



UNSW
SYDNEY

Australia's
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University

Use of GPS Data as Evidence in Court

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SNAP
Lab

Legal Concerns

- Early days: liability
 - “Space Law treaties cannot solve liability questions about the failure of a GNSS signal”
 - ICAO has tried to create a treaty re GNSS liability: not yet
 - Galileo used SA as a lever
 - (ubiquity → liable when GNSS not used..)

Legal Concerns

- Privacy
- Admissibility
- Vulnerability
- “Gathering” of evidence

Legal Concerns

- Specifically to do with GPS “errors”:
 - Police forcing entry to the wrong home
 - Repossession of wrong house
 - Demolition of wrong house
- Recent study (83 cases)
 - 19 criminal/ 11 civil classifications
 - weight given to GNSS data “high” (8%) or “medium” (54%)
 - Significant majority “admissible”

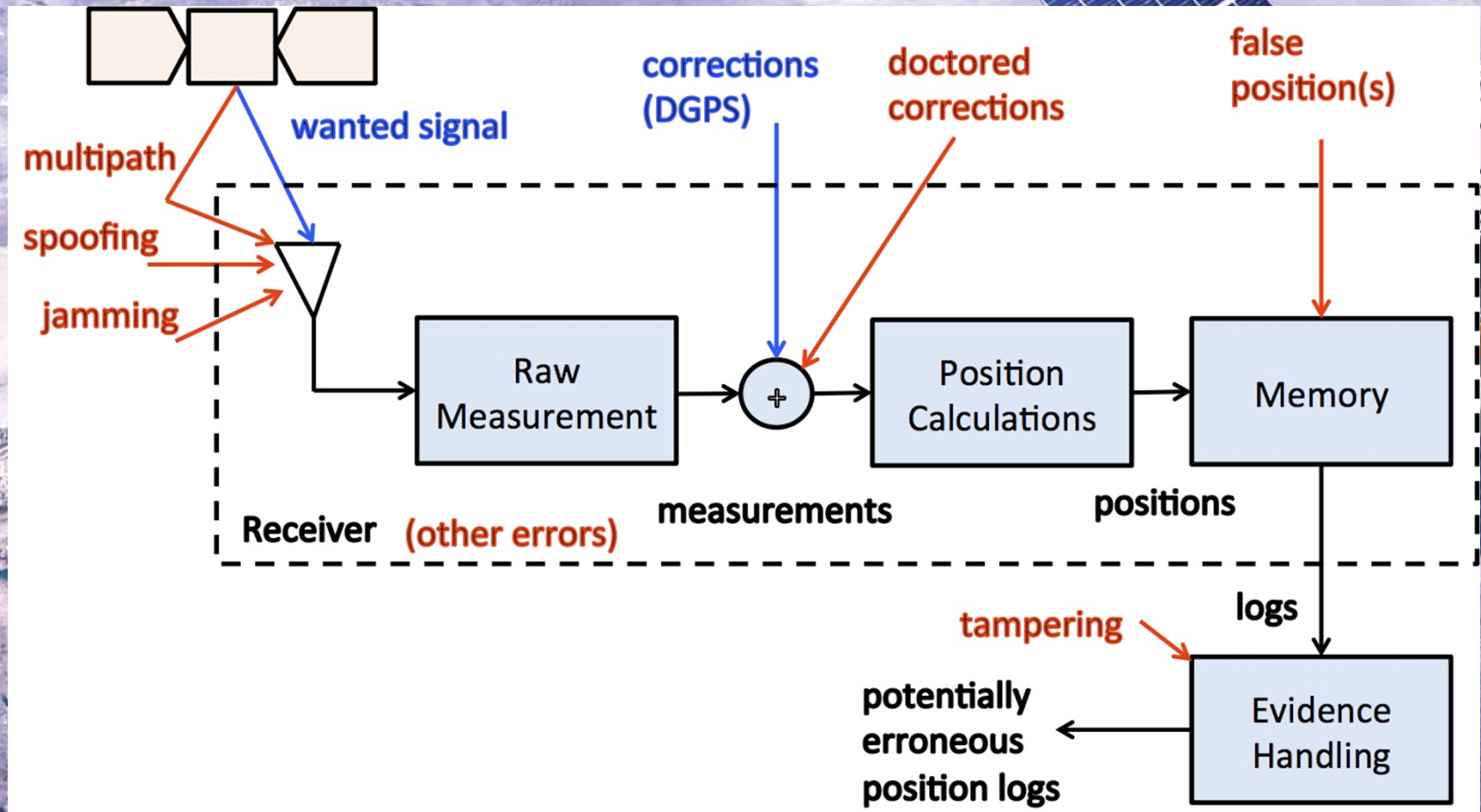
KJ Berman, W B Glisson & L M Glisson, “Investigating the Impact of Global Positioning System Evidence”, 48th Hawaii International Conference on System Sciences, pp5234- 5243, 2015

Our Issue: Quality

- “the prosecution service needs to examine the GPS evidence thoroughly and must present other supporting evidence for GPS evidence to be admissible evidence in court”

Ishwar Khadka, “The accuracy of location services and the potential impact on the admissibility of GPS based evidence in court cases”, BSc(Hons) thesis, University of Derby, 2015

Where Do Erroneous Positions Come From?



Receiver Mitigation

- The receiver can report:
 - Weak signals (CNo)
 - Dilution of precision (DOP) (could also be calculated if actual satellite set is reported)
 - Multipath detection
 - Integrity information. Using e.g. RAIM to define protection limits
 - Spoofing detection.
- Detection of doctored corrections and tampered logs not dealt with here (some standard methods for digital forensics)

NMEA Messages: Common

- GGA: time, lat, long, **fix quality** (GPS, DGPS, PPS, RTK, RTK float, dead-reckoned, manual, or simulated), **no. satellites**, **HDOP**, altitude, height of Geoid
- GSA: 3D fix, satellites, **PDOP**, **HDOP**, **VDOP**.
- GSV: satellites, **elevation**, azimuth, **signal to noise** (SNR)

NMEA Messages: More Useful

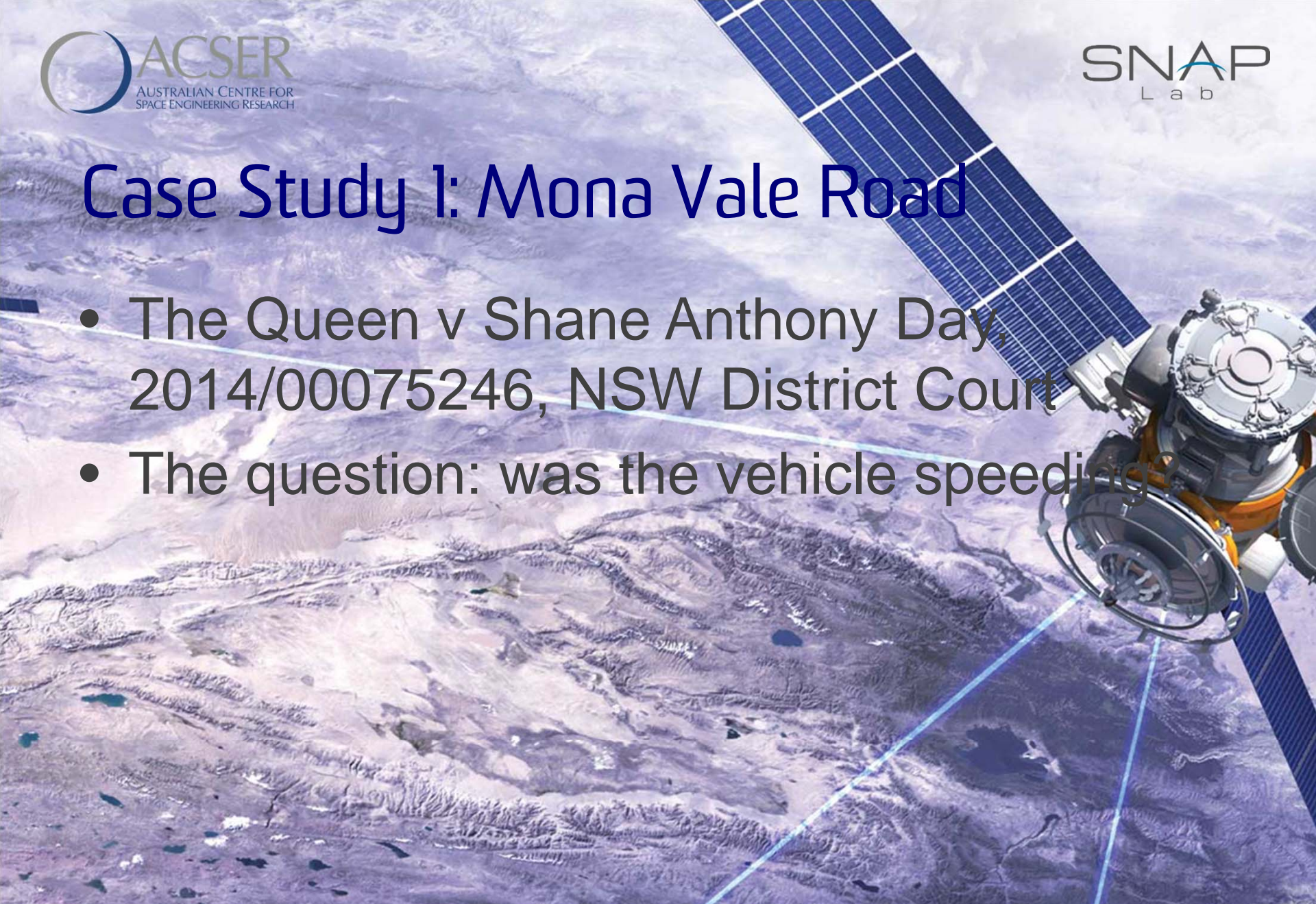
- GRS (Range residuals): time, residuals for each satellite.
- GST (Pseudorange noise statistics): time, RMS value of residuals, error ellipse semi-major axis, semi-minor axis, orientation, lat 1 sigma, long 1 sigma, height 1 sigma

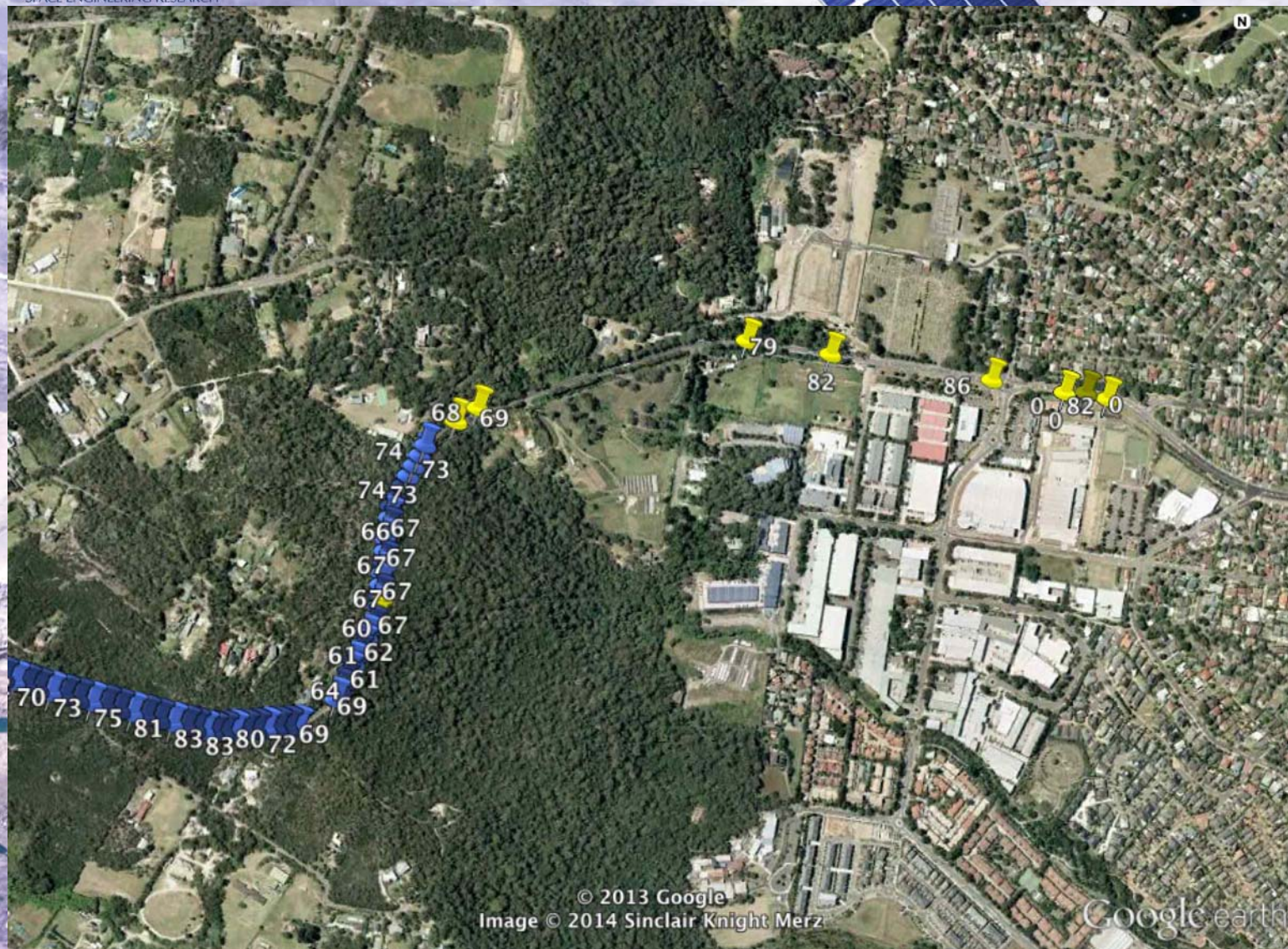
Any Other Formats Provide Quality Info?

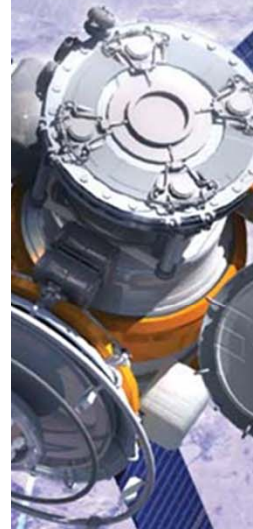
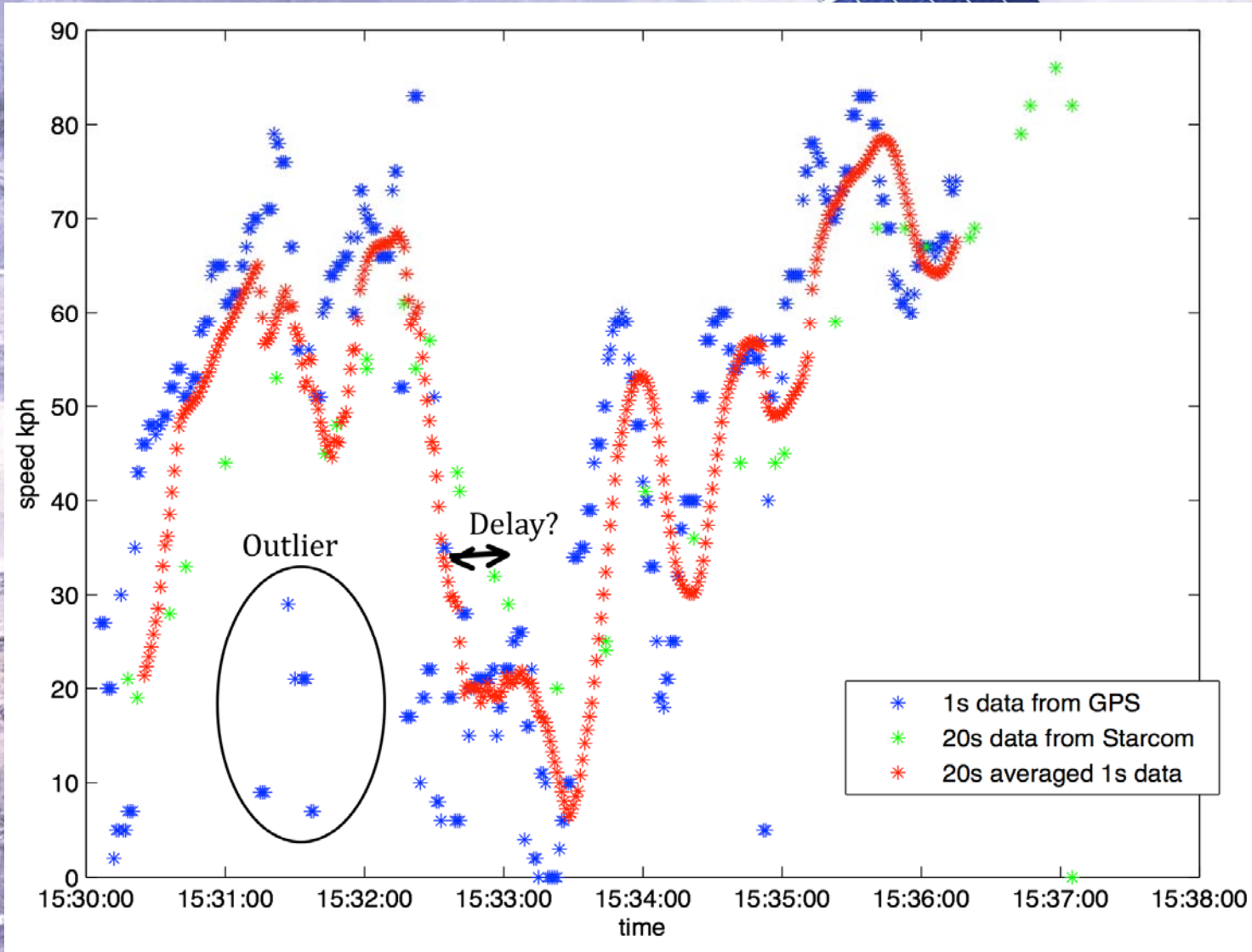
- GPX: none
- Android phones: provide raw range measurements
- Aircraft “black box” has no requirement for quality – even position!
- ADS-B has accuracy and integrity (protection limits)
- AIS has position and whether RAIM guarantees 10m accuracy

Case Study 1: Mona Vale Road

- The Queen v Shane Anthony Day, 2014/00075246, NSW District Court
- The question: was the vehicle speeding?





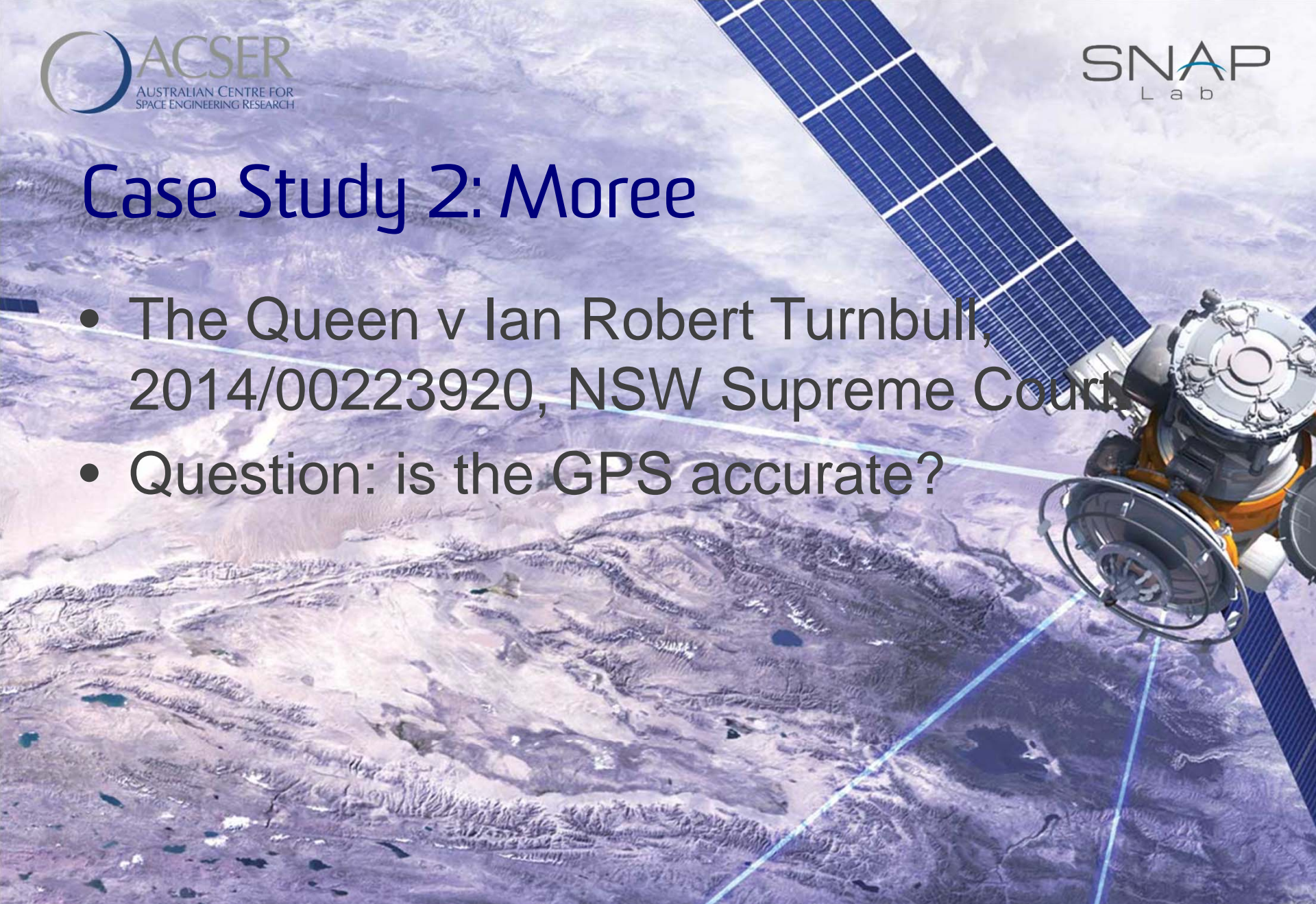




Sector	Length (m)	Speed (kph)
S1	358	72
S2	43	78
S3	482	87
S4	150	108
S5	292	96
A1	1148	74
A2	944	89
A3	905	90
A4	442	100
A5	292	96

Case Study 2: Moree

- The Queen v Ian Robert Turnbull, 2014/00223920, NSW Supreme Court
- Question: is the GPS accurate?







Future Work

- Is this a fruitful area of research?
- Raised more questions than it answered
- Future work:
 - How to present GNSS evidence to meet quality of evidence.
 - Value of different logged data re quality of evidence.
 - A comprehensive study standardised and non-standardised logging
 - A proposal for a standardised logging method that includes integrity etc
 - A proposal for a standardised integrity