



# Interstellar Highway

OEC Programming 2026



# Meet Our Team

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## Problem Overview

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- Golden Age of Space Commerce requires safe, efficient, scalable trade routes
- Merchants need optimal launch dates and trajectories across planets and stations
- **Goal:** To build a smart logistics platform that ranks routes by fuel efficiency and arrival time



# User Inputs & Outputs

## User Inputs

- Departure body (planet/station)
- Destination body
- Launch window (start–end date)
- Ship type
- Payload mass

## System Outputs

- Two ranked routes: Most Fuel-Efficient Flight, Soonest Arrival Flight
- Full leg-by-leg data: launch, stops, refuel, arrival
- Graphical visualization of flight paths
- JSON output via CLI

A futuristic spacecraft, possibly a spaceplane, is shown in orbit against the backdrop of Earth and space. The spacecraft is white with dark grey accents. It features the word 'TENACITY' on its side, the designation 'DC-101' near the nose, and the 'SIERRA SPACE' logo with a small American flag. The background shows the curvature of the Earth and the starry void of space.

# Fleet Overview

- Seven ship classes with unique tradeoffs
- Parameters used in planning:
  - Dry mass
  - Fuel capacity
  - Specific impulse (km/s equivalent)
  - Maximum payload

Different ships produce **different optimal routes** for the same trade request

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# Core Assumptions & Constraints

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- All major bodies (8 planets + Pluto + Ceres) have refueling stations
- Stations are located at 12-hour circular parking orbits
- Launches and arrivals always occur at station orbit
- Refueling time: 1 second per kg of fuel
- Must relaunch within 3 days after refueling
- Delta-V is measured as fuel expenditure, not velocity change

# Orbital Mechanics Model

- Heliocentric (Sun-centered) motion for interplanetary transfers
- Planetary motion retrieved from orbital data (ephemeris)
- Transfers computed using patched conics approximation
- Sphere of influence:  $r = a\left(\frac{m}{M}\right)^{2/5}$
- Instantaneous delta-V burns assumed
- Vectors expressed in solar system ecliptic frame



# Route Planning Strategy

## Step 1

### Candidate Route Generation

- Direct routes
- One-stop and two-stop routes using refueling bodies
- Stops limited to control complexity

## Step 2

### Launch Window Scanning

- Departure times sampled within user window
- Each candidate evaluated for feasibility

## Step 3

### Physics & Constraints Check

- Fuel feasibility based on ship + payload
- Refueling availability and timing
- 3-day relaunch constraint enforced

# Optimization Objective



## Fuel-Efficient Route

Minimize total fuel usage across all legs  
Includes launch, capture, and relaunch burns



## Soonest Arrival Route

Minimize final arrival date  
Subject to fuel and refuelling constraints  
If no valid solution exists → **Flight Impossible**

# Equations

$$R_{fuel} = \sqrt[3]{\mu_{planet} \cdot \left(\frac{T}{2\pi}\right)^2}$$

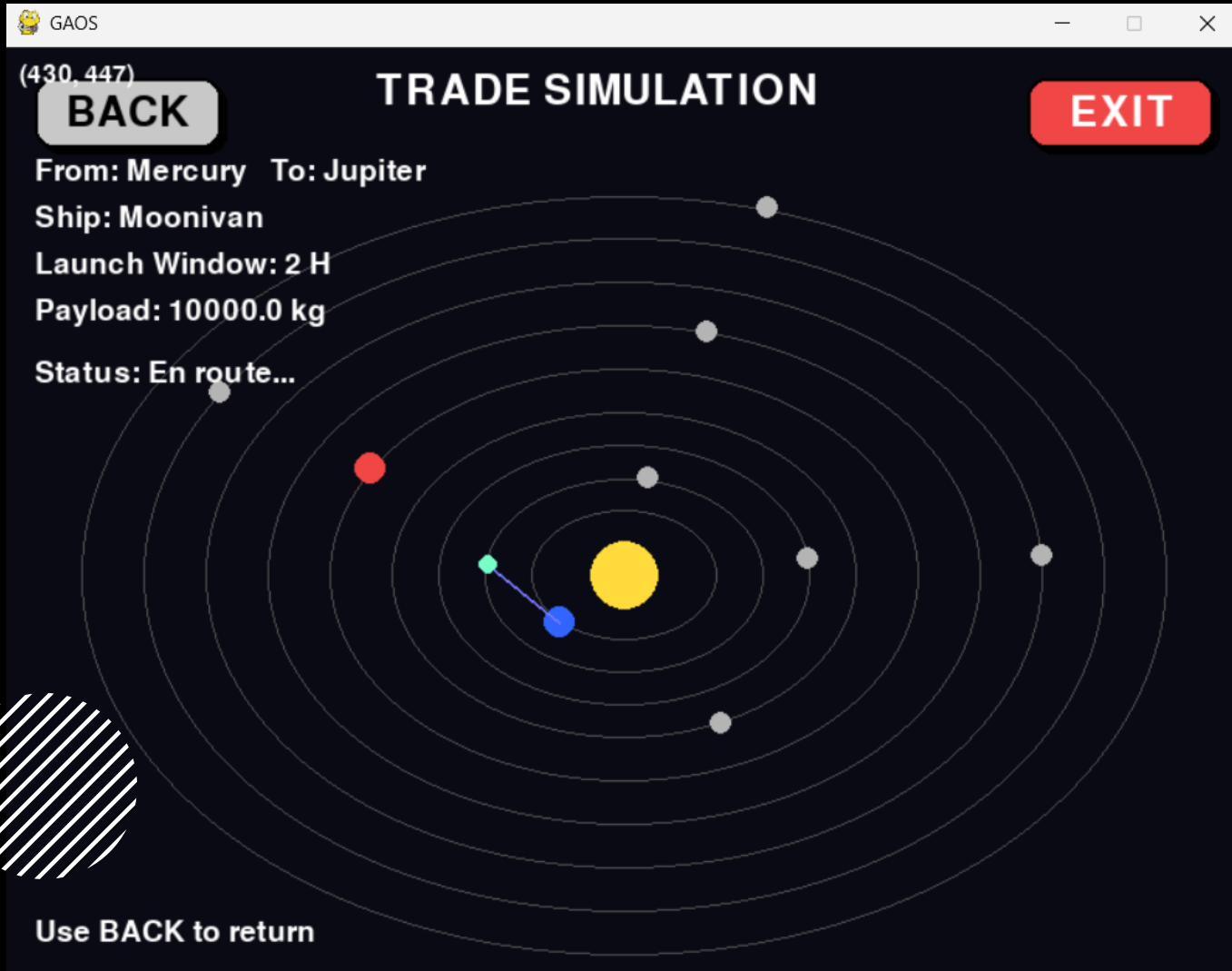
$$v_{park} = \sqrt{\frac{\mu_{planet}}{R_{fuel}}}$$

- This calculates the distance ( $R_{fuel}$ ) and the constant velocity ( $v_{park}$ ) of the refueling station before the ship accelerates toward its destination.

$$\Delta v_{launch} = \sqrt{|iV1|^2 + 2\frac{\mu}{r_{park}}} - v_{park}$$

- This represents the actual "kick" your engines must provide to transition from a stable parking orbit into a hyperbolic escape trajectory toward the next planet.

# OUR SOLUTION



GAOS

(500, 400)

## TAKE OFF THE TRADES

**BACK** **EXIT**

Departure Location:

Destination:

Launch Window:

Ship selection:

Payload Mass:

**LAUNCH**



# Conclusion

- Platform enables reliable interplanetary trade
- Balances realism with computational efficiency
- Scalable foundation for future space commerce
- **The ultimate spacefaring trade assistant**