
IBM
IMS 13
IMS 13 Application Programming
Information Management software
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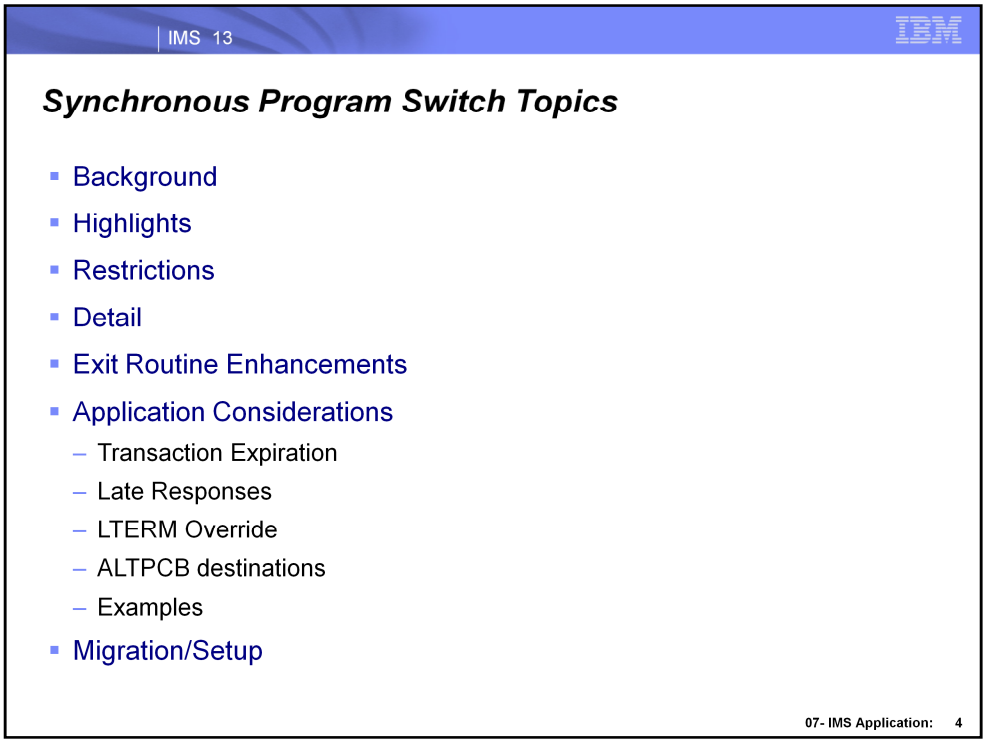
Application Programming Enhancements

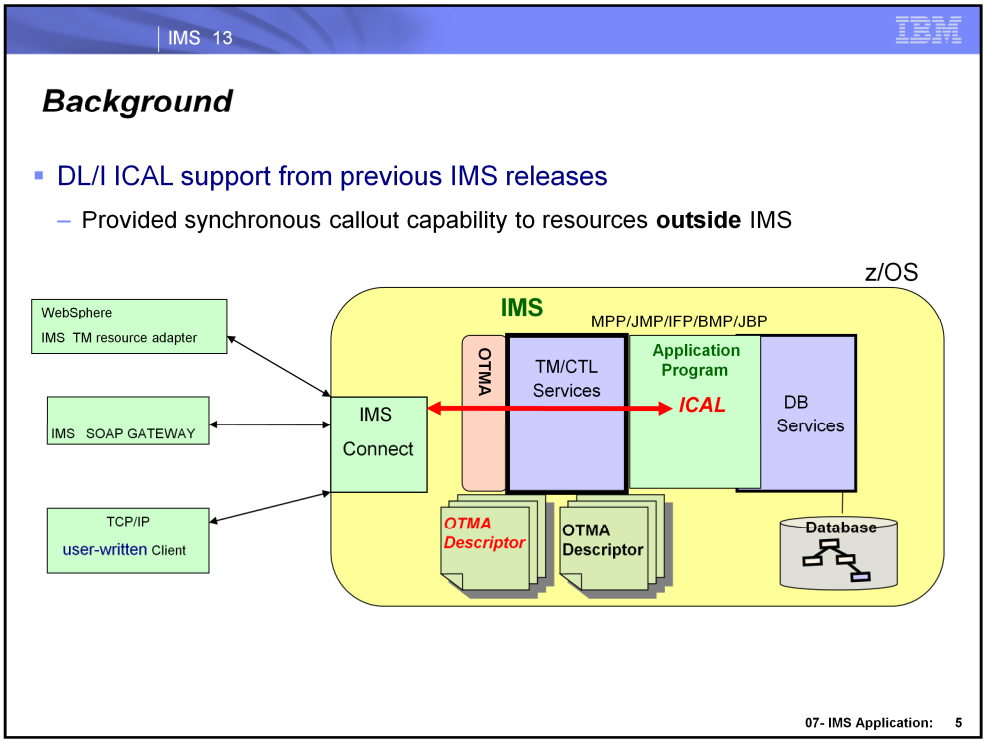
- Synchronous Program Switch
- SSA Qualify by Position and Length
- IMS Universal Driver Enhancements
- IMS Native SQL support for COBOL

07- IMS Application: 2

Synchronous Program Switch



The topics on this visual show the comprehensive support IMS 13 has added for this new application model.

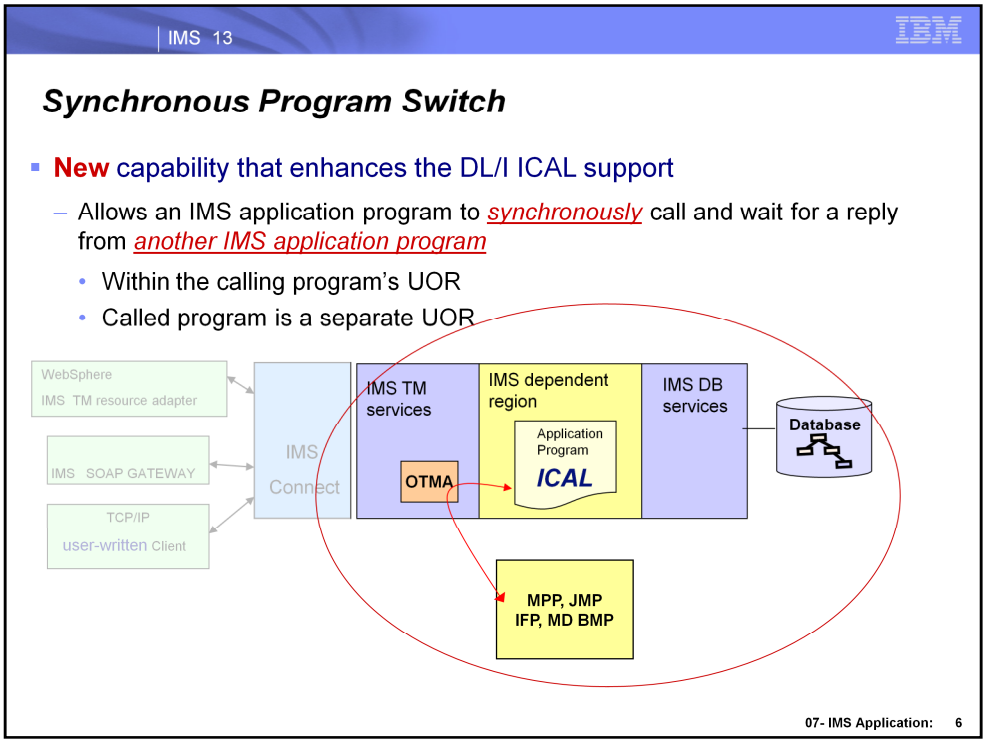


The existing DL/I ICAL in IMS allows IMS applications to synchronously call out to external resources. Specifically, IMS applications can request access to and wait for replies from:

•WebSphere EJBs/MDBs using the IMS TM Resource Adapter

•To any Web Service Provider using the IMS SOAP Gateway

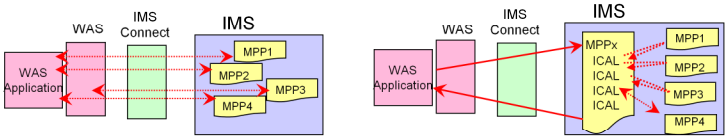
•User-written IMS Connect clients



With IMS V13, a new capability is added to the DL/I ICAL support so that not only is access to resources outside IMS supported, but also the ability to synchronously call another IMS transaction running in any of the dependent region types. The called or target program can be an MPP, JMP, IFP, or Message-Driven BMP in the same or different IMS.

Synchronous Program Switch…

- Benefits
  - Modernization of the IMS application infrastructure
    - Provides an internal service flow of IMS transactions to complete a business process
      - In the same IMS or a different IMS
  - Implementation of a Process Server or Broker inside IMS
    - Reduces unnecessary network traffic when accessing multiple applications in the same IMS or IMSplex



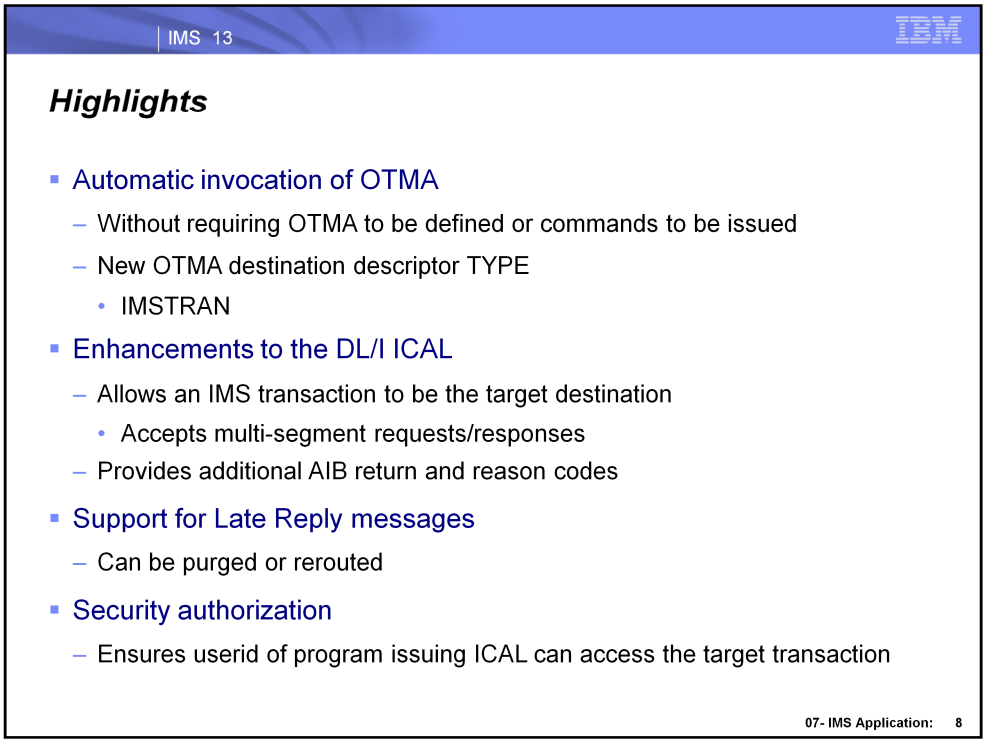
There are many benefits for IMS DB/TM and IMS TM environments that are looking to modernize their application infrastructure. Synchronous program switching provides many opportunities including:

•Modernization of the application infrastructure while continuing to use DL/I functionality to access various destinations

•Support for an internal service flow template that allows multiple IMS transactions to synchronously participate in a business process

•Encouragement of new IMS application development to support business logic on the host.

•Reduction of unnecessary network traffic with a broker implementation that uses synchronous program switching techniques



The highlights include:

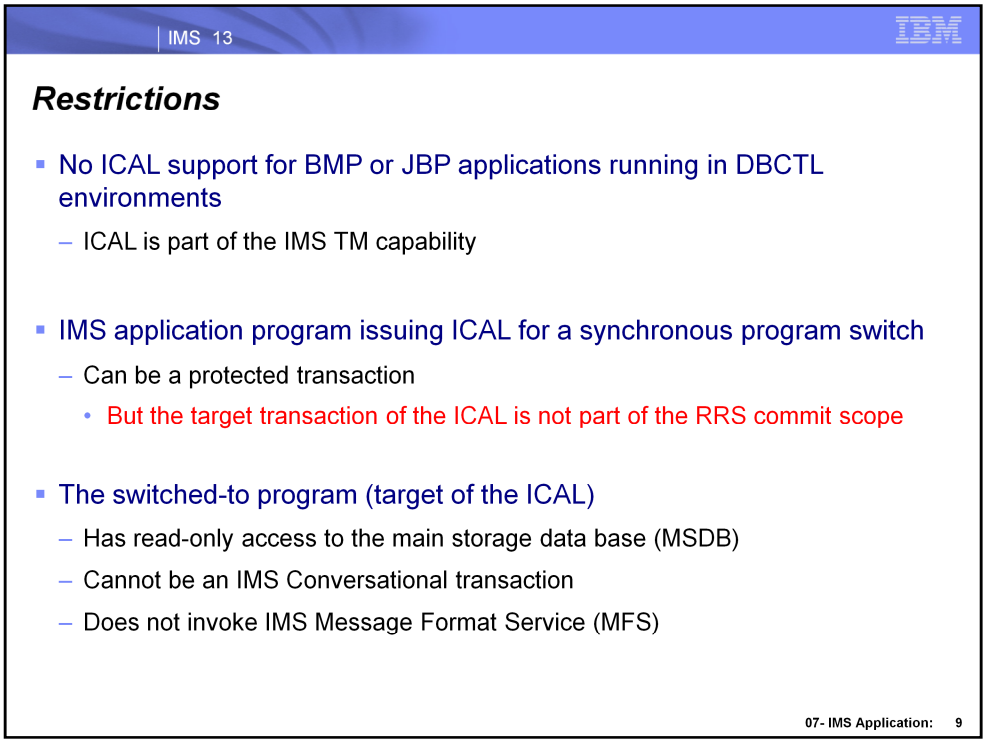
•Automatic invocation of OTMA which is an inherent part of IMS.

•A new OTMA destination descriptor type of IMSTRAN which designates an IMS transaction as the target destination for both single and multi-segment ICAL messages.

•Extensions to the DL/I ICAL to provide additional AIB return and reason codes to provide information about errors that could be experience in this new environment.

•Control of late replies. If the ICAL times out before its target transaction returns a reply, the late response message is automatically purged unless a reroute designation was previously defined in the destination descriptor.

•Support for security. The userid associated with the transaction issuing the ICAL is the same userid that is used to determine whether the target of the ICAL can be accessed.

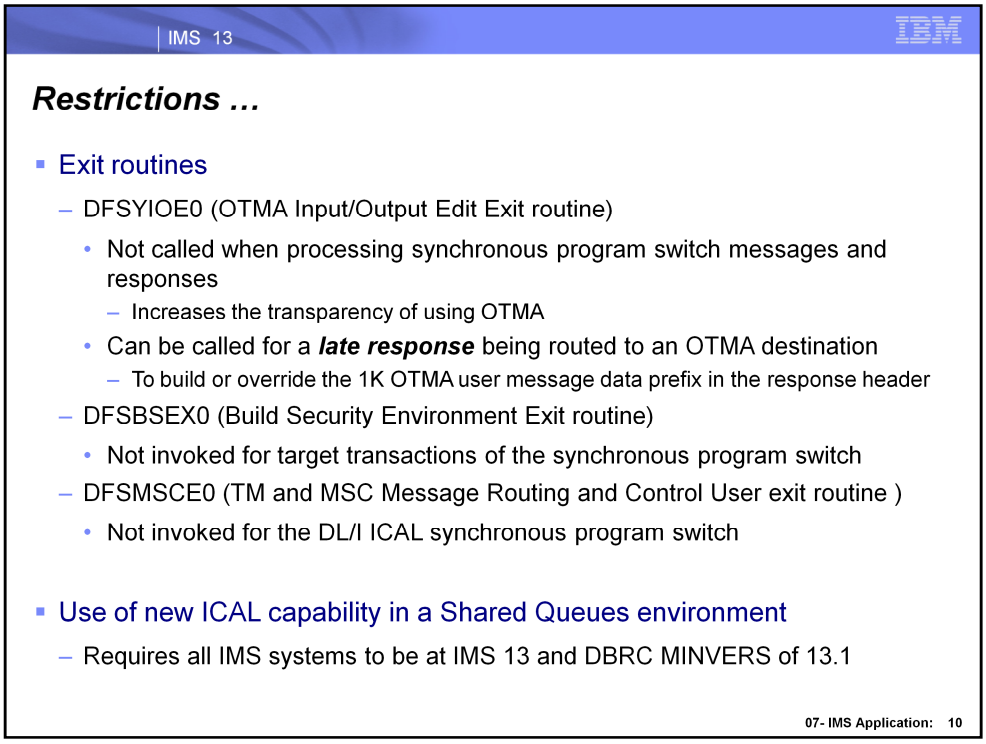


Note the upfront restrictions:

•ICAL is only supported in IMS TM or IMS TM/DB environments. BMPs or JBPs running in DBCTL are not able to issue the ICAL.

•The IMS application program issuing the ICAL can be a participant in a protected transaction but the target of the ICAL cannot be part of the RRS (resource recovery services) commit scope.

•Additionally, the IMS program that is invoked by the ICAL can read but not update MSDBs and cannot be an IMS conversational transaction. MFS services are never invoked.



Restrictions involving exit routines include:

•The DFSYIOE0 (OTMA Input/Output Edit Exit routine) is not called for synchronous program switch messages and responses. It can be called, however, for a ***late response*** that is not purged but instead routed to an OTMA destination.

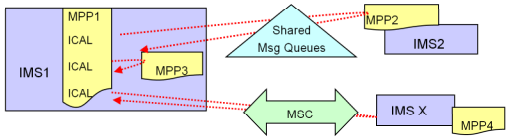
•The DFSBSEX0 (Build Security Environment Exit Routine) is not invoked for the target transaction of the synchronous program switch.

•Unlike the regular ISRT/CHNG call, DFSMSCE0 user exit will not be called for the synchronous program switch using the DL/I ICAL call.

IMS shared queues support requires all systems must be at IMS 13 and a DBRC MINVERS of 13.1.

Synchronous Program Switch – The Details

- An enhancement to the DL/I ICAL to invoke another IMS application
  - In the same IMS
  - In a different IMS
    - In a Shared Queues back-end
    - Across an MSC link
  - And synchronously receive the response back during the same unit of recovery



- Where IMS internally schedules the transaction initiated by the ICAL call as an OTMA transaction
  - Uses a new type of OTMA destination descriptor (TYPE=IMSTRAN) which has been introduced specifically for synchronous program switch support
- And the target transaction can be
  - An IFP, MPP, MD BMP, or JMP in the IMS TM or TM/DB environments

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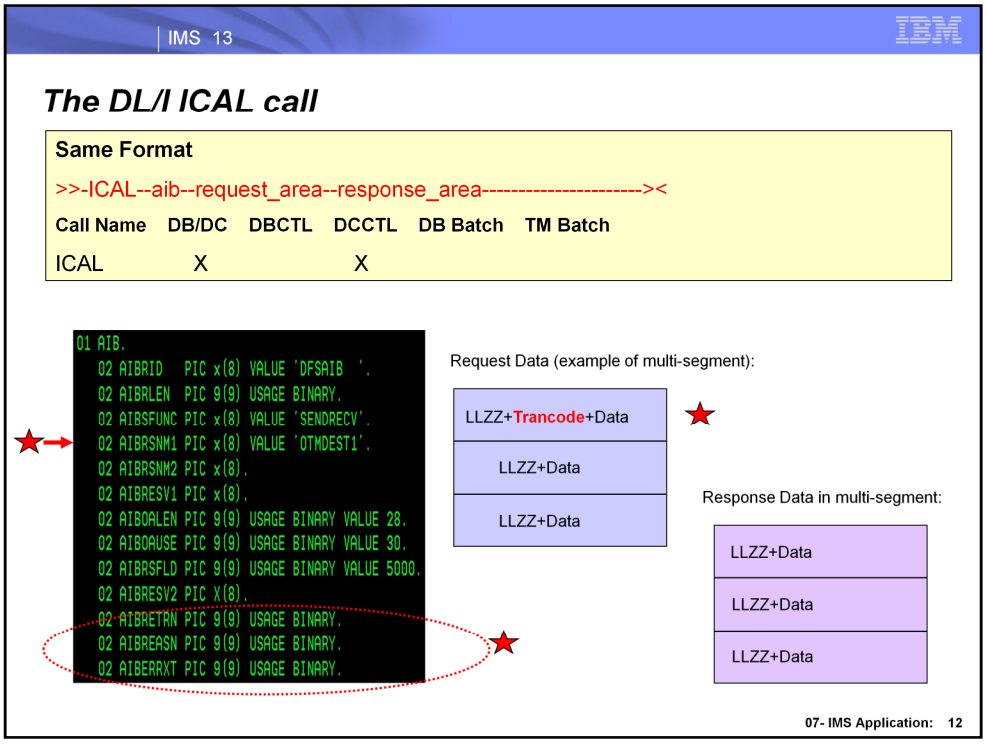
In IMS V13, the function of this DL/I ICAL has been extended to allow customers to call another IMS application, which can be in the same IMS, in the shared-queues back-end IMS, or in the remote IMS via MSC. The ICAL synchronously receives the response back during the same unit of work. This new function is called “Synchronous Program Switch.”

This new synchronous program switch function expands the usage of the OTMA destination descriptor to serve the ICAL requests so that the transaction data can be sent to another IMS application for processing. Multi-segment messages and responses are supported and the target of the call can be an IFP, MPP, BMP, JMP, or JBP running in the same or another IMS TM or IMS TM/DB system



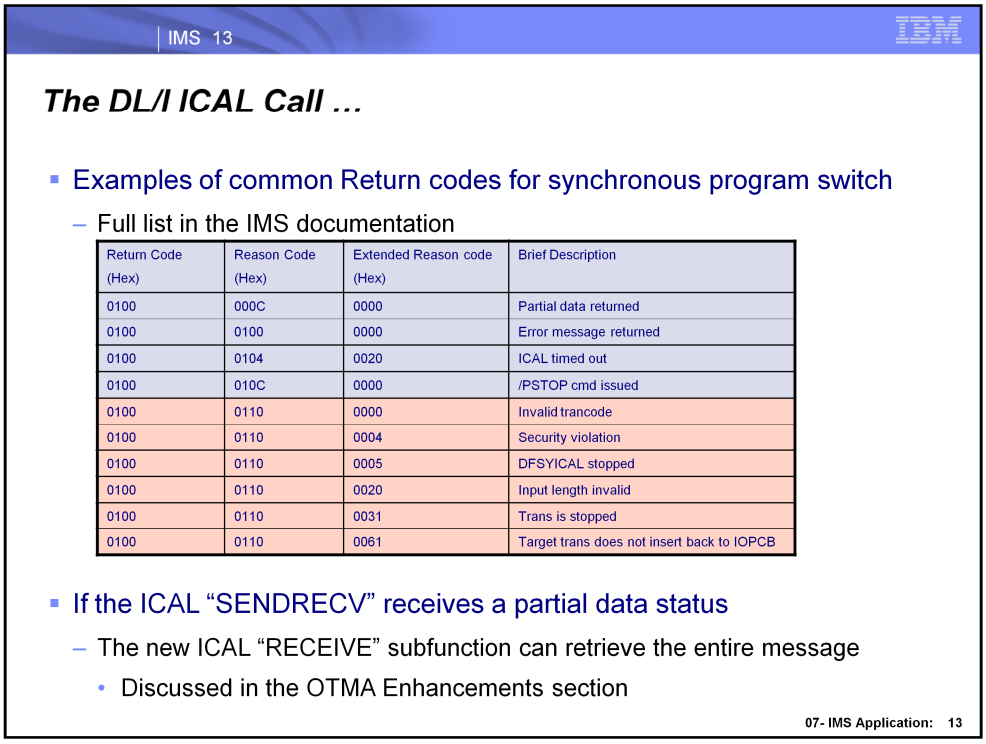
The overall structure of the DLI ICAL continues to be the same as in previous releases. The functionality, however, has been expanded to allow the IMS application program to call another IMS application.

request_area

Specifies the request area to use for this call. This parameter is an input parameter. This request area contains the request message data that is sent from the IMS application program to the application that is specified in the OTMA descriptor. The AIBOALEN field specifies the length of the request message data. If the data is destined for a non-IMS application program or service that runs in a z/OS or distributed environment, the ICAL call will bypass IMS TM message queuing and the format of the request area does not require the LLZZ fields. If the data is destined for an IMS application program, the request data will require the LLZZ fields and the transaction code needs to be specified in the first 8 bytes of the data area following the LLZZ. For transactions specified with MULTSEG, the request data will need to include the entire segments. The standard IMS LLZZ format is required for each segment. The transaction code is only required in the first segment.

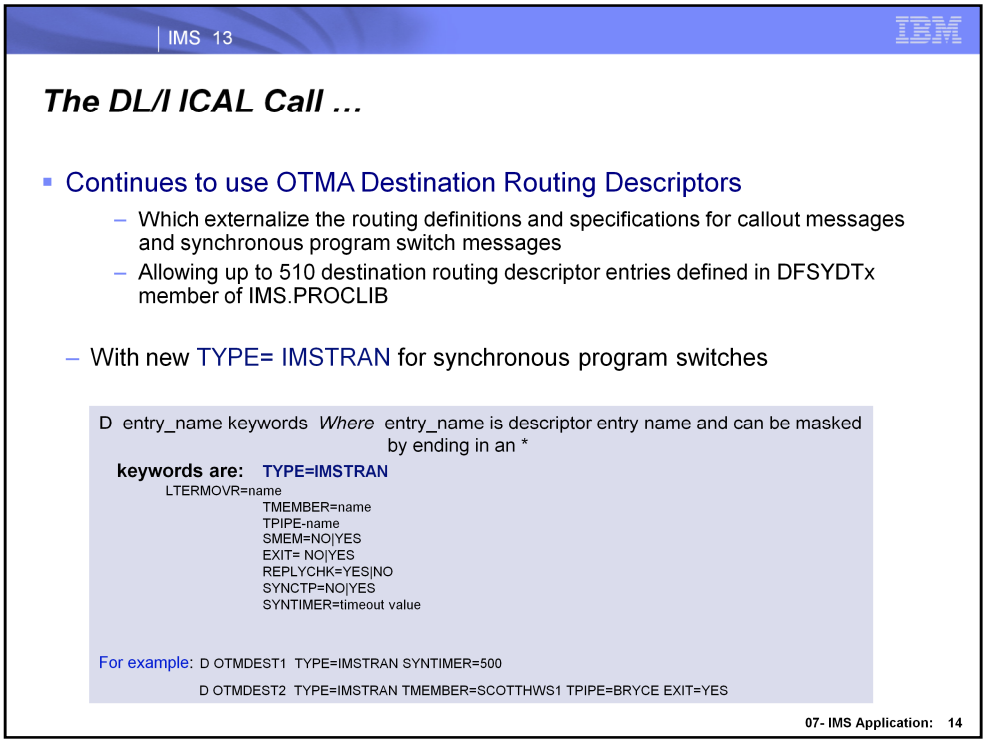
response_area

Specifies the response area to use for this call. This parameter is an output parameter. This response area should be large enough to hold the response that is returned from the application that is specified in the OTMA descriptor. If the response area is not large enough to contain all of the returned data, IMS returns partial data. When partial data is returned, the AIBOAUSE field contains the length of the returned data in the response area, and AIBOALEN contains the actual length of the response message. If the request data is destined for a non-IMS application program or service that runs in a z/OS or distributed environment, the format of the response area does not require the LLZZ fields. If the request data is destined for an IMS application program, the format of the response data will follow the standard LLZZ format for each segment in the response data area, and the response data area will include the entire output segment if the space has been defined as large enough.



Additionally, new return codes, reason codes and extended reason codes for the ICAL are introduced to explain errors that could be encountered in this new type of interaction. The visual shows some examples but the full list is available in the IMS documentation.

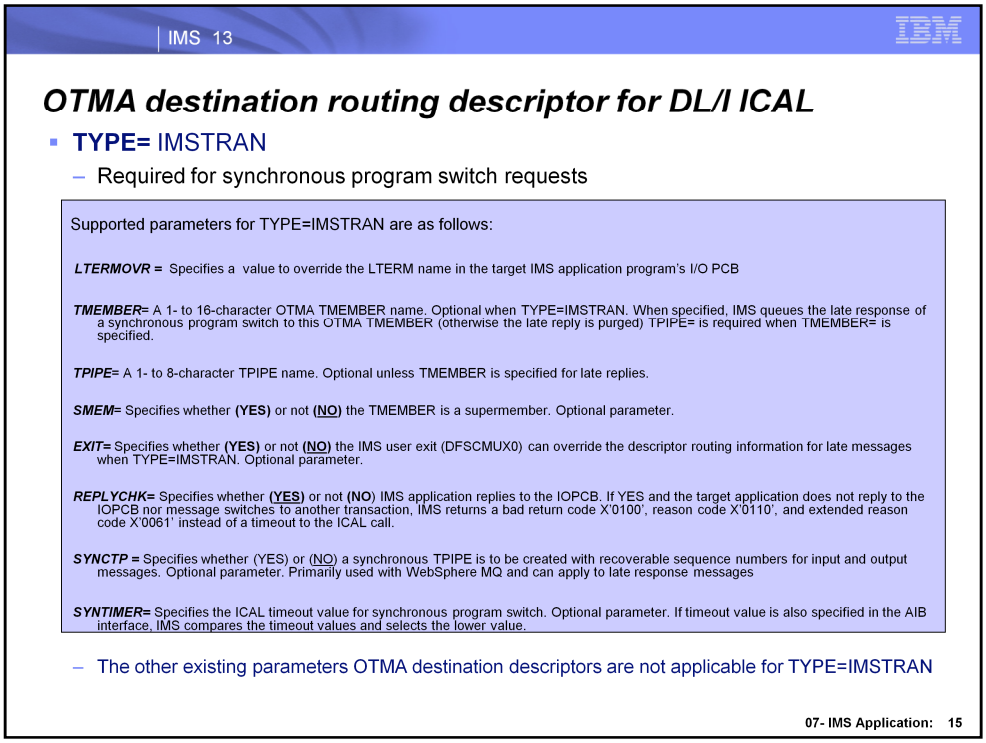
Note that if the response_area is too small and only partial data is returned, then the new ICAL with a sub-function of “RECEIVE” can be used to retrieve the entire message. Detailed information on the RECEIVE subfunction can be found in the OTMA Enhancements section.



The DFSYDTx member of IMS.PROCLIB has been enhanced to support a new type of destination descriptor, **IMSTRAN,** to perform the synchronous program switch via the DL/I ICAL call in the IMS application. They are read and loaded at IMS initialization.

The optional parameters include: TMEMBER, TPIPE, SMEM, SYNCTP, EXIT, LTERMOVR and REPLYCHK. The TMEMBER, TPIPE, SYNCTP, and SMEM parameters for this new type of descriptor can be used to specify the destination of the late response for the synchronous program switch request. The EXIT parameter allows the message control/error exit routine (DFSCMUX0) user exit to override the destination for the late response for the synchronous program switch. The LTERMOVR parameter can be specified to set the LTERM name of the IOPCB for the target transaction of the synchronous program switch. The REPLYCHK parameter can be optionally used when multiple response messages are competing to be sent back to the ICAL call.

These new descriptor type and the corresponding parameters for the synchronous program switch can be specified by using the DFSYDTx member of IMS PROCLIB or the type-2 commands



The supported parameters for TYPE=IMSTRAN are as follows:

•LTERMOVR= Specifies the LTERM name used to override the LTERM name in the IMS application program's I/O PCB.

•TMEMBER= A 1- to 16-character OTMA TMEMBER name. This parameter is optional when TYPE=IMSTRAN. When specified, IMS will queue the late response of a synchronous program switch to this OTMA TMEMBER. And TPIPE= is required when TMEMBER= is specified.

•TPIPE= A 1- to 8-character TPIPE name. This parameter is optional. IMS uses this TPIPE to queue the late response for synchronous programs switch when TYPE=IMSTRAN. And TMEMBER= is required when TPIPE= is specified.

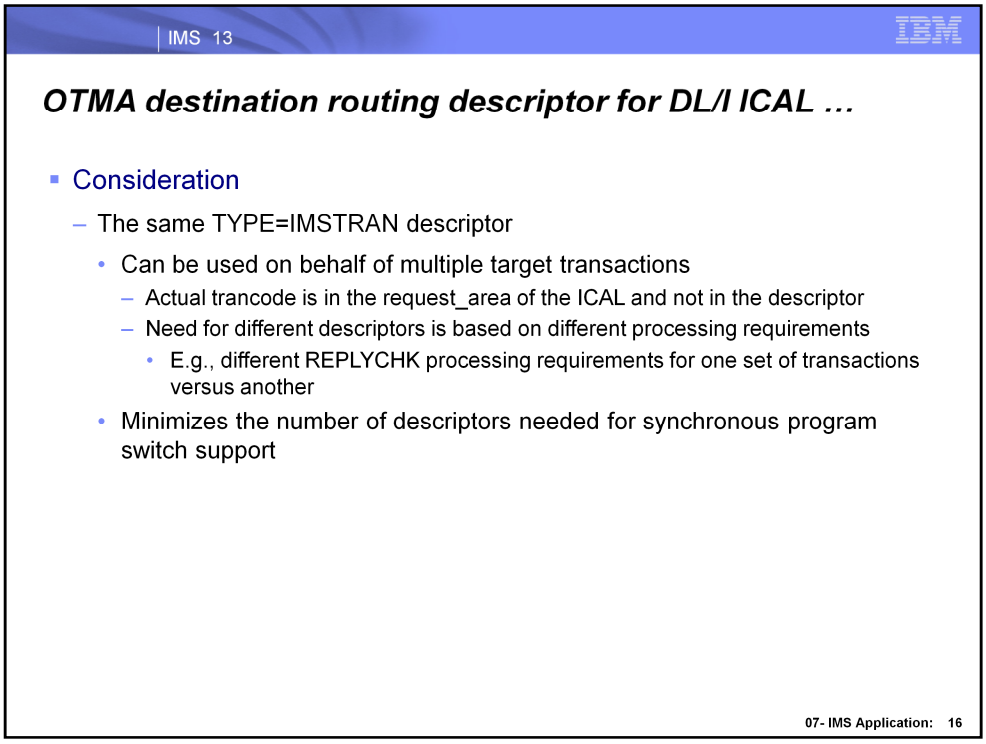
•SMEM= Specifies whether (YES) or not *(NO)* this destination is a supermember.

•EXIT= Specifies whether (YES) or not (NO) the IMS user exit (DFSCMUX0) can override the descriptor routing information for late messages when TYPE=IMSTRAN. It is an optional parameter and defaults to NO.

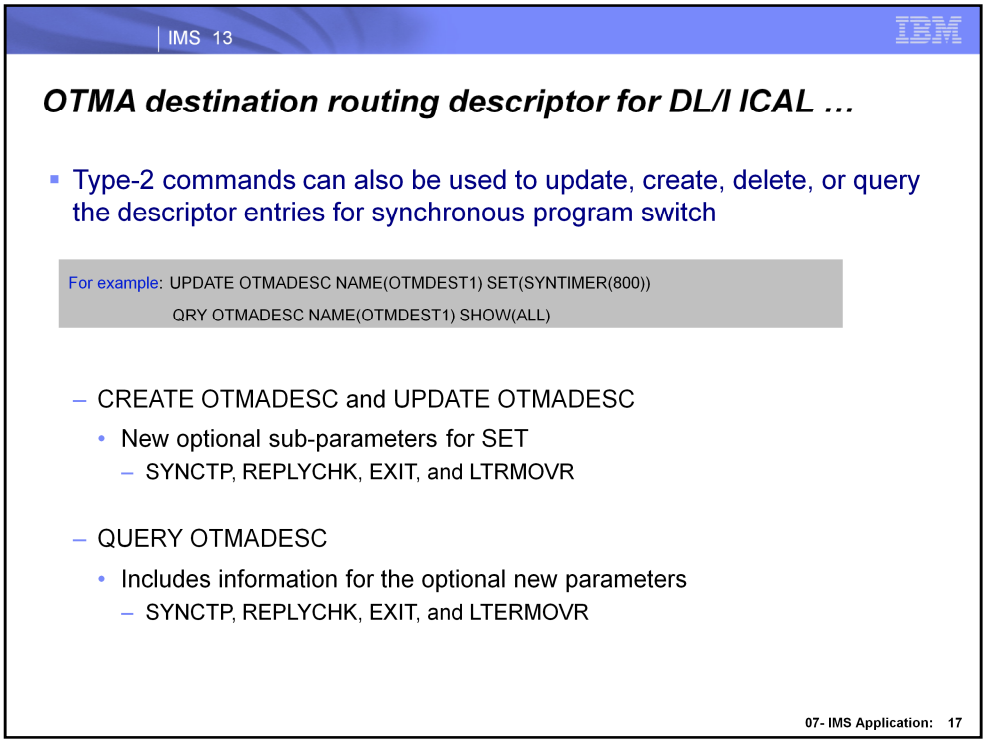
•REPLYCHK= Specifies whether (YES) or not (NO) IMS application replies to the IOPCB. When REPLYCHK=YES and the ICAL switch-to application does not reply to the IOPCB nor message switch to another transaction, IMS will return a bad return code X'0100', reason code X'0110', and extended reason code X'0061' instead of a timeout to the ICAL call. It defaults to YES.

•SYNCTP = Specifies whether (YES) or (NO) a synchronous TPIPE is to be created with recoverable sequence numbers for input and output messages. Optional parameter. Primarily used with WebSphere MQ and can apply to late response messages

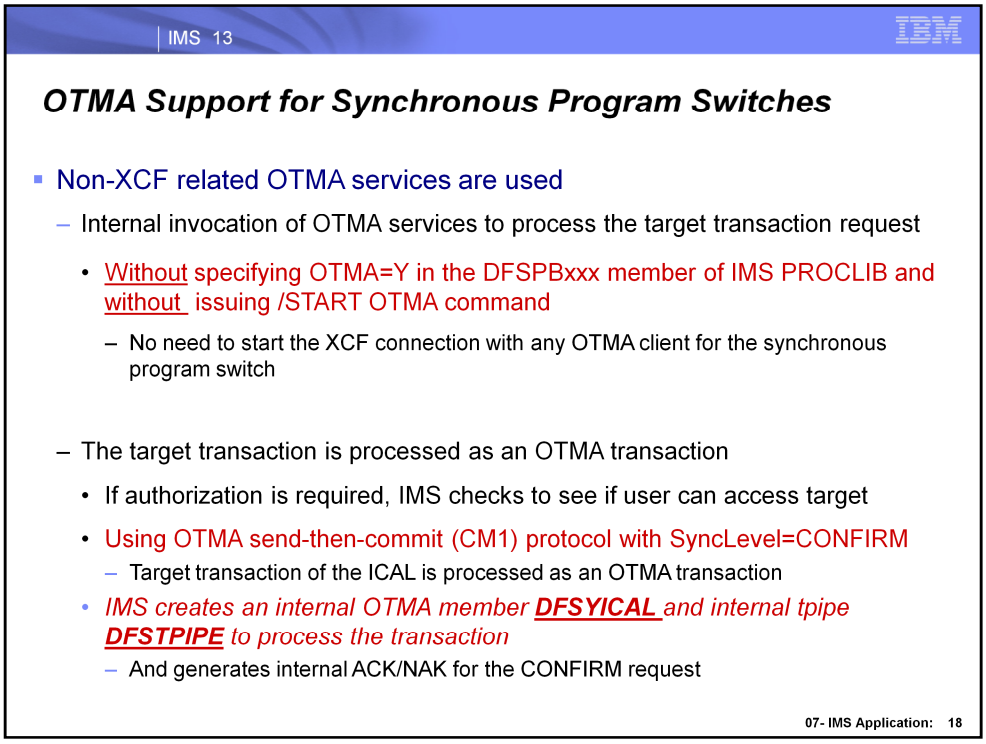
•SYNTIMER= Specifies the ICAL timeout value for synchronous program switch. If timeout value is also specified in the AIB interface, IMS will compare the timeout values and select the lower one for this ICAL call. This is an optional parameter.



The destination descriptor with TYPE=IMSTRAN for synchronous program switch requests can be used on behalf of multiple target transactions. The actual trancode is specified in the message sent by the ICAL and not in the destination descriptor. Creating multiple of the TYPE=IMSTRAN descriptors is useful if different processing characteristics are needed.



In lieu of creating descriptors, the Type-2 commands can be used to update, create, or delete OTMA descriptor entries. Additionally, a QUERY command can be used to display information associated with a descriptor. For synchronous program switch support, the new optional sub-parameters (SYNCTP, REPLYCHK, EXIT, and LTERMOVR) can be SET as well as queried.

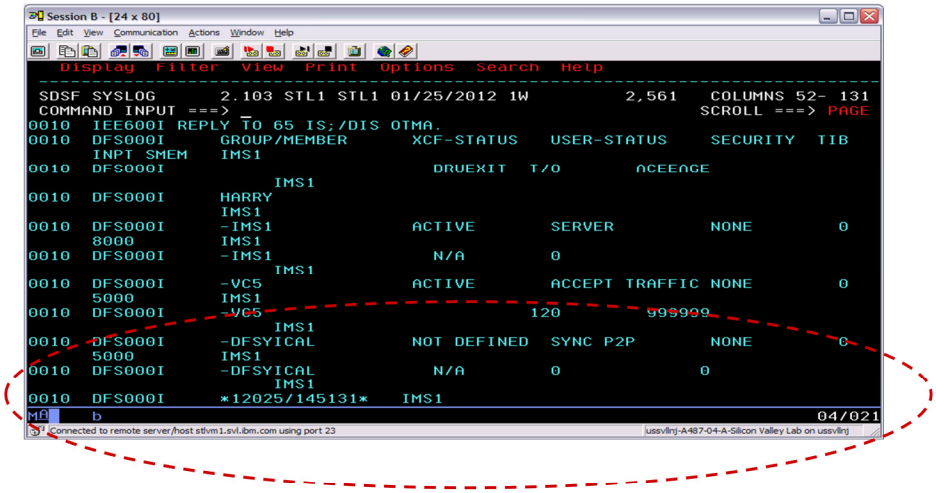


IMS internally schedules transactions initiated by the ICAL as OTMA transactions. Using OTMA, however, for the synchronous program switch support will be transparent and automatic. This means that there will be no need to specify OTMA=Y in the IMS PROCLIB member DFSPBxxx nor will there be a need to issue a /START OTMA command.

Once a DL/I ICAL for synchronous program switch is accepted, IMS first checks to see if authorization is required and, if so, check to ensure the user is allowed to access the target transaction. Once the authorization process is complete, IMS internally use the OTMA send-then-commit (CM1) protocol with SyncLevel=CONFIRM to process this request. An internal ACK for the CM1 response will always be generated. The response is not sent until the IMS syncpoint is complete.

The OTMA TMEMBER DFSYICAL with the TPIPE name DFSTPIPE will be created.

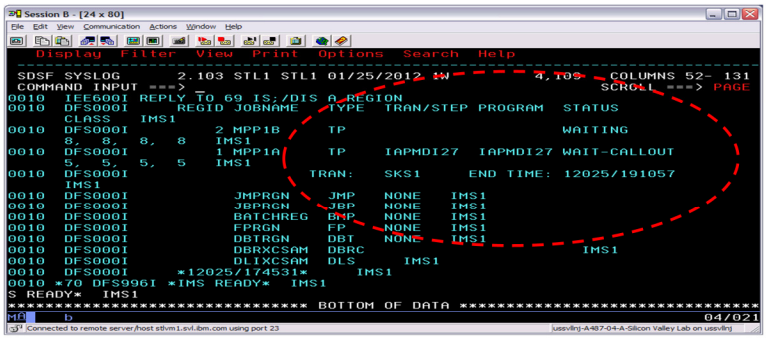
OTMA Support for Synchronous Program Switches …



A /DIS OTMA command can be used to see the existence of the DFSYICAL TMEMBER and associated properties.

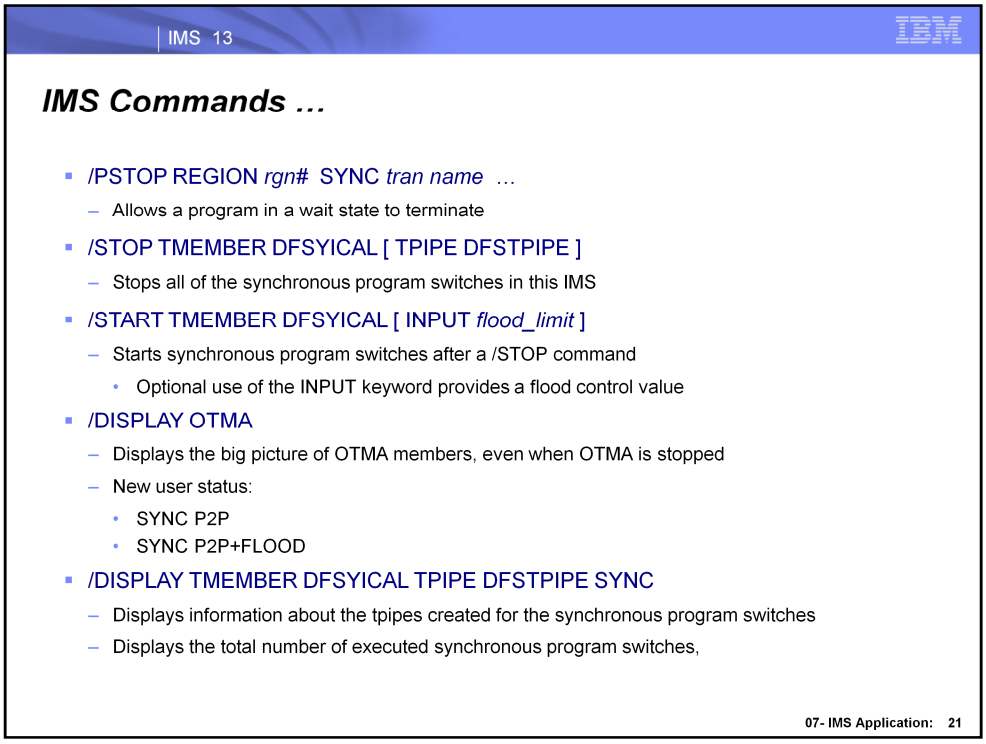
IMS Commands

- /DIS ACTIVE REGION
  - Displays the target transaction for the synchronous program switch
  - Displays the calculated end time of the ICAL
    - Based on the timeout value



Note: Display output will be different for sychronous callout ICAL versus sychronous program-to-program ICAL

In this example, message processing program IAPMD127 is processing transaction IAPMD127 which is waiting for a response to a synchronous callout request (WAIT-CALLOUT). This request is making a synchronous program switch using DL/I ICAL to a target transaction SKS1. The timeout value of this ICAL was used to compute the end time of this ICAL request which is displayed in the END TIME field.

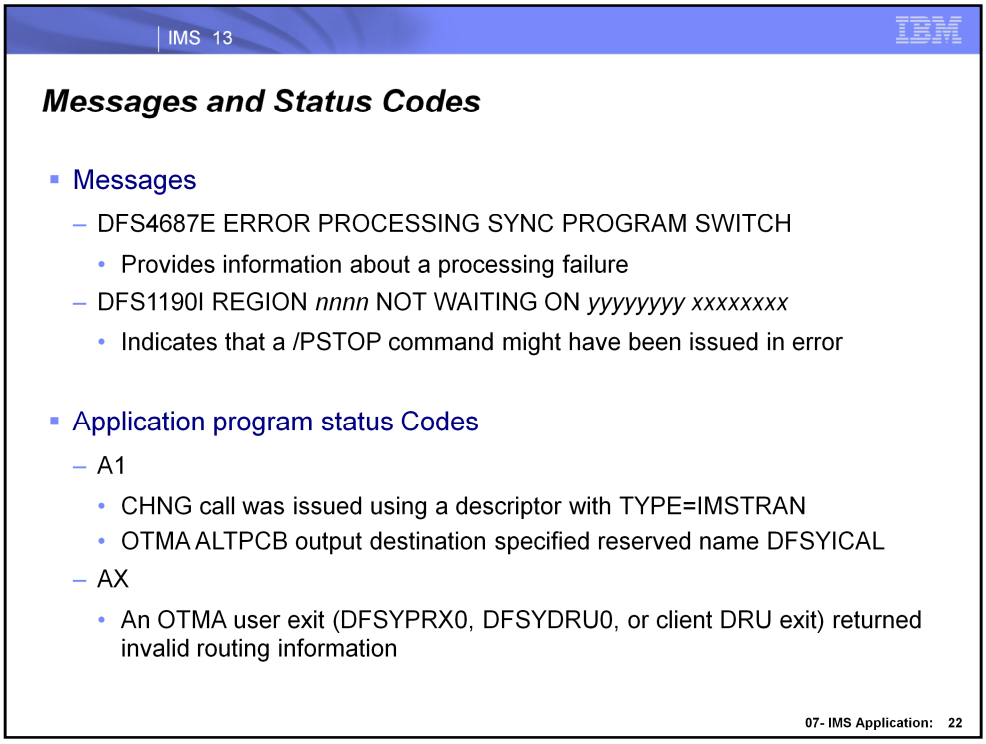


•The /PSTOP command wakes up an application program that is waiting for the response from a DL/I ICAL wait so the program can terminate. If a tran name is specified following the SYNC parameter, it will also apply to an ICAL that is performing synchronous program switch. Additionally, the ICAL call that is in the wait state will be posted and received AIB return code X'0100' with reason code X'010C'.

•The /STOP TMEMBER DFSYICAL can be used to disable the synchronous program switch support. Application programs issuing ICAL requests after this command will receive: AIB return code X'00000100', reason code X'00000110' and extended reason code X'00000005'. If the command also includes TPIPE DFSTPIPE the subsequent synchronous program switches from IMS application issuing ICAL will be rejected with AIB return code X'00000100', reason code X'00000110' and extended reason code X'00000006'.

•The /START TMEMBER DFSYICAL command allows the support to once again be activated. If an INPUT *flood_limit* is specified then the f*lood_limit* value initiates flood control support and limits the number of synchronous program switch requests that can be active.

•The /DISPLAY OTMA command can be used to determine if this IMS has been used to process any synchronous program switch requests. The information displayed includes whether or not there are any active requests waiting for a response and how many of them there are. The OTMA member DFSYICAL is created only for processing the ICAL calls for synchronous program switches. The TIB column can be used to identify how many active synchronous program switches exist in this IMS. Since the DRU exit has meaning to the DFSYICAL member, the DRUEXIT column for its member will have N/A. A new user status "SYNC P2P" has been introduced for the OTMA internal member DFSYICAL which initiated the synchronous program switch using the DL/I ICAL calls. When the flood limit has been set via the /START TMEMBER DFSYICAL INPUT flood_limit command and the flood value has been reached, the user status will show "SYNC P2P+FLOOD". The TIB column also displays a value. For the OTMA internal member DFSYICAL, this indicates the current number of IMS regions waiting for the response of synchronous program switch. When this number reaches the optional flood limit (if set) then no more ICAL for synchronous program switch will be accepted.



Additional messages that can be issued in a synchronous program switch scenario include:

•DFS4687E is a new message that indicates that an error has occurred in the synchronous program switch processing. It provides a short summary that describes the processing failure

•DFS1190I is issued to indicate that a /PSTOP AOITOKEN or /PSTOP REGION SYNC command was entered but the region was not waiting for the specified AOI token or ICAL response.

IMS application programs might additionally receive the following status codes:

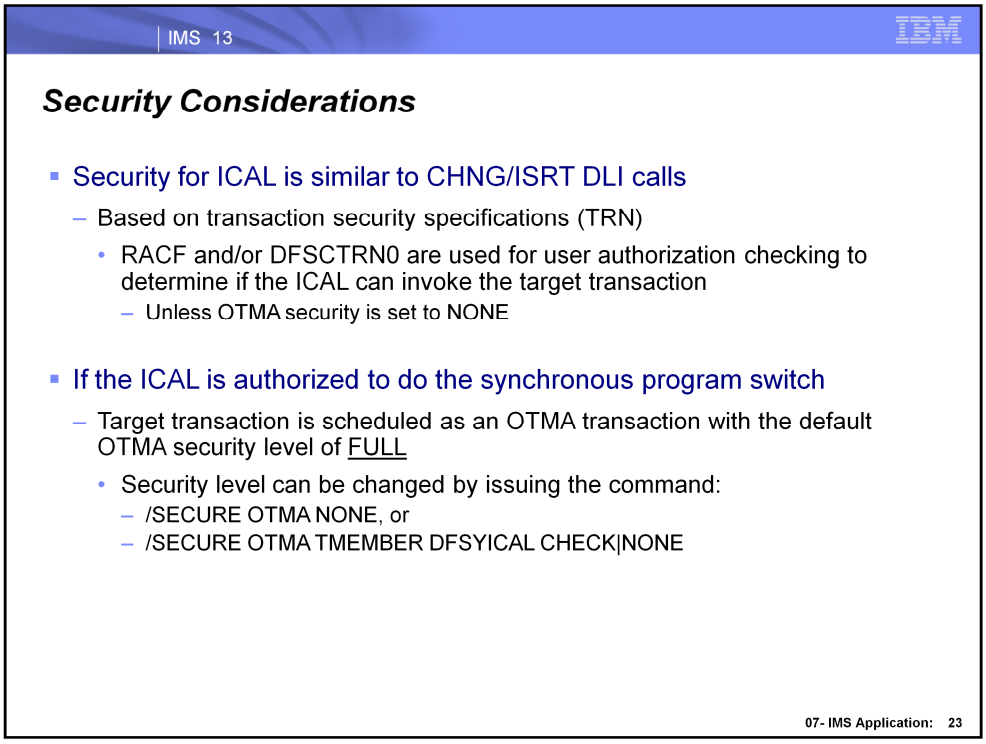
A1:

•The OTMA destination descriptor entry used for a CHNG call specified a TYPE of IMSTRAN. A TYPE=IMSTRAN is only applicable to the ICAL.

•An OTMA ALTPCB output destination was specified with an OTMA member name of DFSYICAL which is a reserved name.

AX:

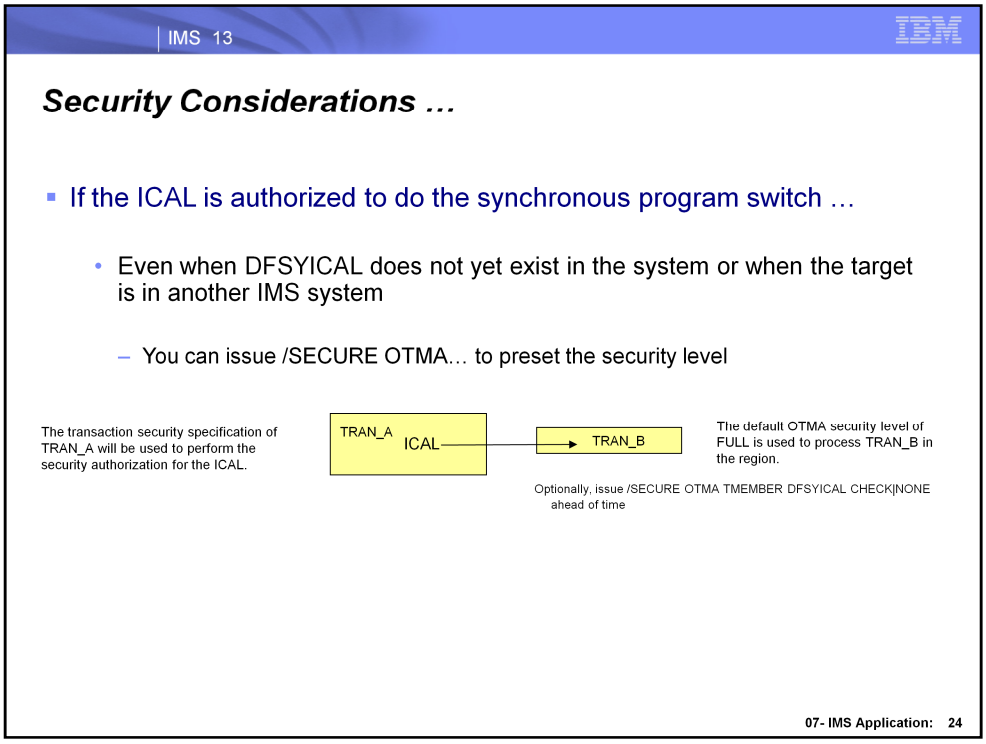
•An OTMA user exit (DFSYPRX0, DFSYDRU0, or client DRU exit) returned invalid routing information. The OTMA return codes in the 67D0 log record can provide more information.



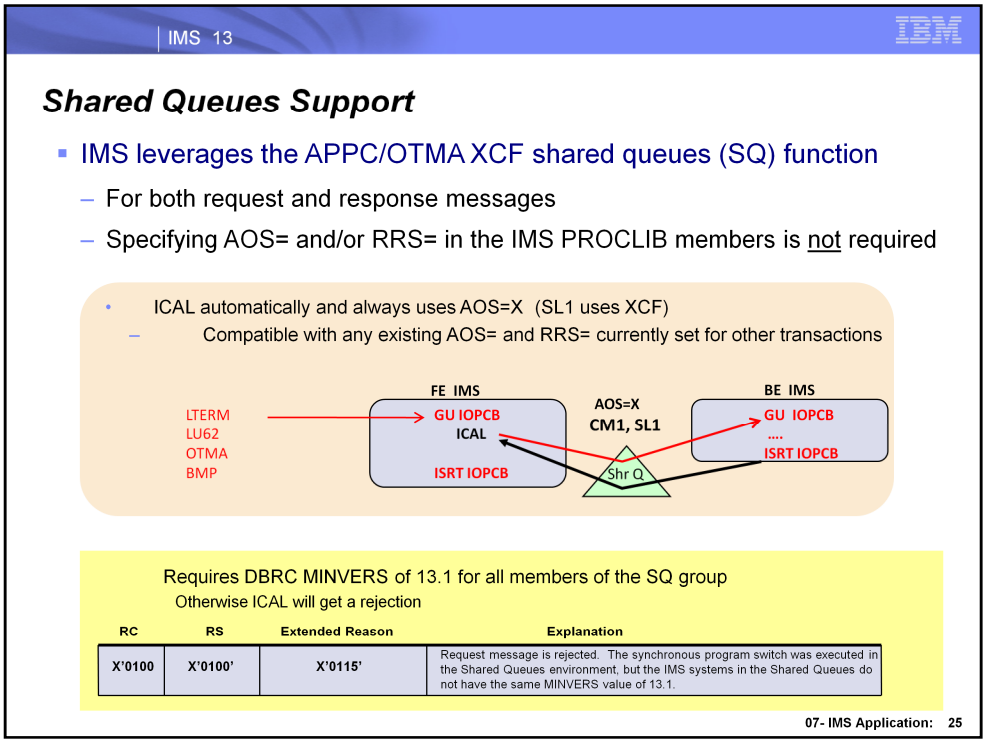
Security for ICAL is similar to CHNG/ISRT DLI calls. Depending on the transaction security specifications (TRN) the IMS region will call RACF and/or DFSCTRN0 user exit to check if the user is authorized to issue the ICAL for the target transaction. For APPC/OTMA transaction it also depends on the security option specified for APPC/OTMA. If the security of NONE has been specified for APPC/OTMA transactions, RACF and/or DFSCTRN0 will not be called even if TRN=Y has been specified.

As mentioned earlier, IMS schedules the transaction initiated by the ICAL as an OTMA transaction which means that OTMA security settings (NONE/ CHECK/ FULL/ PROFILE) are all supported. With or without the activation of OTMA, the OTMA security is set to FULL as the default. This security for ICAL processing can be changed by issuing /SECURE OTMA TMEMBER DFSYICAL CHECK|NONE command. Note that the DFSBSEX0 user exit routine will not be called.

When the /SECURE OTMA command is issued, it sets the security setting for the OTMA internal member DFSYICAL. This member has been created internally by OTMA to process the DL/I ICAL calls for synchronous program switches.



Even when the DFSYICAL member does not exist in the IMS system, this command can still be issued to create this member and to set the security level for the subsequent DL/I ICAL calls.



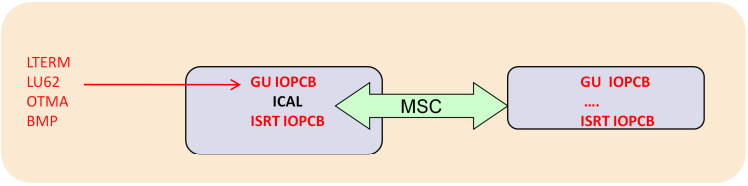
For IMS shared queues (SQ) customers, all of the IMS systems in the same SQ group must have the same MINVERS value of 13.1 in order to use this function.

Note that IMS leverages the APPC/OTMA XCF shared queues function (introduced in IMS 12) to process the switched-to transaction at a shared queues front-end and back-end IMS. This processing for synchronous callout message does not require the specification of AOS= or RRS= in the IMS PROCLIB members, and is compatible with any existing AOS= and RRS= settings used by the customers. What this means is that if an IMS system already uses AOS= and RRS= specifications to process its shared queues transactions, the non-ICAL transactions will continue to use these settings but synchronous program switch message using ICAL calls will be executed in the shared queues environment independently using AOS=X.

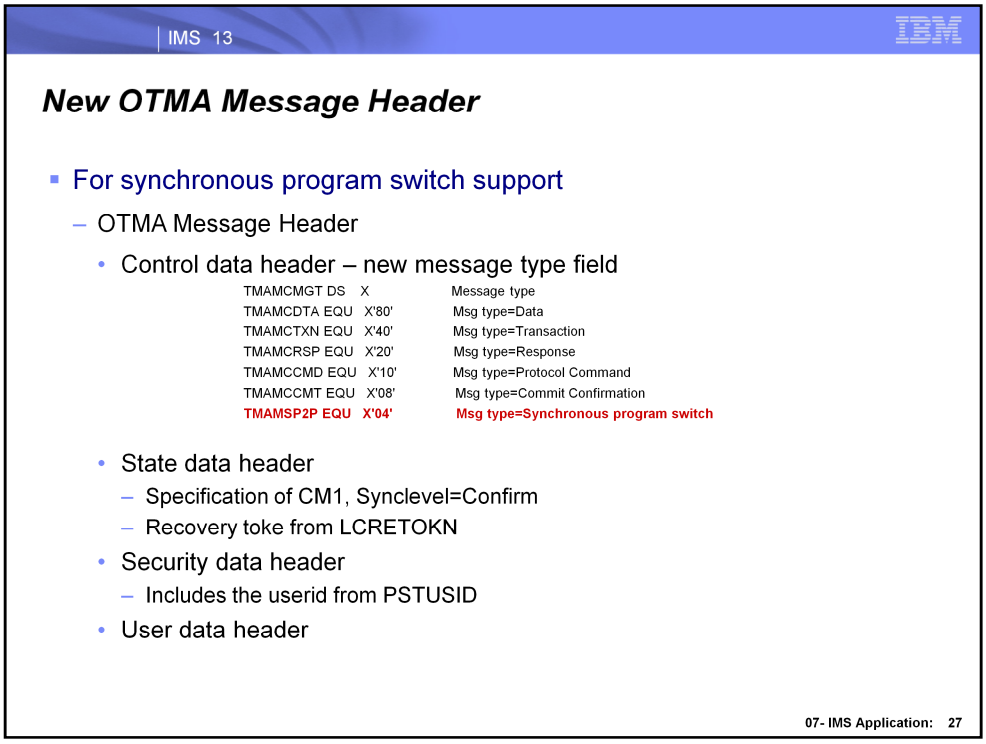
As a reminder, AOS=X allows synchronous transactions with synclevel of NONE|CONFIRM to be processed in a Shared Queues back-end system using XCF communications. The processing of synclevel SYNCPT requests is equivalent to AOS=N.

MSC Support

- IMS supports sending an ICAL request to an MSC back-end system
  - MSC/VTAM
  - MSC/TCPIP with IMS Connect (introduced in IMS 12)



All of the IMS subsystems in an MSC network can process synchronous programs switch messages, as long as the MSC link exists in the front-end IMS.



A new type of OTMA message header is introduced for the synchronous program switch. This type of message consists of OTMA control data header, OTMA state data header, OTMA security header, OTMA user data header, and the request data of the ICAL.

In the control data header, a new flag x'04' is added to the message type field to identify the message for the synchronous program switch:

TMAMSP2P EQU X'04' Msg type=Synchronous program switch

In the state data header, the commit-mode=1, Synclevel=CONFIRM, and recovery token from LCRETOKN are specified.

In the security data header, the userid from PSTUSID is included.

In the user data header, OTMA prepares a special format of user data for the processing of the synchronous program switch.

Exit Routine Enhancements

- *DFSCMUX0*
- *DFSYPRX0*
- *DFSYDRU0*
- *DFSYIOE0*

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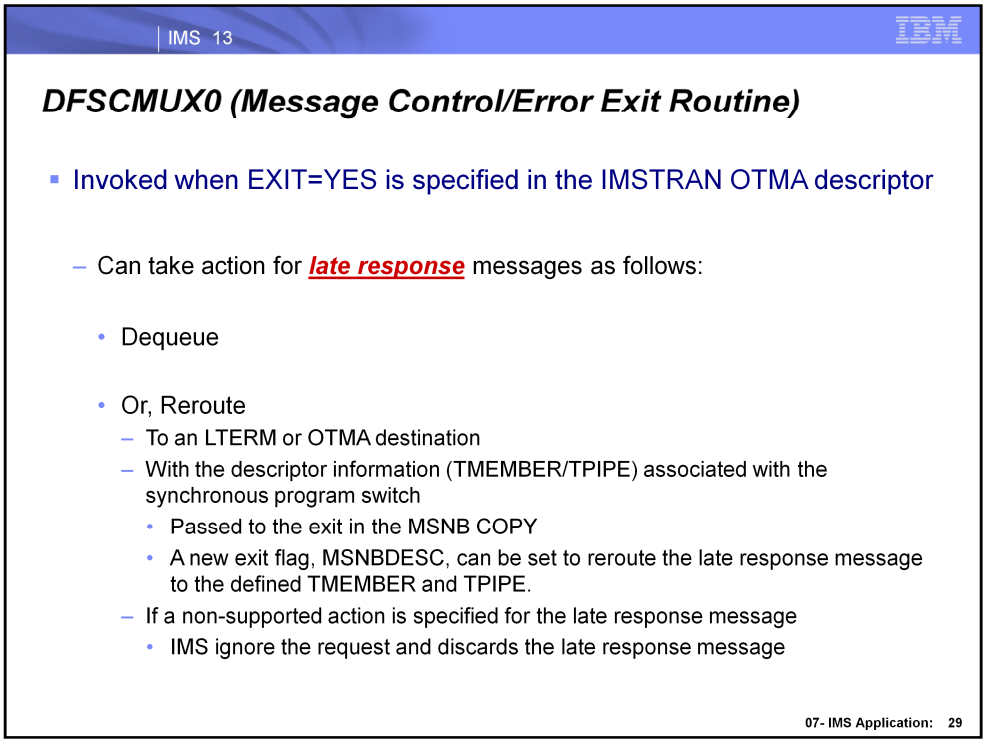
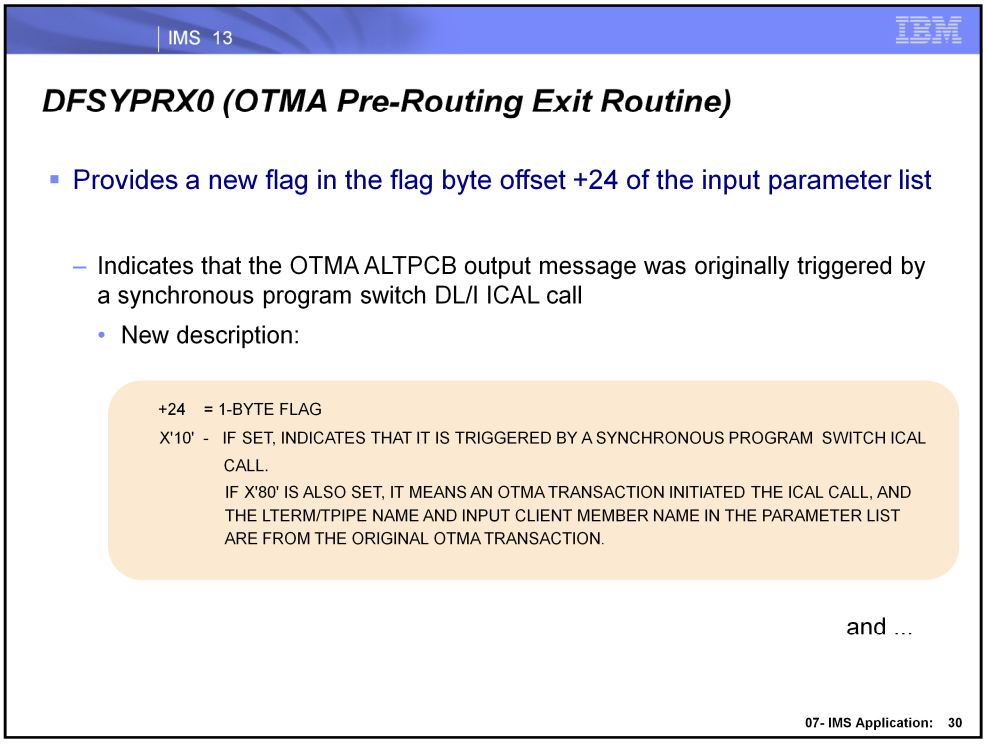
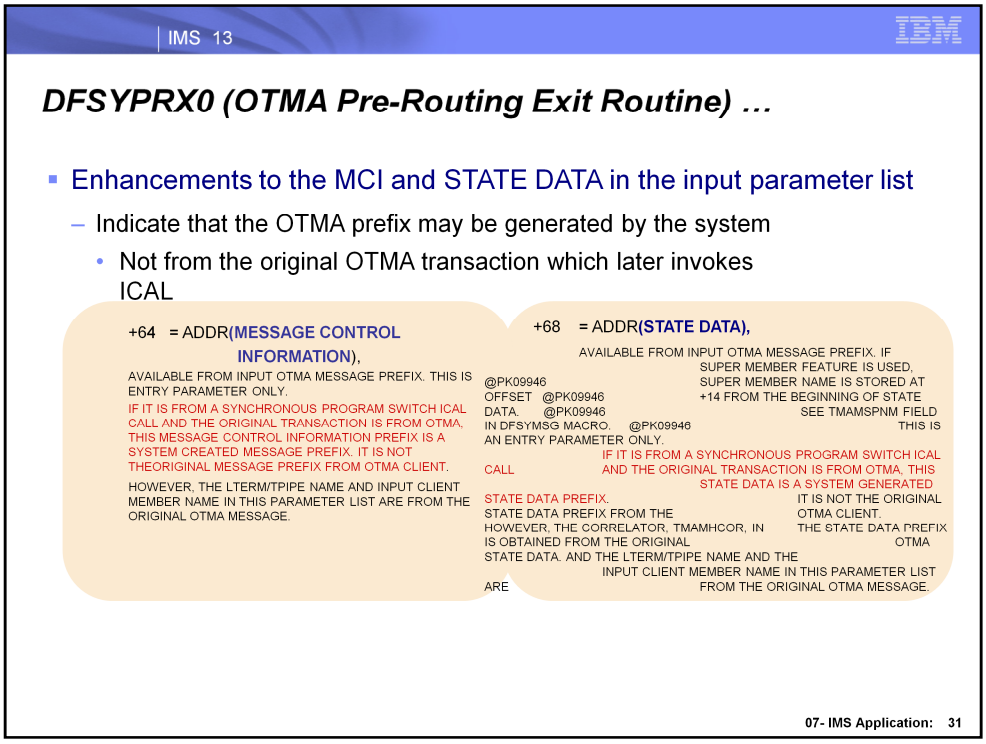


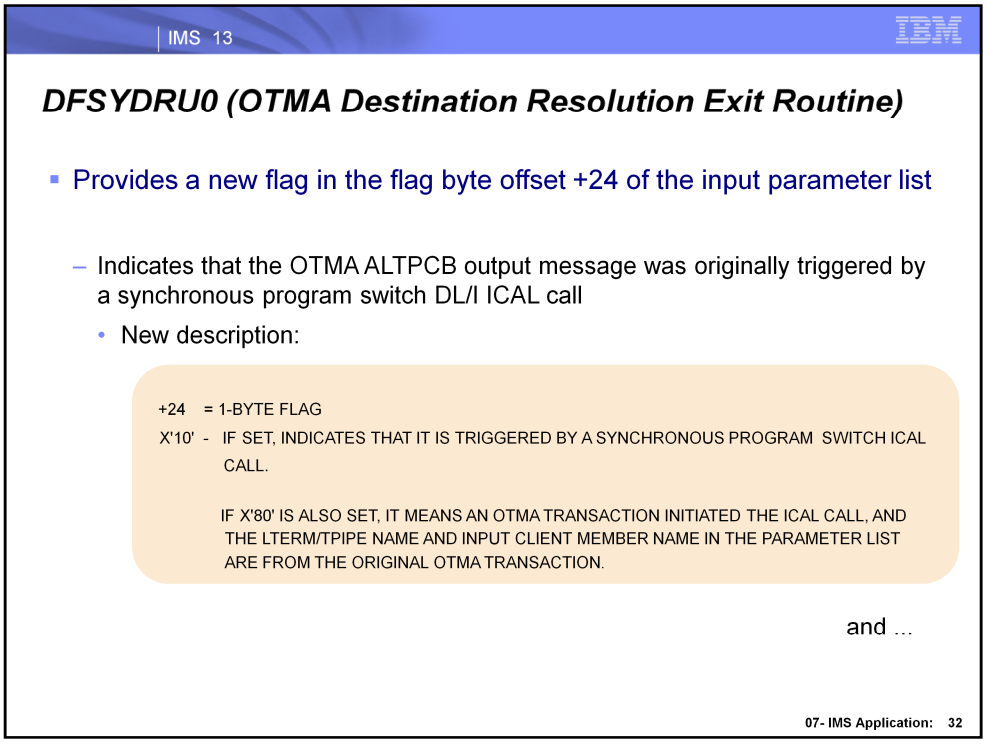
When EXIT=YES is specified in the OTMA descriptor for the synchronous program switch and a late response message is created, DFSCMUX0 user exit will be called to take actions. The supported actions are either to dequeue the late response message or to reroute it. If reroute action is requested and the destination information is provided, the late response message can be rerouted to an LTERM or OTMA destination. If the reroute TMEMBER and TPIPE names are also specified in the OTMA descriptor (associated with the original synchronous program switch), they will be passed in the MSNB COPY for the DFSCMUX0 user exit. The new exit flag, MSNBDESC, can be set to reroute the late response message using the reroute TMEMBER and TPIPE information specified in the descriptor. If a non-supported action is specified for the late response message, IMS will ignore it and discard the late response messages.



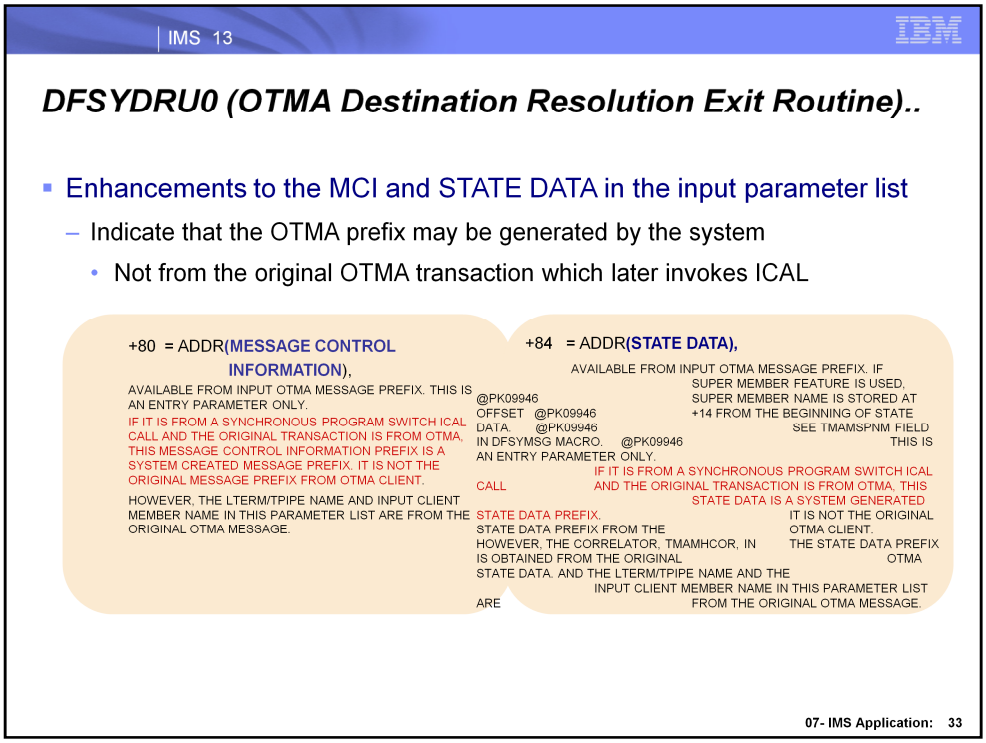
A new flag was added to the flag byte at offset +24 of the input parameter list of DFSYPRX0 (OTMAS Pre-Routing Exit Routine). This new flag indicates that this OTMA ALTPCB output message was originally triggered by a synchronous program switch DL/I ICAL call.



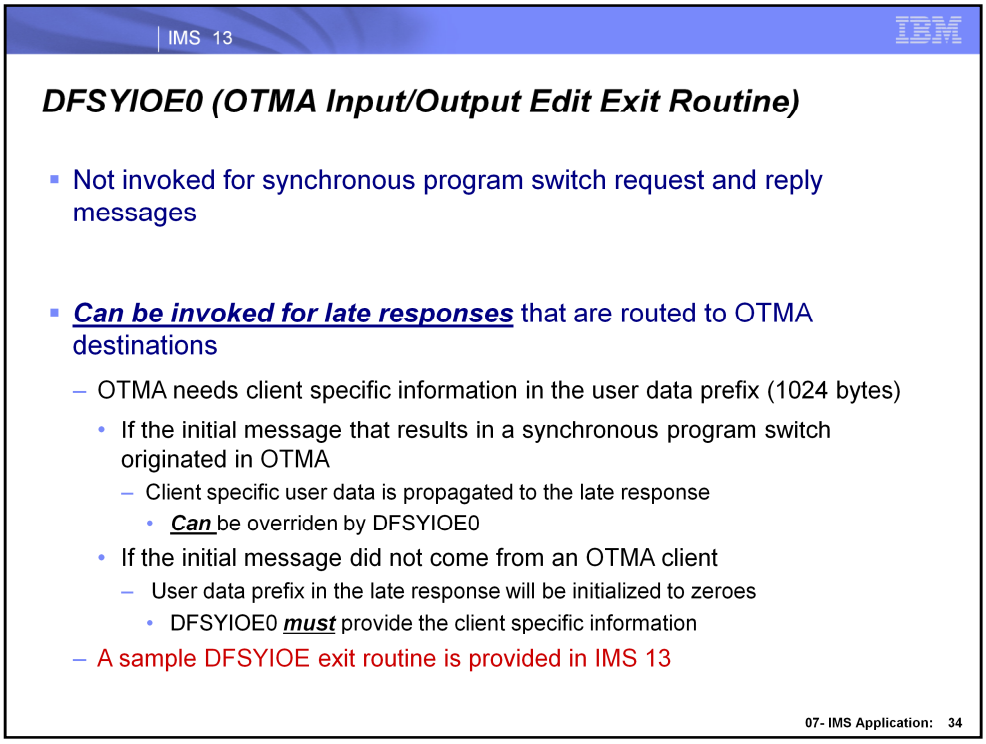
Additionally, enhancements to the MCI and STATE DATA parameter of the input parameter list of the exit indicate that the OTMA prefix may have been generated by the system rather than reflect the original OTMA transaction which invoked the ICAL.



DFSYDRU0 (OTMA Destination Resolution Exit Routine) has also been enhanced to provide a new flag at offset +24 of the input parameter list. This new flag indicates that the OTMA ALTPCB output message was originally triggered by a synchronous program switch DL/I ICAL call



The MCI and STATE DATA parameters of the input parameter list of the exit indicate that OTMA prefix may have been generated by the system are not from the original OTMA transaction which invoked the ICAL.



DFSYIOE0 (OTMA Input/Output Edit Exit Routine) is never invoked for synchronous program switch request and reply messages but it ***can be called for late responses*** that are destined for an OTMA client.

For OTMA destinations, IMS relies on the information in the 1024-byte user data prefix of the late response.

•If the synchronous program switch call was initiated by an OTMA transaction from an OTMA client, then IMS will propagate the initial client user data to the user data prefix of the late response message. This user data prefix can remain as it is or can optionally be updated by the DFSYIOE0 user exit.

•On the other hand, if the program that initially issued the synchronous program switch call was not initiated by an OTMA client, such as IMS Connect, then this prefix will be initialized to zeroes and DFSYIOE0 must be used to build the client specific user data so that it can be correctly sent to the OTMA client.

Application Design Considerations

- *Transaction Expiration*
- *Late Responses*
- *LTERM Override*
- *ALTPCB destinations*
- *Examples*
  - *Multiple ICALs*
  - *Recursive requests*
  - *DFSDDLT0*

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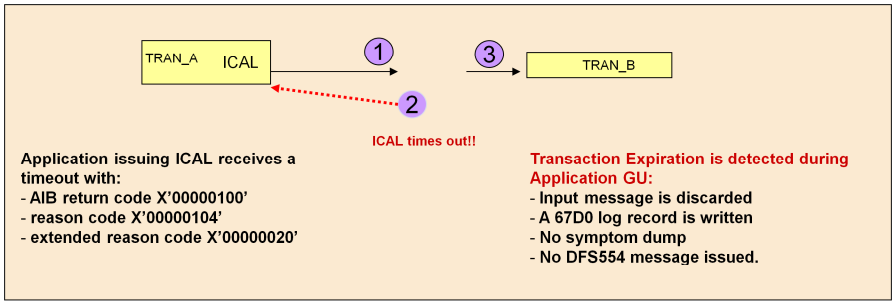
Transaction expiration for the target transaction

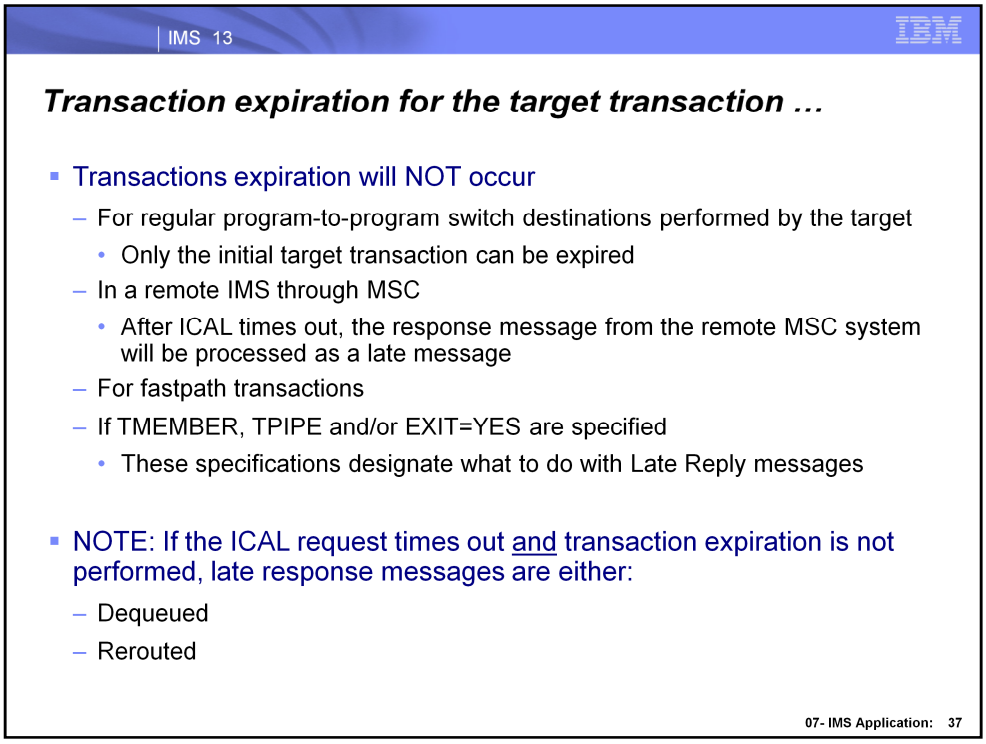
- Transaction expiration for targets of synchronous program switches (new)
  - Uses the timeout value of the synchronous program switch
    - ICAL timeout value is carried in the OTMA header
  - Invoked during application GU time



(1) When a transaction issues an ICAL, e.g., TRAN_A, the OTMA message header that is built for the synchronous program switch message is carries the ICAL timeout value which is used for the target transaction expiration process.

(2) If the ICAL times out before a response is receives, then TRAN_A receives an AIB return code/ reason code indicating the condition.

(3) When TRAN_B is finally scheduled and the application issues a GU IOPCB, transaction expiration is detected. Since the OTMA message header contains the transaction expiration information with TRAN_A's ICAL timeout value, the transaction expiration process discards the input message and a 67D0 log record is written. No DFS message is sent back to the ICAL call since it is no longer waiting, and no symptom dump is produced.



Note that the transaction expiration process does not occur:

•When the target of the ICAL also issues program-to-program switches. Only the initial called program can be expired.

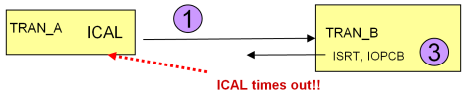
•For ICAL messages sent across an MSC link. If the calling program issuing the ICAL times out, any response message from the remote MSC system is processed as a late response message.

•For Fastpath transactions.

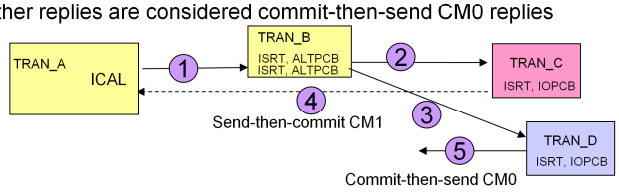
•If the descriptor defines parameters that can deal with a late response.

Late Response Messages?

- A reply is late when:
  - It is returned to the synchronous program switch ICAL call which has already timed out



  - It is a subsequent message(s) returned to the ICAL which has already received and processed a previous response
    - If multiple target transactions are involved that reply to the IOPCB
      - The **first** one to process an application GU,IOPCB has the responsibility for the send-then-commit CM1 response
        - The other replies are considered commit-then-send CM0 replies



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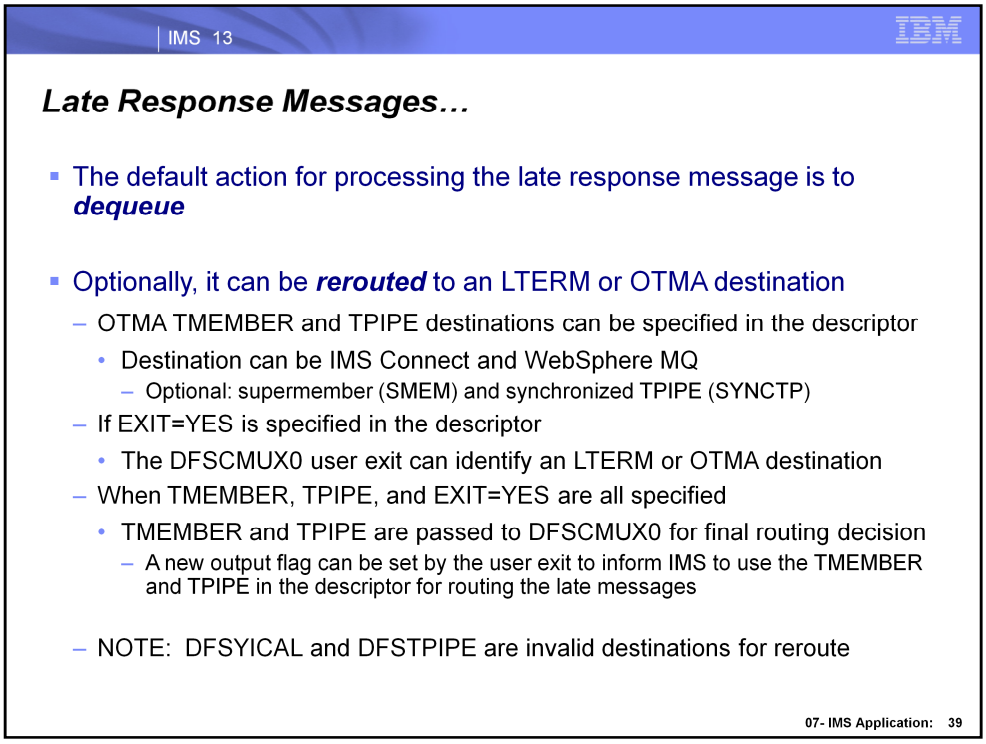
An IOPCB reply is a late response message when IMS attempts to return to a calling synchronous program switch program (issuer of the ICAL) after that program has either: timed out, or already received a previous response message.

The bottom picture on the visual gives an example of the latter. Note that in this scenario, the target of the synchronous program switch TRAN_B does not reply to the IOPCB but rather issues two program-to-program switches. TRAN_C and TRAN_D which both respond to the IOPCB can be ultimately responsible for responding to TRAN_A's ICAL request. The first one to process an application GU,IOPCB gets the responsibility of sending the CM1 response. The other transaction's reply becomes a CM0 reply and is considered a late response.

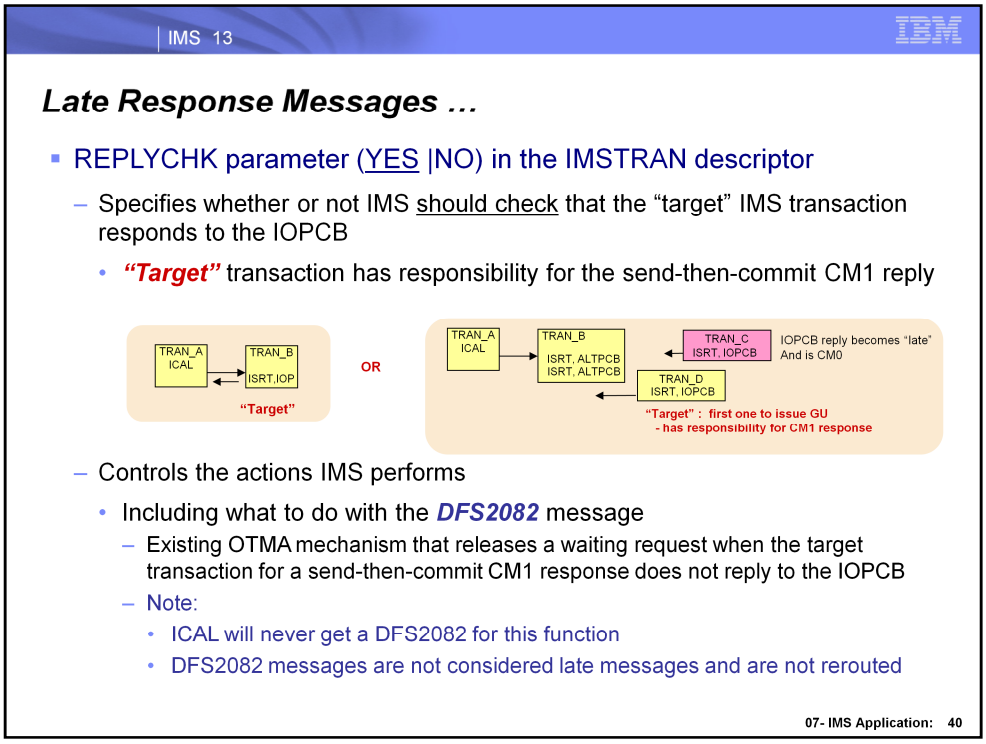


By default, IMS logs and dequeues late response messages if detected. However, customers can save the late response messages by informing IMS to route the late response messages to a LTERM, LU62, or OTMA queue.

The TMEMBER= and TPIPE= parameters in the descriptor of the synchronous program switch can specify an OTMA TPIPE queue so that the late response can be retrieved by an OTMA client, such as IMS Connect or WebSphere MQSeries. Optionally, the SMEM= parameter for super member and SYNCTP= parameter for WebSphere MQ synchronous TPIPEs can be used to further specify special TPIPE queues for the message retrieval request. When the TMEMBER= and TPIPE= parameters are specified without EXIT=YES, all of the late messages are queued to the specified TPIPE and TMEMBER

Specifying the EXIT parameter with YES allows DFSCMUX0 user exit (described earlier) to determine the final fate of the late response message even without TMEMBER and TPIPE specification.

If the TMEMBER, TPIPE, and EXIT=YES are all specified, then the DFSCMUX0 user exit is invoked with the member-name and tpipe-name as defined in the descriptor.



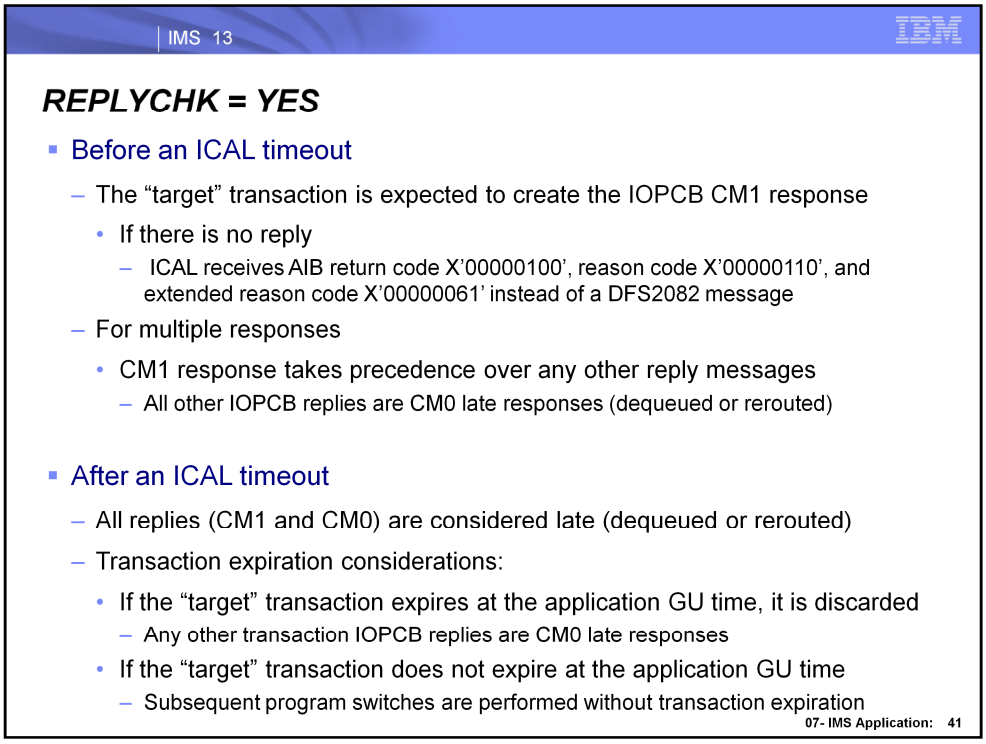
The REPLYCHK parameter can optionally be used when multiple response messages are competing to be sent back to the ICAL call and specifies whether or not IMS should check that a "target" transaction responds to the IOPCB. To better understand this setting (detail in the following visuals) some concepts need to be clarified.

A "target" transaction is the transaction that has the responsibility of replying to the outstanding ICAL request. It could be the only transaction in the ICAL path (e.g., TRAN_B in picture on the left) or it could be the first one that is switched to that issues a GU IOPCB (e.g., TRAN_D in the picture on the right). The assumption is that the "target" will issue an ISRT IOPCB to send a reply.

Additionally, the REPLYCHK specification influences the process that IMS uses for the DFS2082 message. Historically, the DFS2082 message has been used by OTMA to inform the OTMA client that the target transaction does not insert back to IOPCB and does not issue the program to program switches. This is needed so that the client does not need to: wait for an IMS response that will not come, or wait until a timeout occurs.

For synchronous program switches, the caller of the ICAL call will never receive a DFS2082 message but it may receive AIB return/reason codes instead.

There is no reroute or late message processing for the DFS2082 message for ICAL calls.



REPLYCHK=YES

Before an ICAL timeout:

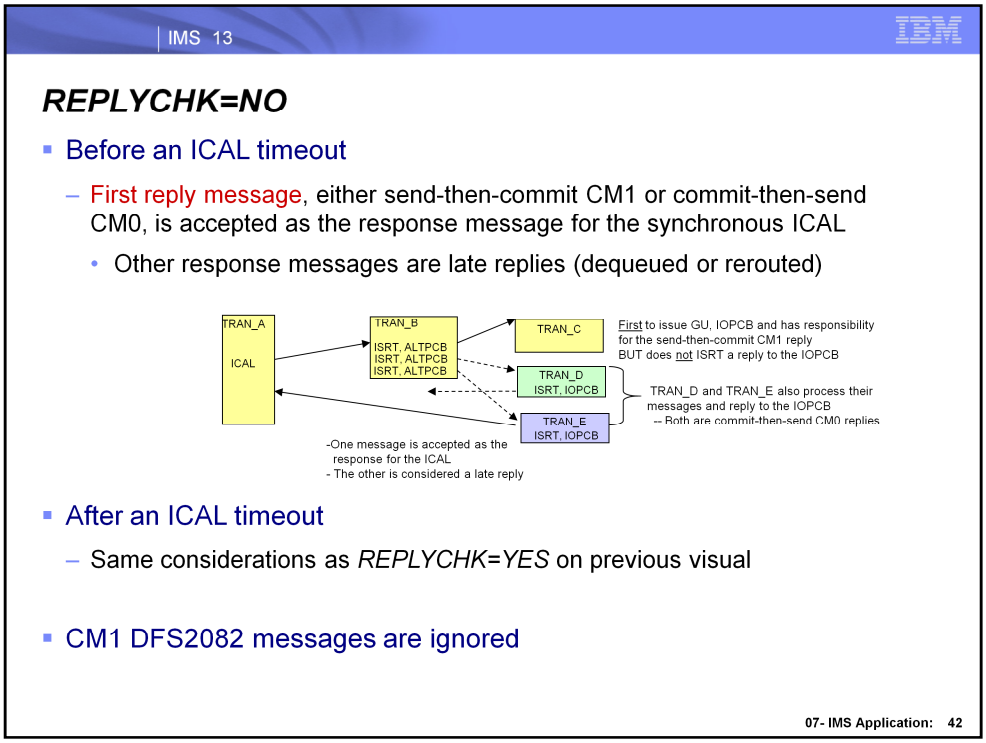
•The target transaction (previous visual) is responsible for sending a reply. If there is no IOPCB reply then DFS2082 processing occurs but instead of sending the message the ICAL receives AIB error codes to clear the outstanding wait.

•On the other hand, if there are multiple responses that could be returned to the ICAL, the CM1 message takes precedence over any CM0 replies.

After an ICAL timeout:

•All replies are considered late and are either dequeued or rerouted.

•Additionally, there could be some transaction expiration considerations. If the initial target transaction of the synchronous program switch expires at application GU time, this target transaction is simply discarded. If the initial target transaction issues the application GU before ICAL timeout and then issues subsequent program-to-program switches, these will be performed without transaction expiration even if the ICAL timer then expires. Multiple late response messages can be generated for the ICAL. These late response messages by default will be discarded if there is no reroute option specified.



REPLYCHK=NO

In the case of REAPLYCHK=NO in the descriptor, IMS expects that there could be multiple responses for the ICAL call. Since the DFS2082 message is not a real response, it will be ignored and not be sent back to ICAL.

Before an ICAL timeout:

If there are multiple response messages for the ICAL, the first response message received, either a send-then-commit output or commit-then-send output, will be accepted as the response message. The rest of the response messages are all late response messages. In the example on the visual, TRAN_A issues an ICAL to TRAN_B. TRAN_B does not reply to the IOPCB but instead issues 3 program-to-program switches. TRAN_C is the first to issue a GU IOPCB and would ordinarily have the responsibility to send the CM1 IOPCB reply to release the ICAL wait. In this example TRAN_C terminates without a reply. Meanwhile the other two transactions, TRAN_D and TRAN_E have processed and replied to the IOPCB. Both the messages are CM0 replies. With the specification of REPLYCHK=NO, IMS chooses one of the messages to be the ICAL response. The other is considered a late response.

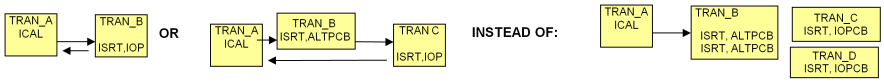
After an ICAL timeout:

Processing is the same as for REPLYCHK=YES (described on the previous visual) with the transaction expiration considerations.

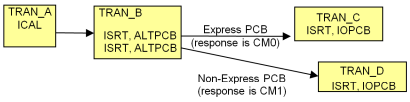
DFS2082 messages are ignored.

REPLYCHK Considerations

- Use the simplest design where possible
  - Avoid spawning transactions



- Use of Express PCBs and non-Express PCBs
  - REPLYCHK=NO would allow Express PCB response to be sent back as the reply



  - REPLYCHK=yes would wait for non-Express PCB response to be sent back as the reply

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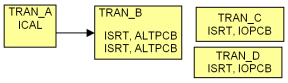
REPLYCHK Considerations ...

- OTMAASY
  - Pre-IMS 13 parameter that addresses synchronous (CM1) requests where multiple spawned transactions can respond to the request



  - Allows transaction definition, e.g., Response Mode versus Non-Response mode, to determine which of the spawned requests should be the CM1 response
  - For Synchronous Program Switches (ICAL)
    - REPLYCHK=YES
      - OTMAASY can be useful in determining which of the spawned transactions is the target for the CM1 reply
    - REPLYCHK=NO
      - Even with OTMAASY, the first response (CM1 or CM0) is selected as the response to the ICAL

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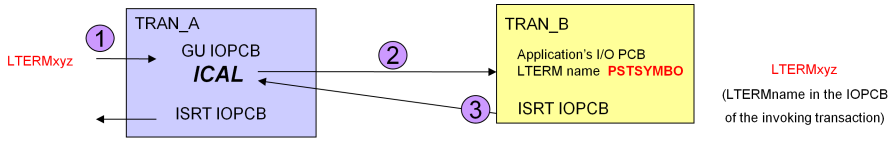
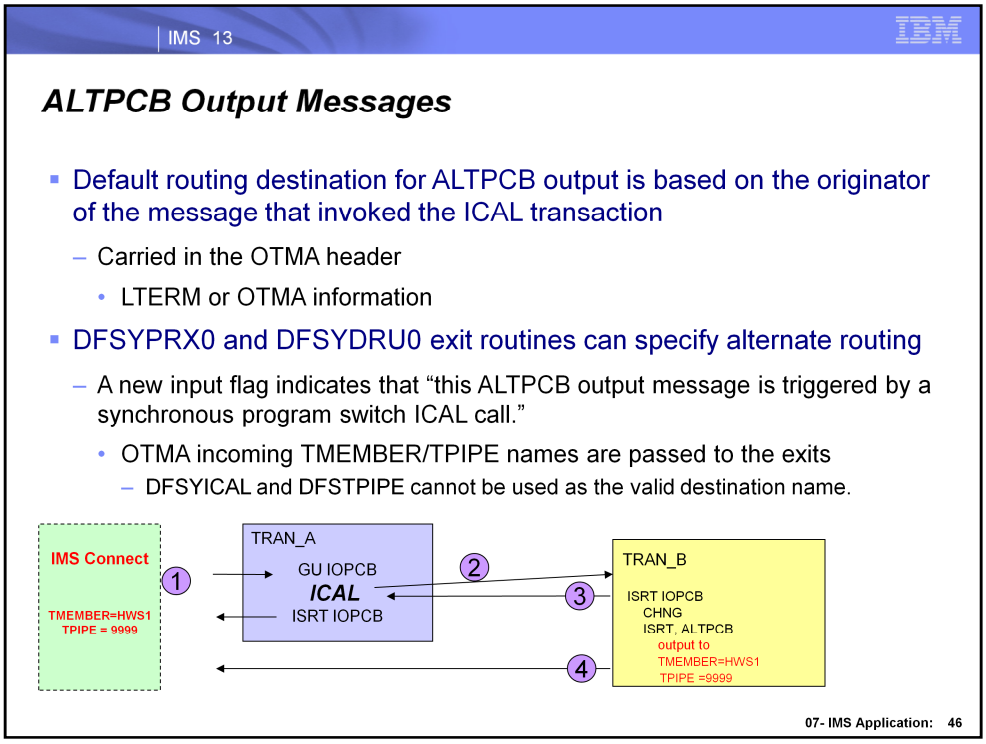
LTERM Override

- The default LTERM name in the IMS application program's I/O PCB is the IMS application terminal symbolic (PSTSYMBO)
  - It can be overridden by the following 2 methods:
    - AIBRSNM2 in AIB block of the ICAL
    - LTERMOVR value in the OTMA descriptor for the ICAL call
  - If both AIB and descriptor has the LTERM override name, the name in the AIB will be used.

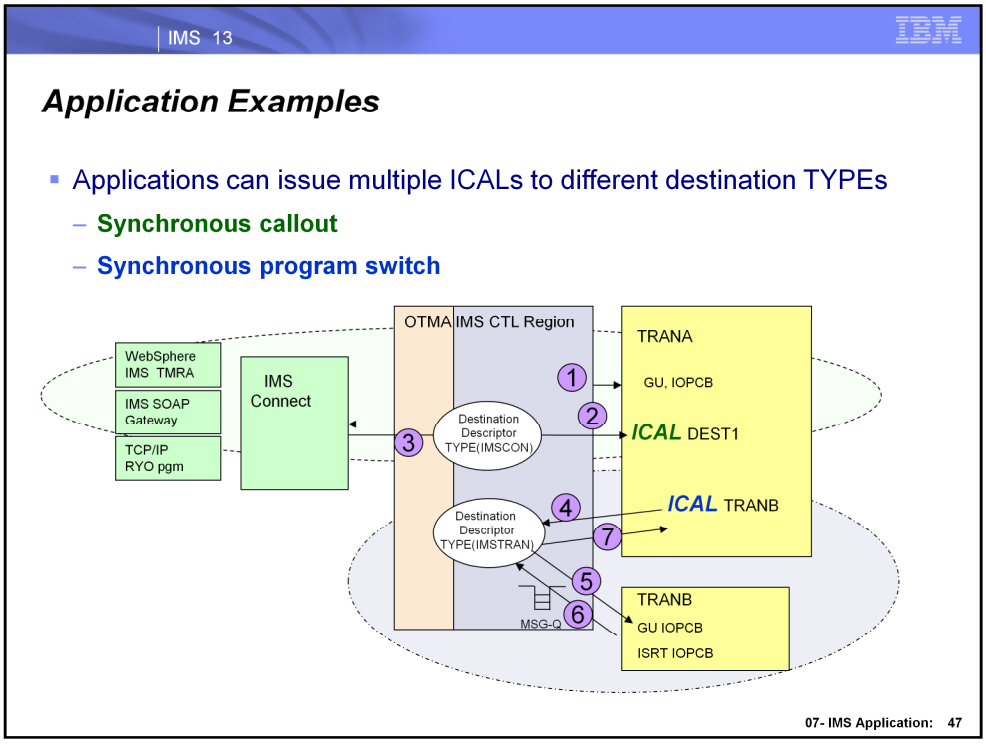


The default LTERM name in the target transaction's IOPCB is the symbolic PSTSYMBO. This value can be overriden in one of two ways: either by specifying a value in AIBRSNM2 of the AIB block used in the ICAL, or by specifying a value in the LTERMOVR parameter of the associated OTMA descriptor. If a value is specified using both methods then the name in the AIB is used.

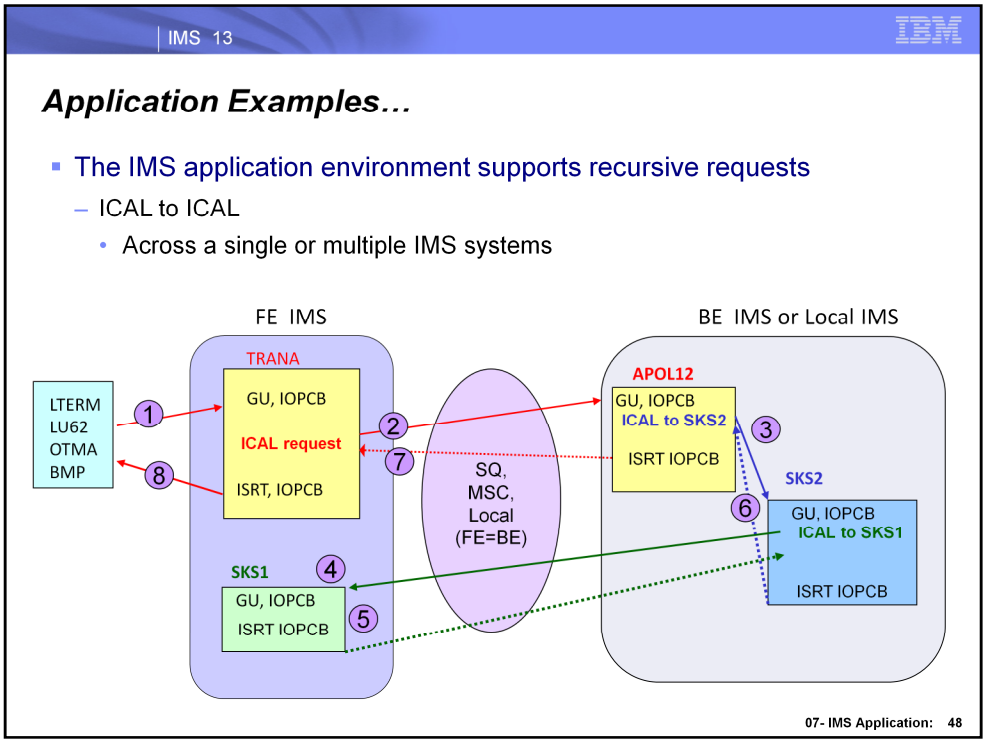


When an IMS application program processing the target transaction of the synchronous program switch issues an ISRT call to an alternate PCB, or issues CHNG call, to generate an ALTPCB output message, IMS checks the originator of the ICAL message to determine the default routing destination. For example, If a terminal initiates a synchronous program switch then the legacy destination by default will be used to process the ALTPCB output. If an OTMA client, such as IMS Connect, initiates a synchronous program switch, the ALTPCB output by default will be delivered back to the incoming TPIPE.

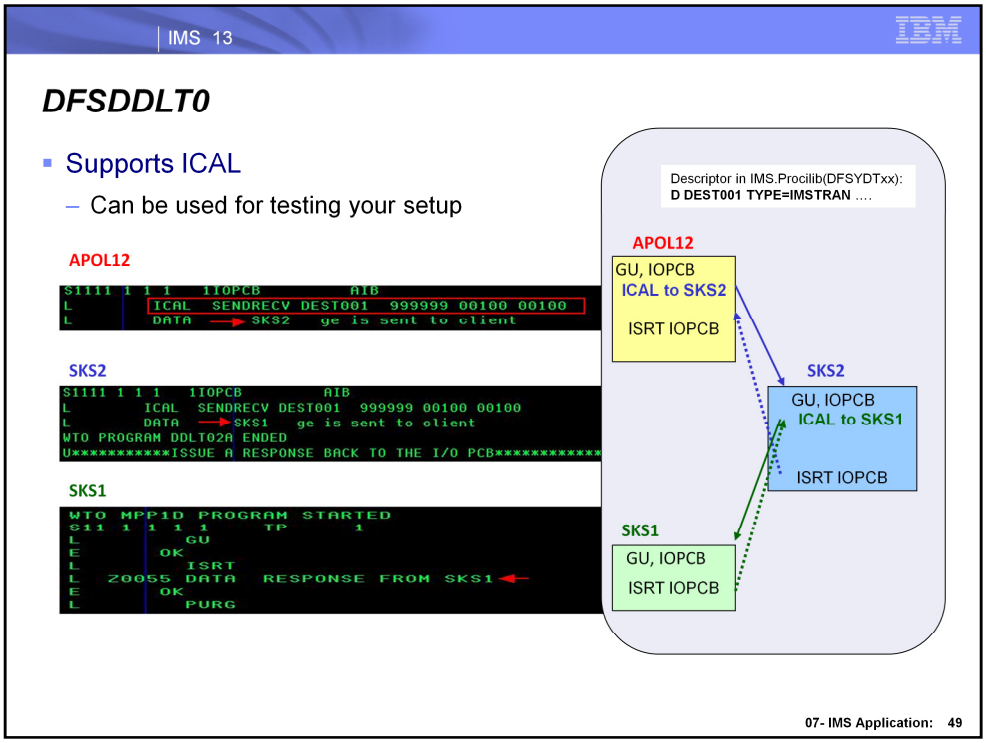
The OTMA Pre-Routing and OTMA Destination Resolution exit routines can specify alternate routing destinations. As a reminder, these exit routines have flags that indicate that the ALTPCB message invoking the routine was originally triggered by a synchronous program switch DL/I ICAL call.



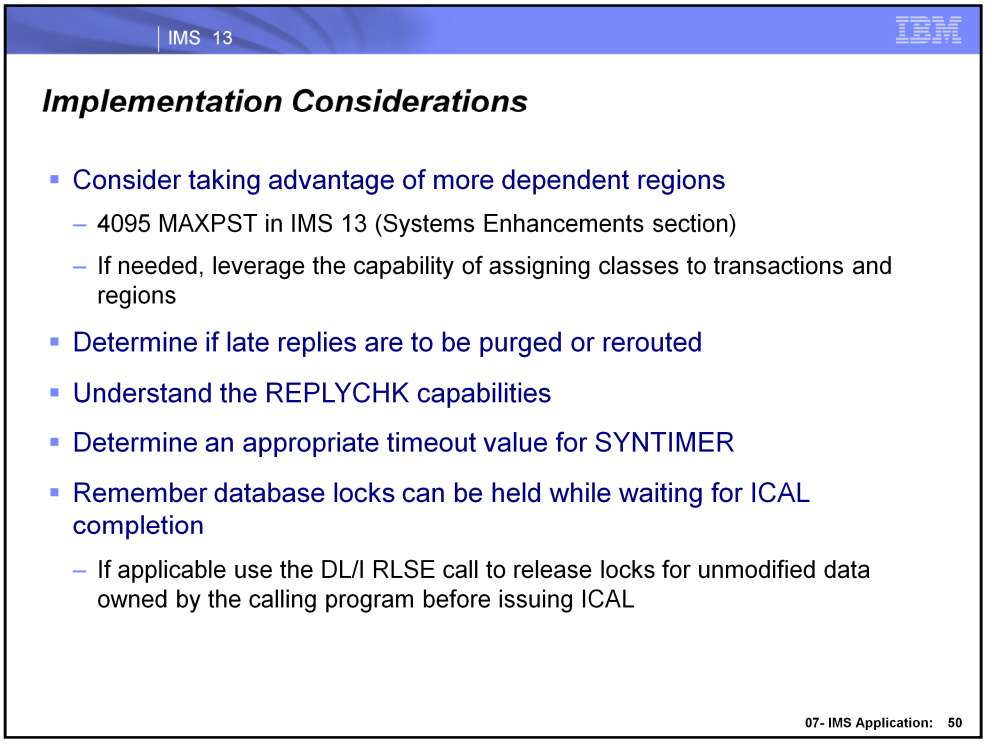
An IMS application can issue ICALs to remote destinations such as web services and also to other IMS applications.



The ICAL for synchronous program switching can be invoked in a recursive manner. There is no limit for the number of recursions allowed. The timeout values of the ICAL(s) should be considered when a recursion is used.



DFSDDLTO can be used to test the synchronous program switch.



When implement the Synchronous Program Switch capability, care should be taken to understand the environment and design accordingly. For example:

•Understand the implication of using synchronous program switches to the existing IMS environment. More dependent regions might need to be defined to address possible elongation of the dependent regions that contain programs issuing ICALs. As described in the Systems Enhancements section, IMS 13 increases the MAXPT value to 4095.

•If needed, IMS provides the ability to control where work is process through its ability to define classes to transactions and dependent regions.

•The default action for late replies is to purge them. If rerouting is to occur instead then this decision has to be built into the design.

•Review the REPLYCHK capabilities and decide which set of actions is more appropriate to your environment.

•Determine an appropriate value for the SYNTIMER parameter of the TYPE=IMSTRAN descriptor so that the calling IMS program does not wait for too long a time.

•Remember that database locks can be held by the application issuing the ICAL. This is not a new consideration. If applicable, leverage the use of the DL/I RLSE call which releases locks currently held for unmodified data.

RLSE call reminder:

For fast path databases, the RLSE call releases all locks held for unmodified data that are owned by an application. For full function databases, the RLSE call releases the locks held by the DB PCB that is referenced in the call. There are considerations, however, to the use of the RLSE. After the RLSE call, all database position information is lost even though there may be no locks to release. Also, a RLSE call between ISRTs will lose the insert position so if no new position is established before inserting a dependent segment then it could possibly go under the wrong root. Note that locks protecting a resource that has been updated will not be released.

Migration/Setup Considerations

- For Non-shared queues
  - Synchronous program switch is a base function of IMS 13
- For Shared Queues
  - DBRC minimum version (MINVERS) value of 13.1 is required to enable the synchronous program switch function
    - Even if it is a single-system Shared Queues environment
- The MSC remote IMS does not need to be an IMS 13 system
- New OTMA trace table entries
  - Documented in the IMS Diagnosis Guide under “OTMA Diagnostic Aids”

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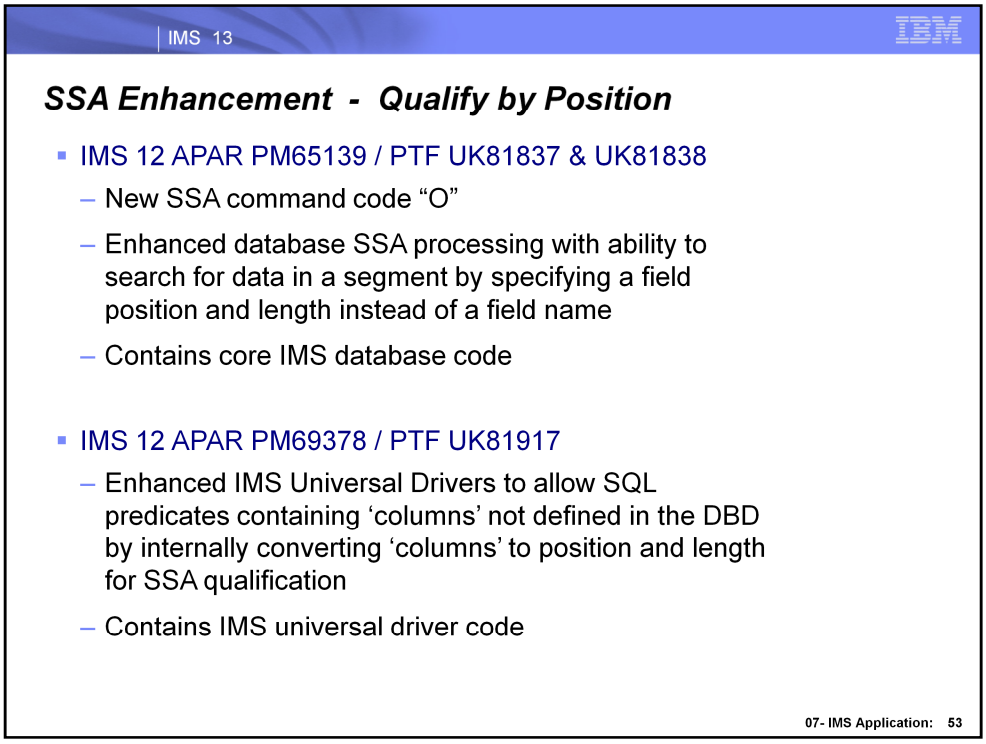
SSA qualification with the position and length of the target data instead of a DBD-defined field name.



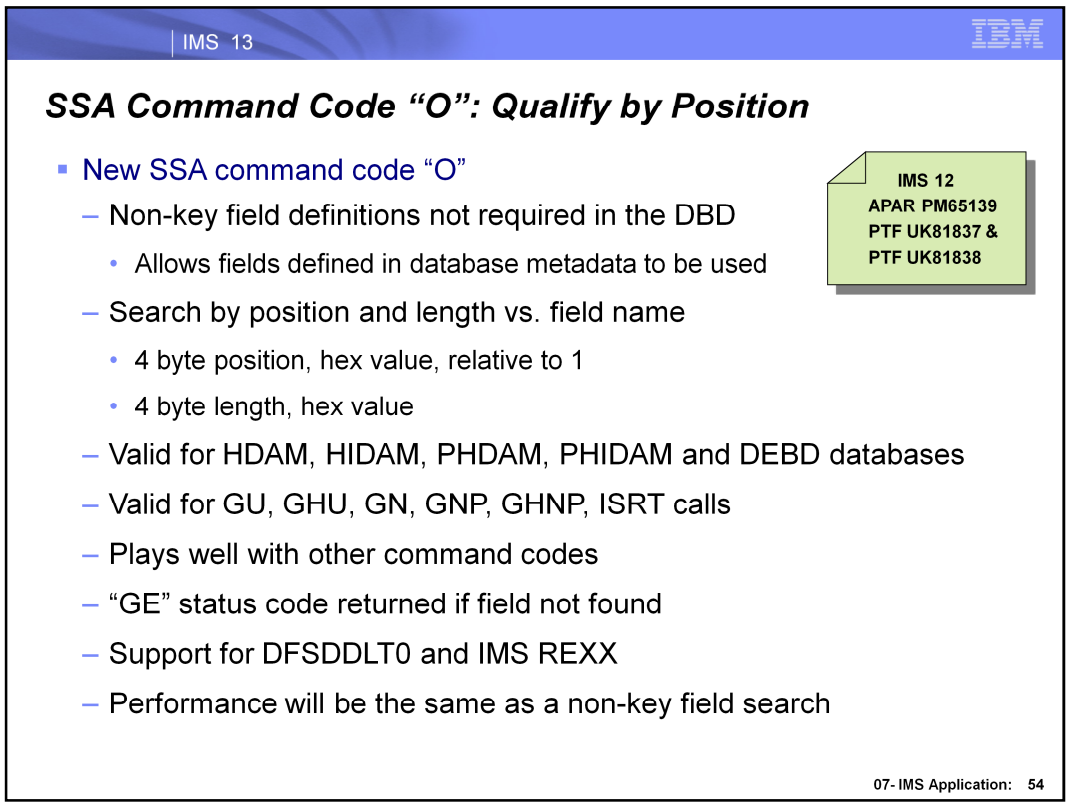
IMS SSA processing has been enhanced. Instead of requiring a field name in a qualification statement, it will be possible to provide the position and length of the field instead. This will allow non-DBD defined fields to be included in segment search arguments.

IMS V12 PTF UK81837 & UK81838 provide maintenance which enables a new SSA Command Code ‘O’, allowing IMS database calls to use a position and length instead of a field name for the SSA qualification.

IMS V12 PTF UK81917 provides maintenance which enables the IMS Universal Drivers to allow SQL calls to use ‘columns’ not defined in the DBD. The ‘column’ will be converted internally to position and length.

Users can now search for any field in a segment by specifying a position in the segment and a length. This feature allows non-DBD defined fields to be included in Segment Search Arguments and continues IBM’s IMS database modernization efforts. This enhances the IMS Simplification story by removing any required special affinity between IMS and JDBC tooling products that generate queries. Qualify by position will greatly enhance IMS support of JDBC tools. JDBC tools such as Data Source Explorer and Cognos generate SQL queries and do not have a concept of searchable and non-searchable fields. Currently when a non-searchable field is placed in the WHERE(SSA) clause the search will fail. This enhancement provides a method of generating searchable SSAs for non-searchable fields.

When the IMS catalog is enabled, the non-DBD fields can be defined using the EXTERNALNAME within the DBD providing support for SQL predicates using the non-searchable fields.



SSA processing is enhanced. Instead of requiring a field name in a qualification statement, it will instead be possible to provide the position and length of the field. This will allow non-DBD defined fields to be included in segment search arguments when accessing HDAM, HIDAM, PHDAM, PHIDAM, DEDB. Command Code "O" is not supported for FP Secondary Index DBs and will return an "SD" status code if used.

To qualify an SSA, you must specify the field position. The field position is either a field, the sequence field of a virtual child or a position and a length. A qualified SSA describes the segment occurrence that you want to access. This description is called a qualification statement and has three parts. The following table shows the structure of a qualified SSA.

SSA component	Field length
Segment name	8
*	1
Command code	Variable
(	1
Field position	8
Relational operator	2
Field value	variable
)	1

The field position and the field value are connected by a relational operator which tells IMS how you want the two compared. The field value contains the data that you want IMS to use as the comparative value. When the field position specifies a field name then the field value must be the same length as the field specified by field name. When command code "O" is specified the field name can be replaced with a position and length. When the field position specifies a position and then the field value must be the same length as the length specified in the qualification. The position and length apply to the physical segment layout.

SSA Command Code "O": Qualify by Position

IMS12
APAR PM69378
PTF UK81917

- Support for IMS Universal Drivers
  - Allows users to issue queries qualified on non-searchable fields and have a field's position and length generated automatically in the qualified SSA
  - SQL
    - Universal Drivers will detect a non-searchable field in the where clause based on database metadata and will internally convert the SSAList qualification
  - DLI
    - Universal Drivers will detect a non-searchable field in the SSAList based on database metadata and will internally convert the SSAList qualification

IMS can only search on fields that are defined in the DBD – sequence/key or search fields. As a result, the Universal Drivers cannot support an SQL predicate containing columns that are not defined in a DBD.

The following is an example exception message users may receive upon issuing a SQL query containing columns not defined by a DBD: java.sql.SQLException: com.ibm.ims.drda.base.DrdaException: com.ibm.ims.dli.SSAConversionException: An error occurred converting the SSA for segment <segmentName>: com.ibm.ims.dli.SSAQualificationConversionException: The field <fieldName> in database segment <segmentName> is not a searchable field.

IMS has been enhanced to allow a search based on offset and length. This removes the requirement that fields need to be defined in the DBD. The Universal drivers have been enhanced to allow SQL predicates containing columns that are not defined in the DBD by internally converting to an offset and length.

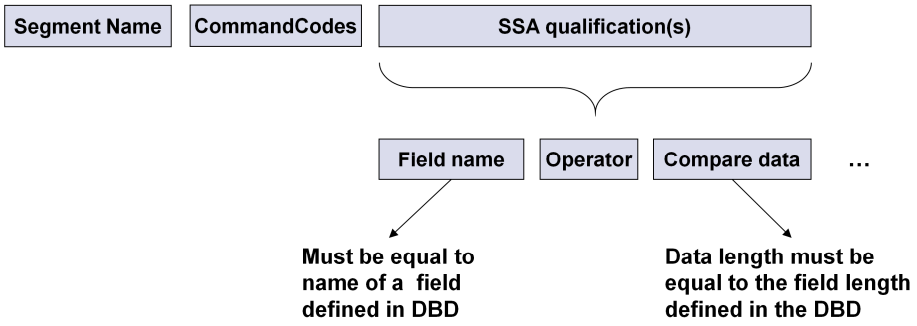
This removes any required special affinity between IMS and JDBC tooling products that generate queries. Qualify by position will greatly enhance IMS support of JDBC tools. JDBC tools such as Data Source Explorer and Cognos generate SQL queries and do not have a concept of searchable and non-searchable fields. Currently when a non-searchable field is placed in the WHERE(SSA) clause the search will fail. This enhancement provides a method of generating searchable SSAs for non-searchable fields.

If segment is in a logical relationship -> position & length apply to only the 1st physical segment, not the combined segment

If PCB uses SENFLD statements -> position applies to physical segment, and fields not available to the PCB cannot be searched

SSA Enhancement - Qualify on Field Name

- Existing SSA with field names



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SSA Enhancement - Qualify on Field Name

- Existing SSA with field names

DBD

Field	Offset	Len
Labname	1	5
Street	10	20
State	30	2

Database

```
0         1         2         3
12345678901234567901235678901
SVL  DEV 555 BAILEY AVE     CA
ARC  RSC 650 HARRY RD       CA
```

COBOL Copybook

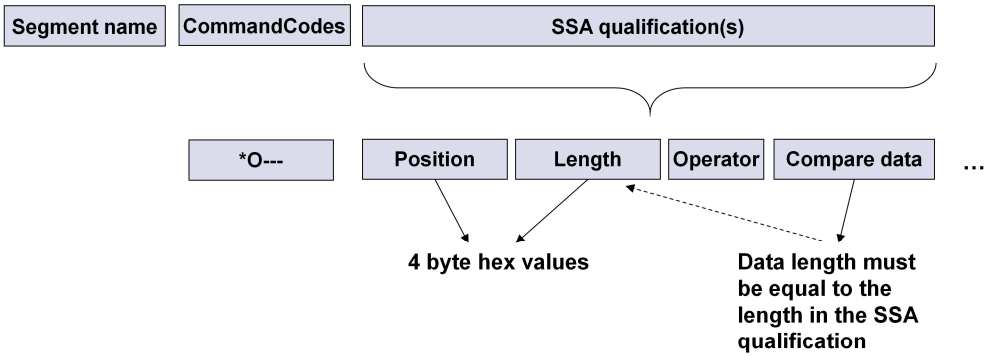
Field	Offset	Len
Labname	1	5
Type	6	3
Street	10	20
State	30	2

```
GU IBMLABS *-(LABNAME EQSVL  )
GU IBMLABS *-(LABNAME EQARC  )
GU IBMLABS *-(STATE   EQCA)
GU IBMLABS *-(TYPE    EQDEV) INVALID
```

'AK' Status Code: SSA contains a field name not defined in the DBD

SSA Enhancement - Qualify by Position

- New SSA using “O” command code with position/length



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SSA Enhancement - Qualify by Position

- New SSA with “O” command code, position and length

DBD

```
Field     Offset Len
Labname   1      5
Street    10     20
State     30     2
```

Database

```
0         1         2         3
12345678901234567901235678901
SVL  DEV 555 BAILEY AVE     CA
ARC  RSC 650 HARRY RD       CA
```

COBOL Copybook

```
Field     Offset Len
Labname   1      5
Type      6  <->  3
Street    10     20
State     30     2
```

```
GU IBMLABS *O(0000000100000005EQSVL   )
GU IBMLABS *O(0000000100000005EQARC   )
GU IBMLABS *O(0000001E00000002EQCA)
GU IBMLABS *O(0000000600000003EQDEV)
```

Position Length

‘bb‘ Status Code: all segments returned successfully

SSA Enhancement - New "SD" Status Code

- Explanation
  - For call-level programs:
    - When command code "O" is specified with a segment search argument, the SSA is not allowed to contain position and length values for a segment of a Fast Path secondary index database
  - For command-level programs:
    - When command code "O" is specified, the SSA format with position and length values is not allowed against a segment of a Fast Path secondary index database
- Programmer response
  - Correct the SSA


```
Response from IMS
FINEST: [ibm][ims][drda] [t4][thread:1][tracepoint:2][Reply.fill]
[ibm][ims][drda][t4]        RECEIVE BUFFER: OPNQRYRM            (ASCII)           (EBCDIC)
[ibm][ims][drda][t4]        0 1 2 3 4 5 6 7   8 9 A B C D E F   0123456789ABCDEF  0123456789ABCDEF
[ibm][ims][drda][t4] 0000   0010D0520001000A  2205000611490000  ...R...."....I..  ..}.............
[ibm][ims][drda][t4]
[ibm][ims][drda][t4]        RECEIVE BUFFER: QRYDSC              (ASCII)           (EBCDIC)
[ibm][ims][drda][t4] 0000   001CD05300010016  241A0676D0260000  ...S....$..v.&..  ..}.........}...
[ibm][ims][drda][t4] 0010   0671E0D000010671  F0E00000          .q.....q....      ..\}....0\..
[ibm][ims][drda][t4]
[ibm][ims][drda][t4]        RECEIVE BUFFER: QRYDTA              (ASCII)           (EBCDIC)
[ibm][ims][drda][t4] 0000   011AD05300010114  241B000000038400  ...S....$.......  ..}...........d.
[ibm][ims][drda][t4] 0010   0000000000000000  0000000000C4C5C4  ................  ............DED
[ibm][ims][drda][t4] 0020   C2D1D5F2F1F0F140  40C8D6E2D7C9E3C1  .......@@.......  BJN2101  HOSPITA
[ibm][ims][drda][t4] 0030   D3000000000CD9F1  F2F1F0F0F1F0F0F0  ................  L.....R121001000
[ibm][ims][drda][t4] 0040   F0C1D9F1F2F1F0F0  F1F0F0F0F0C10000  ................  0AR1210010000A..
(lines removed to save space)
[ibm][ims][drda][t4] 00C0   F2F1F0F0F3F0F0F0  F0C1D9F1F2F1F0F0  ................  210030000AR12100
[ibm][ims][drda][t4] 00D0   F3F0F0F0F0C10000  0003840000000000  ................  30000A....d.....
[ibm][ims][drda][t4] 00E0   0000000000000000  00C4C5C4C2D1D5F2  ................  .........DEDBJN2
[ibm][ims][drda][t4] 00F0   F1F0F14040C8D6E2  D7C9E3C1D3000000  ...@@...........  101  HOSPITAL...
[ibm][ims][drda][t4] 0100   000CD9F1F2F1F0F0  F4F0F0F0F0C1D9F1  ................  ..R1210040000AR1
[ibm][ims][drda][t4] 0110   F2F1F0F0F4F0F0F0  F0C1              ..........        210040000A
[ibm][ims][drda][t4]
[ibm][ims][drda][t4]        RECEIVE BUFFER: ENDQRYRM            (ASCII)           (EBCDIC)
[ibm][ims][drda][t4] 0000   003CD00200010036  220B000611490004  .<.....6"....I..  ..}.............
[ibm][ims][drda][t4] 0010   002CCC0200000000  0000000900000000  .,..............  ................
[ibm][ims][drda][t4] 0020   00000000000000C4  C5C4C2D1D5F2F1F0  ................  .......DEDBJN210
[ibm][ims][drda][t4] 0030   F0C7C24040404040  404040FF          ...@@@@@@@@.      0GB
```

SSA Enhancement - Performance Consideration

- Performance will be similar to a search on a non-key field
- IMS will scan the database looking for field match(es)
- Qualification of the root key will help reduce the impact
- If business need requires searching on a non-key field
  - Consider defining the non-key field as a searchable field in the DBD

Performance should be no different than doing a call using a non-key search field.

It is possible that the call will scan the entire database and not find a match based on the position, length and qualifier, only to return a “GE” status code – just as it would today if you searched on a non-key field and did not find a match.

SSA Enhancement - Qualify by Position

- Benefit
  - Allows non-DBD defined fields to be included in SSAs
  - Allows a search on any field in a segment by specifying a position within the segment and the field length
  - Provides a method of generating searchable SSAs for non-searchable fields
  - Continuation of the IMS database modernization roadmap
    - Enhances and simplifies IMS support of JDBC tools
      - Discovery tools - Data Source Explorer
      - Reporting tools – Optim Data Studio
      - Analytics tools – COGNOS BI V10.2
      - Any JDBC tool that generates SQL calls !

Users can now search for any field in a segment by specifying a position in the segment and a length. This feature allows non-DBD defined fields to be included in Segment Search Arguments and continues IBM's IMS database modernization efforts.

This enhances the IMS Simplification story by removing any required special affinity between IMS and JDBC tooling products that generates queries. Qualify by position will greatly enhance IMS support of JDBC tools. JDBC tools such as Data Source Explorer and Cognos generate SQL queries and do not have a concept of searchable and non-searchable fields. Currently when a non-searchable field is placed in the WHERE(SSA) clause the search will fail. This enhancement provides a method of generating searchable SSAs for non-searchable fields.

IMS 12 SPE Enhancement

Qualify By Position

Reference Slides

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SSA Enhancement - SQL to DLI translation

- **Connection.nativeSQL(String)** method will display the DLI equivalent of an SQL query
- SELECT * FROM LARGE2.GBO02 WHERE GBO01.FIRSTNAME='KIN'

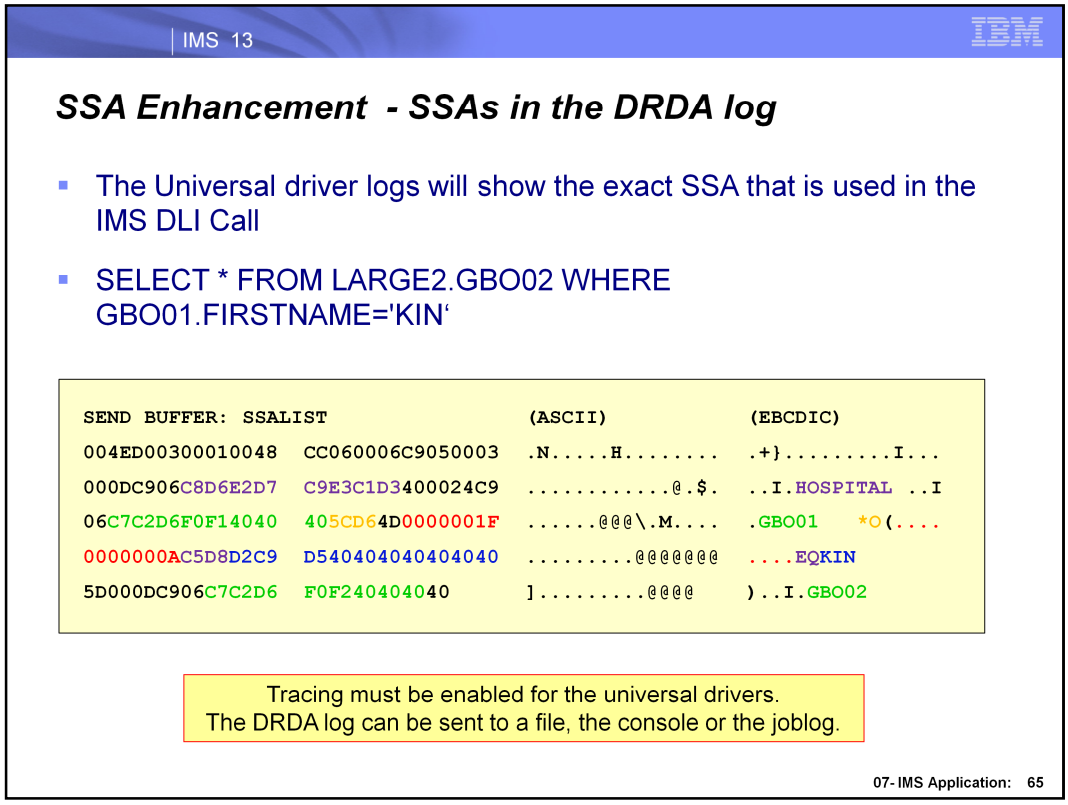
```
GHU HOSPITAL
  GBO01   *O((x'1F',x'A')EQKIN       )
  GBO02

[LOOP]

GHN HOSPITAL
  GBO01   *O((x'1F',x'A')EQKIN       )
  GBO02
```


For troubleshooting and diagnostic purposes, the Connection.nativeSQL(String) method will come in handy.

By using it, one can see the DLI call generated by IMS in place of the JDBC SQL call.



Tracing can be enabled for the universal drivers. The DRDA log can be sent to a file, console or joblog.

http://publib.boulder.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.ims12.doc.apg/ims_odbdli4jtracing.htm

Sample SQL and Trace output:

```
SQL Query: SELECT * FROM PCB01.HOSPITAL
FINEST: [ibm][ims][drda] [t4][thread:1][tracepoint:1][Request.flush]
[ibm][ims][drda][t4]        SEND BUFFER: OPNQRY                 (ASCII)           (EBCDIC)
[ibm][ims][drda][t4]        0 1 2 3 4 5 6 7   8 9 A B C D E F   0123456789ABCDEF  0123456789ABCDEF
[ibm][ims][drda][t4] 0000   0029D05100010023  200C00062141001F  .).Q...# ...!A..  ..}.............
[ibm][ims][drda][t4] 0010   0009C907D7C3C2F0  F100082114000080  ...........!....  ..I.PCB01.......
[ibm][ims][drda][t4] 0020   0000082156000003  69                ...!V...i         .........
[ibm][ims][drda][t4]
[ibm][ims][drda][t4]        SEND BUFFER: DLIFUNC                (ASCII)           (EBCDIC)
[ibm][ims][drda][t4] 0000   0012D0530001000C  CC05D9C5E3D9C9C5  ...S............  ..}.......RETRIE
[ibm][ims][drda][t4] 0010   E5C5                                ..                VE
[ibm][ims][drda][t4]
[ibm][ims][drda][t4]        SEND BUFFER: AIB                    (ASCII)           (EBCDIC)
[ibm][ims][drda][t4] 0000   001BD05300010015  CC010009C901D7C3  ...S............  ..}.........I.PC
[ibm][ims][drda][t4] 0010   C2F0F10008C90400  000384            ...........       B01..I....d
[ibm][ims][drda][t4]
[ibm][ims][drda][t4]        SEND BUFFER: RTRVFLD                (ASCII)           (EBCDIC)
[ibm][ims][drda][t4] 0000   0012D0530001000C  CC04000000020000  ...S............  ..}.............
[ibm][ims][drda][t4] 0010   000C                                ..                ..
[ibm][ims][drda][t4]
[ibm][ims][drda][t4]        SEND BUFFER: SSALIST                (ASCII)           (EBCDIC)
[ibm][ims][drda][t4] 0000   001DD00300010017  CC060006C9050001  ................  ..}.........I...
[ibm][ims][drda][t4] 0010   000DC906C8D6E2D7  C9E3C1D340        ............@     ..I.HOSPITAL
```

(Trace output for IMS Response will follow)

SSA Enhancement - DFSDDLT0 Examples

GU calls with CmdCode “O” searching at position x’01’ for x’10’ bytes

```
**************************************************************************************************************

IMS   1210  TEST PROGRAM OUTPUT  ** BEGIN TEST ****TIME= 16.22.28.84 DATE= 12.128

WTOR CALL:         WTOR   Start of GBO BATCH1
STATUS INPUT: S11 1 1 1 1          01
0002 OF 0005  PCB SELECTED =           DBD SELECTED = DBOHIDK5
COMMENTS           GU    K1

WTO  CALL:         WTO    K1       *O(00010010EQ0000000000000000)
.....................................................................................................
CALL=GU       SEG=K1         COMND=O
                                00000001
                             FIELD=00010000  OPER===     VALUE=0000000000000000)

SEGMENT     =(00000000000000000000@@STARTING@@POINT@@                                    )

DBPCB   LEV=01  SEG=K1         RET CODE=     KFDB LEN=0020  KEY FDB=(0000000000000000000)

WTO  CALL:         WTO    K1       *O(00010010GTAAAAAAAAAAAAAAAA)
.....................................................................................................
CALL=GU       SEG=K1         COMND=O
                                00000001
                             FIELD=00010000  OPER=>      VALUE=AAAAAAAAAAAAAAAA)

SEGMENT     =(00000000000000000000@@STARTING@@POINT@@                                    )

DBPCB   LEV=01  SEG=K1         RET CODE=     KFDB LEN=0020  KEY FDB=(0000000000000000000)
```


Sample DFSDDLT0 control cards and output

SSA Enhancement - DFSDDLT0 Examples

GU call using key field vs. GU call using CmdCode “O” & position

```
**********************************************************************************************************************************

IMS   1210  TEST PROGRAM OUTPUT  ** BEGIN TEST ****TIME= 15.08.19.61 DATE= 12.292

WTOR CALL:         WTOR   Start of batch app
WTOR REPLY:
STATUS INPUT: S 1 1 1 1 1    DBOHIDK5
0002 OF 0010  PCB SELECTED =           DBD SELECTED = DBOHIDK5

WTO  CALL:         WTO   K1      (K1      EQ0KEY K1          1000)
.....................................................................................................................
CALL=GU       SEG=K1       FIELD=K1      OPER=EQ     VALUE=0KEY K1          1000)

SEGMENT     =(0KEY K1          1000@@STARTING@@POINT@@                                                          )

DBPCB   LEV=01  SEG=K1       RET CODE=    KFDB LEN=0020 KEY FDB=(0KEY K1          1000)

WTO  CALL:         WTO   K1      *O(00020013xEQKEY K1          1000)
.....................................................................................................................
.....
CALL=GU       SEG=K1       COMND=O
                                 00000001
                           FIELD=00020003 OPER=EQ     VALUE=KEY K1          1000)

SEGMENT     =(0KEY K1          1000@@STARTING@@POINT@@                                                          )

DBPCB   LEV=01  SEG=K1       RET CODE=    KFDB LEN=0020 KEY FDB=(0KEY K1          1000)
```


Sample DFSDDLT0 control cards and output

IMS Native SQL Support for COBOL

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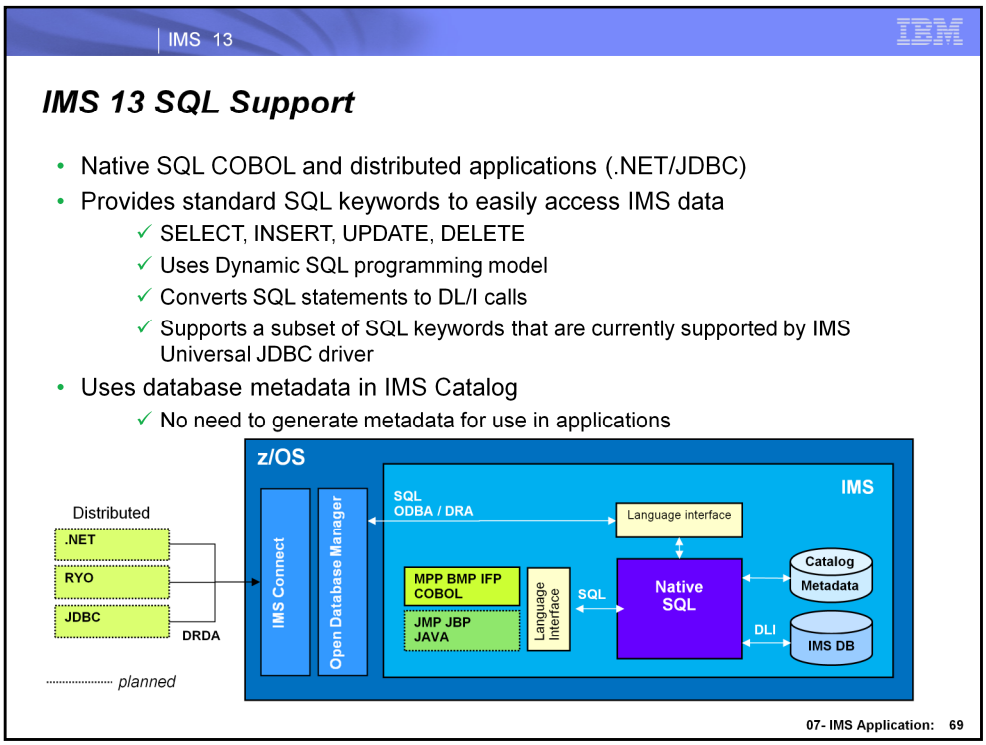
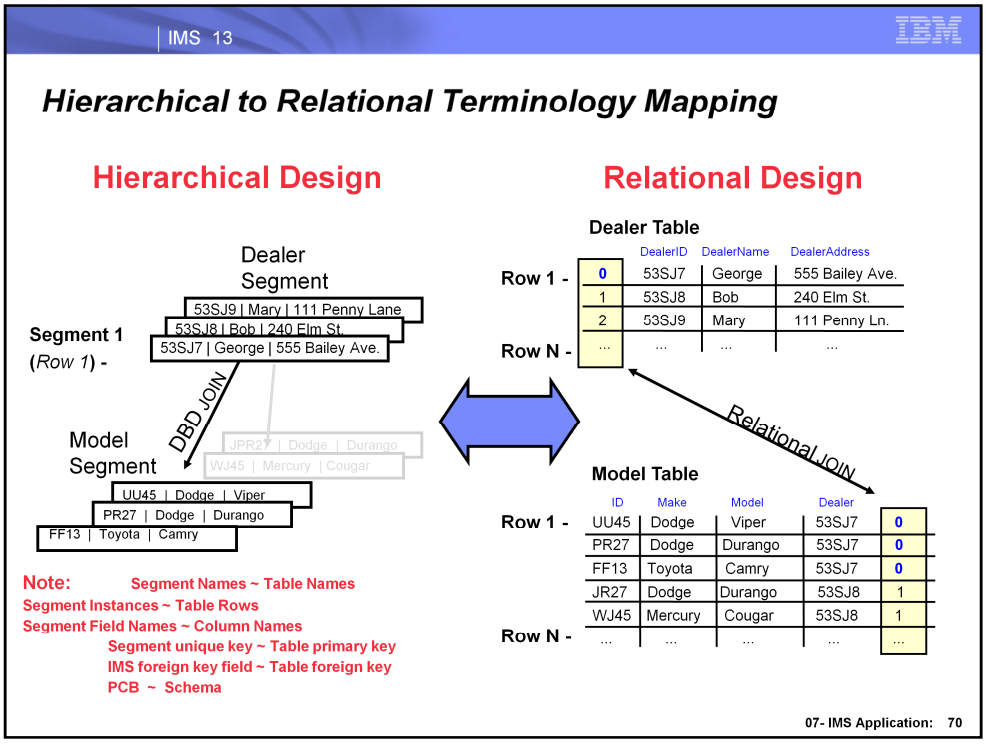


IMS 13 delivers an SQL engine that is capable of evaluating SQL statements (a subset of the SQL keywords supported by the IMS 13 Universal JDBC Driver) and converts them to DL/I calls.

The IMS Native SQL Engine is used to support COBOL and DRDA access.

Note The IBM IMS Enterprise Suite Data Provider for Microsoft .NET and IMS 13 TYPE-4 Universal Drivers will provide the DRDA support via the service process.

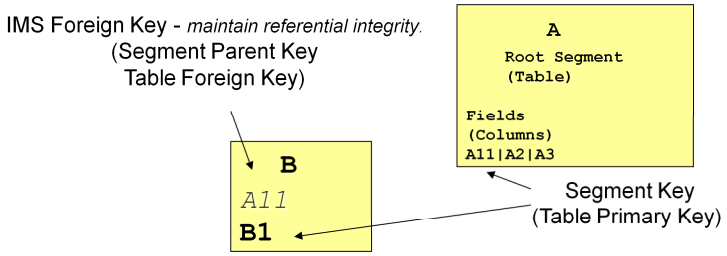


This slide provides a mapping of IMS hierarchical database concepts and relational database concepts.

IMS Native SQL Processor views a Segment as a Table, A field as column and segment instance as a row.

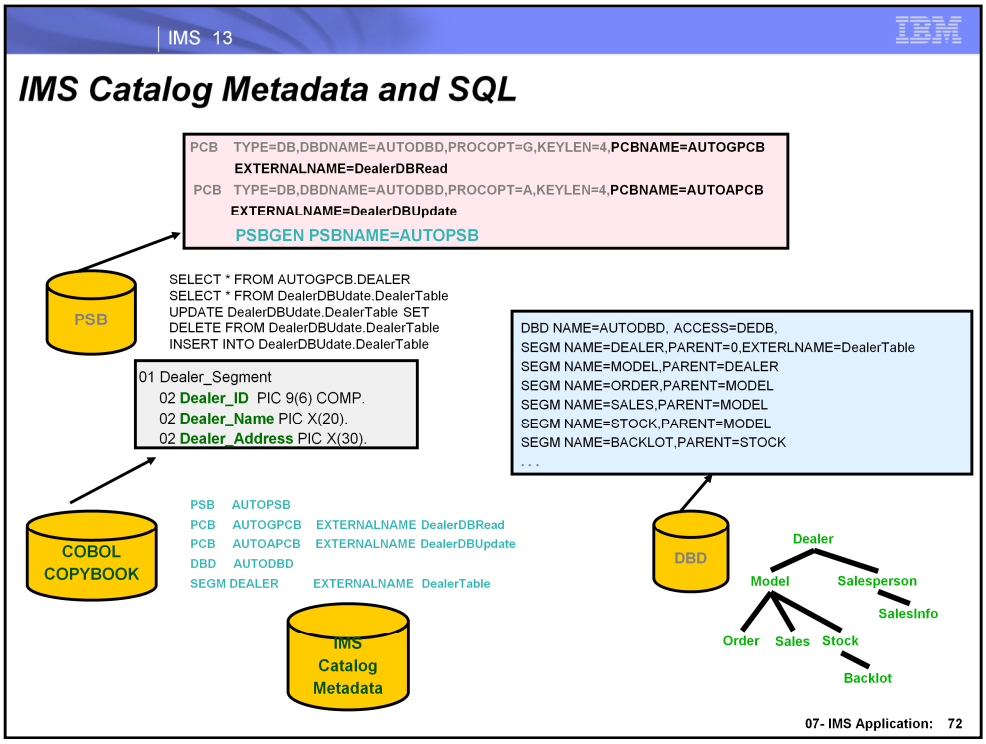
Solution highlights - IMS foreign keys Referential constraint

- IMS cannot insert a dependent segment unless the parent segment exists
  - IMS has built-in foreign keys in each segment which are comprised of keys of each parent segment
    - Exist in the key feedback area not physically stored in the IMS database
      - For INSERT operations the Foreign Keys s are used to establish the correct position in the hierarchy
        - Values aren't actually inserted as they already exist in the database

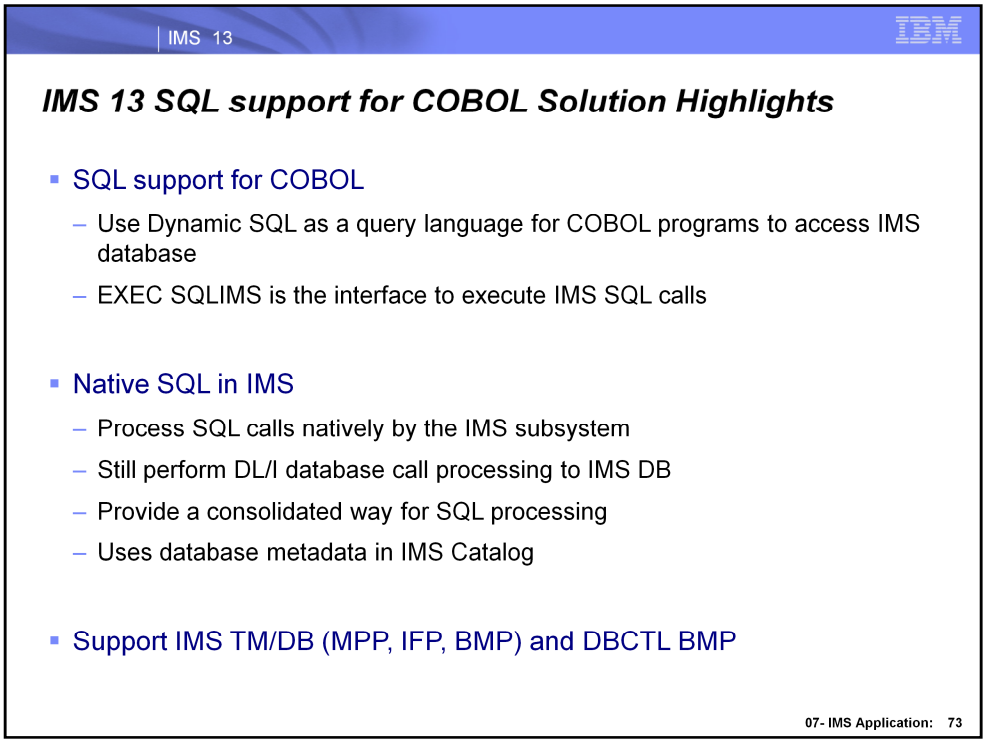


This slide provides a mapping of IMS hierarchical database concepts and relational database concepts. IMS SQL views Segment as a Table, A field as column and segment instance as a row.

The purpose of the IMS foreign key fields is to maintain referential integrity, similar to foreign keys in relational databases. This allows SQL SELECT, INSERT, UPDATE, and DELETE queries to be written against specific tables and columns located in a hierarchic path.



This slide shows how information from PSB,DBD and COBOL copybooks is used to populate IMS Catalog and how SQL statements can be coded with External Names to access IMS databases



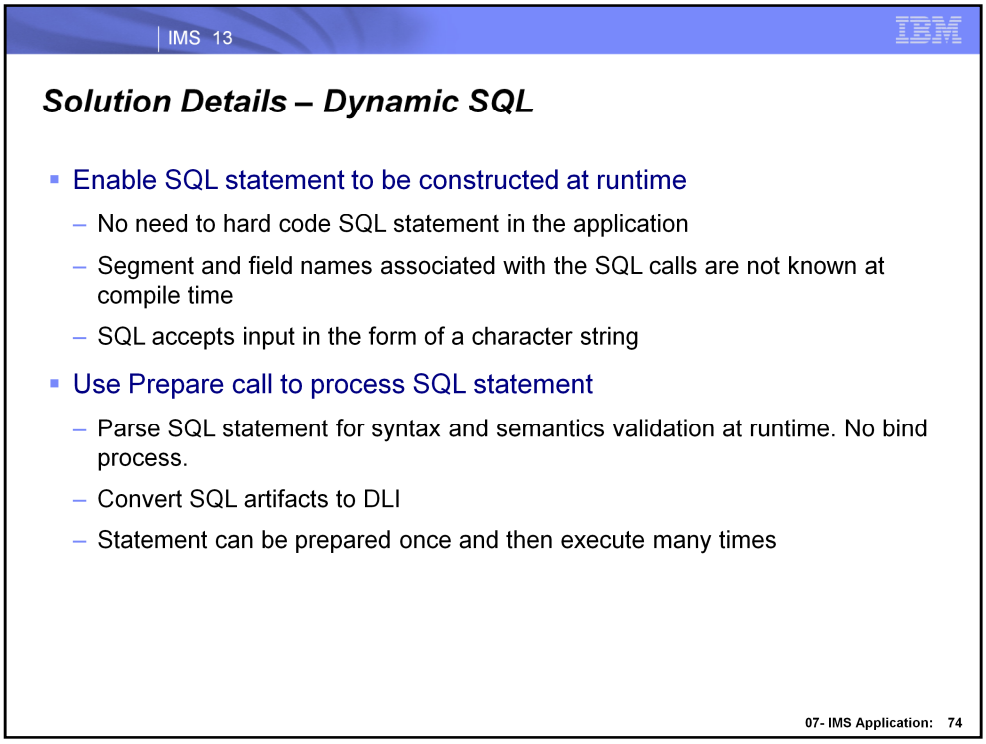
IMS COBOL application programs running in MPP,IFP,BMP for IMS DB/DC and DBCTL BMP .

•DL/I Batch, CICS, and DB2 Stored Procedures are not supported

•SQL to GSAM is not supported.

Static SQL refers to the type of SQL statement that is embedded inside an application and its source form is known before runtime. This is not supported by IMS SQL for COBOL.

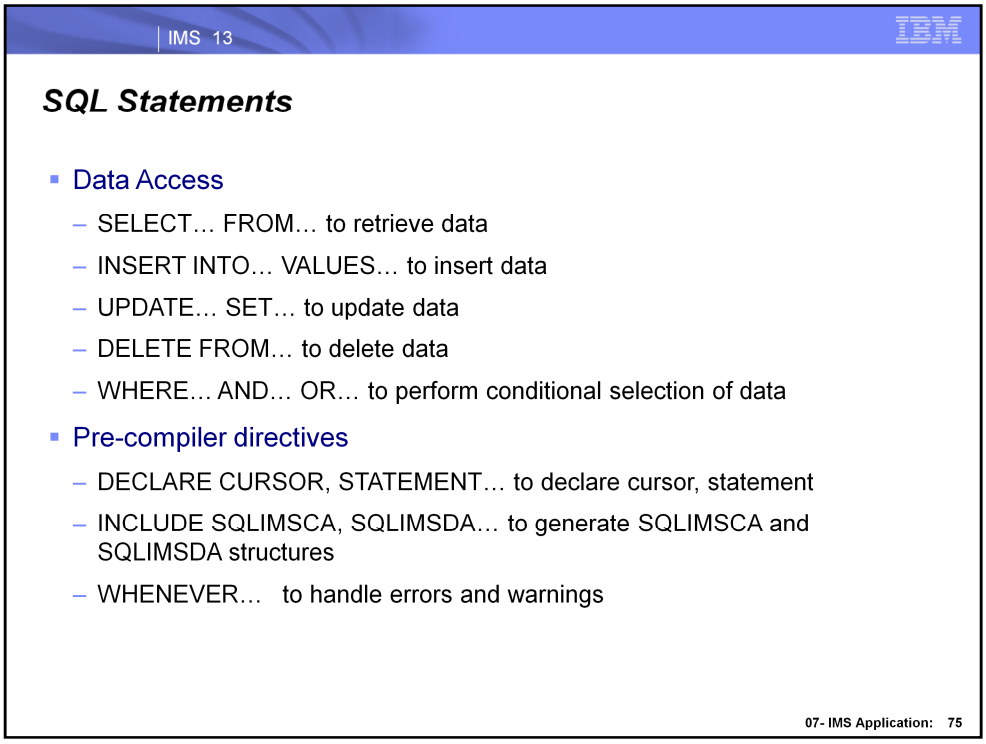
Dynamic SQL refers to the type of SQL statement that the actual content of the statement is constructed and prepared at run time. Segment and field names associated with the SQL calls are defined in the program source and are pre-processed when the program is being compiled.



Programs that contain embedded *dynamic* SQL statements must be precompiled like those that contain static SQL, but unlike static SQL, the dynamic statements are constructed and prepared at run time.

The source form of a dynamic statement is a character string that is passed to IMS by the program using the SQL PREPARE statement. A statement that is prepared using the PREPARE statement can be referenced in a DECLARE CURSOR, DESCRIBE, or EXECUTE statement.

In IMS 13, only dynamic SQL is supported for COBOL.



SQL statements let you retrieve, insert, update, or delete data in IMS databases. When you write an SQL statement, you specify what you want done, not how to do it. To access data, for example, you need only to name the segment and fields that contain the data. You do not need to describe how to get to the data.

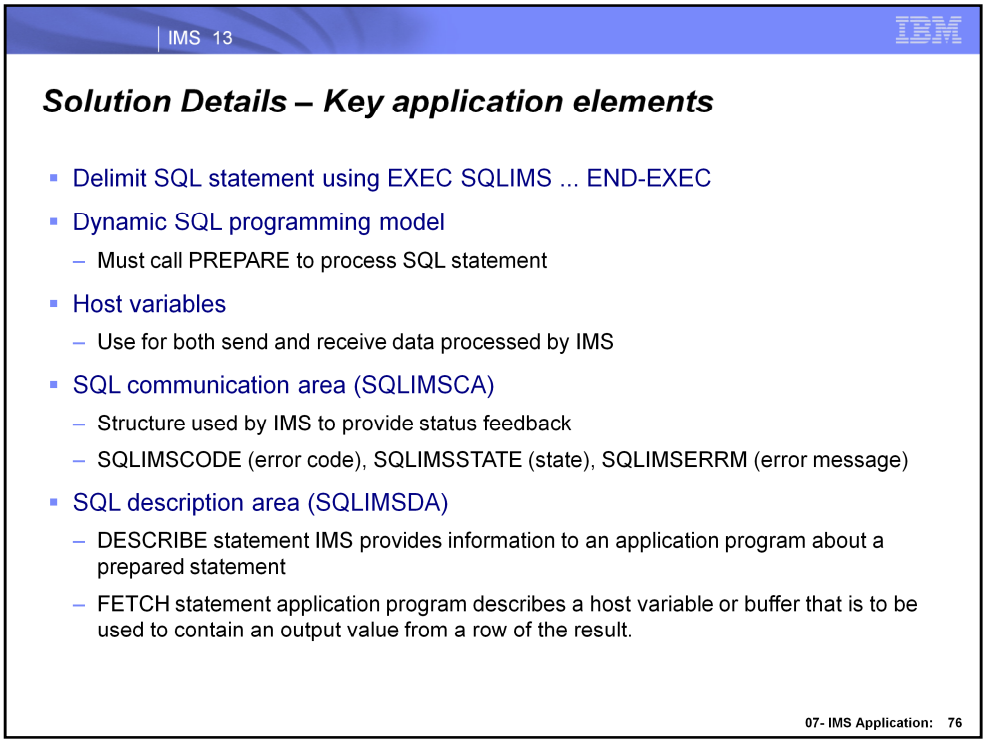
In accordance with the relational model of data:

•The database is perceived as a set of tables.

•Relationships are represented by values in tables.

•Data is retrieved by using SQL to specify a *result table* that can be derived from one or more tables.

IMS transforms each SQL statement, that is, the specification of a result table, into a sequence of operations for data retrieval or modifications. All executable SQL statements must be prepared before they can run.



If your program includes any of the following statements, you must include an SQLIMSDA in your program:

•DESCRIBE *statement-name* INTO *descriptor-name*

•FETCH … INTO DESCRIPTOR *descriptor-name*

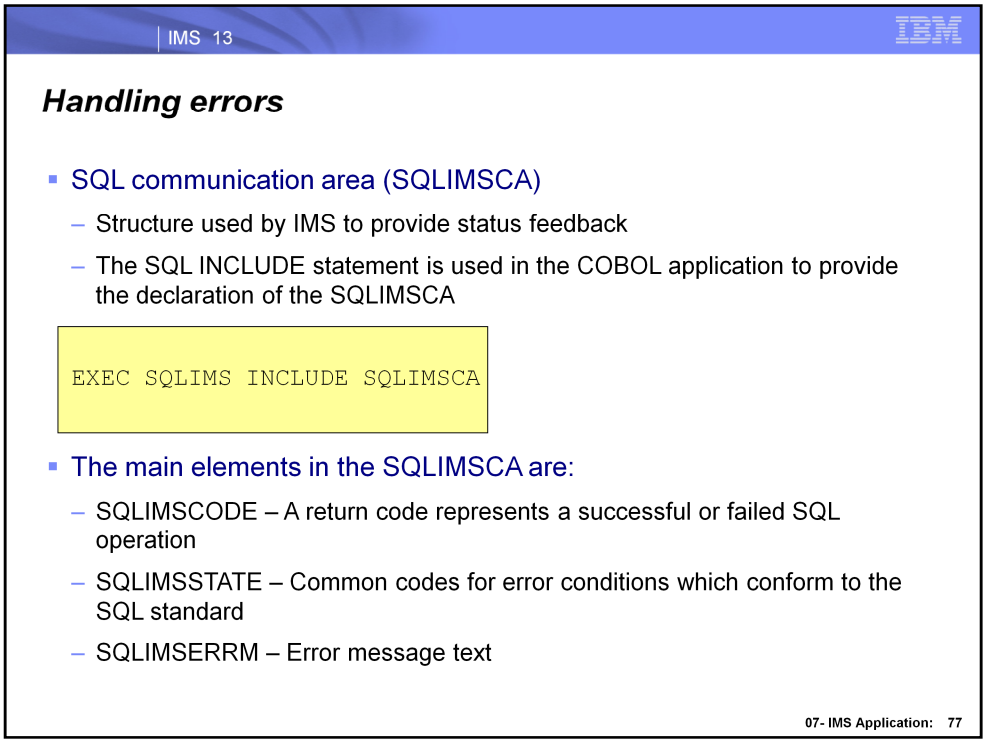
An SQLIMSDA is a collection of variables that is required for execution of the SQLIMS DESCRIBE statement, and can be optionally used by the FETCH statements. An SQLIMSDA can be used in a DESCRIBE statement, modified with the addresses of host variables, and then reused in a FETCH statement. The meaning of the information in an SQLIMSDA depends on the context in which it is used. For DESCRIBE, IMS™ sets the fields in the SQLIMSDA to provide information to the application program. For FETCH, the application program sets the fields in the SQLIMSDA to provide IMS with information:

DESCRIBE *statement-name*

With the exception of SQLIMSN, IMS sets fields of the SQLIMSDA to provide information to an application program about a prepared statement. Each SQLIMSVAR occurrence describes a column of the result table.

FETCH

The application program sets fields of the SQLIMSDA to provide information about host variables or output buffers in the application program to IMS. Each SQLIMSVAR occurrence describes a host variable or output buffer. For FETCH, each SQLIMSVAR occurrence describes a host variable or buffer in the application program that is to be used to contain an output value from a row of the result.



An SQLIMSCA is a structure or collection of variables that is updated after each SQL statement executes. An application program that contains executable SQL statements must provide exactly one SQLIMSCA.

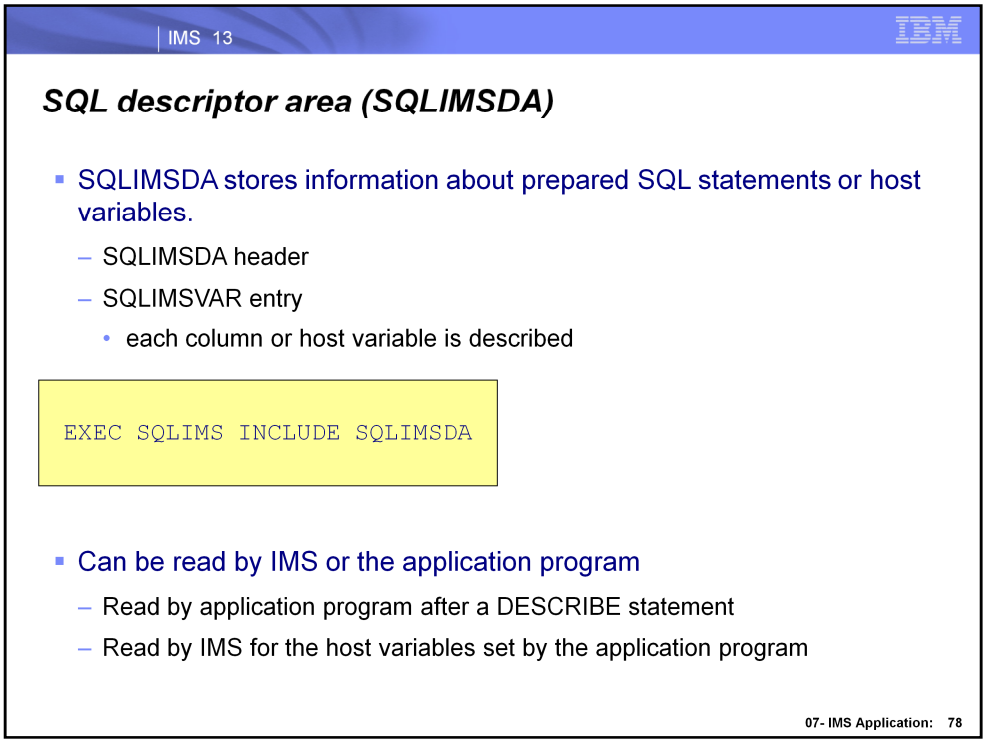
In COBOL, the INCLUDE statement can be used to provide the declaration of the SQLIMSCA.

•When IMS processes an SQL statement, it places return codes that indicate the success or failure of the statement execution in SQLIMSCODE and SQLIMSSTATE.

•When IMS processes a FETCH statement, and the FETCH is successful, the contents of SQLIMSERRD(3) in the SQLIMSCA is set to the number of returned rows.

•When IMS processes a FETCH statement, the contents of SQLIMSCODE is set to +100 if the last row in the segment has been returned with the set of rows.

•When IMS processes an UPDATE, INSERT, or DELETE statement, and the statement execution is successful, the contents of SQLIMSERRD(3) in the SQLIMSCA is set to the number of rows that are updated, inserted, or deleted.



An SQLIMSDA consists of four variables, a header, and an arbitrary number of occurrences of a sequence of variables collectively named SQLIMSVAR. It is a collection of variables that is required for execution of the SQLIMS DESCRIBE statement, and can be optionally used by the FETCH statements. An SQLIMSDA can be used in a DESCRIBE statement, modified with the addresses of host variables, and then reused in a FETCH statement.

The meaning of the information in an SQLIMSDA depends on the context in which it is used. For DESCRIBE, IMS™ sets the fields in the SQLIMSDA to provide information to the application program. For FETCH, the application program sets the fields in the SQLIMSDA to provide IMS with information:

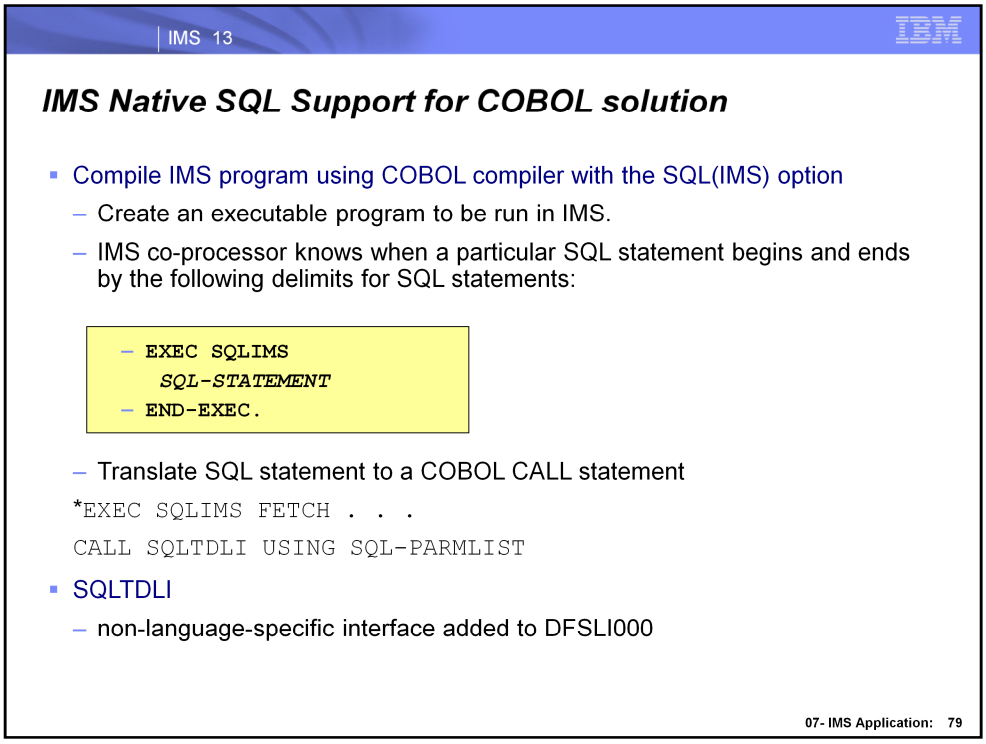
DESCRIBE *statement-name*

With the exception of SQLIMSN, IMS sets fields of the SQLIMSDA to provide information to an application program about a prepared statement. Each SQLIMSVAR occurrence describes a column of the result table.

FETCH

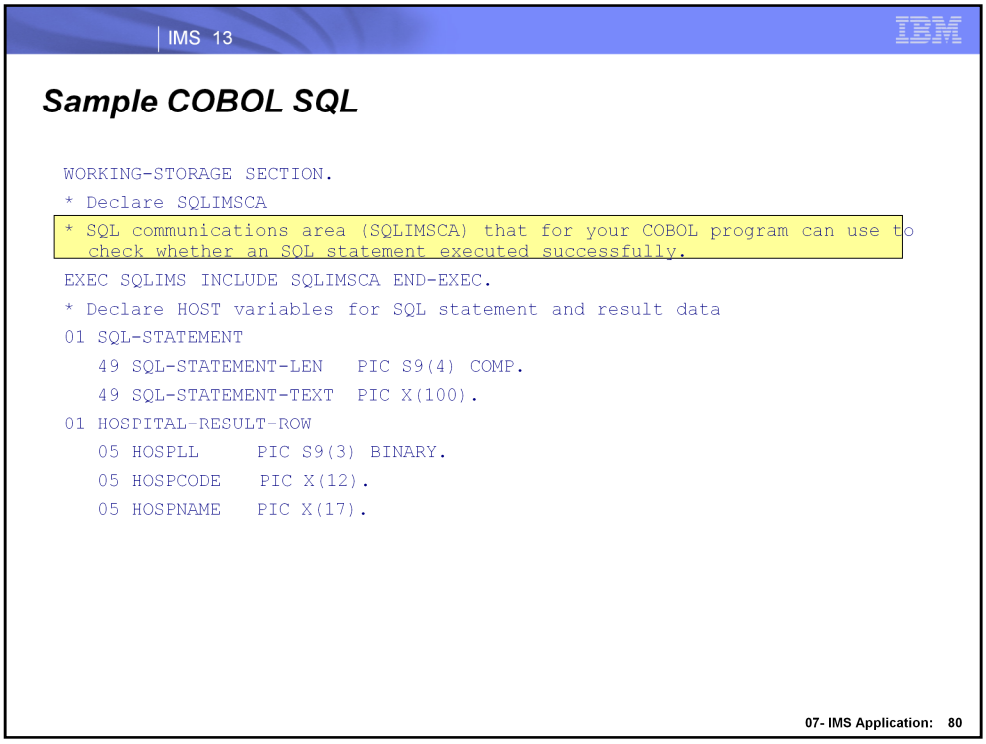
The application program sets fields of the SQLIMSDA to provide information about host variables or output buffers in the application program to IMS. Each SQLIMSVAR occurrence describes a host variable or output buffer.

For FETCH, each SQLIMSVAR occurrence describes a host variable or buffer in the application program that is to be used to contain an output value from a row of the result.

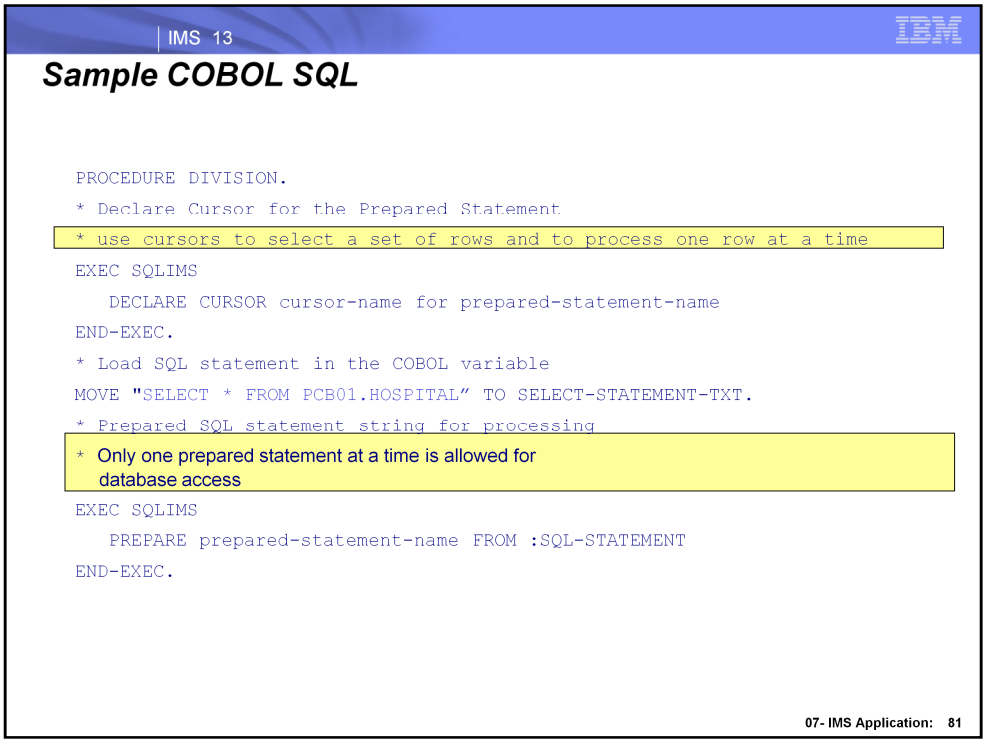


Any segment and field names associated with the SQL calls are defined in the program source and are pre-processed when the program is being pre-compiled. There is no need to use a separate precompile step.

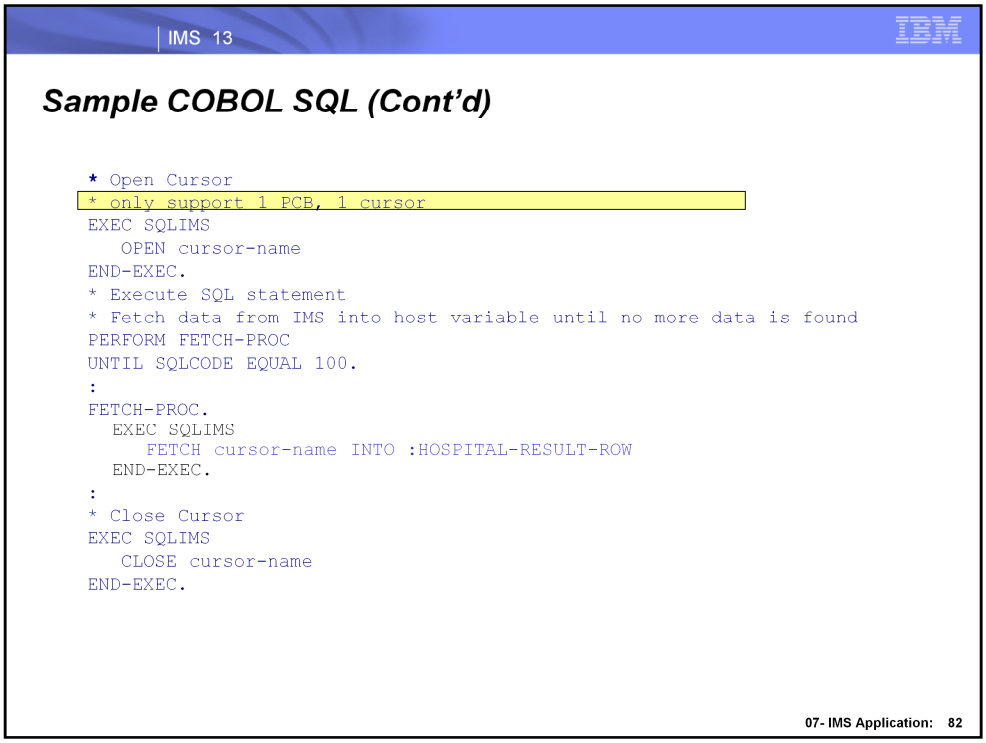
Each executable SQL statement calls IMS through the SQLTDLI language interface with a list of parameters that is generated by the IMS co-processor function. The parameter list contains a collection of addresses for the input and output host variables, the SQL statement string, the SQL call type, the execution parameters and other information. IMS uses this information to determine how the call should be processed



Define an SQL communications area (SQLIMSCA) for your COBOL program which is used to check whether an SQL statement executed successfully.



Use cursors to select a set of rows and then process one row at a time. Only one prepared statement at a time is allowed for database access and a statement cannot be prepared if a cursor is open for another statement.



Only one prepared statement at a time is allowed for database access and a statement cannot be prepared if a cursor is open for another statement. Only support 1 PCB, 1 cursor.

IMS coprocessor

- Compile IMS SQL COBOL application with IMS coprocessor
- Pre-process EXEC SQLIMS statements in COBOL source
- Integrated with Enterprise COBOL V5.1
- Specify ‘SQLIMS’ compiler option to compile COBOL program with IMS SQL calls

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Sample JCL for compile

```
//*********************************
//* COMPILING IMS COBOL SQL PROGRAM
//*********************************
//COBOL1  EXEC PGM=IGYCRCTL,
// PARM='LIST,XREF,CP(37),SQLIMS("APOSTSQL"),DUMP,LIB,DYNAM'
//STEPLIB  DD  DSN=IGYV5R10.TRIAL.SIGYCOMP,DISP=SHR
//         DD  DSN=IGYV5R10.TRIAL.SIGYMAC,DISP=SHR
//         DD  DSN=IMSBLD.IMSTS%%.CRESLIB,DISP=SHR
//SYSLIB   DD  DSN=IGYV5R10.TRIAL.CEEZ1D0.SCEERUN,DISP=SHR
//         DD  DSN=USER.PRIVATE.PROCLIB,DISP=SHR
//SYSPRINT DD  SYSOUT=A
//SYSLIN   DD  DSN=&&LOADSET,DISP=(MOD,PASS),
//             UNIT=SYSDA,SPACE=(80,(500,200))
```


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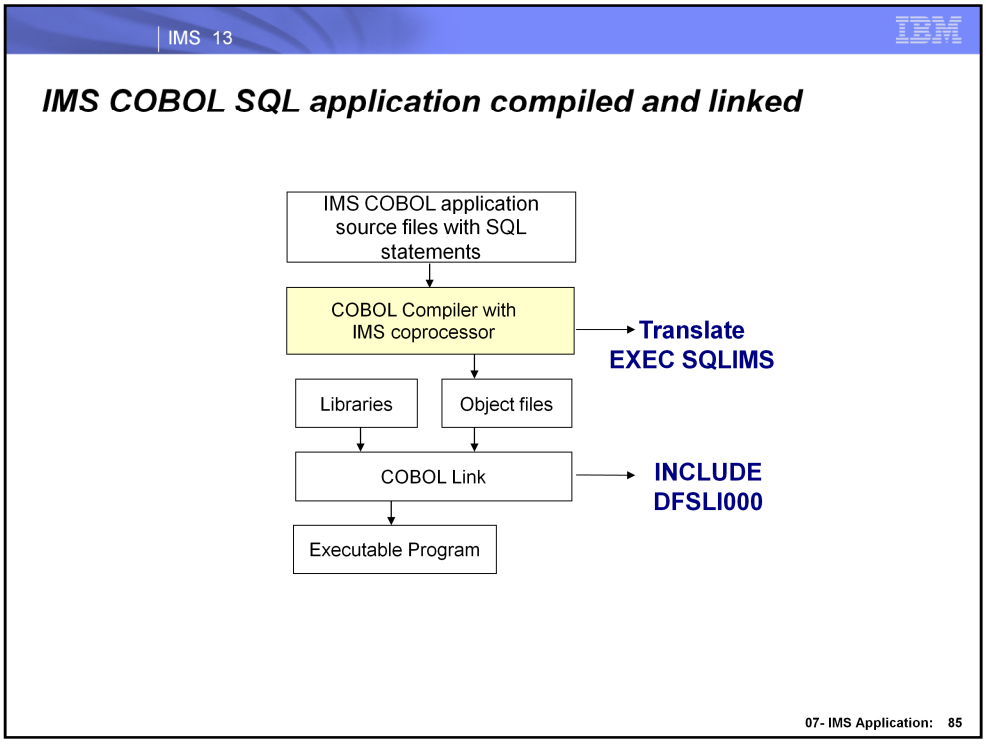
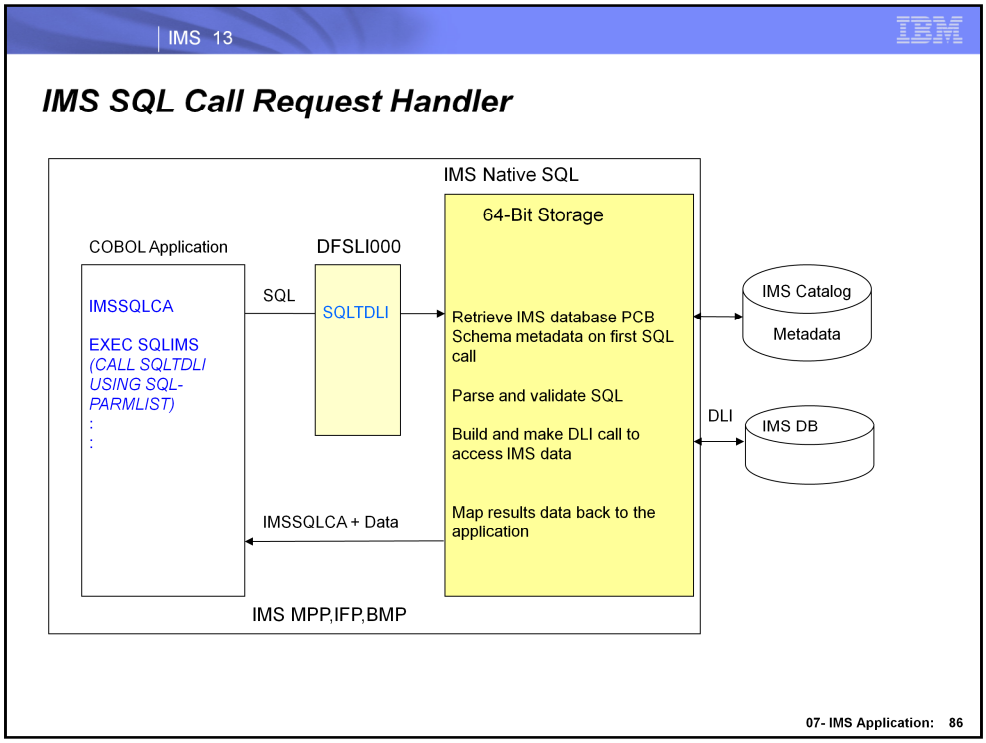


During compilation, the IMS co-processor takes an SQL statement enclosed between the EXEC SQLDLI and END-EXEC keywords and processes it as follows:

•Translate an executable SQL statement to a COBOL CALL statement to invoke the IMS language interface

•Initialize and map host variables for input and output data

•Include and add data structures for SQL processing



IMS SQL is an SQL-to-DLI processor or translator that intercepts a SQL calls and translates them into DLI calls for execution. This diagram shows an example on how a SQL call from a COBOL application is processed by IMS:

1. The COBOL program is first pre-compiled by the IMS co-processor which converts the EXEC SQLDLI statements to COBOL call statements to the new IMS language interface (SQLTDLI).

This interface is used to pass the SQL statement with the host variable information to IMS for processing.

2. Once the COBOL program runs, the SQLTDLI interface uses the native SQL processor.

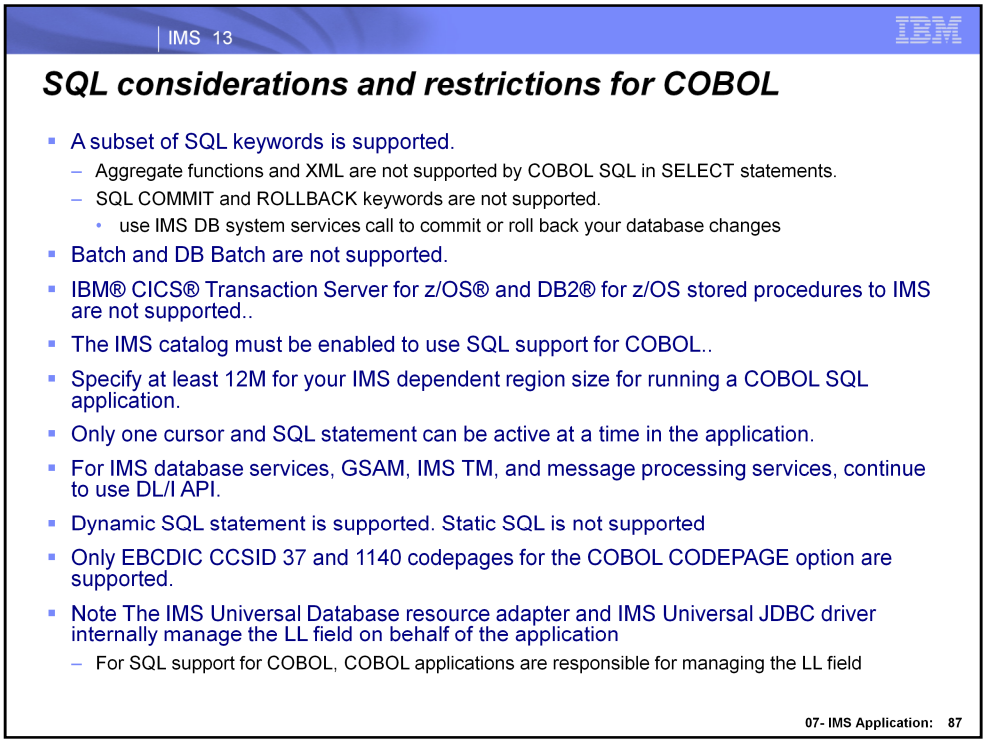
3. The native SQL processor retrieves the corresponding PSB/DBD metadata from catalog based on the SQL call.

4. The SQL statement is parsed and validated by the native SQL processor based on the IMS SQL syntax rules and metadata information.

5. The native SQL processor builds and executes the appropriate DLI call(s) based on the SQL statement to access IMS DB.

6. The native SQL processor processes the result data from IMS DB using 64 bit storage and performs column / aggregation functions if needed.

7. The native SQL processor returns and puts the data back to the host variables for the COBOL application



Dynamic SQL refers to the type of SQL statement where the actual content of the statement is constructed and prepared at run time. For an example, a dynamic SQL statement can be passed to the application as an input message, or the statement is dynamically constructed based on other values at runtime. For Dynamic SQL, the statement type, table or column names are not known when the program is pre-compiled. Since the source of the SQL statement is not known during pre-compile time, the SQL statement is parsed and validated by the database during runtime each time the SQL statement is executed

Using the LL field with COBOL

The LL field is treated as a normal column in the standard SQL result set for all operations. You can read, insert, or update the LL field data directly. Deleting the LL field data also deletes the rest of the associated database record. To set a field to the null state, set the length of the segment (the value of the LL field column) to be smaller than the offset of the field within the segment.

The LL field is 2 bytes long and must be handled as BINARY, SHORT, or USHORT data.

Performance

- Recommendations
  - Fully qualify all tables (segments) and columns (fields) in SQL statements
    - Specify the schema (PCB) name
  - Always use PREPARE call for SQL statement that is going to be executed multiple times
  - Consider using FETCH or cursors to select a set of rows and then process the set either one row at a time or one rowset at a time

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Documentation

- Application Programming Guide
  - Programming for IMS -> Application programming -> Application Programming for SQL
- Application Programming Reference
  - Programming for IMS -> Application programming APIs -> SQL programming reference
- Messages and Codes
  - Troubleshooting for IMS -> IMS component codes -> SQL codes

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Prerequisites

- Software requirements
  - IMS 13 + PTF UK98028
  - IMS Catalog function is required
  - COBOL compiler with IMS co-processor function
    - Enterprise COBOL Developer Trial z/OS V5.1 or
    - Enterprise COBOL for z/OS V5.1 + APAR PM92523
  - Note: COBOL V5.1 requires z/OS 1.13 and above
- Hardware requirements
  - Same as IMS 13 and COBOL V5.1

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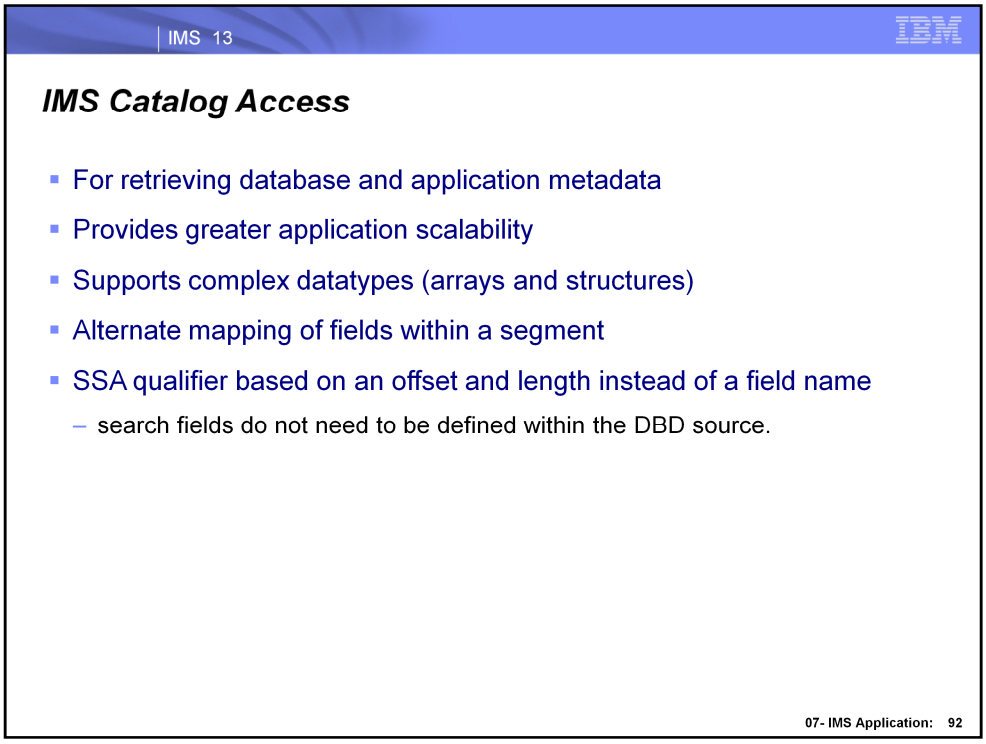
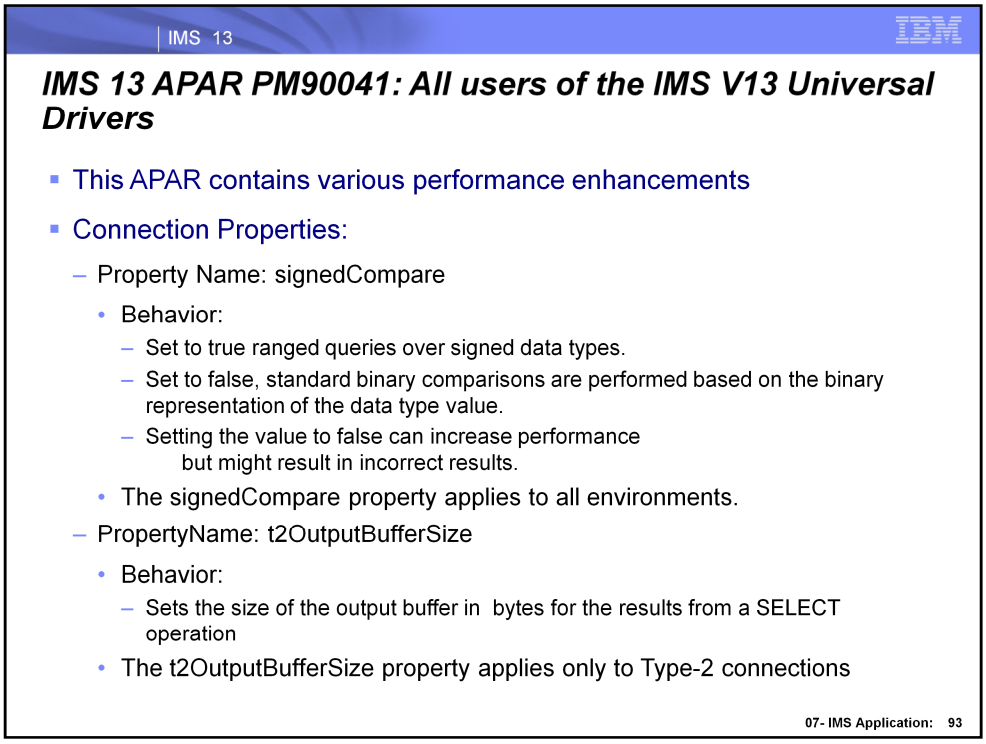
IMS Universal Driver Enhancements



The IMS Universal Drivers are enhanced to support the IMS catalog for retrieving database and application metadata. This support allows for greater application scalability and support for complex datatypes (arrays and structures), and segment maps, which are different cases (sets of fields) within a segment where each case is only valid for a unique value of the map's control field. The drivers have also been enhanced with the ability to search on a qualifier based on an offset and length within a segment instance instead of a field name. This enhancement allows for greater search capabilities as search fields do not need to be defined within the DBD source.



The two new Connection Properties listed below are added to the list of topics in "IMS Version 13 Application Programming" (SC19-3646-00):

Under the following high level path:
Java application development for IMS > Programming with the IMS Universal drivers > Programming using the IMS Universal DB resource adapter > Connecting to IMS with the IMS Universal DB resource adapter
> Connecting using the IMS Universal JCA/JDBC driver in a managed environment.
> Connecting using the IMS Universal DB resource adapter in a managed environment

Under the following high level path:
Java application development for IMS > Programming with the IMS Universal drivers > Programming with the IMS Universal JDBC driver > Connecting to IMS using the IMS Universal JDBC driver:
> Connecting to an IMS database using the JDBC DataSource interface
> Connecting to an IMS database by using the JDBC DriverManage interface

The following two Connection Properties that have been added are:
- signedCompare: When this property is set to true, special SSAs are generated to support ranged queries over signed data types. If the property is set to false, standard binary comparisons are performed based on the binary representation of the data type value. Setting the value to false can increase performance but might result in incorrect results.

- t2OutputBufferSize: The size of the output buffer in bytes for the results from a SELECT operation for a Type-2 connection.

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