Region of Interest interface - proposal

(Proposal approved by the ALICE Technical Board on 14 May 2002) Last updated: 7 May 2002

Introduction

The benefits of the *Region of Interest* (RoI) option are still being evaluated; the system will become operational only some years into the LHC run; only few sub-detectors are likely to participate; *etc*. As a result, and understandably, the project is neither fully defined nor made the responsibility of any ALICE group; it is unlikely that the situation might change in the foreseeable future.

In order to proceed with the development of the CTP, on the other hand, the details of the CTP-RoI *interface* have to be decided without any delay. The definition of the interface must assure that the "space" is created for the RoI's dedicated hardware and the requirements set that make the system compatible and its future integration feasible.

The issue has been addressed in rather general terms in the *approved version 1.0* of the CTP URD. For the convenience, the relevant section is copied here (the text includes some minor updates).

> **3.1.19** ***Region of Interest***
>
> **1.19.1** The implementation of a *segmented readout*, controlled by the *Region of Interest* (**RoI**) logic, shall be an *add-on option*, rather than an integral part of the *baseline* CTP.
>
> **1.19.2** For each **L1** trigger with the asserted *Enable Segmented Readout* flag in the corresponding ***L1** Message*, the RoIP shall generate the ***RoI** Data* and broadcast them to all the sub-detectors participating in the **RoI** option. The broadcast shall take place after the **L1** trigger.
>
> **1.19.3** The ***RoI** Data* shall contain the event *bunch crossing number* (12 bits) and 36 bits of regional information.
>
> **1.19.4** For all the **L2a**-selected events for which the ***RoI** Data* have been generated (the events with the corresponding *Enable Segmented Readout* flag asserted), the ***RoI** Data* shall be attached to the raw event data before they are sent over the DDL to the RORC.
>
> **1.19.5** The CTP system and the readout sub-detectors shall be fully compatible with the transmission of the ***RoI Data*** to the front-end electronics and shall provide the environment for inclusion of the **RoI** hardware.

The following proposal is fully in line with the listed requirements and complies with the current understanding that the RoI is "an *add-on option*, rather than an integral part of the *baseline* CTP". The CTP remains the master-device and controls the operation *via* the *Enable Segmented Readout* flag (**ESR**). The CTP provides the RoI logic with *all the available information* that could be used to define the form of the segmented readout, but leaves to the RoI system the decision how and whether the data will be used. The transmission of the additional data does not interfere with the adopted timing scheme of the CTP; the CTP hardware overhead is acceptable.

Figure 1 shows the sub-detectors that are likely to provide inputs to the RoI system, or might do so, and the sub-detectors that are currently planning to participate in the segmented readout, or are just considering the option. The system is conveniently divided into two blocks: the Region of Interest Processor (RoIP) and the Region of Interest Interface (RoII), following the analogy with the CTP and the LTU. The blocks are only notional - the final

partitioning and definitions of block functions will come eventually from the group responsible for the project; neither issue is a subject of this proposal.

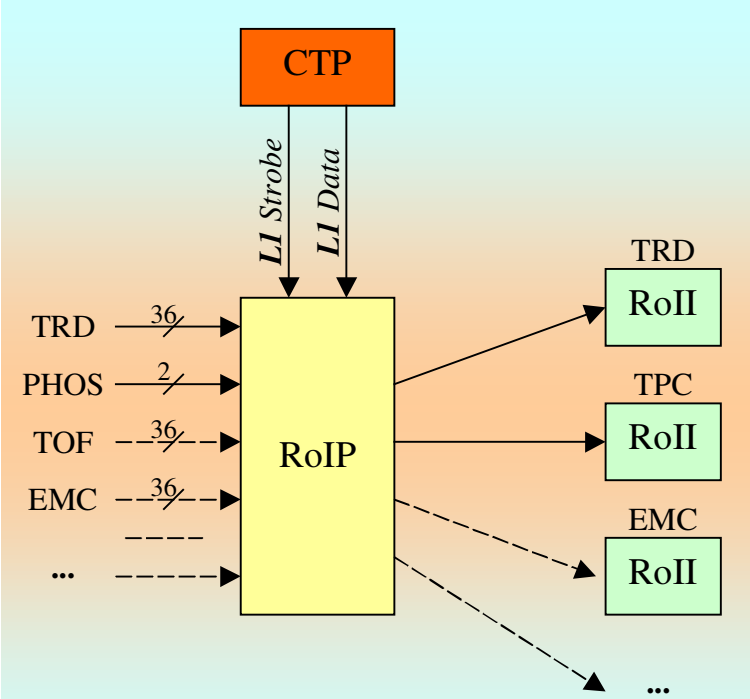

Figure 1 Block diagram of the RoI system

Figure 2 is a context diagram of the RoI system, surrounded by the ALICE Trigger and DAQ electronics. In the following sections, the proposal will deal with the three interface areas:

- CTP to RoIP interface,
- RoII to TTC interface,
- LTU to RoII interface (stand alone mode only).

For reasons of completeness, the generation and the use of the *Enable Segmented Readout* flag will also be reviewed, as well as the requirements on the front-end electronics of the sub-detectors participating in the option.

The proposal will be first circulated among the members of the *RoI Working Group*, nominated by the ALICE Technical Board on 23 April 2002; the members of the *Rapid Trigger Intervention Group* will be kept up-to-date. The intention is to submit the agreed version of the proposal to the Technical Board for the final approval on 14 May 2002.

RoI Interface

CTP to RoIP serial transmission

The serial transmission shall be over two lines **-** ***L1*** *Strobe* and ***L1*** *Data* (**Figure 2**). The ***L1*** *Strobe* is an *OR* of all *Cluster* ***L1*** signals (six *physics clusters* and a single *software cluster)* -

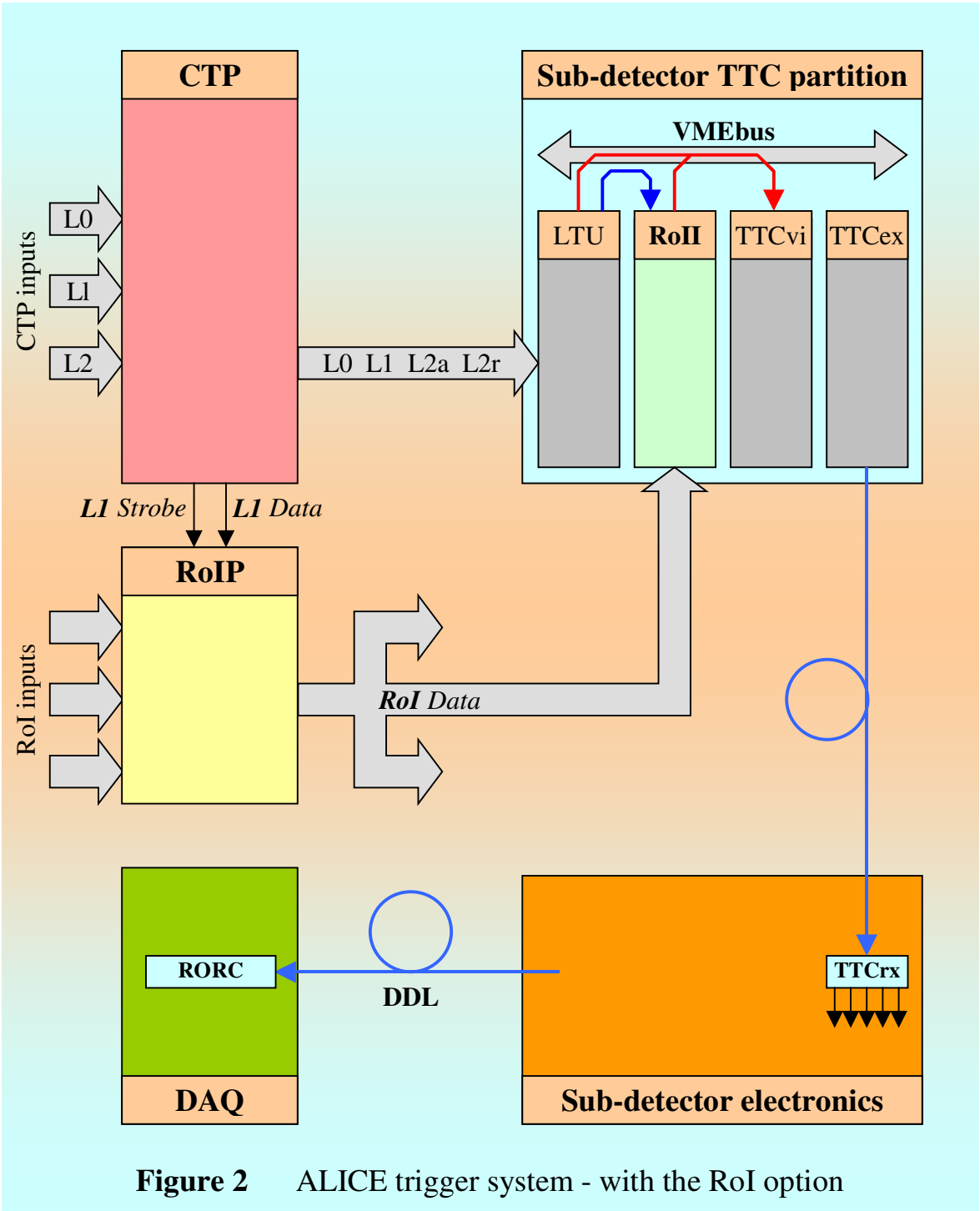

Figure 2 ALICE trigger system - with the RoI option

it coincides with the generation by the CTP of *any* **L1** signal; the ***L1** Data* contains the following:

- *Enable Segmented Readout* flag **(ESR)** 1
- *Software Class **L1*** trigger status (**L1SwC**) 1
- *Class [50..1] **L1*** trigger status (**L1Class[50..1]**) 50

Total **52 bits**

No overlapping of the serial data is possible since the transmission time (1.3μs) is always shorter than the **L0** dead time (minimum time between consecutive **L1** signals). Both signals are in *Non Return to Zero* (NRZ) format; all signal transitions are synchronized with the CTP's **BC** clock.

The ***L1** Strobe* provides the necessary timing both for the occurrence of the **L1** trigger and for the serial transmission; the **ESR** control bit is included in the ***L1** Data*; for a physics trigger, the list of sub-detectors participating in the readout is implicit in the *Class **L1*** trigger status data; the RoI option is never active in case of a *Software Trigger.*

The signals are straight copies of the corresponding signals on the CPT backplane - no additional logic is required on the L1 board. The CTP connection is on the front panel of the L1 board; the signal levels (probably LVDS) and the connector are to be decided.

RoII to TTC transmission

For each **L1** trigger with the asserted **ESR** flag, the RoI logic is obliged to broadcast the *RoI Data* to all the sub-detectors participating in the RoI option. The broadcast takes place after the **L1** trigger.

The *RoI Data* shall be transmitted via the Region of Interest Interface board (RoII) that will be added to the TTC partition of all sub-detectors participating in the option (**Figure 2**). The board shall be a VME master, with a lower bus-grant priority than the *L1 Message/L2r Word/L2a Message* channel on the LTU board, in order to give the priority to the transmission of the *L1 Messages*. The RoI Data shall be transmitted to the priority-level 3 FIFO on the TTCvi board. The transmission of the *RoI Data* over the *Channel B* of the TTC partition shall have the following format:

Word 1:	
RoI header address	4
BCID[12..1]	12
Word 2:	
RoI data address	4
RoIdata[36..25]	12
Word 3:	
RoI data address	4
RoIdata[24..13]	12
Word 4:	
RoI data address	4
RoIdata[12..1]	12

The **BCID[12..1]** is a bunch crossing number of the corresponding **L1** trigger (part of the event identifier); the bits of the **RoIdata** point to the 36 ALICE sectors that are to be included, or otherwise, in the segmented readout.

The first word shall have a unique *RoI header address* (4 bits); the words 2-4 shall have the same *RoI data address.*

Comment: The allocation of a different address to the last word (*RoI trailer address*) was considered. It would have been useful in order to detect an incomplete reception of *RoI Data* message, but the monitoring and reporting task would be too complicated for the front-end electronics (timing jitter, *etc*.). The recovery from an error is automatic - the first word, recognized by its unique address (*RoI header*), resets/restarts the front-end state machine.

LTU to RoII interface

In the *stand alone mode*, the LTU shall emulate the operation of the CTP and generate and transmit all the signals and all the data patterns provided by the CTP in the *global mode*; seen by a sub-detector, the timing and the data structures in both cases shall remain identical, although the data content in the *stand-alone mode* is programmed rather than derived from physics conditions. The emulation option is considered necessary in order to "exercise" the sub-detector front-end electronics during the development phase, or to run it when the CTP is not available (at remote sites) or not wanted.

The block diagram of the LTU board (**Figure 3**) shows the implementation of the CTP emulator. The *Selector* block is controlled by the **Mode** signal (*global run/stand-alone mode*). The groups of signals *External inputs*, *Emulated inputs* and *LTU inputs* are in every respect identical. It enables the *LTU logic* block to operate in exactly the same way in both modes.

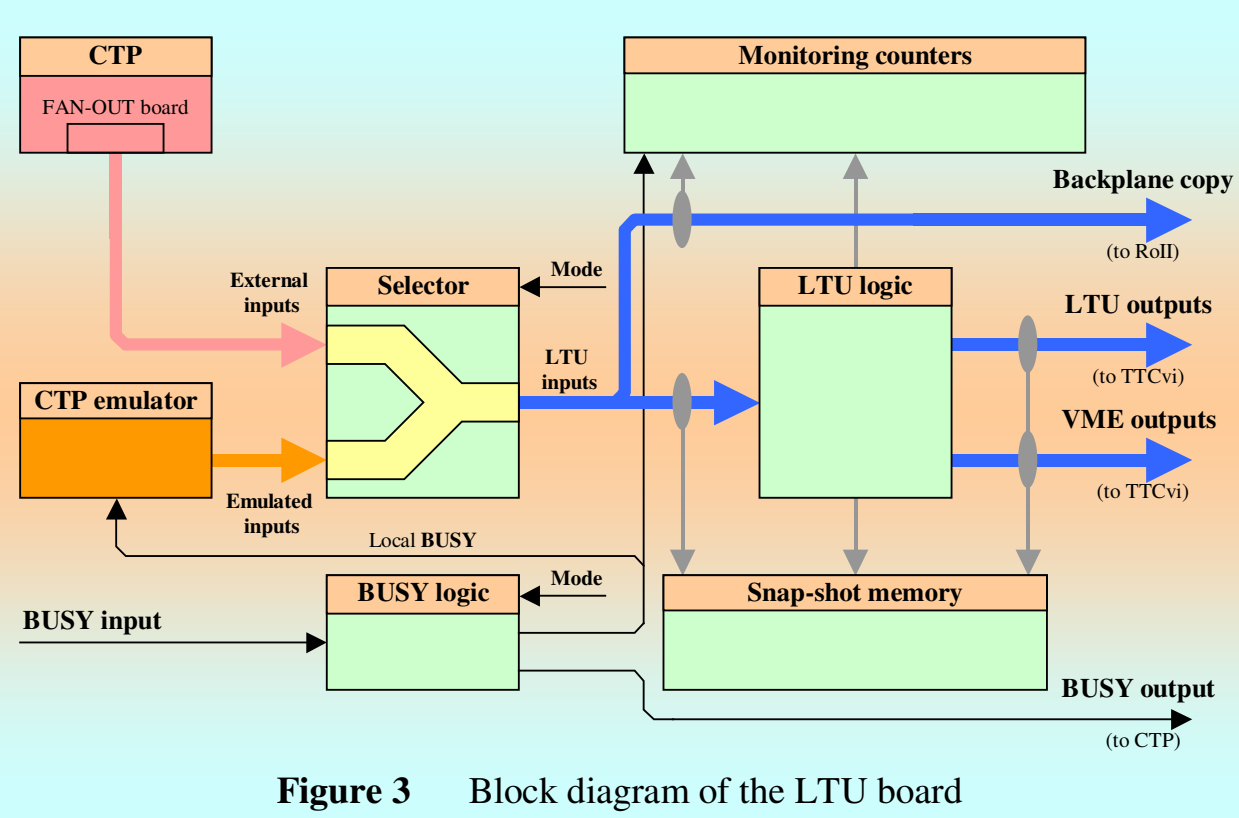

Figure 3 Block diagram of the LTU board

It is assumed that a similar emulation option will be required for the development and testing of the sub-detectors' RoI electronics. A natural place for the RoIP emulator would be the RoII board and the emulated (programmed) *RoI Data* would be transmitted *via* the VMEbus, in the same way, with the same timing and the same data structure used in the *global mode* (see the previous section).

In order to synchronize the RoIP emulation on the RoII board with the CPU emulation on the LTU board, the following signals, generated on the LTU board, need to be transmitted to the RoII board:

- **BC**,
- **Orbit**,
- **L1**,
- **L1D** (***L1*** *Serial Data*).

The **Orbit**, the **L1** and the **L1D** signals shall be in *Non Return to Zero* (NRZ) format; all signal transitions shall be synchronized with the **BC** clock.

The **BC** and the **Orbit** would always be a straight copy of the corresponding signals used by the LTU board; in a *global run*, **L1** and **L1D** would be a copy of the corresponding signals received from the CTP, while, in a *stand-alone mode*, the equivalent signals would be generated by the CTP emulator.

The ***L1*** *Serial Data* (**L1D**) transmission starts with the **L1** signal. The serial data shall contain the following:

– *Calibration Trigger* flag (**CIT**)	1
– *Readout Control* bits (**RoC[4..1]**)	4
– *Enable Segmented Readout* flag **(ESR)**	1
– *Software Class **L1*** trigger status (**L1SwC**)	1
– *Class [50..1] **L1*** trigger status (**L1Class[50..1]**)	50
Total	**57 bits**

The serial transmission time (1.425μs) is not critical - it compares with the minimum time between consecutive **L1** trigger signals (~ 5μs).

In the *stand-alone mode*, upon the reception of the **L1D** data with the asserted **ESR** flag, the RoI emulator on the RoII board shall transmit the *RoI Data* to the sub-detector front-end electronics in a manner described in detail in the previous section (*via* the VMEbus and the TTC partition). The **BCID[12..1]** part shall be generated by the local bunch-crossing counter, synchronous with a similar counter that is part of the CTP emulator on the LTU board. The **RoIdata[36..1]** data are likely to be pre-programmed, but, if required, a more sophisticated structure, more akin to the operation of the RoIP, could be derived from the information available in the **L1D** data.

In the *global mode*, the *RoI Data* shall be generated by the RoI Processor (RoIP), the emulators on both the LTU and the RoII boards shall be disabled and the signals transmitted from the LTU board ignored (apart from the **BC** clock that is likely to be required in all the modes). If found useful, an automatic disabling of the signals could be made a programmable option.

All the signals transmitted from the LTU to the RoII board shall have the LVDS format; the connection shall be made *via* the user-defined pins of the VME J2 connector (*Backplane copy* in **Figure 3**): a slot "reserved" for an optional RoII board shall be next to the LTU board and, if the option is used, a "wired" backplane connection needs to be plugged-in.

Generation of the *Enable Segmented Readout* flag

The generation of the *Enable Segmented Readout* flag (**ESR**) is beyond the scope of this proposal and this section has been included only for reasons of completeness. The issue has already been decided - the algorithm described in the following text has been officially approved by the ALICE Technical Board on 23 April 2002.

The **ESR** is generated by the CTP at the time of **L1** decision. The flag is included in the *L1 Message*, broadcast to all the sub-detectors participating in the trigger; it is also part of the ***L1 Data*** serially transmitted to the RoIP (section ***CTP to RoIP serial transmission***). When the flag is asserted, the readout format of the sub-detectors participating in the RoI option is controlled by the RoIP: depending upon the sub-set of **RoIdata[36..1]** bits that are set, the readout shall include data from *all*, *none*, or only from a *selected group* of sectors.

Comment: If the **L1** trigger is followed by the **L2a** decision, the sub-detectors *must always send the data frame to the DAQ*, even if no sector is selected for the readout; in that special case, the frame shall include the usual header (event identifier, etc.), but the data part of the frame shall be empty. (The details of the frame format shall be decided by the DAQ group.)

The logic diagram of the CTP block that generates the **ESR** is shown in **Figure 4**. A programmable description of a trigger class that always requires a complete readout (all sectors included) shall have the *RoI veto* bit asserted; only classes associated with clusters that include a feasible subset of RoI sub-detectors shall have the *RoI compatible* bit on. The **ESR** flag shall be generated if no active trigger class has the *RoI veto* set and at least one class is *RoI compatible*; the figure also shows that the RoI option is never enabled in case of the *Software Class*.

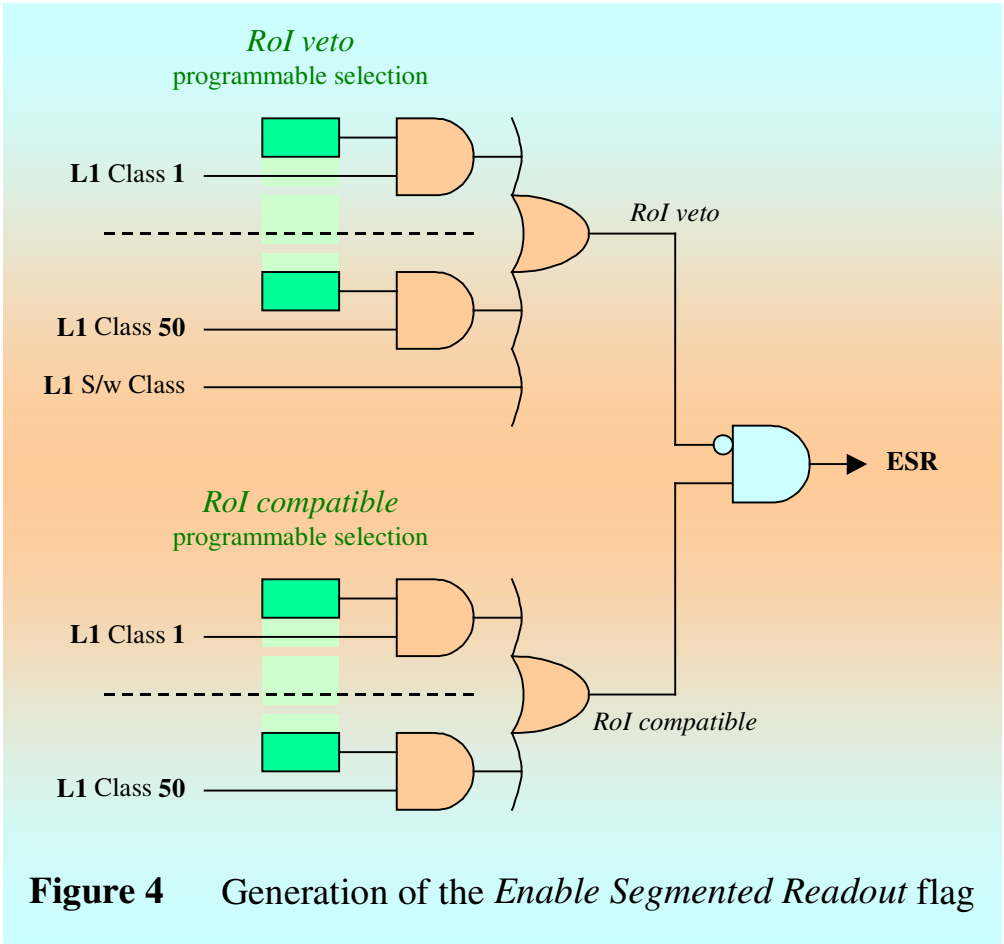

Figure 4 Generation of the *Enable Segmented Readout* flag

Requirements on sub-detectors that participate in the RoI option

This section is also included only for reasons of completeness - to serve as a reminder.

For each **L1** trigger, all the sub-detectors shall receive the status of the **ESR** flag as part of the ***L1 Message,*** transmitted *via* the *Channel B* of the TTC system. The sub-detectors that do not participate in the RoI option shall ignore the bit and proceed with their normal readout.

Whenever the **ESR** is asserted, the sub-detectors that are part of the option shall receive the *RoI Data* message from the RoIP (the format and the content of the message are described in section ***RoII to TTC transmission***). The *RoI Data* are also transmitted *via* the *Channel B* of the TTC partition and are subject to variable delays; some sub-detectors might have to delay the start of their readout until the arrival of the message, since the "shape" of their readout is dependent upon the status of the **RoIdata[36..1]** bits (for more details see the previous section).

When the **L1** trigger is followed by the **L2a** decision, it's likely that the RoI sub-detectors will be required to attach the *RoI Data* message to the raw data in the DAQ readout frame (see the requirement **6.1.3** in the CTP URD, version 1.0). The decision and all the necessary details shall come from the DAQ group.