E21

Getting to Know Your IMS Scheduler

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IMS
TECHNICAL
CONFERENCE

Anaheim, California October 23 - 27, 2000

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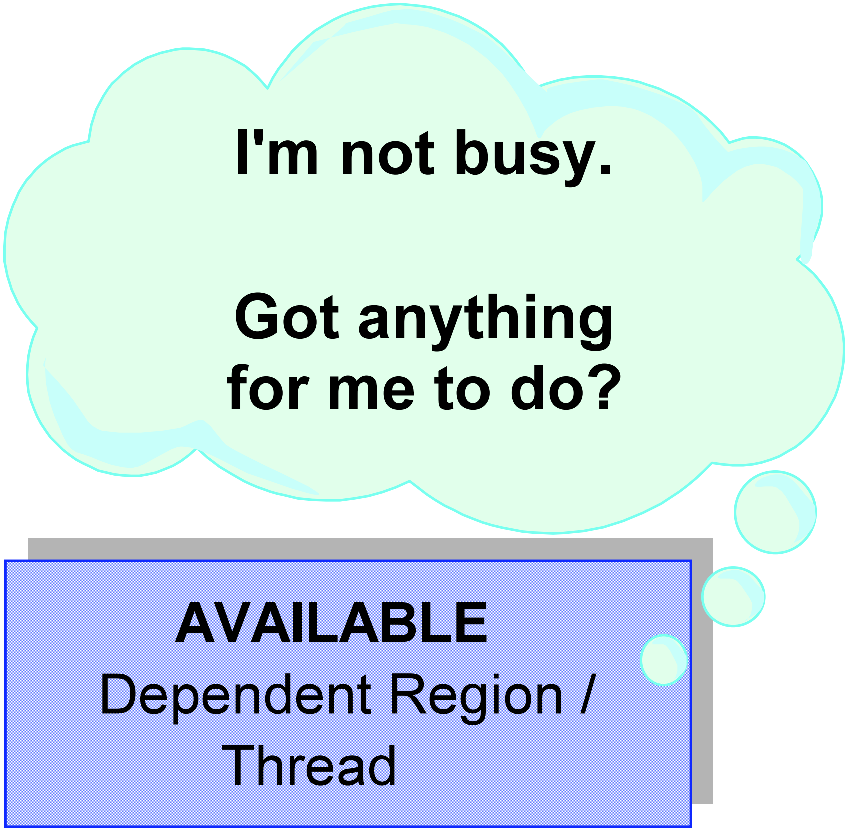
IMS/ESA Scheduler Agenda

- Functions
- Resources
- The Process and Influences
- V6 Shared Queues Considerations
- Summary

Scheduler ITASK Functions

- **Look for work / wait for request for work**
- **Allocate Resources**
- **Maintain control if:**
  - No more work
  - Resources are unavailable
- **Free Resources**
  - When PSB is terminated



I'm not busy.

Got anything for me to do?

AVAILABLE
Dependent Region /
Thread

ITASK: IMS Task

Scheduler Resources - Control Blocks

IMS TM/DM and DBCTL

- PST: Partition Specification Table (IMSCTRL MAXREGN=)
- PDIR: PSB Directory - one per PSB
- PSB: Program Specification Block (APPLCTN PSB=)
- DDIR: DMB Directory - one per DBD
- DMB: Database Management Block (DATABASE DBD=)

IMS TM/DM only

- TCT: Transaction Class Table (IMSCTRL MAXCLAS=)
- SMB: Scheduler Message Block (TRANSACT CODE=)

Scheduler Resources - Pools

IMS TM/DM and DBCTL

PSBP:	Non-resident CSA PSB pool (CSAPSB)
DPSB:	Non-resident DLISAS PSB pool (DLIPSB)
DMBP:	Non-resident DMB pool (DMB)
PSBW:	PSB Work area pool
DFSINTRS:	PSIL resident pool
CSAPSBRS:	Resident CSA PSB pool
DLIPSBRS:	Resident DLISAS PSB pool
DMBRS:	Resident DMB pool

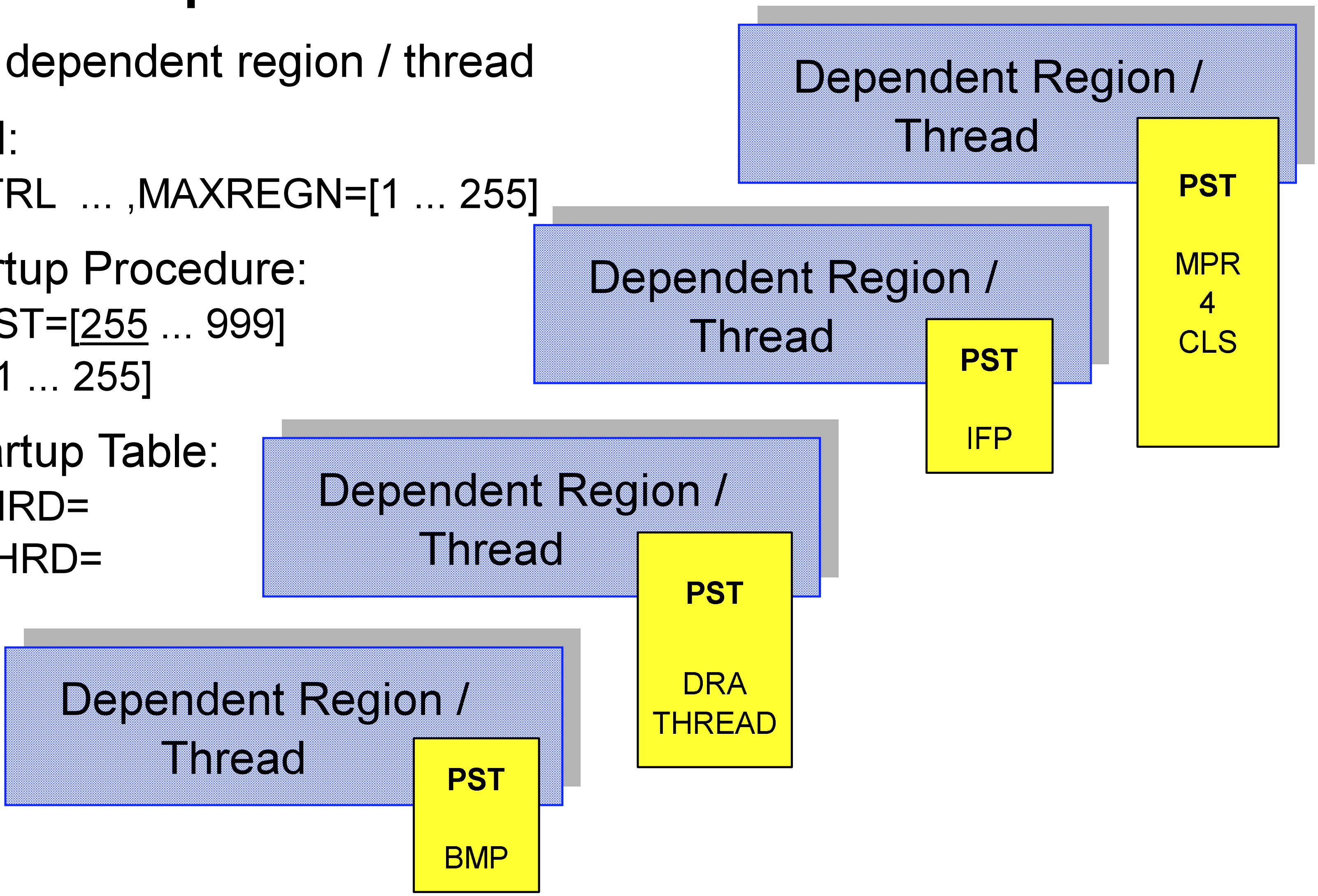
What Kicks Off Scheduling?

- **CICS Transaction**
  - EXEC DLI SCHD PSB(**PSB1**)
  - CALL 'xxxTDLI' USING PCB **PSB1**
- **BMP: Batch Message Processing**
  - Submit IMSBATCH proc
  - // EXEC ...,PARM='BMP,pgm,**PSB1**, ... '
- **MPR: Message Processing Region**
  - Submit DFSMPR proc
  - // EXEC ...,PARM='MSG,**001**006009003, .'
  - MPR requests work when not busy
- **IFP: Interactive Fast Path**
  - Submit IMSFP proc
  - // EXEC ...,PARM='IFP,pgm,**PSB1**, ... '

Dependent Region / Thread

PST: Partition Specification Table

- One per dependent region / thread
- IMSGEN:
  - IMSCTRL ... ,MAXREGN=[1 ... 255]
- IMS Startup Procedure:
  - MAXPST=[255 ... 999]
  - PST=[1 ... 255]
- DRA Startup Table:
  - MINTHRD=
  - MAXTHRD=



Dependent Region / Thread

PST

MPR 4 CLS

Dependent Region / Thread

PST

IFP

Dependent Region / Thread

PST

DRA THREAD

Dependent Region / Thread

PST

BMP

The Scheduling Process

IMS TM/DM MPR

1. Select a transaction
   a. By CLASS, then
   b. By PRIORITY
2. Allocate and reserve resources
3. If unable to allocate and reserve resources for the selected transaction, select another transaction
4. If unable to allocate and reserve resources for any transaction eligible for this region, scheduling fails

CICS TRANSACTION, BMP, IFP

1. Allocate and reserve resources
2. If unable to allocate and reserve resources, scheduling fails

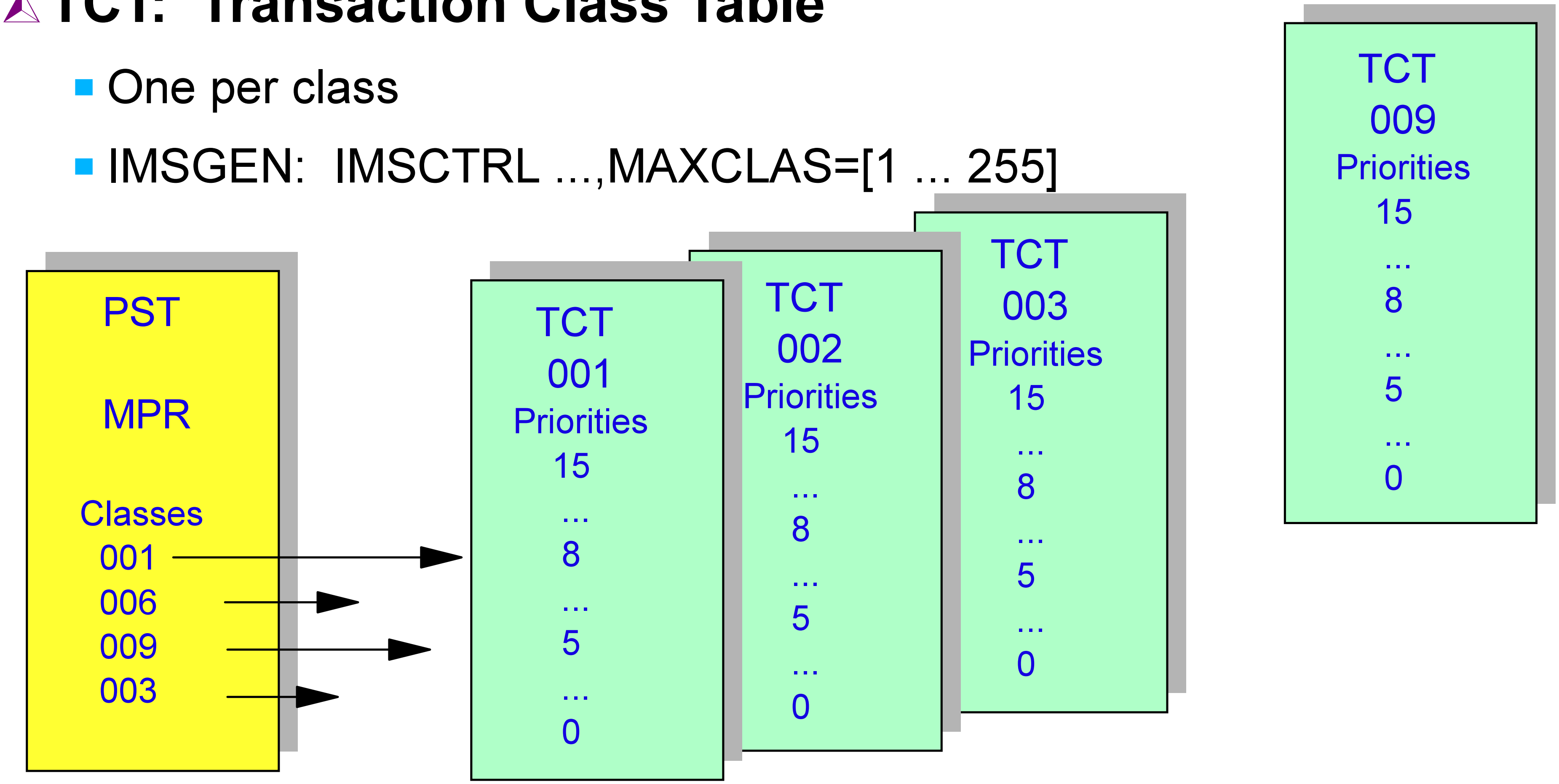
Class - IMS MPR

MPR Classes:

- // EXEC PGM=DFSRRC00,PARM='MSG,001006009003, ... '

TCT: Transaction Class Table

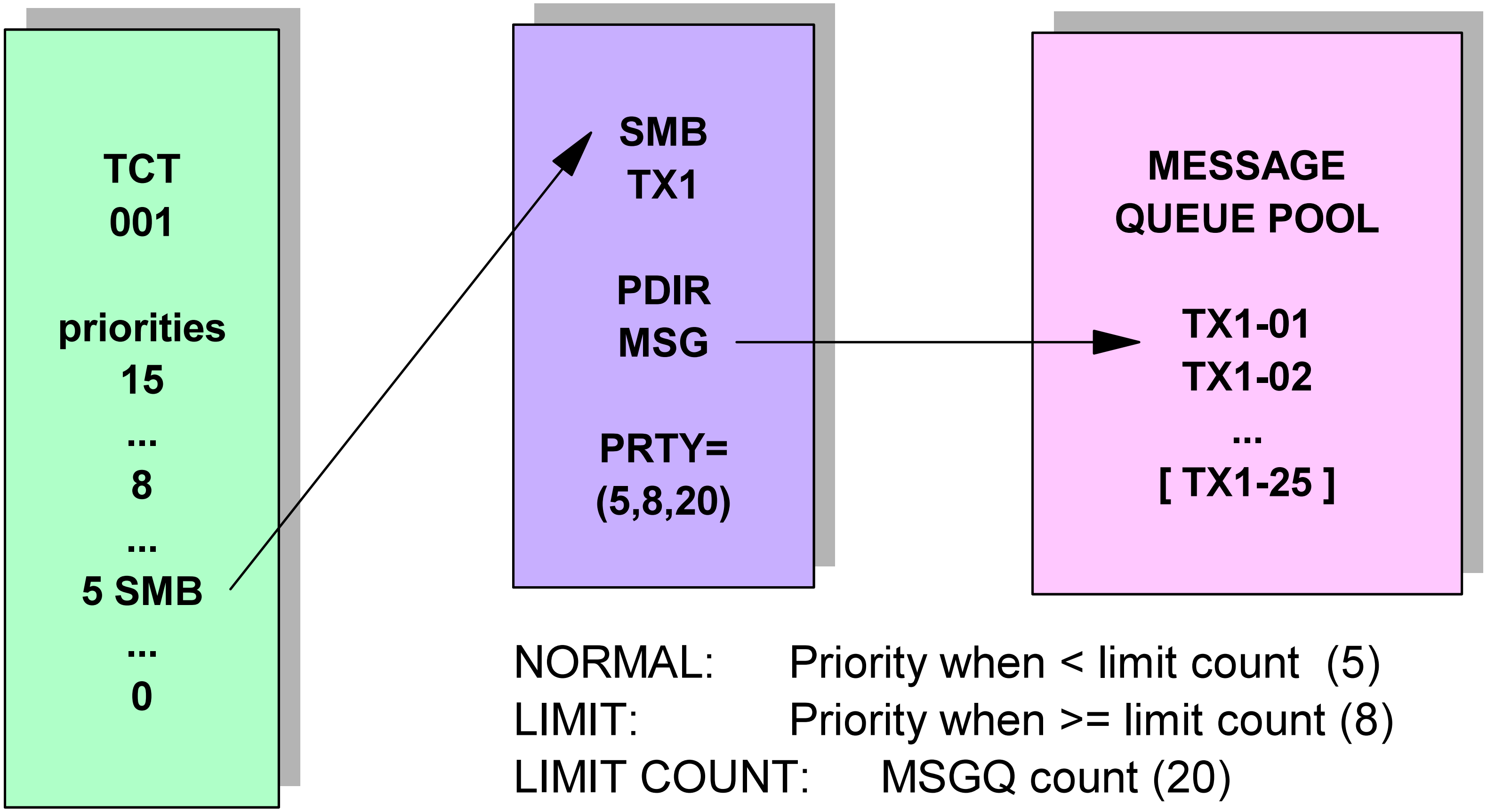
- One per class
- IMSGEN: IMSCTRL ...,MAXCLAS=[1 ... 255]



Transaction Class and Priority - IMS MPR

IMSGEN:

- APPLCTN ...,PGMTYPE=(TP,,**001**)
- TRANSACT CODE=TX1,MSGTYPE=(,,**001**),**PRTY=(5,8,20)**



NORMAL:	Priority when < limit count (5)
LIMIT:	Priority when >= limit count (8)
LIMIT COUNT:	MSGQ count (20)

Transaction Priority Example - IMS TM/DM

```
TRANSACT    CODE=TX1, ... ,PRTY=(5,8,20)
```

	TIME 1	TIME 2	TIME 3	TIME 4
MSGQ COUNT	10	20	15	0
PRTY	5	8	8	5
	NORMAL	LIMIT	LIMIT	NORMAL

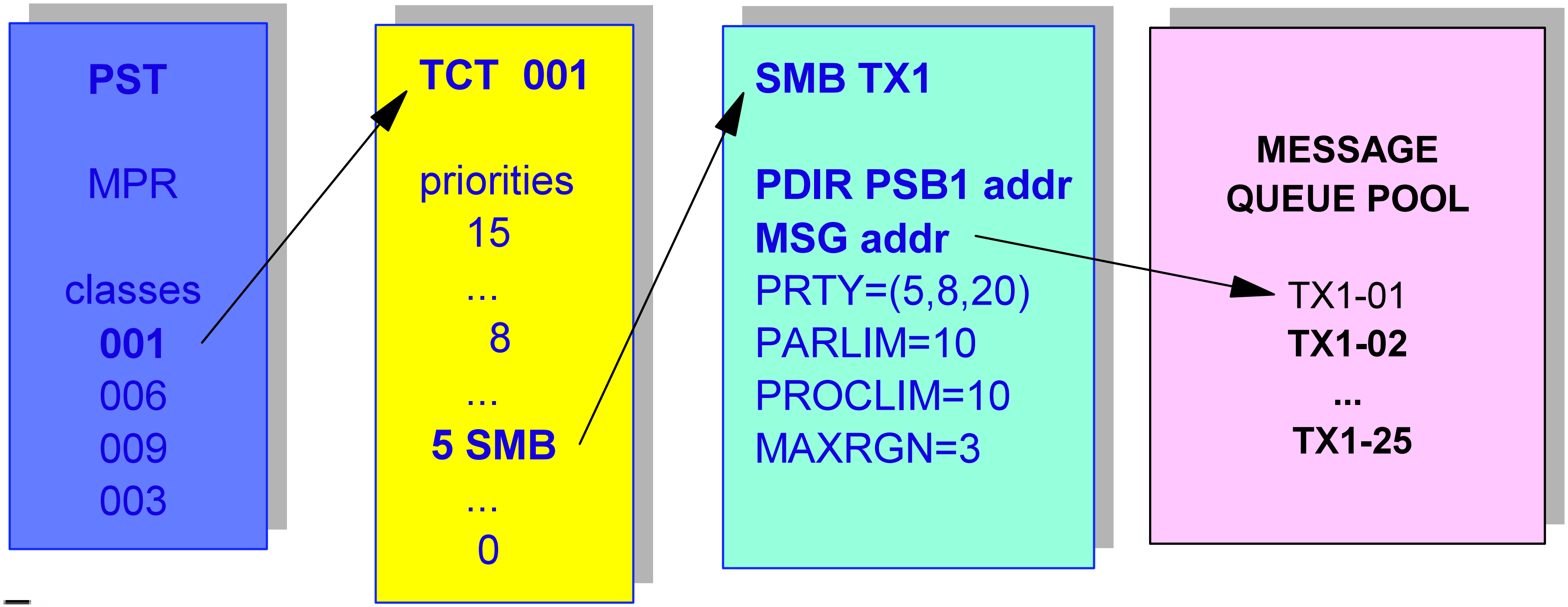
Select a Transaction: IMS MPR

IMSGEN:

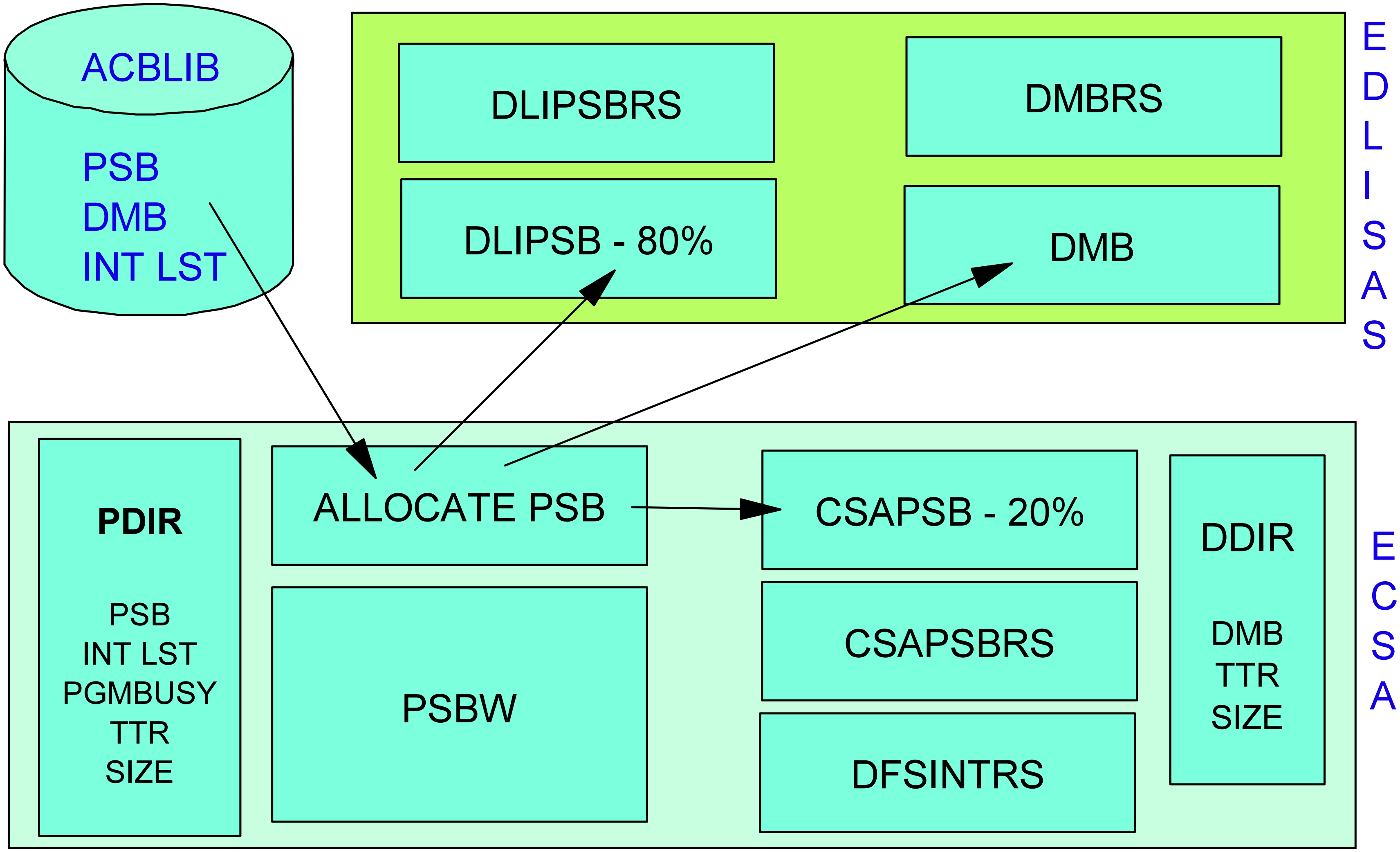
- APPLCTN	...,PGMTYPE=(TP,,**1**),PSB=**PSB1**,...
- TRANSACT	CODE=**TX1**,PRTY=(**5**,8,20),PARLIM=10,PROCLIM=10,
  MAXRGN=3

DFSMPR startup JCL:

- // EXEC PGM=DFSRRC00,PARM='MSG,**001**006009003, .'



Allocate/Reserve Resources



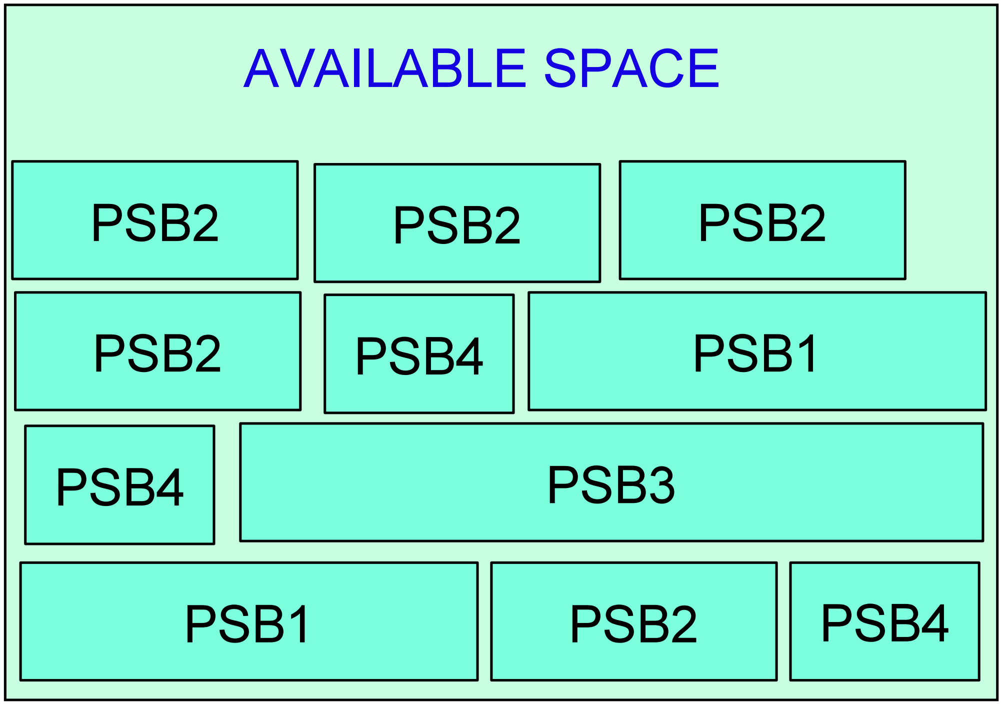
Allocate/Release PSB (APSB)

1. **Latch PDIR to prevent concurrent PSB scheduling**
2. **Latch non-resident PSB pool to serialize obtaining/releasing space**
3. **Latch non-resident DMB pool to serialize obtaining/releasing space**
4. **Latch ACBLIB DCB while doing I/O to load**
    a. PSB
    b. DMB
    c. PSIL
5. **Latch PSBW pool to serialize obtaining/releasing space**

(Release resources at PSB termination)

PSB Pool Space Search

1. Available space >= bytes required?
2. Largest block not-in-use >= bytes required?
3. Combine contiguous not-in-use blocks?
4. Avoid freeing last copy of PSB



AVAILABLE SPACE

PSB2 PSB2 PSB2

PSB2 PSB4 PSB1

PSB4 PSB3

PSB1 PSB2 PSB4

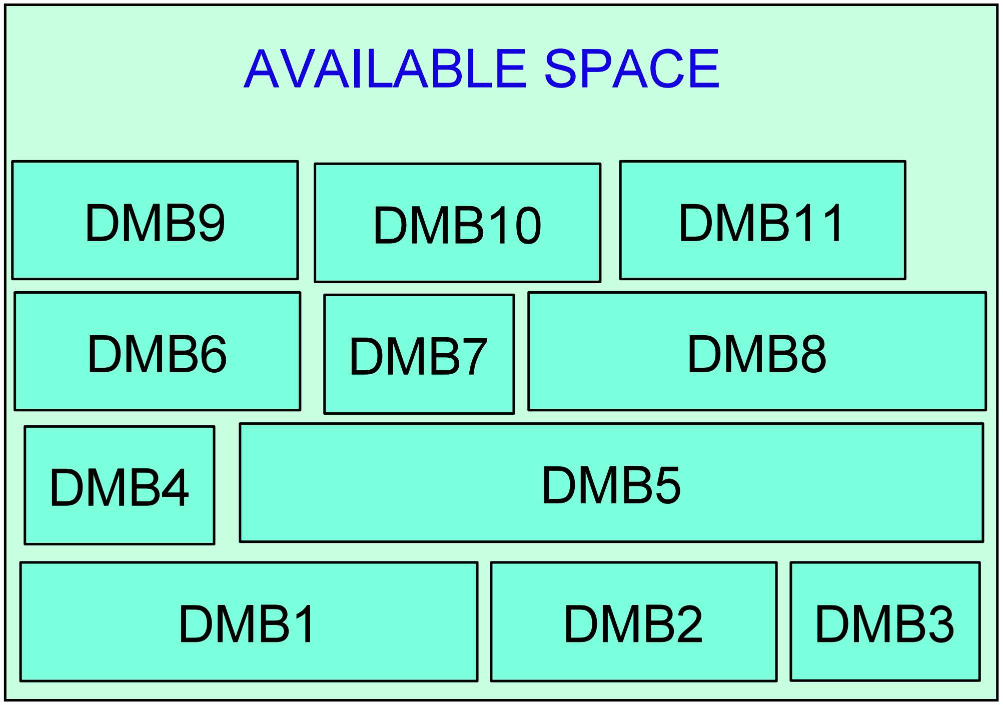
IF NO SPACE:
INTENT IWAIT

BUFPOOLS ...,SASPSB=(csasize1,dlisize2),
PSB=[10000 -9,999,000 bytes]

IMS proc: CSAPSB=
DLIPSB=
PSB=

DMB Pool Space Search

1. Available space >= bytes required?
2. Largest block not-in-use >= bytes required?
3. Combine contiguous not-in-use blocks?


AVAILABLE SPACE

DMB9 DMB10 DMB11

DMB6 DMB7 DMB8

DMB4 DMB5

DMB1 DMB2 DMB3

IF NO SPACE:
INTENT IWAIT

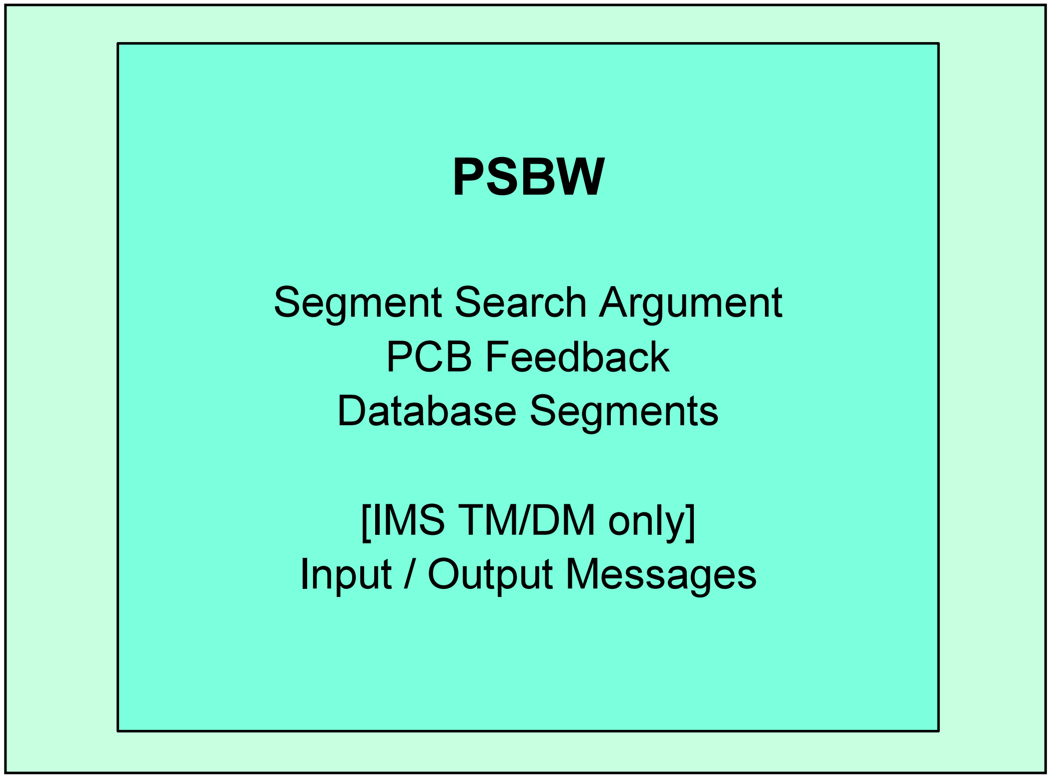
BUFPOOLS ...,DMB=[10,000 - 9,999,000 bytes]

IMS proc: DMB=[nnnnnK | M | G]

PSB Work Pool Space

- Space held only while PSB is scheduled
- Space freed at PSB termination

IF NO SPACE: INTENT IWAIT



PSBW

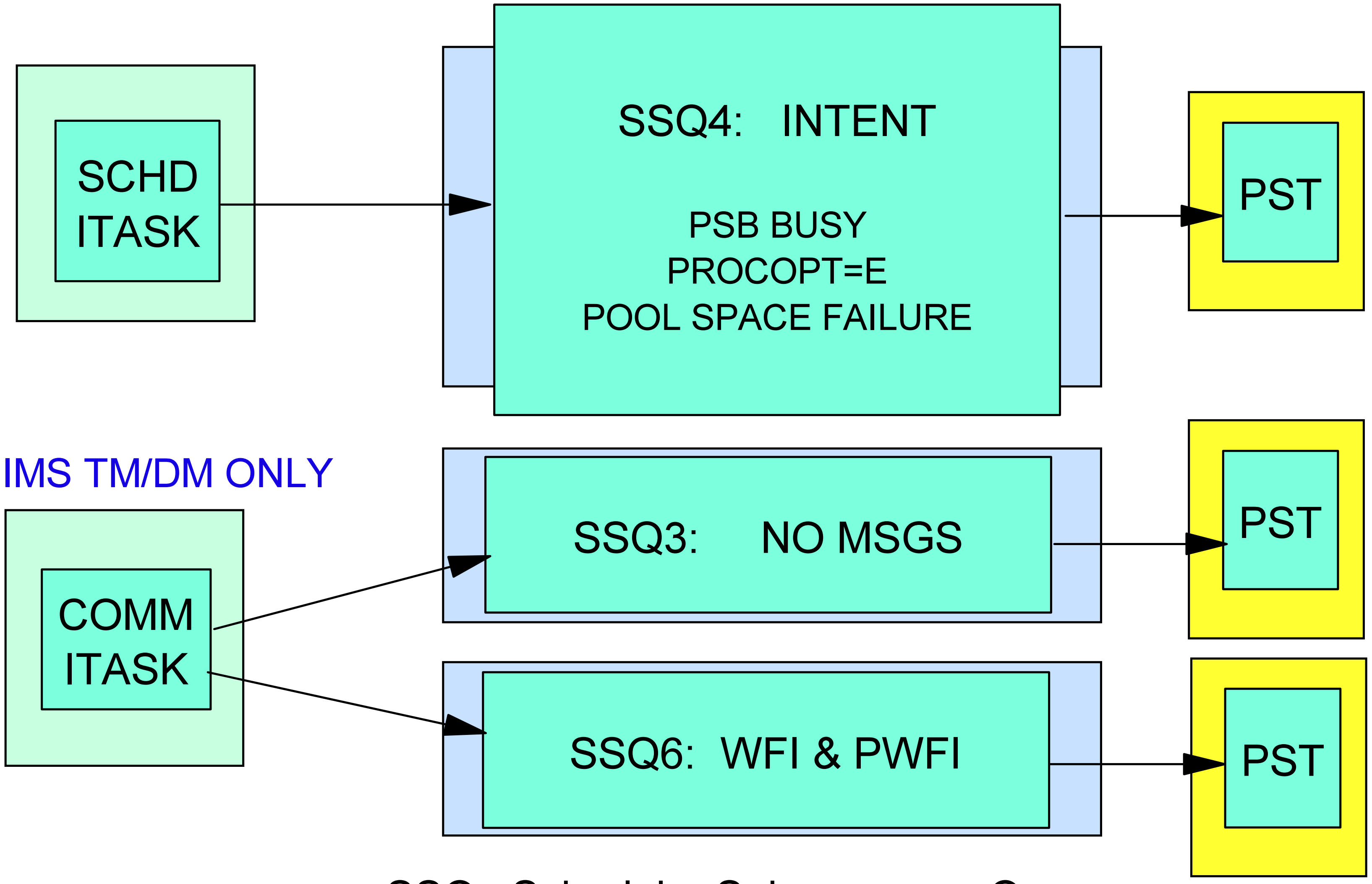
Segment Search Argument
PCB Feedback
Database Segments

[IMS TM/DM only]
Input / Output Messages

BUFPOOLS ...,PSBW=[10,000 -9,999,000 bytes]

IMS proc: PSBW=[nnnnnK | M | G]

Scheduling Failures



SSQ: Scheduler Subsequence Queues

Scheduling Options: IMS MPR

- **What happens if selected transaction cannot be scheduled for INTENT failure?**
  - Look for other work according to SCHD= parameter
- **TRANSACT ...,SCHD=(<u>1 </u>| 2 | 3 | 4)**
  - 1: Equal or higher priority in selected class
  - 2: Higher priority in selected class
  - 3: Any in selected class
  - 4: Skip to next class, highest priority
- **Potential scheduling loops between 1 or 2 and 3 are broken by intent failure counter**
  - When > 5, skip to next class and reset counter

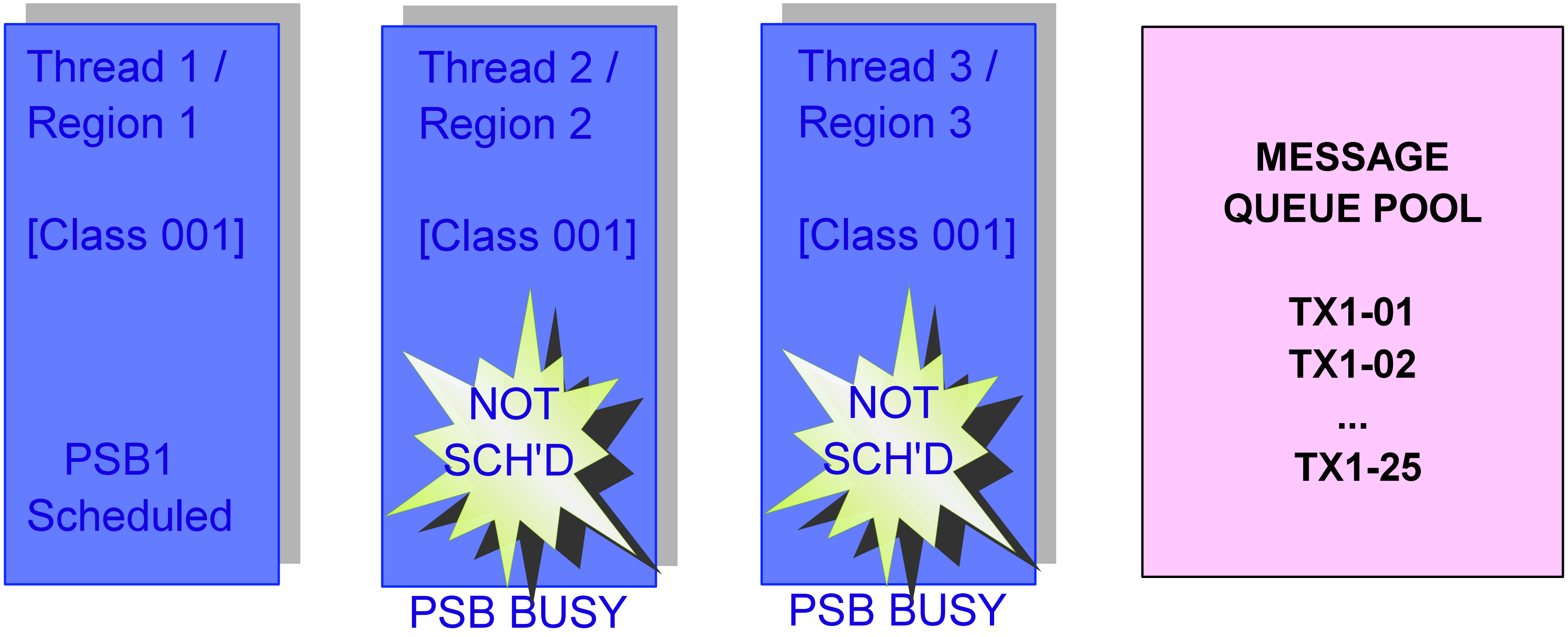
Serial Scheduling

DBCTL and BMP

- APPLCTN ...,PGMTYPE=BATCH,PSB=PSB1,**SCHDTYP=SERIAL**

IMS TM/DM

- APPLCTN ...,PGMTYPE=(TP,,1),PSB=PSB1,**SCHDTYP=SERIAL**
- TRANSACT CODE=TX1, ... ,**PARLIM=10,MAXRGN=3**



Thread 1 / Region 1

[Class 001]

PSB1 Scheduled

Thread 2 / Region 2

[Class 001]

NOT SCH'D

PSB BUSY

Thread 3 / Region 3

[Class 001]

NOT SCH'D

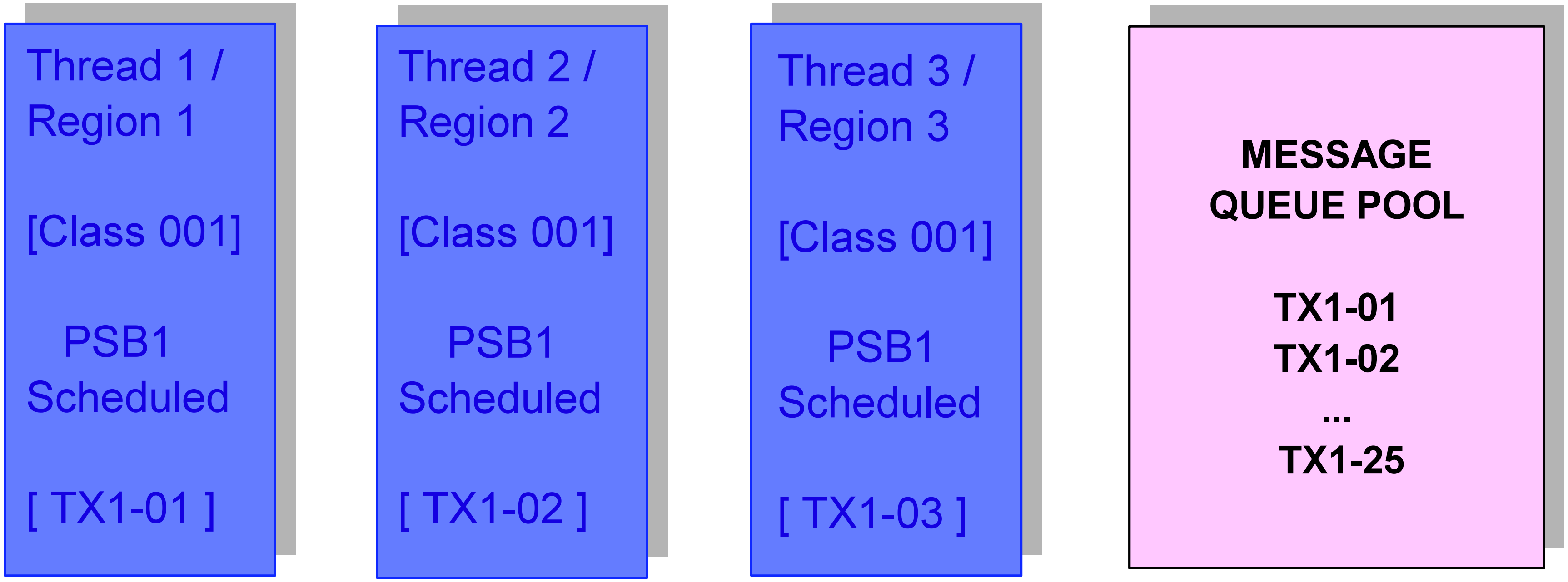
PSB BUSY

MESSAGE QUEUE POOL

TX1-01
TX1-02
...
TX1-25

Parallel Scheduling

- **DBCTL and BMP**
  - APPLCTN ...,PGMTYPE=BATCH,PSB=PSB1,**SCHDTYP=PARALLEL**
- **IMS TM/DM - Transaction Load Balancing**
  - APPLCTN ...,PGMTYPE=(TP,,1),PSB=PSB1,**SCHDTYP=PARALLEL**
  - TRANSACT CODE=TX1, ... ,**PARLIM=10,MAXRGN=3**



Thread 1 / Region 1

[Class 001]

PSB1 Scheduled

[TX1-01]

Thread 2 / Region 2

[Class 001]

PSB1 Scheduled

[TX1-02]

Thread 3 / Region 3

[Class 001]

PSB1 Scheduled

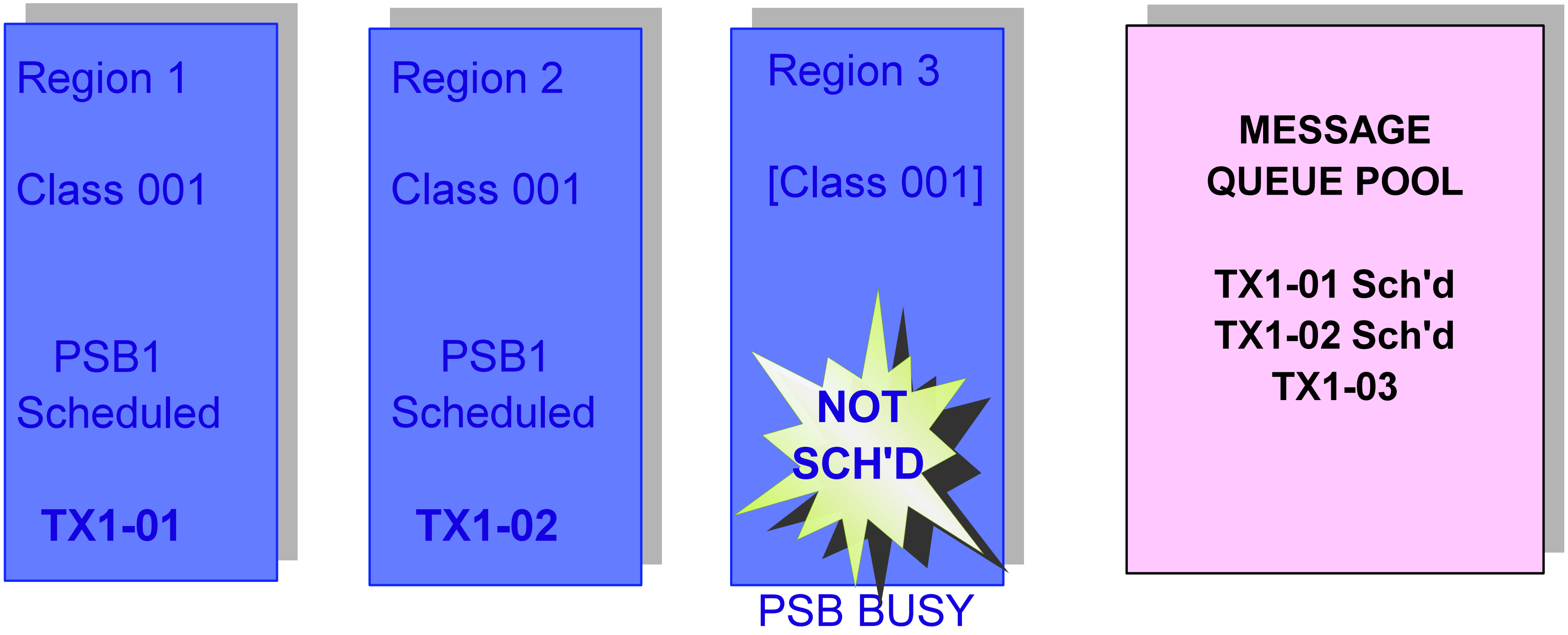
[TX1-03]

MESSAGE QUEUE POOL

TX1-01
TX1-02
...
TX1-25

Transaction Load Balancing Improved: IMS MPR

- **Problem:** Need 3 unscheduled in MSGQ to schedule 3rd region
  - APPLCTN ...,PGMTYPE=(TP,,1),PSB=PSB1,**SCHDTYP=PARALLEL**
  - TRANSACT CODE=TX1, ... ,**PARLIM=1,MAXRGN=3**



Region 1

Class 001

PSB1
Scheduled

TX1-01

Region 2

Class 001

PSB1
Scheduled

TX1-02

Region 3

[Class 001]

NOT SCH'D

PSB BUSY

MESSAGE QUEUE POOL

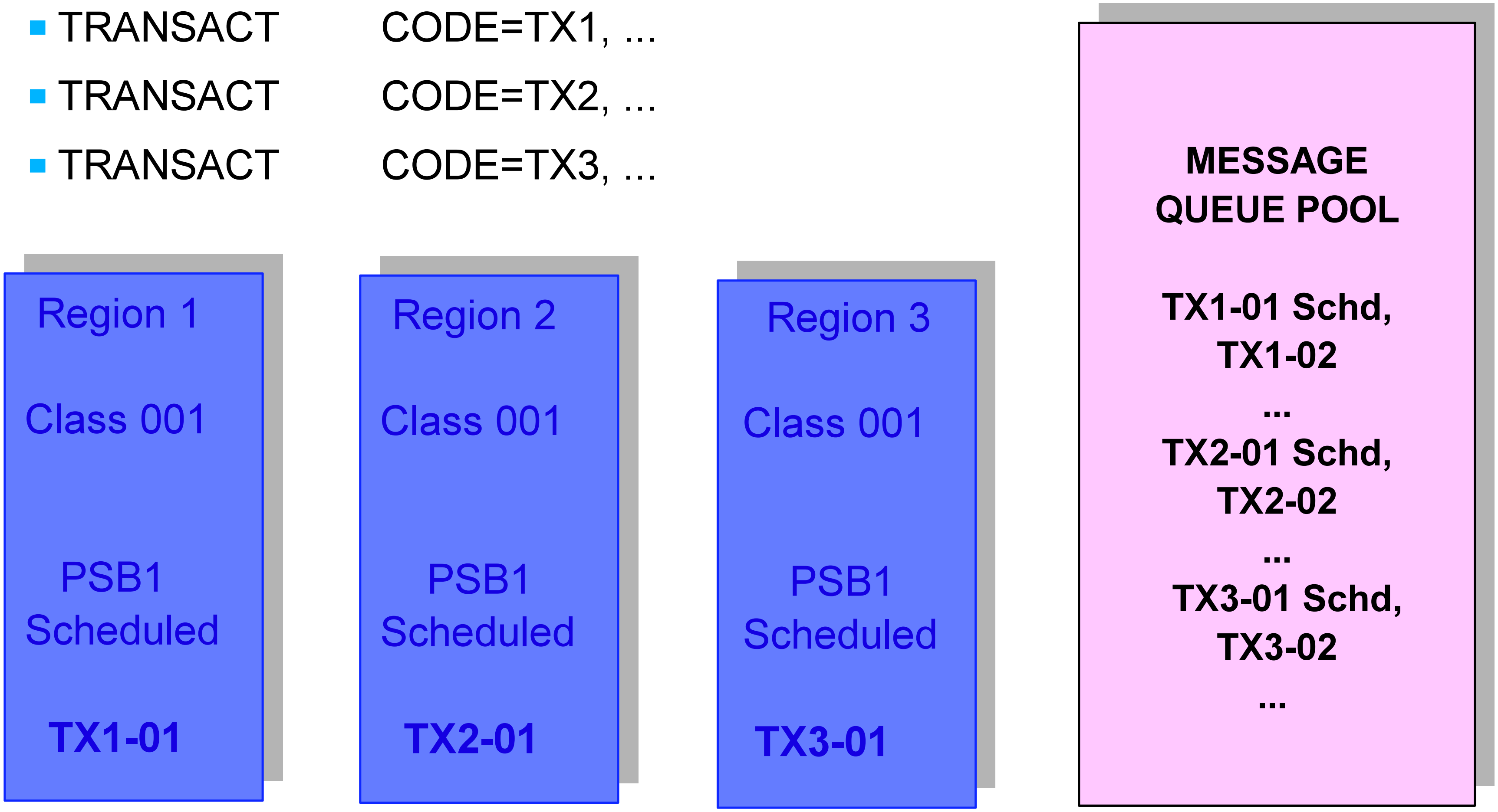
TX1-01 Sch'd
TX1-02 Sch'd
TX1-03

- **Solution: TRANSACT ...,PARLIM=0,MAXRGN=3**

Application Load Balancing: IMS MPR & MD-BMP

PROBLEM: One scheduling can process only one transaction code

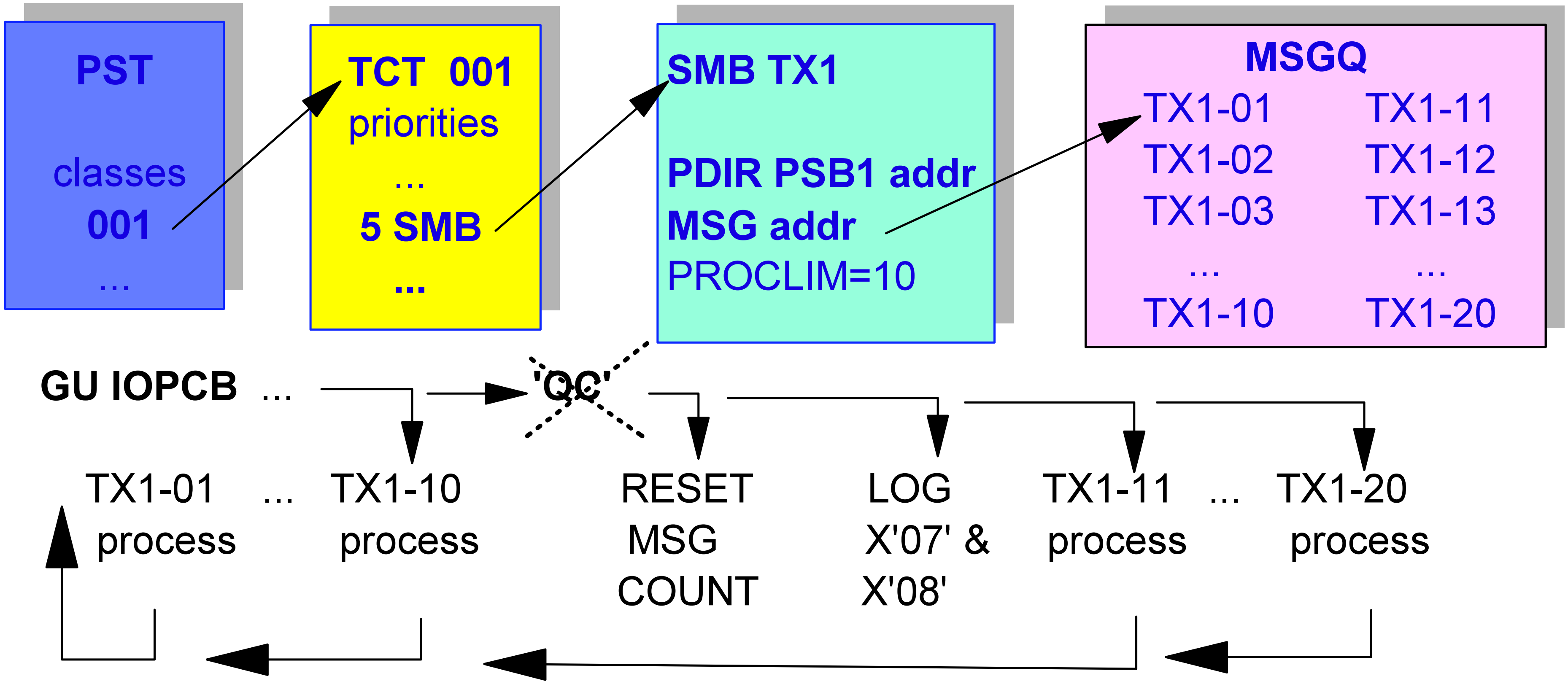
- APPLCTN ...,PGMTYPE=(TP,,1),PSB=PSB1,**SCHDTYP=PARALLEL**
- TRANSACT CODE=TX1, ...
- TRANSACT CODE=TX2, ...
- TRANSACT CODE=TX3, ...



Quick Reschedule: IMS MPR

- Same transaction would be selected for scheduling: do not return 'QC' or free resources

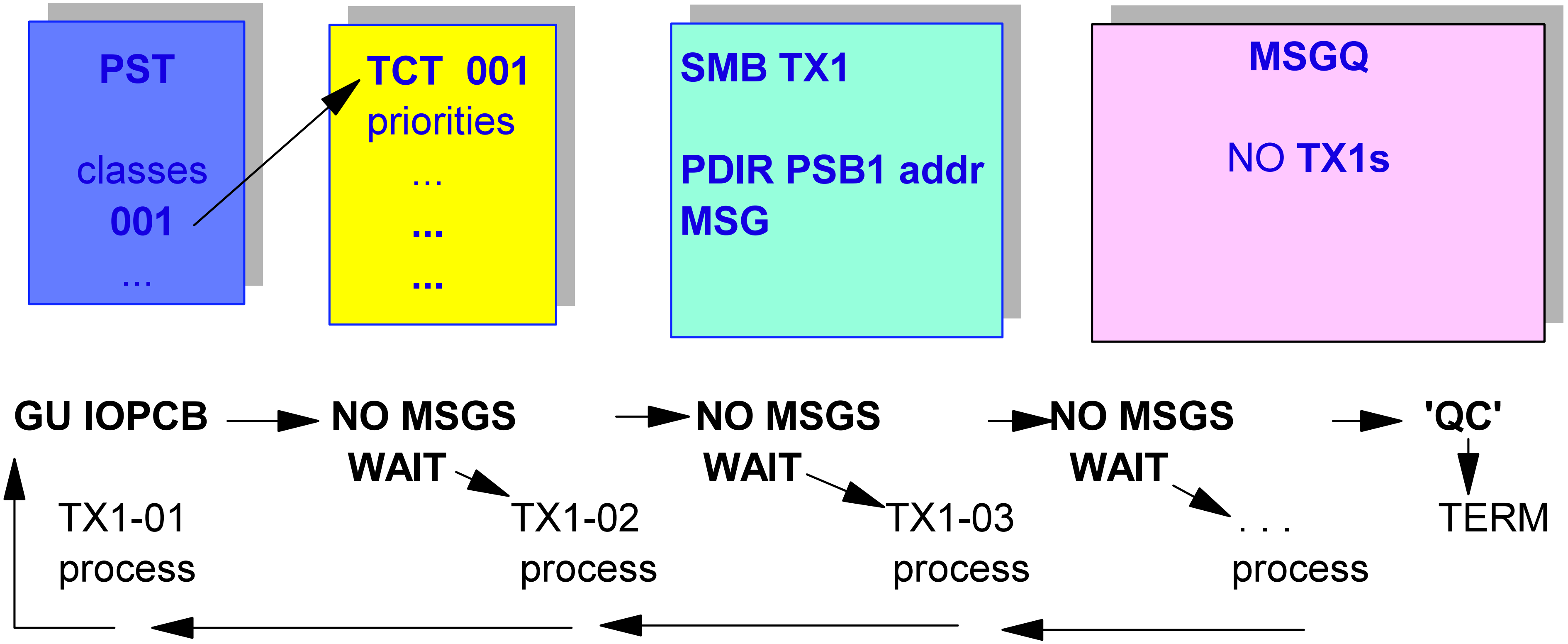
- TRANSACT …,**PROCLIM=(10,t),...**



Wait-For-Input (WFI):
IMS MPR and MD-BMP

- No more of this trancode on the queue - do not return 'QC' or free resources until PROCLIM met

- TRANSACT CODE=TX1, ... ,**WFI**



PST

classes

001

...

TCT 001

priorities

...

...

...

SMB TX1

PDIR PSB1 addr

MSG

MSGQ

NO **TX1s**

GU IOPCB → **NO MSGS WAIT** → **NO MSGS WAIT** → **NO MSGS WAIT** → **'QC'**

TX1-01 process

TX1-02 process

TX1-03 process

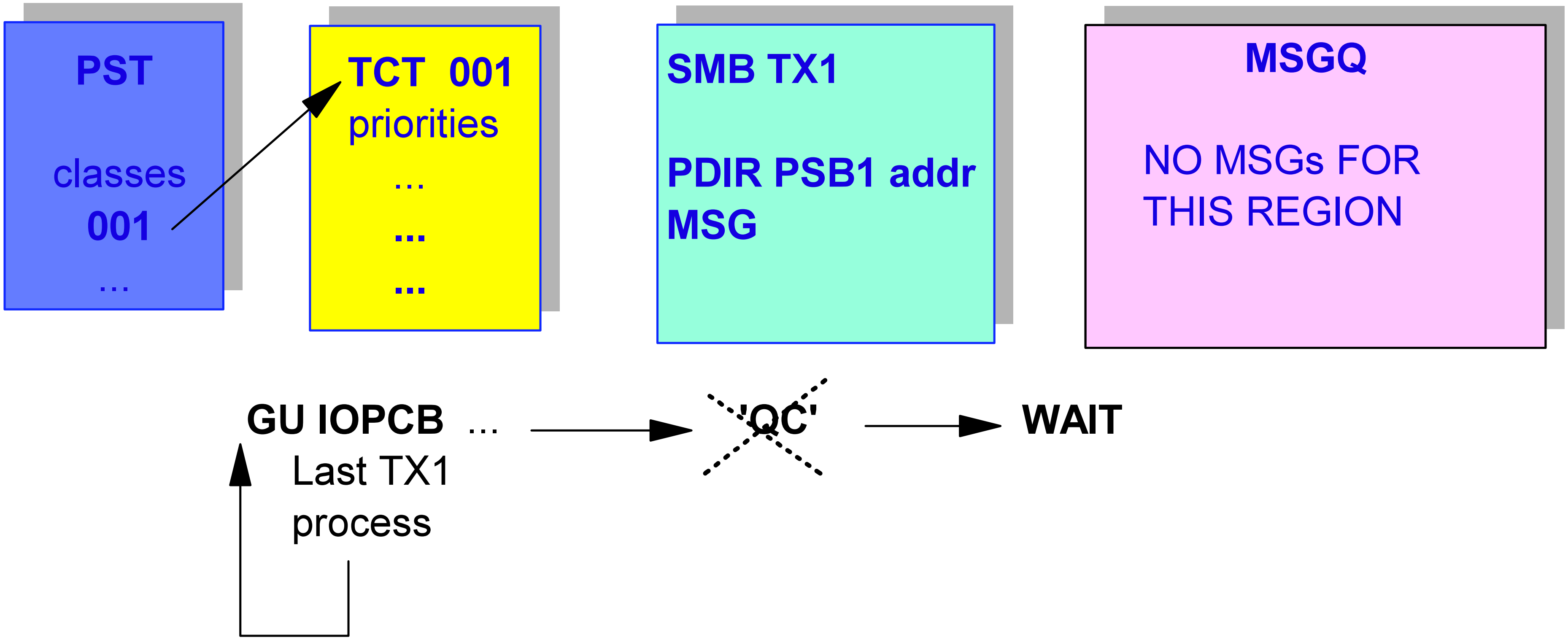
. . . process

TERM

IMS MPR: Pseudo Wait-For-Input (PWFI)

- No more work of any type for this region - do not return 'QC' or free resources

- DFSMPR: // EXEC ...,PARM='MSG,...,**PWFI=Y'**



PST

classes

001

...

TCT 001

priorities

...

...

...

SMB TX1

PDIR PSB1 addr

MSG

MSGQ

NO MSGs FOR THIS REGION

GU IOPCB ...

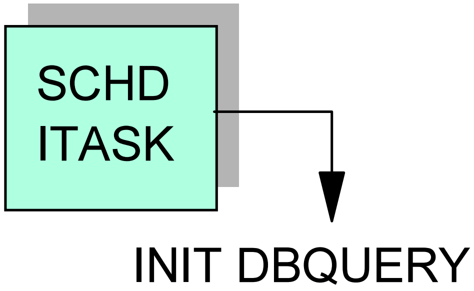
Last TX1 process

~~'QC'~~

WAIT

Serial Processing: IMS MPR

- When a database resouce is unavailable **and** the transactions must be processed in arrival time order
  - TRANSACT ...,**SERIAL=YES**



SCHD
ITASK

INIT DBQUERY

PCB	STATUS
A	NA
B	NU
C	bb

```
APPL.PGM.:

[ INIT STATUS,GROUPA ]

CALL A      [3303 | 'BA' ]
CALL B      [3303 | 'BA' ]
```

3303 ABEND

1. TX remains on input Q

2. TX USTOPped

Non-Serial Processing: IMS MPR

- When a database resouce is unavailable **and** the transactions can be processed in any order
  - TRANSACT   ...,SERIAL=**NO**

SCHD
ITASK

INIT DBQUERY

PCB	STATUS
A	NA
B	NU
C	bb

APPL.PGM.:

[INIT STATUS,GROUPA]

CALL A   [3303 | 'BA']
CALL B   [3303 | 'BA']

3303 ABEND

1. TX moved to SUSPEND Q

2. TX USTOPped when USTOP CTR = 10

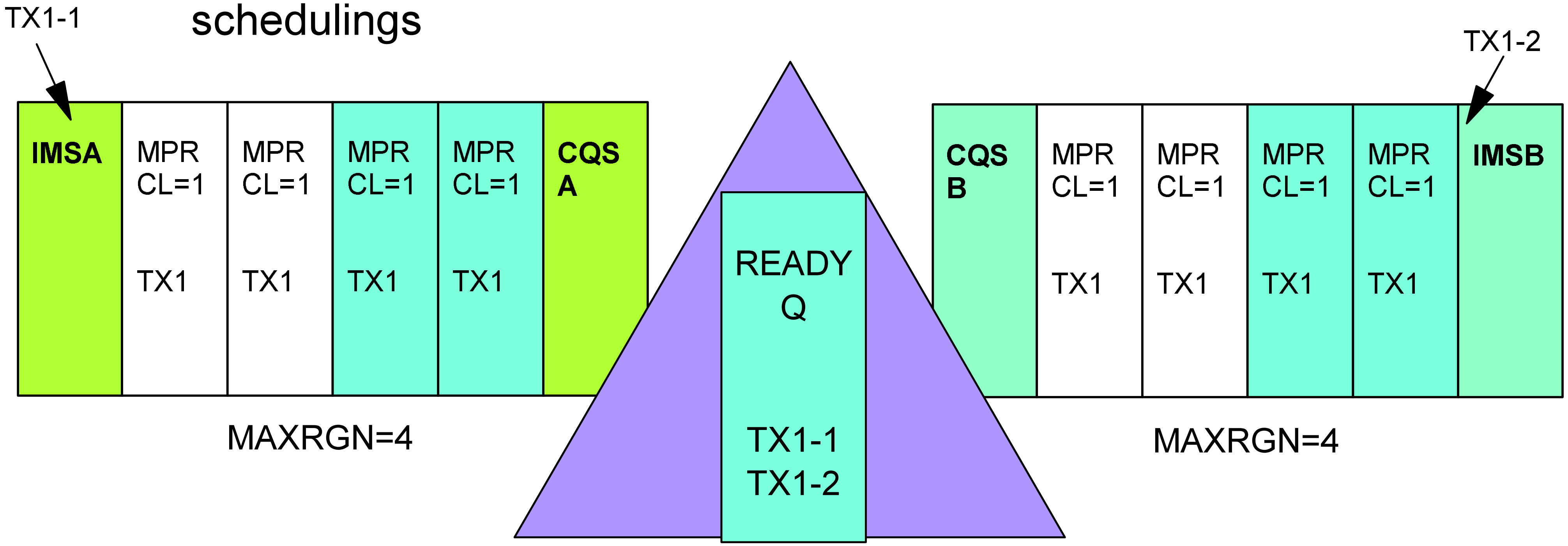
V6 Shared Queues Considerations

- **APPLCTN SCHDTYP=SERIAL**
  - Single scheduling IN THIS IMS
  - Can still be scheduled in other IMSs in IMSplex
- **IMS does not know how many messages on shared Q**
  - TRANSACT Limit Priority has no impact
  - TRANSACT Limit Count has no impact
  - "FALSE" schedulings up to MAXRGN will occur
- **TRANSACT PARLIM=**
  - Causes parallel scheduling if appropriate regions available
- **TRANSACT SERIAL=YES**
  - Transaction scheduled only on the IMS in which it was entered

V6 Shared Queues Considerations . . .

"FALSE" SCHEDULINGS

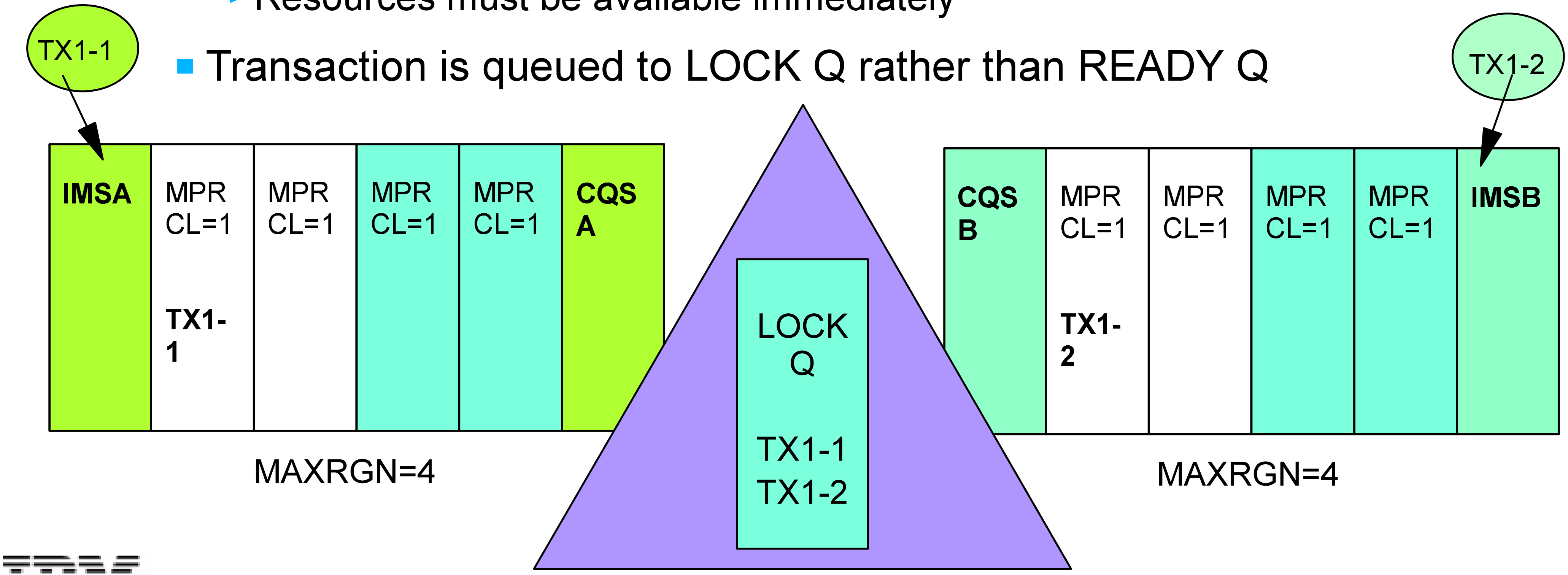
- CQS queues input messages to READY Q
- CQS informs interested IMSs that messages on READY Q
- IMS Scheduling assumes multiple messages on queue, schedules as many available regions up to MAXRGN
- Fewer than MAXRGN messages on queue results in "false" schedulings



V6 Shared Queues Considerations . . .

"FALSE" SCHEDULING partial solution

- Transactions qualifying for LOCAL=YES are scheduled in a single dependent region on IMS receiving input
  - No transactions of this TRANCODE on the READY Q
  - TRANSACT is not SERIAL=YES
  - Message requires only ONE QBuffer
  - MPR with right class available
  - Resources must be available immediately
- Transaction is queued to LOCK Q rather than READY Q



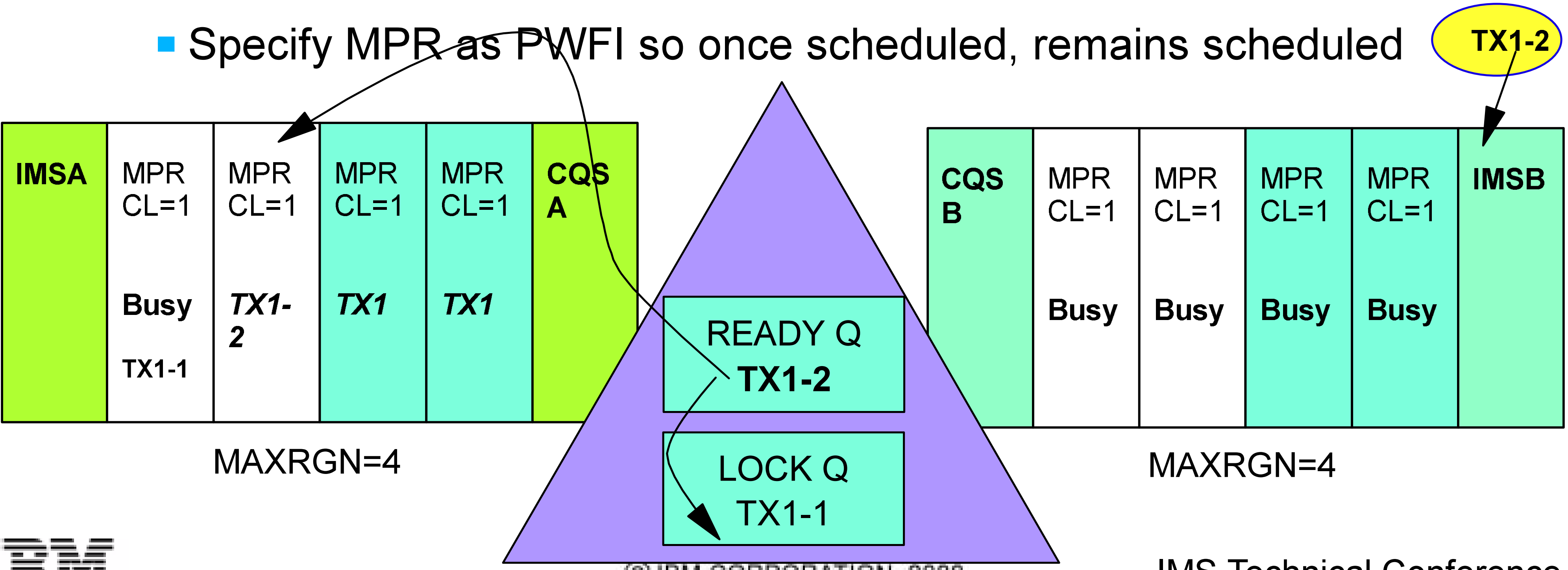
V6 Shared Queues Considerations . . .

HOWEVER . . ."FALSE" SCHEDULING still occur

- TX1-2 queued to READY Q
- IMSA Schedules work in 3 regions - 2 false schedulings

For high volume transactions

- Put in own class
- Dedicate MPRs to a single class
- Specify MPR as PWFI so once scheduled, remains scheduled



V6 Shared Queues Considerations . . .

- **When scheduler tries to schedule a transactions, it looks for a dependent regions in the following sequence:**
  - SSQ6: WFI or PWFI for the transaction code being scheduled
  - SSQ3: any MPR waiting for work and with the right class
  - SSQ4: MPR waiting because of an intent conflict
  - SSQ6: any PWFI MPR waiting for work with the right class
    - "Unscheduling" precedes scheduling
    - Possible "false" scheduling

- **Lower region occupancy**
  - Increases likelihood of local scheduling
  - Decreases likelihood of "false" schedulings
  - Start more MPRs

Scheduling Summary (1 of 2)

IMS TM/DM

1. Select a transaction
2. Allocate and reserve resources
3. If unable to allocate and reserve resources, select another transaction
4. Scheduling failure conditions:
   - NO MSGS
   - INTENT FAILURE
     - ✓ PSB BUSY
     - ✓ Pool Space Failure
     - ✓ PROCOPT=E
5. V6 Shared Qs impact

DBCTL

1. Allocate and reserve resources
2. If unable to allocate and reserve resources, scheduling fails
3. Scheduling failure conditions:
   - INTENT FAILURE
     - ✓ PSB BUSY
     - ✓ Pool Space Failure
     - ✓ PROCOPT=E

Scheduling Summary (2 of 2)

IMS TM/DM only

- MPR
  - ✓ CLASSES
  - ✓ PWFI
- TRANSACT
  - ✓ CLASS
  - ✓ PRIORITY
  - ✓ PARLIM
  - ✓ PROCLIM
  - ✓ SCHD
- APPLCTN
  - ✓ WFI
- QUICK RESCHEDULE

DBCTL and IMS TM/DM

- APPLCTN
  - ✓ RESIDENT
  - ✓ SCHDTYP=PARALLEL
- DATABASE RESIDENT
- PROCOPT=E
- RES=Y
- STORAGE POOLS
  - ✓ CSA PSB
  - ✓ DLISAS PSB
  - ✓ DMB
  - ✓ PSBW
  - ✓ RESIDENT POOLS

E21

Getting to Know Your IMS Scheduler

Thank you for your evaluation, Karen

IMS
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Anaheim, California October 23 - 27, 2000

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