1999880 - FAQ: SAP HANA System Replication

Component: HAN-DB-HA (SAP HANA High Availability (System Replication, DR, etc.)), Version: 264, Released On: 28.10.2023

▌ Symptom

You are interested in further details related to SAP HANA system replication.

▌ Environment

SAP HANA

▌ Reproducing the Issue

▌ Cause

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Resolution

1. What is SAP HANA system replication?

SAP HANA system replication (HSR) provides the possibility to copy and continuously synchronize a SAP HANA database to a secondary location in the same or another data center. Usually system replication is used to support high availabilty and disaster recovery.

It must not be mixed up with the SAP HANA LT Replication Server (SLT) described in SAP Note 2014562.

2. Where do I find further information related to SAP HANA system replication?

Comprehensive information for SAP HANA system replication is available in the SAP HANA System Replication Guide.

The SAP HANA System Replication section of the SAP HANA Administration Guide provides additional information for SAP HANA system replication.

Information about administering SAP HANA system replication with SAP HANA Cockpit (SAP Note 2800006) can be found in SAP HANA Administration with SAP HANA Cockpit - System Replication.

Among others SAP Note 2407186 references the "How To Perform System Replication with SAP HANA" guide that contains a lot of information and references to further documents that can help to implement and use system replication.

SAP Note 2165547 provides further information about backup and recovery in SAP HANA system replication environments.

3. Which indications exist for problems with the SAP HANA system replication?

The following SAP HANA alerts indicate problems in the SAP HANA system replication area:

Alert	Name	Description
21	internal event	Identifies internal database events.

78	Connection between systems in system replication setup	Identifies closed connections between the primary system and a secondary system. If connections are closed, the primary system is no longer being replicated.
79	Configuration consistency of systems in system replication setup	Identifies configuration parameters that do not have the same value on the primary system and a secondary system. Most configuration parameters should have the same value on both systems because the secondary system has to take over in the event of a disaster.
94	Log replay backlog for system replication secondary	System Replication secondary site has a higher log replay backlog than expected.
104	Log shipping backlog for system replication secondary	System Replication secondary site has a higher log shipping backlog than expected.
106	ASYNC replication in-memory buffer overflow	Checks if local in-memory buffer in ASYNC replication mode runs full
107	Inconsistent fallback snapshot	Checks for broken fallback snapshots

SQL: "HANA_Configuration_MiniChecks" (SAP Notes 1969700, 1999993) returns a potentially critical issue (C = 'X') for one of the following individual checks:

Check ID	Details
M1160	Average COMMIT time (ms)
M1810	Services with replication error
M1811	Services with unknown replication state
M1813	Replication connection closed (last day)
M1814	Log position gap (MB)
M1815	Current log shipping delay (s)
M1816	Filling level of async shipping buffer (%)
M1818	Async log shipping buffer full (last day)
M1820	Parameter deviations primary vs. secondary site
M1830	Age of oldest replication snapshot (h)
M1840	Avg. sync log shipping time (ms/req, last hour)
M1843	Avg. sync log shipping time (ms/req, last day)
M1846	Max. sync log shipping time (ms/req, history)
M1852	Current log replay backlog (GB)
M1853	Current log replay delay (s)
M1854	Max. log replay backlog (GB, last week)
M1855	Max. log replay delay (s, last week)
M1860	Datashipping combined with log retention
M1865	System replication savepoint delay (h)

SQL: "HANA_TraceFiles_MiniChecks" (SAP Notes 1969700, 2380176) reports one of the following check IDs:

Check ID	Details
T1200	Communication channel closed
T1203	No host on other system replication site reached

	T1204	No parameter details received from remote site
	T1205	Log shipping timeout
	T1206	Log shipping timeout on secondary
	T1210	Asynchronous log shipping buffer full
	T1215	Host name not found in SR host name resolution
	T1216	Host name resolution problem
	T1220	Incompatible release version
	T1222	Fallback for sending encrypted request
	T1224	Invalid packet size

SQL: "HANA_Threads_Callstacks_MiniChecks" (SAP Notes <u>1969700</u>, <u>2313619</u>) reports one of the following check IDs:

Check ID	Details
C1700	LZ4 log compression

An increased number of SAP HANA threads with one of the following details exist (SAP Note <u>2114710</u>):

Thread State	Lock Name
Semaphore Wait	LoggerBufferSwitch
Semaphore Wait	POSTCOMMIT_FINISH_SMP

4. Which modes of SAP HANA system replication are available?

The following SAP HANA system replication modes exist:

Mode	Details	Behaviour when secondary system is not available
Synchronous	Primary system waits until secondary system has received data and persisted it to disk.	Primary system waits until an error is returned or until ```global.ini -> [system_replication] -> logshipping_timeout``` is exceeded (default: 30 s) and then proceeds without replicating data. Be aware that this parameter defines both the check frequency and the timeout threshold, so the actual timeout will happen between log shipping_timeout and 2 * logshipping_timeout (i.e. 30 and 60 seconds in the default configuration).
Synchronous in-memory	Primary system waits until secondary system has received data.	Primary system waits until an error is returned or until ```global.ini -> [system_replication] -> logshipping_timeout``` is exceeded (default: 30 s) and then proceeds without replicating data. Be aware that this parameter defines both the check frequency and the timeout threshold, so the actual timeout will happen between log shipping_timeout and 2 * logshipping_timeout (i.e. 30 and 60 seconds in the default configuration).
Synchronous full sync	Primary system waits until secondary system has received data and persisted it to disk.	Primary system is blocked until secondary system becomes available.

Async hrono us	Primary system doesn't have to wait for secondary system (unless the asynchronous log buffer is full and waiting is configured, see "Can problems with system replication impact the performance on the primary system?" below for details)	Primary system proceeds without replicating data. The parameter `global.ini -> [system_replication] -> logshipping_timeout` is also considered in this context, but it has no impact on the availability of the primary site.

5. Can SAP HANA system replication be used for system copies?

The normal reason for SAP HANA system replication is high availability and disaster recovery, but it can also be used for system copies. Once the initial synchronization has happened the replication side can be used as copy system by executing a takeover. It is much quicker to establish the system copy based on an existing replication than doing the same with traditional approaches like backup and restore. If the SAP HANA database has to be renamed for the system copy, the hdbrename tool can be used. Make sure that you install a valid license before using the copied system productively.

Be aware that the number of working hosts on the copied system needs to be identical to the original number of working hosts (standby hosts can vary).

6. How can I determine details related to SAP HANA system replication?

System replication information can be found in monitoring views M_SYSTEM_REPLICATION and M_SERVICE_REPLICATION.

The following SQL statements are available in SAP Note 1969700 in order to evaluate system replication related details:

SQL statement	Details
SQL: "HANA_Global_RemoteSystemReplicationSiteReport"	Compilation of information for a remote system replication site (e.g. memory, threads, I/O, savepoints, table optimizations)
SQL: "HANA_Replication_SystemReplication_Bandwidth"	Calculates the required network bandwidth between primary and replication side
SQL: "HANA_Replication_SystemReplication_KeyFigures_Current_CommandGenerator"	Can be used to show current key figures in terms of bandwidth and throughput, manual maintenance of reference values required
SQL: "HANA_Replication_SystemReplication_KeyFigures"	Possibility to analyze the system replication key figures historically (SAP HANA >= 1.0 SPS 09)
SQL: "HANA_Replication_SystemReplication_LogShipping_RetentionTime"	Maximum time a disconnection of primary and secondary site is possible in "logreplay" mode (SAP HANA >= 1.0 SPS 11) before the retained log segments for delta resync are lost
SQL: "HANA_Replication_SystemReplication_Overview"	Provides a general overview of system replication information (configuration, activity details)
SQL: "HANA_Replication_SystemReplication_ParameterDeviations"	Checks for SAP HANA parameters which deviate between primary and replication side
SQL: "HANA_Replication_SystemReplication_Status"	System replication status of individual services
SQL: "HANA_Replication_SystemReplication_Takeovers"	Information about historic system replication takeover activities (SAP HANA >= 2.00.030)

7. Is it possible to initialize a replicated system based on backup / restore?

Up to SAP HANA SPS 11 it is only possible to initialize the replication side based on an snapshot that is created via full data shipping from primary site. An initialization via backup and restore is not possible.

Starting with SAP HANA SPS 12 you can initialize the secondary with a binary copy (via storage snapshot or while primary site is stopped) from the primary site.

8. What are the basic requirements for the SAP HANA system replication network connection regarding throughput and latency?

For system replication it is important that the network throughput (or bandwidth) and the latency (or roundtrip time) are sufficient to fulfill the requirements. SAP Note 1100926 provides further details about these KPIs.

Further details are discussed in the whitepaper for Network Recommendations for SAP HANA System Replication available at Network Configuration for SAP HANA System Replication.

As of SAP HANA 1.0 SPS 09 you can compress data before sending it across the network (see "Is it possible to compress data before sending it to the secondary site?" below). This will reduce the network bandwidth requirements.

Due to the need of data transfer in addition to the log transfer the bandwidth requirements of SAP HANA can be higher than expected. Starting with SAP HANA 1.0 SPS 11 the continuous log replay feature (operation_mode = logreplay) is available that significantly reduces the bandwidth requirements.

For asynchronous system replication in long-distance environments and a related high latency you need to make sure that a reasonable TCP windows size is used:

- Check the network utilization profile for the network link to see if the maximum capacity of the network has been reached
- If the network is not fully utilized, check the linux kernel TCP configuration with:`sysctl -a | egrep "net.core|net.ipv4.tcp"`
- Check that windows scaling is set to the default value of 1:`net.ipv4.tcp_window_scaling = 1`
- Check whether the max size can be increased for:`net.ipv4.tcp_wmem` and`net.ipv4.tcp_rmem`
- Calculate the Bandwidth Delay Product (BDP): Bandwidth * Latency (for example, BDP = 50ms * 3 Gbps = 19.2 MB). The BDP tells you what TCP window size is needed to use the network link fully.

9. Can problems with system replication impact the performance on the primary system?

In the following scenarios the performance of the primary system is impacted by system replication:

Scenario	Replication mode	Details
Connection to secondary system not working	synchronous full sync	Change operations and COMMITs on the primary system have to wait permanently until a connection to the secondary system is established again.
Connection to secondary system not working	synchronous synchronous in-memory	Change operations and COMMITs on the primary system have to wait until a connection to the secondary system is established again or the timeout configured with the following parameter is reached: ```global.ini -> [system_replication] -> logshipping_timeout = <seconds>``` Be aware that this timeout only applies to situations where no error is sent to the primary site (e.g. slow network connection). In case of explict errors (e.g. when the secondary site is terminated or when an explicit network error is returned), the primary site continues processing immediately. Be aware that this parameter defines both the check frequency and the timeout threshold, so the actual timeout will happen between logshipping_timeout and 2 * logshipping_timeout (i.e. 30 and 60 seconds in the default configuration).
Inadequate network connection in terms of latency and throughput	synchronous synchronous full sync synchronous in-memory	Change operations and COMMITs are slowed down because the network communication is within the critical path and they can only proceed after the changes were successfully processed on secondary site.
Slow disk I/O while processing logs on secondary system	synchronous synchronous full sync	Change operations and COMMITs are slowed down because persisting the log information on secondary site is within the critical path.

Asynchronous log shipping buffer full	asynchronous	Per default change operations and COMMITs on the primary system wait until space in the asynchronous log shipping buffer is again available. If you don't accept these waits, you can set the following parameter to 'false' on primary site: ``` global.ini -> [system_replication] -> logshipping_async_wait_on_buffer_full = false ``` In this case SAP HANA will temporarily close the system replication to the secondary system and try to re-establish the connection after the time defined with the following parameter: ``` global.ini -> [system_replication] -> reconnect_time_interval = <seconds> ``` **Attention:** If a full data shipment takes place and system replication is disconnected, it has to start from scratch. So it is useful to keep logshipping_async_wait_on_buffer_full activated until initial data shipment is finished. Be aware that a restarted full data shipment from primary to tier 2 secondary site also results in a completely new full data shipment to a tier 3 secondary site (if configured). In order to reduce the risk of buffer full situations, you can adjust the size of the asynchronous log shipping buffer on primary site using the following parameter: ``` <service>.ini -> [system_replication] -> logshipping_async_buffer_size = <size_in_byte> ``` It is recommended that you set this parameter only for the services with a high log generation, so typically the indexserver (<service>.ini = indexserver.ini), because a setting in global.ini would increase the log shipping buffer for all services and so memory is wasted unnecessarily. See SAP Note 1999997 (heap allocator Pool/PersistenceManager/DisasterRecoveryPrimary) for more details. Starting with SAP HANA 1.00.122.17 and 2.00.024.01 the default of this parameter is increased from 64 MB to 256 MB for the indexserver (SAP Note 2678164). You can use *SQL: "HANA_Replication_SystemReplication_KeyFigures"* (SAP Note 1969700) to check if and when the asynchronous log shipping buffer was already full (column "BF"). Column SHP_BL_MB indicates the filling level of the asynchronous log shipping buffer. If system replication is currently inactive, SHP_BL_MB shows the accumulated redo log size that needs to be shipped once system replication comes back online. If you adjust the buffer between tier 2 secondary and tier 3 secondary site, you need to activate the parameter change via "hdbnsutil -reconfig" on secondary site. In order to activate the new buffer size the target site needs to re-connect to the source site. A reconnect can e.g. be enforced by restarting the target site or by the hdbcons command 'replication start'. To do this for all services, you can use the following distributed execution (the error "cannot find any persistence manager" for services without persistence can be ignored): ``` hdbcons -e hdbnameserver 'distribute e -t * replication start' ``` Be aware that in a cascaded system replication environment (see "Is it possible to set up a cascaded replication environment?" below) a full asynchronous log shipping buffer on the secondary system has a direct impact on the performance of the primary system. Therefore the recommendations above also apply to tier 2 secondary systems serving tier 3 secondary systems asynchronously.
Connection to secondary not working	all	Due to the SAP HANA bug described in SAP Note 2544075 a race condition can result in permanent "LoggerBufferSwitch" waits (SAP Note 1999998).
File system full because log shipping retention size is larger than file system size	asynchronous synchronous synchronous in-memory	In context of logreplay operations modes the following SAP HANA parameter defines the maximum amount of redo logs that are kept on primary site for synchronization with the secondary site (default: 1 TB): ``` global.ini -> [system_replication] -> logshipping_max_retention_size = <size_mb> ``` If the underlying file system isn't large enough to hold the complete configured retention size, it can happen in the worst case that the file system runs full and the primary site comes to a standstill. Therefore SAP recommends to configure this parameter with not more than 80 % of the log volume size (SAP Note 2600030). This parameter is not taken into consideration while full data shipping takes place.

In case of issues you can use *SQL: "HANA_Replication_SystemReplication_KeyFigures_Current_CommandGenerator"* and double-check the key figures. LOG_AVG_SHIP_TIME_MS should typically not be higher than a few milli seconds and the LOG_SHIP_MB_PER_S should be significantly above 10 MB / s. If you see worse values, you have to check both the network and the secondary system and eliminate issues and bottlenecks.

10. Is it possible to take backups on the secondary site?

No, currently you can only take data and log backups on the primary site.

If automatic log backup is enabled, after takeover to the secondary site the log backups will automatically be written there.

11. Is it possible to set up a cascaded replication environment?

Yes, it is possible to set up a sequence of system replications, a so-called multitier system replication.

Example:
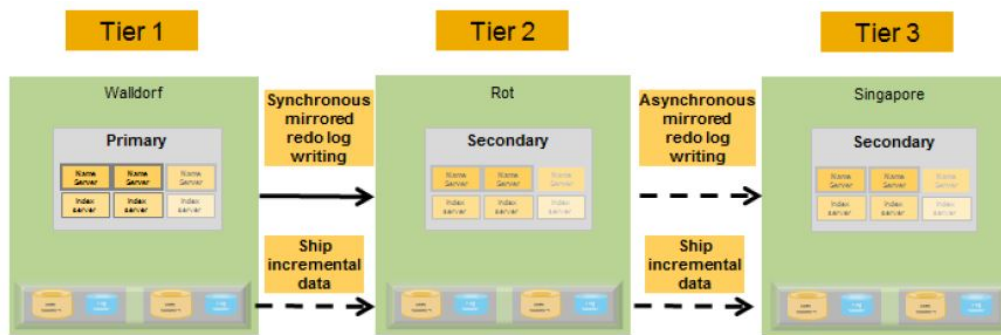
Overview of Multitier System Replication

See SAP Note 2303243 for more details on supported replication modes.

The operation mode must be identical for all multi-tier and multi-target replications, a mixture (e.g. delta_datashipping from tier 1 to tier 2 and logreplay from tier 2 to tier 3) isn't allowed. Only exception: logreplay_readaccess from tier 1 to tier 2 and logreplay from tier 2 to tier 3.

In order to be able to flexibly adjust complex system replication scenarios, you can set the following parameter that makes sure that redo logs are retained in all sites based on the minimum savepoint log position of all systems:

```
global.ini -> [system_replication] -> propagate_log_retention = true
```

12. In which situations does a SAP HANA system replication takeover make sense?

See SAP Note 2063657 that describes what aspects should be considered before performing a takeover. It is important to follow these steps, because otherwise a takeover can even make everything worse (e.g. data loss).

Starting with SAP HANA 2.0 SPS 03 the Python script getTakeoverRecommendation.py is delivered together with SAP HANA that can be used to check if a takeover is useful or possible in a specific scenario.

13. Can multiple SAP HANA databases be replicated to the same target?

It is not possible to replicate different source SAP HANA databases into the same target SAP HANA database.

You can replicate different source SAP HANA databases into different target SAP HANA databases on the same target host. Make sure that the restrictions of SAP Note 1681092 are considered. This includes that all other SAP HANA databases have to be stopped on replication side as soon as one SAP HANA database takes over the productive role for a primary system.

14. Is it supported to set up a replication scenario between systems with different hardware?

Yes, it is possible to set up replication between systems that differ in terms of hardware (e.g. different manufacturer, different memory sizes, different number of CPUs). From a system replication perspective you only need to make sure that the number of hosts is identical on all sites and that every service has a partner on all sites.

It is also possible to run different hardware configurations between the primary and the secondary site in terms of virtualization configurations. In other words, the secondary site can be a virtual configuration compared to the primary site being physically configured and vice versa.

Be aware that it is not possible to set up system replication between platforms with different endianness, because the logs aren't binary compatible. In general, SAP HANA systems are little-endian, with the exception of Power in combination with SLES 11.x.

SAP Note 1984882 describes how system replication can be used for a hardware exchange with minimum downtime.

15. Is it supported to set up a replication scenario between systems with a different SAP HANA patch level?

It is allowed to use different SAP HANA patch levels in a replication scenario as long as the patch level of the replicated system is not lower than the patch level of the primary system. It is also allowed that the replicated system is on a higher SPS level than the primary system. This possibility can be used for near-zero downtime upgrades (NZDU) upgrades in replicated environments. For more information see the near zero downtime upgrade section in How to Perform System Replication for SAP HANA. SAP Note 2386973 describes NZDU in 3-tier system replication scenarios.

Note: You cannot set up SAP HANA system replication between SAP HANA 1.0 single container and a newly installed SAP HANA 2.0 MDC (SAP Note 2101244). Instead you can establish system replication with both sites running on SAP HANA 1.0, then upgrade the secondary to SAP HANA 2.0 with MDC and then reconnect the secondary to the primary.

Please note the following restriction in case of operation mode logreplay_readaccess. The secondary system allows read access if the primary system runs the same SAP HANA version. A different version leads to prohibiting the read access until the same software version is used.

16. What has to be considered when upgrading SAP HANA in system replication environments?

You can stop both the primary and secondary database, then upgrade both databases and then restart both systems. If you want to minimize downtime, you can proceed according to SAP Note 1984882.

17. What has to be considered in terms of SAP HANA parameter settings in replicated scenarios?

In general you should make sure that SAP HANA parameters are set identical on primary and secondary system replication side whenever possible. Deviations can result in unexpected behavior during or after a takeover. You can check SAP HANA alert 21 (<= 1.0 SPS 08) or 79 (>= 1.0 SPS 09) or use *SQL: "HANA_Replication_SystemReplication_ParameterDeviations"* (SAP Note 1969700) in order to check for parameters that are set differently on primary and replication side.

Sometimes different parameter settings are necessary on the primary and the secondary site, e.g. if additional non-productive systems are running on the secondary site. Then the table reload must be turned off and the global allocation limit must be set to a minimum value to make sure that the memory allocation of the replicated database remains on a low level. See SAP Note 2127458 for more information regarding table reload.

In the SAP HANA Admin guide the "parameter checker" is documented, which generates the alerts. It can be manually adjusted to exclude ranges of parameters from these checks. See the section "Monitoring INI File Parameter Changes" in How to Perform System Replication for SAP HANA for more details.

Starting with SAP HANA 1.0 SPS 12 it is possible to automatically replicate parameters from the primary to the secondary site by activating the following parameter on primary site:

```
global.ini -> [inifile_checker] -> replicate = true
```

The check interval can be controlled with the following parameter (in seconds):

```
global.ini -> [inifile_checker] -> interval = <check_interval_s>
```

Attention: The [inifile_checker] parameters need to be set in the system DB and on SYSTEM level to take effect.

When a parameter is replicated, the following type of message will be written to the database trace (SAP Note 2380176):

```
Replicate following ini file entry to site '<site_id>': <file>.ini/<layer>//[<section>]/<parameter
> = <value>
```

Be aware that even with activated automatic parameter replication there can still be mismatches reported in case a parameter is explicitly set to its default value (SAP Note 2737227).

The following scenarios are known in which unexpected parameter mismatches are reported by SAP HANA alert 21:

- Even with activated automatic parameter replication there can still be mismatches reported in case a parameter is explicitly set to its default value (SAP Note 2737227).
- Explicit settings of parameter <service.ini> -> [jwt_identity_provider] -> issuer can be a result of configuration defaults during the SAP HANA installation. The parameter is used as an identifier in scenarios where SAP HANA acts as issuer of JSON Web Tokens (e.g., for authentication at remote sources). The default parameter configuration can include a host specific name, so the default settings can lead to parameter mismatches between primary and secondary. If the feature is not used, corresponding warnings / alerts can be ignored. If the feature is used, use an identifier which is unique in your environment, and make sure that the change is propagated to the secondary site. If parameter replication has been activated, this can lead to a hostname of the source system unexpectedly appearing in the configuration of its secondaries and system copies.

18. Is it possible to perform a takeover even if the secondary database is down?

Yes, a takeover can be performed even if the secondary database is down. In order to make it available, it of course has to be started.

19. How can RECLAIM DATAVOLUME be executed when system replication is active?

With ALTER SYSTEM RECLAIM DATAVOLUME DEFRAGMENT you can reduce fragmentation on disk level and reclaim disk space (SAP Note 1870858). When system replication is used, there are typically snapshots preserved and as a consequence the RECLAIM DATAVOLUME command fails with:

```
general error: Shrink canceled, probably because of snapshot pages
```

See SAP Note 2332284 for required steps to perform a successful RECLAIM DATAVOLUME in context of an active system replication.

Be aware that the error can also be caused by a snapshot-based backup rather than system replication. So in order to make sure that a RECLAIM DATAVOLUME succeeds, you have to make sure that no backup based on snapshots is scheduled at the same time.

20. What can I do if too old system replication snapshots exist?

System replication takes advantage of SAP HANA database snapshots. The retention time of these snapshots is defined with the following parameter:

Parameter	Default	Unit	Details
`global.ini -> [system _replicati on] -> dat ashipping_ snapshot_m ax_retenti on_time`	120 (SA P H ANA 1.0) 300 (SA P H ANA >= 2 .0)	mi nu te s	This parameter defines how many minutes a system replication related database snapshot is preserved, that has been completely shipped to the secondary system. Shipped snapshots older than datashipping _snapshot_max_retention_time will be dropped automatically. Snapshots currently used in data shipp ing are not affected and **are not dropped**, if data shipping takes longer than datashipping_snapshot_ max_retention_time. They can be dropped if data shipping has been finished. If the parameter is set to 0, snapshots are immediately dropped after data replication has been finished. Its default value corresp onds to 2 hours. There is normally no need to change this parameter (exception: See "How can RECLAI M DATAVOLUME be executed when system replication is active?").

In rare cases it can happen that a system replication related database snapshot is not deleted and its age significantly exceeds the configured retention time. You can identify old snapshots (in this example: older than 5 hours) by running *SQL: "HANA_IO_Snapshots" (SNAPSHOT_repli = 'REPLICATION', MIN_SNAPSHOT_AGE_H = 5)* available via SAP Note 1969700.

Example:

```
-----------------------------------------------------------------------
|HOST    |PORT |VOLUME_ID|SNAPSHOT_TIME        |SNAPSHOT_AGE_H|FOR_BACKUP|
-----------------------------------------------------------------------
|saphana|30003|        2|2021/01/21 21:33:26|        16.00|FALSE     |
|saphana|30007|        4|2021/01/21 21:25:41|        16.13|FALSE     |
|saphana|30004|        5|2021/01/21 21:25:41|        16.13|FALSE     |
|saphana|30011|        6|2021/01/21 21:25:41|        16.13|FALSE     |
-----------------------------------------------------------------------
```

Now you can check the current replication status using *SQL: "HANA_Replication_SystemReplication_Status"* (SAP Note 1969700). If the STATUS_DETAILS are empty for the services, you can proceed. Otherwise you should check if the replication of the service permanently remains in the status and analyze what is going on.

You can clean up no longer needed system replication related database snapshots using the hdbcons command line tool (SAP Note 2222218). At first you have to identify the related snapshot ID for the impacted service. In case only a single service with the name exists, you can use "-e" to identify it, otherwise you need to use "-p":

```
hdbcons -e hdb<service_name> 'snapshot l'
hdbcons -p <os_pid> 'snapshot l'
```

It will return an information like the following including the snapshot ID:

```
SnapshotID: 290360 / ForBackup: 0 / ForReplication: 1 / RestartPage: 0x700000020004P [0x20004,16k,
0] / TimeStamp: ...
```

Using the snapshot ID the space allocated by a database snapshot can be checked via:

```
hdbcons -e hdb<service_name> 'snapshot a <snapshot_id>'
hdbcons -p <os_pid> 'snapshot a <snapshot_id>'
```

If you have confirmed that the database snapshot is no longer required, the snapshot ID can be dropped with the following hdbcons command:

```
hdbcons -e hdb<service_name> 'snapshot d <snapshot_id>'
hdbcons -p <os_pid> 'snapshot d <snapshot_id>'
```

21. Does local log buffer writing and log buffer shipping happen in parallel?

Both activities happen in parallel. If *SQL: "HANA_Replication_SystemReplication_Overview"* (SAP Note 1969700) returns the following numbers

```
Avg. local log buffer write time (ms):  2.81
Avg. log buffer shipping time (ms):      2.46
```

you can assume that the total duration of both activities doesn't exceed 3 ms.

22. Is it possible to compress data before sending it to the secondary site?

Starting with SPS 09 you can activate compression of log and / or data using the following parameters:

Parameter	Availability	Default	Details
`global.ini -> [system_replication] -> enable_log_compression`	SAP HANA 1.0 SPS 09 and higher	false	Enables compression of log when it is sent to the secondary site Needs to be set on target site, afterwards target needs to be reconnected to source site
`global.ini -> [system_replication] -> enable_data_compression`	SAP HANA 1.0 SPS 09 and higher	false	Enables compression of data when it is sent to the secondary site Needs to be set on target site, afterwards target needs to be reconnected to source site

The activation of the compression reduces the required network bandwidth, but at the same time there is some CPU overhead for compressing and decompressing the information. Using compression is particularly useful in case of long distances between primary and secondary site or in case of bandwidth limitations.

23. Which factors influence the takeover time?

With operation mode log_replay or log_replay_readaccess the secondary site is already up and running and so a takeover is usually finished quickly. Exception: In case of significant log replay backlog it can take some time until the log replay is finished before the system is synchronized and can be used.

With operation mode delta_datashipping additional steps may be required, so the takeover time is typically significantly longer:

- Open data persistence based on last savepoint
- Load row store
- Replay redo log
- Rebuild row store indexes

Loading of column store data generally happens after the actual takeover. So it doesn't increase the takeover time, but it can impact the performance of the system for some more time after the takeover. Per default columns used on the primary system are regularly loaded into the memory of the secondary system in order to minimize the reload overhead after takeover. See SAP Note 2127458 for more information.

24. What has to be done for a failback?

If a takeover has happened and you want to revert back to the former primary system, you basically have to execute the same steps like during the takeover, but with exchanged system roles. Further details can be found in the SAP HANA Administration Guide.

25. How long does it typically take to initialize a synchronization of primary and secondary from scratch?

The initial synchronization is dominated by the data shipping time across the network. As a rough rule of thumb the following formula can be used:

```
"initial synchronization time" >= "backup size" / "availabe network bandwidth"
```

If data compression is used, the compression factor (compressed data size compared to uncompressed data size) also needs to be considered. The initial synchronization time for a SAP HANA host can then be calculated via:

```
"initial synchronization time" >= "backup size" * "compression factor" / "availabe network bandwid
th"
```

The overall synchronization time of system replication in a scale-out environment is the maximum of the host specific synchronization times calculated above.

Example: If the backup size is 2 TB, the system replication data compression factor is 0.3 (so 2 TB are compressed to 600 GB) and the available network bandwidth is 300 Mbit / s, the minimum initial synchronization time is around 4.5 hours (2 TB * 0.3 / 300 Mbit/s).

See also How can I check the number of parallel channels used for data shipping? for possibilities using multiple data shipping channels.

26. Can a takeover or failback happen without terminating active application processes?

The influence of a takeover or failback on client processes depends both on the implementation of the switch process and the client reaction.

In case of SAP ABAP servers the standard reconnect mechanism makes sure that a temporary unavailability of the SAP HANA database is recognized and can take place without resulting in many terminations (see SAP Note 24806).

In SAP HANA environments you can additionally consider to suspend database connections as described in SAP Note 1913302. With this approach a takeover or failback can happen without any termination on SAP ABAP side.

Please also see What happens with active transactions and statements during takeover? that describes the invisible takeover feature available starting with SAP HANA 2.0 SPS 03.

27. Which log sizes are typically shipped?

Log shipping happens on a log buffer level. The size of a log buffer typically varies between 4 KB and global.ini -> [persistence] -> log_buffer_size_kb (default: 1 MB), depending on the amount of COMMITs. The "Avg. shipped log buffer size (KB)" provided via *SQL: "HANA_Replication_SystemReplication_Overview"* (SAP Note 1969700) contains the average size of a shipped log buffer in the system.

The shipped log buffers are in line with the local log buffers, so mechanisms for SAP HANA disk accesses described in SAP Note 1900823 also apply to the shipped log buffer sizes.

28. Why is the secondary system consistent although undo logs aren't shipped?

Undo logs are part of the data area and so they are not transferred via log shipping. This is no problem, because:

- Undo logs are part of the data shipping
- When redo logs are applied on the secondary system, undo logs for these changes are automatically created.

29. Are there any instance number / port restrictions when using system replication?

The system replication communication internally communicates via the subsequent port number of the installed system. So if SAP HANA is installed with instance number 00, the communication will also use the 01 related ports (e.g. 30103 for the indexserver). As a consequence it is not possible to install another SAP HANA instance with this increased port number. See SAP Note 2176528 for more information. An error like the following will appear when you try to start an instance that wants to use a port that is already occupied by the system replication:

```
Internal Error. Basis/IO/Stream/impl/NetworkChannel.cpp: 1119: Error address in use: $msg$, rc=98:
Address already in use. NetworkChannelBase::bindLocal. bind failed
```

For MDC databases, the port offset is set to 10000 shifting the ports from the 3<instance number>00 to the 4<instance number>00 port range for the services. Therefore, for MDC systems HSR does not block the instance number +1.

See SAP Note 2477204 ("Are there additional ports used in case of system replication?") for more details.

30. How can I check the memory allocation details on the secondary system?

Starting with SAP HANA 1.0 SPS 11 secondary sites can be monitored from the primary system to a certain extent, see Is it possible to monitor remote system replication sites on the primary system?. Among others, monitoring view M_HEAP_MEMORY can be queried with this approach.

For the operation mode logreplay_readaccess, it is possible to directly query the monitoring views via SQL on the secondary site.

In other cases you can to use hdbcons from the operating system (see SAP Note 2222218) and execute "mm list -S" to display the top heap allocators. See SAP Note 1999997 for more information.

31. Are SAP HANA histories still available after a takeover?

During a takeover the whole database is opened on the secondary site, so all statistics server histories are available, even if the content is linked to the primary site. Nevertheless there are the following monitoring views with history information that are based on trace files and so the primary site information is no longer available after a takeover:

- M_CS_LOADS
- M_CS_UNLOADS
- M_EXECUTED_STATEMENTS
- M_EXPENSIVE_STATEMENTS

- M_LOAD_HISTORY_HOST
- M_LOAD_HISTORY_SERVICE

32. What has to be considered in terms of licensing in SAP HANA system replication environments?

For details about licensing see section "License Validity" in the how-to guide <u>How to perform System Replication for SAP HANA</u> and SAP Note <u>2685661</u>.

33. Can I set up a SAP HANA system replication based on a storage snapshot (instead of a full data backup)?

Yes, this is possible. Prior to setting up SAP HANA system replication a full data backup is required, which can also be provided as a storage snapshot.

However, enabling the system replication based on a storage snapshot (no full data backup was created) is currently (i. e. <= SAP HANA SPS 10) only possible from command line using "hdbnsutil –sr_enable ..." and not from SAP HANA Studio.

34. Is it possible to monitor remote system replication sites on the primary system?

Starting with SAP HANA 1.0 SPS 11 several monitoring views of the secondary site are available on the primary system via schema _SYS_SR_SITE_<site_name>. You can manually query these views using:

```
SELECT ... FROM "_SYS_SR_SITE_<site_name>".<view_name> ...
```

<u>Example:</u> (secondary site: hana02)

```
SELECT * FROM "_SYS_SR_SITE_hana02".M_LOG_BUFFERS
```

It is also possible to use the following SQL statements available via SAP Note <u>1969700</u> to monitor the secondary site:

SQL: "HANA_ColumnStore_Merges"
SQL: "HANA_CPU_UtilizationPerCore"
SQL: "HANA_GarbageCollection_Persistence"
SQL: "HANA_Memory_MemoryObjects"
SQL: "HANA_Hosts_FileSystems"
SQL: "HANA_IO_Commits"
SQL: "HANA_IO_ConverterStatistics"
SQL: "HANA_IO_DiskDetails"
SQL: "HANA_IO_KeyFigures_Details"
SQL: "HANA_IO_KeyFigures_Total"
SQL: "HANA_IO_Savepoints"
SQL: "HANA_IO_Snapshots"
SQL: "HANA_Jobs_Executors"
SQL: "HANA_liveCache_Containers"
SQL: "HANA_liveCache_Procedures"
SQL: "HANA_Logs_LogBuffers"
SQL: "HANA_Locks_Internal_LockWaits_Overview"
SQL: "HANA_Network_Statistics_CurrentDetails"
SQL: "HANA_Resources_CPUAndMemory_CurrentDetails"
SQL: "HANA_Transactions_UndoCleanupFiles"

In order to make sure that the data from the secondary site is read, you can execute the following command in advance:

```
SET SCHEMA "_SYS_SR_SITE_<site_name>"
```

If you use DBACOCKPIT (SAP Note <u>2222220</u>), you should lock the used work process beforehand (report RSTRC000), because otherwise the adjusted schema is lost in case a change of the work process happens.

Alternatively you can prefix the monitoring view names in the SQL statement manually with '"_SYS_SR_SITE_<site_name>".'.

With SAP HANA <= 2.0 SPS 05 histories of the statistics server (SAP Note <u>2147247</u>) only contain the primary site information. Starting with SAP HANA 2.0 SPS 06 various statistics server histories also contain information of remote system replication sites, indicated by different values in the SITE_ID column.

SQL: "HANA_Global_RemoteSystemReplicationSiteReport" (SAP Note <u>1969700</u>) is available to provide a compilation of remote system replication site information like thread activity, heap memory allocation or table optimizations.

35. What is the logreplay operation mode?

The following table compares the original operation mode delta_datashipping with the operation mode logreplay available as of SAP HANA 1.0 >= SPS 11:

Operation mode	Restrictions / Version	Description	Advantages
delta_datashipping	no restriction	Synchronization between primary and secondary site is implemented via regular delta data shippings from primary to secondary site.	• Memory footprint of secondary site can be smaller as column store tables don't have to be loaded during system replication • As a consequence it is possible to set the global_allocation_limit (SAP Note 1999997) and run an additional non-production system on the same machine. • History tables are generally supported (for logreplay modes the restrictions described in SAP Note 2480889 apply)
logreplay	>= 1.00.110	Synchronization between primary and secondary site is implemented purely based on redo logs Column store generally has to be loaded into memory to provide reasonable delta merge speed	• Delta data shipping no longer required • Reduced network traffic between primary and secondary site • Reduced network bandwidth requirements between primary and secondary site • Reduced takeover times (shorter log replay, no persistence garbage collection, no file ID mapping and disk LOB initialization, no adjustment of resource container dispositions; see SAP Note 2222217) • No propagation of logical persistence corruptions on disk level (e.g. introduced by the bug described in SAP Note 2375691)
logreplay_readaccess	>= 2.00 add-on license purchased	Synchronization between primary and secondary site is implemented purely based on redo logs Column store generally has to be loaded into memory to provide reasonable delta merge speed See SAP Note 2391079 for restrictions.	• Same advantages like "logreplay" above • Query load can be moved away from primary site

The operation mode can be defined with the following parameter:

```
global.ini -> [system_replication] -> operation_mode
```

In 3-tier environments the following details can be considered for the logreplay mode:

- If the tier 3 secondary system is down, the logs are only saved on the tier 2 secondary system, not on the primary system.
- If the tier 2 secondary system is down and you want to use the tier 3 secondary system as tier 2 secondary system, usually a full sync is required, because the logs retained on primary site are meant for the tier 2 secondary site and so they may not be compatible with the tier 3 secondary system.

SAP Note 2661878 provides settings that can be used to optimize the performance of logreplay on secondary system replication site. These settings are a trade-off between logreplay performance and memory utilization and secondary site, so tests are required in order to identify an optimal compromise.

36. How can I determine the current log replay delay?

The following options exist do determine the current log replay delay (i.e. the amount of logs that is already shipped, but not replayed, yet):

Tool	Availability	SAP Note	Details
Statistics server	>= 1.0 SPS 12	2147247	Starting with SAP HANA SPS 12 alert 94 ("Log replay backlog for system replication secondary") reports increased log replay backlogs.
Mini Checks	>= 1.0 SPS 12	1999993	Mini check 1852 ("Current log replay backlog (GB)") reports significant log replay backlogs as potentially critical.

SQL	>= 1.0 SPS 12	1969700	*SQL: "HANA_Replication_SystemReplication_KeyFigures"* displays among others the log replay backlog (REPLAY_BACKLOG_MB).
			
			As a fallback option you can use the contents of M_SERVICE_REPLICATION to determine the log replay delay on the secondary site:
			
			```SELECT SHIPPED_LOG_POSITION, REPLAYED_LOG_POSITION FROM M_SERVICE_REPLICATION```
			
			Now you can calculate the difference and multiply it with the log position size of 64 byte:
			
			```(SHIPPED_LOG_POSITION - REPLAYED_LOG_POSITION) * 64 = <replay_backlog_byte>```

hdbcons	>= 1.0 SPS 11	2222218	As a fallback option you can use the hdbcons option 'replication info' in order to determine the last shipped log position (shippedLogPos) and the last replayed log position (replayFinishLogPos):
			
			```> hdbcons 'replication info'\n\n- shippedLogPos : 0x1098b6940\n...\n- replayLogPos : 0x10987c1a7```
			
			Now you can convert these hexadecimal numbers into decimal numbers, calculate the difference and multiply it with the log position size of 64 byte. The result is the replay backlog:
			
			```(0x1098b6940 - 0x10987c1a7) * 64 = 239513 * 64 = (4455098688 - 4454859175) * 64 = 239513 * 64 = 15328832 = 14 GB```
			
			For HANA 2.0 >= SPS 02 the replay backlog is displayed directly and no calculation is required:
			
			```- replayBacklog : 0 microseconds\n- replayBacklogSize : 0 bytes```

If you face a high log replay backlog and there are no obvious issues (e.g. in the network between primary and secondary site) you can check SAP Note 2409671 for optimizations. Furthermore it is possible that backlog is caused by single tables / partitions with a particularly high change load because parallelization of log replay isn't possible in this case. Consider to create more partitions in this case (SAP Note 2044468).

37. What happens with the content when the secondary site of a system replication environment is upgraded?

During the SAP HANA upgrade of the secondary site new content is installed. This new content is overwritten at the time the system replication from the primary site is established again, so new objects like views will disappear.

This behavior works as designd because during a takeover from primary to secondary site a catalog upgrade will take place on secondary site and the missing content is automatically recreated.

38. Does the secondary SAP HANA system replication site need to be up and running before activating system replication?

The secondary site needs to be stopped before registering it on primary site. If the secondary site can't start (e.g. due to a page corruption), you can re-initialize it using:

```
hdbnsutil -sr_register --force_full_replica
```

39. What has to be considered for the row store reorganization in system replication scenarios?

See SAP Note 2222277 ("What has to be considered for the row store reorganization in system replication scenarios?") for more details.

40. What can be done if I do not manage to disable replication to the secondary in the normal way?

In order to permanently disable sytem replication to the secondary site *hdbnsutil -sr_unregister* (see SAP Note 1945676) should be used. If this fails, hdbnsutil offers additional options to remove HSR settings, e.g. -sr_cleanup, whose usage is also described in the beforementioned note.

41. Are there specific SAP HANA users and schemas related to system replication?

The following specific schemas and users exist in the context of SAP HANA system replication:

Name	Available with	Type	Details

_SYS_SR	>= 1.00.110	schema, user	Required for create _SYS_SR_SITE_<site_name> schemas and own their data (SAP Note 2499182)
_SYS_SR_SITE_<site_name>	>= 1.00.110	schema	Contains monitoring views holding data from remote system replication sites, see "Is it possible to monitor remote system replication sites on the primary system?" above for more details

42. What are indications for log shipping timeouts?

The following indications exist for log shipping timeouts:

Indication	SAP Note	Details
Database trace entry	2380176	Closing connection to siteID <site_id>. LogShipping was waiting for <seconds> seconds (logshipping_timeout = <timeout_s>)
M_SERVICE_REPLICATION columns SECONDARY_CONNECT_TIME, SECONDARY_RECONNECT_COUNT, REPLICATION_STATUS_DETAILS	1969700	When a log shipping timeout happens, the column SECONDARY_CONNECT_TIME is updated with the reconnect timestamp and SECONDARY_RECONNECT_COUNT is incremented. REPLICATION_STATUS_DETAILS contains 'Log shipping timeout occurred'. SQL statements like *SQL: "HANA_Replication_SystemReplication_Overview"* and *SQL: "HANA_Replication_SystemReplication_KeyFigures"* can be used to display these details (among others).
Runtime dumps: <service>_<host>.<port>.**rtedump**.<timestamp>.**LogshippingTimeout**.trc <service>_<host>.<port>.**rtedump**.<timestamp>.**secondaryLogshippingTimeout**.trc	2400007	Depending on the SAP HANA version and configuration an automatic runtime dump is written when a log shipping timeout happens.

43. Can disk I/O on secondary site have an impact on SYNCMEM system replication scenarios?

SYNCMEM doesn't wait until all data is written to disk on secondary site, so there is no direct impact on the primary site when there are disk I/O issues. If, however, disk I/O is so slow that it can't keep up with the amount of data being received, memory areas like the log buffer can run full. In this case system replication has to wait until space is available in the memory buffer and so an indirect impact of slow disk I/O is possible on the primary site.

44. What is the state of a secondary, if services were not in sync at takeover time?

If the secondary site was in sync at least once and a takeover is performed, the most recent shipped log will determine the timestamp the secondary is running on after takeover. Transactional consistency is given, but newer data, that were created on the primary but could not be shipped, are lost. If the primary and secondary systems have never been in sync or if the secondary site is only started after the primary went down (without the takeover), the secondary system cannot start.

45. What has to be considered when changing the number of SAP HANA nodes?

When nodes are added to or removed from the SAP HANA database and you are anyway in downtime mode, you can proceed as follows:

- Stop system replication
- Adjust node layout first on primary, then on secondary site
- Register secondary site again

Alternatively the change to the host layout can also be done without stopping system replication:

- If a node is added: Add it at first on secondary site, then on primary site
- If a node is removed: Remove it at first on primary site, then on secondary site

46. What has to be considered for Active/Active (read enabled)?

Active/Active (read enabled) is available starting with SAP HANA 2.0 and allows to execute read requests on the secondary system replication site. It requires an add-on license that provides the productive use rights to the secondary SAP HANA instance in a HANA system replication environment. No license key is needed in this context because it is a contract-based license that is auditable.

It is activated during registration of the secondary system via option "--operationMode=logreplay_readaccess" which adds the following entry to global.ini:

```
global.ini -> [system_replication] -> operation_mode = logreplay_readaccess
```

For access restrictions see SAP Notes 2737255 and 2391079.

As described in SAP Note 3063696 it is not possible to access caches of the SAP HANA cache framework (SAP Note 2502256) on the remote site and errors like the following are reported:

```
256: Error occurred while executing a MDX statement. The error message is: An internal error occur
red. Assertion failed with error message Entity cache manager is null
```

Accesses to the secondary system replication site can be executed by using the following hint:

```
RESULT_LAG('hana_sr' [, <seconds>])
```

For hint details see SAP Note 2142945.

A default lag threshold can be configured with the following parameter:

```
indexserver.ini -> [hint_result_lag_hana_sr] -> sr_default_lag_time = <seconds>
```

Also a direct connection to the read enabled secondary system is possible.

Attention: Statement routing to secondary site doesn't work when the system replication protocol version is set to 0 (as e.g. recommended as a workaround in SAP Note 2587258).

Be aware that even with synchronous system replication you can't assume that a query to the secondary site always sees the most up-to-date information. Synchronous system replication only guarantees that log shipping happens synchronously, but the actual log replay happens asynchronously. So in rare cases there can be a delay of several minutes or more before a current change is visible on secondary site.

47. Why do I see deviating values in the system replication mode parameter?

The value in parameter global.ini -> [system_replication] -> mode depends on the original role of the site:

- If site was originally configured as primary site: mode = 'primary'
- If site was originally configured as secondary site: mode = 'sync', 'async', ... (dependent on the system replication mode)

As a consequence the mode value can be different in two identically configured systems if a takeover happened in one system, but not in the other.

48. How can I check the number of parallel channels used for data shipping?

The number of parallel data shipping channels can be configured with the following SAP HANA parameter:

```
global.ini -> [system_replication] -> datashipping_parallel_channels
```

Per default 4 streams are used for a persistence size of >= 4 GB. To monitor the number of used streams, you can activate the sr_dataaccess trace on level "info" (SAP Note 2380176) on secondary system replication site:

```
global.ini -> [trace] -> sr_dataaccess = info
```

In the database trace files you can then grep for "multistream".

Example:

```
sr_dataaccess DisasterRecoverySecondaryImpl.cpp(02207) : multistream, getStreamCount: connections=
4 minStreamSize=1073741824 statusbits=000
sr_dataaccess DisasterRecoverySecondaryImpl.cpp(02235) : multistream, splitTransferSizeToStreams:
maxParallelityPossible=2 is less than that yielded from configuration=4 streams with maxParallelit
yPossible
sr_dataaccess DisasterRecoverySecondaryImpl.cpp(02286) : multistream, splitTransferSizeToStreams:
connections=2 restSize=0 (maxParallelityPossible=2 transferSize=2969567232 minStreamSize=107374182
4
```

Here one can see that the default setting (4 connections) is configured, but – because the data size (transferSize) is smaller - only 2 parallel channels (connections) are used.

49. How can tracing for system replication be activated?

The following database trace options (SAP Note 2380176) can be useful in context of system replication:

Trace setting	SAP Note	Details
global.ini -> [trace] -> sr_dataaccess = info		System replication data access details (including channel information)
global.ini -> [trace] -> sr_nameserver = debug	2694960	System replication nameserver trace
global.ini -> [trace] -> trexnet = info	2694960	System replication network trace

50. Is it recommended to disable system replication during larger upgrade or migration activities?

In general SAP recommends to keep system replication enabled:

- During regular release / SP upgrades within S/4HANA, SAP recommends to keep high availability mechanisms in regular / production mode. This includes ZDO.
- During Suite on HANA -> S/4HANA system conversion the following options are feasible:
  - Keep system replication active during the entire process. Optionally switch into ASYNC mode to remove pressure from system replication during SUM downtime.
    This is the recommended option if using Downtime-optimized Conversion (DoC), and it should already be part of the dress rehearsal testing to ensure sufficient hardware resources are available (network bandwidth, latency, ...)
  - Disable system replication just before entering SUM downtime. Re-establish system replication right after SUM downtime has ended.
- During ERP -> S4H system conversion: Establish system replication after SUM downtime has ended.

If (re-)establishing system replication after SUM downtime has ended, take explicit decision whether hand-over to business can happen before or only after system replication has caught up into production mode.

Beyond these best practices the decision to disable system replication during larger upgrade or migration activities has to be taken individually and depends on the following factors:

- Amount of database changes performed
- Capabilities of system replication infrastructure in terms of throughput and latency
- Impact of system replication on primary site performance
- Necessity and overhead of initial data shipping after the activities are finished

Another reason for stopping system replication is to preserve a system state from before the upgrade or migration activity as a fallback in case of problems. On SAP HANA >= 2.0 SPS 03 you can alternatively think about keeping the secondary site up and running and using timetravel in order to get back to the previous state in case of problems.

51. How can pending savepoints and large page cache sizes on secondary site be explained?

When a full data shipment or a delta data shipment takes place, the pages are transferred into memory structures in allocators like (SAP Note 1999997):

- Data page cache allocators like Pool/PersistenceManager/PersistentSpace/DefaultLPA/DataPage
- Restore / recovery allocators like Pool/PersistenceManager/Recovery/Superblock

Subsequently they are written down to disk on continuous basis. In cases where the shipment across the network is faster than the I/O write throughput on secondary site, the following symptoms can be observed:

- Secondary site is shown in status "Savepoint Pending" or - in case of log shipping timeouts - "ERROR - Log shipping timeout occurred" for a longer time and actual synchronization can't start
- Heap allocators like Pool/PersistenceManager/PersistentSpace/DefaultLPA/DataPage and Pool/PersistenceManager/Recovery/Superblock
  on secondary site shows large size and can even be responsible for OOMs.
- I/O related threads like SubmitThread-DATA-0 are permanently active on secondary site.
- Slowdown of data shipping network transfer in case allocators have already grown to significant sizes
- Many page cache entries are shown with disposition nonSwappable (can be checked with "pageaccess a" option of hdbcons available via SAP Note 2222218 or using *SQL: "HANA_Memory_PageMemory"* available via SAP Note 1969700, SAP HANA >= 2.0 SPS 01).
- If log shipping timeouts happened during the flush phase after initial data shipping, data shipping will be restarted from scratch (issue number 301088). You can temporarily increase the logshipping_timeout setting to reduce the risk of running into this situation. This issue is fixed with SAP HANA >= 2.00.067.02 and >= 2.00.072.

All these symptoms are normal in case the I/O on secondary site can't keep up with the data transferred via network from primary to secondary. The OOM situations will disappear as soon as enough page cache entries are written down to disk.

In order to improve the situation you should check if the performance of the I/O stack on secondary system replication site can be improved. See SAP Note 1999930 for more information related to I/O analysis in SAP HANA environments. Alternatively you can try to reduce the network throughput by reducing the parallel data shipping channels from the default of 4 to 1:

```
global.ini -> [system_replication] -> datashipping_parallel_channels = 1
```

52. Can I set up system replication between systems with different topologies?

The topology of primary and secondary site of a system replication scenario must be identical. As a consequence it isn't possible to replicate from non-MDC to MDC (SAP Note 2101244) and vice versa, and it is also not possible to replicate from single-node to scale-out and vice versa.

53. Can a primary site be replicated to more than one secondary site?

Up to SAP HANA 2.0 SPS 02 a primary system can only be replicated to a single secondary system. Starting with SAP HANA 2.0 SPS 03 multi-target replication is available and so you can connect several secondary sites to the same primary system. All systems involved in multi-target replication should share the same operation mode with only exception when logreplay_readaccess is used between tier 1 and tier 2, logreplay operation mode can be used for tier 3. Operation modes logreplay and delta_datashipping must not be combined in one multi-target replication set up.

54. What happens with active transactions and statements during takeover?

Active transactions and statements are usually terminated and rolled back when a takeover happens. Starting with SAP HANA 2.0 SPS 03 it is possible to take advantage of the invisible takeover feature. When invisible takeover is activated, the SAP HANA client (SAP Note 2393013) keeps track of the required connection information from before the switch and continues to use it after the takeover. This so-called transparent session recovery is currently only available for SQLDBC clients. The following diagram visualizes an invisible takeover:
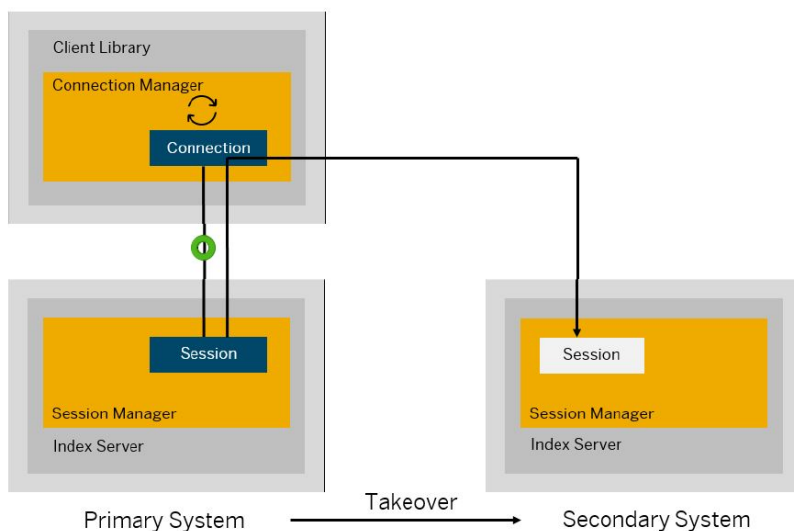
Invisible takeover can be activated / deactivated with the following SAP HANA parameter:

```
<service>.ini -> [session] -> enable_session_recovery
```

The default depends on the SAP HANA Revision level:

- SAP HANA 2.0 SPS 03: false
- SAP HANA >= 2.0 SPS 04: true

Be aware that invisible takeover isn't possible in case of update transactions, i.e. transactions that have already performed modifications to table data.

55. What is secondary time travel?

Secondary time travel is available with SAP HANA >= 2.0 SPS 03 in context of system replication with operation modes logreplay or logreplay_readaccess and allows to access data on secondary system replication sites from earlier points in time.

The following parameters can be used to control secondary time travel:

Parameter	Default	Unit	Details
global.ini -> [system_replication] -> timetravel _call_takeover_hooks	false		Indicates if takeover hook should be called during secondary time travel
global.ini -> [system_replication] -> timetravel _logreplay_mode	auto		Defines replay mode for secondary system replication site (auto or manual)
global.ini -> [system_replication] -> timetravel _max_retention_time	0 (deactivated)	minutes	Controls for how long historic snapshots are preserved for time travel purposes

	1440	minutes	Defines how frequently snapshots are created for secondary time travel
`global.ini -> [system_replication] -> timetravel_snapshot_creation_interval`			

To validate that the parameters are set correctly and the feature is active, you can use the following hdbcons command on the secondary system replication site (SAP Note 2222218):

```
hdbcons 'replication info' | grep timetravel
```

Example:

```
[system_replication] timetravel_max_retention_time          = 28800000000
[system_replication] timetravel_snapshot_creation_interval   = 86400000000
```

The value unit is micro seconds so above values indicate 6 hours / 24 hours.

Be aware that time travel increases the disk space requirements both in the data area (for snapshots) and the log area (for log replay based on snapshots). Increasing timetravel_max_retention_time and / or reducing timetravel_snapshot_creation_interval increases the disk space requirements.

In order to reset the secondary site to different point in time you can stop the SAP HANA database and execute the following command:

```
hdbnsutil -sr_timetravel --startTime=<start_time>
```

The <start_time> has to be specified as UTC timestamp in the format of "dd.mm.yyyy-hh24.mm.ss". Example:

```
hdbnsutil -sr_timetravel --startTime=22.02.2019-17.49.30
```

Afterwards the SAP HANA database can be started again.

56. Which rules apply for memory utilization on secondary system replication sites?

Depending on preloading and the operation mode the following rules apply for memory requirements on secondary system replication sites:

Operation mode	Preload	Minimum memory requirements
delta_datashipping	on (*)	identical to primary site
delta_datashipping	off	MAX(64 GB, row store size + 20 GB) (***)
logreplay	on	row store size + column store memory size + 50 GB (***)
logreplay	off	row store size + column store memory size of tables with modifications (**) + 50 GB (***)
logreplay_readaccess	on	identical to primary site
logreplay_readaccess	off	identical to primary site

(*) No longer available with SAP HANA >= 2.0 SPS 07.

(**) You can use *SQL: "HANA_Tables_ColumnStore_Columns_LastTouchTime" (TOUCH_TYPE = 'MODIFY', BEGIN_TIME = 'C-D30')* available via SAP Note 1969700 in order to check how much data was modified within the last 30 days (or a different number of days specified in BEGIN_TIME) to get a feeling about static and dynamic tables. As a rough rule of thumb you can reduce the memory in case of logreplay / no preload scenarios by the memory used by tables that are not touched since 30 days.

(***) Be aware that a reduced memory size of the secondary site typically increases the takeover times, also in combination with logreplay and preload = on, because other instances running on the secondary site have to be stopped and reconfiguration of memory parameters is required.

Secondary timetravel does not have an impact on memory utilization on the secondary site.

57. Is system replication possible between systems with different operating systems?

Yes, system replication is supported between systems with different operating systems or operating system versions. See SAP Note 2763388 for more information.

Be aware that it is not possible to set up system replication between platforms with different endianness, because the logs aren't binary compatible. In general, SAP HANA systems are little-endian, with the exception of Power in combination with SLES 11.x.

58. How can HSR be paused?

There is no generic pause command for HSR.

HSR is automatically stopped when the secondary system is not reachable (see "Which modes of SAP HANA system replication are available?"). In case system replication should be interrupted, while the secondary is online, hdbnsutil -sr_takeover can be used. A re-registration of the secondary does not necessarily imply a full initial load as long as the persistences are still compatible, e.g. the duration of the seperation does not surpass the limits set by parameter logshipping_max_retention_size for operation mode logreplay and logreplay_readaccess and parameter datashipping_snapshot_max_retention_time for delta_datashippping.

59. How can a reconnect from the secondary be triggered?

Some HSR relevant parameter changes do not require a restart oft he HANA database, but are only effective after a reconnect from the secondary to the primary. There is no generic command to interrupt and reestablish the connection. A restart of the secondary DB also triggers a reconnect.

60. How can a planned takeover be secured?

With SAP HANA 2.0 SPS 04 the takeover with handshake was introduced to secure the takeover against data loss and split-brain situations. The takeover command was enhanced with the following option to achieve this:

```
hdbnsutil -sr_takeover --suspendPrimary
```

61. What are the options for takeover in a multi-target replication landscape?

Multi-target system replication allows to perform takeover to any of the connected secondary systems. Starting from SAP HANA 2.0 SPS 04 an option is available to automatically re-register secondary system to new primary after the takeover.

Re-registered secondary system may be synchronized via log delta shipping after the takeover instead of full delta shipping providing that all required logs are retained on the new primary system and all the pre-requisites below are met:

1. Replication status of secondary systems is ACTIVE before takeover
2. Replication mode of the secondary system that issues takeover is sync/syncmem
3. Primary system is stopped or suspended before takeover to the secondary system is issued

62. How can a secondary site be synced without a full data shipping after a disconnect?

In logreplay contexts a secondary site can only be synced via logs if all redo logs since the disconnect are still available on primary site. The following parameter can be used on both sites to control to what extent logs are cleared on primary site:

```
global.ini -> [system_replication] -> enable_log_retention
```

When it is set to 'on', logs are preserved and a full data shipping isn't required when the secondary site is reconnected (SAP Note 2522261).

In multi-target environments enable_log_retention = 'on' may not have the desired effect in all scenarios with SAP HANA <= 2.00.045.

63. What has to be considered for system replication in context of disabled delta logging?

When log writing is disabled for a specific table (ALTER TABLE ... DISABLE DELTA LOG, SAP Note 1999930) and operation mode log replay is used for system replication, changes to that table are not shipped to secondary site, which means that the state of the data is not the same on both sites and there can be data loss in case of a takeover. See SAP Note 2963542 for more details.

Additionally, if logging for that table is turned on again, a new full shipment needs to be done to synchronize the state of the table between the two sites. Otherwise, logical errors during log replay on secondary site are expected that in the worst case lead to crash dumps and disruptions of the system replication connection.

64. What kind of data do I need to collect for SAP support in case of system replication issues?

See SAP Note 2934640 for details that should be collected for SAP support when opening a SAP case for system replication issues.

65. How can clients be informed about takeovers?

You can use virtual host names and just rebind the IP address for takeover to the secondary site. In hdbuserstore only the virtual node names should be listed which remain after takeover. The IP address change can be managed either automatically by a cluster solution (SAP Note 3007062), manually with the SAP Landscape Manager (LaMa) or via script.

66. What are HA/DR providers?

SAP HANA offers a python based API with a set of predefined functions on certain events which can be used for execution of custom defined operations at these events. Per default no action is set up. You can use *SQL: "HANA_Replication_HADRProviders"* (SAP Note 1969700) to check which actions (also known as hooks) are configured.

67. What is database replication in the context of tenant copy / move?

Database replication refers to the tenant copy / move features that is the process of replicating one tenant to another based on commands like:

```
CREATE DATABASE <new_db> AS REPLICA OF <existing_db> AT '<host>:<port>'
```

See Copying and Moving Tenant Databases for more information.

Technically this kind of database replication uses the same mechanisms like SAP HANA system replication.

Be aware that for tenant copy / move the following SSL settings need to be set consistently:

```
global.ini -> [communication] -> enable_ssl
global.ini -> [multidb] -> enforce_ssl_database_replication
```

See Disable Secure Network Communication for more details.

68. Are system replication scenarios with more than three tiers possible?

Having 4 tiers is possible starting with SAP HANA 2.0 SPS 03. This is e.g. used in context of Multitarget System Replication for Near Zero Downtime Upgrades:
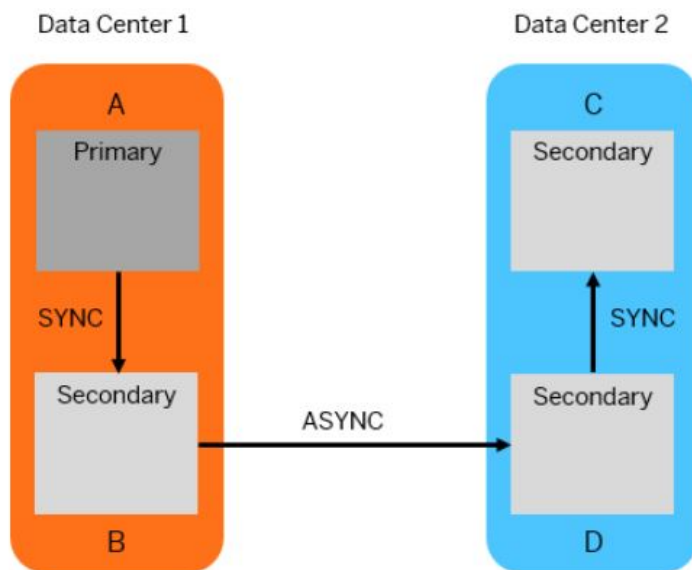
69. Is log recovery possible across the time of a system replication takeover?

Yes, it is possible to recover a new primary system after a takeover based on a backup taken on the previous primary site. See Recovery of a New Primary System After a Takeover for more information.

70. To what extent does log encryption impact the log shipping latency?

Typically log encryption only puts a minor overhead on top of the already existing latency when shipping logs to the remote system replication sites and so far no critical problems were reported. If you want to estimate the overhead, you can use the following operating system command to measure the encryption performance:

- Encryption performance: openssl speed -evp aes-256-gcm
- Decryption performance: openssl speed -evp aes-256-gcm -decrypt

Example:

```
Doing aes-256-gcm for 3s on 16 size blocks: 45985415 aes-256-gcm's in 2.99s
Doing aes-256-gcm for 3s on 64 size blocks: 32360961 aes-256-gcm's in 3.00s
Doing aes-256-gcm for 3s on 256 size blocks: 17563361 aes-256-gcm's in 3.00s
Doing aes-256-gcm for 3s on 1024 size blocks: 5598384 aes-256-gcm's in 3.00s
Doing aes-256-gcm for 3s on 8192 size blocks: 844391 aes-256-gcm's in 3.00s

...
type              16 bytes     64 bytes    256 bytes   1024 bytes   8192 bytes
aes-256-gcm      246075.80k   690367.17k  1498740.14k  1910915.07k  2305750.36k
```

In this example 844391 blocks of 8 KB size (which matches usual redo log sizes quite well) were done in 3 seconds, so an individual encryption took 3.6 us and in one second 2305750 KB (i.e. more than 2 GB) of blocks were encrypted. This is considerably faster than usual log shipping latencies of around 1000 us (1 ms) and so the overhead should be minor.

71. How can I determine if I am connected to the primary or secondary system replication site?

In Active/Active (read-enabled) environments it is possible to select also from secondary system replication sites. Sometimes it is not immediately clear if you are connected to a primary or secondary site. In this case you can check the following parameter:

```
global.ini -> [system_replication] -> actual_mode
```

If it is set to primary, you are connected to the primary site. If it is set to another value like syncmem, sync or async, you are connected to the secondary site.

SQL: "HANA_Configuration_Overview" (SAP Note 1969700) provides a warning "Connected to secondary system replication site!" if it is executed against a secondary site.

72. What do I have to consider if data shipping repeatedly stops at a certain percentage?

Reproducible terminations of data shipping at the same percentage / size is often a consequence of intrusion prevention or network filtering mechanisms. See SAP Note 3287731 for more details.

73. What needs to be done in terms of system replication in case services are added or removed?

Services with persistence (i.e. showing up in M_VOLUMES) are automatically considered on secondary system replication sites when they are added or removed on the primary site. For services without a persistence a manual adjustment is required in order to make sure that both sites are in sync and no issues will happen during system replication:

- Unregister the secondary site
- Add or remove the service on both sites
- Set up system replication again

See SAP Notes 2124346 and 2495505 for more details for specific scenarios.

74. What are reasons for log shipping timeouts?

A log shipping timeout happens when redo logs can't be shipped to a secondary system replication site, the connection is hanging (i.e. not terminated with an explicit error) and the configured logshipping_timeout is exceeded. With the default log shipping timeout of 30 seconds a timeout can be expected when redo logs can't be shipped between 30 and 60 seconds. Typical reasons for log shipping issues are:

Scenario	SAP Note	Details
Connectivity issue between primary and secondary site	2222200	Check the network communication channel between primary and secondary site for issues that can block log shipping for a significant time.
Performance issue on secondary system replication site	2000000	Check if the secondary site works properly or performance issues exist, e.g. a too small memory configuration resulting in a high column unload / load rate or slow performance of the disk I/O stack.
Unavailability of secondary system replication site	2177064	Check if the secondary site runs stable or if there are service crashes or shutdowns that impact the availability.
Delays accessing shared file system on primary site	1999930	I/O issues accessing the shared file system on primary site can result in delays when SSL is used and the libsapcrypto library requires to access configuration files like sectrace.ini, gss.xml, pkix.xml and base.xml in a directory located in the shared file system (directory of libsapcrypto.so, $HOME/sec). Check for issues with the related file system. For example, the following messages in /var/log/kernel indicates an issue with an NFS file system: ```2023-03-16T07:10:56.920851+00:00 saphananode kernel: [23746532.604058] nfs: server saphananode not responding, timed out```
Long running connection-changed hook	3220088	A long running cluster hook can result in unexpected additional log shipping timeouts.

75. Why can the SHIPPED_LOG_BUFFERS_SIZE in M_SERVICE_REPLICATION differ from the actual data size sent to the secondary side?

The following reasons can be responsible for differences of the reported shipped log buffers size from the actual log buffer size:

- SHIPPED_LOG_BUFFERS_SIZE considers only logs that are shipped online. Logs that are transferred during synchronization via missing logs are not taken into account. If the secondary is disconnected for some time the transferred data size can be larger than SHIPPED_LOG_BUFFERS_SIZE. The same limitations also apply to SHIPPED_LOG_BUFFERS_COUNT
- SHIPPED_LOG_BUFFERS_SIZE does not take into account compression. Tail compression is activated by default. Additional compression can be activated via parameter global.ini -> [system_replication] -> enable_log_compression = true. Due to compression SHIPPED_LOG_BUFFERS_SIZE can overestimate the actual data size sent to the secondary.

Be aware that also SHIPPED_FULL_REPLICA_SIZE and SHIPPED_DELTA_REPLICA_SIZE do not consider compression.

76. How can figures reported by the "replication info" option of hdbcons be interpreted?

The output of the hdbcons option "replication info" has the following meaning:

Key figure	M_SERVICE_REPLICATION column	Details
shippedLogBuffersCount	SHIPPED_LOG_BUFFERS_COUNT	Number of shipped log buffers, see Why can the SHIPPED_LOG_BUFFERS_SIZE in M_SERVICE_REPLICATION differ from the actual data size sent to the secondary side? for details
shippedLogBuffersSize	SHIPPED__LOG_BUFFERS_SIZE	Size of shipped log buffers, see Why can the SHIPPED_LOG_BUFFERS_SIZE in M_SERVICE_REPLICATION differ from the actual data size sent to the secondary side? for details
shippedLogBuffersSizeUsed		Used size within the shipped log buffers (excluding alignment fillers)
shippedFullBackupSize	SHIPPED_FULL_BACKUP_SIZE	Source size of data for initial data shipping
shippedFullBackupSizeNet		Actual size of data transferred during initial data shipping (can be smaller than source size when data compression is enabled)
shippedDeltaBackupSize	SHIPPED_DELTA_BACKUP_SIZE	Source size of data for delta data shipping
shippedDeltaBackupSizeNet		Actual size of data transferred during delta data shipping (can be smaller than source size when data compression is enabled)

See Also

Keywords

SAP HANA system replication, M_SERVICE_REPLICATION, high availability, disaster recovery

Attributes

Key	Value
Other Components	HAN-DB (SAP HANA Database)

Products

Products
SAP HANA, platform edition all versions

This document refers to

SAP Note/KBA	Title

3063696	A Query Fails With an Error 'Entity cache manager is null' in Active/Active Read-Enabled Setup
2737255	Limitations and Fallback Conditions of Statement Routing to a Read Enabled Secondary System Using Active/Active(Read Enabled) Feature in System Replication
2678164	Default Configuration of Parameter [system_replication] logshipping_async_buffer_size Increased for Indexserver
2661878	HANA System Replication log replay setting recommendations for large systems
2587258	Application server gets hung after system replication enabled or disabled from SAP HANA 2.0
2544075	HSR Primary System Unresponsive After Connection to Secondary Site is Lost
2391079	Access restrictions in Active/Active (read enabled) system setup
2124346	HANA Secondary site does not start up after enabling script server
1969700	SQL Statement Collection for SAP HANA
	Recovery of a New Primary System After a Takeover
	Use Multitarget System Replication for Near Zero Downtime Upgrades
	Network Configuration for SAP HANA System Replication
	SAP HANA System Replication Guide
	SAP HANA System Replication
	SAP HANA Administration with SAP HANA Cockpit - System Replication
	How to perform System Replication for SAP HANA
	Disable Secure Network Communication
	Copying and Moving Tenant Databases

This document is referenced by

SAP Note/KBA	Title
3350180	SAP HANA System Replication registering a secondary site shows constant status 'Initializing' and 'Preparing Persistence'
3339610	How to setup service(s) in SAP HANA System Replication environment
3334172	Are system replication scenarios with more than three tiers possible?
3320219	Parameter mismatch (different value) alert for parameter <service.ini> -> [jwt_identity_provider] -> issuer in system replication environment
2999990	How-To: SAP HANA Performance Analysis
3206193	Slowness when executing DBACOCKPIT
3209689	How to monitor the remote system replication sites from the primary system
2526877	SAP HANA System Replication Parameter logshipping_max_retention_size
2159435	How-To: Keeping SAP HANA Row Store in Memory when restarting
2499182	_SYS_SR system account
3096264	HANA System Replication tertiary site start fails with wrong checksum error
3092771	HANA license invalid after unregister the secondary site
2562939	HANA Data Volume Used Size is Doubled or Much Larger than Before
2313619	How-To: Generating and Evaluating SAP HANA Call Stacks
3065607	Performance tips & tricks for SAP S/4HANA Migration Cockpit: Migrate Data Using Staging Tables
2821539	Volume /hana/log is full with log segments in status RetainedFree
2177064	FAQ: SAP HANA Service Restarts and Crashes
3016671	Local in-memory buffer in ASYNC ran full even though logshipping_async_buffer_size is set
3009407	Secondary site services restart after topology is updated
2998090	HANA System replication keeps failing for one node with log
2978895	Changing parameters on Primary and Secondary site of SAP HANA system