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Proposal to replace the L1 Trigger-type Word with the L1 Message

(Proposal approved by the ALICE Technical Board on 20 March 2002)

Current requirements

According to the current version of the CTP URD (approved by the ALICE Technical Board on 22 January 2002; the document not yet fully updated), the ***L1** Trigger-type Word* contains:

- *Enable Segmented Readout flag* (ESR, Region of Interest option),
- four *Readout Control bits* (RoC).

The method of generating the RoC bits hasn't yet been decided. In the current proposal, for physics triggers, each bit is an output of a programmable *OR* circuit combining all 50 ***L1** Trigger Class* signals; in case of a *Software Trigger* (calibration triggers etc.), the status of the bits is defined by the trigger requester.

The TRD group has requested the increase to 5 of the number of *OR* circuits and the addition of a look-up table (5 OR inputs and 4 RoC outputs); the look-up table would be used to implement a priority encoding or any other appropriate algorithm.

In the following text, the two implementations will be referred to as *Option 4* and *Option 5*.

Survey of the current use of the *L1 Trigger-type Word*

At the moment, the TPC readout requires 3 control bits, but an additional bit would provide them with a spare for possible future expansion - hence *Option 4*.

The TOF and the DM have no defined use for the ***L1** Trigger-type Word*, but it is expected to emerge in the future and they are confident that the *Option 4* provides all they might require.

The TRD readout has four modes, for the coding of which just two control bits would be sufficient, but future refinements of the hardware might call for more sophisticated control - hence the request for *Option 5*.

All the other sub-detectors have *declared that they did not plan to use the **L1** Trigger-type Word at all.*

Hardware implementation

There are considerable differences in the organisation and control of the readout electronics of the 18 existing sub-detectors and the variety is only likely to increase with a possible addition of new systems (up to the full capacity of 24 ALICE sub-detectors). In order to be manageable, the CTP must remain modular - it must treat all the sub-systems in exactly the same way, regardless of their differences.

In case of the ***L1** Trigger-type Word*, the modularity of the system means that the hardware that satisfies the requirements of the most sophisticated scheme will be provided to all sub-detectors, even if they use only a sub-set of available options or nothing at all.

The implementation of the Option 5 requires *9100 individual bits* to be defined, set and controlled by the CTP; in case of the *Option 4*, the number drops to 4800 bits. In both cases, it is a *significant hardware overhead*, and particularly so if the limited use of the option is taken into account.

New proposal

*The new proposal is to "delegate" the generation of the RoC bits to sub-detectors, while the role of the CTP would be only to provide the necessary inputs - the status of all fifty **L1** Trigger Class signals.*

The proposal offers to sub-detectors a freedom of implementation to suit best their needs and a possibility of easy upgrades/modifications during the lifetime of the experiment. Sub-detectors that do not use the option - need do nothing; sub-detectors that do not need the status of the ***L1** Trigger Class* signals - will only be provided with the reduced input. The hardware overhead of the CTP would be reduced to a practical minimum.

The details of the proposal

For each **L1** trigger, the CTP shall transmit to a sub-detector the ***L1** Message*. The message contains:

- *Trigger-type flag* (TtF),
- *Calibration flag* (ClF),
- *Enable Segmented Readout* flag (ESR),
- four *Readout Control* bits (RoC),
- status of all 50 ***L1** Trigger Class* signals.

The RoC bits are used only for *Software Triggers*; they are defined by the trigger requester.

The message shall be transmitted *via* the *Channel B* of the TTC system. The full message shall consist of five 12-bit words; a programmable option shall be available to suspend the transmission, or to transmit only the TtF, ClF and ESR flags and the four RoC bits (one word).

Timing constraints

Delays

In all the implementations, the **L1** signal is delivered to the sub-detector front-end logic *via* the *Channel A* of the TTC with a minimum possible latency. The ***L1** Trigger-type Word*, or the ***L1** Message* (new proposal), are transmitted *via* the *Channel B* of the TTC and, as a result, incur longer and, due to sharing of the channel, variable delays.

The ***L1** Trigger-type Word* is sent to the TTCvi board (*via* the VMEbus) 1.5μs after the generation of the **L1** signal; the word appears at the output of the TTCrx chip with the delay of 2.7μs; if the transmission coincides with the higher priority transmission of **Orbit** or **Pre-pulse** signals, or the transmission of a lower priority has not yet been completed, the delay can be as high as 4.7μs (the worst case). The given figures do not include the propagation delay of the optical link (~5ns/m).

The delay of the first word of the 5-word ***L1** Message* (new proposal) is similar to the delay of the ***L1** Trigger-type Word*. The complete message (all 5 words) shall be available at the output of the TTCrx after 6.3μs (nominal value), or 8.3μs (the worst case). Again, the propagation delay of the optical fibre is not included. The minimum possible delay between successive **L1** signals (~5μs) is shorter than the transmission time and, in case of a burst of **L1**s, the quoted delays could become even longer since the transmissions will be queued.

A useful information for the sub-detectors that do not intend to use the TTC for the transmission of their ***L1** Trigger-type Word/**L1** Message* (TRD, for example) is that the VMEbus transmission of the message is complete ~2μs after the **L1** signal and the delay is fixed.

A note of warning: while the TTC system is already available and its timing characteristics are well known, the detailed design of the CTP hardware hasn't yet started and the corresponding delays, given in the text, are only estimates.

The estimate of the TTC Channel B traffic

The worst-case scenario (Orlando, private communication, 11 February 2002) assumes the maximum **L1** trigger rate of 40kHz and the maximum **L2a** rate of 1kHz. The effect of the **L2a** rate is negligible and will be ignored.

The dominant traffic is the transmission of the **Orbit** signal (once per orbit - 88μs) and the combination of the 5-word ***L1** Message* and the ***L2r** Word* for each **L1** trigger (every 25μs in the worst case). Each transmission takes about 1.2μs. The worst-case occupancy of the *Channel B* is therefore ~ 35% (~9ns out of 25ns). The result appears acceptable.

The estimate of the VMEbus traffic

It is envisaged that four sub-detector TTC partitions shall be installed in the same VME crate. Assuming 0.3μs for a VMEbus transmission and 6 words (the ***L1** Message* and the ***L2r** Word*) transmitted for each **L1** signal, the bus occupancy for the worst-case trigger rate (see above)

is close to 30% (4x6 words every 25μs). This is an acceptable percentage, but high nevertheless. Since only few sub-detectors plan to use the full length of the ***L1** Message* (that includes the status of 50 ***L1** Trigger Class* signals), it is likely that the real worst-case occupancy won't exceed 15% (one sub-detector per crate with the full-length ***L1** Message* and three with only the single-word ***L1** Message*, 6+3x2 words transmitted every 25μs). A word of warning: the four words of the *RoI Data*, transmitted for every **L1** signal, are not taken into account, but only two sub-detectors (TPC and TRD) participate in the option.