ESA-WPP-219

December 2003

17th European Workshop on

Thermal and ECLS Software

ESTEC, Noordwijk, The Netherlands

21-22 October 2003

(Cover image courtesy of Alenia Spazio)

ABSTRACT

This document contains the minutes of the 17th European Thermal and ECLS Software Workshop held at ESTEC, Noordwijk, The Netherlands on the 21st and 22nd October 2003. It is intended to reflect all of the additional comments and questions of the participants. In this way, progress (past and future) can be monitored and the views of the user community represented. The final schedule for the Workshop can be found after the table of contents. The list of participants appears as the final appendix. The other appendices consist of copies of the viewgraphs used in each presentation and related documents.

Table 1: Printing History

Release	Date of issue	Reason
1.0	2003-11-13	Document creation
1.1	2003-11-18	Draft for internal comment
1.2	2003-12-16	Initial release to participants

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17th European Thermal and ECLS Software Workshop
ESTEC, Noordwijk, The Netherlands
21st-22nd October 2003

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1. Tuesday 21 October 2003: Morning Session

1.1. Welcome and Introduction

C. Stroom (ESA/ESTEC) greeted the participants to the workshop, gave the objectives of the workshop and introduced various members of the workshop organization team. (See Appendix A)

1.2. ESATAN, FHTS and ThermXL current status

H. Brouquet (ALSTOM) described the new features available in the most recent releases of the tools. (See Appendix B)

H. Peabody (TMS) asked whether there was a possibility of transposing the comma-separated value output produced by the new ESATAN output routines to avoid the “256-column limit”. H. Brouquet said that it was Excel which was limited, not ESATAN, but even so, it wasn’t possible to transpose the columns. H. Peabody said that he had often needed to work the other way, with values across the columns and nodes down the rows. The ability to transpose the data was useful when dealing with a large number of nodes.

1.3. THERMICA - news of the year

M. Jacquiau (EADS-ASTRIUM) presented some of the latest features being added to THERMICA and described the current priorities for future work, based on a survey of users within Astrium. He also commented on data exchange issues, the Astrium position on the harmonisation activities, and THERMICA funding and licensing. (See Appendix C)

R. Schlitt (OHB System) noted that the CAD interface to THERMICA which had been described contained both STEP AP203 and CATIA solutions. He asked why both were required when it should be possible to import a CATIA model using STEP. M. Jacquiau said that he had first wanted to support only a STEP interface, but had found in practice that the amount of information contained in the STEP files made them very large when compared to similar files in the native CAD formats. Therefore it was more efficient to use native CATIA files directly. He noted that the OpenCascade libraries provided access to both STEP and CATIA files. HP. de Koning (ESA/ESTEC) said that his understanding was that the CATIA import facilities of OpenCascade were not available for free. M. Jacquiau agreed that they were not free to developers but the import facilities were free for end users, although a CATIA licence was needed during the input of the CATIA model.

M. Molina (Carlo Gavazzi Space) asked about the new functionality for calculating thermal radiation forces on spacecraft. He wanted to know the magnitude and relative importance of these forces, and which sort of application required this information. M. Jacquiau said that Boeing had asked for this functionality, but Boeing had not given any information about the application area. He thought that it might relate to GPS systems. HP. de Koning commented that the forces on the solar arrays were significant for GPS satellites because these had tight pointing requirements. M. Jacquiau said that this related to emission from thermal radiators: if the temperatures across the radiators were not uniform, then the difference in thermal radiation forces could result in a slight torque on the spacecraft.

O. Pin (ESA/ESTEC) asked why M. Jacquiau did not consider TASverter as a suitable long term solution to the data exchange problem. M. Jacquiau said that he did not have all of the technical details of TASverter, and therefore didn't know whether TASverter would be well-suited for the long term. He wanted to be pragmatic and take the best solution.

F. Boursier (EADS-SPACE) noted the description of using NTP files to visualize the temperature results on the THERMICA model. He wanted to know how to produce NTP files in ESATAN for use in THERMICA. Where was this documented? M. Jacquiau answered that this was described in one or two pages in the THERMICA documentation. He suggested that anyone needing help with this should contact Astrium for help. There was a subroutine, freely provided by Astrium as part of the THERMICA distribution, which needed to be called from within the ESATAN code. He said that this subroutine was not available as source code, but the same routine for SINDA was.

J. Kanis (Dutch Space) said that one limitation of THERMICA was the lack of boolean operations on surfaces. He wanted to know whether these were planned. M. Jacquiau said that he had not given any information about THERMICA version 4, but one of the first requirements was for boolean operations and the management of more complex shapes. He said that the ray-tracing code was ready to handle boolean operations, but the modeller and the rest of the framework was not yet complete. The pure calculation part was already available [in version 4] and confirmed that THERMICA would handle boolean operations in future.

1.4. ESARAD current status

B. Castelli (ALSTOM) described the new features in the recent release of ESARAD such as the improved spacecraft pointing options, the simplified language for invoking the calculation, the NASTRAN model import facility, and the first stage of the automatic conductor generation. (See Appendix D)

H. Peabody (TMS) asked whether there were any plans to support BAR elements in the NASTRAN import facility as well as the TRIA and QUAD elements. B. Castelli did not know. H. Peabody explained that the BAR element was a linear conductor and would easily convert to ESATAN. He said that it was useful for electronic boxes attached to plates. B. Castelli said that this functionality had only recently been released, and he welcomed any user feedback about it. C. Kirtley (ALSTOM) stressed the need for user feedback in order to provide the users with what they really wanted.

S. Appel (ESA/ESTEC) asked whether the NASTRAN interface just provided a list of shells from the database which the ESARAD user then needed to combine manually. B. Castelli confirmed that the user needed to combine the flat list of shells manually, and then set the appropriate thermo-optical and material properties. This was where the new functionality for recursive attribute editing came in useful. In fact, this was one of the main drivers for the development of recursive attribute editing. S. Appel said that it might be an idea to join the shells automatically based on their material properties.

M. Gorlani (Blue Group) asked whether the link between ESARAD and NASTRAN worked in both directions. B. Castelli said that the interface worked from NASTRAN to ESARAD, but not in the other direction.

1.5. Capabilities of the ThermPlot Pro Thermal Post-Processing Program

H. Peabody (TMS) presented ThermPlot Pro, a program for producing plots and derived results from the output of the standard thermal modelling tools. He described the simplification of the interface to ThermPlot which was currently under development, and the new features being introduced. (See Appendix E)

V. Perotto (Alenia Spazio) wanted to know whether the implementation of the sink temperature for any particular node considered the contributions from all nodes, or whether it was possible to limit it to specific nodes of interest, or groups of such nodes. H. Peabody explained that the calculations were based on the external RadK's, and that there was the capability to consider ranges of nodes. For calculating back-loads, the engineer did not usually want instrument to instrument exchanges. The free flier model handled this. It was also possible to consider the self view range as well as the back-load range. V. Perotto asked whether it was possible to exclude the space node from the sink temperature calculations. H. Peabody answered that this was possible by including the space node in the "self include" range, and therefore exclude it from the calculation.

V. Perotto asked whether the groups feature could be used to perform model reduction. H. Peabody said that it could, but he did not know that he would do so. The engineer needed to know how to subdivide the nodes into groups in order to give the total conductances between groups. This subdivision was very model dependent. He had not used the group functionality for model reduction. HP. de Koning (ESA/ESTEC) asked whether there were any checks or constraints on the grouping, and was told that each node could only be assigned to one group.

1.6. Overview of GAETAN's latest developments around ESATAN-FHTS

M. Imhof (Silogic) described how GAETAN could be used for all phases of spacecraft design, and the integration of ESATAN-FHTS into the environment. (See Appendix F)

O. Pin (ESA/ESTEC) noted that ESATAN had been released on Linux, and asked whether there were any plans to provide GAETAN on Linux too. M. Imhof said that they were still thinking about it, but had not done anything about porting to Linux so far. C. Marechal (CNES) said that if GAETAN users asked for a Linux version, the priority for a Linux version would become higher.

M. Gorlani (Blue Group) asked whether the CONDOR module within GAETAN made use of its own solver or whether it used ESARAD. M. Imhof said that the user had ESARAD for handling complex geometries. M. Gorlani wanted to know whether CONDOR could calculate fluxes directly. M. Imhof explained that CONDOR had its own solvers, but that these were limited to simple geometries. However, it was possible to use CONDOR to generate the initial mission parameters, and then chain these to ESARAD. M. Gorlani confirmed his understanding that for simple geometries it was possible to just use CONDOR.

R. Schlitt (OHB System) asked whether GAETAN was restricted to French users. He was told that it was not.

1.7. Web Support and Future Developments on ESATAN, FHTS, ESARAD and ThermXL

C. Kirtley (ALSTOM) described new functionality that had already been, or was being implemented in the development versions of the tools, and gave some ideas about features which were still being considered. He stressed that ALSTOM were really interested to hear from users about the features which they actually needed. He said that the ALSTOM web site now allowed users to submit feature requests as well as support problems, and encouraged the user community to make use of it. (See Appendix G)

H. Brouquet (ALSTOM) gave a demonstration of ALSTOM's web site, and showed how users could generate Software Support Requests, and how the visible status changed as the support desk dealt with each request. He also described the on-line user survey, and highlighted the fact that ALSTOM would be giving away a electronic organizer in a prize draw of all eligible respondents.

There were no questions.

2. Tuesday 21 October 2003: Afternoon Session

2.1. Harmonization of thermal and space environment analysis software

R. Schlitt (OHB System) described the current status of the harmonization activity which had been set up since the previous year's workshop, and the composition of the steering board of which he was chairman. He had deliberately included several provocative statements in order to stimulate discussion. He emphasized that although HP. de Koning (ESA/ESTEC) had been shown as the co-author of the presentation, he might not agree with all of the statements made. (See Appendix H)

HP. de Koning noted that an ALSTOM representative had since joined the steering board as an observer. He also said that the steering board had commissioned a first study, to be lead by eta_max, and involving Astrium (UK, D, F).

Questions were deferred until the round table discussion at the end of the afternoon.

2.2. Open Source Software for Engineering Purposes

M. Haupt (TU Braunschweig) described the results of a search for third party and open source software packages which could be used in the production of engineering software. (See Appendix I)

Questions were deferred until the round table discussion at the end of the afternoon

2.3. Applicability of OSS to Space Thermal Engineering

R. Schlitt (OHB System) gave details of the study which he had mentioned in his previous presentation and to which M. Haupt's presentation also related. (See Appendix J)

R. Schlitt noted that part of this study had involved the production of a web site which could be used to support a thermal community software development.[1]

Questions were deferred until the round table discussion at the end of the afternoon.

2.4. Innovations in using Finite Element Modelers for Spacecraft Thermal Design

R. Behee (Network Analysis) described the differences in approach between typical thermal analysis software using a small set of geometrical shapes with simple meshing compared to finite element analysis software which uses simple planar shapes to represent more complex geometries. He explained that some of the advantages of both approaches could be incorporated into new thermal tools. (See Appendix K)

There were no questions.

2.5. Application of the Open Source Approach to Space Environment Analysis Tools

H. Sdunnus (eta_max) described the development of PC-ESABASE using several open source software packages to form the Open Frontier supporting framework into which the ESABASE/ Debris module could be plugged. (See Appendix L)

B. Castelli (ALSTOM) asked whether any enhancements had been made to the ESABASE/ Debris module. H. Sdunnus said that some enhancements had already been made before the project had started, and that these enhancements had not been implemented in the last industrial release of ESABASE.

M. Jacquiau (EADS-ASTRIUM) asked which open source software solution had been chosen for the ray-tracing. H. Sdunnus said that this had not yet been addressed, and that they were still

1. See http://www.therm-oss.org

using a self-developed ray-tracer. The software would be distributed with the new ray-tracing routines. The IPR would rest with ESA. C. Kirtley (ALSTOM) asked whether this ray-tracing code would be available as open source software. H. Sdunnus said that the hoped so. Everything in the Debris plug-in belonged to ESA, and it would be up to ESA to decide whether to release it as open source software or not. C. Kirtley asked whether this include the source for the Debris module as well. H. Sdunnus said that ESA still needed to decide.

C. Stroom (ESA/ESTEC) said that the general mechanics of releasing software as open source was still under debate. The different groups within ESA knew what they wanted on a technical level, but the legal and contractual levels were taking a lot more time to define. He said that discussions were on-going.

2.6. Round Table Discussion

HP. de Koning (ESA/ESTEC) introduced some viewgraphs showing possible points for discussion. (See Appendix M)

C. Stroom (ESA/ESTEC) asked for the users' opinions on open source software. He said that this was an informal workshop and that users could speak on their own behalf, rather than needing to represent their respective companies. He made the appeal for users to speak freely because ESA needed the users' honest input.

HP. de Koning stressed that the current OSS projects were an experiment, and could not be considered as fixed developments with all aspects cast in stone. He said that there were many opportunities for the users to get involved. He noted that R. Schlitt (OHB System) had made many provocative statements in his presentation in order to elicit discussion and to provoke users to give their opinions. He said that no decisions would be made during the session: it was intended for discussion only. The steering board covered all areas of the user community, with all major space companies being represented. He added that people could still apply to be members of the steering board. He hoped that the harmonization had a good chance of succeeding.

C. Stroom asked whether everyone agreed with R. Schlitt, but nobody responded.

C. Kirtley (ALSTOM) asked what had been decided about the licence agreement for the open source software developments. HP. de Koning (ESA/ESTEC) said that no licence agreement had been selected so far. There were various issues concerning how to proceed with development, intellectual property rights, etc. that were still undecided, and hence still completely open. He said that it was one of the tasks of the steering board to find a suitable licensing model.

O. Pin (ESA/ESTEC) said that it was worth mentioning about the "go/nogo" decision for the open source development. HP. de Koning explained that the first study phase, taking 4 or 5 months, was intended to establish a working model for cooperation, IPR, licensing and look at maintenance and funding issues. The outcome of the study would be a "go" or "nogo" recommendation to the ESA Council. Even though this would be open source development, funding would still be required in the end. The project was entering the study phase with all options open, and would probably continue with the current open basis, but the change to a more commercial way was still possible.

JP. Dudon (ALCATEL) asked who was partner to the "go/nogo" decision. HP. de Koning said that there were 14 voting members on the steering board, and it would be decided by a majority vote. This would involve votes from ESA, CNES, the Canadian Space Agency, Alcatel, Alenia, Astrium, Carlo Gavazzi Space, EADS, eta_max, OHB, Onera, Qinetiq and RAL. Additional members representing ESA, CNES, Astrium and Maya would not be able to vote.[2] C. Stroom said that the harmonization effort was concerned with both thermal and space environment software combined.

C. Marechal (CNES) asked how the first study had been awarded to Astrium and eta_max. He wanted to know why no-one else had been involved. HP. de Koning said that the decision for the first part of the study had been made with a major practical consideration for speed. This had been the topic of the first meeting of the steering board, and Astrium and eta_max had been chosen by the steering board as a whole. The outcome of the vote had to be accepted by the other members of the steering board.

J. Kanis (Dutch Space) asked who had selected the members of the steering board. HP. de Koning said that ESA had invited the space companies to participate, but only those who had replied positively had been considered for the steering board. C. Marechal asked whether other members of the audience would like to apply to the steering board who had not received the original invitation. J. Kanis said that Dutch Space had not received the invitation. F. Crampé (Silogic) said that Silogic were working on GAETAN, and that they hadn't been involved in any mailing list. HP. de Koning said that L. Ney (Silogic) should have received the information. C. Stroom admitted that knowing who to include on a mailing list was always a problem, but in principle the list which had been used should have been the same as that used to inform people about the workshop.

A. Sgambati (Laben) said that this was the first time that Laben had heard about the use of open source software in ESA and the involvement of the whole space community. She said that Laben were not aware of the open source activities. O. Pin said that the ITT for the open source activity had been available to all companies. A. Sgambati said she didn't know why Laben had not received the information. C. Stroom said that all of the on-going open source activities, such as PC-ESABASE and THERMOSS, had all been issued as open calls for tender on ESA's EMITS system. These activities were part of the ESA's General Studies Program under a heading such as "applicability of open source software to space projects". He said that they only were listed on EMITS, and not sent out to each company explicitly. A. Sgambati said that they had only received the mail for the workshop and didn't know the purpose of the workshop was to discuss open source development.

F. Lamela (EADS-CASA) felt that he was working under some misunderstanding, and asked whether everyone was seriously talking about the development of radiation analysis code based on open source software. He said that many years of effort had already been spent on both THERMICA and ESARAD, and he wondered why this time should be lost. He said that for a

2. This was the membership of the steering board at the time of the Workshop. It was possible for other companies to apply to become members in the future.

small company like CASA it was important to have competition to improve the tools, and argued that ESARAD had reached its current level because of competition from THERMICA. He said that there was always something announced for ESARAD which became available in a future development of THERMICA, and vice versa.

HP. de Koning argued that the application of open source software did not have to be black and white, and that there needed to be a balance between the different areas. There might be some areas where open source development would be useful, and others where competition would be important. He felt that it was important to have the steering board in the driving seat in order to determine the way forward.

O. Pin said that it was important to have a common framework. He said that there was commonality between ESARAD and THERMICA, but these two examples had made different choices. He felt that there was a need to look at why these choices had been made. He said that it might be necessary to have competition for the individual modules that plugged into the common framework. C. Stroom agreed that there could still be competition if that was what was required. What had been said about open source software was quite valid, but it usually related to large user communities with a large number of contributors to the software. He said that the open source software model had not really been tried in a small user group such as the space thermal community. He emphasized that THERMOSS was a prototype, a vehicle to test whether open source software would work for the space thermal community. He said, yes, it was possible to build a tool using open source software, but would the process work in this particular community. He said that ESABASE/Debris was a running tool, THERMOSS was an experiment.

M. Jacquiau (EADS-ASTRIUM) wanted to know whether open source software was the unique solution to the problems of harmonization. C. Stroom answered that open source software might not be the answer to all of the space thermal community questions, but that it was a serious contender that should not be excluded out of hand. It was something which needed to be considered seriously. Yes, you could take open source software and use it for free, but if it was to survive in the space thermal community, it was necessary to give something back. M. Jacquiau admitted that open source software looked interesting, but said that the harmonization should look at frameworks too. He suggested that any future open source software solution should be compatible with the proprietary software so that the user could choose to use one or the other as required. He gave the example that building a spacecraft geometry could be done using open source tools, the mission aspects could be provided using THERMICA, and the radiative calculations could use ESARAD. C. Stroom agreed that this should be possible.

HP. de Koning agreed that this interaction between the different aspects of design and analysis was the reason why the first set of open source software tools had to be data exchange modules. Data input and output would form an important part of any tool, and it would be a big advantage to be able to release data exchange modules as open source to provide the basis of such a framework.

M. Jacquiau was concerned that the current tools already existed: ESARAD and THERMICA had already reached a certain level of maturity. He asked how long it would be for similar open source software tools to reach the same level of maturity. C. Stroom wondered whether it might not be sooner than many people would think, and said that one of the reasons for proceeding with THERMOSS had been to discover the answers to this sort of question. He said that M. Jacquiau had already shown that THERMICA was benefiting from using open source software such as vtk and fltk. HP. de Koning said that it always took time to assess the quality of any given software. It took time to learn how to use it. It wasn't possible to decide based on the documentation and a few screen-shots alone. He felt it important that there had to be a robust verification of what the tool was supposed to do.

M. Jacquiau noted that for any tool to provide efficient calculation modules it was necessary to have competent people in both the software and thermal areas. He felt that any developer had to be close to the users, and to have a good relationship with them, just like the THERMICA development team had with Astrium's internal users. He wondered whether it would be possible to find the same user community mix for the open source software tools. He agreed that examples of open source software such as Linux and FreeBSD were successful, but their user and developer communities were quite big. However, the space thermal community was very small. C. Stroom said that this was one of the objectives of the THERMOSS study: to set up a web site, provide a download area, and a forum for discussion and comment. One of the questions was whether it would work, whether people would even look at it. He said that everyone's remarks on the thermal tools were valuable, and that was one reason for the workshop: to provide a place where users could discuss their requirements in front of the developers. However, it was necessary to try out other ways of communicating, such as the Internet, with a user forum and discussion groups.

H. Sdunnus (eta_max) said that people should be careful to avoid a common misunderstanding. The open source software activity didn't aim to replace the existing thermal tools, and in fact it might be that the proprietary tools proved to be better in the long run. What was needed was a common framework for plug-ins to overcome the shortcomings of existing tools. One example already given had been the user framework for SINDA. He said that the open source activity should aim to provide a framework which could permit access for both proprietary and open source software solutions.

O. Pin noted a theme from the space environment discussion, and that was that the tools were "sophisticated" and that the components used to build them were complex. He said that the thermal users were not software people. He wondered whether it was realistic to assume that in 5 years the thermal guys would still be participating in any open source development. He was not sure that the open source maintenance model would work for the space thermal community. To make it a success would require 20 developers like Hume Peabody dedicated to the tools.

HP. de Koning said that maintenance could be a paid activity, or involve some sort of contribution in kind. He said it was unlikely that the small user community would be able to maintain such a framework in the usual open source way without some additional funding and some development effort to keep the forum and web site running. He said it was not the same as other open source packages such as POVray where users could make contributions in kind.

O. Pin noted a general issue with the current way of software development. The Bepi-Colombo project had specific new requirements which had been missing in ESARAD [and THERMICA], and that it had taken some time to gather the requirements and to get the development going. He wondered whether open source software development would be any more flexible. He said that there may be individual users who could address their short term needs and develop an internal module as a plug-in to an open source tool framework, but this model was not applicable to the space thermal community as a whole.

C. Stroom said that this could be handled via the maintenance model, where someone could be paid to maintain the tools, which was what currently happened anyway. What would change was that if a user required a particular function, then the user could add this feature for himself if necessary. This was not possible for most of the users at present. Almost all of the companies have this expertise already because they already develop their own tools if the main thermal tools don't offer what they require. With open source software tools a company would be able to see what changes would be needed, and could implement them internally, or ask the developer of the module to implement specific changes for them. The current tool architecture did not support this. C. Stroom said that any open source development would need to have well documented data structures and algorithms in order for different developers to work together. C. Stroom felt that the architectures of the current tools had just grown over time to the point where it was no longer possible to add new data structures and functionality easily.

JP. Dudon (ALCATEL) raised a question about THERMOSS as a prototype thermal software tool. He wanted to know when it had been decided to implement such a tool, and who had been invited to participate. HP. de Koning said that the initial ITT had been available on EMITS, and it had been open to all. C. Stroom said that 8 or 9 offers had been received from different groups. JP. Dudon wanted to know who was involved in the development. C. Stroom said that the group consisted of OHB, IFL, MakaluMedia and Deimos: OHB had defined the user requirements; MakaluMedia had built the web site; and Deimos had been involved in the orbit definition and calculation.

H. Peabody (TMS) said that the critical point on the viewgraph to be considered was "Would you participate as a developer?" and added that if nobody wanted to participate in development then the rest of the questions were irrelevant. If the people you are going to help are also your main competition, what reason do you have to cooperate? HP. de Koning said that this was the whole point of having the harmonization. C. Stroom remarked on the example that R. Schlitt had given where most of the players in the automotive industry had agreed to harmonize certain activities even though they were all competitors. H. Peabody argued that space thermal software was such a niche field. If only 10% of the community agreed to participate, then it would simply not be enough to sustain development. C. Stroom countered by asking how many developers were involved in ThermPlot. H. Peabody answered that there was only one developer, himself, but that it was in his own interest to do it. R. Schlitt said that there were already a lot of developers in Europe, each one developing tools such as CONDOR, ALTAN, etc. H. Peabody argued that in these cases there was funding to address the needs of some project, and such developments were a way of guaranteeing that your own requirements were satisfied once and for all.

C. Stroom said that open source software tools did not just float around and each group modified them in isolation. There needed to be a maintenance model, which usually involved some sort of custodian of the code. A user could make changes to the code and should then submit them to the custodian for inclusion in the main development if the custodian considered the changes appropriate. R. Schlitt said that open source software meant that the source code itself was available to the user. He was sure that THERMICA would have been easier to produce if the source code for ESARAD had been available for inspection. He said that for new requirements in the future, such as the next mission to Mercury, the project would receive some funding for the implementation of the new requirements and it would be possible for them to have access to the source code of any open source software tool and they could make any changes necessary.

C. Kirtley (ALSTOM) said that he would be surprised if companies would be willing to hand over thousands of lines of source code. He could not see any competitive advantage in it. R. Schlitt said that the automotive industry had agreed to standardize on using NASTRAN and CATIA, but even so, there were still some cars that were better than others. He said that simply using THERMICA or ESARAD would not guarantee the success of the satellite.

C. Marechal recalled the statement that the voting members of the harmonization steering board were not supposed to be software developers. He wanted to know how OHB and eta_max were voting members when they were clearly developers. HP. de Koning acknowledged that this was a very grey area. Astrium were major users of the thermal tools, but were also developers of tools. He admitted that the composition of the steering board had involved some compromise. However, he felt that in general the companies which had voting rights tended to be more user than developer. C. Marechal argued that OHB seemed to be the leader in the open source software activity. C. Stroom said that OHB were representing the users of the software, and had produced the user requirements. The developers were actually MakaluMedia, IFL and Deimos. HP. de Koning stressed that the steering board was not a secret society. All companies should have received an invitation to join, but there was a need to be realistic. It would not be practical to have a steering board of 100 members. C. Stroom noted that if of the all companies who had ever developed software had been excluded from the steering board, then only a few companies would have qualified. Almost all companies had developed software at some point.

C. Marechal asked whether there was any link between the steering board and the ITT for the ESATAP activity. O. Pin said that the only link was that ESA had been involved in defining the ITT and in the formation of the steering board. The ESATAP statement of work had been produced before the steering board ever existed. C. Stroom said that the ITT for ESATAP was under the full responsibility of ESA, and had not even been mentioned in the steering board.

C. Prouvost (OpenCascade) said that OpenCascade would also like to be represented on the steering board. C. Stroom said that anyone wishing to join should contact the secretary of the steering board. E-mail addresses would be provided later.

A. Crutcher (FSC) said that if the open source activity was being run as an experiment, then the experiment was being undermined by having user involvement. He felt that open source development and user involvement were different things. He said that the concept of the experiment was good, although he did not agree with many of the assertions which had been made. He felt that the requirement for the activity to be user lead would kill the initiative. He wondered how many users would turn up for steering board meetings. He said that the purpose of most businesses was to make a profit, and wondered how a company could submit its work to everyone else free of charge. HP. de Koning said that the key phrase here was “free of charge”. A. Crutcher said that everyone wanted to benefit from the work of other people, but it was necessary to have real projects to work on in order to make money. HP. de Koning responded that people were already doing open source software development in commercial companies. A. Crutcher asked who would pay for the space open source development, and was told that ESA could be a source of funding.

C. Stroom (ESA/ESTEC) commented that the best example for open source development was the field of science, which was completely open and people were able to build on top of the work of others and develop science further. He said that the payment for doing the open source software development was disjunct from the open nature of the software itself: it was on a different axis. HP. de Koning said that software development could be characterized by different axes: there was the axis from completely open to completely closed proprietary source code; there was another axis describing intellectual property rights from public domain to restricted use; and so on.

A. Crutcher was still dubious about the question of user involvement: his own experience with the ThermXL development had shown that nobody had come to the user requirements meetings that had been organized. C. Stroom countered that users tended to behave differently in open source software development, which typically needed far more user involvement because they were doing the development as well.

M. Molina (Carlo Gavazzi Space) wanted to answer the question about whether they would participate. He said that Carlo Gavazzi Space didn’t have the relevant skills in the software areas, and in fact he felt that the space industry did not have the critical combined users and developers required. He felt that it would still be necessary to use more dedicated software companies.

M. Molina commented on the issue of data exchange using STEP-TAS. He felt that nobody was going to certify whether a particular software tool complied. Would Thermal Desktop be certified? Who would do it? HP. de Koning said that ESA had now made the first robust release of the STEP-TAS converters and was now looking to provide verification tools. If these independent verification tools could be used to determine whether there was a conflict between vendors’ implementations it would then be possible to arbitrate between them.

M. Molina repeated his call from the previous workshop for improved communication via the mailing lists. He said that the mailing list already existed. He knew that it would be a violation of the rules about ITTs if all announcements were made to the whole community, but he felt it would be helpful if the community could be kept up to date with some of the developments within the running contracts. C. Stroom said that this was a difficult area, and he would need to verify whether it would be possible to bypass the official channels in order to provide information in this way.

3. Wednesday 22 October 2003: Morning Session

3.1. Simulation of Furnace Inserts and Sample Cartridge Assemblies using the Thermal Modelling tool CrysVUn

M. Hainke (Fraunhofer) described the CrysVUn system for simulating the physics of crystal growth within a furnace, and the extensions being made under ESA contract to allow the user to model individual experiment cartridges. He then gave a demonstration of the software. (See Appendix N)

M. Molina (Carlo Gavazzi Space) asked whether the CrysVUn software was available to other users, and how. He also wanted to know whether the software provided windows and doors to allow it to communicate to external software packages. M. Hainke said that the Institute sold the program commercially, and that there were currently about 50 licences. He said that there were no links to other systems.

3.2. Plant Growth Chamber Simulation using EcosimPro

L. Ordóñez (ESA/ESTEC) described to use of EcosimPro to simulate the growth of various food plants as part of an regenerative life support system for long duration space missions. (See Appendix O)

H. Peabody (TMS) asked whether plants grew taller in low gravity conditions, and whether this would lead to volume constraints. L. Ordóñez said that the differences between plant responses on Earth and in space were not well known yet. He was waiting to see experimental data.

3.3. Thermal and fluid dynamic analysis of the air cooling/conditioning system on board the MDS (Mice Drawer System) facility

A. Sgambati (Laben) presented details of the Mice Drawer Facility, an experiment to be flown on the ISS involving the study of mouse development and behaviour during a hundred day period in micro-gravity. She described the solution to the different thermal constraints imposed during the transfer to the ISS compared to the main operation. (See Appendix P)

M. Molina (Carlo Gavazzi Space) asked whether it had been possible to check the results obtained using FHTS against any experimental measurements. A. Sgambati said that they had a breadboard system in Genoa, and also a laboratory at Laben for checking system components, such as the fans, etc. They used TMG/IDEAS to check the components and to model the hybrid cold plate. The results had been consistent.

M. Molina asked how much heat was contributed to the system by each mouse. A. Sgambati said that each mouse represented a 1W heat source, so the system had to handle 6W from the mice. The actual heat produced was related to the family of mouse being used.

3.4. Thermal Aspects of Long Term Operations on a Comet Surface.

HP. Schmidt (DLR) described the parameters for the Rosetta mission and the constraints imposed by its new target of Comet 67P/Churyumov-Gerasimenko. He gave details of the different operating scenarios available as the battery temperature could be maintained for longer with comet orbit approached the Sun. (See Appendix Q)

There were no questions.

3.5. Access to ESA funded developments

O. Pin (ESA/ESTEC) gave an unscheduled presentation about doing business with ESA, and the access to information on ESA funded developments. (See Appendix R)

O. Pin said that some of the discussions during the previous day had shown that there was a lot of confusion about how the "ESA system" worked, especially over who had access to the ITTs. He said that ESA had to be very strict in applying the rules, and he wanted to make this point absolutely clear to everyone. All new developments were usually published as open tenders except for some very specific cases for which direct negotiation could be justified. ITTs were published on the EMITS system. The two ITTs which had been mentioned the previous day (the Thermal Concept Design Tool and ESATAP) had been visible to all companies registered with EMITS. It was the responsibility of industry to look for business and to consult EMITS regularly. ESA did not advertise the ITTs nor send out notification to companies.

He said that ESTEC/TOS-MCV maintained four different mailing lists and that these related to ICES, the Workshop, TASverter and the Harmonization activity. In total these contained about 200 e-mail addresses. He admitted that it was difficult for anyone to know whether they were missing from the mailing lists because they would never receive information.

He explained that the "planned" MCV R&D projects were funded from the GSP, TRP and GSTP budgets. The open source software and harmonization activity was only at the feasibility study stage. So far it had been for research only, with only one contract in place so far. In particular, projects and other developments funded under the GSP didn't affect the funding for ESARAD and ESATAN.

Preparations were currently under way in ESTEC for submitting proposals for TRP and GSP funding. Users and projects had been consulted, and 17 proposals had been submitted, of which only 4 related to the open source software and harmonization activity.

Projects which were proposed for GSTP funding would need to have support from the national delegates, so it was important for companies to make sure that their national delegates were aware of any proposals which needed support. Which proposals were selected would be the result of a board decision.

3.6. HDF5 and STEP/NRF database for SINDA/G

R. Behee (Network Analysis) outlined his current ideas for using a neutral file format for storing the model database in a future version of SINDA, and the potential benefits of exchanging such a model database between tools. (See Appendix S)

R. Schlitt (OHB System) asked whether the import of CAD models into SINDA/G would be via STEP or using a direct conversion. R. Behee said that the tools supported the STEP standard, but that SINDA currently pulled the data directly from the CAD file. He wanted to let the modellers deal with the STEP side by pulling the knowledge of the finite element data out of the codes.

H. Sdunnus (eta_max) asked whether the tool offered support for configuration control of the model. R. Behee said that it did not, but recognized this as a good idea and said he would note it down.

C. Stroom (ESA/ESTEC) said that the viewgraph had shown SINDA reading data from the FE codes: this was effectively a database read, and writing would involve the same format. R. Behee said that PATRAN used PCL (Patran Command Language) to write the node data, etc. One way to continue would be by writing the PCL data into HDF files. He said that the transfer of information was currently one way, and that it would only be necessary to send back the temperature and the heat flow to PATRAN.

C. Stroom asked whether R. Behee had considered restructuring the data completely, reading information into a database and then solving directly from the database. R. Behee said that SINDA was similar to ESATAN, and that the data file contained all thermal data on nodes, conductors, etc. Another file provided the directory. He wanted to be able to preprocess all data into HDF files, and maybe to store the SINDA model itself in HDF to allow model export. This would allow similar tools to work on the preprocessed file. C. Stroom asked whether R. Behee would be prepared to publish such a data format. R. Behee said that he would. He said that if all tools could preprocess their models into the same data file format maybe everyone would be able to see that the tools are more similar than they thought. He reasoned that it may be better to store this model data file in some standard format such as STEP-NRF. HP. de Koning (ESA/ESTEC) said that this had been the whole point of developing STEP-NRF, to have common attributes in a common format. R. Behee agreed, and said that to convert models from ESATAN to SINDA maybe it would be possible to use STEP.

HP. de Koning commented that the harmonization effort now appeared to stretch across the Atlantic, and that if people were prepared to push, the community might actually get better interfaces between the tools.

3.7. GOCE - Thermo-Elastic Distortion Analysis

L. Weimer (EADS-ASTRIUM) described a method on integrating both structural and thermal analysis using “unit load cases” for each area of interest on the model. He also gave details of the strong frequency constraints on the thermal stability. (See Appendix T)

H. Peabody (TMS) asked whether there had been any comparison of results with the more traditional “stop” analysis to see the difference with the typical thermo-elastic applications. L. Weimer said that he hadn’t used the traditional approach. He had made two models so far, the second one with 88 loops, and had compared them. The level was almost the same but with some small variations. The other analysis had been performed by the prime contractor. F. Lamela (EADS-CASA) said that CASA had passed the thermo-elastic data to Alenia. H. Peabody said he was interested to know more because he would be involved in performing a “stop” analysis soon for another project. H. Peabody asked about the restrictions in defining the model. L. Weimer said that he didn’t have large temperature gradients between areas in the model.

M. Gorlani (Blue Group) asked how the different configurations had been handled, with the loaded and unloaded cases, etc. L. Weimer said that he had made some experiments with the different linearisation. As the gravity decreases with the square of the distance, moving the masses further apart gives reduced effects in the error. The linearisation error was less than 1%. Same analysis for the gradients had revealed similar results. M. Gorlani asked about the change in configuration between cases. L. Weimer said that the GOCE configuration did not change enough to make it worth redoing the analysis.

F. Lamela questioned the applicability of this methodology. He said that he had worked on an antenna system where the PATRAN/NASTRAN run only took 15 seconds so it would have been no problem to rerun 88 cases. However, the interpolation in the mechanical model had been a disaster because the temperatures appeared within the model. The structural analysts had run so many models and had discovered gradients between the MLI and radiators, etc. The conclusion had been that it was necessary to have better models in all areas, but this was prohibitive. The question was how to select the areas of importance in order to reduce the gradients, this was the critical art.

M. Molina (Carlo Gavazzi Space) asked whether the analysis had considered both Earth temperature and albedo variation. L. Weimer said that both had been taken into account, but he had only shown one during the presentation.

M. Molina said that these new satellite and mission requirements were opening up new domains in spectral analysis, and that everyone involved really needed to agree on a new vocabulary. He gave the example of spectral density being applied to rotational spectral density. He said that his own presentation later in the afternoon would address this very subject.

L. Weimer said that the micro-kelvin variations in the frequency domains were not useful in ESATAN when most analysis was geared to a 4 or 5 degree variation

S. Appel (ESA/ESTEC) asked whether L. Weimer had been aware of the SINAS tool developed for ESA. This provided the interpolation of ESATAN temperatures to finite element nodes and handled gradients. He felt that SINAS was more robust than the technique which had been described during the presentation and had a wider range of applications. L. Weimer said that his group performed the thermal analysis, and the structural analysis had been carried out in Spain. The approach described had reduced the amount of work need to interface with the group in Spain. S. Appel commented that if both groups chose to keep the mapping between the thermal and structural models fixed, then the interfaces would remain the same.

3.8. Methodology for Thermal Model Archiving

F. Lamela (EADS-CASA) described the perennial problem of archiving and maintaining the analysis models for spacecraft projects where different parts of the analysis were handled by different tools and stored in different areas of the file system. He presented a small FORTRAN application for pulling the separate models into a single file for archiving. (See Appendix U)

HP. de Koning (ESA/ESTEC) wanted to know more about the model with the high value conductor which had been mentioned, because a problem like that really needed to be investigated. F. Lamela said that it had been a model of an antenna system, several years previously, where a structure modelled as two nodes, which should have had a temperature difference of less than 0.5 degree, actually resulted in a difference of many degrees. In the end, the structure had been reduced to a single node. O. Pin (ESA/ESTEC) suggested to use the energy balance to control the calculation. F. Lamela said that this could lead to a different set of problems. Relaxing the energy balance difference from 0.0 to 0.06 could give a lot of locally unbalanced nodes, even though the overall solution could be globally balanced.

F. Lamela said that this problem had been reduced to a model of just three nodes, two of which represented a battery and a radiator. They had calculated the power generated, and the heat rejected by the radiator. They had found 6W in the battery, but had 15W at the radiator. C. Kirtley (ALSTOM) suggested that the model could have been converging slowly to the solution in the steady state but had jumped out of the calculation before the solution had stabilized. F. Lamela remembered that there were specific requirements which meant that they were using the transient solvers.

S. Kasper (Jena-Optronik) commented that he was an ESARAD user, and he also preferred to have all related models in a single file set in order to run them via batch mode. He noted that it was possible to do this using the ESARAD language and the appropriate radiative and analysis cases. F. Lamela said that the program he had presented had been intended for their SGI/Unix environment where they were using THERMICA. He had no knowledge of ESARAD. S. Kasper said that this facility was already included in ESARAD, so no extra software was required.

3.9. The far field method for 1D conductor computation

S. Appel (ESA/ESTEC) presented a method for approximating the 1D conductance between touching shells by calculating the heat flow between the interface and the most distant parts of the shell, as seen from the thermal point of view. (See Appendix V)

M. Molina (Carlo Gavazzi Space) asked how the calculated conductance was affected by the choice of epsilon when calculating the far points. S. Appel said that he had found that the size of the far edge was important, and that there were various ways to handle it. Experiments using different values of epsilon from 0.5 down to 0.0 had shown that the method was not so sensitive to its value. The value of 0.15 appeared to be useful for most of the shapes considered, although an ‘exotic’ configuration might call for additional tuning.

J. Kanis (Dutch Space) asked whether the contact conductance had been taken into account.

S. Appel said that if you had two finite element meshes next to each other, it was possible to introduce an additional conductance between the finite element nodes using the spring type elements in NASTRAN. Therefore it was possible to represent contact conductance. HP. de Koning (ESA/ESTEC) said that the result would be a formula containing the contact conductance, and not a simple parameter.

M. Jacquiau (EADS-ASTRIUM) asked whether an approach considering only pairs of nodes was sufficient. Why not consider the whole geometry? S. Appel said that the solution had been designed to allow thermal engineers to play with individual, physically meaningful, conductances between nodes. He said that various studies had been made in the past into using 1D conductors for the 2D and 3D approach. Most star methods resulted in negative conductors, and some thermal engineers did not want to deal with negative conductors. Some methods resulted in solutions where many nodes had conductors to non-neighbour nodes, and some thermal engineers did not like that either. This method provided an easy way for the thermal engineer to work with simple shapes, and meaningful conductors between them,

M. Jacquiau asked whether this method could be extended to several surfaces sharing a common edge. He wondered whether a triangle/star reduction would be sufficient. S. Appel said that he had not investigated this yet, the current solution method was based on pair-wise comparison. M. Jacquiau suggested that a system of three nodes sharing a single edge, and solved on a pair by pair basis could overestimate the couplings in each pair. S. Appel stressed that this method offered a 1D solution, and M. Jacquiau was talking about a 2D problem. O. Pin (ESA/ESTEC) said that this method simply automated what the users were already doing. However, nothing had been said about the meshing: if the meshing was not fine enough then the conductances would not be calculated properly.

C. Kirtley (ALSTOM) asked whether there had been any validation of the method on complex real models. S. Appel said that he had run various tests with simple shapes, some with a growing hole, and with cut sections. He asked for the definition of complex. HP. de Koning (ESA/ESTEC) said that it was only possible to validate this method for pairs of shapes for which analytical solutions already existed. The method had been validated for those pairs for which analytical expressions existed, and it appeared to be mathematically well behaved.

M. Molina asked what would happen if a non-uniform power source was applied to the edge of the node. Was the method still well behaved? S. Appel said that the method assumed a uniform field from far away, and offered only a 1D solution. He said that 1D conductances could not be used as the perfect solution for a 2D temperature field. This method could only ever be an approximation, but in reality, that was all the thermal engineers were using anyway.

A. Robson (EADS-ASTRIUM) noted that the example model had shown node B having 2 far field edges and asked how the -Q value was split between the edges. S. Appel said that the -Q was the total heat for the two far field edges, and you could choose to split this valued however you wanted, using the ratio of the edge length for example. A. Robson said that you could also choose to use the distance between the far field edge and the interface between the nodes, but this would give a different conductance value.

3.10. An Excel Database for the generation of ESATAN and SYSTEMA Thermal Models

S. Barraclough (EADS-ASTRIUM) described a system for the automatic update of relevant ESATAN and SYSTEMA models based on spacecraft component location and orientation information held in an Excel spreadsheet. The use of this system had simplified the configuration of different study cases during the evolution of the AEOLUS satellite design. (See Appendix W)

H. Peabody (TMS) asked whether the orientation of surfaces with respect to the spacecraft was limited to the standard X, Y and Z or whether odd angles could be used. S. Barraclough said odd angles were permitted, the reaction wheels used a 45 degrees orientation, but were not used in general.

O. Pin (ESA/ESTEC) asked whether more than one engineer had been working on the model because multi-user access was difficult to handle in Excel. S. Barraclough said that there was the concept of one control engineer who had access to change the spreadsheet. They had experimented with having a master file which was then used to update slave copies, but this had proved too complicated. O. Pin noted that this implied manual configuration control, and said that if the system had been designed around a proper database then the configuration control could be automatic, with the export of specific model configurations to Excel.

M. Gorlani (Blue Group) noted that for the geometric mathematical model it was still necessary to input all of the data. Therefore he wanted to know where the system really helped to save time. S. Barraclough admitted that the user still needed to type in the geometrical data, but most of the time was saved in the automatic generation of the thermal mathematical model. It had previously taken several days to move a unit as it involved updating and checking all of the models by hand. The new system reduced this time to half a day.

4. Wednesday 22 October 2003: Afternoon Session

4.1. RadTherm

R. Habig (ThermoAnalytics) described a software system for calculating infra-red images and signatures of systems, and various additional packages for simulating air flow and heat transfer. (See Appendix X)

There were no questions.

4.2. Robust industrial model exchange between ESARAD and THERMICA with STEP-TAS

HP. de Koning (ESA/ESTEC) described the current status of the STEP-TAS/NRF protocol development, and the availability of TASverter from the ESA web site. He discussed possible ways forward in integrating the STEP interface into the different thermal tools. E. Lebegue (Graitec) provided additional viewgraphs showing the application of STEP in the French building industry. (See Appendix Y)

M. Jacquiau (EADS-ASTRIUM) asked what solution he should use in THERMICA to import and export STEP-TAS files: to extract modules from TASverter, or to use the C++ libraries. HP. de Koning said that it would be easiest to use TASverter. He said that it was ESA's intention to transfer the THERMICA part of TASverter to Astrium, and it would then be Astrium's responsibility to keep the interface up to date if changes were made to THERMICA. However, it was up to Astrium to decide whether to use the Python or the C++ libraries in the long term. HP. de Koning said that it would be necessary to re-implement the mapping from SYSBAS to STEP-TAS in order to migrate from the old to the new version of STEP-TAS.

O. Pin (ESA/ESTEC) suggested that HP. de Koning give details of the conversion of the Herschel and Planck models. HP. de Koning explained that TASverter had been tested against a very extensive test suite, and had also successfully provided full conversion of many industrial models, including the ISS, METOP and Herschel/Planck. It had therefore been stress-tested on very large models, and he was confident that the whole conversion chain was working correctly.

M. Molina (Carlo Gavazzi Space) asked whether there were any constraints on the ESARAD and THERMICA versions which were handled by TASverter. HP. de Koning said that the interface was with the ASCII SYSBAS file for THERMICA and the erg file for ESARAD.

C. Stroom (ESA/ESTEC) noted that HP. de Koning had given the long term objective of the STEP activities, and emphasized that the current priority was to define tools for the validation of STEP-TAS files. These would give a complete description of the STEP-TAS files, whether they were valid, and would help to characterize the files. These tools could then be used to validate STEP-TAS files, and any non-conformance could be checked back with the tool implementors in order to resolve conflicts when converting between tools. In this way it would be possible to resolve any discrepancies between vendor A and vendor B.

4.3. THER-CFD: a THERMICA/GAMBIT gateway

F. Boursier (EADS-SPACE) outlined the typical problems encountered during the thermal analysis of the combined Ariane and spacecraft configuration during the launch phase, taking into account air flow in the fairing, etc. He described the use of THERMICA and GAMBIT packages, and transferring information between them. (See Appendix Z)

C. Kirtley (ALSTOM) asked if the geometry was always updated in THERMICA, or whether it was a round trip process. He could see that in GAMBIT the engineer needed a detailed model, so what happened when the model was changed in THERMICA? F. Boursier said that the amount of information which needed to be exchanged varied on a case by case basis and the level of change required in the model.

HP. de Koning (ESA/ESTEC) noted that the VIF file only offered six digit accuracy for the numbers and wondered whether this gave rise to any problems with cumulative error.

F. Boursier said that he had not seen any. There were various criteria imposed on meshing, and therefore it was possible to tell whether the meshing was correct.

4.4. Highlights in thermal engineering at CGS: Thermal Stability in the frequency domain and THERMAL DESKTOP/ESARAD translation tools.

M. Molina (Carlo Gavazzi Space) covered the translation tools first because most of it had already been covered during previous presentations and discussions. He then described the current trend in spacecraft modelling, and the need to agree a whole new set of terminology to represent it. (See Appendix AA)

HP. de Koning (ESA/ESTEC) had a remark about data exchange when using STEP-TAS on THERMAL DESKTOP. He said that the import/export facility had been developed three years previously using the old version of the STEP-TAS libraries. The protocol had been updated since then, and therefore it would not be possible to use the current version of the THERMAL DESKTOP STEP interface with other tools using the new libraries. ESA would communicate details of the new protocol and libraries to the various tool vendors.

L. Weimer (EADS-ASTRIUM) said that the temperature flux could cause a small deformation of the optical bench and wanted to know whether the requirements related to the alignment or only to the temperature fluctuations. F. Lamela (EADS-CASA) said that the expansion coefficient for the optical bench was of the order of 10e-13.

A. Robson (EADS-ASTRIUM) had a question for ESA. He said that this frequency based thermal technology was completely new, and that most of the thermal engineers in industry were working with the old technology. Consequently each group was inventing its own technology and techniques for the new areas. He wanted to know whether ESA was planning on doing anything to harmonize such things. HP. de Koning said that it was clearly an important area, and that ESA had been thinking about it. However, he said that there was more to consider than just the area presented. There were new developments and requirements for satellites using cryogenic systems as well as the frequency based thermal systems. He suggested that it might be necessary to set up a working group to discuss the new technologies. M. Molina said that O. Pin (ESA/ESTEC) had suggested providing the background theory for frequency based thermal systems in a future document in the ECSS series.

V. Perotto (Alenia Spazio) asked whether any sensitivity analysis had been made of the results in the frequency domain. M. Molina said that there had only been a sensitivity analysis performed on the steady state solution, and not on the transient.

F. Lamela noted that there were various possibilities. One was to work in the time domain, but then the engineer did not usually know the sources of the variation. The power profile of the instrument was known. He suggested that in future, engineers should avoid the time domain and consider the thermal spectral density only. Working with heat inputs and sources for electronic units was easy, but working with the Sun was more of a problem. Every 3 minutes there was a solar flare. The LISA analysis had avoided MLI because of the sensitivity issues introduced.

M. Gorlani (Blue Group) asked what consideration had been given to the sensitivity related to the configuration of the linear model. F. Lamela said that the main architecture had been based on the optical bench, the thermal shield and another system. A three node model had been used to tune the parameters.

4.5. Designing for milli- and micro-kelvins

V. Perotto (Alenia Spazio) presented a series of questions and musings related to the new trends in satellite missions to work at or beyond the boundaries of the current analysis technology. (See Appendix AB)

M. Molina (Carlo Gavazzi Space) commented that of course Carlo Gavazzi Space needed to move from standard parameters or experiment with convergence criteria because they knew that they were working in a completely new domain. For SINDA they were not yet working at the kelvin stability level.

H. Peabody (TMS) suggested that rather than try to work directly on thermal solutions in milli- and micro-kelvin that the engineer could scale everything in order to work in the "normal" domain and so avoid number round-off and loss of precision. V. Perotto said that this had not been tried, the work had only been an exercise so far in order to see whether the solvers were capable of providing the required accuracy and precision in this temperature domain.

Y. Rubin (Open Engineering) said that it should be possible to estimate the inaccuracy of going from a natural to a 1D model. He said that it would be easy to check those cases which had a simple analytical relation. He suggested that other cases could be checked against results obtained from nature. V. Perotto argued that these other cases could only be verified by using test data, and that this would introduce other sources of inaccuracies. Y. Rubin concluded that this meant that it would never be possible to verify whether the requirements for milli- and micro-kelvin systems had been satisfied.

4.6. Conclusions and Workshop Close

C. Stroom (ESA/ESTEC) said that one of the goals of the workshop, expressed during the welcome and introduction, had been to improve the communications between the different players in the space thermal community. There had certainly been a lot of discussion about the harmonization activity as well as the general discussions. He said that he would try to let everyone know about what was happening via the e-mail list. He felt that the workshop had once again proved useful. He thanked all of the authors for sharing their experiences with the rest of the space thermal community.

Appendix A: Welcome and Introduction

Welcome and Introduction

C. Stroom
ESA/ESTEC

Appendix B: ESATAN, FHTS & ThermXL current status

ESATAN, FHTS
& ThermXL

Current Status

H. Brouquet
ALSTOM

Appendix C: THERMICA - news of the year

THERMICA

news of the year

M. Jacquiau
EADS-ASTRIUM

Appendix D: ESARAD current status

ESARAD

current status

B. Castelli
ALSTOM

Appendix E: ThermPlot Pro

Capabilities of the
ThermPlot Pro
Thermal Post-Processing
Program

H. Peabody
Thermal Modeling Solutions

Appendix F: GAETAN development for ESATAN/FHTS

Overview of GAETAN's latest developments around ESATAN-FHTS

M. Imhof
Silogic

Appendix G: Web Support and Future Developments

Web Support & Future Developments
on
ESATAN, FHTS, ESARAD & ThermXL

C. Kirtley
ALSTOM

Appendix H: Harmonisation

Harmonisation
of
thermal and space environment
analysis software

R. Schlitt
OHB System

Appendix I: Open Source Software for Engineering

Open Source Software
for
Engineering Purposes

M. Haupt
University Braunschweig

Appendix J: Applicability of OSS to Space Thermal Engineering

Applicability
of
Open Source Software
to
Space Thermal Engineering

R. Schlitt
OHB System

Appendix K: Finite Element Modelers for Space Thermal Design

Innovations in Using Finite Element Modelers for Spacecraft Thermal Design

R. Behee
Network Analysis

Appendix L: Open Source Approach to Space Environment Tools

Application
of the
Open Source Approach
to
Space Environment Analysis Tools

H. Sdunnus
eta_max space

Appendix M: Round Table Discussion

Round Table
Discussion

HP. de Koning
ESA/ESTEC

Appendix N: Furnace Inserts and Cartridge Assemblies in CrysVUn

Simulation of Furnace Inserts and Sample-Cartridge Assemblies using the Thermal Modeling Tool CrysVUn

M. Hainke
Fraunhofer Institute

Appendix O: Plant Growth Chamber Simulation using EcosimPro

Plant Growth Chamber
Simulation
using
EcosimPro

L. Ordóñez Inda
ESA/ESTEC

Appendix P: Thermal and fluid analysis of the Mice Drawer System

Thermal and fluid analysis of the
air cooling/conditioning system
on board the
Mice Drawer System facility

A. Sgambati
Laben

Appendix Q: Thermal Aspects of Operations on a Comet Surface

Thermal Aspects
of
Long Term Operations
on a
Comet Surface

HP. Schmidt
DLR

Appendix R: Access to ESA funded developments

Access to ESA funded developments

O. Pin
ESA/ESTEC

Appendix S: HDF5 and STEP/NRF database for SINDA/G

HDF5 and STEP/NRF
database
for
SINDA/G

R. Behee
Network Analysis

Appendix T: GOCE - Thermo-Elastic Distortion Analysis

GOCE
Thermo-Elastic Distortion
Analysis

L. Weimer
EADS-ASTRIUM

Appendix U: Methodology for Thermal Model Archiving

Methodology
for
Thermal Model
Archiving

F. Lamela
EADS-CASA

Appendix V: The far-field method for 1D conductor computation

The Far Field Method
for
1D Conductor Generation

S. Appel
ESA/ESTEC

Appendix W: Excel Database for generating Thermal Models

An Excel Database
for the generation of
ESATAN and Systema
Thermal Models

S. Barraclough
EADS-ASTRIUM

Appendix X: RadTherm

RadTherm

R. Habig
ThermoAnalytics

Appendix Y: Model Exchange between tools using STEP-TAS

Robust Industrial
model exchange between
ESARAD and THERMICA
with STEP-TAS

HP. de Koning
ESA/ESTEC

Appendix Z: THER-CFD: a THERMICA/GAMBIT gateway

THER-CFD:
a
THERMICA/GAMBIT
gateway

F. Boursier
EADS-SPACE

Appendix AA:Highlights in Thermal Engineering at CGS

Highlights in Thermal Engineering at CGS:

Thermal Stability in the frequency domain
and
THERMAL DESKTOP/ESARAD translation tools

M. Molina
Carlo Gavazzi Space

Appendix AB:Designing for milli- and micro-kelvins

Designing for
milli- and micro-kelvins

V. Perotto
Alenia Spazio

Appendix AC: List of Participants

List of Participants

17th European Workshop on
Thermal and ECLS Software

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