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GMAC API Reference Guide

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Content

1. Core Functionality 9
1.1 Introduction 9
1.2 Description 9
1.2.1 Overview 9
1.2.2 Usage 9
1.2.3 Error Handling 9
1.3 Functions 9
1.3.1 GMACCommand() 9
1.3.2 GMACInit() 11
1.3.3 GMACOpen() 11
1.3.4 GMACClose() 11
1.3.5 GMACGetNativeOrderID() 11
1.3.6 GMACIsRecovery() 12
1.3.7 GMACIsRecoveryMulticast() 12
1.3.8 GMACNextExpected() 12
1.3.9 GMACChannelGetTranscodingType() 12
1.3.10 GMACGetLocalChannelID() ** Deprecated ** 13
1.3.11 GMACGetLocalChannelIDEx() ** Deprecated ** 13
1.3.12 GMACCorrectPrice() ** Deprecated ** 14
1.3.13 GMACCorrectPriceFloat() ** Deprecated ** 14
1.3.14 GMACGetFirmwareVersion() 14
1.3.15 GMACGetMaxBoardNum() 15
1.3.16 GMACGetMulticastMappingTable() ** Deprecated ** 15
1.3.17 GMACMulticastIsRefresh() 16
1.3.18 GMACQueryMarketHours() 16
1.3.19 GMACRegisterErrorHandler() 16
1.3.20 GMACDefaultErrorHandler() 16
1.3.21 GMACChannelEnable()** Deprecated ** 17
1.3.22 GMACChannelEnableEx()** Deprecated ** 17
1.3.23 GMACChannelEnableByType()** Deprecated ** 18
1.3.24 GMACChannelEnableByTypeEx()** Deprecated ** 18
1.3.25 GMACSymbolSuffixGenericToNative() 19
1.3.26 GMACSymbolSuffixNativeToGeneric() 19
1.3.27 GMACStatusToString() 19
1.3.28 GMACMulticastTypeToString() 20
1.3.29 GMACIdentify() 20
1.3.30 GMACGetTimestampLog()** Deprecated ** 20

2. Hardware Filtering 21
2.1 Description 21
2.2 Functions 21
2.2.1 GMACFilteringEnable() 21
2.2.2 GMACFilteringInstrumentRequired() 21
2.2.3 GMACFilteringSupportedMode() 22
2.3 Hardware Filtering Guide 22

3. Processing Data 23
3.1 Description 23
3.1.1 Overview 23
3.1.2 Data Classification 23
3.2 Functions 23
3.2.1 GMACQueueInit() 23
3.2.2 GMACQueueOpen() 23
3.2.3 GMACQueueClose() 23
3.2.4 GMACInitDynamicMcDesc() 24
3.2.5 GMACOpenMulticast() 24
3.2.6 GMACCloseMulticast() 24
3.2.7 GMACQueueRead() 25
3.2.8 GMACQueuePoll() 26
3.2.9 GMACQueueRelease() 26
3.2.10 GMACControlQueueWrite() 27
3.2.11 GMACControlQueueWriteMarket() 27
3.2.12 GMACMulticastGetMarketID() ** Deprecated ** 27
3.2.13 GMACMulticastGetMarketIDFromChannel() ** Deprecated ** 28
3.2.14 GMACGetMarket() ** Deprecated ** 28

3.2.15 GMACGetMarketNames() ** Deprecated ** 28
3.2.16 GMACGetQueueWithChannelID() ** Deprecated ** 29
3.2.17 GMACGetQueueWithMarketID() ** Deprecated ** 29
3.2.18 GMACMarketGetTranscodingType() ** Deprecated ** 29
3.2.19 GMACDefaultPriceFactor() ** Deprecated ** 30
3.2.20 GMACDefaultCurrency() 30
3.2.21 GMACDefaultRoundLotSize() 30
3.2.22 GMACGetDefaultStatus() 31
3.2.23 GMACGetADEProperty() 31
3.2.24 GMACMulticastSync() 31
3.2.25 GMACMulticastSetTaint() 32
3.2.26 GMACMulticastBuffer() 32
3.2.27 GMACTranslateMarketToEISIN() 32
3.2.28 GMACTranslateMarketToEISINEx() 33
3.2.29 GMACTranslateEISINToMarket() 33
3.2.30 GMACTranslateEISINToMarketEx() 33
3.2.31 GMACPrintMessages() 33
3.2.32 GMACPrintMessagesEx() 34
3.2.33 GMACSetExpectedSequenceMulticast() 34
3.3 Processing Data Guide 34

4. Statistics 36
4.1 Description 36
4.2 Functions 36
4.2.1 GMACStatsMulticast() 36
4.2.2 GMACStatsChannel() 36
4.2.3 GMACStatsQueueGlobal() 36
4.2.4 GMACStatsMulticastCount() ** Deprecated ** 37
4.2.5 GMACStatsMarketMulticastCount() ** Deprecated ** 37
4.2.6 GMACStatsMarketChannelCount() ** Deprecated ** 37
4.2.7 GMACStatsMarketCount() ** Deprecated ** 37
4.2.8 GMACStatsGetCredit() 38
4.2.9 GMACStatsMulticastPrint() 38
4.2.10 GMACStatsAllMulticastPrint() 38
4.2.11 GMACStatsAllMulticastPrintSqn() 39
4.2.12 GMACStatsMulticastPrintStr() 39
4.2.13 GMACStatsPrintSqn() 39
4.2.14 GMACStatsPrint() 39
4.2.15 GMACStatsDump() 39

5. Latency Measurement 40
5.1 Description 40
5.2 Functions 40
5.2.1 GMACLatencyRealtime() 40
5.2.2 GMACLatencyTotal() 41
5.2.3 GMACLatencyTick() 41

6. Snapshot Support 42
6.1 Description 42
6.2 Level 0 Snapshot Guide 42
6.2.1 Eurex and Xetra Markets 42
6.2.2 Other Markets 43
6.3 Level 1 Snapshot Support Functions 44
6.3.1 GMACMulticastRefreshRequest() 44
6.3.2 GMACMulticastRefreshComplete() 44
6.4 Level 1 Snapshot Guide 44
6.5 Level 2 Snapshot Description 45
6.6 Level 2 Snapshot Support Functions 45
6.6.1 GMACMulticastSnapshotRequest() ** Deprecated ** 45
6.6.2 GMACMulticastSnapshotProcess() ** Deprecated ** 46
6.7 Level 2 Snapshot Request Guide 46

7. Data Retrieval 48
7.1 Description 48
7.2 Functions 48
7.2.1 GMACGetObjCount() 48
7.2.2 GMACGetObjList() 49
7.2.3 GMACGetObjProps() 49

8. Format 51
8.1 Enumerations 51

8.2 Data Structures 57
8.2.1 Packet Header 57
8.2.2 Refresh Handle 59
8.2.3 Default Market Status 59
8.2.4 Dynamic Multicast Descriptor 60
8.2.5 Snapshot Data 61
8.2.6 Multicast Mapping 62
8.2.7 Multicast Mapping Node 63
8.2.8 Stats 63
8.2.9 ADE Statistics 65
8.2.10 GMAC Command 66
8.3 Argument Types 69

9. Shipped Examples 70
9.1 Features 70
9.2 Building the Example 70
9.3 Options 70

Revisions

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R2017-1.1	24 JUL 2017	Release R2017-1.1 - Added details to sections 6.2.1, 8.2.1 and 8.2.8
R2017-1.0	24 MAR 2017	Release R2017-1.0 - Added GMAC_COMMAND_REFRESH and GMAC_COMMAND_REFRESH_STOP to GMACCommandType - Added GMAC_COMMAND_FILTER_ADD and GMAC_COMMAND_FILTER_SWITCH to GMACCommandType - Added a note to GMACDefaultPriceFactor()
R2016-2.0	22 NOV 2016	Release R2016-2.0 - Added GMACInit() - Added GMACQueueInit() - Added GMACQueuePoll() - Added GMACCommand() - Added notes to GMACGetFirmwareVersion() - Added union between MulticastID and DstChannel in GMACPacketHeader - Added union between OrigMulticastID and SrcChannel in GMACPacketHeader - Deprecated the GMACChannelEnable call series
R2016-1.3	28 JUL 2016	Release R2016-1.3 - Added GMAC_PROP_SRC_ARB_LINKED_CHANNEL_ID to GMACObjProp_t enumeration
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R2013-6.1	30 SEP 2013	Release R2013-6.1 - Updated GMACLatencyTotal() description
R2013-5.1	07 AUG 2013	Release R2013-5.1 - Added GMACSetExpectedSequenceMulticast() and GMACGetTimestampLog()
R2013-5.0	31 JUL 2013	Release R2013-5.0 - Added IGMP subscription details to GMACChannelEnable(), GMACChannelEnableByType(), GMACChannelEnableEx() and GMACChannelEnableByTypeEx()
R2013-4.0	18 JUN 2013	Release R2013-4.0 - Added a note to GMACFilteringInstrumentRequired() related to plugin OPRA_BINARY

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		- Added the level 1 snapshot guide
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R2012-8.1	20 DEC 2012	Release R2012-8.1 - Removed Terminology section (refer to GMAC Product Overview)
R2012-6.3	25 SEP 2012	Release R2012-7.0 - Updated DMA queue definition in section Terminology
R2012-6.0	20 AUG 2012	Release R2012-6.0 - Added hardware filtering guide section - Removed software filtering section - Added GMAC_SNAPSHOT_MESSAGES_LIMIT_REACHED to GMACSnapshotStatus enumeration
R2012-5.0	04 JUL 2012	New template
<= 3.18		Older versions

1. Core Functionality

1.1 Introduction

This document should be read in conjunction with:

- GMAC Product Overview
- GMAC Configuration Guide
- GMAC V1 and V3 Messages Templates

1.2 Description

1.2.1 Overview

The GMAC API is a dynamic library which accesses multiple feeds from the FPGA via the PCI Express bus and delivers them to the user application in a normalised format. The library logically separates data into channels for processing. The channels are then directed into multiple DMA queues which deliver the normalised data directly to a predetermined CPU. This enables the use of multiple CPUs when processing the normalised data produced by GMAC.

1.2.2 Usage

The market-dependent configuration information (which multicast addresses are directed to which channels, etc.) is stored in the GMAC configuration file. The user application calls `GMACOpen()` or `GMACInit()`, which accesses the configuration file, initialises the card and the connections.

The channels are mapped to multiple DMA queues according to the workload.

The user should write the processing application with multithreading in mind, to ensure high CPU scalability in the future.

Each thread (CPU) can process one DMA queue. A DMA queue is initialised by `GMACQueueOpen()`.

To read data from the queues call `GMACQueueRead()` or `GMACQueuePoll()`. The data returned is normalised, for more information on data processing, refer to section *Processing Data*.

GMAC also provides a mechanism to send control messages (commands) to specific threads (CPUs) by writing into the control queue. The library then ensures the data is read by the appropriate thread (CPU). This can be done by calling `GMACControlQueueWrite()`.

For performance benchmarking, GMAC is collecting various statistics. For more information, refer to section *Statistics*.

GMAC enables the user to use hardware assisted latency measurement in 8 ns resolution. For more information, refer to section *Latency*.

1.2.3 Error Handling

Most of the GMAC functions return status code, which may indicate an error or simply the state of operation. However, to allow the user to have centralised error handling, the GMAC API calls the error handler before returning the error status code. Users can implement and register their own error handler using `GMACRegisterErrorHandler()`.

The error handler receives an error status code, the function name and a string description. The error handler can then modify which status code is returned by the failing function.

Note:

If an error occurs in a nested function within GMAC, the error handler may be invoked multiple times.

1.3 Functions

1.3.1 GMACCommand()

Description Method used to submit commands to GMAC.

The method allows to:

1. Enable / disable an object: see section 7 for details about objects

handled by GMAC and section 8.2.10.1 for details about the parameters required by this capability

2. Request a data refresh / stop a data refresh: see section 8.2.10.2 for details about the parameters required by this capability and the available refresh types per GMAC plug-in. The following table provides the supported refresh types per GMAC plug-in. Note that more capabilities will be added over the next GMAC releases.

	GMAC_REFRESH_SUBJECT_TYPE_...								
	DICT	INST	BOOK	STATUS	TRADE	STATS	AUCTION	ANNOUNCE	CHANNEL
GTP	✓	✓	✓	✓	✓	✓	✓	✓	✓
CME_BINARY	✓								✓
ICE	✓								
OPTIONS_XDP	✓	✓							

Plug-in CME_BINARY:

> Refresh type GMAC_REFRESH_SUBJECT_TYPE_DICT is used to request on user's demand the generation of GMAC reference data messages GMACMessageReferenceSecurityV3 using the Futures PRF clearing file and/or the Options PRF clearing file as defined by the configuration parameter `<symbol-ref-file>`.

See `GMACCommandStruct` for the structure definition.

See example gmac_interactive to get used to `GMACCommand()`.

Prototype

```
GMACStatus GMACCommand(GMACHandle *GMACH, const
GMACCommandStruct* commandStruct)
```

Arguments

`GMACH`	GMAC handle
`commandStruct`	Structure that defines what is to be commanded

Example #1 If the user needs to disable the source channel defined with ID = 1:

```
GMAC_DECLARE_COMMNAND_STRUCT(cmd, GMACSwitchParam);
cmd->commandType = GMAC_COMMAND_SWITCH;
cmd->objType = GMAC_OBJ_SRC_CHANNEL;
cmd->objID = 1;  //< Source Channel ID

GMACSwitchParam* switch = (GMACSwitchParam*) cmd-
>commandParams;
switch->Activate = false;

GMACStatus status = GMACCommand(GMACHandle, cmd);
```

Example #2 If the user needs to enable the market defined with ID = 1:

```
GMAC_DECLARE_COMMNAND_STRUCT(cmd, GMACSwitchParam);
cmd->commandType = GMAC_COMMAND_SWITCH;
cmd->objType = GMAC_OBJ_MARKET;
cmd->objID = 1;  //< Market ID

GMACSwitchParam* switch = (GMACSwitchParam*) cmd-
>commandParams;
switch->Activate = true;

GMACStatus status = GMACCommand(GMACHandle, cmd);
```

Example #3 If the user requests the full instruments dictionary on market defined with ID = 0:

```
GMAC_DECLARE_COMMNAND_STRUCT(cmd,
GMACRefreshParam);
```

```
cmd->commandType = GMAC_COMMAND_REFRESH;
cmd->objType = GMAC_OBJ_MARKET;
cmd->objID = 0;  //< Market ID

GMACRefreshParam* param = (GMACRefreshParam*)cmd-
>commandParams;
param->PresenceMapAll = 0;
param->RefreshSubjectType =
GMAC_REFRESH_SUBJECT_TYPE_DICT;

GMACStatus status = GMACCommand(GMACH, cmd);
```

Example #4 If the user needs to add symbol AAPL to the symbol filtering list on source channel defined with ID = 1:

```
GMAC_DECLARE_COMMNAND_STRUCT(cmd,
GMACFilterAddParam);
cmd->commandType = GMAC_COMMAND_FILTER_ADD;
cmd->objType = GMAC_OBJ_SRC_CHANNEL;
cmd->objID = 1;  //< Source Channel ID

GMACFilterAddParam * param =
(GMACFilterAddParam*)cmd->commandParams;
param->PresenceMapAll = 1;
param->Symbol = AAPL;

GMACStatus status = GMACCommand(GMACH, cmd);
```

1.3.2 GMACInit()

Description Opens all markets specified in the configuration file.

Prototype `GMACStatus GMACInit(GMACHandle **GMACH, const char* GMACConfigFilePath)`

Arguments

`GMACH`	GMAC handle
`GMACConfigFilePath`	Path to the market configuration file

1.3.3 GMACOpen()

Description Opens all markets specified in the configuration file. The configuration file must be instantiated first.

Prototype `GMACStatus GMACOpen(GMACHandle **GMACH, const Config *GMACConfigPtr)`

Arguments

`GMACH`	GMAC handle
`GMACConfigPtr`	Pointer to the market configuration

1.3.4 GMACClose()

Description Closes all markets specified in the configuration file.

Prototype `GMACStatus GMACClose(GMACHandle *GMACH)`

Arguments

`GMACH`	GMAC handle

1.3.5 GMACGetNativeOrderID()

Description Returns the native coding of an order ID. It is the user's responsibility to provide the buffer.

Celoxica strongly recommends the use of transcoded order IDs. Using this function to recover native order IDs will affect performance.

Prototype `GMACStatus GMACGetNativeOrderID(GMACHandle *GMACH, int MarketID, uint64_t OrderID, char* Buffer, int Length)`

Arguments

`GMACH`	GMAC handle
`MarketID`	Market ID
`OrderID`	Actual normalised order ID
`Buffer`	Text buffer to hold the native order ID, null terminated when returned
`Length`	Length of the buffer supplied. Recommended size is 32 bytes.

1.3.6 GMACIsRecovery()

Description Returns the GMAC general recovery enable flag.

Prototype `int GMACIsRecovery(GMACHandle *GMACH)`

Arguments

`GMACH`	GMAC handle

Returns

1 Recovery is enabled (GMAC level)

0 Recovery is not enabled (GMAC level)

1.3.7 GMACIsRecoveryMulticast()

Description Returns the multicast recovery enable flag.

Prototype `int GMACIsRecoveryMulticast(GMACHandle *GMACH, GMACMulticastID MulticastID)`

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID

Returns

1 Recovery is enabled for the specified multicast ID (overrides the GMAC level)

0 Recovery is not enabled for the specified multicast ID (overrides the GMAC level)

1.3.8 GMACNextExpected()

Description Returns next expected sequence number for the multicast.

Prototype `GMACStatus GMACNextExpected(GMACHandle *GMACH, GMACMulticastID MulticastID, uint64_t *Sequence)`

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID
`Sequence`	Next expected sequence

1.3.9 GMACChannelGetTranscodingType()

Description Returns encoding type for the channel.

Encoding type can be:

- 1 Consolidated book messages

- 0 Deep book messages

Prototype `GMACStatus GMACChannelGetTranscodingType(GMACHandle *GMACH, GMACChannelID ChannelID, int *Enc)`

Arguments

`GMACH`	GMAC handle
`ChannelID`	Channel ID
`Enc`	Pointer to where result is stored

1.3.10 GMACGetLocalChannelID() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACGetObjProps(GMACH, GMAC_OBJ_DST_CHANNEL, DstChannel,
GMAC_PROP_SRC_CHANNEL_CONFIG_ID, LocalChannelID, NULL)
```

Description Returns Channel number from `MulticastID`.

The `MulticastID` returned in **GMACPacketHeader** is globally unique, and generated internally by GMAC. Call this function to get the `LocalChannelID` from the `MulticastID`. The `LocalChannelID` is unique for multicasts of the same type, within the same market. It is the id that is present for each channel in the GMAC configuration file. Moreover, it is used to group complementary channels (of different types).

For instance, a regular 'updates' channel and a snapshot channel would have the same `LocalChannelID` if they are for the same market segment. The same two channels would have different `MulticastID`, generated by GMAC and thus not known before runtime.

Prototype `GMACStatus GMACGetLocalChannelID(GMACHandle *GMACH, GMACMulticastID MulticastID, int *LocalChannelID)`

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID
`LocalChannelID`	Pointer to where channel number is stored

1.3.11 GMACGetLocalChannelIDEx() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACGetObjProps(GMACH, GMAC_OBJ_DST_CHANNEL, MulticastID,
GMAC_PROP_SRC_CHANNEL_ID, &BaseMulticastID,
GMAC_PROP_SRC_CHANNEL_CONFIG_ID, &LocalChannelID,
GMAC_PROP_SRC_CHANNEL_ARBITRAGE, &ArbitrageType, NULL)
```

Description Returns local channel ID and arbitration parameters.

Prototype `GMACStatus GMACGetLocalChannelIDEx(GMACHandle *GMACH, GMACMulticastID MulticastID, GMACMulticastID *BaseMulticastID, int *LocalChannelID, char *LocalChannelChar, int *ArbitrationMode, const char **ArbitrationModeDesc)`

Arguments	`GMACH`	GMAC handle
	`MulticastID`	Multicast ID
	`BaseMulticastID`	The multicast id where this multicast is redirected to (-1 when not assigned)
	`LocalChannelID`	Pointer to where 'channel number' is stored
	`LocalChannelChar`	'A' Line A
		'B' Line B
		'' No arbitration
	`ArbitrationMode`	0 Arbitration off
		1 Redundancy
		2 Lag

1.3.12 GMACCorrectPrice() ** Deprecated **

Note:

This method only uses GMACPriceFactor legacy members i.e. PriceDenominator and PriceNonimator. The function will remain available to allow users to smoothly migrate to the usage of the new members of GMACPriceFactor i.e. Denominator and Numerator. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

Description Returns corrected prices in fixed point precision.

Prototype

```
int64_t GMACCorrectPrice(GMACPriceFactor
*PriceFactor, int64_t Price)
```

Arguments	`PriceFactor`	Price factor
	`Price`	Price from the GMAC message

Returns Price with GMAC_DECIMAL_PLACES fixed point precision

1.3.13 GMACCorrectPriceFloat() ** Deprecated **

Note:

This method only uses GMACPriceFactor legacy members i.e. PriceDenominator and PriceNonimator. The function will remain available to allow users to smoothly migrate to the usage of the new members of GMACPriceFactor i.e. Denominator and Numerator. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

Description Returns corrected prices in floating point precision.

Prototype

```
double GMACCorrectPriceFloat(GMACPriceFactor
*PriceFactor, int64_t Price)
```

Arguments	`PriceFactor`	Price factor
	`Price`	Price from the GMAC message

Returns Price with floating point precision

1.3.14 GMACGetFirmwareVersion()

Note:

This method works only on the legacy stack: it currently doesn't work on the CLX-NG stack.

Description Returns the firmware version.

Prototype
```
GMACStatus GMACGetFirmwareVersion(int BoardNum, int *Revision, int *VersionMajor, int *VersionMinor, char Name[5])
```

Arguments

BoardNum	Board number
Revision	Pointer to the location where the revision number should be stored if the call is successful
VersionMajor	Pointer to the location where the version number should be stored if the call is successful
VersionMinor	Pointer to the location where the version number should be stored if the call is successful
Name	The bitfile name

1.3.15 GMACGetMaxBoardNum()

Description Returns the number of boards installed.

Prototype
```
GMACStatus GMACGetMaxBoardNum(int *MaxBoardNum)
```

Arguments

MaxBoardNum	Pointer to store the total number of boards available

1.3.16 GMACGetMulticastMappingTable() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
uint32_t count = 0, allocated = 0;
GMACGetObjCount(GMACH, GMAC_OBJ_MARKET, MarketID,
GMAC_OBJ_SRC_CHANNEL, &allocated);
GMACObjID* channelIds = calloc(allocated, sizeof(GMACObjID));
GMACGetObjList(GMACH, GMAC_OBJ_MARKET, MarketID,
GMAC_OBJ_SRC_CHANNEL, channelIds,&count, allocated);
for (uint32_t i = 0; i < count; ++i)
      {
            GMACChannelId configID =
UNDEFINED_GMAC_CHANNEL_ID;
            GMACGetObjProps(GMACH, GMAC_OBJ_SRC_CHANNEL,
channelIds[i], GMAC_PROP_SRC_CHANNEL_CONFIG_ID, &configID,
NULL);
            const char* ip = NULL;
            uint16_t port;
            GMACGetObjProps(GMACH, GMAC_OBJ_SRC_CHANNEL,
channelIds[i], GMAC_PROP_SRC_CHANNEL_IP_ADDR, &ip,
GMAC_PROP_SRC_CHANNEL_PORT, &port, NULL);
      }
free(channelIds);
```

Description Returns the multicast mapping table for a specified market.

Prototype
```
GMACStatus GMACGetMulticastMappingTable(GMACHandle *H, unsigned MarketID, GMACMulticastMapping **MulticastMappingPtr)
```

Arguments

GMACH	GMAC handle
MarketID	Market ID
MulticastMappingPtr	Address of the multicast mapping table

1.3.17 GMACMulticastIsRefresh()

Description Returns refresh status for a Multicast.

Prototype
```
int GMACMulticastIsRefresh(GMACHandle *GMACH,
GMACMulticastID MulticastID)
```

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID

Returns

1	Enabled
0	Not enabled

1.3.18 GMACQueryMarketHours()

Description Returns the market status based on the opening hours and last timestamp received.

Prototype
```
GMACStatus GMACQueryMarketHours(GMACHandle *GMACH,
int MarketID, int *MarketOpenPtr, uint64_t
ExchangeTimestamp)
```

Arguments

`GMACH`	GMAC handle
`MarketID`	Market ID
`MarketOpenPtr`	Pointer to the open indicator set by the function
`ExchangeTimestamp`	Exchange timestamp to examine

1.3.19 GMACRegisterErrorHandler()

Description Registers an error handler.

Error handler is called before some status codes are returned. It allows user to change the error code being returned, as well as react on it.

For performance reasons, the error handler is not called when one of following status codes is returned:

- GMAC_STATUS_OK
- GMAC_STATUS_NODATA

Prototype
```
void GMACRegisterErrorHandler(GMACHandle *GMACH,
GMACErrorHandler Handler)
```

Arguments

`GMACH`	GMAC handle
`Handler`	The new error handler

1.3.20 GMACDefaultErrorHandler()

Description Default error handler that is called if an error occurs.

It can be overwritten using function `GMACRegisterErrorHandler()`.

Prototype
```
GMACStatus GMACDefaultErrorHandler(GMACHandle
*GMACH, GMACStatus StatusCode, const char*
Function, char *Msg)
```

Arguments

`GMACH`	GMAC handle
`StatusCode`	Status code

Function	The function where the error happened
Msg	Specific message

1.3.21 GMACChannelEnable()** Deprecated **

Note:

This method can be replaced by the new generic method `GMACCommand()`. The function will remain available along with the new functions to allow users to smoothly migrate. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

See example below using `GMACCommand()`.

If the user needs to enable the source channel defined with ID = 1:

```
GMAC_DECLARE_COMMNAND_STRUCT(activateCmd, GMACSwitchParam);
activateCmd->commandType = GMAC_COMMAND_SWITCH;
activateCmd->objType = GMAC_OBJ_SRC_CHANNEL;
activateCmd->objID = 1;
GMACSwitchParam* switch = (GMACSwitchParam*)activateCmd-
>commandParams;
switch->Activate = true;
GMACStatus = status = GMACCommand(GMACHandle, activateCmd);
```

Description Enables or disables the channel.

The call of the function on a multi-context multicast will propagate to children virtual multicasts. See section 6.2 for details on multi-context multicasts.

Note:

IGMP subscription remains active when the channel is disabled.

Prototype

```
GMACStatus GMACChannelEnable(GMACHandle *GMACH, int
MarketID, int LocalChannelID, int Enable)
```

Arguments

GMACH	GMAC handle
MarketID	Market ID
LocalChannelID	Pointer to where channel number is stored
Enable	To enable or disable the channel

1.3.22 GMACChannelEnableEx()** Deprecated **

Note:

This method can be replaced by the new generic method `GMACCommand()`. The function will remain available along with the new functions to allow users to smoothly migrate. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

See `GMACChannelEnable()` examples using `GMACCommand()`.

Description Enables or disables the channel.

Extended function with additional IGMP membership parameter.

The call of the function on a multi-context multicast will propagate to children virtual multicasts. See section 6.2 for details on multi-context multicasts.

Prototype

```
GMACStatus GMACChannelEnableEx(GMACHandle *GMACH,
int MarketID, int LocalChannelID, int Enable, int
Subscribe)
```

Arguments

GMACH	GMAC handle
MarketID	Market ID
LocalChannelID	Pointer to where channel number is stored
Enable	To enable or disable the channel

Subscribe	To enable or disable IGMP membership. If set to non-zero, GMAC will initiate IGMP subscription or the subscription will remain active if already subscribed. If set to zero, GMAC will drop IGMP subscription.

1.3.23 GMACChannelEnableByType()** Deprecated **

Note:

This method can be replaced by the new generic method `GMACCommand()`. The function will remain available along with the new functions to allow users to smoothly migrate. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

See example below using `GMACCommand()`.

If the user needs to enable referential source channels on a market defined by its ID=0:

```
GMACObjID objs[MAX_CHANNELS];
uint32_t count = 0;

GMACGetObjList(GMACH, GMAC_OBJ_MARKET, 0,
GMAC_OBJ_SRC_CHANNEL, objs, &count, MAX_CHANNELS);
for (unsigned i = 0; i < count; ++i)
{
      uint32_t functionalType = 0;
      GMACGetObjProps(GMACH, GMAC_OBJ_SRC_CHANNEL, objs[i],
GMAC_PROP_SRC_CHANNEL_FUNCTIONAL_TYPE, &functionalType,
NULL);
      if (functionalType & SRC_CHANNEL_REFERENTIAL)
      {
            GMAC_DECLARE_COMMNAND_STRUCT(activateCmd,
GMACSwitchParam);
            activateCmd->commandType = GMAC_COMMAND_SWITCH;
            activateCmd->objType = GMAC_OBJ_SRC_CHANNEL;
            activateCmd->objID = objs[i];
            GMACSwitchParam* switch =
(GMACSwitchParam*)activateCmd->commandParams;
            switch->Activate = true;
            GMACCommand(GMACHandle, activateCmd);
      }
}
```

Description Enables or disables the Channel specifying channel type.

The call of the function on a multi-context multicast will propagate to children virtual multicasts. See section 6.2 for details on multi-context multicasts.

Note:

IGMP subscription remains active when the channel is disabled.

Prototype

```
GMACStatus GMACChannelEnableByType(GMACHandle
*GMACH, int MarketID, int LocalChannelID,
GMACMulticastType MulticastType, int Enable)
```

Arguments

`GMACH`	GMAC handle
`MarketID`	Market ID
`MulticastType`	Channel type
`LocalChannelID`	Pointer to where channel number is stored
`Enable`	To enable or disable the channel

1.3.24 GMACChannelEnableByTypeEx()** Deprecated **

Note:

This method can be replaced by the new generic method `GMACCommand()`. The function will remain available along with the new functions to allow users to smoothly migrate. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

See `GMACChannelEnableByType()` examples using `GMACCommand()`.

Description Enables or disables the Channel specifying channel type.

Extended function with additional IGMP membership parameter.

The call of the function on a multi-context multicast will propagate to children virtual multicasts. See section 6.2 for details on multi-context multicasts.

Prototype

```
GMACStatus GMACChannelEnableByTypeEx(GMACHandle
*GMACH, int MarketID, int LocalChannelID,
GMACMulticastType MulticastType, int Enable, int
Subscribe)
```

Arguments

`GMACH`	GMAC handle
`MarketID`	Market ID
`MulticastType`	Channel type
`LocalChannelID`	Pointer to where channel number is stored
`Enable`	To enable or disable the channel
`Subscribe`	To enable or disable IGMP membership. If set to non-zero, GMAC will initiate IGMP subscription or the subscription will remain active if already subscribed. If set to zero, GMAC will drop IGMP subscription.

1.3.25 GMACSymbolSuffixGenericToNative()

Description Converts generic symbol suffix into market specific suffix if present.

Prototype

```
GMACStatus
GMACSymbolSuffixGenericToNative(GMACHandle *GMACH,
unsigned MarketID, const char * GenericSymbol, char
* Dst)
```

Arguments

`GMACH`	GMAC handle
`MarketID`	Market ID
`GenericSymbol`	Generic symbol to be converted
`Dst`	Pointer to the character array where the resulting string should be stored

1.3.26 GMACSymbolSuffixNativeToGeneric()

Description Converts market specific symbol suffix into generic suffix if present.

Prototype

```
GMACStatus
GMACSymbolSuffixNativeToGeneric(GMACHandle *GMACH,
unsigned MarketID, const char * NativeSymbol, char
* Dst)
```

Arguments

`GMACH`	GMAC handle
`MarketID`	Market ID
`NativeSymbol`	Market specific symbol to be converted
`Dst`	Pointer to the character array where the resulting string should be stored

1.3.27 GMACStatusToString()

Description Transforms the GMAC status to a string representation.

Prototype

```
const char* GMACStatusToString(GMACStatus GMACS)
```

Arguments `GMACS` Status code

Returns String representation of the status

1.3.28 GMACMulticastTypeToString()

Description Transforms the multicast type to a string representation.

Prototype
```
const char*
GMACMulticastTypeToString(GMACMulticastType Type)
```

Arguments `Type` Multicast type

Returns String representation of the multicast type

1.3.29 GMACIdentify()

Description Outputs the information about library and boards.

Prototype
```
GMACStatus GMACIdentify(FILE *f)
```

Arguments `f` File pointer to where the information should be written

1.3.30 GMACGetTimestampLog()** Deprecated **

Note:

This method will not be replaced. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

Description Allows the client code to query a CPU timestamp that is taken when GMAC reads data from the underlying ADE layer. This method is useful to trouble-shoot data flow issues on a specific GMAC queue. The timestamp returned is an absolute value in nanoseconds.

Prototype
```
GMACStatus GMACGetTimestampLog(GMACHandle *GMACH,
int Queue, uint32_t ID, uint64_t *Timestamp)
```

Arguments

`GMACH`	GMAC handle
`Queue`	ID of the hardware queue to read from
`ID`	Timestamp logs ID. Available values: • TMLOG_ADE_READ Timestamp taken at the last ADE read • TMLOG_ADE_READ_STATUS_OK Timestamp taken at the last ADE read with an OK status return
`Timestamp`	Pointer where the timestamp is to be stored

2. Hardware Filtering

2.1 Description

This feature consists in filtering market data according to symbol name and index, so that only market data for specific symbols are processed, with the filtering taking place in the accelerator card. This leads to improved overall performance since 'non-interesting' data are dropped by the card, so are never normalised or passed to the GMAC software-side.

Packet sequence numbers are changed if the card drops some data. Hardware filtering impact on the sequence numbering is illustrated by the following example:

Assuming the following three packets are received, hardware filtering being disabled:

#1	4	5	6	Packet Sequence = 4	Next Sequence = 7	Messages = 3	
#2	7	8	9	10	Packet Sequence = 7	Next Sequence = 11	Messages = 4
#3	11	12	13	Packet Sequence = 11	Next Sequence = 14	Messages = 3	

Hardware filtering being enabled, if message #8 is dropped by the card, the second packet will be re-numbered as follows:

#2	7		**8**	**9**	Packet Sequence = 7	Next Sequence = 11	Messages = 4

Hardware filtering being enabled, if message #7 is dropped by the card, the second packet will be re-numbered as follows:

#2		**7**	**8**	**9**	Packet Sequence = 7	Next Sequence = 11	Messages = 4

The first message in a packet is given the same sequence number as the original packet.

Hardware filtering being enabled, if messages #7 to #10 are dropped by the card (the second packet is fully dropped), the third packet is re-numbered as follows:

#3	11	12	13	Packet Sequence = **7**	Next Sequence = 14	Messages = 3	

Users can therefore easily determine whether packets have been dropped somewhere other than by the hardware filtering module by monitoring the packet sequence and packet next sequence.

2.2 Functions

2.2.1 GMACFilteringEnable()

Description This function enables hardware filtering for the market providing the instruments list to be filtered has been set using `GMACFilteringInstrumentRequired()`.

Once filtering is enabled, it is not allowed to add extra instruments to the list of filtered instruments.

Prototype

```
GMACStatus GMACFilteringEnable(GMACHandle *GMACH,
int MarketID)
```

Arguments

`GMACH`	GMAC handle
`MarketID`	Market ID

2.2.2 GMACFilteringInstrumentRequired()

Description This function is used to add symbol names or symbol indexes to the filtering list for the specified market.

Note #1:

> Only symbol IDs may be passed to the method for the CME plugins i.e. if

a symbol name is passed, the filtering will not work for that symbol.

Note #2:

Only the first three characters in the instrument name specified are used for plugin OPRA_BINARY. That is, an instrument will be filtered in if the first three characters in its instrument name match the first three characters of one of the instrument names in the filtering list.

Prototype

```
GMACStatus
GMACFilteringInstrumentRequired(GMACHandle *GMACH,
int MarketID, const char* InstrumentID)
```

Arguments		
	`GMACH`	GMAC handle
	`MarketID`	Market ID
	`InstrumentID`	Instrument identifier

2.2.3 GMACFilteringSupportedMode()

Description This function returns the filtering mode for a specified market.

If filtering is supported, it also provides whether a symbol index or symbol name has to be provided.

Filtering has to be enabled in the configuration file using `<hardware-filtering>`.

The function returns:

- GMAC_STATUS_OK if hardware filtering is supported for the specified market
- GMAC_STATUS_NOT_IMPLEMENTED if hardware filtering is not supported for the specified market

Prototype

```
GMACStatus GMACFilteringSupportedMode(GMACHandle
*GMACH, int MarketID, GMACFilteringMode
*FilteringMode)
```

Arguments		
	`GMACH`	GMAC handle
	`MarketID`	Market ID
	`FilteringMode`	Filtering mode

2.3 Hardware Filtering Guide

1. The user enables the hardware filtering module in the configuration file using `config.gmac.hardware-filtering`.
2. Then the user enables hardware filtering on a per-market basis in the configuration file using `config.gmac.markets.market.hardware-filtering`.

   Hardware filtering must be enabled globally using `config.gmac.hardware-filtering` to be enabled or disabled at the market level.
3. The user checks whether hardware filtering is supported for a specified market and whether hardware filtering uses a symbol index or symbol name for that market using `GMACFilteringSupportedMode()`.
4. Assuming hardware filtering is supported for a specified market, the users sets the instrument filtering lists using `GMACFilteringInstrumentRequired()`. The function must be called for each instrument to be filtered.
5. The user enables hardware filtering using `GMACFilteringEnable()`.

3. Processing Data

3.1 Description

3.1.1 Overview

The GMAC provides data in a normalised format across all supported feeds. This enables the user to write code processing GMAC messages and listen to all markets supported in GMAC.

GMAC is hiding complexities of maintaining connections, gap detection, recovery mechanisms and various differences between markets.

GMAC is stateless (except sequence checking); each packet received is normalised into one or multiple GMAC messages. Any cross referencing between data (price factor, etc.) in different packets must be done in the layers after GMAC.

On top of that, GMAC provides an easy way to write multithreaded code. Ensuring that data belonging to the same channel is never passed to two different threads at the same time. This allows users to have lockless, high speed code.

3.1.2 Data Classification

GMAC is working with data on the multicast level. Each multicast stream represents a channel. For each channel there is a gap detection and recovery mechanism. Furthermore, each channel belongs to a Market (or exchange), the market implies rules for the channel, how the data should be normalised and how the recovery is handled.

As the channels represents logically separated data, these can be processed in parallel. GMAC architecture ensures that data from the same channel is not passed to two different queues (threads) to hide locking complexities from the user. However, cross-referencing data between channels should be protected by locks or other mechanisms on the user side.

3.2 Functions

3.2.1 GMACQueueInit()

Description Opens a new reading queue and allocates a CPU to the queue.

Prototype
```
GMACStatus GMACQueueInit(GMACHandle *GMACH, int Queue, int CPU)
```

Arguments

`GMACH`	GMAC handle
`Queue`	Queue number
`CPU`	CPU bound to the queue

3.2.2 GMACQueueOpen()

Description Opens a new reading queue.

Prototype
```
GMACStatus GMACQueueOpen(GMACHandle *GMACH, int Queue)
```

Arguments

`GMACH`	GMAC handle
`Queue`	Queue number

3.2.3 GMACQueueClose()

Description Closes a reading queue.

Prototype
```
GMACStatus GMACQueueClose(GMACHandle *GMACH, int Queue)
```

Arguments

`GMACH`	GMAC handle

	`Queue`	Queue number

3.2.4 GMACInitDynamicMcDesc()

Description Initialises **GMACDynamicMcDesc** structure.

Prototype
```
void GMACInitDynamicMcDesc(GMACDynamicMcDesc
*McDesc)
```

Arguments

`McDesc`	Address of multicast descriptor structure to initialise

3.2.5 GMACOpenMulticast()

Description Opens a multicast.

Enables multicasts to be dynamically opened and closed. May be called after the GMAC Queue has been opened.

These functions should be used with care as otherwise they could confuse the code which normalizes to generic GMAC template the message stream for this market.

Prototype
```
GMACStatus GMACOpenMulticast(GMACHandle *GMACH, int
MarketIndex, int LocMid, int Queue,
GMACDynamicMcDesc *McDesc, char *Interface, char
*AdditionalInfo, GMACChannelID ChannelID,
GMACMulticastID *MID)
```

Arguments

`GMACH`	GMAC handle
`MarketIndex`	Multicast ID
`LocMid`	A number to group multicasts for processing
`Queue`	Queue number
`McDesc`	Address of multicast descriptor structure. Can be Null to use defaults.
`Interface`	Interface to use, e.g. "ac0"
`AdditionalInfo`	Generally the IP and port address, e.g. "1.2.3.4:5"
`ChannelID`	Channel (as distinct from Multicast), used to logically group multicasts after GMAC. May be specified as 0xFFFFFFFF when it will be assigned automatically.
`MID`	Address to write the new Multicast ID

3.2.6 GMACCloseMulticast()

Description Closes a multicast.

Enables multicasts to be dynamically closed. No errors are returned, the multicast will not be open.

These functions should be used with care as otherwise they could confuse the code which normalizes to generic GMAC template the message stream for this market.

If the function is called on a Multicontext multicast the close will propagate to children virtual multicasts. See section 6.2 for details on Multicontext multicasts.

Prototype
```
void GMACCloseMulticast(GMACHandle *GMACH,
GMACMulticastID MulticastID)
```

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID

3.2.7 GMACQueueRead()

Description Returns one GMAC packet data on the specific hardware queue.

This function polls data from the hardware queue. It checks channel/queue relations to prevent multiple CPUs processing the same part of the book. It is guaranteed that no other CPU polling on a different hardware queue is processing data from the same channel until `GMACQueueRelease()` is called.

The function calls the market specific GMAC plug-in and returns the data in the Celoxica normalised format. It provides sequence integrity checking and recovery. The returned data are guaranteed to be in the correct order without gaps.

The Data pointer is set to the first packet in the buffer list if the return code is GMAC_STATUS_USER_BUFFERING or GMAC_STATUS_RECOVERY_FAILED (see the note below). This data should not be processed as market data since it will be returned again with GMAC_STATUS_OK. The user should not call `GMACQueueRelease()` until GMAC_STATUS_OK is returned.

Note:

GMAC_STATUS_RECOVERY_FAILED indicates that one of GMAC recovery mechanisms has encountered some issue. Often in such a case GMAC will have failed to recover at least one missed packet so the user can expect to see a gap in sequence numbers. The data pointer is set if possible when this status is returned, but in some cases this is not possible, so the data pointer is set to NULL. In the latter case, user code may determine the MarketID if needed by using the ChannelID that GMACQueueRead() or `GMACQueuePoll()` returns.

The possible list of cases resulting in GMAC_STATUS_RECOVERY_FAILED are as follows:

- Gap recovery
    - The recovery connection is dead
    - Recovery connection protocol error
    - Task timeout reached
    - Number of maximum task retries reached
- Snapshot recovery
    - Snapshot request function called is not supported by the plugin
    - Snapshot complete function called is not supported by the plugin
    - The snapshot connection is dead
    - Snapshot connection protocol error
    - Task timeout reached
    - Number of maximum task retries reached
- Reorder buffer
    - General timeout on the multicast
    - Reorder overflow, (configuration node gmac.reorder-max)
    - The gap recovery request was too big

Since multiple scenarios can result in GMAC_STATUS_RECOVERY_FAILED, users may wish to monitor the GMAC recovery log file (configuration node gmac.recovery-logfile) for details on what occurred.

If the return code is GMAC_STATUS_OK, the user must call `GMACQueueRelease()`, after processing the passed data.

GMAC_STATUS_CONTROL is returned with the Data pointer provided by user in call `GMACControlQueueWrite()`. In this case the mechanism to free the data is the user's responsibility.

GMAC_STATUS_NO_CHANNELS is returned when there are no inputs open on a GMAC/ADE queue. This can occur if there are no inputs (multicasts) on this queue.

GMAC_STATUS_RECONNECT is returned if GMAC attempts to reconnect to a socket channel.

GMAC_STATUS_ADE_ERROR is returned if the maximum number of retries has been reached (set by config node `gmac.markets.market.socket-max-retries`) or the retry time frame has been exceeded (set by config node `gmac.markets.market.socket-max-retries-us`) for a socket channel.

GMAC_STATUS_ADE_ERROR is the default return status if no reconnection parameters are configured or the channel is not a socket.

Note:

> In cases where GMAC needs to dynamically open/close multicasts this may be a 'soft' error. Handling is up to the caller.

If a duplicate packet is found and consequently dropped in the reordering buffer, GMAC_STATUS_NODATA is returned, and **GMACStats** .PacketsDroppedAsDuplicates counter is incremented.

GMAC_STATUS_PACKET_DROPPED is returned only when using lldt2 plugin (i.e. with shared-pipeline firmwares), and is returned when the plugin drops packets because the queue is full - i.e. when the reading side is too slow. The PacketsMissed counter (which can be queried via `GMACStatsQueueGlobal()`) is incremented accordingly, and its value is printed as "Missed packets" by the GMACPrint() API.

The function is non-blocking.

Prototype

```
GMACStatus GMACQueueRead(GMACHandle *GMACH, int
Queue, char **Data, GMACChannelID *ChannelID)
```

Arguments

`GMACH`	GMAC handle
`Queue`	The queue number
`Data`	Pointer to where the returned data are to be stored
`ChannelID`	Channel the data were received from

3.2.8 GMACQueuePoll()

Description Behaves like `GMACQueueRead()` without the need to call `GMACQueueRelease()`.

Note:

> When using `GMACQueuePoll()`, the call to `GMACQueueRelease()` is **not** needed.

Prototype

```
GMACStatus GMACQueuePoll(GMACHandle *GMACH, int
Queue, const char** Data)
```

Arguments

`GMACH`	GMAC handle
`Queue`	The queue number
`Data`	Pointer to where the returned data are to be stored

3.2.9 GMACQueueRelease()

Description Releases data returned from `GMACQueueRead()` for cases where `GMACQueueRead()` status code was GMAC_STATUS_OK.

Prototype `void GMACQueueRelease(GMACHandle *GMACH, char *Data)`

Arguments

`GMACH`	GMAC handle
`Data`	Pointer returned by `GMACQueueRead()`

3.2.10 GMACControlQueueWrite()

Description Writes a control message.

Writes a message to the control queue, the message will be read by the thread responsible for the specified channel. The data will then be read by `GMACQueueRead()` or `GMACQueuePoll()` call with highest priority.

This function allows the user to send control messages to the CPUs responsible for specific channels.

Function `GMACQueueRead()` or `GMACQueuePoll()` will return GMAC_STATUS_CONTROL and supplied data pointer will be given to the user. Any data manipulation alloc/free must be done by the user. `GMACQueueRelease()` must not be called.

Warning: The behavior after supplying NULL pointer is undefined.

Prototype `GMACStatus GMACControlQueueWrite(GMACHandle *GMACH, char *Data, GMACChannelID ChannelID)`

Arguments

`GMACH`	GMAC handle
`Data`	Pointer to a control message
`ChannelID`	The channel the control message applies to

3.2.11 GMACControlQueueWriteMarket()

Description Writes a control message.

Sends the message on all channels the market has, using `GMACControlQueueWrite()` function.

Each channel receives the same copy of the data (same supplied pointer). User should ensure, that data are freed only after read certain times.

Prototype `GMACStatus GMACControlQueueWriteMarket(GMACHandle *GMACH, char *Data, int MarketID)`

Arguments

`GMACH`	GMAC handle
`Data`	Pointer to a control message
`MarketID`	Market ID the messages will be send on

3.2.12 GMACMulticastGetMarketID() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACGetObjProps(GMACH, GMAC_OBJ_DST_CHANNEL, DstChannel, GMAC_PROP_MARKET_ID, &id, GMAC_PROP_MARKET_NAME, NamePtr, NULL)
```

Description Returns the market ID for a specific multicast.

Prototype `int GMACMulticastGetMarketID(GMACHandle *GMACH, GMACMulticastID MulticastID, const char **NamePtr)`

Arguments	`GMACH`	GMAC handle
	`MulticastID`	Multicast ID
	`NamePtr`	Returns the pointer to the market name

Returns Market ID or -1 if there is no market registered on specified multicast

3.2.13 GMACMulticastGetMarketIDFromChannel() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACGetObjProps(GMACH, GMAC_OBJ_DST_CHANNEL, DstChannel,
GMAC_PROP_MARKET_MARKET_ID, &id,
GMAC_PROP_MARKET_MARKET_NAME, NamePtr, NULL)
```

Description Returns the market ID for a specific channel.

Prototype

```
int GMACMulticastGetMarketIDFromChannel(GMACHandle
*GMACH, int ChannelID, const char **NamePtr)
```

Arguments	`GMACH`	GMAC handle
	`ChannelID`	Channel ID
	`NamePtr`	Returns the pointer to the market name

Returns Market ID or -1 if Channel ID is invalid or there is no market registered for the Channel ID

3.2.14 GMACGetMarket() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACGetObjProps(GMACH, GMAC_OBJ_MARKET, MarketID,
GMAC_PROP_MARKET_NAME, &marketName, NULL)
```

Description Returns the name of market for supplied Market ID.

Prototype

```
GMACStatus GMACGetMarket(GMACHandle *GMACH, char
**MarketName, uint8_t MarketID)
```

Arguments	`GMACH`	GMAC handle
	`MarketName`	Pointer to where pointer to the name is stored
	`MarketID`	Market ID

3.2.15 GMACGetMarketNames() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACObjId markets[MAX_MARKETS];
uint32_t count = 0;
GMACGetObjList(GMACH, GMAC_OBJ_ROOT, 0, GMAC_OBJ_MARKET,
markets, &count, MAX_MARKETS);
for (uint32_t i = 0; i < count; ++i)
      {
            const char* marketName = NULL;
            GMACGetObjProps(GMACH, GMAC_OBJ_MARKET,
markets[i], GMAC_PROP_MARKET_NAME, &marketName, NULL);
      }
```

Description Returns the list of market names.

Prototype `GMACStatus GMACGetMarketNames(GMACHandle *GMACH, GMACMarketNames MarketNames)`

Arguments		
	`GMACH`	GMAC handle
	`MarketNames`	Pointer to the market names structure

3.2.16 GMACGetQueueWithChannelID() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

Description Returns the queue for the specified channel ID.

Prototype `GMACStatus GMACGetQueueWithChannelID(GMACHandle *GMACH, GMACChannelID ChannelID, int *Queue)`

Arguments		
	`GMACH`	GMAC handle
	`ChannelID`	Channel ID
	`Queue`	Returns the pointer to the queue

3.2.17 GMACGetQueueWithMarketID() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

Description Returns the queue for the specified market ID.

Prototype `GMACStatus GMACGetQueueWithMarketID(GMACHandle *GMACH, int MarketID, int *Queue)`

Arguments		
	`GMACH`	GMAC handle
	`MarketID`	Market ID
	`Queue`	Returns the pointer to the queue

3.2.18 GMACMarketGetTranscodingType() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACGetObjProps(GMACH, GMAC_OBJ_MARKET,
MarketID,GMAC_PROP_MARKET_TRANSCODING_TYPE, &transcodingType,
NULL)
```

Description Returns the transcoding type.

Prototype
```
GMACStatus GMACMarketGetTranscodingType(GMACHandle
*GMACH, uint8_t MarketID, int *Enc)
```

Arguments		
	`GMACH`	GMAC handle
	`MarketID`	Market ID
	`Enc`	Pointer to where function returns the transcoding type

3.2.19 GMACDefaultPriceFactor() ** Deprecated **

Note:

This legacy method will be removed shortly. Either the price factor is provided by GMACMessageReferenceHeaderV3.PriceFactor or the prices in the GMAC messages are scaled using a fixed price factor. Refer to each plug-in mapping for details.

Description Returns the default price factor for the market specified.

Returns -1 for feeds without default price factor; in that case the price factor needs to be retrieved from the GMAC referential message GMACMessageReferenceSecurityV3.

Prototype
```
GMACStatus GMACDefaultPriceFactor(GMACHandle
*GMACH, GMACChannelID ChannelID, GMACPriceFactor
*PriceFactor)
```

Arguments		
	`GMACH`	GMAC handle
	`ChannelID`	Channel ID
	`PriceFactor`	Pointer to where the price factor is returned

3.2.20 GMACDefaultCurrency()

Description Returns the default currency for the market specified.

Prototype
```
GMACStatus GMACDefaultCurrency(GMACHandle *GMACH,
GMACChannelID ChannelID, char **Currency)
```

Arguments		
	`GMACH`	GMAC handle
	`ChannelID`	Channel ID
	`Currency`	Pointer to where the currency is returned

3.2.21 GMACDefaultRoundLotSize()

Description Returns the default round lot size for the market specified.

Returns -1 if the round lot size is unknown and needs to be determined from a data referential message. Feed that do not use round lots will return a round lot size of 1.

Prototype
```
GMACStatus GMACDefaultRoundLotSize(GMACHandle
*GMACH, GMACChannelID ChannelID, uint64_t
*RoundLotSize)
```

Arguments		
	`GMACH`	GMAC handle

`ChannelID`	Channel ID
`RoundLotSize`	Pointer to where the round lot size is returned

3.2.22 GMACGetDefaultStatus()

Description Returns the default status values for Market, Sector, Segment, Channel and Instrument.

A client can use these as the initial values until they are known. Values for Sector, Segment and Channel are 'Open' where these levels are not used.

Prototype

```
GMACStatus GMACGetDefaultStatus(GMACHandle *GMACH,
int MarketID, GMACDefaultMarketStatus *DefStatus)
```

Arguments

`GMACH`	GMAC handle
`MarketID`	Market ID
`DefStatus`	Pointer to where the status values are returned

3.2.23 GMACGetADEProperty()

Description Returns a plugin-specific property from the underlying ADE channel.

Prototype

```
GMACStatus GMACGetADEProperty(GMACHandle *GMACH,
GMACMulticastID MulticastID, int Property, void
**Result)
```

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID
`Property`	Property index - ADE plugin specific
`Result`	Pointer to where the data are returned

Example We want to obtain the timestamps recorded in a pcap file that we are reading in via the file plugin.

```
struct timeval *tv;
GMACGetADEProperty(..., 0, (void**)&tv);
```

Here we pass 0 as property and a pointer to `struct timeval *` as Result. The function will return the local timestamp of the last read packet, as recorded in the PCAP file.

3.2.24 GMACMulticastSync()

Description Sets the expected sequence number for specific multicast.

This function allows the user to sync on specific sequence number, to take advantage of snapshot messages for example. If there are any data buffered in GMAC until this sequence number, those will be dropped. Any data received with sequence number lower than this one will be dropped as well.

This command will be processed by CPU currently responsible for the specific channel asynchronously.

If the user tries to sync on sequence number lower than the next expected one (means GMAC doesn't have the required data anymore), GMAC tries to recover the missing messages with respect of re-request timeout. The data in the reorder buffer are aging and it can easily happen that the gap is too old to be re-requested.

To avoid synchronising on deprecated sequence numbers, it is recommended to use this function in combination with `GMACMulticastBuffer()`.

The call of the function on a multi-context multicast will propagate to children virtual multicasts. See section 6.2 for details on multi-context multicasts.

Prototype `GMACStatus GMACMulticastSync(GMACHandle *GMACH, GMACMulticastID MulticastID, uint64_t Sequence)`

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID
`Sequence`	Sequence to sync to

3.2.25 GMACMulticastSetTaint()

Description Sets the taint flag for a multicast.

Prototype `GMACStatus GMACMulticastSetTaint(GMACHandle *GMACH, GMACMulticastID MulticastID, int Taint)`

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID
`Taint`	The taint can bet set or reset

3.2.26 GMACMulticastBuffer()

Description Starts buffering data on specific multicast.

This function helps to synchronise onto specific sequence number with the `GMACMulticastSync()` function.

The function call will cause all data on the specific channel to be buffered.

Each time a new packet is buffered, `GMACQueueRead()` will return status GMAC_STATUS_USER_BUFFERING with a pointer to the first buffered packet data, which allows user to get sequence number of the first buffered packet. `GMACQueueRelease()` should not be called.

To disable buffering and start receiving data, user should use the `GMACMulticastSync()` function.

Buffered data will be stored in reorder/user buffer pool; the size can be set in the configuration file via node `config.gmac.bufferpool`.

Note:

> The bufferpool is shared between all channels on a single core.

If there is no space in the buffer pool, the data will be dropped and recovered later using recovery mechanisms. Using buffering will increase the latency and affect the performance so it only should be used for synchronisation reasons.

The call of the function on a multi-context multicast will propagate to children virtual multicasts. See section 6.2 for details on multi-context multicasts.

Prototype `GMACStatus GMACMulticastBuffer(GMACHandle *GMACH, GMACMulticastID MulticastID)`

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID

3.2.27 GMACTranslateMarketToEISIN()

Description Translates market local name to EISIN.

Prototype `GMACStatus GMACTranslateMarketToEISIN(GMACHandle *GMACH, GMACChannelID ChannelID, GMACLocalName Src, GMACEISIN Dst)`

Arguments

`GMACH`	GMAC handle

	`ChannelID`	Channel ID
	`Src`	Market local name
	`Dst`	Pointer to where the EISIN will be copied (must be allocated by caller)

3.2.28 GMACTranslateMarketToEISINEx()

Description Translates the market local name to EISIN if this feature is supported for the specific feed.

Prototype
```
GMACStatus GMACTranslateMarketToEISINEx(GMACHandle *GMACH, int MarketID, GMACLocalName Src, GMACEISIN Dst)
```

Arguments	`GMACH`	GMAC handle
	`MarketID`	Market ID
	`Src`	Market local name
	`Dst`	Pointer to where the EISIN will be copied (must be allocated by caller)

3.2.29 GMACTranslateEISINToMarket()

Description Translates EISIN to market local name if this feature is supported for the specific feed.

Prototype
```
GMACStatus GMACTranslateEISINToMarket(GMACHandle *GMACH, GMACChannelID ChannelID, GMACEISIN Src, GMACLocalName Dst)
```

Arguments	`GMACH`	GMAC handle
	`ChannelID`	Channel ID
	`Src`	EISIN
	`Dst`	Pointer to where the market local name will be copied (must be allocated by caller)

3.2.30 GMACTranslateEISINToMarketEx()

Description Translates the market local name to EISIN if this feature is supported for the specific feed.

Prototype
```
GMACStatus GMACTranslateEISINToMarketEx(GMACHandle *GMACH, int MarketID, GMACEISIN Src, GMACLocalName Dst)
```

Arguments	`GMACH`	GMAC handle
	`MarketID`	Market ID
	`Src`	EISIN
	`Dst`	Pointer to where the market local name will be copied (must be allocated by caller)

3.2.31 GMACPrintMessages()

Description Outputs textual representation of Celoxica normalised messages into the supplied stream.

Prototype
```
void GMACPrintMessages(FILE *f, char *Data)
```

Arguments

`f`	Stream to print to
`Data`	Pointer to where Celoxica messages are

3.2.32 GMACPrintMessagesEx()

Description Outputs textual representation of Celoxica normalised messages into the supplied stream.

Prototype

```
void GMACPrintMessagesEx(FILE *f, char *Data,
int(*IsPrint)(GMACMessageHeader *Header))
```

Arguments

`f`	Stream to print to
`Data`	Pointer to where Celoxica messages are
`IsPrint`	Callback function to determine whether to print the message or not

3.2.33 GMACSetExpectedSequenceMulticast()

Description Sets the next expected sequence number for a specific multicast, usually SEQUENCE_UNDEFINED.

Prototype

```
void GMACSetExpectedSequenceMulticast(GMACHandle
*GMACH, GMACMulticastID MulticastID, uint64_t
NewSequenceNumber)
```

Arguments

`GMACH`	GMAC handle
`MulticastID`	Multicast ID
`NewSequenceNumber`	New sequence number

3.3 Processing Data Guide

1. The user creates a queue for each processor he wishes to use. The queue is initialised using `GMACQueueOpen()`.
2. When a queue is initialised, the user should call `GMACQueueRead()` or `GMACQueuePoll()` in a loop, to poll the data.
3. The user is required to call GMACQueueRelease() when he has finished using the data if the data is read using `GMACQueueRead()`. The call of `GMACQueueRelease()` is not needed if the data is read using `GMACQueuePoll()`
4. The user closes a queue using `GMACQueueClose()`.

GMAC provides some other information about the data as well, for instance:

- `GMACMulticastGetMarketIDFromChannel()` to check which market the channel belongs to
- `GMACDefaultPriceFactor()` to get the default price factor used by some feeds
- `GMACDefaultCurrency()` to get the default currency used by some feeds

Follow the steps below in order to get real prices from the GMAC messages:

1. Call `GMACDefaultPriceFactor()` to retrieve the price factor
2. If the function returns a price factor, apply it to the price to get the price with GMAC_DECIMAL_PLACES fixed decimal places. For example:
   a) If the price factor is 10,000/1, multiply the price by 10,000 to get the price with GMAC_DECIMAL_PLACES fixed decimal places
   b) If the price factor is 1/1, the price is already expressed with GMAC_DECIMAL_PLACES fixed decimal places

3. If the function returns -1, get the price factor from GMAC referential message GMACMessageReferenceSecurityV3 and apply the price factor to the price to get the price with GMAC_DECIMAL_PLACES fixed decimal places

GMAC aims to be able to assign same global name to instruments of different markets which represents the same product. Functions `GMACTranslateMarketToEISIN()` and `GMACTranslateEISINToMarket()`, should translate market local name to EISIN (Extended ISIN code) and other way around. This feature support depends on the feed.

User may require doing some processing on data belonging to specific channel: to avoid locking, GMAC provides a feature which allows to send command to thread responsible for the channel. This ensures the processing will be performed on the thread processing the channel, so no race conditions will be involved.

To send command use the control queue `GMACControlQueueWrite()`. It allows to pass any pointer, it will be picked by `GMACQueueRead()` or `GMACQueuePoll()` in the target thread.

It may be necessary to synchronise the channel on particular sequence number, not known in advance. GMAC provides buffering feature with subsequent synchronisation. Use the calls: `GMACMulticastBuffer()` and `GMACMulticastSync()`. This is required e.g. on EUREX feed.

4. Statistics

4.1 Description

GMAC is gathering statistics about processed data.

Pointer to structure where statistics are stored can be retrieved by calling `GMACStatsMulticast()` and `GMACStatsQueueGlobal()`.

4.2 Functions

4.2.1 GMACStatsMulticast()

Description Returns pointer to live statistics of a particular multicast.

Prototype

```
GMACStatus GMACStatsMulticast(GMACHandle *GMACH,
GMACMulticastID MulticastID, GMACStats **Stats)
```

Arguments		
	`GMACH`	GMAC handle
	`MulticastID`	Multicast ID
	`Stats`	Pointer to where statistics will be passed

4.2.2 GMACStatsChannel()

Description Returns pointer to live statistics of a particular channel.

Prototype

```
GMACStatus GMACStatsChannel(GMACHandle *GMACH, int
MarketID, int LocalChannelID, GMACStats **Stats)
```

Arguments		
	`GMACH`	GMAC handle
	`MarketID`	Market ID
	`LocalChannelID`	Channel ID local to the market, the ID specified in the configuration file
	`Stats`	Pointer to where statistics will be passed

4.2.3 GMACStatsQueueGlobal()

Description Returns global statistics.

The user can get a copy of the global statistics. It is useful for monitoring all the multicast channels.

If the user detects packet drops, the user should check `CRCErrors` count returned by `GMACStatsQueueGlobal()`. A count greater than zero indicates a likely network infrastructure fault such as bad cabling, bad SFPs or a faulty switch.

The statistics are always representing the current state.

Prototype

```
GMACStatus GMACStatsQueueGlobal(GMACHandle *GMACH,
int Queue, GMACStats **Stats, uint64_t
*PacketsMissed, uint64_t *CRCErrors)
```

Arguments		
	`GMACH`	GMAC handle
	`Queue`	The queue number
	`Stats`	Pointer to where statistics will be passed
	`PacketsMissed`	Packets dropped by the accelerator card, because software wasn't keeping up
	`CRCErrors`	Packets dropped by the accelerator card, because of underlying protocol errors

4.2.4 GMACStatsMulticastCount() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACGetObjCount(GMACH, GMAC_OBJ_ROOT, 0,
GMAC_OBJ_SRC_CHANNEL, Count)
```

Description Returns number of open multicasts.

Prototype
```
void GMACStatsMulticastCount(GMACHandle *GMACH, int
*Count)
```

Arguments		
	`GMACH`	GMAC handle
	`Count`	Multicast count

4.2.5 GMACStatsMarketMulticastCount() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACGetObjCount(GMACH, GMAC_OBJ_MARKET, MarketID,
GMAC_OBJ_SRC_CHANNEL, Count)
```

Description Returns number of open multicasts for specific market.

Prototype
```
GMACStatus GMACStatsMarketMulticastCount(GMACHandle
*GMACH, int MarketID, int *Count)
```

Arguments		
	`GMACH`	GMAC handle
	`MarketID`	Market ID
	`Count`	Multicast count

4.2.6 GMACStatsMarketChannelCount() ** Deprecated **

Description Returns number of open channels for specific market.

Prototype
```
GMACStatus GMACStatsMarketChannelCount(GMACHandle
*GMACH, int MarketID, int *Count)
```

Arguments		
	`GMACH`	GMAC handle
	`Count`	Channel count

4.2.7 GMACStatsMarketCount() ** Deprecated **

Note:

This method can be replaced by new generic data retrieval methods, see section Data Retrieval for details. The function will remain available along with the new functions to allow users to smoothly migrate to the new data retrieval API. A notice will be published several months before the removal of the legacy methods to ensure users' readiness.

This method can be replaced by:

```
GMACGetObjCount(GMACH, GMAC_OBJ_ROOT, 0, GMAC_OBJ_MARKET, count)
```

Description Returns number of markets.

Prototype

```
void GMACStatsMarketCount(GMACHandle *GMACH, int *Count)
```

Arguments

`GMACH`	GMAC handle
`Count`	Market count

4.2.8 GMACStatsGetCredit()

Description Queries the status of the DMA queue.

This is a debug function that can be used to query the amount of free space in the DMA queue. It can be useful during integration development, to ascertain whether the user code is processing incoming packets quickly enough and thus not falling behind and causing the DMA queue to fill up. This function call will affect latency and should therefore not be used in performance threads.

This function is only available for the "lldt" plugin (i.e. for data streams emanating from accelerator cards).

Prototype

```
GMACStatus GMACStatsGetCredit(GMACHandle *GMACH, char *Plugin, int Queue, int BoardIndex, uint64_t *CreditAvail, uint64_t *CreditMax)
```

Arguments

`GMACH`	GMAC handle
`Queue`	Queue number
`BoardIndex`	Board index number. If set to -1, the first board on the queue is selected
`CreditAvail`	Available DMA credit in bytes
`CreditMax`	Maximum amount of credit for the given DMA buffer; i.e. the size of the DMA buffer

4.2.9 GMACStatsMulticastPrint()

Description Prints statistics of a multicast.

Prototype

```
void GMACStatsMulticastPrint(GMACHandle *GMACH, int Queue, GMACMulticastID MulticastID, FILE *f)
```

Arguments

`GMACH`	GMAC handle
`MulticastID`	MulticastID
`f`	Stream to print to

4.2.10 GMACStatsAllMulticastPrint()

Description Prints all channels using supplied function.

Prototype

```
void GMACStatsAllMulticastPrint(GMACHandle *GMACH, int Queue, FILE *f, void (*Fnc)( GMACHandle *H, int Queue, GMACChannelID ChannelID, FILE *f))
```

Arguments

`GMACH`	GMAC handle
`Queue`	Queue number
`f`	Stream to print to

4.2.11 GMACStatsAllMulticastPrintSqn()

Description Prints all channels for the next expected sequence.

Prototype
```
Void GMACStatsAllMulticastPrintSqn(GMACHandle *H,
FILE *f, void (*Fnc)( GMACHandle *H, char *Str,
FILE *f))
```

Arguments		
	`GMACH`	GMAC handle
	`f`	Stream to print to

4.2.12 GMACStatsMulticastPrintStr()

Description Prints statistics.

Prototype
```
void GMACStatsMulticastPrintStr(char *Str, FILE *f)
```

Arguments		
	`Str`	String to print
	`f`	Stream to print to

4.2.13 GMACStatsPrintSqn()

Description Prints statistics for the next expected sequence.

Prototype
```
void GMACStatsPrintSqn(GMACHandle *GMACH, FILE *f)
```

Arguments		
	`GMACH`	GMAC handle
	`f`	Stream to print to

4.2.14 GMACStatsPrint()

Description Prints statistics.

Prototype
```
void GMACStatsPrint(GMACHandle *GMACH, int Queue,
FILE *f)
```

Arguments		
	`GMACH`	GMAC handle
	`f`	Stream to print to

4.2.15 GMACStatsDump()

Description Dumps the structure.

Prototype
```
void GMACStatsDump(GMACStats *Stats, FILE *f)
```

Arguments		
	`Stats`	Pointer to where statistics will be passed
	`f`	Stream to print to

5. Latency Measurement

Note:

The following methods are available on the legacy stack ADE only. The availability of latency measurement methods on the new CLX-NG stack is scheduled early 2017.

5.1 Description

All GMAC messages contain a hardware timestamp which is applied as the last byte arrived on the accelerator's card Ethernet port. This timestamp is propagated in **GMACPacketHeader** structure. The user application can query the latency on messages at any time via two latency API functions:

- **Real-time latency function**: `GMACLatencyRealtime()` returns the number of timestamps and the total latency as reported by the accelerator card every 0.5 seconds, for the last 0.5 second window;
- **Total latency function**: `GMACLatencyTotal()` returns the sum of all latencies since the last reset, or application start. This type of request requires a register read from the accelerator card, which blocks access to it for a certain time and should therefore should be used sparingly.

The following figure illustrates how latency is computed.

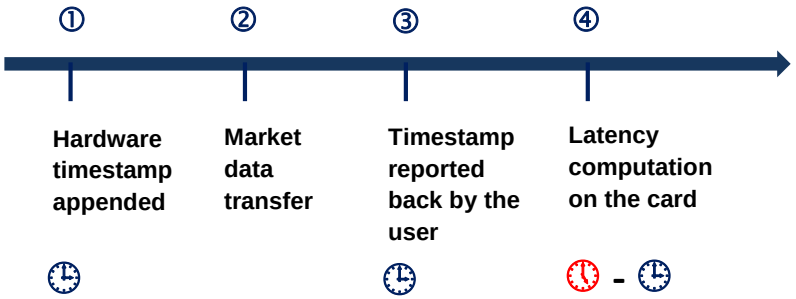


Figure 1 – Latency

① Current hardware timestamp is appended to the packet when the end of the packet is received.

② Market data is transferred to the GMAC software side.

③ Timestamp is reported back to the card. This must be done by the user via `GMACLatencyTick()`.

④ Reported timestamp is evaluated against the current hardware timestamp.

Latency measurement is very light-weight and should not influence performance. Note that the computed latency also includes the time it takes to transfer the timestamp back to the hardware. Therefore the real latency is actually slightly smaller than what's reported.

5.2 Functions

5.2.1 GMACLatencyRealtime()

Description Returns the latency metrics, as reported by the hardware to the GMAC software-side every 0.5 seconds. The values it returns are for the most recent measured 0.5-second window. Calling the function multiple times within a 0.5-second window will therefore result in the same values being returned. This function is fast to return, so can be called in performance-sensitive code.

Note:

The metrics returned depend on the user reporting latency ticks back to the hardware using `GMACLatencyTick()`.

Prototype

```
GMACStatus GMACLatencyRealtime(GMACHandle *GMACH,
int Queue, char *Plugin, uint64_t *TSCount,
uint64_t *LatencyTotal)
```

Arguments	`GMACH`	GMAC handle
	`Queue`	Queue number
	`Plugin`	Name of the ADE plugin
	`TSCount`	Number of reported timestamps
	`LatencyTotal`	Total of all reported latencies in ns

5.2.2 GMACLatencyTotal()

Description Returns the latency metrics for an entire GMAC session: i.e. since the last reset or since the application start. The function accesses registers on the accelerator card, which is an expensive operation. It should therefore not be called excessively, and it should not be called from performance-sensitive code. The function can be called safely from any thread, but the caller should ensure that GMAC does not close during the call (again because it accesses registers on the card).

Note:

> The metrics returned depend on the user reporting latency ticks back to the hardware using `GMACLatencyTick()`.

Prototype

```
GMACStatus GMACLatencyTotal(GMACHandle *GMACH, int
Queue, char *Plugin, uint64_t *TSCount, uint64_t
*LatencyTotal, int Reset)
```

Arguments	`GMACH`	GMAC handle
	`Queue`	Queue number
	`Plugin`	Name of the ADE plugin
	`TSCount`	Number of reported timestamps
	`LatencyTotal`	Total of all reported latencies in ns
	`Reset`	If set to non-zero, the counters will be reset by this read. **This feature is not available yet.**

5.2.3 GMACLatencyTick()

Description Reports a timestamp back to the accelerator card. The accelerator card can use this to provide latency metrics, see `GMACLatencyRealtime()` and `GMACLatencyTotal()`.

Prototype

```
void GMACLatencyTick(GMACHandle *GMACH,
GMACMulticastID MulticastID, uint64_t Timestamp)
```

Arguments	`GMACH`	GMAC handle
	`MulticastID`	Multicast ID of the received data
	`Timestamp`	Received timestamp from **GMACPacketHeader**

6. Snapshot Support

6.1 Description

There are three levels of snapshot support in GMAC:

Level 0 - L0 Manual snapshot support for non-request based feeds handled by using the following functions:

- `GMACCommand()`
- `GMACMulticastSync()`
- `GMACMulticastBuffer()`

In addition the user needs to process all related GMAC messages manually.

The level L0 is usually supported for feeds where snapshot channels are coming in cycles.

Level 1 - L1 Manual snapshot support for request based feeds handled by using the following functions:

- `GMACMulticastSync()`
- `GMACMulticastBuffer()`
- `GMACMulticastRefreshRequest()`
- `GMACMulticastRefreshComplete()`

In addition the user needs to process all related GMAC messages manually.

The level L1 is usually supported for TCP based feeds.

Level 2 - L2 Semi-automatic snapshot support handled by using the following functions:

- `GMACMulticastSync()`
- `GMACMulticastBuffer()`
- `GMACMulticastSnapshotRequest()`
- `GMACMulticastSnapshotProcess()`

The user needs to process all related GMAC messages manually. However the GMAC messages to be processed are selected by `GMACMulticastSnapshotProcess()`, so the user does not need to monitor himself. This level also hides some of the processing complexity as it provides the indication of snapshot request completion, handles error states, manages timeouts and provides the synchronisation points.

Note:

> The snapshot Level 2 feature will be removed shortly. It is strongly recommended to use the snapshot Level 1 instead.

Refer to the Market Data-Market Support Matrix documentation for more details on the available snapshot level per plugin.

The second level is only supported by GMAC for selected markets. The user will get an error if he tries to use this level on the non-supported market.

6.2 Level 0 Snapshot Guide

6.2.1 Eurex and Xetra Markets

Note:

> XETRA and EUREX markets send multiple sequence number contexts per multicast channel. Indeed, several partitions, each with a unique SenderCompID [49], may contribute to the same multicast address. This Level 0 Snapshot Guide is solely valid for plugins XETRA (Xetra EBS feed) and EMDI (T7 Eurex / Xetra EMDI feeds).

1. After opening GMAC, start processing messages from the reference stream and continue to do so until a GMACMessageInformationV3 is received with CycleStatus

= CSTATUS_END_OF_CYCLES. This indicates that GMAC processed a full referential cycle successfully and opened the incremental channels.

2. In the reference stream, use information in GMACMessageReferenceSecurityV3 and the attached GMACExtensionRDIMDFeeds on T7 Eurex / Xetra EMDI feeds or GMACExtensionStructXetraInstrRef and GMACExtensionStructXetraMaintRef on Xetra EBS feed to create a mapping from Instruments to their corresponding IPs and ports.

3. After step 1 completion, use the GMAC data Retrieval API to retrieve the list of all multicasts open and from this look up the IPs and ports from step 2 to create a mapping from instruments to MulticastIDs. This will be used when you detect a gap in the product sequence number for a product to get the multicastIDs to work with.

4. GMAC treats what used to be 'simple' incremental and snapshot multicasts as 'multi-context' incremental and snapshot multicasts, and creates a new 'virtual' incremental/snapshot multicast for each sending context. These virtual multicasts are created on the fly as new sending contexts appear. Specific fields available on each multicast are retrievable using `GMACStatsMulticast()` to support virtual multicasts: **GMACStats** has IsMultiContext flag, and a MultiContextRef field which is the MulticastID of the parent multi-context channel if applicable.

   For each MulticastID in the table created in step 3, call `GMACGetObjProps()` and `GMACStatsMulticast()`. This allows to augment the mapping table with details of which multicasts are live and which are snapshots, localChannelIDs (used with `GMACMulticastBuffer()` and `GMACMulticastSync()`), which single-context multicasts point to which multi-context ones, etc.

5. When a snapshot is needed (i.e. when a gap is detected in the product sequence number for a product), iterate through the table from step 4 and do the following for each entry which has Type = GMAC_MULTICAST_TYPE_LIVE:

   a. Call `GMACMulticastBuffer()` for the multi-context multicasts (the call will propagate to children virtual multicasts): GMAC will start to buffer all virtual channels on that multi-context. The possible new channels will automatically inherit the settings from the multi-context channel.

   b. Call `GMACCommand()` to enable the snapshot channels with the LocalChannelID (the call will propagate to children virtual multicasts): GMAC will enable all virtual snapshot channels on that multi-context. The possible new channels will automatically inherit the settings from the multi-context channel.

   c. From the data received on the appropriate snapshot multicast, store GMACMessageSnapshotUpdateV3::SymbolSyncSequence for each instrument and keep doing so until a given instrument is seen twice (indicating that a complete cycle was seen).

   d. Call `GMACMulticastSync()` with the current multi-context MulticastID (the call will propagate to children virtual multicasts), and with Sequence = 0, to cause GMAC to release all the buffered packets (from step 5.a). In the released data, discard messages that are older than the SymbolSyncSequence from step 5.c (on a per-symbol basis) and process the rest as normal.

   e. Call `GMACCommand()` as in step 5.b to disable the snapshot channel.

Note that as per step 5, the decision as to whether a snapshot is needed should be based on seeing a gap in the product sequence number related to a product i.e. a snapshot should not be triggered any time that GMAC returns GMAC_STATUS_RECOVERY_FAILED as more than necessary snapshot cycles will be performed.

6.2.2 Other Markets

Note:

This Level 0 Snapshot Guide is solely valid for plugins other than XETRA (Xetra EBS feed) and EMDI (T7 Eurex / Xetra EMDI feeds).

When a snapshot is needed i.e. when a gap is detected in the symbol sequence number for a symbol:

a. Start to buffer all messages related to that symbol

b. Call `GMACCommand()` with the LocalChannelID to enable the snapshot channel

c. From the data received on the appropriate snapshot multicast, store GMACMessageSnapshotUpdateV3::SymbolSyncSequence for the symbol for which the snapshot was needed. Process the snapshot messages for that symbol.

d. From the buffered data, discard messages that are older than the SymbolSyncSequence from step c and process the rest as normal

e. Call `GMACCommand()` as in step b to disable the snapshot channel

6.3 Level 1 Snapshot Support Functions

6.3.1 GMACMulticastRefreshRequest()

Description Depending on the RefreshRequest in `GMACRefreshHandle`, this function is used to:

1. Enable a refresh channel
2. Reload live reference data in order to cater for intra-day instrument additions

Prototype
```
GMACStatus GMACMulticastRefreshRequest(GMACHandle *GMACH, GMACRefreshHandle *GRH)
```

Arguments		
	`GMACH`	GMAC handle
	`GRH`	GMAC refresh handle

6.3.2 GMACMulticastRefreshComplete()

Description Disables a refresh channel.

Prototype
```
GMACStatus GMACMulticastRefreshComplete(GMACHandle *GMACH, GMACRefreshHandle *GRH)
```

Arguments		
	`GMACH`	GMAC handle
	`GRH`	GMAC refresh handle

6.4 Level 1 Snapshot Guide

1. The live multicast where the user wants to emit the refresh has to be identified. The user needs to maintain structures to keep information related to the live multicast and its corresponding multicast.

   There is a need to receive at least one GMAC packet on that multicast.

   The Header is the GMACPacketHeader associated with this packet:

   LiveMID = Header->MulticastID;

   Then the user needs to begin the buffering of the data on that multicast:

   GMACMulticastBuffer(GMACH, LiveMID);

2. The user populates GMACRefreshHandle with the live multicast and emits the Refresh snapshot request:

   GMACRefreshHandle GRH;

   memset(&GRH, 0, sizeof(GRH));

   GRH.MulticastID = LiveMID;

   GRH.Sequence = SEQUENCE_UNDEFINED;

   GRH.InstrumentID[0] = '\0';

   GMACMulticastRefreshRequest(GMACH, &GRH);

Where applicable, the instrument ID needs to be populated with the instrument requiring refresh. This is the case where, snapshot refresh is only offered per requested instrument by the exchange. This can be obtained from reference messages or the market data messages themselves.

Example:

strcpy(GRH.InstrumentID, "#001000");

3. Identify and Process Snapshot messages for the live multicast for which Refresh Request was emitted in step #2.

4. Call RefreshComplete when snapshot is finished. Each exchange emits a specific GMAC message to mark the end of snapshot.

   GMACMulticastRefreshComplete(GMACH, &GRH);

5. The last snapshot message should give you a live sequence (live_sequence) to sync. Use (live_sequence+1) to synchronise the live multicast i.e. un-buffer the multicast from step #1. All the packets older than the synchronisation point are automatically dropped by GMAC.

   GMACMulticastSync(GMACH, LiveMID, SnapshotData->SyncSequence);

6. The request is completed.

6.5 Level 2 Snapshot Description

Note:

The snapshot Level 2 feature will be removed shortly. It is strongly recommended to use the snapshot Level 1 instead.

The level L2 snapshot support is based on the request/process basis per live multicast. The request is always associated with some multicast. Also there can be only one pending request per multicast.

The live multicast is a multicast which is of type GMAC_MULTICAST_TYPE_LIVE. It usually contains just incremental live data. This does not mean that the live multicast cannot contain snapshot data.

The user is required to put a snapshot request by using `GMACMulticastSnapshotRequest()` on the live multicast and then make the data from the GMAC queue available to `GMACMulticastSnapshotProcess()`.

On some markets there are multiple live multicasts. If possible GMAC tries to make the snapshot requests independent on different live multicasts on the same market. However this is not always possible; therefore the user must be aware that the request on the live multicast might be rejected in the beginning if there is already a pending request from the past on some other live multicast on the same market. For instance on the markets ICE and Euronext Derivatives XDP it is not possible to have simultaneous request on different live multicasts.

The timeout mechanism of the snapshot request is co-operated internally using the scheduler thread. Therefore it is secured that the timeout occurs also if no data comes from the network at all.

6.6 Level 2 Snapshot Support Functions

Note:

The snapshot Level 2 feature will be removed shortly. It is strongly recommended to use the snapshot Level 1 instead.

6.6.1 GMACMulticastSnapshotRequest() ** Deprecated **

Description When the user is interested to receive a snapshot for certain live multicast he can emit such a snapshot request with this function. The LiveSequence number is the last packet sequence number seen on the live multicast at the time of the request. The snapshot request is completed when the `GMACMulticastSnapshotProcess()` function returns CycleComplete

flag set.

Prototype `GMACStatus GMACMulticastSnapshotRequest(GMACHandle *GMACH, GMACMulticastID MulticastID, GMACLocalName Symbol, uint64_t LiveSequence, uint32_t TimeoutSec)`

Arguments

`GMACH`	GMAC handle
`MulticastID`	The live multicast ID for which a snapshot is needed
`Symbol`	The name of the instrument of interest, or “” (meaning ’all instruments’). Note that currently per-instrument snapshots are not supported so “” (or GMAC_SNAPSHOT_ALL_SYMBOLS) must be used here.
`LiveSequence`	The last packet sequence number seen on the multicast in question. The snapshot mechanism uses this to ensure that it only processes fresh updates and discards stale ones.
`TimeoutSec`	Timeout in seconds, after which the snapshot mechanism should give up waiting for snapshot data. This is useful for feeds where snapshots are requested over TCP but received over UDP, where a failure to receive requested data may not be accompanied by a useful error/rejection code. This timeout should be chosen carefully depending on the market; for example snapshot refresh updates for lightly-traded instruments on ICE can take 2minutes.

6.6.2 GMACMulticastSnapshotProcess() ** Deprecated **

Description When the user has at least one pending snapshot request he can start processing the received data from `GMACQueueRead()` with this function. If there is no pending snapshot this function has no effect.

When the `GMACMulticastSnapshotProcess()` returns the status GMAC_STATUS_OK the user needs to process the `SnapshotData` structure returned. First of all the user needs to process all the messages in the Messages[]. After that the user needs to check the CycleComplete flag. If the flag is set the user can determine the result of the snapshot request in the CycleStatus field.

Prototype `GMACStatus GMACMulticastSnapshotProcess(GMACHandle *GMACH, GMACPacketHeader *Header, GMACSnapshotData **SnapshotData)`

Arguments

`GMACH`	GMAC handle
`Header`	GMAC packet header
`SnapshotData`	Returned snapshot data

6.7 Level 2 Snapshot Request Guide

Note:

The snapshot Level 2 feature will be removed shortly. It is strongly recommended to use the snapshot Level 1 instead.

1. The live multicast where the user wants to emit the refresh has to be identified. There is a need to receive at least one GMAC packet on that multicast.

   The Header is the GMACPacketHeader associated with this packet:

   LiveMID = Header->MulticastID;

   Then the user needs to begin the buffering of the data on that multicast:

   GMACMulticastBuffer(GMACH, LiveMID);

2. The user emits the snapshot request:

   GMACMulticastSnapshotRequest(GMACH, LiveMID,
   GMAC_SNAPSHOT_ALL_SYMBOLS, /* LiveSequence */ Header->Sequence, /*
   Snapshot request timeout in seconds */ 300);

   For instance the common timeout for ICE market is ~ 2 minutes.

3. The data received from `GMACQueueRead()` or `GMACQueuePoll()` is always passed to the process function:

   GMACMulticastSnapshotProcess(GMACH, ReceivedHeader, &SnapshotData);

   The status code is returned.

4. When the status code is set to GMAC_STATUS_OK the user examines the SnapshotData structure. First of all the snapshot messages selected by the processing function has to be processed. Afterwards the CycleComplete flag has to be checked for request completion. Once the request is completed the user determines the resulting state of the snapshot request in the CycleStatus field.

5. Once the request is complete and successful the user gets SyncSequence. This sequence number is used to synchronise the live multicast i.e. un-buffer the multicast from step #1. All the packets older than the synchronisation point are automatically dropped by GMAC.

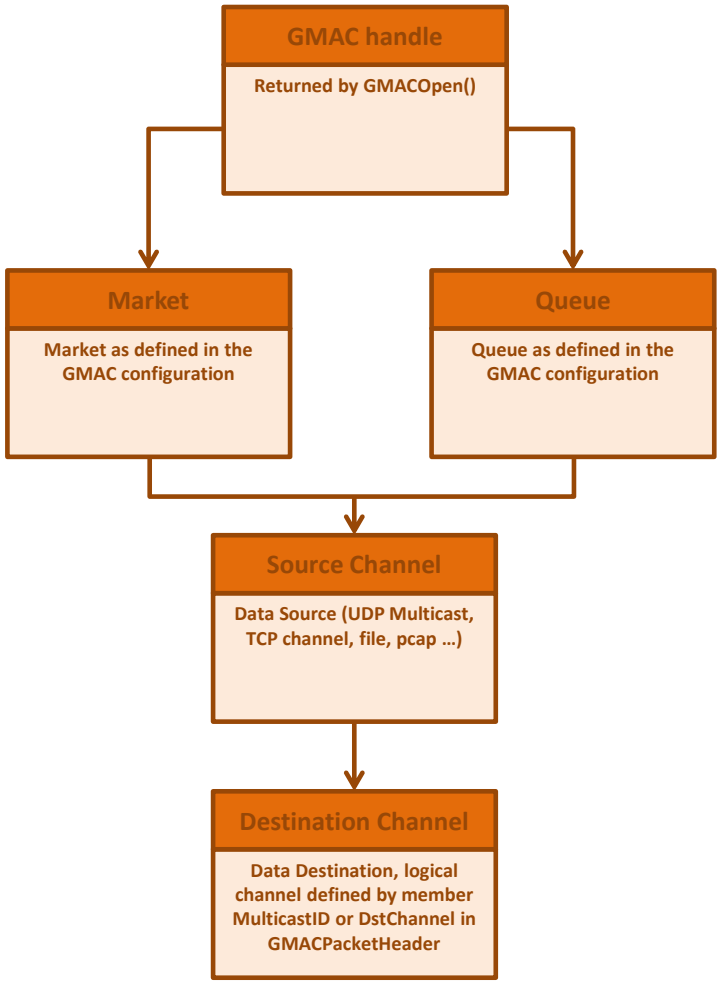
   GMACMulticastSync(GMACH, LiveMID, SnapshotData->SyncSequence);

6. The request is completed.

7. Data Retrieval

7.1 Description

The data, which is exposed to the user, is hereafter depicted:



Each object, Market, Queue, Source Channel and Source Destination is defined by an ID and a Type.

The user is able to count, enumerate and retrieve properties of an object using the following generic methods.

See example gmac_interactive to get used to the data retrieval methods.

7.2 Functions

The header file gmac_info.h contains the following methods.

7.2.1 GMACGetObjCount()

Description Retrieves the number of objects.

The call returns GMAC_STATUS_OK when successful, GMAC_STATUS_PARAM_ERROR otherwise.

Prototype

```
GMACStatus GMACGetObjCount(GMACHandle* handle, const GMACObjType parentType, const GMACObjID parentId, const GMACObjType typeToCount, uint32_t* count)
```

Arguments

`handle`	GMAC handle, returned by `GMACOpen()` or `GMACInit()`
`parentType`	Type of the parent object which contains the object the user wants to count
`parentId`	ID of the parent object which contains the object the user wants to count
`typeToCount`	Type of object the user wants to count
`count`	Number of objects returned if the call is successful

Example If the user requests the number of source channels for a market where id = 3:

```
GMACGetObjCount(handle, GMAC_OBJ_MARKET, 3,
GMAC_OBJ_SRC_CHANNEL, &count)
```

7.2.2 GMACGetObjList()

Description Retrieves the list of IDs of objects.

The call returns GMAC_STATUS_OK when successful, GMAC_STATUS_PARAM_ERROR otherwise.

Prototype

```
GMACStatus GMACGetObjList(GMACHandle* handle, const
GMACObjType parentType, const GMACObjID parentId,
const GMACObjType typeToEnumerate, GMACObjID*
objectVector, uint32_t* countedObj, const size_t
objectVectorSize)
```

Arguments

`handle`	GMAC handle, returned by `GMACOpen()` or `GMACInit()`
`parentType`	Type of the parent object which contains the object the user wants to enumerate
`parentId`	ID of the parent object which contains the object the user wants to enumerate
`typeToEnumerate`	Type of object the user wants to enumerate
`objectVector`	IDs of object returned if the call is successful
`countedObj`	Number of returned IDs in `objectVector`
`objectVectorSize`	Reserved number of IDs of `objectVector`

Example If the user requests the IDs of source channels for a market where id = 3:

```
GMACObjID objVect[1024];
uint32_t count = 0;
GMACGetObjList(handle, GMAC_OBJ_MARKET, 3,
GMAC_OBJ_SRC_CHANNEL, objVect, &count, 1024);
```

7.2.3 GMACGetObjProps()

Description Retrieves properties of an object defined by its type and ID.

The output value is a pointer that depends on the asked property.

This is a sentinel function: this means the list of arguments should be ended with NULL.

The call returns GMAC_STATUS_OK when successful, GMAC_STATUS_PARAM_ERROR otherwise.

Prototype

```
GMACStatus GMACGetObjProps(GMACHandle* handle,
const GMACObjType objType, const GMACObjID objId,
GMACObjProp_t firstProp, ...)
```

Arguments

`handle`	GMAC handle, returned by `GMACOpen()` or `GMACInit()`
`objType`	Object type
`objId`	Object ID
`firstProp`	The first property to be retrieved from a list of properties terminated by NULL. See `GMACObjProp_t` for the full list of available property types.

Example #1 If the user requests the market properties ID and name of a given source channel `SrcChannel`:

```
GMACGetObjProps(GMACH, GMAC_OBJ_SRC_CHANNEL,
SrcChannel, GMAC_PROP_MARKET_ID, &id,
GMAC_PROP_MARKET_NAME, NamePtr, NULL)
```

Example #2 If the user requests the functional type of a given source channel `SrcChannel`:

```
GMACGetObjProps(GMACH, GMAC_OBJ_SRC_CHANNEL,
SrcChannel, GMAC_PROP_SRC_CHANNEL_FUNCTIONAL_TYPE,
&type, NULL)
```

See GMACChannelFunctionalType_t for the full list of available channel functional types.

Example: The returned value `&type` will be a bitmask with SRC_CHANNEL_LIVE and SRC_CHANNEL_MBP set if the source channel is a live market by price channel.

Example #3 If the user requests the paired channel of a given source channel `SrcChannel`:

```
GMACGetObjProps(GMACH, GMAC_OBJ_SRC_CHANNEL,
SrcChannel, GMAC_PROP_SRC_ARB_LINKED_CHANNEL_ID,
&id, NULL)
```

The return value will be GMAC_UNDEF_OBJ_ID if there is no arbitrage.

Example: if there is an A/B arbitrage source channel A (id = 3), source channel B (id = 4), the return value `&id` will be 4.

8. Format

See the header files for more details (macros etc).

8.1 Enumerations

The following table provides the possible values for some GMAC lists:

Enumeration	Values	Description
GMACTradingStatus	**TSTATUS_UNKNOWN**	Unknown or invalid
	TSTATUS_CLOSE	Closed
	TSTATUS_SUSPEND	Suspended or halted
	TSTATUS_QUOTE	Quotation only
	TSTATUS_EXTEND	Extended market hours
	TSTATUS_OPEN	Open
GMACMulticastType	**GMAC_MULTICAST_TYPE_UNKNOWN**	Unknown multicast type
	GMAC_MULTICAST_TYPE_LIVE	Live multicast type
	GMAC_MULTICAST_TYPE_SNAPSHOT	Snapshot multicast type
	GMAC_MULTICAST_TYPE_DATAREF	Referential data multicast type
	GMAC_MULTICAST_TYPE_REREQUEST	Data re-request multicast type
GMACStatus	**GMAC_STATUS_OK**	Success
	GMAC_STATUS_INIT_ERROR	Initialization error
	GMAC_STATUS_CONTROL	Control data return
	GMAC_STATUS_USER_BUFFERING	Data are being buffered on user request i.e in response to a call to `GMACMulticastBuffer()`. The data pointer is set to last packet received.

Enumeration	Values	Description
	GMAC_STATUS_CORE_BUFFERING	GMAC core is buffering data within the recovery mechanism to fill the gaps due to a higher than expected sequence having been received. In such a situation GMAC may be in the process of re-requesting missed sequences.
	GMAC_STATUS_PARAM_ERROR	Parameter error
	GMAC_STATUS_CONFIG_ERROR	Configuration file error
	GMAC_STATUS_PARTIALLY_INITIALIZED	Partially initialised
	GMAC_STATUS_NOT_IMPLEMENTED	Not implemented
	GMAC_STATUS_CONNECTION_ERROR	Connection error
	GMAC_STATUS_PAYLOAD_ERROR	Payload error
	GMAC_STATUS_RUNTIME_ERROR	Runtime error
	GMAC_STATUS_RELEASE_FIRST	GMAC is waiting for `GMACQueueRelease()` to be called
	GMAC_STATUS_RECOVERY_FAILED	Recovery failed on the channel specified in the packet header
	GMAC_STATUS_NOT_FOUND	Market name translation is not possible
	GMAC_STATUS_BUFFER_FULL	Buffer pool for the queue reached the limit in the configuration file. All data is discarded in the reorder/recovery buffers and all corresponding channel expected sequence numbers are set to SEQUENCE_UNDEFINED.
	GMAC_STATUS_RECONNECT	Returned by GMAC when the TCP connection has been lost. Also informing user that a new connection is in asynchronous opening state. When the connection becomes available the GMAC will start to decode and provide market data. If the GMAC is unable to successfully create a new connection within the timeout the GMAC will return this code again.
	GMAC_STATUS_NO_CHANNELS	ADE reports no multicasts in queue for `GMACQueueRead()` or `GMACQueuePoll()`
	GMAC_STATUS_NODATA	No data
	GMAC_STATUS_ADE_ERROR	ADE error

Enumeration	Values	Description
	GMAC_STATUS_MULTICAST_OPEN_ERROR	Error related to the opening of a multicast
	GMAC_STATUS_PACKET_DROPPED	Returned by GMAC when using lldt2 plugin (i.e. with shared-pipeline firmwares) and when the plugin drops packets because the queue is full
	GMAC_STATUS_MALLOC_ERROR	Should never happen, however it signals that GMAC failed to do malloc() call
	GMAC_STATUS_PARTIAL	Never returned to user, although used internally for signalling while hardware filtering is on
	GMAC_STATUS_NOLINK	ADE (layer below GMAC) signals there is missing link signal on at least of one connected ethernet interfaces
GMACSnapshotStatus	**GMAC_SNAPSHOT_OK**	Success
	GMAC_SNAPSHOT_TIMEOUT	Snapshot has timed out
	GMAC_SNAPSHOT_NOT_FOUND	The requested instrument was not found
	GMAC_SNAPSHOT_CYCLE_GAP	There was a gap in the snapshot message cycle
	GMAC_SNAPSHOT_MESSAGES_LIMIT_REACHED	Internal limit of messages reached
GMACFilteringMode	**GMAC_FILTERING_NOT_SUPPORTED**	Filtering is not supported on the market
	GMAC_FILTERING_NOT_ENABLED	Filtering is not enabled
	GMAC_FILTERING_SYMBOL	Filtering is enabled and symbol names need to be provided
	GMAC_FILTERING_INDEX	Filtering is enabled and indexes need to be provided
GMACArbType	**GMAC_ARB_NONE**	No arbitration
	GMAC_ARB_REDUNDANCY	Redundancy arbitration
	GMAC_ARB_SW	Software arbitration
GMACRefreshRequest	**GMAC_REFRESH_REQUEST_DEFAULT**	Instrument snapshot request
	GMAC_REFRESH_REQUEST_SEGMENT	Segment snapshot request
	GMAC_REFRESH_REQUEST_RELOAD_REFERENCE_DATA	Reference data reload when the reference data is stored as a file directly

Enumeration	Values	Description
		downloaded from the exchange using the configuration tag <symbol-ref-file>
	GMAC_REFRESH_REQUEST_RELOAD_PCAP_REFERENCE_DATA	Reference data reload when the reference data is stored as a user-defined pcap file using the Celoxica Market Referential Download Tool
GMACRefreshType	**GMAC_REFRESH_TYPE_DEFAULT**	Order book is requested
	GMAC_REFRESH_TYPE_SYMBOL_STATUS	Trading status is requested
	GMAC_REFRESH_TYPE_INSTRUMENT	Active instruments are requested
	GMAC_REFRESH_TYPE_TRADES	Missed trades are requested
	GMAC_REFRESH_TYPE_STATISTICS	Statistics are requested
	GMAC_REFRESH_TYPE_ANNOUNCEMENTS	Announcements are requested
	GMAC_REFRESH_TYPE_AUCTION_INFORMATION	Auction information is requested
	GMAC_REFRESH_TYPE_DAILY_SCHEDULE	Daily schedule is requested
GMACObjType	**GMAC_OBJ_ROOT**	GMAC Handle parent of all objects
	GMAC_OBJ_MARKET	Object market
	GMAC_OBJ_QUEUE	Object queue
	GMAC_OBJ_SRC_CHANNEL	Object data source: UDP multicast, TCP channel, referential file …
	GMAC_OBJ_DST_CHANNEL	Object data destination: GMAC output logical channel
GMACObjProp_t	**GMAC_PROP_MARKET_ID**	Market ID
	GMAC_PROP_MARKET_NAME	Market name
	GMAC_PROP_MARKET_PLUGIN_NAME	Plugin name
	GMAC_PROP_MARKET_TRANSCODING_TYPE	Market transcoding type
	GMAC_PROP_QUEUE_ID	Queue ID
	GMAC_PROP_SRC_CHANNEL_ID	Source channel ID

Enumeration	Values	Description
	GMAC_PROP_SRC_CHANNEL_CONFIG_ID	Channel ID
	GMAC_PROP_SRC_CHANNEL_FUNCTIONAL_TYPE	Channel functional type (live, snapshot, referential, retransmission, MBP, MBO …). This is a bit mask of GMACChannelFunctionalType_t.
	GMAC_PROP_SRC_CHANNEL_ARBITRAGE	Arbitrage type
	GMAC_PROP_SRC_CHANNEL_INETIP_ADDR	Channel IP inet address
	GMAC_PROP_SRC_CHANNEL_IP_ADDR	Channel IP
	GMAC_PROP_SRC_CHANNEL_PORT	Channel port
	GMAC_PROP_SRC_CHANNEL_PLUGIN_TYPE	Channel plugin type (lldt, socket …)
	GMAC_PROP_SRC_ARB_LINKED_CHANNEL_ID	Source paired channel ID
	GMAC_PROP_DST_CHANNEL_ID	Destination channel ID
	GMAC_PROP_STOP	Sentinel value to determine that a property is not valid or not found
	GMAC_PROP_MARKET_FILTERING_MODE	Market filtering mode
GMACChannelFunctionalType_t	**SRC_CHANNEL_UNDEF**	The source channel is undefined
	SRC_CHANNEL_LIVE	The source channel is a live channel
	SRC_CHANNEL_SNAP	The source channel is a snapshot channel
	SRC_CHANNEL_REFERENTIAL	The source channel is a referential channel
	SRC_CHANNEL_RETRANSMISSION	The source channel is a retransmission channel
	SRC_CHANNEL_MBP	The source channel is a Market By Price ‘MBP’ channel
	SRC_CHANNEL_MBO	The source channel is a Market By Order ‘MBO’ channel
GMACCommandType	**GMAC_COMMAND_INVALID**	Invalid command
	GMAC_COMMAND_SWITCH	Enables / disables an object
	GMAC_COMMAND_REFRESH	Requests a refresh

Enumeration	Values	Description
	GMAC_COMMAND_REFRESH_STOP	Stops a refresh
	GMAC_COMMAND_FILTER_ADD	Adds a symbol name or symbol index to the list of symbols to be filtered
	GMAC_COMMAND_FILTER_SWITCH	Enables / disables symbol filtering
GMACRefreshSubjectType_t	**GMAC_REFRESH_SUBJECT_TYPE_DICT**	The refresh request relates to instruments directory
	GMAC_REFRESH_SUBJECT_TYPE_INST	The refresh request relates to a particular instrument
	GMAC_REFRESH_SUBJECT_TYPE_BOOK	The refresh request relates to order books
	GMAC_REFRESH_SUBJECT_TYPE_STATUS	The refresh request relates to statuses e.g. instrument trading status
	GMAC_REFRESH_SUBJECT_TYPE_TRADE	The refresh request relates to trades
	GMAC_REFRESH_SUBJECT_TYPE_STATS	The refresh request relates to statistics
	GMAC_REFRESH_SUBJECT_TYPE_AUCTION	The refresh request relates to auctions
	GMAC_REFRESH_SUBJECT_TYPE_ANNOUNCE	The refresh request relates to exchange announcements
	GMAC_REFRESH_SUBJECT_TYPE_CHANNEL	The refresh request relates to a channel

8.2 Data Structures

8.2.1 Packet Header

Description The packet header is prefixed to the data returned by `GMACQueueRead()` or `GMACQueuePoll()`. It contains information about data as follows:

- Messages and Sequence can be used to detect gaps in the incoming data

Note:

> GMAC generates data without gaps if the recovery feature is enabled

- TranscodedMessages and/or Length can be used to determine how many normalised messages there are
- MulticastID gives information about which multicast the data come from

Heartbeats can be identified as follows:

- Messages is always set to 0
- And if TranscodedMessages is set to 1, the first (and only) message will not be a Multicast Timeout message (type GMAC_TYPE_MULTICAST_TIMEOUT)

Structure **GMACPacketHeader**

The structure description is as follows:

Field	Type	Description
MulticastID	GMACMulticastID	Multicast ID (old member) If present, DstChannel will not be present (union between the two members)
DstChannel	GMACChannelID	Destination channel (new member) i.e. the data logical destination If present, MulticastID will not be present (union between the two members)
OrigMulticastID	GMACMulticastID	Original Multicast ID (old member)

Field	Type	Description
		Set when packet was redirected from another Multicast ID. Sometimes used for recovery. OrigMulticastID is always initialised to -1 and is never updated for packets generated from reference data files. If present, SrcChannel will not be present (union between the two members)
SrcChannel	GMACChannelID	Source channel (new member) i.e. the data source (UDP Multicast, TCP channel, file, pcap …) If present, OrigMulticastID will not be present (union between the two members)
HWTimestamp	unit64_t	Time stamp expressed in nanoseconds from HW clock, taken when the last byte arrives from the wire
HWTimestampValid	unit8_t	Set to 1 when HWTimestamp is valid, otherwise set to 0. Some messages do not have HWTimestamp, e.g. when the message was received from the recovery server.
Live	unit8_t	Flags whether a packet originates from a live interface and has been delivered directly and without buffering. This flag would be set to 0 for buffered packets (e.g. packets waiting for a retransmission or a snapshot/refresh cycle), or for packets received as a response to a retransmission or snapshot/refresh request.
Tainted	unit8_t	Set to 1 when the GMAC core passes a gap to the user. Remains set until the multicast is closed.
TranscodingType	unit8_t	Encoding type used for this feed, see `GMACChannelGetTranscodingType()`
Messages	unit32_t	Original number of messages in the packet (for next packet sequence checking)
TranscodedMessages	unit32_t	Number of normalised messages
Length	unit32_t	Total length of the data including this header
Sequence	unit64_t	Original sequence number of the first message in the packet
NextSequence	unit64_t	The next expected sequence number
RawExchangeChannelID	unit64_t	Actual identifier for this multicast provided by the exchange. Initialised with -1.
PacketEmissionTime	unit64_t	Exchange gateway packet emission time in nanoseconds since midnight

8.2.2 Refresh Handle

Description This handle represents a refresh channel request.

Note:

> The MulticastID is for the live incremental channel associated with the snapshot/refresh channel and NOT the refresh channel itself.

Structure **GMACRefreshHandle**

The structure description is as follows:

Field	Type	Description
MulticastID	GMACMulticastID	Multicast ID
InstrumentID	GMACLocalName	Instrument name in the format used by the feed. It can be a segment or a sector name as well. If less than GMAC_LOCAL_NAME_LENGTH characters, C-standard zero byte is used at the end (null terminated string).
Sequence	uint64_t	Sequence number when applicable
RefreshRequest	GMACRefreshRequest	Request type (either snapshot request or reference data reload) when applicable
RefreshType	GMACRefreshType	Refresh type when applicable

8.2.3 Default Market Status

Description Default status values for Market, Sector, Segment, Channel and Instrument. A client can use these as the initial values until they are known. Values for Sector, Segment and Channel are 'Open' where these levels are not used.

It is returned by `GMACGetDefaultStatus()`.

Structure **GMACDefaultMarketStatus**

The structure description is as follows:

Field	Type	Description
MarketStatus	GMACTradingStatus	Default (initial) status for the Market
SectorStatus	GMACTradingStatus	Default (initial) status for each Sector
SegmentStatus	GMACTradingStatus	Default (initial) status for each Segment
ChannelStatus	GMACTradingStatus	Default (initial) status for each Channel
InstrumentStatus	GMACTradingStatus	Default (initial) status for each Instrument

8.2.4 Dynamic Multicast Descriptor

Description The GMAC Dynamic Multicast Descriptor is used to hold several values for a multicast to be opened dynamically (after the GMAC Queue has been opened).

It is used by `GMACOpenMulticast()`.

It is initialised to default values by `GMACInitDynamicMcDesc()`.

Structure **GMACDynamicMcDesc**

The structure description is as follows:

Field	Type	Description
OriginalChar	char	Arbitrage 'A' Line A 'B' Line B '-' Default
OriginalArbMode	GMACArbType	Arbitrage mode
Type	GMACMulticastType	Multicast type Default is GMAC_MULTICAST_TYPE_LIVE

Field	Type	Description
Plugin	char	ADE plugin name Default is “lldt”
StartSeq	uint64_t	Initial sequence number Default is SEQUENCE_UNDEFINED

8.2.5 Snapshot Data

Note:

The snapshot Level 2 feature will be removed shortly. It is strongly recommended to use the snapshot Level 1 instead.

Description This structure encapsulates GMAC packet data to return matched snapshot data.

It is used by `GMACMulticastSnapshotProcess()`.

Structure **GMACSnapshotData**

The structure description is as follows:

Field	Type	Description
Header	GMACPacketHeader	Pointer to the GMAC packet header passed to the `GMACMulticastSnapshotProcess()`
MessageCount	int	Size of the Messages[] array returned in this structure
CycleComplete	int	When set the user request has been completed. The resulting status of the user request has to be determined from the field CycleStatus.
SyncSequence	uint64_t	It is valid only when the CycleComplete field is set and the CycleStatus is set to GMAC_SNAPSHOT_OK. This is a packet synchronisation sequence number for the live multicast. Please note that for some feeds this is in fact a minimum synchronisation sequence number across all the snapshot messages associated with the request. This number can be directly used in the `GMACMulticastSync()`. However the user needs to monitor GMACMessageSnapshotUpdateV3.LastMsgSeqNum for the instrument synchronisation. This number might be the same or different. On some markets this number varies across the instrument list for the snapshot request.

Field	Type	Description
		Note that the SyncSequence sequence number is always higher than or equal to LiveSequence + 1 in the user snapshot request.
CycleStatus	GMACSnapshotStatus	GMAC_SNAPSHOT_OK The snapshot request has been successful GMAC_SNAPSHOT_TIMEOUT The user defined timeout has expired GMAC_SNAPSHOT_CYCLE_GAP There was a gap detected in the snapshot cycle GMAC_SNAPSHOT_NOT_FOUND The specified LiveSequence sequence number in the user request is too new (high), i.e. the snapshot message just received has the synchronisation sequence number lower than or equal to the LiveSequence number. The user is expected to repeat the request with the same LiveSequence number. GMAC_SNAPSHOT_MESSAGES_LIMIT_REACHED The number of messages in the snapshot exceeds the size reserved for Messages[]. In such a case, CycleComplete will be set, but the user will need to consider the snapshot as incomplete as overflowed messages won't be part of Messages[].
***Messages[]**	GMACMessageHeader	The array of pointers to all the messages associated with the user request. Currently there is no support for per-instrument requests. Therefore the Messages[] are always pointing to all the messages in the GMAC packet. This array has an internal hard limit.

8.2.6 Multicast Mapping

Note:

This will be removed shortly and replaced by new data retrieval methods, see Data Retrieval for details.

Description It is returned by `GMACGetMulticastMappingTable()`.

Structure **GMACMulticastMapping**

The structure description is as follows:

Field	Type	Description
MappingTableSize	uint32_t	Size of the mapping table in bytes
Count	uint32_t	Number of nodes populated
MappingTable[]	GMACMulticastMappingNode	Table where the multicast map will be stored

8.2.7 Multicast Mapping Node

Note:

This will be removed shortly and replaced by new data retrieval methods, see Data Retrieval for details.

Description This is the format of the mapping table returned by `GMACGetMulticastMappingTable()`.

Structure **GMACMulticastMappingNode**

The structure description is as follows:

Field	Type	Description
MulticastID	GMACMulticastID	Multicast ID
ChannelID	GMACChannelID	Channel ID
IP	uint32_t	IP address of the multicast ID
Port	uint16_t	Port for the multicast ID
Plugin	char [32]	The Plugin used by the multicast ID

8.2.8 Stats

Description It is returned by `GMACStatsMulticast()`, `GMACStatsChannel()`, `GMACStatsQueueGlobal()` and `GMACStatsDump()`.

Structure GMACStats

The structure description is as follows:

Field	Type	Description
MulticastID	GMACMulticastID	Multicast ID
RedirectedToID	GMACMulticastID	Set to ~0 for no redirection. Otherwise the destination multicast ID
MultiContextRef	GMACMulticastID	Set to originating multi-context multicast. See section 6.2 for more details. Otherwise set to ~0.
Type	GMACMulticastType	Multicast type
Buffered	int	Set to 1 when the multicast is currently being buffered. Otherwise set to 0.
Disabled	int	Set to 1 when the multicast is disabled. Otherwise set to 0.
IgnoreGaps	int	Set to 1 when the multicast is ignoring gaps. Not used for plugins where `<max-channel-buffer>` is configured. Otherwise set to 0.
IsMultiContext	int	Set to 1 when the multicast has multiple sequence number contexts (multi-context channel). See section 6.2 for more details. Otherwise set to 0.
ChannelID	GMACChannelID	Channel ID
LocalChannelID	int	Channel ID number private for GMAC plug-in, as defined in the GMAC configuration file
LocalChannelChar	char	Set to 'A' or 'B' when arbitration is enabled. Otherwise ' ' or '-'
ADEPlugin	const char	Name of plugin, points back to Multicast Available values are file, socket, lldt, clxng and clxng_shared. See the GMAC configuration guide for details.
Tainted	int	Set to non-zero value when the GMAC detected any gap or problem in the data (this flag has unspecified behavior)

Field	Type	Description
FilteringModuleInUse	int	Set to non-zero when filtering is enabled in the configuration file and is supported by the plugin
FilteringEnabled	int	Set to non-zero when filtering is enabled for the channel and is running
PacketsReceivedTotal	uint64_t	Number of packets received by GMAC on its inputs
PacketsReceivedADE	uint64_t	Number of packets received by GMAC from ADE
PacketsReceivedTimeout	uint64_t	Number of packets generated by GMAC as timeouts
PacketsReceivedRedirected	uint64_t	Number of packets redirected to a different multicast
PacketsDelivered	uint64_t	Number of packets delivered by GMAC to user
PacketsInReorderQueue	uint64_t	Number of packets stored currently in GMAC reorder queue
PacketsReceivedControl	uint64_t	Number of packets received from the control queue
GapsDetected	uint64_t	Number of gaps GMAC detected after the timeout for reordering expired
GapsPassed	uint64_t	Number of gaps GMAC passed to the user
PacketsDroppedPayloadError	uint64_t	Number of packets which couldn't be normalised
PacketsDroppedInTranscoder	uint64_t	Number of packets dropped by the GMAC plug-in (probably because the sequence number would confuse)
PacketsDroppedSimulated	uint64_t	Number of packets GMAC dropped intentionally on user request
PacketsDroppedAsDuplicates	uint64_t	Number of packets received with lower sequence number than expected
PacketsDroppedInReorderQueue	uint64_t	Number of packets dropped from the reorder queue (reset, buffer full, sync, duplicate, strange sequence)
ExpectedSequenceNumber	uint64_t	Expected sequence number
***RawPacketStats**	ADEStats	Statistics gathered by low level input library

8.2.9 ADE Statistics

Description ADE statistics

Structure **ADEStats**

The structure description is as follows:

Field	Type	Description
BytesRead	uint64_t	Total bytes read on the channel
PacketsRead	uint64_t	Total packets read ion the channel
BytesWritten	uint64_t	Total bytes written on the channel
PacketsWritten	uint64_t	Total packets written on the channel

8.2.10 GMAC Command

Description Structure used to submit a command to GMAC

Structure **GMACCommandStruct**

The structure description is as follows:

Field	Type	Description
commandType	GMACCommandType	Command type
objType	GMACObjType	Object type, see section 7 for details about objects handled by GMAC
objID	GMACObjID	Object ID, see section 7 for details about objects handled by GMAC
commandParamSize	size_t	The size of command parameters structure
commandParams[]	char	The command parameters. See below for details on the structures used to convey the command parameters.

8.2.10.1 Enabling / Disabling an object

Description Structure used to enable / disable an object

Structure **GMACSwitchParam**

The structure description is as follows:

Field	Type	Description
Activate	Bool	Boolean to enable / disable an object

8.2.10.2 Refreshing / Stop Refreshing Data

Description Structure used to request a data refresh / stop a data refresh

Structure **GMACRefreshParam**

The structure description is as follows:

Field	Type	Description
PresenceMapAll	uint32_t	Presence map Fields indexed with “PM” e.g. **RefreshSubject**^{PM} are subject to the presence map: for a given field, set the presence map bit should the field be provided
RefreshSubjectType	GMACRefreshSubjectType_t	Refresh type
RefreshSubject^{PM}	char [32]	Field used to provide a data ID which format is char [32] depending on the refresh type e.g. an instrument ID when RefreshSubjectType = GMAC_REFRESH_SUBJECT_TYPE_INST
RefreshSubjectU64^{PM}	uint64_t	Field used to provide a data ID which format is uint64_t depending on the refresh type e.g. an instrument ID when RefreshSubjectType = GMAC_REFRESH_SUBJECT_TYPE_INST
RefreshSubjectU32^{PM}	uint32_t	Field used to provide a data ID which format is uint32_t depending on the refresh type e.g. an instrument ID when RefreshSubjectType = GMAC_REFRESH_SUBJECT_TYPE_INST
RefreshSubjectU16^{PM}	uint16_t	Field used to provide a data ID which format is uint16_t depending on the refresh type e.g. an instrument ID when RefreshSubjectType = GMAC_REFRESH_SUBJECT_TYPE_INST
RefreshSubjectU8^{PM}	uint8_t	Field used to provide a data ID which format is uint_8t depending on the refresh type e.g. an instrument ID when RefreshSubjectType = GMAC_REFRESH_SUBJECT_TYPE_INST
RefreshContext^{PM}	uint64_t	Field used to provide the refresh starting point (sequence number, timestamp ..) e.g. field Sequence Number in the LSE Group GTP Recovery Request

Field	Type	Description
RefreshDataType[PM]	char	Field used to provide the type of refreshed data to be returned e.g. field Order Book Type in the LSE Group GTP Recovery Request
RefreshCustomerID[PM]	uint64_t	Field used to provide a customer ID e.g. field Request ID in the LSE Group GTP Recovery Request

8.2.10.3 Adding a Symbol to the Symbol Filtering List

Description Structure used to add a symbol to the list of symbols to be filtered

Structure **GMACFilterAddParam**

The structure description is as follows:

Field	Type	Description
PresenceMapAll	uint32_t	Presence map Fields indexed with “PM” e.g. **Symbol**[PM] are subject to the presence map: for a given field, set the presence map bit should the field be provided
Symbol[PM]	char [32]	Field used to provide a symbol name which format is char [32]
SymbolU64[PM]	uint64_t	Field used to provide a symbol index which format is uint64_t
SymbolU32[PM]	uint32_t	Field used to provide a symbol index which format is uint32_t
SymbolU16[PM]	uint16_t	Field used to provide a symbol index which format is uint16_t
SymbolU8[PM]	uint8_t	Field used to provide a symbol index which format is uint_8t

8.3 Argument Types

The following table provides the argument types description:

Enumeration	Description
GMACHandle	Opaque structure
GMACMulticastID	uint32_t
GMACChannelID	uint32_t
GMACPriceFactor	Opaque structure
GMACErrorHandler	`GMACStatus (*GMACErrorHandler)(GMACHandle *GMACH, GMACStatus StatusCode, const char *Function, char *Msg)`
ADEErrorHandler	Opaque structure
Config	See the Configuration Parser API Reference Guide and the GMAC Configuration Guide.
GMACLocalName	char GMACLocalName [GMAC_LOCAL_NAME_LENGTH] Instrument name in the format used by the feed. If less than GMAC_LOCAL_NAME_LENGTH characters C-standard zero byte is used at the end (null terminated string)
GMACEISIN	char GMACEISIN [GMAC_EISIN_LENGTH] The GMAC "Extended ISIN" is a Celoxica-specific code and it provides a global naming scheme for instruments across all the supported markets. The codes are prefixed by 4 characters. The aim is to have a single type of identifier for the instruments, even if there is no real ISIN code.
GMACMessageHeader	See GMAC V1 Messages Specifications and GMAC V3 Messages Specifications
GMACMarketNames	Char GMACMarketNames [MAX_MARKETS] **Note:** This will be removed shortly and replaced by new data retrieval methods, see Data Retrieval for details.
GMACObjID	uint32_t

9. Shipped Examples

Every GMAC software release is shipped with an API Prototype example in /Examples/GMAC/example/ showing most of GMAC's functionality. 'Example' aims to be easy to understand and to illustrate the use of the GMAC API, and so is written with simplicity rather than speed in mind. Hence it uses operations that can degrade performance and that would therefore normally be avoided in production code, for instance locking and printing to the screen. It is possible to dynamically switch multiple modules on and off by changing the `AddModules()` function in example.c as appropriate.

9.1 Features

The example has a number of modules that can be switched on with command line options. These correspond to the distinct functional elements available in the API. To select the modules to enable, use –e followed by the appropriate module name:

1. '**-e dump**' enables the Dump module.
2. '**-e vwap**' enables the Vwap module.
3. '**-e snapshot**' enables the Snapshot module.
4. '**-e tob**' enables the Tob module.
5. '**-e sequencecheck**' enables the SequenceCheck module.
6. '**-e stats**' enables the Stats module.
7. '**-e index**' enables the Index module.
8. '**-e hwfiltering**' enables the HWFiltering module.

'Example' illustrates the use of multiple functional elements in GMAC including:

1. Basic initialization and reading of queue(s), error handling: example.c and error_handler.c
2. Printing normalised messages in text format: dump.c
3. Listing through messages and semantically using the data: vwap.c, tob.c and index.c
4. Following trades and computing VWAP (Volume-Weighted Average Price): vwap.c
5. Building an order book from GMAC messages: tob.c
6. Using snapshot refresh channels for mid-day start: index.c
7. Printing the symbol-to-index mapping extracted from the messages: index.c
8. Printing the statistics on the fly: example.c and statistics.c
9. Detection and reporting of gaps: statistics.c and sequence_check.c
10. Examining latency information on the fly: example.c
11. Hardware filtering: hwfiltering.c

9.2 Building the Example

To build the example:

1. If you haven't done so already, run 'copy_celoxica_examples' to copy the examples to your local directory
2. cd ~/celoxica-examples/GMAC/example/
3. To build the example simply run 'make'.

   This will build the example for all the feed adapters supported by your GMAC library.

9.3 Options

The example must be run with a set of command-line options, the minimum being '**-f <config file>**'.

Example configuration files for the supported markets are stored in directory ~/celoxica-examples/GMAC.

Refer to the ./example -h to get the available options.

The options for each module must follow the module name as shown:

./example [some general options] -e <module_name> [some module options] -e <module_name> [some module options] …