



A Toshiba Group Company

Case Study



888.com Eliminates Database SAN Bottlenecks and Accelerates SQL Server Performance with OCZ's PCIe-based ZD-XL SQL Accelerator

Reducing the External SAN Load by 50% Negated the Need for Costly Storage Upgrades

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1 Objectives and Results

User Objectives

- Reduce database I/O pressure on the SAN
- Reduce/eliminate SAN storage bottlenecks
- Reduce/eliminate annual storage upgrade costs
- Improve SQL Server database performance
- Accelerate key business analytics

Return on Investment (ROI)

- Reduced I/O load on the SAN by approximately 50% alleviating workload pressure placed on it. The overall result made the SAN more efficient and the reduction in I/O traffic enabled the SAN to be used more efficiently for storing additional application data.
- Eliminated the need for annual storage system equipment purchases and associated costs, generating a ROI within several months of deployment.

2 Online Gaming Overview

Online gaming is described as any activity where a person uses the internet to collaboratively play games and is a well-established form of entertainment as the first known websites were launched in the mid-1990s. Since that time, online gaming has been refined dramatically so that the clunky games with poor





The 888 Group is one of the world's most popular online gaming providers having been at the forefront of this industry for over a decade.

graphics are gone. Today's online gaming websites are slick entertainment portals of which almost any game is shared amongst the extensively wide user base.

The global online gaming industry has become one of the biggest and most rapidly expanding markets (according to Research and Markets, a leading international market source based in Dublin, Ireland). With a net worth of \$37 billion at present, online gaming has expanded at a rate of 2.5% annually (beginning after the 2009 global economic recession slowdown), and is expected to continue this trend over the next five years. Europe has become the fastest growing online gaming market (recording an increase of almost 45% of the total online gaming yield). However, due to recent regulation changes, the U.S. market is expanding dramatically.

The global interactive gaming market generated approximately \$37.60 billion in revenue in 2013 and is expected to achieve \$39.50 billion in revenue for 2014 according to Global Betting and Gaming Consultants (GBGC) Analysis. These numbers are based on such interactive gaming categories as wagering (betting on sports events or horse racing), casino games, poker, bingo, skill games (chess, backgammon and gin rummy), and state lotteries.

3 Introduction to 888 Holdings and The 888 Group

888 Holdings Public Limited Company (PLC) is the umbrella organization for one of the world's most popular online gaming providers (The 888 Group) having been at the forefront of this industry for over a decade. It is a publicly traded company on the London Stock Exchange (LSE:888) and employs over 800 full-time workers around the globe. Players are afforded 24x7x365 customer support with assistance available in 11 different languages by phone, email or live online chat.

The 888 Group has several large data centers including one in Gibraltar and in the key American-based gambling hubs of Las Vegas, Nevada and Atlantic City, New Jersey.

The 888 Group's consumer facing websites offer more than just online gaming and are entertainment destinations where people can enjoy an interactive experience and be part of an online community that shares this common interest. Players are afforded a variety of gaming sites such as:



The 888 Group's Gaming Sites

Include:

888.com

Casino-on-Net

Reef Club Casino

888poker

888ladies

888bingo

888sport

888games

- **888.com**

The flagship gaming website includes all of the sites below

- **Casino-on-Net (or 888casino)**

Online casino website has served over 13 million people since its initial launch in May 1997 and includes traditional casino games such as slot machines, craps, blackjack, baccarat, roulette, pai-gow poker, video poker and keno

- **Reef Club Casino**

Online casino website offers an underwater theme to provide a more fantasy-styled alternative to Casino-on-Net

- **888poker**

Online poker website focuses exclusively on poker variants such as Texas Hold'em, Omaha and 7-card Stud

- **888ladies**

Online bingo website offers 75-ball and 90-ball games

- **888bingo**

Alternative online bingo website offers a completely different look and feel and a wide selection of 75-ball and 90-ball games including team bingo, slots, instant games, video poker, and table games such as blackjack, baccarat, roulette and craps

- **888sport**

Online sports betting site enables bets to be placed on a variety of sporting events including football, baseball, basketball, hockey, horse racing, tennis, cricket, rugby, auto racing and a host of other competitive events

- **888games**

Casual online gaming website hosts a variety of games from video slots to scratch cards, table games and casino games

All 888 online gaming sites are backed by complete security and over twenty different deposit methods as credit card details are stored on servers protected by the latest firewall security to prevent the thousands of transactions performed daily from unauthorized access. In order to ensure that game results are truly random, all 888 online games use the trusted MD5 Random Number Generator (RNG) to act as the 'dealer' and provide consistently random results. Additionally, The 888 Group endorses responsible gaming prohibiting anyone



*The 888 Group
implemented a Microsoft
SQL Server RDMS
in support of data
warehousing, OLTP and
OLAP applications.*

under the age of 18 to play, allowing members to set their own maximum deposit amounts and preventing a player from entering the site upon request.

As the online gaming industry continues to expand, players have come to expect the highest quality online facilities, and an objective of The 888 Group as they strive to implement new features and regular system updates to maintain their high-end websites, provide players with a world-class experience, and to stay ahead of the competition in this burgeoning market. As a result, The 888 Group is regarded as one of the world's best and most popular online gaming providers.

4 The 888 Group's SQL Server Databases

Online gaming requires a high-performance IT infrastructure that can process multi-player transactions in real-time, discover usage patterns and data relationships that provide business intelligence (BI) and deliver a world-class gaming experience. To support these requirements, The 888 Group implemented a Microsoft SQL Server RDMS (relational database management system) as part of its initial enterprise infrastructure in support of data warehousing, OnLine Transaction Processing (OLTP) and OnLine Analytical Processing (OLAP) applications.

Key 888.com SQL Server Database


Data Warehousing: provides 888.com customers with the most accurate, online gaming information of its product portfolio

OLTP: facilitates and manages all online transactions directly from the customer

OLAP: sorts through 888.com data to find undiscovered usage patterns and relationships, and through 3rd party BI software analysis tools, helps The 888 Group make good business decisions

The 888 Group's data warehouse provides players with the most accurate online gaming information of its gaming portfolio covering available games, special promotions, registration, payment methods, user agreements, rules and regulations, VIP options, etc. The accuracy of this information and the ability to deliver it in real-time can be the difference in securing players and heightening their experiences.

OLTP databases were also implemented for each gaming site to facilitate and manage all online transactions. These databases capture information



The {888 Group} SAN could not increase performance linearly due to the inherent limitations of its HDD-centric design.

surrounding the bets themselves enabling data to be segmented, grouped, stored and retrieved for a specific use-case or analysed as business intelligence. Examples of data captured include player contact information, payment information, games played, bets made, winnings earned, losses recorded, special promotions used, or any number of other variables available through the online gambling process.

Equally critical for The 888 Group is to have the ability to sort through their SQL Server data and find undiscovered usage patterns and relationships that can help improve operations, make more informed business decisions and heighten the user experience. The intelligence and analysis obtained is presented to executives in reports enabling them to determine their most visited and profitable sites, the least and most popular games played, effectiveness of advertising, promotions and VIP options, player demographics and literally any relationship captured by the databases. In many cases, the analytics must be processed as fast as possible so decisions can be made in real-time, and implemented immediately.

5 Infrastructure Challenges

The millions of database records captured, excessive combinations of bets placed daily, and the need for continuous data analysis created a requirement for a high-performance tier-1 SAN, which included annual upgrades to keep up with ever-increasing demands.

The initial system configuration included an HP ProLiant DL580 server featuring 256GB of memory with 4 processors supporting 10 processor cores used for reading and executing program instructions. This configuration was upgraded to an HP ProLiant DL980 server supporting 4 CPUs, 10 processor cores and 1TB of memory. In addition to the HP ProLiant DL980 server, the storage configuration featured a high-end SAN with multiple RAID sets and a full SSD tier featuring auto-tiering and internal caching that resides in front of the hard disk drives (HDDs).

Even with a full tier of SSDs in the SAN supported by auto-tiering and internal caching, HDD performance could not keep up with the I/O load generated by both the application and data analytic servers. While server performance jumped with the increase of RAM capacity and improved CPU performance from the HP ProLiant DL580 to the DL980, the SAN could not increase performance linearly due to the inherent limitations of its HDD-centric design as shown in Figure 1 below:

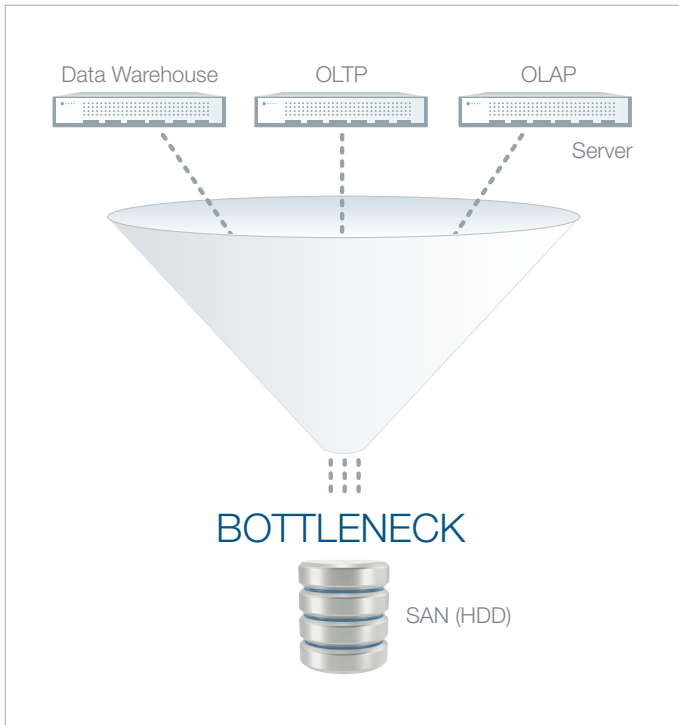


Figure 1: The disparity between server IOPS performance and HDD IOPS performance results in system strain and bottlenecks, non-optimal database performance and expensive upgrades

In order to meet the compute requirements created by the online gaming market, the IT department was required to constantly upgrade its powerful tier-1 SAN in an attempt to keep up with server IOPS and application performance demands. As the tier-1 SAN continued to grow, significantly more power and associated cooling was also required, driving up data center total cost of ownership (TCO) and total operating cost (TOC).

Given the performance challenges in general, and the need to accelerate key data analytics, the IT department decided to evaluate flash caching in 2013 as opposed to upgrading the tier-1 SAN, and in particular, adding more and more expensive HDDs to the mix. The advantages of flash caching would enable access to hot database data on flash locally for immediate use by SQL Server not only accelerating application performance but also reducing I/O pressure on the SAN. With this objective, a bake-off was conducted between selective cache solutions to obtain necessary performance statistics which included OCZ's ZD-XL SQL Accelerator.

6 The ZD-XL SQL Accelerator Solution



OCZ's ZD-XL SQL Accelerator

With the mantra of improving database performance while reducing I/O workload traffic and the strain it places on the SAN, The 888 Group identified two potential PCIe flash-based SSD solutions with caching capabilities to evaluate. One solution, OCZ's ZD-XL SQL Accelerator, was designed specifically to accelerate SQL Server applications and through their local value-added distributor, Bynet, obtained the product for testing.

ZD-XL SQL Accelerator provides optimized and efficient flash acceleration for SQL Server applications through tightly integrated hardware and software elements. It delivers fast flash speed, a unique cache mechanism that makes advanced and statistically-optimized decisions on what data to cache, and includes implementation wizards that enable database

administrators to set-up caching policies and flash resources to help guide them through a plug-and-play installation.

One very unique capability is its ability to partition the flash volumes so that temporary database (tempDB) files, such as transient calculation tables, can benefit from fast flash speed while hot data can be cached on flash locally for immediate application use resulting in optimized and accelerated SQL Server data types.

7 Innovative Flash Caching

ZD-XL SQL Accelerator partitions the flash resource pool into two parts – one that is used for flash caching while the other is used as flash volumes. This unique flash caching employs advanced SQL Server policy-based algorithms and optimized ‘application-specific’ caching policies, and through OCZ’s innovative Direct Pass Caching Technology (see Figure 2), provides The 888 Group’s IT team with advanced, statistically-optimized decisions on what data to store in cache while achieving high hit ratios.

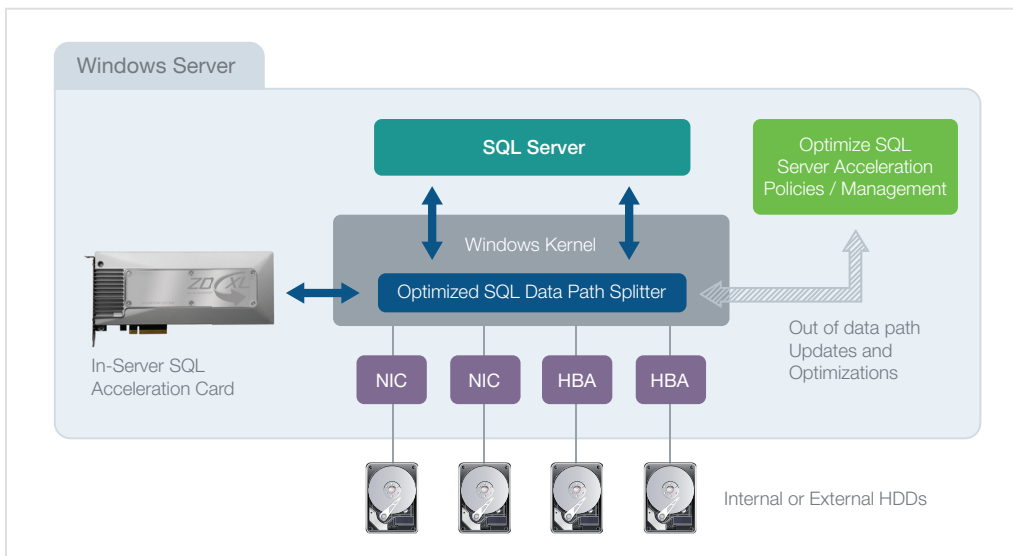


Figure 2: OCZ's innovative ZD-XL SQL Accelerator Direct Pass Caching Technology

A cache director is used to differentiate between relevant and irrelevant data access patterns filtering out background processing tasks to prevent irrelevant data from entering the cache. It dynamically sends data access metadata to the cache analysis engine which then performs deep statistical ‘out-of-band’ analysis without interfering with the

data path itself. The cache analysis engine dynamically directs the optimized selection rules back to the data path cache director so it knows what hot zones need to be inserted into flash cache. This highly advanced ‘decision engine’ is able to efficiently select what data to place in ZD-XL SQL Accelerator’s flash cache without needing to perform cycle-consuming analysis in the data path itself.

Of all the capabilities available in ZD-XL SQL Accelerator, The 888 Group deemed the Direct Pass Caching Technology as the most important to accelerate SQL Server performance and reduce database traffic so that

workload pressure placed on the SAN can be alleviated enabling it to be used more efficiently in servicing other applications.

8 TempDB Flash Volumes

The ability to efficiently place tempDB files on server-side flash volumes was an important capability that ZD-XL SQL Accelerator provided The 888 Group to improve SQL Server performance. It achieves this by exposing part of its flash storage capacity as a volume for tempDB usage while simultaneously exposing other portions of its flash volume for use as a hot data cache as discussed in the previous section and depicted in Figure 3.

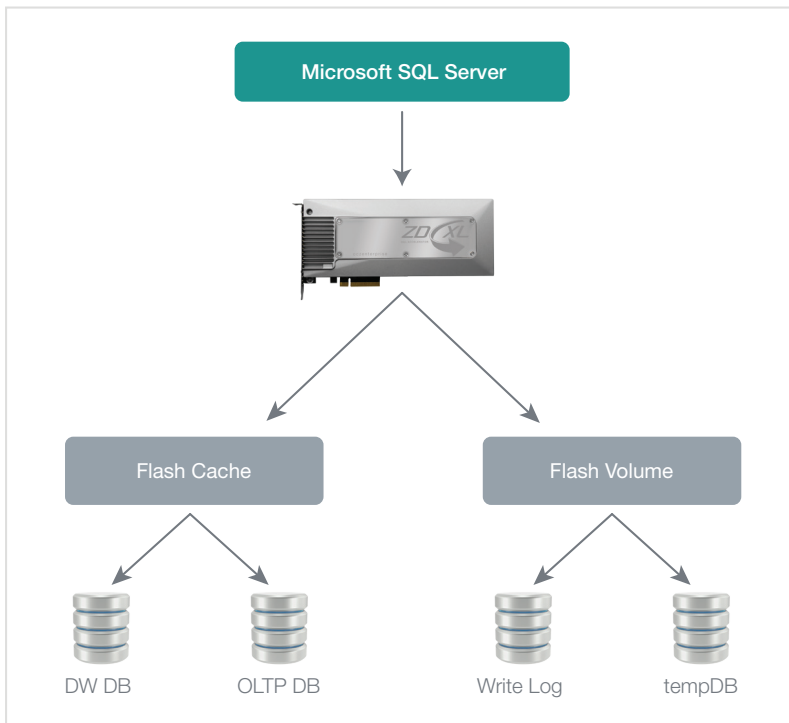



Figure 3: ZD-XL SQL Accelerator exposes its flash volume for tempDB usage and for use as a hot data cache

In many cases, when SQL Server does not have enough RAM available, the queries automatically spill into a tempDB file. When the tempDB file resides on a remote SAN array, the redirections can cause a drop in database performance as experienced by The 888 Group. By exposing its SSD flash volumes on-host locally in any of the 888 gaming venues, ZD-XL SQL Accelerator efficiently distributed the random database workloads in parallel between all available flash, improving performance while reducing the strain on the SAN.

The ability for ZD-XL SQL Accelerator to partition flash volumes provided The 888 Group with the best of both worlds -- an optimized solution where tempDB data files benefit from high flash performance while hot areas of the database are flash cached for immediate use by SQL Server.

9 Test Criteria and Results versus Competitor A

The 888 Group's IT department created a test benchmark to compare ZD-XL SQL Accelerator with a leading competitive solution (Competitor A) using a number of tests. The tests were conducted over a one month period to obtain statistics, assess SQL Server performance, and compare cache results. The 888 Group was provided one ZD-XL SQL Accelerator card supporting 3.2



Data traffic within The 888 Group's SQL Server environment increased substantially causing disk I/O bottlenecks, system performance limitations and costly upgrades.

TBs of storage capacity and five acceleration cards from Competitor A, each supporting 800GB of storage capacity or 3.5 TBs of available cache. During the deployment phase, the implementation wizards built within ZD-XL SQL Accelerator enabled plug-and-play installation through a simple to use GUI versus Competitor A that required each of the five cards to be individually configured.

The first set of tests evaluated the key requirements of lowering pressure on the SAN. For these tests, The 888 Group measured the storage workload placed on the storage processor from a utilization perspective, the I/O load delivered to the SAN, and the bandwidth required to transfer data from the SAN. In all cases, the lower the test result, the better the performance, as ZD-XL SQL Accelerator scored best in all three categories.

The second set of tests evaluated performance as seen from the SQL Server application server itself where the objectives are a reduction in wait times, improved latency responses and a reduction in average I/O workloads. In the highly regarded latency and average I/O workload categories, ZD-XL SQL Accelerator scored best.

The third set of tests evaluated end user impact which included the time it took to complete an extraction, the time to complete key analysis and the time to complete their top ten reports. For these tests, the lower the test result, the better the performance, and although ZD-XL SQL Accelerator was slightly higher in its extraction time, the product was significantly lower in analysis completion times and in completing the top ten reports.

The 888 Group's SSD Cache Bake-off

Pressure on the SAN Tests

- Measures the I/O load on the storage processor
- Measures the I/O load on the SAN
- Measures bandwidth from the SAN

Application Server Tests

- Measures wait times
- Measures latency
- Measures IOPS performance

User Impact Tests

- Measures extraction time
- Measures analysis completion times
- Measures the time to complete 10 reports

The **one** ZD-XL SQL Accelerator faired very well versus Competitor A's **five** 800GB cards and multiple PCIe lanes scoring best on 7 out of the 9 parameters tested. Having won this bake-off, The 888 Group implemented the flash-based ZD-XL SQL Accelerator into a production test environment and evaluated similar bake-off capabilities versus the HP ProLiant server configuration without accelerated flash caching supported. The next section compares these test results and includes the initial HP ProLiant configuration as well as the current HP ProLiant configuration.

10 Production Test Results

Pressure on the SAN Tests

(the lower the test result, the better the performance)

Test Performed	HP ProLiant DL580 256GB RAM (no flash caching)	HP ProLiant DL980 1TB RAM (no flash caching)	ZD-XL SQL Accelerator 3.2TB SSD Capacity (includes flash caching)
Storage Processor Utilization	52%	40%	35%
I/O Load on the SAN	33,000 I/O ops	23,000 I/O ops	11,000 I/O ops
Bandwidth Required from the SAN	1,500 MB/s	900 MB/s	850 MB/s

Application Performance Tests

(the lower the test result, the better the performance)

Test Performed	HP ProLiant DL580 256GB RAM (no flash caching)	HP ProLiant DL980 1TB RAM (no flash caching)	ZD-XL SQL Accelerator 3.2TB SSD Capacity (includes flash caching)
I/O Wait Time	361 hours	163 hours	97 hours
Latency	59.3 ms	46.1 ms	18.6 ms
Average I/O	10,890 I/O ops	6,943 I/O ops	7,132 I/O ops

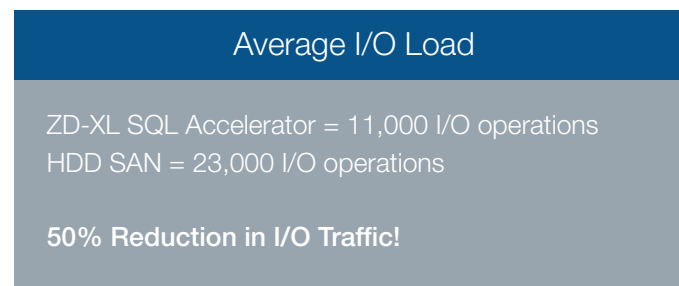
11 Test Summary

The result when compared to the HP ProLiant server configuration without accelerated flash caching is that ZD-XL SQL Accelerator with its Direct Pass Caching and tempDB flash volumes reduced the average I/O load from 23,000 I/O operations down to 11,000. Therefore, the story is not only about how many IOPS were delivered to ZD-XL SQL Accelerator, though that story is impressive in itself, but it's even more critically about the effect that I/O database loads have on the data traffic to the SAN.

Even with a powerful tier-1 SAN supporting its HP ProLiant server configuration, ZD-XL SQL Accelerator was able to dramatically improve performance from a single card with tightly integrated software. So even in an environment complete with a full tier of SSDs and HDDs, auto-tiering and internal caching, ZD-XL SQL Accelerator significantly added value.

12 Implementation Wizards


As part of this case study it is important to quickly review the effectiveness of the ZD-XL SQL Accelerator intuitive graphical user interface (GUI). The implementation wizards guided The 888 Group database administrators (DBAs) through best practice models of the available flash-based resources enabling them to easily deploy it into their SQL Server environment. The intuitive GUI management wizard:



- Divided the ZD-XL SSD resource into a volume section and a cache section, and advised the DBA on what data/workloads to place on the flash volume enabling the DBA to select the databases they wanted to accelerate
- Provided the DBA with a list of the database volumes enabling them to simply select the optimized policy to use on each workload whether it was a transactional or analysis load

13 Conclusion

The combination of more content being added to its data warehouse, more data analysis to improve business intelligence, and more transactions being processed, data traffic within The 888 Group's SQL Server environment increased substantially causing disk I/O bottlenecks, system performance limitations and costly upgrades. The SQL Server database did not scale very well using conventional HDDs and adding more to the SAN drives up TCO and TOC in the enterprise increasing SAN equipment purchases, power and cooling consumption, as well as maintenance, service and deployment costs.



ZD-XL SQL Accelerator reduced I/O traffic by 50%. No new SAN equipment, upgrades, or additional HDDs were required saving The 888 Group a big expense in IT purchases in 2013.

The storage challenges that The 888 Group faced required solid-state capabilities that enable flash caching and improve SQL Server data access. With ZD-XL SQL Accelerator's unique ability to provide optimized flash caching for SQL Server hot database data enabled The 888 Group to optimize and accelerate database performance while reducing I/O traffic by 50%. No new SAN equipment, upgrades, or additional HDDs were required saving the company a big expense in IT purchases in 2013.

"ZD-XL SQL Accelerator is doing a great job by increasing the ETL performance while alleviating storage I/O, leaving room for other applications to use the performance benefits of flash storage. Every year we upgrade the main storage to a more powerful system, and this year for the first time, thanks to our ZD-XL SQL Accelerator deployment, we didn't have to."

– Tzahi Hakikat, ICT
The 888 Group

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