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PCM Compression

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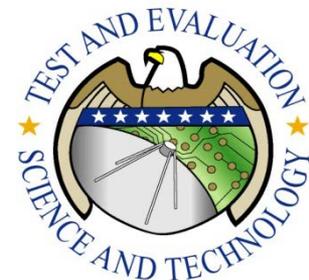
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Session B2: General Interest Topics for T&E Professionals

Session Chair: Mr. Tim Laffoon

PCM Compression

Shannon Wigent & Dr. Andrea Mazzario

17th Test Instrumentation Workshop
Wednesday, 21 May 2014

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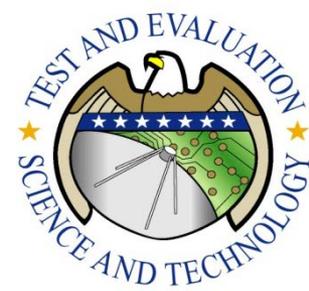
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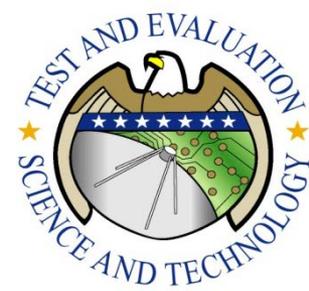
Outline



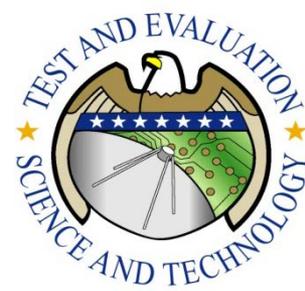
- Introduction
- Project Background
- Smart Data Selection Overview & Results
- Introduction of PCM Compression in SDS Framework
- Benefits to T&E



Project Background



- Smart Data Selection (SDS) initially awarded as a T&E S&T project in 2013
- The objective of SDS was to identify solutions to address the following T&E gaps:
 - The need for enhanced spectrum efficiency to the support level of data being generated on the test article
 - The need to enhance operator awareness during a test event
 - The need to simplify pre-test Test Article setup



SDS 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”

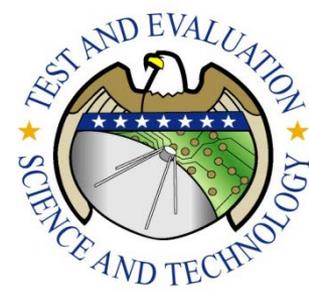
iNET Concept of Operations, v. 2007.1

- 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

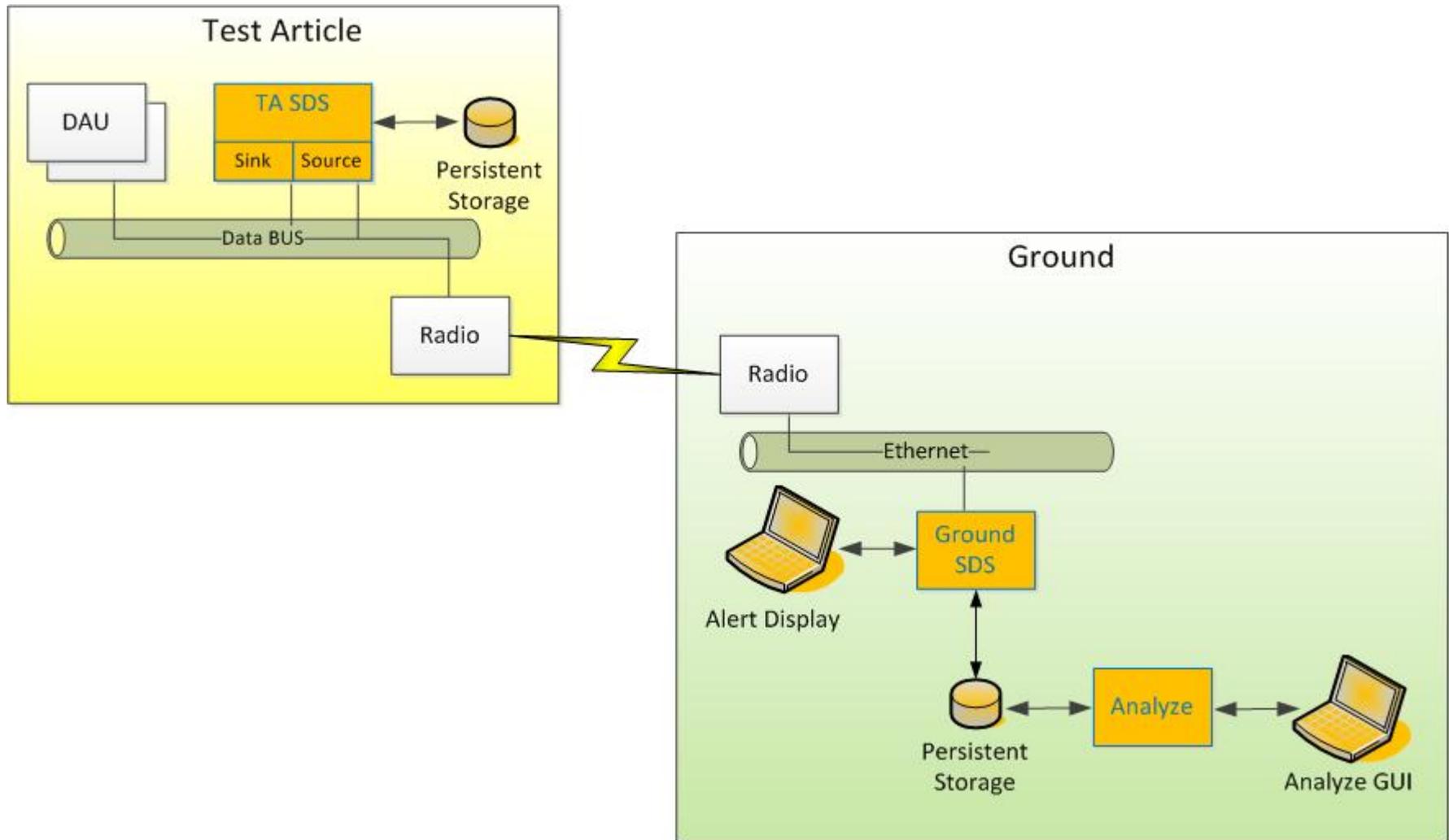
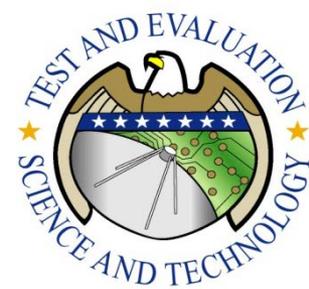


The SDS system:

- 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 selected measurements
- Generates specific messages to be sent to ground
- Provides alerts for data that demonstrate abnormal behavior
- Supports user feedback in response to alerts

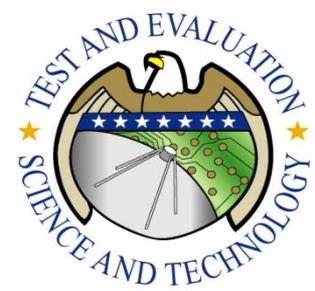


System Description





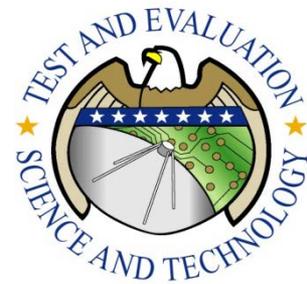
Bandwidth Efficient Algorithms



- SDS applies extrapolation algorithms to “Normal” 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 extrapolation parameters are calculated and transmitted to the ground



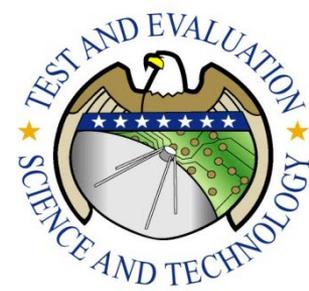
Bandwidth Savings



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



Introduction of PCM Compression



- Utilize existing SDS framework to apply compression to PCM
- Provide a compression solution with minimal alterations to existing PCM telemetry systems
- Provide PCM compression within TmNS messages
- Apply *lossless* data compression algorithms in conjunction with error correction for significant bandwidth savings



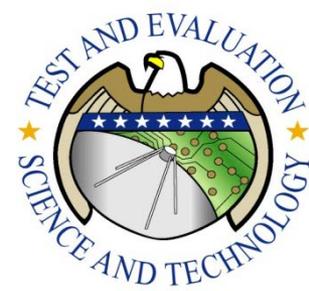
Benefits of Compression



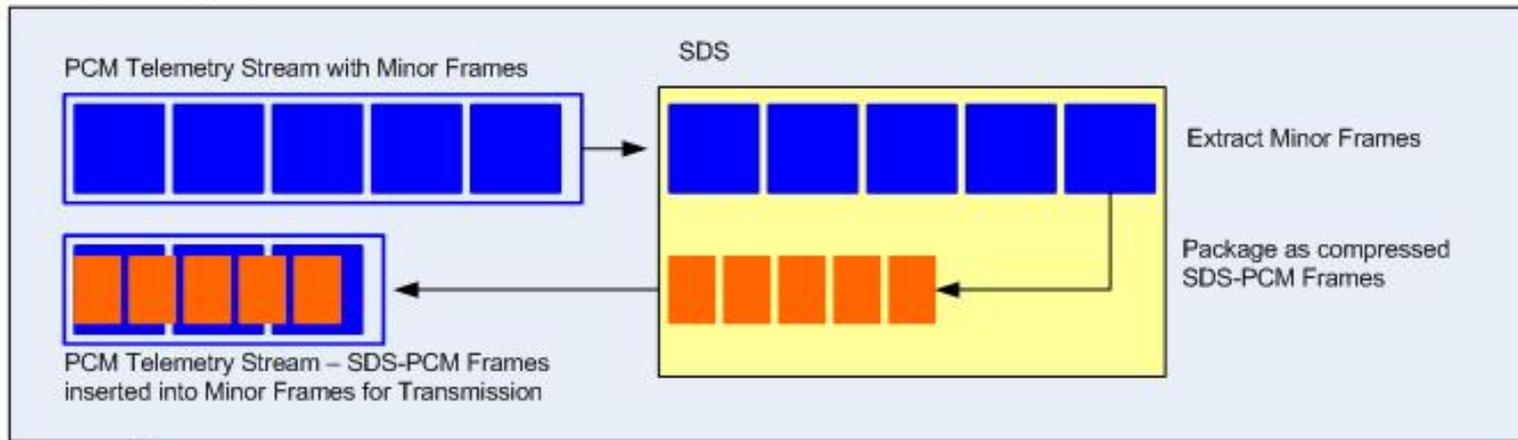
- Potential to yield a 70% increase in bandwidth utilization
 - Provides availability to great volume of test data
 - Provides ability to support increased number of test articles concurrently
 - 70% increase observed in earlier prototypes utilizing lossless compression. Potential exists for even greater than 70%.
- Utilization of telemetry data characteristics improves upon compression rates resulting from standard lossless compression algorithms



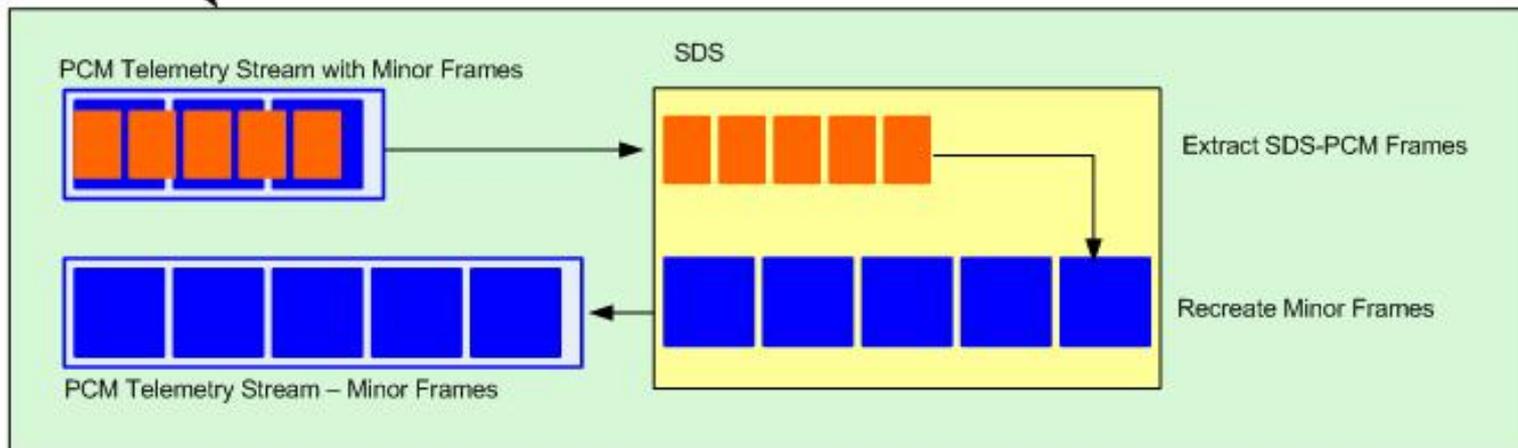
Introduction of PCM Compression



On-Board Test Article



Ground-Based





PCM Enhancement



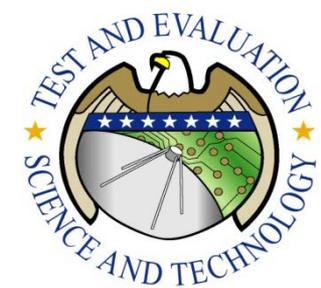
- SDS current implementation is based on TmNS message format
 - Test Article and Ground modules to be updated to process PCM minor frames embedded in TmNS messages
- New capability to be added to process PCM in traditional PCM environment



Benefits to T&E



- Bandwidth Savings/Increased Spectrum Efficiency
- Enhanced Operator Awareness of Test Conditions



QUESTIONS?