Recent Deployments of a Cooperative Intersection Collision Avoidance System (CICAS)-Stop Sign Assist System

2012 National Rural ITS Conference
September 18, 2012
Bennett Pierce, Ted Smith
Starting At the Beginning….

• Once upon a time…there was a RICAS deployment in Minong, Wisconsin
Message Boards to Assist With Gap Selection

- Eastbound Approach to US 53 from STH 77
- Westbound Approach to US 53 from STH 77
- Westbound View through US 53 Intersection

3/9/12
Deployment

- Rural Intersection Collision Avoidance System (RICAS)
  - Radar sensors on the mainline to determine position, speed, and lane of approaching vehicles
  - Inductive loop detectors in minor road approaches and median to sense vehicle presence
  - Variable message boards to display information to motorists on minor road
Examples of Signs Providing Information to Cross-Street Traffic

DIVIDED HIGHWAY
Clear

DIVIDED HIGHWAY
Far Side Alert

DIVIDED HIGHWAY
Near Side Alert

DIVIDED HIGHWAY
Far Side Warning

DIVIDED HIGHWAY
Near Side Warning

DIVIDED HIGHWAY
Near Side Off

Far Side Warning Far
Examples of the Actual Signs in Action
So Now What?

• Battelle Conducted an Extensive Evaluation of The Technology
  – Interviews
  – Focus Groups
  – Survey of Motorists (two sets)
  – Crash Report Analysis
  – Review of the Traffic Video
  – RFID tracking of residents traveling through intersection (University of Minnesota)
What did we find?

• Perception of system equipment
  – Signs are causing motorists to pause before crossing intersection, thus slowing down traffic
  – Some residents have reported that vehicles in turning lane disappear from sign prior to completing their turn
  – Signs are more beneficial at night and during inclement weather when visibility affects ability to see oncoming traffic

• Effect on driver behavior
  – Participants use signs as secondary measure for deciding when to cross
  – Presence of message boards indicates danger, thus may subconsciously affect motorist behavior
  – Many motorists have been observed crossing the intersection when the signs indicate not to cross

9/18/12
Evaluation Findings (cont.)

• Concerns with system equipment
  – Multitude of existing signs makes intersection visually busy and may impact motorists’ ability to process all of the information in a short time
  – Semi trucks in turning lane may block message board from being seen
  – Extreme brightness of message boards at night has caused some motorists to drift left
  – Message boards have sometimes shown information not relevant to the motorists

• Overall impression
  – Roadway geometry makes intersection inherently dangerous
  – Message boards worth the cost – they serve to educate motorists
Intercept Interviews of Passing Motorists

• Conducted over first weekend of October in 2011 and 2012

• Motorists stopping at convenience store by the intersection were interviewed
  – Only motorists travelling on STH 77 (i.e., ones that would have observed the message boards) were interviewed
  – Number of completed surveys was 223 in 2010 and 255 in 2011
  – 2010 survey included 30% tourists, as compared to 20% in 2011
  – 40% of 2010 respondents had crossed through the intersection only 1 time, as compared to 20% in 2011
Survey Results – Usage of Signs

Frequency of Intersection Usage

- Only once: 20% (2010), 20% (2011)
- Once or twice a week: 40% (2010), 40% (2011)
- Every day: 20% (2010), 20% (2011)
- Multiple times a day: 20% (2010), 20% (2011)

Impact of Signs on Decision-making

- The sign tells me when to go: 20% (2010), 20% (2011)
- The sign helps me decide when to cross: 40% (2010), 40% (2011)
- I see the sign, but I decide for myself when to cross: 80% (2010), 80% (2011)
- I ignore the sign: 0% (2010), 0% (2011)

Respondents that Changed Decision to Cross Based on the Signs

- Yes: 100% (2010), 100% (2011)
- No: 0% (2010), 0% (2011)

Respondents that Cross Intersection When Sign Indicates Oncoming Traffic

- Never: 80% (2010), 80% (2011)
- Sometimes: 20% (2010), 20% (2011)
- Most times: 0% (2010), 0% (2011)
- Always: 0% (2010), 0% (2011)
Survey Results – Effectiveness of Signs

**Respondents’ Belief in Accuracy of Sign Information**

- Very accurate and very reliable
- Accurate and usually reliable
- Not always accurate and sometimes not reliable
- Usually inaccurate and not reliable

**Respondents' Rating of Sign Effectiveness in Reducing Accidents (scale of 1-5)**

- Not effective at all
- Very effective

[Bar charts showing data for 2010 and 2011]
Analysis of Accident Reports

- Obtained reports for accidents occurring at intersection between April 2010 and December 2011
  - Post-activation of message boards
- Performed qualitative review of causal factors
- Seven accidents occurred during the time period
- Three accidents were caused by driver error unrelated to RICAS
  - Vehicles travelling north/south on US 53 collided
- Four accidents potentially could have been avoided if motorists properly applied information displayed on message boards
  - STH 77 motorists attempted to cross intersection and were struck by US 53 motorists
  - Weather was not a factor in any of the accidents
  - Severe damage caused to at least one vehicle in three of the accidents
  - Only one accident required medical transport
  - One accident was a “hit and run” (STH 77 motorist)
Evaluation Conclusions

• The technology seemed to cause confusion with motorists
  – Eventually ignored by motorists
  – No detectible change in behavior

• Equipment needs to be better aligned/calibrated
  – Too much information at intersection (too busy)
  – Signs not in intuitive position
  – Confusion about which sign to look at and when
  – Turning vehicles <25 mph do not trigger sign resulting in perception of lack of accuracy

• Crashes were not reduced following installation of the equipment
Now What?
Test Connected Vehicle Technology to see if “In-Vehicle” Signing Overcomes Challenges

• How would it work?


2. Processor Constructs SPaT and GID Message; Transmits to Sign (Fiber) and to Vehicle via DSRC Radio.

3. DSRC Radio In-Vehicle receives message; decodes and instructs smart phone to display sign.

• In “Connected Vehicle” Speak – this is I2V
Now to Implement....

SR 169 and County Road 11
Milaca, MN
The “Trials”…

• Testing against requirements
  – CICAS-SSA Warnings and Alerts within 500 milliseconds of receipt by the In-Vehicle subsystem instance.
    - Mean difference was 3.3 milliseconds, with the largest difference 53 milliseconds
  – Mean difference between the roadside CICAS sign and the in-vehicle display of 425 milliseconds over 23 samples of sign changes, with differences ranging from 0 to 1,667 milliseconds.

• Field Tests by 7 actual residents
  – One day of driving through the intersection
Examples of the Equipment in Action
Examples of the Equipment in Action (Cont.)
Conclusions:

- The use of Connected Vehicle Technology (DSRC RSE and OBE) with Smart phone proved:
  - Viable
  - Reliable
  - Capable of processing the SPaT/GID message in a timely fashion (433 ms).

- Did the use of in-vehicle technology resolve issues for drivers?
  - TBD