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M E E T I N G

meeting date *date de la réunion*	23/04/02	ref./ *réf.* HERSCHEL-HSC-MOM-0244		page/ *page*	1 / 14
meeting place *lieu de la réunion*	ESOC		chairman *président*	SV	
minute's date *dates de minute*	13/05/02		participants *participants*	See appendix	
subject/objet	**HGSSE #18 MoM**		copy/ *copie*		

description/description	ction/action	lue date/date limite

PACS(RH) informed the group of the decision to have Bart Vandenbussche(BV) taking over from Rik Huygen for the GS segment system engineering activities. Bart will therefore now attend regularly the HGSSE meetings. The group thanked Rik for his very positive contributions to the system engineering group and welcome Bart as a new member.

O b j e c t i v e & A g e n d a

See SV's VG#1

R e v i e w o f A c t i o n s

See SV's VG#2&3

AI#171001/8: 3 ICCs to clarify their plan for having High Fidelity HW and EGSE-ILT like set-up after the delivery of the flight model to be used for SPG/QCP & IA test purpose and Ops support purpose . Due date: 07/11.
Open. See HGSSE#17 MoM

AI#171001/9: JD to clarify with FD the added value of validating the PV HSC schedules up to MP2 (i.e. what MP2 will check that is not checked by MP1). Due date: 29/11.
Closed. In agreement with JD, NP stated that the Herschel PV phase schedules will be pre-validated up to MP2 by MOC. This will be reflected in the H/P MIP.

AI# 291101/3 : ICCs to describe their proposed ILT set-up and HCSS ODBMS replication requirements. Due date 17/12. Closed for HIFI, see PR's VG in appendix 2.

Open for PACS and SPIRE, see HGSSE#17 MoM. SPIRE (SS) mentioned that the SPIRE ILT set-up will be described in the SPIRE ICC scenario document to be released end of April 02 as part of the data package for the SPIRE ICC review.

AI#280202/1: SF to clarify the rationale of instrument simulator requirements and other ICCs question marks as minuted below . Due date: 29/03/02.
Closed. See JD's and SF's presentations attached.

AI#280202/2: 3 ICCs to distribute to the group the list and description of their instrument mode failures. Due date: 08/03/02.
Closed. See
–Email from SS dated 11/03: Failure Detection Isolation and Recovery Policy in the SPIRE Instrument, SPIRE-RAL-PRJ-001128, draft 0.1
–Email from PR dated 11/03: Failure Mode, Effect and Criticality Analysis at system level SRON-U/HIFI/RP/2000-001, issue 1.1
–Email from RH dated 11/03: Instrument FMECA, Failure Modes, Effects and Criticality Analysis Report, PACS-ME-GR-004, draft 2
It was however noted that the SPIRE document is still high level and does not yet identify the SPIRE failure modes

AI#280202/3: RH to clarify usage of the S2K OBSM by PACS in ILT and consequent customization of the OBSM. Due date 08/03.
Open. PACS (RH) clarified that the S2K OBSM will not be used for the AVM. RH however understands that PACS made a request to H/P project for the S2K OBSM customization for the DPS processor. More precisions are needed on this request and its outcome before action can be closed. BV to follow-up.

AI#280202/4: NP to clarify compatibility of the LOGICA SW with future S2K versions starting with v2.3e. Due date 28/03.
Closed. NP clarified during the meeting that the LOGICA patch is compatible with future S2K versions, starting with V2.3e. The LOGICA patch requires that the S2K Misc. config. table and the task launcher scripts are modified but no S2K classes or functions have been modified. The modifications are documented in the patch installation manual and updated scripts.

AI#280202/5: NP to investigate solutions to get the TC ID implemented by April 02 and clarify TC Id implementation in V2.3.e. Due date 08/03. See NP's email dated 28/03 on TC Id proposal from TERMA
Closed. NP precised that TERMA will deliver the TC Id implementation to ESOC by mid May 2002 and that it will be integrated with S2K v2.3e.

AI#280202/6: SS to check (possibly with IFSI) when the instrument time gets synchronized with the S/C time. Due date 28/03. See SS email dated 25/03
Closed. Instrument time is synchronized after instrument switch-on procedure once the OBS can communicate with the S/C bus controller. Time unsynchronized packet can be issued by instrument until

then. ICCs do not require any specific handling of these TM packets in the HCSS. NP precised that MOC will not discard these packets, however the way MOC should present them in the DDS is still TBD. This will have to be detailed as part of the DDS ICD, to be discussed but not before next year.

AI#280202/7: ICCs to surface requirements on orbit data and pointing history vis-à-vis MOC .Due date 28/03.
Closed for PACS. See email from RH dated with attachment from HF
Open for SPIRE and HIFI. New due date 01/06
SV precised that the group should discuss these requirements in view of potential update to the IRD.

System design

TC history & OOL data

SPIRE (SS) reported that the LOGICA patch to fetch TC history and OOL data had been successfully installed and tested by LOGICA in RAL on S2K v2.1.1e. SPIRE also tested that their TC history OOL server could interface with the LOGICA SW. However tests have only been performed so far with test data delivered by LOGICA. It remains to be tested that the patch works with TC history and OOL data generated by SPIRE in their S2K environment. This test should be performed by SPIRE before end of April 02. SS will report to the group asap.

TC id

NP sent the updated (after comments from HSC and ICCs) and final TERMA WP description for the implementation of the TC Id in S2K TC history in an email dated 22/04. Work started on 22/04 and is expected to be completed by mid May. TC Id implementation will be part of S2K v2.3e to be delivered by ESOC end of May after provisional acceptance.

Wrt schedule, SV understands from Brian Melton that after S2K v2.3e provisional acceptance by ESOC, one additional month will be needed to bring TOPE in line with S2K v2.3e, i.e. S2K V2.3e + TOPE could be available to ICCs by end of June.

SV raised the question of compatibility of the LOGICA patch with the TERMA TC id implementation (i.e. will the LOGICA patch allow to retrieve the TC Id field in the TC history?). NP believe this is the case but could not confirm on line and took an action.

⇨ **AI#230402/1: NP to confirm or otherwise the compatibility of the LOGICA patch with the TC id additional TC history field. Due date: 15/05.**

NP asked when the ICCs plan to switch to S2K V2.3e. This should be answered by the EGSE WG, however it was agreed that SV should bring the point to the EGSE WG. It was recognized by all parties that it would make a lot of sense to switch to S2K v2.3e before starting the actual ILT.

[Post meeting comment: EGSE WG reported that they can incorporate in ILT any new S2K/TOPE version release before end of August 02]

At this point, the S2K situation for ILT was discussed following issues raised by JRR in a note dated 25/03
"*What we need from Project/ESOC for ILTs is a firm commitment (1) which SCOS version will incorporate which patches and (2) by when these versions will be available to ICCs for use in their EGSEs."*
It was restated at this point that the LOGICA patch (OOL and TC history data server) will not be incorporated in any S2K release, i.e. will remain a patch. The TERMA development for the TC Id in the TC History will be integrated into V2.3e. V2.3e will be available for use end of May (after provisional acceptance by ESOC). See also discussion above.

I S T :

NP reported on the result of the CCS negotiation/KO meeting which took place in TERMA on 20&21/03.

1) The CCS delivery plan was updated as the result of the meeting. The CCS will be first delivered end of April 03 (instead of January). This first delivery will be based on S2K 2.3.e . A second delivery of the CCS will follow in August 03 based on S2K v3.0e.
2) The baseline for the CCS development will be reviewed as part of the H/P PDR, the data package being available by end of June.
3) Instrument EGSE I/F were not explicitly addressed at the meeting, in particular it seems that no decision was made wrt the applicability of the EGSE router protocol.

NP precised that the integration or not of H/P CCS S2K developments into the S2K evolution line will be decided by the S2K CCB in ESOC (Serge Valera is a member of this CCB). Those CCS S2K developments which are decided not to be integrated into the S2K evolution line will remain as S2K patches.

At this point, the S2K situation for IST was discussed following issues raised by JRR in a note dated 25/03:
"What we need from Project for ISTs is a firm commitment that the CCS will run a SCOS v3.xe that contains both of the above patches at times when instrument data are collected that need to be archived in the HCSS."
It was restated that the CCS will run S2K V2.3e (first delivery)and V3.0e (second delivery). Both versions will include the TC Id implementation however they will need to be patched with the LOGICA SW.

"For Ops, we need confirmation from somewhere (ESOC, Project ?) that SCOS will indeed be backward compatible in this sense and from which version onward this will be the case."
It was agreed that as far as TM source packets replay into S2K/RTA is concerned, there should be no compatibility problem as long as TM source packets follow the PS ICD and the S2K/RTA runs a MIB compatible with the TM source packets. Overall, NP clarified that ESOC only maintains S2K version n (the latest one) and the n-1.

CSDT: ILT HCSS replication requirements/issues

SV reported on discussion with Jon Brumfit on the HCSS replication requirements identified at the last meeting (see HGSSE#17 MoM):

1) VERSANT supplies various ways of performing replication, e.g. using
- object migration from command line or java program
- synchronized replication (create replica)
- fault tolerant server
- copy DB
- asynchronous replication

Further study is needed to see which one is best to support ICC requirements - A specific WP will be needed for this purpose.

2) the main issue wrt replication has to do with having objects which can be updated on different copies of the DB as the merging of these update will ncessitate specific handling, e.g. object version branching.

3) the replication issue is linked with currently dealt issues of supporting multiple physical DB: the replication is in fact of multiple DB (not one).

As part of this reporting the following was discussed:

1) It was stresses by RH and BV that the implmentation of the DB replication shall be as much as possible VERSANT independent
2) It was discussed that simply implementing a distributed DB across the test and the development areas was not appropriate as network between development and test areas can be disconnected and part of the DB need to be copied to/from laptops
3) Although a complex issue (SV), the need to be able to update same objects (e.g. observing mode definition) in different areas was confirmed (PR). This certainly requires DB object versioning and implementation of object versions updates conflict detection and handling. Object versioning is a planned WP, conflict detection and handling should be added to the scope of this WP.
4) At SV's request, ICCs agreed to supply UCs to detail the way test and development areas in ILT are going to be used (beyond requirements identified in HGSSE#17 MoM). PR agreed to give it a start.

- ⇨ **AI#230402/2**: PR to produce and distribute to HSC and other ICCs draft UCs driving replication of data between development and test areas in ILT. Due date: 10/05
- ⇨ **AI#230402/3**: SPIRE, PACS and HSC to comment on a.m. HIFI draft UCs. Due date: 24/05

SV mentioned that the replication related WPs will be proposed for the next HCSS iteration, post HCSS v0.1.

Other System activities reporting / monitoring / co-ordination

Under this heading, SS reported that SPIRE will hold an ICC UCs and design review on the 13 & 14 of May. PR will attend the review.

Instrument Simulator discussion

JD and Micha Schmidt (TOS-OFC) joined the meeting for this discussion.

The discussion was supported by a three tier presentation by ESOC:

- an overall presentation on the rationale of ESOC instrument simulator requirements by JD
- a presentation by SF to address specific requirements issues as raised at the last HGSSE meeting, see HGSSE#17 MoM.
- a presentation to address instrument simulator implementation issues by DV

The three presentations can be found in appendices.

JD VGs:

Overall it was discussed and agreed that ESOC needs an instrument simulator which is accurate in terms of interfaces with the rest of the S/C, i.e. in terms of TM/TC and events to/from the CDMS (except for science data see discussion below) and power consumption (report accurately to the S/C simulator the consumption corresponding to its current mode). TM and events needs to be generated by the simulator in a timely fashion.
In particular the instrument simulator model shall be realistic enough to properly support instrument FDIR by MOC and/or CDMS.

The discussion focused then on VG#17. It was agreed by all ICCs that there were no reasons for MOC to be responsible for checking the functional aspects of patches (case 2 as per VG) and that therefore the simulator did not need to support such a feature. Simulator should be limited to supporting patch installation and verification (case 1 as per VG). Several reasons were put forward for that:

- instrument patches will be carried out by instrument teams only, making it difficult for ESOC to verify patches functionality even getting test procedures from instruments teams

- instrument simulator will simulate in the best case only the prime CPUs. In the case of PACS, most of the patches are expected in secondary CPUs (SPU or DECMEC)

The only reason ESOC would like to functionally test an instrument patch would be for making sure that it does not affect the instrument/CDMS interface and the CDMS itself. It was however assumed in the discussion that the CDMS is robust against instrument failures and therefore that ESOC check at this level should not be needed.

Another point of discussion was science data. ESOC(JD) clarified that they do not necessarily need the instruments simulators to generate science data. Science data are only needed for ESOC to check that their GS can support the TM data load and routing. Science data could therefore sit in the SSMM simulator instead (JD VG#20). However the instrument simulator has to meet the requirements of the CDMS simulation, which may involve producing science packets.

In conclusion, it was agreed that emulator (certainly the only way to implement case 2) should then not be seen as the only possible implementation for the instrument simulator in order to meet ESOC requirements and that a functional simulator would also allow to meet these requirements. The final choice should be a trade-off of the options, and is very dependent on the volatility of the instrument software.

SF's VGs:

SF presentation went through the ESOC TN " Herschel & Planck Instrument simulator Statement of minimal functionality "from ESOC dated 08/02 addressing the questions raised at HGSSE#17:

Beyond answers to ICCs questions provided in the slides the following points were discussed:

PE-02: RT issue
SF and JD clarified that instruments simulators should be able to run twice faster than RT to shorten simulation period, e.g. to simulate filling-up the SSMM without taking 48 hours.

MO-09&10:
In line with previous discussion on RAM patches, it was clarified that these two requirements only referred to patches installations and patches installations verification not functional verification of patches.

MO-12&13:
It was clarified that the instruments simulators would need the MIB to allow for calibration/de-calibration of engineering parameters (e.g. voltage, temperature) for commanding by operators e.g. for fault injection purpose but not for TM/TC where only raw values are used. These requirements would need to be reworded accordingly.

MO-17,18 &19:

HK digital values (e.g. on/off or mode values) are expected to be modelled exactly. Analogue values (e.g. temperature or voltage) are expected to be modelled exactly enough for FDIR purpose (e.g. spike in voltage does not need to be modelled if it is not associated with any FDIR).

MO-21:
It was clarified that it shall be possible to simulate (inject) all instrument internal and interface related failures including switch/relay failures which involve MOC and/or CDMS for their FDIR. Other failures do not need to be simulated.

DV's VG:

DV stressed the two following points:

1) instruments simulators for MOC purpose shall be integrated into SIMSAT, i.e. shall interface with the SMI (Simulation Model Interface).
2) TOS-G would be better off with instruments teams delivering specification rather than code for the simulators. The H/P satellite simulator as a whole will be developed as firm fixed price (including the integration of the instruments simulators). In this respect, having no contractual control over the development of the instruments simulators itself brings a high element of risk.

Wrt 1)

- it was clarified at SS request that the SPIRE DRCU emulator which is under development and which is not SMI compliant cannot be used for the MOC instrument simulator.
- On the positive side, having the instrument simulator integrated with SIMSAT will facilitate implementation of requirements regarding RT and Break Point implementation, as SIMSAT is in control of the run time execution.

Wrt 2) JD and PE made it clear that the implementation of the instrument simulators by the instruments teams remained the baseline despite the risk element identified by DV.

Conclusion:

After some discussion, the following course of action was agreed:

1) the Instrument simulator TN will be re-issued taking into account above clarifications, in particular regarding memory patch and DSP emulator
2) the instrument will answer to the new requirements with effort and schedule estimate.
3) in view of instruments estimate, H/P project and ESOC will consider the best way to proceed including instruments teams/TOS_G responsibility in the development of the instruments simulators.

⇨ **AI#230402/4: JD and SF to re-issue H/P instrument simulator MOC requirements. Due date: in time for next HGSSE meeting on 20/06/02.**

A O B

–ObsId:
At SS request, SV recalled that the ObsId counter (28 bits) is preceded by a 4 bits identifier for test/ops site. The test/ops site id were presented at CSDT#12. SV will re-circulate the slide. The HSC/instrument ICD will also be updated to mention these ids.

PR asked if the ObsId unicity in a given site is guaranteed considering that one site can include both a test and a development area where observations can be generated.
[Post meeting clarification by SV after discussion with JB: observations generated in the development area for observing mode definition test purpose are not made persistent, only generation of observations from test control (i.e. in test area) are made persistent. Therefore, when synchronizing test and development area databases, there should be no duplication of observation ids.]

-EGSE TEI TM:
At SV's request, the 3 ICCs re-confirmed that their EGSE-ILT TEI will generate TM compliant with the PS-ICD. SG from SPIRE had implied that this could not be the case which would have impact on the HCSS TM ingestion SW.

–On board time
At SS request, JD re-confirmed that the S/C on board time is initialised to TAI epoch 1958 however it will not be actively maintained to TAI by MOC.

–Pointing data PACS requests
Due to lack of time, the pointing data requirements from PACS were not discussed wrt their impact on IRD. Discussion will take place at next HGSSE meeting. By then inputs should also be received from SPIRE and HIFU, see review of actions above.

N e x t M e e t i n g

The HGSSE#19 meeting will be held on the 20th of June in ESTEC.

A t t e n d e e s:

Otto Bauer (PACS – MPE) (simulator discussion only)
John Dodsworth (ESA – ESOC) (simulator discussion only)
Pierre Estaria (ESA – H/P project)
Steven Foley (ESA-ESOC)
Rik Huygen (KUL)
Nestor Peccia (ESA-ESOC)
Peter Roelfsema (SRON)
Micha Schmidt (ESA-ESOC) (simulator discussion only)
Sunil Sidher (RAL)
Bart Vandenbussche (KUL)
Stephane Veillat (ESA – HSC)
David Verrier (ESA – ESOC) (simulator discussion only)

Cc:

O. Bauer (MPE)
J. Brumfit (Aurora – HSC)
K. Galloway (Aurora – HSC)
M. Graham (Imperial College)
A. Heras (ESA-HSC)
S. Lord (IPAC)
J.J. Mathieu (ESA – TOS-EMS)
Brian Melton (ESA – TOS-EMG)
G. Pilbratt (ESA – HSC)
J. Rector (IPAC)
J. Riedinger (ESA - HSC)
Serge Valera (ESA – TOS-EMG)
Frederick Wechlser (ESA – H/P project)
E. Wiezorrek (MPE)

A p p e n d i x 1 : S V s l i d e s

HGSSE#18, Agenda (draft)

- **Comments on HGSSE#17 MoM and HGSSE#18 agenda**
- **HGSSE pending actions**
  - see slides #2 & #3
- **ILT System design**
  - LOGICA TC and OOL history server testing status (SPIRE)
  - TERMA TC Id development status (NP)
- **ILT HCSS replication requirements/issues**
  - Feedback from Jon Brumfitt on HGSSE#17 raised requirements (SV)
  - Discussion
- **IST**
  - Status including TERMA meeting on 20/03, potential impact to ICCs (NP)
- **Other System activities reporting/ monitoring/ co-ordination**
- **Instrument simulator requirements/issues (starting 14h00)**
  - Synthesis of the replies to questionnaire to instrument teams on instrument simulators and current status of DSP HW emulator study (DV)
  - Presentation on instrument simulator requirements from TOS-O addressing HGSSE#17 raised issues (JD/SF)
  - Follow-up discussion and potential update to simulator requirements TN from TOS-0
- **Next HGSSE meeting & AOB**

List of actions(1)

•AI#171001/8: 3 ICCs to clarify their plan for having High Fidelity HW and EGSE-ILT like set-up after the delivery of the flight model to be used for SPG/QCP & IA test purpose and Ops support purpose . Due date: 07/11.

•**AI#171001/9: JD to clarify with FD the added value of validating the PV HSC schedules up to MP2 (i.e. what MP2 will check that is not checked by MP1). Due date: 29/11**.

•**AI#291101/3: ICCs to describe their proposed ILT set-up and HCSS ODMS replication requirements**. Due date 17/12. Open for SPIRE and **PACS**

•AI#280202/1: SF to clarify the rationale of instrument simulator requirements and other ICCs question marks as minuted below . Due date: 29/03/02.

•AI#280202/2: 3 ICCs to distribute to the group the list and description of their instrument mode failures. Due date: 08/03/02. See

- Email from SS dated 11/03: Failure Detection Isolation and Recovery Policy in the SPIRE Instrument, SPIRE-RAL-PRJ-001128, draft 0.1
- Email from PR dated 11/03: Failure Mode, Effect and Criticality Analysis at system level SRON-U/HIFI/RP/2000-001, issue 1.1
- Email from RH dated 11/03: Instrument FMECA, Failure Modes, Effects and Criticality Analysis Report, PACS-ME-GR-004, draft 2

•**AI#280202/3 RH to clarify usage of the S2K OBSM by PACS in ILT and consequent customization of the OBSM. Due date 08/03.**

•**AI#280202/4: NP to clarify compatibility of the LOGICA SW with future S2K versions starting with v2.3e. Due date 28/03.**

•AI#280202/5: NP to investigate solutions to get the TC ID implemented by April 02 and clarify TC Id implementation in V2.3.e. Due date 08/03. See NP's email dated 28/03 on TC Id proposal from TERMA

List of actions (2)

•AI#280202/6: SS to check (possibly with IFSI) when the instrument time gets synchronized with the S/C time. Due date 28/03. See SS email dated 25/03

•AI#280202/7: ICCs to surface requirements on orbit data and pointing history vis-à-vis MOC .Due date 28/03

Appendix 2: JD slides

Simulators for Operations at ESOC

23 April 2002

D.J. Verrier TOS/GMS
S.J. Dodsworth TOS/OGH

Outline

- Background
  - Why use simulators?
  - Why use Operational Simulators?
  - Major requirements
  - Overall Architecture
- Instrument simulation
- Conclusions

Why use Simulators?

- Replace the Spacecraft
- Support to design
- Support to testing
  - replacement of real equipment in destructive or expensive tests or when real equipment is unavailable
  - validation of embedded software
  - data source for control systems validation
- Support to training
- Support to failure investigation and correction

Why use Satellite Simulators at ESOC?

- Test and validation of mission control systems
- Test and validation of flight control procedures
  - nominal and contingency operations
  - individual procedures and overall timeline
- Training
  - individual staff training
  - team training
- Operational validation of on-board software modifications
- Test and validation of new concepts for satellite operations (studies)

Major requirements on satellite simulators

- Simulation of both service module and payload
  - usually payload simulation is very simple. Occasionally, however, accurate model required (ISO, XMM)
  - modelling accuracy for service module sub-systems is directly proportional to their criticality w.r.t. satellite operations (driver is usually AOCS; but can also be data handling or power or thermal)

Major requirements on satellite simulators (cont'd)

- Production of telemetry with same format, content and frequency as real spacecraft (housekeeping only; usually no science data content modelling)
- Same reaction to telecommands as real spacecraft
  - --> real-time simulation
  - --> dynamic simulation
  - --> close-loop simulation with control system

Major requirements on satellite simulators (cont'd)

- accurate simulation of AOCS telemetry require precise modelling of
  - satellite environment (sun, earth, moon, planets, stars)
  - satellite orbit
  - perturbing effects (atmospheric drag, solar pressure etc.)
  - Actuators (thrusters, wheels, magnetorquers)
  - Sensors (Sun, Earth, stars, gyros)

Major requirements on satellite simulators (cont'd)

- Mission control system shall not realize that it is interfaced with a simulator but must believe it is talking to the real satellite
  - simulator has therefore to include models for the ground station telemetry and telecommand processing equipment

Major requirements on satellite simulators (cont'd)

- Requirement exists for all simulators to execute the actual flight software, at least as far as the data handling and AOCS computers are concerned.
  - for some missions this requirement has been extended to the instrument processors
  - biggest challenge in developing simulators for ESOC

Simulator Overall Architecture

- Simulator includes:
  - satellite model
  - orbit and environment model
  - ground station equipment models
- Glued together with a reusable infrastructure package providing the necessary simulator monitoring and control functions

Simulator Overall Architecture (cont'd): Emulator

- Actual flight software is executed in a software emulator of the on-board processor
  - Executes each instruction
  - Needs fast CPU
  - Historically, space-qualified processors slow
  - leaves enough performance margin to remain with software emulation option

Instrument Simulation

- Driving Requirement
  - What ESOC has to do related to the payload operations

Use of Instrument Simulators

- ✓ Test and validation of mission control systems
- ✓ Test and validation of flight control procedures
  - nominal and contingency operations
  - individual procedures and overall timeline
- ✓ Training
  - individual staff training
  - team training
- ? Operational validation of on-board software modifications
- ✖ Test and validation of new concepts for satellite operations (studies)

Instrument Related Requirements on ESOC

- Instrument Operation
  - Monitoring and control (manual and via mission planning)
  - Software maintenance
  - Response to failures/anomalies
- Collection, storage and routing of instrument TM

Derived Requirements

- Production of telemetry with same format, content and frequency as real spacecraft (housekeeping only; no science data content modelling)
- Same reaction to telecommands as real spacecraft
  - --> real-time simulation
  - --> dynamic simulation
- Proper failure modelling for testing contingency/recovery procedures.

Requirements driven by the s/c simulation

- CDMS:
  - provision of data according to the expectation of the emulator (I.e. data rates have to be consistent with instrument mode)
  - Timely response to Telecommands
- ACMS
  - Peaking-up protocol has to work (converge)

Requirements driven by Software maintenance responsibility

- Required involvement from ESOC:
  - Case 1. Minimum:
    - Configuration management
    - Patch installation and verification according to Instrument procedures
  - Case 2. Maximum:
    - Configuration management
    - Validation of patch installation procedures and results using simulator.
    - Patch installation and verification

Requirements driven by Software maintenance responsibility(2)

- Case 1:
  - Instrument simulator shall be realistic for patch and dump. E.g. patch/dump constraints modelled, dumps reflect patches correctly.
  - Functional change as a result of patch not required
- Case 2:
  - Instrument simulator shall be exact for patch and dump.
  - Functional changes modelled

Other considerations

- Instruments have several processors:
  - Not all may need to be modelled exactly e.g. if the signal processing is largely decoupled from the process control.
- Instruments may have software development and test environments which allow proper validation of changes and procedures.
- One of ESOC's difficulties has always been keeping instrument functional simulation in line with the latest software changes.

Other considerations(2)

- The modelling of instrument science data does not necessarily have to be in the instrument model. Possible locations:
  - SSMM
  - Ground Model

Other considerations(3)

- Science data modelling:
  - Fidelity required
  - Consistency between HK and Science
- Depends on its use within the rest of the Ground segment

Conclusions

- ESOC's requirements on the instrument simulators reflect:
  - ESOC's responsibility for
    - Monitoring and control
    - Data transfer and routing
    - On-board software maintenance
  - The S/C simulator implementation

Conclusions(2)

- Other requirements :
  - Role of the simulator in the overall GS test and validation process.
- There may be other requirements for simulated data to be provided to ESOC related to the overall test and validation process.

Appendix 3: SF slides

Simulator Requirements for Herschel/Planck

23 April 2002

S.Foley TOS/OF/Vega

Introduction

- The requirements presented were all high-level
- Although not an SRD per se, it did present requirements considered appropriate for the H/P simulators
- The requirements were mainly extracted from the Cryosat Simulator Software Requirements Document (SRD).

General Requirements

- The interfaces between the instrument and the CDMU shall be faithfully modelled
- To do this, the simulator must model the major modes of the instrument and also be able to respond to memory load and dump commands in a realistic way
- The overall architecture of the Herschel and Planck simulators will be based on the use of SIMSAT-2000 and the Simulation Model Interface (SMI)

Specific Requirements - MIRD

- The MOC shall develop and maintain a software simulator of each satellite that can be used as a test source of realistic telemetry data and react in a realistic way to telecommands
  - Model all satellite subsystems,
  - Model the satellite environment and ground segment
  - Execute realistically and in real time
  - Represent the satellite behaviour as seen from the MOC
  - Allow direct use of the actual on-board software
  - Model failure cases and non-nominal modes of operations
  - Be representative for both nominal and contingency situations

Specific Requirements - MIRD

- The MOC shall support the PIs in their development of instrument simulators:
  - provide consultancy and training
  - provide requirements on the interfaces to ESOC simulator infrastructure
  - integrate the instrument simulator, together with the PI team, into the ESOC simulation environment
  - agree maintenance and support arrangements for the instrument simulators

Specific Requirements - MIRD

- Three System Validation Tests (SVT's) shall be performed with each spacecraft.
- The aims of the SVT's shall be :

  - Validation of the capability of the MCS with the spacecraft
  - Validation of the Satellite Data Base (SDB)
  - Validation of MCS and Flight Dynamics (FD) processes
  - Validation of spacecraft behaviour
  - Validation of procedures (On the real Satellite)
  - Validation of the MOC spacecraft simulator as a representative test tool by comparison of the behaviour with respect to the “real thing”.

High-Level Requirements

- HL-01 The instrument simulator shall model the Herschel/Planck behaviour in real-time.

  This is appropriate for TC handling and TM generation as well as for power consumption and mode transitions

Set-up Requirements

- SU-01 All configurable instrument parameters shall be part of visualisation data.
- SU-02 The set-up configuration files shall be read at SETUP mode of the simulation.
- SU-03 The simulator end users shall be able to create/modify their own user set-up files.
- SU-04 The parameters in the end user set-up file shall override the parameters in the default set-up files.
- SU-05 It shall be possible to start the simulator without end user set-up files
- SU-06 The simulator shall allow for the set-up files to be re-read during the simulation.

Documentation Requirements

- DO-01 A SPMP shall be produced for each major phase of the instrument simulator development.
- DO-02 A SCMP shall be produced for each phase of the development.
- DO-03 An ADD shall be produced.
- DO-04 A DDD is not required, but after the detailed design phase, an updated ADD will be produced based on the detailed design and delivered together with the source code.
- DO-05 A System Test Plan (SVVP/ST) shall be produced.
- DO-06 The instrument simulator shall be delivered with a Simulator Users Manual (SUM).
- DO-07 The Software Release Note (SRN) shall be delivered with any delivery of the instrument simulator.

Config.Mgmt Requirements

- CM-01 The instrument simulator shall follow a Software Development Cycle comprising the following phases:
  - Software Requirement Definition
  - Architectural Design
  - Detailed Design and Coding
  - Transfer

Performance Requirements

- PE-01 The instrument simulator shall run under nominal conditions for at least 72 hours without loss of accuracy or real time slips.
- PE-02 The instrument simulator shall be designed to support execution up to 2 times faster than real-time in the following configuration without real time slips.

Same comment as for RT operations. Representative TC acceptance, execution, TM generation, and mode switching

System Requirements

- SY-01 The instrument simulator shall satisfy all requirements defined in the SIMSAT-2000 Kernel Software Specification Document which are implemented at the time of the simulator development.

SIMSAT 2000 Simulation Model Interface (SMI):

http://www.estec.esa.nl/wmwww/EMM/activities/stds/smp/

Breakpoint Requirements

- BR-01 The instrument simulator shall support breakpoints. A breakpoint is a copy of the status of the simulator allowing the simulator to be reinitialised to a state identical to the one it was when the breakpoint has been saved.
- BR-02 The instrument simulator configuration shall be delivered with a "Nominal Operation" breakpoint (S/C and instrument fully active in Normal Mode)

Modelling Requirements (1)

- MO-01 Instrument prime and redundant units and cross-strapping shall be modelled.
- MO-02 The instrument configurations that are monitored by the fault detection system, shall be consistently modelled.
- MO-03 Any automatic (on-board) transition between instrument modes shall be modelled realistically in terms of timing and triggering.
- MO-04 The transition between all instrument modes shall be modelled exactly with respect to entry and exit conditions and effect on HK TM.
- MO-05 The transition between instrument modes in response to TCs shall be modelled exactly.
- MO-06 For each of the modelled instrument modes the power consumption shall be modelled realistically.

Modelling Requirements (2)

- MO-07 The bootup of the instrument processor shall be modelled realistically in terms of :

  - time duration, TM (packets) produced during bootup, HW SW models initialisation.
- MO-08 It shall be possible by user command to switch on/off any instrument powered unit.
- MO-09 All functionally modelled instrument processors shall be initialised at start-up with the RAM images of the flight software.
- MO-10 It shall be possible to patch the RAM memory via TC.
- MO-11 It shall be possible to command a dump from the RAM memory by TC.
- MO-12 The instrument simulator shall accept a satellite database conforming to the Herschel/ Planck satellite database ICD as an input to the TM/TC model configuration of the instrument.
- MO-13 All TM/TC characteristics shall be derived from the SDB.

Modelling Requirements (3)

- MO-14 The instrument simulator shall accept and react to all TCs that will be accepted by the satellite and which are contained in the SDB.
- MO-15 The configurations of the instrument set by TCs shall be exactly modelled
- MO-16 The instrument simulator shall generate all housekeeping TM (packet) formats generated by the real instrument.
- The instrument model shall faithfully generate the TM (non-science) expected in the current operating mode.
- MO-17 The status of bi-level non-science TM shall be modelled exactly.
- MO-18 The status of serial digital non-science TM shall be modelled exactly.
- MO-19 The accuracy of analogue TM shall correspond to the accuracy specified in the requirements for the relevant subsystem.

Modelling Requirements (4)

- MO-20 It shall be possible to fail any modelled instrument hardware unit. The unit shall fail so that it consumes power but no longer responds to TCs and its behaviour as seen by TM no longer changes.
- MO-21 The consequences of any injected instrument failures on the rest of the satellite subsystems shall be realistically modelled. (i.e.- Emergency reconfigurations, short circuits).
- MO-22 It shall be possible to fail any switch/relay. This shall have the effect of failing the switch in its current position. The switch shall no longer respond to telecommands until unfailed.
- MO-23 It shall be possible to inject failures separately on prime and redundant instrument units.
- MO-24 It shall be possible to unfail any failed component. The corresponding action shall be that the unit shall return to the state prior to the fail.
- MO-25 Any autonomous switch over from Prime to Redundant units resulting from on-board FDIR analysis shall be modelled.

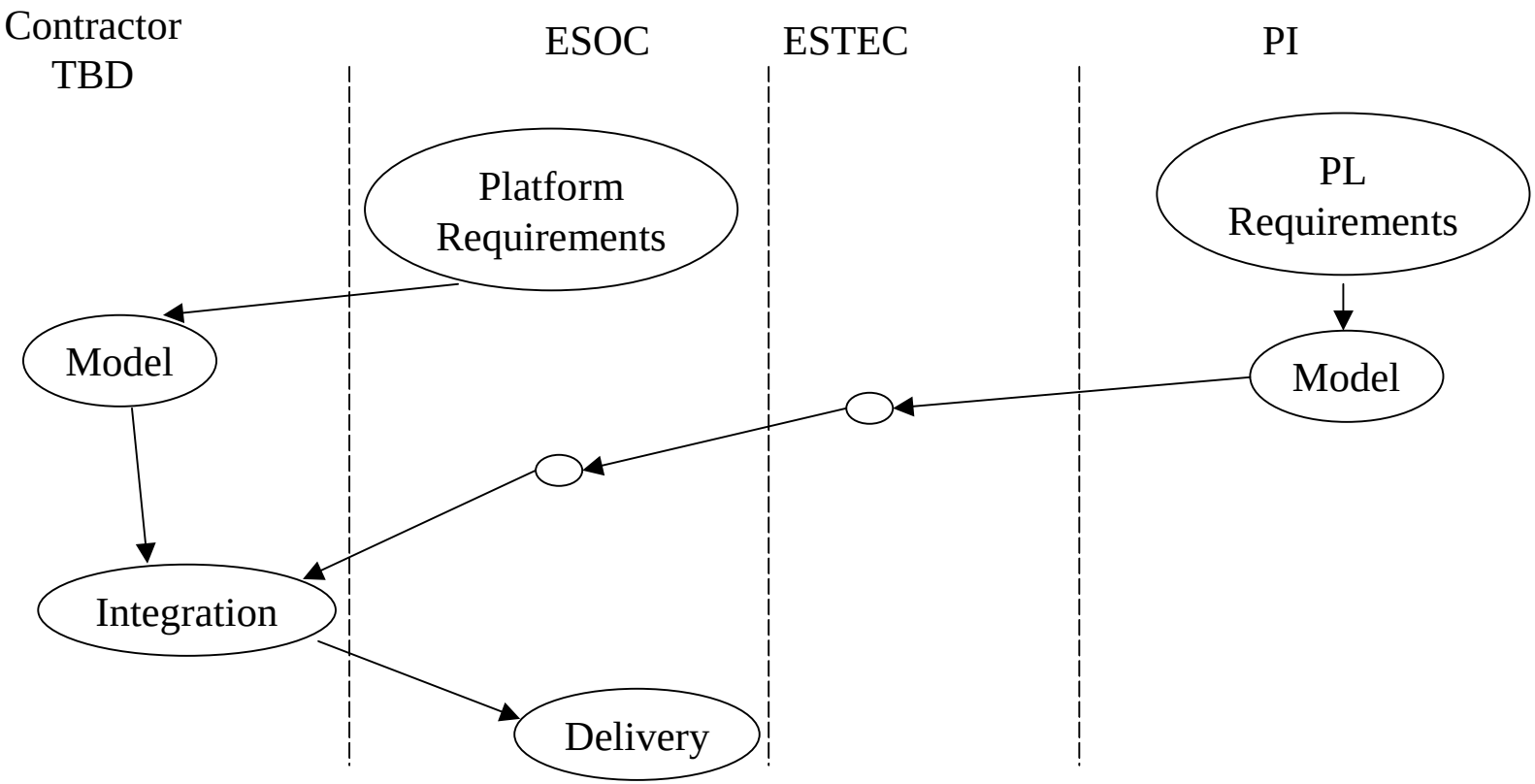
A p p e n d i x 4 : D V s l i d e s

Herschel/Planck Payload Simulators

25 April, 2002

D.J.Verrier TOS/GMS

Development Model



Risks

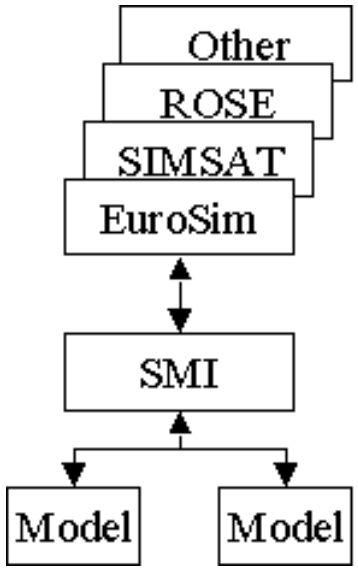
- Integration of third-party software
- Delivery Schedule
- Maintenance Issues
- Need to clarify responsibilities

Problems

- ESOC performs development via FFP contracts to external companies
- ESOC has no contract with PI, consortia or model developers
- Extra CFI to companies
- Difficult to estimate integration costs
- Responsibilities for SPR processing
- Extra deliveries, slower updates to users

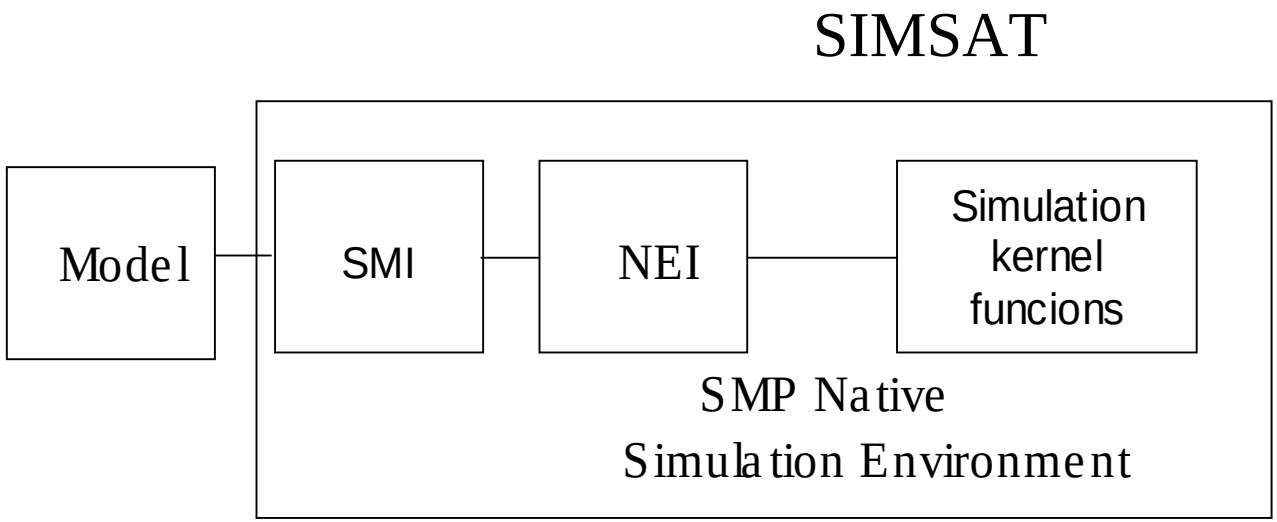
SIMSAT

- Available on NT, W2000
- Simulation Model Portability (*)
- SMI is the SMP for SIMSAT
- Can be individually licensed at no-cost



* http://www.estec.esa.nl/wmwww/EMM/activities/stds/smp/

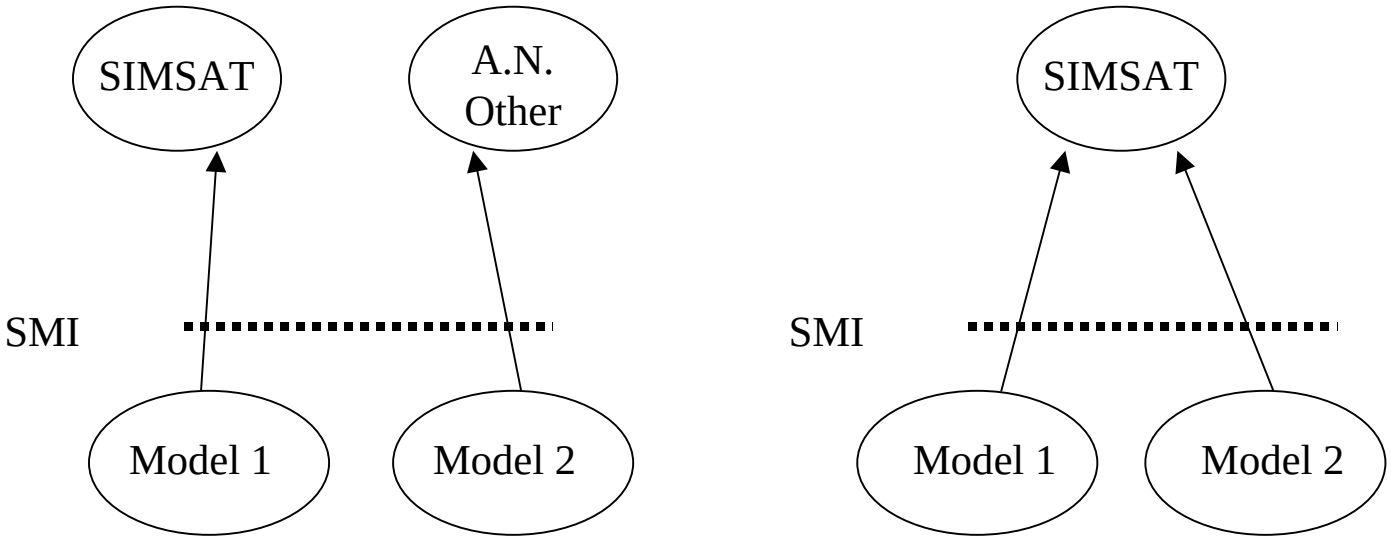
SMP software components



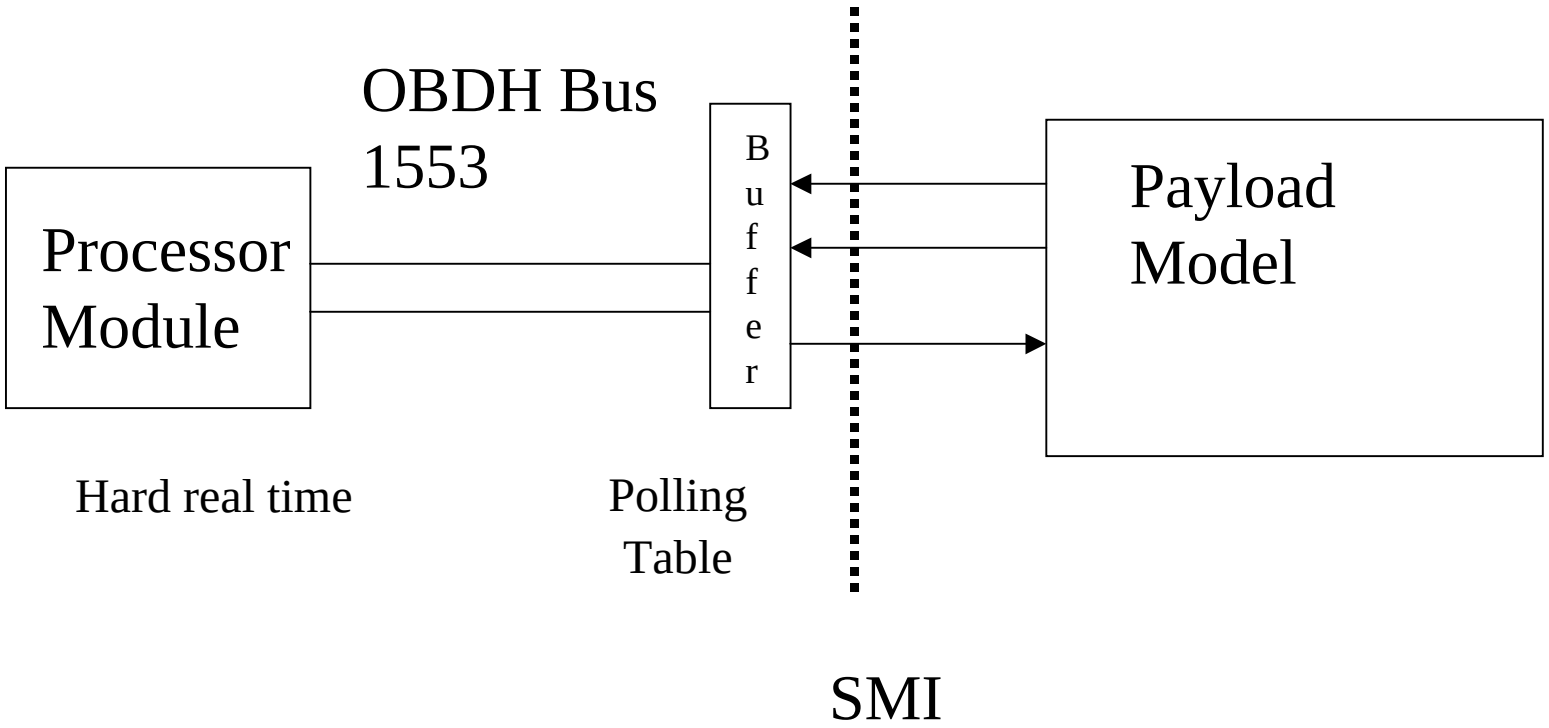
SMP API

- **Publication:** enables models to publish their own services and data to the SMI.
- **Queries:** enables any components in the SMP system to obtain details about the services and data that have been published.
- **Data Transfer**: enables any published data to be transferred one SMP system component to another in a controlled manner.
- **Service Invocation:** enables any published service to be invoked by any SMP system component.
- **Environment support:** enables a model to access environment support features such as simulation time, the environment scheduler etc.

SMI Applicability (Theory)

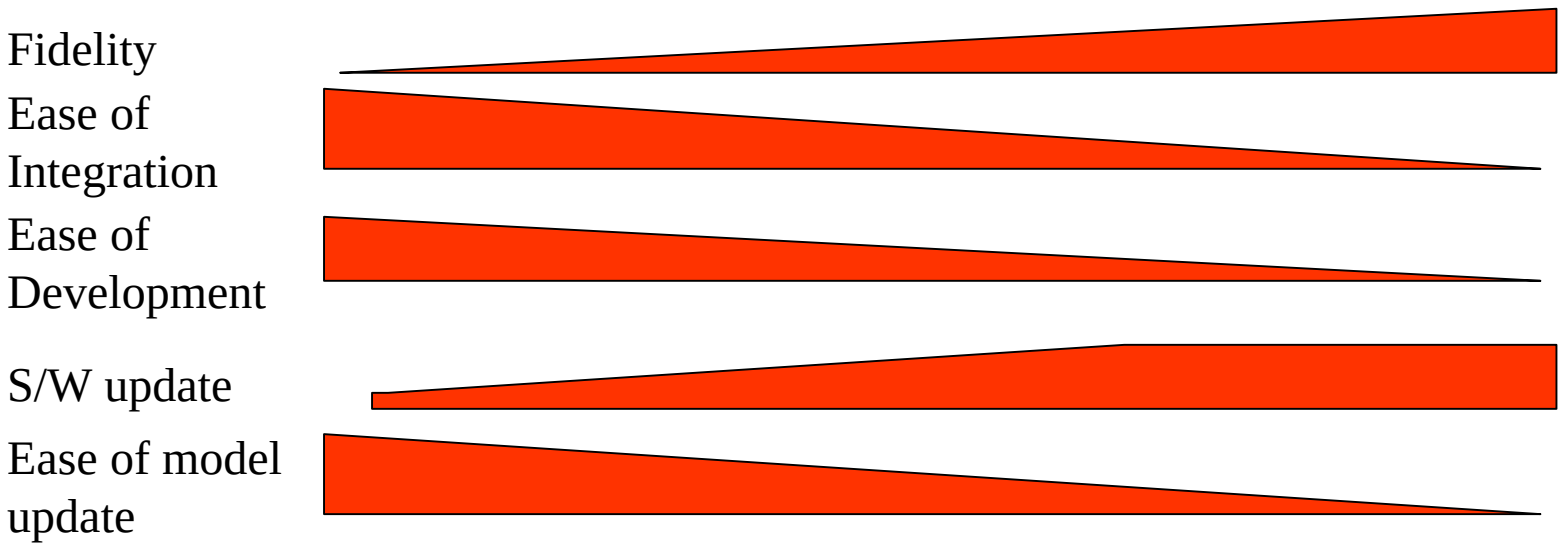


Rosetta Payload Interface

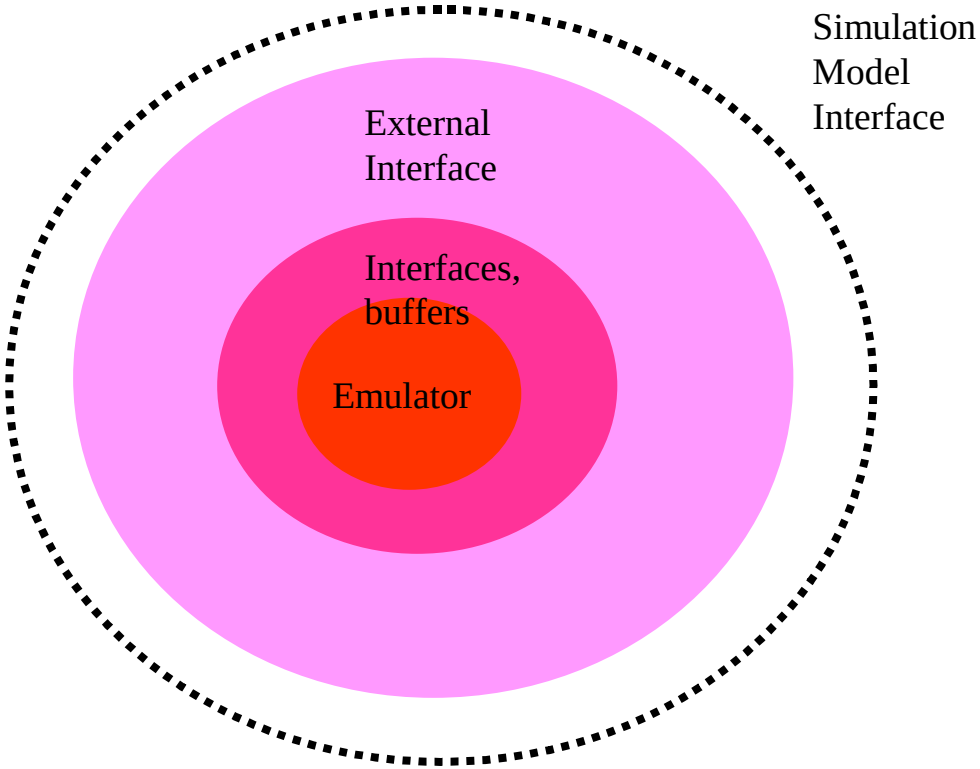


Model Fidelity

	Functional Model	Recompilation of source code	Instruction Emulation	Hardware in the Loop



Use of the Emulator (1)



Use of the Emulator (2)

- One emulator, multiple contexts
- Serialisation is a problem
- Acceptable with a serial interface

Complications (1)

- Is good science data necessary?
- If the ICU/DPU tests the quality of the science data, then the science data must be good! (XMM v's Integral)
- Where will science data be produced?

Complications (2)

- No DSP emulation within ESOC, but study started
- Is ICU/DPU emulation sufficient?
- How many processors per payload?
- Multiple emulators difficult to synchronise
- 5 emulators in Herschel ☹

Example

- One functional model compliant with PS ICD with data tables could be sufficient

Conclusion

- SIMSAT mature,stabile, available
- External model development is possible
- Increases overall project risk
- Cost-savings are uncertain
- Complicated,contradictory contractual environment