WPI PPL System Development Updates & Overview of the results from the August 2008 WPI PIPILTER Workshop

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2008 PPL Workshop Demo Day
WFD: Full CONOPs search and rescue

Five WFD teams test five search and rescue systems

PIPLTER Workshop ’08: Demo Day

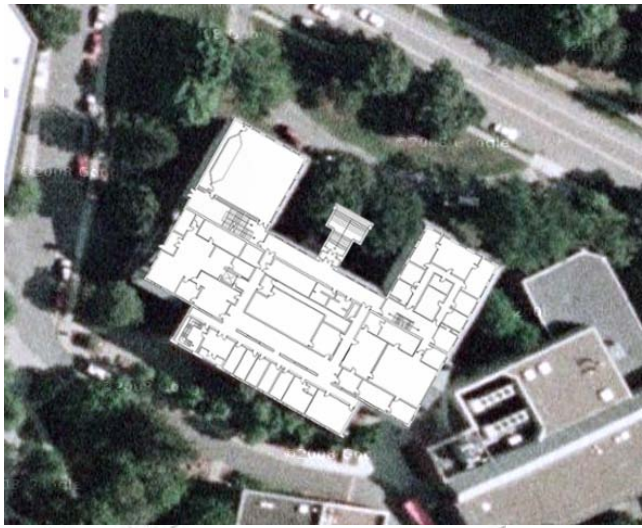
- Demo Day hosted by the WPI Workshop team and the Worcester Fire Department.
- Purpose: Test PPL and Homing technology in the context of simulated “real world” fire service operations so that:
  - Firefighters can assess/understand current technological capabilities
  - Provide feedback to the technologists so that products ultimately developed meet the needs of first responders.

Construction of Test Plan

- The detailed planning for this exercise started many weeks before the Wednesday event
  - Plans assembled and reviewed by WPI workshop team, WFD and CTC.
- The standard operating procedures and policies of the Worcester Fire Department were used as the foundation of the scenario, so that it would closely match the real world needs.

Test Site

- WPI campus building, Atwater Kent, was selected for its availability and a certain degree of challenge due to its layout and steel/concrete structure.



Entrance to 130x75 ft^2 wing used in test

Scenario

- A fire attack team entered the building;
- As conditions worsened, the team was forced to evacuate.
- When personnel were accounted for, it was found that one person was missing.
- Using the various location systems, an RIT attempts to locate the victim for safe removal

A new group of WFD volunteers were used as the attack team and rescue team on each system trial

Locator Tests

- The first two tests were conducted with locator systems, using diverse technologies
  - WPI: RF location
  - Rex Systems Inc./ENSCO: Inertial navigation
- Command console (with screen projection) displayed location of firefighters on building plan.
- WPD incident commander radioed directions over the normal department two way radios.
- Search team was told of hazards, distances, directions to travel and to climb stairs as their locations were tracked by the commander.

Locator Tests

- Training Chief and the Chief in charge of Incident Command provide the firefighters with a briefing of what was expected of each task team.
- Repeated for each system under test

Outfitting the firefighters

- The firefighters usual Personnel Protective Equipment was augmented with locator and possibly bio-monitoring technologies (as with WPI system) that included the locator transmitter, its associated antenna, as well as bio sensors.

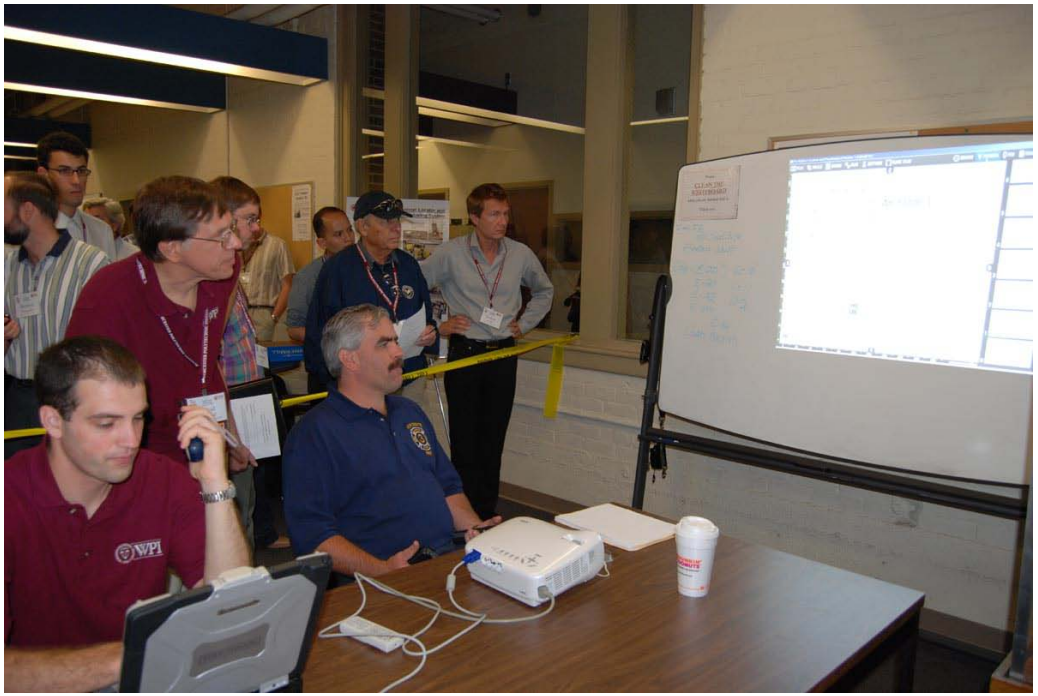
- Note headband with WPI pulse oximeter
- Not visible is Foster Miller T-shirt with bio-sensors which was part of WPI system.

Command Center

- Locator technologists provided support for the incident commander.

Command Display

- Commander monitored progress of the attack team on the locator display.
- The location of each firefighter was shown along with their bio-status if supported.



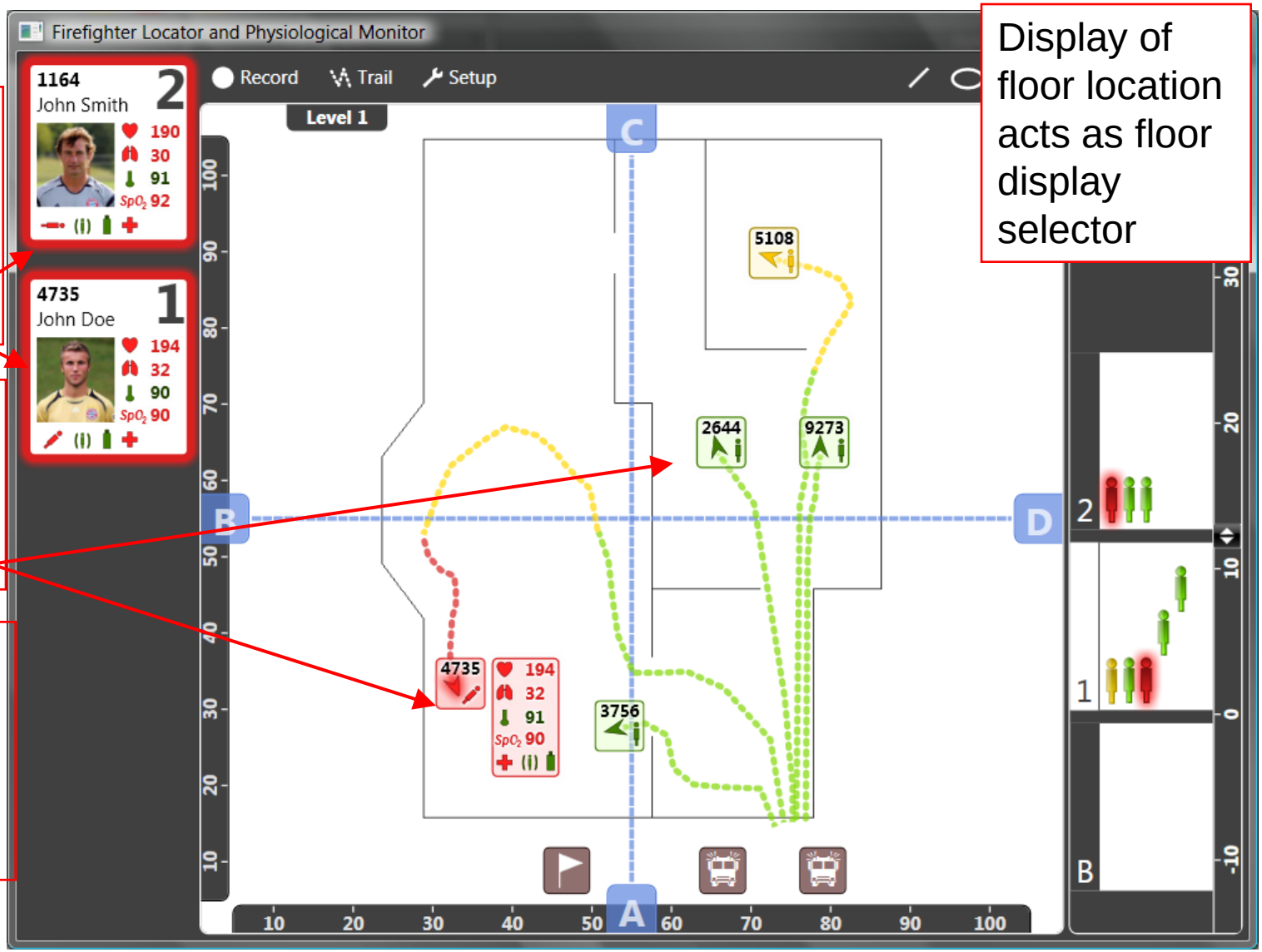
WPI/FMI Locator/Health Status Display

Info pop-ups for all firefighters in physiological distress

Icons indicate location, direction and ID code

Data from FMI "shirt" and WPI pulse-oximeter

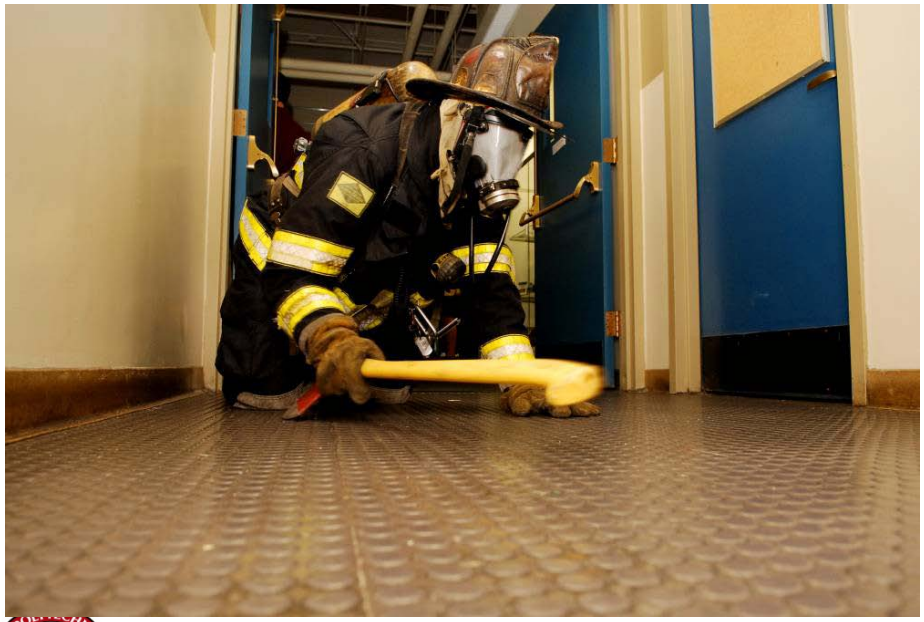
Display of floor location acts as floor display selector



WPI

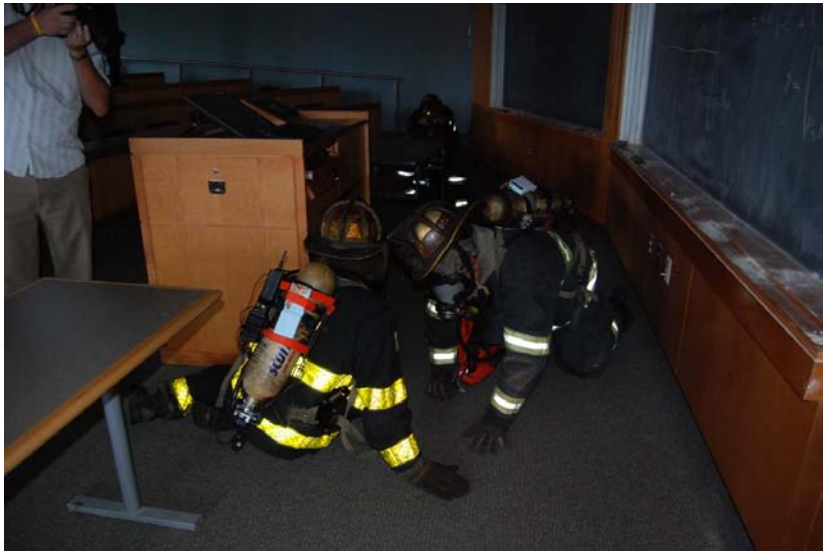
Search Team

- Search team, tied by safety rope, crawled low, as they would in a smoke and heat filled environment.
- Face pieces are masked to simulate low visibility.
- Search path was approximately 175', with many turns and a long stairway to the second floor.



WPI PPL Outcome

- The Rescue Team Leader guided by information from WPI PPL to victim by IC
- Victim rescued while he still had ¾ of a bottle of air left.



Homing System Tests

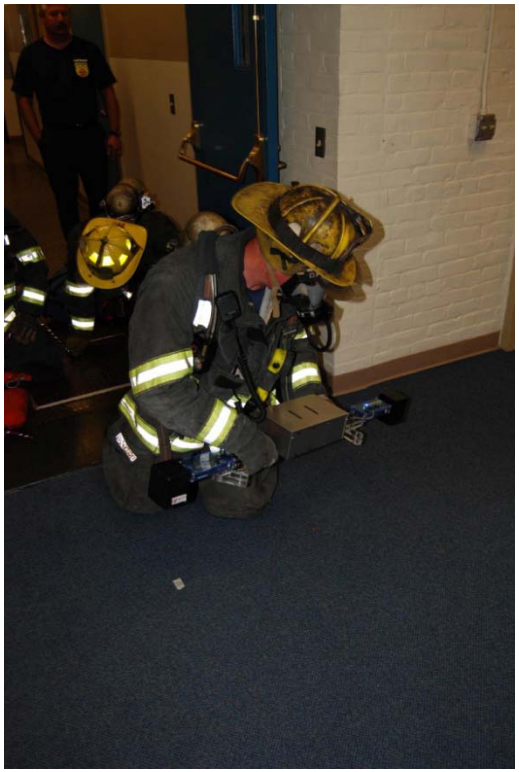
- Three “homing” type systems were tested
  - Handheld devices that indicate direction and relative distance to the victim and are stand-alone systems used by the search team to home in on the victim
- Technologies included:
  - Summit Safety Systems: Ultrasonic direction and range finding
  - WPI: VLF direction and range finding
  - Draeger: LF range finding

Homing based search and rescue

- Primary search function now falls to the Rescue team leader, with the incident commander playing an overseeing role with only radio communications to the search team.
- Some of the homing devices can provide useful information from outside the building with a perimeter search
  - Indicates closest point data as well as a general floor location.

Homing assessment

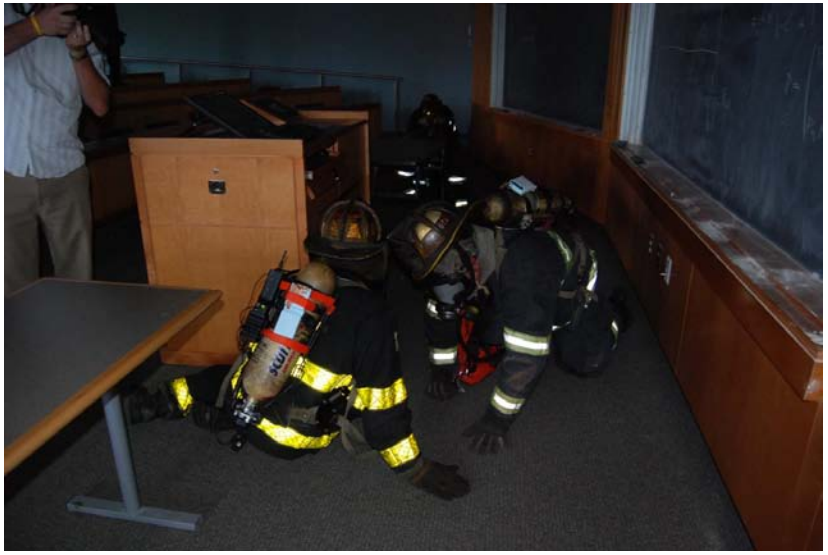
- Each homing device tested had a different set of advantages and disadvantages



- Same search/rescue scenario used as for PPL tracking systems

WPI Mantenna Outcome

- Outdoor scan correctly identified victim's floor and general location within building
- RIT leader picked up signal near stairwell on first floor and led directly to victim



Outcome Review

- After each test run, firefighters, fire officers, technologists and other reviewers met “off line” to gather feedback, both written and verbal.
- The firefighters described performance and ease of use of the systems and made suggestions for improvements

Written summary of results were provided to each system developer

Overall Assessment

- All participants: fire service personnel, technologists and observers from many areas, including the Department of Homeland Security, deemed the “First Annual” Demo Day a great success.
- Deemed a useful demonstration of the new technologies, under tough, simulated fire service conditions, in a tough building.
- These technologies were shown to be of potentially great future value to the fire service community
  - **Homing devices are either near term or in fact available products, offering a useful interim solution sooner than locator systems will be available**.

Update on WPI PPL Development

- Successful in last year's demo
  - But not yet practical/deployable
- General deployment limitations
  - Antennas on three to four sides of building
  - Cables from all antennas to central base
  - Positions of antennas pre-measured
  - Building scale operation only – not ready for LE
- This year's efforts:
  - Eliminate these limitations

Complete Hardware Re-design

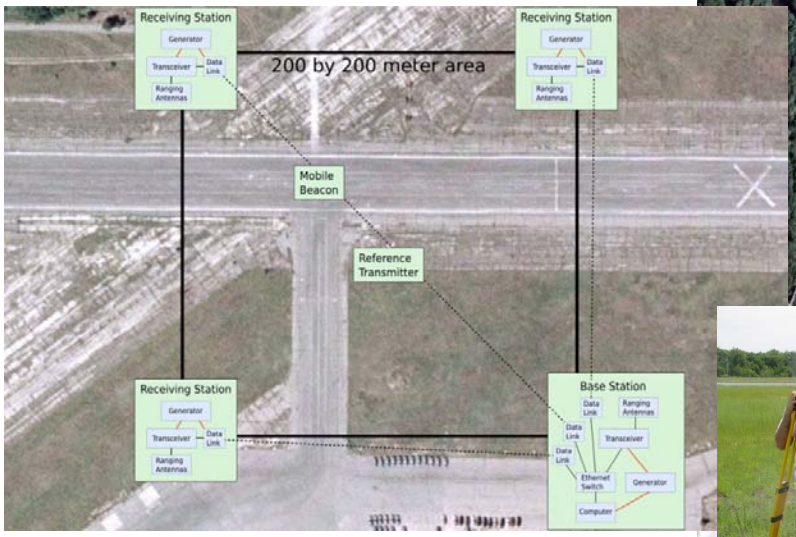
- The custom SDR node system and locator unit re-designed and re-implemented
  - Directly supports Geometric Auto Calibration of antenna positions
  - Hardware support for wireless nodes
  - Higher power transmitters for long distance applications
  - Streaming data acquisition to support vehicle and robot tracking

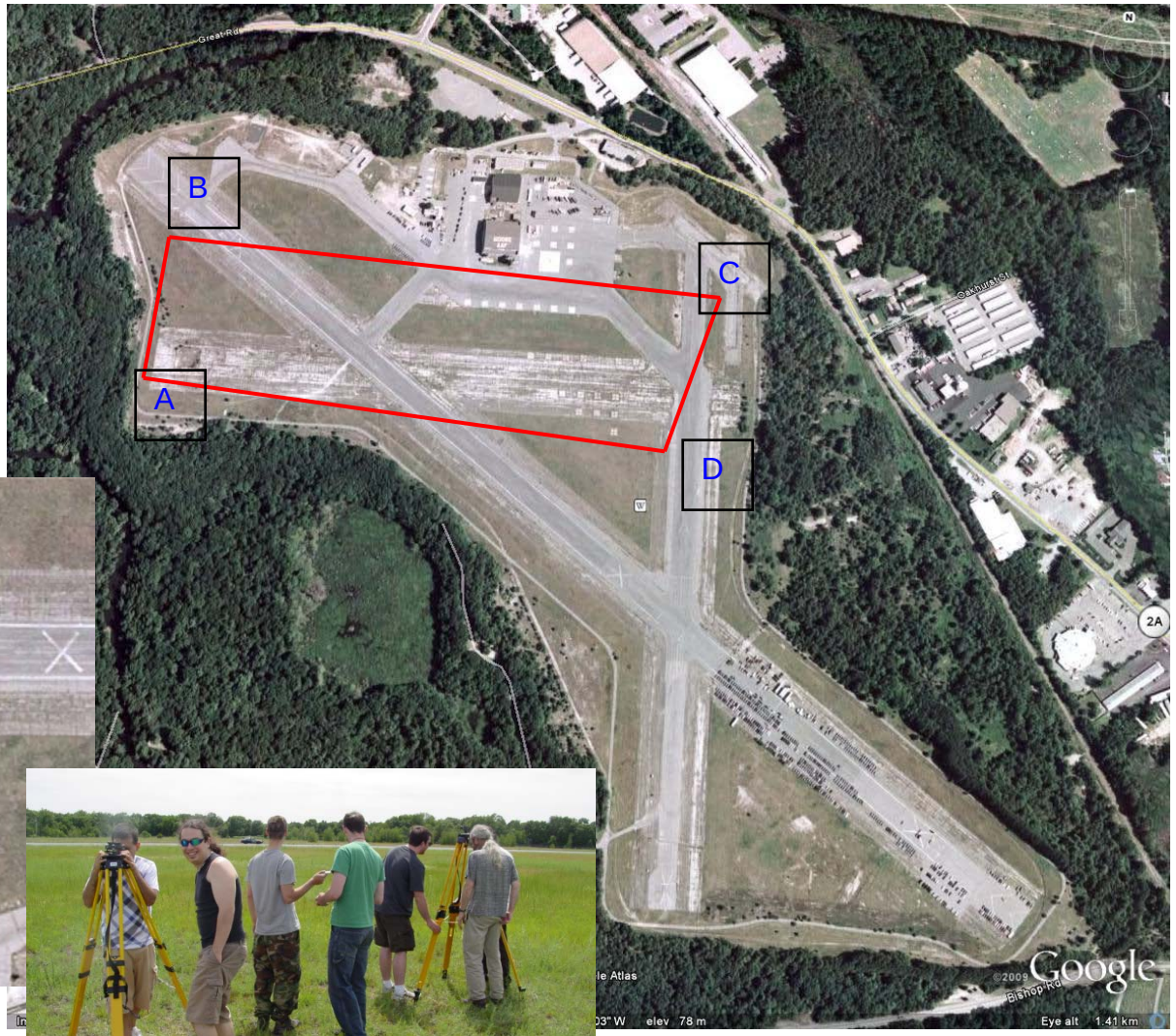
Wireless node stations

- WPI PPL node hardware re-designed and re-implemented to allow wireless operation
- Each node powered by an uninterruptible power unit
- Partially processed data transmitted to base station
- Eliminates all cables between antenna nodes

Distance Test location: Devens Airfield

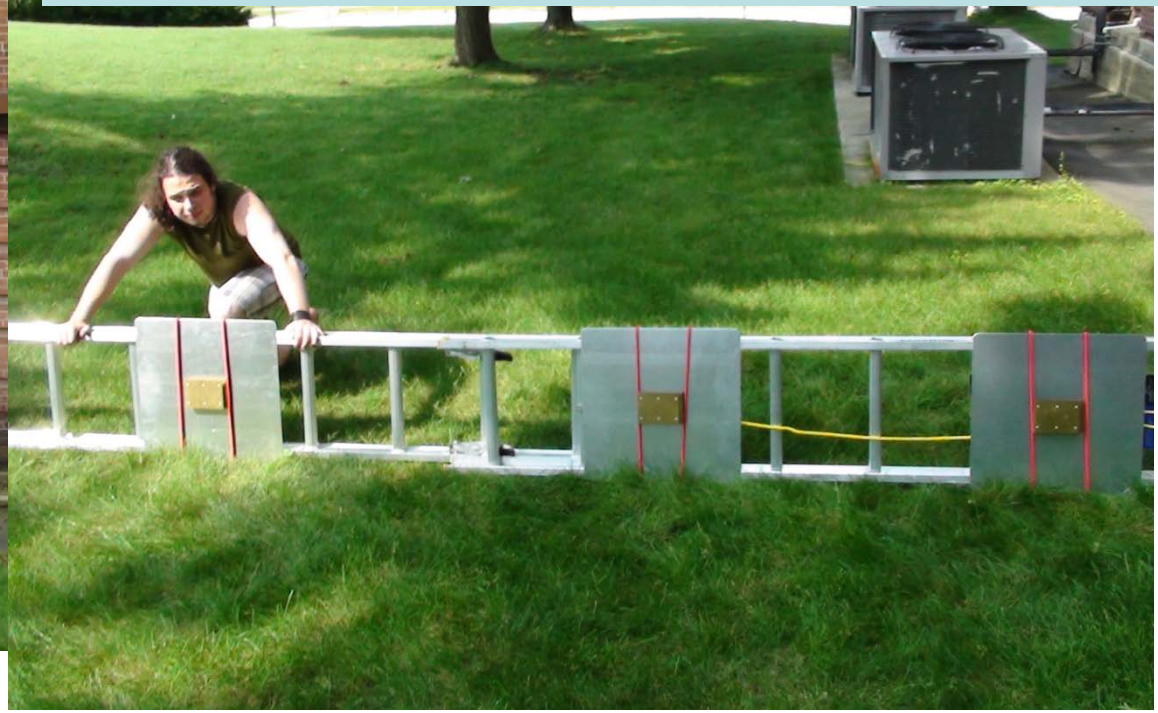
- Up to 1km x 200m tests conducted
- Sub-meter accuracy
- Moving vehicles tracked





Rapid Deployment Antennas

- Prototype uses patch antennas on extension ladders
- Coming: lightweight poles



Low Profile Building Coverage

- Two “ladders” for three floor residence
- Trades depth resolution for height resolution
- “Same side” approach supports GAC

Thank you

- We acknowledge the support off:
  - The rest of the WPI Research Team
  - The support of NIJ, DHS, and FEMA
- Special thanks to the 2008 Demo Day participants
  - Rex Systems Inc./ENSCO,
  - Summit Safety Systems
  - Draeger.
- Greatest thanks must go to Worcester Fire Chief Dio, his Chief Officers, Line Officers and all the fire fighters for their complete dedication to the success of the exercise.

- Thank you!
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www.ece.wpi.edu/Research/PPL/