Joint KSGPC-UNSW Seminar on Geomatics, 15 February 2005, Sydney, Australia

Next Generation Pseudolite Positioning Technology

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Locata D Small, G Voigt, N Gambale, J Lamance

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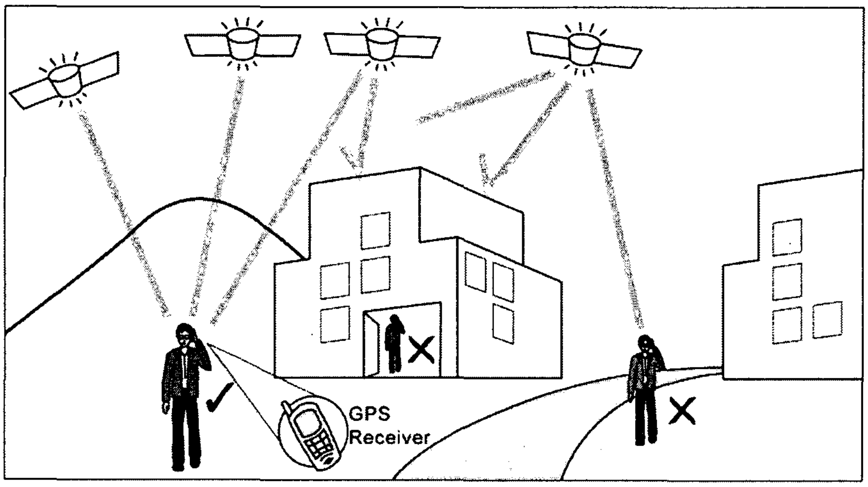
Outline

- Introduction
- Positioning concept of the *Locata* technology
- Prototype hardware
- Proof-of-concept trials & conclusions
- Next generation technology
- Concluding remarks

Positioning problem with GPS



Possible Solutions?

High-sensitivity GPS

Try to use very weak attenuated GPS signals.

Specialised GPS receiver hardware/firmware.

'Assistance' data (e.g. ephemeris) often necessary via mobile-phone network.

Limited building penetration.

Accuracies tens-hundreds of metres at best.

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Possible Solutions?

High-sensitivity GPS

Use signals not designed for positioning

Examples: Mobile phone signals, Television.

Transmitters synchronisation poor (100 nanoseconds) or not at all.

May require base stations to compute timing corrections - passed on to user receiver.

Typically 'weak' geometry.

Accuracies typically 50-hundreds of metres.

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Possible Solutions?

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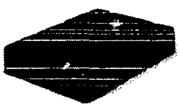
Pseudolites



Transmit GPS-like signals.

Considerable research at UNSW since 1999.

Potential for high accuracy (cm-level).

Cannot be tracked by all GPS receivers.

No synchronisation or poor.

Base station and differential data link required - like RTK GPS.

Near-constellation issues.

Frequency licensing issues.

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Possible Solutions?

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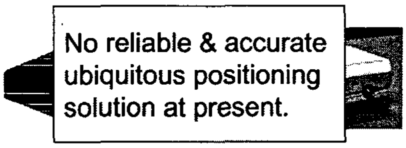

No reliable & accurate ubiquitous positioning solution at present.

- Transmit GPS-like signals.
- Considerable research at UNSW since 1999.
- Potential for high accuracy (cm-level).
- Cannot be tracked by all GPS receivers.
- No synchronisation or poor.
- Base station and differential data link required - like RTK GPS.
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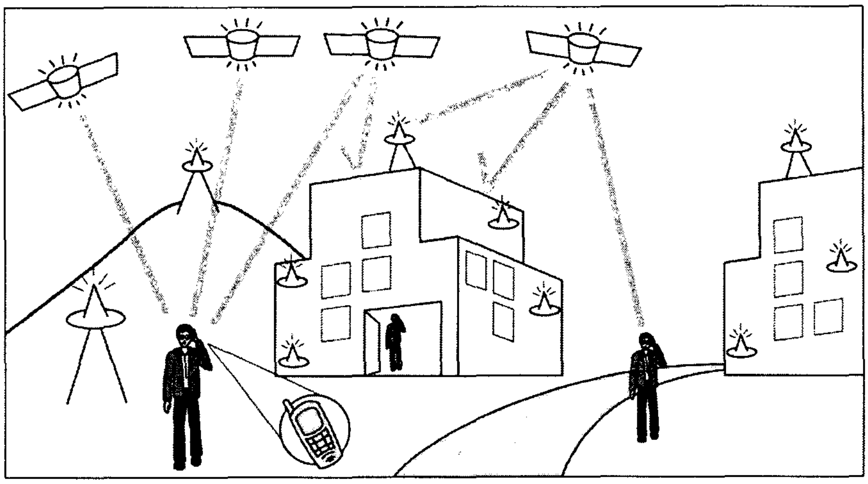
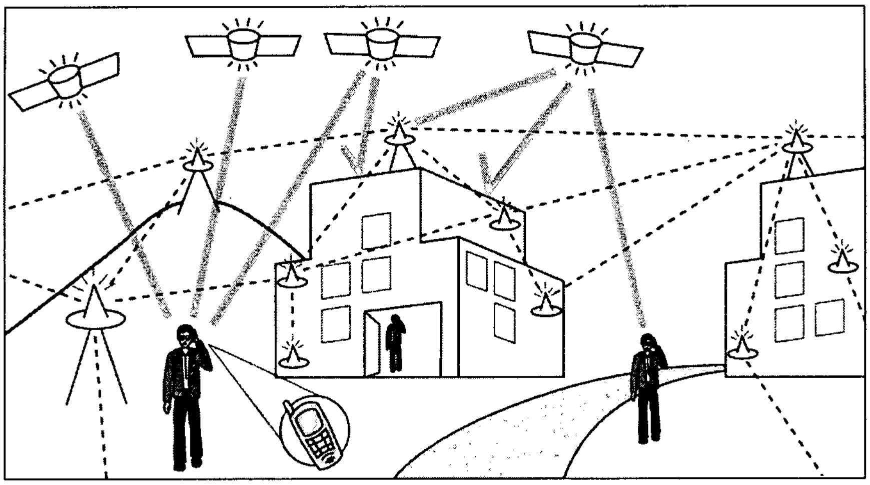
Locata positioning concept 1/3



Deploy ground based transceivers (*LocataLites)*

Locata positioning concept 2/3



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

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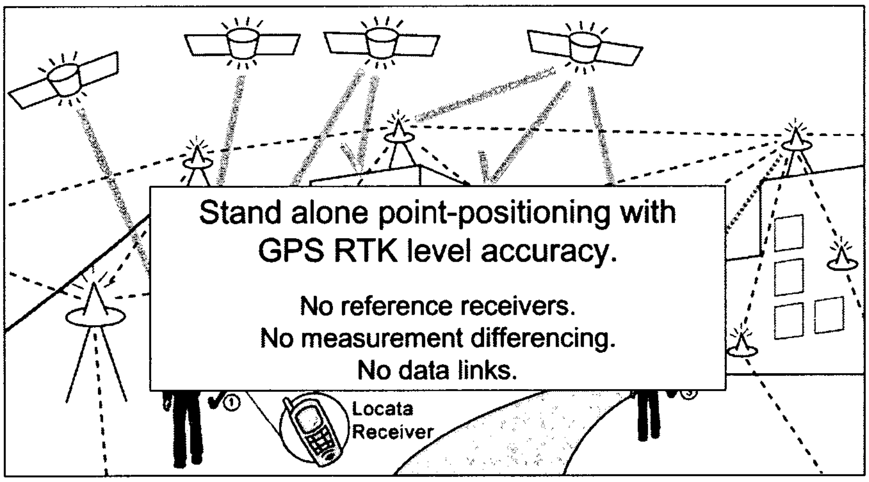
Locata positioning concept 3/3



Locata receiver can use signals from *LocataNet* and GPS.
Once a *LocataNet* is established it can operate independently of GPS.

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Prototype *Locata* technology

LocataLite:

- Intellig
- Transi
  code.
- Cheap
  shared by receiver section.

Locata receiver:

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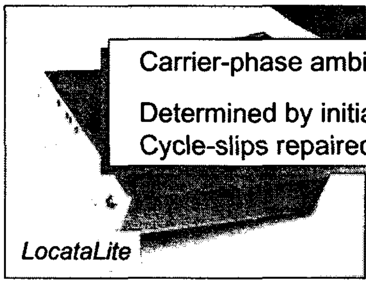
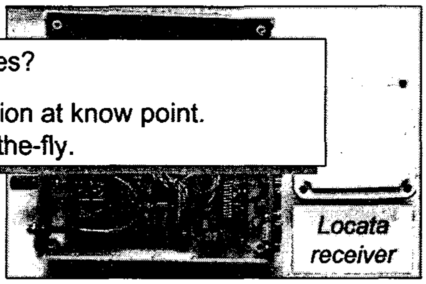
- Carrier phase single point-positioning algorithm.

How accurate must *LocataLites* time synchronise for cm-level positioning?

1 nanosecond error = 30 cm!

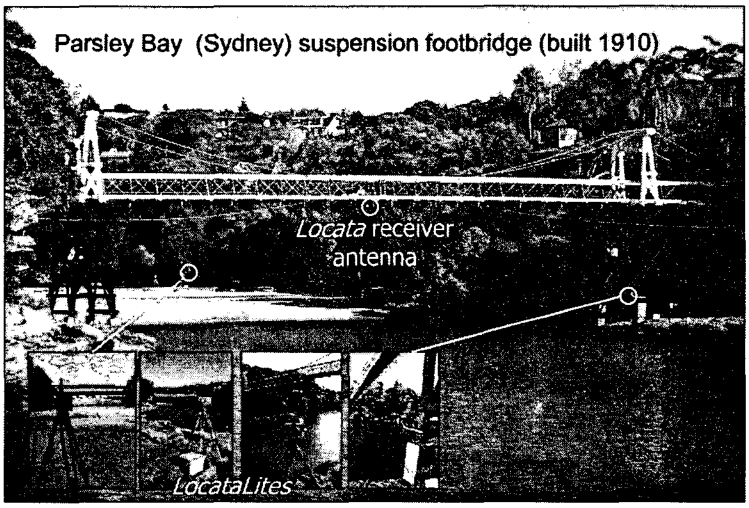




Carrier-phase ambiguities?

Determined by initialisation at know point.
Cycle-slips repaired on-the-fly.

Trial 1: Structural Deformation Monitoring (outdoor line-of-sight, 05/04)



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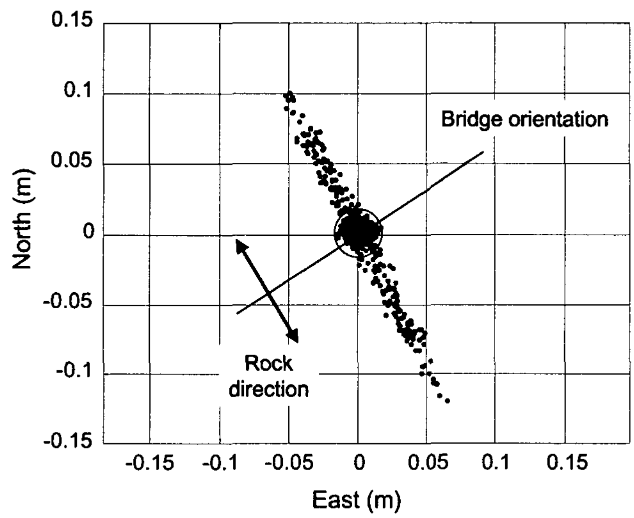

1Hz point positioning

~1 hour data

Induced movement

'Static' standard dev.
East 0.004m
North 0.003m

(EDOP 0.9, NDOP 0.7)

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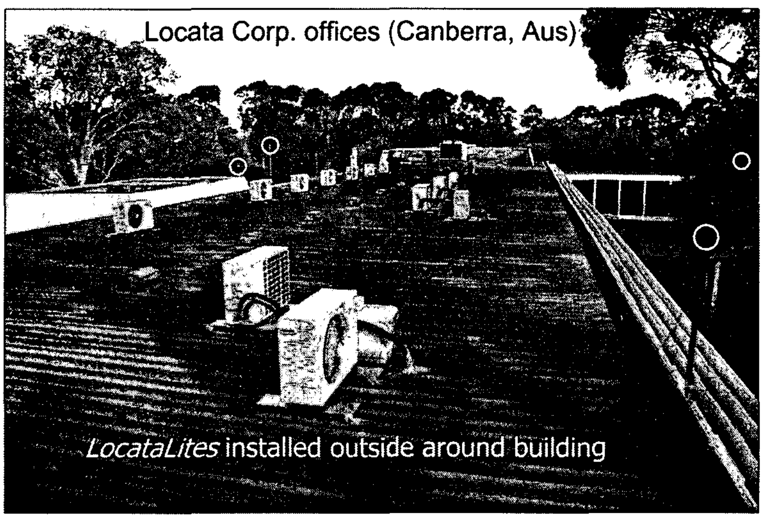
Trial 2: Indoor Tracking (non line-of-sight, 12/02)



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Trial 2: Indoor Tracking (non line-of-sight, 12/02)

No direct line-of-sight to any *LocataLites* in office corridor.

Signals penetrate metal roof and several brick walls.

1Hz point positioning.

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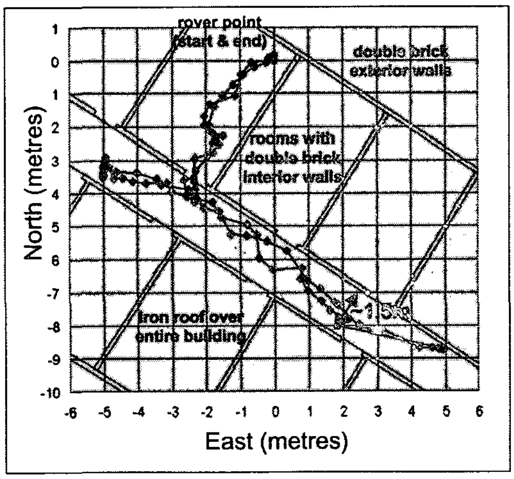

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1Hz point positioning.

Accuracy < 1m

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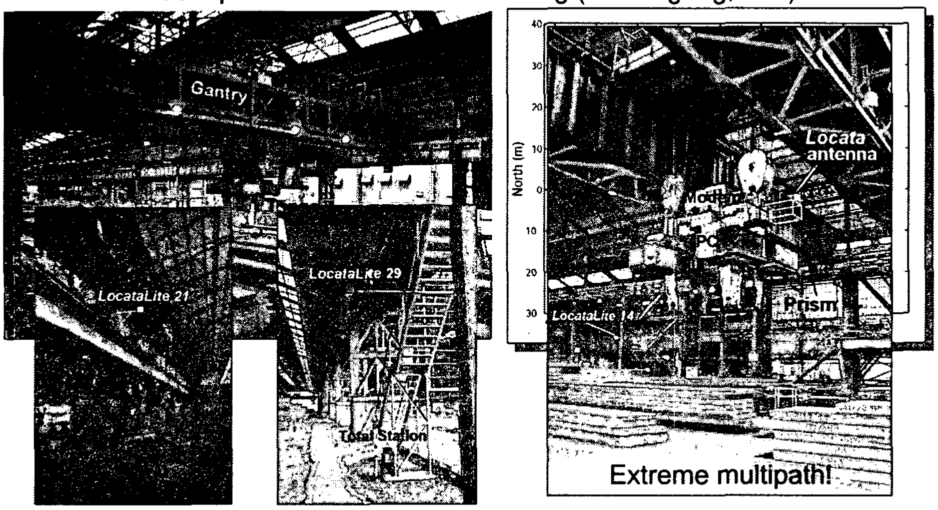
Trial 3: Industrial Machine Guidance (Indoor line-of-sight, 04/04)

BlueScope Steel works crane tracking (Wollongong, Aus)



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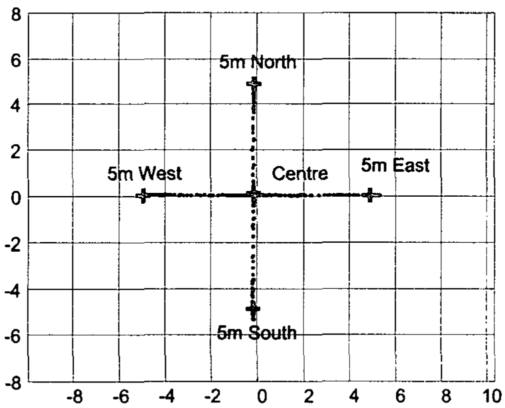

Crane tongs moved to 9 known points (measured with total station).

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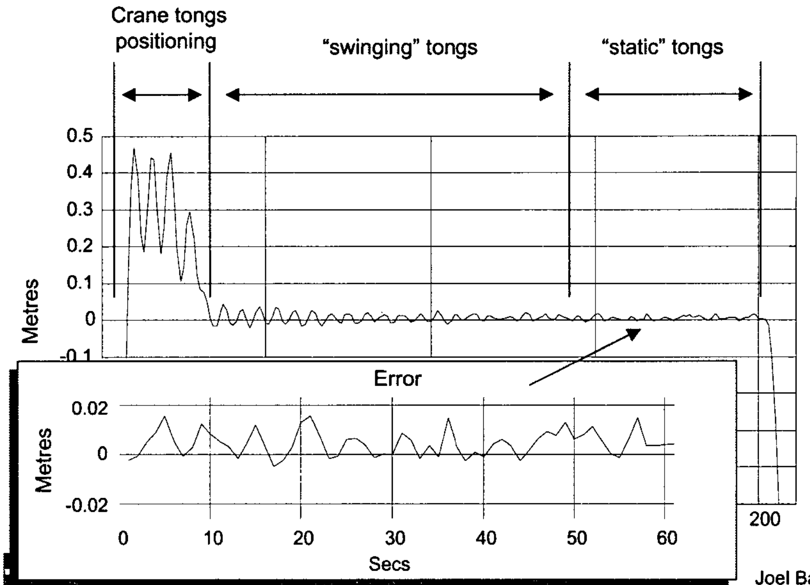
Crane move east: Easting distance from known point



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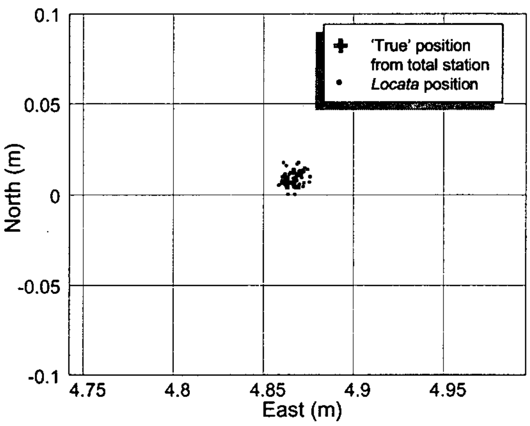

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Accuracy -
Mean position < 1.8 cm error

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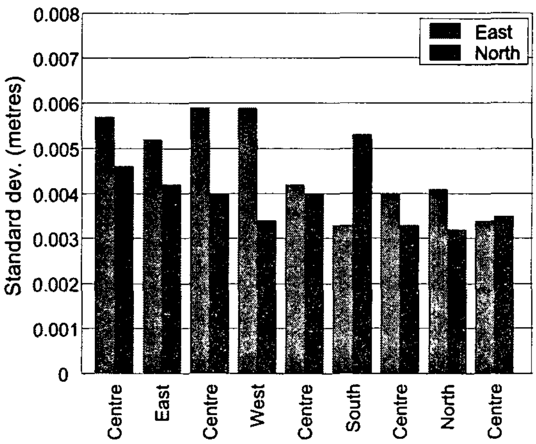

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Accuracy -
Mean position < 1.8 cm error

Precision -
Standard deviation <0.6 cm

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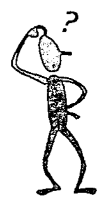
Summary of Trials

- Proof-of-concept:
  - Time synchronous positioning network.
  - Single point positioning with RTK GPS level accuracy.
  - Propagation of *LocataNet*.
  - Positioning with non-direct signals.
  - Suitability in a number of application areas.

- But...issues with
  - OTF carrier phase ambiguity resolution.
  - Multipath.
  - Transmitter range and penetration.
  - Interoperability with GPS.



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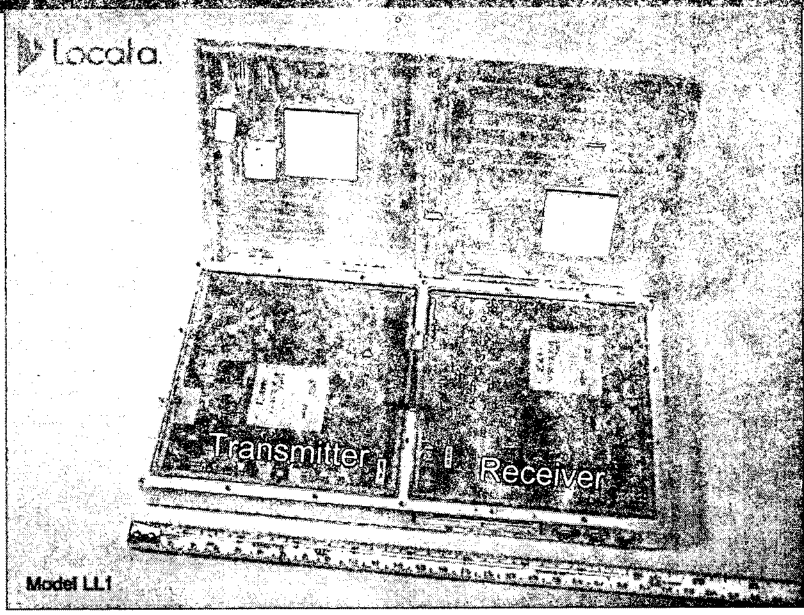
The Next Generation Design (commerical product)

- Stand alone point-positioning
  - RTK GPS cm level accuracy.
  - No reference receivers, no differencing, no data links.
- ISM frequency band (2.4 GHz)
  - No interference with GPS - *complete interoperabilty*.
  - No license requirements.
  - High power in comparsion to GPS - at 1km from transmitter *Locata* signals are 1,000,000 times stronger than GPS signals!
  - Range > 10km line-of-sight - *wide area coverage*.
- Proprietary signal structure
  - Dual frequency code and carrier - *OTF ambiguity resolution*.
  - Proprietary spread spectrum code (10 Mhz) - *multipath mitigation*.
  - Fast acquisition



Concluding remarks

- Proof-of-concept demonstrated using prototype over the past 2.5 years.
- Realisation of *LocataNet* through next generation devices.
- First commercial *LocataNets* will be deployed in 2005.