



Network Monitor and Control of Disruption-Tolerant Networks

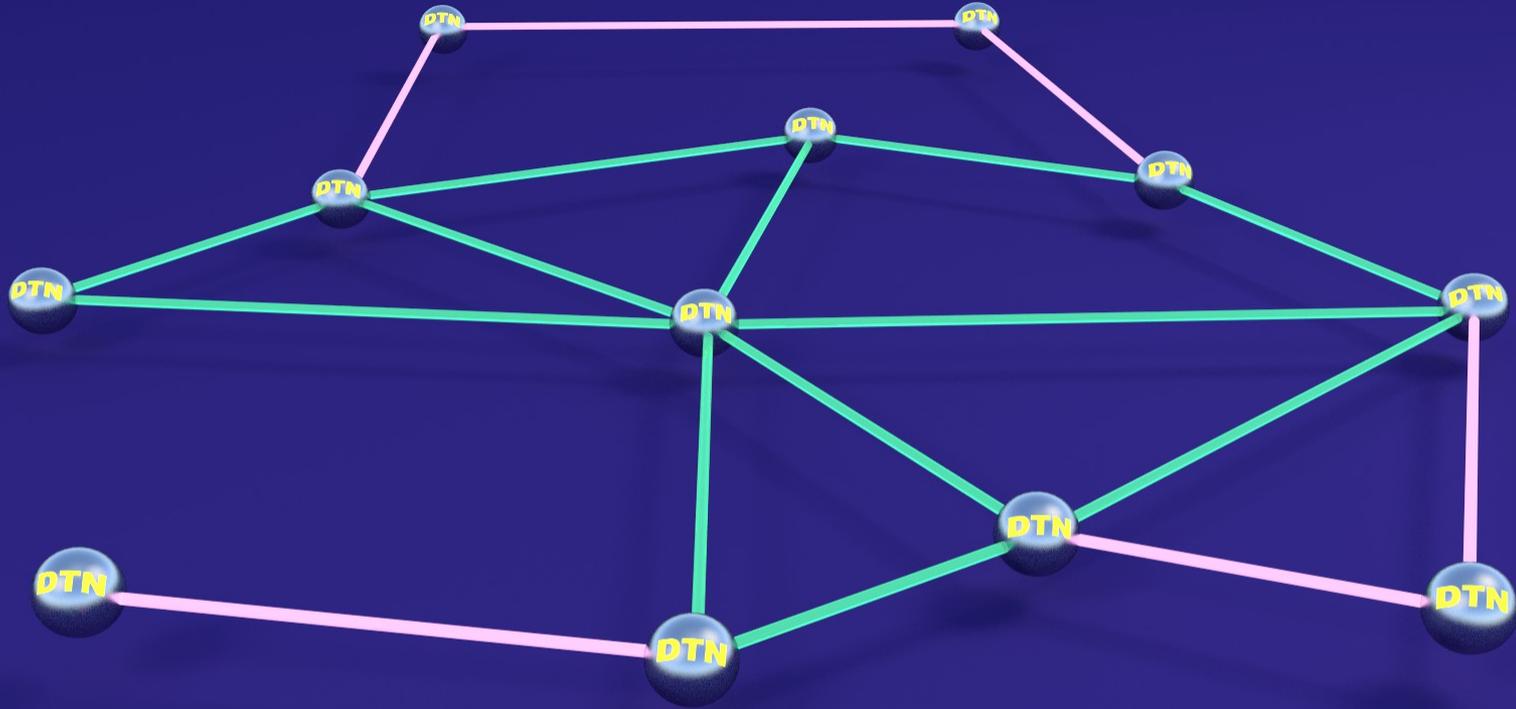
SpaceOps 2014

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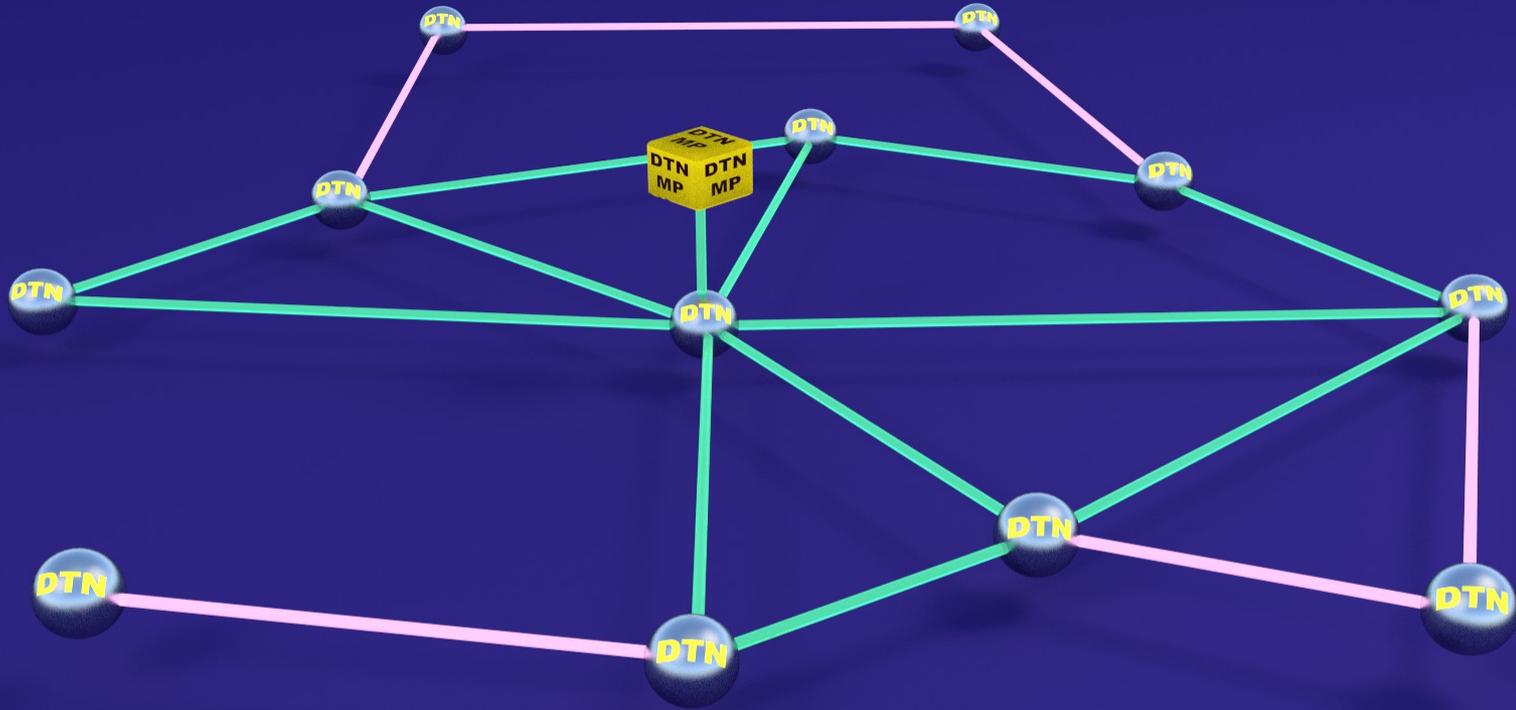
DTN/IP

DTN/RF

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



Network with DTN Management Protocol



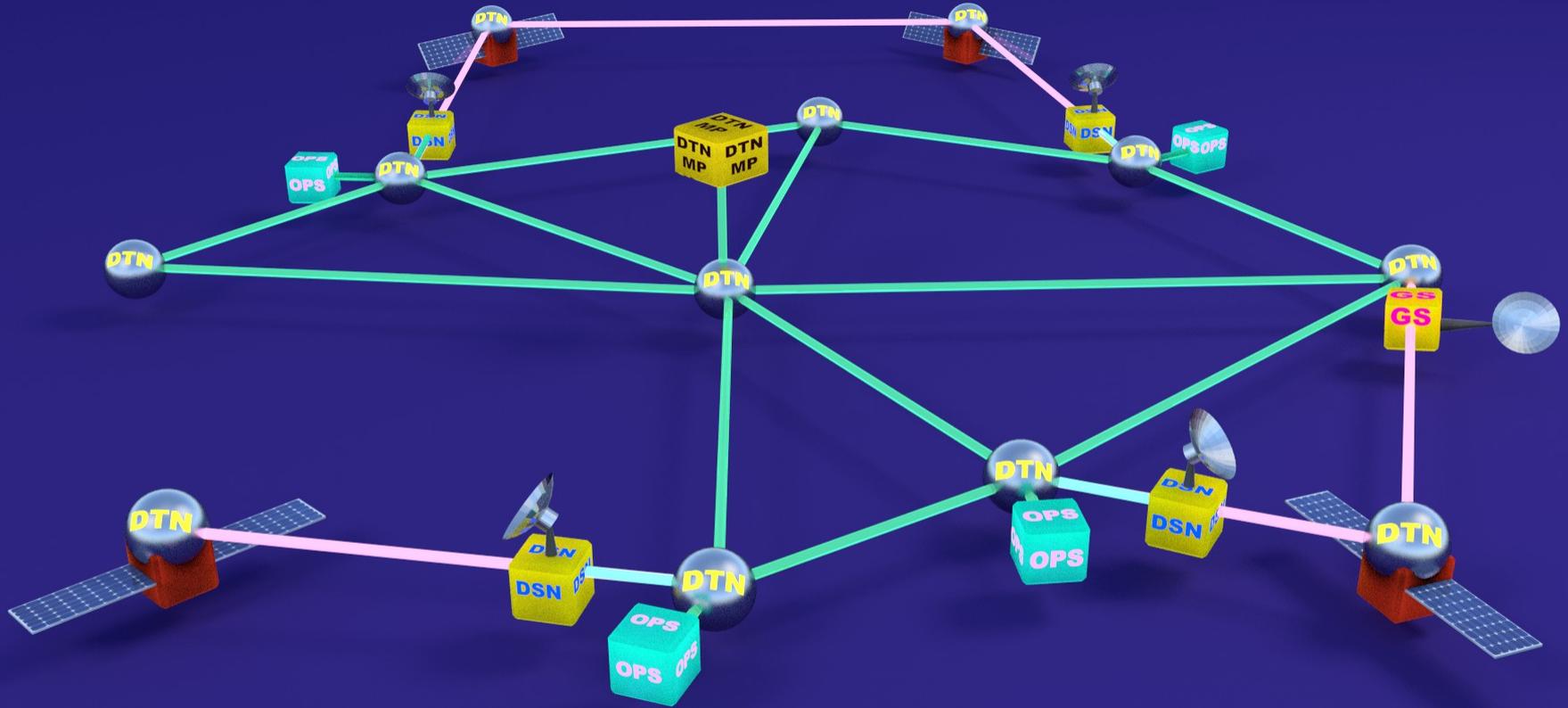
DTN/IP

DTN/RF

- 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



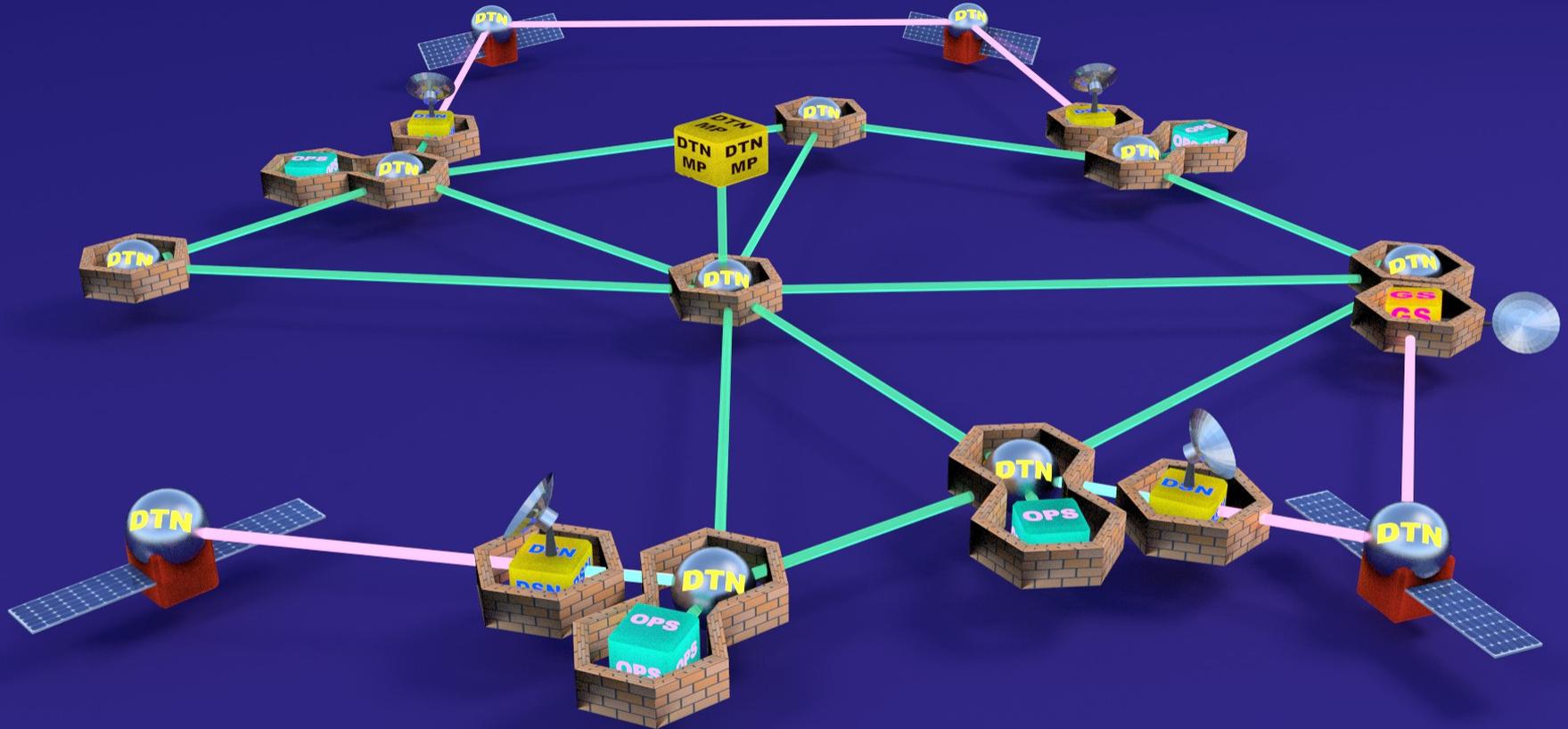
Additional Elements of a DTN Network



DTN/IP

DTN/RF

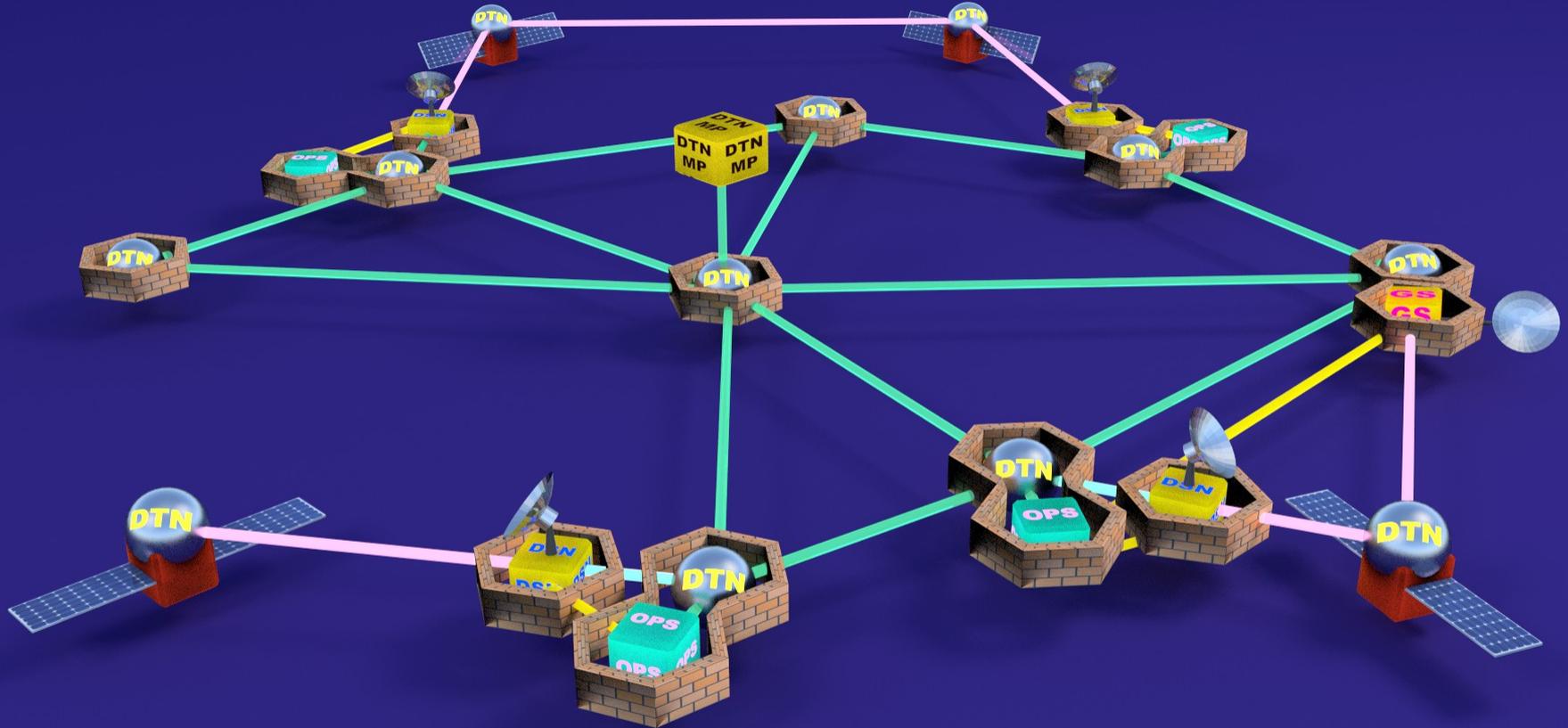
- DTN network have additional link control centers (DSN, SN, GN), as well as mission ops control of individual DTN nodes



DTN/IP

DTN/RF

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

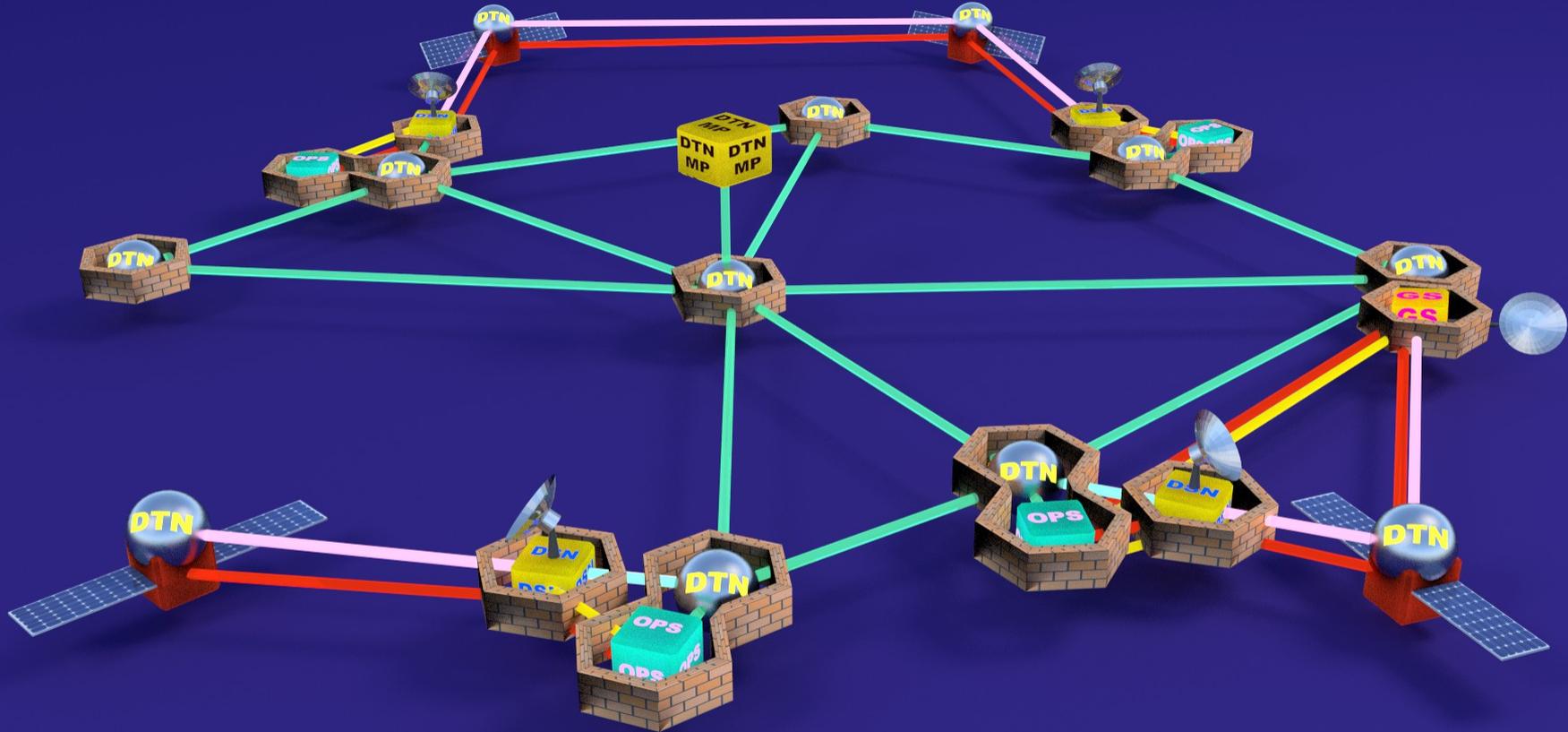


DTN/IP

DTN/RF

OPS/DSN/GS 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



DTN/IP

DTN/RF

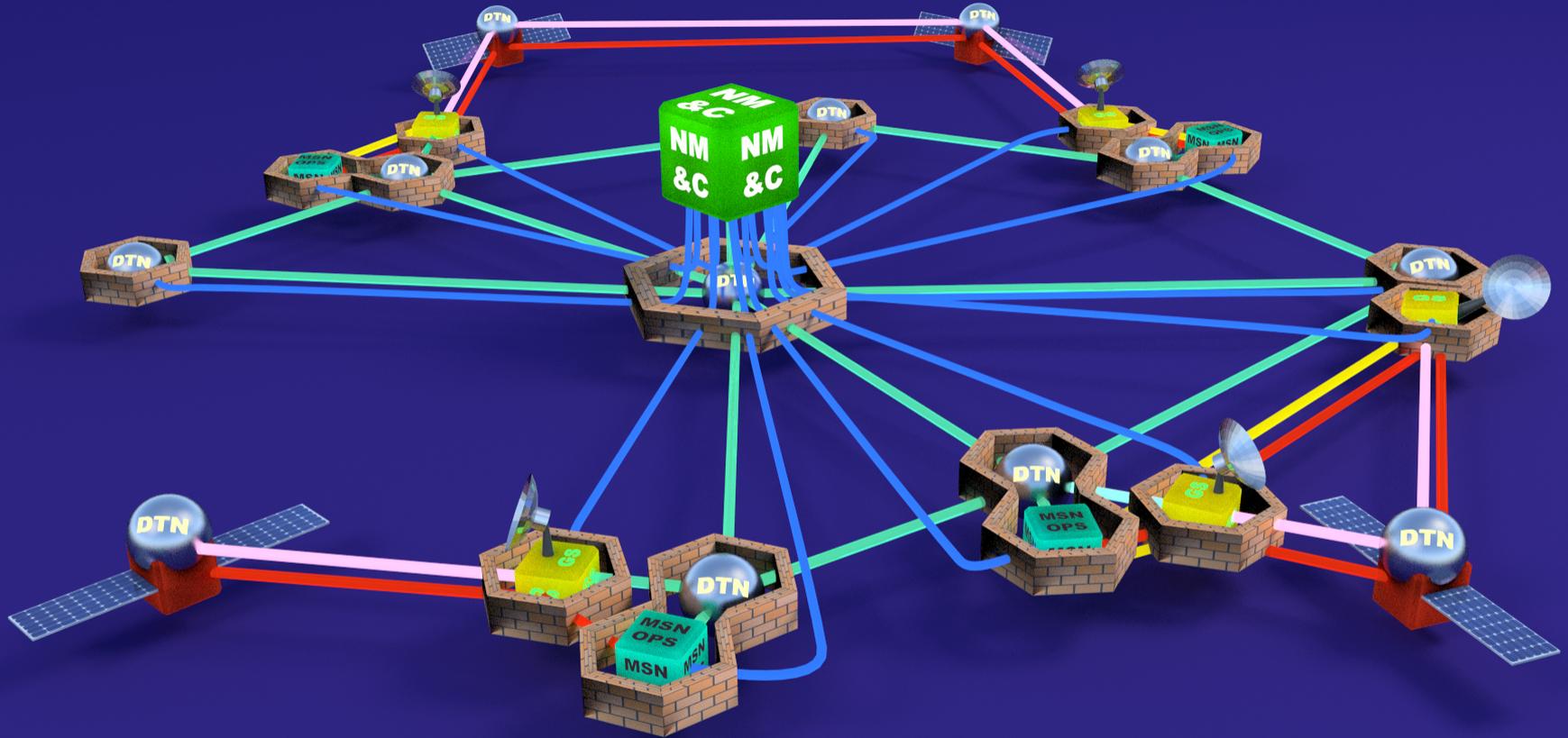
OPS/DSN/GS links

Non-DTAN TLM

- 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/IP

DTN/RF

MSN OPS/GS links

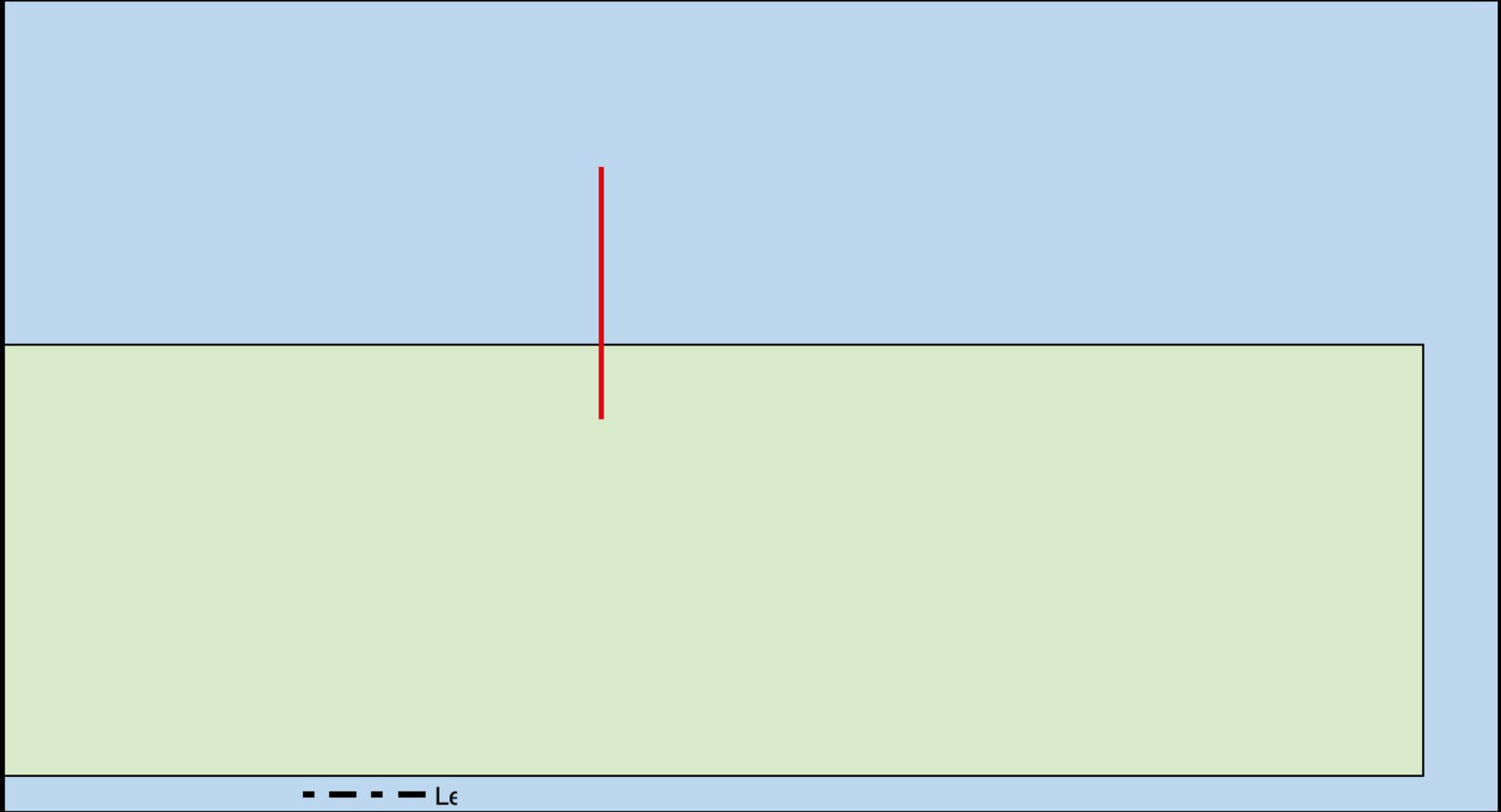
Non-DTN TLM

IP non-DTN CTRL + OOB TLM

- 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



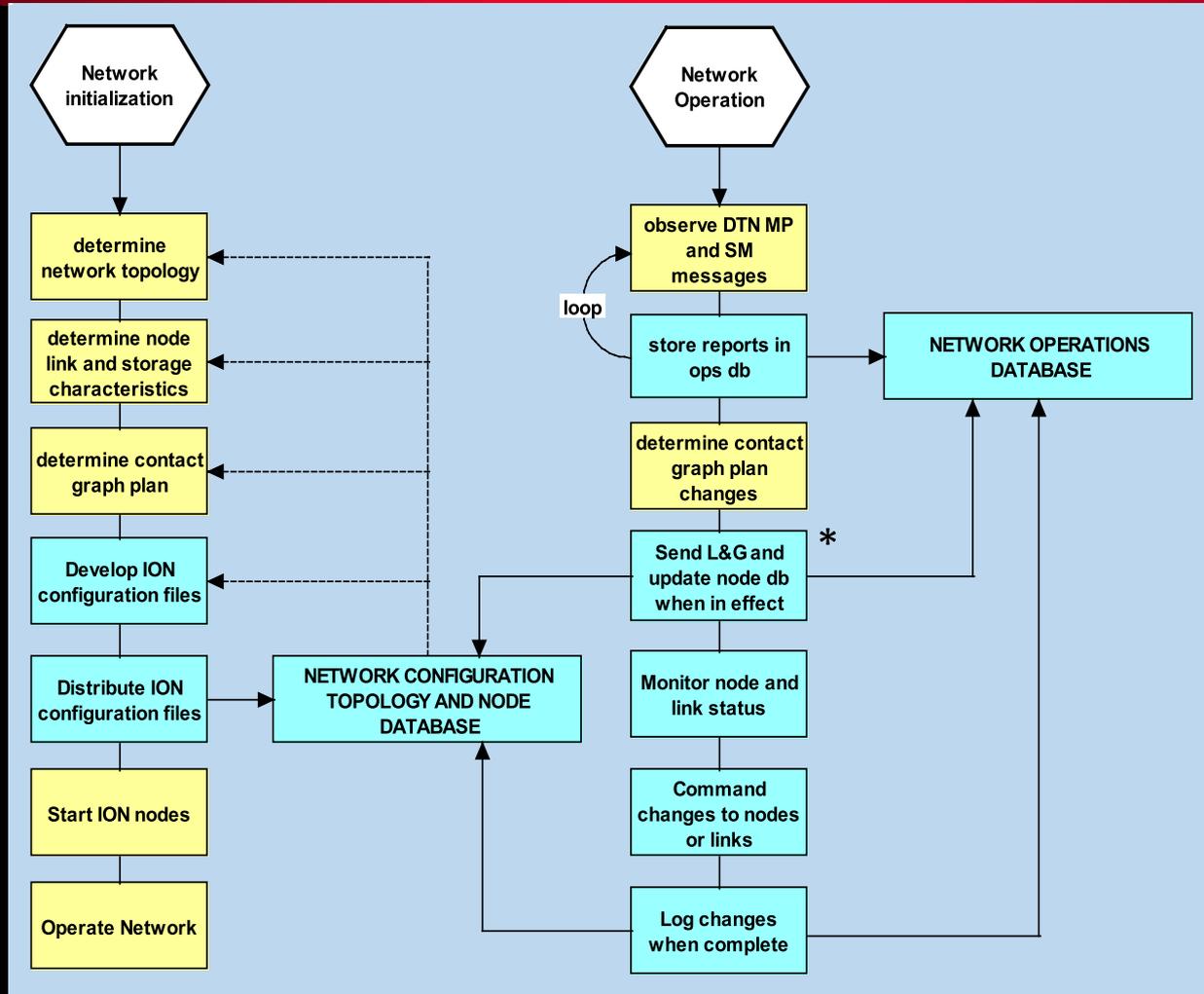
*2

Net Status and Topology Displays, GUI and database(s)

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

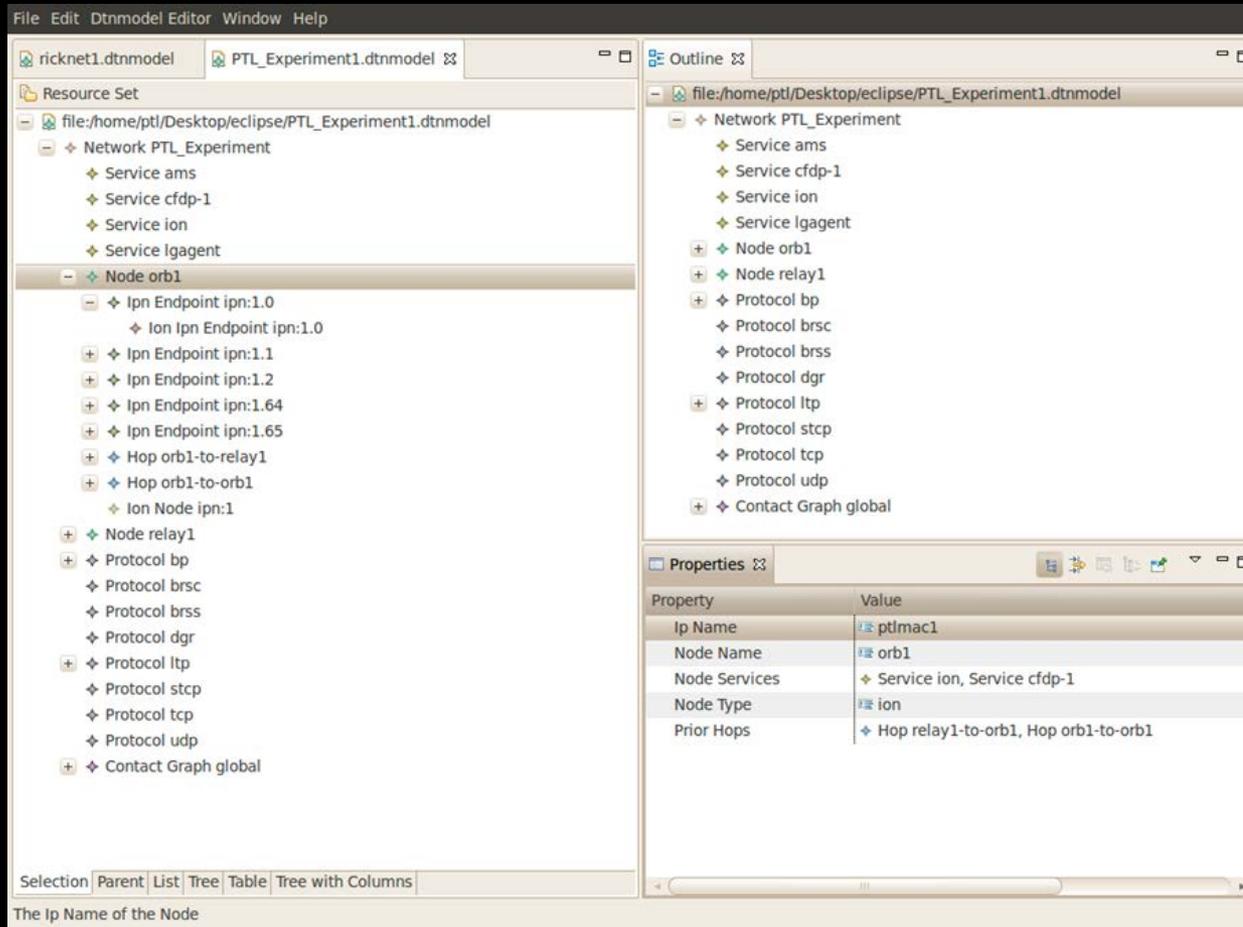


* Load & Go process in ION will be replaced by DTN MP command capability eventually

(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.

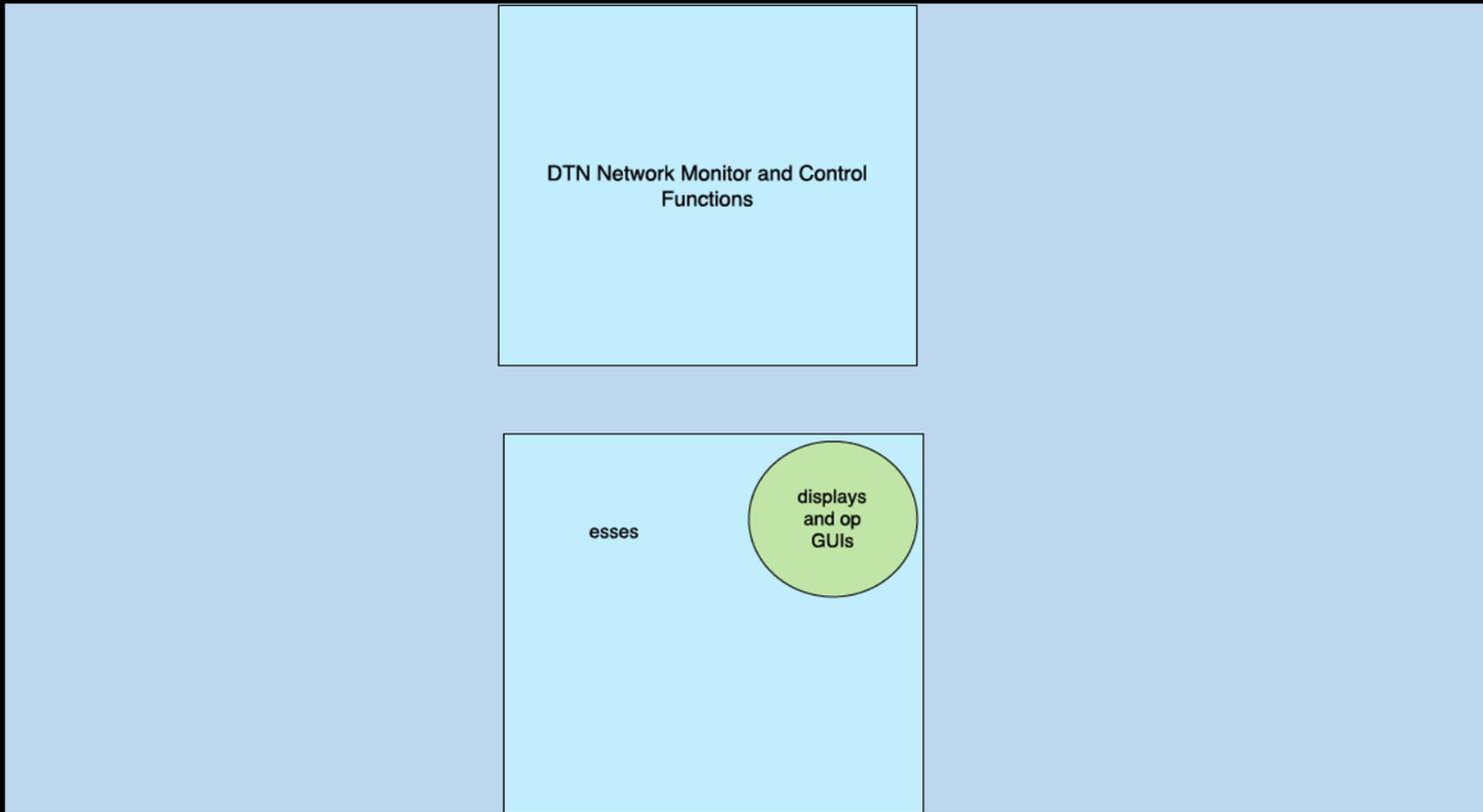
The **validate** operation scans the the entire data model and reports model problems with warnings and errors.

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.

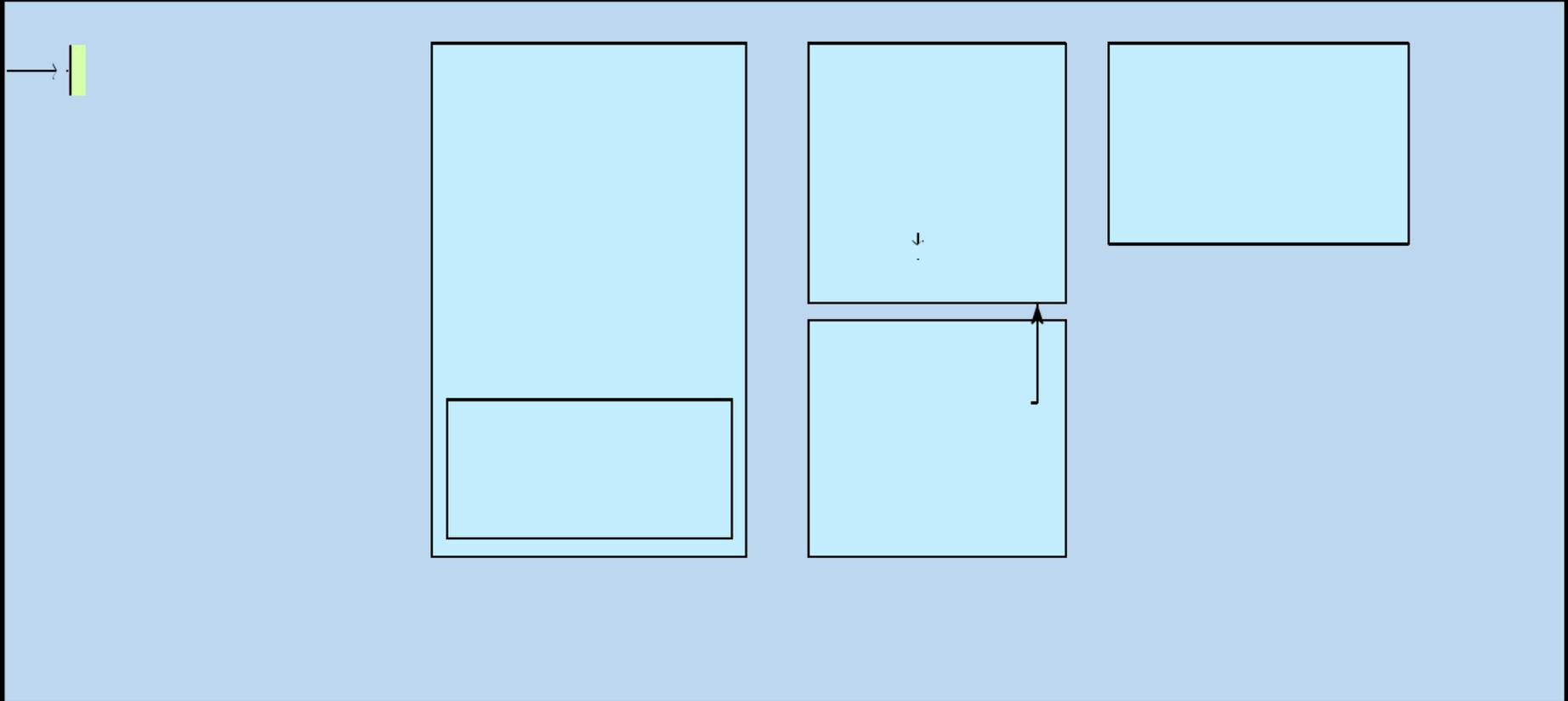


DTN NM&C Software Functions





DTN NM&C Software Details



key design goals: modularity, simplicity, extensibility



Prototype General NM&C Display



DTN Monitor and Control - Mozilla Firefox

http://localhost:8084/DTNMonConAdm/

DTN Monitor and Control

Select Existing Experiment

Enter New Experiment

DSN Status

Mission Name: Mission Year (1997-2010): Mission Week (1-52):

SCHEDULE_ITEM_ID	HOURL	BOT	EOT	Mission	DSS	Pass No	DOY	Data Rate	Bad Frames	Good Frames	Subcarrier Frequency	Carrier
456970	2010-010 22:00	2010-010 20:05:00	2010-011 06:05:00	MRO	DSS-63	0010	2010-010	6000028.1006	5724	1138849	.0000	8430787029.6503
456970	2010-010 23:00	2010-010 20:05:00	2010-011 06:05:00	MRO	DSS-63	0010	2010-010	5993805.3095	9374	1606541	.0000	84309096050.1830
456970	2010-011 1:00	2010-010 20:05:00	2010-011 06:05:00	MRO	DSS-63	0010	2010-010	6000029.4357	4287	844600	.0000	8430829250.8000
456970	2010-011 1:00	2010-010 20:05:00	2010-011 06:05:00	MRO	DSS-63	0010	2010-010	5990312.0297	791054	372959	.0000	78214215808.8648
456970	2010-011 2:00	2010-010 20:05:00	2010-011 06:05:00	MRO	DSS-63	0010	2010-010	6000018.0020	8828	9424	.0000	7365169356.2799
456970	2010-011 3:00	2010-010 20:05:00	2010-011 06:05:00	MRO	DSS-63	0010	2010-010	6000018.0000	0	0	.0000	8439824219.2544

MER1 (2)

No.	Type	Creation Time	Receive Time

MRO (3)

No.	Type	Creation Time	Receive Time

DSN1 (1)

No.	Type	Creation Time	Receive Time

DSN2 (10)

No.	Type	Creation Time	Receive Time

JPL (9)

No.	Type	Creation Time	Receive Time



DTN NM&C GUI Screens



Log Message Query - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Log Message Query

Select Experiment: Select Log Type: Message from Node: Get Last N(-N: first N):

Time Period to Select (Creation time)

Start time: / / : : (yyyy/mm/dd hh:mm:ss)

End time: / / : : (yyyy/mm/dd hh:mm:ss)

Message Type	Creation Time	Receive Time	Message Text	Source Node
c	2009/10/08 18:50:00	2009/10/08 11:50:00 PDT	exp from 1255024200 to 1255027800: (0)0 0 (1) 0 0 (2) 0 0 (@) 0 0	4
c	2009/10/08 18:50:00	2009/10/08 11:50:00 PDT	ctt from 1255024200 to 1255027800: (0)0 0 (1) 0 0 (2) 0 0 (@) 0 0	4
c	2009/10/08 18:50:00	2009/10/08 11:50:00 PDT	ctr from 1255024200 to 1255027800: (0)0 0 (1) 0 0 (2) 0 0 (@) 0 0	4
	2009/10/08	2009/10/08	dlv from 1255024200 to	

(from JPL DINET)

Administration

Agent Registration Status Reporting Policy Status Messages

Registered Agents

ipn:12.10
ipn:21.10
ipn:22.10

DTN Network Manager

Select an option

Thread debug

(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 S/Ca 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?

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