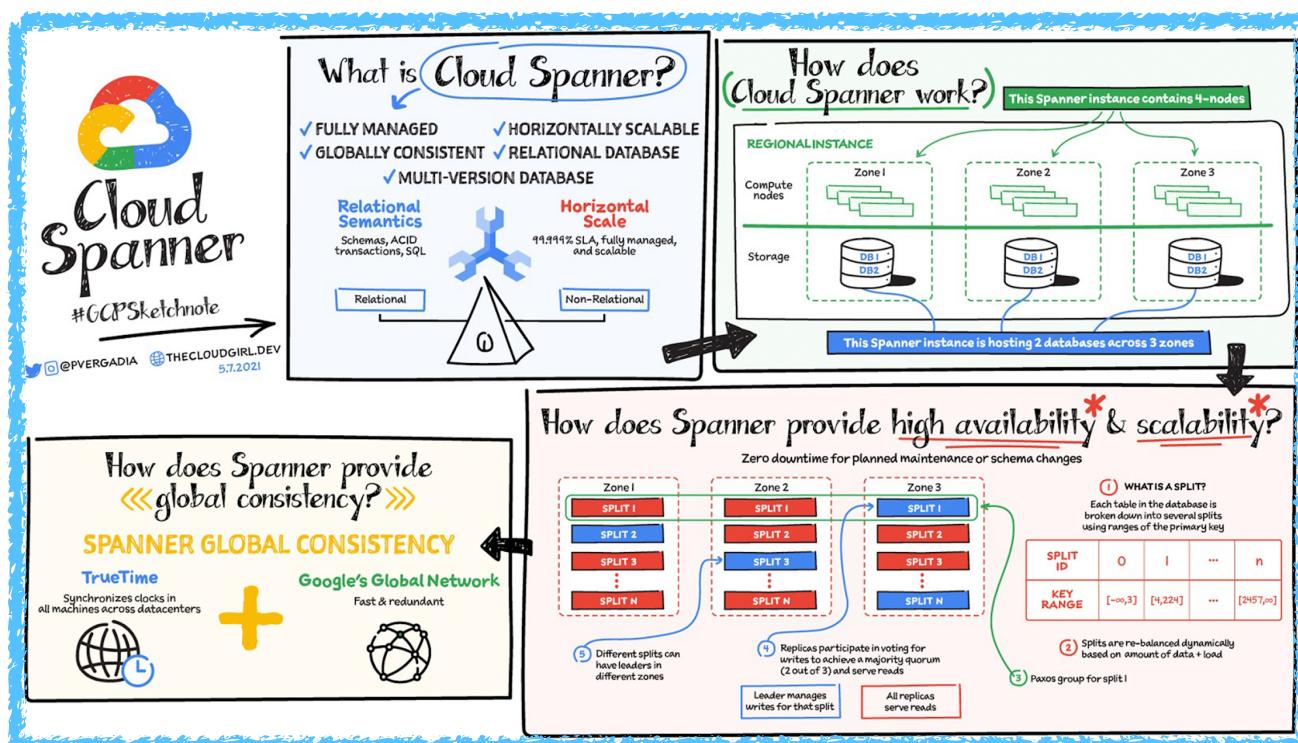


Google Cloud Spanner

- Cloud Spanner is a fully managed, mission-critical, relational database service that offers transactional consistency and horizontal scaling at global level, automatic, synchronous replication for high availability, and support for two SQL dialects:
 1. GoogleSQL (ANSI 2011 with extensions)
 2. PostgreSQL.



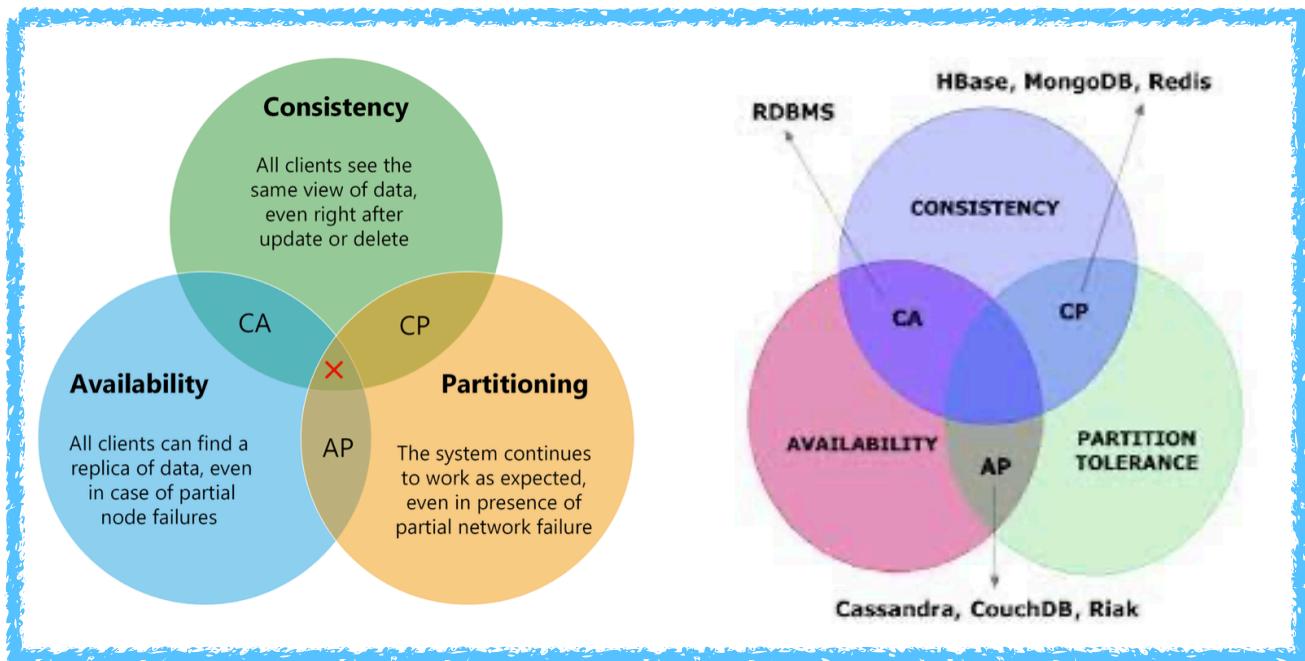
- Cloud Spanner is unique in the marketplace that is a globally distributed, strongly consistent, and the only enterprise-grade service that combines transactions, SQL query, and relational structure with the scalability you typically associate with non-relational or NoSQL databases.
- Cloud Spanner = Cloud SQL + Horizontal Scalable
- It provides excellent data consistency, scalability and eliminates management overhead.

- Cloud Spanner is specially designed for handling a massive amount of data when **Data volume > 2 TB** and suitable for banks, gaming industries, retailing, etc.
 - It provides strong transactional consistency. Highly scalable upto Petabyte.
 - It optimizes the performance by **automatically sharding**(the process of storing a large database across multiple machines) the data based on request load and the volume of the data. It is a relational database specially designed for auto scalability.
 - It is built on Google Cloud's dedicated network that ensures low latency, security, and reliability.
 - You can make schema changes online, such as adding a row or column while serving traffic with zero downtime.
 - Back up your database to store a consistent copy of data and restore on demand. PITR (point-in-time recovery) provides continuous data protection with the ability to recover your past data to microsecond granularity.
 - It supports multiple languages such as C#, C++, Go, Java, Node.js, PHP, Python, Ruby, etc.
 - Supports ACID transactions (atomicity, consistency, isolation, and durability)
 - Synchronizes data across applications and storage systems.
 - The product has regional as well as multi-regional configurations –
 - Regional gives 4 nines of availability
 - Multi-region gives 5 nines of availability
 - Scale-wise, this is the database that is used within Google, including YouTube and Google Ads.
-  Data export, cannot export with gcloud only by using Cloud Console or Cloud Dataflow Job. 
- Cloud Spanner delivers industry-leading 99.999% availability for multi-regional instances—10x less downtime than four nines—and provides

transparent, replicate data across multiple regions with unlimited scale and strong consistency, no planned downtime, synchronous replication across the region and multi-region configurations.

- Is it really achievable? Yes, Spanner is highly available with the right configuration. **It uses CAP theorem.**

What is the CAP theorem



The CAP theorem formulated by Eric Brewer states that in a distributed system that stores data there are 3 fundamental principles - C,A & P:

- A **distributed system** is a network that stores data on more than one node (physical or virtual machines) at the same time.
- NoSQL databases are ideal for distributed network applications.
- The CAP theorem applies a logic to distributed systems—namely, that a distributed system can deliver only two of three desired characteristics: **consistency, availability and partition tolerance** (the ‘C,’ ‘A’ and ‘P’ in CAP).

- Consistency

- Consistency means that all clients see the same data at the same time, no matter which node they connect to.
- For this to happen, whenever data is written to one node, it must be instantly forwarded or replicated to all the other nodes in the system before the write is deemed ‘successful.’

- Availability

- Availability means that any client making a request for data gets a response, even if one or more nodes are down.
- Another way to state this—all working nodes in the distributed system return a valid response for any request, without exception.

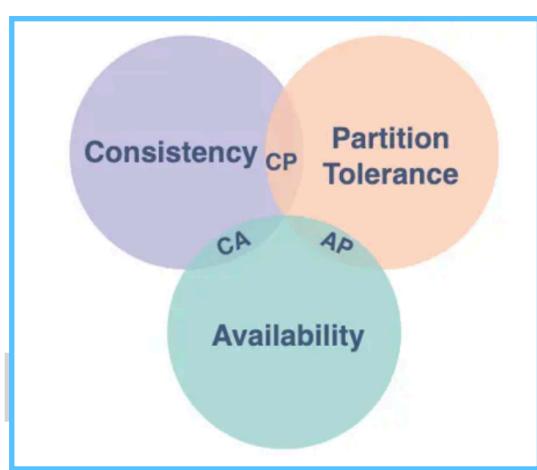
- Partition tolerance

- A partition is a communications break within a distributed system—a lost or temporarily delayed connection between two nodes.
- Partition tolerance means that the cluster must continue to work despite any number of communication breakdowns between nodes in the system.

NoSQL databases are classified based on the two CAP characteristics they support:

I. CP database

- A CP database delivers consistency and partition tolerance at the expense of availability. When a partition occurs between any two nodes, the system has to shut down the non-consistent node (i.e., make it unavailable) until the partition is resolved.



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II. AP database

- An AP database delivers availability and partition tolerance at the expense of consistency.
- When a partition occurs, all nodes remain available but those at the wrong end of a partition might return an older version of data than others. (When the partition is resolved, the AP databases typically resync the nodes to repair all inconsistencies in the system.)

III. CA database

- CA database delivers consistency and availability across all nodes. It can't do this if there is a partition between any two nodes in the system, however, and therefore can't deliver fault tolerance.

Cloud Spanner's attributes

- **Strongly consistent scale-out RDBMS cluster**
 - uses hardware-assisted time synchronization to achieve data consistency.
- **Cross-table transactional support**
 - transactions can span across multiple tables—doesn't have to be limited to a single table (unlike Apache HBase or Apache Kudu).
- **Primary key design driven tables**
 - all tables must have a declared primary key (PK), which can be composed of multiple table columns.
 - Table data is stored in PK order, which makes it very efficient and fast for PK lookups.
 - Like other PK-based systems, the implementation needs to be modeled with caution and target use cases in mind to achieve the best performance.
- **Interleaved tables**
 - Tables can have physical dependencies with each other. Rows of a child table can be collocated with rows of the parent table.

- This approach speeds up lookups of relations that can be defined in the data modeling phase—for example, collocation of customers and their invoices.
- **Indexes**
- Cloud Spanner supports secondary indexes. An index consists of the indexed columns and all PK columns.
 - Optionally, an index can also contain other non-indexed columns.
 - An index can be interleaved with a parent table to speed up queries.
 - Several limitations apply to indexes, like the maximum number of additional columns stored within the index.
 - Also querying via indexes may not be as straightforward as in other RDBMSs.

Features Of Cloud Spanner

Relational database, built for scale	<ul style="list-style-type: none">• Everything you would expect from a relational database—schemas, SQL queries, and ACID transactions—battle-tested and ready to scale for both reads and writes globally.
99.999% availability	<ul style="list-style-type: none">• Industry-leading high availability (up to 99.999%) for multi-regional instances with TrueTime atomic clocks and transparent, synchronous replication.• 100% online schema changes and maintenance while serving traffic with zero downtime.
Automatic database sharding	<ul style="list-style-type: none">• Optimize performance by automatically sharding the data based on request load and data size.

Fully managed	<ul style="list-style-type: none"> Easy deployment at every stage and for any size database. Synchronous replication and maintenance are automatic and built in.
Strong transactional consistency	<ul style="list-style-type: none"> Purpose-built for industry-leading external consistency without compromising on scalability or availability.
Granular instance sizing	<ul style="list-style-type: none"> Start with Spanner with a granular instance for only \$65/month and scale it based on your needs without downtime and with no need for re-architecting.
PostgreSQL interface	<ul style="list-style-type: none"> Combine the scalability and reliability of Spanner with the familiarity and portability of PostgreSQL.
Regional and multi-regional configurations	<ul style="list-style-type: none"> No matter where your users may be, apps backed by Spanner can read and write up-to-date strongly consistent data globally. Additionally, when running a multi-region instance, your database is protected against a regional failure and offers industry-leading 99.999% availability.
Unified analytics and AI on transactional data	<p>A</p> <ul style="list-style-type: none"> Query data in Spanner from BigQuery in real time without moving or copying the data, bridging the gap between operational data and analytics and creating a unified data life cycle.

Built on Google Cloud network	<ul style="list-style-type: none">Cloud Spanner is built on Google's dedicated network that provides low-latency, security, and reliability for serving users across the globe.
Enterprise-grade security and controls	<ul style="list-style-type: none">Customer-managed encryption keys (CMEK), data-layer encryption, IAM integration for access and controls, and comprehensive audit logging.
Backup and Restore, point-in-time recovery (PITR)	<ul style="list-style-type: none">Backup your database to store a consistent copy of data and restore on demand.
Rich application and tool support	<ul style="list-style-type: none">Meet development teams where they are with native client libraries for Java/JDBC, Go, Python, C#, Node.js, PHP, Ruby and C++ as well as the most popular ORMs, including Hibernate and Entity Framework.
Observability	<ul style="list-style-type: none">Monitor performance of Spanner databases with metrics and stats.Analyze usage patterns in Spanner databases with Key Visualizer, an interactive monitoring tool.

90. Lab on Creating Cloud Spanner - Console

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Cloud Spanner Pricing

- Pricing for Cloud Spanner is simple and predictable.
- When you use Cloud Spanner, you are charged for the following.
 - **The amount of compute capacity in your instance**
 - Spanner keeps track of the compute capacity (measured in processing units or nodes) of an instance over time.
 - You are charged for the number of nodes multiplied by the hourly rate.
 - Any compute capacity that you provision will be billed for a minimum of one hour.
 - **The amount of storage that your databases use**
 - Spanner charges you for the average amount of data in your Spanner databases, including tables, secondary indexes, and metadata over a one-month period, multiplied by the monthly rate.
 - **The amount of storage that your backups use**
 - Spanner charges you for the average amount of storage used by your Spanner backups over a one-month period, multiplied by the monthly rate.
 - **The amount of network bandwidth used**
 - Some types of network egress traffic, such as application reads of Spanner databases, are subject to bandwidth charges.
 - There are no bandwidth charges for Spanner replication or network ingress traffic.

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Use Cases of Cloud Spanner

There are many use cases of Cloud Spanner in enterprises to lower down their operational burden.

- **Banks, Fintech Companies, and regulators** demand 24*7 access to the correct information so that they can perform core operations hassle-free. Spanner is used in payment gateways and online banking.
- Cloud Spanner is also used in the **gaming industry**. It supports real-time gameplay and in-gaming purchasing. A million users demand real-time gameplay on the internet. This high burst of traffic requires a platform that can handle heavy loads and requests. Hence Spanner is useful.
- Spanner helps **retail** as well. Online shopping, in-store pickup, digital wallet, rewards, and many other things are there that need a solid platform for computation. There Spanner turns out to be the best fit for these cases.

Drawbacks of Cloud Spanner

- Cloud Spanner is quite an expensive service that runs on hardware with custom clocks that are meant for OLTP data.
- You can expect a little higher latency because it needs to sync data in real-time.
- Its not ideal for high write-throughput use-cases.
- You cannot have hybrid deployments (on-prem and on-cloud data copies).
- You cannot run these applications on any other cloud or on-premise if you ever wanted to, so it is a vendor lock-in.

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Google Cloud SQL Vs Cloud Spanner - Which one to use and When

- A brief comparison of Cloud Spanner vs Relational and Non-relational databases.

	CLOUD SPANNER	TRADITIONAL RELATIONAL	TRADITIONAL NON-RELATIONAL
Schema	✓ Yes	✓ Yes	✗ No
SQL	✓ Yes	✓ Yes	✗ No
Consistency	✓ Strong	✓ Strong	✗ Eventual
Availability	✓ High	✗ Failover	✓ High
Scalability	✓ Horizontal	✗ Vertical	✓ Horizontal
Replication	✓ Automatic	⟳ Configurable	⟳ Configurable

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