Jet Propulsion Laboratory
California Institute of Technology

DSENDS Simulation of Mars 2020 Entry, Descent, and Landing

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Overview

- Motivation: Why are we making this simulation?
  - Simulation is the only end-to-end representation of EDL other than actual EDL. We can't test end-to-end EDL
  - EDL will have more than one complete end-to-end simulation (Mars program requirement)
    - POST 2 (LaRC) provides official project performance results for Mars 2020
    - DSENDS is used for targeting and independent V&V of POST
- Agenda
  - Overview of DSENDS
  - Overview of Mars 2020 EDL and models required
  - Details of model integration and checkout

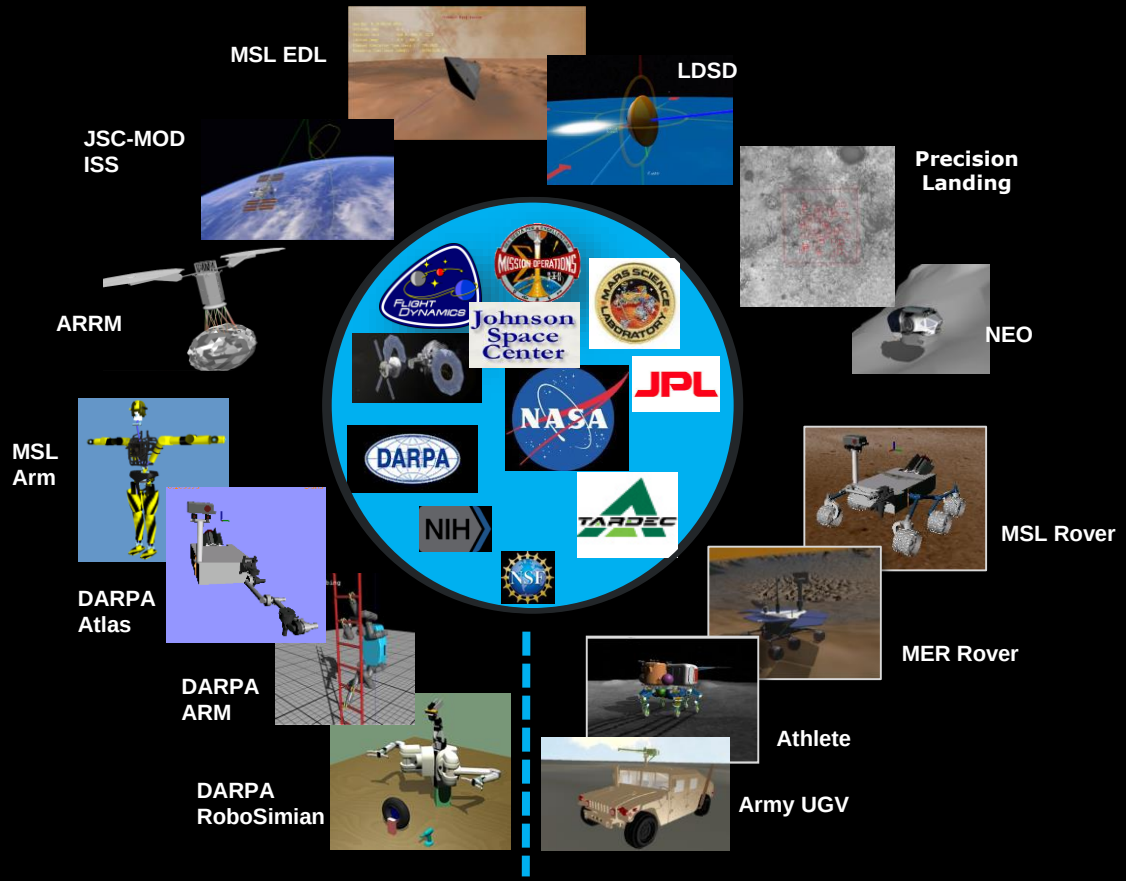
What is DSENDS?

A ***deployment*** of the DARTS Lab's DARTS/Dshell multi-mission simulation toolkit

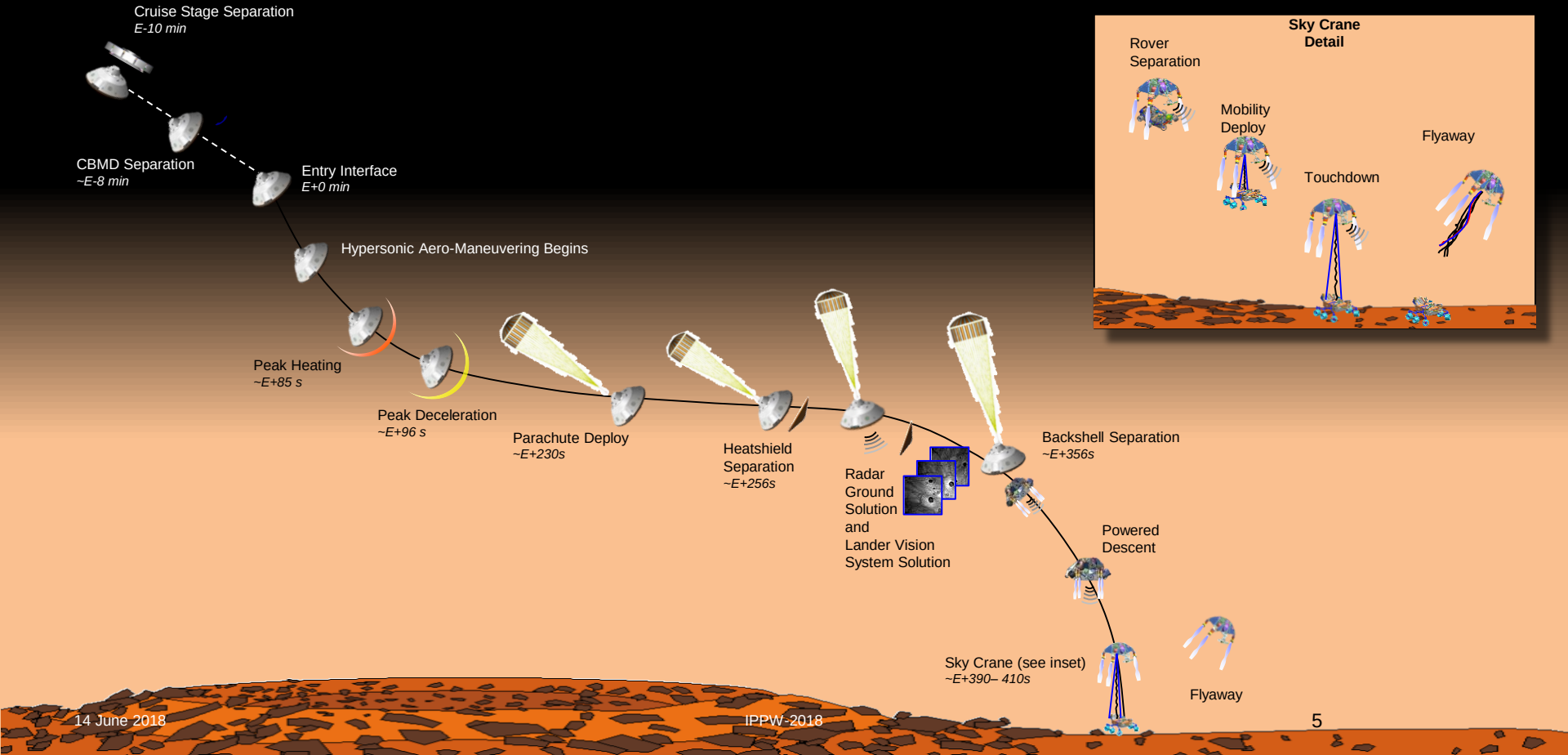
- A high-fidelity, physics-based flight-dynamics system simulation tool in use for EDL (e.g. M2020) and Proximity Operations (e.g. Comet).
- Simulates the multi-body spacecraft's position, attitude, articulation and body flexibility states and the interactions with gravity, atmospheres, terrain, and on-board s/c devices in response to onboard flight-software directed sensing and control actions.
- DSENDS is used for end-to-end simulation and performance evaluation for flight missions, proposal development, internal R&D efforts, mission studies, algorithm & real-time testbeds, EDL targeting and mission operations.

DARTS/Dshell Simulation

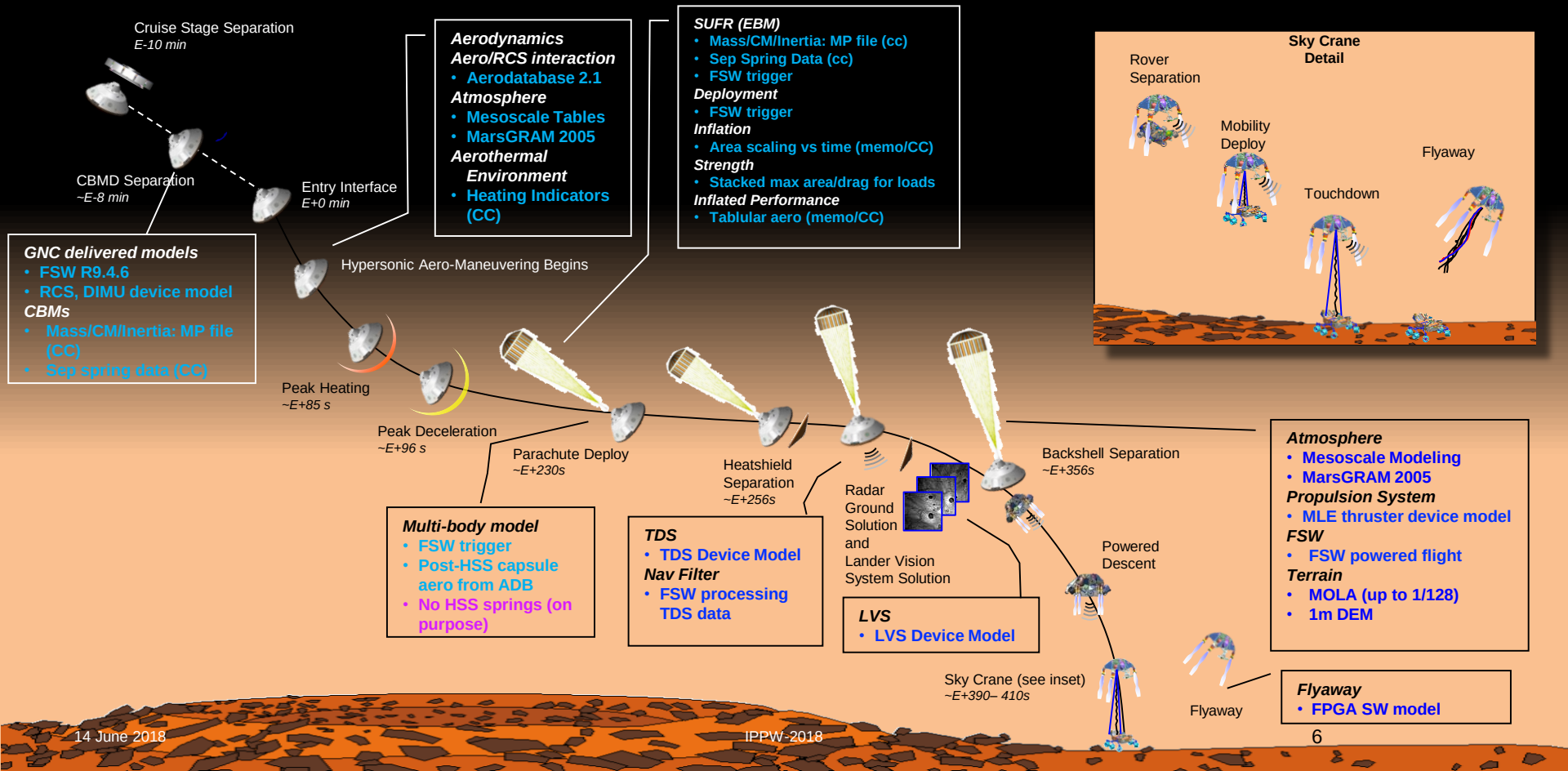
Toolkit Usage



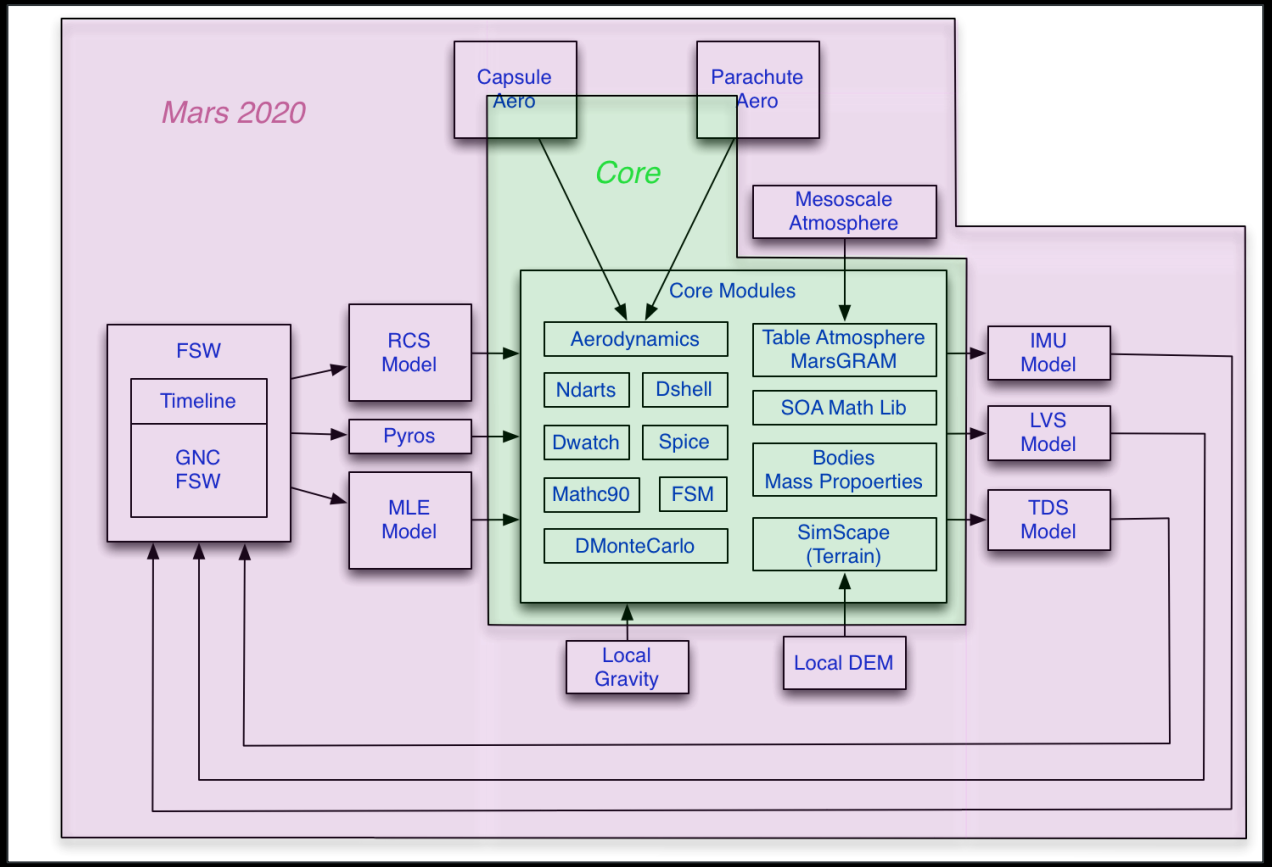
EDL Overview



EDL Overview – Mars 2020 Models



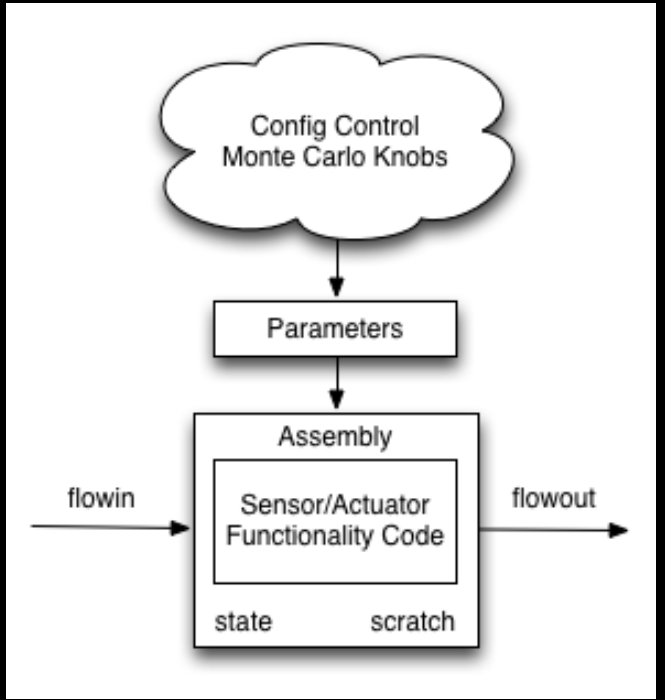
EDL Sim Block Diagram



Interface Functionality

For each module

- Functionality delivered/developed
- Assembly created
  - Parameters: required and/or optional user inputs, handled via parameter class
  - States/scratch: data required external to the module
  - Flowin/flowout: data received from/passed to another module
- Test
  - Parameters properly passed to the assembly
  - Flowin/flowout values passed as expected
  - States and scratch values as expected
  - Setting of parameter values from external source
    - Modified by hand
    - Config control parsing, writing param class
    - Monte Carlo knob evaluation and writing to param class



Model Checkout

Checkout for each model is different

- Environment: Does the model reflect best knowledge?
  - Atmosphere, gravity, terrain – external experts approve model, DSENDS checkout of usage
- Physical spacecraft – data provided and implemented correctly
  - Mass properties, separation springs/ejections, propellant loading/mass properties changes
- Device models – provided a model that is certified against test data, checkout of DSENDS integration
  - Thrusters, IMU, TDS
- FSW: have multiple venues to show it works, prove that we're interfacing with it correctly

Summary

- DSENDS architecture makes the tool well suited to supporting multiple projects and quick turn-around proposals
  - The framework makes adding/removing models to support different tasks quick and simple
- Mars 2020 EDL end-to-end simulation model set required for future analysis in nearing completion of integration and checkout
  - Model checkout demonstrates proper integration and use, assuming the model correctness is addressed elsewhere.
  - Details of checkout vary depending on the model

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