Templado System

Payment Gateway Reference Architecture

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Introduction

In the fast-paced digital era, the need for secure, efficient, and scalable payment gateways has become paramount. As the backbone of modern financial transactions, payment gateways must ensure seamless and reliable communication between customers, merchants, and financial institutions. To meet these ever-increasing demands, technological advancements are essential. One such innovation is the utilization of RISC-V and ARM processors, which have emerged as a game-changer in the field of computing.

RISC-V

RISC-V, an open-source instruction set architecture (ISA), has gained significant traction in recent years due to its flexibility, extensibility, and potential for customization. Unlike proprietary processor architectures, RISC-V offers a level playing field for both established players and emerging startups, fostering innovation and collaboration in the industry. Its open nature enables developers to create highly efficient and tailored processors that can cater to specific use cases, including payment gateways.

Thanks to its flexibility, simplicity, and being of open source, the RISC-V architecture has become an increasingly popular choice in IC design. By harnessing the power of RISC-V processors, payment gateway providers can unlock a new era of efficiency, security, and scalability. The possibilities are vast, ranging from streamlined transaction processing to enhanced fraud detection and prevention. This white paper will serve as a comprehensive guide for stakeholders in the payment gateway industry who are interested in leveraging RISC-V to drive their businesses forward.

ARM

Processors based on the ARM architecture, an alternative to the mainstream x86 architecture, is gradually making the leap from mobile devices to servers and data centers.

Price for performance is a deciding factor for companies that choose ARM, and for good reason. ARM is just as efficient as x86 for cloud computing while still offering attractive prices.

Organizations can save money while processing a broad spectrum of workloads, truly putting Arm's performance into competition with x86 architectures. In this area, its rivals simply cannot surpass ARM's price-to-performance ratio.

The Reference Architecture

Templado System Payment Gateway as shown in Figure 1.

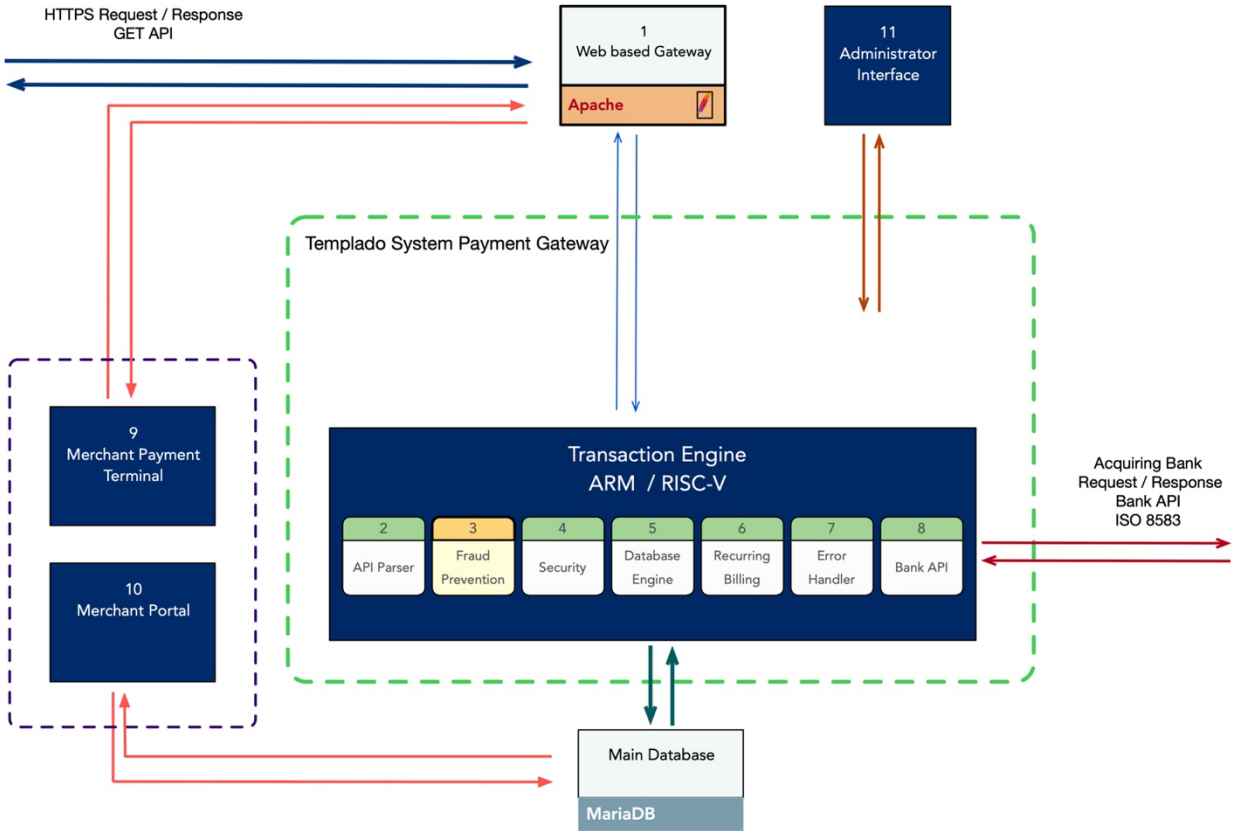

Figure 1

The goal was to design the system free from any third-party licenses such as Microsoft Server, or SQL Server. As a result, the system uses all open-source platform. The system uses Linux AARCH64 platform as a server (Ubuntu 22.04, Fedora ARM) and MariaDB as its main database. For security system utilized OpenSSL to perform necessary cryptographic functions such as SSL API, AES encryption to protect customer data and key management.

Customer are free to use any other Key management to protect data and can use Amazon KSM function or Virtual HSM in case of cloud-base installation, or real HSM Modules (such as Talos, Futurex) in the case of on-premises installation.

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Platform Component

Is where the key payment processing functions resides. It includes payment gateway, transaction engine, data storage and merchant related modules.

WEB Gateway

Web gateway implemented on Apache web server. Using Apache as the web server for your payment gateway offers several advantages. Apache is an open-source web server, which means it is freely available to use. This can be particularly advantageous for small businesses or startups with limited budgets, as it helps reduce infrastructure costs. It is compatible with multiple operating systems, including Linux, Unix, Windows, and macOS. This flexibility allows you to deploy your payment gateway on a wide range of platforms, depending on your specific requirements. Apache provides a range of security features to protect your payment gateway. It supports SSL/TLS encryption, allowing you to secure the communication between clients and your server. Additionally, Apache offers numerous security modules and configurations to help mitigate common web server vulnerabilities. Yes, Apache HTTP Server can be run on ARM-based systems. The Apache software is designed to be cross-platform and is compatible with various operating systems, including those running on ARM architectures.

Transaction Engine

Transaction engine is responsible to authenticate transaction, verifies merchant, fraud detection, selecting appropriate acquiring partner bank and select network protocol / API for bank authentication. Transaction engine submits request to acquiring bank and upon receiving response provide result to the merchant using merchant's API. Additional, transaction engine performs all necessary database functions.

To fully take advantage of ARM and RISC-V Architecture, transaction engine designed and implemented as low lever program combine C / C++ and Assembler languages. It's implemented to be scalable and take advantages of multi-cores architecture. Transaction engine can run on 4 core ARM Cortex 70xx and up to 128 Cores Ampere Ultra CPU.

Transaction Engine has a thread pool with 20 threads available and if the CPU has more than 20 cores, there are a few possibilities for optimizing thread utilization and achieving more efficient processing:

Thread per Core (1:1): In this approach, each available core is assigned a single thread from the thread pool. This maximizes parallelism, allowing each core to execute a thread independently. If there are more cores than threads, some cores may remain idle.

Multi-threading: The transaction engine is designed to support multi-threading; it can spawn multiple threads per core to fully utilize the available resources. For example, if the CPU has 40 cores, the engine can spawn additional threads, resulting in a total of 40 threads and so on. Ampere Ultra ARM CPU has family of 32, 64, 128 cores. RISC-V (SOPHGO SG2042 Chip) has 64 cores. This approach can further enhance parallelism and take advantage of the additional computational power.

API Parser

An API parser module is responsible for parsing and extracting relevant information from incoming API requests.

Fraud Prevention

A payment fraud prevention module is a component designed to detect and prevent fraudulent activities related to payment transactions. Its primary purpose is to identify and mitigate fraudulent behavior. The module utilizes a set of predefined rules and logic to detect specific fraud patterns or known fraud indicators. These rules include velocity checks, IP blacklisting, address verification, and card verification value (CVV) validation.

Security

OpenSSL was used to perform several security tasks, such as Hash, AES encryption / decryption and SSL / TLC transport.

Database Engine

Transaction Engine uses C++ Library to communicate with database. Each thread has its own SQL connection to parallel database request.

Recurring Billing

Templado payment gateway has capability to perform recurring billing based on merchant request. Such capability serves the subscription-based merchants.

Error Handler

Error handle module responsible to handle situation such as Timed Out transaction response, and any other errors on the system related to incorrect API, failed merchant verification, failed fraud result, etc.

Acquiring Bank Communication

Acquiring partner bank API was incorporated directly to the engine. Since there is not standard on acquiring bank API, like ISO8583, we decided to incorporate API directly to transaction engine. This gives additional advantage on speed, but if platform change the partner bank it would require to change API inside the transaction engine. Some other payment gateway creates additional layer, responsible to bank API, that will not require to change / recompile the engine, we decided to keep it simple and fast.

Merchant Portal

A merchant portal for a payment gateway is a web-based application that allows merchants to manage their payment processing activities. It provides a centralized platform for merchants to view and manage transaction data, track sales and revenue, and perform other important tasks related to payment processing.

Payment Terminal

A web-based payment terminal is a payment processing solution that is accessible through a web browser. This type of payment terminal allows merchants to accept online payments without the need for a physical point of sale (POS) system. With a web-based payment terminal, customers can make payments by entering their payment information directly into a secure web form. The payment information is then processed by the payment gateway.

Admin Interface

A payment processor administrative interface is a web-based application that allows payment processing companies to manage their payment processing activities. It provides a centralized platform for payment processors to monitor and manage payment transactions, configure payment settings, add merchants, and perform other important tasks related to payment processing.

Merchant Models

Direct Merchant

The Direct Merchant ID (DMID) model is a payment processing model in which a merchant has a direct relationship with a payment processor. Under the DMID model, the merchant is typically required to obtain their own merchant account with a payment processor. The merchant account is linked to the DMID, which serves as a unique identifier for the merchant when processing transactions and settling funds.

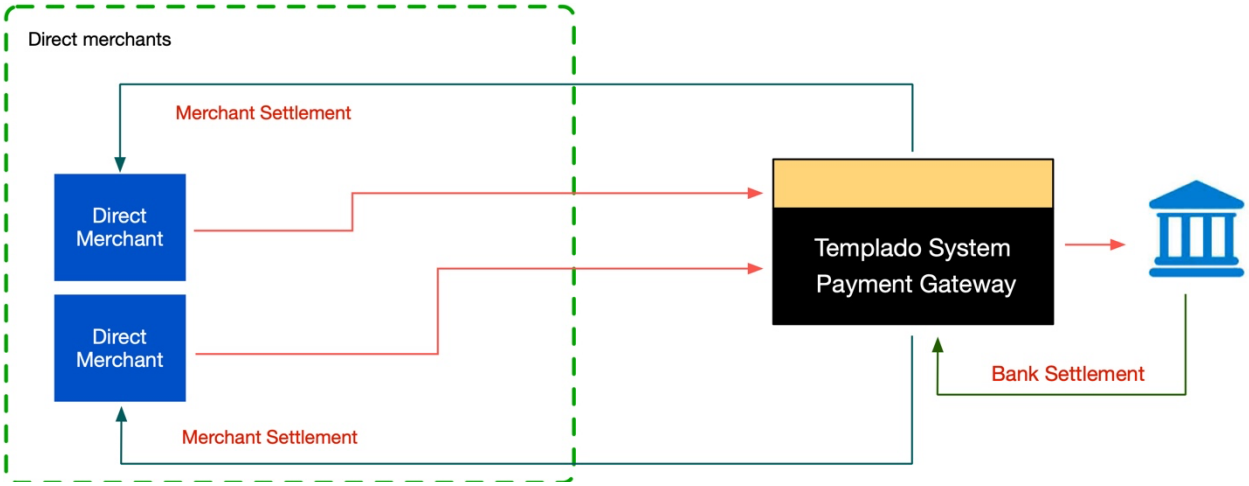

Figure 2. Direct merchant Model

Aggregation Merchant

The merchant aggregation model is a business model in which a company acts as an intermediary between multiple merchants and payment processor. A Master Merchant ID (MMID) is a unique identifier assigned to an aggregator and all of its sub-merchants or merchants, who are working under the aggregator's umbrella. The MMID is used by the aggregator to manage the payment processing for all of its sub-merchants. When a customer makes a payment to one of the sub-merchants, the payment is collected by the aggregator, who then disburses the funds to the appropriate sub-merchant account.

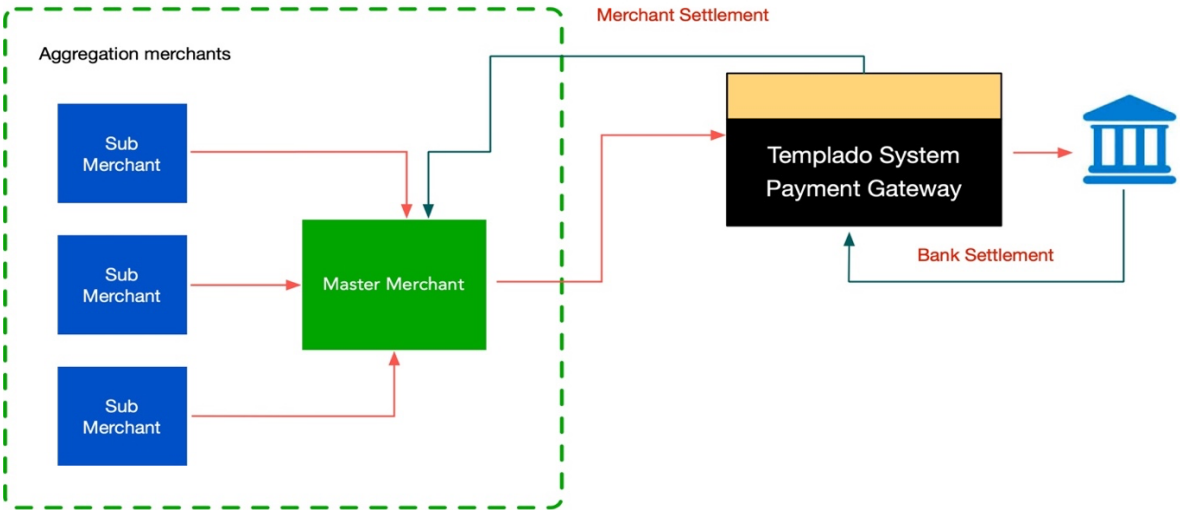

Figure 3. Aggregation Merchant Model

Hybrid Merchant

In Hybrid model, Templado System allows to mix direct merchants and aggregation merchants

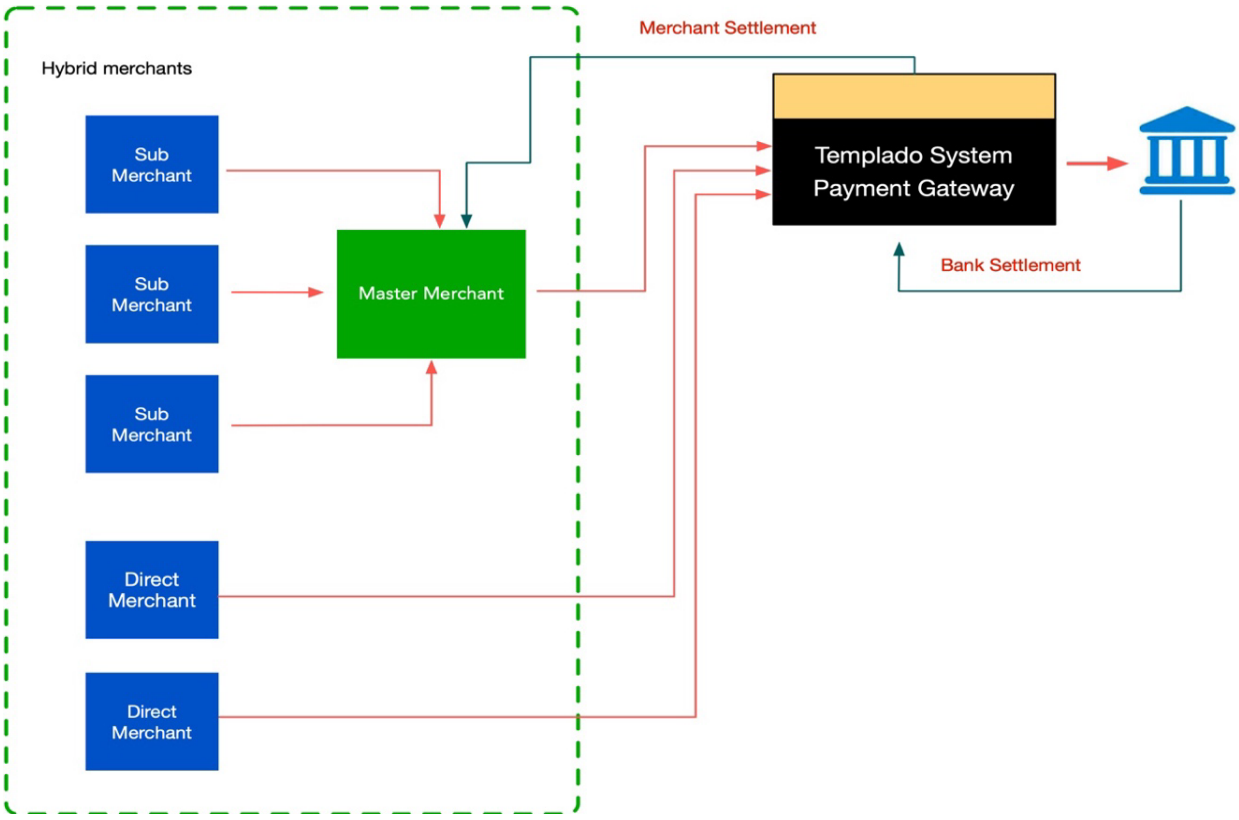

Figure 4. Hybrid Merchant Model

High Risk Merchant

Templado system gateway includes additional features to accommodate high risk merchants.
A high-risk merchant account means payment processors and card networks view the company as being more likely to default on its payments, suffer high levels of chargebacks, or even commit fraud. High-risk businesses are typically those that are new, have a history of credit problems, or operate in an industry that is considered controversial or unpredictable.

Rolling Reserve (RR)

A rolling reserve is a strategy used by banks to shield themselves and the merchant from possible financial loss due to chargebacks from the customer. A portion of the funds are collected via credit card and secured by the bank from the merchant's account to minimize the risk of potential chargebacks. Templado System gateway allows to setup Rolling Reserve for the merchant, such as days of reserve to be kept and percentage it subtracts from settlement. Typically, is is 180 days and 10%. But System amdin can set all parameters accordingly. Gateway settlement module will calculate automatically RR and return on RR.

Chargeback

The risk for the merchant acquirer arises where the merchant becomes insolvent between the date of the transaction and the date of the chargeback and is unable to reimburse the merchant acquirer. Templado System gateway allows to setup Chargeback fee, acceptable percentage for the merchant and automatically calculate the CB percentage to provide the flag is merchant exceed chargeback amount.

Deployment

The platform can be deployed on-premises or in the cloud. As a cloud-native platform it can run on AWS Graviton-2 and Graviton-3 ARM CPU. For Azure cloud it can run on Ampere Ultra ARM CPU. On-premises deployment system can use any ARM or RISC-V based server.

For OS it can uses any Linux AARCH64 or RISC-V variations distro.