RECENT DEVELOPMENTS IN EMERGENCY VEHICLE TRAFFIC SIGNAL PREEMPTION AND COLLISION AVOIDANCE TECHNOLOGIES

Purdue Road School 2017

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Preemption Technology Platform types

- Acoustic
- Optical
- GPS
- Radio
Acoustic

- Use Emergency Vehicle siren as the “emitter”
- Siren must attain decibel level of 120 db.
- Requires four directional microphones for typical intersections
Acoustic Advantages

• Use Emergency Vehicle (EV) siren as the “emitter”
• Makes this the most cost effective preemption solution (emitter is already “built in”)
Acoustic Drawbacks

• Siren must attain decibel level of 120 dB.
• Requires four directional microphones for typical intersections (installation is 4 times more time consuming)
• Reliability is susceptible to:
  • reflected waves
  • ambient noise
  • Loud (120dB) car/truck
  • horns
Optical

Preempts traffic signals:
– Using an infra-red optical “emitter” or strobe
– Under ideal conditions (line of sight)
Optical Advantages

• Initially cost effective
Optical Drawbacks

Preempts traffic signals:
– Works only under ideal conditions (line of sight)
– Requires four receivers at a typical intersection (greater installation cost)
– Reliability is susceptible to visual obstructions
– Can be “blinded” by direct sunlight
– Maintenance requirements are large (realignment due to winds, cleaning due to dust)
– Can lock up traffic signals unless disengaged
– Susceptible to pirating
Radio

• Uses a built in compass to determine it’s direction of travel.
• Relays that information to the traffic signal to initiate preemption.
Radio Advantages

• Overcomes technical limitations of acoustic and optical preemption systems.
• Only one Omni-directional antenna needed per intersection
• No maintenance
• Not limited to line of sight
Radio Drawbacks

Distance to Preemption relies on signal strength
Cannot specify preemption distance
GPS

- System can use one, or both, of two methods to preempt:
  - Estimated time of arrival (ETA) at intersection
  - GEO Windows
ETA

• System calculates arrival time at the intersection
• Preemption “preamble” takes into account:
  • Minimum pedestrian clearance time
  • Intersection “flush” time.
GEO Windows

• System creates preemption “zones” (rectangles) at each approach to the intersection.
• When the system determines that an Emergency Vehicle (EV) has entered the preemption “zone” prior to each intersection, it preempts the traffic signal.
GPS Advantages

• Overcomes technical limitations of acoustic and optical preemption systems.
• Only one Omni-directional antenna needed per intersection
• More precisely preempt at the desired distance
GPS Drawbacks

• Most Expensive of all technology platforms
• Requires GPS triangulation
New Systems

—**Preemption**
  • GPS setup with ETA, GEO Windows, or both
  • Backup IMU (Inertial Momentum Unit), also known as Dead Reckoning when Satellite Triangulation is not available.
  • System can proactively preempt upcoming additional intersections laterally based on turn signal status

—**Collision Avoidance**
  • Warns equipped Emergency Vehicles of an impending collision
  • Alerts do not require traffic signal – works even in rural areas
  • Optional in-vehicle touch screen display that displays preemption equipped traffic signals and other emergency vehicles over a real time map. Includes status of traffic signal preemption request (much like a confirmation beacon)
New Systems

– **Cost**
  - Comparable to the price of a standard Optical system both at the intersection and in the vehicle
  - Cost that fit within modest preemption grants, no need to ask for more funds nor pay for costly studies to justify higher cost.
  - Lower cost means cities can afford the technology without a grant.

– **Installation**
  - Simple easy installation
  - 2 hours or less per vehicle
  - Minimal work at the intersection, antenna installation is the only complicated aspect

– **Maintenance free**
  - No more planning to repair and replace nor budgeting for maintenance
New Systems

• Preempts traffic signals:
  – Under adverse weather conditions
  – Reliably in heavy fog/snow/rain/dust
  – Through obstructions: buildings, buses, semis, foliage, bridges
  – Around curves in roadway
• Does not require realignment after heavy winds
• Provides 360° protection against collision with other emergency vehicles; even at unsignalized intersections
• Only Preemption system with a Graphical User Interface in the vehicle
• Visual confirmation in the vehicle of preemption status, overlaid on a Map.
• “Intelligent Preemption”
  – System will Preempt intersections ahead based on historical data including vehicle ID, time of day, day of week, month of year, and driver of vehicle.
Collision Avoidance

• Gives advanced warning of impending collisions before they occur
• Visual reference of all emergency vehicles in area
• Can calculate and display 100+ impending collisions simultaneously
• Shows the direction and position of impending collisions
• Resolves conflicts at signalized intersections
• Indicates potential collisions even at unsignalized intersections
  – Collision Avoidance does not require a preemption system installed at a traffic signal, nor does it require a traffic signal. Example: would work in the middle of a corn field
• Nearly half (40%) of all firefighter fatalities occur enroute to the scene.
Optional Features

• AVL (Automatic Vehicle Location)
  • Tracks all vehicles in real time
  • Historical view of all vehicle movements
  • Can be turned off individually by vehicle or department
  • Tracks all events including preemption and collision avoidance
• TSP (Transit Signal Priority) for buses and other Public Transit systems
• 7”, 4”, or no screen option
• Full set of features that can be turned on/off individually at each vehicle and intersection.
• 100% remotely managed and monitored
Vehicle Display

* The three squares have been changed to a White square, Red circle, and Green triangle to be color blind friendly.

**TRAFFIC SIGNAL ELEMENTS**

On Screen A you will see the three basic elements of the display. The GREEN Square represents an intersection equipped with the Traffic Signal Control System and Green color specifies that the request for a Green light has been acknowledged by the Traffic Signal Controller.

- **RED** Square will display if a Preemption request cannot be granted due to an overriding priority of another vehicle.

- If an equipped intersection does not have an active preemption request then the square will be devoid of color.
Notice the green square letting the driver know they were granted a preemption at the equipped intersection.

Additionally we see a BLUE chevron to our right, which tells us it is a police vehicle.

*actual screen image from a vehicle unit*
Here we see three vehicles and one intersection.

Remembering that this display is for the vehicle represented by the I-Beam, the traffic signal is Red and there is a Fire Vehicle going through that intersection.

Although each city can customize their priority settings, typically a Fire Vehicle gets highest priority as they are the most difficult to stop/slow down.

Just below the Fire Vehicle is a Police Vehicle. Since the Police vehicle is going the same direction as we are (we being the I-Beam), there is no alert for an impending collision.

However, you do have an impending collision with the Fire Vehicle and therefore the I-Beam and the Fire Vehicle are both highlighted with a Red Circle. There is also a 9s letting you know the ETA of 9 Seconds to the Fire Vehicle.
In this scenario you have an impending collision with a vehicle that is off the screen and a Police Vehicle behind you.

Vehicles behind you are never considered impending collisions.

You still get a 4s indicator letting you know the ETA to the impending collision. You can also use the Pan or Zoom buttons (Right Menu) to bring the “off screen” vehicle into the view.

Additionally, you can use the Center button to quickly reset the map back to the default position.

The vehicle behind our vehicle is BLUE, which means it is a police vehicle.
In this video you will see a basic preemption. Additionally the vehicle has the left turn signal on which triggers preemption of the second signal.

Then at the end you can also see collision avoidance and the release of the signal.
Off Screen Collision Avoidance – Red Preemption

Here we have an off screen collision avoidance to the left (police vehicle). As the vehicle comes on to the screen another vehicle (EMS) to the right is turned on and immediately shows up as well.

The police vehicle already got the preemption (our vehicle is in OFF mode even though our lights are on)
Off Screen Collision Avoidance – Green Preemption

Here we have an off screen collision avoidance to the left (police vehicle).

Additionally we have an EMS vehicle to the right.

In this scenario our lights and sirens are on (we are a Fire Truck) and we get the Green preemption.
Pin Screen

Set of “Admin” and “Tech” screens that are password protected.

This allows city technicians and us to have quick easy access to features, and setup the system.

To the right you will see the screen to enter your PIN code to gain access to these screens.
Device Configuration

To the right you will see the “Admin” screen that indicates the settings for the “Collision Avoidance Trigger Distance” in feet, and the “Collision Avoidance Trigger Window” in seconds.

These can be customized according to the city’s preference and separately for each vehicle.
Collision Distance Settings

To the right is the “Admin” screen where you can set the “Collision Avoidance Trigger Distance” in feet.

A similar screen allows you to set the “Collision Avoidance Trigger Window” in seconds.
To the right you will see the “Tech” screen that shows the system status of the vehicle hardware (light bar, turn signals, etc.).

This screen verifies the operational status of each. It also greatly simplifies the installation process, and verifies that the wiring connections of each vehicle system (light bar, turn signals, etc.) are correctly done.

If not, the installer can just tap the user interface to reverse polarity, instead of rewiring. This screen is also a great troubleshooting tool.
### City of Angola IN

#### Crash Type by Severity

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*See notes attached to this slide for statistical analysis (Angola Road Safety Audit)*
Questions?

Thank you!
Contact Information

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