PCM Compression

May 2014

Tom Young
SET Executing Agent
412 TENG/ENI
(661) 277-1071
Email: tommy.young.1@us.af.mil

DISTRIBUTION STATEMENT A. Approved for public release: distribution unlimited.
15. SUBJECT TERMS
Spectrum, Aeronautical telemetry, algorithm, bandwidth, Smart Data Selection (SDS), Pulse-code modulator (PCM)

16. SECURITY CLASSIFICATION OF:
Unclassified

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

17. LIMITATION OF ABSTRACT
None

18. NUMBER OF PAGES
17

19a. NAME OF RESPONSIBLE PERSON
412 TENG/EN (Tech Pubs)

19b. TELEPHONE NUMBER (include area code)
661-277-8615
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

This project is funded by the Test Resource Management Center (TRMC) Test and Evaluation/Science & Technology (T&E/S&T) Program through the U.S. Army Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI) under Contract No. W900KK-13-C-0028. The Executing Agent and Program Manager work out of the AFTC.

Distribution Statement A: Distribution Unlimited

Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Test Resource Management Center (TRMC) and Evaluation/Science & Technology (T&E/S&T) Program and/or the U.S. Army PEO STRI.

Approval #: 412 TW-PA-14222
Acknowledgements

This project is funded by the Test Resource Management Center (TRMC) Test and Evaluation/Science & Technology (T&E/S&T) Program through the U.S. Army Program Executive Office of Simulation, Training and Instrumentation (PEO STRI) under Contract No. W900KK-13-C-0028.
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
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.”

SDS Description

• 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
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

Test Article

- DAU
- TA SDS
- Persistent Storage
- Data BUS
- Sink
- Source

Ground

- Radio
- Ethernet
- Ground SDS
- Alert Display
- Persistent Storage
- Analyze
- Analyze GUI
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
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?