z/TPF V1.1

TPF Users Group Fall 2007
Title: z/TPF I/O Performance Study

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Venue: System Control Program

AIM Enterprise Platform Software
IBM z/Transaction Processing Facility Enterprise Edition 1.1.0

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Agenda

- **Objectives**
- **IBM Team**
- **Hardware and Configuration**
- **Key Results**
  - Workload Development
  - Throughput Scaling
  - Adaptive Record Caching
  - FlashCopy Performance
  - Failover Test Results
- **Future Work**
- **Summary and Conclusions**

Objectives

- **Use z/TPF as a high intensity I/O driver for performance testing of large scale system including storage, processor and software**
- **Demonstrate the outstanding performance, throughput and scalability of a z/TPF system**
- **Validate the resilience and performance of z/TPF in an I/O failover scenario**
- **Incorporate the knowledge gained to improve the I/O performance of a z/TPF complex**

IBM Team

- **This project was a collaborative effort across the following IBM organizations**
  - TPF Development (Poughkeepsie)
  - Enterprise Disk Performance (Tucson)
  - zSeries Performance (Poughkeepsie)
- **Cross team skills used to analyze the complete hardware/software stack**

z/TPF Configuration

- **z/TPF (PUT 03)**
- **AIR1 driver**
  - Random 4 KB I/O evenly distributed across:
    - 5M 4 KB records – FINDC
      - Configurable up to 15M records
    - 50K 4 KB records – FILEC
      - Configurable up to 2M records
    - 3 Device types – A (147K), B(473K), and C(4.43M)
  - Other macros mixed in – storage access, CREMC, etc
  - Simulated SNA network
    - Project underway to upgrade AIR1 to use TCP/IP
- **TPF Operations Server 1.2.04**

Hardware Configuration

- **z9 processor, model 2094-S18, 2 books, 18-way**
  - 128 Gb memory
  - 32 FICON Express2 2Gb channels
  - 1-16 I-Streams
  - VTS TS7740 and 3592-E05 TS1120
  - 4 SAPs
- **DS8300 Turbo, 2107- 9B2 dual frame, dual SFI**
  - 64 GB total cache memory (32 GB per SFI)
  - 2 GB write cache total (1 GB per SFI)
  - 384 x 146 GB 15K RPM disks (48 RAID
  - 16 x 2 Gb LW host adapters
  - 4 x 720 TPF volumes (3390-9) = 26 TeraBytes usable storage
    - Note: 720 volumes used for performance testing, remainder for copies
  - Configured for resilience to rank, server cluster or SFI failure

z/TPF Workload Characteristics

- **Total storage – 18 GB**
- **VFA storage – 12 GB**
- **1-16 way MP**
- **170K I/O per second max**
- **20K Messages per second**
- **Destage percentage – 10-13%**
- **Read Hit percentage – 96%**
- **Reads per writes – 1.13**

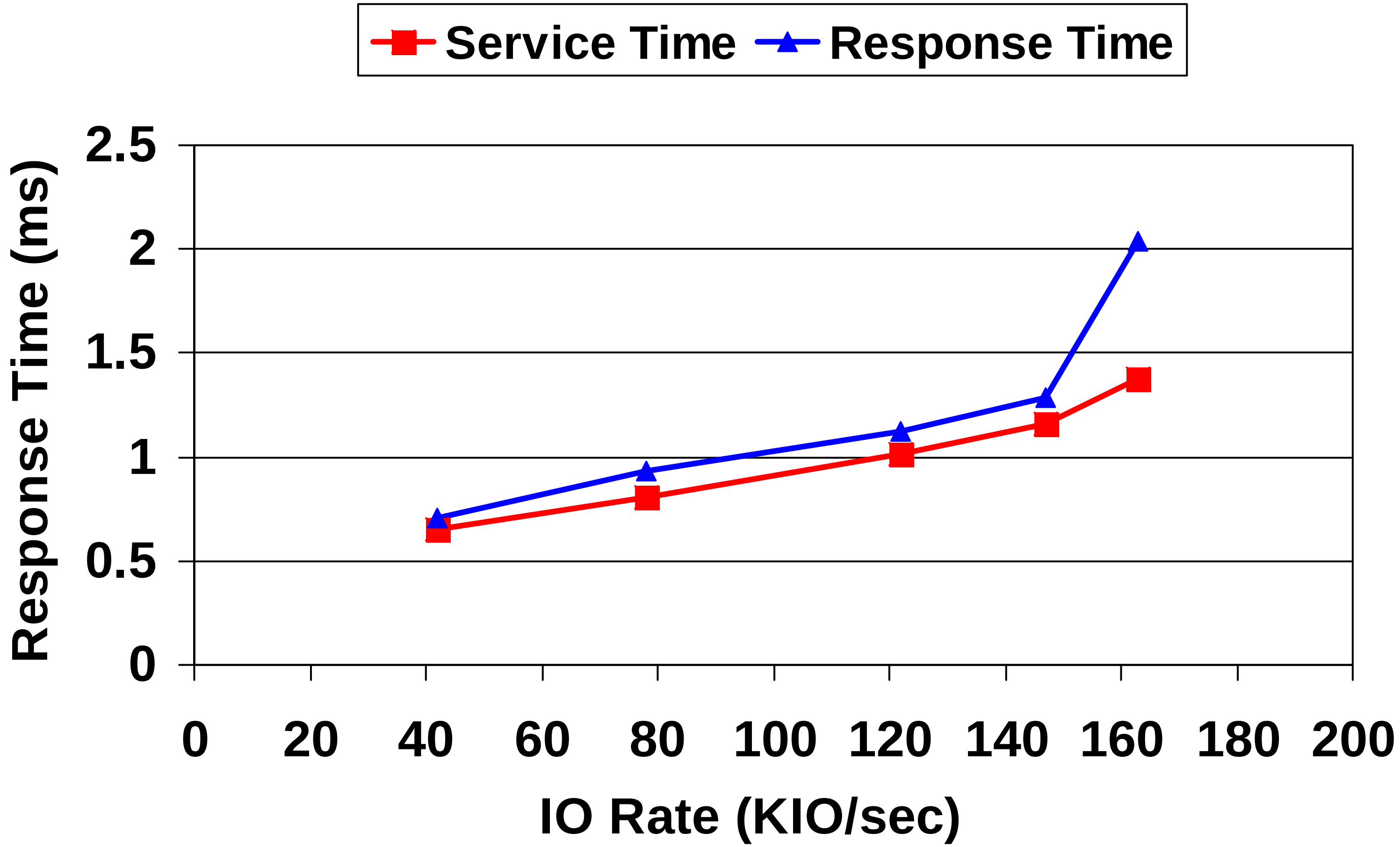
Processor testing

- **Validated processor hardware architecture efficiency for z/TPF workload**
  - Processor Instrumentation
  - Complete instruction traces
  - Processor cache modeling
  - Data Collection
  - Continuous Data Collection
  - Software profiler
- **Verified predicted MP ratio**
  - 1 – 16 way MP

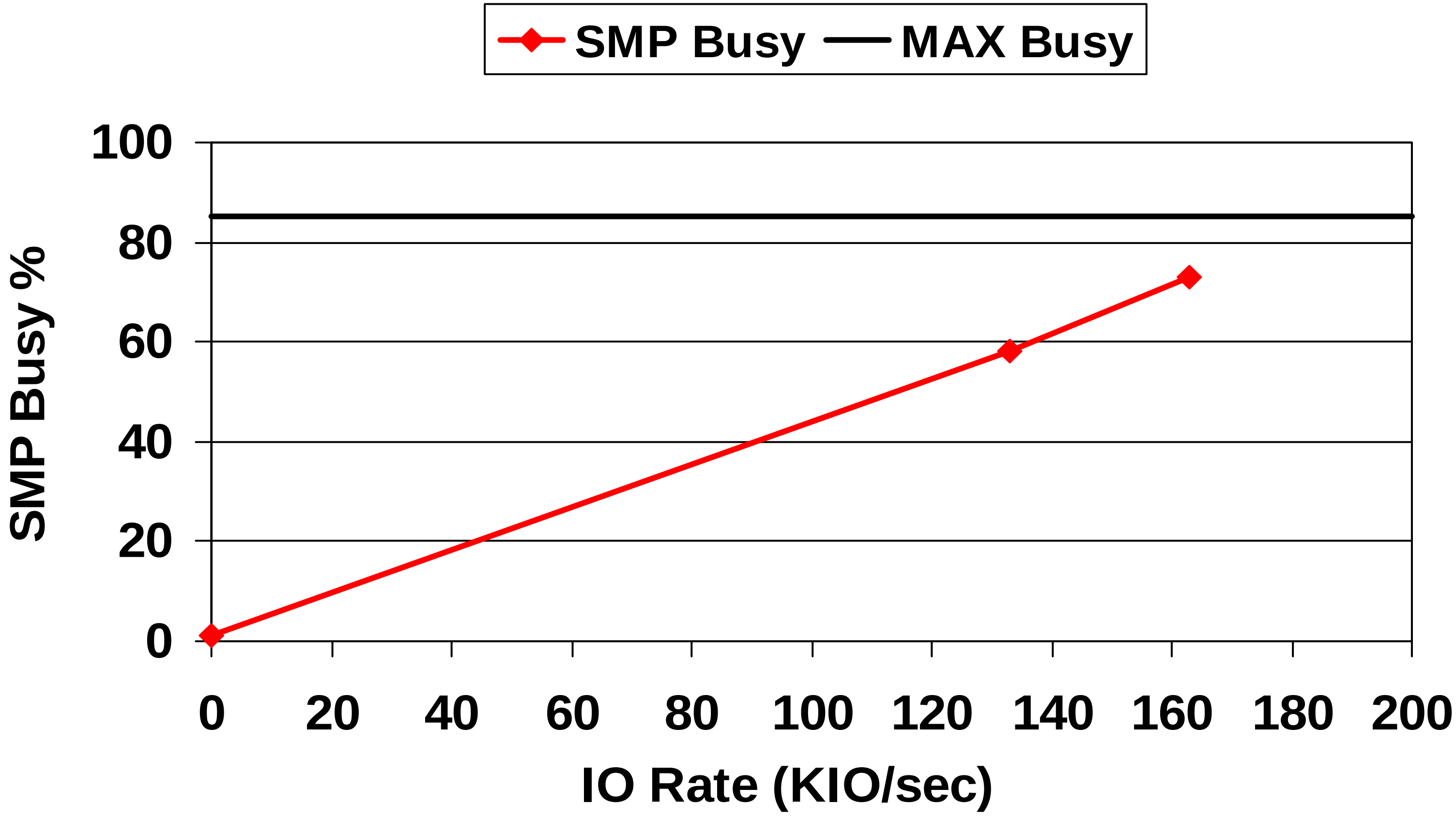
DS8300 Volume Configuration Overview

- **A total of 2880 x 3390-9 volumes were configured**
  - 720 connected to TPF Test system (Test set)
  - 720 connected to z9 host for Performance testing (Perf set)
  - The remainder were allocated for Flash Copy targets, Metro Mirror secondary volumes and spares
- **A total of 36 LCUs were created on 48 RAID ranks**
  - Three LCUs striped across groups of four RAID ranks
  - 20 volumes per LCU in performance set
- **For the performance test volume set**
  - Prime and dup. volumes were placed on separate RAID ranks, SFIs and server clusters for resilience in case of a hardware failure

TPF Disk Ramp Test Results

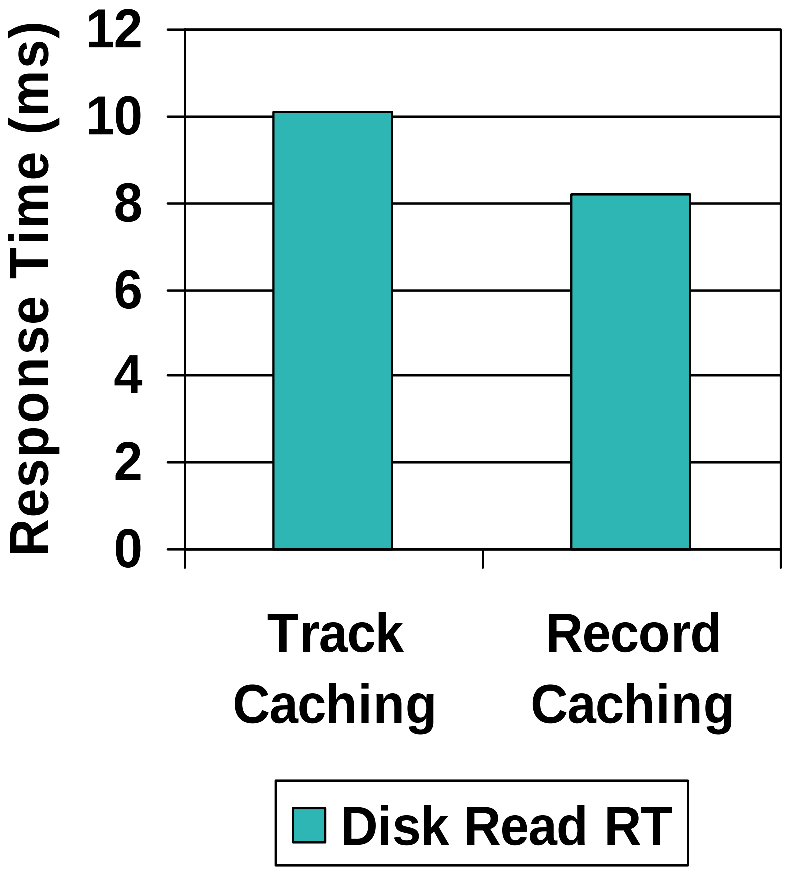


DS8300 Command History SMP Utilization Results



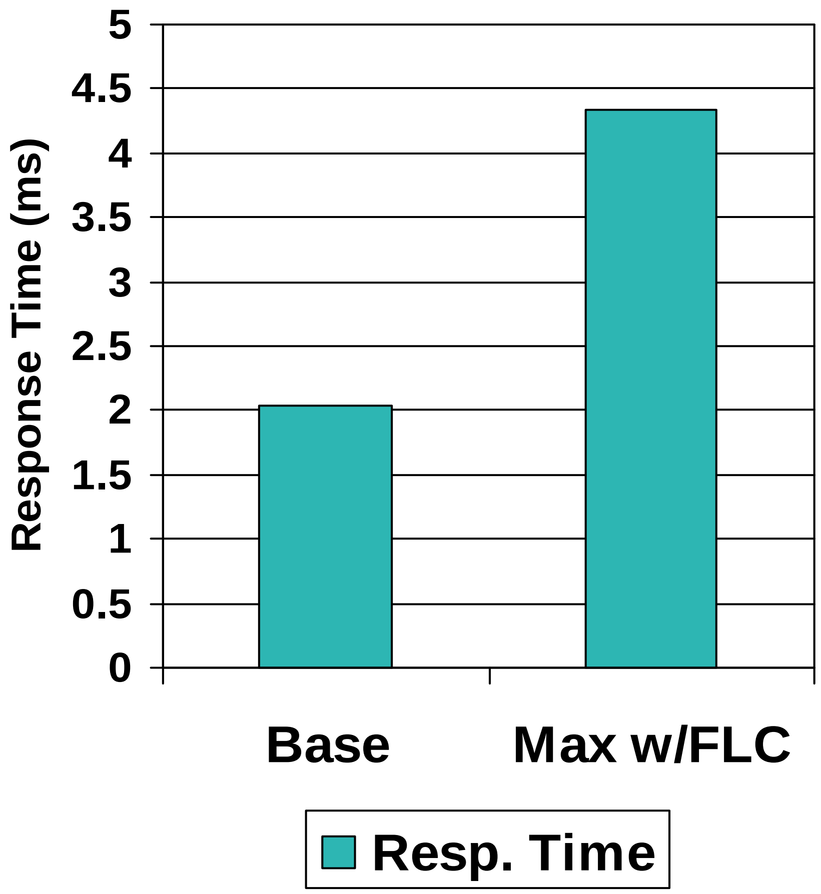
Note: Practical maximum for SMP Busy from Command History is about **85%** because internal mail dispatching times are not measured

Adaptive Record Caching



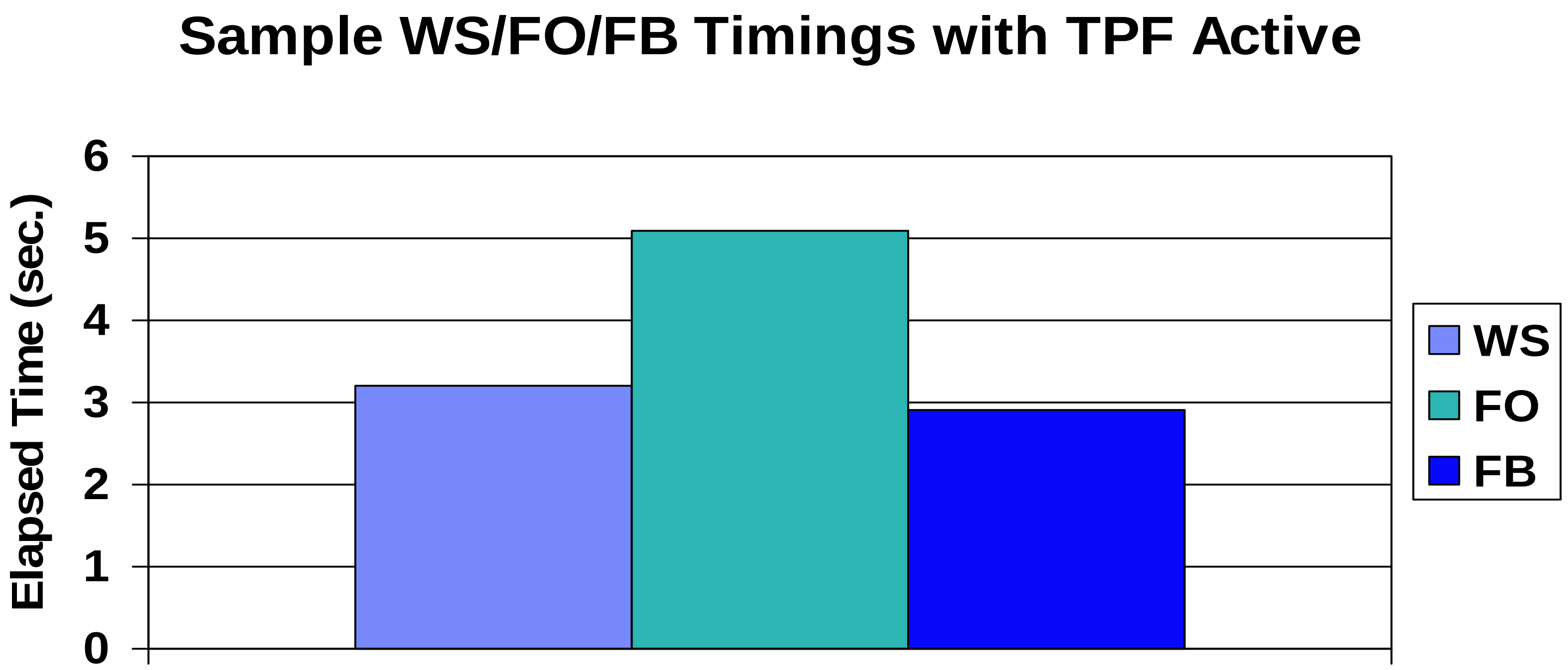
- **Average stage size reduced from 57 KB (full track) to 21 KB when using adaptive record caching.**
- **Adaptive record caching is the default setting for DS8000 and ESS**
- **19% RT improvement with record caching**
  - Drive more disk IOPS
  - Better read miss performance

TPF Disk Performance with FlashCopy



- Workload was running at 164 KIO/sec on the DS8300
- Base is without FlashCopy
- FlashCopy w/ background copy started on 360 prime volumes
- Max FLC is the maximum observed response time after the FlashCopy was initiated (Max IOB count)
- This is a worst case scenario. Normally FlashCopy would be initiated when the host workload was more moderate

TPF I/O Hardware Error Handling Behavior



WS - Warmstart, reset memory in both server clusters

FO - Failover, one server cluster takes over for the other

FB – Failback, the failed server cluster is brought back online

Useful information for tuning TPF shutdown parameters

Future Work Plans

- **Further MP testing beyond 16-way**
- **Loosely Coupled**
- **Remote Copy**
- **Multi-Path Reconnect**
- **Study different TPF workload variations**
- **Study/Improve Error Handling Behavior timings and TPF resiliency**

Summary and Conclusions

- **Very satisfactory results from this full scale z/TPF I/O performance test**
  - Excellent throughput and scalability
  - Performance and resilience meet expectations during simulated I/O hardware failures
- **This type of cross-brand collaboration will continue**
  - Results of studies like this feed into future product designs

Backup

Materials

DS8300 Volume Configuration (repeated six times)

Server 0

Rank 0	Sets	**LSS0**	(P,D)	**LSS2**	(P,D)	**LSS4**	(P,D)
R-10 3+3	TEST	4	(2,2)	4	(2,2)	4	(2,2)
48 x 3390-9	PERF	4	(2,2)	4	(2,2)	4	(2,2)
	FC TGT	2	(2,0)	2	(2,0)	2	(2,0)
	PPRC SEC	4	(2,2)	4	(2,2)	4	(2,2)
	SPARE	2		2		2	
	TOTAL	**16**		**16**		**16**	
	48						

Rank 2	Sets	**LSS0**	(P,D)	**LSS2**	(P,D)	**LSS4**	(P,D)
R-10 4+4	TEST	6	(3,3)	5	(3,2)	5	(2,3)
64 x 3390-9	PERF	5	(2,3)	6	(3,3)	5	(3,2)
	FC TGT	3	(3,0)	3	(3,0)	2	(2,0)
	PPRC SEC	5	(3,2)	5	(2,3)	6	(3,3)
	SPARE	2		3		3	
	TOTAL	**21**		**22**		**21**	
	64						

Rank 4	Sets	**LSS0**	(P,D)	**LSS2**	(P,D)	**LSS4**	(P,D)
R-10 4+4	TEST	5	(2,3)	6	(3,3)	5	(3,2)
64 x 3390-9	PERF	5	(3,2)	5	(2,3)	6	(3,3)
	FC TGT	2	(2,0)	3	(3,0)	3	(3,0)
	PPRC SEC	6	(3,3)	5	(3,2)	5	(2,3)
	SPARE	3		2		3	
	TOTAL	**21**		**21**		**22**	
	64						

Rank 6	Sets	**LSS0**	(P,D)	**LSS2**	(P,D)	**LSS4**	(P,D)
R-10 4+4	TEST	5	(3,2)	5	(2,3)	6	(3,3)
64 x 3390-9	PERF	6	(3,3)	5	(3,2)	5	(2,3)
	FC TGT	3	(3,0)	2	(2,0)	3	(3,0)
	PPRC SEC	5	(2,3)	6	(3,3)	5	(3,2)
	SPARE	3		3		2	
	TOTAL	**22**		**21**		**21**	
	64						

Server 1

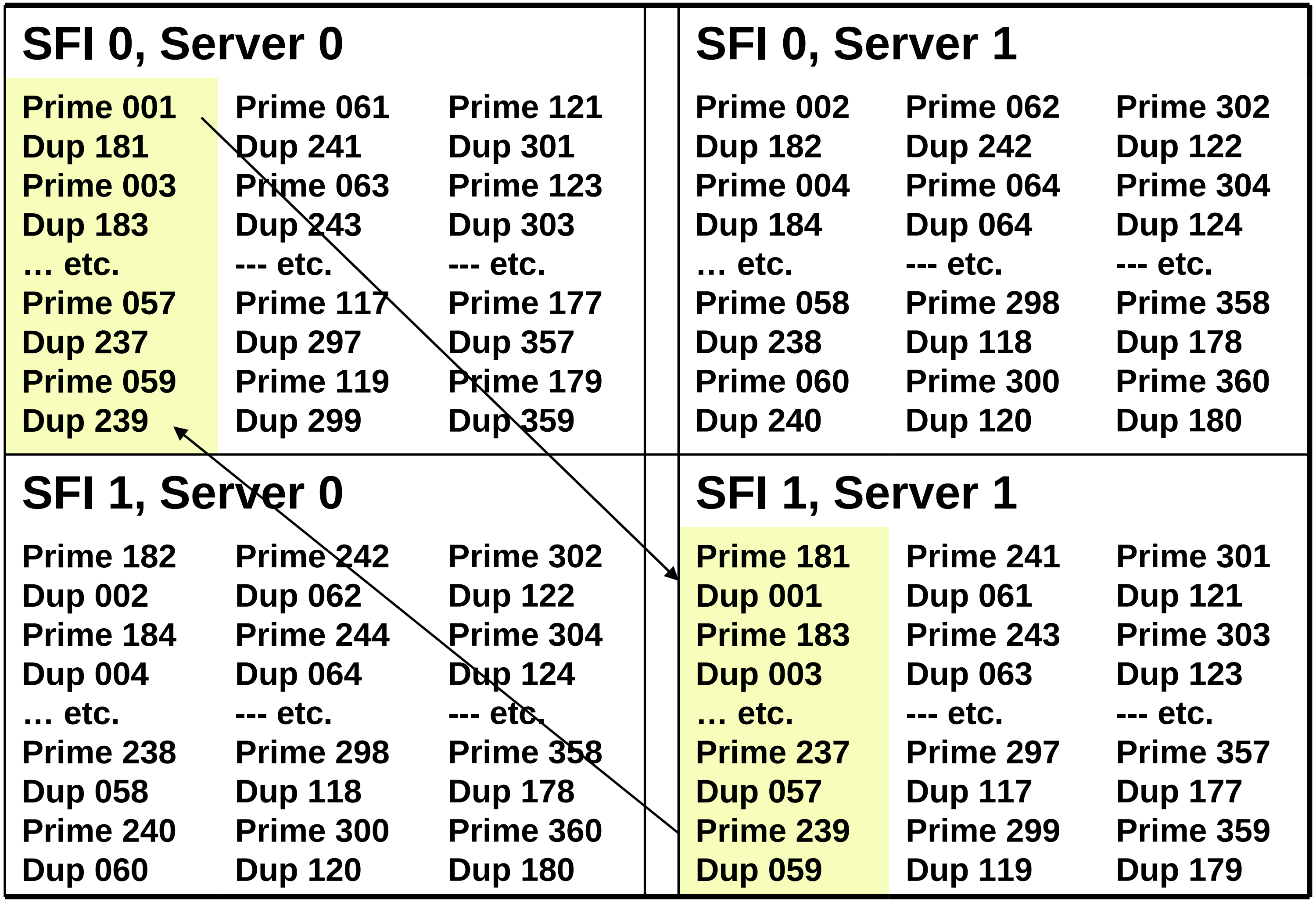
Rank 1	Sets	**LSS1**	(P,D)	**LSS3**	(P,D)	**LSS5**	(P,D)
R-10 3+3	TEST	4	(2,2)	4	(2,2)	4	(2,2)
48 x 3390-9	PERF	4	(2,2)	4	(2,2)	4	(2,2)
	FC TGT	2	(2,0)	2	(2,0)	2	(2,0)
	PPRC SEC	4	(2,2)	4	(2,2)	4	(2,2)
	SPARE	2		2		2	
	TOTAL	**16**		**16**		**16**	
	48						

Rank 3	Sets	**LSS1**	(P,D)	**LSS3**	(P,D)	**LSS5**	(P,D)
R-10 4+4	TEST	6	(3,3)	5	(3,2)	5	(2,3)
64 x 3390-9	PERF	5	(2,3)	6	(3,3)	5	(3,2)
	FC TGT	3	(3,0)	3	(3,0)	2	(2,0)
	PPRC SEC	5	(3,2)	5	(2,3)	6	(3,3)
	SPARE	2		3		3	
	TOTAL	**21**		**22**		**21**	
	64						

Rank 5	Sets	**LSS1**	(P,D)	**LSS3**	(P,D)	**LSS5**	(P,D)
R-10 4+4	TEST	5	(2,3)	6	(3,3)	5	(3,2)
64 x 3390-9	PERF	5	(3,2)	5	(2,3)	6	(3,3)
	FC TGT	2	(2,0)	3	(3,0)	3	(3,0)
	PPRC SEC	6	(3,3)	5	(3,2)	5	(2,3)
	SPARE	3		2		3	
	TOTAL	**21**		**21**		**22**	
	64						

Rank 7	Sets	**LSS1**	(P,D)	**LSS3**	(P,D)	**LSS5**	(P,D)
R-10 4+4	TEST	5	(3,2)	5	(2,3)	6	(3,3)
64 x 3390-9	PERF	6	(3,3)	5	(3,2)	5	(2,3)
	FC TGT	3	(3,0)	2	(2,0)	3	(3,0)
	PPRC SEC	5	(2,3)	6	(3,3)	5	(3,2)
	SPARE	3		3		2	
	TOTAL	**22**		**21**		**21**	
	64						

Placement of Primes and Dups for Resilience



SFI 0, Server 0

Prime 001
Dup 181
Prime 003
Dup 183
… etc.
Prime 057
Dup 237
Prime 059
Dup 239

Prime 061
Dup 241
Prime 063
Dup 243
--- etc.
Prime 117
Dup 297
Prime 119
Dup 299

Prime 121
Dup 301
Prime 123
Dup 303
--- etc.
Prime 177
Dup 357
Prime 179
Dup 359

SFI 0, Server 1

Prime 002
Dup 182
Prime 004
Dup 184
… etc.
Prime 058
Dup 238
Prime 060
Dup 240

Prime 062
Dup 242
Prime 064
Dup 064
--- etc.
Prime 298
Dup 118
Prime 300
Dup 120

Prime 302
Dup 122
Prime 304
Dup 124
--- etc.
Prime 358
Dup 178
Prime 360
Dup 180

SFI 1, Server 0

Prime 182
Dup 002
Prime 184
Dup 004
… etc.
Prime 238
Dup 058
Prime 240
Dup 060

Prime 242
Dup 062
Prime 244
Dup 064
--- etc.
Prime 298
Dup 118
Prime 300
Dup 120

Prime 302
Dup 122
Prime 304
Dup 124
--- etc.
Prime 358
Dup 178
Prime 360
Dup 180

SFI 1, Server 1

Prime 181
Dup 001
Prime 183
Dup 003
… etc.
Prime 237
Dup 057
Prime 239
Dup 059

Prime 241
Dup 061
Prime 243
Dup 063
--- etc.
Prime 297
Dup 117
Prime 299
Dup 119

Prime 301
Dup 121
Prime 303
Dup 123
--- etc.
Prime 357
Dup 177
Prime 359
Dup 179

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