Session A3:
Setting Conditions for T&E Exploration
Session Chair: Mr. Randolph Doring

Smart Data Selection (SDS)

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Outline

- Project Description
- System Description
- Bandwidth Efficient Algorithm
- Telemetry Compression
- Enhanced Telemetry Transmission
- Benefits to T&E

Project Description

"The dominant inherent nature to TM in DoD testing is sampled time-history data from an ultimately analog world, (which) is not going to change drastically regardless of how data is transmitted to ground. A factor that could change that fact most is the degree to which answers instead of data are obtained on board the test vehicle" iNET Concept of Operations, v. 2007.1

- SDS seeks to change this inherent nature of telemetry in DoD testing by:
  - Developing an on-board capability to monitor and analyze test data in order to reduce the amount of data sent to the ground
  - Employing bandwidth efficient algorithms to reduce bandwidth requirements
  - Developing the capability to notify operators when data demonstrate abnormal behavior

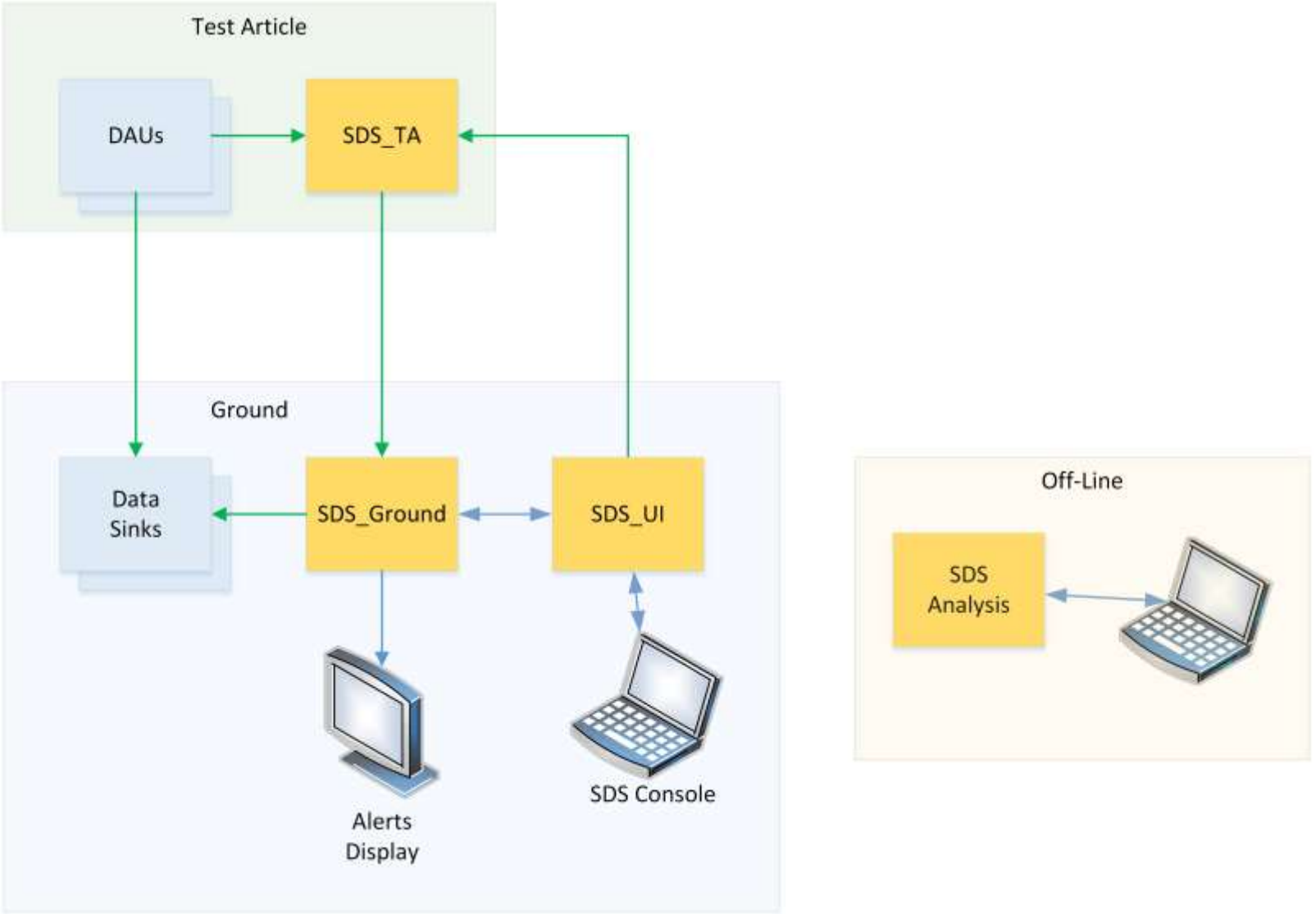
Results in Significant Savings in Spectrum and Increased Operator Awareness

SDS ConOps

The SDS system:

- Analyzes pre-recorded data to identify behavioral trends
- Applies user-defined behavioral criteria
- Subscribes to all on-board parameters
- Determines what live data is of interest for real-time observation and analysis
- Applies bandwidth efficient algorithms to select measurements
- Generates specific messages to be sent to ground
- Provides alerts for data that demonstrate unexpected behavior
- Supports user feedback in response to alerts

System Description



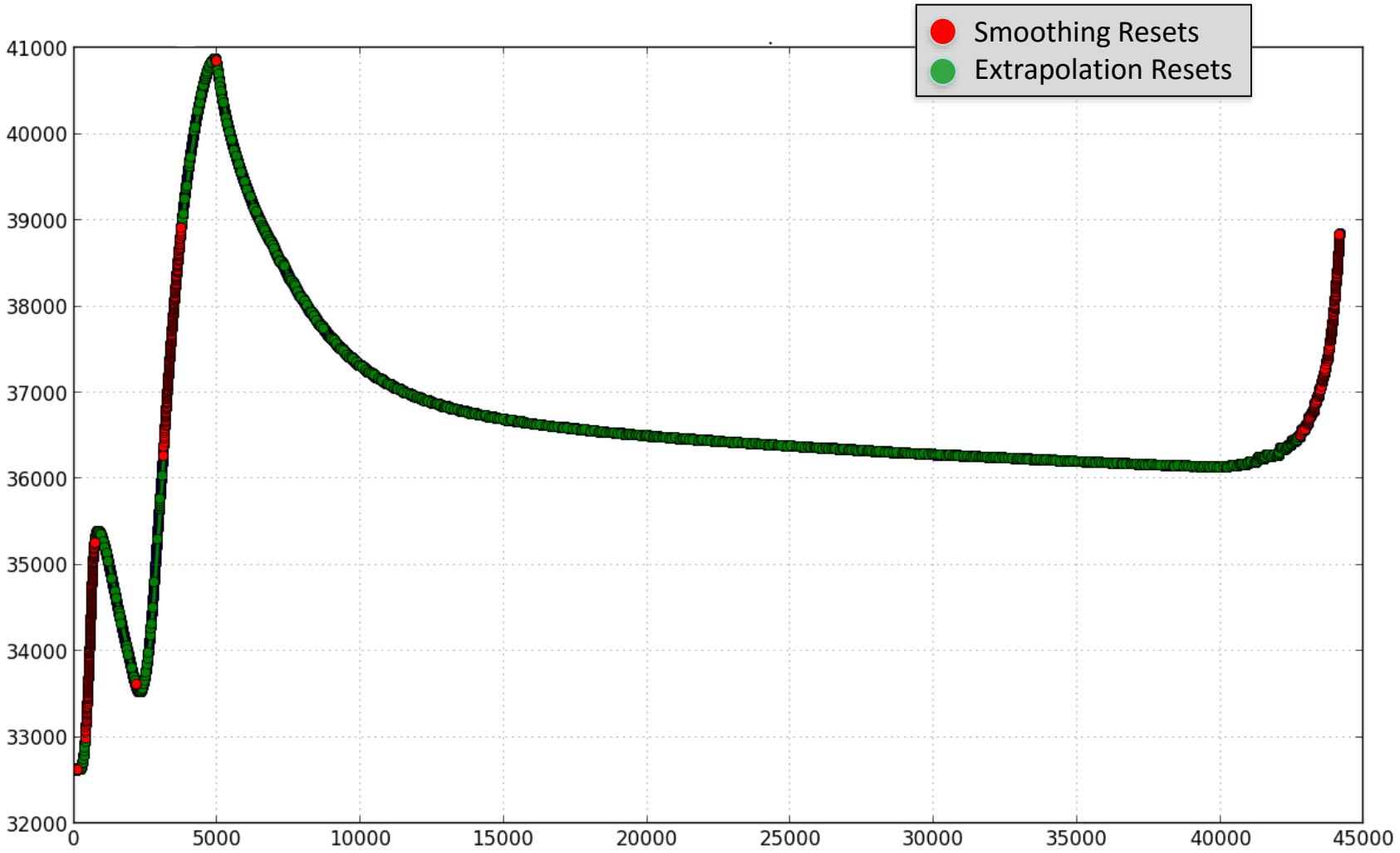
Bandwidth Efficient Algorithms

- SDS applies extrapolation algorithms to selected data
  - Allows for TA transmission of extrapolation parameters rather than individual measurement values
  - Ground calculates and publishes with required frequency
- TA monitors error between extrapolation values and actual measurements
- If error threshold exceeded, new parameters are calculated and applied

Bandwidth Savings

- Representative test results:
  - ~45,000 measurements at 98.04 Hz
- **Very small error threshold:**
  - **Error <= 0.01%**
  - **SDS requires less than 7% of original bandwidth**
- **Small error threshold:**
  - **Error <= 0.02%**
  - **SDS requires less than 3% of original bandwidth**

Thermocouple Example

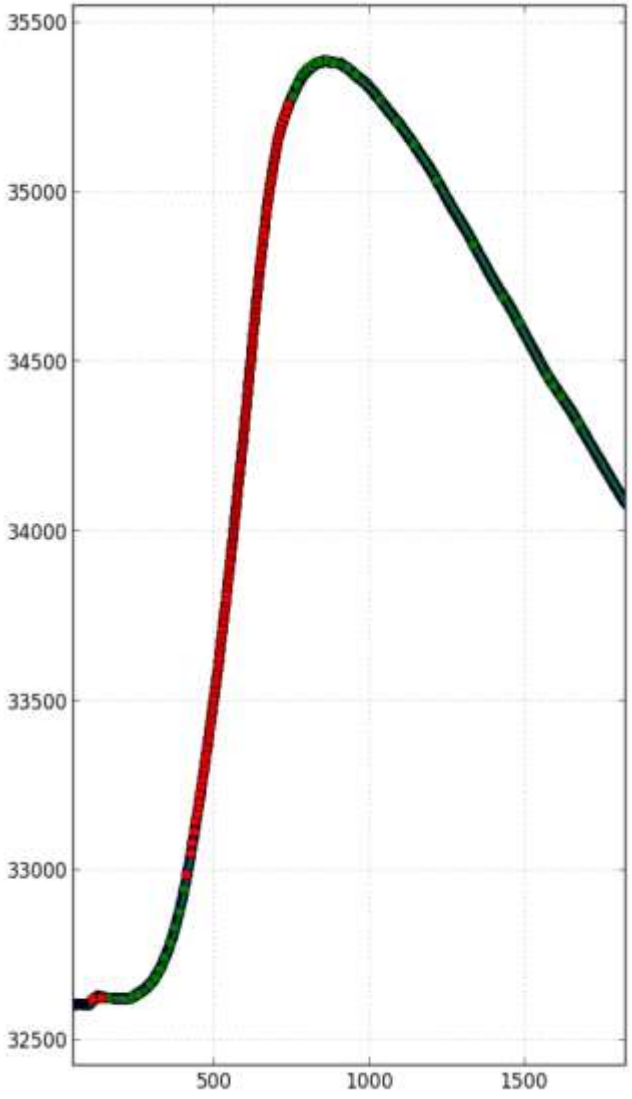


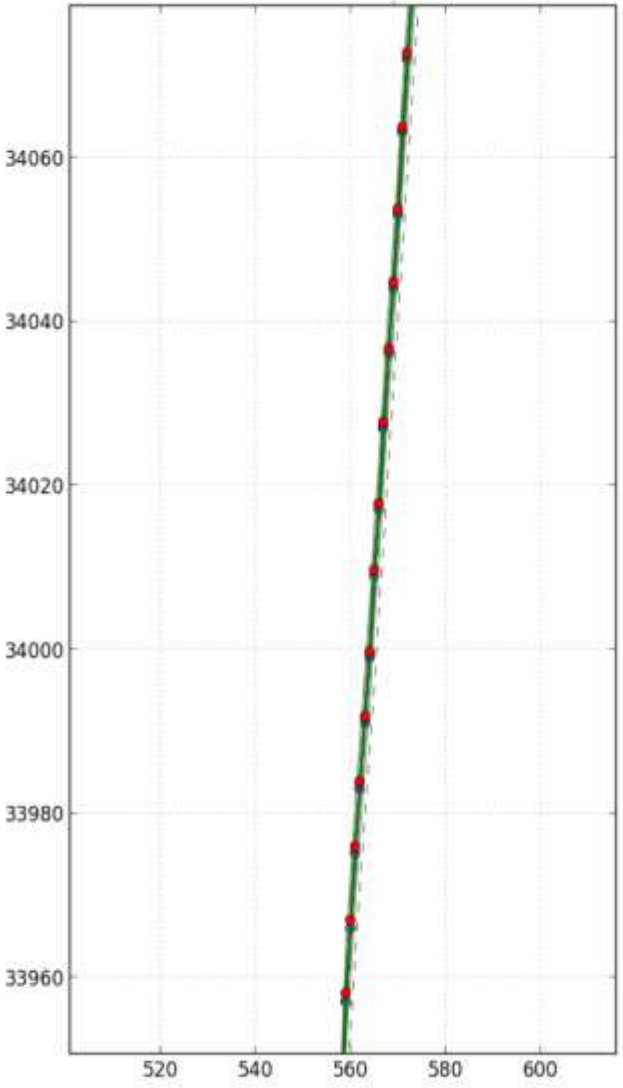
~45000 measurements @ 98.04 Hz

Bandwidth Savings

- 44091 Measurements
- Measurement Size = 2 bytes
- Error threshold of 0.01%
- 1001 EBE Resets
  - Transmission Cost =~3 Measurements
- Extrapolated Data = 1001 x 2 x 3 = 6006 bytes
- Raw Measurements = 44091 x 2 = 88192 bytes
- **SDS uses less than 7% of bandwidth required to send raw data**

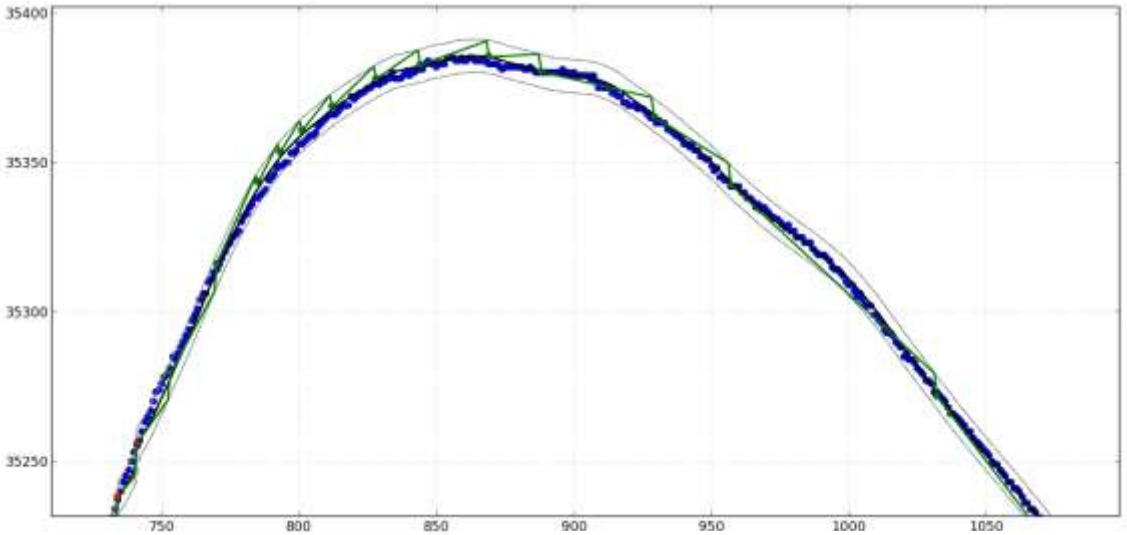
Enlarged View

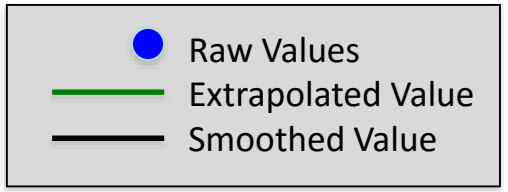


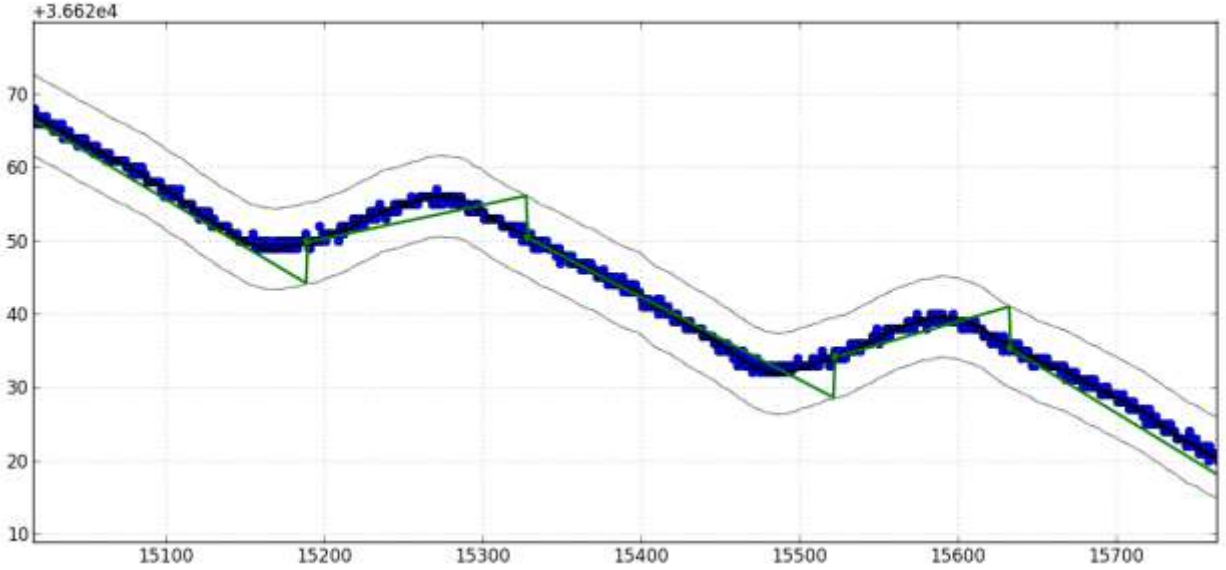


Smoothing Resets
Extrapolation Resets

Enlarged View







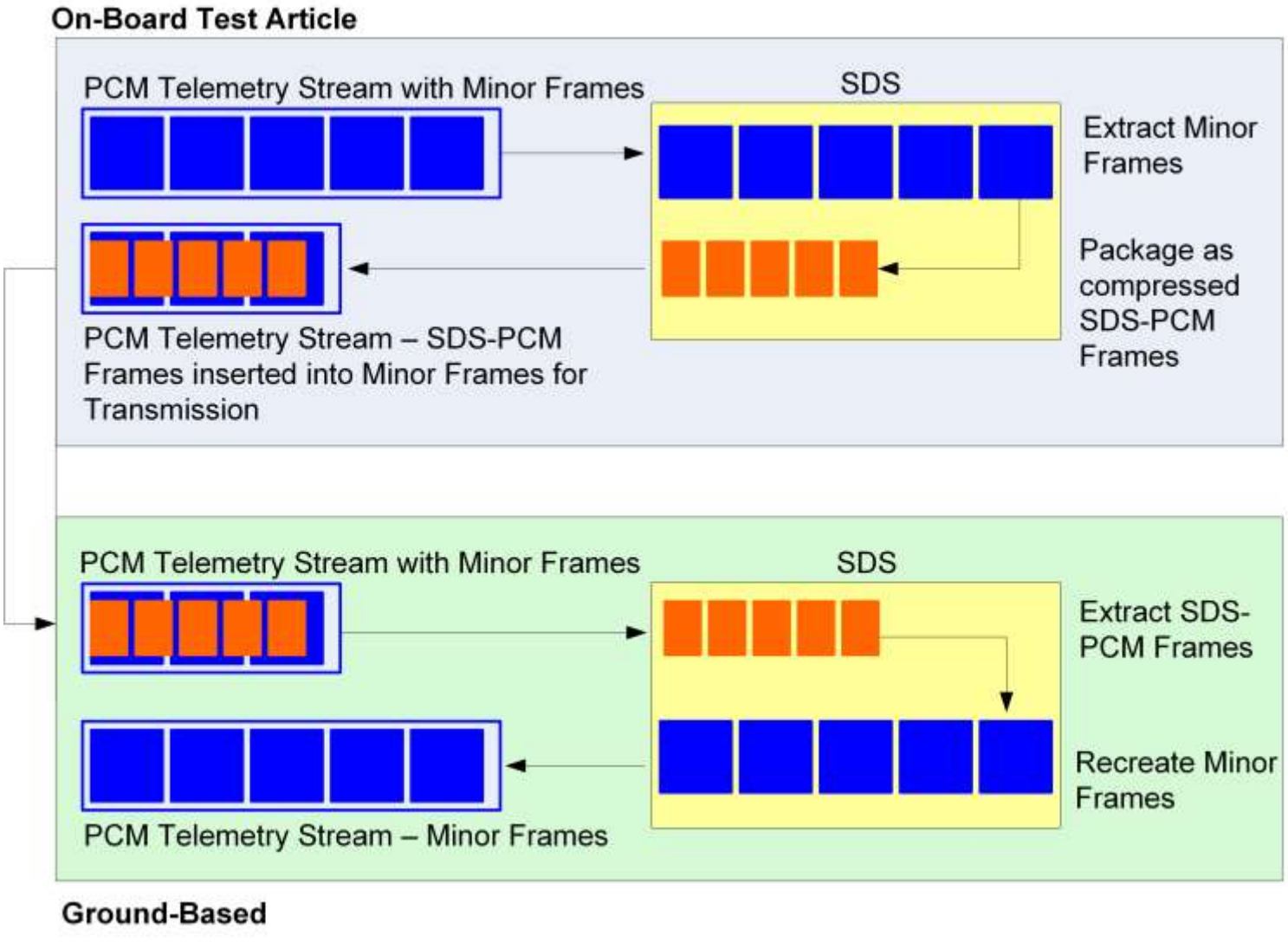
Telemetry Compression

- Utilize existing SDS framework to apply compression to PCM
- Provide PCM compression within TmNS messages
- Apply lossless data compression algorithms in conjunction with error correction for significant bandwidth savings

Benefits of Compression

- Potential to yield a 70% increase in bandwidth utilization
  - Provides availability to great volume of test data
  - Provides ability to support increased number of test articles concurrently
- Utilization of telemetry data characteristics improves upon compression rates resulting application of standard lossless compression

Introduction of PCM Compression



PCM Enhancement

- SDS implementation was based on TmNS message format
  - Test Article and Ground modules updated to process PCM minor frames embedded in TmNS messages
- New capability added to process PCM in traditional PCM environment

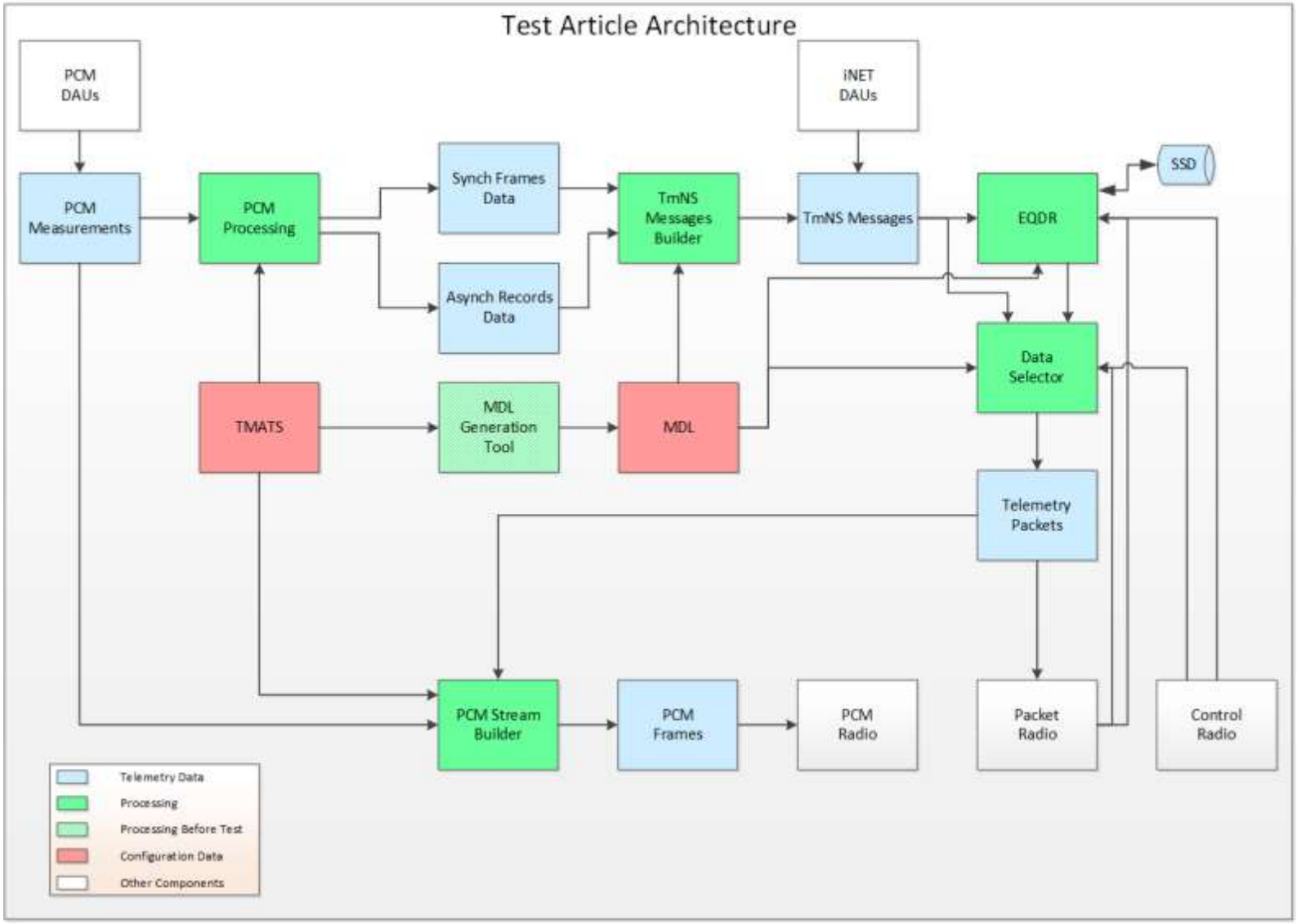
System Performance

- CPU Intel Core i7 – 3632QM @ 2.2 GHz
- RAM 8GB
- Windows 64 bits
- Current Capacity @ 50% CPU (no optimization)
  - 30,000,000 Msmts/sec
  - 16 bits/Msmt: 480 Mbits/sec uncompressed, <~=100 Mbits/sec compressed
- Target Capacity @ 50% CPU (some optimization)
  - 50,000,000 Msmts/sec
  - 16 bits/Msmt: 800 Mbits/sec uncompressed, <~=150 Mbits/sec compressed

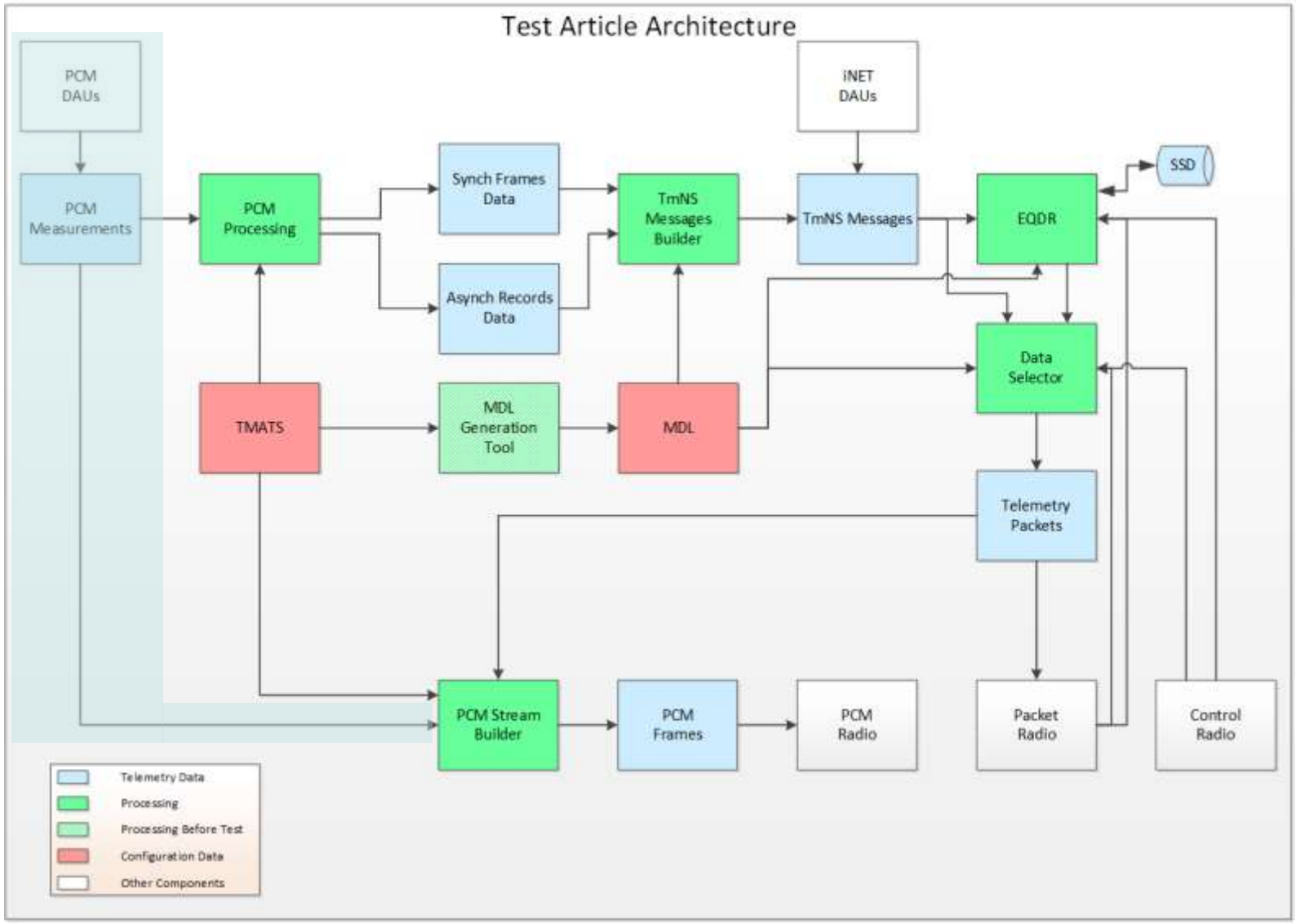
Enhanced Telemetry Transmission

- Implement hybrid architecture to support the efficient transmission of real-time and recorded telemetry data in both the PCM and iNET environments
- Built using iNET standards and may be utilized by both the PCM and iNET environments
- Utilizes mechanisms to add packet-based telemetry capabilities on top of PCM-based data bus and transmission mechanisms with no changes to the existing test article data bus or radio

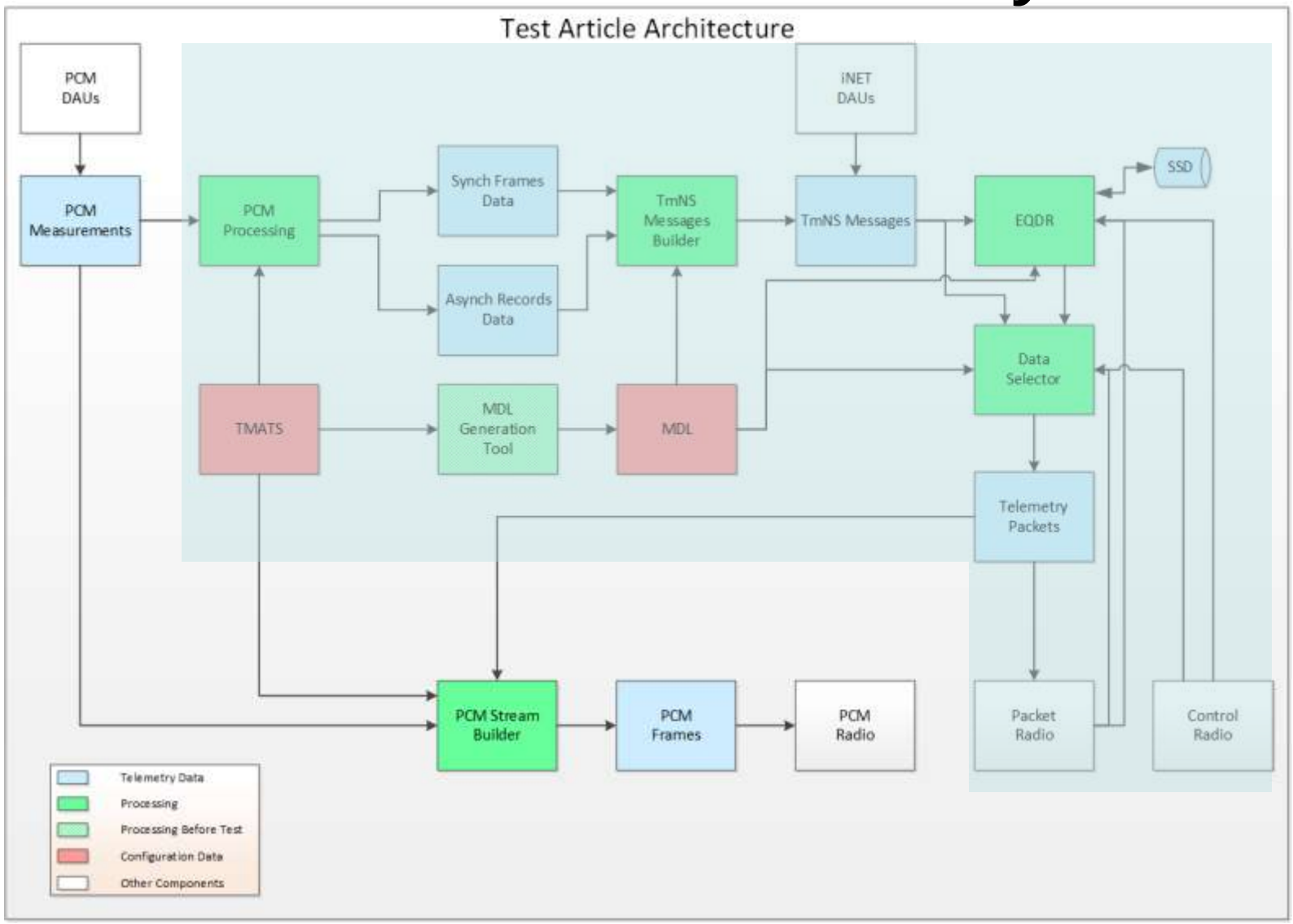
Hybrid Architecture



Traditional PCM Path



iNET and PCM Converted to Packet Telemetry



Benefits to T&E

- SDS
  - Bandwidth Savings/Increased Spectrum Efficiency
  - Enhanced Operator Awareness of Test Conditions
- Telemetry Compression
  - Potential to yield a 70% increase in bandwidth utilization
  - Utilization of telemetry data characteristics improves upon compression rates resulting application of standard lossless compression
- Hybrid Architecture
  - Deployment in a full PCM-based environment with incorporation of iNET standards
  - Supports hybrid environments that include both PCM and iNET standards
  - Supports use of both PCM and packet-based radios