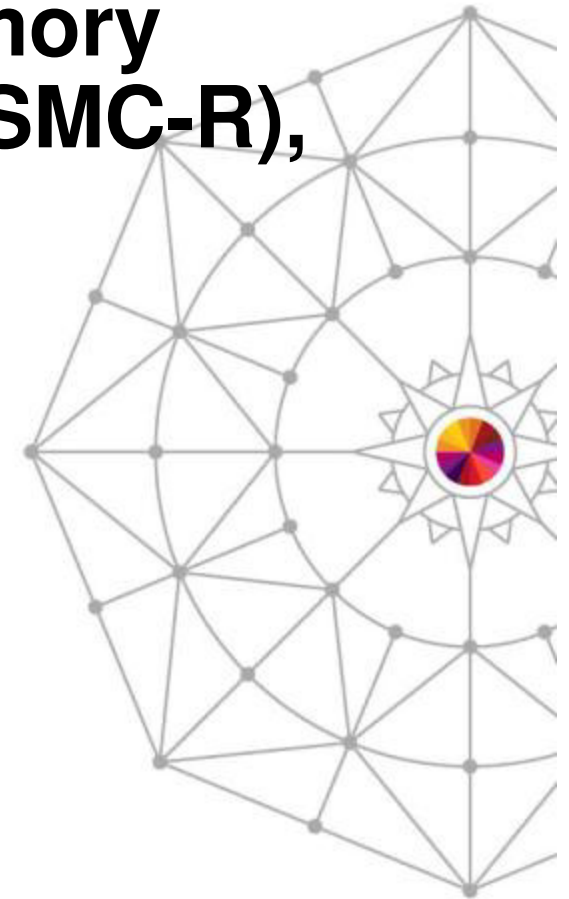




z/OS V2R1 CS: Shared Memory Communications - RDMA (SMC-R), Part 2

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Agenda



Shared Memory Communications – RDMA (SMC-R), Part 2

- SMC-R Configuration and Monitoring
- SMC-R Diagnosis
- Appendix - SMC-R Network Management Interface and SMF enhancements



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SMC-R References

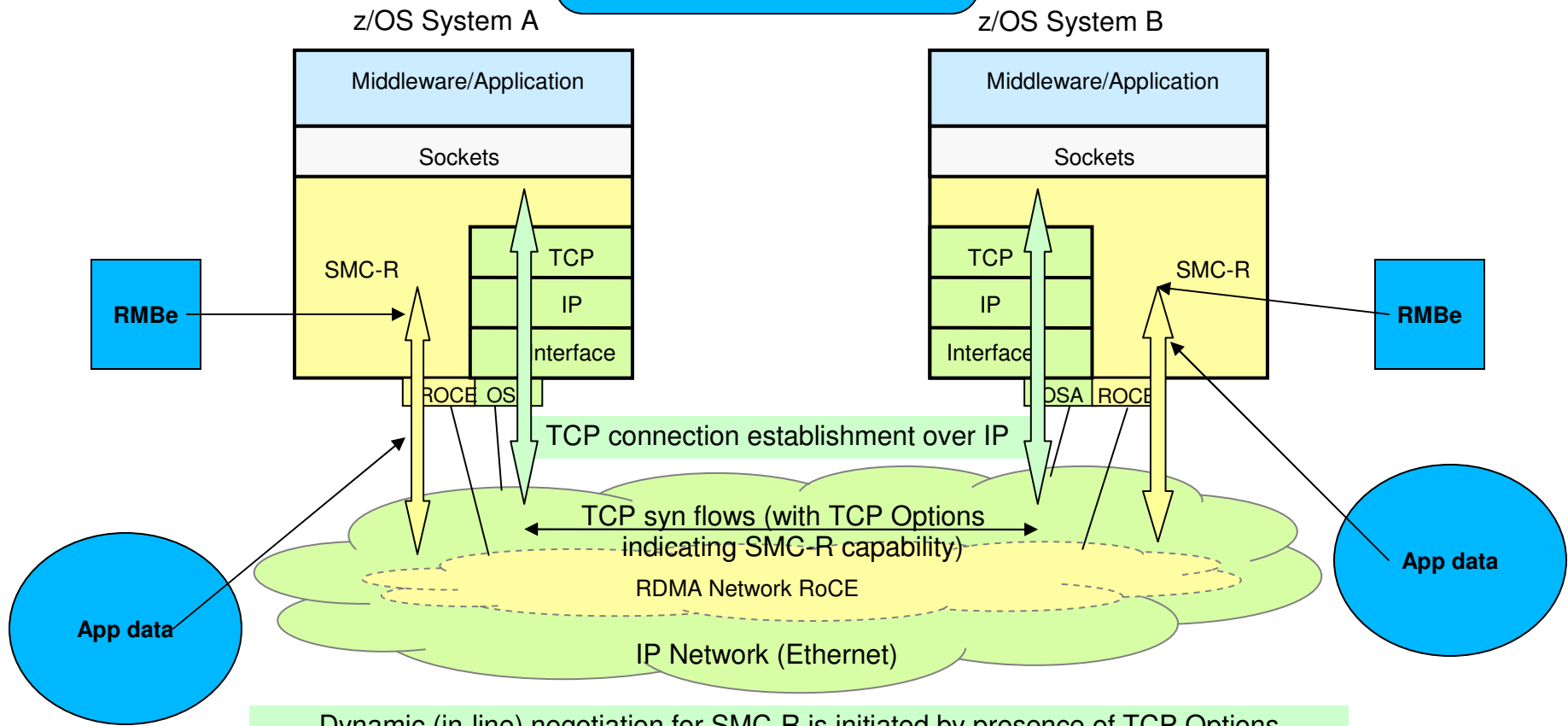
- SMC-R Overview
 - <https://share.confex.com/share/121/webprogram/Session13627.html>
 - Overview with audio (youtube):
 - http://www.youtube.com/watch?v=8_5JviApQXw
- SMC-R Implementation:
 - <https://share.confex.com/share/121/webprogram/Session13628.html>
 - With audio (youtube):
 - <https://www.youtube.com/watch?v=TN0eS-l1FoE>
- Shared Memory Communications over RDMA: Performance Considerations (White Paper)
 - <http://www-01.ibm.com/support/docview.wss?uid=swg27041273>
- Performance information:
 - <https://share.confex.com/share/121/webprogram/Session13633.html>
- FAQ:
 - <https://www-03.ibm.com/support/techdocs/atmastr.nsf/WebIndex/FQ131485>
- Diagnosing Problems with SMC-R
 - <http://www-01.ibm.com/support/docview.wss?uid=swg27039578>
- RFC:
 - <http://tools.ietf.org/html/draft-fox-tcpm-shared-memory-rdma-03>
- SMC-R and Security Considerations White Paper:
 - <http://w3.ibm.com/sales/support/ShowDoc.wss?docid=ZSW03255USEN>

Shared Memory Communications – Remote (SMC-R)

V2R1

SMC-R Background

Both TCP and SMC-R “connections” remain active



Dynamic (in-line) negotiation for SMC-R is initiated by presence of TCP Options

TCP connection transitions to SMC-R allowing application data to be exchanged using RDMA

- Key attributes of RDMA
 - Enables a host to read or write directly from/to a remote host's memory ***without*** involving the remote host's CPU
 - By registering specific memory for RDMA partner use
 - **Interrupts still required for notification (i.e. CPU cycles are not completely eliminated)**
 - Reduced networking stack overhead by using streamlined, low level, RDMA interfaces
 - Key requirements:
 - A reliable “lossless” network fabric (LAN for layer 2 data center network distance)
 - An RDMA capable NIC (RNIC) and RDMA capable switched fabric (switches)

Comm Server SMC-R - Solution

V2R1

- Shared Memory Communications over RDMA (SMC-R) is a protocol that allows *TCP sockets* applications to transparently exploit RDMA (RoCE)
- SMC-R is a “hybrid” solution that:
 - Uses TCP connection (3-way handshake) to establish SMC-R connection
 - Each TCP end point exchanges TCP options that indicate whether it supports the SMC-R protocol
 - SMC-R “rendezvous” (RDMA attributes) information is then exchanged within the TCP data stream (similar to SSL handshake)
 - Socket application data is exchanged via RDMA (write operations)
 - TCP connection remains active (controls SMC-R connection)
 - This model preserves many critical existing operational and network management features of TCP/IP

SMC-R Configuration and Monitoring

SMC-R Configuration and Monitoring

- System requirements
- TCP/IP Profile changes
- Netstat report and TCP/IP display changes
- VTAM command changes
- SMF enhancements

SMC-R System Requirements

- Before using SMC-R, you must take these actions:
 - Configure these values using Hardware Configuration Definition (HCD):
 - PCIe function ID (PFID)
 - *Configure two PFIDs per physical network for redundancy*
 - Physical network ID (PNet ID) for OSA and RNIC interfaces
 - ***NOTE: PNet IDs are required for SMC-R enabled OSD devices and RoCE adapters***
 - Configure Ethernet switches appropriately
 - Optionally define VLAN ID values to be used
 - Enable “flow control” capability

SMC-R HCD Configuration

```

Goto  Filter  Backup  Query  Help
-----
Actions on selected processors

Command ==>

Select one or

/ Proc. ID Ty
_ D76    20
_ H87    20
_ H88    20
_ MR31   28
_ PBUV4  28
/ P88    28
*****

8_  1.  Add like . . . . . (a)
    2.  Repeat (Copy) processor configurations (r)
    3.  Change . . . . . (c)
    4.  *Prime serial number . . . . . (i)
    5.  Delete . . . . . (d)
    6.  View processor definition . . . . . (v)
    7.  View related CTC connections . . . . . (k)
    8.  Work with functions . . . . . (f)
    9.  Work with partitions . . . . . (SMP) (p)
   10. Work with attached channel paths (SMP) (s)
   11. Work with attached devices . . . (SMP) (u)
   12. Copy to channel subsystem . . . (SMP) (y)
   13. Work with channel subsystems . . (XMP) (p,s)

* = requires TSA I/O Operations
F1=Help    F2=Split    F3=Exit    F9=Swap    F12=Cancel
F8=Forward
F20=Right  F22=Command
  
```

HCD Main Panel:
1
3 (Processor list)
Then select (/) processor

SMC-R HCD Configuration

8 RoCE Adapters defined
Function IDs used by
TCPIP config

```
Goto Filter Backup Query Help
-----
PCie Function List          Row 1
Command ==> _____  Sc PAGE
Select one or more PCie functions, then press Enter. To add, use F11.
Processor ID . . . . . : P88          zHelix P88


/ FID  PCHID  VF+  Type+  Description
a 001   380    ___  ROCE   _____
- 002   3A0    ___  ROCE   _____
- 003   3C0    ___  ROCE   _____
- 004   3E0    ___  ROCE   _____
- 005   500    ___  ROCE   _____
- 006   520    ___  ROCE   _____
- 007   540    ___  ROCE   _____
- 008   560    ___  ROCE   _____
***** Bottom of data *****
F1=Help      F2=Split    F3=Exit     F4=Prompt   F5=Backward
F8=Forward   F9=Swap     F10=Actions F11=Add     F12=Cancel  F13=Instruct
F20=Right    F22=Command
```

Physical Channel IDs

SMC-R HCD Configuration – Define a PFID

```
Goto Filter Backup Query Help
-----
PCie Function List
Command ==> _____ Scroll ==> PAGE
S
P
Add PCie Function
Specify or revise the following values.
Processor ID . . . . . : P88          zHelix P88
Function ID . . . . . : ROCE
Type . . . . . : ROCE          +
PCHID . . . . . : 380
Virtual Function ID . . . . . :        +
Description . . . . . : _____
*
F1=Help   F2=Split  F3=Exit   F4=Prompt  F5=Reset  F9=Swap
F12=Cancel

F20=Right  F22=Command
```



SMC-R HCD Configuration – Add PNETID

```

Goto  Filter  Backup  Query  Help
-  -----  Add/Modify Physical Network
C
S  If the PCHID is associated to one or more phys
S  each physical network ID corresponding to each
P  Physical network ID 1 . . NETWORK1
   Physical network ID 2 . . _____
   Physical network ID 3 . . _____
   Physical network ID 4 . . _____
/
c
-
-  F1=Help      F2=Split      F3=Exit      F5=Reset      F9=Swap      F12=Cancel
-
-  006      520      ___      ROCE
-  007      540      ___      ROCE
-  008      560      ___      ROCE
***** Bottom of data *****
F1=Help      F2=Split      F3=Exit      F4=Prompt      F5=
F8=Forward    F9=Swap      F10=Actions  F11=Add        F12=
F20=Right     F22=Command

```

NOTE: Each Physical Network ID entry correlates to a physical port on the Adapter. For RoCE Express, entry 1 correlates to port 1, entry 2 to port 2. For OSA Express entry 1 correlates to Port 0, entry 2 to Port 1

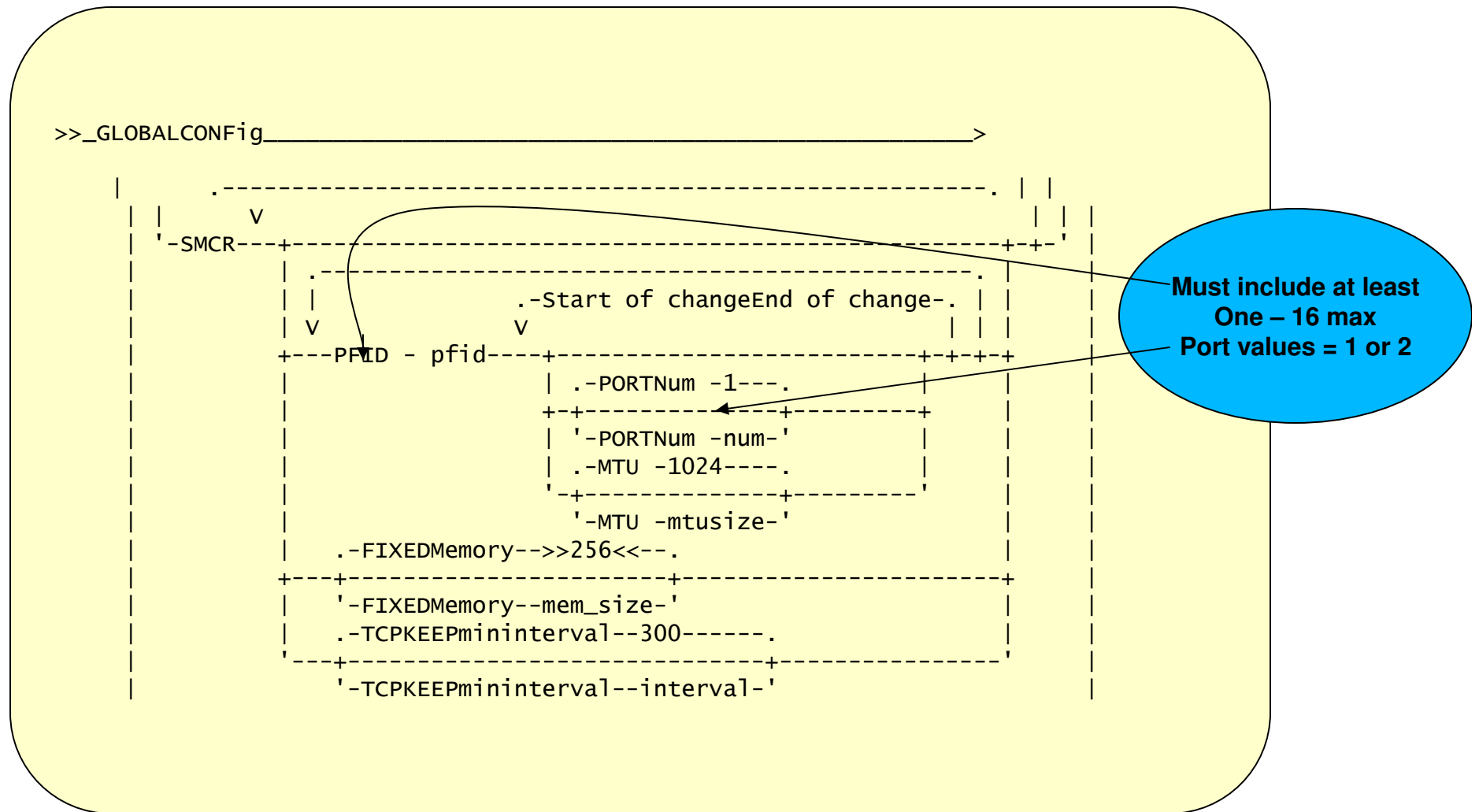
Associates this RoCE adapter to an OSA interface with Same PNETID

SMC-R TCP/IP Configuration

- GLOBALCONFIG statement – Required update
- IPAQENET INTERFACE statement
- IPAQENET6 INTERFACE statement
- PORT statement
- PORTRANGE statement

- SMFCONFIG statement
 - Details are covered with the Network Management enhancements - Appendix

SMC-R TCP/IP Configuration



EZARIUTxyyyy for RNIC interface, **IUTxyyyy** for TRLE, where **x** = PORTNUM and **yyyy** = PFID

SMC-R TCP/IP Configuration – Enable/Disable

- Switching from SMCR to NOSMCR
 - Prevents new TCP connections from using SMC-R and new SMC-R links from being started
 - Existing SMC-R links and TCP connections unaffected
 - SMC-R links are deleted when no more TCP connections are using them
- Switching from NOSMCR to SMCR
 - Existing TCP connections are unaffected, but new TCP connections are eligible to use SMC-R
 - Previous SMCR settings, if any, are used unless new values provided

SMC-R TCP/IP Configuration – Modifying PFIDs

- Full replacement of PFID values
 - PFIDs that you want to continue using must be included on GLOBALCONFIG SMCR statement
 - New PFIDs in list are automatically started, assuming an SMC-R capable OSD interface had been started previously
- Steps to delete an existing RNIC interface
 - VARY STOP the RNIC interface
 - Delete PFID value from the GLOBALCONFIG SMCR statement
 - Issue VARY OBEYFILE
 - RNIC interface is deleted when VARY OBEYFILE completes successfully

SMC-R TCP/IP Configuration – FIXEDMemory

- Maximum amount of fixed 64-bit private storage that TCP/IP can use for SMC-R processing
 - Includes RMB storage and staging buffer storage
- Valid range is 30-9999 (megabytes)
 - Defaults to FIXEDM 256 (megabytes)
- Can be changed using VARY OBEYFILE
 - If SMCR statement specified without FIXEDMemory, the limit is unchanged
 - Lowering the storage limit does not impact existing SMC-R links or TCP connections

SMC-R TCP/IP Configuration – Fixed Memory estimation

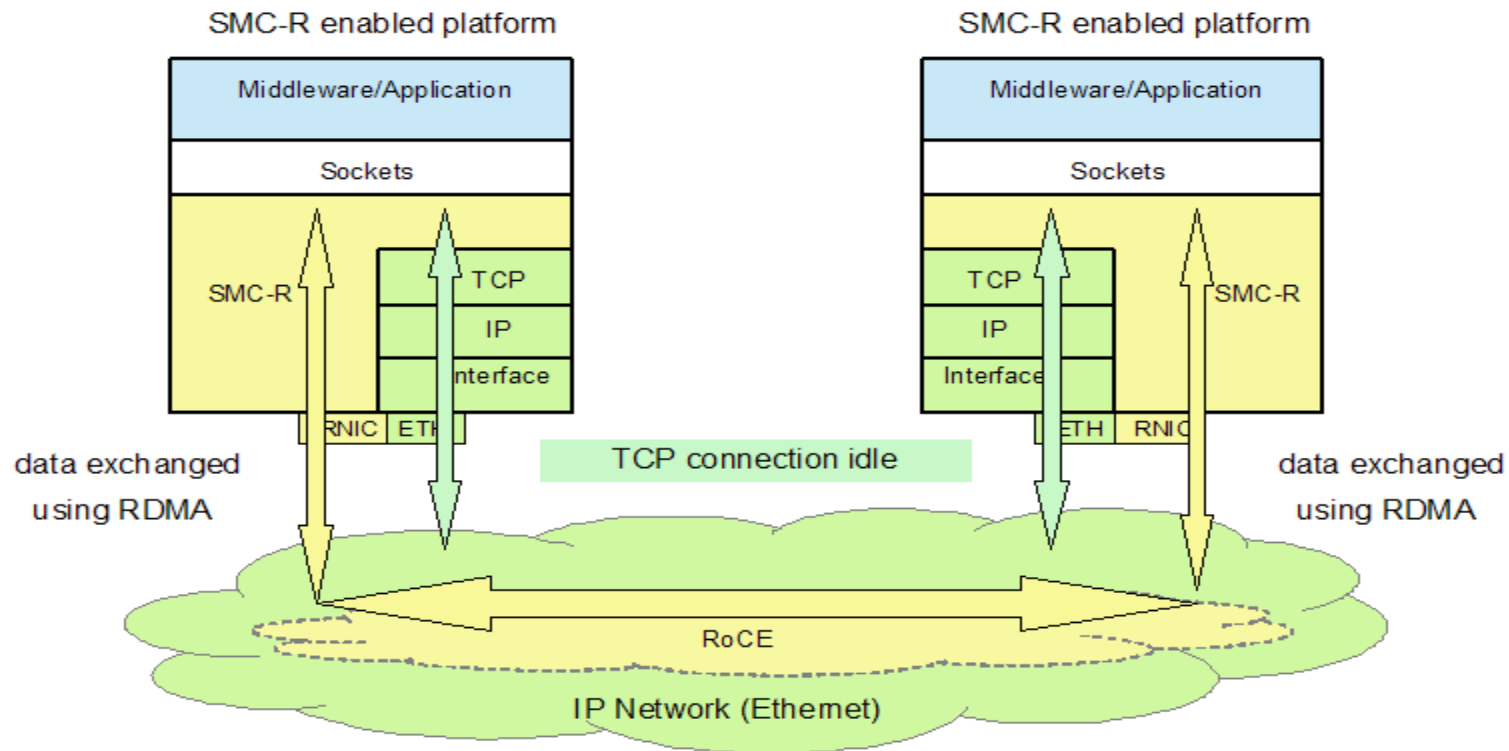
- Configuration and workload assumptions:
 - 2 PFIDs, all on the same physical network
 - 12 SMC-R link groups expected (3 VLANs, 4 peers per VLAN)

"Staging buffers"	=	8M
PFIDs (2 PFIDs*1M)	=	2M
RMBs (12 link groups*3M)	=	36M
Workload ((224 connections/8)*1M)	=	<u>28M</u>
TOTAL	=	74M

Estimation only!
Use Display TCPIP,,STOR
to determine the
right amount for you

TCP connections using SMC-R appear idle - KEEPALIVE

- All application data flows “out-of-band” with SMC-R
- TCP connection is maintained, but just for control purposes



SMC-R TCP/IP Configuration – *SMCR*

TCPKEEPmininterval

- Load balancers might use data traffic as an indication that a TCP connection is healthy
 - Could terminate the connection if no data flows within a certain period of time
- TCP keepalive processing periodically sends a packet over existing TCP connections
 - Application indicates connection is eligible for keepalive by specifying the `SO_KEEPALIVE` `setsockopt()` option
 - Time interval to use is determined by these criteria:
 - `TCP_KEEPALIVE` `setsockopt()` option, if specified
 - `TCPCONFIG INTERVAL` value, or default

SMC-R TCP/IP Configuration – *SMCR* *TCPKEEPmininterval*

- Defines, in seconds, the minimum interval that TCP keepalive packets are sent for TCP connections using SMC-R links
- Valid range is 0 – 2147460 (seconds)
 - 0 means no TCP keepalive packets are to be sent
 - Defaults to TCPKEEP 300 (seconds, or five minutes)
- Can be changed using VARY OBEYFILE
 - If SMCR statement specified without TCPKEEPmininterval, the minimum interval is unchanged
 - The changed value applies to existing SMC-R links and the TCP connections using those links

SMC-R keepalive example

- Assume these values have been specified:
 - Application specifies `SO_KEEPALIVE` and `TCP_KEEPALIVE` `setsockopt()` as 5 minutes
 - `TCPCONFIG INTERVAL` set to 10 minutes
 - `GLOBALCONFIG SMCR TCPKEEP` set to 25 minutes
- For TCP connections that use SMC-R:
 - TCP connection probes sent every 25 minutes
 - SMC-R link probes sent every 5 minutes
- For TCP connections that do not use SMC-R:
 - TCP connection probes sent every 5 minutes



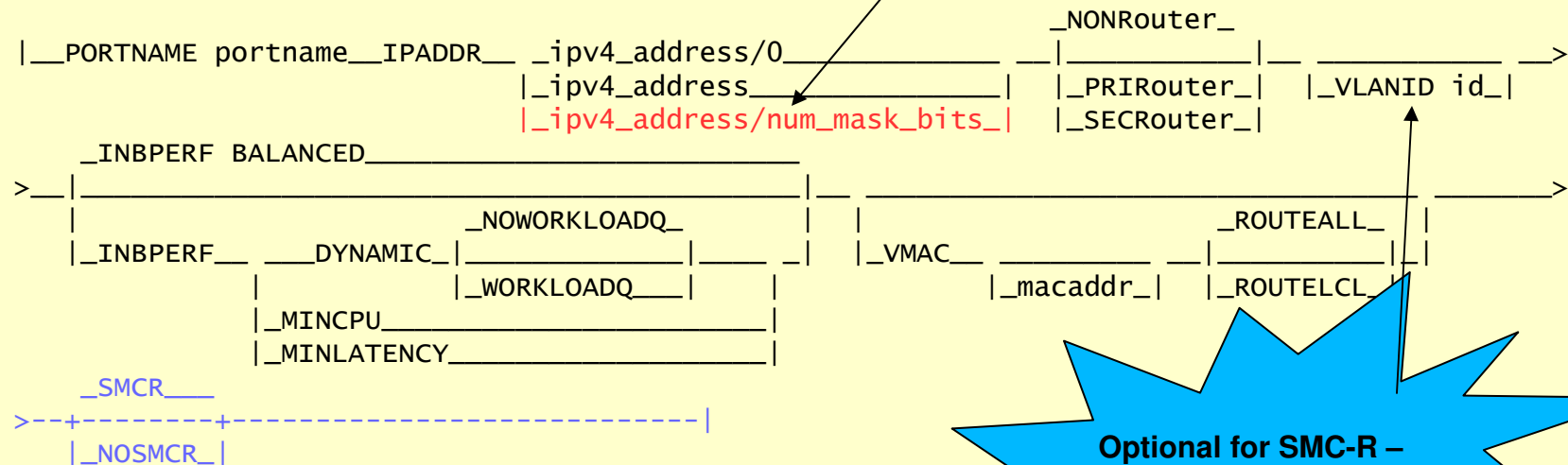
New parm for SMC-R

SMC-R TCP/IP Configuration – OSA Interface

- IPAQENET INTERFACE statements
 - SMCR only valid for CHPIDTYPE OSD
 - SMCR cannot be used with IPv4 OSD interfaces defined using DEVICE and LINK statements

Must be non-zero subnet
For SMC-R

OSD interface definition:



Optional for SMC-R –
RoCE inherits VLANID
from associated OSD

SMC-R TCP/IP Configuration – Server control



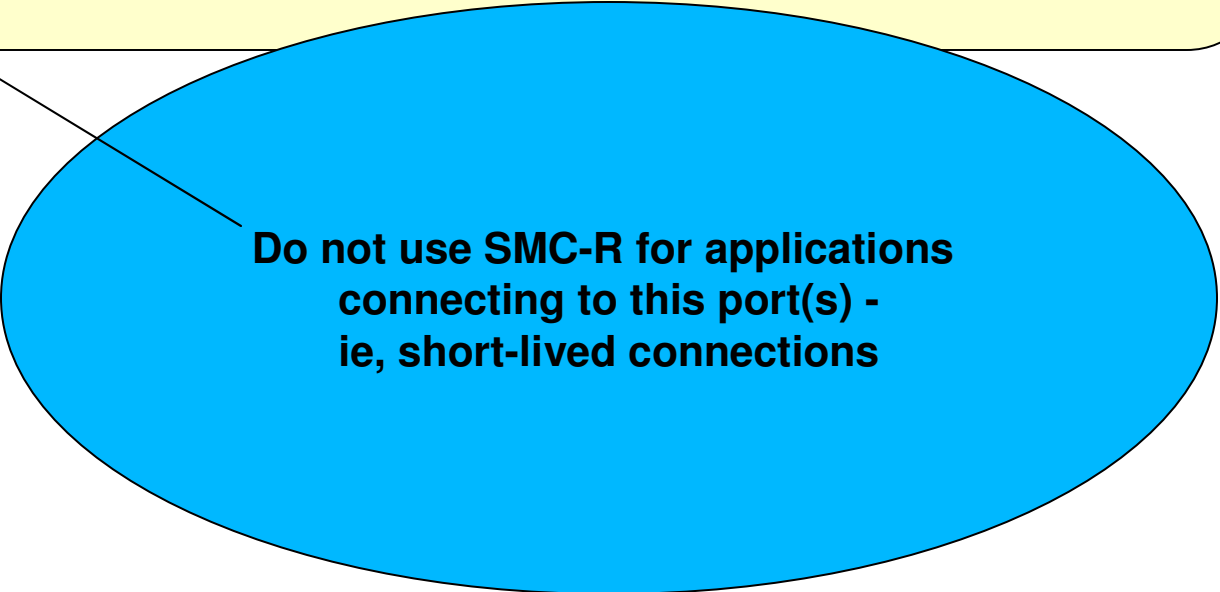
**PORT or
PORTRANGE**

```
>> _PORT_ | V_num | TCP | _RESERVED_ | _><
          | _jobname_ |
          | _ Options _ |
```

Options:

```
| _ DELAYAcks _ |
| _NOAUTOLog_ | | _NODELAYAcks_ | | _SHAREPort_ | | _BIND ipaddr_ | | _SAF resname_ |
| _SHAREPORTWLM_ |
```

```
>> | _NOSMCR_ |
```



**Do not use SMC-R for applications
connecting to this port(s) -
ie, short-lived connections**

SMC-R TCP/IP Configuration – SYNTAXCHECK

- Can be used to validate SMCR profile changes before use
- Run against profile data set

```
11.53.38 v tcpip,tcpcs3,syntaxcheck,dsn=user.tcparms(tcpcs3)
11.53.38 EZZ0060I PROCESSING COMMAND: VARY TCPIP,TCPCS3,SYNTAXCHECK,
        DSN=USER.TCPPARMS(TCPCS3)
11.53.38 EZZ0061I VARY SYNTAXCHECK COMMAND BEGINNING
11.53.38 EZZ0300I OPENED SYNTAXCHECK FILE 'USER.TCPPARMS(TCPCS3) '
11.53.38 EZZ0309I PROFILE PROCESSING BEGINNING FOR
        'USER.TCPPARMS(TCPCS3) '
11.53.38 EZZ0316I PROFILE PROCESSING COMPLETE FOR FILE
        'USER.TCPPARMS(TCPCS3) '
11.53.38 EZZ0062I VARY SYNTAXCHECK FOUND NO ERRORS
11.53.38 EZZ0065I VARY SYNTAXCHECK COMMAND COMPLETE

11.54.32 v tcpip,tcpcs3,syntaxcheck,dsn=user.tcparms(tcpcs3)
11.54.32 EZZ0060I PROCESSING COMMAND: VARY TCPIP,TCPCS3,SYNTAXCHECK,
        DSN=USER.TCPPARMS(TCPCS3)
11.54.32 EZZ0061I VARY SYNTAXCHECK COMMAND BEGINNING
11.54.32 EZZ0300I OPENED SYNTAXCHECK FILE 'USER.TCPPARMS(TCPCS3) '
11.54.32 EZZ0309I PROFILE PROCESSING BEGINNING FOR
        'USER.TCPPARMS(TCPCS3) '
11.54.32 EZZ0312I THE MTU ON LINE 3 CONTAINS AN INCORRECT VALUE 8000
11.54.32 EZZ0316I PROFILE PROCESSING COMPLETE FOR FILE
        'USER.TCPPARMS(TCPCS3) '
11.54.32 EZZ0064I VARY SYNTAXCHECK FOUND ERRORS: SEE PREVIOUS MESSAGES
        11.54.32 EZZ0065I VARY SYNTAXCHECK COMMAND COMPLETE
```

SMC-R Monitoring - PCIe

- Activation of first SMC-R capable OSD causes PFIDs to be activated
- Use DISPLAY PCIE command to display defined PFIDs

```
D PCIE
IQP022I 10.35.27 DISPLAY PCIE
PCIE      0011 ACTIVE
PFID     DEVICE TYPE NAME      STATUS  ASID  JOBNAME  PCHID
001C     10GbE RoCE                CNFG   ← 0578
0015     10GbE RoCE                STNBY  ← 052C
0018     10GbE RoCE                CNFG   ← 0540
```

```
V TCPIP,TCPCS1,START,OSD1
EZZ0060I PROCESSING COMMAND: VARY TCPIP,TCPCS1,START,OSD1
EZZ0053I COMMAND VARY START COMPLETED SUCCESSFULLY
EZZ4340I INITIALIZATION COMPLETE FOR INTERFACE OSD1
EZZ4340I INITIALIZATION COMPLETE FOR INTERFACE EZARIUT1001C
EZZ4340I INITIALIZATION COMPLETE FOR INTERFACE EZARIUT20018
```

Two RoCEs ready for use on this LPAR

First SMC-R enabled OSD activated – All CNFG RoCEs activated

```
D PCIE
IQP022I 10.38.17 DISPLAY PCIE
PCIE      0011 ACTIVE
PFID     DEVICE TYPE NAME      STATUS  ASID  JOBNAME  PCHID
001C     10GbE RoCE                ALLC   0039  VTAMCS  0578
0015     10GbE RoCE                STNBY
0018     10GbE RoCE                ALLC   0039  VTAMCS  0540
```

SMC-R Monitoring – RoCE statistics

- *DISPLAY TRL,TRLE,DEVSTATS* output
- Statistics represent **adapter** activity
- DEVSTATS new and only valid for RoCE devices

```
D NET,TRL,TRLE=IUT1001C,DEVSTATS
IST097I DISPLAY ACCEPTED
...
IST314I END
```

```
IST2396I RNIC STATISTICS FOR IUT1001C
```

IST2397I DESCRIPTION	OVERFLOW	COUNT
IST924I -----		
IST2398I INBOUND RDMA FRAMES	0	65535
IST2398I INBOUND RDMA OCTETS	2	4294967295
IST2398I INBOUND FRAME ERRORS	0	0
IST2398I INBOUND DROPPED FRAMES	0	0
IST2398I OUTBOUND RDMA FRAMES	0	65160
IST2398I OUTBOUND RDMA OCTETS	2	4414812756
IST2398I OUTBOUND FRAME ERRORS	0	0
IST2398I OUTBOUND DROPPED FRAMES	0	0
IST314I END		

SMC-R Monitoring – Netstat changes

- Netstat ALL/-A report
- Netstat ALLConn/-a report
- Netstat CONFIG/-f report
- Netstat COnn/-C report
- Netstat DEvlinks/-d report
- Netstat PORTList/-o report
- Netstat STATS/-S report
- D TCPIP,,STOR command

SMC-R Monitoring – Netstat changes

- Netstat ALL/-A report provides SMC-R information about TCP connections when SMC-R is enabled
 - If TCP connection uses SMC-R, provides SMC link ID and link group ID information
 - If TCP connection does not use SMC-R, provides reason code
- All three connection reports support SMCID/-U filter
 - Reports only those connections using the specified SMC-R link or link group
 - Can specify * on the filter to report all connections using SMC-R

SMC-R Monitoring – Netstat ALL changes

```
D TCPIP,TCPCS1,NETSTAT,ALL,IPPORT=10.1.1.14+21
EZD0101I NETSTAT CS V2R1 TCPCS1
CLIENT NAME: FTPDOE34          CLIENT ID: 0000003B
LOCAL SOCKET: ::FFFF:10.1.1.14..21
FOREIGN SOCKET: ::FFFF:10.1.1.24..1024
```

...

SMC INFORMATION:

SMCSTATUS:	ACTIVE	SMCGROUPID:	2D8F0100
LOCALSMCLINKID:	2D8F0101	REMOTESMCLINKID:	729D0101
LocalSMCRcvBuf:	64K	RemoteSMCRcvBuf:	64K

```
1 OF 1 RECORDS DISPLAYED
END OF THE REPORT
```

Connection is using
SMC-R!!

- SMCID filter – Show only SMC-R connections with xxxxxxxx link or group ID
 - Asterisk (*) can be specified to show all SMC-R connections
 - Works on CONN and ALLCONN commands

SMC-R Monitoring – Netstat ALL changes

```
D TCPIP,TCPCS1,NETSTAT,ALL,IPPORT=10.1.1.14+21
EZD0101I NETSTAT CS V2R1 TCPCS1
CLIENT NAME: FTPDOE34          CLIENT ID: 0000003B
LOCAL SOCKET: ::FFFF:10.1.1.14..21
FOREIGN SOCKET: ::FFFF:10.1.1.24..1024
...
SMC INFORMATION:
SMCSTATUS:          INACTIVE
SMCREASON:          00005301 - PEER DID NOT ACCEPT SMC-R REQUEST
-----
1 OF 1 RECORDS DISPLAYED
END OF THE REPORT
```

Connection is not using
SMC-R!!

```
D TCPIP,TCPCS1,NETSTAT,ALL,IPPORT=10.1.1.14+21
EZD0101I NETSTAT CS V2R1 TCPCS1
CLIENT NAME: FTPDOE34          CLIENT ID: 0000003B
LOCAL SOCKET: ::FFFF:10.1.1.14..21
FOREIGN SOCKET: ::FFFF:10.1.1.24..1024
...
SMC INFORMATION:
SMCSTATUS:          INACTIVE
SMCREASON:          00008888 - *Peer generated*
-----
1 OF 1 RECORDS DISPLAYED
END OF THE REPORT
```

Connection is not using
SMC-R – Reason
generated by Peer

SMC-R Monitoring – Netstat ALL

- For SMC-R connections:
 - BytesIn and BytesOut equal data sent/received on this SMC-R link for this connection
 - SegmentsIn and SegmentsOut are count of RDMA read/write operations
 - Other fields reflect the TCP component of the connection

Data over SMC-R link

```
D TCPIP,TCPCS1,NETSTAT,ALL,IPPORT=10.1.1.14+21
```

```
MVS TCP/IP NETSTAT CS V2R1          TCPIP Name: TCPCS          21:42:39
Client Name: FTPD1                  Client Id: 000000F9
Local Socket: 9.42.104.43..21      Foreign Socket: 9.42.103.165..1035
BytesIn:          0000000035      BytesOut:          0000000265
SegmentsIn:      0000000017      SegmentsOut:      0000000014
Last Touched:    21:41:20        State:            Establish
RcvNxt:          0214444666      SndNxt:          0216505563
ClientRcvNxt:    0214443596      ClientSndNxt:    0216504670
InitRcvSeqNum:   0214443560      InitSndSeqNum:   0216504404
```

SMC-R Monitoring – Netstat CONFIG changes

```
GLOBAL CONFIGURATION INFORMATION:  
TCPIPSTATS: YES  ECSALIMIT: 2096128K  POOLLIMIT: 2096128K  
MLSCHKTERM: NO   XCFGRPID: 11         IQDVLANID: 27  
  
SYSPLEXWLMPOLK: 060  MAXRECS: 100  
EXPLICITBINDPORTRANGE: 05000-06023  IQDMULTIWRITE: YES  
WLMRIORITYQ: YES  
  IOPRI1 0 1  
  IOPRI2 2  
  IOPRI3 3 4  
  IOPRI4 5 6 FWD  
SYSPLEX MONITOR:  
  TIMERSECS: 0060  RECOVERY: YES  DELAYJOIN: NO  AUTOREJOIN: YES  
  MONINTF:  YES  DYNROUTE: YES  JOIN:  YES  
ZIIP:  
  IPSECURITY: YES  IQDIOMULTIWRITE: YES  
SMCR: YES  
  FIXEDMEMORY: 200M  TCPKEEPMININT: 00000300  
  PFID: 001C  PORTNUM: 1  
  PFID: 0015  PORTNUM: 2
```



**2 RoCE adapters
defined**

Netstat CONFIG/-f report includes new GLOBALCONFIG SMCR settings

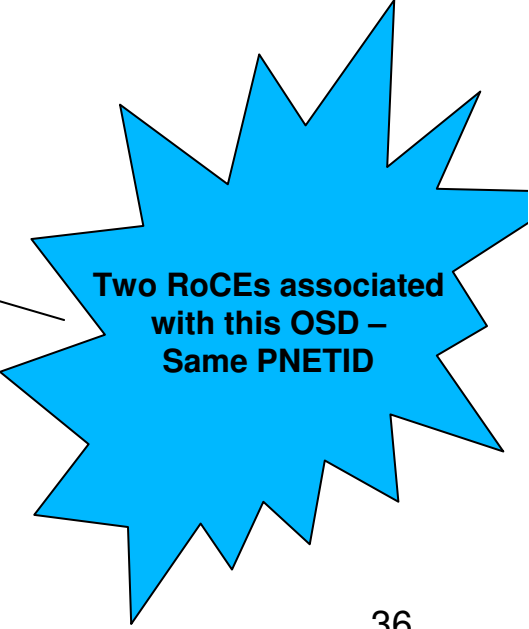
SMC-R Monitoring – Netstat DEVLINKS changes

```
D TCPIP,TCPCS1,NETSTAT,DEVLINKS,INTFNAME=OSD1
EZD0101I NETSTAT CS V2R1 TCPCS1
INTFNAME: OSD1          INTFTYPE: IPAQENET  INTFSTATUS: READY
PORTNAME: OSDP00B     DATAPATH: 0B22    DATAPATHSTATUS: READY
CHPIDTYPE: OSD        SMCR: YES
PNETID: ZOSNET
...
VLANID: 100          VLANPRIORITY: DISABLED
...
ASSOCIATED RNIC INTERFACE: EZARIUT1001C
ASSOCIATED RNIC INTERFACE: EZARIUT20015

D TCPIP,TCPCS1,NETSTAT,DEVLINKS,INTFNAME=OSXC9INT1
EZD0101I NETSTAT CS V2R1 TCPCS1
INTFNAME: OSXC9INT1    INTFTYPE: IPAQENET  INTFSTATUS: READY
PORTNAME: IUTXP0C9    DATAPATH: 0E56    DATAPATHSTATUS: READY
CHPIDTYPE: OSX        CHPID: C9
PNETID: IEDN
```



RoCEs will use same VLANID



Two RoCEs associated with this OSD – Same PNETID

Netstat DEvlinks/-d report shows associated RoCE adapters

SMC-R Monitoring – Netstat DEVLINKS, SMC changes

```
D TCPIP,TCPCS1,NETSTAT,DEVLINKS,SMC
EZD0101I NETSTAT CS V2R1 TCPCS1
INTFNAME: EZARIUT1001C      INTFTYPE: RNIC      INTFSTATUS: READY
PFID: 001C  PORTNUM: 1  TRLE: IUT1001C
PNETID: ZOSNET
VMACADDR: 02000035F740
GIDADDR:  FE80::200:FF:FE35:F740
INTERFACE STATISTICS:
  BYTESIN                = 160
  INBOUND OPERATIONS    = 5
  BYTESOUT               = 344
  OUTBOUND OPERATIONS   = 11
  SMC LINKS              = 1
  TCP CONNECTIONS       = 1
  INTF RECEIVE BUFFER INUSE = 64K
SMC LINK INFORMATION:
LOCALSMCLINKID: 2D8F0101  REMOTESMCLINKID: 729D0101
SMCLINKGROUPID: 2D8F0100  VLANID: 100  MTU: 1024
LOCALGID:  FE80::200:FF:FE35:F740
  LOCALMACADDR: 02000035F740  LOCALQP: 000040
REMOTEGID: FE80::200:1FF:FE35:F740
  REMOTEMACADDR: 02000135F740  REMOTEQP: 000041
SMCLINKBYTESIN:          160
SMCLINKINOPERATIONS:     5
SMCLINKBYTESOUT:         344
SMCLINKOUTOPERATIONS:    11
TCP CONNECTIONS:         1
LINK RECEIVE BUFFER INUSE: 64K
  64K  BUFFER INUSE:     64K
```

One SMC link over this
RoCE adapter

What size RMB is this
connection using

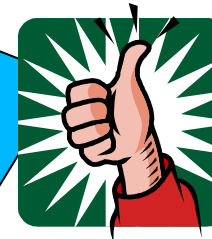
SMC-R Monitoring – Netstat changes

```
SMC LINK GROUP INFORMATION:  
SMCLINKGROUPID: 2D8F0100 PNETID: ZOSNET  
REDUNDANCY: FULL  
LINK GROUP RECEIVE BUFFER TOTAL: 3M  
64K ← BUFFER TOTAL: 1M  
LOCALSMCLINKID REMOTESMCLINKID  
-----  
2D8F0101 729D0101  
2D8F0102 729D0102  
2 OF 2 RECORDS DISPLAYED  
END OF THE REPORT
```

Total RMB storage for this group
and type in use

Two SMC-R links in this group

Full redundancy – this
is the ideal setting



A bit more about redundancy

- SMC-R link groups provide for load balancing and recovery
 - New TCP connection is assigned to the SMC-R link with the fewest TCP connections
 - Load balancing only performed when multiple RNIC adapters are available at each peer
- Full redundancy requires:
 - Two or more RoCE Express adapters at each peer
 - Follow installation guidelines to assure each (PCIe) adapter has a unique system internal path:
 - RoCE Express adapter I/O drawer plugging / provisioning: Each LPAR is provisioned 2 adapters where:
 - * 1st card is plugged into the left side and
 - * 2nd card is plugged into the right side of the I/O drawer
(using hardware configuration tools: eConfig, HCD and CMT)
 - Unique physical RoCE switches
- Partial redundancy still possible in the absence of one or more of these conditions

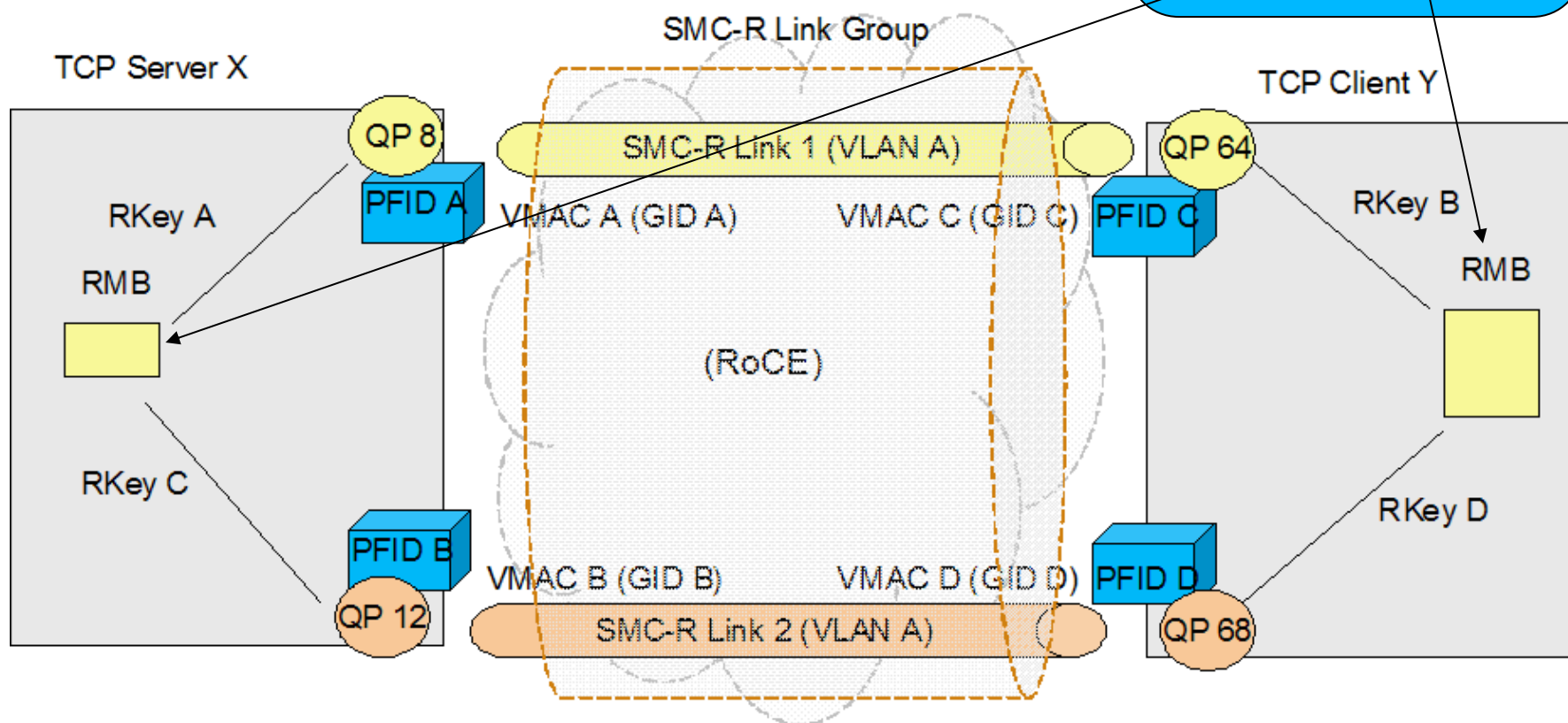


CHPID Mapping Tool

A bit more about redundancy

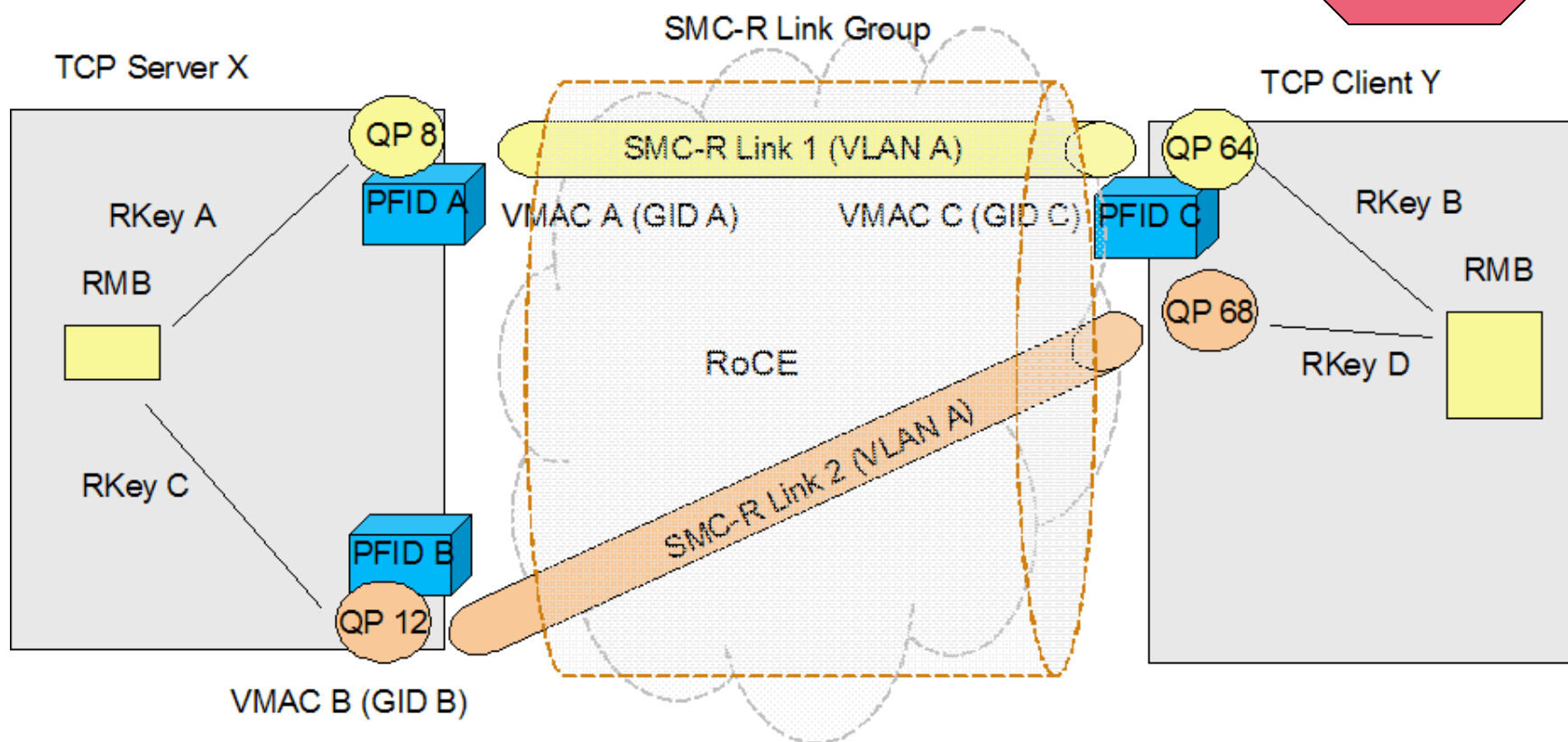
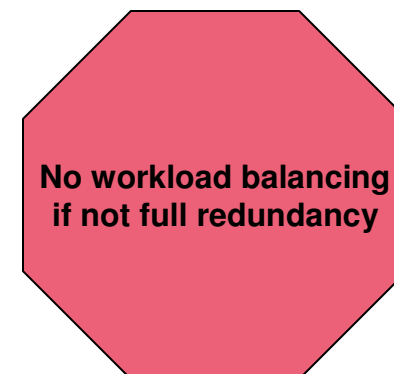
- Full failover capability exists at both server and client
 - Recommended configuration

Note the redundant links share the same RMB(s)



A bit more about redundancy

- Partial redundancy
 - Failover recovery is possible at the TCP server, but not at the TCP client



SMC-R Monitoring – Netstat STATS changes

```
D TCPIP,TCPCS1,NETSTAT,STATS,PROTOCOL=TCP
EZD0101I NETSTAT CS V2R1 TCPCS1
TCP STATISTICS
  CURRENT ESTABLISHED CONNECTIONS      = 2
  ...
  CONNECTIONS DROPPED BY KEEPALIVE     = 0
  CONNECTIONS DROPPED BY FINWAIT2     = 0
SMCR STATISTICS
  CURRENT ESTABLISHED SMC LINKS        = 2
  SMC LINK ACTIVATION TIME OUTS       = 0
  ACTIVE SMC LINKS OPENED              = 0
  PASSIVE SMC LINKS OPENED             = 2
  SMC LINKS CLOSED                     = 0
  CURRENT ESTABLISHED CONNECTIONS     = 2
  ACTIVE CONNECTIONS OPENED            = 0
  PASSIVE CONNECTIONS OPENED           = 2
  CONNECTIONS CLOSED                   = 0
  SEGMENTS RECEIVED                    = 8
  SEGMENTS SENT                        = 284
  RESETS SENT                           = 0
  RESETS RECEIVED                      = 0
END OF REPORT
```



Blue – SMC-R only stats
Red - Subset of TCP statistics

Netstat STATS/-S report shows SMC-R connection stats with PROTOCOL=TCP

SMC-R Monitoring – Display STOR command

```
D TCPIP,TCPCS1,STOR
EZZ8453I TCPIP STORAGE
EZZ8454I TCPCS1 STORAGE CURRENT MAXIMUM LIMIT
EZZ8455I 2925K 3972K NOLIMIT
EZZ8455I PRIVATE 8980K 8980K NOLIMIT
EZZ8455I ECSA MODULES 10073K 10073K NOLIMIT
EZZ8455I 1M 1M NOLIMIT
EZZ8455I HVPRIVATE 2M 2M NOLIMIT
EZZ8455I TRACE HVCOMMON 2579M 2579M 2579M
EZZ8455I SMC-R FIXEDMEMORY 11M 11M 256M
EZZ8455I SMC-R SEND MEMORY 4M 4M
EZZ8455I SMC-R RECV MEMORY 3M 3M
EZZ8459I DISPLAY TCPIP STOR COMPLETED SUCCESSFULLY
```

New connections will “fallback”
to TCP/IP if limit reached

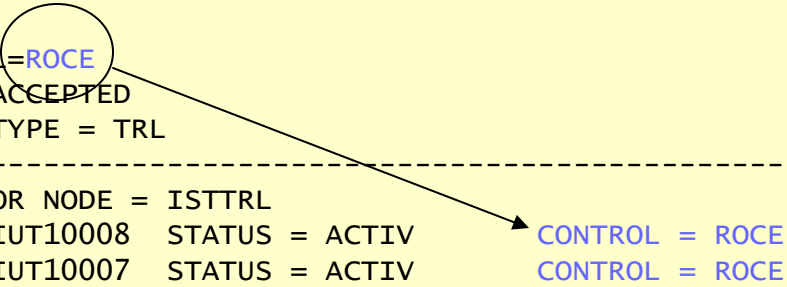
RMBs

Total Fixedmemory includes control blocks
used in outbound operations

SMC-R Monitoring – VTAM Commands

- List only those TRLEs that are dynamically created to represent RNIC interfaces

```
D NET,TRL,CONTROL=ROCE
IST097I DISPLAY ACCEPTED
IST350I DISPLAY TYPE = TRLE
IST924I -----
IST1954I TRLE MAJOR NODE = ISTTRL
IST1314I TRLE = IUT10008 STATUS = ACTIV CONTROL = ROCE
IST1314I TRLE = IUT10007 STATUS = ACTIV CONTROL = ROCE
IST1454I 2 TRLE(S) DISPLAYED
IST924I -----
IST1954I TRLE MAJOR NODE = TRLEALLBV
IST1454I 0 TRLE(S) DISPLAYED
IST314I END
```



SMC-R Monitoring – VTAM Commands

- DISPLAY ID=*RNIC_trlename* generates the same output
- Provides RNIC adapter information, including which TCP/IP stacks are currently using the RNIC TRLE

RoCE adapter

```
D NET,TRL,TRLE=IUT1001C
IST097I DISPLAY ACCEPTED
IST075I NAME = IUT1001C, TYPE = TRLE
IST1954I TRL MAJOR NODE = ISTTRL
IST486I STATUS= ACTIV, DESIRED STATE= ACTIV
IST087I TYPE = *NA* , CONTROL = ROCE, HPDT = *NA*
IST2361I SMCR PFID = 001C PCHID = 0130 PNETID = ZOSNET
IST2362I PORTNUM = 1 RNIC CODE LEVEL = 2.11.1200
IST2389I PFTP = 02112103
IST924I -----
IST1717I ULPID = TCPCS1 ULP INTERFACE = EZARIUT1001C
IST1724I I/O TRACE = OFF TRACE LENGTH = *NA*
IST924I -----
IST1717I ULPID = TCPCS2 ULP INTERFACE = FZARIUT1001C
IST1724I I/O TRACE = OFF TRACE LENGTH = *NA*
IST314I END
```

2 TCP/IP stacks
using this RoCE

SMC-R Monitoring – VTAM Commands

- Provides PNet ID value, if available
 - A value of ***NA*** is displayed if no PNet ID was configured

OSD adapter

```
D NET,TRL,TRLE=QDIO101
IST097I DISPLAY ACCEPTED
IST075I NAME = QDIO101, TYPE = TRLE
IST1954I TRL MAJOR NODE = TR LCS
IST486I STATUS= ACTIV, DESIRED STATE= ACTIV
IST087I TYPE = LEASED , CONTROL = MPC , HPDT = YES
IST1715I MPCLEVEL = QDIO MPCUSAGE = SHARE
IST2263I PORTNAME = QDIO4101 PORTNUM = 0 OSA CODE LEVEL = ABCD
IST2337I CHPID TYPE = OSD CHPID = C1 PNETID = ZOSNET
IST2184I QDIOSYNC = ALLINOUT = SYNCID = QDIO101 - SAVED = NO
IST1577I HEADER SIZE = 4096 DATA SIZE = 0 STORAGE = ***NA***
. . .
```

**OSD device –
Can link to RoCE adapters
by PNETID (new)**

SMC-R Monitoring – TNSTAT changes

- MODIFY TNSTAT,TRLE=RNIC_trlename
- RNIC-wide statistics and user-specific statistics provided

```
IST1230I TIME      = 18051835   DATE      = 09182      ID   = IUT1001C
IST1719I PCIREALO  = 0          PCIREAL   = 5
IST1751I PCIUNPRO  = 0          PCIUNPRD  = 3
IST2366I POLLEQO   = 0          POLLEQ    = 15
IST2367I POLLEQEO = 0          POLLEQE   = 25
IST924I -----
IST2368I ULP_ID    = TCPCS1
IST2369I POLLCQO  = 0          POLLCQ    = 250
IST2370I POLLCQUO = 0          POLLCQU   = 50
IST2371I POLLCQEO = 0          POLLCQE   = 1800
IST2372I SRBSCHDO = 0          SRBSCHD   = 15
IST2373I SRBRSCHO = 0          SRBRSCHD  = 0
IST2374I INBBYTLO = 0          INBBYTEL  = 176
IST2375I INBBYTMO = 0          INBBYTEM  = 0
IST2376I INBBYTNO = 0          INBBYTEN  = 305306
IST2377I DATAREQO = 0          DATAREQ   = 60
IST2378I POSTO    = 0          POST      = 70
IST2379I POSTEO   = 0          POSTELEM  = 178
IST2380I POSTQEO  = 0          POSTQUED  = 10
IST2381I OUTBYTLO = 0          OUTBYTEL  = 176
IST2382I OUTBYTMO = 0          OUTBYTEM  = 0
IST2383I OUTBYTNO = 0          OUTBYTEN  = 58950
```

Stats for TCP/IP stack –
TCPCS1

Bytes received over SMC-R
Request from TCP/IP to send data

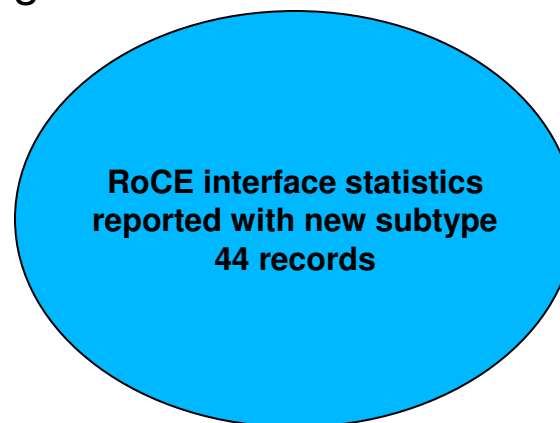
SMC-R Monitoring – Network Management Enhancements

Please refer to the appendix
for more details

- Network Management Interface (NMI)
 - Updates to some existing callable NMI reports
 - Creation of two new SMC-R specific callable NMI reports
- System Management Facilities (SMF)
 - Updates to some existing SMF Type 119 records
 - Creation of four new SMC-R specific records
- Minor Simple Network Management Protocol (SNMP) changes

SMC-R Monitoring – SMF Enhancements

- **Support added to existing SMF 119 records**
- TCP Termination (subtype 2)
 - Report SMC-R capability of the TCP connection, if applicable
- TCPIP Profile (subtype 4)
 - Report SMC-R configuration settings
- TCP Statistics (subtype 5)
 - Report SMC-R statistics and storage usage
- Interface statistics (subtype 6)
 - OSD – PNet ID, SMC-R capability



SMC-R Monitoring – SMF Enhancements

- New SMF 119, subtype 44 interval record
 - Controlled by **existing** SMFCONFIG IFStatistics and NOIFStatistics parameters
- One record generated per RNIC interface
 - SMC-R link and TCP connection usage statistics
 - Storage statistics
 - PNet ID for correlation with SMC-R link groups
- Close-out record generated if recording stopped or TCP/IP stack terminates
- No close-out record if RNIC interface is stopped during interval

SMC-R Diagnosis

SMC-R Diagnosis – Traces

- Even though TCP does not create traditional packets for SMC-R data, data is formatted as packet trace data
 - Trace enabled same as for TCP/IP connections (protocol, port, IP addr..)
 - Application traffic
 - Connection Layer Control (CLC) and Link Layer Control (LLC) flows
- Full support for TCP/IP component trace (CTRACE), Data trace and VTAM Internal Trace (VIT) – No additional config necessary

SMC-R Diagnosis – CLC Packet trace

- Example of Connection Layer Control (CLC) Proposal request sent over TCP connection

TCP

```
Source Port      : 4005  ()           Destination Port: 4005  ()
Sequence Number  : 4142276139        Ack Number: 2044371877
Header Length    : 32                Flags: Ack Psh
Window Size     : 4096               CheckSum: D329 FFFF Urgent Data Pointer: 0000
Option          : NOP
Option          : NOP
Option          : Timestamp          Len: 10 Value: F1DE7250 Echo: F1DE724E
```

SMCR

```
Eyec            : SMCR                MsgType: Proposal
Length          : 52                  Version: 1
Flag1           :                     PeerId: 7718D4C1C302A003
RNICaddr:       : fe80::d4c1:c302:a003
Macaddr:        : D4C1C3-02A003
Subnet Mask     : 172.16.1.5          Mask bits: 16
```

```
Ip Header       : 20                  IP: 10.81.5.5, 10.81.3.3 Offset: 0
000000 45000068 002F0000 40065DB8 0A510505 0A510303
```

```
Protocol Header : 32                  Port: 4005, 4005          Offset: 14
000000 0FA50FA5 F6E61E2B 79DAA3A5 80181000 D3290000 0101080A F1DE7250 F1DE724E
```



**Request to use
SMC-R**

SMC-R Diagnosis – Data packet trace

CTE: 84 178FA25E(0x25e) 212 00000008 2013/02/27 11:23:20.339971

```

84 MVS030 SMC 00000008 11:23:20.339971 SMC Trace
To Interface : EZARIUT1A003 Device: RNIC Full=22
Tod Clock : 2013/02/27 11:23:20.339965 Intfx: 23
Segment # : 0 Flags: Out SMC
Source : 10.81.3.3
Destination : 10.81.5.5
Source Port : 4005 Dest Port: 4005
    
```

```

SMC Protocol: TCP
Payload : 22 VlanId: 0
Local Conn Id : C3770101 Remote Conn Id: AC830101
Local Gid : fe80::d4c1:c301:a003
Remote Gid : fe80::d4c1:c302:a003
Local Qid : 000001 Remote Qid: 000002
Local Conn Index : 1 Remote Conn Index: 1
Local RMB RKey : 00000101 Remote RMB RKey: 00000201
Producer Cursor : 22 Sequence Number: 0
Producer Flags : 00 ()
Consumer Cursor : 0 Sequence Number: 0
Connection State : 00 ()
    
```

```

Data : 22 Data Length: 22 Offset: 0
000000 6E6E6E40 A3839740 8481A381 40A39640 |>>> tcp data to nnn@...@...@...@|
000010 83938985 95A3 |client .....
    
```

Outbound SMC-R data

**VTAM Internal Trace (VIT)
And TCP/IP Ctrace
Support as well**

Application data

Formatted to appear like TCP packets!

SMC-R Configuration & Monitoring Summary

- ✓ Consider the NOSMCR option on the PORT/ PORTRANGE statements for short-lived connections
- ✓ Consider using larger TCP RECEIVE buffer sizes for streaming/bulk connections
- ✓ At least two RNIC adapters per peer per physical network are highly recommended for reliability and load balancing
- ✓ Combination of PFID and PORTNUM values on GLOBALCONFIG SMCR statement define a given RNIC adapter
- ✓ You can specify either PORTNUM 1 or PORTNUM 2 for a given PFID, but you cannot use both
- ✓ Client and server must be in the same physical network (and VLAN)
- ✓ SMC-R enabled OSD interfaces must have non-zero subnets or prefix (IPv6)
- ✓ Use DISPLAY TCPIP,,STOR to monitor storage as workloads increase

Appendix: SMC-R Network Management Interface and SMF enhancements

Function externals: Network Management enhancements

- Network Management Interface (NMI)
 - Updates to some existing callable NMI reports
 - Creation of two new SMC-R specific callable NMI reports
- System Management Facilities (SMF)
 - Updates to some existing SMF Type 119 records
 - Creation of four new SMC-R specific records
- Minor Simple Network Management Protocol (SNMP) changes

Function externals: Updates to callable NMI reports

➤ GetIfs

- Report SMC-R capability and PNet ID for OSD interfaces
 - Use PNet ID to associate OSD with RNIC interfaces
- Report PNet ID for OSX interfaces
- Report minimal information about RNIC interfaces

➤ GetProfile

- Report GLOBALCONFIG SMCR and SMFCONFIG settings
- Report SMC-R information from INTERFACE, PORT and PORTRANGE statements

Function externals: Updates to callable NMI reports, part 2

- **GetConnectionDetail** (when SMC-R is enabled)
 - Report local SMC-R link group ID, and remote and local SMC-R link IDs if TCP connection is using SMC-R
 - Report reason code if TCP connection is not using SMC-R
- **GetGlobalStats**
 - Report SMC-R specific statistics and TCP statistics which might include SMC-R related statistics
- **GetStorageStatistics**
 - Report SMC-R storage usage
- No changes to **GetIfStats** and **GetIfStatsExtended**

Function externals: New GetRnics callable NMI

- Provides combination of Getlfs, GetlfStats and GetlfStatsExtended for RNIC interfaces
 - One record per RNIC interface
 - Same RNIC information as reported in Getlfs for RNIC interface
 - Provided to correlate this record with Getlfs information
 - PNet ID can be used to correlate this record with GetSmcLinks information
 - RNIC stack statistics (GetlfStats) always provided, even if RNIC interface is not active
 - VTAM tuning statistics (GetlfStatsExtended) only provided for active RNIC interface
- No filters supported on this NMI

Function externals: New GetSmcLinks callable NMI

- Provides SMC-R link and link group information
 - One record per SMC-R link group
 - One section for SMC-R link group statistics
 - One or more sections of SMC-R link statistics
 - One section for each SMC-R link that is part of the link group
 - PNet ID associated with the SMC-R link group can be used to correlate the group with RNIC interfaces
- No filters supported on this NMI

Function externals: Updates to existing SMF records

- TCP Termination (subtype 2)
 - Report SMC-R capability of the TCP connection, if applicable
 - If using SMC-R, remote and local SMC-R link ID and local SMC-R link group ID
 - If not using SMC-R, reason code
- TCPIP Profile (subtype 4)
 - Report GLOBALCONFIG SMCR and SMFCONFIG settings
 - Report INTERFACE SMCR settings
 - Report PORT and PORTRANGE NOSMCR settings

Function externals: Updates to existing SMF records, part 2

- TCP Statistics (subtype 5)
 - Report SMC-R specific statistics
 - Report TCP statistics which might include SMC-R related statistics
 - Report SMC-R storage usage
- Interface statistics (subtype 6)
 - Report PNet ID for OSX interfaces
 - Report SMC-R capability and PNet ID for OSD interfaces
 - Use PNet ID to associate OSD with RNIC interfaces
 - **RNIC interfaces are reported using new subtype 44 records**

Function externals: SMFCONFIG updates

- Two new options for controlling new SMC-R specific settings
 - SMFCONFIG TYPE119 IFStatistics controls subtype 44 now as well

```
>>-SMFCONFIG-----+-----+----->
      '-| Type 118 options |-'

-----
v                                     |
>-----+-----+-----<<
      +-TYPE118--| Type 118 options |-+
      '-TYPE119--| Type 119 options |-'

Type 119 options
-----
v                                     |
|-----+-----+-----|
|  -NOSMCRGROUPStatistics-  |
| +-+-----+-----+ +-+ |
|  '-SMCRGROUPStatistics---' |
|  -NOSMCRLINKEvent----- |
| +-+-----+-----+ +-+ |
|  '-SMCRLINKEvent-----'  |
```

Function externals: Netstat CONFIG/-f report, SMFCONFIG

- Netstat CONFIG/-f report includes new SMFCONFIG settings

```
SMF PARAMETERS:  
TYPE 118:  
  TCPINIT:      00   TCPTERM:      02   FTPCLIENT:    03  
  TN3270CLIENT: 04   TCPIPSTATS:   05  
TYPE 119:  
  TCPINIT:      YES  TCPTERM:      YES  FTPCLIENT:    YES  
  TCPIPSTATS:   YES  IFSTATS:      YES  PORTSTATS:    YES  
  STACK:        YES  UDPTERM:      YES  TN3270CLIENT: YES  
  IPSECURITY:   NO   PROFILE:      YES  DVIPA:        YES  
  SMCRGRPSTATS: YES  SMCRLNKEVENT: YES
```

Function externals: New SMCR Link Group Statistics record

- New SMF 119, subtype 41 interval record
 - Controlled by SMFCONFIG SMCRGROUPStatistics and NOSMCRGROUPStatistics parameters
- One record generated for all SMC-R link groups
 - One section for each active SMC-R link group
 - Includes RMB usage statistics
 - One section for each active SMC-R link
 - SMC-R link section includes SMC-R link group ID for correlation
- Close-out record generated if recording stopped or TCP/IP stack terminates
- No close-out record if SMC-R link group terminates during interval

Function externals: New SMCR Link State Start record

- New SMF 119, subtype 42 event record
 - Controlled by SMFCONFIG SMCRLINKEvent and NOSMCRLINKEvent parameters
- One record generated when SMC-R link starts
 - Provides minimal information about the link
 - SMC-R link and link group ID values
 - Link identification (7-tuple) information

Function externals: New SMCR Link State End record

- New SMF 119, subtype 43 event record
 - Controlled by SMFCONFIG SMCRLINKEvent and NOSMCRLINKEvent parameters
- One record generated when SMC-R link terminates
 - Provides same information as SMC-R Link State Start record
 - Provides statistical information related to SMC-R link
 - Storage statistics
 - TCP connection usage statistics

Function externals: New RNIC Interface Statistics record

- New SMF 119, subtype 44 interval record
 - Controlled by SMFCONFIG IFStatistics and NOIFStatistics parameters
- One record generated per RNIC interface
 - SMC-R link and TCP connection usage statistics
 - Storage statistics
 - PNet ID for correlation with SMC-R link groups
- Close-out record generated if recording stopped or TCP/IP stack terminates
- No close-out record if RNIC interface is stopped during interval

Function externals: SNMP updates

- Provide configured SMCR value for OSD interfaces
- Provide PNet ID information for OSD and OSX interfaces
 - Provided regardless of whether SMC-R is enabled or not
- Provide minimal information for RNIC interfaces
 - PNet ID value
 - Associated TRLE name
- Provide information about ports that are restricted, at the server, from using SMC-R