SPACE AND RANGE STANDARDIZATION:

The Real-Time Telemetry Networks (RTTN) Initiative

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RTTN: “Who’s it for?”

- DOD
  - Aircraft
  - Space Vehicles
  - Ground Vehicles
- NASA
  - Ships
- Commercial
  - Missiles
  - UAVs
  - Satellites
  - Soldiers
Precursors to the RTTN

• **The Emergence of Joint Programs:**
  – 1997+: Range Commanders Council early baselining of Packet Telemetry for onboard aircraft recording
  – 1998+: Advanced Range Telemetry (ARTM) program at Edwards
  – 1998: joint DOD/NASA efficient communications standards program proposed, based around CCSDS and ARTM.
  – 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
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<th>Presenter and Affiliation</th>
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Advanced Range Telemetry

Data Acquisition System

Processing and Recording

C/C XCVR

XMTR Encryptor

Improved Antennas

On-Board Processing

C² Link

Bandwidth Efficient Modulation

Dynamic Data Set Mgt

Data Compression and Error Correction

Demand Assignment Multiple Access

Schedule Deconfliction

Data Processing

Decryptor

Receivers

Channel Management

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/TSDD
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

- 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!

Instrumentation in a Networked World

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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
An Integrated Path to T&E Networks

- FireWire shows promise
- NexGenBus
- RCC task TG-54
- ARTM
- RCC task TG-53
- RCC task TG-55
- Std Packet
- JDANS
- RTTN
AFSCN STANDARDS AND PROTOCOLS GOALS

STANDARDS AND PROTOCOLS FOR FUTURE AIR FORCE SATELLITE CONTROL NETWORK
- PRELIMINARY INVESTIGATION-

• 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

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

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

Today
Centralized Control, Centralized Execution, Point to Point Links
Comm Satellite
Mission Satellite
AFSCN Control Node
AFSCN RTS
SOCs

After Comm Upgrades (2003)
Centralized Control, Decentralized Execution, DISN Network
NCC
SOC
WANU
DISN ATM
WANU
AFSCN RTS
Mission Satellite

2007
Centralized Scheduling, Decentralized Execution, Multi-User WAN Service
DoD, Other Govt, Commercial Satellite
Network Management
Schedule
SOCs
Other Govt
Commercial
WAN Service
Std User Interface
Other Govt RTS
Commercial RTS
AFSCN RTS
Dedicated RTS
PROPOSED ARCHITECTURE FOR TELEMETRY NETWORK

LEGEND:
C -- Control
A -- Annotation
TLM -- Telemetry
SOC -- Satellite Operation Center
DISN -- Defense Integrated Switching Network
WANIU -- Wide Area Network Interface Unit
RTS -- Remote Tracking Station
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


Ongoing R&D span all these areas

Networks on the Vehicle

Networks at the core

Networks in the field

Networks in between (wireless)
• On top of Java virtual machine, build a **network service** for data acquisition and distributed test operations

• example of *3rd* generation data acquisition applications: multivendor components

• use it to build networks of cooperating applications
Scope of Real Time Telemetry Networks

- Familiar Web-based interfaces
- Wired Internet
- Untethered
- Highly Stressed Wireless Network

- Significant Delay
- Constrained Processing/Storage
- Constrained Power/Bandwidth
- Weak Signals - High Errors
- Asymmetric Data Rates
- Often Unidirectional
- Disjoint Connectivity

- No Delay
- Today’s computers
- Plenty of Power/Bandwidth
- Clean Data
- Symmetric Data Rates
- Bidirectional Data Transfer
- Continuous Connectivity

Wired Internet

Untethered
Highly Stressed Wireless Network
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