Appendix I

ESATAN Thermal Suite Status

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Introduction

- ESATAN™ Thermal Suite, comprises
  - ESATAN™ (inc FHTS, Ablation, Fluid Property Interface)
  - ThermXL
  - ThermNV

- Present development over the year
  - ESATAN™ 9.6 Release
  - ThermXL 4.4 Release
  - ThermNV 2 & 2.2 Release
  - ESATAN™ 10 Release

- On-going developments
ESATAN™ 9.6 Release

**Dec 2005**

**ESATAN™ 9.6**

- **Enhance Scalability & Performance**
  - removal of intrinsic limits
  - target models obtained (FEM)
    - 300,000 nodes
    - 7,000,000 conductors
    - 1,000,000 arrays
  - significant improvements achieved
  - eliminate compiler memory limits
  - optimise compile & link time

- **Zero order interpolation**

- **Large number of user reported issues resolved**

**ESATAN™ Scalability & Performance**

- **ESATAN™ 9.6 Release**

- **Transient air-humidity analysis**
  - all single-phase routines now support air-humidity solution
  - water vapour balance
  - condensation calculation
  - CHX element extended

- **Outlet Rel. Humidity**

- **ESATAN™ Thermal Suite: Status 2006**
ThermNV 2 Releases

- Pre- and Post-Processing Network Model -

ThermNV 2

Mar 2006

Aug 2006

ThermNV 2.2

- ThermNV 2 released March 2006
  - major functionality enhancements
  - high performance pre- and post-processing environment

- ThermNV 2.2 released August 2006
  - working in batch

- To be presented in detail tomorrow by Julian

ThermXL 4.4 Release

- Network Licence Available For ThermXL -

ThermXL 4.4

Apr 2006

- Replacement of licence manager
  - allow a network licence model
  - simplifies licensing
    - single licence for the ESATAN™ Thermal Suite
    - eliminates problems experienced with existing system

- Import ESARAD 5.8 radiative data
  - post-process thermal results against the geometric model

- Improvements to the sensitivity analysis capability

- Resolution of user reported problems
ESATAN™ 10 Release

Oct 2006

ESATAN™ 10

What’s new in version 10?

- Revised architecture to support parametric analysis,
  - parametric studies
  - sensitivity analysis
  - correlation against test results
  - stochastic analysis
- Supporting Parametrics Manager GUI
- Completely rewritten ESATAN™ Training Guide
- Resolution of open user requests

- ESATAN™ 10 Announcement -

ESATAN™ 10 Release

- Parametric Analysis -

- To support parametric analysis require,
  - easy control of model parameters ✓
  - efficient & stable solvers ✓
  - output control ✓

- ESATAN™ 10 builds on these strengths and provides,
  - ability to efficiently change parameters and rerun a model
    • without re-preprocessing, compiling & linking
  - definition of study parameters to record for post-processing
  - control of data to output & frequency of output
  - traceability through the process
Overview of the modelling process

- ESATAN™ 10 Architecture -

ESATAN™ 10 Release

$PARAMETERS, PARMONLY
!INITIAL = 'varMaterials'
SCALE C: PANEL1:101 * 1.3 # scale operator
SC C: '#10-15; PANEL1:20-30' * .85
CH C: PANEL1:* = 950.0 # scale capacitance
SCALE C: PANEL1: *-ONLY * 1.2
CH QS: TopRadiator * 1.2 # alias
#
!FINAL = 'extRadiation'
#
SCALE GR: PANEL1: (*) * 1.2
SCALE GR('#10 - 25', *) * 1.2
SCALE GR(*-ONLY) * 1.2
#
!FINAL = 'varConductivity'
#
SCALE COND (2, *) * 1.2

- Parametric Analysis: Parameters File -

- existing $PARAMETERS block language forms the basis
- control of running nominal case via PARMONLY
- new SCALE command
- full ZLABEL strength
  - multiple node references
  - use of wild card
  - ONLY this sub-model
- support reference node alias
- FINAL & INITIAL cases
- flexible conductor addressing
- easy update of array data
Definition of output parameters

- comma-separated data (post-process using Microsoft® Excel)
  - \(,\text{CSV}_\text{ENTITIES} = (T:*,*Q\text{S:}'#/101 = 110')\)
  - single or multiple CSV file output
  - \(,\text{CSV}_\text{OUTPUT} = \text{MULTIPLE}\)
  - file name <model>_PARnnnn_<parameter case name>.csv

<table>
<thead>
<tr>
<th>Parameter case number</th>
<th>Parameter case name</th>
<th>Time</th>
<th>T1001</th>
<th>T1002</th>
<th>T1003</th>
<th>T1004</th>
<th>T1005</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>InitRadiation.1</td>
<td>0.00E+00</td>
<td>2.92E+01</td>
<td>3.02E+01</td>
<td>3.16E+01</td>
<td>3.37E+01</td>
<td>3.71E+01</td>
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<tr>
<td>2</td>
<td>InitRadiation.2</td>
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<td>2.76E+01</td>
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<td>3.19E+01</td>
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<tr>
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<td>2.64E+01</td>
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<tr>
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</tr>
<tr>
<td>5</td>
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<td>2.53E+01</td>
<td>2.65E+01</td>
<td>2.83E+01</td>
<td>3.15E+01</td>
</tr>
</tbody>
</table>

- Parametric Analysis: Parameters File -
Many possible applications,
  – initialisation of properties

\[
\text{CHANGE T:* = -20.10} \quad \# \text{Re-initialise all temperatures} \\
\text{CHANGE T:ANEL1:* = 30.0} \quad \# \text{Re-initialise model PANEL1}
\]

– reset control constants

\[
\# \text{Steady state model} \\
\text{CHANGE NLOOP = 1000} \quad \# \text{Reset Maximum Loop Counter} \\
\text{CHANGE DAMPT = 0.7} \quad \# \text{Run with a smaller damping factor}
\]

or for a transient model

\[
\# \text{transient model} \\
\text{CHANGE DTIMEI = 10.0} \quad \# \text{Increase initial time step} \\
\text{CHANGE TIMEND = 2350.0} \quad \# \text{Run for full orbit}
\]

- Parametric Analysis: Other Use-Cases -

Parametric analysis facility provides powerful building blocks

Supporting user interface provided
  – definition of multiple analysis cases
    • generation of parameter cases
    • Range & Series operators
  – definition of output parameters
  – control of output
  – automatic generation of Parameter File

Demonstrate through an example

- Parametrics Manager Utility -
ESATAN™ 10 Release

- PCB2 heat loads
- radiation to internal closure
- external radiation from unit top to environment
- conduction through PCB supporting links (not shown)
- conduction through to boundary Mounting Panel
- model sensitivity to internal, external radiation & conduction through links

- Parametrics Analysis: Example Model -

ESATAN™ 10 Release

- Parametrics Analysis: Example Model -
ESATAN™ 10 Release

ESATAN™ 10 Release

- Parametrics Analysis: Example Model -
ESATAN™ 10 Release

ESATAN™ 10 Developments

- Now porting ESATAN™ 10 to Linux 64
  - plan to support SUSE O/S
  - continue to support Red Hat O/S on Linux 32
  - expect to release shortly

- Further user submitted Feature Requests to be addressed
  - inc, improvement to error handling (ease of use)
Conclusion

- ESATAN 9.6 saw significant improvements to scalability & performance
- ThermXL provided as part of the ESATAN™ Thermal Suite
- ThermNV provided as part of the ESATAN™ Thermal Suite
- Flexibility of ESATAN™ ideally suited for parametric simulation
  - stochastic licence option now available
- ESATAN™ 10 builds on this, providing a powerful new architecture for running simulations