LVL2 interaction with the RoBs

**Data from RoBs** : data stored in the RoBs and required for analysis in the LVL2 system.

  - event data from physics collisions indicated by the LVL1 trigger (possibly including the LVL1 trigger decision record)
  - test data generated in response to control commands
  - calibration data (e.g. front-end pulse data not produced from a collision)

**RoB Data Requests** : requests sent to RoBs for data required for analysis by LVL2

  - message specifying the data to be transferred (by event number, RoI position and type) and their destination(s).

**LVL2 accept/reject** : decision information sent to the RoBs and/or the EF/DAQ system.

  - LVL2 decision (accept/reject) for a given event number.
  
    Note that only accept decisions may be sent to the Event Filter/DAQ system and that decisions, particularly reject decisions, may be grouped to limit message rates.

**Level-2 decision record** : data written to RoBs for access by Level-3

  - output of trigger algorithms (probabilities, masses, etc.) and event specific errors

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**UR-MENU 1 : trigger object recognition**

The LVL2 system shall be able to recognise trigger objects (muon, electron, gamma, charged hadron, jets, and missing-\(E_T\)) with \(E_T\) above the target thresholds given in the table (to be supplied), but exclusive classification is not required (i.e. the same data may satisfy selection criteria for more than one type of trigger object).

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**UR-MENU 5 : high-Pt mode**

The LVL2 trigger shall be able to operate in “high-\(P_t\)” mode. On the basis of RoI information provided by the LVL1 trigger, the LVL2 trigger system decides which data are needed as input for the feature extraction algorithms.

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**UR-MENU 6 : low-Pt mode**

The LVL2 trigger shall be able to operate in “low-\(P_t\)” mode to support B physics. In this mode the LVL1 system provides RoI information only for muon candidates above a low-\(P_t\) threshold. After confirmation of the trigger muon, a full scan of data from the TRT is performed in search of track candidates thus defining new RoIs. These RoIs may then be used to search for features in other sub-detectors (e.g. SCT); all the information is combined in making the final global decision.
UR-OUT 2 : LVL2 output storage

The data generated by the LVL2 processing (RoI building, pre-processing, feature extraction, global processing and internal error conditions encountered during processing) shall be transferred to the Event Filter system via standard RoBs, depending on the operational mode and on the final LVL2 decision (accept or reject). The original RoI data received from LVL1 shall be included. The data shall be sufficient to permit checks on LVL2 algorithm correctness and trigger efficiency to be performed at a subsequent stage or off-line. It shall be possible to include data to guide Event Filter processing.

UR-ROB 1 : RoI request format

Level-2 shall send a request to a RoB in an agreed format to allow the RoB to extract, pre-process and output data in the way specified in the request. The extraction, pre-processing and output options having been specified at initialisation.

UR-ROB 2 : ROB failure

Level-2 shall continue to operate if some fraction of RoBs fail to deliver data following an RoI request.

UR-ROB 3 : LVL2 reject

Level-2 shall generate a reject signal for each event not accepted by level-2 and deliver this to every RoB. Rejects may be grouped.

UR-ROB 4 : LVL2 accept

Level-2 shall generate an accept signal for each event accepted by level-2 and deliver this signal to every RoB. Accepts may be grouped.

UR-ROB 5 : LVL2 decision records

Level-2 shall send decision records to RoBs in a format which obeys the ROB-ROD protocol.

UC-CSTR 2 : Buffer-nearly-full deadtime

The distribution of LVL2 decision times should be short enough to guarantee a contribution to the deadtime due to Buffer-nearly-full conditions of less than 0.1 %
UC-ROD 1: **message type identification**

RoDs must be capable of serving a mix of *physics* and *test events* and *error messages* to the RoBs. It must be possible to *distinguish between each message type*.

UC-ROD 2: **calorimeter data BC processing**

The calorimeter RoDs shall process their data so that the *information* supplied to the readout buffers is non-zero *only for energy deposits* in the calorimeter *associated with the event trigger bunch crossing*.

UC-ROB 1: **data availability**

For time isolated events, *all data* from all sub-detectors and the LVL1 system shall be *stored in the RoBs* and available to LVL2 within 100 µs of the LVL1 accept signal.

UC-ROB 2: **data modularity and formats**

The details of the *readout modularity and data format* must be *fixed* by the front-end groups only *after consultation with the trigger group*. (ref: "Detector and Readout Specifications seen from the Level-2 trigger" DAQ # 62).

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**RoB complex - LVL2 functional view**

(functions can be mapped onto as many or as few components as required)

- **RoB-in**
  - collects and stores data from RoDs

- **RoB controller**
  - manages complex

- **LVL2 In**
  - data requests and decisions

- **LVL2 processing**
  - data selection, processing, formatting

- **LVL2 output**
  - network connection

- **Other**
  - DAQ/EF, monitoring, initialisation
  - I/O and processing

- **RSI functions**
LVL2 implications for maximum storage time / memory size

Data requests are (likely to be) by event number and eta-phi information and not by buffer memory addresses.

Mean fragment size assumed ~1 kB (100 MB/s at 100 kHz)

Buffer organisation could be by paged memory or by circular buffer

- **paged memory** - the buffer size is determined by the mean LVL2 decision time 5 - 10 ms requiring 1 MB (assumes parallel TRT scan)
- **circular buffer** - the size is determined by the maximum LVL2 decision time 25 ms or greater requiring >2.5 MB

**Grouped decisions** increases buffer size by the size of the grouping to be accommodated (probably 100 events - 100 kB).

**DAQ/EF and monitoring** requirements will impose additional loads.

Requirements of LVL2 algorithms

Basic objects

- **muon** muon chambers, inner tracking, calorimeter (m.i.)
- **electron** calorimeter, inner tracking
- **gamma** calorimeter, (no) inner tracking
- **charged hadron** calorimeter, inner tracking
- **jet** calorimeter
- **missing-$E_t$** calorimeter, muon chambers

Three cases need special consideration - **missing-$E_t$**, TRT scan and HCAL accesses.

1. **missing-$E_t$** (~1 kHz) needs information from
   - (a) complete calorimeter
     - Ex and Ey values can be calculated locally (in RoBs or RoDs?)
     - can we avoid pushing all data through network from RoBs to LVL2 processors?
   - (b) muon chambers
     - add muon energies at LVL2
       - (we need cost/benefit analysis of using this + LVL1 calo Et-miss value?)
2. **TRT scan** (≈4 kHz)  
   used to generate secondary RoIs for B-physics triggers at low luminosity.  
   ~50 ms if performed in single processor (500 Mips) - can it be made parallel?

3. **HCAL accesses**  
   Modelling and *emulation* show problem is worse than indicated by paper models  
   Try to avoid **head-of-line blocking** (separation of data requests ~ wait-to-send time)  
   *request/respond* solves but at cost of low network utilisation  
   (multiple active requests can give back original problem)  
   **traffic shaping** (how controlled)?  
   **Intelligent I/O** which allows later request to overtake blocked request?

   *Also* need to consider what could/should be done locally for each sub-detector on  
   data formatting and ordering; other processing; data selection (part fragments)  
   for multi-RoBs - non-tower based front-ends -> towers  
   We still need **cost/benefit analyses** of  
   **Size of RoI** in sub-detectors  
   we should understand effect of shrinking/enlarging RoI size.  
   **HCAL**  
   we should understand effect of using/not using HCAL at first stage of LVL2 processing  
   current use of HCAL implies one (100 Mb/s) network connection per RoB with  
   intelligent traffic shaping  
   **TRT scan**  
   how far can we make the TRT scan parallel  
   Maria Smizanska's work indicated we could use 16 independent phi segments;  
   probably, we can use 4 eta segments;  
   combining 8 (4?) RoBs could be sufficient for secondary RoI extraction  
   what is optimum segmentation (64, 16, other)  
   **Other detectors**  
   rates and data volumes depend on trigger strategy -  
   we need to settle that before we can make "definitive" statements.