

**Software Test
& Performance**
CONFERENCE

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Bellwether metrics for diagnosing performance bottlenecks



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Objectives

➤ ***Help you identify key resource metrics that help diagnose performance bottlenecks***

➤ ***Target audience***

➤ ***Performance testers***

➤ **Acknowledgements:**

➤ The attendees of WOPR12* contributed content to this presentation:

Henry Amistadi

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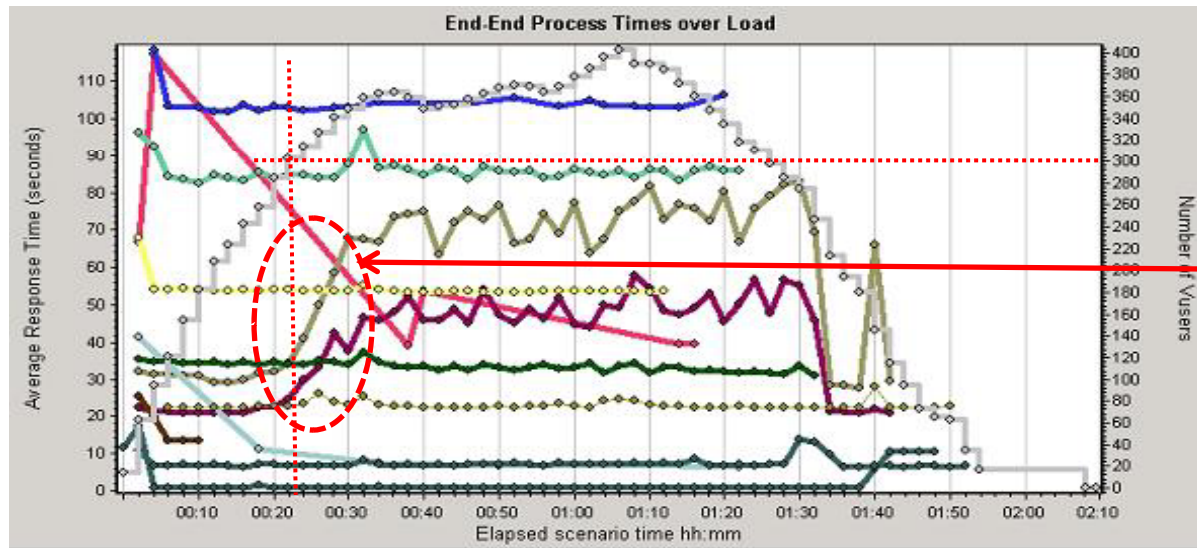
Roland Stens

Nick Wolf

What does a bottleneck look like?

- **At the system level**
 - Poorly scaling processes/pages/transactions
 - Throughput plateaus while load is still ramping (bandwidth, page view rate, completed transactions)
- **At the tier level**
 - Key resource saturation (cpu, jvm heap size)
 - Key resource **under**-utilization (cpu)
 - Ineffective load balancing
 - Queuing growth (http requests, IO queue length, app queues)
 - Errors (http 500s, system events, DB deadlocks)
- **At the component level**
 - Maxed http connections, slow DB query, lock waits on key table,...

Scalability over Load

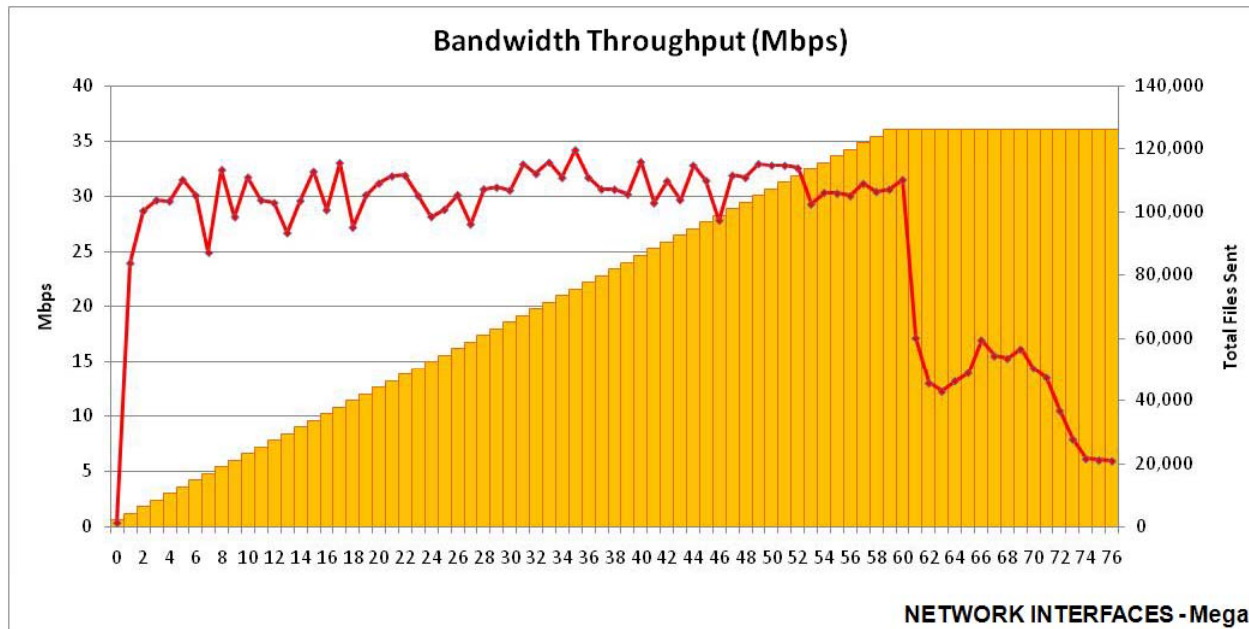


Two transactions degrade significantly above 300 concurrent users

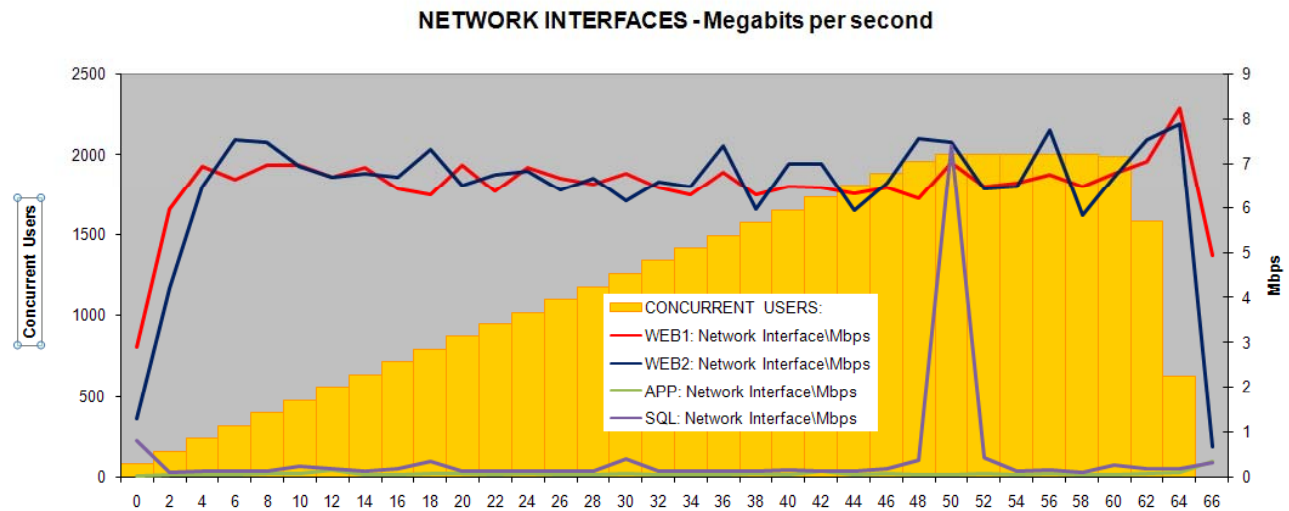
6 transactions miss their target averages, one significantly

Measurement	Min.	Ave.	Max.	90 th %	Target Avg	Delta vs. Avg
CON1_add_entitlements	2.1	2.6	4.1	3.1	2.0	(0.6)
CON2_end_end	38.8	61.5	165.3	142.3	120.0	58.5
CUS1_04_sel_form_sgcustmstr ¹	3.8	7.1	49.9	10.7	5.0	(2.1)
CUS1_05_search_by_namezip	0.5	1.8	39.7	7.4	5.0	3.2
CUS2_07_input_cust_data	3.7	8.2	33.6	33.4	5.0	(3.2)
CUS2_end_end	6.0	13.4	49.0	45.6	60.0	46.6
SAL4_04_view_openopp	0.9	2.3	8.6	6.1	10.0	7.7
SAL4_05_sel_opportunity	1.5	4.7	16.2	13.7	0.5	(4.2)
SVC3_04_sel_form_dispatchcenter	91.3	158.6	304.2	277.3	26.0	(132.6)
SVC6_07_submit_charge2	0.4	0.6	6.5	0.6	50.0	49.4
SVC2_assisted_search	2.2	2.4	5.0	2.5	2.0	(0.4)

Bandwidth Throughput over Load



Bandwidth plateaus early while load still ramping



What do we measure to find them?

- **System**
 - Throughput (bandwidth, transactions completed, page view rate)
- **HW Component**
 - CPU (% total, load avg), IO (% busy, storage iops), memory (available, paging), queue depths (cpu, disk), load balancing
- **SW Component**
 - Web service (connections, queued requests, req. wait time, http 500s)
 - App services (jvm heap memory, db connection pools,
 - DBMS
 - Network
- **Network**
 - Total mbps vs capacity of each link
 - Packet retransmits
 - Latency due to dynamic internet routing

With what tools?

Component	Metrics	Tool	OS	Cost	Pluses	Minuses
Server HW	cpu, memory, IO, queue length, NIC bw	perfmon	Win	free	Export to csv	
		sar	Unix	free		non-csv format
		prstat	Unix	free		non-csv format
		dtsat	Unix	free	Adds t csv export	requires python
Web Services	connections, queued requests, errors	perfmon	Win	free		
Java Virtual Machine	heap memory, garbage collection, threads	<u>Jconsole</u>	Both	free	Latest version enables csv export	Requires JDK6 & configuring app jvm port
Java Messaging	MQ queues	<u>Hermes JMS</u>	Both	free		
Application Servers	DB Connection Pool	Consoles for WebLogic, WebSphere, JBOSS...				
DBMS-SQL Server	locking, Table scans, AQL compilation	perfmon	Win	free		
DBMS-Oracle	Slow queries, deadlocks, lock waits	<u>AWR</u>	Both	free		10g; earlier versions, statspack
		Perfmon	Win	free		Requires installing Oracle client libraries
EMC SAN	IOPS, bandwidth	<u>Navisphere Analyzer</u>	Win	\$\$\$	Exports to csv	
All-Integrated	Many	LoadRunner	Win	\$\$\$\$		Limited points; unstable under heavy load
Network	tcp & http traffic	<u>wireshark</u>	Win	free		
	tcp & http traffic	<u>network observer</u>	Win	\$\$		
	http traffic	<u>fiddler</u>	Win	free		
	http headers visualizer	<u>livehttpheaders</u>	Win	free		

How do we use these tools?

- **Overhead considerations**
 - HW metrics are collected anyway; small incremental overhead to log
 - If high overhead, run monitoring tool on separate server
- **Sample how often?**
 - Minimum every 15 seconds for highly varying metrics (cpu, db locks, ...)
 - Every 1-2 minutes for slower-varying metrics (IOs, jvm heap)
- **Measure when?**
 - Start 15-30 minutes before test to establish steady-state
 - Stop 15-30 minutes after test, to assess recovery
- **How select, summarize & graph?**
 - Select metrics with any significant variation
 - Graph against load (2 y-axes) so can visually correlate resource to load
 - Scatter chart to see all spikes
 - Average over 1-2 minute intervals
 - For $SD > 2$, compute 90th percentile

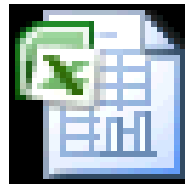
Bellwether metrics

- **Load!**
 - Concurrent sessions, files / messages transmitted,...
 - Graph all metrics against load to get visual correlation
- **Bandwidth utilization**
 - Healthy system usually shows bandwidth following load profile
 - Measure at load-driving point, and at web server NICs
- **Server cpu**
 - % Total (Win), 100 - % idle (Unix); tells you if server is cpu-bound
- **Queue lengths**
 - CPU queue; tells you if server may be in IO wait state
 - Avg Disk queue; tells you if disk IO is backed up

Bellwether metrics – cont.

- **Web server**
 - Active connections / threads
 - Queued requests
 - cpu on all servers if load balanced
 - http 5xx errors!
- **DB Servers**
 - Full table scans
 - SQL Compilations
 - Lock waits
 - Deadlocks
- **App Servers**
 - JVM heap memory / garbage collection
 - DB connection pools

Examples



Microsoft Office
Excel 97-2003 Worksheet

Graphical Analysis Tools

Tool	OS	Cost	Pluses	Minuses
Excel	Win	\$	Summarization function (pivot table) and graphing options	
<u>Performance Analysis of Logs (PAL)</u>	Win	free		
<u>Tableau</u>	Win	\$\$	Advanced charting and chart comparion	
<u>Panorama</u>	Both	\$\$\$		Requires SQL Server or Oracle
LoadRunner Analysis	Win	\$\$\$\$	Works well with LR-captured metrcis	External monitor log import is limited

Distillations from WOPR12

- **Assess app bandwidth vs. capacity *before you even plan a test***
 - Analysis of a wireshark capture can reveal much about overall system throughput (don't even need access to the app for this)
 - Response Time = (Payload size / bandwidth) + Application turns time + server time + client time
- **Take a DBA (sysadmin, network engineer) to lunch!**
 - Determine what to measure through informal chats
 - Enroll their participation in analysis
- **Start your monitors well before running a test**
 - Quantify idle state, ID other active processes/users
- **Compare measurements to max capacities of key hardware to ID maxed components**
 - Internet connection, switches, network interfaces, IO subsystem
- **Perfmon can be used to monitor Oracle!**
 - Install Oracle client libraries and use configure (see Appendix)

Distillations from WOPR12 – cont.

- **Sample at appropriate granularity**
 - Else risk “missing” key spike activity
- **Use scatter charts to see *all* spikes**
 - Averaging will hide significant variations
- **Don’t rely on a single metric for diagnosis**
 - Find corroborating measurements before developing hypothesis
- **Graph like metrics with different amplitudes on separate scales**
 - A single scale may obscure variations of the lower amplitude items
- **Beware of measurements on virtual machines**
 - Depending on VM OS, metrics may be server-wide vs. *your* VM
- **Monitor your injectors!**
 - Make sure the bottleneck is not in your load drivers

Resources

- **Appendix: Performance Resource Monitoring Examples.xls**
- **On cpu queue length**
<http://technet.microsoft.com/en-us/library/cc940375.aspx>
http://www.metron-athene.com/reference/performance_tips/unix/unix_tip07.html
- **On context switching**
http://en.wikipedia.org/wiki/Context_switch
http://www.linfo.org/context_switch.html
<http://technet.microsoft.com/en-us/library/cc938606.aspx>
- **On monitoring overhead**
<http://windowsitpro.com/Windows/Articles/ArticleID/500/pg/2/2.html>
- **On monitoring databases with perfmon**
<http://www.daschmelzer.com/cm2006/PDFs/097.pdf>
- **On common resource bottlenecks**
STP Mag Article 12/04 issue, *Bottlenecks Exposed*
- **White Papers on performance testing**
http://mentora.com/kb_papers.asp

Questions?

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