SMART SIGNALS:

ENABLING TRAFFIC CONTROLLER TECHNOLOGY

CONFERENCE PROCEEDINGS NOVEMBER 2, 2006

INSIDE THIS REPORT:

ABSTRACT

On November 2, 2006, approximately 60 people gathered at the University of Idaho to discuss the potential uses for Smart Signals traffic controller technology, particularly focused on serving the often overlooked needs of pedestrians. Dr. Richard Wall, UI Professor of Electrical Engineering, facilitated the workshop. Attendees represented universities, state and federal agencies, representatives of advocacy groups for pedestrians, cyclists, and people with disabilities. Experts in the design of the Smart Signals technology, as well as traffic experts and groups interested in traffic safety, addressed the assembly. Participants also engaged in question/answer sessions and small group work. The workshop comprised a full day of thoughtful work on the question of how the new technology could best serve the interests of efficient human transportation and safety, the technological and regulatory assets and barriers to its use, and the long term vision for Smart Signals application.

BACKGROUND

The focus of the work shop was how to use technology to improve safety and access for pedestrians with a range of physical capabilities. It is universally agreed that current traffic signal timing practices treat pedestrian with a "one size fits all" attitude regardless of physical capability. When a vehicle and pedestrian collide, the pedestrian always is at the greater risk.

Despite the fact that advanced communications technology exists, a universe of information remains locked in the modern traffic controller cabinet, due to an I/O bound architecture with a limited bandwidth. While the automotive and computer technology industries envision a future where transportation is made safer and more streamlined--thanks to advanced communications between vehicles, signals, and virtually any entity that is network capable-- traffic controllers are currently unable to respond in an interactive manner to real time situations.

Dr. Richard Wall welcomes the group.

For further information on the pedestrian timer research and technology, please see the article at http://seniordesign.engr.uidaho.edu/2005_2006/litebright/index.htm .

Issues of safety and efficiency compel researchers to continue to improve traffic signal technology. Funded by a US Department of Transportation (USDOT) grant, engineers from the University of Idaho's National Institute of Advanced Transportation Technology (NIATT) have been working since 2004 to develop and integrate Smart Signals technology, which utilizes Plug and Play (PnP) distributed signals and sensors and broadband communications, to improve functionality and adaptability of traffic controllers. During the first year, the research team developed a demonstration model using the Smart Signals technology, which could eventually be integrated into an existing traffic controller system. The demonstration model was shown to individuals at the Transportation Research Board in the summer of 2005. A multi-disciplinary research task force was created that fall to discuss the direction of future research in developing an architecture for smarter traffic signals. This team met to discuss and summarize safety and technological concerns. A senior research design project was proposed, which focused on developing a smart pedestrian countdown timer using the PnP distributed sensor network. In 2006, a full-size demonstration model of the countdown timer was developed, and it won awards at the University of Idaho Engineering Expo. The Smart Signals workshop in November of 2006 summarized the group's work to date, and provided the opportunity for reflection and feedback that could ultimately guide future research.

PRESENTATIONS

Welcome, Introductions and Overview of the Research

Dr. Richard Wall, Associate Professor of Electrical Engineering, University of Idaho
Dustin DeVoe, *LightBrite* team member, ECE student, University of Idaho

Dr. Richard Wall convened the conference by welcoming everyone, and by introducing his student research team. The "*LightBrite* Team" as they dubbed themselves, included senior undergraduates Dustin DeVoe, Michael Busby, Ty Rallens, and Steven Allen. The *LightBrite* team designed the pedestrian signal, countdown timer, signal button, and distributed sensor network on display at the workshop.

Dr. Wall then went on to identify the goals of the workshop, which consisted of:

- Focusing the design effort for 2006-2007
- Identifying specific goals and outcomes
- Identifying limitations to the technology
- Understanding the needs of the pedestrian community

The LightBrite Team

Dr. Wall stated that the limited types of information signals are able to receive and convey cause incorrect operations and service to a limited clientele. These result from what he called, "archaic electrical practices," and cumbersome construction which is expensive to install, repair, and maintain. These things, said Wall, mean that intersections are less safe, less efficient, and that the financial cost is great, due to taxes and extended construction delays. However, by redistributing the complexity inherent at intersections, and by creating more dynamic robust systems which harness the latest technology available, Wall said enthusiastically that traffic signals can be "moved into the 21st century!"

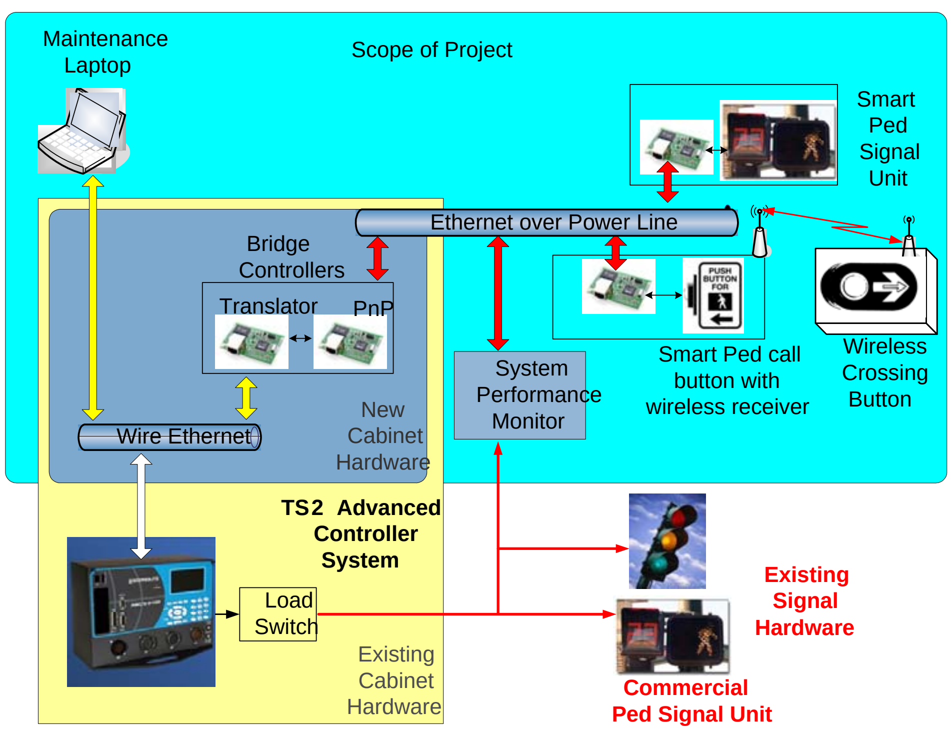
He went on to describe the history of the technology used in modern traffic signals, and the evolution of his own interest in solving the problems caused by its limitations. He had been inspired by presentations at an IECON meeting held in Spain, at which smart sensor PnP networks and the IEEE 1451 standard were discussed- illuminating in his mind the potential for the application of the broadband technology to traffic signal innovation. In 1999, NIATT developed a controller interface device (CID) which allowed for signal timing plans to be simulated using the traffic controller hardware, but the interface with existing controllers was very cumbersome due to the hardware configuration within the controller cabinet. Subsequently, the research project was proposed to streamline and redistribute the intelligence at intersections, and Wall's team began their work.

Research team member Dustin DeVoe went on to describe the project. Through the senior design project of 2005-2006, students used an ASC/3-2100 series traffic controller made by Econolite, which uses National Transportation Communications ITS protocol (NTCIP) to interface with existing hardware at intersections. The students also designed the sensor network, pedestrian call button, and countdown display that would operate at the intersection.

The Lightbrite team developed this Smart Signal design using Distributed Signal and Sensor Network (DSN) technology to improve traffic intersection control.

Included are four prototype DSN Devices:

–Pedestrian Signal
–Countdown Timer
–Crosswalk Button
–Wireless Button



Future Home of the Smart Signal demonstration site:

6th & Deakin
Moscow, Idaho

The researchers discovered that the new Smart Signal design protocols were easy to set up—making use of Ethernet over a power line, while the AC power allowed smart devices to identify their own capability and functionality-but did require configuration management to assign the spatial orientation of the equipment. They also found that the design solved the problem of pedestrian timer accuracy, and that many new features were possible, allowing for expanded interactivity with users. These features included crosswalk button acknowledgement, a remote wireless button for the disabled, variable power levels for improved visibility under different environmental conditions, and dynamic signaling to accommodate timing changes and emergency preemption.

The student team identified several possibilities for the future application of their design, including:

Senior Designer, Dustin DeVoe

- An IEEE Standard for traffic networks
- Fully implemented Plug and Play traffic intersections
- The elimination of the centralized traffic controller
- Third-party devices for pedestrians, including the disabled and children, plus cyclists
- Communication with vehicles
- Video sensors

The next step, said Wall, is to set up the system at an existing intersection. The corner of 6th and Deakin, on the University of Idaho campus in Moscow was chosen due to the fact that it is an isolated actuated intersection with a major access point to the campus, and it experiences a high volume of pedestrian and bicycle traffic. It is also a common approach for emergency vehicles. Additionally, the amount of equipment required to set up the system would be limited, and there is a place to mount cameras. Here, the research team hopes to build and test a pedestrian traffic signal designed for people who are vision impaired and mobility handicapped, while demonstrating the capability of intelligent traffic signal design and implementing safety critical Ethernet control.

DeVoe and Wall concluded their presentation by saying that the potential for this design is far-reaching, and may provide the entry point into larger scale technological innovation by dovetailing with new movements in traffic safety and design, including VII, or Vehicle Infrastructure Integration—discussed later in this paper; the Cooperative Intersection Collision Avoidance system, or CICAS; Accessible Pedestrian Signals (APS), which provide non-visual pedestrian timing information to users; and the Sustainable Transportation movement.

Sarah Hubbard
Purdue University

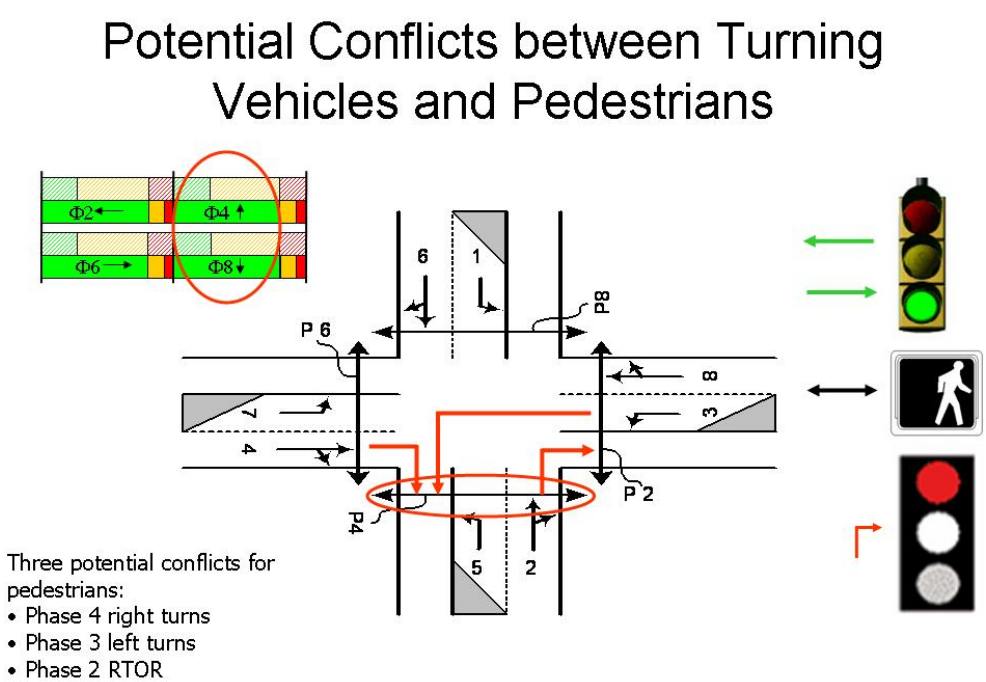
Level of Service for Pedestrians

Sarah Hubbard, Purdue University

Sarah Hubbard from Purdue University addressed the group on the subject of measuring Level of Service (LOS) for pedestrians crossing at intersections. She stated that there are several common myths regarding pedestrian safety, including the myth that a green light means that it is safe to cross, that a pedestrian is safe in the crosswalk, and that a driver will stop if a pedestrian is in the crosswalk or at a green light. She asserted that there needs to be a measure of effectiveness (MOE) to show that pedestrian crossing improvements are occurring. The 2003 Manual of Uniform Traffic Control Devices (MUTCD) indicates that concurrent pedestrian service with traffic flow is safe for pedestrians, assuming that right turning traffic will yield if pedestrians are present. However, Hubbard wanted to document what she believed was a high incident of driver failure to yield, through a survey, in order to determine if there was a need for a safer phasing or signal option.

Using multiple choice questions and video clips, she surveyed 37 law enforcement officers from West Lafayette, Indiana, 176 internet users, and 45 older adults. On a scale from 1-6, participants were to indicate whether a drivers in the video clips failed to yield, and whether or not a citation was warranted. In general, the surveyed group indicated that if the pedestrian was in the intersection, but had to hurry or stop or step aside to avoid traffic, a citation was warranted. However, if traffic volume prevented the pedestrian from leaving the curb at all, then there was no citation indicated for the turning traffic, despite the fact that the pedestrians had a walk indicator at the time.

Hubbard said that the Highway Capacity Manual level of service measurements do not capture the benefits of pedestrian signal timing strategies. She proposed to quantify the impact of turning vehicles on pedestrian service through a measurement called “Percent Compromised.” A good LOS measurement, she said, is quantifiable, can be estimated based on existing data, can be confirmed by observation, and allows comparison between timing strategies. The Percent Compromised measurement distinguishes between a “non-conflicting” crossing— where there is no delay or change in path or speed due to turning vehicles, and a “compromised crossing” where people have to pause, run or change path due to turning vehicles. She calculated the percentage of each type at thirteen intersections in urban areas: five in central business districts (CBD), two in shopping districts classified as CBD, and six non-CBD intersections.



The sight impaired pedestrian must not only navigate through traffic, but must also be able to locate pedestrian call buttons, which are often inconveniently placed or impeded.

Her study demonstrated that as the number of right turns correlate with the number of compromised crossings, a conflict which is not considered in most timing equations. She also found, however, that the number of conflicts was lower in the central business districts than in suburban areas with a higher speed and a lower pedestrian crossing rate, presumably because drivers in a CBD are more cognizant of the larger number of pedestrians present, and expect to yield. The number of compromised crossings, she said, indicates some intervention, such as a leading pedestrian interval, is needed when considering the timing of the intersection. She also found that the right turn rate is more critical than the pedestrian flow rate in predicting whether or not a crossing will be compromised, though the HCM equations currently favor the pedestrian flow rate. These results have led her to conclude that "If we are going to improve pedestrian service at signalized intersections, it is important to develop a new MOE that is sensitive to improved phasing."

Sarah Hubbard responded to several questions, acknowledging that she knows of several instances in which pedestrians were struck by vehicles failing to yield. She also noted that traffic timing simulation programs are lacking in their consideration of pedestrian timing calculations, and operate under the assumption that vehicles will yield. In the absence of good testing procedures and metrics, Hubbard's assertion at the beginning of her presentation is reinforced-- that crossing a street is often a matter of "divine intervention and good luck."

Needs of the Blind and Visually Impaired Users

Jeanne-Marie Kopecky, Mobility Instructor, Idaho School for the Deaf and Blind
Carol Baron, Outreach Director, Idaho School for the Deaf and Blind
Michael Graham, Mobility Specialist, Idaho Department of Vocational Rehabilitation

Jeanne-Marie Kopecky of the Idaho School for the Deaf and Blind spoke to the group about the skills and challenges of pedestrians who are visually impaired. Currently in Idaho, she said, there are 450 children from birth through high school age who are visually impaired or blind. 4.3 million Americans are severely visually impaired, 1.1 million are legally blind, and as people age incidents of visual impairments increase. And though most adults and children who are visually impaired have some usable vision, many tools and adaptations are necessary in order that they may safely navigate streets and intersections. In order to be an independent traveler, said Kopecky, one must be trained in active sensory use and concept development. Motor development, formal orientation and formal mobility skills must be honed in order for a visually impaired pedestrian to detect the locations of intersections, obstacles, and changes in traffic pattern, sidewalk texture, and directional orientation.

For those who have limited vision, glare or poor lighting and poor weather present challenges for detecting the situation at an intersection. The blind and visually impaired are also challenged to anticipate the environmental layout of an intersection and location of the crosswalk, to locate pedestrian call buttons, and to listen for idling or surging traffic.

Jeanne-Marie Kopecky, Carol Baron and Michael Graham

Michael Graham, who is blind, declared his presentation time to be a PowerPoint-free zone. This simple statement amused and enlightened the visually dependent audience, who so far had enjoyed a morning of visual presentations, including colorful slides, charts, and video clips. Graham asked his audience to imagine that they were in the center of a dome, where the perimeter indicates one's auditory horizon. In a public place or outdoors, he said, much of the sound is not useful. Only the useful sound is considered within the horizon. Therefore, as a blind person navigates the world, his auditory horizon changes in response to ambient noise and the hearing level of the individual. A blind person's safety correlates with the size of his auditory horizon. At large intersections, most individual's horizon is inadequate.

Graham's research studied the rate of dual impairment and its impacts. As a generation ages, the rate of dual impairment increases. Visual and hearing impairment, or some form of sensory impairment, plus motor impairment, such as arthritis or joint replacement, create severe impediments to mobility. Orientation becomes difficult, and the individual is less likely to travel independently. Graham was hopeful about modern adaptive technology, such as GPS systems with vibration, for providing locational information to people with visual impairments.

Carol Baron, who is sight impaired, wished to convey to the group that she is very excited about possible innovations that will make mobility easier. Mobility skills are the most important asset, she stated, though new technology, such as remote pedestrian call buttons, GPS devices that give and auditory or signal with tactile feedback, and renovations made to intersections to clearly define crosswalks are a great help. The audience then engaged in a discussion with speakers about inconsistencies at intersections: pedestrian buttons are not in a predictable or accessible location, sidewalks do not lead directly to crosswalks, and there are no indicators for a diagonal crossing.

The Federal Highway Administration's Vehicle Infrastructure Integration Initiative

Gary Duncan, Econolite Control Products, Inc. Anaheim, California

Gary Duncan, Econolite

Gary Duncan of Econolite presented information on the Vehicle Infrastructure Integration Initiative, which seeks to harness new technologies to create a vehicle to vehicle and vehicle to roadway communications system envisioned to be deployed in all vehicles by the automotive industry, and on all major US roadways by the transportation public sector[1].

Duncan began by describing what he termed, "a national crisis," that is the fact that approximately 42,000 people are killed every year on our roadways, and that vehicle related accidents are the leading cause of death for Americans four to thirty-three years old. Most of these accidents occur at intersections. The financial cost to the economy is $230 billion per year. Traffic injuries cost employers $60 billion per year. Traffic congestion costs Americans $63 billion per year. Traffic congestion wastes billions of gallons of fuel.

[1] http://www.its.dot.gov/vii/vii_overview.htm

FIGURE 1: VII COMMUNICATIONS SPECIFICATIONS

- **Dedicated Short Range Communications (DSRC)**
- **FCC Regulated 5.9 GHz**
- **802.11p Wireless technology**
- **Vehicle speed (up to 120 mph)**
- **Communication range (up to 1000 meters for special vehicles; nominal is 300 meters)**
- **System Latency (< 50 ms)**
- **Data rate (default is 6 Mbps; up to 27 Mbps)**
- **Single transaction size (up to 20K bytes)**

The purpose of VII, he stated, is "to enable a number of new services that provide significant mobility, safety, and commercial benefits." The specifications for VII are listed in Figure 1.

VII comprises a consortium of agencies, including eight automobile manufacturers, private sector companies, and transportation agencies, including the US Department of Transportation, Industry Canada, the American Association of State Highway and Transportation Officials (AASHTO) and ten state transportation agencies. By 2008, the coalition intends to have developed the completed standards, and begun field operations testing. By 2010, all new vehicles and the roadway infrastructure is to be outfitted with a nationwide DSRC network. The US Department of Transportation has committed to invest $3 to $10 billion.

Duncan showed a video, produced by Motorola, one of the private sector firms in the consortium that presented some the possibilities for the VII initiative. The film showed a scene depicting a family attending a sporting event on a snowy day. As the family drove their car, their onboard unit interfaced with a DSRC transponder which warned them of snow plows and unplowed roads, careless drivers and a burned out turn signal bulb. The vehicle also interfaced with the traffic signals on their route for real time detection and timing response. Upon arrival at the sporting event, a parking reservation was made, the parking fee was charged to the individual's credit card, and directions were given to the reserved space. Equipment showcased in the video included a signal controller and sensor array, an onboard computer and display, a roadside unit and roadside equipment cabinet, all interfaced via a network connection with a traffic management center server.

The video elicited a certain amount of nervous laughter, as participants absorbed the possibilities and considered issues of privacy. Duncan read the room's response, and mentioned that the system would keep identifying information private within the network, unless one opted in for certain features.

VII would bring broadband service to every intersection, using an IEEE protocol. Through this connection, a long list of uses is possible. Some of these are included in Figure 2. Duncan elaborated on ways that VII would bring increased safety at intersections, as well as a variety of innovations to traffic control. The big efforts behind VII, he explained, are safety related.

The Intelligent Transportations Systems (ITS) America Outreach Program is a partnership of ITS America members, ITS state chapters, and local departments of transportation. The VII Technology Showcase, put on by the program seeks to demonstrate the feasibility of the VII Initiative at national expos and

FIGURE 2: VII USE CASES

Wireless communication enhances driving safety and mobility:

- **Intersection Safety**
  - **-Signal violation warning**
  - **-Cooperative Intersection Collision Avoidance System (CICAS)**
    - **Cooperative effort between intersection controller and CICAS application processor (internal or external to controller)**
  - **-Left turn gap acceptance**
  - **-Dilemma zone elimination**
  - **-Automatic arterial incident detection**

- **Traffic Control**
  - **-Improved control using probe data to supplement local vehicle detection**
  - **-Probe data (speed, location, ETA, trajectory, etc.)**
  - **-Transit and emergency vehicle priority/preemption**
  - **-Data collection for transportation optimization**
  - **-Improved performance measures**

fairs. Duncan encouraged interested individuals and agencies to "join the debate and get involved with the program." He stated, in light of the earlier presentations of the day, that only with outside involvement would the VII scope be broadened to encompass considerations involving the specialized pedestrian needs discussed at this workshop.

Richard Wall wondered aloud why the VII program is not instead the UII program, standing for User Infrastructure Integration, to encompass all modes.

For more information of the VII initiative, please see http://www.its.dot.gov/vii/ .

Smart Signals: What Will It Take to get Industry Acceptance?

Paul Olson, Federal Highway Administration Resource Center. Denver, Colorado

Paul Olson took the podium next, and declared, "I'm with the Feds, and I'm here to help!" He began his presentation with a history of traffic controller technology, demonstrating that things haven't changed in a long time. Many existing systems at intersections have been around since the 1970's, and the PnP technology represents a "completely new concept."

In order for the change to intelligent systems to be accepted the following things need to take place, stated Olson:

- Users need to understand the technology
- Users need to put it in procurements
- Manufactures must be willing to build it
- Users must actually put it to use
- There must be a long term commitment

But there is a Catch 22, like with the development of Biodiesel fuels. Olson described it this way: "If manufacturers don't build it, users won't buy it. If users don't demand it, manufacturers won't build it." And Olson asked the hard question: "Who's Gonna Pay?" Because most agencies don't have the money for product development and manufacturers may not risk development without demand, funding sources present one hurdle in the acceptance of the Plug and Play technology.

Additionally, Olson said that questions concerning standards will have to be considered. A widely accepted standard would be needed, since standardization at intersections is absolutely critical. He asked, "Who will develop the standard? Who will test it? How will interoperability be defined and assured?" Further, Olson wondered if customers, once they have purchased a unit, will be able to easily test it. And finally, he wondered how an open architecture can be assured, and the product not become proprietary?

Olson then went on to address the marketing of the technology. Customers need to become aware of its advantages, and somehow momentum must be built. He asserted that with all successful innovations, such as the PC, there has to be what he termed, "a killer application." That is, there needs to be one use of the product that is so essential, that it becomes the standard for the industry, as the spreadsheet did for the personal computer. He asked the group to consider if the Smart Signals technology has such an application, and if so, can it be retrofit into existing signal technology, so consumers will want it. Olson proposed that the Vehicle Infrastructure Integration Initiative may provide the movement to market the technology.

Paul Olson:

"If manufacturers don't build it, users won't buy it. If users don't demand it, manufacturers won't build it."

The product, he continued, would have to go through a series of approvals. There would need to be successful field tests, and the product must meet industry standards such as those set by National Electronics Manufacturers (NEMA), the Institute of Traffic Engineers (ITE), the Institute of Electrical and Electronics Engineers (IEEE), the Manual on Uniform Traffic Control Devices (MUTCD), and perhaps others, such as the Americans with Disabilities Act (ADA). Olson concluded by saying that it is good come together for information gathering, to determine the next steps, and "what we have not yet realized."

Olson was asked what he considered to be the next steps, and he stated that the development of field demonstrations for marketing would be logical. The proposed field test at Sixth and Deakin offers an opportunity for demonstrating success. Other means of demonstrating success, Olson concluded, are fewer traffic deaths and injuries, and signal timing efficiency that takes into consideration all modes, including pedestrians. The safety and efficiency measures increase the likelihood for endorsements from organizations such as IEEE.

Paul Olson, Federal Highway Administration Resource Center

Manufacturer's Needs and Requirements

Gary Duncan, Econolite Control Products, Inc. Anaheim, California


Gary Duncan and Richard Wall

Gary Duncan resumed his place at the podium to discuss Smart Signals implementation from a manufacturer's point of view. He began by revisiting the changes in technology from TS1 to TS2 to ATC, explaining that with the evolution of the I/O interface from parallel to serial to Ethernet, current technology allows for smart controllers, cabinets and sensors. However, the signal display and the method used to control it remains simple and somewhat constrained. He said that there needs to be a market driving force to spur change, as "manufacturers are capitalists, and will respond to the marketplace."

Duncan identified the following criteria for manufacturer acceptance of Smart Signal acceptance. He said that the technology must:

- **Conform to existing signal display standards (ITE, MUTCD, etc.).**
- **Be functionally equivalent to existing approach and provide additional benefits.**
  - **Ball, arrow, flashing, Pedestrian, light rail T, etc.**
  - **What user needs are solved or benefits generated?**
- **Be easy to use and install.**
  - **Installation done by untrained contractors**
- **Work with established infrastructure.**
  - **Easily retrofitted to existing installations and field wiring**
- **Be as reliable as the current approach.**
  - **Survive in the existing environment and require little if any maintenance over product life**
- **Be safe.**
  - **Implies that the signal display must fail safe and be able to be monitored by a separate monitoring unit**
  - **Liability issues will have a bearing on acceptance**
- **Have a long usable life with minimal maintenance.**
  - **Current signals may be in place for decades**
- **Not force a major change to the controller/cabinet design.**
  - **A hurdle to acceptance will be that the controller will have to be changed to use the Smart Signal concept**
- **Be based on standards.**
  - **Ultimate market acceptance will require standards that allow supply by multiple vendors**
- **Be cost effective and relatively low cost.**
  - **Current traffic and pedestrian signals are a commodity item**

In order to overcome these challenges Duncan said that the technology must address major issues facing the traffic industry, such as increased safety and efficiency. There needs to be "viable user benefits," such as the "killer application" that Paul Olson identified. An early adopter or champion of the technology needs to be found who will validate the benefit of the technology. And finally market data needs to be gathered to support NRE (I don't know what this means- non-recurring expense?) and to show a reasonable return on investment.

Dr. Tom Urbanik

Photo courtesy of University of Tenessee College of Engineering website

Technical Requirements for Improved Pedestrian Operations

Dr. Tom Urbanik, professor of Civil Engineering, University of Tennessee, Knoxville

Dr. Urbanik began by stating that pedestrians have always been part of the traffic equation, and though often ignored, he has a hypothesis that "We can improve pedestrian operations and improve traffic flow through smarter traffic signals." Signal operation, according to Urbanik is part science, and part policy. The traffic flow principles, time- space relationships and the calculations used to measure performance are all considered within the framework of traffic policies, which are created based on perceptions of acceptable performance, and a balance of competing objectives. "Successful signal timing," declared Urbanik, "understands both (the science and the policy aspects.)"

One can examine the policies used today from several perspectives. Prioritization in traffic control offers a snapshot of the current setting. Drawbridges and the railroad take preemption over all modes, even emergency vehicles. According to Urbanik, pedestrians are low on the list, and pedestrians are considered to be "a relative hazard"—that is, it is worse for a train to hit a car, than a car to hit a person.

Improvements made to improve safety for pedestrians, such as the countdown timer, offer a partial solution to a complex problem, according to Urbanik. The pedestrian still needs to be able to navigate complicated intersections, be visually able to read the information being given at the signal, be spry enough to get across the intersection in the time given, and is still at the mercy of turning traffic, which may or may not yield. Timing policy has changed over the years, improving, to a certain extent, the odds that a pedestrian can make it all the way across the intersection during the ped green phase. However, in many situations, a pedestrian is still stranded on an island in the middle of the street, or is forced to cross against the light, at his peril.

What's Wrong with this Picture?

Smart Signals pedestrian control offers an opportunity for improvements in capacity and safety, while creating less delay, according to Urbanik. Using a new core logic model, timing can be implemented according to priority based control. The VII initiative creates a vision for a truly interactive intersection with a logical prioritized timing response. Pedestrians can be offered their place in the interactive loop through improvements in the call button technology, including remote activation through wireless technology. For the sight impaired, Urbanik proposed a handheld GPS unit with technology that would allow users to communicate with the intersection hardware, indicating the pedestrian's distance from the intersection, and special needs for crossing time, etc.

Priority based control is becoming more common, according to Urbanik. The signal control concepts are changing, and standards are being established. He encouraged more research and involvement, in order that new technologies can be harnessed to create a user-based transportation system with increased efficiency and safety.

The audience asked several questions of Urbanik about potential uses for the GPS technology, and measures of success. Urbanik stated that simply stretching the potential uses for the technology and trying these new things would be the first measure of success. There was a consensus during this post-presentation dialogue that these new technologies should be applied to all modes of transportation- that a wheelchair is as much a vehicle as an SUV.

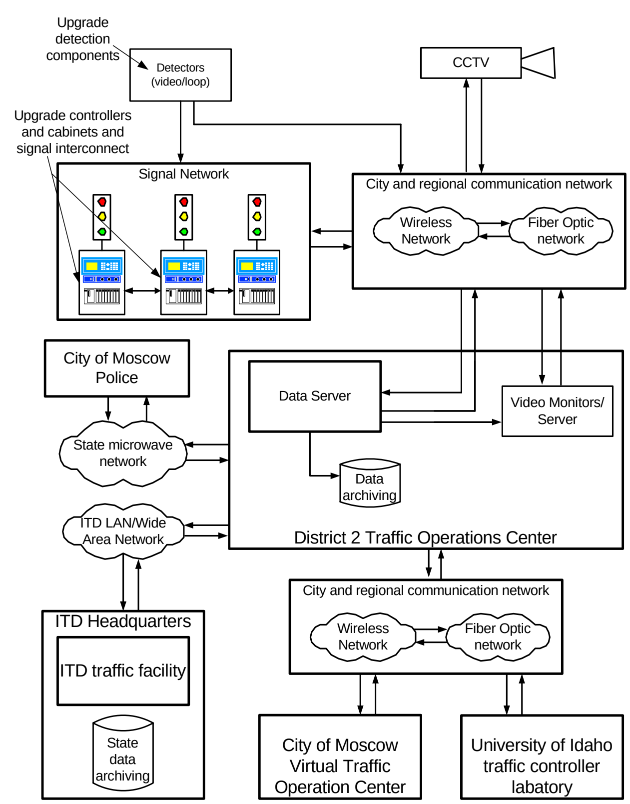
Dr. Ahmed Abdel-Rahim
Photo courtesy of the UI website

Moscow Intelligent Traffic System (ITS) Project

Dr. Ahmed Abdel-Rahim, University of Idaho

In the afternoon session, Dr. Abdel-Rahim addressed the group in order to describe the Moscow Intelligent Traffic System Project, which focused on the development of a controller interface device (CID) which would allow for the traffic controller hardware to be linked to different simulation environments, and which would allow for remote data gathering and monitoring of intersections in Moscow. A multidisciplinary team, including civil, mechanical and computer engineers, in partnership with private industry, local and state government, and regulatory agencies responded to the statewide ITS strategic plan, which recommended signal integration as a high priority for addressing traffic flow problems. Additionally, through this project, a HILS (Hardware in the Loop Simulations) laboratory is being developed, while new NTCIP standards are being tested in a small city environment.

City Of Moscow Traffic Signal Integration Components as Identified by stakeholders needs



The project has resulted in improved control and coordination of traffic signals, surveillance of traffic, and monitoring of malfunctions in traffic controllers. Meanwhile, other functions, such as transit vehicle priority, highway-rail intersection coordination, emergency vehicle preemption and other IP communications applications are being explored.

Through the ITS project a fiber optic communications network was created that connects all sixteen intersections in Moscow, Idaho with various state and local agency traffic control offices; and controllers, cabinets and software have been upgraded. So that now, NIATT engineers can observe traffic patterns in real time, and can use data in an educational environment. Also, data is collected and archived, and there is the potential that data can be collected, using the ITS system, when the Smart Signal test takes place at the intersection of 6th and Deakin, providing Dr. Wall and the *LightBrite* team with essential information.

Dr. Abdel- Rahim concluded that the primary lesson learned from the ITS project was that though it takes time and patience, it is a powerful experience to work on a large project with a multidisciplinary team and various stakeholders in order to bring a vision to fruition.

PowerPoint slides from the day's presentations are available online at :
http://www.webs1.uidaho.edu/niatt/Conferences/Presentations.htm

Small Group Work

The final hours of the workshop were spent on pooling the expertise in the room into small groups to work on several questions pertaining to the application of the Smart Signals technology. Dr. Wall had color-coded the nametags of participants in advance, so that groups could focus on specific topics. The subject matter was divided in the following manner:

Group A: Accessible Pedestrian Buttons
Group B: Traffic Controller Technology
Group C: Traffic Controller Regulations
Group D: Moscow Smart Signals Installation
Group E: Vision and Long-Term Work

Each group met and considered facets of the problem they had been assigned. The group then created a presentation, and a representative reported the results of their discussion to the assembly. The results from each group are reported below.

Group A: Accessible Pedestrian Buttons

Group A discussed the difficulties involved in safe and efficient pedestrian crossing, especially for the disabled. They brainstormed different ways for signal activation and crosswalk design to be better accessible to any individual.

Three difficulties that they identified included clearance time, ease of use of the pedestrian call buttons, and orientation at the intersection. The group emphasized that although their suggestions have particular advantages for the hearing or sight impaired, that broader considerations for ease of use should be considered for all modes and all pedestrians, including the "temporarily able-bodied people" that use the intersection.

The group suggested several improvements to ensure that a pedestrian would have adequate time to cross an intersection. These included a square sign to tell turning traffic to yield to pedestrians, a timing protocol which would respond to a call which indicated that a person needed additional time to cross, and a detection system that would tell the timer that a person was still in the intersection (with a maximum time limit.)

The group also suggested improvements to features in the intersection which would better orient pedestrians, such as yellow lines, grooves, or rails for the sight impaired, pedestrian buttons which are consistently placed and easy to find, and information provided in Braille, alerting the pedestrian to the number of lanes one is required to cross. Improvements to the call button could include a remote button- integrated into a cell phone or GPS system, or placed on the rails orienting users to the intersection, and an auditory or vibrational response to confirm activation. Also, audio countdown timers, and signals that intensify in brightness when activated by a sight impaired person were encouraged.

The group encouraged researchers to use video data gathering and human testing to get a real feel for what different users experience. They also recommended that the research team get information from different advocacy groups about the needs of people with different disabilities.

Group B: Traffic Controller Technology

There was a consensus in Group B that the time is right to use the current technology for improving traffic controllers. The technological tools exist, the needs of pedestrians and the disabled are starting to be acknowledged and defined, and there is a real opportunity to leverage the efforts of the VII initiative to include the needs of this population.

The challenge lies in getting the needs of the users articulated. There is not a consensus among advocacy agencies or the users themselves. Another challenge is that the technology needs to be deployed at the same time and in the same way. Users do not want to have to learn different systems or use different interfaces. Also, policy makers need to be educated and spurred to champion the cause of these improvements. And finally, a business case needs to be articulated, demonstrating a tangible return on investment, and perhaps, the aforementioned "killer application."

The group suggested some improvements to the current proposed technology, including better phasing for the visually impaired, and a means to sense and communicate to the visually impaired the presence of traffic in opposing and adjacent movements that often occur at the same time as the pedestrian phase.

Group C: Traffic Controller Regulations

The members of Group C could foresee a complex set of implications for regulating the use of the new Smart Signals technology. The people involved, they stated, would be the users, and their process of learning the new system; the city government (in this case, Moscow, for the application at the test intersection); the state transportation departments; and NHTSA and FHWA for safety and testing regulations. Also, current MUTCD guidelines would have to be considered before experi-

Small Group Work focused on specific issues of implementing the Smart Signals concept.

menting with clearance intervals, etc. There may be traffic legislation that would have to be considered. And there may be regulations for the profits from the technology- who gets it, and who regulates it?

Other agencies that would have to be considered/consulted include regulators of safety and standards, risk managers, law enforcement agencies, and licensing bodies. The intersection hardware and hand held devices would also need to be licensed and regulated. And, finally, training would need to be provided to users, regulators, law enforcement, and installers.

Group D: Moscow Smart Signal Installation

Group D discussed the particular considerations for a Smart Signals installation at the test intersection at 6th and Deakin. The group identified the following needs:

- Replace the TS2-type 1 cabinets with those with extra power outlets
- Maintain railroad and emergency preemption
- Document controller operations and collect data using an IP addressable camera
- Ensure MUTCD compliance, FWHA permission, and Human Subjects testing permission
- Test for power filter and surge protection, to verify PnP imperviousness to power fluctuations
- Determine the advantages of operating parallel systems vs. eliminating unnecessary ones.

In order to test the new system, the group recommended that researchers maintain the same controller settings, and gather data one week previous to and one week after setup. They said that signs should be placed to inform pedestrians about the experiment, with the added benefit of promoting the new system and educating the public. Also, the controller and cabinet should be tested in the lab before installation. Environmental testing should measure outputs from the PnP components. And, finally, a set of criteria should be developed which would determine the success of the experiment.

This group also identified several capabilities of the new system which should be tested. These included variable visual and audio signals, a wireless call button, a pedestrian countdown timer, a right turn "yield to pedestrian" sign with ped activation, and adjustable pedestrian timing based on video detection of ped/bike density.

Group E: Vision and Long-Term Work

Group E tackled the complex question of the future vision for the Smart Signals design and implementation. In terms of research and development, the group identified a number of questions that will help determine how the technology is developed and used. First, the group asked how to change the mindset of the VII movement to a UII (User Infrastructure Integration) environment to include pedestrians in the equation. How would these changes be administered, and how do good ideas get put into practice? The group asked how the system could revert to the previous technologies if flaws are found, and how the new technology could best be used in conjunction with existing technology. They said that standards for the new technologies and devices need to be explored, and that human factors research needs to be done.

A great deal of collaboration will need to take place in order to implement the Smart Signals technology. Consumer groups will need to be made aware of the safety, environmental and economic advantages to improvements offered by the Smart Signals technology. Coalitions will need to create a network, and identify a champion to advocate for their needs. Developers and manufacturers need to be brought to the table to collaborate on the design and implementation. This input, along with that of the public, will be critical to the success of the project. And finally, committed funds need to be found to sustain the project. With the voice of experts and advocacy groups championing the technology, and a clear vision which can be communicated to others, funding may be found which will allow for action now, and movement for a broader vision into the future.

Workshop Recap and "Marching Orders"- What did we Learn, and Where do we Go?

Darcy Bullock, University of Idaho

Bullock gave the group a list of topics from the workshop, and asked the assembly to prioritize them. He classified the different topics into the following categories, and then took a vote for top priority. The categories were as follows:

- Law Enforcement/Regulations
  - Drivers failing to yield, enforcement of existing traffic laws to improve safety.
- User Ability
  - Human Interface- use of pedestrian buttons, Walk/Don't Walk confusion
- Policies
  - Improved policies for pedestrian service- addressing guidelines in MUTCD, based on input from advocacy groups
- Technology
  - Improved phasing for disabled pedestrians- technology research based on input from advocacy groups

The assembly voted on the different categories, and determined that the most important issue to be pursued in future research was the technology component- that is, improving safety and efficiency through advanced communications technology which improves phasing for pedestrians.

CONCLUSION

The 2006 Smart Signals workshop provided a rich discussion and some clear direction for areas of exploration for the research team to pursue. Advancements in traffic controller technology point to a future in transportation with advanced detection, responsive signaling, user-friendly access, and improved safety and efficiency at intersections. Thanks to the presentations from experts and the input from workshop participants, important considerations for the development and use of the Smart Signals technology were identified. The needs of pedestrians were clarified and brought to light, including considerations for pedestrians with different needs. A futuristic vision of broadband communications between vehicles, intersections, other entities was described which led participants to recognize the potential for dovetailing with an existing movement to promote improved mobility for all modes, including pedestrians; and for harnessing the momentum of such a movement to promote the new technology. The needs and requirements of regulators and manufacturer's were identified, so that future work could proceed in light of these essential criteria. And further discussion of facets of the technology and its application at the 6th and Deakin St. location illuminated considerations for the next steps in the research.

Finally, an important message was conveyed at the workshop on the need for multidisciplinary collaboration and cooperation between entities. For a new technology to have widespread appeal, a variety of advocates needs to be found in consumer groups, regulatory agencies, research institutions and the private sector. Further, for this networking to take place, the new application needs to have wide reaching positive impacts on people's lives, ensuring improved safety and mobility; and, perhaps most importantly, the application must be genuinely accessible to all users.

Further Reading

I can come up with a list of links or you can make suggestions for this section.

Acknowledgements

With Special Thanks To:

Photography by:
University of Idaho Event Photographers

Report Writer/Editor
Karen Faunce

NIATT

University of Idaho

Other Sponsorship logo?