Institute for Software Integrated Systems
Vanderbilt University

Oak Ridge
National Laboratory

Dirty Bomb Detection and Localization

IPSN 2006 Demonstration
Vanderbilt Football Stadium
April 20, 2006

Sponsored by NSF, DARPA and Crossbow Inc.

Johnny Tolliver, David Resseguie,
Morey Parang, Mark Gardner, Frank Denap

Branislav Kusy, Gyorgy Balogh, Andras Nadas, Janos Sallai,
*Yuan Xue, Taojun Wu, Peter Volgyesi, Miklos Maroti, Akos Ledeczi*

http://www.isis.vanderbilt.edu/projects/rips

What you are going to see…

Outside the window

Jumbotron/Screen: Tracking info inside Google Earth
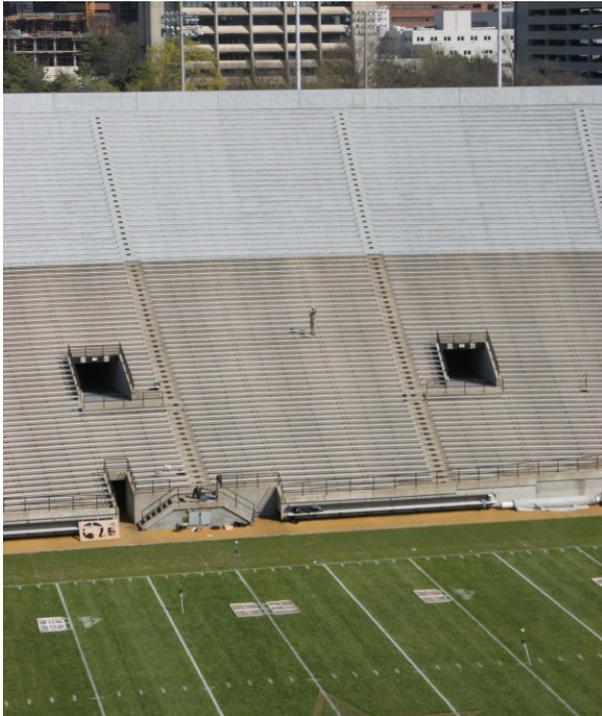
Jumbotron: automatic camera feed
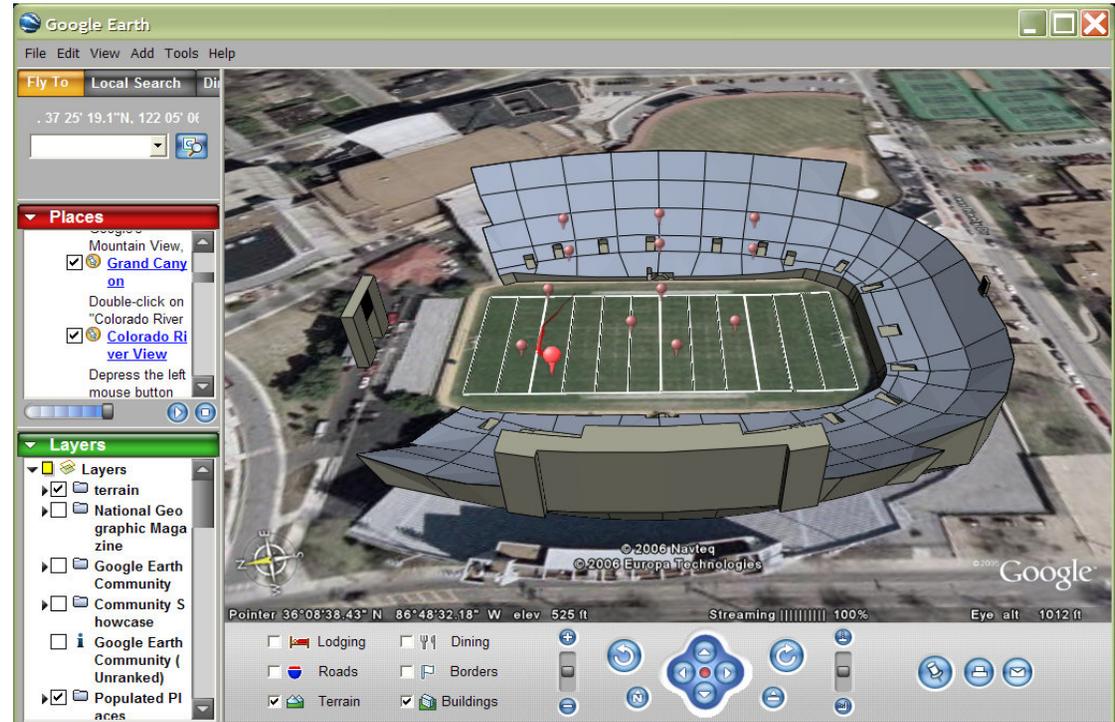
→ Security is guard walking around the stadium with a cell-phone connected radiation detector and an Crossbow XSM mote.

→ His position is continuously tracked using a radio interferometric technique running on the motes.

→ A camera automatically tracks his position using the geolocation info from the mote network.

→ When the radiation level crosses a threshold the detector sends an alarm and the camera zooms in on the position.

OaK RidGe NaTional LaboraTorY

Demonstration Architecture

Rad detector, mobile phone mote

Mote network

Tracking service and user interface

Nextel/ Internet

Rad level servlet and camera glue code

Internet

VGA to NTSC adapter

Camera control node (Linux)

Jumbotron controller
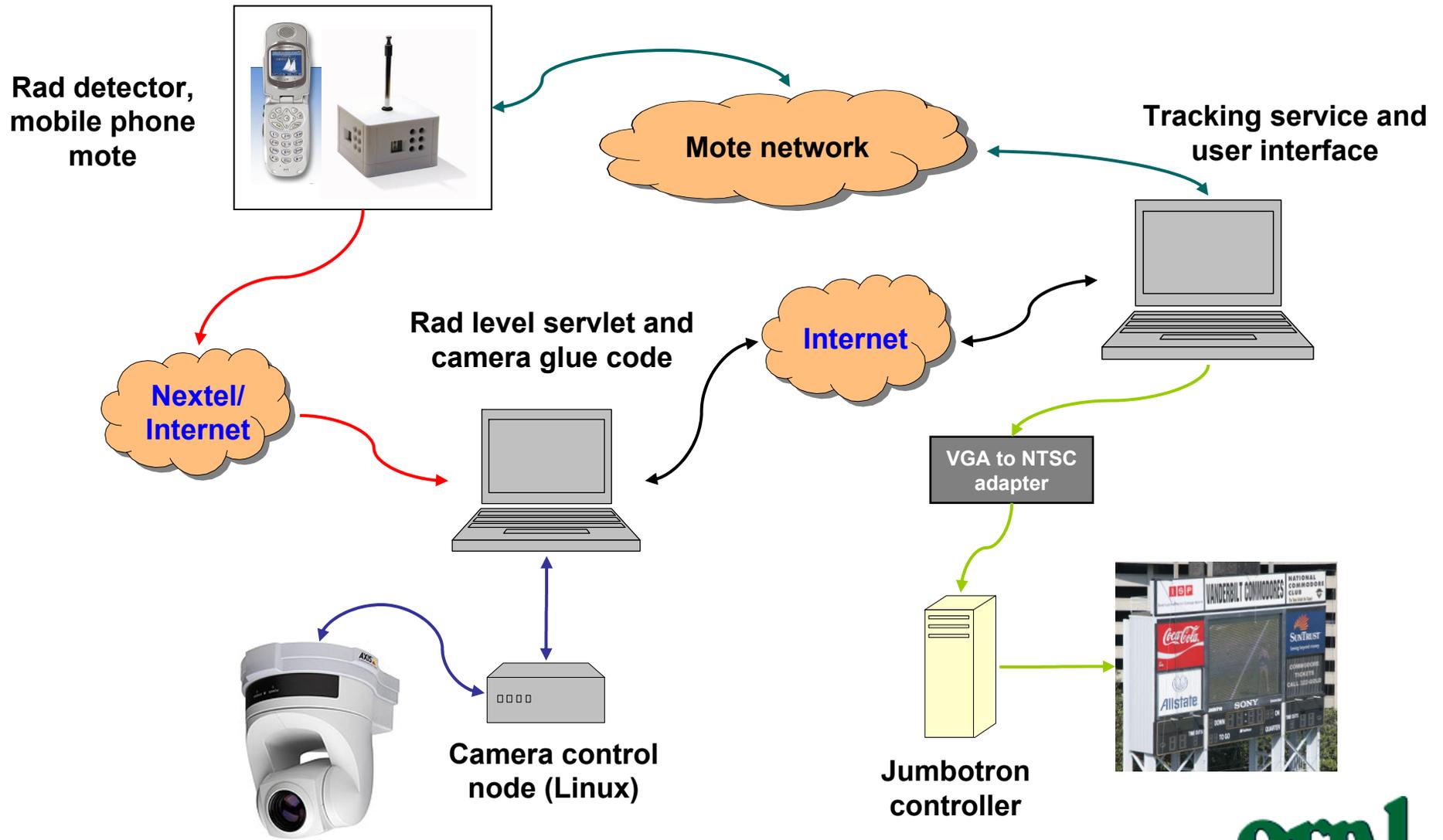
Radio Interferometric Ranging and Tracking (Vanderbilt)

→ *Ranging:*
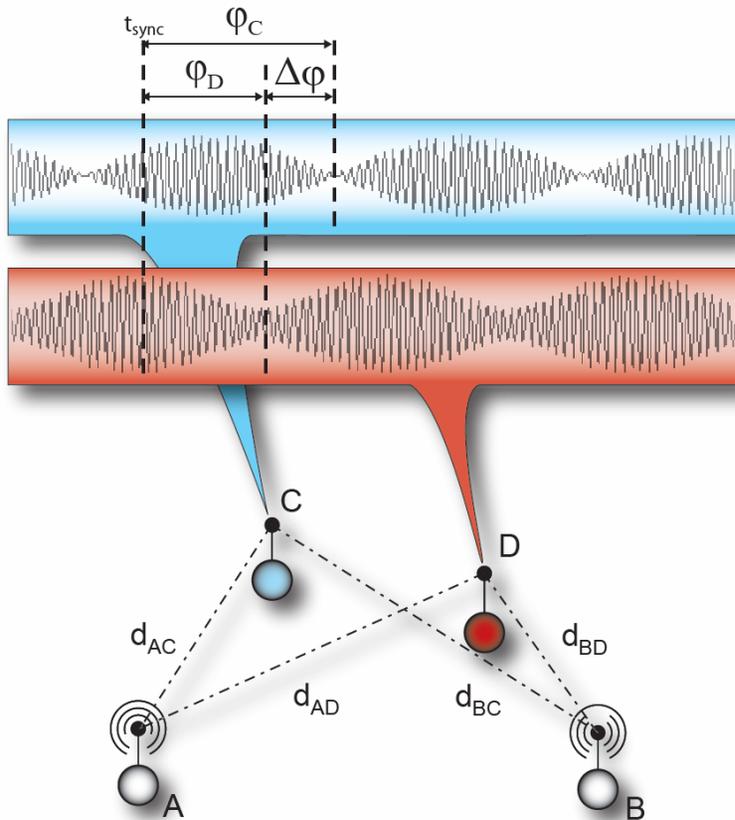
$$D_{ABCD} \pmod{\lambda} = \Delta\varphi * \frac{\lambda}{2\pi}$$

$$D_{ABCD} = d_{AD} - d_{BD} + d_{BC} - d_{AC}$$

→ *Tracking:*

- 12 motes deployed at known positions
- One extra node is tracked
- The tracked node and one other are the transmitters, the rest are receivers
- 11 channels are measured, but only 4 consecutive ones are used at a time in the sensor fusion
- Consistency function based multiresolution search algorithm running on the base station finds location estimate
- Accuracy: <1m
- Update rate: ~1 per 3 seconds
- Max speed: ~4m/s

→ *Authentication:*

- group-based peer authentication
- prevents false tracking command and information injection from spoofed nodes
- SkipJack implementation in TinySec
- predefined keys stored in FLASH (8 bytes)
- multiple message authentication codes are calculated for every message (2 bytes)

Radiation Detector and Camera Control (ORNL)
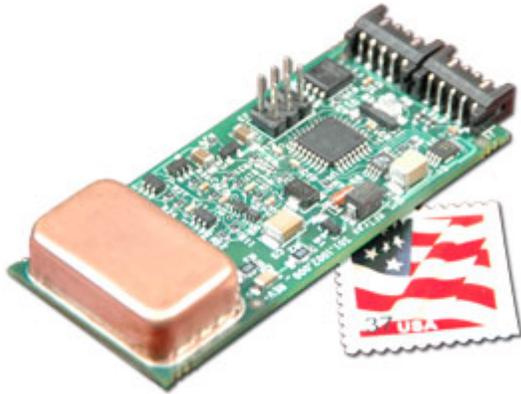
RFTrax, Inc. RAD-CZT™ detector
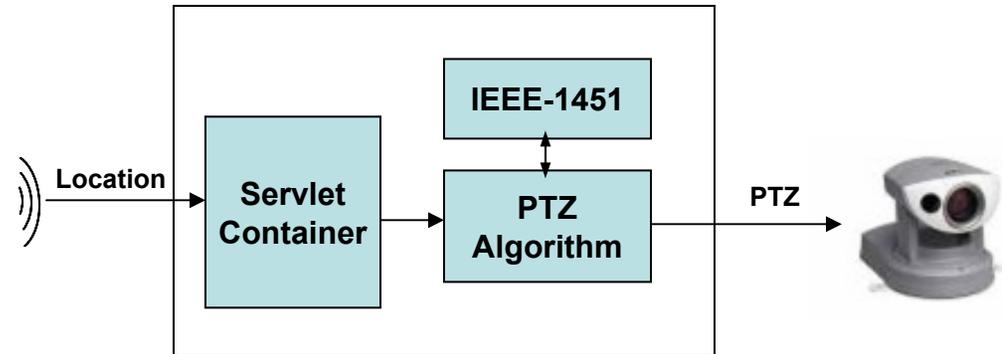
Camera Controller

- Rad detector connected to phone via RS-485/RS-232 cable
- Java app on phone reads detector data
- Java app uploads data to ORNL server approximately once per second using Nextel data network
- Server displays rad readings, obtains location from Vanderbilt server, and sends commands to camera

- Camera controller is a Java servlet running in Tomcat on a Linux box
- Java servlet issues IEEE-1451 commands to the Pan-Tilt-Zoom (PTZ) algorithm that controls camera positioning and field-of-view
- Camera image is served as a streaming JPEG over HTTP