Guide to MySQL in Government

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Introduction

Governments worldwide are increasingly adopting open source software as their default for a variety of reasons. Not only do they benefit from dramatic cost savings, but they can also better serve their constituencies and improve their local economies. We've indeed come a very long way since the first public acknowledgements of open source usage by governments in the 1990s.

However, while open source software is extremely attractive, its adoption can also be challenging for governments. They may lack the expertise and experience to effectively implement and manage open source solutions, having spent many years building up skills in other technologies.

In this white paper, we will help you better understand both the benefits and the typical challenges facing governmental organizations adopting open source software. We will then specifically consider the adoption of MySQL, the world's most popular open source database, increasingly implemented at the heart of mission critical government applications at the request of government executives. Finally, we will recommend a method allowing governmental organizations to maximize the desired benefits of open source and MySQL while minimizing potential risks.

1. Open Source in Government

Open Source adoption by governments worldwide is today significant. Consider the following headlines and information:

Indian Government Mandates Use of Open Source Software
Open source was embraced by the Indian government in the recent years as they focused on digitization initiatives: "The Indian government has directed the use of open source software across all systems used by the public sector, mandating that all Request for Proposals (RFPs) to instruct suppliers to consider the use of such applications."
See: http://www.zdnet.com/article/indian-government-mandates-use-of-open-source-software/

What's Behind Europe's Love Affair with Open Source?
Open source technology is playing an increasingly important role in international governments and policy-making. In fact, "Open-source has become a matter of national policy in the U.K., a critical part of the infrastructure at the European Commission, and the standard for the city of Munich."
See: http://www.networkworld.com/article/3008522/

The US Digital Services Playbook
The US Government has issued a Digital Services Playbook designed to help government agencies better interact with American citizens. The introduction to the playbook reads:

"By building better digital services that meet the needs of the people that use our services, we can make the delivery of our policy and programs more effective. Today, too many of our digital services projects do not work well, are delivered late, or are over budget. To increase the success rate of these projects, the U.S. Government needs a new approach. We created a playbook of 13 key "plays" drawn from successful best practices from the private sector and government that, if followed together, will help government build effective digital services."

One of plays encourage government organizations to "Choose a modern technology stack" and as part of it to "Consider open source software solutions at all layers of the stack."

See: https://playbook.cio.gov/

One can easily find many more such examples. Governments worldwide are facing unprecedented budget pressure, creating a new reality for government Information Technology. Financial deficits and major cuts in spending have forced government IT to take a close look at how to slash expenses. At the same time, governments are turning to open source software and opening government data to make it easier and faster for agencies to develop applications that deliver high quality services to their constituents.

Beyond cost reduction, there are compelling reasons for government organizations to adopt open source software, including:

Access for all: A government cannot discriminate against any of its constituencies by requiring any specific proprietary technology for online interactions.

Vendor independence: What if a vendor goes out of business, stops supporting a product, or makes changes that leave documents incompatible with earlier versions? Open source software alleviates this risk.

Archiving: Government agencies must often archive documents for decades. A vendor, at its own discretion, can stop supporting a format at any time. Even vendors who commit to supporting their formats can upgrade them in ways that render old documents unmanageable. Using open formats also alleviate that risk, allowing government agencies to effectively store digital information.

Additionally, According to Rogerio Santanna, Secretary of Logistics and IT at the Brazilian Ministry of Planning, Budget and Management, "open source is a strategic choice of the Brazilian Federal Government since 2003 **because it reduces costs, increases the competition, creates jobs and develops the knowledge and intelligence of our country**. Our preference for open source is not motivated only by economic aspects. But there is also **the possibility to develop new products, distribute the knowledge, access to new technologies and to stimulate the development of software in collaborative environments**".

MySQL is the world's most popular open source database, and can help governments worldwide significantly save taxpayers' money while achieving their additional objectives.

2. MySQL Overview

MySQL is powering some of the most demanding Web-based applications, a testament to its performance, scalability and reliability. For example:

- A typical day sees over 500 million tweets, which means about 5,700 per second with MySQL. More details at: https://blog.twitter.com/2013/new-tweets-per-second-record-and-how
- Facebook runs tens of thousands of MySQL servers, a typical instance counting 1 to 2 TB of data. Data Performance Manager Harrison Fisk described how 11.2 Million row changes and 2.5 Billion rows read per second are handled in MySQL: http://medianetwork.oracle.com/video/player/2686521204001
- Over 6 billion hours of video are watched each month on YouTube, served to you via MySQL: http://highscalability.com/blog/2012/3/26/7-years-of-youtube-scalability-lessons-in-30-minutes.html
- PayPal built a globally-distributed database with 100 terabytes of user-related data based on MySQL Cluster. http://medianetwork.oracle.com/video/player/1873920417001)

MySQL is also an extremely popular choice in government applications. A few examples include:

Aadhaar, India Biometrics Identity System
India's Unique Identification project, also known as Aadhar, is the world's largest Biometric Identity System. It is an identity system used to capture demographic and biometric data of India's over half a billion residents. This number is expected to grow as residents increase.

Her Majesty's Revenue and Customs (HMRC) plays a crucial and unique role in the UK, collecting the tax money that pays for the UKs public services, and helping families and individuals with targeted financial support. HMRC is responsible for more than two-thirds of all government transactions, with 1.23 billion during 2012 to 2013. HRMC's new trade tariff tool is powered by MySQL.

Tax Management of the German State Nordrhein-Westfalen
Hundreds of MySQL databases are deployed across the tax management applications, including financial management forms, taxation-independent directories (bank code, postal code and street directory) as well as software license management applications.

IT Dashboard
The MySQL-based IT Dashboard is a website enabling US federal agencies, industry, the general public and other stakeholders to view details of federal information technology investments. IT Dashboard tracks over $76 billion in federal IT spending.

The Swedish National Police
The Swedish National Police standardized on an Open Source Software stack including Linux, MySQL and JBoss for new applications. The aim was to cut costs while remaining independent of vendors and ensuring the reliability and security

inherent in police work. The savings over 5 years were significant, corresponding to the ability to fund 400 additional fully equipped police cars.

The US Navy
MySQL Cluster is used by the US Navy to power the flight deck and operations management system on US Navy aircraft carriers. MySQL Cluster provides complete redundancy with no single point of failure and minimizes the physical hardware footprint requirements.

The key attributes that have made MySQL such a popular choice in government applications are:

- **Low Total Cost of Ownership (TCO)**: MySQL enables to reduce TCO by up to 90% compared to Microsoft SQL Server[1]
- **Performance and scalability**: As noted earlier, MySQL is used by some of the world's most demanding applications
- **Reliability**: MySQL is famous for its rock-solid reliability. In addition to extensive QA testing at Oracle, MySQL has been battle-tested by millions of users in a very wide variety of application scenarios. As Eric Raymond noted: "given enough eyeballs, all bugs are shallow"[2], the enormous MySQL community contributes to the extremely high quality of the world's most popular open source database.
- **Ease of Use and Administration**: Also a hallmark of MySQL, ease of use has been a design goal for the database since its inception. MySQL offers exceptional quick-start capabilities with the average time from software download to installation completion being less than fifteen minutes. The visual database design, development, administration and monitoring tools delivered within MySQL Enterprise Edition and presented later in this document further enhance MySQL's ease of use and administration.

The fact that MySQL is the world's most popular open source database presents a number of advantages including:

Product Maturity

MySQL is a proven and mature solution. It has evolved over the years benefitting from feedback from millions of developers and DBAs - relying on it for the most demanding Web applications in the world, pushing its limits, and contributing in a number of ways to the performance, reliability and ease of use of MySQL.

Ubiquity: Platforms and languages

MySQL is available on all major platforms: Linux, Microsoft Windows, Oracle Solaris, Apple Mac OS, FreeBSD and more.

MySQL has connectors for all key development languages including PHP, Perl, Python, Java, C, C++, C# and Ruby but also Node.js, Go and more.

Integration with third party tools:

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[1] http://www.mysql.com/tcosavings/
[2] Linus' Law: http://en.wikipedia.org/wiki/Linus%27s_Law

MySQL integrates with a wide range of third party solutions for High Availability, Backup, Business Intelligence…etc. They include both open source software such as DRBD, Jaspersoft, Talend or Pentaho, and proprietary solutions such as Windows Server Failover Clustering, Business Object or Symantec.

Additionally, Oracle is integrating MySQL with all relevant Oracle solutions. Completed certifications include so far:

- Oracle Linux
- Oracle VM
- Oracle Enterprise Manager
- Oracle GoldenGate
- Oracle Secure Backup
- Oracle Audit Vault and Database Firewall
- Oracle Fusion Middleware
- Oracle Clusterware
- Oracle OpenStack for Oracle Linux
- MyOracle Online Support

Let's now consider how MySQL typically gets adopted in governmental organizations.

3. MySQL's Adoption

We are observing two major MySQL deployment models, which can be qualified as "top down" and "bottom up":

In the "top down" scenario, MySQL usage is mandated by government or IT executives. This model is ever more frequent as decision makers, and local public opinions, are increasingly aware of the major advantages open source software delivers. Such an adoption scenario delivers the most benefits as the MySQL deployment can be very effectively planned from the outset, including:

- Applications considered
- Staff training
- Implementation best practices
- Planning for application monitoring, backup, security and availability management
- On-going support and maintenance

As we will see later in this document, Oracle provides MySQL Enterprise Edition – and Oracle MySQL Cloud Service - to help organizations reduce the risk, cost and time needed to develop, deploy and manage MySQL applications. Governments planning early on the "operationalization" of their MySQL deployments and relying on MySQL Enterprise Edition or Oracle MySQL Cloud Service can maximize benefits while minimizing risks. They are the ones who will benefit the most of the advantages of open source in general and MySQL in particular.

Let's now consider the second, or "bottom-up", MySQL adoption model. Quite frequently, a developer or system administrator facing an ad-hoc need makes the choice to develop an application based on MySQL, on its own initiative. It is then important to consider what we call the "Power Curve of MySQL Deployments":

Power Curve of MySQL Deployments
Typical "Bottom up" Adoption Model
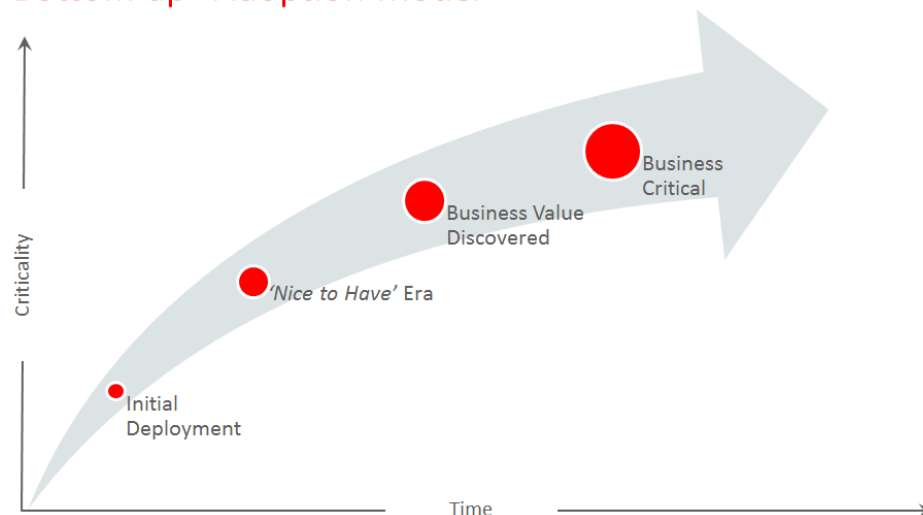
Initially, the application is typically not critical to the organization and its technical support, backup, monitoring, and security management are usually handled by the developer or team in charge on their own, without any third party vendor support. This is not inherently bad at this stage but conditions evolve, and can do so very quickly. Indeed, as more and more people discover the value of those applications, rely on them and possibly expand their scope, many of them do become important and then "business critical", i.e. essential for the organization to perform one or more of its tasks. Once business critical, the application cannot fail, and at this point in time, self-support becomes a significant overhead and is no longer a valid option.

The amount of data we need to manage is constantly increasing, consequently the power curve is accelerating, and it has become fairly common to see numerous applications become business critical in well under twelve months. It is therefore recommended to consider the so-called "operationalization" of those applications upfront in order to avoid missing a budget cycle and potentially face consequences of inadequate or unreliable service delivery. Proper operationalization helps ensure the performance, security and uptime of those applications while significantly lowering costs.

Additionally, it has been noted in a report[3] commissioned by the European Commission that "Europe's public administrations are struggling to profit from the benefits of free and open source software solutions, including huge costs savings and innovations". The report notes that:

- "Public agencies in most countries lack the expertise, the experience, the will, and sometimes the courage to purchase open source."

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[3] https://joinup.ec.europa.eu/news/inertia-hindering-governments-profit-open-source-benefits

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- "The gap between authorities and open source has until now often been bridged by system integrators. These however lack in-depth expertise in open source, and generally don't have good connections with the developer communities."

Oracle helps bridge the gap between fully supported proprietary solutions and the open source software world by enabling customers to benefit from the advantages of open source with a true enterprise-class support. To help organizations reap the benefits of open source and achieve the highest levels of MySQL reliability, security and performance for on-premises deployments, Oracle provides MySQL Enterprise Edition. A cost-effective subscription offering relied upon by thousands of MySQL customers; MySQL Enterprise Edition includes the most comprehensive set of advanced features, management tools and technical support.

Operationalizing your MySQL deployments with MySQL Enterprise Edition will enables you to:

- **Reduce TCO** improving operational efficiency, consistently using the best MySQL monitoring, backup and other management tools available, and increasing automation.
- **Dramatically lower risks** associated with data loss, security, application availability and other areas.

In the next section, we will review in more detail the various MySQL Enterprise Edition components, and how they can help you safely, rapidly and cost-effectively benefit from the advantages of the world's most popular open source database. We shall subsequently review Oracle MySQL Cloud Service, enabling you to rapidly, securely and cost-effectively develop & deploy MySQL-based applications in the cloud.

4. MySQL Enterprise Edition

MySQL Enterprise Edition reduces the risk, cost and time required in developing, deploying and managing business-critical MySQL applications. In addition to the MySQL Database, MySQL Enterprise includes:

The MySQL Enterprise Monitor:

The MySQL Enterprise Monitor provides at-a-glance views of the health of your MySQL databases. It continuously monitors your MySQL servers and alerts you to potential problems before they impact your system. It's like having a "virtual DBA" assistant at your side to recommend best practices and eliminate security vulnerabilities, improve replication, and optimize performance. As a result, DBAs and system administrators can manage more servers in less time.
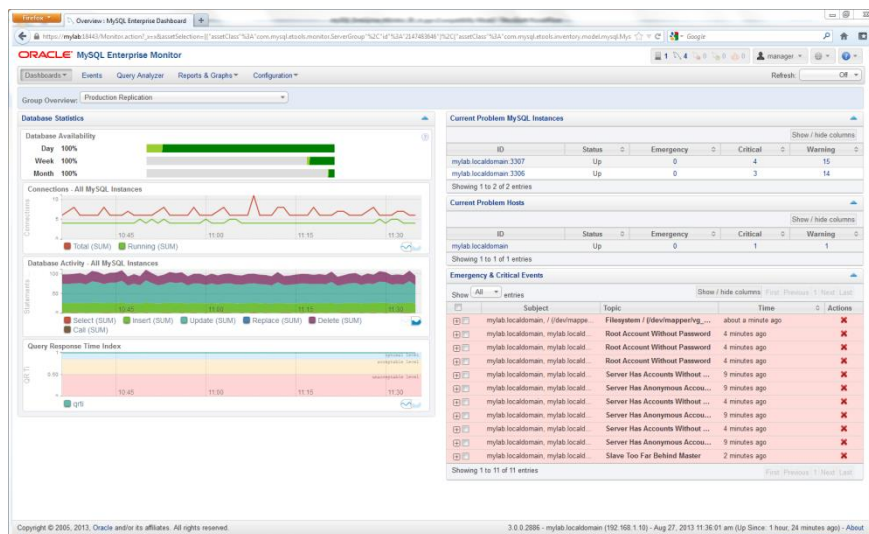
The MySQL Enterprise Monitor is a web-based application that can manage MySQL within the safety of a corporate firewall or remotely in a public cloud. MySQL Enterprise Monitor provides:

- **Performance & Availability Monitoring** - Continuously monitor MySQL queries and performance related server metrics
- **Visual Query Analysis** – Monitor query performance and pinpoint SQL code that is causing a slow-down
- **InnoDB Monitoring** - Monitor key InnoDB metrics that impact MySQL performance
- **MySQL Cluster Monitoring** - Monitor key MySQL Cluster metrics that impact performance and availability
- **Replication Monitoring** – Gain visibility into the performance, and health of all MySQL Masters and Slaves
- **Backup Monitoring** – Ensure your online, hot backups are running as expected
- **Disk Monitoring** – Forecast future capacity requirements using trend analysis and projections.
- **Security Monitoring** - Identify and resolve security vulnerabilities across all MySQL servers
- **Operating System Monitoring** - Monitor operating system level performance metrics such as load average, CPU usage, RAM usage and swap usage

The MySQL Query Analyzer

The MySQL Query Analyzer helps developers and DBAs improve application performance by monitoring queries and accurately pinpointing SQL code that is causing a slowdown. Using the Performance Schema, data is gathered directly from the MySQL server without the need for any additional software or configuration.

Queries are presented in an aggregated view across all MySQL servers so DBAs and developers can filter for specific query problems and identify the code that consumes the most resources. With the MySQL Query Analyzer, DBAs can improve the SQL code during active development and continuously monitor and tune the queries in production.
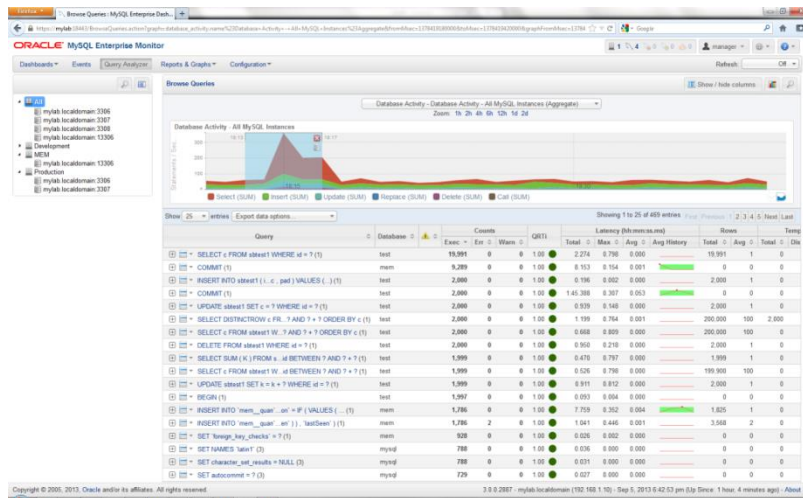
MySQL Workbench Enterprise Edition

MySQL Workbench is a unified visual tool that enables developers, DBAs, and data architects to design, develop and administer MySQL databases. MySQL Workbench provides advanced data modeling, a flexible SQL editor, and comprehensive administrative tools.
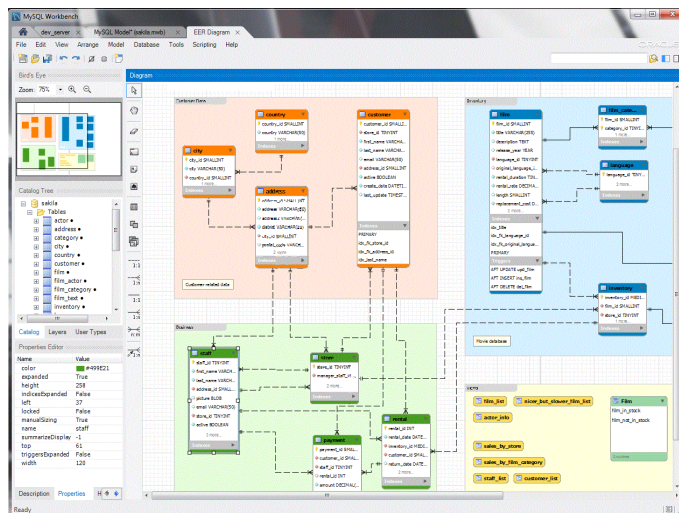
MySQL Workbench allows you to:

- **Design**: MySQL Workbench includes everything a data modeler needs for creating complex ER models, forward and reverse engineering, and also delivers key features for performing difficult change management and documentation tasks that normally require much time and effort.

- **Develop**: MySQL Workbench delivers visual tools for creating, executing, and optimizing SQL queries. The SQL Editor provides color syntax highlighting, reuse of SQL snippets, and execution history of SQL. The Database Connections Panel enables developers to easily manage database

connections. The Object Browser provides instant access to database schema and objects.

- **Administer**: MySQL Workbench provides a visual console to easily administer MySQL environments and gain better visibility into databases. Developers and DBAs can use the visual tools for configuring servers, administering users, and viewing database health.

- **Migrate**: MySQL Workbench now provides a complete, easy to use solution for migrating Microsoft SQL Server, Microsoft Access, Sybase ASE, PostgreSQL, and other RDBMS tables, objects and data to MySQL. Developers and DBAs can quickly and easily convert existing applications to run on MySQL. Migration also supports migrating from earlier versions of MySQL to the latest releases.

MySQL Enterprise Backup

MySQL Enterprise Backup performs online, non-blocking "Hot" backups of your MySQL databases. You get a consistent backup copy of your database to recover your data to a precise point in time. In addition, MySQL Enterprise Backup supports creating compressed backup files, and performing backups of subsets of InnoDB tables. Compression typically reduces backup size up to 90% when compared with the size of actual database files, helping to reduce storage costs. In conjunction with the MySQL binlog, users can perform point in time recovery.

MySQL Enterprise Scalability

MySQL Enterprise Scalability enables you to meet the sustained performance and scalability requirements of ever increasing user, query and data loads. The MySQL Thread Pool provides an efficient, thread-handling model designed to reduce overhead in managing client connections, and statement execution threads.

MySQL Enterprise Authentication

MySQL Enterprise Authentication provides ready to use external authentication modules to easily integrate MySQL with existing security infrastructures including PAM and Windows Active Directory. MySQL users can be authenticated using Pluggable Authentication Modules ("PAM") or native Windows OS services.

MySQL Enterprise Transparent Data Encryption (TDE)

MySQL Enterprise Transparent Data Encryption (TDE) enables data-at-rest encryption by encrypting the physical files of the database. Data is encrypted automatically, in real time, prior to writing to storage and decrypted when read from storage.   As a result, hackers and malicious users are unable to read sensitive data from tablespace files, database backups or disks. MySQL Enterprise TDE uses a two-tier encryption key architecture, consisting of a master encryption key and tablespace keys, which provides easy key management and rotation.

MySQL Enterprise Encryption

To protect sensitive data throughout its lifecycle, MySQL Enterprise Encryption provides industry standard functionality for asymmetric encryption (Public Key Cryptography). MySQL Enterprise Encryption provides encryption, key generation, digital signatures and other cryptographic features to help organizations protect confidential data and comply with regulatory requirements including HIPAA, Sarbanes-Oxley, and the PCI Data Security Standard.

MySQL Enterprise Firewall

MySQL Enterprise Firewall guards against cyber security threats by providing real-time protection against database specific attacks, such as an SQL Injection. MySQL Enterprise Firewall monitors for database threats, automatically creates a whitelist of approved SQL statements and blocks unauthorized database activity.

MySQL Enterprise Audit

MySQL Enterprise Audit enables you to quickly and seamlessly add policy-based auditing compliance to new and existing applications. You can dynamically enable user level activity logging, implement activity-based policies, manage audit log files and integrate MySQL auditing with Oracle and third-party solutions

MySQL High Availability

MySQL InnoDB Cluster delivers an integrated, native, high availability solution for your databases. MySQL InnoDB Cluster consists of:

- **MySQL Servers with Group Replication** to replicate data to all members of the cluster while providing fault tolerance, automated failover, and elasticity.
- **MySQL Router** to ensure client requests are load balanced and routed to the correct servers in case of any database failures.
- **MySQL Shell** to create and administer InnoDB Clusters using the built-in AdminAPI.

Oracle Premier Support for MySQL

MySQL Enterprise Edition provides 24x7x365 access to Oracle's MySQL Support team, staffed by database experts ready to help with the most complex technical issues, and backed by the MySQL developers. Oracle's Premier support for MySQL provides you with:

- 24x7x365 phone and online support
- Rapid diagnosis and solution to complex issues
- Unlimited incidents
- Emergency hot fix builds forward compatible with future MySQL releases
- Access to Oracle's MySQL Knowledge Base
- Consultative support services
- The ability to get MySQL support in 29 languages

Consultative support service

It is important to understand that technical support from Oracle does not simply include the usual incident reporting and subsequent provision of a solution. In addition, many customers have come to rely on the consultative support offering, with a significant proportion viewing it as an invaluable part of their subscription.

Consultative support provides those implementing MySQL projects the ability to ask "how to" questions, getting advice from MySQL experts on best practices, and helping them optimize their MySQL deployments.

With most other support offerings this service is available only as a paid consulting engagement, which can be expensive and difficult to instigate with contractual and statement of work considerations. MySQL consultative support is however included in the MySQL Enterprise Edition subscription.

If you are new to MySQL then consultative support and the full package of training options (both classroom and self study) deliver real benefits to MySQL customers, truly helping people take advantage of the MySQL open source proposition.

In addition to leveraging open source, governments and governmental organizations increasingly wish to leverage the advantages of the cloud. Oracle MySQL Cloud Service enables them to do so.

5. Oracle MySQL Cloud Service

Built on the proven MySQL Enterprise Edition and powered by the Oracle Cloud, Oracle MySQL Cloud Service provides a simple, automated, integrated and enterprise-ready cloud service that enables governmental organizations to deliver MySQL-based applications in the cloud.

The Oracle MySQL Cloud Service video provides a rapid overview:
https://www.youtube.com/embed/xXUlHvAYtiE?autoplay=1

The only public cloud service integrating MySQL Enterprise Edition, Oracle MySQL Cloud Service represents the most comprehensive MySQL offering in the cloud. Customers benefit from:

- **Automated & Effective Management**: Best-in-class Oracle management tools including web-based cloud tooling, MySQL Enterprise Backup, MySQL Enterprise Monitor, MySQL Query Analyzer, MySQL Workbench and integration with Oracle Enterprise Manager reduce administrative efforts and costs.
- **Multi-layered Security**: Enterprise-grade security features such as network access control, MySQL Enterprise Firewall, MySQL Enterprise Authentication, MySQL Enterprise Encryption, MySQL Enterprise Transparent Data Encryption and MySQL Enterprise Audit help customers achieve regulatory compliance and ensure data is protected against external attacks and misuse of information. We've reviewed in more details the aforementioned MySQL Enterprise security features earlier in this document.

- **Developer Enablement & Integrations**: Pre-integration with Oracle Cloud Platform Application Development offerings such as Oracle Java Cloud Service and Oracle Application Container Cloud Service enables developers to quickly spin up a development environment. Pre-integration with Oracle Cloud Infrastructure gives them the choice to for example backup data to Oracle Storage Cloud.
- **Global Scalability**: Developers & ISVs can instantly scale their applications globally relying on Oracle Cloud. Automated scaling enables users to elastically scale compute and storage resources as well as MySQL replicas. The MySQL Thread Pool provides sustained performance and scalability facing ever increasing user, query and data loads.
- **Hybrid Deployments**: Relying on the exact same database platform and tools on premises and in the cloud allows customers to quickly and easily migrate existing applications to the cloud, move workloads between on-premises deployments and the cloud and architect hybrid deployments.
- **Expert Technical Support**: As reviewed earlier in this document, technical support is provided directly by the MySQL experts, backed by the engineers that develop MySQL solutions, in order to solve customer's most complex issues and help them make the most of their MySQL deployments. Additionally, Oracle Premier Support gives customers a one-stop support solution for both cloud infrastructure and MySQL related issues.

Oracle MySQL Cloud Service makes it extremely easy to rely on MySQL either to migrate existing on-premises applications to the cloud or deliver new ones. You can:

- **Increase Business Agility**: Focusing your resources on innovation, not on infrastructure management.

- **Ensure Security, Performance & Uptime**: relying on the most comprehensive MySQL cloud platform – straight from the source.

- **Reduce Total Cost of Ownership**: Saving on infrastructure and database management operations costs while improving uptime.

> Download eBook: "Oracle MySQL Cloud Service; Propel innovation and time-to-market"
> Visit https://cloud.oracle.com/mysql to learn more & sign up for a free trial.

6. Oracle and MySQL

Oracle significantly invests in MySQL and drives MySQL innovation. Under Oracle's stewardship the MySQL Engineering team delivered the best MySQL releases ever, and produced more and better products than ever before in MySQL's history. Oracle doubled the size of both the MySQL Engineering team and the technical support team and tripled the size of the Quality Assurance (QA) team since the acquisition of Sun Microsystems.

For governmental organizations relying on MySQL, Oracle's ownership and investment in MySQL represents excellent news at multiple levels:

- The performance, scalability reliability and security of MySQL has never been better than it is now, and keeps improving thanks to Oracle's investment in MySQL
- Oracle's MySQL Enterprise Edition includes the tools, support services and indemnification provisions enabling you to safely and cost-effectively deploy MySQL on premises. Oracle MySQL Cloud Service allows you to do so in the cloud, and to easily move workloads between on-premises and the cloud.
- You get all the benefits of the world's most popular open source database, delivered to you by the #1 database company.

Conclusion

In this whitepaper we have reviewed the significant benefits derived by governmental organizations using open source software and MySQL. We have also highlighted typical challenges associated with the adoption of those solutions, and provided a method allowing you to maximize benefits while minimizing risks – either on premises or in the cloud.

MySQL is in the unique position to be the world's most popular open source database, while being owned by a major software vendor significantly investing in the product. MySQL customers get the best of both worlds, all the advantages of open source solutions, combined with the ability to get assistance from the #1 database company.

Additional Resources

https://cloud.oracle.com/mysql

http://www.mysql.com/

MySQL Enterprise Edition Demo:
https://www.youtube.com/watch?v=ypQh9H9Rf9w

To contact an Oracle MySQL Representative:
http://www.mysql.com/about/contact/