
Rule CIC320: A large percent of structure list entries were in use

Finding: The CICS Shared Temporary Storage (TS) Queue Server statistics showed that a large percent of structure list entries had been used in the coupling facility structure containing the shared TS pool.

Impact: This finding has a MEDIUM IMPACT or HIGH IMPACT on the performance of the CICS region.

Logic flow: This is a basic finding, based on an analysis of the data. The finding applies only with CICS/Transaction Server for OS/390 or for z/OS.

Discussion: Data items in shared temporary storage (TS) are kept in queues whose names are assigned dynamically by the program storing the data. These shared temporary storage queues are stored in *named pools* in an MVS coupling facility. These queues are related to a shared TS pool using the SYSID keyword to specify the shared queue pool to which the request is directed.

Each TS pool is defined, using MVS cross-system extended services (XES), as a keyed list structure in a coupling facility.

Access to a TS pool by CICS transactions running in an AOR is through a *TS data sharing server* that supports a specific named pool. A shared TS pool server is started in an MVS image by starting a queue server region (as either a batch job or a started task) for each shared TS pool. Starting the queue server region invokes the queue server region program, DFHXQMN, which resides in an APF-authorized library. Each TS server provides access to only one pool of TS queues, so there must be multiple TS server regions if there are multiple shared TS pools.

A variety of parameters are provided to the TS pool server, to specify the name of the shared TS pool, list structure attributes, tuning parameters, various thresholds for warning and automatic server actions, etc. These parameters (other than the pool name) have default values, but the defaults can be changed based on user-specific requirements.

The application tasks issue a few general commands to read, write, or delete shared TS storage (READQ TS, WRITEQ TS, and DELETEQ TS). The queue server region is responsible for translating these application task commands into XES list structure interfaces.

A list structure consists of a set of lists and an optional lock table of exclusive locks (which can be used to serialize the use of lists, list entries, or other resources in the list structure). Each list is pointed to by a *list header* and can contain a number of *list entries*. With shared TS queues, the list structure is the named pool, while the lists themselves are shared TS queues within the named pool. The shared TS pool server designates the maximum number of lists (or queues) the TS pool is to have, and allocates the list structure based on parameters that are provided to the TS pool server.

A list entry consists of list entry controls and can optionally include an *adjunct area*, a *data entry*, or both.

- The first connector to a list structure specifies whether the list structure has adjunct areas, and that status (presence or absence of an adjunct area) is fixed for the life of the structure. An adjunct area can be used to hold up to 64 bytes of data. With shared TS pools, this area contains the read cursor for small queues and the queue status information.
- Data entries are composed of units of storage called *data elements*. In a coupling facility of CFLEVEL=0, data entries can be composed of 0 to 16 data elements. In a coupling facility of CFLEVEL=1 or higher, data entries can be composed of 0 to 255 data elements. In either case, a data entry could contain up to 64K (65536 bytes) of data.

While data elements can be 256, 512, 1024, 2048, or 4096 bytes in size, the default value for shared TS pools is 256 bytes. IBM states that “there is no known reason to specify other than the default value of 256.”

Although a data entry can be composed of a number of data elements, list operations treat the data entry as a single entity; data elements cannot be read or written individually.

When the list structure is allocated, XES establishes the number of data elements that are associated with data entries. This division of storage is referred to as the “entry-to-element ratio”.

The structure *alter* function provides for the expansion or contraction of the size of a structure, the reapportionment of the entry-to-element ratio of the structure's storage, and the alteration of the percentage of structure storage set aside for event monitor controls (EMCs). The structure alter processing is done either by using the IXLALTER macro or by issuing the SETXCF START,ALTER command. The IXLALTER macro allows an authorized user to request a change to the structure's size, the entry-to-element ratio, and the percentage of storage allocated for EMCs.

Starting with OS/390 Release 10, a structure can be *automatically* altered when it reaches an installation-defined or defaulted-to percent full threshold as determined by structure full monitoring. The alter process may increase the size of the structure, reapportion the objects within the structure, or both.

With shared temporary storage, the queue server monitors the total number of data entries and data elements in use in the structure, using information returned by the coupling facility on every request. When the numbers in use exceed thresholds specified by the TS queue server *warning parameters*, a warning message (DFHXQ0411 or DFHXQ0412, for entries and elements, respectively) is issued. The warning message is repeated each time the number in use increases beyond further thresholds.

Each time the warning is issued, the TS queue server tests whether an automatic ALTER for the entry to element ratio should be performed. The test is done based on the TS queue server *automatic structure alter parameters*. This is based on the ratio between the current numbers of elements and entries actually in use.

IBM suggests that no more than 75% of the structure be used, to minimize the risk of the structure becoming full, to avoid triggering low space warning messages, and to avoid additional activity required to alter entry to element ratios. However, the default ELEMENTWARN and ENTRYWARN warning parameters have a default value of **80**, which specify that warnings and automatic ALTER actions should be first triggered when 80% of the elements or entries are used.

Section 2.2.2.1 (Approximate storage calculations) of the *CICS/TS System Definition Guide* provides calculations that can be used to calculate initial sizing of the storage. However, this algorithm might not yield an adequate structure size for some environments.

Further, the default element to entry ratio in the shared TS server *tuning parameters* is a simple 1:1, which might not be optimum for any particular shared temporary storage environment.

Consequently, CPExpert provides an earlier warning of structure element and entry shortage by analyzing the maximum number of elements and entries that were used.

Shared temporary storage queue server statistics for the coupling facility are available in MXG file CICXQ1. CPExpert uses data in CICXQ1 to calculate the maximum percent of the structure list entries that had been used, using the following algorithm:

$$\text{Maximum percent structure list entries used} = \frac{S1ENTRHI}{S1ENTRMX}$$

where S1ENTRHI = Maximum number of list entries used since last reset
S1ENTRMX = Total list entries in the currently allocated structure

CPEXpert produces Rule CIC320 when the maximum percent structure list entries used is more than the value specified by the **TSPCTENT** guidance variable in USOURCE(CICGUIDE). The default value for the **TSPCTENT** is 70 indicating that CPEXpert should produce Rule CIC320 whenever more than 70% of the list entries had been used.

Suggestion: Rule CIC320 indicates that the TS queue server either is exercising automatic alter algorithms, or is likely to exercise these algorithms as the thresholds in the *automatic structure alter parameters* are reached. If this finding is produced often, you should consider the following alternatives:

- Increase the initial amount of structure space that is available for the shared TS pool identified by this finding. Increasing the amount of initial structure space can be accomplished by increasing the INITSIZE (so more structure space is initially available). If more structure space is initially available, more entries and elements will be available and there is less probability that there will be a shortage of list entries.
- Increase the amount of storage allocated for the *maximum size* specified in the coupling facility resource management policy for the shared temporary storage queue identified by this finding. This action normally should be taken only if the structure size has approached the maximum size specified. Be aware that Rule CIC325 will be produced if the structure runs out of space, but frequent occurrence of Rule CIC320 might indicate a pending “no space” condition.
- You could change the TSPCTENT guidance variable in USOURCE(CICGUIDE) so Rule CIC320 is produced less often. This action is not recommended, however since you should be aware of the potential problems (it is particularly important to be aware of pending problems) revealed by Rule CIC320

Reference: *CICS/TS for OS/390 Release 1.1*
CICS System Definition Guide: Section 3.4.3 (Defining TS server regions)

CICS/TS for OS/390 Release 1.2

CICS System Definition Guide: Section 3.4.3 (Defining TS server regions)

CICS/TS for OS/390 Release 1.3

CICS System Definition Guide: Section 4.2.2 (Defining TS server regions)

CICS/TS for z/OS Release 2.1

CICS System Definition Guide: Chapter 21 (Starting a temporary storage server)

CICS/TS for z/OS Release 2.2

CICS System Definition Guide: Chapter 21 (Starting a temporary storage server)