

NovaSAR-S: A Low Cost Approach to Applications

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- Mission and performance
- How NovaSAR-S can support applications
- Project status
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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

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• Highly flexible modes of operation

Dnepr with three NovaSAR satellites 4

Mission Overview

Orbit

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- Nominal altitude ~580 km
- 14 day repeat



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- 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



S-band

Operational/planned civilian spaceborne SAR systems:



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 operation⁸

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



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- 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

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- 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



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Sea clutter modelling using homogeneous and textural models compared for 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



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

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Demonstration maritime services tool displaying an S-band airborne SAR image with simulated AIS data 15

Maritime – Oil detection

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- 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 facilites (oil/gas exploration) and shipping routes
- ScanSAR for ice edge mapping for shipping routes
- Potential to use polarimetry for sea ice classification

Average revisit time for single NovaSAR satellite using 30m ScanSAR mode



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

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Average revisit for 1 NovaSAR satellite in 30m ScanSAR Wide mode (3-4 days)¹⁸

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 Geoinformation Services investigated S-band airborne data for wetland monitoring under the GIONET project and found good classification of wetland vegetation

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Wetland mapping using S-band airborne data of Llanrhidian salt marsh South Wales

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

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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

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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

Nadir Antenna

Zenith

Antenna