Countdown Pedestrian Signals & Role of Powerline Carrier

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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
• 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.
• **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?)*
• 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 devises 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 feedback

• 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
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

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Smarts Pedestrian Signals Software

- Information Flow Diagram
  - 220 ms network update

- Pedestrian Timer
- Pedestrian Status
- NTCIP based communication
- Local Time
- Signal Status

-Control Network

-Pedestrian Call

-Encrypted Power-line Ethernet Communications-
Smart Signals Research

• Advanced Smart Signals Pedestrian Call System
  – Campbell Company
  – ADA APS operations
    • Audio beaconsing
    • 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
Advanced Pedestrian Controller (APC)

Diagram showing the components and connections of the APC:

- Pedestrian Call Inputs to Traffic Controller
- Pedestrian Signal Outputs to Traffic controller
- AC/DC Switch
- AC Sensors
- Pedestrian Management Processor
- WWVB Receiver
- Power Supply
- WAN Ethernet connection to Service Laptop & Traffic Controller
- LAN Ethernet connection to EoP Modem
- 12VAC Power and Communications wires
- Serial data connection

Date: 9/15/2008

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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
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

Cypress PSoC CY8C29466
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

Pedestrian Safety Links

- Pedestrian Forum - Summer 2008
  http://safety.fhwa.dot.gov/PED BIKE/ped/pedforum/pedforum_sum08.htm
- Intersections
  http://safety.fhwa.dot.gov/intersections/intersectionsap.htm
- Senior Pedestrian
- Road Engineering Journal
  http://www.usroads.com/journals/p/rej/9710/re971002.htm
- No signals
  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
- NEMA TS2 Standard www.ite.org/standards/ITScabinet/ITS_Cabinet_v01.02.17a.doc