CDI COMPUTER DESIGN & INTEGRATION LLC

VIRTUAL DESKTOP (VDI) PERFORMANCE TROUBLESHOOTING

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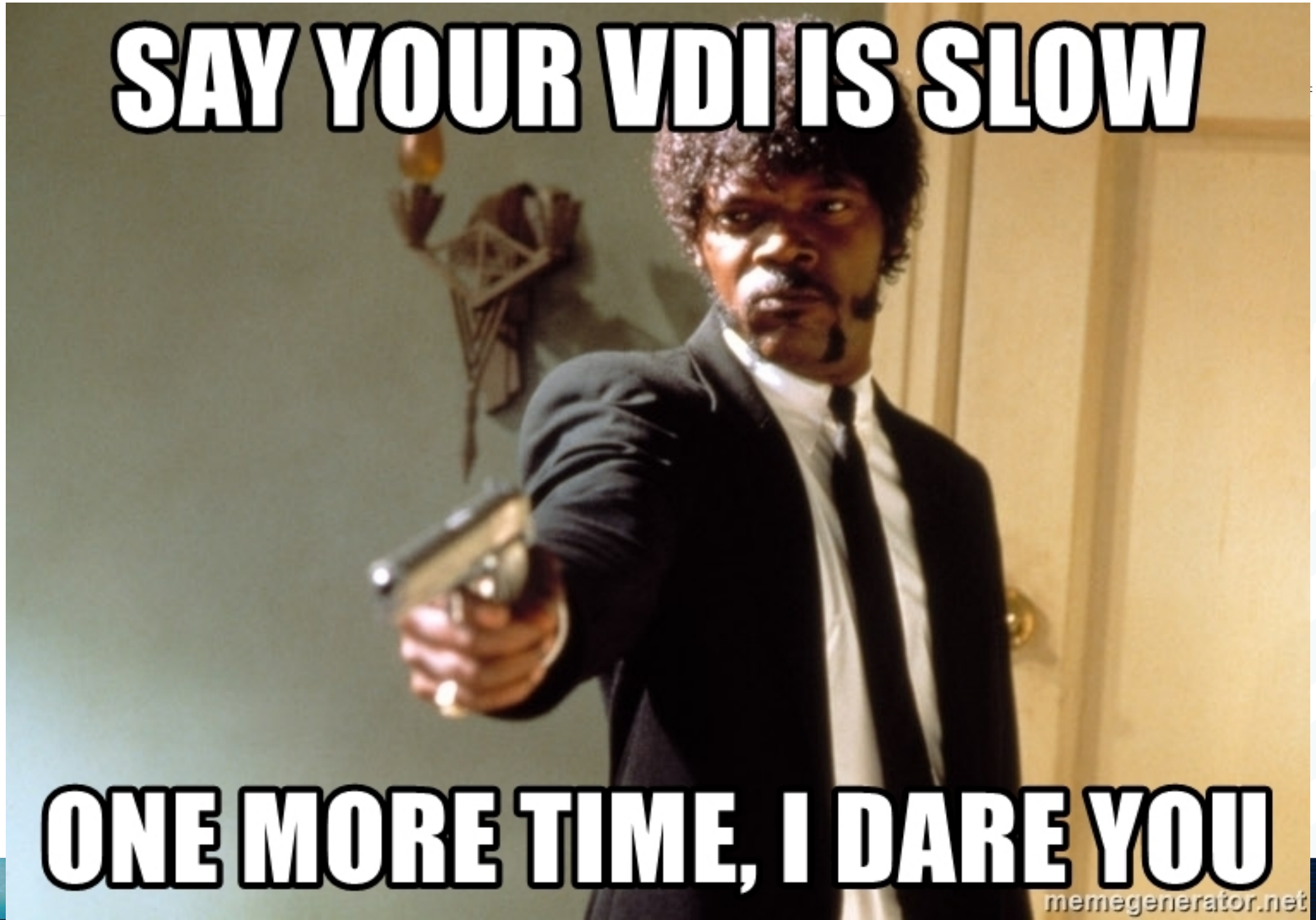
SAY YOUR VDI IS SLOW
ONE MORE TIME, I DARE YOU
memegenerator.net

AGENDA

- Perception of Performance
- Types of Virtual Computers
- Performance monitoring and analysis tools
- User experience components
- Common Solutions

PERCEPTION OF PERFORMANCE

1. How do we perceive performance?
   - How long does it take to boot the computer?
   - How long it takes to login?
   - How responsive are drop-down menus like Start menu?
   - How fast do applications start?
   - How responsive are letters being typed in word processor?
   - How fast is scrolling in documents?
   - Does video run choppy or smooth?
   - Are there any freezes in applications?
2. Whitepaper: Performance improvement only noticeable when on technical side we change something by 20% or better.

TYPES OF VIRTUAL COMPUTERS

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1. Remote Desktop Services Host (RDSH)
    1. Very high maximum memory, typically 4-24 TB
    2. Typical memory 32 GB to 256 GB
    3. Storage Area Network (SAN) or Network Attached Storage (NAS), SSD or mechanical
    4. Multiple quad core processors, 3 GHz to 4 GHz
    5. All resources are shared between all users on the server
    6. VMware solutions – on-prem or custom in private cloud like CDI VDIaaS, Citrix, Microsoft
2. Virtual Desktop Infrastructure (VDI)
    1. High maximum memory – depends if Windows 7/10 client version or Server 2008/2016 skinned to look like Windows 7/10
    2. Typical memory 2 GB to 32 GB, sweet spot 8 GB
    3. Storage Area Network (SAN) or Network Attached Storage (NAS), SSD or mechanical
    4. Multiple quad core processors, 3 GHz to 4 GHz processors
    5. Typically 2-8 virtual processors configured
    6. All memory, CPU and hard drive performance and space dedicated to 1 user
    7. VMware solutions – on-prem or custom in private cloud like CDI VDIaaS, Citrix
3. Desktop as a Service (DaaS) – VMware Horizon Cloud DaaS, Amazon Workspaces, Microsoft WVD, smaller providers like Workspot, Nutanix Xi Frame.

VDI PERFORMANCE MONITORING AND ANALYSIS TOOLS

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1. VMware vRealize Operations for Horizon
    - Ongoing alerts, Blast protocol analysis superior
2. Liquidware Labs Stratusphere UX
    - First VDI user experience measurement tool on the market
3. Lakeside Systrack
    - VMware uses for assessments, can do Macs as well as PCs.
4. ControlUp
    - Cloud-based model
5. NexThink
    - Has user feedback module integrated
6. EG Innovations VDI Monitor
7. Goliath Performance Monitor for VMware Horizon
8. Windows Performance Monitor

MEASUREABLE USER EXPERIENCE METRICS – FRONT-END

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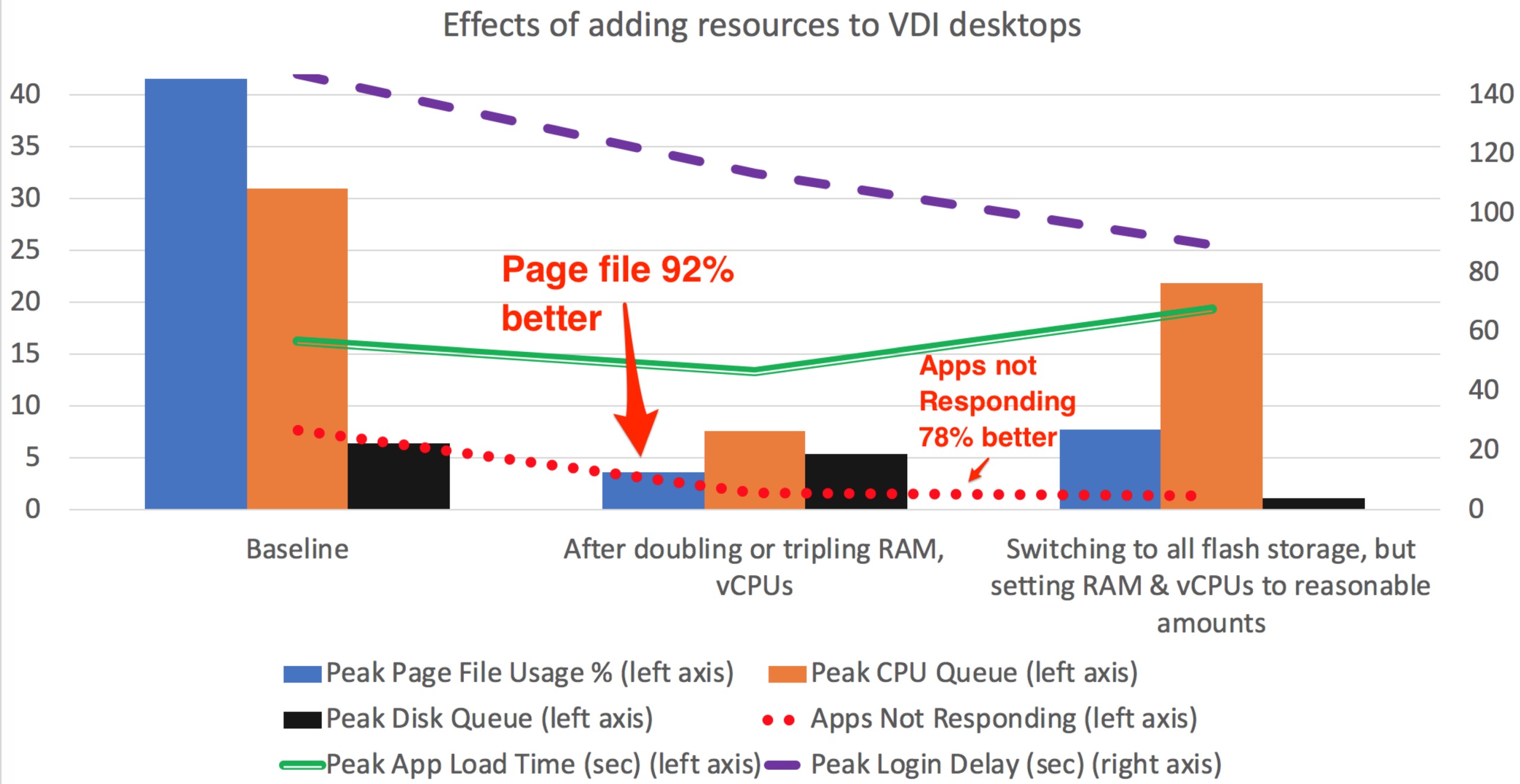
1. User login delay
    1. From the moment user types username/password and presses Login, until Windows start menu appears, clickable
    2. Average user login delay in the industry = 30 seconds.
    3. How to improve – address page file, memory, CPU, storage first. Then, if still too slow, look at unnecessary Group Policy objects, scripts, printer drivers, Antivirus drivers (Quick scan)
2. Application Load time
    1. From the moment user double-clicks on the application, until the application presents its initial screen
    2. 3 seconds or less is best, 4-10 seconds is barely OK, 10-30 seconds is subpar.
    3. How to improve – address page file, memory, CPU, storage first. Then, if still too slow, look at Antivirus drivers, optimization inside (specific to) the app
3. Applications Not Responding (ANR)
    1. When Windows detects that an application is freezing or crashing for various reasons, it generates this message in Task Manager
    2. Maximum 1 per user per day is best, 2-3 and beyond is subpar.
    3. How to improve – address page file, memory, CPU, storage first. Then, if still too many crashes, look at installing latest updates, optimization inside (specific to) the app.

BACKEND METRICS – PAGE FILE AND MEMORY

1. Page File Utilization %
    1. When Windows does not have enough RAM, it begins to use hard drive space for storing memory data. Hard drive is much slower, so that is not preferable.
    2. Should be - under 3% good, 4-16 worrisome, above 16 poor.
    3. How to improve – add RAM, SSD storage. Set page file in Windows to minimum size, but do NOT turn off.
2. Memory Utilization %
    1. How much RAM is being used vs total RAM available
    2. Should be less than 75%.
    3. How to improve – add RAM.

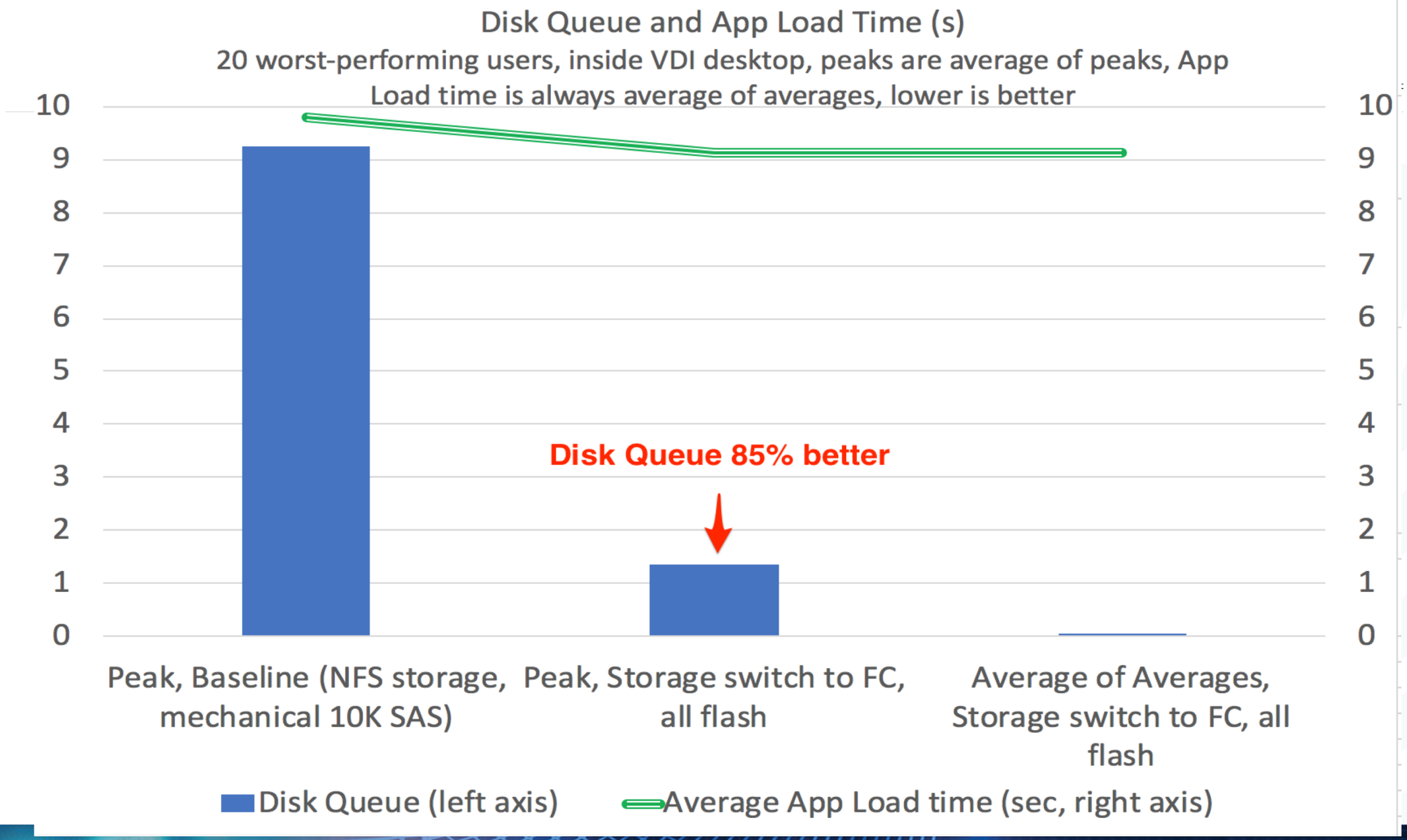

Effects of adding resources to VDI desktops
40
35
30
25
20
15
10
5
0
140
120
100
80
60
40
20
0
Page file 92% better
Apps not Responding 78% better
Baseline
After doubling or tripling RAM, vCPUs
Switching to all flash storage, but setting RAM & vCPUs to reasonable amounts
Peak Page File Usage % (left axis)
Peak CPU Queue (left axis)
Peak Disk Queue (left axis)
Apps Not Responding (left axis)
Peak App Load Time (sec) (left axis)
Peak Login Delay (sec) (right axis)

BACKEND METRICS – CPU QUEUE AND CPU UTILIZATION

1. CPU Queue
    1. When threads have to wait in queue because another active thread is being processed by the processor
    2. Under 1 good, 1-3 OK.
    3. How to improve – resolve high page file utilization, add extra CPU, add hardware GPU or protocol accelerator for graphics and protocol offload
2. CPU Utilization %
    1. How much CPU is being used vs total CPU available
    2. Under 50% is best, during a 1 hour interval. Between 50% and 80% is acceptable. Over 80% is subpar.
    3. How to improve – resolve high page file utilization, add extra CPU, add hardware GPU or protocol accelerator for graphics and protocol offload.

BACKEND METRICS – DISK QUEUE AND DISK IOPS

1. Disk Queue
    1. When disk Input/Output requests have to wait in queue because another active request is being processed by the hard drive
    2. Zero is best, 1-2 is barely OK, beyond 2 is subpar.
    3. How to improve – resolve high page file utilization, replace mechanical disk with SSD (flash).
2. Disk Latency – under 10 ms good. Improve by going to flash, optimizing HBA drivers.
3. Disk IOPS
    1. Disk Input/Output requests per second. How many commands are being sent by the operting system to disk for processing either as a write or a read.
    2. Average Windows PC generates 20-35 IOPS in idle state. During login, Windows may generate 150 IOPS on average.
    3. How to improve – resolve high page file utilization, replace mechanical disk with SSD (flash).


Disk Queue and App Load Time (s)
20 worst-performing users, inside VDI desktop, peaks are average of peaks, App Load time is always average of averages, lower is better
10
9
8
7
6
5
4
3
2
1
0
Disk Queue 85% better
Peak, Baseline (NFS storage, mechanical 10K SAS)
Peak, Storage switch to FC, all flash
Average of Averages, Storage switch to FC, all flash
Disk Queue (left axis)
Average App Load time (sec, right axis)

BACKEND METRICS – GRAPHICS INTENSITY (GDI)

1. Graphics Intensity
    1. How many times Windows has to call its graphical subsystems (DLLs, APIs) to show something on the screen.
    2. Less than 100 is best, above 1000 cause for worry, may indicate a GDI leak, DVD movie or professional graphical application.
        1. If GDI leak, use this link to troubleshoot:
            1. https://blogs.msdn.microsoft.com/dsui_team/2013/04/23/debugging-a-gdi-resource-leak/
    3. Some applications may be coded poorly. For example, a database can still reach above 1000 GDI even while displaying only text and fields on screen.
    4. How to improve – provide bigger amounts of memory and CPU. In general, if you are using any professional graphical applications, you need at least a 3 GHz clock speed of processor.
        1. Above 100, consider providing a GPU offload hardware acceleration card.
        2. For VDI or RDSH, you can add a card like Nvidia GRID Tesla P6 on Blades, Tesla M10 or M60 on rack servers, or the older K1/K2 cards.
        3. For DaaS, use a GPU-backed instance.

BACKEND METRICS - NETWORK

1. Session Latency
    1. How long the Keyboard, Video and Mouse data take to reach from your access point like a PC/Mac/Ipad/Android tablet/Thin client to the Virtual Desktop or Remote Desktop session
    2. Less than 50 milliseconds (ms) is best, starting at 200-250 ms you won't be able to have good experience with graphics/video (but text and basic navigation is ok).
    3. Typical latencies: USA East Coast to West Coast – 50-80 ms, USA to India – 200-380 ms
    4. How to improve – measure latency using pings, get a different network provider
2. Packet Loss
    1. How much data was lost on the way to you.
    2. Less than 0.1% per session is ideal, 0.30% is OK, otherwise you will experience artifacts on screens and mouse drag.
    3. How to improve – replace Ethernet cable going from your access point (PC/Mac/thin client) to the wall jack, troubleshoot Wifi – move to a different area of the room/building, update Wifi drivers, replace Wifi card. Troubleshoot cable from wall jack to switch/router and everywhere along the path. Do NOT use VPN to access virtual computers.
3. Network Bandwidth – 150-400 kbps low-end user, YouTube use brings sessions to 1-5 mbit, streaming applications can make the user go up to 30-50 mbps.

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CITY PAIRS	Atl	Aus	Cam	Chi	Cle	Dal	Den	Det	Hou	Ind	Kan	LA	Mad	Nas	NO	NY	Orl	Pa	Phx	SA	SD	SF	StL	Sea	Was
Austin	23																								
Cambridge	28	49																							
Chicago	23	27	23																						
Cleveland	18	36	18	7																					
Dallas	20	6	49	28	29																				
Denver	35	24	44	20	26	19																			
Detroit		38	22	8	4	34	26																		
Houston	18		50	32	34		25	39																	
Indianapolis				5																					
Kansas City	23	15	32	12	18	10	15	19	15																
Los Angeles	51	34	70	45	52	32	27	52	36		41														
Madison				5							18														
Nashville	6	24	30	18	11	18	32	15	24		17	49													
New Orleans	12	13	42	35	33	13	31	36			22	43		17											
New York	22	45	6	19	13	40	36	22	42		27	63		25	35										
Orlando	10	28	37	33	27	26	45	31	22		32	58		15	14	33									
Philadelphia	21	46	8	18	11	39	37	14	41		25	63		21	32	3	32								
Phoenix	41	21	65	46	47	19	37	53	24		30	11		39		62	45	60							
San Antonio	22	3	54	34	37	8	26		5		17	30		26	12	46	26	47	20						
San Diego	43	29	75	49	56	27	30	55	31		37	3		45	38	67	53	67	8	26					
San Francisco	57	45	72	47	51	42	30	54	45		44	9		61	51	67	64	61	20	39	13				
St. Louis	19	25	27	7	14	20	21	14	25	13	6	49	11	12	32	21	27	20			44	50			
Seattle	71	57	71	47	53	52	34	53	58		49	29		64		65	78	63	39	59	32	20	53		
Washington	19	41	11	22	14	36	41	23	44		22	67		25	30	5	29	4	55	41	65	66	17	68	

Current Overall Average:
33 ms

International Path Latency

Trans-Atlantic Path		
Wash	91	Frankfurt

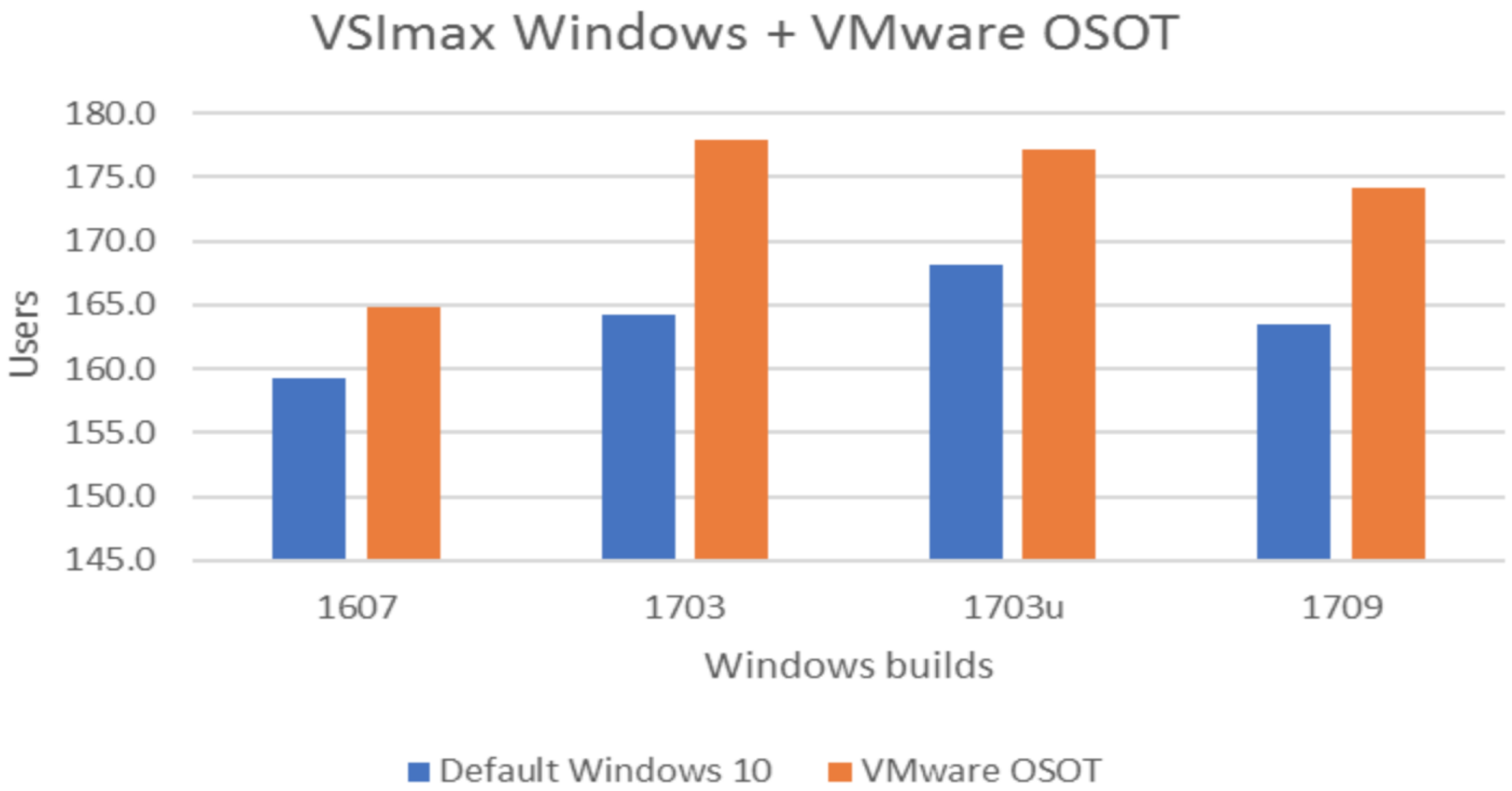
Trans-Pacific Path		
SF	141	Hong Kong

Legend | Increasing Latency

COMMON SOLUTIONS

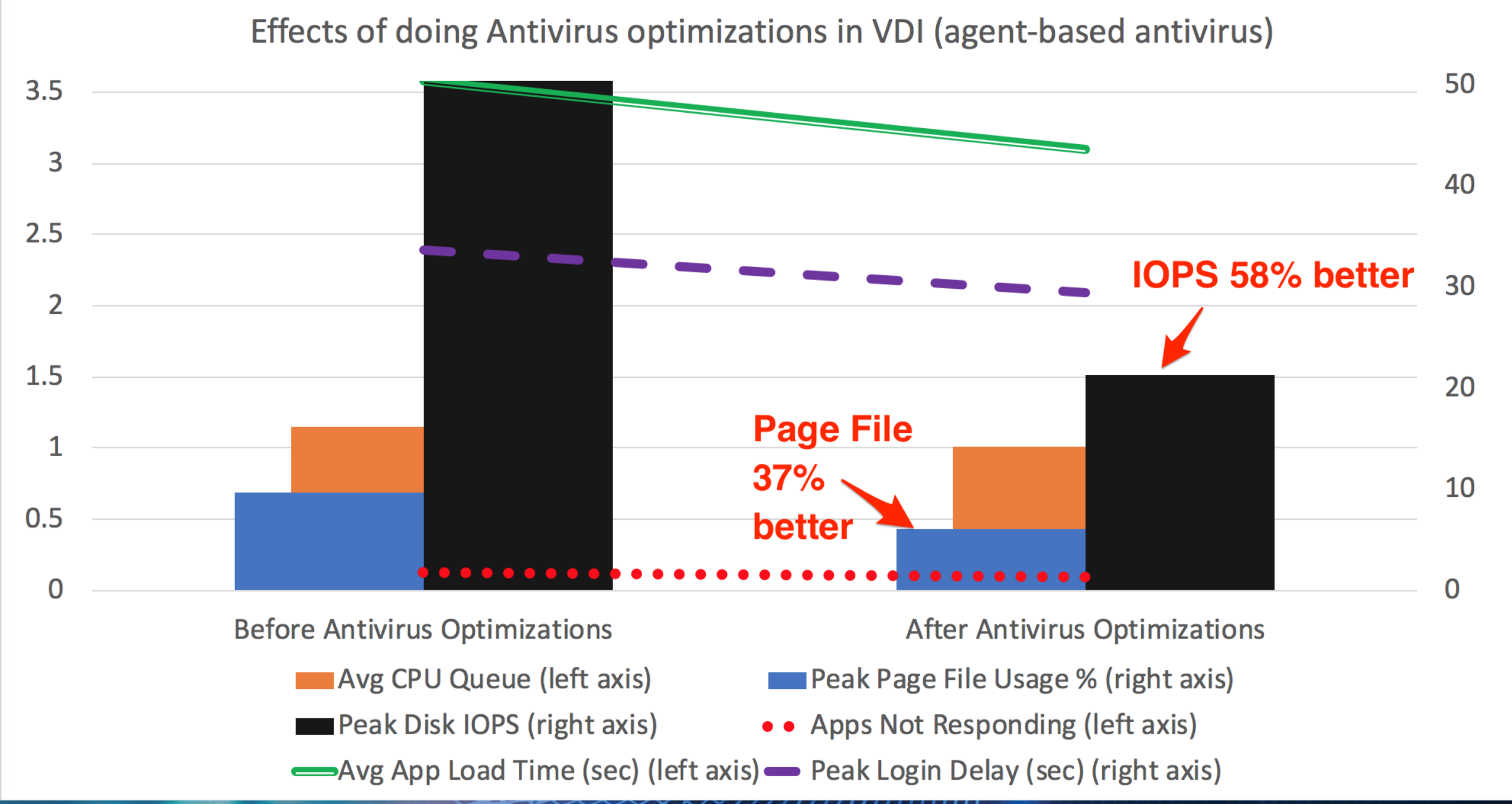
1. Virtual Desktop Infrastructure (VDI)
    1. Reboot all VDI desktops every week, or set option to provide a non-persistent desktop that is fresh with each logon.
    2. Add memory/CPU. Do NOT add too many vCPUs for all your hosts. Watch out for CPU Ready % on your hosts.
    3. Rebuild and optimize desktop image at least once per year.
    4. Use agentless antivirus like Trend Micro Deep Security or McAfee MOVE for 30% reduction in IOPS overhead.
    5. If not using agentless, adjust antivirus to turn off Scheduled/Quick Scan, do not scan after definitions update, use reduced definitions package size.
    6. Set Windows updates to be done automatically, but when you are not using the computer.
    7. Add maximum amount of memory.
        1. Less than 8 GB almost does not make sense anymore.
    8. Make sure your hard drive is SSD/flash.
2. Remote Desktop Services Host (RDSH)
    1. Reboot server every week.
    2. Rebuild server image at least once per year.
    3. Use agentless antivirus like Trend Micro Deep Security or McAfee MOVE for 30% reduction in IOPS overhead.
    4. If not using agentless, adjust antivirus to turn off Scheduled/Quick Scan, do not scan after definitions update, use reduced definitions package size.
    5. Set Windows updates to be done automatically through WSUS or SCCM, but when less people are using the server.
    6. Add memory and CPUs. 16-256 GB is typical. Add memory/CPU. Do NOT add too many vCPUs for all your hosts. Watch out for CPU Ready % on your hosts.
    7. Make sure your SAN or hard drive is SSD/flash.
    8. Add more server nodes to distribute the load.

PERFORMANCE EFFECT OF USING VMWARE OS OPTIMIZATION TOOL

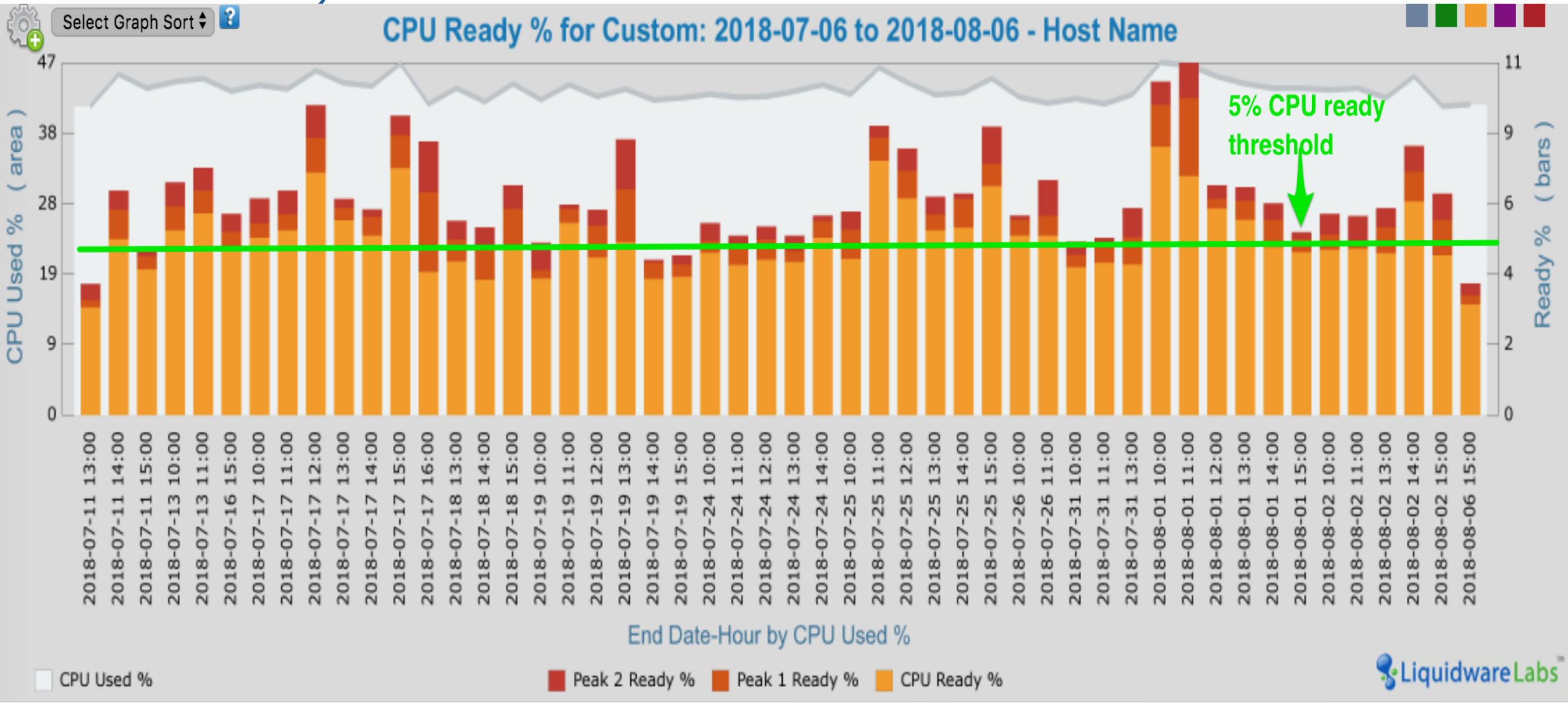


Graph 1: VSImax, higher is better

Thank you to Mark from LoginVSI for graph.


Effects of doing Antivirus optimizations in VDI (agent-based antivirus)
3.5
3
2.5
2
1.5
1
0.5
0
50
40
30
20
10
0
IOPS 58% better
Page File
37%
better
Before Antivirus Optimizations
After Antivirus Optimizations
Avg CPU Queue (left axis)
Peak Page File Usage % (right axis)
Peak Disk IOPS (right axis)
Apps Not Responding (left axis)
Avg App Load Time (sec) (left axis)
Peak Login Delay (sec) (right axis)

CPU READY % (VM SITTING WAITING TO GET PHYSICAL CPU ACCESS) VS CPU USED %



OPTIMIZATIONS FOR COMMON APPLICATIONS

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1. Outlook
    1. Do not store more than 1 month of email in your Inbox folder.
    2. Do not store more than 100,000 messages in your Inbox folder.
    3. Starting from Outlook 2013, adjust your Outlook cache to only download 1 month of e-mail.
    4. Every 3 months, rebuild your Outlook profile.
    5. Remove shared calendars and shared mailboxes of people you no longer need to view, they waste memory.
    6. Disable Window Search Indexing on Windows.
    7. If running without GPU, disable Hardware Acceleration for all Office Applications.
    8. Use FSLogix solution to offload cache – now free from Microsoft with RDSH licenses.
2. Google Chrome
    1. If running without GPU, disable Hardware Acceleration.
    2. Disable unused Chrome extensions.
    3. Do not open too many tabs and close unused tabs. Each tab uses memory, just as a separate application would.
        1. Especially close tabs with Flash, videos or Java.
    4. Open Chrome Task Manager and sort by CPU and memory. Close tabs with highest utilization.
    5. Move away from using Chrome to Edge or Firefox – Chrome has become a resource hog.

Special thanks to LoginVSI, Chris Walker and Matt Boyajian, who's guidance I used here.

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Thank you!

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