MinhaHistoriaDigital: An Scalable Fog-Based Architecture for Efficient Vital Signs Monitoring over Smart Cities

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Abstract. *Internet of Things (IoT) is currently present in several areas, including healthcare. IoT offers technology to track and monitor the state of patients remotely. In this context, this article presents MinhaHistoriaDigital, a scalable Fog-based solution for real-time monitoring and data processing from patients wearing wearable devices. Its main contribution is a hierarchical architecture that provides low latency response time.*

1. Introduction

Over the past few years, the healthcare industry has come to understand that the Internet of Things (IoT) can improve life quality and patients' care conditions [Vijayalakshmi et al. 2022]. Recently, the Coronavirus disease (COVID-19) pandemic demonstrated how important it is to monitor the public health conditions constantly [Adetunji et al. 2022]. In this regard, Internet technologies can provide a crucial ally to combat diseases' spread. Among other advantages, real-time data analysis and processing using remote servers can accelerate response to health crises both individually and collectively [Rayan and Tsagkaris 2022].

Cloud and Fog Computing environments can provide the necessary computing infrastructure to support health systems to process large amounts of data on a large scale. However, sending data to Cloud servers relies on network routing over public Internet infrastructure. As the amount of data increases, the system response time also increases due to network overhead and growing latency. Although that might not be a problem for some domains, health applications might not tolerate unstable services.

In this context, this article presents MinhaHistoriaDigital, a Brazilian project sponsored by PPSUS/FAPERGS that aims at developing a solution to track and capture people's vital signs in real-time. The project offers a strategy to track long-COVID and its variations spread by monitoring patients in their homes and how they respond to the infection. The project consists of employing Fog Computing to process health parameters from patients according to their location. Depending on the patient's physical location, the system selects a given Fog node to process its data focusing on improving response time. The following section presents the proposed solution and its description.

2. MinhaHistoriaDigital

The solution comprises algorithms and an architecture employing different strategies to improve scalability: (*i*) resource elasticity; (*ii*) Serverless; (*iii*) data compression; and (*iv*) sharding to efficient data access. The architecture has a hierarchical topology in which patients' sensors at the bottom provide health parameters to the system. Employing Edge and Fog Computing, the system processes either data locally or remotely. The system aims at proving the best response time according to the patient location and system load. Both Ege and Fog nodes provide specific services to process data and generate alarms according to the output of the services. Figure 1 presents the solution's architecture detailing the two main components: (*i*) Edge Controller (EC); and (*ii*) Fog Node (FN).

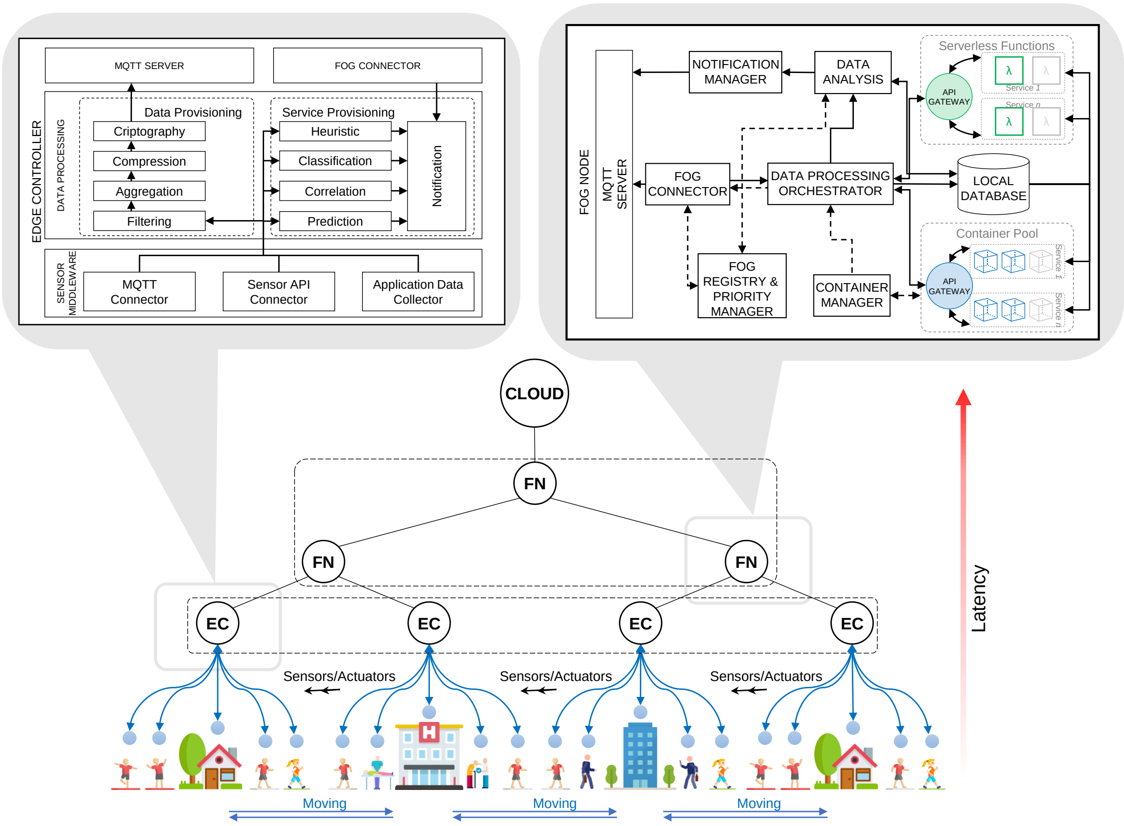

Figure 1. Hierarchical architecture topology and its main components.

The components connect in a hierarchical topology according to their physical location. Therefore, the system can provide low latency and data aggregation by region. Patients wearing sensors can provide their health parameters to an Edge Controller node. This node is either a mobile application or a Single Board Computer placed at the patient's house. In turn, the Edge Controllers connect to a specific Fog Node according to location and latency parameters to transmit processed data. Fog Nodes apply aggregation algorithms and data forecasting to produce alarms for critical situations.

References

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