

# Oracle Autonomous Database

Oracle Autonomous Database is the world's first fully automated cloud database platform powered by machine learning. By eliminating human factor from database management, it provides unprecedented security, reliability and performance for enterprise data management in the cloud.



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## 1 Introduction

Oracle Corporation is a multinational technology company headquartered in Redwood City, California, USA. Established in 1977 to develop a relational database management system, Oracle has grown into one of the largest companies in the software industry. Owing partially to its extensive acquisition strategy, Oracle's portfolio of products and services is remarkably wide, including database, middleware and application software, enterprise management solutions, and even operating systems and development tools.

As companies are dealing with increasing volumes of digital information that powers their key business processes and in many cases, becomes their most prized asset, storing, analyzing and protecting this information is growing increasingly complicated. Ensuring that business data remains accessible even for the most critical workloads, that the most sensitive information is secured from external and internal threats and that both existing and new business applications are able to take advantage of the cloud model – to address all these challenges, a team of database experts is required, and those are, like in any other IT field, in an increasingly short supply.

Addressing this skills gap with new intelligent automation tools based on machine learning to reduce the amount of menial labor for administrators and to allow them to focus on more business-relevant tasks is a popular trend in various areas of IT and information security. As a result, the role of database administrators (DBA) is changing: instead of wasting their time on mundane repetitive maintenance tasks, they can now focus on more meaningful aspects of their jobs like data modeling, performance monitoring and even regulatory compliance.

However, as the very notion of “autonomous” implies, Oracle goes much further than just automation with its newest offering: their Autonomous Database is designed not to expose any controls to human administrators at all, thus completely eliminating human factor from database management. A DBA only needs to define a few policies, and the rest happens automatically, including instance provisioning, resource scaling, patching and updates, backup and recovery and even performance tuning. This approach has immense potential benefits not just for reducing labor and costs for customers, but for dramatically improving database's resiliency against both human errors and malicious activities, internal or external. Each database is also guaranteed to have all security features enabled by default and all relevant parameters automatically configured according to the current security best practices and compliance requirements.

It should be stressed however that the Autonomous Database does not refer to a particular product from Oracle's software portfolio. Rather, this outlines the company's long-term strategy for supporting their customers' journey to the Digital Transformation. At the initial stage, the company is offering a number of specialized cloud services for various types of enterprise database workloads, building upon the latest innovations in the Oracle Database 18c, power of Oracle Exadata hardware platform and the expertise of the company's leading engineers. Needless to say, the services are exclusively available in the Oracle Cloud.

## 2 Product Description

Oracle Autonomous Database is the world's first self-driving, self-healing and self-securing database that completely replaces human labor with machine learning for all database maintenance tasks. That, in a nutshell, was the announcement made by Oracle at the recent Oracle Open World conference. Of course, it has caused quite a stir in the audience and among database professionals around the world. Does it mean that a DBA will now be completely replaced by artificial intelligence built into every Oracle database? Should thousands of IT specialists around the world fear for their jobs? Will it still be possible to manage and tune an instance manually if needed? And finally: where is the catch? Can an autonomous database really be better than a traditional one in every aspect?

To answer these questions and to put the minds of DBAs around the world to rest, we have to clarify a few crucial points about this announcement. First and foremost, the very notion of the Autonomous Database does not refer to a single product from Oracle's software portfolio. Rather, this outlines the company's long-term strategy for supporting their customers' journey to the Digital Transformation.

Deploying intelligent automation tools based on machine learning to help IT administrators focus on business-relevant tasks instead of mundane and repetitive maintenance is a popular trend in various areas of IT and information security. However, there is an important distinction between "automated" and "autonomous". Although Oracle has a long history of implementing various automation features in its database products, no degree of automation can completely eliminate the need of human intervention, even if it's limited to just a few technical decisions. With management controls still exposed, such a database remains vulnerable to the full range of security and availability risks, from hacking attacks to misconfigurations and other mistakes.

An autonomous database, to the contrary, is designed to be fully sealed from human access immediately after initial provisioning, exposing no management controls to the outside world. All maintenance, security and other management activities are supposed to be fully automated: this includes resource management and scaling, performance tuning, version upgrades and patches, disaster recovery and, of course, information protection and threat prevention. If this sounds too good to be true, that's because it is – designing a completely autonomous database as a piece of software fully adaptable to every possible hardware configuration or type of workload is still a too ambitious task even for a veteran database vendor.

However, by combining the latest innovations of the recently released Oracle Database 18c with the power of highly scalable Oracle Exadata hardware platform optimized for enterprise database workloads and by adding the expertise of its leading database engineers in performance tuning and incident response, Oracle is able to offer its customers the next best thing: a fully autonomous cloud platform for migrating their existing data to Autonomous Databases either in the Oracle Public Cloud or Oracle Cloud at Customer environments in their own data centers. So, Oracle Autonomous Database is not a software product, but a fully managed service (or rather, a family of services) for running mission-critical enterprise databases in the Oracle Cloud.

And like any solution powered by machine learning, it's not supposed to replace human experts, but instead relieve them of the tedious and repetitive database maintenance tasks, giving them the

opportunity to focus more on innovative and business-relevant tasks like architecture and data modeling, security and information protection and application-level performance optimization. Quick and simple instance provisioning also makes enterprise-class databases much more accessible to application developers and data scientists, which no longer need to involve a DBA to start a new project, set up a testing environment or conduct an experiment.

However, potential benefits of this approach go way beyond convenience. By completely eliminating potential human interference into the instance lifecycle, Oracle promises to make the Autonomous Database not just self-driving, but self-securing and self-repairing as well, to say nothing about “self-sustainable”. In fact, one of the boldest claims made by the company is that with all the added benefits of the new solution it’s still substantially cheaper to run than existing managed databases from their competitors: since the instance running on Exadata platform can automatically scale compute and storage up and down independently to minimize resource consumption at any given time, runtime costs can be lowered up to 90%.

Leaving the latter claim aside, let’s look more closely at the Autonomous Database’s security benefits. As mentioned earlier, provisioning a new database instance is the only step where human intervention is needed. Still, even here a user only needs to select the intended workload type and define the amounts of compute and storage resources needed along with the geographical location of the new instance – everything else is automated. This includes resource allocation, configuration, storage and network security, backup and disaster recovery parameters, etc. In less than 30 seconds, the database is ready for connections. If needed, customers may choose a mission-critical service level agreement, which will automatically provision a standby database instance, increasing guaranteed availability from 99.95% to 99.995%. This equals to less than 2.5 minutes downtime per month without any exclusions (like scheduled maintenance – a common practice among many cloud service providers). Again, all the existing Oracle technologies that enable high availability and disaster recovery are set up and configured automatically behind the scenes.

Since an autonomous instance does not even expose any management controls to a human administrator, its stability and resilience against human error is obviously substantially higher than a traditional database. Not only it prevents both honest mistakes and malicious insider actions, this also dramatically reduces the potential cyberattack surface and simplifies compliance with data protection regulations. Each instance has data encryption enabled by default, both at rest and in transit. Access control and auditing are also enabled by default, ensuring that each instance is always configured according to current security best practices. In future releases, Oracle is planning to incorporate its existing data security technologies like Data Masking and Redaction into the autonomous database instances as well.

Keeping the database patched against the latest discovered vulnerabilities is a crucial factor for security and compliance. Oracle Autonomous databases can patch themselves automatically. Updates for the whole technology stack are released at least quarterly, but critical updates for zero-day exploits are made available sooner. All updates are applied in a rolling fashion on individual cluster nodes to ensure that the instance always remains accessible. Still, even with no downtime, an update may cause a short decrease in performance, so customers are allowed to override the automatically selected maintenance window. For future releases, Oracle is planning full support for replaying production workloads in a test environment to ensure that an update does not affect critical business applications in any way.

The same principles apply to disaster recovery. Even without a standby copy in a different datacenter for mission-critical scenarios, each instance is triple-mirrored to withstand outages within the datacenter. In addition to automated recovery from hardware failures, The Autonomous Database can restore the data to any point in time (with a configurable retention policy) to roll back user errors. Finally, daily backups are automatically configured for each instance.

A diagnostics engine powered by machine learning is constantly monitoring the database for performance bottlenecks, capacity limits or potential issues across different layers. It will automatically detect anomalous events and adjust database parameters to prevent resource exhaustion or other impending errors. Collected diagnostic data will be submitted to Oracle support and used by developers to establish root causes and develop patches. At no time Oracle engineers have access to the database behind the customer's backs. For the rare events when automated disaster recovery is not enough, a clearly defined break-glass procedure can be initiated to allow them to step in under the customer's supervision.

Although Oracle databases incorporate various performance optimization and tuning technologies developed over decades, the new 18c release has introduced further improvements powered by machine learning. As new data is loaded into an instance, the optimizer is constantly gathering new statistics, allowing the SQL plans to be re-evaluated and recommending performance improvements. However, even with all the Oracle's decade-long expertise, developing a universal optimization algorithm is a too complex challenge. This is why the company had to make two major compromises.

First of all, Oracle acknowledges that the best possible performance for every customer or workload is impossible to achieve with a universal algorithm and a tradeoff between careful manual optimization and reasonable performance out of the box will always exist. However, the company claims that for most test workloads, the Autonomous Database is able to provide better performance without any manual tuning, and only in rare cases fine-tuned database schemas created by customer DBAs were able to provide better results. In the future, the company is planning to introduce "Guided Autonomous" services, where customers retain partial control over database structures and policies.

More important, however, is the fact that there will not be a single universal Autonomous Database service for all types of workloads – instead, Oracle is planning to offer different services for different workload types. The first one, available now, is Oracle Autonomous Data Warehouse Cloud – a cloud service for migrating on-premises data warehouses or data marts to the cloud to support high-performance analytics workloads. The next one, available sometime in 2018, will be optimized for enterprise OLTP and mixed workloads. The long-term roadmap includes support for NoSQL, graph and other database types.

Additionally, Autonomous Database Cloud for Departments or Developers is offered as an entry level service for app development with low code development tools. Speaking of app development, it's worth mentioning that Autonomous Database provides a set of REST-based APIs for provisioning and lifecycle operations on database instances, which simplifies integration with customer's existing automation infrastructures or CI/CD toolchains. Additionally, Oracle provides a set of migration and data loading tools for simplifying migration to the cloud.

### 3 Strengths and Challenges

The concept of Autonomous Database is without doubt a disruptive innovation comparable to the recent developments in other fields of information technology like machine learning or serverless computing. By combining its decade-long experience in developing enterprise database solutions, the latest AI-powered innovations in the Oracle Database 18c and the scalability and performance of the dedicated Exadata hardware platform, Oracle has created a unique offering for the most demanding enterprise database customers, which finally moves the competition from the playing field of other cloud service providers into the territory where Oracle has traditionally been a dominant player.

Like any other disruptive service, in its initial release, the Autonomous Database doesn't yet contain all the promised features and makes several compromises to address technological challenges. Still, even the first member of the new service family, the Oracle Autonomous Data Warehouse Cloud, already demonstrates impressive scalability, performance and security benefits (not to mention cost optimization).

Of course, Autonomous Database may not be the optimal solution for every data management project in the cloud. To use the popular analogy that compares a wide range of managed database solutions currently available on the market with diverse types of vehicles, one could say that for many customers, a compact car or even a bicycle are still perfectly fine. But if your project calls for a jumbo jet instead, you will find one, and a pilotless electric-powered one to boot, in the Oracle cloud.

Strengths	Challenges
<ul style="list-style-type: none"> <li>● Fully automated cloud database platform combining enterprise-grade dedicated hardware with the latest Oracle Database release</li> <li>● Automated provisioning according to the best practices in availability, security and performance</li> <li>● Completely eliminates administrative user access, increasing resiliency against human errors, malicious insiders and hackers</li> <li>● Automated patching, backup and disaster recovery with no downtime; impressive 99.995% availability SLA</li> <li>● Automated performance optimization, elastic resource usage lead to substantial cost reduction</li> </ul>	<ul style="list-style-type: none"> <li>● Available in the Oracle cloud only, further enforcing vendor lock-in</li> <li>● Initial release doesn't yet contain all promised features, limited to certain workload types</li> </ul>

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