Alternatives to GNSS Positioning

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GNSS is a positioning technology that has revolutionised navigation, surveying & geodesy...

Enhanced performance (accuracy, integrity, productivity, etc) when appropriate ground infrastructure is available to user...

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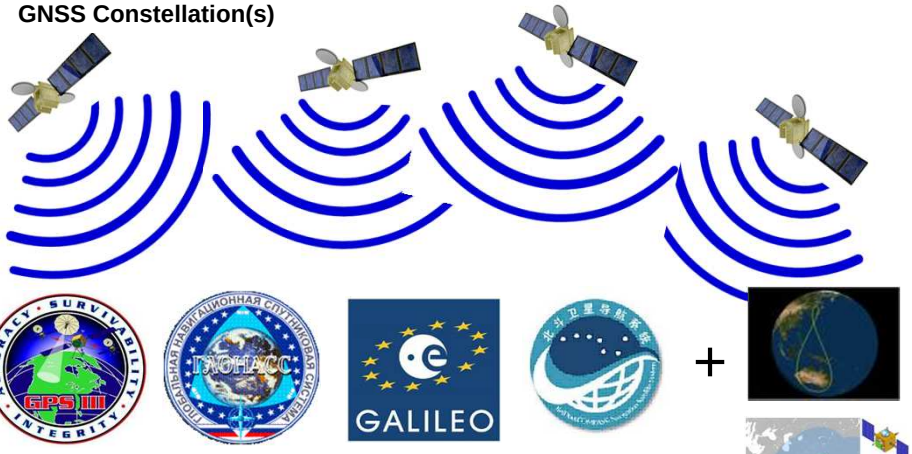
Signal Providers' Infrastructure...

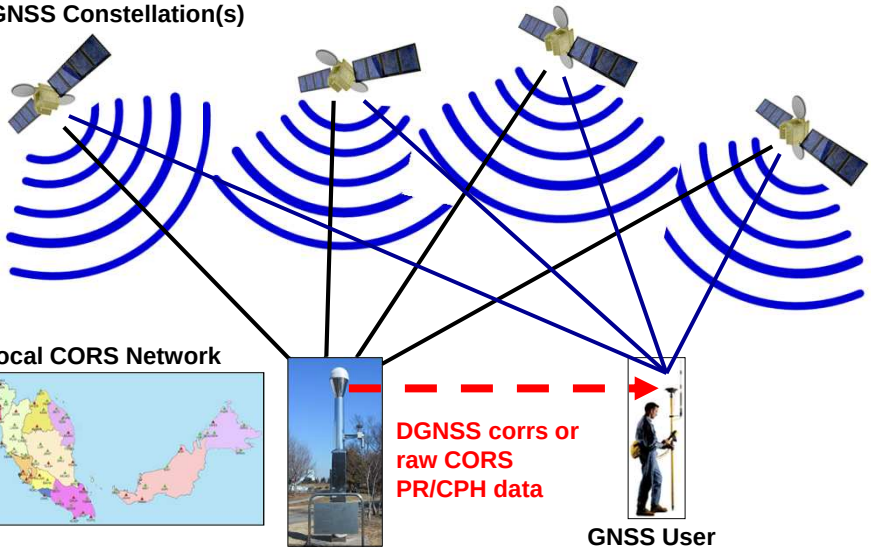
GNSS Constellation(s)



UNSW

Service Providers' Infrastructure for DGNSS...

GNSS Constellation(s)



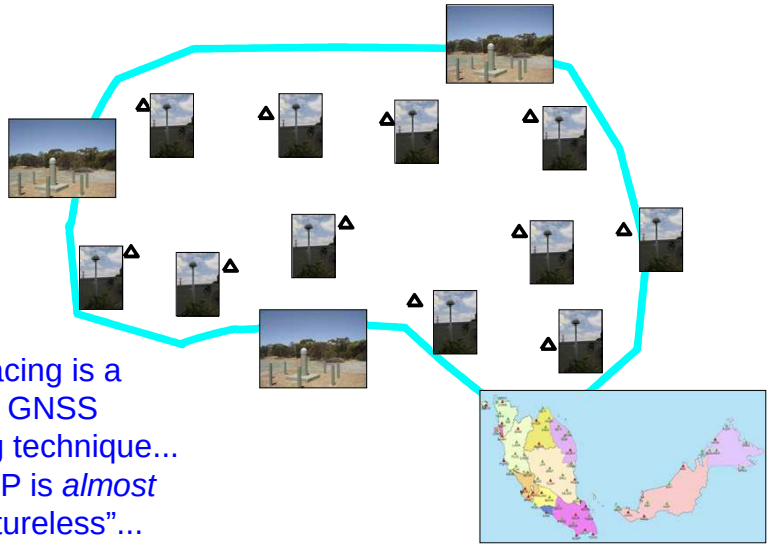
Local CORS Network

DGNSS corrs or raw CORS PR/CPH data

GNSS User

UNSW

Service Providers' Infrastructure for DGNSS...



CORS spacing is a function of GNSS positioning technique... though PPP is *almost* "infrastructureless"...

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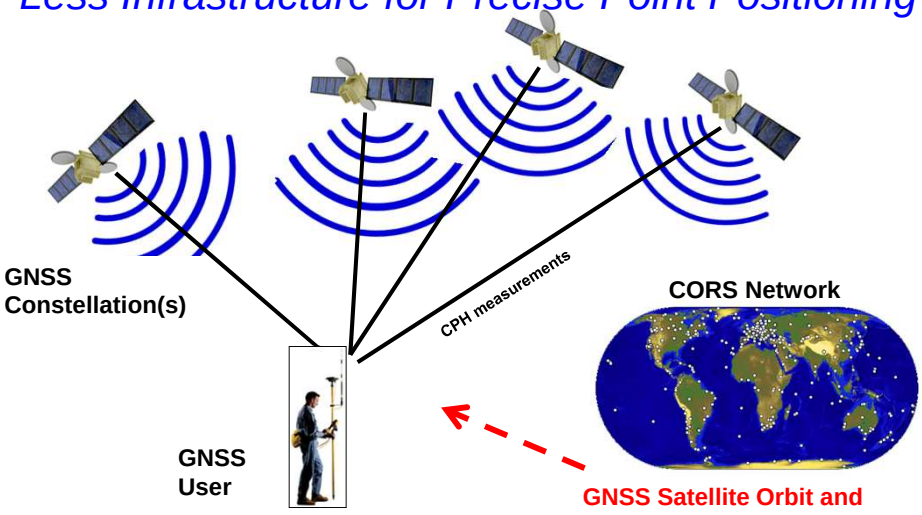
Less Infrastructure for Precise Point Positioning



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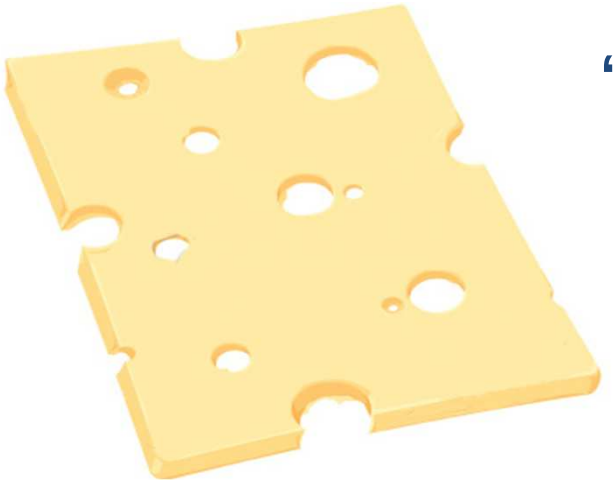
GNSS is an incredibly versatile positioning technology...able to address a very broad range of PNT applications...*but it has some limitations*

It cannot be relied upon in environments where signals are blocked, weak, degraded, jammed or spoofed



"GNSS is like Swiss cheese…

… it's full of holes"

Nunzio Gambale

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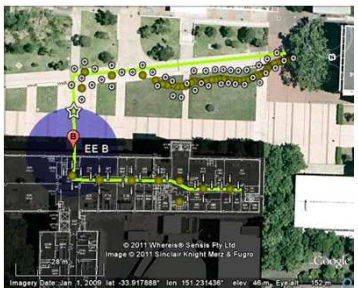
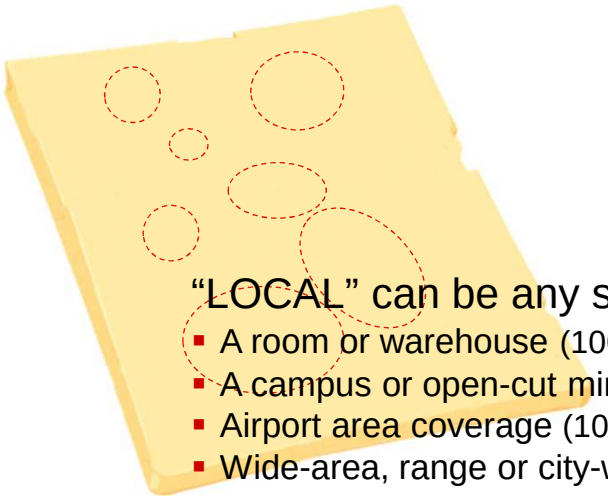


GNSS signals are attenuated indoors... blocked in urban environments, open cut mines, underground, in tunnels, steep terrain, etc…

- There is no shortage of non-GNSS engineering options...
- Some technological choices: (1) use "signals-of-opportunity", (2) dedicated ranging systems, or (3) non-signal options (inertial, geomagnetics)...
- Possible accuracy, coverage area, nature & cost of infrastructure and user equipment, *varies greatly*...
- However, signal-based options have similar issues because they all are *terrestrial systems*

Ideally want local solutions…that fill the "holes"



"LOCAL" can be any size:

- A room or warehouse (100's mtrs^2)
- A campus or open-cut mine (<10's km^2)
- Airport area coverage (100's km^2)
- Wide-area, range or city-wide (1,000's km^2)

Terrestrial solutions = Local solutions

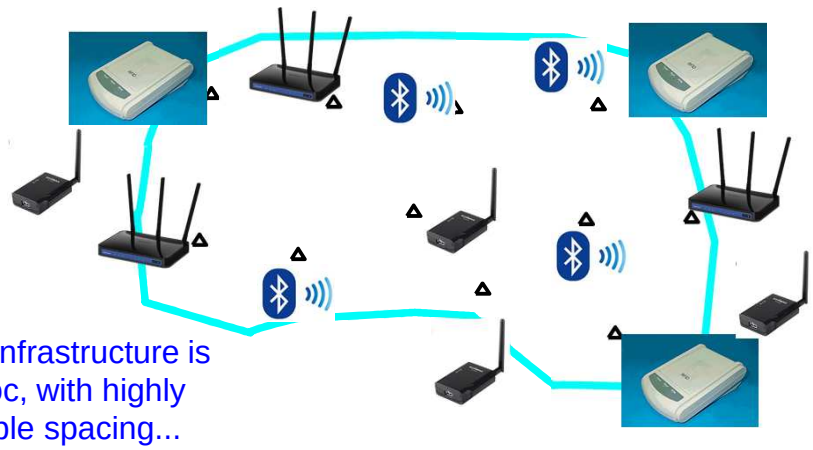
Pros

- *Local* control... *governance, sovereignty, etc*.
- Customisable technical characteristics... *frequencies, power, signals, etc*.
- Identifiable user community... *receiver devices*
- Quality of Service is "tunable"
- Scalable transmitter deployment... *how "local"?*
- Secure... *encryption, closed systems, robust, etc*.

Cons

- Expensive options... *vis-a-vis GNSS*
- Need user, operator, & manufacturer "ecosystem"... *many technical options*
- Variable conditions... *geometry, signal strengths, etc.*
- Poor vertical positioning
- Infrastructure deployment may be too expensive... *hence geographically constrained solutions*

Routers, APs, Reader, etc, Infrastructure...



This infrastructure is ad hoc, with highly variable spacing... but these should be mapped...

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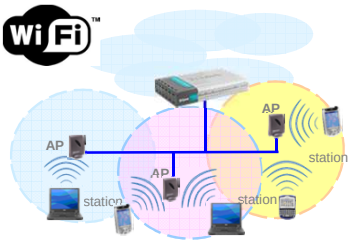


WiFi ubiquity...

WiFi is globally available in urban environments, it is reliable (though inconsistent), with no barriers to deployment…

- "Signals-of-opportunity" option... *ubiquitous AP/cell infrastructure*
- Proximity/cellID or RSS "finger-printing" techniques... *commercial solutions address smartphone location market*
- Accuracies from few metres to >50m... *depending on wireless communications "granularity" & (RF) environmental factors*
- Mobile comp/comm devices are all WiFi-capable
- *Current "best efforts" solution...*

Ad hoc solutions based on wireless comms…

plugging the holes...

...using "signals-of-opportunity"...*trading consistency for availability*

GNSS-like performance everywhere, using dedicated user equipment, where signal transmission infrastructure has been deployed…

Terrestrial Ranging Systems

- Dedicated terrestrial signal systems... *GNSS-like performance*
- Total control over transmit freqs, signal power, signal structure...
- Transmitters established where required... *"hotspot" coverage*
- Initially not for mass market... *eLoran is promoted as GNSS "back-up"*
- Pioneering applications, *e.g. logistics, emergency services, indoor mapping, mines, robotics*...
- Many systems have been developed... *some being commercialised*

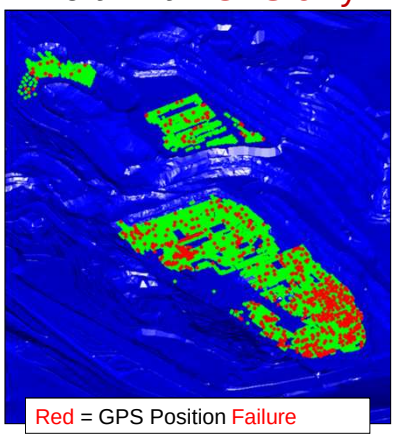
Consider high accuracy & availability positioning...
i.e. high performance positioning for non-mass market applications, for which "patchwork" solutions are unsuitable...
Example *Locata* technology... (there are others that we need to monitor)

GNSS+Locata...open-cut mining application

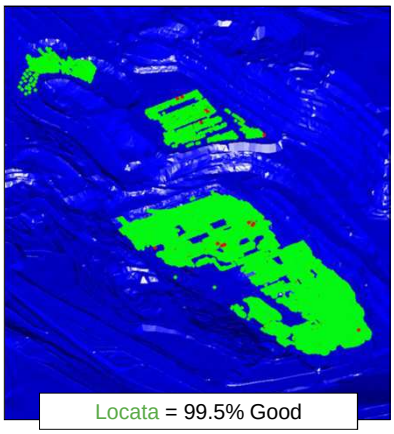
- First commercial Leica GNSS+Locata equipment & infrastructure installation for mining
- Located 140kms south of Perth (Western Australia)
- Consists of two Pits, North and South Pit -- South Pit is now about 300m deep, going to over 850m

Drill Performance – Typical availability over 1 week

North Pit – GPS only



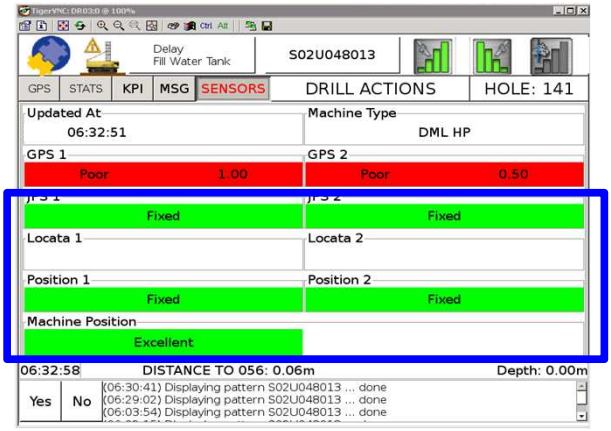
North Pit – With Locata



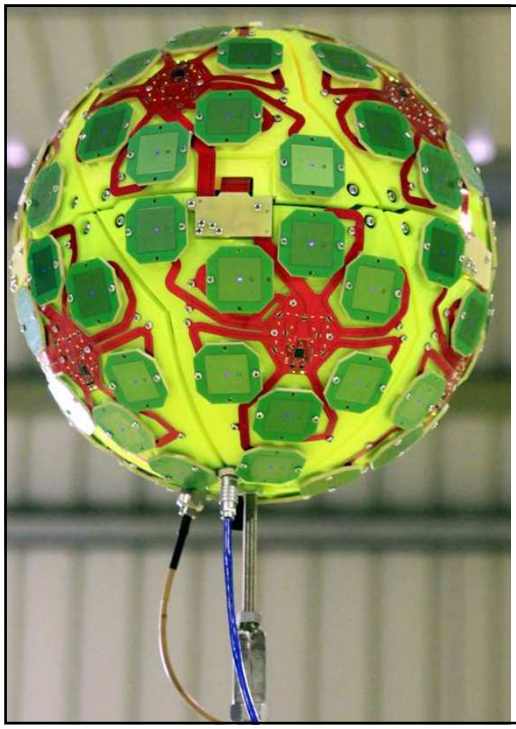
Locata

Locata

During Recent GLONASS Failure…



- GLONASS failure made all GPS-RTK fail
- All GPS receivers have “no position” (red)
- Locata (JPS) still delivers “fixed RTK” cm-accurate positioning (green)
- Machine position: Excellent



Going Indoors... addressing multipath

- Takes advantage of *Locata’s* signal structure and time synchronisation
- Dynamically tracks *only* direct line-of-sight ranging signals
- New ORB-80 3D design
- Tests being conducted mid-2014

Data collection: At different indoor points

Non-GNSS positioning technologies can not simultaneously satisfy user requirements *that GNSS can*...
such as *low cost*, *low complexity*, *minimal infrastructure*, *wide coverage*, *good accuracy*, *low latency*, *high reliability*, *high versatility*...
But they may still be of value... GNSS vulnerability is a new driver for non-GNSS backups

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