Cross-platform TCP/IP Socket programming in REXX

Abstract:

TCP/IP is the key modern network technology, and the various REXX implementations have useful, if incompatible interfaces to it. In this session, we cover writing TCP/IP clients and servers in REXX, on MVS, Win32, and UNIX platforms, and propose a workable solution to the incompatibility issues

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1

Contents

2

TCP/IP Application Functionality

Via TCP/IP users may:

- Use terminal access to other systems (Telnet)
- Send commands to other systems and receive responses
- Transfer and share files between systems (FTP and NFS)
- Use devices on other systems (Printing)
- Enable cross-platform communication between cooperating applications

3

Two Similar Packet Delivery Systems

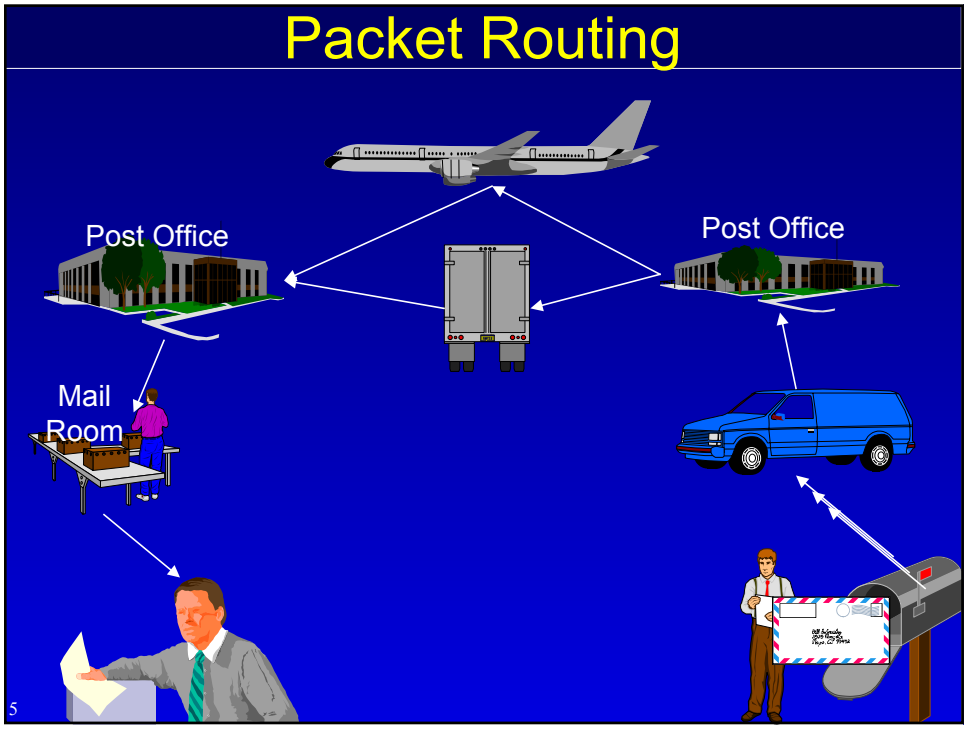
FROM:
ProTech
One Monroeville Center, Suite 622
Monroeville, PA 15146

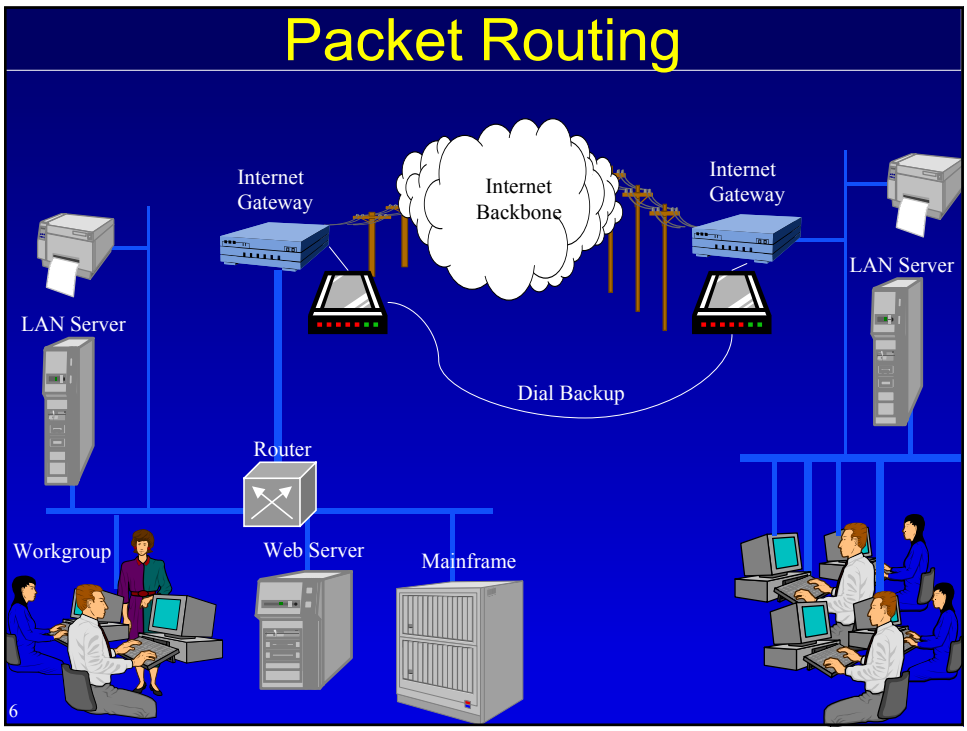
TO:
You
Your Company
Your street address
Your city, State, zipcode

Ethernet frame:
TO: 00:23:44:31:A1:19
FROM: 00:23:44:38:F1:D4
DATA:

IP packet:
TO: 192.168.1.20 PORT: 21
FROM: 192.168.1.252 PORT: 1019
DATA: Your data
goes here

4



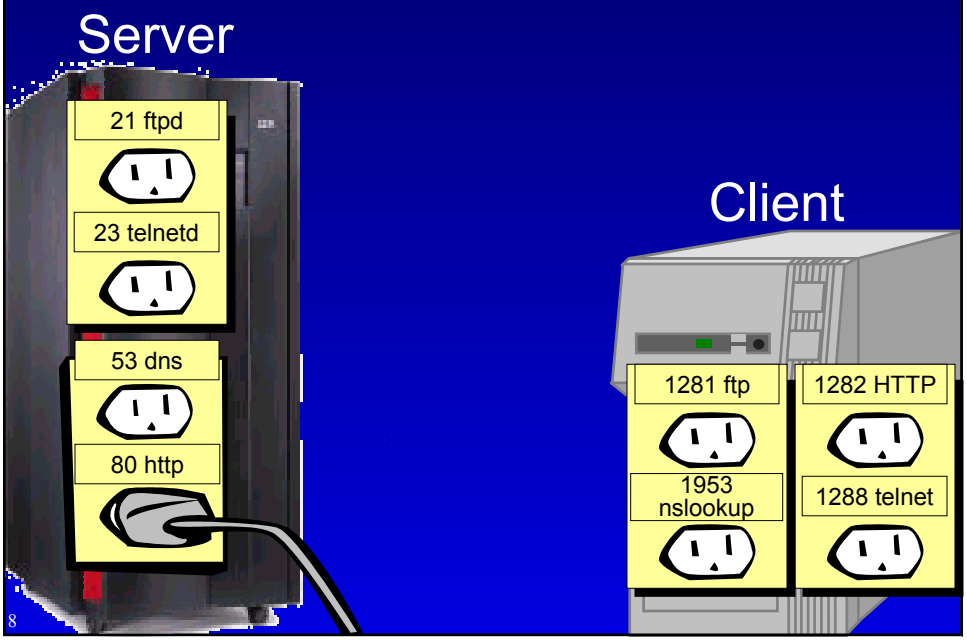


Network Physical Layer, IP Layer

- Physical layer
  - Ethernet is the most common physical network type in use today (others include ATM, FDDI, Token Ring)
  - Each Ethernet card contains a unique hardware address, burned into it by the manufacturer
- IP Addressing
  - Every network interface card (NIC) gets an IP Address
  - Forms a network of interconnected networks
  - Example:
    - Host: 209.161.92.101 (rexxdog.protechpts.com)
    - Net Mask: 255.255.255.0 (Class C network, 254 hosts)
    - Network: 209.161.92.0

7

OS/390 TCP/IP Sockets



8

Well Known UDP & TCP Ports

Port	Application	Description
Echo	7/udp	Echo Datagram back to sender
FTP-Data	20/tcp	File Transfer data transfer
FTP	21/tcp	File Transfer dialogue
Telnet	23/tcp	Telnet remote login port
SMTP	25/tcp	Simple Mail Transfer Protocol
DNS	53/udp	Domain name server
HTTP	80/tcp	Default Web server port
POP3	110/tcp	PC mail retrieval service
NNTP	119/tcp	Network news access
NTP	123/udp	Network Time Protocol
SNMP	161/udp	Simple Network Management queries
SNMP-trap	162/udp	Simple Network Management alerts

9

TCP/IP Services

- ARP - Address Resolution Protocol
  - Translates between hardware address & IP address
  - Routers use arp to find out which machine on its network is to receive a given IP data packet
- DNS - Domain Name Service
  - Translates between hostnames & IP addresses
  - Essential for "human" use of the Internet
  - Each domain is locally managed, i.e. ProTech gets to name the machines in protechpts.com
  - Slow TCP/IP response often related to DNS problems
  - nslookup - UNIX command used to query the domain name server

10

TCP/IP Applications

- telnet - Terminal emulation
  - Allows terminal -> host connection w/o dedicated wire
  - Terminal type and capabilities are negotiated
  - TN3270 is telnet for 3270 terminals
- ftp - File Transfer Protocol
  - Allows files to be transferred between hosts
  - Supports transfer between dissimilar machines
    - OS/390 (EBCDIC) to PC (ASCII) or other UNIX (ASCII)
    - Dataset name <-> UNIX filename
- sendmail - e-mail transfer program
  - Stores and forwards mail to other users, machines

11

TCP/IP Applications

- NFS - Network File System
  - Allows remote disks on another system to appear local
  - Slower, more convenient for accessing common data
  - Has several cousins w/ additional features, complexity
    - AFS - Andrew File System
    - DFS - Distributed File System
    - OSF DCE - Distributed Computing Environment
- WWW - World Wide Web
  - Client-server protocol with generic client, the *browser*
  - Provides interconnected Hypertext documents, forms
  - Supports application development via CGI scripts, Java

12

Telnet Access

- The telnet Command
- The telnet client is a TCP/IP utility that enables terminal access
- telnet is normally invoked from the command line in the format:

```
$ telnet hostid
```

- telnet also supports an interactive mode
- Upon connection you will be prompted for Userid and Password

13

TCP/IP Applications: rsh, rexec

- rsh - Remote Shell
  - Permits you to issue a command on another machine and receive the response
  - Sending host, userid must be pre-authorized
    - .rhosts file contains permitted machines, usernames
  - Userid and cmd text traverses network, but not passwd

```
$ rsh rexxdog ls -al
```

- rexec - Remote Execution
  - Issue a command on remote host & receive response
  - Userid, password, and cmd text traverses the network

```
$ rexec -l bstark -p pswd rexxdog ls -al
```

  - Userid and password from .netrc file in home directory

```
machine rexxdog login bstark password pswd
$ chmod go-rwx .netrc
```

(Remove others access)

14

FTP (File Transfer Protocol)

- File Transfer Protocol (ftp)
- ftp allows users to transfer files between systems
- Any machine (UNIX or otherwise) may make an ftp connection to any other machine if both support the protocol
- ftp has a command line mode and an interactive or command mode
- From the command line, ftp operates like telnet:

```
$ ftp rexxdog.protechtraining.com
```

-or-

```
$ ftp 209.161.92.101
```

15

Socket Programming Overview

- TCP/IP implementations provide a C language programming API for socket functions
- Sockets are like file handles:
  - Open a socket, read from the socket
  - Write to the socket, close the socket
- You can use TCP or UDP protocols, but most applications use TCP, since it is easier
- Data sent and received on a socket is not translated
  - The standard is to send ASCII characters, so you must provide your own EBCDIC translation on mainframes
  - You must also work out the byte ordering for numbers (big-endian or little-endian)
- Sockets are full duplex: a program can both read and write to the same socket

16

Socket Programming Overview

REXX Programming interfaces are provided for:

- z/OS & OS/390 TSO/E REXX via IBM TCP/IP stack
  - Documented in SC31-8788 z/OS Communications Server IP Application Programming Interface Guide
  - Uses the SOCKET() function
  - Compatible with VM and VSE
- Windows, AIX, Linux, OS/2 via RxSock function library
  - Documented in Object REXX for Windows REXX TCP/IP Socket Library Functions (RxSock)
  - Provides 27 REXX functions, all starting w/ Sock…()
- Regina REXX (many platforms) provides an RxSock compatible version matching the IBM Object REXX

17

Basic Socket Send/Receive Functions

- SockSocket(*domain, type, protocol*) PC
  Socket('SOCKET', *domain, type, protocol*) MVS
  - Creates a new socket and returns its number
  - Typical parms: **'AF_INET','SOCK_STREAM', 'IPPROTO_TCP'**
- SockRecv(*socket, buffer, length, flags*) PC
  Socket('Recv', *socket*, *length, flags*) MVS
  - Reads data from *socket*, up to *length* bytes (may return less)
- SockSend(*socket, dataToSend, flags*) PC
  Socket('Send', *socket*, *dataToSend, flags*) MVS
  - Writes *dataToSend* to *socket*
- SockClose(*socket*) PC
  Socket('Close', *socket*) MVS
  - Closes *socket* (makes it unusable on both sides)

18

Resolver, Port number

- Socket functions deal with IP addresses, not hostnames
- SockGetHostByName()
  - Converts a hostname to an IP address, by interfacing to the resolver on the local machine
  - Generally, the resolver communicates with one or more DNS servers
  - Use this to accept both IP addresses and/or hostnames
- Multiple servers on a machine are distinguished by port number
  - Client and server MUST agree on the port number
  - Hard-code the port number in your program, or accept it as a parameter in both client and server

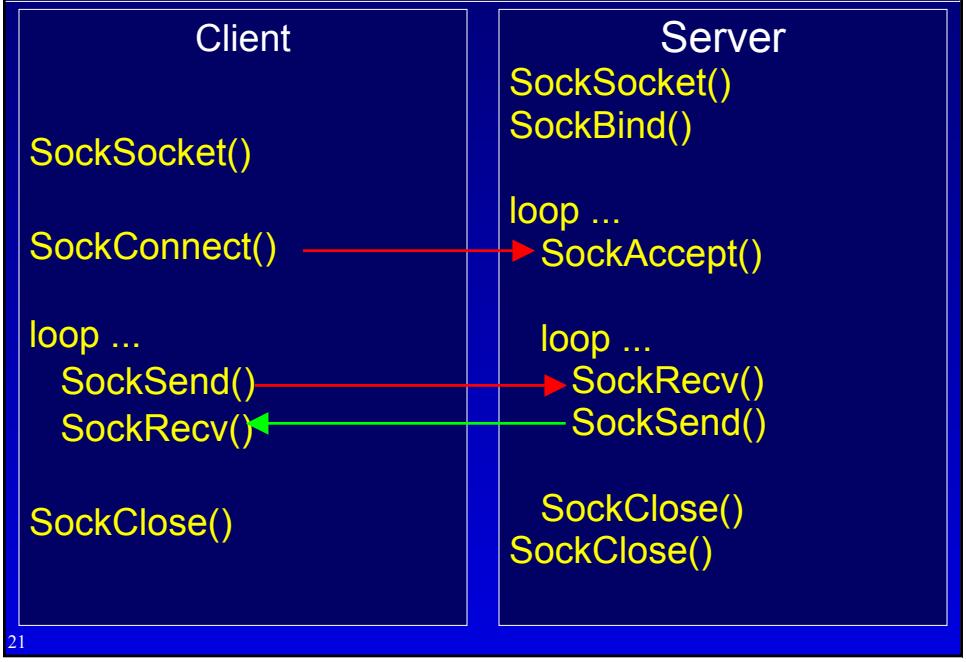
19

Basic Socket Connection Functions

- SockBind(*socket, address*) PC/UNIX
  Socket('Bind', *socket, address*) MVS
  - Used by servers to reserve a port
- SockAccept(*socket,* [*address*]) PC/UNIX
  Socket('Accept', *socket*) MVS
  - Used by servers to wait for a client to make a connection
  - *socket* must have been previously bound
  - When a connection occurs, a new socket is returned, which is used for further communication with the client (original socket remains open, waiting for new connections)
- SockConnect(*socket, address*) PC/UNIX
  Socket('Connect', *socket*) MVS
  - Used by clients to connect to a server

20

Basic Socket Connection Functions



21

Sample TCP/IP Socket Application

- Echo client and server, written by Thorsten Schaper of IBM
  - Client sends a string to the server
  - Server appends text to the string and sends it back
- Contains both Mainframe and PC/UNIX implementations
- Server can handle multiple clients, Host or workstation
  - EBCDIC <-> ASCII translation is handled
- Available for download at:
  ftp://service.boulder.ibm.com/ps/products/ad/obj-xx/rxsocket.zip

22

Sample TCP/IP Socket Application

Server

```
D:\>rexx serverw.rex
-> trying to bind service to:
  host = 127.0.0.1
  port = 5000
...listening for clients on socket: 300

-> trying to accept a new client
...OK, new client is connected on socket: 308
...clientInfo: WindowsNT COMMAND
      D:\download\rexx\rxsocket\clientw.rex
-> got a request from client connected at socket: 308
...received:  'TXTHello, this is a test message'
...answering: 'server has received your text :'TXTHello, this is a test
      message'
-> got a request from client connected at socket: 308
...received:  'CMDshutDownService'
-> shutting down all sockets...
  308: is down.
  300: had problems -> RC = -1
-> Socket REXX-API functions NOT dropped to avoid crashing othe
  REXX programs that are using the Socket API at the moment.
good bye
```

Client

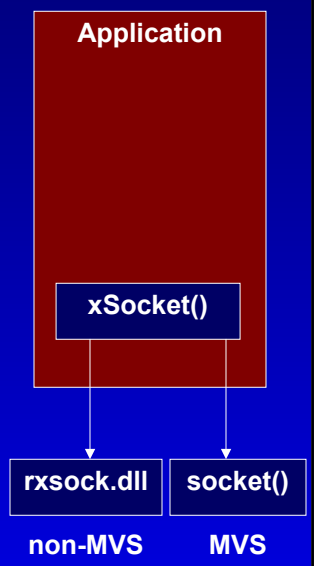
```
D:\>rexx clientw.rex
...trying to connect to service at:
host = 127.0.0.1
port = 5000
--> established on socket: 300

1.) send 'TXTHello World!'    text    message
2.) enter text for sending a  text    message
3.) send 'CMDshutDownService' command message
4.) close connection & exit
2
Hello, this is a test message
=====================================
...sent text was   : 'TXTHello, this is a test message'
...server replied  : 'server has received your text
      :'TXTHello, this is a test message"
=====================================
1.) send 'TXTHello World!'    text    message
2.) enter text for sending a  text    message
3.) send 'CMDshutDownService' command message
4.) close connection & exit
3
=====================================
...sent text was   : 'CMDshutDownService'
```

23

xSocket() Internal Function

- Internal REXX function used to map calls to MVS socket() into Windows/Linux/OS/2 Socket API
- Pasted in via rxcopy edit macro
- On MVS, it is a strait pass-thru
- Other platforms, it calls the appropriate socket function, and places the data into MVS format
- Sets variables:
  - xsrc = 0 (no error), or mnemonic, e.g. EWOULDBLOCK
  - xsrcmsg = '' (no error), or error msg, e.g. Operation would block



24

Practical Applications from the Field

- Client connection between CA-OPS/MVS (Automated Operations) & BMC Patrol Enterprise Manager (PEM)
  - Client replaced BMC host product but kept PEM
  - Interface enabled MVS REXX code to open alerts on PEM
  - Implemented as an MVS Started Task written in REXX
- Trouble Ticket interface between MVS and Expert Advisor running on Windows
  - Expert Advisor has a command line interface for integration with HP-OpenView and NetView for AIX
  - Installed Denicomp systems rexec daemon www.denicomp.com - 800-2424-PSL
  - Implemented rxrexec() external function, which implements REXEC protocol but stores encrypted password elsewhere

25

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26