

The Role of Scalable, “Client” & “Server” Technologies in Emerging Space Ground Systems

by

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communications

Telemetry & Instrumentation

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Objective

Describe “Client” and “Server” technologies used in telemetry processing segments of modern ground station architectures which provide for:

- **Scalability**
 - *Rate independence*
- **Portability**
 - *Platform independence*
- **Interoperability**
 - *Vendor Independence*
- **Affordability**
 - *Financial Independence*

Background

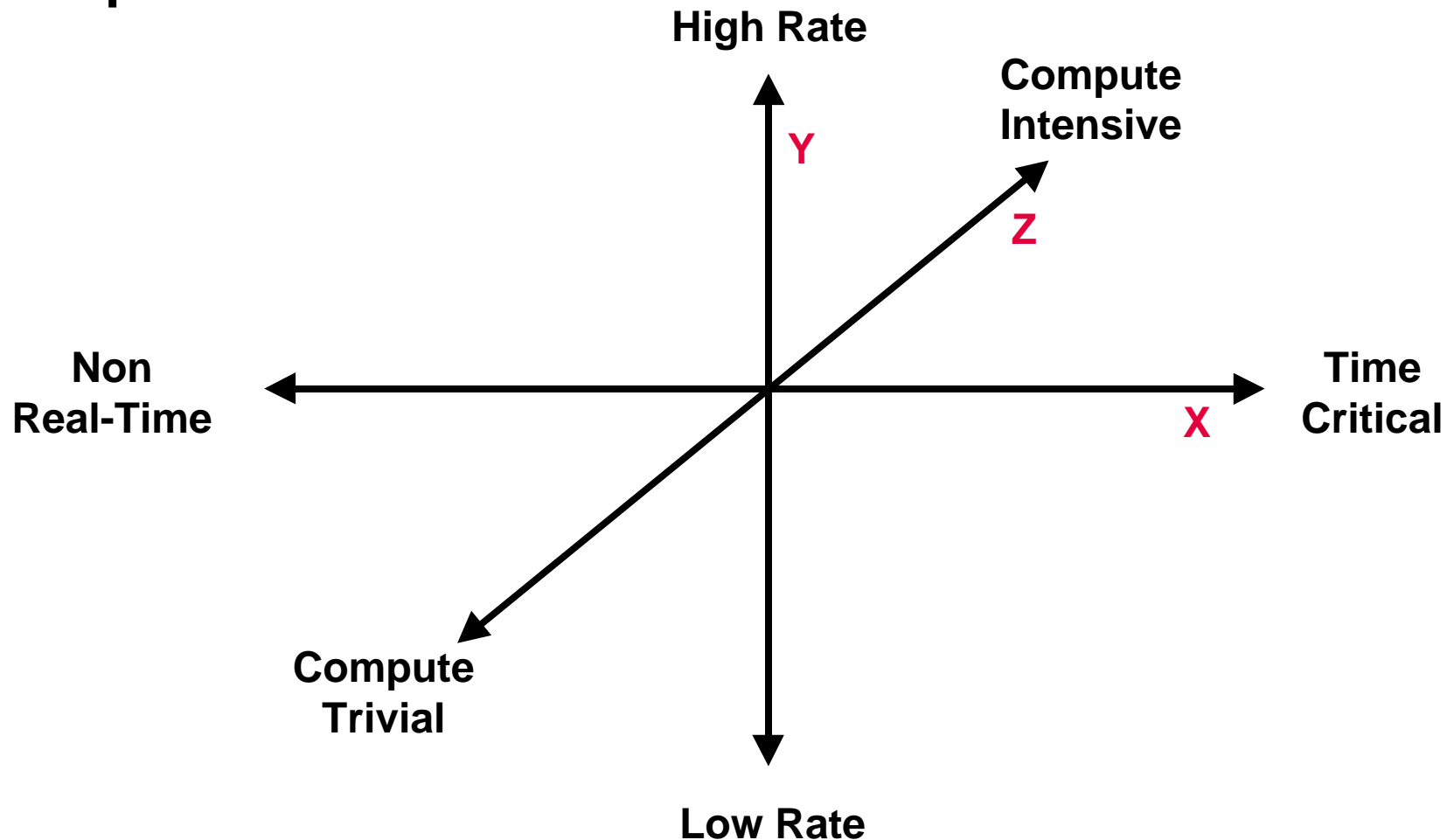
- **Past attempts to standardize on an architecture and implementation which meets the preponderance of USAF's Space Ground Segment (SGS) requirements have been thwarted by:**
 - *Costs associated with retrofitting legacy architectures*
 - *Development costs associated with tailoring standard systems for first use*
 - *Mission schedules*
 - *Etc.*
- **Current Military SGS acquisition strategies now focus on obtaining the optimum solution based on specific mission requirements - MISCS, LANCE**

SGS Missions

- **Specific SGS telemetry processing requirements vary widely from mission to mission**
- **Low rate**
 - *GEO satellite Telemetry, Tracking & Commanding (TT&C)*
 - *Payload State of Health (SOH)*
- **Intermediate Rate**
 - *Expendable Launch Vehicle (ELV) processing / monitoring*
 - *Research, Development, Test & Evaluation (RDT&E) satellite mission data processing*
- **High Rate**
 - *Mission data processing*

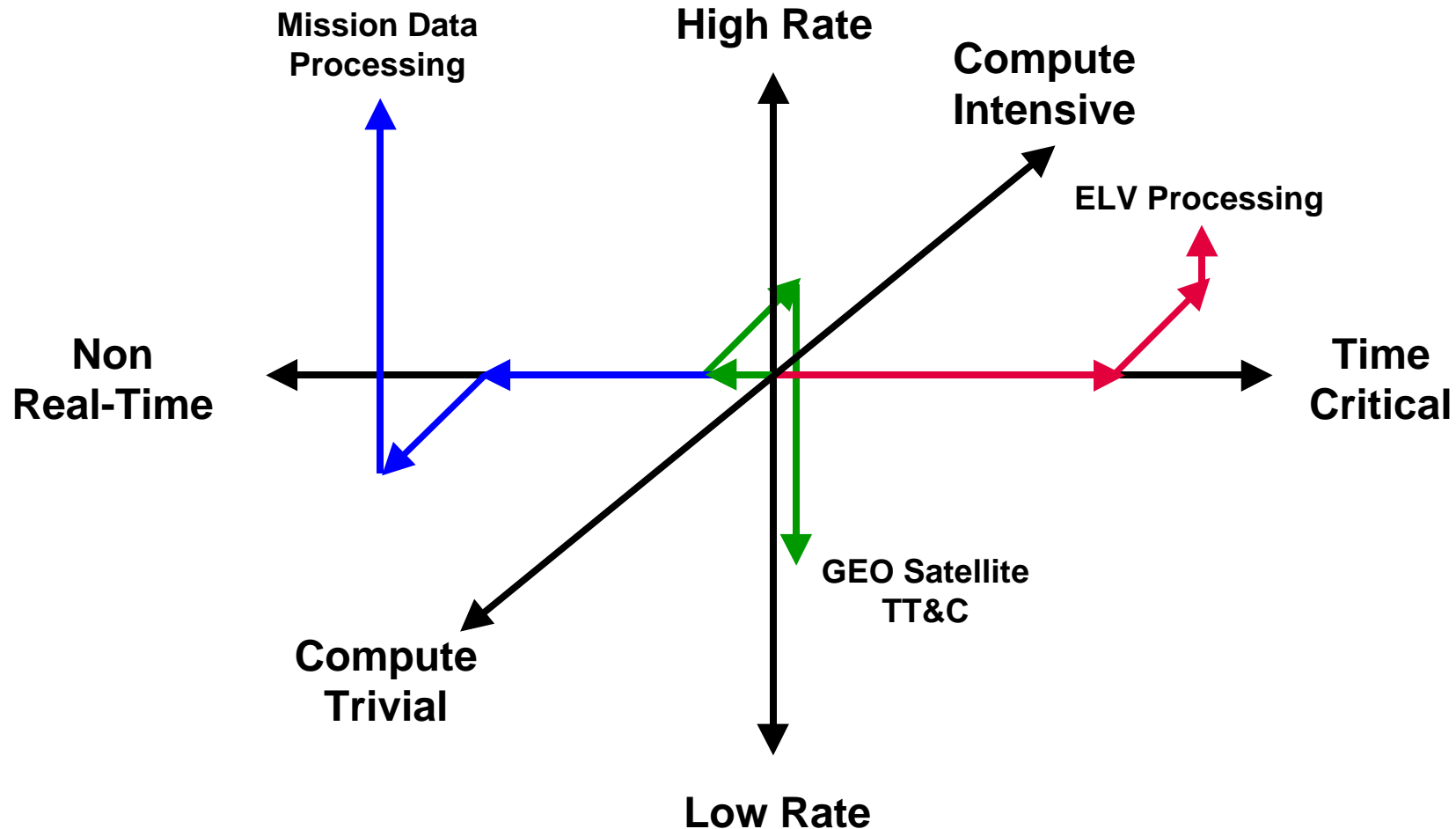
SGS Telemetry Processing Domain

Telemetry processing missions are subject to multiple independent factors:



SGS Telemetry Processing Examples

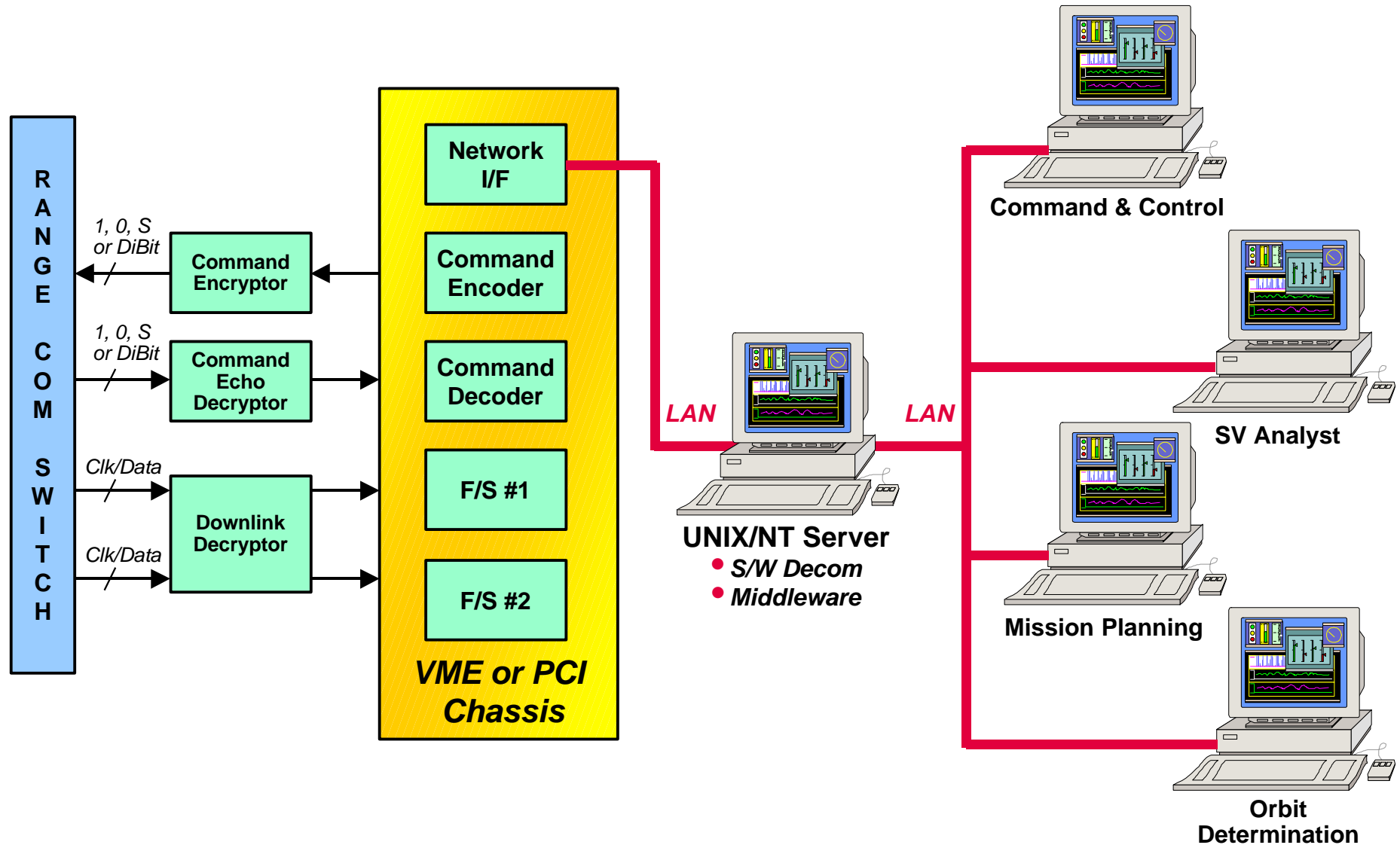
Specific missions diverge widely upon examination:



SGS Telemetry Processing Architecture Implementation Trades

- **Based on requirements, system engineers must consider many implementation options:**
 - *Remote/local telemetry processing*
 - *Hardware, Software, Hybrid Decommutator*
 - *Raw, processed and/or compressed data archival*
 - *UNIX, Windows NT or Real-time Operating Systems*
 - *Dual bus or Uni-bus TFE (aka Frame Sync)*
 - *Disk, Tape and/or Optical archival and playback*
 - *COTS Middleware and/or COTS API interfaces*
 - *Re-use of legacy hardware and software components*
 - *Etc.*

Low Rate SGS Implementation

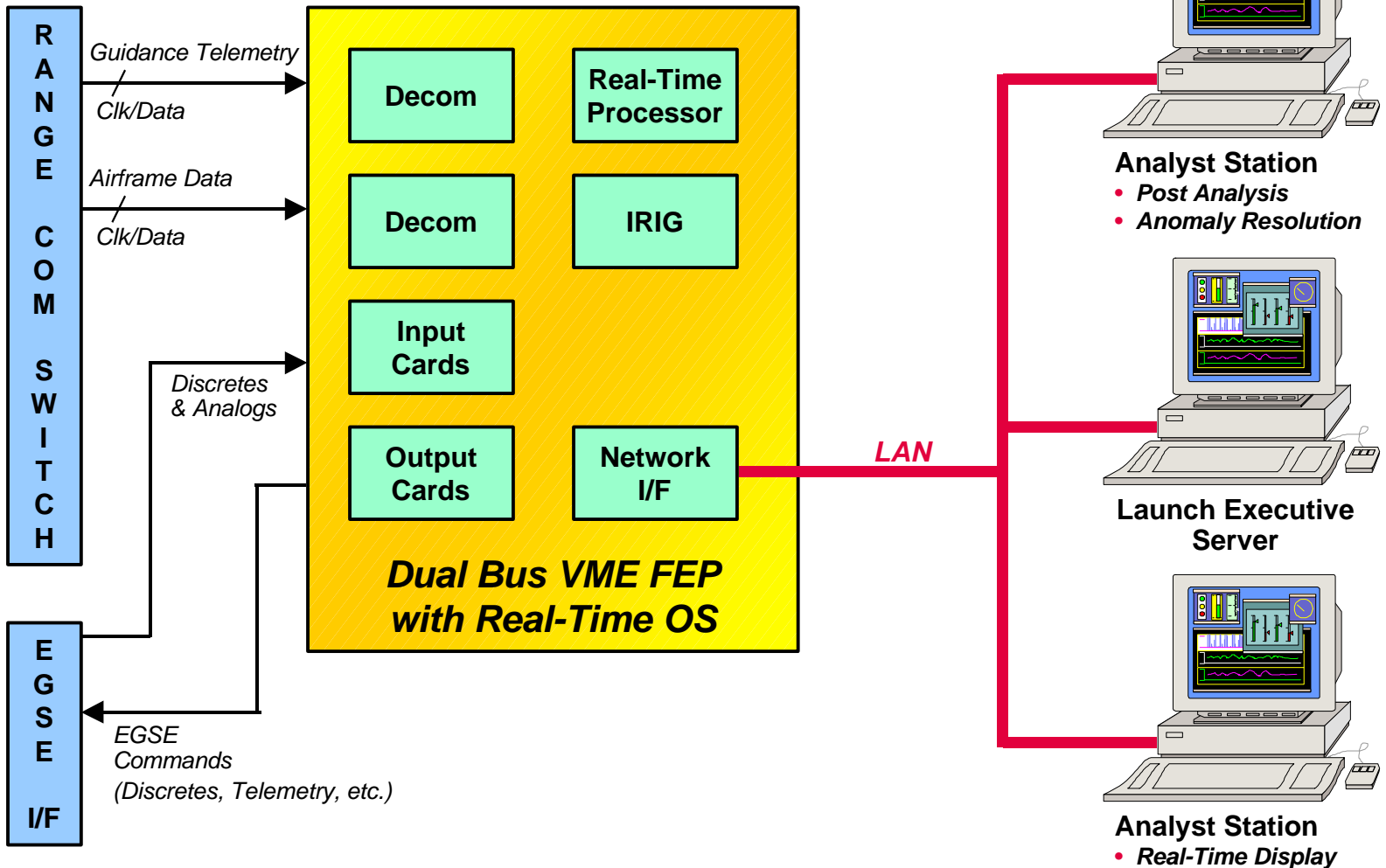


Software Decom Characteristics

- **Flexible decommutation schemes**
- **Lower acquisition costs**
- **Offers platform portability**
- **Strong diagnostic tools**
- **Limited data overhead**
- **Subject to vendor O.S. changes**
- **Subject to rate, compute, real-time requirements/changes**

Intermediate Rate SGS Implementation

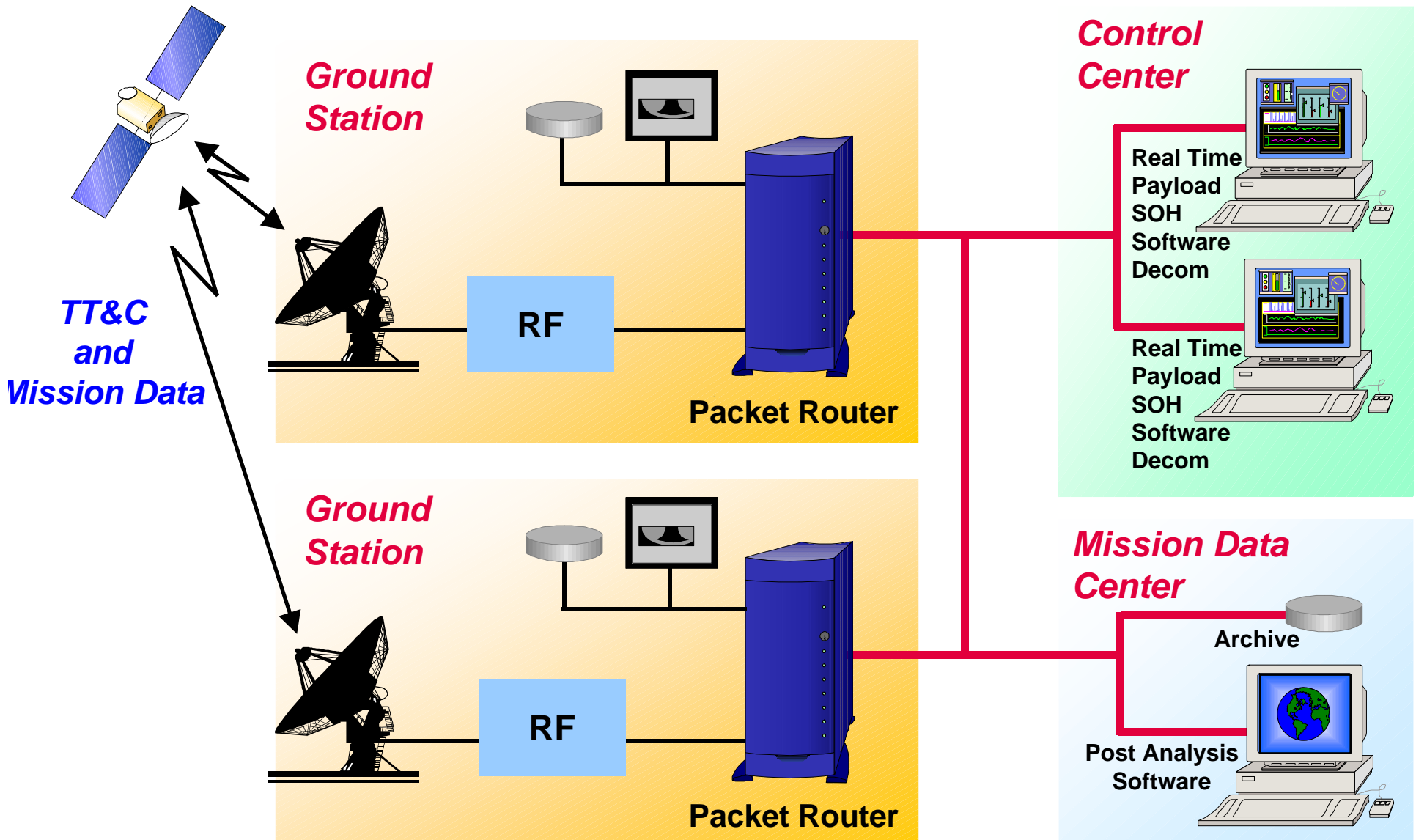
Implementation — Intermediate Rate



Hardware/Hybrid Decom Characteristics

- **Offers rate change immunity**
- **Supports time critical processing**
- **Multi-stream extensible**
- **Strong “inter” stream processing**
- **Fixed maintenance costs**
- **Higher acquisition costs**
- **Reduced decom flexibility**

High Rate SGS Implementation

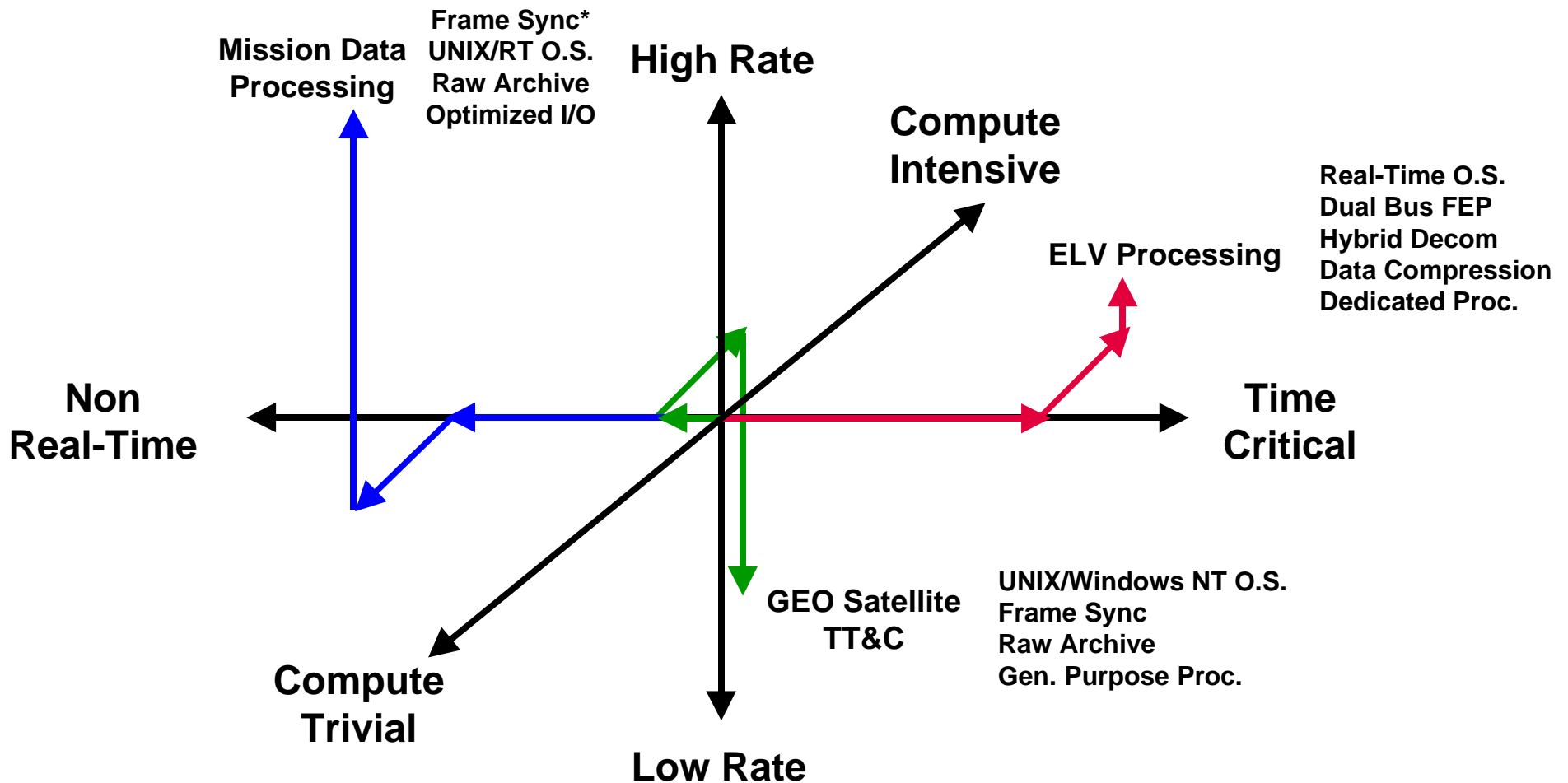


Operating System Trades

	<i>PROs</i>	<i>CONs</i>
<i>Windows NT</i>	PC compatible Lower acquisition costs One version to maintain	Reliability Issues Limited H/W platforms
<i>UNIX</i>	High performance Mature space S/W Applications Robust system diagnostics	Higher costs Long term support
<i>Real-Time</i>	Highest performance Determinism Exploit dedicated processors	Higher costs Limited diagnostics Limited platforms

Telemetry Processing Implementations

Implementations diverge widely based on requirements:



“Client” and “Server” Technologies Used in SGS

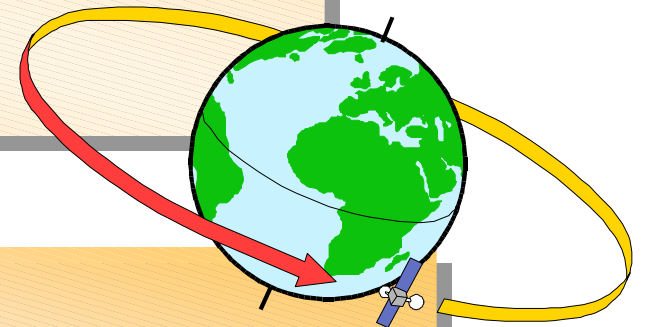
- **Modern SGS exploit varied “Client” and “Server” technologies in their implementation**
 - ***Frame Synchronizer***
 - Frame server
 - ***Telemetry front end (hardware / hybrid decom)***
 - Measureand server
 - ***Software decom***
 - Frame server client
 - Measureand server
 - ***Application programmer I/F***
 - Frame / measureand client
 - ***Middleware***
 - TFE and software decom client
 - Measureand server

L-3 Technologies Applied to Client/Server Solutions

- **L-3 Communications Telemetry and Instrumentation (T&I) has traditionally fielded client/server based telemetry processing solutions for intermediate rate, time critical and high reliability applications (System 500 Model 550)**
- **T&I also offers telemetry solutions for commercial space applications with a low rate and low cost integrated solution (Visual Test System and NeTstar)**
- **T&I has recently introduced two new client and server product offerings to address a wider application envelope – Impact 2000 and SWIFT**

What is the Impact 2000?

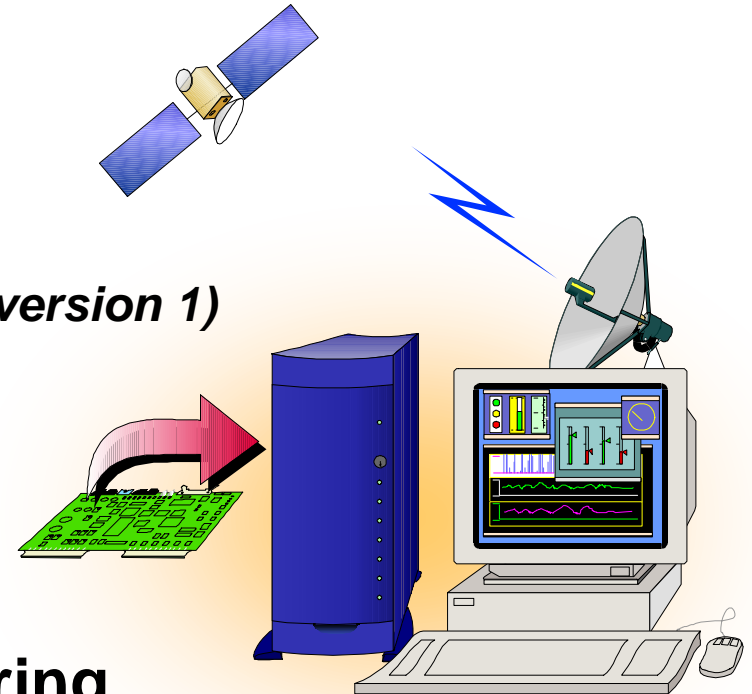
- A scalable system for processing space link formats and protocols (up and down links) with a network interface for distributing data and receiving commands



- The Impact 2000 acts as a router for satellite data, seamlessly bridging space links to local and wide area networks

Impact 2000 System Features

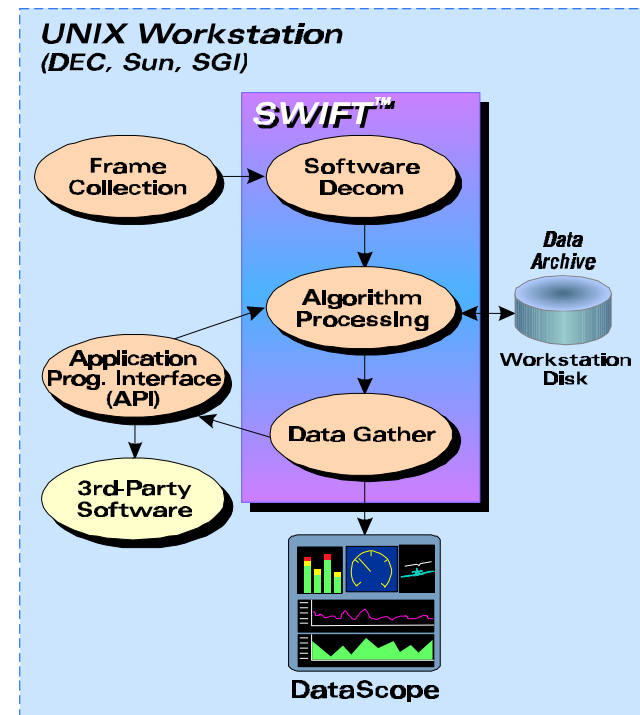
- Scalable to 250 Mbps
- CCSDS
 - *Packet Telemetry & Telecommand (version 1)*
 - *AOS (version 2)*
- Non-standard frame formats
- Remote control
- GUI or API control and monitoring
- Portable Java GUI
- Store and forward
- Loopback testing



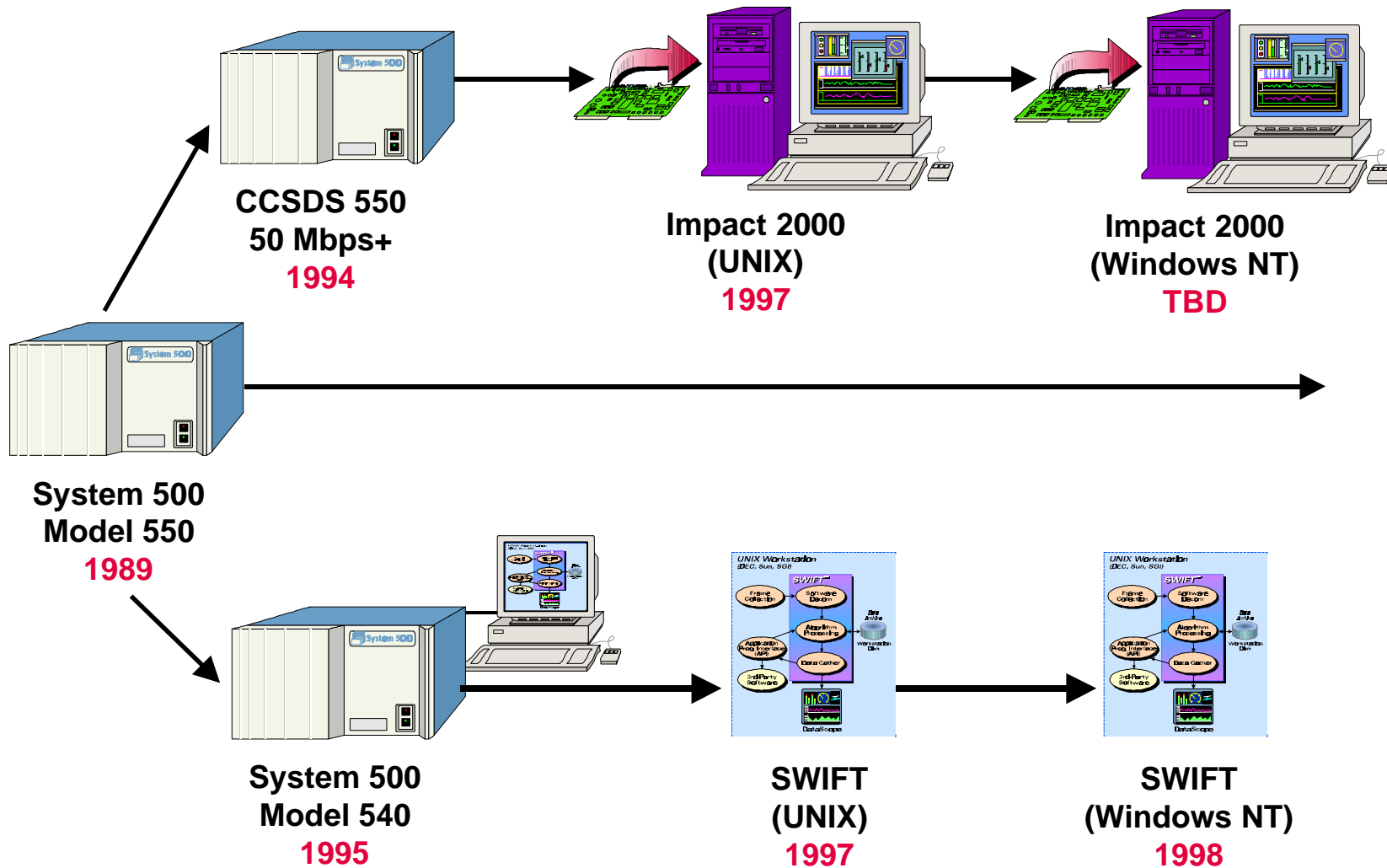
What is SWIFT?

Software Instrumentation for Telemetry

- SWIFT is derived from System 500 application software and includes:
 - *Software decom*
 - Multiformat, EADS, multi-stream
 - *Algorithmic processing*
 - “Virtual” FPP, algorithm development
 - *Telemetry data archival and retrieval*
 - *Data base functions and control*
 - ASCII import and export, LFE
 - *Display environment*
 - Datascope, Microscope
 - *Data distribution*
 - API, Middleware I/F



Impact 2000 / SWIFT Product Heritage / Migration



T&I Telemetry Servers

- **Impact 2000**
 - *High rate PCI/UNIX based packet router*
- **System 500 Model 550**
 - *High performance UNIX/VME TFE*
- **System 500 Model 540**
 - *Intermediate performance TFE and software decom*
- **NeTstar / VTS**
 - *Intermediate performance Windows NT integrated terminal*
- **SWIFT**
 - *Sophisticated UNIX / Windows NT software decom*

T&I Telemetry Clients

- **SWIFT**

- *Sophisticated UNIX / Windows NT software decom*
- *550, 540, Impact, NeTstar, VTS, Third Party TFE, SWIFT, Third Party Software decoms can be frame server*

- **System 500 API**

- *UNIX / Windows NT data interface to third party software*

- **VTS / NeTstar client**

- *Windows NT based telemetry data processing*

Summary

- **Space ground segment telemetry implementations are application unique and requirements driven**
- **L-3 Communications offer COTS telemetry client/server technologies which cover applications from mission data processing to post analysis**
- **Both Windows NT and UNIX offerings are available and provide for platform preference**
- **L-3 Com T&I products are designed to be fielded in both an L-3 homogenous or vendor heterogeneous environment**
- **Selecting the right product allows engineers to quickly end development cycles!**

Questions / Comments

If you have any questions or comments,
please e-mail me at *paul@ti.L-3com.com*

Thank you for your time.

Telemetry Processing Requirements Domain

- **Telemetry Processing Architectures must respond to varied requirements:**
 - *Telemetry data rates*
 - *Telemetry protocols used*
 - *Wavetrain complexities*
 - *Number of simultaneous telemetry streams*
 - *Time/data correlations*
 - *Use of COTS/legacy components*
 - *System availability and reliability*
 - *Data archival and playback*
 - *Acquisition, operations and maintenance costs*
 - *Etc.*

Low Rate SGS Implementations

<i>Function</i>	Mil. Const. TT&C	Mil. GEO TT&C	Com. GEO TT&C	Com. Payload SOH
<i>TFE</i>	VME Frame Sync	VME Frame Sync	VME Frame Sync	PCI Frame Sync
<i>Decom</i>	Software	Software	Software	Software
<i>Operating Sys.</i>	UNIX	UNIX	UNIX	Window NT
<i>Middleware</i>	API	Yes	Yes	Yes

Intermediate Rate SGS

<i>Function</i>	Booster #1	Booster #2	Booster #3	Range Safety
<i>TFE</i>	Dual Bus w/VME/Other	Dual Bus w/VME/Other	Dual Bus w/VME/Other	Dual Bus w/VME/Other
<i>Decom</i>	Hybrid	Software	Hybrid	Hybrid
<i>Operating System</i>	UNIX	Real-time	UNIX	Real-time

High Rate SGS Implementations

<i>Function</i>	Com. Sensing	NASA Science	Com. Relay
<i>TFE</i>	UNIX File Server	Dual Bus w/VME/Other	Dual Bus w/VME/Other
<i>Decom</i>	Hybrid Proc./Frame sync w/Software Decom	Hybrid Packet Proc./Frame Sync w/Software Decom	Packet Proc. Hardware Decom
<i>Operating System</i>	UNIX	Real-time	Real-time

Impact 2000

Features

- Complete CADU synchronization, Reed-Solomon decoding, and de-randomization processing
- Real-time link analysis and error reporting
- High-rate processing and archiving to 150Mbps
- Supports framing types of data used in remote sensing
- Selectable frame lengths up to 32,768 words
- Flexible frame synchronization strategies
- Scalable architecture to accommodate multiple processing loads
- Standard network compatibility

