



eta\_max space

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# Application of the Open Source Approach to Space Environment Analysis Tools

Seventeenth European Thermal & ECLS Software Workshop  
21 – 22 October 2003

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Seventeenth European Thermal & ECLS Software Workshop, 21 – 22 October 2003, ESA/ESTEC, Noordwijk, The Netherlands

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## Outline

- Background
- The “Open Frontier” platform
  - × Components
  - × Licensing Issues
  - × Data model
  - × Architectural Design
- The ESABASE/Debris plugin
  - × Open Frontier + ESABASE/Debris = PC ESABASE
  - × PC ESABASE Online Presentation
- Summary + Outlook

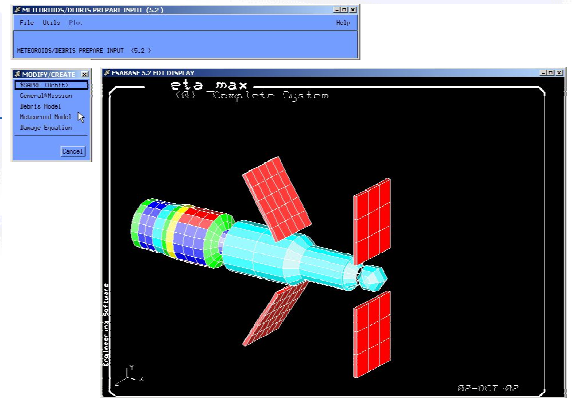
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# Background

## Background

- **ESA Study**
  - × „Porting of the existing ESABASE/Debris Application to PC platform“
  - × Study Manager: G. Drolshagen (TOS-EES)
  - × Duration: 01/2003 - 06/2004
  - × Usage of Off The Shelf (OTS) tools and Open Source software strongly recommended
  - × Open Interfaces (STEP) is a “must”
  
- **Approach:**
  - × Provide a generic platform offering everything a high level SE analysis tool needs (Open Frontier)
  - × Plug in ESABASE/Debris (pre-processors, post-processors and solver)
  
- **Open Frontier + ESABASE/Debris = PC-ESABASE**
- **Open Frontier plugin philosophy is open to other pre- and post processors, solvers and also to different disciplines**



- Problem
  - × Ageing Space Environment Analysis Tools
    - Cumbersome user interfaces
    - Restricted data models
    - Platform dependence
    - Undefined or non-existent interfaces to external tools
    - Extensive Pre- and post-processing
  - × Serious constraints of their acceptance and availability (ESABASE;..)
- Task (→ related to ESABASE/Debris)
  - × Provide a PC based solution (Windows; Linux)
  - × Replace the existing framework
  - × Retain existing kernels (solver) as far as possible (ESABASE/Debris)
  - × Provide interfaces to external tools (CAD → STEP)

- Usage of “Off The Shelf” (OTS) Software
  - × prevents re-invention of the wheel and may save development effort
  - but ...**
  - × OTS solutions are normally far from providing ‘plug + play’ capabilities
  - × Not every problem is solved by an OTS solution
- Open Source Software
  - × avoids ‘proprietary’ dead-ends
  - but ..**
  - × does not always provide a business case

# Open Frontier

Components  
Licensing Issues  
Data model  
Architectural Design

## Identification of OTS Solutions

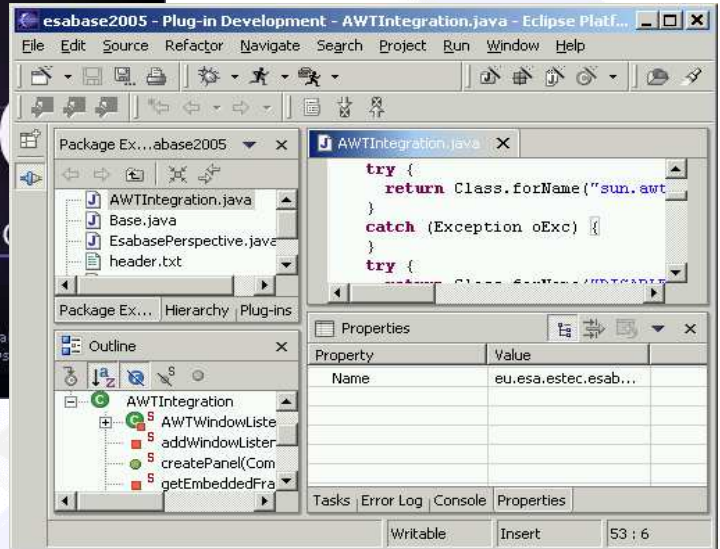
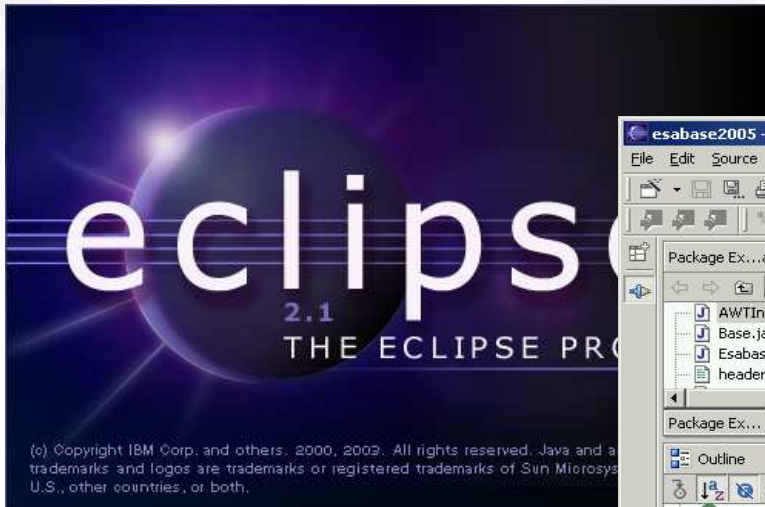
- What is needed ?

- × Framework Components

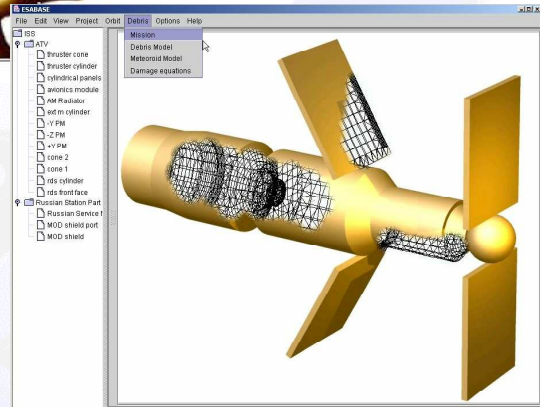
- |                                                  |              |
|--------------------------------------------------|--------------|
| • Graphical User Interface                       | Eclipse      |
| • Geometrical Model Viewer + Builder             | Open Cascade |
| • Result Viewer (2D; 3D graphs; 'Special Plots') | VisAD        |
| • Report generator                               | JFreeReport  |

- × Platform

- |                                               |              |
|-----------------------------------------------|--------------|
| • Flexible, transparent + scalable data model | OCAF         |
| • CAD data exchange (STEP compliance)         | Open Cascade |

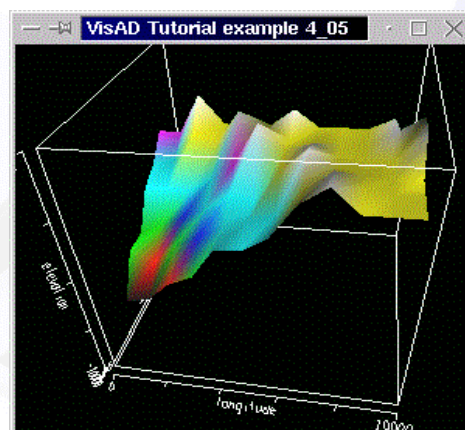
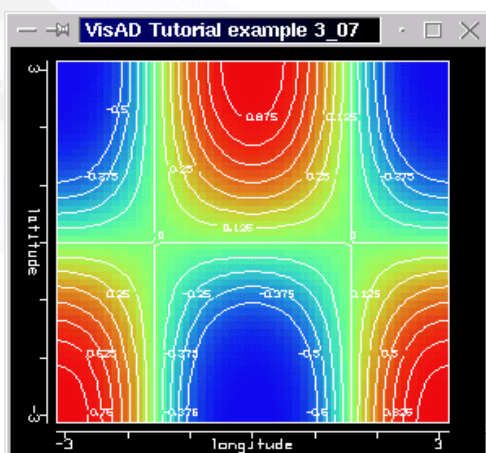


- What is Eclipse?
  - ✗ IBM states that "*Eclipse is an IDE for anything, and for nothing in particular.*"
  - ✗ Wide distribution as Java IDE, but also in the IBM commercial tool world (WebSphere)
- Eclipse is a high level GUI platform
  - ✗ Widely accepted Look & Feel
  - ✗ Native GUI components → native user experience
  - ✗ Existing framework → less components to develop
  - ✗ Primitive GUI elements → Buttons, Checkboxes, Textfields, Trees
  - ✗ complex display/edit views → Viewers, Editors
  - ✗ Always state-of-the-art in contrast to self-developed solutions
- Eclipse is Open Source
- Eclipse encourages platform building
  - ✗ Plugin model with well defined interfaces
  - ✗ Built-in plugin development environment

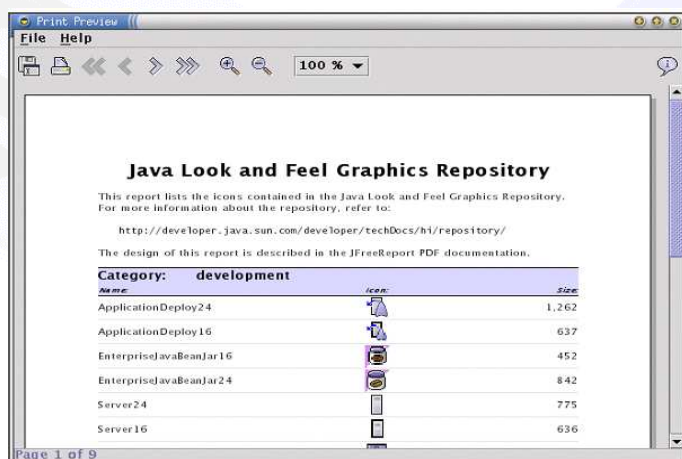
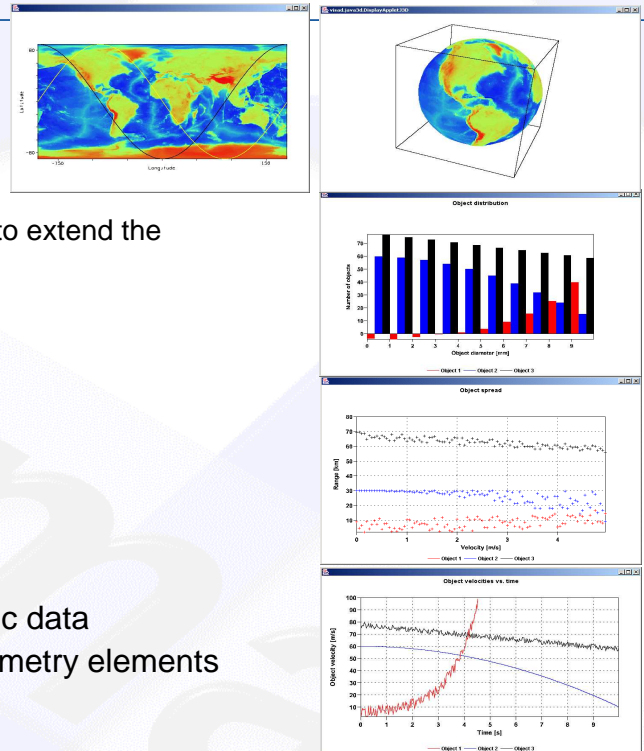


- What is Open Cascade?
  - × Open Cascade is a geometric modelling toolkit
    - Create primitives such as prism, cylinder, cone and torus
    - Perform Boolean operations (addition, subtraction and intersection)
    - Compute properties such as surface, volume, centre of gravity, curvature
    - Compute geometry using projection, interpolation, approximation
  - × Open Cascade is a 3D Viewer
    - ready-to-use user interaction and visualization services
    - 3D rotation, Zoom, Shading, graphical selection of geometrical objects
  - × Open Cascade is Open Source
  - × Based on the Swing Java 2™-based library, the Java Application Desktop (JAD → commercial) makes the application portable on all platforms running the Java 2™ Virtual Machine

- Open Cascade allows data exchange through standard interfaces
  - × STEP
    - AP 203, 214
    - [209], “rough implementation” in latest release
    - SPE – PC ESABASE compatibility to be established by eta\_max under ESA contract (prime:Simulog)
  - × CAD
    - IGES, BREP, CSFDB
    - CATIA → free for users if bought by developer (license required)



- What is VisAD?
  - ✗ VisAD is dedicated to the visualisation of scientific results
  - ✗ VisAD provides a wide range of customisation capabilities plus the possibility to extend the analysis and visualisation features.
  - ✗ VisAD is open source
- VisAD Benefits
  - ✗ highly customizable
  - ✗ huge feature range
  - ✗ supports 2D and 3D chart types
  - ✗ supports data manipulations
- VisAD is very well suited to visualise scientific data
- Geometry related results are mapped to geometry elements and displayed by means of OCC



- JFreeReport supports
  - ✗ formatted on-screen display,
  - ✗ printer output and
  - ✗ PDF output.
  - ✗ XML based templates to define report formats.

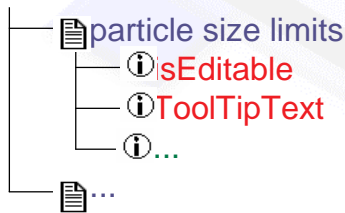
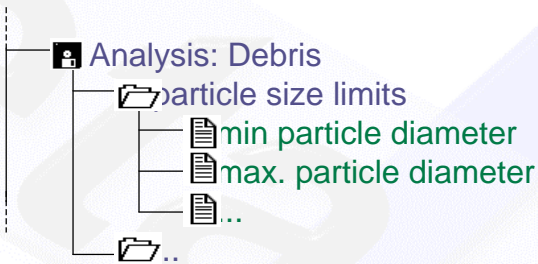
- **Open Cascade**
  - × being licensed under the Open Cascade Public License. It allows the distribution of „Derivative Programs“ with different licenses.

- **Eclipse**
  - × Common Public License „[...] this license is intended to facilitate the commercial use of the Program [...]“

- **VisAD** → LGPL
- **JFreeReport** → LGPL
- **Open Frontier** → to be agreed with ESA
- **PC ESABASE** → to be agreed with ESA

|                       | Proprietary | Freeware | Shareware | GPL | LGPL | CPL |
|-----------------------|-------------|----------|-----------|-----|------|-----|
| Zero Cost             | -           | x        | -         | x   | x    | x   |
| Source available      | -           | -        | -         | x   | x    | x   |
| Copying possible      | -           | x        | x         | x   | x    | x   |
| Modification possible | -           | -        | -         | x   | x    | x   |
| Reselling possible    | -           | -        | -         | -   | x    | x   |

- **The establishment of a “good” data model is seen as a key issue**
- OCAF supports a key-driven data structure
  - × Allows to use any type topological and non-topological data
  - × Allows free form data model structure as well as a hierarchical structure
- OCAF allows label attributes
  - × Ready-to-use attributes as well as user-defined attributes
- OCAF Features
  - × Existing data browser → transparent and ‘readable’ data model
  - × Open/Save functionality → allows creation and exchange of data model images
  - × Undo/redo mechanism → allows data model changes at run time
  - × Accessible from high level programming languages and from script languages
- Open Frontier data model as implemented by means of OCAF is flexible, easily maintainable,scalable.



## Document

- × a complete data tree
- × capable of loading/saving into/from files

## Node/Label

- × a container for data parameters

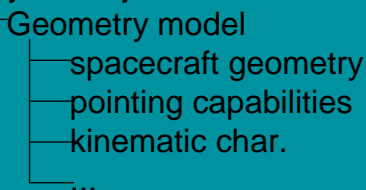
## Leaf/Parameter

- × a named variable containing a single value or an array of values

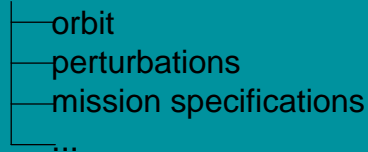
## Property

- × each leaf/parameter has assigned a list of properties that describe the parameter and its behaviour in the GUI

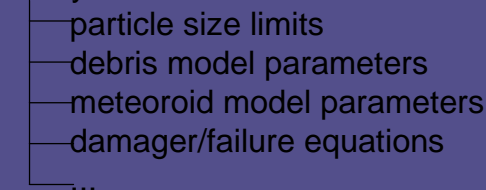
## Analysis Project



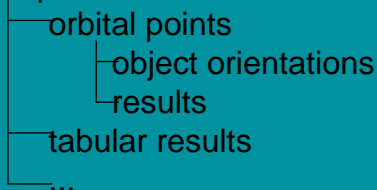
## Mission



## Analysis: Debris



## Output



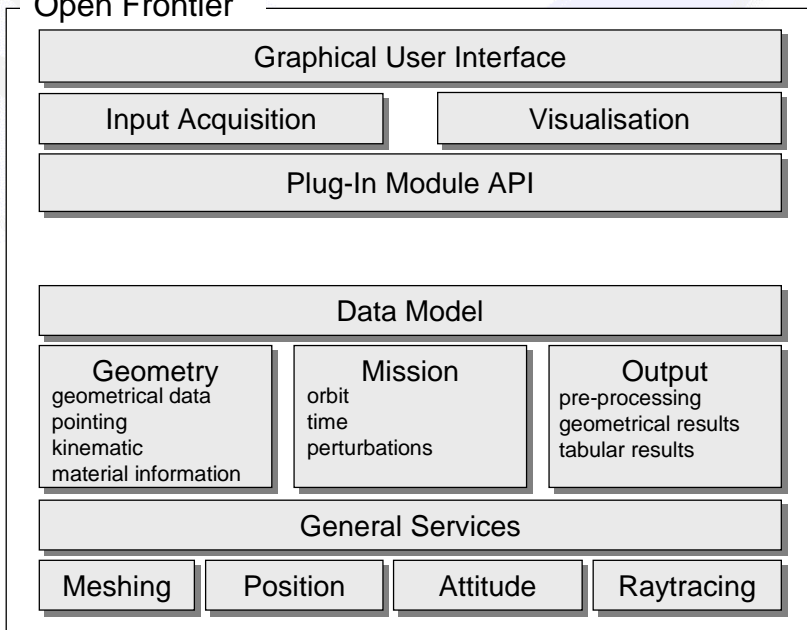
PC ESABASE specific model

Open Frontier generic model

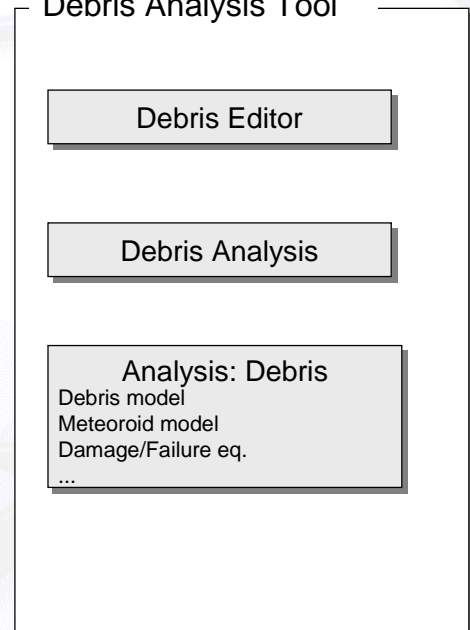
# Open Frontier + ESABASE/Debris = PC ESABASE

## The platform concept

### Open Frontier



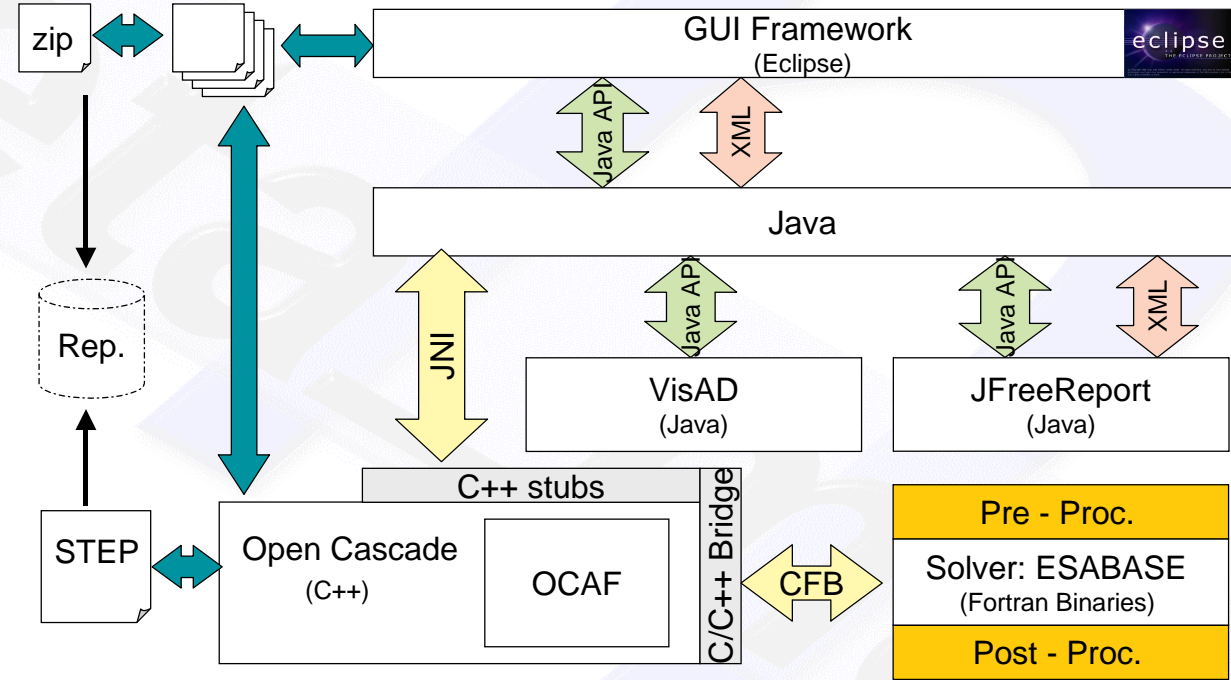
### Debris Analysis Tool





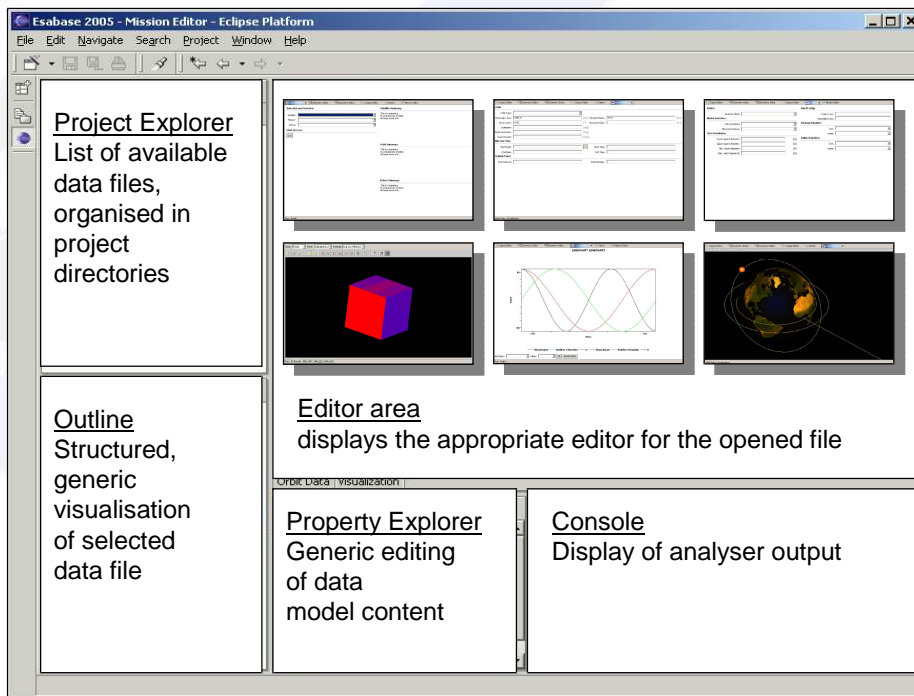
# Architecture

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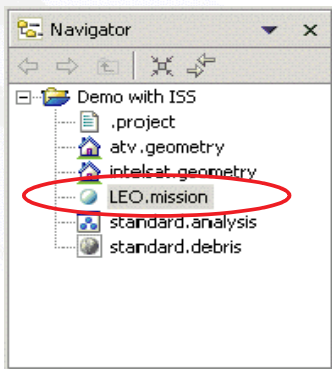
# GUI concept

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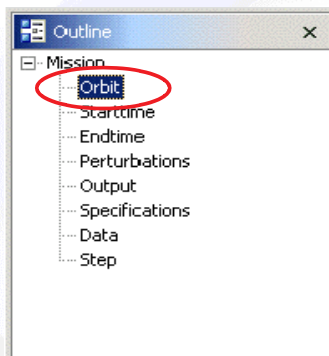


# Online Presentation

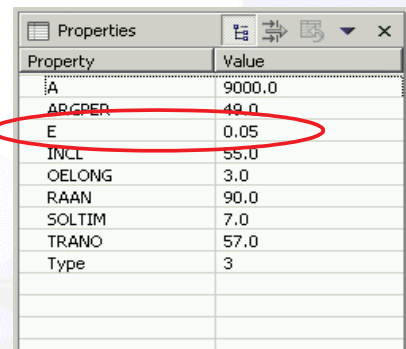
## Implementation Approach: Purist Workflow



Choose File



Choose Section



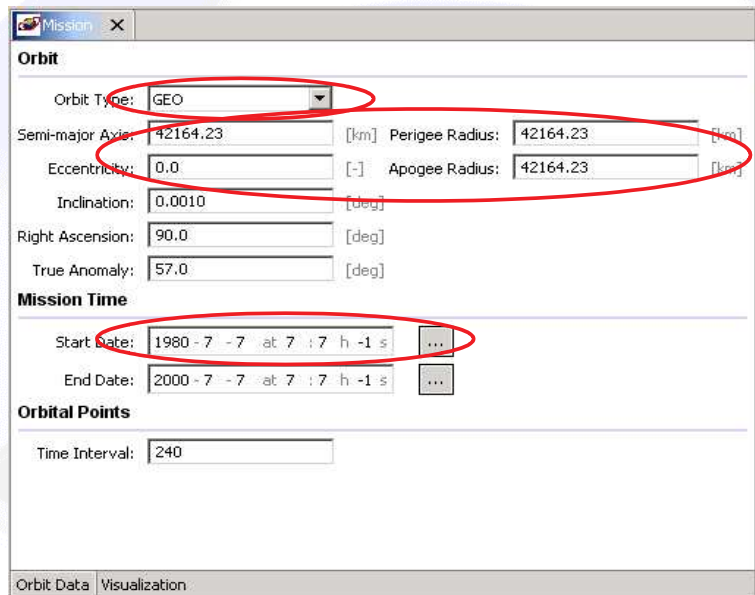
| Property | Value  |
|----------|--------|
| iA       | 9000.0 |
| ARCDER   | 49.0   |
| E        | 0.05   |
| INCL     | 55.0   |
| OELONG   | 3.0    |
| RAAN     | 90.0   |
| SOLTIM   | 7.0    |
| TRANO    | 57.0   |
| Type     | 3      |

Edit Property

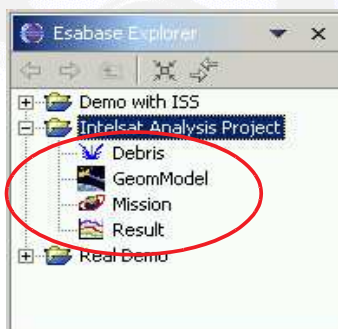
Cascade by Choice

Calculation by Others

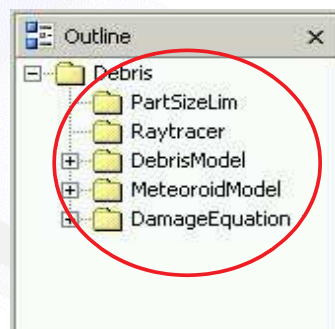
Date Editor with Dialog



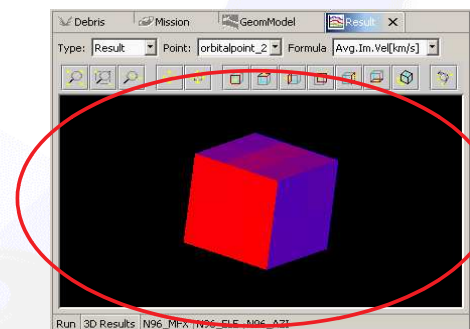
- Open Cascade is integrated by an JNI contract
  - ✗ Eclipse file matches OCAF document
  - ✗ Tree nodes match OCAF labels
  - ✗ OCC view panel is integrated into Eclipse geometry editor



OCAF documents

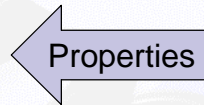
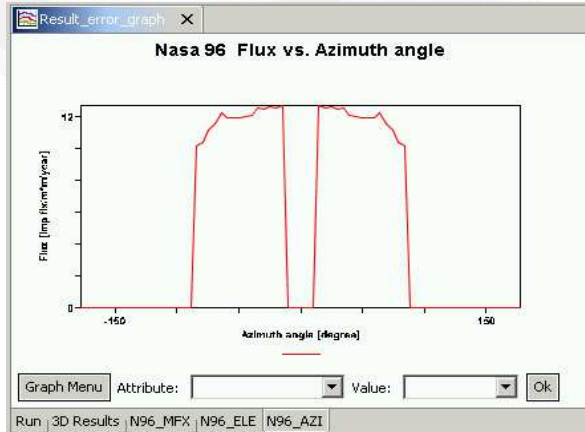


OCAF labels



OCC panel

- VisAd is included via AWT/SWT integration bridge
  - ✗ VisAd panel is placed into an SWT editor panel
  - ✗ Commands are piped from OCAF to VisAd thru an automatic synchronization model



| Property        | Value               |
|-----------------|---------------------|
| Absolute ID     | CHARTS/N96_MFX      |
| BACKGROUNDCOLOR | Color.white         |
| BOX             | ON                  |
| DIMENSION       | 2                   |
| FOREGROUNDCOLOR | Color.black         |
| HASLEGEND       | ON                  |
| MAJORTICKS      | ON                  |
| MINORTICKS      | OFF                 |
| PARAMETER       |                     |
| PROJECTION      | RECTANGULAR         |
| RATIO           | 2.0:1.0             |
| REFID           | 2E445667-F811-48... |
| CTDINC          | ...                 |

## Summary and Outlook

- Based on Open Source OTS tools the Open Frontier Platform has been created
- Open Frontier provides
  - × An ergonomic framework for user input acquisition and visualisation
  - × A highly flexible and scalable data model
  - × An interface to external CAD tools
  - × A generic plugin model for solvers from various disciplines
- The Plugin approach allows also proprietary plugins
- Open Frontier + ESABASE/Debris = PC ESABASE
  - × Beta version providing most functions in principle implemented and running
  - × The PC ESABASE tool providing all existing capabilities of ESABASE/Debris plus the Open Frontier advantages will be available in the second half of 2004
- Open Frontier demonstrates the applicability of Open Source software to high-profile analysis tools

