

NOTE

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Noordwijk, 29 April 1997

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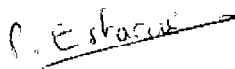
O. Bauer (MPE) -- by fax
K. King (RAL) -- by fax
A. Robson (ESOC/MOD) -- by fax
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Subject : FINDAS prototype - Statement of Work

Please find attached for review the SOW for the FINDAS prototype. I have done the following modifications w.r.t. the draft that we discussed at the latest FSODG meeting on 11-12 March 1997 :

- Added a few sentences on the possible merger of FIRST and Planck. This is not expected to impact on the prototype in any significant way but sets the stage for an expanded mission if required.
- Clarified some of the requirements as suggested by J-J. Mathieu.
- Incorporated the changes agreed on 11-12 March 1997.
(Please note that some of the material in sections 5 and 9 may be moved to the ITT's cover letter).

I would be grateful if you could let me have your comments no later than 16th May (SOW still needs to be translated into French before issuing).



P. Estaria

Att.

FIRST | ESA | N | 0009-1

FIRST

FAR-INFRARED AND SUB-MILLIMETRE SPACE TELESCOPE

FINDAS PROTOTYPE REQUIREMENTS

STATEMENT OF WORK

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DISTRIBUTION LIST

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DOCUMENT REVISION STATUS

Revision	Revision Date
1st Draft	12 March 1997
Issue 1	30 April 1997

DOCUMENT CHANGE RECORD

ACRONYM LIST

(see attached hard-copy)

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- 1. INTRODUCTION**

The Far Infra-Red and Sub-millimetre Telescope (FIRST) is the fourth "cornerstone" (CS4) mission in the European Space Agency (ESA) long term science plan "Horizon 2000". FIRST is a multi-user ('observatory type') mission which targets the far infrared and sub-millimetre part of the spectrum between 85 and 600 μm . A substantial fraction of the observing time will be allocated to dedicated, large key projects. The key scientific topics to be addressed by FIRST will include deep broadband extragalactic surveys, follow-up spectroscopy of especially interesting objects discovered in the surveys, detailed studies of the physics and chemistry of the interstellar medium in galaxies, including star formation, objects at high redshift, observational astrochemistry (gas and dust) and detailed high resolution of a number of comets.

It is likely that FIRST will be combined with the PLANK mission in a single spacecraft accommodating both payloads. PLANK will perform a complete survey -duration 18 months- of the cosmic microwave background at high angular and spectral resolution using two instruments. The operational scenario of the combined missions is not yet finalised but it is clear that both payloads would not be operated simultaneously, rather the satellite would be operated for several months in one mode (say FIRST) until a switch to the other mode (say PLANK) takes place. A limited number of mode switches could occur during the entire duration of the mission. The combined mission would be launched end-2005 (TBC) by an Ariane 5 and would conduct its scientific observations from a Lissajous orbit around the Earth/Moon - Sun

Libration point L2 for a minimum of *four and a half* years (3-years FIRST and 18 months PLANK). L2 lies approximatively on the Earth-Sun line at 1.5×10^6 kms from the Earth in the anti-Sun direction and will be reached after a total transfer time of about 50 days after launch.

ESA is responsible for the overall FIRST/PLANK project; it will procure the satellite with the exception of the scientific instruments, is responsible for testing and validation, for mission design, launch and all real time interactions with the satellite during orbital operations.

The scientific instruments will be supplied by Principal Investigators (PIs) representing Institutes, or consortia of Institutes with national funding.

Three instruments are foreseen for FIRST:

- A multi-channel heterodyne instrument for high resolution spectroscopy in the 500-1200 GHz (250-600 μm) band
- An imaging photoconductor instrument for spectroscopy and photometry in the 85-200 μm or 85-300 μm band.
- An imaging bolometer instrument for photometry in the 200-600 μm and spectroscopy in the 200-400 μm bands.

Two instruments are foreseen for PLANK:

- A Low Frequency Instrument (LFI) covering the frequency range 30-135 GHz
- A High Frequency Instrument (HFI) covering the frequency range 116-1000 GHz.

The scientific operations of FIRST will be conducted in a novel 'decentralised' manner. The concept comprises 5 centres *geographically* separated:

- An Instrument Control Centre (ICC) for each instrument, provided by the PIs.
- A FIRST Science Centre (FSC), provided by ESA.
- A Mission Operations Centre (MOC) provided by ESOC.

These centres are connected (FSC to MOC and FSC to ICCs) by dedicated realtime computer links -capacity 128 Kbs (TBC)-, via the *FIRST Integrated Network and Data Archive System (FINDAS)* for which the FSC is

responsible. For each dedicated communication line an ISDN back-up is available. Non-operational communications between the centres are carried out via Internet (or equivalent), phone and mail.

The ICCs handle all instrument-specific aspects of their instrument during mission preparation, operations and post operational phase..

The FSC ensures overall science coordination, support of the science community and Time Allocation Committee, handling of the observation proposals and science mission planning, operations and management of FINDAS.

The MOC is responsible for all real time operations of the satellite (spacecraft and instruments). It generates all commands to be uplinked to the satellite based on inputs from the FSC, the ICCs and its own subsystems (Mission Planning/Scheduling System and Flight Dynamics System). The commands will be uplinked during a dedicated telecommunications phase of 4 hours (TBC) every day, and stored on board for later execution. During the prime observation phase of 20 hours per day -without ground contact- the spacecraft will collect scientific (and housekeeping) data which will be stored in an on-board mass memory for transmission to the ground station during the subsequent telecommunications phase. Limited scientific observations may also be conducted during the telecommunications phase. The MOC receives, processes, and delivers telemetry to FINDAS so that the ICCs have access to instrument and housekeeping data within a couple of minutes -goal *one* minute- of reception at the MOC. The MOC ensures health and safety of the satellite and all its subsystems, including the scientific instruments.

The observation pattern will be single instrument observations lasting from minutes to hours. The other two instruments may be on, gathering data in a unique mode (parallel mode). They will not point at the prime target. In addition, one or more instruments may be operated during the slews between celestial targets (serendipity mode).

Instruments will have few (max *five* -TBC-) well identified observing modes. These modes are accessed through Astronomical Observation Templates (AOTs) which allow the users to define their observations.

The scheduling of observations will maximise scientific return. It will be stochastic but will permit some fixed-time observations. A mechanism will be provided to handle Targets of opportunity (TOOs).

In the PLANK mode of the mission the ICCs'role is ensured by Data

Processing Centres (DPCs) -one for each instrument-. It is foreseen that PLANK payload data and housekeeping data, as well as pointing information is made available from the MOC to each of the two DPCs via FINDAS.

2. DOCUMENTS

The following documents of the latest issue are relevant to this SOW.

In the event of a conflict between this document and other applicable documents, the conflict should be brought to the attention of the FIRST Mission Operations Engineer (P. Estaria).

In case of a conflict between this SOW and reference documents, this SOW shall have precedence.

2.1 Applicable documents

- AD1: FIRST Science Management Plan
- AD2: Guide to applying the ESA Software Engineering Standards to small software projects (BSSC(96)2 Issue 1).

2.2 Reference Documents

- RD1: FIRST Science Operations Concept and Ground Segment Document (PT-03056)
- RD2: FIRST Science Operations Implementation Requirements Document (SIRD) (PT-03646)
- RD3: FIRST Mission Assumption Document (MAD). Issue 2 -L2 option-
- RD4: FIRST Satellite System Spec. (PT-SP-00211)
- RD5: XMM Packet Utilisation Standards.

3. TOP LEVEL REQUIREMENTS ON FINDAS

- R1: FINDAS shall be able to capture and store all significant FIRST mission data (for a description see Appendix 1 in RD1) - initial estimate 2 Terabytes-
- R2: FINDAS shall be able to capture and store PLANK science and housekeeping data. -initial estimate .5 Terabytes- The data shall be stored in such a way that it is immediatly and unambiguously distinguishable from FIRST data.
- R3: FINDAS shall be operational for at least 15 years (7 years pre-launch,

3 years operations, 5 years archive). Therefore "*adaptability*" to change is essential.

- R4: FINDAS shall support *expert* and *novice* users.
- R5: FINDAS shall support different *views* of the data it contains.
- R6: FINDAS shall support *local* and *remote* users.
- R7: FINDAS shall support *internal* users (the FIRST/PLANK Project users) and *external* users (the FIRST scientific community)
Note: PLANK is a PI-type mission, interface with the user's community is, therefore, carried out outside FINDAS
- R8: FINDAS shall provide a *lock-out* facility to prevent external access, if required, e.g. in the case of temporary overload conditions.
- R9: FINDAS shall support decentralized operations using network facilities
- The MOC, ICCs, DPCs, and FSC are geographically separated entities linked to the FSC hosting FINDAS via dedicated communication links operating at up to 128 Kbps (TBC)
 - The communications between the centres shall be *secure*
 - The communication between the centres shall be *efficient*. This means both *fast* and *easy*.
- R10: FINDAS shall provide queries on selected data in the Archive to "*local*" (e.g. operations staff) as well as to "*external*" users. (science community)
- R11: FINDAS shall support logging of all transactions.
- R12: Access to FINDAS data shall be controlled via *access rights*, allocated to various users by the Archive Manager. The Archive Manager shall be able to change the access rights when required.
- R13: FINDAS shall support allocation of access rights to various levels of *granularity*.
e.g. access right such as *read*, *write* can be set at high level (such as record or object) or at field level (for instance *grade* field of an observation proposal)

- R14: FINDAS shall allow the following type of access to external users:
- E-mail
 - Browsing of selected data.
 - downloading (FTP) (subject to specific conditions)
 - remote logging (subject to specific conditions)
- R15: FINDAS shall provide the necessary facilities to support *automatic messaging* between system components, users and/or processes.
- R16: FINDAS shall provide a secure *fully integrated* Configuration Control system (audit trail, version control, history, etc.)
- R17: FINDAS shall provide a mechanism which allows to mark a set of related data as *"proprietary"* (based on user id). A mechanism shall be provided to remove the proprietary feature upon occurrence of a specific event (specific date, expiration of a grace period, etc)
- R18: FINDAS shall provide a mechanism to allow *"automatic" "binding"* into a unique set of data of several data items which are inter-related. For example an observation data set for one user could be "bound" with the corresponding "calibration" file(s), "auxilliary data", and "science processing" software prior to downloading to this user.
- R19: FINDAS shall provide a mechanism to support *"bulk"* loading of the Archive, e.g. support *"populating"* of the Archive from data/files originating outside of FINDAS.
- R20: FINDAS shall support *"batch-type"* transactions (e.g. updates)
- R21: TM data (packets) received from the S/C by the MOC - rate up to 120 Kbs seconds- shall be made available via FINDAS to up to three ICCs (geographically separated from the MOC) *within 60 secs.*

4. SCOPE OF WORK

The work required is limited to the implementation of a FINDAS prototype. The main objective is to prove (or otherwise) the feasibility of the approach as described in RD1. To this end the prototype will concentrate on the *critical* aspects of FINDAS. These are detailed in chapter 7.

5. SCHEDULE AND MAJOR MILESTONES

The work shall be organised in two phases:

- **Phase 1:** Analysis Phase: Duration 4 months with a review at end of phase and reconfirmation for phase 2.
- **Phase 2:** Design/Implementation Phase: Max. duration 8 months. ESA and the contractor will commonly agree at the Mid-Term Review (see 10.) on the total duration of Phase 2, whose maximum duration is limited to 8 months.

Major contract milestones:

- mid-June 1997: ESA issues "prototype" Call for Tender.
- end-August 1997: Deadline for submission of Proposals.
- end-September 1997: Contractor's selection.
- beg-October 1997: K-O meeting, start of Phase 1

The work must be completed at the latest by end-December 1998.

Prototype delivery to the FSC is planned for Jan. 1999.

Major Project milestones:

- Issue of Instrument AO: end-Sept 1997.
- Instrument selection: early-June 1998
- FSC selection: early-June 1998

The first (preliminary) operational version of FINDAS is planned for Jan. 2000.

6. CONSTRAINTS AND CONDITIONS

- This contract is placed according to the ESA "Open Competitive Tender" procedure (Article 5.1 of Contracts Regulations). The work is to be performed in Europe by a European company or institute.
- The work shall be carried out at the Contractor premises. Any dedicated hardware and/or software which must be procured by the Contractor for the fulfillment of the contract, must be delivered to ESA at the end of the contract (unless purchased on the contractor's own funds).
- Analysis, Design and Implementation of the prototype shall be carried out using state of the art technology, e.g. an Object-Oriented Approach.
- Commercial-of-the-shelf (COTS) products must be used to the maximum

extent possible in the implementation.

- Prototype implementation shall be platform independant
- The prototype must be compatible with POSIX standards w.r.t. operating system.
- The prototype must follow the X Windows standards with OSF/MOTIF as the general user's interface.
- The Prototype must be compatible with WWW-type interface and make use of WWW-type browsers (e.g. Netscape).
- exchange of information with external users must support the FTP and E-mail standards for Internet. TCP/IP is the communication protocol of choice.
- The Prototype shall be designed and implemented in such a way that it can be used as the basis for the implementation of the operational FINDAS system (unless it demonstrates infeasibility of the overall FINDAS concept)
- The Prototype shall be designed and implemented in such a way that "scalability" and "extendibility" are maximised (FINDAS extended lifetime) In particular it must be modular in design to allow a baseline version which fulfills only basic requirements to be implemented first and later extended to full functionality.
- The prototype shall be implemented in such a way that it can easily interface with other system/sub-systems designed/implemented using non O-O techniques. If anO-O implementation is selected and if it imposes constraints on the design of other non-FINDAS software systems, these constraints shall be clearly identified.
- The prototype shall operate as the "server" in a client-server environment.
- The prototype shall support a distributed data base environment. Local copies of selected subsets of data will be held (in order to improve performance) e.g. in the ICCs. A central node (FSC) shall keep the complete master copy of all data sets.
- General performance requirements cannot be given here, but the prototype shall demonstrate that (after proper scaling) the system will be able to sustain the necessary throughput requirements.

7. DETAILED TASKS AND DELIVERIES

Note: In the following text FINDAS is used as synonym for the prototype implementation.

The contractor shall carry out the following task:

Phase 1:

- using ESA's initial data model as input, define a *basic, simplified* FIRST overall data model. The overall model shall include the following components:

- Object Model
 - Dynamic Model
 - Functional Model
- | = = > (or equivalent)

- recommend a design/implementation methodology. The methodology should be based on an existing methodology (e.g. OMT) with possible modifications/extensions.

- define a basic set of "Views" providing a high level description of the FIRST model.

- identify a basic set of the major model components (e.g. "Classes") and provide a preliminary description/definition of these classes.

- recommend a *basic* overall FINDAS system architecture.

- recommend a commercially available Data Base (Relational-DB or O-O DB) for the implementation of the prototype. Provide rationale for the recommendation.

- recommend a software development environment (programming language, tools, etc.) for the implementation of the prototype in Phase 2.

Phase 2:

- refine (if required) the data model, and the set of classes and views defined in Phase 1.

- identify the cost-driving requirements from chapter 3 and suggest alternatives and/or work arounds when relevant.

- agree with ESA the subset of requirements (R1 to R21) which will be

prototyped.

- Implement the prototype whose capabilities have been defined during phase 1.
- Identify system bottlenecks (or potential bottlenecks) and propose solution for their removal.
- provide a rough estimate of the total manpower (in man-months) required to implement the full FINDAS. Provide a top-level implementation schedule with major milestones.
- provide a demonstration of the prototype (at the contractor premises) at the Mid-term and at the final (acceptance) review.
- At the end of the contract the prototype "source" code and related documentation shall be delivered to ESA. ESA shall have the right to use this code internally and or make it available to external parties.

8. AGENCY SUPPLIED SERVICES

- ESA will provide a preliminary FIRST Data Model to the contractor at the beginning of Phase 1.
- No further deliveries from the Agency are planned. In particular ESA will *not* provide hardware and/or equipment to the Contractor.
- (Limited) technical support might be provided by ESTEC/WMS upon Contractor's request. This, however, must be exceptional. Any such request will be treated on a case by case basis.

9. MANAGEMENT REQUIREMENTS

- The Contractor shall nominate:
 - A person responsible for the administrative management of the contract with ESA.
 - A technical manager who carries the technical responsibility for the implementation of the work.
- The contractor shall provide the CVs of all its technical staff allocated to the contract. ESA reserves the right to interview the contractor's technical manager prior to contract's award.

- The contractor may sub-contract part of the work. This shall be transparent to ESA, in particular, the contractor retains full responsibility vis-a-vis ESA for the work sub-contracted.

- Due to the short duration of the work, ESA expects that the contractor staff allocated to the task will not be changed before the completion of the work. If for any reason a contractor staff needs to be replaced, written confirmation is due to ESA at least *one month* in advance. An overlap period of at least *two weeks* shall be provided. Costs to be borne by the Contractor.

ESA's representatives for this contract:

- Administrative management: Mr. P. Reynaud (ESTEC/ECP)
- Technical management: Mr. P. Estaria (ESTEC/PT)
- Technical officer: Mr. J-J Mathieu (WMS)

10. MEETINGS

The following meetings shall be held during the course of the contract:

- (i) A kick-off meeting at the start of the contract.
- (ii) Progress Meetings to be held monthly.
- (iii) A formal Review, at the end of phase 1, where the results of Phase 1 will be presented and discussed and Phase 2 will be kicked-off.
- (iv) A Mid-Term review half way through Phase 2 were critical results will be presented and discussed. A small demo shall be provided.
- (v) Final meeting and acceptance of all deliverables at the end of Phase 2.

Progress meetings shall be held alternatively at the Contractor's premises and ESTEC, the first such meeting being held at the Contractor's premises.

The above schedule of meetings shall not preclude the holding of additional technical meetings as necessary; such meetings shall be arranged by mutual agreement between the Contractor and the Agency.

It will be the Contractor's responsibility to issue the minutes of all meetings.

The Contractor shall give to the Agency prior notice of any meetings to be held in connection with this work with third parties. The Agency reserves the

right of participation in such meetings.

The related documentation shall be submitted to the Agency one week prior to end of Phase 1 review, two weeks prior to the Mid-Term Review and Final meeting.