

A wireframe globe centered on the Pacific Ocean, showing the outlines of Australia, New Zealand, and parts of Asia and the Americas. The globe is overlaid with a network of white dots and lines, representing a GNSS network. The background is split into three large triangular sections: light blue on the left, light green on the right, and a darker blue-green at the bottom left.

Dissemination of Real-Time and Post-Mission value added GNSS data – A Global Operator’s Perspective

Noor Raziq – GNSS Network Manager Australia

Workshop on the Applications of Global Navigation Satellite
Systems, Suva, Fiji

24 – 28 June 2019

- when it has to be **right**

Leica
Geosystems

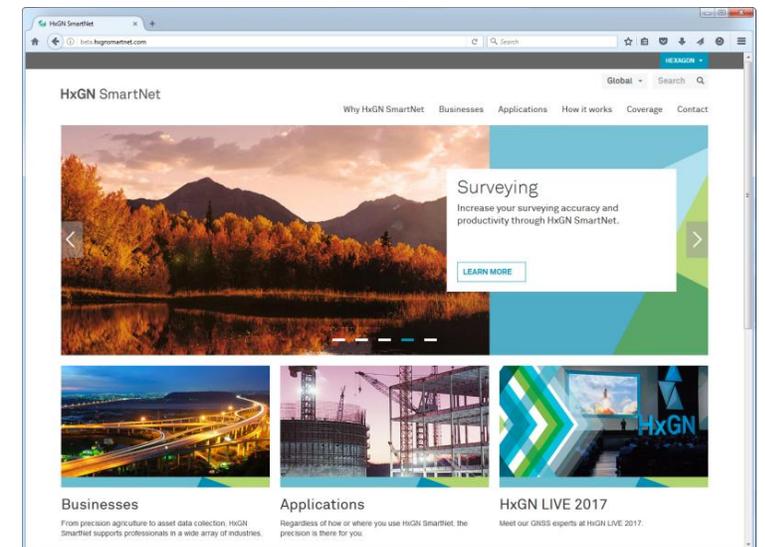
 **HEXAGON**

Outline

- Introduction
- History and Trends
- Australia – use case
 - Coverage
- Fiji – current situation
- Real time and post processing GNSS data dissemination

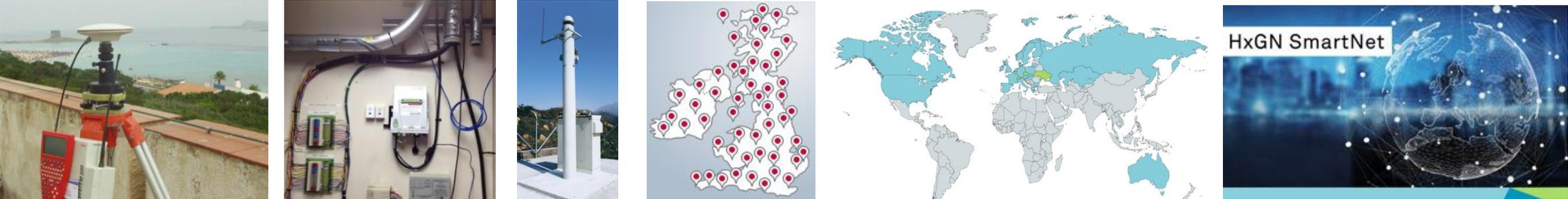
HxGN SmartNet – Correction Service

- Cloud based service to provide **centimeter-level** accuracy to GNSS rovers via mobile internet **in seconds** with **24/7/365 availability**
- Largest network with over 4,500 Reference Stations world-wide available in 22 countries is providing **Open Standard GNSS correction** for RTK positioning
- Over 13 years experience in the correction service market with a globally experienced team



Evolution to HxGN SmartNet

From single base solution to a world-wide network correction services build on technology from Leica Geosystems



HxGN SmartNet Applications & Businesses



Land Surveying



Agriculture



Machine Control & Construction



GIS



Utilities



UAV



Automotive



Agriculture



Logistics



Telecoms



Asset Data Collection



IoT Applications

HxGN SmartNet: Commercial Service Offering

Commercial service offering differs from country to country (market driven)

B2C offering

- Real time correction data streams as
 - Flat rate subscription
 - Consumption-based subscription
- Download of post processing products (RINEX files, Online Post-Processing, etc.)
- Mobile app and web page access



B2B offering

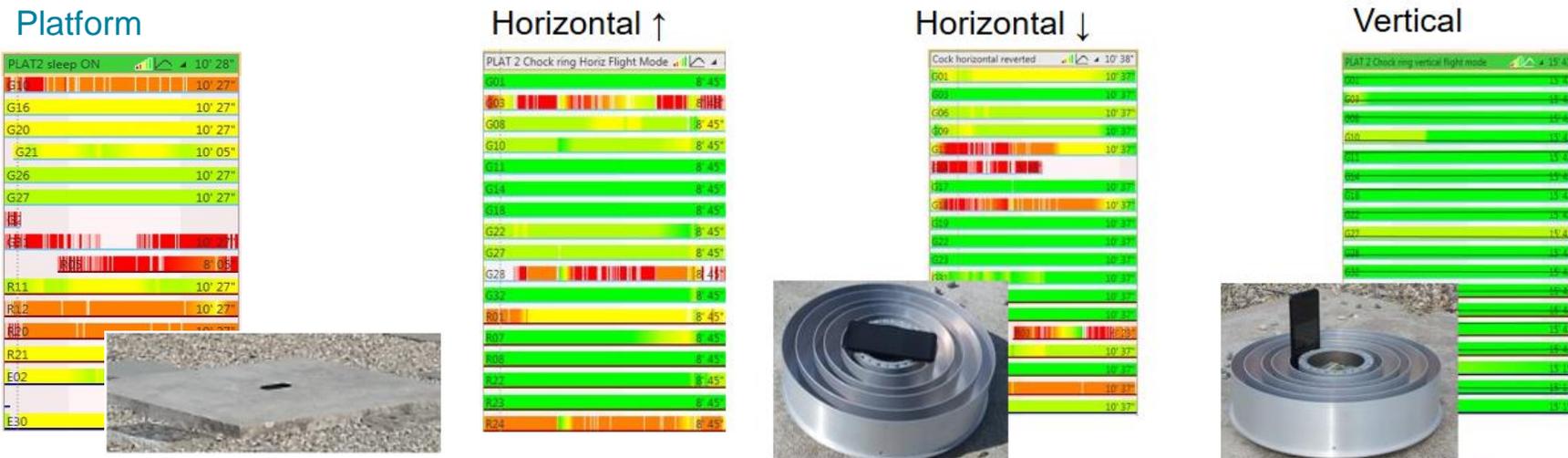
- Enterprise subscription models (Consumption or based on the number of users)
- Integration of API for automation of subscription administration
- Integration of API for post processing automation (using X-pos technology)



Industry Trend 1

Dual Frequency GNSS introduced to the mass market

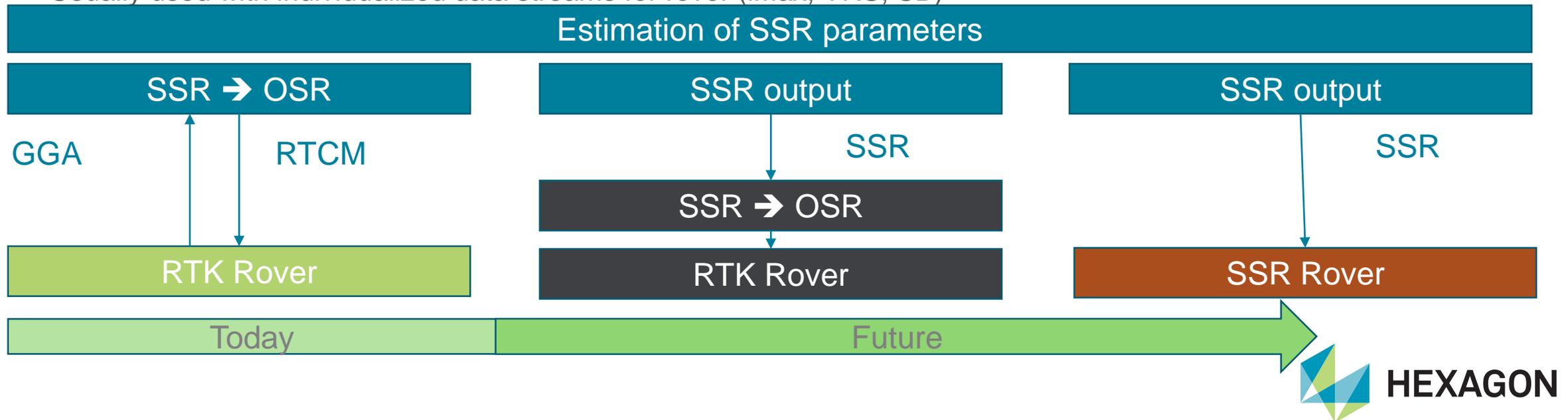
- Evolution of low cost chipset from single to dual frequency (at same low price)
- First Xiaomi Android phone with Broadcom dual-frequency chip
- Access to GNSS raw data via Android operating systems
- Possibility to utilize correction data for RTK positioning
- Main limiting factor for precise positioning: GNSS antenna in mobile phones
- Second limiting factor: number of channels for GNSS signal tracking



Industry Trend 2

SSR vs RTK

- SSR (State Space Representation): correction data format that transmits the error of the relevant GNSS sources
 - Clocks Orbits, Ionosphere, Troposphere, etc.
 - No standard established
 - Broadcast capability for larger area at low bandwidth
- RTK (OSR – Observation Space Representation): correction data format that transmits the errors as a lump sum
 - Widely implemented on dual-frequency GNSS hardware and **standardized via RTCM**
 - Usually used with individualized data streams for rover (iMax, VRS, SB)



Industry Trend 3

GNSS on the road



3cm
Local



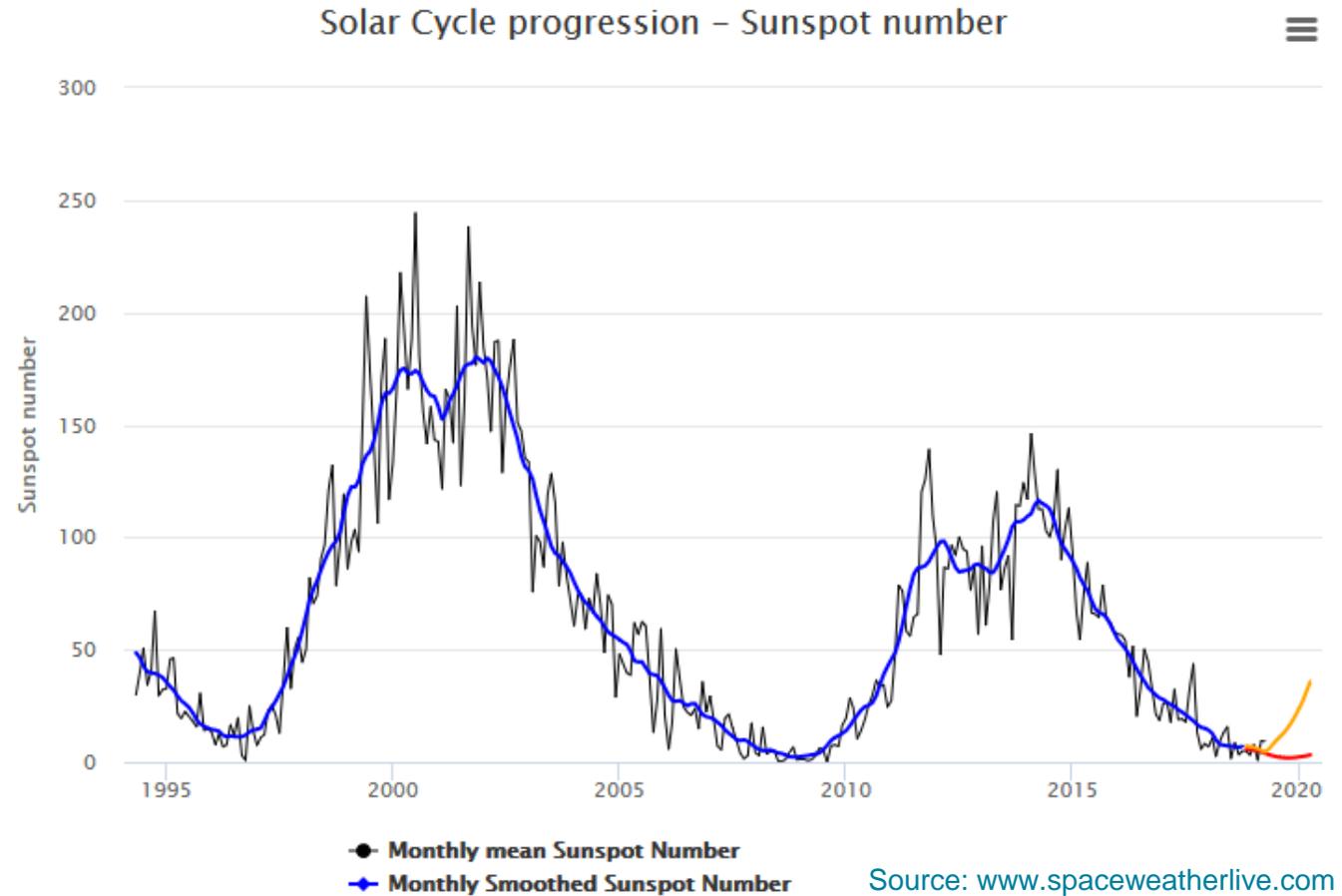
30cm
Continental

- Long history of autosteering with GNSS guidance systems (&IMU)
- Accuracy requirements on the road are lower but reliability becomes the key requirement (failure rate: <math><0.00000001\%</math>)
- Technology: SSR with Integrity on a pan-continental level and sensor fusion
- Automotive requires to serve a very high number of users (broadcast)
- Connected Car → Assisted Driving → Autonomous driving

Industry Trend 4

Stretch the station separation of the network

- Higher station density is required during high solar activity to estimate the ionosphere correctly
- RTK positioning requires dense network of ~75km (limitations on the rover side)
- Positioning with SSR technology can further stretch the station spacing (reduction in convergence time at the rover)
- Network design for good or bad times?
 - Saving potential : ~3/4 of base stations
 - Station separation 75km...120km...240km
 - Consideration on redundancy for individual station failures



Conclusion on Industry trends

Things will change ... but slowly

RTK will remain the most important technology in the classic GNSS market for the next 5 years (at least)

- Large user base (that will modernize slowly)
- Fastest and most accurate GNSS positions

SSR will come!

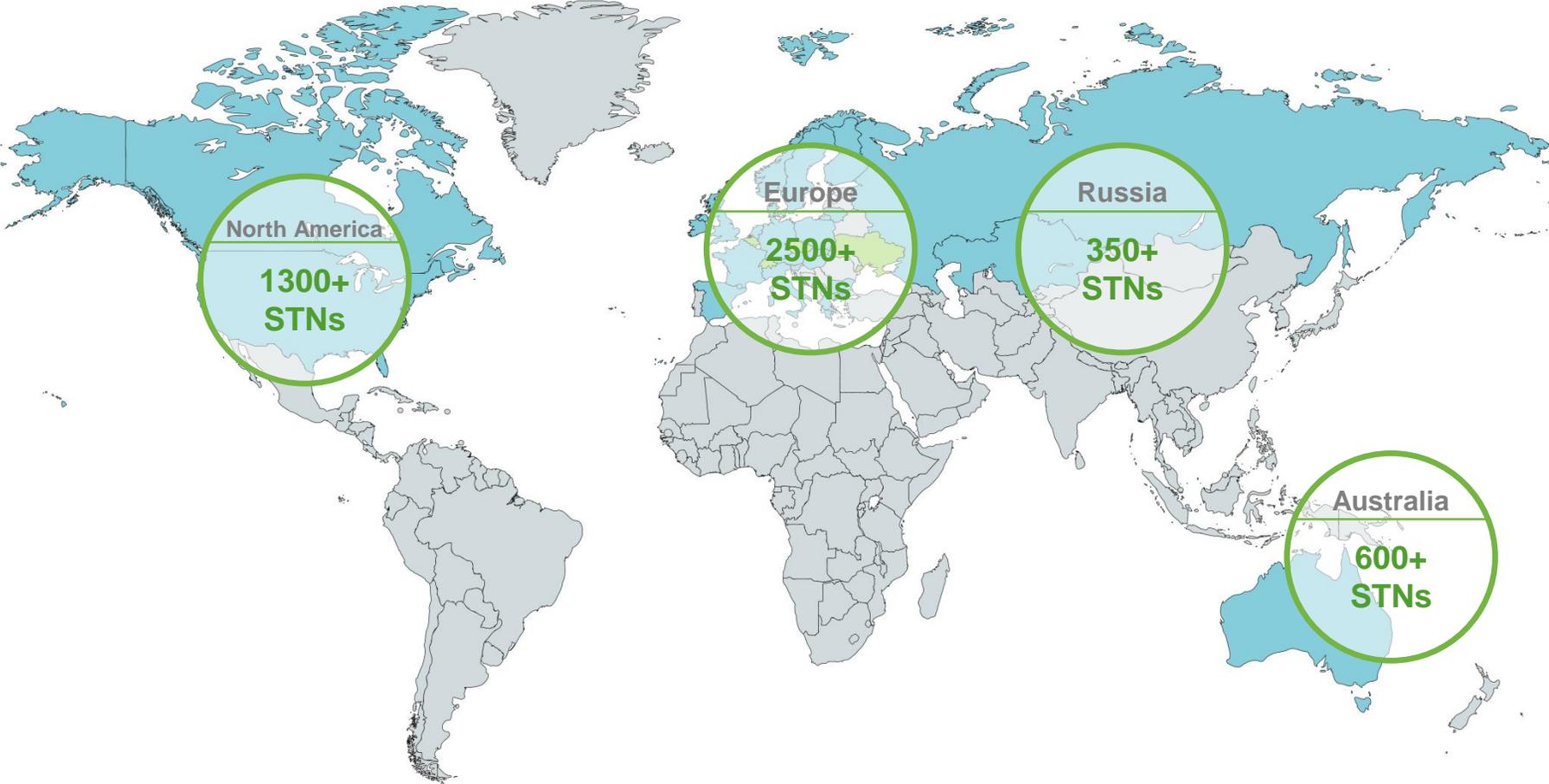
- Standardization will be the main driver
- Introduction first for mass market application (cars, mobile phones, and other new 'rovers')
- Low bandwidth and cheap broadcast capability will be the striking arguments for SSR
- More flexible on station separation

Cheap broadcast capabilities will be the main argument for service providers

- Cloud dissemination vs Native carrier dissemination via 3GPP

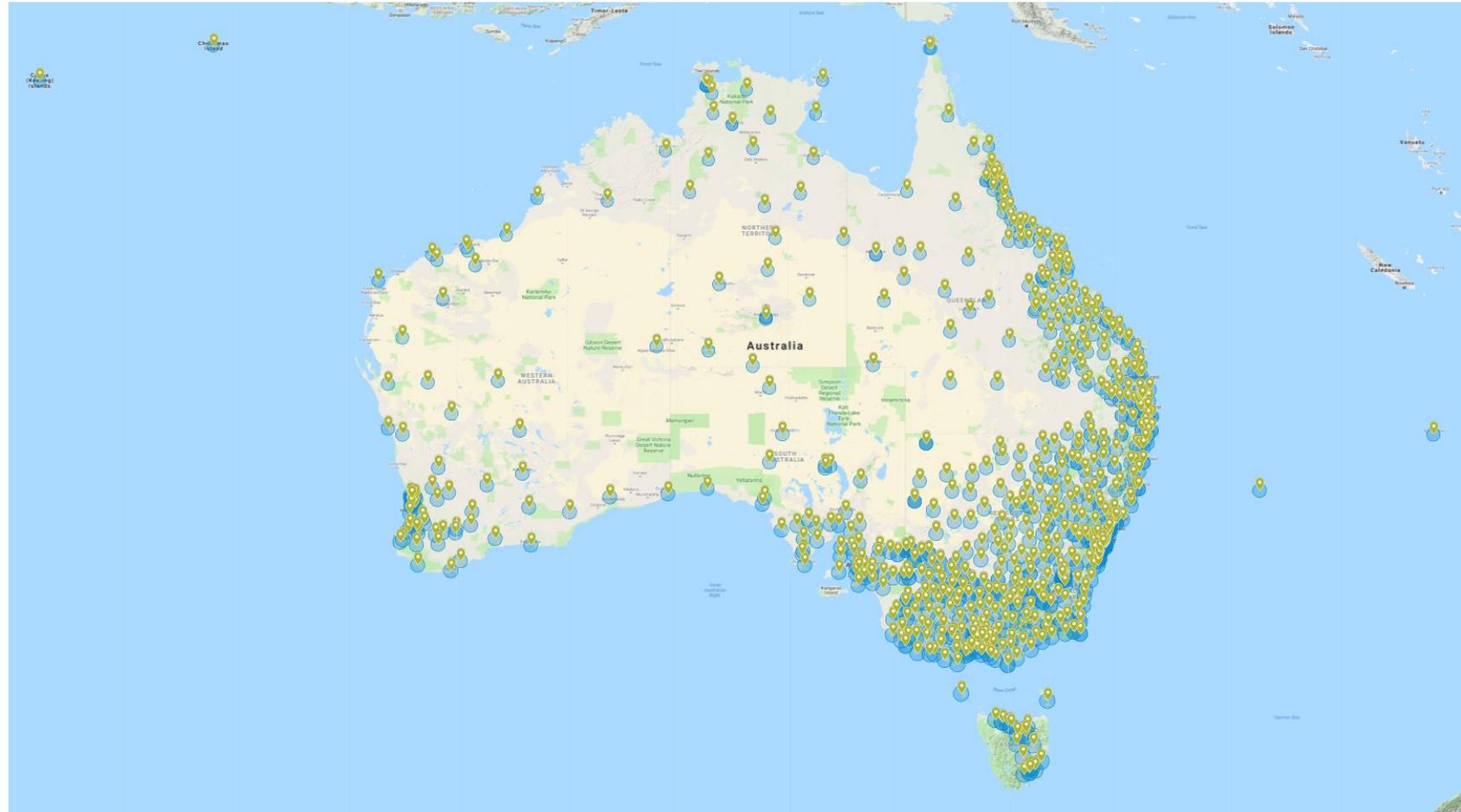


Correction Service on a worldwide scale build on over 4,500 reference stations



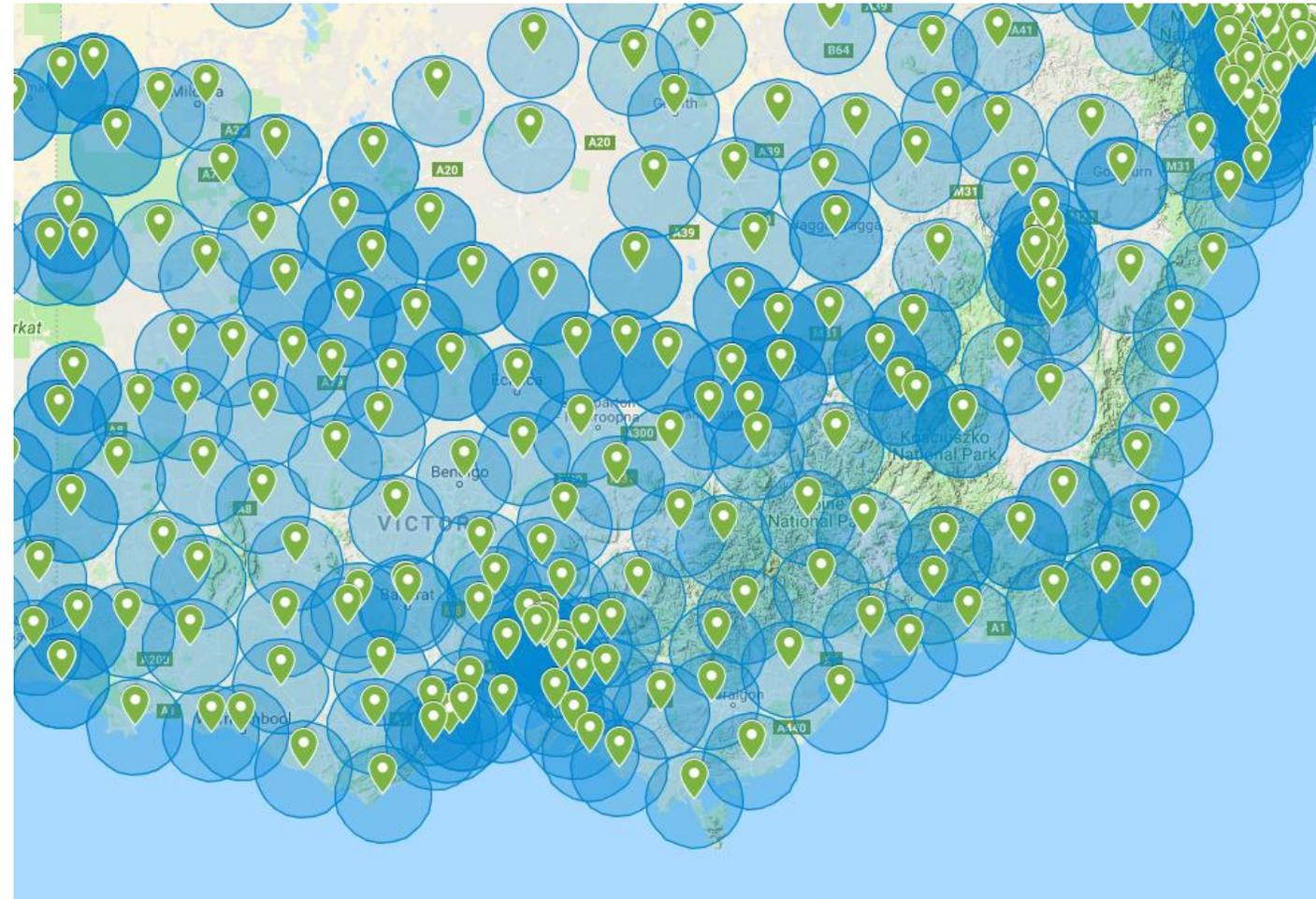
HxGN SmartNet - Australia

- Largest provider of CORS service (670+) in Australia since 2009.



HxGN SmartNet - Australia

- Coverage – Victoria (125 sites)
 - Agreement with DELWP VIC = 116
 - GA = 1
 - HSN = 8
 - Integration of cross-border sites (SA & NSW)



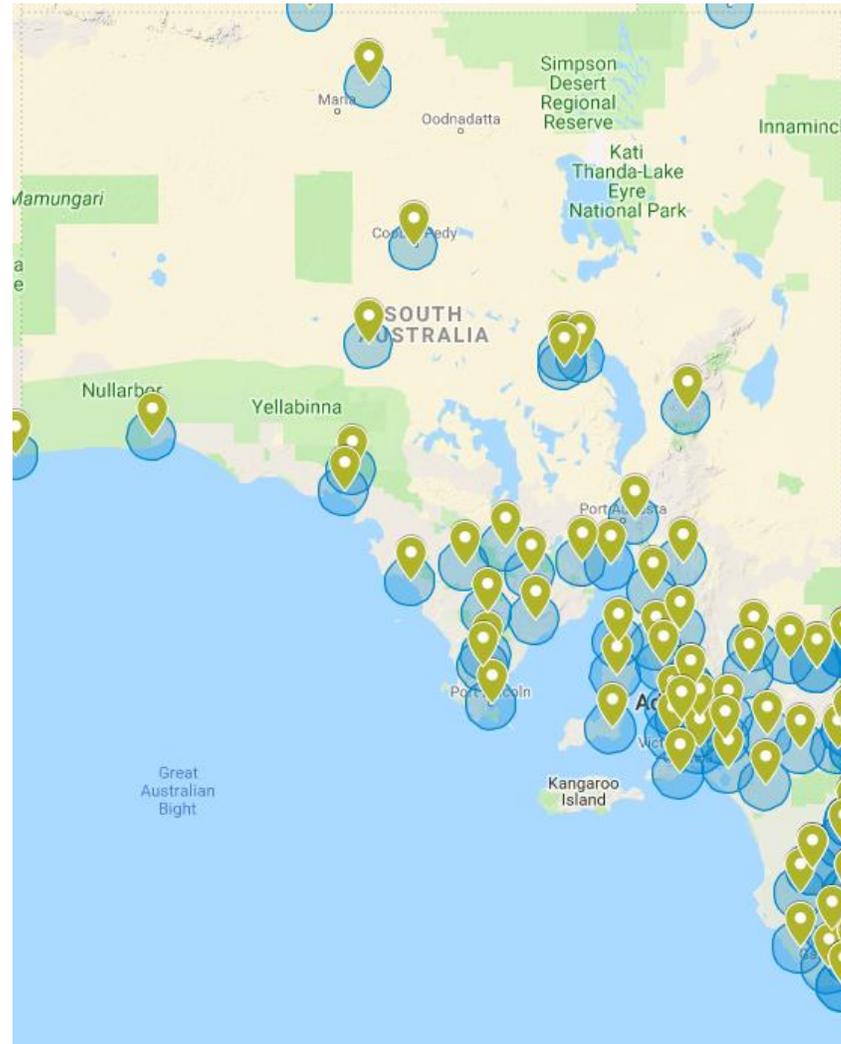
HxGN SmartNet - Australia

- Coverage – New South Wales (228 sites)
 - DFSI-SS = 180
 - GA = 11
 - HSN = 37
 - Continuous coverage from SA and VIC through to QLD



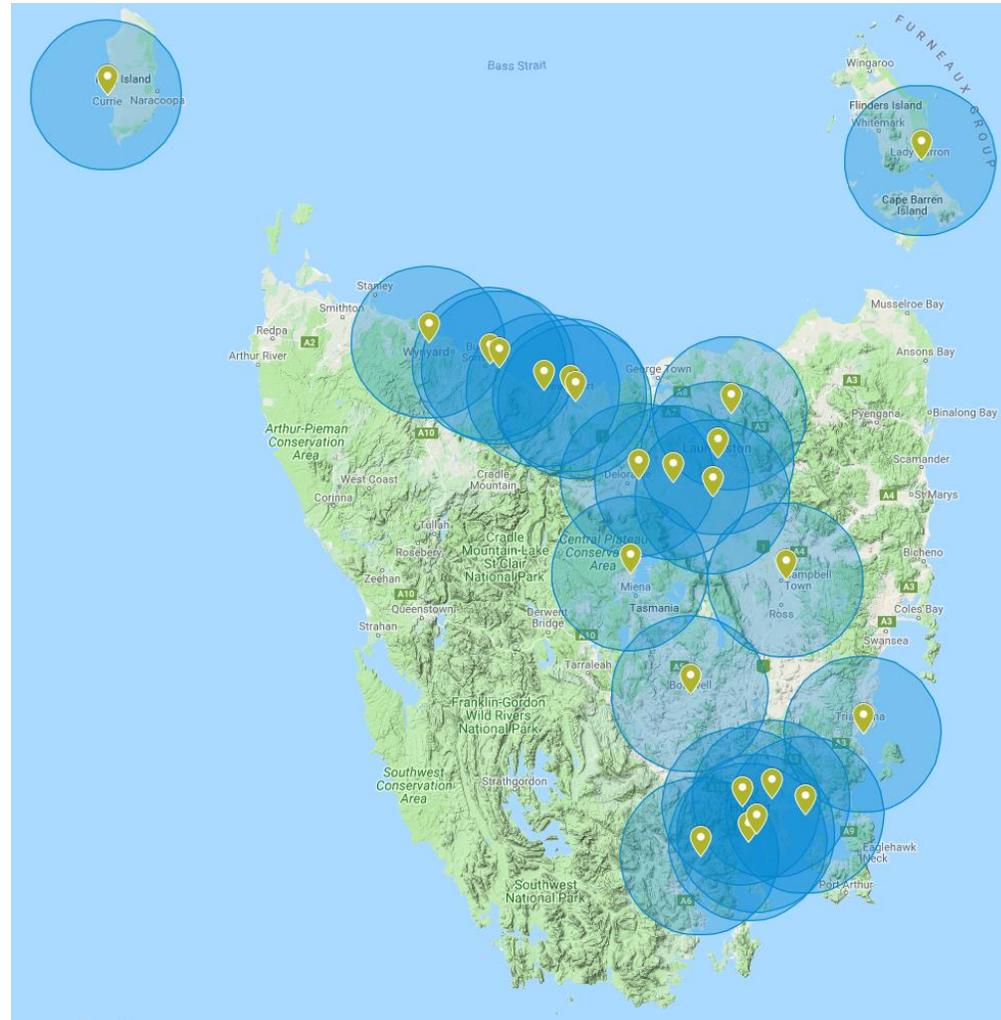
HxGN SmartNet - Australia

- Coverage – South Australia (54 sites)
 - GA = 12
 - HSN = 42
 - Coverage is expanding
 - Offer cross border service – SA & VIC



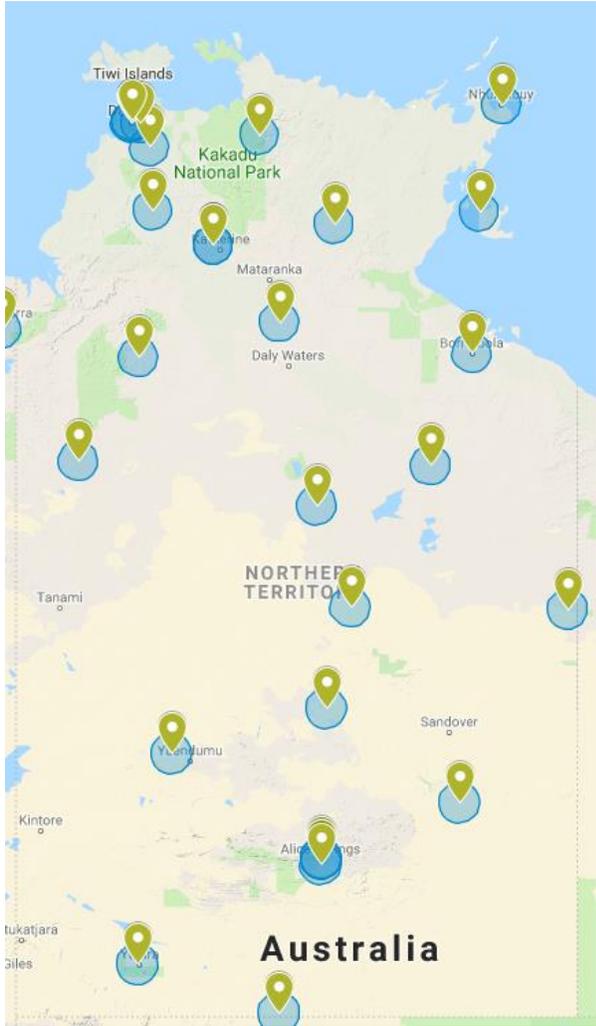
HxGN SmartNet - Australia

- Coverage – Tasmania (23)
 - GA = 10
 - HSN = 13
 - Predominately Ag usage in North
 - Plans to expand coverage between the main towns



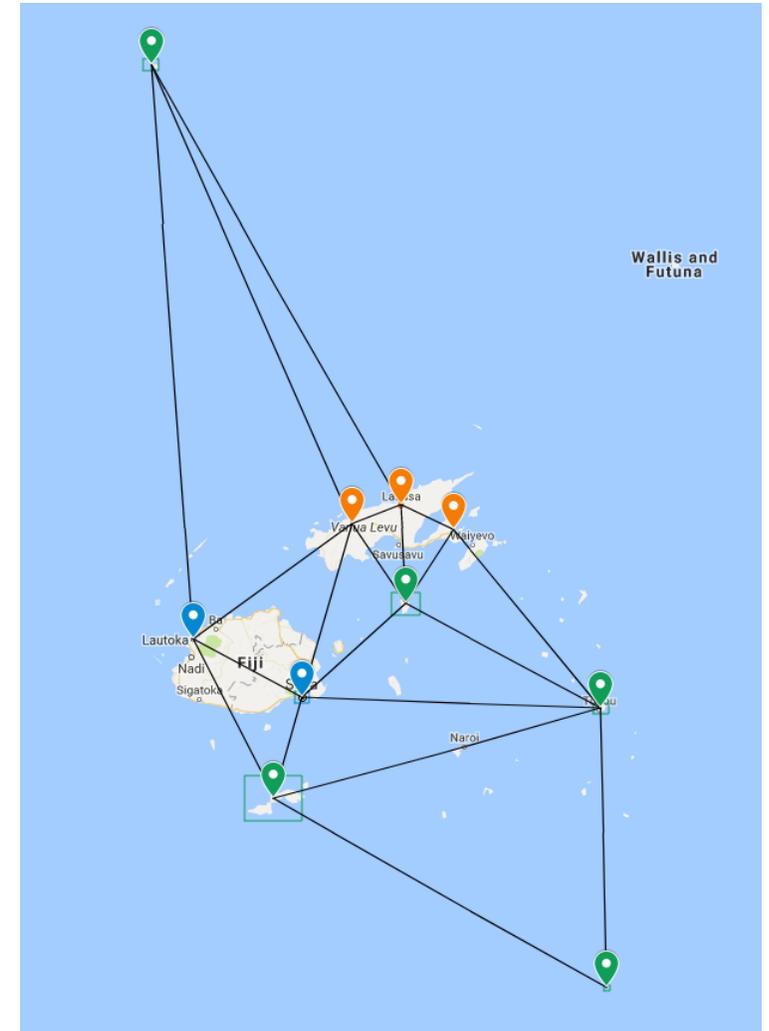
HxGN SmartNet - Australia

- Coverage – Western Australia and Northern Territory (96 sites)
 - GA (Land NT + LandGate) = 61
 - HSN = 35
 - Coverage is growing
 - Focus on expansion around metro Perth



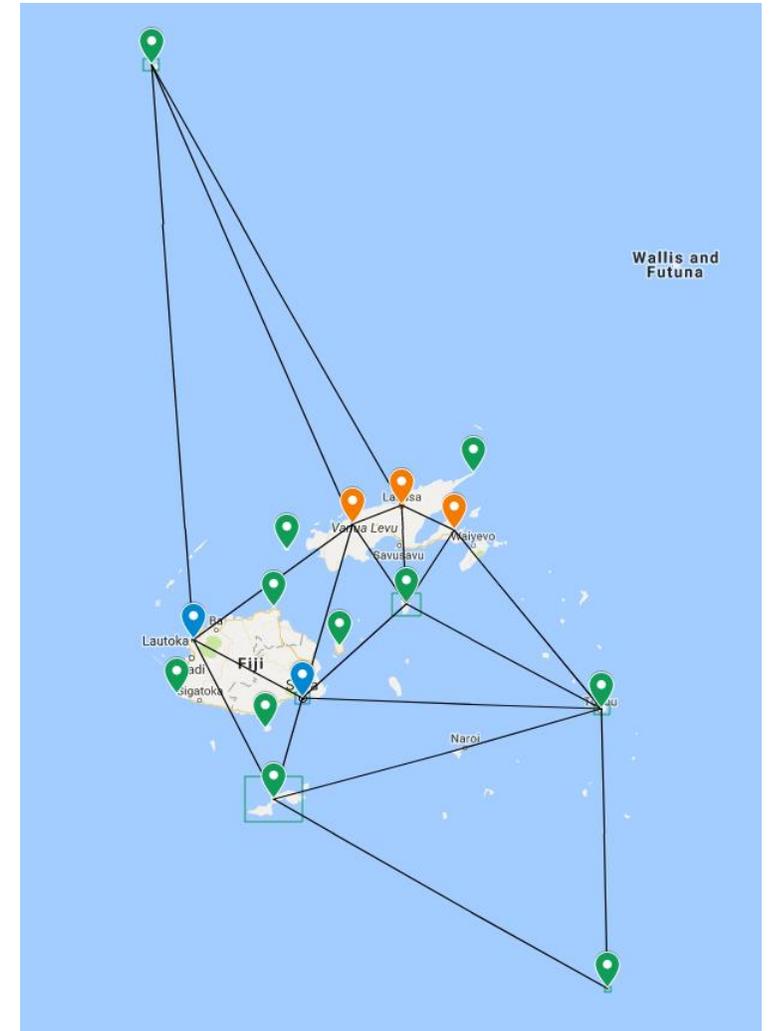
Fiji CORS Network

- Current Network – Base Stations
 - Geosciences Australia / South Pacific Community Sites
 - LTK
 - SUV
 - High Target Sites
 - LAB
 - TAV
 - NAB
 - Leica Geosystems
 - ROT
 - KOR
 - KDV
 - LAK
 - ONO



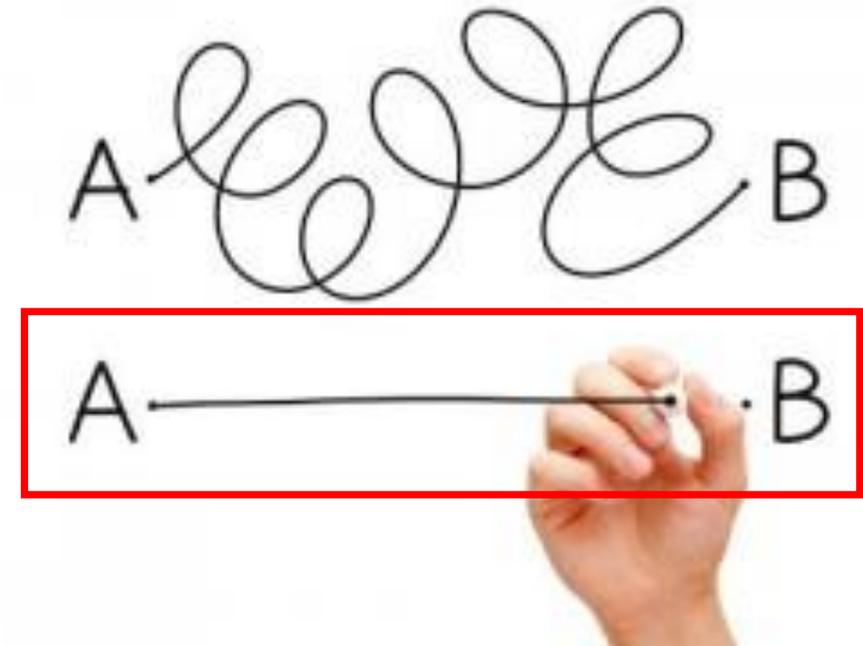
Fiji CORS Network

- Future
 - Base stations currently being installed
 - More Base Station
 - Upgrade of stations
 - Networking Software Installation and Operation
 - What software
 - Business Model
 - Public Private Partnership
 - Publicly operated.
 - Expected adoption by the industry / private and public sector
 - Operation and maintenance



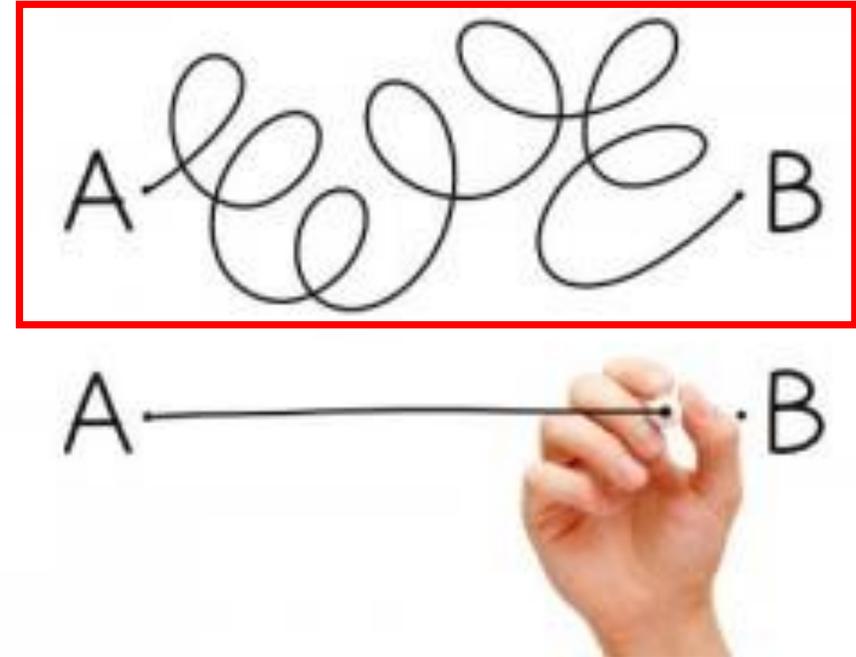
GNSS Data Dissemination

- Seems simple
 - Get data from base stations
 - Provide to end users



GNSS Data Dissemination

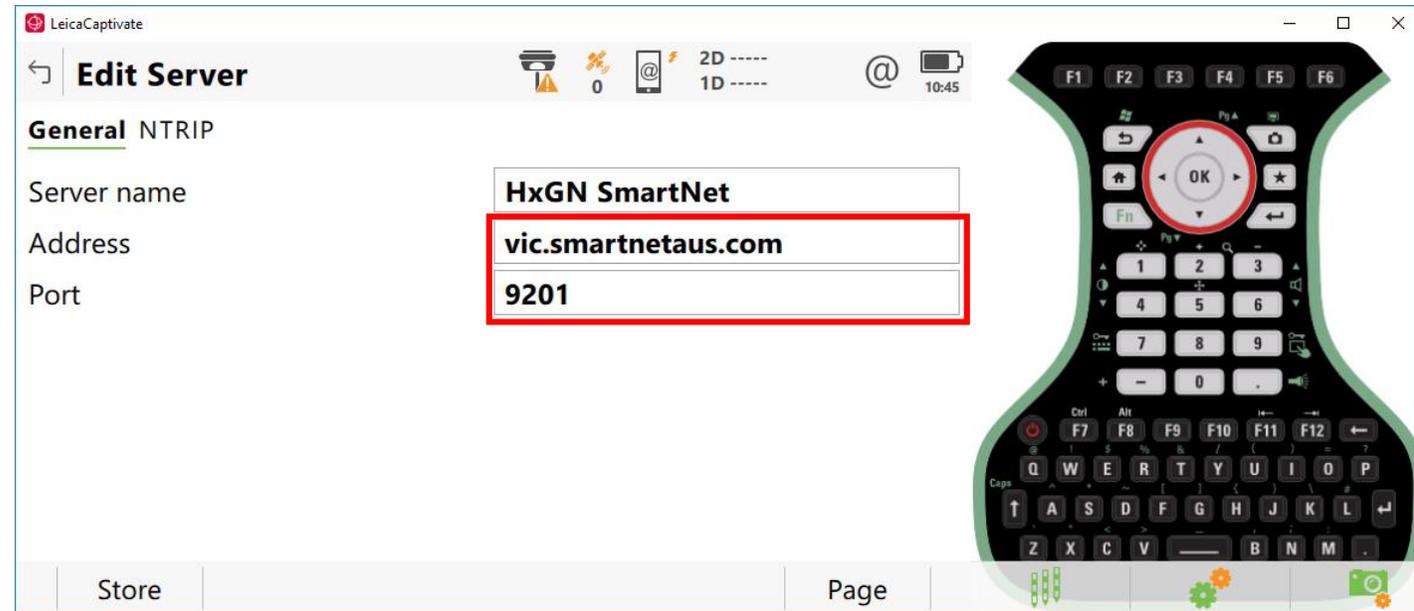
- Extensive Network
 - 670+ sites
- Range of Users
 - Different applications
 - Agric
 - Survey
 - Machine Control
 - UAVs
 - Utilities finding
 - PPK users
 - Different geographical regions
 - State
 - National
- Real Time Data
 - Most users
- Post Processing Data
 - PPK users
- Processing Methodology
 - Network
 - MAC
 - VRS
 - FKP
 - SSR
- GNSS
 - GPS only
 - GPS+GLONASS
 - Everything
- Datums
 - GDA94
 - GDA2020



Real-Time Data Dissemination

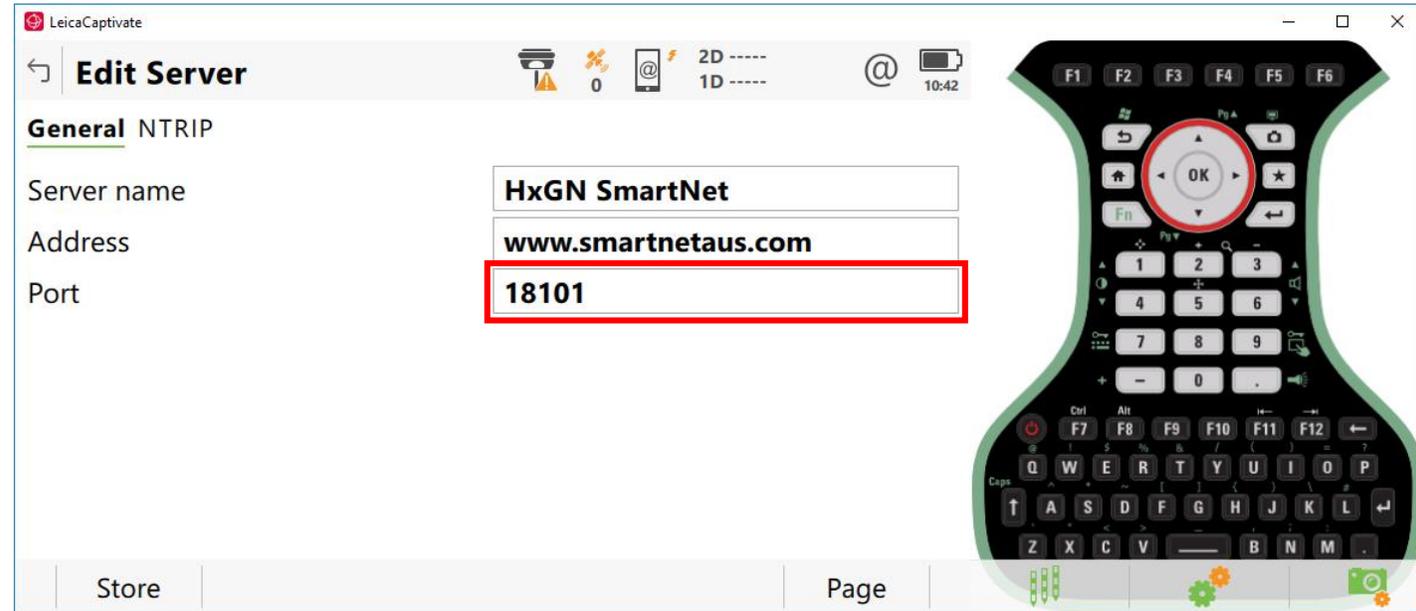
- Application Based Division

- Survey and everything else except some GIS
- Agric
- Some GIS



Real-Time Data Dissemination

- Geographic Based Division
 - Single State License => Following Post Code
 - Most users
 - NSW
 - VIC
 - QLD
 - SA
 - WA
 - TAS
 - NT
 - National License
 - Some users
 - Will need to change port number when move states
- Currently working on an ubiquitous National and possibly Global solutions
 - Change settings automatically when crossing borders



Real-Time Data Dissemination

- Formats

- Mount Point Names

- MSM
 - RTCM 3.x
 - RTCM 2.3
 - CMR+

- Correction Methodology

- Mount Point Names

- MAC
 - VRS
 - iMAX
 - Others

- Datums

- Identifier

LeicaCaptivate

Internet Port Connection

Internet port: CS Internet 1

Server to use: HxGN SmartNet - Australia

NTRIP mountpoint: MSM_iMAX

Press 'Source' to get a list of mountpoints

| | |
|----|--------|
| OK | Source |
|----|--------|

CMR_VRS

Identifier: GDA2020 Distance: N/A

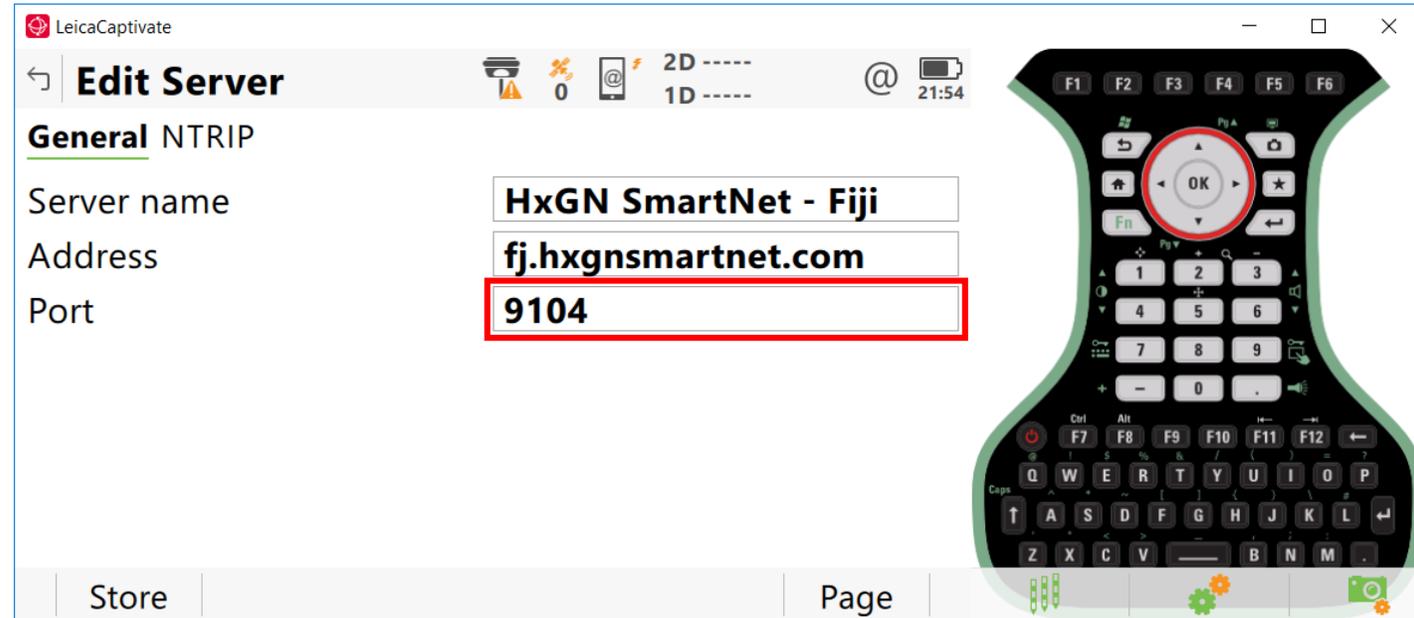
| | | | | |
|----|----|------|------|----|
| Fn | OK | Info | Sort | Fn |
|----|----|------|------|----|

Fiji CORS – Real Time Data Dissemination

- DNS Name = fj.hxgnsmartnet.com

- Ports

- Survey = 9101
- GIS = 9102
- Agric = 9103
- MC = 9104



Post-processing Data Dissemination

- RINEX files

- Multi-GNSS RINEX 3.XX from the new portal
- RINEX 2.XX from the old portal
- Basic QC information
 - Data completeness
 - Multipath

SNA-Melb Obs File Availability

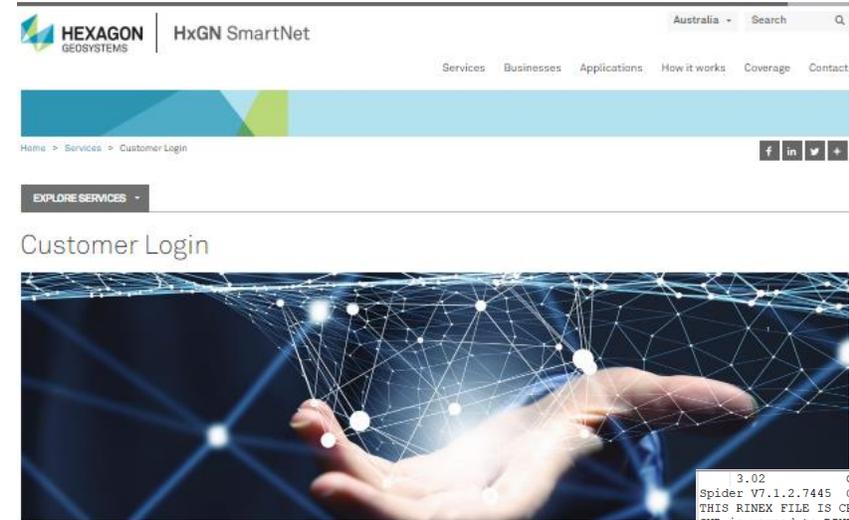
[Site Overview](#) | [Quality Plots](#) | [File Summary](#) | [File Availability](#)

File availability for the last 30 days

| Date | DOY | Files* |
|-------------|-----|----------------------------|
| 16 Sep 2018 | 259 | abcdefghijklmnopqrstuvwxyz |
| 15 Sep 2018 | 258 | abcdefghijklmnopqrstuvwxyz |
| 14 Sep 2018 | 257 | abcdefghijklmnopqrstuvwxyz |
| 13 Sep 2018 | 256 | abcdefghijklmnopqrstuvwxyz |
| 12 Sep 2018 | 255 | abcdefghijklmnopqrstuvwxyz |
| 11 Sep 2018 | 254 | abcdefghijklmnopqrstuvwxyz |
| 10 Sep 2018 | 253 | abcdefghijklmnopqrstuvwxyz |
| 9 Sep 2018 | 252 | abcdefghijklmnopqrstuvwxyz |
| 8 Sep 2018 | 251 | abcdefghijklmnopqrstuvwxyz |
| 7 Sep 2018 | 250 | abcdefghijklmnopqrstuvwxyz |
| 6 Sep 2018 | 249 | abcdefghijklmnopqrstuvwxyz |
| 5 Sep 2018 | 248 | abcdefghijklmnopqrstuvwxyz |
| 4 Sep 2018 | 247 | abcdefghijklmnopqrstuvwxyz |
| 3 Sep 2018 | 246 | abcdefghijklmnopqrstuvwxyz |
| 2 Sep 2018 | 245 | abcdefghijklmnopqrstuvwxyz |
| 1 Sep 2018 | 244 | abcdefghijklmnopqrstuvwxyz |
| 31 Aug 2018 | 243 | abcdefghijklmnopqrstuvwxyz |
| 30 Aug 2018 | 242 | abcdefghijklmnopqrstuvwxyz |
| 29 Aug 2018 | 241 | abcdefghijklmnopqrstuvwxyz |
| 28 Aug 2018 | 240 | abcdefghijklmnopqrstuvwxyz |
| 27 Aug 2018 | 239 | abcdefghijklmnopqrstuvwxyz |
| 26 Aug 2018 | 238 | abcdefghijklmnopqrstuvwxyz |
| 25 Aug 2018 | 237 | abcdefghijklmnopqrstuvwxyz |
| 24 Aug 2018 | 236 | abcdefghijklmnopqrstuvwxyz |
| 23 Aug 2018 | 235 | abcdefghijklmnopqrstuvwxyz |
| 22 Aug 2018 | 234 | abcdefghijklmnopqrstuvwxyz |
| 21 Aug 2018 | 233 | abcdefghijklmnopqrstuvwxyz |
| 20 Aug 2018 | 232 | abcdefghijklmnopqrstuvwxyz |
| 19 Aug 2018 | 231 | abcdefghijklmnopqrstuvwxyz |
| 18 Aug 2018 | 230 | abcdefghijklmnopqrstuvwxyz |

* - See below for the meaning of the colours.

| Status | Meaning |
|--------|--|
| Green | File is available. |
| Red | File is not available. |
| Blue | Unknown file availability. File has not been processed by Leica SpiderQC SMARTNET VERSION. |



Spider Business Center

Spider Business Center combines all the elements you need to efficiently operate your infrastructure, including powerful and secure user and access management, network and GNSS status monitoring, and access to status information and post-processing services (RINEX download).

[LOGIN >](#)

SpiderWeb

Smart or Virtual RINEX Files can be downloaded via SpiderWeb to benefit from a network solution in post-processing. Alternative to Spider Business Centre, RINEX data can also be ordered through the RINEX Job Service on the SpiderWeb portal.

Please note that SpiderWeb service will be discontinued once Smart RINEX service is made available on the Spider Business Center portal.

[LOGIN >](#)

How can

Want to learn more? We have questions.

[CONTACT US >](#)

```

3.02 OBSERVATION DATA M: MIXED RINEX VERSION / TYPE
Spider V7.1.2.7445 GA 20180402 060756 UTC PGM / RUN BY / DATE
THIS RINEX FILE IS CREATED FROM RTCM V3.0 DATA COMMENT
SNR is mapped to RINEX snr flag value [1-9] COMMENT
LX: < 12dBHz -> 1; 12-17dBHz -> 2; 18-23dBHz -> 3 COMMENT
24-29dBHz -> 4; 30-35dBHz -> 5; 36-41dBHz -> 6 COMMENT
42-47dBHz -> 7; 48-53dBHz -> 8; >= 54dBHz -> 9 COMMENT
Product COMMENT
Site Information : COMMENT
Melbourne Observatory COMMENT
Victoria COMMENT
Australia COMMENT
MOBS COMMENT
50182M001 MARKER NAME
Ryan Ruddick Geoscience Australia OBSERVER / AGENCY
3007645 SEPT POLARX4 REC # / TYPE / VERS
CR20020709 ASH701945C_M NONE ANT # / TYPE
-4130635.7881 2894953.0968 -3890531.4629 APPROX POSITION XYZ
0.0000 0.0000 0.0000 ANTENNA: DELTA H/E/N
G 12 C1C L1C S1C C2L L2L S2L C2W L2W S2W C5Q L5Q S5Q SYS / # / OBS TYPES
R 9 C1C L1C S1C C2P L2P S2P C2C L2C S2C SYS / # / OBS TYPES
E 9 C1C L1C S1C C7Q L7Q S7Q C8Q L8Q S8Q SYS / # / OBS TYPES
C 6 C1L L1L S1L C7I L7I S7I SYS / # / OBS TYPES
J 9 C1C L1C S1C C2L L2L S2L C5Q L5Q S5Q SYS / # / OBS TYPES
DBHZ SIGNAL STRENGTH UNIT
INTERVAL
1.0000 TIME OF FIRST OBS
2018 04 02 05 45 0.0000000 GFS TIME OF LAST OBS
2018 04 02 05 59 59.0000000 GFS
0 RCV CLOCK OFFS APPL
G L2S -0.25000 SYS / PHASE SHIFT
G L2X -0.25000 SYS / PHASE SHIFT
R L2P 0.25000 SYS / PHASE SHIFT
E L8Q -0.25000 SYS / PHASE SHIFT
24 R01 1 R02 -4 R03 5 R04 6 R05 1 R06 -4 R07 5 R08 6 GLONASS SLOT / FRQ #
R09 -2 R10 -7 R11 0 R12 -1 R13 -2 R14 -7 R15 0 R16 -1 GLONASS SLOT / FRQ #
R17 4 R18 -3 R19 3 R20 2 R21 4 R22 -3 R23 3 R24 2 GLONASS SLOT / FRQ #
18 18 1929 7 GLONASS COD/PHS/BIS
LEAF SECONDS
END OF HEADER
    
```

Post-processing Data Dissemination

- Virtual RINEX Request
 - Complete user input on one single page
 - Minimum user interaction
 - Fully automated generation of optimal virtual, non-physical data
 - Use of Virtual RINEX in Post-Processing has similar advantage like Virtual Reference Station corrections in Real-Time

The screenshot displays the 'RINEX Data' interface within the SPIDER BUSINESS CENTER. The page title is 'RINEX Data' and the breadcrumb is 'Home / Post Processing / RINEX Data'. A sidebar on the left lists navigation options: Shop, Post Processing, RINEX Data, Computation, Transformation, Results, Account Details, and Contact. The main content area features a map of a region with a red location pin and a 15.28km distance marker. The map shows a network of roads and geographical features. The right side of the interface contains a form for RINEX marker details, including fields for RINEX marker name, RINEX marker number, Latitude, Longitude, Ellipsoidal height, and Observation rate. A 'Submit' button is visible at the top right of the form area. The interface also shows a 'Data Availability 30 Days' indicator with a 90.04% status.

Post-processing Data Dissemination

- Online PPK Processing Engine
- X-POS Positioning Server
 - Leica Geosystems Infinity Kernel
 - Static or Kinematic
- Customised Processing Parameters
 - Single Base Processing
 - Loose Network Processing – Many base stations
 - Tight Network Processing – Combined network solution
- Detailed Reports
 - With full error ellipses and uncertainty values

GNSS Processing Report - Summary HxGN SmartNet

Request Details

| | |
|---|--|
| General Processed at: 2018-03-23 10:38:08 SBC version: 7.1.0.183 | User Details User name: TestUser01 Name: SNA Test Company: Email: support@smartnetaus.com |
|---|--|

Point Results

| Point-ID | Solution Type | Occupations / Baselines | WGS84 Latitude | WGS84 Longitude | WGS84 Ellip. Height [m] | SD Latitude | SD Longitude | SD Height |
|----------|---------------|-------------------------|-------------------|-------------------|-------------------------|-------------|--------------|-----------|
| MOBS | Phase Fixed | 2/5 | -37° 49' 45.8970" | 144° 58' 31.2060" | 40.6646 m | 0.0030 m | 0.0018 m | 0.0028 m |

| Point-ID | Solution Type | Occupations / Baselines | WGS84 Cartesian X | WGS84 Cartesian Y | WGS84 Cartesian Z | SD X | SD Y | SD Z |
|----------|---------------|-------------------------|-------------------|-------------------|-------------------|----------|----------|----------|
| MOBS | Phase Fixed | 2/5 | -4130635.7850 m | 2894953.0883 m | -3890531.4543 m | 0.0026 m | 0.0022 m | 0.0029 m |

Target Coordinate System

| | |
|------------------|---------------------------|
| Name: | GDA94_MGA Zone 55_NSJ_VIC |
| Ellipsoid: | GRS 1980 |
| Projection Type: | TransverseMercator |
| Geoid Model: | AG09_NSW_VIC |
| CSCS Model: | - |

| Point-ID | Coordinate System | Northing | Easting | Ellip. Height | Ortho. Height | SD Easting | SD Northing | SD Height |
|----------|---------------------------|---------------|---------------|---------------|---------------|------------|-------------|-----------|
| MOBS | GDA94_MGA Zone 55_NSJ_VIC | 581180.0373 m | 321419.5988 m | 35.8897 m | - | 0.0030 m | 0.0018 m | 0.0028 m |

HxGN SmartNet Multiple Reference Frames Support

- Maintenance of **multiple reference frames** in one installation
- Send out raw data and RTK corrections in a selected reference frame
 - allowing the rover user position directly in their chosen reference frame without the need for transformation.

The screenshot shows the 'General' tab of the HxGN SmartNet configuration interface. The 'Coordinate Reference Frame' dropdown menu is highlighted with a red box. The options in the dropdown are: Product Marker Coordinates Product, Physical Marker Coordinates Physical, ITRF2008, and ETRF2000. The 'Product Marker Coordinates Product' option is currently selected and highlighted in blue. Other visible fields include: RT Product name: New RT product; Type: Automatic cells; Message type: MAX RTCM 3.x (Extended, 1015, 1016); RTCM version: 3.x; End of message: Nothing; Target Coordinate System: Product Marker Coordinates Product; and Satellite system: ITRF2008, ETRF2000. There are also checkboxes for BDS and QZSS at the bottom.

HxGN SmartNet Web and App Tools

- HxGN SmartNet web access
 - More transparency into your subscriptions (logins, rovers, status)

The screenshot displays the 'Live Usage' interface. At the top, it shows 175 total rovers, with 82 (46%) in a grid view and 64 (36%) in a list view. Below this is a table with columns: Pin, No., NMEA, Fixing, User Name, Full Name, Duration, Update, Satellites Ref./Rover, Ref. Station RTCM/NMEA, and Distance. The table lists three rovers with their respective details.

| Pin | No. | NMEA | Fixing | User Name | Full Name | Duration | Update | Satellites Ref./Rover | Ref. Station RTCM/NMEA | Distance |
|-----|-----|------|-----------------|-----------|-----------|----------|----------|-----------------------|------------------------|----------|
| | 4 | | Fixed (Network) | | | 4:27:47 | 14:27:34 | 16/13 | ORNG-0204 / 204 | 3.16 km |
| | 5 | | Fixed (Network) | | | 5:57:02 | 14:27:31 | 13/13 | 0000 (BLRN) / - | 23.47 km |
| | 8 | | Not fixed | | | 7:08:35 | 14:27:34 | 12/5 | WCX2-0142 / 142 | 1.30 km |

Below the table is a map of Australia and New Zealand. The map shows the locations of the rovers, with red and green markers indicating their positions. The map includes a search bar, zoom controls, and a scale bar. The coordinates at the bottom left are Lon: 114° 56' 34.979" E Lat: 8° 40' 08.420" S. The map is powered by Esri, Earthstar Geographics, Esri, HERE, Garmin, OpenStreetMap contributors, and the GIS user community.

HxGN SmartNet Web and App Tools

- HxGN SmartNet app
 - Ideal for checking Site Status & Rover Credentials in the field
 - Network Status & NTRIP port connectivity
 - NTRIP login (username, password)
 - Mount tables
 - Subscription status

HxGN SmartNet

Select your SmartNet location
Tap the country you are in



[Back to country selection](#)

Want to learn more about SmartNet?

Australia
 Tap here to select Australia

Please find below detailed information for your SmartNet subscription

2000801_AUS_SUI
LE-AHVGWBXUPN-1

Article Number

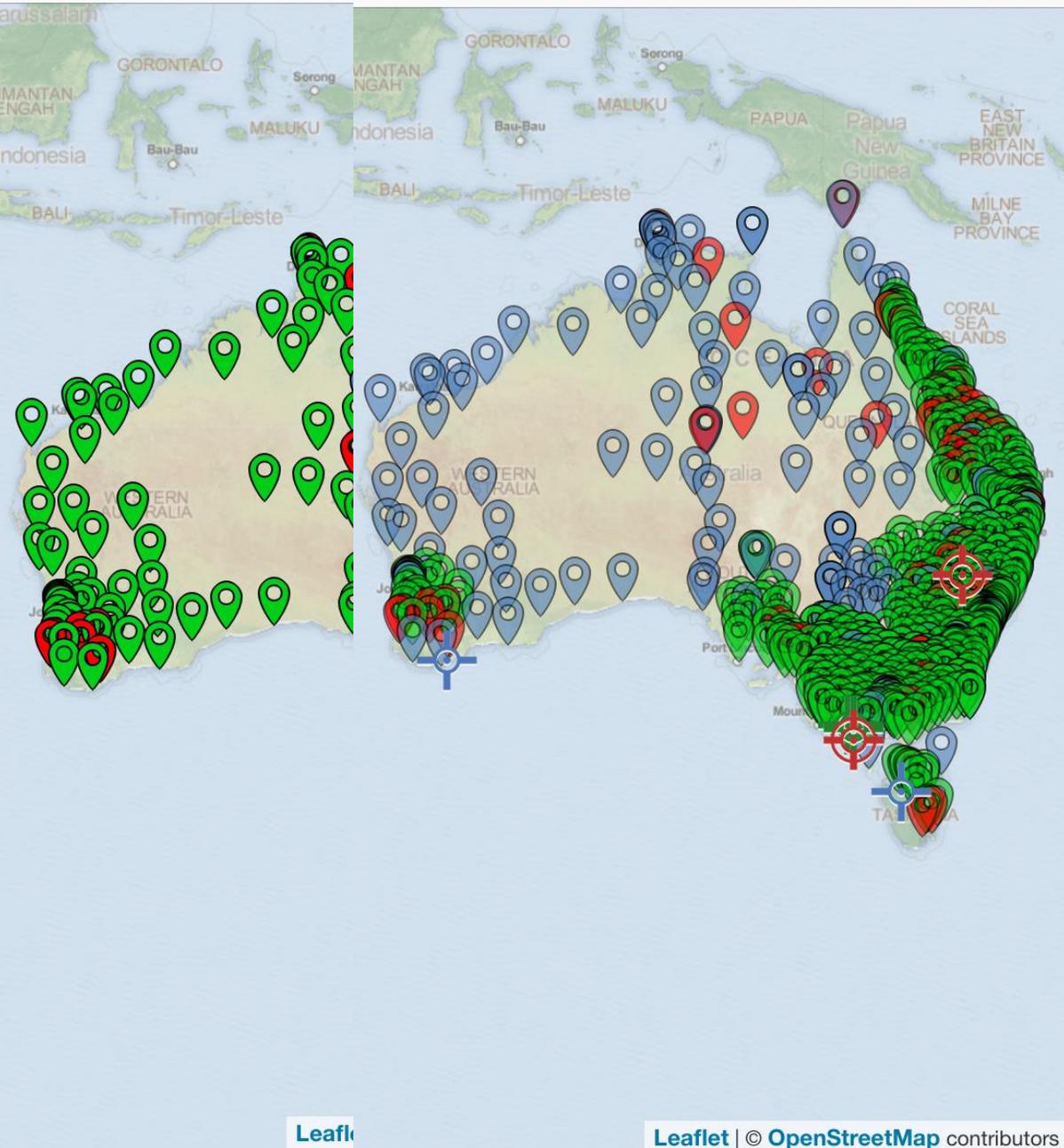
Status

Subscription period

Start Date

Renewal Date

| Start date | Subscription A |
|------------|----------------|
| 2018-01-23 | 267 Days Rem |



Thank you for your attention!
Vinaka veka levu!



Visit our web page: <https://au.hxgnsmartnet.com>
Email: Noor.Raziq@Hexagon.com