Space technology, integration of intelligent in situ sensors using navigation and satellite telecoms

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Astrum: part of EADS

EADS
a global leader in aerospace and defence

Astrum’s activities are based in three key areas

ASTRIUM
SPACE TRANSPORTATION
The European prime contractor for civil and military space transportation and manned space activities

ASTRIUM
SATELLITES
A world leader in the design and manufacture of satellite systems

ASTRIUM
SERVICES
At the forefront of satellite services in the secure communications, geo-information and navigation fields

Astrum Satellites

TELECOMS
Established in a challenging commercial market and a major provider of military systems
Eurostar E3000, best-selling telecoms platform

EARTH OBSERVATION
NAVIGATION & SCIENCE
Prime manufacturer of Earth observation satellites
Design and manufacture of highly versatile platforms, optical and radar instruments
Ground segment equipment

PRODUCTS
World-class developer and supplier of space products
In-house development of key equipment, subsystems and leading-edge technologies
Leading small satellite design, manufacture and launch
Earth Observation & Optical instruments
Ground Mission control

Astrum Services

GEO-INFO SERVICES
Services to governments & commercial users
The leading European provider of geo-information products & services

SATCOM SYSTEMS & SOLUTIONS
Systems & Ground Segments to MoDs
The UK leader for secure space-based communication systems & ground segments

TELECOM SERVICES
Services to national MoDs, governments & multinationals.
The unique one-stop-shop provider for commercial & military band services.

Astrum Facts & Figures 2011
Employees: 18,000 (UK 3,500)
Turnover: €5 billion
Order backlog: €14.7 billion

All Astrum Satellites and Astrum Services divisions shown represented in Astrum UK
Space has some unique capabilities
Irrigation monitoring: Khufra (Lybia) and Ahvaz (Iran)
Irrigation patterns in Olton (USA) seen by Pleiades (01/2012)
SMOS: moisture and drought in France (2010-2011)
Floods in Tewkesbury monitored with TerraSAR-X

Left, Terrasar-X image acquired in July 2007

Right, simulation results and map display
From satellite imagery to GIS information

Map of irrigated crops
South-West of France

Cultures d'été irriguées
surfaces en ha

- 0 - 31
- 32 - 79
- 80 - 131
- 133 - 191
- 192 - 260
- 262 - 338
- 340 - 432
- 434 - 550
- 553 - 670
- 676 - 811
- 814 - 962
- 982 - 1179
- 1192 - 1400
- 1511 - 1983
- 2089 - 2688

Bassins Adour/Garonne
Bassin_Adour_Garonne
Space based assets supporting Critical National Infrastructure

- Military & Commercial Communication
  - Mobile command centre communication
  - Inter agency communication
  - Rapidly replace previous communication
  - Facility monitoring
  - Text, voice, data, video
  - Database and images distribution

- Observation
  - Rapid update Optical images
  - Rapid update SAR (RADAR) images
  - Overlay onto map data
  - Database of images

- Weather & Environmental
  - Weather forecasts
  - Prediction of debris / affected areas
  - Environmental impact analysis

- Navigation
  - Location
  - Navigation
  - Resource location

All the space you need
Commercial telecom Eurostar 3000

- 2009/10 Astrium built a ¼ of world telecoms satellites by value
- E3000 SX, M, L and LX range
- Highly modular multi-variant product
- Payload power 4 to 14+ kW
- Launch mass up to 6.8 tonnes
- Comms Module 1, 2 or 3 floors
- Electric &/or Chemical propulsion
- Tank capacities 2.6 to 3.3 tons
- Scalable solar array and batteries
Space science

- World-renowned expertise for building satellites, probes and instruments for exploration missions
- Planetary exploration
- Deep space missions
- Astronomy
- Fundamental physics missions
- Monitoring solar activities and Sun-Earth interaction
Astrium UK Key Competencies

- Satellites Centres of Competence
  - Scientific & Exploration Prime Missions
  - Military Telecom Prime Missions
  - Civil Telecom Payload Prime
  - All Eurostar Mechanical Platform & Telecom Payloads
  - Instruments (inc. Radar)
  - Telecom RF Products, Antennas, Processors and Mechanisms
  - Satellite & Equipment Propulsion Design Authority
  - Engineering (inc. Systems, Mechanical, Stress, Thermal, 3D, Electronics, Power, Flight & Ground Software, Avionics & orbital control systems)
  - Manufacturing, Assembly, Integration & Test. Environmental Test

- Paradigm:
  - Skynet 5 Concession
  - Milsatcom Service Delivery
  - Satellite Operations, Procurement, In orbit test
  - Welfare Service delivery

- Satcom Systems & Solutions:
  - Military Satellite Systems
  - Military Ground Systems, Network Management Systems
  - Military Ground, Mobile, Naval & Airborne Terminals

- SSTL:
  - Small Satellite Missions
  - Optical Missions (e.g. DMC3)
  - Galileo Payload WO1 & WO2

- Infoterra: Geo Info Services
  - Satellite/Aerial Imagery
  - Mapping & Analysis
  - Geo-information products & services
Telecom Space systems offer advantages

- Where access to remote zone is not covered by classical networks
  - there are power sub-networks in Canada, that are controlled via satcoms.

- Where a worldwide, or large geo zone with seamless coverage is required
  - container tracking, S&R over maritime zones, multinational pipes monitoring…

- Where a secured system is required beyond the national systems & networks
### Application domain - example

- **Huge potential market in Home Area Networks – the smart home**
  - Billions of units foreseen eg. Zigbee or Blue-tooth Low Energy chipsets
  - Smart metering is the first service to be mandated in the UK
  - Many other potential applications including health monitoring

- **Wide Area connectivity.**
  - Actual data rates can be low
  - Bandwidth minimized through use of deterministic polling
  - Proprietary air interface for security and reliability
Suppliers purchase from DCC:
- Secure comms links to meters
- Processed data products

DCC purchases capacity from WAN Comms Carriers

Suppliers provide meters, IHDs, WAN modules and HANs

**WAN Comms Carriers**

- Long-range radio eg BT/Arqiva
- Cellular Op 1
- Cellular Op n
- Satellite Op 1
- Power line to aggregate point (Backhaul via Satop, ADSL, ..)

**DCC WAN Network (TBD)**

- Data Functions
- WAN Interfaces

**Suppliers**

**WAN Operators**

**Others**

**WAN Module**

**HAN**

**Elec**

**Gas**

**IHD**

**Water**
Satellite Modem key features

- Low data rate, simple antenna, very low costs, self-install
- Wireless link to indoor HAN and connected services
- Protocol optimized to minimize message size & overheads (includes polling and broadcast modes)
- Secure, reliable, intrinsically safe within system
- Environmentally friendly device
- Self-registry and auto-configuration Device
- Low power Device (e.g. 15 years from an AA battery or solar powered)
Sat WAN - Concept evolution

- Basic ideas are not new
  - Potential of direct satellite communications to "throw-away" terminals identified in BNSC S@tcom study (2003)

- Large satellite antennas and throw-away terminals not available in 2003.
  - Example: Feasibility of very low power terminal communications via Inmarsat 4 confirmed in Astrium funded study (2010)

- Low cost satellite terminals are now feasible
  - Very low power mixed analogue and digital chip-sets now available in quantity at <$1 cost.
  - High integrity throw away modems now used in the medical sector
Potential modem development

- LDR modem similar to a sat nav
  - Small size, integral antenna
  - For many applications powered by ambient light
  - 50mm square solar cell adequate

- Modem “always off” ensures very low power
  - Broadcast frame structure defines operating mode
  - Deterministic polling - rapid or slow
  - Random access mode for setup and emergency
  - Integral GPS/Galileo chip for TDM timing and position
  - Streaming mode for repetitive data sets
  - High integrity wireless connectivity built in
  - Very simple user setup
Small Satellites Applications

- Small Satellites are ideally suited to asset tracking and monitoring applications
- ‘ExactEarth-1’ (Left) – an AIS (Automatic Identification System) satellite
- 100kg, <$10m
Small Satellite Constellations

- SSTL has built a number of Small Satellite constellations for Earth Observation
- Disaster Monitoring Constellation (DMC), and RapidEye (left)
- Store and Forward type messaging missions (asset tracking & monitoring, e.g.) can be based on very similar platforms and constellations
- SSTL bid to build the Orbcomm 2 constellation; ~16 satellites of ~200kg each.
Backup
• New concept in radar remote sensing
  • Low cost programme generating low cost data products and services
  • Partnership between Astrium & SSTL provides an ideal combination of expertise in SAR payloads and low-cost spacecraft
• Optimised for targeted applications
  • Addressing underserved market for medium resolution imagery
  • Applications include maritime, security, environmental monitoring (incl. deforestation) and disaster relief (incl. flooding)
• Complementary to other data sources
NovaSAR Operating Modes

15-20km swath width imaging:
- 6m resolution single-polarisation
- 7.5m resolution dual-polarisation
- 10m resolution, triple-polarisation
NovaSAR Operating Modes

20m resolution imaging mode: 100km swath width, single-polarisation

75km swath width, dual-polarisation

50km swath width, triple-polarisation

Also a 30m resolution imaging mode: 150km swath width, single-polarisation

112km swath width, dual-polarisation

75km swath width, triple-polarisation