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# Transforming Real-Time Payments with Oracle's Distributed Database: Sovereignty, Scalability, and Survivability

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# Introduction

The demand for real-time payments has surged, driven by the need for immediate access to funds and streamlined financial transactions. Both businesses and individuals are increasingly enthusiastic about adopting instant payments, as reflected by impressive growth statistics. According to Juniper Research, the volume of real-time payment transactions is projected to surpass 376 billion globally by 2027, a significant rise from 97 billion in 2022, marking a 289% increase. This surge is fueled by the implementation of instant cross-border payment systems in numerous countries. The demand for real-time payments is escalating across various industries, including online marketplaces, traditional retail, and platforms providing customized financial services or facilitating fund transfers from non-bank entities. This growing trend, often featured in payment industry publications, is driven by customers who desire instant responses, transactional accuracy for reliable processing, and enhanced security to prevent fraud associated with irreversible real-time transactions.

Additionally, every day, innovative use cases surface, such as merchant settlements, rebates, automobile financing, insurance claims and payouts, real estate transactions, and the rapid adoption of instant payroll for earned wages. Real-time payments are also being utilized for peer-to-peer transfers, gig economy payments, emergency disbursements, government benefits distribution, healthcare reimbursements, and cross-border remittances. Key factors driving the adoption of real-time electronic payments include enhanced time and cost efficiencies and improved cash flow management. As a result, real-time payments have become an essential component of modern financial infrastructure, catering to the evolving needs and expectations of stakeholders across various sectors.

# What are Real-time Payments?

Real-time payments, as the name suggests, occur almost instantly, with transactions initiated and settled within seconds. This makes them a game-changer for individuals and businesses needing immediate access to funds. Unlike traditional payment methods that involve delays, real-time payments offer 24/7/365 access, ensuring availability even on weekends and holidays. Compared to regular money transfers, real-time payments provide additional benefits such as improved data and messaging capabilities, enhanced security, and instant access to funds. These features support better cash flow, customer experience, operational efficiency, transparency, and precision for all stakeholders in the payments ecosystem. Key characteristics include immediate fund availability, settlement finality, instant confirmation, and integrated workflows.

Real-time payments also offer valuable insights into spending patterns, helping businesses improve their financial management practices. With streamlined workflows and enhanced liquidity management, businesses can save costs and focus on essential operations.

# The Global Real-Time Payments Landscape

In some countries, such as India and Brazil, real-time payments have become the norm, while in other countries, like the United States, they are still gaining traction. The Real-Time Payment systems are live in several countries, with India and Brazil leading the way in transaction volume, followed by China.

| Rank | Country | Number of Real-Time Payment Transactions, 2023 | Year-on-Year Growth (Volume of Real-Time Payments) 2022-2023 |
|---|---|---|---|
| 1 | India | 129.3B | 44.6% |
| 2 | Brazil | 37.4B | 77.9% |
| 3 | Thailand | 20.4B | 37.5% |
| 4 | China | 17.2B | 3.8% |
| 5 | South Korea | 9.1B | 11.4% |

**Fig1. Top Five Real-Time Markets by Volume**

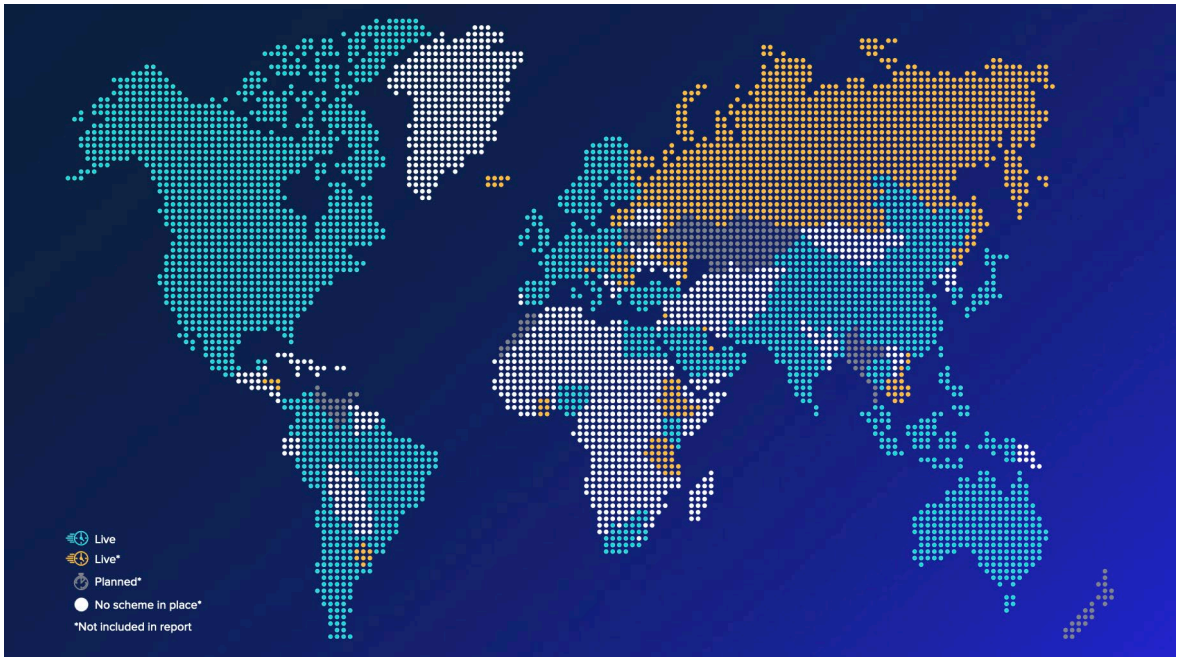


**Fig2. Global Real-Time Payments Adoption**

**Source :** ACI Worldwide's 2022 Prime-Time for Real-Time Report

Since 2010, numerous countries have implemented real-time payment systems, with 60 countries live on real-time payment networks. Moreover, the global adoption of real-time payment systems has quadrupled since 2014.

**Some examples of real-time solutions include**:

## Unified Payments Interface (UPI)

India is a leader in real-time payments adoption, thanks to its Unified Payments Interface (UPI). UPI is a real-time payment system that allows users to instantly send and receive money between bank accounts. This system has been incredibly successful in India, boasting over a billion users and processing more than two billion transactions every month.

### Pix

Brazil has also experienced rapid adoption of real-time payment systems, with Pix being particularly popular. In less than three years, Pix has garnered over 100 million users and processes more than one billion transactions each month within Brazil.

### FedNow

In the United States, the Federal Reserve has developed FedNow as its instant payments' solution. FedNow allows banks to build products on top of its platform, providing safe and efficient instant payment services in real-time, accessible 24/7/365. This service is designed to accommodate financial institutions of all sizes across all communities. Although FedNow is similar to The Clearing House's RTP® Network, having both options enhances economic security in the U.S. However, real-time payments are still in the early stages of adoption in the United States.

### RTPs® Network by The Clearing House

Introduced in 2017 by The Clearing House Payments Company LLC, the RTP® Network was the first real-time payments platform available in the U.S. The RTP® Network is accessible to all federally insured U.S. commercial banks, credit unions, and savings institutions. It supports a wide range of use cases, including payroll, credit transfers, business-to-business (B2B) real-time transactions, P2P payments, request-for-pay (RfP), and more.

### P2P Payment Apps

Peer-to-peer (P2P) apps like Zelle, Cashapp, Venmo, and PayPal have become real-time digital payment solutions due to their integration with The Clearing House's RTP® Network. By sending payments over the RTP networks, these apps can perform real-time settlements and efficient back-office processing, reducing costs.

The rise of P2P payment apps has transformed financial transactions, offering quick and convenient solutions for splitting expenses and transferring money instantly. For example, PayPal's Venmo began offering instant transfers through the RTP network in August 2019, and Zelle transactions can now be cleared and settled over the RTP network.

### REN Payment Platform

REN, developed by global fintech provider Euronet, is a payments application designed on a microservices architecture. Leveraging cutting-edge development languages and industry best practices, REN serves multiple sectors including fintech, traditional banking, hospitality, governments, and online marketplaces, providing robust and adaptable payment solutions.

## Future Trajectory of Real-Time Payments in the Global Market

The payment industry is undergoing a transformative change, with transaction times being reduced from days to mere seconds. This shift has led institutions to reevaluate their innovation strategies and prioritize enhancing the data infrastructure that enables these lightning-fast transactions.

According to a Research firm, the global real-time payments market size was valued at $13.8 billion in 2021, and is projected to reach $123 billion by 2031, growing at a Compound Annual Growth Rate (CAGR) of 24.5% from 2022 to 2031. This expansion is driven by the widespread adoption of real-time payments in payroll processing, bill payments, and peer-to-peer transactions. Additionally, advancements in digital infrastructure, increasing smartphone penetration, and the demand for faster and more efficient payment solutions are further propelling market growth.

# Navigating the Challenges with Distributed Database

The future of payment systems lies in enhancing speed and ensuring compliance with ISO-20022 standards for structured information and data transmission. These advancements present significant challenges that can be effectively addressed using distributed database platforms.

Real-time payment systems demand a core database that is:

- Exceptionally Fast: Capable of minimizing latency and addressing scalability issues.
- Highly Resilient: Ensuring continuous availability to prevent downtime.
- Elastically Scalable: Able to handle massive transaction volumes during peak times.

Being cloud-native further accelerates the development of technology stacks needed to meet these rigorous demands.

Selecting the right database is pivotal in transforming modern payment systems into sophisticated communication networks that facilitate seamless money movement. This foundation opens up exciting possibilities for the future of financial technology.

# Why Choose Oracle Globally Distributed Database for Real-Time Payment Processing?

Oracle Globally Distributed Database is an ideal choice for real-time payment processing due to its unparalleled speed, scalability, and reliability. Designed to handle the most demanding transactional workloads, Oracle's solution ensures instant processing of payments with minimal latency, a critical requirement for real-time transactions. Its distributed architecture allows for horizontal scaling, efficiently managing high transaction volumes and peak loads without performance degradation.

Moreover, Oracle's database offers exceptional resilience, ensuring continuous availability and robust data protection. In the event of a node failure, Oracle's system seamlessly redirects traffic to other nodes, maintaining uninterrupted service and enhancing trust and reliability for financial transactions.

Oracle's advanced security features and compliance with global standards, ensure that payment data is protected, and regulatory requirements are met. The cloud-native capabilities of Oracle's database allow for rapid deployment and flexibility, enabling businesses to quickly adapt to changing market demands and technological advancements.

Choosing Oracle Globally Distributed Database for real-time payment processing means leveraging cutting-edge technology to achieve faster, more reliable, and scalable payment solutions, ultimately providing a superior experience for both businesses and their customers.

## Hyperscale Performance and Scalability

In real-time payments, hyperscale performance and scalability are paramount for handling vast transaction volumes instantly and maintaining operational efficiency. Oracle's Globally Distributed Database excels in this regard with its shared-nothing architecture, supporting millions of transactions and petabytes of data. The Oracle storage engine has been honed over decades, with no database-level limits on data or transaction volume per node—it is only constrained by the available infrastructure resources (CPU, memory, storage) of the machine on which the database is deployed. Oracle Globally Distributed Database automatically distributes data across all nodes and rebalances data and workload when shards are added or removed. It ensures consistent performance during peak loads and eliminates single points of failure. The built-in replication mechanisms, including the Raft consensus protocol and Oracle Data Guard, guarantee strict data consistency and zero data loss, safeguarding the financial institution's operational efficiency and data integrity. This robust infrastructure empowers financial institutions to process transactions swiftly, manage data surges, and scale globally, thus meeting the rigorous demands of real-time payments effectively.

## Versatile Replication Solutions for Real-World Wide Area Networks

In real-time payments, versatile replication mechanisms are critical for maintaining data consistency, resilience, and operational reliability across distributed networks. Financial institutions must ensure that transactions are processed swiftly and accurately, even in challenging network environments with long latencies and intermittent slowdowns.

Oracle's Globally Distributed Database addresses these challenges by offering a comprehensive and adaptable replication architecture. This solution provides unparalleled data protection, supporting diverse deployment needs and ensuring high availability and disaster recovery.

Oracle's options include synchronous replication, asynchronous replication, adaptive synchronous replication, and various other combinations that allow precise configuration to suit your application requirements.

These configurations enable financial institutions to maintain faster response times and uninterrupted operations, crucial for real-time payments.

Oracle Database 23ai introduces a robust Active-Active architecture with Raft quorum-based consensus replication, enabling automatic sub-second failover with zero data loss. This advancement ensures continuous service availability and enhances reliability beyond traditional database failover capabilities, meeting the rigorous demands of real-time payments effectively.

## Deployment Flexibility

Deployment flexibility is essential for real-time payments to adapt to diverse infrastructure needs and ensure optimal performance and scalability.

Oracle's Globally Distributed Database offers extensive deployment flexibility, supporting on-premises, cloud and multi-cloud infrastructures. It accommodates various hardware configurations such as commodity hardware with VMs, containers, bare metal nodes, and the advanced Exadata scale-out technology. This flexibility allows financial institutions to establish a unified data environment across different regions and countries, seamlessly integrating cloud and on-premises deployments. Each shard can leverage the optimal hardware configuration available in its respective location.

Additionally, Oracle's Globally Distributed Autonomous Database is a fully managed service provided by Oracle, complete with comprehensive database operations support. This ensures simplified management and optimization across distributed environments, enabling institutions to focus on enhancing real-time payment capabilities without operational constraints.

## Most Comprehensive Data Distribution Choices

Comprehensive data distribution choices play a crucial role in meeting the needs of real-time payments customers. For distributed applications, the flexibility and effectiveness of data distribution mechanisms are paramount. Oracle's Globally Distributed Database leads the industry with support for six advanced data distribution methods, offering unparalleled versatility and scalability. These include

- **Hash**: Enables automatic data distribution and online rebalancing when new shards are added, ensuring efficient scalability and load balancing.
- **List**: Distributes data based on specific values (e.g., state of residence or dealer ID), ideal for categorizing and managing segmented data.
- **Range-based:** Distributes data across ranges (like customer IDs)
- **Composite:** Facilitates two levels of sharding with two different sharding methods and sharding keys (like country code followed by customer ID), providing enhanced customization and performance.

  - **List followed by Hash:** Combines specific value distribution with automatic load balancing for dynamic datasets.
  - **Range followed by Hash:** Utilizes range-based distribution followed by efficient hash-based management, ensuring optimal data organization.
- **User-defined:** Empowers customers to define a table governing sharding key placement and partitioning, automating data movements based on updated criteria.

### Rich set of security features

Leveraging decades of expertise, Oracle offers a comprehensive suite including Transparent Data Encryption, network encryption, Data Redaction, row- and column-level security, fine-grained access control, Oracle Data Masking and Subsetting Pack, Oracle Audit Vault and Database Firewall, Oracle Key Vault, Database Vault, Label Security, and Virtual Private Database. These integrated features safeguard sensitive data across all layers of the database infrastructure, providing robust security for real-time payments while enhancing overall data protection strategies and regulatory adherence.

### Converged Database

Oracle's Globally Distributed Database provides financial institutions with a converged database to build their instant payment platforms. This architecture simplifies data sovereignty for modern applications that utilize multiple data types and workloads, allowing existing SQL applications to transition seamlessly to distributed environments without extensive rewrites.

Oracle's Converged Database Architecture streamlines distributed data complexities, offering comprehensive support for all modern data types, workloads, and development styles within a single database. This includes relational, JSON, text, and vector data in both row and columnar storage formats, supporting OLTP and analytics.

Oracle's Converged Database ensures unified data sovereignty for all data types and workloads, removing the necessity for multiple specialized databases and providing a robust, efficient solution for real-time payments.

### Proven Expertise for Mission-Critical Applications

Oracle's decades of experience in mission-critical environments make it a trusted leader in powering real-time payment processing systems. This expertise, combined with its robust infrastructure, ensures that organizations can confidently scale their operations while maintaining optimal performance.

## Oracle Globally Distributed Database Enabled Seamless Localization of Payments Database for a Global Bank

**Functional Requirements:**

- **Localization of Payments Database:** The bank requires the localization of its payments database, which contains data from multiple channels including multiple credit card providers.
- **Data Scope:** The database contains payment data for 42 countries, currently deployed in Hong Kong with plans to move to Singapore within the next two years.
- **Regulatory Compliance:** The bank operates in a highly regulated environment, necessitating stringent data governance and compliance measures.
- **24x7 Availability:** There is a critical requirement for the database to be available 24x7, ensuring uninterrupted operations.
- **Initial Localization:** The immediate focus is on localizing data for India. Data can only remain in the central Hong Kong database for 24 hours, after which it must be purged.

- **Future Localization:** Other countries expected to follow include Indonesia, Pakistan, and South Korea.

**Application Tier:** Payment Application

- **Architecture:** Java Microservice and API-based.
- **Deployment Control:** Extensive controls around code deployment.
- **Platform:** Deployed on OpenShift Pods.
- **Current Setup:** Operates as a single, centralized code base, which needs to remain unchanged.
- **Type of Data:** Handles highly transactional data.
- **Latency Requirement:** Requires less than 40ms latency between the application tier and the database.

**Database Tier:**

- **Database Version:** Oracle 19c.
- **Configuration:** 3-node RAC (Real Application Clusters) database.
- **Resources:** 48 CPUs and 3 TB RAM.
- **Instances:** Multiple Container Database Instances.
- **Disaster Recovery:** Utilizes Data Guard for replication to a disaster recovery site.
- **Localization Need:** Requirement to relocate the India "stripe" of the database to India while keeping the Application Tier in Hong Kong

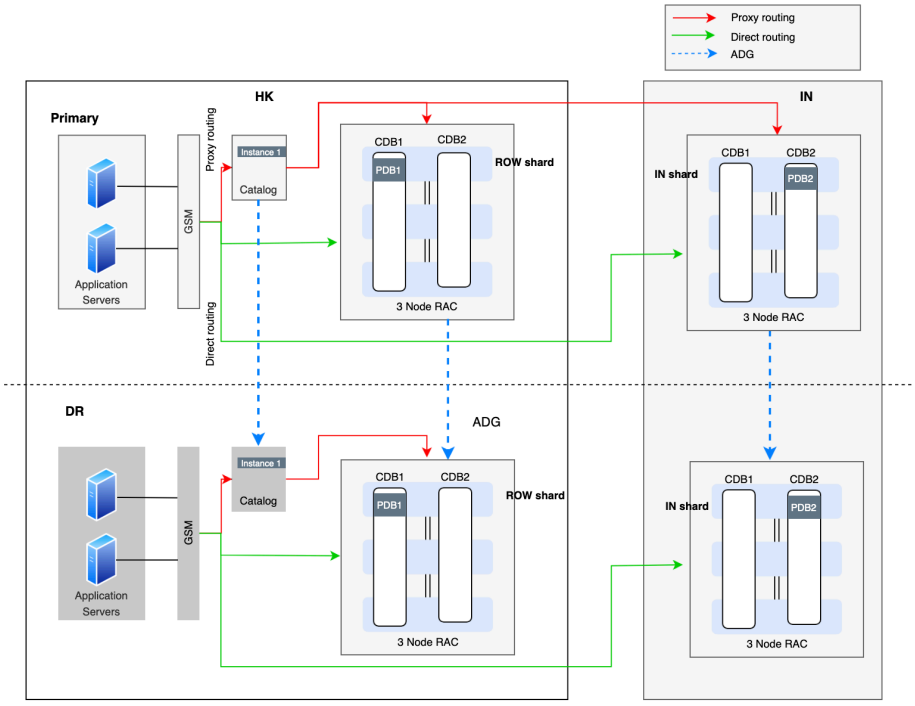


**Fig3. Data Localization with Globally Distributed Database**

**Solution Deployed:**

Initially, all data was stored in Hong Kong. To address localization requirements, we created an additional shard in India, effectively splitting their database into two shards. We implemented a user-defined data distribution method to manage this setup.

As illustrated in Fig3., all nodes are presented to the application as a single logical database with a single connection endpoint. Data is automatically stored and processed seamlessly, without impacting the application. This configuration allowed the bank to maintain its application stack in Hong Kong while the database automatically stores and processes India-specific data in India and the rest of the global data in Hong Kong.

**Benefits:**

- Avoids the expense of deploying the entire application stack in each country.
- Requires minimal changes to the existing application to comply with data residency regulations.
- Utilizes current Oracle database DBA and AppDev skills, reducing the need for additional training.
- Ensures a smooth transition to the new architecture with minimal downtime.
- Simplifies adherence to regulations in other countries, facilitating easy compliance

## Live Labs

- Learn how to achieve Data Sovereignty with Oracle Globally Distributed Database

## Addressing the Migration, Performance, Availability, and Regulatory Challenges with Oracle Globally Distributed Database

| What do you need? | How you can achieve it with Oracle's Globally Distributed Database |
|---|---|
| Hybrid Cloud | Explore Terraform-based Oracle Globally Distributed Database deployment : On-premises and Oracle Cloud Infrastructure |
| Multi-cloud | Read Deploying linearly scalable Oracle sharded databases across multi-cloud (Oracle Cloud, Microsoft Azure, and Amazon Web Services) |
| Seamless Data Migration | Read Migrating to a Sharded Database |
| Linear Scalability | Read How Oracle BlueKai Data Management Platform scales to 1 Million transactions per second with Oracle Globally Distributed Database deployed in Oracle Cloud Infrastructure |
| Data Sovereignty & Data Proximity | Read How to Achieve Data Sovereignty with Oracle Globally Distributed Database |
| Availability | Read Replication in Oracle Globally Distributed Database |

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