New York Implements <u>Standards</u> Based Traffic Control System

ASTC – **A**dvanced **S**olid-State **T**raffic **C**ontroller

30 September 2010

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Outline

- Background
  - History of Traffic Control in NYC
- Traffic Controller Replacement Program
  - Hardware Requirements
  - Functional Requirements
  - Testing Program
  - Communications Requirements
- Current Status of System Deployment

Background

- NYC has > 13,000 signalized intersections
- Communications
  - 100 VDC pulses (cir. 1968) - now removed
  - Manhattan 56 Kbps coax (cir. 1995) - 2,800 intersections
  - New Installation – Wireless (NYCWiN) – 2,400 ➔ 12,000
- >90% of controllers are simple 2 phase (2Veh/2Ped) pretimed – interval based
- **City Requirements**
  - Low cost unit
  - Small/compact unit – similar to existing cabinets
  - Use proven and accepted ***standards based technology***
  - Reliability is extremely important

  - NTCIP communications
  - Vendor independence for future procurements

Old Central System

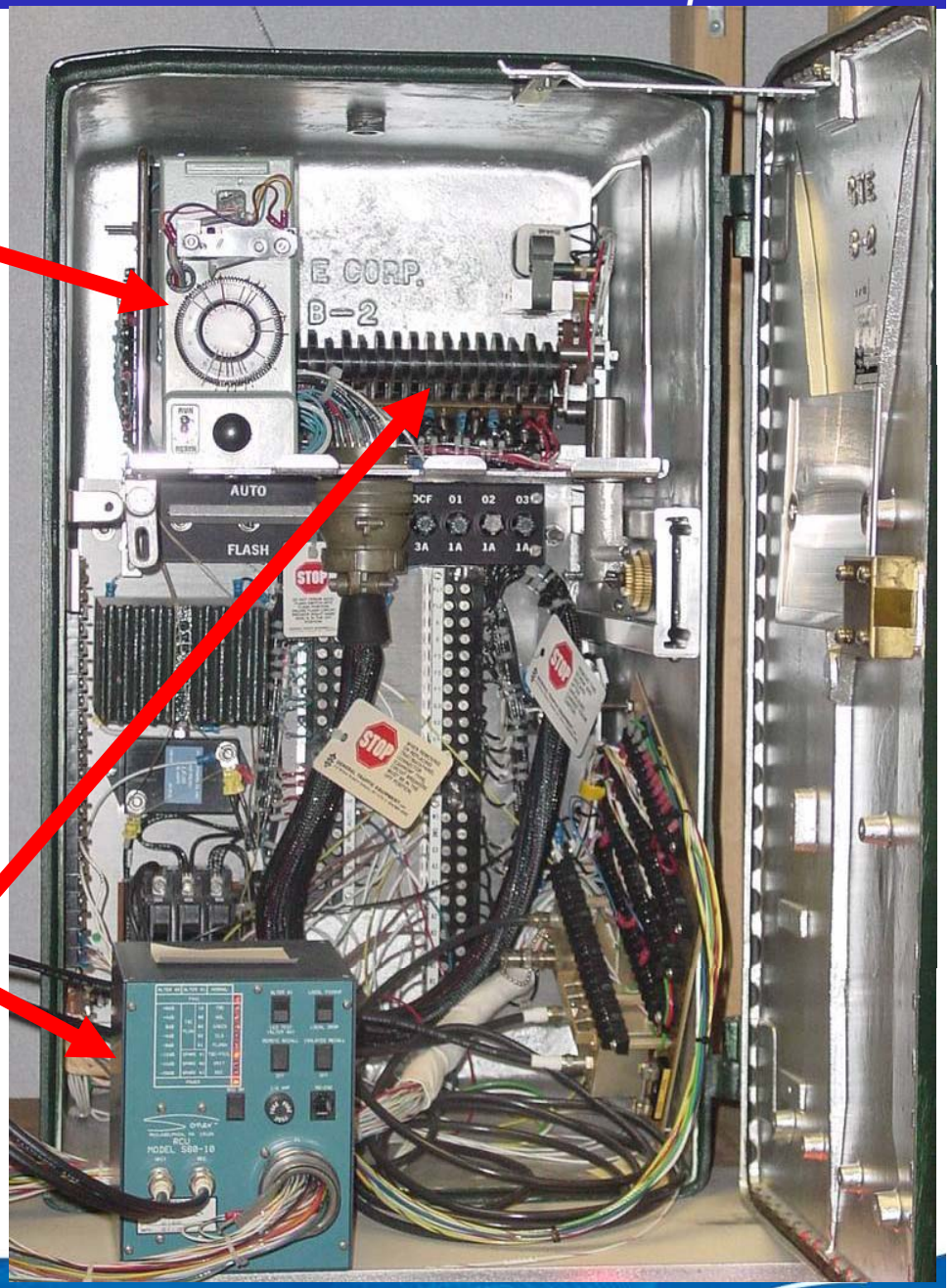
- ~6,600 on-line intersections (5 Boroughs)
- Central system Control:
  - Real-time interval advance pulses; each interval is **"advanced"** from central
  - Old electro-mechanical controllers are all timed from central
  - New controllers time clearance intervals
- ~~Supports advance pulses over DC interconnect~~
- Manhattan added time-of-day scheduler and limited local timing through *Remote Communications Units*
- The system provided Time-of-day plans, data logging, failure monitoring and correction, coordination

Original Electro-Mechanical Controllers

Cir. 1970's

- **Shown with Manhattan Remote Communications Unit** Cir. 1995

Single dial, 12 step 18 & 24 circuit cam shaft.



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New Central System

- **Hybrid (12,000 controllers)**
  - **Local database and timing (ASTC)**
  - **Central database management (upload/download)**
  - **Central plan selection includes TOD scheduler, Dynamic Split Allocation, Traffic Responsive plan selection, adaptive real-time pattern adjustments, as well as manual operation**
  - **Central monitoring (*second-by-second*) Controller status**
  - **Data collection from various types of detection devices**
- **All NTCIP communications to new controllers.**
- **PC based servers and workstations**
- **Integrated with Freeway and Incident Management Systems**

Traffic Management Center

STANDARDS BASED CONTROLLER REPLACEMENT PROGRAM

Started in 2000

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Controller Specification Development

- Procurement based on user needs:
  - City maintenance technicians
  - City traffic engineers
  - **ATC** standards development program
- A 'straw man' design was developed
- NEMA and 170 vendors interviewed
- Specifications were finalized
  - Reviewed by FHWA and NY State DOT
  - First Project was bid in the 2001

Standards Based Approach

- NY State 170/179/330 cab. Controller & Modules
  - Input Cards, L/S, FTR, Flasher
- NEMA (TS2-2003) **B**us **I**nterface **U**nit (BIU)
  - 1 for ASTC-6 (6 load switches)
  - 2 for ASTC-12 (12 load switches)
- 2010ECL monitor (modified voltage thresholds)
- NEMA functionality (TS2-2003)
- NTCIP (1103 – SNMP, STMP - 1201 & 1202)
- ATC Standard engine board (5.2b)
- ATC-2070 form factor modem slot in controller
- ATC/NEMA connectors and front panel
- Specified the **interfaces** and **functionality**

Other Requirements

- NY State Power Distribution Assembly (PDA)
  - Added 12 VAC for PED circuits (NEMA)
  - Adopted **ATC** wiring for FTR/Contactor (NEMA)
- Pole Mounted Cabinet – rear mounting and conduit entry
- **4.75 mm Al. cabinet (most in US are 3.175 mm)**
- Shelf mounted controller
- **Embedded** cabinet address (16 bit)
  - Special PC card
- Heavy duty field terminal blocks
- Ease of field maintenance
- USB Memory device to field configure

NTCIP Requirements

- Full support for the TS2 NTCIP
  - Compliance group A2N level 2
- Special objects identified
  - Pre-timed interval based operation
  - Download request
  - Configurable I/O
  - IP address XX.XX.AA.AA
  - Configurable routing (Gateway and subnet mask)
  - Transit Signal Priority parameters
  - Clock management Line-UPS transition
  - Special Interfaces to UPS and Conflict Monitor
- No 'vendor specific' functionality
  - Goal was interchangeability
- **No proprietary objects**

NTCIP Communications Standards Used

- Full support for NTCIP Upload and Download
  - NTCIP 1201 – Global Objects
  - NTCIP 1202 – Actuated Signal Control
- Support for UDP/IP over wireless
- Support for STMF (NTCIP 2301)
  - SNMP – Simple Network Management Protocol
  - STMP – Simple Transportation Management Protocol
- ***Goal: to adhere to the NTCIP Standards where possible***

National Transportation Communication for ITS Protocol

User Datagram Protocol/Internet Protocol

Simple Transportation Management Framework

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Major Controller Characteristics

ASTC-6

- Features
  - 6 load switches (18 Circuits)
  - 2 FTR
  - 4 Flash program jumpers
- Dimensions
  - 36 inches tall (91 cm)
  - 19 inches wide (48 cm)
  - 15 inches deep (38 cm)
- 4 slot input file (8 vehicle detectors)
- 1 BIU (NEMA Bus Interface Unit)
- 2010 NY/TEES Monitor Unit
- Power Distribution Assembly

ASTC - 12

- Features
  - 12 load switches (36 Circuits)
  - 6 FTR
  - 12 Flash program jumpers
- Dimensions
  - 49 inches tall (124 cm)
  - 22 inches wide (56 cm)
  - 15 inches deep (38 cm)
- 10 slot input file (20 vehicle detectors)
- 2 BIU (NEMA Bus Interface Unit)
- 2010 NY/TEES Monitor Unit
- Power Distribution Assembly

Major Characteristics - Continued

- 2 Ethernet Interface (10/100BaseT) (local and system)
- Fully configurable input/output mapping (EIA485 serial TS2)
- Lap-top interface (cabinet address = database ID)
- 6 Serial Ports
  - 4 Front mounted
  - 2 Modem Slot
- USB port (upload/download database, firmware, OS, logs)
- 4x40 Diagnostic Display – 4 button Navigation
  - Diagnostic and view only
- Firmware is field upgradeable (Serial Port, Ethernet, USB)
- No batteries – super capacitors

Other Contract Requirements

- Materials Procurement (No contractor)
- City has rights to traffic controller source code
  - For NYCDOT only
  - City receives full software development system
- Comprehensive, rigorous testing program
  - Prototype testing (Factory)
  - Integration testing with the system (NYC)
  - Design approval testing (Factory)
  - Factory acceptance testing with full burn-in (Factory)
  - On-site acceptance period (NYC)
  - Warranty 18 months after acceptance

Extensive hardware testing

- Hardware testing – Design Approval Testing
- 5 units tested simultaneously
- NEMA TS2-2003 temperature/humidity profile
  - -34C to +74C
  - 95-135 VAC operation
  - 57-63 Hz
  - Transients – 300V, 600V
- Extensions to NEMA TS2-2003 testing profile
  - 8 hour power interruption testing
  - 2000V transients “live”
  - Electro Static Discharge
  - Power interruptions
    - 2 minutes 350 ms off 650 ms on
    - Slow 120-0-120 @<1 V/S
  - Condensation 0-25C @40% RH

Controller Procurement History

- 1st Project awarded April 2001
- Bid for 1000 controllers (a trial order)
  - 950 ASTC Basic 2 phase (18 Circuit)
  - 50 ASTC-12 (36 Circuit)
  - Support & spare parts included
    - Bench testers (2010, BIU, Controller)
    - Spare Parts
    - Inventory management system
    - Software development environment
- Communications supported
  - DC 100 VDC Direct control (Interval Advance)
  - Coaxial Cable using the existing Manhattan RCU
  - NTCIP – IP to field devices (wireless Ethernet)

Initial procurement ~$4050.00 each

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Additional Procurements

- Purchased 5,400 controllers 1Q2007
  - Bid price < $4,000 each
  - 2 bidders within ½ % of each other
- New standard required **ATC** standard (5.2b)
  - Linux operating system
  - ATC Engine Board
- Added **Transit Signal Priority**

- Purchased 5,000 more 3Q2010
  - Bid Price <$4,000 each
  - 3 Bidders

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Changes Introduced

- Lower current for LED signal heads
- Fixed fan thermostat
- Elimination of **mercury** contactor
- Added functionality
  - Remote activated Transit Signal Priority
  - Flashing Yellow Arrow
- Added an 8 load switch version – support bicycles
- Added auxiliary Cabinet for additional circuits

Wireless Communications Network

- City-wide Wireless network (NYCWiN)
  - Full deployment completed 2009
- Supports Traffic Controllers - NTCIP
  - VPN tunnels TMC-Controller
  - Data upload/download
  - Exception based reporting – real time
    - Second-by-second reporting
    - Adherence to NTCIP 1103 traps
  - Peer-to-peer communications – inhibited
    - Security risks

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Shared Wireless Network

- Emergency services
  - Mobile applications
  - Video
  - Automatic vehicle location (AVL)
- Emergency call boxes
  - VoIP
- Sanitation – AVL and applications
- Transit – Transit Signal Priority City-wide support

Licensed Frequency, cell structure
~400 cell sites

Highlights of the Traffic Controller Hardware

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Phase 2 Controller

Optimized ATC Engine Board

- 300 MHz PowerPC (MPC8248)
  - 570 MIPS (compared to 5 MIPS for 2070)
  - Internal Communications Co-Processor @ 200 MHz
- Bus-connected USB device
  - Improves communications performance
- Additional 68302 Communication Co-processor
  - Allows partitioning of communication tasks
- 16 MB DRAM (64 bit wide), 16MB Flash, 1MB SRAM
- Dual 10/100 Ethernet with Security Encryption Engine
- Supports Static or Dynamic IP Addresses, DHCP client or server

Ethernet Capabilities

- Two External Ports
  - Additional port(s) available on different versions
- Integrated Switch
  - Supports VLANs, IP Filtering, etc
- External Ports can be configured on separate networks or same network as desired
- Static or Dynamic IP Addresses
  - Can act as a DHCP Client or Server as needed

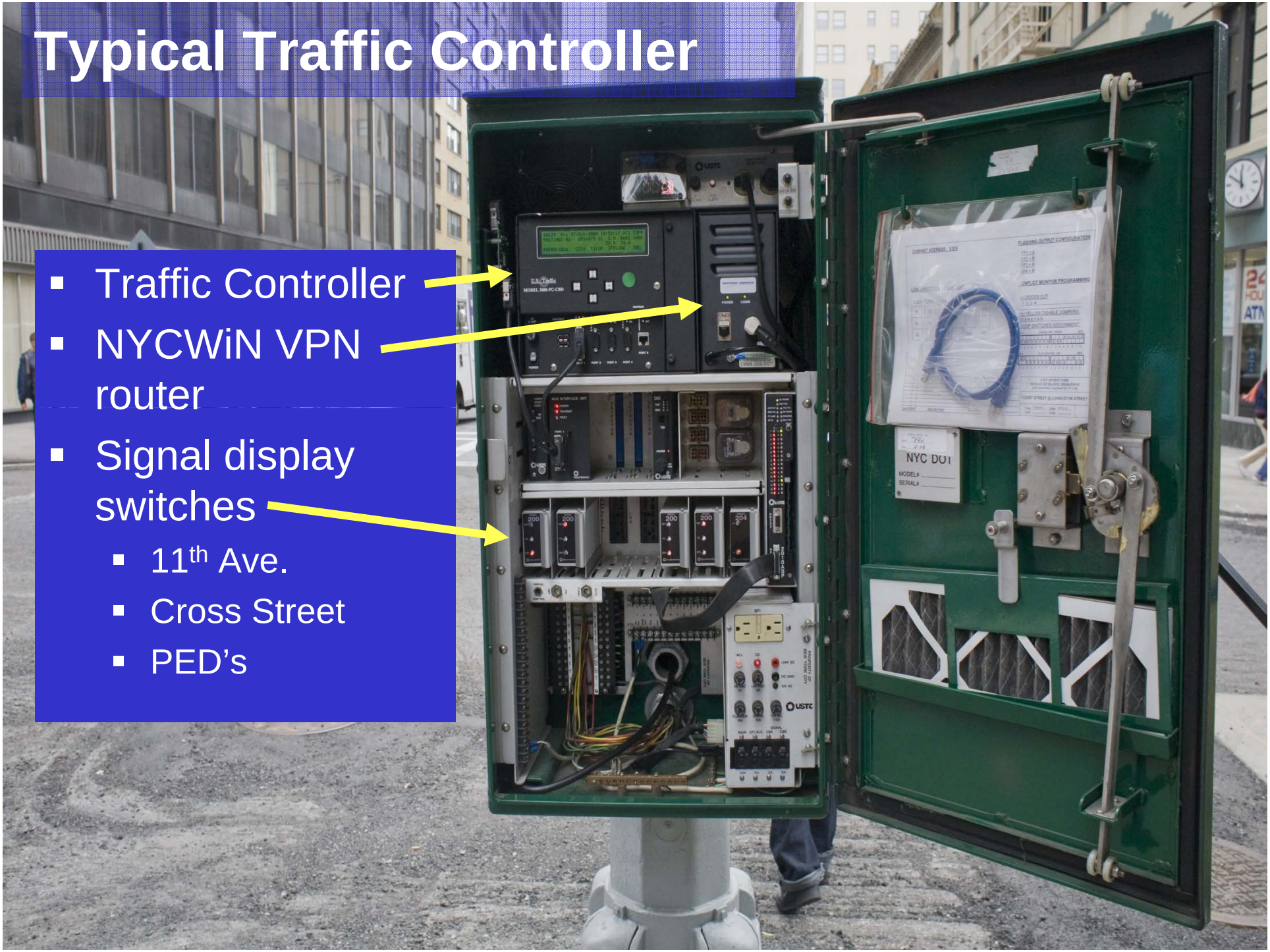
Power Supply

- Modular power supply with excess capacity to support power hungry “modem modules”
  - E.g. Ethernet / Wireless modules consume more power than allowed by TEES (e.g. 2A vs. 0.5A)
- Hold up capacity on all voltages
  - Prevents undesirable resets including modems
- Generates voltage for LCD Heater when needed (e.g. when door is open and temp < threshold)

Front Panel

- Heated, Graphical LCD
  - 240 x 128 dots, programmable as 16 or 13 lines
  - ATC keyboard control modified for heater
- Limited Keypad
  - Use a laptop or system to configure / control ATC
  - **City uses USB memory devices!**
  - Keys allow User to view status / database and set the time/date
- Dual Ethernet allows ATC to remain connection to system while being accessed by a laptop, etc ***(Used for RSE/VII/WC2008)***

Typical Traffic Controller



- Traffic Controller
- NYCWiN VPN router
- Signal display switches
  - 11th Ave.
  - Cross Street
  - PED's

CONTROLLER HARDWARE DETAILS

Skip the details

Typical ASTC-6

MIMO Antenna

ASTC Controller Unit

Wireless router

Cabinet address card

BIU

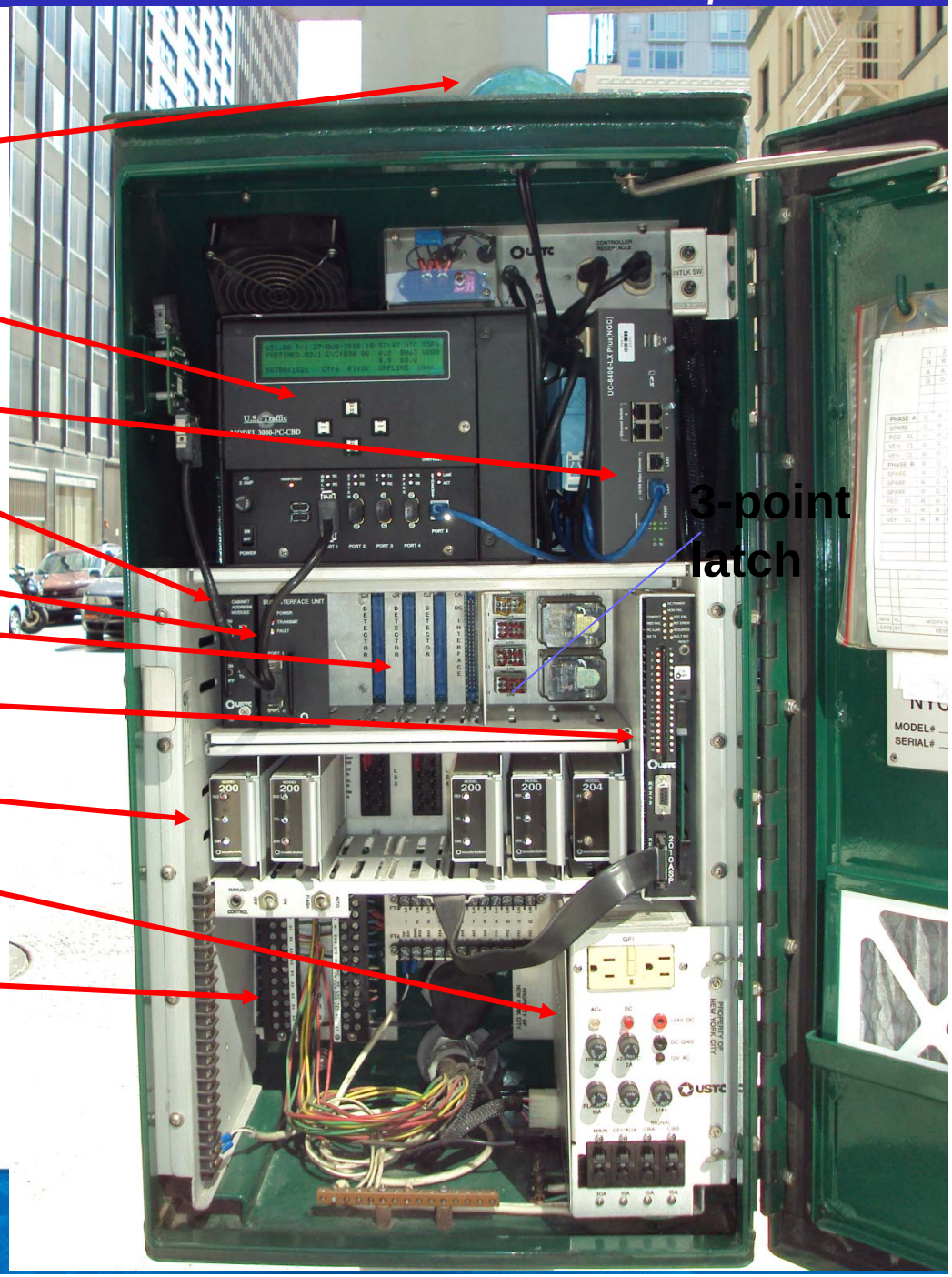
Input Sensors

Conflict Monitor

Load Switches

DC Power supply and power distribution

Field Terminal Blocks



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Typical ASTC-12

ASTC Controller Unit

Wireless Router

BIU's (2)

Input sensors

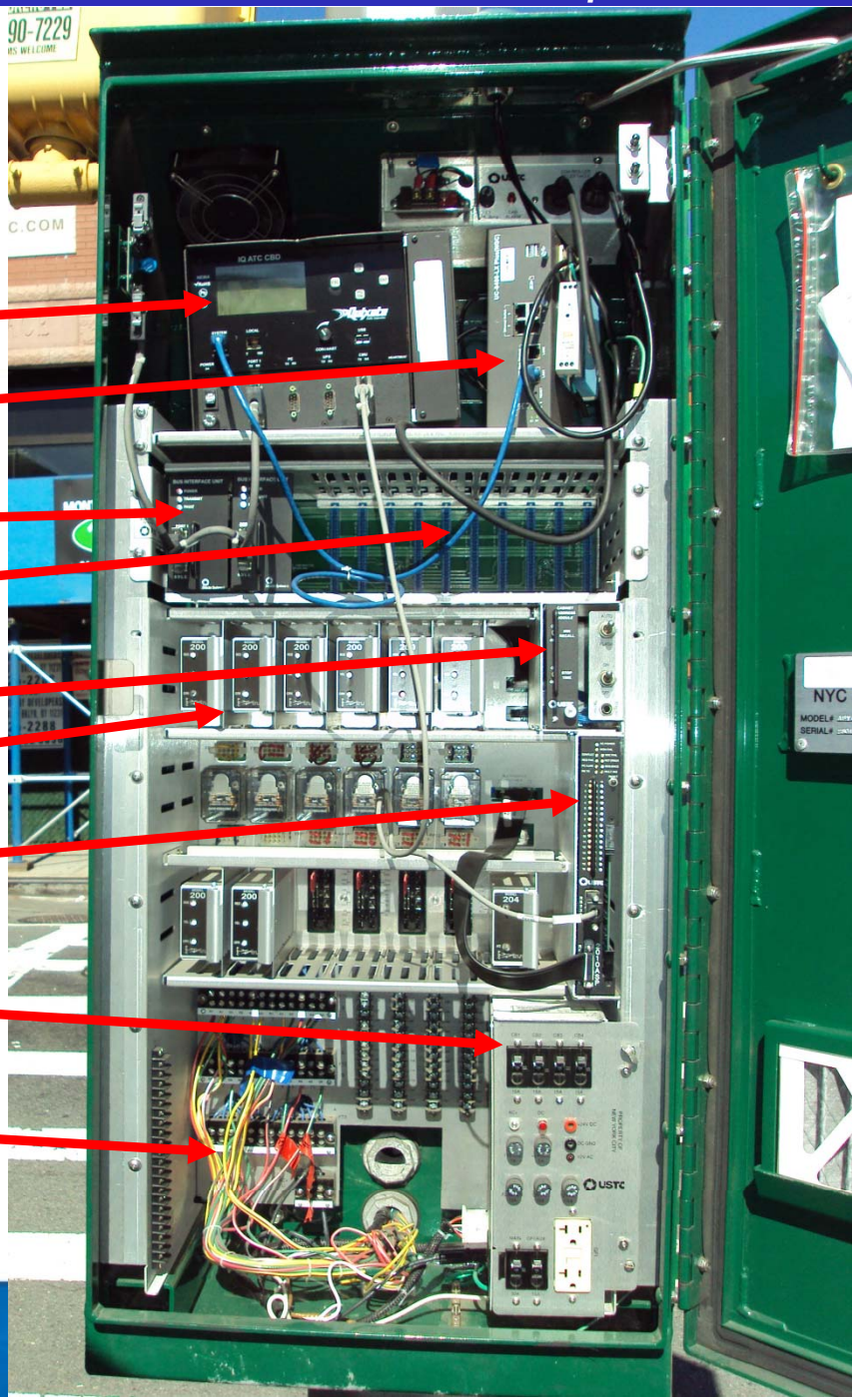
Cabinet address card

Load Switches

Conflict Monitor

DC Power supply and power distribution

Field Terminal Blocks



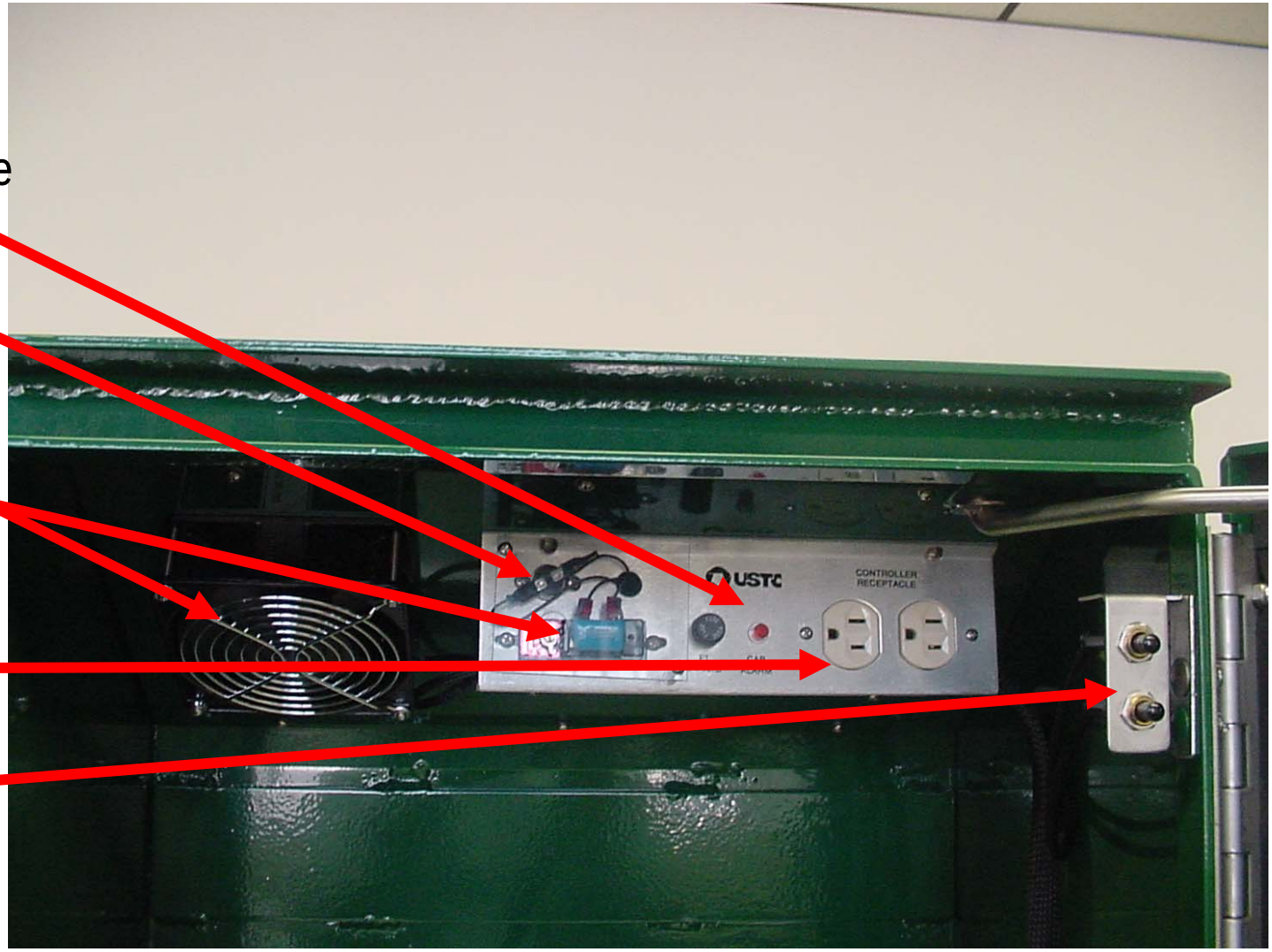
Fan/Thermostat and Power

Over temperature alarm & sensor

Fan & thermostat

Controller outlet

Door switches



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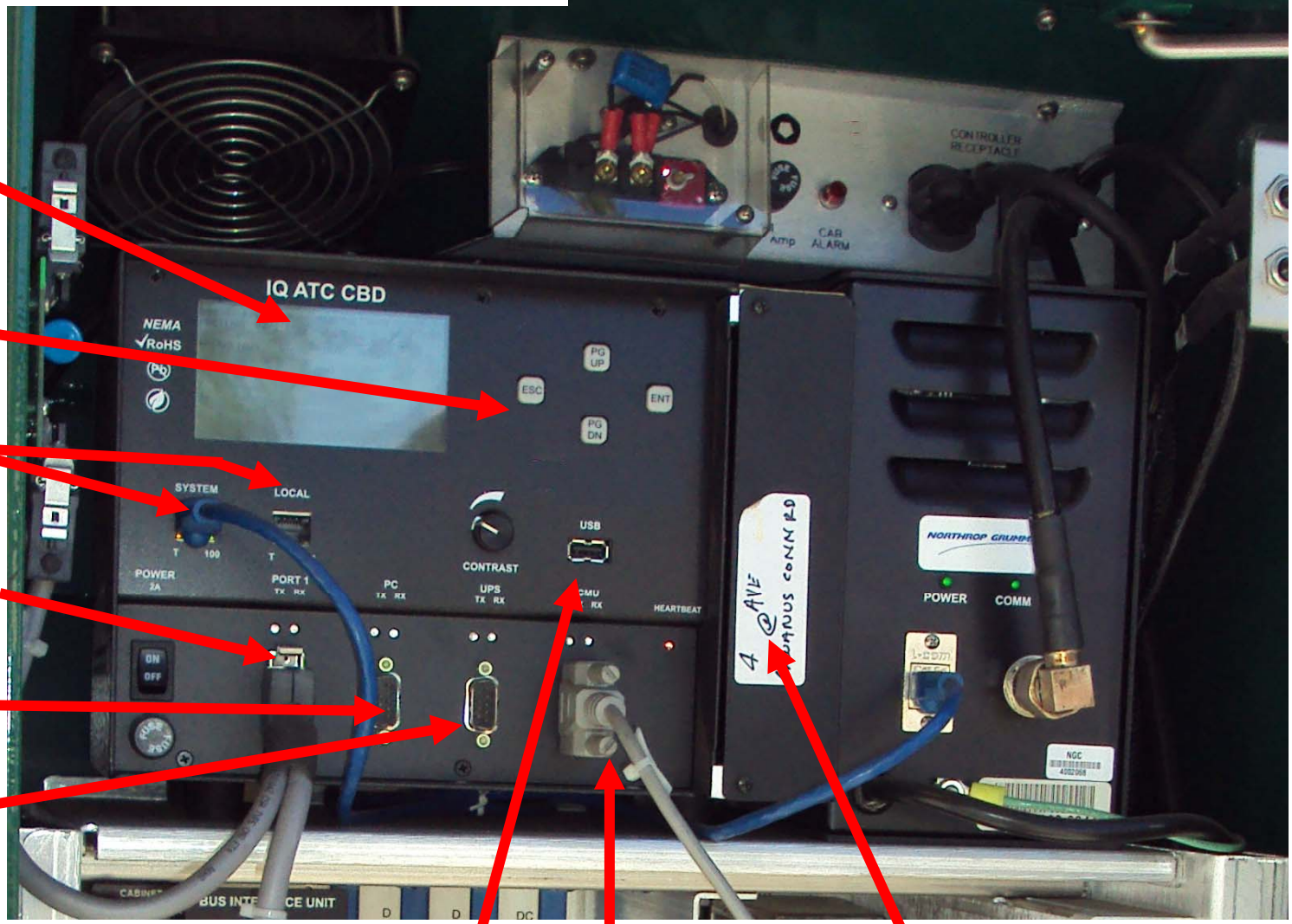
Controller Unit Version 2



diagnostic display

Navigation buttons

Ethernet

485 Port 1

Serial 1 UPS

Lap-top port

USB

AUX

2070 Modem Slot

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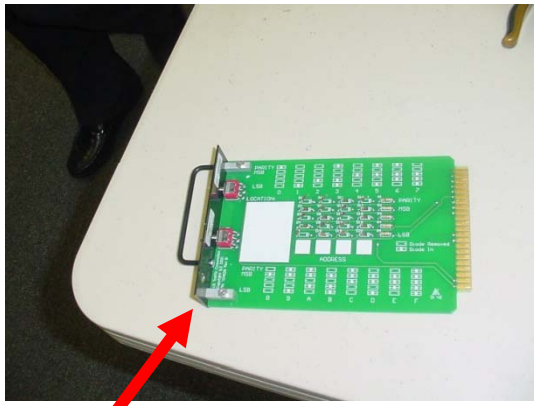
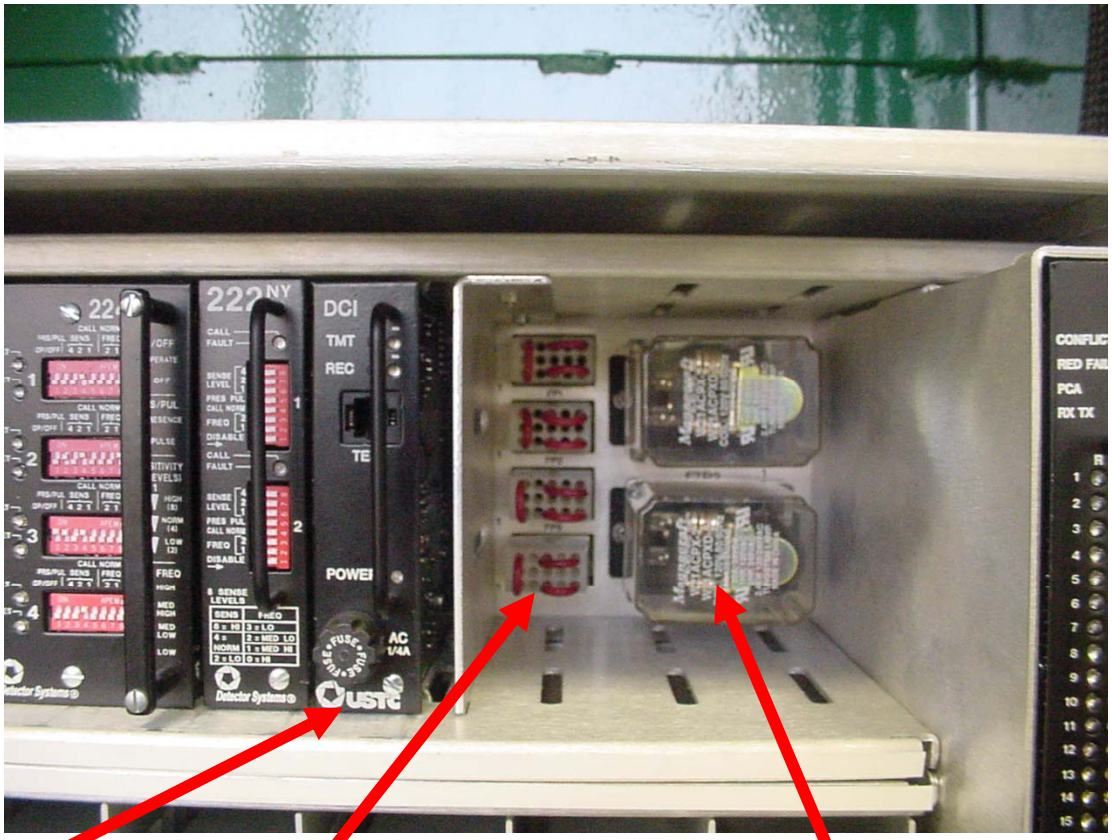
Input File and Flash Transfer



Address Card with *min recall* and *stop timing* switch



100 VDC Interconnect Module

Flash programming jumpers and transfer relays

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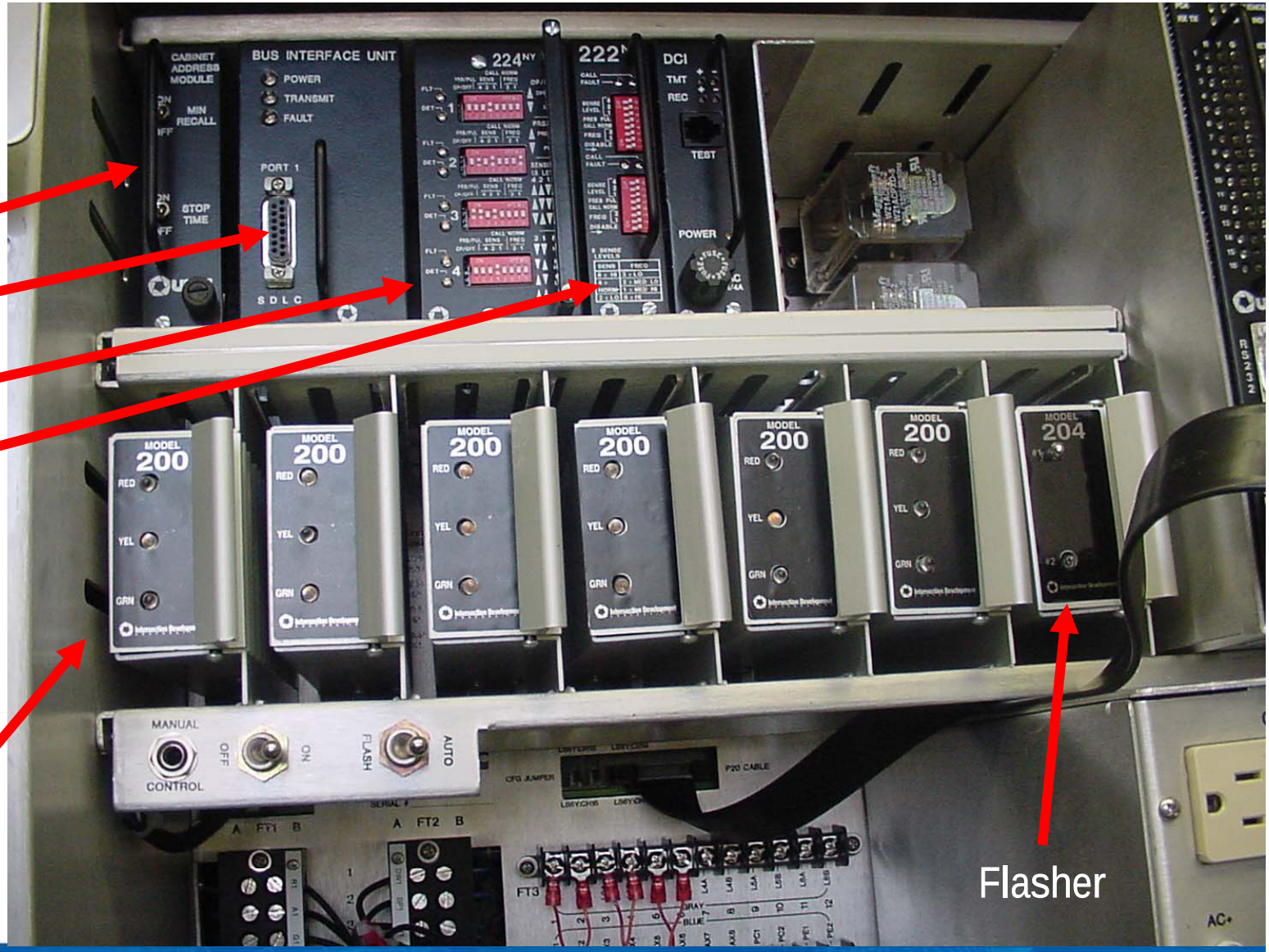
Input File and Output File



Address

BIU

4 Ch Det.

2 Ch Det.

Load Switches (6)

Flasher

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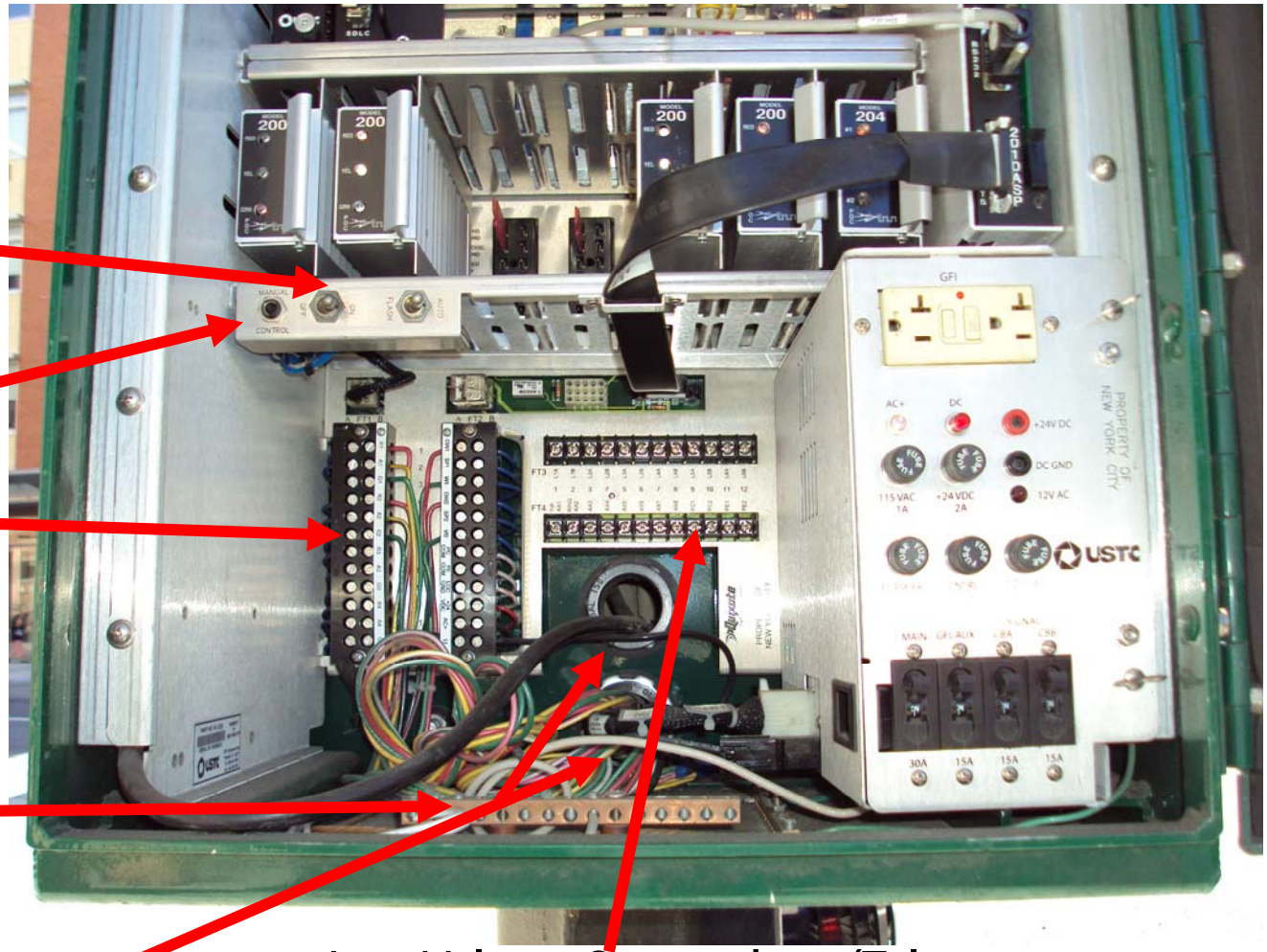
Signal Terminations



Cabinet Flash and Signals On/Off

Police Jack

Signal Connections

Ground and Neutral

Conduit Entry

Low Voltage Connections (Tel, Loop, Ped, etc.)

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Power distribution assembly

Red Monitor Cable

2010 CFM

PDA

Service Outlet

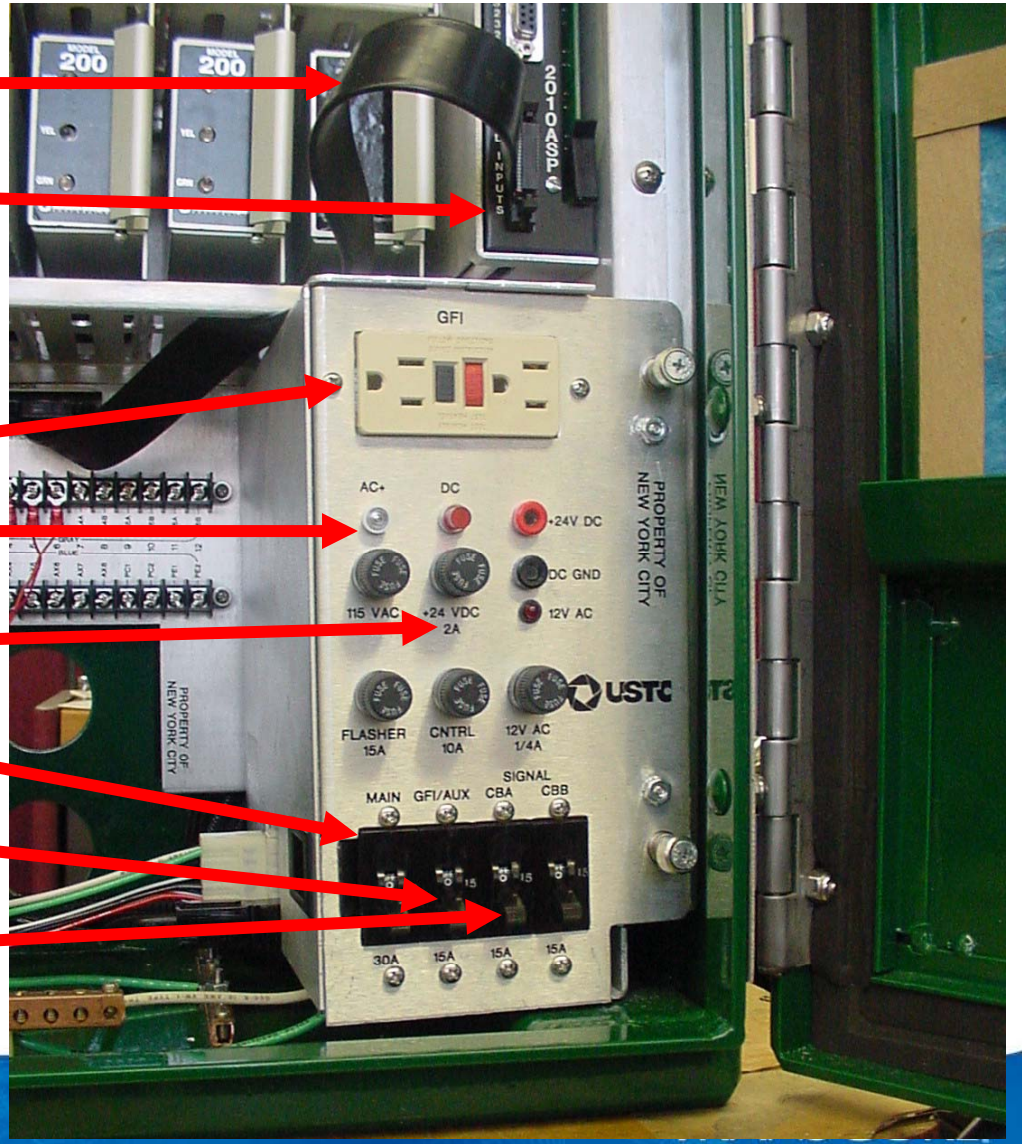
12 VAC

24 VDC

Main breaker

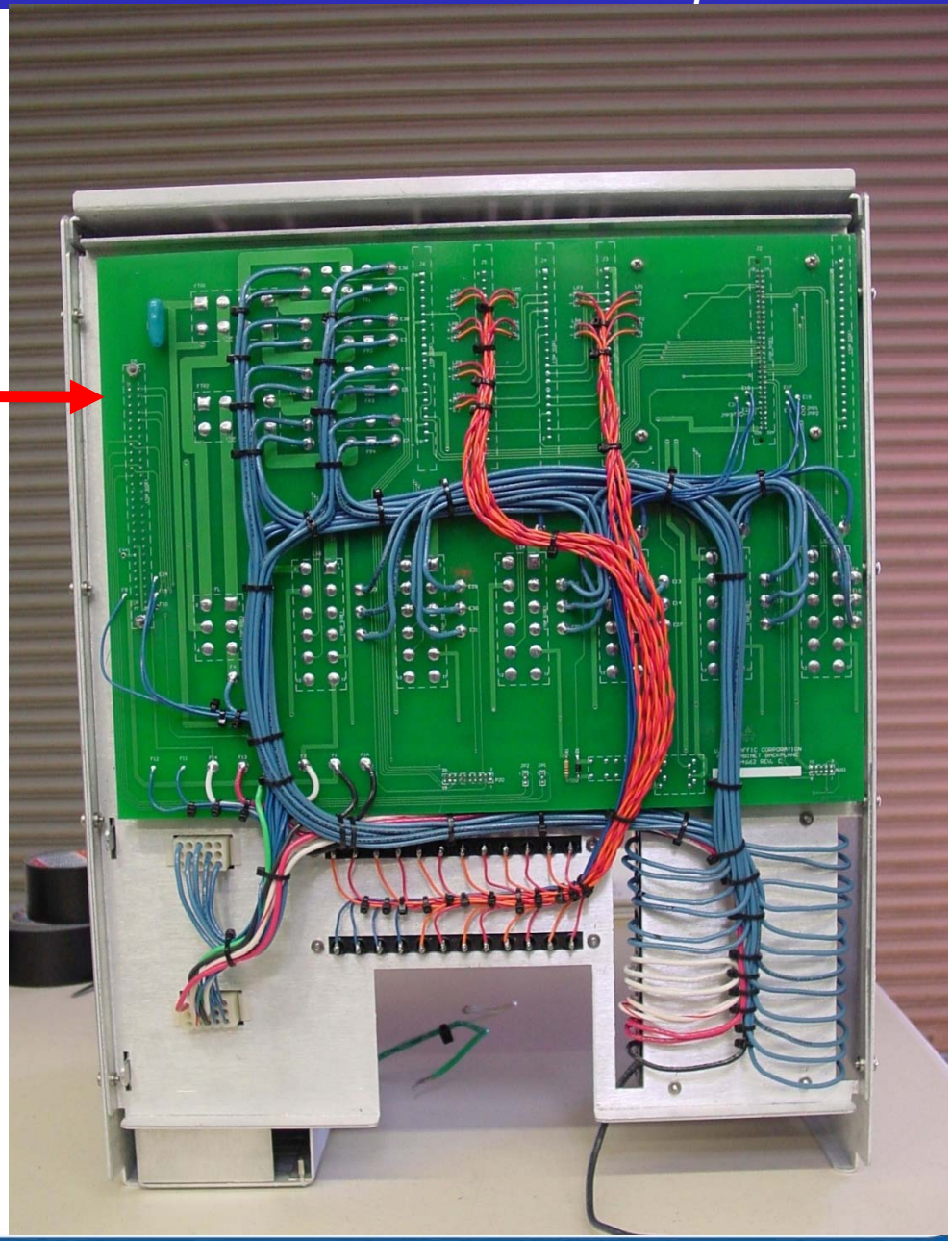
Service breaker

Signal Breakers (2)



Backplane Wiring

Basic ASTC-6



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Summary

- Developed a standards based controller using the best of NEMA, ATC, NY State
- Rigorous testing – required project time extension, but units very reliable
- NTCIP incorporated with extensions for special functionality
- NTCIP adapted for exception based reporting for the wireless network
- Public MIB – and Public description of functionality

Summary – Continued

- Units have been installed for 4 years
- NTCIP testing took 18 months to complete!
- City expects to have ~12,000 intersections changed out and under computer control by end of 2011!
- Installation continues at approximately 50-100 per week
- The City just completed a 3rd bid – there have been three bidders in the ~$4,000 (6 L/S) and $5,000 (12 L/S) range
  - Delivered complete including software, cabinet, all plug-ins "ready to install"

Thank you

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