MULTISAT-WEBSERVICE
MOBILE ON-DEMAND SERVICES FOR MOBILITY AND TRAFFIC

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ABSTRACT

MultiSat WebService is a spaceborne service concept primarily to support, extend or substitute information services for mobility and traffic purposes. It allows the determination of traffic data from space on a global and near-real-time scale. Main objective is to provide a profitable service for mobility and traffic management. A market survey being made shows that spaceborne online information services may be viable. The service provides the possibility to receive pre-processed, near-real-time Earth surface data with E-commerce compatible methods. The system design gives the opportunity to freely configure the space system according to customers needs.

The MultiSat infrastructure design features a satellite constellation with imaging Synthetic Aperture Radar (SAR) and optical payloads combined with low-rate communication especially established to support this service. Also included is a scalable, fault tolerant, multi-computer system. The development cycle focuses on an airborne demonstration of the service idea as a first milestone.

The MultiSat WebService concept is being created and designed by a consortium consisting of German Aerospace Center (DLR), Technische Universität Dresden and Fraunhofer Gesellschaft FIRST and presented here as a visionary feasibility study.

1. INTRODUCTION

MultiSat WebService is a web-based multipurpose satellite service concept characterized by an on demand freely configurable and programmable on-board processing of payload data. For the first time, customers such as content providers will have access to data via a transparent and application-independent interface to destined payload components. The overall objective is to achieve a maximum broad applicability of the spacecraft payload configuration. The content provider will be capable to develop and implement value-added information services on promising business fields with high commercial relevance. Best access to the market shall be achieved using E-commerce compatible methods via Internet. The concept shall cover all value chains as an end-to-end scenario from final users to space and ground system infrastructure.

The vision for MultiSat WebService in the application field of mobility and traffic is to provide current information of mobile objects in a selected region at any time and from anywhere via modern media.

The operational system of MultiSat WebService will consist of a low Earth orbit satellite constellation (LEO) with a corresponding ground segment for data distribution and customer access. Usually satellite based networks are dedicated to special tasks like Earth observation or telecommunications. However, value-added information services targeting on different market segments such as traffic management, object tracking or disaster management mostly require a combined payload system with capabilities in the areas of Earth observation, communications and onboard computing.

MultiSat WebService merges these three kinds of capabilities in order to achieve the envisaged quality of service according to the requirements in the selected fields of applications. The system concept foresees satellites with a combined remote sensing payload and low-rate communication. The payload is supported by an advanced onboard data management system for its data pre-processing & classification and augmented by existing navigation services as Global Positioning System (GPS). The payload shall be capable to be configured and programmed on demand by content-providers according to the needs of existing users via a web-based service portal. The system provides current information in the field of mobility and traffic in near-real-time on demand via Internet.

2. SYSTEM DESCRIPTION

2.1 Vision

The vision for MultiSat WebService in the application field of mobility and traffic is to provide current information of

mobile objects in a selected region at any time and from anywhere via modern media.

2.1.1 Costs. To determine the costs first of all the different recording systems should be compared in order to find out what is the position of the satellite based traffic data recording. Due to the cross-border operation of such a system it would be at the disposal of a continental economic area. For this reason the costs should also be addressed to an international user circle.

According to a conservatively calculated full cost analysis for a system as developed in the study "MultiSat WebService" as one realistic variant costs would be in the order of magnitude of those of the GALILEO satellite navigation system. However the result would be a multi-purpose system that can be used for a broad variety of applications.

The costs are another reason for which a cross-border operation of such a globally available, satellite based traffic recording system is required. As the total budget of the European Space Agency amounts to $ 2.7 billion it is not realistic to try to implement such a system in a short period of time. However in 2000 the turnover of the commercial satellites for Earth observation and telecommunication amounted to $ 80 billion, this figure representing a 17 % increase of the turnover compared to 1999. The European traffic sector covers a share of over 10 % of the gross domestic product. This corresponds to a volume of approx. € 1,000 billion. Based upon this figure the expected costs for the building up of the system described would represent a share of less than 0,08 %.

2.1.2 European and Global Dimensions. Considering the up-coming globalization of transportation routes with future borderless transportation on land and sea the service has to be designed, developed and implemented according to requirements derived from general evolutions in the area of mobility and traffic. The service has to work trans-boundary both over nations and topographical conditions (land, sea).

The vision for borderless transportation and traffic on the European and global scale is strongly envisaged by the MultiSat WebService system. Borderless transportation means to combine traffic data from the applicable countries. Even on an European scale a globally operating data collection system such as MultiSat WebService is economically beneficial, if comparing its costs with those of local terrestrial systems for traffic data collection.

2.2 Objectives

Main objective is to establish a profitable service. Most promising market segment is the road traffic management aiming to congestion avoidance or disaster management in emergency cases. Targeting on road traffic management as a pilot application requires the most technical challenges due to high dynamics and large number of mobile objects to be detected. However, once service has been realized the service infrastructure is compliant to enter additional market segments in the field of mobility and traffic or even in other lines of business. Other segments are object tracking, disaster management and urban & rural planning.

The objectives of the study for satellite based traffic measurement are:

- to identify the transport and traffic management architecture functions where MultiSat WebService can provide solutions.
- to demonstrate that a spaceborne based service for Mobility and Traffic is feasible.

The study discusses the implications in the different fields of applications. Existing systems for traffic management can either be replaced or, in most cases, upgraded. New applications are possible where MultiSat WebService can make use of its product advantages, e.g. the coverage of a whole area in a simultaneous manner. Especially for traffic planning and research, this feature will lead to considerable progress in understanding, modeling and handling of traffic behavior.

MultiSat WebService describes a spaceborne image based (optical and SAR image) global information system on traffic situations which can optionally be augmented by low bandwidth communications. Basic idea is to cover the whole world from space using a surveillance system providing high resolution pictures, which leads to easy access of high quality traffic data.

2.3 Concept

Implementation of a proper road traffic management system seems to have the most significant impact on the improvement of the existing traffic infrastructure especially in regions with high volume of traffic. One method to prevent traffic congestion and high traffic density is to establish a traffic management system for dynamic route guidance as a top level service which monitors and influences traffic flow pattern. The top level requirements for an efficient traffic management system are

- the capability to detect traffic density data (vehicles per meter) for the considered road section.
- the capability to determine the velocity (meters per second) of all detectable vehicles at selected cross sections and to detect the cruising speed over long distances.
- determining of local co-ordinates during position detection to fix the length of a traffic jam and to fix traffic distortions to an accuracy of 1 to 5 meters.
- detection of all relevant traffic data in near-real-time (minimum resolution of 15 minutes revisit time).
- detection of position and velocity of at least 1 % (significant value) of the total volume of vehicles for combination with terrestrial generated traffic data.
- a system availability of more than 90 % with respect to time and space (also during bad weather and darkness conditions).
- a global availability of the system and interoperability with terrestrial systems.

To meet these requirements a frequent revisit time in monitoring the target area of less than 15 minutes is made possible by a satellite constellation with the respective number of units. This provides full and continuous coverage. Through direct access via internet or a direct data link via low-rate communication it will be possible for the customer to get instantaneous information of the current traffic state from the on-board pre-processed image data. Typical customers besides content providers will be road authorities and traffic researchers. Advantages and benefits lie both in terms of

quality and quantity compared to existing terrestrial systems or airborne systems for traffic management purposes.

The following work flow illustrates the MultiSat WebService tasks to provide near-real-time information service to content providers and final users:

Step 1
- Collect content provider data or payload configuration requests via Internet service portal
- Schedule content provider requests
- Transfer list of scheduled requests to satellite constellation

Step 2
- Generation of Earth observation images by remote sensing payload

Step 3
- On-board payload data pre-processing, i.e. thematic image data reduction by dedicated on-board software
- On-board data evaluation and classification
- Low-bandwidth downlink of application data

Step 4
- Data transfer to the content provider via Internet service portal

Step 5
- Subsequent data processing on ground by content provider including
- Merging with terrestrial generated traffic data
- Generation of requested traffic data
- Data transfer to the final user via Internet or other media.

3. SERVICE SCENARIO

MultiSat WebService offers global near-real-time Earth surface data from required regions which are pre-processed and intermediately stored in a ground data base. Data products for traffic management purposes such as vehicles per region are simply accessible on the web-based service portal via Internet. MultiSat WebService data products enable the customers to increase their quality of traffic management services in offering near-real-time, global and borderless online traffic information to final users.

The following example illustrates the added value of MultiSat WebService in the area of cargo logistics.

In the area of long-distance road haulage, fast and just-in-time delivery of cargo as well as high transportation load are the most important criteria for competition. So leading logistics companies tend to optimize the routes of their trucks depending on the current traffic situation and delivery schedule. Nowadays voice communication via radio media or mobile phone in combination with a static navigation system plays a decisive role. These components depend on local boundary conditions changing rapidly at geographical or political borders. Weaknesses of existing systems are:

- Correct exchange of information between instructors and drivers via radio media is not assured.
- Digital roadmap data basis of navigation systems differ significantly over national borders with respect to actuality and degree of detail.
- Communication costs of mobile phones increase rapidly at national borders, e.g. as soon as the so called roaming services are necessary for passing on information.

Dynamic guidance of a truck to its destination is almost impossible due to the current traffic situation, due to customers willing to change the delivery destination or changing sequence priorities of cargo delivery. MultiSat WebService can improve this situation by providing a completely new kind of data base for traffic guidance purposes. Traffic information as well as navigation services can be provided in a comprehensive and borderless way with reliable quality. This can be achieved for example by the fact that a single content provider can offer this service on European level. Even larger logistics or transportation companies may extend their services in offering exclusive route information to their own fleets for the whole region of business activities or even to competitors including intermodal traffic information.

4. MARKET ANALYSIS

4.1 Overview

In a first step traffic management, object tracking, disaster management and urban & rural planning can be identified as potential market segments. Related hereto, the implementation of a proper traffic management system seems to have the most significant impact on the improvement of the existing traffic infrastructure under economical point of views, especially in regions with high volume of traffic. According to a survey, a representative number of entrepreneurs expects benefits for their companies in the area of sales of up to 20 % from a load reduction in traffic network utilization. So traffic congestion and high traffic density decline economical growth significantly.

4.2 Market Survey and Method

The market survey, which was a part of this feasibility study, is based on a classification of traffic telematics applications taken from the European Community´s classification definition. The corresponding functions have been compared with the main objectives of the MultiSat WebService. Interviews with professionals, experts and potential customers have been performed to support the results of the targeted application evaluation and priorization process. The list of the targeted applications has been used for market segmentation. First estimation of the market volume and the potential market share has been made to give an idea for a MultiSat WebService business opportunity. The survey is focused on the transportation and mobility. Promising results are expected for other areas as mentioned above which are subjects for further market analysis.

4.3 Product Classification

Classifying the products of MultiSat WebService leads to various system parameters and quality of services.

There are three different observation classes (A – C). They are characterize by:

A) Complete optical and complete SAR constellation, revisit time of 15 minutes.
B) Complete optical constellation small SAR constellation, revisit time 15 minutes (optical) and 12 hours (SAR).
C) System demonstrator.

The classes have been compared with the demand of the traffic telematics service functions.

4.4 Method 1: Interviews

Professionals, experts and competitors as potential customers have been selected for an interview survey based on standardized questionnaires.

Most of the companies show hesitance to accept a satellite based service, if floating car data (FCD) methods are available to offer traffic forecasting services based on terrestrial communication with mobile cars. Common opinion is that high investments for a satellite based infrastructure cannot compete with low-cost terrestrial traffic monitoring systems. However, companies are interested in short term digital map production derived from remote sensing data on a day-by-day delivery time. Registration of the Earth's surface with larger time periods seems to be reasonable for an updating service of traffic simulation and forecasting (georeferencing and mapping).

4.5 Method 2: Market Size Estimation

Initial potential market volume is estimated to be 60 Million EURO / year. Estimation is based on a market share world-wide of up to 40 % after 10 years, taking in account to enter the market with 5 % in the first year of business. Hence, the cumulative market volume after 10 years with a yearly penetration growth of 25 % is expected to be 105 Million EURO.

The estimation is based on three types of MultiSat's services penetrating the market:

1) Substitution of Existing Services:

Existing services might be substituted due to the fact that a global borderless service is more cost efficient than local services.

2) Extending Solutions with Improvements:

Services might be extendible with respect to increasing quality of services (e.g. wide area information, timeliness).

3) Creating new Services:

Using MultiSat WebService could arise the creation of new services and user demands.

4.6 Marketing Strategy

4.6.1 Product Placement. Main purpose of MultiSat WebService is to offer a business-to-business service highly adaptable in terms of payload configuration and user needs. MultiSat WebService is supplier of a processing service for traffic monitoring and control in providing access to near-real-time Earth surface data for further processing by professional service providers primarily for the transportation and logistics segment. MultiSat intends to provide an end-to-end service including operations of the space segment and ground infrastructure, data pre-processing and web-based system access.

Cost-wise the market specialization of MultiSat primarily on transportation and mobility and its independence from other systems, offers the advantages of a single-point sale and optimization of service costs. Hence, price on a scale and on performance levels is not economically achievable otherwise. Main products of MultiSat on the transportation and mobility segment are to provide

- global available traffic observation data,
- E-commerce interfaces via customer portal and mobile communication,
- traffic information derived from image data (optical and SAR) and
- data for congestion forecasting based on online traffic simulation.

4.6.2 Unique Selling Proposition. MultiSat intends to offer services to customers being able to extend and improve their market position in the field of transportation and mobility. In a strategic partnership with transportation professionals and content providers MultiSat will be capable to offer an "Online Mobile Traffic Management from everywhere". The partnership enables MultiSat to provide global services as an unique selling proposition (USP) which are on-demand global information services

- for wide area and borderless traffic information
- as an extension and linking of existing traffic services
- integrated in E-Commerce compatible traffic services (customer integration).

4.6.3 Value Chain. MultiSat understands itself as one element of the value chain between manufacturers and existing service providers. Main purpose is to operate the necessary infrastructure satellite system made by manufacturer for further data processing by the existing service providers. Seeking for partners as the manufacturer of the satellite system helps to reduce risks of high investments. Focusing on global players as potential customers in the area of traffic and transportation services is the most important strategy to reduce risks in entering the market.

4.6.4 Further Market Penetration. The challenging technological requirements of the MultiSat WebService infrastructure in order to support the online market of transportation and mobility fully satisfies the demands of other market segments. With its agility, near-real-time property and the compatibility with E-commerce interfaces it is intended to offer the services relying on partners and subsidiaries in the field of geographical information systems applications, science, infotainment and media.

5. SYSTEM DESIGN AND ENABLING TECHNOLOGIES

5.1 Space Segment Design

Space segment of the MultiSat WebService system will include a constellation of satellites on low Earth orbit (600 km). The possible realization of a 60 satellites constellation means that MultiSat WebService will be the first (civil) system offering the possibility of any Earth observation in regular and relatively small time distances. This will be essential for any kind of applications as traffic monitoring, catastrophes and natural disasters monitoring and prediction or media support. The constellation is planned to include two payload types: Optical imaging payload and SAR payload. Operation of SAR does not depend on weather and illumination conditions, but requires a considerably large and expensive satellite platform. Optical imaging payload can be accommodated within relatively small and cheap platforms, but requires clear sky and cannot be used at night. In the final extension the constellation will combine the advantages of both imaging approaches.

MultiSat WebService is based both on existing, commercially available and cost efficient technologies and on technologies, which are not established up to now within satellite applications. Development and implementation of such key or enabling technologies highlight the uniqueness of the MultiSat WebService approach. For system feasibility demonstration it could be installed some of these enabling technologies like the optical smart imaging system onboard the International Space Station (ISS) or on a small satellite.

5.2 Smart Optical Imaging Payload

State-of-the-art remote sensing cameras are suffering from high attitude stability requirements, resulting in high efforts on engineering and attitude control equipment for the hosting satellite.

MultiSat offers innovative imaging systems which can work even on poorly stabilized satellites by application of embedded optical computer technology. These new intelligent, compact and robust high-quality remote sensing cameras are fully compatible with moderate attitude stability performances of standard small satellites, general purpose free-flying platforms or LEO communication satellites.

The solutions are based on advanced optical computer technology, currently developed at Technische Universität Dresden, which allows in-situ measurement of disturbing camera image motion and successive image correction in real-time, while preserving extremely compact camera dimensions and simple camera design.

Two complementary imaging systems are currently under development, incorporating different means for image correction:
High-Resolution Panchromatic Imager

- ground resolution 2 meters
- swath width 20 km
- small aperture, panchromatic charged coupled devices (CCD)
- opto-mechatronic image correction (integrated focal plane stabilization assembly).
- Medium-Resolution Multi-Spectral Imager
- ground resolution 20 meters
- swath width 240 km
- wide angle, line sensors, 4 spectral bands (blue, green, red and near IR)
- opto-electronic image correction (integrated image motion measurement and posteriori image correction).

Images from the high-resolution imager will be used for vehicle detection as well as for vehicle velocity estimation from image sequences. Off-nadir observations can be realized by an one-axis tilting mechanism (±25 deg).

The wide angle multi-spectral imager will be used as navigation aid for the high resolution imager and as stand alone imager for medium-resolution environmental/ background remote sensing.

5.3 SAR Payload

5.3.1 State-of-the-Art. The SAR payload can produce high resolution (1–3 m) image data with an instantaneous swath width of 10–20 km. Larger swaths would require to reduce resolution. The position of the swath with respect to the nadir can be changed by steering of the beam or the satellite (15–60 deg). The average power consumption of such a SAR system would be in the order of 500 W. The weight can be estimated by 200–500 kg. A SAR antenna with two different phase centers is capable to measure the velocity and direction of moving objects (MTI – Moving Target Identification mode). This mode is of special interest for traffic monitoring. Experimental airborne systems with MTI mode have been successfully demonstrated by relevant institutions.

5.3.2 Further Developments. From today's perspective a dramatic reduction of mass and power consumption of a monostatic SAR sensor can not be expected. Nevertheless, there are especially two developments which have the potential for considerable improvements:

- The use of large inflatable-deployable antennas could increase the field of regard of a single sensor. This would reduce the total number of satellites to fulfill a certain requirement on the revisit time.
- A bistatic system with a large illuminator and a large number of small receiving satellites could possibly improve the revisit time and the overall costs.

The development of MultiSat WebService will benefit from ongoing SAR satellite projects, e.g. ENVISAT or TerraSAR.

5.4 Onboard Data Processing System

Given the objectives of MultiSat WebService, the onboard computer system has to provide a powerful and flexible computation and communication infrastructure. MultiSat's computing system will be realized as a scalable, fault tolerant, multi-computer system which will execute all control, telemetry and monitor tasks as well as the application specific payload data processing. Depending on the required computing power and redundancy for fault-tolerance, the system will comprise 3–16 identical node computers, which are connected by a redundant bus system. Technologically, the onboard computer will benefit from using the latest very large scale integration (VLSI) technology. However, to take advantage of the VLSI technology without decreasing the system's reliability, special hardware and software features will be implemented in each of the system's nodes to handle the mission-critical radiation problems.

MultiSat's software architecture follows the approach of the hardware architecture forming a modular, distributed and highly redundant system architecture. The notion of a software back-plane allows the system to be dynamically configured by simply plugging software components in and out of the back-plane. The software buses transparently provide secure, fault-tolerant and location-independent communication among the tasks by using the redundant physical connections between the nodes. A dedicated task of the operating system implements the Java virtual machine (JVM) execution environment. This encapsulated execution of Java applications ensures that the vital control functions of the satellite are securely protected from user applications which can be dynamically loaded and executed.

5.5 Web-based Access Portals

Final users or content providers will have access to the service via the Internet and will receive information based on their need (area or road). No knowledge about Earth observation methods is required because on-board and ground processing

of the traffic images results in data reduced, textual information. The customer will not recognize that the context related information is derived from pre-processed Earth observation images. Two different access methods are foreseen.

5.5.1 MultiSat Service Portal – Access Portal to the Space System. Professional users or content providers in the business range of traffic management will get access to the satellite payload via an Internet service portal. The portal gives the opportunity to adjust and configure the sensor data processing and time-scheduling. Security mechanism make sure that basic satellite functions (e.g. power management or communication system) are not accessible by the content provider.

5.5.2 User Access Portal – Access Portal to Traffic Data. A web-based access solution, based on an Internet data base type of application is offered. Basically, the final user pulls near real-time traffic data via a web-based user access portal provided by the content provider. The MultiSat service task is to update the traffic information database of the customer with traffic data generated in space. MultiSat´s space operations infrastructure is designed to control the satellites and the data processing in order to ensure a quality of service (data availability, integrity, timeliness) according to the customer needs.

Both types of access will be fully compliant with existing traffic systems such as route planers or traffic information systems. The web-based portal gives the opportunity to access the data via all available types of Internet communication, e.g. wireless Local Area Network (LAN), Universal Mobile Telecommunications System (UMTS) or Digital Subscriber Line (DSL).

CONCLUSION

During the preparation of the study presented here the partners came to the conclusion that this concept has to be analyzed in more detail under scientific aspects. For this reason the Institute of Transport Research of the German Aerospace Center has formed an international consortium that will take part in the 6th Framework Program of the EU. Besides a laboratory for the interdisciplinary cooperation on the issue of the satellite-based traffic data recording will be set up and put into operation.

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ABSTRACT

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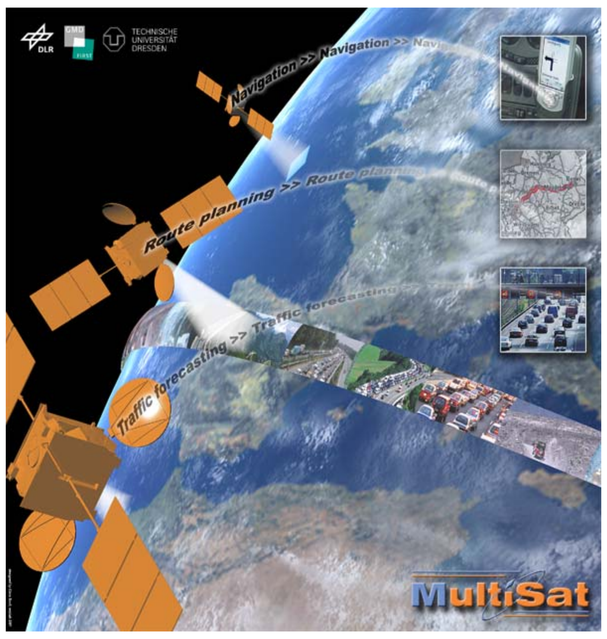

Fig. 1: The MultiSat WebService a Low-Earth-Orbit constellation of small satellites with remote sensing payload.

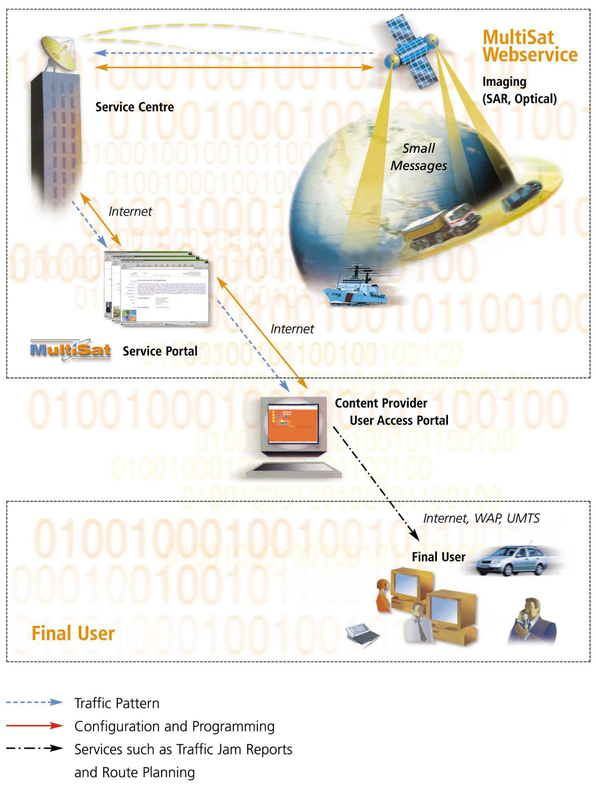

Fig. 2: The MultiSat WebService.

SYSTEM DESIGN

Space segment of the MultiSat WebService system will include a constellation of satellites on Low-Earth-Orbit. With the realization of a 60 satellites constellation MultiSat WebService will be the first (civil) system offering the possibility of any Earth observation in regular and relatively small time distances.

This will be essential for any kind of applications such as traffic monitoring, catastrophes and natural disasters monitoring and prediction or media. The constellation is planned to include two payload types: Optical imaging payload and SAR payload. Operation of SAR does not depend on weather and illumination conditions, but requires a considerably large and expensive satellite platform. Optical imaging payload can be accommodated within relatively small and cheap platforms, but requires clear sky and cannot be used at night.

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ENABLING TECHNOLOGIES

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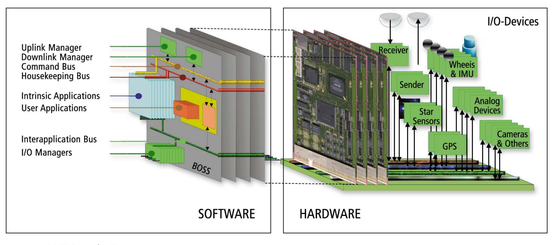
The solutions are based on advanced optical computer technology, currently developed at Technische Universität Dresden, which allows in-situ measurement of disturbing camera image motion and successive image correction in real-time, while preserving extremely compact camera dimensions and simple camera design.

In detail the following technologies are considered to become enabling for a system of spaceborne traffic measurement: smart optical imaging payload, SAR payload, onboard data processing system and a Web-based access portal.



- HW-SW Co-design
- Parallel and distributed architecture
- Scalable & dynamic redundancy

Fig. 3: The software and hardware design of the MultiSat board computer.

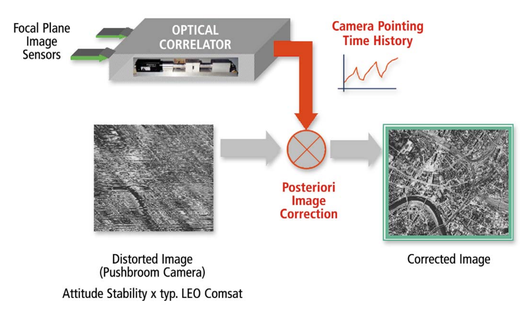
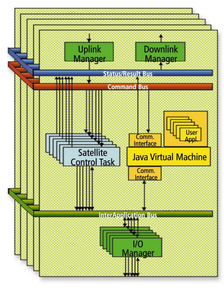


Fig. 4: Posterior image correction with optical correlator.



MultiSat – Powerful Thematic On-Board Data Processing based on Parallel Computing

- RT LINUX or real time OS kernel
- Modular software structure based on standardized software busses
- Java Virtual Machine (JVM) for protected execution of applications
- Web based satellite communication
- In orbit reconfiguration and upload of new applications
- Replicated satellite survival system

Fig. 5: MultiSat board computer system.

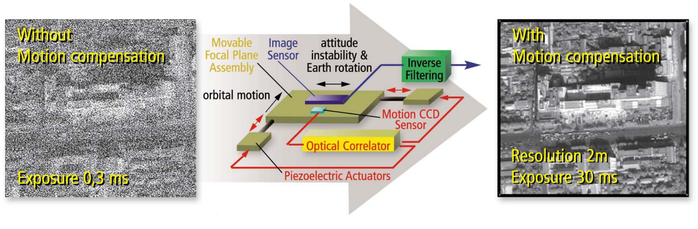


Fig. 6: The motion compensation of the smart optical sensor.

MARKET ANALYSIS

The market survey is based on a classification of traffic telematics applications taken from the European Community´s classification definition. The corresponding functions have been compared with the main objectives of the MultiSat WebService.

Class A Observation Operational	Class B Observation Operational	Class B Observation Demonstrator
Complete Optical Constellation	Complete Optical Constellation	One Imager
High Resolution 2m Multi-Spectral 24 m	High Resolution 2 m Multi-Spectral 24 m	High Resolution 2 m Multi-Spectral 24 m
Complete SAR Constellation	Small SAR Constellation	No SAR
Revisit Time 15 Minutes	Revisit Time 15 Minutes Bad Weather 12 Hours	Revisit Time 24 Hours Good Weather Only

Tab. 1: Different modes of operation to identify the possible tasks for the market analysis.

Interviews with professionals, experts and potential customers have been performed to support the results of the targeted application evaluation and priorization process. The list of the targeted applications has been used for market segmentation. First estimation of the market volume and the potential market share has been made to give an idea for a MultiSat WebService business opportunity.

Function	Task 1	Task 2	Task 3	MS
A1 Road Management and Logistics				
F1.1 AMBIENT CONDITIONS MONITORING	Weather	Visibility	Air	B
F1.2 ROAD STATUS MONITORING	Surface	Road works	Weighing	B
F1.3 FORECASTING	Pollution	Capacity	Icy Roads	B
F1.4 RESCUE SERVICE AND MAINTENANCE	Emergency	Hazards	Rescue	A
F1.5 ROAD FEE COLLECTION MANAGEMENT	Calculation	Collection	Enforcement	A
A2 Demand Management				
F2.1 DEMAND RESTRAINTS	Area control	Deviations	Parking	B
F2.2 DEMAND ORGANISATION	HOV	Modal Split	Logistics	C
A3 Traffic Management				
F3.1 SECTION TRAFFIC CONTROL	Status	Incidents	Actuation	A
F3.2 INTERSECTION TRAFFIC CONTROL	Status	Actuation	Ramps	A
F3.3 NETWORK TRAFFIC CONTROL	Status	O/D Analysis	Routing	A
F3.4 LOCALISED AREA TRAFFIC CONTROL	Direction	Lane	Tunnel	A
A4 Parking Management				
F4.1 PARKING SPACE MANAGEMENT	Entry/Exit	Occupancy	Availability	A
F4.2 PARKING GUIDANCE	Area	Facility	Space	A
A5 Public Transport Management				
F5.1 PT TRANSPORTATION PLANNING	Travel Time	Schedule	Disposition	C
F5.2 PT OPERATIONS MANAGEMENT	Surveillance	Connections	Centre	A
F5.3 PASSENGER INFORMATION (PI)	Information	Arrival	Trip	A
F5.6 ON-DEMAND SERVICE PROVISION	Collection	Disposition		A
A6 Traffic Information				
F6.1 MIXED MODE INFORMATION	Calculation	Mediation		B
F6.2 NAVIGATION (ROUTE GUIDANCE)	Positioning	Routing		C
F6.3 DYNAMIC ROUTE INFORMATION	Collection	Adaption	Calculation	A
A7 Travel Information				
F7.1 TRAVEL PLANNING	Mode	Route	Information	B
F7.2 STATISTIC ROUTE INFORMATION	Mapping	Parking	PT	C
A8 Freight and Fleet Management				
F8.1 LOGISTICS AND FREIGHT MGMT (LM)	EDI	Planning	Surveillance	B
F8.2 FLEET/RESSOURCE MANAGEMENT (FM)	Disposition	Surveillance	Maint.	B
F8.3 VEHICLE/CARGO MANAGEMENT (VM)	Preparation	Operation	Assessment	B
F8.4 HAZARDOUS GOODS MONITORING (HGM)	Route Planning	Control	Emergency	A
A9 Vehicle Control				
F9.1 MONITORING ENVIRONMENT & ROAD	Conditions	Regulations		A
F9.3 MONITORING VEHICLE	Dynamics	Machine		A
F9.7 DIALOGUE MANAGEMENT	Presentation	Training		A
F9.9 VEHICLE NAVIGATION (ROUTE GUIDANCE)	Updates			C

Tab. 2: List of the targeted applications for the "MultiSat WebService for Mobility and Traffic".

The main purpose of MultiSat WebService is to offer a business-to-business service highly adaptable in terms of payload configuration and user needs. MultiSat WebService supplies processing service for traffic monitoring. Classifying the products of MultiSat WebService leads to various system parameters and qualities of services as shown in Table 1. The observation classes A – C have been compared with the demand of the traffic telematics service functions. This results in the MultiSat WebService application list as shown in Table 2.

Cost-wise the market specialization of MultiSat primarily on transportation and mobility and its independence from other systems, offers the advantages of a single-point sale and optimization of service costs. List prices and prices depending on performance levels are otherwise not economically achievable otherwise. Main products of MultiSat on the transportation and mobility segment are to provide

- globally available traffic observation data,
- E-commerce interfaces via customer portal and mobile communication,
- traffic information derived from image data and
- data for congestion forecasting based on online traffic simulation.

MultiSat intends to offer services to customers enabling them to extend and improve their market position in the field of transportation and mobility. In a strategic partnership with transportation professionals and content providers MultiSat will be capable of offering an "Online Mobile Traffic Management from everywhere".

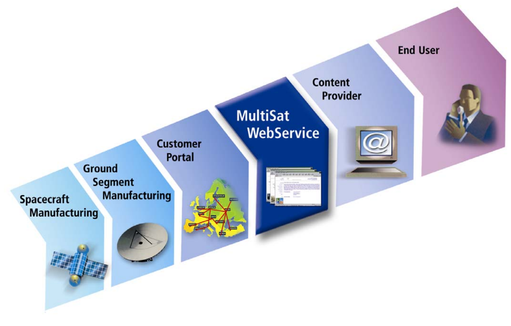


Fig. 7: MultiSat is one element of the value chain between spacecraft manufacturing and end user.