

Unix System Performance Analyzing and Understanding Unix System Resources

*Using today's data to plan for future,
hassle-free processing.*

Lund Performance Solutions

240 Second Avenue SW
Albany, OR 97321

Phone: (541) 812-7600

Fax: (541) 926-7723

www.lund.com

Presented by:

D. Scott Pierson

Craig Lalley

Chris Reimer



Analyzing System Resources

- Introduction
- Client-Server Environment
- Major Resources
 - CPU
 - Memory
 - Disk I/O
 - Network
- Questions & Answers

Data Collection & Analysis Tools

- Standard Unix tools
 - sar, top, iostat, vmstat, netstat, uptime
- HP Tools
 - GlancePlus, MeasureWare, PerfView
- Lund Tools
 - SOS/9000, SOSLOGD, SOSLOGX, Performance Gallery Gold

Workload Definition

- In MeasureWare, workloads are configured in /var/opt/perf/parm, and are called applications
- In SOS/9000, workloads are configured in /etc/opt/lps/cfg/workdefs

Workload Definitions – Using MeasureWare

```
# Add user applications here

application = network
file = nfs*,biold,automount,inetd,snmp*,rpc*,llbd,netfmt,portmap
file = rbootd,telnet*,ftp*,*rlogin*,remsh*,rcp,nktl*,nvsisr,ttisr
file = lcsp,gcsp,strmen,strweld,vtdaemon,mib*,trapdest*,*web*,xntpd,yp*
file = hp_unixagt,ntl*,pty*

application = perf tools
file=midaemon, glance, gpm, rx, scopeux, pv, extract, utility, mwa
file=alarmgen, rep_server, perflbd, agdbserver

application = memory management
file = swapper,vhand,syncer,pageout,fsflush,vxfsd

application = other user root
user = root
```

Workload Definitions – Using SOS

```
# Define workload for performance tools
Perf_Tools
mix
PROG=lpssmid
PROG=sos
PROG=soslogd
PROG=soslogx
PROG=sar
PROG=iostat
PROG=vmstat

# Define INTERACT as all interactive processes.
INTERACT
INTERACT

# Define BATCH as non-interactive processes w/low nice value.
# This should be refined by the user.
BATCH
BATCH
NICE=21-39

# Define DAEMON as all remaining non-interactive processes.
# This should be refined by the user.
DAEMON
DAEMON
```

Data Logging Interval

- MeasureWare has a fixed 5 minute interval for logging Global, Application, and Device data. Interesting Process data is logged every minute.
- SOS/900 has a user-defined logging interval, with a default value of 5 minutes. A snapshot of process data is taken when the other data is logged.

Resources vs. Performance

- We usually measure *resource utilization* and say that we are measuring *performance*
- But there are only two ways to really measure Performance
 - Response Time
 - By Process
 - By Workload
 - System-wide
 - Throughput

Automation

- Automatic reporting
- Analysis instead of reporting
- Export to web page

Bobcat File Server Activity

Welcome to Bobcat's performance information page!

This page contains up-to-the-hour performance data about a live file server at LUND. It uses the automation features of one of our products, [Performance Gallery Gold](#), to automatically display performance data to the web.

See the [Q & A](#) section of this page for details on how this page was constructed.

Quick Links

[CPU Utilization](#)
[Network Traffic](#)

[File Server Statistics](#)
[Paging Information](#)

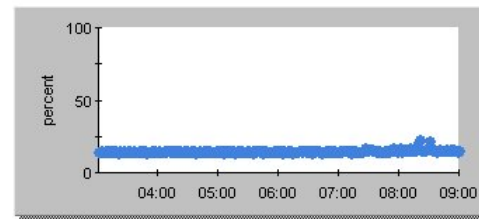
[Session Information](#)
[Virtual Memory](#)

[Disk Queue Length](#)
[Automated Index Page](#)

CPU Utilization

[Back to Top](#)

Bobcat File Server
CPU Utilization (NT)
11/14/2001 03:01 - 11/14/2001 09:00



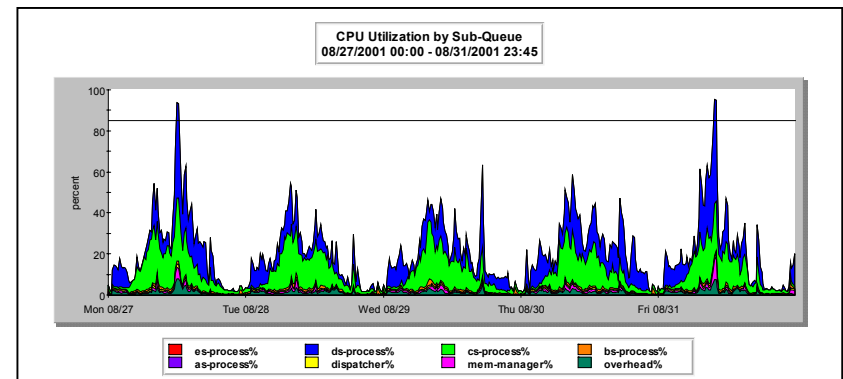
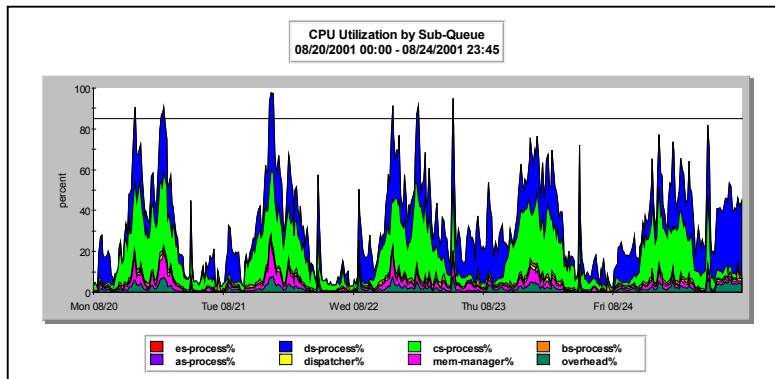
Bobcat's CPU utilization is generally quite low and rarely exceeds 20% during the course of an average work day.

Bobcat currently runs an Intel Pentium III 500 Mhz processor.

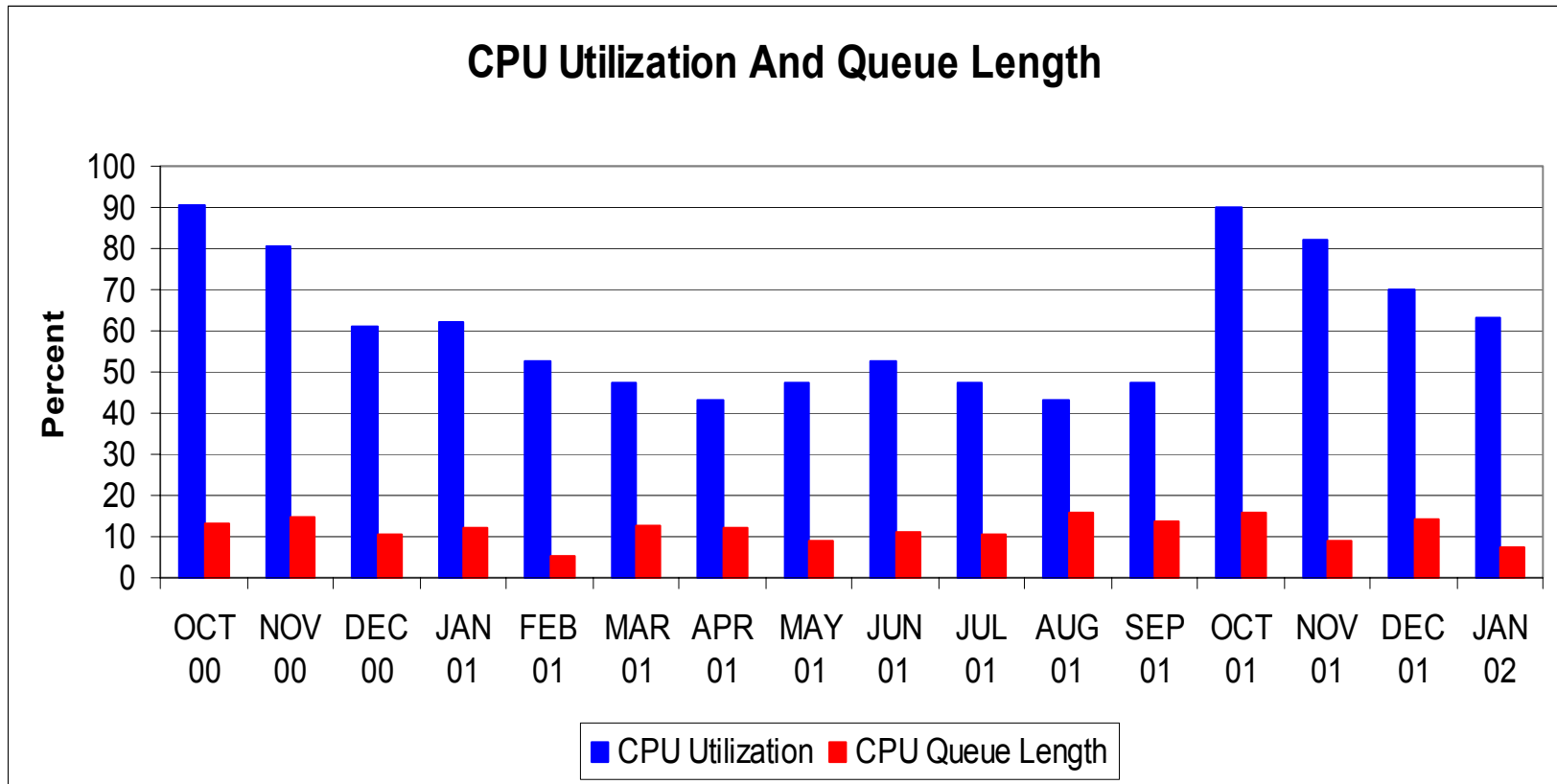
Analysis Method — Implementing Change

- Identify issue
- Determine possible solutions
- Implement solution
- Test results

← *Before* *After* →



Trending



Client-Server Environment

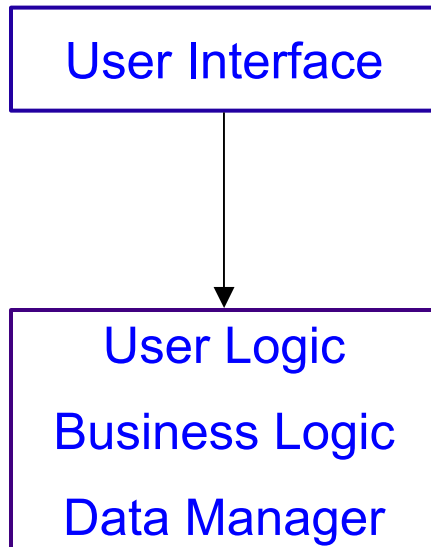
- Definitions
- Client-Server Styles
- 3 Tier Architecture
- Problem Analysis
- Components of Response Time

Client Server – Definitions

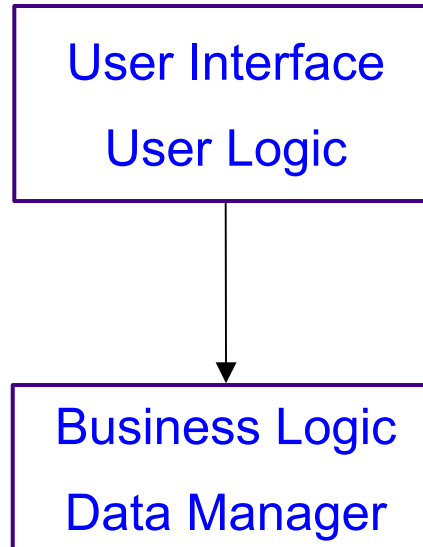
- Client-Server
 - When a transaction or function has components that execute on 2 or more computers
- Response Time
 - The elapsed time between hitting the ENTER or RETURN key and getting results back on the screen

Client Server – Styles

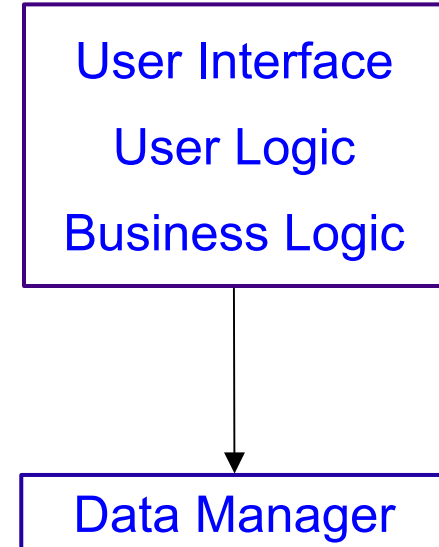
Distributed Presentation



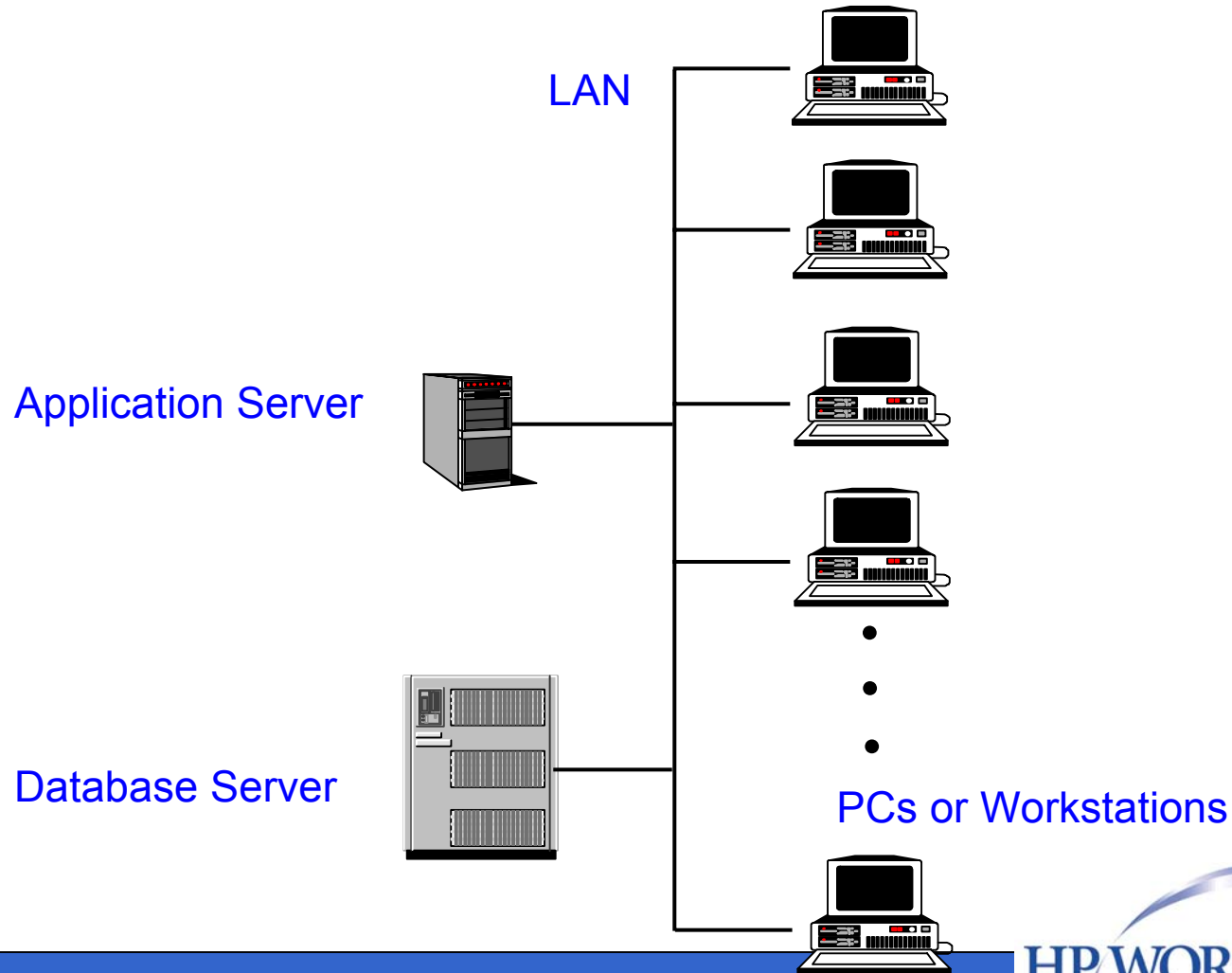
Remote SQL



Business Transaction



Client Server – 3 Tier Architecture

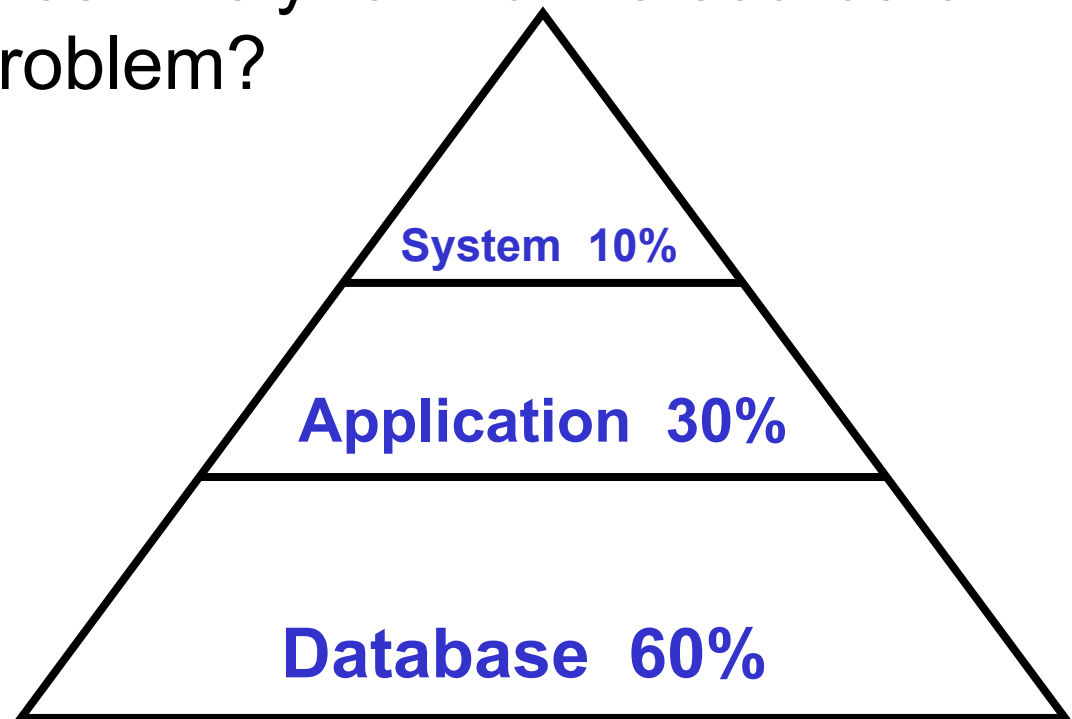


Client Server – Problem Analysis

- Components to Analyze on Each System
 - CPU
 - Memory
 - Disk I/O
 - Network

Client Server – Problem Analysis

Where are you most likely to find the source of a performance problem?

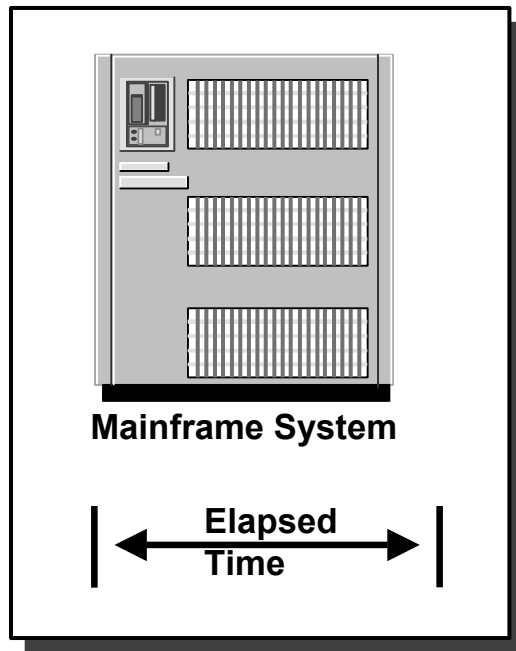


Client Server – Problem Analysis

- Once you identify a performance problem, there are only two ways to resolve it:
 - Increase the resource
 - More Processors, Memory, Disk
 - Faster Processors, Disk
 - Decrease the demand
 - Tune the application
 - Tune the Operating System
 - Redistribute the work

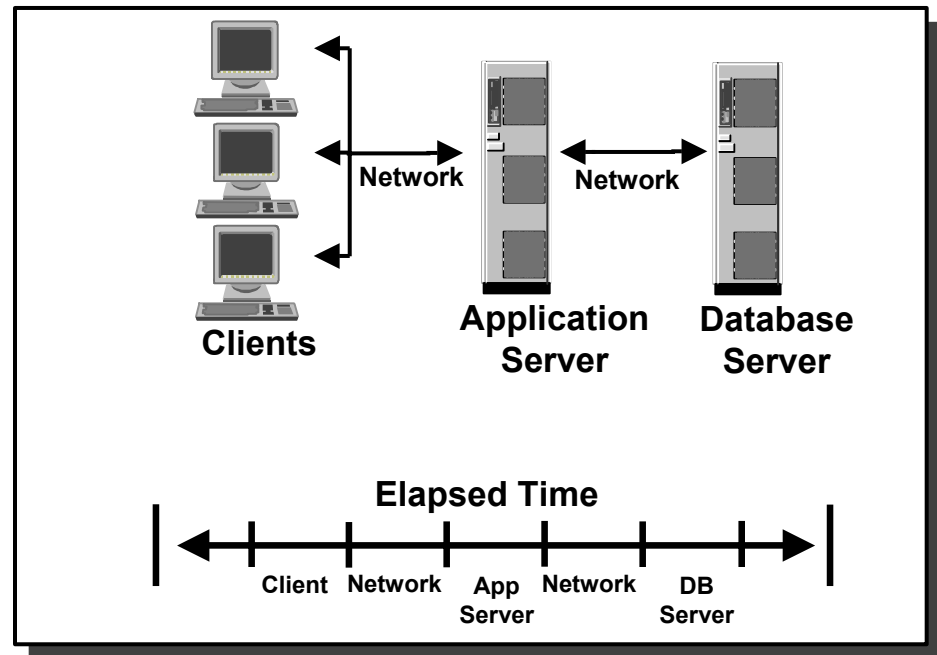
Client Server – Response Time Component

Centralized Environment



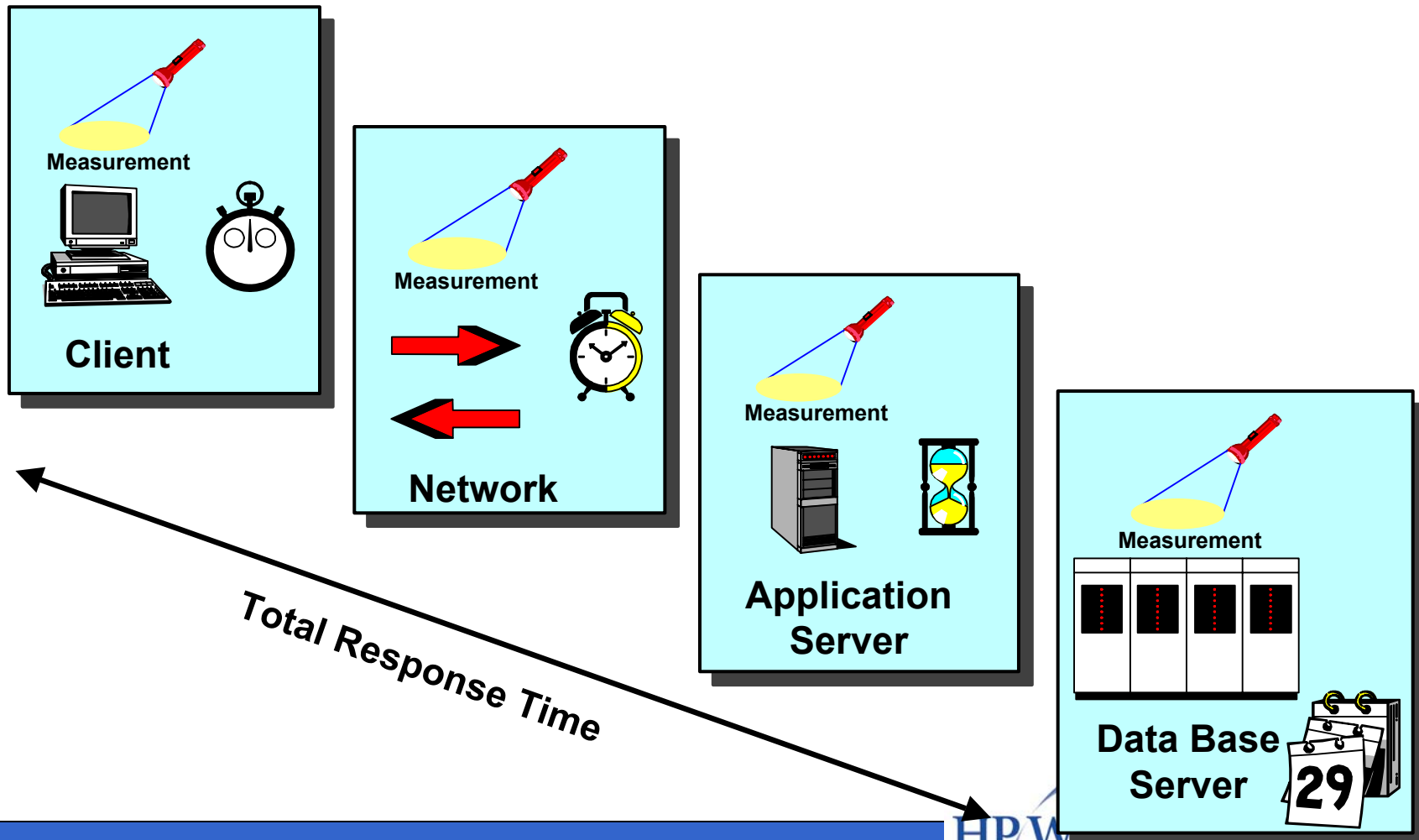
Data from one business transaction is typically fully contained

Client Server Distributed Environment



Data from One Business Transaction is not fully contained

Client Server – Response Time Component



Global Summary

```

SOS B.01y eagle WED, 30 JAN 2002, 08:45 E: 00:22:00 I: 00:00
----- CPU UTILIZATION ----- CPU MISC -----
TOTAL BUSY: 61.3[ 1] HIGH PRI: 61.3[ 1] | Capture Ratio 0.8[ <]
User 0[ <] Sys 27.9[ <] Mem 0[ <] | RunQ Avg 0[ 0]
Real 0[ 0] Intr 6.3[ <] Idle 38.7[99] | 5/15 Min RunQ Avg 0/ 0
Nice 0[ 0] C SW 0[ <] | RunQ Busy % 0[ <]
NNice 27.0[ <] Trap 0[ <] |
----- MEM/VM -----
Read Hit % 100.0[100] Page Outs 0[ <]/s Mem Used % 67.1[ 67]
Write Hit % 100.0[ 55] Deact Byte 0[ 0]/s VM Used % 25.9[ 25]
----- MISC -----
#Sessions: 1 #Procs: 52 #Wait I/O: 0 Transactions: 33.0[ 9.2]/s
#Active: 0 #Active: 2 #Deact: 0 Avg Response Time: <
----- DISK -----
Disk IO/s IO% QLen | Disk IO/s IO% QLen | Disk IO/s IO% QLen
c0t5d0 0 100 0 | c0t2d0 0 0 0 | c0t6d0 0 0 0
----- PROCESS SUMMARY -----
PID Name User Name TTY CPU% Nice Pri RSS/Size #Rd #Wr Wait Resp
The CPU was used a total of 61.3 of its capacity during this interval <CI01>
This interval's 'hog' process is (PID 3644) with 68.1% of the CPU <PI01>
This interval's highest disk I/O user was (PID 3644) with 1 I/O's <PI02>
FLOCKS too high at 4 <GE03>

Enter command: (Showing lines 4 - 8 of 8)
UPDATE RESET SCREEN HELP MORE FREEZE PRINT EXIT

```

System Tables

SOS B.01y eagle			WED, 30 JAN 2002, 08:50			E: 00:26:56		I: 00:59							
----- MISC TABLE/CACHE SUMMARY -----															
			Entries		Used		Used %		High						
File Table			920		197		21.4		202						
File Lock Table			200		4		2.0		4						
Pseudo TTY Table			60		1		1.7		1						
Process Table			276		54		19.6		55						
Inode Cache			476		322		67.6		476						
----- IPC TABLE/CACHE SUMMARY -----															
	Size		Entries		Used		Used %		High						
Message Table	N/A		50		2		4.0		2						
Message Buffer Cache	800k		N/A		0		0		0						
Semaphore Table	N/A		70		10		14.3		10						
Shared Memory Table	N/A		200		5		2.5		5						
Shared Memory	200g		N/A		326		0		326						
----- DNLC CACHE SUMMARY -----															
Entries			Hit %						Lookups/s						
1500			94.5						4.9						
----- SYSV BUFFER CACHE SUMMARY -----															
HEADER TABLE			Min	Max	DATA CACHE										
Entries	Used	Used %	Size	Size	Size	Used	Used %	High	Hit %						
27104	27104	100.0	26212k	256m	207m	207m	100.0	207m	72.7						

Enter command:															
UPDATE		RESET		SCREEN		HELP		MORE		FREEZE		PRINT		EXIT	

System Resources

- CPU
- Memory
- Disk I/O
- Network

Central Processing Unit

- Metrics
- Process Scheduling
- Metric Thresholds
- Analysis Desktops
- Trending

CPU – Metrics

General Metrics	User Mode	System Mode
CPU Busy %	CPU User %	CPU Sys %
Run Queue Length	CPU Nice %	CPU CSw %
CPU Busy % by Workload	CPU Neg Nice %	CPU Intr %
(CPU High-Pri Busy %)	CPU Real %	CPU Trap %
		CPU Vflt %

CPU – Summary Screen

```

SOS B.01y eagle WED, 30 JAN 2002, 08:46 E: 00:23:22 I: 00:00
----- CPU SUMMARY -----
                                TOTAL HIGH PRI
USER  REAL  NICE  NNICE  SYS   INTR  C SW  TRAP  MEM   IDLE  BUSY  BUSY
    0     0     0   16.0 23.7    5.3  0.8    0     0   54.2  45.8  45.8
----- RUNQ STATISTICS -----
Interval Avg:    0[ <]  1/5/15 Min Avg:  0.1/  </  <  Occ %:    0[ 1]
----- MISC STATISTICS -----
Forks:          0[ <]/s                                C Sws:          <[ 11]/s
Intrs:          <[ 333]/s          Traps:          <[ <]/s          Sys C:          <[ 121]/s
----- PER CPU UTILIZATION -----
                                1/5/15 Min  Last
CPU   TOTAL  BUSY USER  REAL  NICE NNICE   SYS   INTR   OHD  IDLE  RunQ Avgs  PID
-----
  1   45.8    0    0    0   16.0  23.7   5.3   0.8  54.2  0.1/  </  <  3644
      [ 2] [ <] [ 0] [ 0] [ 1] [ 1] [ <] [ <] [98]

Enter command:

```

UPDATE	RESET	SCREEN	HELP	MORE	FREEZE	PRINT	EXIT
--------	-------	--------	------	------	--------	-------	------

CPU – Process Scheduling

Real Time Scheduling

System

| 0-----127 |

Highest

Time Share Scheduling

System

| 128-----177 |

User

| 178-----255 |

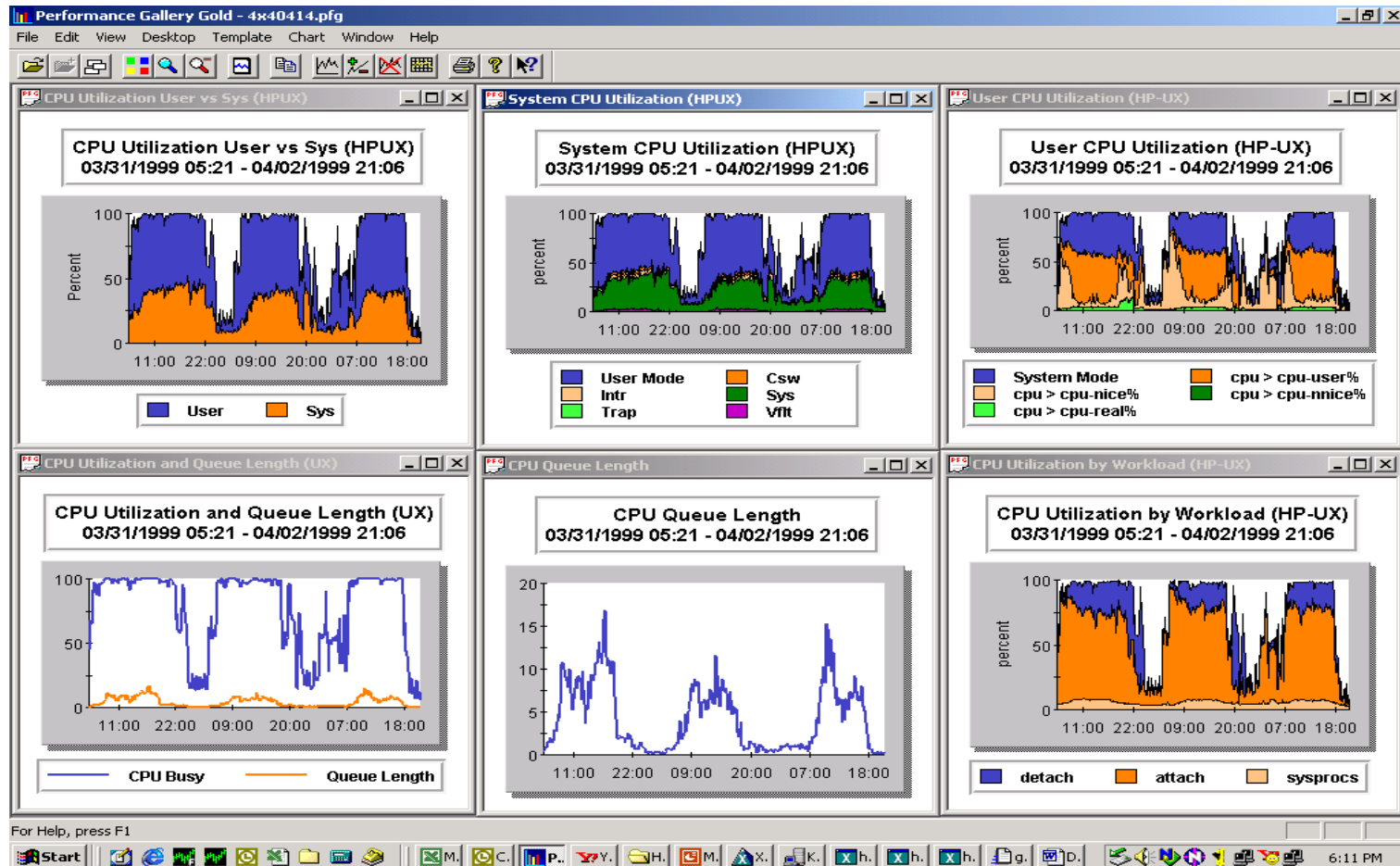
Lowest

- Nice lowers the priority, but increases the Unix priority number
- Negative nice raises the priority, but decreases the Unix priority number

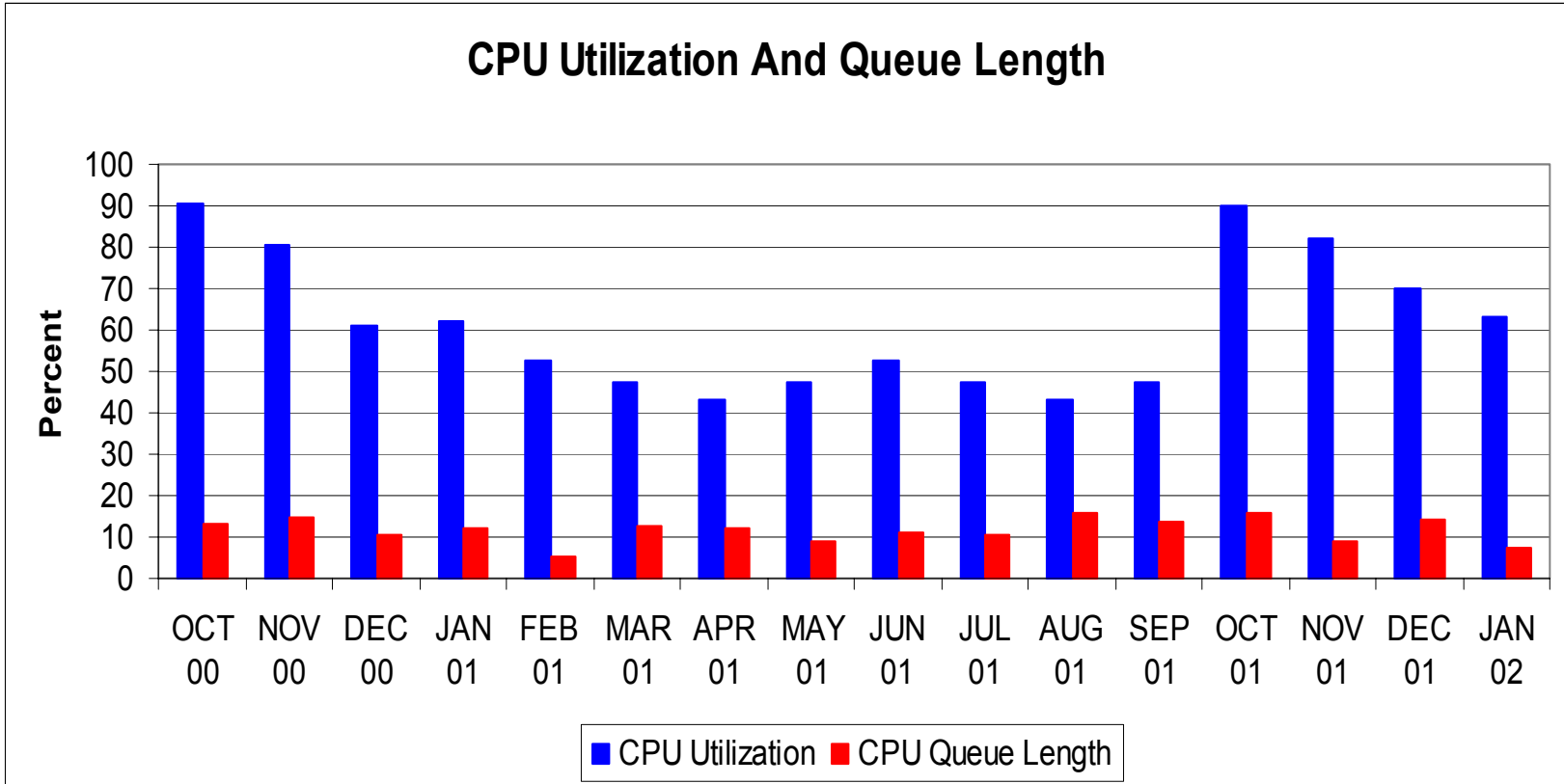
CPU – Thresholds

CPU Busy.....	85%
CPU Real Time.....	5%
System (Kernel) Mode.....	30%
Run Queue Size.....	10

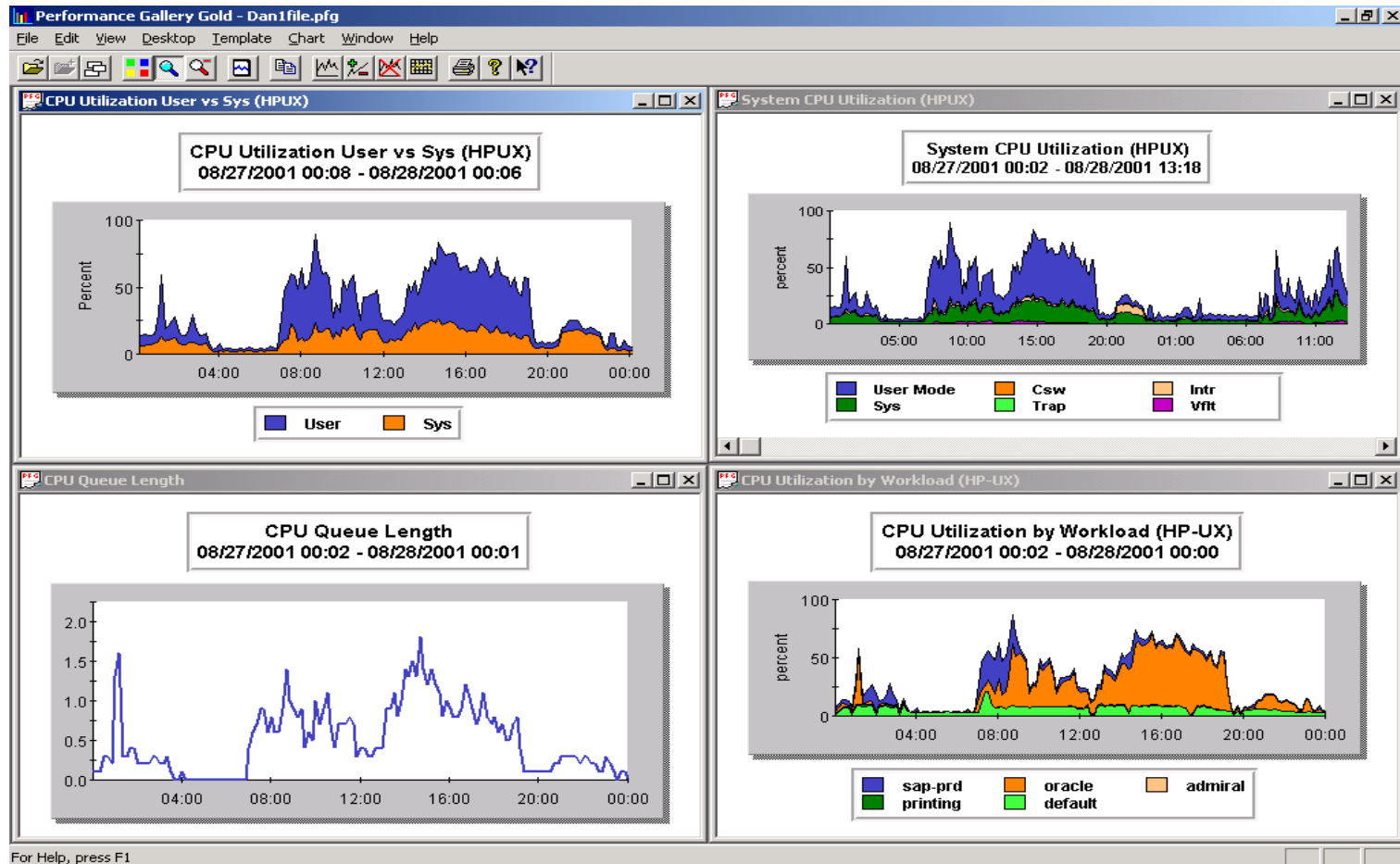
CPU – Analysis Views



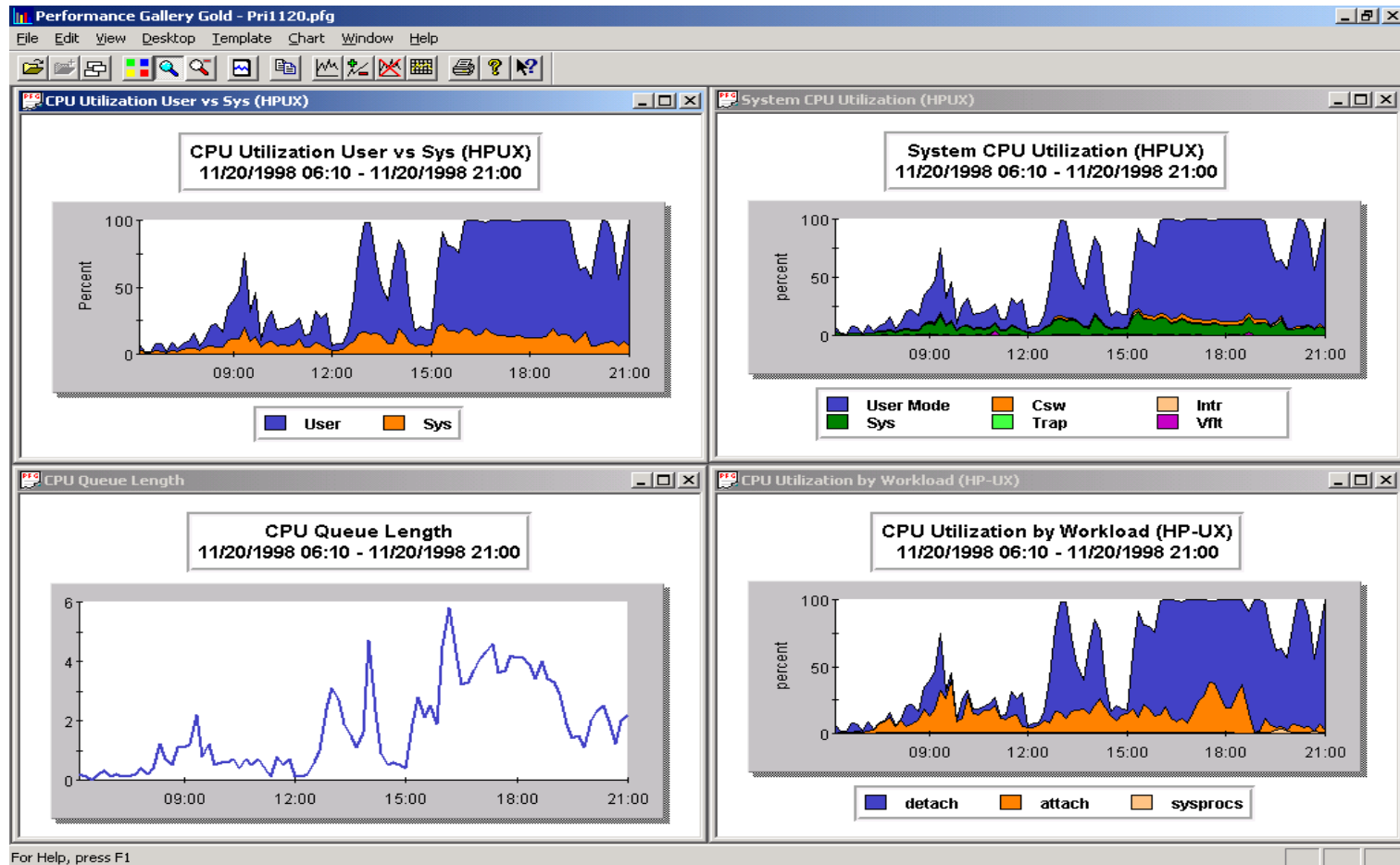
CPU – Trending



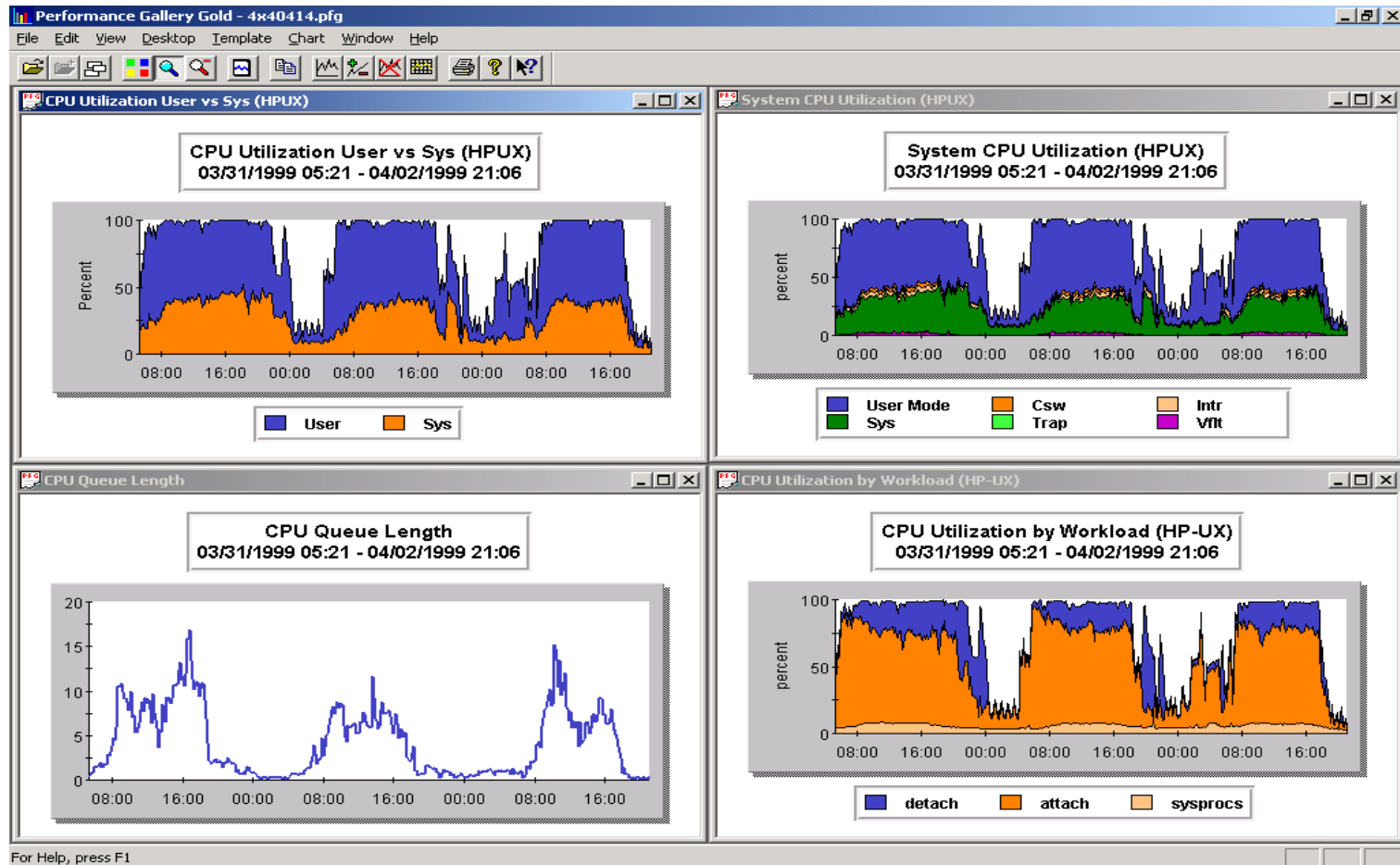
CPU – Minimal Queueing



CPU – Moderate Queueing



CPU – Excessive Queueing



Memory

- Metrics
- Memory Management
- Metric Thresholds
- Analysis Desktops
- Trending

Memory – Metrics

Memory Utilization	Virtual Memory I/O
Used Memory %	Page In Rate
System Memory	Page Out Rate
Buffer Cache	Deactivation Rate
User Memory	
Free Memory	

Memory – Summary Screen

```

SOS B.01y eagle WED, 30 JAN 2002, 08:48 E: 00:24:53 I: 00:01
----- MEM/VM ALLOCATION ----- PROC MEM STATUS -----
      Size      User      Sys      Buffer      Free      |      Run      Sleep      Total
Mem      512m      131m      35m      177m      167m      |      Loaded      0      55      55
VM      1146m      301m      ---      ---      845m      |      Deact      ---      ---      0
----- PAGING -----
      In(/s)      Out(/s)      In(byte/s)      Out(byte/s)      #In      #Out
Pg Flts      0[ 2]
Pages      0[ <]      0[ <]      0[ 30]      0[ 16]      0[ 4]      0[ 6]
(De)act      0[ 0]      0[ 0]      0[ 0]      0[ 0]      0[ 0]      0[ 0]
VM I/O      0[ <]      0[ <]      0[ 30]      0[ 16]      0[ 4]      0[ 6]
Forks      0[ <]
              0[ 5272]
              0[ 34]
----- PAGE SCANNER -----
Page Recs      0[ 1]/s
Page Scans      0[ 0]/s
----- SYSV BUFFER CACHE -----
Read Cache Hit % 100.0[100]
Write Cache Hit % 98.2[ 99]
headers 22834 size 177m DBC min size 26212k DBC max size 256m
----- MEMORY MANAGEMENT CONFIG -----
lotsfree: 27m desfree: 4096k minfree: 1024k
umem: 27m page size: 4096
-----
Enter command:

```

UPDATE	RESET	SCREEN	HELP	MORE	FREEZE	PRINT	EXIT
--------	-------	--------	------	------	--------	-------	------

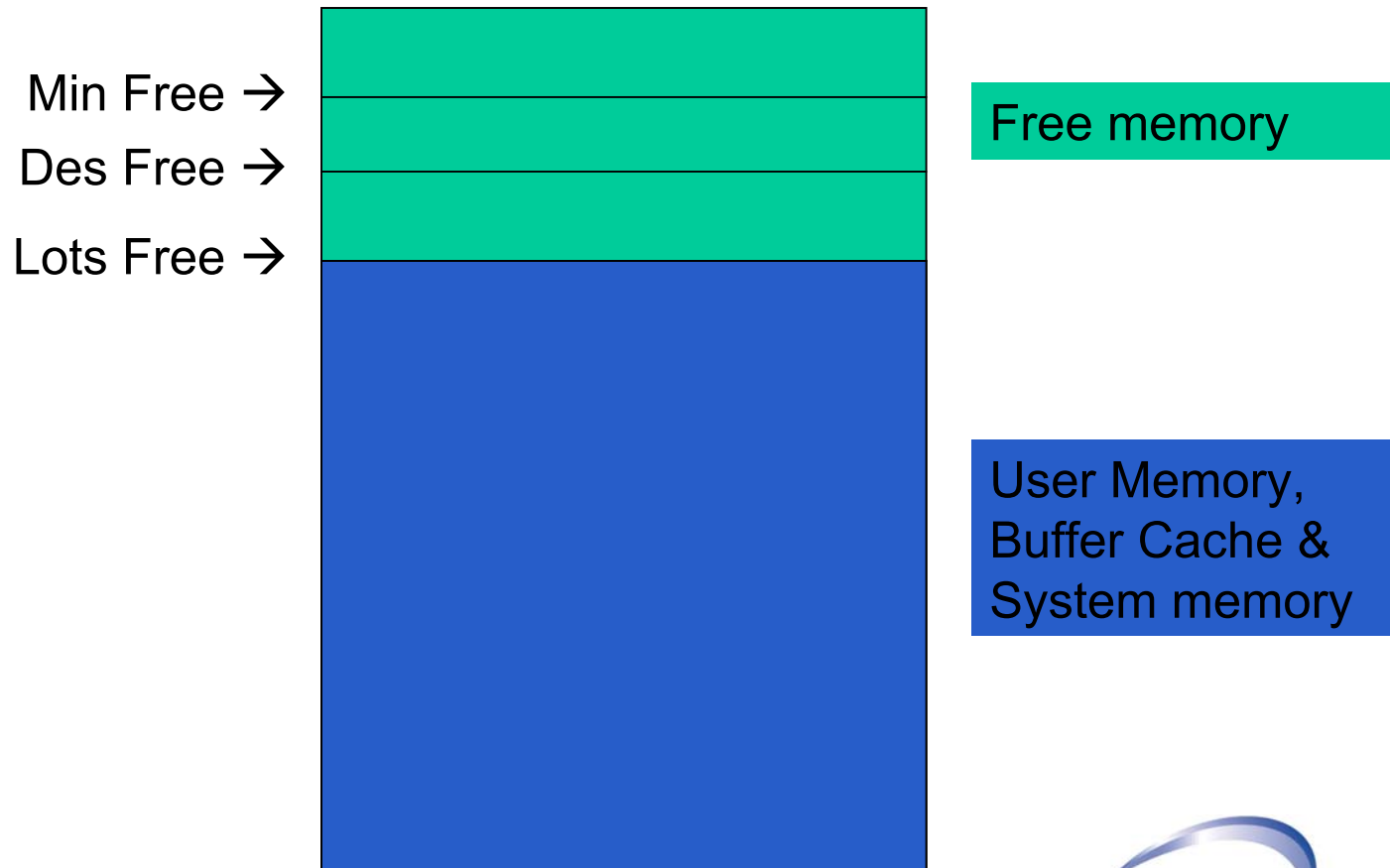
Memory – Management

- There are 3 kernel parameters that affect paging and deactivations
 - LOTSFREE (Lots Free)
 - DESFREE (Desired Free)
 - MINFREE (Minimum Free)
- Memory Manager tries to keep free memory above DESFREE

Memory – Management

- Paging begins when free memory drops between LOTSFREE and DESFREE
- Deactivations occur (paging stops) while free memory is below MINFREE
- Paging continues until free memory is above LOTSFREE

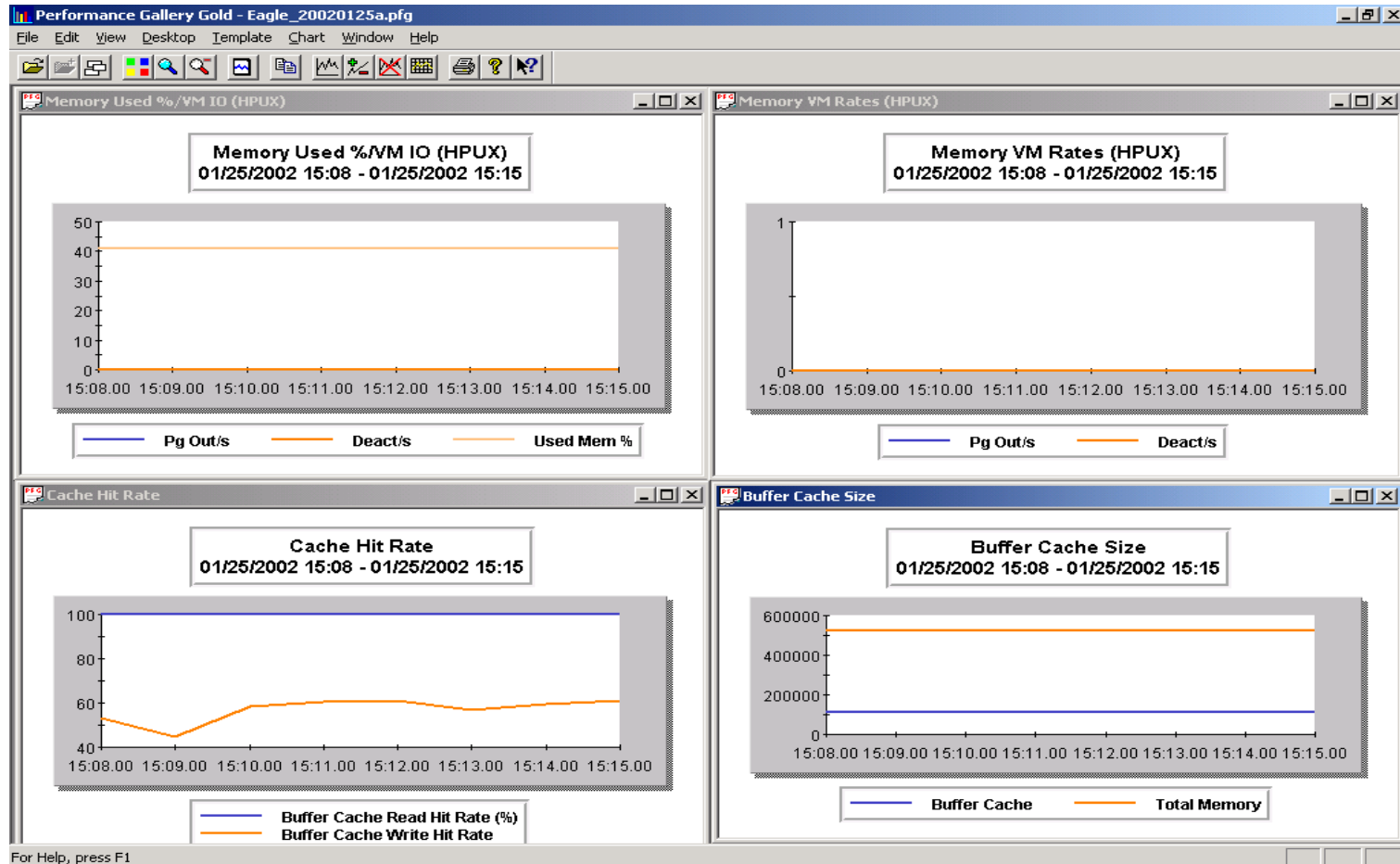
Memory – Management



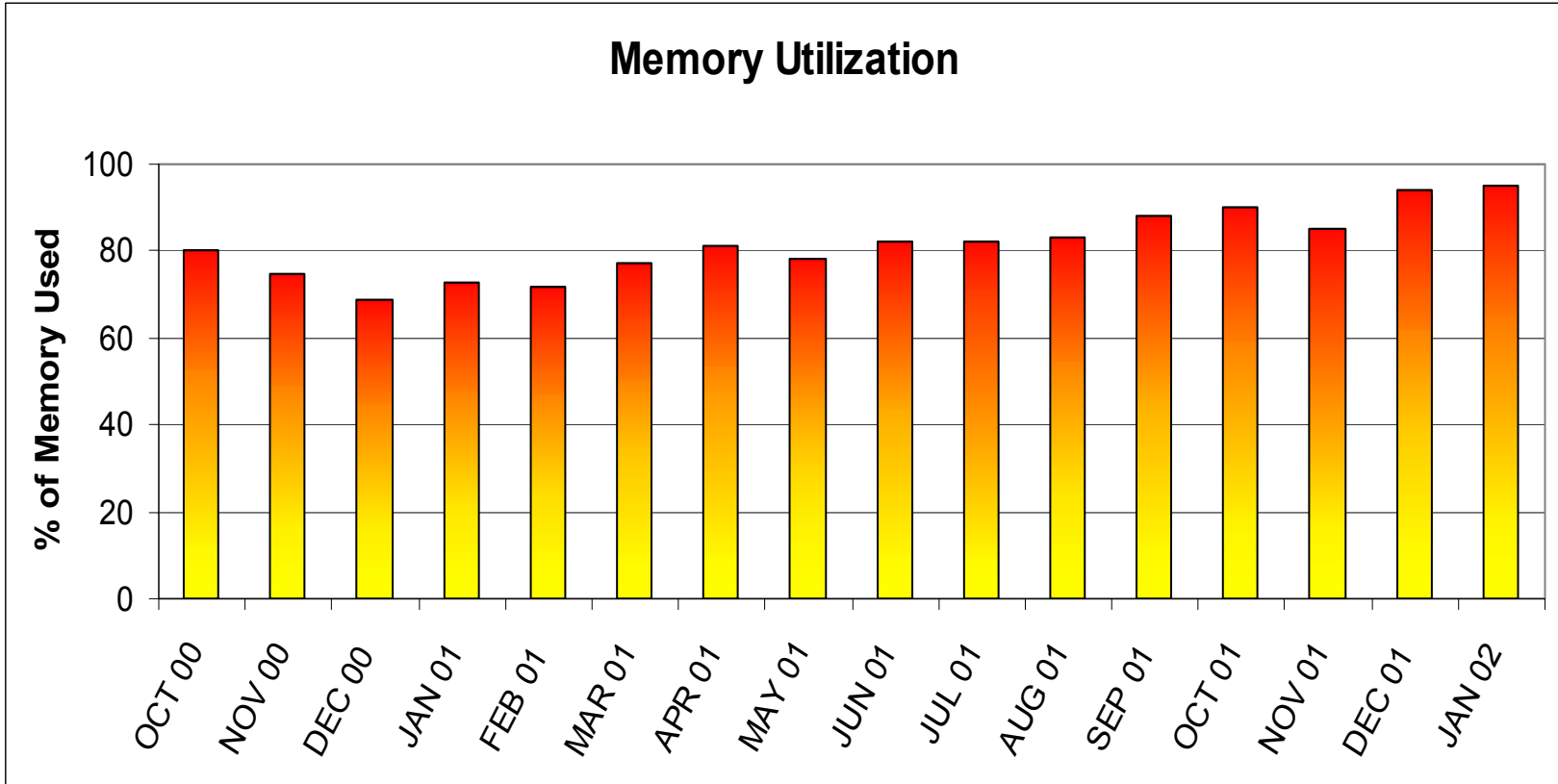
Memory – Thresholds

Used Memory %.....	95%
Free Memory %.....	5%
Deactivation Rate.....	0

Memory – Analysis Views



Memory – Trending



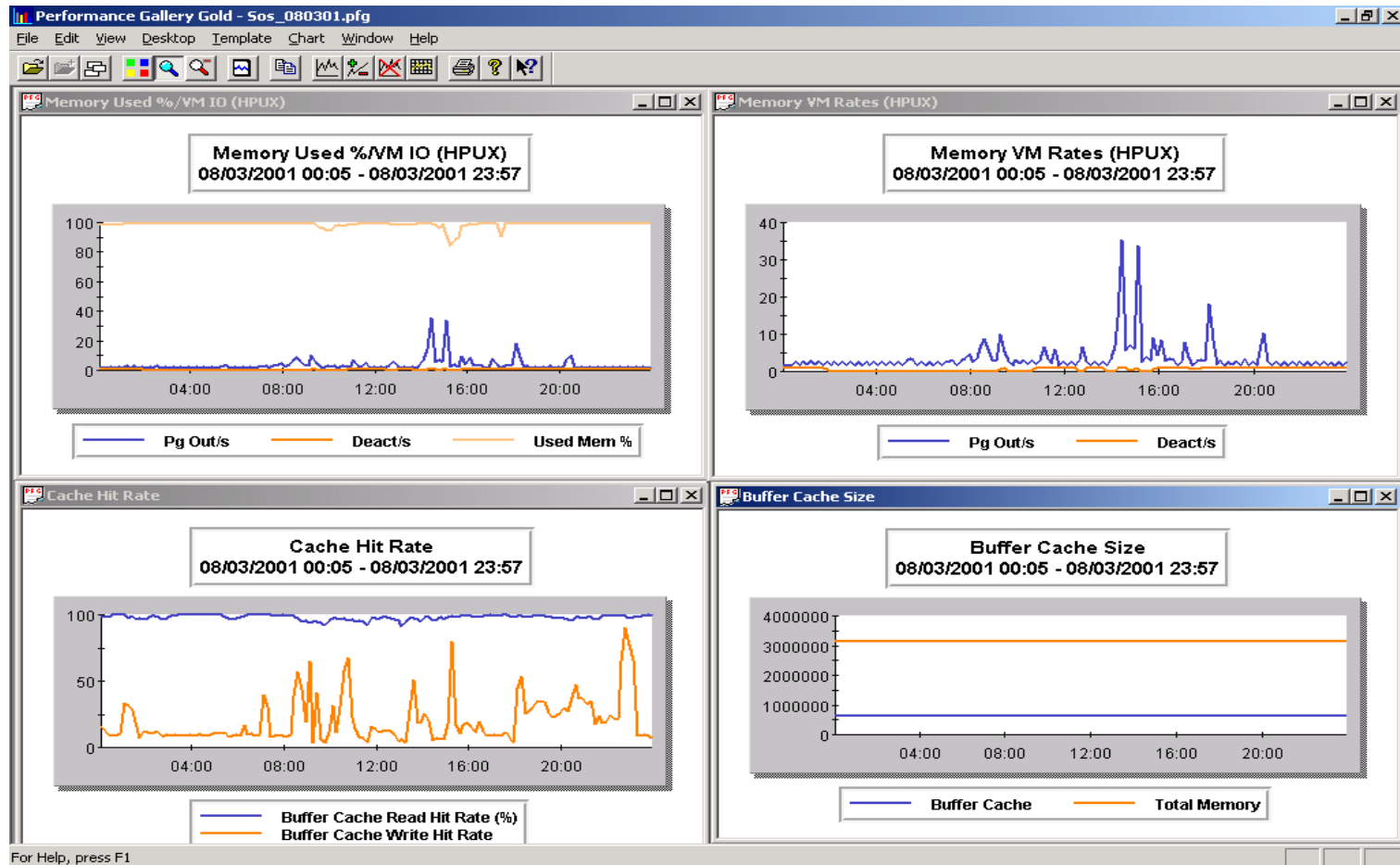
Memory – No Pressure



Memory – Minimal Pressure



Memory – Excessive Pressure



Disk

- Metrics
- Buffer Cache
- Metric Thresholds
- Analysis Desktops
- Threshold Filtering
- Trending

Disk – Metrics

General	I/O Rates
Queue Length	Logical I/O (FS)
Wait Times	Physical I/O
Service Times	User I/O (FS)
Utilization %	Raw I/O
Buffer Cache Hit Rate %	VM I/O
	System I/O

Disk –

Metrics Global I/O Detail

SOS B.01y eagle		WED, 30 JAN 2002, 08:49				E: 00:25:56		I: 00:02	
----- GLOBAL I/O DETAIL -----									
				Rate (/s)		Avg Size (kb)			
		Reads	Writes	Read	Write	Read	Write		
Local	Logical	28	0	14.0	0	<k	0		
		[10258]	[90]	[6.6]	[0.1]	[<k]	[<k]		
	Physical	0	9	0	4.5	0	3		
		[7]	[807]	[0]	[0.5]	[8]	[4]		
	User FS	0	0	0	0	0	0		
		[3]	[10]	[0]	[0]	[5]	[4]		
	Sys FS	0	9	0	4.5	0	3		
		[0]	[791]	[0]	[0.5]	[0]	[4]		
	Virt Mem	0	0	0	0	0	0		
		[4]	[6]	[0]	[0]	[11]	[4]		
	Raw	0	0	0	0	0	0		
		[0]	[0]	[0]	[0]	[0]	[0]		
Remote	Logical	0	0	0	0	0	0		
		[7251]	[144k]	[4.7]	[93]	[9]	[<k]		
	Physical	1	192	0.5	96.0	1	<		
		[351]	[9067]	[0.2]	[5.8]	[<k]	[<]		
Enter command:									
UPDATE		RESET		SCREEN		HELP			
MORE		FREEZE		PRINT		EXIT			

Disk – Summary Screen

SOS B.01y eagle WED, 30 JAN 2002, 08:49 E: 00:25:56 I: 00:02

----- DISK I/O SUMMARY -----

Dev	I/O%	Qlen	Util%	Wait Time(ms)	Service Time(ms)	Rates (/s)		Avg Size(kb)	
						Read	Write	Read	Write
c0t6d0	0	0	0	0	0	0	0	0	0
c0t2d0	0	0	0	0	0	0	0	0	0
c0t5d0	100	0	3.9	0	8.6	0	4.5	0	3
TOTALS	100	0	1.3	0	8.6	0	4.5	0	3

Enter command:

UPDATE

RESET

SCREEN

HELP

MORE

FREEZE

PRINT

EXIT

Disk – Buffer Cache

- A pool of buffers in memory to maintain data in memory to avoid disk access
- Fixed vs. Dynamic (default)
- Default Kernel Parameters
 - `bufpages = 0`
 - `dbc_min_pct = 5`
 - `dbc_max_pct = 50`

Disk –

Buffer Cache Physical Disk I/O

Physical Disk Read =
User (FS) Read +
Raw Read +
VM Read +
System Read

Physical Disk Write =
User (FS) Write +
Raw Write +
VM Write +
System Write

Disk –

**Buffer Cache
Hit Rate**

Buffer Cache Hit Rate %

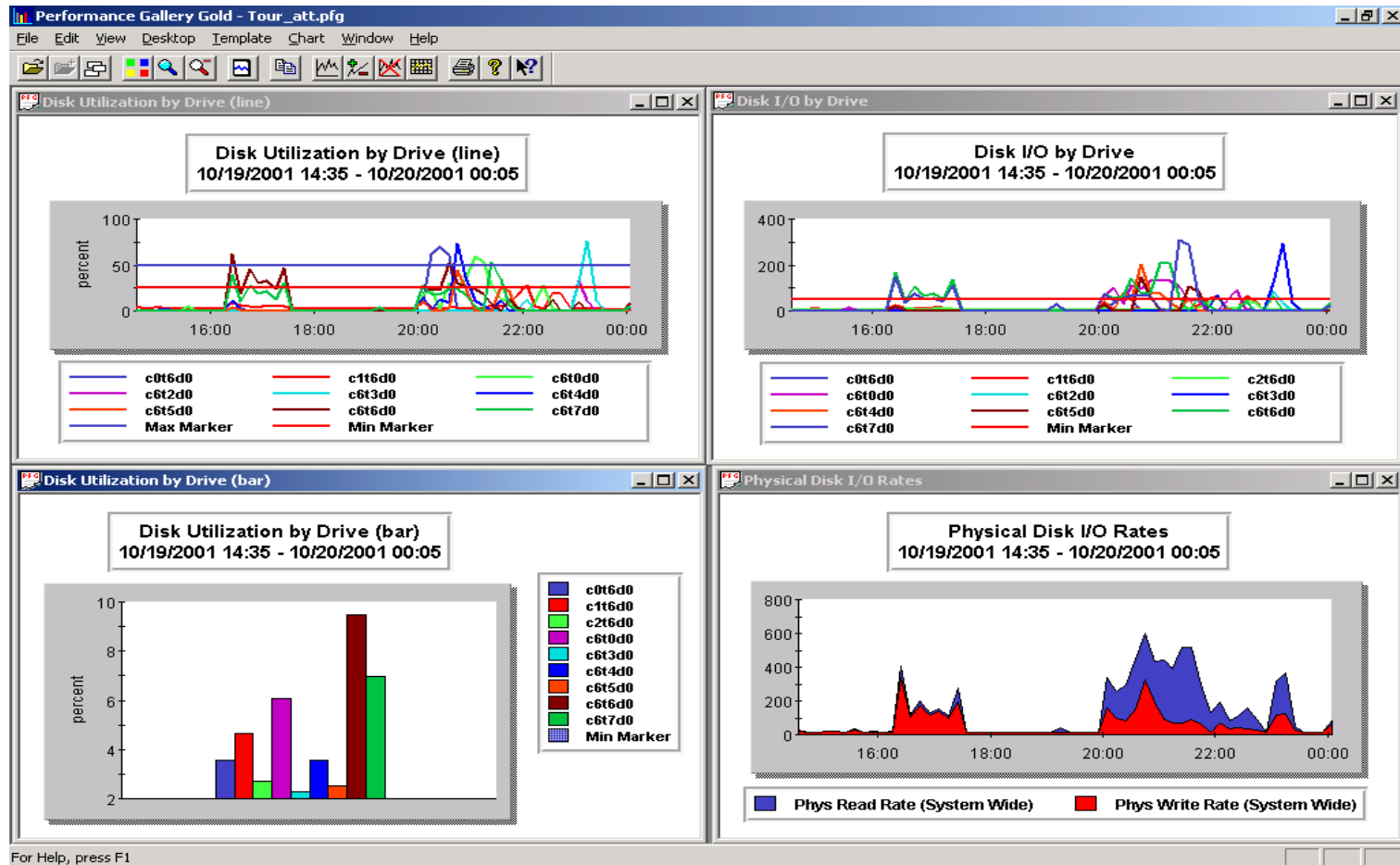
$$= \frac{\text{Logical Reads} - \text{Physical Reads}}{\text{Logical Reads}} * 100$$

$$= \frac{\text{Logical Rd Rate} - \text{User Rd Rate}}{\text{Logical Rd Rate}} * 100$$

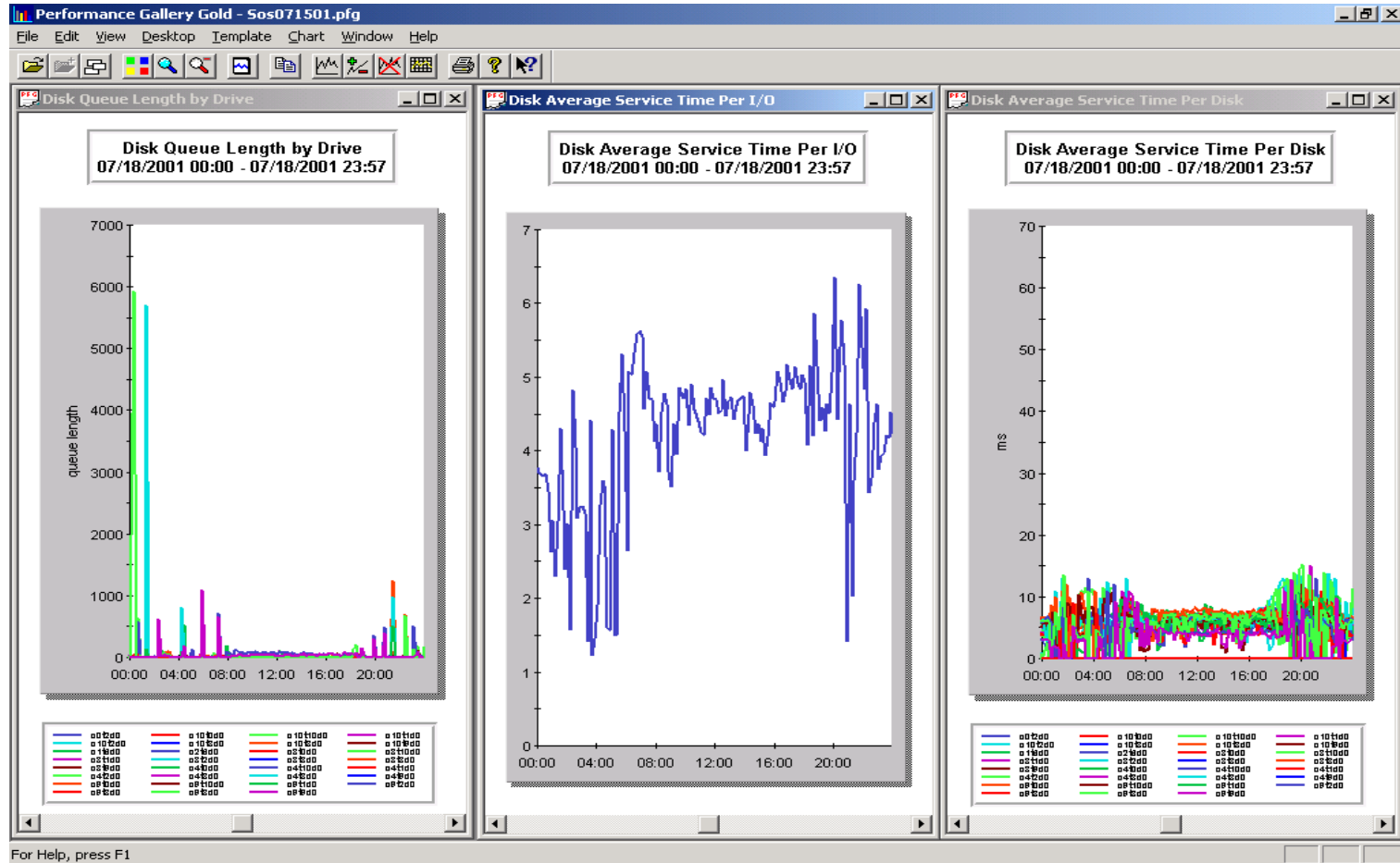
Disk – Thresholds

Disk Utilization %.....	25-50%
Buffer Cache Hit Rate %.....	90-95%
Disk Queue Length.....	3

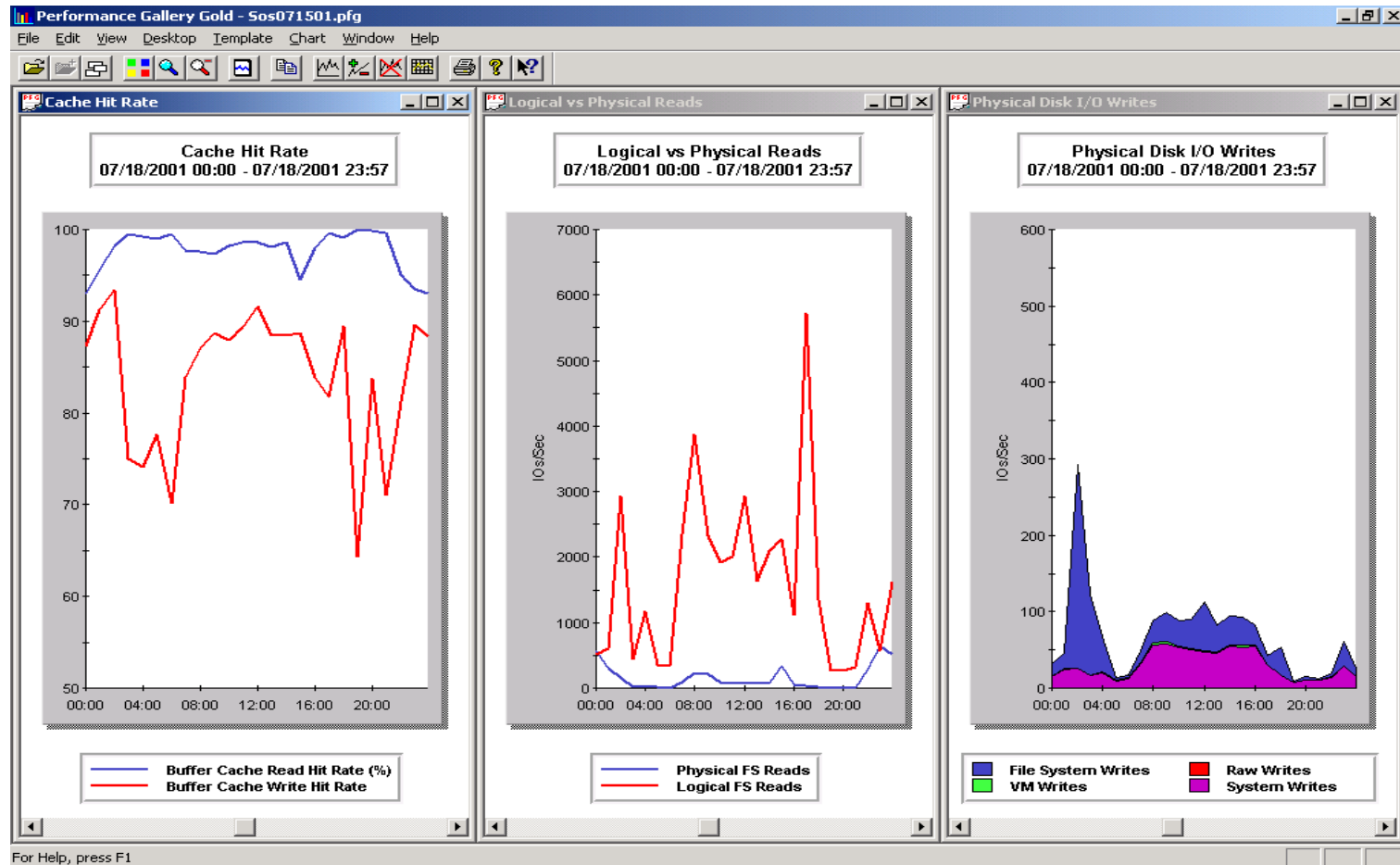
Disk – Analysis Views



Disk – Analysis Views

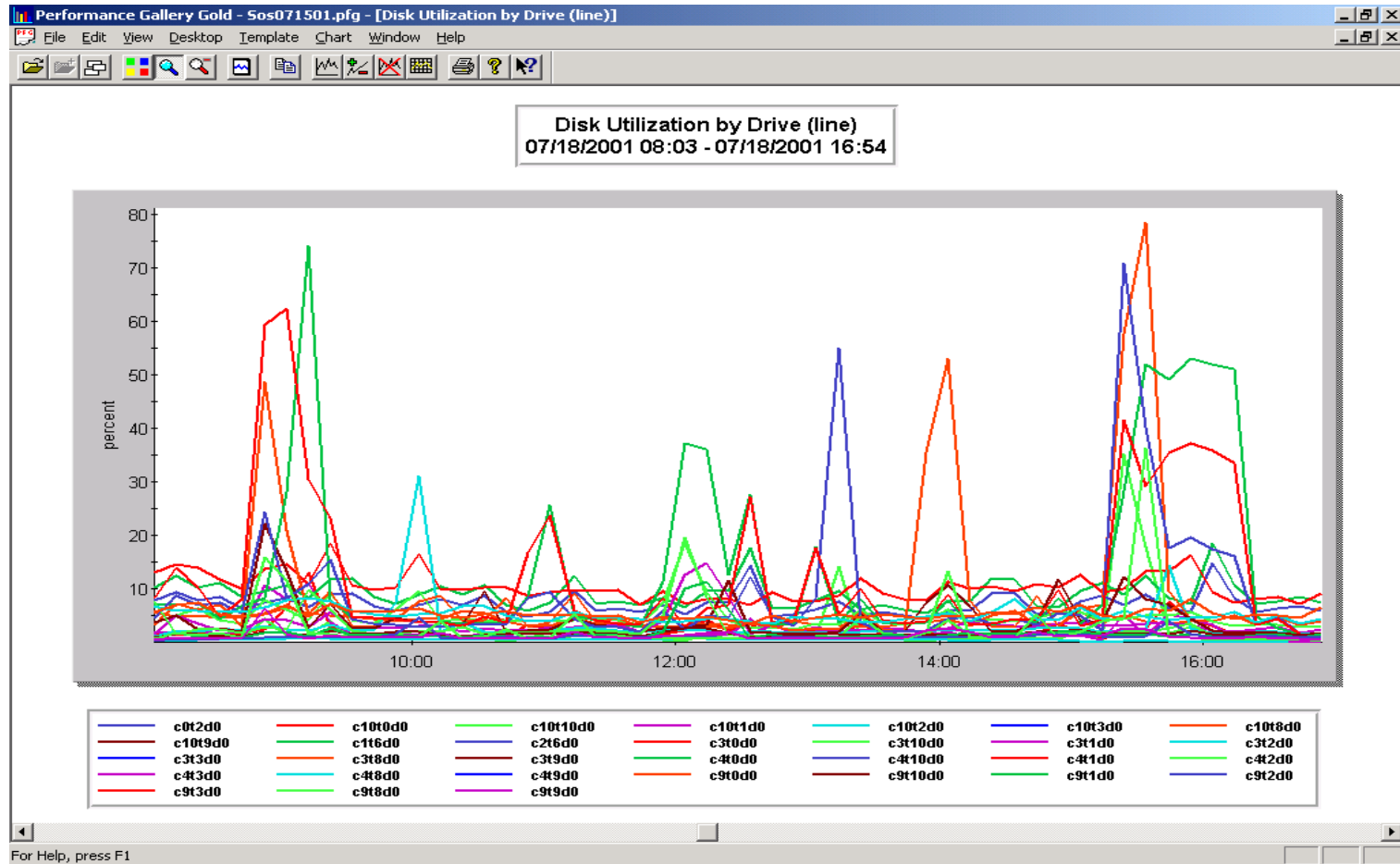


Disk – Analysis Views



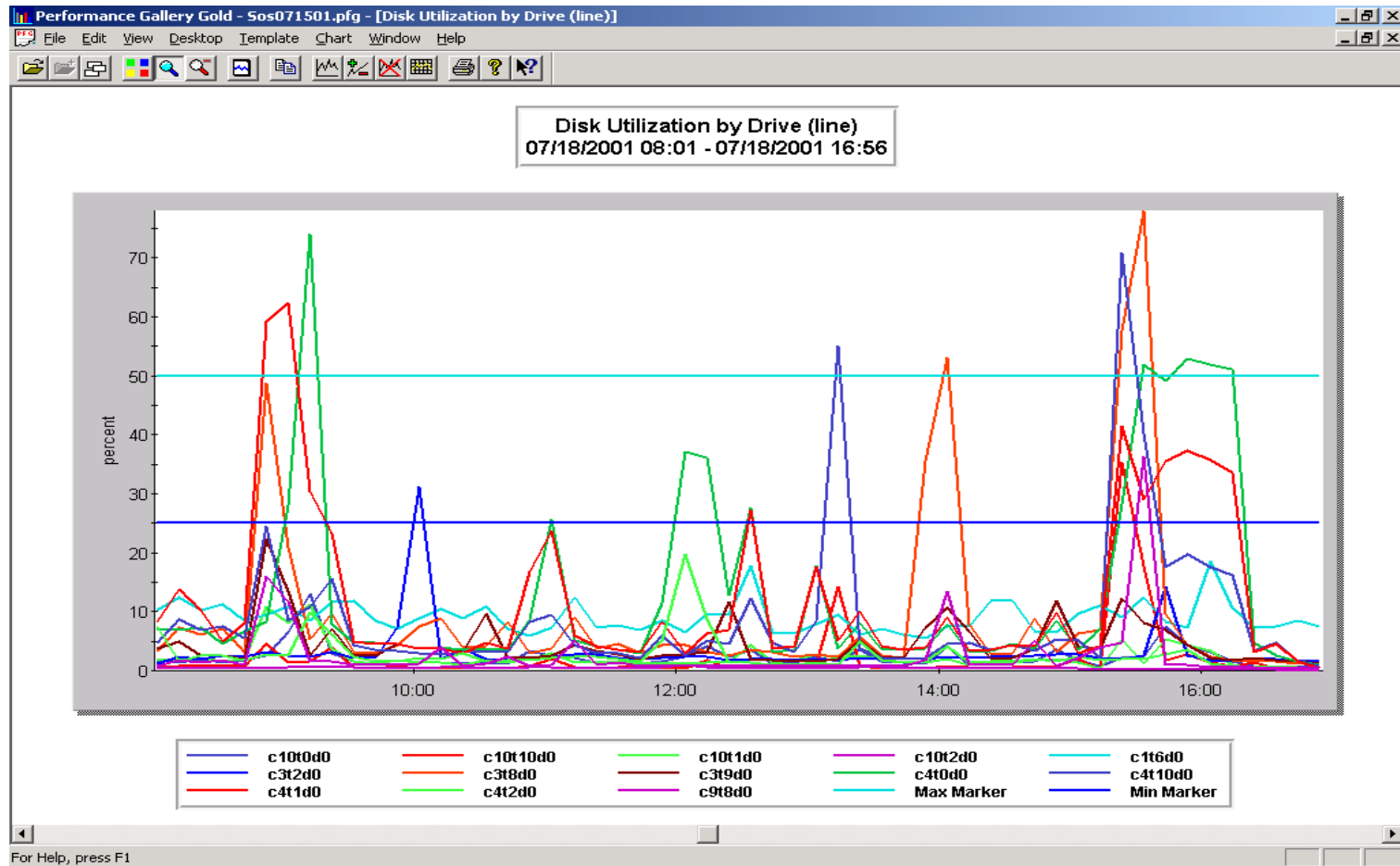
Disk –

Threshold Filtering Before Filter



Disk –

Threshold Filtering After Filter



Disk – Threshold Filtering

Location In Lund's Performance Gallery Gold to filter data by threshold settings

The screenshot shows the 'Template Properties' dialog box with the 'Thresholds' tab selected. The 'Name' field is 'Disk Utilization by Drive (line)' and the 'Validate' checkbox is checked. The 'General' tab is also visible. The 'Maximum' section has 'Enable Threshold' checked, 'Drop sets always above' unchecked, 'Add as a data set' checked, and a 'Value' of 50.000. The 'Minimum' section has 'Enable Threshold' checked, 'Drop sets always below' checked, 'Add as a data set' checked, and a 'Value' of 25.000. On the right side, there are buttons for 'New', 'Rename', 'Apply', 'Save', 'Save as...', 'Delete', 'Open Chart', 'Help', and 'Close'.

Template Properties

Name: Disk Utilization by Drive (line) ☒ Validate

General Graph Table **Thresholds** Data Links

Maximum

☒ Enable Threshold

☐ Drop sets always above Value:

☒ Add as a data set 50.000

Minimum

☒ Enable Threshold

☒ Drop sets always below Value:

☒ Add as a data set 25.000

New

Rename

Apply

Save

Save as...

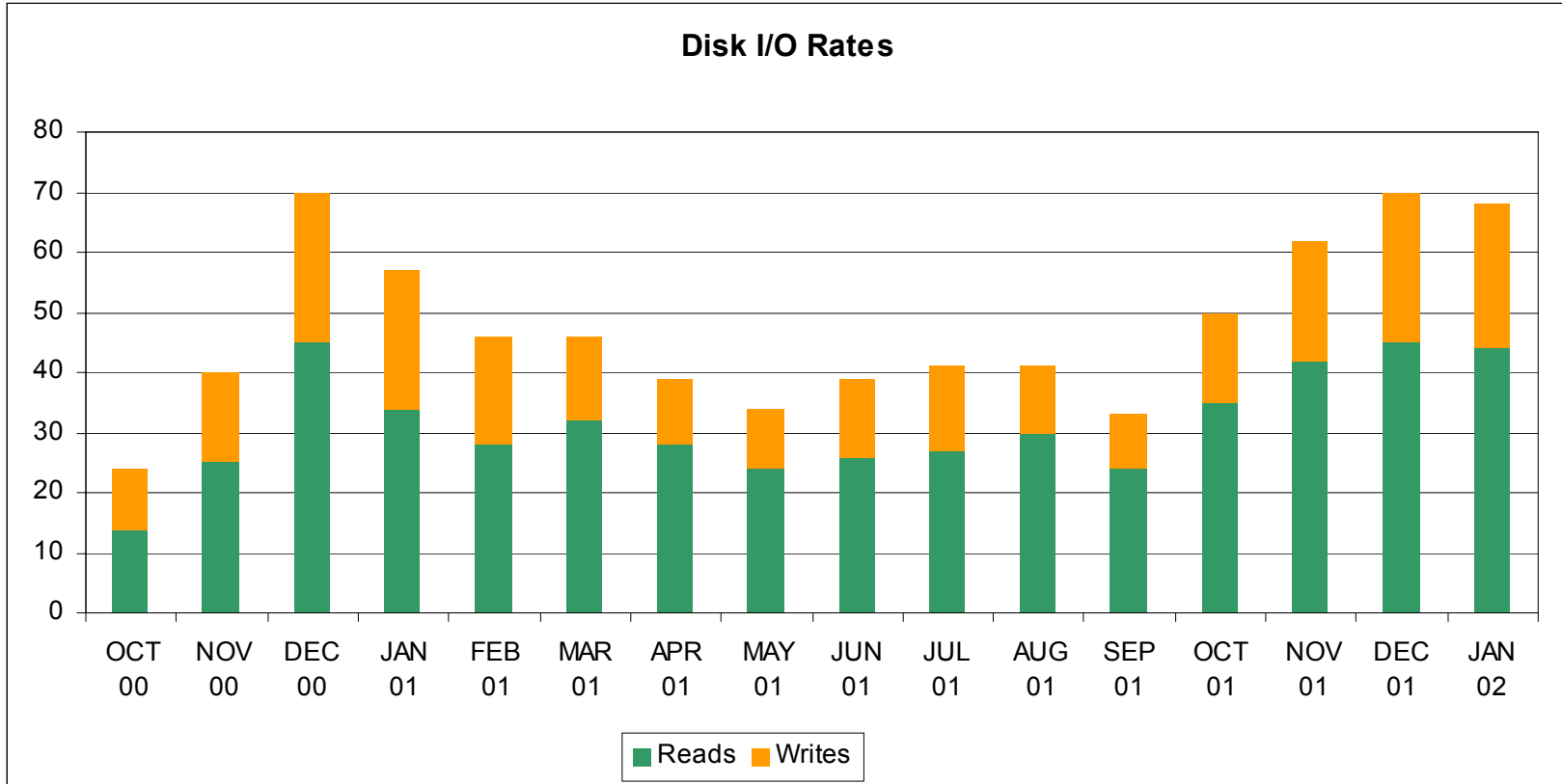
Delete

Open Chart

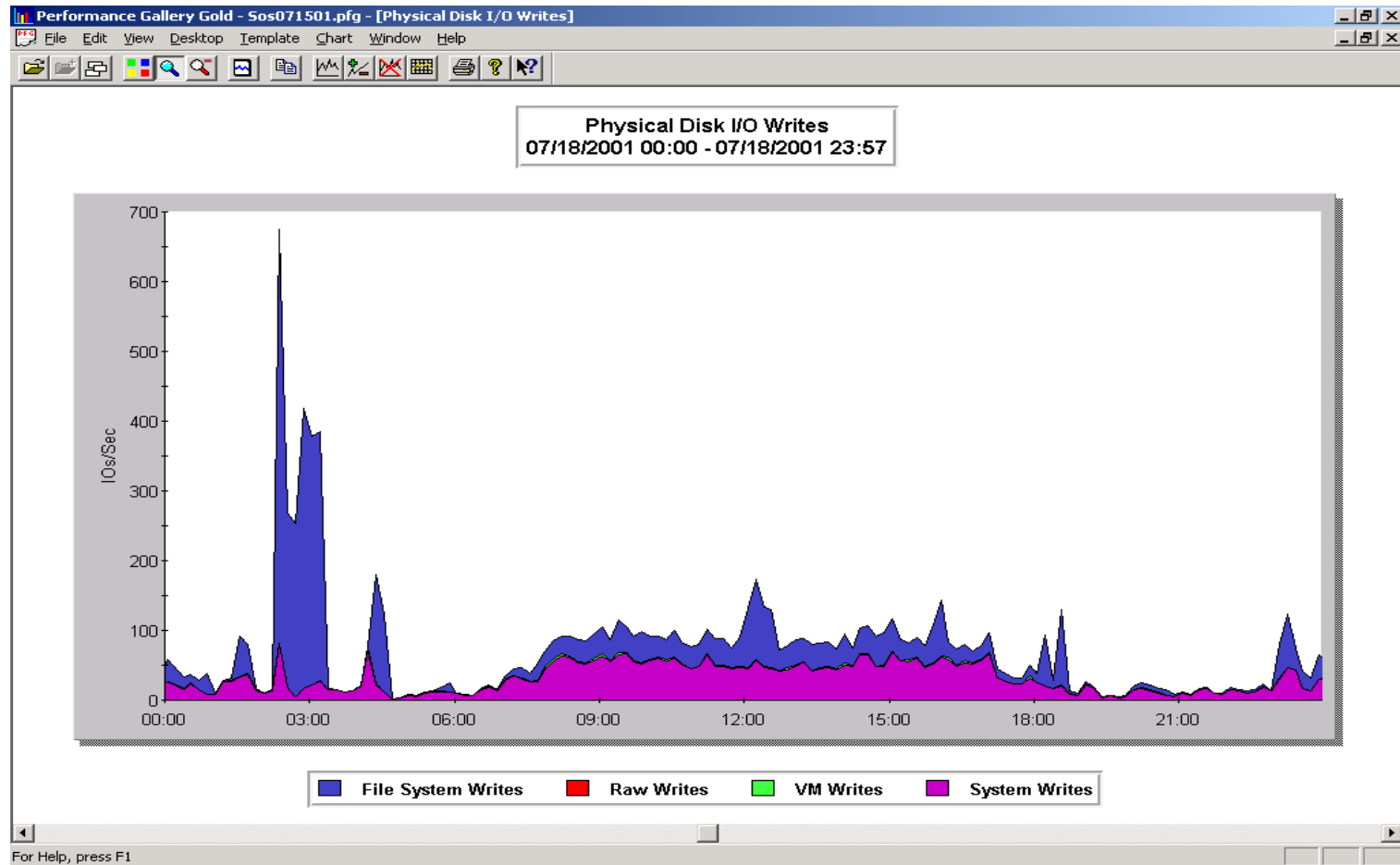
Help

Close

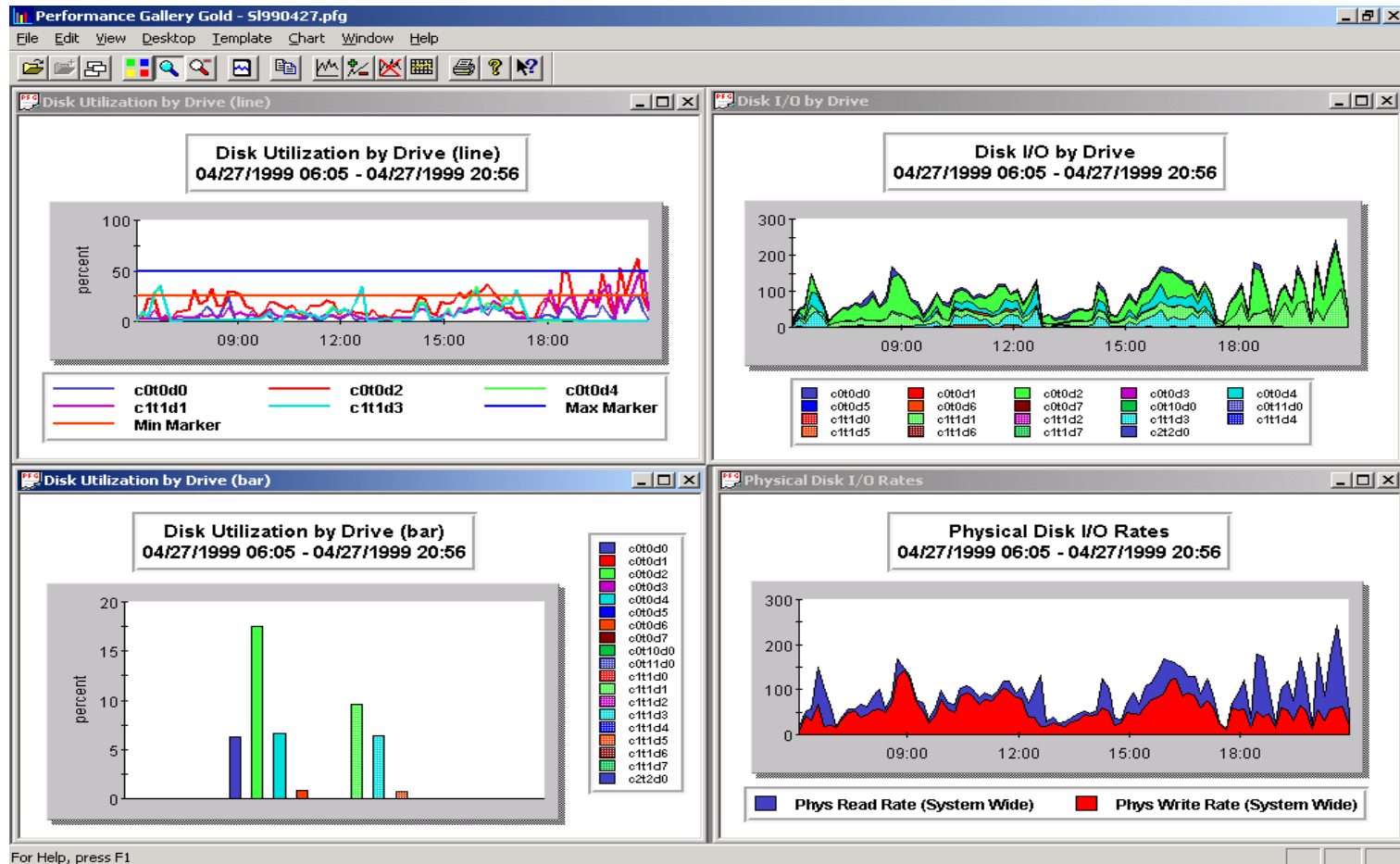
Disk – Trending



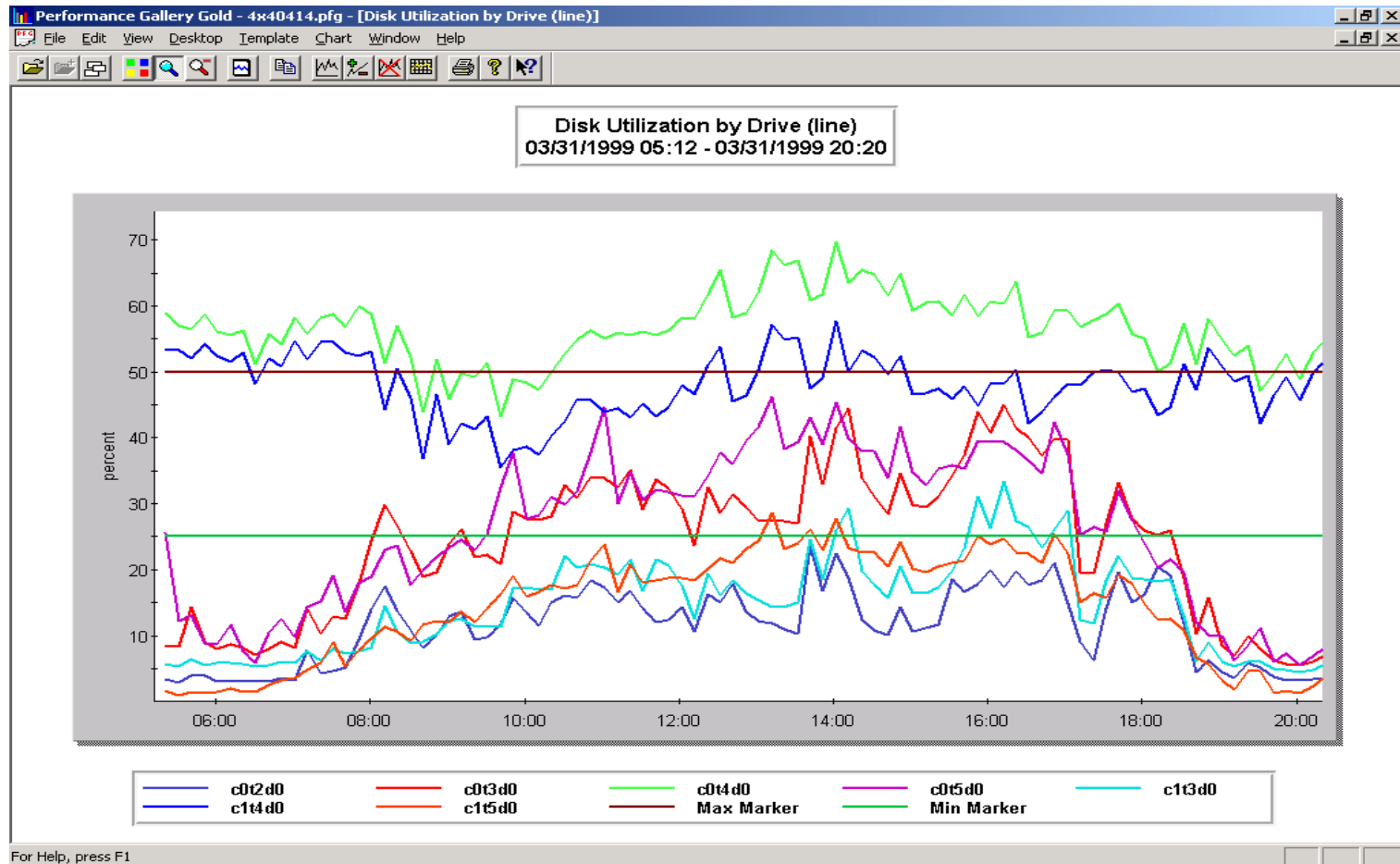
Disk – File System I/O



Disk – Reasonable Utilization



Disk – Excessive Utilization



Network

- Metrics
- Metric Thresholds
- Analysis Desktops

Network – Metrics

- TCP packets in & out
- UDP packets in & out
- Collisions
- Errors

Network – Summary Screen

SOS B.01y eagle WED, 30 JAN 2002, 08:50 E: 00:26:56 I: 00:59

NETWORK SUMMARY								
Protocol	Packets In/s		Packets Out/s		Errors In%		Errors Out%	
IP	6.0[	13]	15.5[	32]	0[	0]	0[	0]
TCP/IP	5.5[	7]	14.9[	25]	0[	0]	0.91[	0.65]
ICMP	<[	<]	0[	0]	0[	0]	0[	0]
UDP	0.5[	6]	0.5[	6]	0[	0]	N/A[	N/A]

NETWORK INTERFACES								
Interface	Packets	In/s	Packets	Out/s	Collision%	Error	In%	Error Out%
lan0	6.0[	13]	15.5[	60]	0[0.68]	0[	0]	0[0]
lo0	0[	0]	0[	0]	0[0]	0[	0]	0[0]
TOTALS	6.0[	13]	15.5[	60]	0[0.68]	0[	0]	0[0]

Enter command:

UPDATE

RESET

SCREEN

HELP

MORE

FREEZE

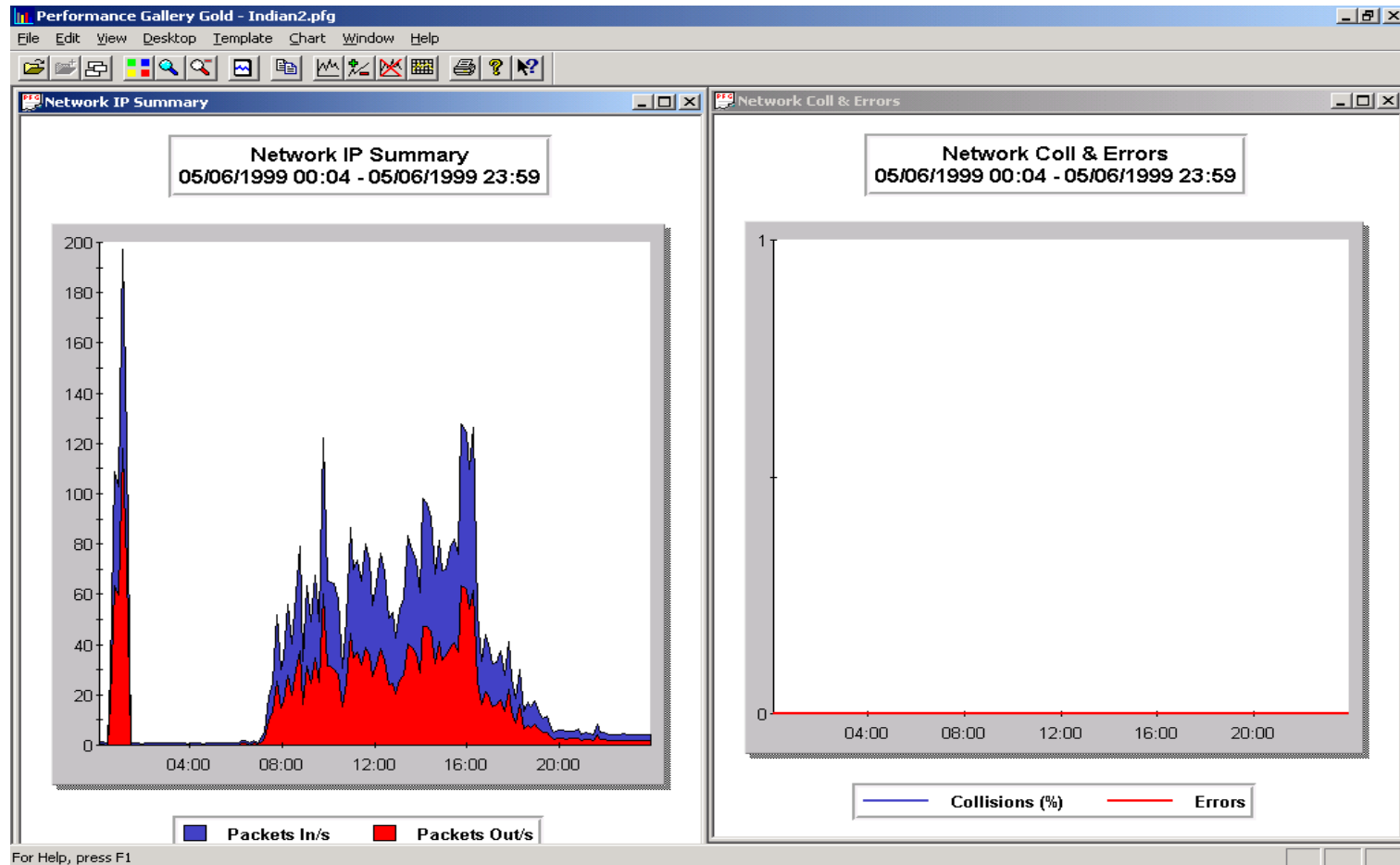
PRINT

EXIT

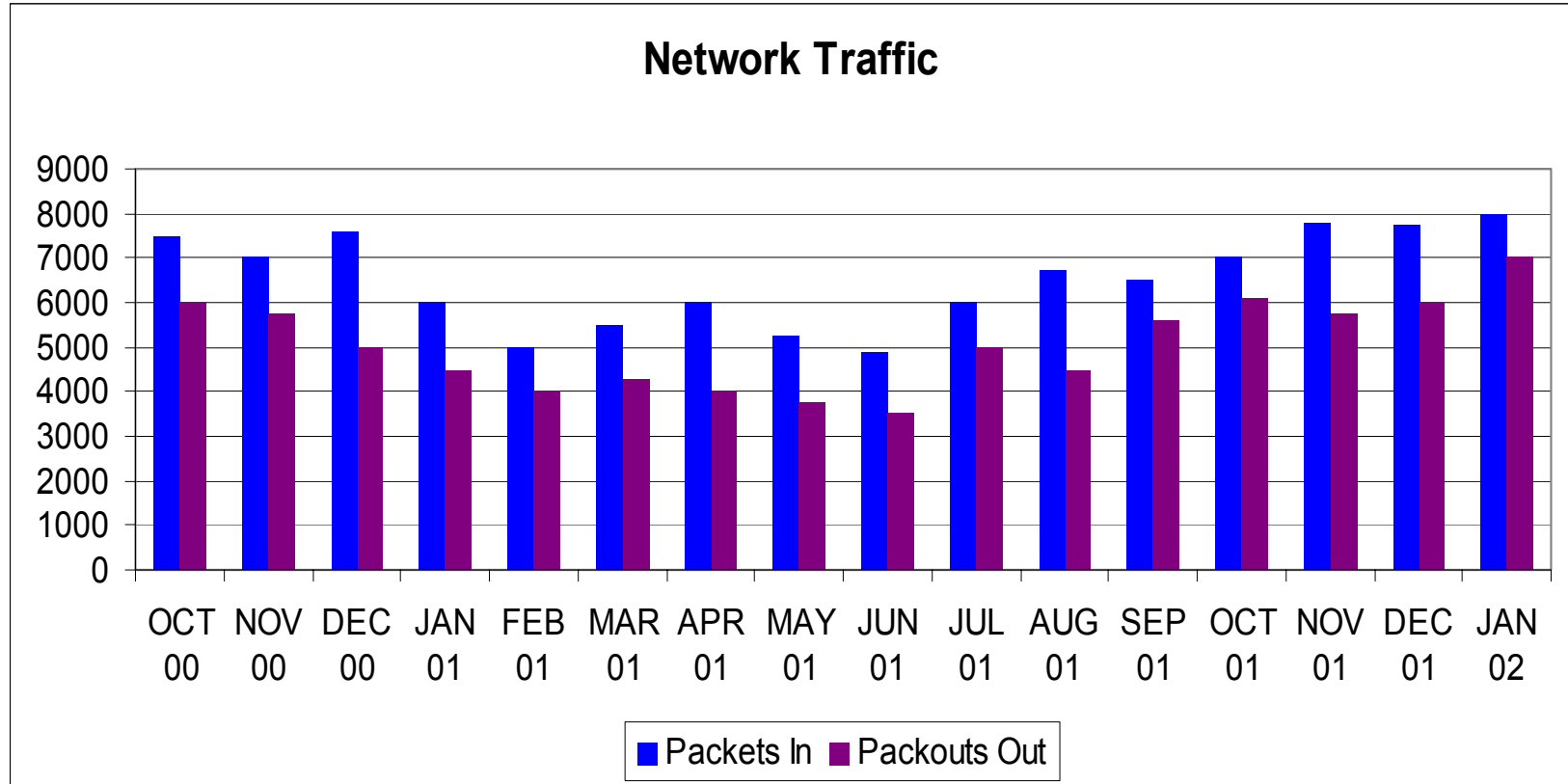
Network – Thresholds

Collisions %.....	10%
Errors	0

Network – Analysis Views



Network – Trending



UNIX Performance (in review)

- Perform analysis on a regular schedule
- You must know what *normal* is, in order to recognize a problem
- Resolve each pressure symptom as it is identified to maintain good performance
- Develop a standard method of reporting

Questions and Answers