

Sentinel-1 SAR Mission Current Status

Malcolm Davidson, Sentinel-1 Mission Scientist
Evert Attema, Sentinel-1 Mission and System Manager

Sentinel-1 Mission Requirements - Background

- Sentinel satellite family represent space component of ESA/EU initiative for Global Monitoring for Environment and Security (GMES)
- Sentinel-1 imaging SAR mission aimed at providing continuity of data for user services
- Preliminary user requirements through ESA GSEs - further inputs from EU (FP5, FP6, Fast Track Services)
- Main applications covered:
 - ◆ Monitoring sea ice zones and the arctic environment
 - ◆ Surveillance of marine environment (wind speed, oil spills, ship detection)
 - ◆ Monitoring land surface motion risks
 - ◆ Mapping of land surfaces: forest, water and soil, agriculture
 - ◆ Support to humanitarian aid in crisis situations

Derivation of Mission Requirements

User Service Requirements

- Description of service/application
- Description of radar information product
- Geographical Coverage requirements
- Access to data (e.g. timeliness)

Mission Requirements

- Data availability (Continuity, quality, Operations, Processing and archiving, Distribution)
- Coverage and revisit
- Timeliness
- Characteristics of data products (e.g. spatial & radiometric resolution, swath width, polarisation)

System Requirements

- Detailed payload, system and ground segment specification of mission (e.g. Noise-equivalent Sigma0, Ambiguity ratio, antenna size)

Observation Requirement	GMES Service									
	2.1 European Marine Environment	2.2 Arctic Environment and Sea-Ice	2.3 Land Surface Motion Risks	2.4 Open Ocean Surveillance	2.6 Forest Monitoring	2.7 Water Management and Soil Protection	2.8 Forest Fire and Flood Management	2.9 Food Security & Crop Monitoring	2.10 Humanitarian Aid	
3.1 Data Availability										
3.1.1 Continuity										
At least 10 years of service, no gaps w.r.t. ERS/Envisat	X	X	X	X	X	X	X	X	X	
3.1.2 System Performance and Data Quality										
ERS/Envisat baseline unless specified otherwise	X	X	X	X	X	X	X	X	X	
3.1.3 Operations										
Systematic	X	X	X	X	X	X	X	X		
On Demand							X		X	
3.1.4 Processing and Archiving										
All products processed to level-1 and archived	X	X	X	X	X	X	X	X	X	
3.1.5 Distribution										
From Archive			X		X	X	X	X	X	
Near Real Time	X	X	X	X			X		X	
3.2 Coverage and Revisit										
Global Monthly						X	X			
Global Annual					X			X		
Fast Global Access on Demand							X		X	
Regional bi-weekly			X					X		
Regional Daily (12 hourly desirable)	X	X		X						
3.3 Timeliness										
3 hours (1 desirable for special cases) after observation	X	X	X	X			X		X	
24 hours turn-around from order to delivery									X	
Not Critical -- typically 24 hours to 3 days			X		X	X		X		
3.4 Characteristics of Data Products										
3.4.1 Centre Frequency										
C-Band	X	X	X	X	X	X	X	X	X	
3.4.2 Interferometry										
Interferometry		X	X		X	X	X	X	X	
Intensity only	X	X		X	X	X	X	X	X	
3.4.3 Spatial and Radiometrical Resolution										
ERS/Envisat baseline	X	X	X	X	X	X	X	X	X	
3.4.4 Swath Width										
Minimum 200-300 km, larger desirable	X	X								
Follows from Revisit Requirement	X	X	X		X	X	X	X	X	
20 x 20 km (Wave Mode)				X						
3.4.5 Polarisation										
VV (Wind, Waves and Oil Spills)	X			X						
HV or VH (ship detection)	X									
VV or HH		X	X							
VV and HH (desirable)		X								
VV and VH or HH and HV	X	X	X		X	X	X	X	X	
Full Polarimetry (best for classification)	X	X	X		X	X	X	X	X	

Key mission requirements

- Continuity of data for user services
 - ◆ Data availability - no data gaps w.r.t. ENVISAT ASAR/ERS-2
 - ◆ Long term commitment to data provision
 - ◆ Data quality e.g resolution, radiometry compatible with existing SARs
- Revisit
 - ◆ Daily coverage of high priority areas
- Coverage
 - ◆ Global coverage every 14 days
- Timeliness
 - ◆ Fast and reliable data delivery
 - ◆ Conflict-free satellite operation for reliable access to data and exploitation of archive

Sentinel-1 Mission Implementation

- In general almost all user requirements can be satisfied through a SAR mission with
 - ◆ Wide-swath -> frequent revisit and large instantaneous coverage
 - ◆ High resolution -> services based on current strip map products e.g. 5 x 20m 1L
 - ◆ Interferometry -> services related to ground motion hazards
 - ◆ Dual-Pol. -> marine and land services
 - ◆ Simplified operations through single mode of operation -> reliability through elimination of conflicts + consistent archive
- IW mode part of Sentinel-1 baseline meets these requirements

Sentinel-1 Development Schedule

- ☞ Baseline Mission Requirements established 2005
- ☞ First phase of design consolidation by industry (Phase B1) completed successfully in 2006
- ☞ Main contract for development, manufacturing and launch of the satellite to be signed with industrial consortium in March 2007
 - ◆ Covers Phases
 - ☞ B2 - design consolidation
 - ☞ C - design confirmation
 - ☞ D - integration and testing
 - ☞ E1 - launch and commissioning
 - ◆ Development based on detailed technical specification of spaceborne mission and technical specifications of payload (SAR system)
- ☞ Launch expected in 2011

Sentinel-1 SAR Technical Characteristics

- Orbit: 12 day repeat
- Operational Modes:
 - ◆ Interferometric Wide-swath (5x20m, 250km)
 - ◆ Extra Wide-swath (25x80m 3L, 400km)
 - ◆ Strip Map (5x5m, 80km)
 - ◆ Wave Mode (20mx5m, 20kmx20km)
- Polarisation: Dual pol all modes VV+VH or HH+HV
- NESZ: -22 dB
- Absolute radiometric accuracy: <1.0 dB
- More than 20min/orbit of operations

Sentinel-1 Technical Concept

- Modular concept -two satellite baseline would be required to meet revisit requirement
- Launch date for 1st Sentinel-1: mid 2011
- Operations:
 - ◆ Consistent, reliable conflict free mission operations
 - ◆ NRT delivery - 1h after reception
 - ◆ Data from archive within 24 hours
 - ◆ Expected to work in pre-programmed fashion, imaging of global land masses, costal zones, shipping routes (IW) and covering the ocean with imageries (WV mode)

Future work

- ☞ Management of industrial study through all project phases
 - ◆ Formal Project Reviews
- ☞ Supporting activities
 - ◆ System analysis
 - ◆ Establish radar products and quality requirements
 - ◆ Cal./Val.
 - ◆ Define guidelines to reply in real-time to waivers from industry
- ☞ Mission requirements
 - ◆ Verification of mission concept with EU fasttrack requirements (underway)
 - ◆ Continued evaluation of mission concept with respect to evolution in service community requirements

Concluding remarks

- Sentinel-1 mission is being designed to meet user requirements in terms of data availability, coverage & revisit, timeliness and the quality of its data products.
- Sentinel-1 SAR mission design
 - ◆ satisfies most currently known service requirements
 - ◆ avoids conflicts and preserves revisit performance
 - ◆ provides robustness and reliability of service
 - ◆ simplifies mission planning
 - ◆ decreases operational costs
- Sentinel-1 industrial activity leading to building and launching of satellite initiated with launch expected during 2011