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A207a: Building an ITS Infrastructure Based on the Advanced Transportation Controller (ATC) 5201 Standard Part 1 of 2
Instructor

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Target Audience

- Engineering Staff
- Traffic Management Center (TMC)/operations staff
- Traffic Signal Maintenance Staff
- System Developers
- Software Developers
- Private and public sector users including manufacturers
Recommended Prerequisite(s)

- I101: Using ITS Standards: An Overview
- A101: Introduction to Acquiring Standards-based ITS Systems
- A102: Introduction to User Needs Identification
- A201: Details On Acquiring Standards-based ITS Systems
- A202: Identifying and Writing User Needs When ITS Standards Do Not Have SEP Content
- A103: Introduction to ITS Standards Requirements Development
Recommended Prerequisite(s) (cont.)

- A203 Writing Requirements When ITS Standards Do Not Have SEP Content
- C101: Introduction to the Communications Protocols and Their Uses in ITS Applications
Curriculum Path (Non-SEP)

I101 Using ITS Standards: An Overview

A101 Introduction to Acquiring Standards-based ITS Systems

A102 Introduction to User Needs Identification

A201 Details on Acquiring Standards-based ITS Systems

A202 Identifying and Writing User Needs When ITS Standards Do Not Have SEP Content

A103 Introduction to ITS Standards Requirements Development

A203 Writing Requirements When ITS Standards Do Not Have SEP Content

C101 Intro. to Comm. Protocols and Their Uses in ITS Applications

A207a Building an ITS Infrastructure Based on the ATC 5201 Standard Part 1 of 2

A207b Building an ITS Infrastructure Based on the ATC 5201 Standard Part 2 of 2
Learning Objectives

1. Explain the purpose of the ATC family of standards
2. Identify the basic components and operation of transportation field cabinet systems
3. Identify the features of the ATC 5201 Standard
4. Describe the ATC 5201 architecture
5. Describe how the ATC 5201 Standard works with other ITS standards
6. Specify ATC equipment for system and equipment procurements
Learning Objective #1 – Explain the Purpose of the ATC Family of Standards

- Identify uses for transportation controllers
- Evolution of transportation controllers
- Brief overview of ATC family of standards
- Clear up misstatements in the industry
Definition of a Transportation Controller

A transportation controller (a.k.a. controller, controller unit, traffic controller) is a field-hardened computational device that runs application program(s) as part of a transportation field cabinet system.
Some of the Uses for Transportation Controllers

- Traffic Signal Control / Traffic Management
- Ramp Metering
- Data Collection
- Transit / Light Rail Priority
- Emergency Management
- Lane Use
- Access Control
- Advanced Traveler Information Systems
- Connected Vehicle Applications
  - Safety, Eco-driving, Platoon Management
Controllers as a Part of a Transportation Field Cabinet System (TFCS) for Traffic Management

Learning Objective #1

Graphics: Ralph W. Boaz
Controllers as a Part of a Transportation Field Cabinet System (TFCS) for Traffic Management

Graphics: Ralph W. Boaz
Most NTCIP Center-to-Field Standards Refer to Devices Within or Partly Within a TFCS

Graphics: Ralph W. Boaz
Field Architectures for Performing Traffic Management

Learning Objective #1

- TFCSs Under Central Control
- TFCSs in a Peer-to-Peer System
- Standalone TFCSs
- Hybrid – TFCSs in a Closed-Loop System and Under Central Control
- TFCSs in a Closed-Loop System

* Field Management Station

Graphics: Ralph W. Boaz
Evolution of Transportation Controller Equipment

- 1940s: Electro-mechanical
- 1976: NEMA TS 1 Model 3XX
- 1980s: NEMA TS 2
- 1992: TS 2 with NTCIP
- 1998: ITS Cabinet
- 2006: (Electromechanical and NEMA TS 1 excepted)

Graphics and Photos: Ralph W. Boaz
Evolution of Transportation Controller Equipment

ATC Standards to Support All Legacy TFCS Architectures

Electromechanical

1940s

1976

1980s

1992

1998

2006

NEMA TS 1

Model 3XX

NEMA TS 2

TS 2 with NTCIP

ITS Cabinet

Graphics and Photos: Ralph W. Boaz
(Electromechanical and NEMA TS 1 excepted)
Purpose of the ATC Family of Standards

- Provide a general purpose field computing platform for transportation applications that is:
  - Open architecture
  - Modular
  - Multi-process / Multi-application
  - Can grow with technology
  - Upgrade legacy TFCSs
Which of the following is NOT an application area that has been identified for ATC controller units?

**Answer Choices**

a) Emergency Management  
b) Personal Computer Backup Systems  
c) Traffic Signal Control / Traffic Management  
d) Connected Vehicle Systems
Review of answers

a) Emergency Management
   Incorrect. Emergency management has been identified as an application area supported by ATC controller units.

b) Personal Computer Backup Systems
   Correct. There are more effective alternatives for backing up personal computers.

c) Traffic Signal Control / Traffic Management
   Incorrect. ATC controller units are used to provide for traffic control and traffic management applications.

d) Connected Vehicle Systems
   Incorrect. ATC controller units will be used to support CV applications especially in the areas of intersection safety.
New ATC Document Identification Scheme

- ATC 5201 Standard
  - Advanced Transportation Controller
- ATC 5202 Standard
  - Model 2070 Controller
- ATC 5301 Standard
  - Intelligent Transportation Systems (ITS) Roadside Cabinet
- ATC 5401 Standard
  - Application Programming Interface (API)
ATC Family of Standards

ATC 5201 Standard

- Transportation Controller
- Generally, a functional standard – non-specific size/shape
- Operates in any existing TFCS architecture
- Provides minimum computational power (60 MIPS) without limiting future advancements
- Provides external interfaces
- Uses Linux operating system
- Multi-process / Multi-application
ATC Family of Standards (cont.)

ATC 5202 Model 2070 Standard

- Transportation Controller
- Originally developed as a Model 170 controller replacement
- Prescriptive in size, shape, thumb screws, etc.
- Slide in modules for numerous options
- National Model 2070 Standard only has a selected set of the most common options
- Old CPU and operating system
  - Some agencies have added selected ATC 5201 concepts into their Model 2070 specifications
ATC Family of Standards (cont.)

ATC 5301 ITS Cabinet Standard

- Transportation Field Cabinet System (TFCS)
- Uses strengths from rack mount systems and serial cabinets
  - Rack mount assemblies secured in place
  - Serial cabinets have fewer wires and more capability
- Each assembly relocatable within the rack
- Higher speed serial communications bus
- Designed for ease of maintenance
ATC Family of Standards (cont.)

ATC 5401 Application Programming Interface (API) Standard

- Defines a software environment for both application programs and user interfaces for an ATC 5201 controller
- Allows application programs from different vendors to run concurrently on a controller
- Concurrent application programs share the input/output resources of the cabinet system
- Concurrent application programs share the front panel of the controller
# ATC Standards and Status

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<tr>
<th>Document Identifier</th>
<th>Abbreviated Title</th>
<th>Version</th>
<th>Date</th>
<th>Status</th>
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<td>06</td>
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<td>User Comment Draft July 2012</td>
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<td>Published</td>
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<td>Dec 2012</td>
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# Systems Engineering (SE) Content

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<td>Describes “Representative Usage” from a users perspective but no formal SE process information.</td>
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<td>ITS Roadside Cabinet</td>
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<td>Using formal SE process and content. Standard development in progress.</td>
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# Where to Find the ATC Standards

<table>
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<th>Document Identifier</th>
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<td><a href="http://www.ite.org/standards/atcapiversion2.asp">http://www.ite.org/standards/atcapiversion2.asp</a></td>
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Clearing Up Misstatements

- All standards listed on the previous slide are a part of the family of ATC Standards

- “Engine Board” portion of the ATC 5.2b Standard has been used in some Model 2070 controller units
  - Special provisions are required, see Module A207b

- No current Model 2070 standard or specification fully conforms to ATC 5201 v06 or ATC 5.2b

- Get written confirmation that the product is ATC 5201 v06 or ATC 5.2b conformant
Which of the following is not in the ATC family of standards?

Answer Choices

a) Application Programming Interface Standard
b) ITS Roadside Cabinet Standard
c) Model 170 Standard
d) Advanced Transportation Controller Standard
Review of answers

a) Application Programming Interface Standard

Incorrect. ATC 5401 allows application programs to share resources of the controller unit.

b) ITS Roadside Cabinet Standard

Incorrect. ATC 5301 design uses strengths from both rack mount and serial cabinets.

c) Model 170 Standard

Correct. Model 170 is not in the ATC family. It was a specification developed by the states of CA and NY.

d) Advanced Transportation Controller Standard

Incorrect. ATC 5201 provides a functional standard for a transportation controller that can grow with technology.
Specifying an ATC 5202 Model 2070 controller unit guarantees conformance with the ATC 5201 Standard

Answer Choices

a) True
b) False
Review of answers

a) True

Incorrect. There is currently no Model 2070 standard that is fully conformant with the ATC 5201 Standard.

b) False

Correct. Specifying a Model 2070 does not guarantee conformance. Users must make special provisions to conform to the ATC 5201 Standard if using a Model 2070 controller.
Summary of Learning Objective #1

Explain the Purpose of the ATC Family of Standards

- Identify uses for Transportation Controllers
- Evolution of Transportation Controllers
- Brief overview of ATC family of standards
- Clear up misstatements in the industry
Learning Objective #2 – Identify the Basic Components and Operation of Transportation Field Cabinet Systems

- Traffic terminology
- Basic transportation field cabinet components
- Differences in transportation field cabinet systems
Traffic Terminology

Detection Zone

- An area in which traffic parameters can be measured and/or traffic data can be generated

Vehicle Phase or Phase

- Any combination of traffic movements receiving right-of-way simultaneously during one or more intervals (green, yellow, red)
Traffic Terminology

Detection Zone

Graphics: Ralph W. Boaz
Traffic Terminology

Vehicle Phases

Graphics: Ralph W. Boaz
Basic Transportation Field Cabinet System Components

Graphics: Ralph W. Boaz

Learning Objective #2
Inputs

- On/Off states of the detection zones reported through “detectors” housed in a “detector rack,” “input assembly” or “input file”

- Many different sensing technologies used
  - Inductive loops
  - Video
  - Radar
  - Many others
Inputs (cont.)

NEMA TS 2 Cabinet

ITS Cabinet v01

Photos: Ralph W. Boaz
Controller

- Field hardened computer to run the traffic control application program
- Detection zones associated with phases within the controller
- Receives inputs from detectors
- Determines how to safely provide service to vehicles
- Sends field display states to load switches (switch packs) and signal monitor
Controller (cont.)

NEMA TS 2 Cabinet

ITS Cabinet v01

Graphics: Ralph W. Boaz
Outsputs

- Load switches (switch packs) receive the field display states (red, yellow and greens) from the controller
- Load switches control 110 VAC to the signal heads
- May be plugged directly into a “cabinet back panel,” “load bay” or “terminal and facilities area”; or housed in an “output assembly” or “output file”
Outputs (cont.)

NEMA TS 2 Cabinet

ITS Cabinet v01

Graphics: Ralph W. Boaz
Monitoring (Signal Monitoring)

- Monitors outputs against a separate programmable device to insure that the combination of displays is allowable and safe
- Insures that the controller is operating
- Insures internal cabinet and output voltages are within allowable parameters
- Many additional features for more advanced monitors
- If problem detected, puts intersection into a flash condition
- Called a Malfunction Management Unit (MMU), Cabinet Monitor Unit (CMU), Conflict Monitor Unit (CMU), Signal Monitor Unit (SMU)
Monitoring (Signal Monitoring) (cont.)

NEMA TS 2 Cabinet

ITS Cabinet v01

Graphics: Ralph W. Boaz
Basic Transportation Field Cabinet System Operation

- **Inputs**
- **Controller**
- **Outputs**
- **Monitoring**

Controller/Monitor Communications Used in NEMA TS 2 and ITS Cabinets

Field Sensors

Field Displays

Graphics: Ralph W. Boaz
# Differences in TFCSs

<table>
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<tr>
<th>TFCS</th>
<th>Physical Mounting</th>
<th>Internal Bus</th>
<th>Signal Monitor</th>
<th>Input Channels</th>
<th>Monitored Output Channels</th>
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<tr>
<td>NEMA TS 1</td>
<td>Shelf</td>
<td>Parallel / Discrete Wiring</td>
<td>Conflict Monitor</td>
<td>8</td>
<td>3/6/12/18</td>
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<tr>
<td>Caltrans Model 33X</td>
<td>Rack</td>
<td>Parallel / Discrete Wiring</td>
<td>Conflict Monitor</td>
<td>44</td>
<td>16/18</td>
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<td>NEMA TS 2</td>
<td>Shelf</td>
<td>Serial 153.6 kbps</td>
<td>Malfunction Management Unit</td>
<td>64</td>
<td>16</td>
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<td>ITS Cabinet v01</td>
<td>Rack</td>
<td>Serial 614.4 kbps</td>
<td>Cabinet Monitor Unit</td>
<td>120</td>
<td>28</td>
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</table>
Which element of a TFCS determines the sequence of traffic movements to provide service to a vehicle?

Answer Choices

a) Inputs  
b) Controller  
c) Outputs  
d) Monitoring
Review of answers

a) Inputs
Incorrect. Inputs refer to detection zone information.

b) Controller
Correct. The controller runs the operational program, which includes the traffic signal software.

c) Outputs
Incorrect. Outputs refer to load switches, which provide power for the appropriate indications on the field displays.

d) Monitoring
Incorrect. Monitoring verifies that the state of the field displays do not present an unsafe condition.
Summary of Learning Objective #2

Identify the Basic Components and Operation of Transportation Field Cabinet Systems

- Traffic terminology
- Basic transportation field cabinet components
- Differences in transportation field cabinet systems
What We Have Learned

1. There are various standards and specifications for Transportation **Field Cabinet** Systems in use today.

2. The basic components of TFCSs are: **Inputs**, **Controller**, **Outputs**, and **Monitoring**.

3. The ATC 5201 Standard can be used to specify ATC controller units that can operate in **any** major TFCS.
Resources

- *Caltrans Transportation Electrical Equipment Specifications (TEES), March 12, 2009*

- *Intelligent Transportation System (ITS) Standard Specification for Roadside Cabinets v01.02.17b*

- *NEMA Standards Publication TS 1-1989 Traffic Control Systems*

- *NEMA Standards Publication TS 2-2003 v02.06 Traffic Controller Assemblies with NTCIP Requirements*

- *ITS PCB Training*
  
  [www.pcb.its.dot.gov](http://www.pcb.its.dot.gov)
QUESTIONS?
Next Course Module

A207b: Building an ITS infrastructure based on the ATC 5201 Standard Part 2 of 2

3. Identify the features of the ATC 5201 Standard
4. Describe the ATC 5201 Architecture
5. Describe how the ATC 5201 Standard works with other ITS standards
6. Specify ATC equipment for system and equipment procurements