KAP – AN IN-ORBIT TEST FACILITY FOR TECHNOLOGY DEMONSTRATION AND SCIENTIFIC USE

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OVERVIEW

The success of Kayser-Threde's test satellite MAQSAT-B2 on Ariane L521 in February 2005 (2nd Ariane 5 ECA qualification flight) and its instrument platform equipped with experiments, sensors and an autonomous telemetry system has led to the development of a new autonomous experiment platform called KAP. KAP stands for Kayser-Threde Arianespace Platform and is a direct spin-off product out of Kayser-Threde's Ariane 5 post projects and experience. The main idea is to use the available remaining payload capacity of the launcher to provide a flexible and low-cost test facility for scientific experiments and In-Orbit Demonstration of new technologies remaining attached to the launcher upper stage. KAP is a fully autonomous kit providing the complete necessary infrastructure (power, data acquisition and telemetry) to minimize constraints and interactions with the launch vehicle increasing significantly the possibility for regular flight opportunities.

Two different mission scenarios are foreseen. One with KAP only being working during the launcher mission itself (called short mission), the other as medium mission to be switched on after upper stage passivation for up to 7 days in orbit. Different accommodations for KAP are foreseen in order to ease its integration on the entire European launcher family including Ariane 5, Soyuz and Vega. KAP can either be mounted on an additional load carrying raising cylinder located underneath the launcher payload adaptor (MFD type), or integrated on a platform for auxiliary payloads (ASAP-5 type). The technical concept for both mechanical and electrical subsystems for space segment and ground support equipment is mainly based on existing and space qualified technologies from the successful MAQSAT-B2 project and Kayser-Threde's sounding rocket programme TEXUS/MAXUS. In particular the data acquisition and telemetry unit as back bone of the KAP experimental payload infrastructure is a direct adaptation from these programmes to the specific mission needs.

In January 2007 KAP entered a Phase B with a co-funding from ESA in the frame of the GSTP-4 programme. A demonstration mission either on Soyuz or Vega is scheduled end 2009. A Call for Interest published in ESA EMITS News will be issued in the 3rd quarter of 2007 in order to identify and select first launching customers. The 2nd KAP Customer Day will take place in October/November 2007 in Munich, Germany. Finally, the KAP programme is planned to have one flight opportunity per year on altering launchers depending on the flight opportunities availability and on the auxiliary payloads requirements (orbits, low-gravity, separation, etc.).

The present paper summarizes the latest status of the KAP development, including system design and mission scenarios, and provides information regarding the demonstration mission scheduled end 2009.

1. KAYSER-THREDE'S ARIANE EXPERIENCE

Kayser-Threde has been working in space business for nearly 40 years in manifold areas. Due to its system integration heritage, Kayser-Threde is specialized in bringing scientific and technology experiments into space. This was demonstrated in several programmes as presented hereafter.

1.1 MAQSAT – Maquette Satellite

Since 1997 Kayser-Threde is involved in Ariane 5 payload bay activities based on the development and manufacturing of a series of dummy and test satellites and structures, refer to [1] and [2]. The latest success was the MAQSAT-B2 mission, a test satellite for the Ariane 5 ECA L521 re-qualification in February 2005. It was equipped with a fully autonomous power and telemetry systems providing servitude to the environmental monitoring system and additional onboard experiments. These equipments can be considered as the back bone of the autonomous KAP Kit.

FIG 1: MAQSAT-B2 on Ariane L521

Five experiments were selected for the MAQSAT-B2 mission: Sloshsat (tank fluid dynamics experiments satellite from ESTEC/Dutch Space), Boucle fluide (heat pipe experiment from EADS/CNES), DVCAM (Camera observation of separations from Dassault), CDVP (Vacuum pressure sensor – later cancelled), and QCM (Pollution sensor – later cancelled).

1.2 MFD – Multi-Purpose Fitting Dummy

In addition to the MAQSAT activities Kayser-Threde has delivered several Multi-Purpose Fitting Dummies (MFD-325 and MFD-500) to adjust the overall payload configuration of an Ariane 5 launch. These metallic raising cylinders of 325 mm and 500 mm height were introduced underneath the primary passenger ACU as shown in the following figure.

FIG 2: MFD-325 configuration on Ariane 5 L517

1.3 OCAM – Online Camera System

Kayser-Threde developed a fully autonomous Online Camera System (OCAM), capable to monitor boosters, third stage and payload separation. The Online Camera System provides video sequences from up to 4 cameras via telemetry to ground. It supports acquisition and transmission of video data from 2 cameras in parallel. The picture information will be transmitted in real time in parallel to the monitoring data.

The first application for OCAM was to monitor Ariane 5 boosters and main stage separation in October 2006 using an external camera on Ariane L533. In addition, two cameras mounted on ASAP 5 monitored a deployment experiment of a large reflector from JAXA during 90 minutes.

Due to its full autonomy the camera system can be used also on other launchers for launch and separation monitoring. It is designed to withstand the Ariane 5 environment and therefore shall fulfil respective requirements of other launchers. For more details please refer to [3].

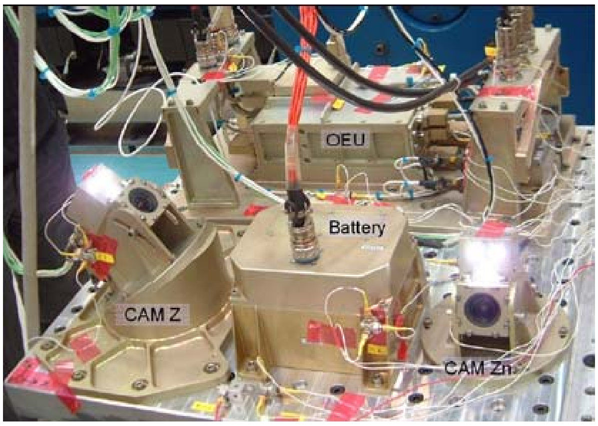

FIG 3: OCAM test set-up for Ariane 5 L533

FIG 4: OCAM picture from Ariane 5 L533 Lift-Off

2. KAP OVERVIEW

KAP (Kayser-Threde Arianespace Platform) shall serve as future recurrent standard autonomous kit for the European launchers family for In-Orbit-Demonstration (IOD) of new technologies and as test (exposure) facility for scientific experiments. KAP shall provide the complete necessary infrastructure (power, data acquisition and telemetry) to be fully autonomous from the launcher. These features significantly ease the integration of KAP, minimizing constraints and interactions with the launch vehicle, and therefore should provide recurrent flight opportunities.

2.1 General Mission Scenarios

Two different mission scenarios are available depending on specific mission needs: a short mission and a medium mission. For KAP on Ariane 5 the main constraints are a GTO, no µg-phases and no separations. The accommodation of KAP on other European launchers such as Soyuz and Vega is also possible. In this case the mission takes place in LEO and additional capabilities are provided such as stabilized phases with low-gravity environment and possible separations (e.g. CubeSats). For both mission scenarios the experiments will be controlled by an onboard timer. All data transfer will be done via the Launcher Ground Stations network during lift-off (if required) and via European ground stations after main passenger(s) separation (Malindi and Kiruna/Weilheim respectively for GTO and LEO missions). The major performance data for the KAP missions are presented in Table 1.

The short mission is derived directly from the MAQSAT-B2 mission providing experiment monitoring during lift-off until upper stage passivation only. This mission scenario will typically be used for launcher technologies needing to be demonstrated during the launcher mission. The data can either be downloaded during lift-off using the Launcher Ground Stations network or stored during lift-off and then downloaded after main passenger separation(s) via the selected European ground stations. The medium mission is defined for a mission life time of nominal duration three days and maximum duration 7 days depending on the battery power needs which is the main design driver for the mission duration. Depending on the experimenters needs the monitoring and control during lift-off can be switched on or off.

The described constraints shall ensure a cost-efficient solution for a KAP flight opportunity using available remaining launcher payload capacities. Further performance increase of KAP like telecommanding is technically feasible (in option) but will increase the cost for a dedicated mission.

2.2 KAP Accommodation

Different accommodations for the KAP kit are foreseen in order to ease its integration onto the launcher and to have maximum flexibility for available flight opportunities. KAP can either be mounted on an additional load carrying raising cylinder, refer to Figures 5 and 7, located underneath the launcher payload adaptor, or integrated on a platform for auxiliary payloads, refer to Figure 8. Both configurations were designed focusing on minimizing interactions and constraints with the launch vehicle, and benefit from direct intensive Kayser-Threde's experience as Principal System Integrator.

2.2.1 Raising cylinder configuration

From structural point of view the raising cylinder configuration serves as a metallic structure having dedicated properties and characteristics similar to the flight proven MFD concept, refer to Figure 2.

The structure is constituted by an external cylindrical shell, an internal platform supported by a conical shell and two aluminium flanges interfacing to the adjacent upper and lower structure. Another concept consists in a light-weight structure configuration without the internal platform and conical supporting structure.

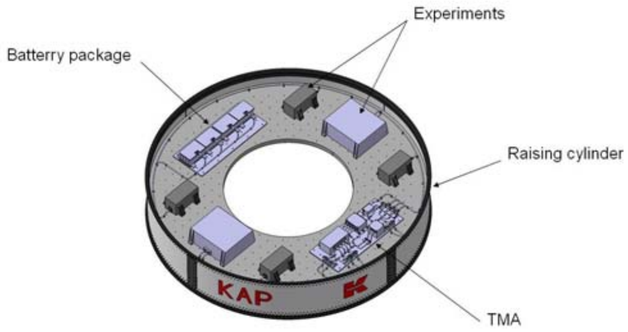

FIG 5: Raising cylinder configuration with KAP Kit mounted on internal platform

In this configuration the payload and equipment can be mounted directly on the inside or outside wall of the raising cylinder.

An overview of these two KAP configurations is given in Figure 6. Several accommodations are feasible: with or without SYLDA or SPELTRA, with a long or a short fairing. The following figure (left side) shows possible KAP accommodations on Ariane 5, and on Soyuz and Vega (right side).

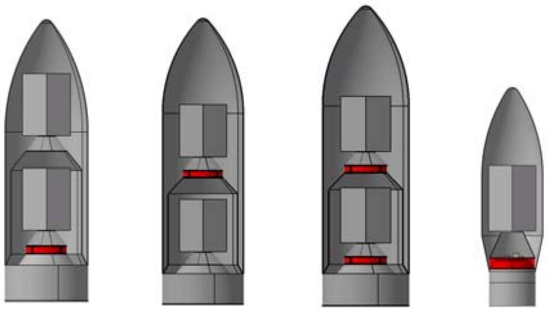

FIG 6: Possible accommodation scenarios of the Raising cylinder configuration (A5 and VEGA)

In addition to that, the raising cylinder serves as a trimming structure and shock damper to the overall launch configuration. This combination of auxiliary payload accommodation and improvement of primary passenger accommodation and launch environment is an optimum starting point to consider KAP as a possible flexible and recurrent flight opportunity.

Name	Duration	Major characteristics
KAP-SM	3 h (short mission)	Online data transfer with data rate up to 5 Mbps and full amount of data up to 2 GB, power via batteries, 25W* total average payload power (250W peak power manageable)
KAP-MM	3 days nominal 7 days maximum (medium mission)	Data storage and data transfer during playback with data rate up to 5 Mbps and full amount of data up to 2 GB, power via batteries, 25W* total average payload power (250W peak power manageable)

**) Payload capacity can be substituted by additional battery on demand*

TAB 1: KAP baseline missions scenarios valid for all European launchers

Furthermore, first assessments have confirmed that it can be expected to have no negative effects on the QSL on the primary passengers when introducing a raising cylinder leading to a respective shift of primary passengers CoGs.

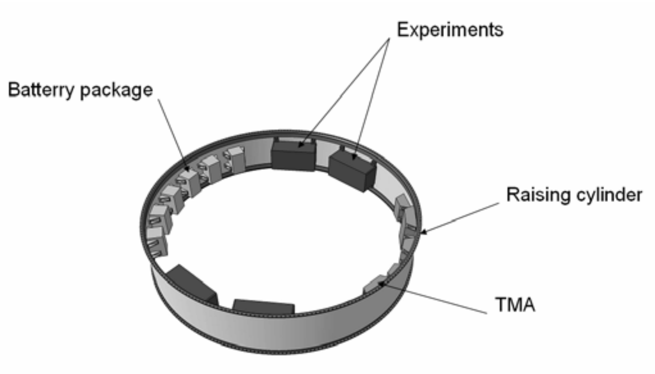

FIG 7: Raising cylinder configuration with KAP Kit mounted on cylinder wall

To facilitate the recurrent KAP accommodation for Arianespace, each cylinder will be designed, manufactured and trimmed, in such a way, that it has always identical mechanical characteristics allowing the launcher authority to simply add a model of KAP with each time the same static and dynamic characteristic to the CLA to be performed for each launch.

2.2.2 Platform for auxiliary payloads configuration

The KAP Kit can also be mounted on any platform for auxiliary payloads providing additional flexibility. Such kind of auxiliary payload platforms are used or planned to be used on all European launchers having in most cases empty slots available potentially to be used by KAP. The accommodation of KAP on the last Ariane ASAP-5 mission in August 2008 was previously foreseen as a potential candidate for the demonstration mission. However due to the commercial character of this flight, no clear agreement with Arianespace could be established.

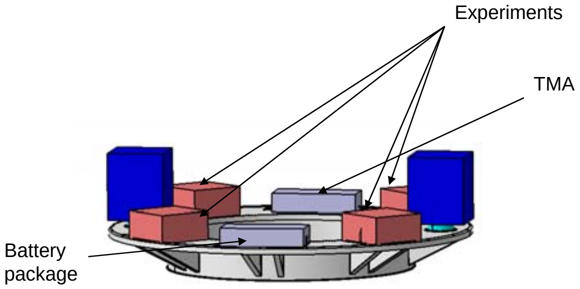

FIG 8: Platform for auxiliary payloads configuration

2.3 Payload Budget

Regarding the payload mass, Table 2 presents the general figures depending on the selected flight configuration. Payload mass will be homogenized around the structure in order to cope with physical measurement requirements. Regarding the payload available power, Table 2 presents the general figures depending on the selected mission scenarios. Power budget will be tuned to optimise power availability depending on the selected experiments and mission scenarios. The available power is determined by the available battery power for Short and Medium Missions. The table above shows that it has been assumed that for Short Mission and Medium Mission, approximately 25 Watt average power will be available (250 W peak power manageable) for KAP experiments.

Baseline scenarios		
Payload Mass *)	**KAP-SM**	**KAP-MM**
Raising cylinder with internal platform	200 kg	180 kg
Raising cylinder without internal platform	120 kg	80 kg
Platform for auxiliary payloads	200 kg	200 kg
Payload Power **)	**KAP-SM**	**KAP-MM**
Experimental payload – Average power	25 W	25 W
Experimental payload – Peak power	250 W	250 W
Experimental payload - Voltage	28 V	28 V

**) Payload capacity can be substituted by additional battery on demand **) Average current*

TAB 2: KAP baseline payload capacity and power budge valid for the European Launcher family

3. POTENTIAL CUSTOMERS

As outlined before there are different concepts available for access-to-space of auxiliary payloads. Therefore, it is necessary to highlight the differences between the KAP concept and other solutions and to stress in further details the concept logic. One of the main problems for auxiliary payloads in Europe is that there is no European-wide self-standing programme coordinating together both the different flight opportunities and the experimenter’s needs. Such a programme is well established meanwhile in the United States and there is a clear need to have such a similar programme in Europe, preferably organized by ESA for any European experiment looking for a flight opportunity.

An initiative such as KAP is not straight forward to establish. In fact due to the lack of flight opportunities, lots of experimenters do not get approval to develop such an experiment to have it available in case of a single flight opportunity suddenly occurs with usually very tight programmatic schedules (refer to MAQSAT-B2 on L521 in 2005). ESA announcements of flight opportunities for such single event are often not successful due to the same reason. However, the announcement of opportunity for the German OOV-programme (On-Orbit Verification) for identifying payloads for the TET satellites was very successful receiving more than 60 answers from German institutes and industry. The difference is clear: The announcement of opportunity was embedded in a national space agency programme and TET will not be a single event but minimum two satellites and even more in case of success.

In the meantime Kayser-Threde was awarded with the Phase B of the TET contract scheduled to be finalised end 2007. The Phase C/D is planned to take place immediately at the end of Phase B with a flight opportunity end 2009.

In April 2006 Kayser-Threde organized a first KAP Customer Day where institutes, industry and agencies gathered to discuss the concept and the needs of such a kind of In-Orbit-Demonstration facility and recurrent programme. The discussion has shown, that there is a clear need Europe-wide for such a kind of programme, 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 able to be expanded and adapted on the complete European launcher family providing a wide range of applications.

A dedicated Call for Interest for the KAP-DM (Demonstration Mission) and the KAP programme will be published in ESA-EMITS in the 3rd quarter of 2007. This Call of Interest will include all necessary information (User Manual, KAP Policy, etc.) about the KAP-DM and gives an outlook on the activity planning. This shall allow for all experimenters to raise their interest without any obligations. Kayser-Threde together with ESA will evaluate all proposals and contact all interesting experimenters to discuss the next steps. It is planned to invite all experimenters to the 2nd KAP Customer Day in October/November 2007.

THE KAP PAYLOAD

The KAP family shall provide In-Orbit-Demonstration for a wide range of technology and scientific experiments:

- Solar arrays
- Navigation equipment
- Gyros
- GPS, GALILEO equipment
- Electronics
- Electronic drift analyzer
- Lasers
- Thermal equipment
- Antennas
- Telemetry experiments
- Star sensors
- Video experiments
- Mechanisms
- Communication technology
- Propulsion technology
- Sloshing experiments
- Deployables
- Separation devices
- Plasma analyzer
- etc.

KAYSER-THREDE

Invitation to the

KAP Customer Day

Kayser-Threde Arianespace Platform | for the European Launcher Family

Wednesday, April 5th 2006, 19:30 h
and
Thursday, 6th 2006, 09:00 h
at Kayser-Threde Main Office in Munich, Germany

FIG 9: Overview on potential KAP experiments (left), Invitation to 1st KAP Customer Day in 2006 (right)

4. KAP KIT DETAILS

The following chapter describes 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 programmes. Additional information regarding the environment conditions and services, design requirements and technical details are available in the KAP User’s Manual.

FIG 10: MAQSAT-B2 Telemetry Kit

4.1 Electrical Architecture & Interfaces

The electrical architecture of the KAP Short Mission is identical to the one of the MAQSAT-B2 instrument platform qualified on Ariane L521. The short mission is mainly of interest for experiments to be exposed to the launcher environment only. The MAQSAT-B2 programme was a major step in development and successful verification of the autonomous telemetry kit because it could be demonstrated, that such kind of subsystem based on the CMA 2000 is fully compatible with the launcher. The data being acquired during the KAP Short Mission will be transmitted down simultaneously using the launcher RF system and ground station network (if applicable).

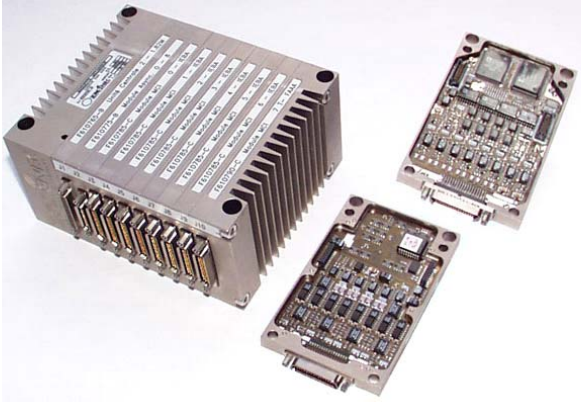

FIG 11: CMA 2000 as key element of the KAP-SM TMA

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 timeline per day. This means, the data has to be stored on board and sent down only during dedicated time slots. That for the CMA 2000 needs to be upgraded with an onboard data storage and management capability.

For the Medium Mission there is a more advanced onboard system planned to be used. Here, Kayser-Threde has adapted the experience from another experimental platform: the sounding rocket programme TEXUS/MAXUS providing 7 and 14 minutes of microgravity-environment respectively to experiments on board. Kayser-Threde's responsibility in that programme is the provision of the necessary infrastructure to the experiments. Its qualified encoder system called CTS 3000 is currently defined as baseline for the KAP Medium Mission providing now the necessary functionality.

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.

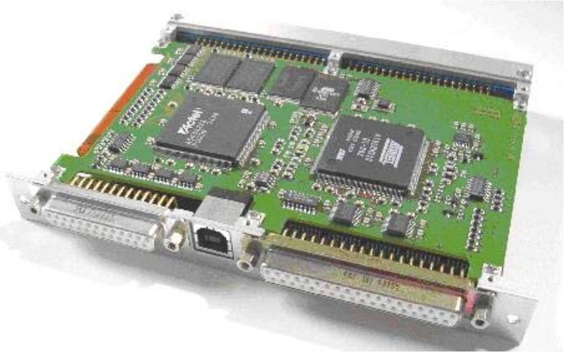

FIG 12: CTS 3000 as key element of the KAP-MM TMA

The power for the Short and Medium Mission will be provided by a battery package using Li-Ion batteries to limit the mass impact instead of using Ni/Cd batteries as used on MAQSAT-B2. Finally, the MM mission duration is limited by the power system. It has been estimated to have a three days nominal mission, but this can be flexible depending on the final experiments configuration and extended up to 7 days. 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 interaction with the launcher than the Short Mission which might need an antenna on the outside of the fairing or VEB leading to a small constraint on the launch vehicle configuration if real time data needed. The Short and Medium Mission will be controlled autonomously by an onboard timer. Tele-commanding is not part of the baseline scenario (for cost saving reasons), but can be added optionally on request enabling to control the experiments' operation from ground.

Finally, the EGSE concept for the two mission scenarios has been defined based on the existing experience and space qualified hardware from previous and currently running missions and projects. The electrical interfaces preliminary defined and serving as baseline for customer survey and experiment adaptation are given in Table 3.

The telemetry link is established via S-Band. Up to 2 GB of data can be downloaded to the dedicated ground station (onboard mass memory of 2GB). The interfaces may be increased in terms of numbers (e.g. outlets, data lines etc.) taking into account that the overall resources such as power, mass storage, data processing and communication performance are limited to fixed values and have to be shared between the experiments.

4.2 Optional Pico-Satellite Separation

During the KAP promoting tour and recently on the first KAP Customer Day in 2006, it turned out that the optional integration of Pico-Satellite separation devices would provide KAP with a further interesting feature enabling to support the CubeSats community with additional launch opportunities. A new single launch separation device called SPL (Single Pico-satellite Launcher) has been developed within the frame of the OOV-programme by the German company Astro- und Feinwerktechnik GmbH. Several SPLs deployment system depending on the final requests from the CubeSat community can be accommodated. This device shall be mainly used for LEO missions.

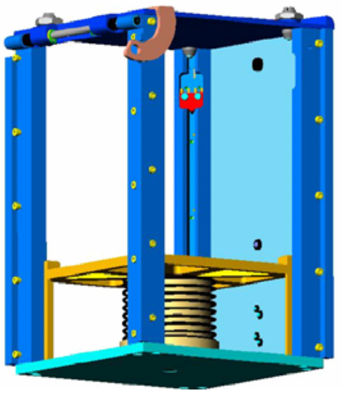

FIG 13: Single PicoSat Launch Device SPL

Electrical I/F	SM	MM	Remark
Power I/F	28 V 25W average for experiments (250 W peak manageable)		Li-ion battery
	6 outlets 2 x PCDU (increment of 4)		Includes current protection
Data I/F	**CMA 2000** 2 serial async. lines (up to 6 possible, 1 x MilBus possible) 16 analog channels (with conditioning) 20 digital in 80 standard analog channels 1 serial synchr **Baseline 1 unit (2 units max)**	**CTS 3000** 6 serial async. lines with 1 master and 2 slaves (each slave increases by 2) 64 analog channels (with conditioning) 96 digital in / 72 digital out 8 analog channels out 1 serial synchr **Baseline 2 slaves (12 slaves max)**	RS-422 (max rate 38.4 k Baud) Data handling can be upgraded (more mass and power needed, reducing payload resources)

TAB 3: KAP baseline electrical interfaces

5. THE DEMONSTRATION MISSION

A potential demonstration mission on either Soyuz or Vega is scheduled for end 2009. A possible accommodation scenario of KAP on Soyuz/FREGAT is shown in Figure 13. For that demonstration flight Kayser-Threde has agreed with the respective launch authorities to have a minimum interfacing mission scenario to the launcher and a maximum re-use of existing design and ground equipment to lower the risk and to have the necessary flexibility due to the existing schedule constraints. Nevertheless, it is planned to realize a maximum duration of 7 days to provide significant in-orbit mission time for the experimenter community. A study is currently under preparation regarding the possibility of introduction of new features such as possible stabilisation of the upper stage providing low-gravity conditions during the complete mission. It is worth noting that during the Giove-A mission an “empty” load carrying cylinder was introduced between the upper stage and the payload adaptor, refer to Figure 14. A KAP will have naturally found its place with such configuration.

After separation of the main passenger(s) approximately 30 minutes after lift-off, KAP-DM remains on the launcher upper stage in LEO orbit with a moderate spin-rate motion around the launcher longitudinal axes.

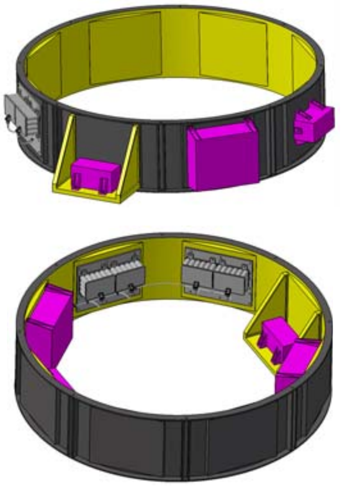

FIG 14: KAP Kit accommodations for Soyuz and Vega

Three different possible LEO orbits are foreseen for the KAP-DM with the following orbital parameters:

- Orbit 1: 700 km, SSO, circular
- Orbit 2: 700 km, equatorial, circular
- Orbit 3: 1,200 km, 70° inclination, circular

The attitude pointing at separation will be defined by respective launch authorities according to mission requirement. The thermal and radiation environments requirements for the KAP payloads are preliminary defined and available in the dedicated KAP User's Manual.

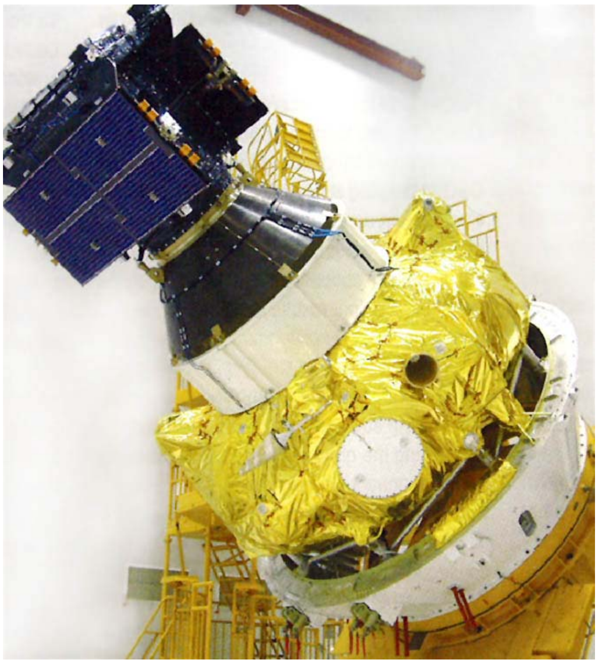

FIG 15: GIOVE-A on Soyuz/FREGAT

The KAP environment is defined by the launcher environment and the final upper stage orbit. A complete set of environmental analyses have been performed to allow defining this environment for the experimental payload. For Soyuz and Vega solely the launch environment differs, their injection orbit having similar orbital parameters.

6. PROGRAMMATIC ASPECTS

The main objective of the KAP programme is to provide recurrent flight opportunities 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 stopped at a certain level (Technology Readiness Level) with an on-ground verification programme missing the chance for an access to space to finalize the development especially when the requested representative space environment for qualification cannot be simulated on ground. Here, KAP shall serve as one possible solution for an "In-Orbit Test Facility" for technology demonstration on equipment and subsystem level, refer to Figure 15.

On the other hand KAP can also serve as "In-Orbit Exposure Facility" to be used by the scientific community for the defined short or medium range missions. A database of both auxiliary payloads and flight opportunities has to be generated, preferably to be maintained by ESA, in order to provide up-to-date information on current and future opportunities. This is one of the objectives of the current Phase B of the Demonstration Mission. In parallel to that the mission and system requirements shall be specified, and the mission and design concept for the KAP demonstration mission shall be frozen.

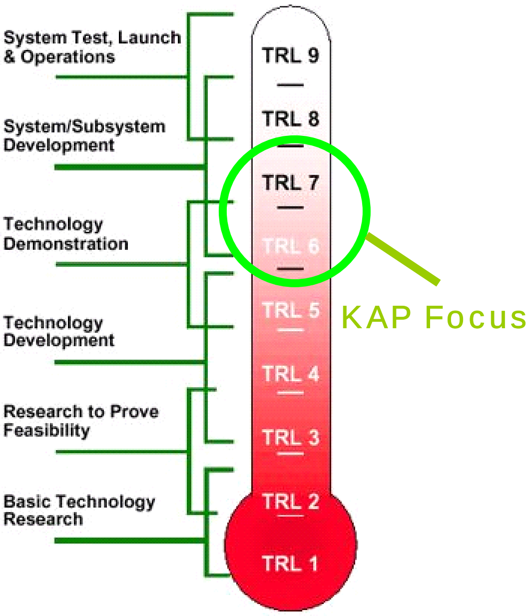

FIG 16: Definition of Technology Readiness Level to be passed before entering of a new technology into real service

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 that programme is to pursue its system integrator role and in addition to act as a flight opportunity broker being the interface between the auxiliary payloads and the launcher authority. The KAP payload life cycle will cover:

- Experiment's decision and selection for flight opportunity with KAP
- Experiments industrialization and verification
- Experiments acceptance
- Integration activities with KAP
- System Test including final verification steps
- Transport and storage activities
- Launch preparation activities
- Launch campaign
- Mission operation

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

- Support to experiments to achieve on time flight readiness
- Integration of experiments
- Integration of KAP and experiments on the launcher
- Organization and completion of the launch campaign
- Mission operations and data transferred to ground
- Deliver experiment's data and environmental measurement data to the experimenters

With a successful demonstration mission in 2009, the logic of the KAP programme will be of such a kind that it will allow for a 1-year sequence between each KAP mission. Based on the logic as described in Figure 16 the full industrialization phase of KAPn is expected to last one year from KAPn programme Kick-Off to acceptance and shipping to the launch site providing a full set of KAP payload is available and all experiments for that certain mission are ready for integration in due time.

Figure 16 shows the logical flow during the development and industrialization of KAPn from Programme Kick-Off to the final in-orbit mission. After a certain acquisition phase which can include a dedicated Call of Interest (like planned for the DM) and will always include a specific KAP Customer Day, the experimenters are invited to place a request for flight on KAP to Kayser-Threde. Having a minimum number of experiments available a Programme Kick-Off starts the delta-development and industrialization phase of a KAP mission.

In a Delta-Phase B the mission will be specified (depending on the available flight opportunity and the experiments needs) and the necessary design adaptations of the KAP Kit will be identified to be frozen at a specific KAPn Mission Review. Within Delta-Phase C the identified design and interface changes will be implemented and LLI will be procured to secure the schedule. A Delta-CDR shall release the KAP Kit equipment manufacturing and assembly phase called D1. In parallel to that the experimenters will develop and industrialize their flight experiment which may differ from experiment to experiment depending on the design or hardware maturity level existing at Programme Kick-Off. Kayser-Threde will follow that parallel activities the experimenters are fully responsible for with specific intermediate inspection and review points as indicated where inputs to the overall system reviews and preliminary verification steps are foreseen.

The overall schedule shall be synchronized between the experimenter and Kayser-Threde to have finally at the same time an acceptance of both KAP Kit subsystems and flight experiments releasing the final KAP system integration and test phase D2. This phase will be finalized by a system acceptance and release for shipping to the launch site. Intermediate storage or waiting periods may occur now. This flexibility on the launch site is necessary to ensure the integration as piggyback payload to the launcher with now impact to the overall launch preparation phase by KAPn itself. Any attendance of the experimenter to the programme in Phase D2 and D3 (final launch site preparation phase) will be agreed case by case based on the specific experiment's needs.

According to Kayser-Threde's experience it is necessary in some cases to start the industrialization of a flight experiment well in advance before starting the dedicated KAPn programme. But having a reliable and recurrent programme such as 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 programme shall provide such a kind of flexibility that a late exchange of payload in case of delays is possible due to standardized interfaces. Kayser-Threde is available for the experimenters as potential customers to support them as early as possible to get on KAP and to select the right flight opportunity depending on the experimenters needs.

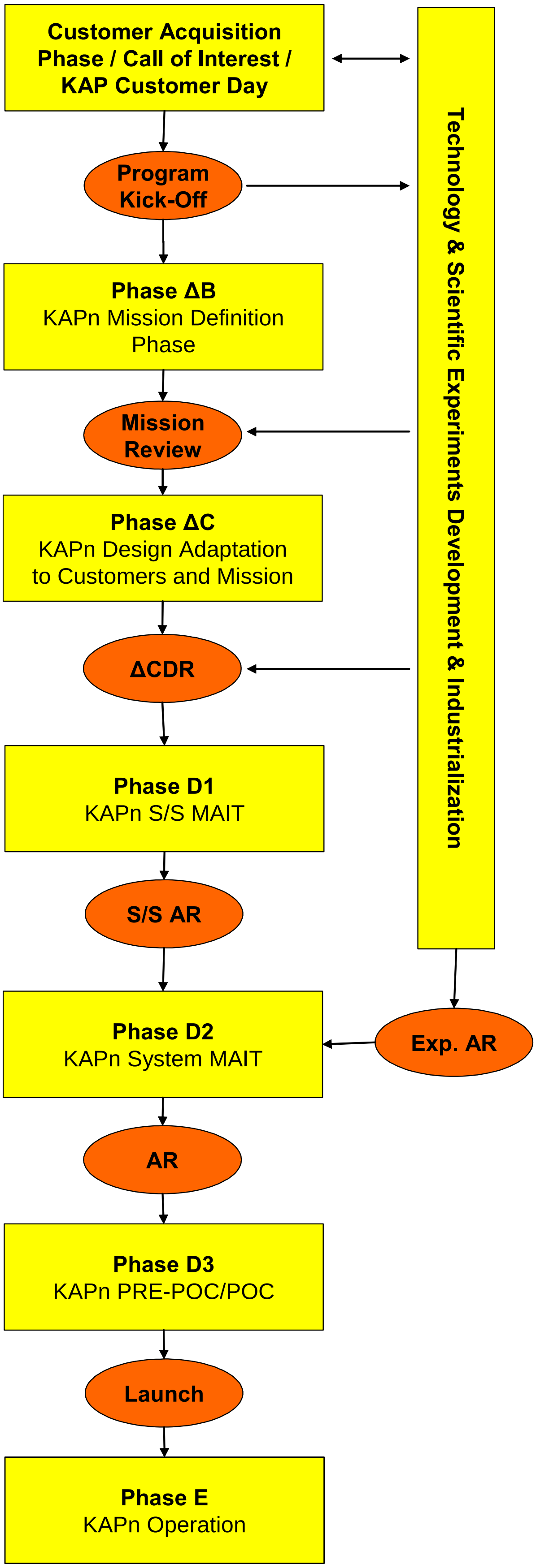

FIG 16: KAPn programme logic

7. SUMMARY

The success of Kayser-Threde's test satellite MAQSAT-B2 on Ariane L521 in February 2005 (2nd Ariane 5 ECA qualification flight) and its instrument platform equipped with experiments, sensors and an autonomous telemetry system has led to the development of a new autonomous telemetry kit called KAP. KAP stands for Kayser-Threde Arianespace Platform, and is a direct spin-off product out of Kayser-Threde's post projects and experience, developed in collaboration with Arianespace one of the worldwide leaders in commercial space transportation. The main idea is to use the available remaining payload capacity of the launcher to provide a flexible and low-cost solution for In-Orbit Demonstration of scientific experiments and new technologies. KAP is a fully autonomous kit providing the complete necessary infrastructure (power, data acquisition and telemetry) to minimize constraints and interactions with the launch vehicle, increasing significantly the possibility for recurrent flight opportunities. Different accommodations for KAP are foreseen in order to ease its integration. KAP can either be mounted on an additional load carrying raising cylinder located underneath the launcher payload adaptor (MFD type), or integrated on a platform for auxiliary payloads (ASAP-5 type). The technical concept for both mechanical and electrical subsystems is mainly based on existing and space qualified technologies from successful MAQSAT-B2 and Kayser-Threde's sounding rocket programme TEXUS/MAXUS. In particular the data acquisition and telemetry unit as back bone of the KAP experimental payload infrastructure is a direct adaptation from these programmes to the specific mission needs

In January 2007 KAP entered a Phase B with a co-funding from ESA in the frame of the GSTP-4 programme. A demonstration mission on either Soyuz or Vega is scheduled end 2009. A Call for Interest published by ESA will be issued in mid 2007 in order to identify and select first launching customers. KAP adapted to the entire European Launchers' Family shall provide additional possibilities. This shall diversify possible orbits trajectory, provide additional opportunity for low-gravity phases and secure finally a recurrent programme with at least one flight opportunity per year on altering launchers.

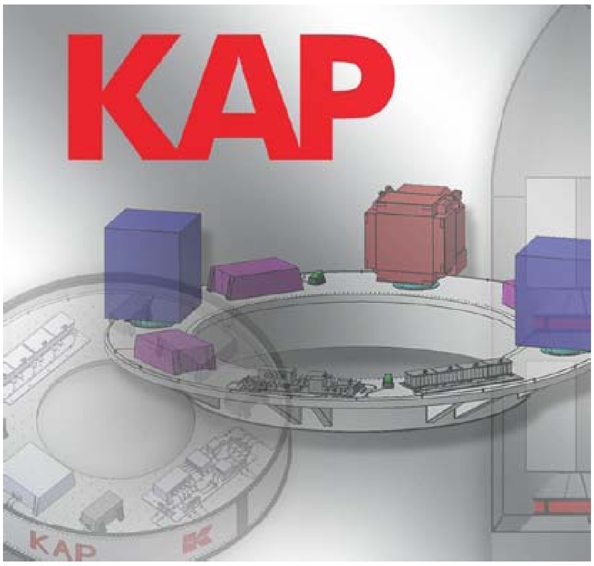

FIG 17: KAP Logo

8. REFERENCES

[1] C. Kaiser, E. Pfeiffer, C. Widani, W. Gambietz: Ariane 5 Dummy Satellites and Structures, 54th IAF Congress, 29.9.-3.10.2003, Paper No. 16131, Bremen, Germany

[2] C. Kaiser, E. Pfeiffer, G. Schmitt, C. Widani: MAQSAT-B2 DGLR Annual Congress, 25.-28.9.2005, Paper No. 2005-056, Friedrichshafen, Germany

[3] G. Fricke, H. Pfeuffer, M. Roy, C. Lannic: Flight Monitoring with OCAM, 7th International Symposium on Launcher Technologies, Barcelona, Spain

[4] H.-V. Heyer, H. Pfeuffer, C. Kaiser: The new data handling system CTS 3000 on the Kayser-Threde Ariane 5 platform, DASIA Conference 2006. 22.-25.5.2006, Berlin, Germany

[5] http://www.kayser-threde.com/KAP