

# **SPACE AND RANGE STANDARDIZATION:**

## **The Real-Time Telemetry Networks (RTTN) Initiative**

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**The MITRE Corporation**

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**Jet Propulsion Laboratory**

# RTTN: "Who's it for?"

DOD

NASA

Commercial

Aircraft

Ships

Missiles

UAVs

Space Vehicles

Satellites

Ground Vehicles

Soldiers

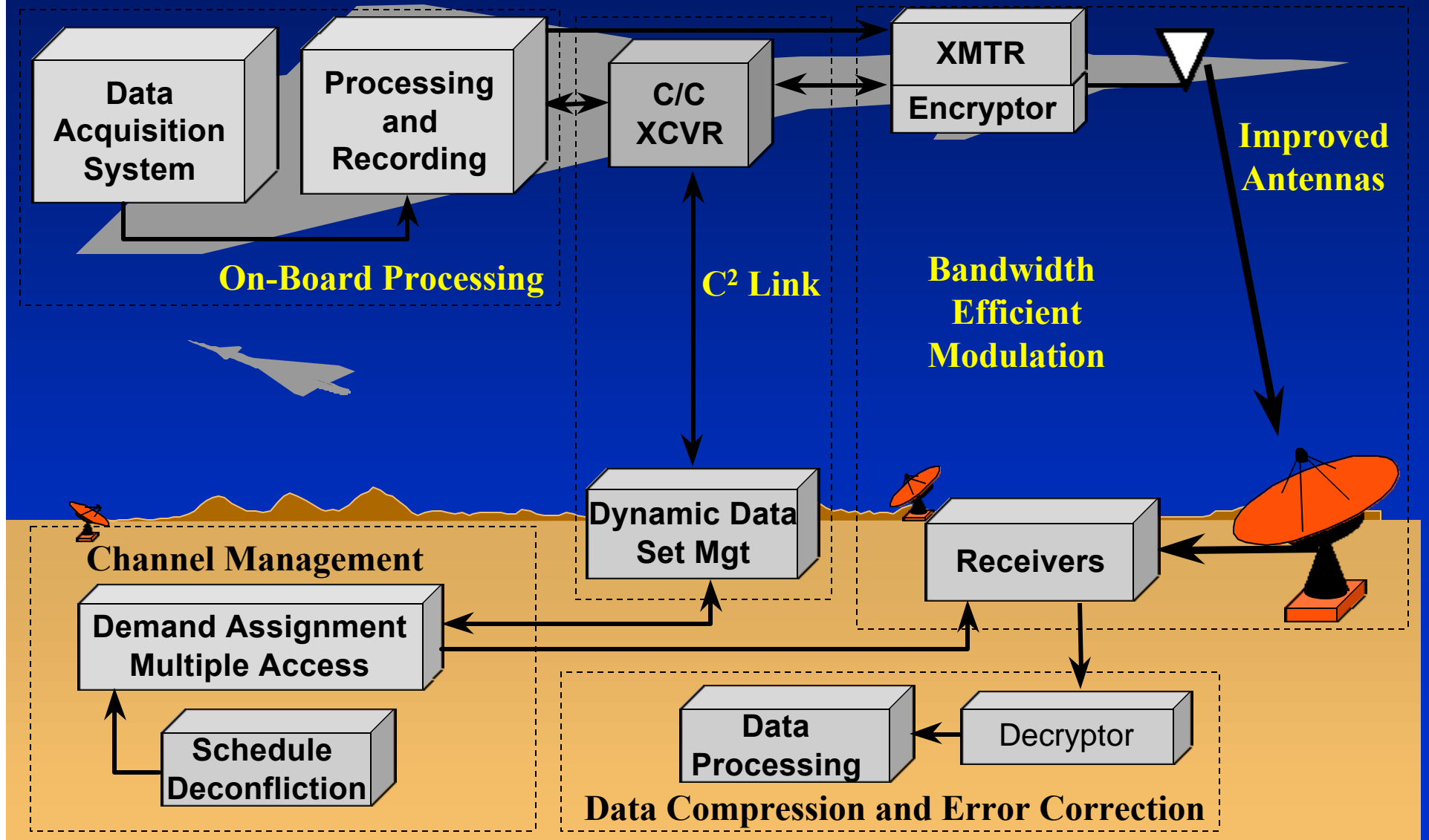
## Precursors to the RTTN

- *The Emergence of Joint Programs:*
  - 1992-1998: joint NASA/DOD SCPS Project
  - 1997+: Range Commanders Council early baselining of Packet Telemetry for onboard aircraft recording
  - 1998: AIAA Efficient Communications Working Group: Efficient Modulation recommendation
  - 1998+: Advanced Range Telemetry (ARTM) program at Edwards
  - 1998: joint DOD/NASA efficient communications standards program proposed, based around CCSDS and ARTM.
  - 1999-2000: National Security Space Architecture “Satellite Operations Transition Plan”
  - 2000: Range Commanders Council baselines of Packet Telemetry for air/ground interface on missile and aircraft test ranges
- *The emergence of a national community with similar needs:*
  - NASA space + DOD Space + DOD Ranges + NASA Aeronautics
- *Four workshops were held to bring this community together:*
  - August 2000, Colorado Springs
  - September 2000, Oxnard (RCC meeting)
  - October 2000, El Segundo (Aerospace)
  - October 2000, ITC, San Diego

**RCC/NASA/DoD Telemetry Networks**  
**ITC Session #18**  
**Wednesday, 25 October 2000**  
**1400-1700**

<b>1400</b>	<b>Session Kickoff</b>	<b>Ray Faulstich (Session Chair)</b> <i>Navy - Pax River</i>
<b>1410</b>	<b>RCC Telemetry Group Intro/Overview</b>	<b>Ken Schoeck (RCC-TG Chair)</b> <i>Vandenberg</i>
<b>1420</b>	<b>TM Networking – A Social Perspective</b>	<b>Tomas Chavez (WSMR)</b> <i>White Sands</i>
<b>1440</b>	<b>DoD Range Perspective</b>	<b>Sid Jones (NAWC-AD)</b> <i>Navy - Pax River</i>
<b>1500</b>	<b>NASA Range Perspective</b>	<b>Larry Freudinger (NASA Dryden)</b>
<b>1520</b>	<b>DoD Space Perspective</b>	<b>Tien Nguyen (Aerospace)</b> <i>Air Force - SMC</i>
<b>1540</b>	<b>NASA Space Perspective</b>	<b>Adrian Hooke (NASA JPL)</b>
<b>1600</b>	<b>Joint NASA/DoD Program</b>	<b>Chuck Irving (AFFTC)</b> <i>Edwards AFB</i>
<b>1620</b>	<b>Q&amp;A “Roundtable”</b>	<b>ALL</b>

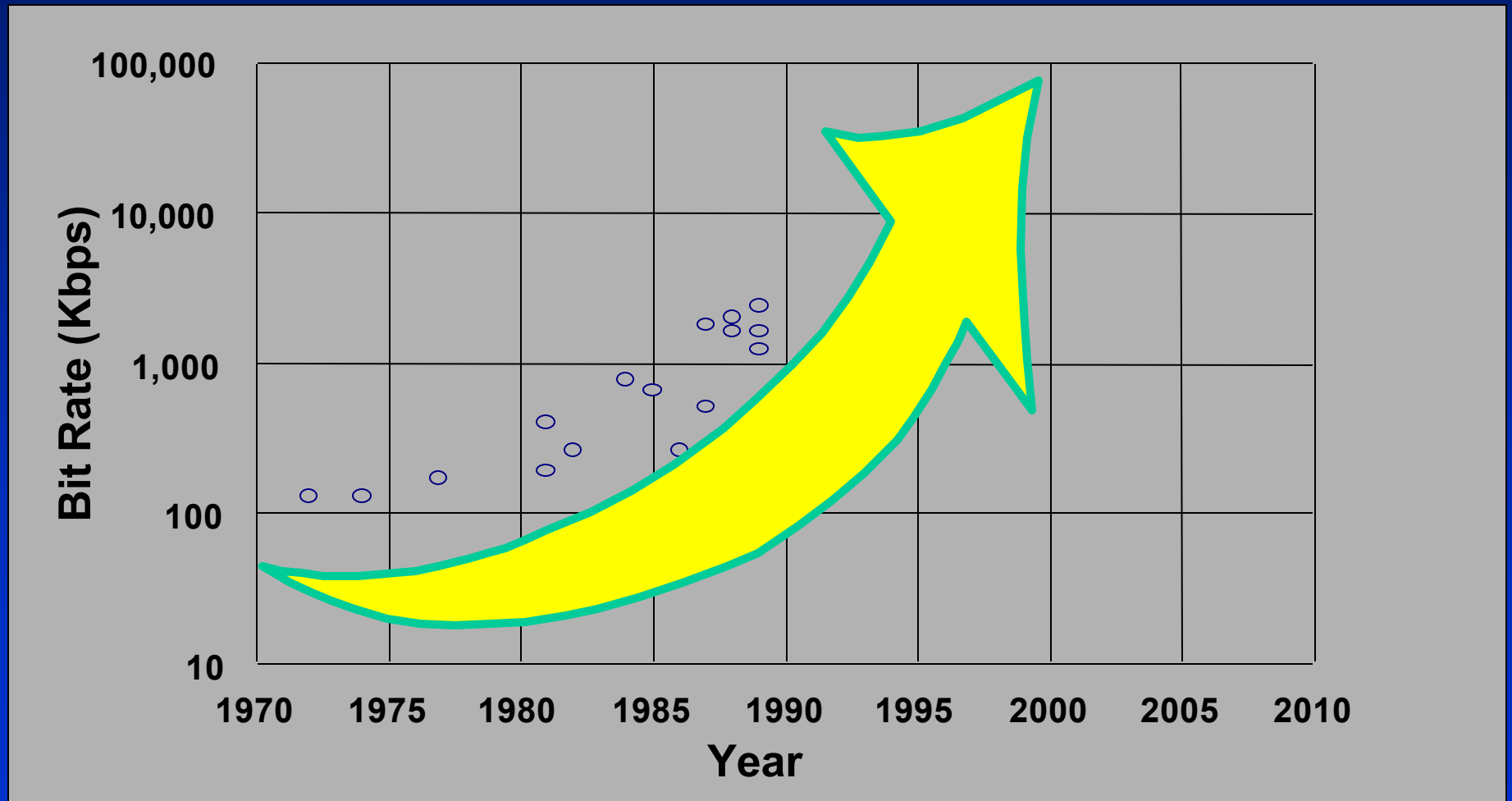
# Advanced Range Telemetry



# What We'll Need Tomorrow

Proposed Roadmap for Telemetry  
Development in a spectrally uncertain  
environment

Tim Chalfant  
Air Force Flight Test Center  
412th TW/TSD



# ARTM Goals

- Increase effective link throughput by 4X.
- Reduce error rates in real-time test data.
- Increase spectral efficiency by 2X.

# Data Acquisition Systems

## T&E Need

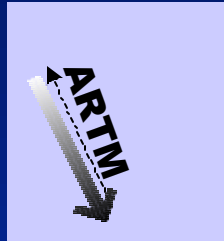
Instrumentation in  
a Networked World

Dan Skelley  
SkelleyDS@Navair.Navy.Mil

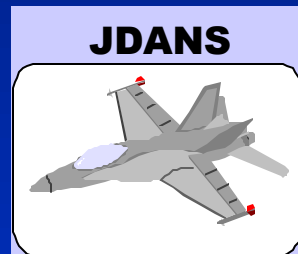
- **Current data requirements exceed the capacity of any single instrumentation system**
- **Ever increasing data acquisition requirements**
  - **Driven by complex weapons platforms**
  - **Faster avionics**
  - **Increased simulation and modeling**
- **Timely insertion of leading edge technology is crucial**
- **Data acquisition systems must be network oriented**
  - **A “network-centric” universe demands it!**



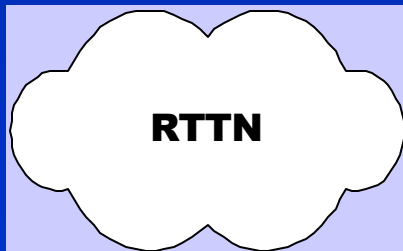
# The Big Picture



- Test vehicle to ground station
- Data link efficiencies and improvements



- Within the vehicle
- Standard data formats/packets
- Standard software support



- Node to Node
- Bi-directional network link



# AFSCN STANDARDS AND PROTOCOLS GOALS

## **STANDARDS AND PROTOCOLS FOR FUTURE AIR FORCE SATELLITE CONTROL NETWORK**

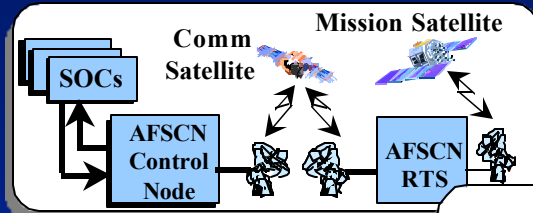
*-PRELIMINARY INVESTIGATION-*

Dr. TIEN M. NGUYEN  
THE AEROSPACE CORPORATION  
EL SEGUNDO, CALIFORNIA

- **OBJECTIVES:**
  - **ENHANCE INTEROPERABILITY WITH OTHER SATELLITE CONTROL SYSTEMS**
  - **SUPPORT GREATER USE OF COTS EQUIPMENT AND SERVICES**
- **ADD ASTRODYNAMIC STANDARDS TO ORBIT ANALYSIS AREA**
- **ADD STANDARD WAN INTERFACE TO NEW RTS (AND SOC)**
- **ADD USB AND CCSDS SPACE-TO-GROUND LINK TO RTS**
- **ADD STANDARD SCHEDULING AND NET STATUS INTERFACES**

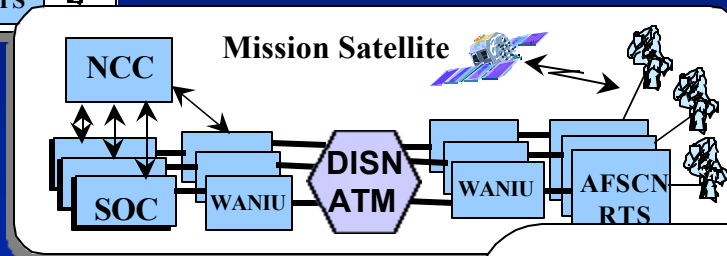
# AFSCN ARCHITECTURE EVOLUTION

Centralized Control, Centralized Execution, Point to Point Links



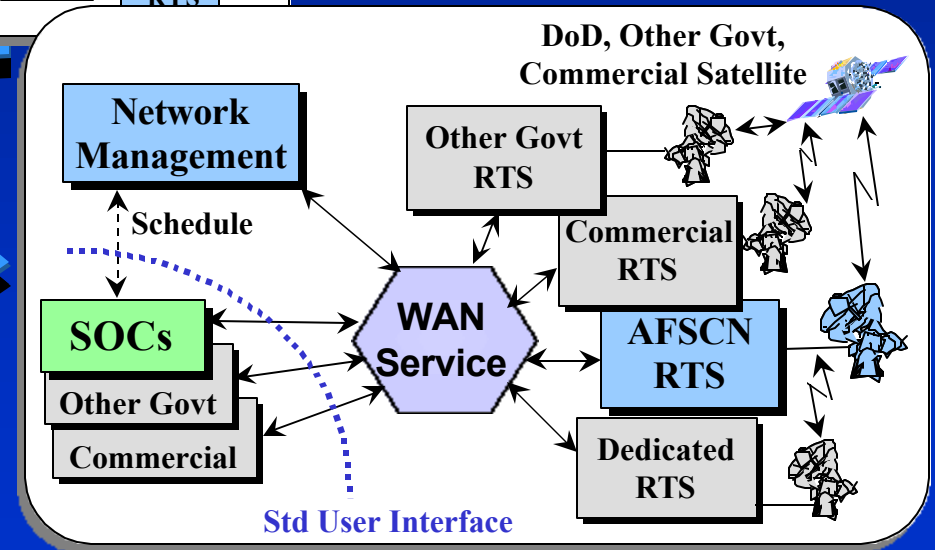
Today

Centralized Control, Decentralized Execution, DISN Network



After Comm Upgrades (2003)

Centralized Scheduling, Decentralized Execution, Multi-User WAN Service

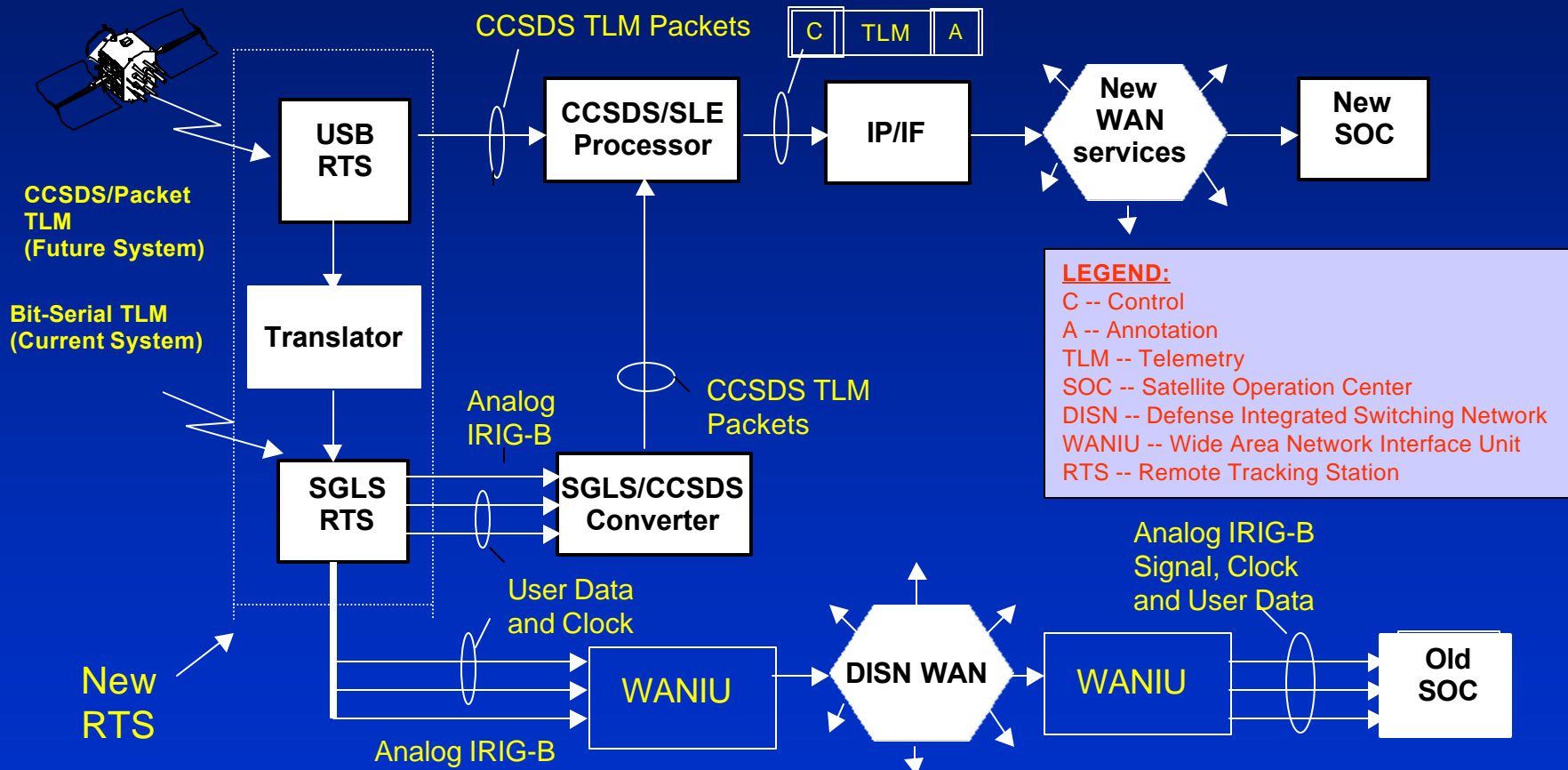


2007

LEGEND:

RTS = REMOTE TRACKING STATION  
 NCC = NETWORK CONTROL CENTER  
 SOC = SPACE OPERATION CENTER  
 WAN/IU = WIDE AREA NETWORK/INTERFACE UNIT  
 DISN = DEFENSE INTEGRATED SWITCHING NETWORK

# PROPOSED ARCHITECTURE FOR TELEMETRY NETWORK



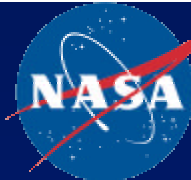
# **SPACE LINK EXTENSION (SLE) APPLICATIONS TO AFSCN**

- **RECOMMEND THE USE OF SLE PROTOCOLS FOR FUTURE AFSCN APPLICATIONS:**
  - **TO PROVIDE THE REQUIRED AFSCN SERVICES FOR:**
    - **SOC-NCC LINK**
    - **SOC-RTS LINK**
  - **FOR INTERACTION WITH RTS**
  - **TO PROVIDE TIME TAGGING SERVICES FOR TELEMETRY DATA:**
    - **SLE PROTOCOLS CAN PROVIDE TIME TAGGING SERVICE FOR ENCRYPTED TELEMETRY DATA, IF THE DATA IS FORMATTED IN CCSDS-TELEMETRY PACKET BEFORE TRANSMISSION AT S/V**

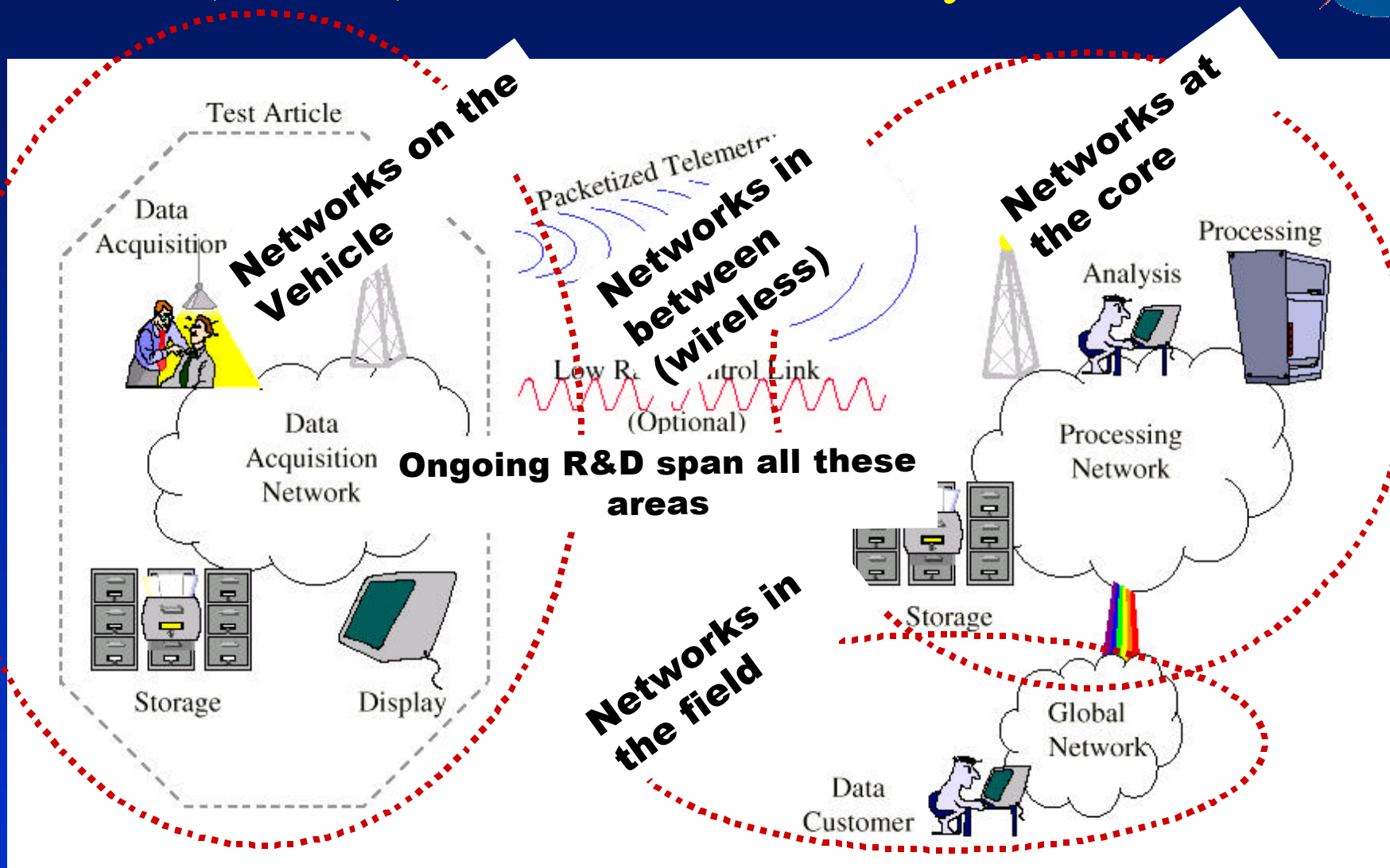
# **SCPS PROTOCOLS**

## **WHY SCPS FOR AFSCN APPLICATIONS?**

- **SCPS TAILORS INTERNET PROTOCOLS FOR SPACE ENVIRONMENT**
- **SCPS PROTOCOLS STANDARDS PROVIDES STANDARDIZED ACCESS OF SPACE ASSETS VIA RTSs**
  - **SUPPORTED BY NATIONAL AND INTERNATIONAL SPACE AGENCIES (INTEROPERABILITY ISSUE)**
  - **PROMOTES THE DEVELOPMENT OF THE COMMERCIAL OFF-THE-SHELF COMPONENTS (COST ISSUE)**
- **SERVICE AND LAYER ORIENTED:**
  - **DEFINES A STANDARD SET OF SERVICES**
  - **STANDARDIZES THE FUNCTIONALITY OF EACH SERVICE**
  - **STANDARDIZES THE INTERFACE TO EACH SERVICE**
  - **HIDES IMPLEMENTATION DETAILS**
- **FLEXIBLE AND MODULAR**
  - **USER MAY CHOOSE TO USE ALL THE SCPS PROTOCOL LAYERS, OR ANY COMBINATION THEREOF, OR SUBSTITUTE HIS OWN**

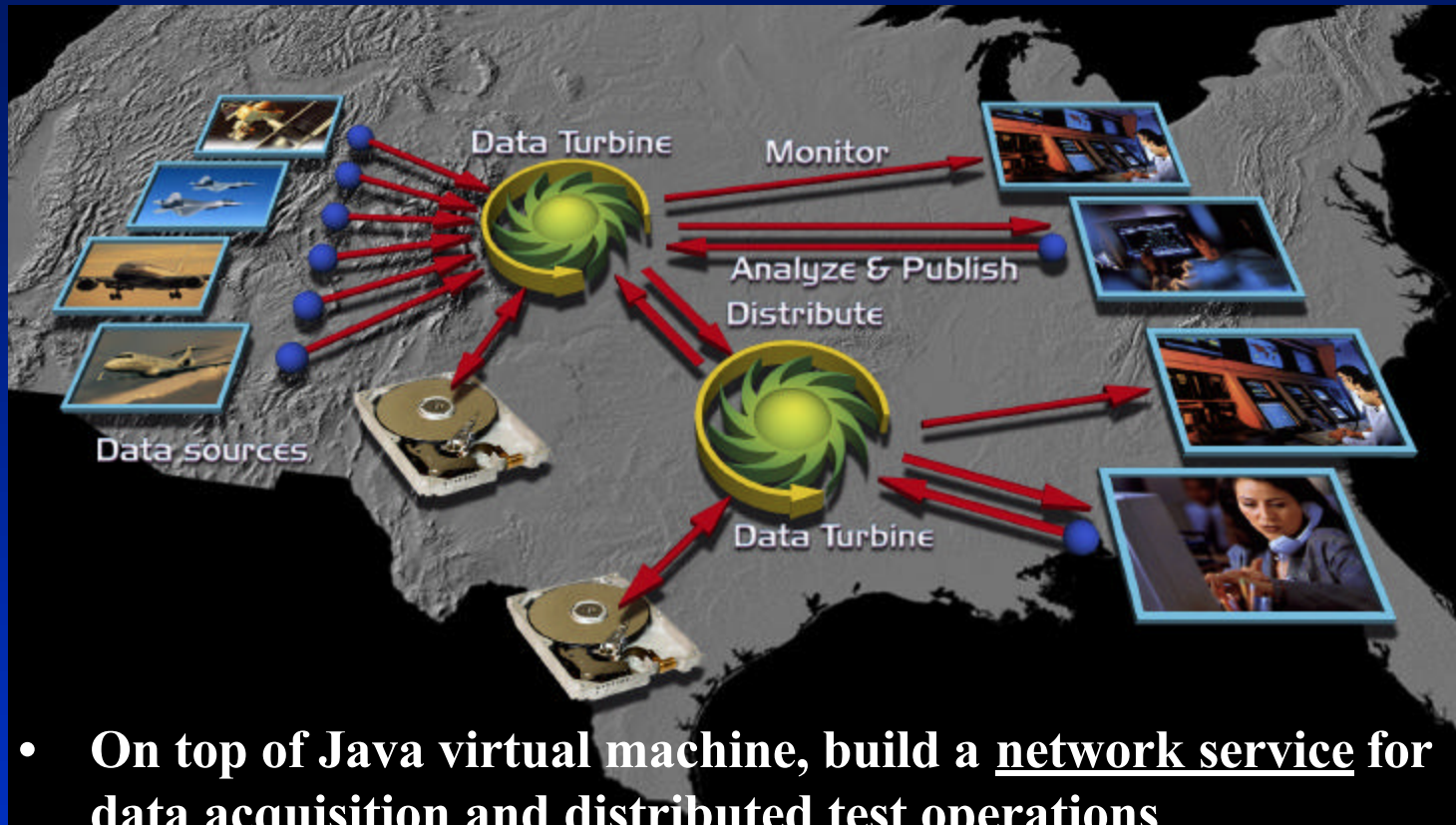
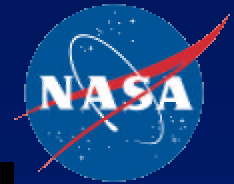


# (RTTN) Realtime Telemetry Networks



Adapted from: Skelley & Jones, *The Impact of Network Architecture on Data Acquisition Systems*, Int'l Telemetry Conference 1998, <http://nexgenbus.nawcad.navy.mil/Docs/ITC98-NetworksPaper.pdf>

# Ring Buffered Network Bus



- **On top of Java virtual machine, build a network service for data acquisition and distributed test operations**
- **example of 3<sup>rd</sup> generation data acquisition applications: multivendor components**
- **use it to build networks of cooperating applications**



## What is the RTTN Initiative?

- **A joint DOD/NASA program focused on providing “next generation” high performance communications in support of mobile airborne and spaceborne systems operating in stressed wireless environments :**
  - Aircraft
  - Missiles
  - Spacecraft
- **A fundamental concept of operations is to upgrade classical point to point “telemetry” to embrace *wireless networking* technology**
  - Aircraft and spacecraft are “nodes on a network” rather than just “the ends of a link”
- **Close integration with (and exploitation of) commercial wireless Internet technologies**
  - Partner with the emerging wireless networking industry to maximize use of their techniques in the RTTN environment
    - 1) Adopt
    - 2) Adapt
    - 3) Develop
- **Use standardization to foster:**
  - a) interoperability to permit resource sharing and
  - b) creation of a sufficiently large marketplace to stimulate investment in COTS
- **Use experimentation and testing as an integral part of demonstrating the readiness of new technologies for operational use**

# What Next?

- **Band together to stimulate a “common market” for COTS products by initiating a strong national program across the **aerospace community****
  - initial focus on developing an open, interoperable stack of bandwidth and power-efficient wireless communications protocols for use by:
    - *DOD Ranges*
    - *DOD Space*
    - *Civil Aeronautics*
    - *Civil Space*
- **Synchronize this national program with the international community by orchestrating its participation in open standards organizations**