The Role of Positioning Infrastructure in the Technological Future of our Profession

Matt Higgins

FIG Vice President

Presentation Outline

- An explanation of Positioning Infrastructure;
- The Economic and Environmental Benefits;
- Technological Future Trends and their Impact.

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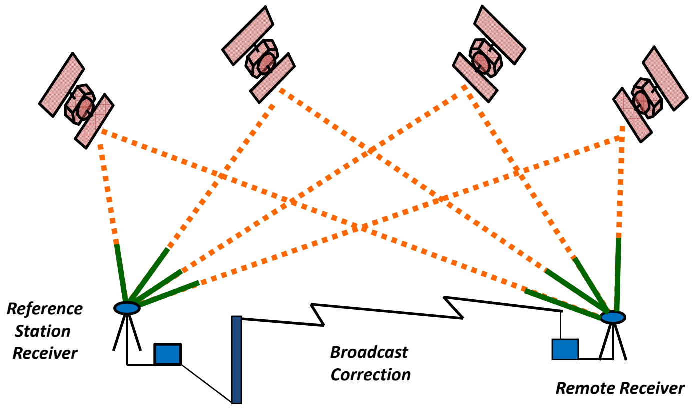
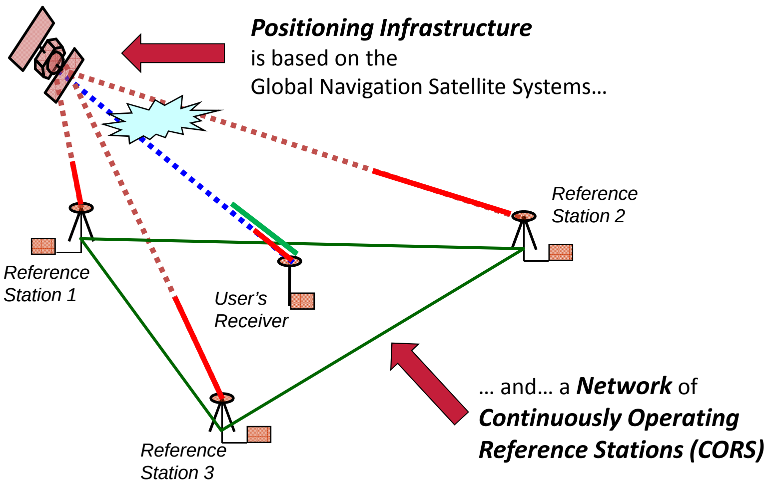
Precise Positioning



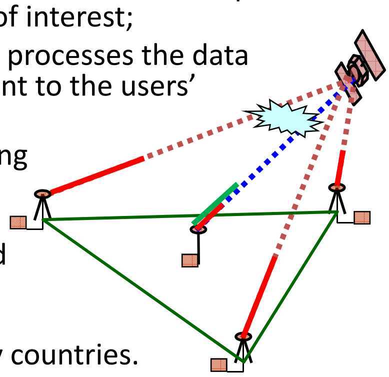
If User has access to GNSS Reference Receiver(s) and Communications…
"Real Time Precise Positioning"

Continuously Operating Reference Stations (CORS)



Positioning Infrastructure

- Network of Continuously Operating Reference Stations placed at a spacing of 70km covering the area of interest;
- Feeding data to a Control Centre that processes the data and computes corrections that are sent to the users' GNSS receiver;
- Requires communications for gathering data from the Reference Stations and delivering corrections to users;
- Better reference station coverage and more reliable data communications improve productivity;
- Network coverage is growing in many countries.



Economic Benefits of Precise Positioning Applications

From Surveying to Machine Guidance

- In Surveying we have seen huge productivity increases from GNSS Precise Positioning;
- However, surveying is no longer the major market for precise positioning;
- It is in guiding heavy machinery used in Agriculture, Construction and Mining;
- ***"Machine Guidance"***

Leica Geosystems

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Economic Benefits – Agriculture

- GNSS machine guidance can be applied widely in the grain, cotton, sugar and horticultural sectors of agriculture;
- Using "control traffic farming" can significantly reduce input costs;
- Condamine study findings:
  - ***Annual Yields up 10%;***
  - ***Fuel and oil costs reduced 52%;***
  - ***Labour costs reduced 67%;***
  - ***Crop gross margin up by ($110);***
- An estimated 10-15% of grain growers in Australia use GNSS for machine guidance;
- ***Increasing uptake requires better reference station infrastructure***.

IGNSS 2008

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Economic Benefits - Construction

In civil engineering, machine guidance is delivering significant increases in productivity and improved on-site safety;

Using GNSS machine guidance on Port of Brisbane Motorway:
30% time reduction, 10% reduction in total project costs, 10% reduction in traffic management costs, 40% reduction in lost time injuries *(Lorimer, 2007)*;

A recent study by Caterpillar comparing conventional road construction to machine guidance: better finish grade and a safer working environment with 100 percent increase in productivity and 43 percent reduction in fuel consumption.

Lorimer 2007

Economic Benefits - Mining

- In open cut Mining, precise positioning is used for a variety of tasks including surveying, grading, dozing, drilling and fleet management;
- Productivity increases are as high as 30% by adopting GNSS.;
- Also safety benefits such as collision avoidance.

Benefit Across Australia

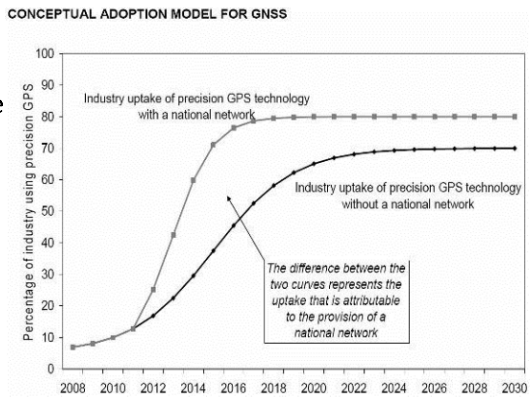
- Australia's Cooperative Research Centre for Spatial Information and the Victorian Government funded Allen Consulting Group to estimate the benefits across Australia;
- Found productivity gains with potential cumulative benefit of $73 to $134 billion (AUD) over the next 20 years - in agriculture, construction and mining alone.

How to Increase Adoption Rates

The Allen Consulting Group study also found that a coordinated roll-out of a national network of reference stations (rather than solely by market forces) would increase total uptake and rate of uptake;

Additional cumulative benefit of $32 to $58 billion to 2030;

Based on that the Australian Spatial Consortium applied for Federal Government funding (300m AUD) for a National Positioning Infrastructure;



Allen Consulting 2008

Australia is 20 times the area of Germany with only 25% of its population (taxpayers/CORS ratio in Germany vs Australia is 84:1);

Also pursuing means to increase cooperation with non-Govt CORS operators and service providers to achieve a unified Infrastructure.

Environmental Benefits of Precise Positioning Applications

Climate Change:
Understanding, Adapting and Mitigating

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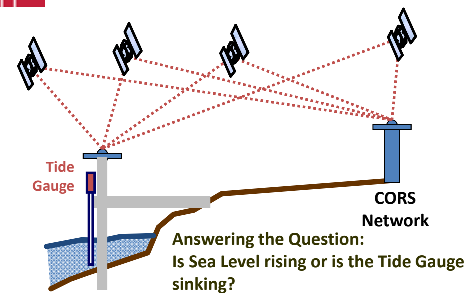
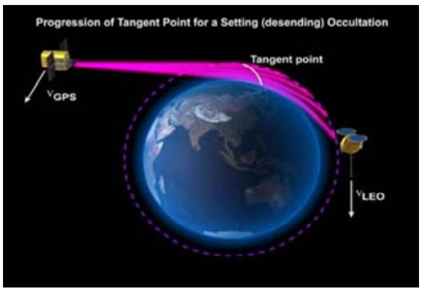
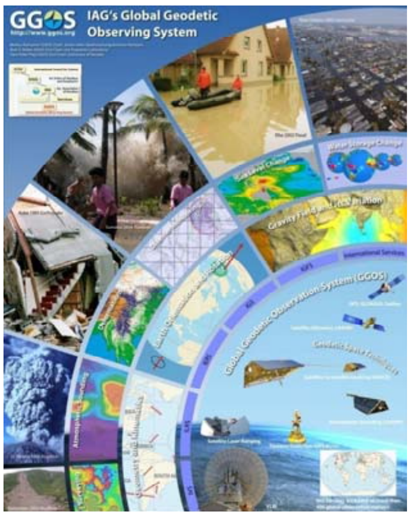
Understanding Climate Change







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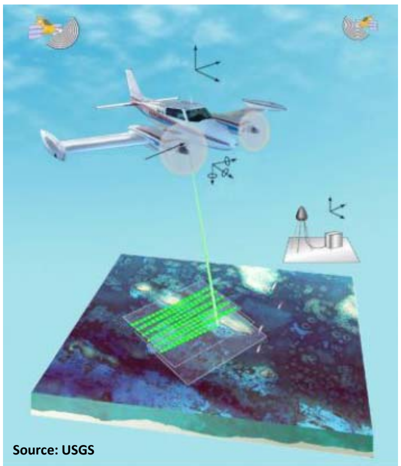
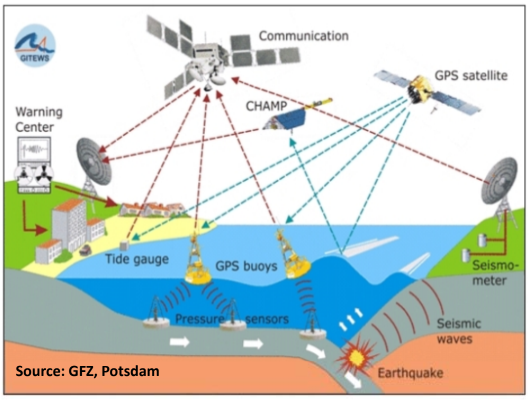
Adapting to Climate Change





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Mitigating Climate Change

- Significant proportion of the Economic Benefit from Precise Positioning comes from Fuel Savings:
  - ***52% less fuel in Wheat farming;***
  - ***43% less fuel in Road construction***
- **Less Fuel = Less Carbon Footprint.**

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Societal Benefits of Precise Positioning Applications

In a triple bottom line context there are also Societal Benefits such as safety-of-life applications etc...
...but I don't have time today!

8 Millennium Development Goals

Goal 1: Eradicate extreme poverty and hunger
Goal 2: Achieve universal primary education
Goal 3: Promote gender equality and empower women
Goal 4: Reduce child mortality
Goal 5: Improve maternal health
Goal 6: Combat HIV/AIDS, malaria and other diseases
Goal 7: Ensure environmental sustainability
Goal 8: Develop a Global Partnership for Development

Positioning Infrastructure can make a significant contribution

Business Case for Positioning Infrastructure

Consider all the arguments and pick those that best fit...

- Economic Benefits
  - Agriculture
  - Construction
  - Mining
- Environmental Benefits
  - Climate Change
  - Pollution reduction
- Water management
- Disaster Management
  - Earthquakes
  - Tsunamis
  - Volcanoes
- Transport
  - Safety
  - Efficiency
- Emergency Management
- Etc…

…then it is also there for

- Geodetic Reference Frame
- Surveying and Mapping
- Spatial Data Infrastructure

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Organisational Roles

Specify → Stations → Network → Process → Deliver

Specify System
- Target Density, Coverage Reliability and Availability
- Site Quality
- Equipment Quality
- Geodetic Reference Frame
- Data Services Produced
- Data Access Policy

Own Stations
- Site Selection
- Site Construction
- Equipment Purchasing
- Station Data Comms
- Site Maintenance
- Equipment Replacement Cycle

Typical Government Role

Network the Data
- Data Comms from Network Stations
- Control Centre
- Data Archive

Process Network
- Copy of Network
- Data Processing (for RTK)
- Production of Data Streams
- Distribution of Data Streams
- Data Wholesaling
- Retailer Support

Deliver Service
- Retail Sale of Data Products
- Marketing
- Rover Equipment support
- End User Support
- Liaison with User Comms Providers

Typical Private Sector Role

Governance

Higgins, 2008

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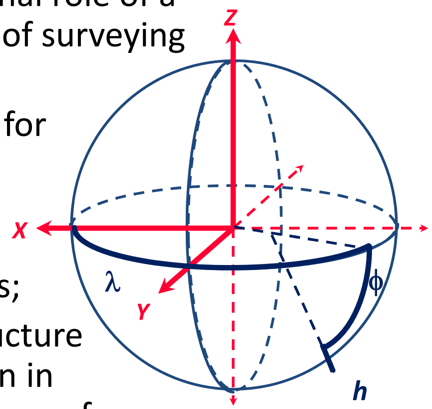
The Role of Positioning Infrastructure

1. Continuation of the traditional role of a Geodetic Datum in support of surveying and mapping activities;
2. As a stable reference frame for precise measurement and monitoring of global processes such as sea level rise and plate tectonics;
3. Extension to a true infrastructure that underpins the explosion in industrial and mass market use of positioning technology.

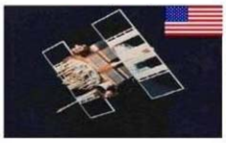


Trends in Positioning Infrastructure and their impact on the Technological Future of the Profession

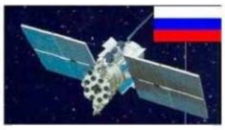
From the Global Positioning System to multiple Global Navigation Satellite Systems

From GPS to GNSS

GPS



GLONASS

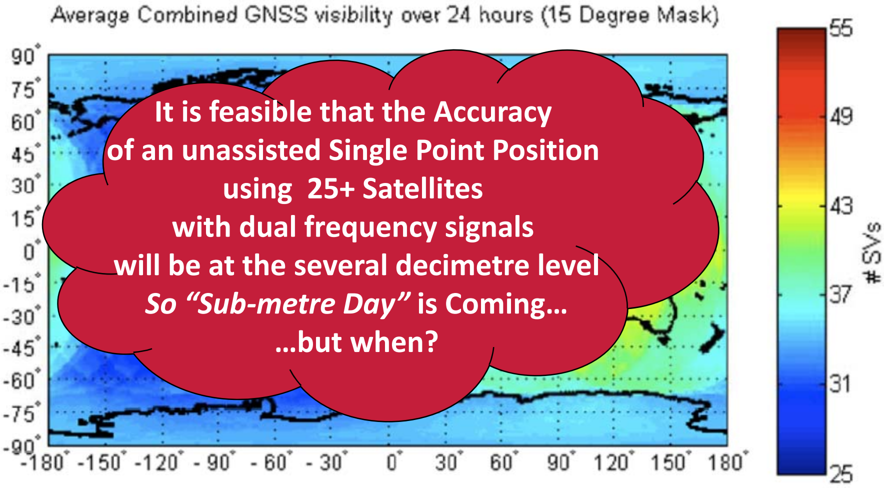


Galileo

In the next decade we are moving from 1 to 4 Global systems:
- USA: Global Positioning System (GPS) - Now;
- Russian Federation: GLONASS – during 2010;
- European Union: Galileo – 5 to 10 years;
- China: Compass – 5 to 10 years;

Plus at least 2 Regional Systems:
- India: Regional Navigation Satellite System (IRNSS);
- Japan: Quasi-Zenith Satellite System (QZSS).

Multi-System Visibility

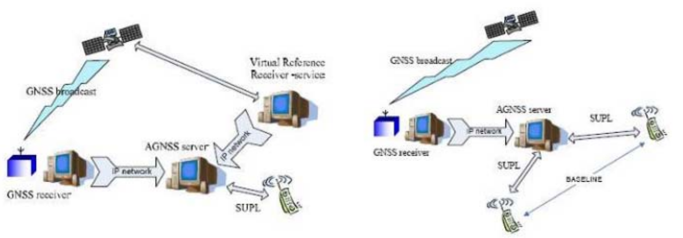


It is feasible that the Accuracy
of an unassisted Single Point Position
using 25+ Satellites
with dual frequency signals
will be at the several decimetre level
So "Sub-metre Day" is Coming…
…but when?

Constellations GPS, Galileo, Glonass, Compass, QZSS, WAAS, EGNOS, MSAS, GAGAN, IRNSS (Source Rizos, 2009)

Precise Positioning is coming to your Mobile Phone!

mobile-RTK : Two options



- Assistance data server has an interface to regional Virtual Reference Receiver - service
- Assistance data server works as a router
  - Establishes data connection between the two terminals

A-GNSS Phone sales will reach
400 Million per year by 2011

(Wirola, 2008)

NOKIA

FIG

New GNSS
mean
New Possibilities

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FIG

Interesting Aspects of Emerging GNSS

- Applications need new capabilities to bring new innovations;
- Japan's QZS ... may turn out to be ... signals;
- Galileo - S...
- China's C... hich is a simple but powerful e... ,000 messages in the wake of Sichuan Earthquake);

These and other new capabilities will enable a new wave of Innovation

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Evolution from Separate Systems to a true and integrated Infrastructure

Multi-GNSS as Broad Infrastructure

Underlying Systems	A broad definition of Infrastructure *"Hard and Soft Infrastructure"*
Capacity Building	
Research and Development	
Industry Development	
Institutional Arrangements	
Standards	
User Access	

From Local to Global

	Local	National/Regional	Global
Underlying Systems	➢Loc… tio… ➢C…	…mentations	➢Space Segment ➢Control Segment ➢Ground Segment
Capa…			➢International Conferences ➢Assist Developing Countries
			➢International Cooperation in R&D
Ind…			➢Conferences ➢Business Networks
		…g Local Activities	➢UN International Committee on GNSS ➢Bi-Lateral Agreements
S…		…ion ➢National Standards and Guidelines	➢International Standards ➢Global Activities ➢Data Formats
User Access	➢Local Communications Solutions	➢National Communications Networks	➢Civil Signals ➢Downlinks eg Galileo

Coordination Mechanisms are Crucial

ICG International Committee on Global Navigation Satellite Systems

Compatibility and Interoperability
Coordinating Geodetic and Timing References

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Increasingly Demanding Users

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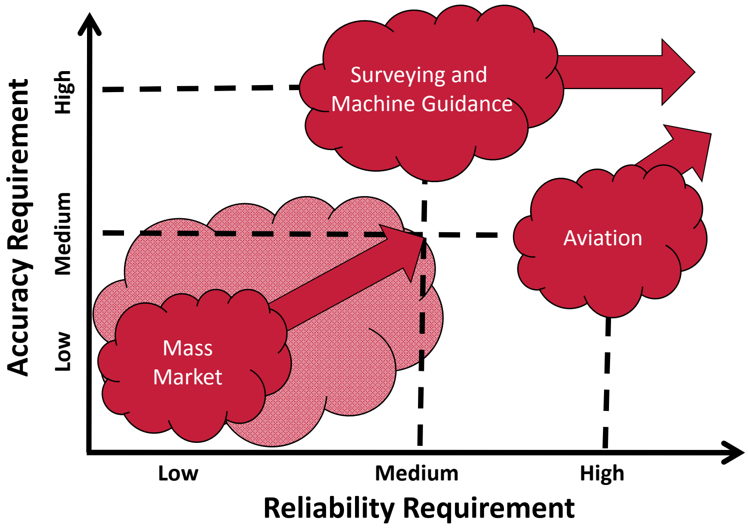
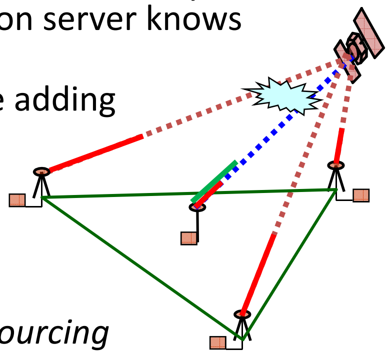
Increasingly Demanding Users



"Real Time" as the Next Wave of Enablement

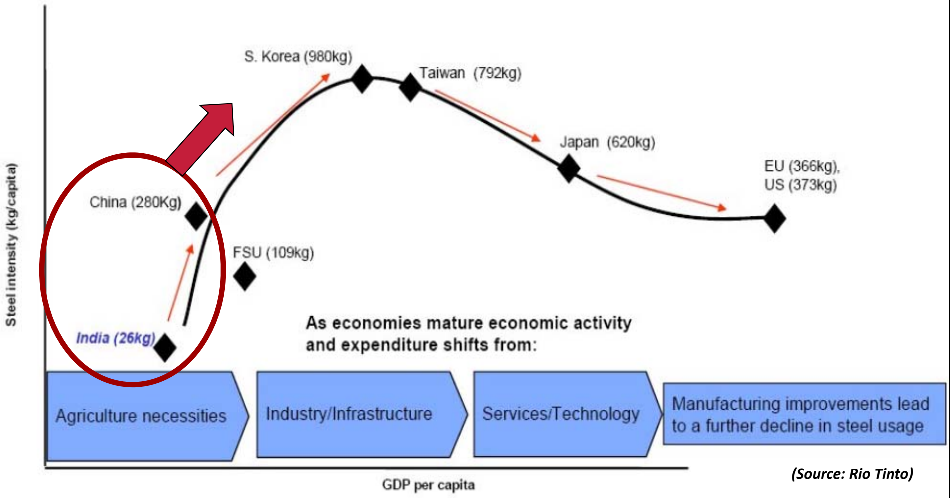
Knowing where users are in Real Time

- Precise Positioning typically involves two-way communications so the correction server knows where the users are;
- Enables possibility to send value adding information to the users that is tailored to their location;
- Enables monitoring of condition of the person/machine being positioned;
- Enables extension from *crowd sourcing* to “*crowd out-sourcing*”.



Current emphasis on Machine *Guidance* will evolve to Full *Automation*

GDP Growth vs Steel Demand



(Source: Rio Tinto)

Mining Automation

- Driverless trucks ferry their loads around the mine with the synchronized perfection of a ballet, reporting to the workshop as maintenance falls due or faults are predicted. The processor makes constant fine adjustments to itself to win more metal ... om the ever varying str... es do much of t...
- The a... since human... g exclude... nsconced in an urban mis... kilometres away, running the mine "... , scrutinizing its functions in minute detail from an avalanche of data, and tweaking them ever closer to the technical limits to win the edge in the fiercely competitive world of resources in the 2020s.

This Level of Automation Requires High Accuracy with Very High Reliability

(Source: Rio Tinto Review Sep 2007)

Positioning will become Truly Ubiquitous

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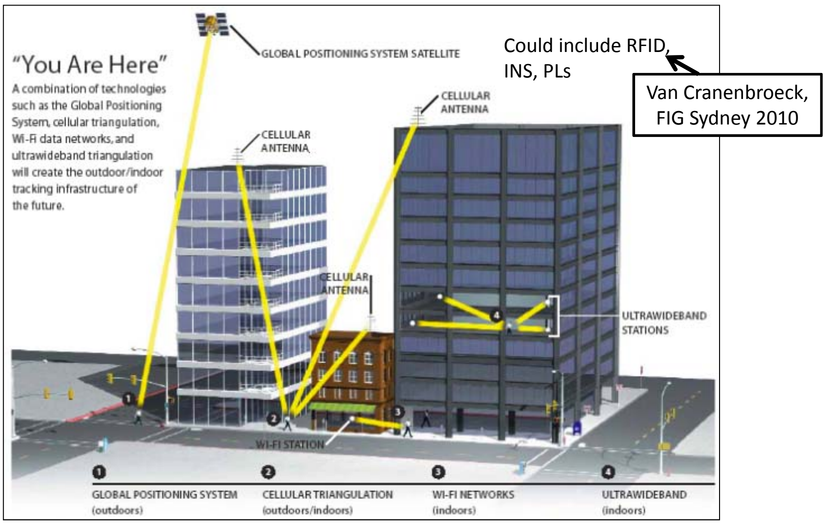
'Hot Zone' & Seamless/Ubiquitous Positioning Scenario



(Source Rizos, 2008)

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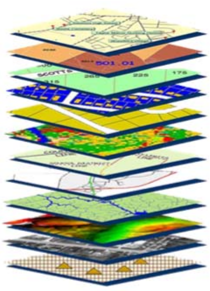
The relationship between Positioning Infrastructure and Spatial Data Infrastructure

Changing role of Spatial Data

- We used to use maps to find our position *and* context about our surroundings;
- Now people can position themselves directly so:
  - In many applications spatial data can be more about a *value-add* to a position;
  - Position and context are now *de-coupled* – some positioning applications don't even need context.

Positioning Infrastructure versus Spatial Data Infrastructure?



Infrastructure Item	Application/Content
Water	Drinking, Irrigation, Fire Fighting etc
Energy	Electrical Appliances
Internet	Web content
Positioning Infrastructure Spatial Data Infrastructure	Spatial Enablement

Summary

- Positioning Infrastructure based on GNSS and CORS has significant economic, environmental and societal benefits;
- Impacts to expect in our *"Technological Future"*:
  - From GPS to GNSS ~ sub-metre day is coming;
  - New possibilities from new GNSS;
  - Evolution to a true, integrated global infrastructure;
  - Increasingly demanding users;
  - Real time as the next wave of enablement;
  - From Machine Guidance to Full Automation;
  - Making positioning truly ubiquitous;
  - The changing relationship between Positioning Infrastructure and Spatial Data Infrastructure.

Thanks for your attention.

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