Lecture Overview

- Evolution of Traffic Signal Controller Standards
- Design Goals and Application
- ATC Controller
- ATC Cabinet
- ATC Application Programming Interface

Cabinets and Controllers

Electro-mechanical Digital


ATC 5.2 & API
ATC/2070
NEMA TS-2
NEMA TS-1 170
TS-2 with NTCIP
The ATC is attempting to bring the Model 170 and the TS-2 standards as a national standards while preserving the best of both.

**ATC/2070 Controller Overview**

- The ATC is attempting to bring the Model 170 and the TS-2 standards as a national standards while preserving the best of both.

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**Box-Level Improvement Not The Answer**

- Camera Controllers
- Conflict Monitor On Load Switches

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**ATC/2070 Controller Overview**

- The ATC is attempting to bring the Model 170 and the TS-2 standards as a national standards while preserving the best of both.

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**ATC/2070 Controller Overview**

- The ATC is attempting to bring the Model 170 and the TS-2 standards as a national standards while preserving the best of both.
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### ATC/2070 Controller Evolution

- Mid 1990's, [California](#) began development of a specification for the Type 2070 controller as a Type 170 controller replacement.
- Late 1990's, the FHWA set forth an initiative to develop an Advanced Transportation Controller (ATC) standard. Three standards organizations form consortium to national standard.

### ATC/2070 Goals

- Open Architecture
- Modular
- Multi-process / Multi-application
- Grow with technology (ATC only)
- General purpose computing platform for the transportation community ("PC-like" concepts)

### ATC/2070 Applications

- Traffic Signal
- Traffic Surveillance
- Transit
- Communications
- Field Master
- Ramp Meter
- Variable/Dynamic Message Sign
- General ITS Beacons
- CCTV Cameras
- Roadway Weather Information
- Weigh in Motion
- Irrigation Control
- Lane Use Signals
ATC/2700 Standards Family

- No ATC Application Software or Communications Standard
  - NEMA TS Standards describe functionality of traffic signal controller
  - NTCIP Standards describe information and communications protocols
  - There are references to Scoot having support for NTCIP

2070 Controller

- Typical 2070L Configuration

2070 Controller

- Typical 2070LN Configuration
Unit Chassis and Serial Backplane

VME Backplane allows multiple CPUs but not deployed due to expense

2070-5A VME Cage Assembly and VME Backplane

CPU Modules
- 2070-1A MC 68360 with OS 9 with VME Backplane
- 2070-1E -1A but w/o VME
- 2070-1C ATC Engine Board concept w/Linux
Field I/O Modules

- 2070-2A “C” Connector for Type 170 Cabinets
- 2070-2B Serial SDLC for ITS Cabinet

Front Panel Assemblies

- 2070-3A Large Character 4x40 LCD Display
- 2070-3B 8x40 LCD Display
- 2070-3C No LCD Display or Keypad
- 2070-3D 16x40 LCD Display

Power Supply 2070-4 Module
Communication Modules

- Async Serial Comm Modules
  - 2070-7A Async Only
  - 2070-7B Async/Sync Capable
- Async/Modem Serial Comm Modules
  - 2070-6A 300/1200 BPS
  - 2070-6B 0-9600 BPS

Communication Modules (cont.)

- 2070-6D Fiber Optic Modem
- 2070-6E Serial 2 Network
  - Terminal Server
- 2020-6W Wireless Modem
  - Coax port
- 2070-9A/B FSK/Dial-Up Modem
- 2070-Fx Universal Network Card

2070-8 NEMA Interface Module
Summary of Modules

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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<tr>
<td>Model 2070</td>
<td>CPU Module (Multiple Board VME)</td>
<td>X</td>
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<td>Model 2070</td>
<td>CPU Module (Engine Brd and Linux)</td>
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<td>VME Cage Assembly</td>
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<td>Model 2070</td>
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<td>Model 2070</td>
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<td>Model 2070</td>
<td>NEMA Interface Module</td>
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<tr>
<td>Model 2070</td>
<td>Model 2070N Back Cover</td>
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</table>

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2070 Newest Controller Configurations

2070V UNIT
VME version which mates to 170 & ITS cabinets. Consists of: Unit Chassis, 2070-1A TB, 2070-1A MCB, 2070-2A FI/O, 2070-3A Front Panel, 2070-4 Power Supply, and 2070-5 VME Cage Assembly.

2070LX UNIT
LX Unit mates to 170 & ITS cabinets. Consists of: Unit Chassis, 2070-1C CPU, 2070-2A FI/O (-2B if ITS Cabinet), 2070-3B Front Panel and 2070-4 Power Supply

Partial List of Manufactures

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ITS Cabinet Standard

ITS Cabinet Components

• Buses
  – Serial Bus 1
    • Time critical information between Controller to Input & Output Cages and to Power Supply
  – Serial Bus 2
    • Non-time critical information between Controller and Input & Output Cages and to Power Supply
  – Serial Bus 3
    • CMU to AMU special bus for monitoring output states.

ITS Cabinet Components

• Pre-existing Detectors
  – Model 222 – Two Channel
    • Loop Amplifier (Existing Design)
  – Model 204 – Four Channel
    • Loop Amplifier (Existing Design)

• ATC Cabinet defined
  – Model 231 One Channel
    • Magnetometer
  – Model 232 Two Channel
    • Magnetometer
  – Model 242 Two Channel Input
    • DC Isolator
  – Model 262 Two channel Input
    • AC Isolator
ITS Cabinet Components

• Inductive Loop Detectors
  – 50-700 micro Henries
  – Q minimum = 5
  – Four operating frequencies
  – Pulse and presence mode
  – Sensitivity
  – Sensitivity change
  – Cross coupling
  – Response time

• Magnetic Detectors
  – Input resistance
  – Max size of sensor

• Isolator Inputs
  – General purpose
  – 20 or 80 Volt inputs

ITS Cabinet Components

• Inductive Loop Detectors Manufacturers
  – Detector Systems
  – Diablo Engineering
  – Eberle Designs
  – Northstar Controls
  – Reno A&E
  – 3M

• Magnetic Detectors
  – M.Systems
  – TEECO Safety

• Isolator Inputs
  – Detector Systems
  – Perfect Distribution Control
  – Eberle Designs
  – GDI
  – Traffic Sensor Corporation

ITS Cabinet Components

• After Market Product Examples
  – Naztec/Traficon Dual Video Detector
  – Econolite/Autoscope 8 Channel Video Detector
  – 3M 2070 Optical Signal Processor (Visible/Infrared Preemption Module)
ITS Cabinet Components

• Inductive Loop Detectors Evaluation
  – See California, North Carolina (et al) Qualified Products List
  • www.dot.ca.gov/hq/traffops/electsys/QPL
  – Research papers on evaluation of different detector technologies
  • tti.tamu.edu/documents/2119-1.pdf
  • tti.tamu.edu/documents/1715-1.pdf

See Handout of 2119 - Project Summary Report

ITS Cabinet Components

• CMU Controller Monitor Unit
  – Basic fault coverage includes Conflict, 24Vdc, and Cu Watchdog monitoring.
  – Red monitoring senses the absence of signals on a channel.
  – Dual indication monitoring detects simultaneous active signals on a channel.
  – Sequence monitoring ensures sequencing of signals with a proper minimum yellow clearance interval.
  – AC Line Monitoring detects and responds to low AC Line voltages as well as interruptions with a minimum flash interval

• Typical Extras
  – Event Logging
  – Real Time Clock
  – PC Interface

Cabinet Types

• Cabinet Housing 1
  – Similar to Type 332 cabinet – 24” x 30” x 67”
• Cabinet Housing 2
  – Similar to Type 336 cabinet – 24” x 20” x 46”
• Cabinet Housing 3
  – NEMA P cabinet base dimensions with double front and back doors with two racks – 44” x 26” x 66”
• Cabinet Housing 4
  – Proposed compact version for pole mounting
ATC Controller Standard

- ATC Controller Standard 5.2 centers around an "engine board" concept
- Engine board is a building block for new ATC architectures
- Must support the ATC API and 2070 Comm modules
As technology changes, new Engine Boards can be designed to take advantage of it:
- Make, model, and version of CPU is not defined
- Type and amount of memory is not defined
- Interface to Host Module is standardized
ATC Application Programming Interface

• **What is API?**
  - An API is a set of functions that can be called by an application program to access underlying hardware features and establish inter-processing communications

• **GOALS:**
  - Make applications portable between different hardware / operating systems
  - Allow multiple applications to run on the same controller (e.g. CCTV, Ramp Control, Intersection control)

• **Two levels**
  - Layer 1 basic services
  - Layer 2 Multiple applications

ATC API Standard

• Historically, most application software not portable between manufacturers
**ATC API Standard**

- Portability and interoperability achieved at "compile time"

**ATC Software Organization**

- Operational User
- Application USER
- Interface and behavior defined by ATC controller standard
- Linux OS & Device Drivers

**User Supplied Software**

**Vendor Supplied Software**

**ATC FROM VENDOR 1**

**ATC FROM VENDOR 2**

**ATC FROM VENDOR 3**

**ATC FROM VENDOR 4**

**API Library**

**OS-9**

**MC68360 or other processor**

**X86 or other processors**

**Level 1 API Function Calls**

**Level 2 API Function Calls**

**User Supplied (as applicable)**

**Software Vendor Supplied**

**Hardware Vendor Supplied**

- Linux OS & Device Drivers
- API
- Application Software
ATC API Standard

- Allows software to be written that can operate on any ATC regardless of manufacturer
- Provides interoperability of multiple software applications on a single controller unit
- API software runs “on top of” Linux O/S on ATC Engine Board
- Creates a broader software market

User Interfaces

Applications
ATC API Standard allows assignment of cabinet I/O points to controller application programs.
### API Function Calls

#### Front Panel Manager
- General
- Character Attributes
- Read
- Write
- Cursor

#### Field I/O Manager
- General
- Character Attributes
- Read
- Write
- Cursor
- LED
- Field I/O Manager
- Utilities
- Aux Switches

#### Utilities
- LED
- Field I/O Manager
- Utilities
- Aux Switches
- Transition Buffer
- Watchdog Monitor
- Fault/Voltage Monitor
- CMU/MMU/Channel Functions

#### Utility Functions
- Set/Get Time
- Daylight Saving Time
- Time Source and Signaling

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### ATC vs Non-ATC Comparisons

<table>
<thead>
<tr>
<th>Feature</th>
<th>170</th>
<th>NEMA Controller Non-ATC</th>
<th>ATC/2070</th>
<th>ATC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Initial Cost</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<td>Multiple Sources For Software</td>
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<td>X</td>
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<tr>
<td>Multiple Application Operation</td>
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<td>Advanced Features</td>
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<td>Full-Color High End HW Features</td>
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<td>X</td>
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<tr>
<td>Built-in Future Upgrades</td>
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<td>X</td>
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### Controller Comparison

<table>
<thead>
<tr>
<th>Controller</th>
<th>Operating System</th>
<th>MIPS*</th>
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<tbody>
<tr>
<td>170</td>
<td>None</td>
<td>0.2-3.2</td>
</tr>
<tr>
<td>2070-1A,1E</td>
<td>OS-9 (proprietary O/S)</td>
<td>4.5</td>
</tr>
<tr>
<td>2070-1C</td>
<td>Linux (open O/S) + API</td>
<td>400+</td>
</tr>
</tbody>
</table>

* Millions of Instructions Per Second
ATC vs Non-ATC Comparisons

Increasing Functionality

- Non-ATC Curve
- ATC Curve

Standards / Specifications
- Caltrans Transportation Electrical Equipment Specifications (TEES) 07/21/08
- ATC Controller Standard v5.2b 06/26/2006
- ITS Cabinet Standard v01.02.17b 11/16/2006
- ATC API Standard v02.06b 09/21/2007

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