

Introduction to the GMAT Project

GMAT Fundamentals
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Presentation Overview

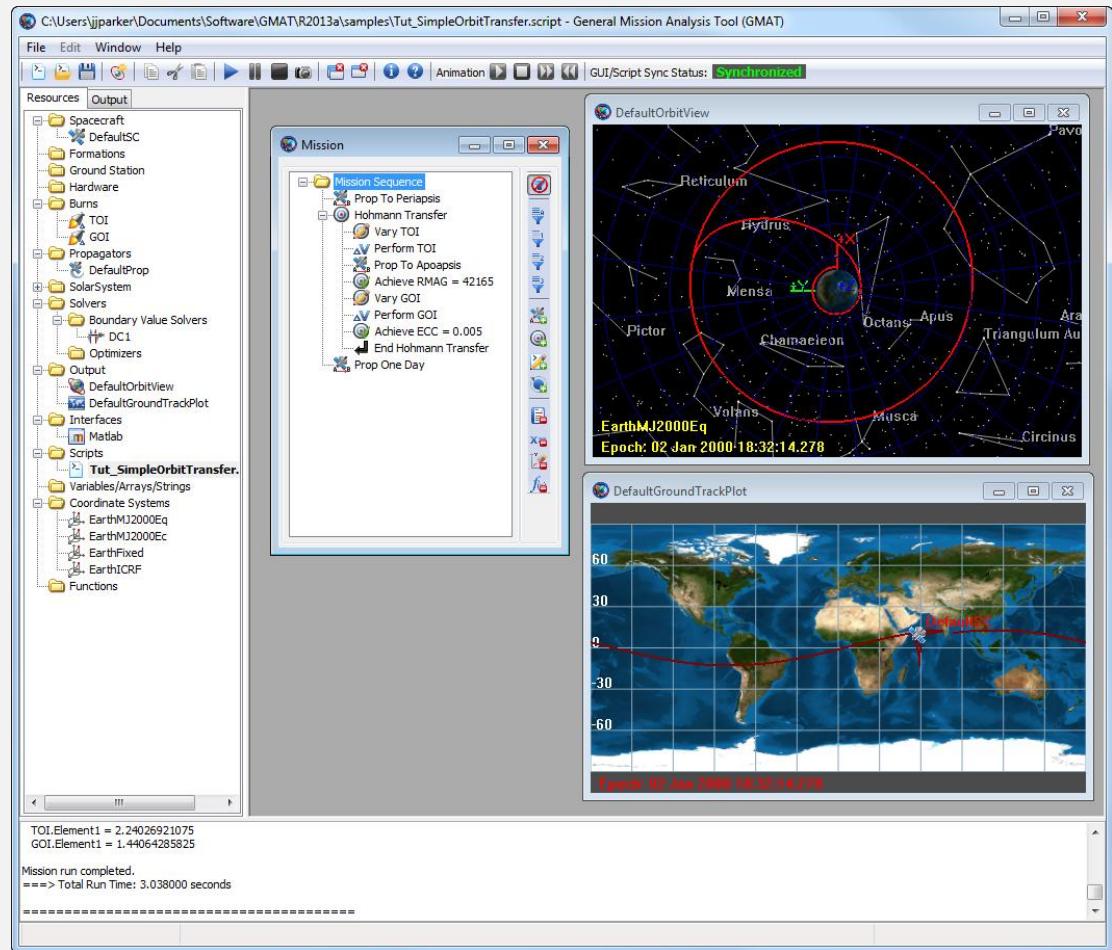
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What is GMAT?

GMAT is a general mission design and analysis tool.

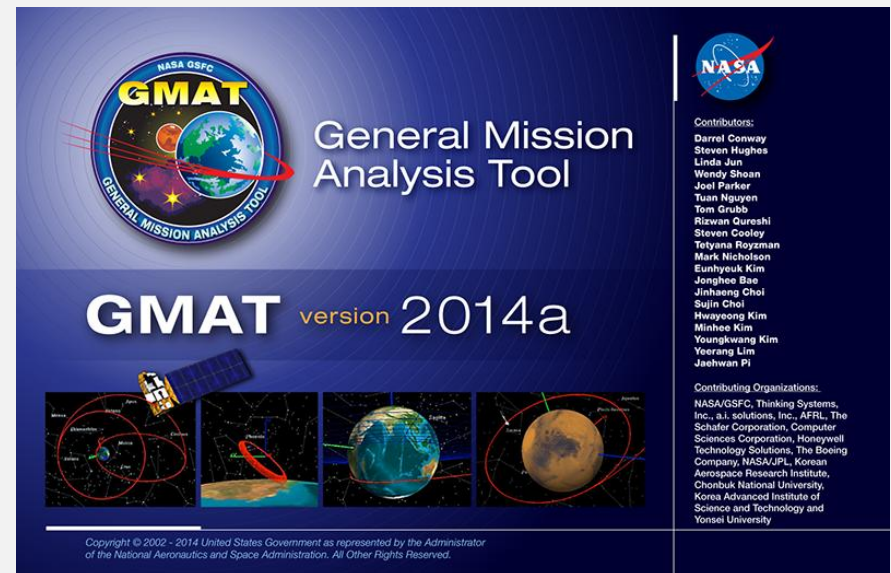
Key characteristics:

- open source
- high fidelity
- feature rich
- publicly developed
- desktop oriented



System Overview

- Applications
 - Mission analysis/optimization
 - All orbital regimes
- Comparable to
 - AGI STK/Astrogator
 - A.I. Solutions FreeFlyer
- Functionality
 - Full-featured GUI
 - Custom script infrastructure
 - Cross-platform core
 - Precision orbit propagation
 - Built-in targeting & optimization
- Status: Fully tested and certified for operational use



Key Features

Basic Models

Spacecraft model	<ul style="list-style-type: none">• Orbit state• Kinematic attitude• Mass properties• Viz properties• Attached hardware
Solar system	<ul style="list-style-type: none">• User-defined bodies• Libration points• Barycenters• SPK & DE ephemerides
Coordinate systems	<ul style="list-style-type: none">• Inertial• Body-fixed• Relative• Rotating

Propagation

Numerical integrators	<ul style="list-style-type: none">• Runge-Kutta (several)• Prince-Dormand (several)• Adams-Bashforth-Moulton• Prince-Dormand
Force models	<ul style="list-style-type: none">• Third-body point-mass gravity• Central-body non-spherical gravity• Atmospheric drag• Solar radiation pressure• Earth tides• Relativistic corrections
SPK ephemeris propagator	

Key Features

Powered Flight

Fuel tank w/ mass depletion

Thruster model

Impulsive burn

Finite burn

Solvers

Targeting w/ differential correction

- | | |
|--------------|--|
| Optimization | <ul style="list-style-type: none">• VF13 optimizer• Interface to MATLAB fmincon optimizer• Nonlinear constraints |
|--------------|--|

Programming Infrastructure

User-defined variables

- Numeric
- Array
- String

Control flow

- If/Else
- While
- For

External interfaces

- Call MATLAB functions

Built-in math

Calculated parameters

Project History

- 2001: Requirements gathering
- 2002: Architectural design
- 2003: Implementation of system core
- *...feature development...*
- 2010: Decision to prepare for operational use
- *...feature development...*
- 2013: First production release (R2013a)
- 2013: Operationally certified (ACE mission)
- Public releases:
 - 2007-08-23
 - 2007-12-10
 - 2008-09-30
 - R2011a (April 2011)
 - R2012a (May 2012)
 - R2013a (April 2013)
 - R2013b (Aug. 2013)
 - R2014a (May 2014)

Participants/Contributors/Users

- Government
 - NASA Goddard
 - AFRL
 - JPL
 - ESA
 - KARI
- Industry
 - Thinking Systems, Inc.
 - Schafer Corporation
 - a.i. solutions
 - Numerica
 - Boeing
 - CSC
 - Honeywell
 - Decisive Analytics Corporation
- GSFC Flight Projects
 - LCROSS (backup tool)
 - ARTEMIS
 - LRO
 - OSIRIS
 - MMS
 - ACE
 - MAVEN
 - TESS (primary)
 - Future mission studies
- R2014a public release: ~850 downloads/mo.
- >30 published papers using GMAT results

Development Metrics

- 14 active team members
 - 6 engineers (GSFC Code 595, A.I. Solutions)
 - 7 developers (Code 582/583, Thinking Systems)
 - 1 tester (A.I. Solutions)
- 450k lines of C++ code
- 12k public commits
- 11k automated script tests
- 4k automated GUI tests
- Nightly automated build/test process

Recent Activities

- GMAT R2013a
 - First production (non-beta) release
 - Focused entirely on QA and documentation
 - Very few new features—but many improved
 - New support for ICRF coordinate systems
- GMAT R2013b (internal)
 - First operationally-certified release
 - Focused on ACE mission requirements
 - Initial state file reader
 - Binary-format ephemeris generator
- GMAT R2014a
 - New aligned-constrained coordinate system
 - New parameter types
- GMAT R2014a
 - Public release of all R2013b features
 - New KARI-developed features
 - State representations
 - Attitude models
 - Customizable orbit segment colors
 - Mars-GRAM 2005 atmosphere model
 - LHS parameter dependencies
 - New solver algorithms

Near-Term Activities

- Large-scale features
 - Event location utility (w/ KARI)
 - GMAT functions
 - Low-thrust development (w/ KARI)
- Mission-specific development
 - TESS
 - MAVEN
 - JWST
- Navigation subsystem revitalization

Project Resources

- Homepage & Wiki:
<http://gmatcentral.org/>
- User Forums:
<http://forums.gmatcentral.org/>
- Documentation:
<http://gmat.sf.net/docs>
- Issue tracker:
<http://bugs.gmatcentral.org/>

Getting Involved

Easier

- Community support (forums, lists)
- Submit bugs, feature requests to JIRA
- Improve documentation
- Fix bugs, contribute to “starter” feature requests
- Contribute to new features

Harder