

# GT.M

## Release Notes

V6.3-014

## Contact Information

GT.M Group  
Fidelity National Information Services, Inc.  
200 Campus Drive  
Collegeville, PA 19426  
United States of America

GT.M Support for customers: [gtmsupport@fisglobal.com](mailto:gtmsupport@fisglobal.com)  
Automated attendant for 24 hour support: +1 (484) 302-3248  
Switchboard: +1 (484) 302-3160  
Website: <http://fis-gtm.com>

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This document contains a description of GT.M and the operating instructions pertaining to the various functions that comprise the system. This document does not contain any commitment of FIS. FIS believes the information in this publication is accurate as of its publication date; such information is subject to change without notice. FIS is not responsible for any errors or defects.

Revision History		
Revision 1.0	06 October 2020	V6.3-014

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# V6.3-014

## Overview

V6.3-014 enhances the available statistics to indicate process pwaits on a set of critical resources. It enhances the MUPIP FTOK utility and implements the MUPIP SEMAPHORE utility to supplant functionality previously provided by the separate, and now deprecated, ftok and semstat2 utilities. Also, MUPIP FREEZE provides cross-region consistency.

V6.3-014 also includes other fixes and enhancements. For more information, refer to the Change History section.

Items marked with 🟢 document new or different capabilities.

Please pay special attention to the items marked with the symbols 🟡 as those document items that have a possible impact on existing code, practice or process. Please be sure to recompile all objects to ensure all the updates are in place - we apologize that this release does not force the recompile.



### Note

Messages are not part of the GT.M API whose stability we strive to maintain. Make sure that you review any automated scripting that parses GT.M messages.

## Conventions

This document uses the following conventions:

<b>Flag/Qualifiers</b>	-
<b>Program Names or Functions</b>	upper case. For example, MUPIP BACKUP
<b>Examples</b>	lower case. For example: mupip backup -database ACN,HIST /backup
<b>Reference Number</b>	A reference number is used to track software enhancements and support requests. It is enclosed between parentheses ().
<b>Platform Identifier</b>	Where an item affects only specific platforms, the platforms are listed in square brackets, e.g., [AIX]



### Note

The term UNIX refers to the general sense of all platforms on which GT.M uses a POSIX API. As of this date, this includes: AIX and GNU/Linux on x86 (32- and 64-bits).

The following table summarizes the new and revised replication terminology and qualifiers.

Pre V5.5-000 terminology	Pre V5.5-000 qualifier	Current terminology	Current qualifiers
originating instance or primary instance	-rootprimary	originating instance or originating primary instance.  Within the context of a replication connection between two instances, an originating instance is referred to as source instance or source side. For example, in an B<-A->C replication configuration, A is the source instance for B and C.	-updok (recommended)  -rootprimary (still accepted)
replicating instance (or secondary instance) and propagating instance	N/A for replicating instance or secondary instance.  -propagateprimary for propagating instance	replicating instance.  Within the context of a replication connection between two instances, a replicating instance that receives updates from a source instance is referred to as receiving instance or receiver side. For example, in an B<-A->C replication configuration, both B and C can be referred to as a receiving instance.	-updnok
N/A	N/A	supplementary instance.  For example, in an A->P->Q replication configuration, P is the supplementary instance. Both A and P are originating instances.	-updok

Effective V6.0-000, GT.M documentation adopted IEC standard Prefixes for binary multiples. This document therefore uses prefixes Ki, Mi and Ti (e.g., 1MiB for 1,048,576 bytes). Over time, we'll update all GT.M documentation to this standard.

✔ denotes a new feature that requires updating the manuals.

⚠ denotes a new feature or an enhancement that may not be upward compatible and may affect an existing application.

🚫 denotes deprecated messages.

⚠ denotes revised messages.

⊕ denotes added messages.

## Platforms

Over time, computing platforms evolve. Vendors obsolete hardware architectures. New versions of operating systems replace old ones. We at FIS continually evaluate platforms and versions of platforms that should be Supported for GT.M. In the table below, we document not only the ones that are currently Supported for this release, but also alert you to our future plans given the evolution of computing platforms. If you are an FIS customer, and these plans would cause you hardship, please contact your FIS account executive promptly to discuss your needs.

Each GT.M release is extensively tested by FIS on a set of specific versions of operating systems on specific hardware architectures (the combination of operating system and hardware architecture is referred to as a platform). This set of specific versions is considered Supported. There may be other versions of the same operating systems on which a GT.M release may not have been tested, but on which the FIS GT.M Group knows of no reason why GT.M would not work. This larger set of versions is considered Supportable. There is an even larger set of platforms on which GT.M may well run satisfactorily, but where the FIS GT.M team lacks the knowledge to determine whether GT.M is Supportable. These are considered Unsupported. Contact FIS GT.M Support with inquiries about your preferred platform.

As of the publication date, FIS supports this release on the hardware and operating system versions below. Contact FIS for a current list of Supported platforms. The reference implementation of the encryption plugin has its own additional requirements, should you opt to use it as included with GT.M.

Platform	Supported Versions	Notes
IBM Power Systems AIX	7.1 TL 5, 7.2 TL 3	<p>Only 64-bit versions of AIX with POWER7 as the minimum required CPU architecture level are Supported.</p> <p>While GT.M supports both UTF-8 mode and M mode on this platform, there are problems with the AIX ICU utilities that prevent FIS from testing 4-byte UTF-8 characters as comprehensively on this platform as we do on others.</p> <p>Running GT.M on AIX 7.1 requires APAR IZ87564, a fix for the POW() function, to be applied. To verify that this fix has been installed, execute <b>instfix -ik IZ87564</b>.</p> <p>Only the AIX jfs2 filesystem is Supported. Other filesystems, such as jfs1 are Supportable, but not Supported. FIS strongly recommends use of the jfs2 filesystem on AIX; use jfs1 only for existing databases not yet migrated to a jfs2 filesystem.</p>
x86_64 GNU/Linux	Red Hat Enterprise Linux 7.8; Ubuntu 16.04 LTS, 18.04	<p>To run 64-bit GT.M processes requires both a 64-bit kernel as well as 64-bit hardware.</p> <p>GT.M should also run on recent releases of other major Linux distributions with a contemporary Linux kernel (2.6.32 or</p>

Platform	Supported Versions	Notes
	LTS, and 20.04 LTS	<p>later), glibc (version 2.12 or later) and ncurses (version 5.7 or later).</p> <p>Due to build optimization and library incompatibilities, GT.M versions older than V6.2-000 are incompatible with glibc 2.24 and up. This incompatibility has not been reported by a customer, but was observed on internal test systems that use the latest Linux software distributions from Fedora (26), Debian (unstable), and Ubuntu (17.10). In internal testing, processes either hung or encountered a segmentation violation (SIG-11) during operation. Customers upgrading to Linux distributions that utilize glibc 2.24+ must upgrade their GT.M version at the same time as or before the OS upgrade.</p> <p>GT.M requires a compatible version of the libtinfo library. On Red Hat, the ncurses-libs and ncurses-compat-libs packages contain the libtinfo library. On Debian/Ubuntu, libtinfo5 and libncurses5 packages contain the libtinfo library. If any of these packages is not already installed on your system, please install using an appropriate package manager.</p> <p>To support the optional WRITE /TLS fifth argument (the ability to provide / override options in the tlsid section of the encryption configuration file), the reference implementation of the encryption plugin requires libconfig 1.4.x.</p> <p>Only the ext4 and xfs filesystems are Supported. Other filesystems are Supportable, but not Supported. Furthermore, if you use the NODEFER_ALLOCATE feature, FIS strongly recommends that you use xfs. If you must use NODEFER_ALLOCATE with ext4, you <i>must</i> ensure that your kernel includes commit d2dc317d564a46dfc683978a2e5a4f91434e9711 (search for d2dc317d564a46dfc683978a2e5a4f91434e9711 at <a href="https://www.kernel.org/pub/linux/kernel/v4.x/ChangeLog-4.0.3">https://www.kernel.org/pub/linux/kernel/v4.x/ChangeLog-4.0.3</a>). The Red Hat Bugzilla identifier for the bug is 1213487. With NODEFER_ALLOCATE, do not use any filesystem other than ext4 and a kernel with the fix, or xfs.</p> <p>Ubuntu 19.10 is Supportable.</p>
x86 GNU/Linux	Debian 10 (buster)	<p>This 32-bit version of GT.M runs on either 32- or 64-bit x86 platforms; we expect the x86_64 GNU/Linux version of GT.M to be preferable on 64-bit hardware. Running a 32-bit GT.M on a 64-bit GNU/Linux requires 32-bit libraries to be installed. The CPU must have an instruction set equivalent to 586 (Pentium) or better.</p> <p>Please also refer to the notes above on x86_64 GNU/Linux.</p>



## Platform support lifecycle

FIS usually supports new operating system versions six months or so after stable releases are available and we usually support each version for a two year window. GT.M releases are also normally supported for two years after release. While FIS will attempt to provide support to customers in good standing for any GT.M release and operating system version, our ability to provide support diminishes after the two year window.

GT.M cannot be patched, and bugs are only fixed in new releases of software.

## 32- vs. 64-bit platforms

The same application code runs on both 32-bit and 64-bit platforms; however there are operational differences between them (for example, auto-relink and the ability to use GT.M object code from shared libraries exist only on 64-bit platforms). Please note that:

- \* You must compile the application code separately for each platform. Even though the M source code is the same, the generated object modules are different - the object code differs between x86 and x86\_64.
- \* Parameter-types that interface GT.M with non-M code using C calling conventions must match the data-types on their target platforms. Mostly, these parameters are for call-ins, external calls, internationalization (collation) and environment translation, and are listed in the tables below. Note that most addresses on 64-bit platforms are 8 bytes long and require 8 byte alignment in structures whereas all addresses on 32-bit platforms are 4 bytes long and require 4-byte alignment in structures.

## Call-ins and External Calls

Parameter type	32-Bit	64-bit	Remarks
gtm_long_t	4-byte (32-bit)	8-byte (64-bit)	gtm_long_t is much the same as the C language long type.
gtm_ulong_t	4-byte	8-byte	gtm_ulong_t is much the same as the C language unsigned long type.
gtm_int_t	4-byte	4-byte	gtm_int_t has 32-bit length on all platforms.
gtm_uint_t	4-byte	4-byte	gtm_uint_t has 32-bit length on all platforms



### Caution

If your interface uses gtm\_long\_t or gtm\_ulong\_t types but your interface code uses int or signed int types, failure to revise the types so they match on a 64-bit platform will cause the code to fail in unpleasant, potentially dangerous, and hard to diagnose ways.

## Internationalization (Collation)

Parameter type	32-Bit	64-bit	Remarks
gtm_descriptor in gtm_descript.h	4-byte	8-byte	Although it is only the address within these types that changes, the structures may grow by up to 8 bytes as a result of compiler padding to meet platform alignment requirements.



### Important

Assuming other aspects of code are 64-bit capable, collation routines should require only recompilation.

## Environment Translation

Parameter type	32-Bit	64-bit	Remarks
gtm_string_t type in gtmxc_types.h	4-byte	8-byte	Although it is only the address within these types that changes, the structures may grow by up to 8 bytes as a result of compiler padding to meet platform alignment requirements.



### Important

Assuming other aspects of code are 64-bit capable, environment translation routines should require only recompilation.


## Additional Installation Instructions

To install GT.M, see the "Installing GT.M" section in the GT.M Administration and Operations Guide. For minimal down time, upgrade a current replicating instance and restart replication. Once that replicating instance is current, switch it to become the originating instance. Upgrade the prior originating instance to become a replicating instance, and perform a switchover when you want it to resume an originating primary role.



### Caution

Never replace the binary image on disk of any executable file while it is in use by an active process. It may lead to unpredictable results. Depending on the operating system, these results include but are not limited to denial of service (that is, system lockup) and damage to files that these processes have open (that is, database structural damage).

- \* FIS strongly recommends installing each version of GT.M in a separate (new) directory, rather than overwriting a previously installed version. If you have a legitimate need to overwrite an existing GT.M installation with a new version, you must first shut down all processes using the old version. FIS suggests installing GT.M V6.3-014 in a Filesystem Hierarchy Standard compliant location such as /usr/lib/fis-gtm/V6.3-014\_arch (for example, /usr/lib/fis-gtm/V6.3-014\_x86 on 32-bit Linux systems). A location such as /opt/fis-gtm/V6.3-014\_arch would also be appropriate. Note that the **arch** suffix is especially important if you plan to install 32- and 64-bit versions of the same release of GT.M on the same system.
- \* Use the appropriate MUPIP command (e.g. ROLLBACK, RECOVER, RUNDOWN) of the old GT.M version to ensure all database files are cleanly closed.
- \* Make sure gtmsecshr is not running. If gtmsecshr is running, first stop all GT.M processes including the DSE, LKE and MUPIP utilities and then perform a **MUPIP STOP pid\_of\_gtmsecshr**.
- \* Starting with V6.2-000, GT.M no longer supports the use of the deprecated \$gtm\_dbkeys and the master key file it points to for database encryption. To convert master files to the libconfig format, please click  to download the CONVDBKEYS.m program and follow instructions in the comments near the top of the program file. You can also download CONVDBKEYS.m from <http://tinco.pair.com/bhaskar/gtm/doc/articles/downloadables/CONVDBKEYS.m>. If you are using \$gtm\_dbkeys for database encryption, please convert master key files to libconfig format immediately after upgrading to V6.2-000 or later. Also, modify your environment scripts to include the use of gtmcrypt\_config environment variable.

## Recompile

- \* Recompile all M and C source files.

## Rebuild Shared Libraries or Images

- \* Rebuild all Shared Libraries after recompiling all M and C source files.
- \* If your application is not using object code shared using GT.M's auto-relink functionality, please consider using it.

## Compiling the Reference Implementation Plugin

If you plan to use database encryption, TLS replication, or TLS sockets, you must compile the reference implementation plugin to match the shared library dependencies unique to your platform. The instructions for compiling the Reference Implementation plugin are as follows:

1. Install the development headers and libraries for libgcrypt, libpgme, libconfig, and libssl. On Linux, the package names of development libraries usually have a suffix such as -dev or -devel and are available through the package manager. For example, on Ubuntu\_x86\_64 a command like the following installs the required development libraries:

```
sudo apt-get install libgcrypt11-dev libgpgme11-dev libconfig-dev libssl-dev
```

Note that the package names may vary by distribution / version.

2. Unpack \$gtm\_dist/plugin/gtmcrypt/source.tar to a temporary directory.

```
mkdir /tmp/plugin-build
cd /tmp/plugin-build
cp $gtm_dist/plugin/gtmcrypt/source.tar .
tar -xvf source.tar
```

3. Follow the instructions in the README.

- \* Open Makefile with your editor; review and edit the common header (IFLAGS) and library paths (LIBFLAGS) in the Makefile to reflect those on your system.
- \* Define the gtm\_dist environment variable to point to the absolute path for the directory where you have GT.M installed
- \* Copy and paste the commands from the README to compile and install the encryption plugin with the permissions defined at install time



### Caution

These are separate steps to compile the encryption plugin for GT.M versions V5.3-004 through V6.3-000 when OpenSSL 1.1 is installed and OpenSSL 1.0.x libraries are still available.

- \* Download the most recent OpenSSL 1.0.x version

- \* Compile and install (default installs to /usr/local/ssl)

```
./config && make install
```

- \* Adjust the configuration : Move the newly installed libraries out of the way

```
mv /usr/local/ssl/lib /usr/local/ssl/lib.donotuse
```

- \* Adjust the configuration : Create another /usr/local/ssl/lib and symlink the existing 1.0.x library into it as the default. This ensures that the encryption plugin is compiled using the compatible OpenSSL 1.0.x library. Adjust the path below as necessary.

```
mkdir /usr/local/ssl/lib && ln -s /path/to/existing/libssl.so.1.0.x /usr/local/ssl/libssl.so
```

- \* Recompile the encryption plugin following the above directions.

- \* Remove /usr/local/ssl/lib.donotuse to avoid future complications.

## Upgrading to GT.M V6.3-014

The GT.M database consists of four types of components- database files, journal files, global directories, and replication instance files. The format of some database components differs for 32-bit and 64-bit GT.M releases for the x86 GNU/Linux platform.

GT.M upgrade procedure for V6.3-014 consists of 5 stages:

- \* Stage 1: Global Directory Upgrade
- \* Stage 2: Database Files Upgrade
- \* Stage 3: Replication Instance File Upgrade
- \* Stage 4: Journal Files Upgrade
- \* Stage 5: Trigger Definitions Upgrade

Read the upgrade instructions of each stage carefully. Your upgrade procedure for GT.M V6.3-014 depends on your GT.M upgrade history and your current version.

### Stage 1: Global Directory Upgrade

FIS strongly recommends you back up your Global Directory file before upgrading. There is no one-step method for downgrading a Global Directory file to an older format.

#### **To upgrade from any previous version of GT.M:**

- \* Open your Global Directory with the GDE utility program of GT.M V6.3-014.
- \* Execute the EXIT command. This command automatically upgrades the Global Directory.

#### **To switch between 32- and 64-bit global directories on the x86 GNU/Linux platform:**

1. Open your Global Directory with the GDE utility program on the 32-bit platform.
2. On GT.M versions that support SHOW -COMMAND, execute SHOW -COMMAND -FILE=file-name. This command stores the current Global Directory settings in the specified file.
3. On GT.M versions that do not support GDE SHOW -COMMAND, execute the SHOW -ALL command. Use the information from the output to create an appropriate command file or use it as a guide to manually enter commands in GDE.
4. Open GDE on the 64-bit platform. If you have a command file from 2. or 3., execute @file-name and then run the EXIT command. These commands automatically create the Global Directory. Otherwise use the GDE output from the old Global Directory and apply the settings in the new environment.

An analogous procedure applies in the reverse direction.

If you inadvertently open a Global Directory of an old format with no intention of upgrading it, execute the QUIT command rather than the EXIT command.

If you inadvertently upgrade a global directory, perform the following steps to downgrade to an old GT.M release:

- \* Open the global directory with the GDE utility program of V6.3-014.
- \* Execute the SHOW -COMMAND -FILE=file-name command. This command stores the current Global Directory settings in the file-name command file. If the old version is significantly out of date, edit the command file to remove the commands that do not apply to the old format. Alternatively, you can use the output from SHOW -ALL or SHOW -COMMAND as a guide to manually enter equivalent GDE commands for the old version.

## Stage 2: Database Files Upgrade

Before starting the database file upgrade, use the prior GT.M version to perform an appropriate MUPIP action to remove abandoned GT.M database semaphores and releases any IPC resources.

### To upgrade from GT.M V6\*:

There is no explicit procedure to upgrade a V6 database file when upgrading to a newer V6 version. After upgrading the Global Directory, opening a V6 database with a newer V6 GT.M process automatically upgrades the fields in the database file header.

### To upgrade from GT.M V5.0\*/V5.1\*/V5.2\*/V5.3\*/V5.4\*/V5.5:

A V6 database file is a superset of a V5 database file and has potentially longer keys and records. Therefore, upgrading a database file requires no explicit procedure. After upgrading the Global Directory, opening a V5 database with a V6 process automatically upgrades fields in the database fileheader.

A database created with V6 supports up to 992Mi blocks and is not backward compatible. V6 databases that take advantage of V6 limits on key size and records size cannot be downgraded. Use MUPIP DOWNGRADE -VERSION=V5 to downgrade a V6 database back to V5 format provided it meets the database downgrade requirements. For more information on downgrading a database, refer to Downgrading to V5 or V4.



### Important

A V5 database that has been automatically upgraded to V6 can perform all GT.M V6.3-014 operations. However, that database can only grow to the maximum size of the version in which it was originally created. A database created on V5.0-000 through V5.3-003 has maximum size of 128Mi blocks. A database created on V5.4-000 through V5.5-000 has a maximum size of 224Mi blocks. A database file created with V6.0-000 (or above) can grow up to a maximum of 992Mi blocks. This means that, for

example, the maximum size of a V6 database file having 8KiB block size is 7936GiB (8KiB\*992Mi).



### Important

In order to perform a database downgrade you must perform a MUPIP INTEG -NOONLINE. If the duration of the MUPIP INTEG exceeds the time allotted for an upgrade you should rely on a rolling upgrade scheme using replication.

If your database has any previously used but free blocks from an earlier upgrade cycle (V4 to V5), you may need to execute the MUPIP REORG -UPGRADE command. If you have already executed the MUPIP REORG -UPGRADE command in a version prior to V5.3-003 and if subsequent versions cannot determine whether MUPIP REORG -UPGRADE performed all required actions, it sends warnings to the syslog requesting another run of MUPIP REORG -UPGRADE. In that case, perform any one of the following steps:

- \* Execute the MUPIP REORG -UPGRADE command again, or
- \* Execute the DSE CHANGE -FILEHEADER -FULLY\_UPGRADED=1 command to stop the warnings.



### Caution

Do not run the DSE CHANGE -FILEHEADER -FULLY\_UPGRADED=1 command unless you are absolutely sure of having previously run a MUPIP REORG -UPGRADE from V5.3-003 or later. An inappropriate DSE CHANGE -FILEHEADE -FULLY\_UPGRADED=1 may lead to database integrity issues.

You do not need to run MUPIP REORG -UPGRADE on:

- \* A database that was created by a V5 MUPIP CREATE
- \* A database that has been completely processed by a MUPIP REORG -UPGRADE from V5.3-003 or later.

For additional upgrade considerations, refer to Database Compatibility Notes.

### To upgrade from a GT.M version prior to V5.000:

You need to upgrade your database files only when there is a block format upgrade from V4 to V5. However, some versions, for example, database files which have been initially been created with V4 (and subsequently upgraded to a V5 format) may additionally need a MUPIP REORG -UPGRADE operation to upgrade previously used but free blocks that may have been missed by earlier upgrade tools.

- \* Upgrade your database files using in-place or traditional database upgrade procedure depending on your situation. For more information on in-place/traditional database upgrade, see Database Migration Technical Bulletin.

- \* Run the MUPIP REORG -UPGRADE command. This command upgrades all V4 blocks to V5 format.



### Note

Databases created with GT.M releases prior to V5.0-000 and upgraded to a V5 format retain the maximum size limit of 64Mi (67,108,864) blocks.

## Database Compatibility Notes

- \* Changes to the database file header may occur in any release. GT.M automatically upgrades database file headers as needed. Any changes to database file headers are upward and downward compatible within a major database release number, that is, although processes from only one GT.M release can access a database file at any given time, processes running different GT.M releases with the same major release number can access a database file at different times.
- \* Databases created with V5.3-004 through V5.5-000 can grow to a maximum size of 224Mi (234,881,024) blocks. This means, for example, that with an 8KiB block size, the maximum database file size is 1,792GiB; this is effectively the size of a single global variable that has a region to itself and does not itself span regions; a database consists of any number of global variables. A database created with GT.M versions V5.0-000 through V5.3-003 can be upgraded with MUPIP UPGRADE to increase the limit on database file size from 128Mi to 224Mi blocks.
- \* Databases created with V5.0-000 through V5.3-003 have a maximum size of 128Mi (134, 217,728) blocks. GT.M versions V5.0-000 through V5.3-003 can access databases created with V5.3-004 and later as long as they remain within a 128Mi block limit.
- \* Database created with V6.0-000 or above have a maximum size of 1,040,187,392(992Mi) blocks.
- \* For information on downgrading a database upgraded from V6 to V5, refer to: Downgrading to V5 or V4.

## Stage 3: Replication Instance File Upgrade

V6.3-014 does not require new replication instance files if you are upgrading from V5.5-000. However, V6.3-014 requires new replication instance files if you are upgrading from any version prior to V5.5-000. Instructions for creating new replication instance files are in the Database Replication chapter of the GT.M Administration and Operations Guide. Shut down all Receiver Servers on other instances that are to receive updates from this instance, shut down this instance Source Server(s), recreate the instance file, restart the Source Server(s) and then restart any Receiver Server for this instance with the -UPDATERESYNC qualifier.



### Note

Without the -UPDATERESYNC qualifier, the replicating instance synchronizes with the originating instance using state information from both instances and potentially rolling back information on the replicating instance. The -UPDATERESYNC qualifier declares the replicating instance to be in a wholesome state matching some prior (or



current) state of the originating instance; it causes MUPIP to update the information in the replication instance file of the originating instance and not modify information currently in the database on the replicating instance. After this command, the replicating instance catches up to the originating instance starting from its own current state. Use `-UPDATERESYNC` only when you are absolutely certain that the replicating instance database was shut down normally with no errors, or appropriately copied from another instance with no errors.



### Important

You must always follow the steps described in the Database Replication chapter of the GT.M Administration and Operations Guide when migrating from a logical dual site (LDS) configuration to an LMS configuration, even if you are not changing GT.M releases.

## Stage 4: Journal Files Upgrade

On every GT.M upgrade:

- \* Create a fresh backup of your database.
- \* Generate new journal files (without back-links).



### Important

This is necessary because MUPIP JOURNAL cannot use journal files from a release other than its own for RECOVER, ROLLBACK, or EXTRACT.

## Stage 5: Trigger Definitions Upgrade

If you are upgrading from V5.4-002A/V5.4-002B/V5.5-000 to V6.3-014 and you have database triggers defined in V6.2-000 or earlier, you need to ensure that your trigger definitions are wholesome in the older version and then run `MUPIP TRIGGER -UPGRADE`. If you have doubts about the wholesomeness of the trigger definitions in the old version use the instructions below to capture the definitions delete them in the old version (-\*), run `MUPIP TRIGGER -UPGRADE` in V6.3-014 and then reload them as described below.

You need to extract and reload your trigger definitions only if you are upgrading from V5.4-000/V5.4-000A/V5.4-001 to V6.3-014 or if you find your prior version trigger definitions have problems. For versions V5.4-000/V5.4-000A/V5.4-001 this is necessary because multi-line XECUTES for triggers require a different internal storage format for triggers which makes triggers created in V5.4-000/V5.4-000A/V5.4-001 incompatible with V5.4-002/V5.4-002A/V5.4-002B/V5.5-000/V6.0-000/V6.0-001/V6.3-014.

To extract and reapply the trigger definitions on V6.3-014 using `MUPIP TRIGGER`:

1. Using the old version, execute a command like **mupip trigger -select="\*" trigger\_defs.trg**. Now, the output file `trigger_defs.trg` contains all trigger definitions.
2. Place `*` at the beginning of the `trigger_defs.trg` file to remove the old trigger definitions.
3. Using V6.3-014, run **mupip trigger -triggerfile=trigger\_defs.trg** to reload your trigger definitions.

To extract and reload trigger definitions on a V6.3-014 replicating instance using `$ZTRIGGER()`:

1. Shut down the instance using the old version of GT.M.
2. Execute a command like **mumps -run %XCMD 'i \$ztrigger("select") > trigger\_defs.trg**. Now, the output file `trigger_defs.trg` contains all trigger definitions.
3. Turn off replication on all regions.
4. Run **mumps -run %XCMD 'i \$ztrigger("item","-\*")** to remove the old trigger definitions.
5. Perform the upgrade procedure applicable for V6.3-014.
6. Run **mumps -run %XCMD 'if \$ztrigger("file","trigger\_defs.trg")** to reapply your trigger definitions.
7. Turn replication on.
8. Connect to the originating instance.



### Note

Reloading triggers renumbers automatically generated trigger names.

## Downgrading to V5 or V4

You can downgrade a GT.M V6 database to V5 or V4 format using `MUPIP DOWNGRADE`.

Starting with V6.0-000, `MUPIP DOWNGRADE` supports the `-VERSION` qualifier with the following format:

```
MUPIP DOWNGRADE -VERSION=[V5|V4]
```

`-VERSION` specifies the desired version for the database header.

**To qualify for a downgrade from V6 to V5, your database must meet the following requirements:**

1. The database was created with a major version no greater than the target version.
2. The database does not contain any records that exceed the block size (spanning nodes).

3. The sizes of all the keys in database are less than 256 bytes.
4. There are no keys present in database with size greater than the Maximum-Key-Size specification in the database header, that is, Maximum-Key-Size is assured.
5. The maximum Record size is small enough to accommodate key, overhead, and value within a block.

To verify that your database meets all of the above requirements, execute MUPIP INTEG -NOONLINE. Note that the integrity check requires the use of -NOONLINE to ensure no concurrent updates invalidate the above requirements. Once assured that your database meets all the above requirements, MUPIP DOWNGRADE -VERSION=V5 resets the database header to V5 elements which makes it compatible with V5 versions.

To qualify for a downgrade from V6 to V4, your database must meet the same downgrade requirements that are there for downgrading from V6 to V5.

If your database meets the downgrade requirements, perform the following steps to downgrade to V4:

1. In a GT.M V6.3-014 environment:
  - a. Execute MUPIP SET -VERSION=v4 so that GT.M writes updates blocks in V4 format.
  - b. Execute MUPIP REORG -DOWNGRADE to convert all blocks from V6 format to V4 format.
2. Bring down all V6 GT.M processes and execute MUPIP RUNDOWN -FILE on each database file to ensure that there are no processes accessing the database files.
3. Execute MUPIP DOWNGRADE -VERSION=V4 to change the database file header from V6 to V4.
4. Restore or recreate all the V4 global directory files.
5. Your database is now successfully downgraded to V4.

## Managing M mode and UTF-8 mode

With International Components for Unicode (ICU) version 3.6 or later installed, GT.M's UTF-8 mode provides support for Unicode® (ISO/IEC-10646) character strings. On a system that does not have ICU 3.6 or later installed, GT.M only supports M mode.

On a system that has ICU installed, GT.M optionally installs support for both M mode and UTF-8 mode, including a utf8 subdirectory of the directory where GT.M is installed. From the same source file, depending upon the value of the environment variable gtm\_chset, the GT.M compiler generates an object file either for M mode or UTF-8 mode. GT.M generates a new object file when it finds both a source and an object file, and the object predates the source file and was generated with the same setting of \$gtm\_chset/\$ZCHset. A GT.M process generates an error if it encounters an object file generated with a different setting of \$gtm\_chset/\$ZCHset than that processes' current value.

Always generate an M object module with a value of \$gtm\_chset/\$ZCHset matching the value processes executing that module will have. As the GT.M installation itself contains utility programs

written in M, their object files also conform to this rule. In order to use utility programs in both M mode and UTF-8 mode, the GT.M installation ensures that both M and UTF-8 versions of object modules exist, the latter in the utf8 subdirectory. This technique of segregating the object modules by their compilation mode prevents both frequent recompiles and errors in installations where both modes are in use. If your installation uses both modes, consider a similar pattern for structuring application object code repositories.

GT.M is installed in a parent directory and a utf8 subdirectory as follows:

- \* Actual files for GT.M executable programs (mumps, mupip, dse, lke, and so on) are in the parent directory, that is, the location specified for installation.
- \* Object files for programs written in M (GDE, utilities) have two versions - one compiled with support for UTF-8 mode in the utf8 subdirectory, and one compiled without support for UTF-8 mode in the parent directory. Installing GT.M generates both versions of object files, as long as ICU 3.6 or greater is installed and visible to GT.M when GT.M is installed, and you choose the option to install UTF-8 mode support. Note that on 64-bit versions of GT.M, the object code is in shared libraries, rather than individual files in the directory.
- \* The utf8 subdirectory has files called mumps, mupip, dse, lke, and so on, which are relative symbolic links to the executables in the parent directory (for example, mumps is the symbolic link ../mumps).
- \* When a shell process sources the file gtmprofile, the behavior is as follows:
  - \* If \$gtm\_chset is "m", "M" or undefined, there is no change from the previous GT.M versions to the value of the environment variable \$gtmroutines.
  - \* If \$gtm\_chset is "UTF-8" (the check is case-insensitive),
    - \* \$gtm\_dist is set to the utf8 subdirectory (that is, if GT.M is installed in /usr/lib/fis-gtm/gtm\_V6.3-014\_i686, then gtmprofile sets \$gtm\_dist to /usr/lib/fis-gtm/gtm\_V6.3-014\_i686/utf8).
    - \* On platforms where the object files have not been placed in a libgtmutil.so shared library, the last element of \$gtmroutines is \$gtm\_dist(\$gtm\_dist/..) so that the source files in the parent directory for utility programs are matched with object files in the utf8 subdirectory. On platforms where the object files are in libgtmutil.so, that shared library is the one with the object files compiled in the mode for the process.

For more information on gtmprofile, refer to the Basic Operations chapter of GT.M Administration and Operations Guide.

Although GT.M uses ICU for UTF-8 operation, ICU is not FIS software and FIS does not support ICU.

## Setting the environment variable TERM

The environment variable TERM must specify a terminfo entry that accurately matches the terminal (or terminal emulator) settings. Refer to the terminfo man pages for more information on the terminal settings of the platform where GT.M needs to run.

- \* Some terminfo entries may seem to work properly but fail to recognize function key sequences or fail to position the cursor properly in response to escape sequences from GT.M. GT.M itself does not have any knowledge of specific terminal control characteristics. Therefore, it is important to specify the right terminfo entry to let GT.M communicate correctly with the terminal. You may need to add new terminfo entries depending on your specific platform and implementation. The terminal (emulator) vendor may also be able to help.
- \* GT.M uses the following terminfo capabilities. The full variable name is followed by the capname in parenthesis:

```
auto_right_margin(am), clr_eos(ed), clr_eol(el), columns(cols), cursor_address(cup),
cursor_down(cud1), cursor_left(cub1), cursor_right(cuf1), cursor_up(cuu1),
eat_newline_glitch(xenl), key_backspace(kbs), key_dc(kdch1),key_down(kcud1),
key_left(kcub1), key_right(kcuf1), key_up(kcuu1), key_insert(kich1),
keypad_local(rmkx),keypad_xmit(smkn), lines(lines).
```

GT.M sends keypad\_xmit before terminal reads for direct mode and READs (other than READ \*) if EDITING is enabled. GT.M sends keypad\_local after these terminal reads.

## Installing Compression Libraries

If you plan to use the optional compression facility for replication, you must provide the compression library. The GT.M interface for compression libraries accepts the zlib compression libraries without any need for adaptation. These libraries are included in many UNIX distributions and are downloadable from the zlib home page. If you prefer to use other compression libraries, you need to configure or adapt them to provide the same API as that provided by zlib.

If a package for zlib is available with your operating system, FIS suggests that you use it rather than building your own.

By default, GT.M searches for the libz.so shared library in the standard system library directories (for example, /usr/lib, /usr/local/lib, /usr/local/lib64). If the shared library is installed in a non-standard location, before starting replication, you must ensure that the environment variable LIBPATH (AIX) or LD\_LIBRARY\_PATH (GNU/Linux) includes the directory containing the library. The Source and Receiver Server link the shared library at runtime. If this fails for any reason (such as file not found, or insufficient authorization), the replication logic logs a DLLNOOPEN error and continues with no compression.

Although GT.M uses a library such as zlib for compression, such libraries are not FIS software and FIS does not support any compression libraries.



## Change History

### V6.3-014

Fixes and enhancements specific to V6.3-014:

Id	Prior Id	Category	Summary
GTM-7628	-	Admin	Up to 64GiB for Source and receiver buffers
GTM-8800	-	Admin	👍 MUPIP FTOK enhancements and MUPIP SEMAPHORE replace separate utilities 🟢
GTM-8863	-	DB	Provide GT.M statistics indicating use of various critical sections 🟢
GTM-9102	-	Admin	MUPIP FREEZE is consistent across regions except for AIO
GTM-9266	-	Admin	Correction to replication connection failure message
GTM-9285	-	Admin	👍 MUPIP REPLICATE -SOURCE -CONNECTPARAMS changes 🟢
GTM-9308	-	Admin	Better messages from MUPIP RUNDOWN when in FREEZE -ONLINE
GTM-9320	-	Admin	Suppress inappropriate EN022 syslog messages associated with use of READ_ONLY databases
GTM-9321	-	Language	Correct \$REFERENCE maintainance in \$ORDER(<indirection>,<literal>)
GTM-9322	-	DB	More care to release the replication journal pool when not doing so might cause a deadlock
GTM-9328	-	Language	No interrupting an already interrupted process
GTM-9329	-	Language	\$ZTIMEOUT issue corrections
GTM-9331	-	Language	Prevent signal interference from external calls
GTM-9332	-	Language	Prevent high LOCK activity over a region instantiation from causing moment of LOCK "confusion"

Id	Prior Id	Category	Summary
GTM-9335	-	DB	Prevent unusual case in which an abnormal process exit might cause an apparent database hang when using AIO
GTM-9336	-	Admin	Correct an issue with MUPIP SIZE occasionally failing with a damaged stack
GTM-9337	-	DB	Prevent spurious error in a process that contributed to the snapshot facility used by MUPIP INTEG
GTM-9338	-	Admin	Allow the \$gtm_tmp environment variable to control the placement of files used in trigger compilation 🟢



## Database

- \* GT.M provides toggle statistics to indicate when a process is in a critical code section, and the general characterization of that critical section. When a process enters a critical section, it sets the appropriate toggle statistic to '1' and when it leaves the critical section, sets it back to '0'. GT.M provides toggle statistics designated DEXA, GLB, JNL, MLK, PRC, TRX, ZAD, JOPA, AFRA, BREA, MLBA & TRGA, which are documented in the "ZSHOW" section of the GT.M Programmers Guide. All of the standard GT.M tools and facilities for examining statistics operate on the toggle statistics, and the only operational difference between the toggle statistics and the counter statistics previously provided by GT.M is that, since toggle statistics provide a near real-time report on GT.M process status rather than a cumulative state, they are neither saved on process exit nor loaded on process initialization. Note that we are still considering feedback on these added statistics, so they may be the subject of future changes. (GTM-8863) 🟢
- \* GT.M processes appropriately handle releasing the replication journal pool resource; previously in rare circumstances, processes might not release the resource as intended leading to a dead-lock that can only be cleared by stopping the process inappropriately continuing to hold the resource. (GTM-9322)
- \* GT.M deals with the loss of a process involved with AIO database writes more promptly; previously it could take material time for it to recognize and deal with the issue, which manifested as a database hang. This behavior was seen in in-house testing and was never reported by a customer.(GTM-9335)
- \* GT.M process disengaging from the snapshot mechanism used by MUIP INTEG ignores an error indicating the associated shared memory is already gone. Previously, such a process could occasionally and inappropriately get a SYSCALL error associated with shmdt and ENO22. (GTM-9337)



## Language

- \* Name-level \$ORDER(<indirection>,<literal>), where the indirection contains a subscripted or unsubscripted gvn, correctly maintains \$REFERENCE; a change in V6.3-013 caused this case to incorrectly maintain \$REFERENCE, giving it the value of the last prior global reference rather than that within the indirection. (GTM-9321)
- \* When handling a MUPIP INTRPT, GT.M discards any other such requests. Starting in V6.3-006, GT.M could inappropriately accept multiple invocations of \$ZINTERRUPT causing the process to get a fatal STACKOFLOW. (GTM-9328)
- \* GT.M handles an edge case for \$ZTIMEOUT properly. Previously, cancelling a timer by setting \$ZTIMEOUT to -1 before completely processing the \$ZTIMEOUT action for an expired timeout could cause the \$ZTIMEOUT action to repeat indefinitely. GT.M retains the vector in \$ZTIMEOUT properly. Previously, attempting to assign \$ZTIMEOUT an incorrect vector routine, caused GT.M to inappropriately clear the prior vector value. These behaviors were seen in in-house testing and were never reported by a customer. (GTM-9329)
- \* The GT.M external call and timer logic ensure that GT.M recovers from external calls that ignore GT.M timers or disrupt GT.M signal handling. Note that GT.M exposes a timer mechanism for use by external calls that integrates external timer needs with those of GT.M. Note also that GT.M external calls have a configuration option that claims an external call does not change the GT.M signal handling; this option makes signal handling more efficient. As a result of changes in V6.3-006 associated with GTM-7952, an external call could suspend GT.M's timer mechanism for a process, which caused timed operations (HANG, JOB, LOCK, OPEN, READ, and some Z\* operations) to suspend indefinitely. The workaround was to signal such a process with a SIGALARM. (GTM-9331)
- \* GT.M deals appropriately with large numbers of LOCK releases. One aspect of this change eliminates counting LOCK pending removals, mostly from timeouts, as wake ups in internal counters. Previously if the releases reached 2\*\*32 in the active life of a region (between shutdowns), processes could, for some typically brief period, receive an incorrect indication they had received the LOCK, when they had not. (GTM-9332)



## System Administration

- \* If there is enough free shared memory available, the MUPIP REPLICATE qualifier `-BUFFSIZE` accepts values of up to 64 GiB for source and receiver servers. Previously, this maximum was 4GiB. (GTM-7628)
- \* MUPIP FTOK recognizes the `-ID=<integer>` qualifier to specify the signature use for the ftok; if unspecified, it defaults to the signature for a GT.M database file. MUPIP FTOK also recognizes the `-ONLY` qualifier to restrict the output to only the file's ftok; if a file is not valid and accessible, FTOK reports -1 values. By default, the utility provides additional information about the file, including its file ID which provides the basis for the FTOK. In addition, MUPIP FTOK recognizes the `-[NO]HEADER` qualifier; `-ONLY` output has no header, but by default other forms include a header that `-NOHEADER` suppresses. Any existing parsing of the output require adjustments to deal with the additional information and revised spacing. If the database file is unavailable, the utility defaults to the `-ONLY` behavior. In addition, the utility accepts a space (`<SP>`) delimited list of files, such as that provided by the use of the `*` and `?` shell wildcard characters. With either the `-JNLPOOL` or `-RECVPOOL` qualifier, MUPIP FTOK ignores any files in the list. Note that to minimize ftok collisions, GT.M uses its own ftok generation algorithm. This added functionality in MUPIP FTOK replaces the standalone ftok utility provided in the GT.M distribution; that executable has been removed from the release package. Previously, MUPIP FTOK did not recognize these qualifiers, only processed a single file, and did not show the FTOK in its output. MUPIP SEMAPHORE reports the details of the a space delimited list of semaphores IDs. This replaces the undocumented standalone semstat2 utility in the GT.M distribution; that executable has been removed from the release package. Note the output format differs slightly from that of semstat2. Previously MUPIP did not support the SEMPHORE command. (GTM-8800) 🍏 🍏
- \* MUPIP FREEZE `-ONLINE` institutes the FREEZE on all regions in parallel to produce a consistent snapshot for a multiple-region database. FREEZE `-ONLINE` momentarily suspends updates to all regions while instituting the freeze. This action could slow regular processing until all regions are frozen. When AIO is ON, FREEZE `-ONLINE` institutes the FREEZE serially. Previously, MUPIP FREEZE `-ONLINE` froze each region serially which could result in an inconsistent snapshot with the final regions have sequence numbers higher than the first regions. (GTM-9102)
- \* The replication source server includes the correct error text when logging failed connection attempts. Previously, the wrong error text may have been included in the message. This was found during internal testing and has never been reported in the field. (GTM-9266)
- \* The `-CONNECTPARAMS` qualifier MUPIP REPLICATE `-SOURCE -START` includes the following fixes and enhancements:
  - \* `-CONNECTPARAMS` takes the fourth comma-delimited value as the approximate alert-time in seconds after which the Source Server records the REPLALERT message in the Source Server log file when it fails to establish a replication connection during soft connection attempts. Specify 0 if you want to disable the REPLALERT logging behavior. By default, the logging of the REPLALERT message for soft connection attempt failures is disabled. Previously, MUPIP only reported the REPLWARN message for such failures with an inaccurate time.

- \* The Source Server sleeps for `hard-tries-period` when it fails to resolve the network address specified with the `-SECONDARY` qualifier. Also, the Source Server allows users to bypass hard connection attempts by specifying zero (0) as the `hard-connection-count` for more timely logging of the `REPLALERT` messages as the Source Server bypasses hard connection attempts. Previously, it was not possible to bypass hard connection attempts and the Source Server did not sleep for `hard-tries-period` when the network address specified with `-SECONDARY` resulted in a network resolution failure.
- \* GT.M automatically adjusts the values for `soft-tries-period` and `hard-tries-period` to about half of the GT.M determined shutdown wait time. GT.M logs these adjustments in the Source Server log file. This helps prevent inadvertent timeouts of a Source Server shutdown due to high `soft-tries-period` and/or `hard-tries-period` and prevents out-of-design conditions. The Source Server log file includes the units for `hard-tries-period` in milliseconds and the units of `soft-tries-period` and `alert-time` in seconds. Previously, the Source Server log file did not include the time measurement units.
- \* MUPIP reports a `BADCONNECTPARAM` if the specification is incorrect or the user specifies a value that may lead to an out-of-design situation. MUPIP also allows users to specify up to six parameters with `-CONNECTPARAMS` and uses the defaults for the parameters not specified. Previously, MUPIP displayed the same "Error parsing or invalid parameter in `CONNECTPARAMS`" message for parsing error in any `-CONNECTPARAMS` parameter and required all six parameters.

Please refer to the "Starting the Source Server" section of the Administration and Operations Guide for complete information on `-CONNECTPARAMS`. (GTM-9285) 🚫🟢

- \* When MUPIP `RUNDOWN` encounters a region with an active `FREEZE -ONLINE`, it skips running down the region and issues an `OFRZACTIVE` warning message. Previously under these circumstances, MUPIP issued less appropriate messages. (GTM-9308)
- \* GT.M does not issue warning messages to the syslog when processes close `READ_ONLY` databases; previously it did, which was noticeable when using `^%PEEKBYNAME`. (GTM-9320)
- \* When MUPIP `SIZE` encounters an apparently invalid key, it either ignores it or reports a database integrity error, depending on the nature of the issue; previously some such keys could cause the utility to fail due to a damaged stack. (GTM-9336)
- \* Trigger compilation responds to the location specified by the `gtm_tmp` environment variable; previously it always used the default for `gtm_tmp`, which is `/tmp`. (GTM-9338) 🟢







## Error and Other Messages

### BADCONNECTPARAM

**BADCONNECTPARAM**, Error parsing or invalid parameter. [XXXX]

MUPIP Error: MUPIP produces this message when there is an error in any connection parameter specified with -CONNECTPARAMS. XXXX contain a brief description of the parameter and its a valid value range.

Action: Specify valid values for the -CONNECTPARAM parameter. Refer to the -CONNECTPARAM documentation in the Administration and Operations Guide for more information.

### BADPARAMCOUNT

**BADPARAMCOUNT**, -CONNECTPARAMS accepts one to six parameter values

MUPIP Error: MUPIP produces this message when there are more than six parameters specified for -CONNECTPARAMS.

Action: Specify one to six parameters or omit -CONNECTPARAMS from the MUPIP REPLICATE -SOURCE -START command to use the default connection parameters.

### REPLALERT

**REPLALERT**, Source Server could not connect to replicating instance [XXXX] for [NNNN] seconds

MUPIP Warning: The Source Server records this warning message when the Source Server fails to establish a replication connection with the secondary instance [XXXX] for [NNNN] seconds. The frequency of recording this warning message can be adjusted with the soft connection attempt period (the fourth -CONNECTPARAM).

Action: Use the REPLALERT message as a mechanism to alert operations about replication network issues. Specify 0 as the REPLALERT period parameter (the fourth -CONNECTPARAM) to disable logging this message. The REPLALERT messages are disabled by default (that is, without specifying -CONNECTPARAM).

