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Deliberate Motion Analytics (DMA)

An Enabling Technology For New Security Architectures

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In Collaboration with Management Sciences Inc. (MSI)

RIC Conference

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Beyond Guns, Gates, and Guards: Innovative Approaches to Securing Advanced Reactors

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U.S. DEPARTMENT OF ENERGY

NNSA

Funded by Two Programs within the DOE Office of Nuclear Energy (DOE-NE)

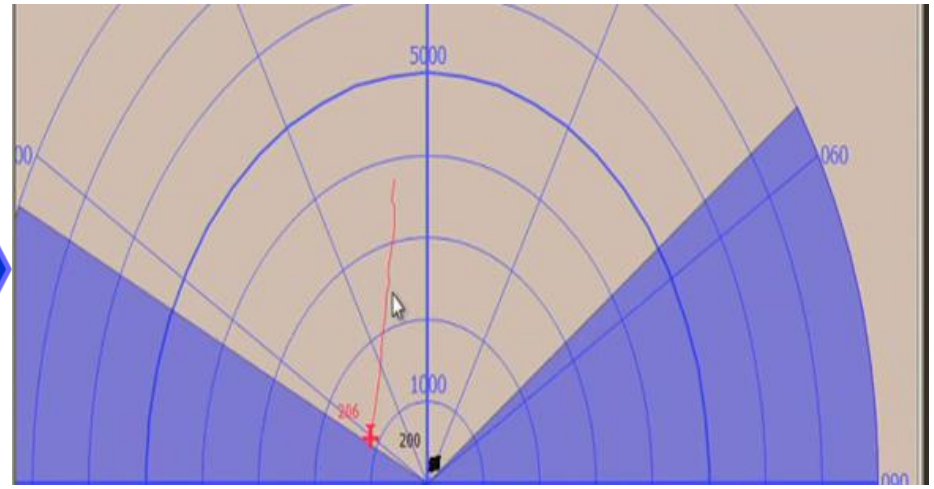
DOE-NE Advanced Reactor Safeguards (ARS)
Seeks to "remove roadblocks in the deployment of new and advanced reactors by solving regulatory challenges, reducing safeguards and security costs, and utilizing the latest technologies and approaches for robust plant monitoring and protection."

Light Water Reactor Sustainability (LWRS)
Seeks to "develop technologies and other solutions to improve the economics and reliability, sustain the safety, and extend the operation of our nation's fleet of nuclear power plants by providing science and technology-based solutions to industry."

What is Deliberate Motion Analytics (DMA):
An enabling technology for new security architectures

- A sensor algorithm that can fuse multiple sensors to create a multi-physics hybrid-sensor system
- Enables explicit implementation of the principal of complementary sensors
- It uses deliberate motion to differentiate intruder alarms from nuisance alarm sources, including weather, moving fences, and foliage
- A Multi-Intelligence Fusion Algorithm – uses machine learning, probabilistic techniques, multi-hypothesis tracking, and Bayesian Networks
- It decides when to “and” and when to “or” sensor alarm outputs

Actual screen shot – High NAR, during light rain



What you want to see

DMA in Action

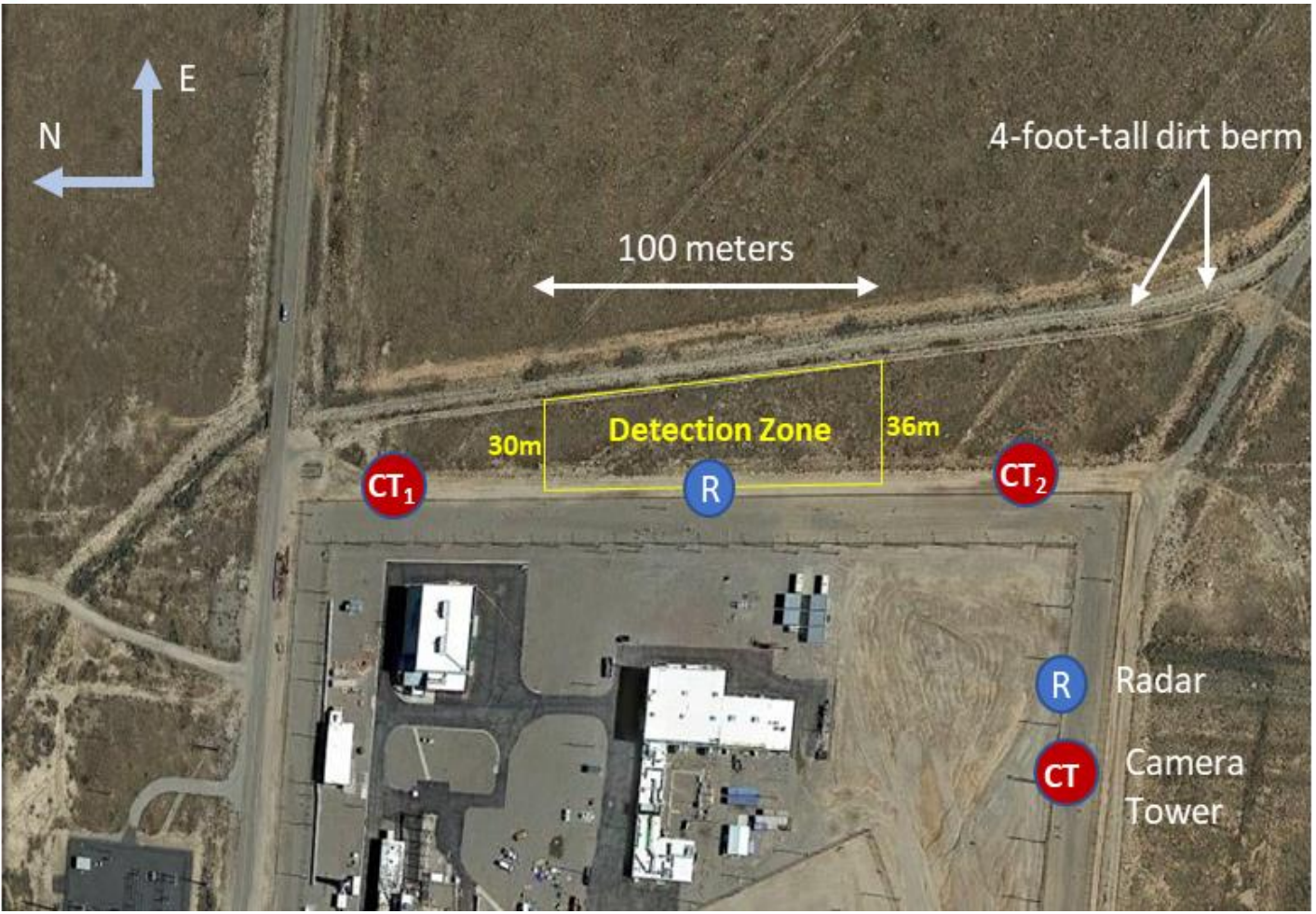
Video during a Rain Storm in a Traditional Perimeter

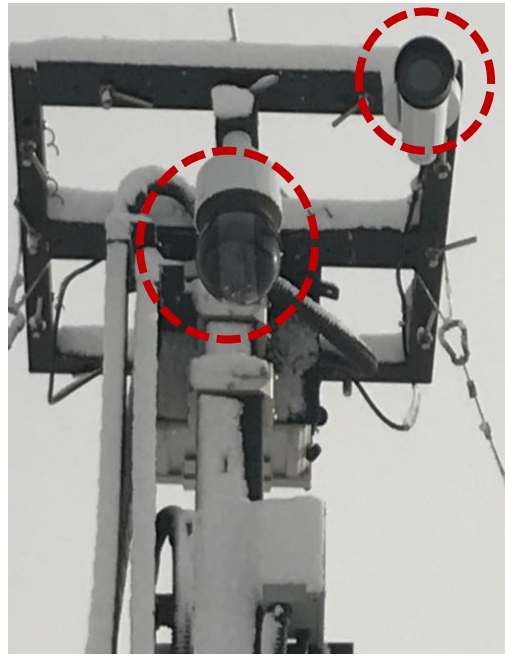
- About 5000 alarms from radar and video that day
- Zero Nuisance Alarms from the Fused Sensor Algorithm

Example 1:DMA Performance in a Traditional Two-Fence Perimeter, 2015
Fused Radar and Video Analytics

- **Detection Performance:** Exceeded DOE detection requirements for runners, walkers, and crawlers
- **Nuisance Alarm Rate:** Over 150,000 nuisance alarms from the radar and video analytics, July-December
- **DMA NAR Filter:** Declared 1 nuisance alarm in 6 months

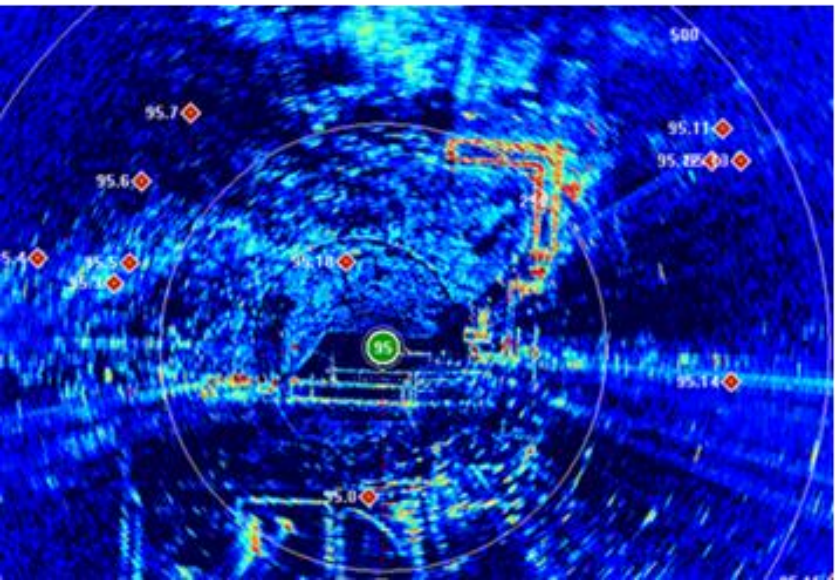
Example 2: DMA Sensor System Installed beyond the fence in a desert environment





Example 2: Intrusion Tests and Nuisance Alarm Rate
Beyond the fence in desert environment

- **Detection Performance:** Exceeded DOE detection requirements for a two fence perimeter for, runners, walkers, crawlers
- **Nuisance Alarm Rate:** Radar and Video Analytics generated over 150,000 nuisance alarms from weather, foliage, wildlife, during 28 hour period
- **DMA NAR Filter:** 0 NAR



Diamonds shows radar False Positives

True detection from video

Circles shows video False Positives

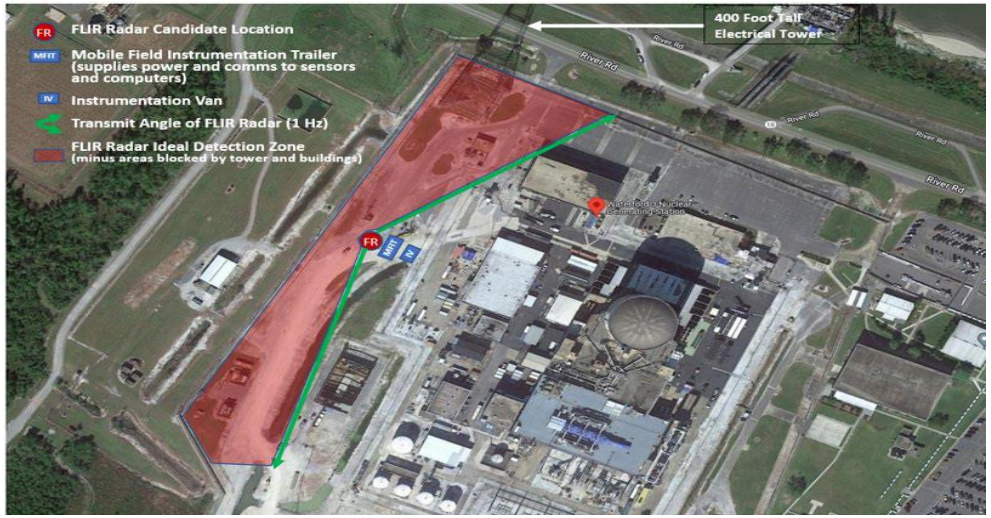
Example 3: DC Cook Pilot Deployment, Feb-March 2022 (Cold Temps)
Detection zone along the water line of Lake Michigan

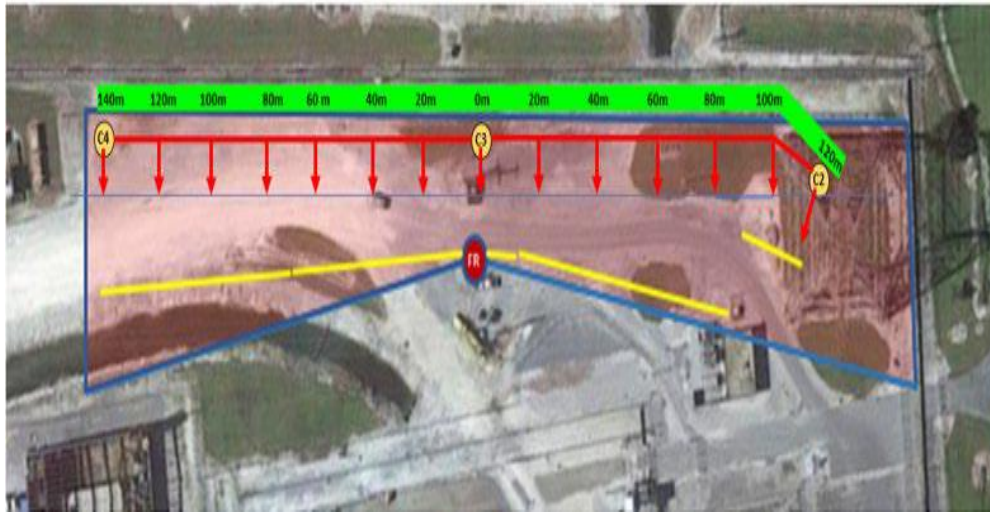
- **Detection Performance:** Exceeded DOE detection requirements for a two-fence perimeter, except for running, needed a faster sensor
- **Nuisance Alarm Rate:** Radar generated thousands of nuisance alarms from weather, waves, and wildlife, during 61 hour period
- **DMA NAR Filter**
  - 0 NAR from weather and waves
  - For wildlife, did not meet DOE NAR requirements for a two fence perimeter

Example 4: Waterford III Pilot Deployment, August 2022 (Rainy Season)
Test conducted beyond PIDs fence line

- **Detection Performance:** Exceeded DOE detection requirements for a two-fence perimeter, where the radar had line of site for walkers, runners, and belly crawlers.
- **Nuisance Alarm Rate:** Radar generated thousands of nuisance alarms from rain and hundreds from birds during the 15 day test period.
- **DMA NAR Filter**
  - 0 NAR from weather/rain
  - Less that 1 nuisance alarm per day from birds
  - Meets DOE requirement for NAR within two-fence perimeter

12-inch Al Ball to simulate belly crawl



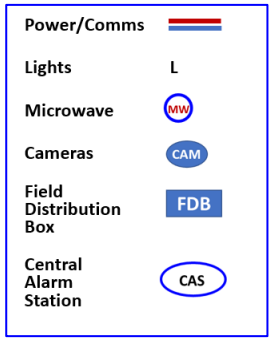


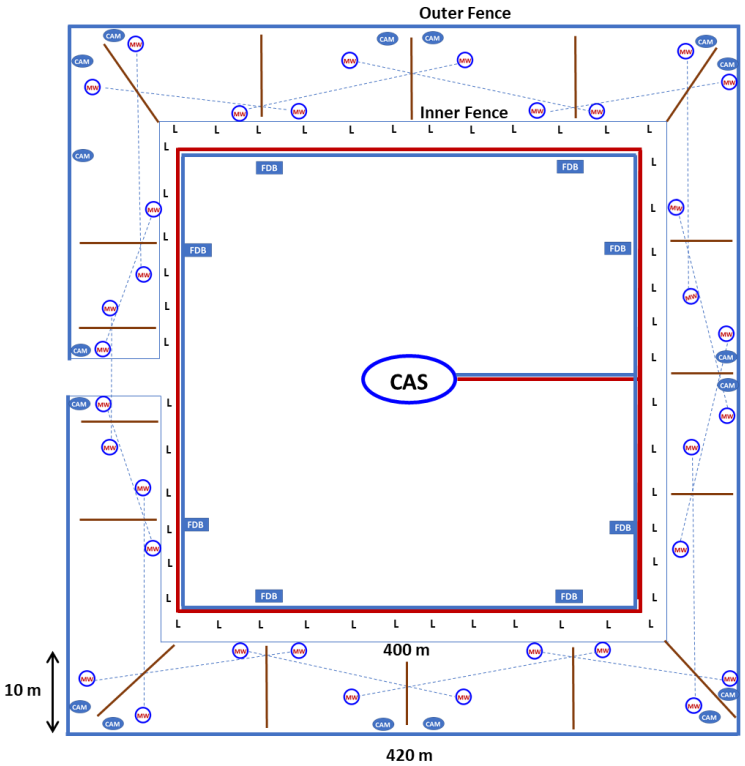
Example of Test Paths for run, walk, belly crawl

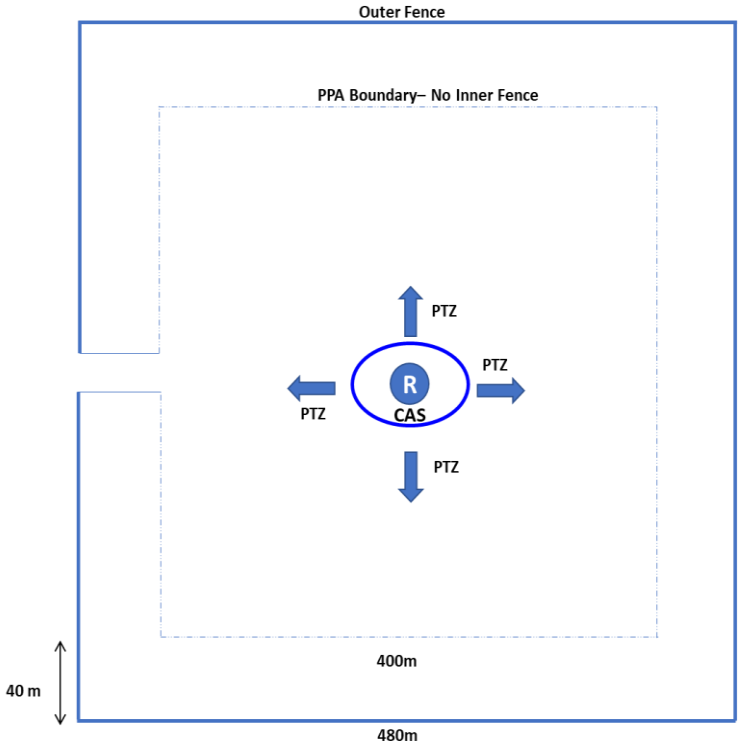
Advanced Small Modular Reactor Design Cost Comparison
Traditional Design vs DMA-Enabled Perimeter Intrusion Detection System (DPIDS)

Traditional

- PPA Boundary 400 m sides
- 17 Sectors
- 34 Microwaves
- 17 Cameras
- 8 FDBs (Field Distribution Boxes)
- 48 Lights/Light Poles
- Trenching for Power or Comms
- 8 Foot Security Fence
- Inner and Outer Fence, 3280m (10800 ft)
- 9 meter clear zone





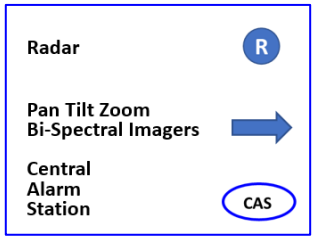


DPIDS

- PPA Boundary 400 m sides
- No Sectors
- No FDBs (Field Distribution Boxes)
- No Lights/Light Poles
- No Trenching for Power or Comms
- 8 Foot Security Fence
- Outer Fence, 1920m (6340 ft)
- 40 meter clear zone

Caveat Regarding "No Lights"

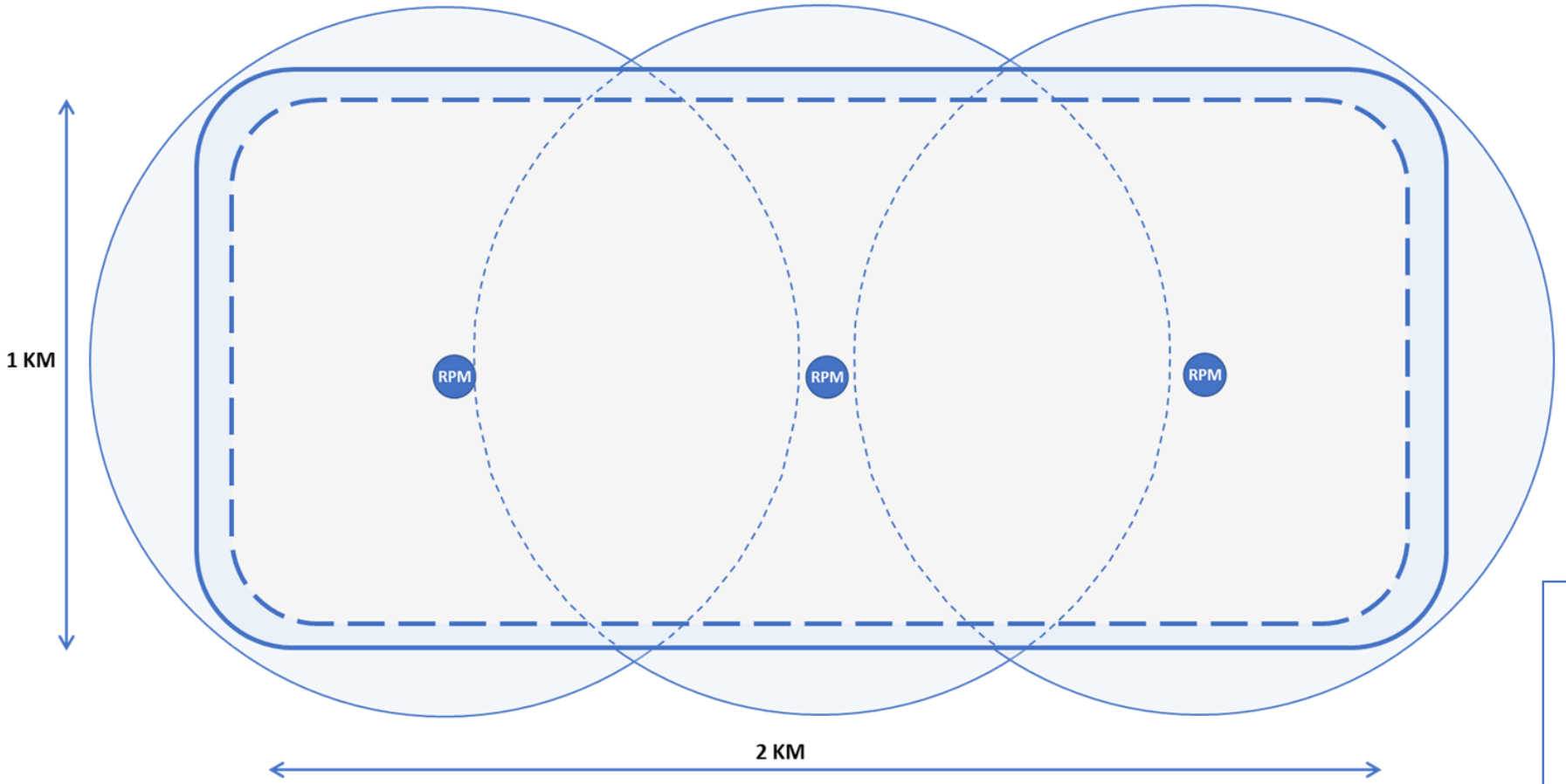
- No Lights on perimeter needed for intrusion detection
- Lights on/around the CAS
- Safety and Response Force may require lights



DPIDS Design is an estimated to cost 40% less than Traditional Design

Used RSMeans Construction Cost Manual and from Advertised Material/Construction Costs
More detailed breakdown in "DMA enabled PIDS (DPIDS) A New Architecture for Intrusion Detection Based on Deliberate Motion Analytics," SAND2022-12659 R

New PIDs Modular Design: DPIDS-2

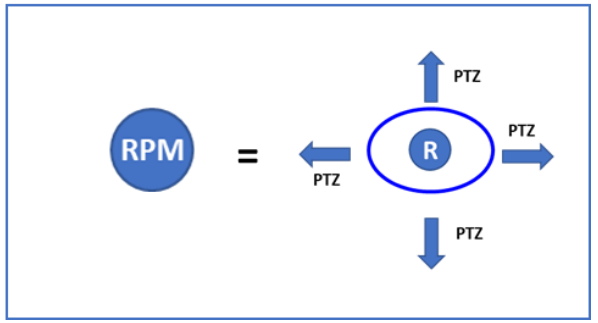


Use RPM as a building block for larger sites

Good performance expected if weather allows longer range Vis/IR Imagery

PPA Boundary - - - -
est. 6km (19,800 ft)

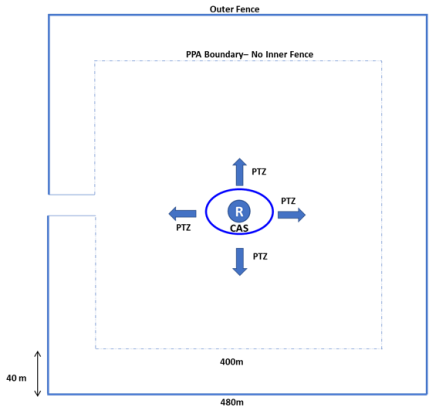
Detection Zone

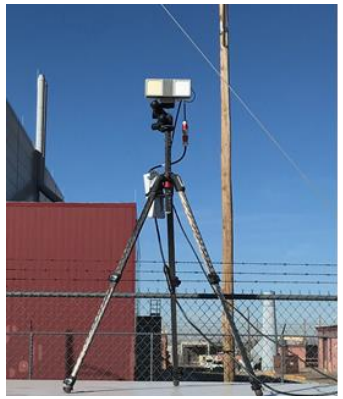


RPM = Radar/Pan Tilt Zoom Imager Module

What's Next in FY23

- **Build ASMR DPIDS system**
  - Radar and Video
- **Complete prototype Fused UAV detection system**
  - Fortem Radar and Passive RF
- **Pilot deployments for Ground Intrusion**
  - Palo Verde (Arizona)
  - Braidwood Nuclear Power Plant (Illinois)
- **Build prototype Water Intake Swimmer Detection**
  - Fuse Sonar, Visible and Thermal Imagers
  - Conduct testing at two Nuclear Power Plants
    - Braidwood (Illinois)
    - Monticello (Minnesota)
- **Incorporate new Sensors**
  - Faster, less expensive radar
  - Lidar



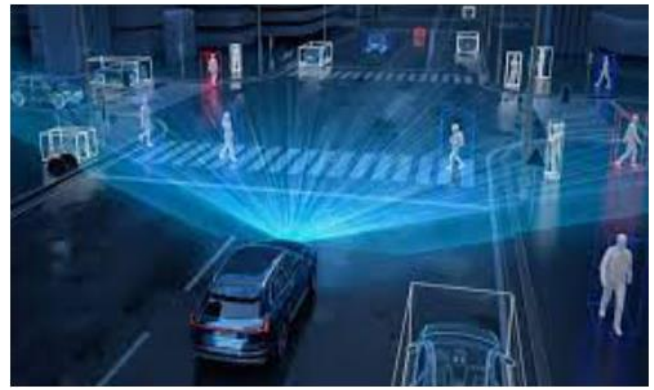


Fortem Radar

Wind Talker Passive RF

Sonar (Fish Finders)

Less Expensive Radar



LIDAR