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Socket Programming

Will J. Roden, Jr.

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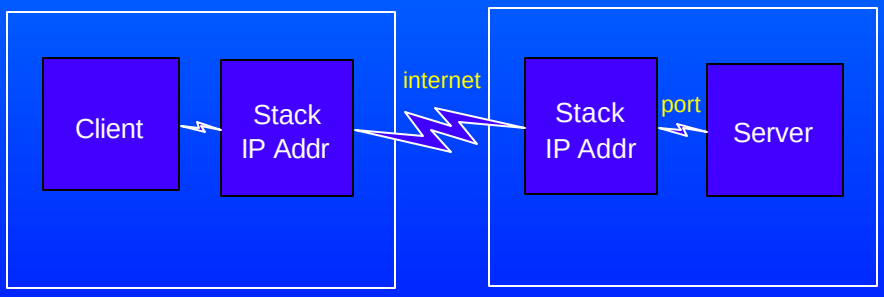
Agenda

- What are sockets?
- C Socket Calls
  - Basics of Sockets
- REXX Socket Calls
- Pipeline Socket Stages
- Sniffer

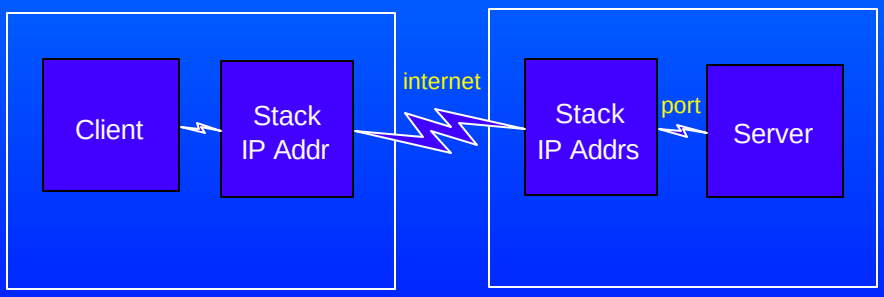
What are Sockets?

- Goal
  - Provide a way for two computers to communicate
- Socket
  - One way for that to happen



What are Sockets?

- What is needed?
  - Get communication with the stack
  - Describe yourself to the stack
  - Tell the stack if you are asking (client) or waiting to be asked (server)
  - Ask or wait to be asked, then wait for data
  - Send / Receive communications
  - End communication



What are sockets?

- What is needed?
  - Get communication with the stack
    - socket()
  - Describe yourself to the stack
    - bind()
  - Tell the stack if you are asking (client) or waiting to be asked (server)
    - connect() or listen()
  - Wait to be asked (server) or wait for data (both)
    - accept() or select()
  - Send / Receive communications
    - send() or recv()
  - End communication
    - close()

What are Sockets?

- Just like a new Dr's office
  - socket() - Register your business
  - bind() - Put up the sign with your skills
  - listen() - Put an advertisement in the paper
    - Mention the number of chairs in your waiting room
  - accept() or select() - Wait for patients
    - Put "Open" sign on your door
    - Assign patients to their examination room
  - send() or recv() - Communicate with patient
  - close() - discharge patient
    - Put "Closed" sign on your door

C Socket Calls

- Socket - establishes connection with stack
  - Used by both client and server
  - socket(domain, type, 0);
    - domain
      - AF_INET - use the internet
        - AF_IUCV - use VM's IUCV
        - AF_UNIX - Local use
    - type:
      - SOCK_STREAM - TCP
        - SOCK_DGRAM - UDP
        - SOCK_RAW - IP, ICMP
    - protocol:
      - 0, IPPROTP_UDP, IPPROTO_TCP
  - Returns the socket number (int)

C Socket Calls

- Bind - describe who you are to the stack
  - Used by server and optionally client
  - bind(socket, struct sockaddr *, sizeof());
    - if AF_INET specified in socket() call
    - use 'inet_addr("1.2.3.4");' to specify IP @ in sin_addr

```
struct sockaddr_in {
   unsigned char sin_len;      /* len of sockaddr or 0 */
   unsigned char sin_family;   /* AF_INET              */
   unsigned short sin_port;    /* htons(5001)          */
   struct in_addr sin_addr;    /* INADDR_ANY           */
   unsigned char sin_zero[8]; /* 0's                   */
}
```

C Socket Calls

- Listen - tells stack that this port will only listen.
  - Used by server
  - listen(socket , backlog);
    - socket: rec'd from socket()
    - backlog: 0 to SOMAXCONN
      - Number of chairs in waiting room

C Socket Calls

- Accept - waits for and accepts a new connection
  - Used by server
    - adlen = sizeof adminIn;
  - Blocked, use fcntl() to unblock
  - accept(SO, (struct sockaddr *) &adminIn, &adlen);
  - Returns the new socket number that was obtained for this connection. This is usually passsed to a different thread allowing this thread to get ready for another connection.

C Socket Calls

- Connect - attempt to establish a connection
  - Only used by client
  - Will also do bind's function
  - connect(socket, struct sockaddr *, sizeof());
    - if AF_INET specified in socket() call

```
struct sockaddr_in {
   unsigned char sin_len;       /* len of sockaddr or 0 */
   unsigned char sin_family;  /* AF_INET                */
   unsigned short sin_port;    /* htons(5001)            */
   struct in_addr sin_addr;     /* INADDR_ANY          */
   unsigned char sin_zero[8]; /* 0's                     */
}
```

C Socket Calls

- Send
  - Used by both client and server
  - Blocked, use fcntl() to unblock
  - bytes = send(socket, &buffer, len, flags)
    - &buffer is ptr to the buffer
    - len is the length of the buffer
    - flags are usually '0'
- consider converting buffer to ascii or ebcdic
- others: sendmsg, sendto, write, and writev

C Socket Calls

- Recv
  - Used by both client and server
  - Blocked, use fcntl() to unblock
  - bytes = recv(socket, &buffer, len, flags)
    - &buffer is ptr to the buffer
    - len is the length of the buffer
    - flags are usually '0'
- consider converting result to ascii or ebcdic
- others: recvmsg, recvfrom, read, and readv

C Socket Calls

- Select - waits for multiple events
  - Used by both client and server
  - Can wait for accept, send, recv, or time out
  - rc2 = select(num_fds, read, write, except, timeout);
    - rc2 contains the number of ready file descriptors
    - Test for ... with FD_ISSET()
    - zero and reset FDs before every call to select().

```
fd_set reading;

FD_ZERO(&reading);                  /* reset to zero      */
FD_SET(0, &reading);                /* std in             */
FD_SET(socket, &reading);           /* other socket       */
num_fds = 1+socket;                 /* max socket num */
rc2 = select(num_fds, &reading, NULL, NULL, NULL);
FD_ISSET(0, &reading)               /* test               */
```

C Socket Calls

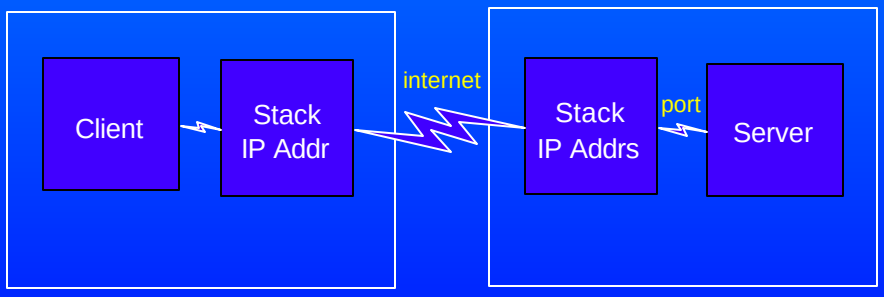
- Close - shuts down the socket
  - Used by both client and server
  - rc = close(socket);
    - socket - rec'd from socket()

C Socket Calls

- Error Checking
  - rc is different on different calls
    - socket, accept: <= socket number
    - send, recv: <= number of bytes
    - select: <= number of ready file descriptors
    - all others: rc=0 <= success
    - all: rc=-1 <= error
      - Check variable 'errno' for specifics

C Socket Calls

- **Client**
  - socket()
  - connect()
  - send() recv()
  - close()
- **Server**
  - socket()
  - bind()
  - listen()
  - accept()
  - recv() send()
  - close()



C Socket Calls

- **Example - socket preparation**

```
int SO, NS, rc, adlen;
struct  sockaddr_in sinet;
struct  sockaddr_in adminIn;

SO = socket(AF_INET, SOCK_STREAM, 0);
rc = bind(SO, (struct sockaddr *) &sinet, sizeof(sinet));
rc = listen(SO, 5);
adlen = sizeof adminIn;
NS = accept(SO, (struct sockaddr *) &adminIn, &adlen);
```

C Socket Calls

- **Example - receive data**

```
char buffer[999]
char *pBuf;
int read_len = 0, nb = 0, len = 998;

while (read_len < len) {
  nb = recv(NS, pBuf + read_len, len - read_len, 0);
  if (nb > 0)
    read_len += nb;
  else
    break;
}
    ........ or ........
rc = recv(NS, buffer, len, 0);
buffer[rc] = '\0';
```

C Socket Calls

- **Example - send data**

```
char out[999];  /* data to be sent */
int rc=0, len;

len = strlen(out);
rc = send(NS, out, len, 0);
```

- **Example - Close**

```
rc = close(NS);
```

REXX Socket Calls

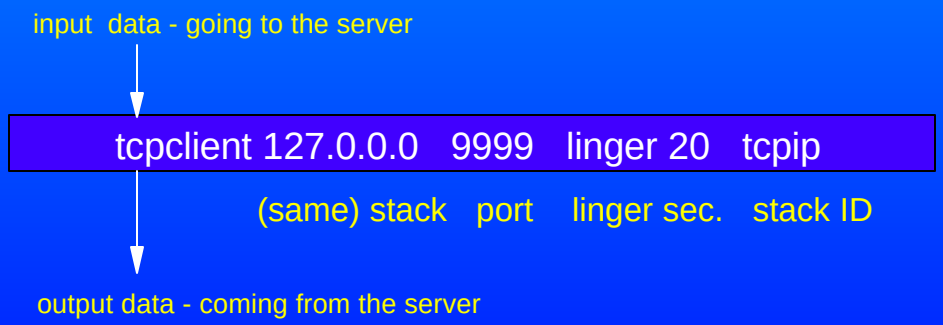
- socket('SOCKET', 'AF_INET', 'SOCK_STREAM')
- socket('BIND', socket, 'AF_INET port ip@')
- socket('LISTEN', socket, backlog)
- socket('ACCEPT', socket)
- socket('CONNECT', socket, AF_INET port ip@')
- socket('SEND', socket, data, '')
- socket('RECV', socket)
- socket('SELECT', mask, timeout)
- socket('CLOSE', socket)

Pipeline Socket Stages

- tcpclient - all client calls
  - socket, connect, send, recv, close
- tcplisten - server setup
  - socket, bind, listen, accept, close
- tcpdata - server data movement
  - send, recv, close

Pipeline Socket Stages

- Tcpclient
  - primary input stream -> tcpip
  - tcpip -> primary output stream
  - stops when output stream terminated or 20 seconds have passed

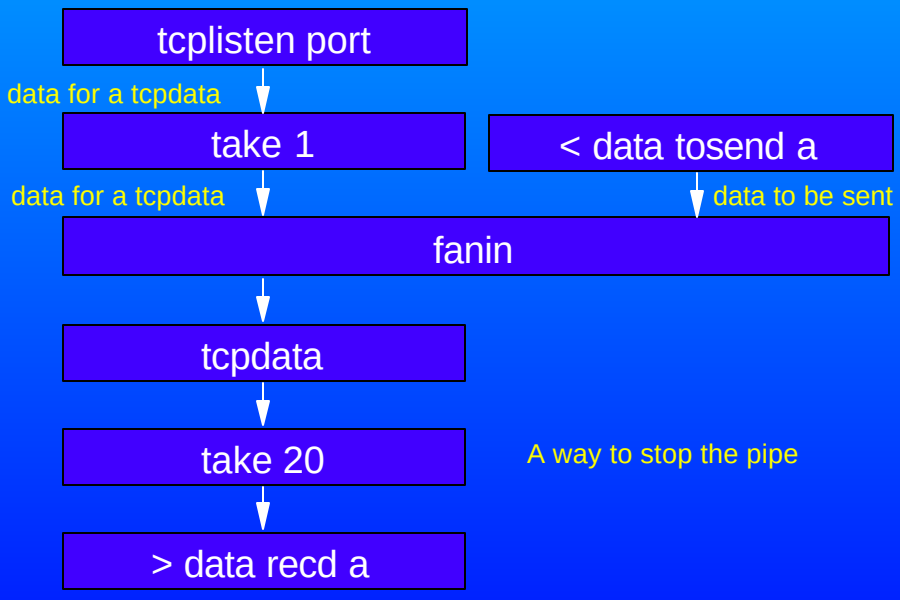


Pipeline Socket Stages

- Tcplisten
  - must be the first stage
  - passes information to tcpdata
  - stops when output stream terminated
- Tcpdata
  - input stream:
    - first record must be from tcplisten
    - following records are treated as data
  - output stream is data from the network
    - can do blocking
  - stops when output stream terminated
- Considerations
  - how to handle multiple connections
  - how to stop the pipeline

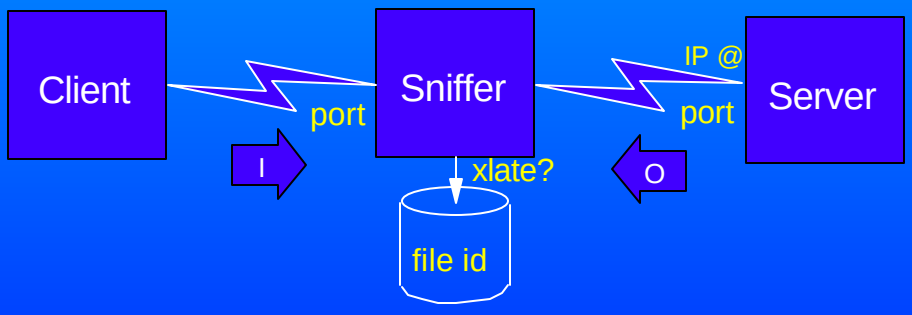
Pipeline Socket Stages

- Flow diagram for only one connection



Pipeline Sniffer

- What is a sniffer?
  - ►Debug tool that records packets sent between a client and a server



- To run TCPSNIFF

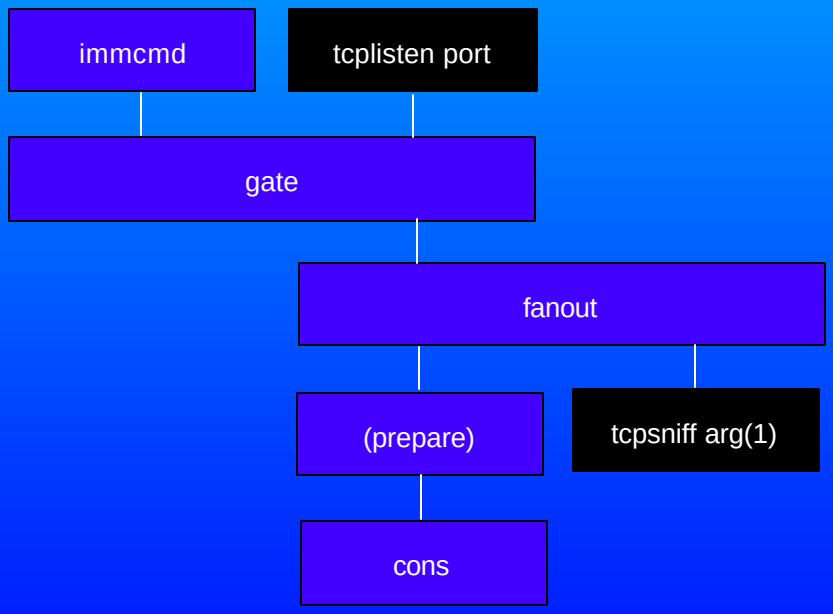
tcpsniff 10001 — input port

1.2.3.4 3000 — IP@out and port

tcpsn output a — output fileid

Pipeline Sniffer Code

- TCPSNIFF EXEC - diagram



Pipeline Sniffer Code

- TCPSNIFF EXEC - page 1

```
/* TCP port sniffer.                                    */
/*                        John Hartmann  7 Feb 1996 12:38:57 */
Signal on novalue

parse arg port remote_sys remote_port fn ft fm '(' options

/*********************************************************************/
/* Send TCP socket  data to a remote host and  pass the result back. */
/* To sniff  a telnet session, this  program would be the  server as */
/* seen by the  telnet client.  The real telnet  server is specified */
/* as the second and third operand.                                  */
/*                                                                   */
/* Specify (ascii  if the data stream  is in ASCII and  you want the */
/* log file in EBCDIC (from 850 to 1047).                            */
/*********************************************************************/
say 'Type:  stop   to stop this sniffer.'
```

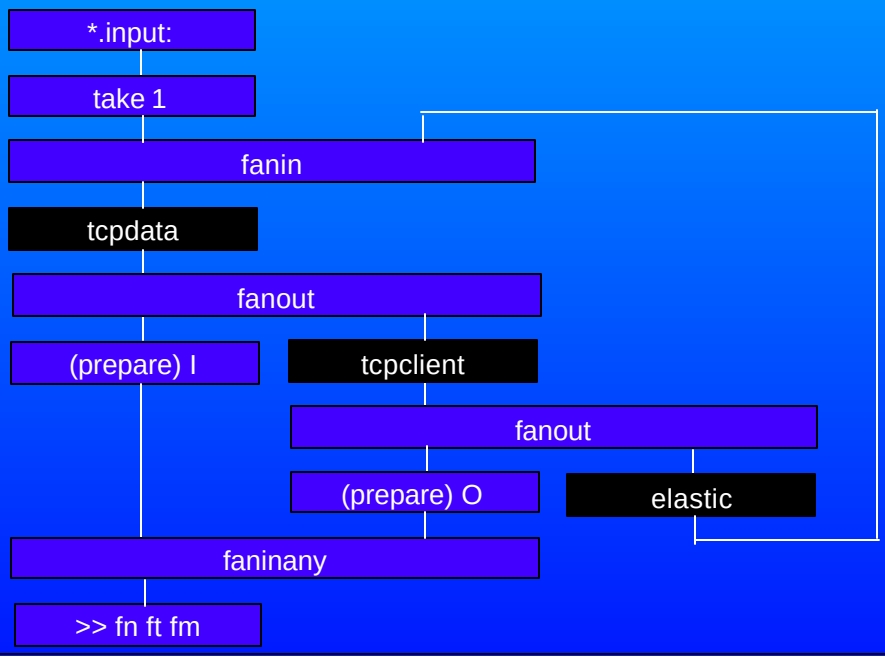
Pipeline Sniffer Code

TCPSNIFF EXEC - page 2

```
address command
'PIPE (end \ name TCPSNIFF.EXEC:18)',
  '\immcmd stop',
  '|g:gate',
  '\tcplisten' port,
  '|g:',
  '|go:fanout',
  '|change 72 //x00',          /* Make sure positive...      */
  '|change 71 //x00',          /* ...numbers for...          */
  '|change 70 //x00',          /* ......formatting.          */
  '|change 69 //x00',
  '|spec 67.2 c2d 1',
     '69.2 c2d nw  71.2 c2d nw',
     '73.2 c2d nw  75.2 c2d nw',
  '|spec /Request from port/ 1 w1 nw /on/ nw',
     'w2 nw /./ n w3 n /./ n',
     'w4 n /./ n w5 n',
  '|cons',
  '\go:',
  '|tcpsniff' arg(1)
Exit RC
```

Pipeline Sniffer Code

TCPSNIFF REXX - diagram



Pipeline Sniffer Code

- TCPSNIFF REXX - page 1

```
/* Sniffer to process one connection request                    */
/*                          John Hartmann  7 Feb 1996 12:49:10 */
Signal on novalue
signal on error

parse arg . remote_sys remote_port fn ft fm '(' options
upper options
xlate=''
If wordpos('ASCII', options)>0
  Then xlate='|xlate from 850 to 1047'
```

Pipeline Sniffer Code

- TCPSNIFF REXX - page 2

```
do forever
  'peekto'
  'callpipe (end \ name TCPECHOD.REXX:7)',
    '\*.input:',
    '|take 1',
    '|i:fanin',
    '|tcpdata',
    '|in:fanout',
      xlate,
    '|change ,,I ,',
    '|wi:faninany',
    '|>>' word(fn 'TCP', 1) word(ft 'TRACE', 1) word(fm 'A', 1),
    '\in:',
    '|tcpclient' remote_sys remote_port,
    '|o:fanout',
      xlate,
    '|change ,,O ,',
    '|wi:',
    '\o:',
    '|elastic',
    '|i:'
  say 'Connection closed.'
end
error: exit RC*(RC<>12)
```

What did we discuss?

- What are sockets?
- C Socket Calls
  - Basics of Sockets
- REXX Socket Calls
- Pipeline Socket Stages
- Sniffer

References

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Development Contacts

- Will J. Roden, Jr.
  - Phone: (607) 429-3278
  - Internet: RODEN@US.IBM.COM
  - Web: http://www.vm.ibm.com/devpages/roden
  - Postal mail
    - IBM Department G79G
    - 1701 North Street
    - Endicott, NY 13760 U.S.A.