Modern High Speed FTI Systems utilizing Recorders & Switches
Goal of this Paper

- Discuss Trends in Flight Test Instrumentation
- How these Trends can have an effect on the system design of a FTI system
- How does one design the architecture for an FTI System
  - Recorded Data
  - Transmitted Data
- What are the components to an FTI system
  - Designing for Bulk & Selected data for Real Time Telemetry
- How can we plan for the future
- What are some use cases for 10G for future planning
- Highlight some TMNS features
Recent Trends in FTI

- Modernization is happening across FTI Systems due to increased data rate requirements
  - Aggregation of Data from multiple sources
  - Upgrades from existing systems with low data rates to networks with 10Gbps or higher
  - Applications requiring data from sensor suites, vastly increasing data rate capture by magnitudes

- How the data is being recorded is critical to most operations due to existing post processing software

- FTI needs for collection of bulk data, and selection for messages / data real time TM is growing
How can we plan for these factors?

- **FTI Switches solve many issues that need to be addressed**
  - Data Aggregation to various data sinks on network
  - Time synchronization (IEEE 1588), system wide programming, and control (SNMP)

- **FTI Recorders drive recorded data formats**
  - Need to support what data processing needs (PCAP, DARv3, Chapter 10/11, TMNS)

- **FTI Architecture (DAQ’s, Recorders, and Switches) designed as a single system**
  - Is there TM?
    - Bulk Bus Data + Selected?
    - Is all this data being sent to the recorder?
  - Chapter 4 or Chapter 7?
FTI Network Architecture

- Incluores Acceleration, Tov, Voltage, Speed, Strain (analog, Digital)
- Video, Voice, Etc.
- XE03, ARINC-429, IEEE-1553, 1553, ARINC, IEEE-1553, 1553, ARINC
- GbE, RS-422/485, Link-10/16
- 100BaseT

- 12-Port GbE Switch

- Spare Ports

- Bulk recording and data cherry pick fr:
  - Optical Fibre C
  - Electrical Fibre C
  - Gigabit Ethernet
  - IEEE 1394 FireW
  - Future optical 10G
  - Mil-Std-1553

High Speed B
FTI Network Architecture - DAS

DATA ACQUISITION

FUNCTIONS

- Time Synchronization (1588 Slave)
- Analog Sources
  - Accel’s, Strain Gages, Temperature, Pressure, etc.
- Digital Sources
  - MIL STD 1553, IEEE 1394, ARINC 429, Ethernet
  - Bulk & Selected
- Data Outputs (PCM or UDP Network Base)
  - DARv3, TMNS, CH10 UTH

MnACQ-2600
(Data Acq. Units)

Sensor & Bus Data

Sensor & Bus Data

Sensor & Bus Data

Sensor & Bus Data

Includes Accel, Microphone, Speed, Strain Gage, Acceler, Current, Discrete, etc.

1553, ARINC-429, IEEE Gigabit Ethernet, RS-422/10
FTI Network Architecture – Switches

**SWITCHES**

- NSW-5GT-1 (5-Port GbE Switch)
- NSW-16GT-1 (16-Port GbE Switch)
- NSW-12GT-1 (12-Port GbE Switch)
- GPS Antenna
- GbE

**FUNCTIONS**

- **Time Synchronization**
  - 1588 Master or Slave
- **Time Inputs** – IRIG DC, GPS
- **Health & Status from System**
  - SMNP MIB support
- **System Programming**
- **Data Aggregation**
- **Data Routing**
FTI Network Architecture – Data Sinks

**SWITCHES**

- nGWY-2000 (Net to PCM)
- Selected PCM Data For Ground
- nREC-7000

**FUNCTIONS**

- **Time Synchronization**
  - 1588 Master or Slave
- **Record All Data on Network**
  - Ch10, iNET, PCAP, DARv3
- **TMNS Compatible Recorders – PCM Back Fill**
- **Ability to send safety of flight data to ground**
- **Ability to potentially send data back onto network**
- **Encrypted Data for TM & Record**
FTI Network Architecture – Distributed System 10G Modernization

<table>
<thead>
<tr>
<th>SWITCHES</th>
<th>FUNCTIONS – 10G EQUIPMENT</th>
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<tbody>
<tr>
<td></td>
<td>nREC-7000 (10G) Recorder</td>
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<td>– Provides all previous requirements of a Recorder</td>
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<td>– Provides ability to record 10G data on a different partition</td>
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<td>NSW-16GT (10G) Switch</td>
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<td>– Provides 4 10G SR Fiber Optical Interfaces to route, and manage high speed data</td>
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Distributed FTI System – Take-aways

FUNCTIONS

- DAU’s Collect Data
- DAU’s send data to switches
- Switches manage network, and send data to data sink’s
- Network Gateway provides selected PCM data for TM to ground
- Recorder Bulk Records Data as necessary
- Addition of 10G to existing network system can be seamless
FTI Network Architecture – Recorder Centric FTI System

RECORDER CENTRIC SYSTEM

Recorder Centric Flight Test Acquisition System

ADSR-4003F-8

Selected Data from Digital Buses

Chapter 4 PCM

Selected Data from Digital Buses

1GbE - DARx3

Instrumentation Article
Recorder Centric FTI System—Take-aways

FUNCTIONS

- Similar needs as a typical FTI System
  - Interfaces to Data Source
  - Timing Requirements
  - Bulk & Selected Data Capture
  - Ideal for targeted applications

- Requirements for TM
  - Similar ‘Network Gateway’ functionality to provides selected PCM data for TM to ground

- CW has been able to leverage a lot of COTS equipment to make these compact recorder acquisition based solutions
## Recorder Centric FTI System – Currently Developed or Planned

<table>
<thead>
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<th>ADSR Centric FTI System</th>
<th>ADSR-4003F-1</th>
<th>ADSR-4003F-2</th>
<th>ADSR-4003F-3</th>
<th>ADSR-4003F-5</th>
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HIGH SPEED CAMERA SYSTEM

FTI Network Architecture – High Speed Camera System with 10G Improvements
Recorder Centric FTI System– Take-aways

FUNCTIONS

- Similar needs as a typical FTI System
  - Interfaces to Data Source
  - Timing Requirements
- Requirements for TM
  - Similar ‘Network Gateway’ functionality to provides selected RS-170 data for TM to ground
- 10G Addition vastly improves the speed at which the cameras can be ready for the next event
Wrap Up

- Switches & Recorders are vital to the design of a FTI System
- The ability to provision for the future allows 10GbE to easily integrate into existing systems