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# NASA's Use of Commercial Satellite Systems: Concepts & Challenges

Presented at **Satellite Networks: Architectures, Applications and Technologies Workshop**

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## Abstract

- Lewis Research Center's Space Communications Program has a responsibility to investigate, plan for, and demonstrate how NASA Enterprises can use advanced commercial communications services and technologies to satisfy their missions' space communications needs. This presentation looks at the features and challenges of alternative hardware system architecture concepts for providing specific categories of communications services.

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## Presentation Agenda

- Background Regarding "Commercial Utilization"
- Potential Service Categories
- System Architecture Concepts
- Features and Challenges
- Conclusions

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## Commercial Utilization

- *"In the conduct of these research and development programs, NASA will seek to **privatize or commercialize its space communications operations.**"*
- *"U.S. Government agencies shall **purchase commercially available goods and services to the fullest extent feasible** and shall not conduct activities with commercial applications that preclude or deter commercial space activities except for reasons of national security or public safety."*

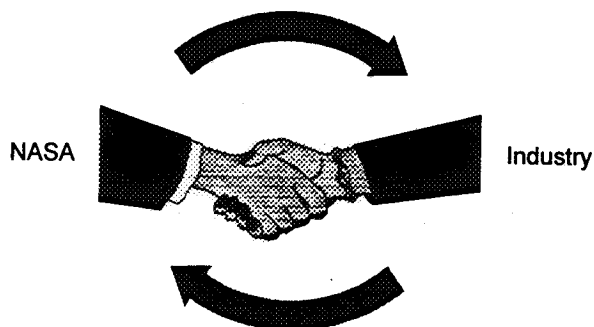
– White House National Space Policy  
Civil Space Guidelines  
Commercial Space Guidelines  
September 19, 1996

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## Commercialization & Utilization

**Commercialization of NASA Technology & Services**



**NASA Utilization of Commercial Technology & Services**

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## LeRC Role

- Lewis Research Center's Space Communications Program has a responsibility to investigate, plan for, and demonstrate how NASA Enterprises can use advanced commercial communications services and technologies to satisfy missions' space communications needs.
- Identify candidate commercial SatCom systems to be leveraged
  - Develop an implementation plan for aligning NASA's needs with commercial capabilities
  - Select, develop and demonstrate enabling technologies and services to mitigate risk
  - Enhance U.S. industry capabilities and competitiveness

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## Physical Architectures

- NASA's use of commercial communications systems requires both:
  - physical links and interfaces compatible with commercial space and terrestrial network infrastructures
  - compatible data communication network protocols
- This presentation focuses on alternative architectures for the physical communications system:
  - to establish the necessary framework for interoperability with commercial space and terrestrial networks
  - to effectively enable the suite of desired communications services

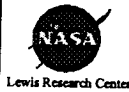
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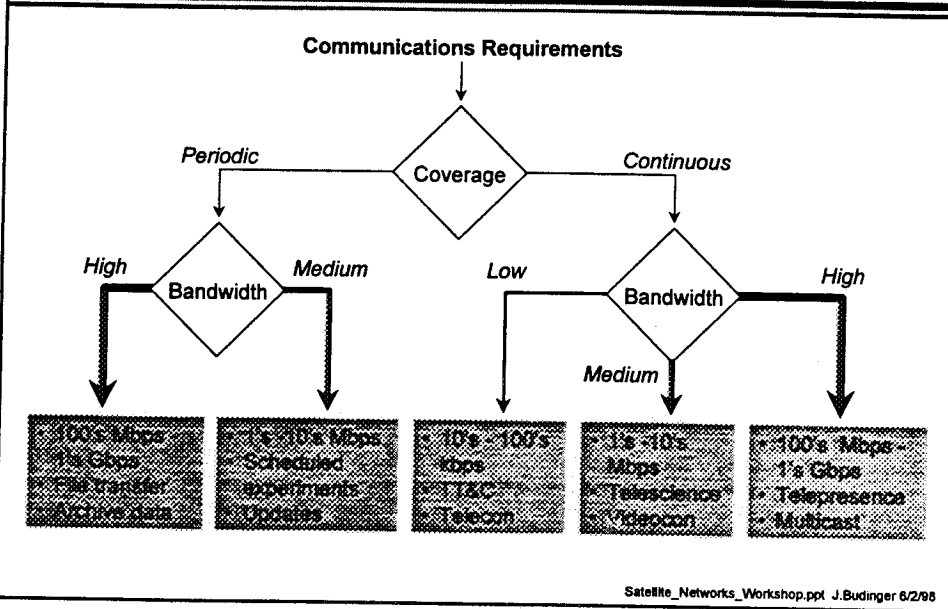
## Potential Service Categories

<b>Service Category</b>	<b>Characteristics &amp; Applications</b>
Narrowband communications	Low-rate data, TT&C, personal communications for humans in space
Wideband tele-science	Asymmetrical, experiment configuration, command, and scientific data return
Broadband tele-presence	Nearly continuous, real-time interaction with space segment
High-capacity storage and distribution	Latency-tolerant, content-rich data, file transfers to PI's and archives
On-demand integrated services	Real-time video, data, and voice, "Spacecraft on the Internet"

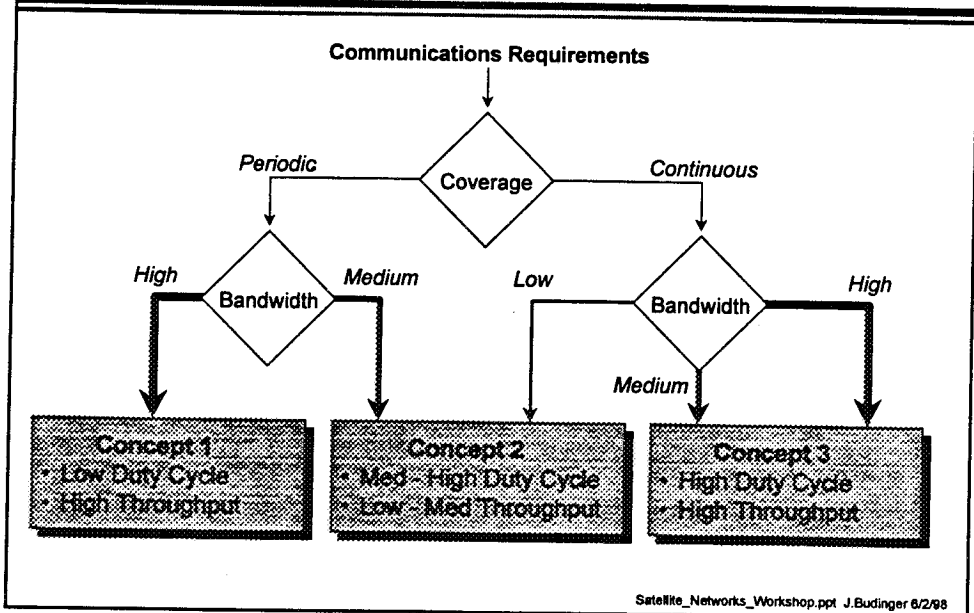
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# Potential Service Categories

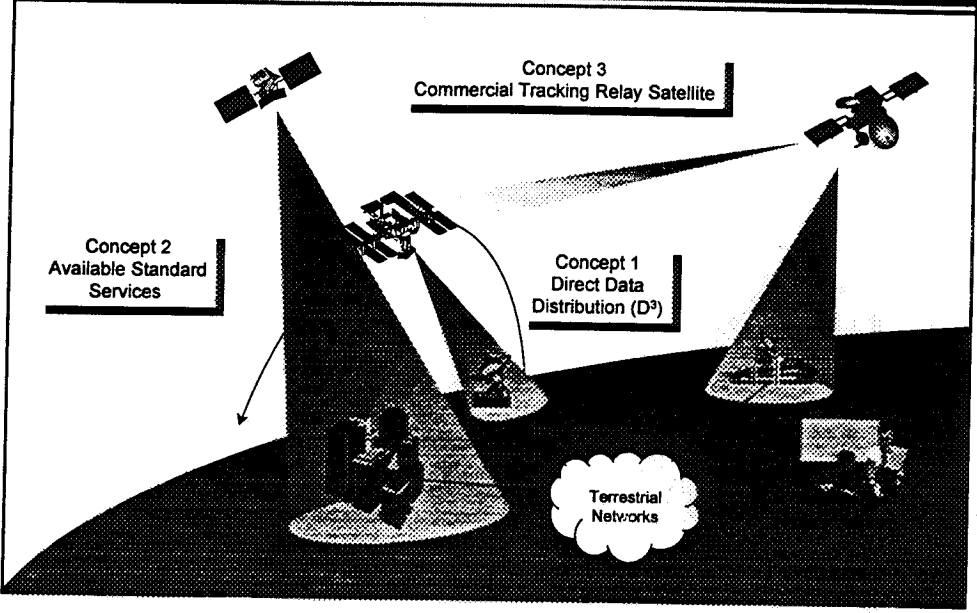


# Responsive Architectural Concepts



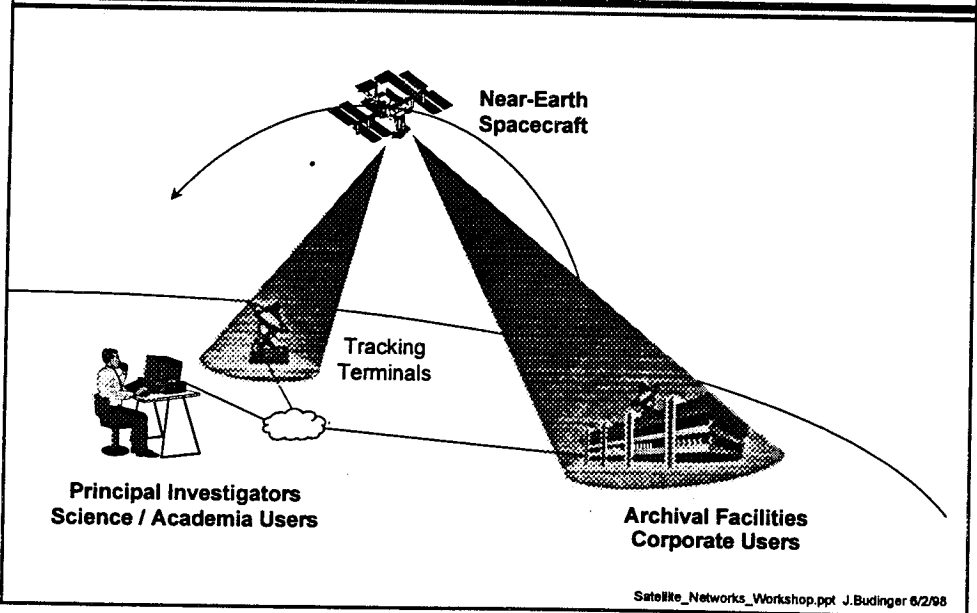


# Architecture Concepts



# Direct Data Distribution (D<sup>3</sup>)

## Architectural Concept 1



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# Direct Data Distribution (D<sup>3</sup>)

## Features

- Onboard data storage and burst data delivery
- 1.2 Gbps downlink in commercial K-band
- ~10 Mbps uplink if needed
- Multi-beam phased array
- Efficient digital modem / codec
- 1.8-m tracking terminals
- Located to maximize contact
- Terrestrial interoperability for wide area distribution
- ~ 72 Gigabits / 1 minute contact
- No reliance on relay satellites
- Experimental capability in 2002

## Challenges

- Latency tolerant applications only
- Onboard storage sufficient for multiple orbits
- Fast acquisition and tracking
- Limited contact:
  - once per orbit at poles
  - 1 or 2 per day elsewhere
- Commercially owned, licensed, & operated on NASA spacecraft & ground segment
- Close coordination with commercial gateways

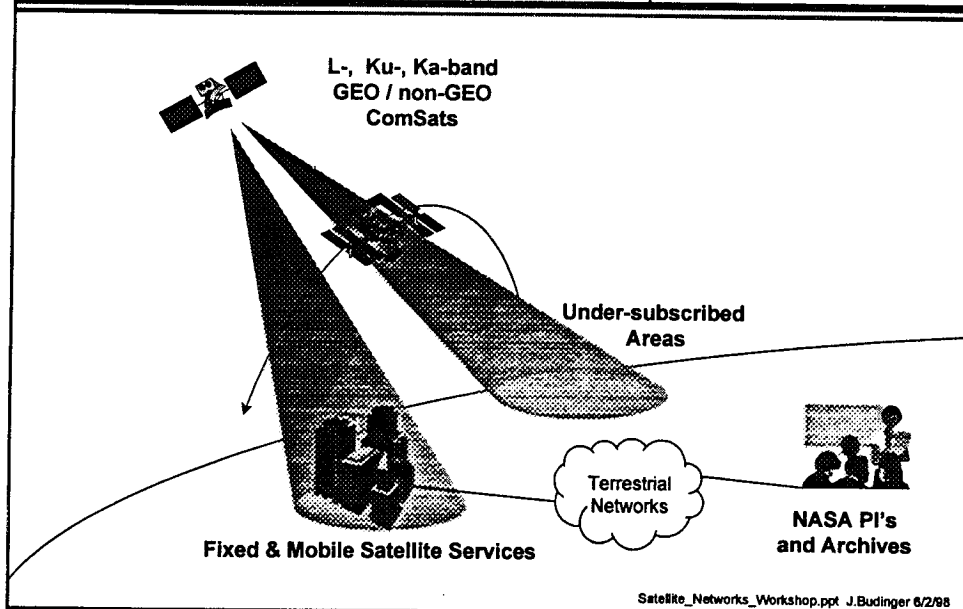
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# Available Standard Services

## Architectural Concept 2



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# Available Standard Services

## Features

- Capture available or unused, unmodified commercial L-, Ku-, and Ka-band capacity
- Global narrowband coverage
  - Multiple 64-kbps circuits
  - TT&C, Low-rate data, voice,
- Periodic wideband coverage
  - 1 to 25 Mbps Forward Link
  - 10 to 155 Mbps Return Link
  - Interactive telescience, video
- 33 to nearly 100% Coverage
- Narrowband demo in 1998 (STS-91 Spacehab - Inmarsat)
- Wideband demos in 2003

## Challenges

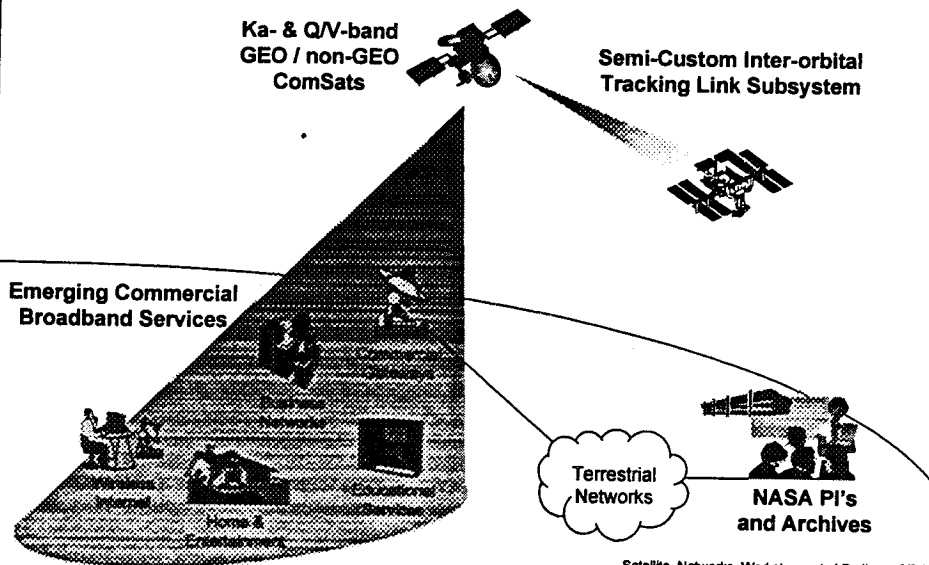
- Current global coverage limited to voice rate applications
- Wideband transponders cover populated areas only
- Close coordination to avoid wideband interference
- Handoffs for non-GEO coverage
- Sufficient business case to provide capacity over unpopulated areas
- Regulatory issue regarding S-S use of S-E and E-S allocations

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# Commercial Tracking Relay

Architectural Concept 3



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## Commercial Tracking Relay

### Features

- Semi-custom rf or optical inter-orbital tracking links
- Periodic to continuous broadband coverage
  - 10 to 55 Mbps forward link
  - 155 to 622 Mbps return link
  - Interactive telepresence
- Video, Data, Voice, Multicast
- 33 to 100% Coverage
- Commercial Ka- and V-band
- **“First generation commercial transceiver”** for NASA
- Service demos in 2004
- Available commercially in 2005 to 2010

### Challenges

- Semi-custom modification to planned systems
- Handoffs for non-GEO system coverage
- Sufficient business case to provide global coverage
- NASA / Industry development of a **common space interface**
- Commercially owned, licensed, & operated on NASA spacecraft

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## Conclusions

- **Opportunities are present and increasing** for NASA missions in near-Earth orbit to use commercial satellite services in the future.
- **No single commercial system** is likely to provide the entire range of services desired by NASA missions.
- Proposed concepts present technical, regulatory and economic challenges, **but none appear to be insurmountable.**
- Commercial systems have limited **windows of opportunity** for modification.
- Government/Industry collaboration is required on interoperability standards for a **common space interface** to commercial satellite networks.
- Communications services first provided for NASA may have potential to open **new markets for the U.S. satellite industry.**

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