

Understand how the new transaction tracking feature in CICS improves troubleshooting and system management

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Transaction tracking in CICS TS Version 4.2

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CICS icon of progress: <http://www.ibm.com/ibm100/us/en/icons/cics/>

Executive Summary

This paper sets out how the transaction tracking enhancements provided in CICS® Transaction Server for z/OS® Version 4.2 deliver evolutionary enhancements to the problem determination facilities available in CICS. Using these enhancements it is now much simpler to locate a transaction in CICS based on knowledge of the entry point, such as an IP address, queue name, or SNA logical unit (LU) name. With this information, it is possible to use new search functions in the CICS Explorer® to search the CICSplex to locate other active tasks that have been initiated from the originating task, and to build a picture of the relationships between the associated tasks.

These extensions to transaction tracking have significantly strengthened problem determination facilities in CICS TS. Together with the search functions in CICS Performance Analyzer there now exists a comprehensive infrastructure to allow customers to quickly understand the topology of transactions, no matter where they have been dynamically routed. This will be a significant aid in auditing and problem determination and simplifies the administration skills required to diagnose business applications in CICS.

The need for transaction tracking

The growing demands of today's business have led to the requirement for existing CICS applications to be integrated with a variety of external systems. These often consist of web front ends that use Java EE application servers such as WebSphere® Application Server, messaging products such as WebSphere MQ®, or an enterprise service bus such as WebSphere Message Broker (Figure 1).

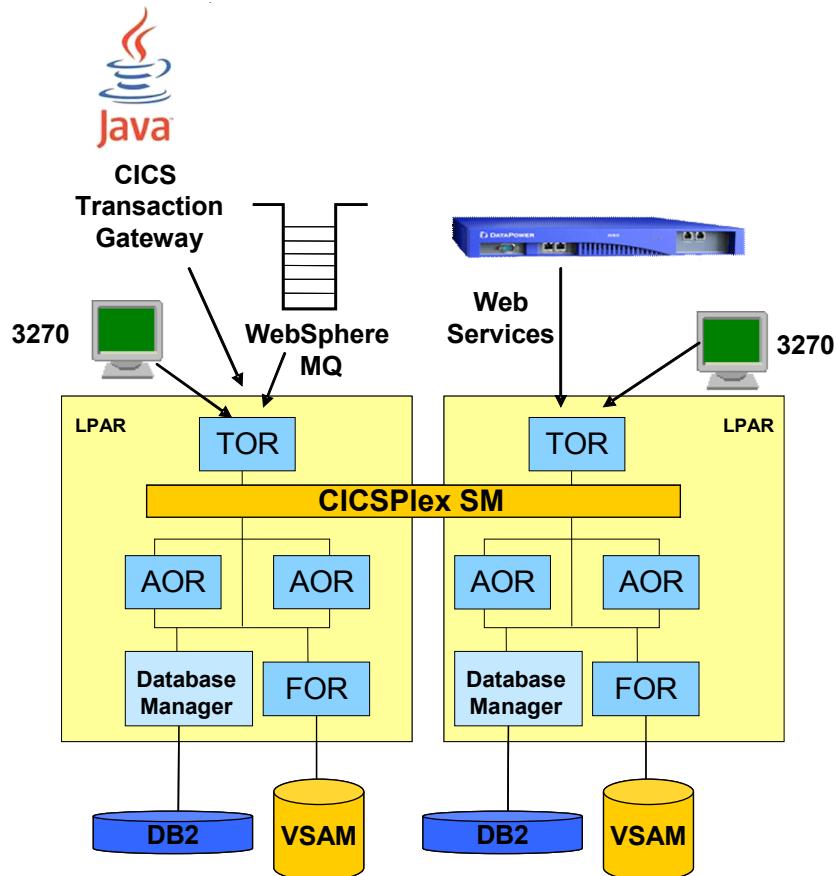


Figure 1. CICSplex with multiple front ends

The process of integration can create new challenges in the day to day management of the existing CICS transaction processing systems. For instance:

1. New integration technologies are typically based upon TCP/IP instead of SNA networking, and so the resulting CICS transactions do not have SNA session or terminal IDs as principal facilities. This leads to a lack of visibility about the point of origin for CICS transactions that enter via these new TCP/IP technologies, hampering efforts to correlate individual CICS tasks to the clients from which they originated.
2. IP facilities (such as IP addresses, ports, and socket descriptors) are poorly exposed and managed via traditional CICS management interfaces such as CEMT, hampering end-to-end problem diagnosis between CICS components and the IP network.
3. Modern CICS integration technologies such as the CICS web services pipeline or tasks started by the WebSphere MQ trigger monitor lack the unit of work context inheritance previously used by SNA based technologies. In a large CICSplex with requests dynamically routed between CICS regions, this often

leads to the inability to navigate back along an execution path to the originating task and its point of origin in the CICSplex.

The CICS TS development team recognized these issues, and in CICS TS 4.2, introduced the transaction tracking feature. Transaction tracking is designed to simplify operational tasks and provides the following capabilities:

- The ability to identify the entry point into a CICSplex for all user tasks no matter how they are initiated; this is termed the *point of origin*.
- The ability to associate all tasks in a CICSplex that have caused a subsequent task to be attached ¹ and to identify the parent/child relationship between these tasks.
- The ability to locate specific tasks based on information from the point of origin, such as the client IP address or the TCP/IP service which dispatched the request.
- A new mechanism for tracking transactions attached by adapters supplied by other software products, such as WebSphere MQ or the WebSphere Application Server for z/OS using the WebSphere Optimized Local Adapter (WOLA).

The following section discusses the new functionality provided in CICS TS 4.2 that enables these features.

Task association data

Association data is a set of task metadata that describes the environment in which user tasks run and the way that user tasks are attached in a region. Association data is built during task attach processing and represents context information specific to the task itself. For example, fields are provided detailing the task ID, the authenticated RACF user ID under which the task is running, the way the task was started, and the details of the TCP/IP Service or SNA LU that initiated the task. As such, it provides a new way of viewing the relationship between tasks and the external requests that initiated them. In CICS TS 4.2 all user transactions now have association data that consists of task context data and origin data.

Task context data

Task context data is context information about the user task such as transaction ID, user ID, and the facility that attached the task; along with additional information about any IP facilities used by the task such as client and server IP addresses and ports, and CICS resources such as TCP/IP services and IPIC connections.

Origin data

Data created at the point of origin that describes how and where the request that initiated the task came from. Origin data is created for each user task that is started when an external request arrives at a CICSplex. It includes the time of attach, along with details about the facility type used to receive the request (e.g. web, socket,

¹ Transactions that are initiated by a START command that specifies a terminal device, or are triggered by automatic transaction initiation (ATI) from a transient data (TD) queue are considered to be at a new point of origin and so do not inherit origin data from the starting task.

terminal) and identification details about the CICS task that was attached (e.g. transaction ID, task number, and CICS region APPLID). This data is transmitted between tasks that are associated and contains the following additional components.

- **Adapter data** – Optional information about an external adapter that introduced work into CICS (e.g. the queue manager and queue used by the WebSphere MQ adapter to trigger a transaction).
- **Transaction group ID** – A unique binary token in the task association data that is propagated to associated tasks.
- **Previous hop data** – Information passed across an intercommunication link, describing the identity of the sender of the request. This allows any task to be very quickly tracked back step by step to the task from which it originated.
- **User correlation data** – User information that can optionally be added at the point of origin by using the XAPADMGR global user exit program.

The following illustration (Figure 2) shows the creation of the origin descriptor and how it flows between associated tasks in different CICS regions, and how the previous hop data can be used to identify the previous task in the chain.

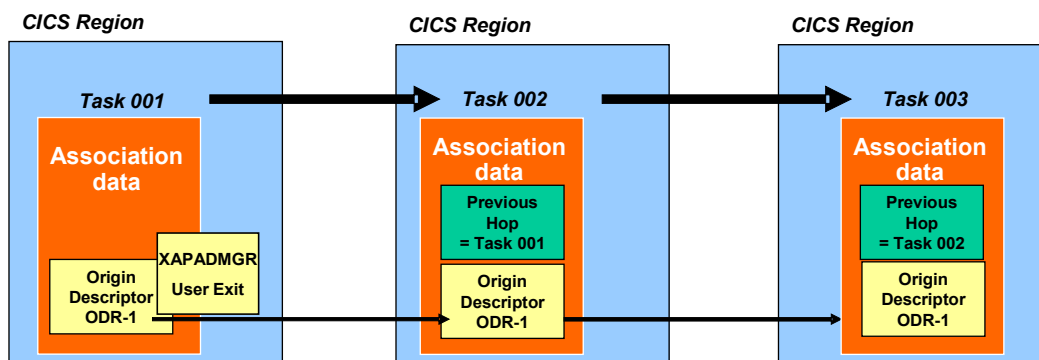
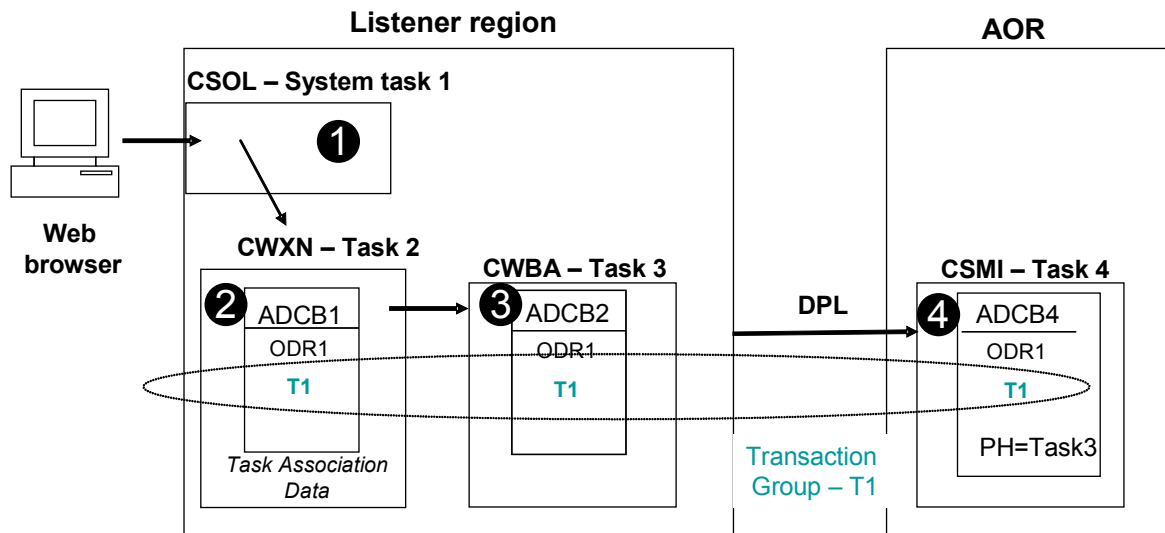


Figure 2. Association data and origin descriptors

In CICS TS 4.2, origin data is propagated between requests that flow over either MRO or IPIC connections between CICS regions. However, tasks initiated using APPC connections between CICS regions, or that intercommunicate using distributed transaction processing (DTP) commands, do not propagate origin data and so will not be viewed as *associated* within a CICSplex.

Tracking transactions

Using this new infrastructure, you can track the hierarchy of requests as they flow between multiple CICS regions. The key information is the previous hop data. Figure 4 shows the creation of origin data at the point of origin for a web-based HTTP request and the flow of data between tasks, as the request flows from a listener region to an application-owning region (AOR).



ADCB=Association data control block
 ODR=Origin descriptor record
 PH=Previous Hop

Figure 4. Transaction association

1. At point 1 in the diagram, the sockets listener CSOL receives the HTTP request. This is a system task and does not generate any association data. Having read the data from the socket, the listener attaches the web attach transaction CWXN.
2. The CWXN transaction creates a new origin descriptor record in its task association data (ADCB1), using information such as the client IP address and the URIMAP resource that was used in step 1. Because this is a web request, CWXN calls the web alias transaction CWBA to process the HTTP message.
3. The CWBA transaction receives the point of origin data from CWXN and uses this information to populate the point of origin in its own task association data (ADCB2). CWBA then links to a CICS program that is defined as remote and invokes a DPL request to the AOR using the mirror transaction CSMI.
4. The mirror transaction is called in the AOR and receives the origin data from Task 2 and uses this information to populate the point of origin in its own association data. Because the request uses an MRO communication link, the previous hop section of the association data is populated naming the calling task as the web alias (CWBA) task 3 from the listener region.

All the user tasks (task 2, task 3, and task 4) in this scenario are *associated* as they share a common transaction group ID, that is unique across all tasks in the CICSplex. This transaction group ID can be used by tools such as CICS Explorer to search for and correlate active tasks in the CICSplex. This search can be based either on a task at the point of origin in a listener region, such as CWXN, or a suspended application in an AOR, such as the CSMI mirror task in the example.

Figure 5 shows a real life search example of the scenario in Figure 4 using the **Search** → **Associated Tasks** function from the CICS Explorer *Task* view. Each column in the Search view is customizable and can display any of the Task or Task Association properties. In the example, the *Prev Hop Count* value of 1 shows that the CSMI mirror task 498 was initiated across an intercommunication link; the *Origin Trans ID* value of CWXN shows that all tasks have the same point of origin created by CWXN, and the *Facility Type* shows how each task has been initiated.

Tasks	Transaction ID	Region	Origin Task	Origin Trans ID	Facility Type	Prev Hop Count	Origin IP ...	Start Time	Run Status
0015911	CWXN	IYK2Z32C	0015911	CWXN	SOCKET	0	9.20.213.71	2011-10-03T14:37:50.521461...	SUSPENDED
0015912	CWBA	IYK2Z32C	0015911	CWXN	WEB	0	9.20.213.71	2011-10-03T14:37:50.522101...	SUSPENDED
0000498	CSMI	IYK2Z32B	0015911	CWXN	MRO	1	9.20.213.71	2011-10-03T14:37:50.523057...	SUSPENDED

Figure 5. CICS Explorer - associated tasks search

IP facilities

Another benefit of task association data is the correlation it provides between the facilities in the IP network and tasks in CICS. A range of new information is provided (see Table 1) that you can use to analyze tasks by point of origin.

Table 1. IP facility information

Value	Description
Appl Data	Socket application data describing CICS protocol listener etc.
Client IP address	IP address of remote client
Client IP format	IPV4 or IPV6 address format
Client port	IP port used on remote client
ClusterConnType	SO_CLUSTERCONNTYPE options returned by Communications Server, describing if the socket is local to the sysplex, LPAR, or external.
IPCONN resource	Name of IPCONN resource used to receive request
Server IP format	IPV4 or IPV6 address format
Server IP address	IP address used by CICS to receive request
Server port	IP port used by CICS to receive request
TCP/IP service	Name of CICS TCPIP SERVICE resource used to receive request
TCP/IP security zone	Name of z/OS TCP/IP security zone
TCP/IP job	Name of z/OS TCP/IP stack

All of this information is viewable in the Task Association view in CICS Explorer, and can be filtered and sorted using the standard facilities in CICS Explorer. In addition several new IP network centric search functions have been introduced. These are as follows and allow specific tasks in the CICSplex to be located based on prior knowledge about IP facilities in use in a CICS listener region. The searches available are as follows:

1. Task Association view: **Search** → **Tasks from Origin IP Address**
2. IPIC Connections view: **Search** → **Tasks from IP Resolved**
3. TCP/IP Services view: **Search** → **Tasks from TCP/IP Service**

The screen capture in Figure 6 shows the results of a search for Tasks from TCP/IP Service *IPIC* in region *IYK2Z32C*. 10 different CSMI tasks have been found, each of which are listed as using the *IPIC* TCP/IP Service in region *IYK2Z32C*.

The screenshot shows the IBM CICS Explorer interface. The main window displays search results for 'Tasks from TCP/IP Service "IPIC" - 10 results - 1'. The results are shown in a table with columns: Tasks, Transa..., Region, TCP/IP Service, Client IP Address, Run Stat, and a final column for IP address. A context menu is open over the table, showing options like 'Open', 'Open TCP/IP Service', 'Deregister', 'Search', 'Close TCP/IP Service', and 'Discard'.

Region	Name	Service Status	Protocol	IP Address	Port	Urm	Num...	Backlog	Socket
IYK2Z32C	CWS	OPEN	HTTP	9.20.138.199	8113	DFHWBADX	0	5	WAIT
IYK2Z32C	ECI	OPEN	ECI	9.20.138.199	7113		0	250	WAIT
IYK2Z32C	IPIC	OPEN	IPIC	9.20.138.199	6113	DFHISAIP	6	100	WAIT

Tasks	Transa...	Region	TCP/IP Service	Client IP Address	Run Stat	
SDAYPEG						
IYK2Z32C						
0000301	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139
0000302	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139
0000303	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139
0000304	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139
0000305	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139
0000306	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139
0000307	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139
0000308	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139
0000309	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139
0000310	CSMI	IYK2Z32C	IPIC	9.20.138.199	RUNNING	9.146.156.139

Figure 6. Search tasks from TCP/IP Service

Adapter data

Adapter data is an additional section of information in the origin data. It is new in CICS TS 4.2 and provides information about the external adapter that introduced work into CICS. The value of adapter data is that it solves a unique issue with requests

initiated by task-related user exit (TRUE) based adapters such as WebSphere MQ.

These adapters rely on CICS START commands to initiate work in CICS. Typically, tasks initiated by START commands are associated with the parent task that issued the START, and therefore inherit their point of origin from the starting task. In the case of the WebSphere MQ trigger monitor, this is usually the WebSphere MQ trigger transaction CKTI. However, if the TRUE is enabled to set adapter data, then each request that starts a new CICS transaction becomes a new point of origin and the TRUE annotates the point of origin with extra information about the source of the external request.

In the case of WebSphere MQ, this extra data includes information about the Queue Manager and initiation queue and trigger queues. Adapter data is supported by the WebSphere MQ trigger monitor supplied with CICS TS 4.2, and also by the WebSphere Optimized Local Adapter (WOLA) supplied with WebSphere Application Server V8.0.0.1 for z/OS.

Adapter data tracking example

The following example (Figure 7) shows how transaction tracking data can be used to track back from a suspended task, to determine information about the transaction that originated the request.

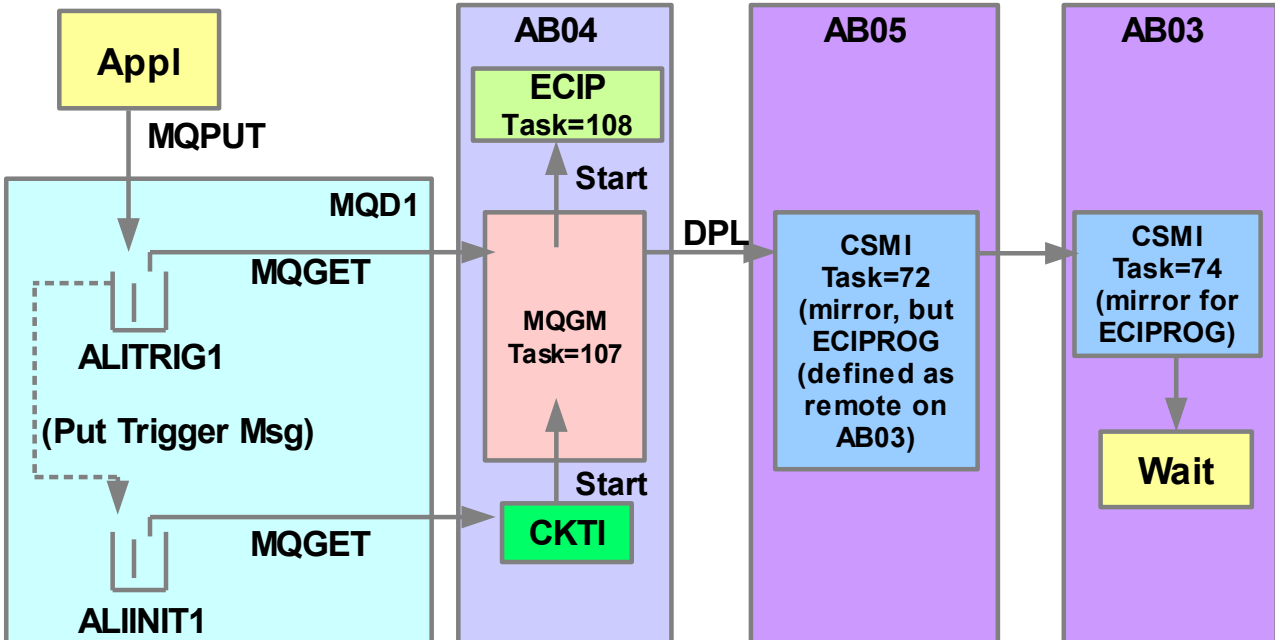


Figure 7. Transaction tracking from the WebSphere MQ trigger monitor

In the example an application puts a message on to trigger queue ALITRIG1 causing the following chain of events:

1. Queue Manager MQD1 generates a trigger message and places it on initiation queue ALIINIT1.
2. The trigger monitor transaction CKTI gets the trigger message and starts an

instance of the triggered transaction MQGM in CICS region AB04.

3. Transaction MQGM issues a local START for transaction ECIP which suspends.
4. Transaction MQGM also issues a Distributed Program Link (DPL) request for program ECIPROG, which is first routed to CICS region AB05, and then on to CICS region AB03 where it suspends.

From the CICS Explorer Tasks view, the tasks associated with the suspended CSMI task 74 can be seen using **Search** → **Associated Tasks**, as shown in the screen capture in Figure 8.

This screen capture shows that task 72, the first instance of transaction CSMI, and task 107 (transaction MQGM) are both associated with task 74 (the second instance of transaction CSMI), as is also task 108 which is the started transaction ECIP.

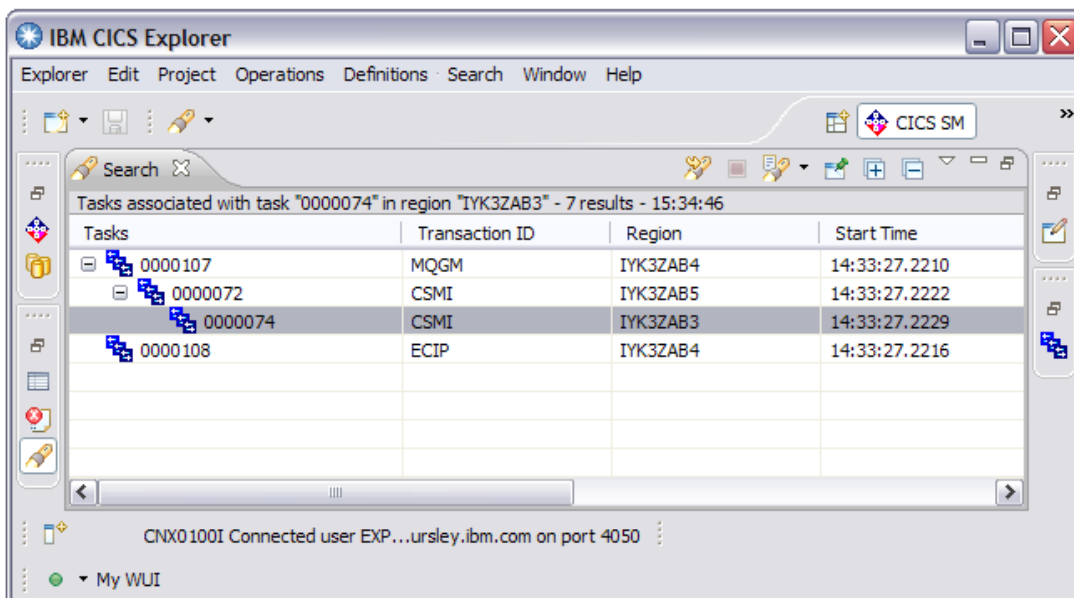
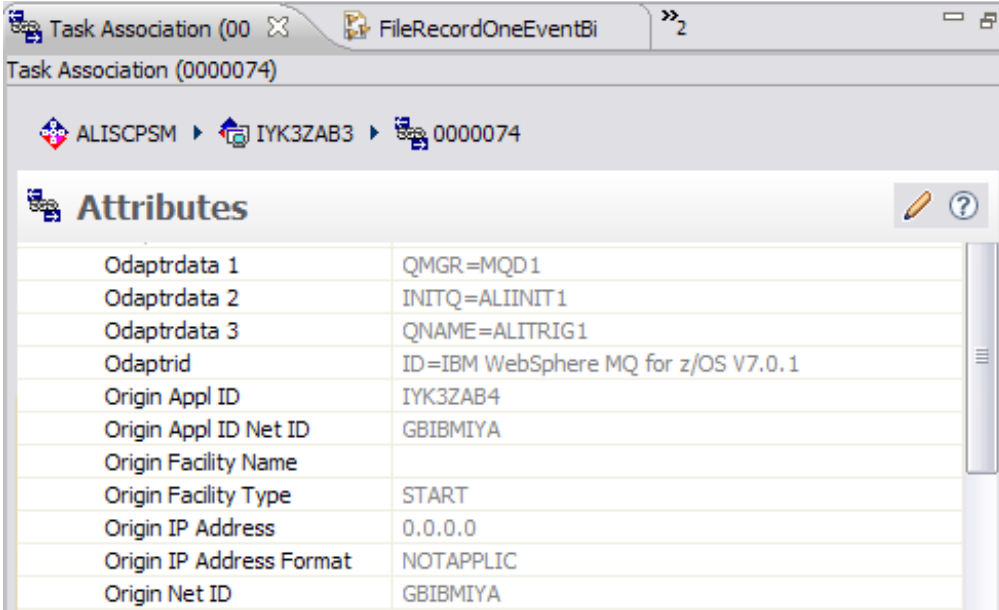


Figure 8. Task association showing task hierarchy

In Figure 9, the task association data view for task 74 shows the four adapter data fields. These fields list the queue manager name (MQD1), the initiation queue (ALIINIT1), the request queue (ALITRIG1), and the WebSphere MQ version (V7.01). This adapter data is part of the origin descriptor record and has been inherited from the MQGM task 107, which was started by the MQ trigger monitor task CKTI.



Attribute Name	Value
Odaptrdata 1	QMGR=MQD1
Odaptrdata 2	INITQ=ALIINIT1
Odaptrdata 3	QNAME=ALITRIG1
Odaptrid	ID=IBM WebSphere MQ for z/OS V7.0.1
Origin Appl ID	IYK3ZAB4
Origin Appl ID Net ID	GBIBMIYA
Origin Facility Name	
Origin Facility Type	START
Origin IP Address	0.0.0.0
Origin IP Address Format	NOTAPPLIC
Origin Net ID	GBIBMIYA

Figure 9. Adapter data added by WebSphere MQ

Other interfaces

The above examples show how the power of CICSplex SM and the CICS Explorer work together to provide a CICSplex wide search tool for simplified problem determination. In addition, the following user interfaces also support the viewing of task association data and can be used to report or query on associated tasks:

- CICS Performance Analyzer (CICS PA) Transaction Tracking Summary and List reports and Performance Summary report
- CICS TS monitoring data print program, DFH\$MOLS
- CICSplex SM WUI and CICSplex SM completed task history (HTASK)
- CICS SPI command, INQUIRE ASSOCIATION

Conclusion

This paper has described the enhancements provided in CICS TS 4.2 to simplify and extend the tracking of transactions across the CICSplex. The following key enhancements are provided that enable this new function.

- Task association data is now created for all user-initiated transactions, and the origin data is now propagated across both MRO and IPIC connections whenever tasks are initiated in subsequent regions. Additional previous hop and adapter data information is also provided, and describes the initiating task and the number of communication hops in the transaction flow, and a mechanism for exploitation by TRUE based adapters
- Transaction tracking for adapters is enabled through the provision of adapter data fields in the origin data section of the association data. When a request to start a new task is made, a TRUE can specify information to identify the adapter as the point of origin for the task. This data is placed into the new origin data adapter fields of the task. The CICS-WebSphere MQ trigger monitor, supplied with CICS TS 4.2, exploits this function to identify the queue manager, application queue, and initiation queue for each task that is initiated by a WebSphere MQ trigger message.
- New association data information is now used by enhanced task search functions in CICS Explorer, which can display the flow topology of interrelated tasks in the CICSplex, and locate tasks based on the originating TCP/IP address or TCP/IP service. Together with performance monitoring records these functions provide a powerful transaction tracking capability. This can be used to visualize interrelated tasks as they flow across regions in a CICSplex, to locate specific tasks based on information in the point of origin, and to improve any charge-back accounting of user transactions

These extensions to transaction tracking have significantly strengthened problem determination facilities in CICS TS. Together with the search functions in CICS Performance Analyzer, a comprehensive infrastructure exists to help customers quickly understand the topology of transactions no matter where they may have been dynamically routed. This will be a significant aid in auditing and problem determination and simplifies the administration skills required to diagnose business applications in CICS.

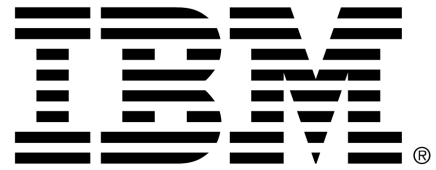
Further reading

1. System management enhancements in CICS TS 4.2:

<http://publib.boulder.ibm.com/infocenter/cicsts/v4r2/topic/com.ibm.cics.ts.whatsnew.doc/themes/theme4.html>

2. The Transaction Tracking demonstration by Daniel Millwood

<http://www.ibm.com/software/http/cics/tserver/v42/library/videos/tt4.html>



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