T/R Data Format

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1. Format

Given below is the format of data transferred from the FRC (TRDF) to the other boards in the system – referred to as the T/R Data. It is compatible with the header/data/trailer format expected by the LTB cards as specified in the LTB document[1]. The L1CTT data format is taken from the CTT System Communication and Protocols documents (version v07-00 on 11-Nov-02)[2]. Note that the number of 32-bit words in L1CTT data is required to be a multiple of four. Pad words (data marked as valid, but with contents equal to zero) are added after the L1CTT trailer to extend the L1CTT block to meet this boundary condition.

1.1 Data from the VTM

Data from the VTM arrives at the FRC in 20-bit frames. The 4 most significant bits of each frame are control characters marking the frame as Begin-of-Event (BoE), Data (D) or End-of-Event (EoE). Only these types of frames are passed to the FRC. No G-link *idle* frames (no data) are sent by the VTM.

Endianess of the bytes in the two 16-bit frames from the VTM that are used to construct 32-bit words containing L1CTT information is shown in Table 1.

from VTM			**TRDF word**	
Frame #	**Byte # (Bits)**		**Byte # (Bits)**	
1	2 (15-08)	⇒	1 (15-08)	
1	1 (07-00)	⇒	0 (07-00)	lsb
2	2 (15-08)	⇒	3 (32-24)	msb
2	1 (07-00)	⇒	2 (23-16)	

Table 1: Definition of VTM to TRDF endianess. This corresponds to the ordering assumed by the L2 Alphas.

Control characters for data from the VTM are defined in Table 2 and are set by the requirements of the VRBs. Unfortunately, these control characters cannot be used in all test modes of the FRC. Given in the table below are the control characters assumed for each of the possible running modes. These modes correspond to all possible combinations of externally generated (real) or internally generated (fake) data for the two inputs to the FRC (the L1CTT through the VTM and the SCL through the SCL mezzanine). In the table, mode 0 corresponds to normal data taking, while modes 1-3 are test modes.

Currently, different firmware files must be downloaded to the FRC to run in modes 0,1 and 2,3.

	Data Source		Control Characters: VTM[19..16]		
Mode	**CTT**	**SCL**	**BoE**	**Data**	**EoE**
0	real	real	0101	0000	1010
1	real	fake	0101	0000	1010
2	fake	real	0001	0100	0010
3	fake	fake	0001	0100	0010

Table 2: Control characters assumed for L1CTT data coming over the VTM (data) or generated internally (fake).

1.2 Data produced by the FRC

The FRC passes along the L1CTT information (in 32 bit words) exactly as it is received. Bit definitions are given at the end of the document and are also available off of the L1CTT web pages [2]. Padding characters are added by the L1CTT after its trailer word to ensure that the number of 32-bit words sent is a multiple of 4 (128 bits are required for Mbus transfers to L2 Alpha processors). The TRDF adds a header and trailer around this data.

Data – Byte 3								**Data – Byte 2**								**Data – Byte 1**								**Data – Byte 0**							
31							24	23							16	15							8	7							0
L1_QUAL																LTB channel ID								L1_BX							
H. Format			O. Format					Object Length								Header Length								Number of Objects							
L1_TURN																L1_BX								L2 Data Type							
L2 Status Bits																Firmware Minor Ver								Firmware Major Ver.							
H Doublet (0-43)				I	0	D	Trig Sector Addr (0-79)									C	Ptbin		Ext Pt		T	L		Err Code		R	RA PSC				
H Doublet (0-43)				I	0	D	Trig Sector Addr (0-79)									C	Ptbin		Ext Pt		T	L		Err Code		R	RA PSC				
H Doublet (0-43)				I	0	D	Trig Sector Addr (0-79)									C	Ptbin		Ext Pt		T	L		Err Code		R	RA PSC				
Vertical Parity (16-bit words)																Data Type								L1_BX							
pad								pad								pad								pad							
pad								pad								pad								pad							
pad								pad								pad								pad							
L1_BX								LTB error flags								FRC error flags								word count (FRC & LTB)							

Table 3: Format of data output from the FRC (TRDF). The first and last words in the data block (shaded yellow) are produced by the TRDF with those bytes labeled "LTB" overwritten by the LTB[3]. The rest of the words are copied directly from the L1CTT

Pt-Bin	Range	Pt-Bits	Ext-Pt	A-Offset	Pt-min	Pt-max	Pt-ave
low	1.5-3.0	11	111	14			
			110	13			
			101	12			
			100	11			
			011	10			
			010	9			
			001	8			
			000	7			
med	3.0-5.0	10	011	6			
			010	5			
			001	4			
			000	3			
high	5.0-10	01	011		5.0	5.7	5.3
			010		5.7	6.7	6.2
			001		6.7	8.0	7.3
			000		8.0	10.0	8.9
highest	10-∞	00	011		10.0	13.3	11.4
			010		13.3	20.0	16.0
			001		20.0	40.0	26.7
			000		40.0	∞	80.0

Table 4: Definitions for Pt-bins and Ext. Pt [2]

Bit in *error flag*	Name	Description[4]
0	*NO_BOE*	missing BoE in L1CTT data
1	*NO_EOE*	missing EoE in L1CTT data
2	free	
3	free	
4	free	
5	free	
6	free	
7	free	

Table 5: Bit assignments in *FRC error flag* portion of T/R Trailer word.

2. Glossary

Headers & Trailers:

- L1_QUAL — processing information for the event (from Trigger F'work)
- L1_BX — bunch number within turn
- L1_TURN — accelerator rotation number
- Data Type — what type of data (CFT,CPS,etc.) – see L1CTT general [2].
- Firm. min/maxV — for Alpha use only
- Status Bits
  - 00 MC Data
  - 01-03 reseved
  - 04 trailer receiver error
  - 05 object list truncated
  - 06 no processing attempted
  - 07 general error condition
- P — positive tracks in this Pt-bin
- N — negative tracks in this Pt-bin
- Vertical Parity — calculated on 16-bit G-Link words
- pad — zeros inserted after trailer to pad total L1CTT data size to a multiple of 4 (32-bit) words

Data:

- C — sign of Pt (curvature)
- Ptbin — Pt-bin of track (see Table 4)
- Ext Pt — extended Pt information for track (see Table 4)
- T — track associated with tight assoc. to CPS-axial Cluster
- L — track associated with loose assoc. to CPS-axial Cluster
- Err. Code
  - bit-0 = transmission errors detected and corrected
  - bit-1 = transmission errors detected and not corrected
  - bit-2 = transmission of truncated data (at sector level)
  - note: these are currently all set to zero
- R — track associated with cluster outside sector
- PSC RA — relative address of assoc. CPS-axial cluster centroid (0-15)
- H Doublet — relative address of H-layer hit on track in 4.5^{o} sector (0-43)
- I — isolated track
- D — track sent to two adjacent segments
- Trig Sector Addr — absolute addr of 4.5^{o} sector where track was found (0-79)

References

[1] E. Hazen, *PC-MIP Link Transmitter Board Specification* (29 March, 2000) http://ohm.bu.edu/~hazen/my_d0/TxRx/Tx_spec_new.pdf
[2] see http://d0server1.fnal.gov/projects/VHDL/General/ (information taken from version v07-00, 11 November, 2002).
[3] see http://budoe.bu.edu/~sfatakia/ltb_lrb_info.html (11 September, 2001)
[4] see *T/R Data Transfer* (19 July, 2000)