

# THE GOSSAMER SPACECRAFT INITIATIVE

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## What is a Gossamer Spacecraft?

Gossamer -- *Something light, delicate, insubstantial, or tenuous;  
A film of cobwebs floating in air*

- A gossamer spacecraft is a large, ultra-lightweight system.
- A gossamer spacecraft incorporates subsystems that are highly-integrated with a thin structure, and that perform multiple functions.
- A gossamer spacecraft has adaptive capabilities, and eventually will be able to reconfigure itself or evolve in response to changing mission conditions.
- A gossamer spacecraft achieves substantial reductions in mission cost with breakthroughs in structures and materials, coupled with advancements in power, propulsion, autonomy, communications, and avionics.

## Science with Gossamer Spacecraft

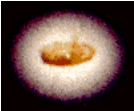


### If you want to:

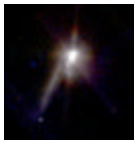
### You need:



take a picture of remote galaxies    a large telescope



investigate planet surface from orbit    large radar



take a picture of a black hole    a large VLBI antenna



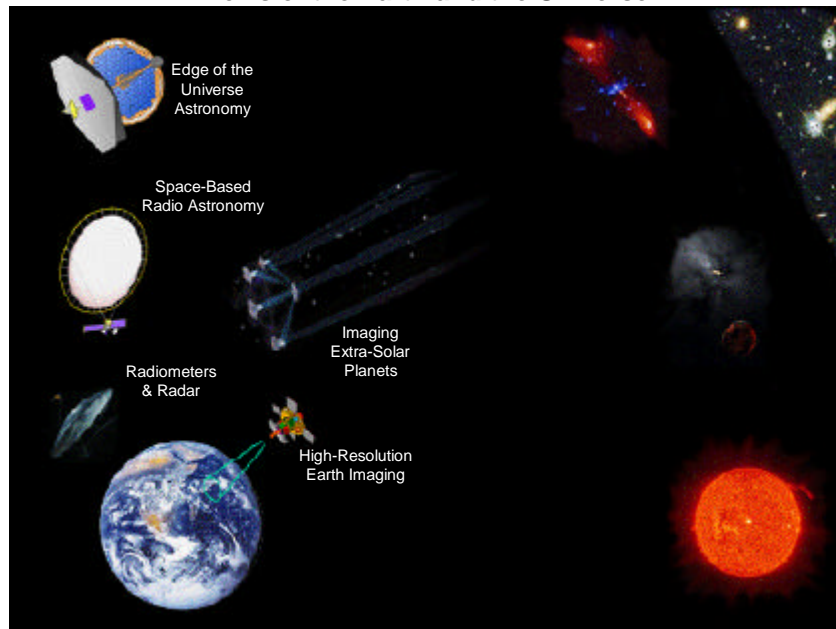
send video from deep space    large RF antenna



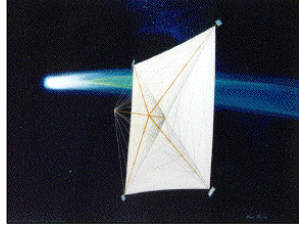
take a picture of extrasolar planet    array of telescopes

solar power in deep space    large solar arrays

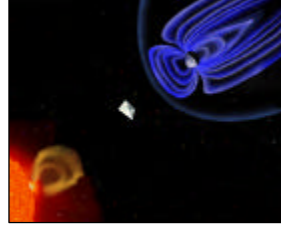
## Gossamer technology will enable large apertures for new views of the Earth and the Universe



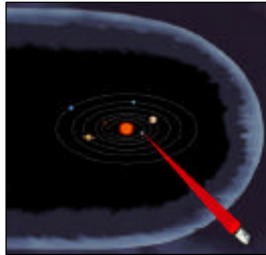
## Gossamer technology will enable solar sails for reaching new vantage points in space



Low-cost rapid transit throughout the solar system



Stationkeeping in unstable orbits for geomagnetic storm warning and continuous polar viewing

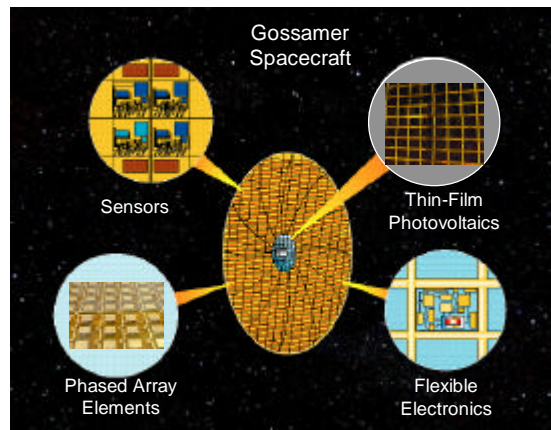


Laser-propelled light sails for missions to the edge of the solar system and precursor interstellar exploration

## Gossamer technology will enable breakthrough reductions in cost with highly-integrated systems

### Vision

Highly-integrated gossamer spacecraft consists of very thin membrane partly populated with multifunctional patches. The patches contain thin-film photovoltaics to produce power, phased array antenna elements for communications, flexible microelectronics for command and data handling, and flexible sensors. The membrane functions as a sail for propulsion, and as a large aperture for observing.

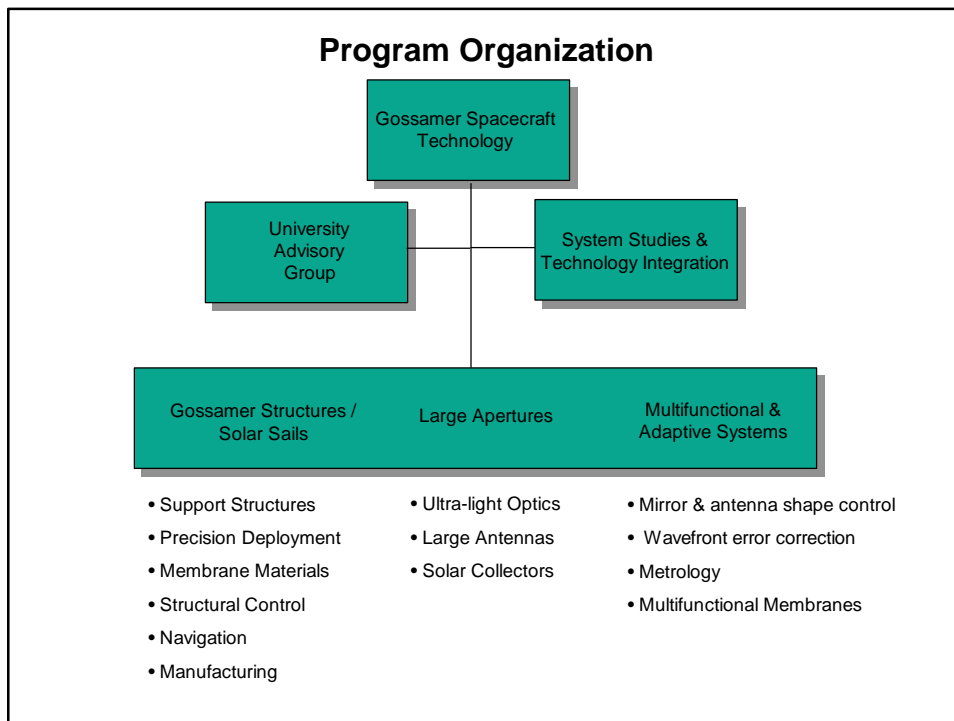
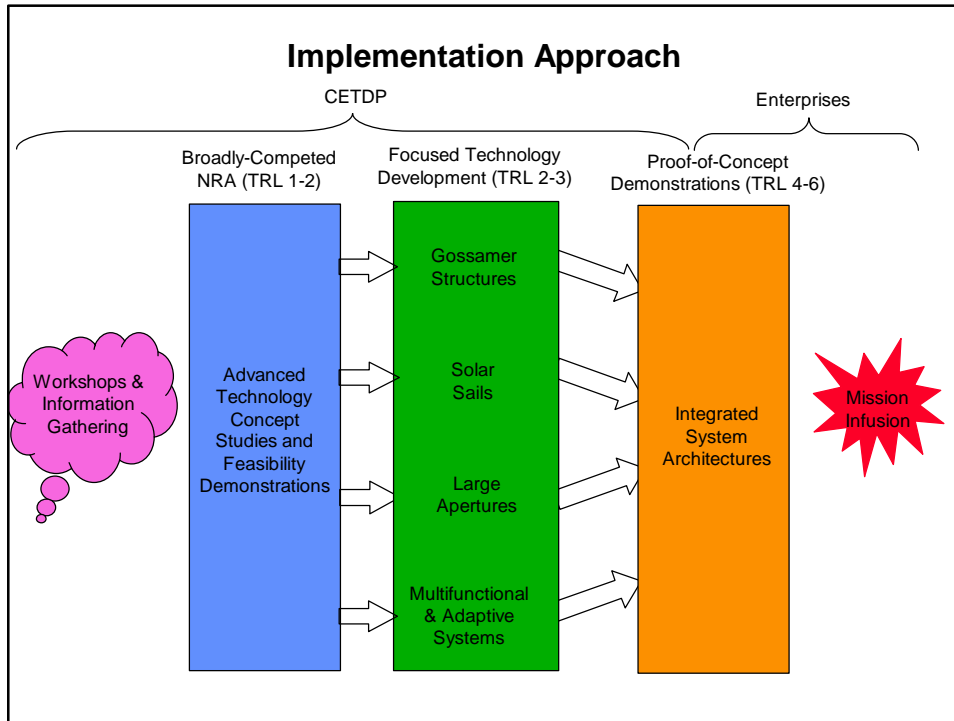


## **Gossamer Spacecraft Initiative**

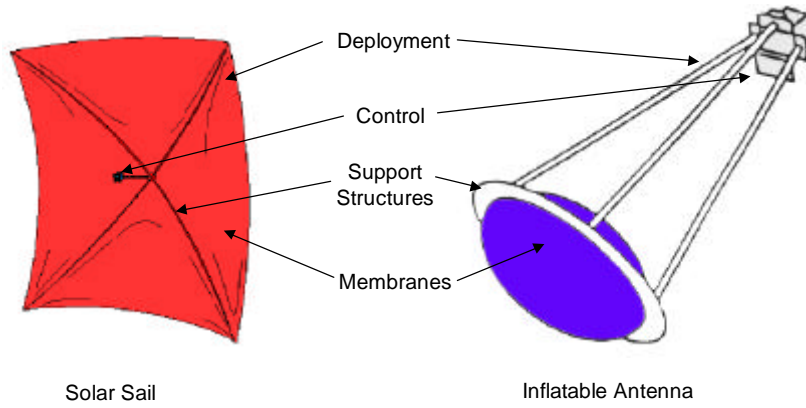
- New Program starting in October, 1999
- The Gossamer Spacecraft Initiative is part of NASA's Cross-Enterprise Technology Development Program (CETDP). The Office of Space Science has overall program management responsibility of the CETDP.
- The program will encourage broad participation by NASA Centers, academia, industry, and other government agencies.
  - An external advisory group will be formed to explore the approach and review program content. Members will be openly selected.
  - Funding for technology development activities will be awarded through broadly-competed solicitations.

## **Program Objectives**

- Stimulate the development of revolutionary far-term concepts for gossamer spacecraft in a broadly-competed program.
- Systems studies to define conceptual system architectures, to identify high-payoff component technologies, and to develop requirements.
- Focused development of key component technologies to advance their readiness to the point where they can be integrated into large-scale systems.
- Demonstration of proof-of-concept gossamer spacecraft systems in ground testbeds and flight experiments.
- Infusion of gossamer spacecraft technology into mission applications that support the long-term strategic visions of the NASA Enterprises.

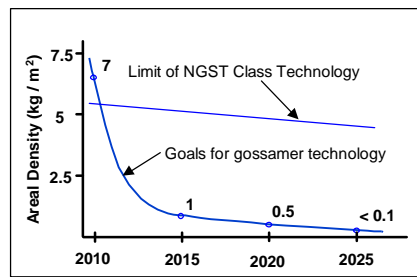


## Focus Area: Gossamer Structures

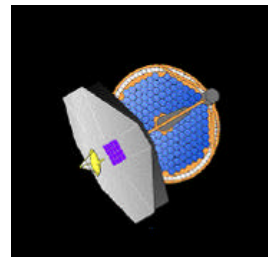


- 100 m class structures
- 100x reduction in launch volume

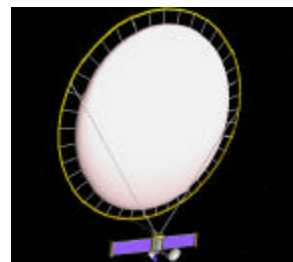
## Focus Area: Large Apertures



Ultra-low areal density accomplished by extensive use of membrane and other breakthrough materials



20-40 m telescopes



25-100 m antennas

## Focus Area: Multifunctional and Adaptive Systems



### Technologies

⇨ Shape control of telescope mirrors and antenna surfaces



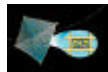
⇨ Adaptive optics and antenna feeds for correcting wavefront errors



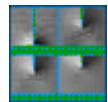
⇨ High-precision metrology systems for determining surface errors



⇨ Control of flexible structure dynamics



⇨ Multifunctional membranes



⇨ Self-healing materials

### Benefits

- Breakthrough reductions in mission cost
- Reconfigurable systems for handling new scientific opportunities as they arise
- Systems that reactively respond to environmental stimuli
- Robust operational capability
- Substantial reductions in system mass and launch volume

## Gossamer Spacecraft Technology Roadmap

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2015-2020

### First Generation



Solar Arrays Antennas



Sunshields



Membrane Materials

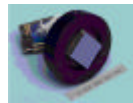


Ultra-Light Booms



Solar Sail

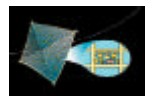
### Second Generation



Adaptive Optical / RF Systems



Membrane Optics



Multifunctional Membranes

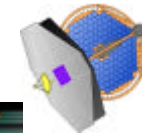


Large Antenna

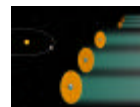
### Third Generation



Evolving/ Reconfigurable Systems



Gossamer Telescope



Multi-Sail Fleets



Interstellar Sail

## R&D Opportunities

- NASA Research Announcement (NRA) for "Technology Development for NASA Science Missions"
  - Solicits proposals for technology development across broad range of technical disciplines, including ultra-lightweight optical systems.
  - Open to industry, universities, and non-NASA governments organizations
  - NRA to be released in mid-April
  - Draft NRA can be found at <http://spacescience.nasa.gov/research/future.htm>
  - \$10M funding available in 1999
  - Funding award will be ~\$300K/year for up to 3 years
- NASA Research Announcement (NRA) for "Gossamer Spacecraft Technology"
  - Fundamental research and development for large apertures and adaptive systems
  - NRA to be released in late-1999
  - ~\$3M available funding
- Ultra-Lightweight Space Optics challenge
  - Solicitation may be issued for ultra-lightweight optics technologies identified at ULSOC workshop
  - NRA/RFP released in mid-1999
  - Expect ~\$500K available funding (authorization pending)

## Summary

- Gossamer spacecraft technology will enable bold new missions of discovery for NASA:
  - Studying galaxy formation at the beginning of time
  - Searching for Earth-like planets around other stars
  - Exploration of nearby star systems with ships sailing on beams of light
- The Gossamer Spacecraft Initiative will involve external scientific and technical advisors to ensure a visionary outlook and excellence in program implementation.
- Proposed implementation approach includes broadly-competed solicitations, and focused technology development areas.
- We need your help to identify high-payoff technologies and innovative approaches for development.