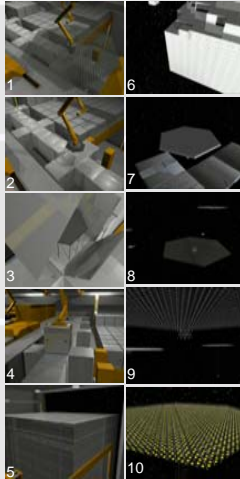


**SMART architecture from start to finish**

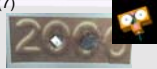
**SMART assembly, shipping, and deployment using SMART boxes**

Autonomous assembly from SMART components  
 3D tetrahedral 3D truss structure from layers of MEMS nodes (1-2)  
 Sail (shell) and subsystems deployed from specialized nodes  
 Stowed to 1/100 size in propulsion/communication capable box for shipping (3-4)  
 1000 boxes form 1 meter cube package shippable to launch location (5-6)  
 Spacecraft deployed from boxes for launch in space (7)



**SMART deployable spacecraft (8)**

Uses SMART Sail, Subsystem Platform, Tethers  
 Can be multiple tethered platforms  
 Optimized for pre and post deployment ops



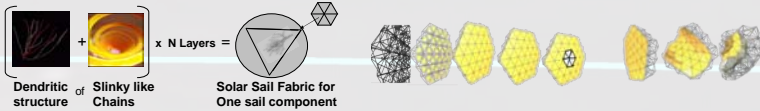
**SMART deployable subsystems (9)**

SMART Space Frame and Separate Platform for subsystems  
 Communication either thin wire or wireless  
 Nodes (MEMS) spool/unspool carbon nanotubes  
 form tethers, struts, fibers or act as attach points for subsystems



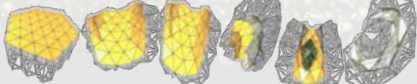
**SMART Solar Sail characteristics (10)**

10 to 100 times linear stretch from multilayer dendritic polymers  
 Polymers consist of layers of Slinky-like helical nanotubule chains  
 Multilayer fabric has sufficient reflectivity when fully extended  
 Self-configuring morphology for attitude control or adaptation  
 Self-deploying surface and struts for attitude control or repair



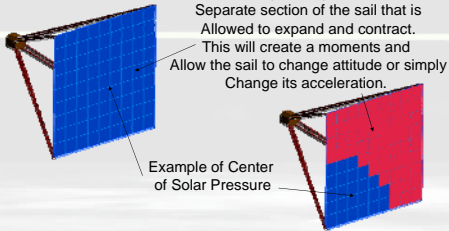
**Attitude Control: Using SMART Sail or Surface Self-Configuration**

Sail achieves dynamic attitude control through capability for dynamic change in its morphology, thus changes the effective area and distribution of solar reflectivity to change its acceleration and momentum vectors to achieve required orbit and orientation.



**Attitude Control: Using SMART Sail or Surface Self-Deployment**

Each square represents a Separate section of the sail that is Allowed to expand and contract. This will create a moments and Allow the sail to change attitude or simply Change its acceleration.



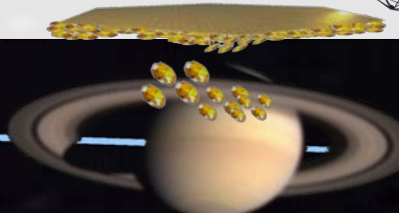
**SMART deployable Nuclear Propulsion Craft**

Uses SMART Nuclear Propulsion self-configuring for control of thrust  
 Expand or Contract to control Critical Mass Properties  
 Vary thermal coefficient to control Heat Flow  
 Other Subsystems can be tethered to shell  
 Pre-deployment size much smaller than post



**SMART Hive Carrier characteristics**

Sail special reflective shell material  
 Individual spacecraft self-tether for transport  
 Self-configuring/Self-deploying for attitude control



**SARA: The Saturn Autonomous Ring Array**

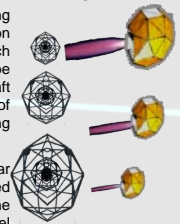
ANTS application to survey dense, dynamic, high G population  
 1000 spacecraft swarm  
 10 types of 'specialists' with common spacecraft bus  
 10 subswarms, ~100 spacecraft each, ~10 each specialist  
 Hybrid propulsion for operation in two regimes:  
 Solar Sail Transport 'Hive Ship' cruise to outer solar system  
 Nuclear Propulsion for individual craft navigate around rings  
 Small nuclear batteries for 100's of mWatt power requirements  
 Primary objective is in situ exploration of Saturn's Rings to understand formation and origin of planetary systems

**ANTS Application: SARA, Saturn Autonomous Ring Array**

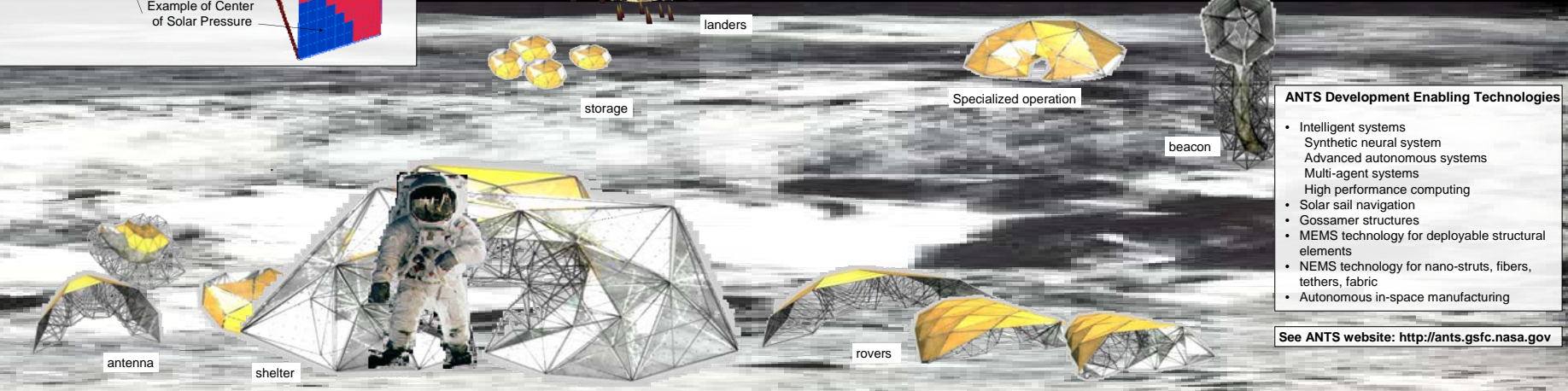
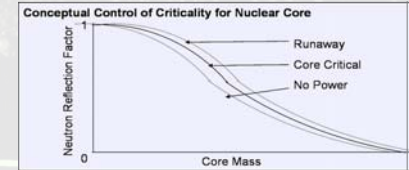
Time Frame: 2025-2030. NEMS  
 Environment: Space, High G, High density dynamic population  
 Power: 100's mWatts, Solar<3.5AU Nuclear Battery>3.5AU  
 Material: 1-3 kg, 100 m<sup>2</sup>/kg  
 Locomotion: 1-3 Sail Carrier<3.5 AU, Nuclear Thermal>3.5AU  
 Challenges: Rapid reconfigurability of nuclear source required for attitude control to avoid collisions, take samples

**SMART Nuclear Propulsion System Self-Configuration**

Design of Self-configuring nanostructures for nuclear propulsion and power control necessary Such autonomous control would be essential in maneuvering the craft and the instrument for collection of rather than collision with ring particles.



The power and speed of the nuclear propulsion drive system proposed would be varied by controlling the temperature and criticality of the fuel element using ANTS technology.



**ANTS Development Enabling Technologies**

- Intelligent systems
  - Synthetic neural system
  - Advanced autonomous systems
  - Multi-agent systems
  - High performance computing
- Solar sail navigation
- Gossamer structures
- MEMS technology for deployable structural elements
- NEMS technology for nano-struts, fibers, tethers, fabric
- Autonomous in-space manufacturing

See ANTS website: <http://ants.gsfc.nasa.gov>