



SANTA-G TEST REPORT

SOFTWARE TEST AND VALIDATION REPORT

WP4 TASK4 - Verification and Quality Control

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Abstract: This report describes the tests of the SANTA-G non-invasive monitoring tool developed by CrossGrid WP3 task 3.3.2. The tests were performed by CrossGrid task 4.4.



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1. CONTEXT

Test and validation of the SANTA-G v1.1.2 non-invasive network traffic monitoring tool developed by CrossGrid WP3 task 3.3.2.

1.1. TEST REQUEST

A properly formatted request test form was sent by e-mail to Mario David (david@lip.pt) on 18 August 2003. The URL's for the following documents were also sent: Installation manual [1], Users manual [2], Software requirements [3] and Software design [4]. All documents are provided in a RPM package: "cg-wp3.3.2-santag-doc-1.1.2-1".

Both the development manual and the unit test programs were not available. In spite of these limitations, the test procedure was applied.

The test requester was Stuart Kenny (stuart.kenny@cs.tcd.ie) from TCD and CrossGrid WP3 task 3.3.2. The test was authorized by Jorge Gomes (jorge@lip.pt) from the WP4 integration team.

1.2. TEST TEAM

The following task 4.4 members from LIP performed the tests.

- Mário David (david@lip.pt)
- João Martins (martinsj@lip.pt)
- Jorge Gomes (jorge@lip.pt)

1.3. RESOURCES INVOLVED

The tests involved a R-GMA server system (fm01.lip.pt) hosting the Fabric Monitoring, Information Catalog and MDS services and a User Interface (ui02.lip.pt). These systems are part of the development testbed deployed at LIP running RedHat 7.3 and EDG 2.0.0.

2. TEST AND VALIDATION

2.1. SOFTWARE INSTALLATION

The SANTA-G packages were provided in RPM format, the version was 1.1.2. As required in the test request, the operating system used was RedHat 7.3 with the middleware EDG 2.0.0, which provides the latest version of R-GMA v3.2.22.

A LCFGng server was used for the installation of the RPM's. The following RPM lists were created:

- santag-server-rpm.h:
 - ❖ cg-wp3.3.2-santag-common-1.1.2-1
 - ❖ cg-wp3.3.2-santag-queryengine-1.1.2-1
 - ❖ cg-wp3.3.2-santag-sensor-1.1.2-1
 - ❖ cg-wp3.3.2-santag-viewer-1.1.2-1
 - ❖ cg-wp3.3.2-santag-doc-1.1.2-1
 - ❖ cg-wp3.3.2-santag-examples-1.1.2-1
- santag-client-rpm.h:
 - ❖ cg-wp3.3.2-santag-common-1.1.2-1
 - ❖ cg-wp3.3.2-santag-sensor-1.1.2-1
 - ❖ cg-wp3.3.2-santag-doc-1.1.2-1
 - ❖ cg-wp3.3.2-santag-viewer-1.1.2-1
- santag-viewer-rpm.h:
 - ❖ cg-wp3.3.2-santag-viewer-1.1.2-1

For the tests, the RPM list `santag-server-rpm.h` was included in the `fm01.lip.pt` list and `santag-client-rpm.h` was included in the `ui02.lip.pt` list.

The command `"/etc/obj/updaterpms start"` was issued in both systems (`fm01` and `ui02`). The software was properly installed and no dependency problems were detected. The software on which SANTA-G depends upon was already installed, namely: R-GMA v3.2.+ and Java SE v1.4.

However there was a problem with the version of TCPdump. The "Test Request" specified `tcpdump 3.7` as a requirement. This version is only available in RPM format for RedHat 9 and compiled with `glibc-2.3`. The problem was circumvented by compiling the source code in a RedHat 7.3 system and manually copying the `tcpdump` executable to the necessary systems (`fm01` and `ui02`). This issue has to be taken into account in the near future.

The software installs under `/opt/cg` as required by the Crossgrid guidelines. Other installation procedures seem to be compliant with these guidelines.

2.2. SOFTWARE CONFIGURATION

The configuration has to be done manually after installation. There were no LCFGng components or source profiles for the automatic configuration through LCFGng. The instructions of the "Installation manual" were followed.

The system fm01.lip.pt had R-GMA already configured and running, i.e., it had the Registry and Archiver servlets. MySQL and tomcat4 needed to support the Consumer servlets were also running. Therefore, fm01.lip.pt was chosen to be the SANTA-G server. The SANTA-G configuration script was then executed following the installation manual instructions:

```
[root@fm01 sbin]# /opt/cg/sbin/santag-config
----- SANTA-G Setup Script -----
Please report any problems to Stuart Kenny at stuart.kenny@cs.tcd.ie

SANTA-G Install Directory [/opt/cg]:
R-GMA props file location [/opt/edg/etc/edg-rgma]:
Please enter the hostname of the QueryEngine host [localhost]:
Please enter the port number on which the QueryEngine should listen [8998]:
Turn on QueryEngine logging (y/n) [n]:
Would you like to run a dynamic sensor (y/n) [n]:
Enter the path to the directory which stores the TCPdump log files
[/opt/share/santag/exampleTrace]: /opt/cg/share/santag/exampleTrace
Please enter the MySQL server hostname [localhost]:

#####
# The configuration variables have been written to
# two files:
# etc/santag/QueryEngine.conf
# etc/santag/Sensor.conf
# These two files can be edited by hand if required.
#####
```

The system fm01.lip.pt was configured to run the SANTA-G Query Engine. For this purpose another script had to be executed in order to create the necessary MySQL tables through which the Query Engine would produce the information (using the Canonical Producer servlet):

```
[root@fm01 sbin]# /opt/cg/sbin/create-sensor-db
Please enter the MySQL server hostname [localhost]:
Please enter the MySQL root password on []:
```

The SANTA-G configuration script was also executed in ui02.lip.pt system indicating that the Query Engine and MySQL server were running in fm01.lip.pt.

With this configuration, the Sensor Engine could be executed in both elements.

The distribution provides “*init.d*” scripts to start both the Query Engine and the Sensor:

```
/opt/cg/etc/init.d/cg-santag-queryengine
/opt/cg/etc/init.d/cg-santag-sensor
```

Issues related to the configuration and start of the daemons will be reported in section 3.

2.3. ADDITIONAL TESTBED MODIFICATIONS

No changes or additional configuration was necessary in other testbed elements for the software to be usable.

2.4. TEST DEVELOPMENTS

No software was developed by the test team to test and validate the software.

2.5. USABILITY

The SANTA-G software deployment depends critically on the correct deployment and configuration of the R-GMA software distributed by EDG. Assuming the correct deployment of R-GMA, SANTA-G is easy to deploy but not easy to use and understand.

Concerning the configuration and usage of the Query Engine, Sensor and Viewer, it depends on the location of the R-GMA properties (*props*). The lack or incorrect location of those props leads to:

- Errors on the Query Engine daemon startup, which are misleading.
- The Viewer takes “infinite” time to start and gives no error messages. The log file produced by the Query Engine does not contain any error message hinting the problem.

If the tracefile contains only TCP, UDP or ICMP packets, the Viewer, i.e., the user is able to view them and perform queries, although the whole packet content is not available, which can be a major limitation. If it contains also other types of packets like ARP, the viewer gives the message of “*Unknown packet type*”. Although it is possible to continue to browse the other packets, it is not possible to perform queries. Query execution to such tracefiles hangs the Viewer.

When everything is in its right place, the interactive response speed seems acceptable.

2.6. FUNCTIONALITY

The full functionality will only be possible to test after availability of the other monitoring tools for which the SANTA-G net tracing information is complementary.

There are two modes in which the Sensor can be configured: DYNAMIC and STATIC.

When the DYNAMIC Sensor is started, it captures live network packets using TCPdump and writes them to a tracefile. In this mode the Viewer fails to start, i.e., it fails to make some initial queries to the Query Engine. The correct use of this mode is not explained in the Installation or User manuals. Therefore, it was not possible to use this mode in combination with the Viewer and only the STATIC Sensor was used and tested in combination with the Viewer. This is a major limitation. Another issue that prevents the usage of the dynamic sensor is its capture behaviour. Once started the dynamic sensor does not go into daemon mode and stays attached to the terminal from which was started capturing data to the tracefiles files. The tracefiles in the capture directory should be closed after reaching 1MB and moved to an upper directory where they would be visible to the query engine. Unfortunately, this does not happen and therefore the captured data is never made available to the Query Engine.

The STATIC Sensor makes use of files containing previously captured network packets produced by TCPdump. Therefore this mode is not interesting for real use, however it is useful for testing and debugging the Query Engine, the Viewer and R-GMA setup.

In any case, the tracefiles have to be in a directory accessible to the Query Engine although the Sensor can be running in any other system. The capability of having multiple sensors running in multiple systems with just one Query Engine is very useful since the Sensor deployment must be simple to allow its installation in any machine. Unfortunately, the requirement of having direct access to the tracefiles from the Query Engine prevents the decoupling between the sensors and the Query Engine.

It was observed that even when the tracefiles are not directly accessible by the Query Engine their names are shown in the Viewer since the Sensor passes the file names to Query Engine. However, when queries are performed on those files the Viewer hangs. In addition, no error is reported, and the Viewer has to be “killed”. It would be very useful if the Query Engine could also access the tracefile through the network taking profit from the decoupling.

The SANTA-G user requirements states that SANTA-G will have three main functions:

- Allow a user to initiate non-invasive tracing of grid resources through tcpdump.
- Allow a user to select the required subset of trace data through the grid information system and persistently store it in a relational trace database and provide access to this data for further analysis.
- Provide information required by other CrossGrid subsystems.

The release tested does not allow a general user to initiate the non-invasive tracing since the trace must be started through the “*init.d*” mechanism at boot time and needs root privileges. This major functionality is lacking from the tested release. In the future SANTA-G should allow a general user to remotely start and stop a specific sensor after proper authentication and authorization. Currently the sensor must be running permanently which means that the system hosting the sensor may suffer a high performance impact depending on the amount of network traffic seen by the interface.

Similarly SANTA-G does not allow a general user to specify the packet capture selection for the tracefiles. The tested release requires the capture selection expression to be specified in a sensor configuration file and the sensor restarted. Actually the tests performed seem to show that the specification of a capture expression in the configuration file does not work since actually all packets are captured disregarding the selection entered. In the future SANTA-G should provide functionality to allow a general user to remotely specify the tcpdump packet capture expression for a specific sensor. Allowing the user to specify the capture expression will also allow reducing the performance impact on the system hosting the sensor since the amount of data to be written in the tracefiles will be much reduced.

Some of the software flaws were reported in the previous section and will be further detailed in the “Issues” section.

2.6.1. Unit tests

The tests performed consisted in the following:

- Correct startup of the Query Engine daemon.
- Correct startup of the Sensor daemons, both STATIC and DYNAMIC modes.
- Inspection of the MySQL database “*sensor*” tables.

Some errors in the Query Engine daemon startup were detected. These errors were related with incorrect R-GMA props location and with a `log4j` option:

```
[root@fm01 init.d]# ./cg-santag-queryengine start
Starting QueryEngine:
log4j:ERROR Could not find value for key log4j.appender.A1
log4j:ERROR Could not instantiate appender named "A1".
Schema path          =/opt/cg/etc/santag/Schema/db.rschema
Reverse Schema path  =/opt/cg/etc/santag/Schema/db.schema
/opt/cg/varsantag-queryengine.pid
QueryEngine started: [ OK ]
```

The following option is commented by default in the `log4j.props` file, and had to be uncommented:

```
log4j.appender.A1=org.apache.log4j.ConsoleAppender
```

After the solution of the previous errors, the Sensor daemon gave the following error:

```
[root@fm01 init.d]# ./cg-santag-sensor start
Starting Sensor:
/santag-sensor.out: No such file or directory
NetTracer Sensor running...
Sensor started: [ OK ]
```

The error was caused by the environment variable “CG_TMP” not being set. The usage of this variable is in accordance with the CrossGrid developer’s manual.

The distribution contains a file named `/opt/cg/etc/santag/cg-santag-sensor.in` that is used by the SANTA-G configuration script to build the shell scripts to be sourced at startup. These scripts set the required environment variables. The following was added to this file in order to have a proper default value for “CG_TMP”:

```
if [ -z $CG_TMP ]; then
    CG_TMP="/tmp"
fi
```

After this fix, the Sensor was started successfully in STATIC mode in the `fm01.lip.pt` and `ui02.lip.pt` systems. Inspection through the MySQL database “*sensor*” table has shown all files and running sensors registered in the Query Engine.

Afterwards the Sensor was configured to run in DYNAMIC mode in the fm01.lip.pt system. The SANTA-G configuration script has the capability to pass options for the TCPdump program. Although this was done, the options were not written in the `/opt/cg/etc/santag/Sensor.conf` file. Therefore, the sensor configuration file had to be manually edited to add the following TCPdump capture expression:

```
SENSOR.TCPDUMPARGS=-a tcp or udp
```

The above option should restrict the TCPdump packet capture only to “tcp” or “udp” packets.

Starting the Sensor daemon in DYNAMIC mode does not return the prompt, i.e., it runs in foreground attached to the terminal from which was started. The Sensor can be stopped with CTRL-C, or by killing the process. During the Sensor execution, it was verified that the tracefiles were being produced:

```
/opt/cg/share/santag/exampleTrace/tcpdump
[root@fm01 tcpdump]# ll
total 3092
-rw-r--r--  1 root   root    1000077 Sep  9 12:29 dumpfile
-rw-r--r--  1 root   root    1000017 Sep  9 12:51 dumpfile2
-rw-r--r--  1 root   root    1000063 Sep  9 13:12 dumpfile3
-rw-r--r--  1 root   root    137963 Sep  9 13:15 dumpfile4
```

The number of lines or file size of the tracefiles is not configurable, so each file has a fixed size of 1MB. When a file reaches this size it is closed and a new one is open. Although the Sensor was configured to capture only “tcp” or “udp” packets, the tracefiles contained all types of packets, apparently the options in the `Sensor.conf` file were somehow ignored by the Sensor.

Starting the Viewer in combination with the DYNAMIC Sensor fails. Its not clear how the dynamically generated tracefiles are to be registered into the Query Engine since the Query Engine points to the directory `/opt/cg/share/santag/exampleTrace` and the sensor writes the capture packets in tracefiles stored in the directory:
`/opt/cg/share/santag/exampleTrace/tcpdump`.

2.6.2. System tests

The “system tests” consisted in executing the Viewer, opening and inspecting/querying the tracefiles through the Query Engine using Sensors running in one or more systems. The most common “error” is that the Viewer takes a very long time to start. This happens when one of the following situations occur:

- The Query Engine daemon starts but is not well configured.
- The Query Engine is running in a given machine and the STATIC Sensor and tracefiles are in a different machine, i.e., if the tracefiles are not accessible, or pointed to by the Query Engine.
- The Sensor is started in DYNAMIC mode.

Another type of error occurs when the Viewer has already started correctly. If the tracefiles have packet types other than TCP, UDP or ICMP, the visualization of individual packets fails for those

other types (such as ARP) giving a message of “unknown packet type” and performing queries hangs the Viewer.

2.6.3. Stress tests

No “stress tests” were performed.

2.7. COMPATIBILITY

The software is compliant with the other components of the distribution, the only issue is the availability of a tcpdump 3.7 RPM for RedHat 7.3.

The software is compatible with EDG 2.0 middleware.

Backward compatibility is not applicable, since this version was the first released for tests.

2.8. SECURITY

The execution of the Sensors requires root access to the systems where the sensors are to be executed.

The TCP port used for communication between the Query Engine and the Sensor and Viewer has a default value of 8998. However, the port number can be set to any other value by the SANTA-G configuration script.

The tracefiles are kept in the systems running the Sensors. Therefore these files have either to be transferred to the system running the Query Engine, or the directory where the tracefiles reside must be accessible to the Query Engine through NFS. Otherwise, each Sensor system must also contain a Query Engine, which is considered heavy and may have an impact on the packet capture by the DYNAMIC Sensor.

Currently there isn't any access control to the tracefiles information. Any Viewer can connect to a Query Engine and browse the packets in the tracefiles. The only way to restrict access to the captured data is by setting a firewall. However even this option does not offer the required granularity since it is not possible to distinguish and control the access by different users. In the future, a mechanism for authentication and authorisation preferably based in GSI should be implemented.

3. ISSUES FOUND

3.1. ISSUES FOUND IN THE SOFTWARE

3.1.1. Software issue 001

(Severity: High Priority: High)

TCPdump version 3.7 RPM not available for RedHat 7.3. This version (or higher) is required for the SANTA-G Sensor to run in DYNAMIC mode. The problem was solved for the tests by compiling the tcpdump source code in a RH7.3 system and copying the executable (and man page) to the necessary testbed systems.

3.1.2. Software issue 002

(Severity: Medium Priority: Medium)

The default values for the SANTA-G configuration script should be, as much as possible, the correct ones. For example:

```
Enter the path to the directory which stores the TCPdump log files
[/opt/share/santag/exampleTrace]: /opt/cg/share/santag/exampleTrace
```

The above directory is created and contains files from a SANTA-G RPM, so that it should be the default in the configuration script.

3.1.3. Software issue 003

(Severity: Critical Priority: Immediate)

This issue is partly due to a change between versions in the R-GMA default configuration from EDG. The directory location of the R-GMA properties (*props*) changed from `/opt/edg/etc/edg-rgma` to `/opt/edg/var/edg-rgma`. Although the R-GMA props location is configurable in the SANTA-G config script, such a change was not noticed leading to some severe issues. The Query Engine doesn't start, giving the error:

```
[root@fm01 init.d]# /opt/cg/etc/init.d/cg-santag-queryengine start
Starting QueryEngine:
Exception in thread "main" java.lang.NoClassDefFoundError:
org/edg/info/RGMAException
QueryEngine started: [ OK ]
```

A similar error also occurred in the Viewer startup. It occurs because the info.jar class file was not being invoked in the java command to execute both the Query Engine and Viewer. It is included if the location of the R-GMA props is correct along with the correct setup of some R-GMA environment variables.

This issue was solved for the tests with the help of the test requester Stuart Kenny. The documentation and the software installation should be updated to reflect the R-GMA changes.

3.1.4. Software issue 004

(Severity: Critical Priority: Immediate)

This issue is due to a R-GMA default configuration from EDG. The following error occurs in the Query Engine startup:

```
[root@fm01 init.d]# ./cg-santag-queryengine start
Starting QueryEngine:
log4j:ERROR Could not find value for key log4j.appender.A1
log4j:ERROR Could not instantiate appender named "A1".
Schema path          =/opt/cg/etc/santag/Schema/db.rschema
Reverse Schema path =/opt/cg/etc/santag/Schema/db.schema
/opt/cg/varsantag-queryengine.pid
QueryEngine started: [ OK ]
```

The following option is commented by default in the log4j.props file, and has to be uncommented:

```
log4j.appender.A1=org.apache.log4j.ConsoleAppender
```

This issue was solved for the tests with the help of the test requester Stuart Kenny, and should be referred in the documentation.

3.1.5. Software issue 005**(Severity: High Priority: High)**

This issue is related with the previous ones. Although the Query Engine gave an error, it also reports a startup status of OK that is misleading.

```
QueryEngine started: [ OK ]
```

Also related with the startup “*init.d*” scripts it was noticed that neither the Query Engine nor the Sensor daemons have the `status` option, i.e.:

```
[root@fm01 init.d]# /opt/cg/etc/init.d/cg-santag-queryengine status
[root@fm01 init.d]# /opt/cg/etc/init.d/cg-santag-sensor status
```

3.1.6. Software issue 006**(Severity: High Priority: High)**

When the environment variable `CG_TMP` is not set up, the following error occurs upon starting the STATIC Sensor:

```
[root@fm01 init.d]# ./cg-santag-sensor start
Starting Sensor:
/santag-sensor.out: No such file or directory
NetTracer Sensor running...
Sensor started: [ OK ]
```

The file `/opt/cg/etc/santag/cg-santag-sensor.in` used by the SANTA-G configuration script to generate the shell scripts which have to be sourced should be updated to provide reasonable defaults for the `CG_TMP` environment variable.

```
if [ -z $CG_TMP ]; then
    CG_TMP="/tmp"
fi
```

3.1.7. Software issue 007

(Severity: High Priority: High)

Sensor in DYNAMIC mode. The options to pass to the TCPdump program executed by the DYNAMIC Sensor, are supposed to be configured by the SANTA-G configuration script, however this does not work. These options have to be manually inserted into the `Sensor.conf` file.

Even after setting manually the option in the sensor configuration file, inspection of the produced tracefiles has shown that those options were not passed to the TCPdump program.

3.1.8. Software issue 008

(Severity: High Priority: Immediate)

Sensor in DYNAMIC mode. The test was performed running the Query Engine and the Sensor in the same system. In DYNAMIC mode, the Viewer is not able to start. The tracefiles are created in the directory `/opt/cg/share/santag/exampleTrace/tcpdump` while the directory which is being accessed by the Query Engine is `/opt/cg/share/santag/exampleTrace`. There should be a mechanism to move a closed file to the directory used by the Query Engine.

```
/opt/cg/share/santag/exampleTrace/tcpdump
[root@fm01 tcpdump]# ll
total 3092
-rw-r--r--  1 root   root    1000077 Sep  9 12:29 dumpfile
-rw-r--r--  1 root   root    1000017 Sep  9 12:51 dumpfile2
-rw-r--r--  1 root   root    1000063 Sep  9 13:12 dumpfile3
-rw-r--r--  1 root   root    137963  Sep  9 13:15 dumpfile4
```

The tracefiles should have a name that correlates the file with the hostname of the system where they were captured such as: `HOSTNAME_XXX.log`.

3.1.9. Software issue 009

(Severity: High Priority: High)

Sensor in DYNAMIC mode. There is no option to configure the size of the tracefiles, they are always 1MB.

3.1.10. Software issue 010

(Severity: High Priority: High)

The Sensor recognizes only “tcp”, “udp” and “ICMP” packet types. Therefore, other packet types like ARP give a message of “unknown packet type” in the Viewer. If queries are performed through the Viewer to tracefiles containing those “other” packet types the viewer hangs.

3.1.11. Software issue 011

(Severity: Critical Priority: Immediate)

There are several situations where the Viewer is not able to start:

- The Query Engine daemon starts but is not well configured.
- The Query Engine is running in a given machine and the STATIC Sensor and tracefiles are in a different machine, i.e., if the tracefiles are not accessible by the Query Engine.
- The Sensor is started in DYNAMIC mode.

In this case, the Viewer process has to be killed. No error messages are sent to console or logged in the Query Engine logfile explaining the problem. Better error detection and logging is required.

3.2. ISSUES FOUND IN THE DOCUMENTATION

3.2.1. Documentation issue 001

(Severity: High Priority: High)

The operation of the DYNAMIC Sensor must be better explained.

3.2.2. Documentation issue 002

(Severity: High Priority: High)

The documentation should provide suggestions or recommendations on which type of nodes the various RPM's should be installed.

3.2.3. Documentation issue 003

(Severity: High Priority: High)

The changes in the R-GMA props location or configuration should be mentioned in the installation documentation. In addition, the documentation should refer to the installation manual of R-GMA.

4. RECOMMENDATIONS

Besides the correction of the already mentioned issues the following recommendations are suggested:

- The `cg-wp3.3.2-santag-sensor` should be compiled with the dependency on the `tcpdump 3.7` package.
- A `tcpdump 3.7` RPM compiled in RH7.3 should be provided.
- A general user should be able to remotely start, stop and define the capture expression for the dynamic sensors through the Viewer after proper authentication and authorization.
- The Query Engine should be able to access the tracefiles through the sensors without requiring direct file system access. Hence effectively decoupling the Sensors from the Query Engines.
- The number of tracefiles and even their existence should be hidden from the end user. The user does not care about how many tracefiles exist. Once the user enters a query expression in the viewer, all matching packets independently from the file where they are stored should be shown.
- Provide the list of RPM's LCFGng style, referring the machines on which they should be included.

The issues and recommendations should be addressed in order to make SANTA-G deployable and usable in the testbed.

5. REFERENCES

[1] <http://www.cs.tcd.ie/Stuart.Kenny/crossgrid/docs/santag/userdoc/installation.pdf>

[2] <http://www.cs.tcd.ie/Stuart.Kenny/crossgrid/docs/santag/userdoc/user.pdf>

[3] <http://www.eu-crossgrid.org/Deliverables/M3pdf/Task3.3-SRS.pdf>

[4] <http://www.cs.tcd.ie/Stuart.Kenny/crossgrid/docs/santag/deliverables/CG3.3.2-D3.2-v1.2-TCD020-SantaGDesign.pdf>