



# Mobile Remote Sensing

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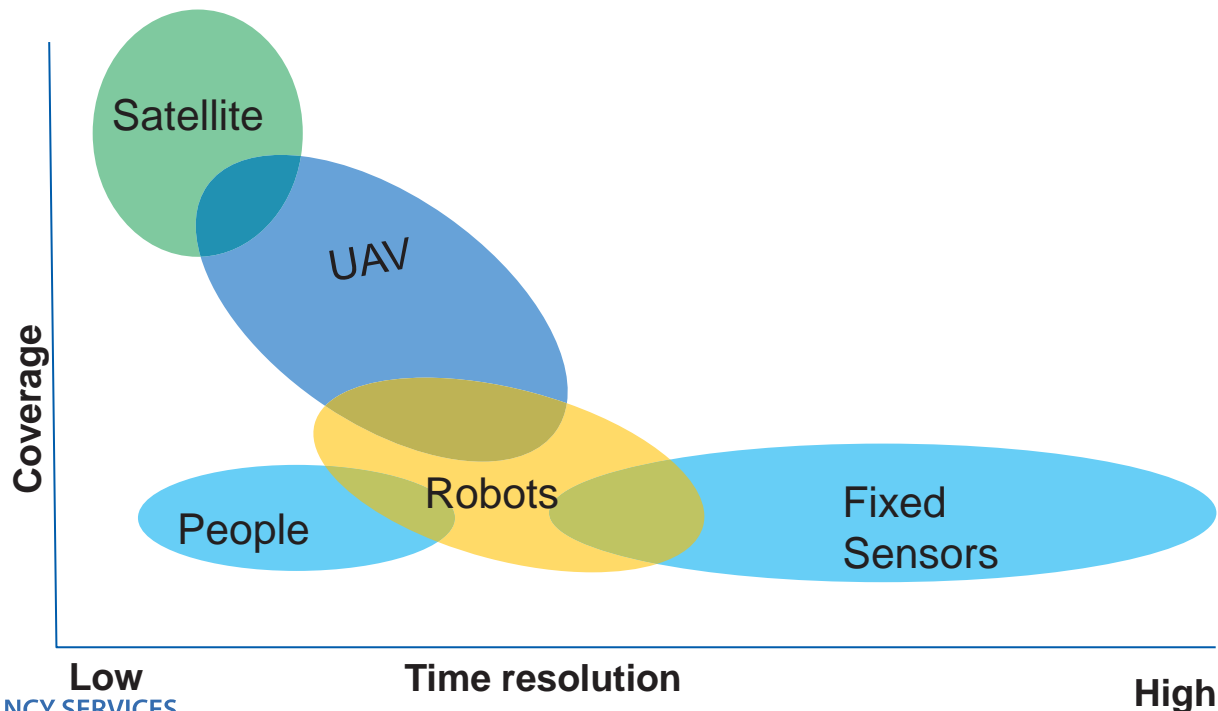
# Mobile Interactive Sensing

- The Internet is continuously being supplied with eyes and ears, but it desires arms and legs to take action.
- The Internet of Things (IoT) can integrate gateways that can walk, swim and fly, and, finally, can turn digital decisions into physical actions.
- Mobile Sensing systems is all about integrating people, vehicles, robots as mobile gateways to the IoT system.

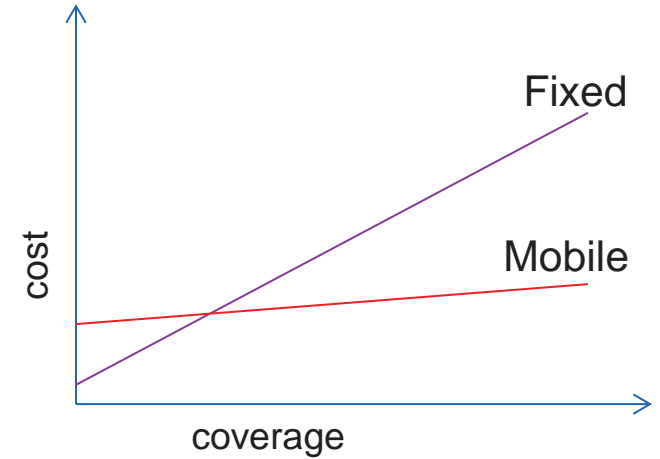
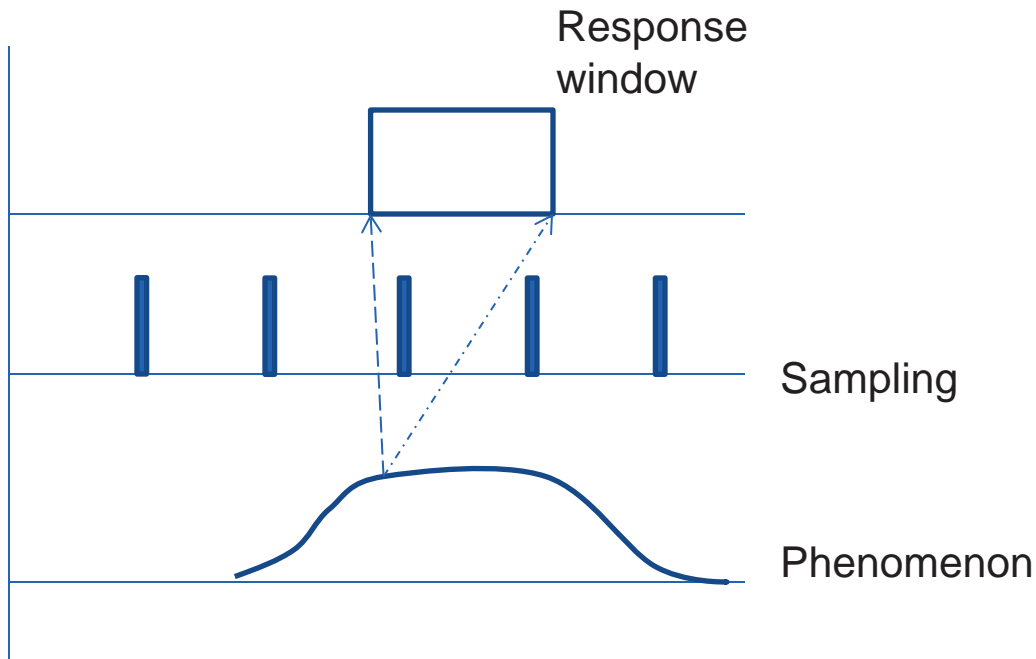
# Mobile Sensing - An Integrated Approach

Monitoring of large spatially distributed systems through fixed sensors seems to be a costly approach to achieve required coverage

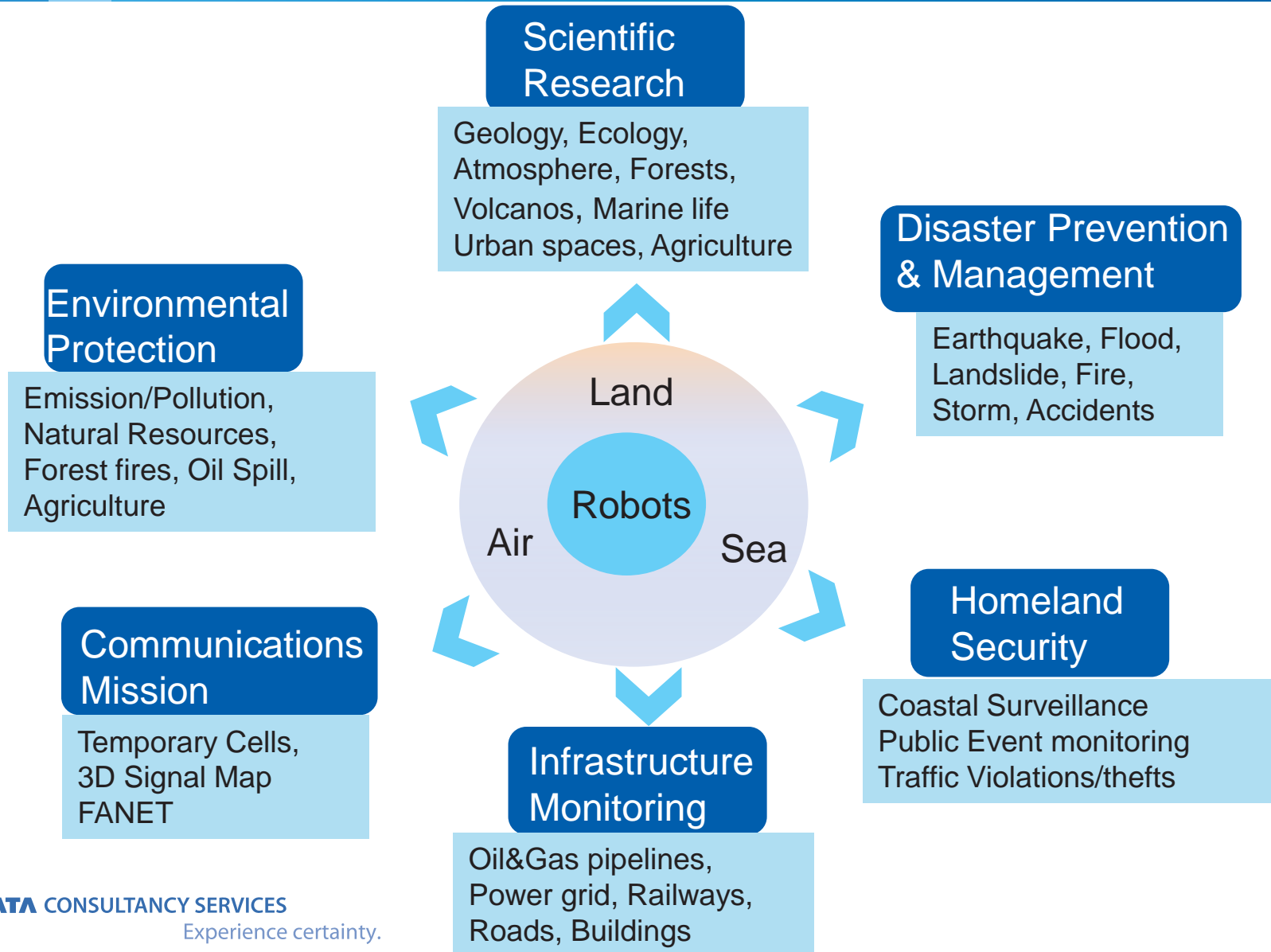
Multi-scale seamless remote sensing for monitoring and Visualization using moving platforms such as Robots, UAVs, Satellites and People to provide a cost-effective coverage.



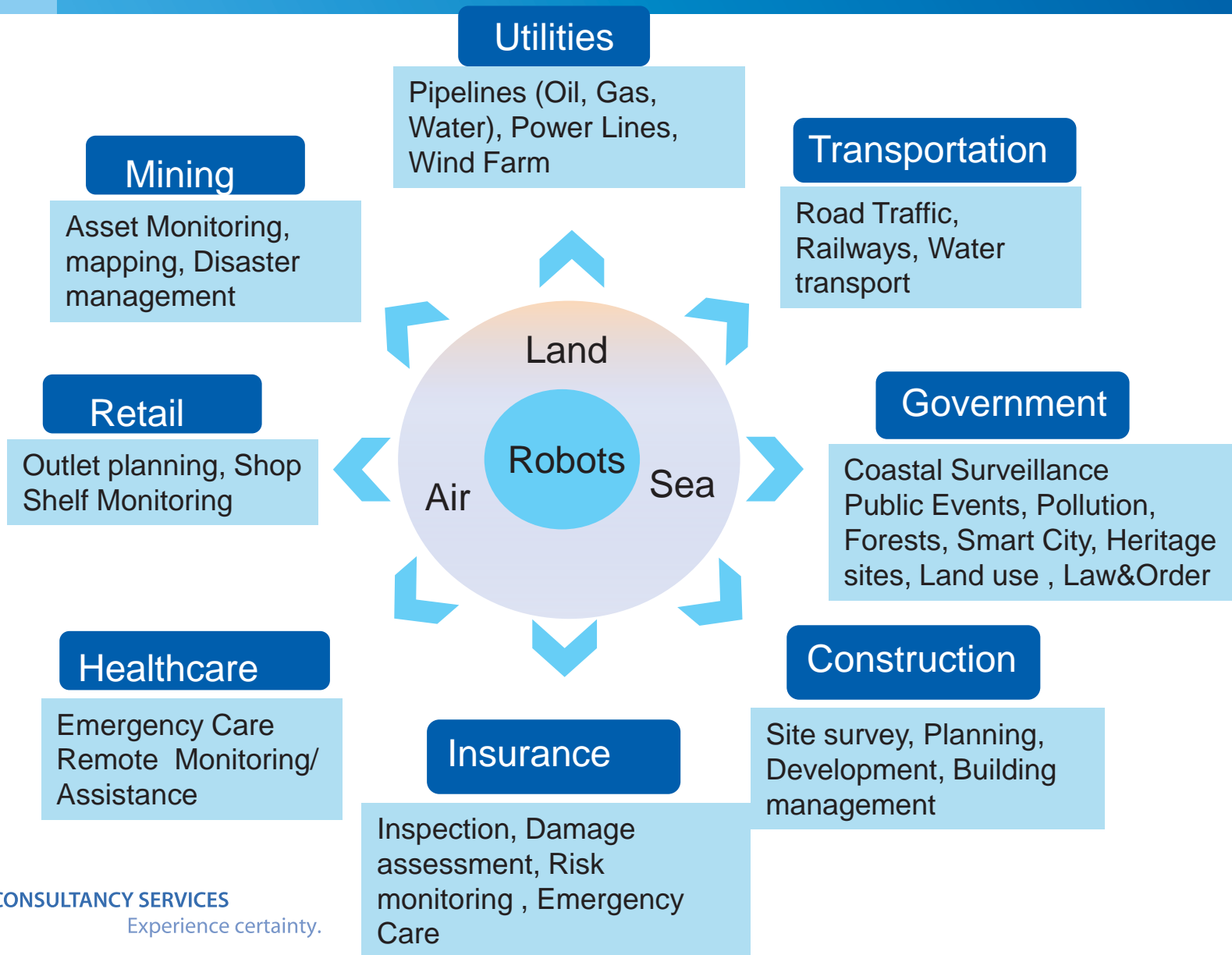
# Economics of Mobile Sensing



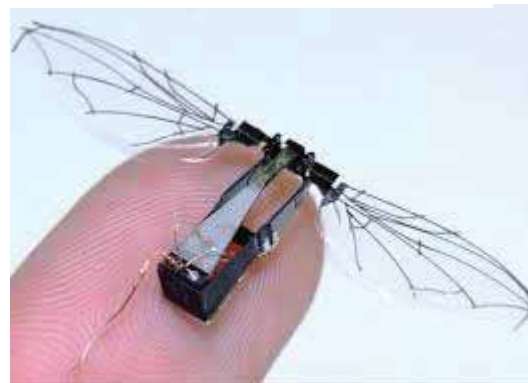
# Mobile Remote Sensing Applications



# Remote Sensing– Potential to Businesses



# Innovative Robotic Devices

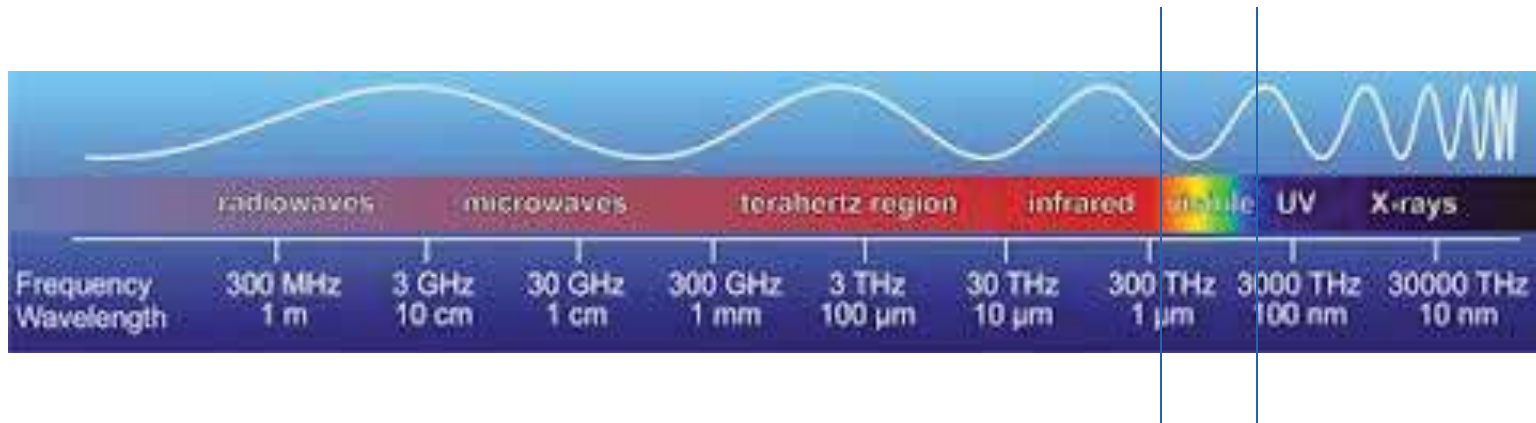


# VTOL and Tethered Drones





# Spectrum of Sensors



Visual

Infrared

Hyper Spectral

Terahertz

LRF

Ultra  
Sound

Infrasound

LIDAR

Laser

Ultrasonics

Laser Doppler

Vibrometry

# Ground Robots for Sensing Applications

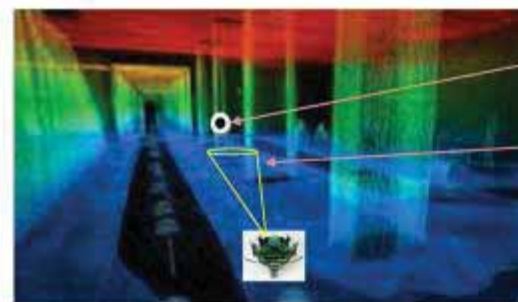
# Retail Robotics

- Searching for a product in the shelf
- Planogram checking



# Robotic Indoor Sensing

- Real-time perception and provide situational awareness around its surrounding environment deployed in unknown / uncertain environments
- Understanding the hostile environment of a potential disaster scenario through specialized sensors (5 senses computing)
  - Heat, haze and fumes
  - Sound sources
  - Chemical and gas sources



Possible Heat Source

Heat Direction and Intensity

Cloud point from 3D vision



# Leveraging UAV for Remote Infrastructure Monitoring

# Aerial Image Analysis of Power Lines

## Power transmission lines faces several threats

### Natural disasters affecting the lines

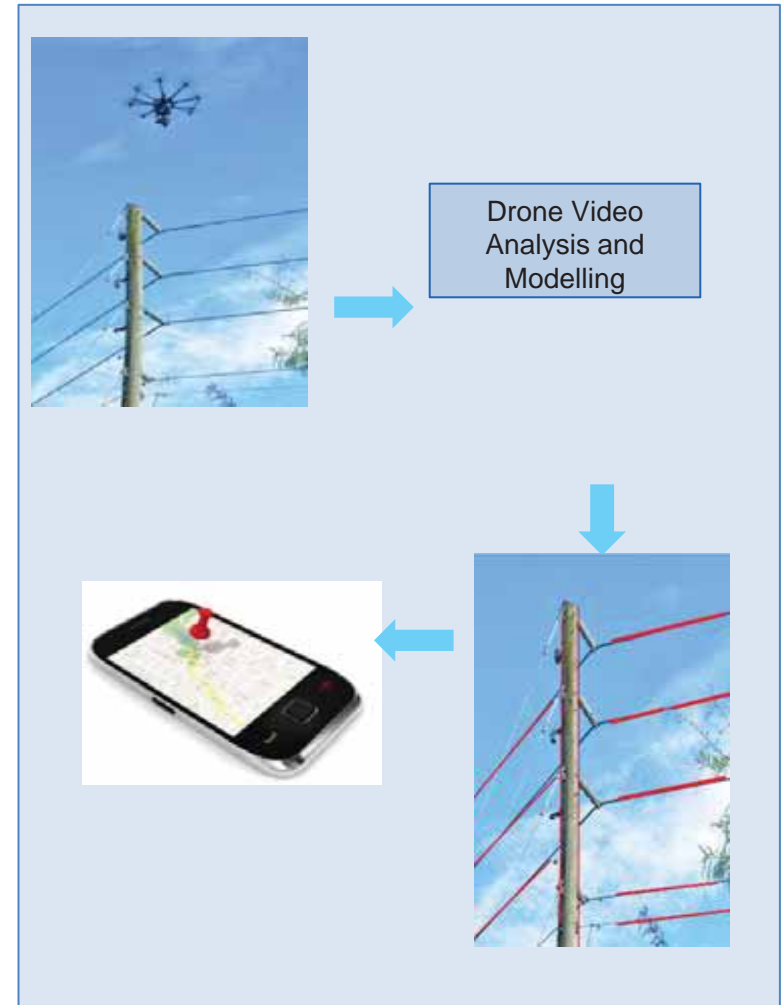
Conductor snapping, sagging, separation, proximity to damaged trees / structures, structural damage to towers, arcing joints

### Right of way infringements

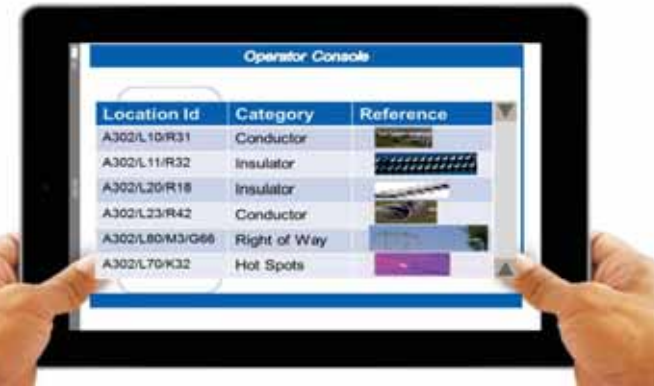
Vegetation growth, Temporary structures etc

### Aging / Fatigue related Damages

Structure and components like insulators



# UAV Based Powerline Monitoring

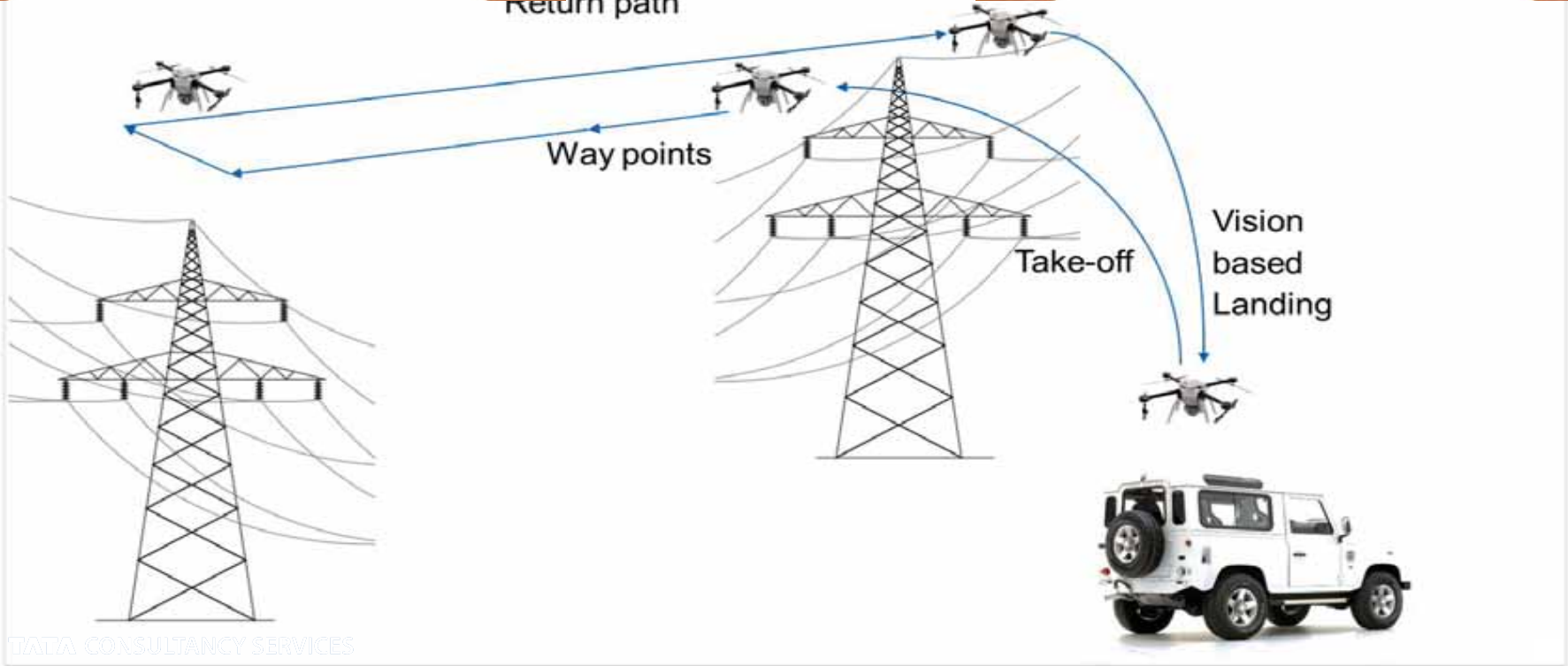


Return path

Way points

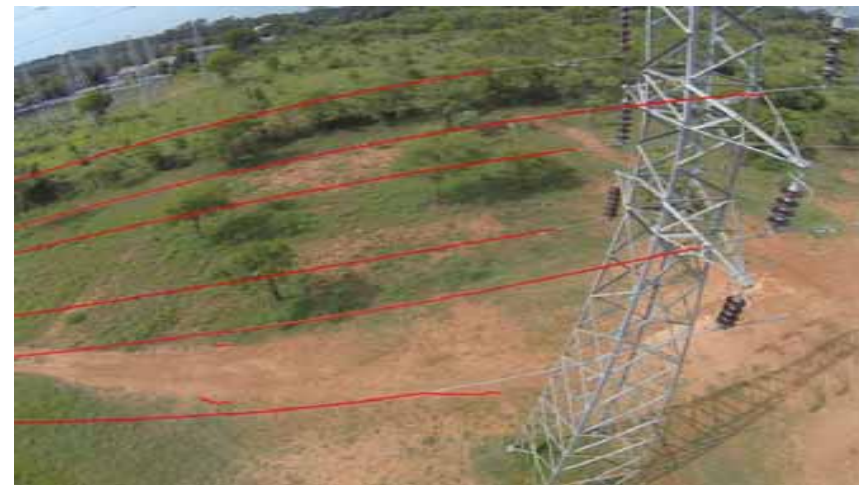
Take-off

Vision based Landing





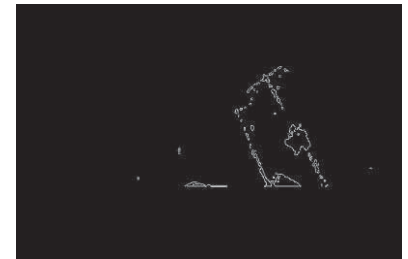
# Aerial Inspection of Power Lines



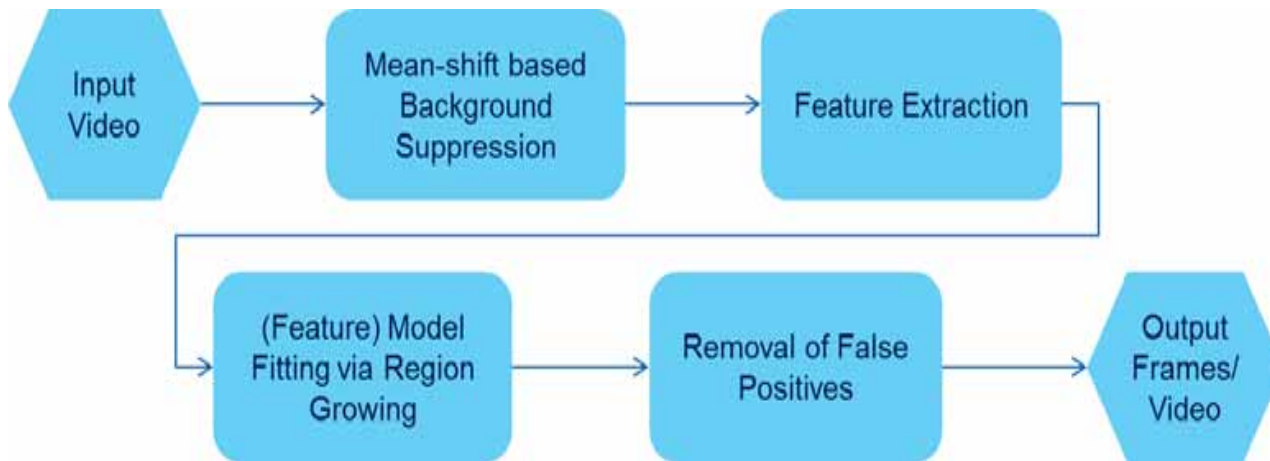


# Low altitude Aerial Image / Video processing

- Object Recognition
- Vision based Navigation
- Damage Detection & Classification



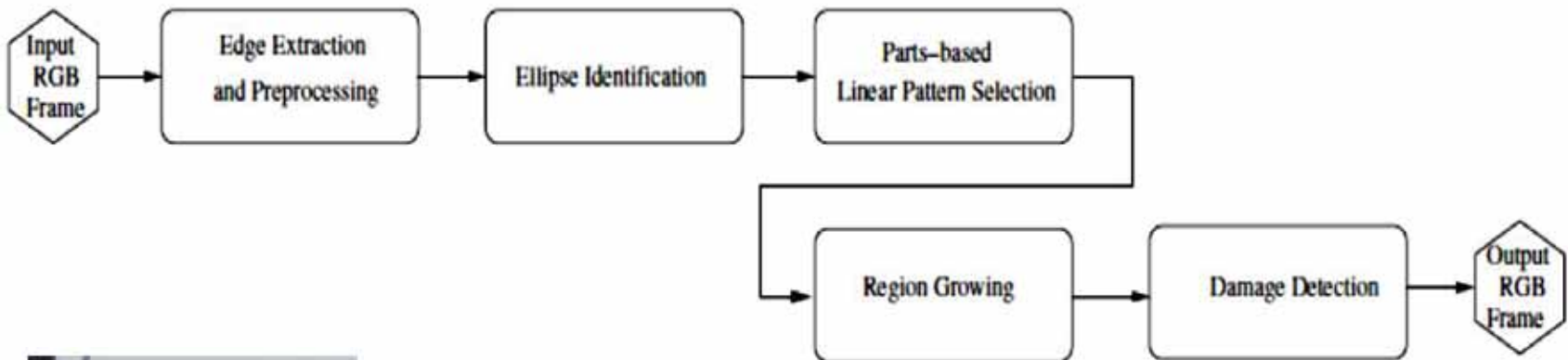
# Segmentation of Powerline components for damage analysis



Experience certainty.

# Shape based Analysis for Object Inspection

- Shape based object modelling
- Shape extraction
- Contour integrity for damage/deformation detection



# Multi-Modal remote Sensing in Storm Damage Assessment

Storm Damage Assessment and recovery of utility infrastructures – An integrated approach involving Low Altitude Aerial Sensing, Participatory Sensing/Crowd Sourcing and Tele-Robotic Augmented Reality

Reference Asset Catalogue

Asset images, asset specific attributes (dimensions, color, material) etc

Crowd Sourced Images With additional contextual info

Aerial Images (Satellite, UAV )

Image Analysis Engine for Asset Identification and Damage Assessment

Validation & Feedback

Identified Assets and Associated Damage

Remote Inspection using Robots and AR





# Urban Demography



# Classification of Urban Spaces

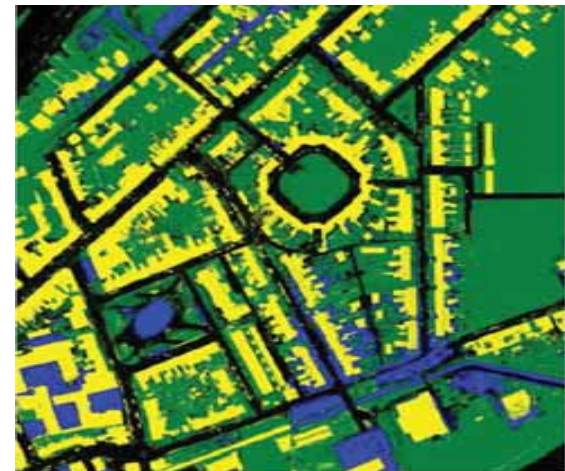
- Analysis of satellite & LIDAR data for the classification of Urban spaces
  - Port container parking lots
  - Open spaces
  - Road network
- Emphasis on semantics/generative model
  - Image pixel – 4 dimensional vector (RBGZ)
  - Image is a collection of themes (for example, economy zone, port, city)
  - Each theme is a collection of objects (cars, buildings, roads etc.)
- Linguistic approach to process aerial data
  - word and topic analogies to images and used Latent Dirichlet Allocation (LDA) approach– learns mixture model using Dirichlet priors - Used extensively for text topic discovery

*IEEE-GRSS Data Fusion Challenge Submission*

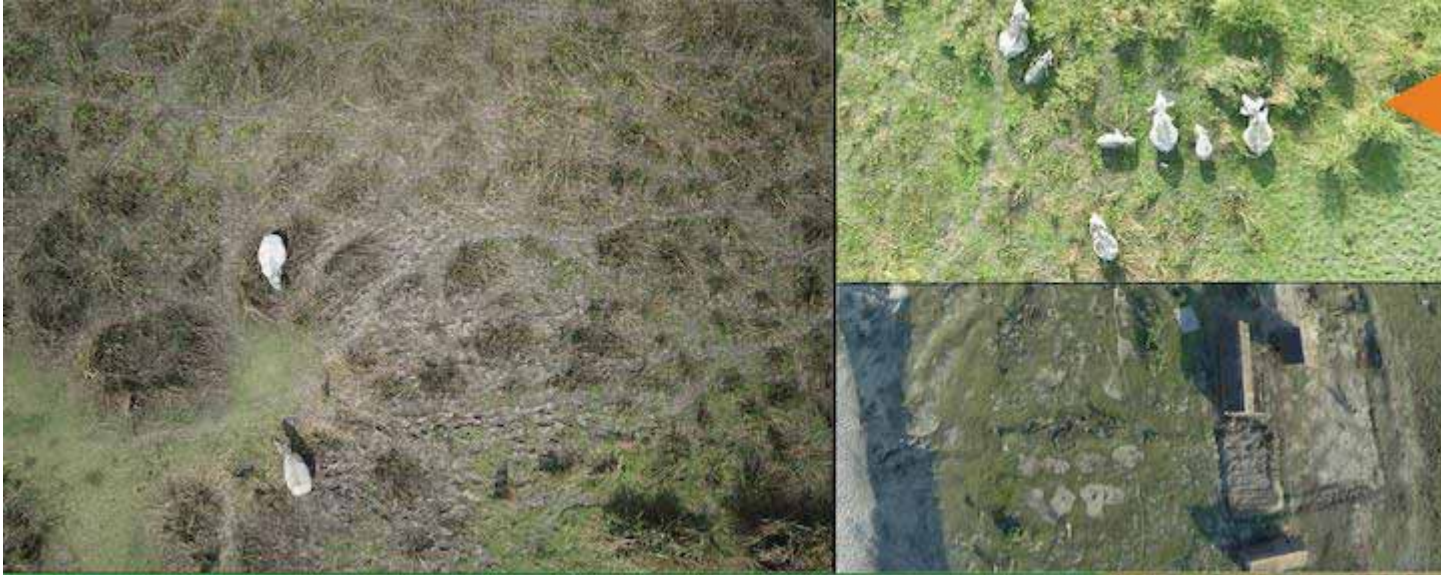
Input Image



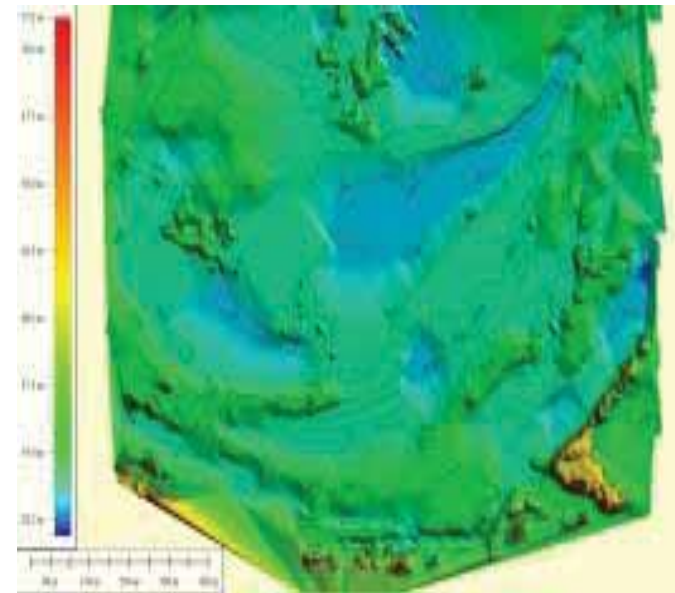
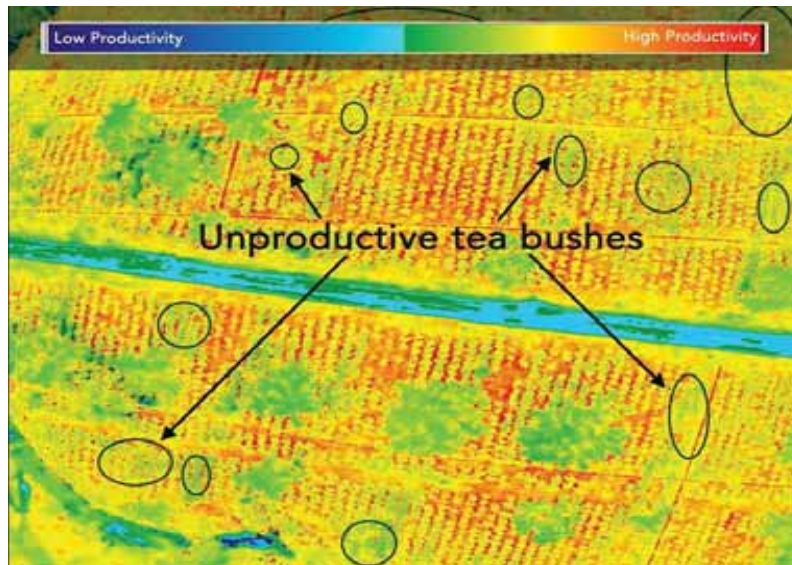
Classified Regions



# Wild Life Monitoring



# Agriculture – Tea Plantation



TCS Ignite



# Challenges for Civilian UAV systems

- Safety and Security
  - For the system and the people
- Privacy Concerns
  - People are not comfortable with overhead flying cameras
- Regulations
  - Many countries have severe restrictions in using drones

# Summary

- ‘Digital Earth’ needs effective and efficient sensing mechanisms with cost effective coverage is to be deployed
- Mobile Sensing Platforms have an important complementary role to play there along with static sensor systems.
- Advancement in technologies will make mobile sensing platforms more robust, reliable and safe for regulatory acceptance in near future

Thank You

The background is a deep blue gradient. On the right side, there is a glowing, semi-transparent globe. The globe's surface is covered in a grid of small, bright blue dots, giving it a digital or data-like appearance. In the lower-left and bottom-center areas, there are several concentric, glowing arcs of binary code (0s and 1s) that appear to be floating or scrolling. The overall aesthetic is futuristic and technological.