A Fog-Assisted Architecture to Support an Evolving Hospitality Industry

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Abstract

In this paper, we propose a fog-assisted architecture with specialized guest-facing and back-of-house (BoH) management systems geared towards improving guest experience, building business insights, and increasing revenue. The proposed architecture integrates cloud services platform with the Internet of things (IoT) devices at the network edge through intermediary fog computing nodes to create an architectural paradigm with benefits of low cost, high responsiveness, improved quality of service (QoS), and local and global analytics. To demonstrate the effectiveness and utility of the proposed architecture for hospitality industry, we present various use cases that can be implemented and/or enhanced by our proposed architecture.

Keywords: Hospitality services, Guest-facing systems, Back-of-House (BoH) management systems, Internet of Things (IoT), Cloud services, Fog computing

INTRODUCTION

The future of the hospitality industry is being shaped by current innovations in the Internet of things (IoT) technology. Hospitality service providers (HSPs) must stay on the leading edge of IoT technology to maintain a competitive edge in the market. The IoT paradigm offers HSPs a subtle means of interacting with guests and collecting their real-time data which opens new avenues for immediate, personalized, and localized services as HSPs can gauge guest behavior and preferences with high accuracy. The IoT also enables HSPs to increase efficiency of multiple back-of-house (BoH) departments (Adelson, 2016) (e.g., front desk, housekeeping, sales, and marketing, etc.) as well as enact cost-saving policies like smart energy management (Sunny, 2016). For effective implementation of IoT technology in the hospitality industry, certain technological challenges such as interoperability, scalability, data analytics and management, privacy and security, and low-latency responsiveness must be properly addressed. In this paper, we outline a fog-assisted architecture to overcome these challenges in the hospitality industry.

FOG-ASSISTED ARCHITECTURE FOR HOSPITALITY INDUSTRY

We propose a hierarchical network architecture, as shown in Figure 1, which integrates edge-of-network IoT devices with a centralized cloud server by means of intermediary fog nodes. A fog is defined as the physical and logical network that implements fog computing services (OpenFog Consortium Architecture Working Group, 2017). In our proposed architecture, edge-of-network IoT devices that facilitate the hospitality service exchange, lie at the lowest tier of the hierarchy. Fog nodes lie in the middle tier of the hierarchy. Each fog node manages a cluster of edge-of-network IoT devices. The communication between fog nodes and IoT devices occurs over a radio network. Fog nodes add computation and storage resources closer to the network edge. IoT devices can utilize these resources by offloading complex applications, computations, and services to the fog. This helps in improving battery-life of IoT devices by lessening their computation burden. The dense geographic distribution of fog nodes also ensures precise location-based services and near real-time local analytics. The fog nodes are connected to a central cloud server through the core network. The core network carries vital data from the fog to the cloud. Thus, fog nodes help to significantly reduce the volume of data communicated over the core network (OpenFog Consortium Architecture Working Group, 2017). The cloud constitutes the topmost tier of the hierarchy. The cloud facilitates broader accessibility scopes for guest profiles, comprehensive loyalty and rewards point management, and global data analytics. The main goal of our proposed fog-assisted architecture is to provide personalized, adaptive, and predictive next generation guest experience.

Fog computing provides an open standardized interface for the integration of systems into a network. It eliminates the dependence on proprietary and single-vendor solutions by promoting interoperability between multi-vendor systems and solutions. The vendor diversity significantly reduces system cost and improves quality of service (OpenFog Consortium Architecture Working Group, 2017). Open standards and interoperability also play a key role in the scalability of fog computing.

Fog computing also addresses many of the challenges posed in customer data security and response/service latency. The distributed network of fog nodes in our proposed paradigm pushes computing and storage resources closer towards edge-of-network devices (e.g., IoT devices including guests' personal devices). For edge-of-network devices that are not equipped with complex computing capabilities, the fog node is the first entity in the network that can implement complex security protocols (OpenFog Consortium Architecture Working Group, 2017). The computing resources available in fog nodes help secure data gathered by the edge-of-network devices. Fog computing also facilitates timely responses to guests' requests due to the proximity of fog nodes to the guests as compared to the distant cloud. The computing resources in the fog enable local analytics of guest profiles as well as of data gathered from local sensors and systems, which helps in providing high quality services to guests.

FOG-ASSISTED ARCHITECTURE USE CASES

In this section, we describe how our proposed fog-assisted architecture can be used by hotels to provide highly personalized services to their guests.

Events Customization based on Hotel Location

Fog nodes can be used to keep track of when and why guests visit the hotel. Although many hotel establishments already do this on a regular basis for large conventions, conferences, and festivals, etc., fog nodes can be used to broaden the scope of the events covered. For example, guest data in fog nodes can be leveraged to determine when guests visit the hotel to attend personal events such as, birthdays, anniversaries, etc. Such data, which is otherwise easily overlooked in advertising and in special booking offers, can be used to send targeted and highly personalized deals to guests. Fog nodes are better suited than cloud servers to manage offers based on personal events because such events are highly localized and rarely have global scope.

Guest Preferences and Behavior

As fog nodes are located closer to the network edge, the fog nodes are most suitable to handle local processing tasks whose results are relevant in the local context. These processing tasks are too burdensome to be performed in the cloud due to cost, latency and bandwidth constraints. Thus, hotel fog nodes are more suitable than the cloud to launch local service actions based on guest preferences and behavior. Guest preferences such as types of meals, beverages, entertainment, and games can be analyzed by the hotel fog to personalize services for guests. For example, records of a guest's meal preferences (vegetarian, vegan, etc.) as well as any food intolerances (e.g., lactose) or allergies (e.g., peanuts, sea-food), etc., can be maintained in guest profiles on the hotel fog nodes which can then be used by on-property restaurants to present guests with a filtered list of menu items on a digital menu.

Automatic Connectivity

The hassle of connecting to hotel Wi-Fi is a major complaint among hotel guests. Hotel fog nodes can provide automatic and hassle-free means to connect to hotel Wi-Fi for repeat and loyal guests. Fog nodes can authenticate guest devices belonging to repeat and loyal guests for automatic Wi-Fi connection by means of MAC address authorization and room reservation and booking information. Alternatively, Wi-Fi connection can also be provided to guest devices based on authentication through hotel loyalty applications.

Anticipation of Guest Requests

Hotel fog nodes can utilize data gathered by in-room sensors and devices to anticipate guest requests and to automate certain in-room or on-property services based on guest activity. For example, hotel fog nodes can use in-room lighting sensors to detect the amount of natural light entering the room and decide whether to turn on certain hotel room lights. The fog nodes can also use in-room thermostat to detect the temperature and humidity in the hotel room and adjust the heating, ventilation, and air conditioning (HVAC) accordingly. The hotel fog thus can make services available to guests before they even feel the need to ask for them resulting in increased customer satisfaction and loyalty to the hotel brand.

CONCLUSION

In this paper, we have proposed a specialized fog-assisted architecture for hospitality industry that integrates IoT, fog computing, and cloud computing paradigms. Our proposed architecture can provide localized information and services, high volume data aggregation, and low latency service responses through energy-efficient computing and bandwidth-efficient communication. Our proposed architecture also enables local, regional, and global analytics of aggregated data which provides valuable insights into improving quality of service as well as building better business models. We also present several relevant use cases which can be implemented or enhanced by our proposed architecture. These use cases provide an insight into how hospitality services need to evolve in tandem with the evolution of IoT and fog computing to keep the hospitality industry progressing at a steady pace.

Word Count – 1244 words.

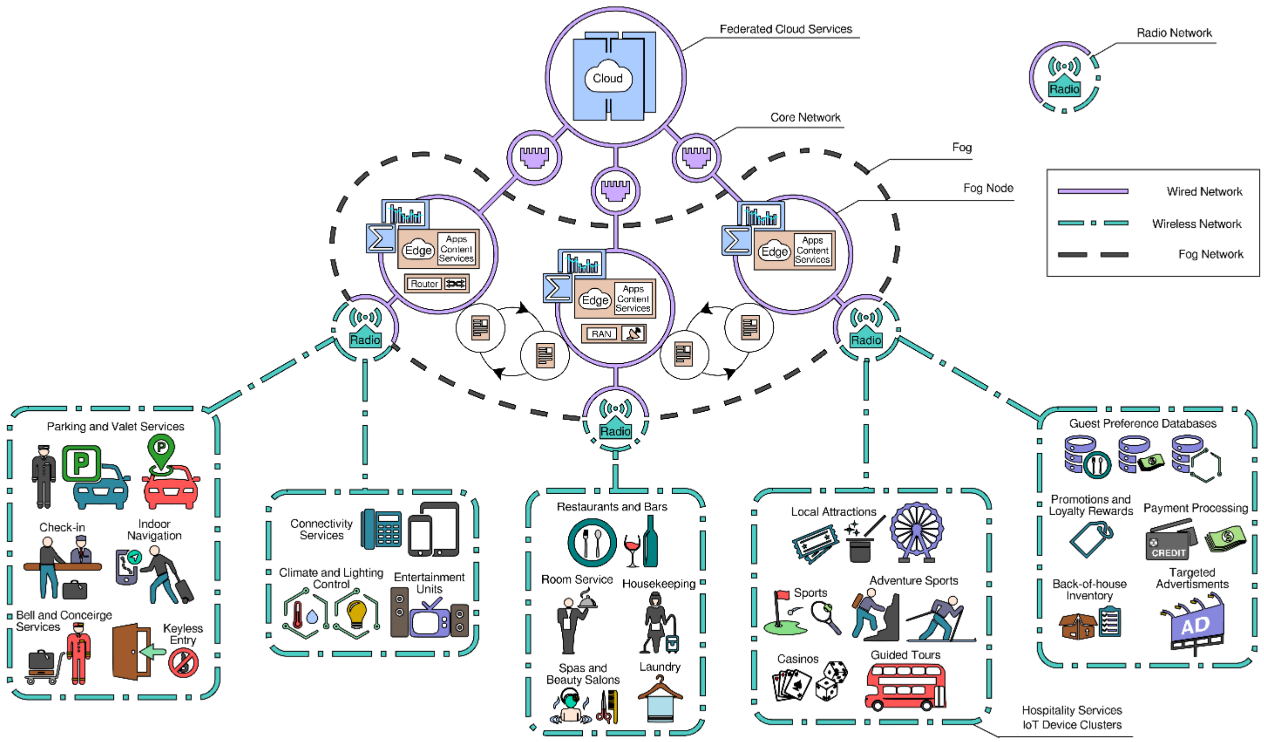

Figure 1: Fog-assisted architecture for the hospitality industry.

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