ADVANCED TRACKING AND DATA RELAY SATELLITE SYSTEM

Daniel Stern
NASA Headquarters
Washington, D.C. 20546

ADVANCED TDRSS

PURPOSE:

- Provide NASA needs for satellite tracking and communications through the year 2012

- Maintain and augment the current TDRS System when available satellite resources are expended in the latter part of the next decade

- Provide the necessary ground upgrade to support the augmented services

- Introduce new technology to reduce system life-cycle cost.

ATDRSS Configuration
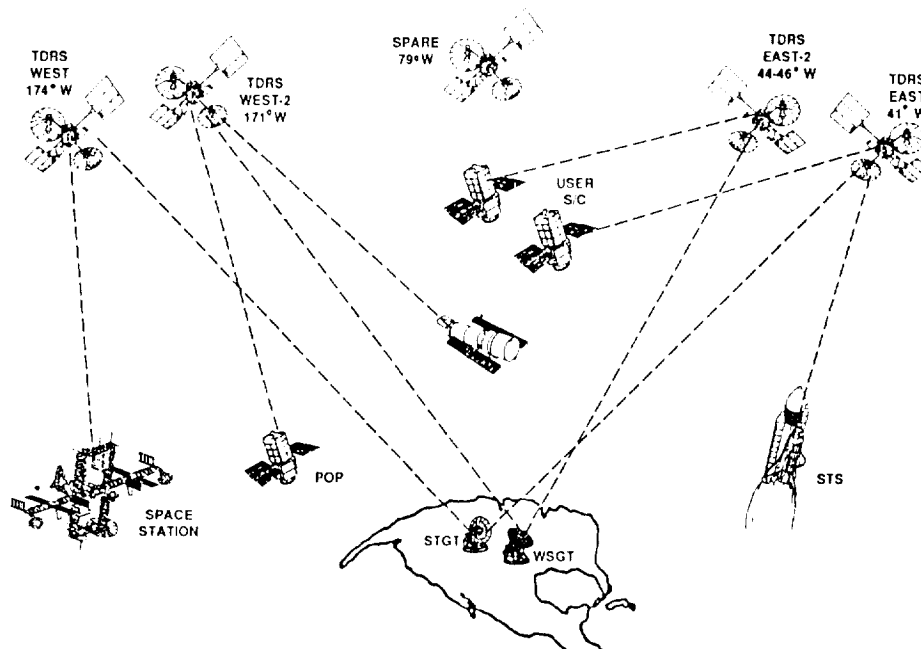
TDRS LAUNCH SCHEDULE

TDRS 1 - Launched 4/83; Degraded Capability
TDRS 2 - Lost in Challenger accident 1/86
TDRS 3 - Launched 9/88
TDRS 4 - Launched 3/89; replaced F-1

TDRS 5 - In orbit spare in 1990
TDRS 6 - Ground spare or fourth satellite in constellation
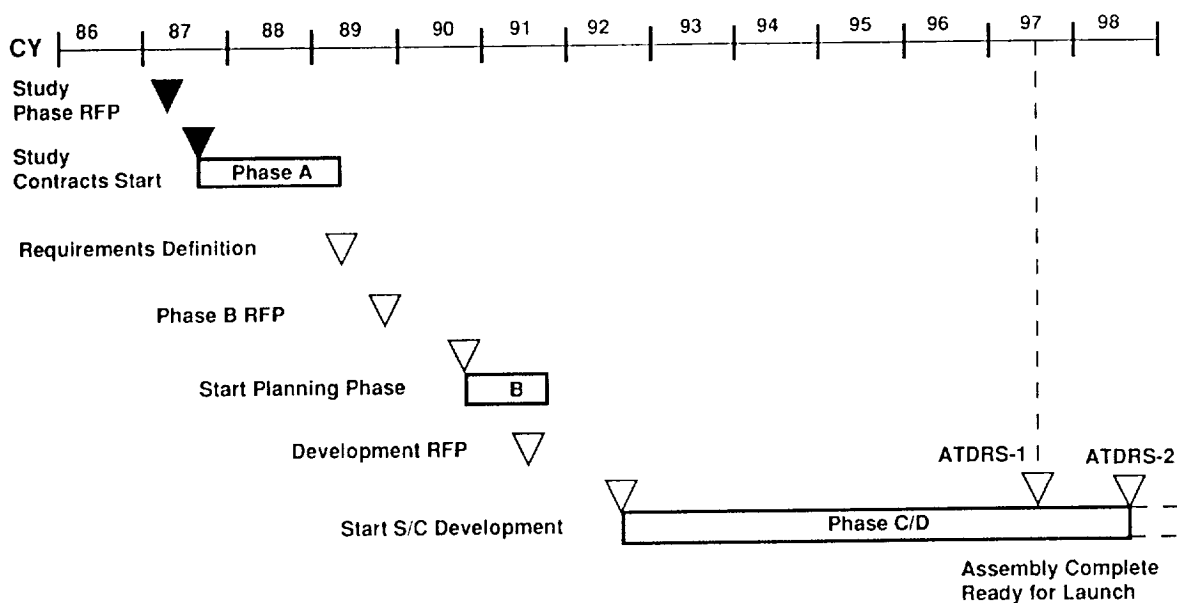TDRS 7 - Replacement spacecraft; available 1992
TDRS 8 - Optional spacecraft; not available before 1994
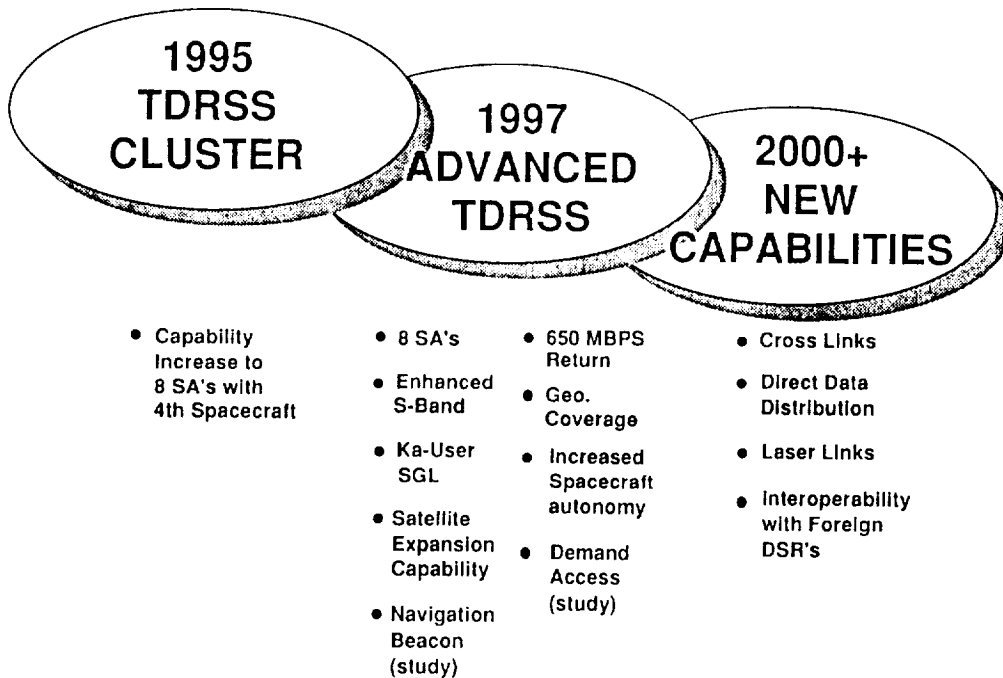ATDRS - Advanced TDRS; not available before July 1997

ADVANCED TDRSS STATUS

- Completed 18-month Conceptual Design Studies (Phase A) in March; Ford, GE, Hughes, Lockheed, TRW

- Phase B RFP to be released in August 1989 for a competitive award to multiple contractors

- Delivery of the first ATDRS is planned for July, 1997

ATDRSS
PROGRAM SCHEDULE

TDRSS EVOLUTION

1995 TDRSS CLUSTER
- Capability Increase to 8 SA's with 4th Spacecraft

1997 ADVANCED TDRSS
- 8 SA's
- Enhanced S-Band
- Ka-User SGL
- Satellite Expansion Capability
- Navigation Beacon (study)
- 650 MBPS Return
- Geo. Coverage
- Increased Spacecraft autonomy
- Demand Access (study)

2000+ NEW CAPABILITIES
- Cross Links
- Direct Data Distribution
- Laser Links
- Interoperability with Foreign DSR's

POTENTIAL SERVICES UNDER EVALUATION

	Status
● Cost vs. benefit of closing the zone of exclusion	Defer
● Increased single access capacity (>300 Mb/sec)	✔
● Direct downlink to some locations or users	Defer
● Demand Access on MA channels	Study
● Interoperability with other data relay satellite systems	Defer
● Increased satellite reliability and redundancy	✔
● GEO user coverage	✔
● Command/Navigation Broadcast (Beacon)	Study
● Pre-Operational Demonstration (Satellite Expansion)	✔

I

TDRSS / ATDRSS
BASELINE SERVICE COMPARISON

Single Access	Max. Rate (MBPS)	No. of Channels	
		1996 TDRSS Cluster	2003 Advanced TDRSS
S-Band	FWD..................0.3 RTN.....................6	8	4* + Spare
Ku-Band	FWD...................25 RTN..................300	8	4* + Spare
Ka-Band	FWD...................50 RTN..................650		4* + Spare
	Total No. of Independent Pointable Antennas	8	8 + 2 Spare

		TDRSS	ATDRSS
Multiple Access	FWD...4 @ 10 KBPS		8 @ 10 KBPS (+3 dBW)
	RTN..20 @ 50 KBPS		12 @ 3 MBPS**

	TDRSS	ATDRSS
Tracking Accuracy	150 M, 3 σ	Study Improvement to 50M, 3 σ

* Minimum- possibly larger   ** MA Gain equal to TDRS Single Access - S-Band

QPSK

- **Expansion to Ka-Band obviates need for highly bandwidth-efficient modulation techniques**

- **Minimizes User and Spacecraft impact**

ATDRSS MODULATIONS

Telecommand: SQPN and data
- PN Range and Command Channel
  PN Spread for ≤ 300 KBPS
- New 50 MBPS Ka-Band is
  Balanced SQPSK

Telemetry:

- **DG1, mode 1+2**   SQPN and data
  - PN Spead at Lower Rates

- **DG1, mode 3**   PSK in quadrature
  - Only I-Channel is PN Spread

- **DG2**   BPSK, QPSK, SQPSK
  - Unbalanced and Balanced Mode
  - SQPSK Used for Equal
    I & Q Data Rates

ATDRSS SIGNAL PARAMETERS

- **Bent-Pipe as TDRS**

- 1×10^{-5} **BER**

- **Convolutional Encoding/Viterbi Decoding
  at 1/2 & 1/3 rates for some modes as in TDRS**
  - **User can provide own End-to-End Encoding**

CONCLUSIONS

- **No ATDRS Spacecraft Requirement for New Modulation Techniques**

- **Data Rate of 650 MBps is Required**

    - **Opportunities Exist for Applications of Advanced Modulation Techniques for Ground Data Distribution**

- **Space Station Freedom Requirement for 650 MBps Data Some Time After the Year 2000**

I