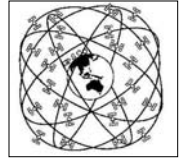## Position Determination Technologies

- GNSS
- Proximity / beacons
- Wave-based range PDT
- Autonomous / "dead reckoning"
- Mobile Telephony
- Augmentations / integrated systems

All require "infrastructure reference stations"… *connect to the reference frame*

Because GPS is not 100% available…

---

(1) GPS/GNSS

Reference stations or infrastructure:

- *Satellites themselves*
- *Global frame networks, e.g. IGS*
- *Local CORS for relative positioning*

GPS reference stations now recognised as Survey/Geodetic infrastructure…

---

(2) 'Proximity' or 'Beacon' Systems

Issues: range, cost, installed infrastructure, non-global, etc.

- Many varieties of **proximity** sensors … *optical, infrared, RF, acoustic, etc* …
- Passive (CCTV), 'transaction' (ATMs, credit cards), 'entry' (swipe cards), etc…
- Primarily for indoor applications, but some vehicle systems (transponders, optical, etc) …
- Track/tag people, animals, vehicles & assets ...
- New 'lease of life' with short-range wireless communications technologies such as Bluetooth, UWB, ZigBee, WiFi, etc., and barcode replacement technologies such as RFID … also "Cell-ID" (see mobilephone systems) …

Who positions the Beacons?… who is responsible for the infrastructure?

---

(3) Wave-based Range PDTs

Issues: range, cost, installed infrastructure, non-global, etc.

- Many varieties of **wave** sensors can allow signal strength or timing measurements to be made … *optical, infrared, RF, acoustic* …
- Range (distance) derived from SS or TOA …
- Need multiple transmitters or "access points" ...
- Potentially can be long-range (even over-the-horizon), and high accuracy …
- Range of accuracies from cms to dekametres … *like GPS*
- Using installed infrastructure for short-range wireless communications technologies such as Bluetooth, UWB, ZigBee, WiFi, etc., is clever …
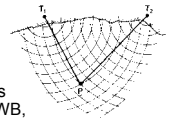
Who is responsible for the infrastructure?

---

(4) DR/INS, Autonomous Systems

*Know where you are, and direction/speed/distance -> calc position*

- Requires **no signal transmission** …
- Works anywhere, totally autonomous ... *hence no infrastructure*
- Low-cost MEMS or expensive INS ...
- Compass, gyros, accelerometers, odometers, pedometers, barometers …
- **However subject to (significant) drift error** ...
- *Need regular calibration against datum.*
- Often used in combination with GPS, e.g. *GPS/DR & GPS/INS*

Need 'connection' to Survey/ Geodetic infrastructure?

---

(5) Mobilephone Systems

- Variety of techniques, need one or more Base Stations ...
- Limited accuracy ... *10s-100s metres*
- 'E911' obligations is the driver in the U.S. ... *safety & security … competing with A-GPS*
- Ubiquitous where mobilephone coverage is good ... *Good geometry is a challenge!*
- Implemented in MU or server …

BTS position is returned in this case
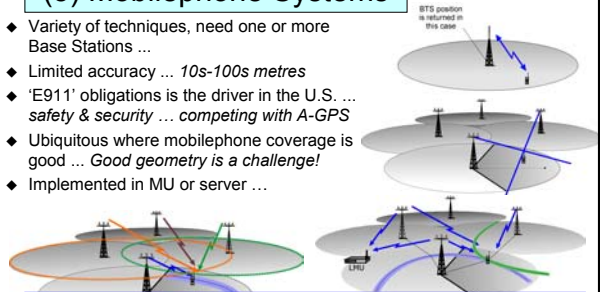
Requires carriers & handset manufacturers to make investment

Who is responsible for the infrastructure?

'Hot Zone' & Seamless Positioning Scenario