Space Situational Awareness

- Space Weather Element -

Potentially a Future ESA Optional Programme

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Scope

- A **Space Weather service** component of the **SSA** programme aims at providing to operational teams accurate, relevant and timely information on the status of the **space environment** and the **risk** of predicted or ongoing space weather phenomena to the **operational capability of European assets** (e.g. through radiation induced spacecraft anomalies, space-to-ground radio-link perturbation, enhanced spacecraft drag).
- Spin-off applications would also address other industrial needs especially in the area of power industry.

ESA Space Weather Programme Preparation Activities

- Space weather user requirements, system service requirements, system requirements have been well established by ESA studies led by Alcatel and RAL (1998-2001).
- A pilot service provision infrastructure has been developed through the ESA space weather pilot project (2001-2005) and is still operational.
- ESA SSA parallel studies (Astrium, QinetiQ, ONERA) reviewed space weather requirements in this new context:
  - requirements were discussed by SSA user groups (and focussed on spacecraft effects).
  - technology requirements have been investigated as part of three parallel studies.
- A Space Weather element as part of an optional Space Situational Awareness Programme proposal prepared jointly by DG-P, D/OPS, D/TEC, and D/SCI was discussed at ESA council Dec 2007.
- Draft declaration based on March 2008 ESA council still foresees a Space Weather element.

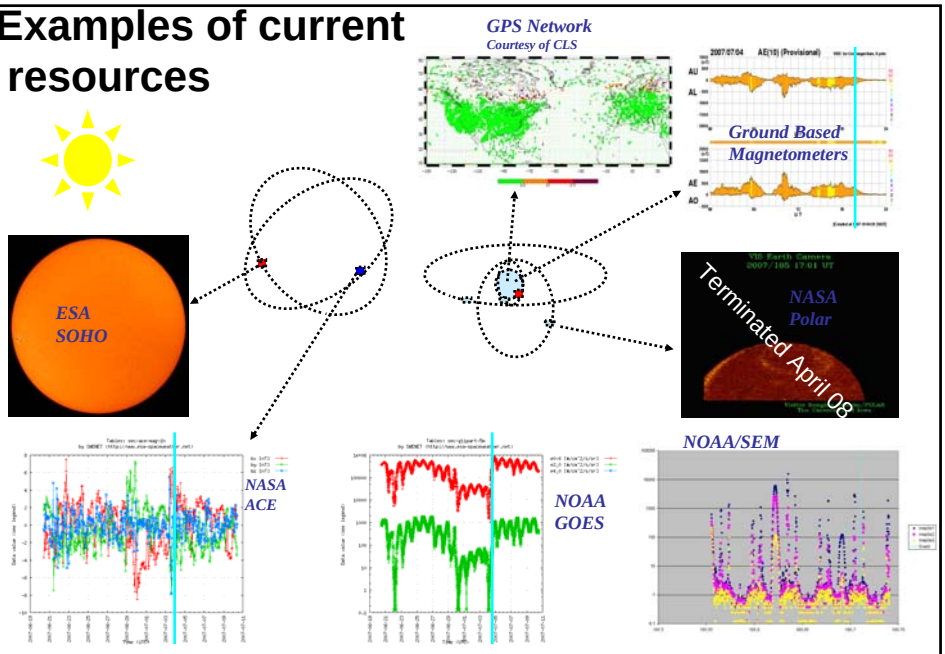
Targeted space weather services

- User needs:
  - local spacecraft environment (radiation, electrical, geomagnetic, …) forecast, nowcast[1] and post-event analysis
  - neutral atmosphere nowcast and forecast
  - ionospheric density profile and perturbations nowcast and forecast, with specific reference to Galileo accuracy degradation at high latitude
  - ground-level magnetic field variation monitoring and forecast.
- Space weather services:
  - monitoring of the Sun, the solar wind, the radiation belts, the magnetosphere and the ionosphere.
  - provision of reliable local spacecraft (and launcher) radiation, plasma and electromagnetic environment data for historical re-construction, nowcast and forecast of hazardous conditions.
  - provision of timely and reliable ionospheric disturbances nowcast and forecast
  - prediction of thermospheric density for spacecraft drag calculation.
  - provision of timely and reliable ionospheric density profile nowcast and forecast.
  - Provision of results of ground-level magnetic field variations monitoring and forecast

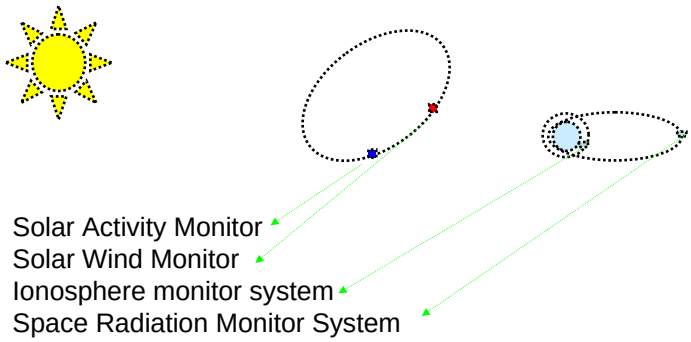
[1] To nowcast is the action of re-constructing in real-time the present environment based on actual data, proxies and models.

Table 2: **High level measurement requirements versus high level service requirements**. Relevance scale in each category: XXX: Critical for all services XX : Critical for some services X : Important but not critical - : Not relevant		Service category				
		local spacecraft environment post-event re-construction, nowcast or forecast	prediction of thermospheric density	ionospheric scintillation nowcast or forecast	ionospheric density profile nowcast or forecast	ground-level magnetic field variations monitoring or forecast
Measurement requirements	Space based in-situ radiation monitoring	XXX	-	-	-	-
	Space based in-situ magnetospheric plasma monitoring	XX	X	X	X	X
	in-situ monitoring of the solar wind plasma and magnetic field	XX	XX	XX	XX	XX
	Ground geomagnetic field monitoring	XX	XX	XX	XX	XXX
	Ionospheric remote sensing (ground based and space-based monitoring)	XX	-	XXX	XX	X
	Solar surface and low corona real-time imaging	XX	XX	XX	XX	XX

Examples of current resources



Possible European Architecture
CDF Study, Santovincenzo, 2001.

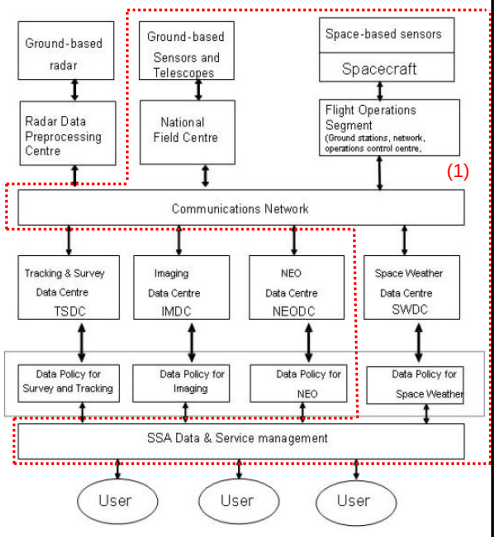


- Solar Activity Monitor
- Solar Wind Monitor
- Ionosphere monitor system
- Space Radiation Monitor System

- Existing monitors on ESA or Member States S/C
- METOP

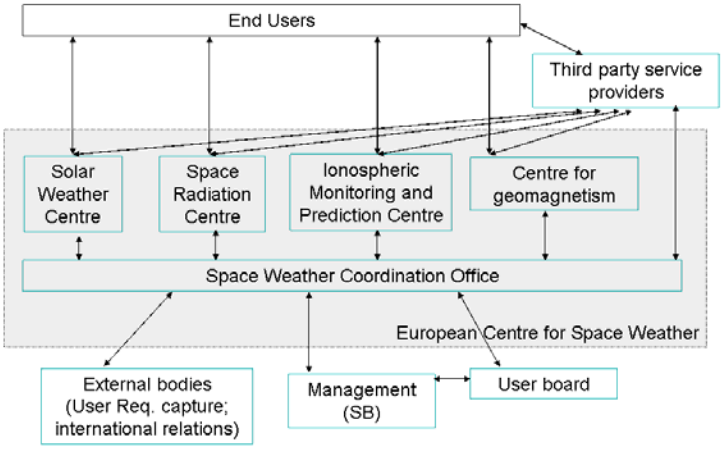
Organisation

- **4 service elements**:
  - Surveillance and Tracking of man-made space objects
  - Man-made Space Objects Imaging
  - **Space weather monitoring and forecast**
  - Near-Earth Objects Surveillance and Tracking
- **1 support element**:
  - Networking and data centres



(1) Identification of space weather related components

Organisation



Possible baseline

Period 1:

- Consolidation of the requirements related to the Space Weather activities in Europe
- ***Implementation of the envisaged European Centre*** and related network infrastructure for Space Weather Services based on utilisation & consolidation of existing distributed assets.
- Initiation of the **design of the required spacecraft payloads and platforms** (e.g. through the CDF at ESTEC)
- Establishment of agreements and designs for implementation of **SW auxiliary payloads on already planned ESA/European partner spacecraft**.
- Definition and enhancement of the services provided using the existing prototype Space Weather Network (SWENET)
- Establishment of a detailed list of **standards for Space Weather data**
- Coordination with international partners.

Period 2:

- targeted development & deployment of **ground-based space weather monitors**
- **development of a dedicated space weather service precursor (micro-satellite based)** based on operational experience an requirements.
- Launch of a first **service precursor for radiation belt monitoring**.
- Further extension, development, validation of Period 1 - in response to **evolving user requirements**. Range of fully operational services expanded. Developments include **full scale** service including **precursor space segment** (possibly micro-satellite based) potentially monitoring the state of radiation belts, solar wind, and solar eruptive phenomena.

Next steps

- Potential participant board activities (next meeting: 10 June)
  - Programme declaration (in drafting)
  - Update of programme proposal (if needed)
  - Implementing rules (drafting)
- User meetings continue
- EDA gathers certain requirements.
- Discussion at October 2008 Council meeting
- Submission for approval at November council meeting.