Real-time Immersive Visualization for Satellite Configuration and Version Comparison

Y. Liu, M. Deshmukh, J. C. Wulkop, P. M. Fischer and A. Gerndt

Simulation and Software Technology
German Aerospace Center

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- Introduction of version comparison for spacecraft design
- Architecture for visualization of Virtual Satellite
- Version comparison in Virtual Satellite
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Version Comparison for Spacecraft Design

Displaying differences between different versions of configuration data

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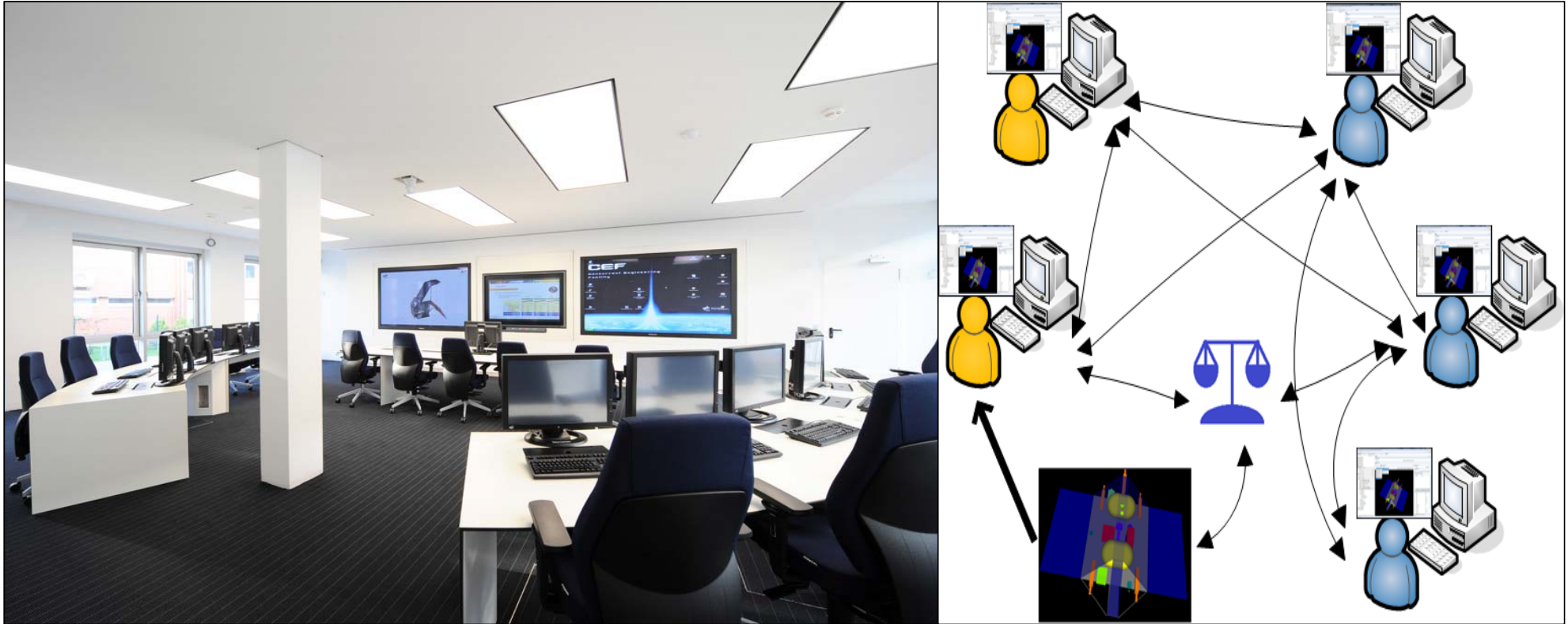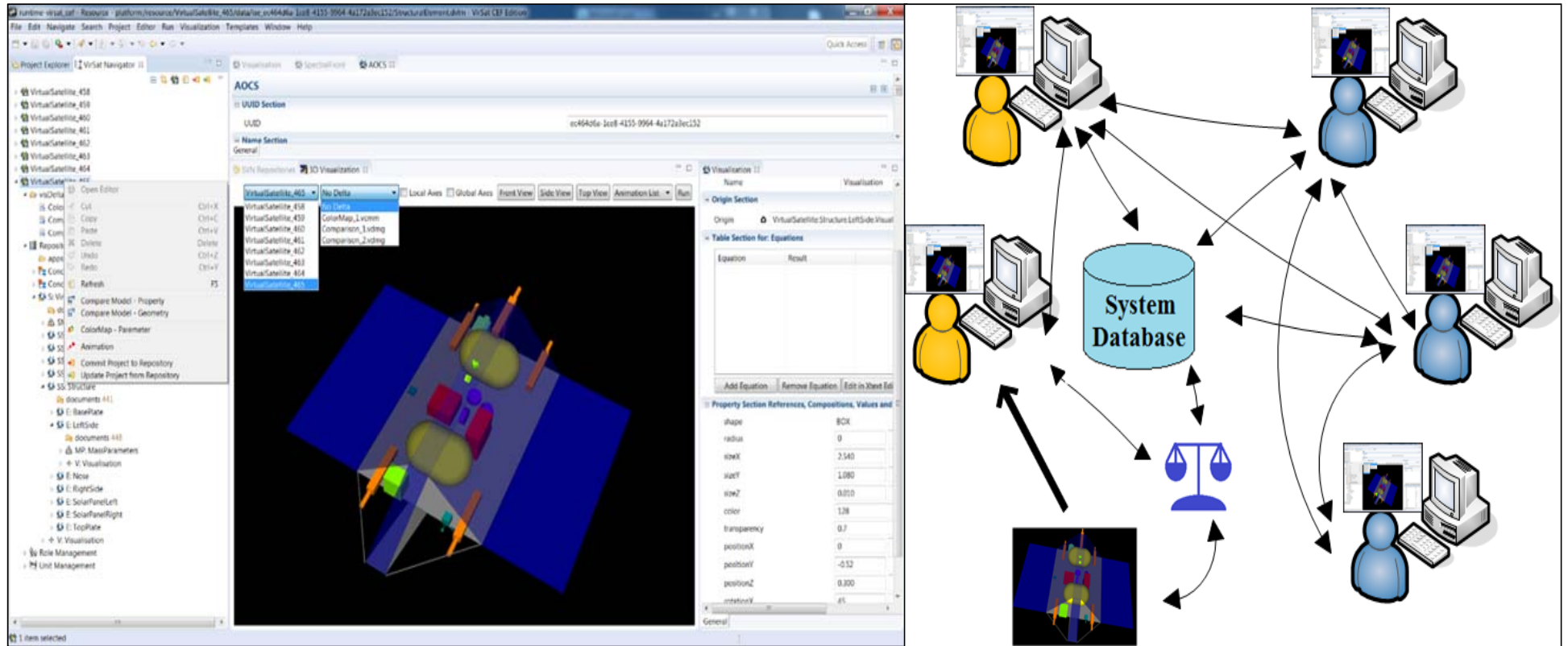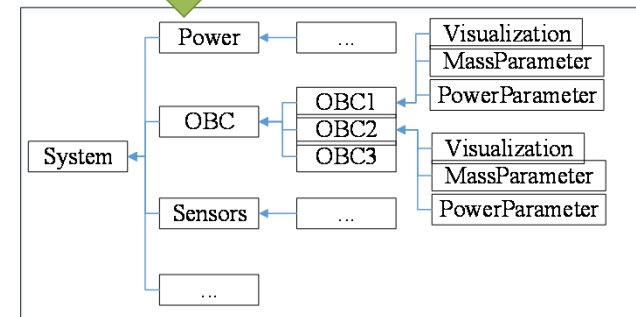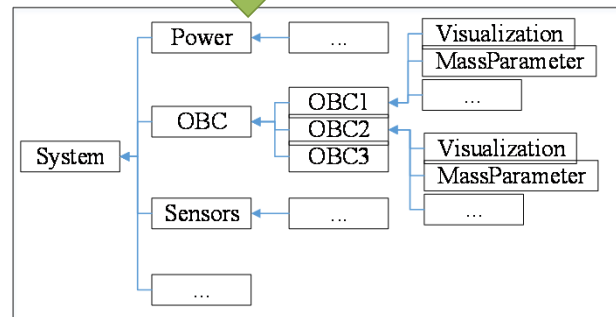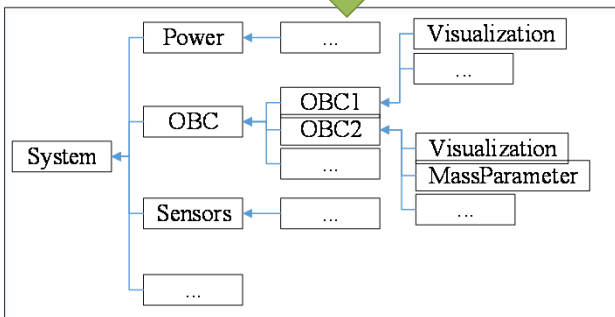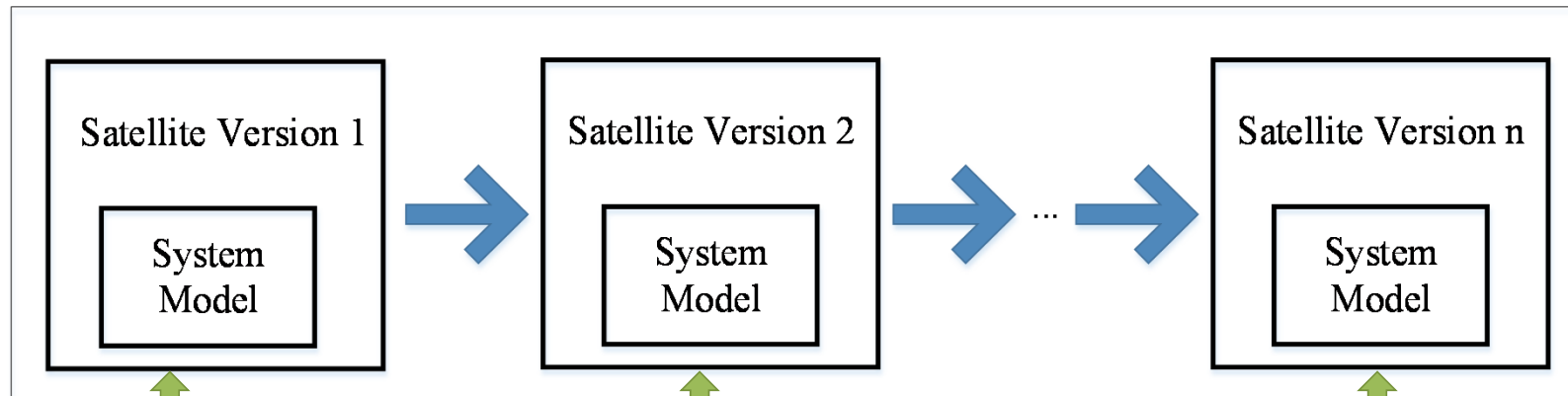# Spacecraft design in a Concurrent Engineering Facility

Image from paper "Interactive 3D Visualization to Support Concurrent Engineering in the Early Space Mission Design Phase"

# Virtual Satellite as the standard tool for Concurrent Engineering studies

# Configuration differences of many versions of design need to be handled

Advantages of version comparison

- Decision making

- For stakeholders
  - Grasp design progress

- For experts
  - Learn lessons from the comparison between evolving versions
  - If needed, the current design may be refused and a different version may be selected
  - Design decisions might be approved
  - A new system based on older versions or other similar systems.
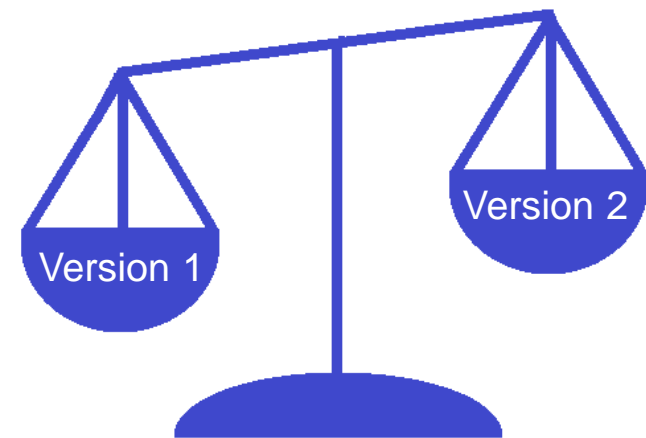
Problems for getting comparison results of multi versions

- Problems:
  - Many versions of one system
  - Many subsystems, many parameters of one system
  - Textual data files
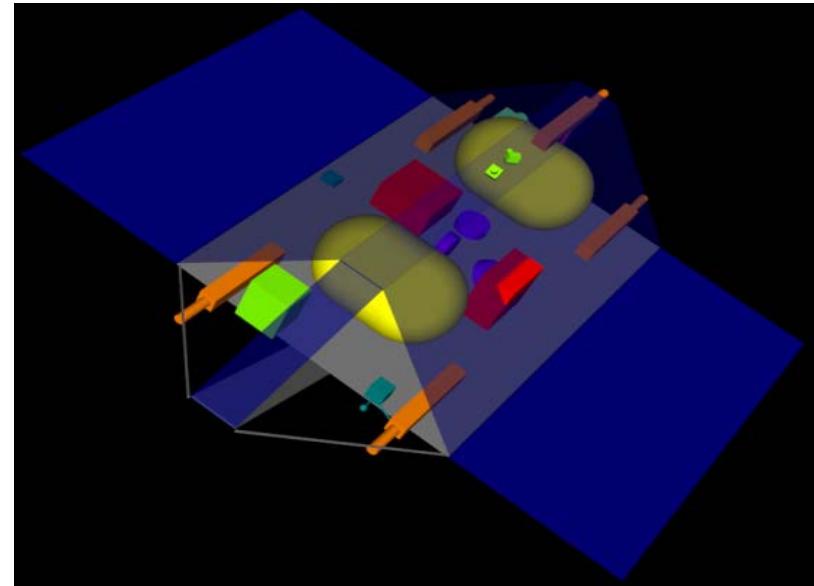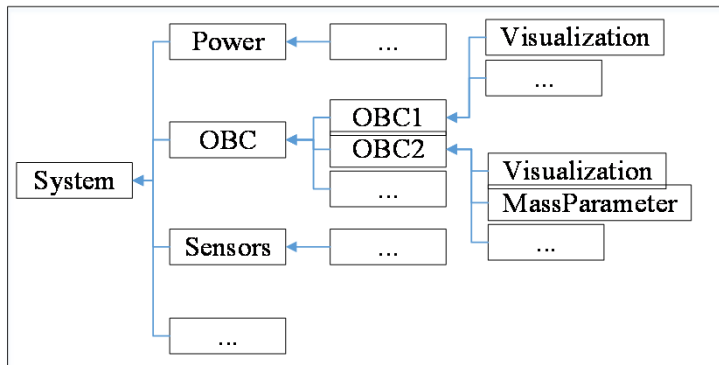
# Our effort: graphical comparison approaches for intuitive understanding

Architecture for Visualization of Virtual Satellite

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Architecture overview for visualization

- Each expert
  - One Instance of Virtual Satellite
  - Local copy of system model data
  - Only can alter data if with sufficient permissions

- Version Control System
  - Subversion

- Consistent System Data
  - Concept data model following MBSE approach
  - Hierarchical tree-like demonstration
  - System, subsystems, and equipment
  - Geometric, other configuration parameters

- Visualization Environment
  - 3D visualization in Virtual Satellite
  - VR environment
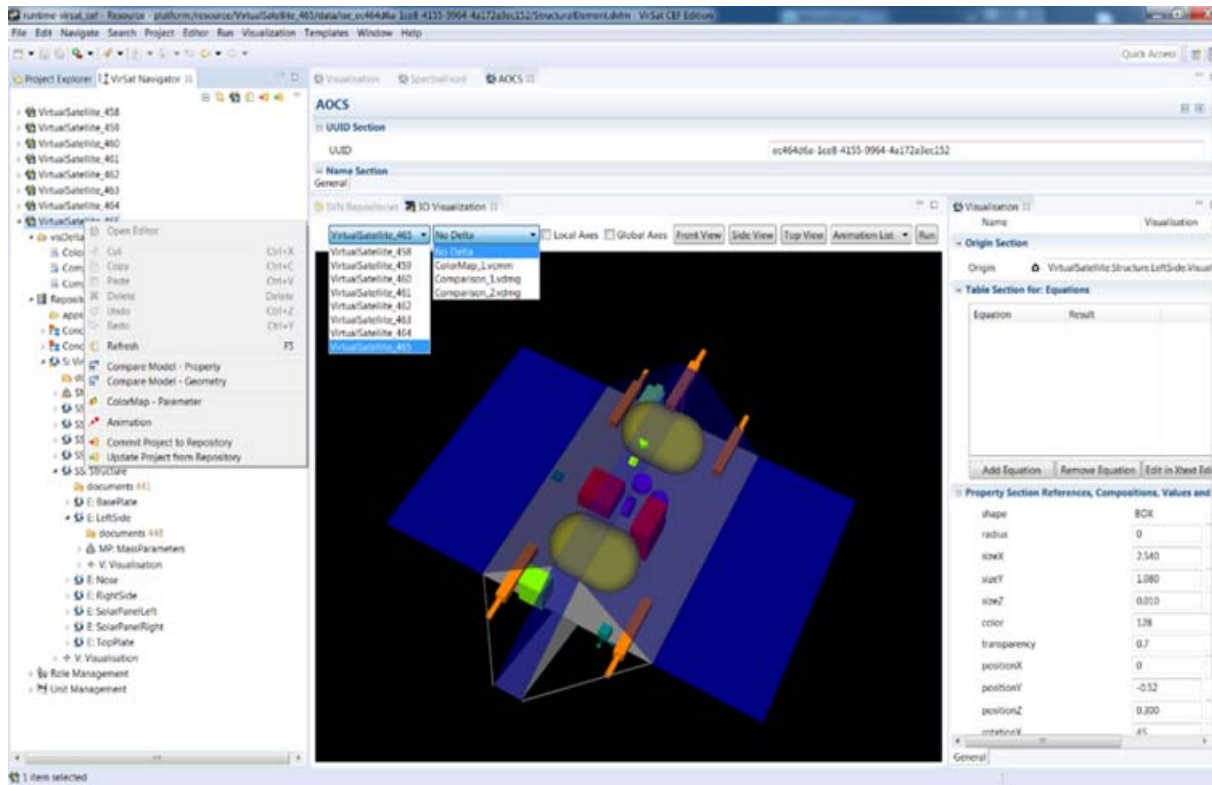 - Transmission Control Protocol
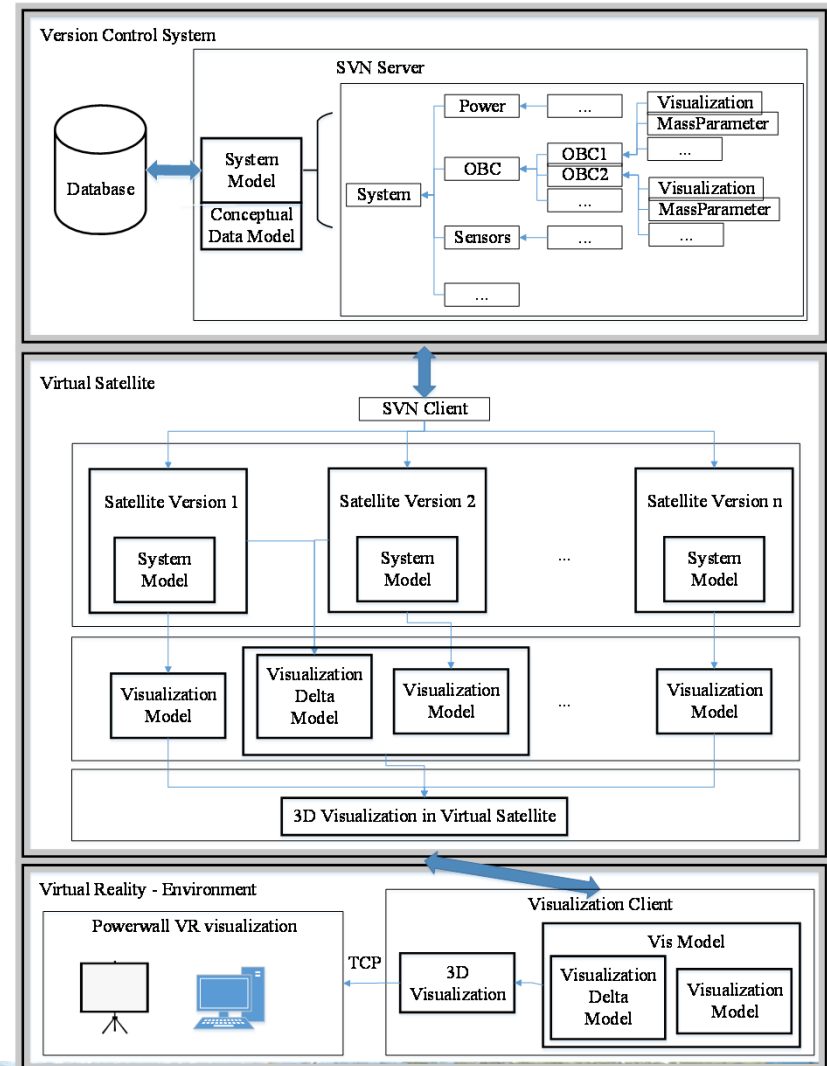
Version Comparison in Virtual Satellite

Version comparison with 3D visualization and VR
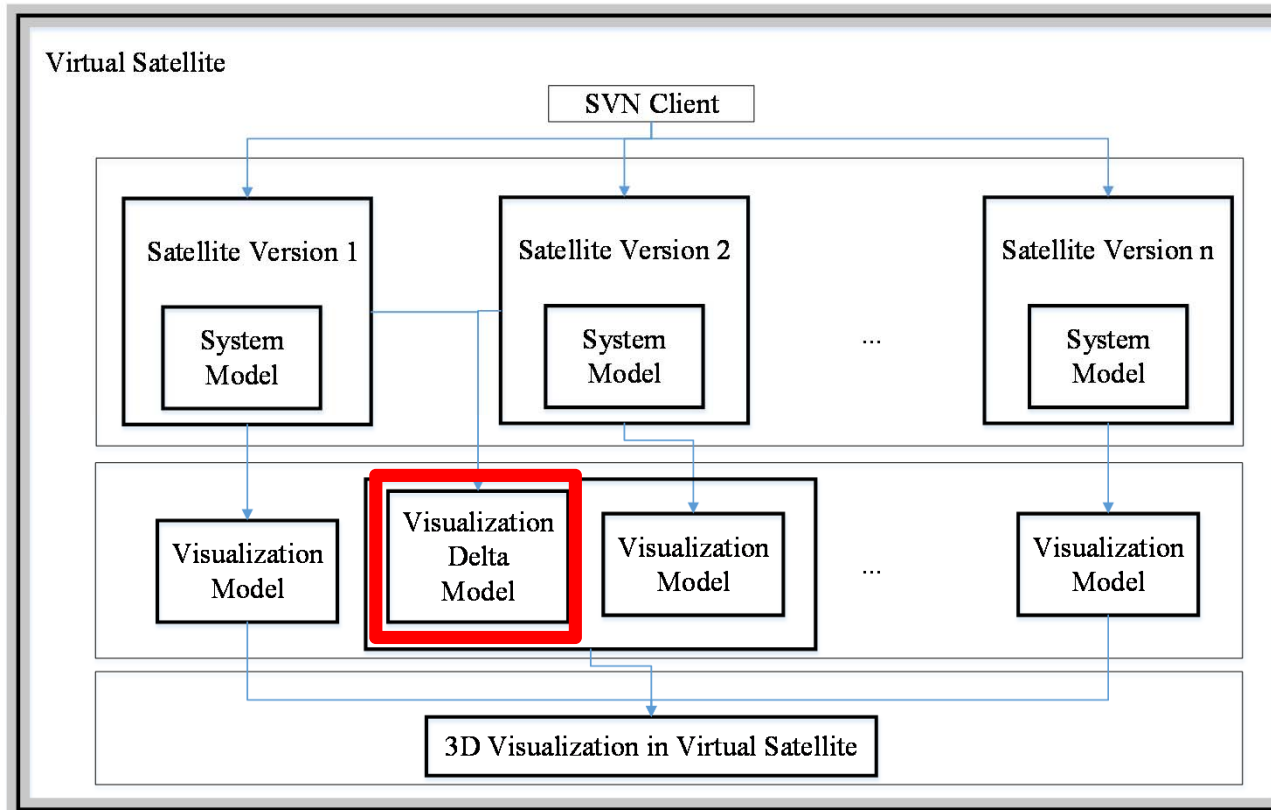
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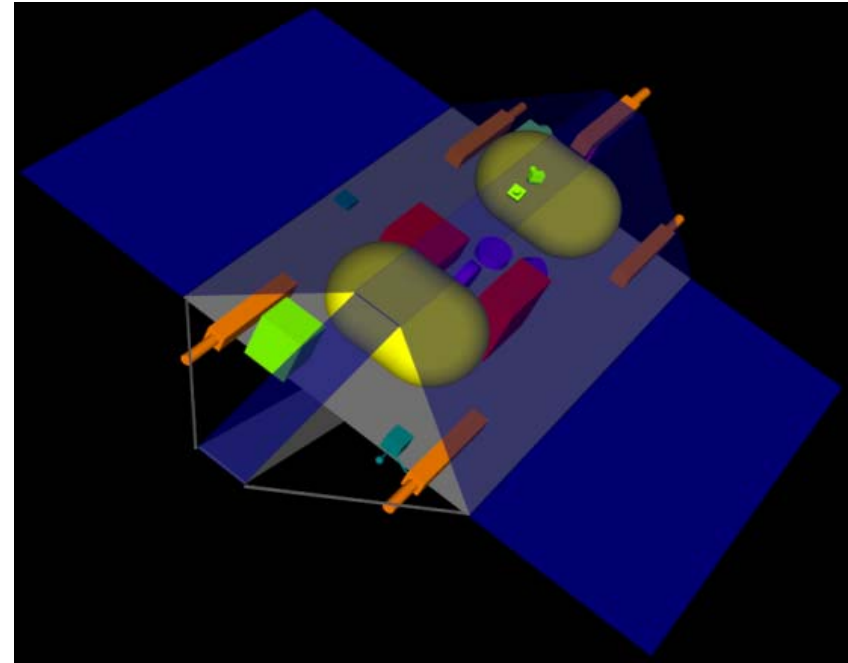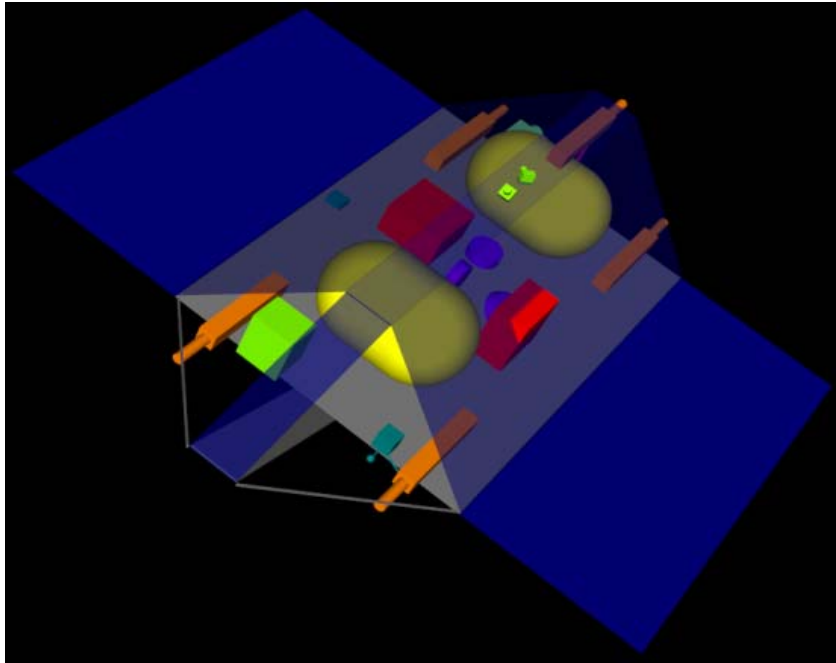
Virtual Satellite interface

- Virtual Satellite Navigator
  - Multiple versions

- Textual Editor
  - Geometric model
  - Other configuration parameters

- 3D visualization viewer

- Comparison operation
  - Comparison of geometry
  - Comparison of parameter
  - Color Map for parameters
  - Animation

Delta Model for comparison visualization

Version Comparison

- Hard to find differences with eyes from pictures
- Other kinds of parameter beside geometry: mass, power, temperature…
- Tedious, unclear, and time consuming to check the textual files

Our effort: graphical comparison approaches for intuitive understanding

- Our effort to solve these problems:
    - Virtual Satellite extended for graphical comparison approaches
    - Differences between versions computed automatically
    - 3D visualization and VR environment

- Intuitive, quick, clear understanding of differences between versions.

Version Comparison of geometry
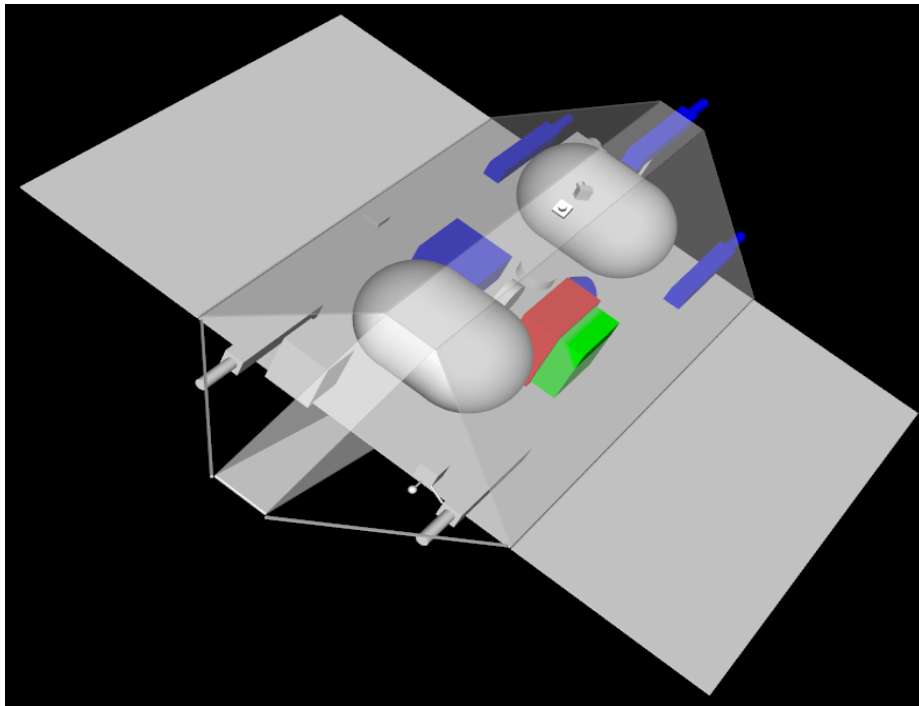
- Geometry
  - Shape
  - Size
  - Position
  - …

- Four kinds of comparison possibilities :
  - Something has been added
  - Something has been removed
  - Something has been modified
  - Something is unchanged

- Keep removed equipment

- Too much detailed will cause confusion
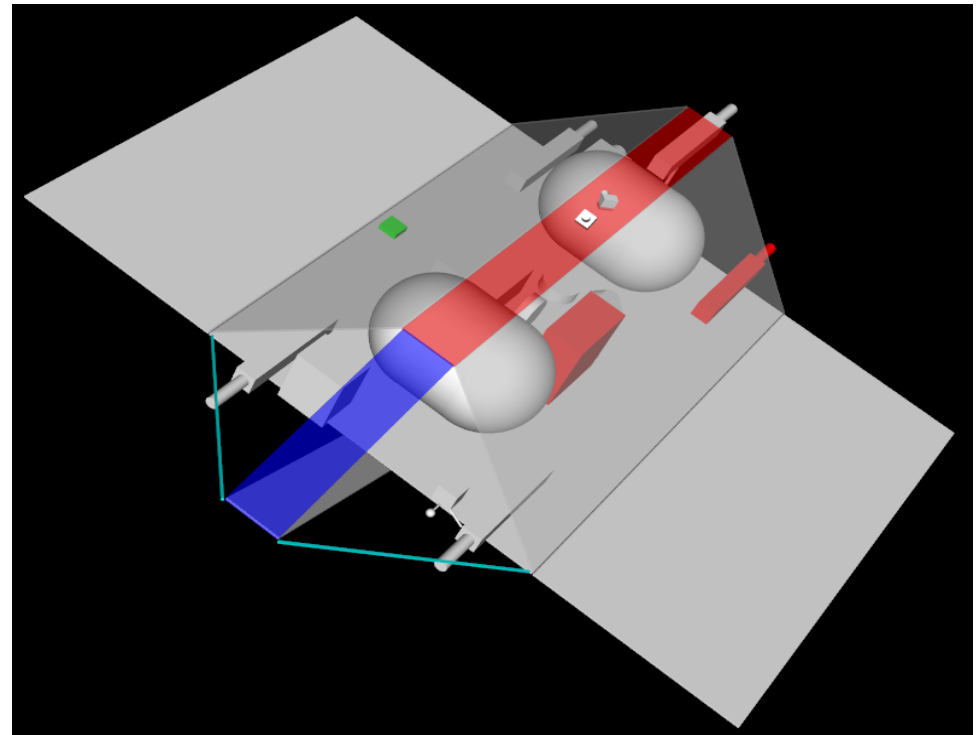
Animation mode for Version Comparison
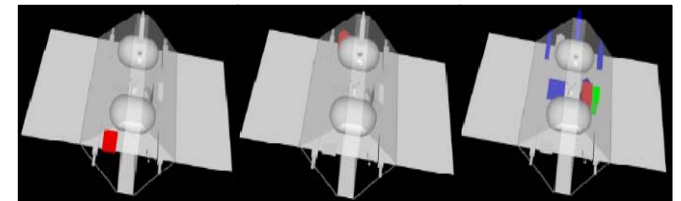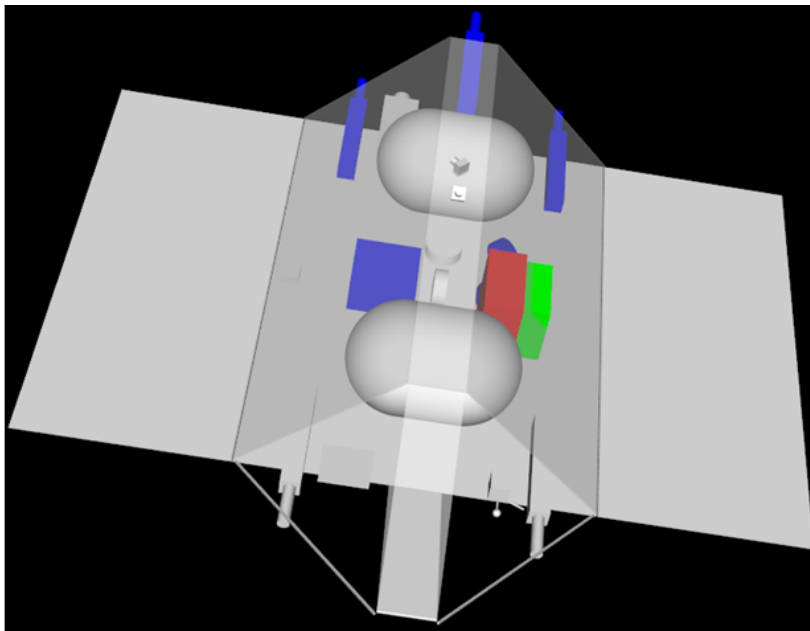
Version Comparison of parameter

- Key performance indicator, important parameter
  - Mass, Power consumption, Temperature
  - Restriction due to vehicle's capacity
  - Center of gravity
  - Thermal constrains

- Five kinds of comparison possibilities :
  - Something has been added
  - Something has been removed
  - Value has been increased
  - Value has been decreased
  - Something is unchanged

| Added | Removed | Higher | Lower | Unchanged |

Color Map of parameter

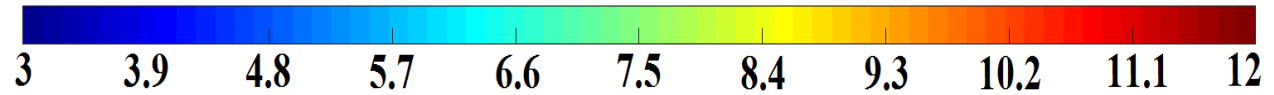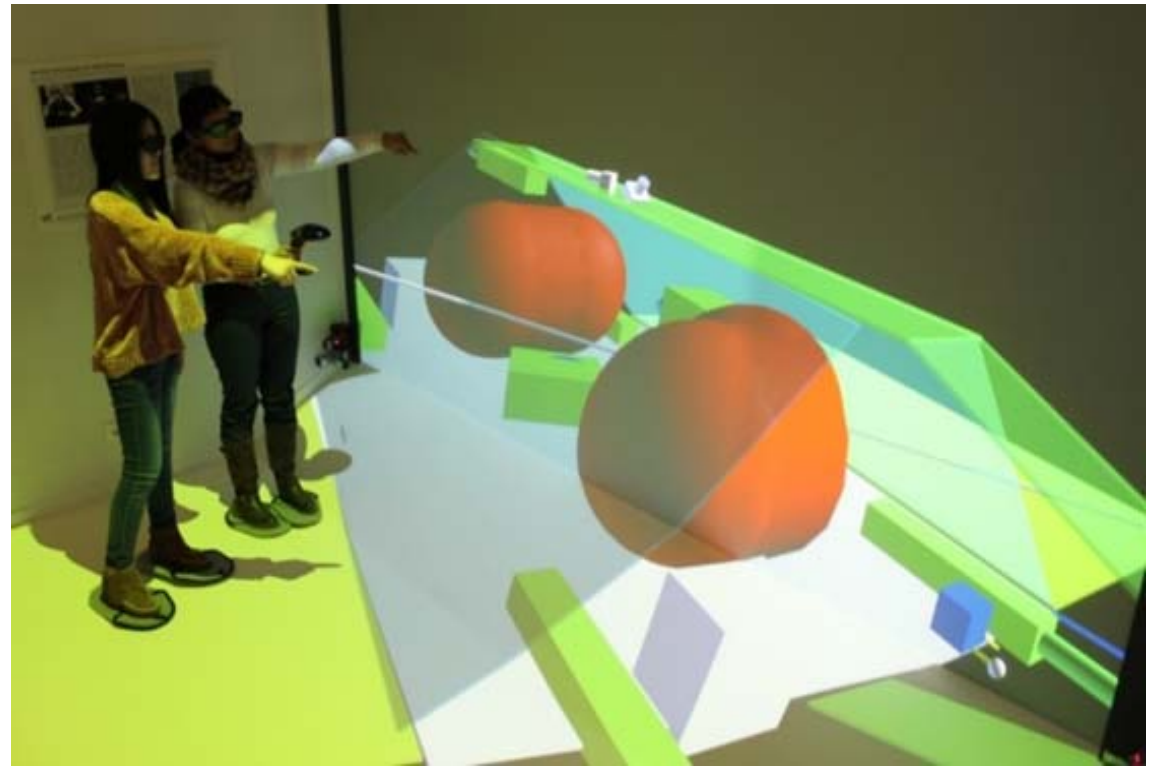- Not comparison within versions
    - For one version
    - Different color according to parameter value

- Key performance indicator, important parameter
    - Mass, Power consumption, Temperature

- Parameter value distribution of each equipment
    - Overview perception
    - No need to create table of distribution of subsystems
    - No need to check textual data

- Remind of equipment without parameter

| 3 | 3.9 | 4.8 | 5.7 | 6.6 | 7.5 | 8.4 | 9.3 | 10.2 | 11.1 | 12 |
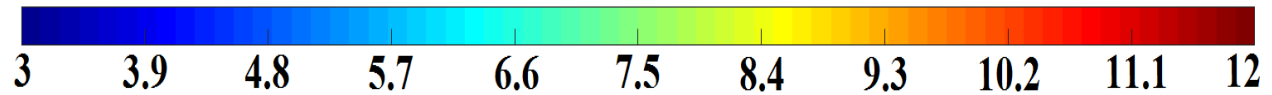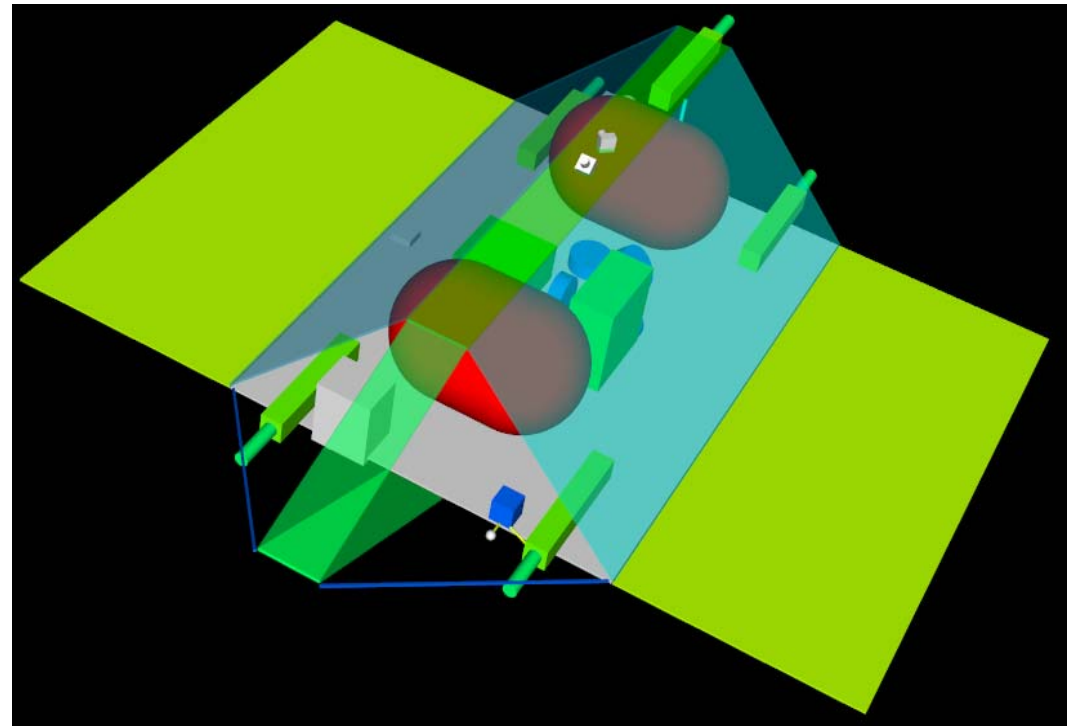
Version Comparison In VR

- VR immersive environments
  - Dynamic
  - First-person viewing perspective
  - Communication in nature way

Summary and Outlook

Version comparison with 3D visualization/VR and Future challenges

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Version comparison with 3D visualization and VR technology

- Intuitive, quick, clear understanding
    - Version Comparison of geometry
    - Animation of design progress
    - Version Comparison of property
    - Color Map of property

- Delta Model
    - Describing differences between versions
    - Easily fused into visualization
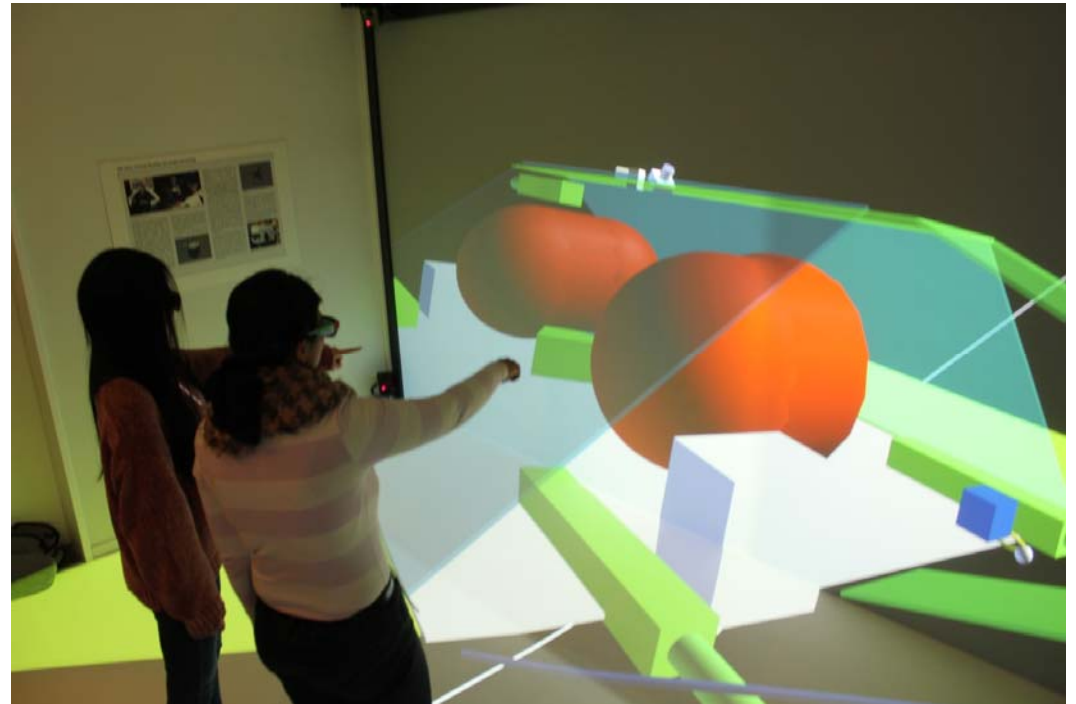
The Future and next steps

- Interaction with model data in VR environment

- Combination of emerging trends
  - Microsoft HoloLens

- Later projects phases
  - Assembly Integration and Test (AIT)

End of Presentation

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