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FIRST Science Operations Definition Group

Presentation to the
Science Operations Review Panel

FSODG

2 October 1996

Major FIRST Milestones

(of relevance to the FSODG work)

• FIRST SELECTED CS4 (SUBJECT TO RECONFIRMATION) BY SPC	NOV 93
• CRYOSTAT & CRYOCOOLER STUDIES COMPLETED	JUL 96
• RE-USABILITY OF XMM BUS (3 OPTIONS: ISO ORBIT, XMM ORBIT, L2-ORBIT) STUDY COMPLETED	NOV 96
• OVERALL COST TO COMPLETION ESTIMATE	JAN 97
• MISSION REQUIREMENTS DOCUMENT (DRAFT)	JAN 97
• SCIENCE MANAGEMENT PLAN	FEB 97
• OPERATIONS REQUIREMENTS FOR INSTRUMENTS (DRAFT)	APR 97
• MISSION RECONFIRMATION BY SPC	JUN 97
• ISSUE OF AO	SEP 97
• PAYLOAD SELECTION BY SPC	JUN 98

Introduction - Background

- FIRST WELL ABOVE CS4 BUDGET IN NOVEMBER 93

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- MAJOR SAVINGS REQUIRED !!

- ALL AREAS OF THE MISSION <u>INCLUDING</u> OPERATIONS TO BE CONSIDERED

<u>BUT</u>

- OVERALL SCIENCE OUTPUT MUST NOT BE COMPROMISED

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- EARLY (PRE-PHASE B) DEFINITION OF THE OVERALL MISSION OPERATIONS CONCEPT

- TOTAL SYSTEM APPROACH : SATELLITE, OPERATIONS, GROUND SEGMENT, AIV

Introduction - Background

- FIRST SCIENCE OPERATIONS DEFINITION GROUP (FSODG)
  SET UP END JANUARY 1996

OBJECTIVE

- DEFINE A SCIENTIFIC OPERATIONS CONCEPT WHICH MINIMISES
  OVERALL COST OF SCIENTIFIC OPERATIONS BUT
  DOES NOT SACRIFICE SCIENCE OUTPUT

METHOD

- CONSIDER SCOPE OF FIRST SCIENCE OPERATIONS
- CRITICAL REVIEW OF ISO SCIENCE OPERATIONS
  (IMPLEMENTATION AND ACTUAL OPERATIONS)
- MONITORING OF CURRENT DEVELOPMENTS (e.g. XMM, INTEGRAL)
- OTHER RELEVANT EXPERIENCE (e.g. CLUSTER)

FIRST Science Operations Definition Group - Composition

▶ BOL - REPRESENTATIVE (RAL)	K. King
▶ HET - REPRESENTATIVE (SRON)	P. Roelfsema
▶ PHOC - REPRESENTATIVE (MPE)	O. Bauer
▶ PROJECT SCIENTIST (ESTEC/SSD)	G. Pilbratt
▶ SCIENCE COMMUNITY REPRESENTATIVE	O. Bauer
▶ FIRST PROJECT	P. Estaria (Chairman)
	H. Schaap (AIV)
▶ ESOC	A. Robson

Introduction - FSODG - Schedule Milestones

- 25.06.96 PRESENTATION to SAG - PRELIMINARY FINDINGS
- 04.07.96 PRESENTATION TO D/SCI - REVIEW REQUESTED
- 12.09.96 PRELIMINARY REVIEW - FSODG MEETING #5
- 02.10.96 FORMAL REVIEW (ESA + SAG + PWG + ISO PIs)
- 31.10.96 ISSUE 1 MISSION CONCEPT / GROUND SEGMENT DOCUMENT (PRELIMINARY COST ESTIMATES)
- 30.04.97 ISSUE 2 - REFINED COST ESTIMATE
- 01.06.97 :
  - INSTRUMENT - GROUND SEGMENT INTERFACE DOCUMENT
  - INSTRUMENT DESIGN GUIDELINES
  - GROUND SEGMENT IMPLEMENTATION GUIDELINES
  - IMPACT OF MISSION CONCEPT ON SATELLITE SYSTEM SPECS

Introduction - Background

STATUS

- FINDINGS PRESENTED TO THE SAG ON 25th JUNE 1996
- FINDINGS PRESENTED TO D/SCI ON 4th JULY 1996
- SAG FEEDBACK HAS BEEN PROCESSED
- PRELIMINARY CONCEPT AVAILABLE

MAJOR CONCLUSIONS

- IMPLEMENTATION AND OPERATIONS RESPONSIBILITIES SHALL BE ALLOCATED TO THE MOST QUALIFIED ENTITIES
- AN INTEGRATED DATA ARCHIVING AND COMMUNICATION SYSTEM RIGOROUSLY CONTROLLED BUT EASILY ACCESSIBLE IS REQUIRED
- ACROSS THE BOARD COMMONALITY IS ESSENTIAL
- SOME MAJOR FUNCTIONS SHOULD BE CENTRALISED

Contents

Main Assumptions (1)

- FIRST IS AN OBSERVATORY-TYPE MISSION (INCLUDING SURVEYS)
- SELECTED PAYLOAD WILL HAVE 3 INSTRUMENTS
- PI SELECTION TAKES PLACE MID 1998
- LAUNCH IN MID-2007
- MISSION DURATION IS 3 YEARS (COSTING)
- THE MISSION OPERATIONS CENTRE (MOC) IS RESPONSIBLE FOR ALL SATELLITE OPERATIONS INCLUDING EXECUTION OF INSTRUMENT OPERATIONS AND RESPONSIBILITY FOR INSTRUMENTS HEALTH AND SAFETY
- TM & TC ACCORDING TO ESA PACKET STANDARDS
- 3-DAY SPACECRAFT SAFETY / AUTONOMY MODE (INSTRUMENTS SWITCHED OFF)
- INSTRUMENT AUTONOMY DURING NON-COVERAGE PERIOD

Main Assumptions (2)

- ONE SINGLE GROUND STATION (IN EUROPE) - ROUTINE PHASE -
- ON BOARD DATA STORAGE : - TELEMETRY
  - SCHEDULE
- MAX ON-BOARD DATA RATE 68 KBS
- MAX DOWN-LINK TM RATE 100 KBS
- MAX TC BIT RATE 2 KBS OR 4 KBS
- INFRASTRUCTURE-TYPE SOFTWARE USED IN THE MOC (e.g. ORATOS, SCOS)
- ISO-TYPE ORBIT
- NO SCIENCE OPERATIONS DURING ECLIPSE
- NO SCIENCE OPERATIONS IN EARTH RADIATION BELT (APPROX. 40.000 KMS)
- TYPICAL OBSERVATION DURATIONS AS ISO

Key Features (1)

- OPTIMUM USE OF THE INSTRUMENT TEAMS' EXPERTISE
- MUST MAXIMISE COMMONALITY ON :
  - INSTRUMENT DESIGN STANDARDS
  - GROUND SEGMENT TO INSTRUMENT INTERFACES
  - INSTRUMENT TESTING AND OPERATIONS
  - SOFTWARE DEVELOPMENT AND STANDARDS
- ONE MISSION OPERATIONS CONTROL CENTRE (MOC) WITH
- ONE INTEGRATED OPERATIONS TEAM

Key Features (2)

- AN ARCHIVE SYSTEM CENTRAL TO THE OPERATIONS CONCEPT
  - DE FACTO CONFIGURATION CONTROL SYSTEM
  - MEANS OF COMMUNICATION BETWEEN ALL FIRST PARTICIPANTS
  - LIVING DATA REPOSITORY OF ALL MISSION DATA
  - NO GENERATION, NO DISTRIBUTION OF STANDARD DATA PRODUCTS
  - NO ARCHIVING OF "INTERMEDIATE" PRODUCTS ⇒ REPROCESS
- MAXIMUM RE-USE OF USEFUL CONCEPTS (e.g. ISO)
  - CALIBRATION UPLINK SYSTEM (CUS)
  - ASTRONOMICAL OBSERVATIONS TEMPLATES (AOTs)
  - INSTRUMENT COMMAND SEQUENCES (ICSs)
  - TRANSPARENT DATA (VIA DUMMY COMMANDS)
- OVERALL SYSTEM APPROACH
  - FSODG INPUT TAKEN INTO ACCOUNT IN SATELLITE SYSTEM SPECIFICATIONS (e.g. POINTING, MASS MEMORY UNIT)
- NO CONCATENATION OF OBSERVATIONS
- LINKING OF OBSERVATIONS THROUGH STANDARD MISSION PLANNING FACILITIES

Instrument Design (1)

ALL INSTRUMENTS SHALL USE :

- IDENTICAL INTERFACES TO THE S/C
- IDENTICAL MICRO-PROCESSORS AND PROGRAMMING TOOLS
- A KEEP ALIVE LINE TO PRESERVE RAM CONTENTS WHEN UNPOWERED
- IDENTICAL INTERNAL REDUNDANCY CONCEPT
- IDENTICAL ON-BOARD SOFTWARE MANAGEMENT TECHNIQUES
- IDENTICAL RAM PATCHING TECHNIQUES
- A MACRO-COMMANDING STRUCTURE WHEREBY BASIC OPERATIONAL BUILDING BLOCKS SHALL BE INSTRUMENT RESIDENT
- COMMON SUBSYSTEM DESIGN WHERE POSSIBLE
- A HIGH LEVEL OF INSTRUMENT-INTERNAL AUTONOMY
- A LIMITED NUMBER OF OBSERVING MODES

Instrument Testing (2)

- ONE INSTRUMENT PARAMETER DATABASE
- INSTRUMENT FULLY CALIBRATED UPON DELIVERY TO ESA
- COMMONALITY FOR THE VARIOUS TEST LEVELS SUCH AS ILT (Instrument Level Tests), IST AND COMMISSIONING PHASE
- TWO TEST LEVELS AFTER INSTRUMENT DELIVERY:
  - PLM LEVEL
  - SYSTEM LEVEL
- THREE INSTRUMENT TESTS :
  - SFT SHORT FUNCTIONAL TEST
  - SIST SHORT INTEGRATED SYSTEM TEST
  - IST INTEGRATED SYSTEM TEST (shall include verification of observing modes)

Operations Scenarios (1)

- IDENTIFICATION OF MAJOR SCIENCE OPERATIONS FUNCTIONS
- ALLOCATION OF FUNCTIONS TO "CENTRES"
- SEVERAL SCENARIOS EVALUATED
  - ANALYSIS OF TASKS TO BE PERFORMED BY EACH CENTRE
  - EVALUATION OF INTERFACES BETWEEN CENTRES
  - (ROUGH) COSTING FOR EACH CENTRE
- ONE SCENARIO SELECTED/RECOMMENDED BY FSODG
- FSODG SCENARIO ALSO FAVOURED BY SAG

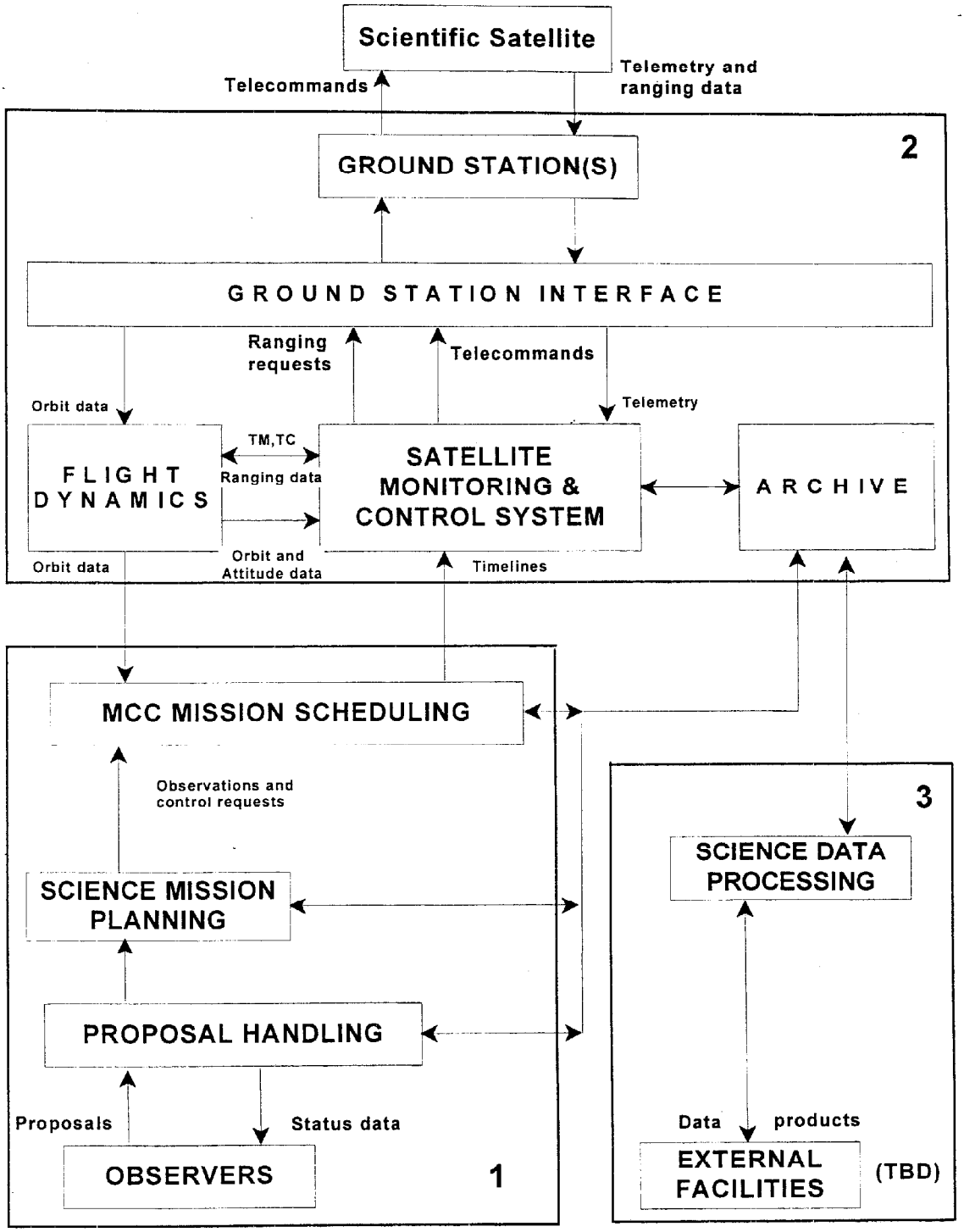
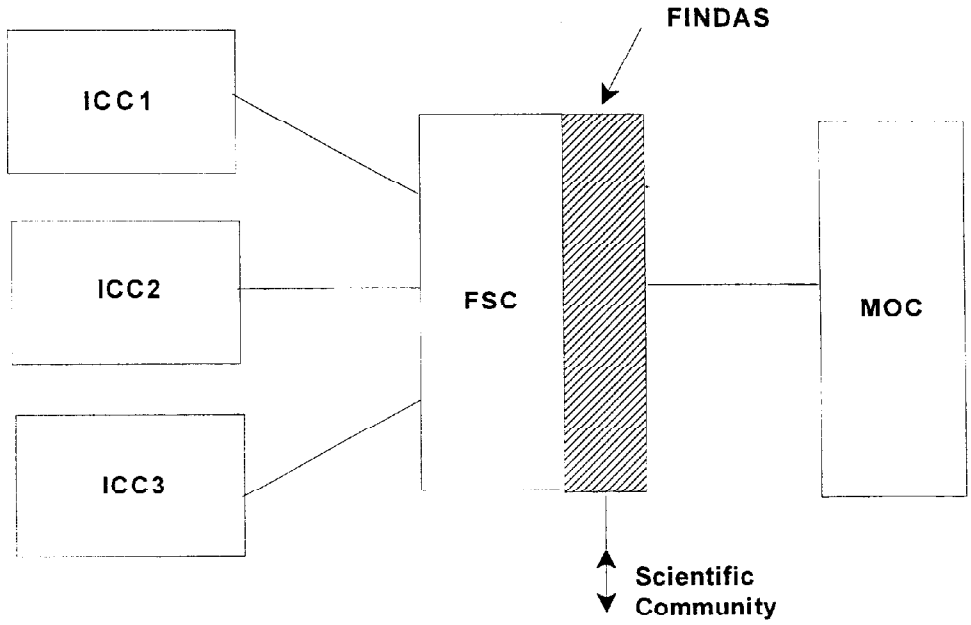


Fig. 4.1 Ground Segment Overview (Standard)

Main Components

- ICCs - INSTRUMENT CONTROL CENTRE(S)
- FSC - FIRST SCIENCE CENTRE
  - OVERALL SCIENCE COORDINATION
  - ARCHIVE SYSTEM
- MOC - MISSION OPERATIONS CENTRE



- MOC PROVIDED BY ESOC
- ICCs PROVIDED BY THE PI-INSTITUTES
- FSC : TWO POSSIBILITIES
    1) FSC PROVIDED BY ESA
    2) FSC PROVIDED BY A EUROPEAN INSTITUTE

Fig. 4.2 - FIRST OPERATIONAL SCENARIO

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FINDAS

FIRST Integrated Network Data Archive System

Peter Roelfsema

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FIRST Integrated Network Data Archive System

- introduction
- what is needed?
- old style archiving
- advanced style archiving
- more advanced style archiving
- configuration control
- communication
- phased development

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FIRST Integrated Network Data Archive System

- must provide:
  - configuration track and control
  - communication between teams
  - archive and retrieval of software and data
- must be:
  - accessible to many people/groups
  - accessible over networks
  - flexible and expandable
- must contain:
  - data in raw form
  - data processing and analysis software (in multiple versions)

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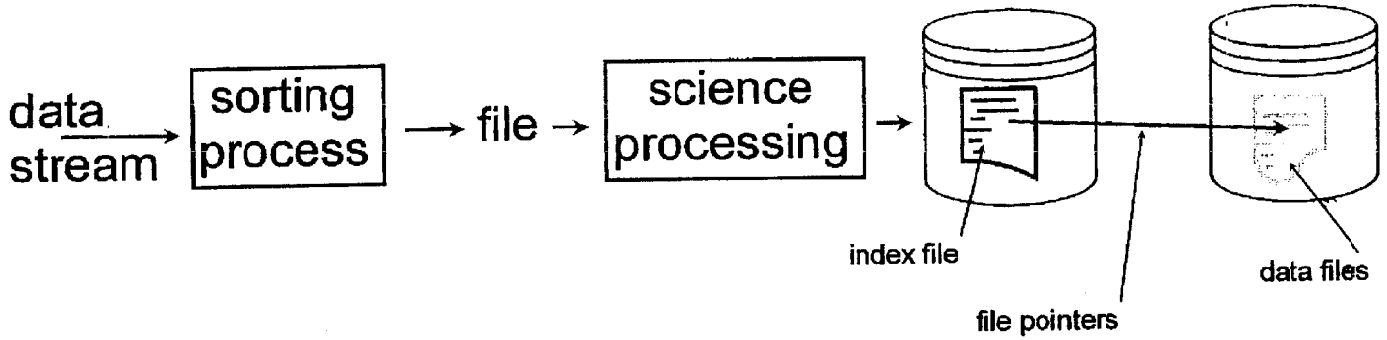
Classical archive = collection of files

1. data stream is captured
2. data is sorted into files
3. files are further processed into (science-) product files
4. files are stored and indexed in separate lookup table



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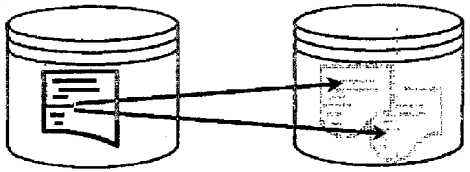
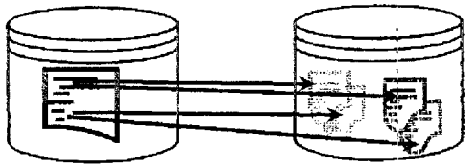
Problems with the classical archive

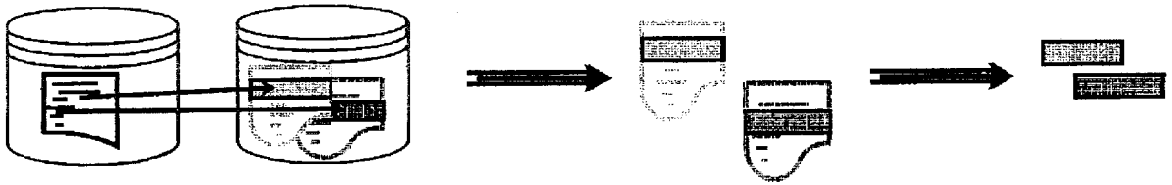
- multiple data sets => list of files:



- files belong together => multiple pointers:



- extracting part of a data set =>archive- and data processing:



- processing may have been out of date => reprocessing and rearchiving needed

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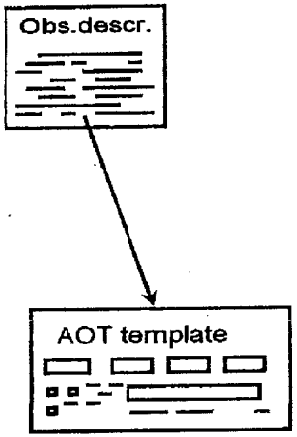
Modern archive = objects + relations



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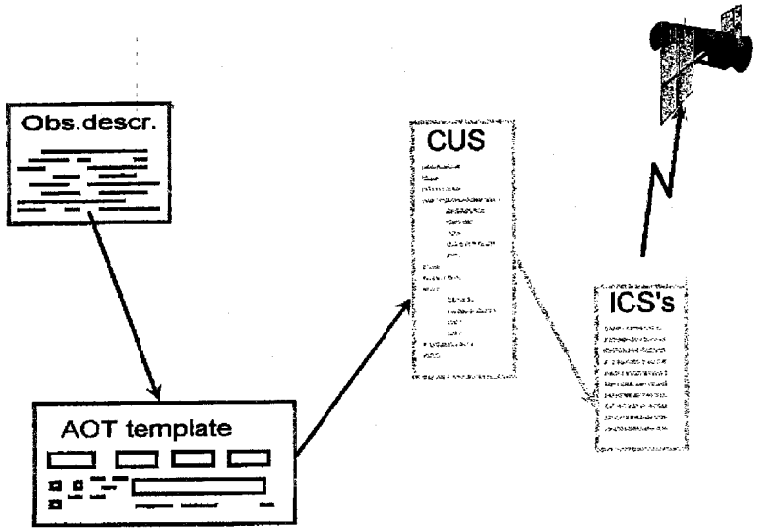
Modern archive = objects + relations



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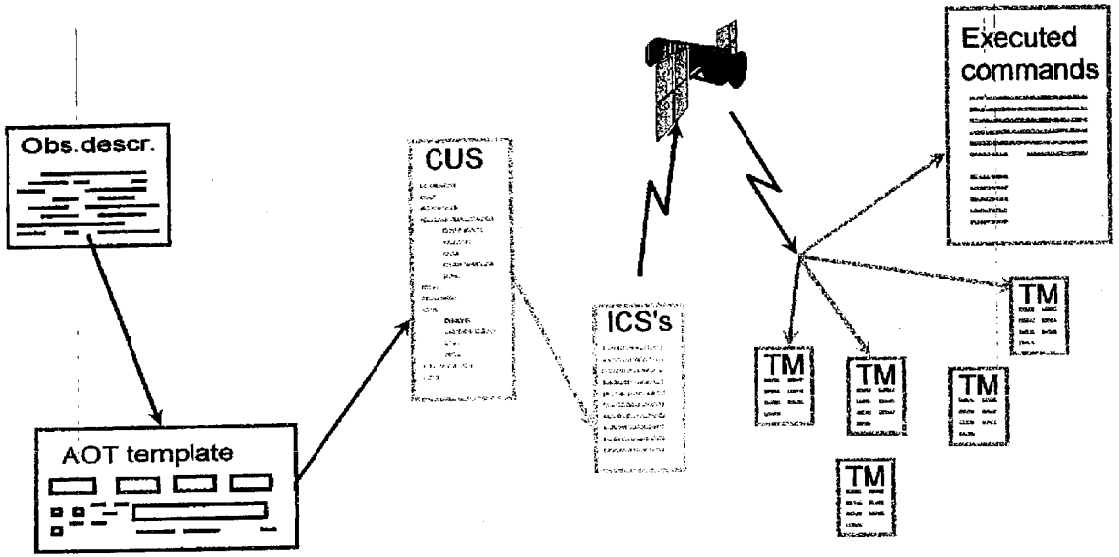
Modern archive = objects + relations



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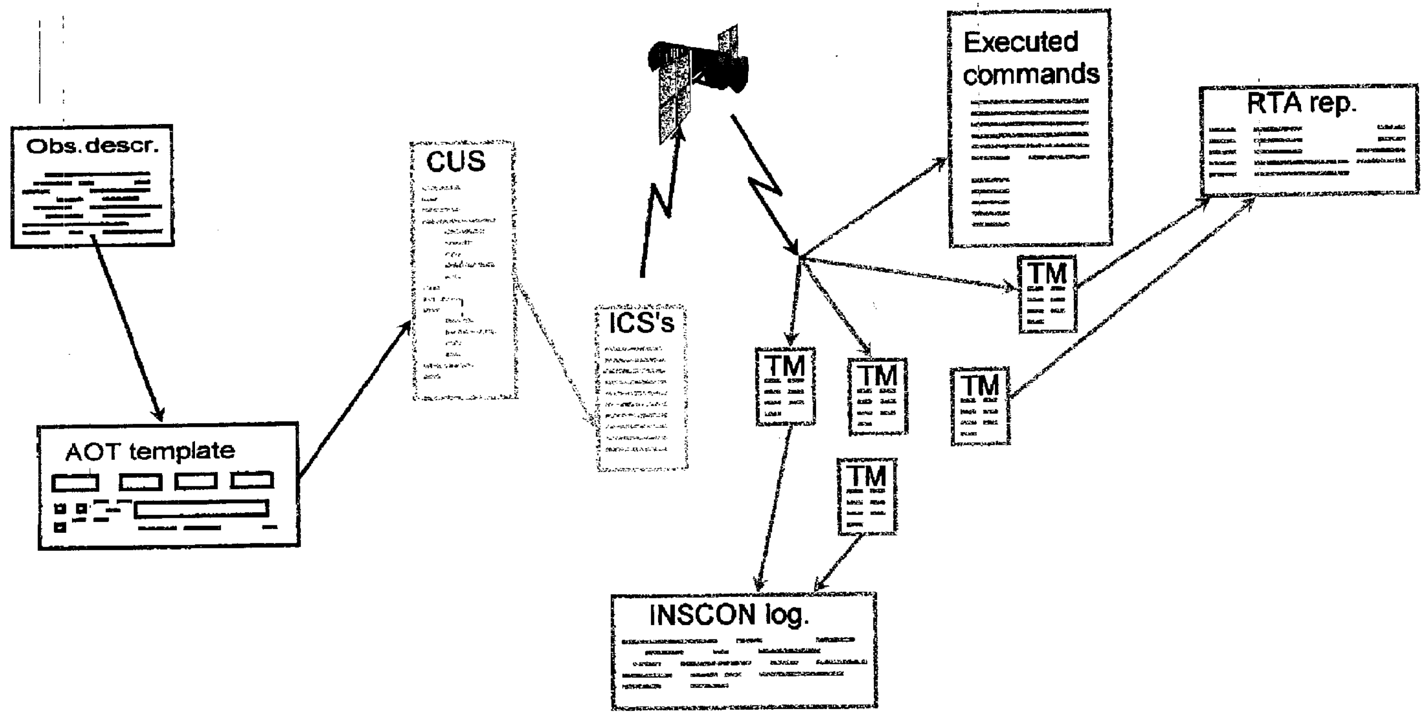
Modern archive = objects + relations



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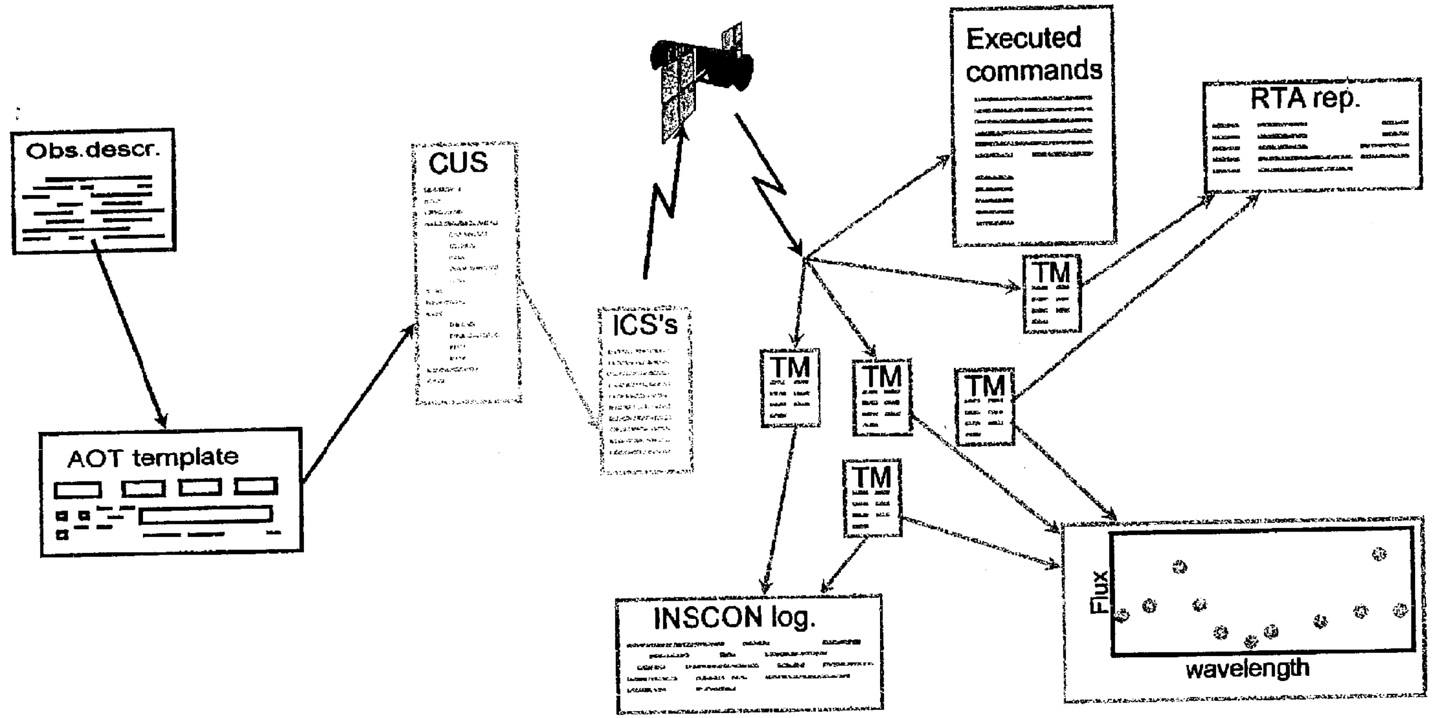
Modern archive = objects + relations



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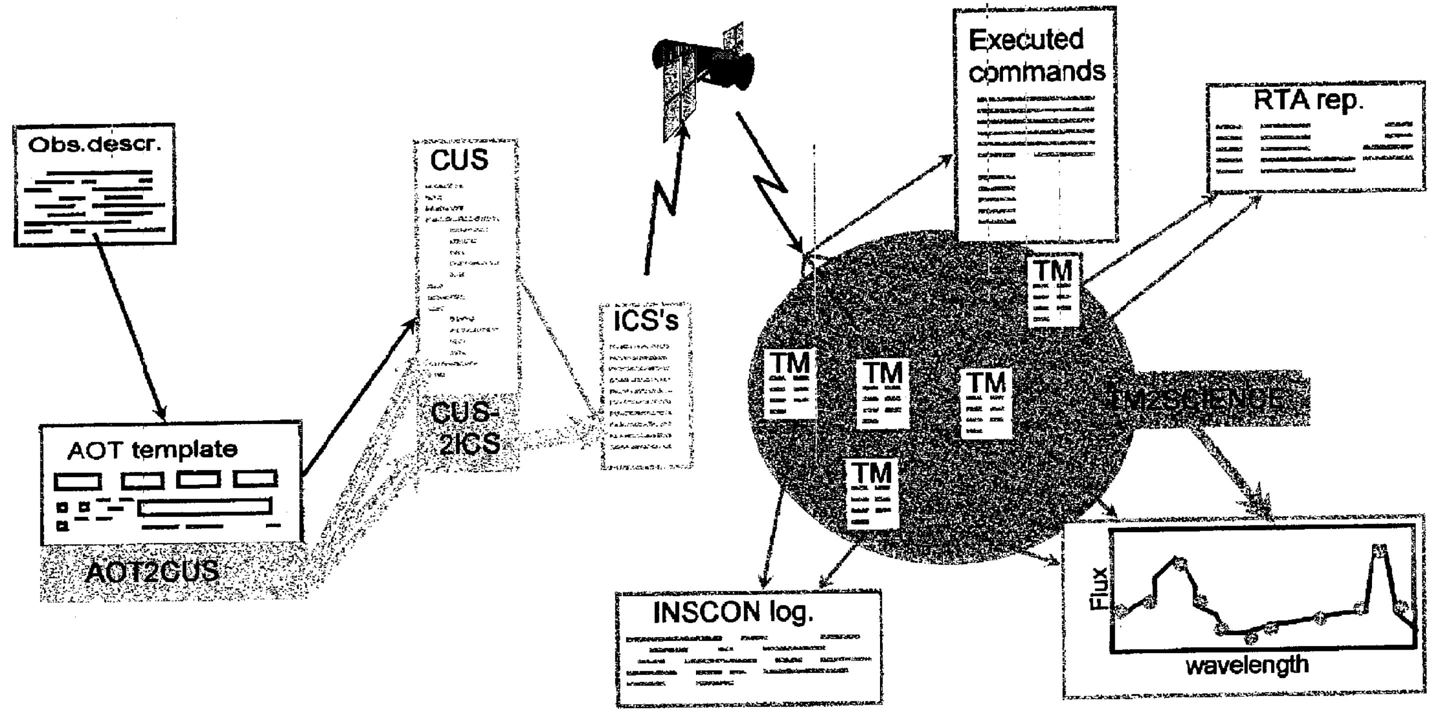
Very modern archive = objects + relations + methods



Configuration Control

- needed for tracking ,... but needs flexibility (e.g. PV <-> routine)
- all objects/methods have preset access rights per group/person (**RESERVE**, **UPDATE**, **PROMOTE** etc)
- two (or more) 'existence levels' needed; **TEST** and **SYSTEM**
- change cycle:
  - (**CREATE**)
  - **RESERVE** => prohibits other **RESERVE/UPDATE** etc.
  - **EXTRACT** => modify and test in local area
  - **UPDATE** => make available for system test
  - testers test the object in **TEST**
  - **PROMOTE** => object goes from **TEST** to **SYSTEM**
- **UPDATE/PROMOTE** must have many automatic 'functionality tests' (compilability, adherence to standards etc.)

Communication

- special pre-defined messages for objects for defined clients
  - **RESERVE =>** send message to other (potential) modifiers
  - **UPDATE =>** send message to 'testers'
  - **PROMOTE =>** send message to users
  - e.g. for the schedule:
    - POL **CREATE**d by science planner
    - **UPDATE =>** functional test
    - **PROMOTE =>** message to MOC scheduler
    - MOC scheduler **RESERVE**s and makes schedule
    - **UPDATE =>** 'functional test
    - **PROMOTE =>** message to operations and science (and ICC's?)

Design and implementation phases

- design can be phased as follows:
  - configuration control system/protocol
  - storage definition for documentation
  - storage definition for methods
  - messaging protocol
  - raw telemetry objects
  - 'CUS' type observation specifications
  - 'AOT' type observation specifications
  - further design of data types and object relations
  - convert manual procedures to automatic procedures
- early ptototyping is probably needed to explore the concept
- possible future (?) addons:
  - meeting minutes
  - action lists
  - etc.

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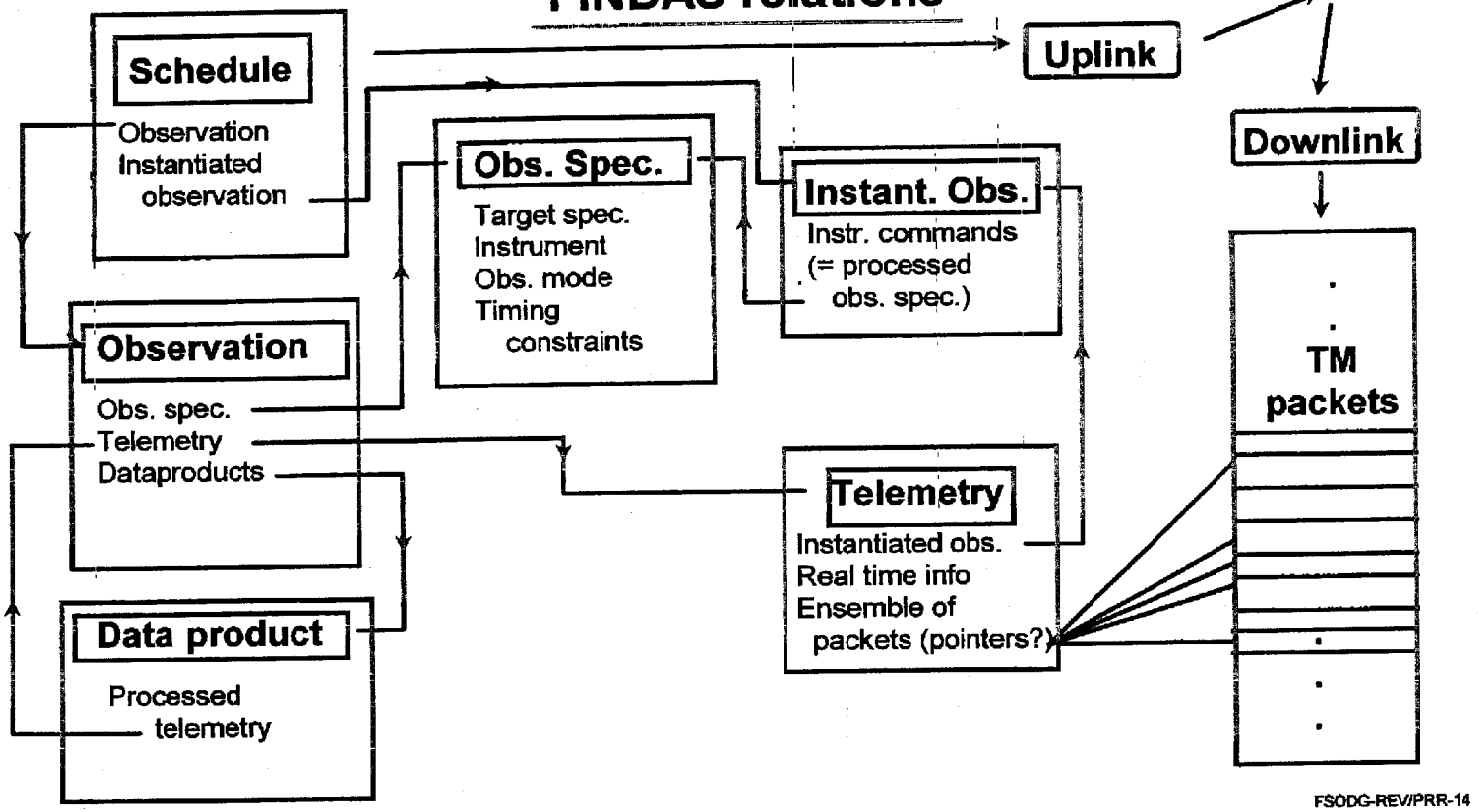
FINDAS relations



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FIRST Science Centre - (1)

CENTRALISED FACILITIES

- ARCHIVE MANAGEMENT
  - OPTIMISED DESIGN AND OPERATIONS
  - BETTER CONFIGURATION CONTROL, INTEGRITY, CONSISTANCY

- SCIENTIFIC PROGRAMME COORDINATION
  - PROPOSAL HANDLING, TIME ALLOCATION, MISSION DATABASE
  - CALIBRATION: GROUND BASED, CROSS CALIBRATION
  - SURVEYS
  - OPERATIONS

➡ FIRST SCIENCE CENTRE

FIRST Science Centre - (2)

ADVANTAGES OF FIRST SCIENCE CENTRE

- SINGLE INTERFACE TO COMMUNITY
  - SINGLE INPUT (PROPOSALS), SINGLE OUTPUT (DATA + SOFTWARE)
  - CENTRAL HELPDESK
  - CENTRAL INFRASTRUCTURE FOR SCIENTIFIC COMMUNICATIONS (SEMINARS, NEWSLETTERS, WWW, PR)

- POTENTIAL FOR FOURTH PI INVOLVEMENT
  - SINGLE INTERFACE TO COMMUNITY
  - SURVEY PROCESSING

- ARCHIVE IN PLACE FOR POST MISSION PHASE

FIRST Science Centre - (3)

MAIN TASKS

- SET-UP AND MANAGEMENT OF ARCHIVE
- PROVIDE SCIENCE COMMUNITY SUPPORT (BEFORE, DURING & AFTER MISSION)
- PROPOSAL HANDLING AND TIME ALLOCATION
- GENERATION OF MISSION DATABASE OF OBSERVATIONS
- SCIENCE MISSION PLANNING AND SCHEDULING
- COORDINATION OF CALIBRATION PROGRAMME (INCL. GROUND BASED)
- TO MAKE AVAILABLE ALL REQUIRED DATA (SCIENCE, CALIBRATION, ANCILLIARY) AND SCIENTIFIC PROCESSING SOFTWARE TO OBSERVERS
- TO COORDINATE AND PROCESS SURVEY OBSERVATIONS AND DISTRIBUTE THE RESULTS
- ENSURE ADHERENCE TO ALL AGREED COMMONALITY STANDARDS

FIRST Science Centre - (4)

MANPOWER DEPLOYMENT AND COST ESTIMATE				
		STAFF	ADDITIONAL COSTS	TOTAL COSTS
MID	1998	1	14	74 kAU
	1999	3	54	287 kAU
	2000	3	54	287 kAU
	2001	8	143	754 kAU
	2002	8	143	754 kAU
	2003	13	226	1193 kAU
	2004	14	249	1314 kAU
	2005	17	298	1573 kAU
	2006	19	336	1776 kAU
	2007	19	336	1776 kAU
	2008	18	314	1660 kAU
	2009	17	301	1591 kAU
MID	2010	9	172	907 kAU
			COMPUTER EQUIPMENT	650 kAU
			INFRASTRUCTURE	1000 kAU
			TOTAL	15596 kAU

Assumptions: PI selection (mid 1998) -- Launch of FIRST (mid 1997) -- Mission duration (3 years)

Instrument Control Centre(s) - (1)

- IMPLEMENTATION AND OPERATIONS RESPONSIBILITIES SHOULD BE ASSIGNED TO THE MOST QUALIFIED GROUPS "COMPETENCE CENTRES"
  - INCREASES EFFICIENCY
  - REDUCES OVERHEAD
  - INCREASES MOTIVATION
  - SIMPLIFIES INTERFACES
- ISO IDTs VERY SUCCESSFUL, BUT
  1) SET-UP VERY LATE
  2) COLLABORATION WITH SUPPORT TEAMS DIFFICULT

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- ESTABLISH INSTRUMENT CONTROL CENTRES (ICCs) UNDER PI RESPONSIBILITY

Instrument Control Centre(s) - (2)

MAIN FEATURES:

- OPTIMUM USE OF INSTRUMENT TEAM EXPERTISE
- ONE ICC PER INSTRUMENT
- LOCATED AT PI - INSTITUTES
- ICC RESPONSIBLE FOR ITS OWN ACCOMMODATION, ORGANISATION AND MANAGEMENT
- NO DIRECT INTERACTION WITH OBSERVERS → FSC
- NO REAL-TIME OPERATIONAL RESPONSIBILITY

MAIN TASKS:

- DEFINE INSTRUMENT DATA BASE
- DEFINE INSTRUMENT MODES AND COMMAND SEQUENCES
- CALIBRATE INSTRUMENT (PRE- AND POST LAUNCH)
- PRODUCE INSTRUMENT USER's MANUAL

Instrument Control Centre(s) - (3)

- PRODUCE INSTRUMENT FLIGHT OPERATIONS PROCEDURES
- PRODUCE SCIENTIFIC PROCESSING SOFTWARE
- SUPPORT INSTRUMENT COMMISSIONING AND PV PHASES (CO-LOCATION AT THE MOC) IN REAL-TIME
- PRODUCE "TIME" ESTIMATORS (OBSERVERS SUPPORT)
- PRODUCE INSTRUMENT SOFTWARE SIMULATORS (OPERATIONAL TESTING)
- PROVIDE INSTRUMENT ON-BOARD SOFTWARE MAINTENANCE (PRE- AND POST LAUNCH)
- SUPPORT ROUTINE OPERATIONS (LOCATION ICC)
- SUPPORT INSTRUMENT-LEVEL TESTS, AIV AND SIMULATIONS
- PROVIDE PRE-LAUNCH INSTRUMENT CALIBRATION TABLES
- POPULATE AND USE 'FINDAS' AS EARLY AS POSSIBLE

FIRST ICC : Manpower deployment and cost estimate (75 kAU/year)

	Manpower	Overhead	Costs
mid 1999	3	10%	247,5 kAU
2000	5	10%	412,5 kAU
2001	7	10%	577,5 kAU
2002	10	10%	825,0 kAU
2003	10	10%	825,0 kAU
2004	12	10%	990,0 kAU
2005	15	10%	1.237,5 kAU
2006	15	10%	1.237,5 kAU
2007	15	10%	1.237,5 kAU
2008	15	10%	1.237,5 kAU
2009	15	10%	1.237,5 kAU
mid 2010	15	10%	1.237,5 kAU
Computer equipment			500,0 kAU
		Total costs	10.565,0 kAU

NOTE: Launch of FIRST : mid 2007
---- Mission duration: 3 years

FIRST MOC Concepts - (1)

GROUND STATIONS

- LEOP : ESA 15 m S BAND NETWORK
  - NEAR CONTINUOUS COVERAGE

- INSTRUMENT COMMISSIONING AND PV PHASE : 2 STATIONS
  - FULL COVERAGE OVER 20 KKM
  - TESTS AND OBSERVATIONS UNDER GROUND OR ON-BOARD CONTROL AS REQUIRED
  - REAL TIME OPERATIONS

- ROUTINE PHASE : 1 STATION
  - COVERAGE, ca 50%
  - OBSERVATIONS UNDER ON-BOARD SCHEDULE CONTROL
  - REAL TIME AND PLAYBACK DATA SIMULTANEOUSLY
  - DAILY OBSERVATION SCHEDULE UPLINK

FIRST MOC Concepts - (2)

CONTROL CENTRES

- LEOP : MAIN CONTROL ROOM IN ESOC
- INSTRUMENT OPERATIONAL PHASES :
  FIRST DEDICATED CONTROL ROOM IN ESOC
  - INSTRUMENT HEALTH & SAFETY WITHIN FDCS :
    SINGLE MOC OPERATOR TEAM
  - INSTRUMENT H & S PROCEDURES FROM ICC SPECIALISTS
  - COMMISSIONING AND PV :
    ICC INSTRUMENT SPECIALISTS AND EQUIPMENT IN ESOC
  - ROUTINE : NO ICC INSTRUMENT SPECIALISTS IN ESOC
    BUT EQUIPMENT INTERFACES MAINTAINED
  - DAILY UPLINK OF OBSERVATION SCHEDULE COMMANDS
  - OPERATIONAL MONITORING OF OBSERVATIONS DURING
    STATION COVERAGE PERIOD
  - DAILY OPERATIONS REPORTING ON FINDAS

FIRST MOC Concepts - (3)

MOC FACILITIES DEVELOPMENT

- ▣ GROUND STATIONS : TAILORING TO FIRST CHARACTERISTICS
- ▣ LEOP CONTROL CENTRE : CONFIGURE FOR FIRST
- ▣ INSTRUMENT AREA : SPACE, FURNITURE AND COMMS ONLY
  EQUIPMENT TO BE PROVIDED BY ICC
- ▣ FIRST DEDICATED CONTROL SYSTEM :
  - USE OF ESOC TM/TC INFRASTRUCTURE
  - RE-USE, AS FAR AS POSSIBLE, PREVIOUS SCIENTIFIC SATELLITE CONTROL SYSTEMS
  - COMMONALITY, WHEN ECONOMIC, WITH EGSE
  - INSTRUMENT HEALTH AND SAFETY M & C AS SPACECRAFT SUBSYSTEM - NO SCIENCE PACKET PROCESSING
  - MISSION SCHEDULING WILL BE A NEW DEVELOPMENT

FIRST MOC Concepts - (4)

- FLIGHT DYNAMICS SYSTEM :
  - STANDARD ORBIT FACILITIES
  - ATTITUDE SYSTEMS, AS FAR AS POSSIBLE, BASED ON PREVIOUS SCIENTIFIC SATELLITE SYSTEMS
  - AOCS CALIBRATION SYSTEM MAY BE A NEW DEVELOPMENT (TBC)

- ARCHIVE AND DISTRIBUTION SYSTEM :
  USE OF FINDAS AS COMMONLY DEFINED

- COMMUNICATION CIRCUITS
  - MOC to STATIONS, DEDICATED LEASED FOR PRIME AND BACK-UP
  - MOC to FSC, DEDICATED PRIME, ISDN BACK-UP (TBC)
  - FSC to ICCs, DEDICATED PRIME, ISDN BACK-UP (TBC)
  - FSC to EXTERNALS, ISDN

- SIMULATOR : DESIGN AND BUILD SATELLITE SIMULATOR WITH INTERFACES TO INSTRUMENT MODELS / SOFTWARE (TO BE PROVIDED BY PIs) - TO BE DEVELOPED BY TBD

FIRST MOC Concepts - (5)

MISSION PLANNING

- ORBIT AND VISIBILITY CONSTRAINT PARAMETERS AVAILABLE TO FSC

- SEQUENCED OBSERVATION LIST FROM FSC TO MOC
  - UP TO 2 WEEKS OBSERVATIONS
  - TARGETS, INSTRUMENT COMMANDS, T DATA COMMANDS, TIME

- MISSION SCHEDULING BY MOC
  - SPACECRAFT COMMANDS
  - DETAILED OBSERVATION COMMAND SCHEDULING (AS REQUIRED)

- SCHEDULES PUBLISHED ON FINDAS

FIRST MOC Concepts - (6)

GROUND SEGMENT INTEGRATION AND TEST

- GROUND STATIONS COMPATIBILITY TESTING WITH SATELLITE EQUIPMENT
- EARLY AVAILABILITY OF FINDAS GIVES CONTINUOUS FACILITIES INTEGRATION AS NORMAL WORK AND ACCESS TO SATELLITE TEST DATA
- MOC TO FIRST -- OPERATIONS COMPATIBILITY TESTING (SYSTEM VALIDATION TESTING)
- INTEGRATED OPERATIONAL VALIDATION TESTS (END TO END) SIMPLER THAN ISO

Costing (1)

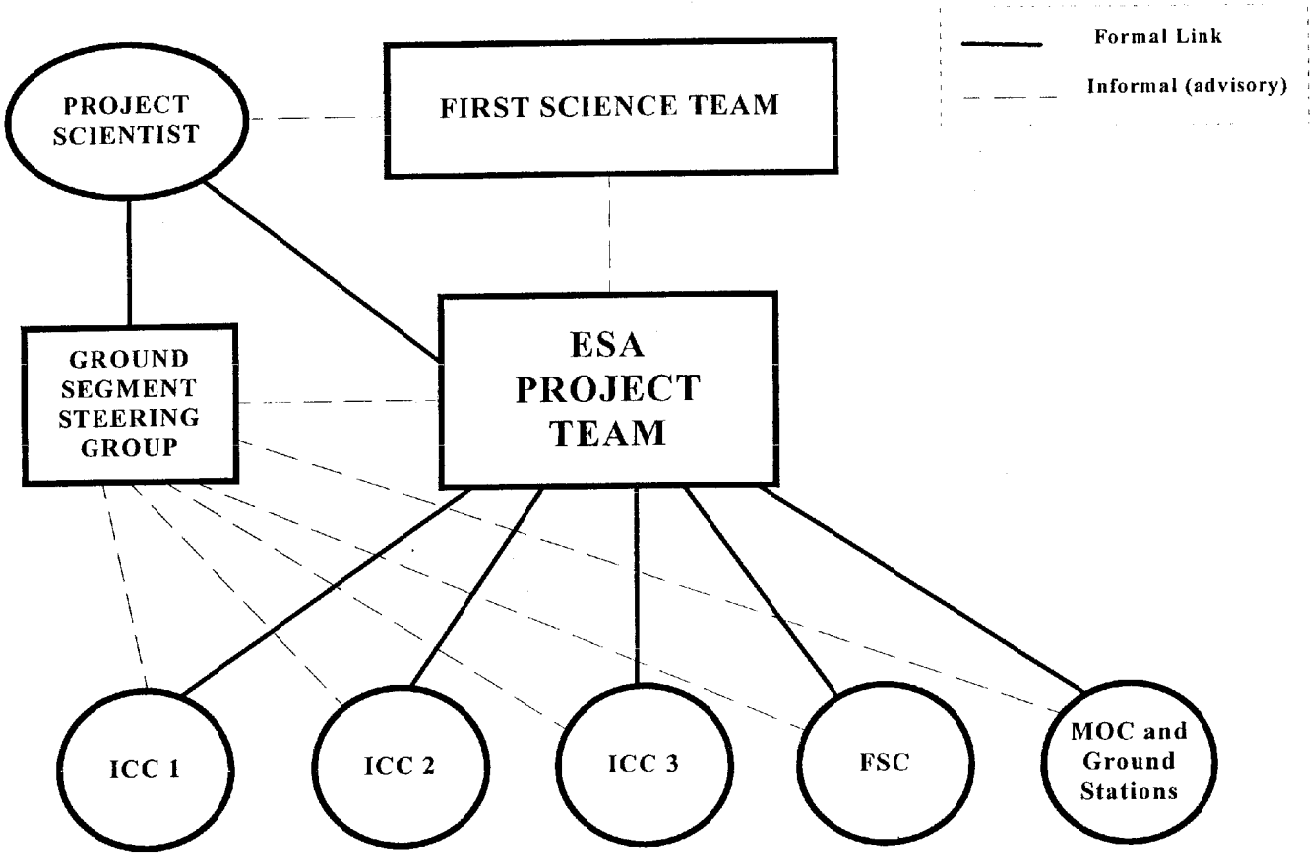
- POST OPERATIONAL AND ARCHIVE PHASES NOT COSTED
- RUN DOWN COSTS NOT INCLUDED
- COMMUNICATION LINES NOT INCLUDED
- COSTS INCLUDE INFRASTRUCTURE, HARDWARE, SOFTWARE, MANPOWER, OVERHEADS, ETC.
- ESTIMATES ARE VERY PRELIMINARY
- ESTIMATES BASED ON ACTUAL FIGURES FOR ROSAT, CLUSTER JSOC, ISO
- ASSUMPTIONS - START OF WORK BEG. 2000 - END OF OPERATIONS MID 2010

Costing (2)

- COMPARISONS / EXTRAPOLATIONS VERY DIFFICULT
- MORE ACCURATE COSTING REQUIRES :
  - RESOLUTION OF OPEN POINTS
  - DEEPER LEVEL OF DEFINITION

- ICC COST ≈ 10.5 MAU (per ICC)
- FSC COST (WITHOUT ARCHIVE) ≈ 11 MAU
- FINDAS ≈ 5 MAU

Fig. 4.3 **FIRST GROUND SEGMENT ORGANISATION**



Main Open Points (1)

- TYPE OF MISSION ?
  - ASSUMPTION : OBSERVATORY TYPE INCLUDING SURVEYS
    - WHICH PERCENTAGE ?, WHEN ?, DURATION ?
    - ANY OTHER ACTIVITY, e.g. KEY PROGRAMMES ?
  - AFFECTS MOSTLY PROPOSAL HANDLING AND SCIENCE COORDINATION

- FSC IMPLEMENTATION ?
  - ESA OR EUROPEAN INSTITUTE
  - FUNCTIONALITY IS THE SAME BUT CHOICE OF OPTION AFFECTS :
    - DISTRIBUTION OF TASKS - RESPONSIBILITY -
    - MANAGEMENT SCHEME
    - OVERALL GROUND SEGMENT AND OPERATIONS COSTS
    - ARCHIVE LOCATION

Main Open Points (2)

- CRYOSTAT OR CRYOCOOLERS ?
  - INSTRUMENT SWITCHED OFF DURING LONG ECLIPSES (> 90 mins)
  - UP TO 80 LONG ECLIPSES IN A 3-YEAR PERIOD
    (LAUNCH DATE DEPENDANT - 1400 KM PERIGEE HEIGHT)
  - WITH CRYOCOOLER OPTION :
    - NO SCIENCE OPERATIONS ON THE ENTIRE ORBIT AFFECTED BY A LONG ECLIPSE
    - PV PHASE REQUIRED AFTER EACH ECLIPSE SEASON

- RE-USE OF XMM BUS ?
  - AFFECTS
    - POINTING
    - ORBIT
  - ONE GROUND STATION PROVIDES NEAR-COMPLETE ORBIT COVERAGE ON A XMM ORBIT

Conclusions

- SCIENCE OPERATIONS CONCEPT - WITH ROUGH COSTING - AVAILABLE
- KEY GROUND SEGMENT CONCEPTS
  - HIGH LEVEL OF COMMONALITY BETWEEN INSTRUMENTS
  - DISTRIBUTION OF DEVELOPMENT AND OPERATIONAL ACTIVITIES TO "COMPETENCE" CENTRES
  - INSTRUMENT CONTROL CENTRES AT INSTITUTES
  - FIRST SCIENCE CENTRE : EUROPEAN INSTITUTE OR ESA
  - ARCHIVE / WORKING DATA REPOSITORY FOR ALL DATA EXCHANGES
  - OBSERVER ACCESS TO RAW TM DATA, SCIENCE PROCESSING SOFTWARE AND CALIBRATION DATA
  - NO PROCESSED DATA DISTRIBUTION
- REQUEST REVIEW PANEL TO :
  - PROVIDE FEEDBACK NOW
  - PROVIDE WRITTEN RECOMMENDATION/ENDORSEMENT BY 20.10.96