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Information Model for Large-Scale Measurement Platforms (LMAP)  
draft-burbridge-lmap-information-model-00

## Abstract

This Information Model applies to the Measurement Agent within a Large-Scale Measurement Platform. As such it outlines the information the is pre-configured on the MA or exists in communications with a Controller or Collector within an LMAP framework. The purpose of such an Information Model is to provide a protocol and device independent view of the MA that can be implemented via one or more Control and Report protocols.

## Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

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## [1.](#) Introduction

A large-scale measurement platform is a collection of components that work in a coordinated fashion to perform measurements from a large number of vantage points. The main components of a large-scale measurement platform are the Measurement Agents (hereafter MAs), the Controllers and the Collectors.

The MAs are the elements actually performing the measurements. The MAs are controlled by one or more Controllers and the Collectors gather the results generated by the MAs. In a nutshell, the normal operation of a large-scale measurement platform starts with the

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Controller instructing a set of MAs to perform a set of measurements at a certain point in time. The MAs execute the instructions from the Controller and once they have done so they report the results of the measurements to the Collector. The overall framework for a Large Measurement platform is described in detail in [in <xref target="I-D.eardley-lmap-framework" />](#) and the terminology used in this document is defined in [\[I-D.eardley-lmap-terminology\]](#).

A large-scale measurement platform involves basically three protocols, namely, a Control protocol between the Controller(s) and the MAs, a Report protocol between the MAs and the Collector(s) and several measurement protocols between the MAs used to actually perform the measurements. In addition the some information is required to be provisioned to the MA prior to any communication with the Controller.

This document defines the information model for both the Control and the Report protocol along with pre-configuration information that is required before communicating with the Controller, broadly named as the LMAP Information Model (or LMAP IM for short). The measurement protocols are out of the scope of this document.

As defined in [\[RFC3444\]](#), the LMAP IM defines the concepts involved in a large-scale measurement platform at a high level of abstraction, independently of any specific implementation or actual protocol used to exchange the information. It is expected that the proposed information model can be used with different protocols in different measurement platform architectures and across different types of MA device (e.g. home gateway, smartphone, PC, router etc.).

## [2.](#) LMAP Information Model

### [2.1.](#) Information Structure

The information described herein relates to the information stored, received or transmitted by a Measurement Agent as described within

the LMAP framework [[I-D.eardley-lmap-framework](#)]. As such, some subsets of this information model are applicable to the measurement Controller, Collector and systems that pre-configure the Measurement Agent. The information described in these models will be transmitted across the protocols and interfaces between the Measurement Agent and such systems according to a Data Model.

For clarity the information model is divided into six sections:

1. Pre-Configuration Information. Information pre-configured on the Measurement Agent prior to any communication with other components of the LMAP architecture, specifically detailing how to register with a Controller
2. Configuration Information. Information delivered to the MA on registration with a Controller or updated during a later communication, specifically detailing how to retrieve measurement and reporting instruction information from a Controller along with information specifically about the MA
3. Instruction Information. Information that is received by the MA from the Controller pertaining to the measurement and reporting configuration. This includes measurement configuration, report channel configuration, measurement schedules and measurement suppression information
4. Logging Information. Information transmitted from the MA to the Controller detailing the results of any configuration operations along with error and status information from the operation of the MA
5. Status Information. Information on the general status and capabilities of the MA. For example, the set of measurements that are supported on the device
6. Reporting Information. Information transmitted from the MA to the Collector including measurement results and the context in which they were conducted

In addition the MA may hold further information not described herein, and which may be optionally transferred to or from other systems including the Controller and Collector. One example of information in this category is subscriber or line information that may be reported by the MA as optional fields in the reporting communication to the Collector.

## [2.2.](#) Pre-Configuration Information

This information is the minimal information that needs to be pre-configured to the MA in order for it to successfully communicate with a Controller during the registration process.

This pre-configuration information needs to include an address of the Controller to contact along with the security information required for the communication including the MA private and public keys and the public key of the Controller. Such keys will be contained within security certificates and are likely to be obtained and validated through communication with a Trusted Certificate Authority.

In addition the information will describe how often to attempt communication with the Controller.

Detail of the information model elements:

1. MA MAC: MAC Address
2. Controller: FQDN
3. MA Certificate: Certificate
4. Controller Communication Timing: Timing

The detail of the timing object is described later since it is common to several parts of the information model.

### [2.3.](#) Configuration Information

During registration or at any later point at which the MA contacts the Controller, the choice of Controller and details for the timing of communication with the Controller can be changed. For example the pre-configured Controller may be replaced with a specific Controller that is more appropriate to the MA device type, location of characteristics of the network (e.g. access technology type or broadband product). The initial communication timing object may also be replaced with one more relevant to routine communications between the MA and the Controller.

In addition the MA will be given further items of information that relate specifically to the MA rather than the measurements it is to conduct or how to report results. The assignment of an ID to the MA is mandatory. Optionally a Group ID may also be given which identifies a group of interest to which that MA belongs. For example the group could represent an ISP, broadband product, technology, market classification, geographic region, or a combination of multiple such characteristics. Where the Measurement Group ID is set an additional flag (the Report MA ID flag) is required to control whether the Measurement Agent ID is to be reported. This allows the MA to remain anonymous which may be particularly useful to prevent tracking of mobile MA devices.

Detail of the additional information model elements:

1. Measurement Agent ID: String
2. Measurement Group ID (optional): String
3. Report MA ID flag (optional): Boolean

### [2.4.](#) Instruction Information

The Instruction information model has four sub-elements:

1. Measurement Task Configurations: Set
2. Report Channels: Set

### 3. Measurement Schedules: Set

### 4. Measurement Suppression: Object

Conceptually each Measurement Task Configuration defines the parameters of a Measurement Task that the Measurement Agent (MA) may perform at some point in time. It does not by itself actually instruct the MA to perform them at any particular time (this is done by a Measurement Schedule).

Example: A Measurement Task Configuration may configure a single Measurement Task for measuring UDP latency. The Measurement Task Configuration could define the destination port and address for the measurement as well as the duration, internal packet timing strategy and other parameters (for example a stream for one hour and sending one packet every 500 ms). It may also define the output type and possible parameters (for example the output type can be the 95th percentile mean) where the measurement task accepts such parameters. It does NOT define when the task starts (this is defined by the Measurement Schedule element), so it does not by itself instruct the MA to actually perform this measurement task.

The Measurement Task Configuration will include a local short name for reference by the Measurement Schedule, along with a registry entry [[I-D.bagnulo-ippm-new-registry](#)] that defines the Measurement Task. The MA itself will resolve the registry entry to a local executable program. In addition the Measurement Task is specialised through a set of configuration Options. The nature and number of these Options will depend upon the Measurement Task and will be defined in the Measurement Task Registry. In addition the Measurement Task Configuration may optionally also be given a

Measurement Cycle ID. The purpose of this ID is to easily identify a set of measurement results that have been produced by Measurement Tasks with comparable Options. This ID is manually incremented when an Option change is implemented which could mean that two sets of results should not be directly compared.

A Report Channel defines how to report results to a single Collector. Several Report Channels can be defined to enable results to be split

or duplicated across different report intervals or destinations. E.g. a single Collector may have three Report Channels, one reporting hourly, another reporting daily and a third on which to send immediate results for on-demand measurement tasks.

Each Report Channel contains the details of one collector (including location and security information such as the certificate), and the timing for the report i.e. when to report the results. The Report Channel can use the same timing information object as a Measurement Schedule defined later and the Controller Communication Timing defined earlier. There are several options, such as immediately after the results are obtained or at a given interval or calendar based cycle). As with the Measurement task Configuration, each Report Channel is also given a local short name by which it can be referenced from a Measurement Schedule.

Example: A Report Channel may specify that results are to be sent to the Collector resolved by the FQDN (collector.foo.org), using the appropriate digital certificate to establish a secure channel. The Report Channel specifies that the results are to be sent immediately as available and not batched.

A Measurement Schedule contains the instruction from the Controller to the MA to execute a single or repeated series of Measurement Tasks. Each Measurement Schedule contains basically three elements: a reference to a list of Measurement Task Configuration, a reference to a set of one or more Report Channels, and a timing object for the schedule. The schedule basically states what measurement task to run, how to report the results, and when to run the measurement task. Multiple measurement tasks in the list will be executed in order with minimal gaps. Note that the Controller can instruct the MA to report to several Collectors by specifying several Report Channels.

Example: a Measurement Schedule references a single Measurement Task Configuration for the UDP latency defined in the previous example. It references the Report Channel in the previous example to send results immediately as available to the specified Collector. The timing is specified to run the configured Measurement Task Configuration every hour at 23 minutes past the hour.



Measurement Schedule and stop measurements from the MA for a defined or indefinite period. While conceptually measurements can be stopped by simply removing them from the Measurement Schedule, splitting out separate information on Measurement Suppression allows this information to be updated on the MA on a different timing cycle or protocol implementation to the Measurement Schedule.

The goal when defining these four different elements is to allow each part of the information model to change without affecting the other three elements. For example it is envisaged that the Report Channels and the set of Measurement Tasks Configurations will be relatively static. The Measurement Schedule on the other hand is likely to be more dynamic as the measurement panel and test frequency are changed for various business goals. Another example is that measurements can be suppressed with a Measurement Suppression command without removing the existing Measurement Schedules that would continue to apply after the Measurement Suppression expires or is removed. In terms of the Controller-MA communication this can reduce the data overhead. It also encourages the re-use of the same standard Measurement Task Configurations and Reporting Channels to help ensure consistency and reduce errors.

Definition of the information model elements:

1. Measurement Task Configurations: Set

1. Measurement Task Configuration: Object

1. Task Name (used for referral from the Measurement Schedules): String
2. Registry Entry: URN
3. Options: Set (optional)
4. Measurement Cycle ID: String (optional)

2. Report Channels: Set

1. Report Channel: Object

1. Channel Name (used for referral from the Measurement Schedule): String
2. Collector: FQDN
3. Report Timing: Timing

### 3. Measurement Schedules: Set

#### 1. Measurement Schedule: Object

##### 1. Schedule Name: String

##### 2. Measurement Task Configuration Names (reference by Name to one of the measurement tasks defined in the Measurement Task Configuration set): List

###### 1. Task Name: String

##### 3. Report Channel Names (reference by Name to one of the measurement tasks defined in the Measurement Task Configuration set): Set

###### 1. Channel Name: String

##### 4. Measurement Timing: Timing

#### 4. Measurement Suppression: Object (optional)

##### 1. Start: datetime

##### 2. End: datetime

##### 3. Set of Measurement Task Configuration Names (optional - default all)

###### 1. Task Name: String

### [2.5.](#) Logging Information

The MA will report back success/failure and status information to the Controller. These messages will fall into a number of different categories:

#### 1. Success/failure messages in response to information updates from the Controller. For example:

\* "Report Channel 'hourly db' configured"

\* "Measurement Schedule does not conform to schema, Row 211"

#### 2. Status updates from the operation of the MA. For example:

\* "out of memory: cannot record result"

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\* "Collector 'collector.example.com' not responding"

Each log message will have the following Information model elements:

1. Log Time: datetime
2. Log Event: Object

#### [2.6.](#) Status Information

In addition to the information reported by the MA through the logging information, the MA will hold further status information that can be retrieved by a Controller. One category of additional information that has not been defined in earlier sections is the availability of Measurement Tasks on that MA.

MA Status information model elements:

1. MA ID: String
2. MA Device: String
3. MA IP: IP Address
4. Last Measurement: datetime
5. Last Report: datetime
6. Last Instruction: datetime
7. Last Configuration: datetime
8. Supported Measurements: Set
  1. Registry Entry: URN

#### [2.7.](#) Reporting Information

At a point in time specific by the Report Channel, the MA will

communicate a set of measurement results to the Collector. These measurement results should be communicated within the context in which they were collected.

The report is structured hierarchically to avoid repetition of report, Measurement Agent and Measurement Task Configuration information. The report starts with the timestamp of the report generation on the MA and details about the MA including the optional Measurement Agent ID and Group ID (controlled by the Configuration

Information). In addition optional further MA context information can be included at this point such as the line sync speed or ISP and product if known by the MA.

After the MA information the results are reported grouped into the different Measurement Tasks. Each Task starts with replicating the Measurement Task Configuration information before the result headers (titles for data columns) and the result data rows.

Information model elements:

1. Report Date: datetime
2. Measurement Agent ID: String (optional)
3. Measurement Group ID: String (optional)
4. MA Context: Set (optional)
  1. Context Item: Object
5. Measurement Task: Set
  1. Measurement Task Configuration: Object
  2. Result Headers: List
    1. Column Name: String
  3. Result Data: List
    1. Result Row: Object

1. Measurement Time: datetime
2. Cross-traffic: Integer (optional)
3. Result Columns: List

1. Column Data

## [2.8.](#) Timing Information

The Timing information object used throughout the information models can take one of four different forms:

1. Periodic. Specifies a start, end and interval time in milliseconds

2. Calendar: Specifies a calendar based pattern - e.g. 22 minutes past each hour of the day on weekdays
3. One Off: A single instance occurring at a specific time
4. Immediate: Should occur as soon as possible

Optionally each of the first three options may also specify a randomness that should be evaluated and applied separately to each indicated event.

### [2.8.1.](#) Periodic Timing

Information model elements:

1. 1. Timing Name: String
2. 2. Start: datetime (optional)
3. 3. End: datetime (optional)
4. 4. Interval: Integer (in milliseconds)
5. 5. Randomness: Timing Randomness (optional)

### [2.8.2.](#) Calendar Timing

Information model elements:

1. Timing Name: String
2. Start: datetime (optional)
3. End: datetime (optional)
4. Months: Set (optional - default [1-12])
  1. Month: Integer
5. Weekdays: Set (optional - default [Mon-Sun])
  1. Weekday: String (one off Mon, Tue, Wed, Thu, Fri, Sat Sun)
6. Days: Set (optional - default [1-31])
  1. Day: Integer
7. Hours: Set (optional - default [1-24])

1. Hour: Integer
8. Minutes: Set (optional - default [1-60])
  1. Minute: Integer
9. Seconds: Set (optional - default [1-60])
  1. Second: Integer
10. Randomness: Timing Randomness (optional)

### [2.8.3.](#) One-Off Timing

Information model elements:

1. Time: datetime

## 2. Randomness: Timing Randomness (optional)

### [2.8.4.](#) Immediate Timing

The immediate timing object has no further information elements. The measurement or report is simply to be done as soon as possible.

### [2.8.5.](#) Timing Randomness

The Timing randomness object specifies a random distribution that can be applied to any scheduled execution event such as a measurement or report. The intention is to be able to spread the load on the Controller, Collector and network in an automated manner for a large number of Measurement Agents. The randomness is expressed as a distribution (e.g. Poisson, Normal, Uniform etc.) along with the spread over which the distribution should be applied. In addition optional upper and lower bounds can be applied to control extreme spread of timings.

Information model elements:

1. Distribution: String
2. Upper Cut: Integer (optional)
3. Lower Cut: Integer (optional)
4. Spread: Integer

## [3.](#) IANA Considerations

This document makes no request of IANA .

Note to RFC Editor: this section may be removed on publication as an RFC.

## [4.](#) Security Considerations

This Information Model deals with information about the control and reporting of the Measurement Agent. There are broadly two security

considerations for such an Information Model. Firstly the Information Model has to be sufficient to establish secure communication channels to the Controller and Collector such that other information can be sent and received securely. The second consideration is that no mandated information items pose a risk to confidentiality or privacy given such secure communication channels. For this latter reason items such as the MA context and MA ID are left optional and can be excluded from some deployments. This would, for example, allow the MA to remain anonymous and for information about location or other context that might be used to identify or track the MA to be omitted or blurred.

## [5.](#) Acknowledgements

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