SMART SIGNAL TECHNOLOGY

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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
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).
49-803. PEDESTRIAN-CONTROL SIGNALS. Whenever a pedestrian-control signal showing the words "Walk" or "Wait" or "Don't Walk" is in place, the signal shall indicate the following:

(1) Flashing or Steady "Walk". A pedestrian facing the signal may proceed across the highway in the direction of the signal, but shall yield the right-of-way to vehicles lawfully within the intersection at the time the signal is first shown.

(2) Flashing or Steady "Don't Walk" or "Wait". No pedestrian shall start to cross the highway in the direction of the signal, but any pedestrian who has partially completed crossing shall proceed to a sidewalk or safety island while the "Don't Walk" or "Wait" signal is showing.

49-702. PEDESTRIANS’ RIGHT-OF-WAY IN CROSSWALKS.

(1) When traffic-control signals are not in place or not in operation the driver of a vehicle shall yield the right-of-way, slowing down or stopping, if need be, to yield to a pedestrian crossing the highway within a crosswalk.

(2) No pedestrian shall suddenly leave a curb or other place of safety and walk or run into the path of a vehicle which is so close as to constitute an immediate hazard.
Problem

• Infrastructure design
  – Archaic design methodologies
  – vehicle centric
• Inaccurate information for abnormal operations
• Technical limitations
  – Countdown pedestrian signals
  – MMU cannot validate pedestrian display and audible messages
• Inconsistent compliance to MUTCD
• Driver attitude
Current Engineering Practices
Current Engineering Practices

Traffic Controller Cabinet – before - - after
Infrastructure Complexity
Contradictory Information
Driver Attitude
Driver Attitude
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
Remote Pedestrian Control
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)
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Smarts Pedestrian Signals Software

- Information Flow Diagram
  - 220 ms network update

- NTCIP based communication

- Pedestrian Status

- Pedestrian Timer

- Signal Status

- Local Time

- Pedestrian Call

- Encrypted Power-line Ethernet Communications
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
Advanced Smart Signals Pedestrian Call System

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AAPS

TS1/TS2 – 170/270/2070 Traffic Controller

Signal Load Switches

Existing Pedestrian Call Inputs

Advanced Pedestrian Controller

Existing Traffic and Pedestrian Signals

Cabinet Power

APC Maintenance Interface

Smart Signals Network

Smart Ped Signal

EoP Modem

APS

EoP Modem

APS

EoP Modem

APS

EoP Modem

APS

APB

APB

APB

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Advanced Pedestrian Controller (APC)
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)
Conclusion

• Pedestrians at intersections are underserved
• 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
• Powerline carrier has major role in system integration
Smart Signals Bibliography


Pedestrian Safety Links

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• Washington Department of Transportation  http://www.wsdot.wa.gov/walk/laws.htm