



Development of Performance Metrics & Test Methods for First Responder Locating/Tracking Technologies



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What is the Problem?

No consistent methodology to evaluate the usefulness of location/tracking systems

- Many different applications of location/tracking systems for first responders
- Many different operational environments and user needs
- Many different technologies (and hybrid systems), each with testing quirks
- Many stakeholders doing different things to standardize/evaluate systems

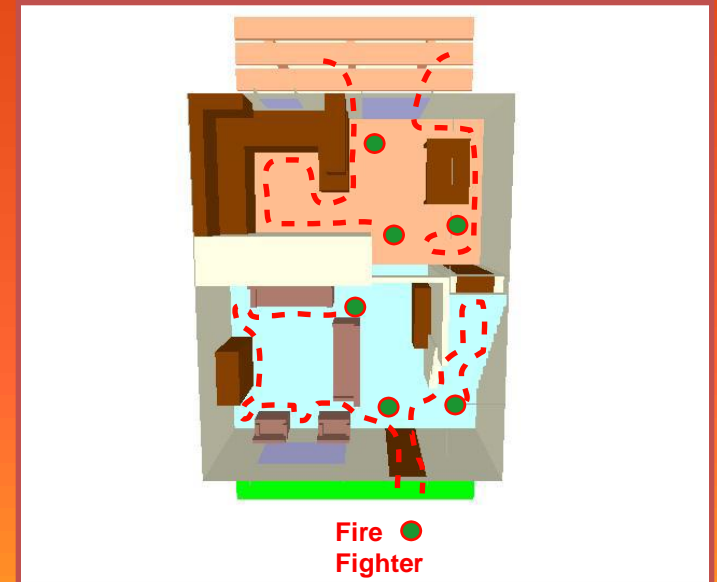
Who is doing what?

- **Military**
- **Government Agencies**
 - DHS
 - DOJ
 - NIST
 - Other...
- **Standards Developing Organizations**
- **Private Industry**
- **Academia**
- **Other...**



What are the applications?

- **Military**
- **Law Enforcement**
 - Swat
 - Security, surveillance
- **Prisons**
- **Mining industry**
- **Fire Service**
 - Structural
 - Wildland
- **Employees, children, pilots, other...**



How can we make this easier?

- **Share our ideas! Learn from each other!**
- **Examine similarities/differences in**
 - User requirements
 - Technologies
 - Performance metrics
 - Test methods
 - Technical barriers
 - Non-technical barriers
- **Establish a network of stakeholders that can draw on each other's strengths**

What is NIST doing?

- **Manufacturing Engineering Lab**
 - Robotic search & rescue (Jacoff, Hong)
- **Electronics & Electrical Engineering Lab**
 - RF signal measurements & characterization (Remley)
- **Building & Fire Research Lab**
 - Ground truth measurements (Saidi, Franaszek, El Khoury)
 - Prioritization of fire service operational environment (Amon, Lock)
- **Information Technology Lab**
 - Location/tracking system (Moayeri)
 - Modeling RF system performance (Gentile)

Robotic Search & Rescue

- **Developing standard test methods and performance metrics**
 - Quantify key capabilities of emergency response robots
- **Requirements:**
 - Robot mobility, manipulation, sensors, energy, communications, human-robot interfaces, logistics and safety
 - remotely operated ground, aquatic, and micro/mini aerial vehicles for urban environments
- **Guidance for purchasing decisions and to understand deployment capabilities**



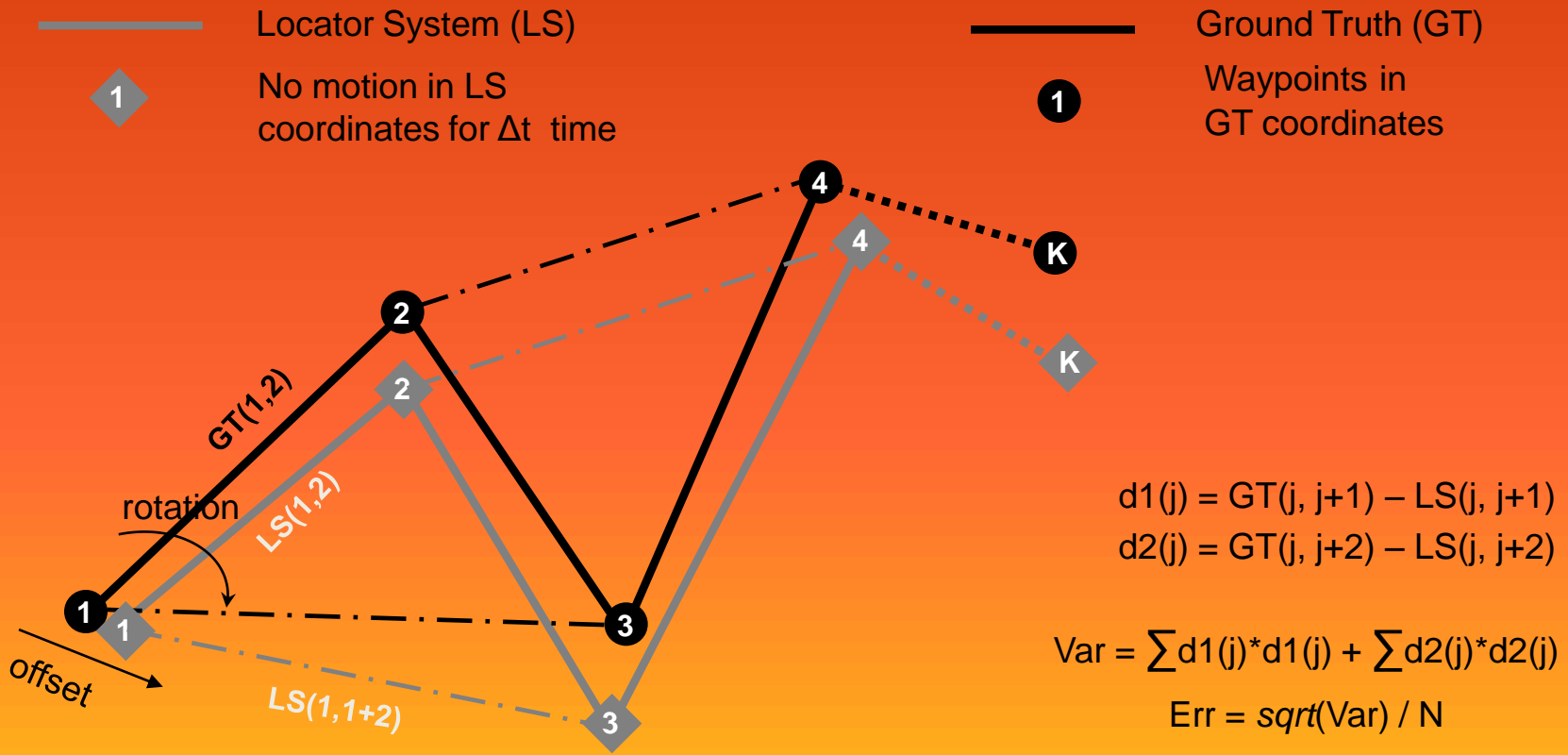
RF Signal Meas & Characterization

- **RF signals inside-to-inside or inside-to-outside a structure**
 - Challenges: signal attenuation, multi-path, interference
- **Measurement campaign on various building types**
 - Characteristics: time-of-arrival, angle-of-arrival, received-signal-strength
- **Reverberation chamber**
 - Creates a “virtual” RF link reproducibly
 - Commercial systems are tested in the virtual environment
 - Virtual characteristics are validated against ground truth measurements

Modeling RF System Performance

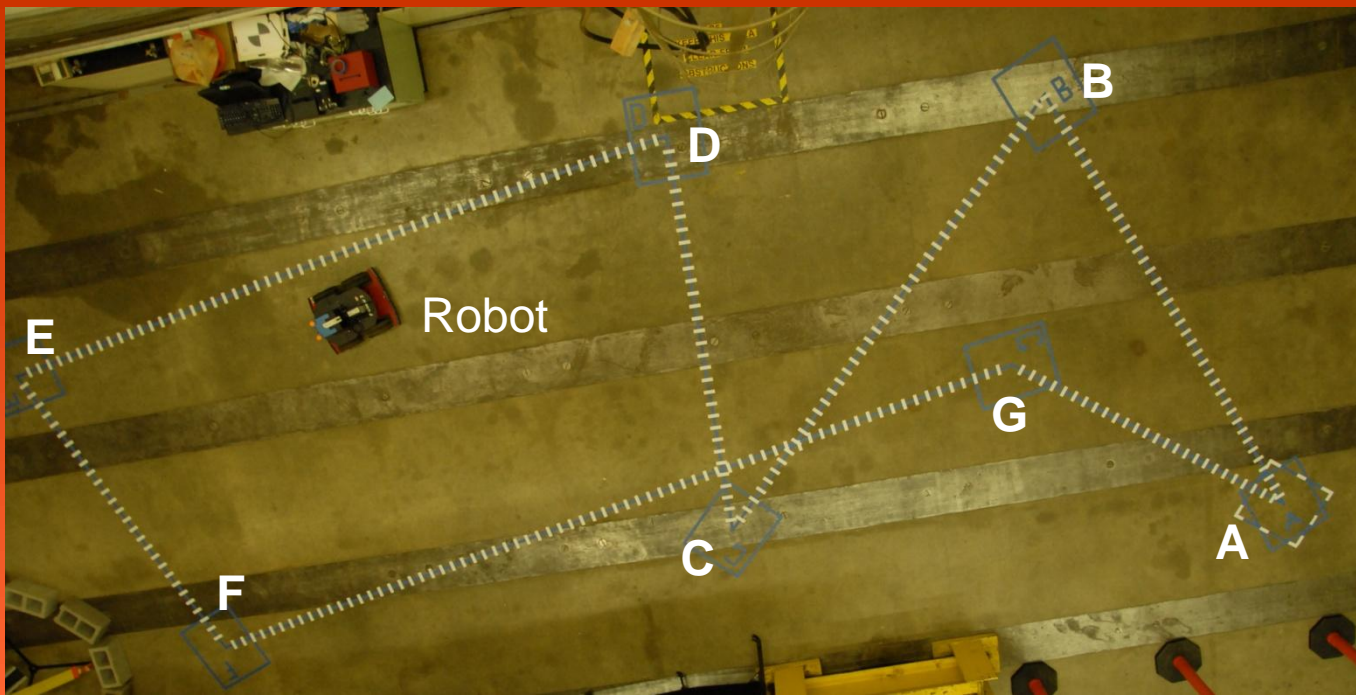
- **Develop computer simulator**
 - Reduce RF link measurements to a stochastic parametric channel propagation model
 - Validate model
 - Feed into simulator to characterize links of a deployed network
- **Provides reproducibility & scalability to RF-based test methods**
- **Conduct round robin for quality assurance**
 - All test methods

Ground Truth Measurements

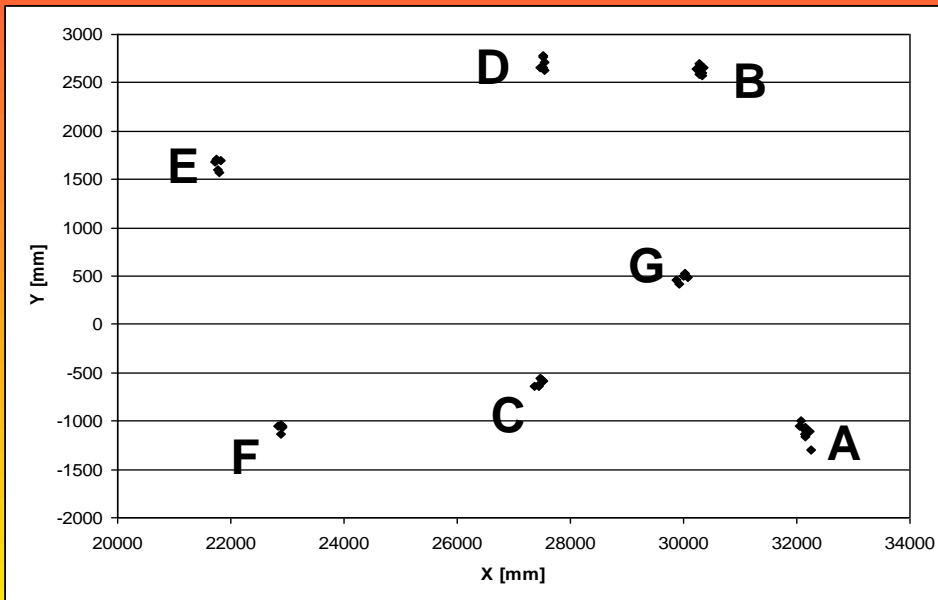


LS coordinates have to be registered to GT coordinates (rotation and offset)

Small Err \rightarrow geometry of path ◆—◆—◆—... close to geometry ●—●—●—...



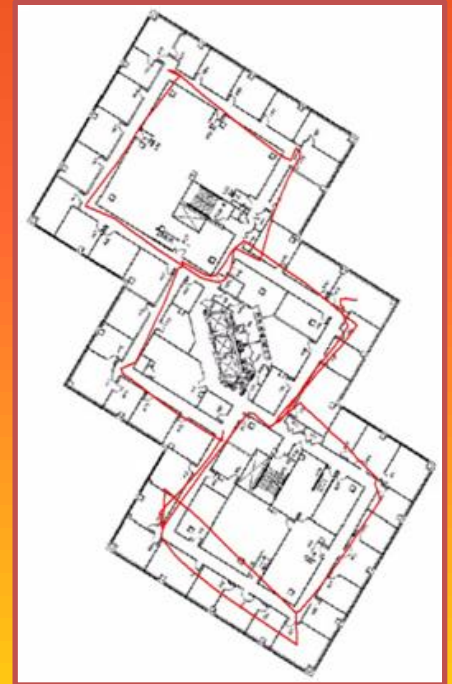
Evaluating minimum test procedure



Waypoints in robot coordinate system, automatically extracted from recorded X(t) & Y(t)
Err \approx 21 mm

Fire Service Operational Environment

- **Prioritized list of localization-challenged environments**
 - Building types, sizes, layout, materials
 - Signal interference
 - FCC regulations
 - Full-scale vs reduced-scale tests
- **Thermal Environment**
 - Heat, smoke, water, dust, debris
- **Fire service operations**
 - Ruggedness, weight, user interface

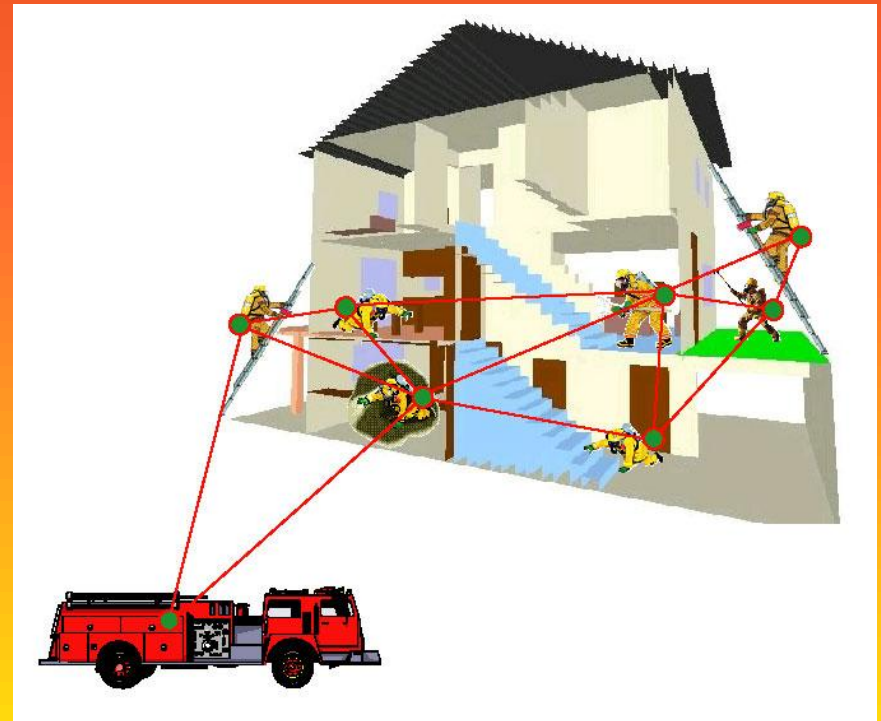


What are the Technical Barriers?

- **Different technologies are affected by different conditions**
 - Inertial → person movements (walking, crawling, etc...), heat
 - Radio Frequency → electrical environment (other radios, appliances, structure)
 - GPS → access to satellite
 - Hybrid Systems → may confound or complement component vulnerabilities
 - New location technologies are still emerging
- **Scaling of performance tests is not feasible in all cases**
 - Need access to suitable structures for testing

What are the non-Technical Barriers?

- Uncoordinated efforts by various stakeholders
- Intellectual property issues
- Classified information
- Users unfamiliar with technology



Where do we go from here?

- **Come to the standards development break-out session!**
- **Contribute to the process from (near) the start**
- **Help fill gaps with your knowledge and perspective**
- **Learn about relevant work that others are doing**

Thank You

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