

LWA Station-Level Metadata

Ver. 1

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1 Introduction

This memo documents the format of station-level metadata for the LWA-1 initial operational capability (IOC) monitoring and control system (MCS). The metadata described in this document consists of “station static” and ”station dynamic” information, which is distinct from the observation-related metadata described in [1].

2 Format of a Station Static MIB Initialization File

Initialization files for the station static MIB is a human-readable text files. See the example provided in Appendix A. These files consist of lines, with each line having the following structure:

- A keyword identifying a parameter
- At least one whitespace character
- Data intended to be assigned to the parameter
- Newline (line terminator)

A line may be up to 4096 characters long. Empty lines are allowed, ignored, and encouraged as a way to improve the readability. The “Data” field contains only alphanumeric characters (including space) plus standard punctuation and common symbols, but not special/invisible characters.

The following is a list of defined parameters, in the order in which it is recommended that they appear in the file. For each parameter, the identifying keyword is given, followed by a definition and information on valid values.

- **COMMENT**: A comment. Ignored by MCS, but useful for documenting the values appearing in the file and/or providing additional information that may be useful to users. Any number of these lines may appear, in any location in the file.
- **FORMAT_VERSION**: An integer equal to the version number of this document. Included to account for the possibility of format modifications over time.
- **STATION_ID**: Station Identification. This is a two-letter code intended to enable concise, unambiguous identification of the station.
- **GEO_N**: WGS84 latitude of the origin of the station’s local coordinate system. Decimal, with North and South being indicated as “+” and “-”, respectively. This position is an arbitrarily-selected reference point and may not necessarily correspond to the location of the phase center of the station during an observation.
- **GEO_E**: WGS84 longitude of the origin of the station’s local coordinate system. Decimal, with East and West being indicated as “+” and “-”, respectively. This position is an arbitrarily-selected reference point and may not necessarily correspond to the location of the phase center of the station during an observation.
- **N_STD**: Maximum number of stands; expected to be 260.
- **STD_LX[n]**: x coordinate [m] of the feedpoints of stand n ($1 \leq n \leq N_STD$) in the local coordinate system. The $+x$ points East.
- **STD_LY[n]**: y coordinate [m] of feedpoints of stand n ($1 \leq n \leq N_STD$) in the local coordinate system. The $+y$ points North.
- **STD_LZ[n]**: z coordinate [m] of feedpoints of stand n ($1 \leq n \leq N_STD$) in the local coordinate system. The $+z$ points to the Zenith.
- **ANT_STD[n]**: The stand on which antenna n ($1 \leq n \leq 2 \times N_STD$) is mounted.
- **ANT_ORIE[n]**: The intended orientation (polarization) of antenna n ($1 \leq n \leq 2 \times N_STD$); 0 = “intended to be North-South”; 1 = “intended to be East-West”.
- **ANT_STAT[n]**: The status of antenna n ($1 \leq n \leq 2 \times N_STD$). See Note 1.

- **ANT_THETA**[n]: The undesired rotation [deg] of the North or East arm of antenna n ($1 \leq n \leq 2 \times \text{N_STD}$) in the elevation plane, relative to nominal (0°). Positive sign means increasing angle with respect to the $+z$ -axis of the local coordinate system, in the direction of the $z = 0$ plane.
- **ANT_PHI**[n]: The undesired rotation [deg] of the North or East arm of antenna n ($1 \leq n \leq 2 \times \text{N_STD}$) in the azimuth plane, relative to nominal (0°). Positive sign means increasing angle with respect to the $+x$ -axis of the local coordinate system in the direction of the $+y$ axis.
- **ANT_DESI**[n]: An integer code which identifies the design of antenna n ($1 \leq n \leq 2 \times \text{N_STD}$). See Note 2. Design information expected to be indexed by this code includes the mechanical specification (specific design/manufacture/model), complex vector effective length vs. frequency and pattern direction, and self-impedance vs. frequency.
- **N_FEE**: Number of FEEs to be described in this file.
- **FEE_ID**[m]: Label or serial number which unambiguously identifies FEE m ($1 \leq m \leq \text{N_FEE}$).
- **FEE_STAT**[m]: The status of FEE m ($1 \leq m \leq \text{N_FEE}$). See Note 1.
- **FEE_DESI**[m]: An integer code which identifies the design of FEE m ($1 \leq m \leq \text{N_FEE}$). See Note 2. Design information expected to be indexed by this code includes electrical and mechanical descriptions and frequency-domain transfer function described as (a) coefficients in a polynomial fit (representative of all FEEs with this design code) and (b) measurements of a representative FEE.
- **FEE_GAI1**[m]: Gain [dB] of FEE m ($1 \leq m \leq \text{N_FEE}$) port 1, assuming nominal input and output terminations, at the reference frequency of 38 MHz.
- **FEE_GAI2**[m]: Gain [dB] of FEE m ($1 \leq m \leq \text{N_FEE}$) port 2, assuming nominal input and output terminations, at the reference frequency of 38 MHz. If this FEE has only one port, then this should be -200.
- **FEE_ANT1**[m]: Antenna to which port 1 of FEE m ($1 \leq m \leq \text{N_FEE}$) is connected. Normally in the range 1 to $2 \times \text{N_STD}$. A value of 0 means the FEE input is open-circuited.
- **FEE_ANT2**[m]: Antenna to which port 2 of FEE m ($1 \leq m \leq \text{N_FEE}$) is connected. Normally in the range 1 to $2 \times \text{N_STD}$. A value of 0 means the FEE input is open-circuited or has only one port.
- **FEE_RACK**[m]: From the perspective of SHL, this is the rack (1-6) in which the power supply powering this FEE is located. A value of 0 means this parameter is unknown. This parameter is used in conjunction with **FEE_PORT**[m] to identify the power source for this FEE.
- **FEE_PORT**[m]: From the perspective of SHL, this is the power port corresponding to the power supply powering this FEE. A value of 0 means this parameter is unknown. This parameter is used in conjunction with **FEE_RACK**[m] to identify the power source for this FEE.
- **N_RPD**: Maximum number of cables connecting to FEEs to SEP; typically 520.
- **RPD_ID**[m]: Label or tag which unambiguously identifies cable m ($1 \leq m \leq \text{N_RPD}$).
- **RPD_STAT**[m]: The status of cable m ($1 \leq m \leq \text{N_RPD}$). See Note 1.
- **RPD LENG**[m]: Length [m] of cable m ($1 \leq m \leq \text{N_RPD}$).
- **RPD_ELNS**[m]: Electrical length [ns] of cable m ($1 \leq m \leq \text{N_RPD}$) at the reference frequency of 38 MHz.

- **RPD_DESI** $[m]$: An integer code which identifies the design of cable m ($1 \leq m \leq N_RPD$). See Note 2. Design information expected to be indexed by this code includes cable type, electrical and mechanical descriptions, frequency-domain transfer function described as coefficients in a polynomial fit (representative of all cables with this design code).
- **RPD_GAIN** $[m]$: Gain [dB] of cable m ($1 \leq m \leq N_RPD$) at the reference frequency of 38 MHz. Since cables are passive and lossy, this will always be negative.
- **RPD_ANT** $[m]$: Antenna to which cable m ($1 \leq m \leq N_RPD$) is ultimately connected. Normally in the range 1 to $2 \times N_STD$. A negative value means the cable is connected at its input, but not at its output. A value of 0 means this cable is disconnected at both ends, or that its connections are unknown.
- **N_SEP**: Maximum number of ports through SEP; typically 520. Note that a “SEP port” is defined as the path from the jack on the outside of the shelter, to the end of the cable that connects to the ASP input.
- **SEP_ID** $[m]$: Label which unambiguously identifies SEP port m ($1 \leq m \leq N_SEP$) on the SEP panel.
- **SEP_STAT** $[m]$: The status of SEP port m ($1 \leq m \leq N_RPD$). See Note 1.
- **SEP_CABL** $[m]$: Label or tag which unambiguously identifies the cable that connects the SEP panel to the ASP input.
- **SEP LENG** $[m]$: Length [m] of the cable that connects the SEP panel to the ASP input.
- **SEP_DESI** $[m]$: An integer code which identifies the design of SEP port m ($1 \leq m \leq N_RPD$), including the cable to ASP. See Note 2. Design information expected to be indexed by this code includes cable type, electrical and mechanical descriptions, frequency-domain transfer function described as coefficients in a polynomial fit (representative of all cables with this design code).
- **SEP_GAIN** $[m]$: Gain [dB] of SEP port m ($1 \leq m \leq N_RPD$) including the cable to ASP, at the reference frequency of 38 MHz. Since cables are passive and lossy, this will always be negative.
- **SEP_ANT** $[m]$: Antenna to which SEP port m ($1 \leq m \leq N_RPD$) is ultimately connected. Normally in the range 1 to $2 \times N_STD$. A negative value means the SEP port is connected at its input, but not at its output. A value of 0 means this SEP port is disconnected at both ends, or that its connections are unknown.
- **N_ARB**: Maximum number of ARX boards.
- **N_ARBCH**: Maximum number of channels per ARX board; expected to be 16.
- **ARB_ID** $[m]$: Label or serial number which unambiguously identifies ARX board m ($1 \leq m \leq N_ARB$).
- **ARB_SLOT** $[m]$: Unambiguous identification of the slot of the ASP chassis in which ARX board m ($1 \leq m \leq N_ARB$) is installed.
- **ARB_DESI** $[m]$: An integer code which identifies the design of ARX board m ($1 \leq m \leq N_ARB$). See Note 2. Design information expected to be indexed by this code includes board revision number, electrical and/or mechanical descriptions, frequency-domain transfer function described as coefficients in a polynomial fit (representative of all ARX board channels with this design code).
- **ARB_RACK** $[m]$: From the perspective of SHL, this is the rack (1-6) in which the power supply powering this ARX board is located. A value of 0 means this parameter is unknown. This parameter is used in conjunction with **ARB_PORT** $[m]$ to identify the power source for this ARX board.

- **ARB_PORT**[m]: From the perspective of SHL, this is the power port corresponding to the power supply powering this ARX board. A value of 0 means this parameter is unknown. This parameter is used in conjunction with **ARB_RACK**[m] to identify the power source for this ARX board.
- **ARB_STAT**[m] [p]: The status of channel p ($1 \leq p \leq N_ARBCH$) of ARX board m ($1 \leq m \leq N_RPD$). See Note 1.
- **ARB_GAIN**[m] [p]: Maximum gain [dB] of channel p ($1 \leq p \leq N_ARBCH$) of ARX board m ($1 \leq m \leq N_ARB$), at the reference frequency of 38 MHz in full-bandwidth mode. “Maximum gain” means gain when programmable attenuation is minimum.
- **ARB_ANT**[m] [p]: Antenna that channel p ($1 \leq p \leq N_ARBCH$) of ARX board m ($1 \leq m \leq N_ARB$) is ultimately connected to. A negative value means the channel is connected at its input, but not at its output. A value of 0 means this channel is disconnected at both ends, or that its connections are unknown.
- **ARB_IN**[m] [p]: Label unambiguously identifying the input connector to channel p ($1 \leq p \leq N_ARBCH$) of ARX board m ($1 \leq m \leq N_ARB$) on the ASP rack.
- **ARB_OUT**[m] [p]: Label unambiguously identifying the output connector from channel p ($1 \leq p \leq N_ARBCH$) of ARX board m ($1 \leq m \leq N_ARB$) on the ASP rack.
- **N_DP1**: Maximum number of DP1 boards. Expected to be 26.
- **N_DP1CH**: Number of channels per DP1 board. Expected to be 20, where 1 & 2 are a stand, 3 & 4 are a stand, and so on.
- **DP1_ID**[m]: Label or serial number which unambiguously identifies DP1 board m ($1 \leq m \leq N_DP1$).
- **DP1_SLOT**[m]: Unambiguous identification of the slot of the DP chassis in which DP1 board m ($1 \leq m \leq N_ARB$) is installed.
- **DP1_DESI**[m]: An integer code which identifies the design of DP1 board m ($1 \leq m \leq N_DP1$). See Note 2. Design information expected to be indexed by this code includes board revision number, firmware version, TBN bandpasses described as coefficients in a polynomial fit.
- **DP1_STAT**[m] [p]: The status of channel p ($1 \leq p \leq N_DP1CH$) of DP1 board m ($1 \leq m \leq N_RPD$). See Note 1.
- **DP1_IN**[m] [p]: Label unambiguously identifying the input connector to channel p ($1 \leq p \leq N_DP1CH$) of DP1 board m ($1 \leq m \leq N_DP1$) on the DP rack.
- **DP1_ANT**[m] [p]: Antenna that channel p ($1 \leq p \leq N_ARBCH$) of DP1 board m ($1 \leq m \leq N_DP1$) is ultimately connected to. A value of 0 means this channel is not connected, or that its connection is unknown.
- **N_DP2**: Maximum number of DP2 boards. Expected to be 2.
- **DP2_ID**[m]: Label or serial number which unambiguously identifies DP2 board m ($1 \leq m \leq N_DP2$).
- **DP2_SLOT**[m]: Unambiguous identification of the slot of the DP chassis in which DP2 board m ($1 \leq m \leq N_DP2$) is installed.
- **DP2_STAT**[m]: The status of DP2 board m ($1 \leq m \leq N_DP2$). See Note 1.
- **DP2_DESI**[m]: An integer code which identifies the design of DP2 board m ($1 \leq m \leq N_DP2$). See Note 2. Design information expected to be indexed by this code includes board revision number, firmware version, DRX bandpasses described as coefficients in a polynomial fit.

- `N_DR`: Maximum number of MCS-DR subsystems. Expected to be 5.
- `DR_STAT[m]`: The status of MCS-DR m ($1 \leq m \leq N_MDR$). See Note 1.
- `DR_ID[m]`: Serial number which unambiguously identifies MCS-DR m ($1 \leq m \leq N_MDR$).
- `DR_SHLF[m]`: Unambiguous identification of the shelf in the MCS-DR chassis in which this MCS-DR PC is installed.
- `DR_PC[m]`: The model of this MCS-DR PC; e.g., “Dell XPS435”.
- `DR_DP[m]`: Which DP output this MCS-DR is connected to. Values are 1-4 for beam outputs, and 5 for TBN/TBW.
- `N_PWR_RACK`: Maximum number of racks, from the perspective of SHL. Expected to be 6 at IOC.
- `N_PWR_PORT[m]`: Maximum number of power ports in rack m ($1 \leq m \leq N_PWR_RACK$), from the perspective of SHL.
- `PWR_SS[m][p]`: Subsystem that receives power from port p ($1 \leq p \leq N_PWR_PORT$) of rack m ($1 \leq m \leq N_PWR_RACK$). Valid values are SHL, ASP, DP-, MCS, DR1, DR2, DR3, DR4, and DR5. A value of UNK means this port is not connected, or that its connection is unknown.
- `PWR_NAME[m][p]`: Specific item that receives power from port p ($1 \leq p \leq N_PWR_PORT$) of rack m ($1 \leq m \leq N_PWR_RACK$). A value of UNK means this port is not connected, or that its connection is unknown. Valid values are:
 - For `PWR_SS[m][p] = SHL`, valid values are MCS, *others TBD*
 - For `PWR_SS[m][p] = ASP`, valid values are MCS, *others TBD*
 - For `PWR_SS[m][p] = DP-`, valid values are MCS, *others TBD*
 - For `PWR_SS[m][p] = MCS`, valid values are SCH (Scheduler), EXE (Executive), TP (Task Processor), CH (Command Hub), and GW (Gateway).
 - For `PWR_SS[m][p] = DR1, DR2, DR3, DR4, and DR5`, valid values are PC, DS1 (DRSU 1), and DS2 (DRSU 2)

It should be noted that while this information is largely (but not exactly) redundant with respect to the the “_RACK” and “_PORT” parameters for subsystems, the former is intended primarily as an aid to operators and maintainers. MCS may use either for actionable control decisions, so it is important that they be consistent.

Note 1: For status (“_STAT”) entries, 3 = “OK”, 2 = “Suspect; possibly bad (If used, provide warning)”, 1 = “Bad (Don’t use)”, 0 = “Not Installed”.

Note 2: The details of the use of “_DESI” parameters has not yet been worked out.

3 Format of the Station Dynamic MIB

The station dynamic MIB is a Gnu dbm (“gdbm”) database, consisting of the files `station_dynamic.pag` and `station_dynamic.dir`. For information about dbm databases generally, suggested starting points are [2] and [3]. It might also be of interest to know that dbm is supported by Python [4].

The record structure for the station dynamic MIB database can be defined in the form of a C language code segment, as follows:

```
#include <sys/time.h>
char ssm_keyword[32];          /* the keyword; also, the key for the dbm database */
struct ssm_record {
    char val[1024];            /* parameter value; always stored as char. */
    char format[6];           /* used to identify actual data format; see below */
    struct timeval last_change; /* time this value was last changed */
                                /* .tv_sec is seconds into current epoch */
                                /* .tv_usec is fractional remainder in microseconds */
};
```

In this code segment, the field `format[]` is a “\0”-terminated string indicating how the data in the field `val` should be interpreted. `format` has one of the following values, with the associated interpretation of `val`:

“*sn*”: character string, *n* bytes (exclusive of terminating characters), right-padded with “\0” characters.

In all cases, data is left-justified in the `val` field, and the values of any leftover bytes are undefined. The time given in `last_change` is expressed as a Linux/C “`timeval`”; for those not familiar with this a useful starting point is [5].

The following is a list of defined keywords with corresponding formats (indicated in square brackets) and corresponding values. We begin with parameters which are analogous to parameters appearing in the subsystem MIBs defined in the MCS Common ICD:

- **SUMMARY**: [s7] Summary state of station. Valid values are as follows:
 - **NORMAL**
 - **WARNING** (issue(s) found, but still fully operational)
 - **ERROR** (problems found which limit or prevent proper operation)
 - **BOOTING** (initializing system; not yet fully operational)
 - **SHUTDOWN** (shutting down system; not ready for operation)

Note that this is analogous to MCS Common ICD MIB entry 1.1, except it refers to the entire station. **SUMMARY** is determined by MCS using (among other things) the subsystem **SUMMARY** values.

- **INFO**: [s256] When **SUMMARY** is **WARNING** or **ERROR**, this value begins with a list of MIB keywords, separated by single spaces, and terminated by the character ! (exclamation mark). The MIB keywords will be those containing values indicating the problem condition. A human-readable text string which provides further explanation may be included following the character !. A non-blank value when **SUMMARY** is not **WARNING** or **ERROR** is not specified, but is not prohibited.

The following parameters indicate the summary status of defined level-1 subsystems, and are nominally equal to the “**SUMMARY**” and “**INFO**” entries of the associated subsystem MIBs. There will be a latency, typically on the order of seconds, between the time the subsystem MIB entries are updated and the time the associated parameters (below) are updated.

- **SHL_SUMMARY**: [s7] The current value of **SUMMARY** in the SHL MIB.
- **SHL_INFO**: [s256] The current value of **INFO** in the SHL MIB.
- **ASP_SUMMARY**: [s7] The current value of **SUMMARY** in the ASP MIB.
- **ASP_INFO**: [s256] The current value of **INFO** in the ASP MIB.
- **DP__SUMMARY** (note: two underscores): [s7] The current value of **SUMMARY** in the DP MIB.
- **DP__INFO** (note: two underscores): [s256] The current value of **INFO** in the DP MIB.
- **DR n _SUMMARY**: [s7] The current value of **SUMMARY** in the DR n MIB, $1 \leq n \leq N_DR$.
- **DR n _INFO**: [s256] The current value of **INFO** in the DR n MIB, $1 \leq n \leq N_DR$.

The following “_STAT” parameters are analogous to similarly-named parameters appearing in the station static MIB. As in the station static MIB, 3 = “OK”, 2 = “Suspect; possibly bad”, 1 = “Bad”, 0 = “Not Installed”. The integer value of this parameter can only be equal to or less than the value of the same parameter in the station static MIB. When this value is less than the value appearing in the station static MIB, it is either because (1) MCS demoted it, perhaps as a result of a diagnostic; or (2) an operator demoted it. **N_STD**, **N_DP1**, **N_DP2**, and **N_DR** are defined in the station static MIB. Note that for parameters other than **ANT_STAT[]**, a unit will not appear in the station dynamic MIB unless it is indicated in the station static MIB as being associated with an antenna. In other words, if the station static MIB says it isn’t associated with an antenna, then it doesn’t appear in the station dynamic MIB.

- **ANT_STAT[n]**: [s1] Current status of antenna n ($1 \leq n \leq 2 \times N_STD$).
- **FEE_STAT[n]**: [s1] Current status of the FEE channel connected to antenna n ($1 \leq n \leq 2 \times N_STD$).
- **RPD_STAT[n]**: [s1] Current status of the cable associated with antenna n ($1 \leq n \leq 2 \times N_STD$). See
- **SEP_STAT[n]**: [s1] Current status of the SEP port associated with antenna n ($1 \leq n \leq 2 \times N_STD$). See
- **ARX_STAT[n]**: [s1] Current status of the ARX channel associated with antenna n ($1 \leq n \leq 2 \times N_STD$).
- **DP1_STAT[n]**: [s1] Current status of the DP1 channel (including digitizer and per-antenna processing located on a DP1 board) associated with antenna n ($1 \leq n \leq 2 \times N_DP1$).
- **DP2_STAT[m]**: [s1] The status of DP2 board m ($1 \leq m \leq N_DP2$).
- **DR_STAT[p]**: [s1] The status of MCS-DR p ($1 \leq p \leq N_DR$).

Additional parameters:

- **FORMAT_VERSION**: [s3] An integer equal to the version number of this document. Included to account for the possibility of format modifications over time.

A Example of a Station Static MIB Initialization File

To appear in a future version of this document.

B Document History

- Version 1 (June 16, 2010): First version.

References

- [1] S. Ellingson, "LWA Station-Level Observing Procedure and Associated Metadata," Ver. 1, LWA Engineering Memo MCS0030, June 15, 2010.
- [2] <http://en.wikipedia.org/wiki/Dbm>.
- [3] N. Matthew and R. Stones, *Beginning Linux Programming*, 4th Ed. Wrox Press, 2008. See Chapter 7.
- [4] <http://docs.python.org/library/dbm.html>.
- [5] <http://linux.die.net/man/2/gettimeofday>