User’s View of GST

- **Goal:** Responsive, iterative conceptual design of ground systems, addressing interactions of communications, information architecture, software, processing, staffing, facilities, cost
  - Rapidly assess design impacts of ground architectural trades by means of a well-defined process -- not ad hoc
  - Emphasize cross-program consistent systems thinking for a broad range of ground systems -- not component-level design

- **Types of studies:** New systems, block upgrades, insertion of technology and COTS components, alternate architectures, space/ground trades
  - Identify requirements/CONOPS high-level impacts on design, risk and costs
  - Define and explore trade space for follow-on detailed design activities applicable to both shared and dedicated ground systems
  - Focus on data processing, storage, retrieval, and dissemination
User’s View of GST -- Space/Ground Trades

- **Space/ground communications system**
  - Crosslinks vs. (multiple) ground terminals/entry points
  - Orbit geometry vs. ground terminal locations and capabilities

- **Space/Ground Processing system**
  - Onboard vs. ground mission processing vs. communications (downlink) requirements

- **System robustness and survivability**
  - On-board vs. ground-based fault detection & resolution
  - Presence, number & capability of redundant/survivable/endurable (e.g., mobile, relocatable) ground elements vs. space segment survivability/autonomy
CDC: Distributed Design/Analysis

Description:

- Multi-disciplinary teams, co-located with tools and customer, able to generate study results in a real-time environment
- Formalized process for group interaction, information transfer, and product generation

Attributes:

- Team includes all relevant expertise and customer
- Team members own and maintain models in their areas of expertise
- Networking of results and team consistency enhances accuracy
- Real-time iteration, including customer redirection if needed
- Data generated in several days once study sessions are initiated
- Rapid generation of consistent point designs facilitates broad trade space exploration once study sessions are initiated
Ground Systems Meta-Architecture
Example Ground System and GST Model

Remote Ground Station
- Wide Band & TLM
- CMDS, Reports

Primary Input Ground Station
- Status
- System Configuration Data, CMDS

Backup Input Ground Station (warm)
- Semi-Raw Data
- Reports, Status
- Data Requests
- Comm w/ Users

Node 4
- Link 4-1
- Link z-1
- Link 1-z

Node 1
- Link 1-4
- Link 1-2
- Link 1-3
- Link 1-z

Node 2
- Link 2-1
- Link 2-3
- Link 2-x
- Link 2-y

Node 3
- Link 3-2
- Link 3-1
- Link 3-x
- Link x-3

Node 0

CDC
Concept Design Center
Another Ground System Example

Common Centralized Facility

Mobile Facilities

Ground Terminal

Processing

Node 1

Link 1-1

Link 1-

Link 1-2

Node 2

Link 2-1

Link 2-3

Node 3

(N copies)
Node Design Captures Dependencies

- **Node**
  - Functions

- **Staffing**
  - Workstations
  - Office Space

- **Software**
  - S/W Arch

- **Information Architecture**
  - LANs
  - WANs

- **Processing**
  - HW

- **Spacecraft**

- **Comm Architecture**

- **Facilities**
  - HW

- **Cost**
GST Support for Space/Ground Tradeoffs

- GST capabilities provide an efficient mechanism to support space/ground tradeoffs
  - Identify the space/ground tradeoff issues for the total system under consideration
  - Define the ground system architectural variations implied by the space segment alternatives
  - Evaluate the ground system architectures with a GST study

- Methodology is viable & efficient because rapidly assessing the design impacts of ground architectural variations is an inherent GST strength
  - Key issue is the explicit identification of ground system architecture variations that correspond to specific space system design alternatives
  - GST study can be performed in parallel with CDC space system study
Conclusions

- GST provides a meta-architecture for ground systems consisting of nodes and links
- Node design captures detail, dependencies, and relationships among key elements/subsystems
- Formalized, multi-step process ensures rigor and applicability of results
- Identifiable ground system impacts of space/ground tradeoffs can be assessed by the current or planned GST capability