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Long term performance analysis of a new ground-transceiver positioning network (*LocataNet*) for structural deformation monitoring applications

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Outline

- Introduction
- Positioning concept of the *Locata* technology
- Current system design
- Simulated structural monitoring tests at UNSW
- Concluding remarks

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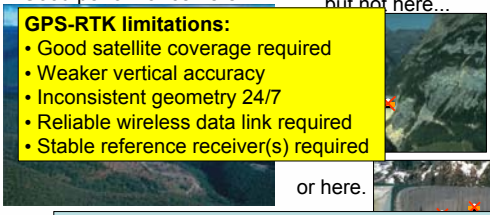
RTK GPS & structural monitoring

Good performance here...

but not here...

GPS-RTK limitations:
- Good satellite coverage required
- Weaker vertical accuracy
- Inconsistent geometry 24/7
- Reliable wireless data link required
- Stable reference receiver(s) required



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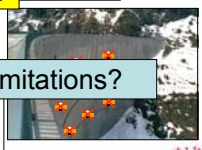

GPS is How to overcome these limitations?

engineering geodesy applications …

RTK systems are very popular

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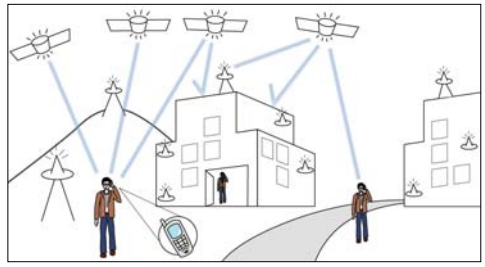
Locata positioning concept 1/3



Deploy ground based transceivers (*LocataLites*)

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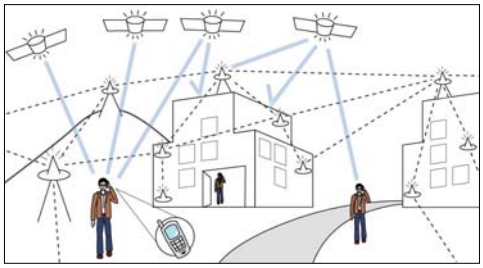
Locata positioning concept 2/3



LocataLites self-survey* to form a time-synchronised positioning network – *LocataNet*

**Under development*

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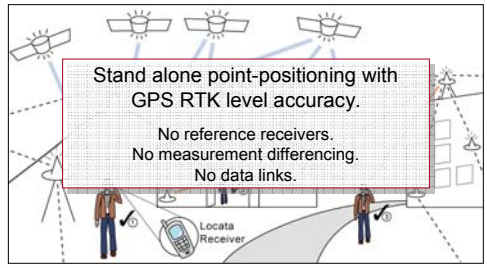
Locata positioning concept 3/3



Locata receiver can use signals from *LocataNet* and GPS*.
Once a *LocataNet* is established it can operate independently of GPS (all tests to date).

*Under development

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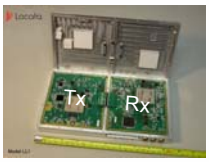
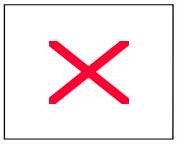
Current system

- Signal structure
  - Free ISM frequency band (2.4GHz)
  - Dual-frequency carrier (SF at present)
  - Proprietary CDMA PRN code (10MHz)
  - Precise TDMA pulsing - *for near-far*
  - Up to 1 watt output power - *range of over 10km line-of-sight*
- *LocataLite (LocLite)*
  - Time-synchronised transceiver
  - Dual Tx – *for multipath signal fading*
  - Modular board design using FPGA & DDS technology - *design upgrade through compact flash*
  - Uses cheap clock (TCXO) which is shared by receiver section
- *Locata* receiver
  - Carrier phase single point-positioning algorithm
  - Initialisation via external position (OTF to come with dual-frequency)
  - Positioning at 10Hz on-board





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News 2005-2007

- Sept. 05: first results of 2.4GHz system - *presented at ION-GNSS 2005*
- April 06: dual transmitter concept introduced as solution for severe multipath signal fading – a *dual Tx* antenna system gives 5 times smaller maximum DOP values over *single Tx antenna system* - *presented at PLANS 2006*
- July 06: Leica Geosystems and Locata Corporation sign co-op agreement to develop and distribute Locata-enabled products for certain markets - *see Leica Geosystems website*
- Leica is the first company to announce the development of an integrated GPS/Locata receiver
- Oct. 06: first tests in open pit mine environment
- Jan. 07: UNSW starts testing suitability of *Locata* for structural monitoring

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Preliminary structural monitoring evaluation at UNSW

- *UNSW LocataNet*
  - Small network established over hundreds of metres
  - Initial performance evaluation study of the Locata system for structural deformation monitoring applications
- Test overview
  - *LocataNet* of 10 dual Tx *LocataLites* (20 signals)
  - Network situated on roof-top buildings around UNSW campus
  - Static long term stability test (13.5 hours)
  - Simulated structural deformation test

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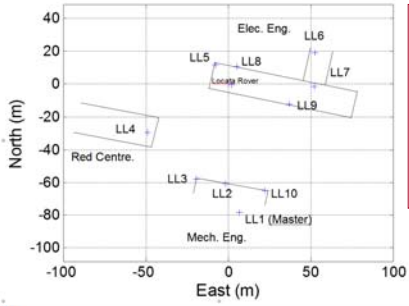
UNSW *LocataNet* configuration



- *LocataLites*
  Mounted on poles on roof-tops

  Tx antennas surveyed using GPS and TPS.
- *LocataNet*
  All *LocataLites* time-synchronised to LL1

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Typical *LocataLite* installation

Locata receiver antenna setup for static test

Moderate multipath environment

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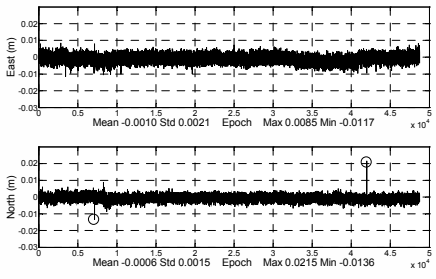
Static test East-North error



- 13.5 hour test
- 2Hz epoch-by-epoch position solutions
- No filtering or smoothing
- Consistent positioning sub-cm precision

  EDOP 0.55
  NDOP 0.53
- Occasional outlier

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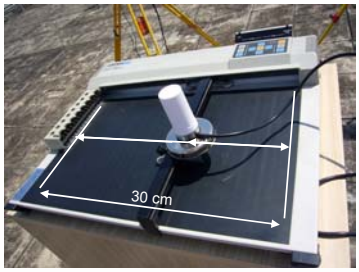
Simulated structural deformation test



- Plotter table used
- *Locata* receiver antenna moved in 1cm increments East-West
- Antenna stationary for 1 minute between moves
- 2Hz epoch-by-epoch solution
- Test continued out for 2.5 hours (repeated many times)

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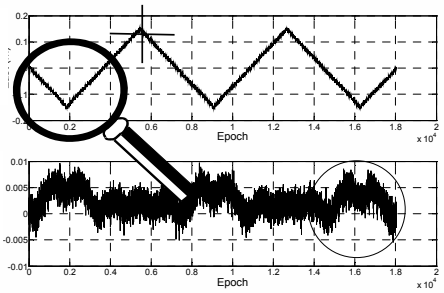
East-North time series



Possible multipath signature…
Calibration possible?

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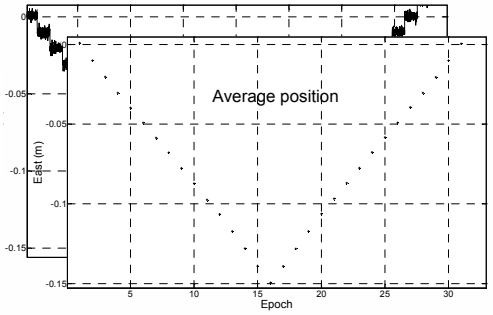
East series for first 30 moves



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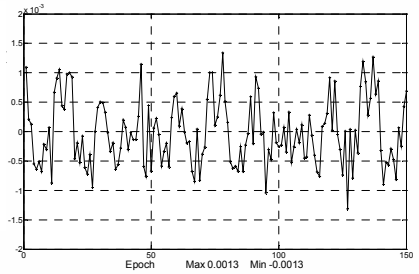
Error in 1cm movement

Mean position used to compute distance travelled and compared with 1cm.



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Concluding remarks

- *Locata* & Leica Geosystems
  - Collaborating to develop products in open pit mining and structural deformation monitoring markets
- UNSW preliminary evaluation of *Locata* for structural monitoring
  - Test conducted in moderate multipath environment
  - Sub-cm precision achieved
  - Promising long term stability, but need integrity improvements
  - Tests over small network, so insignificant tropospheric effects
- What next?
  - Testing in more 'real-world' environments with greater distances – *significant tropospheric effects*
  - Research focussed on improved modelling and algorithms

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Thank you

http://www.gmat.unsw.edu.au/snap/about/publications_year.htm

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