

Optimizing the Performance of Multi Eval. List Mode Tests

Application Note

Products:

| R&S® CMW500

The duration of a measurement in multi evaluation list mode is sensitive to the test setup. This document describes various methods to achieve optimized performance for such measurements. The availability of the methods depends on the CMW500 version.

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1 Introduction

1.1 Multi Evaluation List Mode

The multi evaluation list mode is a method to get sets of measurement results for a list of analyzer setups in a single measurement. The analyzer setups correspond to the properties of the expected input signals (each setup can include e.g. expected power and frequency).

In multi evaluation list mode the measurement interval is subdivided into segments according to groups of input signals. Each segment contains a number of sub-steps and operates with constant analyzer settings; the analyzer settings usually change from segment to segment.

The figure below shows an example for the LTE Measurements firmware application. The example consists of three segments with different lengths, expected powers and signal properties as listed in green colour. Orange rectangles depict sub-steps.

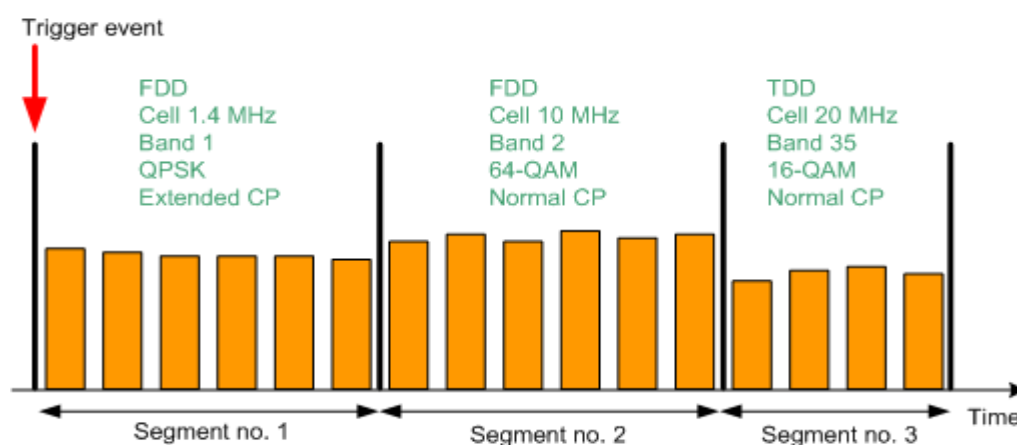


Figure 1: Principle of an LTE Measurement in Multi Evaluation List Mode

The list mode is essentially a single-shot remote control application. When a measurement is initiated in list mode, all defined segments are measured once. Afterwards the results can be retrieved using FETCH commands. Different fetch methods are available.

Before starting a measurement in multi evaluation list mode, the number of segments, the segment lengths and the analyzer settings for each segment have to be configured. Segment configuration and measurement are independent from each other.

1.2 Impacts on Performance

Tests in multi evaluation list mode are characterized by lots of steps and repeated actions. The performance of such tests strongly depends on those actions which take long and are often repeated. Therefore, the performance is very sensitive to the test setup and even to details within the implemented CMW500 firmware applications.

2 Steps for Performance Optimization

With the following solutions the performance of tests in multi evaluation list mode (MELM) can be kept high.

Adopting Optimized CMW500 Firmware

Firmware optimization has significantly improved the performance of MELM tests. The optimization was done step by step over different CMW500 firmware versions depending on the network technology (between 2.0.10 and 3.0.10).

Fetching Measurement Results over all Segments

- *Fetching only the Required Measurement Results:*
One fetch command is related to all segments and to just one measurement parameter. Within one fetch command, the result values for the specified measurement parameter are fetched for all configured segments. In the same way the result values for any other measurement parameter and all segments are fetched via a specific command. Since the number of required measurement parameters usually is much smaller than the length of the complete parameter set, much time can be saved.
This method was introduced in different versions for the different firmware applications beginning with CMW500 2.1.30.
- *Fetching Result Groups over all Segments:*
One fetch command is related to all segments and to a group of measurement parameters. Within one fetch command, the result values for all measurement parameters of this command are fetched for the first segment, then the same is done for the next segment, and so on for all configured segments. In this way the number of required fetch commands is decreased and the performance is improved.

Former Method:

One fetch command is related to one segment and usually to an array of several or many measurement parameters. Thus, as much fetch commands are required as segments have been configured, and often much more measurement parameters than required are taken into account.

Replacing Configurations by Partial Save/Recalls

Repeated configurations have been identified as the main source of unnecessary slow performance:

- In previous remote control scripts a configuration is done after each reset, and the reset plus configuration action often appears in order to have a well defined starting position for different sections of the test (a section can be determined by a network technology, e.g. LTE).
- Each configuration sets the values of the parameters relevant for the current section (e.g. for the network technology). This takes a long time if many segments are defined because several CMW500 control mechanisms and processes are affected.

The Partial Save/Recall feature eliminates the need for repeated configurations: A set of partial saves each of them including just the parameters for one test section (e.g. one network technology) is generated once at the begin of the test. After a reset during the test, only the relevant partial save is re-called to get the desired configuration for the current test section. Since the content of the partial save file is small and affects less CMW processes than a configuration, the recall of each partial save is much faster than the former configuration.

This feature has been introduced with the CMW500 3.0.10 version.

Using Application Specific Reset Commands

Each measurement section begins with a reset in order to have well-defined starting parameter values. While the usual `*RST` command resets the parameters of all loaded firmware applications and the base system parameters to their default values, the application specific reset command allows to restrict the reset to the parameters of the current firmware application. Hence, the application specific reset command saves a significant amount of time in MELM tests with many measurement sections and resets.

Application specific reset commands have been introduced with the CMW500 3.0.10 version.

3 Details

This section gives detailed information for the solutions of the previous chapter.

3.1 Adopting Optimized CMW500 Firmware

When changing from an older CMW500 firmware version to a newer one which includes the required firmware optimization, former remote control scripts can be re-used without changes.

Performance tests show the following results:

- The performance of MELM configurations was strongly improved from version 2.1.10 to version 3.0.10 for GSM measurements and LTE measurements. For GPRF measurements and CDMA2000 measurements a strong performance improvement was already achieved from version 2.0.10 to version 2.1.10.
- The performance of the applications which have already been fast in version 2.1.10 is not or not significantly improved when changing from 2.1.10 to 3.1.0. CDMA2000 and 1xEV-DO measurements even get a bit slower due to additions to the firmware.
- In 3.0.10 all measurement applications show similar performance values for MELM configurations. The MELM configuration for LTE measurements takes the longest time due to the highest firmware complexity.
- Changing from version 2.1.10 to 3.1.0 significantly improves the overall performance of a MELM test which comprises all network technologies.

3.2 Fetching Measurement Results over all Segments

3.2.1 Vertical and Horizontal Fetching

In a MELM test, there is one measurement value for each measurement parameter and each segment. n segments and m measurement parameters lead to $n \times m$ measurement values. If the $n \times m$ measurement values are arranged in a matrix, the fetching of the result values for an array of measurement parameters and one segment is related to one row, while the fetching of the result values for one measurement parameter and all configured segments is related to one column. Consequently, fetching of a result array for a segment is called **horizontal fetching**, and fetching of all results for one parameter is called **vertical fetching**.

When applying the horizontal fetch method, n fetch commands are necessary to get the values of the related measurement parameters for n segments. When applying the vertical fetch method, k ($\leq m$) fetch commands are required to get the values of k measurement parameters for all segments.

For applying the vertical fetch method, the remote control scripts have to be adjusted.

Note: Currently (version 3.0.10), the WiMAX and WLAN measurements firmware applications offer the multi evaluation list mode but no vertical fetch commands.

Example

The figure below shows the 40×20 measurement matrix for a fictional GSM test with 40 segments and 20 modulation parameters. Each result value is indicated as a rectangular field, the numbers in the fields show the order of fetching the values.

Vertical fetching with 3 fetch commands gets the measurement values of the modulation parameters FreqError, TimingError and BurstPower.

Horizontal fetching with 40 fetch commands gets all measurement values for all modulation parameters.

So, the number of required vertical fetch commands in this example is much smaller than the number of segments, and the number of measurement results obtained via vertical fetching is much smaller than the overall number of measurement results obtained by horizontal fetching.

Commands in the remote control script for vertical fetch (new):

```
FETC:GSM:MEAS:MEV:LIST:MOD:FERR:AVER?
FETC:GSM:MEAS:MEV:LIST:MOD:TERR:AVER?
FETC:GSM:MEAS:MEV:LIST:MOD:BPOW:AVER?
```

This sequence of 3 commands returns the average FreqError (FERR) values for all configured segments, then the average transmit TimingError (TERR) values for all segments and the average BurstPower values for all segments.

Commands in the remote control script for horizontal fetch (old) for comparison reason:

```
FETC:GSM:MEAS:MEvaluation:LIST:SEGM1:MOD:AVER?;SEGM2:MOD:AVER?;
...;SEGM40:MOD:AVER?
```

This sequence of 40 commands returns the average values of all modulation parameters – ..., frequency error (FreqError), transmit time error (TimingError), ..., burst power – for the first segment, then the average values for the same measurement parameters for the next segment and so on up to the 40th segment.

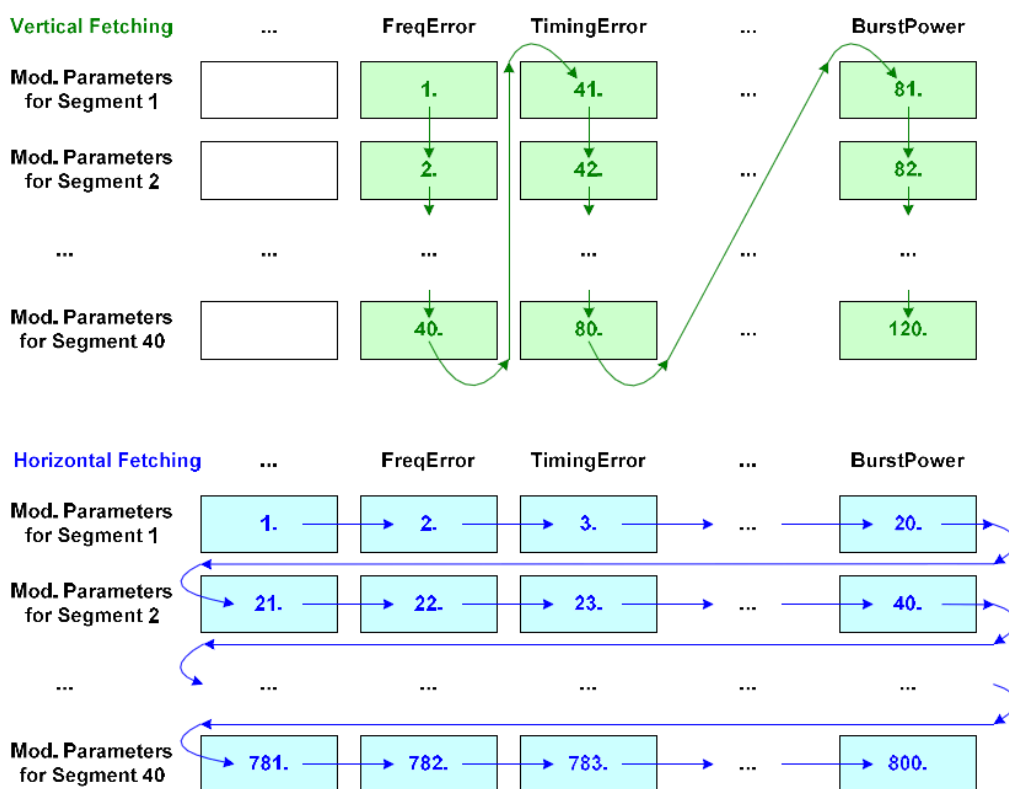


Figure 2: Vertical and Horizontal Fetching

3.2.2 Fetching Result Groups over all Segments with one Command

This method can be seen as horizontal fetching repeated over all segments: Beginning with the first configured segment, a horizontal array of result values is fetched, then the same is done for the next segment (next row in the matrix of result values) and so on.

Note: This method is not available for the LTE measurement application.

Example:

```
FETC:GSM:MEAS:MEV:LIST:MOD:AVER?
```

This command fetches the average values of all modulation parameters for the first configured segment, then for the next segment, and so on up to the last configured segment.

3.2.3 Performance Characteristics

- The vertical fetch method is much faster than the horizontal fetch method for moderate and particularly for high segment numbers.
- Reducing the number of vertically fetched parameter values shortens the required time.
- The result group fetching over all segments with one command is faster than the horizontal fetch method for moderate and particularly for high segment numbers – even if the same result values are fetched as with the horizontal fetch method.

- The test time increases with the number of segments for all test cases. Horizontal fetching shows the strongest dependency on the number of segments.

Vertical fetching has a better performance than horizontal fetching due to:

- The reduced number of fetch commands in case of moderate and high numbers of segments
- The reduced number of fetched measurement values

3.3 Replacing Configurations by Partial Save/Recalls

For applying the partial save/recall feature, the remote control scripts have to be adjusted.

Variant A) below shows an example for the lines of interest in such a script. The MELM test includes several firmware applications (FWAs, e.g. GSM measurements, LTE measurements). The script consists of a base part with initial configurations etc. and of FWA specific measurement sections. While the base part is performed only once at the beginning of the test, the FWA measurement sections may be repeated many times. Hence, the FWA measurement sections are seen as critical regarding performance.

Variant B) shows the corresponding lines of the remote control script with the former configurations instead of the partial save/recalls.

In the example the recall (or configuration) is done after a reset at the beginning of each FWA specific measurement section which is the most common use case. Of course, a recall can replace a configuration anywhere in the script and without previous reset – with the same effects.

The lines related to the feature are indicated by bold style.

Variant A) Partial Recall after Reset (new)

```

...
// GSM configuration:
CONF:GSM:MEAS:MEV:LIST:SEGM1:SET:...;...;SEGM40:...
CONF:GSM:MEAS:MEV:LIST:SEGM1:MOD:...;...;SEGM40:...
...
// Save GSM configuration:
MMEM:STOR:ITEM "gsmms_meas:MEV:LIST", "@SAVE\\@INSTR\\gsm.df1"

// LTE configuration:
CONF:LTE:MEAS:MEV:LIST:SEGM1:SET:...;...;SEGM40:...
CONF:LTE:MEAS:MEV:LIST:SEGM1:MOD:...;...;SEGM40:...
...
// Save LTE configuration:
MMEM:STOR:ITEM "lteue_meas:MEV:LIST", "@SAVE\\@INSTR\\lte.df1"

// GSM measurement section including recall of GSM configuration:
*RST
MMEM:LOAD:ITEM "gsmms_meas:MEV:LIST", "@SAVE\\@INSTR\\gsm.df1"
INIT:GSM:MEAS:MEV
...

```



```
// LTE measurement section including recall of LTE configuration:
*RST
MMEM:LOAD:ITEM "lteue_meas:MEV:LIST", "@SAVE\\@INSTR\\lte.dfl"
INIT:LTE:MEAS:MEV
...
```

Comments:

- In the first part of the script the partial saves for the GSM and LTE specific configurations are generated once. Just the required partial save is recalled in each FWA measurement section of the script after the reset.
- @SAVE is the alias for the save directory (c:\program files\rohde-schwarz\cmw\userdata\save),
- @INSTR is the alias for the sub-instrument (inst1 or inst2). If the CMW is not used with sub-instrument division, the directory string can also be written as "@SAVE\\xyz.dfl" (but this string might cause conflicts in case of parallel operation with two sub-instruments).

Variant B) Configuration after Reset (old)

```
...
// GSM measurement section including GSM configuration:
*RST
CONF:GSM:MEAS:MEV:LIST:SEGM1:SET:...;...;SEGM40:...
CONF:GSM:MEAS:MEV:LIST:SEGM1:MOD:...;...;SEGM40:...
...
INIT:LTE:MEAS:MEV
...
// LTE measurement section including LTE configuration:
*RST
CONF:LTE:MEAS:MEV:LIST:SEGM1:SET:...;...;SEGM40:...
CONF:LTE:MEAS:MEV:LIST:SEGM1:MOD:...;...;SEGM40:...
...
INIT:LTE:MEAS:MEV
...
```

3.3.1 Performance Characteristics

Within an Application

- The configuration time increases strongly and about linearly with the number of segments. The configuration time is short for moderate segment numbers but unacceptably high for high segment numbers.
- The partial recall time is very short and almost independent of the number of segments.
- The partial recall time is much shorter than the configuration time even for moderate segment numbers (e.g. 40 segments).

Across Applications

- The partial recall times of the different measurement applications differ significantly. These differences reflect differences in the complexity of the applications and in details of the implementations.
- The configuration times for the different applications differ significantly. These differences reflect the differences in the complexity of the applications.

3.4 Using Application Specific Reset Commands

The command `SYSTem:RESet <application>` has been introduced in order to allow further specification which parameter sets shall be reset to their default values. Here the performance of `SYSTem:RESet` is compared with that of the usual `*RST` command for MELM tests based on the following typical command sequences. The lines of interest are indicated by bold style.

Variant A) Application Specific Reset (new)

```
CONF:GSM:MEAS:MEV:LIST:...           // GSM configurations
CONF:LTE:MEAS:MEV:LIST:...           // LTE configurations
...
// GSM measurement section:
SYST:RES "GSM Meas1"
...
INIT:GSM:MEAS:MEV
...
// LTE measurement section:
SYST:RES "LTE Meas1"
...
INIT:LTE:MEAS:MEV
...
```

Variant B) Common Reset (old)

```
CONF:GSM:MEAS:MEV:LIST:...           // GSM configurations
CONF:LTE:MEAS:MEV:LIST:...           // LTE configurations
...
// GSM measurement section:
*RST
...
INIT:GSM:MEAS:MEV
...
// LTE measurement section:
*RST
...
INIT:LTE:MEAS:MEV
...
```

3.4.1 Performance Characteristics

- The application specific reset time is much shorter than the duration of the common reset command.
- The application specific reset time is almost independent of the number of configured FWAs while the reset time with `*RST` increases with the number of configured FWAs. Thus, replacing `*RST` by `SYST:RES <application>` gives the highest performance gain for MELM tests with many FWAs.
- The minimum durations of the application specific resets are very similar for all FWAs while the maximum durations differ significantly: The maximum duration depends on the number of changed parameters after the previous reset, and this number is the highest for the GPRF measurement FWA.

Note: *RST is not only effective on the FWA parameters but also resets the base system parameters.

4 Additional Information

Complete descriptions of the multi evaluation list mode can be found in the CMW500 operating manuals for the measurement applications.

Please contact tm-applications@rohde-schwarz.com for comments and further suggestions.

About Rohde & Schwarz

Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radio-monitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

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