Technical Note 129

LUMS System Performance Specification

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LUMS System Performance Specification

This document describes the performance specifications for the Lane Use Management System (LUMS) that apply at a system level.

The specifications in this document describe the performance that is required at a system level to meet the objectives of managed motorways.

Terms used in this document:

- LC (Lane Control): the feature that allows remote control of lane availability for use by traffic
- VSL (Variable Speed Limits): the feature that allows remote control of the speed limit
- VSL/LC (Variable Speed Limit): signs with Lane Control functionality
- LUMS (Lane Use Management System): the name of the STREAMS component that controls VSL and VSL/LC signs.

Notes:

1. All references that appear within this document will refer to VSL/LC sites which are gantry mounted; however, the performance specifications also apply to VSL only signs which are generally pole mounted.
2. This document does not primarily address the timing of the operation of a set of VSL/LC signs that together comprise a single LUMS site. For those requirements, refer to MRTS206 *Provision of Variable Speed Limit and Lane Control Signs*. This document addresses the timing requirements that apply across a set of LUMS sites.

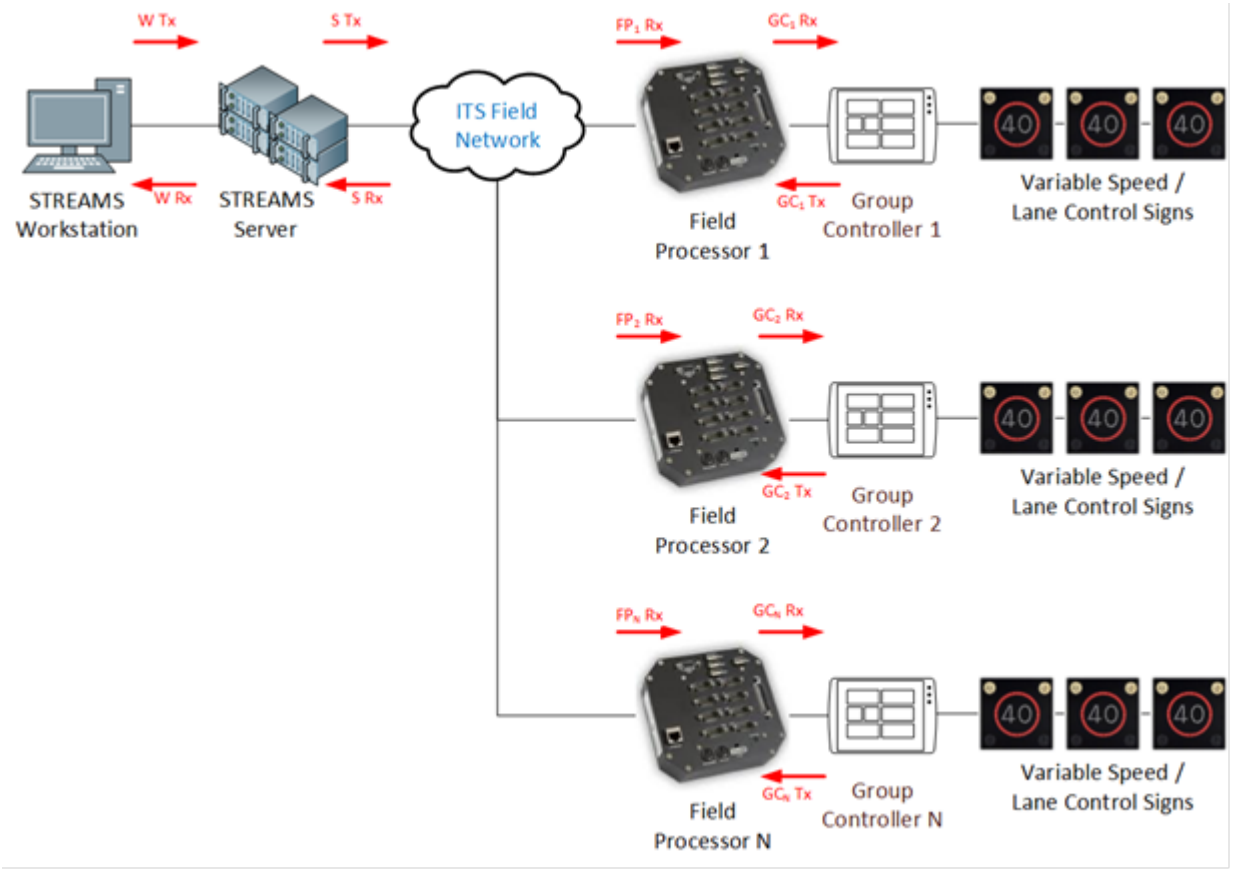
1 References

This document should be read in conjunction with MRTS01 *Introduction to Technical Standards* and MRTS206 *Provision of Variable Speed Limit and Lane Control Signs.*

2 LUMS System overview

The hardware and communications links associated with LUMS used by the Department of Transport and Main Roads is shown in Figure 2 below:

Figure 3 – STREAMS LUMS tool chain



In the above diagrams, the red arrows indicate the messages that are transmitted and/or received by each device. The following descriptions apply:

- W Tx = The set of messages transmitted by the STREAMS workstation to the STREAMS server to request a change to VSL/LC signs.
- S Tx = The set of messages transmitted by the STREAMS server to the Field Processors to request a change to VSL/LC signs.
- FP_n Rx = The set of messages received by a Field Processor to request a change to VSL/LC signs.
- GC_n Rx = The set of messages received by a Group Controller to request a change to VSL/LC signs.
- GC_n Tx = The set of messages sent by a Group Controller to confirm a change to VSL/LC signs.
- S Rx = The set of messages received by the STREAMS server from the Field Processors to confirm a change to VSL/LC signs.
- W Rx = The set of messages received by the STREAMS workstation from the STREAMS server to confirm the change in the displayed state of the VSL/LC signs.

These performance specifications refer to the timing requirements for the implementation of a set of VSL/LC requests that form a step in the VSL or LC response.

3 System response time requirements

This section defines the specific performance requirements for LUMS. The actual timing requirements that apply to each of these parameters are defined in Table 5.

3.1 Requirement 1: Maximum time for LUMS to begin implementing response T_{RS}

When a change is required in the current VSL/LC site displays, the first VSL/LC site in the LUMS display request must change within this specified time after the request to change has been initiated.

In Figure 3, this is shown as the time between the "S Tx" message and the first "GC_X Tx" message that confirms a VSL/LC site display change. Subscript "x" in "GC_X Tx" refers to whichever VSL/LC site responds first to a set of VSL/LC display change requests that are sent.

3.2 Requirement 2: Maximum time window for LUMS response step activation T_{RA}

When a change is required in the current VSL/LC displays, the maximum time between the first VSL/LC site beginning to change and the last VSL/LC site completing the change must be within this specified time. Where a change to a VSL/LC display requires transitionary VSL/LC displays, this time window applies to each set of VSL/LC site display changes requested across the affected area.

In Figure 3, this is shown as the time between the first and the last "GC_n Tx" message that confirms the VSL/LC site display change.

3.3 Requirement 3: Maximum time for LUMS major faults to be reported T_{MFR}

When a LUMS changes state due to a major fault, this defines the maximum time between the change of state occurring and the status change being visible on the workstation with an alarm raised.

Major faults are those which put at risk the operation of the LUMS site to manage speed or lane closures. Relevant state changes include: sign failure/recovery (loss/restoration of communications between site controller and sign) and site controller failure/recovery (loss/restoration of communications between FP and site controller).

In the case of recovery after a LUMS site power fail, the time allowed to report the recovery begins at the completion of the power recovery delay time (Refer LUMS ConOps Design Principle 13).

Note: LUMS sites can keep their current display for between one second and 10 minutes after a communications loss. Current value in Metropolitan is 60 seconds (set per LUMS site). Refer LUMS ConOps, Appendix G, Section 5.0, Design Principle 9.

3.4 Requirement 4: Maximum time for LUMS minor faults to be reported T_{FR}

When a minor fault is detected at a LUMS, this is defined as the maximum time for minor faults to be logged and reported in STREAMS. Minor faults are those which do not put at risk the operation of the LUMS site to manage speed or lane closures. Examples include, for example, individual LED faults in signs.

3.5 Requirement 5: Maximum time to implement rollback T_{IR}

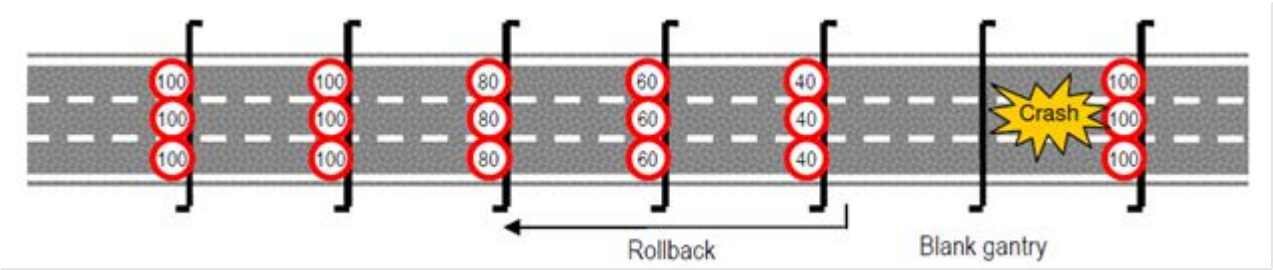
When a LUMS sits in an active response (non-default display) loses communications or has a major fault, STREAMS shall detect and implement the appropriate VSL/LC rollback within this time period. This period is the additional time required to respond and implement the necessary rollback change on the upstream VSL/LUMS sites after detection of the fault.

As such, the total time allowed for a rollback response can be defined as:

Total Rollback Response Time = Time to Report Major Fault T_{MFR} + Time to Implement Rollback T_{IR}.

This is shown in Figure 4.5 below.

Figure 4.5 – LUMS rollback



3.6 Requirement 6: Maximum time to implement rollback recovery

When the LUMS site failure described in Item 5 recovers, STREAMS shall detect and remove the implemented rollback within this time period.

Performance specification is as per Requirement 5, T_{IR}.

3.7 Requirement 7: Maximum time to implement interlock rollback T_{IIR}

One of the requirements of LUMS is that the traffic entering a managed freeway must have the same speed limit as the traffic on the freeway that it will be merging with. To perform this function, the LUMS immediately upstream of an on-ramp is interlocked with the on-ramp VSL signs. The system ensures that these locations always display the same speed. When an active LUMS response plan loses communication with a LUMS site that is interlocked with an on-ramp VSL, STREAMS shall detect and implement the appropriate on-ramp speed limit at the next upstream LUMS site.

The Maximum Time for LUMS Minor Faults to be Reported TFR defines the maximum time taken for the LUMS fault to be detected. The Maximum Time to Implement Interlock Rollback T_{IIR} defines the maximum additional time required to respond and implement the rollback change on the next upstream VSL/LUMS site. As such, the total time allowed for an interlock rollback response can be defined as:

Total interlock rollback response time = Time to Report Major Fault T_{MFR} + Time to Implement Interlock Rollback T_{IIR}.

3.8 Requirement 8: Maximum time to implement interlock rollback recovery

When the LUMS site failure described in Item 7 recovers, STREAMS shall detect and remove the implemented rollback within this time period.

Performance Specification is as per Requirement 7, T_{IIR}.

4 Allocation of response time budget

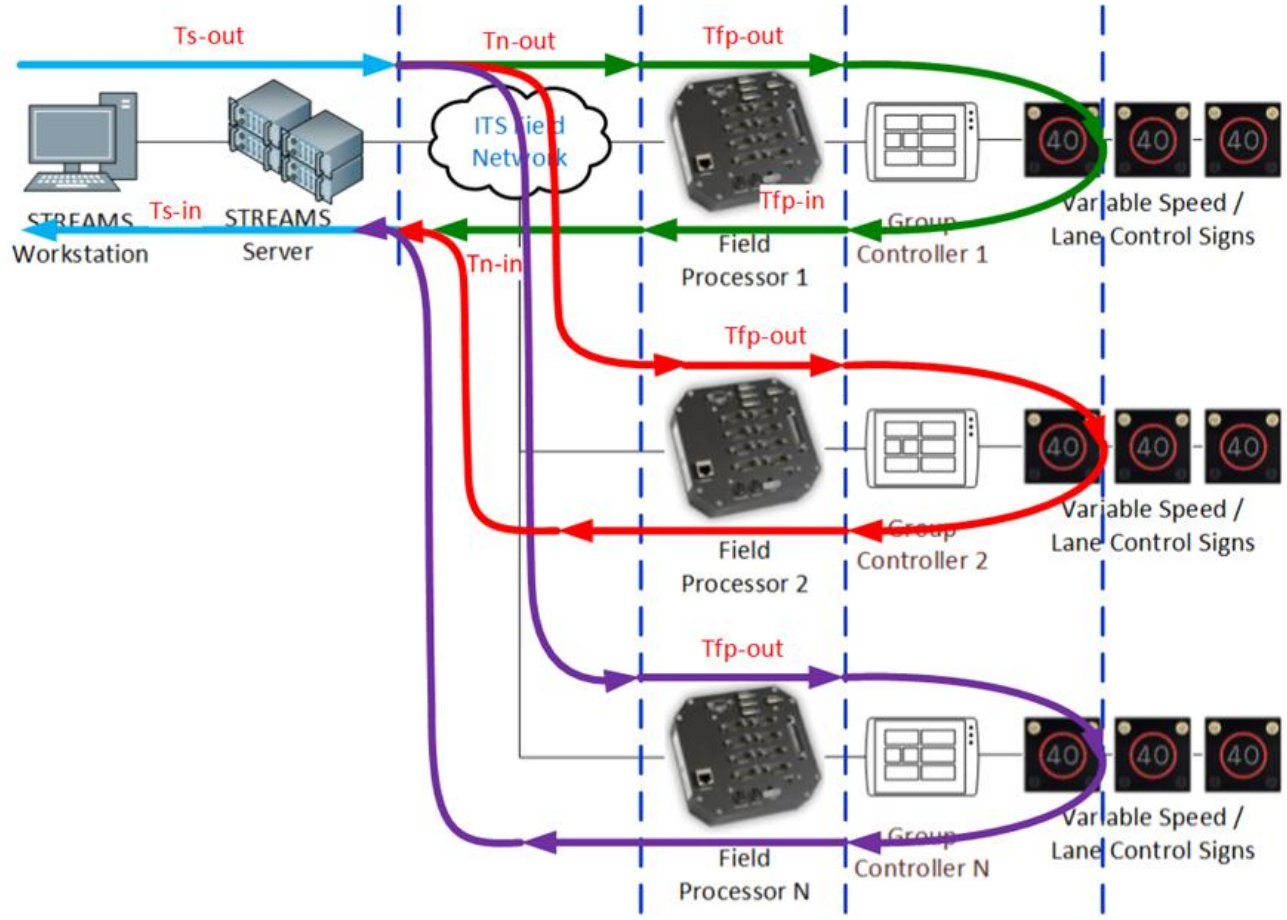
The LUMS tool chain involves the supply of different components by different suppliers. For example:

- STREAMS Workstation, Server and Field Processor software supplied by Transmax
- STREAMS Workstation to Server network supplied by Transport and Main Roads
- STREAMS Server to ITS Field Network (cloud VPN) provided by Telstra

- ITS Field Network (cloud VPN) to Field Processors provided by LUMS project
- Field Processor to Group Controller and VSL/LC Signs provided by sign supplier.

This situation creates additional complexity in the testing acceptable response times during the delivery of a LUMS project. To address this need it is necessary to allocate a time budget to each element that could be supplied by different parties. This allows for specific performance targets to be defined in the specification of each deliverable in the project to achieve the overall system response time.

Figure 4-A – LUMS Tool Chain Response Time Budget Segments



The diagram above can also be represented as a timing diagram shown in Figure 4-B. The arrows in the diagram show the movement of information required to implement a LUMS Response Frame across a set of gantries.

Table 4 shows the required response times as labelled in Figure 4-A.

Table 4 – LUMS tool chain segments response time budgets

		Time allowed (secs)							
	Response time	**Ts-out**	**Tn-out**	**Tfp-out**	**Tsign**	**Ttp-in**	**Tn-in**	**Ts-in**	**TOTAL**
Elements	Time to begin response T_{RS}	2	1	1 (1st sign)	1 (1st sign)	n/a	n/a	n/a	**5 sec**
	Time window to activate response T_{RA}	n/a	n/a	2 (across all signs)		n/a	n/a	n/a	**2 sec**
	Time to report LUMS Major Faults T_{MFR}	1	1	1	2	2	1	2	**10 sec**
	Time to report LUMS Minor Faults T_{FR}	No need to specify segment budgets here if other requirements met							**120 sec**
	Implement or Recover Rollback T_{IR},T_{IIR}	2	1	1	1	n/a	n/a	n/a	**5 sec**

In the above table:

- ‘n/a’ means that there is no response time requirement for this segment as it does not apply to the corresponding system response time requirement
- ‘(across all signs)’ means that the timing provided defines the window that applies to all signs involved in a specific LUMS response display across multiple LUMS/VSL sites.

During project delivery and acceptance testing, it is recommended that if one portion of the tool chain exceeds its response time budget the system should only be accepted if the supplier of another portion of the tool chain is willing to relinquish an appropriate portion of their response time budget to ensure that the overall response time target is met. Suppliers of different portions should not rely on this mechanism being available to them.

The parameters have been defined in such a way as to be measurable outcomes during system testing. Each specified time requirement lists the specific event that starts and completes the time period to be measured. In some instances, a network data capture tool will be required to log the timing of some of these events (such as a message transmittal from a field processor).

Figure 4-B – LUMS tool chain response timing diagram