JSatOrb: Simplified Mission Analysis REST-based Tool Dedicated to Education and Training

Thibault Gateau, Lucien Senaneuch, Patrice Labeledan

2019 May 23
JSatOrb

Simulation_1

File
Display
Simulation
Analysis
Tools

New
Open
Save
Quit

Start: 10/31/2010 14:27:16
Current: 10/31/2010 16:57:16

Pipe

Ephemeris
Maneuvers
RF Links

Coverage
Access
Attitude

Data Conversion
TLE Format

Position/Access

Latitude: -12.31°
Longitude: -48.15°
Altitude: 8492.29

Current Date: 10/31/2010 15:20:48

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Orekit Day 2019 - Darmstadt
Memories Orekit Day 2017: conclusion on JSatorb Project

Nowadays academics requirements

- Open-Source
- Cross-platform
- Standardized

Next steps - Take home Message

- Still cover **teachings** requirements
- Still allow customization for **research**
- Required software suite for a whole nanosatellite project
  - Mission analysis
  - Simulation
  - Operation
- Intercompatibility - Input/Outputs Standardization
ISAE-SUPAERO: Teaching Space Stuff

Teaching support

- Space Mechanics
- Mission Analysis
- Thermal Architecture
- Space Telecom
- Power system
- ADCS
- Launchers
- Project Management

...
ISAE-SUPAERO: Doing Space Stuff

Research & Support
- Engineering Projects
- Research Projects

Facilities
- UHF/VHF antenna/station
- S-Band antenna/station
- Control Center
- Clean Rooms ...
Examples of 3U Nanosats projects on the way

- Entrysat
- Phase D
- Currently in the ISS
- Eyesat
- Phase D
- Nimph
- Phase C
Examples of software developments

- **Satorb Mission Analysis**
  - Used for teaching purpose

- **SCC Simple Control Center Operations Management**

- **NSS Nanostar Software Suite Full Mission Pre-design**
### NANOSTAR Consortium

- 7 Partners (Portugal, Spain, France)
- 2 aerospace clusters
- 2018-2020, 2 millions € budget
NANOSTAR Goal

- Provide relevant training on nanosat technology
- To provide a formation tool for students... and also engineers
- To support the emergence of nanosat environment
NANOSTAR work plan

- Setup a **collaborative platform**, with adapted software tools
- Setup geographically distant **Concurrent Design Facilities**
- Propose **student challenges** relevant for nanosats missions
CDF: Concurrent Design Facility
CDF: Concurrent Design Facility
Mission Analysis

- GMAT
- Orekit
- Poliastro
- Celestlab
- Satorb
- RTK
- SimuCIC
Mission Analysis

- GMAT
- Orekit
- Poliastro
- Celestlab
- Satorb
- RTK
- SimuClC

ADCS

- Simulink
- Basile
ISAE-SUP AERO Software Legacy
JSatorb: short evolution story
Conclusion & Questions

ISAE-SUP AERO: Teaching Space Stuff
ISAE-SUP AERO: Doing Space Stuff
Nanostar SUDOE Project

Mission Analysis
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- Orekit
- Poliastro
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- Satorb
- RTK
- SimuClC

ADCS
- Simulink
- Basile

Structure
- Catia
- Sketchup
- Blender
### Mission Analysis
- GMAT
- Orekit
- Poliastro
- Celestlab
- Satorb
- RTK
- SimuClC

### Structure
- Catia
- Sketchup
- Blender

### Mass Budget
- Excel
- IDM-CIC

### ADCS
- Simulink
- Basile
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ISAE-SUP AERO Software Legacy
JSato rb: short evolution story
Conclusion & Questions

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Visualisation
- Celestia
- VTS
- IDM view

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Nanostar Software Suite (One soft suite to bind them all)
Mission Analysis Module: JSatorb interface
Mission Analysis Module: JSatorb interface

Related works

- STAVOR (mobile)
  https://www.orekit.org/stavor/

- Dromobil (HTML5, CSS, WebGL, js)
  www.hayabusa.isas.jaxa.jp/kawalab/dromobile/

- Cesium
  https://cesiumjs.org/

- Orbitalpredictor (Cesium)
  http://www.orbitalpredictor.com/
Mission Analysis Module: JSatorb interface

Related works

- **STAVOR (mobile)**
  [https://www.orekit.org/stavor/](https://www.orekit.org/stavor/)

- **Dromobil (HTML5, CSS, WebGL, js)**

- **Cesium**
  [https://cesiumjs.org/](https://cesiumjs.org/)

- **Orbitalpredictor (Cesium)**

**YAVISO** - Yet Another Visualization Interface for Spacecrafts Orbits
1. **ISAE-SUPAERO Software Legacy**
   - Satorb
   - Current Statement

2. **JSatorb: short evolution story**
   - JSatorb: Increasing Modularity
   - Full Java Solution
   - JSatorb: Service Oriented Architecture

3. **Conclusion & Questions**
1. ISAE-SUPAERO Software Legacy
   - Satorb
   - Current Statement

2. JSatorb: short evolution story

3. Conclusion & Questions
ISAE-SUPAERO Space Software Suite

People involved

- Initiator (before 2001!):
  - Christian Colongo
- Current Dev Team:
  - Patrice Labedan
    - Guillaume Garrouste
    - Thibault Gateau
- Lot of support from:
  - Students Projects
  - Internships
  - PhD students
  - Collaborations (TUM)
Satorb

Current Statement

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Orekit Day 2019 - Darmstadt

17 / 35
Satorb & Friends

Features: creating objects and links

- Satellites;
- Some satellites specs;
- Constellations;
- Ground stations;
- Upward, downward links;
- Inter-satellite links;
Features: Obtaining reports

- Ground trace;
- 3D Orbital position;
- Evolution of the created elements;
- Coverage maps;
- Link budgets.
Kerbal Space Program before Kerbal Space Program...
ISAE-SUPAERO Software Legacy

**Pros: Homemade**
- Fit exactly to ISAE-SUPAERO needs
- Adapt what we want
- No intellectual property issue
- Short dev cycles

**Cons: Homemade**
- Not open-source, no community behind
- Costful for internal developers
- Not cross platform
- Validation by hand
1 ISAE-SUPAERO Software Legacy

2 JSatorb: short evolution story
   - JSatorb: Increasing Modularity
   - Full Java Solution
   - JSatorb: Service Oriented Architecture

3 Conclusion & Questions
Satorb: VBnet Heavy Client (evol. from vb6)
Create the germ of JSatOrb, a version of SatOrb in Java

Student-focused learning tool
Professional software for researchers

Implement a clear division in the coding

Calculations
User interface
Choosing an Astrodynamics Library

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From Satorb...

... To JSatorb
Feedback

Some objective reached...

- Increase modularity
- Cross Platform
Feedback

Some objective reached...
- Increase modularity
- Cross Platform

But...
- Still a heavy client
- UI and domain specific code still dependent
- Standardized?
JSatorb: Service Oriented Architecture

Front-end

Back-end

«Web Browser»
User Interface

«Component»
Facade / Gateway

«Component»
Coverage

«Component»
Visibility

«Component»
Propagation

«Component»
TLE

Text
JSatorb: Typical Use Case Scenario

User throw his UI → Gateway

- Add a satellite with orbit
- Display ephemeris

Gateway → Propagator Services

- Calculation ephemeris request
- Ephemeris Response

Gateway → Visibility Services

- Visibility calculations request
- Visibility response

Gateway → Coverage Service

- Coverage calculation request
- Coverage response

Gateway → Other Services

Other Services: Visibility Services, Coverage Service, Other Services

Display visibiltiy

Coverage Map Windows

Display Coverage map
JSatOrb: Angular UI (Theo Koudlanski)
JSatorb: Cesium JS and RESTfull API (Lucien Senaneuch)
JSatorb: Cesium JS and RESTfull API (Lucien Senaneuch)
JSatorb: Demo (Lucien Senaneuch)

Small Video
1 ISAE-SUPAERO Software Legacy

2 JSatorb: short evolution story

3 Conclusion & Questions
Nowadays academics requirements

- Open-Source
- Cross-platform
- Standardized

Take home Message

- Still cover *teachings* requirements
- Still allow customization for *research*
- Intercompatibility - Input/Outputs Standardization
- Open-Source under AGPL licence

(https://sourceforge.isae.fr/projects/jsatorb/repository)
Thank you for your attention!

Any question?