SUMMARY
This Information Paper introduces a slide presentation on the GPS Interference Event at Sydney, Australian on 26 February 2015.

The presentation describes:
- the interference event
- the operational impact
- use of ADS-B to localise the source of the interference
- use of GPS units associated with Wide Area Multilateration system to localise the source of interference
- avionics that did not behave as expected during the event
- the advantages of recording the output from the aircraft GPS

1. SEE PRESENTATION SLIDES BELOW
GPS Interference Sydney 26 Feb 15

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Technology & Asset Planning
Contents

• Initial Report

• WAM Rx Unit (GPS) behavior

• Geoscience Australia GPS Monitoring

• Sydney Airport

• ACMA

• Defence

• GPS Constellation

• RAIM

• Initial Conclusion
Observations Reported by ATC:

- Aircraft arriving and departing Sydney reporting loss of GPS. Aircraft within 20NM of Sydney below 7000 ft
- All RWY directions affected
- Reports received from large number of aircraft, various types and companies
- Whole TMA area is affected – very unusual
- Normally RAIM outages go un-noticed i.e. pilots don’t report to ATC

Later reports

Affected Area had increased to 45NM

Contingency provisions invoked:

- Increased use of radar vectors
- ILS for approach guidance
GBAS
- normal operation
- no interference detected
- Logs reviewed / checked

Velos (ADS-B on airport vehicles)
- normal operation

Aircraft on ground
- normal operation
None affected
Defence Joint Operations Centre (JOC)
- No GPS jamming activity known (admitted)

Defence Spectrum Office
- No GPS jamming activity known (admitted)
- investigating
GPS NANU & Operational Advisory’s:

- One NANU of possible relevance #2015010:
  - On approximately 26 Feb 2015 SVN27 will resume transmitting L-band utilizing PRN26.
  - At L-band activation, SVN27/PRN26 will be unusable until further notice.
  - Additionally, no broadcast almanacs will include SVN27/PRN26

- Not considered relevant:
  - PRN26 not in broadcast almanac - TSO avionics should ignore
  - GPS avionics operating normally everywhere else in the country
  - No reports by other GPS users of difficulty

- NOT a Constellation issue
RAIM Prediction

0030 UTC 26/02/15 AIRSERVICES AUSTRALIA
GPS RAIM PREDICTION
YSSY

TSO-C129(A) (AND EQUIVALENT)
FAULT DETECTION
1502260239 TIL 1502260300
1502270235 TIL 1502270256

GPS RAIM FD UNAVBL FOR NPA
TSO-C146A (AND EQUIVALENT)
FAULT DETECTION ONLY

NO GPS RAIM FD OUTAGES FOR NPA
TSO-C146A (AND EQUIVALENT)
FAULT DETECTION AND EXCLUSION
1502260041 TIL 1502260108
1502260317 TIL 1502260326
1502262143 TIL 1502262149
1502270037 TIL 1502270108
1502270313 TIL 1502270322

Not Lack of RAIM
Some stations report loss of GPS
Initial Conclusion

- Not a Constellation issue
- Not lack of RAIM
- Local Interference source
  - Probably ground level
  - Terrain shielding many ground GPS receivers
  - Visible to aircraft in the air
  - Range/strength of interference suggests more than a PPD or “ebay jammer”
ACMA (RF Interference)

- 11:05a
  - ACMA field interference investigator briefed and interference detection/monitoring assistance requested
  - ACMA staff positioned at Terry Hills and North Ryde; depending on outcome at those sites will consider also deploying staff to eastern suburbs

- 12:55p
  - Update provided to ACMA
    - affected area out to 45+ NM
  - ACMA advised that staff in position at Terry Hills and Ryde
    - nil detected thus far
  - deploying to third location at eastern suburbs / Bondi Junction

- 01:15p
  - ACMA reported no GPS RFI detected at Terry Hills or Ryde
  - ACMA notified that jamming ceased at 0122UTC, operations now normal
Interference Source Localisation

- Need very dense network of monitoring stations
  - Not practical

- Paper at ION proposed “crowd source”
  - Use everyone’s smart phone / tablet
  - Show GPS availability (or lack of) by location
  - Creates (tens of) thousands of monitoring stations

- Aircraft use GPS for ADS-B and ADS-B message has position FOM
  - Not such a large number of aircraft (as phones)
  - Aircraft move and rapidly cover area (routes)
GPS (partial) lockup?
Line of Sight Determination

Map of Multi-Lateration RU locations
WAM – SV Count at each RU

Signal Lost: 150225 223100 UTC     Returned: 150226 012215 UTC
Duration: 2:51:25
<table>
<thead>
<tr>
<th>RU</th>
<th>Location</th>
<th>Height</th>
<th>Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>RU01:</td>
<td>Bondi Junction</td>
<td>206m</td>
<td>Yes - high</td>
</tr>
<tr>
<td>RU02:</td>
<td>Parks Plaza</td>
<td>144m</td>
<td>Yes - severe</td>
</tr>
<tr>
<td>RU03:</td>
<td>Kurnell</td>
<td>46m</td>
<td>No</td>
</tr>
<tr>
<td>RU04:</td>
<td>Cronulla Rydges</td>
<td>79m</td>
<td>No</td>
</tr>
<tr>
<td>RU05:</td>
<td>Terry Hills</td>
<td>251m</td>
<td>No</td>
</tr>
<tr>
<td>RU06:</td>
<td>Woronora</td>
<td>349m</td>
<td>No</td>
</tr>
<tr>
<td>RU07:</td>
<td>Calga 1</td>
<td>279m</td>
<td>No</td>
</tr>
<tr>
<td>RU08:</td>
<td>Richmond RAAF</td>
<td>64m</td>
<td>No</td>
</tr>
<tr>
<td>RU09:</td>
<td>Kings Tableland</td>
<td>948m</td>
<td>No</td>
</tr>
<tr>
<td>RU10:</td>
<td>Camden Tower</td>
<td>113m</td>
<td>No</td>
</tr>
<tr>
<td>RU11:</td>
<td>Knights Hill 1</td>
<td>865m</td>
<td>No</td>
</tr>
<tr>
<td>RU12:</td>
<td>Pennant Hills</td>
<td>234m</td>
<td>Yes - severe</td>
</tr>
<tr>
<td>RU13:</td>
<td>Calga 2</td>
<td>279m</td>
<td>No</td>
</tr>
<tr>
<td>RU14:</td>
<td>Knights Hill 2</td>
<td>872m</td>
<td>Yes - low</td>
</tr>
<tr>
<td>RU15:</td>
<td>Sydney ATCT</td>
<td>72m</td>
<td>Yes - medium</td>
</tr>
<tr>
<td>RU16:</td>
<td>Sydney TCU</td>
<td>52m</td>
<td>No</td>
</tr>
</tbody>
</table>
Conclusion - Localisation

- Assume Interference Source:
  - Line of sight visible to affected RUs; AND also
  - (due terrain shielding) NOT line of sight visible to non-affected RUs

- Interference Source in North Parramatta / Ryde area
  - Consistent with ADS-B reports

- North Parramatta / Ryde – Aerospace Industrial Precinct
  - Thales
  - BAE Systems
  - Rockwell Collins
  - Honeywell
  - CAE
  - Macquarie University
  - University of Western Sydney
Conclusion – Localisation …

- A very high density of monitoring stations required to be useful
  - Impractical for fixed monitoring stations

- “crowd sourcing” using mobile phones has potential
  - hard to organise

- ADS-B shows promise as a means of interference location
  - easy for an ANSP to implement
  - probably sufficient to get a ground team close to source

- Aircraft recording of GPS status / maintenance data is useful
  - propose routine recording in QAR (or similar)
Conclusion – Avionics

- **1x Airbus A320 – GPS: Thales TLS755, XPDR: Honeywell TRA67A**
  - ADS-B - NUC=0 for the duration the flight in Australia
  - ADS-B - No geometric altitude or geometric vertical rate
  - GPS receiver **partial “lock up”** ??

- **1x Boeing B777 – GPS: Thales TLS-755, XPDR: Honeywell TRA67**
  - ADS-B: incorrect position reports with good NUC for a short period
  - ADS-B: then generated NUC=0 for the remainder of the flight
  - ADS-B: No geometric altitude or geometric vertical rate
  - GPS receiver partial “lock up” ??

- **1x Airbus A330 – GPS: Honeywell RMA-55B, XPDR: ACSS XS950**
  - ADS-B: good ADS-B data on departure until 2000 feet
  - ADS-B: Then **NIC or NAC=0** for the duration the flight
  - ADS-B: No geometric altitude or geometric vertical rate
  - GPS receiver partial “lock up” ??

- **3x Airbus A320 – GPS: Thales TLS755, XPDR: Honeywell TRA67**
  - ADS-B: incorrect position reports with good NUC declaration
  - ADS-B: Obviously wrong – did not miss lead ATC
Conclusion – Aircraft Operations

- Aircraft with inertial (B717 and larger) – no loss of navigation
- ADS-B lost – ADS-B not used at Sydney

- Contingency provisions invoked:
  - Increased use of radar vectors (used at greater range than usual)
  - ILS for approach guidance

- Contingency works satisfactorily
  - No more that trivial delay to arriving aircraft
  - One aircraft elected not to depart

- Occurred during a period of medium traffic
  - ATC estimate 10% reduction in capacity in high traffic periods