Transaction Processing with MySQL HeatWave

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Product Management – MySQL HeatWave
Agenda

• Introduction
• MySQL HeatWave: Fully Automated Database as a Service
• OLTP with MySQL HeatWave
  • Scalability
  • Data protection and durability
  • High Availability
  • Reliability
  • Security
  • Observability
• Summary
Introduction
Managing data can be complicated and expensive

- High cost and risk to run and maintain
- Barriers to innovation
- Reduce costs and risks
- Simplify and accelerate time to value
Is there a better way to meet business requirements?

<table>
<thead>
<tr>
<th>High cost and risk to run and maintain</th>
<th>Reduce costs and risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost to upgrade and secure</td>
<td>Automated operations without manual interventions</td>
</tr>
<tr>
<td>Cost to run and optimize</td>
<td>Pay for what the business needs</td>
</tr>
<tr>
<td>Multiple database vendors and security models</td>
<td>Secure and unified data architecture</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Barriers to innovation</th>
<th>Simplify and accelerate time to value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disparate systems for transactions, analytics, and ML slowing down modern app dev</td>
<td>Ability to support multiple workload types</td>
</tr>
<tr>
<td>Time spent integrating data and building apps</td>
<td>Productive low-code/no-code development tools</td>
</tr>
<tr>
<td>Highly distributed data and disconnected clouds</td>
<td>Integrated data eco-system and multi-cloud support</td>
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How should databases be managed in the future?

What if your cloud database could do the following:

- Make it **trivial** to patch and upgrade thousands of databases
- **Remove** need to track versions + one-off fixes for every database
- **Automatically** deploy critical security bug fixes into production databases as soon as they are available
- **Simplify** planning of hardware capacity for workloads to meet all future business requirements
- **Simplify** maintaining and testing disaster-recovery infrastructure
- Fully **automate** processes for database lifecycle operations
- Provide **24x7 support** for every database availability issue
- **Automatically** file service requests + gather all diagnostics information for every database issue
- Significantly **reduce** operational and licensing costs
MySQL HeatWave

Fully Automated MySQL Database as a Service
- Eliminate system and database administration with a fully managed database service
- Customize operational policies to meet governance requirements

Complete automation and management
- Automatically configure, secure, update, tune, and scale databases

Workload optimizations
- Unified platform for transactions and analytics with built-in ML

Efficient database lifecycle management
- Eliminate infrastructure management by offloading it to Oracle
- Increase administrator productivity with user-controlled cloud automation
  - Web and API-driven lifecycle operations
  - Provisioning, updates, backups, etc.

Built-in Observability
- Database management service for expanded database metrics and query performance diagnostics
OLTP with MySQL HeatWave
### MySQL HeatWave: fully managed database service

100% developed, managed, and supported by Oracle

<table>
<thead>
<tr>
<th>Automation</th>
<th>MySQL HeatWave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database</td>
<td></td>
</tr>
<tr>
<td>High Availability</td>
<td>✔️</td>
</tr>
<tr>
<td>Read Replicas</td>
<td>✔️</td>
</tr>
<tr>
<td>Backup</td>
<td>✔️</td>
</tr>
<tr>
<td>Query Acceleration</td>
<td>✔️</td>
</tr>
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<td>AutoPilot</td>
<td>✔️</td>
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<td>AutoML</td>
<td>✔️</td>
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<tr>
<td>Security Patch &amp; Upgrade</td>
<td>✔️</td>
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<td>Provision &amp; Configure</td>
<td>✔️</td>
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<td>OS</td>
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<tr>
<td>OS Security Patch &amp; Upgrade</td>
<td>✔️</td>
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<tr>
<td>OS Installation</td>
<td>✔️</td>
</tr>
<tr>
<td>Server</td>
<td></td>
</tr>
<tr>
<td>Hardware Provisioning &amp; Maintenance</td>
<td>✔️</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
</tr>
<tr>
<td>Storage Provisioning &amp; Maintenance</td>
<td>✔️</td>
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<tr>
<td>Data Center</td>
<td></td>
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<tr>
<td>Rack &amp; Space</td>
<td>✔️</td>
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<tr>
<td>Power, HVAC, Networking</td>
<td>✔️</td>
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## OLTP with MySQL HeatWave

### Server side capabilities

<table>
<thead>
<tr>
<th>InnoDB transactional storage engine</th>
<th>SQL Optimizer</th>
<th>Develop and run modern apps</th>
<th>Ability to manage by exception</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACID compliant</td>
<td>Cost-based optimizer</td>
<td>Document Store for developing both SQL and NoSQL document applications</td>
<td>OpenSSL as the default TLS/SSL library in MySQL</td>
</tr>
<tr>
<td>Data integrity through foreign key constraints</td>
<td><strong>Common Table Expressions</strong> also known as WITH queries</td>
<td>Native JSON data type for managing unstructured data</td>
<td>Performance Schema with queries that are up to 30x faster.</td>
</tr>
<tr>
<td>Stored Procedures to improve developer productivity.</td>
<td><strong>Window Functions</strong> to reduce code complexity and help developers be more productive</td>
<td><strong>Enhanced GIS</strong> to support geography and Spatial Reference Systems (SRS).</td>
<td><strong>Invisible Indexes</strong> to better manage software upgrades and database changes for applications that run 24x7</td>
</tr>
<tr>
<td>Triggers to enforce complex business rules at the database level.</td>
<td></td>
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<tr>
<td>Views to ensure sensitive information is not compromised.</td>
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MySQL HeatWave Components

MySQL DB System: Interface to automate the management of tasks such as provisioning, backup and restore, monitoring, etc.

- A compute instance (with resources defined by the associated shape)
  - Two default configurations for most of the shapes:
    - Standalone: Optimized for standalone DB systems and read replicas
    - HA: Optimized for highly available DB systems
  - Oracle Linux Operating System
  - MySQL Server Enterprise Edition version 8.0 or higher
- Choose from two categories of shapes: ECPU and OCPU
- Virtual Network Interface Card (VNIC) that attaches the DB system to a subnet of the Virtual Cloud Network (VCN).
- Network-attached block storage
  - Uses the OCI Block Volume service Higher Performance option over iscsi
  - Provides a linear performance scale of 75 IOPS/GB up to a maximum of 50,000 IOPS per volume
  - Throughput scales at the rate 600 KB/s/GB up to a maximum of 680 MB/s per volume
MySQL DB System abstraction

- Connect effortlessly via **endpoints**, bypassing architectural complexities.
- Use the best **architecture** for your needs, optimizing key non-functional requirements without application changes.

Choose from two categories of shapes: ECPU and OCPU
MySQL HeatWave Scalability

Read replicas

- Increase capacity for read-intensive workloads
- Add and remove Read Replicas for horizontal read elasticity
- Easy to deploy and maintain
- You can create a maximum of 18 read replicas of a DB system
- Built-in Load Balancer for the read-only endpoint
- 5-Tuple Hash Load Balancing Policy: source IP and port, destination IP and port, protocol
- HA Cluster continues reliable and ready for switchover or failover
MySQL HeatWave Scalability
Cross Region Read replicas

• Outbound replication can be used to copy transactions from a DB system to another OCI region
• This is not a managed functionality, you are responsible for configuring and maintaining the channel

- Hybrid deployments
- Disaster Recovery
- Cross-region deployments
  - DB system to DB system
MySQL HeatWave data protection and durability
MySQL HeatWave data protection and durability

Backups

**Automatic backup:**
Created automatically at a time selected while creating the DB system.
Define the retention period between 1 and 35 days
• Default retention period is 7 days
For a high availability DB system, the automatic backups are created on the primary instance

**Manual backup:**
Create a manual backup by an action in the Console, or a request through the REST API
Retain the manual backup for a minimum of 1 day and a maximum of 365 days

**Operator backup:**
MySQL Support team creates this backup to assist in investigating potential issues with your service.
**MySQL HeatWave data protection and durability**

**Point-In-Time Recovery**

Restore data from a DB system to a new DB system at the latest available point-in-time or a specific point-in-time.

**Pre-requisites**
- Enable automatic backups and enable point-in-time recovery on the backup plan of the DB system.

MySQL HeatWave Service takes an initial full backup (Backup type: Full, Creation Type: automatic) and incremental backups thereafter.

DB system operations such as stop, start, restart, or upgrade do not impact the point-in-time recovery operation.

Provides Recovery Point Objective (RPO) of approximately five minutes for an active DB system, while the daily backup provides you a RPO of 24 hours.
Cross-Region Backup Copy

Coming soon!

TestDbSystemBackup_IAD

Backup information
- OCID: ...
vkydazwucq
- Description: DB system backup in IAD region.
- Compartment: mysqlbaastest (root)/canary/compute
- Shape: VM.Standard.E2.1
- MySQL version: 8.3.0 - Innovation
- Retention days: 1 (Thu, Feb 8, 2024, 10:27:39 UTC)
- State: Active

Tags

Backup type: Full backup
Creation type: Manual
Backup size: 1 GB
Storage size: 50 GB
Created: Wed, Feb 7, 2024, 10:27:39 UTC
Last updated: Wed, Feb 7, 2024, 10:29:32 UTC

DB system

General information
- Name: TestDbSystem_IAD

Backup
- Automatic backups: Disabled
MySQL HeatWave High Availability
MySQL HeatWave High Availability
Higher uptime and zero data loss tolerance
MySQL HeatWave High Availability
Higher uptime and zero data loss tolerance

A high availability DB system is made up of three MySQL instances: a primary instance and two secondary instances

Provisioned across different availability or fault domains

The primary instance functions as a read/write endpoint

Automatic or Manual Promotion of a Secondary Instance
MySQL HeatWave High Availability
Higher uptime and zero data loss tolerance

- SLA 99.99%
- Automatic failover
- Manual switchover
- Rolling upgrades during maintenance
  - Less than 30 seconds impact
  - MySQL version upgrades and OS security patches

Online change of shape and configuration of a high availability DB system and read replicas with minimal downtime
### High Availability RTO/RPO Matrix

Recovery Time (RTO) and Potential Data Loss (RPO) service SLO

<table>
<thead>
<tr>
<th>Failure and Maintenance Events</th>
<th>Downtime (RTO)</th>
<th>Potential Data Loss (RPO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodic software and hardware maintenance updates</td>
<td>Seconds to minutes</td>
<td>Zero</td>
</tr>
<tr>
<td>Localized, per instance events, including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Storage connectivity failures</td>
<td>Minutes</td>
<td>Zero</td>
</tr>
<tr>
<td>• Network connectivity failures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Full database failures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Availability or fault domain failures (depending on high availability type)</td>
<td>Minutes</td>
<td>Zero</td>
</tr>
<tr>
<td>• Complete storage failures</td>
<td></td>
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</table>

MySQL HeatWave supports crash recovery, which ensures durability and enables data recovery in the event of an unexpected server exit.
MySQL HeatWave Reliability
MySQL HeatWave Reliability
Maximize reliability with automated upgrades and patching

1. No customer actions required
   No need to schedule patches, track patch contents or request one-off patches

2. Minimal downtime
   Existing connections to the primary are closed and no new connections are permitted.

3. Always up-to-date security fixes
   Frequent patches to meet compliance requirements

4. Full-stack patching
   Includes database and all cloud infrastructure

5. Continuous delivery of new cloud features
   Multiple new features available every month
Example: zero-effort, zero-downtime automatic hardware upgrades

If you manage your own database servers:
1. Procure new hardware and install in data center
2. Test and validate hardware and networking
3. Install database software and configure database environment
4. Validate sizing and performance
5. Create and test migration strategy
6. Schedule and execute production migration (with downtime?)

If you run MySQL HeatWave:
Zero-effort hardware upgrades: Hardware refreshes occur transparently during regularly scheduled maintenance windows
- No hardware planning or testing
- No database downtime
- No extra cost

Maintenance
Maintenance window start: Monday 06:55 Edit
# MySQL HeatWave Security

<table>
<thead>
<tr>
<th>Simplified access management</th>
<th>User Assessment</th>
<th>Activity Auditing</th>
<th>Simplified certificate management (BYOC)</th>
<th>Connection control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign-On with flexible authentication options: support for federated, social, and delegated sign-on.</td>
<td>Assesses the database and highlights accounts that could pose a risk.</td>
<td>Audit service automatically records calls to MySQL HeatWave API endpoints as log events.</td>
<td>Easily create, deploy, and manage Secure Sockets Layer/Transport Layer Security (SSL/TLS) certificates available in Oracle Cloud.</td>
<td>Remove brute force attacks attempting to guess MySQL login credentials</td>
</tr>
</tbody>
</table>
Advanced security
Built-in, server-side features to implement additional security measures

- **Asymmetric encryption with key generation and digital signatures**: to increase the protection of confidential data using both public and private keys and implement digital signatures to confirm the identity of people signing documents.

- **Data masking and deidentification**: to help protect private data against external attacks and malicious employees.

- **Database firewall**: protecting against database-specific attacks, such as SQL injections.

- **Compliance – attestations & certifications**:
  - Global: PCI DSS, SOC 1 2 3, CSA STAR, ISO/IEC 27001/27017/27018/27701, etc.
  - Regional: HIPAA, CSF, HITRUST, EU CoC, ENS, C5, MTCS, IRAP, ISMS, MeitY, etc.
MySQL HeatWave Observability
MySQL HeatWave Observability
OCI monitoring and Database Management

OCI Monitoring
- Find performance bottlenecks
- Collect metrics
- Define thresholds

Database Management
- Fix problem queries
- Rapidly troubleshoot performance issues

Ops Insights
- Predictive Insights with AI
- Trend and forecast
MySQL Autopilot indexing (Coming soon)
Recommends secondary indexes for OLTP workloads
Autopilot Indexing (Coming soon)
ML automation with MySQL HeatWave

Features
- ML-based feature designed to help optimize database systems for better cost and performance
- Considers both query and DML performance
- Recommends CREATE and DROP of indexes
- Generates DDLs for index creation/drop
- Provides performance prediction
- Provides storage prediction
- Continuous learning and adapting

Benefits
- DBAs no longer need to manually identify the secondary indexes for the database workload.
- Considers both the query performance and the cost of maintaining the indexes
- Predicts expected improvement without creating the indexes
- Provides explanation for the recommendations
- Oriented by performance objectives: throughput, latency, storage
Maximizing reliability with **automated proactive monitoring**

MySQL HeatWave service finds the problems before you do

Oracle Cloud Operations uses continuous monitoring for each database:

**8000+ metrics and 1500+ alarms**
- Much broader than any on-premises customer
- Consolidated monitoring of entire stack: infrastructure, load balancer, connection manager, database

**Automatic service requests** are generated for each deviation
- Immediate investigation and resolution by cloud ops
- Root cause analysis for every issue
- Zero customer actions required
One database is better than two

One service for OTLP & OLAP
No ETL duplication
Unmatched performance, at a fraction of the cost
Real-time analytics
Improved security
Applications work without changes

1>2 with MySQL HeatWave
MySQL HeatWave
Fully-managed, cloud native, Database as a Service

Reduce costs and risks
- Auto-patching, auto-backups, auto-configuration
- Elastic auto-scale with enterprise business continuity
- Always-on security and compliance

Simplify and accelerate time to value
- Unified platform for transactions and analytics with built-in ML
- Built-in low-code/no-code development tools
- Deep integration with multi-cloud ecosystem