

India's International Borders and Coasts

Every State has an international border or coast except five

106 KM Afghanistan (in PoK today)

3488 KM

China (Tibet and Xinjiang)

3323 KM
Pakistan

1751 KM
Nepal

699 KM
Bhutan

Smart Border Surveillance

1643 KM
Myanmar

4097 KM
Bangladesh

7516 KM
Maidland
coast

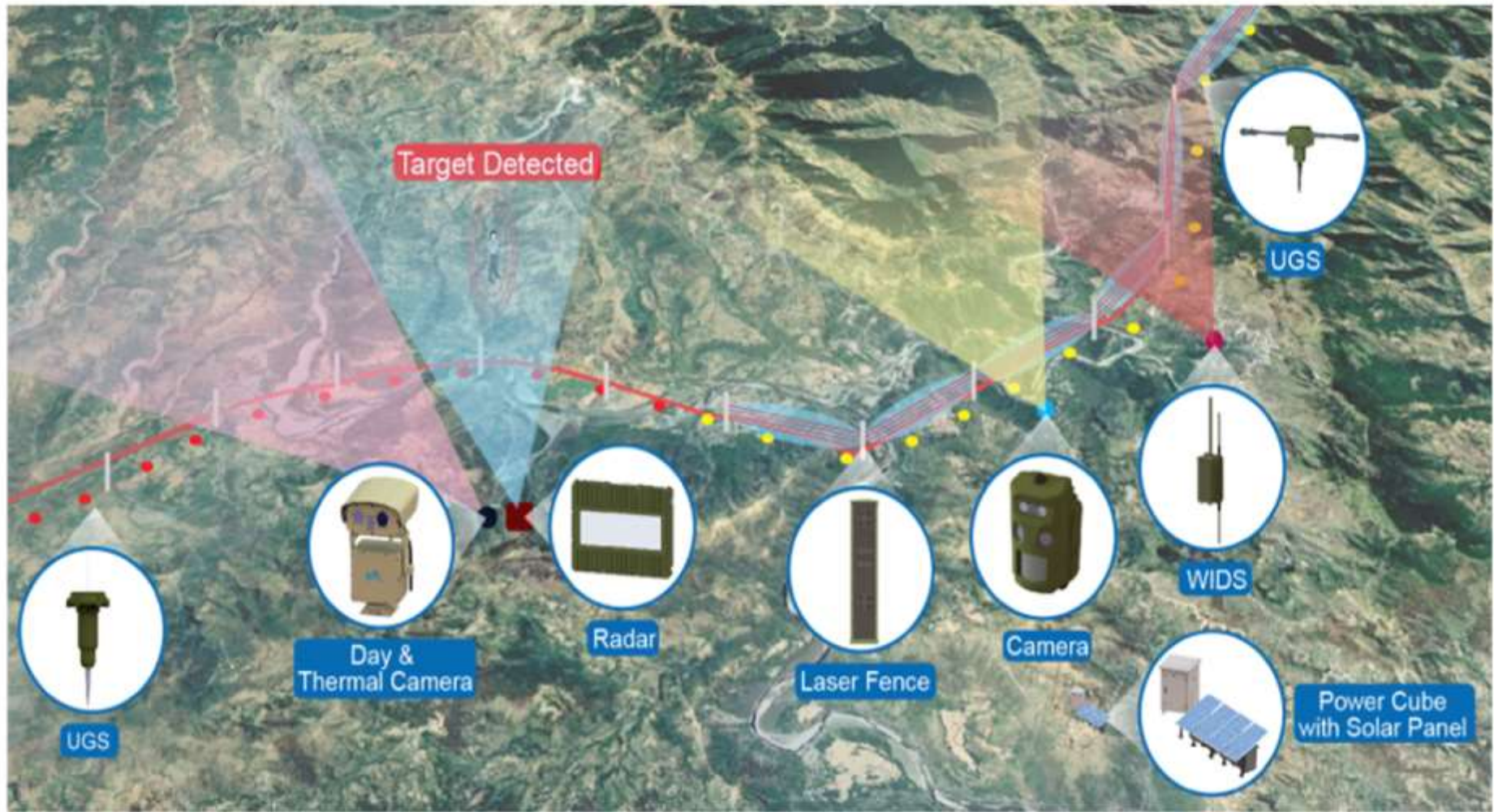
No Border
or Coast
(5 states)

2094 KM Island coast

By

Col Chetan Dewan

What is Smart Border Surveillance?

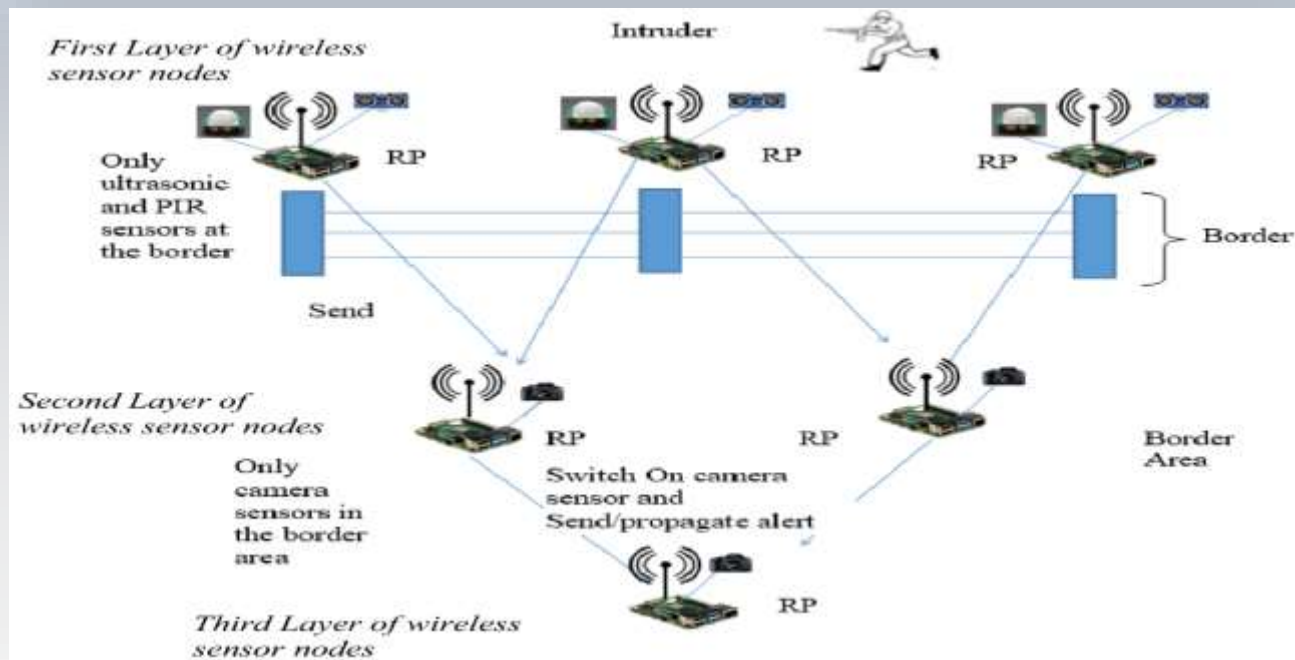


Typical intrusion detection scenario for mountainous borders



Multi layered Approach?

- ▶ Smart border surveillance uses
 - ▶ Integrated Sensors
 - ▶ Power supply
 - ▶ Automated Analytics & AI



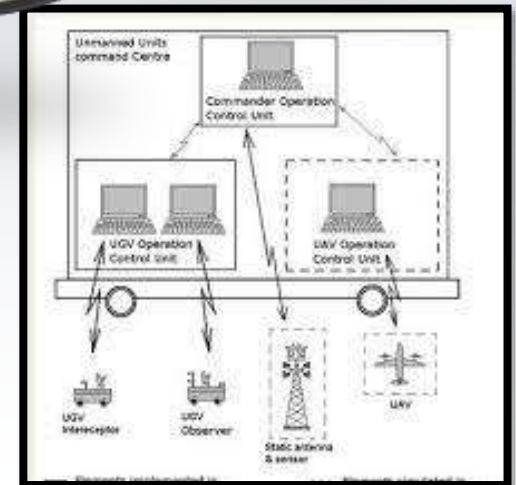
Objectives

- ▶ Detection
 - ▶ reliably spot incursions and suspicious activity
- ▶ Monitoring
 - ▶ maintain persistent coverage
- ▶ Rapid response
 - ▶ ensuring alerts translate into immediate operational actions
- ▶ Deterrence
 - ▶ making attempts at illicit crossings measurably harder

Every technical choice should trace back to one of these objectives

Key Technologies Overview

- ▶ High resolution Cameras
 - ▶ Thermal +Night Vision
- ▶ Advanced Sensors
 - ▶ WIDS, UGS, Optical Fiber
- ▶ RADAR, LIDAR
- ▶ UAVs
 - ▶ Fixed Wing, Multi rotor, Hybrid
- ▶ AI/ML pipelines for Analytics
- ▶ Communication Infrastructure
 - ▶ Sensor networks, LORA
- ▶ Command and Control Systems
 - ▶ Track while Scan
 - ▶ Rapid response



High-Resolution Imaging

- ▶ Thermal + night vision cameras
 - ▶ Cameras provide the primary visual modality
- ▶ YOLO
 - ▶ You Only Look Once - a fast and efficient real-time object detection system used in computer vision using neural networks



- ▶ Open CV
 - ▶ Free, Open-Source software library with over 2,500 algorithms for computer vision and machine learning tasks

Ground and Aerial Surveillance

RADAR & MAD

▶ RADAR

- ▶ Ground detection
- ▶ Aerial detection
- ▶ Fused with Optical Sensors

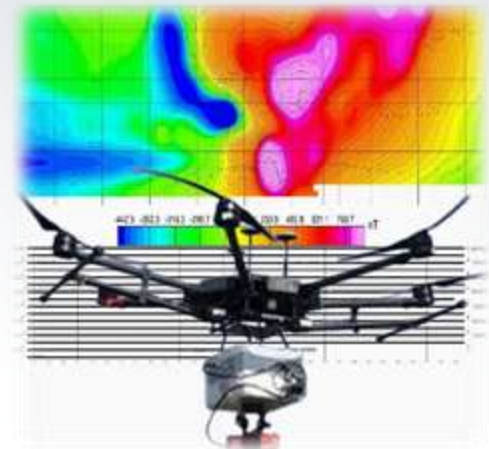


▶ MAD

- ▶ Detects small changes in earth's magnetic field
- ▶ Point cloud data comparison

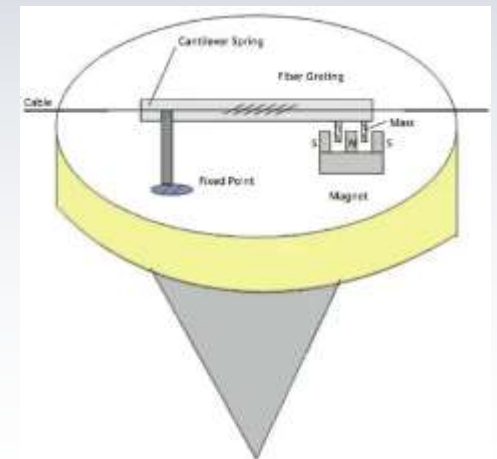
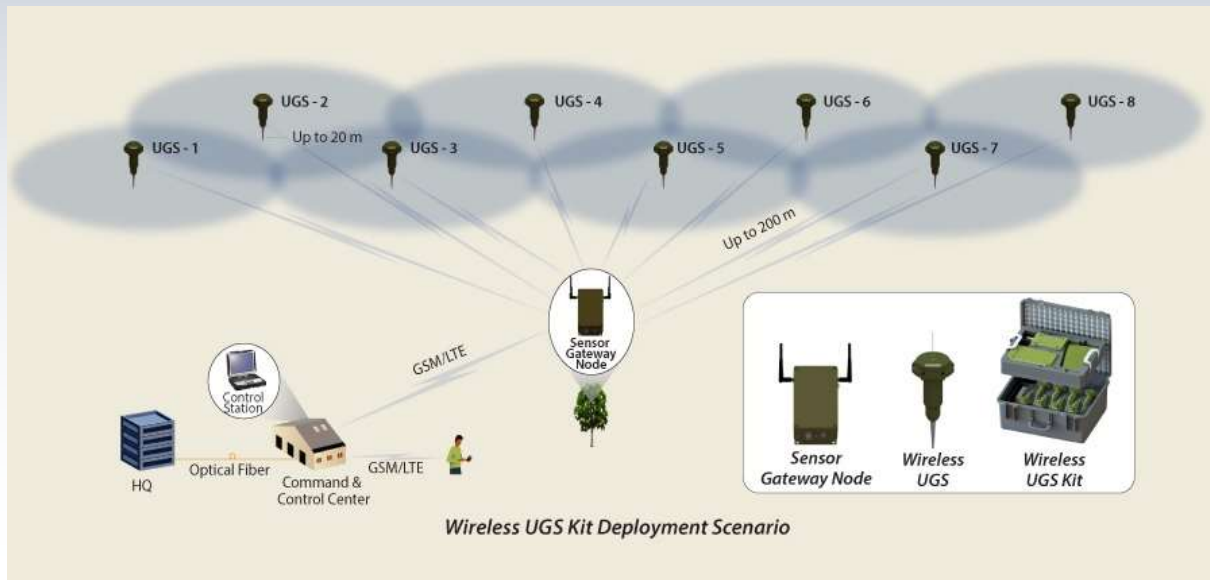


▶ Sensor Fusion



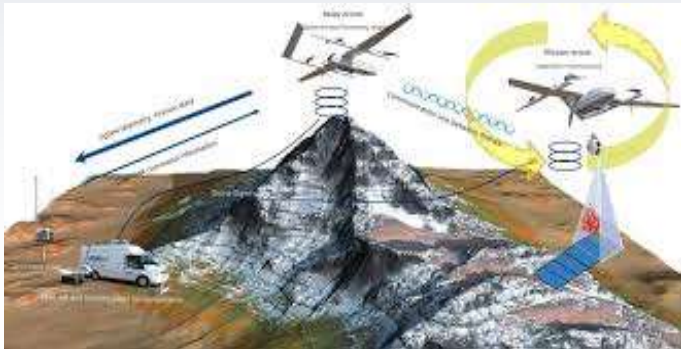
Unattended Ground Sensors

- ▶ Seismic
 - ▶ Acoustic
 - ▶ Magnetic sensors
 - ▶ Fiber optic cables
- detect footfall, vehicle vibrations, or engine sounds
 - low-power, discreet and can trigger targeted camera pan/tilt movements or UAV dispatch



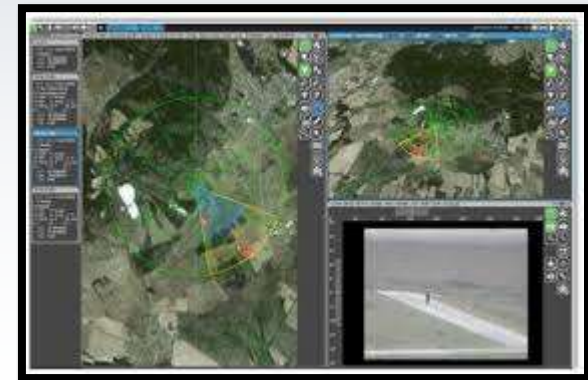
Drones & UAVs

- ▶ Persistent aerial surveillance
 - ▶ Mobile, persistent visual and thermal inspection
 - ▶ Investigating sensor alerts or for scheduled patrols
 - ▶ Indispensable rapid-response layer



AI & Predictive Analytics

- ▶ Automated threat detection
 - ▶ AI transforms raw sensor streams into prioritized events
 - ▶ Computer vision models can detect human shapes, vehicles, and unusual behavior
 - ▶ Anomaly detection algorithms flag outliers in multi-sensor time series
- ▶ AI filters benign activity escalating truly suspicious events



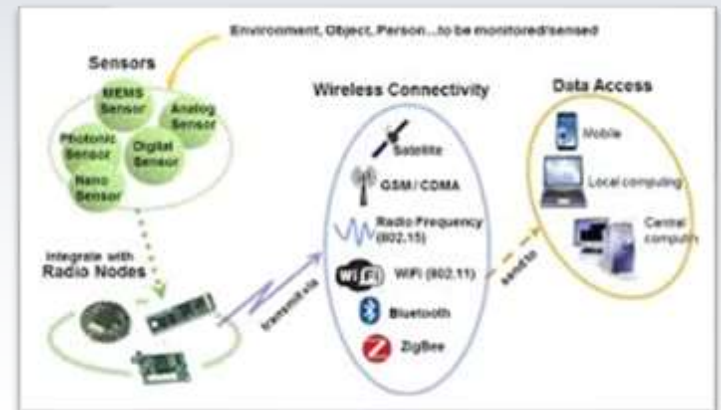
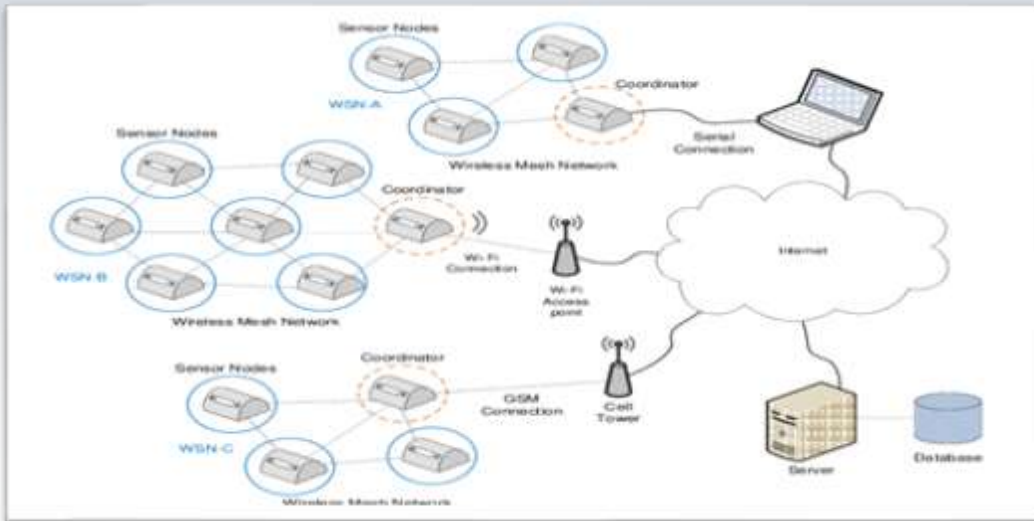
Satellite Monitoring

- ▶ High-altitude persistent monitoring
- ▶ Wide-area situational awareness
- ▶ Ideal for macro-level monitoring
- ▶ Less temporal resolution than UAVs
- ▶ Supplement ground assets
- ▶ Area-wide pattern analysis



IoT Networks

- ▶ Interconnected border devices
 - ▶ An IoT fabric ties distributed sensors together with secure telemetry
 - ▶ Lightweight messaging protocols
 - ▶ edge compute enable local preprocessing
 - ▶ critical events are sent to central servers



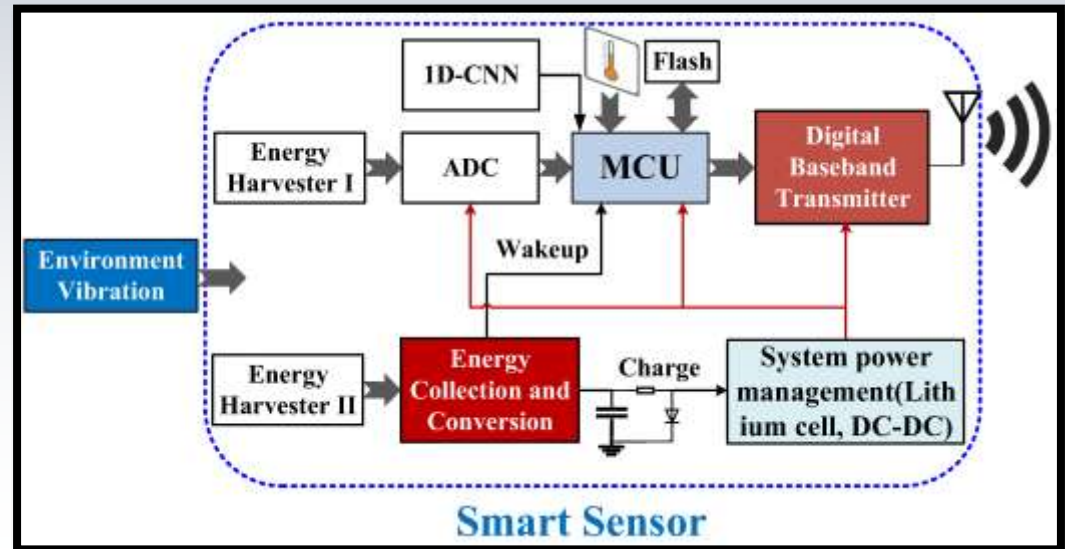
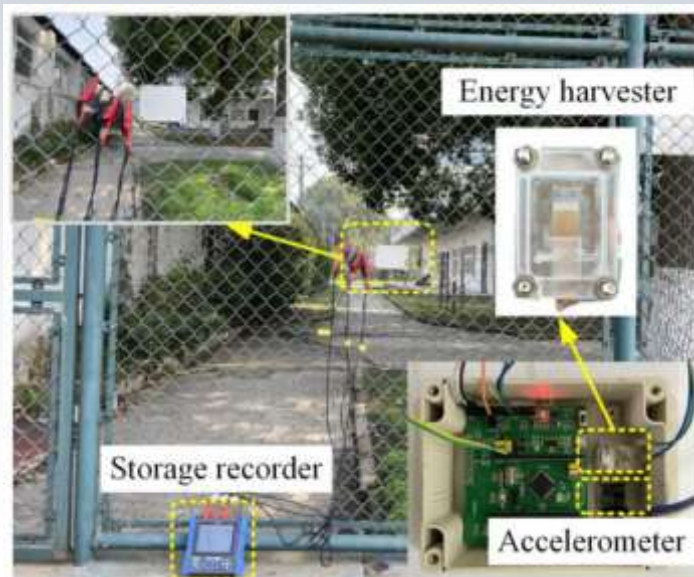
C4I3 Command Centers

- ▶ C4-Command, Control, Communications, and Computing, and I3-Intelligence, Information, Interoperability
- ▶ Real-time situational overview
 - ▶ Aggregates fused sensor inputs
 - ▶ Presents a single operational picture
 - ▶ Orchestrates responses
- ▶ Clear symbology, persistent tracking, and rapid evidence retrieval---rapid decision



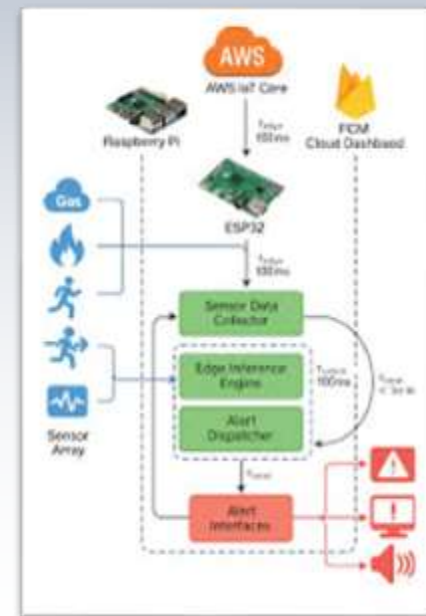
Smart Fencing

- ▶ Hybrid physical + digital fence
 - ▶ Smart fencing is a hybrid of physical barrier and embedded sensor nodes that can detect, localize and classify attempts to breach
 - ▶ Combining fiber optic strain sensors, vibration detectors, and cameras with location tagging



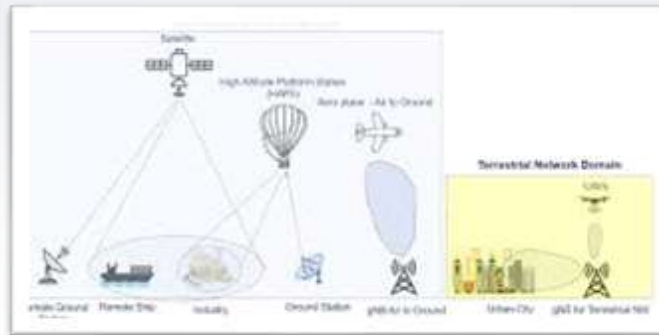
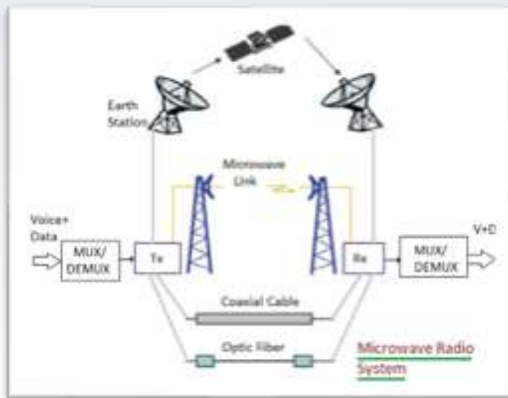
Automated Alerts

- ▶ Instant threat notifications
 - ▶ Automated alerting minimizes human latency
- ▶ Generate graded alerts—local alarms, operator notifications, or automatic UAV dispatch
- ▶ Human-in-the-loop validation to prevent wrongful responses



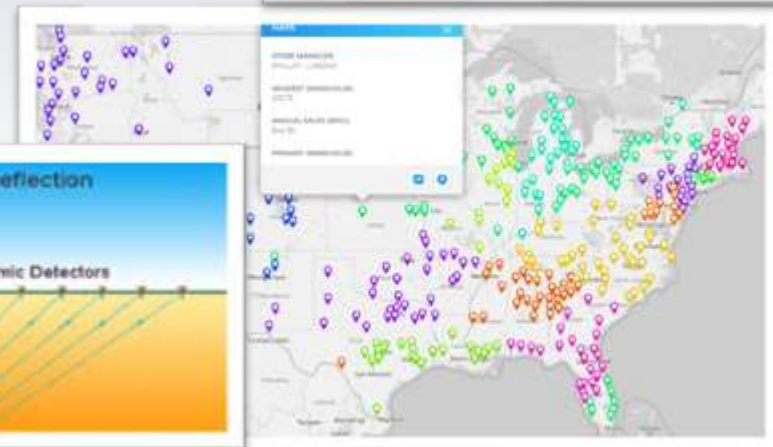
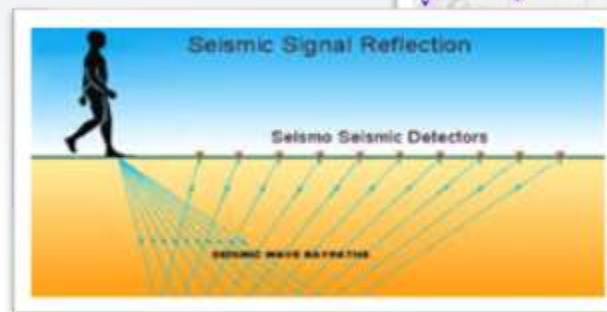
Secure Communication

- ▶ Encrypted & layered networks
 - ▶ Secure, redundant communications are non-negotiable
 - ▶ End-to-end encryption, tamper detection, and hardened hardware
 - ▶ protect the telemetry and command channels from interference, interception & Jamming



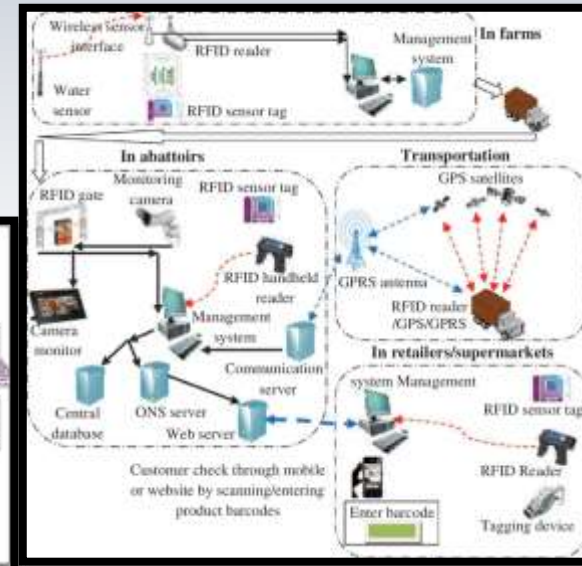
Indian Context

- ▶ Borders with difficult terrain or high illicit traffic---adopted mixed sensor systems with measurable success
 - ▶ reduced crossings
 - ▶ Intercepting smugglers
 - ▶ improved first-responder safety
- ▶ Tailoring sensor mixes
 - ▶ local geography
 - ▶ threat types



Challenges

- ▶ Cost and Sustainment
- ▶ Terrain complexity
- ▶ Sensor losing fidelity under adverse weather
- ▶ False positives from animals
- ▶ Secure communication
- ▶ Power management
- ▶ Response time



Future Trends

▶ Swarm Drones

- ▶ Swarm UAVs will enable cooperative search patterns

▶ Edge AI processing

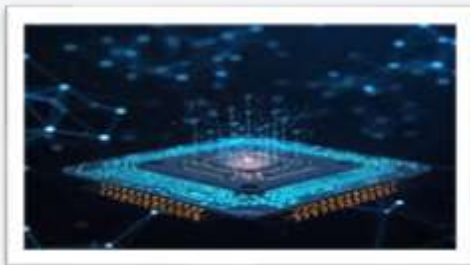
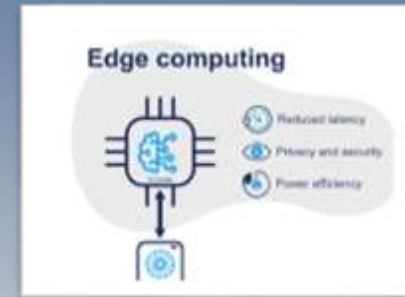
- ▶ AI models on Sensors

▶ Quantum Sensing

- ▶ quantum mechanics principles like superposition and entanglement

▶ Quantum coms

- ▶ Post-Quantum Cryptography (PQC)
- ▶ Quantum Key Distribution (QKD)



Impact on National Security

- ▶ Increased accuracy
- ▶ Rapid response
- ▶ More coverage
 - ▶ smart surveillance increases detection rates
- ▶ Resource efficiency
- ▶ Stronger deterrence
- ▶ Fewer successful incursions—without proportionally increasing manpower costs

Conclusion

- ▶ A strategic necessity for modern defense
- ▶ smart border surveillance --- a systems problem
 - ▶ Sensor fusion
 - ▶ Secure communications
 - ▶ AI analytics
 - ▶ Operator workflows
- ▶ Detection Engineering

Jai Hind

I am open to Questions now

Detection Lifecycle

