

# **Using Systems Engineering To Develop TMDD Version 3.0**

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# Acknowledgements

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## Presentation Outline

- **Background**
- **Review of the Systems Engineering Process**
- **Development Approach**
- **Using the TMDD Standard**

# Background

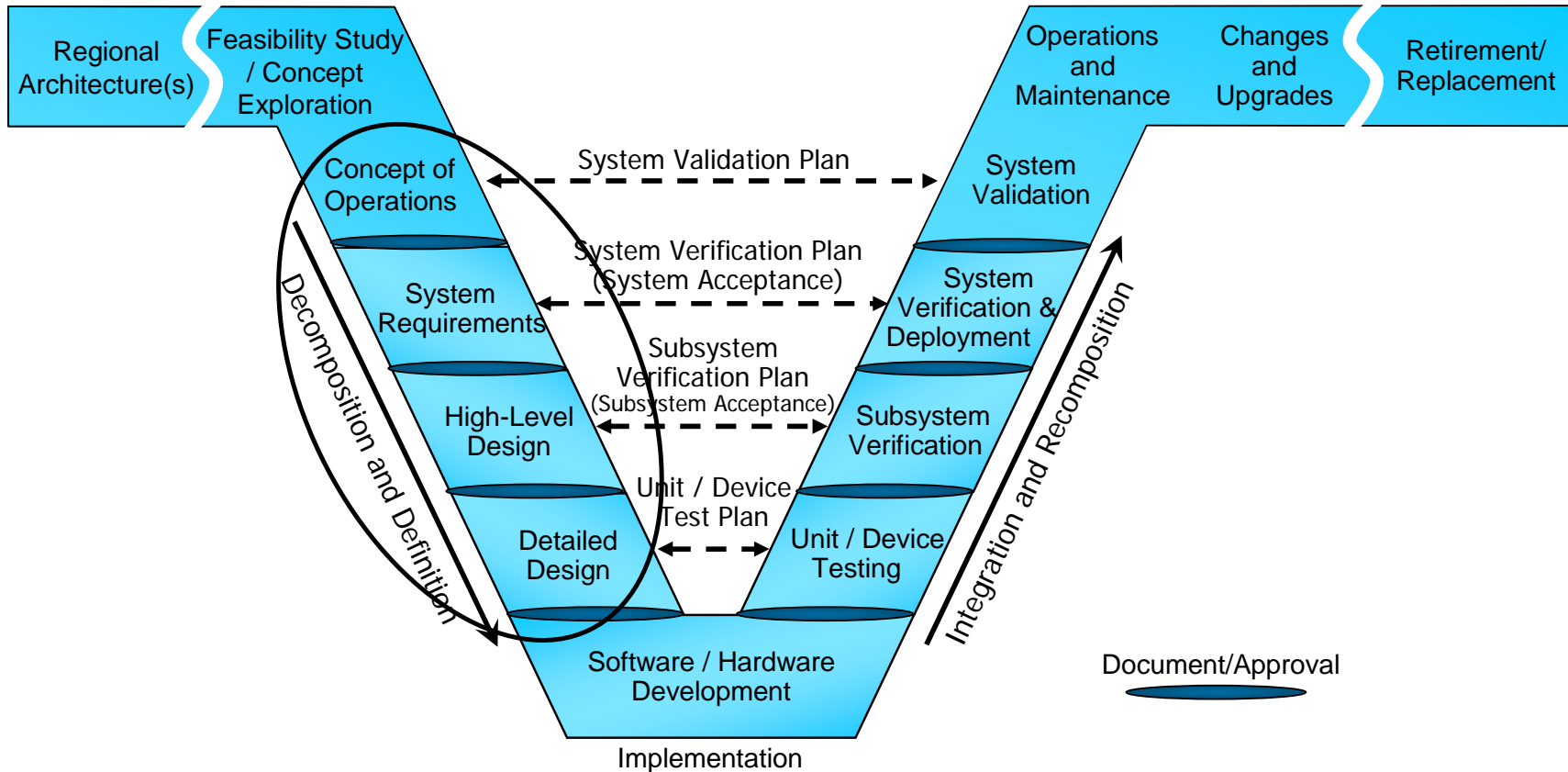
- **TMDD / MSETMCC**

- Traffic Management Data Dictionary / Message Sets External Traffic Management Center Communications
- Supports exchanging information between a traffic management center and other centers
  - Traffic Network
  - Events
  - Traffic Devices
- Version 1 – 2000
- Version 2.1- 2004

# Background

- **Version 3.0**
  - Incorporate feedback received from deployments of the standard (CARS, TRANSCOM, TxDOT, FDOT)
  - Address additional areas of scope
  - Address issues unresolved from earlier versions of the standard.
  - Extend support for the Clarus initiative and the Archived Data User Service (ADUS) standards effort.
  - Effort started Fall 2006

# Systems Engineering Process



# Systems Engineering Process

- **Using the SEP to develop the standard**
  - Makes the selection of interfaces easier and traceable to user needs
  - Simplifies setting up a requirements-based verification and validation program.

# Systems Engineering Process

- **Systems Engineering Management Plan**
  - Is a top-level plan to manage the SE effort
  - Defines how the engineering effort will be organized, structured and conducted to provide a product that fulfills customer requirements
  - Configuration Management Plan – Change process
  - Verification and Validation Plan – Verify requirements and validate the concept of operations
  - Risk Management Plan – Identify, track and resolve risk.



# Development Approach

- **Concept of Operations**

- Define the user needs to be addressed by the standard
- User workshop for all stakeholders – September 2006
- 123 user needs identified

## 2.3.3 Need to Provide Information on Organizations, Centers, and Contacts

To support the exchange of other types of data it is important to share information about the organization, centers and contacts that are connected. Additionally, this information can be used to help operations personnel contact the other centers with which they do not often coordinate. Also, the contact information for each center is important as a prerequisite for shared control.

*Centers need to exchange organization, center and contact information. This includes:*

- *Organization name and identification;*
- *Center site-level information; and*
- *Contact personnel who contribute to or use C2C data.*

# Development Approach

- **Requirements**

- Identify the interface requirements to satisfy the user needs
- Face-to-face Meeting – July 2007
- 1,124 requirements identified

3.3.5.2.1.5.1 Required Node Inventory Information Content  
The node inventory information sent from an owner center to an external center shall include:

- a. Unique identifier of the owner organization;
- b. Unique identifier of the roadway network;
- c. Unique identifier of each node; and
- d. Geographic location of each node (longitude and latitude).

3.3.5.2.1.5.2 Optional Node Inventory Information Content  
The following are optional requirements that an owner center may include in the node inventory information sent to an external center.

3.3.5.2.1.5.2.1 Node Name  
The owner center shall provide the name of the node as assigned by the owner organization as part of the node inventory information for each node.

3.3.5.2.1.5.2.2 Node Description  
The owner center shall provide a textual description of the node as part of the node inventory information for each node.

## Development Approach

- **User Need – Requirements Traceability**
  - Used Rational RequisitePro, to maintain traceability between user needs and requirements
  - Needs to Requirements Traceability Matrix documents the traceability.

# Development Approach

UN ID	User Need	UN Selected	Requirement ID	Requirement	Project Requirement	Other Requirements
		Y/N	3.3.6.2.4.3.2.6	Operational Date and Time	<input type="radio"/>	
		Y/N	3.3.6.2.4.3.2.7	Non-Operational Date and Time	<input type="radio"/>	
		Y/N	3.3.6.2.4.3.2.8	Description of Repair	<input type="radio"/>	
		Y/N	3.3.6.2.4.3.2.9	Owner Organization	<input type="radio"/>	
		Y/N	3.3.6.2.4.3.2.10	History Date and Time Change Information	<input type="radio"/>	
2.3.6.2.1	Need to Share CCTV Device Inventory	Y/N	3.3.6.1.1.1	Contents of Device Information Request	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.1	Required Device Information Request Content	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.2.1	Username of the Requesting Operator	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.2.2	Password of the Requesting Operator	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.2.3	Owner Organization	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.2.4	External Center Organization	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.3	Content of Device Information Request Filter	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.3.1	Device Identifier Filter	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.3.3	Roadway Network Identifier Filter	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.3.4	Link Identifier Filter	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.3.5	Route Designator Filter	<input type="radio"/>	
		Y/N	3.3.6.1.1.1.3.6	Linear Reference Filter	<input type="radio"/>	
		Y/N	3.3.6.1.2.1	Contents of the Device Inventory Header	<input type="radio"/>	
		Y/N	3.3.6.1.2.1.1	Required Device Inventory Content	<input type="radio"/>	
		Y/N	3.3.6.1.2.1.2.1	Device Description	<input type="radio"/>	
		Y/N	3.3.6.1.2.1.2.2	Device Control Type	<input type="radio"/>	
		Y/N	3.3.6.1.2.1.2.3	Controller Description	<input type="radio"/>	
		Y/N	3.3.6.1.2.1.2.4	Uniform Resource Locator (URL)	<input type="radio"/>	
		Y/N	3.3.6.1.2.1.2.5	Roadway Network Identifier	<input type="radio"/>	

# Development Approach

- **Design**

- Identifies the design to fulfill interface requirements
- Face-to-face meeting (Initial design) - July 2007
- Completed design via series of focus teleconferences and webconferences
  
- Consists of data elements, data frames, messages, and dialogs
  - 207 data elements, 187 data frames, 85 messages, 124 dialogs
  
- Intended to be protocol-independent
  - Data elements – ISO 14817 standard
  - Data frames / messages – ASN.1 and XML formats

# Development Approach

## 3.2.10.6 HARStatusMsg

### 3.2.10.6.1 DEFINITION

The information content describing an owner center's highway advisory status for a given set of devices.

### 3.2.10.6.2 ASN.1 REPRESENTATION

```

hARStatusMsg ITS-MESSAGE ::= {
  DESCRIPTIVE-NAME "hARStatusMsg:message"
  ASN-NAME "hARStatusMsg"
  ASN-OBJECT-IDENTIFIER { tmddMessages 49 }
  DEFINITION "The information content describing an owner center's highway advisory status
  for a given set of devices."
  DESCRIPTIVE-NAME-CONTEXT {"Manage Traffic"}
  ARCHITECTURE-REFERENCE {
    "traffic information coordination"
  }
  ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
  ARCHITECTURE-VERSION {"6.0"}
  DATA-CONCEPT-TYPE message
  STANDARD "TMDD"
  META-DATA-SOURCE direct
  PRIORITY "routine"
  FREQUENCY-OR-MESSAGE-MODE "on demand"
  REFERENCED-DATA-FRAMES {
    { tmddDataFrames 122 }
  }
  DATA-TYPE "
    HARStatusMsg ::= SEQUENCE (SIZE(1..10240)) OF HARStatus
  "
}

```

### 3.2.10.6.3 XML REPRESENTATION

```

<xs:element name="hARStatusMsg">
  <xs:complexType>
    <xs:sequence maxOccurs="10240">
      <xs:element name="har-status-item" type="HARStatus"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>

```

# Development Approach

## 3.3.8.17 EventHeadline

### 3.3.8.17.1 DEFINITION

The information content describing an event, including a list of phrases and identification of the key phrase.

### 3.3.8.17.2 ASN.1 REPRESENTATION

```
eventHeadline ITS-DATA-FRAME ::= {
  DESCRIPTIVE-NAME "EventHeadline:frame"
  ASN-NAME "EventHeadline"
  ASN-OBJECT-IDENTIFIER { tmddDataFrames 82 }
  DEFINITION          "The information content describing an event, including a list of phrases and
  identification of the key phrase."
  DESCRIPTIVE-NAME-CONTEXT {"Manage Traffic"}
  DATA-CONCEPT-TYPE data-frame
  STANDARD "TMDD"
  REFERENCED-DATA-FRAMES {
    { tmddDataFrames 94 }
  }
  REFERENCED-DATA-ELEMENTS {
    { tmddDataElements 85 }
  }
  DATA-TYPE "
  EventHeadline ::= SEQUENCE {
    headline EventType,
    headline-element Event-headline-element OPTIONAL,
    ...
  }
  "
}
```

### 3.3.8.17.3 XML REPRESENTATION

```
<xs:complexType name="EventHeadline">
  <xs:sequence>
    <xs:element name="headline" type="EventType"/>
    <xs:element name="headline-element" type="Event-headline-element"
  minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0"/>
  </xs:sequence>
</xs:complexType>
```

# Development Approach

## 3.4.12.10 Intersection-timing-duration

### 3.4.12.10.1 DEFINITION

The measure of time in seconds that a signal indication is on.

### 3.4.12.10.2 ASN.1 REPRESENTATION

```
intersection-timing-duration ITS-DATA-ELEMENT ::= {
  DESCRIPTIVE-NAME "IntersectionSignal.Intersection-timing-duration:qty"
  ASN-NAME "Intersection-timing-duration"
  ASN-OBJECT-IDENTIFIER { tmddDataElements 137 }
  DEFINITION "The measure of time in seconds that a signal indication is on."
  DESCRIPTIVE-NAME-CONTEXT {"Manage Traffic"}
  DATA-CONCEPT-TYPE data-element
  STANDARD "TMDD"
  DATA-TYPE "
Intersection-timing-duration ::= INTEGER (0..360)
"
  FORMAT "ASN.1 encoding"
  UNIT-OF-MEASURE "tenths of a second"
  VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"
}
```

### 3.4.12.10.3 XML REPRESENTATION

```
<xs:simpleType name="Intersection-timing-duration">
  <xs:restriction base="xs:unsignedInt">
    <xs:minInclusive value="0"/>
    <xs:maxInclusive value="360"/>
  </xs:restriction>
</xs:simpleType>
```



# Requirements Traceability Matrix

- **Requirements – Design Traceability**
  - Identifies the design (dialog, message, data frames, data elements) to fulfill the interface requirements
  - Key part of the validation activity
  - Completes the traceability documentation

# Requirements Traceability Matrix

Requirement ID	Requirement Title	Dialog	Data Concept Name	DC Type	Standards Clause
3.3.5.2.1.4	Contents of the Node Inventory Request		trafficNetworkInformationRequestMsg	message	3.2.19.1
3.3.5.2.1.5	Contents of the Node Inventory Information		nodeInventoryMsg	message	3.2.14.1
3.3.5.2.1.5	Contents of the Node Inventory Information		NodeInventory	data-frame	3.3.16.1
3.3.5.2.1.5.1	Required Node Inventory Information Content		NodeInventoryList	data-frame	3.3.16.2
3.3.5.2.1.5.1	Required Node Inventory Information Content		OrganizationInformation	data-frame	3.3.17.3
3.3.5.2.1.5.1	Required Node Inventory Information Content		Transportation-network-identifier	data-element	3.4.20.1
3.3.5.2.1.5.1	Required Node Inventory Information Content		lrms:GeoLocation	data-frame	LRMS:5.14
3.3.5.2.1.5.2.1	Node Name		Transportation-network-name	data-element	3.4.21.1
3.3.5.2.1.5.2.2	Node Description		Transportation-network-name	data-element	3.4.21.1
3.3.5.2.1.5.2.3	Roadway Network Name		Transportation-network-name	data-element	3.4.21.1
3.3.5.2.1.5.2.4	Route Designator		Link-route-designator	data-element	3.4.14.29
3.3.5.2.1.5.2.5	Linear Reference		Link-location-linear-reference	data-element	3.4.14.15
3.3.5.2.1.5.2.5	Linear Reference		Link-location-linear-reference-version	data-element	3.4.14.16
3.3.5.2.1.5.2.6	Node Direction		Link-direction	data-element	3.4.14.9
3.3.5.2.1.5.2.7	Node Type		Node-type	data-element	3.4.15.3
3.3.5.2.1.5.2.8	Number of Links		Node-links-number	data-element	3.4.15.1
3.3.5.2.1.5.2.9	Owner Organization		OrganizationInformation	data-frame	3.3.17.3
3.3.5.2.1.5.2.10	Inventory Date and Time Change Information		DateTimeZone	data-frame	3.3.10.1
3.3.5.2.2.1	Send Node Status Information Upon Request	2.4.1	dINodeStatusRequest	<b>dialog</b>	3.1.14.3
3.3.5.2.2.2	Publish Node Status Information	2.4.3	dINodeStatusUpdate	<b>dialog</b>	3.1.14.4
3.3.5.2.2.3	Subscribe to Node Status Information	2.4.2	dITrafficNetworkInformationSubscription	<b>dialog</b>	3.1.19.1
3.3.5.2.2.4	Contents of the Node Status Request		trafficNetworkInformationRequestMsg	message	3.2.19.1
3.3.5.2.2.5	Contents of the Node Status Information		nodeStatusMsg	message	3.2.14.2

# Conclusion

- **Process**

- Can be applied to define, build, and test any project specific communications specification
- Structured the standard in a format that is easy for agencies and implementers to deploy because the focus is now user-centric.
- Traceability, from user needs, to requirements, and to the systems interface specification, is maintained and documented.

## Conclusion

- <http://www.ite.org/standards/tmdd>
- <http://ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf>

**THANK YOU**

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