Satellite and GPS technology

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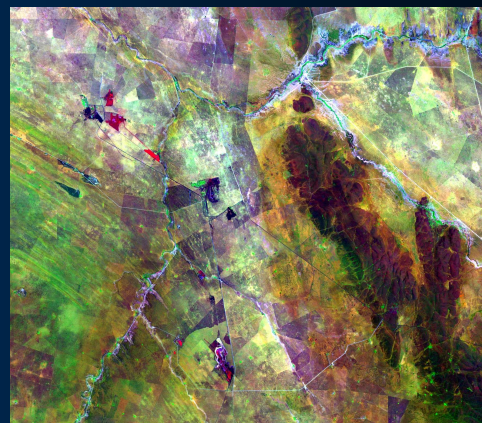
Overview

- General
- How Earth Observation Satellites work
- Uses of different EOS outputs
- How GPS work
- Types of GPS receivers and their different uses
- What influences GPS accuracy
- What to look out for if you implement post-processing GPS

General info

- EOS's' GPS's, Astological and Telecommunication satellites all are different types and they do not overlap in function
- There are over 2000 satellites orbiting the earth, 230+ of which SA had some involvement in
- SAC's mandate and only mandate is to service govt, and is govt-subsidised, so private requests gets 2nd priority
- Soon: "open access telemetry license" with other countries, so SAC will be the only centre in SA through which to acquire satellite images
- No restrictions over Africa, but owner will still have ultimate control: currently no bi-lateral agreements re: any other African country



SAC today

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Engineers and Scientists

- SA “Space Agency Bill” approved Dec 2007, will now become an Act.
- SAC will become NASA for SA
- Will do manufacturing of SA satellites in Stellenbosh (Denel)

- Launch capabilities: micro and macro satellites (up to 40kg): est 5-10 years after SASA is established
- Will have SA constellation by 2018, can select own resolutions: more independent, but more costly
- All SA-satellite data will be free for Govt-agencies

Earth Observation Satellites (EOS)

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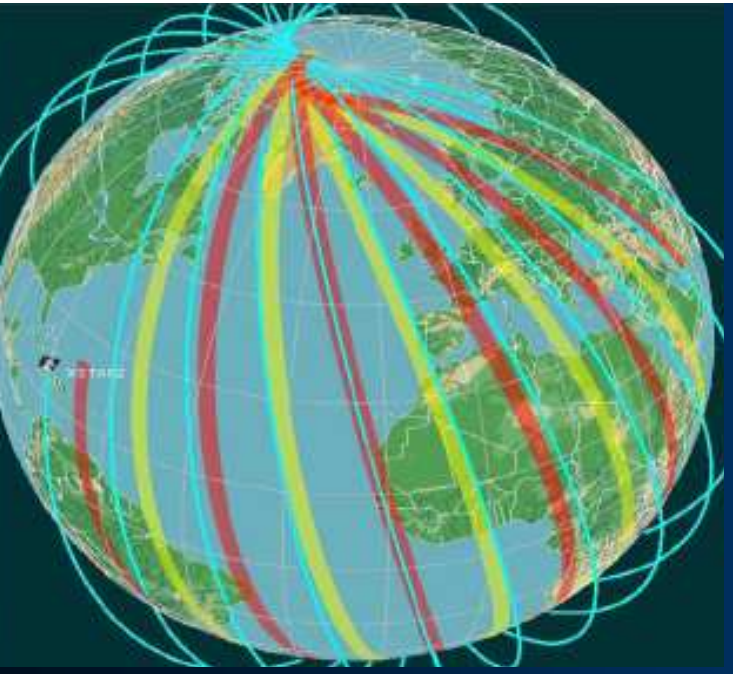
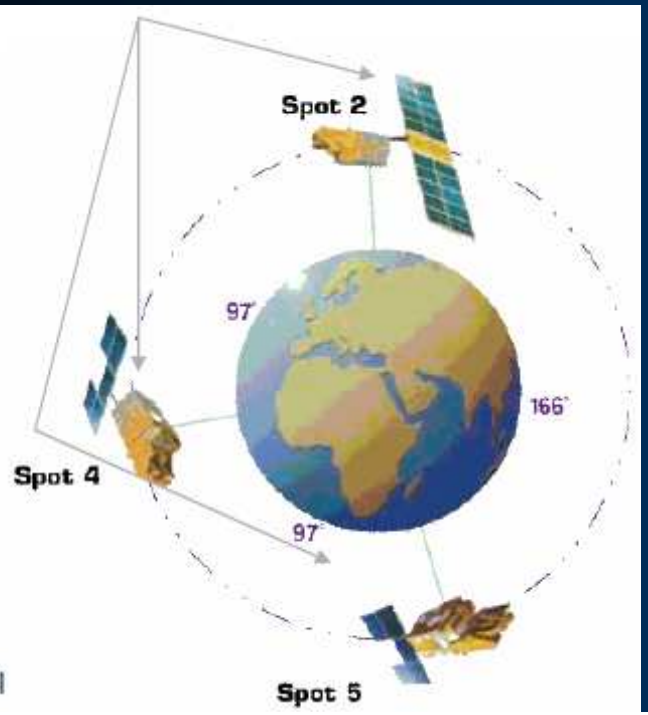
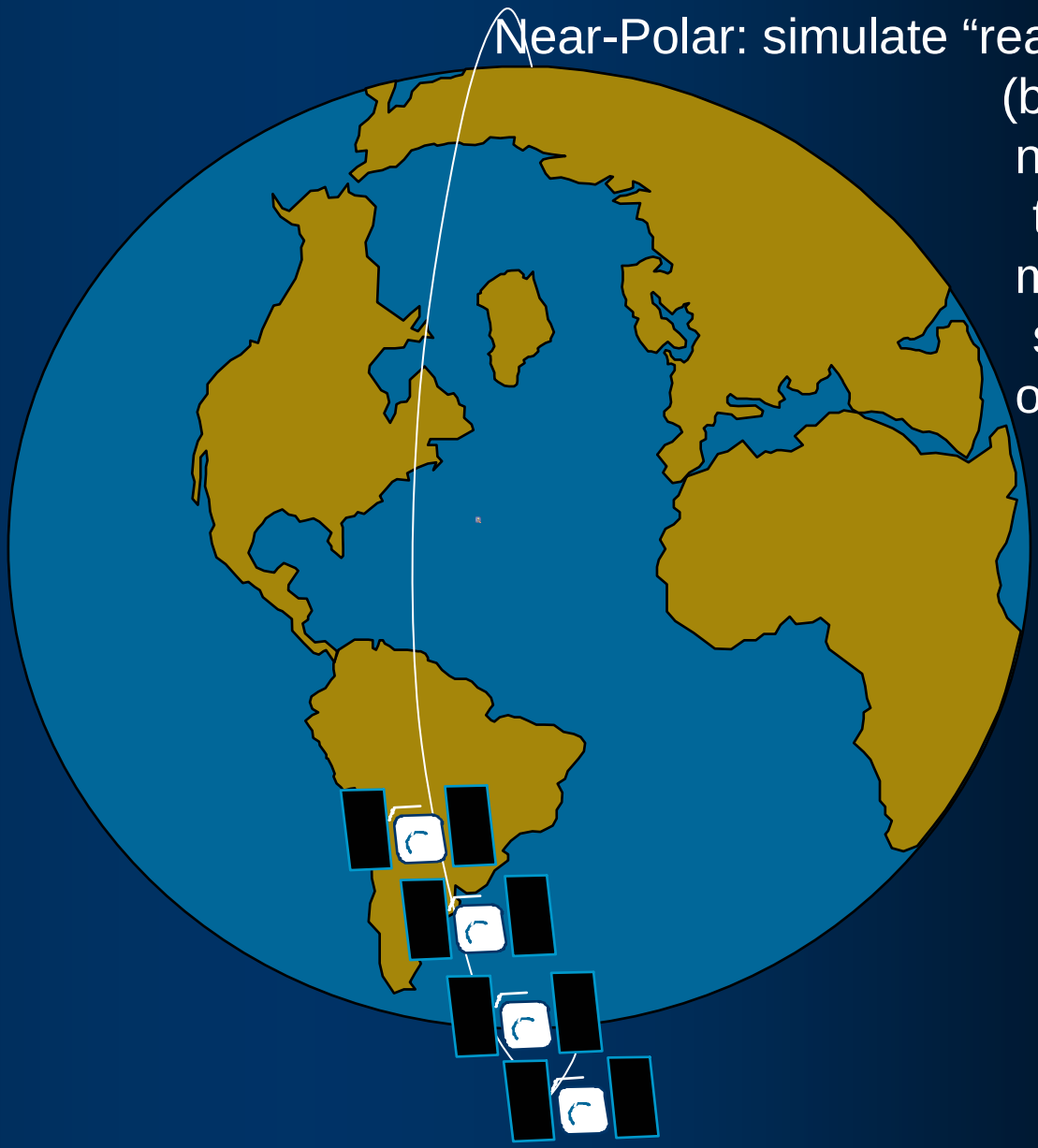
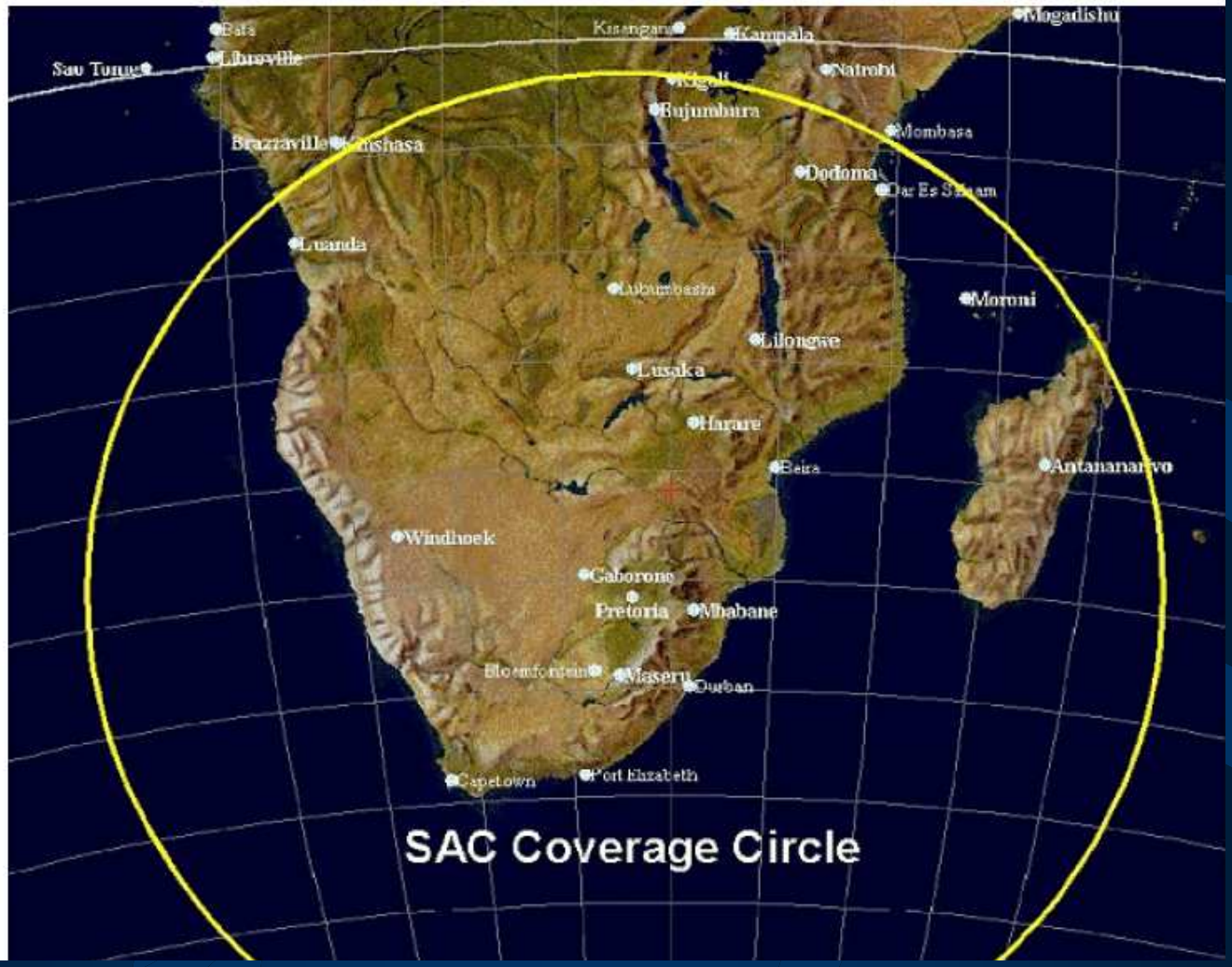




Near-Polar: simulate “real-time” (but there is no such thing as movement-space-observation)



Earth Observation Reception Footprint



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Types of EOS's

- Optical (Landsat; temporal revisits e.g. every 16 days: also measures e.g. water vapour and particulate matter)
- Radar ("ping" and record info on refraction of the image: not nice to look at but can be very useful
- Hyperspectral (becoming more common: e.g. to id indigenous vegetation in a forest; measures CO2, SO2, PM > 2 micron, Water vapour, Ozone; daily at the same time)

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Resolution

- 60cm = very high res; 30m = med res
- Resolution x 3 = object identification, thus 60cm res = 1.8m object identification

Image catalogue

- www.csir.co.za
- www.sac.co.za > find image catalogue > space

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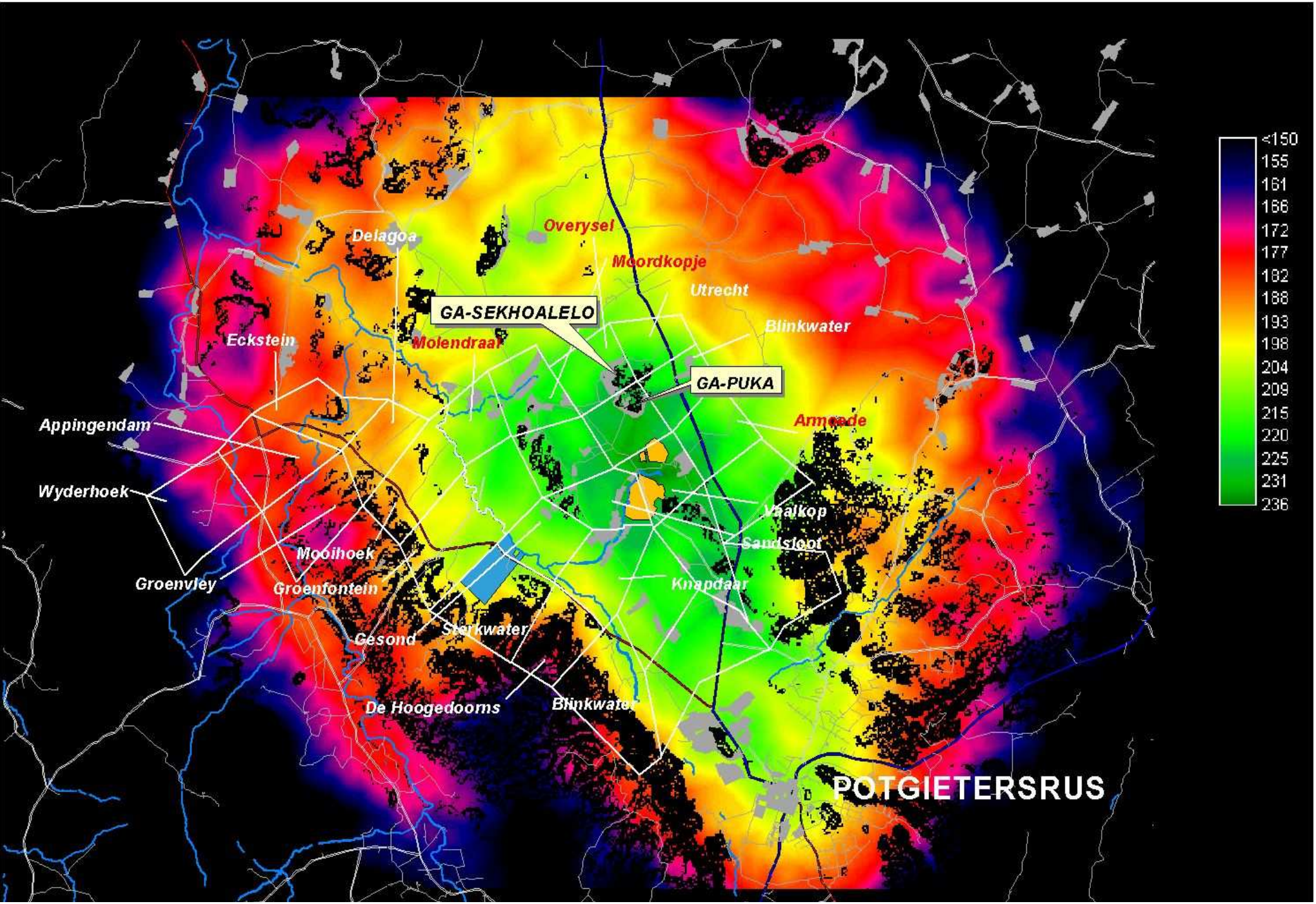
Satellite Name	Res / Swath	What is it good for	Cost/Owner	Details
ERS2	30m Panchromatic; 100x100 km	Flooding analysis	ESA: Particularly expensive	Direct Ingestion (D/I) Radar : cloud cover o.k.
Landsat 5 (7 broke down)	30m Multispectral; 120m Thermal 180x180 km	Enforcing water legislation: check who uses how much	USGS (USA); Cost depends on size of area required	D/I; 1986 – present
NOAA	1.1 km; 2000 km	Vegetation, drought	NOAA (USA)	D/I
Quickbird	60cm Panchromatic; 2.4m Multispectral 16x16km	See smoke particles: for air pollution	Digital Globe (USA)	Distributor (D)
World View 1	50cm Pan; 16x16 km		Digital Globe (USA)	D; Aerial photo resolution
IKONOS	1m Panchromatic; 11x11 km		Space Imaging (USA)	D
Spot 2 & 4	20m Multispectral; 10m Panchromatic	Environmental applications	Spot Image (France)	D/I; Lens can swivel
Spot 5	2.5m; All Spot: 60x60 km	Change detection (2006 vs 2007); 3D; Pleiades (next version); enforcing water legislation: who uses how much	Spot Image (No cost to SA Govt agencies)	Entire SA covered; 2nd version avail in March 08
TerraSAR-X	Various 1m – 50m; 5 km – 500 km	Disaster Management: while disasters occur: 24hr turnaround time	Infoterra GBMH	Interpretation & mapping by SAC takes 48 hrs only after download received
ENVISAT		Environmental		Need special software tools
FormoSat	2m Panchromatic 8m Multispectral; 24x24 km	Every day same angle same time: Short-term change detection	Spot Image	Eastern part of SA more covered than Western side
Meteosat		Every 15 minutes: Weather		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Utrecht
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Blinkwater
Eckstein
Molendraai
GA-PUKA
Appingendam
Wyderhoek
Groenvley
Mooihoek
Groenfontein
Gesond
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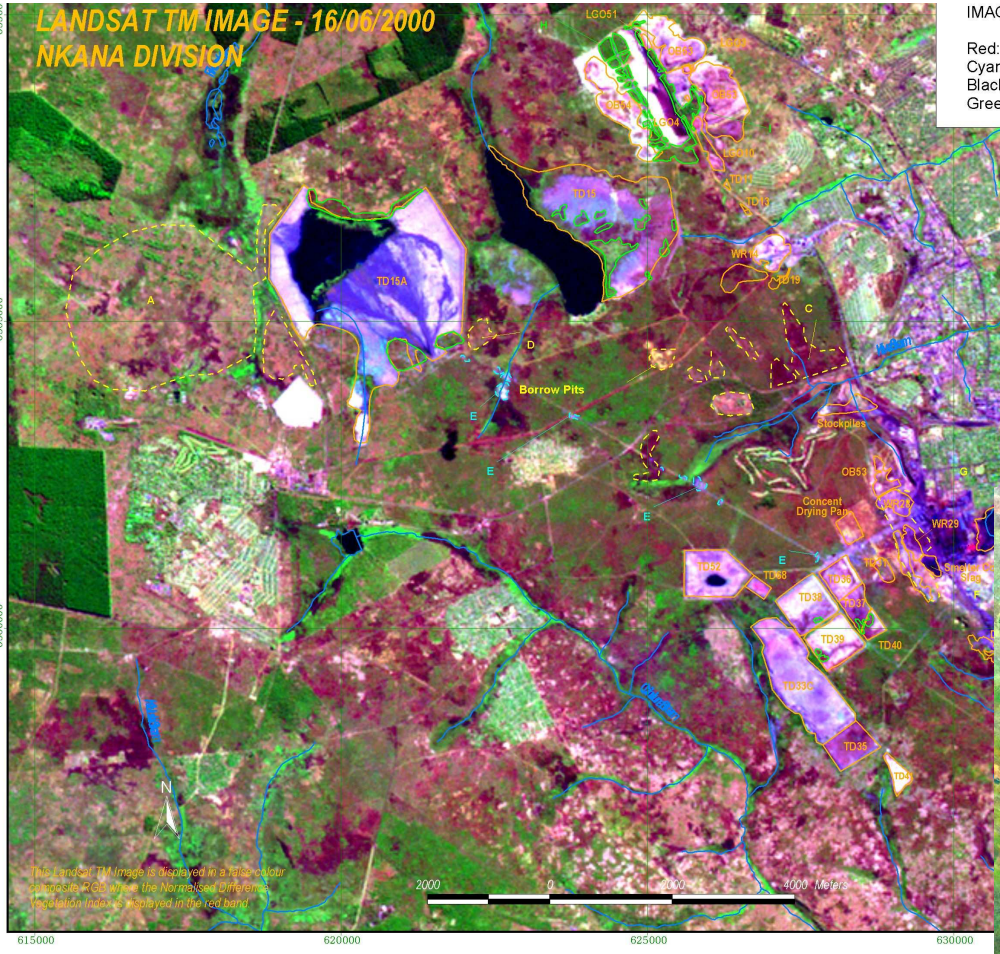
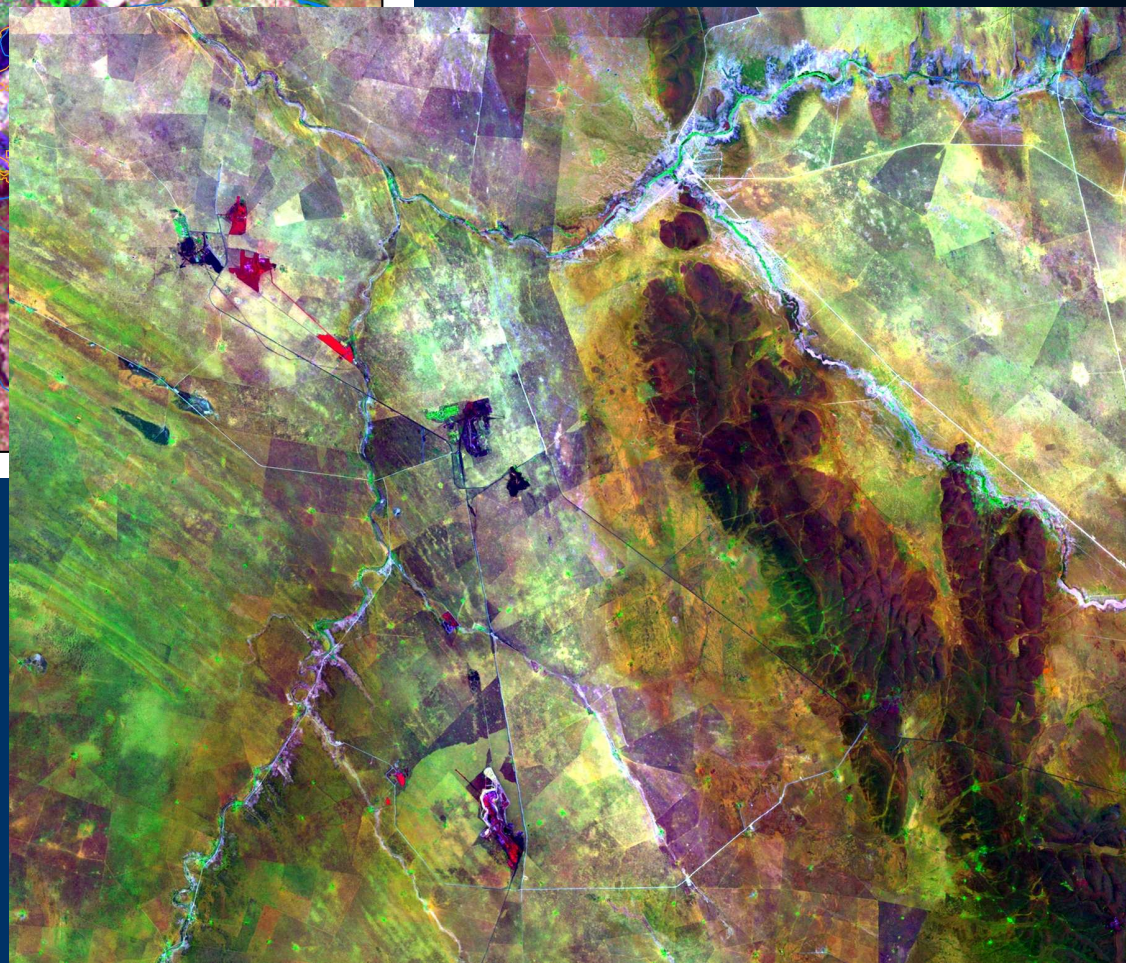
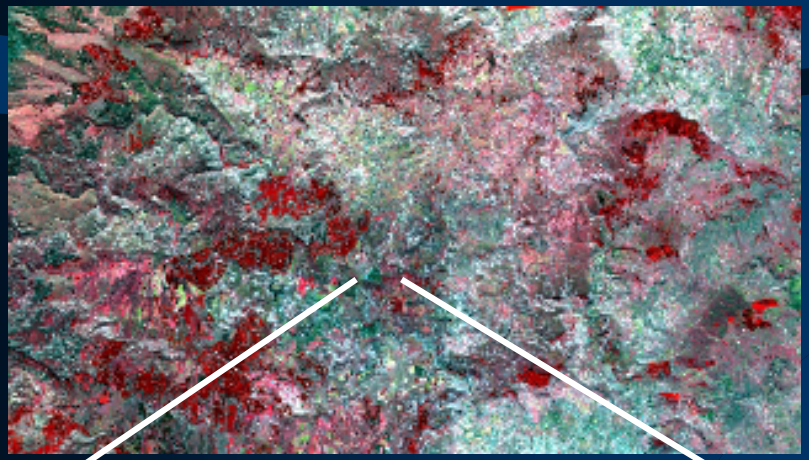
POTGIETERSRUS

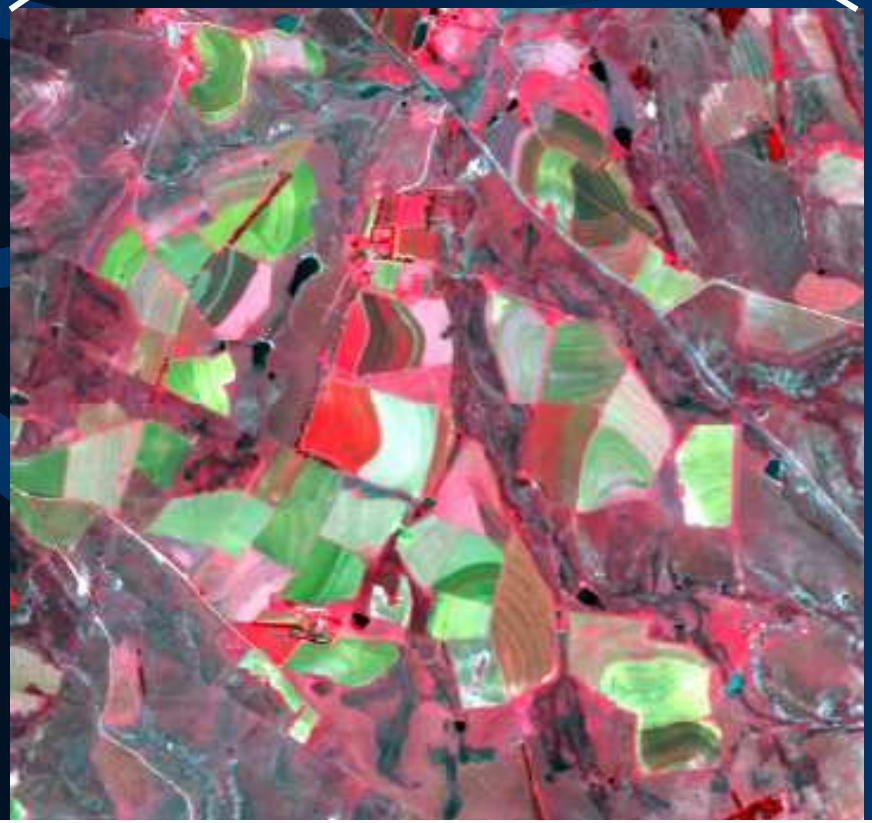
LANDSAT TM IMAGE - 16/06/2000
NKANA DIVISION



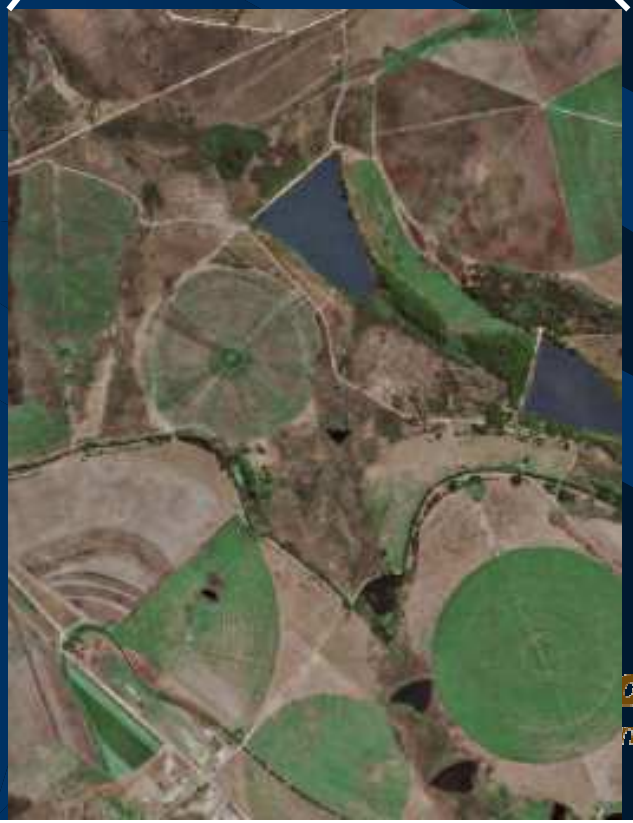


Spot5 multi-spectral





Spot5 natural colour



3D

3D navigation over Toulouse city

Airborne Simulation And Toulouse City urban data base

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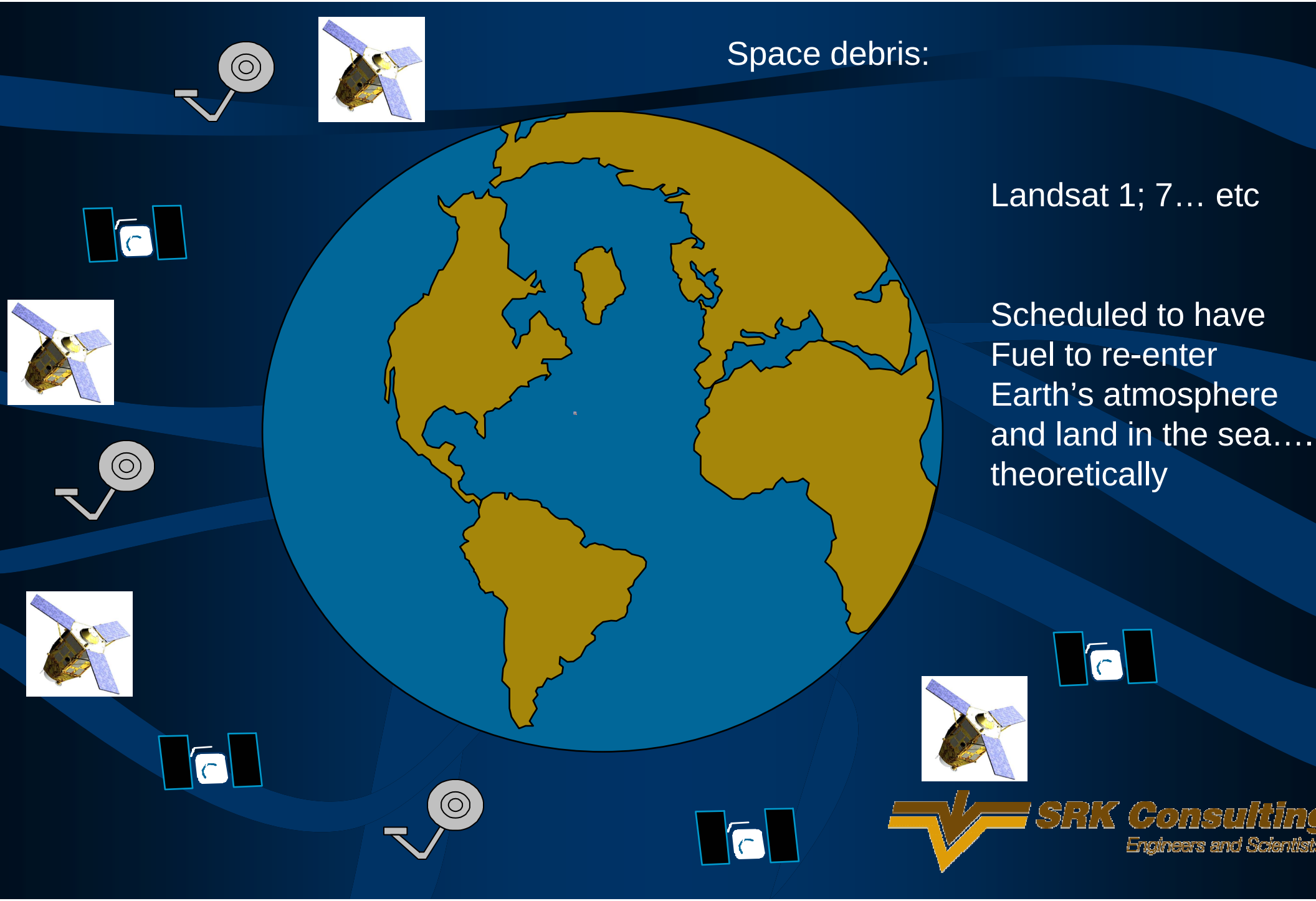
Space debris:



Landsat 1; 7… etc

Scheduled to have Fuel to re-enter Earth's atmosphere and land in the sea…. theoretically

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AFIS (Advanced Fire Information System)

- www.wamis.co.za/eskom/checkboxes/eskom.htm

- 1km res for veld fires
- Update every 15 minutes
- History search of fires in particular area

- Meraka Institute: Philip Frost; CSIR; University of Maryland

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AFIS- Web Fire Mapper

ESKOM

Select data layers from the list to be displayed in the initial interactive map.

Data layers

- [x] Countries
- [x] Province
- [x] Labels: Province
- [ ] Dams
- [ ] Protected Areas (IUCN categories 1-6)
- [ ] Roads
- [ ] ESKOM Distribution grid
- [x] ESKOM Transmission grid
- [ ] ESKOM Transmission Sub stations
- [x] Major cities
- [ ] Cities
- [ ] Towns
- [x] Towers

Active fire detection

MODIS
Fire detections are updated at
03:00 AM ,06:00AM,11:30AM,1:30PM,3:00PM,6:00PM,10:30PM

- [ ] MODIS Active Fire Detections - (27th April 2004 onwards)
- [x] Fires Last 24 hours

MSG

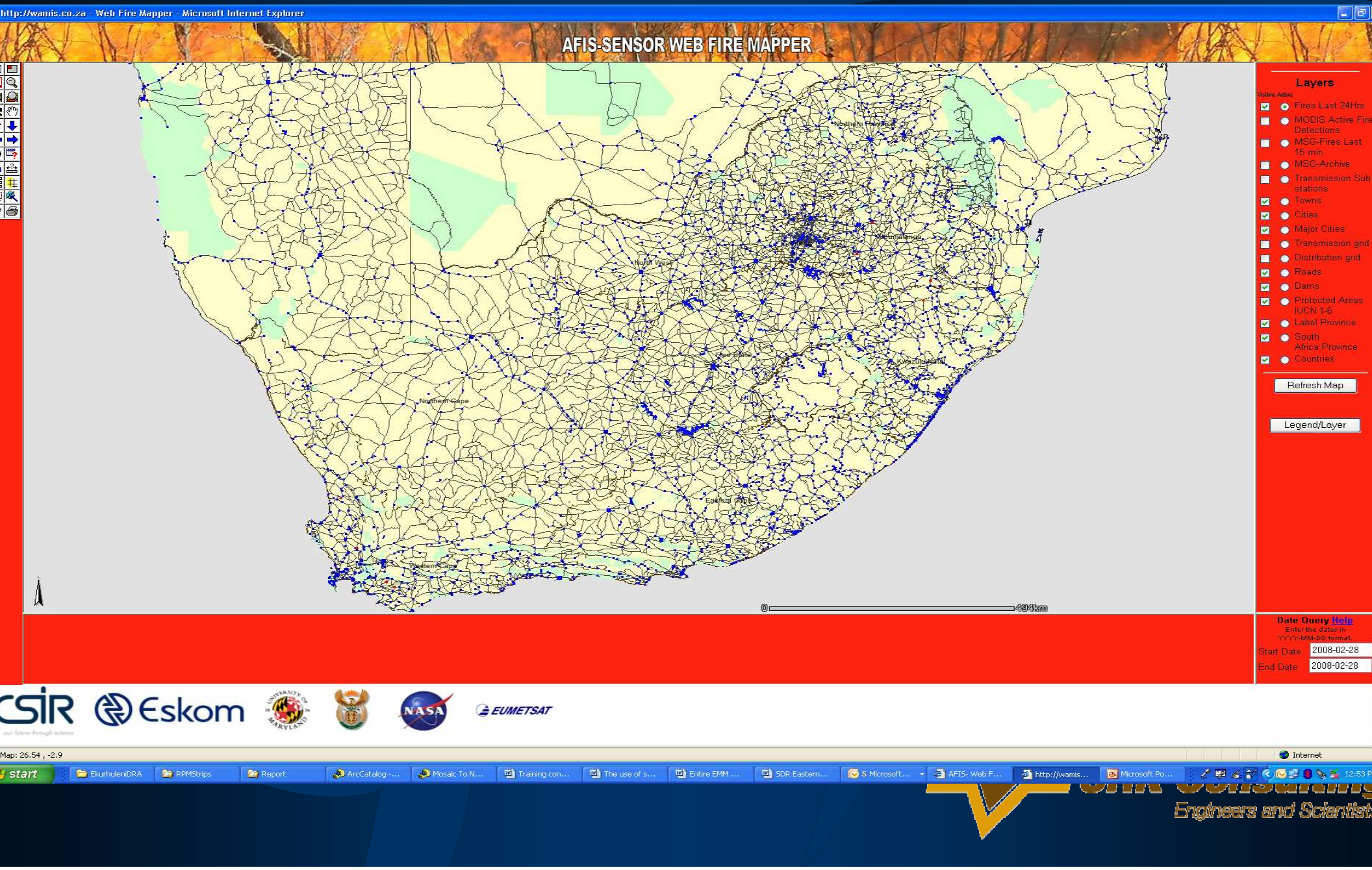
- [ ] MSG Active Fire Detections -- Last 15 minutes
- [ ] MSG Fires Archive

Note: A new version of AFIS web mapper will be replacing this one in the near future.

Open Map

DEPARTMENT OF GEOGRAPHY
AT THE UNIVERSITY OF MARYLAND, COLLEGE PARK

Questions or Comments? Webmaster


http://wamis.co.za - Web Fire Mapper - Microsoft Internet Explorer
AFIS-SENSOR WEB FIRE MAPPER
Layers
Visible Active
Fires Last 24Hrs
MODIS Active Fire Detections
MSG-Fires Last 15 min
MSG-Archive
Transmission Sub stations
Towns
Cities
Major Cities
Transmission grid
Distribution grid
Roads
Dams
Protected Areas IUCN 1-6
Label Province
South Africa:Province
Countries
Refresh Map
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North West
Free State
KwaZulu-Natal
Eastern Cape
Western Cape
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Date Query Help
Enter the dates in YYYY-MM-DD format.
Start Date 2008-02-28
End Date 2008-02-28
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Eskom
NASA
EUMETSAT
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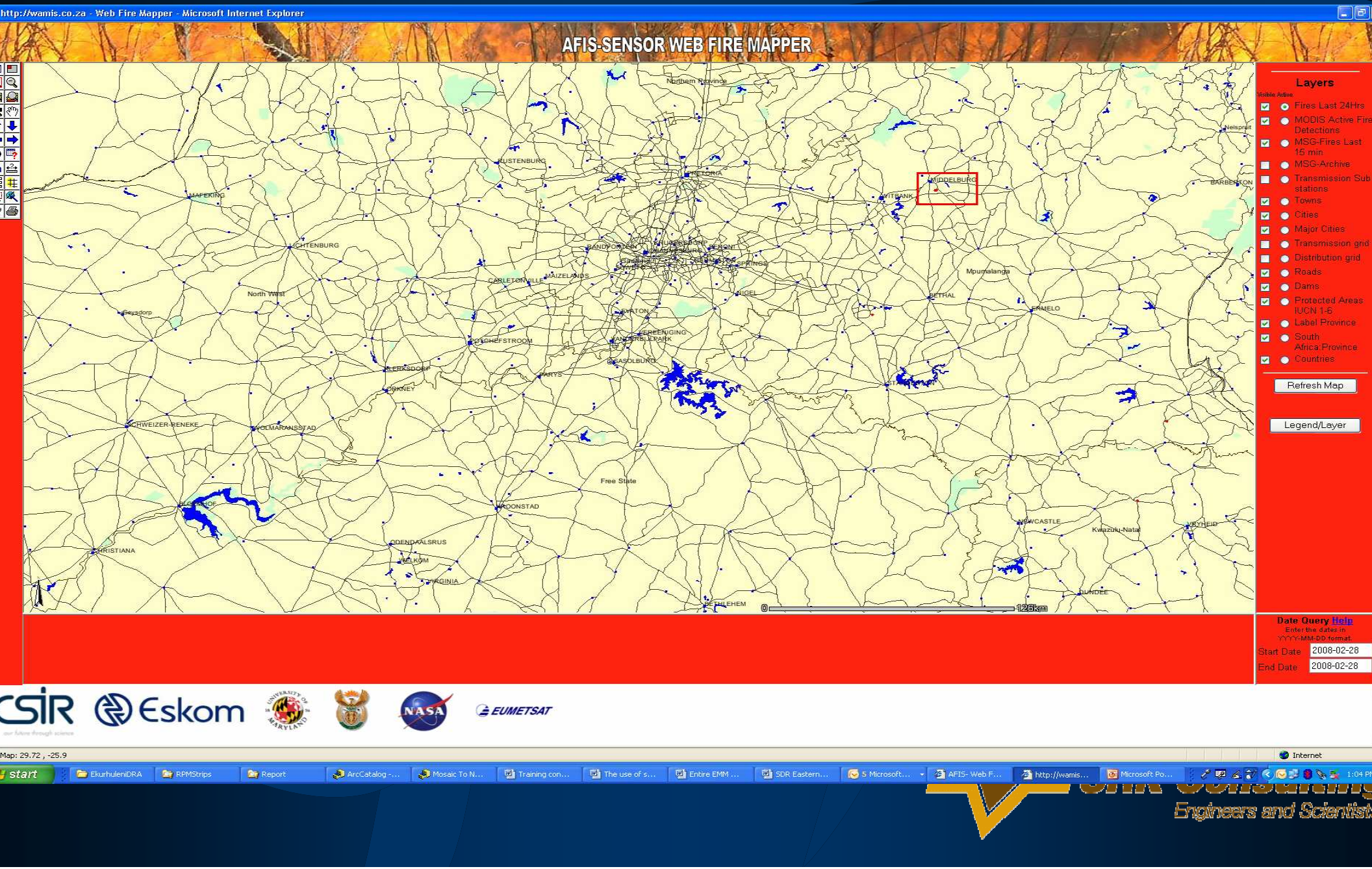
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Protected Areas IUCN 1-6
Label Province
South Africa Province
Countries
Refresh Map
Legend/Layer
Date Query Help
Enter the dates in YYYY-MM-DD format.
Start Date 2008-02-28
End Date 2008-02-28
Northern Province
RUSTENBURG
PRETORIA
MIDDELBURG
WITBANK
MAFEKING
LICHTENBURG
North West
CARLETONVILLE
MAIZELANDS
NIGEL
BETHAL
ERMELO
Mpumalanga
POTCHEFSTROOM
VEREENIGING
SASOLBURG
PARYS
ORKNEY
SCHWEIZER-RENEKE
VOLMARANSSTAD
Free State
KROONSTAD
ODENDAALSRUS
WELKOM
VIRGINIA
CHRISTIANA
NEWCASTLE
Kwazulu-Natal
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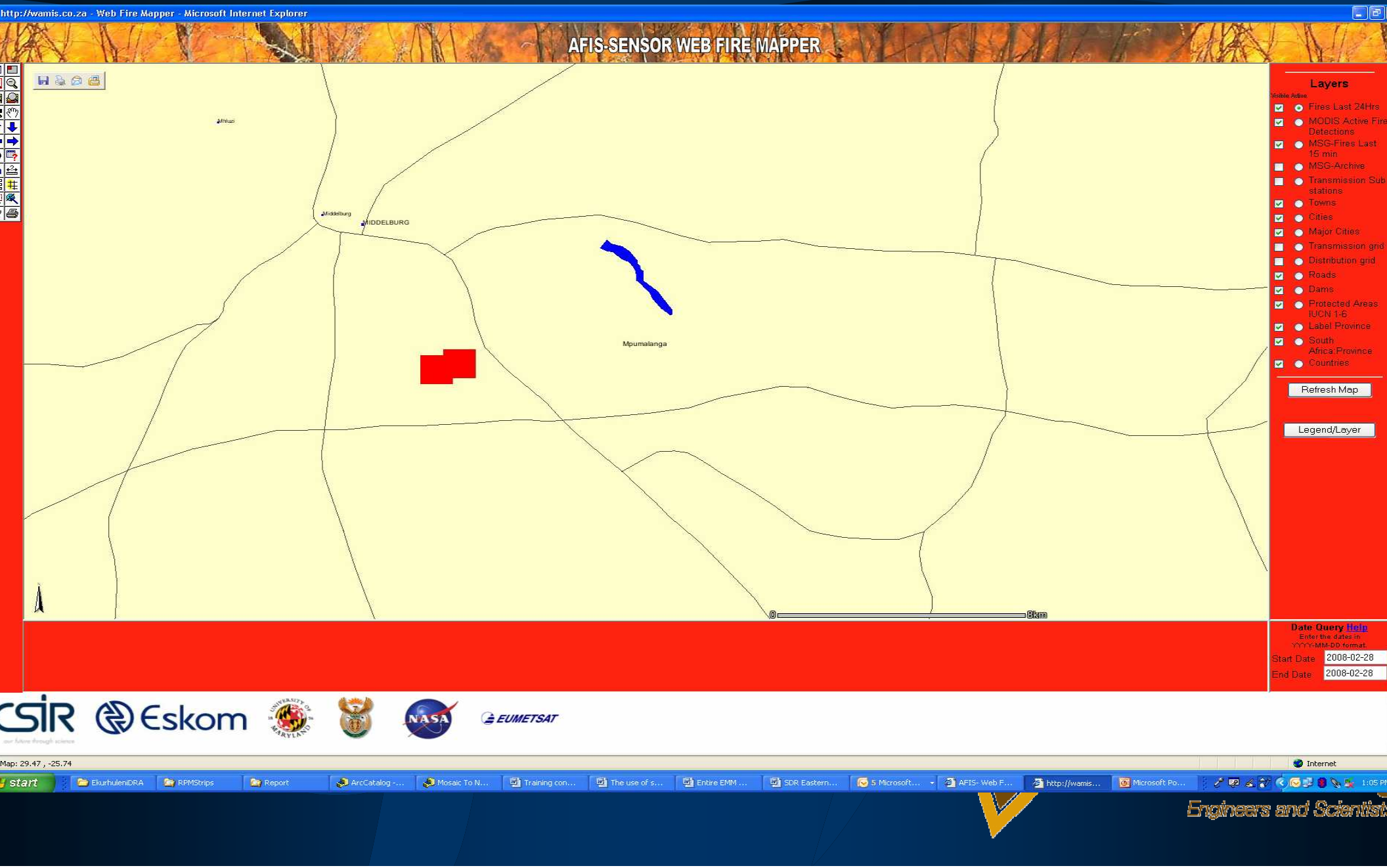

CSIR Eskom NASA EUMETSAT

Engineers and Scientists

EOS's: conclusion

- Bilateral cooperation with other African countries are envisaged
- Want to negotiate "Southern African License" for SPOT 5, but not there yet
- International Charter on Space and Major Disasters: www.disastercharter.org/charter_e.html :
- Aim to provide: first satellite over an area will provide image: in next 5 – 10 years (need own satellite to share, to be a priority-member, else: the current turn-around time can be up to two months)

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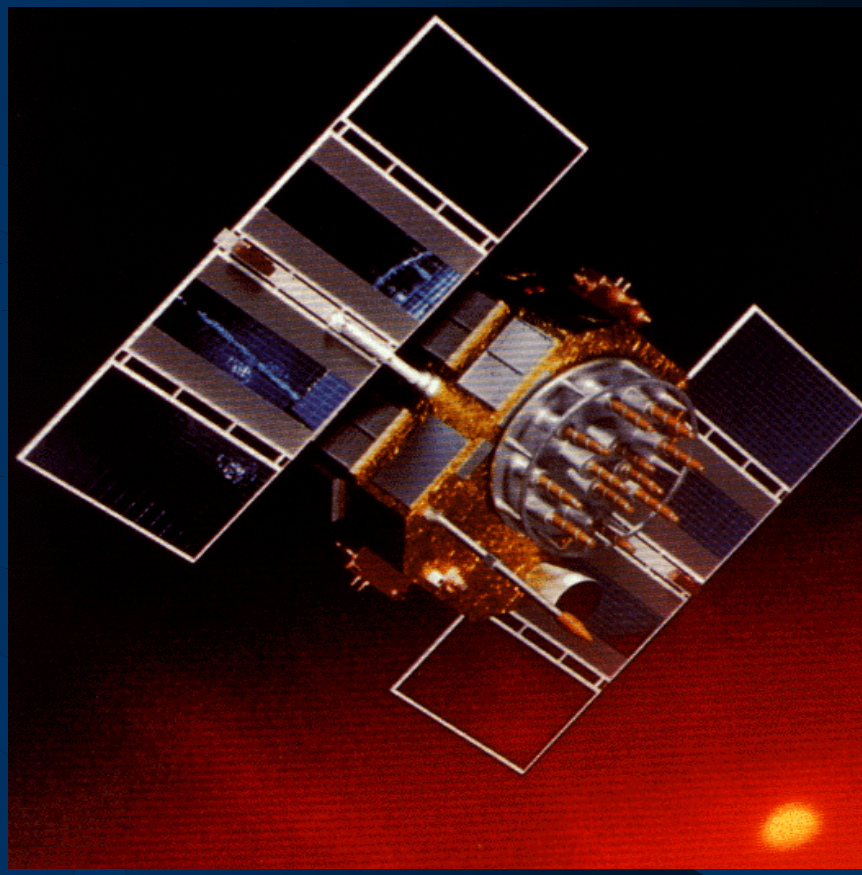
What is GPS??

"Global Positioning System"

- **SPACE SEGMENT**:
  - 24+ Satellites orbiting Earth at 20,000km
  - Orbital period 12 hours
  - 3 Orbital planes at 55 degrees to Equator
- **CONTROL SEGMENT**:
  - 4 ground monitoring stations
  - 1 ground master control station
- **USER SEGMENT**:
  - You and me



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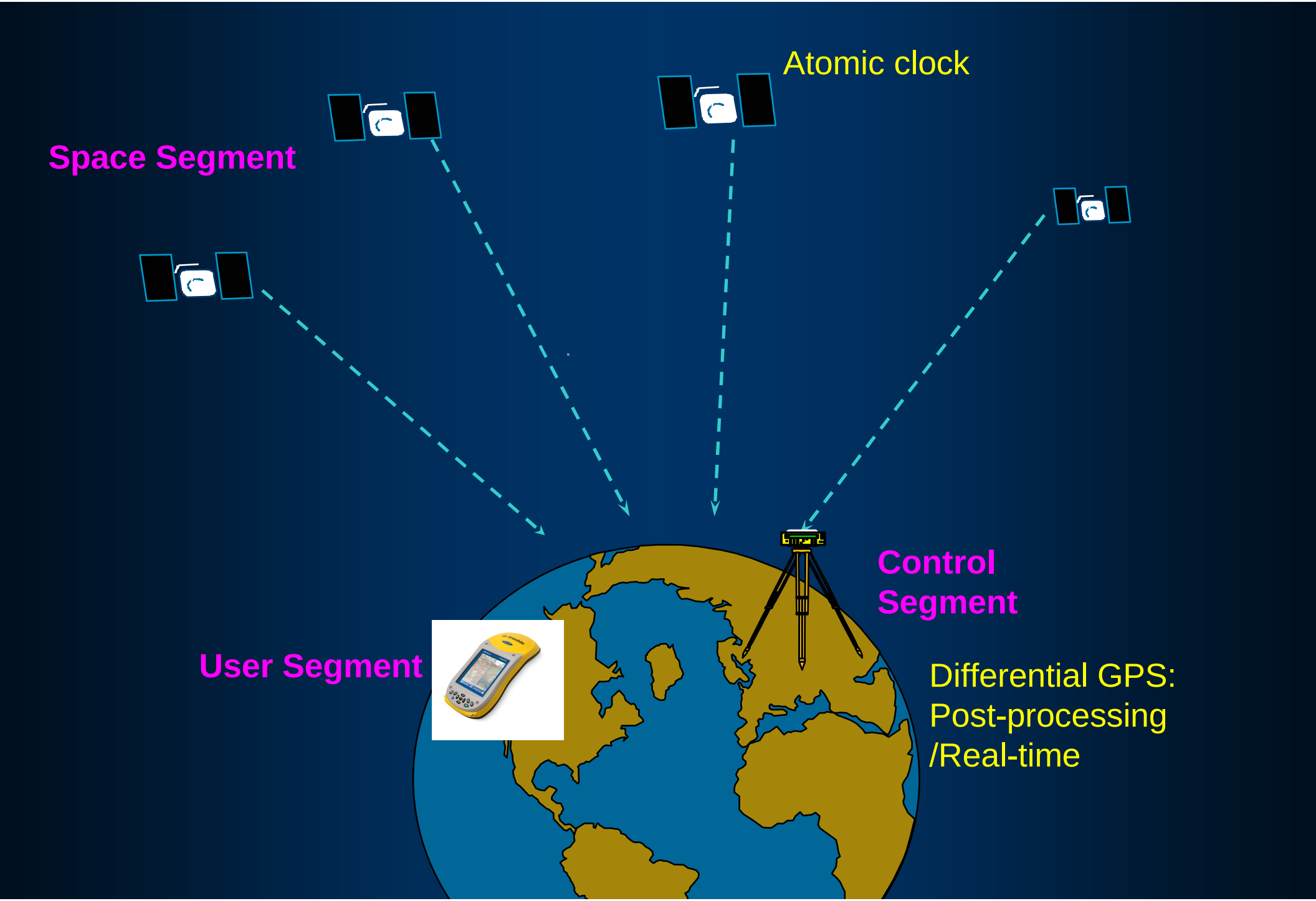
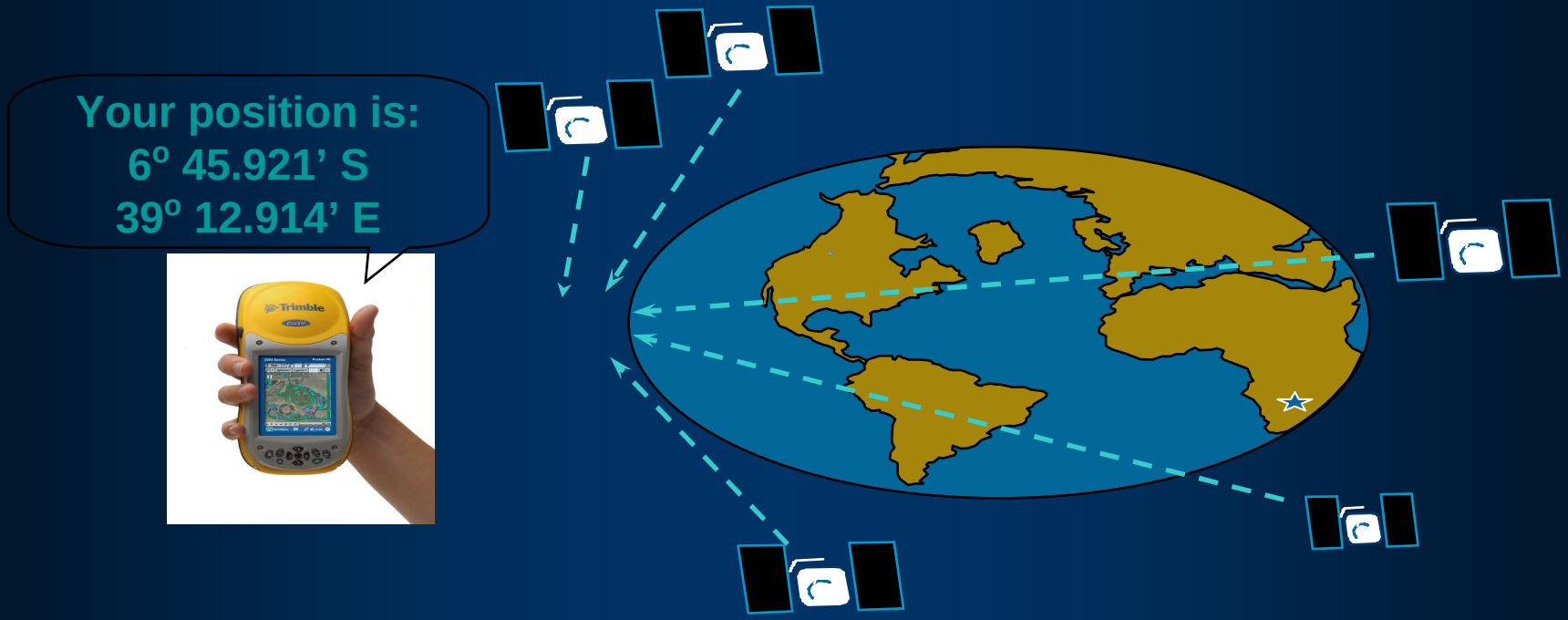
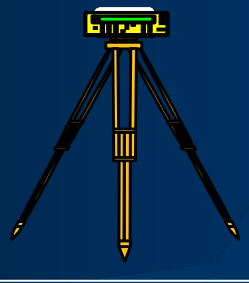

Atomic clock
Space Segment
Control
Segment
User Segment
Differential GPS:
Post-processing
/Real-time

Global Positioning System: A system of radio-emitting and -receiving satellites used for determining positions on the earth. The orbiting satellites transmit signals that allow a GPS receiver anywhere on earth to calculate its own location through triangulation and trilateration (known location & orbits, accurate timing, distances).



Post-processed Differential GPS



Base Station

PC Software

"Rover"

Corrected Position

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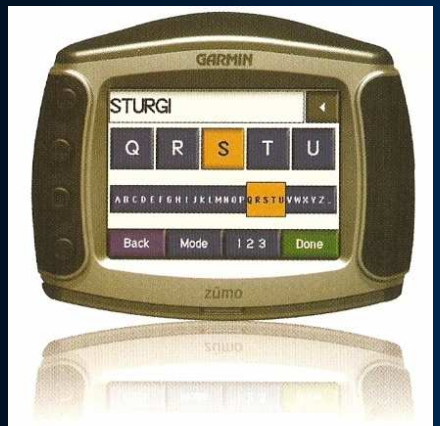
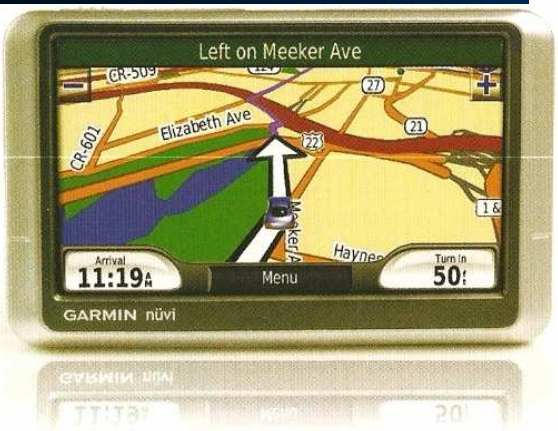
GPS Equipment

- Recreational(15m)……..…...Garmin/ Magellan/TopNav/TomTom/JNC/Trimble etc…
- GIS/Mapping (30 cm - 5m)
- GIS/Mapping (1m Real-Time) (e.g. Trimble ProXRS, OmniSTAR)

Receivers



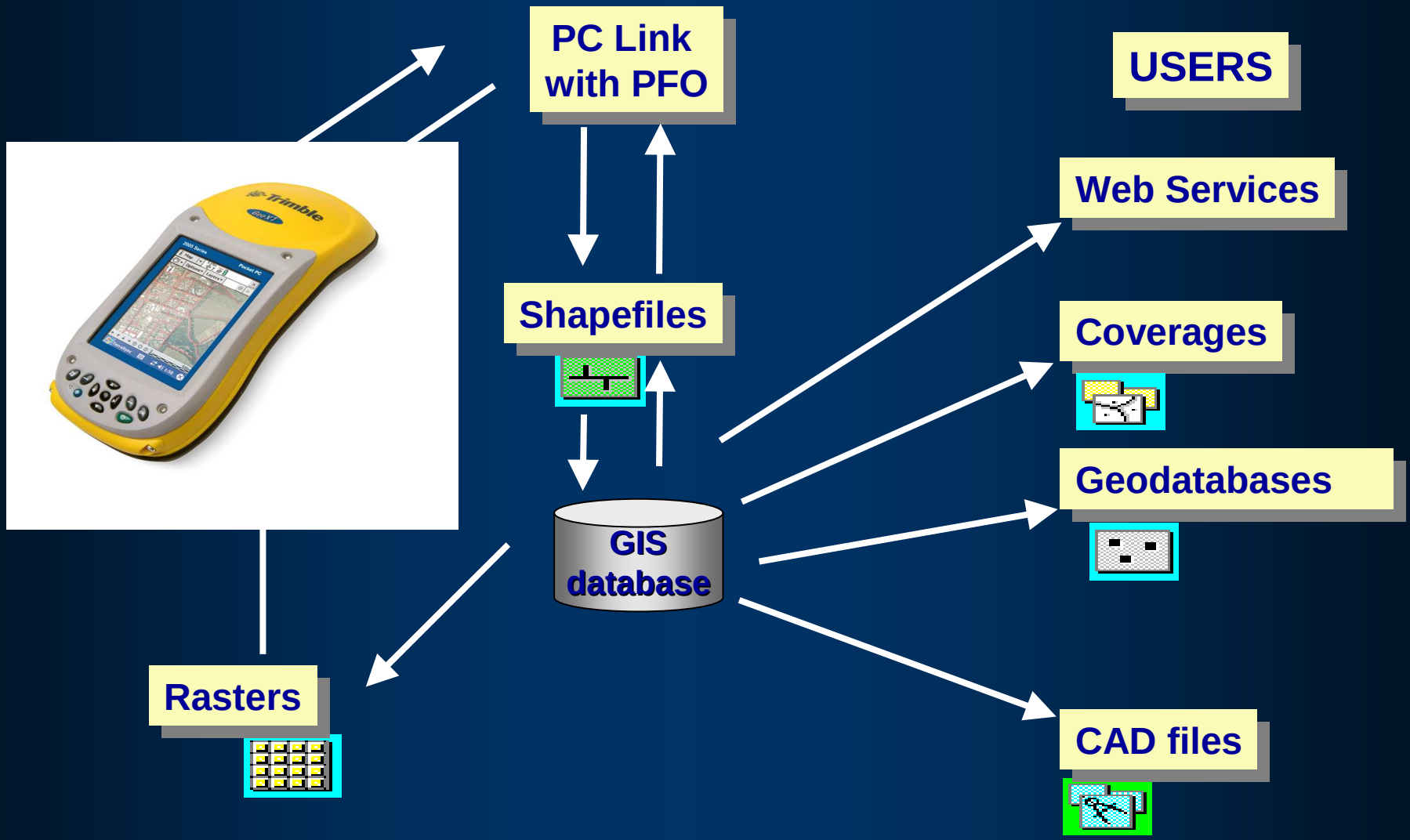
zūmo™ 550

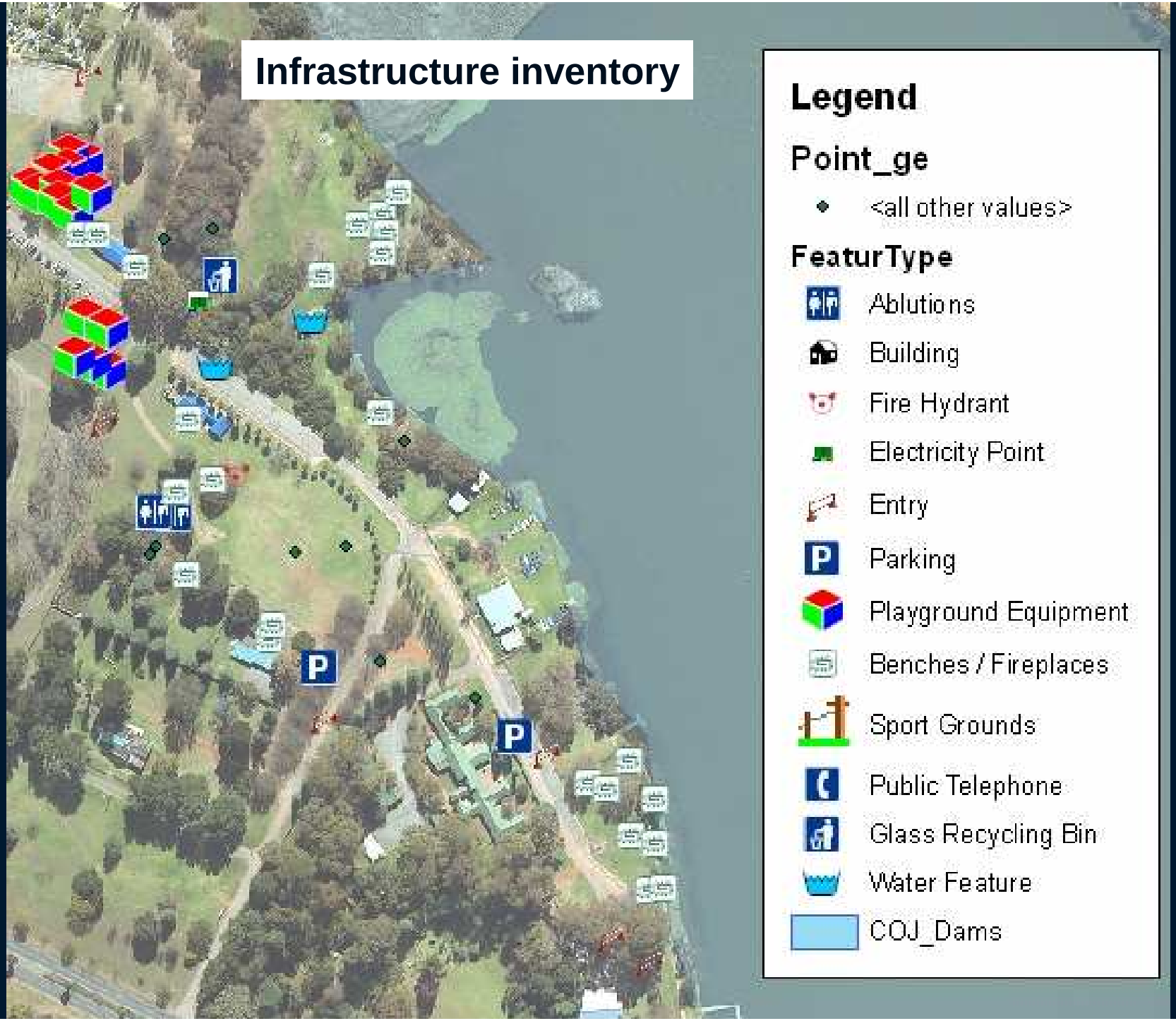


nüvi™ 200W

- Routes
- Easy to Use Touch Screen
- FM Radio
- Voice Guidance
- Bluetooth
- Text-to-Speech Voice Guidance announces street names
- MP3 Player Picture viewer and Audio Book Player
- Garmap™ Southern African maps
- Safety Camera Locations Preloaded
- IPX7 Waterproof Rating
- Garmin Lock Security Anti-Theft Feature
- Fuel gauge monitoring, active in motocycle mount

Seamless Integration into GIS

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Parking
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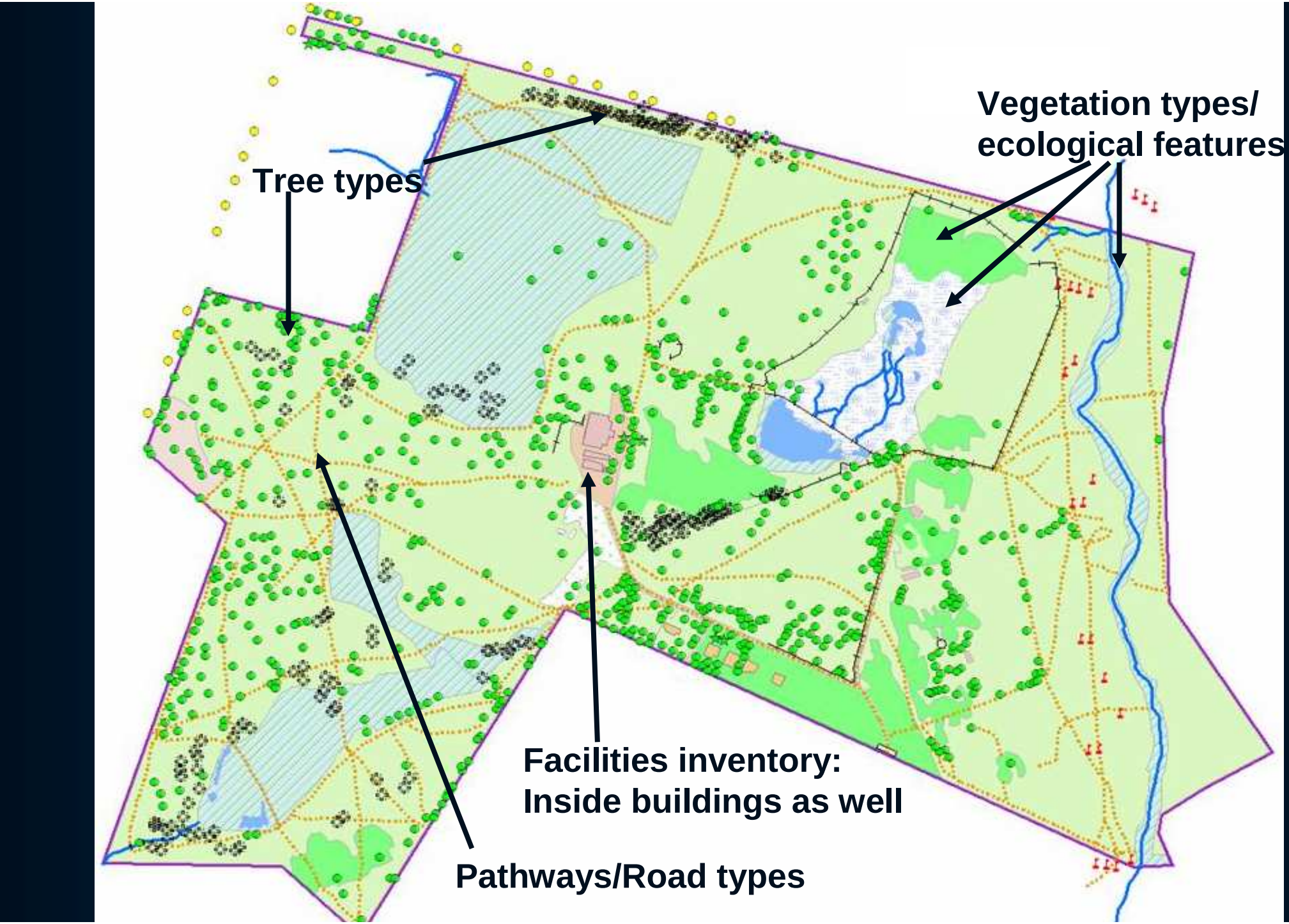
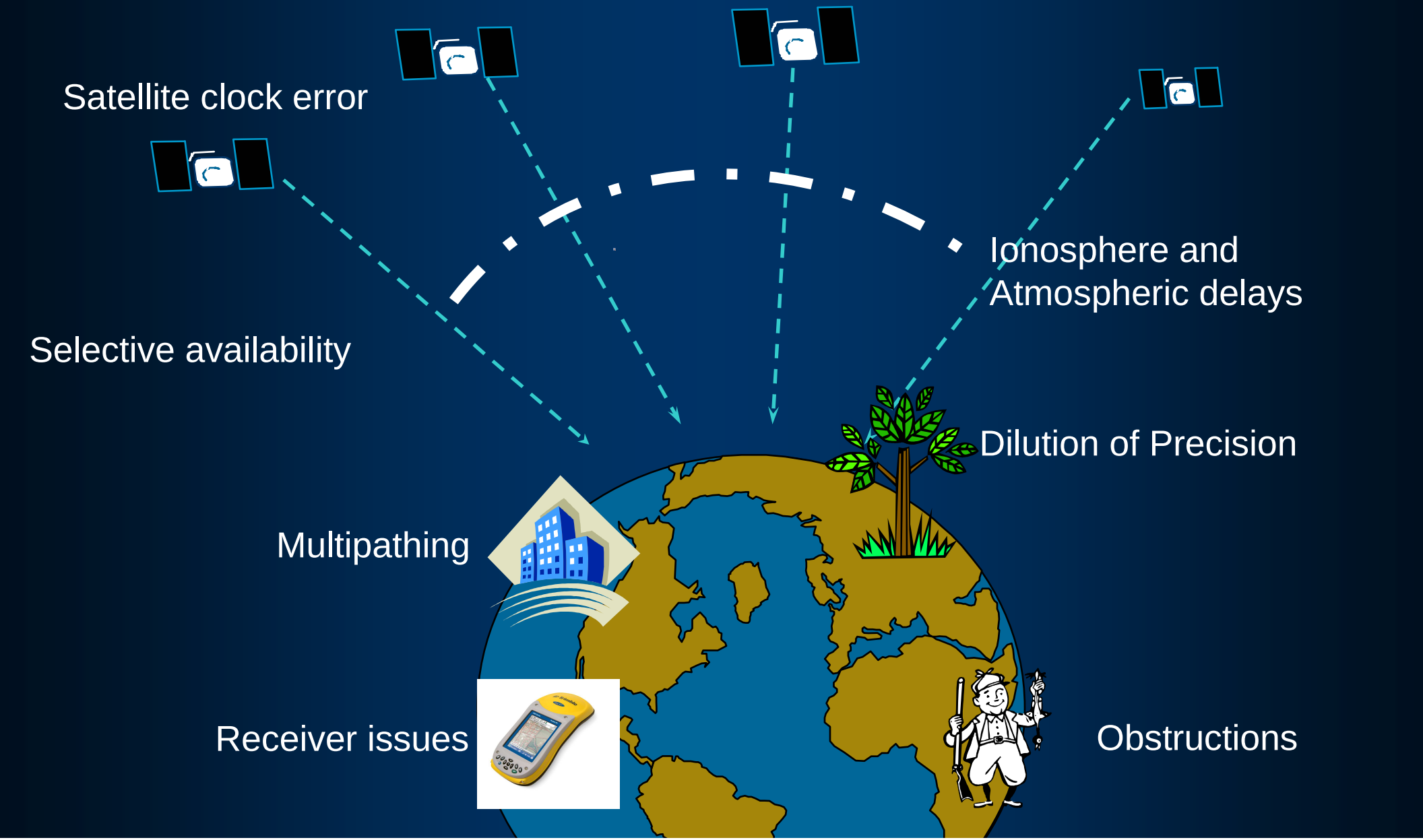
Sport Grounds
Public Telephone
Glass Recycling Bin
Water Feature
COJ_Dams


Vegetation types/
ecological features
Tree types
Facilities inventory:
Inside buildings as well
Pathways/Road types

What influences GPS accuracy?



Common fieldwork problems/GPS set-up issues/15m vs 1m

Post-processing corrections
VICTORIA
EMPIRE

What criteria can be used to select hardware and software?

- Hardware:
  - Rugged: water-resistant; impact-resistant?
  - (15)m; > 1m accuracy?
  - Antenna-connections (to push through tree foliage/over fences/walls)?
  - Connection to digital camera?
  - Physical size?
  - Battery life?
  - RAM / SD card additional?

- Software:
  - Easy to operate for non-GIS and non-PC literate personnel/Specialists?
  - Data dictionary / lookup-list creation?
  - Forced actions / users able to do own work?
  - Easy upload and download / reporting?
  - GIS-compatible?
  - Bluetooth / transfer mode?

Lessons learned

"Over-the-counter" GPS's usually does not allow for customised forms/lookup tables;

- Lookup tables need testing: do not roll out for final work immediately: first do selected sites/tests and then edit the lookup lists (data dictionaries).
- Get information regarding the need for e.g. cap-mounted antennas and pole-mounted antennas.
- Understand the influence that tall buildings, fences, trees can have, esp. when capturing lines/polygons (areas): include editing time afterwards.

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