# IBM VSE/ESA TCP/IP Performance Considerations

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# General Remarks

# Notes

All information contained in this document has been collected and is presented based on the current status.

It is intended and required to update the performance information in this document.

It is the responsibility of any user of this VSE/ESA document
- to use the latest update of this document
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This document is unclassified and intended for VSE cuctomers. It is part of the package VE21PERF which resides on an IBM disk, called IBMVSE.

Access to the VExyPERF packages is available for any IBM person without additional authorization, just by typing the CMS command

TOOLS SENDTO BOEVM3 VMTOOLS IBMVSE GET VExyPERF PACKAGE

The following documents are also available, both on the IBMVSE tools disk, and also via the INTERNET VSE/ESA home page

http://www.ibm.com/s390/vse/

or directly via FTP links

http://www.ibm.com/s390/vse/vsehtmls/s390ftp.htm

Starting with VSE/ESA 2.4, these documents are also available on the VSE/ESA CD-ROM kit SK2T-0060 in Adobe Reader format (.PDF):

'IBM VSE/ESA 1.3/1.4 Performance Considerations'
'IBM VSE/ESA V2 Performance Considerations'
'IBM VSE/ESA Turbo Dispatcher Performance'
'IBM VSE/ESA I/O Subsystem Performance Considerations'
'IBM VSE/ESA VM Guest Performance Considerations'
'IBM VSE/ESA Hints for Performance Activities'
'IBM VSE/ESA TCP/IP Performance Considerations' (this doc)
'IBM DFSORT/VSE Performance Considerations'
'IBM VSE/ESA CICS Transaction Server Performance'
'IBM VSE/ESA V2.5 Performance Considerations' (to come)

The files are
VE13PERF.PDF, VE21PERF.PDF, VE21TDP.PDF, VEIOPERF.PDF, VEVMPERF.PDF, VEPERACT.PDF, VETCPPER.PDF, VESORTP.PDF, VECICSTS.PDF, VE25PERF.PDF

# Notes ...

## Disclaimer

This document has not been subjected to any formal review or testing procedures and has not been checked in all details for technical accuracy. Results must be individually evaluated for applicability to a particular installation.

Any performance data contained in this publication was obtained in a controlled environment based on the use of specific data and is presented only to illustrate techniques and procedures to assist to understand IBM products better.

The results which may be obtained in other operating environments may vary significantly. Users of this document should verify the applicability of this data in their specific environment.

The above disclaimer is required since not all dependencies can be described in this type of document.

## Acknowledgements

Thanks to all who contributed directly or indirectly, be it by measurements, suggestions or in other ways.

Specific thanks to
Hanns-Joachim Uhl doing all the performance runs
and
to all CSI people answering and clarifying all my questions

All mistakes and inaccuracies in this document are owned by me.

Please, as in the past, contact us if you have

- suggestions or questions regarding this document
- questions on VSE/ESA performance, not covered in any of the VSE/ESA performance documents

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# Notes ...

## Related Documents

This document deals with the performance aspects of the native TCP/IP solution ....

The VSE/ESA performance documents (see a previous foil) are also available to any IBM person, as part of the VE12PERF/VE13PERF/VE21PERF PACKAGEs on the same IBMVSE TOOLS disk. Contact your IBM representative to retrieve a copy for you by entering the following CMS command:

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These documents contain references to further VSE performance info.

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UNIX X/Open Company Limited
Windows Microsoft Corporation
.....

## What has been essentially added/changed?

„ Updates as of 98-05-15
- NFS support for the IBM shipped product
- Detailed FTP performance results for LIBR and POWER plus VSAM ESDS first results
- New performance PTFs

„ Updates as of 99-06-25
- Inclusion of service packs H to J, editorial improvements
- Separate TCP/IP partition for FTP (new chart)
- FTP results for Service Pack I
- Service Pack J (description of VSCR, FTPBATCH, and new Telnet results)

„ Updates after 99-06-25
- Inclusion of GPS
- Service Pack K (Telnet and FTPBATCH results)
- Telnet Capacity increase

# References

The following are some references for further information in the context of TCP/IP.

## General TCP/IP References


„ TCP/IP Introduction, GC31-6080

„ TCP/IP Tutorial and Technical Overview, Fifth Edition,
by Eamon Murphy, Steve Hayes, Mathias Enders,
Prentice Hall PTR, ISBN 0-13-460858-5, or
ITSO Raleigh Redbook, GG24-3376-04, 06/95, 477 pages

„ TCP/IP - Architecture, Protocols, and Implementation-
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„ TCP/IP Illustrated, Volume 1 'The Protocols', by W. Richard
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„ Internetworking with TCP/IP,
Vol I: Principles, Protocols, and Architecture,
by Douglas E. Comer, 2nd Edition, Prentice Hall, SC31-6144-00

„ IBM TCP/IP Performance Tuning Guide, SC31-7188-02, 03/97, 282
pages
As TCP32PTG on the IBM MKTTOOLS tools disk
(Addresses MVS, VM, AIX, OS/2, DOS, OS/400,
Concepts, Tuning, Benchmark data)

„ Using the Information Super Highway, ITSO Austin Redbook,
GG24-2499-00, 05/95, 206 pages

„ Introduction to TCP/IP, by Richard F.Lewis, IBM Washington.
VM and VSE Tech Conf, 06/97, Mainz, Germany, Session 1B1,
05/98, Reno, Nevada, Session 11F

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## References for TCP/IP with MVS


„ IBM MVS TCP/IP -Performance Tuning Tips and Capacity Planning-,
by L.Groner, D.Patel and R.Perrone from IBM Network Systems,
SHARE 85, Session 2542, 08/95
by L.Ferdinand, B.Kay, D.Patel, R.Perrone, S.Rimbey, IBM,
SHARE 88, Session 3912, 03/97
As TCPPERF PACKAGE on MKTTOOLS (for your IBM representative)

„ IBM TCP/IP for MVS -Customization and Administration Guide-,
V3 R2, SC31-7134-03, 09/96, 726 pages

„ IBM TCP/IP V3.2 for MVS -Implementation Guide-,
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## References for TCP/IP with VM


„ IBM ICP/IP for VM -Planning and Customization-
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V2 R4, SC31-6082-03, 12/96, 412 pages

„ VM/ESA TCP/IP Performance, by Bill Bitner, IBM
VM and VSE Tech Conf, 05/97, Kansas City, MO, Session 26E
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SHARE 88, Session 9224, 03/97
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http://www.vm.ibm.com/devpages/bitner/presentations/tcpip/

„ VM/ESA V2.1.0 Performance Report, 12/95, p117
TCP/IP file transfer via TCPNJE RSCS between 9121-320s using CTC with 3088

„ VM/ESA V2.2.0 Performance Report, 12/96, p58
TCP/IP 2.4 vs 2.3, File transfer from AIX to VM/ESA, with RPC UDP, using Token-Ring at a 3172-1

„ TCP/IP for VM/ESA V2R3, by Alan Altmark
(includes TCP/IP Level 310 enhancements)
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05/98, Reno, Nevada, Session 20A

„ Getting Started with VM TCP/IP, by Alan Altmark
VM and VSE Tech Conf, 05/98, Reno, Nevada, Session 20A

# References for TCP/IP with VSE

## IBM documents

- „ TCP/IP for VSE/ESA -User's Guide-, SC33-6601-00, 494 pages, 12/97.
  -01 available 07/98. Replaced by:
  TCP/IP for VSE/ESA -IBM Program Setup and Supplementary Information, SC33-6601-03

- „ The Native TCP/IP Solution for VSE,
  SG24-2041-00, ITSO Boeblingen Redbook, 223 pages, 08/97
  Obsolete, applies to CSI TCP/IP Rel 1.2.
  Replaced by the following redbook ..

- „ Getting Started with TCP/IP for VSE/ESA 1.4
  SG24-5626-00, ITSO Boeblingen Redbook, 265 pages, 03/2000

- „ VSE as a Webserver, SG24-2040-00, ITSO Boeblingen Redbook, 01/98

## CSI (Connectivity Systems) documents

- „ TCP/IP for VSE -Product Presentation-,
  WAVV Conference Albany, NY, 10/98
  WAVV Conference Cincinnatti/Ft. Mitchell, 10/99

- „ TCP/IP for VSE Manuals by CSI:
  Version 1.3 09/97, Version 1.4 11/99

  - Installation and Operation Guide
  - Commands
  - User's Guide
  - Programmers Reference
  - Messages and Codes
  - Optional Products Guide

- „ TCP/IP for VSE with Network File System. By Leo Langevin,
  Connectivity Systems Inc., 09/98
  VSE Customer Conference Call 09/16/98

- „ Visit the WWW site: http://www.tcpip4vse.com/
  to check further information from CSI

# References for TCP/IP with VSE (cont'd)

## Conference contributions


„ TCP/IP Solutions for VSE/ESA
by Boris H. Barth/Ingo Adlung, IBM Boeblingen.
VM and VSE Tech Conf, 06/97, Mainz Germany, Session 52A

„ TCP/IP for VSE and the Heterogeeous World of WERU AG
IBM S/390 Enterprise Systems Bulletin, 03/97

„ CGI Programming for VSE -Using VSE as a Web Server-
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VM and VSE Tech Conf, 05/97, Kansas City MO, Session 32B

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WAVV 97 Chattanooga, 11/97, WAVV 98 Albany, NY, 10/98

„ WWW and VSE/ESA, by Anette Stolvoort, IBM.
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„ TCP/IP for 'Dummies', by Eric Vaughan, Intelliware,
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„ TCP/IP for VSE/ESA, Installation and Implementation,
by Jon vonWolfersdorf, VM and VSE Tech Conf, 04/98, Frankfurt,
Germany, Session 81J

„ TCP/IP Socket programming with VSE/ESA, by Ingo Adlung.
VM and VSE Tech Conf, 04/98, Frankfurt, Germany, Session 90K
VM and VSE Tech Conf, 05/98, Reno, Nevada, Session 30B

„ TCP/IP for VSE -The Last Word on Performance-,
by John Rankin, CSI. WAVV 98 Albany, NY, 10/98
WAVV 99 Cincinnatti/Ft. Mitchell, 10/99

# Glossary/Abbreviations

| | |
|---|---|
| ACK | Acknowledgement |
| ARP | Address Resolution Protocol |
| CAF | CICS Access Facility |
| CGI | Common Gateway Interface |
| CETI | Continuously Executing Transfer Interface |
| CLAW | Common Link Access to Workstations |
| CTC(A) | Channel to Channel (Adapter) |
| FDDI | Fiber Distribution Data Interface |
| FTP | File Transfer Protocol |
| GPS | General Print Server |
| HTML | HyperText Markup Language |
| HTTP | HyperText Transfer Protocol |
| ICMP | Internet Control Message Protocol |
| IP | Internet Protocol |
| LPR/LPD | Line Printer Requester/Daemon |
| LIBR | VSE Librarian |
| MAC | Medium Access Control |
| MIPS | Million Instructions per second, or Meaningless Indication of Processor Speed (if you misuse it) |
| MSS | Maximum Segment Size |
| MTU | Maximum Transmission/Transfer Unit |
| NFS | Network File System |
| OSA | Open Systems Adapter |
| OSI | Open Systems Interconnect |

## Glossary/Abbreviations (cont'd)

| | |
|---|---|
| PING | Packet Internet Groper |
| RPC | Remote Procedure Call |
| SMTP | Simple Mail Transfer Protocol |
| SNMP | Simple Network Management Protocol |
| TCP | Transmission Control Protocol |
| TN3270 | TELNET 3270 |
| UDP | User Datagram Protocol |
| URL | Universal Resource Locator |
| WAVV | World Alliance of VM and VSE |
| XPCC | VSE Cross Partition Communication Control |

# PART B.

# TCP/IP General Intro -Performance View-

## Some Terms

- **Client**
  - **... a computer or process that initiates a request.**

    **Each client program makes requests to S/W running at a remote location**
- **Server**
  - **... a computer or process that provides service to clients**
- **Daemon**
  - **... a program that 'listens' for requests from clients and then passes control to a server**

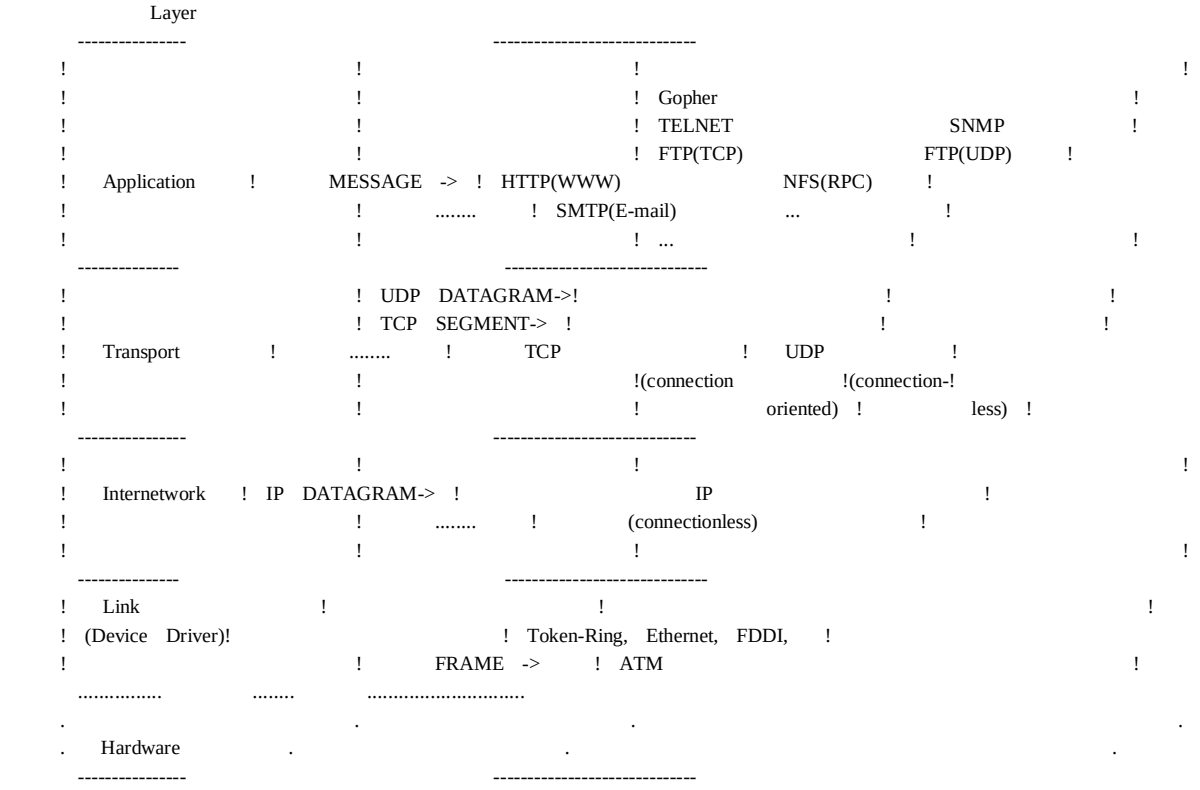
    (A daemon is often called a 'server', since it is associated to a server, quasi controlling access, like in hell)
- **Host**
  - **... may be thought of as an end system (which gets a unique network address), not necessarily a mainframe**

    **E.g. - any VSE partition with TCP/IP**
    **- any PC on a TCP/IP network**

# Protocol Layers

The following likewise applies to any TCP/IP network




This layer model here is same as the OSI model,
except that OSI shows Presentation and Session as separate layers
(here included in Application layer).

## Protocol Layers

Both TCP and UDP are on the 'Transport Layer'.

- **TCP = Transmission Control Protocol**

  **Accepts data transmission requests of any length**

  **Breaks the transmission data into chunks (TCP segments)**

  **Reliably sends them across the network**

  **Employs checksums, sequence numbers, timestamps, timeout counters for retransmission**

  **Uses and exploits ACKnowledgements for 'windowing'**

  ACKs used are always
  - cumulative, i.e. not selective
  - positive, i.e. no negative ACKs

  (Many TCPs send ACKs for every 2nd data segment it receives)

- **Connection oriented**

## Protocol Layers (cont'd)

- **UDP = User Datagram Protocol**

  **UDP datagrams treated as 'single entities'**

  Each UDP datagram directed separately to the receiving application

  **No checking for successful delivery, no usage of ACKs**

  **UDP provides Send space and Receive space. If space full, extra data is discarded**

  - Inbound:

    Data moved from 'Receive Space' in UDP layer (Receive Buffer) to User Data Buffer in application

  - Outbound:

    Sender does not know when receiving buffer is full. Receiver discards extra incoming data, to be retransmitted

- **Connectionless**

  Less frequently used,
  but used e.g. for NFS in TCP/IP for VSE/ESA

  Less reliable, but potentially faster

# Protocol Layers for Internet ...

- **IP = Internet Protocol (Network Layer)**
  - **Creates a virtual network view**
  - **Has no reliability, flow control or error recovery,**

    i.e. no timeout, no retransmission
  - **Can do fragmentation and reassembly of its datagrams**

    Loss of a fragment causes ALL fragments to be re-transmitted
    (no ACK mechanism provided on fragmented IP datagram level)
  - IP transmission protocol requires that each 'data packet' either be delivered in a timely fashion or thrown away
  - **Just performs the transfer of IP datagrams**

- **Encapsulation principle for layers:**

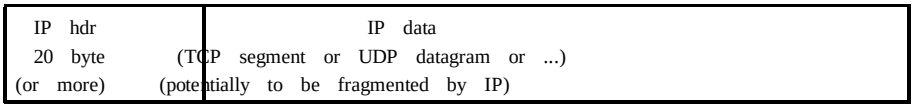
  **Each layer**
  - **sends its data down the protocol stack by adding header info to the data ('outbound')**
  - **receives its data from the layer below by looking at certain identifiers and by removing its own headers ('inbound')**

# Frames, Datagrams, Segments

## „ Physically Transferred (Frame)


## „ IP Datagram

Often also called 'Packet'

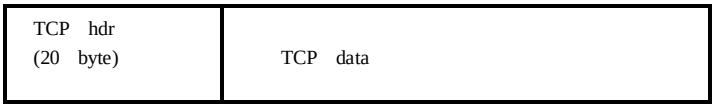



IP header:

- IP protocol version
- header length (<60)
- type of service (priority, ...)
- fragmentation info
- type of higher level protocol
- header checksum

- IP does not impose a maximum IP datagram length, but all subnetworks must be able to handle at least 576 bytes

## „ TCP Segment

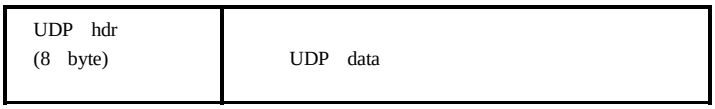



TCP header:

- source/destination info
- sequence number
- header size
- checksum

- From the receiving TCP an ACK is required for each segment
  -> A byte data stream is composed of multiple TCP segments

## „ UDP Datagram




UDP header:

- source/destination info
- length ....

- Composition of data from different UDP datagrams and control of transmission is NOT part of UDP, to be done by application

# Frames, Datagrams, Segments ...

## MTU (Maximum Transfer Unit)

- **Maximum amount of data in a frame that can be sent over the physical media**

and thus ...

**Max. IP datagram size**

(w/o fragmentation by local IP)

| Adapter Type | Default | Minimum | Maximum (examples) | |
|---|---|---|---|---|
| Ethernet | 1500 | 576 | 1500 | |
| Token-Ring | 1500 | 576 | about 4000 | (4 Mbit/sec)<br>about 8000 (16Mbit/sec) |
| FDDI | 1500 | 576 | 2000 | |
| CTC | 4096 | 576 | 16K | (RS/6000 CLAW)<br>32K (S/390 CTCA) |
| OSA-2 | 1500 | 576 | | |

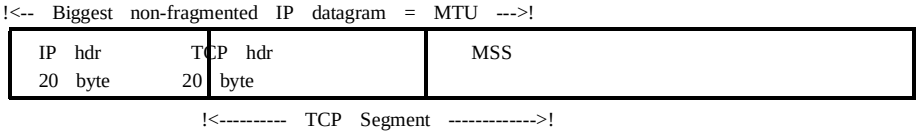
- All sizes in byte
- For any P/390 or R/390 simulated 3172, MTU must not exceed 1492

If a connection is across multiple nodes ...
the smallest MTU of any data link that the connection uses will be relevant: 'Path MTU'

## MSS (Maximum Segment Size)

- **Biggest amount of data a TCP can receive in a single TCP segment**

This value is sent at session setup to the TCP partner, who has to observe this value (Default is 536).
Assuming for the moment a constant IP hdr size of 20 bytes:




MSS = MTU - 40 bytes (if w/o fragmentation by local IP)

## MSS (cont'd)

The max. amount of data TCP can put into a single TCP segment (w/o requiring later IP fragmentation) is in general

| MSS + 40 - (size of TCP + IP headers) |
|---|

## Resulting MSS Value for a TCP Connection

### „ Scenario

When establishing a TCP connection, the server and client exchange info that specifies the maximum 'packet' size each can receive:

the MSS value from the other system.

This value is considered when a partner TCP/IP sends TCP segments out.

### „ Optimal MSS for a TCP Connection (Direction)

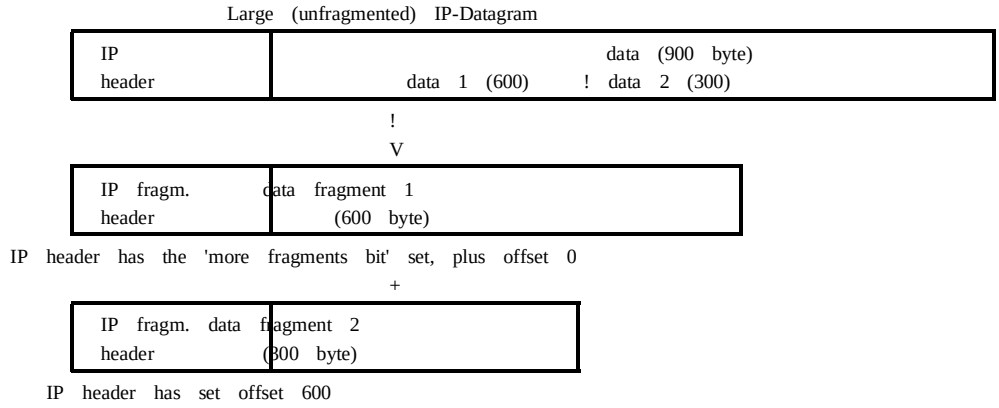
| MIN out of<br>- the MSS value of the other system<br>- the MTU-value of the route minus 40 byte |
|---|

The resulting actual maximum size of TCP data is usually optimal, if ...

- it is as large as possible, but without requiring any IP fragmentation (and thus no reassembly) along the path from source to destination

# IP Fragmentation and Reassembly

## Example (MTU=620)




- Large IP datagrams ('packets') can be fragmented, each getting its own header
- Transmissions via gateways through other networks should use the 'default TCP/IP packet size' of 576, unless all intervening gateways and networks are known to accept larger packets
- The complete datagram is restored
  - only at the final destination (reassembly)
  - as soon as all fragments have arrived at the IP level

## Performace Impacts

For sender

- CPU overhead to create and transmit additional packets
- Retransmit ALL packets in a datagram if a packet is lost

For receiver

- CPU overhead to re-assemble the packets
- Memory overhead for buffers to re-assemble the packets
- Delays if a packet is lost

If fragmentation only occurs occasionally, no problem

# TCP/IP Window Technique

## Ù Send as much data as possible/reasonable before waiting for an ACKnowledgement

In case of TCP, this principle is applied on the TCP level. (Thus, here we talk of segments instead of packets).

Largest TCP window size is 64K, except 'Window Scale' would be used (RFC 1323).

## Ù General

„ A Receiver decides how much data it is willing to accept

„ A Sender must stay within this limit

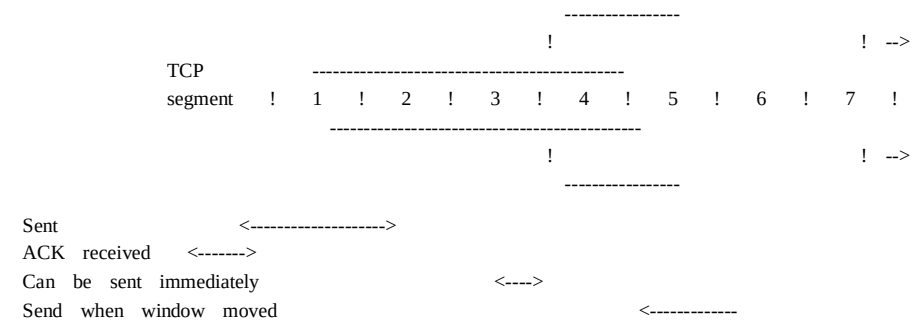
„ A Window is always related to a single session and direction

„ At connection setup, each partner assigns receive buffer space
(usually a multiple of the maximum segment size)

„ Every ACK sent back by the receiver

- contains the highest segment number received 'in sequence'
- and the size of its current receive window left

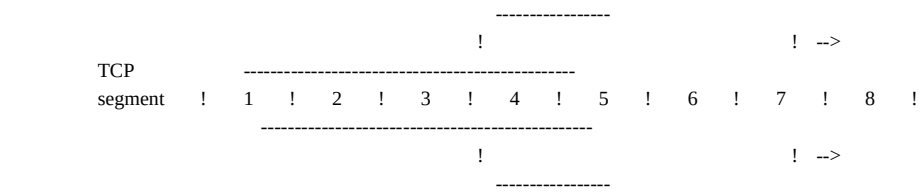
## Sliding and Breathing Window (SEND)




Cont'd on next page

# TCP/IP Window Technique (cont'd)

## Sliding and Breathing Window (RECEIVE)




Received <----------->
ACK sent out <---------->
Can be received immediately <--->
Can be received after the RECEIVE window moved <----------

## Ù TCP Windowing Rules (SEND)

„ Send out all segments within the current window, independent of any ACK

„ For each segment sent, start a time-out timer.
Retransmit segment after time-out, if no ACK received

„ Move/Adapt current window based on

- highest ACK received
- changed window size (if so) in last ACK

„ Sizes/Number of Send and Receive buffers on TCP layer determine maximum window sizes

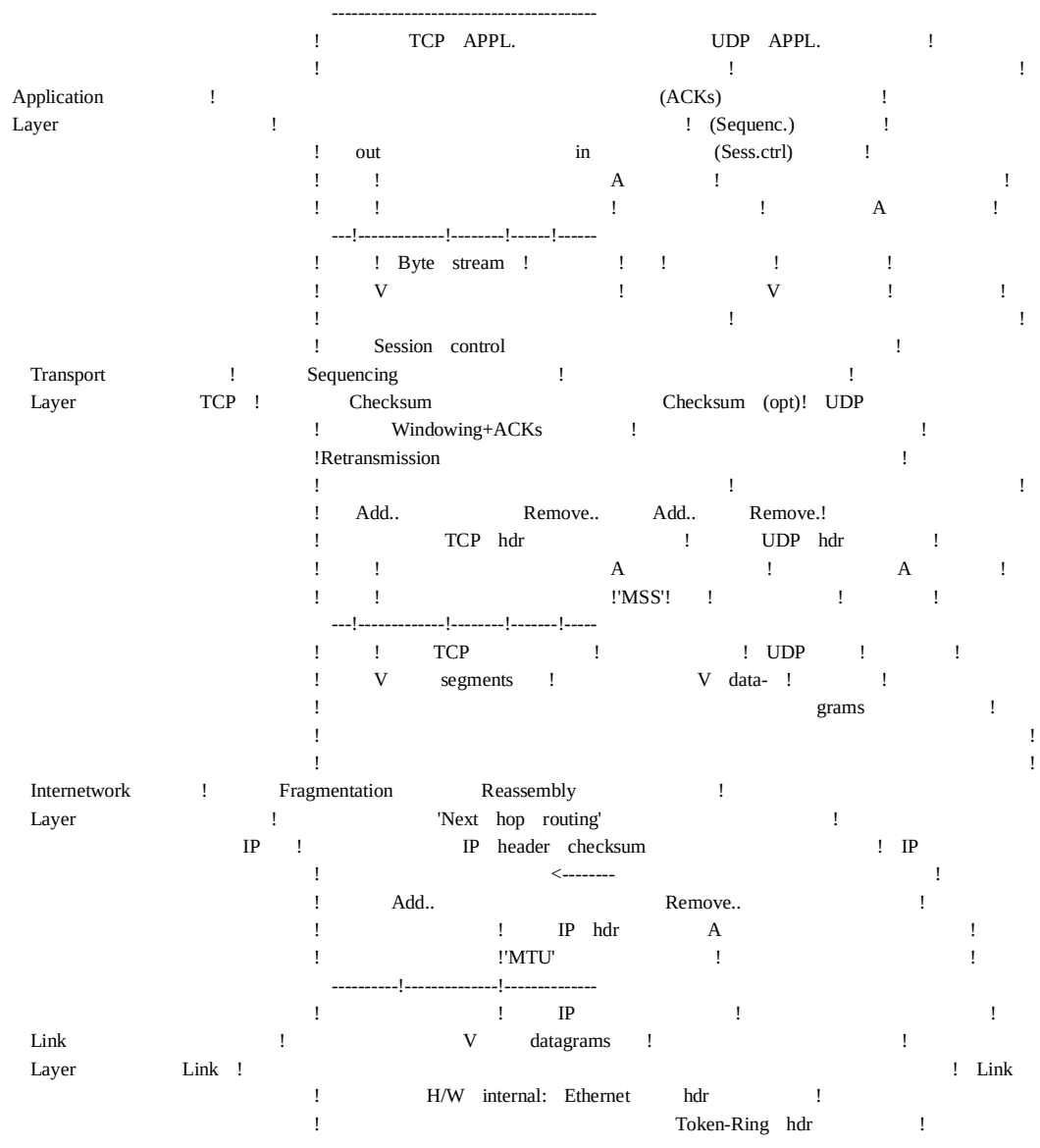
„ Maximum window sizes also depend on platform

| | |
|---|---|
| PS/2 | 16384 (fixed size) |
| RS/6000 | 4096, 16384, 32768 |

## í Effect similar to Pacing in SNA-networks

# TCP/IP Protocol Layers (Revisited)

## Summary and Location of Activities




Outbound fragmentation may occur if

MTU-40byte < MSS of other system

Inbound reassembly may occur if

MTU-40byte < MSS of VSE host

# TCP/IP Concepts and Algorithms

## Basic Concepts of TCP/IP

On order to better understand potential effects of parameter selection, it is very helpful if some basic TCP/IP concepts are understood.

These concepts include

- **Frames, Datagrams and Segments**
- **Fragmentation and Reassembly**
- **Send and Receive Buffer management via Window sizes and Acknowledgements**

These concepts have been schematically sketched in the previous charts.

## Performance Algorithms for Communication

Several of the many performance algorithms for TCP are discussed in Dr. Sidnie Feit's book, pp 233 to 243.

They include

- Delayed ACKs
- Duplicate ACKs
- Slow Start
- Silly Window Syndrome
- Nagle Algorithm
- Retransmission Timeout
- Exponential Backoff

Regarding the ACKs, refer to a following chart.
The other algorithms are advanced and are not discussed here.

For faster links with very high transmission rates, there exists a Request For Comment (RFC 1323)

'TCP Extensions for High Performance'

which includes

- Window Size Limit (using an implicit scale factor)
- Selective (vs cumulative) ACKs

# TCP/IP Performance Tuning

TCP/IP performance is influenced by a number of parameters that can be tailored for the specific operating environment. In general these tuning parameters can be grouped into ...

## „ Operating System tuning

Operating System tuning should be familiar to most VSE/ESA customers, thus needs not to be mentioned in more detail here.

It also may include to tune local VSE file attributes, especially for the purpose of TCP/IP file transfers.

## „ TCP/IP setup tuning

TCP/IP tuning is expected to be a new experience for many VSE customers.

It refers mostly to the optimal setup of a TCP/IP partition.

## „ Communication/Network tuning

### Mainframe end
### Network
### Workstation end

Communication (or Configuration) tuning is closely related to TCP/IP setup tuning.

It refers to the configuration (including links etc) of the network, and may be also the parameter selection on the other side, where also a TCP/IP resides.

## „ TCP/IP Application tuning

This is only possible, if the customer can influence the TCP/IP application, e.g. at the Sockets level.

## Practical Performance Aspects

- **TCP/IP performance is limited by the**
  - **speed of the slowest link**

    Throughput potentially is greatest when using FDDI for LANs.
    Ethernet and 16Mbps Token-Ring networks are about comparable, lowest throughput usually is obtained for 4 Mbps Token-Ring
  - **speed of the slowest memory involved**
  - **window size of the receiver, divided by the round trip time**
  - **speed of reading/writing data from/to disk (e.g. FTP)**

- **Note**

  **Many TCP/IP performance problems are**

  **- environment specific**
  **- implementation deficiencies**

  **- not caused by inherent protocol limits**

  (Partridge and Pink 1993)

## Network Performance

## Long transfer times in a net may be caused by ...

(set aside too heavy network traffic)

- **Slow links or small MTU sizes**
- **Too many links involved/broken or Routing not efficient**
- **Inefficient setup of packet and window sizes**
- **Higher share of discarded IP datagrams**

  E.g. since 'time_to_live' expired

- **Higher share of resent TCP segments**

  'Retransmission rate'

  E.g. ACKs are delayed too long

# TCP/IP Acknowledgement Consideration

Here some re-visited and more info on TCP ACKs.

- **Background Info (Re-visited)**
  - **TCP ACKs are 'cumulative' (not selective)**

    The receiver only tells the number of the 'lowest' missing packet (=TCP segment).

    No indication included on any 'higher' packet received.
  - **No packet must be individually and immediately ACKnowledged**
  - **Packets are only sent, as long as the receiver's window can hold the data**
  - **Packets are re-sent, if after a timeout no ACK was received by the sender**

    Sometimes earlier, when multiple ACKs refer to the same segment
- **Performance Implications**
  - **Sender should proceed to send data, as long as receive window is open and not too huge**
  - **A too low timeout in the sender may cause unnecessary re-transmissions of packets**
  - **A too high timeout may reduce the data rate**

    - especially when transfer is unreliable
    - when receiving window is small or not enough data is sent before the sender waits for an ACK

# TCP/IP Principal Performance Dependencies

The following is a list of principal parameters which tries to globally categorize performance/tuning impacts.

Overall Performance

Response Times, Elapsed Times,
Throughput,
Resource Consumption

is determined by the components shown:

| Parameter (type) | CPU-time | Host Storage | Host time | Network Transfer time * | DASD | |
|---|---|---|---|---|---|---|
| Host CPU speed | X | - | - | | - | |
| S/390 Op.Syst. & setup | X | X | - | | x | |
| MTU/MSS used | X | | x | X | - | |
| Window size | | | x | X | - | |
| #Xfer buffers | | X | x | | - | |
| Type of Comm. Adapter | | | X | | - | |
| Network/Line speed | | | X | | - | |
| Network reliability | X | x | X | | - | |
| #Appl.-bytes in/out | X | X | X | | X | |
| TCP/IP implementation | X | X | X | | X | |
| TCP/IP application | X | X | X | | X | |
| Other TCP/IP parameters | X | X | X | | X | |
| DASD I/O Subsystem | - | - | - | | X | |
| DASD I/O Blocking | x | - | - | | X | |

X means major impact
x means smaller or secondary impact
- means no or negligible impact ... in general

- Transfer time here includes wait for transfer

* DASD time only applicable if DASD involved (e.g. FTP)

Overall Capacity is also of interest and of specific importance for multiple concurrent sessions (e.g. TN3270)

# TCP/IP Communication Tuning

Improving communication performance for a given network:
- increasing Throughput
- improving Response Times

## High Impact of
- Send and Receive Buffer/Window Sizes
- Packet Sizes

## Ù Optimum/Minimum Window Size

### Round-trip times

Round-trip times for IP datagrams (obtained e.g. via PINGs, refer to separate chart) roughly correspond to the average time between the sending of an IP datagram and receiving the ACK, sent from the partner TCP and the originating TCP, even better, when average datagram sizes are used for PINGs.

### Calculation

Roundtrip times can be used to roughly determine optimum (or better minimum) buffer sizes:

If you could transfer (instantaneously) P MB per sec via TCP/IP through the network (link(s)), and you need Tping msec to transfer each IP datagram, then, roughly

| P MByte/sec x Tping msec = P x Tping KByte |
|---|

should be at least the window size (for SEND, and for RECEIVE); also-called 'Bandwidth*Delay product'.

(This simply is the average maximum amount of data which may be sent w/o acknowledgement)

### Example

Assume - a (slowest) network link of 8 Mbit/sec = 1.0 MB/sec
- an approximate PING time of 20 msec

1.0 MB/sec x 20 msec = 1.0 x 20 KB = 20 KB

In this case, about 20 KB would be required as window size

# TCP/IP Communication Tuning (cont'd)

## Ù Optimum/Minimum Packet Size

Avoid that packets usually are fragmented. Small fragmentation still may be acceptable.

- FTP, NFS: Bigger packet sizes are desired.
- TN3270: Increasing the allowed packet size may not help and potentially wastes virtual storage.

Refer to the previous considerations.

## Ù 'The bigger the better'?

When starting with small buffer sizes and/or packet sizes, this usually holds.

But this is only true as long as

- the network is relatively reliable and
- no fragmentation is forced

and

- there is enough real storage to back up the increased total buffer sizes

and

- you do not have reached a performance limit, determined by any other resource

# TCP vs UDP Performance

## „ UDP may (formally) have less overhead

The overhead for managing a connection-driven environment is not included in UDP itself.

## „ Note of care

Some application (must) provide connection management, so this CPU time is just required on the application layer.

## Send and Receive Buffers (MVS and VM)

Terminology and parameters from the TCP/IP for MVS and VM products

| Type | Parameter (MVS and VM terms) | | Number Deflt. Rec. | Size | Purpose | |
|---|---|---|---|---|---|---|
| Data Buffers | DATABUFFERPOOLSIZE | n | 160 - | 8..256K 16K 32K | Regular data | |
| Small Data Buffers | SMALLDATABUFFERPOOLSIZE | n | 2048 0 - | *S) - - | | |
| Tiny Data Buffers | TINYDATABUFFERPOOLSIZE | n | 256 0 - | *T) - - | | |
| Envelopes | ENVELOPEPOOLSIZE | n | 2048 750 - | *E) - - | | |
| Large Envelopes | LARGEENVELOPEPOOLSIZE | n | = MTU | 8..64K | *L) 50 - | 8K - |

*S) Used for TELNET and Offload function, overflow to regular
*T) Used for Offload function
*E) Used for UDP datagrams >2K
*L) Used if packet (UDP datagram) does not fit into Envelopes

- Data are discarded, if 'Data' or 'Large Envelopes Buffers' are exhausted
- The size of the Large Envelopes also determines the MTU size

# IBM 3172 Specifics

## 3172 Modes of Operation with TCP/IP

### Ù ICP Mode

#### The software in the 3172 is the IBM Interconnect Controller Program (ICP)

„ Short data blocks received are packed into frames of up to 20K before sending them over the channel to the host. Before the next frame is sent, a DE (device end) has to be waited for (in contrast to CLAW or CETI).

Maximum response length: Frames smaller than that are sent directly to the host w/o delay. Optimal: 500 byte. Default: 100 byte

Block delay time: Amount of delay which is allowed while received frames are blocked for retransmission. Optimal: 10 msec. Default: 20 msec

„ Configure the adapters to reject traffic not explicitly addressed to it. This will avoid unnecessary CPU-time overhead.

### Ù Offload Mode

#### Software is OS/2 with the Offload Feature for TCP/IP for MVS or VM

„ Moves some TCP/IP processing from MVS or VM to the 3172-3.
Some S/390 CPU-time reductions (from SC31-7188):
12 - 15% for MVS and VM using Telnet
30 - 50% for MVS and VM using FTP
Note that using 3172 Offload may show reduced throughput, up to 30% for FTP

### Ù OSA-2

„ An integrated H/W feature

- Looks to S/W as 3172, does not have the Offload function.
- Avoids inspection of IP traffic to other hosts (filtering)

# PART C.

# TCP/IP for VSE/ESA Product (TCP4VSE)

Here, the TCP/IP for VSE/ESA product from Connectivity Systems is referred to:

'IBM TCP/IP for VSE/ESA Vers.1 Release 3' (Pgm number 5686-A04).

It is key-enabled and part of the VSE/ESA 2.3 base and available as

- Base Pak
- Application Pak (includes Base Pak functions)

## í New connectivity capabilities for VSE/ESA

# Highlights

- **VSE native implementation**
- **Especially developed for VSE**
- **Runs in a separate VSE partition**
  - **Own multitask mechanism**
    Uses several VSE subtasks (plus internal 'pseudo-tasks')
  - **All daemons/servers run in the TCP/IP partition**
  - **Each TCP/IP partition has a unique ID in the EXEC card**
    Links between TCP/IP partitions can be configured
  - **XPCC is used to communicate with POWER**
    Other partition communications are done via XMOVE
- **More info**

Refer e.g. to the official TCP/IP for VSE literature, or

- TCP/IP for VSE/ESA -User's Guide-, SC33-6601-00, 12/97, -01
  available 07/98
- TCP/IP Solutions for VSE/ESA
  by Boris H. Barth, ITSO Boeblingen
  VM and VSE Tech Conf, 06/97, Mainz Germany, Session 52A
- IBM S/390 Open Systems Adapter -Rerformance Report-.
  As OSAPERF PACKAGE on MKTTOOLS, available to your IBM representative, 11/96

# Supported Environments

## Ù VSE/ESA 2.3 and up (IBM shipped version)

VSE/SP and VSE/ESA releases (CSI V1.3 shipped version)
VSE/ESA releases 1.3 and up (CSI V1.4 shipped version)

- CSI TCP/IP for VSE versions running on VSE/SP have no Librarian API (other functions are supported)

- VSE/SP is no more supported, and has major storage restrictions (24 bit, plus VTAM in shared space).

- S/370-mode is formally available only in VSE/ESA 1.4

## Ù Communication H/W

### „ 3172/8232 LAN Channel Station Controller

- Token-Ring, FDDI, Ethernet
- 3172 emulation by PC Server S/390 systems (P/390, R/390)

### „ ES/9221 Integrated Adapter (CETI)

Token-Ring, X.25, Ethernet

### „ OSA-2 (Oct 95)

Token-Ring (4/16 mbps), Ethernet(10/100 mbps).
FDDI and ATM (LAN Emulation only).
OSA/SF is highly recommended, partly required
OSA-Express (06/99) NOT supported by VSE/ESA

### „ 2216 Nways Multiaccess Connector

Channel attachments to S/390 are fast and appear as 2 adjacent devices (for input and output):

### „ CTCA to any S/390 operating system

Maybe even a virtual CTCA if both under same VM.

Note: No need to care for the VSE MIH setting
(MIH is always disabled for CTCs).

### „ Channel attached RS/6000 (CLAW)

# TCP/IP Application Types ('Internet Services')

- **TELNET (Client and Server)**

  Terminal access from and to VSE systems

- **FTP (Client and Server)**

  Transfer files from and to VSE systems

- **GPS (Server)**

  Direct VTAM printer data to any TCP/IP printer

- **Intranet/Internet Server**

  Access from TCP/IP network to HTML objects/data under VSE

  - **HTTP Server**

    **VSE as WEB server in Internet**

  - **Gopher Server**

    Distributed document search and retrieval
    by means of a series of menus

**Access to data via a TCP/IP network**

- **LPR/LPD (Client/Server)**

  Print on any TCP/IP printer / on a remote VSE system
  via Line Printer Requestor/Daemon

- **NFS (Server only)**

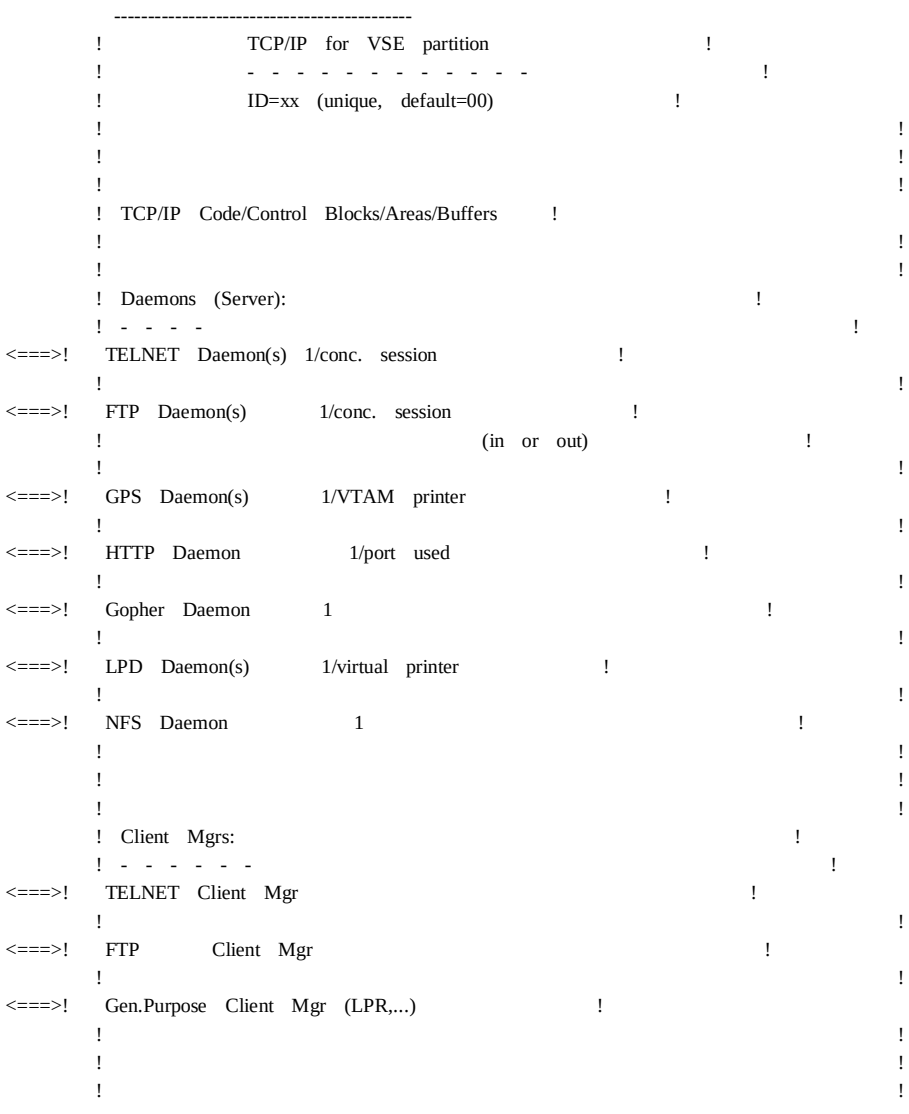
  Access data stored in VSE as if it were local.
  Appears to DOS, Windows etc as a drive, to UNIX as a subdirectory

All these TCP/IP applications use TCP protocol, except most of NFS, which uses UDP.

- **APIs (Sockets)**

  For major programming languages, building TCP/IP applications

# TCP/IP for VSE Partition




1 TCP4VSE server can have -at one point in time- ...

- only a session with 1 client:
  TELNET, FTP

- sessions with multiple clients:
  HTTP, LPD, NFS

# TELNET

- Teletypewriter Network, does not support graphics.
- Makes the user's terminal (Client) appear as a local terminal
- TN3270 is TELNET with 3270 emulation:
  pass 3270 screen data and keyboard inputs

## Ù As Server (Daemon)

### „ Allow remote access/logon from any TCP/IP to VTAM applications via TN3270

„ Runs as 'subtask' in the TCP/IP partition

„ 1 concurrent TN3270 session requires
- 1 TELNET daemon, defined via DEFINE TELNETD
  (only 1 session per socket is inherent to TCP)
- 1 VTAM APPL-id
- 1 VTAM terminal LU-name

„ VTAM 4.2 needs 1MB of addt'l dataspace for each TCP/IP partition running TELNET daemons (runs as a VTAM appl.)

„ CICS Access Facility (CAF, not part of VSE/ESA 2.3.0 GA)

- Would allow TN3270 to bypass VTAM
  (TCP/IP appears to CICS as a TOR).

## Ù As Client

### „ Access to other applications (on 3270 or UNIX platform) from local CICS

„ VSE users (in CICS, also batch) get

- full 327x emulation (connecting to VM/MVS and VSE) if a 3270 session negotiation with the foreign host is successful

- Network Virtual Terminal (TTY line-)support otherwise

# General Print Server (GPS)

## Ù Allows, in a TN3270 environment, to direct VTAM 328x print data to any TCP/IP capable printer

„ Function not available/possible within TN3270 daemons

„ No change in application req'd

## Ù Method of Operation

„ A GPS daemon in TCP/IP partition

- identifies itself to VTAM as a locally attached 3287 printer
- intercepts VTAM non-SNA print data and reformats it
- uses the LPR/LPD protocol

## Ù Function available with APAR PQ27233 (99-07-16).

## A TCP/IP for VSE/ESA feature

- Key protected
- Priced

## Ù Performance

Service Pack L allows to select, where the print data is stored, before it is sent out:

QUEUEING=MEMORY!DISK In TCP/IP GETVIS-31 ! VSE library

GPS Virtual Storage Capacity was also improved in Service Pack L.

For more info, refer to the VSE/ESA homepage

http://www.s390.ibm.com/vse

# FTP

## Transfer data or files from/to remote systems

Requestor is client.
File transfer (uses TCP) can be any direction (GET/PUT).

### Ù As Server (Daemon)

#### „ Allow bi-directional access from FTP clients to data/files under local VSE

1 FTP daemon required for each concurrent FTP session, defined via the DEFINE FTPD command.
A long running task, listening to FTP requests from any client, even when initiated locally.

### Ù As Client

#### „ Starting an FTP session (initiate a file transfer) between VSE and a remote system

via - FTP client outside of VSE
- CICS txn (-> Interactive FTP client)
- Batch job (// EXEC FTP or FTPBATCH)
(-> Internal or External Batch FTP client)
- Program APIs
- A defined event (POWER LST or PUN)
(-> 'Automatic FTP', Service Pack H, 08/98):
e.g. DEFINE EVENT,ID=AFTP,TYPE=POWER,CLASS=F,-
QUEUE=LST,ACTION=FTP
Refer to APAR II11362 for a detailed description.

-> Interactive, automatic, programmatic, or via Batch

#### „ Sequence of user operations

Here an example for remotely initiated FTP:
- Connect to a remote host
- Select a directory
- List files available for transfer
- Define the transfer mode
- Copy files from/to the remote host (GET/PUT)
- Disconnect from the remote host

# FTP (cont'd)

## Ù Supported file types

FTP itself does not know file characteristics, only the server:

- VSAM ESDS and KSDS
- VSE SD files
- VSE libraries (via LIBRM I/F)
- POWER files (job submission or retrieval of listings)
- VSE/ICCF libraries (Read only)

TCP/IP for VSE does not support the very simple level of functionality of TFTP (Trivial FTP) using UDP datagrams.

## Ù FTP Setup Comparison

| | Type of Files (FTP Daemon) | File I/O initialized in | FTP in |
|---|---|---|---|
| Interactive FTP | DEFINE FILEd files | TCP/IP part. | FTP client | *1 |
| Batch FTP (// EXEC FTP) | - " - or 'Autonomous' | - ' | - Batch part. | |
| 'FTPBATCH' (// EXEC FTPBATCH) | 'Autonomous' or (ServPack L) DEFINE FILEd | Batch part. | Batch part. | |

- 'Autonomous' is specification via locally defined DLBLs (but, consider security aspects)
- TCP and IP activity is always in the TCP/IP partition

*1 FTP client is outside VSE or a CICS txn

- For FTPBATCH (ServPack J etc) refer to Info APAR II11596

## Í FTPBATCH allows

### - best load balancing vs other TCP work

Especially when only 1 TCP/IP partition

### - highest aggregate data rates for multiple FTPs

Due to multiple File-I/O routines

# HTTP (Web Server) and Gopher

## HTTP

- **As Server (Daemon), only**
  - **VSE as WEB server in an Inter/Intranet i.e. storing HTTP objects in VSE libraries**

    - HTML documents
    - JPEG/GIF/TIF
    - JAVA or other objects
    - Video etc.

    1 HTTP daemon required regardless of the # of Web sessions, defined via the DEFINE HTTPD command.

    It is expected that most of the HTTP objects will reside in a VSE Library.

    Requests to the WEB server are issued from WEB browsers outside the VSE host:

    **WEB server and client communicate using HTML**

## Gopher

- **As Server (Daemon), only**
  - **Access from remote systems to data/files under local VSE**

    The Gopher client uses easy-to-use menus, and both are using the Gopher protocol.

    1 Gopher daemon required for any number of Gopher sessions, defined via the DEFINE GOPHERD command

# LPR/LPD

## Ù LPD (=Server or Daemon)

### „ Print data of any TCP/IP system on a VSE printer

1 LPD daemon required for each virtual printer, defined via the DEFINE LPD command.

LPD interfaces

- with the POWER LST queue (printing is controlled by POWER)

- with a disk-based VSE file: 'print' to a file

## Ù LPR (=Client)

### „ Print VSE data on any TCP/IP network printer

Invoked

- automatically AUTOLPR, monitoring POWER LST classes (done via a generic GET for a class, every 45 sec). Service Pack K allows to modify this interval via SET AUTO_TIME = nnnn.

- via CICS txn 'LPR'-txn

- via batch job: // EXEC CLIENT,PARM='ID=0x,APPL=LPR' lpr command ...

# NFS Server

## NFS

In TCP/IP for VSE/ESA, Serv.Pack G, 07/98, separate product key

## As Server (Daemon), only

- **Transparent access from NFS client (PC or UNIX) to files stored in a remote VSE as if it were local:**

  **'Share file systems across a TCP/IP network'**

- **NFS assumes a hierarchical file system, with each file being a byte stream of certain length, essentially w/o record structure**

File names and structures are automatically converted to what is normal to the client.

NFS itself is NOT an Data Base Access method, just an access method for total files.
(Single records of a VSE file only theoretically could be retrieved, but only if the byte offset in a file and the exact length would be known to the PC or UNIX application).
Depending on the interfaces used, also VSE members within a single VSE file can be accessed.

This lack of record positions in a file causes that upon record changes in a file, usually the entire file is being written.

In PC and UNIX land, logical records are delimited by indicators.
They may be added by NFS for VSE at the end of each record.

- **NFS Implementation**

1 NFS daemon required in total, defined via DEFINE NFSD.
It uses:

- Remote Procedure Call (RPC)
- The NFS V2 protocol
- The UDP transport protocol
  (Sequence of packets ensured by NFS, TCP used only to setup communication)
- 31-bit GETVIS storage

to access LIBR and POWER members, and VSAM ESDS files

# NFS (cont'd)

## „ Scenario

RPC API allows to call subroutines that are executed on a remote system. A caller (client) sends a call message to the server process and waits for a reply message.

## The NFS client first initiates the MOUNT protocol

- to 'mount' any remote item, e.g.
  - a VM minidisk
  - a VSE library/sublibary
  - a VSE/VSAM file

as a new local subdirectory (UNIX)
as a new drive's root (DOS, Windows, OS/2)

## and then the NFS protocol

- to actually do basic I/O operations to a remote file
  e.g. LOOKUP search
  READ and WRITE
  RENAME, REMOVE ...

You may e.g. - edit VSE library members with Notepad
- look at POWER lsitings in Word
- use VSAM files in EXCEL

## „ READ/WRITE

NFS client itself has no idea whoelse is updating records in a (source) file which was mounted in NFS.
Thus READs may be 'dirty READs'. Use of a VSAM file (here ESDS) with appropriate SHROPT definition would avoid that.

The VSE NFS server will do synchronous ('immediate') WRITEs to ensure file integrity.

## „ NFS Server vs LANRES Virtual PC Disk

- LANRES data are logically not understandable by VSE
  (i.e. is a separate 'subset' of files)

- NFS access is concurrent to VSE native access
  (i.e. data can also be used by NFS clients)

# Socket APIs

## SOCKET macro

Programmer can interface not only with TCP and UDP,
but also with TELNET or FTP clients in the TCP/IP partition.

Assembler, COBOL, PL/I and C programming languages can be used

## SOCKET type,connect,keywords

Some types:

OPEN, CLOSE, SEND, RECEIVE

Some keywords:

LOCAL=YES tells that a socket call is local to the TCP/IP partition and thus no XPCC call and no system GETVIS is required

SHORT=YES reduces the ACKnowledgement meachanism if issued in a SEND request. Beneficial for a single query over a connection

CICS=YES should be used in CICS partitions to use CICS GETMAINs (DSA) instead of VSE GETVISs

## Performance

Measurements with TCP/IP for MVS sockets have shown that TCP always outperformed UDP:

- less CPU-time overall
- higher throughput
  (loss of UDP packets must be avoided, thus risky when UDP is driven the hard way)

# Value of Multiple TCP/IP Partitions

Each TCP/IP copy ('protocol stack') has

- a separate IP address
- a separate host name
- its own set of active, started interfaces (e.g. adapters)
- its own setup of startup parameters

## Multiple TCP/IP stacks for functional or performance reasons

## Functional Reasons

### Separation of workloads

Include the following aspects

- Availability
- Security
- Buffer pool and priority selections

### Separation of Production and Test and/or Education

### Separation of production workloads (greater operational flexibility)

### Separation of networks (e.g. security)

- the Internet
- an intranet

# Value of Multiple TCP/IP Partitions ...

## Multiple TCP/IP Partitions (cont'd)

- **Performance Reasons**

  - **Exploit the speed of more than 1 engine for TCP/IP: 'Concurrent Dispatch'**

    Most of protocol stack related processing is done under a single task (from an operating system view)

    Multiple stacks can exploit multiple engines on an n-way (requires VSE/ESA Turbo Dispatcher).

    This may be important for TN3270, e.g.

  - **Exploitation of more virtual storage below the line for TN3270**

    (No more required since Service Pack K)

    Before TELNET daemons with POOL=YES were available, and before major areas are moved above the 16M line ...

    it was more often required to have >1 TCP partitions (for VS-24 capacity reasons).

    With POOL=YES defined TELNET daemons ...

    the TELNET capacity of a single TCP/IP partition has been increased a lot, and will further increase with 31-bit exploitation
    (Refer to the separate charts on TELNET capacities)

  - **Individual Customization**

    Usually, it should be possible to find a good compromise e.g. for TN3270 and other concurrent activities.

  - **Separation of TN3270 and FTP/LPR activities**

    For higher concurrent FTP or LPR activity, a separate TCP/IP partition may be reasonable, cross linked to the first one.

    Refer to 'Mixed TCP/IP Load (TN3270 + FTP)'

## TCP/IP for VSE and VM/VSE

- **TCP/IP for VM provides similar functions as TCP/IP for VSE**

- **Some Aspects**

  - **Both TCP/IPs could communicate via Virtual CTC**

  - **Network ports could be 'shared' between both or partly 'dedicated' to VM or VSE**

    Each OSA port consists of several device addresses (CUUs).
    Sharing is also possible between LPARs.

  - **TCP/IP for VSE 'is closer' to VSE data**

    thus
    - separate steps or constructs between VM and VSE are not required

  - **Functions you only can do with TCP/IP for VSE:**

    - directly get/put data from/to a VSE file (FTP, NFS, ...)
    - ...

  - **Reasons to have TCP/IP for VM on top of TCP/IP for VSE:**

    - VM/ESA applications with TCP/IP sockets
    - Access to VM/ESA files

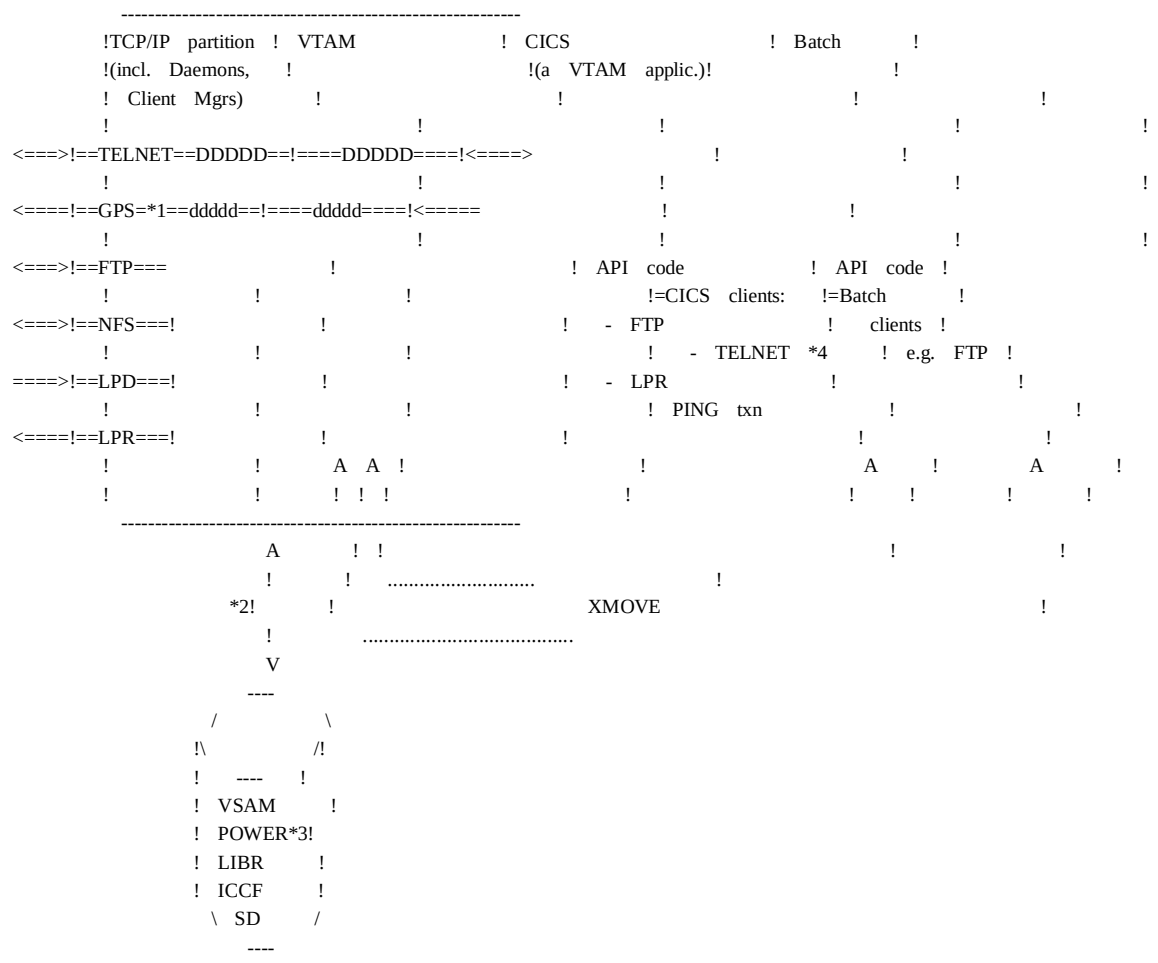
    - VM/ESA as central router for several VSE guests
    - Use of TN3270 in VM/ESA for single/multiple VSE/VTAMs (via DIAL)

# PART D.

# TCP4VSE Performance View

For the sake of briefness, sometimes 'TCP/IP for VSE/ESA' is only referred to here as 'TCP/IP for VSE' or 'TCP/IP'

# TCP/IP and VSE Partitions




- VTAM is only involved in case of TELNET or GPS

*1 GPS data optionally buffered in VSE library
(ServPack L)

*2 Access to VSE data is via official interfaces,
refer to separate foil.

*3 Access to POWER data is via the POWER partition,
moving data with XPCC in access register mode

*4 For TELNET, any CICS performance monitor shows that the number
of CICS transactions per message pair (txn) is increased by 2
(1 CICS-txn in, 1 out).
Consider that when comparing throughput vs VTAM SNA

# TCP/IP's Access to VSE Data

## Ù Summary

| Data | Access via |
|---|---|
| VSAM | VSAM macros and VSAM code in SVA |
| POWER | POWER SAS and XPCC (SENDR) |
| LIBR | LIBRM macro |
| ICCF | SLI (READ Only) and DTSIPWR in SVA |
| SD | DTFSD macro (BAM) |

## Ù More info (performance related)

- VSAM (ESDS and KSDS):
  GET and PUT, Direct and Sequential
  OPENs are done with 10 index and 10 data buffers

- POWER SAS:
  SAS PUT and SAS GET macros are used.
  CPU-time relevant is the XPCC Send and Reply buffer size,
  which can be up to 64K. TCP/IP uses 32K.

  Per POWER I/O to the POWER Data file, only 1 DBLK block
  is transferred (READ or WRITE).

  -> A bigger DBLK size definitely will help speed up
  transfer of bigger POWER jobs

- LIBRM:
  GET and PUT with BUFFERSIZE=32000 byte is used

- ICCF:
  SLI and DTSIPWR is used to read members

- DTFSD (Sequential Disk/SAM/BAM) access:
  Per GET and PUT request BLKSIZE bytes are transferred,
  just as the local VSE definition of the file.

## Ù These file related macros hold for FTP, NFS, and HTTP

# TCP/IP Virtual Storage Requirements

## Virtual Storage Requirements

### „ TCP/IP partition:

31-bit exploitation in the TCP/IP partition started with NFS and continued with Telnet and other functions.

All TCP/IP GETVIS allocations are tagged with a unique GETVIS subpool-ID.

### „ Other partition(s) with Socket applications:

TCP/IP for VSE/ESA allows sockets applications to exploit 31-bit addressing

- SOCKET macro
- BSD/C macros
- Pre-processor API (EXEC TCP)

## Shared Storage Aspects

### „ VLA-31:

| | | | |
|---|---|---|---|
| C runtime module | CEEEV003 | (1186K) | Recommended (to avoid FETCHes) |

### „ VLA-24:

| | | | |
|---|---|---|---|
| TCP connection manager | IPNTCTCP | (25K) | Recommended for stability reasons, not performance |

Do NOT put the TELNET Daemon TELNETD (46K) into the VLA-24. There is no performance or other benefit. This reentrant phase is only loaded as a single copy when in partition space.

### „ System GETVIS-31:

Refer to chart 'Telnet VS Capacity'

### „ System GETVIS-24:

E.g. SOBLOKs (Buffers for external socket requests) <1K

# TCP/IP for VSE/ESA Startup Job

```
* $$ JOB JNM=TCPSTRT,CLASS=7,DISP=L                    (F7 is default)
// JOB TCPSTRT
... LIBDEFs etc ...
// SETPFIX LIMIT=900K
// EXEC IPNET,SIZE=IPNET,PARM='ID=0x,INIT=IPINIT0y',DSPACE=3M
/*
/&
* $$ EOJ
```

## „ VSE partition size

### a) Before Service Pack J (02/99):

#### í Let it end 1M above the 16M line

just to be able to fully exploit 24-bit private space:
Avoid 31-bit eligible pgms/areas below 16M.

to provide some GETVIS-31 for system functions,
including space for VSAM buffers.

### b) Sevice Pack J and later:

#### í Specify sufficient space above the line

Be generous and provide enough space for all areas moved above the line (refer to separate chart).

Non-used virtual storage does only occupy VSIZE, so you really can afford to be generous

You may monitor GETVIS via 'GETVIS part-ID'.

#### í Add 3M on top for NFS (any Service Pack)

to provide enough GETVIS-31 for NFS functions

Just for starting, maybe reduce later if you want

# TCP/IP for VSE/ESA Startup Job (cont'd)

## „ SETPFIX LIMIT=

All I/O interface drivers are PFIXed, including I/O buffers. This is required, since due to also supporting unknown devices, the CCW translation is done by TCP/IP.

All task control blocks are PFIXed, in order to avoid page faults in this performance relevant code.

### í Start e.g. with SETPFIX LIMIT=900K

- to cope for all adapter types/configs/high loads
- just to be on the safe side.

### í Monitor actual requirements via MAP REAL

But specifying a higher value than required does not harm.

## „ Type of VSE partition

Since TCP/IP for VSE/ESA is up for long times ...

- it is a long lasting VSE job step

### í A VSE dynamic partition is very well suited

# TCP/IP for VSE/ESA Startup Job (cont'd)

## „ SIZE=IPNET

Should be as indicated, to give as much storage as possible to partition GETVIS-24.

Note

- There is only code contained in the partition program area
- NFS code is being loaded into GETVIS (currently GETVIS-24)
- Leave about 1M GETVIS-24 for the (old) command processor (no more required/applicable for new command processor)
- Do not increase dynamic space GETVIS beyond shipped values (reduces GETVIS-24)

## „ IPINIT0x

Contains all relevant TCP/IP parameters discussed later on

Can be setup with the TCP/IP for VSE/ESA Configuration Support Tool (on Windows 3.1 or higher, or OS/2).

## „ DSPACE=3M

This is the maximum size of the dataspace used by VTAM for this VTAM application.

It is better to specify DSPACE, otherwise its default SYSDEF DSPACE,DFSIZE=mM has to be found out, or even may be too low.

## „ DSPACE parameter for VTAM startup

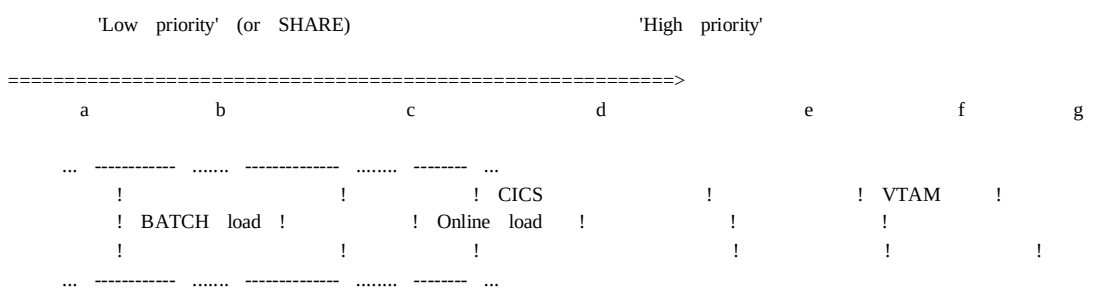
The DSPACE parameter in the VTAM startup job specifies the maximum size of VTAM's own dataspace.
With heavy TCP/IP traffic, up to 6M and more may be required

# TCP/IP for VSE/ESA Dispatch Priority

## General

Usually, a high TCP/IP for VSE partition priority improves TCP/IP performance/throughput, but reasonble settings also depend on

- Type of TCP/IP application (TN3270, FTP)
- Mix of TCP/IP applications (in same TCP/IP partition)
- Potential impact on other loads (TCP/IP and others)
- Dispatcher type (TD allows PRTY SHARE settings and n-ways)




Reasonable PRTY selections:

TCP/IP partition with - TN3270 only: d e f g
- FTP only: b c d
- both: c d e

- 'a' to 'g' are potential priority 'positions'
  (b, d, f stand for 'in same Partition Balancing group as the pertinent load'; note that only 1 PB group is allowed)
- VSE/POWER not shown here.
  Separate priority considerations may apply, already w/o TCP/IP
- Guaranteed share of CPU resource is only provided by the Relative VSE Shares of the TD.
- Selection of individual TCP/IP partition priorities is also influenced by need for concurrent batch throughput
- TCP/IP partition priority should be as high as required,

in order to avoid unnecessary retransmissions

# TCP/IP for VSE/ESA Dispatch Priority (cont'd)

## TN3270 (only) general rule

If for online transactions different partitions are required for processing, usually it is best to give HIGHEST priority to that partition of this set, which has LOWEST CPU consumption.

First experiences with TN3270-only workloads have shown that response times only hardly suffered when the TCP/IP partition even had lower priority than the related CICS partition.

Putting the TCP/IP partition (F7) into the same partition balancing group as CICS in Fx, was a reasonable compromise:

e.g. PRTY ..., 'Fx'=F7,F3,F1

## FTP (only) general rule

For FTP, a tradeoff between potentially higher transfer rates and lower impact on other loads must be chosen.

## TN3270 and concurrent FTP in 1 TCP/IP partition

Parameter selection itself may be a compromise, partition priority also.

## Separate TCP/IP partitions for TN3270 and FTP

Refer also to the foil 'Mixed TCP/IP Load'

# Mixed TCP/IP Load (TN3270 + FTP)

## Ù High concurrent FTP (or LPR/LPD) activity may/will impact e.g. TN3270 response times

via - processor (CPU-time)
- DASD access
- high network/link/adapter utilization

Both type of loads are using the same resources

## Ù Conflicting Targets

- Make FTP as fast as possible (especially single stream)
- Have a small impact on other concurrent loads

## Ù Potential Solutions

### „ Separate the files and DASDs

Normally not feasible, since often the same data are transferred as used by other Online loads (e.g. TN3270)

### „ Do NOT allow huge FTPs during prime shift

E.g. limit the number of FTP daemons via COUNT=0x.
Not THE solution for all cases

### „ Vary MAX_BUFFERS (Service Pack 'G')

Use MAX_BUFFERS=1 to limit single FTP session buffer usage.

### „ Separate adapters may help

if FTP bandwidth to be limited on a higher level

### „ Make it controllable by the system programmer

VSE cannot e.g. THROTTLE a device like VM.

Best would be within TCP/IP, but FTP uses the SAME TCP/IP stack as TN3270

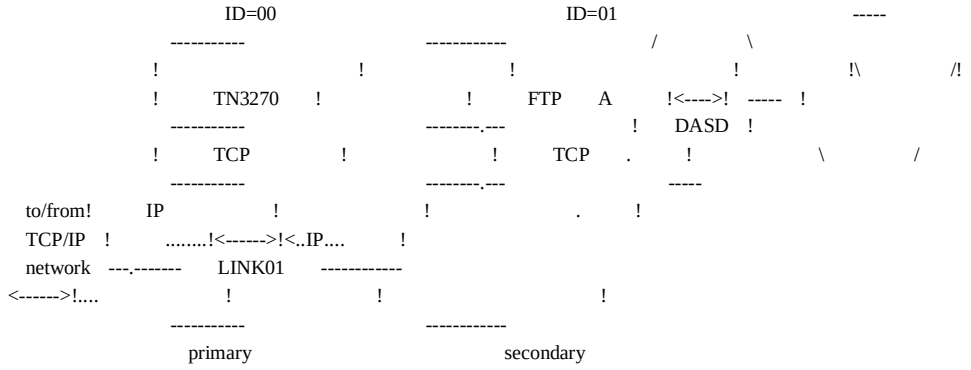
### „ A separate TCP/IP partition for FTP

Refer to next foil

### „ Use FTPBATCH in a separate partition

(Service Pack J and up). Refer to separate chart.
Reduces the need for a separate 'FTP TCP/IP partition'.

# Separate TCP/IP partition for FTP




- **Setup**
  - **Set up a 2nd TCP/IP partition (for FTP)**

    with separate IPINIT01 initialization member
    and 1 additional IP-address

  - **You may leave the network connection to outside VSE in 1st TCP/IP partition**

  - **Cross partition connect both**

    via DEFINE LINK,ID=LINK01,TYPE=IPNET,SYSID=01
    DEFINE LINK,ID=LINK01,TYPE=IPNET,SYSID=00

- **Benefits**
  - **Different VSE priorities possible for TN3270 and FTP**

    Priorities are even changeable on the fly

  - **For TD environments**
    - **VSE Relative Shares may help on top**
    - **FTP even may run on another engine**

Í FTP only consumes remaining CPU power
- only when no higher priority load is dispatchable,
  i.e. does not overduly hurt TN3270 (or even CICS SNA) load

Some impact of FTP on TN3270 remains, since an IP-layer is common

# Batch FTP from a Separate VSE Partition

- **// EXEC FTP**

  FTP initialization is done from a VSE batch partition

  **No performance related benefits**

  Only FTP initialization and termination runs in a separate batch partition.

- **// EXEC FTPBATCH (Service Pack J, 02/99)**

  A special FTP program for autonomous files.

  **Performance related benefits**

  - **Potential exploitation of >1 engine of an n-way**
  - **Separate File-I/O routine used per FTP**

    Single thread TCP/IP File routine in TCP/IP partition not used/blocked
  - **Control of FTP batch CPU dispatch priority**

    - via PRTY setting with Std Dispatcher
    - via PRTY (and TD Relative Shares) on 1- or n-way
  - **Move of data between batch and TCP/IP partition using access registers**
  - **Separate counting of CPU-time and file I/Os via VSE JA**

    File access of other FTPs is done in TCP/IP partition
  - **Info on '#bytes sent/received so far'**

    - via MSG to partition
    - via setup ('timed')

# 31-bit Exploitation in Service Pack J (and up)

- **Many control blocks and buffers moved above the line**
  - **Task blocks**

    Applies to any type of TCP/IP load. Subpool TKBLOK.
  - **TN (Telnet) blocks**

    Telnet definitions. Subpool TNBLOK
  - **IBBLOCKs**

    Buffers for transfer of data (TCP, UDP, ARPs...).
    Subpools IBBKxxx.
  - **Telnet buffers**

    POOL=YES and POOL=NO

    Refer to SET TELNETD_BUFFERS description. Subpool TBBLOK.
  - **FTP transfer buffers**

    Refer to SET TRANSFER_BUFFERS description. Subpool TBBLOK.
- **Major Virtual Storage Constraint Relief (VSCR), especially beneficial/required for Telnet**
- **Start with e.g. 20M partition size**

If real storage is no problem ...

select POOL=NO for TELNET
(2x8K TELNET buffers per daemon, in GETVIS-31)

# Product/Shipped Defaults for TCP/IP for VSE/ESA

Please distinguish between the following type of defaults:

## „ Product defaults

Used whenever

- NO assignment of a value is explicitly specified in the IPINIT0x source book ('assembled defaults')

and

- also was not explicitly set via a SET command

## „ Shipped defaults

Values specified in the shipped IPINIT00.L source book in PRD1.BASE.

Changes can be done by the user, be it
- via any editor or
- via the Configuration Dialog.

The shipped startup values usually represent a good starting point for being used, except there are good reasons for a change, based on specific loads or configurations.

In some instances, the IBM shipped values may differ from the values shipped by CSI.

For NFS, shipped defaults are contained in the NFSCFG.L member, and in general are identical with the product defaults.

In the following command descriptions, both the product default, and the IBM shipped default are cited.

# TCP/IP for VSE Commands

## MTU values are defined in the following DEFINEs

They here only apply to outbound traffic

### Ù DEFINE ADAPTER

```
DEFINE  ADAPTER,LINKID=...,NUMBER=...,TYPE=...,MTU=maxunit,
FRAGMENT=...,MODIFY  ...
```

FRAGMENT=YES!NO  YES allows that fragmented IP datagrams are being sent out by TCP/IP for VSE/ESA (which always can receive fragmented datagrams).

NO is default and avoids that the receiving side can get fragmented IP datagrams (which it may not be able to handle)

MTU=xxxx  (default is 1500). 576 is min, optimal values may be higher, but any selected value must be supported by every device attached to the adapter

### Ù DEFINE LINK

```
DEFINE  LINK,ID=...,TYPE=...,DEV=...,MTU=xxxx,FRAGMENT=...,
...
```

TOKEN-RING:

FRAME=xxx  max frame size of T-Ring adapter, default=2052 (512, 1500, 2052, 4472, 8144, 11407, 17800)

CLAW (Common Link Access for Workstations) only:

INFACTOR=infact,OUTFACTOR=outfact,
INBUFFERS=inbuff,OUTBUFFERS=outbuff

with

infact = size of the input buffers
outfact = size of the output buffers 1 .. 8 (K), default=4,

inbuff = #input buffers chained, 1..16, default =4, VM needs 1
outbuff = #output buffers chained, 1..16, def=recomm=4

LINK to other TCP/IP partition in same VSE: TYPE=IPNET

## Ù DEFINE TELNETD

```
DEFINE  TELNETD,ID=...,  ...,POOL=YES!NO
```

POOL=NO (default) Each TELNET daemon gets 2x8=16K buffers assigned when activated (8K for in-, 8K for outbound) for exclusive use.
In GETVIS-24 or GETVIS-31 (ServicePack J)

POOL=YES The TELNET daemon uses a 2x8=16K buffer from the TELNETD buffer pool when required (8K for in-, 8K for outbound).

Shared buffers are allocated immediately when their number is defined via SET TELNETD_BUFFERS.
In GETVIS-24 or GETVIS-31 (ServicePack J)

## Ù DEFINE FILE

```
DEFINE  FILE,TYPE=..,DLBL=..,LRECL=..,BLKSIZE=..,NFSTIMER=..
```

This command adds a VSE file to the TCP/IP file system, for use by FTP and NFS.

LRECL Logical record length, should be consistent with the file definition.
Default value is 80 byte.

BLKSIZE Physical blocksize, should be consistent with the file definition (no default value exists).

The order of precedence for LRECL and BLKSIZE is:
DLBL, DEFINE FILE, and then the FTP SITE command.

What values in DLBL??
What is the performance impact if BLKSIZE bigger??

NFSTIMER Time interval (in sec) for NFS to keep directory info of that file in its NFS directory cache (Refer to NFS part).

## Ù PING

```
PING  ipaddr
```

ECHOes to a specified IP address and gives individual round-trip times for 5 successive PINGs in msec.

Ping uses specific ICMP messages (Echo and Echo Reply), which are directly put into IP datagrams (ICMP must conceptually be implemented on the IP level).

TCP/IP for VSE has PING implemented

- as CICS transaction  PING ipaddr
- as TCP/IP command  PING ipaddr
- as Batch client  // EXEC CLIENT,PARM='AAPPL=PING'
  SET HOST=ipaddr
  PING

In TCP4VSE, it however does not allow to also specify the size of the packet(s) to be sent and measured.

## PING can be used ...
## - for functional purposes (to test connection)
## - (very very roughly) for performance purposes

Usually, these round-trip times for IP datagrams very roughly correspond to the average time until an IP datagram has caused an ACK to be sent back from the remote TCP. In any case, it is a Snapshot and also done with another protocol]

## Usage hints:

For best-can-do determination of PING times ...

„ Do multiple PINGs.
First PING may be much longer (if an ARP request was needed since no MAC address was available). Don't use it, if so.

Use an average value, since PING times vary with

- the actual traffic on the network
- the priority of TCP/IP in VSE
  (and the current processor situation)
- the priority of TCP/IP on the other side
- the route(s) taken

## Some Performance Related SET Commands

All timer values are in multiples of 1/300 sec.

### Ù SET ALL_BOUND (all loads)

```
SET  ALL_BOUND=atime
```

Maximum idle time, similar to CICS ICV. Default is 9000 (30 sec). Shipped 'default' is 30000 (100 sec)

This value is 'only' to ensure that no TCP/IP work is available. There is no risk to set it higher for VSE/ESA, since this should not occur due to a POST mechanism used.

If the value is too low, unnecessary CPU overhead is caused

### Ù SET DISPATCH_TIME (all loads)

```
SET  DISPATCH_TIME=dtime
```

Maximum time-slice a single TCP/IP pseudo task can get, before being interrupted in favor of another TCP/IP pseudo task. Default is 6 (0.02 sec). Shipped 'default' is 30 (0.1 sec)

CPU-time impact is similar as for ALL_BOUND.

For FTP this time should be high (avoid CPU-time overhead). For TELNET and any interactive TCP/IP use, a lower value may give better and more consistent response times

### Ù SET ARP_TIME (all loads)

```
SET  ARP_TIME=arptime
```

Amount of time, before the ARP table is being rebuilt. Default is 90000 (5 min), should not be smaller.

## Some Performance Related SET Commands (cont'd)

### Ù SET PULSE_TIME (all loads)

```
SET  PULSE_TIME=arptime
```

Amount of time a connection is allowed to be idle, before checked ('dead' connection).
Default is 18000 (1 min), should not be smaller.

### Ù SET REDISPATCH (all loads)

```
SET  REDISPATCH=rdtime
```

Stall(=Wait) interval to re-dispatch pseudo-tasks. This value determines the time interval after a non-interruptible TCP/IP pseudo task is again being tried to be interrupted. Default is 1 (1/300 sec). Shipped 'default' is 10 (1/30 sec)

Too high values may cause erratic response times, too low values will increase CPU-time by too frequent unsuccessful trials.

Redispatch counter:

The redispatch counter in the SET RECORD=ON display shows how often a certain task was redispatched, since it could not be interrupted at the end of its time slice (in 'fragile' state).

Due to VTAM services, TELNET daemons tend to show higher redispatch counters.

## Some Performance Related SET Commands (cont'd)

- **SET REUSE_SIZE=nn (all loads)**

```
SET  REUSE_SIZE=nn
```

REUSE_SIZE controls the depth of the reusable control block queues for IBBLOCKs (new in Sevice Pack J).

nn is the number of free control blocks of each fixed size that are retained for reuse (i.e. not FREEVISed), default is 10.

Before J, a high value was used (implicitly), thus potentially saving GETVIS/FREEVIS requests, at cost of virtual storage below (now above) the line.

This effect depends on the amount of data transferred, and is lower for Telnet than for FTP mass transfer of data. For Telnet runs shown, more than 20 did not show measurable CPU-time benefit.

Using the default of 10 for Telnet looks OK, more does not harm.

# Some Perf. Related SET Commands ...

## Some Performance Related SET Commands (cont'd)

### Ù SET MAX_SEGMENT (any TCP inbound load)

```
SET  MAX_SEGMENT=num
```

Is the maximum size of TCP data and thus limits the max. accepted TCP segment size (to tell to remote hosts only). Range is 576 .. 32684, default is 32684. 'RECEIVE MSS' in QUERY ALL display

It is recommended to use the max. MTU-size for the adapter/link minus 40 bytes, except for functional problems with Token Rings.

A MAX_SEGMENT size of 576 would cause a maximum frame size of 576+40=616 (if FRAGMENT=NO and IP header is 20 byte)

TCP/IP for VSE/ESA

- uses MTU size to limit outbound traffic only (max. frame size)

- always could provide sufficient buffering to receive the largest datagram valid to the protocol

### Ù SET WINDOW (any TCP inbound load)

```
SET  WINDOW  =  wsize
```

RECEIVE window size (#bytes a sender may send to VSE TCP/IP before an ACK is required). Default is 8192 (bytes). Shipped 'default' is 4096, max. value is 64K.

A high value may slow down detection of a lost connection, a low value may cause delays due to waiting for ACKs.

This value is used in order to set the SEND window size at the remote TCP/IP, when a session is established.

It holds for transfer into 1 direction (inbound).

# Some Perf. Related SET Commands ...

## Some Performance Related SET Commands (cont'd)

### Ù SET WINDOW_DEPTH (any TCP inbound load)

```
SET  WINDOW_DEPTH=wd
```

Number of IBBLOKs (Inbound Buffer Blocks) for a connection which can be concurrently queued inbound in TCP, before a sender is notified by indicating a current window size of 0 ('window shutdown'). Default is 30.
'WINDOW DEPTH' in QUERY SET display

### Ù SET WINDOW_RESTART (any TCP inbound load)

```
SET  WINDOW_RESTART=wr
```

Number of IBBLOKs at which the TCP window is re-opened for inbound transmissions. Default is 10.

'WINDOW RESTART' in QUERY SET display

The size of an IBBLOK is (256 + IP_datagram_size)

### Ù SET ADDITIONAL_WINDOW (any TCP outbound)

```
SET  ADDITIONAL_WINDOW=  bytecnt
```

This value allows to avoid the 'Silly Window Syndrome' (SWS). SWS may occur if a TCP/IP partner host signals too small number of bytes which are freed in his formerly closed window.

Restart after a windowsize=0 from the partner is only done, when the advertised window of the partner is
> 80% of max_window + ADDTL_WINDOW

Default is 100 (byte).

Service Pack L will allow SET DIAGNOSE=SWS, which will give hints what to use in case of such a problem.

## Some Performance Related SET Commands (cont'd)

### Ù SET RETRANSMIT (any TCP outbound load)

```
SET RETRANSMIT=rttime
```

Time interval before retransmission of unacknowledged 'packets'.
Default is 50 (0.166 sec). Shipped 'default' is 100 (0.33 sec)

An optimal value is

- not too low to avoid unnecessary retransmits
  (network link(s) are slow, but reliable)
- not too high to cause unnecessary delays in case of required retransmissions
  (network link(s) are not reliable)

TCP/IP applies a dynamic/adaptive retransmission concept for each individual TCP connection, using this value as a starting point.

Starting with Service Pack I, this concept can be overruled by a new parameter setting:

### Ù SET FIXED_RETRANS (any TCP outbound load)

```
SET FIXED_RETRANS = ON!OFF
```

ON forces that the RETRANSMIT value is not dynamically adjusted.

In case of too many 'retransmissions' done by TCP/IP, you may switch from the default (OFF) to ON (but consult CSI Technical Support before).

Function was added in Service Pack I.

# Some Perf. Related SET Commands ...

## Some Performance Related SET Commands (cont'd)

### Ù SET TELNETD_BUFFERS (TELNET only, in/out)

```
SET  TELNETD_BUFFERS=numtd
```

Number of 16K buffer (8K per direction) in the TELNETD buffer pool. Used only for TELNET daemons defined with POOL=YES.

Default is 20, appropriate for at least 100 TELNET daemons.

Since buffers are only used when actual data transfer occurs,
- this number can and should be much lower than the number of POOL=YES defined TELNET daemons
- any number greater than that is waste of virtual storage below the line (before Service Pack J)

Rules of Thumb: Use 15 TELNETD buffers for 10 txn/sec
or 2.5 to 7.5 buffers for 100 terminals

### Ù SET TRANSFER_BUFFERS (FTP only, in/out)

```
SET  TRANSFER_BUFFERS  =  numt
```

Total number of 32K transfer buffers allocated to the FTP buffer pool (above the line) shared by all FTP daemons.
Default is 10, shipped 'default' is 20 if FTP used.

See MAX_BUFFERS for trade-offs

### Ù SET MAX_BUFFERS (FTP only, in/out)

```
SET  MAX_BUFFERS=numx
```

Limits the number of 32K transfer buffers available to an individual FTP daemon. The range is 1... 65535, 4 is default.
- Do NOT specify 0, will fail, though currently accepted.
- The FTPBATCH command is : SET BUFFMAX=numx

More buffers can temporarily compensate a high FTP transfer rate (e.g. via CTCA) vs a lower DASD speed.

Too many buffers may
- limit concurrent data move in and out of the transfer buffers
- even reduce overall data rate
- cause VSE paging in very extreme cases

# CPU-time Overhead of other SETs

## Ù SET SECURITY

All SECURITY defaults are OFF

SET SECURITY=OFF!ON — Verify for user ID and password
-> negligible performance impact

SET SECURITY_IP=OFF!ON — Check IP addressing, every time a connection is established for TCP
-> small performance impact

SET SECURITY_ARP=OFF!ON — Check H/W address for inbound requests
-> higher performance impact

## Ù SET DEBUG

SET DEBUG=OFF!ON!FULL — Controls how much internal debug info
!PRINTER is displayed on console (or SYSLST).
Of special value during initialization.
-> CPU-time overhead, highest for FULL
(default is OFF)

## Ù SET DIAGNOSE

SET DIAGNOSE=OFF! — Controls production of diagnostic info for specific functions.

| | |
|---|---|
| STORAGE | Allocations of all IBBLOKS |
| SWS | Info to diagnose Silly Window Syndrome (window not fully re-opened by partner) -> CPU-time overhead (Serv. Pack L) |
| PERFORM | See separate charts. |

## Ù SET MESSAGE

SET MESSAGE xxx=ON!.. — Controls production (type and target) of messages.
TCP/IP for VSE does issue only seldomly console messages when up

## Ù DEFINE TRACE

DEFINE TRACE,ID=... — Starts tracing into memory for a specified IP address or all incoming traffic
-> bigger CPU-time overhead

# TCP/IP Performance Relevant Parameters

The following 2 tables show those settings in TCP/IP for VSE which are performance relevant, together with the type of TCP/IP activities a parameter has influence on.
Settings for traces or debugging are not inluded.

| Scope of TCP/IP Activity | | | | | | | |
|---|---|---|---|---|---|---|---|
| TCP/IP Parameter/setting | Any | Outbnd. | Inbound | Out+In | Out+In | TCP TN3270 | FTP |
| DEFINE ADAPTER!LINK MTU | | | X | | | | |
| TELNETD POOL | | | | | | | X |
| SET ALL_BOUND | X | | | | | | |
| DISPATCH_TIME | X | | | | | | |
| REDISPATCH | X | | | | | | |
| ARP_TIME | | X | | | | | |
| REUSE_SIZE | x | | | | | | |
| SET MAX_SEGMENT | | | | | X1 | | |
| WINDOW_DEPTH | | | | | X1 | | |
| WINDOW_RESTART | | | | | X1 | | |
| SET RETRANSMIT | | | X1 | | | | |
| FIXED_RETRANS | | | x1 | | | | |
| WINDOW | | | | X1 | | | |
| ADDITIONAL_WINDOW | | | x1 | | | | |
| SET TELNETD_BUFFERS | | | | | | X2 | |
| TRANSFER_BUFFERS | | | | | | | X |
| MAX_BUFFERS | | | | | | | X |
| NFS Parameter/setting | NFS | Any MOUNTs | NFS READs | NFS READs | Dir WRITEs | NFS | NFS |
| DEFINE FILE NFSTIMER | | | | X | | | |
| DIRCACHESIZE | | | X | | | | |
| DIRGROUPSIZE | | | | | X | | |
| READCACHESIZE | | | | | | X | |
| READCACHETIME | | | | | | X | |
| VSAMTABLESIZE | | | | | | | X3 |
| WAKEUPTIME | | X | | | | | |
| WRITECACHETIME | | | | | | | X |
| MAXREQUESTS | | X | | | | | |

X1 Only for TCP loads (includes FTP, but not NFS)
X2 Only for POOL=YES TELNET daemons/sessions
X3 NFS VSAM WRITEs only
- No individual tuning parameters for LPR/LPD and HTTP

# IPINIT Excerpts for Performance

The following are some lines of an IPINIT member for TCP/IP. Here, just performance relevant lines or parameters are shown.

It may be good practice, to specify values even with their product or shipped defaults, to be aware of their existence/relevance.

For details, refer to foils explaining the individual commands.

```
*////////////////////////////////////////////////*
*                    Define the constants                    *
  ...
* Next 2 lines are to assure no waste of virtual
* storage in case these buffers are not needed
*
SET TELNETD_BUFFERS    = 0
SET TRANSFER_BUFFERS = 0
* ====== For all TCP/IP Activities ============ *
*
SET ALL_BOUND                = 30000
SET DISPATCH_TIME        = 30
SET REDISPATCH             = 10
*
* ====== For all TCP Inbound Activities ======== *
*
SET MAX_SEGMENT            = 32684
SET WINDOW_DEPTH         = 30
SET WINDOW_RESTART     = 10
*
* ====== For all TCP Outbound Activities ======= *
*
SET RETRANSMIT             = 100
SET WINDOW                    = 4096
*
* ====== For TELNET_3270 Only ================== *
* Comment out next line if no TELNET used]
SET TELNETD_BUFFERS    = 20
*
* ====== For FTP Only ========================== *
* Comment out next line if no FTP used]
SET TRANSFER_BUFFERS = 20
SET MAX_BUFFERS          = 6
  ...
SET DEBUG    = OFF
SET RECORD = OFF
SET DIAGNOSE = OFF
*------------------------------------------------*
*                    Wait for VTAM Startup                   *
WAIT          VTAM
...
```

# IPINIT Excerpts for Performance ...

```
  ...
*-------------------------------------------------*
*                    Define the Communication Links          *
*  DEFINE LINK,  ...  ,MTU=1500,FRAGMENT=NO,  ...
    ...
*  DEFINE ADAPTER,  ...  ,MTU=1500,FRAGMENT=NO,  ...
    ...
*-------------------------------------------------*
*                    Define Routine Information              *
*  DEFINE ROUTE,...
*-------------------------------------------------*
*                    Define TELNET Daemons                   *
DEFINE TELNETD,  ...  ,POOL=YES,  ...
*-------------------------------------------------*
*                    Define FTP Daemons                      *
DEFINE FTPD,...,  COUNT=0x
*-------------------------------------------------*
*                    Line Printer Daemons                    *
DEFINE LPD,...,LIB=library
*-------------------------------------------------*
*                    Automated Line Printer Client           *
DEFINE EVENT,...
*-------------------------------------------------*
*                    Setup the File System                   *
DEFINE FILESYS,LOCATION=SYSTEM,TYPE=PERM
*
DEFINE FILE,PUBLIC='IJSYSRS',DLBL=IJSYSRS,TYPE=LIBRARY
  ...
*-------------------------------------------------*
*                    Define Gopher Daemons                   *
DEFINE GOPHERD,  ...
*-------------------------------------------------*
*                    Define HTTP Daemons                     *
DEFINE HTTPD,  ...
*-------------------------------------------------*
*              Define NFS Daemon (after DEFINE FILEs)        *
DEFINE NFSD,CONFIG=NFSCFG,  ...
*-------------------------------------------------*
*                    Setup member NETWORK.L                  *
INCLUDE NETWORK,DELAY
*/////////////////////////////////////////////////*
```

NOTE:
TELNETD shared buffers and TRANSFER buffers for FTP are allocated directly when SET in the startup, even before any POOL=YES TN daemon or FTP is defined.

===> These statements should be made inactive if not required

# Some Informational Display Commands

## Ù QUERY VERSIONS

Displays the TCP/IP version and current maintenance level

## Ù QUERY ALL

Display current setting of all system variables (voluminous)

## Ù QUERY SET

Display current setting of all values that can be set via SET

## Ù QUERY STATS

Display overall operational statistics:

- FTP/Telnet daemons: Current/max active, max. active buffers
- LP/HTTP/Gopher daemons: #daemons, #sessions, #requests
- TCP inbound rejections
- FTP Files/bytes sent/received
- Telnet bytes sent/received
- TCP/UDP/IP bytes sent/received
- Received Blocks Total
  Inbound Datagrams
  Non-IP (should be 0)
  Mis-Routed (should be very small)
- Transmitted Blocks Total
  Outbound Datagrams

These statistics are also displayed at TCP/IP shutdown.

## Ù QUERY TASKS

Display all currently active TCP/IP for VSE (pseudo) tasks

## Ù QUERY CONNS | CONNECTION,IPADDR=addr

Displays all active connections and/or connection data,
plus

- Maximum Segment Sizes (MSS) for SEND, and for RECEIVE
- Maximum Window that has occurred thus far
- Number of segments/datagrams in/out

Use QUERY CONNECTION, IPADDR=... to check the actually used MSS sizes]

## Some Informational Display Commands (cont'd)

- **QUERY LINKS**

  Displays the status of all links

- **QUERY ACTIVE,TYPE=...**

| | |
|---|---|
| QUERY ACTIVE,TYPE=... | Displays all active items |
| TELNETD | all active Telnet daemons |
| ... | |

- **QUERY TRACES**

  Lists all traces in progress. No trace should be active for optimal storage use and lowest CPU-time.

- **QUERY ISTATS**

  Display internal info (TCP/IP dispatching statistics).
  Available since Service Pack J, to be interpreted by CSI.

| | |
|---|---|
| Number of Dispatches: | Total |
| | Active |
| | Fixed |
| | Quick |
| | Persistent |
| | Passed |
| | Complete |

  Refer to description in SET RECORD=ON, which displays this info on a task basis

# Some Informational Display Commands ...

## Seldom Used Displays and Traces

### Ù SET TRAFFIC=ON (any inbound load)

SET TRAFFIC=FULL!OFF!ON Allows to control how non-IP traffic is handled

- FULL — No traffic is discardded at IP level. Allows to trace non-IP data via DEFINE TRACE for 1 or all IP addresses (big overhead)
- OFF — All traffic is discarded (no practical use)
- ON — Non-IP incoming data is rejected at the IP level (default)

Can be useful in diagnosing performance problems (to detect discarded packets)

### Ù DUMP ...

Use this diagnostic command only when instructed.

# Some Informational Display Commands ...

## Seldom Used Commands (cont'd)

### Ù SET RECORD=ON (any load)

| | |
|---|---|
| SET RECORD=ON | Logs task info on SYSLST, each time a task terminates.<br>Default is OFF.<br>Full interpretation only by CSI. |

IPNTXTCP Di 1628 Av 281 T 457700 Ac 890 Qu 0 Pr 7 Co 1 Pa 730

- Di Dispatch count
- Av Average usec this task was dispatched (Av=T/Di)
- T Accumulated Elapsed Time (ET) this task had control of the TCP/IP partition
  (is usually in VSE/ESA native cases similar to CPU-time)
- Ac Number of scans of ACtive queue
- Qu Number of QUick scans
- Pr Number of scans of PeRsistence queue (hot spots of total)
- Co Number of COmplete total scans
  (Should be as low as possible)
- Pa Number of times control is PAssed directly from another task
- More FTP (MAX_BUFFERS) specific info (Serv. Pack 'G') ??

- Recent TELNET measurements (Service Pack J) showed a CPU-time overhead for SET RECORD=ON of about 0.5% CPU-time

### Ù SET DIAGNOSE=PERFORM (any TCP load)

| | |
|---|---|
| SET DIAGNOSE=PERFORM | Provides additional statistics upon termination of a connection, e.g. an FTP session=transfer.<br>Very low CPU-time overhead.<br>Default is OFF. |

For explanation of the IPT324I output lines, refer to next foil.

# Some Informational Display Commands ...

## Sample DIAGNOSE=PERFORM Output

```
 FTP  Daemon  Retrieving  File,  Count:  131070     Userid:  SYSA
                                                File:     PRD3.TEST.A.A

-------------(  Performance  Display  )---------
 IP:  10.0.0.1  Port:  1030  Local  Port:  20
                                                                          In   Out
 Connection duration.............          22519708     (usec)     X        X
     Maximum turn around time......            27185     (  "  )    X        X
     Transmission block count......              731                 -        X
     Maximum depth count.....                      1                 X        -
     Maximum foreign window.....               32768     (byte)     -        X
     Byte count of data sent.....           10747742                 -        X
     Byte count of data resent.....                0                 -        X
     Byte count of data received...                2                 X        -
 SWS mode total time.............          16160538     (usec)     -        X
     Number of times in mode.....                123                 -        X
 Retransmission mode total time..                  0     (usec)     -        X
     Number of times in mode.....                  0                 -        X
     Number of retransmissions.....                0                 -        X
 Maximum Depth mode total time...                  0     (usec)     X        -
     Number of times in mode.....                  0                 X        -
```

- All times are in usec
- Inbound and Outbound data (TCP) are marked (In/Out) here on top]

- Connection duration is the time from first to last byte
  (not including any setup/close time)
- Max. turn around time is the max. time for an individual block
  from send time to ACK
- 'Transmission block' is a TCP Segment
- Byte count of data sent/received is the total size of a file
  (in case of FTP)
- Max. Depth count is the max. number of inbound packages enqueued
  in that single connection

- SWS means 'Silly Window Syndrome'
  (Receiver gives a small window, filled very fast by the sender).

  Number of times in SWS mode means how often window was closed
  and waits occurred until restart

- Retransmission mode is entered as soon as the 6th TCP segment
  is being retransmitted

- Maximum Depth mode means that TCP/IP is no more able to accept
  any incoming packets, until IBBLOCKs are freed

# Remove Unnecessary Actions from TCP/IP

## Symptom

- TCP/IP partition consumes sporadically CPU-time, 'without doing anything'

## Background info

- TCP/IP must inspect EVERY data packet it gets

This includes also
- Non-IP datagrams (e.g. Novell)
- Mis-routed datagrams
- ARP datagrams

QUERY STATS now inludes also counters for such traffic.

## Recommendations

- Make sure IP-Filtering is ON for OSA and 3172 etc

TCP/IP for VSE/ESA should only see the datagrams directed for itself

- Do not use an 'old gateway address' as IP address
- Find out the source for frequent ARP updates

ARP requests from outside TCP/IP for VSE/ESA cannot be avoided or influenced.

Use QUERY ARPS and check that the C: parameter is not high. Naturally, SET ARP_TIME should not be too low, also.

- Filter away unnecessary data packets

# NFS Related Areas

## Buffers, Control Blocks, Modules

| Area & Purpose | Size | GETVIS- | Note | |
|---|---|---|---|---|
| NFS Modules (code) | 210K | -24 | a) | |
| NFS Control Blocks | 12K | -31 | b) | |
| NFS Directories | c) | -31 | c) | |
| File READ Caches (for file data) | d) | -31 | d) | |
| VSAM Attribute Tables (DIR cache) | e) | -31 | e) | |
| File WRITE Caches (for file data) | dynamic | -31 | f) | |
| File Request Blocks (FRBLOKs) | n x 4.5K | -24 | g) | |
| NFS Request Blocks | m x .16K | -31 | h) | |

Notes:

a) Current size is about 210K. Prepared for RMODE=ANY.
Running in AMODE=31, except when SOCKET calls are done

b) About 8 to 16K, varying according to traffic

c) 1 NFS directory is built/required for each MOUNTed tree.
Each one is built by requesting GETVIS of DIRCACHESIZE byte
(1 or multiple times) and by returning unused parts.
Total space required is very environment specific

d) Each File READ Cache is up to READCACHESIZE and kept at
least for READCACHETIME seconds.

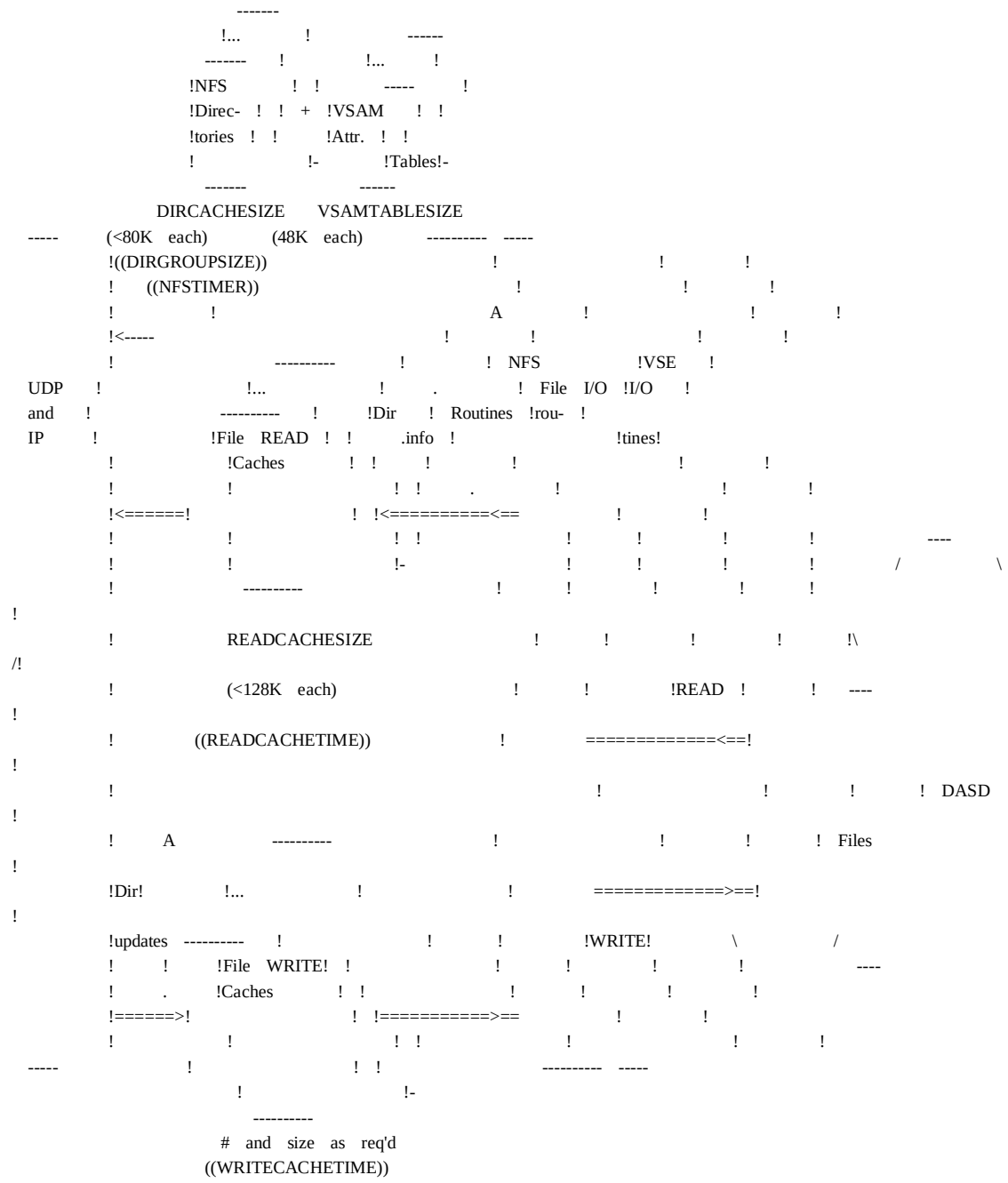
e) 1 VSAM Attribute Table is built/required for each VSAM MOUNT.
Its size is VSAMTABLESIZE, a fixed value

f) The size and number of File WRITE caches is dynamic

g) n is the number of FRBLOKs (1 per 'NFS session')

h) m is equal to MAXREQUESTS (default=1000), so 160K in total

# NFS Related Data Areas and Parameters




- Sizes shown refer to default values

# Some Performance Related NFS Commands

Settings are usually included in NFSCFG.L (default member).
If omitted there, product defaults are used, which currently all are also contained in this shipped NFSCFG.L member.

The values can also be set from the console by prefixing 'NFS '.

You will be able to display all settings by NFS QUERY CONFIG.

Except indicated otherwise, NFS buffers may reside above the 16M line.
'NFS WRITE' means VSE inbound data, 'NFS READ' means outbound data.

All settings marked by *) are for internal use and should not be used, unless requested by Technical Support.

## Ù DATAGRAMTRACE *) (all NFS loads)

| DATAGRAMTRACE=YES!NO | (default=NO) |
|---|---|

When set, this allows to simply trace the UDP datagrams used for the transfer of NFS data.
YES will have some performance degradation, so only use when required. Default is NO.

Enter NFS DATAGRAMTRACE to see the current setting. (?)

## Ù DEBUG *) (all NFS loads)

| DEBUG=YES!NO | (default=NO) |
|---|---|

When set, this trace simply shows the datagrams transferred.
Note that this trace is different from SET DEBUG.
DEBUG=YES will have a severe performance degradation, so in any case use the default (NO).

Enter NFS DEBUG to see the current setting.

## Some Performance Related NFS Commands (cont'd)

### Ù DIRCACHESIZE (all NFS MOUNTs)

| DIRCACHESIZE=nnnnK!M | (default=80K) |
|---|---|

NFS caches each NFS directory in 1 or more NFS directory blocks.
Each directory block is GETVISed (has an initial value) in blocks
of DIRCACHESIZE bytes.
Each NFS directory is built at first reference, requesting as many directory blocks as required. When the entire directory is
read, unused GETVIS space is being given back.

Each NFS directory exists until shutdown or until the directory is flushed.

Select your value

- such that most NFS directories fit into 1 directory block
  (1 entry is between 40 and 90 byte,
  a huge directory of about 6000 entries may need 512K)
- ample, since GETVIS-31 should not be a problem,
  and unused space is being returned

Since it is incremental, DIRCACHESIZE usually is not critical

### Ù DIRGROUPSIZE (all NFS directory READs)

| DIRGROUPSIZE=nnnn | (default is 10 entries) |
|---|---|

This value determines when directory data for a first 'DIR' command are being sent to the NFS client.
For subsequent DIRs, this parameter is ignored/not required.

A low value will give a fast first response, but may also increase the number of total IP packets or UDP segments sent.

A high number will avoid this 'clustering' of requests and may use less resources in total.

# Some Perf. Related NFS Commands ...

## Some Performance Related NFS Commands (cont'd)

### Ù READCACHESIZE (all NFS READs)

| READCACHESIZE=nnnnK!M (default is 128K) |
|---|

All data of any file to be transferred to the NFS client is being cached in a (file specific) File READ Cache.

Each cache is GETVISed once dynamically (READCACHESIZE) and kept until the transfer of the file is completed, or until an idle-time limit of READCACHETIME is expired.
If a file is < READCACHESIZE, the remainder is returned.
Each cache is being treated as 2 areas of equal size, just to allow overlaps of emptying and filling it.

Since READCACHESIZE/2 usually is much bigger than any I/O blocking, values bigger than its default are expected to be only marginally better.

### Ù READCACHETIME (all NFS READs)

| READCACHETIME=nnnn (default is 30 sec) |
|---|

Maximum time a File READ cache is being held w/o any actual READ activity.
You may select a smaller value, but GETVIS-31 (where these buffers are located) should not be a problem.

The selection of this value may also be impacted by the amount of 'dirty READs', which NFS itself cannot avoid.

### Ù MAXPACKETSIZE *) (all NFS WRITEs)

| MAXPACKETSIZE=nnnnK!M (default is 8K) |
|---|

This value determines the maximum size of the IP-data plus header
which is accepted by the NFS server when a file is being written to VSE.

Helps to reduce the max IP datagram size coming in, provided the NFS client is intelligent enough to adapt.

With Service Pack J, this parameter is ignored, since no more required.

# Some Perf. Related NFS Commands ...

## Some Performance Related NFS Commands (cont'd)

### Ù DEFINE FILE...NFSTIMER (all NFS directory READs)

| DEFINE FILE..NFSTIMER=nnn | (default is 0 sec) |
|---|---|

Defines the time limit (in sec) for NFS to keep the file or directory in its NFS directory cache. When expired, NFS causes the cache to be rebuilt at the next file request.
The default of 0 means no automatic clearing of the NFS directory cache for that file.

You may set NFSTIMER to a lower time value, if a file is often used.

### Ù VSAMTABLESIZE (all NFS VSAM WRITEs)

| VSAMTABLESIZE=nnnnK!M | (default is 64K) |
|---|---|

This is the size of the VSAM attribute table (or DIRLIST cache), where each accessible/MOUNTed file is listed.
About 80 byte is required for each entry/file.
When this table is too small, a VSAM file update will fail.
So, make it big enough, it resides in GETVIS-31 anyhow.

### Ù WAKEUPTIME (all NFS loads)

| WAKEUPTIME=nnnn | (default is 5 sec) |
|---|---|

This is the (unconditional) time interval after which certain caches are are being inspected and potentially released, and/or files closed.
It refers to: NFS Directories, File READ/WRITE Caches

## Some Performance Related NFS Commands (cont'd)

### Ù WATCHDIRCACHE *) (all NFS MOUNTs)

| WATCHDIRCACHE=ON!OFF | (default is OFF) |
|---|---|

This parameter traces the GETVIS allocation and deallocation of the NFS directories, and thus may help in case of problems with DIRCACHESIZE.

### Ù WATCHREADCACHE *) (all NFS READs)

| WATCHREADCACHE=ON!OFF | (default is OFF) |
|---|---|

This parameter allows you to watch the allocation of the File READ Cache for a VSE file, and thus may help to properly select READCACHESIZE.

### Ù WATCHREADS *) (all NFS READs)

| WATCHREADS=ON!OFF or YES!NO | (default is OFF) |
|---|---|

This parameter allows you to trace all incoming READs.

Some overhead, use it only for debugging purposes

### Ù WATCHWRITES *) (all NFS WRITEs)

| WATCHWRITES=ON!OFF or YES!NO | (default is OFF) |
|---|---|

This parameter allows you to trace all incoming WRITEs.

Some overhead, use it only for debugging purposes

# Some Perf. Related NFS Commands ...

## Some Performance Related NFS Commands (cont'd)

### Ù WATCHWRITECACHE *) (all NFS WRITEs)

| WATCHWRITECACHE=ON!OFF | (default is OFF) |
|---|---|

This parameter allows you to watch the allocation of the WRITE Cache for incoming data.

Some overhead, use it only for debugging purposes

### Ù WRITECACHETIME (all NFS WRITEs)

| WRITECACHETIME=nnnn | (default is 30 sec) |
|---|---|

This is the time interval after which the File WRITE Cache for an incoming file request is being released, provided no activity took place during this interval since the last record arrived.

It also causes the file being closed then, if required, and thus remaining data are flushed out.

You may set this value to 15 sec, in case you may have a temporary GETVIS-31 problem and cannot bring TCP/IP down

### Ù MAXREQUESTS (all NFS loads)

| MAXREQUESTS=nnnn | (default is 1000) |
|---|---|

Every request from a client needs an NFS request block of about 160 byte, as long as this request is still 'in use'; e.g. for a DIRLIST request a long time, for a READ a much shorter time.

The default of 1000 should be sufficient for most cases. A too low value will not allow the additional concurrent function, but displays the current NFS request block usage.

# TCP/IP for VSE/ESA Performance PTFs

Note that each TCP/IP 1.3 PTF is a full replacement and thus does not have any TCP/IP pre-req (they get bigger and bigger).

| IBM APAR | IBM PTF(s) | Subject | ServPack' | 'CSI Date |
|---|---|---|---|---|
| PQ11216 | UQ12233 | Miscellaneous | 2.3.0-GA | 97-12-09 |
| This PTF provides few missing modules, new functions, and gives some reduction in CPU-time for TN3270 daemons and other TCP/IP loads, by a streamlined internal task structure. (This PTF together with VSE/ESA 2.3.0 as of 97-12-05, here is referred to as '2.3.0 GA-level') | | | | |
| PQ11981 | UQ13349 | Performance, superseded | 98-01-20 | |
| PQ12876 | UQ14494 | | 'E' | 98-02-15 |
| This PTF measurably reduces the required CPU-time for TCP/IP loads (especially for higher number of Telnet users). Most of the reductions stem from a more efficient setup of TCP/IP internal queues and search algorithms. | | | | |
| PQ14724 | UQ16971 | Performance for FTP | 'F' | 98-04-xx |
| This PTF reduces CPU-time requirements for FTP by better internal buffering (VSAM, POWER, and SAM variable records). TCP/IP dispatching in general was enhanced. | | | | |
| PQ14716 | UQ19196 | NFS function, etc. | 'G' | 98-07-03 |
| This PTF introduces NFS and 2216 support, announced 98-05-07.<br>It also comprises performance enhancements<br>- Restructured TCP/IP subtasks<br>- Reduced Non-Parallel Shares<br>- FTP kernel changes (incl. MAX_BUFFERS enhancements)<br>- Improved SET DIAGNOSE=PERFORM displays<br>- New QUERY ARPS display<br>- API Socket appl's now also 31-bit mode | | | | |
| PQ18295 | UQ20719 | Misc, etc. | 'H' | 98-08-31 |
| This PTF introduces misc. enhancements, e.g. AUTO-FTP, incl. slight performance enhancements for FTP and LPR. | | | | |

# TCP/IP for VSE/ESA Performance PTFs (cont'd)

| | | | | |
|---|---|---|---|---|
| PQ19496 | UQ22503 | Misc, | etc. | 'I' 98-10-30 |

This PTF includes misc. modifications/enhancements and the SET FIXED_RETRANS setting.

| | | | | |
|---|---|---|---|---|
| PQ20942 | UQ26288 | VSCR, | etc. | 'J' 99-02-12 |

This PTF, again, introduces misc. functional changes and performance enhancements, like

- VSCR by moving several control blocks and buffers above the line (most benefit for Telnet)
- FTPBATCH program, running in a separate partition
- Reduced CPU-time for interfacing with POWER files (FTP, NFS)

| | | | | |
|---|---|---|---|---|
| PQ24008 | UQ30758 | Misc. | etc. | 'K' 99-06-11 |

This PTF, again, introduces a huge number of modifications and enhancements, like

- optional new command processor

plus functional enhancements for

- FTPBATCH
- display
- trouble shoot (DEFINE TRACE for all incoming TCP traffic) ...

| | | | |
|---|---|---|---|
| PQ27233 | UQ32439 | GPS | 99-07-17 |

General Print Server as a priced feature

| | | | | |
|---|---|---|---|---|
| PQ27252 | UQ38659 | Misc. | etc. | 'L' 99-11-xx |

This PTF, again, introduces a big number of modifications and enhancements, like

- SET DIAGNOSE=SWS
- improved directory access for FTP
- some detection of orphaned storage

Be aware of problems when installing a CSI Service Pack on top of the TCP/IP for VSE/ESA IBM shipped product.
As indicated, this is an unsupported environment.

# TCP/IP for VSE/ESA 1.4

| | | |
|---|---|---|
| PQ29053 | UQ..... Rel 1.4 | 2000-0x-xx |
| New Release TCP/IP for VSE/ESA 1.4 | | |

# PART E.

# TCP4VSE Performance Results - General

- **General Aspects**

- **Measurement Environments & Tools**

## General Performance Issues

## Usual types of performance data:

- **Resource Consumption of an Activity**

  **- CPU-time, #I/Os, storage ...**

  **required to perform a certain TCP/IP activity**

  (e.g. - to use TELNET for CICS transactions,
  or - to transfer 1M of data)

- **Achieveable Performance Values**

  **(Response/Elapsed times, Data Rates, Thruput)**

  For example, ...
  What response times to expect at a certain TN3270 transaction rate?
  What effective data rate (EDR) can I achieve for 1 single FTP activity in my environment?

  **plus impact on other loads**

- **Resulting Usage of System Resources**

  **- CPU utilization, I/O rate, Storage**

  **at a certain activity level**

  Also required for Setup and Capacity Planning purposes.

# General Performance Issues (cont'd)

## Ù Impact of Performance Parameters

What effect has, based on the current situation, a specific performance relevant parameter change?

### „ If possible, change only 1 parameter at a time

### „ Parameter sensitivity varies

It may well be that changing a parameter in your environment may not produce any delta, since another resource represents a bigger bottleneck.

BUT, after having changed the biggest bottleneck, the same change may have an impact you directly can see.

This is especially understandable e.g. for FTP, where all components in the chain must work with the same global speed.

Even if e.g. the network is capable of much higher overall data rates, the throughput will be limited/synchronized by e.g. the average speed of the DASDs.

### „ Check before change

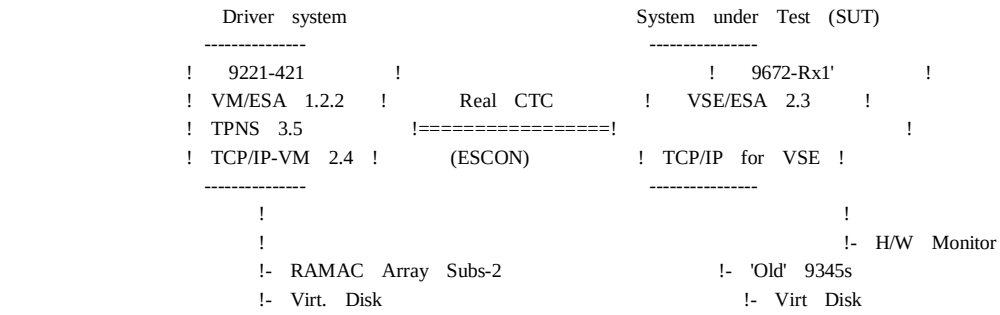
Before changing a parameter, make sure that this parameter can have at all an influence on the type of workload(s) you consider.
To that end, refer e.g. to a previous foil 'TCP/IP Performance Relevant Parameters'

## Ù What are performance-optimal values?

„ The optimal selection of performance-relevant setup or operational parameters is often very important.

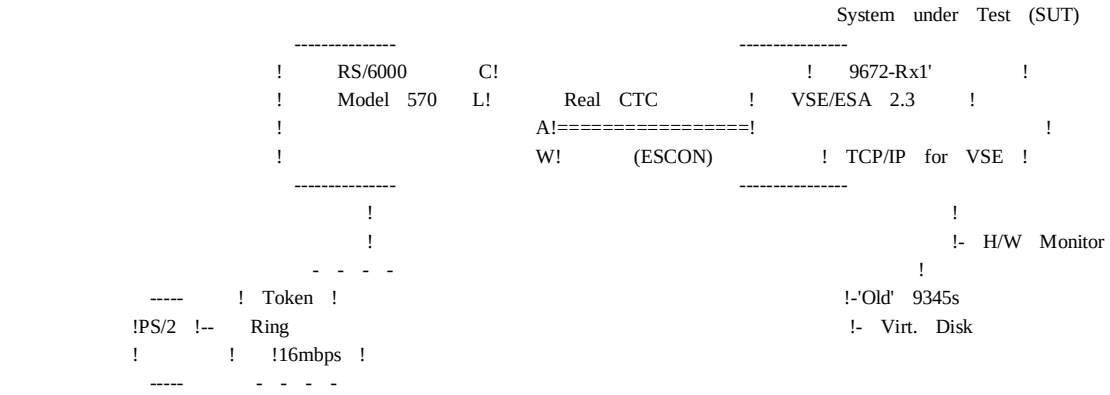
# Measurement Setups

A) Connection to S/390 Host




This configuration is similar to our traditional setup for non-TCP/IP online workloads (VTAM SNA) with has/had a parallel channel each to a 3745 with NCP. This configuration is used for TN3270, and so far for all FTP applications (LIBR, POWER, VSAM ESDS).

B) Connection to RS/6000




So far, this RS/6000 configuration was used for FTP with VSAM ESDS.

Our primary task here was seen
- to optimize the TCP/IP for VSE product itself
- to provide optimal guidelines for it.

Network and Communication performance results for TCP/IP have been published widely and are not VSE/ESA specific.

Regarding the 'old' types of disks, only for the measurements with FTP the disk speeds were of influence to TCP/IP itself.
To assess faster disks, also virtual disks were used in some cases to show DASD speed impact (and to extrapolate to 'todays real disks').

# Measurement Scheme (TELNET)

The following sequence was applied to each TELNET measurement run.
It assumes a single TCP/IP partition in F7.

# Production run:

All parameters correctly set for startup, VTAM started in F3

* Start TCP/IP partition (F7)

====> 'TCP/IP up'

SIR, PRTY
(SET DEBUG=FULL) (reset later, use with care)
DEBUG (VSE, must be OFF)
MAP, MAP REAL, MAP F7
GETVIS SVA, GETVIS F3, GETVIS F7
D NET,BFRUSE

* Enable TELNET logon to outside VSE

====> 'Sessions up' (ACT/S)

MAP REAL
GETVIS SVA, GETVIS F3, GETVIS F7 ... to check TCP/IP TN3270 Logon
QUERY STATS and QUERY ISTAYS ... to get info BEFORE any real TN3270 traffic starts

* Enable TELNET activity

====> 'Traffic up'

(After total activity is stable, just before measurement start)

QUERY VERSIONS
(QUERY ALL)
QUERY SET
QUERY STATS and QUERY ISTATS, QUERY TRACES
SET DEBUG=OFF

MAP REAL, MAP F7
GETVIS SVA, GETVIS F3, GETVIS F7
D NET,BFRUSE + DSA display

* At measurement interval begin (-2sec):

'TPNS'+'VM'
QUERY STATS and QUERY ISTATS
SYSDEF TD,RESETCNT
//////////// MEASUREMENT (10 min) ////////////
QUERY TD,INTERNAL
QUERY STATS and QUERY ISTATS
'TPNS'+'VM'
(QUERY ALL)

D NET,BFRUSE + DSA display
GETVIS SVA, GETVIS F3, GETVIS F7
MAP REAL, MAP F7

# Optional Full Monitoring run:

```
   * At post measurement interval begin (-2sec):

       QUERY STATS and QUERY ISTATS

 -> SIR MON=ON
       'TPNS'+'VM'
       SYSDEF TD,RESETCNT

       ////////// 'POST MEASUREMENT' (10 min) ///////////

       QUERY TD,INTERNAL
 -> SIR MON                                  ...to display SVC, FC and BOUND stats

       QUERY STATS and QUERY ISTATS
       'TPNS'+'VM'

       D NET,BFRUSE
       GETVIS SVA, GETVIS F3, GETVIS F7
       MAP REAL
 -> SIR MON=OFF



'VM' means              NETSTAT POOLSIZE
                                GATE
                                ALL

Also of interest:   Total CPU-time for TCP/IP for VM
                              TCP/IP for VM profile
```

# Tools Used

- VSE/ESA Display System Activity in IUI
- QUERY TD statistics
- TPNS (Teleprocessing Network Simulator) under VM/ESA.
  Used for TN3270
- Hardware monitor for 9672 CMOS processor.
  The processor itself is a 1 to 6-way, but -for internal reasons-
  running at lower speed than a 9672-Rx1
- VSE/ESA internal patches to more selectively collect CPU-times

# PART F.

# TCP4VSE Performance Results - TN3270

- **TN3270 Results & Hints**
  - **CPU-time Overhead and Requirements**
  - **Virtual Storage Capacity**

# TN3270 Measurement Results for DSW/LE

## Environment

- VSE/ESA 2.3.0/2.3.2 + TCP/IP 1.3
  Status 01/98 (SPack E), 07/98 (SPack G), 03/99 (SPack J)
- DSW online workload, set up with COBOL/LE
- VTAM 4.2 (F3)
- 2 CICS/VSE partitions (F4,F5)
- TCP/IP for VSE/ESA (F7)
- F4 and F5 partition balanced with F7, by default

## Measurement runs

- 125 active terminals per CICS partition, driven by TPNS ('2x125').
  Different loads created by different #terminals or thinktime.
  Default thinktime TT was 11 sec.
- Each run lasted 10 minutes, after a stabilization interval.
- TD was used by default, but also SD.
- POOL=YES was used with TELNETD_BUFFERS=20,
  but also POOL=NO runs were done
- Except indicated otherwise, runs were done with a single engine.
  2-way runs to come.
- ALL terminals were 'converted' from VTAM SNA to TCP/IP

# TN3270 Measurement Results for DSW/LE

TCP/IP Serv.Pack E, runs done 98-01-13 (E)
" Serv.Pack G, runs done 98-07-17 (G)
" Serv.Pack J, runs done 99-03-05 (J)
" Serv.Pack K, runs done 99-07-07 (K)

| Run | Case | Var. | % | CPU ut. /sec | txn Avg. RT sec /txn | CPUT: msec | NPS /txn | Delta: msec | ITRR | |
|---|---|---|---|---|---|---|---|---|---|---|
| Runs with VTAM SNA (no TCP/IP) | | | | | | | | | | |
| SV1 | SD | 2x200 | 50% | 26.63 | 0.19 | 18.96 | - | Base2 | 1.00 | |
| SV2 | SD | 2x125 | 30% | 16.70 | 0.21 | 18.27 | - | - | - | |
| TV1 | TD | 2x200 | 54% | 26.63 | 0.23 | 20.81 | 0.289 | Base1 | 1.00 | |
| TV2 | TD | 2x125 | 34% | 16.73 | 0.22 | 21.02 | 0.300 | - | - | |
| Runs with POOL=NO | | | | | | | | | | |
| TN1 | TD | 2x125 | E 70% | 13.39 | 0.39 | 42.33 | 0.623 | 21.52 | 0.45 | |
| TN1 | TD | 2x125 | G 71% | 16.74 | 0.25 | 43.44 | 0.365 | 22.63 | 0.44 | |
| TN1 | TD | 2x125 | J 70% | 16.69 | 0.23 | 42.97 | 0.388 | 22.16 | 0.44 | |
| Runs with POOL=YES | | | | | | | | | | |
| TY2 | TD | 2x 50 | E 28% | 6.72 | 0.33 | 44.65 | 0.639 | 23.84 | 0.465 | |
| TY5 | TD | 1x125 | K 40% | 8.40 | 0.19 | 48.52 | 0.380 | - | - | |
| TY1 | TD | 2x125 | E 70% | 16.70 | 0.28 | 43.86 | 0.633 | 23.05 | 0.47 | |
| TY1 | TD | 2x125 | G 76% | 16.64 | 0.24 | 46.41 | 0.390 | 25.60 | 0.45 | |
| TY1 | TD | 2x125 | J 74% | 16.69 | 0.24 | 44.84 | 0.425 | 24.03 | 0.46 | |
| TY1 | TD | 2x125 | K 74% | 16.62 | 0.24 | 45.63 | 0.419 | 24.82 | 0.46 | |
| TY3 | TD | 2x125 TT5 | E 95% | 23.57 | 0.97 | 40.82 | 0.612 | 20.01 | 0.51 | |
| TY4 | TD | 2x125 TbC | E 71% | 16.68 | 0.38 | 43.50 | 0.627 | 22.69 | 0.48 | |
| SY1 | SD | 2x125 | E 64% | 16.68 | 0.22 | 43.86 | - | 24.90 | 0.46 | |

TbC TCP/IP priority below CICS priority
TT Thinktime in sec (default is 11 sec, TT5 =5 sec)

- Refer to 'Important Note'

- Results for SPack G: Slightly increased CPU-time, but significantly lower NPS for TD
- Results for SPack J: CPU-time back on E, plus huge VSCR

# Some TN3270 Measurement Observations

## Ù Important Note

When working with TCP/IP and when analysing the results, it became more and more clear that ....

### Measurement setup for TN3270 is some kind of worst case here

... regarding TCP/IP CPU-time overhead.

This is caused
- by the fact that only 1 port (source) and 1 port (target) is used,

combined with the internal design of TCP/IP for VSE/ESA:

The more 'packets' TCP/IP finds when visiting a level of the TCP/IP stack, the more effective can it work.
Traces have shown that in 9x% of all cases at most a single 'packet' was eligible for being promoted up or down the stack.

Due to visible potential for performance improvements, currently highest priority was given to product improvements, rather than investigations on representativeness.

## Ù VTAM Base Measurements

„ Only small dependency of CPUT/txn from CPU utilization. Varies between about 19 to 21 msec

„ TD vs SD overhead depends on the CPU utilization:

15% for low, 10% for medium, and 5% for high utilization

## Ù TCP/IP Measurements with Variations

„ Total CPUT/txn varies between about 41 to 45 msec

## Some TN3270 Measurement Observations (cont'd)

- **TCP/IP Overhead in terms of CPU-time/txn**

| Delta/txn = msec/txn(TCP/IP) - msec/txn(VTAM) |
|---|

  - **Varies here between 20.0 and 24.9 msec**

    - Overhead is lower for high traffic, higher for low traffic

      This effect is to be considered for capacity planning

    - POOL=YES overhead is about 5 to 7% higher than for POOL=NO

      This is the cost for sharing TN3270 buffers, allowing a higher TCP/IP partition capacity for Telnet, before Service Pack J.

    - Overhead with SD here is not less than for TD

    - TCP/IP overhead is lower when TCP/IP has lower priority

      The small response time overhead when giving TCP/IP a lower priority suggests to give TCP/IP not highest priority in order to save some CPU cycles

  - **Overheads for Service Pack E are 20% and more lower than for 'TCP/IP 2.3.0 GA'**

  - **Service Pack J overheads regained the values of Service Pack G**

# TN3270 Performance Results ...

## Some TN3270 Measurement Observations (cont'd)

### Ù Assessment of TCP/IP Overhead

$$\text{ITRR} = \text{ITR ratio} = \frac{\text{msec/txn (VTAM)}}{\text{msec/txn (TCP/IP)}}$$

This ratio (and thus the relative TCP/IP overhead) depends directly on the total CPU-time (or pathlength) of a customer's average transaction.

To be independent of processor speed, and for simplicity reasons, let's turn over to (approximate) pathlengths and 'MIPS'.

In the measured cases, average overall (VTAM based) CPU-time of a transaction was about 20 msec, corresponding to about 280KI. TCP/IP overhead was between 280KI and 350KI.

Average customer transaction pathlength may vary between say 300K ('300 KI') and 1 Million instructions:

Average todays txn-pathlength:

$$\frac{\text{Total-CPU-time by online txns x 'MIPS'}}{\text{\#txns in that interval}}$$

## Some TN3270 Measurement Conclusions

Expected rel.CPU-time and ITR-ratio vs SNA

| Type/CPU-Heaviness of Load | Rel. CPUT | ITRR w/ TCP/IP | |
|---|---|---|---|
| DSW, measured 280KI | 2.0 | 0.5 | |
| Medium cust.txn 560KI | 1.5 | 0.67 | |
| Heavier cust.txn 840KI | 1.33 | 0.75 | |
| Heavy cust.txn 1000KI | 1.28 | 0.78 | |
| Your workload .. ____KI | _.__ | 0.__ | |

- ITR-ratios and total overhead only apply to TCP/IP related terminal activity.

Response time impact is small: about 0.17 sec delta, here.

This delta is the same, independent of the pathlength of a txn.

# Processor Capacity Planning Examples

## Ù VSE/ESA Native

VSE/ESA on a 2003-207 processor (about 24 MIPS).
50% CPU utiliz. during peak hour, 20 txn/sec,
plus 20% batch ==> 70% total CPU

Part of the terminals are now being attached via TCP/IP,
here a subset causing 10 txn/sec (with the same mix).

0.50x24MIPS / 20 txn/sec = 600 KI/txn avg. txn-pathlength

## Calculation:

The additional CPU power required is:

10 txn/sec x 280 KI/tx = 2800 KI/sec TCP/IP overhead = 2.8 MIPS

2.8 MIPS is about 2.8/24= 12% CPU utilization.

So Online work increases from 50% to 62%. So still enough CPU
power is available for concurrent batch.
Total CPU utilization will be 82% (at same throughput).

## Online utilization increases from 50% to 62%

## Ù VM/VSE Guest

For simplicity, the same situation (VSE throughput and CPU
utilizations) is assumed here as in the native case above.

VM/VSE guest with a T/V ratio of 1.20.

Total utilizations (including VM/CP overhead related to
the guest):
50% x 1.2 =60% Online related
20% x 1.2 =24% Batch ==> 84% total CPU

## Calculation:

Overhead is about 2.8 MIPS x1.2 = 3.36 MIPS = 14% CPU,
and starts to impact batch throughput.

## Online utilization increases from 60% to 74%

# Telnet Capacity of a TCP/IP Partition

## TN3270 Partition Capacity (before Serv. Pack J)

Before Service Pack J, Telent capacity of a TCP/IP partition was limited essentially by the amount of virtual storage below the 16M line.

### Ù Virtual Storage (-24) Consideration for TELNET

**P = PA + GD + GN + GS + GR**

P is the actual total partition size below the 16M line. It can be easily made equal to the private space below the 16M line, which is 10, 11, or 12 MB.

PA is the Program Area size. It is recommended to use SIZE=IPNET, which gives (independent of NFS) 744K/768K/788K/888K for Service Pack G/I/J/K.

GD is the required GETVIS-24 for defined TN3270 daemons. We observed 14.4K/13.0K per defined POOL=NO/YES daemon

GN is the required GETVIS-24 for nonshared (POOL=NO) daemons and is 2x8K each (allocated when active)

GS is the required GETVIS-24 for shared (POOL=YES) TELNET daemons and is #TELNETD_BUFFERS x 2 x 8K (allocated when SET), plus about 1K per daemon (measured)

GR is the amount of GETVIS-24 you may/must reserve, e.g.

- 1008K for being in MSG Fx mode (command processor, currently required for parsing input commands)
- enough GETVIS for TRACEing
- some area for NFS code and FRBLOKs

Here, no NFS is considered, since most of it resides above the line.

Using the constant values (PA and GR w/o NFS), it results

P - GA - GR = 8620K for P=10M private space
or 10668K -"- P=12M -"-

= GD + GN + GS

# Telnet Capacity of a TCP/IP Partition ...

## Ù Calculation Examples (before Service Pack J)

### a) POOL=NO TN daemons only (GS=0)

Number of POOL=NO daemons = $\frac{GD + GN}{(14.4 + 16)K}$ = 185 (10M) = 230 (12M)

### b) POOL=YES TN daemons only (GN=0)

- Assumption A (confirmed by measurements):

  It is on the safe side to define

  1.5 x tx_rate TELNETD buffers

  tx_rate is the tx-rate in tx/sec

  i.e. 15 TELNETD buffers for 10 txn/sec.

  Or 1.5 x #act.termnls x (#txn per termnl and minute)/60

  With 1.0 to 3.0 txn per terminal and minute...

  1.5 to 4.5 x (#act.termnls/60) TELNETD buffers

  i.e. 2.5 to 7.5 TELNETD buffers for 100 terminals

- Assumption B (to be adapted to specific environments):

  Each TN terminal produces about 2 txn/min

  i.e. 1 tx/sec corresponds to 30 terminals
  or 100 terminals produce 3.33 txn/sec
  and thus need 1.5 x 3.33 = 5 TELNETD buffers

- Calculation:

  The GD + GS required delta for e.g. 100 terminals:
  100 x 13.0K + 3.33 txn/sec x 1.5 x 2 x 8K + 100K
  = 1300K + 80K + 100K = 1480K
  Dividing the available GD+GS size by 1480K gives

8620/1480 = 5.82 => 580 (POOL=YES) avg intensive
10668/1480 = 7.21 => 720 TELNET terminals/sessions

# Old Cmd Processor

## Space Relief for Cmd Processor

## Before Service Pack K ...

if you really have problems with space below the line ...

- **You may run the command processor from another VSE partition, using the TCP/IP Batch Facility**

  Not elegant, BUT very effective

- **Command Processor Space Circumvention**

```
R  RDR,PAUSExy

// EXEC  IPNETCMD,IZE-IPNETCMD,PARM='ID=nn'

  Enter TCP/IP console commands for the TCP/IP partition
  with ID=nn, as specified above (default is 00).

  The command processor is not required for the TCP/IP
  partition
  (except you would also enter console commands from there).

    - Use xy as REPLID.
    - Let the xy REPLID stand forever.
```

  IPNETCMD uses XPCC under the cover to route TCP/IP commands to the selected target TCP/IP partition.

## New Command Processor in Sevice Pack K

Refer to the following chart

# New Command Processor (Serv. Pack K)

- **Now written in Assembler**
  - **Much faster than before**
  - **Much smaller size**

Now moved fully into phase IPNET in 24-bit.

| | Serv.Pack J | Serv.Pack K |
|---|---|---|
| IPNET size | 788K | 888K |

Going into reply mode via MSG F7 does no more cost

- GETVIS-24
- heavy CPU consumption

**Startup is automatically adjusted, if SIZE=IPNET is used**

- **Old command processor still selectable via OLDPARS initialization parameter**

Only in Serv. Pack K

- **Caution**

If you meanwhile installed GPS, the old command processor still is used by default.

You would have to specify NEWPARS as initialization parameter.

# TN3270 Partition Capacity (Serv. Pack J)

## TN3270 Virtual Storage (Serv. Pack J)

### Ù GETVIS Used Results for Telnet

Measurement setup as described in chart for DSW/LE results

| | POOL=YES -24 GETVIS | -31 | | POOL=NO -24 GETVIS | -31 |
|---|---|---|---|---|---|
| TCP/IP just started | 2752K | 2124K | | 2752K | 2128K |
| All sessions started | 2760K | 2132K | | 2760K | 6168K *2 |
| Telnet fully active | 2760K | 2208K | *1 | 2760K | 6268K |

- 250 Telnet daemons, SET TELNETD_BUFFERS=20 for POOL=YES
- Partition size 40M, 12M below incl. 788K EXEC size
- Time instant of allocation of Telnet buffers:
  POOL=YES: when required *1 (5 to 20 were used)
  POOL=NO : at session logon *2
- At all times, the (old) cmd processor was loaded (below)

### „ No GETVIS-24 delta anymore between POOL=YES and NO

Thus same total capacity for both POOL definitions, regarding storage below the line.

### „ POOL=NO needs more space (vs POOL=YES), but in TCP/IP GETVIS-31

The delta here (4060K) is from 250x2x8K =4000K Telnet buffers (minus up_to_20x2x8 = up to 320K for POOL=YES buffers).

### í You may use POOL=NO and save about 5% CPU-time at cost of GETVIS-31 storage. Recommended

### í By moving Telnet buffers above the line Telnet capacity has increased a lot

For details refer to Service Pack K capacity

# VTAM Startup Variations for Telnet Capacity Check

These VS measurements were done with Serv. Pack K,
but the conclusions apply to other service packs as well.

Naturally, here enough space above the line was available.

Also the VTAM APPL B-book for TCP/IP was varied.

## Ù Conclusion

### By careful setup of the VTAM APPL B-book, you may save some space, but only above the line

- No deltas seen in any space used below the line
  (neither in GETVIS nor in SIZE)
  -> no VS bottleneck seen here

- Negligible deltas above the line BEFORE TCP/IP start

- Deltas seen ABOVE the line, after TCP/IP start:

| | 400 termnls EAS=1 | 400 termnls EAS=dflt | 200 termnls EAS=dflt | |
|---|---|---|---|---|
| TCP/IP GETVIS | Same | Base | -32K | |
| VTAM GETVIS | Same | Base | -64K | |
| SVA | -972K | Base | -608K | |

- EAS is the Estimated Active number of Sessions, this 'application program' (Daemon) will have with other LUs. Is always 1 for each Telnet terminal. The default is 509 (or 256?)

- **EAS=1 saves about 2.4K/terminal in SVA-31**

- **1 terminal costs about 0.15K in TCP/IP, 0.3K in VTAM, and 3.0K (EAS=dflt) in SVA-31**

- **Telnet capacity not limited by VTAM books**

# TN3270 VS-Capacity (Serv. Pack K)

## Ù GETVIS Used Results for Telnet

Measurement setup as described in chart for DSW/LE results.

In all cases, POOL=YES was used (99-07-07).

| GETVIS USED | TCP/IP -24 | TCP/IP -31 | SVA -24 | SVA -31 | VTAM |
|---|---|---|---|---|---|
| a) 250 Telnet daemons, SET TELNETD_BUFFERS=20 | | | | | |
| Only POWER started | - | 436K | 520K | - | |
| Only VTAM started | - | 1036K | 3340K | 164K 4240K | |
| TCP/IP just started with old cmd proc | 1708K 2184K (2716K) | 1120K 4600K | 164K | 4396K | |
| TCP/IP just started (new cmd proc) | 1584K 2188K | 1080K 4512K | 164K | 4396K | |
| All sessions started | 1592K 2196K | 1112K 4796K | -"- | 4504K | |
| Telnet fully active | -"- 2288K | 1120K -"- | -"- | -"- | |
| b) 125 Telnet daemons, SET TELNETD_BUFFERS=20 | | | | | |
| TCP/IP just started | 1108K 1588K | 1116K 3988K | 164K | 4344K | |
| All sessions started | 1116K 1600K | 1100K 4084K | -"- | 4392K | |
| Telnet fully active | -"- 1668K | -"- -"- | -"- | -"- | |
| c) 125 Telnet daemons, SET TELNETD_BUFFERS=30 | | | | | |
| Telnet fully act.*1 | 1116K 1836K | 1100K 4084K | 164K | 4392K | |

- TCP/IP partition was 40M, 12M below incl. 888K EXEC size
- VTAM partition was 20M
- New cmd processor was used, except in 1 variation of a)

*1 Same values w/ 30 buffers, except TCP/IP GETVIS-31
- All VTAM startups used a B-book for APPLs with 400 terminals and with EAS default (256 or 509 ?)

Conclusions are given on the next charts.

# Telnet VS-Capacity (Serv. Pack K) ...

## TN3270 VS-Capacity (cont'd)

## Observations:

- **New cmd processor saves about 1.1M**

  In TCP/IP GETVIS-24, in reply-mode.

- **Message Traffic costs below the line is negligible**

- **Cost of Telnet Daemons**

| | | 125 daemons | | Per daemon | |
|---|---|---|---|---|---|
| | | -24 | -31 | -24 | -31 |
| TCP/IP GETVIS | 476K | 600K | 3.8K *) | 4.8K | |
| VTAM GETVIS | | 0K | 52K | 0K | 0.4K |
| SVA | | 20K | 524K | 0.16K | 4.2K |

Remember from other variations:

- Different setup of VTAM APPL B-book for Telnet did not show any deltas below the line

## Conclusion:

- **Rough estimate for TN3270 VS-Capacity**

Based on *) above

```
Max. #TN daemons = (remaining GETVIS-24) / 4K
```

'Remaining GETVIS-24' is that GETVIS which is available in your TCP/IP partition, IF you would start it again, BUT w/o any Telnet daemons defined.

Here, the remaining GETVIS-24 was about 10M, resulting in (theoretically) 2500 TN daemons.

- **Much higher Telnet capacity per TCP/IP partition**

# PART G.

# TCP4VSE Performance Results - FTP

- FTP General Hints
- FTP Results
  - Interactive FTP with various file types
  - Interactive vs Batch FTP vs FTPBATCH
- Resource Planning

# General FTP Related Aspects

EDR = Effective Data Rate (KB/sec)

Usually it denotes the rate for a single FTP transfer,
but for capacity planning the aggregate EDR must be used.

## „ Achievable EDRs w/o TCP/IP

### IND$FILE (Workstation File Transfer):

Based on customer experiences and statements, about 30 to 50 KB/sec can be achieved as (single thread) EDR.

### LANRES/VSE:

Higher EDRs can be seen (100 to 200 KB/sec, sometimes 300 KB/sec), also depending on the parameters cited above.

(Let us know if your experience should differ significantly)

## „ It is irrelevant, who initiated an FTP transfer

There is the same EDR whether the FTP of a file from A to B was initiated via GET in system B or PUT in System A.

## „ To transfer a file from A to B may differ in EDR from transferring the identical file from B to A

Even if identical FTP parameters and local file definitions are used, differences in effective DASD speeds may come into play:

- speed of the physical HDD
- type of READ and of WRITE caching
- blocksize used (KB/IO)

## „ The higher the EDR of an FTP transfer, the higher is the required CPU utilization

Some key value for a given FTP setup is e.g.

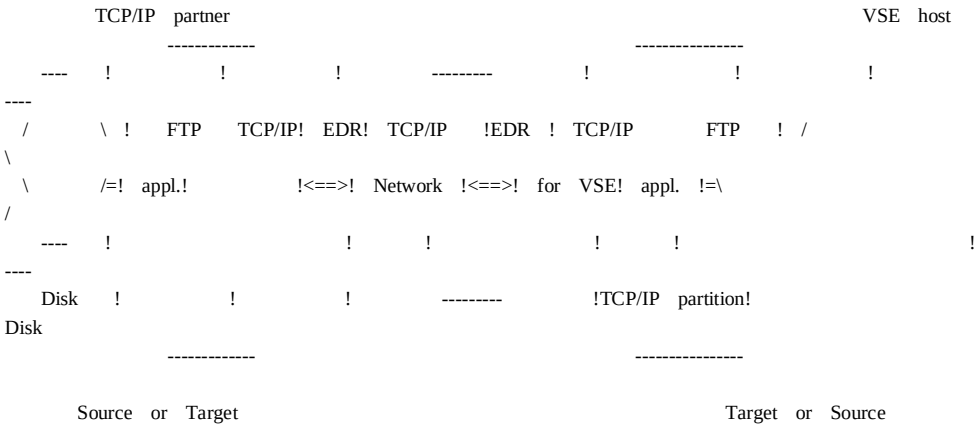
### 'MIPS consumed per 100 KB/sec'

or

### 'KI consumed per KB transferred' ('KI per KB')

# Effective FTP Data Rates

## „ Achievable Effective Data Rates (EDRs) depend on both ends and the connecting network




Actual file transfer is from Source to Target, independent who initiated the FTP as a client.

| Relevant Parameters for ... | FTP Speed(s) | CPUT/KB | | |
|---|---|---|---|---|
| | | Source Target Network | | |
| Network speed and load | - | X | - | |
| TCP/IP parameters | X | X x | x | |
| FTP parameters | X | X x | x | |
| DASD speed (READ/WRITE) | X | X - | - | |
| Local file definition *1 | | - | | |
| - type | | X X | - | X |
| - log. record length (NFS) | x | - | | |
| - blocksize on disk | x | x - | x | |
| - I/O blocking (KB/IO) | X | X - | x | |
| - ASCII/EBCDIC/BINARY | x | x - | X | |
| Size of file(s) | X | - | x | |
| Processor speed | X | X - | X | |
| Other concurrent activities | X X | x - | | |
| TCP4VSE PTF level | X | X x | X | |

X Yes, parameter is relevant
x Parameter with smaller impact
*1 Especially important on VSE side(s)

The table above mainly holds for SINGLE FTP transfers.

# Effective FTP Data Rates

Maximum aggregate EDRs for MULTIPLE FTP transfers depend on the utilization of all involved resources

# Effective FTP Data Rates (cont'd)

## „ EDRs displayed by TCP/IP for VSE

Starting with TCP/IP level UQ16971 (Service Pack F), the following data are being displayed to the initiator of the FTP transfer:

```
Transfer sec:  20.93      (524 KB/sec)
File I/O sec:  11.76      (954 KB/sec)
```

```
   ! Start              X-fer of all TCP segments          End !
   V-----------------------------------------------V

/===/    /=====/  /===/  /==/       /======/  File I/O routine
```

Transfer sec: Elapsed time from the start of the transfer of the first TCP segment till the last TCP segment was ACKnowledged (includes idle times)

-> Actual EDR w/o setup overhead, but with internal delays

File I/O sec: The sum of all times the TCP/IP File Routine needed to complete logical file requests

-> This would have been the resulting EDR, in case no TCP transfer (only File-I/O) would have been done

If the File I/O rate is very close to the transfer rate, ...

- the disk (including type of file access) is presumably the area which determines the overall FTP data rate. Check file definition/IO settings. To confirm, you may try a VSE Virtual Disk; or use the $null 10M file, created by FTP in VSE virtual storage.

If the File I/O rate is much higher than the transfer rate, ...

- the disk (including type of file access) does not represent a bottleneck. Instead, the TCP network transfer may be the determining factor.

In addition, you also may check the CPU utilization for a potential CPU bottleneck

# FTP Performance Result Summary

## Ù Achieveable data rates vary a lot

Depending on

- VSE type of data
  (fixed or variable logical records)
- type of DASDs
- direction of transfer, etc

## EDR ranges observed so far:

| Effective Data Rate (KB/sec) ranges | | | |
|---|---|---|---|
| | FTP to VSE | FTP from VSE | Major impact/Comment |
| LIBR | 340 | 470 | DASD, network speed |
| POWER | (60)<br>115 - ... | (80)<br>290 - ... | (Improved, DBLK=7K)<br>DBLK |
| VSAM ESDS<br>(binary) | ...<br>... 360<br>... | 460<br>To RS/6000<br>160 | To S/390<br>CLAW<br>Via CLAW & T/R |

## Ù CPU resources required

Vary also, depending on similar parameters

| KI/KB values observed | | | |
|---|---|---|---|
| | FTP to VSE | FTP from VSE | Dependencies |
| LIBR | 18.9 - 20.1e | 11.9 - 13.3e | |
| POWER | (200)<br>85 | (157)<br>45 | (Improved) |
| VSAM ESDS | ... 7.6 | - 9.2 | Conversion |
| - E.g. 20 KI/KB correspond to 2 MIPS per 100 KB/sec<br>- Standard Dispatcher (SD) showed up to 10% lower values | | | |

Impact of SD on data rate varies, depending on CPU-time share in total elapsed time (= CPU utilization)

## í Understanding all FTP figures and setting up hints is a challenge

# FTP Performance Result Summary ...

## I/A FTP Performance Results

## Environments

- VSE/ESA 2.3.0/2.3.2 + TCP/IP level as indicated.

- Setup was basicly same as for the TN3270 runs (but w/o TPNS).

- TD was used by default, and a uni-processor.
  'Old' SD was used for selected cases.

- All CPU-time (for TD) on VSE was obtained from QUERY TD.
  For SD, a H/W monitor was used.

- For TCP/IP, all default values were used.
  By intent the following ('ample') parameters were selected
  as working point:

  SET WINDOW=32684 (default is 4096), also set in VM
  DEFINE LINK CTC ... MTU=4096

## Measurement runs and variations for 'I/A FTP'

- In TCP/IP for VM a PUT or MPUT was done (as FTP client and source)
  or GET or MGET (as FTP client and target).

We varied so far:

- the file(s) transferred: 1x10 MB or 10x1 MB TXT file
  (no conversion was included)
  For VSAM ESDS, the VSE.MESSAGES.ONLINE file (3M) was used

- the target location of the file in VSE: VD and Real Disk
  (9345 cached)

- the source location of the file in VM : VD and Real Disk

## Sets of runs:

- FTP to and from VSE w/ LIBR (to/from a VSE library)

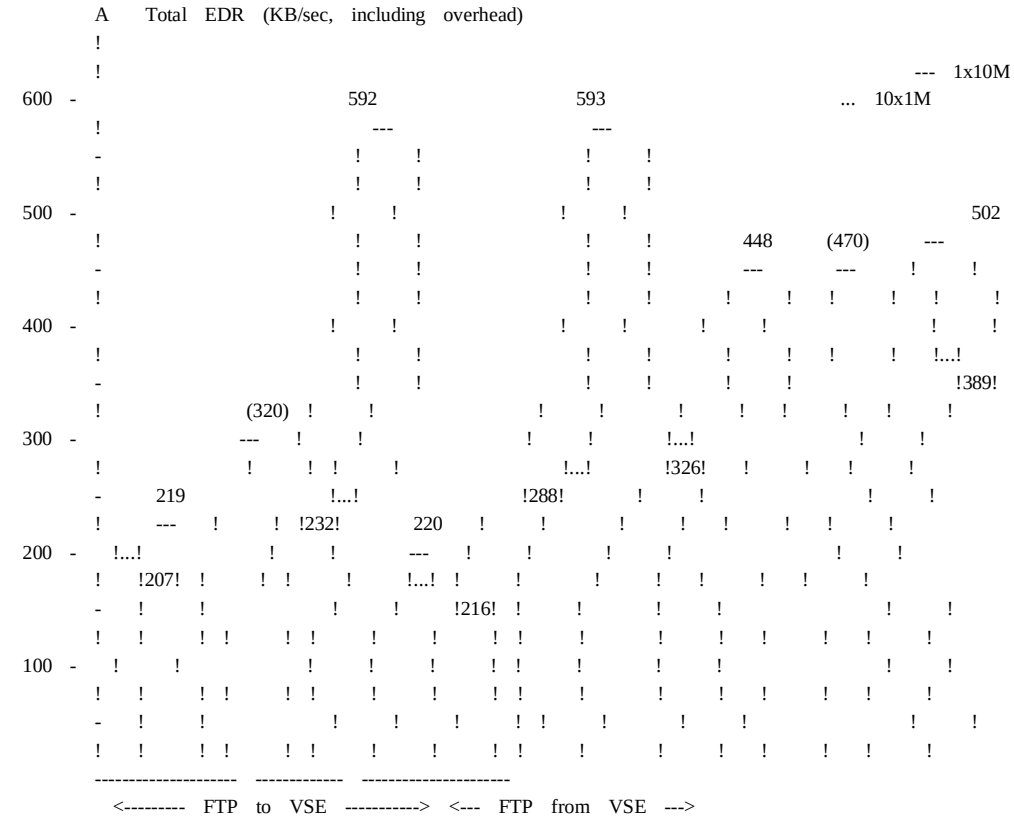
- FTP to and from VSE w/ POWER (to/from a POWER queue)

- FTP from VSE w/ VSAM ESDS (from the VSE OME file)

FTP measurements with Batch partitions were also done

# FTP Performance Results (LIBR)

TCP/IP level UQ14494 (Service Pack E), runs were done 98-03-10/16.




VSE CPU

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1x10M: | >32% | - | >79% | >32% | >78% | ! | >39% | - | >44% |
| 10x1M: | >31% | - | >33% | >32% | >41% | ! | >32% | - | >38% |

VSE NPS (improved meanwhile)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1x10M: | 0.310 | - | 0.273 | 0.313 | 0.289 | ! | 0.336 | - | 0.350 |
| 10x1M: | 0.308 | - | 0.307 | 0.312 | 0.311 | ! | 0.382 | - | 0.391 |

VSE KI/KB

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1x10M: | 21.0 | - | 19.9 | 21.0 | 19.7 | ! | 12.9 | - | 12.9 |
| 10x1M: | 21.4 | - | 20.7 | 21.1 | 20.7 | ! | 14.3 | - | 14.3 |

Data Rates w/o overhead (from VM TCP/IP) were
up to 20% higher (1x10M)
up to 35% higher (10x1M)

* E is a (conservative) extrapolation from the 9345 (no DFW) to a faster and WRITE-cached I/O subsystem

# FTP Performance Results (LIBR) (cont'd)

## FTP to VSE (LIBR)

- KI/KB varied between 19.9 and 21.4

- 10x1M vs 1x10M (many small vs 1 big member):
  - needed up to 5% more CPU-time (member overhead in LIBR/TCP)
  - needed about twice the Elapsed time for VSE VD
    about 5% more Elapsed time for VSE real disk

- VSE Virtual Disk:
  - gave higher EDRs in all cases
  - gave much higher EDRs for 1x10M

- VM Virtual Disk:
  - did not change CPU-time in VSE (as expected)
  - gave only higher EDRs when VSE VD is used AND 10x1M

Possible assessment of these data rates (based on available info)
---

The biggest bottleneck was the slow 9345 for WRITEing

- When using VSE VD, the 1x10M case improved a lot,
  until it reached close to 100% CPU utilization.

  The 10x1M case improved much less, reason TBD
  (maybe VM CPU util, maybe VM directory access, etc).

- When using VM VD, only the 10x1M case improved,
  so this may be an indication for a slow VM directory access.

- It is unknown to what extent the CTC speed was exploited
  but it is at least as high as the 593 KB/sec case shows

## FTP from VSE (LIBR)

- KI/KB varied between 12.9 and 14.3
- READ performance of the cached 9345 is much better than WRITE

# More Recent FTP Results (LIBR)

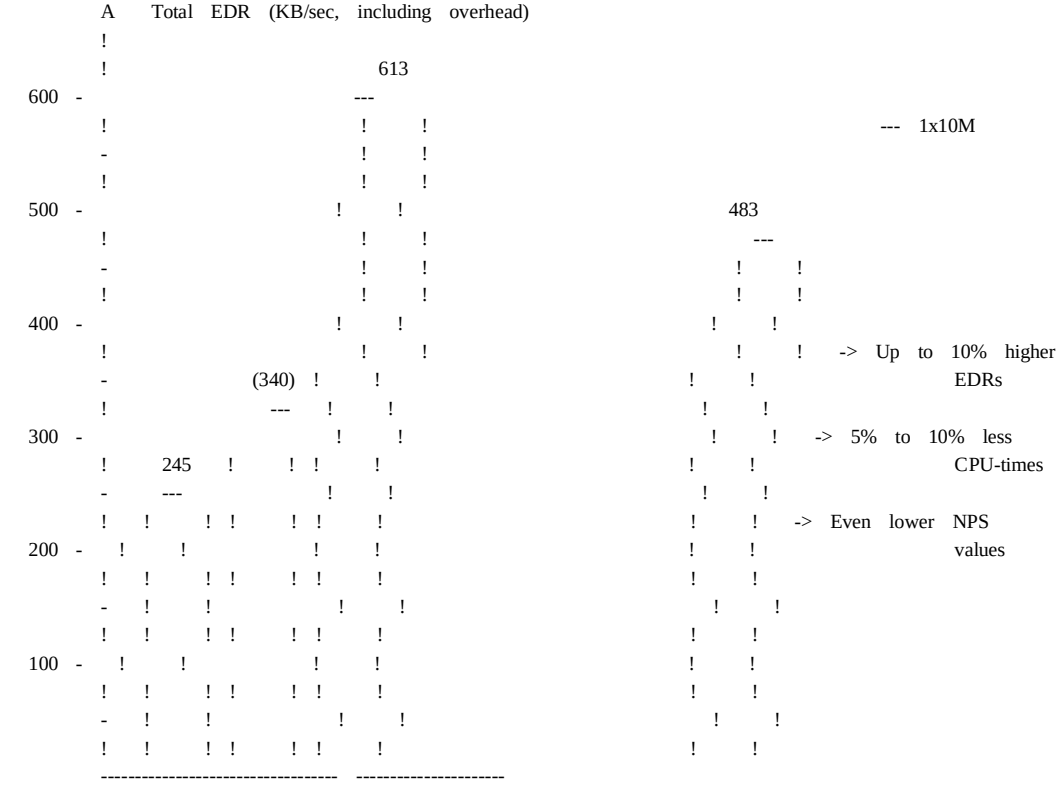
## FTP Results (LIBR) for Service Pack F

Runs were done 98-04-08.

- EDRs and CPU-times very similar to UQ14494 (Service Pack E)
- NPS values reduced by about 35%:
  0.310 -> 0.190, or 0.336 -> 0.221

## FTP Results (LIBR) for Service Pack I

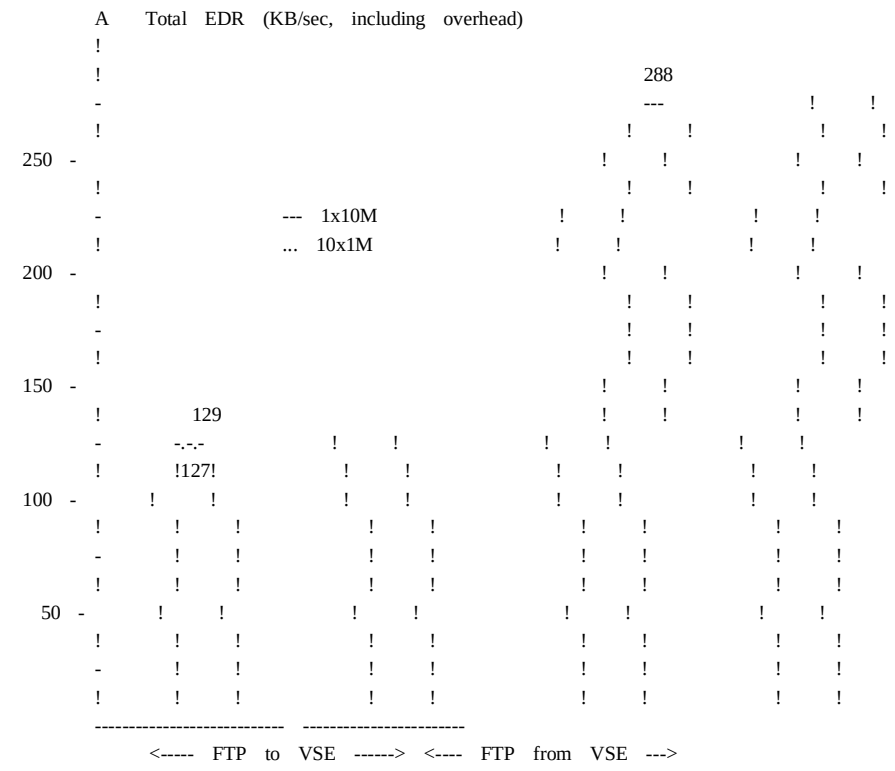
TCP/IP level UQ22503, available 10/98, runs were done 98-10-09.




- Data Rates w/o overhead (from VM TCP/IP) were up to 10% higher.

# FTP Performance Results (POWER)

TCP/IP level UQ16971 (Service Pack F), runs were done 98-04-08.




| | VSE DBLK: 7K | 23K | 7K | 23K |
|---|---|---|---|---|
| VSE CPU tot(POWER) | | | | |
| 1x10M: | >73%(49%) | | >92%(6%) | |
| 10x1M: | >72%(48%) | | | |
| VSE NPS | | | | |
| 1x10M: | 0.812 | | 0.118 | |
| 10x1M: | 0.818 | | | |
| VSE KI/KB | | | | |
| 1x10M: | 87.7 | | 45.0 | |
| 10x1M: | 87.1 | | | |

- Data Rates w/o overhead (from VM TCP/IP) were up to 10% higher.

- FTP to VSE also determined by slow WRITEs of 9345 DASDs.

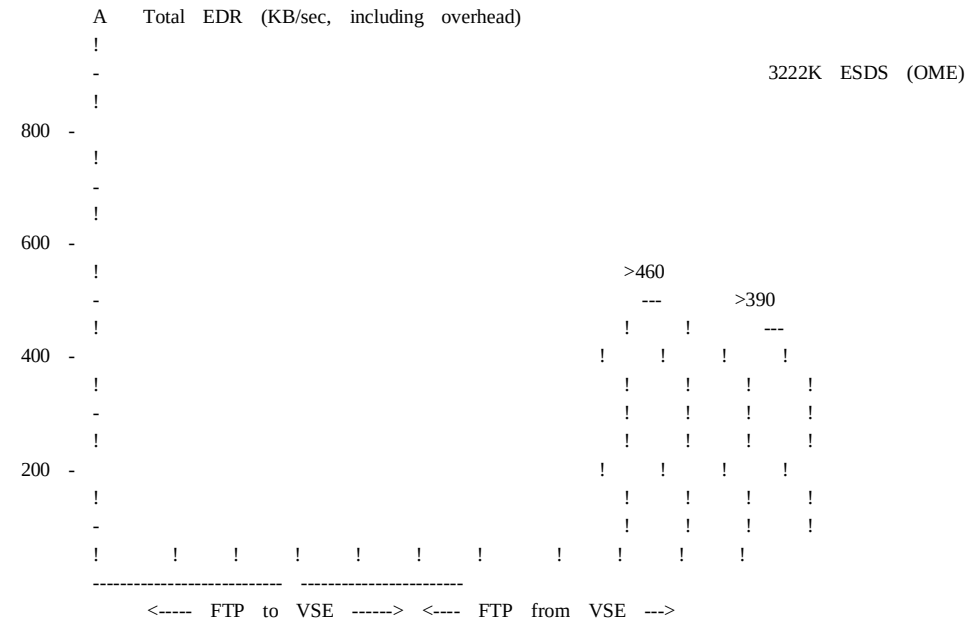
- Benefits of bigger DBLKs for EDR are limited by the still high CPU consumption

# FTP Performance Results (VSAM ESDS)

TCP/IP level UQ16971 (Service Pack F), runs were done 98-04-08.

So far only FTP from VSE was done.

Besides BINARY, also EBCDIC to ASCII was selected.




| MODE: | BIN | EBC/ASC |
|---|---|---|
| VSE CPU tot | | |
| 1x 3M: | >21% | >23% |
| VSE NPS | | |
| 1x 3M: | 0.364 | 0.311 |
| VSE KI/KB | | |
| 1x 3M: | 7.6 | 9.2 |

- Data Rate w/o overhead (from VM TCP/IP) for this short activity was 946 and 573 KB/sec

# FTP Performance Hints -DASD Access-

DASD access time is a major performance factor for FTP

- **General**

  **The 'better' a file locally is defined, and ...**
  **the faster an I/O subsystem is ...**

  - **the higher is the potential FTP data rate for single and multiple FTPs of any kind.**

- **POWER related**

  Check the priority of your POWER partition.

  **Single FTP:**

  Per POWER I/O to its Data File, only 1 DBLK is read/written

  - **Select a bigger DBLK size**

    Use a DBLK size of about tracksize/2. This will speed up DASD access to the Data File, also for multiple FTPs

  **Multiple (concurrent) FTPs:**

  Or for single FTPs with high concurrent POWER spool activity.

  POWER can concurrently issue 1 I/O to each data file extent, if on different logical DASDs (volumes)

  - **Select a bigger number of POWER Data File extents on different volumes**

    This will increase the I/O concurrency, though it cannot be influenced on which extent certain data reside

# Processor Resources Needed for FTP

## Total CPU-time for FTP

The total CPU-time (CPUT) for FTP is (all in the TCP/IP partition) for a certain amount of transferred data (of certain type) is:

```
    CPUT in FTP application      =f(file type, blocking ...)
+ CPUT in TCP/IP layers          =f(TCP/IP parms, network ...)
-------------------------
= total CPU-time for FTP
```

The CPU-time per KB transferred likewise varies with these parameters.

To be basicly processor speed independent, it may be appropriate to roughly use

CPU-time = pathlength / MIPS.

'KI per KB' observed values roughly were

20 / 13 K instructions (KI) per KB (to/from LIBR)
87 / 45 K instructions (KI) per KB (to/from POWER)

## Processor Capacity Needed for FTP

This 'KB per KI' value determines, together with the achieved actual total EDR, the actually used/required CPU utilization when FTP is actually running:

$$\text{CPU utiliz.} = \frac{\text{'KI per KB'} \times \text{EDR}}{\text{KIPS of 1 engine}}$$

EDR is the rate for a single or multiple FTP transfers.
Use this formula multiple times if KI per KB differs.

Assumed example:

20 KI/KB (LIBR)
300 KB/sec total FTP rate, on a (approx.) 20 MIPS processor:

$$\text{CPU utiliz.} = \frac{20 \text{ KI/KB} \times 300 \text{ KB/sec}}{20000 \text{ KIPS}} = 0.30 = 30\%$$

# Batch FTP Performance Results

## Environments

- same as for the I/A FTP runs

## Measurements and variations for 'FTP with Batch'

- FTP was initiated in a VSE Batch partition,
  via // EXEC FTP or FTPBATCH

- The 10M file was used in BINARY mode, except 1 run
  with 1M (to determine batch part. overhead)

- The target location was a VSAM ESDS file

- All FTPs were from VM (real disk) to VSE via real CTC

- So far, only Service Pack K was used

We varied so far:

- the type of partition (static/dynamic) for
  - TCP/IP for VSE/ESA
  - Batch FTP (// EXEC FTP)
  - FTPBATCH (// EXEC FTPBATCH)

- the location of the target file in VSE
  - VSE Virtual Disk
  - VSE Real Disk (9345 only read-cached)

- the VSAM CI-size was varied once (8K instead of 4K CIs)

- Batch FTP and FTPBATCH were run once also on a 2-way

- Multiple concurrent FTPs (not yet)

## Sets of runs:

- FTP to VSE with different partition types

Runs were done 99-07-19 and 99-07-21.

# Batch FTP Performance Results ...

## FTP with Batch, Performance Observations

### „ CPU-time Overhead vs I/A FTP

'Overhead' here includes

- Batch partition initiation (incl. Job Control etc).

and

- Movement of data between FTPBATCH and TCP/IP partition.

| | | Static part. | Dynamic Part. |
|---|---|---|---|
| Batch FTP | CPU-time | 1.45 sec | 1.62 sec |
| | ET (rough) | 6 sec | 7.5 sec |
| FTPBATCH | CPU-time | 2.38 sec | 2.45 sec |
| | ET (rough) | 11 sec | 12.5 sec |

- All values here are deltas to I/A FTP
- Emphasis here is on principal deltas, not typical values
- Here, the total ET varied around about 30 sec.

### í Dynamic Partition overhead is slightly higher than static

As expected
(of interest only for small file transfers).

### í FTPBATCH has data movement overhead vs Batch FTP

Refer to next foils

# Batch FTP Performance Results ...

## FTP with Batch, Performance Observations (cont'd)

### „ Data Rates when Transfer was started

Here mostly the base measured cases are shown.

| | 'Overall EDR' Transfer KB/sec | | File I/O KB/sec | |
|---|---|---|---|---|
| | Real 9345 | Virt.Disk | Real 9345 | Virt.Disk |
| I/A FTP | 639 | 930e | 682 | 1462e |
| Batch FTP | 639 | 930 | 682 | 1462 |
| FTPBATCH | | | | |
| stat-stat | 511 | | 682 | |
| dyn -dyn | 538*1 | 787 | 682 | 1462 |
| dyn -dyn | 568*2 | - | 731*2 | - |

- Total Transfer time includes File-I/O time.
- File I/O rates to Virtual Disk are much higher than to non-WRITE-cached 9345.

*1 Higher rate if both FTPBATCH and TCP/IP run in a dynamic partition.

*2 Higher rate to 9345s with CISIZE=8K (vs 4K)

- EDRs for I/O Subsystems with DFW are expected to be about 30% higher than shown above for 9345s, since much faster for seq. WRITEs.

### í Same rates as for I/A FTP, except Transfer rate seen by FTPBATCH

Data rate is measured in FTPBATCH partition and includes move to TCP/IP partition, plus TCP and IP layers there.

### í Overall EDRs for FTP with batch depend on share of partition overhead

### í Overall EDRs for (single) FTPBATCH are about 15% lower here than for Batch FTP

Cont'd

# Batch FTP Performance Results ...

## FTP with Batch, Perf. Observations (cont'd)

### „ CPU-time and overall EDRs (Real Disk)

FTP of a 10M file (BINARY) to VSE ESDS on Real Disk (1-way)

| TCP-Batch | CPU-time | KI/KB | EDR (via ET) |
|---|---|---|---|
| I/A FTP | 10.167 sec | 13.9 | > 492 KB/sec |
| Batch FTP | | | |
| stat-stat | 11.619 sec | 15.9 | > 380 KB/sec |
| stat-dyn | 11.791 sec | 16.1 | > 362 KB/sec |
| dyn -dyn | 11.359 sec | 15.5 | > 391 KB/sec |
| *1 dyn -dyn | - | 15.0e | 500eKB/sec *1 |
| FTPBATCH | | | |
| stat-stat | 12.550 sec | 17.1 | > 300 KB/sec |
| stat-dyn | 12.622 sec | 17.2 | > 305 KB/sec |
| dyn -dyn | 12.375 sec | 16.9 | > 303 KB/sec |
| *1 dyn -dyn | - | 15.5 | 471 KB/sec *1 |

- CPU-time and KI/KB include variable partit. overhead
- All EDRs here apply to the slow 9345 disks

*1 Without JCL overhead, from 10M run -1M run.

e estimate

- The VSE JA CPU-time in the Batch partition
  (which is a part of the total CPU times shown above)
  were (approx): 5% for Batch FTP
  70% for FTPBATCH

- **No specific impact seen for Batch FTP depending on partition type**
- **FTPBATCH with slightly higher CPU-time and with lower EDR**

# Batch FTP Performance Results ...

## FTP with Batch, Perf. Observations (cont'd)

### „ CPU-time and EDRs (Virt. Disk, Single Stream)

FTP of a 10M file (BINARY) to VSE ESDS on Virtual Disk.
All values include (dynamic) partition overhead.

| Single Stream | CPU-time | KI/KB | NPS | EDR (via ET) | |
|---|---|---|---|---|---|
| Batch FTP | | | | | |
| 1-way | 11.025 sec | 15.05 | .265 | > 495 KB/sec | |
| 2-way | 11.460 sec | 15.67 | .267 | > 468 KB/sec | |
| FTPBATCH | | | | | |
| 1-way | 12.832 sec | 15.54 | .318 | > 375 KB/sec | |
| 2-way | 15.027 sec | 20.54 | .353 | > 386 KB/sec | |
| - NPS is lower for real disk and w/o partition overhead | | | | | |

### í A 2nd engine

#### - does not help at all for Batch FTP

5% lower data rate, 4% higher CPU-time

#### - hardly helps for single stream FTPBATCH

3% higher data rate, at cost of 17% higher CPU-time

### „ CPU-time and EDRs (Virt. Disk, Mult. Stream)

Figures to be provided, no runs done so far

### í FTPBATCH file transfers

#### can be better workload balanced (controlled) via PRTY/PRTYIO

Especially needed when only 1 TCP/IP partition is used

#### can run concurrently and thus achieve a higher sum of FTP EDRs

Especially beneficial when FTPs are to/from multiple real disks
(where a single File I/O routine would be a bottleneck)

#### allow to exploit >1 processor

## Summary

- **TCP/IP performance tuning is not easy**
  - **Many S/W parameters included and potentially big networks**
  - **Careful setup and analysis may be required**
- **We need to further improve TN3270 performance**
  - **CPU-time overhead per txn**
  - **Partition capacity (via 31-bit exploitation)**

    Resolved by Service Packs J and K
- **FTP processor requirements and FTP data rates**
  **- have been already improved**
  **- will be enhanced further**

  Multiple FTP data rates improved via FTPBATCH
- **We always try to improve/extend the tuning guidelines and documentation**

  Naturally, first priority here is the performance of the product

| | |
|---|---|
| EOD | End Of Document |
| HAND | Have A Nice Day |