

GT.M

Release Notes

V7.1-006

Empowering
the Financial World

FIS

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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		
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V7.1-006

Overview

V7.1-006 provides some additional sting primitive capabilities and the ability to autodelate autodbs as well as numerous changes aimed at improving ease of use and also a number of fixes.

Items marked with the  symbol document new or different capabilities.

Please pay special attention to the items marked with the  symbol. 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.



Note

While FIS keeps message IDs and mnemonics quite stable, message texts change more frequently as we strive to improve them, especially in response to user feedback. Please ensure you review any automated scripting that parses GT.M messages.

Conventions

This document uses the following conventions:

Flag/Qualifiers	- (dash)
Program Names or Functions	upper case. For example, MUPIP BACKUP
Examples	lower case. For example: mupip backup -database ACN,HIST /backup
Reference Number	A reference number enclosed between parentheses () used to track software enhancements and support requests.
Platform Identifier	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 x86_64.

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, we refer to the combination of operating system and hardware architecture as a platform. We deem this set of specific versions: 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. We deem this larger set of versions: 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 and therefore deem them: 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 reference plugin has its own additional requirements.

Platform	Supported Versions	Notes
IBM Power Systems AIX	7.1 TL 5, 7.2 TL 5, 7.3 TL 2	<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 instfix -ik IZ87564.</p>

Platform	Supported Versions	Notes
		<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>
<p>x86_64 GNU/Linux</p>	<p>Red Hat Enterprise Linux 7.9, 8.10, 9.4; Ubuntu 20.04 LTS, and 22.04 LTS; Amazon Linux 2</p>	<p>To run 64-bit GT.M processes requires both a 64-bit kernel as well as 64-bit hardware. As of V7.1-001, GT.M on x86-64 requires hardware/virtualized support for AVX instructions.</p> <p>GT.M should also run on recent releases of other major Linux distributions with a contemporary Linux kernel (2.6.32 or 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 or later.</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 must ensure that your kernel includes commit d2dc317d564a46dfc683978a2e5a4f91434e9711 (search for d2dc317d564a46dfc683978a2e5a4f91434e9711 at https://www.kernel.org/pub/linux/kernel/v4.x/ChangeLog-4.0.3). 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>

Platform	Supported Versions	Notes
		<p>Our testing has shown an interaction between glibc 2.36 and all versions of GT.M on Linux/x86_64 systems without AVX2 support. This can cause segmentation violations (SIG-11) in processes performing concurrent updates to the same database block, which terminate the process, but do not damage the database. The issue is due to the way glibc performs certain memory operations when using SSE2 instructions. The glibc behavior was subsequently modified to avoid this issue, and the change was included in glibc 2.37. Linux/x86_64 systems with support for AVX2 instructions are not vulnerable, as glibc chooses its AVX2 implementation, when available, over its SSE2 implementation, and the problematic behavior is specific to SSE2. Note, depending on how CPU virtualization is configured, that virtual environments may not support AVX2 even if the underlying hardware does.</p> <p>Ubuntu 24.04 LTS is Supportable.</p> <div style="border: 1px solid black; padding: 10px; margin-top: 10px;">  <p>Note</p> <p>FIS recommends recompiling the reference encryption plugins to match the target platform. See Compiling the Reference Implementation Plugin section for instructions.</p> <p>OpenSSL 3.0 by default does not allow client-side initiated TLSv1.2 renegotiation requests due to potential DoS attacks. Because of this, the reference TLS implementation in GT.M versions before V7.0-004 do not use the appropriate OpenSSL 3.0 API to enable support for client-side initiated TLSv1.2 renegotiation. Customers needing to replicate to/from GT.M versions before V7.0-004 with OpenSSL 3.0 must use -RENEGOTIATE_INTERVAL=0 in the Source Server startup. This limitation only affects database replication and not SOCKET devices.</p> </div>



Important

Effective V7.0-003, GT.M is no longer Supportable on the 32 bit x86 platform. Please contact your FIS account manager if you need ongoing support for GT.M on this platform.

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.

We support GT.M releases in a rolling support model based on two years of certified releases. A release becomes no longer officially supported once a given release is more than one release beyond the two year window. Historically we have produced GT.M releases on a quarterly basis, subject to change. Note: customers always get the best support by staying current with releases as they are made available.

FIS will continue to attempt to support any release of GT.M in use by a Profile customer under that client's maintenance agreement, while that agreement is still in effect. FIS's ability to provide an appropriate level of support may become increasingly costly to the client. In other words, FIS may need to enact a special maintenance agreement to continue to provide support. The additional costs required would be maintain client release level specific servers, operating systems and other ancillary software for a given and reasonable time frame beyond the normal window.

FIS policy is only to provide remediation, in the current release, for identified issues in generally available and supported releases. It is not FIS policy to provide ongoing support of client specific release levels of unsupported software.

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

GT.M as Open Source Software (OSS)

FIS maintains and releases GT.M on Linux as OSS. GT.M does not include any OSS libraries.

However, using some GT.M capabilities activates APIs that require the user make some OSS software available:

- Compression: zlib
- Encryption: libconfig and openssl (or equivalent as determined by the encryption plugin); key management is the user's responsibility
- UTF-8 mode: libicuio

while those are what FIS tests with, as long as the API is compatible, substitutions should work.



Note

Linux distributions include various OSS components some of which GT.M relies on.


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 V7.1-006 in a Filesystem Hierarchy Standard compliant location such as `/usr/lib/fis-gtm/V7.1-006_arch` (for example, `/usr/lib/fis-gtm/V7.1-006_x86_64` on Linux systems). A location such as `/opt/fis-gtm/V7.1-006_arch` would also be appropriate.
- 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 `gtmconfig` 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 the example / reference implementation plugin in support of database encryption, TLS replication, or TLS sockets, you must compile the reference plugin in order to match the shared library dependencies specific to your platform. The instructions for compiling the Reference Implementation plugin are as follows:

1. Install the development headers and libraries for libgcrypt, libgpgme, 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. For example, on RHEL 9 the libraries required to recompile the reference implementation encryption plugin are libgcrypt-devel, gpgme-devel, libconfig-devel, and openssl-devel.

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
4. When reinstalling or upgrading GT.M, stop existing gpg-agents. The agents may be working with information about the prior GT.M installation, such as GNUPGHOME, that will not work with the new version. Additionally, if the process deletes the GPG agent's socket, proper operation requires a new agent.
5. It is a good idea to read the Administration and Operations Guide section entitled "Special note - GNU Privacy Guard and Agents" and re-evaluate the GPG configuration options in use.

Re-evaluate TLS configuration options

The GT.M TLS reference encryption plugin implements a subset of options as documented in the OpenSSL man page for `SSL_set_options` which modify the default behavior of OpenSSL. Future versions of the plugin will enable new options as and when the OpenSSL library adds them. To enable options not supported by the GT.M TLS reference plugin, it is possible to create an OpenSSL configuration for GT.M processes. See the OpenSSL man page for "config".

<para/>

Upgrading to V7.1-006



Before you begin

GT.M supports upgrade from V5*, V6.* and V7.* versions to V7.1-006.

GT.M does not support upgrading from V4* versions. Please upgrade V4 databases using instruction in the release notes of an appropriate GT.M V6.* version.

The GT.M database consists of four types of components- database files, journal files, global directories, and replication instance files.

GT.M upgrade procedure for V7.1-006 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

Before starting, read the upgrade instructions of all stages carefully. Your upgrade procedure for GT.M V7.1-006 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 V7.1-006.
- Execute the EXIT command. This command automatically upgrades the Global Directory.
- 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 V7.1-006.
- 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.

An analogous procedure applies in the reverse direction.

Stage 2: Database Files Upgrade

Before starting the database file upgrade, use the prior GT.M version to perform an appropriate MUPIP action (i.e. `ROLLBACK`, `RECOVER`, `RUNDOWN`) to remove abandoned GT.M database semaphores and release any IPC resources.

There are three upgrade paths available when you upgrade to V7.1-006.

V7 Upgrade Path 1: In-place Upgrade

To upgrade from GT.M V7*:

There is no explicit procedure to upgrade a V7 database file when upgrading to a newer V7 version. After upgrading the Global Directory, opening a V7 database with a newer V7 GT.M process automatically upgrades the fields in the database file header.

To upgrade from GT.M V6* (or V5*):

There are two phases to upgrade from V6 to V7:

- Phase 1: MUPIP `UPGRADE` phase; requires standalone access
- Phase 2: MUPIP `REORG -UPGRADE` (GVT Index Block Upgrade); may optionally run with concurrent access if performance is acceptable

Both phases operate once per region. Phase 1 is not restartable. Phase 2 is restartable.

While these are the basic steps, customers must integrate them with appropriate operational practice and risk mitigating procedures, such as comprehensive testing, backup, integrity checks, journal and replication management, and so on based on their environments and risk tolerance. FIS strongly recommends performing a MUPIP `INTEG (-FAST)`, of the database and creating a backup prior to upgrade. Customers must test these utilities against copies of their own production files, using their planned procedures, before undertaking the conversion of current production files.

Using MUPIP `UPGRADE` and MUPIP `REORG -UPGRADE` should be a significantly faster alternative to using MUPIP `EXTRACT` and `LOAD`. FIS favors using a "rolling" upgrade using a replicated instance.

Whatever the approach you choose, FIS requests capturing all logs in case there are issues or questions leading to support requests.

Phase 1: Standalone MUPIP UPGRADE

MUPIP UPGRADE performs Phase 1 actions of upgrading a database to V7. The format of the UPGRADE command is:

```
MUPIP UPGRADE {-FILE <file name>; | [-REGION] <region list>}
```

As the GT.M version upgrade changes the journal format to support 64-bit block pointers, MUPIP UPGRADE does not maintain journal files or replication; configured journaling and replication resumes for activity after MUPIP UPGRADE.

UPGRADE:

- Requires standalone access
- Turns off journaling and replication for the duration of UPGRADE
- When encountering an error where the command specifies multiple regions, UPGRADE moves on to the next region, while for a single file/region, it terminates; avoid any unnecessary <CTRL_C> or MUPIP STOP (or kill) of an active MUPIP UPGRADE process, as such an action leaves the database region effectively unusable
- Estimates and reports the space required for its work
 - UPGRADE estimates are intended to be generous, and, particularly for small databases, they may seem unnecessarily large
 - If MUPIP is not authorized to perform a required file extension, that is, the extension amount is defined as zero (0), it produces an error before it does anything that would damage the selected database file
- Moves blocks from immediately after the existing master map to make room for a V7 master map
 - Depending on the block size and the GT.M version with which it was created, the new starting Virtual Block Number (VBN), the location of block zero for the database file, may exceed the starting VBN for a database created with V7, which causes a minor waste of space
 - UPGRADE relocates blocks in multiples of 512 to align blocks with their local bitmaps
- Eliminates any globals that previously existed, but have been KILL'd at the name level; these global variable trees (GVTs) contain only a level one (1) root block and an empty data (level zero) block and are "invisible" to the GT.M process run-time
- Stores the offset GT.M must apply to the original block pointers as a consequence of the relocation of the starting VBN
- Upgrades the directory tree (DT) block pointers from 32- to 64-bits; this requires splitting any blocks that do not have sufficient space to accommodate the larger block pointers

- Ensures that all is work is flushed to secondary storage
- Reports completion of its activity on a database file with a "MUPIP MASTERMAP UPGRADE completed" message

At this point, after a successful MUPIP UPGRADE:

- All DT blocks are in V7m format and all GVT index blocks remain in V6/V6p format
- Subsequent activity that updates index blocks for existing GVTs implicitly converts any V6 index blocks to V6p format after applying the offset
- No process other than MUPIP REORG -UPGRADE converts GVT index blocks from V6p format to V7m format; in other words, adding new nodes does not create GVT index blocks with V7 format - adding new nodes splits existing index blocks and such block splits retain the pre-existing block format
- Newly created GVTs, storing new global names, have V7m format
- Data blocks, at level zero (0), and local bit map blocks have the same format in V6 and V7, so, for consistency, normal updates also give those blocks a V7m format designation

These database changes are physical rather than logical, and thus do not require replication beyond noting the increase in transaction numbers.

Phase 2: MUPIP REORG -UPGRADE (GVT Index Block Upgrade)

MUPIP REORG -UPGRADE performs Phase 2 actions of upgrading a database to V7 format. The format of MUPIP REORG -UPGRADE is:

```
MUPIP REORG -UPGRADE {-FILE <file_name> | [-REGION] <region_list>}
```

Before image journaling with MUPIP REORG upgrade provides maximum resiliency. MUPIP REORG -UPGRADE reports it has completed its actions for a region with a MUPGRDSUCC message, at which point all index blocks have V7m format with 64-bit block pointers. You can resume and complete a MUPIP REORG -UPGRADE stopped with a MUPIP STOP (or <Ctrl-C>); avoid a kill -9, which carries a high risk of database damage.

MUPIP REORG -UPGRADE:

- Requires standalone access
- Runs on an entire region; as a result, MUPIP REORG -UPGRADE prevents multiple concurrent REORG -UPGRADE runs per region
- Stops execution when a concurrent Online ROLLBACK is detected because that operation changes the block content of the database
- Can be subject to stopping and restarting at any point
- Processes the GVTs within a database file

- Splitting any index blocks that do not have sufficient space to accommodate the block pointer upgrade from 32 to 64 bits
- Updating the block pointers from 32 to 64 bits, also changing the version of the block to V7m
- Journaling its work as before images (if so configured) and INCTN records

Phase 3: Optional GVT Data and Local Bit Map Block Upgrade

While it makes no operational or processing difference, GT.M does not consider the database "fully upgraded" until the block version format of all data blocks becomes V7m. Any of the following operations upgrade some or all of the remaining data blocks:

- MUPIP REORG

Because this operation may not visit every block in the database it may fail to upgrade static/unchanging blocks

- MUPIP REORG -ENCRYPT

- MUPIP INTEG -TN_RESET

This operation requires standalone access and resets the transaction number on all blocks in the database.

Failure to perform Phase 3 has **NO** implications for V7.1-006 but might be an issue for any as-yet unplanned further enhancement.



Important

Taking the steps in the following list that use MUPIP REORG -MIN_LEVEL=1 significantly reduce upgrade time.

The following lists the recommended ordered steps for the full upgrade process:

1. Offline Upgrade instance to use new GT.M V7.1-002+ version - at this point, customers can use the upgraded the GT.M version without any DB changes
2. Online MUPIP SET -INDEX_RESERVED_BYTES=n - where n is 1/3 the block size
3. Online MUPIP REORG -MIN_LEVEL=1 -NOSWAP - free up space in all index blocks to ease the block reference change from 32bits (4bytes) to 64bits (8bytes); this operation alters only index blocks (-MIN_LEVEL=1), and so generates a much lower volume of before image journal records.
4. Offline MUPIP UPGRADE -move blocks around to make space for the expanded master bitmap and upgrade the index blocks in the directory tree (tree of Global names).
5. Online MUPIP REORG -UPGRADE - upgrade the remaining index blocks

6. Online MUPIP SET -INDEX_RESERVED_BYTES=0 - remove the previously applied reservation as it is no longer needed; some application may find it produces a continuing performance benefit.
7. (optional) Online REORG -MIN_LEVEL=1 -NOSWAP -NOSPLIT - coalesce the index blocks to leave index blocks in a less fragmented state

V7 Upgrade Path 2: EXTRACT and LOAD

Two commonly used mechanisms are as follows. We recommend you use replication to stage the conversion and minimize down time.

- MUPIP EXTRACT -FREEZE followed by a MUPIP LOAD

Using MUPIP EXTRACT with -FREEZE ensures that the V6 database files are frozen at the point of the extract, preventing updates without administrative action to unfreeze the database. MUPIP LOAD the extracts into newly created V7 database files

Use this operation when there is insufficient space to make a database extract

- MERGE command with two global directories and Extended References

Using this approach to transfer data from a V6 database file to a V7 database, administrators must take some action to prevent updates during the transfer

This operation consumes less disk space and disk I/O. As a result the operation is faster than an EXTRACT and LOAD.



If you are using triggers, extract the triggers from the V6 database and load them in the new V7 database.

V7 Upgrade Path 3: No change

Continue using your V6 databases with GT.M V7.1-006. In case you do not wish to operate with files of differing format, specify the -V6 qualifier when invoking MUPIP CREATE.

Choosing the right upgrade path

Choose V7 Upgrade Path 1 or 2 if you anticipate a database file to grow to over 994Mi blocks or require trees of over 7 levels as V7.1-006 supports 16Gi blocks and 11 levels. Note that the maximum size of a V7 database file having 8KiB block size is 114TiB (8KiB*16Gi).

Choose the V7 Upgrade Path 3 if you do not anticipate a database file to grow beyond the V6 database limit of 994Mi blocks or a tree depth limit of 7 levels. Note that the maximum size of a V6 database file having 8KiB block size is 7TiB (8KiB*992Mi).

Other than the new maximum database file size and greater tree depth that comes with V7 Upgrade Path 1 and 2, there is no difference between V7 Upgrade Path 1 and 2 and V7 Upgrade Path 3. You can choose V7 Upgrade Path 3 first and then later choose V7 Upgrade Path 1 or 2 if a need arises.

For additional details on differences in factors involved in the V6 to V7 upgrade refer to Appendix G in the GT.M Administration and Operations Guide.

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 the V5 version of 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 through V6.3-014 have a maximum size of 1,040,187,392 (992Mi) blocks.
- Database created with V7.0-000 and up have a maximum size of 17,112,825,856 (~16Gi) blocks.

Stage 3: Replication Instance File Upgrade

GT.M V7.1-006 does not require new replication instance files when upgrading from any version after V6.0-000.

Stage 4: Journal Files Upgrade

On every GT.M upgrade:

- Create a fresh backup of your database
- Generate new journal files (without back-links), typically by turning journaling OFF and then back ON



Important

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

MUPIP UPGRADE temporarily disables journaling and replication settings for the duration of its activity. Once complete, MUPIP UPGRADE restores prior settings.

Stage 5: Trigger Definitions Upgrade

GT.M V7.1-006 does not require trigger definition upgrade when upgrading GT.M from any version after V6.3-000. If upgrading from a prior GT.M release, please see the instructions in the release notes for V6.3-014.

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. During installation, GT.M provides an option that allows placing the object code in shared libraries in addition to 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_V7.1-006_i686`, then `gtmprofile` sets `$gtm_dist` to `/usr/lib/fis-gtm/gtm_V7.1-006_i686/utf8`).
 - On platforms where the object files have not been placed in a `libgtmutil.so` shared library, the last element of `$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.

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Change History

V7.1-006

Fixes and enhancements specific to V7.1-006:

Id	Prior Id	Category	Summary
GTM-8647	GTM-DE201061	Language	✔ Changes to OPEN and USE handling of terminal device parameters, especially with split \$PRINCIPAL ✔
GTM-9830	GTM-DE572556	Admin	Prevent replication shutdown with wrong version and protect replication instance file
GTM-9913	GTM-F135036	DB	✔ Reduce bit map restarts
GTM-10677	-	Language	Optional 4th argument for \$[Z]TRANSLATE() to focus its actions on the front and/or back of the 1st argument ✔
GTM-10714	-	DB	✔ GT.M supports AUODELETE for sutodb database files ✔
GTM-10846	-	Admin	Eliminate an occasional discrepancy in blocks-to-upgrade
GTM-10876	-	Admin	Resolve rare deadlock caused by concurrent execution of MUPIP ROLLBACK -ONLINE and MUPIP REORG -UPGRADE
GTM-10889	-	Language	\$ZREPLACE() for sub-string replacement ✔
GTM-10894	-	Other	Prevent libjsig.so warning message when used with LD_PRELOAD

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Database

- For databases using the BG access method, GT.M attempts to minimize metadata concurrency conflicts on the bit maps it uses for space management. The algorithm it employs may occasionally cause aggressive file extensions. Please review the extension size for production databases to see they are appropriately large; remember existing databases can be adjusted with MUPIP SET, but GDE changes only apply at MUPIP CREATE and the two may best be maintained in tandem. Previously customers expressed concerns over the number of bit map restarts.



Warning:

A single bit map controls 512 blocks. A file extension count less than 512 will trigger numerous file extensions. Customers should configure optimal file extension counts for their applications.

(GTM-9913) 🟡

- GT.M supports AUTODELETE DBs, a type of autodb automatically deleted when the final user exits. Users may specify any non-journaled autodb as an -AUTODELETE region using GDE. GT.M handles autodb creation and initialization under a fine-grained locking mechanism, allowing concurrent initialization of multiple autodbs. GT.M treats statsdbs as AUTODELETE autodbs, and statsdb deletion can occur while other operations appropriately continue in the corresponding base DB. Previously, deletion of autodbs required operational actions without support from GT.M, statsdb recreation contended with processes attaching to a base DB, and statsdbs remained in existence as long as the base DB was active, even if all statsdb activity ceased. (GTM-10714) 🟡 🟢

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Language

- A USE command applies terminal device parameters specified for a split \$PRINCIPAL device only to a terminal device and only if appropriate for input or output. Previously, USE inappropriately applied some parameters to the non-terminal device side of a split \$PRINCIPAL device which could have caused unexpected behavior. In addition, an OPEN command applies a specified [NO]WRAP parameter for a terminal; previously, it ignored [NO]WRAP on OPEN of a terminal. (GTM-8647) 🚫 ✅
- When the fourth argument specifies "L", "R" or "B" corresponding to Left, Right, or Both, \$[Z]TRANSLATE() selectively translates, or, if the third argument is NULL, omits, characters for \$TRANSLATE() or bytes for \$ZTRANSLATE() from the specified side(s) of the first argument, based on the second argument (characters or bytes to replace). \$[Z]TRANSLATE() continues until it encounters a character or byte not found in the second argument on a side of the first argument specified in the fourth argument. Note that without a fourth argument, \$[Z]TRANSLATE() operates in the standard fashion, and with a fourth argument of "B" they may perform asymmetric replacements or removals. Previously, \$TRANSLATE() did not support a four-argument format. (GTM-10677) ✅
- \$[Z]REPLACE() returns a transformed representation of the first argument by replacing occurrences of the second sub-string argument with the third sub-string argument. Previously, GT.M did not support \$[Z]REPLACE(). (GTM-10889) ✅

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System Administration

- GT.M produces a REPLINSTFMT error when the replication instance file format does not match the format expected by MUPIP; this prevents the Replication Server from shutting down. Note that following the installation instructions should prevent this situation. Previously, a mismatch between the software and the replication instance file left the replication instance file damaged, even though the Receiver Server properly shutdown. (GTM-9830)
- GT.M processes maintain blocks-to-upgrade count correctly. Previously, under rare circumstances, GT.M process could miss decrementing the blocks-to-upgrade count which resulted in a DBBTUWRNG error from MUPIP INTEG. (GTM-10846)
- MUPIP ROLLBACK -ONLINE verifies that a concurrent MUPIP REORG -UPGRADE still exists before waiting for the concurrent activity to end. MUPIP REORG -UPGRADE does not cause a deadlock by failing to recognize a concurrent MUPIP ROLLBACK -ONLINE. GT.M processes clear the MUPIP REORG -UPGRADE in-progress flag if none is running. When doing so, processes issue the PIDRESET message to indicate the reset. Previously, if a MUPIP REORG -UPGRADE terminated unexpectedly without clearing the MUPIP REORG -UPGRADE in progress flag, it could not be cleared until another MUPIP REORG -UPGRADE executed. While this did not impact the operation of GT.M, it did cause conflicts with MUPIP REORG -TRUNCATE and MUPIP ROLLBACK -ONLINE. These issues were only seen during testing and not reported by a customer. (GTM-10876)

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Other

- GT.M updates for standards conformance. Previously, using MUPIP with OpenJDK's JNI library, libsig.so, defined in LD_PRELOAD could result in warning messages about calls to the deprecated signal() function when users pressed Control-C. When using GTMJI, FIS recommends using LD_PRELOAD for MUMPS software interacting with the Java environment. (GTM-10894)

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Error and Other Messages

INVALIDAUODELDB

INVALIDAUODELDB, Autodelete DB must be specified as non-journaled autodb

GDE Error: The AUTODELETE region qualifier cannot be used with a -JOURNAL qualifier.

Action: Use an appropriate combination of qualifiers

PIDRESET

PIDRESET, Region RRRR had PID PPP doing MMMM but PID did not exist, reset to zero

MUPIP Warning: The region RRRR had an internal field indicating that process PPPP was doing a MMMM, but that process no longer exists. Therefore the current process reset the field.

Action: Please check the log files for messages from the MMMM operation that terminated unexpectedly. Additional messaging from GT.M should help determine if there is a larger problem.

REPLINSTFMT

REPLINSTFMT, Format error encountered while reading replication instance file xxxx. Expected yyyy. Found zzzz.

Run Time/MUPIP Error: This error is issued by GT.M or MUPIP whenever it tries to open the replication instance file and finds that it was created with a format that the current version of GT.M cannot interpret. GT.M also produces this error when it encounters:

1. an instance file created on a different endian system or
2. Shutting down a replication server using a different GT.M version, indicating that the instance is not shutdown.

Action: Recreate the instance file using the mupip replic -instance_create command with the current version of GT.M.



The REPLINSTCORRV message that was displayed in V5.0-000 has now been replaced by REPLINSTFMT

Action: If the error is issued by GT.M review the accompanying message(s) in the operator log.

If a MUPIP SET -JOURNAL=ON command produces this message for the region in the operator log, it may indicate that one or more of the current generation journal files are damaged/missing and new

journal files were created with no back pointers to the previous journal files. FIS recommends taking a database backup at the earliest convenience because a MUPIP RECOVER/ROLLBACK will not be able to go back past xxxx. If this message is for a specified region(s), consider switching the journal files for all regions (with REGION "**") that the process has opened (all journaled/replicated regions in the instance if replication is in use) to ensure that the RECOVER/ROLLBACK for other regions remains unaffected.

No action is required if the MUPIP BACKUP -NEWJNLFILES=NOPREVLINK issues the error.

TPTIMEOUT

TPTIMEOUT, Transaction timeout

Run Time Error: This indicates that the transaction took too long to process successfully. Timeouts prevent runaway processes, damage from software bugs, and transactions so large as to be hostile to other users.

Action: Review the message(s) for any information about the cause of the transaction timeout, and/or research what the process was doing at the time of the warning or error. If the transaction uses custom programs, routines, or functions, they may need to be debugged.