SSTDM 2014 IISc Bangalore

Sustainable Small Satellite Systems and Sensor Networks for Environment and Disasters Management in India

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Different Phases for derivation at Early Warning Systems

- D] Geo informatics for assessing EWS in watersheds
- E] DSS for EW communication and policy analysis aiming at sustainable development of resources
- F] Environmental data relay via satellites

SCADA System Vulnerability and RMCT

- Identity all connections to SCADA Networks
- Remove unnecessary connections to the SCADA network
- Evaluate and strengthen the security of any remaining connections to the SCADA network
- Flatten SCADA Networks by removing or disabling unnecessary services

SCADA System Vulnerability and RMCT

- Establish strong controls over any medium that is used as a backdoor into the SCADA network
- Perform technical audits of SCADA devices and networks and any other connected networks to identity security concerns.
- Establish SCADA red teams to identity evaluate possible attack ……
- Establish policies and conduct training to minimize the likelihood that organizational personnel will inadvertently disclose sensitive information

Environmental Data Relay via Satellites and bridging them for EWS for disasters

- 1.ARGOS Systems, GOES Systems, Meteosat Systems
- 2. Land Mobile Mapping Systems
- 3.Space borne digital Imaging sensors and systems
- 4. Small Satellite missions

Sensor Networks or Quake Sats for Earth quakes ?

- Arduino EQ vibration sensors in active fault zones / strain measured zones
- InSAR based strain measurements throughout the 100 km / 200km buffer on epi center
- Quake Sats using Cubesats
- Smallsats for ionospheric disturbances
- Nearspace remote sensing

Sensor networks or Smallsats for Forest fires ?

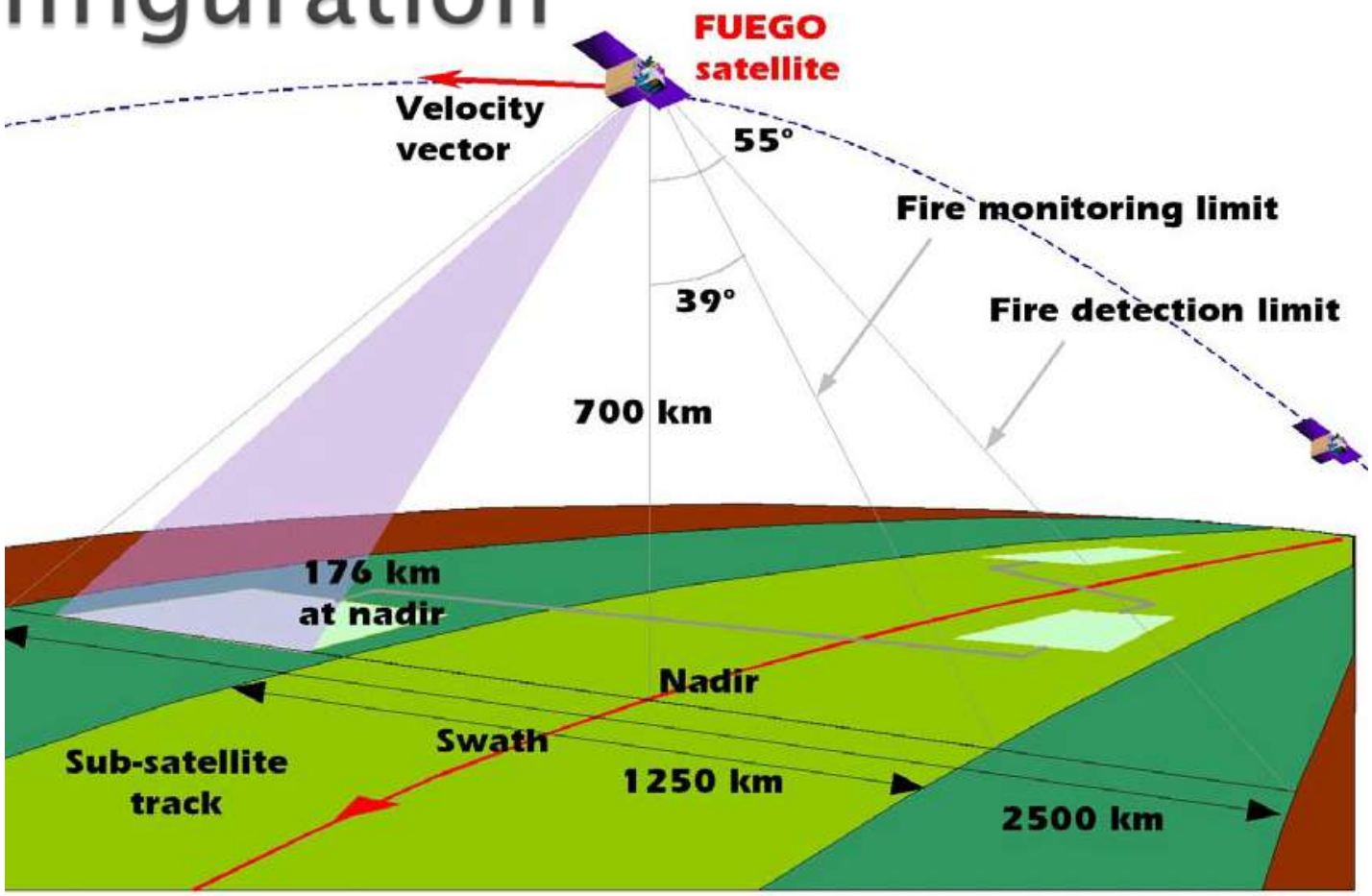
- Large satellites- MODIS Channels 3.7 μ m (high gain 21 and low gain 22) to cover the MIR , 11 μ m TIR channel (32) – 1 km native resolution
- 2.1 μ m (MODIS 7 ch) at 500 m native resolution

Sensor networks or Smallsats for Forest fires ?

- NSW-Rural Fire Service in Australia: Airborne fire intelligence – Dedaulus scanner (multi spectral system with 12 bands) + NOAA AVHRR (thermally hot areas) + current and forecast weather conditions + GIS (PyroMap-fire mapping software)

- Distributed sensor networks
- FEUGO – small satellite

Forest Fire Monitoring Configuration



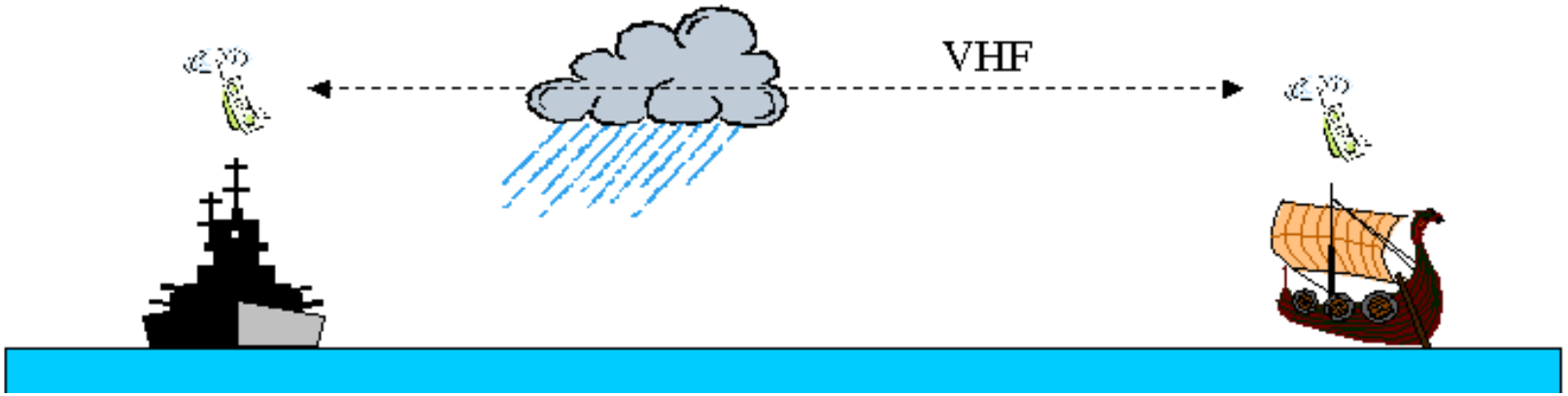
Forest Fire Monitoring Configuration

- *Baseline mission parameters*
- **Orbit Profile**
- Altitude 700 Km
- Orbital inclination 47.5 deg
- Orbital period 98.8 min
- Orbital geometry Circular
- **Satellite constellation design**
- Number of satellites 12
- Configuration Direct Walker (12/3/2)
- Symmetry Homogeneous
- Revisit time 23.8 min medium & 25.8
- min maximum
- Service Continuous (24 h a day)

SS for Maritime / High Seas Surveillance (Use of AIS)

- Marine Pollution
- Fisheries Control
- Illegal Immigration
- Drug Smuggling, cross border crime (e-dumping)
- Terrorism

AIS concept



ORBCOMM Constellation

Satellite Planes

ALL satellites to have AIS

Planes A, B C and D: *[45 Deg]*
Four to Six Satellites

Plane E: *[Equatorial]*
One Satellite

Plane P: *[Polar]*
One to Two Satellites

ORBCOMM AIS

- AIS data (name, callsign, MMSI#, destination, etc) available in locations not supported by systems with which can provide specific vessel data sent ship and voyage information

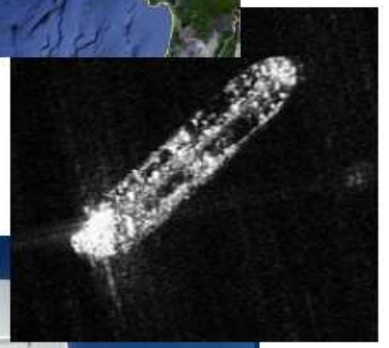
+

Spaceborne SAR Sensors

- RADARSAT-1 and RADARSAT-2 offer all weather, low illumination (day/night) imaging

=

Combining SAR sensors with timely AIS data provided ability to reliably detect vessels which allowed for the rapid identification of the non-AIS emitting ships



Small Satellites for Marine / Oceans

- Sat – AIS
- Inter-satellite comparison for detection rates
- Shared satellites –for AIS
- Shared satellites- for Communication
- Critical maritime route program- Oil spill detection and finding the Offender

Distributed Sensor Networks for new Tsunami Warning system

Conventional DART systems disadvantages : Cost- 250000/- dollars for one system. Maintenance per annum is 125000/-dollars

Life- two years only

DSN of Sonabouys - either on surface or bottom of oceans. They work on sonar signals . They can be designed to come to surface periodically , to reckon their positions by listening to GPS [stealthy equivalents of UAVs]

“energy conserving , persistent and operational”

A Mobile GPRS – Sensors Array for Air Pollution monitoring

It consists of :
A. Mobile DAQ (data acquisition unit)
B. Fixed internet –enabled pollution monitoring server (Pollution-Server)
Unit A integrates a single chip microcontroller,
air pollution sensors array,
a General Packet Radio Service Modem
(GPRS –Modem) ,
and a Global Positioning System module (GPS-module)

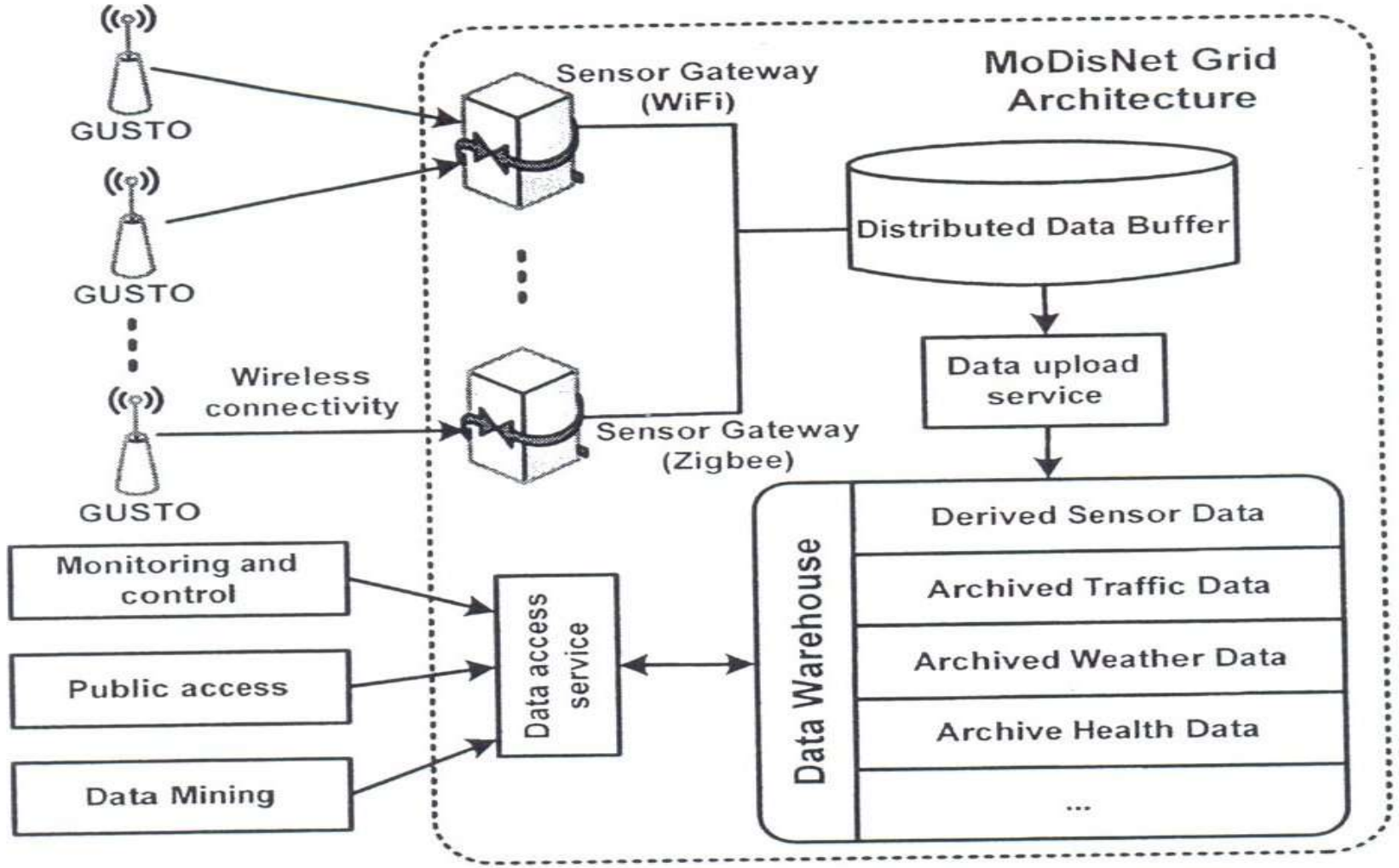
A Mobile GPRS – Sensors Array for Air Pollution monitoring

- Unit B is a high end personal computer application server with internet connectivity
- Unit A gathers air pollution levels (CO,NO2,and SO2), and packs them in a frame with the GPS physical location ,time and date. The frame is subsequently uploaded to the GPRS-Modem and transmitted to the Pollution-server via the public mobile network.

A Mobile GPRS – Sensors Array for Air Pollution monitoring

A database server is attached to the Pollution- Server for storing the pollutants levels
(CO,NO2, and SO2), for further usage by various clients such as environment protection agencies, vehicles registration authorities , and tourist and insurance companies. [Ex: China, Iceland volcano and Europe]

Sensor Grid Architecture



MSW Management using RS

- RS is for detecting environmental anomalies that may indicate contamination of ground and surface waters from landfill leachate

- RS techniques provide perspective and cost effectiveness not always available with other investigative techniques for monitoring landfills for environmental impact.

MSW Management using RS

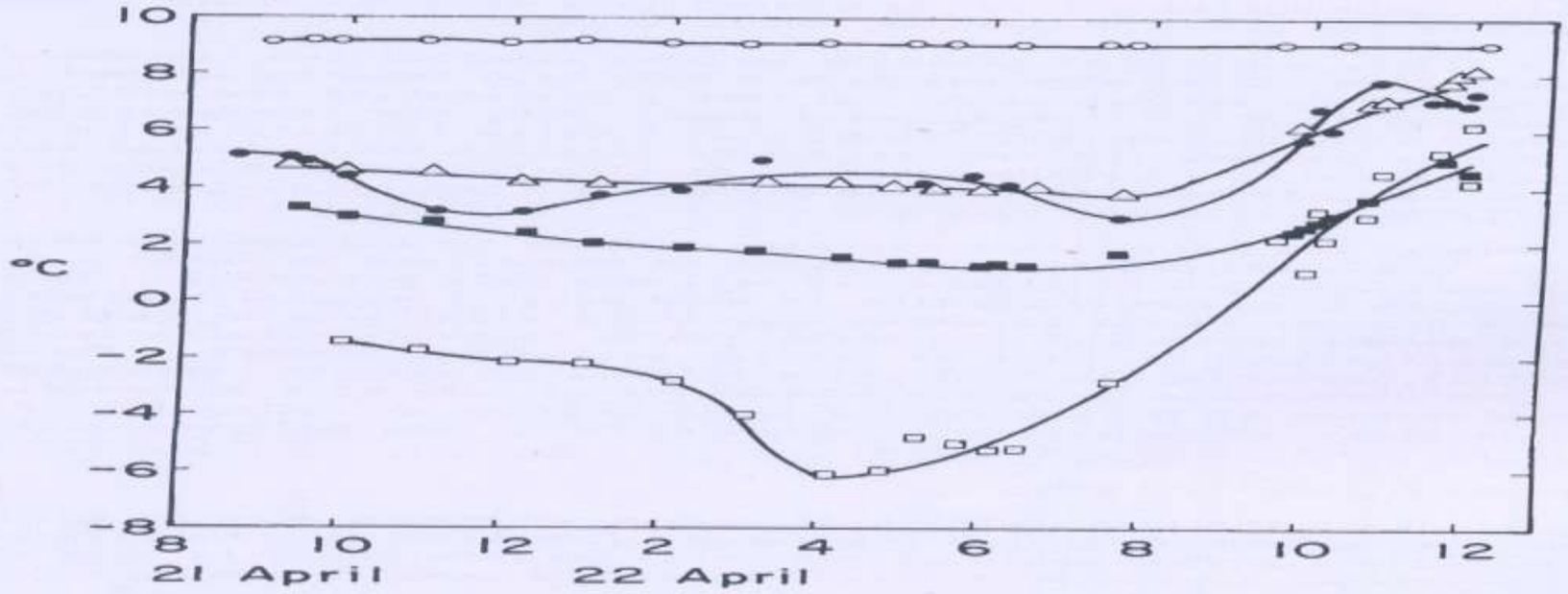


FIGURE 5.3. TYPICAL TEMPERATURE VARIATION AROUND A LANDFILL (AFTER SANGREY ET AL., 1976)

TABLE 5.5. SPECTRAL BANDS FOR DETECTING LEACHATE THROUGH REFLECTED RADIATION

LEACHATE INDICATOR	PRIMARY	SECONDARY
Gaps		
Vegetation/Soil, Rock	Infrared, Red	
Snow/Soil, Rock	Blue, Green	
Wetness		
Soil	Infrared	Red
Soil with Grass	Infrared	
Spectral Anomalies		
In Water	Red, Green	Blue
On Water (lipids)	Ultraviolet	Blue, Infrared
On Soil	Red, Green	Infrared
On Grass	Red	Infrared, Green
Stressed Vegetation	Infrared	Green, Red

TABLE 5.7. PHOTOGRAPHIC CAMERA AND SCANNER SYSTEMS FOR LEACHATE DETECTION

SENSING OPTION	METHOD OF SENSING	BANDS SENSED AND RECORDED SEPARATELY	COMMENTS
1. Photography			
a. color film	single camera; single image	B, G, and R* recorded as B, G, and R, respectively	UV can be sensed if recorded with B**; contrast of B layer will be lowered; proper exposure for UV and B will likely underexpose G & R
b. color infrared film	Idem	G, R, and IR recorded as B, G, and R respectively	UV and B cannot be sensed without affecting G, R, and IR
c. panchromatic film (black & white)	Multilens camera or several cameras, with spectral filters; multiple images	UV, B, G, and R, each recorded as black & white	Lower contrast of UV image will not affect other spectral images
d. black & white infrared film	Idem	UV, B, G, R, and IR, each recorded as black & white	Most multilens cameras have 4 lenses; lower contrast of UV image will not affect other spectral images
2. Multispectral scanner	Single scanner; magnetic tape, with or without image of one band off cathode ray tube or similar monitor	Any reflected or emitted bands from UV, visible & IR, including thermal; each band recorded as digital or analog signal on tape; if recorded in aircraft, one band as black & white film	Analog or digital data for any band or combination of bands can be printed on paper, displayed on video, or converted to photographic film
3. Thermal scanner	Single scanner; magnetic tape and/or image of one band off cathode ray tube or similar monitor	Commonly 8-14μm and/or 3 - 5μm; recorded as digital or analog signal on tape, or as black & white film	Idem, if recorded on tape

*B-Blue, G-green, R-red, IR-infrared, UV-ultraviolet

**Sensing of ultraviolet radiation will be limited by glass lens to wavelengths longer than about 0.36μm.

Small Satellites

- Technology readiness levels for monitoring the disaster in each country / for each technology it is different.
- How to match , economise and standardize?

DM options

Is it small satellites ?
Or Near space remote sensing?
Or Large satellites?
Or Distributed sensor networks,?
Or UAVs?
Or MICAVs?
OR a combination of these

Thank you

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