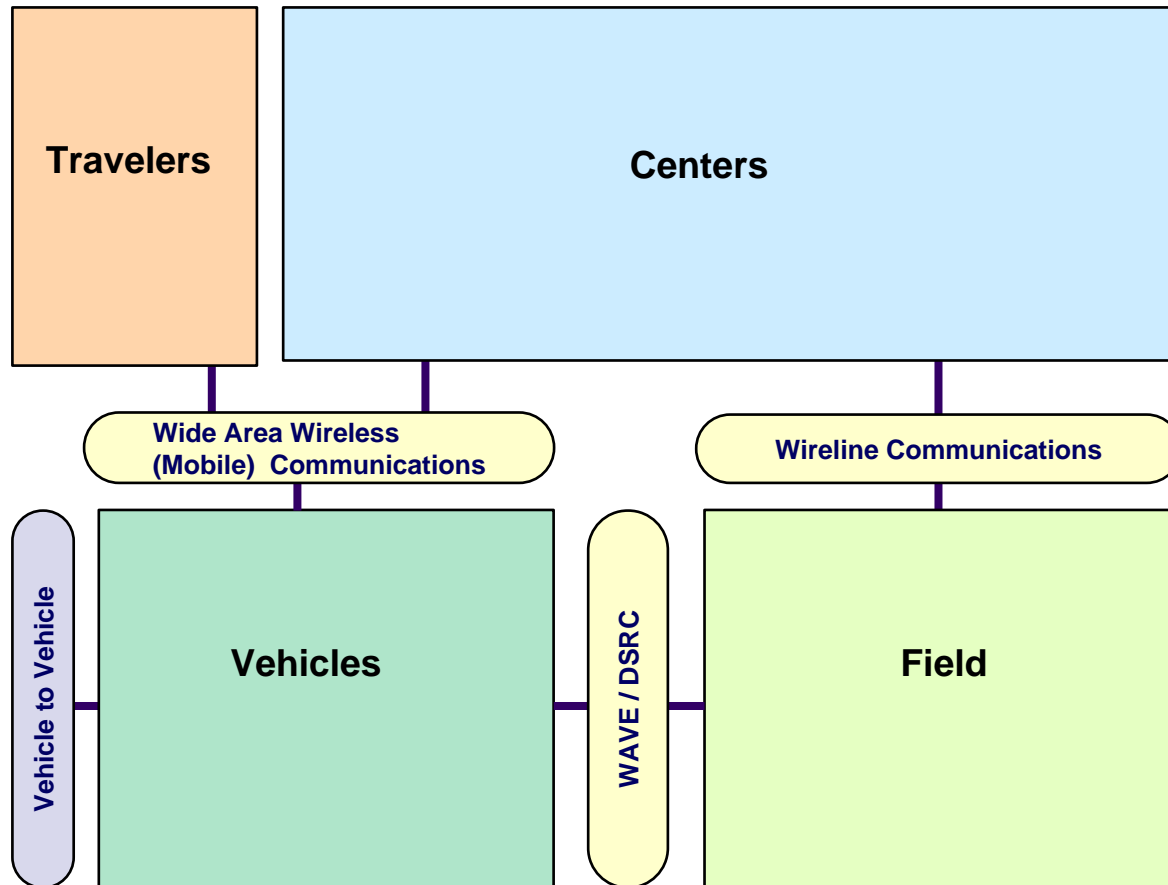




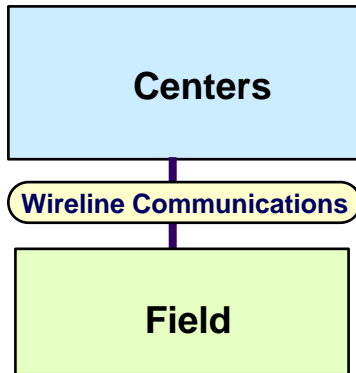
# ITS Standards Framework Communications Packages



- Introduce the term “Communications Packages (CPs)”
  - A communications package represent high-level design alternatives for ITS Communications, based on the National ITS Architecture communications layer
  - Total of 10 Communications Packages defined

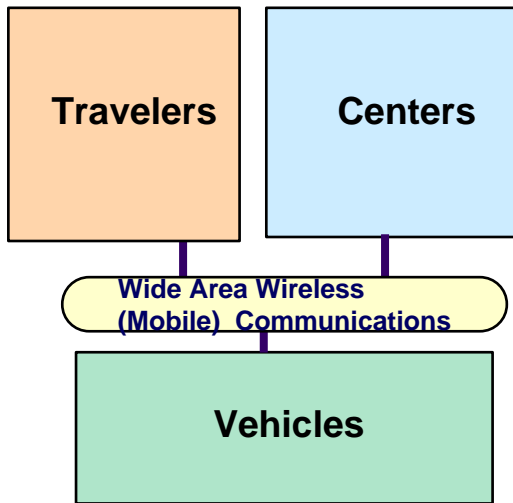


# ITS Standards Framework Communications Packages



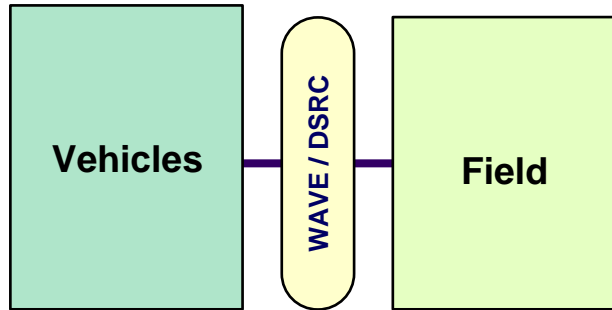
## Wireline Communications Packages

1. Center-to-Field Communications over IEEE 802 IP Networks
2. Center-to-Field Communications Point-to-Point or Point-to-MultiPoint
3. XML Messaging for Center-to-Center Communications



## Wide Area Wireless Communications Packages

1. Mobile XML Messaging over Cellular Networks
2. Mobile XML Messaging over Wi-Max Networks
3. Mobile XML Messaging over Private IP Networks
4. Mobile XML Messaging over Private non-IP Networks
5. Mobile XML Messaging over Wi-Fi Local Area Networks



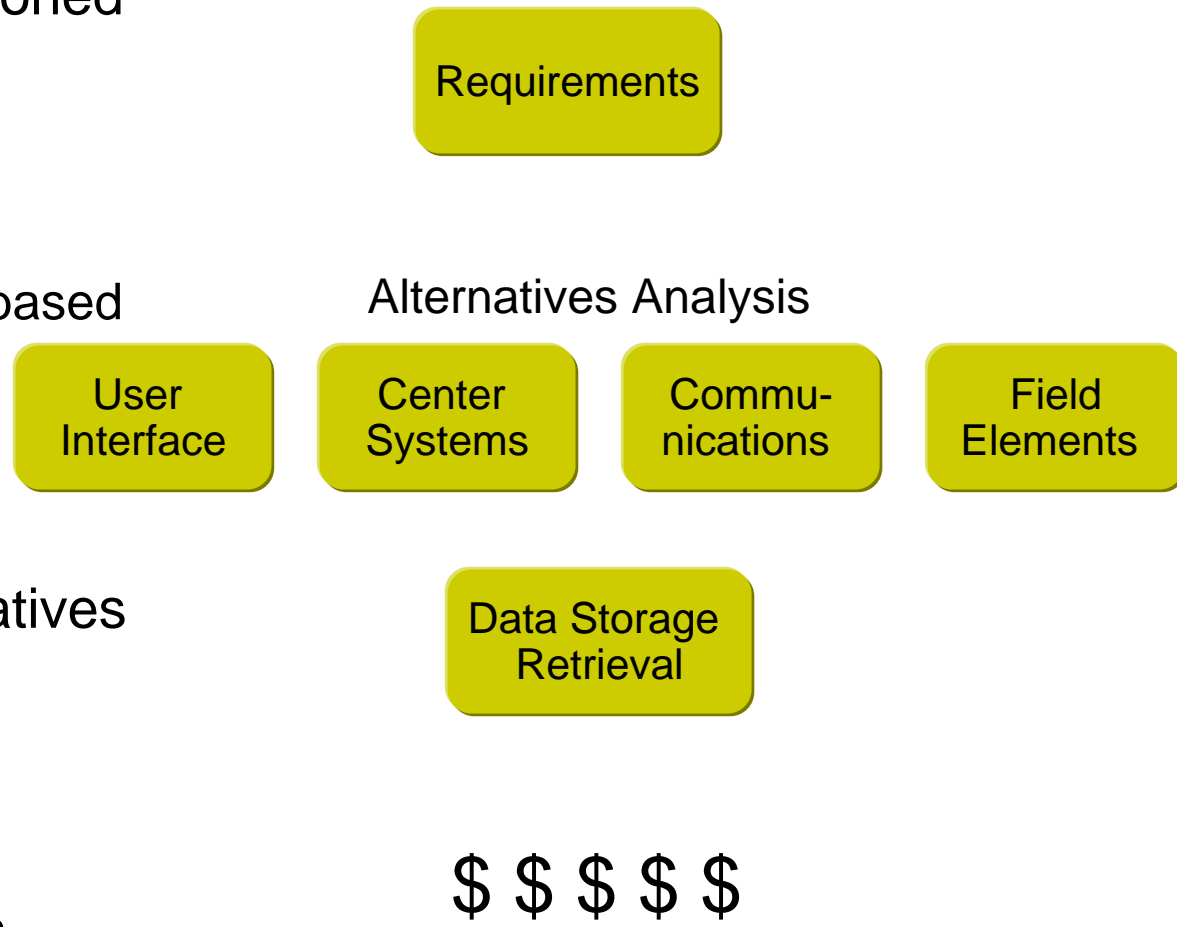
## WAVE/DSRC Communications Packages

1. Resource Manager Applications
2. IP Applications

# Alternatives Analysis (High Level Design)



- Requirements are partitioned to system components
- User Interface:
  - Mobile
  - Web Browser
  - Map-based vs. Forms-based
- Computing Architecture Trade-off:
  - Client-Server
  - Web Services
- Communications Alternatives
- Field Elements
  - Equipment Technology
- Data Storage / Retrieval
  - Data Warehouse
  - Geographic Information Systems
- Cost Assessment
  - Build-Buy



# Alternatives Analysis (High Level Design)

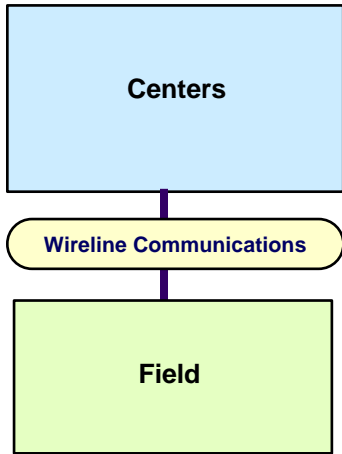


- ITS Standards Framework and Communications Alternatives Analysis
  - Initial Communications Alternatives Analysis
    - Select one or more alternatives from the communications packages, OR
    - Build a new one
  - Use the communications packages as a checklist for standards to review for your project specifications

# Example: Wireline Communications Package



## Wireline CP 1 - Center-to-Field Communications over IEEE 802 IP Networks

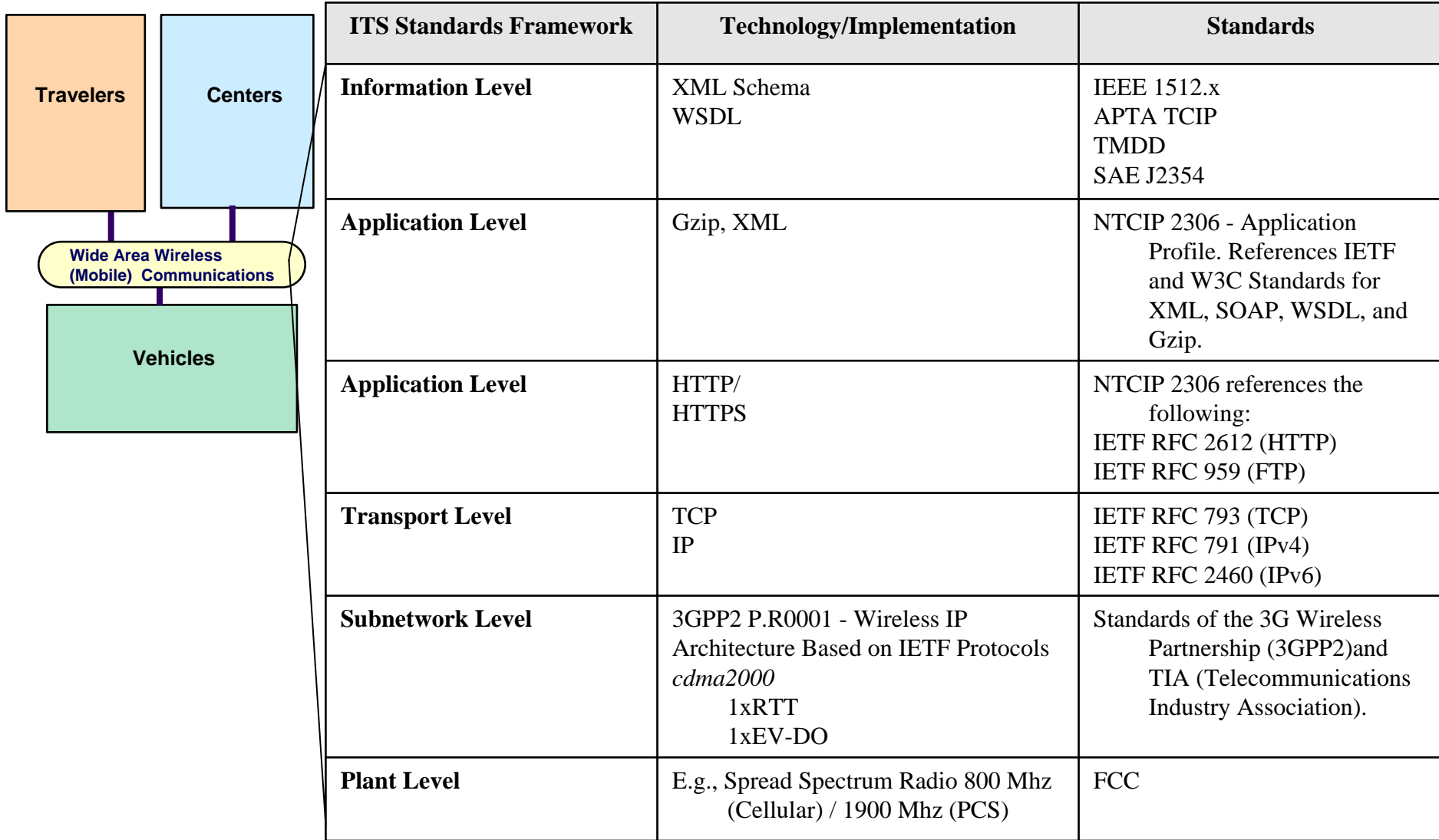


ITS Standards Framework	Technology/Implementation	Standards
<b>Information Level</b>	NTCIP MIB Objects	NTCIP 1200 Series MIBs
<b>Application Level</b>	SNMP	NTCIP 2301
<b>Transport Level</b>	TCP IP	NTCIP 2202 identifies the use of these IETF Standards
<b>Subnetwork Level</b>	Layer 2 – Data Link IEEE 802 Networks, Token Ring, FDDI, HDLC, Frame Relay, ATM, Fibre Channel  Layer 1 - Physical T1, E1, 10BASE-T, 100BASE-TX, ISDN, SONET, DSL	NTCIP 2104 defines framework for IEEE 802 Networks.
<b>Plant Level</b>	Fiber, Coax	

# Example: Wide Area Wireless Communications Package



## Wide Area Wireless CP 1 - Mobile XML Messaging over Cellular Networks





# Module 7.2: ITS Architecture Flow to Standards Mapping





# The New York Statewide ITS Standards Framework contains a mapping of Regional ITS Architecture Flows to ITS Standards Messages

## Regional ITS Architecture

ITS Architecture Flow:

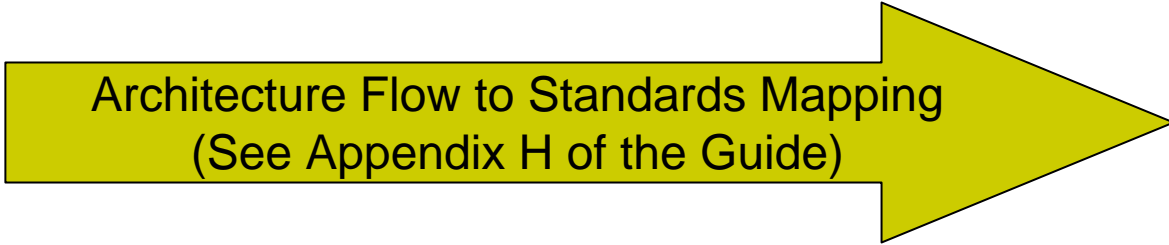
*field equipment status*

## ITS Standard and Message

TMDD Standard:

*DMS Status*

Architecture Flow to Standards Mapping  
(See Appendix H of the Guide)



The mapping in the NYS Statewide ITS Standards Framework is more detailed than what is in the New York Regional ITS Architectures. The mapping in the NYS Statewide ITS Standards Framework maps to a standard and message within a standard.

# TMDD Center-to-Center Mapping (Partial)



Source Standard	Message or MIB	Architecture Flow
TMDD	Organization Information	traffic information coordination
TMDD	DMS Inventory	traffic information coordination
TMDD	DMS Status	traffic information coordination
TMDD	DMS Status	field equipment status
TMDD	DMS Control Request	traffic control coordination
TMDD	CCTV Inventory	traffic images_ud
TMDD	CCTV Status	traffic images_ud
TMDD	CCTV Status	field equipment status
TMDD	CCTV Inventory Request	video surveillance control
TMDD	CCTV Inventory	traffic images_ud
TMDD	CCTV Inventory Request	video surveillance control
TMDD	ESS Inventory	environmental conditions data
TMDD	ESS Status	environmental conditions data
TMDD	ESS Status	field equipment status
TMDD	HAR Inventory	traffic information coordination
TMDD	HAR Status	traffic information coordination
TMDD	HAR Status	field equipment status
TMDD	HAR Control Request	traffic control coordination

# IEEE 1512 C2C Mapping (Partial)



Source Standard	Message or MIB	Architecture Flow
IEEE1512.BASE	IncidentDescription (IDX)	incident report
IEEE1512.BASE	IncidentDescription (IDX)	incident information
IEEE1512.BASE	IncidentDescription (IDX)	incident response status
IEEE1512.BASE	CloseIncidentEvent (CIE)	incident report
IEEE1512.BASE	CloseIncidentEvent (CIE)	incident information
IEEE1512.BASE	CloseIncidentEvent (CIE)	incident response status
IEEE1512.BASE	AvailableForHandOff (AHO)	incident response coordination
IEEE1512.BASE	GrantHandOff (GHO)	incident response coordination
IEEE1512.BASE	IncidentDescription (IDX)	incident report
IEEE1512.BASE	IncidentDescription (IDX)	incident information
IEEE1512.BASE	EstablishCenterOn-line (ECO)	incident response coordination
IEEE1512.BASE	DisableCenterOn-line (DCO)	incident response coordination
IEEE1512.BASE	EstablishCenterProperties (ECP)	incident response coordination
IEEE1512.BASE	ChangeCenterProperties (CCP)	incident response coordination
IEEE1512.BASE	CenterPlans (CP)	incident response coordination

# SAE-J2354 C2C Mapping



Source Standard	Message or MIB	Architecture Flow
SAE-J2354	Information Request	traveler information request
SAE-J2354	Roadway Link Traffic Information	road network conditions
SAE-J2354	Roadway Link Geography	road network conditions
SAE-J2354	Weather Information	weather information
SAE-J2354	Weather Information	weather information

# Center-to-Field Mapping



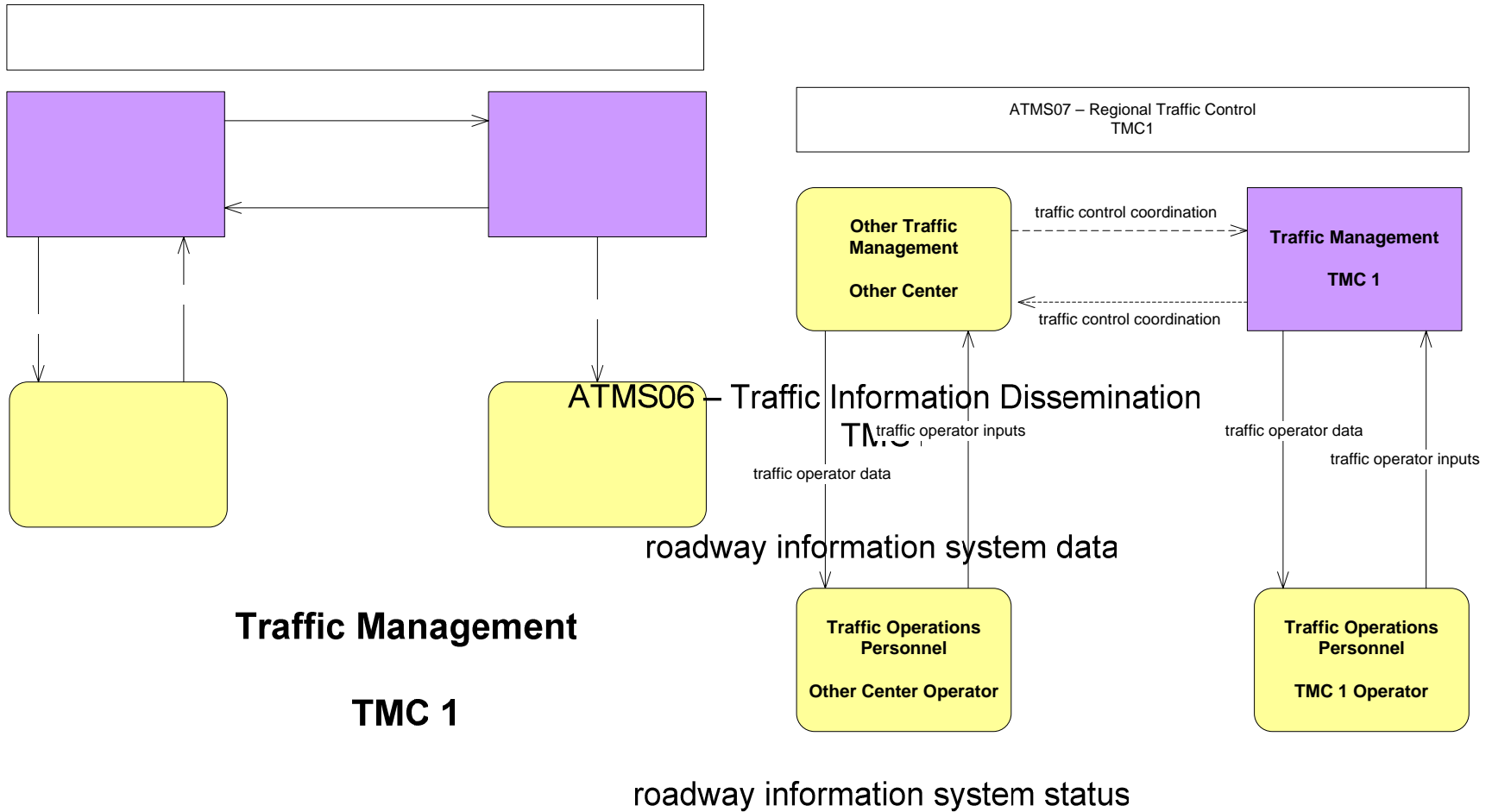
Source Standard	Message or MIB	Architecture Flow
NTCIP 1202 - ASC	Actuated Signal Control	signal control data
NTCIP 1202 - ASC	Actuated Signal Control	signal controls status
NTCIP 1203 - DMS	Dynamic Message Sign	roadway information system data
NTCIP 1203 - DMS	Dynamic Message Sign	roadway information system status
NTCIP 1204 - ESS	Environmental Sensor Station	environmental sensors control
NTCIP 1204 - ESS	Environmental Sensor Station	environmental probe data
NTCIP 1204 - ESS	Environmental Sensor Station	environmental conditions data
NTCIP 1205 - CCTV	Closed Circuit Television	traffic flow
NTCIP 1205 - CCTV	Closed Circuit Television	traffic images
NTCIP 1205 - CCTV	Closed Circuit Television	video surveillance control
NTCIP 1206 - DCM	Data Collection and Monitoring	data collection and monitoring control
NTCIP 1206 - DCM	Data Collection and Monitoring	roadside archive data
NTCIP 1207 - RM	Ramp Meter	freeway control data
NTCIP 1207 - RM	Ramp Meter	freeway control status
NTCIP 1209 - TSS	Traffic Sensor Station	traffic sensor control
NTCIP 1211 - SCP	Signal Control Priority	request for right-of-way



# Module 7 - Standards Identification Exercise

- Given the Following Regional ITS Architecture Market Package Diagrams Identify Applicable Standards using 2 methods
  - Communications Packages
  - Architecture Flow to ITS Standards Mapping
- Hint: Only do System to System Interfaces

# Module 7 - Standards Identification Exercise





# ITS Standards Framework: Resources & Where in the Guide

- Resources
  - NTCIP 9001 – NTCIP Guide
  - NTCIP 9010 – Information Report on ITS Center-to-Center Communications
  - National ITS Architecture
  - ITS Standards
- Where in the Guide
  - Chapter 6 – ITS Communications Framework
  - Appendix D – Key ITS Standards for New York State
  - Appendix E – ITS Standards Documents Overview
  - Appendix F – Core Information and Application Level Standards for New York State
  - Appendix G – ITS Standards Communications Framework
  - Appendix H – Mapping of ITS Architecture Flow to ITS Standard Dialogs, Messages, and NTCIP Object Definitions





# Module 8: ITS Standards Specification Development and Case Studies



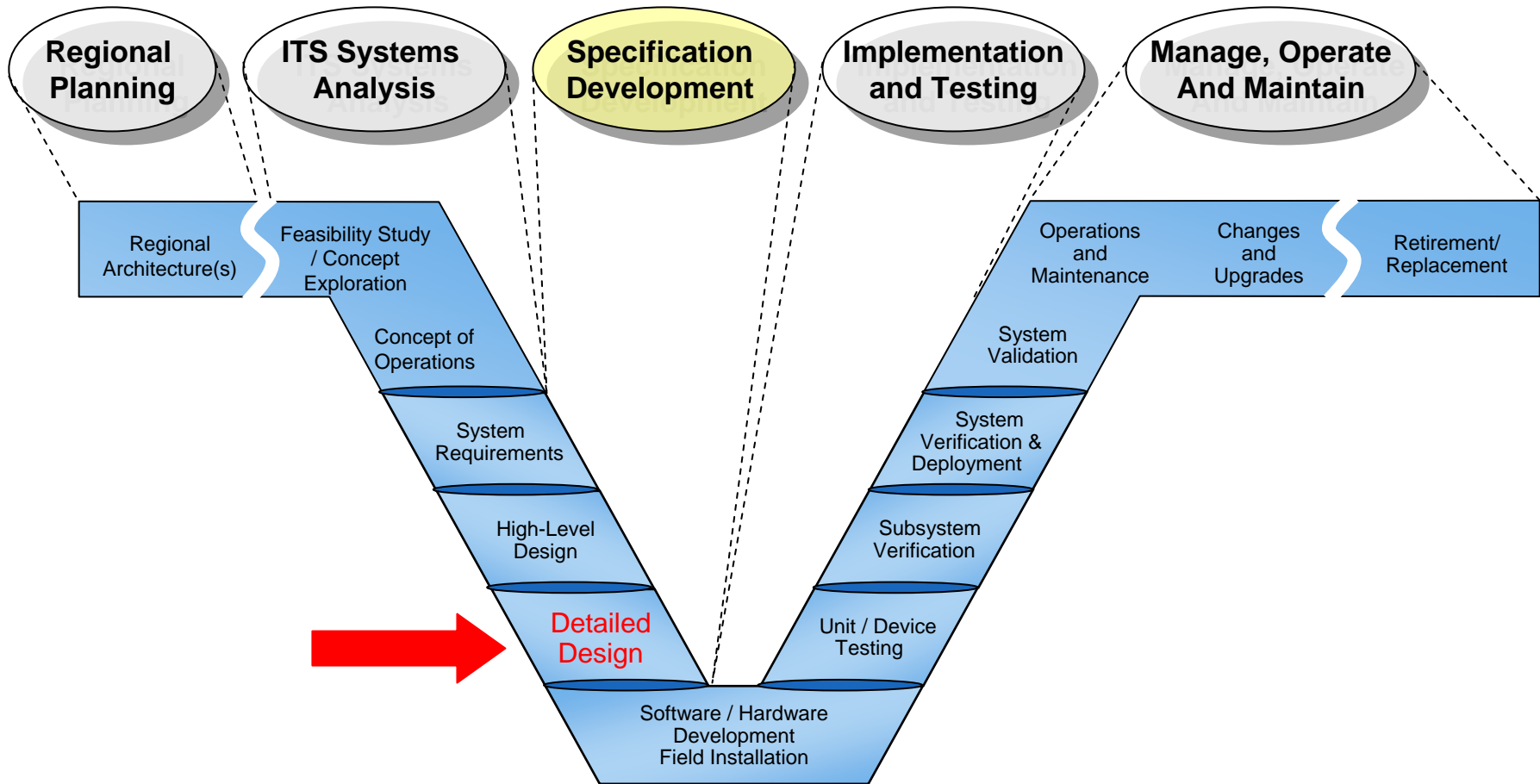


# Module 8 – Specification Development

## Learning Objectives

- Understand relevant processes for development of C2C and center-to-field standards specs
- Understand what a Systems Engineering Analysis Report is

# Specification Development (Detailed Design)



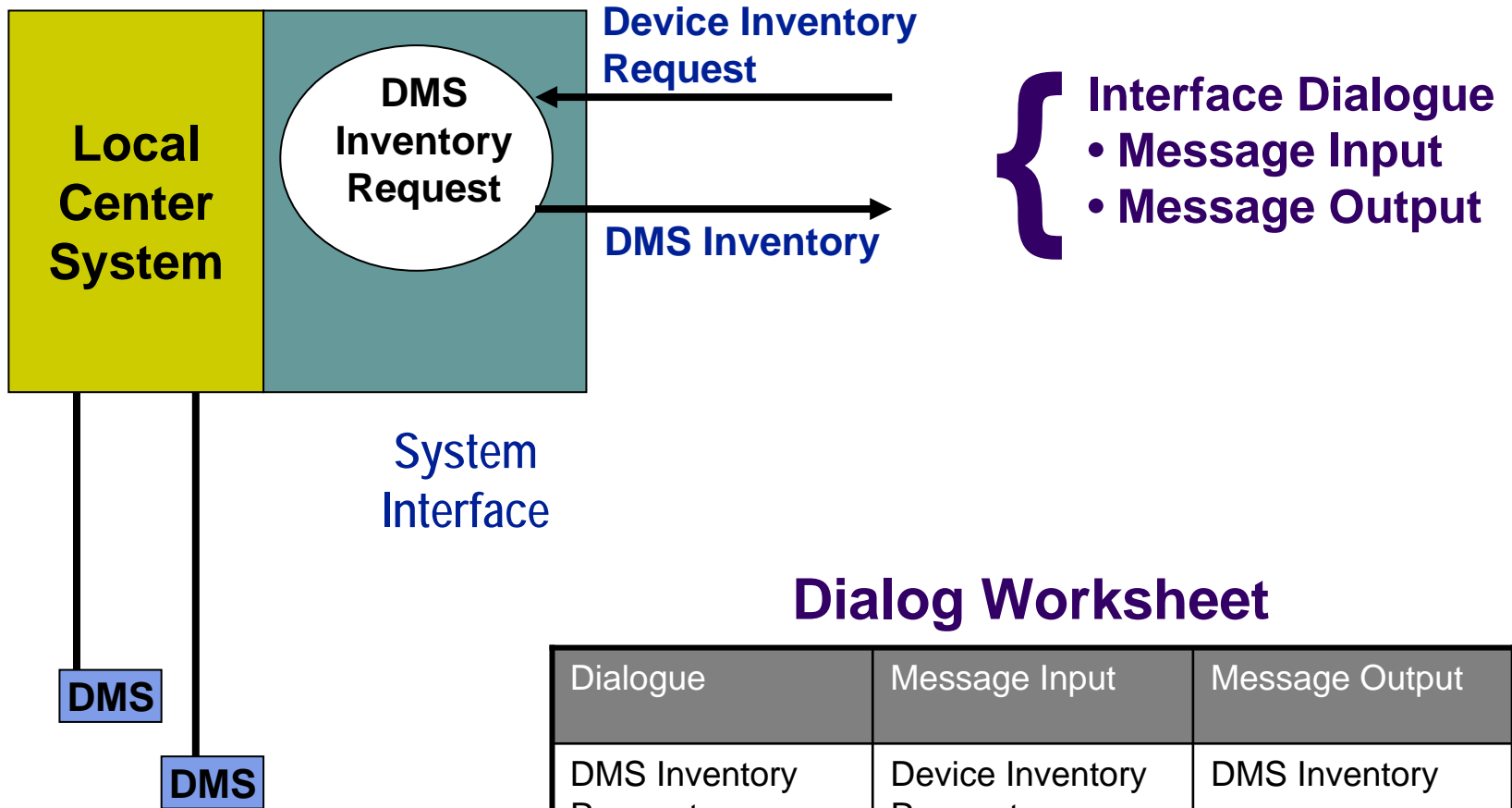


# Module 8.1: ITS Standards Specification Development and Case Studies (Center-to-Center)

# Regional Center Integration Concept



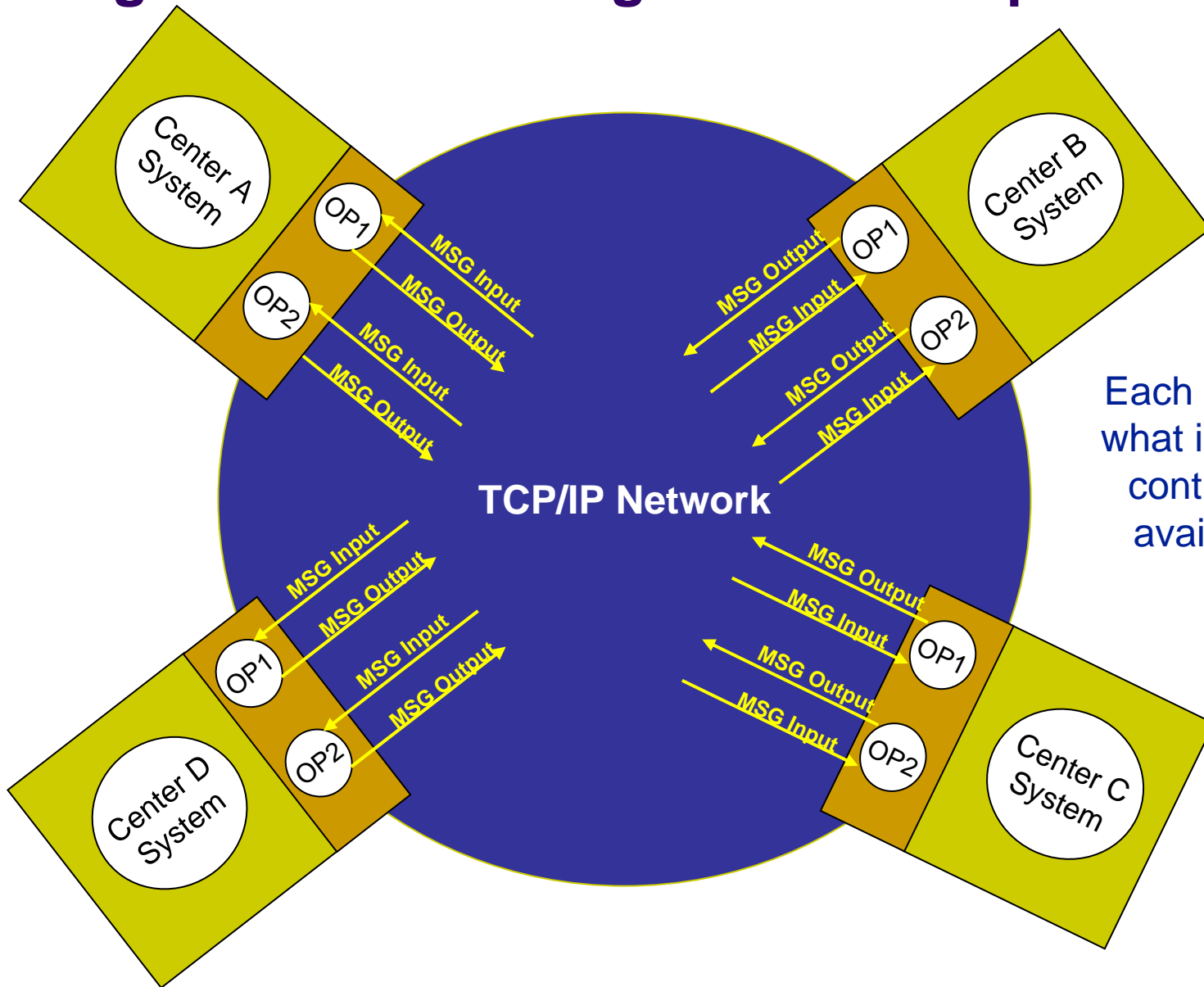
## Interface Dialogue: DMS Inventory Request



### Dialog Worksheet

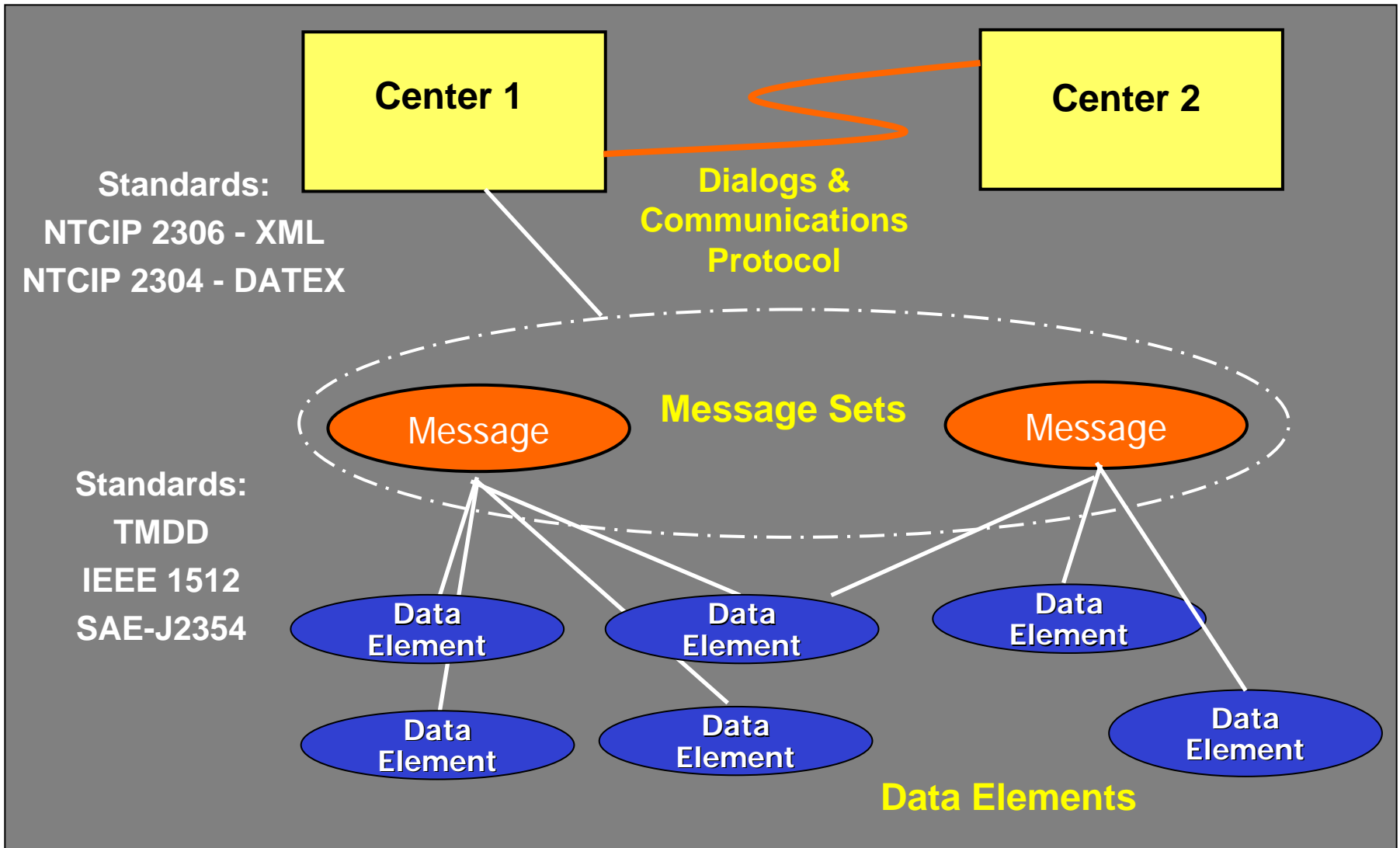
Dialogue	Message Input	Message Output
DMS Inventory Request	Device Inventory Request	DMS Inventory

# Regional Center Integration Concept



Each center controls what information and control they make available to other centers.

# C2C Interface Design Concept



# Specification Development Approach



1. Set up and Maintain Requirements Traceability Matrix
2. Design Messages
3. Design Interface Dialogues
4. Write the Specification

*Steps 1 through 3 are iterative. Get these correct and consistent before writing the specification.*



# Specification Development Approach (1 of 4)

## Requirements Traceability Matrix



- Set up Requirements Traceability Matrix
  - Create “spreadsheet version” of the requirements
  - Based on a requirement, determined whether requirement would/could be satisfied through implementation of a dialog, message, or data element.
  - Update of RTM ongoing throughout design process

# C2C Interface Specification

## Requirements Traceability Matrix (RTM)



### Columns Shown

- Requirement ID
- Requirement Doc Clause
- Requirement
- Data Concept Type
- Hyperlink to XML Data Concept Definition

AZTech Requirements Traceability Matrix (RTM)				
ReqId	ReqDocSection	Requirement	MsgConcept	MsgConceptName
3.1	3.1 - Provide DMS Control to Remote Agencies		TOC	
3.1 a	3.1 - Provide DMS Control to Remote Agencies		DL	<a href="#">DL_DMSControlRequest</a>
3.1.1	3.1.1 - Send DMS Control Request	<p>The remote center shall be capable of sending a DMS control request message to the local center that controls a sign that a message is to be posted onto. The request shall include the following:</p> <ul style="list-style-type: none"> <li>- The ID of the receiving center</li> <li>- The ID of the sending center</li> <li>- The device ID of the DMS</li> <li>- The unique request identifier assigned by the requesting center</li> <li>- The security attribute (user name and password)</li> <li>- The operator and agency name making the request</li> <li>- The message number for the pre-defined message that is to be displayed, or</li> <li>- The specific message to be displayed</li> <li>- The message page flash time</li> <li>- The priority of the message being requested</li> <li>- The start time for the message</li> <li>- The start date for the message</li> <li>- The expiration time for the message</li> <li>- The expiration date for the message</li> <li>- Additional information/comments</li> </ul>	MSG	<a href="#">MSG_DMSControlRequest-AZTech</a>
3.1.2	3.1.2 - Receive DMS Control Request	The local center shall be capable of accepting and processing valid DMS control requests to display a pre-defined or new text message from one or more authorized remote centers.	MSG	<a href="#">MSG_DMSControlRequest-AZTech</a>
3.1.3	3.1.3 - Send DMS Control Response	<p>The local center shall be capable of sending a response to the requesting center. The response to a DMS control request shall include the following:</p> <ul style="list-style-type: none"> <li>- The ID of the receiving center</li> <li>- The ID of the sending center</li> <li>- The unique request identifier</li> </ul>	MSG	<a href="#">MSG_DeviceControlSubscriptionResponse-AZTech</a>

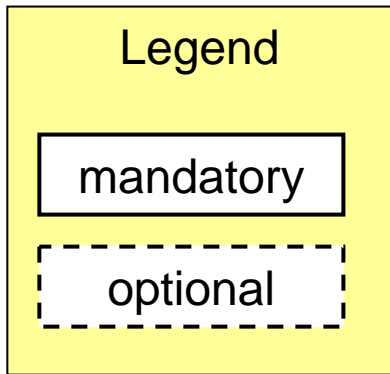
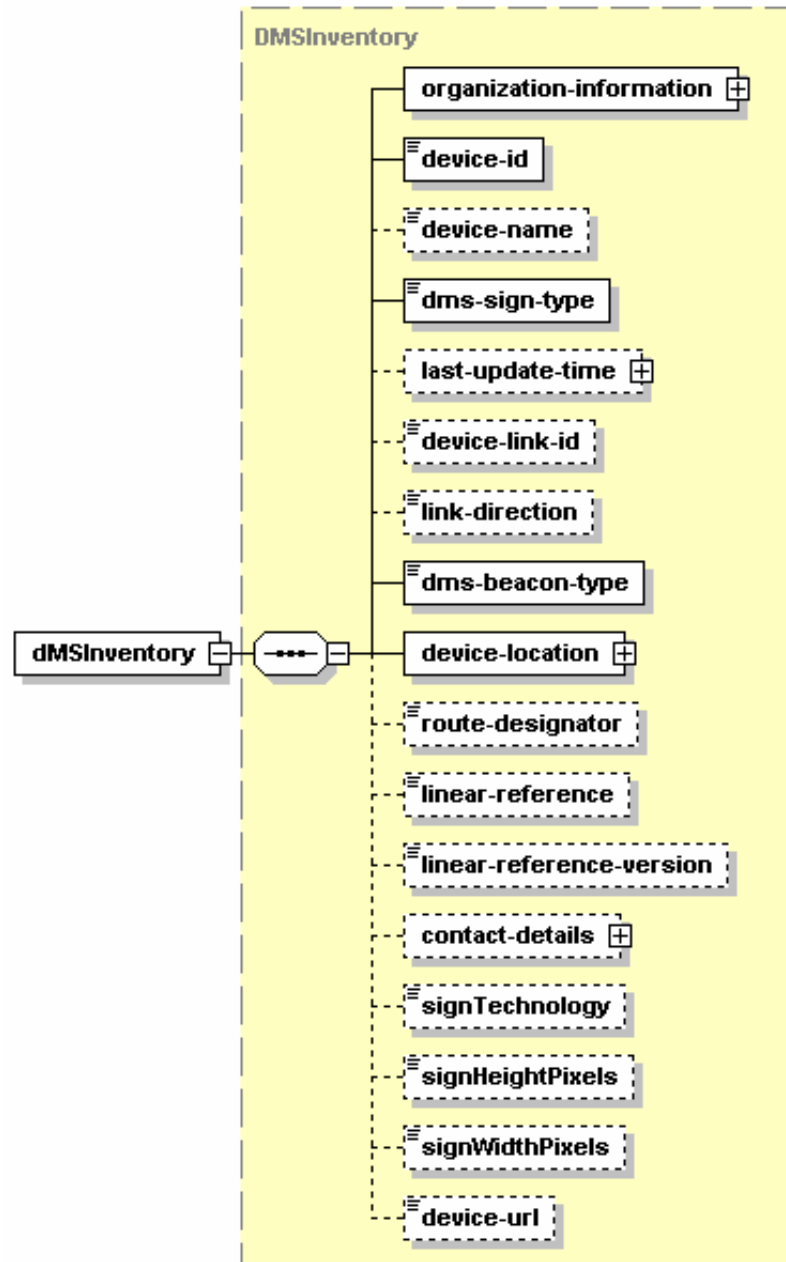


# Specification Development Approach (2 of 4)

## Initial Detailed Design

- Inspect message set standard (e.g., TMDD, IEEE 1512, SAE-J2354) to determine closest match of design to requirement
- Refine design (e.g., TMDD XML Schema) to
  - Include new data elements
  - Remove optional elements not required
  - Determine which optional elements need to be made mandatory
  - Make choices based on requirements
  - Annotate any modifications
  - Update the Requirements Traceability Matrix

# Example C2C XML Message Template Showing Optional and Mandatory Data Elements



# Example C2C Message



```
<dMSInventory>
  <device-list>
    <device>
      <organization-information>
        <organization-id>
          tmc.dot.state.org
        </organization-id>
        <organization-name>
          The State DOT
        </organization-name>
      </organization-information>
      <operator-id>0</operator-id>
      <device-id>22</device-id>
      <device-name>22.dms.dot.state.org</device-name>
      <dms-sign-type>variable message sign</dms-sign-type>
      <device-location>
        <latitude>XXXXXXXXX</latitude>
        <longitude>YYYYYYYYY</longitude>
      </device-location>
    </device>
    <!-- Continue with additional devices -->
  </device-list>
</dMSInventory>
```



# Specification Development Approach Design for Interoperability

- Key points:
  - Start from the National ITS Standard Schema and tailor it for your project
  - Make your project specific schema narrow
    - Constrain or eliminate CHOICE and OPTIONAL elements at design time
      - Choices SHOULD NOT be decided at implementation time or resolved by a programmer – this will cost you!!
    - Result is a clear, interoperable, testable spec that can be implemented at reduced cost

# Specification Development Approach (3 of 4)

## Interface Dialogue Design

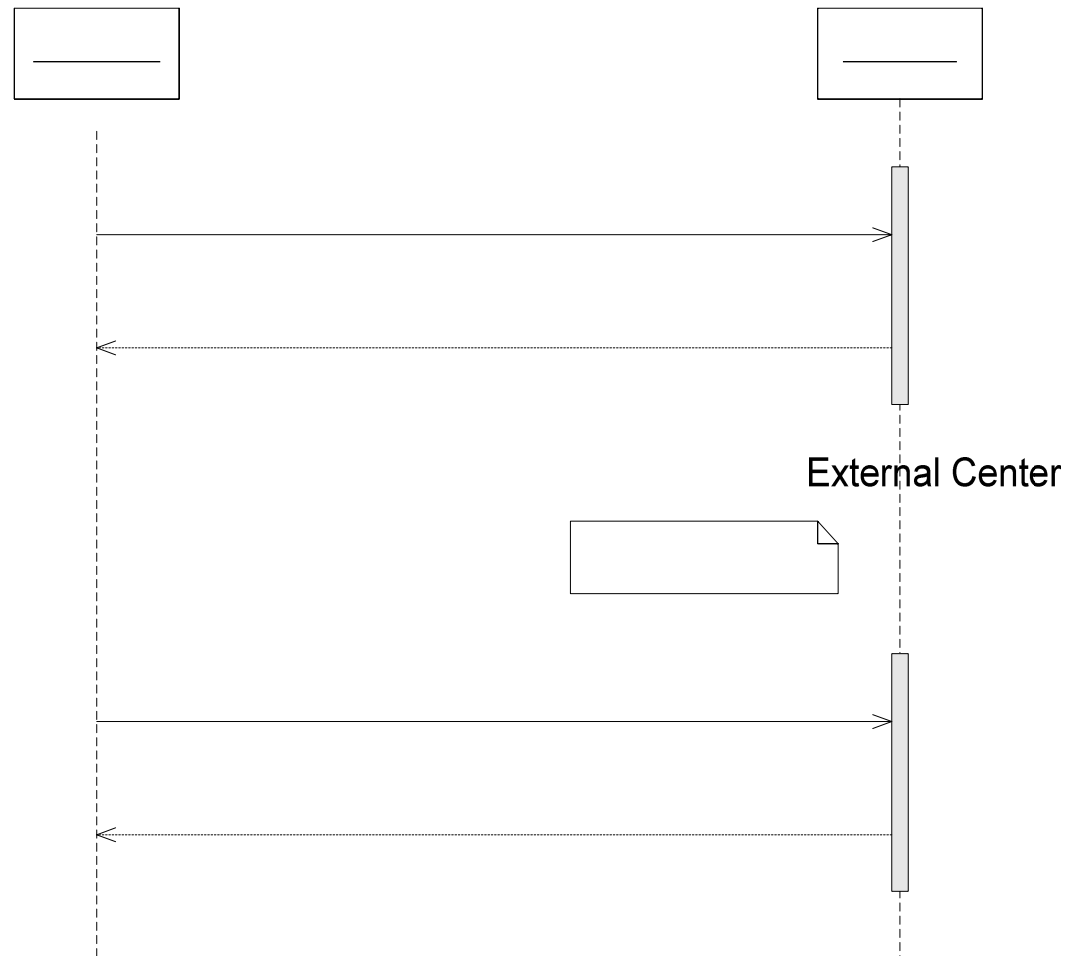


- Some standards have dialogs – use these for your project
- For standards that do not have dialogs, develop these as a separate activity
  - Use an NTCIP 2306 Dialog Worksheet
- Two approaches for message encoding and transport
  - NTCIP 2306 – XML Web Services
  - NTCIP 2304 – DATEX-ASN
- Electronic Data Security not fully covered by C2C Standards – so you will need to design a solution

# C2C Interface Dialogues



- UML Sequence Diagram
- Message Inputs and Outputs





# C2C Interface Specification Contents (4 of 4)



1. Project Overview
2. General Requirements
  - Definitions
  - Conformance Statement
  - References
3. Application Profile PICS for NTCIP 2306
4. Dialog Definitions
  - UML Sequence Diagram
  - Dialog Worksheet (Per NTCIP 2306)
5. Messages, Data Frames, and Data Element Definitions
6. Appendices
  - Requirements Trace Matrix
  - Web Services Description Language (WSDL) - Describes Dialogs
  - XML Schema - Describes Messages and Data Elements

**AZTech™ Center-to-Center (C2C)  
Interface Specification**

(Version 1.1)

Prepared by

Consensus Systems Technologies Corp.  
SubCarrier Systems Corp.

Prepared for

Maricopa County Department of Transportation  
Arizona Department of Transportation  
AZTech™

**September 2006**



# Module 8.2: AZTech Center-to-Center Interface Specification



# Introduction

- AZTech is a consortium of multiple and diverse public surface transportation agencies and private sector companies in the Greater Phoenix Area.
- AZTech has taken a leadership role in applying the systems engineering approach to ITS standards specification development.

# Objectives and Strategy: The Opportunity and Challenges



- Objective:
  - To meet multi-agency system integration needs (information and control exchanges)
  - To achieve regional system interoperability.
- Strategy:
  - Regional interface specification approach
  - High-priority functions - Traffic Signal Control and Dynamic Message Sign information and control.
  - Focus was on the system interfaces and not the systems themselves
  - Specification would be based on National Standards
    - ITE-AASHTO TMDD V2.1 / NTCIP 2306 Web Services
  - Systems Engineering Process (SEP) led to a regional **consensus** ConOps and Requirements **prior** to specification development

# Objectives and Strategy:

## The Opportunity and Challenges

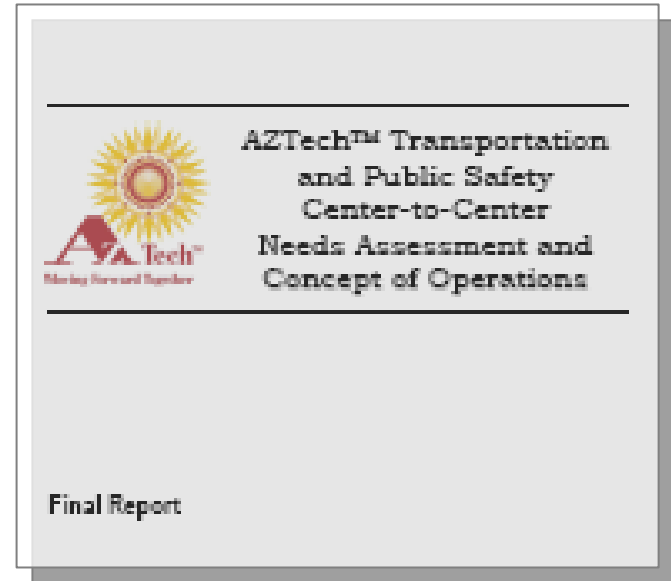


- Challenges/Risks:
  - Different teams worked on different pieces – example, ConOps and Requirements, Specification, and Implementation. SEP used as a guide.
  - Limited (if any) experience in developing C2C specifications; standards were new.

# Concept of Operations Report Content



- Mission and Objectives
- National Research on what others were doing
  - LA County IEN
  - Texas Center-to-Center
  - NY/NJ/CT TransCOM
  - GCM Gateway
- Documented Major System Elements and Interconnections (System Architecture)
- Needs Assessment

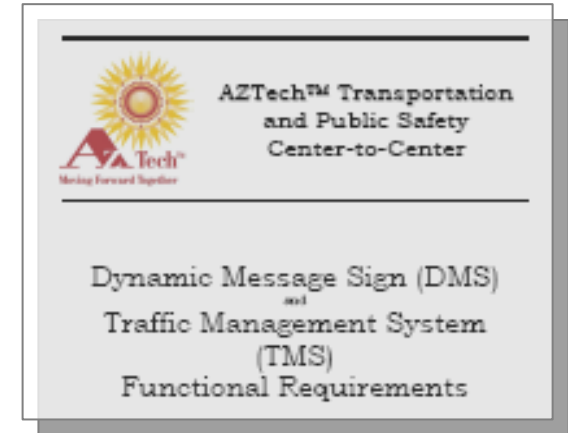


May 2005

# Requirements Report Content



- Requirements to Needs Trace
  - No formal traceability
  - Used need heading as title for requirements groups
- Requirements effort started with TMDD v2.1
  - Added New Requirements
  - Modifications have been given to V3.0 Steering Committee for Consideration
- Focus was on Dynamic Message Sign (DMS) and Traffic Signal Control (TSC) information sharing and shared control through C2C



January 2006



# AZTech C2C Interface Specification

## Example Message – Device Status Request

- Top graphic shows Information Structure
- XML Schema Definition shown below

complexType DeviceStatusRequest-AZTech

diagram	
namespace	http://www.AZTECH-Local-Draft-01-00-09
children	<a href="#">organization-owning</a> <a href="#">organization-requesting</a> <a href="#">authorization</a> <a href="#">device-type</a> <a href="#">device-list</a> <a href="#">request-id</a>
used by	element: <a href="#">DeviceStatusSubscription-AZTech</a> <a href="#">deviceStatusRequest</a> <a href="#">deviceStatusRequest-AZTech</a>
source	<pre>&lt;xs:complexType name="DeviceStatusRequest-AZTech"&gt;   &lt;xs:sequence&gt;     &lt;xs:element name="organization-owning" type="OrganizationInformationShort"/&gt;     &lt;xs:element name="organization-requesting" type="OrganizationInformationLong"/&gt;     &lt;xs:element name="authorization" type="AuthorizationSet"/&gt;     &lt;!-- same question for device type here as before --&gt;     &lt;xs:element name="device-type" type="Device-type"/&gt;     &lt;!-- 3747 --&gt;     &lt;xs:element name="device-list"&gt;       &lt;xs:complexType&gt;         &lt;xs:sequence maxOccurs="100000"&gt;           &lt;xs:element name="device" type="Device-identifier"/&gt;           &lt;!-- 3701 an id = 0 means request all items below added by Azdot to meet local needs --&gt;         &lt;/xs:sequence&gt;       &lt;/xs:complexType&gt;     &lt;/xs:element&gt;     &lt;xs:element name="request-id" type="Device-request-identifier"/&gt;     &lt;!-- 3717 --&gt;   &lt;/xs:sequence&gt; &lt;/xs:complexType&gt;</pre>



# AZTech C2C Interface Specification

## Interface Dialogue Design



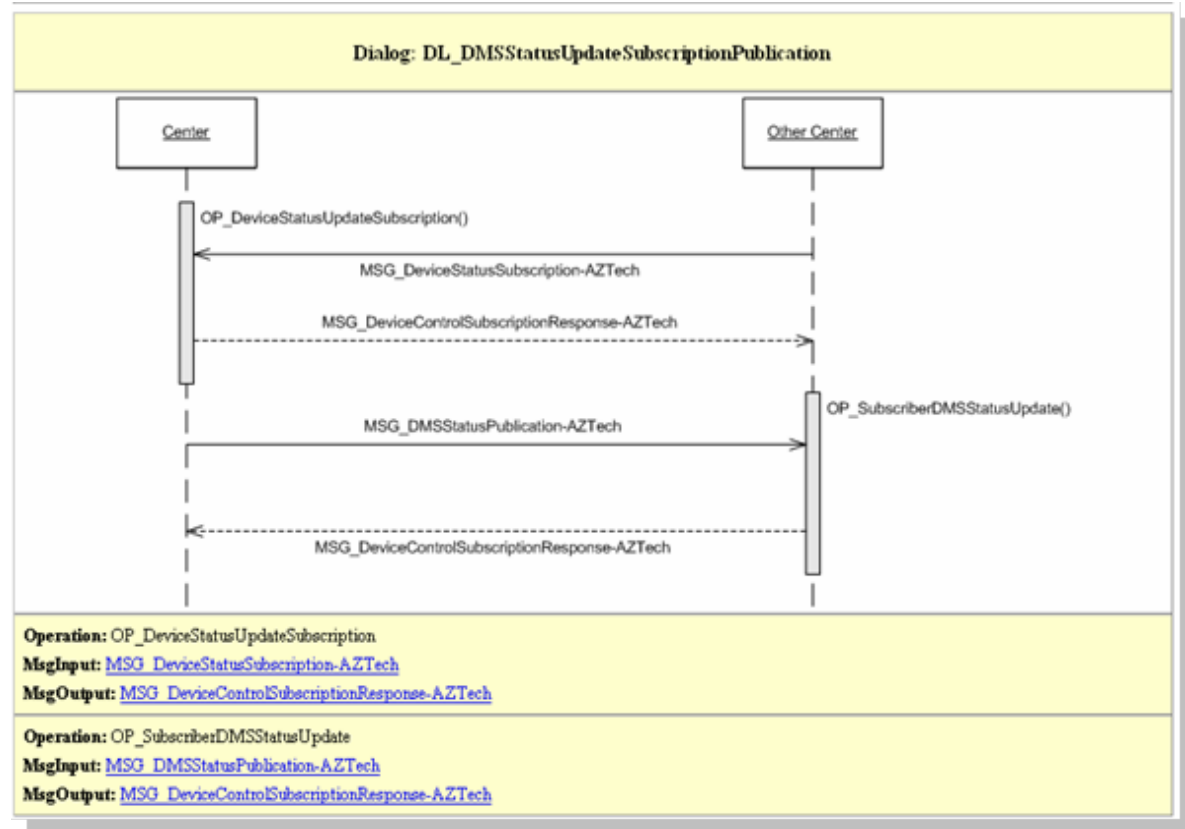
- TMDD v2.1 had no dialogs, so these were developed as a separate activity
  - Developed a NTCIP 2306 Dialog Worksheet
- Started from Technical Constraints
  - Technical requirement to use XML and Web Services became basis for the NTCIP 2306 portion of the specification
- Electronic Data Security not fully covered by TMDD and NTCIP 2306
  - Security White Paper was developed
  - Solution selected based on X.509 Security Certificates dovetails nicely with “elements” of TMDD and 2306.
- Developed WSDL

# AZTech C2C Interface Specification

## Interface Dialogs



- UML Sequence Diagram
- Message Inputs and Outputs
- [Hyperlink to XML Message Definitions](#)





# Specification Development Approach

## Project Web Site

- Developed a project web site to allow developers to have Internet Access to the Design
  - Web Site Navigation: Top-Down from Requirements to Dialogs and Messages to XML Schema
  - Web Site had electronic versions of the ConOps and Requirements
  - Links to referenced standards

# AZTech C2C Interface Specification

## Project Web Site



*Allow developers to navigate and inspect the design via Internet*

- Navigation: Top-Down
  - Requirements
  - Dialogs
  - Messages
  - XML Schema
- Project Docs:
  - ConOps
  - Requirements
  - Specification
- Links to standards

### AZTech Center-to-Center Interface Specification

**Project Documents**

- [AZTech Concept of Operations](#)
- [AZTech Stakeholder Agreement](#)
- [AZTech Functional Requirements](#)
- [AZTech Requirements Traceability](#)
- [AZTech Dialogs](#)
- [AZTech WSDL Worksheet](#)
- [AZTech Message List](#)
- [AZTech C2C Specification](#)
- [AZTech C2C WSDL](#)
- [AZTech C2C XML Schema](#)
- [XML Schema \(XMLSpy View\)](#)
- [SOAP Message Security White Paper](#)

**Project Links**

- [AZTech Home](#)
- [TMDD Documents](#)
- [NTCIP Documents](#)
- [OASIS WS-Security](#)

**ITS Standards**

- [ITE/AASHTO TMDD v2.1](#)
- [ITE/AASHTO TMDD v2.1 - Annexes](#)
- [NTCIP 2306 v0168](#)
- [NTCIP 2306 v0168 - Annexes](#)
- [NTCIP 9010 - Information Report](#)
- [OASIS Web Services Message Security](#)

### Concept of Operations and Requirements

The (Draft) AZTech Center-to-Center Specification has been developed through the consensus input of regional stakeholders. Following a Systems Engineering Methodology, a user needs assessment and concept of operations (ConOps) were developed. Based on the ConOps system functional requirements and a regional stakeholder agreement were then developed. The [figure](#) below shows the application of the 'VEE' model to the AZTech C2C project.

**Requirements Analysis and Design**

Stepping from problem (requirements) to solution (design) the requirements traceability matrix (RTM) documents how the analysis of requirements translates to the project-specific design of center interfaces, from which in future steps technical specifications will be developed. This concept is illustrated in the [figure](#) below.

ConSysTec

Using ITS Standards for Deployment: Identification, Specification, and Testing

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# Specification Development Approach

## Specification Documentation & Comment Review



- Held 1-day workshop with agencies and ITS system providers to review initial draft design
- Based on Comments Developed Initial Draft Design Specification
- Based on Comments Developed Second and Final Draft Specification



June 2006

# AZTech C2C Interface Specification Contents



1. Project Overview
2. General Requirements
  - Definitions
  - Conformance Statement
  - References
3. Application Profile PICS for NTCIP 2306
4. Dialog Definitions
  - UML Sequence Diagram
  - Dialog Worksheet (Per NTCIP 2306)
5. Messages, Data Frames, and Data Element Definitions
6. Appendices
  - Requirements Trace Matrix
  - Web Services Description Language (WSDL) - Describes Dialogs
  - XML Schema - Describes Messages and Data Elements

## AZTech™ Center-to-Center (C2C) Interface Specification

(Version 1.1)

Prepared by

Consensus Systems Technologies Corp.  
SubCarrier Systems Corp.

Prepared for

Maricopa County Department of Transportation  
Arizona Department of Transportation  
AZTech™

September 2006

# Implementation



- Vendor Quotes
  - Vendors were given the specification (which they helped to develop) and asked for quotes to develop an AZTech C2C Compliant Interface
- Prototype / Reference Implementation
  - Being Development and Testing Underway by as Proof of Concept

# Lessons Learned



- Use Systems Engineering Process (SEP) to build Consensus
  - Takes time to do,
    - *but leads to a reliable, high quality system you can depend on.*
- Conduct the SEP in a public/open process at regional level
- Be diligent with traceability - ensure that needs lead the requirements lead the design leads to implementation
- Remember this is detailed design of an interface and not the system itself
  - This design will be strictly enforced, otherwise you defeat the goal of regional interoperability
- Limit or eliminate (resolve) CHOICE and OPTIONAL elements of the National Standards when building your regional or project spec
  - This should be based on the requirements, for which you should already have consensus.





# **Module 8.3: ITS Standards Specification Development and Case Studies (Center-to-Field)**

# Specification Development Approach



1. Determine your projects needs (See ConOps)
  - Examine which needs from standards map closest to your stated project needs
2. Use the Profile Requirements List (PRL) to determine requirements
  - The PRL maps needs to requirements
  - The PRL indicates what needs are MANDATORY to conform to the standard
3. Protocol Implementation Conformance Specification (PICS)
  - A PICS is a completed PRL
  - The PICS indicates what needs are REQUIRED to comply with your project specifications.
  - Your specification on how to implement the standard.

# C2F Interface Specification

## Profile Requirements List (PRL)



### Columns Shown

- User Need ID
- User Need
- Requirement ID
- Requirement
- Conformance
- Support / Project Requirement
- Additional Project Requirements

User Need Section Number	User Need	FR Section Number	Functional Requirement	Conformance	Support / Project Requirement	Additional Project Requirements
2.5.3.1.5 (Environment)	Monitor Sign Environment			O	Yes / No	
		3.5.3.1.4.7	Monitor Sign Housing Temperatures	M	Yes	
		3.5.3.1.4.8	Monitor Sign Housing Humidity	O	Yes / No	
		3.5.3.1.4.9	Monitor Control Cabinet Temperatures	O	Yes / No	
		3.5.3.1.4.10	Monitor Control Cabinet Humidity	O	Yes / No	
		3.5.3.1.7	Monitor Ambient Environment	Temp:M	Yes / NA	
2.5.3.1.6	Monitor the Sign Control Source			M	Yes	
		3.5.3.1.5	Monitor the Sign's Control Source	M	Yes	
2.5.3.1.7	Monitor Attached Speed Detectors			O	Yes / No	
		3.5.3.1.9 (Speed)	Monitor Speed Detector Reading	O	Yes / No	
2.5.3.1.8 (Door)	Monitor Door Status			O	Yes / No	
		3.5.3.1.3.10	Monitor Door Status	M	Yes	
2.5.3.1.9 (ControllerOp)	Monitor Controller Software Operations			O	Yes / No	
		3.5.3.1.3.5	Monitor Controller Software Operations	M	Yes	
2.5.3.1.10	Monitor Automatic Blanking of Sign			O	Yes / No	
		3.5.3.1.1.1 (LampTest)	Execute Lamp Testing	Lamp OR Fiber:M	Yes / NA	
		3.5.3.1.1.2 (PixelTest)	Execute Pixel Testing	Matrix:M	Yes / NA	
		3.5.3.1.2	Provide General DMS Error	M	Yes	

# Specification Development Approach



1. Use the Requirements Traceability Matrix (RTM) to determine how to satisfy requirements:
  - The RTM maps requirements to design.
  - The design indicates how to CONFORM to the standard and SATISFY the requirements.
2. Design
  - Dialogs - Sequence of data exchanges
  - NTCIP Objects – Data elements including limits

# C2F Interface Specification Requirements Traceability Matrix (RTM)



NTCIP 1203 v02.35  
Page A-14

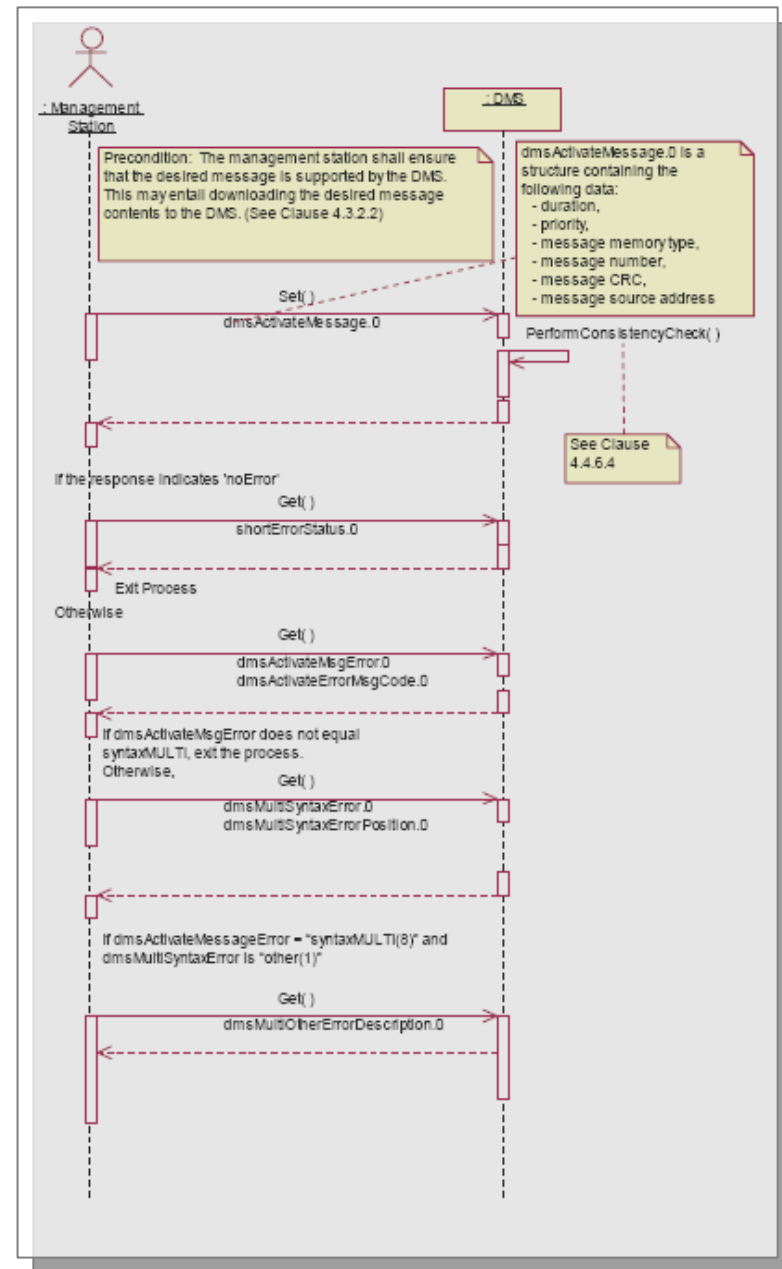
## Columns Shown

- Requirement ID
- Requirement
- Dialog ID
- Object ID
- Object
- Additional Specifications

FR Clause Number	Functional Requirement	Dialog ID	Object Clause Number	Object	Additional Specifications
			5.8.7	dmsIllumBrightnessValues	
			5.8.8	dmsIllumBrightnessValuesError	
3.5.1.6	Configure Current Speed Limit	G.3			
			5.11.1.4	dmsCurrentSpeedLimit	
3.5.1.7	Configure Low Fuel Threshold Value	G.3			
			5.11.3.2	lowFuelThreshold	
3.5.2	Control the DMS				
3.5.2.1	Manage Control Source	G.3			
			5.7.1	dmsControlMode	
3.5.2.2	Reset the Sign Controller	G.3			
			5.7.2	dmsSWReset	
3.5.2.3	Control the Sign Face				
3.5.2.3.1	Activate a Message	4.2.3.1			
			5.7.3	dmsActivateMessage	
			5.7.17	dmsActivateMsgError	
			5.7.24	dmsActivateErrorMsgCode	
			5.7.18	dmsMultiSyntaxError	
			5.7.19	dmsMultiSyntaxErrorPosition	
			5.7.20	dmsMultiOtherErrorDescription	

# C2F Interface Dialog

- UML Sequence Diagram
- Sequence of NTCIP Object Sets and Gets on Device across an SNMP Interface



# Example Object Definition



## 5.2.4 Sign Width Parameter

dmsSignWidth OBJECT-TYPE

SYNTAX INTEGER (0..65535)

ACCESS read-only

STATUS mandatory

DESCRIPTION

"<Definition> Indicates the sign width in millimeters including the border (dmsHorizontalBorder).

<Unit>millimeter

<Object Identifier> 1.3.6.1.4.1.1206.4.2.3.1.4"

::= { dmsSignCfg 4 }

## 5.2.5 Horizontal Border Parameter

dmsHorizontalBorder OBJECT-TYPE

SYNTAX INTEGER (0..65535)

ACCESS read-only

STATUS mandatory

DESCRIPTION

"<Definition> Indicates the minimum border distance, in millimeters, that exists on the left and right sides of the sign.

<Unit>millimeter

<Object Identifier> 1.3.6.1.4.1.1206.4.2.3.1.5"

::= { dmsSignCfg 5 }

# C2F Interface Specification Contents



1. Introduction
2. DMS Specification Operations Plan
  - Normal Operations
  - Exception Operations
  - Control Modes
  - Monitoring
3. NTCIP Communications Specification
  - General Requirements
  - Physical Features
4. Protocol Implementation Conformance Specification (PICS)
  - PICS
  - Functional Requirements & RTM
  - Dialogs
  - Object Definitions
5. Software and Integration Support
6. Installation and Testing
7. Documentation

Appendix J  
New York State ITS Standards Specification Development  
Guide

Example New York State ITS Project  
Dynamic Message Sign (DMS)  
Information Level  
NTCIP Communications Specification

Prepared for  
New York State Department of Transportation

Prepared by  
Consensus Systems Technologies Corp.

January 16, 2007



# Module 8: NTCIP Center-to-Field Specification Exercise



- Completing a PRL
  - Objectives:
    - Create a PICS
    - Determine Dialogs and Objects for a given set of needs.



# **Module 8.4: Western New York ATMS Center-to-Field Communications Specification**

# Case Study



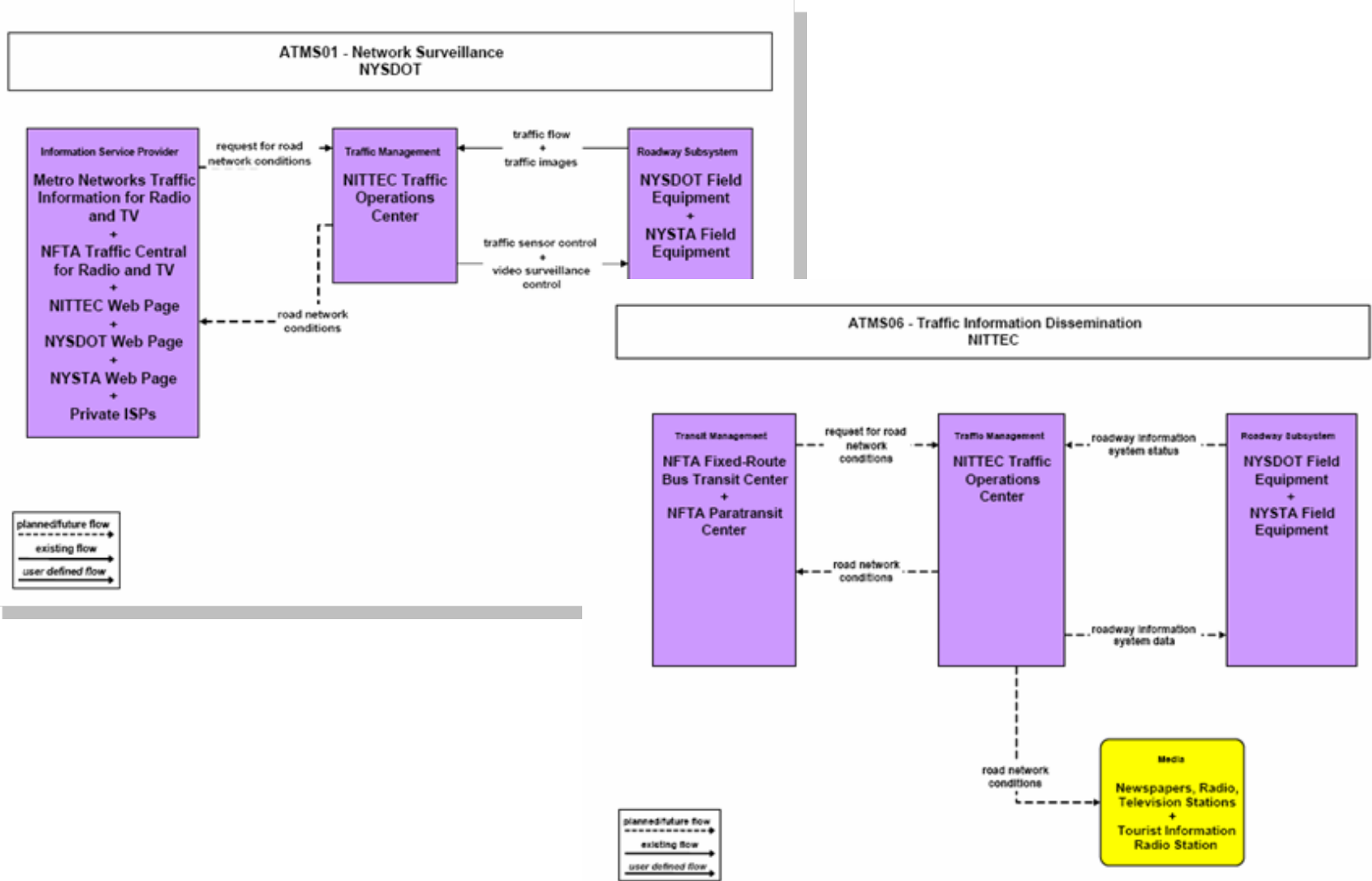
**DRAFT DESIGN REPORT**  
NYSTA Contract D212922  
Design of ITS in the Buffalo/Niagara Falls/Southern Ontario Region  
TASK 3 – PHASE 3 WESTERN NY ATMS EXPANSION

**Prepared for:**  
New York State Thruway Authority  
200 Southern Boulevard  
Albany, New York 12209

March 4, 2003



# Design Report Included an ITS Project Architecture



# Specification Development Approach

## Specification Documentation & Comment Review



- Held 1-day workshop with stakeholders and ITS system providers to review DMS Operations Plan
- Based on Comments Developed Initial Functional Requirements
- Project used a modified version of NYSTA / NYSDOT Specification



# Testing



- Project Called in Specialist to Develop NTCIP Test Plan and Conduct NTCIP Testing
- Testing included Factory and Field Tests

# Summary / Lessons Learned



- Because Version 2.0 of NTCIP Specification was in development, project specifications were based on the NTCIP 1203 V1.0
- Project did not apply formal Systems Engineering
- Held Workshop to Aid in Determining Operational Needs, which were then used to develop (select from spec) the functional requirements
- Called in Special Consulting Services for:
  - ITS Project Architecture
  - Functional Requirements Development & NTCIP Specification Development
  - NTCIP Testing



# Module 8.5: Systems Engineering Analysis Report



# Systems Engineering Analysis Report



- Defined in and Required by FHWA Rule 940
- Complements information in the Regional ITS Architecture with a focus on Project Elements
- Should be submitted with Design Report

# Systems Engineering Analysis Report Contents



1. Portion of Regional ITS Architecture Being Implemented
2. Participating Agencies Roles and Responsibilities
3. Requirements Definition
4. Alternative System Configuration and Technology Options
5. Applicable ITS Standards and Testing Procedures
6. Procurement Options
7. Procedures and Resources Necessary for the Operations and Management of the System

# Resources & Where in the Guide



- Resources
  - NTCIP Case Studies
- Where in the Guide
  - Chapter 7 – Project Scoping and Design Reports / System Engineering Analysis
  - Chapter 8 – ITS Standards Specification Development
  - Appendix I – Example Systems Engineering Analysis Report
  - Appendix J – Example DMS NTCIP Communications Specification
  - Appendix K – Example Center-to-Center Interface Specification



# Module 9: ITS Standards Testing and Tools





# Module 9 – Standards Testing Learning Objectives

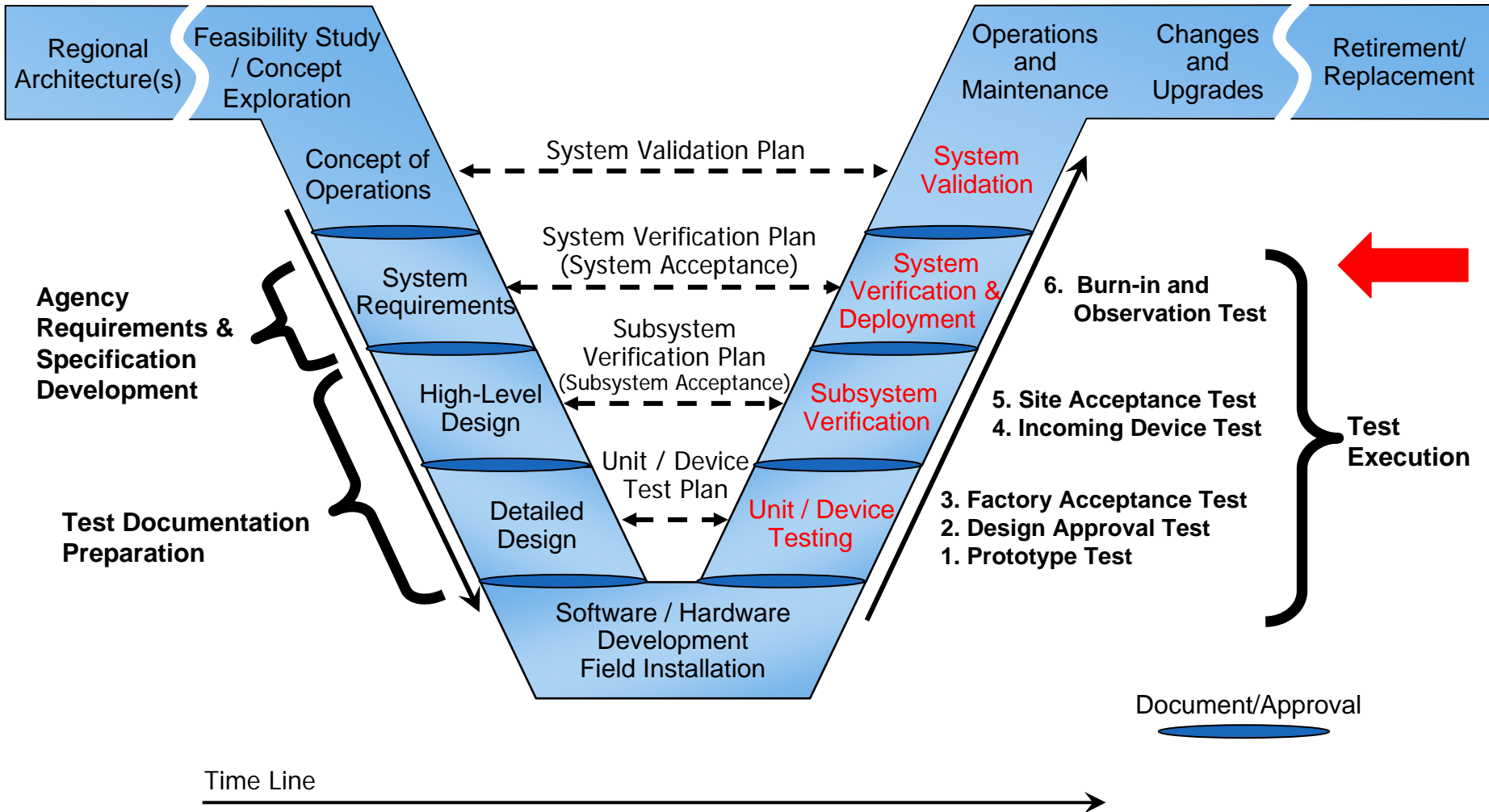
- To understand methods and resources used in testing of ITS standards and communications
- To understand what commercially available tools are available to support ITS standards testing

# Testing Concepts



- Purpose of Testing
  - To validate user needs are satisfied and requirements are fulfilled in an implementation.
  - Recall that the Needs to Requirements Traceability Matrix identifies requirements that satisfy one or more needs
  - Recall types of requirements
    - Functional Requirements
    - Performance Requirements
    - Maintainability Requirements
    - Hardware, Electrical, and Mechanical
- Requirements to Test Case Traceability Matrix
  - Is a tool to ensure that at least one test case covers each requirement.

# Implementation and Testing



# Testing Phases



Test Phase	Purpose	Number of Units	Test Location
<b>Prototype Test and Inspection</b>	Verify the electrical and mechanical design.	One prototype.	Test Laboratory
<b>Design Approval Test and Inspection</b>	Verify the final design.	Pre-production or a small percentage of the production units	Laboratory
<b>Factory Acceptance Test</b>	Verify production units are identical to the final design and production quality	A percentage of the production unit.	Production factory.
<b>Incoming Device Test</b>	Inspect for damage due to shipping and handling.	All delivered units, including spares	Agency.
<b>Site Acceptance Test</b>	Full functionality of the entire system.	All installed units.	Final location for operation.
<b>Burn-in and Observation Test</b>	Monitor proper operation of the installed unit.	All installed units.	Final location for operation.



# Test Documentation



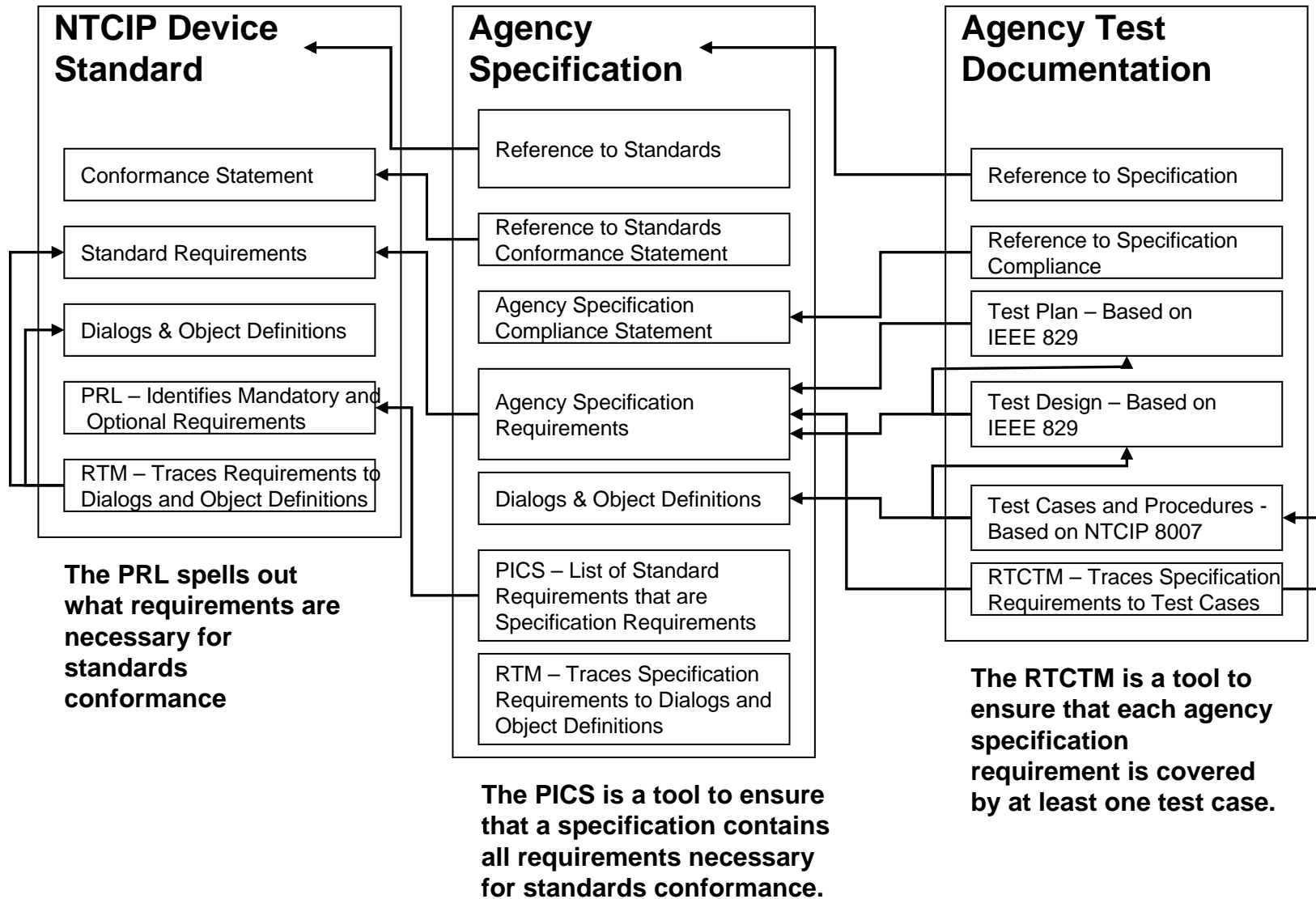
- Test Plans. Describes the scope, approach, resources, and schedule of testing activities
- Test Designs. Describe which requirements are to be tested and which test cases cover which requirements. Pass-fail criteria.
- Test Cases. Describe the inputs, outputs, expected results, and procedures used to verify one or more requirements.
- Test Procedures. Sequence of steps in a test.

# Test Documentation Standards



- NTCIP 9012 - *Testing Guide for Center-to-Field Communications*
- NTCIP 8007 - *Testing and Conformity Assessment Documentation within NTCIP Standards Publications*
- NEMA TS 2-2003: *Traffic Controller Assemblies with NTCIP Requirements*
- NEMA TS 4-2005: *Hardware Standards for Dynamic Message Signs (DMS) with NTCIP Requirements.*
- IEEE 829-1998: *IEEE Standard for Software Test Documentation.*

# Example Specification and Test Documentation: Putting it all together



# Center-to-Center Standards Testing



- What to Test
  - Dialogs are implemented as specified
  - System can exchange messages
  - System can extract data elements from message content

# Center-to-Field Standards Testing



- What to Test
  - Hardware Tests
    - Electrical, Mechanical
  - Environmental Tests
    - Temperature, Humidity, Vibration
  - Functional Tests
    - Does it do what I expect it to do?
  - Performance Tests
    - Does it respond or function in a timely manner?
  - Standards Conformance Tests

# Standards Testing



- ITS Standards are NOT functional requirements.
  - The data “objects” and messages defined **SUPPORTS** the functional requirements.
- Functional Testing
  - Tests if the device “complies” with the functional requirements.
- Standards Testing
  - Tests if the device “conforms” with the specified standard



# Standards Testing

- Conformance
  - To claim “Conformance” to a Standard, the vendor must minimally satisfy the mandatory requirements as identified in the Standard.
  - In addition, a conformant device may offer additional (optional) features, as long as they are conformant with the requirements of the Standard and the standards it references.



# Standards Testing

- Certification
  - ITS standards do not certify, nor provide a way to certify, a device or manufacturer
  - Certification is ideal for public sector, but there are issues:
    - Each unit is different
    - Who certifies the certifiers?
  - Considering Conformance Statements





# Test Tools

- Center-to-Field
- Center-to-Center

## Test Tools – Center-to-Field

	Information Level NTCIP 1200 Series			Application Profile NTCIP 2301			Transport Level NTCIP 2201		SubNet	Transp Level NTCIP 2202	SubNetwork			
	MIB Verifica tion	Dialog Pattern / Content Verification	Content Verification against MIB (1)	SNMP - BER	SFMP- OER (2)	STMP – OER (2) (3)	TCP / UDP	IP	TCP- UDP/IP	TP- NULL (4)	TP-NULL	PPP NTCI P21X X	PMPP/ FSK NTCIP 21XX (5)	PMPP/ RS-232 NTCIP 21XX
SMIC	X													
SNMP Client		X		X										
SimpleSof t NTCIP		X		X										X
FTS NTCIP		X		X										X
NTester		X		X										
IDI		X		X		X								
TTCP							X							
PING									X					
PPP Dialer												X		
Ethernet Packet Sniffer									X					



# Resources & Where in the Guide



- Resources
  - NTCIP 8007 – Testing and Conformity Assessment Documentation
  - NTCIP 9012 – User Guide to Testing
  - IEEE 829 – Software Test Documentation
  - IEEE 1012 – Software Verification and Validation
- Where in the Guide
  - Chapter 9 – ITS Standards Specification Catalog and Testing Framework
  - Appendix L – ITS Standards Test Procedure Guidance and Tools



# END OF DAY 2

