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KAP - A NEW STANDARD PLATFORM FOR IN-ORBIT VERIFICATION PROVIDING EFFICIENT ACCESS TO SPACE

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ABSTRACT

The success of Kayser-Threde's test satellite MAQSAT-B2 for L521 (2nd Ariane 5 ECA qualification flight in February 2005) which was equipped with experiments, sensors and an autonomous telemetry system has led to the development of a new experimental platform called KAP (Kayser-Threde Arianespace Platform) allowing an efficient access to space for technology in-orbit verification and small scientific experiments. KAP contains a fully autonomous experiment infrastructure, power and telemetry unit as a kind of complete package or kit to be mounted on a payload bay structure like a raising cylinder underneath the ACU of Ariane 5 using remaining payload capacities of the launcher. As a piggy-back solution in the launcher payload bay KAP will remain attached to the upper stage after primary passenger separation. Although being flexible in terms of e.g. possible payload to be accommodated and number of needed batteries, the whole KAP with a standardized raising cylinder shall be trimmed in such a way to have identical mechanically and dynamically properties each time to be finally like a black box easily to be adapted to the launcher payload configuration for the launcher authority increasing significantly the chance of a recurrent flight opportunity.

As a result of a Phase A study co-funded by DLR in the frame of its OOV program, three baseline mission scenarios have been defined: 3 hours (to monitor online experiments / technology demonstrators exposed to the launcher environment), 3 days (starting after upper stage passivation) for short experiments and 1 year. The technical concept for both mechanical and electrical subsystems is mainly based on existing and flight proven technologies from MAQSAT-B2 and Kayser-Threde's successful sounding rocket program TEXUS/MAXUS. Especially the data acquisition and telemetry unit as heart of the KAP experimental payload infrastructure is adapted from these programs to the specific mission needs.

The KAP basic concept provides an auxiliary payload mass of up to 220 kg on Ariane 5 to GTO leading to favorable launch costs for the experimenters. A Demonstrator Mission on Ariane 5 is under detailed investigation for an envisaged launch in 2008. KAP on VEGA for LEO applications is the next step to adapt the concept to other members of the European Launcher Family (including SOYUZ). Especially for VEGA it is planned to stabilize the platform by simple means providing an optimum environment for microgravity experiments.

Besides the basic concept of KAP the complete KAP program has been developed to provide sufficient flexibility to be mounted also on other structures, like ASAP5 or future single flight opportunity events. Main idea is to standardize the interfaces to the auxiliary payloads and to leave the responsibility to find a flight opportunity to Kayser-Threde as system integrator which allows for a reliable planning for the experimenters aiming for a ticket in the frame of the KAP program.

INTRODUCTION

KAP (Kayser-Threde Arianespace Platform) shall serve as future recurrent standard platform for In-Orbit-Demonstration (IOD) of new technologies and scientific experiments for the European launcher family. The original idea is to integrate an additional load-carrying raising cylinder to the launcher payload adapter which is able to carry additional auxiliary payloads. KAP shall provide the complete necessary infrastructure (power, data acquisition, telemetry) to be finally fully autonomous from the launcher which eases significantly the integration and increases the chance of a launch opportunity.

The paper gives an overview on the current technical and programmatic status of KAP derived in strong collaboration with Arianespace and other participating entities. Technical details and interfaces shall be presented to provide full view on KAP capabilities as a future recurrent, reliable and affordable access to space for small payloads embedded in a consistent KAP program.

KAYSER-THREDE'S ARIANE 5 EXPERIENCE

Kayser-Threde has gained meanwhile significant experience with Ariane 5 payload bay activities based on the development and manufacturing of a series of dummy and test satellites (MAQSATs) and structures for ARIANE 5 since 1997 [1], [2].

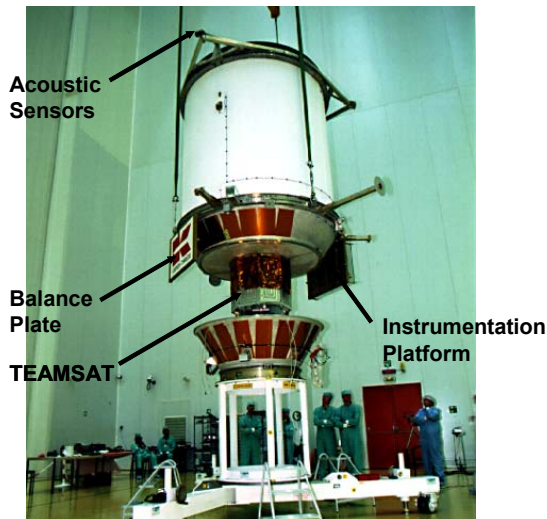


Figure 1: MAQSAT-H for L502

Each MAQSAT (MAQuette SATellite) was realized fulfilling dedicated requirements, in two cases including complete autonomous instrumentation and telemetry system to measure the environmental conditions during lift-off, in two other cases

simulating real passengers w.r.t. statics and dynamics as a back-up solution (examples are shown in figures 1 and 2).



Figure 2: MAQSAT-3 for L503

In addition to the MAQSAT activities Kayser-Threde has delivered several Multi-Purpose-Fitting Dummies (MFD) for adjusting the overall payload configuration of an Ariane 5 launch. These metallic raising cylinders will be introduced underneath the primary passenger ACU as shown in Figure 3.



Figure 3: MFD500 delivered for L513

The latest test satellite was MAQSAT-B2 realized for the re-qualification of Ariane 5 ECA in 2005 and shown in figure 4. It was equipped with additional scientific and technology experiments [3]. It was decided by ESA to use this MAQSAT-B2 as single flight opportunity for several experiments and to separate a micro-satellite from the top deck.

With MAQSAT-B2 it could e.g. be demonstrated, that both shock and acoustic environment for the payload of Ariane 5 ECA is covered by the Ariane 5 User Manual with sufficient margin [4]. This mission of MAQSAT-B2 – by acquiring all environmental

measurement and experiment data during lift-off and transmit it successfully to ground – was a kind of very first demo-mission of a “kit” called TMA being able to serve as fully autonomous and complete infrastructure for auxiliary payloads and experiments for In-Orbit-Demonstration.



Figure 4: MAQSAT-B2 for L521 with

Currently Kayser-Threde is involved in the In-Orbit-Demonstration program of a large deployable reflector to be tested on ASAP5 scheduled to be launched in October 2006. Based on the TMA technology of MAQSAT-B2 an on-board video system has been developed able to collect video data during lift-off and in-orbit and to transmit it autonomously to ground. This OCAM system is accommodated on ASAP5 and the VEB to film the LDREX-2 experiment deployment (see figure 5)

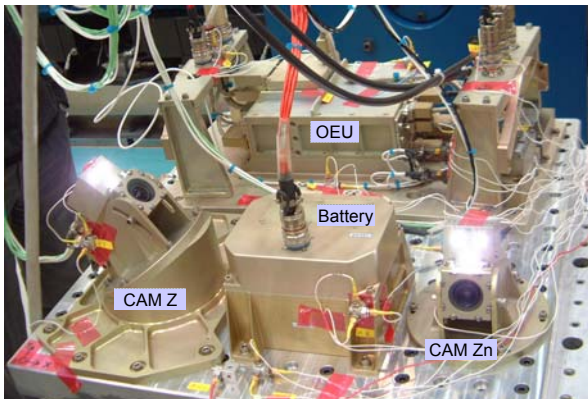


Figure 5: OCAM for Ariane 5 qualification testing

KAP OVERVIEW

KAP Baseline Concept

Already with the MFD-project in 2001 the idea was born together with Arianespace to find a solution for a kind of Ariane 5 standardized piggy back solution for auxiliary payload using the remaining payload capacity of Ariane 5 able to carry up to 10t into space which will not always fully used. The flexibility of the launcher authority to introduce such kind of MFD structures led to the first concept of KAP: to introduce a raising cylinder underneath the ACU like the MFD shown in figure 3 remaining attached to the upper stage and to use the internal platform to mount additional flight hardware on it instead of trim masses – called the baseline design concept of KAP.

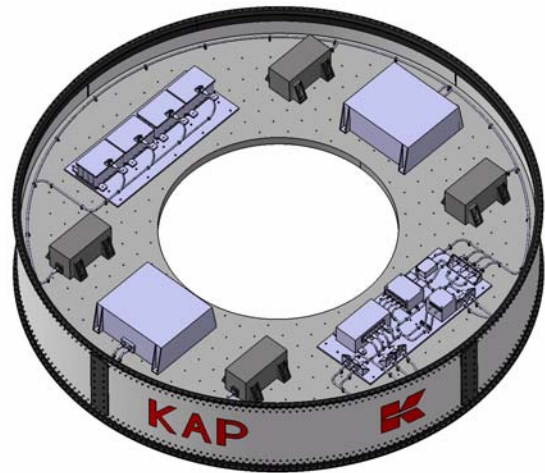


Figure 6: KAP baseline concept

This baseline design concept is illustrated in figure 6 and one can identify easily the final location of such a KAP when looking to figure 4 identifying the gap between the ACU and the 3936 cone.

The KAP concept logic follows a certain approach. Scientific and/or Technology Experiments have the following flight opportunities up to now:

- Single Piggy Back Solutions
- Manned Space Flight (e.g. Space Shuttle, EUTEF on ISS)
- Autonomous, free-flying Test-Satellites and -Platforms (STENTOR, TET, etc.)
- Russian Capsules (FOTON) or Russian Launchers

These options normally provide limited envelope, mass, power, data transfer due to:

- Interface and mission constraints
- Costs

- Overall physical budget allocations for the payload

KAP in contrast shall:

- provide significant higher payload mass and significant larger payload envelope,
- thus, allow for in-orbit demonstration of also large experiments not realizable up to now,
- be fully autonomous (very limited launcher I/F) but will not be separated,
- be fully customer oriented, means complete infrastructure will be adapted for experimental payload
- lead finally to a cost-efficient solution
- be a recurrent standard experimental platform for reliable planning of experiment's flight opportunities
- be an European solution for the European Launcher Family

Baseline Mission Scenario

During the Phase A study of KAP three different mission scenarios have been defined to provide maximum flexibility for the market analysis started in parallel and ongoing promoting tour. The *short mission* is derived directly from the MAQSAT-B2 mission providing experiment monitoring during lift-off until upper stage passivation only.

The *medium mission* is defined to be maximum battery powered providing a mission life time of three days. Depending on the experiment's power need and the maximum use of payload capacity (which can be converted into further batteries if not used) even more than three days can be realized. Depending on the experimenters need the monitoring and control during lift-off can be switched on or off.

The *long mission* was identified to have a full compatible system to TET with the same mission life time envisaged. To realize this, KAP must be updated to a full satellite w.r.t. solar power generation, on-board computer etc.

From the efficiency point of view the medium mission has been identified as the most realistic one. Nevertheless, the short mission might be of interest especially for testing new launcher technologies combining with measurements of the launcher environment for flight assessments. The long mission will be of highest complexity and highest costs comparing to the other scenarios and is currently seen as option only in the KAP program.

Table 1 shows an overview of the three different mission scenarios identifying also the major technical characteristics.

KAP as Element of the German OOV-Program

The first concept of a future standard platform for In-Orbit-Demonstration was presented to the German space agency DLR in 2003. The national "On-Orbit-Verification" initiative [5] contains a free-flying test satellite program called "TET" as major element.

After an announcement of opportunity in 2005 several experiments have been selected to fly either on TET 108 or TET 210 which shall start its Phase B begin of 2007. KAP has been introduced to the program as a complementary element providing a different access-to-space opportunity. A KAP Phase A study co-funded by DLR has been performed in 2004. Since beginning of 2005 Kayser-Threde has invested in promoting the concept in Europe and setting-up a database of potential KAP customers.

Name	Duration	Major Characteristics
KAP-SM	3 h (short mission)	Online data transfer with 500 kbps (switch to 100 kbps after fairing separation), power via batteries, 220 kg payload* at 600 kg total mass, min. 100W* const. payload power, antennas attached outside of ARIANE (e.g. on ACY), possibility of flight environment monitoring
KAP-MM <i>Baseline</i>	3 days (medium mission)	Data storage and data transfer during playback with 15kbps to GSOC Weilheim, power via batteries, 180 kg payload* at 600 kg total mass, min. 25W* average payload power
KAP-LM	1 year (long mission)	Data storage and data transfer during playback with 15kbps to GSOC Weilheim, power via solar generators, 180 kg payload at 600 kg total mass, min. 50W average payload power

Table 1: KAP mission scenario overview and baseline mission scenario

KAP Marketability

As outlined before there are different concepts available for access-to-space of auxiliary payloads. Therefore, it is necessary to highlight the differences of the KAP concept to other solutions and to stress the concept logic again. One of the biggest problems for small payloads in Europe is that there is no Europe-wide self-standing program bringing together both, the different flight opportunities and the experimenter's needs. Such a program is well established meanwhile in the United States and there is a clear need to have such a similar program in Europe preferably organized by ESA.

That means, that such an initiative like KAP is not easy to establish due to a kind of hen-egg problem existing in Europe. Due to missing flight opportunities, a lot of experimenters do not see the need to develop such an experiment to have it available in case of a single flight opportunity suddenly occurs (like the MAGSAT for L521 in 2005). Respective announcements of opportunities of ESA for such single events are often not successful due to that reason.

Comparing to that, the AO for the German OOV-program for identifying payloads for the TET satellites were very successful receiving answers from more than 60 institutes and companies. The difference is easy to identify: The AO is embedded in an agency program and TET will not be a single event but minimum two satellites and even more in case of success.

For the planned up-coming Phase B1 of KAP in the frame of the GSTP-4 program it is planned to harmonize the Europe-wide activities for auxiliary payloads and technology In-Orbit-Demonstration together with ESA.

Typical experiments and technologies to be tested on KAP could be:

- Solar Arrays
- Gyros
- Electronics
- Laser
- Antenna
- Special Equipment for future scientific missions
- Star sensors
- Communication equipment
- Navigation equipment
- GPS, GALILEO equipment
- Simple mechanisms

- Thermal Equipment
- Telemetry Experiments
- Heat Pipe Experiment
- Video Experiment
- Sloshing Experiment
- Electronic Drift Analyzer
- 3D- Plasma Analyzer
- Deployment/Separation Experiment
- Thermal Louvers
- Cryo-Cooler
- Propulsion Experiments

In April 2006 Kayser-Threde has organized a first KAP Customer Day where institutes, industry and agencies came together to discuss the concept and the needs of such kind of In-Orbit-Demonstration facility and program (see figure 7).

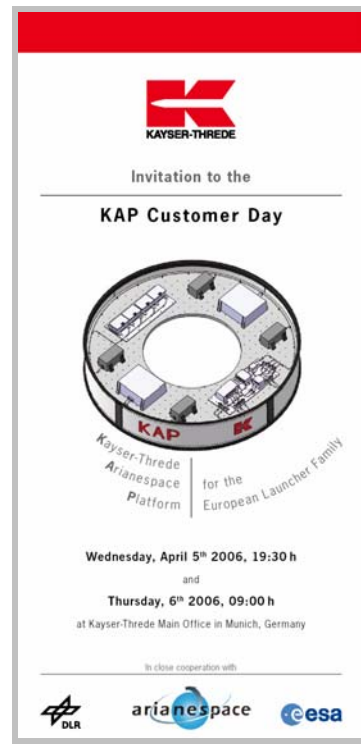


Figure 7: Flyer for the first KAP Customer Day

The fruitful discussion has shown, that there is a clear need Europe-wide for such kind of program, but the concept has to be specified in more details to take into account the different customer needs. Therefore, KAP shall be understood as a flexible kit with a baseline concept and mission scenario on Ariane 5 able to be expanded on the complete European launcher family for different applications. For more results of the KAP Customer Day please refer to [6].

KAP Advanced Concept

The market assessments performed up to now including the output of the KAP Customer Day has shown, that such kind of program has to provide certain flexibility in terms of applications and mission scenarios keeping always in mind, that a cost-efficient solution – means no free-flying stabilized satellite platform – has to be found. Coming back to the original baseline concept of figure 6 as has been sketched from the early beginning of the KAP initiative in 2002 only specific customer can be addressed, but it was a key to start the discussion and to come to the point where KAP currently is.

With a raising cylinder mounted underneath the ACU of an Ariane 5 primary passenger and KAP remaining attached to the upper stage after passivation the constraints w.r.t. environmental conditions are the following:

- GTO (high radiation environment)
- No micro-gravity environment, upper stage spinning (10min⁻¹) and starting slowly to nutate due to small remaining disturbances.

For a number of experiments these conditions are fine and even appreciated (e.g. testing of electronics). Also future launcher technologies are interested to be demonstrated/qualified on an Ariane 5 launch with the Ariane 5 environment being the harshest and therefore most representative one. But, there have been various other experiments meanwhile identified interesting in LEO applications and micro-gravity conditions.

For a realization in LEO, there have been ideas exchanged with the VEGA-team to accommodate such a raising cylinder in the VEGA payload bay in the same way as for Ariane 5 leading to a potential IOD-system in LEO. A big advantage of KAP on VEGA is the much higher visibility on the launcher comparing to Ariane 5. Besides some modifications in the telemetry-unit of KAP the concept is in the same range of cost-efficiency as on Ariane 5.

This would no longer be valid when trying to provide a micro-gravity environment. Here, a clear update of such kind of platform is necessary by adding a simple AOCS able to stabilize KAP being attached to the upper stage. Due to size and mass of the ECA this solution is not possible on Ariane 5. But on VEGA with the much lighter AVUM upper stage such kind of stabilization is feasible as first assessments have shown.

Keeping in mind, that also SOJUZ will join the European Launcher Family when starting to launch from Kourou the following outline of the KAP family concept can be given:

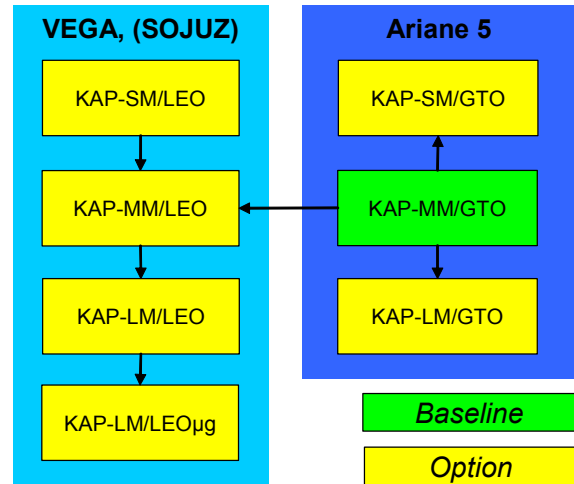


Figure 8: KAP Family Concept Overview

All the family elements shown in figure 8 are based on the concept of introducing an additional raising cylinder equipped with the TMA, power and the experiments to the payload configuration. The advantage of such kind of concept is that KAP can serve like a black box having identical mechanical properties and performance per launcher type. This means, that e.g. Arianespace as operator of Ariane 5 can easily assess the possibility of adding such a clear defined raising element into a launch configuration having sufficient remaining payload capacity by switching on/off the KAP element in the launcher coupled load analysis.

Another enlargement of the concept is possible, when thinking of KAP as a kind of kit (TMA, power, experiments) to be mounted on a structure for an IOD flight opportunity already existing or suddenly occurring. Typical examples for structures, where a KAP kit can be installed are:

- ASAP5 (recurrent program)
- MAQSAT (single event)
- ACU (recurrent program)

Nevertheless, to bring KAP forward and to establish it as a program for cost-efficient access to space for auxiliary payload and In-Orbit-Demonstration it is necessary to have a clear defined baseline scenario able to be enlarged in the right way with only those elements which are necessary to provide a coherent and marketable program.

KAP DETAILS

The following chapter shall describe the techniques, interfaces and boundary conditions in more detail to give a closer view on the single design solutions and adaptations made from other Kayser-Threde programs.

Electrical Architecture & Interfaces

The electrical architecture of the KAP Short Mission is identical to the one of the MAQSAT-B2 instrument platform qualified with L521. According to the chapter before, the short mission is mainly of interest for experiments to be exposed to the launcher environment only. The MAQSAT-B2 program was a major step in development and successful verification of the autonomous KAP platform because it could be demonstrated, that such kind of subsystem based on the CMA2000 is fully compatible to the launcher (see figure 9).

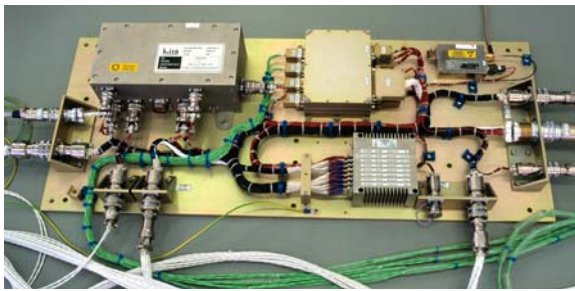


Figure 9: MAQSAT-B2 TMA planned to be used also for KAP-SM

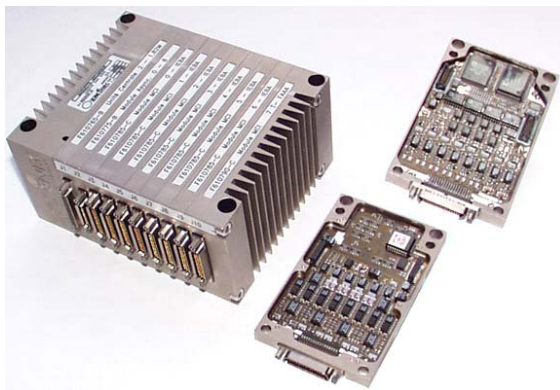


Figure 10: CMA2000 as key element of the KAP-SM TMA

The data being acquired during the KAP Short Mission will be transmitted down simultaneously using the Ariane 5 RF system and Arianespace ground station network. After passivation of the upper stage, this cannot be done any longer and in case KAP shall collect experiments data longer than

3 hours the data has to be transmitted to ground using a specific ground station contacted during a specific time per day. This means, the data has to be stored on board and send down only during dedicated time slots. The CMA2000 cannot be used for that purpose.

For the Medium Mission being faced to that problem a more advanced onboard system is needed. Here, Kayser-Threde has adapted the experience from another experimental platform: the sounding rocket program TEXUS/MAXUS providing 7 and 14 minutes of μg -environment respectively to experiments on board. Kayser-Threde's responsibility in that program is the provision of the necessary infrastructure to the experiments. Its qualified encoder system called CTS3000 is defined as baseline for the KAP Medium Mission providing now the necessary functionality (see figure 11 and 12) [7].

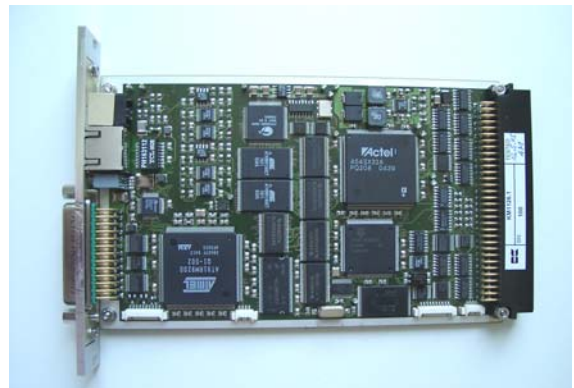


Figure 11: Master Module KM1126 of the CTS 3000 TEXUS/MAXUS Data Acquisition System as baseline for KAP-MM TMA

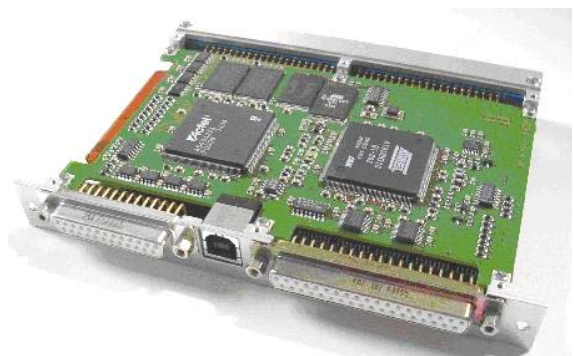


Figure 12: Slave Module KM1127 of the CTS 3000 TEXUS/MAXUS Data Acquisition System as baseline for KAP-MM TMA

Besides that, the system is more powerful in terms of interfaces to the experiments. The CTS 3000 Encoder has a modular design which allows a centralized design (box with the master and slave together in one housing similar to the CMA 2000

design) or a decentralized design, where each experiment or several experiments gets one slave within the experiment electronic. This allows for reducing the harness because of the concentration of the measurement data to one serial data stream. To harmonize the experiments' infrastructure it is planned to have at a later stage only the CTS3000 for KAP-SM and -MM.

The power for the Medium Mission will be provided by a battery package, now using Li-Ion batteries to limit the mass impact instead of using NiCd batteries for KAP-SM. Finally, the MM mission duration is limited by the power system. It has been estimated to have a three days mission, but this can be more or less optimized depending on the final experiments configuration. For the downlink own antennas will be used, which will be placed on the outside of the raising cylinder. If no monitoring, data acquisition and downlink during lift-off is required the Medium Mission has even less constraints to the launcher than the Short Mission which needs an antenna on the outside of the fairing leading to a small impact on the launcher configuration.

The Short and Medium Mission will be controlled autonomously by an onboard timer. Telecommanding is not part of the baseline scenario (for cost saving reasons, but can be added optionally on request). Only for the Long Mission of up to one year the system has to provide telecommanding capability

to allow for operations and experiment's control from ground.

The reason for having assessed also the long mission scenario and technical concept was to identify the constraints and technical risk if going to such kind of solution. KAP LM might not be the best platform for a 1 year in-orbit mission, but it is obvious, that it will be still the most cost-efficient one comparing to free flying technology satellites, which was the primary goal for that development. This means a full working onboard computer system is needed in combination with a solar generator. Here, the outer surface of the raising cylinder can be fully used for placing solar cells. Due to the fact, that the upper stage is no longer controlled after passivation it will have a kind of growing nutation which has been accounted for the sizing of the solar cell area. Also for that mission concept the complete system has been defined and verified by respective analyses e.g. for the power and link budget within Phase A.

Finally, the EGSE concept for all three mission scenarios has been defined completely based on the existing experience and hardware from previous and currently running missions and projects.

The electrical interfaces preliminary defined as output of the Phase A study and serving as baseline for customer survey and experiment adaptation are given in table 2.

Interface	SM	MM	LM
Power I/F	28V 100W const.	28V 25W average	28V 50W average
	6 outlets, 2 x PCDU (increments of 4)	6 outlets, 2 x PCDU (increments of 4)	10 outlets, 1 x PDU (increments of 10)
Data I/F	2 serial async. lines (up to 6 possible) (- 1 x MilBus possible) (CMA 2000) - 16 anal. ch. with conditioning - 80 standard analogue channels - 20 digital in - 1 serial synchr. Baseline one unit. (2 units max.)	6 serial async. Lines with 1 master & 2 slaves (for each slave add 2 lines) (CTS3000) - 64 anal. channels - 96 digital in - 72 dig.out (relay/TTL comm.) - 8 analogue out - 1 serial synchr. Baseline two slaves (12 Slaves Max.)	4 serial async. Lines up to 8 with 2 Boards (OBC, e.g. SAAB) - 1 Mil Bus & Space wire - 48 anal. channels - 96 Thermistor channels - 16 digital inputs - 8 digital outputs per I/O Board Baseline one (6 x I/O Boards max)
Timer / computer	None	Timer, time line controlled by programming	Computer, time line controlled by telecommand
TC	None	None	19.2 Kbit/sec
Telemetry	500Kbit/sec S-Band link, switch to 100Kbit/sec (Kourou)	15Kbit/sec S-Band link 411MBit/per day (GSOC)	15Kbit/sec S-Band link 411MBit/per day (GSOC)
Memory	None	32Mbyte per slave	4GByte flash EDAC protected
Heater I/F	32 Watt		32W (20% of orbit)
EGSE I/F	Via LAPTOP for each Exp. Ethernet for Data, 28V power	Via LAPTOP for each Exp. Ethernet for Data, 28V power	Via LAPTOP for each Exp. Ethernet for Data, 28V power

Table 2: KAP baseline electrical interfaces

KAP Payload Constraints

For the baseline concept with KAP on Ariane 5 using an additional raising cylinder with an internal platform to mount the TMA and power kit and the experiments it is obvious that such kind of element will have an impact to the overall launcher configuration. The constraints, requirements and boundary conditions for KAP on Ariane 5 have been derived from the previous Ariane MAQSAT and MFD projects and précised in close collaboration with Arianespace.

Top level requirements are: 1) demonstrating a satisfying qualification status of KAP before integration into the Ariane 5 payload bay and 2) no constraints and impacts on the main mission. KAP has to fulfil all requirements being typically applicable for structures and electronics in the Ariane 5 payload area as documented in the several General Specifications (electrical, mechanical etc.). The interfaces to the launcher have to be minimized to increase the chance of a flight opportunity in one of the five/six Ariane 5 launches per year.

The KAP on Ariane 5 environment is defined by the Ariane 5 environment and the final upper stage orbit (GTO). A complete set of environmental analyses have been performed within Phase A to allow for defining this environment for the experimental payload. This includes radiation, irradiation and thermal and mechanical environment (also within fairing and during lift-off). For the dedicated mechanical loads specified for the experiments the goal was to be within the A5-SG-1-40 requirements' envelope. For shock protection further respective means by introducing dampers at the mounting interface can be realized in case of experiment's high shock sensitivity.

One of the big advantages of KAP as access-to-space opportunity for auxiliary payloads is to use not only remaining payload capacity (for the baseline concept on Ariane 5 up to 220 kg of experiment's payload on KAP allocated) but also respective available envelopes. The combination of both high auxiliary payload mass and large envelope allows for defining and developing a new class of technology experiments having had not chance for a flight opportunity up to now or only causing high costs.

All these constraints and boundary conditions are described in the first issue of the KAP on Ariane 5 (the baseline concept) User Manual which can be downloaded from the KAP homepage [6]. This User Manual describes also all the interfaces as outlined

before, the safety rules to be followed and the proposed qualification approach. On the homepage the experimenter will find also a questionnaire which shall guide the experimenter to identify the ways and needs to a flight opportunity within the KAP program.

For the advanced concept like KAP on VEGA (in LEO) such kind of information is not yet fully available because these concepts have not the same level of maturity as KAP on Ariane 5. Step by step the details of the KAP family members will be elaborated to provide finally a coherent program for In-Orbit Demonstration.

OPTIONAL PICOSAT SEPARATION

During the KAP promoting tour and latest on the KAP Customer Day it turned out, that the optional integration of PicoSat separation devices would give a further interesting feature of KAP leading to provide to the community an interesting launch opportunity for CubeSats. A respective new single launch separation device called SPL as shown in figure 13 has been developed within the frame of the OOV program by the German company Astro Feinwerktechnik GmbH.



Figure 13: Single PicoSat Launch Device SPL (by courtesy of Astro Feinwerktechnik)

A number of SPLs according to the final requests from the CubeSat community can be accommodated as "KAP payload" taking into account respective view to space for safe separation. In case of the baseline KAP concept as shown in figure 6 the SPLs would be placed on the outside of the raising cylinder wall with separation direction in radial direction.

PROGRAMMATIC ASPECTS

Main goal of the KAP program initiative is to provide finally a recurrent flight opportunity for auxiliary payloads as piggy-back solutions on members of the European Launcher Family. There is a clear need for In-Orbit-Demonstration of future technologies to be used in space. A number of technology developments stops at a certain stage with an on-ground verification program missing the chance for an access to space to finalize the development phase before being introduced as real flight hardware.

To harmonize that within overall Europe a database of both auxiliary payloads and flight opportunities has to be generated preferably to be maintained by ESA. This is one of the next steps within the frame of the upcoming Phase B1 in the frame of the GSTP-4 program under supervision of ESTEC, Noordwijk to be started end of 2006. In parallel to that the mission and system requirements shall be specified and the mission and design concept of KAP shall be frozen. Last but not least, preparation work for the demonstrator mission shall be started mainly by identifying the launching customers for KAP 1. Together with ESA and Arianespace Kayser-Threde is assessing the possibility of a first KAP mission in 2008. Following the experience from the previous MAQSAT-B2 project, the KAP itself will not be on the critical path – it will always be the experiments to derive finally to a qualification status that approves the accommodation on KAP and finally on the launcher.

Kayser-Threde has collected manifold experience as experiment's system integrator and partner of the science both in manned and unmanned space business. Based on that, Kayser-Threde's role in the program is again the one of a system integrator and in addition as flight opportunity broker being finally the interface between the several small auxiliary payloads and the launcher (authority) and fully experiment-success oriented. The "KAP payload life cycle" will cover:

- Experiment's decision/selection for flight on KAP
- Experiments industrialization and verification
- Experiments Acceptance
- Integration on KAP
- System Test incl. additional Verification Steps
- Transport and Storage
- Launch Preparation

- Launch Campaign
- Mission Operation

With the KAP program Kayser-Threde will provide a full service package to the customer comprising:

- help experiments to achieve flight readiness
- integrate experiments onto KAP
- adapt the experiment's infrastructure on KAP
- integrate KAP and its experiments into the launcher
- organize and perform complete launch campaign
- perform KAP operations and acquire all data transferred to ground
- deliver experiment's data and environmental measurement data to experimenters

The ticket for a KAP flight will not be calculated by price per kg only but will be a formula depending on several parameters like experiments mass, volume, power need, data rate, etc. This formula will be consolidated within the next development phase.

Assuming a successful demonstration of a KAP 1 mission in 2008 (current planning) the logic of the KAP program will be of such a kind that it will allow for a 1-year sequence between each KAP mission in the optimum case. Based on the logic as described in figure 14 and 15 the full industrialization phase of KAPn is expected to last one year from KAPn program Kick-Off to acceptance and shipping to the launch pad providing a full set of KAP payload is available and all experiments for that certain mission are ready for integration in due time.

According to Kayser-Threde's experience it is necessary in some cases to start the industrialization of a flight experiment in advance before starting the dedicated KAPn program. But having a reliable and recurrent program like KAP available, the experimenters can plan for their flight opportunity on a much more reliable basis than in the past with single and suddenly occurring flight opportunities. The KAP program shall provide finally such kind of flexibility that a late exchange of payload in case of delays is possible due to standardized interfaces and the industrialization processes.

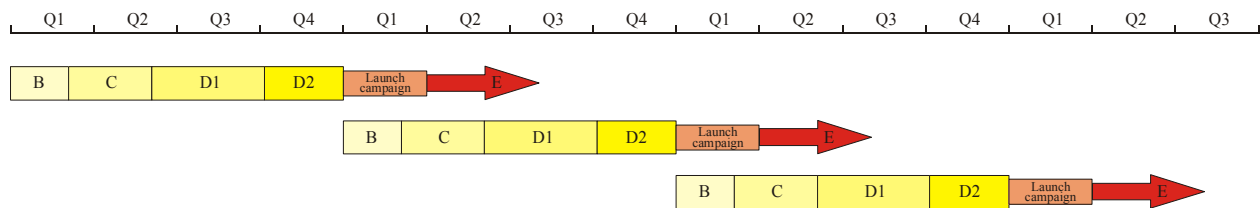


Figure 14: KAPn program cycle with a 1-year sequence in the optimum case based on program logic of figure 15

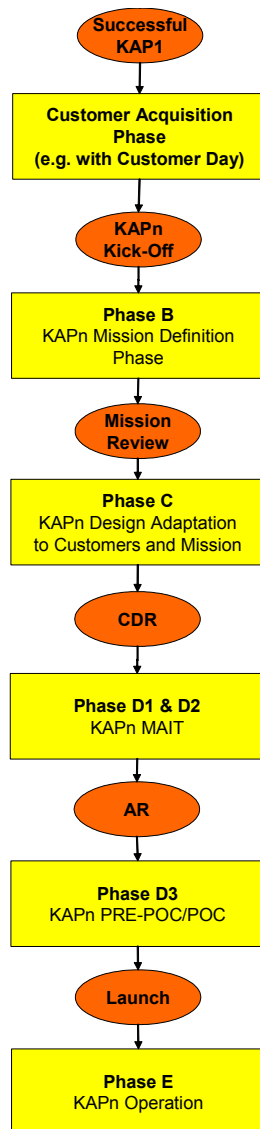


Figure 15: KAPn program logic

SUMMARY

Based on its experiences of having developed and manufactured a series of dummy satellites and structures for ARIANE 5 flights, Kayser-Threde together with Arianespace has established the idea of a future and recurrent easy-access-to-space platform for auxiliary payloads for In-Orbit Demonstration

purposes. Having passed successfully a DLR co-funded Phase A study a baseline and advanced concept for KAP has been defined able to provide flight opportunities for experiments and new technologies to be tested in space. With the baseline mission scenario on Ariane 5 directly derived from the successful MAQSAT-B2 mission for the Ariane 5 ECA re-qualification on L521 KAP shall finally serve as flexible kit able to be mounted either on payload bay structures like raising cylinders underneath the ACU or on any further single event like future MAQSATs for launcher qualification. Entering the next Phase B until end of 2006 KAP shall have its first demo-mission in 2008.

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