

The background of the slide is a close-up, slightly blurred image of the American flag. The stars and stripes are visible, with the red stripes running diagonally across the frame from the top right towards the bottom left. The blue field with white stars is on the left side.

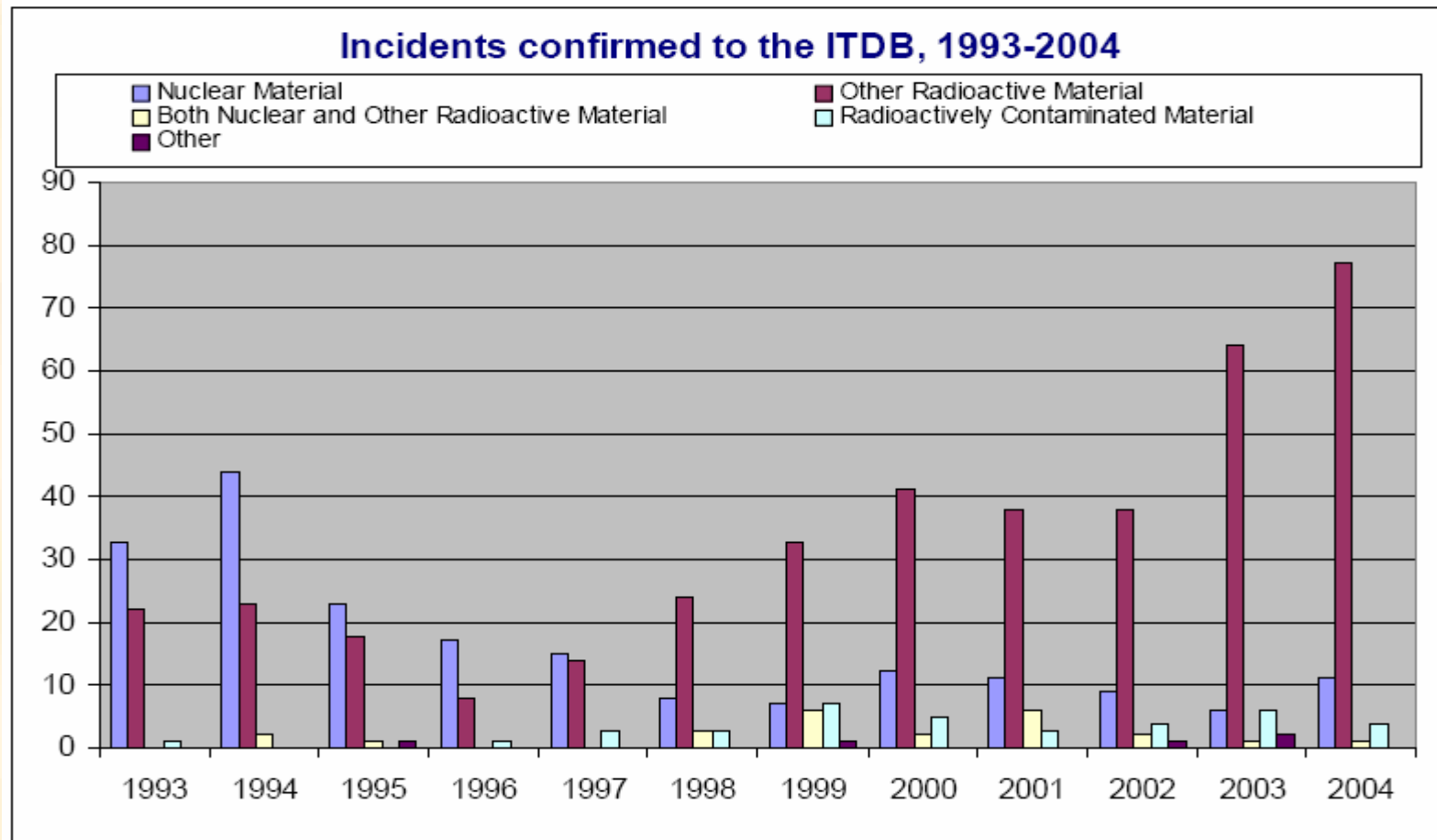
# **Nuclear Security in the 21st Century**

**American Physical Society  
Division of Nuclear Physics**

**Daniel E. Archer  
October 28, 2006**

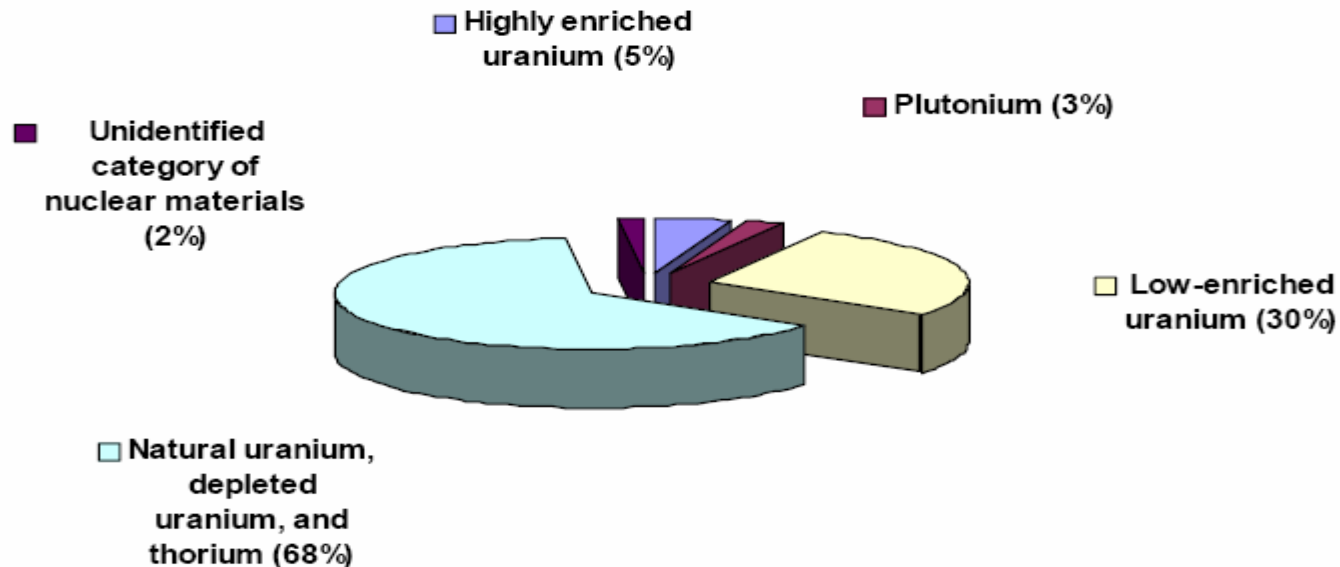
**Oak Ridge  
National Laboratory**

# Illicit Trafficking of Radioactive Sources



# Illicit Trafficking – Nuclear Materials

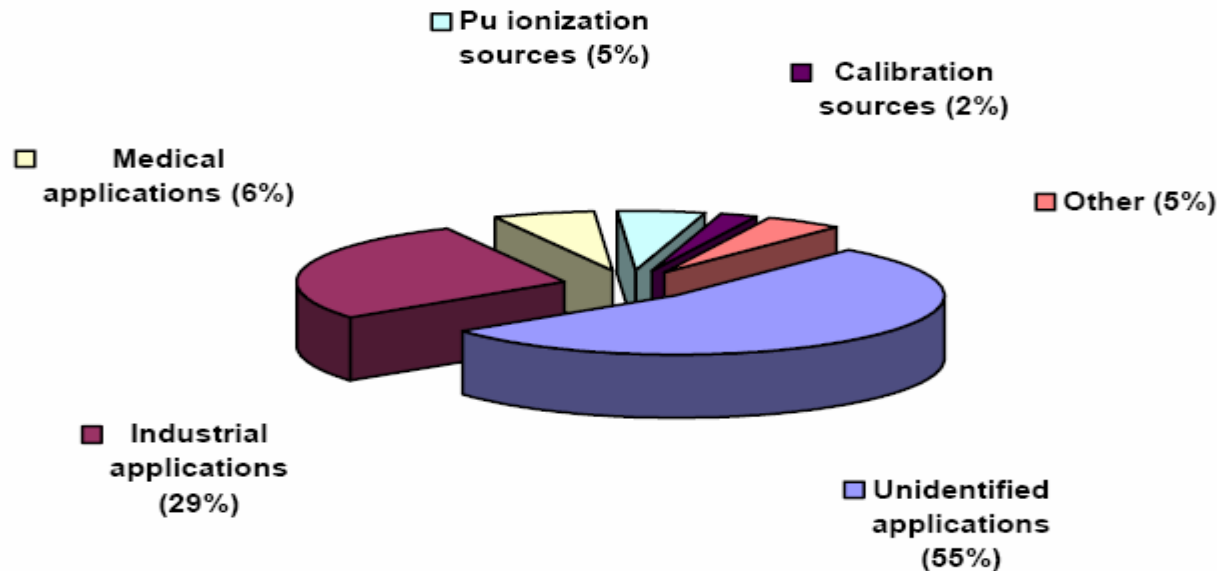
## Incidents involving nuclear materials confirmed to the ITDB, 1993-2004



Note: The total is higher than 100% because some incidents involved more than one category of nuclear materials.

# Illicit Trafficking – More than just Nuclear Materials!

**Incidents involving radioactive sources confirmed to the ITDB,  
by type of application, 1993-2004**



Note: The total is higher than 100% because some incidents involved more than one source with different applications.



# Example Accident - Goiania Brazil

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- **Sept 13, 1987, two men were searching an abandoned radiotherapy building for scrap metal that could be salvaged for money.**
- **They found a 1400Ci  $^{137}\text{Cs}$  radiotherapy source, where the source was in pellets the size of rice grains (that glowed in the dark).**
- **The source was sold to a junkyard owner and then to another junkyard owner.**
- **Family and friends took the 'glowing trinkets' home...**
- **On Sept 28, a link was drawn between the rad source and sickness that followed it.**
- **113,000 people monitored, 250 people contaminated, 4 people died**
- **Homes: 85 contaminated, 41 evacuated, 4 demolished**

# Reality

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**“There is no doubt in my mind that there will be a nuclear detonation. I would prefer that it not be in the United States. In order to prevent this from happening, we have to make the risk of getting caught heavily outweigh the possibility of success. This can only be accomplished through a multi-layer defense, an onion skin approach.”**

**- Parney Albright, Assistant Secretary for Science and Technology,  
Department of Homeland Security**

**(Excerpt from an address at Lawrence Livermore National Laboratory, 2002)**

# **We entered the nuclear age during World War II**

## **(Times of the Manhattan Project)**

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Security is also built upon a combination of trust, intelligence, and paranoia

Security during the Manhattan Project was manifest in:

- Deterrence
  - Guns
  - Guards
  - Gates
- Secret cities
- Secrets and Compartmented information
- Code words (or jargon)
- Safes / Need-To-Know
- Illiterate workers

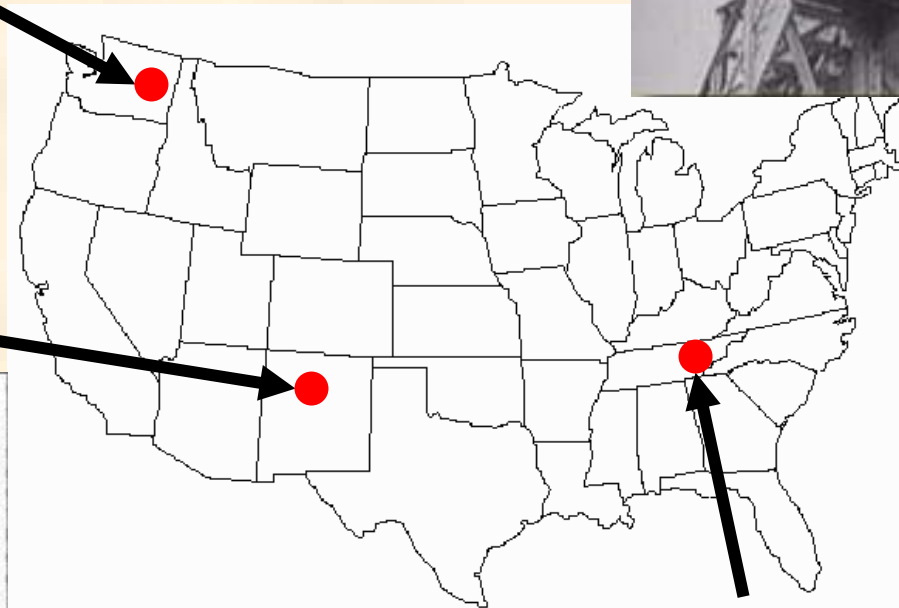
# Secret Cities, Guns, Guards, and Gates

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**Hanford  
Richland, Washington**



**Los Alamos, New Mexico**



**Oak Ridge, Tennessee**

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# Secrets / Compartmented Information

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Many workers did not know the significance of their jobs – example calutrons operators using EM fields for isotope separation of U



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**Calutrons Girl –  
Uranium Isotope Separation**

Information security was a way of life inside and outside the work area.

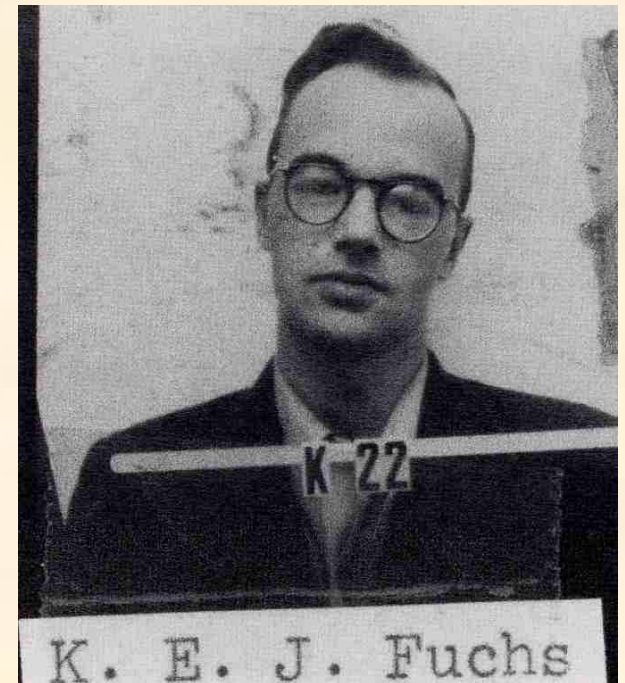
# Manhattan Project Espionage

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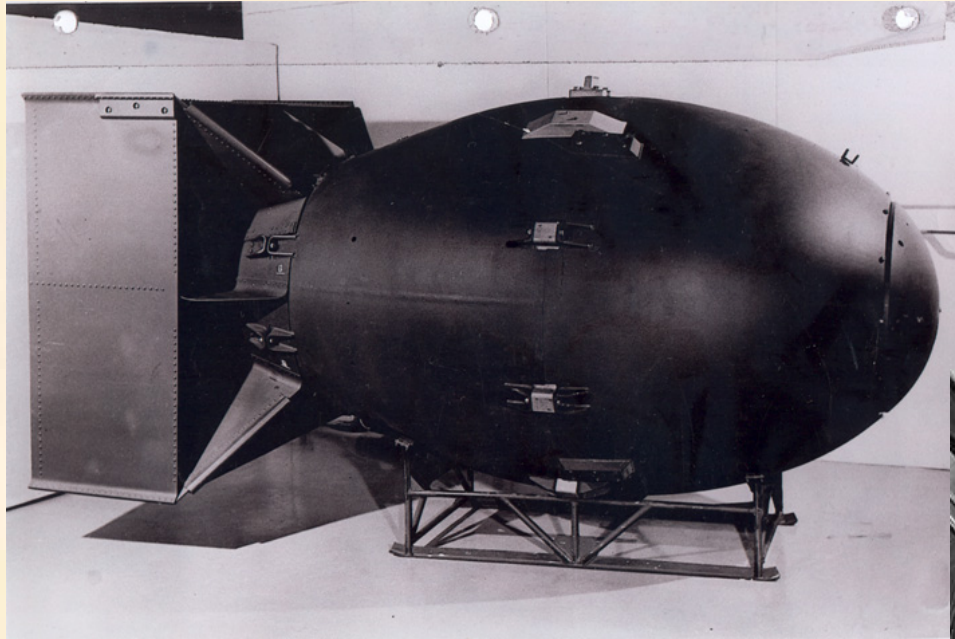
Theodore Hall – Working at Los Alamos during the Manhattan project passed limited information passed to Russia on early weapons design confirming information from Klaus Fuchs

Klaus Fuchs – British physicist working at Los Alamos during the Manhattan project was perhaps the most damaging spy during the early atomic age.



# Manhattan Project Espionage

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United States Fat Man Model



Russian "Joe-1" Model

# What security measures are being taken now?

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- **MPC&A – Materials Protection, Control and Accounting**
  - Installation of MPC&A equipment at civilian nuclear sites in Russia
- **SLD – Second Line of Defense**
  - Securing international borders, seaports and airports
- **MegaPorts and Container Security Initiative**
  - Securing containerized cargo through cooperative agreements
  - Developing secure containers
- **Securing US borders**
  - Customs and Border Protection installation of radiation monitoring equipment
- **PPRA – Plutonium Production Reactor Agreement**
  - 1997 Russian/US agreement to move away from the use of Pu reactors
  - 3 Russian cities remain that rely on Pu reactors for power
- **HEU Transparency**
  - 1993 Russian/USA agreement for the US to purchase 500 metric tons of downblended HEU from Russian weapons
- **Nuclear Cities Initiative**
  - Removing equipment from Russian weapons complex while creating sustainable business in the formerly closed cities

**Note: Similar programs and initiatives are in place with countries other than Russia**



# What types of equipment are being used?

## Gross counters and spectroscopic systems are in use.

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Different technologies have emerged to meet national needs for radiation detection

- Belt mounted
- Handheld
- Portal (pedestrian and vehicle)
- Vehicle mounted
- Cargo Screening (VACIS)
- Imaging





# ARAM – Paving the R&D road to the RadTruck

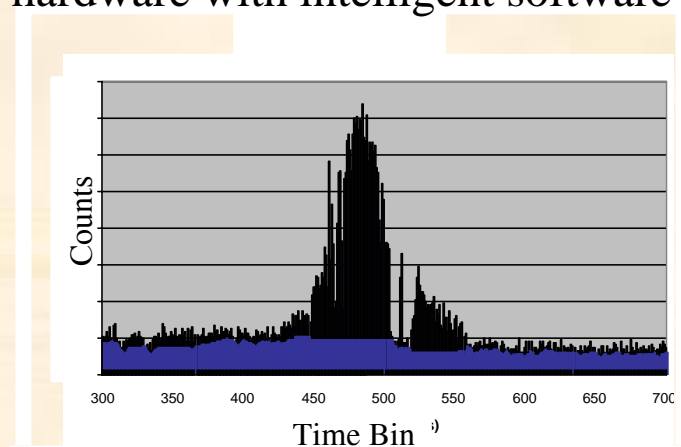
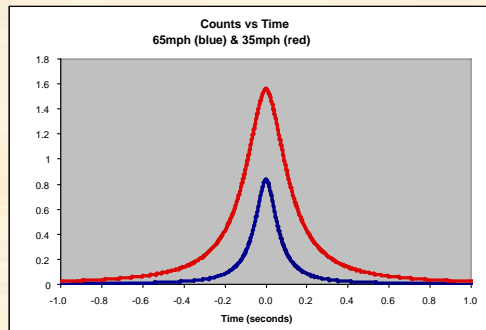
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ARAM – The Adaptable Radiation Area Monitor (Project started in 2000)

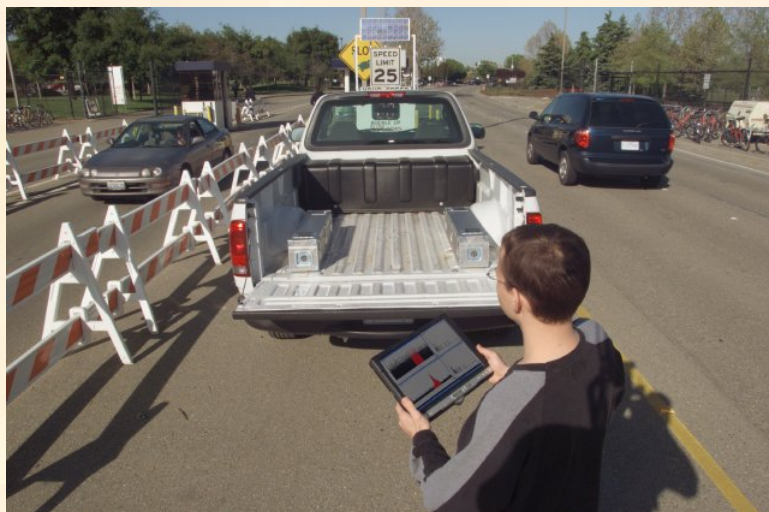
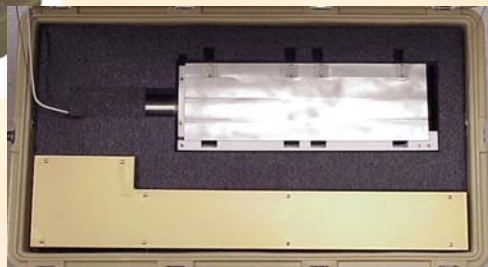
- ARAM focus
  - Forward thinking
    - Build an adaptable system that can be used in many different radiation monitoring situations with only simple changes
    - Simple change – no new hardware, turn software switches on/off
  - Process the data real time
  - Store data for post processing
  - Modular components – Adaptable – Reduction in overall cost
- Rapid production
  - Use cutting edge technology that is commercially available
- Research and development
  - Integration of (mostly) existing hardware
  - Develop highly specialized software that is key to the system

# ARAM Design

- Real time radiation monitoring system requiring new electronics
  - Spectral data collection (1024 channels)
  - List mode or near list mode (50ms – 100ms)
  - Record all data
  - Make decisions on the fly
- Adaptable to most situations
  - Pedestrian
  - Cargo
  - Vehicle (highway speed)
  - Package
- Design to record the most information possible to rebuild spectral data from the event with the highest signal to noise
  - Nuclide determination from limited information, e.g. ~100 counts from the signal
- Limited failure points by minimal hardware with intelligent software



# ARAM – Keeping it simple



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# ARAM – Demonstrations and Installations

- PAPD vehicle original
- FedEx monitoring
- Buoys
- DTS
- PAPD “Rad Truck”
- Licensed Oct 2003

Temporary Monitoring



**FedEx**  
Express

DoD/DTRA  
UNWD Program  
Fort Leonard Wood,  
Missouri



UNWD Buoy



Permanent Installation



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**UT-BATTELLE**

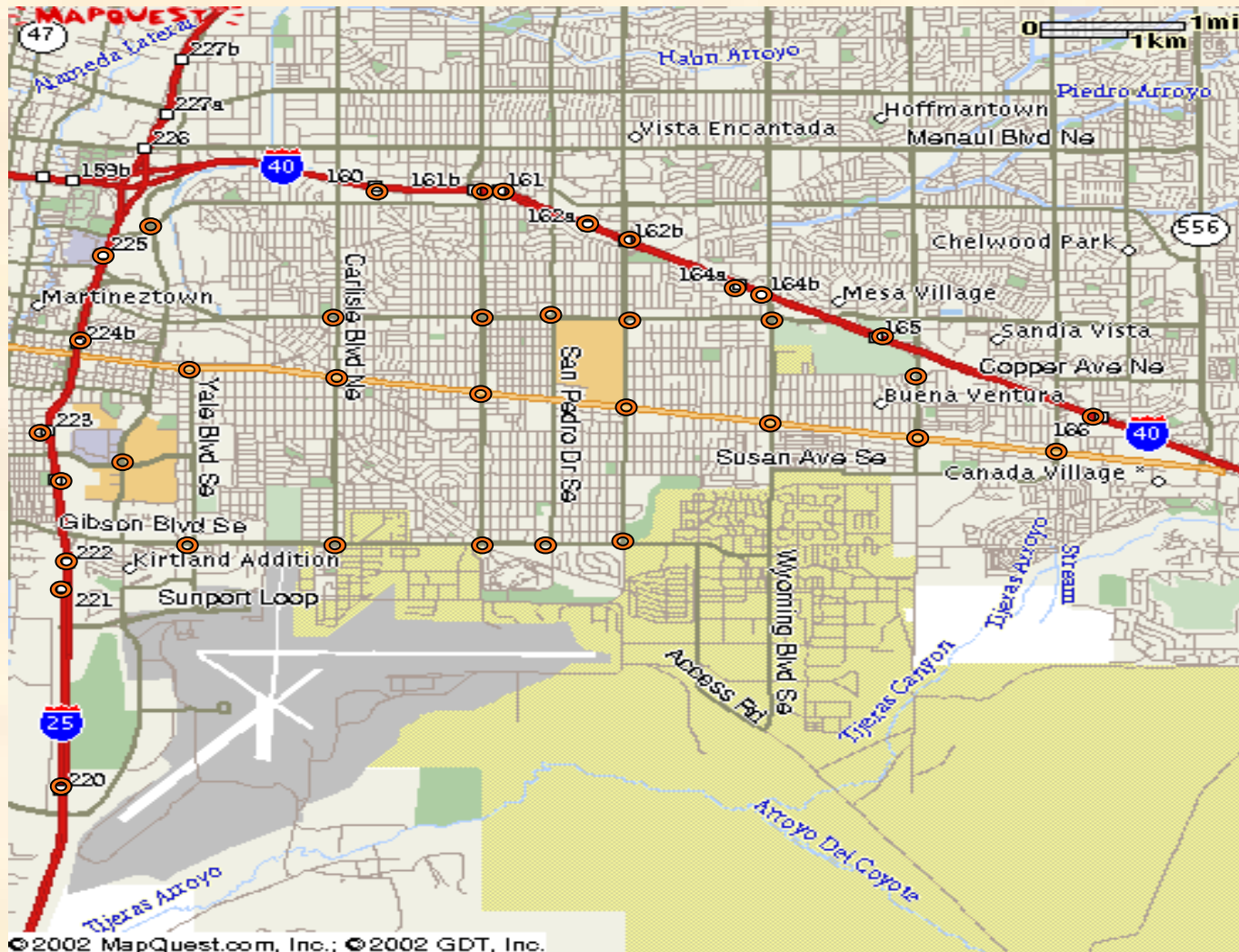


DTS is a radiological “sentry” for monitoring large areas. It is designed to identify and track vehicles with nuclear threats.





# Notional Detector Network



# DTS Demonstration

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## Congress directed DTRA and the NNSA to establish:

- Partnerships to conduct testing, analysis, and evaluation of off-the-shelf technologies that can be quickly integrated
- Program to design and demonstrate Unconventional Nuclear Warfare Defense (UNWD) test beds at four DOD installations

## UNWD Objectives:

- Rapidly deploy detectors and sensors capable of detecting nuclear materials that might be used by terrorists
- Develop system architectures and deploy
- Demonstrate feasibility, capability, reliability and performance, and network with existing emergency response systems at four separate military installations, each representing unique challenges (topography, traffic, water craft, weather.)

## Effort Level:

- 5 physical scientists, 6 computer scientists, 30 engineers - 9 months



# Detection & Tracking System Fort Leonard Wood Deployment

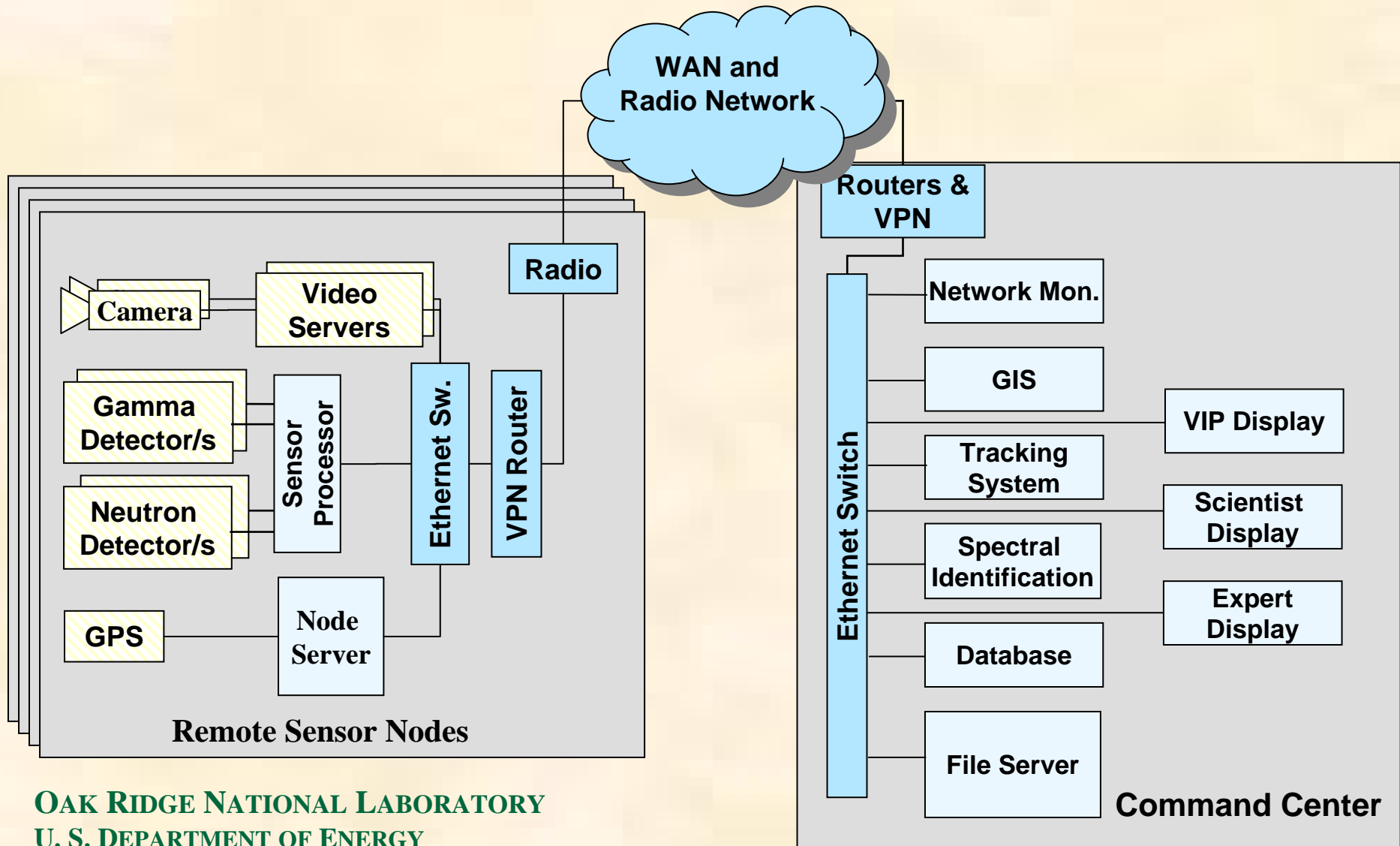


# System Components

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- **18 nodes with energy-discriminating gamma detectors, two video cameras.**
- **10 nodes with neutron detectors.**
- **The command center receives data from remote nodes, store the data, characterize and correlate detections, predict source direction, and alarm on specified threat source.**
- **A wired and wireless communication system ties all nodes together using standard IP interfaces.**

# DTS System Diagram





# Building detector nodes



← Start with this



Two days of this →

# Node fully configured





## Locations of sensors and communication links for Fort Leonard Wood demonstration

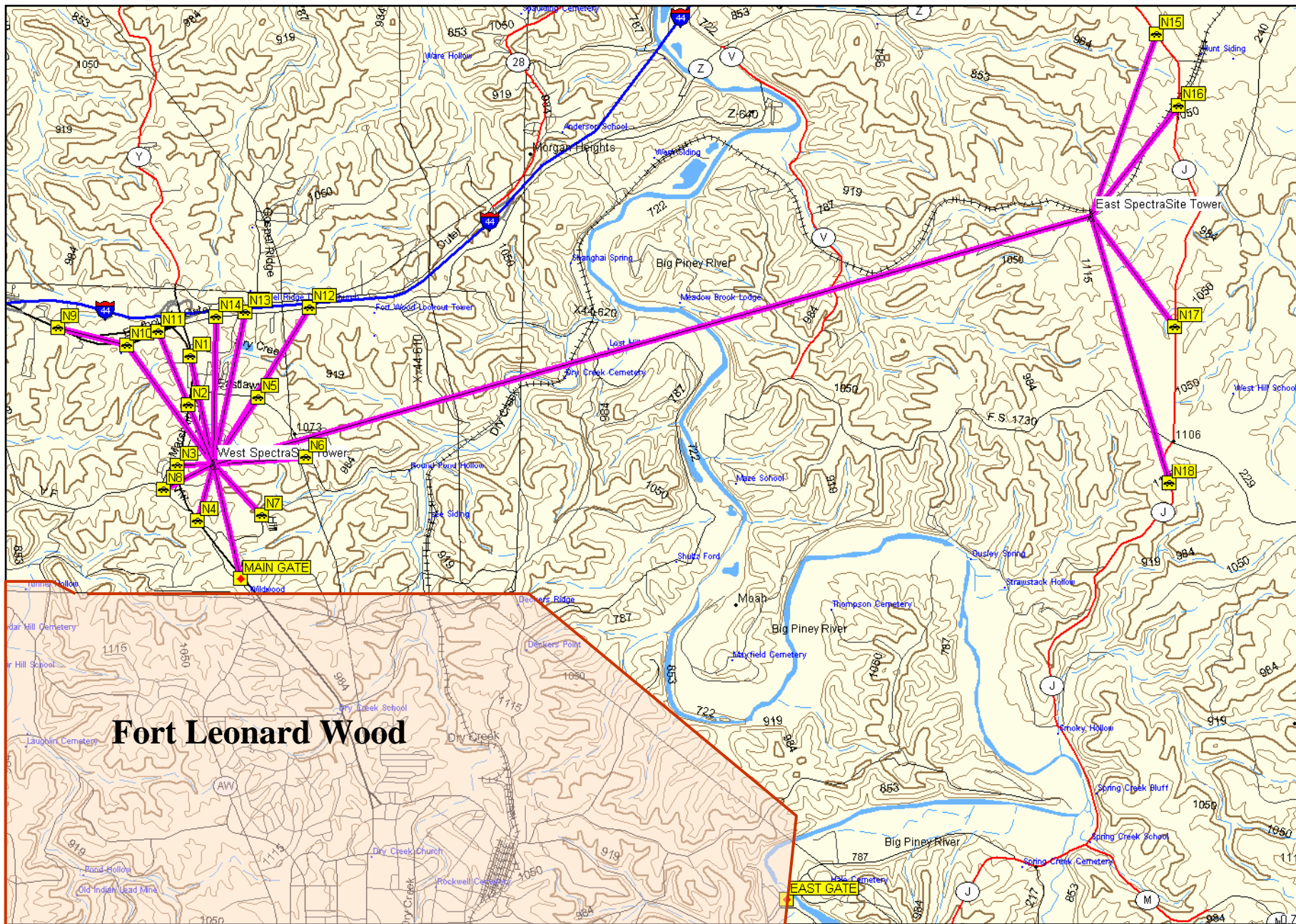
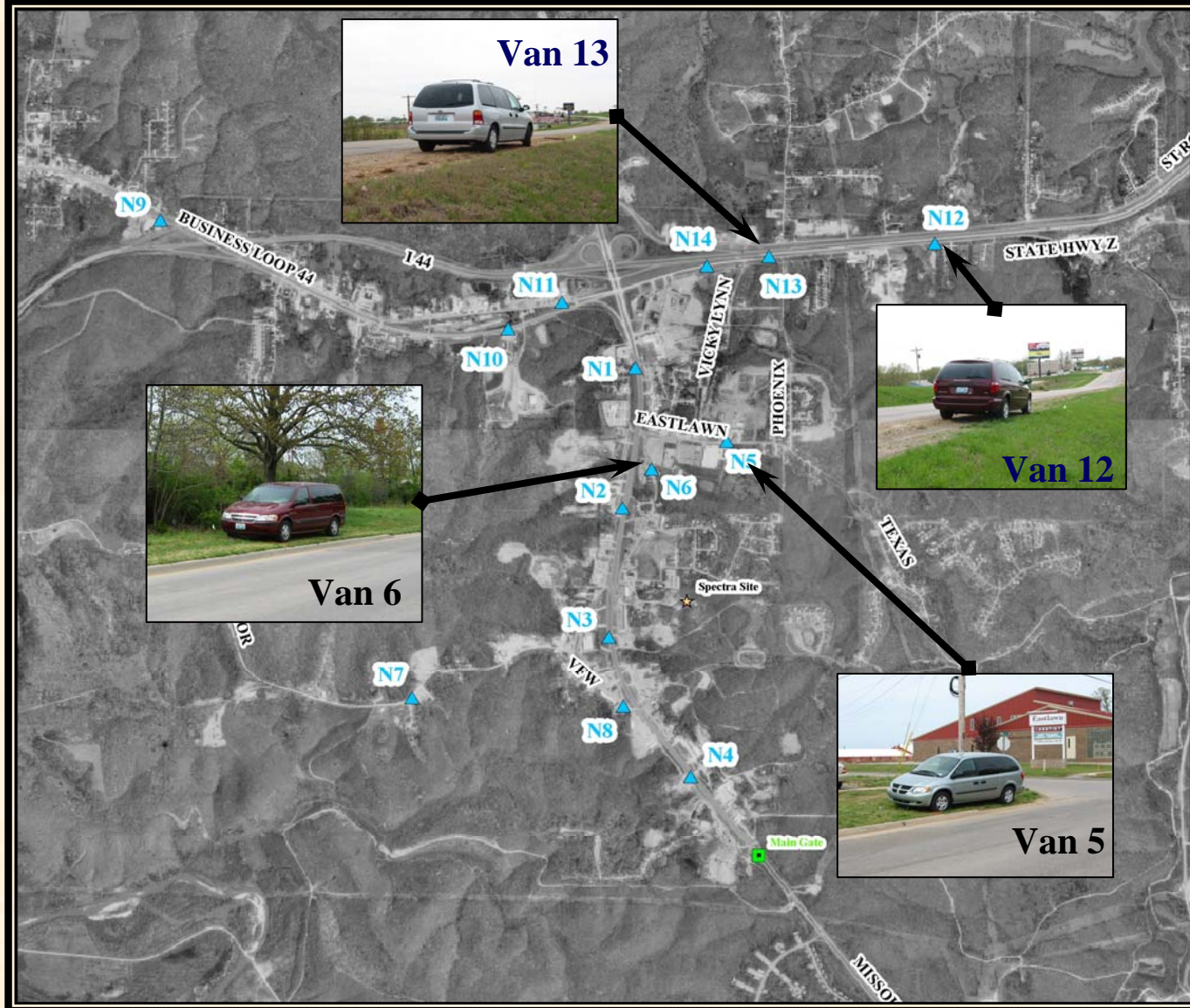


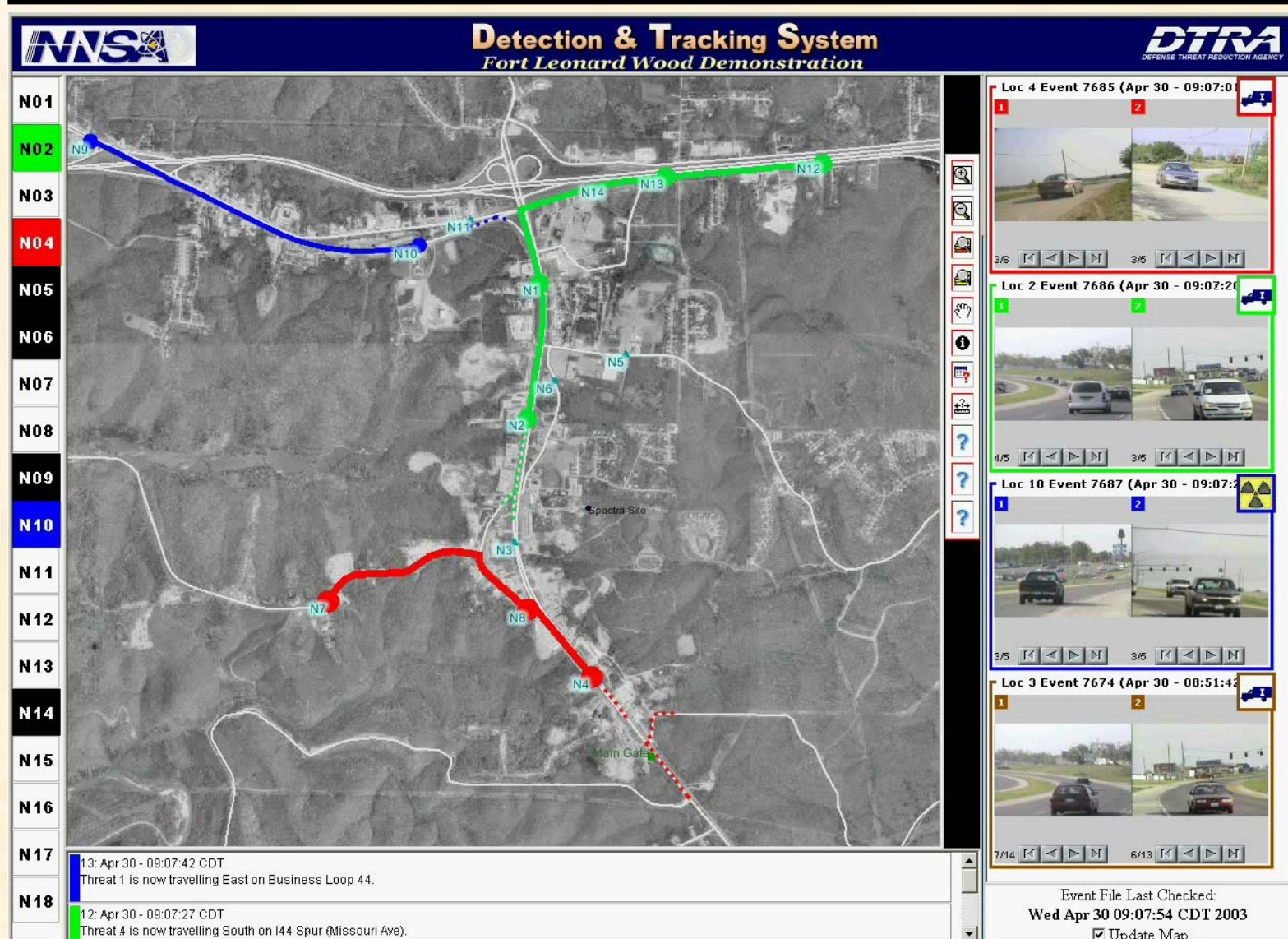
Figure 2

## Asset Locations





# DTS Display





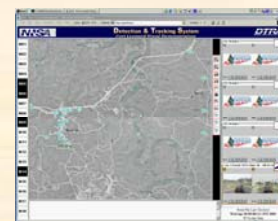
# DTS – FLW Video

**NNSA** **Detection & Tracking System**  
*Fort Leonard Wood Demonstration* **DTRA**  
DEFENSE THREAT REDUCTION AGENCY

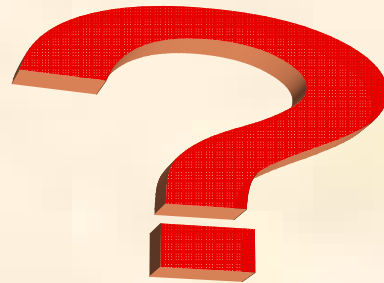
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Local intranet



# Are there still research and development opportunities?



# Summary

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- Nuclear security is of the utmost importance
  - Accidents occur each year, sometimes with horrible results
  - Illicit trafficking is on the rise
  - Nuclear states are still emerging
- Global progress in security has been made in the past few years
  - Securing materials
  - Securing borders
- New detection systems have been developed
  - Gross counters and spectroscopic systems
  - DTS – demonstrating that multiple sources can be identified and tracked in real time
- There is still research and development to be performed
  - Measuring multiple attributes through orthogonal detectors
  - Nuclide determination through automatic analysis
  - Advanced field systems that any user can operate