Distance Enlargement and Reduction Attacks on Ultrasound Ranging

Sahar Sedighpour (NESL-UCLA), Srdjan Capkun (IMM, Technical University of Denmark),
Saurabh Ganeriwal, Mani Srivastava (NESL-UCLA)

Introduction:

Motivation

Localization is a critical middleware service in sensor networks:

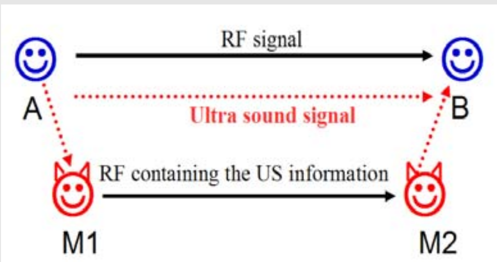
- Tracking of targets,
- Sensor Deployment, …

•Most positioning techniques are currently studied in non-adversarial settings.

Problem Description: Distance Reduction And Enlargement

Wormhole Attacks

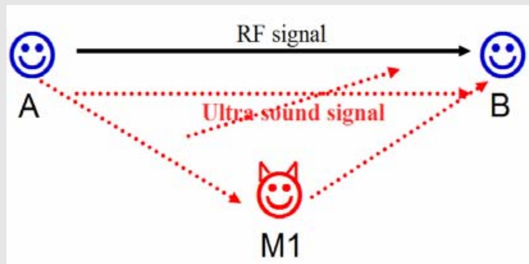
Exploits the fact that light travels faster than light



- **Distance between A and B can be arbitrarily reduced.**
- **Attackers can pass the signal between them through a fast radio link, so that the signal would be to the listener much faster.**
- **This would only work if:**

$$\frac{x}{c} \geq \frac{x_1}{c} + P_{USreceive} + P_{RFsend} + P_{RFpropegate} + P_{RFreceive} + P_{USsend} + \frac{x_2}{V_{us}}$$

Pulse-Delay Attacks



•Distance between A and B can be arbitrarily increased.

- **Attacker can make the distance seem longer by jamming the ultrasound signal from the beacon, and replay it at a later time.**

Prototype Implementation:

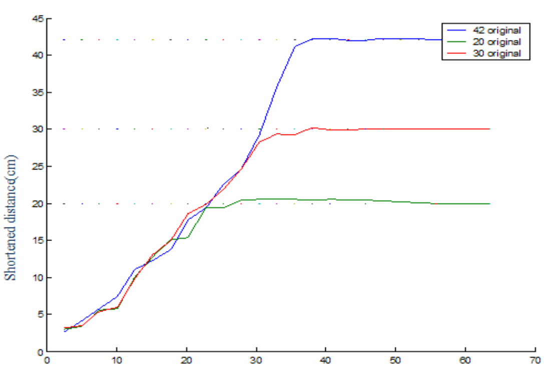
Setting

We used Crickets from MIT with V2 Software:

Two Cricket nodes (A and B) are placed at distance *d*. This distance is then measured using ultrasonic ranging: an ultrasonic signal and a radio signal are sent at the same time from node A to node B; node B then measures the difference between the reception time of the ultrasonic signal and the reception time of the radio signal; based on this difference, B estimates its distance to A. Case Study: M1 and M2 placed in 90°wrt Beacon and Listener.

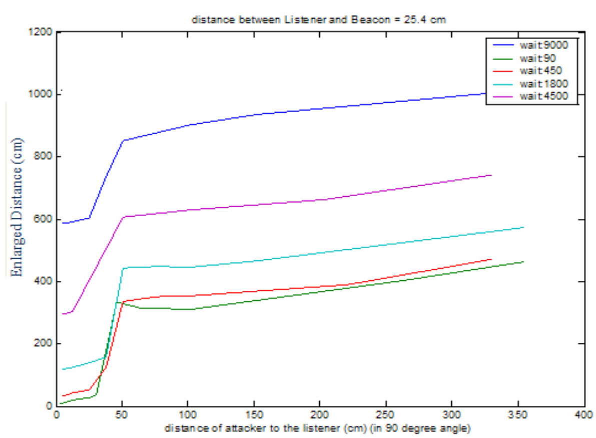
Distance Reduction:

Average distance measured with Attackers vs. Distance of Attackers to beacon and listener



When A1 also wait for US from B to send RF to A2

Distance Enlargement:



When original distance b/w L and B is 25 cm