Aerospace Network Traffic Characterization

Jamie Zaehring
Boeing Commercial Airplanes
The Boeing Company

Background

Information from SAE AS-1 to IEEE 802.1 presentation:

http://www.ieee802.org/1/files/public/docs2020/new-Jabbar-TSN-for-Aerospace-0520-v01.pdf

Traffic Characterization Approach

- Reviewed IIC Traffic Types, IEEE/IEC 60802, IEEE 802.1DG traffic characterization
- Standardized the traffic characterization using the IIC traffic types definitions
- Characterized onboard aerospace network traffic across 10 use cases
- Assessed current vs. growth network needs
- Include future traffic types and private data bus switch over
- In-Work Data captured in spreadsheet

Current Domain	Traffic Type Coverage
ARINC 664 (ACD)	100%
PIESD/AISD	50%
Legacy Buses	25%
High Perf Subsystems	10%

ACD Traffic Type Screenshot

Use Case Scenario	Periodicity	Typical Period	Application Synchronized to Network	Data Delivery Guarantee Mode	Delivery Guarantee Value	Application Tolerant to Jitter	Tolerable Jitter Value	Applications Tolerant to packet loss	Tolerable packet loss Value	Application payload size variability	Payload Value (Bytes)	Data Criticality	Safety Critical Data
Function Specific													
Mission loading (file loading)													
Video transfer (file transfer)													
Image transfer (target image) – another file transfer													
ARINC 661 (display graphics server)													
Parametric Data for sensing (Military)													
Parametric Data for fly by wire system													
Parametric Data for displays													
Audio Streaming													
Text transfer (SMS, CPDLC)													
Sensor data (Aynchronous)													
Inertial data													
Weapons release authorization													
Weapons release commands (MIL-STD-1553)													
ARINC 818 (Uncompressed real-time video)													
Closed loop control (synchronous Sensor VMS - worst case													
Closed loop control (synchronous Sensor - commercial)													
(Raw) I-Q data													
(Raw) Plot data													
AS6509 Flows													
FC-AE 1553 Traffic (command response) part of HS1760													
FC-AE 1553 Traffic (command response) part of HS1760													
FC-AE-1553 File Transfer													
FC-AV Traffic Flow (Video or sensor) part of HS1760													
FC2TSN Gateway Control Traffic (virtual pause frames)													

Traffic Characterization Term Alignment

Aerospace Terminology

(Intention to be most recognizable to aircraft integrators):

- Periodic and Aperiodic
  - Industrial: used Cyclic and Sporadic
- Synchronous Applications (to network)
  - Industrial: used ‘Isochronous’

Traffic Characterization Summary – ACD Traffic

Parameter	Current 90% Range	Current 100% Range	Future/Next Gen Range
Periodicity	Periodic as well as Aperiodic		
Typical Period	1 msec to 100 msec	1 msec to 5 secs	<100 usec to 5 secs
Application Synchronization	No apps synchronized	Some apps are synchronized	More apps will be synchronized Currently synchronized apps will join the system bus (as opposed to their own bus)
Data Delivery Mode	Latency bounded mostly Some Bandwidth guaranteed	Latency, BW, and Deadline	Latency, (Jitter?), BW, and Deadline
Delivery Guarantee Value	Latency bounds as varies between 1 msec all the way to cycle time.	Latency bounds as varies between 1 msec all the way to 3 times the cycle time.	
Latency/Jitter Tolerant and Limit (in bounded contention networks, latency and jitter are often equal, so true jitter sensitivity is difficult to derive.)	Both Yes and No For jitter tolerant types, the limit again varies between 10 mS and latency limit	Both Yes and No For jitter tolerant types, the limit again varies between 1 mS and latency limit	With more synchronized apps and deadline mode, lower ranges of jitter might be more prevalent (100 uS?)
Loss Tolerance and Limit	Yes and No For loss tolerant apps, the limit is 1-3 frames		Loss intolerant use cases may grow with synchronized apps from special buses joining the system bus

Thank You!

ACD Traffic Type Excerpt

Traffic Type Name	Periodic (Interval) / Aperiodic	Guarantee (Value)	Redundancy
Ultra Low Latency Synchronized Periodic (Ex: Synchronized Sensors or Video Streams)	P (1-10mS)	Latency (<1 mS)	Seamless Assumed
Ultra Low Deadline Synchronized Periodic	P (1-10mS)	Deadline (within Cycle)	Seamless Assumed
Ultra Low Latency Periodic (Ex: Parametric Data for fly-by-wire or military sensing, audio)	P (1-10mS)	Latency (<1 mS)	Seamless Assumed
Low Latency Periodic (Ex: Sensor data (airspeed, attitude, etc), ARINC 661 Display Data	P (5–100 mS)	Latency (within Cycle)	Seamless Assumed
Medium Latency Periodic	P (100-1000 mS)	Latency (within Cycle)	Seamless Assumed
No Latency Periodic	N/A	N/A	Seamless Assumed
Ultra Low Latency Aperiodic (Ex: Weapon Release, etc)	A	Latency (< 5 mS)	Seamless Assumed
Etc…			