

Countdown Pedestrian Signals & Role of Powerline Carrier

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The logo for NIATT, featuring the letters "NIATT" in a bold, black, sans-serif font. A green horizontal line is positioned below the letters, and a black swoosh underline is positioned above the letters.

University of Idaho
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Presentation Outline

- Rules, regulations, and standards
- Current pedestrian control practices and technology
- Problem definition
- Proposed solution
- Implementation strategy
- Research activities at the University of Idaho
- References

MUTCD 2003 Rev. 1

- **Section 4E.07 Countdown Pedestrian Signals**
 - If used, the display of the number of remaining seconds shall begin only at the beginning of the pedestrian change interval. After the countdown displays zero, the display shall remain dark until the beginning of the next countdown.

MUTCD 2003 Rev. 1

- **Section 4E.07 Countdown Pedestrian Signals**
 - If used, the countdown pedestrian signal shall display the number of seconds remaining until the termination of the pedestrian change interval.
Countdown displays shall not be used during the walk interval nor during the yellow change interval of a concurrent vehicular phase. (Why not?)

MUTCD 2003 Rev. 1

- **Section 4E.07 Countdown Pedestrian Signals**
 - If the pedestrian change interval is interrupted or shortened as a part of a transition into a preemption sequence (see [Section 4E.10](#)), the countdown pedestrian signal display should be discontinued and go dark immediately upon activation of the preemption transition.

Washington Laws

- **Drivers must yield to pedestrians at intersections**
 - Vehicles shall stop at intersections to allow pedestrians and bicycles to cross the road within a marked or unmarked crosswalk (RCW 46.61.235).
- **Pedestrians must obey traffic signals**
 - Pedestrians must obey traffic-control signals and traffic control devices unless otherwise directed by a traffic or police officer (RCW 46.61.050).

NEMA TS2 Monitoring Requirements

- [4.4.6.2 ITS Cabinet Standard v01.02.17a](#) (March 24, 2006)
 - When any conflicting channels are detected as concurrently active for less than 200 milliseconds the CMU shall not cause a LATCHED FAILED STATE ACTION (LFSA).
 - When any conflicting channels are detected as concurrently active for 500 milliseconds or more, the CMU shall cause a LFSA.
 - When any conflicting channels are detected as concurrently active for more than 200 milliseconds but less than 500 milliseconds, the CMU may or may not cause a LFSA.
 - The time interval between the beginning of the concurrently conflicting channels and the transfer to the LFSA shall not exceed 500 milliseconds.

Pedestrian Signals - How they work

- Learn by observing pedestrian clearance phase
 - Flashing wait
 - Yellow signal output (Usage practice?)
- Silence if proven wrong
 - Preemption
 - Timing signal changes
- MUTCD 2003 Rev. 1 Guidance note:
 - Because some technology includes the countdown pedestrian signal logic in a separate timing device that is independent of the timing in the traffic signal controller, **care should be exercised by the engineer when timing changes are made to pedestrian change intervals. (Admission that there is no supervision by MMU!)**

What's the Problem

- Incorrect display for preemption
- Takes time to learn traffic timing
- MMU cannot validate pedestrian display
- Optional noncompliant MUTCD operations
 - Washington DC – in conflict with **Section 4E.07**

The Source of the Problems

- Lack of communications
 - Single function outputs
 - No feed back
- Legacy traffic control engineering practices
 - MUTCD
 - Based on technical constraints
 - Lacks human factor justification (my opinion only)
 - NEMA
 - SDLC based upon 35 year old technology
 - Independent processor control of signals not observable by MMU

Solution Requirements

- Better communications
 - Higher bandwidth
 - More information
 - Bi-direction communications
- Economics: Low cost
 - Equipment
 - Installation
 - Operations and maintenance

Smart Signals Research History

- Smart Signals
 - 2004-05: Plug and Play Traffic signals using IEEE 1451
 - Ethernet distributed control
 - 2005-06: Smart Signals Demonstration
 - Addressed countdown pedestrian timer
 - 2006-07: NTCIP distributed architecture
 - TS2 compatible
 - 2007-2008: Advanced APS
 - Distributed network control based upon NTCIP
 - TS1 – TS2 compatible

NTCIP Smart Signals

- Ethernet Distributed control
- Uses NTCIP MIB objects
- Safety Critical Network based upon IEEE 1588 PTP
- Utilizes 200MB Ethernet over power line for field wiring
 - Minimum network security issues
 - High data rates
 - Long distance (tests > 2500')
 - Uses existing infrastructure
- Modified Econolite ASC/3 TS2 controller
 - Required software modification for pedestrian timing objects

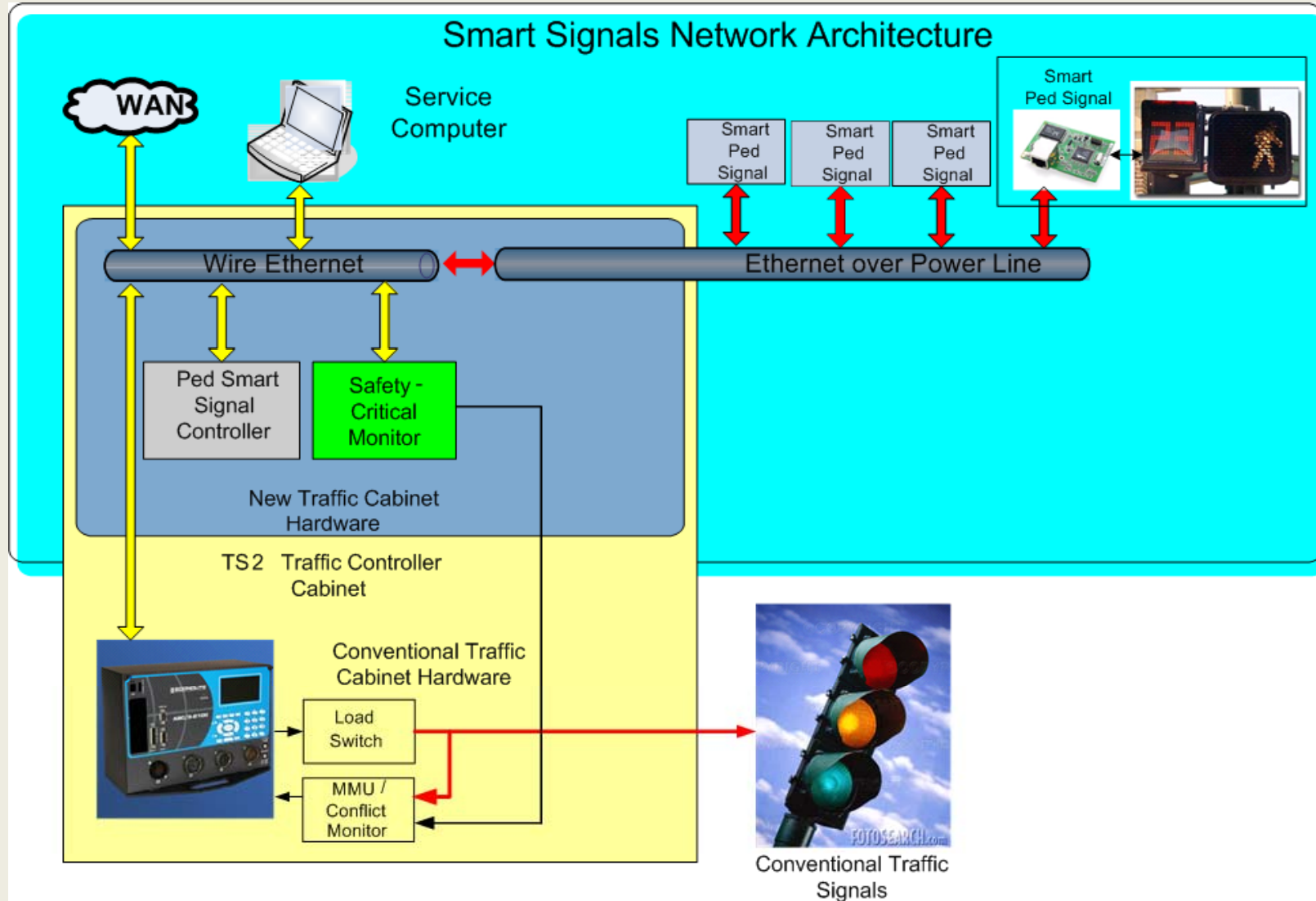
Smarts Pedestrian Signals Demo

[Changing Pedestrian Clearance Times](#)

[Pedestrian Signals During Preemption](#)

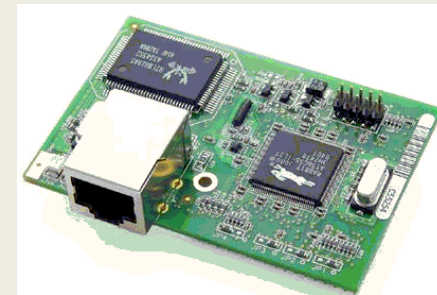
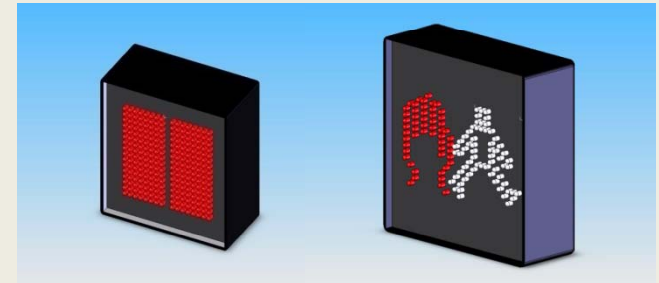


NTCIP Smart Signals



Smarts Pedestrian Signals Hardware

- Proprietary Pedestrian Signal
 - Full LED array
 - Contrast control
- Rabbit Semiconductor RCM3000 Processor (\$65)
 - 28Mhz 8bit Z80
- Netgear HDX101 Powerline HD Ethernet adapter (\$65)

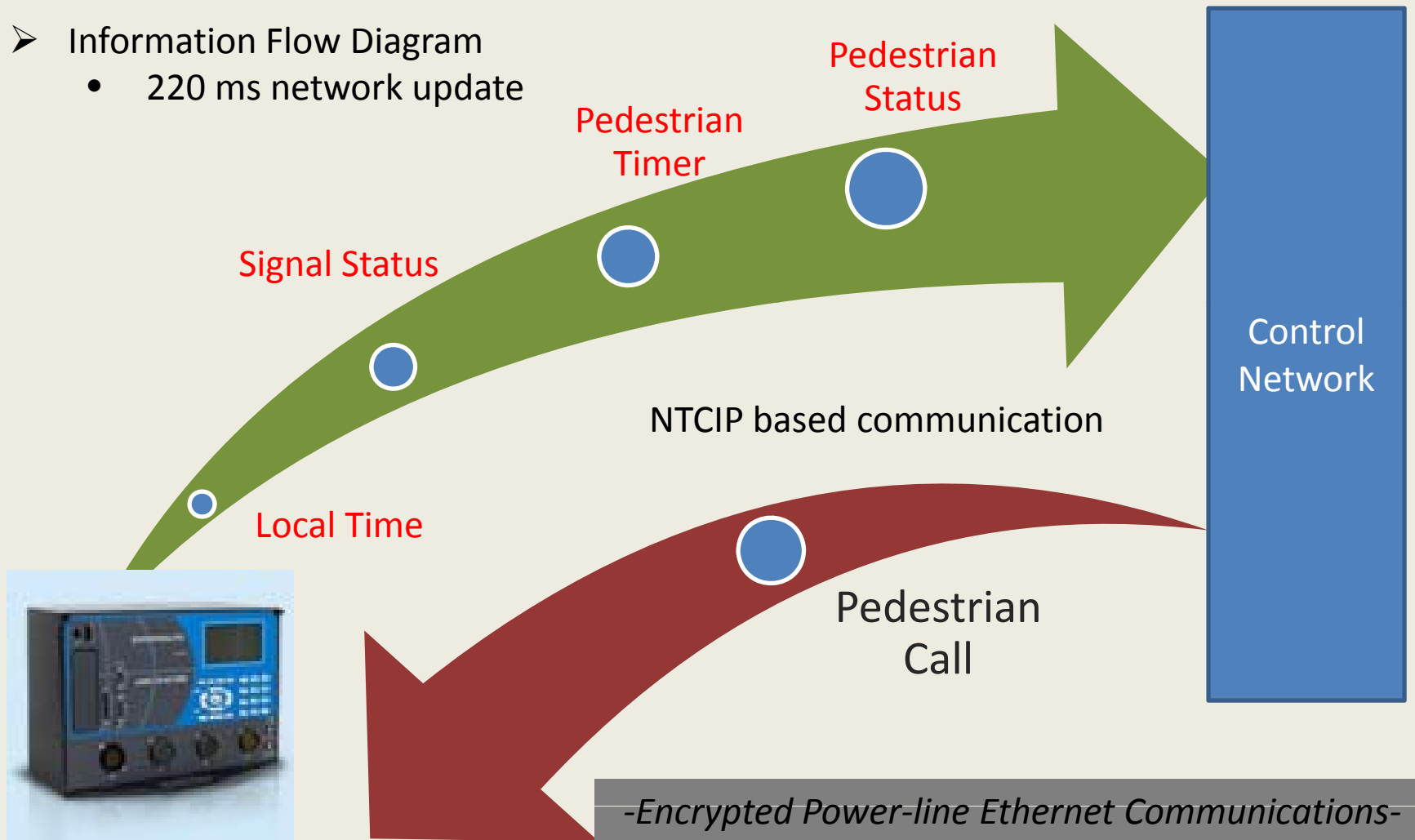


Smarts Pedestrian Signals Software

Standard	Object ID	Table Entries
1201	1.3.6.1.4.1.1206.4.2.6.3.6.0	controller-localTime
1202	1.3.6.1.4.1.1206.4.2.1.1.1.0	maxPhases
1202	1.3.6.1.4.1.1206.4.2.1.1.3.0	maxPhaseGroups
1202	1.3.6.1.4.1.1206.4.2.1.1.5.1.7	phaseControlGroupPedCall
1202	1.3.6.1.4.1.1206.4.2.1.1.4.1	phaseStatusGroupEntry: Red, Yellow, Green, PedCall, PhaseOns, PhaseNexts
1202	1.3.6.1.4.1.1206.4.2.1.1.2.1	phaseEntry: Walk; Pedestrian Clear; Minimum Green; Startup; Options; Ring
Pro- prietary	1.3.6.1.4.1.1206.3.5.2.1.19.1.2, 1.3.6.1.4.1.1206.3.5.2.1.19.1.3	PedStatusState, PedStatusTimer

Smarts Pedestrian Signals Software

- Information Flow Diagram
 - 220 ms network update



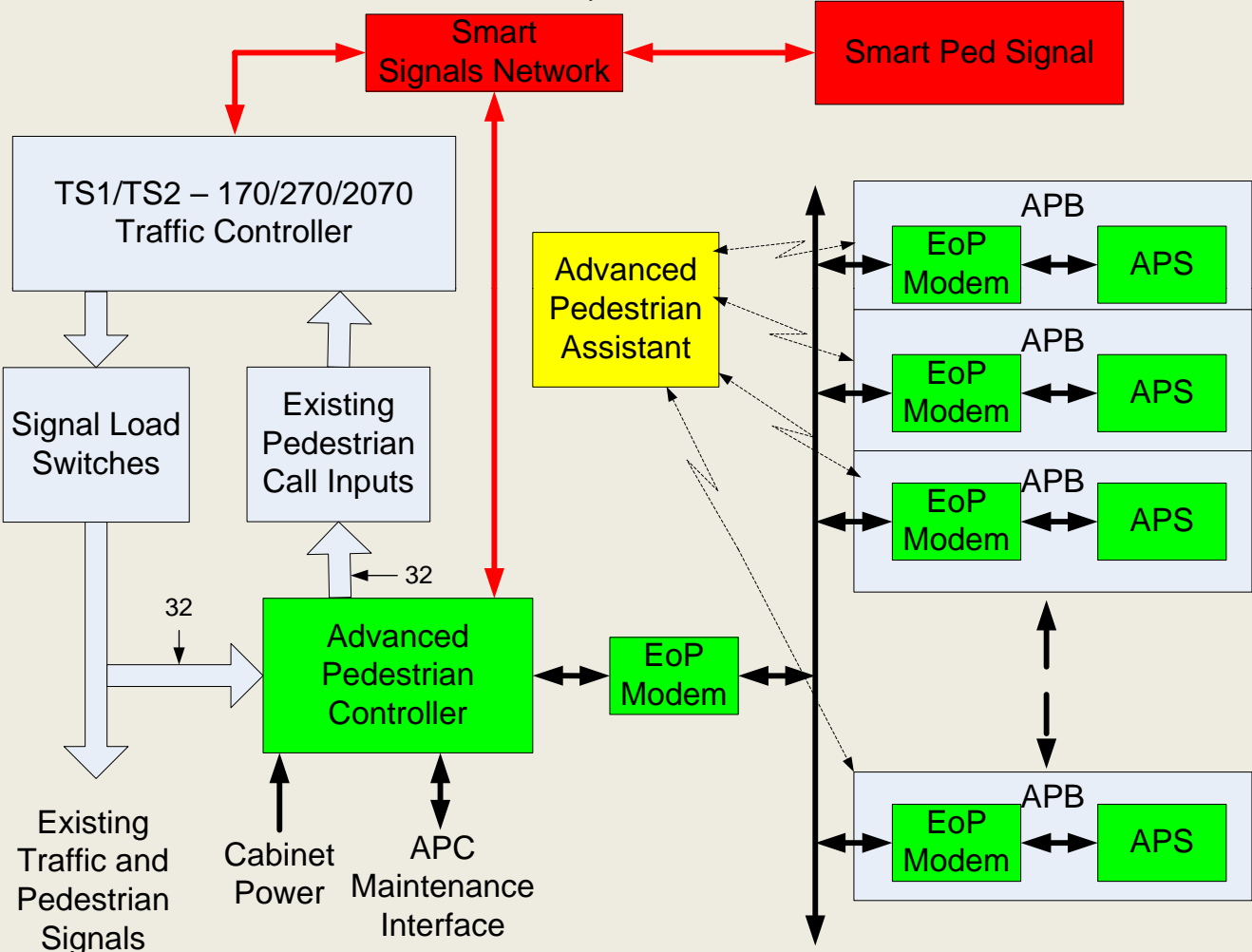
Smart Signals Research

- Advanced Smart Signals Pedestrian Call System
 - Campbell Company
 - ADA APS operations
 - Audio beaconing
 - Night time mode
 - WWVB time synchronization
 - MMU type functionality
 - Uses existing pedestrian button wiring
 - No external wiring to pedestrian signals
 - Low voltage Ethernet over power line
 - Intellon MX5500 200 MB communications
 - WEB based installation and maintenance

AAPS

Advanced Smart Signals Pedestrian Call System

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AAPS Installation and Maintenance

- Single Point programming
- WEB page hosted on APC
- No proprietary software

Smart Signals - Windows Internet Explorer
http://wallonr.ece.uidaho.edu:8080/smart_signals.html

File Edit View Favorites Tools Help
Google G Go [Icons] Bookmarks 27 blocked ABS Check AutoLink AutoFill Settings

Links Bus Canterworld Weather ECE 340 ECE 341 ECE 443 Google Calendar Homepage Kimberly Lawn Our Daily Bread

Smart Signals [Icons] Page Tools

Smart Signals

AAPS System Status	AAPS System Configuration
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System Time

Ped Displays:

1	2	3	4	5	6	7	8

Ped Calls:

1	2	3	4	5	6	7	8

Number of Systems:

APS Mode

Beacon Mode

Night Mode

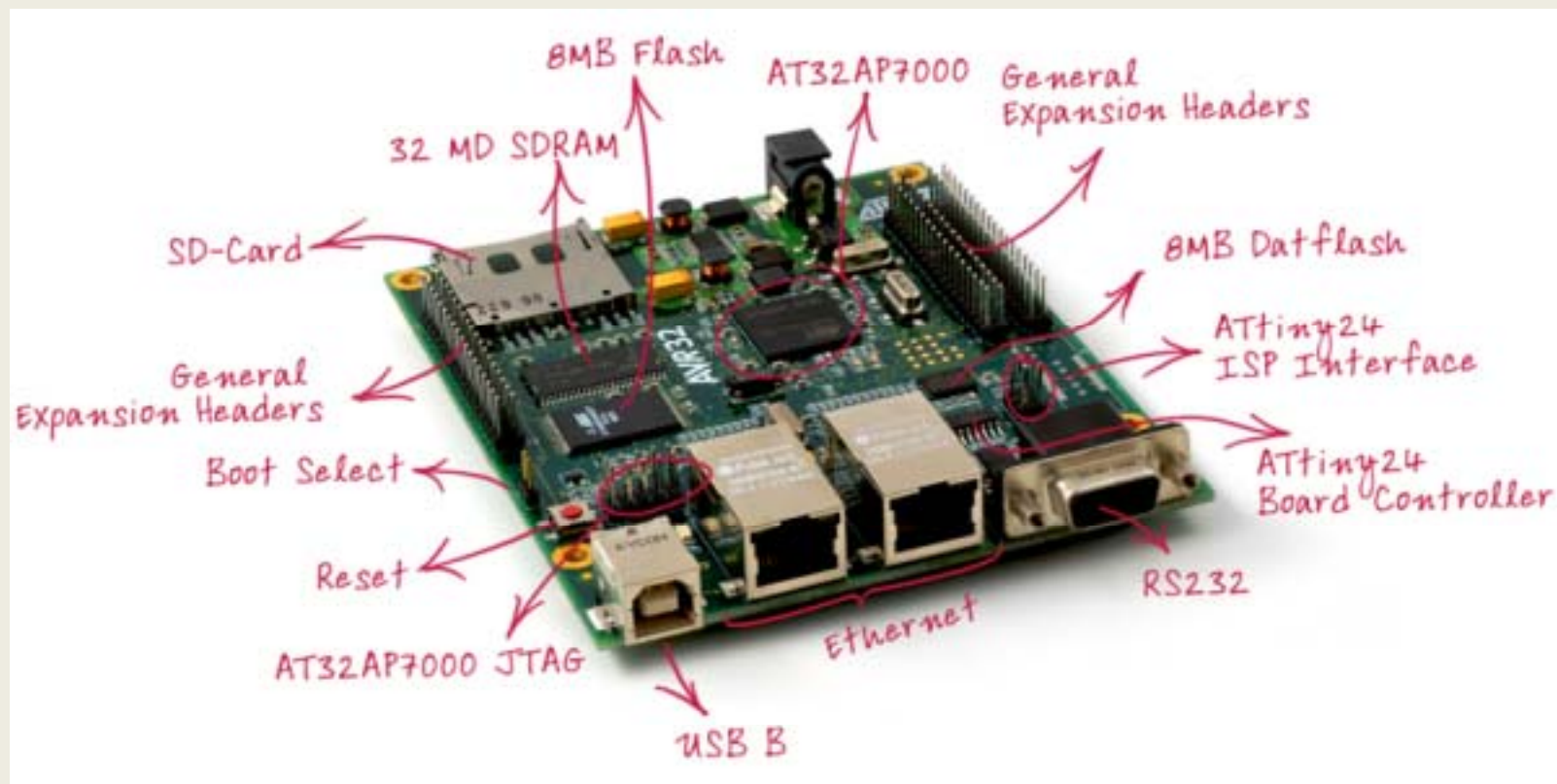
System Time

AAPS Station

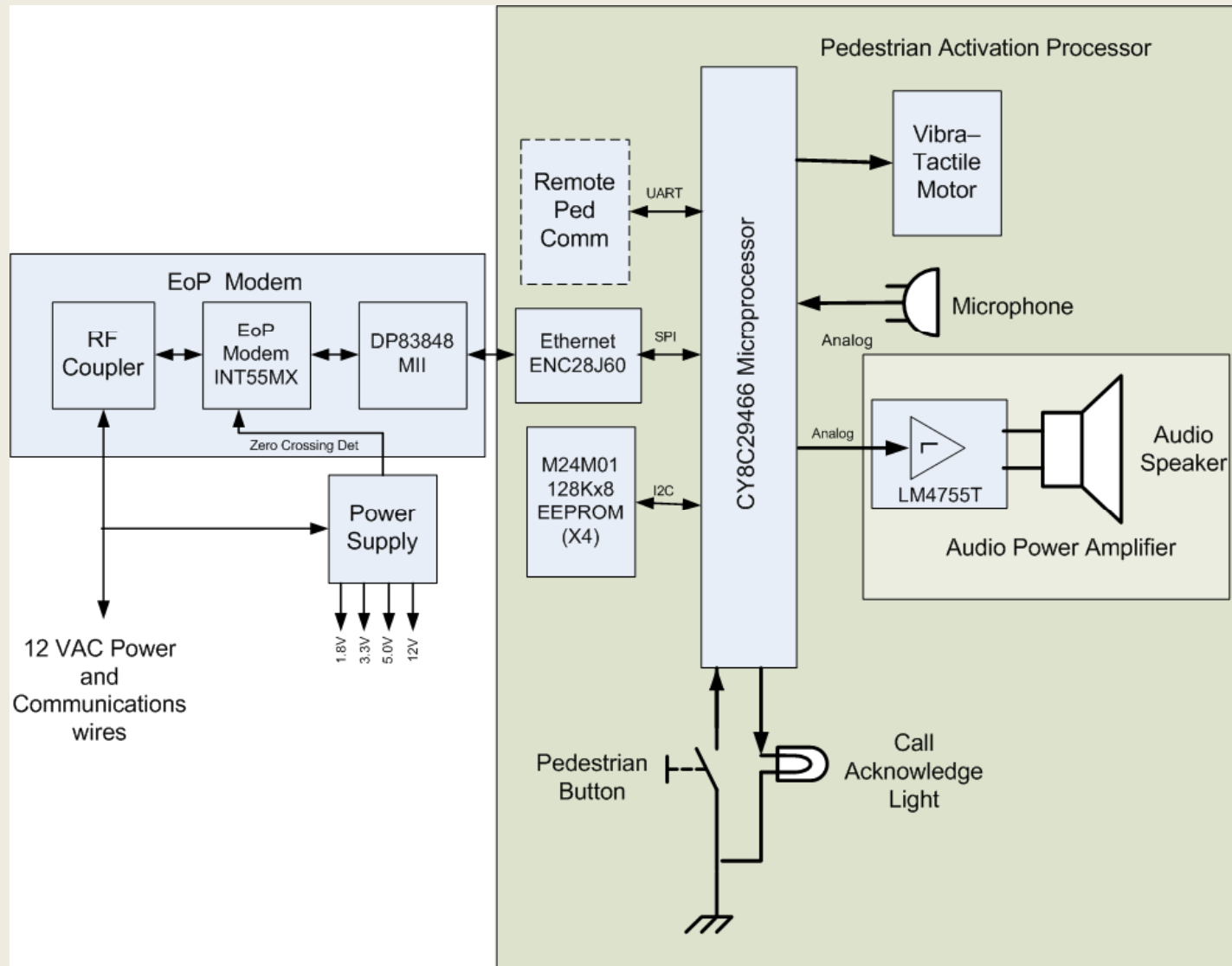
Configuration		Status
Msg 1 <input type="text"/>	APS Group <input type="text" value="2"/>	Button State <input type="text"/>
Msg 2 <input type="text"/>	APS Phase <input type="text" value="1"/>	Audio Msg. # <input type="text"/>
Msg 3 <input type="text"/>	APS Button Hold Time <input type="text" value="2"/>	Ped Calls <input type="text"/>
Msg 4 <input type="text"/>	APS Base Volume (%) <input type="text" value="75"/>	APS Calls <input type="text"/>
Msg 5 <input type="text"/>		Updates <input type="text"/>
Msg 6 <input type="text"/>		
Msg 7 <input type="text"/>		
Msg 8 <input type="text"/>		
Msg 9 <input type="text"/>		

Advanced Pedestrian Controller (APC)

- CPU Network controller
 - \$90 - 200MHZ Linux kernel
 - Free development environment
 - 32MB SDRAM / 16MB Flash / 256 MB SD-card
 - 2 - 10/100 Mbps Ethernet ports



Advanced Pedestrian Button (APB)



Smart Signals Research

Advanced Pedestrian Assistant

- What is it:
 - A handheld device for activation of pedestrian calls
 - Provides orientation and guidance information to user while in intersection
 - Interacts with traffic controller to protect user
- Why is it needed:
 - 4.3 million Americans are severely visually impaired
 - Incidence increases with age
 - By 2010, expect there to be 20 million visually impaired persons over age 45



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Advanced Pedestrian Assistant

- Infrastructure Problems: impediments for vision and mobility impaired



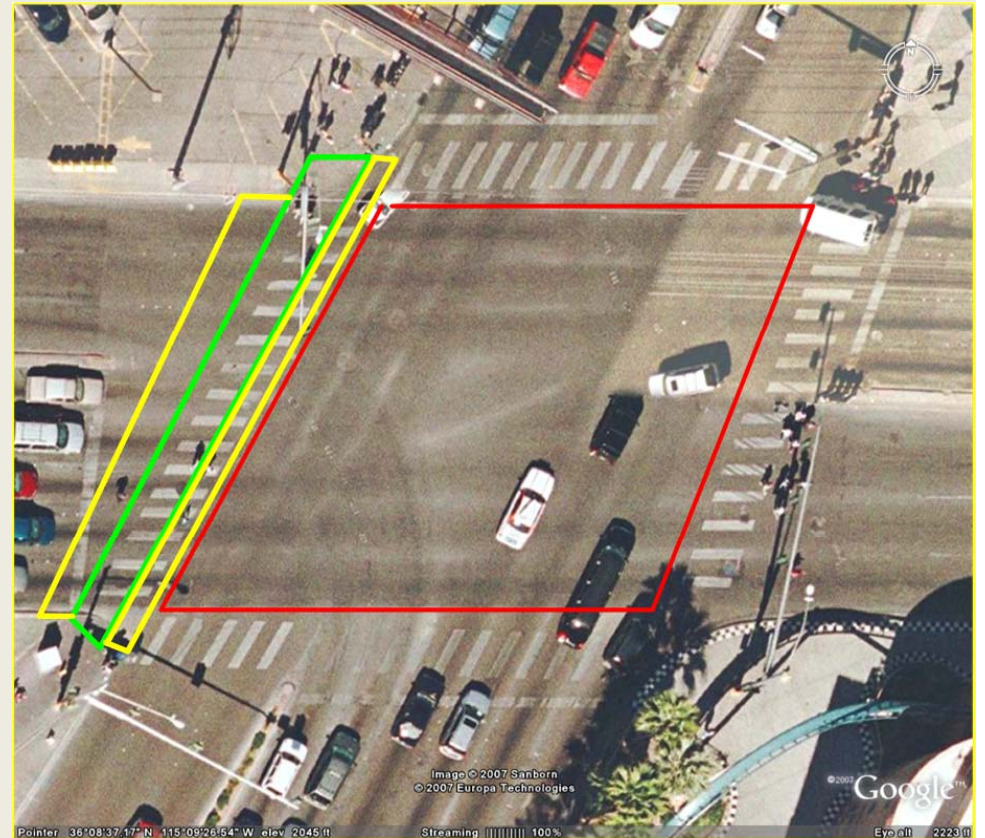
Inaccessible Pedestrian Button



Unusual intersection geometries

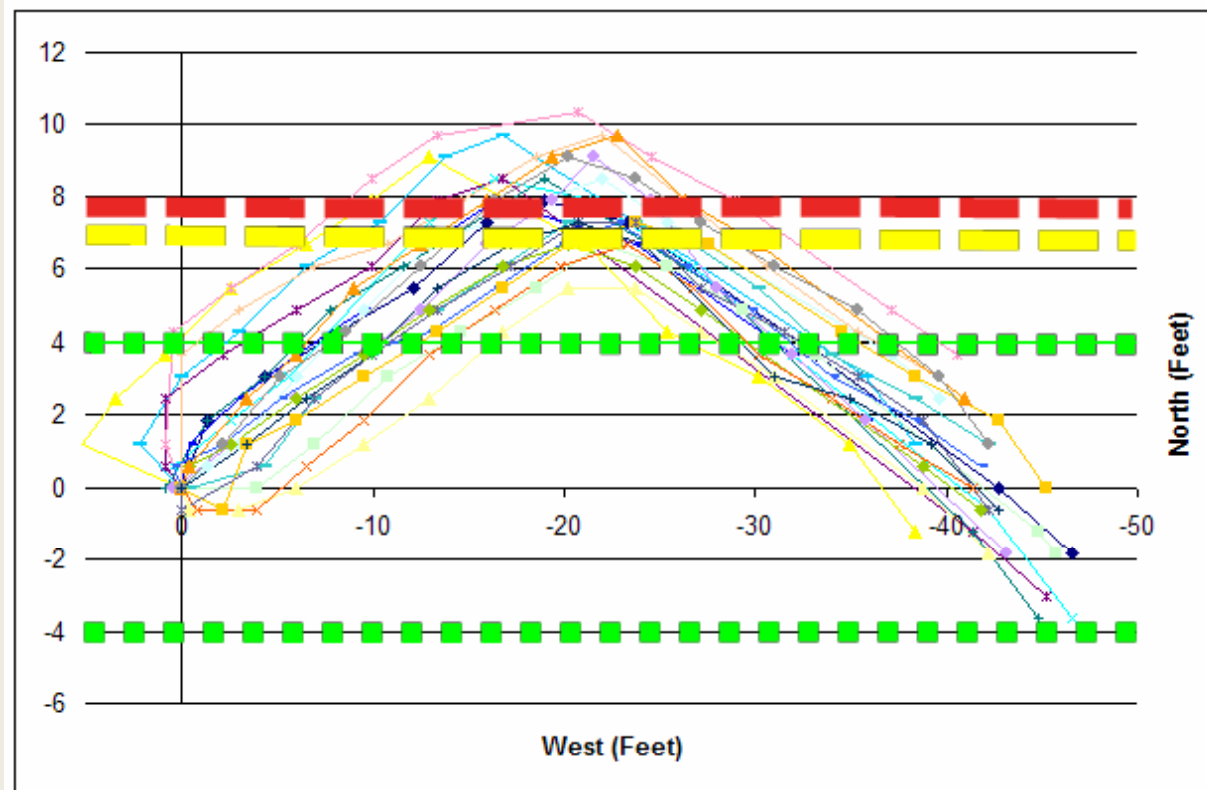
Advanced Pedestrian Assistant

- Functionality
 - Remote pedestrian button
 - APS audible messages
 - Navigation cues to user
 - Traffic control

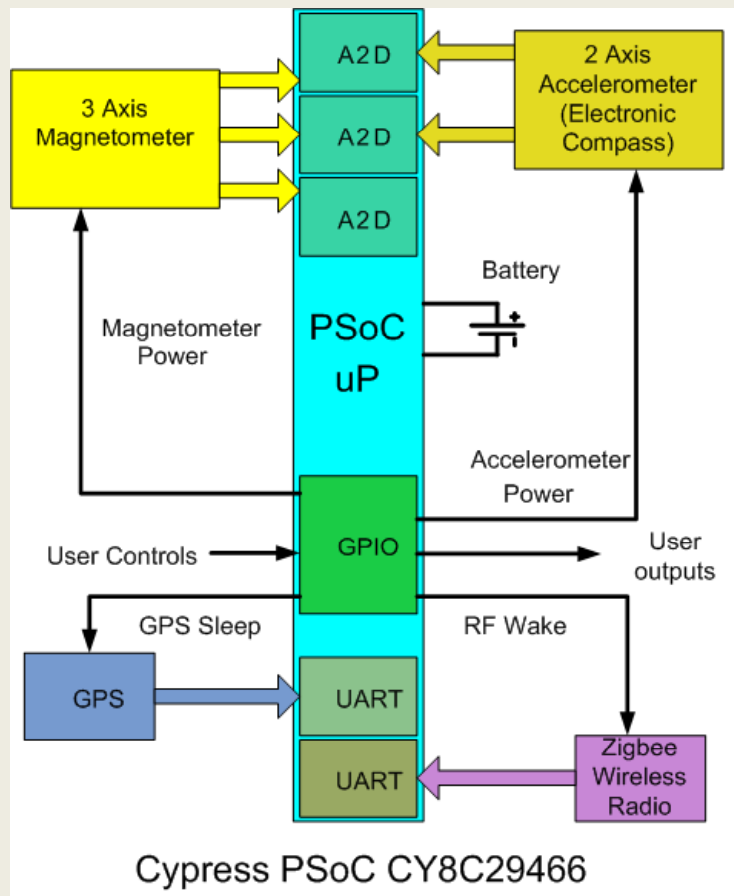


Advanced Pedestrian Assistant

- Preliminary test results



Advanced Pedestrian Assistant



UI System



Nokia 6210

Conclusion

- Pedestrians at intersections can be better served
- Countdown pedestrian timers have limited functionality due to current engineering practices
- Better information can resolve some known issues
- Research in distributed technology for traffic controls is gaining recognition
- Power line carrier has major role in system integration

Questions?



Smart Signals Bibliography

- DeRuwe, Gabriel and R. W. Wall, "Pedestrian Navigation and Integration with Distributed Smart Signal Traffic Controls", Submitted to 88th Annual Meeting of the Transportation Research Board, Washington, DC, January 11-15, 2009
- DeVoe, D. and R.W. Wall, "A Distributed Ethernet Network of Advanced Pedestrian Signals", Submitted to 88th Annual Meeting of the Transportation Research Board, Washington, DC, January 11-15, 2009
- Giri Sanjeev, and R.W. Wall, "A Safety Critical Network for Distributed Smart Traffic Signals", IEEE Instrumentation and Measurement Society Magazine, scheduled for publication – December 2008
- DeRuwe, Gabriel and R. W. Wall, "Pedestrian Navigation and Integration with Distributed Smart Signal Traffic Controls", The 34th Annual Conference of the IEEE Industrial Electronics Society, Orlando, FL, November 11, 2008, Paper # HD-010979
- DeVoe, D. and R.W. Wall, "A Distributed Smart Signal Architecture for Traffic Signal Controls", 2008 IEEE International Symposium on Industrial Electronics, Cambridge, UK, July 2, 2008, paper # CD-004928
- Wall, R.W., T. Urbanik, D. Bullock, S. Allen*, M. Busby*, D. DeVoe*, A. Huska*, T. Rallens* "Distributed Traffic Signal Control: Improving Pedestrian Control as A First Step", Transportation Research Board 2007 Annual Meeting, Washington D.C. January 21-25, 2007, Paper No. 07-0989
- Wall, R.W., A. Huska*, and D. Bullock, "Application of Plug and Play Distributed Signal Technology to Traffic Signals," Transportation Research Board 2006 Annual Meeting, Washington D.C., January 22-26, 2006, Paper No. 06-2728.
- Wall, R.W. and A. Huska*, "Design Platform for Plug-and-Play IEEE 1451 Traffic Signal," The 31st Annual IEEE Industrial Electronics Conference, Raleigh, NC, Nov 6-10, 2005, Paper No. RD-001973.

Pedestrian Safety Links

- [Pedestrian Forum - Summer 2008](http://safety.fhwa.dot.gov/PED_BIKE/ped/pedforum/pedforum_sum08.htm)
http://safety.fhwa.dot.gov/PED_BIKE/ped/pedforum/pedforum_sum08.htm
- [Intersections](http://safety.fhwa.dot.gov/intersections/intersectionsap.htm)
<http://safety.fhwa.dot.gov/intersections/intersectionsap.htm>
- [Senior Pedestrian](http://www.tfhrc.gov/safety/pedbike/facts/oldped.htm)
<http://www.tfhrc.gov/safety/pedbike/facts/oldped.htm>
- [Road Engineering Journal](http://www.usroads.com/journals/p/rej/9710/re971002.htm)
<http://www.usroads.com/journals/p/rej/9710/re971002.htm>
- [No signals](http://www.bikewalk.org/pdfs/trafficcontrol_backtobasics.pdf)
http://www.bikewalk.org/pdfs/trafficcontrol_backtobasics.pdf
- [SPECIFICATIONS FOR PEDESTRIAN LED COUNTDOWN TIMER FEBRUARY 14, 2005](https://www.nysdot.gov/portal/page/portal/divisions/operating/oom/transportation-systems/repository/pcdspec.pdf)
<https://www.nysdot.gov/portal/page/portal/divisions/operating/oom/transportation-systems/repository/pcdspec.pdf>
- NEMA TS2 Standard www.ite.org/standards/ITScabinet/ITS_Cabinet_v01.02.17a.doc
- *Low Vision Pedestrians* <http://safety.fhwa.dot.gov/intersections/roundaboutsummit/rndabtatt4.htm>