CICS and Threadsafe

Exploiting the Open Transaction Environment

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Objectives

- History of Multithreading
- The Open Transaction Environment
- Making programs Threadsafe
- Exploiting the OTE
- OTE Performance Considerations
- Diagnosing Threadsafe Problems
- Recommendations

History of Multithreading

- CICS as a Single TCB
  - Most efficient on a uni-processor
  - “Quasi-Reentrancy”
  - Issues:
    - Runaway tasks
    - OS Waits = Region Wait
    - Many restricted OS and COBOL Commands
    - Limited by speed of one processor

History of Multithreading

- CICS Exploiting Multiple Processors
  - Multiple TCBs
  - Primary TCB is “QR”, Quasi-Reentrant
  - Additional TCBs for:
    - VSAM
    - DB2
    - Program Loader
    - etc.

History of Multithreading

- CICS and DB2
  - Separate TCB (‘thread’) for each DB2 Request
  - Task is switched to DB2 TCB for DB2 work, DB2 system code runs on DB2 TCB
  - Significant workload shifted to DB2 TCBs, but measurable overhead from TCB switching

Open Transaction Environment

- Transaction runs under own TCB
- Introduced in TS 1.3 for Java
- DB2 Support added for TS 2.2
- Supports full OS function
- Allows true Multitasking in CICS
- Pseudo-reentrancy no longer **allowed**

OTE and DB2

Without Threadsafe

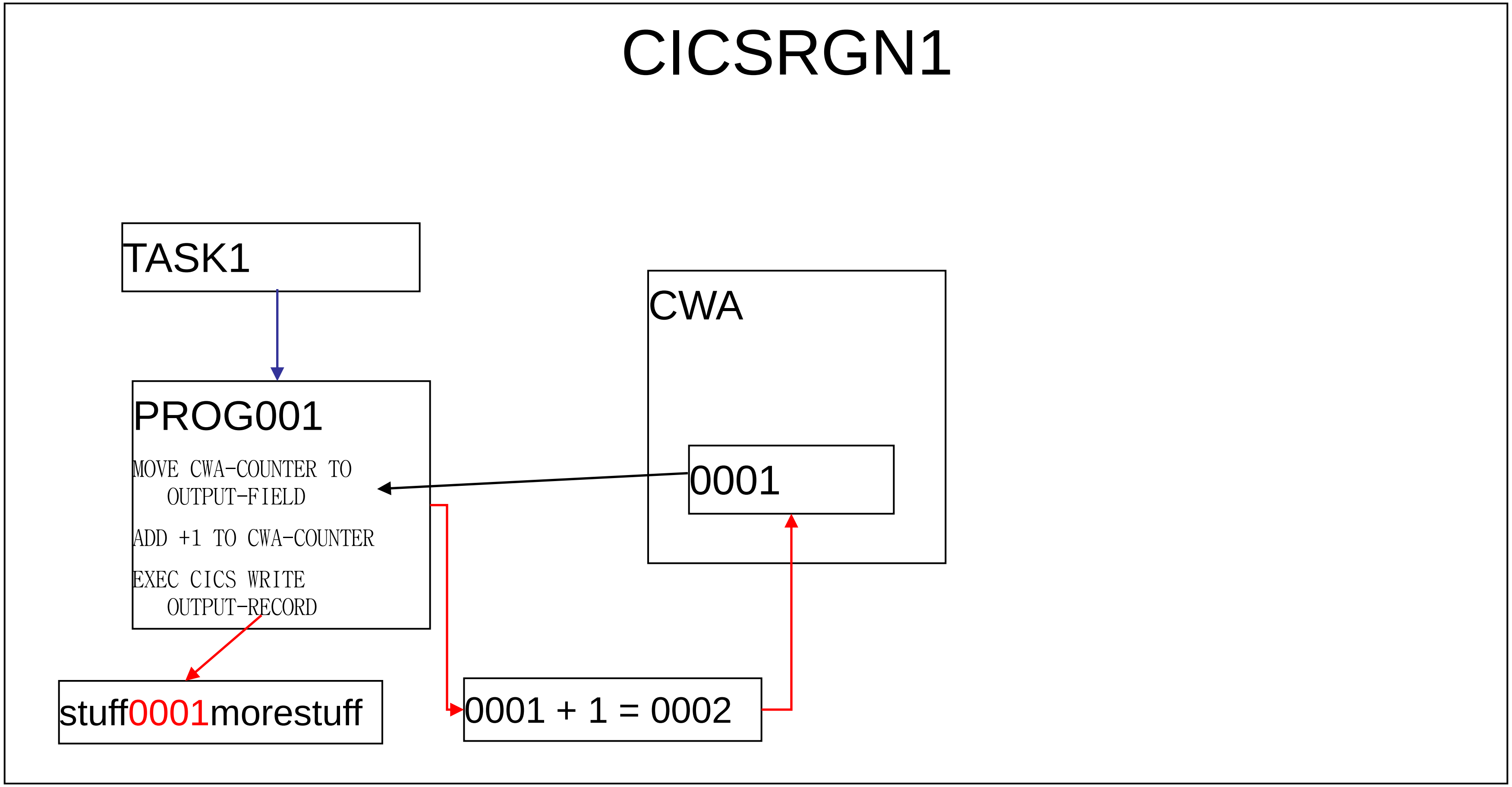
QR TCB		Open TCB
Task Starts		
EXEC CICS		
EXEC SQL	→	DB2 Code executes
Application Code	←	DB2 Code completes
EXEC SQL	→	DB2 Code executes
	←	DB2 Code completes

OTE and DB2

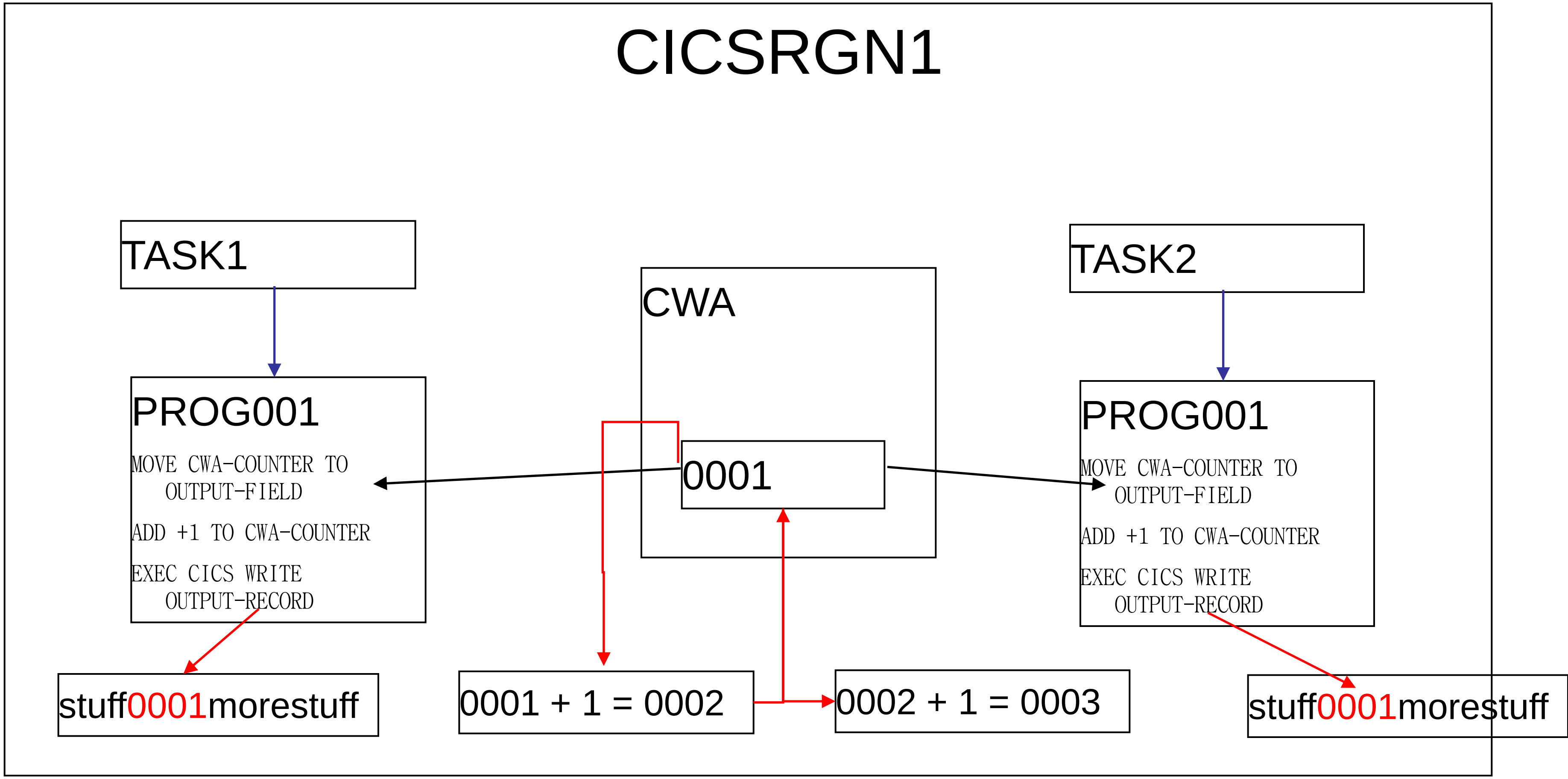
With Threadsafe

QR TCB		Open TCB
Task Starts		
EXEC CICS		
EXEC SQL	→	DB2 Code executes
		Application Code
		DB2 Code executes
Task Termination	←	Task completes

So, What’s the Problem



So, What's the Problem



Definitions

Define “threadsafe”

1. “A threadsafe **program** is one that does not modify any area of storage that can be modified by any other program at the same time, and does not depend on any area of shared storage remaining consistent between machine instructions.”

Controlling Threadsafe

- At the program level:
  Parameter on Program Definition
  - CONCURRENCY=QUASIRENT (Not Threadsafe)
  - CONCURRENCY=THREADSAFE
  - CONCURRENCY=REQUIRED
- At the region level, new SIT parm:
  FORCEQR=YES/NO
  - FORCEQR=YES All programs run non-Threadsafe
  - FORCEQR=NO Programs follow CONCURRENCY parm on program definition

Identifying Threadsafe Programs

- No automated method of identification
- IBM Tool can help
- Rules of thumb:
  - COBOL and PL/1 must be LE
  - All programs must be re-entrant
  - Aps with no affinities are more likely to be threadsafe

Identifying Threadsafe Programs

Ensure programs are re-entrant:

- COBOL:
  - Compile with RENT
  - Link with RENT
- Assembler:
  - Code review, possible coding changes required
  - Assemble/Link with Rent
- CICS:
  - RENTPGM=PROTECT
  - Adjust RDSA/ERDSA sizes
  - Non-reentrant activity will generate DFHSR0622 followed by S0C4/ASRA
  - Possible conflicts with debuggers

Identifying Threadsafe Programs

No automated method of identification

CONCURRENCY

parm is a

promise

by you, not an order to CICS

Definitions

Define “threadsafe”

1. “A threadsafe **program** is one that does not modify any area of storage that can be modified by any other program at the same time, and does not depend on any area of shared storage remaining consistent between machine instructions.”
2. “A program **defined** as CONCURRENCY=THREADSAFE is one that will be **allowed** to run on an open TCB.”

Identifying Threadsafe Programs

Continued...

There is a tool available to help start…..

- Utility DFHEISUP will scan for CICS commands commonly used in non-threadsafe applications
- Use command table DFHEIDTH

Making Programs Threadsafe

After identifying non-Threadsafe code you have two choices:

1) Alter the code to serialize the shared storage access
   A) Use CICS to automatically ensure serialization
   B) Manually ensure serialization
2) Do nothing

Making Programs Threadsafe

continued...

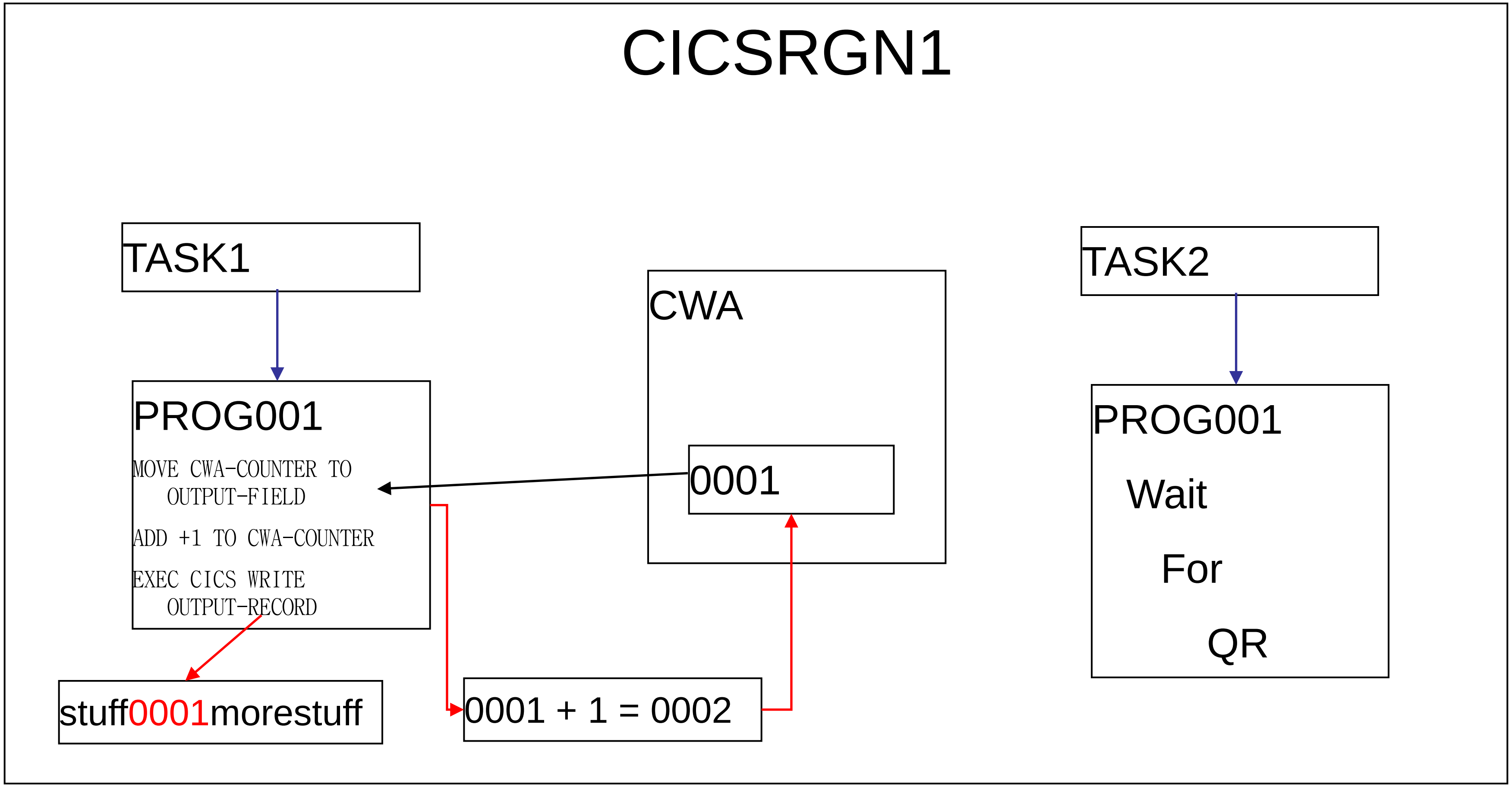
If shared storage use is limited to few programs:

- Leave non-threadsafe programs QUASIRENT
- CICS will switch to QR on LINK or XCTL (But…**not for CALL!**)
- Access to shared storage is automatically serialized

Making Programs Threadsafe

continued...

Leave Program CONCURRENCY(QUAISRENT)



Making Programs Threadsafe

continued...

Advantages:

- No coding changes, so quick implementation

Disadvantages:

- Additional TCB switching overhead
- Maintenance issues
- All programs that access these areas **<u>must</u>** also remain QUASIRENT

Making Programs Threadsafe

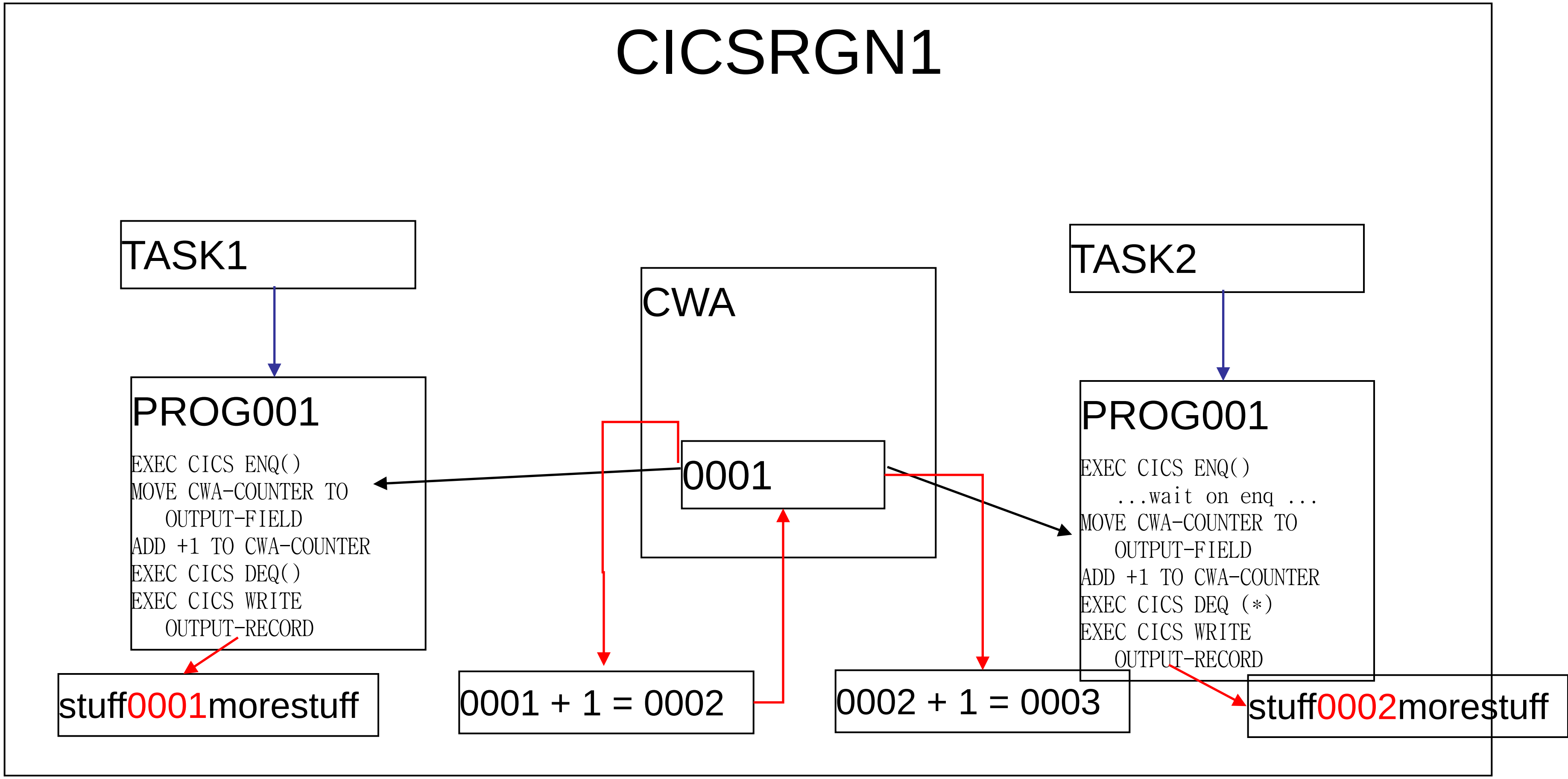
continued...

To serialize access to shared storage:

- “Wrap” access in CICS ENQ/DEQ
- For Assembler, use CS/CDS
- Move data to a threadsafe but serialized facility:
  - CICS Maintained Data Table
  - DB2 table
  - Coupling Facility
- Force single-threading with TCLASS??

Making Programs Threadsafe

continued...



ENQ Issues:

- CPU Cost
- Potential bottleneck
  - Limit ENQ duration by issuing DEQ as soon as possible
  - Ensure no possibility of deadly embrace

Making Programs Threadsafe

continued...

Regardless of which method, remember:

All programs that access the same shared storage area in the same CICS region **must** be converted before **any** of these programs are marked as Threadsafe!

Accessing The OTE

Three methods of executing on OTE TCB

- Create a dummy OPENAPI TRUE
- Define program as API(OPENAPI)
- Define program as CONCURRENCY(REQUIRED)

Accessing The OTE

Using a dummy TRUE

For CICS 2.2 and above, write a “dummy” TRUE

- Include OPENAPI on the ENABLE command
- The TRUE program **must** be defined as Threadsafe
- See the CICS Customization Guide section on Task Related User Exits

Accessing The OTE

Functions like DB2 call:

- When task calls OPENAPI true, spun to L8 TCB
- If user program THREADSAFE, task remains on L8 until forced off
- L8 TCB owned until task termination
- No supported method to tell if task is on L8 or QR
- **Review restrictions defined in Customization Guide!**

Accessing The OTE

```
DMYRMCAL TITLE ' - Sample Dummy stub for TRUE for OPENAPI Processing.
**---------------------------------------------------------------*
** Name    : DMYRMCAL                                            *
** Purpose : Provide a means to programmatically force a task to *
**           be spun to an L8 TCB.                               *
**           This is the callable stub that invokes the dummy    *
**           TRUE. This stub must be linked into any program     *
**           wishing to use the TCB spin TRUE. It is called via  *
**           standard call syntax:                               *
**                CALL DMYRMCAL                                  *
**           As no actual work is performed by the TRUE, no parms*
**           are used on the call statement.
**                                                               *
**---------------------------------------------------------------*
**
**
** ------------------------------ Module entry point.
DMYRMCAL CSECT ,                  Define the module environment
DMYRMCAL AMODE 31
DMYRMCAL RMODE 31
         DFHRMCAL TO=DMYTRUE      Call the TRUE
         LTORG ,
         END   DMYRMCAL
```

Accessing The OTE

```
DMYTRUE TITLE ' - Sample Dummy TRUE for OPENAPI Processing.'
**---------------------------------------------------------------*
** Name    : DMYTRUE                                             *
** Purpose : Provide a means to programmatically force a task to *
**           be spun to an L8 TCB.                               *
** Returns : Rc in R15 == 0                                      *
**                                                               *
**---------------------------------------------------------------*
         DFHUEXIT TYPE=RM        Parmlist is passed in R1
**
**
** ----------------------------- Module entry point.
DMYTRUE CSECT ,                  Define the module environment
DMYTRUE AMODE 31
DMYTRUE RMODE 31
         SR    15,15
         BR    14                Return to caller
         LTORG ,
         END   DMYTRUE
```

Accessing The OTE

QR TCB

Open TCB

Task Starts

Non-threadsafe code
E.C. non-threadsafe

CALL 'DMYRMCAL' → DMYTRUE executes

Threadsafe user code
E.C. threadsafe

E.C. non-threadsafe ← E.C non-threadsafe
Task Termination

Accessing The OTE

Returning The Task to QR TCB

- Clone DMYTRUE/DMYRMCAL
- Define DMxTRUE as CONCURRENCY=QUASIRENT
- Enable the new exit as QUASIRENT

Accessing The OTE

QR TCB		Open TCB
Task Starts		
Non-threadsafe code E.C. non-threadsafe		
CALL ‘DMYRMCAL’	→	DMYTRUE executes
		Threadsafe user code E.C. threadsafe
Non-threadsafe code	←	CALL ‘DMxRMCAL’
Task Termination		

Accessing The OTE OPENAPI

For CICS 3.1 and higher, modify the PROGRAM definition on the application program to API=OPENAPI

- The program **must** be Threadsafe
- **All** application code runs in the OTE environment
- **All** application code runs on the same TCB instance on which the program was initialized.

Accessing The OTE

Forces program to run on L8/9 TCB:

- Program is initialized on L8 TCB if CICS key
- Program is initialized on L9 TCB if USER key
- If program issues non-threadsafe command, task is spun to QR
- Once command has completed, task is spun to L8/9
- Use INQUIRE_CURRENT_PROGRAM and INQUIRE_PROGRAM to identify

Accessing The OTE

QR TCB		Open TCB
		Task Starts
		E.C. threadsafe E.C. threadsafe
Command Starts	←	E.C. non-threadsafe
Command Completes	→	
		Task Termination

Accessing The OTE

There are performance issues for USER key OPENAPI programs that also access OPENAPI TRUEs (includes DB2)

- USER key Program is initialized on L9 TCB
- OPENAPI TRUE is initialized on L8 TCB
- When L9 program issues DFHRMCAL to OPENAPI TRUE:
  - Task is spun to L8 TCB for duration of TRUE
  - Task is returned to L9 following completion of TRUE
- L8 TCB instance held until task termination

Accessing The OTE

There are performance issues for USER key OPENAPI programs that also access OPENAPI TRUEs (includes DB2)

– Review MAXOPENTCB for possible increase
– Review TCBLIMIT for possible increase
– Open TCB “stealing” performance issues
– Potential TCB deadly embrace

Accessing The OTE CONCURRENCY(REQUIRED)

For CICS 4.2, modify the PROGRAM definition on the application program to API(CICSAPI) and CONCURRENCY(REQUIRED)

- The program **must** be Threadsafe
- **All** application code runs in the OTE environment
- **All** application code runs on the same TCB instance on which the program was initialized.
- **All** application code runs on an L8 TCB

Accessing The OTE

Forces program to run on L8 TCB:

- Program is initialized on L8 TCB
- If program issues non-threadsafe command, task is spun to QR
- Once command has completed, task is spun to L8
- Use INQUIRE_CURRENT_PROGRAM and INQUIRE_PROGRAM to identify

Accessing The OTE

QR TCB		Open TCB
		Task Starts
		E.C. threadsafe
		E.C. threadsafe
Command Starts	←	E.C. non-threadsafe
Command Completes	→	
		Task Termination

Accessing The OTE

There are no additional performance issues for USER key CONCURRENCY(REQUIRED) programs that also access OPENAPI TRUEs (includes DB2)

- USER key Program is initialized on L8 TCB
- OPENAPI TRUE is initialized on L8 TCB
- Only one L8 TCB is acquired by the task
  - L8 is shared by user program and all OPENAPI TRUEs
- L8 TCB instance held until task termination

Accessing The OTE

So.......

Which

Way

Is

Best?

Accessing The OTE

Via Dummy TRUE

Advantages:

- Control application environment programmatically
- CPU savings if large number of non-threadsafe commands
- CPU savings when accessing OTE in USER key
- Non-threadsafe application code may continue to run on QR TCB
- Available in CICS 2.2 and above.

Accessing The OTE

Via Dummy TRUE

Disadvantages:

- Requires changes to application code
- Requires process to enable TRUE
- If any non-threadsafe commands, must call TRUE prior to any OTE activity
- Cannot determine environment programmatically
- Probability future maintenance results in inadvertent use of restricted code on QR, data corruption, region failure

Accessing The OTE

Via OPENAPI Parm

Advantages:

- No coding changes required
- All application code **guaranteed** to run in OTE
- No requirement to enable TRUE
- Can determine environment programmatically
- All user code on same TCB – no issues with “paired” z/OS macros

Accessing The OTE

Via OPENAPI Parm

Disadvantages:

- CPU overhead when accessing OPENAPI TRUE in USER key (DB2, etc.)
- CPU overhead when issuing non-threadsafe EXEC CICS commands
- **All** application logic **must** be threadsafe
- Can increase the number of open TCBs required.
- Overhead if TCB stolen to switch key

Accessing The OTE

Via CONCURRENCY(REQUIRED) Parm

Advantages:

- No coding changes required
- All application code **guaranteed** to run in OTE
- No requirement to enable TRUE
- Can determine environment programmatically
- All user code on same TCB – no issues with “paired” z/OS macros

Accessing The OTE

Via CONCURRENCY(REQUIRED) Parm

Disadvantages:

- CPU overhead when issuing non-threadsafe EXEC CICS commands
- **All** application logic **must** be threadsafe

Accessing The OTE

Via CONCURRENCY(REQUIRED)
with
API(OPENAPI)

Disadvantages:

- Can increase the number of open TCBs required.
- Overhead if TCB stolen to switch key

Accessing The OTE

Via CONCURRENCY(REQUIRED)
with
API(CICSAPI)

Disadvantages:

- Limited to using standard CICS services
- Potential problems if unsupported z/OS services used

Accessing The OTE

One restriction in OPENAPI programs:

- **Do not attempt to initialize batch LE environment under CICS OPENAPI.**

Implications of New TCB Types

- Multiple TCB types
- Application code running in OTE
  - Application programs fighting for CPU
  - Poor coding only affects program user, not region
  - Resource hogs build up
- CICS system code running in multiple TCBs
- IBM converting sub-products to use OTE
  - MQ
  - Sockets
  - XML parser

Why Bother?

Run tasks on an open TCB to:

- Reduce QR CPU constraint by moving tasks to other processors
- Use z/OS functionality forbidden on QR TCB
  - Activity generating z/OS waits
    - I/O
    - ENQ/DEQ
- Segregate troublesome transactions

Reducing QR CPU Constraint

QR TCB is limited to the speed of one processor

When QR hits CPU limit, region stalls

- Classic fixes
  - Clone Region to offload CPU
- Modern fix = Exploit OTE to offload CPU

Reducing QR CPU Blocking

QR TCB is single threaded

- Current task “owns” QR until next EXEC CICS (*)
- Heavy CPU routines don’t release QR
- Region appears to lock up
- While task runs, CICS workload backs up
  - VSAM, DB2 I/O Completes
  - New tasks ready for dispatch
  - .....

Reducing QR CPU Blocking

OTE is Multi-Threaded

- OTE task “owns” his TCB until next EXEC CICS (*)
- QR is available for other workload
- No region hold-up
- No extended response times
  - Other workload unaffected
  - Response time improves

Reducing QR CPU Constraint

Warning: Consider LPAR CPU Implications when converting a QR constrained region to exploit open TCBs:

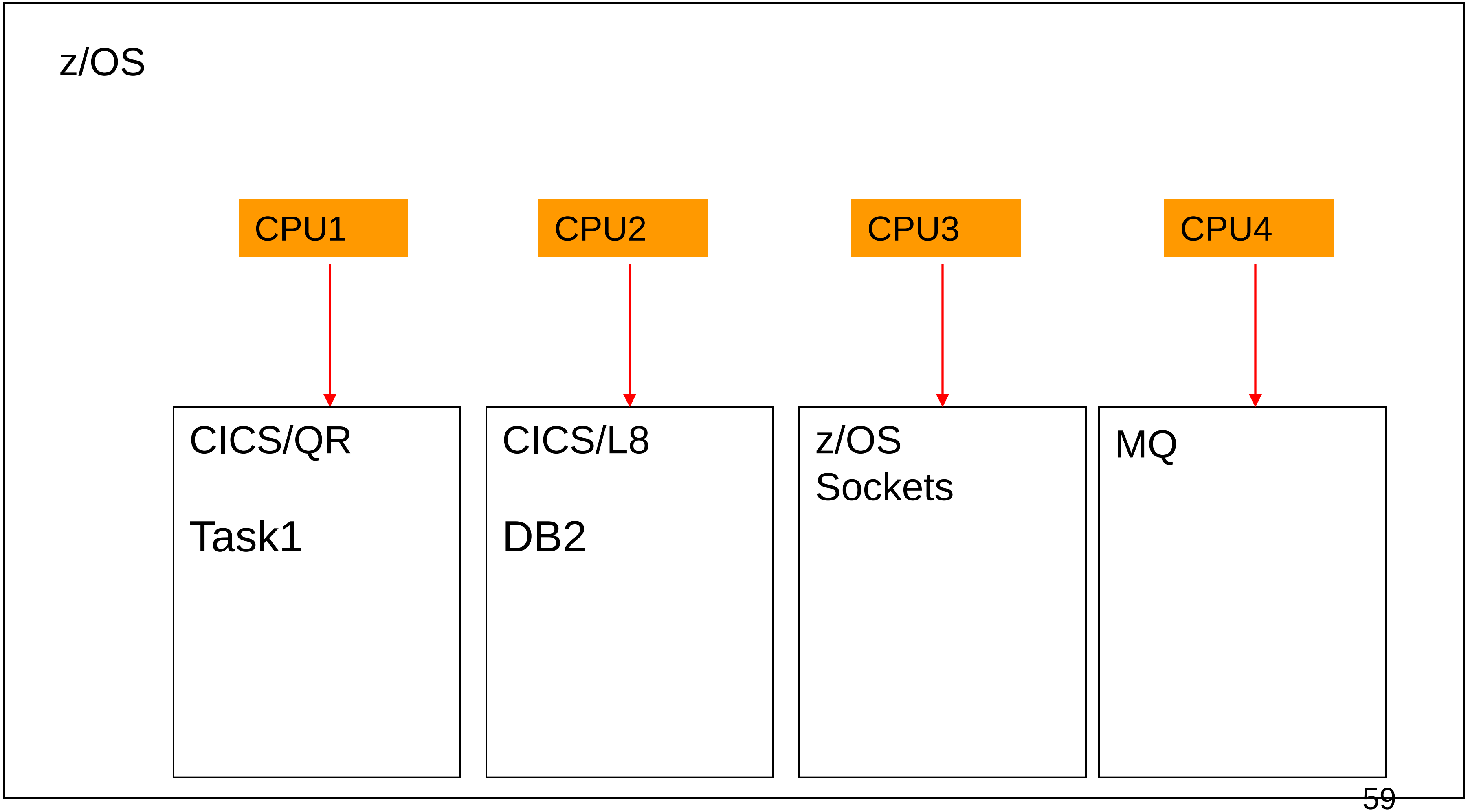
- Reduce QR constraint by moving tasks to other processors
- In MP environment, total CICS CPU will increase until:

  1. CICS CPU requirements satisfied
  2. Box CPU capacity met

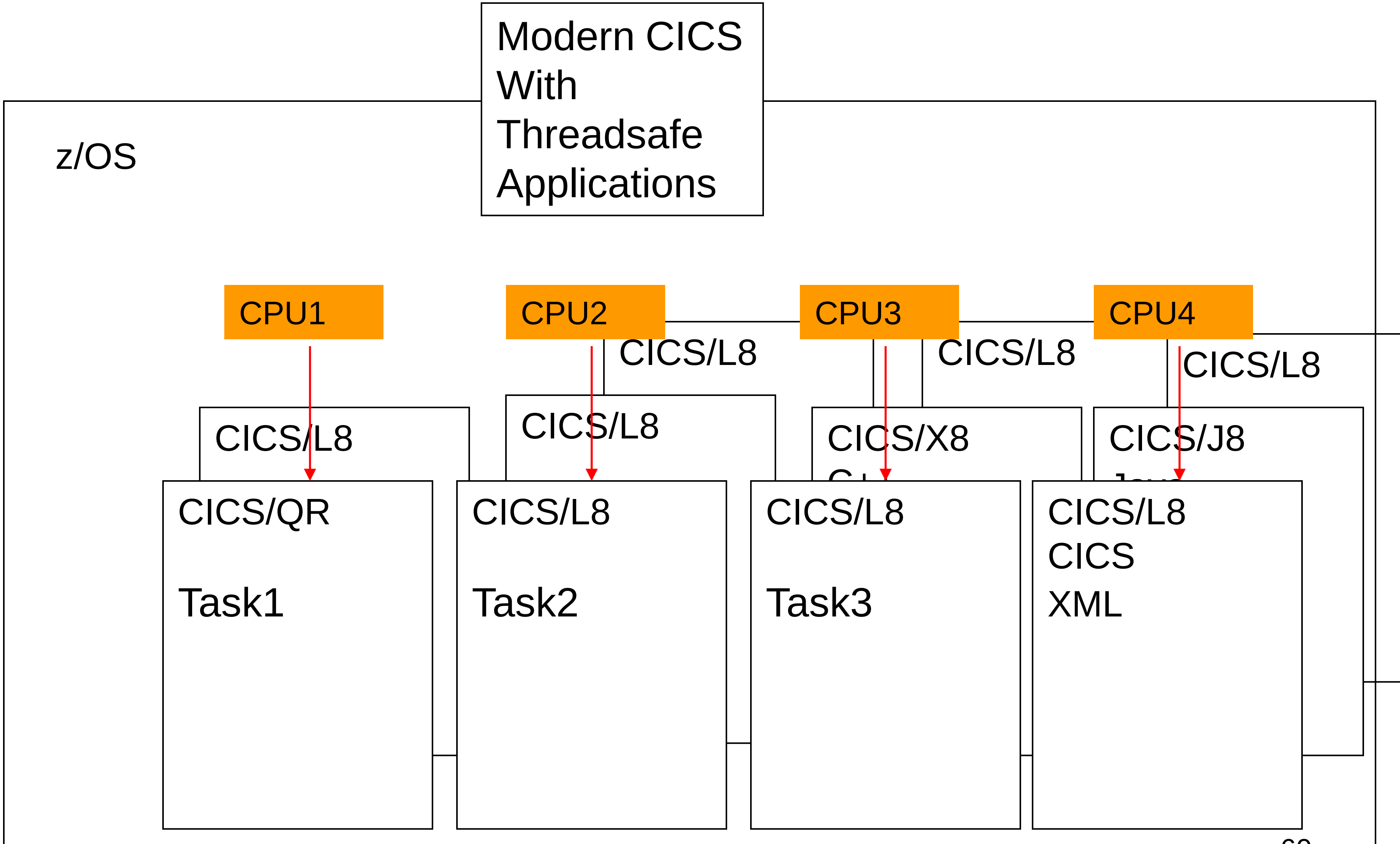
- Can negatively impact z/OS workload CICS depends on

Multiple TCB Structure

Classic CICS



Multiple TCB Structure



Using Forbidden Functionality

Use almost any z/OS function:

- Communicate with operator via WTOR
- Make use of flexibility of STORAGE OBTAIN/RELEASE
- Issue I/O without CICS file control
- Use z/OS ENQ/DEQ to synchronize with batch jobs
- ……….

Using Forbidden Functionality

Transaction initiated communication with operator via WTOR:

- OTE TCB waits, not entire region
- Synchronous waits on external events/requests
- CICS command input from master console
- Enable use of standard auto operation facility

Disadvantages:

- Task shows as “running”
- No way to track WTOR back to task

Using Forbidden Functionality

Use of z/OS STORAGE OBTAIN/RELEASE

- Powerful options not available from EXEC CICS GETMAIN
- Storage acquired outside of CICS subpools
- More efficient than CICS GETMAIN

Disadvantages:

- Storage invisible to CICS monitor
- No automatic cleanup at task termination
- Storage not displayed in dump, trace, etc.
- Problems with OS GETMAIN and USER key OPENAPI tasks

Using Forbidden Functionality

Error on STORAGE OBTAIN causes ASRB, not region failure:

DFHAP0001 CICSD225 An abend (code 878/AKEB) has occurred at offset X'FFFFFFFF' in module TEST.

```
00057 L9002 AP 00E1 EIP   EXIT  LOAD
00057 L9002 AP 1942 APLI  *EXC* Abend
00057 L9002 AP 0791 SRP   *EXC* MVS_ABEND
00057 L9002 DS 0010 DSBR  ENTRY INQUIRE_TASK
00057 L9002 DS 0011 DSBR  EXIT  INQUIRE_TASK/OK
00057 QR    PG 0500 PGIS  ENTRY INQUIRE_CURRENT_PROGRAM
00057 QR    PG 0501 PGIS  EXIT  INQUIRE_CURRENT_PROGRAM
00057 QR    AP 0782 SRP   *EXC* ABEND_ASRB
```

TCB is marked as unusable:

```
DSTCB QR    KE 0502 KEDS  ENTRY DETACH_TERMINATED_OWN_TCBS
DSTCB QR    KE 0503 KEDS  EXIT  DETACH_TERMINATED_OWN_TCBS/OK
```

Using Forbidden Functionality

Issue I/O without CICS file control:

- Bypass CICS file control
- “Batch” transactions segregated from normal processing

Disadvantages:

- Cannot issue OPEN/CLOSE in COBOL program
- No backout or forward recovery
- Activity not in dump, trace, etc.

Using Forbidden Functionality

Reminder: the OTE only supports CICS LE service routines:

- COBOL display becomes a WRITEQ TD (not threadsafe until CICS TS 5.2!)
- COBOL dynamic call modified for CICS
- OPEN/CLOSE unavailable
- Storage obtained via EXEC CICS GETMAIN

Segregating Transactions

OTE provides some insulation from difficult transactions

- CPU intensive tasks don’t own QR TCB
- QR available for CEMT, etc.

OTE Performance Considerations

There are several performance issues that are unique to the OTE:

- Non-Threadsafe EXEC CICS commands
- Non-Threadsafe CICS Global User Exits
- Multi-TCB issues with OPENAPI programs

Definitions

Define “threadsafe”

1. “A threadsafe **program** is one that does not modify any area of storage that can be modified by any other program at the same time, and does not depend on any area of shared storage remaining consistent between machine instructions.”
2. “A program **defined** as CONCURRENCY=THREADSAFE is one that will be allowed to run on an open TCB.”
3. “A threadsafe CICS **command** is one that is **allowed** to run under an open TCB. A non-threadsafe command is one that is **not allowed** to run under an open TCB”

Non-Threadsafe CICS Commands

- ~~Many~~ ~~Some~~ A few commands (still) not Threadsafe
- Use of non-Threadsafe commands *is **fully** supported* by CICS
- CICS detects non-threadsafe command and switches task to QR TCB
- Task's TCB status following command depends on API definition
- Potential performance issue for API=OPENAPI

Non-Threadsafe CICS Commands

A list of the commands that are threadsafe can be found in the *CICS Application Programming Reference Manual*, under **CICS threadsafe commands in the API.**

A list of the threadsafe SPI commands can be found in the *CICS System Programming Reference Manual*, in Appendix D, **Threadsafe SPI commands**

Non-Threadsafe CICS Exits

- Significant area of concern
- Task switched to QR for duration of exit, then back to Open TCB
- Infrequently referenced exits less of a problem
- Frequently referenced exits (eg., XEIIN) are a major performance problem
- XRMIIN/OUT and Dynamic Plan Selection most worrisome
- Worst case: significant (20%++?) increase in CPU utilization.
- Can cause CPU impact even if FORCEQR=YES

Non-Threadsafe CICS Exits

- Use DFH0STAT to identify exits in use
  - Select DB2, User Exit and Global User Exit options
  - Identifies all active exits by program name, CONCURRENCY option, exit point, and GWA usage
  - Shows Dynamic Plan exits
- Identify vendor exits and contact vendor
  - Do not mark threadsafe without vendor OK
  - Do not convert with heavily used QUASIRENT exits
- Review homegrown exit code to ensure threadsafe

Minimizing CPU Overhead

CPU overhead is incurred when a non-Threadsafe command is issued while the task is running on an Open TCB. Overhead is zero when no non-Threadsafe commands are issued while the task is running on an Open TCB.

```
EXEC SQL OPEN CURSOR
PERFORM UNTIL ...
    EXEC SQL FETCH….
    EXEC CICS WRITEQ TD
END-PERFORM
```

Minimizing CPU Overhead

Once the command has been identified…..

- Replace it

  Replace Transient Data with CICS TempStor?

- Relocate it

  Move the command outside of the SQL loop?

Minimizing CPU Overhead

Replace Transient Data with CICS Temporary Storage:

```
EXEC SQL OPEN CURSOR
PERFORM UNTIL ...
    EXEC SQL FETCH….
    EXEC CICS WRITEQ TS
END-PERFORM
```

Minimizing CPU Overhead

DFH$MOLS of modified program running Threadsafe in test:

EXEC CICS WRITEQ TD replaced with WRITEQ TS

DB2REQCT	00004E20	20000	
USRDISPT	00066339000001E3	00:00:06.69787	483
USRCPUT	0003A4D3000001E3	00:00:03.82084	483
SUSPTIME	00002570000001E3	00:00:00.15334	483
DISPWTT	000003CE000001E2	00:00:00.01558	482
QRDISPT	0000065400000141	00:00:00.02592	321
QRCPUT	000002B100000141	00:00:00.01102	321
KY8DISPT	000659D3000000A1	00:00:06.65937	161
KY8CPUT	0003A1F7000000A1	00:00:03.80913	161
L8CPUT	0003A1F7000000A1	00:00:03.80913	161
QRMODDLY	0000032D00000140	00:00:00.01300	320
DSCHMDLY	0000033C00000144	00:00:00.01324	324

Minimizing CPU Overhead

QR TCB		Open TCB
Task Starts		
FETCH	→	DB2 Code executes
		WRITEQ TS
		FETCH
		WRITEQ TS

Minimizing CPU Overhead

Relocate Transient Data Writes:

```
EXEC SQL OPEN CURSOR
PERFORM UNTIL ...
    PERFORM VARYING…
          EXEC SQL FETCH….
          MOVE RESULTS TO WS-RESULTS()
    END-PERFORM
    PERFORM VARYING…
          EXEC CICS WRITEQ TD FROM(WS-RESULTS())
     END-PERFORM
END-PERFORM
```

Minimizing CPU Overhead

DFH$MOLS of modified program running Threadsafe in test

Results of 10 SQL FETCH placed in Working Storage, then issue 10 EXEC CICS WRITEQ TD at once

DB2REQCT	00004E20	20000	
USRDISPT	00066339000001E3	00:00:06.69787	2612
USRCPUT	0003A4D3000001E3	00:00:03.82084	2612
SUSPTIME	00002570000001E3	00:00:00.15334	2612
DISPWTT	000003CE000001E2	00:00:00.01558	2611
QRDISPT	0000065400000141	00:00:00.02592	1052
QRCPUT	000002B100000141	00:00:00.01102	1052
KY8DISPT	000659D3000000A1	00:00:06.65937	526
KY8CPUT	0003A1F7000000A1	00:00:03.80913	526
L8CPUT	0003A1F7000000A1	00:00:03.80913	526
QRMODDLY	0000032D00000140	00:00:00.01300	1050
DSCHMDLY	0000033C00000144	00:00:00.01324	1055

Minimize OTE Overhead: Dummy (OPENAPI) TRUE

CPU overhead is minimized when no non-Threadsafe commands are issued between the DMYRMCAL and the end of OTE user code

```
PERFORM UNTIL ...
    CALL ‘DMYRMCAL’
    [ote user code]
    EXEC CICS WRITEQ TD
END-PERFORM
```

Minimize OTE Overhead: Dummy TRUE

<u>QR TCB</u>		<u>Open TCB</u>
Task Starts		
CALL ‘DMYRMCAL’	→	OTE user code
	←	WRITEQ TD
CALL ‘DMYRMCAL’	→	OTE user code
	←	WRITEQ TD

Minimize OTE Overhead: OPENAPI Program

CPU overhead is minimized when:

1. No non-Threadsafe commands are issued by the program

2. If USER key, no DB2 or OPENAPI TRUE calls issued by the program

Minimize OTE Overhead: OPENAPI Program

MQ Series With OPENAPI program in USER key

L9 TCB	L8 TCB	QR TCB	MQ TCB
Task Starts			
EXEC SQL	DB2 code executes		
	DB2 code complete		
E.C.WRITEQ TD		WRITEQ TD starts	
		WRITEQ TD ends	
MQ PUT			
			MQ code executes
			MQ code complete
E.C. RETURN		Task termination	

Minimize OTE Overhead: OPENAPI Program

MQ Series With OPENAPI program in CICS key

L9 TCB	L8 TCB	QR TCB	MQ TCB
Unused		Task Starts	
	DMYTRUE executes	CALL ‘DMYRMCAL’	
	Threadsafe code		
	EXEC SQL		
	E.C. WRITEQ TD	WRITEQ TD starts	
		WRITEQ TD ends	
	MQ PUT		MQ code executes
			MQ code complete
	Task termination		

Minimize OTE Overhead: REQUIRED Program
with API(CICSAPI)

CPU overhead is minimized when:

1. No non-Threadsafe commands are issued by the program

Reducing CPU Overhead

Note:

Prior to CICS 4.2, IRC is not threadsafe. This means that Threadsafe commands that are function shipped will be treated as if they are non-threadsafe.

CICS 4.2 IPIC connections support threadsafe mirror transactions

Ensuring Threadsafe Coding When Creating New Programs

Design is critical

- Ensure threadsafe coding standards are met
- Minimize number of TCB switches

Ensure Threadsafe Coding Standards

- Eliminate updates to shared storage areas:
  - CWA
  - GWA
  - GETMAIN(SHARED)
  - OS GETMAIN
  - LOAD HOLD
- Require use of RENT on link-edit step
- Use RENTPGM=PROTECT in CICS

Ensuring Threadsafe Coding When Creating New Programs

Minimize number of TCB switches

- Maximum performance
- Use only Threadsafe commands
- Design program flow to cluster OTE usage
- Issue non-Threadsafe commands before or after OTE activity complete

Diagnosing Threadsafe Problems

No way to prove threadsafe!

- Threadsafe problems most likely to occur during peak time.
- Stress testing more likely to bring out threadsafe problems.
- Best way to ensure success is strong application knowledge.
- Be thorough in your review.

Diagnosing Threadsafe Problems

How to tell when Testing is Complete?

- Errors based on probability
- Difficult to force simultaneous execution of code path
- Use stress testing
  - Set MAXTASK high
  - Set DSALIMITs high
  - Set SYSDUMPING on!
  - Use driver program to issue large number of STARTs

Diagnosing Threadsafe Problems

Unpredictable Results Means Just That!

- Difficult to identify
- “Impossible” behavior likely to be threadsafe issue
- Use CICS auxtrace
- CICS system dump

Diagnosing Threadsafe Problems

Paired MVS macros that need same TCB

- Macros such as ENQ and DEQ must run on same TCB
- Intervening user code can force TCB switch
- Second macro in pair fails
- Macros include:
  - ENQ/DEQ
  - ATTACH/DETACH

Diagnosing Threadsafe Problems

A Statically Called Assembler Program Isn't Threadsafe

COBPGM

CALL 'ASMPGM1'
USING PARM-LIST.

```
ASMPGM1   CSECT
          LA   R13,SAVEAREA
          STM  R14,R12,12(R13)
                .
                .
          LM   R14,R12,12(R13)
          BR   R14
                .
                .
SAVEAREA  DS   18F
```

Diagnosing Threadsafe Problems

All Called Routines Run on TCB of the Caller

- Because ASMPGM1 issues no CICS commands, the code runs normally in a non-threadsafe environment
- CICS is not notified for calls
- Simultaneous access to SAVEAREA results in overlay
- Probable S0C4
- Identifiable in test via RENTPGM=PROTECT

Diagnosing Threadsafe Problems

All Called Routines Run on TCB of the Caller

Possible solutions:

1. Convert ASMPGM1 to Command Level
2. Alter COBPGM to pass address of RSA
3. Leave COBPGM non-Threadsafe
4. Convert ASMPGM1 to LE enabled Assembler

Threadsafe File Control

Threadsafe VSAM RLS available with CICS 3.2

Threadsafe **local** VSAM shipped in CICS 3.2 as disabled

New SIT parm:

FCQRONLY=[YES | NO]

- FCQRONLY=YES forces all file control to run on QR TCB
- FCQRONLY=NO allows threadsafe file control requests to run on L8/L9 TCB

Remote VSAM on non-IPIC connections remains non-threadsafe

Futures

"It is the intention of IBM for future releases of CICS Transaction Server for z/OS to continue to enhance OTE support to enable the ongoing migration of CICS and application code from the QR to open TCBs."

Threadsafe considerations for CICS

Recommendations

- Convert XRMIIN/OUT and Dynamic Plan Selection exits **before** migrating to a threadsafe capable CICS release
- Convert all frequently used exit programs to threadsafe before converting programs
- Verify that required maintenance is on CICS and vendor products before converting programs to threadsafe
- Review IBM Redbook “Threadsafe Considerations for CICS”
- Beware of COBOL dynamic CALLs