

A208: Using the ATC 5401 Application Programming Interface (API) Standard to Leverage ITS Infrastructures



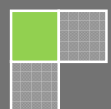
RITA Intelligent Transportation Systems
Joint Program Office



A208: Using the ATC 5401 Application Programming Interface Standard to Leverage ITS Infrastructures

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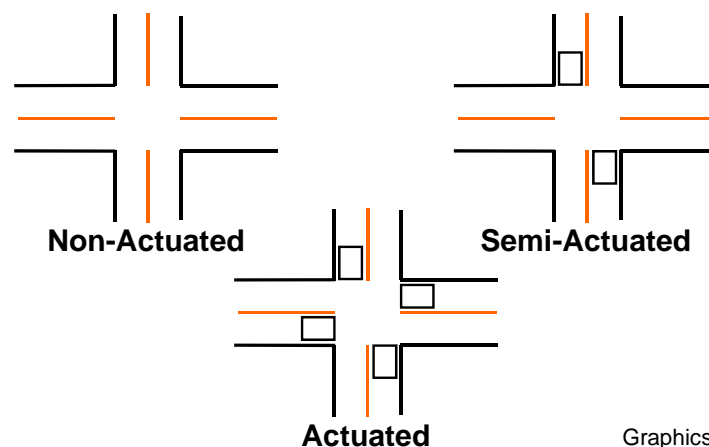


1. Introduction/Purpose

A208: Using the ATC 5401 Application Programming Interface Standard to Leverage ITS Infrastructures is the third module in the Professional Capacity Building (PCB) program on using the Advanced Transportation Controller (ATC) standards. Module A208 identifies the features of the ATC 5401 Standard, it describes the API Software defined by the standard, describes how ATC 5401 works with other ITS standards, and helps users specify ATC equipment that includes API Software for procurements.

2. Traffic Concepts

Intersection Actuation – The extent at which an intersection is equipped for vehicle detection.



Graphics: Ralph W. Boaz

Figure 1. Diagram illustrating different types of actuation in an intersection.

Cycle – The time required for one complete revolution of the timing dial (old definition). One complete sequence of signal indications.

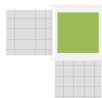
Interval – Any one of the several divisions of the time cycle during which signal indications do not change. Examples:

- Minimum Green
- Vehicle Extension (passage)
- Pedestrian Clearance Interval
- Red Clearance Interval
- Yellow Change Interval

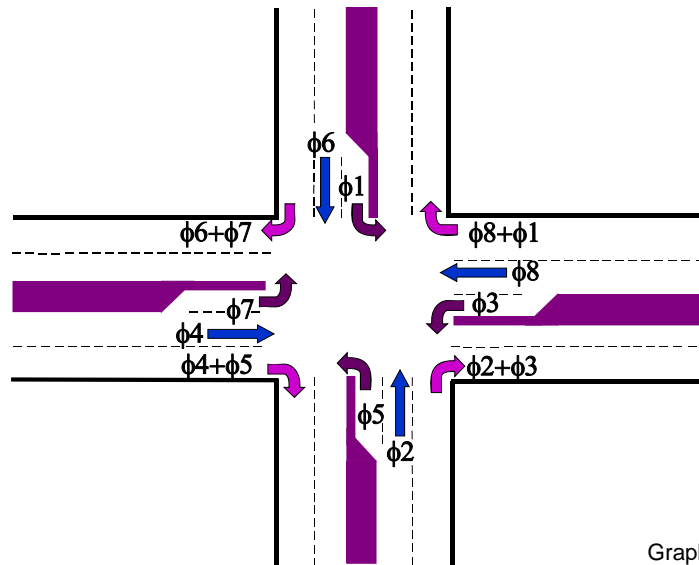
Phase – Any combination of traffic movements receiving right-of-way simultaneously during one or more intervals

- Vehicular/Pedestrian Phases
- Conflicting / Non-Conflicting Phases

Overlap – A traffic movement timed concurrently with one or more phases (parent phases). Typically, the yellow and red clearance timing of the overlap is equal to that of the phase terminating the overlap.



Standard Quad or 8-Phase Intersection. The odd numbered phases represent left turn movements. The even numbered phases represent through movements. Overlaps are indicated by the plus signs and indicate that the right arrow would appear during the timing of the two phases indicated. Example: The overlap $\Phi 8 + \Phi 1$ would be allowed during the timing of $\Phi 8$ and $\Phi 1$. No U-turns on left arrow allowed.



Graphics: Ralph W. Boaz

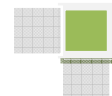
Figure 2. Diagram illustrating a “Standard Quad” or 8-Phase intersection.

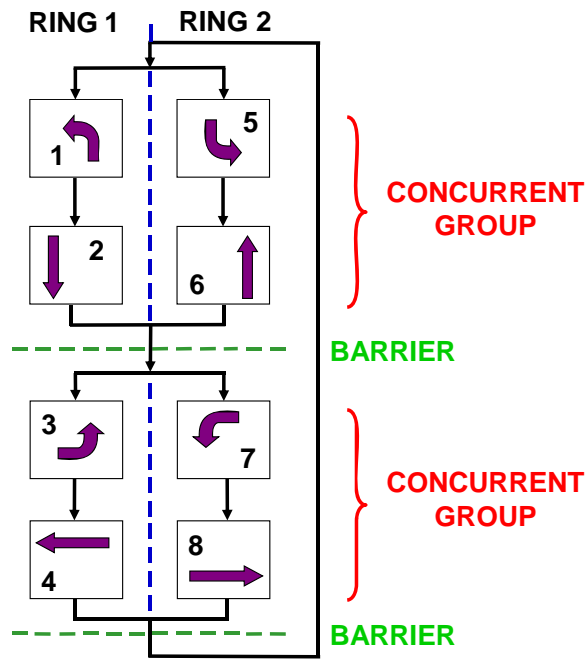
Ring – Consists of two or more sequentially timed and individually selected conflicting phases so arranged as to occur in an established order.

Barrier – A reference point in the preferred sequence of a multi-ring controller at which all rings are interlocked. Barriers assure there will be no concurrent selection and timing of conflicting phases for traffic movements in different rings. All rings cross the barrier simultaneously to select and time phases on the other side.

Concurrent Groups – All of the phases between two barriers. Typically, they are the left turn and through movements on a single street.

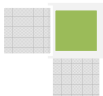
Dual Ring Operation for a Standard Quad – See the following diagram. There are two rings. The first consists of phases 1-4 and the second consists of phases 5-8. A phase in Ring 1 can time with a phase in Ring 2 provided they are a part of the same concurrent group.



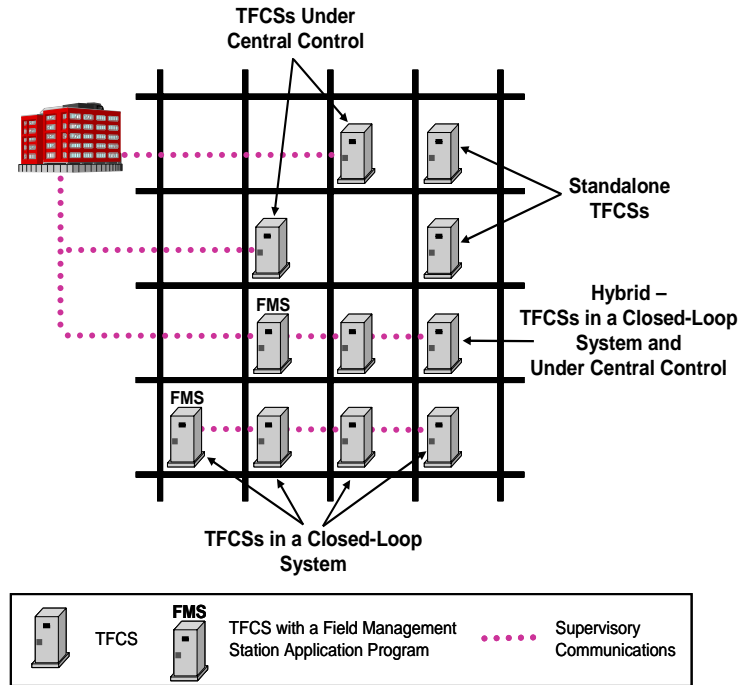


Graphics: Ralph W. Boaz

Figure 3. Diagram illustrating a "Standard Quad" or 8-Phase intersection.

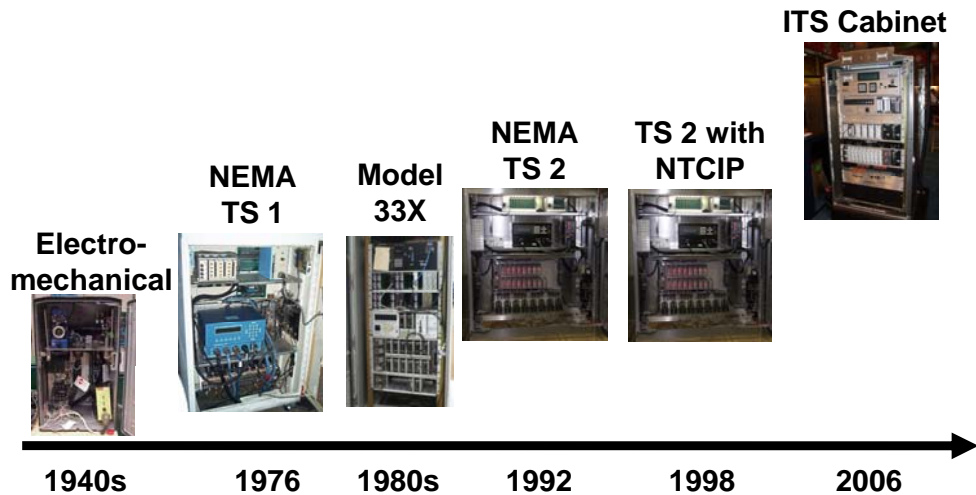


3. ATC Concepts



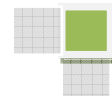
Graphics: Ralph W. Boaz

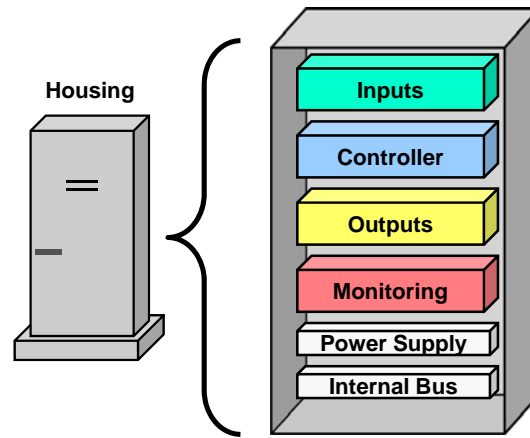
Figure 4. Field architectures using Transportation Field Cabinet Systems (TFCs) for Performing Traffic Management.



Graphics: Ralph W. Boaz

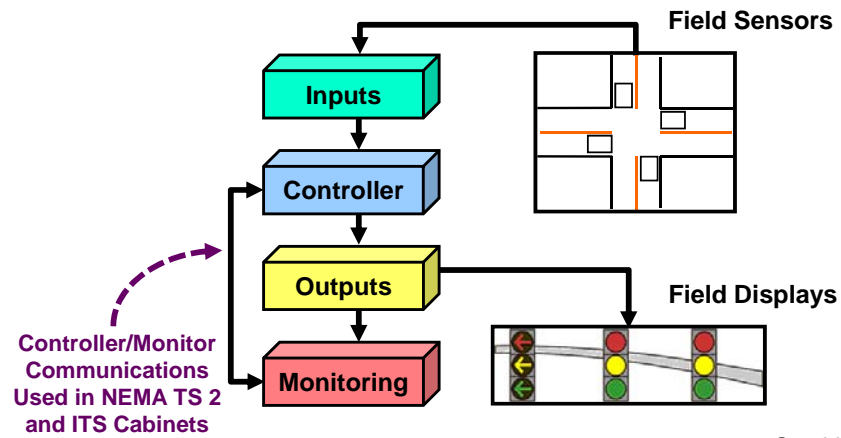
Figure 5. Evolution of Transportation Control Equipment.





Graphics: Ralph W. Boaz

Figure 6. Basic TFCS components.



Graphics: Ralph W. Boaz

Figure 7. Basic TFCS Operation.

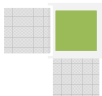


Table 1. Differences in Transportation Field Cabinet Systems.

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

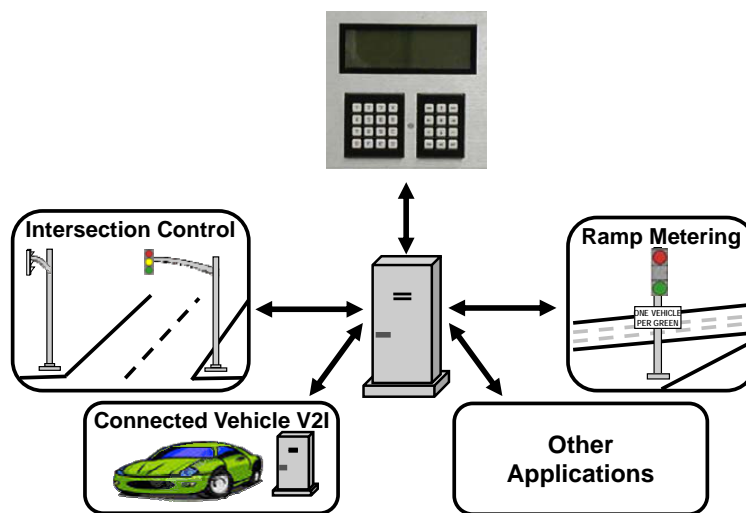
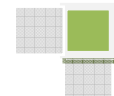
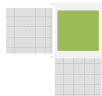


Figure 8. ATC 5401 Standard allows applications to share the resources of the ATC Controller Unit and TFCS.

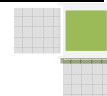


4. Glossary

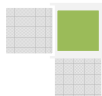
TERM	DEFINITION
Model 170	A traffic control device that meets one of the California Department of Transportation (Caltrans) standards for Model 170 traffic control devices.
Model 2070	A traffic control device that meets one of the California Department of Transportation (Caltrans) standards for Model 2070 traffic control devices or one of the standards for the ATC 2070 traffic control devices.
AASHTO	American Association of State Highway and Transportation Officials
API	Application Programming Interface. In this standard, when API is used by itself as a noun it refers to the software that is compliant to the ATC API Standard.
API Managers	API software that manages an ATC resource for use by concurrently running application programs.
API Utilities	API software not included in the API Managers that is used for configuration purposes.
Application Program	Any program designed to perform a specific function directly for the user or, in some cases, for another application program. Examples of application programs include word processors, database programs, Web browsers and traffic control programs. Application programs use the services of a computer's O/S and other supporting programs such as an application programming interface.
ASCII	American Standard Code for Information Interchange. A standard character-coding scheme used by most computers to display letters, digits and special characters. See ANSI-X3.4-1986(R 1997).
ATC	Advanced Transportation Controller
ATC Device Drivers	Low-level software not included in standard Linux distributions that is necessary for ATC-specific devices to operate in a Linux O/S environment.
Aux Switch	A physical "auxiliary" switch on the Front Panel of ATC 2070 controllers that may be used by application programs.
BIU	Bus Interface Unit. A transportation cabinet device which is used for communications within some cabinet systems.
Board Support Package	Software usually provided by processor board manufacturers which provides a consistent software interface for the unique architecture of the board. In the case of the ATC, the Board Support Package also includes the O/S.
BSP	See Board Support Package.
CMU	Cabinet Monitor Unit. A transportation cabinet device which monitors the operational status of some cabinet systems.
CPU	Central Processing Unit. A programmable logic device that performs the instruction, logic and mathematical processing in a computer.
Device Driver	A software routine that links a peripheral device to the operating system. It acts like a translator between a device and the application programs that use it.



TERM	DEFINITION
DRAM	Dynamic Random Access Memory
DST	Daylight Saving Time
EEPROM	Electrically Erasable, Programmable, Read-Only Memory. EEPROMs differ from DRAMs in that the memory is saved even if electrical power is lost.
ELF	Executable and Linking Format. A software library format.
Epoch	An origin of time measurement commonly used in computers. It is midnight UTC of January 1, 1970.
FAT	File Allocation Table. A Microsoft Windows file system format.
FHWA	Federal Highway Administration
FIFO	First In/First Out. A method of storage in which the data stored for the longest time will be retrieved first.
FIO	Field Input and Output
FSA	Failed State Action
FTP	File Transfer Protocol. A protocol used to transfer files between computers on a network.
GMT	Greenwich Mean Time
I/O	Input/Output
IEC	International Engineering Consortium
IEEE	Institute of Electrical and Electronics Engineers
IPv4	Internet Protocol version 4. The fourth revision in the development of the Internet Protocol (IP). Addresses are usually written in dot-decimal notation, which consists of four octets of the address expressed in decimal and separated by periods.
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
JC	Joint Committee
kbps	Kilobits per second (thousands of bits per second)
LED	Light Emitting Diode. A display technology that uses a semiconductor diode that emits light when charged.
Linux Device Drivers	Low-level software that is freely available in the Linux community for use with common hardware components operating in a standard fashion.
Linux Kernel	The Unix-like operating system kernel that was begun by Linus Torvalds in 1991. The Linux Kernel provides general O/S functionality. This includes functions for things typical in any computer system such as file I/O, serial I/O, interprocess communication and process scheduling. It also includes Linux utility functions necessary to run programs such as shell scripts and console commands. It is generally available as open source (free to the public). The Linux Kernel referenced in this standard is defined in the ATC Controller Standard, Section 2.2.5, Annex A and Annex B.
Mb/s	Mega/Million Bits per Second



TERM	DEFINITION
MMU	Malfunction Management Unit. A transportation cabinet device which monitors the operational status of some cabinet systems.
Ms	Millisecond. One thousandth (10 ⁻³) of a second.
NEMA	National Electrical Manufacturers Association
NEMA Controller	A traffic control device that meets one of the NEMA standards for traffic control devices.
Operational User	A technician or transportation engineer who uses the controller to perform its operational tasks.
O/S	Operating System
PCB	Printed Circuit Board
Process	A process is an instance of a program running in a computer. In Linux, a process is started when a program is initiated (either by a user entering a shell command or by another program). A process is a running program in which a particular set of data and unique process identifier (ID) is associated so that the process can be managed by the operating system.
Programmatic	Having to do with a computer program or software.
RAM	Random Access Memory
RTC	Real-Time Clock
SDD	Software Design Document
SDLC	Synchronous Data Link Control. A communication protocol used in some transportation cabinet systems.
SDO	Standards Development Organization
SIU	Serial Interface Unit. A transportation cabinet device which is used for communications within some cabinet systems.
SRAM	Static Random Access Memory
SW	Software
Telnet	Teletype Network. A network protocol used on the Internet or local area networks to provide a bidirectional interactive communications facility.
TFCS	Transportation Field Cabinet System
TOD	Time of Day
TTL	Transistor Transistor Logic
WG	Working Group
USDOT	United States Department of Transportation
USB	Universal Serial Bus. An external peripheral interface standard for communication between a computer and external peripherals.
User Developer	A software developer that designs and develops programs for controllers.
UTC	Coordinated Universal Time. A high-precision atomic time standard. Time zones around the world are expressed as positive or negative offsets from UTC. As the zero-point reference, UTC is also referred to as Zulu time (Z). UTC is often referred to as Greenwich Mean Time (GMT) when describing time zones.

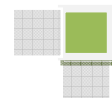


5. Reference to Other Standards

- Institute of Transportation Engineers, *Application Programming Interface (API) Standard for the Advanced Transportation Controller (ATC) v02.17*. ATC Joint Committee, 1 September 2011. <http://www.ite.org/standards/index.asp>
- Institute of Transportation Engineers, *ATC 5201 Advanced Transportation Controller (ATC) Standard Version 06*. ATC Joint Committee, 30 July 2012. <http://www.ite.org/standards/index.asp>
- Institute of Transportation Engineers, *ATC 5202 Model 2070 Controller Standard Version 03*. ATC Joint Committee, 28 December 2012. <http://www.ite.org/standards/index.asp>
- Institute of Transportation Engineers, *ATC Controller Standard Revision Version 5.2b*. ATC Joint Committee, 26 June 2006. <http://www.ite.org/standards/index.asp>
- Institute of Transportation Engineers, *Intelligent Transportation System (ITS) Standard Specification for Roadside Cabinets v01.02.17b*. ATC Joint Committee, 16 November 2006. <http://www.ite.org/standards/index.asp>
- National Electrical Manufacturers Association, *NEMA Standards Publication TS 2-2003 v02.06 Traffic Controller Assemblies with NTCIP Requirements*. NEMA, 2003.
- National Electrical Manufacturers Association, *NEMA Standards Publication TS 1-1989 Traffic Control Systems*. NEMA, 1989.

6. References

- Alexander, Ian and Ljerka Beus-Dukic. *Discovering Requirements*. Wiley, 2009.
- Berenbach, Brian, Daniel Paulish, Juergen Kazmeier, and Arnold Rudorfer. *Software and Systems Requirements Engineering: In Practice*. McGraw Hill, 2009.
- California Department of Transportation, *Caltrans Transportation Electrical Equipment Specifications (TEES)*. California Department of Transportation, 12 March 2009.
- IEEE Computer Society Press. *Software Requirements Engineering*, Second Edition. IEEE Computer Society Press, 2000.
- ITS PCB Training
http://www.pcb.its.dot.gov/stds_training.aspx.
- United States Department of Transportation Federal Highway Administration. *Systems Engineering Guidebook for Intelligent Transportation Systems Version 3.0*. November 2009. <http://www.fhwa.dot.gov/cadiv/segb/>



7. Study Questions

- 1) **Which of the following elements of the TFCS is not shared by API Software?**
 - a) Outputs
 - b) Inputs
 - c) Controller
 - d) Power

- 2) **Which of the following statements is TRUE regarding the operation of the Front Panel Manager Window?**
 - a) The Default Window is always position [1] on the Front Panel Manager Window
 - b) An Intersection Control window comes standard with the API Software
 - c) Pressing {**, <ESC>} causes the Front Panel Manager Window to be put in focus
 - d) The Front Panel Manager is designed for an 8 line display only

- 3) **Which of the following is TRUE in regards to the Field I/O Management of API Software?**
 - a) All application programs may have read access to all of the input points
 - b) All application programs may have write access to all of the input points
 - c) All application programs may have write access to all of the output points
 - d) Application programs must communicate with each other to avoid writing to the same output points

- 4) **Which of the following is not a standard utility provided in API Software?**
 - a) Ethernet
 - b) Bluetooth
 - c) Linux/API Information
 - d) System Time

- 5) **Which of following parts of the ATC Engine Board is not managed by API Software?**
 - a) Front Panel Port
 - b) Real-Time Clock
 - c) General Purpose Serial I/O Ports
 - d) Field I/O Ports

- 6) **What must a User Developer do to make an application portable and compatible on two different ATC controllers in different TFCS architectures? Choose the best answer.**
 - a) Write the application software so that it uses the API Standard function calls whenever they are applicable
 - b) Compile and link the application source code with API libraries
 - c) Compile and link the application source code for the ATC Engine Board used in each controller
 - d) All the above

- 7) **What is NOT a benefit of the API Reference Implementation?**
 - a) Guarantees bug free software
 - b) Lowers development cost to the industry
 - c) Best opportunity for consistent API Software behavior
 - d) Promotes collaboration of developers across the transportation industry

