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ACTIVITY
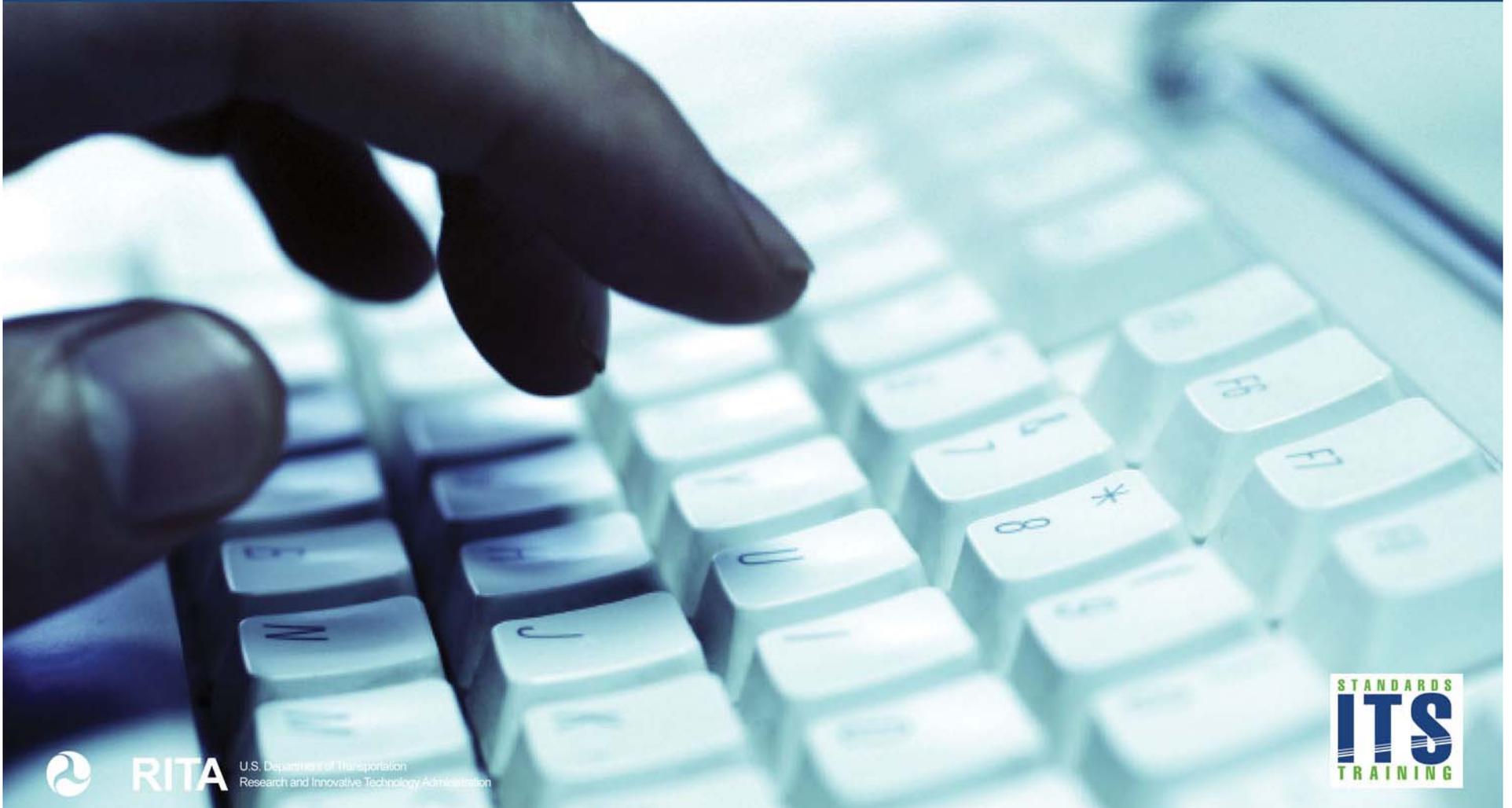
A207a:

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

Instructor

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President
Pillar Consulting, Inc.
San Diego, CA, USA

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)

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┌──────────────────┐     ┌──────────────────┐     ┌──────────────────┐
│ I101             │     │ A101             │     │ A102             │
│ Using ITS        │ ──> │ Introduction to  │ ──> │ Introduction to  │
│ Standards:       │     │ Acquiring        │     │ User Needs       │
│ An Overview      │     │ Standards-based  │     │ Identification   │
│                  │     │ ITS Systems      │     │                  │
└──────────────────┘     └──────────────────┘     └──────────────────┘

┌──────────────────┐     ┌──────────────────┐     ┌──────────────────┐
│ A201             │     │ A202             │     │ A103             │
│ Details on       │ ──> │ Identifying and  │ ──> │ Introduction to  │
│ Acquiring        │     │ Writing User     │     │ ITS Standards    │
│ Standards-based  │     │ Needs When ITS   │     │ Requirements     │
│ ITS Systems      │     │ Standards Do Not │     │ Development      │
│                  │     │ Have SEP Content │     │                  │
└──────────────────┘     └──────────────────┘     └──────────────────┘

┌──────────────────┐     ┌──────────────────┐     ┌──────────────────┐
│ A203             │     │ C101             │     │ A207a            │
│ Writing          │ ──> │ Intro. to Comm.  │ ──> │ Building an ITS  │
│ Requirements     │     │ Protocols and    │     │ Infrastructure   │
│ When ITS         │     │ Their Uses in    │     │ Based on the     │
│ Standards Do Not │     │ ITS Applications │     │ ATC 5201         │
│ Have SEP Content │     │                  │     │ Standard Part    │
│                  │     │                  │     │ 1 of 2           │
└──────────────────┘     └──────────────────┘     └──────────────────┘

┌──────────────────┐
│ A207b            │
│ Building an ITS  │
│ Infrastructure   │
│ Based on the     │
│ ATC 5201         │
│ Standard Part    │
│ 2 of 2           │
└──────────────────┘
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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
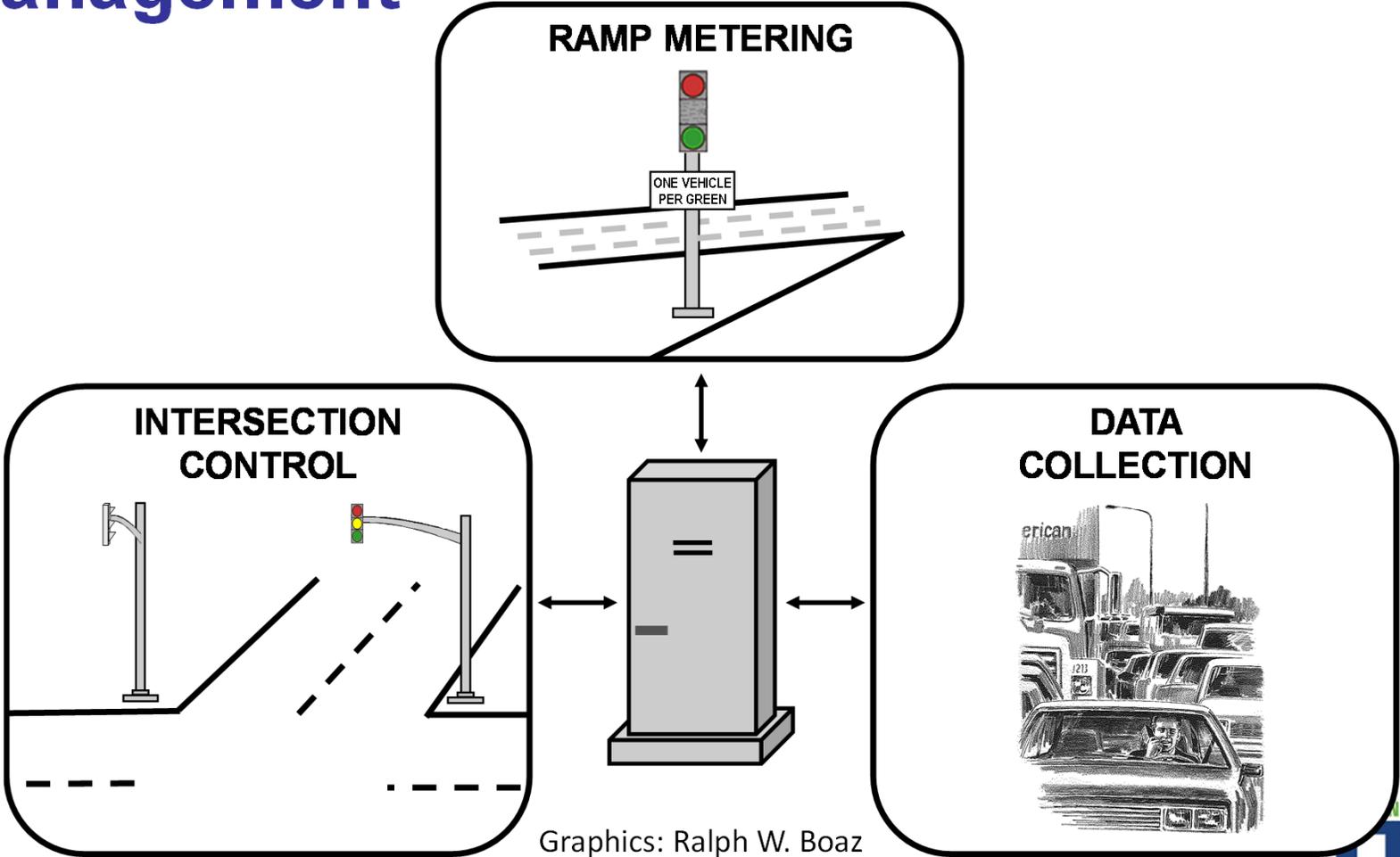
Graphics: Ralph W. Boaz

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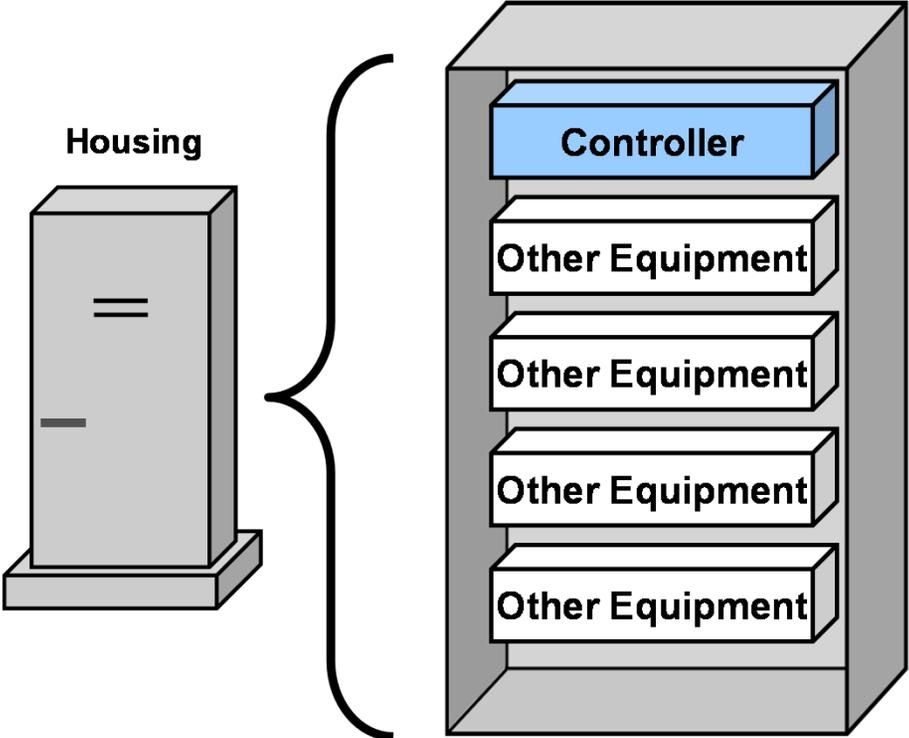
Graphics: Ralph W. Boaz

Most NTCIP Center-to-Field Standards Refer to Devices Within or Partly Within a TFCS

NTCIP Communications

NTCIP 1202 ASC
NTCIP 1203 DMS
NTCIP 1204 ESS
NTCIP 1205 CCTV
NTCIP 1206 DCM
NTCIP 1207 RMC
NTCIP 1209 TSS
NTCIP 1210 FMS
NTCIP 1211 SCP
NTICP 1213 ELMS

Controller

Other Equipment

Other Equipment

Other Equipment

Other Equipment
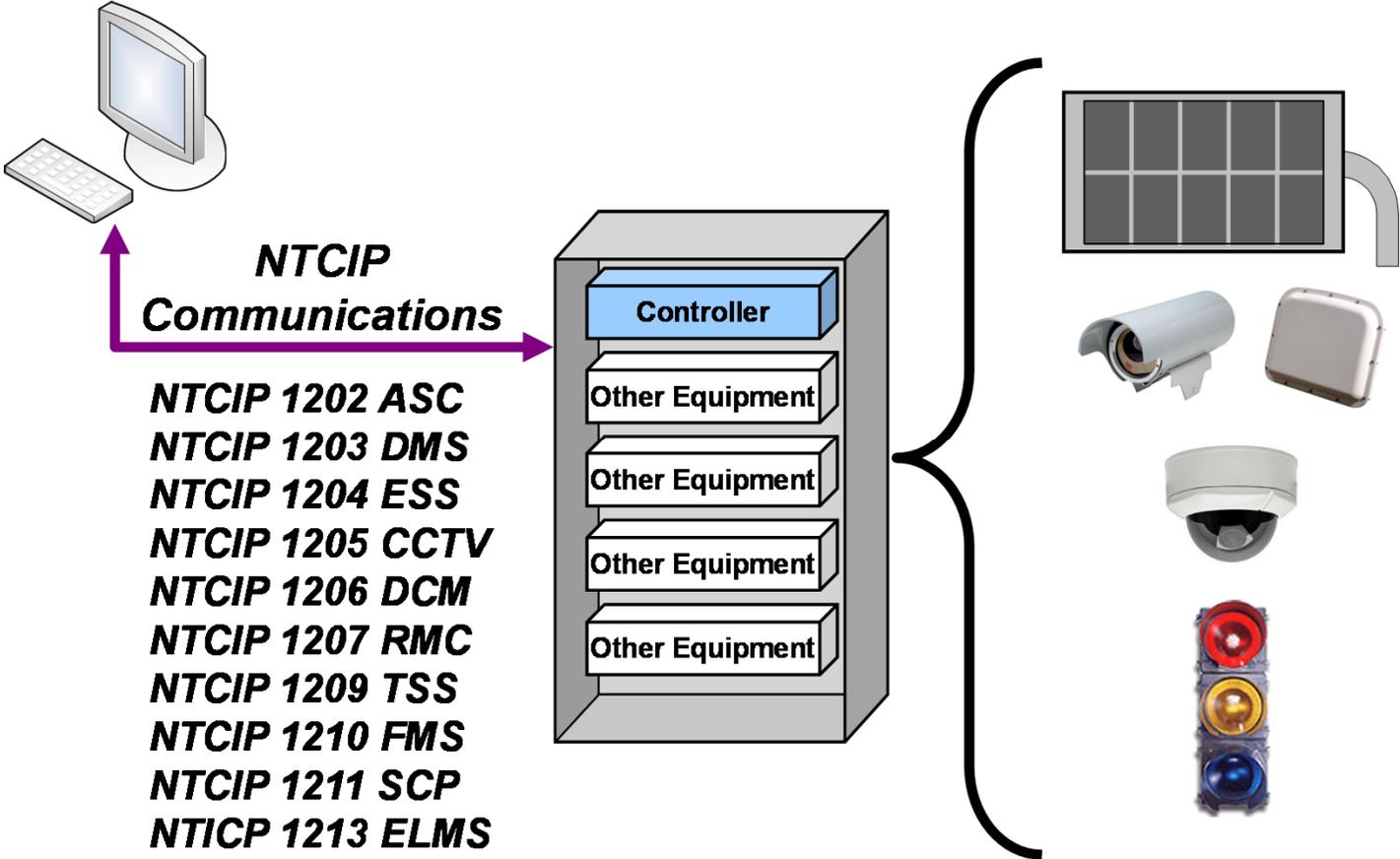
Graphics: Ralph W. Boaz

Field Architectures for Performing Traffic Management

TFCSs Under Central Control   **TFCSs in a Peer-to-Peer System**

Standalone TFCSs

FMS*

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

FMS*

TFCSs in a Closed-Loop System
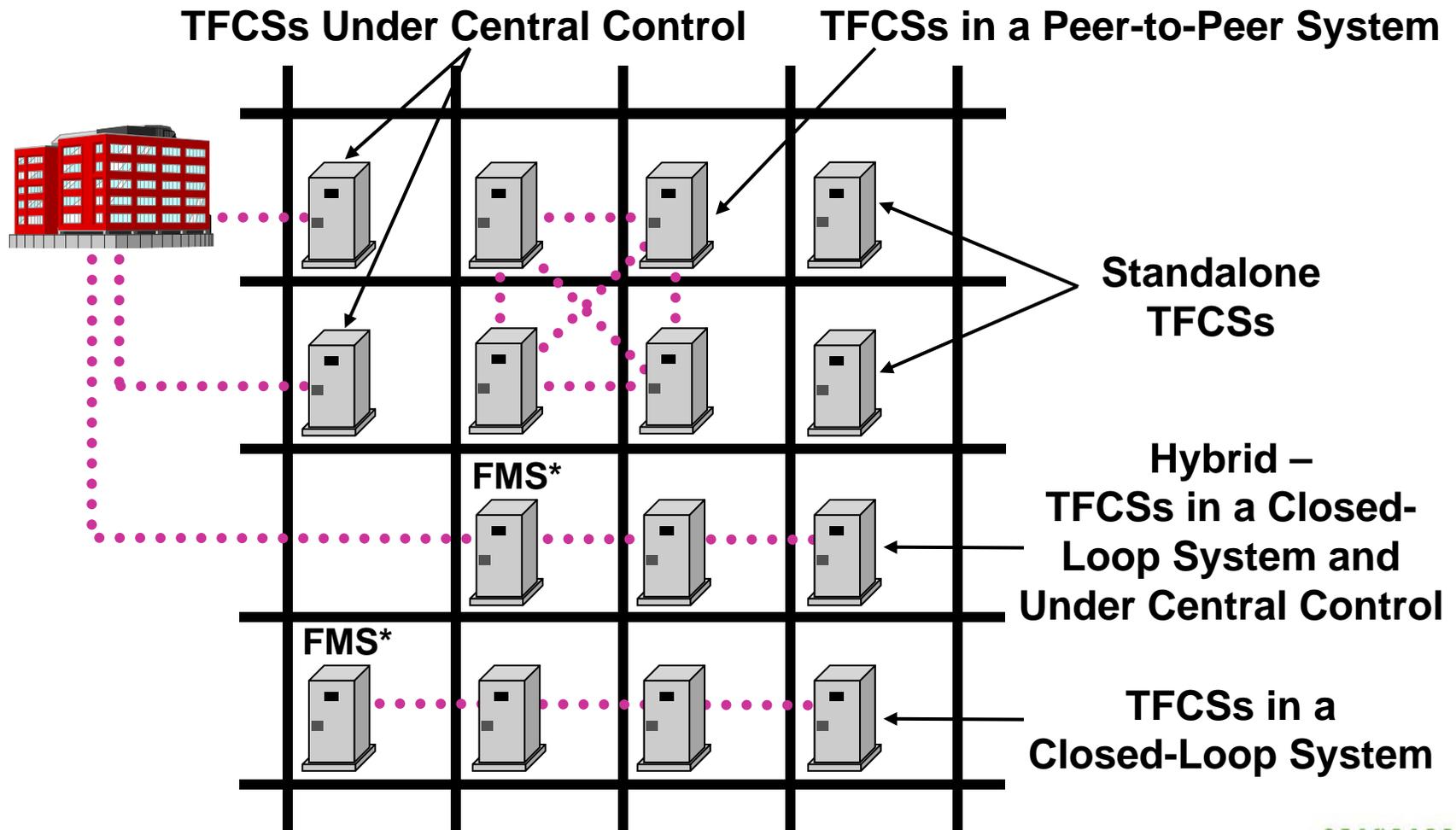
* Field Management Station

Graphics: Ralph W. Boaz

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Evolution of Transportation Controller Equipment

ITS Cabinet

NEMA TS 2 | **TS 2 with NTCIP**

NEMA TS 1 | **Model 3XX**

Electro-mechanical

| 1940s | 1976 | 1980s | 1992 | 1998 | 2006 |
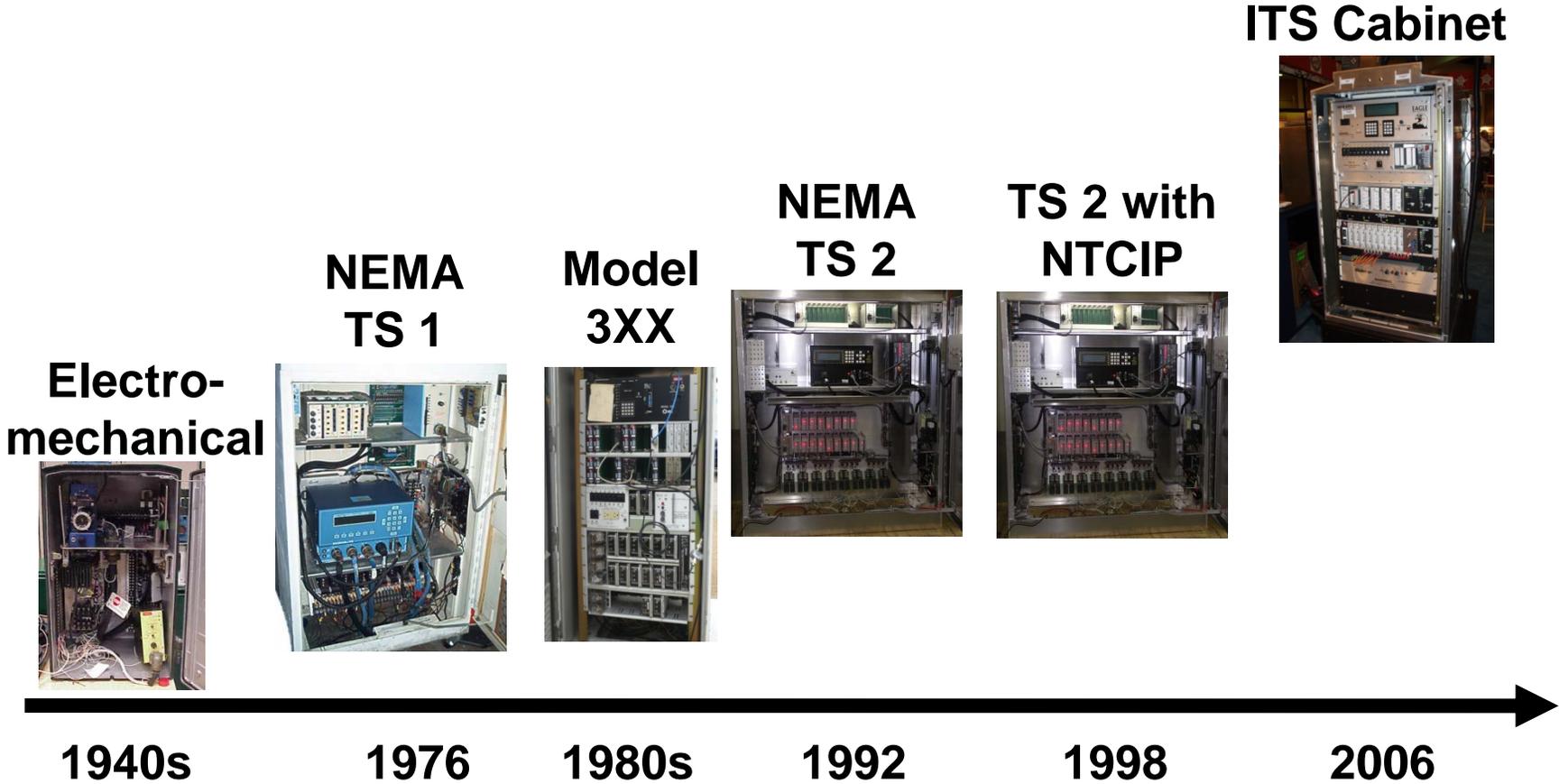
Graphics and Photos: Ralph W. Boaz   (Electromechanical and NEMA TS 1 excepted)

Evolution of Transportation Controller Equipment

ATC Standards to Support All Legacy TFCS Architectures

ITS Cabinet

Electro-mechanical

NEMA TS 1

Model 3XX

NEMA TS 2

TS 2 with NTCIP

| 1940s | 1976 | 1980s | 1992 | 1998 | 2006 |

Graphics and Photos: Ralph W. Boaz   (Electromechanical and NEMA TS 1 excepted)

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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

ACTIVITY
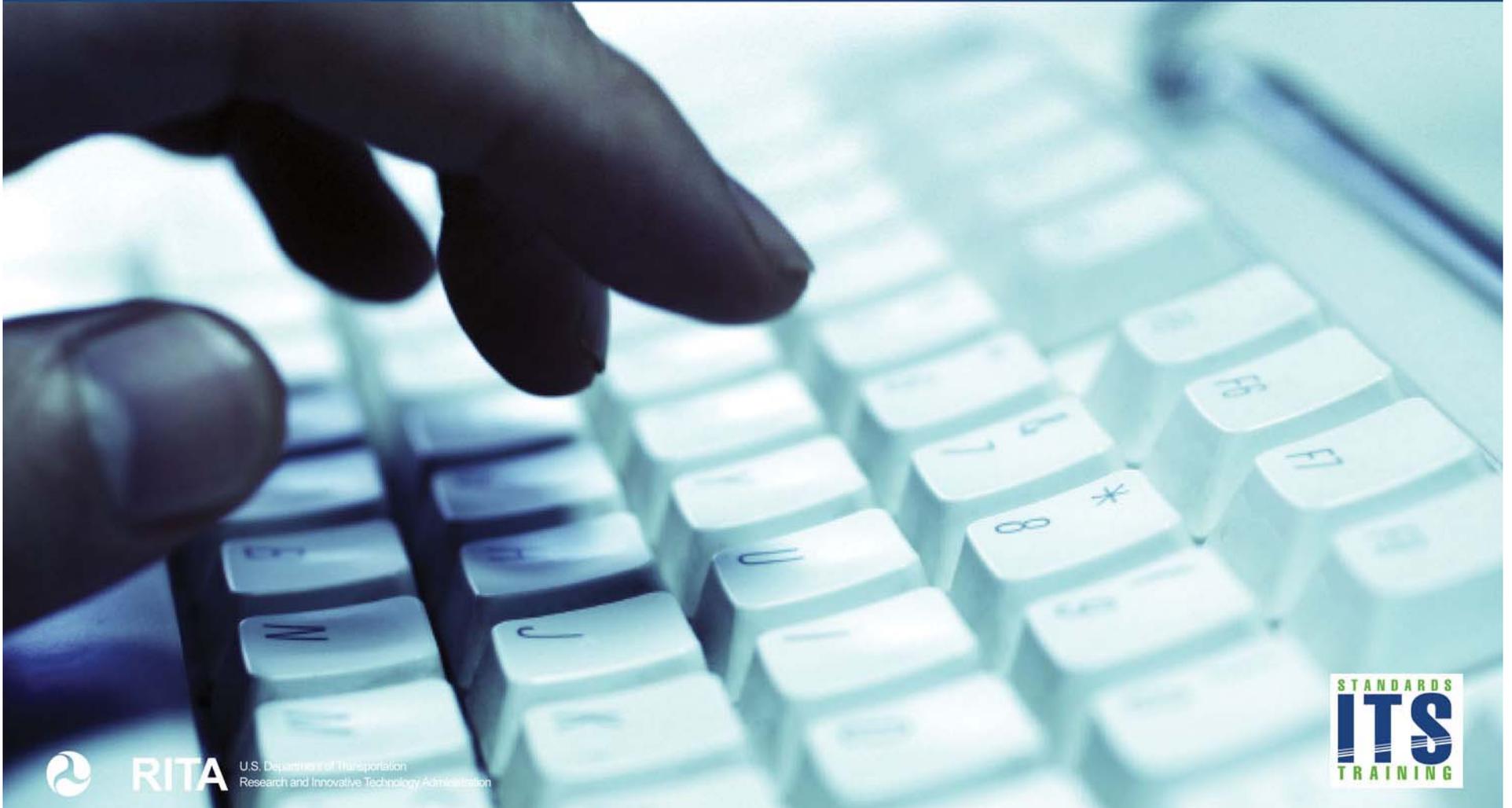
Which of the following is NOT an application area that has been identified for ATC controller units?

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

Document Identifier	Abbreviated Title	Ver-sion	Date	Status
ATC 5201	Advanced Transportation Controller (ATC)	06	In Progress	User Comment Draft July 2012
	Advanced Transportation Controller (ATC)	05	Sept 2006	Published
ATC 5202	Model 2070 Controller	03	Dec 2012	Published
ATC 5301	ITS Roadside Cabinet	02	In Progress	Under Development
	ITS Roadside Cabinet	01	Nov 2006	Published
ATC 5401	Application Programming Interface (API)	02	Sept 2011	Published

Systems Engineering (SE) Content

Document Identifier	Abbreviated Title	Ver-sion	System Engineering (SE) Content
ATC 5201	Advanced Transportation Controller (ATC)	06	Update of v05. No formal SE process information. Standard development in progress.
	Advanced Transportation Controller (ATC)	05	Describes "Representative Usage" from a users perspective but no formal SE process information.
ATC 5202	Model 2070 Controller	03	No formal SE process information.
ATC 5301	ITS Roadside Cabinet	02	Using formal SE process and content. Standard development in progress.
	ITS Roadside Cabinet	01	No SE content.
ATC 5401	Application Programming Interface (API)	02	Developed using formal SE process and content.

Where to Find the ATC Standards

| Document Identifier	Abbreviated Title	Ver-sion	URL
ATC 5201	Advanced Transportation Controller (ATC)	06	http://www.ite.org/standards/ATCcontroller/
	Advanced Transportation Controller (ATC)	05	http://www.ite.org/standards/ATCcontroller/
ATC 5202	Model 2070 Controller	03	http://www.ite.org/standards/atc2070/default.asp
ATC 5301	ITS Roadside Cabinet	02	http://www.ite.org/standards/ITScabinet/v2.0.asp
	ITS Roadside Cabinet	01	http://www.ite.org/standards/ITScabinet/v01.02.17b.asp
ATC 5401	Application Programming Interface (API)	02	http://www.ite.org/standards/atcapi/version2.asp

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

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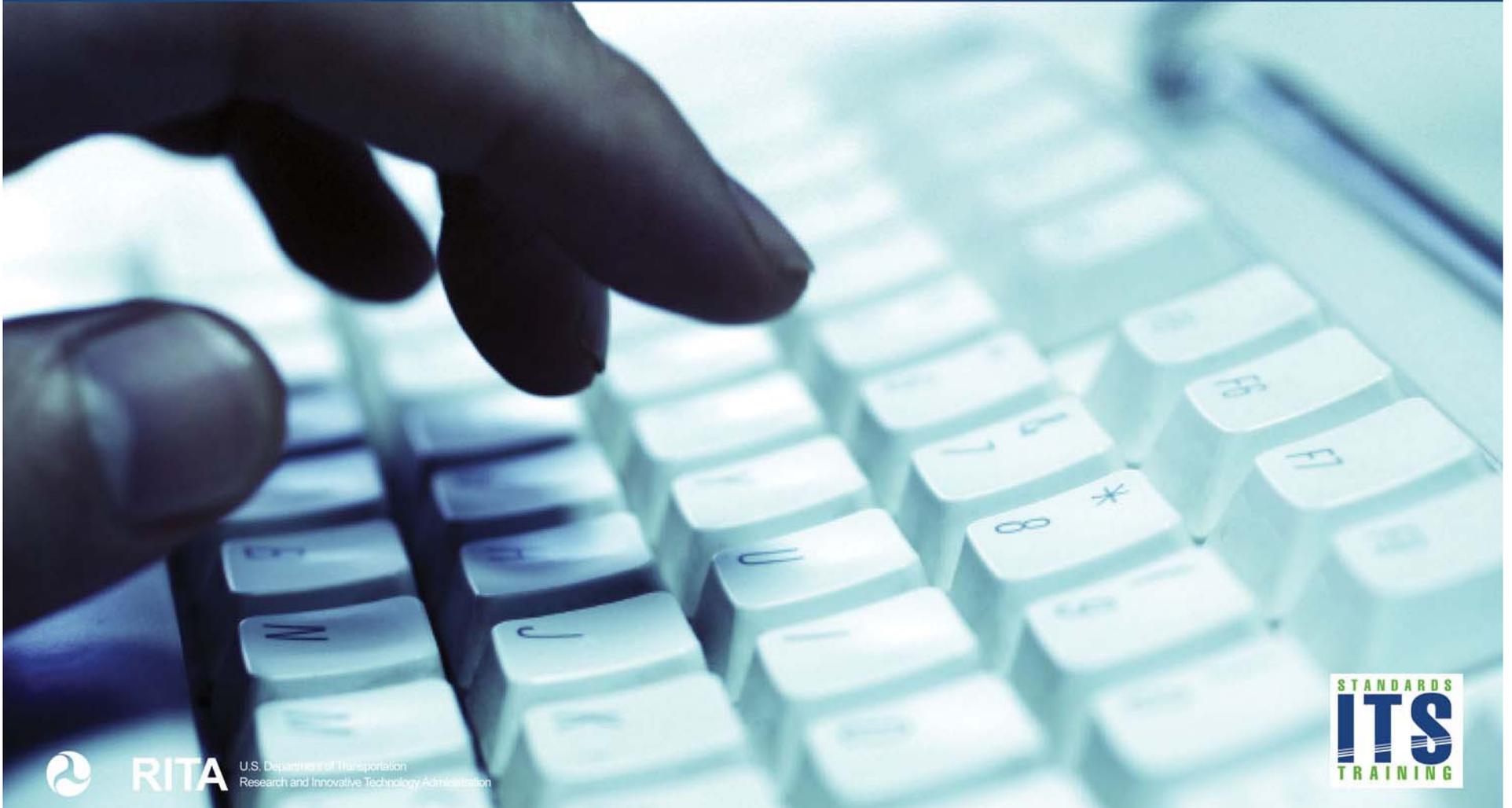
Which of the following is not in the ATC family of standards?

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.

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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

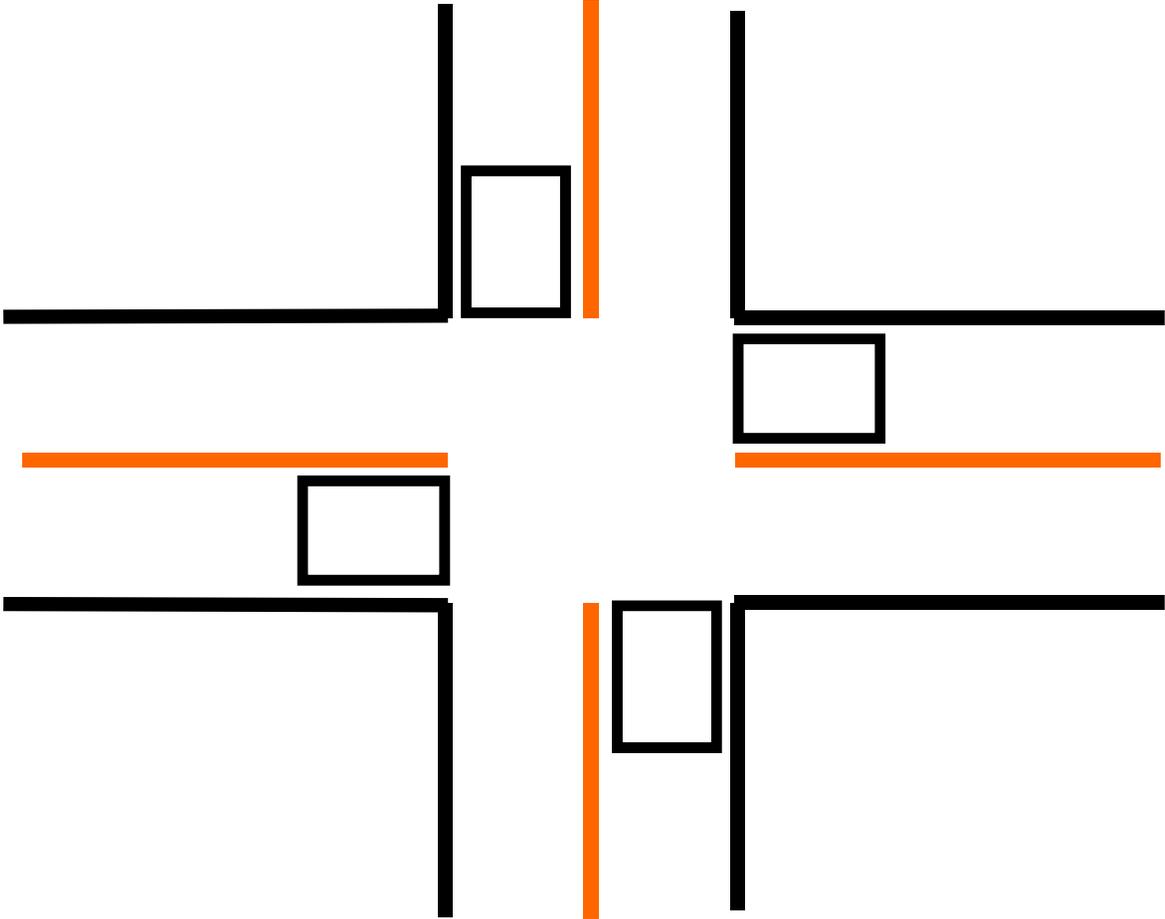- An area in which traffic parameters can be measured and/or traffic data can be generated

Vehicle Phase or Phase

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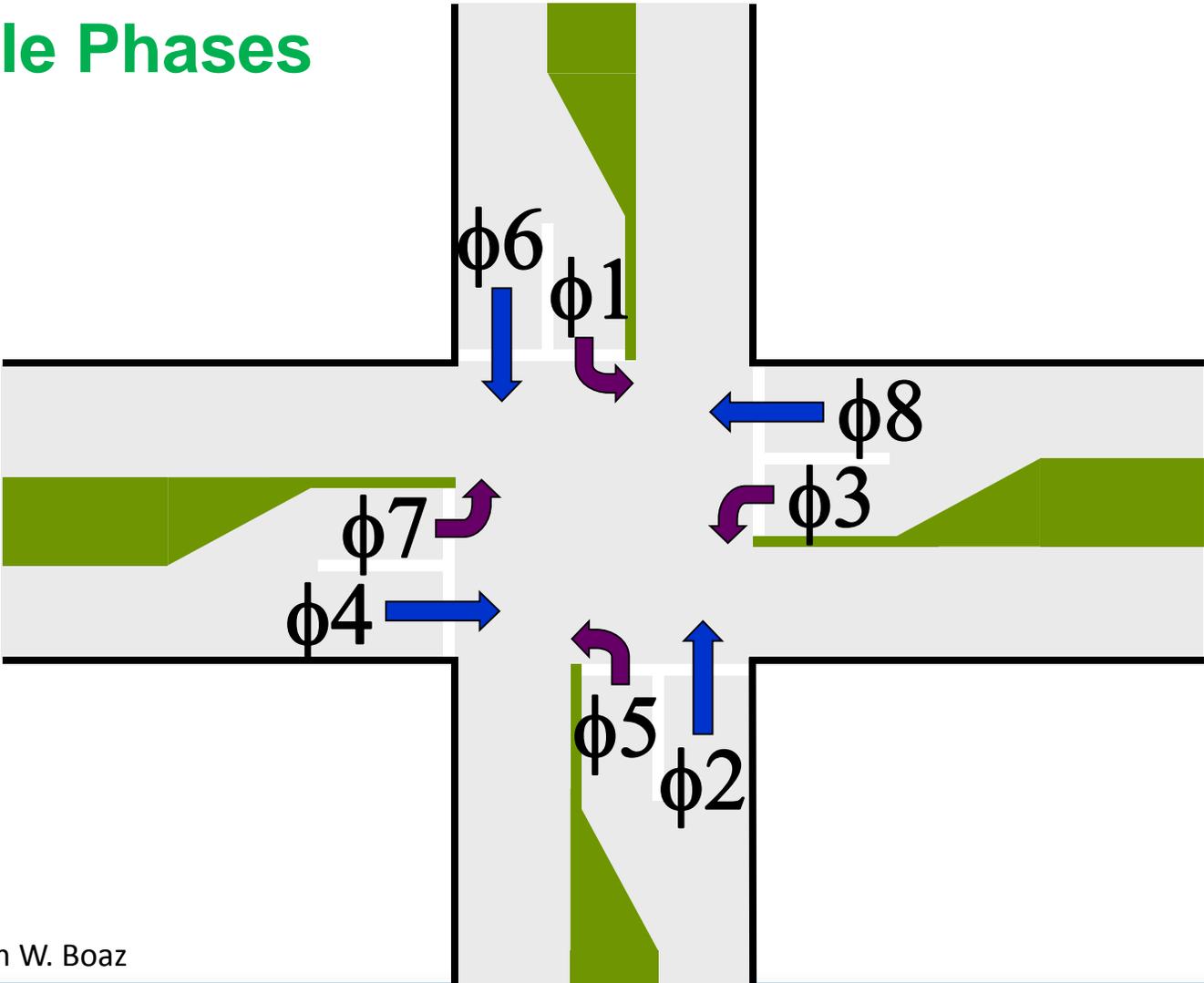
Traffic Terminology

Detection Zone
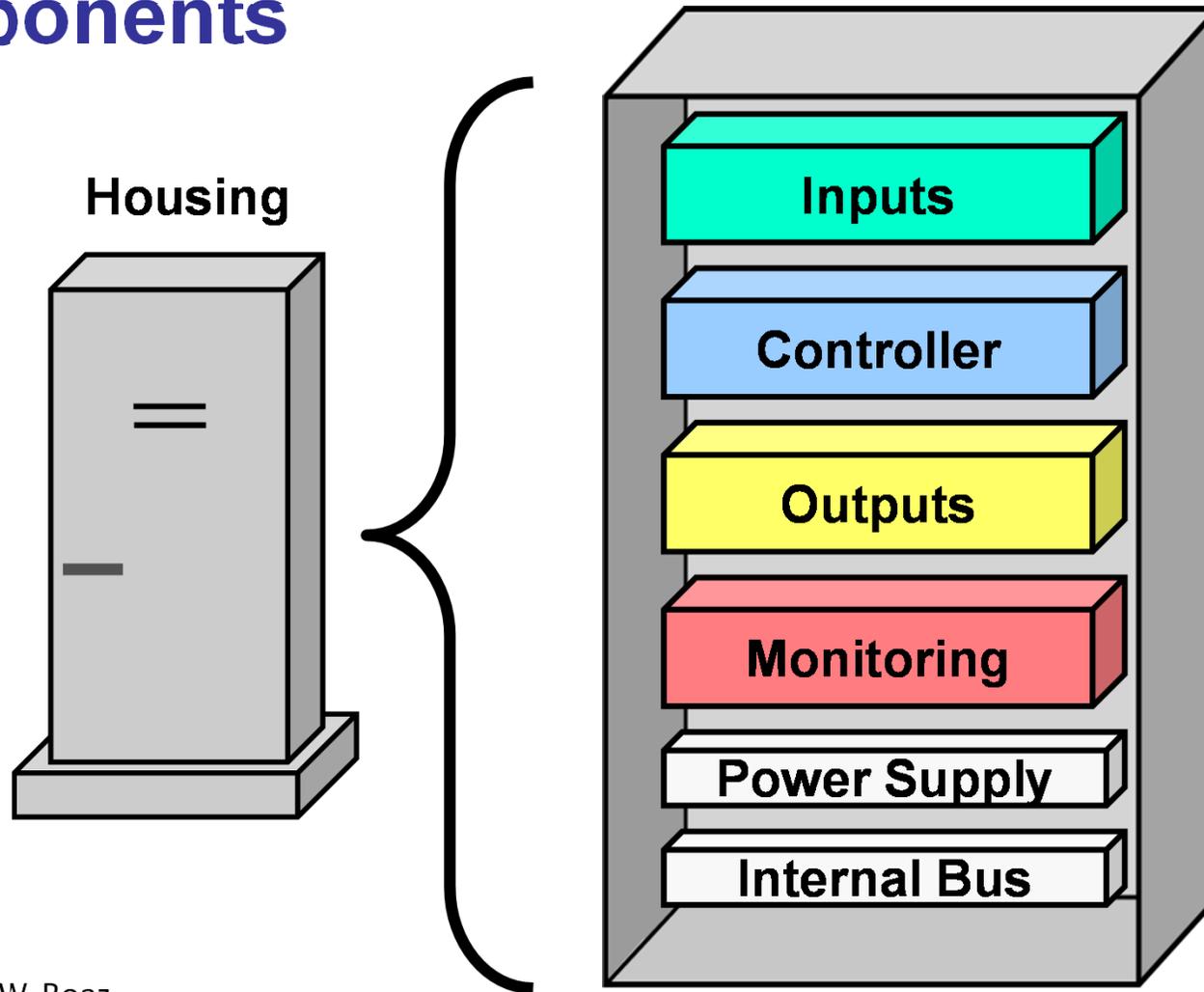

Graphics: Ralph W. Boaz

Traffic Terminology

Vehicle Phases

Graphics: Ralph W. Boaz

# Basic Transportation Field Cabinet System Components

Housing

Inputs

Controller

Outputs

Monitoring

Power Supply

Internal Bus

Graphics: Ralph W. Boaz

STANDARDS ITS TRAINING

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.)
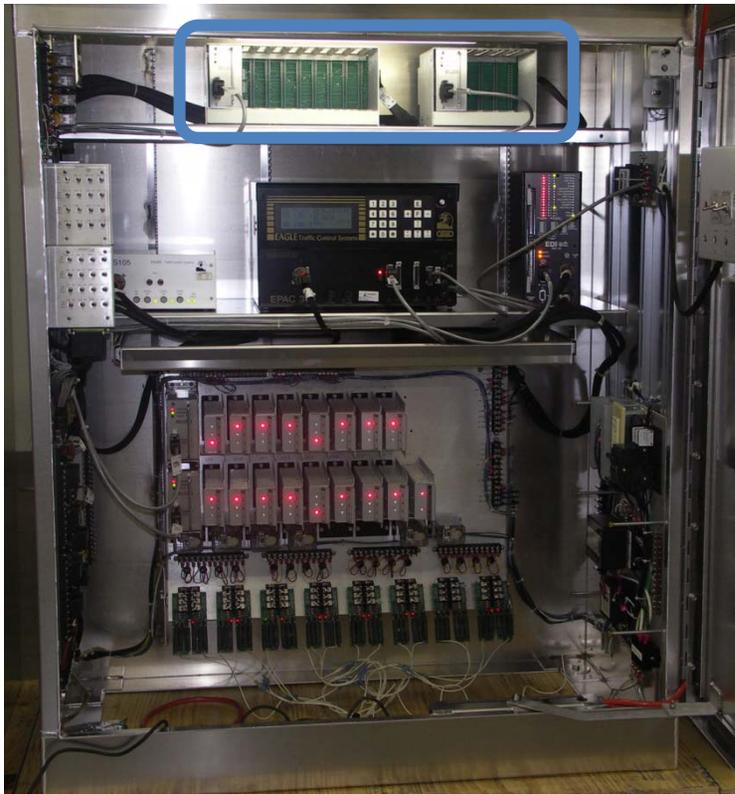
NEMA TS 2 Cabinet

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.)

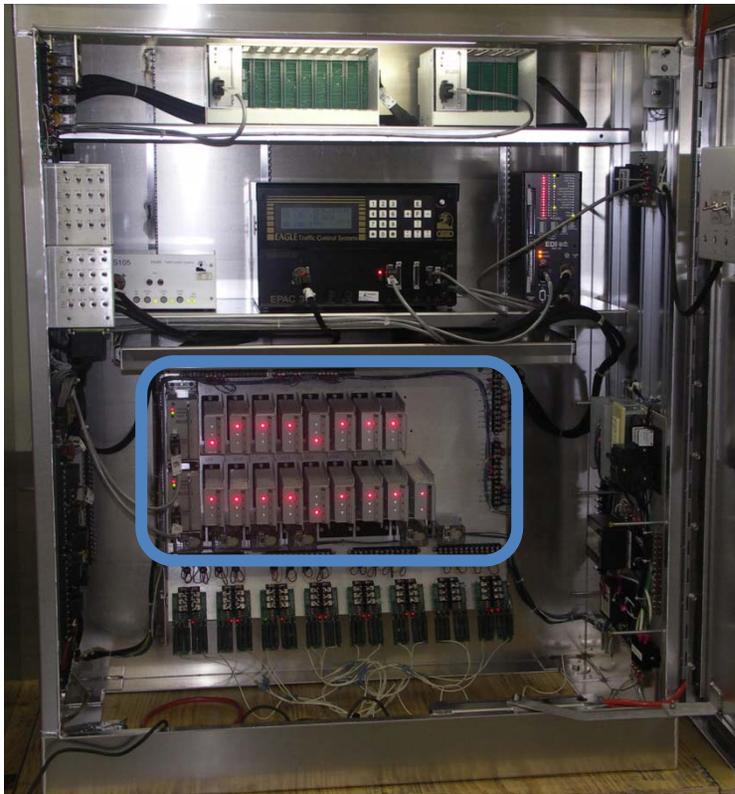**NEMA TS 2 Cabinet**

ITS Cabinet v01

Graphics: Ralph W. Boaz

Outputs

- 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

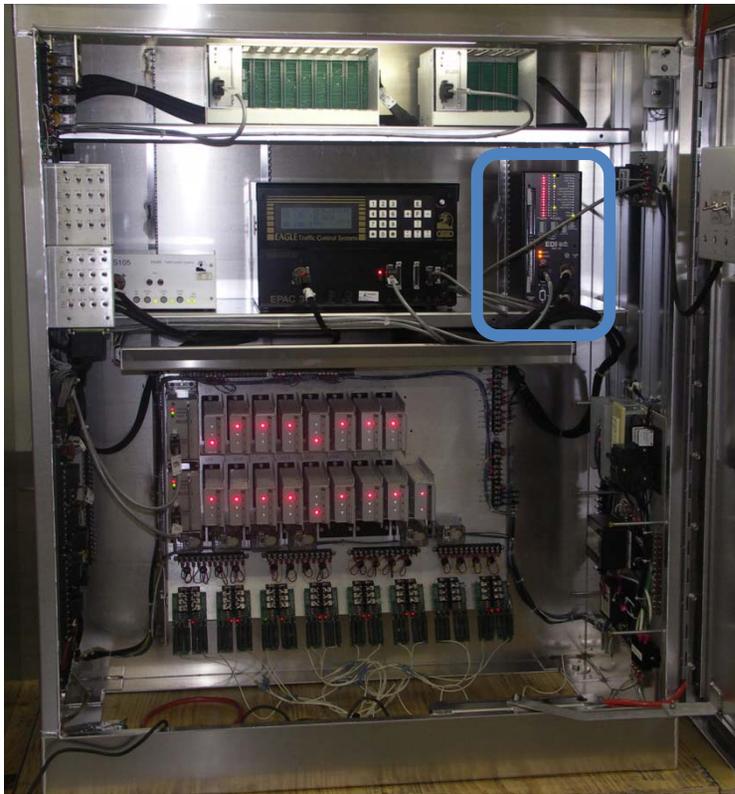**ITS Cabinet v01**

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)
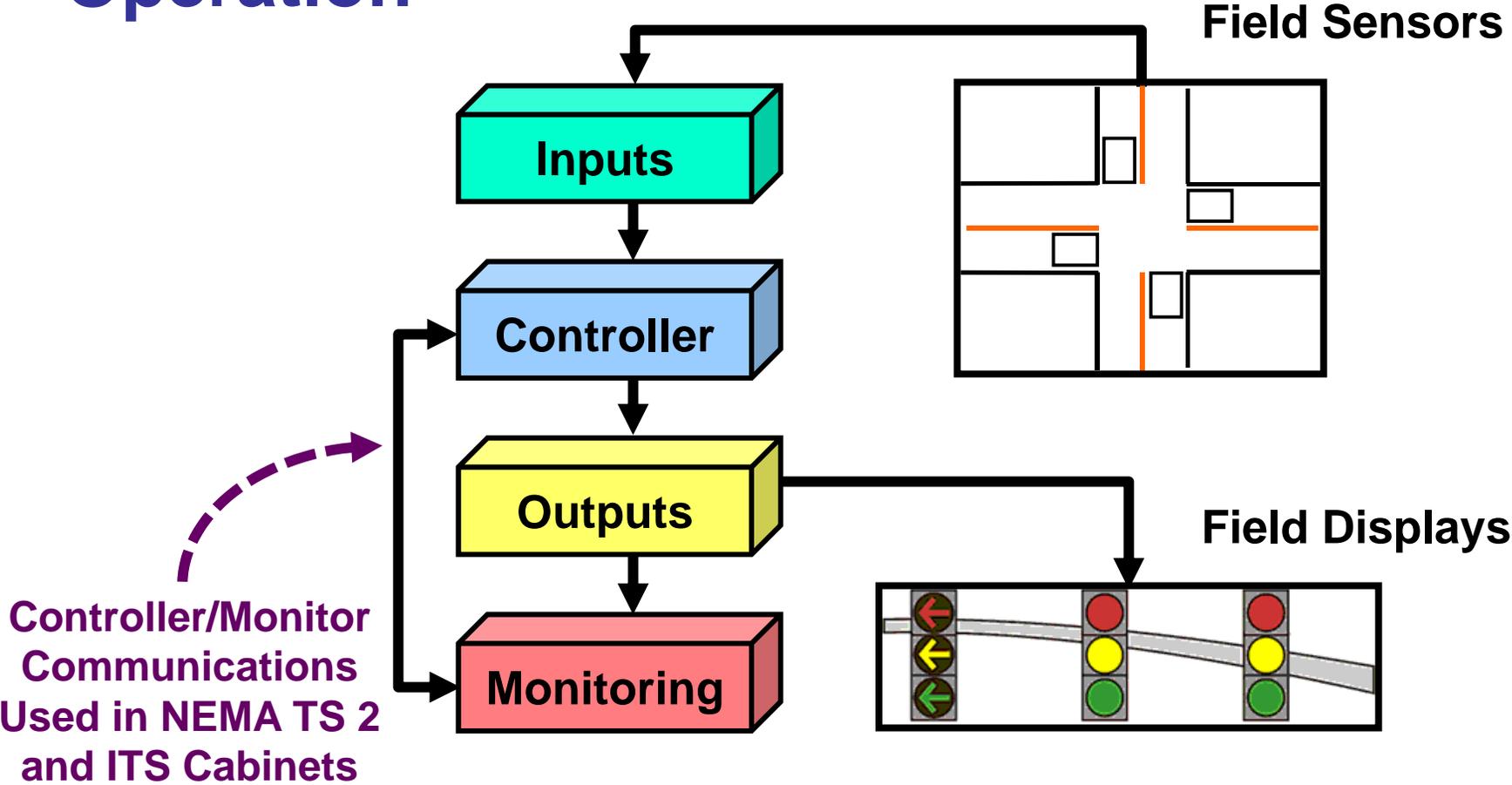
Monitoring
(Signal Monitoring) (cont.)

NEMA TS 2 Cabinet

ITS Cabinet v01

Graphics: Ralph W. Boaz

# Basic Transportation Field Cabinet System Operation

Field Sensors

Inputs

Controller

Outputs

Monitoring

Field Displays

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

Graphics: Ralph W. Boaz

Differences in TFCSs

TFCS	Physical Mounting	Internal Bus	Signal Monitor	Input Channels	Monitored Output Channels
NEMA TS 1	Shelf	Parallel / Discrete Wiring	Conflict Monitor	8	3/6/12/18
Caltrans Model 33X	Rack	Parallel / Discrete Wiring	Conflict Monitor	44	16/18
NEMA TS 2	Shelf	Serial 153.6 kbps	Malfunction Management Unit	64	16
ITS Cabinet v01	Rack	Serial 614.4 kbps	Cabinet Monitor Unit	120	28

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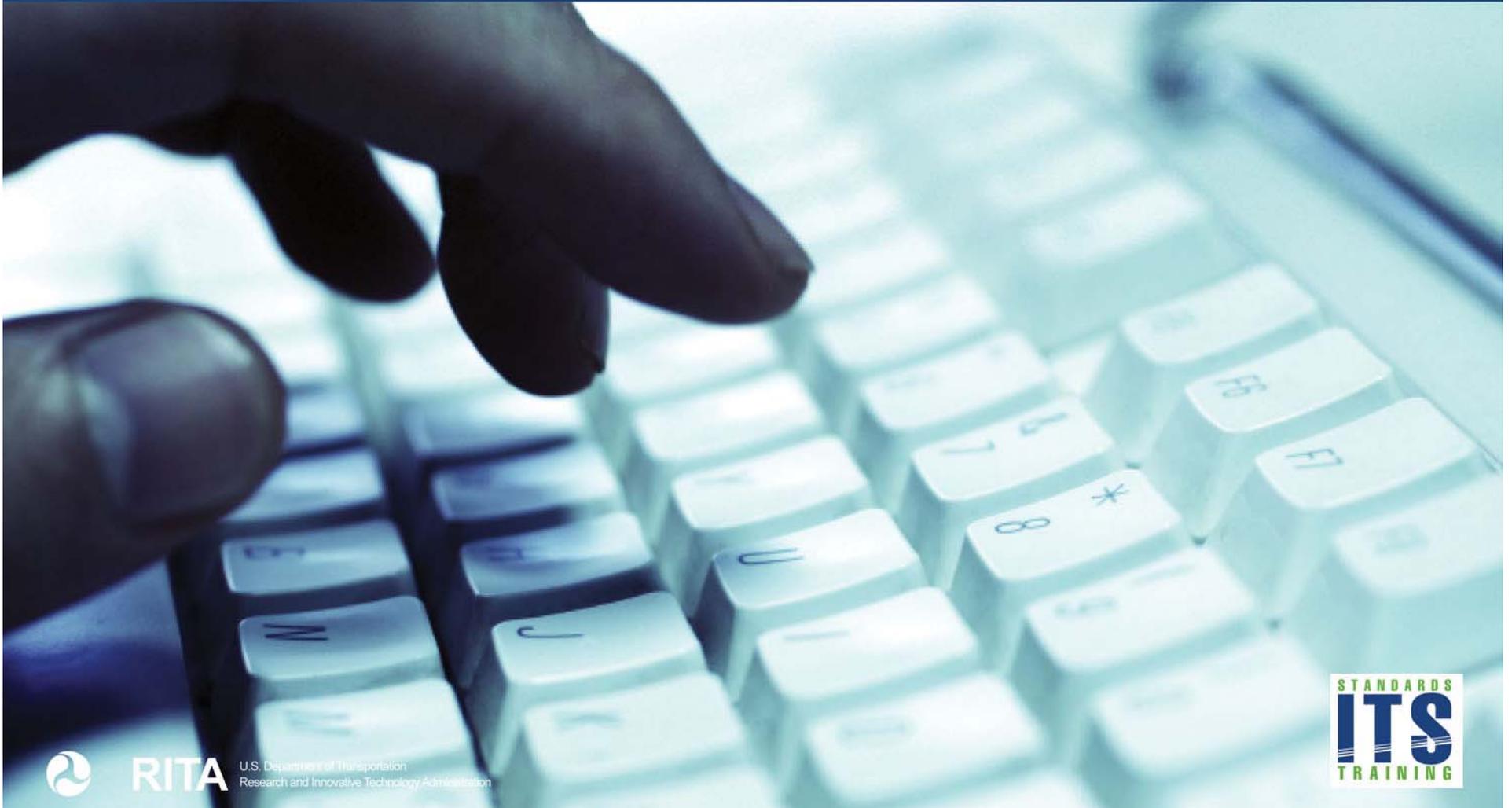
STANDARDS ITS TRAINING

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

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