Network Monitor and Control of Disruption-Tolerant Networks

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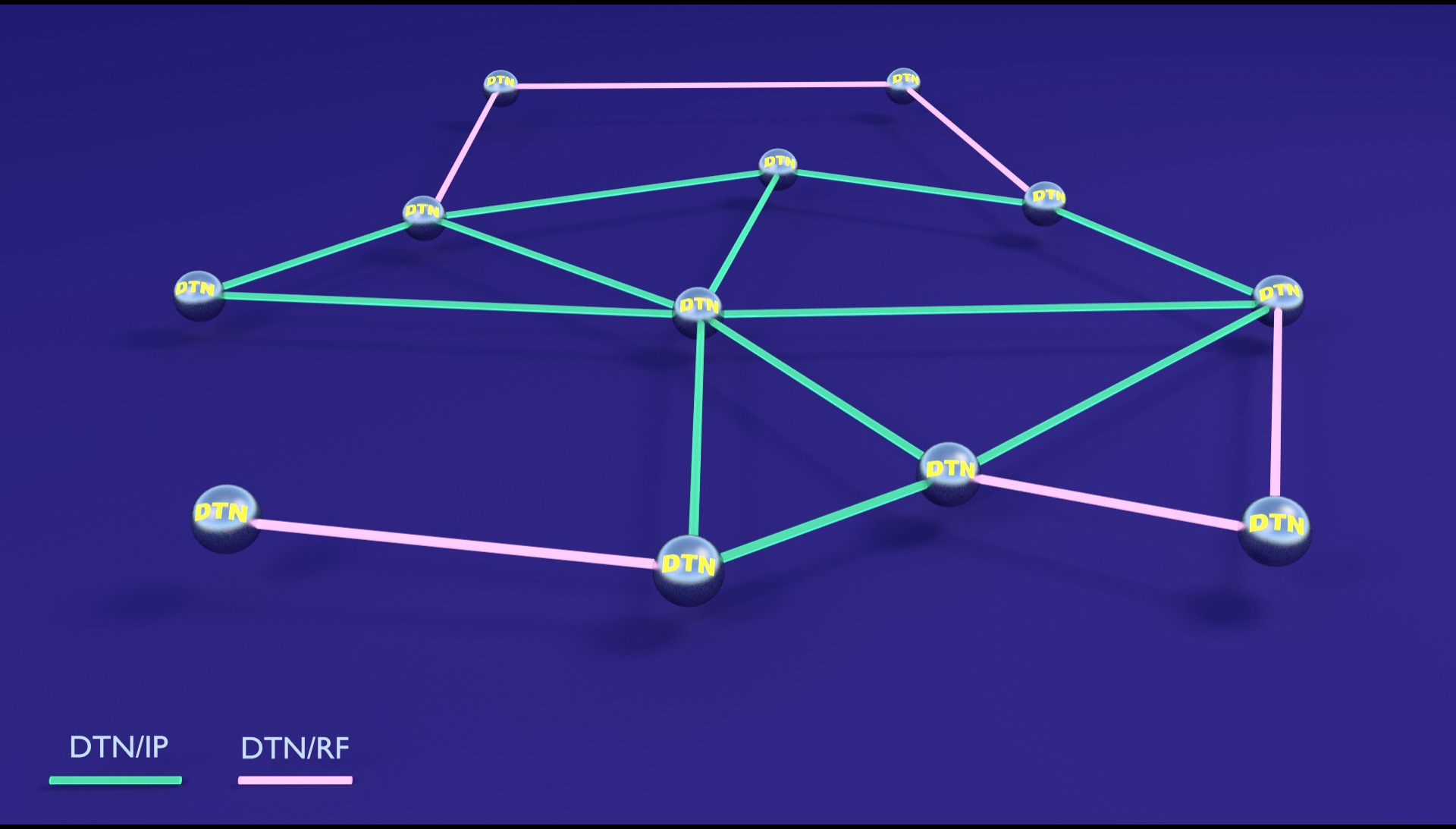
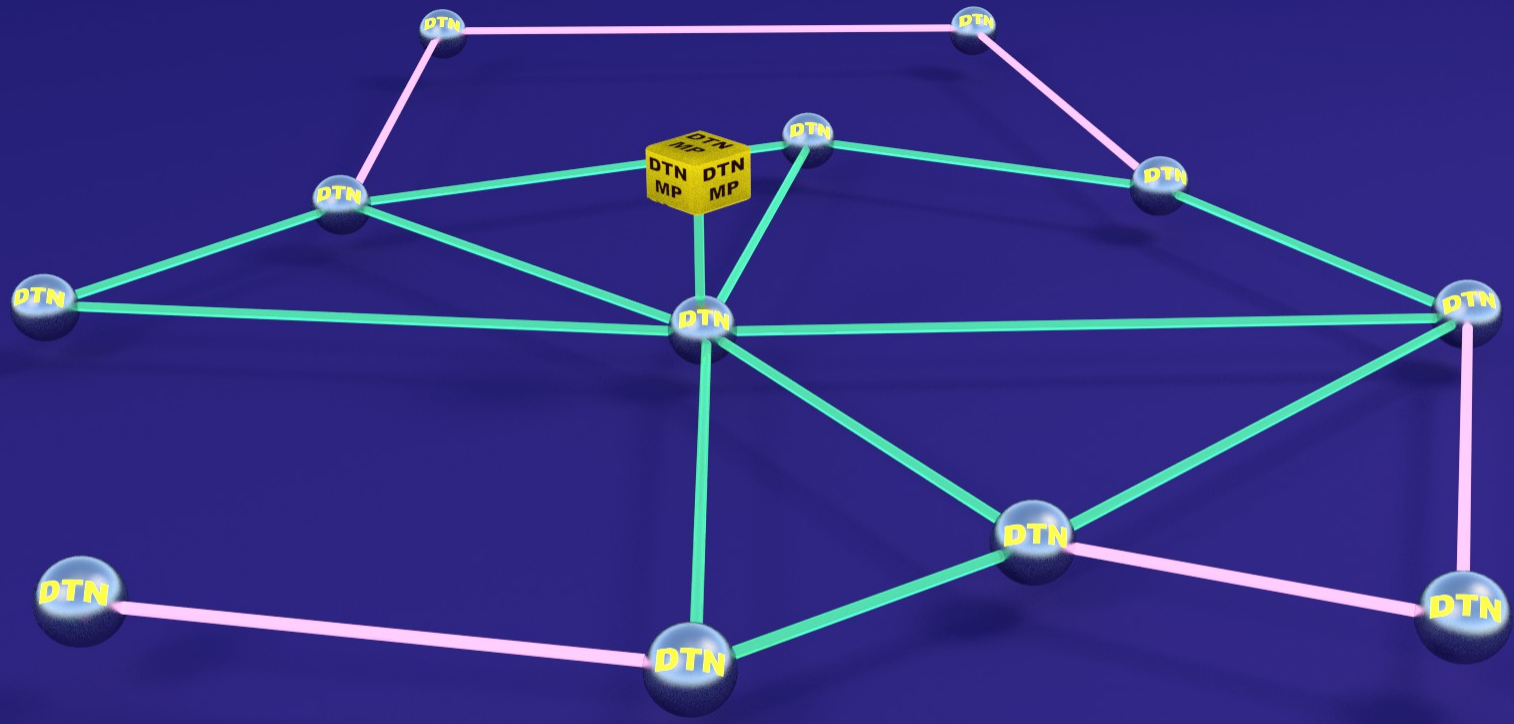
Notional DTN Network



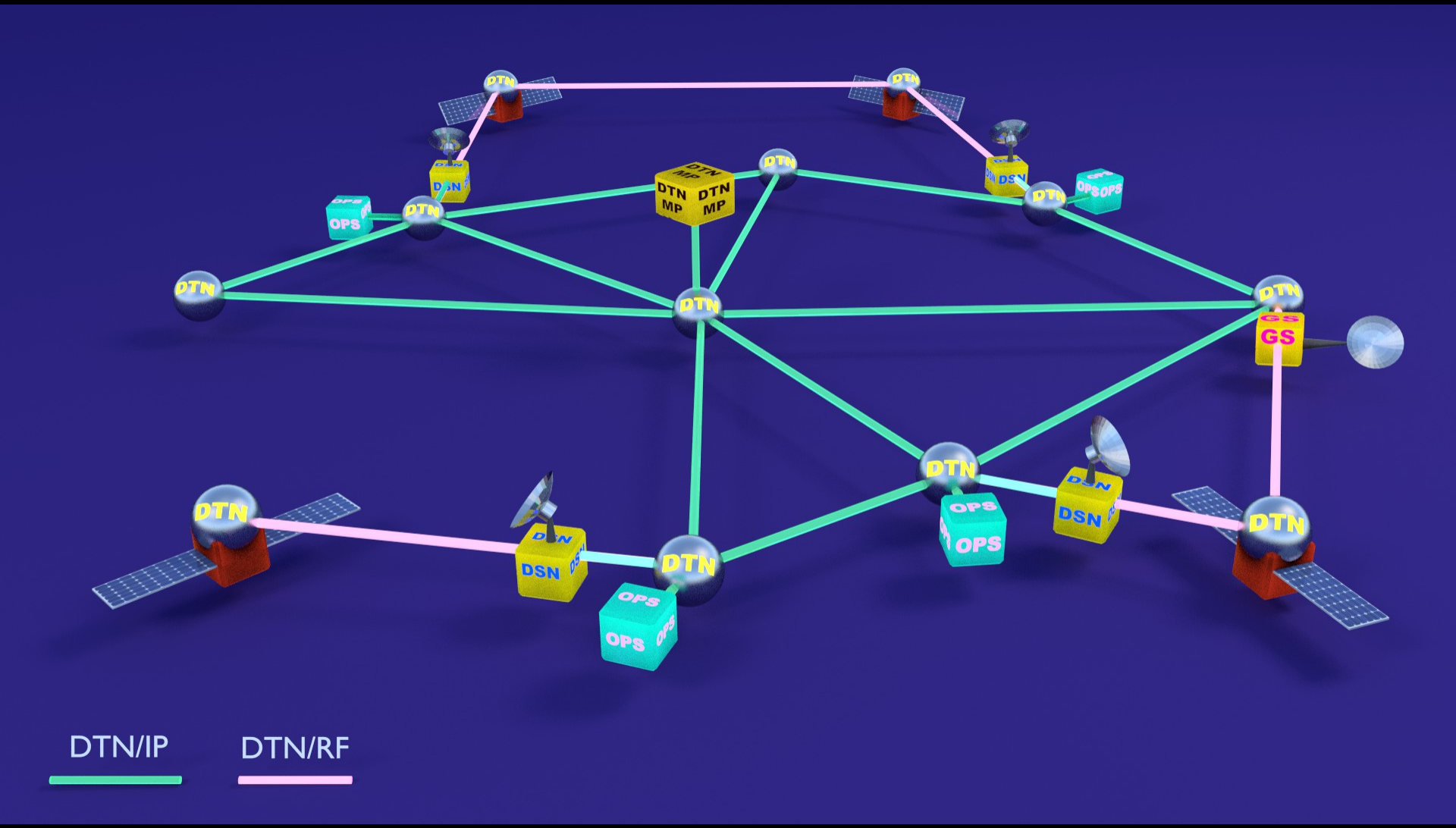
- Example space mission DTN network with terrestrial IP links, and RF links

Network with DTN Management Protocol



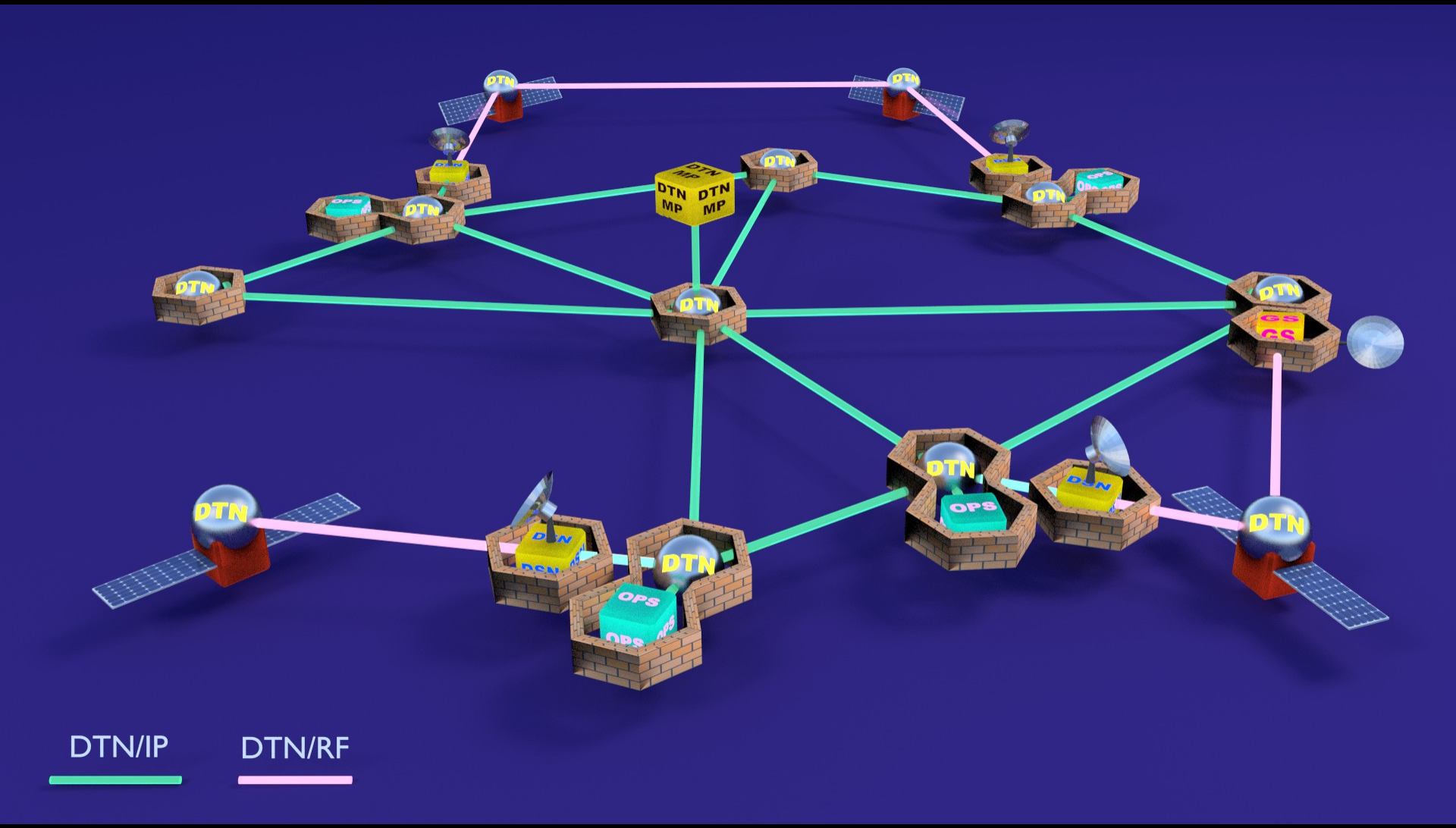
- DTN MP added to an administrative node gives visibility into DTN node states and some measure of control as permitted by the DTN node owner

Additional Elements of a DTN Network



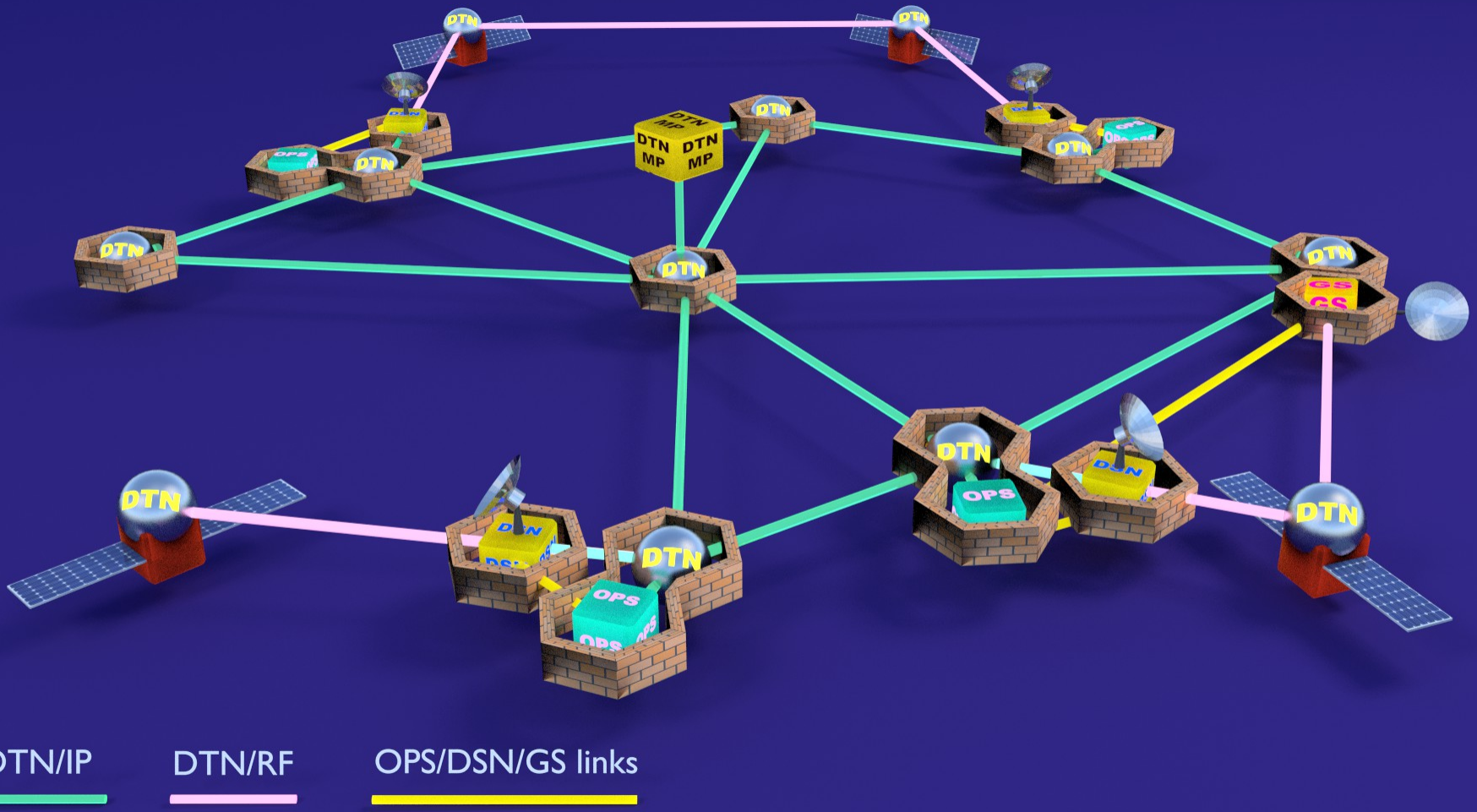
- DTN network have additional link control centers (DSN, SN, GN), as well as mission ops control of individual DTN nodes

Firewalls in a typical DTN Network



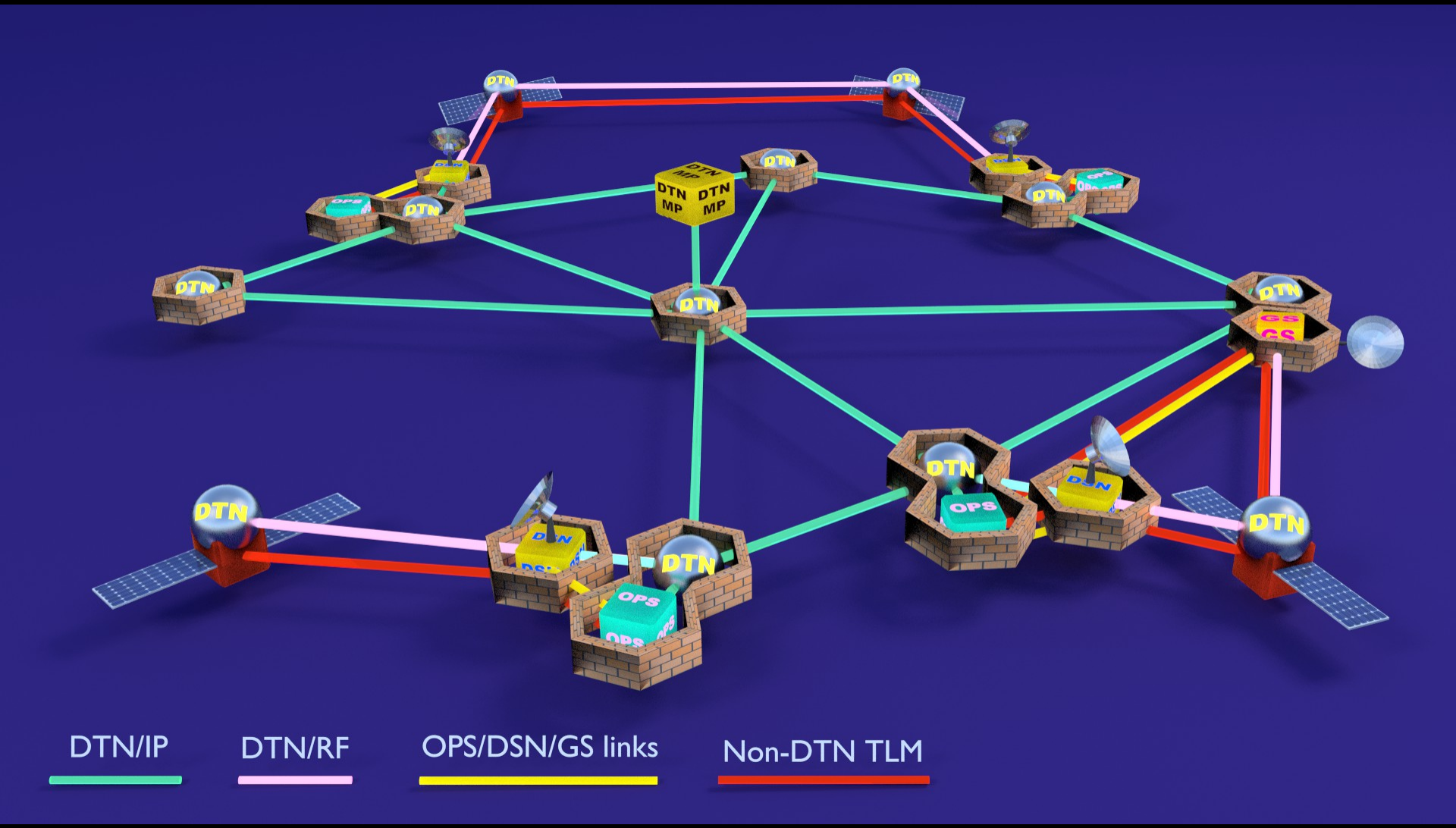
- Any centralized Network Monitor and Control activity also has numerous firewalls and security considerations to deal with

Mission Ops Control of Space Links



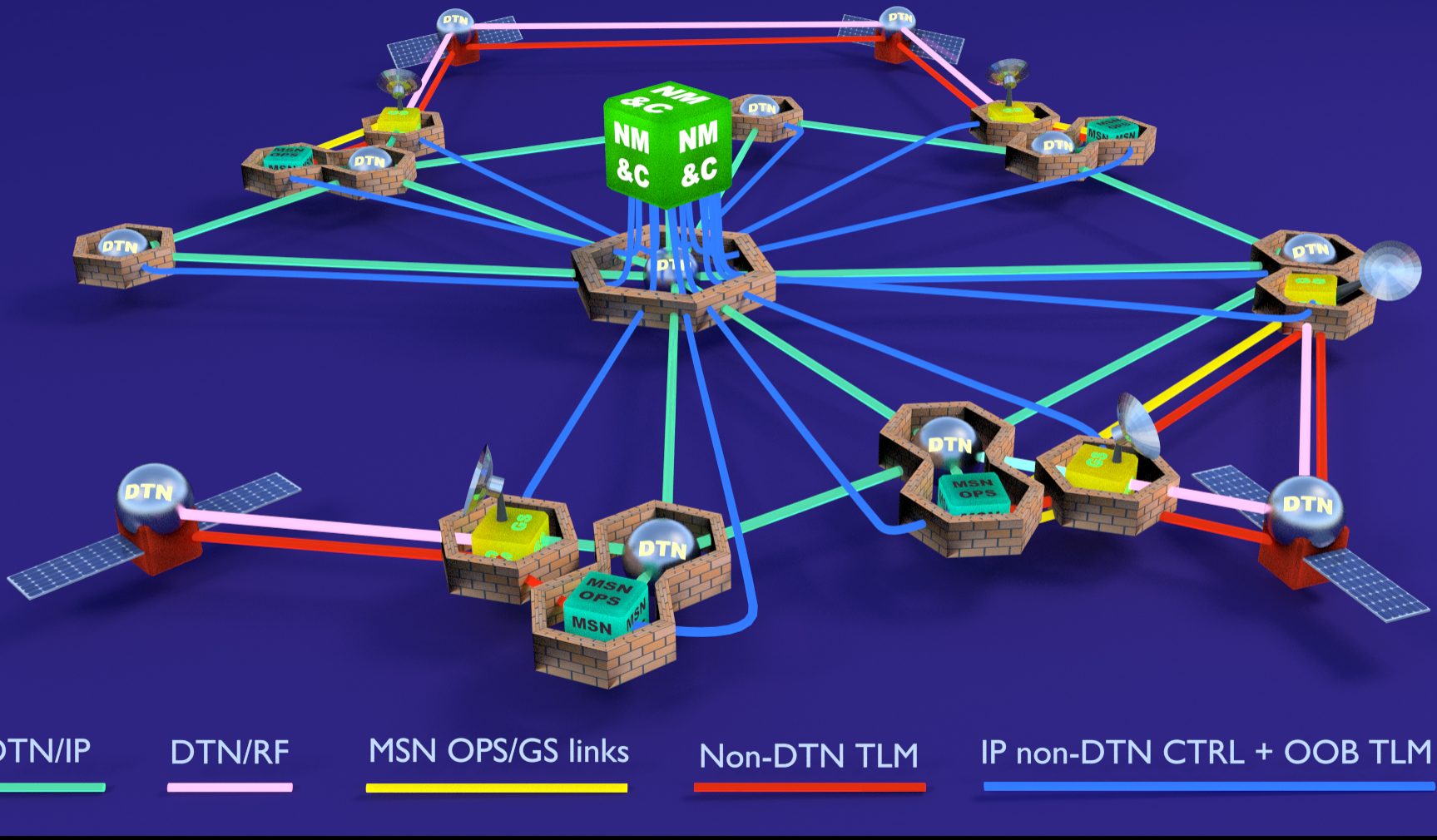
- Depending on the network, mission ops personnel may have control of their individual space link scheduling, as the DTN node may just be an adjunct to the primary mission

Non-DTN Spacecraft Telemetry



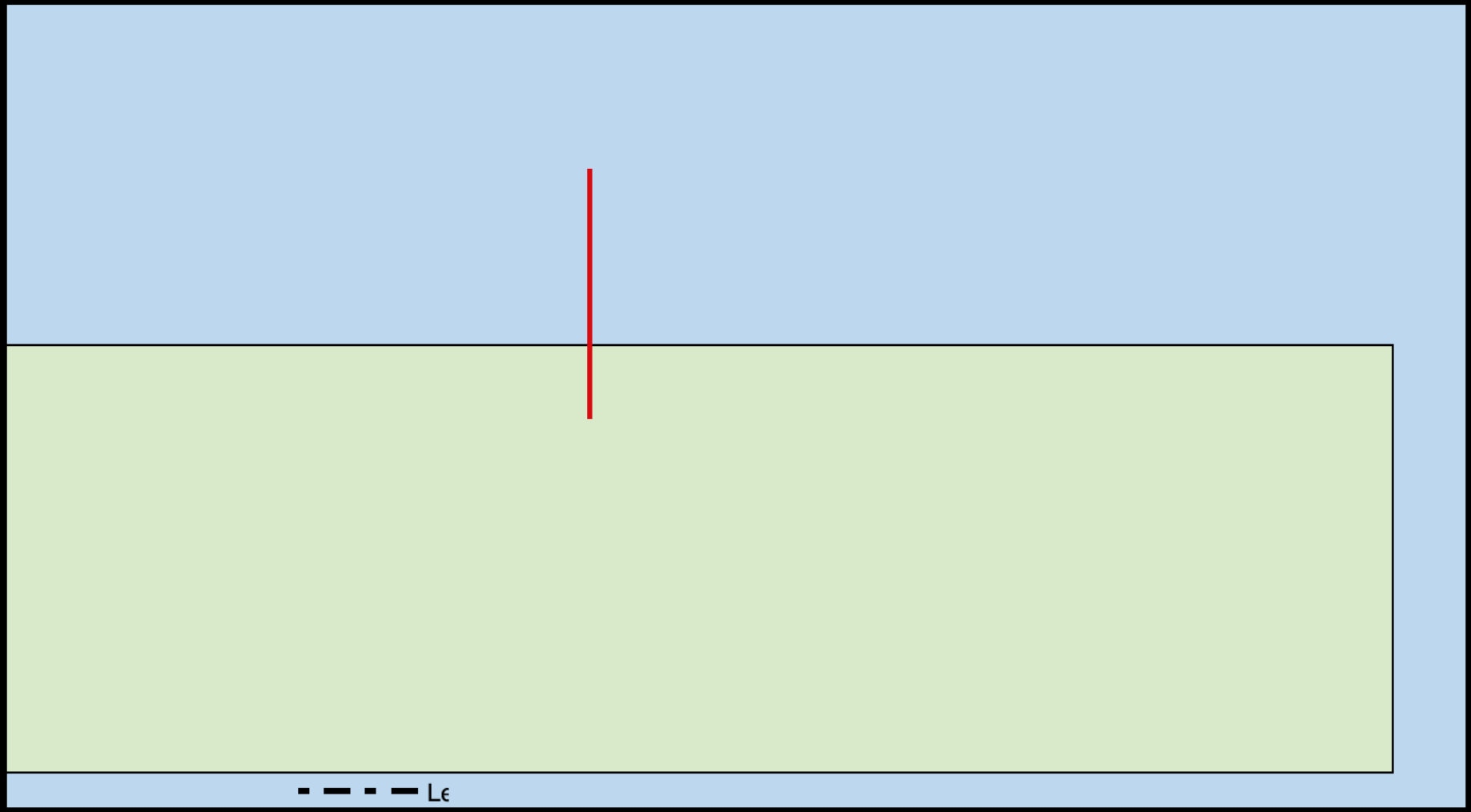
- DTN node control and storage management may be via legacy telemetry, not through DTN MP
- At this point, much is out of reach of the DTN MP protocol; it is necessary but not sufficient

Central Network Monitor and Control

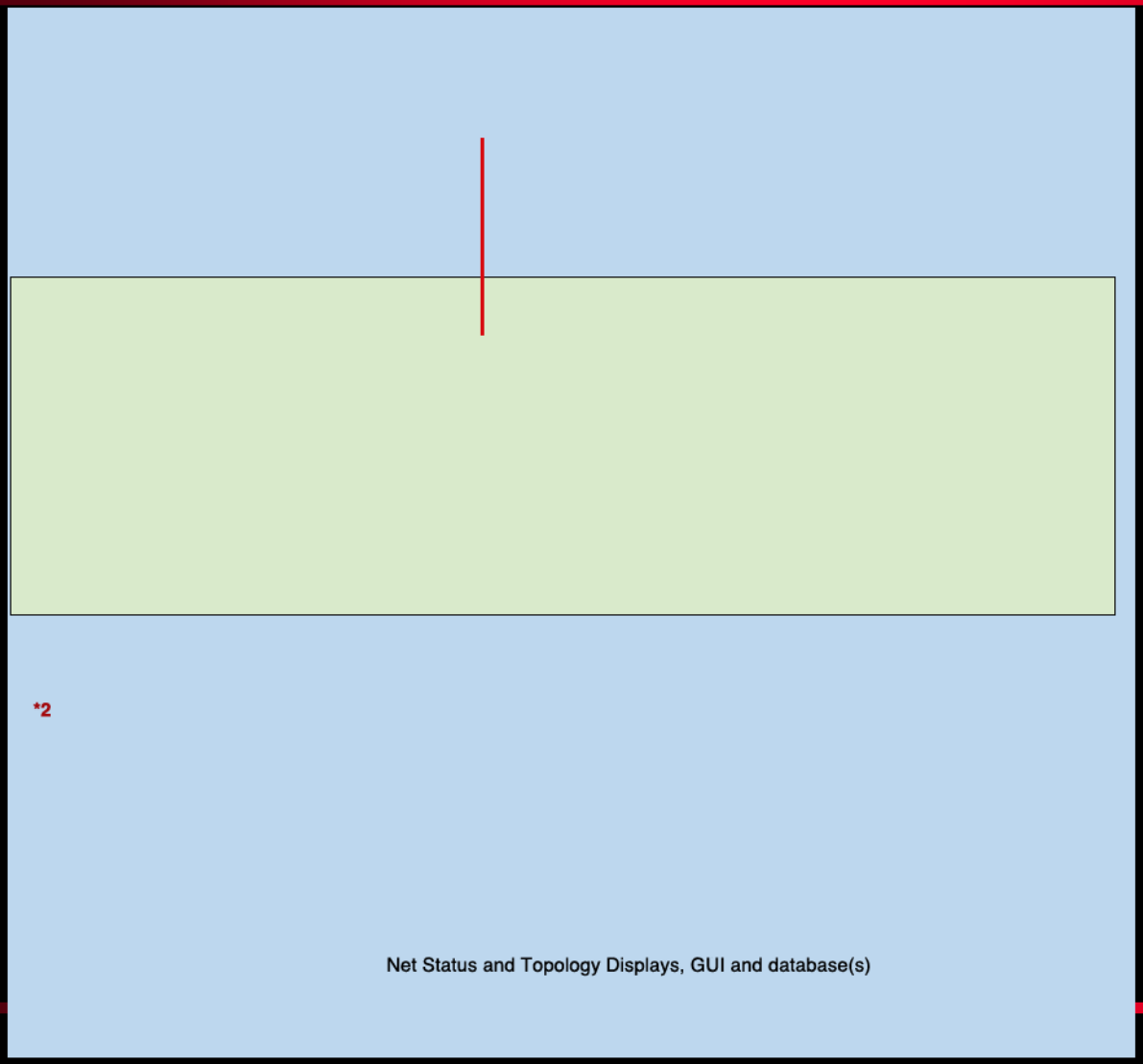


- DTN Network Monitor and Control needs DTN MP, but also many IP-based tools to obtain link status from stations, to revise relay schedules and to work with DTN node owners

Example DTN Overlay Network

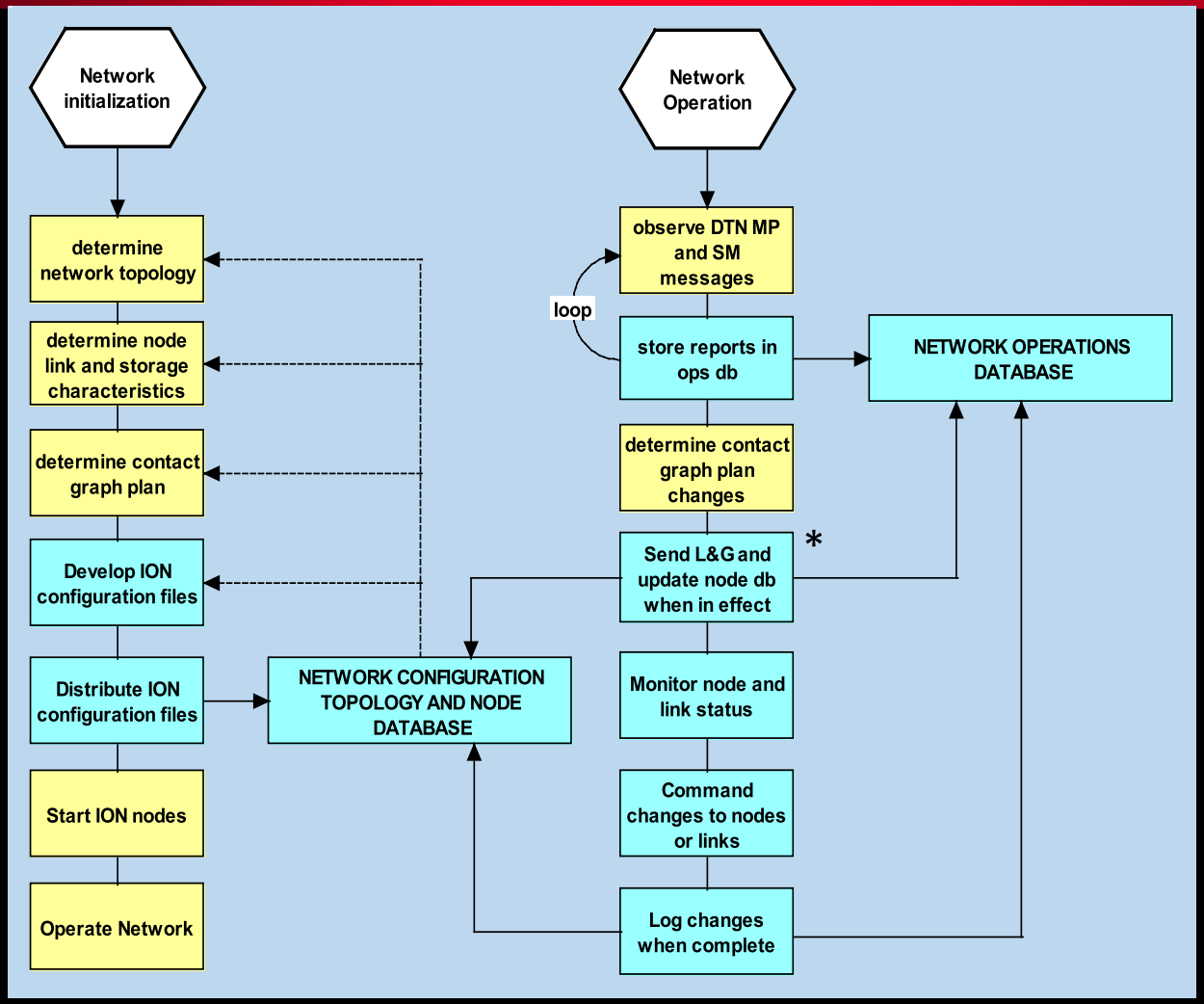


DTN NM&C Suite



1. Subnet management is not part of DTN NM&C; underlying network (e.g. NISN, DSN, TDRSS etc) - Interfaces with DTN NM&C
2. Most of NM&C suite available to all users; access control policies will limit what they can see / control.
3. Link management tools include SLE SM, i/f with SCaN, ESA ESOC, s/c telecom status/control, etc.
4. Node management tools include bping, bptrace, etc. as well as either SSH or other means of getting ion.log data

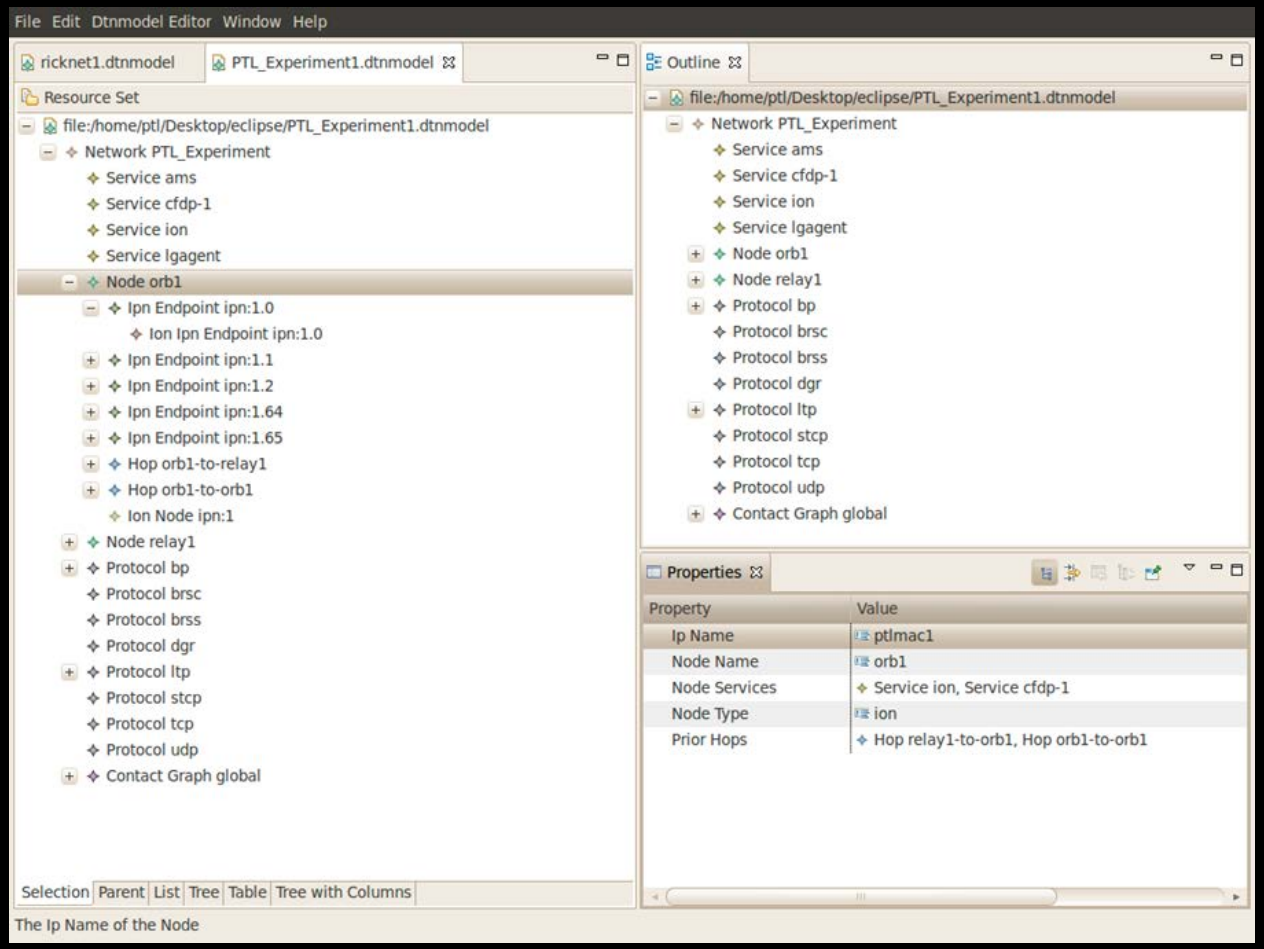
DTN Network Initialization and Operation



* Load & Go process in ION will be replaced by DTN MP command capability eventually

(yellow is ops procedure, blue denotes software)

FY13 ION Configuration Tool



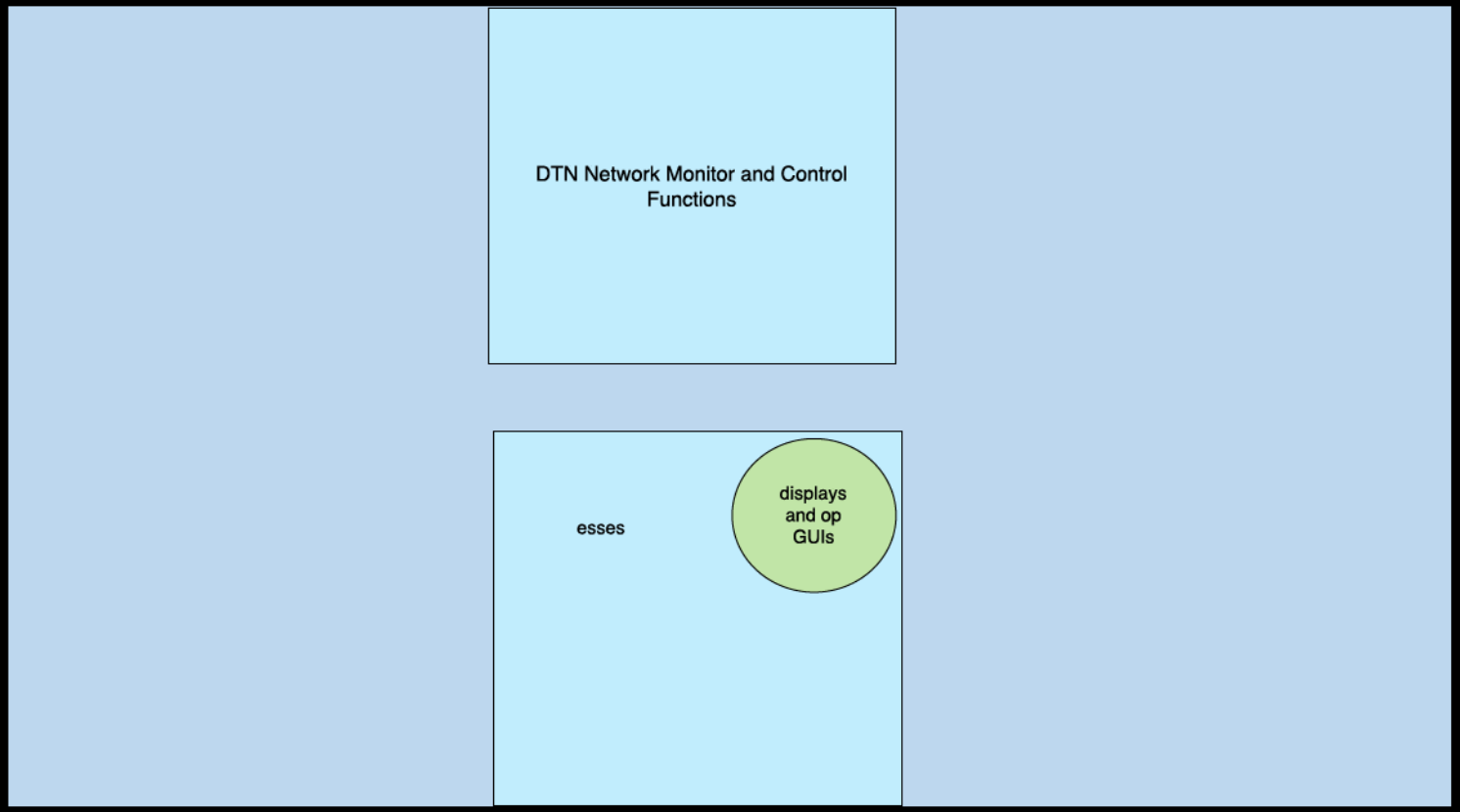
Uses Eclipse Modeling Language, and works on a data model of the entire network.

The ION Configuration Editor enables one to create and edit the model, that is, to create the Objects, and Relationships that describe a DTN network and to provide each Attribute with an appropriate value.

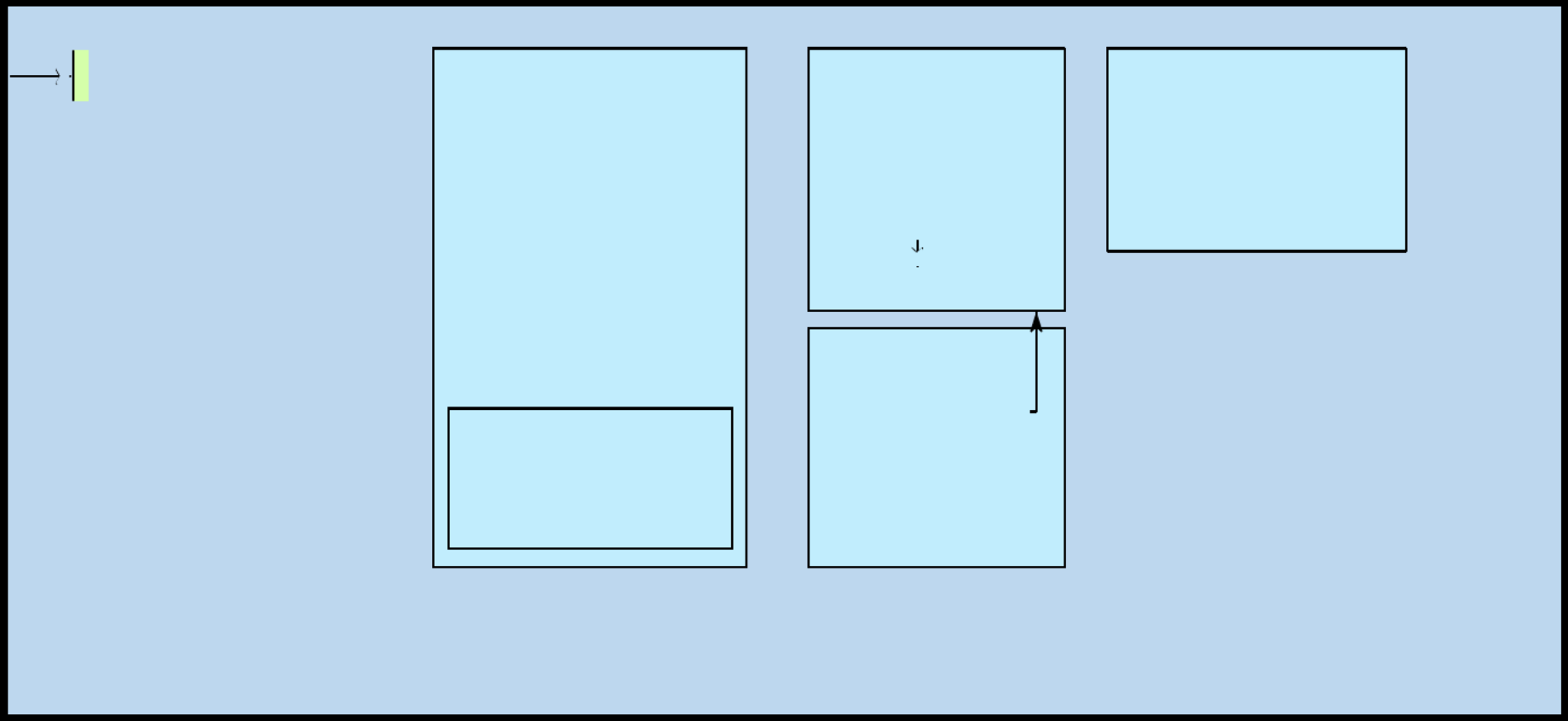
The editor can automatically **generate** all of the necessary configuration files for each ION node with the correct syntax.

The **validate** operation scans the the entire data model and reports model problems with warnings and errors.
A **survey** operation provides a variety of model-based reports that provide a summary overview of the network and its interconnections.
The editor provides default values for most parameters plus several auto-generation commands to automatically complete the model.

DTN NM&C Software Functions

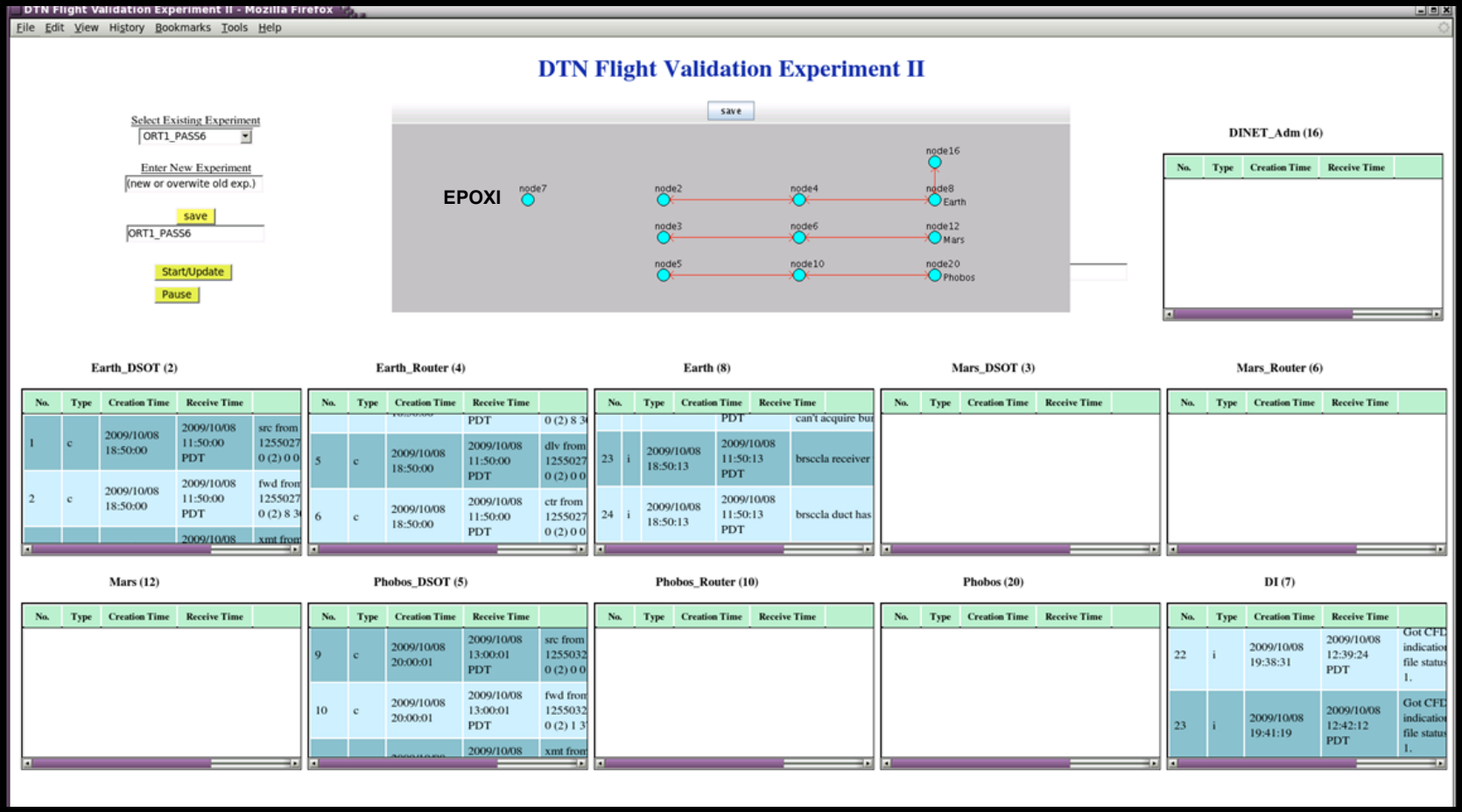


DTN NM&C Software Details

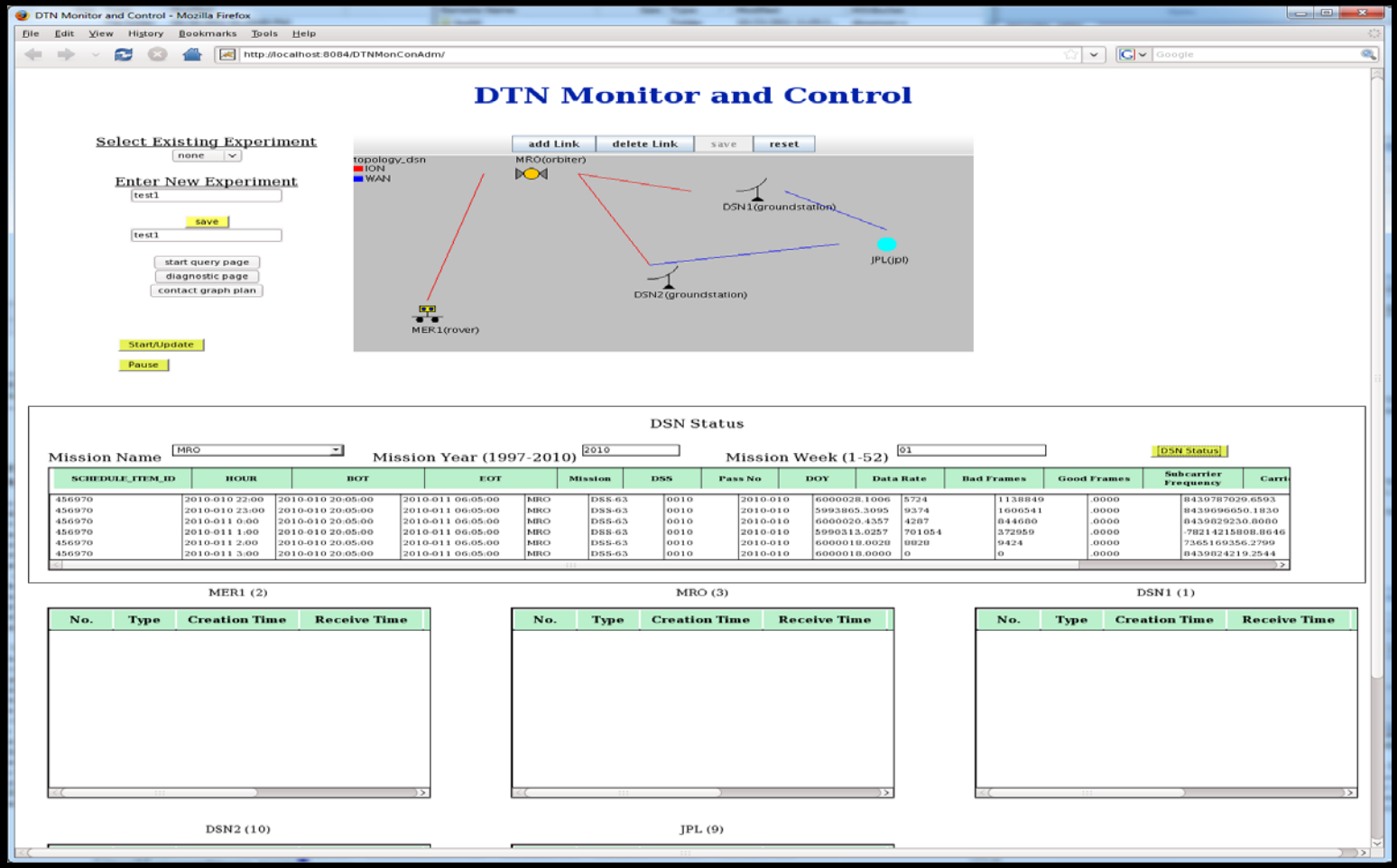


key design goals: modularity, simplicity, extensibility

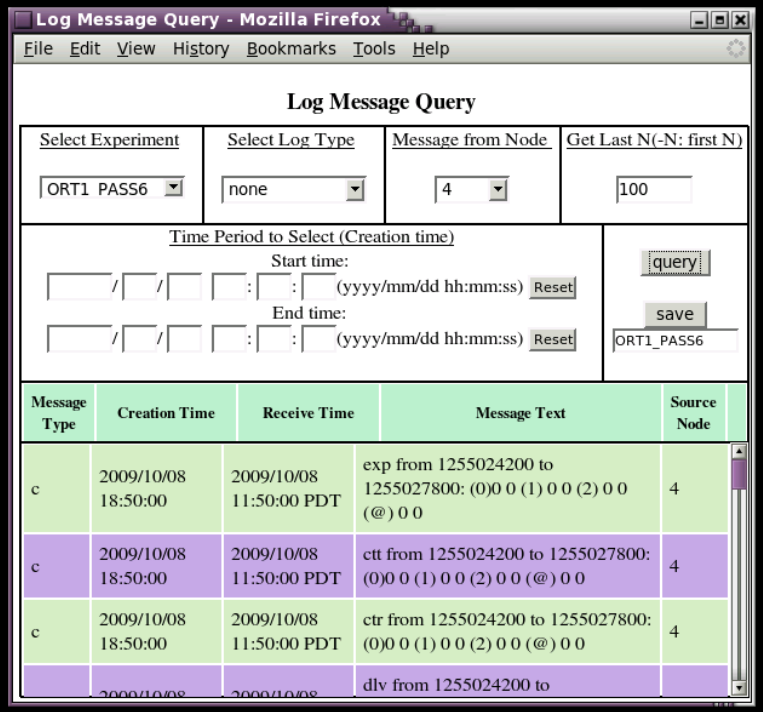
DTN Experiment Ops Center Display



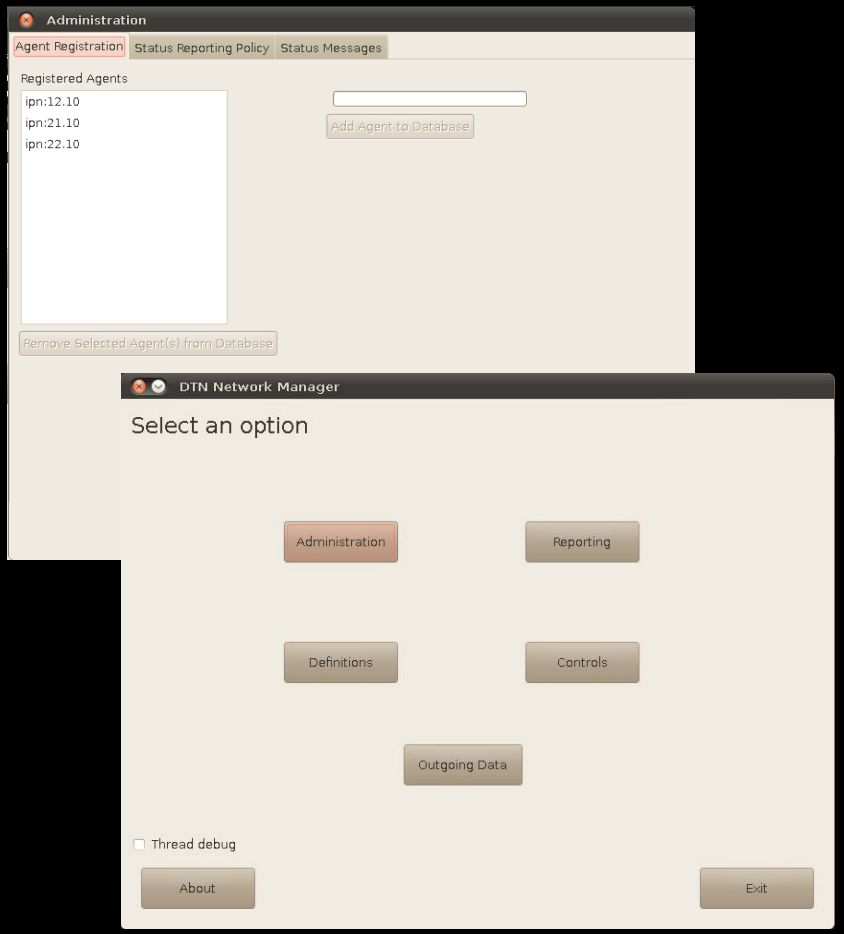
Prototype General NM&C Display



DTN NM&C GUI Screens



(from JPL DINET)



(by NASA GSFC)

Future Plans for DTN NM&C

- During the remainder of FY14, the DTN Readiness Program plans to continue the development and refinement of the tools described above, and to package up a basic suite of DTN NM&C tools, GUIs and documentation for general release.

- In FY15, we expect to add a number of vital components to the DTN NM&C suite, to include items such as
  - Addition of DTN2 NM&C capabilities to the ION Configuration Tool
  - Extended capability of DTN MP to do **node control** commands as well as node status reporting
  - Security Key management for DTN security protocols
  - Formalize interfaces with SCaN networks (SLE SM, DSN or TDRSS pass planning, etc.)
  - Explore potential for standardizing interfaces with S/C teams, Multimission Ops Team, etc.

- In addition, it is hoped that in FY15 or FY16, it will be possible to continue the development of the FY13 design of a DTN Network Fault Detection and Management tool that would allow for automatic monitoring and operator alerts to problems or unexpected network conditions in a monitored DTN network.

Questions?

This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration