TCP and EZA

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What is EZA?

- EZA is the IBM product prefix for TCP/IP on MVS
- MVS has three major programming interfaces to TCP/IP
  - BSD/C Sockets
  - EZASMI (Assembler Macro)
  - EZASOKET (HLL API)
  - REXX

MVS EZA BSD/C Sockets

- Based on “Berkeley” standards
  - Open Group Technical Standards for Networking Services
  - http://www.opengroup.org/onlinepubs/009619199/
- Example:
  - int recv(int, char *, int, int);
  - result = recv(socket,&buffer,length,flags);

EZASMI

- Assembler Macro Interface
  - OS/390 SecureWay Communications Server IP Application Programming Interface Guide Version 2 Release 8 Document Number SC31-8516-03
- Example:
  - EZASMI Type=Recv,S=socket, Buf=,Nbyte=,Flags=,Errorno=,Retcode

EZASOKET

- High Level Language API
  - (Same document as EZASMI)
- Example:
  - CALL 'EZASOKET' USING SOC-FUNCTION S FLAGS NBYTE BUF ERRNO RETCODE

REXX

- REXX API
  – (Same document as EZASMI)
- Example:
  – Socket(‘RECV’,s,maxlength,flags)

EZA and VSE

- BSD/C
  - Implemented by LE/VSE C Runtime
- REXX
  - Implemented by REXX/VSE
- EZASMI and EZASOKET
  - Implemented on VSE 2.5 by IBM
  - Implemented on VSE 2.1 and higher by BSI for use on their TCP/IP stack

Relationships

- BSD/C calls are the basic building block
- Other interfaces just enable other languages to communicate to the BSD/C calls.
- REXX, EZASMI, and EZASOKET all have calls that are subsets of the available BSD/C calls.

History on VSE

- IBM/MVS saw the need for using TCP/IP from Cobol and Assembler and so designed the EZASMI/EZASOKET to have as much of the flexibility found in the BSD/C sockets as possible.
- BSI investigated these interfaces and decided that IBM had done it right on MVS and so implemented the same interface.
- IBM/VSE has since decided to implement the same interface for VSE starting with VSE 2.5.

Comparisons

- EZASMI contains a subset of the functions available in the BSD/C interface
- EZASOKET contains a subset of the functions available in the EZASMI interface.
  - Major defect is Asynchronous request support.
- REXX contains a subset of the functions available in the BSD/C interface.

Vendor Comparisons

- All functions available in the IBM/VSE interface are available from BSI
- One additional function available from BSI
  - GETIBMOPT
    - Supports 'INITAPI' field 'TCPNAME'
- Several functions have keyword limits when compared to MVS
  - See spreadsheet for details (view)
    - HTTP://WWW.VSE2PDF.COM/COOLSTUFF/EZAPARMS.XLS

Vendor Comparisons

- Switching between the IBM EZA and the BSI EZA implementations
  - For the most part, not a problem unless using some of the more specialized functions and then only if using some of the sub-functions
  - Verify the EZASMI INITAPI function
    - Stack id can be specified for BSI, but not for IBM
    - ASYNC exit supported in BSI, but not in IBM
  - See spreadsheet for details

Storage Requirements

- The IBM implementation of EZAMI and EZASOKET requires LE services
  - 3.5 Meg
    - "If not loaded into the SVA, (EZASMI Interface) will be loaded into the VSE/POWER partition. The total size may reach 3500 KB, depending on the service level, and approximately 10% of this must reside in GETVIS-24 storage. The pre-tailored VSE/ESA loads a large portion of the LE-Base and LE-C Runtime phases into the SVA (about 300 KB into Getvis-24 and 2500 KB into Getvis 31 SVA)." VSE/POWER 2.5 Administration and Operation Guide SC33-6733-01
- Less if already using LE (i.e. COBOL/VSE)

Storage Requirements

- The BSI implementation of EZAMI and EZASOKET does not require LE services
  - As little as 16K. Normally less than 64K.

EZASMI
vs.
CSI SOCKET Marco

- CSI Socket macro has less calls.
  - 4 (open, close, send, receive)
- CSI has multiple types.
  - 7 (TCP, UDP, TELNET, FTP, CLIENT, CONTROL, RAW)
- EZA interface has many functions.
  - 38

EZASOKET
vs.
CSI Pre-Processor API

- CSI API has less calls.
  - 4 (open, close, send, receive)
- CSI has multiple EXEC types.
  - 5 (TCP, TELNET, FTP, CLIENT, CONTROL)
- EZA interface has many functions.
  - 31

Why Use the EZA Interface?

- Portability
  - HLL (call ‘EZASOKET’)
  - ASM (EZASMI macro)
  - REXX (s=SOCKET(‘Open’,…)
- Non-portability
  - HLL (EXEC TCP …)
  - ASM (SOCKET macro
  - REXX (s=SOCKET(‘TCP’,‘OPEN’)

Why Use the EZA Interface?

- For simple open/send/receive/close functions, the CSI Interface is easier to code, but it does require a pre-translate step for the API.
- And the CSI API is TCP/IP Version specific.
  - Going to TCP/IP 1.4 required relinking of all phases using the API.

Why Use the EZA Interface?

- Each CSI open or close performs many TCP/IP functions.
  - For programs that perform multiple opens, this overhead can not be eliminated.
- Each EZA call performs only the function being used.
  - For programs performing multiple opens, the overhead is greatly reduced.

Why Use the EZA Interface?

- Some capabilities of TCP/IP can not be used when using the CSI Interface
  - Simultaneous Reads and Writes
  - Giving and Taking of open communication links (can be done, but not documented)
  - “Look Ahead” or “PEEK” processing
  - IBM could not program NJE over TCP/IP without first implementing EZASMI in VSE

Why Use the EZA Interface?

- CICS
  - Special linking is required for CSI calls from the CICS environment
    - If the special linking is not performed, the program “works” but places CICS into a “wait” when waiting on data
    - It appears to work during testing, but creates unexpected problems when moved to production
  - The EZA interface does not require any special linking

EZA Programming

Support Routines

• EZACIC04	EBCDIC-to-ASCII
• EZACIC05	ASCII-to-EBCDIC
• EZACIC06	SELECT bit stream setup
• EZACIC08	HOST field processor

Types of Programs

- Client
  - Connects to a Server
- Iterative Server
  - All processing is self-contained
- Concurrent Server
  - A Listener that spawns a Child when connected
- Child
  - A “partial” server to handle sends/receives

Concurrent Server and Child

- Why?
  - Iterative Server has deficiencies
    - 1 to 1 only
    - processing is tied up while handling the sends and receives
    - Additional Clients can not get a connection

EZA Client Program Flow

- INITAPI (EZASMI only)
- SOCKET
- CONNECT
- SEND/RECV loop
- SHUTDOWN
- CLOSE
- TERMAPI (EZASMI only)

EZA Client Program Flow

- INITAPI (EZASMI only)
  - Loads interface programs into GETVIS
  - Allocates storage
  - Initializes default control information
  - Verifies that the TCP/IP stack is available
  - The EZASOKET interface performs this function behind the scenes

EZA Client Program Flow

- SOCKET
  - Assigns a socket number (Binary half-word)
  - Allocates socket specific storage
  - Informs caller of socket number
- CONNECT
  - Establishes a communications session with the requested server

EZA Client Program Flow

- WRITE, SEND, or SENDTO
  - Transmits data
- READ, RECV, or RECVFROM
  - Receives Data

EZA Client Program Flow

- SHUTDOWN
  - Informs stack to close down communications once all buffers are transmitted
- CLOSE
  - Releases socket specific storage acquired by the SOCKET call
- TERMAPI (EZASMI only)
  - Releases all storage acquired by the INITAPI call
  - The EZASOKET interface performs this function behind the scenes

EZA Iterative Server Flow

- INITAPI (EZASMI only)
- SOCKET
- BIND
- LISTEN
- ACCEPT loop
  - SEND/RECV loop
  - SHUTDOWN
  - CLOSE
- SHUTDOWN
- CLOSE
- TERMAPI (EZASMI only)

EZA Iterative Server Flow

- INITAPI
  - Same as Client Program
- SOCKET
  - Same as Client Program
- BIND
  - Informs interface as to what local port to use
- LISTEN
  - Informs the stack that the program wants any data destined for the local port specified by the BIND

EZA Iterative Server Flow

- ACCEPT Loop
  - Informs the stack that the program is ready to receive data
  - When data is received, a new socket area is allocated and the program is informed of this new socket number on which the communication is to occur.
  - The original socket number is NOT used. It remains available for more ACCEPT calls

EZA Iterative Server Flow

- SEND/RECV
  - Transfers data (on the NEW socket)
- SHUTDOWN
  - Informs stack to close down communications once all buffers are transmitted (on the NEW socket)
- CLOSE
  - Releases socket specific storage acquired by the ACCEPT call for the new socket

EZA Iterative Server Flow

- ACCEPT Loop
  - Accepts continue to be performed against the original socket. Anytime data is available, SEND/RECV loops are performed
- SHUTDOWN
  - Informs the stack that the program no longer wishes to receive data on a specific port
- CLOSE
  - Releases socket specific storage acquired by the original SOCKET call

EZA Iterative Server Flow

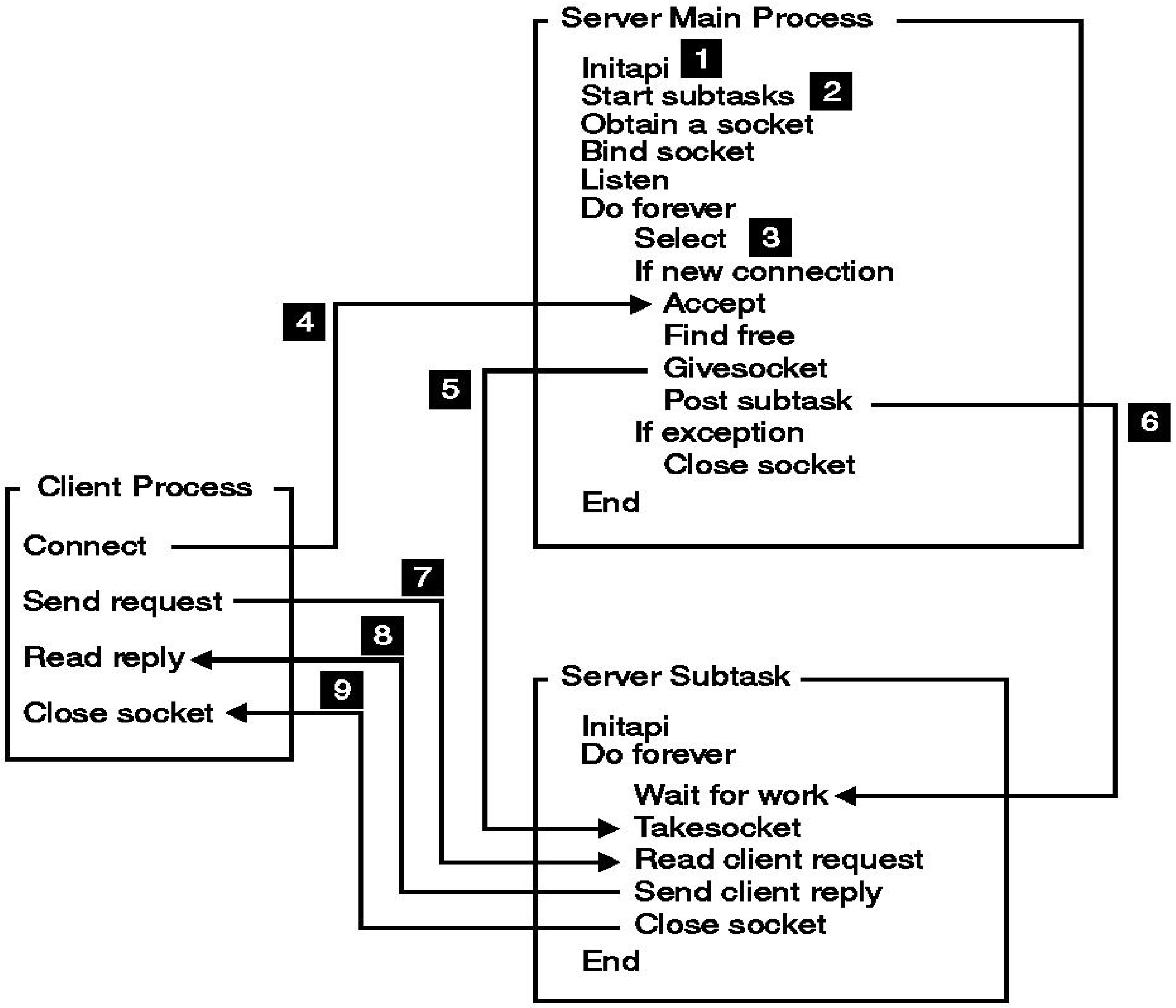
- TERMAPI (EZASMI only)
  - Releases all storage acquired by the INITAPI call

EZA Concurrent Server

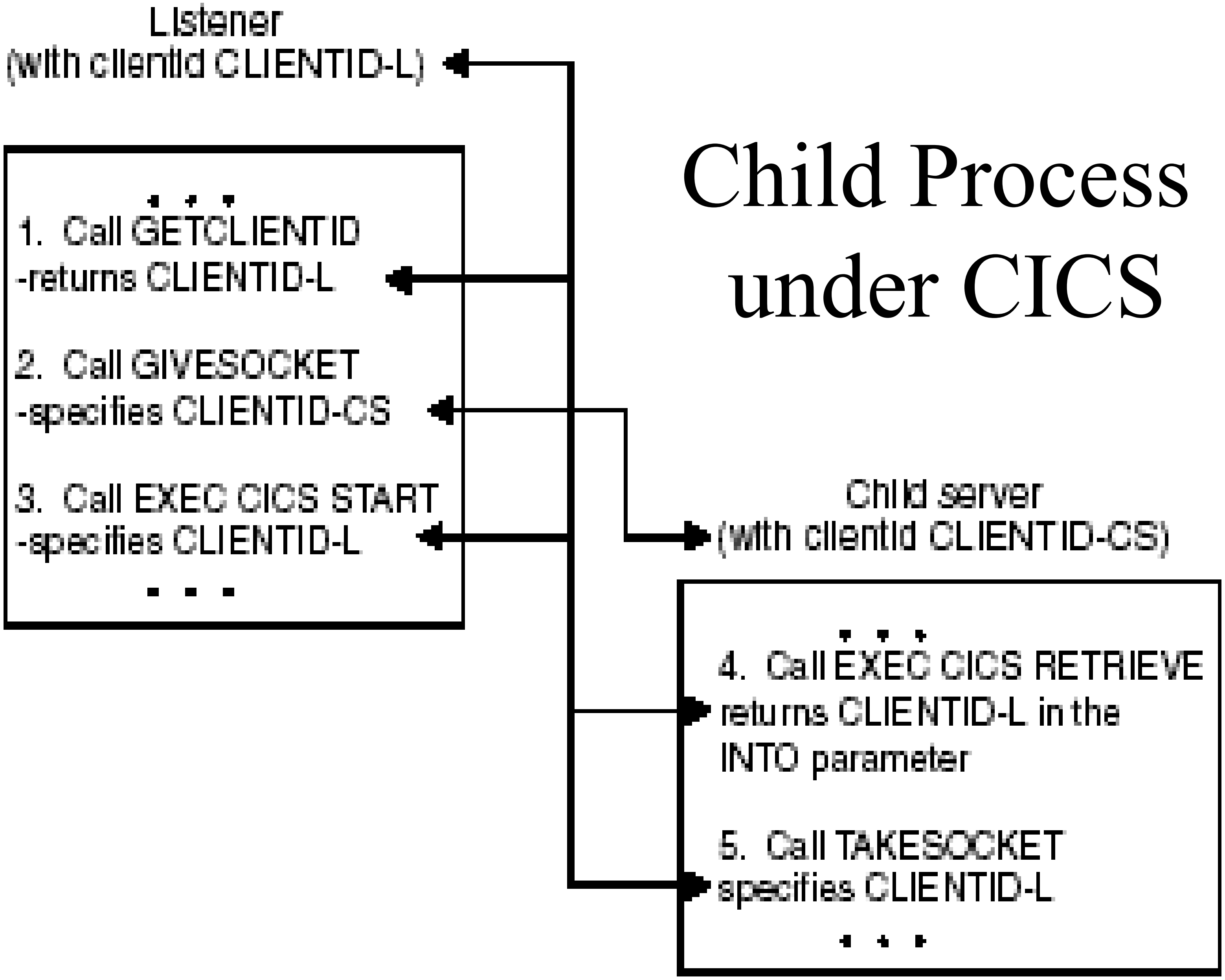
- The original server continues to perform ACCEPT calls, but instead of handling any SEND/RECV calls, it transfers the socket to another program.
- This allows the original program to quickly handle many requests without being slowed by data transfers

EZA Concurrent Server

- Used to service multiple clients simultaneously
- Depends on multiple tasks
  - Main Server
  - Client Subtasks
- Connections are passed using
  - GIVESOCKET
  - TAKESOCKET


Server Main Process
Initapi 1
Start subtasks 2
Obtain a socket
Bind socket
Listen
Do forever
Select 3
If new connection
Accept
Find free
Givesocket
Post subtask
If exception
Close socket
End
4
5
6
Client Process
Connect
Send request
Read reply
Close socket
7
8
9
Server Subtask
Initapi
Do forever
Wait for work
Takesocket
Read client request
Send client reply
Close socket
End

Child Process under CICS



```
                                  __________________________
      Client:                    |       LISTENER           |
 _____________________           |       EZACIC02           |
|                     |          |__________________________|
|  Program CLIENT     |          |                          |
|                     |    | |<__|(11)INITAPI               |
|_____________________|    | |<__|(12)SOCKET                |
|                     |    | |<__|(13)BIND                  |
|                     |    |S|<__|(14)LISTEN                |
|                     |    |O|<__|(15)GETCLIENTID           |
|(1)INITAPI___________|___>|C|<__|(16)SELECT                |
|(2)SOCKET____________|___>|K|   |                          |                Child server:
|(3)CONNECT___________|___>|E|   |                          |             _____________________
|                     |    |T|   |                          |            |                     |
|(4)WRITE/SEND 'SERV'_|___>|S|<__|(17)ACCEPT                |            | Transaction SERV    |
|                     |    | |   |                          |            |      calling        |
|                     |    | |<__|(18)RECVFROM              |    | |     |   program SERVER    |
|                     |    | |   |(19)EXEC CICS INQ 'SERV'  |    |S|     |                     |
|                     |          |(20)GIVESOCKET____________|___>|O|     |_____________________|
|                     |          |(21)EXEC CICS START 'SERV'|___>|C|     |                     |
|                     |          |                          |    |K|     |(7)EXEC CICS RETRIEVE|
|                     |          |                          |    |E|<____|(8)TAKESOCKET        |
|                     |          |(22)SELECT________________|___>|T|     |                     |
|                     |          |(23)CLOSE_________________|___>|S|     |                     |
|(5)READ/WRITE________|          |__________________________|    | |     |                     |
|                     |_______________>|S|                               |                     |
|(6)CLOSE_____________|                |O|<______________________________|(9)READ/WRITE        |
|                     |_______________>|C|                               |                     |
|_____________________|                |K|<______________________________|(10)CLOSE            |
                                       |E|                               |_____________________|
                                       |T|
```

GIVE/TAKE Restrictions

- Both processes must be using the same stack
- There is no capability to transfer between IBM and BSI applications.

Control Functions

- FCNTL
- GETHOSTBYADDR
- GETHOSTBYNAME
- GETCLIENTID
- GETHOSTID
- GETHOSTNAME
- GETPEERNAME
- GETSOCKNAME
- GETSOCKOPT
- IOCTL

SELECT Processing

- Allows a program to wait for multiple actions to occur
- SELECT
  - Wait for new ACCEPT at the same time as waiting for a GIVESOCKET to complete
  - Waiting for multiple ports
  - Waiting for timers
  - Wait for a port or a timer at the same time
- SELECTEX
  - Will also wait for an external ECB

Not Implemented

- SENDV/WRITEV/SENDMSG Functions
  - Allows multiple buffers to be processed with one call
- ALET options
  - Allows buffers to reside outside of the normal partition area.

Debugging

- IBM
  - Operator command
    - EZAAPI TRACE=ON[,PART=xx][,SYSLST]
  - Help available
    - EZAAPI ?
- BSI
  - // SETPARM IPTRACE=‘YYY’
  - Output is in LST queue under the partition id
    - EZALOGxx
      - EZALOGF2 (example)

Other Helpful Manuals

- IBM TCP/IP for MVS: Application Programming Interface Reference
  - Version 3 Release 2
  - SC31-7187-03
    - I like this one better than the latter manual motioned on slide 8
- TCP/IP for VSE/ESA: IBM Program Setup and Supplementary Information
  - As of VSE 2.5
  - SC33-6601-05

Other Helpful Manuals

- Redbook: A Beginner's Guide to MVS TCP/IP Socket Programming
  - GG24-2561-00
  - Although written for MVS and a little dated, it is a very good book to learn the basics.
  - Watch out for the SYNC call used after a SELECT
    - No longer needed or supported in MVS or VSE

Information

- Download this presentation, compatibility spreadsheet, and all the sample programs: http://www.vse2pdf.com/coolstuff
- IBM 2000 VM/VSE Technical Conference presentation
  - TCP/IP for VSE/ESA Socket Programming (Ingo Adlung)
    - http://www-1.ibm.com/servers/eserver /zseries/os/vse/pdf/orlando2000/E06.pdf

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- Batch
  - Server
  - Client
  - Child
- CICS
  - Listener (Server)
  - Client
  - Child
  - Starter/stopper