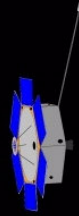


Frank Sperber, DL6DBN/AA9KJ



P5-A



P3-E



AO-40



## Towards Phase 3-E

- Do we need another P3 satellite?
- Aspects of a new Phase 3 mission?

### Do we need another Phase 3 satellite?

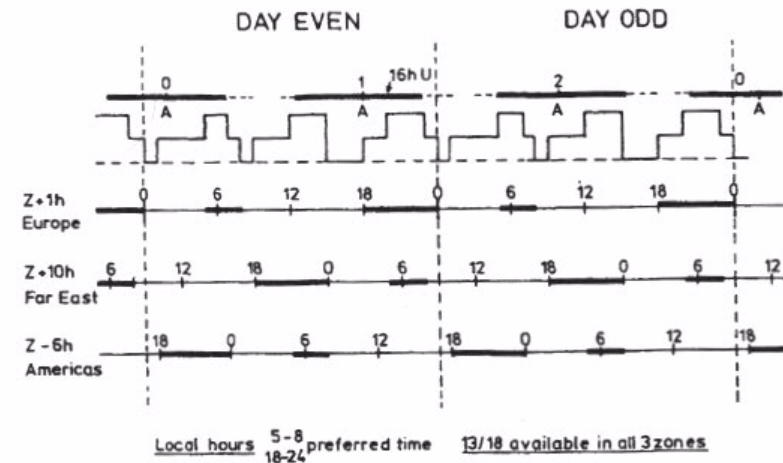
To get an answer for this question, we must at least have a look on:

- What were the goals of AO-40 and what came out so far and still might come out?
- What will be the needs of amateur radio and amateur radio in space in the next two decades?
- Are there questions for research of uncoordinated multiple access via linear transponders and digital systems left?
- Can scientific research still be done by AMSAT and related groups from a P3-like orbit?
- Can other missions benefit from a Phase 3-E spacecraft?

## What were the goals of AO-40?

AO-40 (P3-D) should

- give time phased access for the main populated areas (America, Far East, Europe),
- demonstrate new propulsion technology and attitude control (ATOS, momentum wheels),
- improve communication links by 10 dB in uplink and downlink,
- improve uncoordinated multiple access (LEILA),
- provide Earth images (SCOPE, YACE),
- do research (IHU-2, CAN, GPS, RUDAK, CEDEX, HF-Monitor).



### What came out of it or still might come out?

- After the tragic incident of Dezember 2000 AO-40 ended up in an almost uninclined orbit with a period of approximately 19.25 hrs instead of a high inclination and 16 hrs period.
- Due to the malfunction of the TMFC a major improvement of this orbit by a „hot“ burn of ATOS was impossible.
- The final orbit gives less chance of mutual windows between the main populated areas an the leisure time of radio amateurs living there (morning and evening hours).
- As a result less activity than expected can be observed.
- Operational time can be increased, if three-axis control can be implemented.

# Towards Phase 3-E



- The failure of transmitters U, S1 and the probable malfunction of V-tx and X-tx resulted in worse downlink conditions than the users did expect after the first signals heard from V- and S1-downlinks.

IHU-1:	↑	H/T-RX:	?	V-TX:	↔	RUDAK-A:	↘
IHU-2:	↑	V-RX:	↑	U-TX:	↓	RUDAK-B:	↘
Magntorq:	↑	U-RX:	↑	S1-TX:	↓	SCOPE-A:	↑
E/S-Sens.:	↑	L1-RX:	↑	S2-TX:	↑	SCOPE-B:	↑
Wheels:	↘	L2-RX:	↑	X-TX:	↔	YACE:	↑
400 N Thr:	↘	S1-RX:	?	Ka-TX:	↑	Cedex:	↑
ATOS:	↘	S2-RX:	?	Laser:	?	GPS:	↑
Sol-Arr.:	↑	C-RX:	↔	LEILA-1:	↑	RF-Exp:	?
Omnis:	↓	IF-Matrix:	↑	LEILA-2:	↑	SmrtNde:	↑
Stab-Mode: Spin		Sol-Arr: undepl.					

↑ functional/operational	↘ commissioning	↔ more tests to do
↘ partially failed	↓ unusable	? not yet tested

- Uplink margins have obviously increased almost as expected but desensing of the receivers (U, L) can be observed by radar pulses.
- LEILA improved signal balance noticeable. But operation schemes and modulation and the urge for higher and better downlink levels by the users are driving the AGC still high.
- As a result the expectations weren't fulfilled. Investments in the ground segments are higher as it would have been with a fully operational communication payload. This prevents obviously many stations from getting on the satellite.

- It discloses people in areas with lower income and less or almost no access to technologies like microwaves or PCs.
- The link situation can be improved by three-axis control with an almost nadir pointing satellite giving lower squint angles, especially needed with the high gain uplink antennas.
- The distortion of RUDAK's FSK-downlinks by transponder and beacon operation might influence future transponder schedules and give less access time to transponder and RUDAK.
- SCOPE and YAHU already sent thrilling Earth images, but unfortunately a degradation of quality can be seen after the December 2000 event.
- Scientific results of CEDEX and the GPS experiment seem to be outstanding and very successful. Further and regular operation has to come, perhaps when three-axis control can be established.

### **What will be the needs of amateur radio in space?**

The amateur radio community is facing changes which will influence future amateur radio spacecrafts. To mention some:

- Commercial pressure on amateur radio frequencies increases and usage with other services (ISM, LPD) worsens rx situation.
- Higher demands in everyones' jobs lower the time that can be spent with amateur radio. As a result more COTS equipment will be used.
- The higher availability of powerful computers led to more interest in soundcard DSP technologies (like PSK31, MFSK, SSTV).
- Automated and passive services like APRS (PCsat) or for example SSTV from MIR caught high attraction.
- RFI-limitations and urban space limitations raised QRP operation and operation from remote locations (IOTA, lighthouse etc.).

### **Are there questions for research of uncoordinated multiple access left?**

Research and improvement of uncoordinated multiple access via satellite communication systems was one of the major projects with all P3-satellites. HELAPS, RUDAK and as latest LEILA were the results so far.

- First results with LEILA are showing the need for further development of techniques able to handle pulsing modulation schemes like CW or highly frequency variant schemes like e.g. SSTV.
- Modern DSP systems might help on-board a satellite together with non full duty-cycle schemes for image and data transfer via linear transponders to be developed.
- The Broadcast protocol still provides good throughput via digital satellite systems. But as data services are changing from file based to content based, the demand for changes is probably only a matter of time.

### Can scientific research still be done?

- Depending on the size of a future spacecraft there will be space for research instruments (e.g. CEDEX TDE couldn't be used on AO-40).
- The magnetic bearing momentum wheels on AO-40 can be modified for other missions (miniaturization is already under progress). Similar systems might be useful for motion actions like camera positioning.
- Experiments like GPS on AO-40 could be interesting for the future European navigation system GALILEO, extending the use of this system into space.
- ATOS still needs to be qualified „hot“ in space. An EPU is already under construction.
- Chip and electronics research can be continued as with the IHU before (e.g. COSMAC 1802, RTX2000, StrongARM). The development of a FPGA-based AMSAT-CPU has started.

### Can other missions benefit from P3-E?

- LEO satellite missions could transfer real time data for longer periods via a P3 satellite as repeater in a highly elliptical orbit.
- The already known P5-A mission to Mars requires skills and knowledge AMSAT has to earn or needs some training in them.
- For accurate trajectory maneuvers to Mars precision attitude measurement and control is required. This includes perhaps „star sensors“ and an attitude control by small thrusters. A real-life test environment is highly recommendable.
- People involved in a P5-A project, especially newcomers, need training on complex systems in advance and for the time beyond.
- A P3-E mission can demonstrate communication capabilities (S/X-band, modulation and data formats), gather performance data for a flight to Mars and relay Mars data to remote observers without Internet access.

### So, do we need another Phase 3 satellite?

**YES, because**

- major goals of AO-40 still have to be demonstrated after the December 2000 accident or are waiting for continuation,
- amateur-radio people-to-people communication develops and wants to be extended into space for a world wide coverage,
- people all over the world need and want easy accessible satellites to learn about orbital parameters, space systems and communication,
- scientific and technological research are still in need of an Earth orbiting platform,
- new technologies and systems for a possible future Mars mission need real qualification in space,
- people joining such a mission and projects beyond will need training on real hard- and software in advance.

### Aspects of a new P3-mission

As with all Phase 3 satellites before four major factors will determine how the satellite will look like and what it can do.

- **Launch opportunity**  
With the excellent relationship between Arianespace and AMSAT an ARIANE 5 launch would be a first choice. ASAP 5 or the SBS could provide a platform for P3-E. A new spacecraft should be attractive to Arianespace as auxiliary payload.
- **Financial resources**  
depend on various yet unknown circumstances.
- **(Wo)Manpower**  
This meeting will hopefully show how much interest is in P3-E from the developers point of view. *(Post note: There is a lot of interest.)*
- **Good ideas**  
will come with and from people who joined P3-D and „fresh blood“.

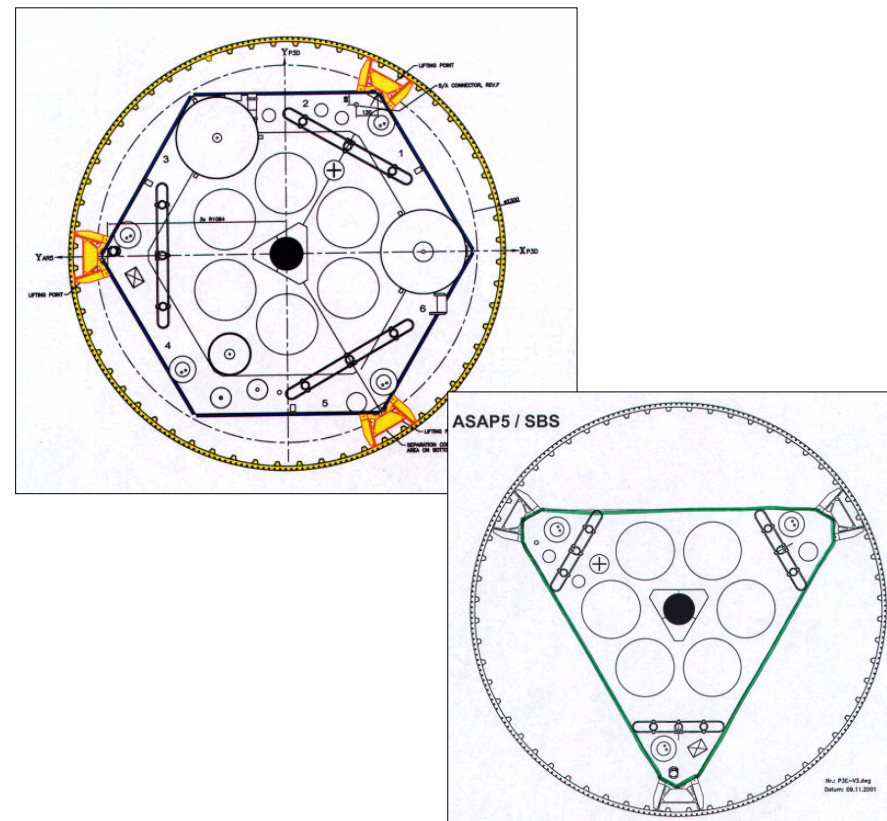
## Launch opportunities

With Arianespace as well-known and cooperative partner and ARIANE 5 as reliable and successful launcher two platforms seem to be possible.

- **SBS  
(Satellite Bearing Structure)**

The SBS developed by AMSAT is a qualified and at hand technology for AMSAT, able to carry P3-D like, similar or other structures.

Fits to ARIANE 5 if main payload leaves height and mass.

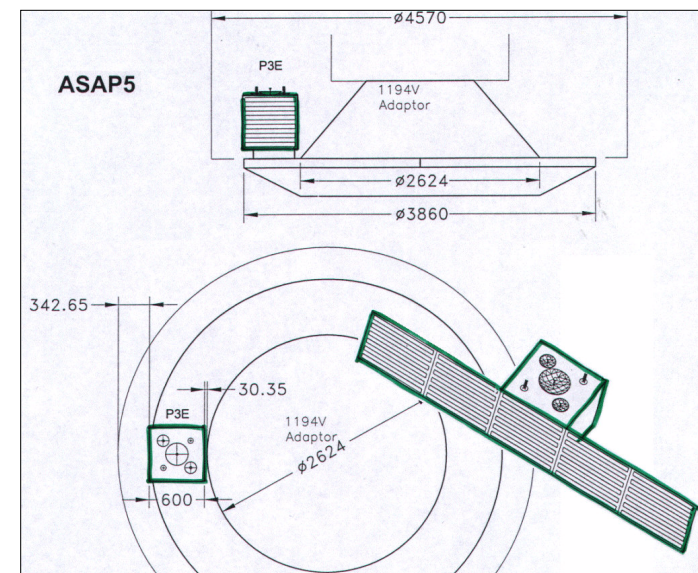
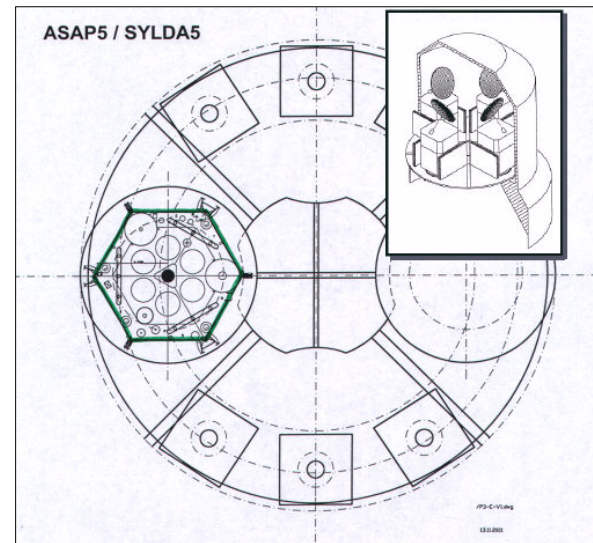


- **ASAP 5**

The ASAP 5 platform can carry up to eight microsatellites or up to four minisatellites.

Minisatellites unfortunately require an additional SYLDA containment.

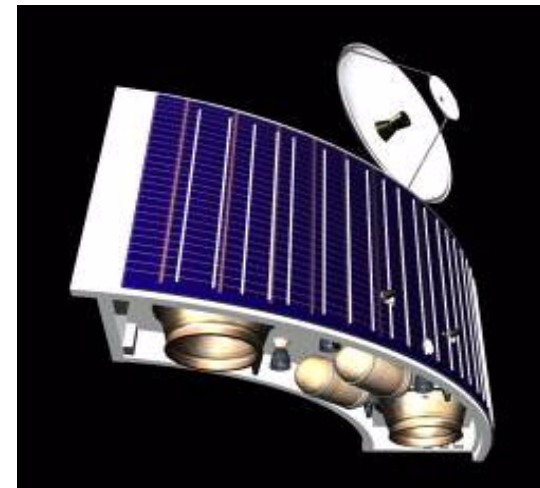
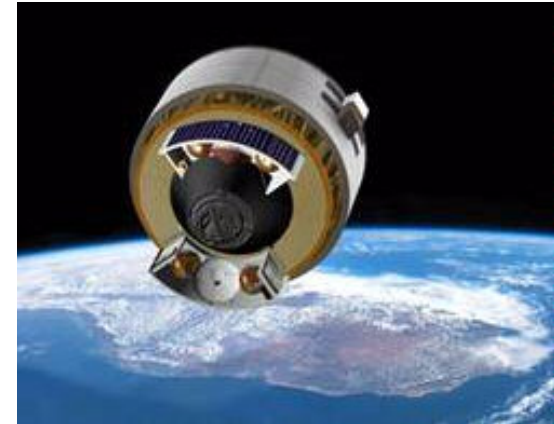
- With knowledge from AO-40 like three-axis control and deployable solar arrays high-power microsatellites could be realized.



## Towards Phase 3-E

- Even unusual structures occupying two or more ASAP-positions seem to be possible.
- Other launch opportunities should be kept in mind or have to be looked for.

For example those injecting payloads in orbits with Molniya characteristics like from Plesetsk in Siberia or Kodiak in Alaska.



*Micromission Images: NASA/JPL*

**Overview**



In January 1998, the Alaska Aerospace Development Corporation began building a commercial spaceport at Narrow Cape on Kodiak Island, about 250-miles south of Anchorage and 25 miles southwest of the City of Kodiak. Kodiak Island is one of the best locations in the world for polar launch operations, providing a wide launch azimuth and unobstructed downrange flight path. KLC's superb location combined with innovative low-cost operations will make it ideal for launching telecommunications, remote sensing, and space science payloads of up to 8000 pounds into low earth polar (LEO) and Molniya orbits.

### Financial Resources

The need for money depends very much on factors like:

- launch opportunity
- infrastructure to be created or found for integration
- the need of salaries for employees
- donations from industry
- funding within amateur radio community and organizations
- governmental and university support for research projects to carry out on P3-E
- synergy effects with other missions e.g. P5-A

## **(Wo)Man Power and Good Ideas**

**Join in !**