



Understanding the z/OS System Trace

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**Patty Little
John Shebey
IBM Poughkeepsie**

plittle@us.ibm.com
jshebey@us.ibm.com



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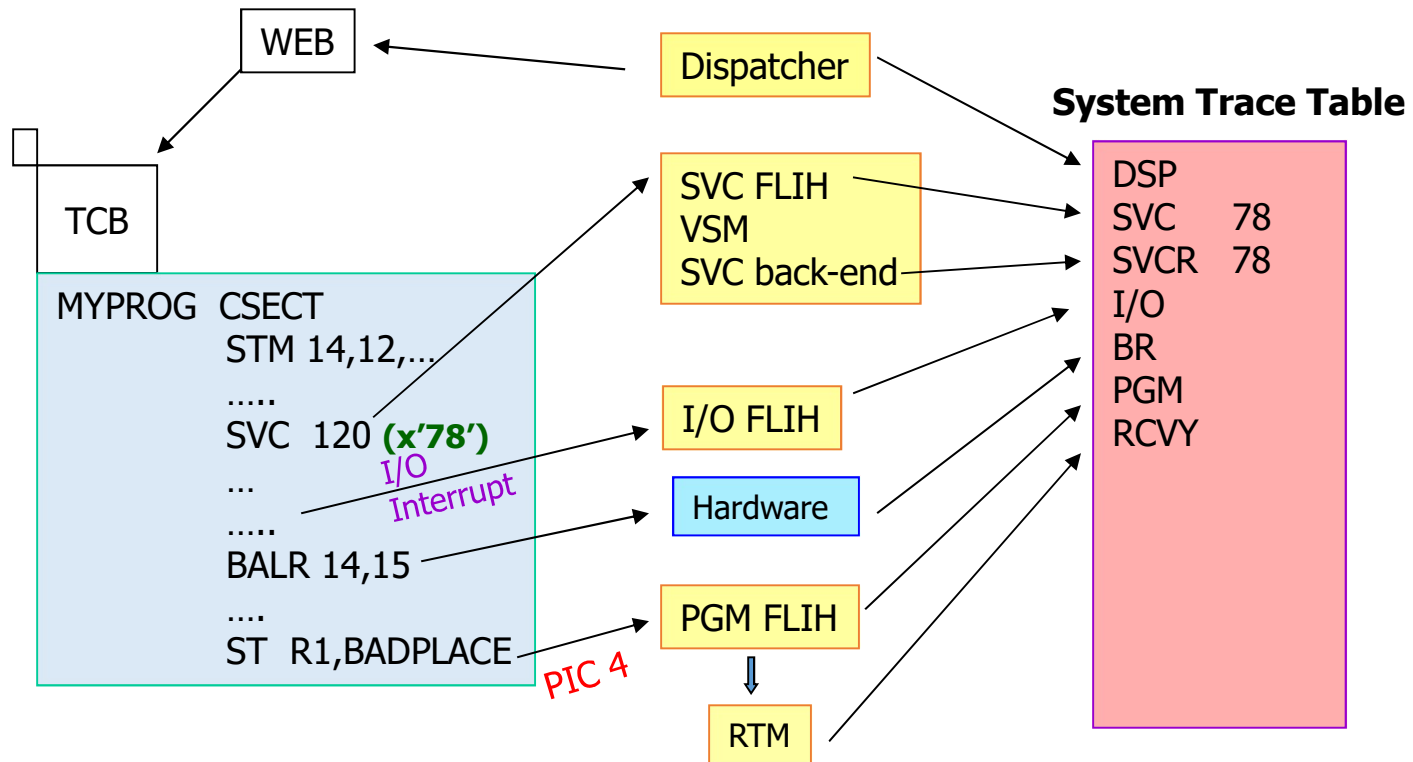


The Basics

The z/OS System Trace holds a wrap-around history of significant system events such as dispatching of work, interrupts, and errors

- Kept in-core in page-fixed CPU-related trace buffers
 - Buffers default to 1Meg in size
 - Typically holds .1 to 1 second of trace history
- Found in various types of dumps
 - Included in SVC dump via SDATA TRT option
 - Included in user dumps by default
 - Included in SAdumps
- Formatted chronologically via **IPCS SYSTRACE**
 - Activity on various CPs get merged by timestamp

A Conceptual View





System Trace Reference Material

- MVS IPCS Commands
 - SYSTRACE command
- MVS Diagnosis: Tools and Service Aids
 - Section “System Trace” describes trace entries
- MVS Diagnosis: Reference
 - Chapter 4 defines SVC interface registers
- MVS Data Areas
 - Defines Unique fields for certain types of SSRV entries
- MVS System Commands
 - TRACE ST command to adjust System Trace buffer size, turn on/off branch tracing

Reading SYSTRACE output

```

IPCS OUTPUT STREAM -----
Command ==>
***** TOP OF DATA *****
----- SYSTEM TRACE TABLE -----
--
--
PR ASID WU-ADDR- IDENT  CD/D PSW----- ADDRESS-  UNIQUE-1 UNIQUE-2 UNIQUE-3 PSACLHS- PSALOCAL PASD SASD TIME
                               UNIQUE-4 UNIQUE-5 UNIQUE-6 PSACLHSE

00 0021 009FE030  DSP      00000000_014C9DDE 00000000 814C9DDE 00FB3788 00000000 00000000 0021 0021 23:00:07.958350
                               07041000 80000000
00 0021 009FE030  SVC      4F 00000000_014CA396 009FDCB0 00000011 FFFFFFFF Status Start SRBs only 23:00:07.958354
                               07041000 80000000
02 0165 009FFB00  DSP      00000000_0137DA1C 00800000 00000001 05882000 00000000 00000000 0049 0165 23:00:07.958355
                               07044000 80000000
00 0021 009FE030  SVCR    4F 00000000_014CA396 00000000 00000000 05616F00                               23:00:07.958365
                               07040000 80000000
02 0165 009FFB00  PC      ... 0 095701CE                               01F01
02 0165 009FFB00  PR      ... 0 095701CE 29A06B5A                               0165
  
```

- Entries are presented in chronological order
 - Oldest entry at the TOP
 - Newest entry at the BOTTOM
 - Entries are inter-mixed across CPs
- Entries typically 1-2 lines each



Exploring the columns

Columns 1 - 74

What was done?

IDENT - trace entry identifier
 CD/D - a number related to this entry

```

IPCS OUTPUT STREAM -----
Command ==>
***** TOP OF DATA **

----- SYSTEM TRACE TABLE -----
PR ASID WU-ADDR- IDENT  CD/D PSW----- ADDRESS-  UNIQUE-1 UNIQUE-2 UNIQUE-3
UNIQUE-4 UNIQUE-5 UNIQUE-6
02 013A 009FF3C8 DSP      00000000_086D1208 00000000 009FF3C8 29AF92F0
07850000 80000000
02 013A 009FF3C8 SVC      79 00000000_086D1236 29AFDF88 29AFA62C 29AF92F0
07850000 80000000
02 013A 009FF3C8 SVCR     79 00000000_086D1236 00000000 01397DD3 29AF92F0
07850000 80000000
00 0010 05616F00 PR      ... 0 29C0F8AA 7F69848C
00 0010 05616F00 I/O    0761E 00000000_29C10740 00C04007 73BCC580 0C000000
07046000 80000000 022126A8 0040001E
    
```

Environment

CPU number (logical)

Who did it and where?

ASID
 Work Unit Addr (TCB mode: TCB address)
 (SRB mode: WEB address)
 (Special cases: Zero or PURGEDQ TCB)
 Module addr/PSW (PSW words 3 & 4 appear above words 1 & 2)

Exploring the columns...

Columns 1 - 74

```

IPCS OUTPUT STREAM -----
Command ==>
***** TOP OF DATA **

----- SYSTEM TRACE TABLE -----
PR ASID WU-ADDR- IDENT  CD/D PSW----- ADDRESS-  UNIQUE-1 UNIQUE-2 UNIQUE-3
                               UNIQUE-4 UNIQUE-5 UNIQUE-6
02-013A 009FF3C8 DSP      00000000_086D1208 00000000 009FF3C8 29AF92F0
                               07850000 80000000
02-013A 009FF3C8 SVC      79 00000000_086D1236 29AFDF88 29AFA62C 29AF92F0
                               07850000 80000000
02-013A 009FF3C8 SVCR    79 00000000_086D1236 00000000 01397DD3 29AF92F0
                               07850000 80000000
00 0010 05616F00 PR      ... 0 29C0F8AA 7F69848C
00 0010 05616F00 I/O    0761E 00000000_29C10740 00C04007 73BCC580 0C000000
                               07046000 80000000                               022126A8 0040001E
  
```

What was done ?

IDENT – trace entry identifier
 CD/D – a number related to this entry

How was it done ?

Up to 6 unique fields containing additional information about the entry

Exploring the columns...

Columns 77 - 123

----- Line					
					SCR

PSACLHS-	PSALOCAL	PASD	SASD	TIMESTAMP-LOCAL	CP
PSACLHSE				DATE-09/28/2009	
00000000	00000000	013A	013A	23:00:07.958350	29
VSAM				23:00:07.958354	29
				23:00:07.958355	29
		0010			
00000080	00000000	0010	0010	23:00:07.958365	29
00000000					

PC, SVC or SSRV Info →

Physical CPU number ←

Environment

When was it done ?

PSACLHS, PSACLHSE, PSALOCAL – lock information
PASD, SASD – cross memory information

Date and Time

Summary of common entries

- Entries indicating Dispatch of work
 - **DSP** – TCB Dispatch
 - **SRB** – Initial SRB Dispatch
 - **SSRB** – Suspended SRB Dispatch
 - **WAIT** – Dummy (No-work) Wait Dispatch
- Entries indicating an Interrupt has occurred
 - **SVC** – SVC interrupt (System Service entered via SVC)
 - **I/O** – I/O interrupt
 - **EXT** – External interrupt
 - **CLKC, TIMR, WTI, EMS, EXT, CALL, SS** subtypes
 - **PGM** – Program Check Interrupt
 - **MCH** – Machine Check Interrupt
 - **RST** – Restart Interrupt
- Entries indicating an error has been encountered
 - **RCVY** – RTM has been entered
 - **SVCE** – SVC Error

Summary of common entries...

- Entries indicating execution of Cross Memory instructions
 - **PC** – Program Call
 - **PR** – Program Return
 - **PT** – Program Transfer
 - **SSAR** – Set Secondary Address Space Number
- Entries indicating an I/O operation has been performed
 - **SSCH** – Start Subchannel
 - **MSCH** – Modify Subchannel
 - **HSCH** – Halt Subchannel
 - **RSCH** – Resume Subchannel
- Miscellaneous entries
 - **SVCR** – SVC Return
 - **SSRV** – System Service entered via PC or Branch
 - **SUSP** – Suspension due to lock not available
 - **SPER** – SLIP PER event has occurred

Common *RCVY* entries

- **RCVY PROG*** – RTM1 is being entered for a program check interruption
- **RCVY FRR*** – RTM1 is invoking a functional recovery routine (FRR)
- **RCVY RTRY*** – Retry from an FRR
- **RCVY PERC*** – RTM1 FRRs did not retry; control “percolates” to RTM2
- **RCVY ESTA**** – RTM2 is invoking an ESTAE-type recovery routine
- **RCVY ESTR**** – Retry from an ESTAE-type recovery routine
- **RCVY ABT*** – Request for abnormal end of a TCB via CALLRTM macro
- **RCVY MEM*** – Request for abnormal end of an address space via CALLRTM macro

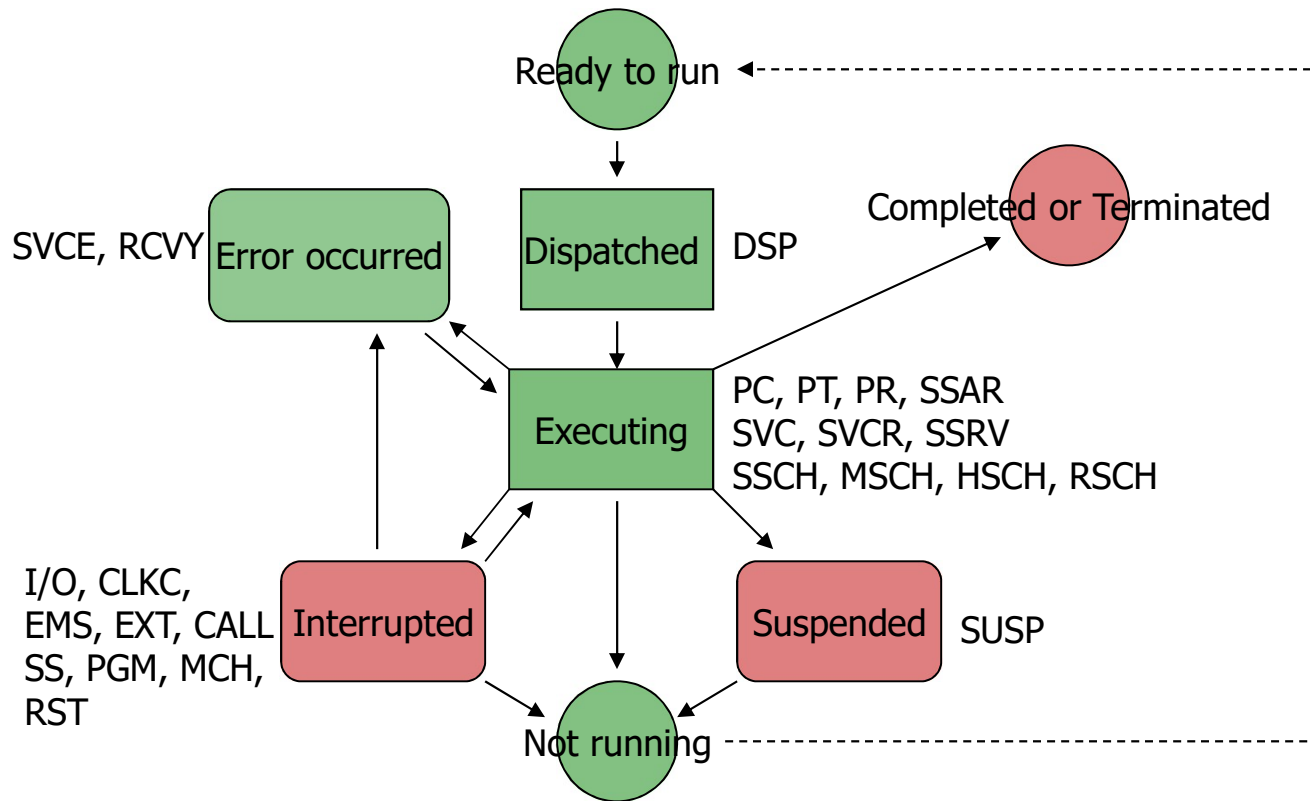
* *UNIQUE1 = Completion Code UNIQUE2 = Reason Code*

** *UNIQUE1 = SDWA address UNIQUE2 = 64-bit parm ptr
(available as of z/OS R2.1)*

Interpreting system trace entries

- **All system trace entry types** are described in the “System Trace” chapter of MVS Diagnosis: Tools and Service Aids
- **SVC routine interface registers (15, 0, and 1)** are defined in chapter 4 of MVS Diagnosis: Reference
 - UNIQUE 1/2/3 fields on SVC entry map to registers 15/0/1, respectively
- **Unique trace data for some SSRV events** can be obtained from the MVS Data Areas manuals as follows:
 - PC Auth – PCTRC data area
 - Supervisor Control – SPTRC data area
 - Task Management – TMTRC data area
- **Unique trace data for other components’ SSRV events such as VSM, RSM, and GRS** is described under the SSRV section of the “System Trace” chapter in MVS Diagnosis: Tools and Service Aids.

Life of a TCB in the System Trace

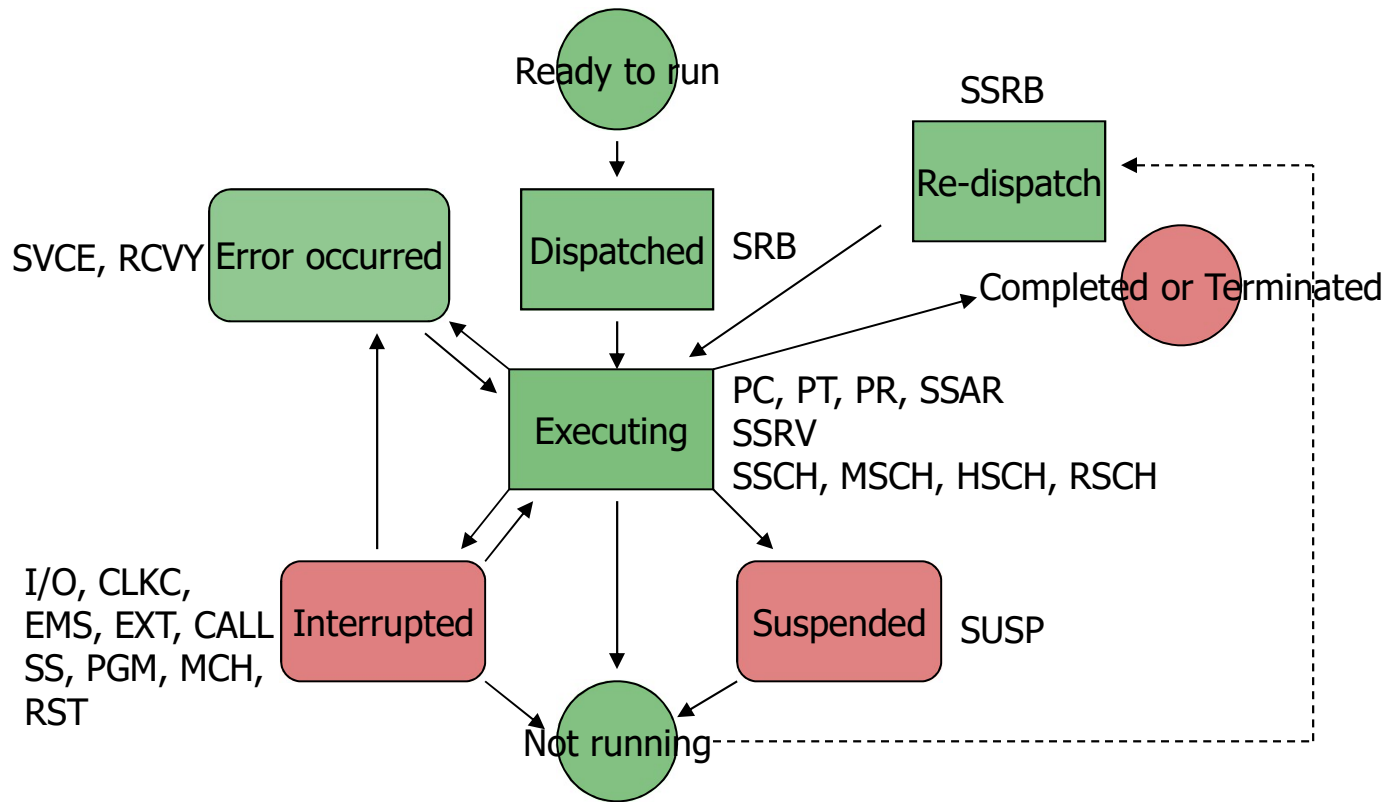


TCB Dispatch - DSP

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS-	PSALOCAL	PASD	SASD
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE			
00	0021	009FE030	DSP			00000000_014C9DDE 07041000_80000000	00000000	814C9DDE	00FB3788	00000000	00000000	0021	0021
00	0021	009FE030	SVC	4F		00000000_014CA396 07041000_80000000	009FDCB0	00000011	FFFFFFFF	Status	Start SRBs only		
00	0021	009FE030	SVCR	4F		00000000_014CA396 07041000_80000000	00000000	00000000	05616F00				
00	0021	009FE030	I/O	02E76		00000000_014C97A2 07041000_80000000	00C04007	7E94C6F0	0C000001	00000080	00000000	0021	0021
00	012A	0096ECD8	DSP			00000000_074C2C12 07040000_80000000	00000000	00000001	3B5EF6BC	00000000	00000000	012A	012A

- Represents **dispatch** of a **TCB**
- Address of TCB in **WU-ADDR**
- UNIQUE-2 and UNIQUE-3 contains contents of **R0** and **R1** on dispatch
- TCB will execute on this CPU until the trace shows that a new unit of work is dispatched on the same CPU
 - **There is no trace entry produced when a TCB stops executing**

Life of an SRB in the System Trace



SRB Dispatch/Suspend/Redispatch

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1 UNIQUE-4	UNIQUE-2 UNIQUE-5	UNIQUE-3 UNIQUE-6	PSACLHS- PSACLHSE	PSALOCAL	PASD	SASD
05	0032	071671F0	SRB		00000000_014EBF98	47040000_80000000	00000032 008EDE88	0689C500 20	0689C500	00		0032	0032
05	0032	071671F0	SSRV	78		80FEC8BA	4080E552 00320000	00000058	008E6FA8	Getmain			
05	0032	008EDE88	SUSP			80067964	00000000 09F247E0	LOCL	00000000	00000000 00000000			
..... <i>Entries omitted</i>													
01	0032	071671F0	SSRB		00000000_00067964	47043000_80000000	00000032 008EDE88		09F247E0		01	00000000	0032 0032

- WEB address in WU-ADDR except...
 - PURGEDQ TCB address traced in WU ADDR field of SRB SUSP
- SSRB entry's UNIQUE-3 field contains SSRB address
- PSW matches original PSW at point when SRB was suspended
(or, in the case of a preemptable SRB, interrupted off the CP)

Where do I begin in System Trace?

It depends on the type of dump!

- Recovery initiated dump
 - Find the **error event** and review previous activity
- SLIP dump
 - Find where the **SLIP matched** and review previous activity
- Console dump
 - No particular milestone
 - Need to review overall activity of address space(s) dumped
- Standalone dump
 - Go to **end** of system trace and review most recent activity

SYSTRACE Filters & Formatting Options

Filters

- Address space ASID, JOBNAME
- Work unit TCB, WEB [for SRBs]
- CP CPU, CPUTYPE, CPUMASK
- No filter ALL

Other options

- Time TIME(LOCAL/GMT/HEX)
- Statistics PERFDATA, STATUS

REPORT VIEW on SYSTRACE report command line

- Provides advanced ISPF-like editing capability

Some filters can be combined.

SYSTRACE examples

- 1) SYSTRACE JOBNAME(TEST1)
- 2) SYSTRACE ASID(X'1B',X'20') TI(LO)
- 3) SYSTRACE ASID(59) WEB(X'05311280')
- 4) SYSTRACE ASID(X'3B') TCB(X'987658')
- 5) SYSTRACE CPU(X'12') ALL
- 6) SYSTRACE CPU(0:11) ALL TI(LO)
- 7) SYSTRACE CPUMASK(FFF) TI(LO)
- 8) SYSTRACE CPUTYPE(STANDARD) ASID(8)
- 9) SYSTRACE CPUTYPE(ZIIP) ALL
- 10) SYSTRACE ALL TI(LO)
- 11) SYSTRACE PERFDATA(DOWHERE)
- 12) SYSTRACE STATUS TI(LO)

Examples

PGM Interrupts: The good, the bad, & the RCVY

- There are 3 possibilities after a program interrupt (aka program check)
 - **The Good** – interrupt is resolvable
 - Interrupt is synchronously resolved and program continues running
 - Unit of work is suspended and gets redispached after the interrupt is asynchronously resolved
 - **The Bad** – interrupt is unresolvable
 - **The RCVY PROG** entry is written and RTM is entered
- **Absence of a RCVY entry after the PGM means that the program interrupt was successfully resolved.**

The good PGM

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS-	PSALOCAL	PASD	SASD
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE			
00	0136	009FFB00	PC	...	0	08BE587C		0030B		Storage	Obtain		
00	0136	009FFB00	SSRV	132		00000000	4000E600	00002200	7FFCBE00	Storage	Obtain		
							01360000						
00	0136	009FFB00	PR	...	0	08BE587C	0159A552					0136	
00	0136	009FFB00	PGM	011	00000000	08BE590A	00060011	00000000		00000000	00000000	0136	
					07041000	80000000		7FFCC000		00000000			
00	0136	009FFB00	PC	...	0	08BDB964		00C04		DFSMS			

- No **RCVY** trace entry after PGM
 - The interrupted unit continues to run after the interrupt is resolved synchronously (above example),
- OR**
- The interrupted unit is suspended and will be re-dispatched after the interrupt is resolved asynchronously
 - PGM, then next entry for same work unit is a DSP

The bad PGM

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS-	PSALOCAL	PASD	SASD
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE			
0B-05AE	006D4B58	SSRV	78			812B301A	4000EF50	00000998	00EB9668	Getmain			
							00010000						
0B-05AE	006D4B58	SSRV	112			819715BA	08EA35A8	00FDC800	8BBEB508	Schedule			
							00000000						
0B-05AE	006D4B58	PGM	011		00000000_0C137114		00040011	00000000		00000000	00000000	02CA	02CA
					07046000_80000000			00013001		00000000			
0B-05AE	006D4B58	*RCVY	PROG				940C4000	00000011	00000000	00000000	00000000	02CA	02CA
										00000000			
0B-05AE	006D4B58	*RCVY	FRR		070C4000	8C136F10	400C4000	00000011	00000000	00000000	00000000	02CA	02CA
									00000001	00000000			

- **RCVY PROG** trace entry after PGM
 - The program interrupt is not resolvable and RTM is entered

RTM1 Trace Pattern: FRR Retry

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE
00	0001	009A8A10	PGM	011	00000000	_14111D9E	00020011	00000000		
					07044000	80000000		00002001		
00	0001	009A8A10	*RCVY	PROG			940C4000	00000011	00000000	
00	0001	009A8A10	SSRV	78		811CB9EA	4000EF50	00000970	00F9D690	Getmain
							00010000			
00	0001	009A8A10	*RCVY	FRR	070C0000	94111E94	940C4000	00000011	00000000	
									00000001	
00	0001	009A8A10	*RCVY	RTRY	070C0000	94111E7C	140C4000	00000011	00000000	
									00000001	
00	0001	009A8A10	SSRV	78		811C5158	0000EF03	00000970	00F9D690	Freemain
							00010000			
00	0001	009A8A10	PR	...	0	06E95C7C	14111E7C			

- RTM1 is entered for a Program Check
- RTM1 gives control to an FRR at 14111E94
- The FRR requests retry to 14111E7C
- RTM1 freeing the SDWA
- The mainline code is now executing following retry

RTM1 Trace Pattern: No FRR retry, RTM1 percolates

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE
00	0054	0097BE88	PGM	004	00000000_	014EEB6E	00060004	00000000		
					47041000_	80000000		00000000		
00	0054	0097BE88	*RCVY	PROG			940C4000	00000004	00000000	
00	0054	0097BE88	SSRV	78		810F41E2	4000EF50	00000998	00FC8668	Getmain
							00010000			
00	0054	0097BE88	*RCVY	FRR	470C0000	813D1318	940C4000	00000004	00000000	
									00000001	
00	0054	0097BE88	*RCVY	PERC			94206000	000000C8		
									00000000	
00	0054	0097BE88	SSRV	12D		8154B464	0097BE88	000C8000	FF3A0000	Status
							00000000			
00	0054	0097BE88	SSRV	12D		8154B480	0097BE88	000B8000	00000000	Status
							00000000			
00	0054	0097BE88	SSRV	78		812C0AA0	0000EF03	00000998	00FC8668	Freemain
							00010000			
00	0054	0097BE88	DSP		00000000_	012C0C38	00000000	00000658	7F43D9A8	
					47542000_	80000000				
00	0054	0097BE88	SVC	D	00000000_	012C0C3A	00000000	00000658	7F43D9A8	
					47542000_	80000000				

The only FRR did not retry so RTM1 will “percolate” to RTM2.
RTM1 passes control to RTM2 by forcing an SVC D.

RTM1 Trace Pattern: No FRR defined

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACL
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACL
01-001C	008DBC48		PGM	004	00000000_	24600C16	00040004	00000000		
					07850000_	80000000		00000000		
01-001C	008DBC48		*RCVY	PROG			940C4000	00000004	00000000	
01-001C	008DBC48		SSRV	12D		8153CF34	008DBC48	000C8000	FF3A0000	Status
							00000000			
01-001C	008DBC48		SSRV	12D		8153CF50	008DBC48	000B8000	00000000	Status
							00000000			
01-001C	008DBC48		DSP		00000000_	01299712	00000000	00000000	24600BDC	
					07850000_	80000000				
01-001C	008DBC48		*SVC	D	00000000_	01299714	00000000	00000000	24600BDC	
					07850000_	80000000				
01-001C	008DBC48		SSRV	78		833614AE	0000FF50	000000C8	008CFEB0	Getmain
							001C0000			
01-001C	008DBC48		SSRV	78		833614E4	0000FF70	00001220	7F711DE0	Getmain
							001C0000			

No RCVY FRR entry between RCVY PROG and SVC D

RTM2 Trace Pattern: ESTAE receiving control

Tourist Info:
CP number is
4 digits as of
z/OS R2.1.

0004	01F6	00AF8368	DSP		00000000_01417E18	00000000	1C39C260	00A93E88	00000000	
					07040000_80000000					
0004	01F6	00AF8368	*SVC	D	00000000_01417E1A	00000000	1C39C260	00A93E88		
					07040000_80000000					

0002	01F6	00AF8368	*RCVY	ESTA	A530A194	7D3666D8	00000000	7F6C701C	00000000	
							00000000	00AFF5D0	00000000	
0002	01F6	00AF8368	SVC	C	00000000_0933D434	0933DAFD	A530A194	7D3666D8	Synch	
					07041000_80000000					
0002	01F6	00AF8368	SSRV	78	81330192	1000FF52	00000088	00ACCEF0	Getmain	
						01F60000				
0002	01F6	00AF8368	SVCR	FF00	00000000_0933DAFC	8933DAFC	A530A194	7D3666D8		
					07040000_80000000					
0004	01F6	00AF8368	DSP		00000000_0933DAFC	00000000	A530A194	7D3666D8	00000000	
					07040000_80000000					

RTM2 is entered via SVC D

RTM2 traces RCVY entry for **ESTAE/ARR getting control** (as of R2.2),
 RTM2 passes control to the ESTAE/ARR via SVC C SYNCH,
 SYNCH obtains and initializes a new RB,
 resulting in the SSRV 78 and SVCR FF00 entries

SDWA

An example of parallel activity

```

IPCS OUTPUT STREAM -----
Command ==>
***** TOP OF DATA *****
----- SYSTEM TRACE TABLE -----
--
--
PR ASID WU-ADDR- IDENT  CD/D  PSW----- ADDRESS-  UNIQUE-1  UNIQUE-2  UNIQUE-3  PSACLHS-  PSALOCAL  PASD  SASD  TIME
                                UNIQUE-4  UNIQUE-5  UNIQUE-6  PSACLHSE
00 0021 009FE030  DSP      00000000_014C9DDE 00000000 814C9DDE 00FB3788 00000000 00000000 0021 0021 23:0
                                07041000 80000000
00 0021 009FE030  SVC      4F 00000000_014CA396 009FDCE0 00000011 FFFFFFFF Status Start SRBs only 23:0
                                07041000 80000000
02 0165 009FFB00  DSP      00000000_0137DA1C 00800000 00000001 05882000 00000000 00000000 0049 0165 23:0
                                07044000 80000000
00 0021 009FE030  SVCR    4F 00000000_014CA396 00000000 00000000 05616F00                                23:0
                                07040000 80000000
02 0165 009FFB00  PC      ... 0 095701CE 01F01
02 0165 009FFB00  PR      ... 0 095701CE 29A06B5A                                0165
  
```

- TCB1 at 9FE030 in ASID X'21' gets dispatched on CP0
- TCB1 invokes system service STATUS START SRBs via SVC 4F
- TCB2 at 9FFB00 in ASID X'165' gets dispatched on CP2
- TCB1 returns from STATUS (SVCR 4F – SVC/SVCR PSWs match)
- TCB2 issues PC 1F01 which is a user PC (unknown to formatter)
 - PC/PR PSW addresses match

Tourist info:
Here we see
an xmem
environment

A general example (continued on next slide)

TCB starts I/O then waits for it to complete

CP found no work to dispatch

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS-
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE
04	012A	007FB128	SVC	0	00000000	05926A8E	00FEF220	007EAFCC	007EAF00	Excp
04	012A	007FB128	SSCH	CE59	00 02	00F5FB2C	00F2C9E8	03C2FF81	00DB2BE8	
04	012A	007FB128	SVCR	0	00000000	05926A8E	00000000	00000000	007EAF00	
04	012A	007FB128	SVC	1	00000000	05926AA2	00000000	00000001	007EAEFC	Wait
04	012A	007FB128	SVCR	1	00000000	05926AA2	807FD6B8	00000001	007EAEFC	
04	0001	00000000	WAIT							
03	0006	007F9E88	DSP		00000000	0137ADFA	00000000	00000080	02EDD01C	00000000
03	0006	007F9E88	SSRV	78		8137AEFE	0000F502	00000080	02EDD000	Getmain
03	0006	007F9E88	SSRV	1		8137ADFA	02EDD01C	00000001	00000000	Wait
03	0001	00000000	WAIT							
04	0001	00000000	I/O	CE59	00000000	00000000	00C04007	00D80950	0C000000	00000080
04	012A	02DF7DC0	SRB		00000000	0104C2C0	0000012A	00F5FB00	00F5FB2C	00
04	012A	02DE7DC0	SSRV	2		80FECC3C	007EAEFC	7F000000	00000000	Post
							00000000			

I/O interrupt signals completion of the I/O request. IOS receives control on the interrupt and schedules an SRB to wake up (POST) the waiting TCB

A general example (continued)

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1 UNIQUE-4	UNIQUE-2 UNIQUE-5	UNIQUE-3 UNIQUE-6	PSACLHS- PSACLHSE
04	012A	007FB128	DSP		00000000_	05926AA2 07042000 80000000	00000000	00000001	007EAEFC	00000000
04	012A	007FB128	SSRV	78		8591F94C	4050E603	00000148	007EAE88	Freemain 012A0000
04	012A	007FB128	SVC	10	00000000_	00D29A32 07840000 00000000	00000000	000065B0	007D5FB8	Purge
04	012A	007FB128	SSRV	A		812E8442	FFFFFFFF	FE0000F8	007D73D8	Freemain 012A00FF
04	012A	007FB128	*SVCE	D	00000000_	0116E06E 07041000 80000000	00000010	84000000	8430A000	00000001 00000000

TCB gets redispached now that its I/O has completed.
 However, a little while later it suffers an ABEND30A when
 trying to freemain storage in LSQA SP254.

So let's debug with SYSTRACE!

The Mystery of The Disappearing Workarea

IP SYSTRACE ASID(X'1A') TCB(X'5D8728') TI(LO)

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS-
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE
00	001A	005D8728	DSP		00000000_	08102A00	00000000	00000001	08103D00	00000000
					07850000	80000000				
00	001A	005D8728	PGM	011	00000000_	08102A20	00060011	00000000		00000000
					07851000	80000000		0810B800		00000000
00	001A	005D8728	*RCVY	PROG			940C4000	00000011	00000000	00000000
										00000000
00	001A	005D8728	SSRV	12D		814C0AF6	005D8728	000C8000	FF3A0000	Status
							00000000			
00	001A	005D8728	SSRV	12D		814C0B12	005D8728	000B8000	00000000	Status
							00000000			
00	001A	005D8728	DSP		00000000_	01187B18	00000000	00000001	08103D00	00000000
					07851000	80000000				
00	001A	005D8728	SVC	D	00000000_	01187B1A	00000010	00000001	08103D00	
					07851000	80000000				

Here we see the now-familiar picture of a program check occurring, resulting in an ABEND0C4 PIC11. RTM1 is entered for the ABEND0C4. There are no FRRs so the error is percolated from RTM1 to RTM2.

The Mystery of The Disappearing Workarea

TCB 5D8728 has just been ATTACHED. Therefore we see ATTACH backend processing at the start of the trace.

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS-
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE
00	001A	005D8728	DSP		00000000_	01163FCE	00000000	00000000	00000000	00000000
					07040000	80000000				
00	001A	005D8728	SSRV	A		81164026	FFFFFFFF	FA000098	00006EC8	Getmain
							001A0000			
00	001A	005D8728	SSRV	78		81085734	1000FF72	00000490	7F522B70	Getmain
							001A0000			
00	001A	005D8728	SSRV	78		81448A06	1000FF52	00000088	005FF2F8	Getmain
							001A0000			
00	001A	005D8728	SSRV	78		80FF15DC	0000FF03	000000F8	005FF518	Freemain
							001A0000			
00	001A	005D8728	SVCR	FF00	00000000_	081028E0	881028E0	08103F5C	08103F30	
					07850000	80000000				
00	001A	005D8728	SVC	78	00000000_	0810291E	10000072	00000228	00000000	Getmain
					07850000	80000000				
00	001A	005D8728	SVCR	78	00000000_	0810291E	00000000	00000228	08103C78	
					07850000	80000000				
00	001A	005D8728	SVC	3C	00000000_	0810296E	00000000	00000100	08103D58	Estae
					07850000	80000000				
00	001A	005D8728	SVCR	3C	00000000_	0810296E	00000000	00000000	08103D58	
					07850000	80000000				

Application code
Starts running here

Between this slide and the next we see all activity under this TCB from the start of the trace output until the point of the ABEND0C4.

The Mystery of The Disappearing Workarea

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS-
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE
00	001A	005D8728	SVC	78	00000000	_08102998 07850000 80000000	30000072	00007000	00000000	Getmain
00	001A	005D8728	SVCR	78	00000000	_08102998 07850000 80000000	00000000	00007000	08104000	
00	001A	005D8728	SVC	78	00000000	_081029BA 07850000 80000000	30000072	00001000	00000000	Getmain
00	001A	005D8728	SVCR	78	00000000	_081029BA 07850000 80000000	00000000	00001000	0810B000	
00	001A	005D8728	SVC	78	00000000	_081029EE 07850000 80000000	00000003	00007000	08104000	Freemain
00	001A	005D8728	SVCR	78	00000000	_081029EE 07850000 80000000	00000000	00007000	08104000	
00	001A	005D8728	SVC	2	00000000	_081029F6 07850000 80000000	00000000	00000000	08103F58	Post
00	001A	005D8728	SVCR	2	00000000	_081029F6 07850000 80000000	00C100FF	00000002	00C100FF	
00	001A	005D8728	SVC	1	00000000	_08102A00 07850000 80000000	00C100FF	00000001	08103D00	Wait
00	001A	005D8728	SVCR	1	00000000	_08102A00 07850000 80000000	805FF318	00000001	08103D00	
00	001A	005D8728	DSP		00000000	_08102A00 07850000 80000000	00000000	00000001	08103D00	00000000
00	001A	005D8728	PGM	011	00000000	_08102A20 07851000 80000000	00060011	00000000		00000000
								0810B800		00000000
00	001A	005D8728	*RCVY	PROG			940C4000	00000011	00000000	00000000

The Mystery of The Disappearing Workarea

IP SYSTRACE ASID(X'1A') TI(LO)

PR	ASID	WU-ADDR-	IDENT	CD/D	PSW-----	ADDRESS-	UNIQUE-1	UNIQUE-2	UNIQUE-3	PSACLHS-
							UNIQUE-4	UNIQUE-5	UNIQUE-6	PSACLHSE
00	001A	005D8728	DSP			00000000_01163FCE 07040000 80000000	00000000	00000000	00000000	00000000
00	001A	005D8728	SVCR	FF00		00000000_081028E0 07850000 80000000	881028E0	08103F5C	08103F30	
00	001A	005D8728	SVC	78		00000000_081029BA 07850000 80000000	30000072	00001000	00000000	Getmain
00	001A	005D8728	SVCR	78		00000000_081029BA 07850000 80000000	00000000	00001000	<u>0810B000</u>	
00	001A	005D8728	SVC	1		00000000_08102A00 07850000 80000000	00C100FF	00000001	08103D00	Wait
00	001A	005D8728	SVCR	1		00000000_08102A00 07850000 80000000	805FF318	00000001	08103D00	
00	001A	005D8590	SVC	78		00000000_08102EF8 07850000 80000000	00000003	00001000	<u>0810B000</u>	<u>Freemain</u>
00	001A	005D8590	SVCR	78		00000000_08102EF8 07850000 80000000	00000000	00001000	0810B000	
00	001A	005D8728	DSP			00000000_08102A00 07850000 80000000	00000000	00000001	08103D00	00000000
00	001A	005D8728	PGM	011		00000000_08102A20 07851000 80000000	00060011	00000000 <u>0810B800</u>		00000000 00000000
00	001A	005D8728	*RCVY	PROG			940C4000	00000011	00000000	00000000 00000000

TCB 5D8728
GETMAINs a
page of storage
at 810B000.

TCB 5D8590 freed
the storage that
TCB 5D8728 had
GETMAINed and
was trying to use!

TCB 5D8728
abends trying to
touch the storage
it obtained.

The Smoking Gun

IP LIST TITLE

```
TITLE  
LIST 00. LITERAL LENGTH(X'4D') CHARACTER  
00000000 | COMPON=TASK MGMT,COMPID=SC1CL,ISSUER=IEAVEPST,POST FAILED -- UNE |  
00000040 | XPECTED ERROR |
```

Problem: A dump was produced with a title indicating a failure in the POST service module IEAVEPST.

The Smoking Gun

IP WHERE 1265720 shows PSW points to POST module IEAVEPST+FB8

IP SYSTRACE ASID(X'3F') TI(LO)

PR	ASID	WU-Addr-	Ident	CD/D	PSW-----	Address-	Unique-1	Unique-2	Unique-3	PSACLHS-	PSALOCAL	PASD	SASD
							Unique-4	Unique-5	Unique-6	PSACLHSE			
0000	003F	04464C80	SRB		00000000	127CF7A0	0000003F	124C9084	124C9010	00		003F	003F
					07040000	80000000	008D5988	20					
0000	003F	04464C80	PC	...	6	1	14D405BE	0018A500					
0000	003F	04464C80	PC	...	0	00	14F079A4	0030E		Post			
0000	003F	04464C80	PGM	011	00000000	01265720	00040011	00000000		00000001	00DBC580	0099	0099
					07042000	80000000		00F0F800		00000000			
0000	003F	04464C80	*RCVY	PROG			940C4000	00000011	00000000	00000001	00DBC580	0099	0099
										00000000			

- An SRB entered POST via a PC 30E.
- While running under POST processing, a PGM 11 occurred trying to touch storage on the page at 00F0F000 in ASID 99.
- The PGM 11 was not resolvable, resulting in an ABEND0C4 PIC11
- What happened??

The Smoking Gun

- Inspection of POST module IEAVEPST's code shows the following instructions leading up to time of error:

```
ICM      R5,X'7',X'00' (R6)
AHI      R5,-X'40'
SLR      R4,R4
ICM      R4,X'3',X'3A' (R5)  [PGM 11 occurred on this instruction]
```

- At time of error:
 - Reg6=61305FF4 and Reg5=00F0F0B0
 - Content of storage at 61305FF4 is F0F0F0F0 (consistent with above)
 - In fact, the entire page at 61305000 contains X'F0' throughout
 - Other pages around 61305000 contain X'F0' throughout
- **Theory:** Pages at and around 61305000 in ASID X'99' have been overlaid.

The Smoking Gun

Gotcha!!

Reminder: our address of interest is 61305000.

IP SYSTRACE ASID(X'99') TI(LO)

PR	ASID	WU-Addr-	Ident	CD/D	PSW-----	Address-	Unique-1	Unique-2	Unique-3	PSACLHS-	PSALOCAL	PASD	SASD
							Unique-4	Unique-5	Unique-6	PSACLHSE			
0004	0099	007A2E00	PGM	011	00000000_34D4D79E	07040400 80000000	00060011	00000000		00000000	00000000	0099	0099
						07040400 80000000		612D3400		00000000	00000000		
0004	0099	007A2E00	PGM	011	00000000_34D4D79E	07040400 80000000	00060011	00000000		00000000	00000000	0099	0099
						07040400 80000000		612D4400		00000000	00000000		
0004	0099	007A2E00	PGM	011	00000000_34D4D79E	07040400 80000000	00060011	00000000		00000000	00000000	0099	0099
						07040400 80000000		612D7400		00000000	00000000		
0004	0099	007A2E00	PGM	011	00000000_34D4D79E	07040400 80000000	00060011	00000000		00000000	00000000	0099	0099
						07040400 80000000		612D8400		00000000	00000000		
0004	0099	007A2E00	EXT	TIMR	00000000_34D4D782	07040400 80000000	00001005			00000000	00000000	0099	0099
						07040400 80000000				00000000	00000000		
0004	0099	007A2E00	DSP		00000000_34D4D782	07040400 80000000	00000000	00000243	00000000C	00000000	00000000	0099	0099
						07040400 80000000				00000000	00000000		
0004	0099	007A2E00	PGM	011	00000000_34D4D79E	07040400 80000000	00060011	00000000		00000000	00000000	0099	0099
						07040400 80000000		612D9400		00000000	00000000		
0004	0099	007A2E00	PGM	011	00000000_34D4D79E	07040400 80000000	00060011	00000000		00000000	00000000	0099	0099
						07040400 80000000		612DA400		00000000	00000000		
0004	0099	007A2E00	PGM	011	00000000_34D4D79E	07040400 80000000	00060011	00000000		00000000	00000000	0099	0099
						07040400 80000000		612DB400		00000000	00000000		

Appendix

What's new?

Recent changes

- RCVY ESTA and RCVY ESTR show ESTAE entry/retry (R2.2)
- CP numbers now 4 digits rather than 2 (R2.1)
- Friendlier formatting of external interrupts (R2.1)
- New EXT WTI (Warning Track Interrupt) (R2.1)

Version	CP	Address	Interrupt Type	Subtype	Address 1	Address 2	Address 3	Address 4
R13	02	00D5 00AA5288	EXT	1005	00000000_00849A32	00001005		
					07851400 80000000			
	03	0001 00000000	CALL		00000000_00000000	00001202	00000000	
					07060000 00000000			
	00	00D5 00AC1E88	CLKC		00000000_00FF2B34	00001004	00000000	0000
				07040000 80000000				
R2.1	01	00D5 00AA57A0	EMS		00000000_0084A78C	00001201	40800000	1870EF28
					07851400 80000000	815BC1B8		
	0008	00EC 00000000	EXT	TIMR	00000000_253725E8	00001005		
					07846000 80000000			
	0008	0001 00000000	EXT	CALL	00000000_00000000	00061202	00000000	
				07060000 00000000				
R2.1	0004	008E 00AFE990	EXT	CLKC	00000000_00CE59CA	00001004	06AD7030	0000
					07850000 00000000			
	0008	0001 00000000	EXT	EMS	00000000_00000000	00021201	40800000	0715BA50
					07060000 00000000	81197E20		
	0008	00EC 056B3280	EXT	WTI	00000000_20D184D8	00001007		
				07042000 80000000				

Hyphens and gaps

'-' entries and related messages

```
0001-00B2 008BA3D0 SVC      1 00000000_39A87DC4 39781370 80000001 C6805778
                                07851000 80000000
0001-0001 00000000 WAIT
***** Trace data is not available from all processors before this time.
0000 00B2 009C37D8 SVC      78 00000000_396F7740 00000002 00000208 00000000
                                07850000 80000000
0000 00B2 009C37D8 SVCR    78 00000000_396F7740 00000000 00000208 397F62F0
0001 0066 33483B80 SRB      00000000_013A443E 00000066 32AECFAC B2AECF80
                                07040000 80000000 009C2D00 00

many lines omitted here.....

0000 0005 03917900 PC      ... 0      38D07A64      00503
***** Trace data is not available from all processors after this time.
0001-0010 009F79D8 SVC      1 00000000_38EBFF2E 80000000 00000001 C7140BD8
                                07040000 80000000
```

- '-' entries indicate trace entries from one or more CPUs are not available in this section
- 2nd message 'Trace....after this time' is issued for SVC dumps but not standalone dumps
- See next slide for explanation of why this is seen in any system trace table.

Explanation of “hyphenated” entries

- Trace buffers are CPU-based
- At any given time, some CPUs may be driving work that writes many trace entries, while other CPUs may be driving work that writes few trace entries
- CPUs driving work with much trace activity will fill up and wrap faster and thus hold a shorter history
- Consider this simplistic example:
 - Work on CP0 is writing 10000 entries in .1 sec
 - Work on CP1 is writing 20000 entries in .1 sec
 - If each trace buffer holds 20000 entries, then:
 - CP0’s buffer holds .2 seconds worth of history
 - CP1’s buffer holds .1 seconds worth of history
 - SYSTRACE formatter merges entries by time, so CP0 will have a .1 second range of entries that does not exist in CP1

zIIPs, Parked CPs, and Hyphens (oh my!)

- A zIIP is a specialty engine
 - zIIPs often drive less workload than general CPs, therefore writing fewer trace entries, so wrapping their trace buffer less frequently
- A parked CP is a discretionary (vertical low) CP that WLM has decided is not needed under the present workload volume
 - Discretionary CPs may be frequently parked/unparked
 - Parked CPs are not creating trace entries
 - Discretionary CPs will typically have a longer history in their trace buffers than general CPs due to trace inactivity while parked
- It is common for zIIPs and/or discretionary CPs to have a much longer trace history than general CPs

zIIPs, Parked CPs, and Gaps

- Sometimes a zIIP may go several seconds without any work to do
- Sometimes a discretionary CP will be parked for several seconds and so not be executing any work
- Such periods of inactivity can lead to “gaps” in the system trace table:
 - The formatter reports gaps of roughly 2 seconds or greater

From: **IP SYSTRACE CPU(3) ALL TI(LO)**

```
0003-0001 00000000 WAIT 03:16:58.45044950
0003 ***** Time-gap over 00000002 secs. Previous timestamp= 03:16:58.45044950, Current timestamp= 03:17:00.63006119.
0003-0001 00000000 CALL 00000000_00000000 00011202 00000000 00000000 00000000 0001 0001 03:17:00.63006119
07060000 00000000 00000000
```

Hyphens and gaps – should I care?

- It depends on the problem you are investigating
- In general, you should be aware that **the complete picture or event history** may not be available in the section of the system trace with '-' entries
- A TCB can get interrupted off of one CP and dispatched on another, so you may not be able to successfully read TCB flow in a hyphenated section of trace
- If the problem can be related to or caused by events on other CPUs, you should try to limit your investigation to the section of the trace table with no '-' entries

Handy commands

TRACE Console Command

- TRACE ST,3M (for example)
 - Change size of each CPU-related trace buffer to 3M
 - Don't go crazy with the size!
 - Default is 1Meg and typically works well
 - Suggest keeping size <10Meg
(See speaker notes for important information)
 - System offers protection against setting too large a trace buffer size:
IEA135I REQUESTED TRACE BUFFER SIZE PER
PROCESSOR EXCEEDS MAX OF *scaled value*
- TRACE ST,BR=OFF/ON
 - Turn hardware branch tracing off or on

Captured system trace in SAdump

- SYSTRACE TTCH(LIST) TI(LO)
 - Provides the TTCH address and timestamp of system trace snapshots that existed for errors in flight when the system was stopped
- SYSTRACE TTCH(X'yyyyyyyy') plus other trace filters as desired
 - Formats the captured trace represented by a specific TTCH
 - Looks just like a regular system trace report
 - Example on next slide

Example: captured system trace

IP SYSTRACE TTCH(LIST) TI(LO) [against SAdump only]

Asterisk
denotes a
mini-trace,
not full-sized

TTCH	ASID	TCB	TIME
*7F543000	0038	009CB308	11/20/2015 16:42:46.743560
*7F559000	000C	009FACD8	11/20/2015 16:42:46.740580
*7E666000	0005	009CFE88	11/20/2015 16:42:46.714808
7E684000	0005	009CFE88	11/20/2015 16:42:46.693258
7EC58000	0038	009CB308	11/20/2015 16:42:46.443832
7EFD2000	0001	009BCA40	11/20/2015 16:42:46.345454

IP SYSTRACE TTCH(X'**7EC58000**') TI(LO) ALL

```

----- System Trace Table -----
--
--
PR  ASID WU-Addr- Ident  CD/D PSW----- Address- Unique-1 Unique-2 Unique-3 PSACLHS- PSALOCAL PASD SASD Time Local-----
                                Unique-4 Unique-5 Unique-6 PSACLHSE PSALOCAL PASD SASD Date=11/18/2015

002C-0001 009FC350 PTI    ...  0      015900FC          0001
002C-0001 009FC350 SSIR   ...    0001
002C-0001 00000000 EXT    EMS 00000000_0123E7D4 00001201 40800000 02FD7958 00000000 00000000 0001 0001 17:34:41.919299338
                                05041000 80000000 8ACA51AE          00000000
. . . . . Etc . . . . .
    
```

Questions?