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 **Cloud Databases**

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**1. Introduction to Cloud Databases**

## A cloud based database refers to a database that is created, deployed and accessed within a cloud environment, such as a public or hybrid cloud setup. Cloud databases offer advantages compared to on-premise databases;

* 1. Scalability; Cloud databases can easily adapt to changing demands by scaling up or down. This flexibility helps save on hardware expenses while ensuring performance at all times.
* 2. Availability; Cloud databases are designed for availability, meaning they are consistently accessible and operational. This feature is particularly beneficial for businesses requiring the clock availability of their databases.
* 3. Security; Cloud databases boast security measures compared to their on premises counterparts. Cloud providers employ security teams for safeguarding your data from potential threats.
* 4. Cost effectiveness; Utilizing cloud databases can be more cost effective than, on premises options since you only pay for the resources you actually use.

These advantages highlight why businesses often opt for cloud based solutions when it comes to their database needs.

There are primarily two types of cloud databases available;

1. Managed database, as a service (DBaaS); This refers to a service where the cloud provider handles all aspects of hosting and managing the database. You don't need to concern yourself with the underlying infrastructure, as it is taken care of by the provider.

2. Self-managed database: With this type, you have the responsibility of deploying and overseeing your database on a cloud platform. While you have control over the database itself, you also need to manage and maintain the underlying infrastructure.

The best type of cloud database for you will depend on your specific needs and requirements. If you are looking for a fully managed service that is easy to use and secure, then a managed DBaaS is a good option. If you need more control over the database, then a self-managed database may be a better choice.

Here are some of the most popular cloud databases:

* Amazon Relational Database Service (RDS): This is a managed DBaaS that offers a variety of relational database engines, including MySQL, PostgreSQL, and Oracle.
* Microsoft Azure SQL Database: This is a managed DBaaS that offers a variety of relational database engines, including SQL Server and MySQL.
* Google Cloud SQL: This is a managed DBaaS that offers a variety of relational database engines, including MySQL, PostgreSQL, and SQL Server.
* MongoDB Atlas: This is a managed DBaaS that offers the MongoDB database engine.
* CockroachDB Cloud: This is a managed DBaaS that offers the CockroachDB database engine.

If you are considering moving your database to the cloud, there are a few things that you need to keep in mind:

* Data migration: You will need to migrate your data from your on-premises database to the cloud. This can be a complex process, so you should carefully plan your migration.
* Security: You need to make sure that your data is secure in the cloud. Cloud providers offer a variety of security features, but you should also implement your own security measures.
* Cost: Cloud databases can be more expensive than traditional on-premises databases. However, the cost savings can be significant if
* you need to scale your database up or down frequently.

**1.1 What are Cloud Databases?**

A cloud database is a database that is hosted on a cloud computing platform. This means that the database is not stored on your own computer or server, but on a remote server that is managed by a cloud provider. Cloud databases offer a number of advantages over traditional on-premises databases, including:

* Scalability: Cloud databases can be scaled up or down as needed, so you only pay for the resources you use.
* Reliability: Cloud databases are highly reliable, as they are backed up regularly and are protected from outages.
* Security: Cloud databases are secure, as they are encrypted and access is controlled.
* Cost-effectiveness: Cloud databases can be more cost-effective than traditional on-premises databases, as you do not need to purchase or maintain your own hardware.

There are two main types of cloud databases:

* Relational databases: Relational databases are the most common type of cloud database. They are designed to store structured data, such as customer records or product inventory.
* NoSQL databases: NoSQL databases are designed to store unstructured or semi-structured data, such as social media data or sensor data.

Some of the most popular cloud databases include:

* Amazon Relational Database Service (RDS): RDS is a fully-managed relational database service that offers a wide range of database engines, including MySQL, PostgreSQL, and Oracle.
* Microsoft Azure SQL Database: Azure SQL Database is a fully-managed relational database service that offers a wide range of database engines, including SQL Server and MySQL.
* Google Cloud SQL: Cloud SQL is a fully-managed relational database service that offers a wide range of database engines, including PostgreSQL, MySQL, and SQL Server.
* MongoDB Atlas: MongoDB Atlas is a fully-managed NoSQL database service that offers the MongoDB database engine.
* Amazon DynamoDB: DynamoDB is a fully-managed NoSQL database service that offers the DynamoDB database engine.

If you are considering moving your database to the cloud, there are a few things you need to keep in mind:

* The type of data you need to store: If you need to store structured data, then a relational database is a good choice. If you need to store unstructured or semi-structured data, then a NoSQL database is a good choice.
* The size of your database: If you have a small database, then you can probably get away with using a free or low-cost cloud database service. If you have a large database, then you will need to choose a more expensive cloud database service.
* Your budget: Cloud databases can range in price from free to hundreds of dollars per month. You need to choose a cloud database service that fits your budget.

Once you have chosen a cloud database service, you need to migrate your database to the cloud. This process can be complex, so you may want to hire a professional to help you.

After your database has been migrated to the cloud, you need to monitor it to make sure that it is performing as expected. You should also regularly back up your database to protect it from data loss.

**1.2 Advantages of Cloud Databases**

Cloud databases offer a number of advantages over traditional on-premises databases, including:

* Scalability: Cloud databases can be scaled up or down as needed, so you only pay for the resources you use. This is especially important for businesses with fluctuating workloads.
* Reliability: Cloud databases are highly reliable, as they are backed up regularly and are protected from outages. This is because cloud providers have multiple data centers located in different geographic regions, so if one data center goes down, your data is still accessible from another data center.
* Security: Cloud databases are secure, as they are encrypted and access is controlled. Cloud providers have a team of security experts who are constantly monitoring the security of their systems.
* Cost-effectiveness: Cloud databases can be more cost-effective than traditional on-premises databases, as you do not need to purchase or maintain your own hardware. Cloud providers also offer a variety of pricing options, so you can choose the one that best fits your budget.
* Accessibility: Cloud databases are accessible from anywhere with an internet connection. This means that you can access your data from your office, home, or even on the go.
* Innovation: Cloud providers are constantly innovating and adding new features to their cloud database services. This means that you can be sure that your cloud database will be up-to-date with the latest features and security measures.
* Ease of use: Cloud databases are typically easier to use than traditional on-premises databases. This is because cloud providers provide a variety of tools and services that make it easy to manage and administer your database.
* Flexibility: Cloud databases are more flexible than traditional on-premises databases. This is because you can easily scale your database up or down as needed, and you can also choose the type of database that best meets your needs.
* Global reach: Cloud databases can be accessed from anywhere in the world. This is important for businesses that have a global customer base.

**1.3 Challenges and Considerations**

Cloud databases offer a number of advantages, but there are also some challenges and considerations that you should be aware of before you move your database to the cloud.

Challenges

* Security: Cloud databases are secure, but there is always a risk of a security breach. You need to make sure that you choose a cloud provider that has a strong security track record.
* Compliance: If your business is subject to compliance regulations, you need to make sure that your cloud database is compliant. Cloud providers can help you with this, but you need to be aware of the regulations that apply to your business.
* Latency: Cloud databases can be located in different geographic regions. This means that there is a potential for latency, which is the delay between when you send a request to the database and when you receive a response.
* Cost: Cloud databases can be more expensive than traditional on-premises databases, especially if you need to scale your database up or down frequently. You need to carefully calculate the cost of moving your database to the cloud before you make a decision.

Considerations

* Your needs: Before you move your database to the cloud, you need to carefully consider your needs. What type of database do you need? How much data do you need to store? How much traffic do you expect?
* Your budget: Cloud databases can be expensive, so you need to make sure that you have a budget in place. You also need to consider the cost of migrating your database to the cloud.
* Your expertise: If you do not have the expertise to manage a cloud database, you may need to hire a consultant or a managed service provider.

Overall, cloud databases offer a number of advantages over traditional on-premises databases. However, there are also some challenges and considerations that you should be aware of before you move your database to the cloud.

Here are some additional considerations when moving to a cloud database:

* Data sovereignty: If you are storing data that is subject to data sovereignty laws, you need to make sure that your cloud provider can store your data in the appropriate region.
* Performance: Cloud databases can be more performant than traditional on-premises databases, but this depends on a number of factors, including the type of database you choose, the amount of data you store, and the amount of traffic you expect.
* Support: Cloud providers offer a variety of support options, so you need to choose the option that best meets your needs.

If you are considering moving your database to the cloud, you should carefully consider your needs and budget. You should also be aware of the challenges and considerations that are involved in moving to a cloud database.

**2. Types of Cloud Databases**

 2.1 Relational Cloud Databases

A relational cloud database is a database that is hosted on a cloud computing platform and uses a relational database management system (RDBMS). Relational databases are the most common type of database, and they are designed to store structured data. Structured data is data that is organized in a predefined format, such as a table.

There are a number of benefits to using a relational cloud database, including:

* Scalability: Relational cloud databases can be scaled up or down as needed, so you only pay for the resources you use. This is especially important for businesses with fluctuating workloads.
* Reliability: Relational cloud databases are highly reliable, as they are backed up regularly and are protected from outages. This is because cloud providers have multiple data centers located in different geographic regions, so if one data center goes down, your data is still accessible from another data center.
* Security: Relational cloud databases are secure, as they are encrypted and access is controlled. Cloud providers have a team of security experts who are constantly monitoring the security of their systems.
* Cost-effectiveness: Relational cloud databases can be more cost-effective than traditional on-premises databases, as you do not need to purchase or maintain your own hardware. Cloud providers also offer a variety of pricing options, so you can choose the option that best fits your budget.
* Ease of use: Relational cloud databases are typically easier to use than traditional on-premises databases. This is because cloud providers provide a variety of tools and services that make it easy to manage and administer your database.
* Flexibility: Relational cloud databases are more flexible than traditional on-premises databases. This is because you can easily scale your database up or down as needed, and you can also choose the type of database that best meets your needs.
* Global reach: Relational cloud databases can be accessed from anywhere in the world. This is important for businesses that have a global customer base.

If you are looking for a scalable, reliable, secure, and cost-effective way to store your structured data, then a relational cloud database is a good option.

Here are some of the most popular relational cloud databases:

* Amazon Relational Database Service (RDS): RDS is a fully-managed relational database service that offers a wide range of database engines, including MySQL, PostgreSQL, and Oracle.
* Microsoft Azure SQL Database: Azure SQL Database is a fully-managed relational database service that offers a wide range of database engines, including SQL Server and MySQL.
* Google Cloud SQL: Cloud SQL is a fully-managed relational database service that offers a wide range of database engines, including PostgreSQL, MySQL, and SQL Server.
* MongoDB Atlas: MongoDB Atlas is a fully-managed NoSQL database service that offers the MongoDB database engine.
* Amazon DynamoDB: DynamoDB is a fully-managed NoSQL database service that offers the DynamoDB database engine.

 **2.2 NoSQL Cloud Databases**

NoSQL cloud databases are a type of database that is hosted on a cloud computing platform and uses a NoSQL database management system (NoSQL DBMS). NoSQL DBMSs are designed to store unstructured or semi-structured data. Unstructured data is data that does not have a predefined format, such as text documents or social media data. Semi-structured data is data that has a loose predefined format, such as XML or JSON documents.

There are a number of benefits to using a NoSQL cloud database, including:

* Scalability: NoSQL cloud databases can be scaled up or down as needed, so you only pay for the resources you use. This is especially important for businesses with fluctuating workloads.
* Reliability: NoSQL cloud databases are highly reliable, as they are backed up regularly and are protected from outages. This is because cloud providers have multiple data centers located in different geographic regions, so if one data center goes down, your data is still accessible from another data center.
* Security: NoSQL cloud databases are secure, as they are encrypted and access is controlled. Cloud providers have a team of security experts who are constantly monitoring the security of their systems.
* Cost-effectiveness: NoSQL cloud databases can be more cost-effective than traditional on-premises databases, as you do not need to purchase or maintain your own hardware. Cloud providers also offer a variety of pricing options, so you can choose the option that best fits your budget.
* Flexibility: NoSQL cloud databases are more flexible than traditional on-premises databases. This is because you can easily scale your database up or down as needed, and you can also choose the type of database that best meets your needs.
* Global reach: NoSQL cloud databases can be accessed from anywhere in the world. This is important for businesses that have a global customer base.

If you are looking for a scalable, reliable, secure, and cost-effective way to store your unstructured or semi-structured data, then a NoSQL cloud database is a good option.

Here are some of the most popular NoSQL cloud databases:

* MongoDB Atlas: MongoDB Atlas is a fully-managed NoSQL database service that offers the MongoDB database engine.
* Amazon DynamoDB: DynamoDB is a fully-managed NoSQL database service that offers the DynamoDB database engine.
* Cassandra: Cassandra is a distributed NoSQL database that is open-source.
* Redis: Redis is an in-memory NoSQL database that is open-source.
* Neo4j: Neo4j is a graph database that is open-source.

These are just a few of the many NoSQL cloud databases that are available. When choosing a NoSQL cloud database, you need to consider your needs and budget. You also need to make sure that the database you choose is compatible with your applications.

Here is a table that summarizes the key differences between relational and NoSQL cloud databases:

| Feature | Relational Cloud Database | NoSQL Cloud Database |
| --- | --- | --- |
| Data model | Structured | Unstructured or semi-structured |
| Scalability | Horizontal | Horizontal or vertical |
| Performance | Good for transactions | Good for analytical queries |
| Flexibility | Less flexible | More flexible |
| Cost | More expensive | Less expensive |

The best type of cloud database for you will depend on your specific needs and requirements. If you are storing structured data and need a high-performance database for transactions, then a relational cloud database is a good option. If you are storing unstructured or semi-structured data and need a scalable database for analytical queries, then a NoSQL cloud database is a good option.

**2.2.1 Document databases**:

 Document databases store data in documents, which are similar to JSON or XML documents. Documents can contain a variety of data types, including text, numbers, and images. Document databases are a good choice for storing unstructured or semi-structured data. Some popular document databases include MongoDB, CouchDB, and Elasticsearch.

**2.2.2 Key-value store**s:

 Key-value stores store data in key-value pairs. The key is a unique identifier for the data, and the value is the data itself. Key-value stores are a good choice for storing small amounts of data that needs to be accessed quickly. Some popular key-value stores include Redis, Memcached, and DynamoDB.

**2.2.3 Column-family stores**

: Column-family stores store data in columns. Each column contains a single type of data, such as name, age, or address. Column-family stores are a good choice for storing large amounts of data that needs to be accessed quickly. Some popular column-family stores include HBase, Cassandra, and Bigtable.

**2.2.4 Graph databases**:

 Graph databases store data in a graph structure. A graph is a network of nodes and edges. The nodes represent entities, such as people, products, or places. The edges represent relationships between entities. Graph databases are a good choice for storing data that has a natural graph structure, such as social networks or transportation networks. Some popular graph databases include Neo4j, OrientDB, and FlockDB.

**2.3 NewSQL Databases**

NewSQL databases are a new breed of database that combines the scalability and performance of NoSQL databases with the ACID (atomicity, consistency, isolation, and durability) guarantees of traditional relational databases.

NewSQL databases are designed to meet the needs of modern applications that require high performance, scalability, and transactional integrity. They are a good choice for applications that need to handle a high volume of transactions, such as online banking or e-commerce.

Some of the most popular NewSQL databases include:

* CockroachDB: CockroachDB is a distributed, fault-tolerant NewSQL database that is open-source.
* VoltDB: VoltDB is a real-time, in-memory NewSQL database that is also open-source.
* MariaDB Galera Cluster: MariaDB Galera Cluster is a high-availability, scalable NewSQL database that is based on the MariaDB database engine.
* Percona XtraDB Cluster: Percona XtraDB Cluster is a high-availability, scalable NewSQL database that is based on the MySQL database engine.

NewSQL databases are still a relatively new technology, but they are gaining popularity as businesses look for a way to meet the needs of modern applications.

Here is a table that summarizes the key differences between NewSQL and traditional relational databases:

| Feature | NewSQL Database | Traditional Relational Database |
| --- | --- | --- |
| Data model | Relational | Relational |
| Scalability | Horizontal | Horizontal or vertical |
| Performance | High | High |
| Transactional integrity | ACID | ACID |
| Flexibility | More flexible | Less flexible |
| Cost | More expensive | Less expensive |

 **2.4 In-Memory Databases**

In-memory databases are a type of database that stores data in memory instead of on disk. This makes them much faster than traditional databases, as memory access is much faster than disk access.

In-memory databases are designed for applications that require high performance, such as real-time analytics or trading applications. They are also a good choice for applications that need to process large amounts of data quickly.

Some of the most popular in-memory databases include:

* Memcached: Memcached is an open-source, in-memory key-value store.
* Redis: Redis is an open-source, in-memory data structure store.
* Hazelcast: Hazelcast is a distributed, in-memory data grid.
* Couchbase Memcached: Couchbase Memcached is a commercial, in-memory key-value store.

In-memory databases are still a relatively new technology, but they are gaining popularity as businesses look for a way to improve the performance of their applications.

Here is a table that summarizes the key differences between in-memory and traditional databases:

| Feature | In-memory Database | Traditional Database |
| --- | --- | --- |
| Data storage | Memory | Disk |
| Performance | High | Low |
| Scalability | Horizontal | Horizontal or vertical |
| Cost | More expensive | Less expensive |

 **2.5 Time-Series Databases**

A time-series database (TSDB) is a type of database that is optimized for storing and querying time-series data. Time-series data is data that is collected at regular intervals, such as sensor data or stock market data.

TSDBs are designed to handle the following challenges:

* High volume: TSDBs are designed to store large amounts of time-series data.
* High velocity: TSDBs are designed to handle high-velocity data streams.
* High accuracy: TSDBs are designed to ensure the accuracy of time-series data.
* High availability: TSDBs are designed to be highly available and reliable.

Some of the most popular TSDBs include:

* InfluxDB: InfluxDB is an open-source TSDB that is popular for IoT and DevOps applications.
* Kafka: Kafka is a distributed messaging system that can be used as a TSDB.
* OpenTSDB: OpenTSDB is an open-source TSDB that is popular for monitoring applications.
* Elasticsearch: Elasticsearch is a search engine that can be used as a TSDB.
* Azure Time Series Insights: Azure Time Series Insights is a cloud-based TSDB that is offered by Microsoft.

TSDBs are a good choice for applications that need to store and query large amounts of time-series data. They are also a good choice for applications that need to handle high-velocity data streams or that require high accuracy.

Here is a table that summarizes the key features of TSDBs:

| Feature | TSDB |

 |---|---|---| |

 Data model | Time-series |

 | Scalability | Horizontal |

| Performance | High |

| Accuracy | High |

 | Availability | High |

 | Cost | Varies |

The best type of TSDB for you will depend on your specific needs and requirements. If you need a TSDB that is highly scalable and can handle high-velocity data streams, then InfluxDB or Kafka is a good option. If you need a TSDB that is highly accurate and reliable, then OpenTSDB or Elasticsearch is a good option.

I understand you're looking for references to support the content in your table of contents. While I can't directly provide live links, I can suggest reputable sources where you can find information related to each section of your table of contents:

**3 .Reference**

1. <https://aws.amazon.com/products/databases/>
2. <https://azure.microsoft.com/en-us/services/sql-database/#features>
3. <https://cloud.google.com/products/databases>
4. <https://dzone.com/articles/challenges-in-deploying-cloud-databases>
5. <https://www.datastax.com/blog/2019/06/top-cloud-database-challenges-you-need-solve>
6. <https://www.postgresql.org/docs/>
7. <https://dev.mysql.com/doc/>
8. <https://www.mongodb.com/nosql-explained>
9. <https://www.postgresql.org/docs/>
10. <https://www.mongodb.com/nosql-explained>
11. <https://cassandra.apache.org/doc/latest/>
12. <https://redis.io/documentation>
13. <https://neo4j.com/developer/>
14. <https://www.cockroachlabs.com/docs/>
15. <https://cloud.google.com/spanner>
16. <https://www.gartner.com/en/information-technology/glossary/in-memory-database-management-system-IMDBMS>
17. <https://docs.influxdata.com/influxdb/>

**1. Introduction to Cloud Databases:**

 1.2 Advantages of Cloud Databases:

 - AWS Advantages of Cloud Databases: [[Link](https://aws.amazon.com/products/databases/%29)]

 - Microsoft Azure Database Benefits: [[Link](https://azure.microsoft.com/en-us/services/sql-database/#features))]

 - GCP Cloud Databases Overview: [[Link](https://cloud.google.com/products/databases%29)]

 1.3 Challenges and Considerations:

 - "Top Cloud Database Challenges You Need to Solve" by DataStax: [[Link](https://www.datastax.com/blog/2019/06/top-cloud-database-challenges-you-need-solve%29)] - "Challenges in Deploying Cloud Databases" by DZone: [[Link](https://dzone.com/articles/challenges-in-deploying-cloud-databases)]

**2. Types of Cloud Databases:**

 2.1 Relational Cloud Databases:

 - MySQL Official Documentation: [[Link](https://dev.mysql.com/doc/)]

 - PostgreSQL Documentation: [[Link](https://www.postgresql.org/docs/)]

 2.2 NoSQL Cloud Databases:

 - "Introduction to NoSQL Databases" by MongoDB: [[Link](https://www.mongodb.com/nosql-explained)]

 - Redis Documentation: [[Link](https://redis.io/documentation)]

 - Apache Cassandra Documentation: [[Link](https://cassandra.apache.org/doc/latest/)]

 - Neo4j Learning Center: [[Link](https://neo4j.com/developer/)]

 2.3 NewSQL Databases:

 - Google Spanner Documentation: [[Link](https://cloud.google.com/spanner)]

 - CockroachDB Documentation: [[Link](https://www.cockroachlabs.com/docs/)]

 2.4 In-Memory Databases:

 - "In-Memory Database Systems: An Overview" by Gartner: [[Link](https://www.gartner.com/en/information-technology/glossary/in-memory-database-management-system-IMDBMS)]

 2.5 Time-Series Databases:

 - InfluxDB Documentation: [[Link](https://docs.influxdata.com/influxdb/)]