PCM Compression

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Outline

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

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PCM Compression

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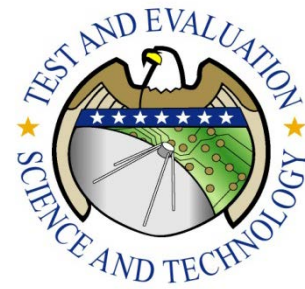
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Acknowledgements

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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
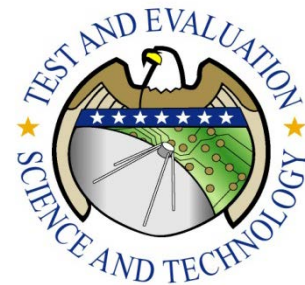
The SDS system:

- 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
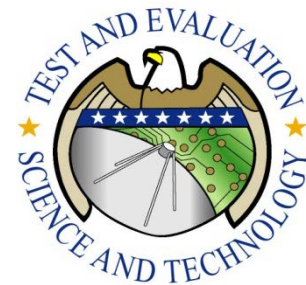- Supports user feedback in response to alerts

System Description
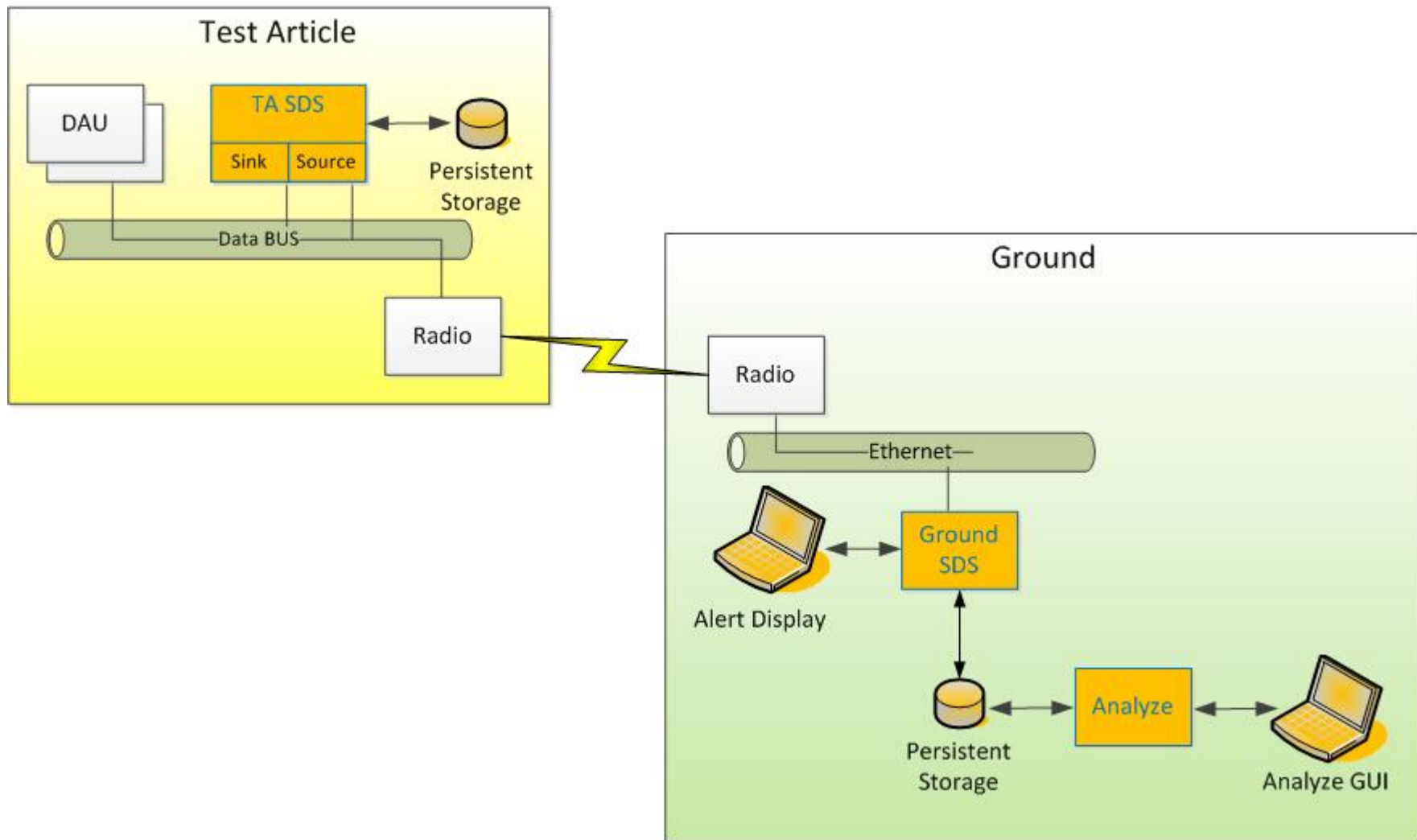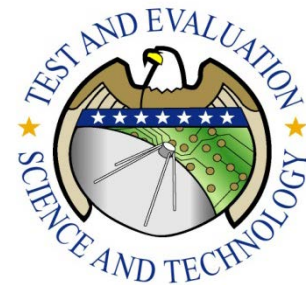
Bandwidth Efficient Algorithms

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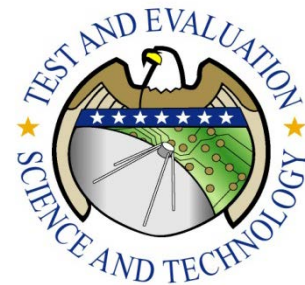
Bandwidth Savings
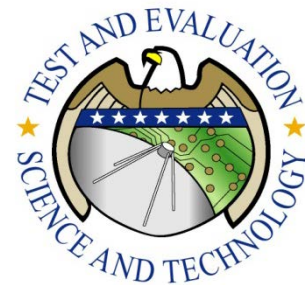
- Representative test results:
  - ~45,000 measurements at 98.04 Hz
- **Very small error threshold:**
  - **Error <= 0.01%**
  - **SDS requires less than 7% of original bandwidth**
- **Small error threshold:**
  - **Error <= 0.02%**
  - **SDS requires less than 3% of original bandwidth**

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
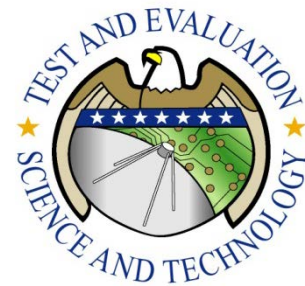
Benefits of Compression

- 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
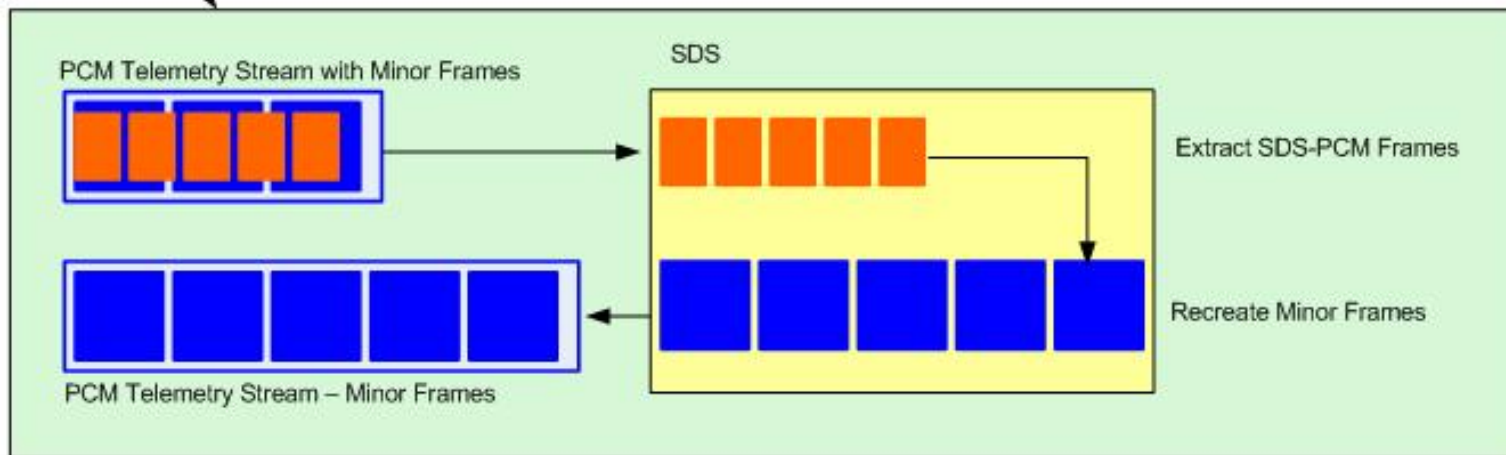
Introduction of PCM Compression
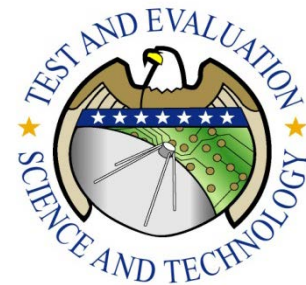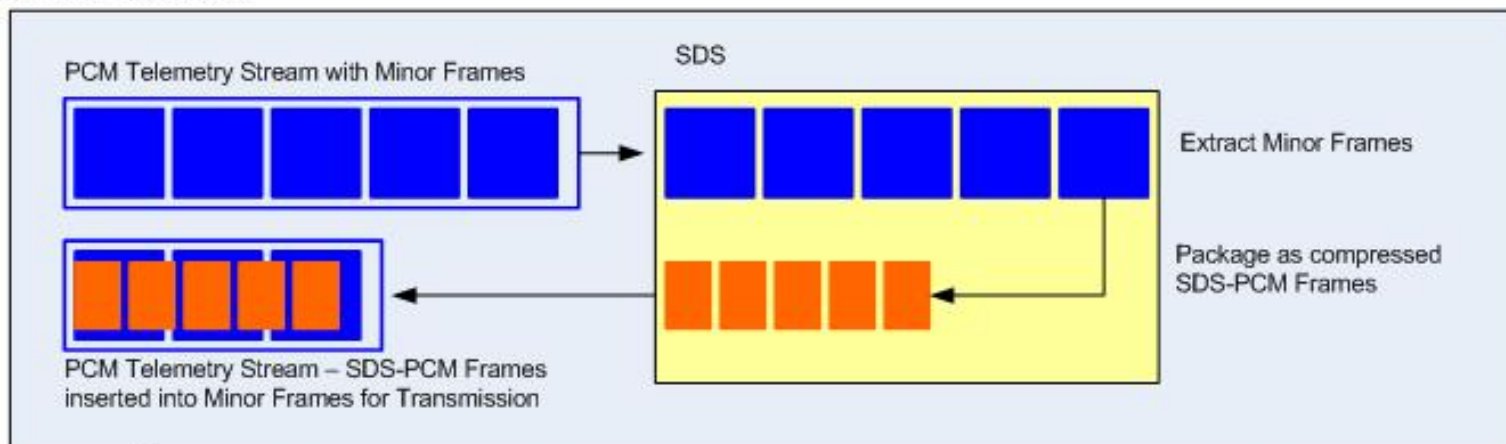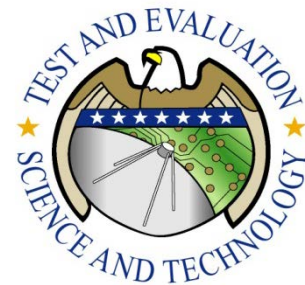
PCM Enhancement

- 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
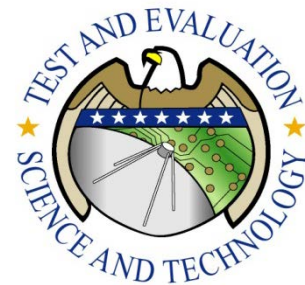
Benefits to T&E

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

QUESTIONS?