Université IBM i 2017

17 et 18 mai – IBM Client Center de Bois-Colombes

S48 – IBM i et stockage SSD/Flash : retour d'expérience

Jeudi 18 mai – 15h15-16h45

Ludovic Ménard – IBM IT Specialist IBM i

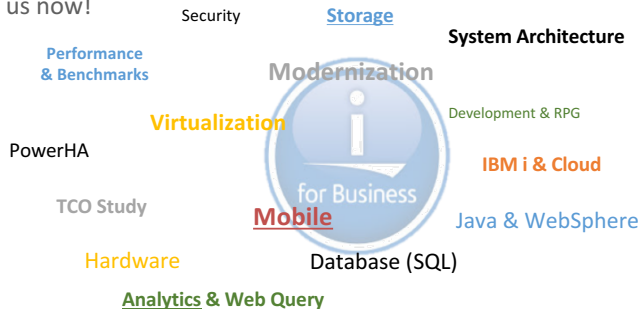# IBM i - Montpellier Design Center Offering Contact us

A Center of Competency committed to your success:

- ❑ Personalized workshops, all focused on **IBM i solutions**, including Live demonstrations, design sessions, testing & hands-on capabilities.
- ❑ Experience & Expertise from the Benchmark & Design Center.
- ❑ Innovation & hot topics around Digital Transformation: IBM i & Cloud, Analytics, Mobility… Always be at the edge of IBM latest technology.
- ❑ Focal point for ISVs and IBM Partners on IBM i.

Utilization terms

- ❑ In Center or on your site, for a design session or a large event. Contact us now!

Security   **Storage**   **System Architecture**

Performance & Benchmarks

Modernization

Virtualization   Development & RPG

PowerHA   **IBM i & Cloud**

TCO Study   **Mobile**   Java & WebSphere

Hardware   Database (SQL)

Analytics & Web Query

for Business

Power Systems

POC/POT& DEMOS   BRIEFINGS

MULTI-CLIENT EVENTS   HANDS-ON LABS

ENABLEMENT

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+33 4 9958 0614 (Office)

IBM

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Use IBM i Expertise from Montpellier

Bring your clients & convince them!

### IBM i System Management & Performance

Topics covered look at system management & performance using iDoctor and Database monitoring, Java & Websphere best practices and System management solutions.

Power Systems Roadmap & Infrastructure

Topics covered highlight the Power Systems technology and IBM i roadmap, Storage & Flash, and High Availability Solutions with IBM i.
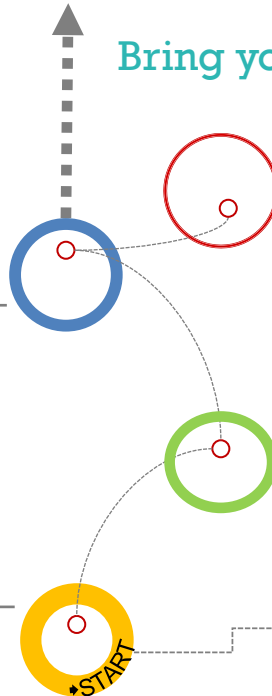
Digital Transformation

Digital Transformation with IBM i, covering Hybrid Cloud, Analytics with Web Query & Cognos, Mobile Solutions on i based on MobileFirst & ISV solutions, New developments tools & modernization. Live demonstrations

Virtualization & Consolidation

Topics covered address Power Virtualization with IBM i, PowerVC, VIOS Best Practices, Integration with Linux, iVirtualization. Live Demonstrations

Customizable Agenda

Build your own Agenda with topics taken from this 4 themes.

START

IBM i Modernization Workshops & Briefings

Digital Transformation / Modernization

Compose your Agenda!

- **Bluemix** for Developer productivity & Innovation - What is bluemix? includes a demo and/or lab
- **Mobility** & Hybrid **Cloud** : Mobile Applications on IBM i - Demonstrations with MobileFirst, IBM i and Bluemix
- Retail Demo - IBM i & Hybrid **Cloud** - Demonstrations with Node.js, Bluemix, Watson Services & IoT…
- **API Management & Integration** Studio - IBM i & Hybrid **Cloud** – Design , Create and Manage your API on IBM i.
- **Development** & modernization using RPG Free, Node.js & new languages, all on IBM i!
- **Security**: IBM **QRadar** & IBM i Security & Compliance solution (ISV Solution) - Includes a demo
- Analytics & Security: **Fraud Detection** Solution on Power Systems (AIX/Linux/IBM i) with IBM **ODM** , **Analytics** and ISV Solution. Includes a demo
- Power Systems & **Cloud Solutions** (private, public, hybrid) - Includes demos

Infrastructure Solutions

- Power Systems **Strategy**
- IBM i **Roadmap** , New Products & Beta Testing
- IBM i & **Storage** - Which Storage to choose? Feedback from Power/Storage Benchmark/Design Center
- **OpenPower**, Linux on Power, **PowerKVM**
- Solutions **Architecture & Virtualization** best practices: PowerVM & VIOS, iVirtualization, PowerVC , Live Partition Mobility.
- Storage & PowerHA with IBM i: SAN Storage & Flash Systems, IASP, HyperSwap…
- System **Performance** with iDoctor & Database monitoring, Java & WebSphere on IBM i Best Practices, System security & administration.
- **Analytics** Solutions with IBM i using IBM Cognos & DB2 Web Query
- Total Cost of Ownership – Economics Study

IBM i Benchmark center activities

IBM Systems Benchmark Centers have the expertise and tools to provide

- Proofs of concept (PoCs)
  - Demonstrate functions (flashcopy, brms)
- Proofs of technology (PoTs)
  - Demonstrate new hardware
- Performance benchmarks
  - Stress, tune, test workload and applications
- Pre-sales activities

Benchmark center portal
  http://www-03.ibm.com/systems/services/benchmarkcenter/

2 Benchmarks SSD

2 Benchmarks Flash

Storage comparative

What is the problem and Why a Bench ?

Application changes

Cost reduction

Batch time reduction

Backup window

Business growth

What is the problem and Why a Bench ?

Application changes
RPG free form
New languages
SQL

Cost reduction
Power 8 price
Storage price

Batch time reduction
CPU
Response time

Backup window
Flashcopy
BRMS

Business growth
Consolidation of infrastructure performance

for Business

Hardware and Software used

EJ14 card

- PCIe3 12 GB Cache RAID PLUS SAS Adapter Quad-port 6 Gb x8 (FC EJ14; CCIN 57B1); Adapter FRU number 01DH742PCIe3 x8

- Transfer speed of 6 Gbps

- 12 GB write cache

- Up to 1.6M read IOPS, Up to 360k write IOPS, Up to 878k mixed IOPs (70-30)

- One PCIe x8 slot per adapter

- Adapters are installed in pairs

- OS support: AIX, IBM i, and Linux operating systems

- VIOS supported

IBM i 7.3
IBM i 7.2 Technology Refresh 4
IBM i 7.1 Resave RS-710-S

EXP24SX or ESLS

- Up to 12Gb throughput

- 24 2.5-inch SFF SAS bays

- Designed to support future 12Gb SAS interfaces

HDD 10k RPM	HDD 15k RPM	SSD
600/571 GB 4k (#ESEV, #ESEU)	300/283 GB 4k (#ESEZ, #ESFA)	387 GB 4k (#ES85, #ES86)
1.2/1.1 TB 4k (#ESF3, #ESF2)	600/571 GB 4k (#ESFP, #ESFN)	775GB 4k (#ES8C, #ES8D)
1.8/1.7 TB 4k (#ESFT, #ESFS)		1.55 TB 4k (#ES8F, ES8G)
		1.9 TB 4k RI (#ES80, #ES81)

IBM i 7.3 Technology Refresh 1
IBM i 7.2 Technology Refresh 5

V9000

Encryption
Compression

2 * 6 ports 16GB used
Software level 7.8.1.0

IBM i 7.1 Technology Refresh 8
IBM i 7.2
IBM i 7.3

Power 8

S824 – 8286-42A
16 cores
512 GB MEM

E880 – 9119-MHE
192 cores
16 TB MEM

IBM i 7.1 Technology Refresh 8
IBM i 7.2
IBM i 7.3

iDoctor for IBM i

- ❑ Suite of performance tools
- ❑ Investigate and analyse performance data
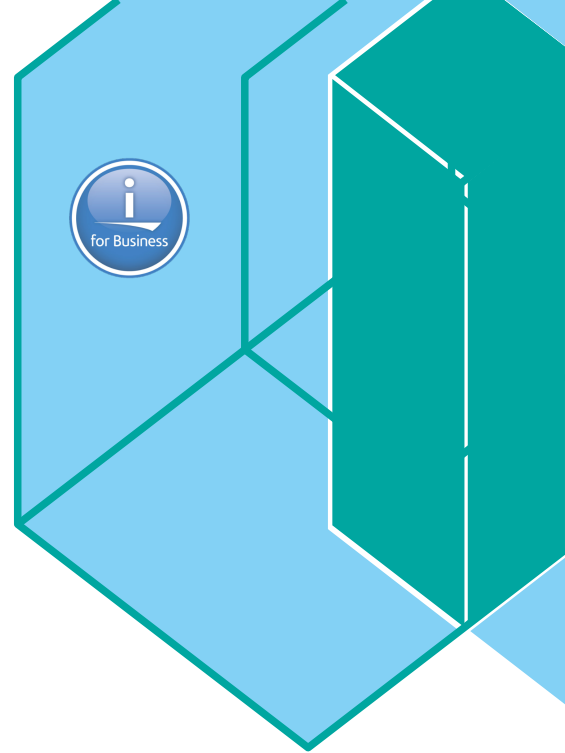- ❑ Monitor overall system health
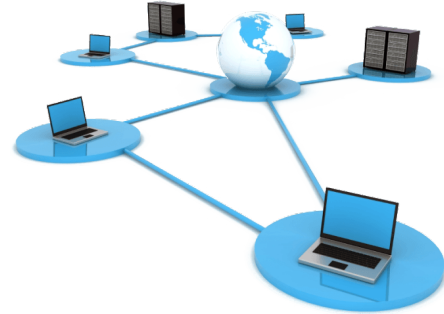
Case N°1

EJ14 – EXP24SX – 17 SSD

Power 8 S824

IBM i 7.2

Client configuration

- **Power**
  - Power 720
  - 6 cores 3,6GHz
  - 256GB memory
- **Storage**
  - 72 disks HDD 139 GB 15K Raid5 protection
  - 4 x 5887 disks drawer EXP24S
  - 4 x PCI gen2 1.8GB Cache RAID SAS Adapter Tri-port 6Gb
  - ERP M3 Application response time : 1ms to 4ms
- **IBMi partition**
  - IBM i V6.1
  - 4 cores
  - 249 GB memory
  - 68 disks HDD 139 Go 15K Raid5 protection
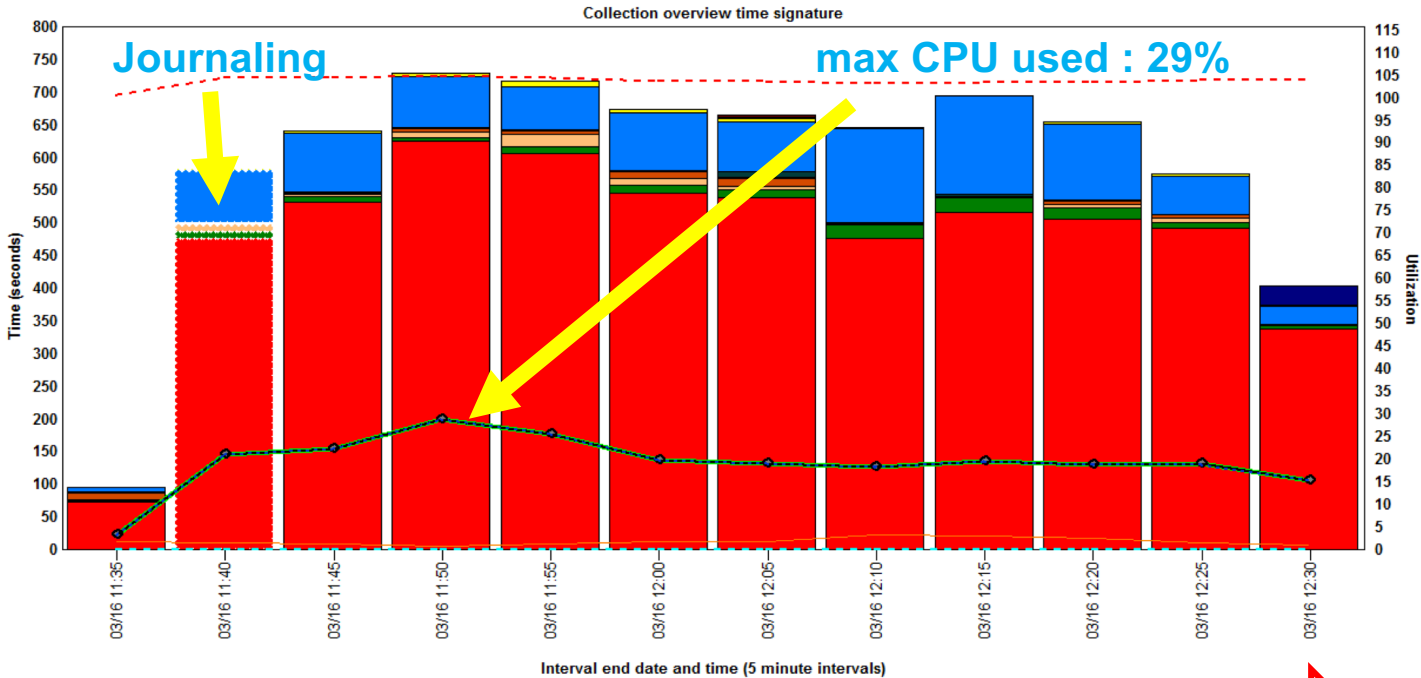 - Disk capacity available 8,7 TB, 70% used

Objectives

The customer's objective is to test the performance of a set of batch jobs of the M3 version 10.1 ERP in an IBM i V7.2.

Power System S824 and internal SSD disks, similar to that envisaged to replace the client infrastructure.

Benchmark Infrastructure

Power Systems

8286-42A
16 cores
512 GB MEM
S824

TS3500
2 x LTO6
IBM TotalStorage LTO Ultrium
2FC

EJ14

IBM i
V7R2
4 cores
384 GB

Virtual I/O Server 2 LPAR
0.5 Core 4GB
ETH

Virtual I/O Server 1 LPAR
0.5 Core 4GB
ETH

2FC

EJ14
YO12
AA
AA
YO12

EXP24SX
ESLS

17 SSD
387GB
RAID 5

1 SSD
387GB
HOT
SPARE

ETH
ETH

1GB   VLAN
Ethernet

VLAN injection   1GB

INTERNET

HMC
• Power Administration
• 5250 Connection

iDoctor   Room

Workstations
OPENVPN™

Windows 2008 R2
SP1 Server

Injection server

IBM

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Benchmark Results - System activity

Collection overview time signature

Journaling

max CPU used : 29%

Batch time : 60 minutes vs 2h - 53% gain

- Journaling
- Dispatched CPU

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Benchmark Results - Disk activity

Read/write rates for ASP 1

17000 I/Os per second

Average response time: < 0.1 ms

Interval end date and time (5 minute intervals)
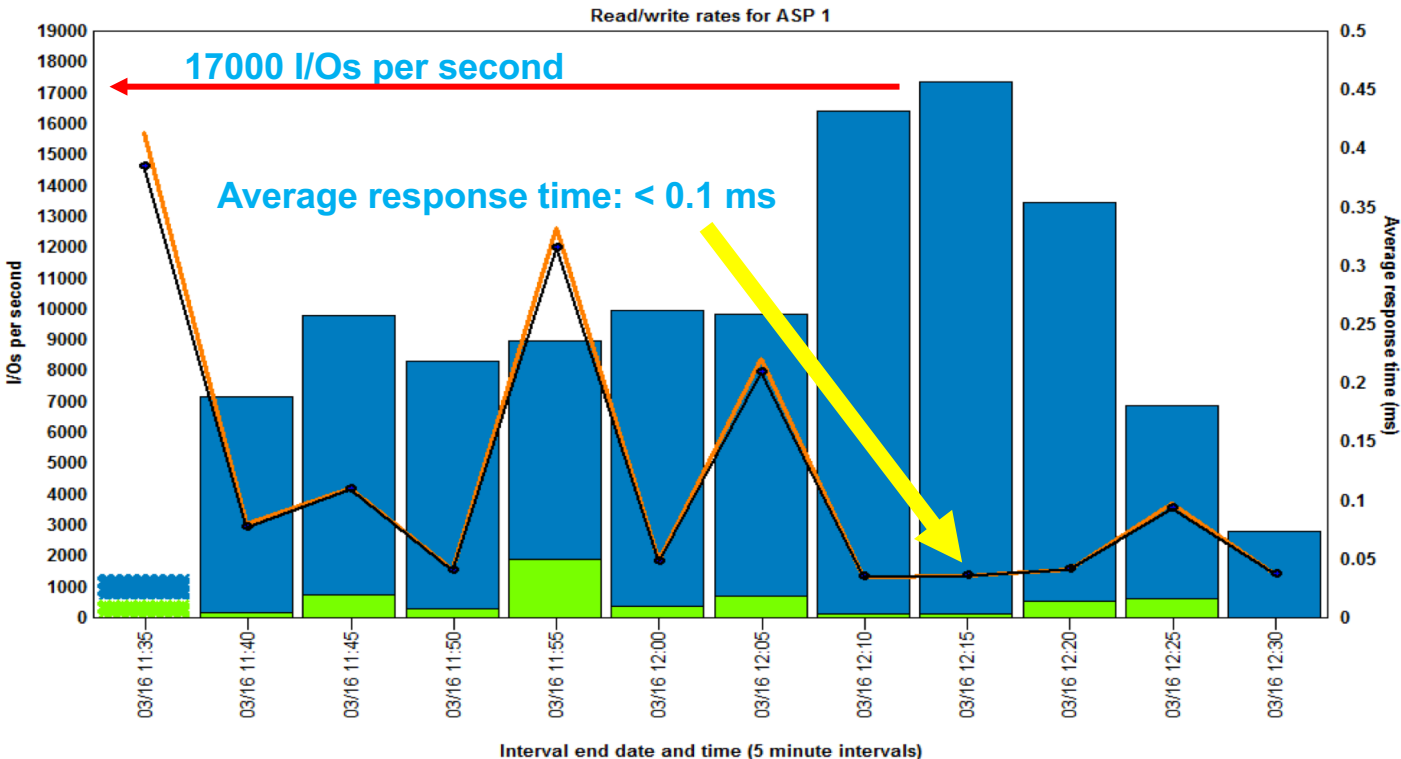
Legend:
- Writes per second
- Reads per second
- Average response time
- Average service time

Conclusion

- **Reduce number of disk**
  - 68 disks HDD to 17 disks SSD

- **IBM i V6R1 to V7R2 M3 validate**

- **Same number of cores**
  - 4 cores
  - Batch time divides per 2 (53% gain)
  - ERP M3 Interactive query divides per 10
  - LTO 6 Backup window reduction from 4h to 1h40

- **Response time**
  - Close to 0,1 ms
  - divides per 10

- **Customer hardware proposition**
  - S814 - 8 cores 'internal 24 SSD' buy.
  - It's on hold

Case N°2

EJ14 – EXP24SX – SSD

End of Month Batch Job time between 8h-9h

Benchmark time 4h32

Client configuration

- **Power**
    - Power 720
    - 6 cores 3 GHz
    - 80 GB memory
- **Storage**
    - 39 disks HDD 139 Go 15K Raid5 protection
    - Response time : 4ms to 10ms
- **IBMi partitions**
    - IBM i V7.1
    - 1,5 cores
    - 64 GB memory
    - 32 disks HDD 139 GB 15K Raid5 protection
    - Disk capacity available 4 TB, 68% used

    - IBM i V7.1
    - 0;25 core
    - 13 GB memory
    - 7 disks HDD 139 GB 15K Raid5 protection
    - Disk capacity available 837 GB, 81% used

Objectives

The client is currently migrating data from the second partition to the first partition. In the end, there should be only one partition.

IBM proposed to client a new IBM POWER System :

- S814 - 2 active cores on 6-core 3.02 GHz POWER8)
- 128 GB MEM
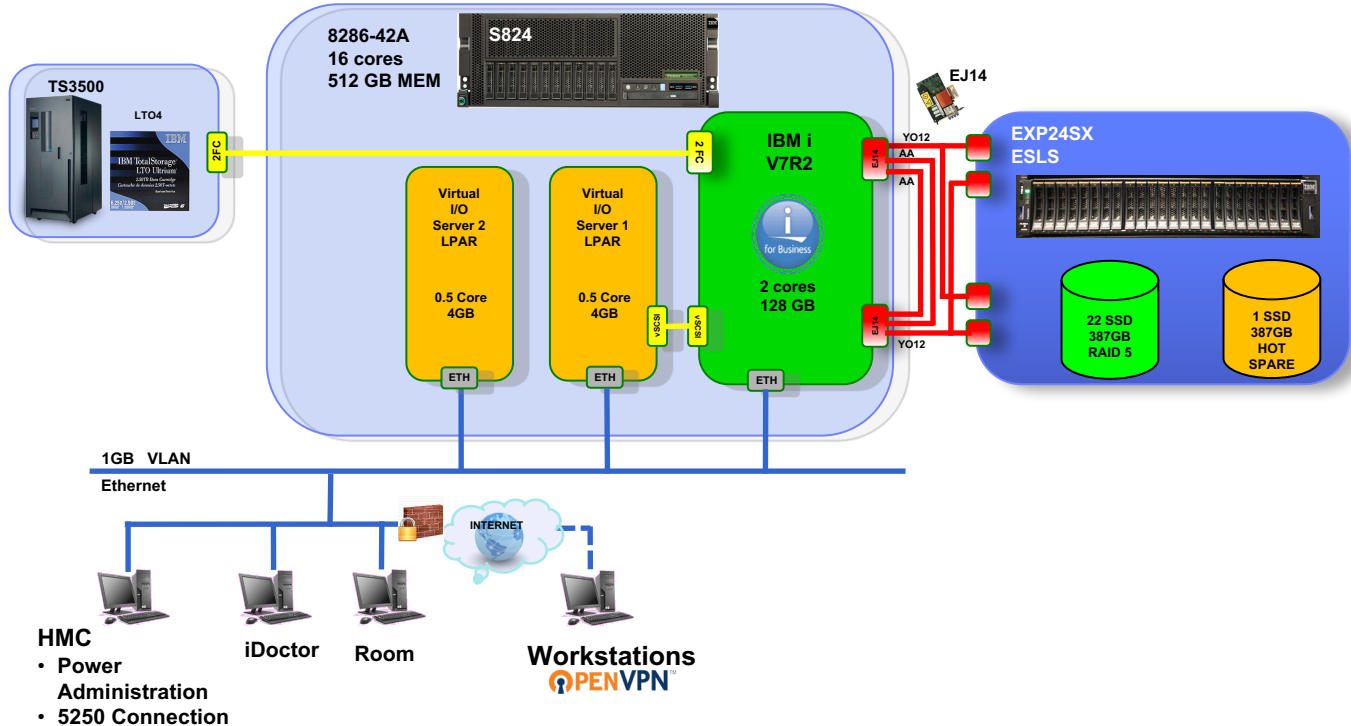- 2 Cards EJ14 in pair (12Gb cache)
- 11 disks of 775 GB SSD*

Client wants the batch duration divided by at least 2. The original batch duration is 9h.
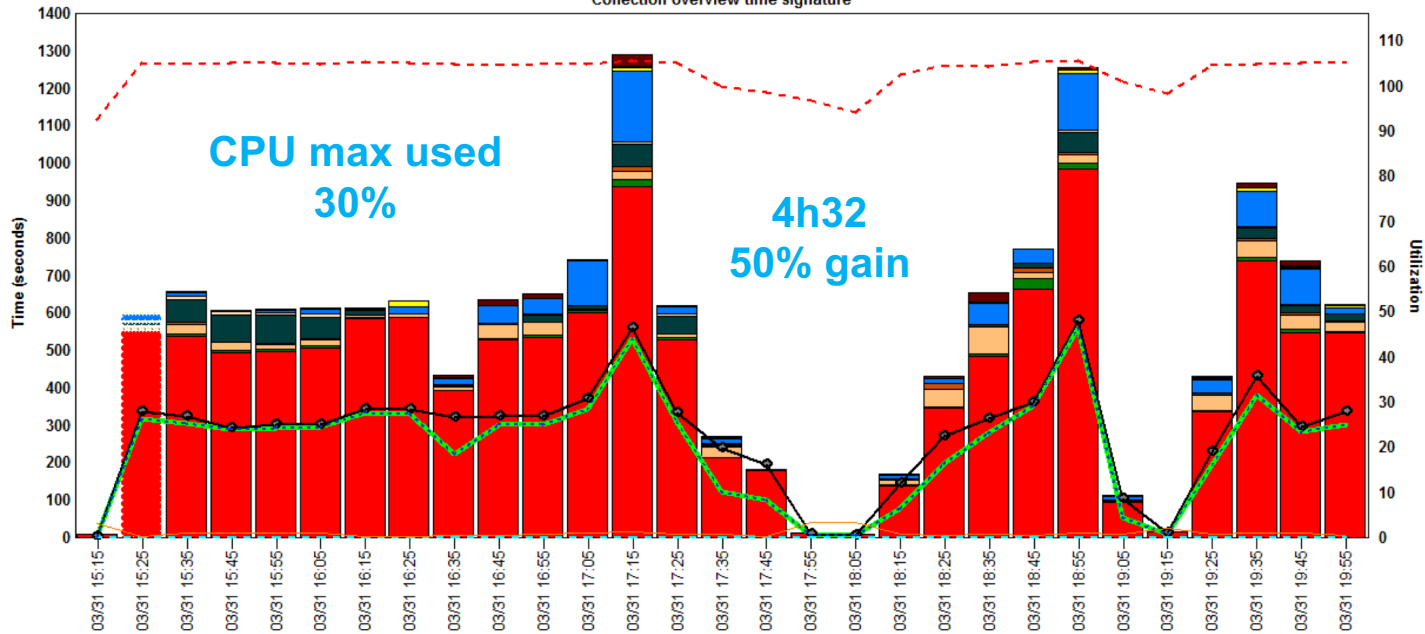
* 22 disks 387 GB used

Benchmark Infrastructure

8286-42A
16 cores
512 GB MEM

S824

TS3500

LTO4

IBM TotalStorage LTO Ultrium

2 FC

EJ14

YO12
AA
AA
EJ14
YO12

EXP24SX
ESLS

2 FC

IBM i
V7R2

i for Business

2 cores
128 GB

Virtual
I/O
Server 2
LPAR

0.5 Core
4GB

Virtual
I/O
Server 1
LPAR

0.5 Core
4GB

vSCSI vSCSI

ETH   ETH   ETH

22 SSD
387GB
RAID 5

1 SSD
387GB
HOT
SPARE

1GB   VLAN
Ethernet

INTERNET

HMC
• **Power**
  Administration
• **5250 Connection**

iDoctor

Room

Workstations
OPENVPN

IBM   © IBM France 2017

Benchmark Results - System activity

Collection overview time signature

CPU max used 30%

4h32 50% gain

Legend:
- **Journaling** (blue)
- **Dispatched CPU** (red)

Interval end date and time (10 minute intervals)

- Average partition CPU utilization
- Maximum partition CPU utilization
- Average batch CPU utilization
- CPU power-savings rate(Scaled CPU: Nominal CPU)
- VCPU delays a percentage of Dispatched CPU

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Benchmark Results - Disk activity

Read/write rates for ASP 1

14500 I/Os per second

Response Time ≈ 0.1 ms

- Writes per second
- Reads per second
- Average read response time (ms)
- Average service time (ms)
- Average response time (ms)
- Average write response time (ms)

Interval end date and time (10 minute intervals)

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Conclusion

Response Time

Response time divides per 10

Batch

10ms

0,1ms

0   1   2   3   4   5   6   7   8   9   10

TIME (MS)

Project is hold on

Conclusion

Batch Time

Batch time divides per 2

Bar chart titled "Batch Time" showing Batch metric. Red bar = 9H, Teal bar = 4H30. X-axis TIME (HOUR) from 0 to 10. Y-axis labeled "Batch".

Project is hold on

Case N°3

V9000 FlashSystem

VIOS - NPIV

IBM i V7R2
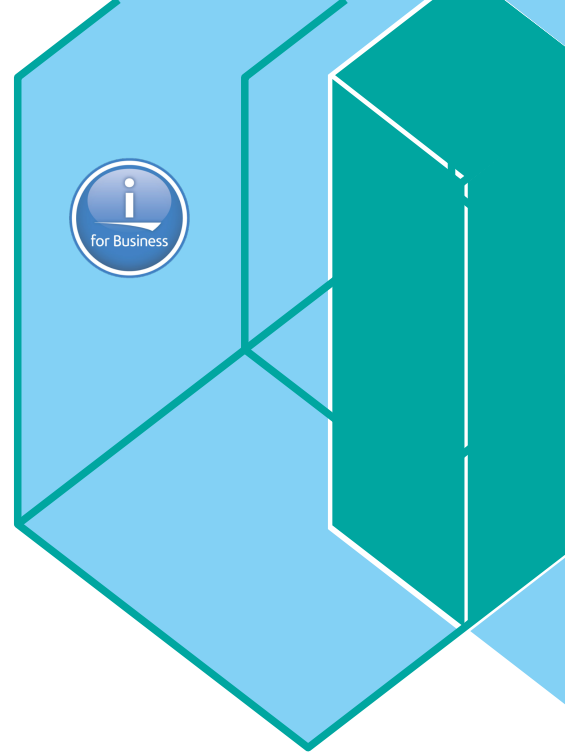
Client configuration

- **Power**
  - Power 740
  - 6 cores 4,2 GHz
  - 64 GB memory
- **Storage**
  - Storwize V7000 Gen 1
  - 84 disks HDD 146 GB 15K Raid5 protection
- **IBMi partitions**
  - IBM i V7.2
  - 2 cores
  - 20 GB memory
  - 32 LUNs 139 GB
  - Disk capacity available 2,8TB, 75% used
  - Redundant VIOS vSCSI connection

Objectives

- The objective of this benchmark is to test the performance of a batch job in an IBM i V7.2

- Power System S824 and FlashSystem V9000, similar to that envisaged in replacement of the existing infrastructure

- This batch job populates a Business Intelligence (BI) database from IBM i DB2.

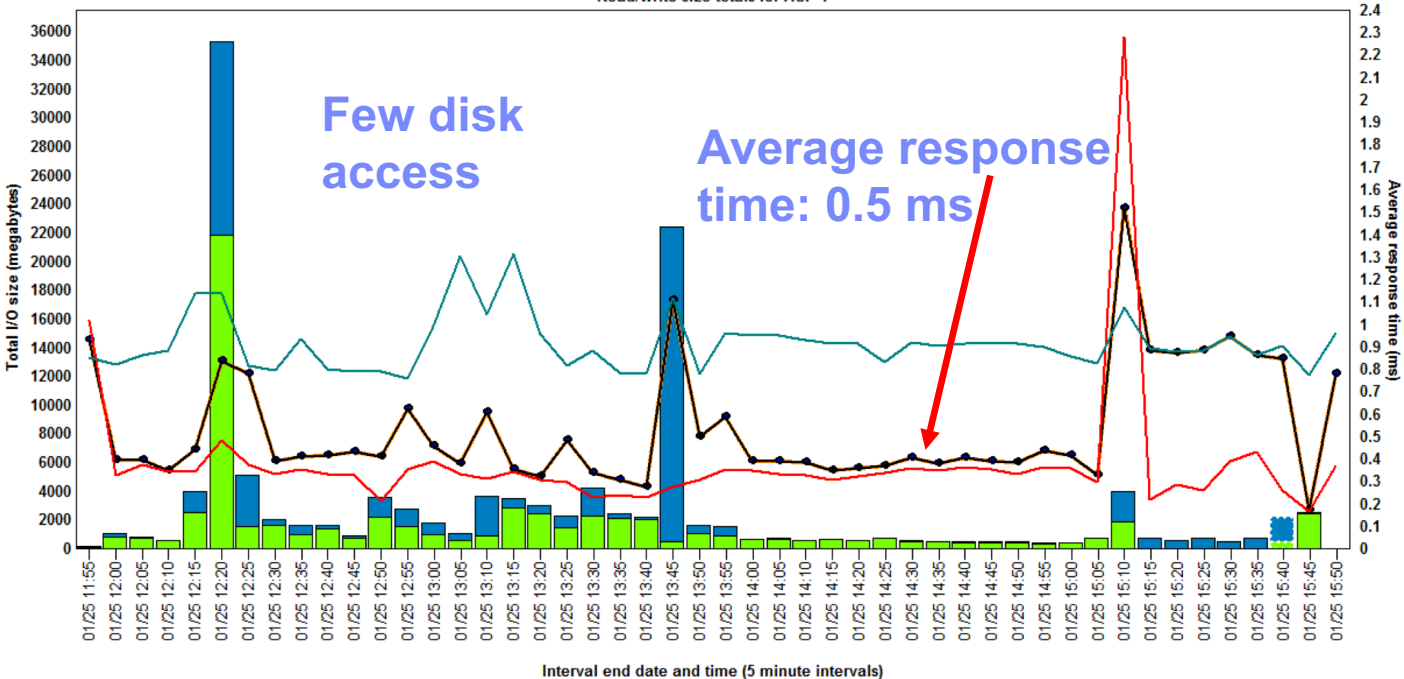# Benchmark Infrastructure

TEST 1 : system activity

Collection overview time signature

27% CPU used

Disk non fault reads

Dispatched CPU

Average partition CPU utilization
Maximum partition CPU utilization
Average batch CPU utilization
CPU power-savings rate(Scaled CPU: Nominal CPU)
VCPU delays a percentage of Dispatched CPU

Interval end date and time (5 minute intervals)

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TEST 1 : disk activity

Read/write size totals for ASP 1

Few disk access

Average response time: 0.5 ms

Interval end date and time (5 minute intervals)

Writes per second
Reads per second

Average read response time (ms)
Average service time (ms)
Average response time (ms)
Average write response time (ms)

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TEST 2 : system activity

Collection overview time signature

27% CPU used

DB2 symmetric used
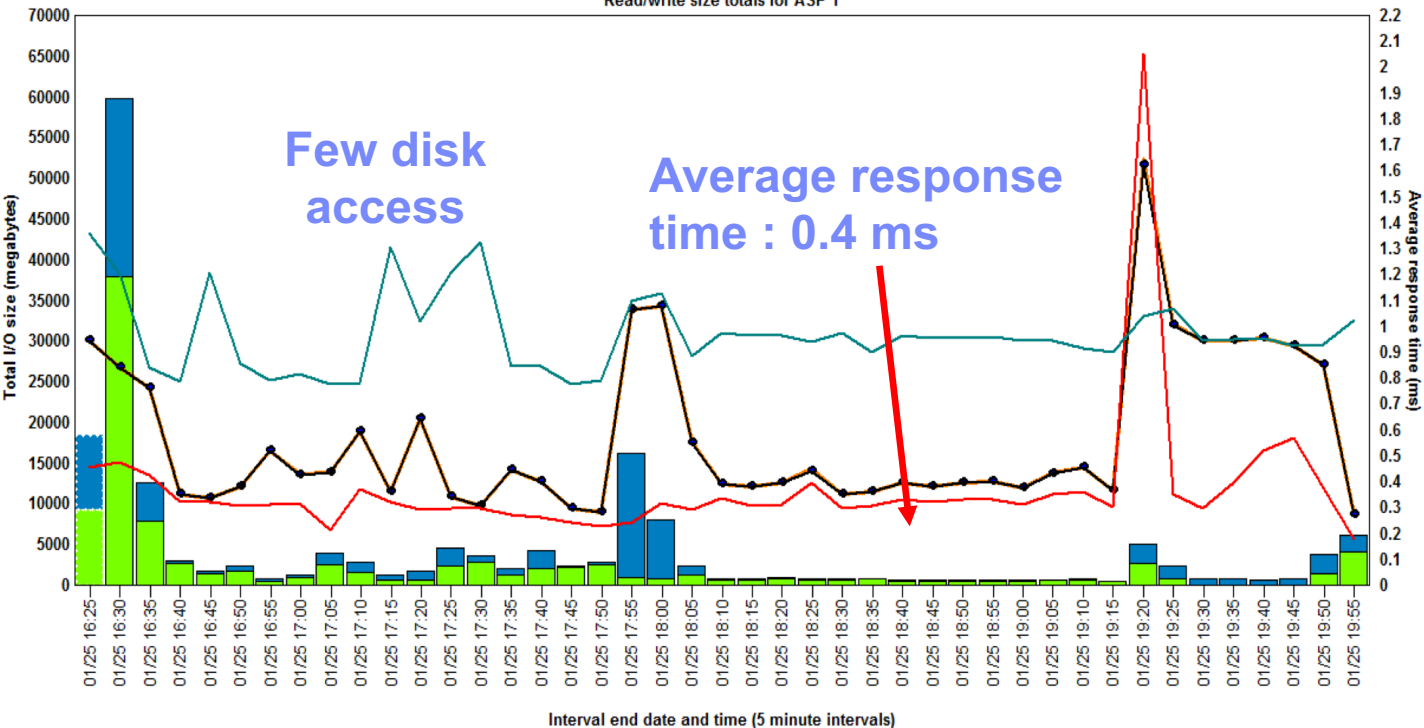
Legend:
- Disk non fault reads
- Dispatched CPU
- Average partition CPU utilization
- Maximum partition CPU utilization
- Average batch CPU utilization
- CPU power-savings rate(Scaled CPU: Nominal CPU)
- VCPU delays a percentage of Dispatched CPU

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TEST 2 : disk activity

Read/write size totals for ASP 1

Few disk access

Average response time : 0.4 ms

Interval end date and time (5 minute intervals)

- Writes per second
- Reads per second

Average read response time (ms)
Average service time (ms)
Average response time (ms)
Average write response time (ms)

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Conclusion

- The Power System S824 and FlashSystem V9000 architecture improve BI batch run time by 18%.

- The first test shows a CPU usage of less than 30%, a memory usage of up to 50 GB, and moderate disk activity with an average response time of 0.5 ms.

- The second test (activation of parallelization of DB2 queries) gives similar results, which means that this function does not improve (the ONPQRYF function is only slightly used).

- The performance of this batch processing can not be improved beyond this result without studying an optimization of the code.

A Storwize V7000 Gen2 full SSD would provide an equivalent performance gain compared to this batch process.

Case N°4

FS900 – SVC - VIOS - NPIV

Encrypted Compressed

Encrypted Uncompressed

IBM i V7R1

Client configuration

- **Power**
    - 4 Power 770
        - 2 systems with 48 cores and 1TB of memory
        - 2 systems with 48 cores and 1,25TB of memory
    - 97 partitions – production
    - 71 partitions – non production and DR
- **Storage**
    - 2 DS8880 with 2 expansions by DS8880
    - Prod DS8880
        - 608 disks 146GB 15K
        - 62,8 TB usable
    - Non prod DS8880
        - 1056 disks 146/300GB 15K
        - 126 TB usable
- **IBMi**
    - 2 x Partitions @ 3TB Disk, 4GB Memory and 0.33 CPU (1 virtual) uncapped
    - 2 x Partitions @ 1.5TB Disk, 13GB Memory and 0.21 CPU (1 virtual) uncapped
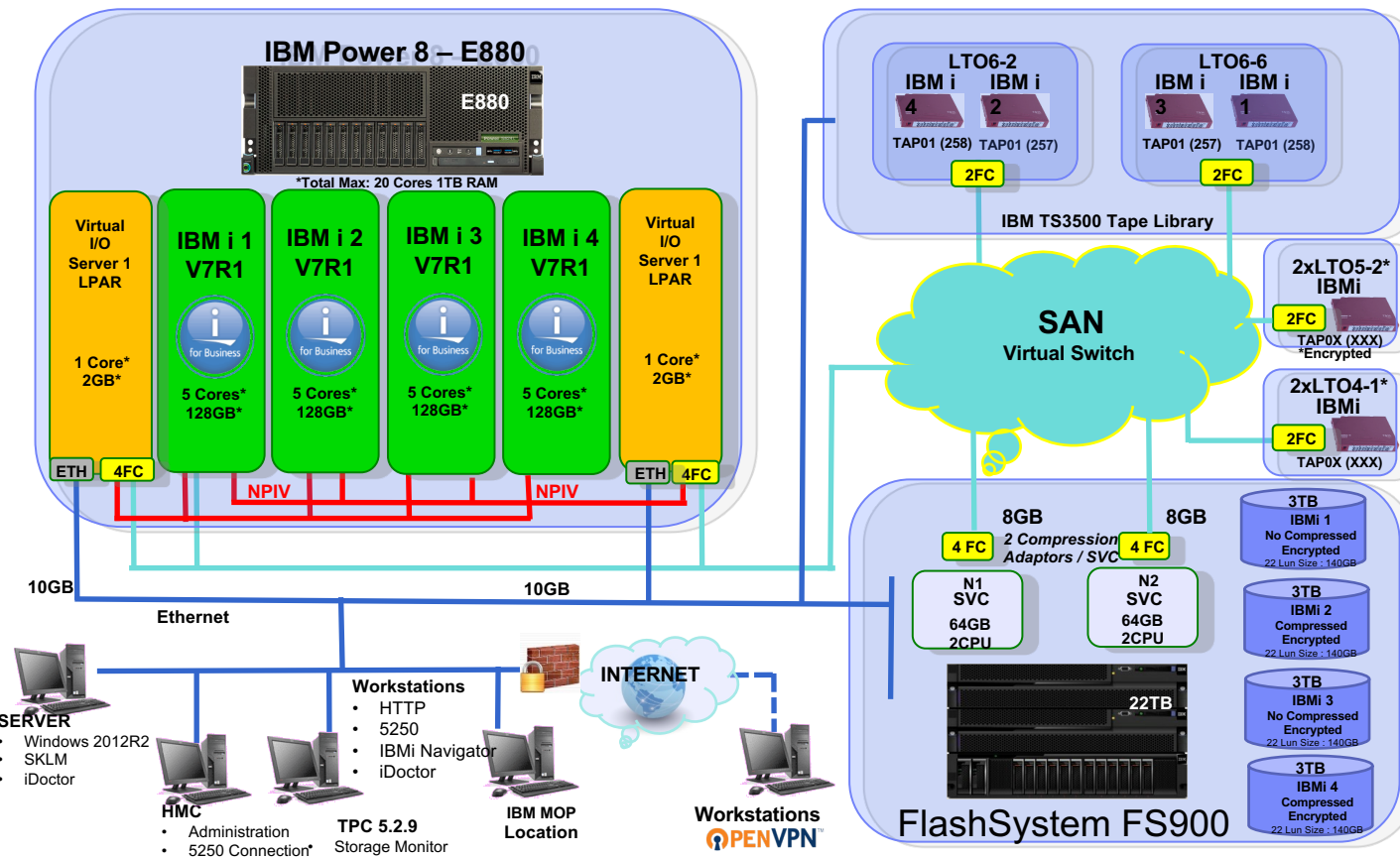
Objectives

- Client wants to drive the cost per TB down as it currently is just over 10k EUR per TB usable using 15k RAID5 ranks on IBM DS8800 with same performance.

- Compare performances data running batchs Power 7 and DS8880 versus Power 8 and FlashSystem.

- IBM i environments in the following configurations:
  - Non-compressed but encrypted disk with encrypted tape drives
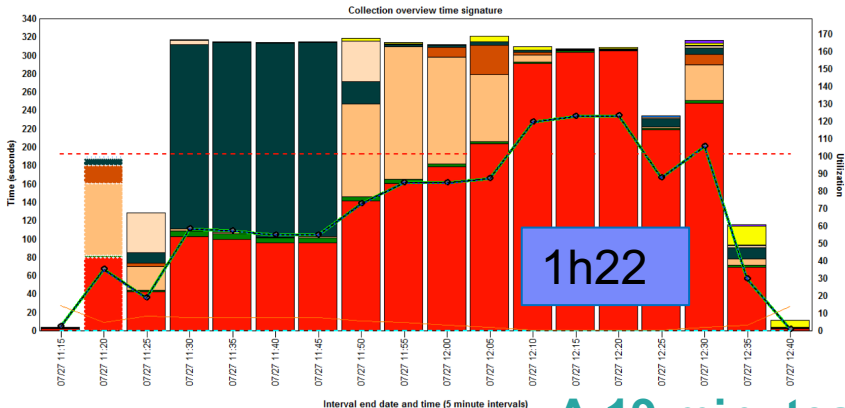 - Compressed and encrypted disk with encrypted tape drives

Benchmark Infrastructure

Power Systems

IBM Power 8 – E880

E880

*Total Max: 20 Cores 1TB RAM

| Virtual I/O Server 1 LPAR | IBM i 1 V7R1 | IBM i 2 V7R1 | IBM i 3 V7R1 | IBM i 4 V7R1 | Virtual I/O Server 1 LPAR |

1 Core* 2GB*

5 Cores* 128GB* | 5 Cores* 128GB* | 5 Cores* 128GB* | 5 Cores* 128GB*

1 Core* 2GB*

ETH 4FC   NPIV   NPIV   ETH 4FC

10GB

Ethernet

10GB

SERVER
- Windows 2012R2
- SKLM
- iDoctor

HMC
- Administration
- 5250 Connection*

TPC 5.2.9
Storage Monitor

Workstations
- HTTP
- 5250
- IBMi Navigator
- iDoctor

IBM MOP Location

INTERNET

Workstations
OPENVPN

LTO6-2
IBM i 4 **IBM i** 2
TAP01 (258) TAP01 (257)
2FC

LTO6-6
IBM i 3 **IBM i** 1
TAP01 (257) TAP01 (258)
2FC

IBM TS3500 Tape Library

SAN Virtual Switch

2xLTO5-2* IBMi
2FC
TAP0X (XXX) *Encrypted

2xLTO4-1* IBMi
2FC
TAP0X (XXX)

8GB 8GB
2 Compression Adaptors / SVC
4 FC 4 FC

| N1 SVC 64GB 2CPU | N2 SVC 64GB 2CPU |

22TB

FlashSystem FS900

3TB IBMi 1 No Compressed Encrypted 22 Lun Size : 140GB

3TB IBMi 2 Compressed Encrypted 22 Lun Size : 140GB

3TB IBMi 3 No Compressed Encrypted 22 Lun Size : 140GB

3TB IBMi 4 Compressed Encrypted 22 Lun Size : 140GB

FlashSystem Hardware Encryption Activated

42

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Benchmark Results - System activity

IBM i uncompressed

Average partition CPU utilization
Maximum partition CPU utilization
Average batch CPU utilization
CPU power-savings rate(Scaled CPU: Nominal CPU)
VCPU delays a percentage of Dispatched CPU

Δ 19 minutes

Disk writes
Dispatched CPU
Disk page faults
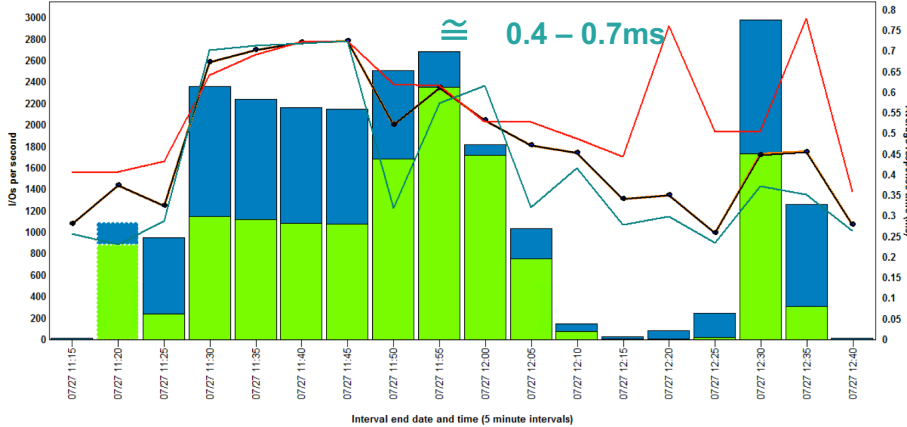
IBM i compressed

70 % disk space saving
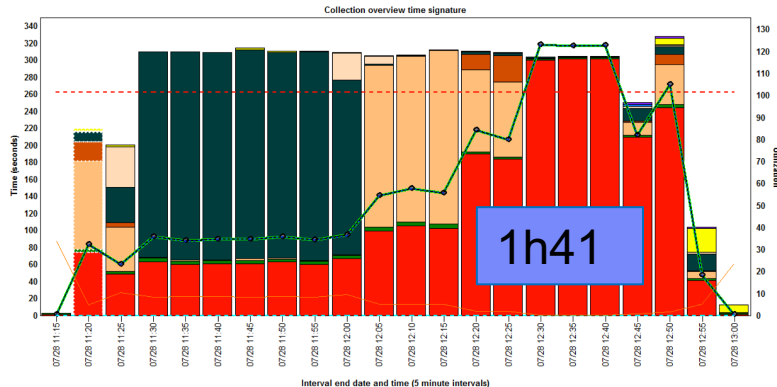
1h22

1h41

Benchmark Results - Disk activity

IBM i uncompressed

≅ 0.4 – 0.7ms

Read/write rates for ASP 1

- ■ Average read response time (ms)
- ■ Average service time (ms)
- ■ Average response time (ms)
- ■ Average write response time (ms)

- ■ Writes per second
- ■ Reads per second

IBM i compressed

70 % disk space saving

≅ 1 ms

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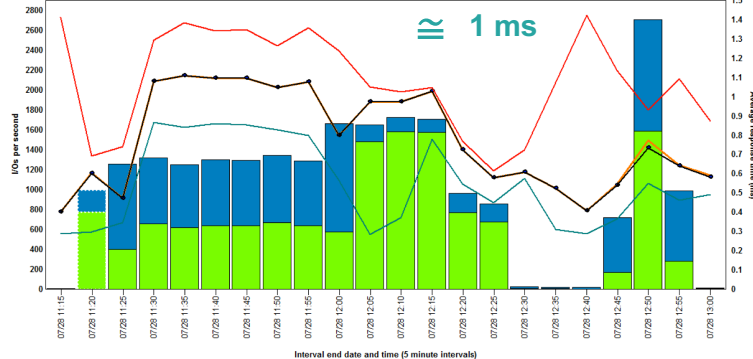
Storage Overall I/O rate & Latency : TPC

**IBM i
uncompressed**

Capacity	Real Capacity	Used Capacity	Compression Savings
140.00 GiB	15.55 GiB	12.73 GiB	72.29% (33.22 GiB)
140.00 GiB	15.58 GiB	12.77 GiB	72.21% (33.19 GiB)
140.00 GiB	15.58 GiB	12.77 GiB	72.20% (33.17 GiB)
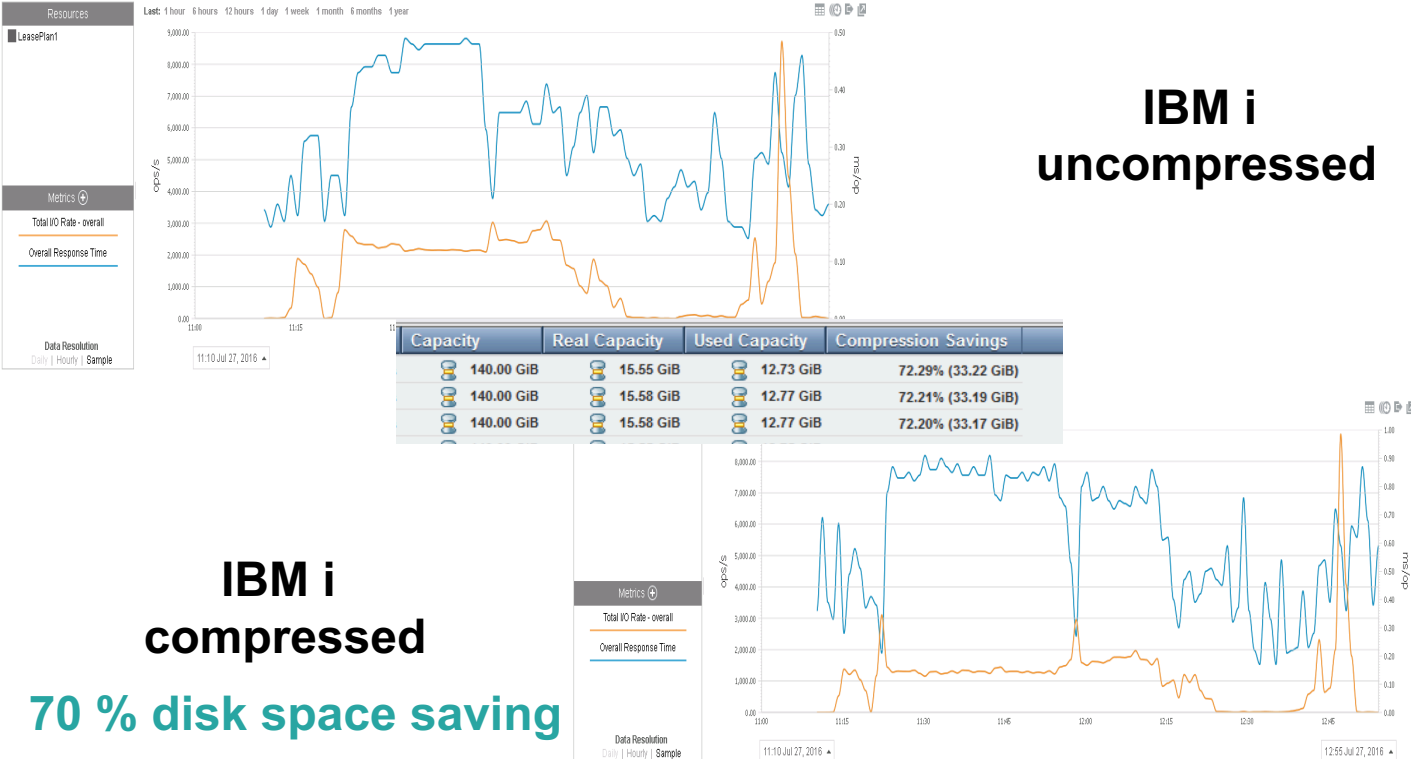
**IBM i
compressed**

70 % disk space saving

Conclusion

- **Original Daily batch run : 2h**
  - compressed : **1h41**
  - uncompressed : **1h22**

- **Original Weekly backup : 9h**
  - DS8K/LTO3 vs Flash/LTO6
  - compressed : **3h30**
  - uncompressed : **3h**

Conclusion

Batch time

- Original - Compressed - uncompressed

Batch	
Original	02:00:00
Compressed	01:41:00
uncompressed	01:22:00

Project is hold on

Conclusion

Backup time

- Original
- Compressed
- uncompressed

Backup

- 09:00:00
- 03:30:00
- 03:00:00

Project is hold on

for Business
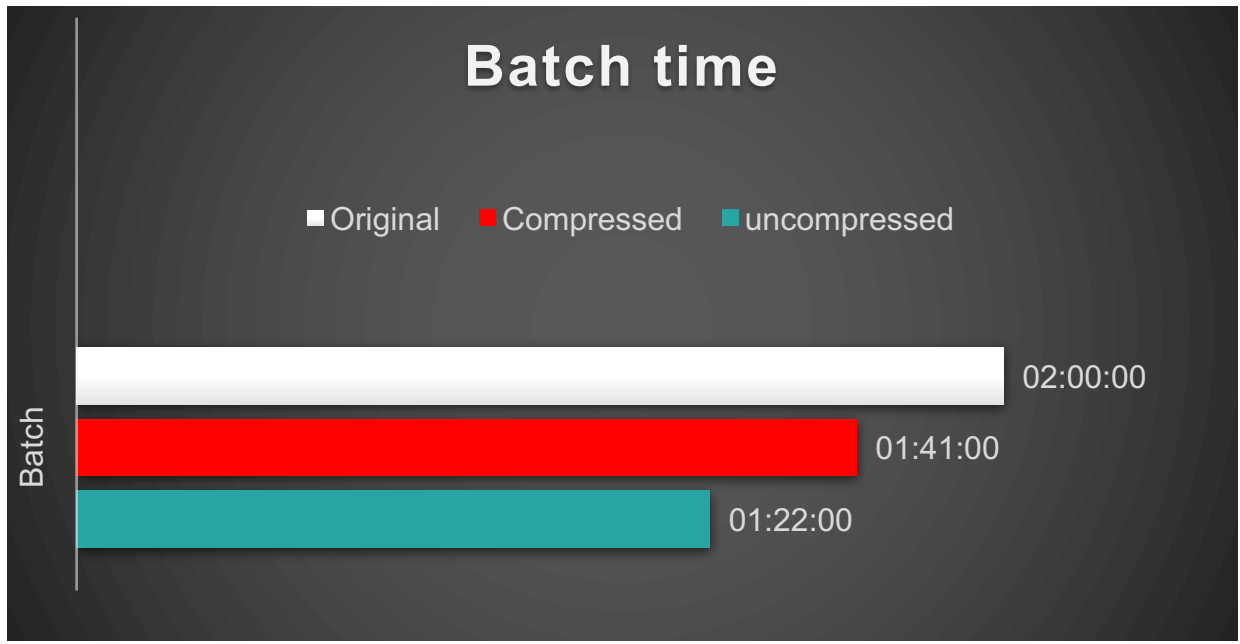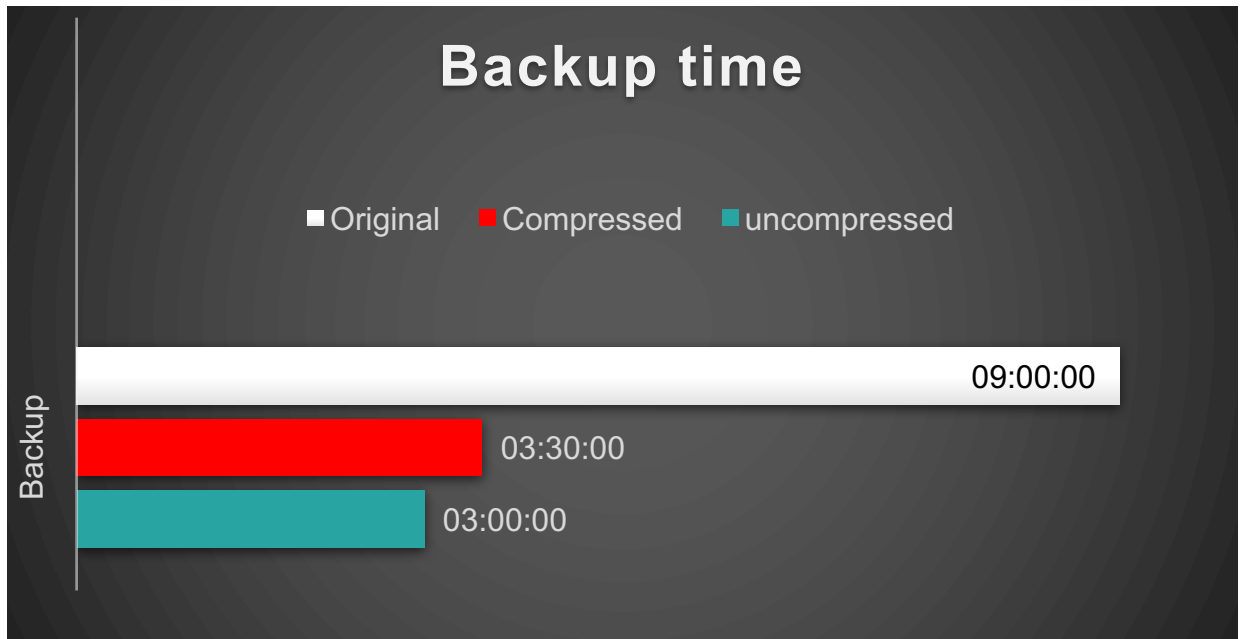
COMPARATIVE STORAGE

Comparative storage

Description of the workload

- **Writefile (WF)**: RPG programs that write to 24 files at the same time, 70 million records to each file in 24 jobs. The record in each file is 75 packed decimal. OVRDBF with FRCRATIO(1000) is used for each file.

- **Readfile (RF)**: RPG programs that sequentially read the files with 70 million records that were written with WF in 24 jobs. Each file is red 16 times. OVRDBF with SEQONLY(*YES 2000) is used on each file.

Power 8 Configuration

VIOS

OLERON
Data Collected: 05-11-2017, 15:15:00 PM

Data Collection

Processor Usage / Peak	4%	Installed: 16.00 Average: 0.58
		Activated: 16.00 Peak: 5.08
		Available: 8.00

Memory Allocated / Available	52%	Installed: 512.0 Average: 264.0
		Activated: 512.0 Peak: 264.0
		Available: 235.0

Network I/O Usage	0%	Sent/Received: 0.000 TB/s
		Sent/Received: 0.000 packets/s

Storage I/O Usage	35%	Written: 12.387 KB/s
		Read: 0.067 KB/s

View Performance Dashboard

OLERON

i   C₊

⏻ **Operating**

⚠ **Attention LED**

2%
52%
0%
36%

D-OLERON-VIOS1

i   C₊

⏻ Not activated

0.50 PU 4 VP

4.00 GB Allocated

D-OLERON-VIOS2

i   C₊

⏻ **Running**

0.4%
4 GB Allocated

12%
9%

IBM i partitions

DIRECT_IBMi

i   C₊

⏻ **Running**

⚠ **Attention LED**

9%
128 GB Allocated

0%
0%

EJ14-IBMi

i   C₊

⏻ Not activated

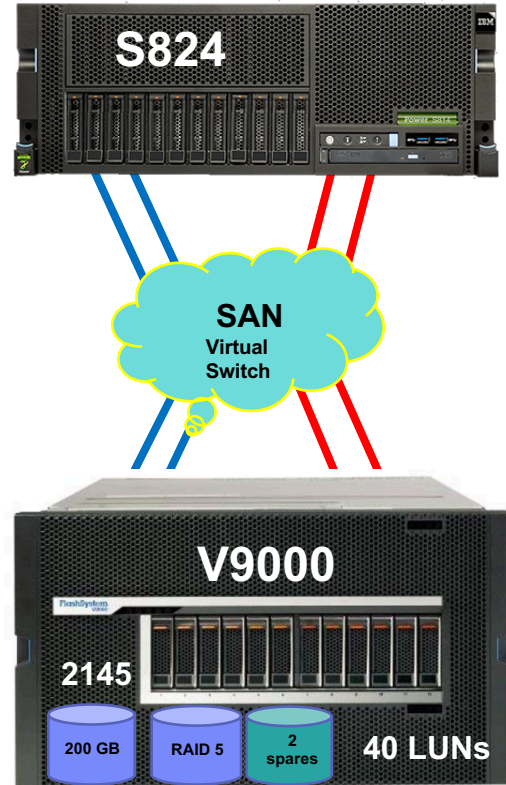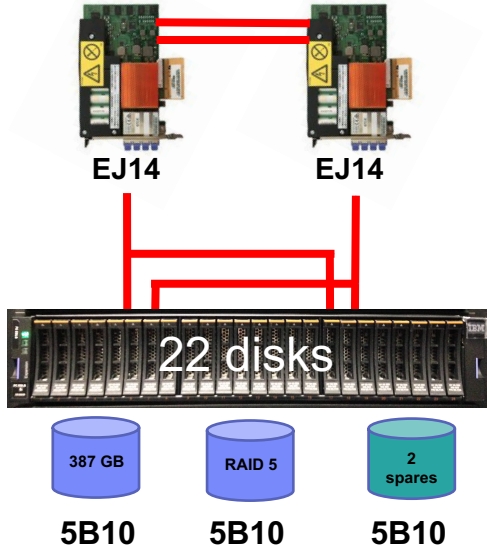0.00 Processors Allocated

0.00 GB Allocated

VIOS_IBMi

i   C₊

⏻ Not activated

1.00 Processors Allocated

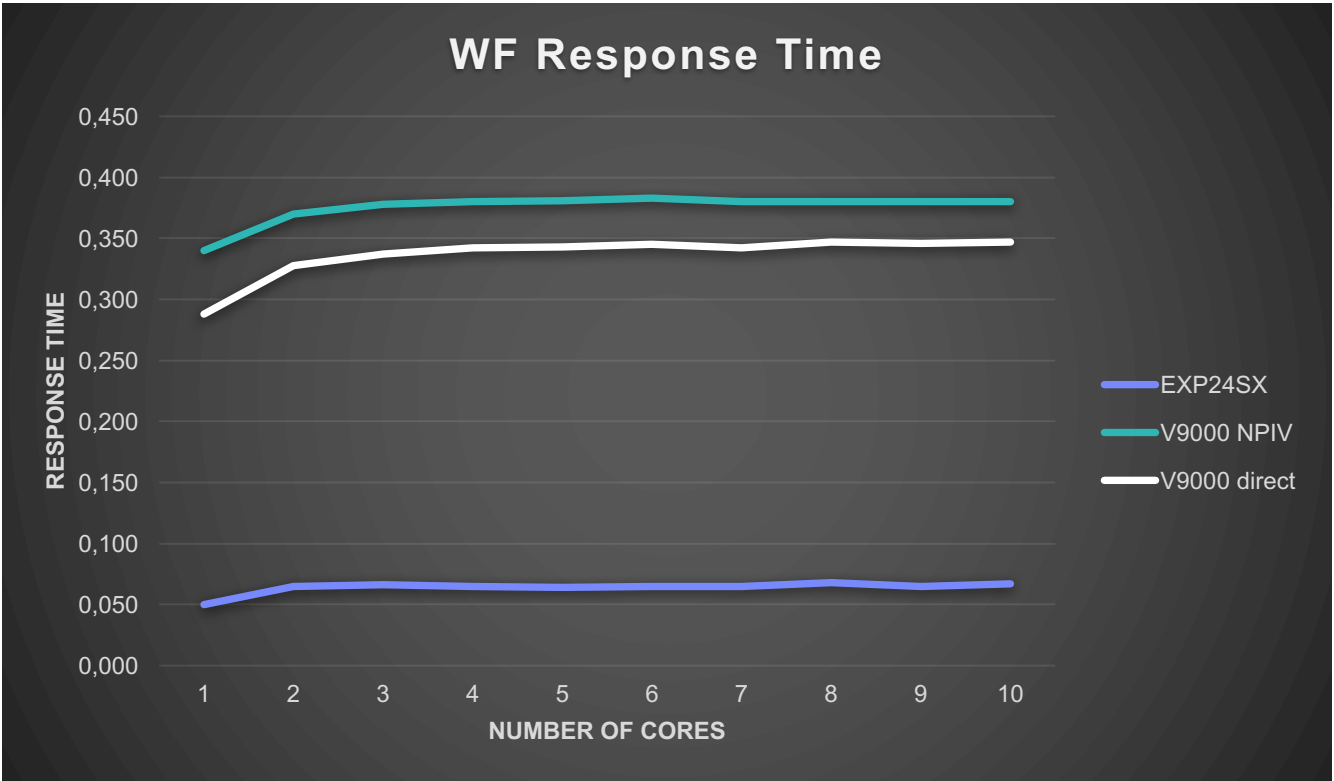128.00 GB Allocated

Storage Configuration

S824

SAN
Virtual
Switch

EJ14   EJ14

22 disks

387 GB   RAID 5   2 spares

5B10   5B10   5B10

V9000

2145   200 GB   RAID 5   2 spares   40 LUNs

NPIV
Direct Attach

WF Response Time

RF Response Time

RF Response time

Legend:
- EXP24SX
- V9000 NPIV
- V9000 direct

X-axis: NUMBER OF CORES (1–10)
Y-axis: RESPONSE TIME (0 – 1,4)

WF I/O per second

WF I/O per second

Chart showing NUMBER I/OS (y-axis, 0 to 160000) versus NUMBER OF CORES (x-axis, 1 to 10) for three series:
- EXP24SX
- V9000 NPIV
- V9000 direct
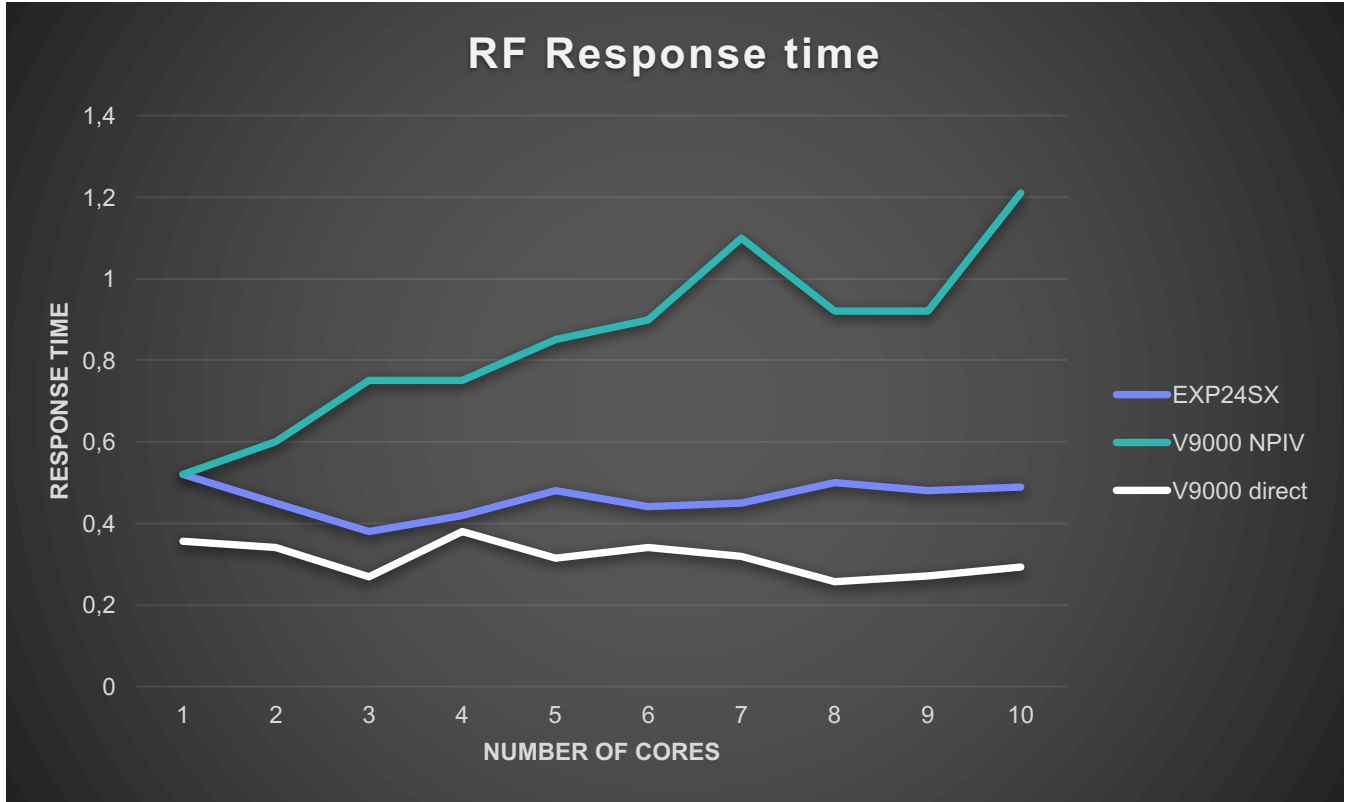
RF I/O per second

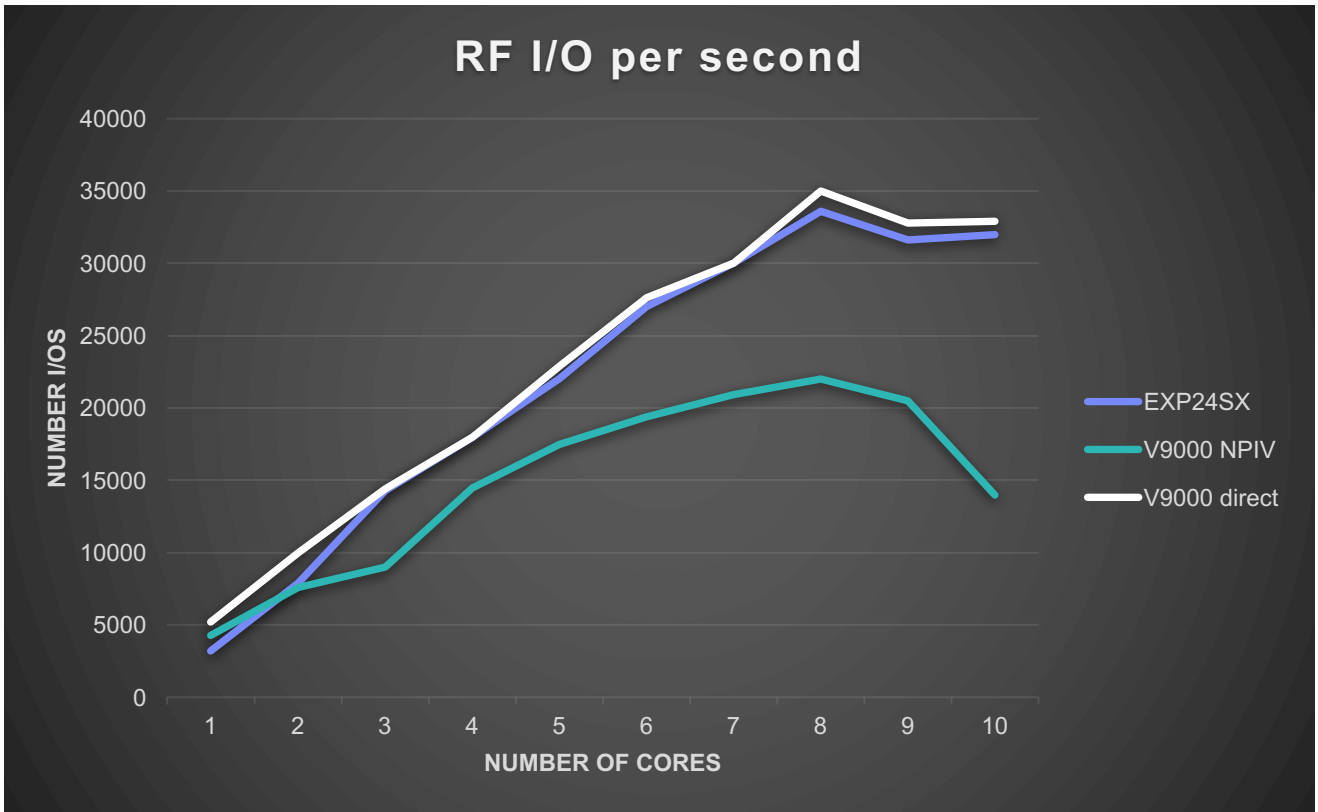RF I/O per second — chart of NUMBER I/OS versus NUMBER OF CORES, comparing EXP24SX, V9000 NPIV, and V9000 direct.
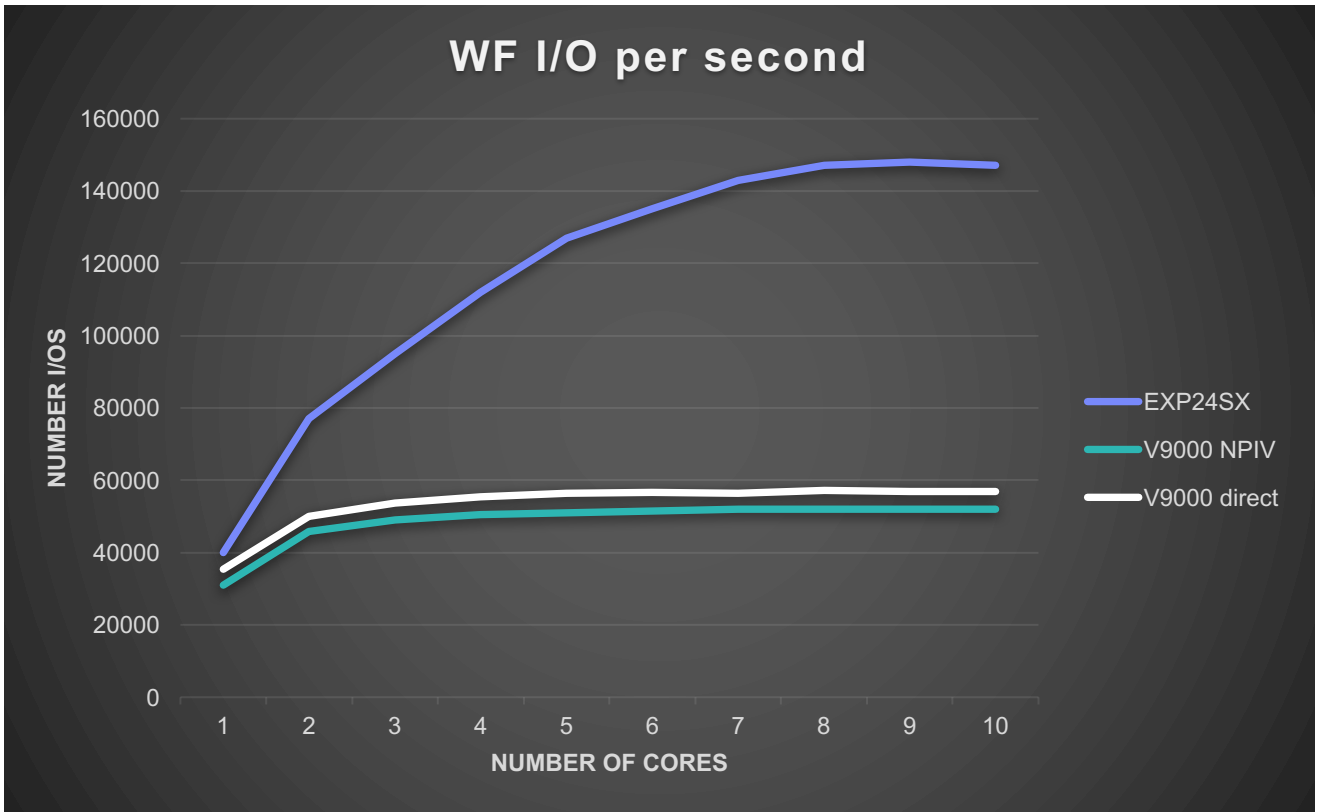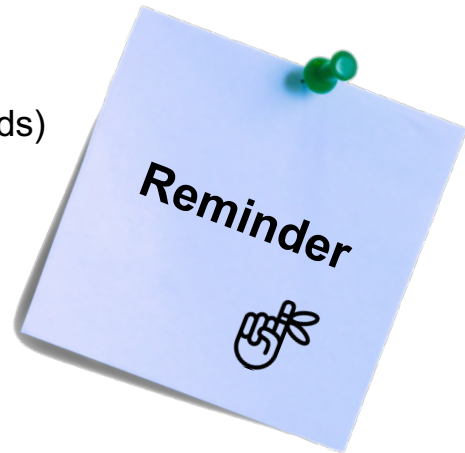
The key point is

- EJ14/EXP24SX + SSD Best performance

- Flashsystem and EJ14/EXP24SX Read intensive same performance

- External storage : FlashCopy, Windows reduction, best way to manage LUNs

- IBM i workload : 80-20 (80% writes – 20% reads)

- It depends on the workload

Reminder

- Questions ?

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