International Federation of Surveyors
Fédération Internationale des Géomètres
Internationale Vereinigung der Vermessungsingenieure

An Update on GNSS Issues from the International Federation of Surveyors

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Chair of Commission 5 on Positioning and Measurement
International Federation of Surveyors

Outline of Presentation

- ***Brief Outline of FIG***
- ***Global Issues and FIG***
- ***What FIG has done since last December***
- ***Issues for GNSS Surveyors from Future GNSS***
- ***Roles FIG Can Play***

What is FIG?

- ***Federation of national associations and is the only international body that represents all surveying disciplines***
- ***FIG was founded in 1878 in Paris***
- ***Recognised non government organisation (NGO) by UN***
- ***Over 110 countries represented in FIG***
- ***Over 250,000 Surveyors around the World in the Member Associations***

The FIG Commissions

1. *Professional Standards and Practice*
2. *Professional Education*
3. *Spatial Information Management*
4. *Hydrography*
5. *Positioning and Measurement*
6. *Engineering Surveys*
7. *Cadastre and Land Management*
8. *Spatial Planning and Development*
9. *Valuation and Real Estate Management*
10. *Construction Economics and Management*

Also Standards Network

I represent all 10 on FIG Council for 05/06

Commission 5 Working Groups

1. ***Standards, Quality Assurance and Calibration***
2. ***Reference Frame in Practice***
3. ***Integrated Positioning, Navigation and Mapping Systems***
4. ***Cost Effective Surveying Technology and Techniques for Developing Countries (Joint with Com 3 and 7)***

Com 5 also Administers MoU with International Association of Geodesy and UN Office for Outer Space Affairs

Global Issues and FIG

- ***United Nations Organizations***
  - ***Habitat (MoU with FIG)***
  - ***Food and Agriculture Organization (FAO) (MoU with FIG)***
  - ***Committees on Spatial Data Infrastructure, eg Permanent Committee Geographic Information Infrastructure for Asia Pacific***
  - ***UN OOSA (New MoU with FIG)***
- ***International Standards Organization***
  - ***ISO TC 211 – Geographic Information/Geomatics***
  - ***ISO TC 172 – Instruments – New Work Item on testing of GPS Surveying Instruments***

Progress in 2004 on UN Action Team Issues

Progress in 2004

- ***FIG Working Week in Athens in May 2004***
  - ***Takemi Chiku from UN OOSA gave a plenary session presentation.***
  - ***In Athens, Ms Chiku also met with FIG President, Director FIG Office and me. We agreed on wording of the draft MoU between FIG and UN OOSA.***
  - ***President of IAG presented in the same plenary session.***
- ***The MoU between FIG and OOSA was signed at UN OOSA on 13 December 2004***
  - ***Actions on GNSS (Coordination, Support to Action Team Projects and Education) and Disaster Management (Need to explore broader issues but GNSS User Guide is a potential immediate action)***

Progress in 2004

- ***In my Commission we have established the Commission 5 Sub Group 5.3.3 on "GNSS Developments and Modernization"***
- ***It sits Under Working Group 5.3 on Integrated Positioning, Navigation and Mapping Systems – Chaired by Dr. Naser El-Sheimy (Canada)***
- ***Our goal is to present surveying users with current information regarding the international efforts being made towards the development and improvement of GNSS (i.e. GPS, GLONASS, GALILEO, JRANS and others).***

Progress in 2004

- ***Sub-Group 5.3.3 Activities:***
  - ***Creation of a comprehensive database of researchers involved in GNSS development/modernization***
  - ***Exposure of current developments in the field***
  - ***Development of a repository of relevant reference materials (including links, publications and presentations) with particular emphasis on information needed by practitioners***
  - ***Provide a platform for the exchange of ideas and information between members and national delegates***
  - ***Provide a discussion forum for the potential benefits in practical applications of a modernized GPS constellation, multiple and integrated satellite systems (GPS, GLONASS, GALILEO, etc).***
- ***Input mechanism for FIG's Membership of ICG***

Progress in 2004

Sub-Group 5.3.3 Chair: Larry Hothem, USGS
Vice-chair: Georgia Fotopoulos, University of Calgary
Vice-chair: Robert S. Radovanovic, SARPI Ltd.

- *Chris Pikridas (Greece)*
- *Marcelo Santos (Canada)*
- *Naser El-Sheimy (Canada)*
- *Tomas Soler (USA)*
- *Joyo Agria Torres (Portugal)*
- *Martti Pietikäinen (Finland)*
- *Anna Jensen (Denmark)*
- *Paserio Samisoni (Fiji)*
- *Craig Roberts (Australia)*
- *Allison Kealey (Australia)*
- *Cedric Seynat (Australia)*
- *Kefei Zhang (Australia)*
- *Georgi Milev (Bulgaria)*
- *Keranka Vassileva (Bulgaria)*
- *William Martinez Diaz (Colombia)*
- *Luiz Paulo Souto Fortes (Brazil)*
- *Toya Nath Baral (Nepal)*
- *Ales Cepek (Czech Republic)*
- *Israel Kashani (USA)*
- *Pawel Wielgosz (USA)*
- *Joël van Cranenbroeck (Switzerland)*

FIG

Progress in 2004

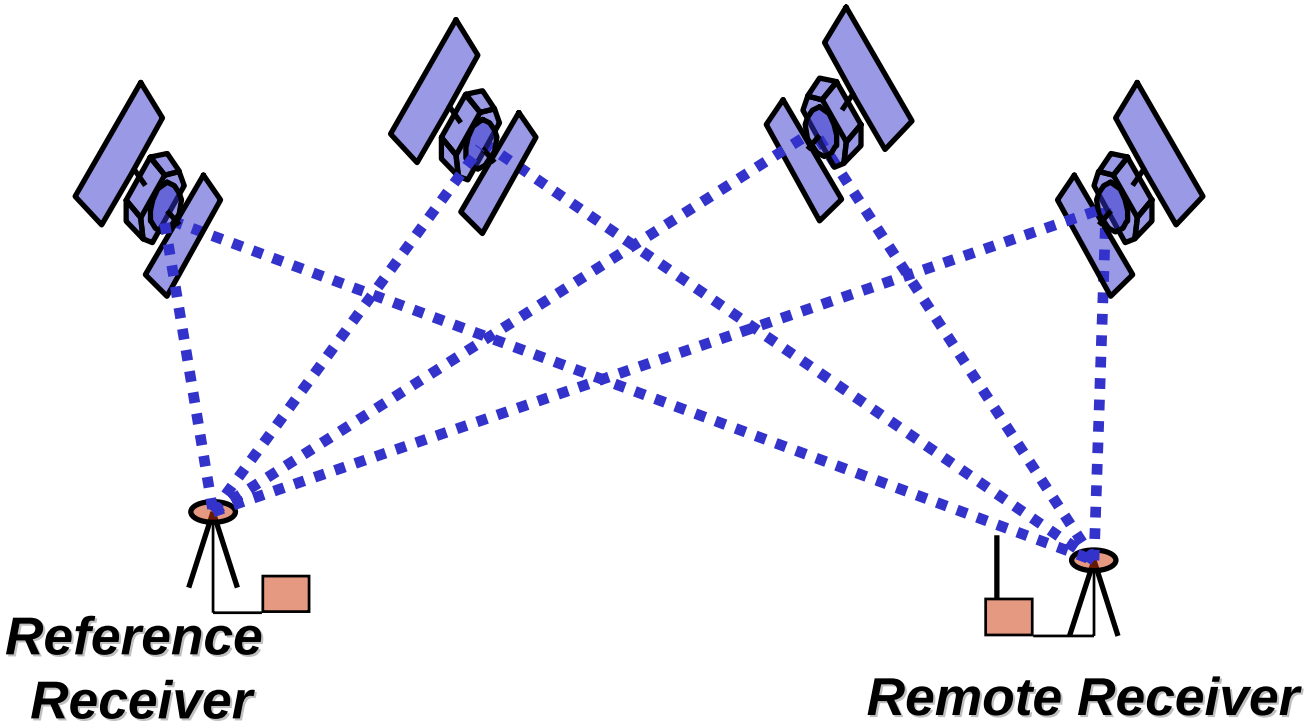
- ***Agreed with Chair of Commission 4 of the International Association of Geodesy (IAG) that once this FIG Sub-Group gathers momentum we will review the situation and see if it is worth making this a Joint Working Group between FIG and IAG***
- ***That possibility is also open to our other "Sister Associations" such as:***
  - ***International Cartographic Association or***
  - ***International Society of Photogrammetry and Remote Sensing***

GNSS Surveying

3 Levels of Accuracy from GNSS

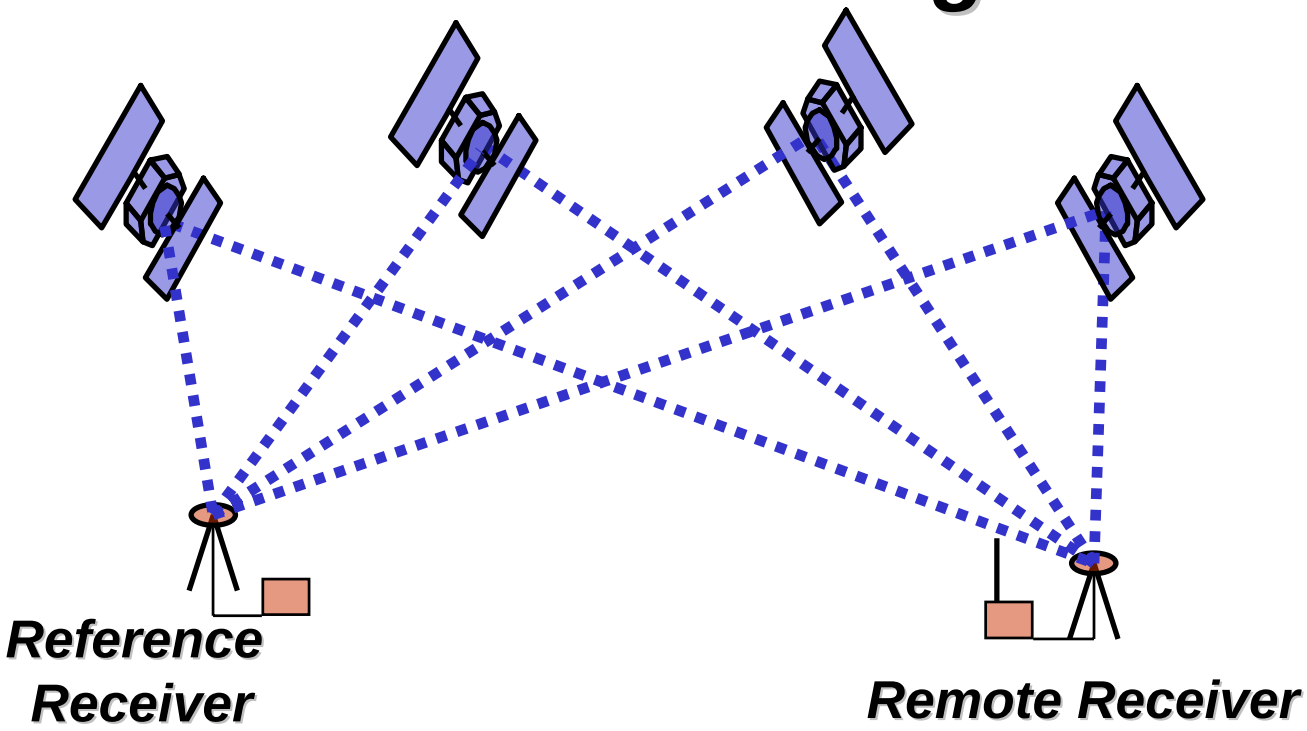
- *Single Point Positioning (metres)*
- *Differential Positioning (sub-metre)*
  - *Pseudorange Measurements*
- *GNSS Surveying (centimetre)*
  - *Carrier Phase Measurements*
  - *All of interest to FIG but this Presentation will concentrate on GNSS Surveying with Carrier Phase*

GNSS Surveying



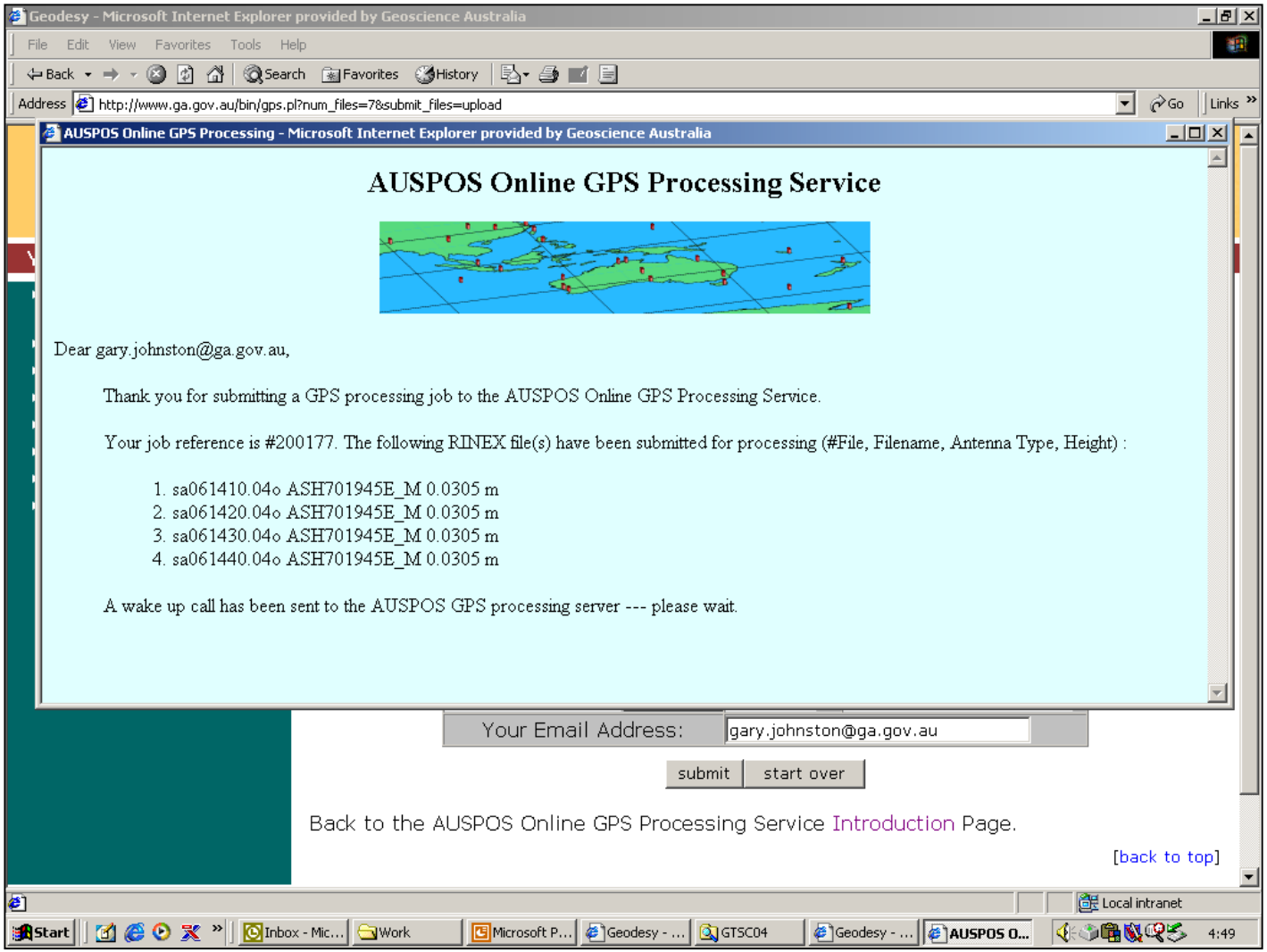
- 1985 – 4 satellites – 4 hours per day
- Observation period per new point several hours
- Data post processed

Improved Coverage, Equipment and Processing

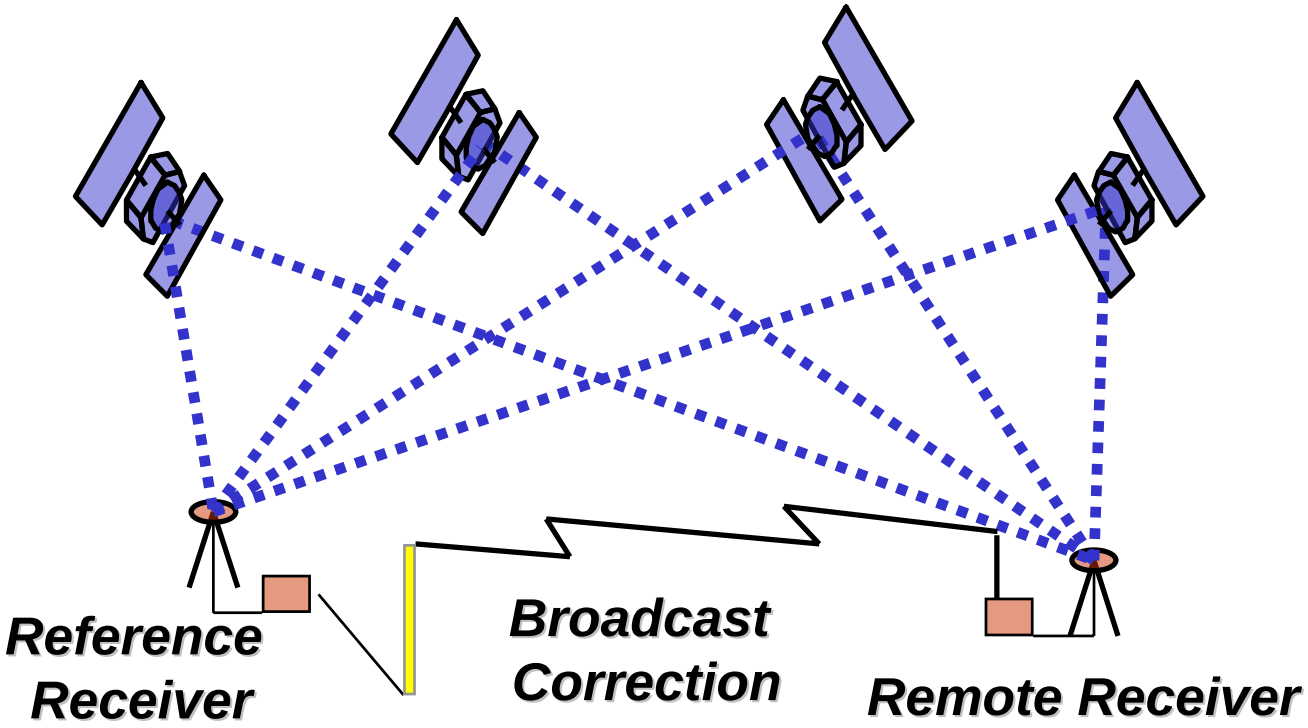


- Early 1990s - More satellites – 24 hour coverage
- Observation period per new point 10s of minutes
- Data post processed

AUSPOS Online GPS

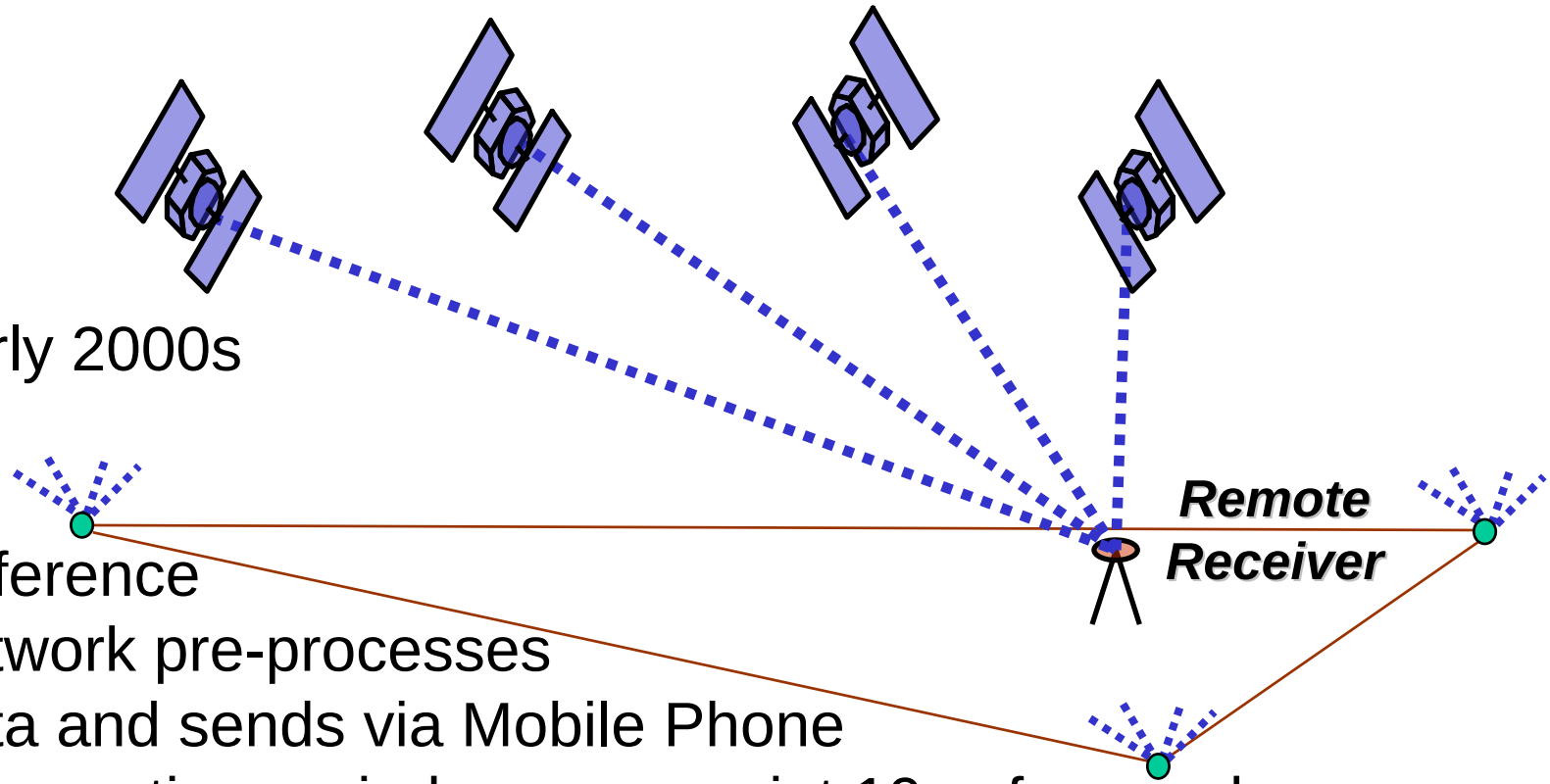


“Real Time” GNSS Surveying



- Mid-1990s – Reference Data via Radio – 5+ SVs
- Observation period per new point 10s of seconds
- Data post processed in “Real Time”
- Emergence of Receivers tracking Glonass

Networked Reference Stations



- Early 2000s
- Reference
  Network pre-processes
  Data and sends via Mobile Phone
- Observation period per new point 10s of seconds
- Data processed in Real Time
- Users work as though they are stand-alone
- Network is becoming Infrastructure

Networked Real Time Surveying

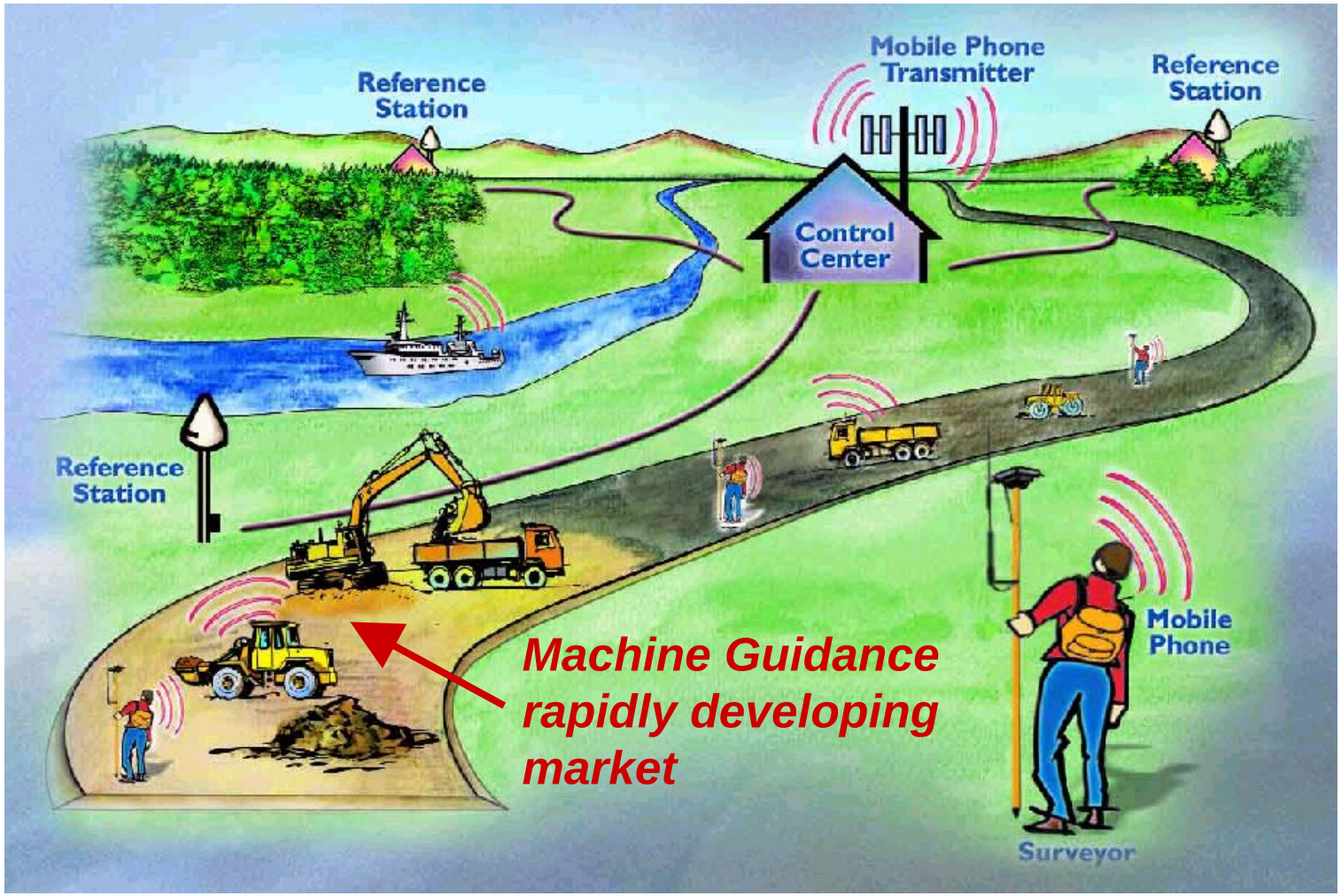
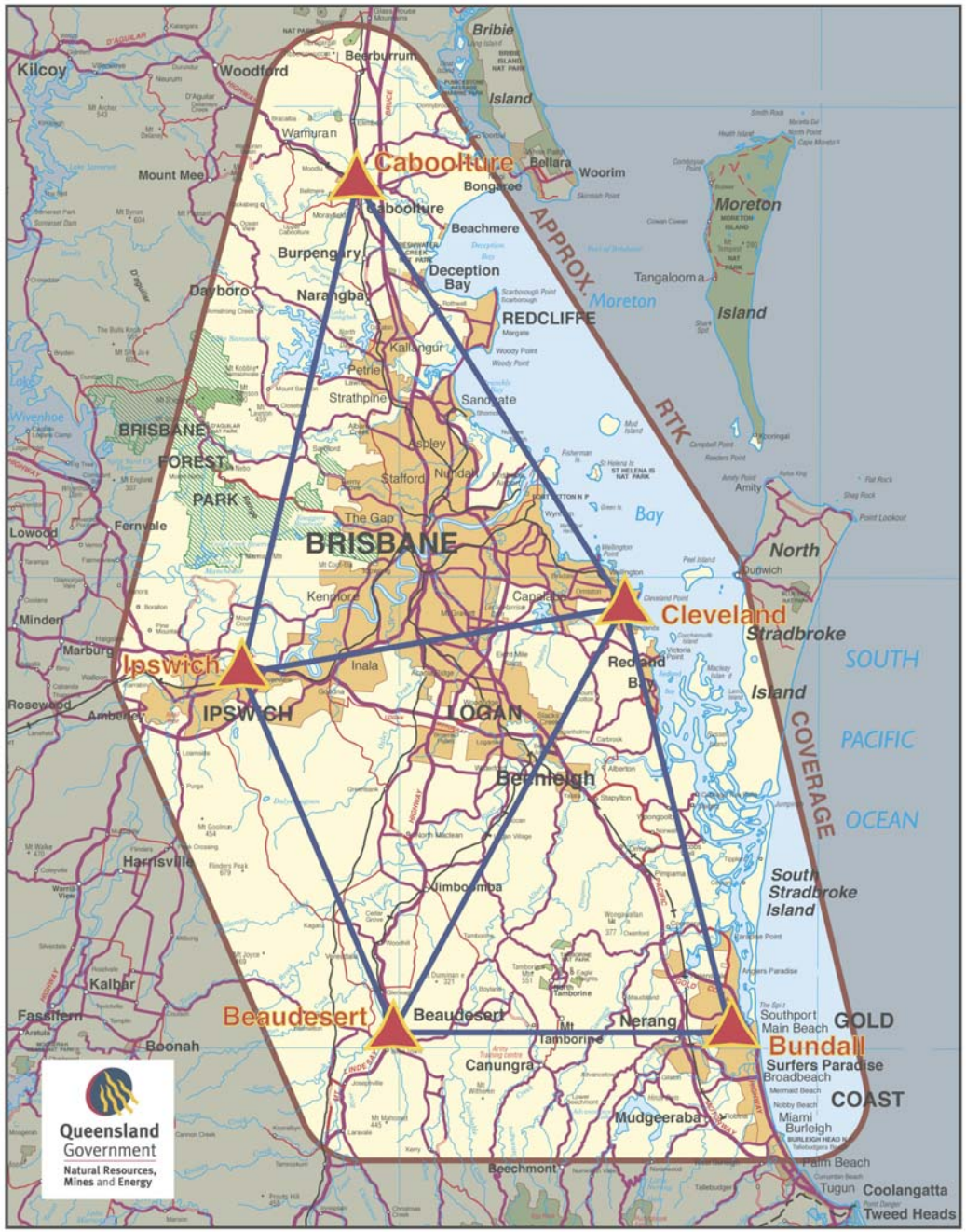


Diagram from Trimble Terrasat

Virtual Reference Station - Network Coverage



What Surveyors need from Future GNSS

Surveyors as GNSS Users

- ***Surveyors small numbers but high value;***
  - ***eg expensive equipment***
  - ***eg working on large infrastructure projects***
- ***Intelligent users at "top end" of accuracy, by squeezing high accuracy we learn a lot***
- ***We can use new capabilities sooner than say transport which tends to need global coverage before adoption***
- ***We are a glimpse of future users because many other users start with low accuracy and move to more accuracy***

Issues for GNSS Surveying

- ***Current techniques squeeze mm from least possible amount of data, in real time, using all satellites in view and multiple frequencies but need carrier phase***
- ***More Signals will give better redundancy, accuracy, efficiency and reliability (3 frequencies bring very quick initialisation)***
- ***More Satellites will mean applicability in areas where masking currently occurs, eg more application in urban canyon or in open cut mining***
- ***Coded Signals mean receivers will be less complicated than current codeless L2 GPS receivers and should be cheaper***
- ***Cheaper centimetre capable receivers will move current "survey" techniques more towards mass market applications***

FIG

Issue - Spectrum

- *It is a shame for centimetre applications that there are not 3 common carrier frequencies on both GPS and Galileo*
- *For Surveyors the question will be… Which approach delivers the most satellites with the most frequencies at the lowest cost?*
- *So to be controversial… If Galileo has a full constellation with 3 coded frequencies by 2010 (perhaps a big IF), and GPS is still on current schedule then it is possible that:*
  - *Instead of thinking of a GPS Receiver that also measures Galileo and GLONASS*
  - *Surveyors may be thinking of a Galileo Receiver that also measures GPS (L1, L2 C and L5 as they come on line) and GLONASS*
- *So it is possible that centimetre application will switch to a Galileo emphasis sooner than some people think*
- *BUT in reality it will be more "messy" than that*
  - *That will need good information and coordination - both ICG tasks*

FIG

Issue – Reference Frame

- ***Next generation GNSS will have an accuracy that requires plate tectonics to be considered:***
  - ***For example Geocentric Datum Australia was fixed at 1994.0 so we already have 0.7m vs ITRF 2000 at 2004 epoch***
  - ***This has prompted Omnistar (Commercial DGPS) to move their Australian "sub-metre" service from GDA94 to ITRF2000 and update at regular intervals (eg 6 monthly)***
- ***This will also be an issue for Galileo's planned 0.1m accuracy commercial service***
- ***FIG should work with IAG and its services (eg IERS) on this issue***

Issue - Augmentation

- *GNSS augmentation systems will become more dense for higher accuracy in certain regions*
- *More integrated with communication networks; particularly 3rd generation mobile phone systems*
- *Therefore, GNSS augmentation systems will be more transparent parts of general infrastructure*
- *It is noted that augmentations for GPS are typically supplied by a 3rd party*
- *With Galileo such augmentations can be built into its more open architecture*
- *All these points will increase the need for coordination - an important issue for ICG*

Roles
FIG Can Play

Surveyors, FIG and UN GNSS

- ***FIG is well placed to help with UN Action***
  - ***Committed to developing country issues***
  - ***National Delegates to many Commissions working in GNSS applications***
  - ***Can assist with implementing and publicising reports and road maps***
  - ***GNSS Education – FIG Database - over 240 institutes with 425 courses in 64 countries***
  - ***Working with IAG on Reference Frame matters and helping GNSS users understand technical and policy issues***
  - ***Agrees need for ICG***