NovaSAR-S: A Low Cost Approach to Applications

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NovaSAR-S Programme Overview

- Low cost S-band SAR imagery
  - Designed as a solution for medium resolution applications where there is a market for more data or a desire for a national capability
- First satellite planned for launch early 2016
  - SSTL-300 platform avionics with bespoke structure
  - S-band SAR payload (Airbus Defence&Space)
- A collaborative constellation is planned to support timely data through rapid revisits
- UK Government £21M grant to support development of first mission
- 15% of capacity of first mission is for UK government use
NovaSAR-S Approach

- Objective - to widen access to spaceborne SAR systems and data by reducing system costs
- Low mission cost target with useful performance (spacecraft + launch + ground segment)
- Small satellite approach to manufacture and operations
  - Re-use of heritage space segment and ground segment solutions from DMC optical missions
- Flexibility on orbits and launchers
  - Shared launches
- Highly flexible modes of operation
Mission Overview

• Orbit
  – Nominal altitude ~580 km
  – 14 day repeat
  – Design optimised for Sun Synchronous Orbit (LTAN 10.30) – first mission
    • Design can be adapted for other orbits

• Ground stations
  – One ground station in the UK
  – Depending on the partner for the FNM there may be ground stations in other countries

• Mission lifetime - 7 years

• Schedule - KO to Flight Readiness Review 24 months
NovaSAR-S

Payload

Platform and ground segment solution
S-band

• Operational/planned civilian spaceborne SAR systems:

**L-band**
- ALOS-2 (2016)
- SAOCOM
- NI-SAR (2020)

**S-band**
- HJ-1-C (2016)
- NovaSAR-S (2016)
- NI-SAR (2020)

**C-band**
- RADARSAT-2
- SENTINEL-1
- RADARSAT RCM (2018)

**X-band**
- TerraSAR-X/TanDEM-X
- COSMO-SkyMed
- PAZ (2014)
What can NovaSAR-S do?

- Multiple baseline imaging modes
- Novel maritime mode – designed for ship detection
- Multi-polarisations:
  - Single, dual, tri and quad polar (incoherent) imaging available (with some compromise in resolution or swath)
- Minimum payload orbital duty cycle of >120s (>800km strip image)
  - Over 1 million km² ground coverage per day
- Experimental interferometric mode
  - Capability for repeat pass interferometry to be investigated during mission – not baseline operation
Baseline Imaging Modes

• Mode 1: Medium resolution
  – 20 m res / 100 km swath
  – 4 looks

• Mode 2: Maritime Mode
  – 30 m res / 750 km swath
  – Ship detection only

• Mode 3: Highest resolution
  – 6 m res / 20 km swath
  – 3 looks

• Mode 4: Maximum Swath
  – 30 m res / 140 km swath
  – 4 looks
Data access and products

• Data access
  – Through Satellite Applications Catapult (15% of data)
  – Commercially through partner for FNM

• Products – being defined but current plan
  – Stripmap - SLC/D, MGD
  – ScanSAR - MGD
  – Maritime - TBD (Lat/lons of detections)

• Output format
  – GeoTiff with Metadata file
  – Ellipsoid geocoded to WGS84
  – Terrain correction not part of baseline processing
Demonstration airborne data

- Flight trials in 2010 captured S-band (and X-band) data of a variety of land types for initial application and demo product development.

- 2014 AirSAR project – flights this week
  - A collaborative project between the Satellite Applications Catapult, Airbus and NERC
  - Data acquisitions in response to user EOIs
Applications

- Based on discussions with potential customers expect main application areas to be:
  - Maritime
    - Shipping, oil slick detection, ice monitoring, etc.
  - Forestry
  - Flooding
  - Agriculture
- But as with any SAR system applications are numerous so utility could be much wider …..
Maritime – Ship detection

- ScanSAR modes for coastal ship detection
- Maritime wide swath (up to 750km) mode for open ocean areas
- LTAN 10.30 orbit of first satellite complementary to dawn/dusk orbit of other SAR systems

Average revisit time in hours using Maritime mode (750km swath)
Maritime – Ship detection

- Airbus Group Innovations-Singapore are carrying out a study into sea clutter modelling and ship detection using S-band airborne data.

- A PhD study at the University of Surrey is investigating ship detection in low PRF modes (Maritime Mode):
  - Image formation not important
  - Investigating mitigation of ambiguities and point target detection.

Sea clutter modelling using homogeneous and textural models compared for S-band airborne data.

Low PRF image formed from S-band airborne data.
Maritime – AIS

- NovaSAR-S will carry an AIS receiver as a secondary payload to support data fusion

Demonstration maritime services tool displaying an S-band airborne SAR image with simulated AIS data
Maritime – Oil detection

- Stripmap for monitoring specific areas around existing facilities for leaks; ScanSAR for monitoring wider areas for illegal spills from shipping and natural seeps
- Potential to use polarimetry for classification of different types of oil

Demonstration maritime services tool displaying an S-band airborne SAR image with simulated oil slick and AIS data
Maritime - Ice

- Stripmap for localised iceberg detection around polar facilities (oil/gas exploration) and shipping routes
- ScanSAR for ice edge mapping for shipping routes
- Potential to use polarimetry for sea ice classification
Forestry

- ScanSAR modes can provide good coverage and revisit rates for forestry monitoring
- Stripmap can be used for more detailed assessment of specific areas of concern
- Potential for change detection using InSAR in Stripmap mode
  - temporal coherence will be less affected by vegetation growth than higher frequencies
Flooding and wetland

- ScanSAR modes can be used for wide area flooding assessment whereas Stripmap modes can provide more accurate mapping of specific areas.
- S-band is less affected by rain shadowing than higher frequencies.
- University of Leicester and Airbus Geo-information Services investigated S-band airborne data for wetland monitoring under the GIONET project and found good classification of wetland vegetation.
Agriculture

- Stripmap modes can be of use for mapping of fields, crop classification, growth stage etc.
- A study carried out by the University of Surrey using S-band airborne data and associated ground truth demonstrated that S-band SAR data shows good potential for vegetation classification

S-band airborne data and ground truth data of agricultural land in Wiltshire, England
Programme Status

- **Payload**
  - EQM activities complete
  - FM in manufacture
  - One phase centre will fly as an experimental altimeter on TechDemoSat-1
    - Launch 8 July

- **Platform**
  - Module Readiness Review this week
  - Platform integration begins July
  - Currently seeking first mission partner
Summary

• NovaSAR-S offers low cost access to a spaceborne SAR capability
• Designed for orbit and launcher flexibility
• Highly flexible modes of operation for a wide range of applications
• The first NovaSAR-S satellite will launch in 2016
• We are seeking partners to build a constellation
Thank You
SGR-ReSI on TechDemoSat-1

• TechDemoSat-1
  – 160 kg UK Satellite, 8 UK Payloads
  – Launch 8th July 2014

• “SGR-ReSI” one of the payloads
  – Sponsored by CEOI 2009-11
  – First CEOI payload in orbit?

• GNSS Reflectometry Instrument
  – Using GPS signals to measure wind and waves
  – Working with NOC, Southampton
    • Collection of data for models
    • Real-time demonstration

• CEOI Instrument development enabled NASA CYGNSS mission
  – 8 small satellite constellation
  – Measuring hurricanes using SGR-ReSI as payload
  – 2016 launch