Australian Centre for Space Engineering Research (ACSER)

in collaboration with
The Defence Science Technology Group,
Department of Defence

Biarri Point on Orbit Performance of the Namuru V32 GPS Receiver

Presented by

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at

IGNSS 2018

7 - 9 February 2018

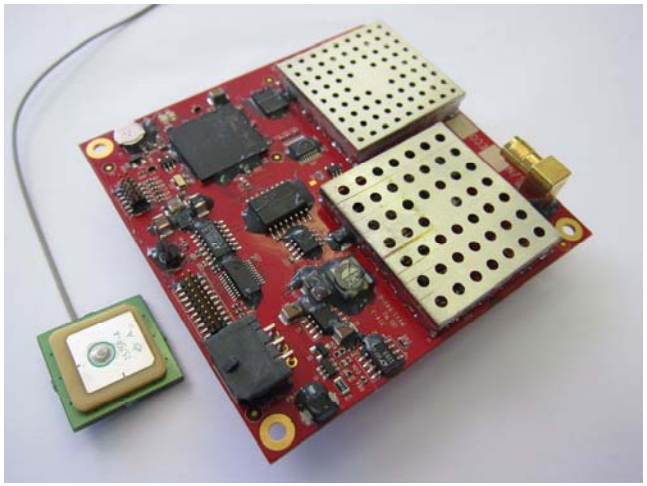
University of NSW, Sydney, Australia

Biarri-Point Mission

- Biarri is a Five Eyes cubesat mission that will do research into Space Situational Awareness (SSA)
- Biarri Point is being used to validate technologies to be used in future missions
- Deployed from the ISS in May 2017
- Australian contribution to the mission is an Australian & NZ designed & manufactured Namuru V32R3A GPS receiver

Namuru V32R3A GPS Receiver

- Hardware designed & manufactured in NZ
- Embedded C code firmware and Verilog FPGA designs developed & tested in Australia
- FPGA based GPS receiver consisting of a SmartFusion A2F500 SoC, a ProASIC3E A3PE1500 FPGA, 512k x 16 bit SRAM, 8Mb serial flash, GP2015 RF front end, …
- Aquarius firmware designed to navigate in orbit
- Functional testing performed by ACSER, UNSW



First 100% Australian & NZ GPS in Space

- Namuru V32R3A is the first fully Australian & NZ designed and manufactured GPS receiver to successfully navigate and function in orbit
- The SigNav designed MG5001 (rebadged as a Phoenix GPS receiver by DLR and SGR05 by Surrey Satellite Technology Limited) employed firmware that was developed by their respective organisations and hence was not 100% Australian and NZ content

Namuru V32 On-Orbit Data Files

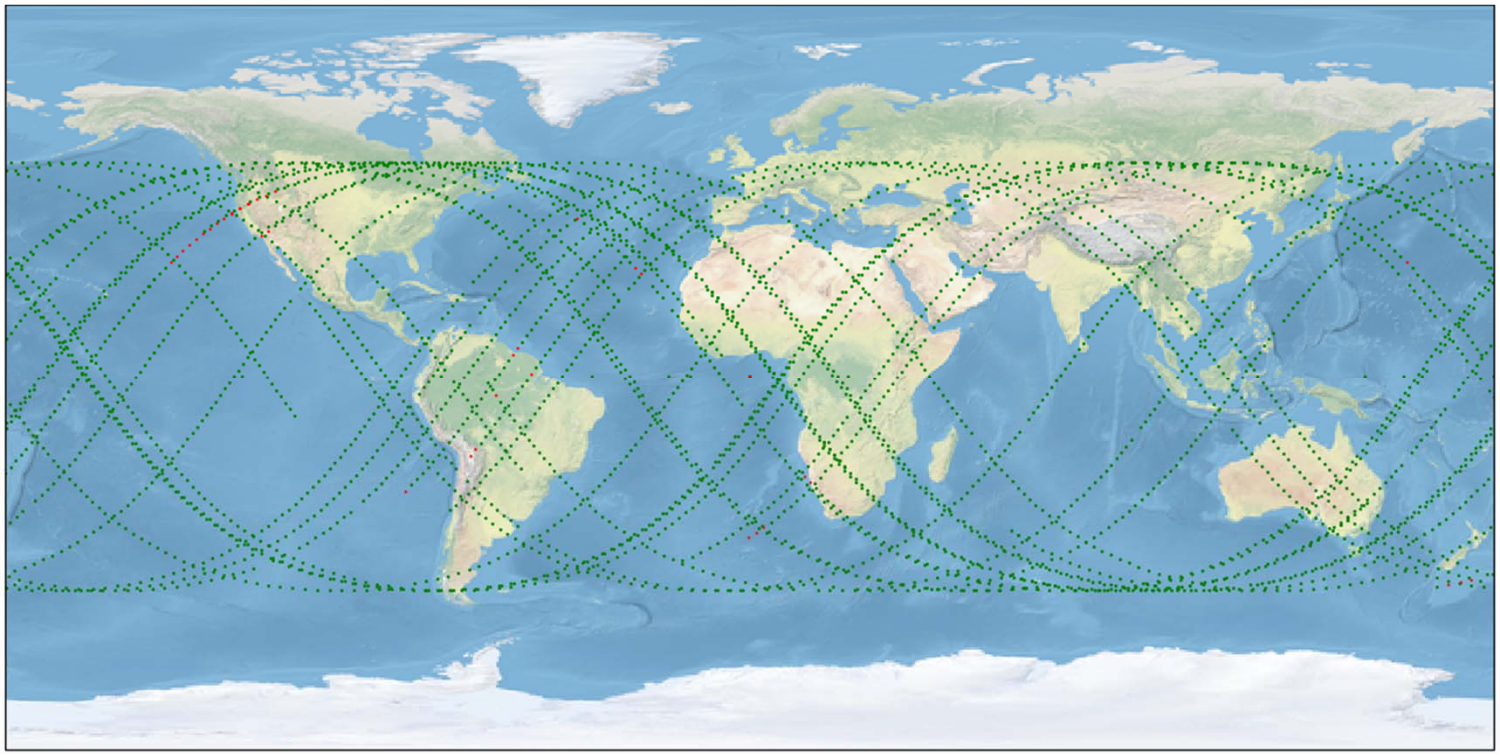
- Namuru V32 has been used to provide PVT information for Biarri Point
- Namuru V32 is the prime source of such information due to difficulties with the other GPS receiver that was installed on the spacecraft
- 5.4 MB of compressed ASCII data or 70 MB of uncompressed ASCII data has been provided by DST-Group to ACSER for analysis
- The data is in the NMEA ASCII sentences received from the GPS receiver supplemented with various time-tags and telemetry flags that have all been provided in the form of ‘comma separated variables’ (CSV) files
- After the unnecessary time-tags, telemetry and message duplications were stripped using an ad-hoc Python script, the data ended up being reduced to 17 MB of NMEA ASCII data provided by the GPS receiver
- Data files typically provided as date-hour sets covering 1 hour intervals

Namuru V32R3A Sentences 1

- Most data received from Namuru is in the form of XYZ sentences, with an example shown below
- $PNSWR,XYZ,
  1,
  1979,420667.999999989,
  6610563.1,-1075491.1,963680.3,
  1540.467,4131.356,-5922.792,
  -4.2,0.467*10
- $PNSWRXYZHeader, Quality, Week, TOW,
  Xm, Ym, Zm, Xdotms, Ydotmps, Zdotmps, Tm, TDotmps * Checksum
- Period of the output XYZ sentences range from the default 1 second to up to 30 seconds

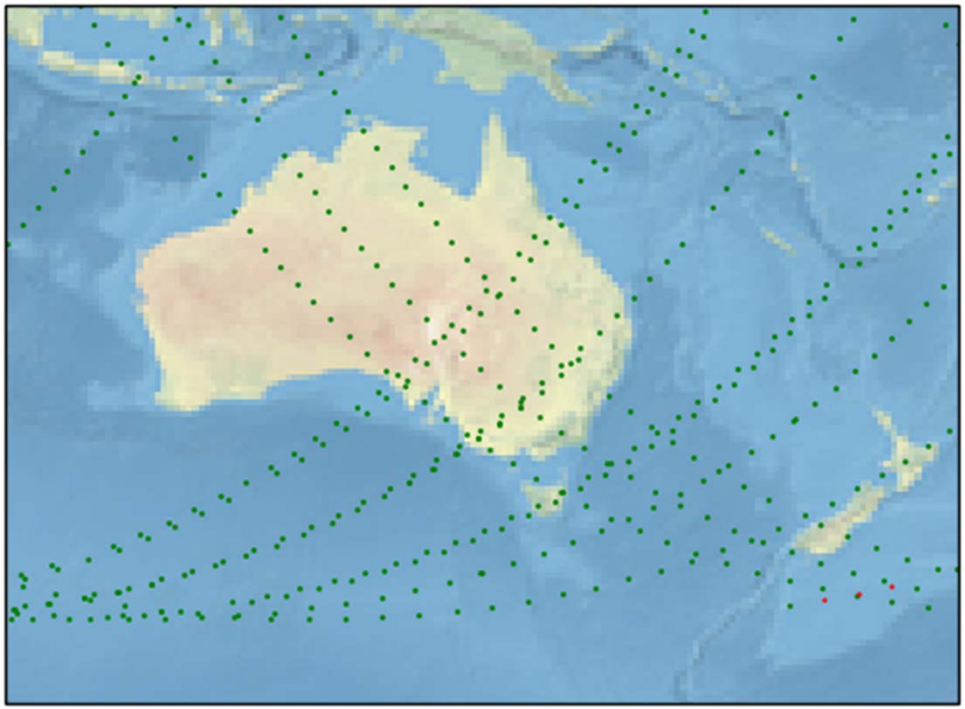
Ground Tracks

- Biarri Point Ground track data between 1-Nov-2017 to 15-Dec-2017 (data sets are not continuous)



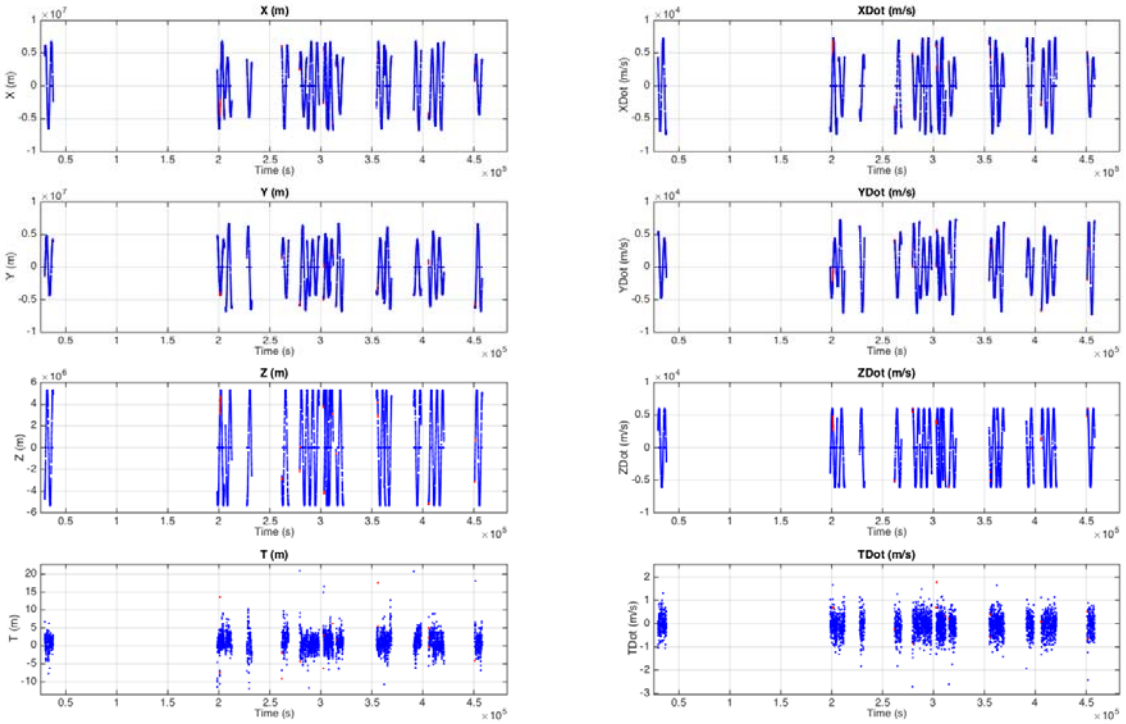
Ground Track Zoomed Over Australia

- Biarri Point Ground track data zoomed over Australia between 1-Nov-2017 to 15-Dec-2017 (same as previous plots)



VC-TCXO Control

- Examination of the clock bias (T) and clock drift (Tdot) terms shows effectiveness of the clock disciplining
- Tdot within 1 m/s and T within 3 to 4 meters (3 sigma) → Working well



OBS Report Analysis

- Some logs contain OBS reports containing raw observables for each satellite being tracked
- Logs show receiver is being permitted to run for as long as 4 hours, but data is being polled every 60 seconds or so
- Good values for C/N0 being observed
- OBS reports also contain readings from an on on-board temperature sensor – temperatures between 30 and 45 degrees were observed

Other Remarks

- Namuru is working well in orbit
- Possibility of doing some additional experiments, such as checking the effectiveness of the TLE estimation
- Examination of logs shows that some starts appear to be cold starts on account of the RTC super-capacitor discharging to a point at which the RTC stops running
  - Recommendation would be to switch the receiver on more often (perhaps every 6-8 hours or so) and let it navigate for a minute or two
  - This would recharge the supercapacitor and should result in most starts being warm starts