

# **z/OS IPv6**

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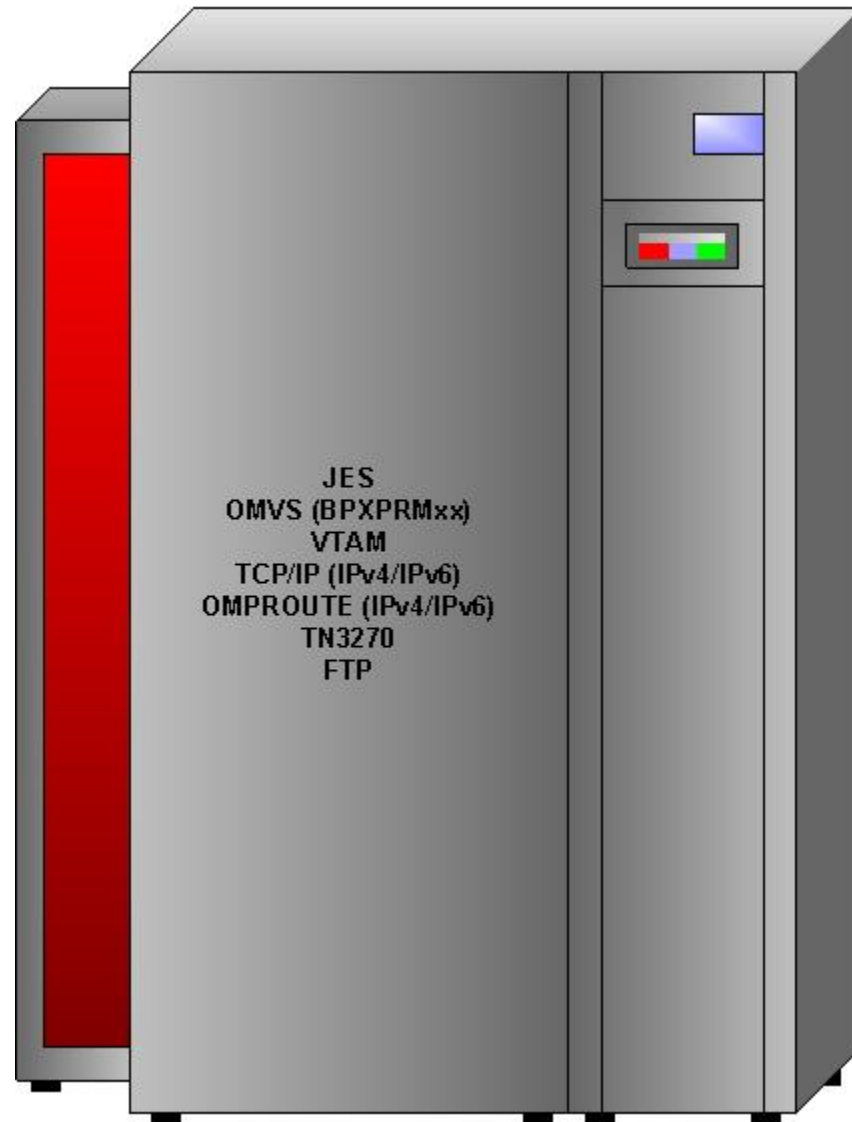
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# Motivation

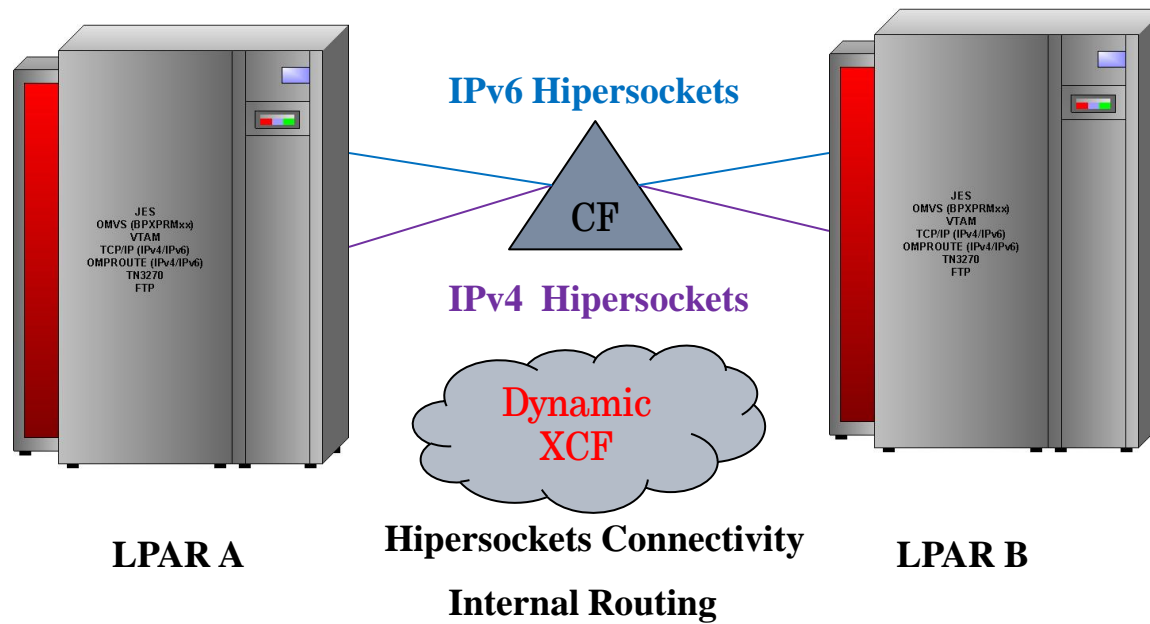
- **We will eventually run out of IPv4 addresses to use. IBM 2009 Austin SHARE Presentation noted IPv4 addresses will be exhausted 2-8 years. To minimize disruption, IPv6 needs to be in place and in use before exhaustion occurs. This justify the use of supporting dual mode stack for preparedness.**
- **Most devices/software, vendors, and application support dual mode stack (IPv4 and IPv6).**
- **Growth of Internet, mobility, computers/appliances , use of a common IP backbone with voice, data, and video.**
- **Most Federal Government Agencies have converted or currently using IPv4/IPv6 (Strategic Direction of IPv6). This will eventually force everyone by Big Brother (e.g. Television to digital frequency).**
- **IPv4 is a 32 bit address compare to IPv6 128 bit address (Expanded addresses means more IP addresses available to use). Now- 205.50.40.30  
Future- 2001:0DB8:0:0:240:2BFF:FE3D:71AD**
- **IPv6: dynamic- ease of configuration (Plug and Play, security (IPSEC), and built in Class of Service, etc..**

# Logical Drawing



**zOS running Dual Mode Stack IPv4/IPv6 (1 TCP/IP Stack running in one LPAR)**

# Logical Drawing



XCF signaling

1. Exchange of information between all TCP/IP stacks in the Sysplex (Sysplexrouting and Vipabackup).
2. Used as a IP and APPN (IUTIQDIO, IQDIOINTF6 and IUTSAMEH) interface for data. Dynamic Definitions being used

# IPv6 Checklist

- **IBM Design Request**

IPv6 EE request for Ipaddr to code. Current IPv6 allows hostname coding only.

- **Netstat (new display for IPv6 in longer format)**

Netstat home

Netstat byteinfo

Netstat allconn

Netstat allconn,port=xxxx

- **OSPF (additional IPv6 OMPR OSPF command and messages if IPv6 OSPF Routing is not enabled)**

D tcpip,,ompr,ipv6ospf,nbrs

EZZ7937I The IPv6 OSPF ROUTING PROTOCOL IS DISABLED

# IPv6 Checklist

- **IPv6 Hipersockets only support on z9**

EZZ434471- Hardware does not support IPV6.

- **Do not use site local address or you will get a warning messages of no longer supported (FEC0) in TCP syslog.**

In addition, in V1R11 IBM retired the following message:

EZD0011I USE OF SITE LOCAL ADDRESS *ipv6\_address* IS NOT RECOMMENDED

as the site local address space was moved to the global address space by the IETF.



# Current - Single Mode Stack for z/OS

**SYS1.PARMLIB.CUSTOM(BPXPRM00)**

```
NETWORK DOMAINNAME(AF_INET)  
  DOMAINNUMBER(2)  
  MAXSOCKETS(100000)  
  TYPE(INET)
```

```
/* NETWORK DOMAINNAME(AF_INET6) DOMAINNUMBER(19)           /* For IPv6*/  
/*  Type(INET)
```

**Default value in BPXPRM00- IBM commented out as dual mode stack by the /\*.**

**Note of MAXSOCKETS(100000), ensure you add to the IPv6 statement when enabled.**

**Below is the command you can enter in TSO option 6 to verify if IPv6 is enable.**

- **ISPF Command Shell**

Enter TSO or Workstation commands below:

===> **netstat up**

**TCPIP started at xx:xx:xx on xx/xx/xxxx with IPv6 disabled**

# Current - Display Single Mode Stack for z/OS

## D TCPIP,,N,HOME

EZZ2500I NETSTAT CS V1R10 TCPIP 192

HOME ADDRESS LIST:

ADDRESS	LINK	FLG
aaa.aaa.aaa.aaa	VLNK001	P
bbb.bbb.bbb.bbb	LOSAE1	
ccc.ccc.ccc.ccc	LOSAE2	
ddd.ddd.ddd.ddd	LOSAE3	
eee.eee.eee.eee	LOSAE4	
111.111.111.110	EZASAMEMVS	
111.111.111.111	VIPLABB11D93	
111.111.111.112	VIPLABB11D94	
111.111.111.113	VIPLABB11D95	
111.111.111.xcf	EZAXCF12	
127..0.0.1	LOOPBACK	

Display shows current 4 Octet IPv4 - Current display

# Testing Netstat Commands without enabling IPv6 in zOS

## ISPF Command Shell

Enter TSO or Workstation commands below:

**==> netstat home format long**

Address: aaa.aaa.aaa.aaa

Flags: Primary

LinkName: LOSAE1

Address: bbb.bbb.bbb.bbb

Flags:

LinkName: LOSAE2

Address: ccc.ccc.ccc.ccc

**Display shows current 4 Octet IPv4 - Current display with long format.**

# Enabling Dual Mode Stack for z/OS

## **SYS1.PARMLIB.CUSTOM(BPXPRM00)**

```
NETWORK DOMAINNAME(AF_INET)  
  DOMAINNUMBER(2)  
  MAXSOCKETS(100000)  
  TYPE(INET)
```

```
NETWORK DOMAINNAME(AF_INET6) DOMAINNUMBER(19)           /* For IPv6 */  
  MAXSOCKETS(100000)  
  TYPE(INET)
```

**Uncomment /\* to Enable dual mode stack by using AF\_INET6) within 'Sys1.Parmlib(BPXPRM00). Copy Maxsocket value from IPv4.**

## **ISPF Command Shell**

Enter TSO or Workstation commands below:

```
===> netstat up
```

**TCPIP started at xx:xx:xx on xx/xx/xxxx/2010 with IPv6 enabled**

**Netstat UP via TSO shows IPv6 enabled.**

# Display Dual Mode Stack for z/OS

## D TCPIP,,N,HOME

INTFNAME: EZ6SAMEMVS

ADDRESS: FC00::9:67:100:14

TYPE: GLOBAL

FLAGS:

ADDRESS: FE80::ECED:9843:EDE9:DC31

TYPE: LINK\_LOCAL

FLAGS: AUTOCONFIGURED

INTFNAME: IQDIOINTF6

ADDRESS: FC00::9:67:100:14

TYPE: GLOBAL

FLAGS:

ADDRESS: FE80::ECED:9843:EDE9:DC31

TYPE: LINK\_LOCAL

FLAGS: AUTOCONFIGURED

INTFNAME: LOOPBACK6

**Display shows support of 8 Octet IPv6 - New display**

# Current - TCP/IP Configuration Display

## D TCPIP,N,CONFIG

### TCP CONFIGURATION TABLE:

DEFAULTRCVBUFSIZE: 00262144 DEFAULTSNDBUFSIZE: 00262144

DEFLTMAXRCVBUFSIZE: 00262144

MAXRETRANSMITTIME: 120.000 MINRETRANSMITTIME: 0.500

IPSECURITY: NO

ARPTIMEOUT: 07200 MAXRMSIZE: 65535 **FORMAT: LONG**

IGREDIRECT: YES SYSPLXROUT: YES DOUBLENOP: NO

STOPCLAWER: NO SOURCEVIPA: YES

MULTIPATH: CONN PATHMTUDSC: YES DEVRTRYDUR: 0000000090

DYNAMICXCF: YES

IPADDR: 111.111.111.xcf SUBNET: aaa.aaa.aaa.0 METRIC: 01

SECCLASS: 255

IQDIOROUTE: NO

TCPSTACKSRCVIPA: NO

### **IPV6 CONFIGURATION TABLE:**

**FORWARDING: YES HOPLIMIT: 00255 IGREDIRECT: NO**

**SOURCEVIPA: NO MULTIPATH: NO ICMPERRLIM: 00003**

**IGRTRHOPLIMIT: NO**

**Display shows IPv6 enabled with custom code to match some parm of IPv4. Note: IPCONFIG for IPv4 on TCP/IP command will be format: LONG (mix). Format: SHORT means IPv6 is not supported. SHORT is not supported for IPv6.**

# Current - Profile (member)

aa.tcparms(member)

```
000028 ;*****  
000029 IPCONFIG  
000030 ARPTO 7200  
000031 DATAGRAMFWD  
000032 IGNOREREDIRECT  
000033 MULTIPATH PERCONNECTION  
000034 PATHMTUDISCOVERY  
000035 SOURCEVIPA  
000036 SYSPLEXROUTING  
000037 TTL 120  
000038 ;*****
```

**Current Profile has no IPv6 IPCONFIG statement parm coded.**

# Matching Profile (member) for IPv6

aaa.tcparms(member)

```
000028 ;*****
000029 IPCONFIG
000030 ARPTO 7200
000031 DATAGRAMFWD
000032 IGNOREREDIRECT
000033 MULTIPATH PERCONNECTION
000034 PATHMTUDISCOVERY
000035 SOURCEVIPA
000036 SYSPLEXROUTING
000037 TTL 120
000039 ;*****
000040 ; IPCONFIG6 *
000041 ;*****
000042 IPCONFIG6
000036 DYNAMICXCF FC00::9:67:100:14
000037 DATAGRAMFWD
000044 IGNOREREDIRECT
000045 PATHMTUDISCOVERY
000035 SOURCEVIPA
000036 SYSPLEXROUTING
000037 TTL 120
000038 ;*****
```

**When enabling IPv6 in the stack, IPCONFIG6 takes the default . Code IPCONFIG6 statement to match some IPv4 parm if you want same value on most parameter that are supported.**



# Obey- Matching Profile (member) for IPv6

VARY TCPIP,,O,aaa.tcparms(member)

22:49:50 E EZZ0300I OPENED OBEYFILE FILE 'aaa.tcparms(member)'  
22:49:50 E EZZ0309I PROFILE PROCESSING BEGINNING FOR 'aaa.tcparms(member)'  
22:49:50 E EZZ0396I SNMP SUBAGENT ALREADY STARTED  
22:49:50 E EZZ0316I PROFILE PROCESSING COMPLETE FOR FILE 'SYS1.TCPPARMS(ZC  
22:49:50 E EZZ0641I IP FORWARDING NOFWMULTIPATH SUPPORT IS ENABLED  
22:49:50 E EZZ0335I ICMP WILL IGNORE REDIRECTS  
22:49:50 E EZZ0350I SYSPLEX ROUTING SUPPORT IS ENABLED  
22:49:50 E EZZ0351I SOURCEVIPA SUPPORT IS ENABLED  
22:49:50 E EZZ0632I MULTIPATH PERCONNECTION SUPPORT IS ENABLED  
22:49:50 E EZZ0623I PATH MTU DISCOVERY SUPPORT IS ENABLED  
22:49:50 E EZZ0331I NO HOME ADDRESS ASSIGNED TO LINK VLNK002  
22:49:50 E EZZ0701I **ICMPV6 REDIRECTS WILL BE IGNORED**  
22:49:50 E EZZ0702I **IPV6 SOURCEVIPA SUPPORT IS ENABLED**  
22:49:50 E EZZ0704I **IPV6 MULTIPATH PERCONNECTION SUPPORT IS ENABLED**  
22:49:50 E EZZ0336I A LIMIT ON INCOMING UDP DATAGRAM QUEUE SET  
22:49:50 E EZZ0613I TCPIPSTATISTICS IS ENABLED  
22:49:50 E EZZ0053I COMMAND VARY OBEY COMPLETED SUCCESSFULLY

# Dual Mode Stack TCP/IP Configuration Display

## D TCPIP,N,CONFIG

### TCP CONFIGURATION TABLE:

FORWARDING: YES HOPLIMIT: 00255 IGREDIRECT: YES  
SOURCEVIPA: YES MULTIPATH: CONN ICMPERRLIM: 00003  
ARPTIMEOUT: 07200 MAXRMSIZE: 65535 **FORMAT: LONG**  
SMF PARAMETERS:  
TYPE 118:  
TCPINIT: 00 TCPTERM: 00 FTPCLIENT: 00  
TN3270CLIENT: 00 TCPIPSTATS: 00

### IPV6 CONFIGURATION TABLE:

FORWARDING: YES HOPLIMIT: 00255 IGREDIRECT: YES  
SOURCEVIPA: YES MULTIPATH: CONN ICMPERRLIM: 00003  
IGRTRHOPLIMIT: NO  
IPSECURITY: NO  
DYNAMICXCF: NO  
TCPSTACKSRCVIPA: NO  
SMF PARAMETERS:  
TYPE 118:  
TCPINIT: 00 TCPTERM: 00 FTPCLIENT: 00  
TN3270CLIENT: 00 TCPIPSTATS: 00

**Display shows IPv6 enabled with custom code to match some parm of IPv4. Note: IPCONFIG for IPv4 on TCP/IP command will be format: LONG (mix). Format: SHORT means IPv6 is not supported. SHORT is not supported for IPv6. LONG means mixed mode.**

# IPv6OSPF Configuration Display

D TCPIP,,OMPR,IPV6OSPF,LIST,ALL

```
EZZ7937I THE IPV6 OSPF ROUTING PROTOCOL IS DISABLED D TCPIP,N,CONFIG
```

**Above display shows additional command with IPv6 prefix for OSPF command. Disabled due to that we have not coded IPV6 interface and no IPv6 addresses.**

**Below display shows IPv6 enabled routing and should be this way when all is good in coding.**

```
EZZ7970I IPV6 OSPF INFORMATION 949
```

```
TRACE6: 0, DEBUG6: 0
```

```
STACK AFFINITY      TCPIP
```

```
IPV6 OSPF PROTOCOL:  ENABLED
```

```
IPV6 OSPF ROUTER ID:  aaa.aaa.aaa.osa1
```

```
DFLT IPV6 OSPF INST ID:  0
```

```
EXTERNAL COMPARISON:  TYPE 2
```

```
AS BOUNDARY CAPABILITY:  DISABLED
```

```
DEMAND CIRCUITS:      ENABLED
```

```
DR MAX ADJ. ATTEMPT:   0
```

```
EZZ7973I IPV6 OSPF AREAS
```

```
AREA ID    STUB DFLT-COST IMPORT-PREF DEMAND IFCS NETS RTRS ABRS
```

```
0.0.0.0    NO      N/A   N/A   ON   1    1  2  0
```

```
EZZ7958I IPV6 OSPF INTERFACES
```

```
NAME      AREA      TYPE  STATE COST HELLO DEAD NBRS ADJS
```

```
IQDIOINTF6  0.0.0.0  BRDCST 128   5    5    20   0    0
```

# IPv6OSPF Enabling

Display shows coding of IPv6 in the OMPRoute member to use dynamic routing and enabled neighbors

```
; Hiversockets IPv4 Interface *
,*****
OSPF_INTERFACE IP_Address=a
  Attaches_To_Area=aa
  Cost0=5
  Dead_Router_Interval=20
  Destination_Addr=b
  Hello_Interval=5
  MTU=8192
  NAME=IQDIOLNKCOA8DCB5
  Router_Priority=1
  SUBNET_MASK=aaa.aaa.aaa.0;
; Hiversockets IPv6 Interface *
,*****
IPV6_OSPF_INTERFACE NAME=IQDIOINTF6
  Cost0=5
  Dead_Router_Interval=20
  Hello_Interval=5
  Router_Priority=1;
```

## D TCPIP,,OMPR,IPV6OSPF,NBRS

EZZ8129I IPV6 OSPF NEIGHBORS 181

ROUTER ID	STATE	LSRXL	DBSUM	LSREQ	HSUP	RTR-PRI	IFC
a	128	0	0	0	OFF	1	IQDIOINTF6

# IPv6Route Enabled

**D TCPIP,,N,ROUTE,ADDRTYPE=IPV6**

```
DESTIP: ::1/128
  GW:  ::
  INTF: LOOPBACK6      REFCNT: 0000000000
  FLGS: UH             MTU:  65535
DESTIP: FC00::9:67:100:14/128
  GW:  ::
  INTF: IQDIOINTF6     REFCNT: 0000000000
  FLGS: UHS            MTU:  8192
DESTIP: FC00::9:67:100:15/128
  GW:  ::
  INTF: EZ6SAMEMVS     REFCNT: 0000000000
  FLGS: H              MTU:  0
DESTIP: FC00::9:67:100:15/128
  GW:  ::
```

**Display shows active route.**

```
D TCPIP,,OMPR,RT6TABLE,DEST=FC00::9:67:100:14
EZZ7980I IPV6 ROUTE EXPANSION 308
DESTINATION: FC00::9:67:100:14/128
ROUTE TYPE:  STAT
COST:      0
AGE:      1288
NEXT HOP(S): ::                (IQDIOINTF6)
```

# Important to code Costing – IPv4

## D TCPIP,,OMPR,OSPF,LIST,ALL

EZZ7831I GLOBAL CONFIGURATION 380

TRACE: 0, DEBUG: 0, SADEBUG LEVEL: 0

STACK AFFINITY: TCPIP

OSPF PROTOCOL: ENABLED

EXTERNAL COMPARISON: TYPE 2

AS BOUNDARY CAPABILITY: DISABLED

DEMAND CIRCUITS: ENABLED

DR MAX ADJ. ATTEMPT: 0

## EZZ7832I AREA CONFIGURATION

AREA ID	AUTYPE	STUB?	DEFAULT-COST	IMPORT-SUMMARIES?
aa	0=NONE	NO	N/A	N/A
0.0.0.0	0=NONE	NO	N/A	N/A

## EZZ7833I INTERFACE CONFIGURATION

IP ADDRESS	AREA	COST	RTRNS	TRDLY	PRI	HELLO	DEAD	DB_E*
aaa.aaa.aaa.osa1	aa	10	5	1	0	5	20	20
aaa.aaa.aaa.osa2	aa	10	5	1	0	5	20	20
aaa.aaa.aaa.osa3	aa	10	5	1	0	5	20	20
aaa.aaa.aaa.osa4	aa	10	5	1	0	5	20	20
aaa.aaa.aaa.mpc	aa	1	5	1	1	10	40	40
aaa.aaa.aaa.bbb	aa	1	N/A	N/A	N/A	N/A	N/A	N/A
<b>a aa</b>		<b>5</b>	<b>5</b>	<b>1</b>	<b>1</b>	<b>5</b>	<b>20</b>	<b>20</b>

**Important: If you want Hipersockets to route first to make costing lower than other devices.**

# Important to code Costing – IPv6

## D TCPIP,,OMPR,IPV6OSPF,LIST,ALL

EZZ7970I IPV6 OSPF INFORMATION 392

TRACE6: 0, DEBUG6: 0

STACK AFFINITY TCPIP

IPV6 OSPF PROTOCOL: ENABLED

IPV6 OSPF ROUTER ID: aaa.aaa.aaa.osa1

DFLT IPV6 OSPF INST ID: 0

EXTERNAL COMPARISON: TYPE 2

AS BOUNDARY CAPABILITY: DISABLED

DEMAND CIRCUITS: ENABLED

DR MAX ADJ. ATTEMPT: 0

## EZZ7973I IPV6 OSPF AREAS

AREA ID	STUB	DFLT-COST	IMPORT-PREF	DEMAND	IFCS	NETS	RTRS	ABRS
---------	------	-----------	-------------	--------	------	------	------	------

0.0.0.0	NO	N/A	N/A	ON	1	1	2	0
---------	----	-----	-----	----	---	---	---	---

## EZZ7958I IPV6 OSPF INTERFACES

NAME	AREA	TYPE	STATE	COST	HELLO	DEAD	NBRS	ADJS
------	------	------	-------	------	-------	------	------	------

<b>IQDIOINTF6</b>	<b>0.0.0.0</b>	<b>BRDCST 128</b>		<b>5</b>	<b>5</b>	<b>20</b>	<b>1</b>	<b>1</b>
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## EZZ7970I IPV6 OSPF INFORMATION 392

### EZZ8129I IPV6 OSPF NEIGHBORS

ROUTER ID	STATE	LSRXL	DBSUM	LSREQ	HSUP	RTR-PRI	IFC
-----------	-------	-------	-------	-------	------	---------	-----

<i>a</i>	<i>128</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>OFF</i>	<i>1</i>	<i>IQDIOINTF6</i>
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**Important: If you want Hipersockets to route first to make costing lower than other devices.**

# Bibliography and References

## 2009 IBM SHARE (Austin) IPv6 Presentation

### IBM Technical Documents

<http://www.ibm.com/support/techdocs>

### IBM Redbooks

<http://www.redbooks.ibm.com>

### z/OS Home Page

<http://www.ibm.com/servers/eserver/zseries/zos/>

### IPv6 Information Pages

<http://playground.sun.com/pub/ipng/html/ipng-main.html>

<http://www.ipv6forum.com>

<http://arin.net>

<http://www.internet2.edu>

### IPv4 Address Report

<http://www.potaroo.net/tools/ipv4/>

### IPv6 Portal (Great place to monitor IPv6)

<http://www.ipv6tf.org>

### Free book IPv6

<http://ip6.com/us/book/index.html>