

A yellow L-shaped line starts at the top-left corner of the slide, extends vertically down, then horizontally right, and ends with a small yellow circle at the right end.

UWB for Lunar Surface Tracking

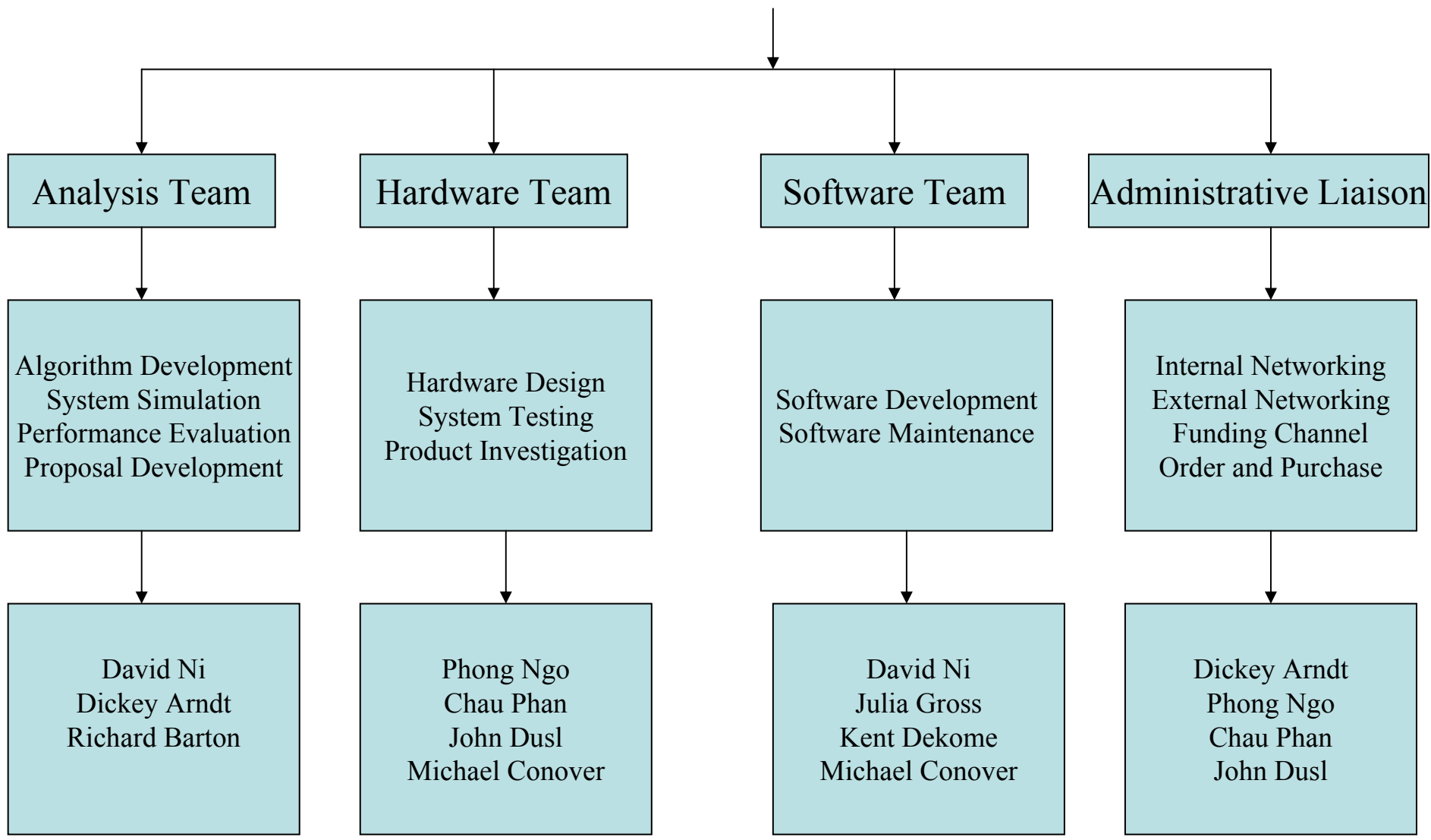
**Richard J. Barton
ERC, Inc.
NASA JSC**

- **NASA JSC is investigating ultrawideband (UWB) impulse radio systems for location estimation and tracking applications on the lunar surface:**
 - **Localization and tracking of mobile nodes on the lunar surface**
 - ◆ **lightweight, low-power network deployed on the lunar surface to track autonomous vehicles or EVAs**
 - **Indoor (habitat) asset localization**
 - ◆ **track and record the storage location of arriving inventory**
 - ◆ **locate assets that are re-distributed on a regular basis**
 - ◆ **track rovers within the environment**
 - **Precision tracking of robots or robotic manipulators**
 - ◆ **precision tracking and guidance of remotely operated vehicles**
 - ◆ **track and control the position and orientation of robotic manipulators with high precision**

- **NASA JSC UWB Systems Group**
- **Background on UWB**
- **Current UWB Development at NASA JSC**
- **UWB Two-Cluster AOA Tracking Prototype System**
- **Questions**



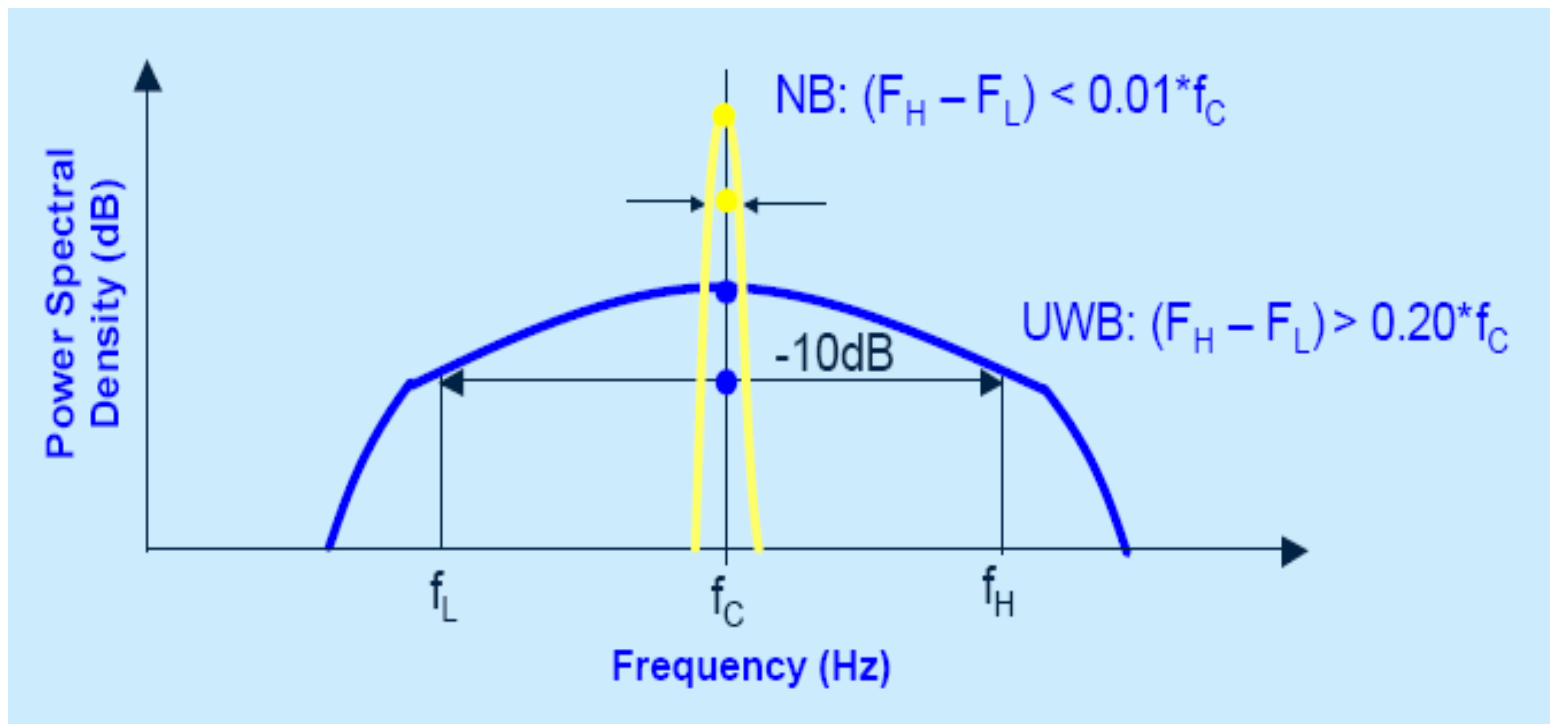
JSC UWB Systems Group



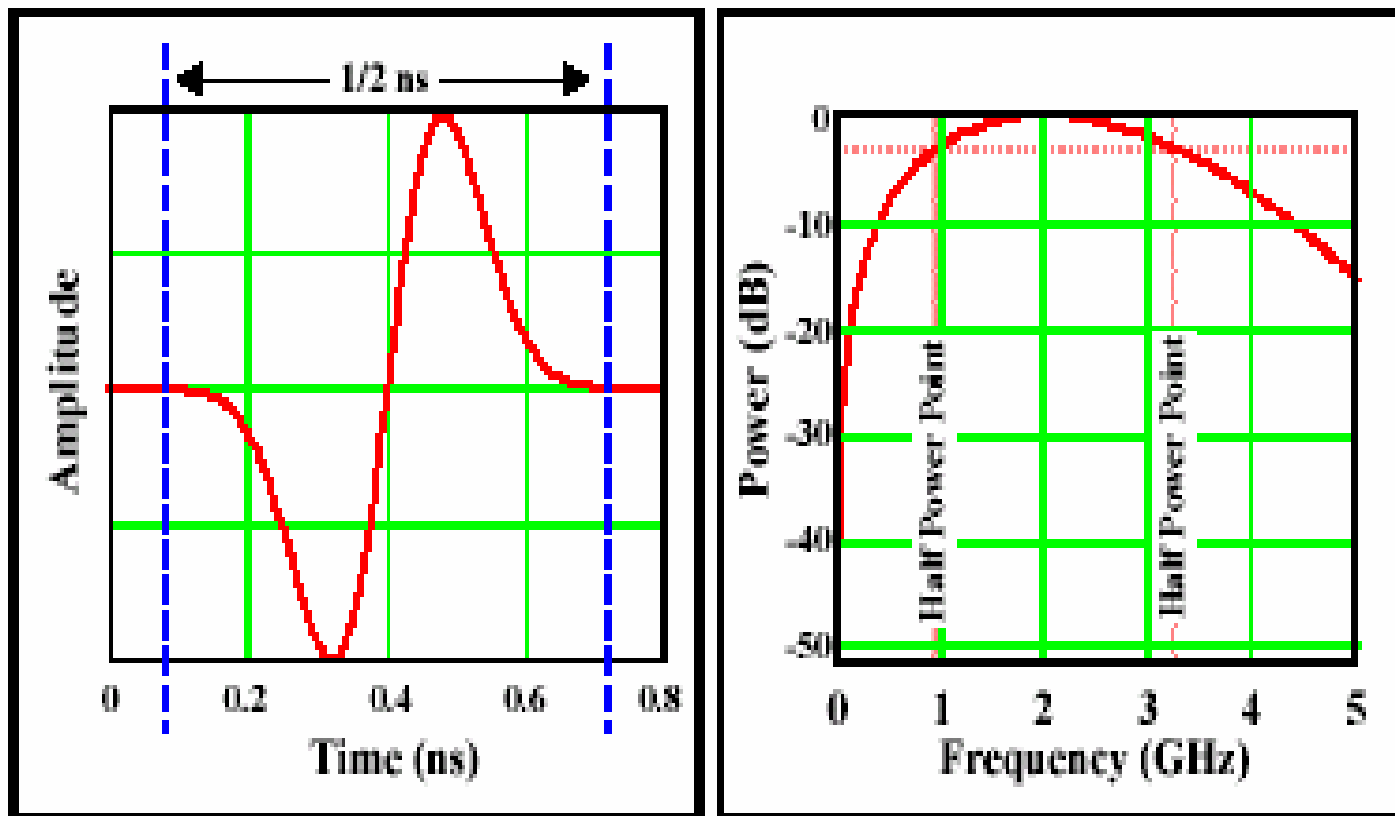


Background on UWB - Definition

- UWB signal - any signal with fractional bandwidth **greater than 0.20** or total bandwidth **greater than 500 MHz**



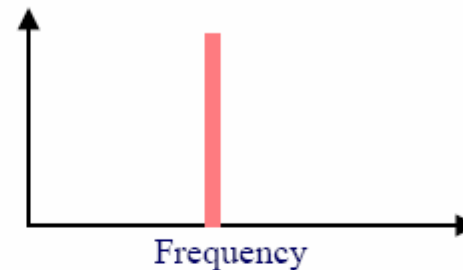
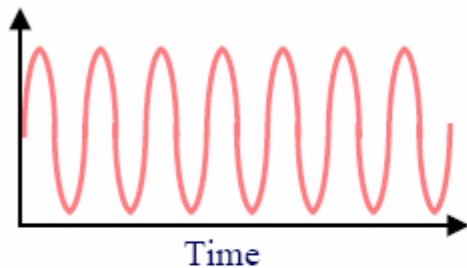
- Typical UWB impulse waveform is the **Gaussian monocycle**



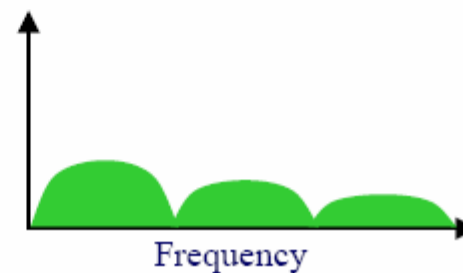
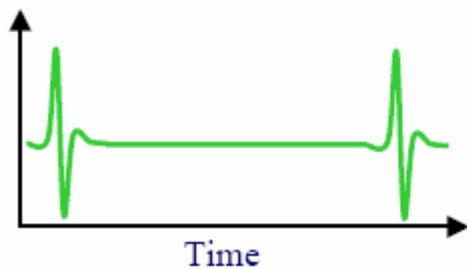


- **UWB impulse signals are the time-frequency dual of sinusoidal signals**

Sinusoidal, Narrowband



Impulse, Ultra-Wideband



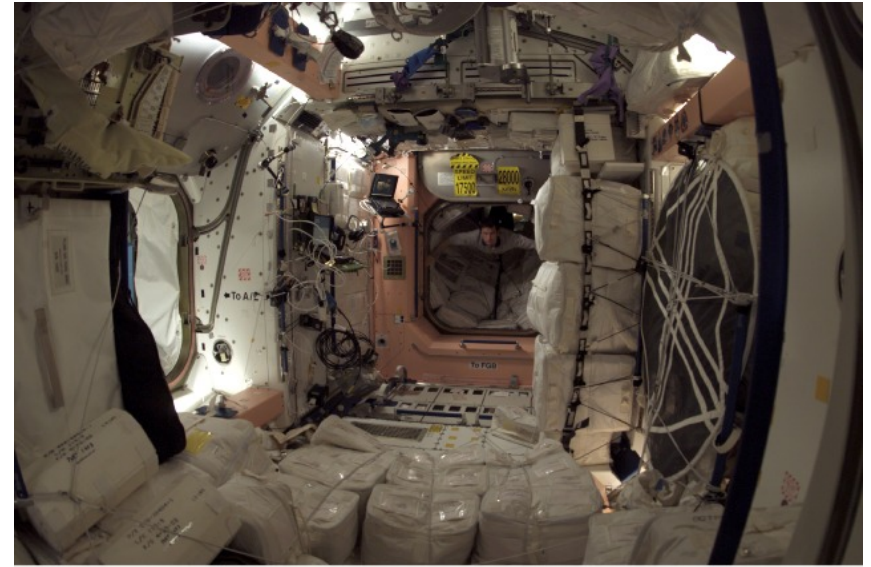
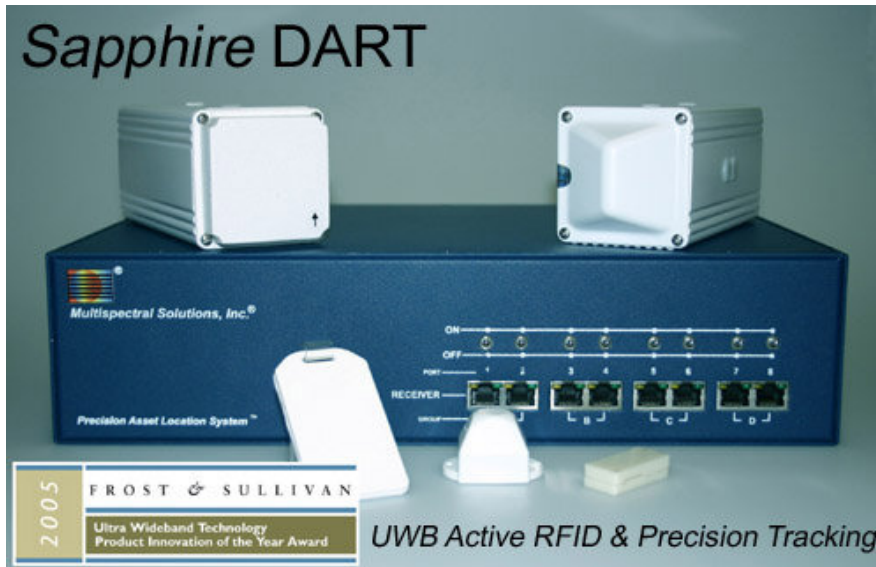


Background on UWB - Advantages

- **Robust against multipath interference - minimal fading, LOS signal can be isolated and detected**
- **Minimal mutual interference with conventional narrowband systems**
- **Wide bandwidth supports very high data rates**
- **LPI/LPD characteristics - low PSD and short time duration hard to detect by conventional means**

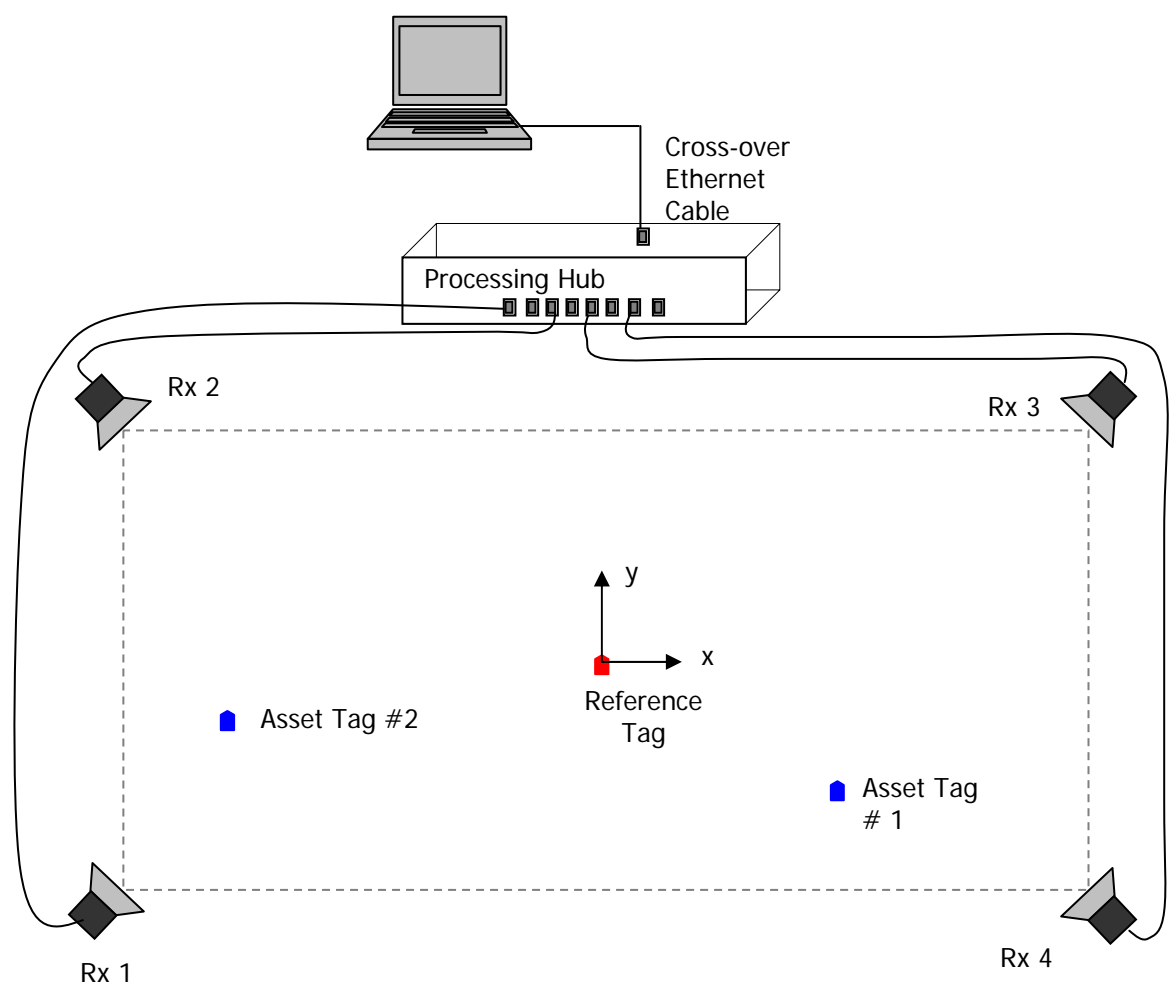


- **UWB-RFID for ISS inventory tracking**
 - Evaluate UWB-RFID system Sapphire DART
 - Customize the system and enhance the tracking performance

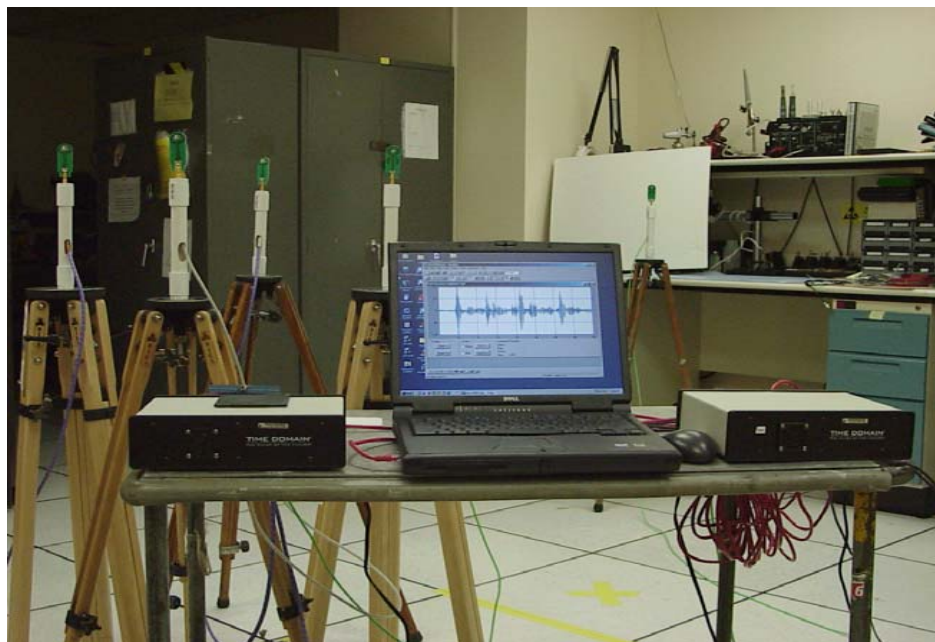




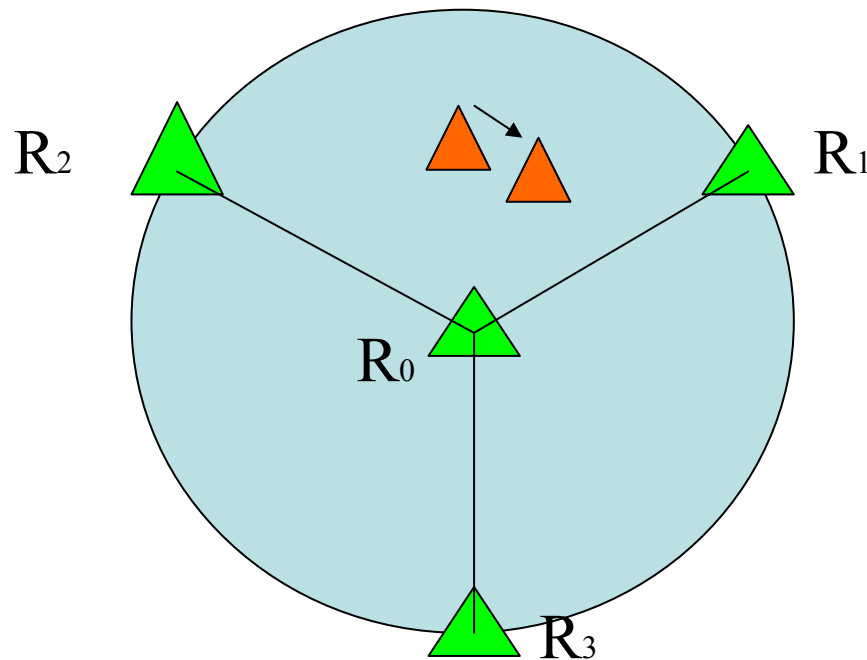
■ Laboratory test configuration for Sapphire DART



- **UWB TDOA high resolution proximity tracking for robonaut**
 - **Theoretical analysis and simulation for TDOA proximity applications**
 - **Lab tests show sub-inch tracking resolution**



- Laboratory test configuration for high resolution proximity tracking

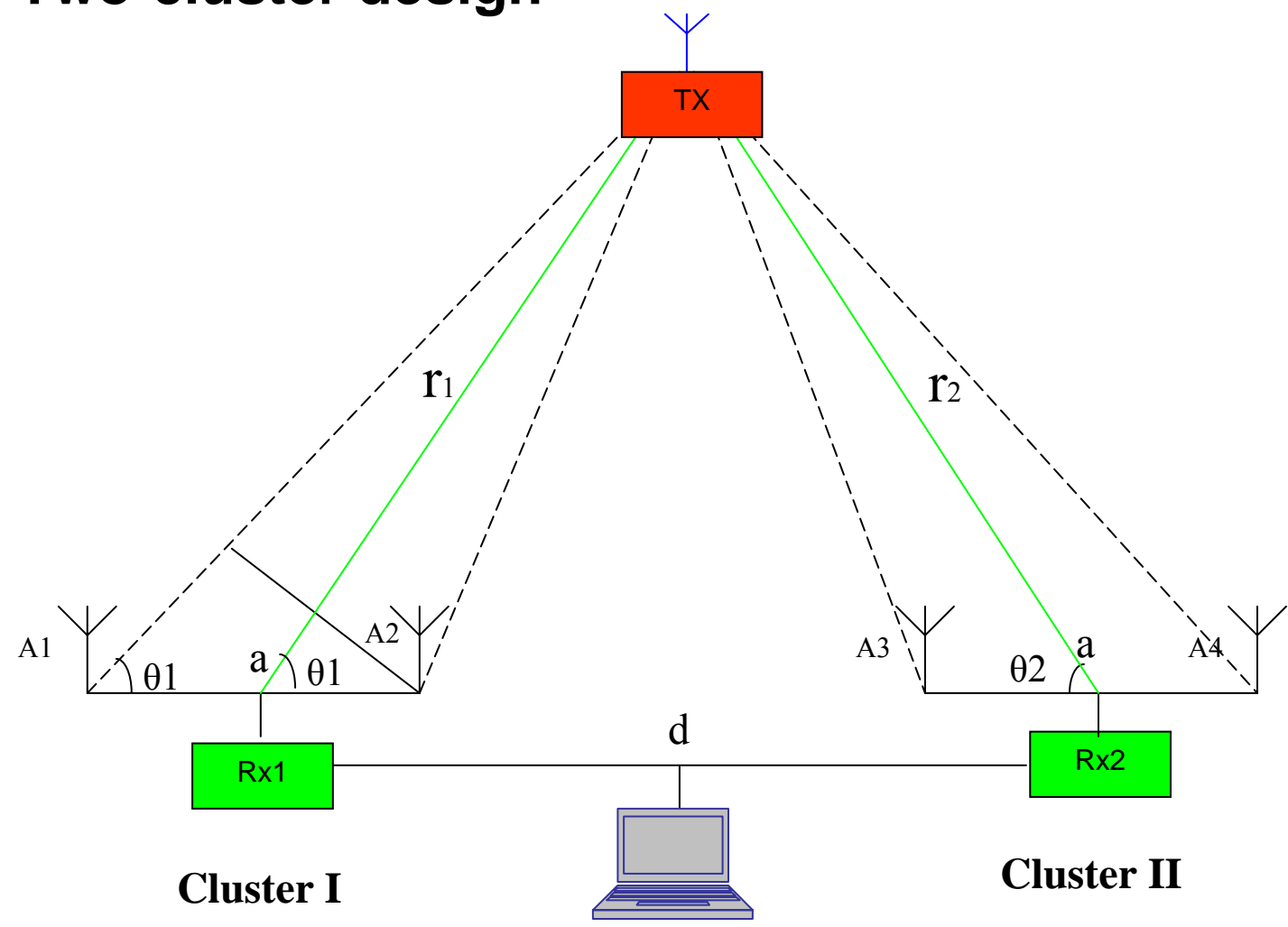


- **UWB two-cluster AOA tracking prototype system**
 - **Excellent tracking performance - less than 1% error at ranges up to 3500 feet**
 - **No RF interference with on-board GPS, video, audio, and telemetry systems**



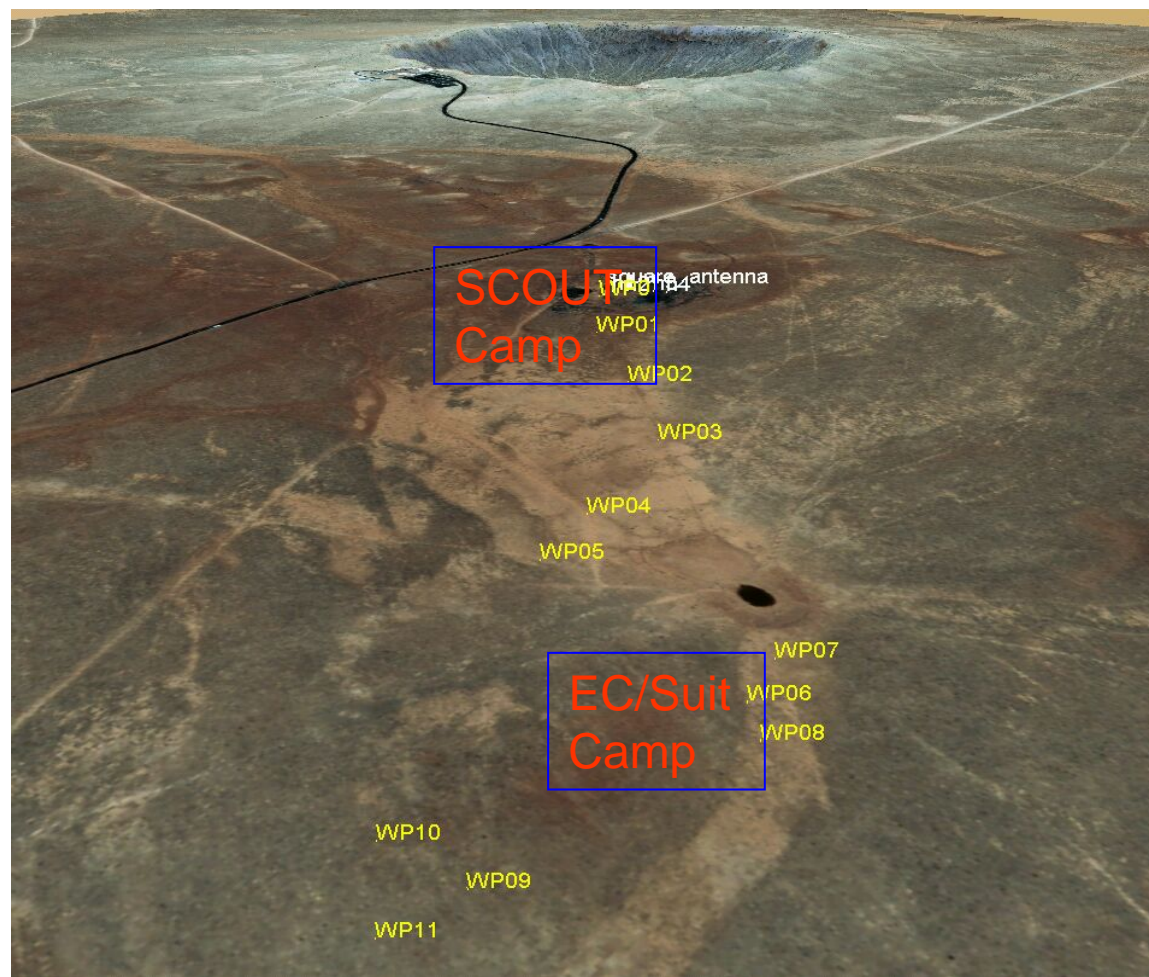


■ Two-cluster design





■ Test site - Arizona meteor crater



- **Test baseline configuration**

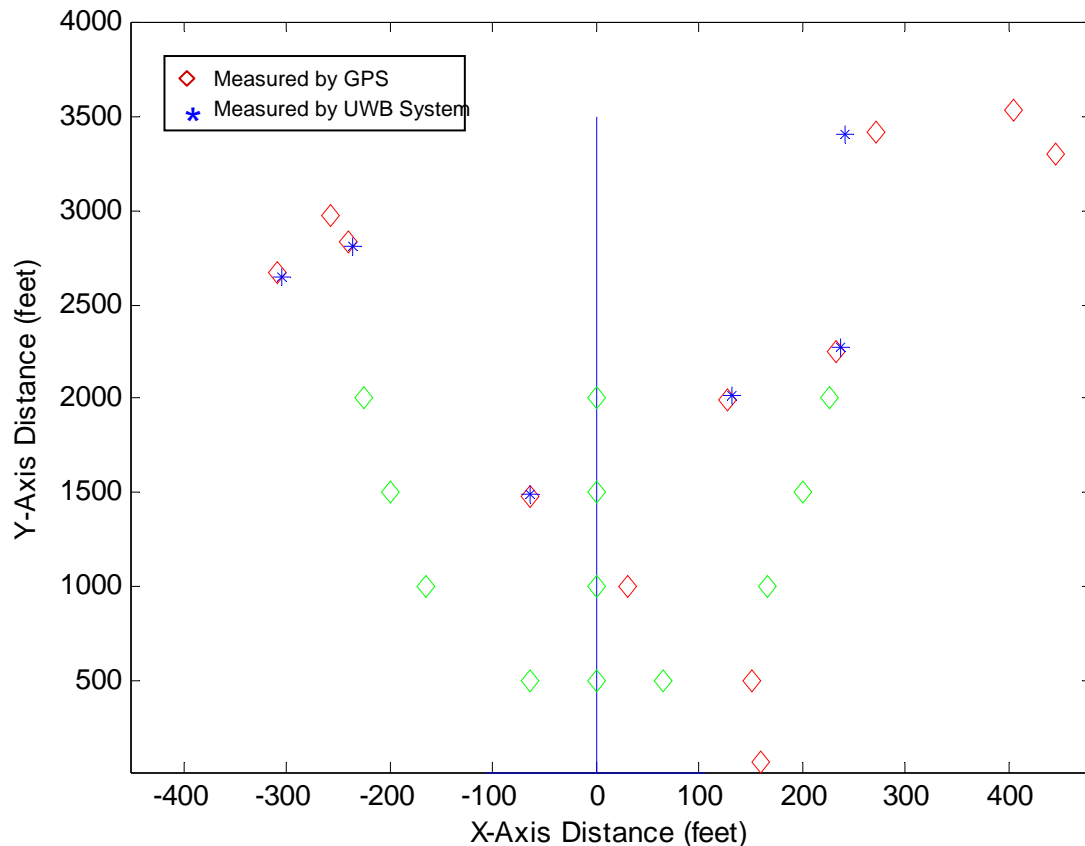




- Tracking target - SCOUT vehicle

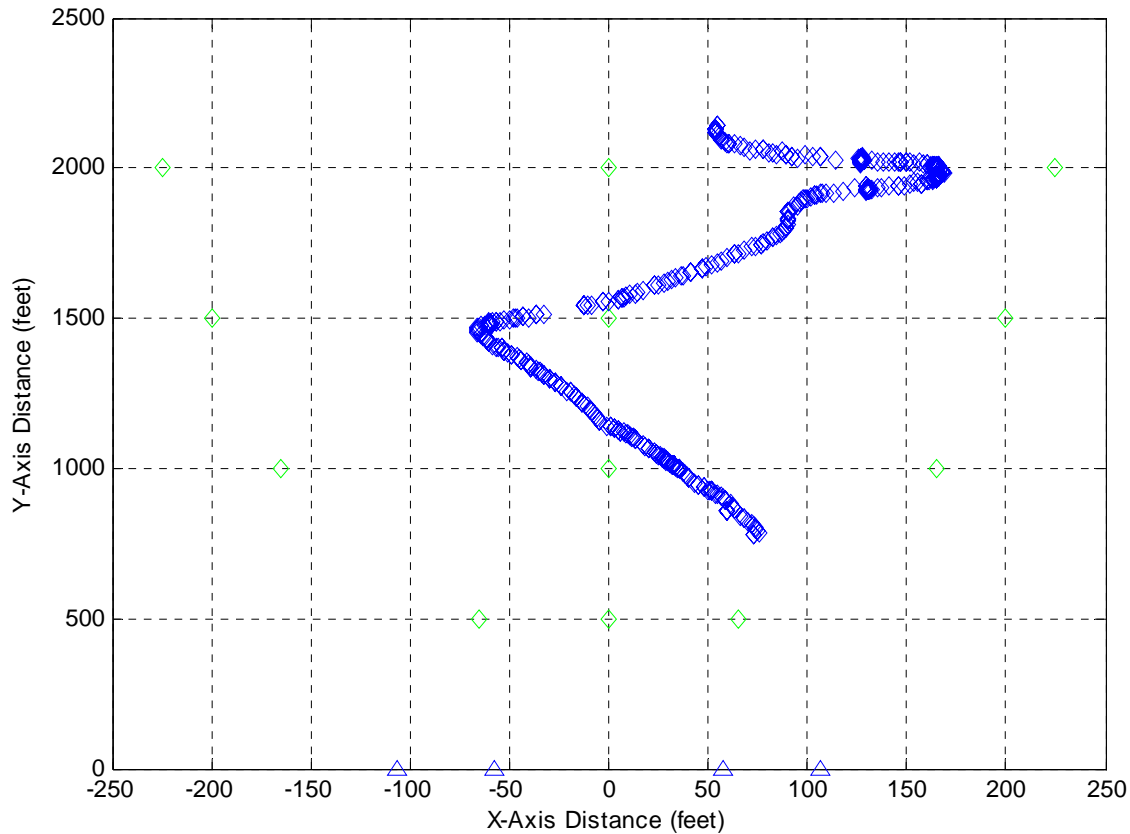


Tracking results - accuracy



Accuracy Comparison: GPS vs. UWB System

■ Tracking results - trajectory



Trajectory: UWB System tracking the SCOUT vehicle



■ Conclusions

- **UWB tracking system can co-exist with other RF communication systems aboard SCOUT**
- **Tracking resolution less than 1% of range (up to 3500 feet) successfully demonstrated**
- **Moving target can be tracked in real time (update rate = 10 Hz)**
- **Steerable antennas have been implemented to increase tracking coverage**
- **Two-way voice communication has been integrated with tracking system**



■ Future work

- **Integrate video with communication/tracking system**
- **Add additional clusters to baseline to improve performance**
- **Add wireless (802.16) connectivity between clusters to increase tracking coverage**
- **Refine initial AOA location estimates with maximum-likelihood estimates to improve accuracy**
- **Add multiple target capability and multi-hypothesis target tracker**

A yellow L-shaped graphic consisting of a vertical line segment on the left and a horizontal line segment extending to the right, with a yellow circle at each end.

Questions?

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Backup Slides



■ Vendor Specifications:

- **Frequency: 5.94 to 7.12 GHz**
- **Accuracy: within +/- 1 foot**
- **Tag battery life: in excess of 4 years (1 Hz rate)**
- **Tag read range: up to 160 ft indoors**
- **Hub is configurable to accommodate various configurations/coverages**



■ Evaluation kit:

- One processing hub
- Four receivers, each with its own antenna
- Eleven tags, one for use as a reference tag
- Four 150 ft CAT 5E cables
- Management software and documentation

■ Tracking technique:

- Short burst of pulses transmitted by the active tags received by sensors located at the periphery of the coverage area
- One tag designated as a reference tag and used for automatic system calibration and synchronization
- Location of asset tags based on the TDOA technique
- Accurate and reliable 2D TDOA tracking requires at least 4 receivers (3D will require at least 5 receivers)