Towards an "Internet of Things" Framework for Financial Services Sector

Vemula Dineshreddy
1.SCIS, University of Hyderabad, Hyderabad, India
2. Institute for Development and Research in Banking Technology, Hyderabad, Telangana, India
dineshvemula@gmail.com

***Abstract*— The ability to apply state-of-the-art Internet of Things (IoT) technology to extract customer insights through analytics by shaping the information into consumables for other connected systems is creating a lot of opportunities for banking and financial services. This paper presents an architecture based on Internet of Things for banking and finance sector by managing, mobile, household devices, wearable sensors and other sensing devices for various applications including retail banking, insurance, and investments. We have presented a case study of different banking applications flow with IoT-intelligence by analyzing users' data. In addition, we have a mapping of the proposed architecture onto the various applications of banks and financial services.**

Keywords—Internet of Things; big data; financial services;

I. INTRODUCTION

The Internet of Things (IoT) is a trending communication paradigm that embeds some intelligence in the objects of everyday life that are interconnected to communicate, transfer messages, take decisions, make predictive actions and provide appropriate services [1]. IoT is applied for several applications including healthcare, smart cities, agriculture, earthquake early detection, smart homes, traffic congestion, waste management, smart grid, smart environment, and intelligent shopping.

The development of branchless banking services via multiple communication channels has made it possible to create a new kind of added value for customers, in the banking and financial service sector. With the growing use of mobile phones, especially other wireless devices such as wearable and sensors, has made the IoT as a tool to improve customer experience, a logical development in electronic banking [2]. Potential applications of the IoT in these sectors include insurance through telematics, life and health insurance, investment management and worker's compensation in the commercial arena. IoT will definitely enhance the customer experience and enhance overall network infrastructure in banks. However, IoT implementation becomes effective if and only if the big data analytics and cloud accessibility are integrated with the IoT structures.

This paper presents a conceptual framework and design model leveraging the state-of-the-art IoT technologies for data processing and performing analytics in banking and financial services sector. We analyzed this model considering a case study of investment management, which improved customer satisfaction. We presented the deployment model with mappings of functional modules to the architectural view.

The remainder of this paper is organized as follows. Section 2 presents related work on using Internet of Things in various sectors. Section 3 describes our proposed framework that highlights the tasks performed at various layers. Section 4 presents a case study on IoT for investment management with functional modules. Section 5 describes concluding remarks and challenges in implementing Internet of Things for financial organizations.

II. RELATED WORK

Nowadays, Internet of Things is applied for various applications in various sectors. Nicola et. al [12] illustrated unified IoT communication framework requirements and focused mainly on communication requirements for health care applications such that they can be offered as a web service. Xiaojun et. al [4] presented on agricultural facility units using IoT in Beijing, enabling remote diagnosis, early warning, command decision about the diseases and pests, intelligence control of water and tracing about facility agricultural products. The concept of IoT is explained in technology and application perspectives with the use of IoT in agricultural production and agricultural product supply system in [5]. Foschini et. al [6] investigated the design and implementation of an M2M application on top of currently available solutions for traffic management. The application of IoT in smart cities with technical solutions and best-practice guidelines adopted in the Padova Smart City project are discussed in [7]. An architecture focusing on data acquisition and evaluation of unstructured data using different options like map-reduce is proposed in [8]. However, this architecture lacks features like sensing and data transfer of millions of heterogeneous devices.

Although today, in banking and financial service sector, online and mobile banking systems deliver reasonably high

quality services to consumers, the quality of services could be made better by using Internet of Things technologies. To the best of our knowledge, there is no framework using IoT and analytics for banks and financial organizations today.

III. PROPOSED FRAMEWORK

Fig. 1 shows the proposed framework for IoT based financial services system. With our proposed framework customers can be provided targeted offers based on a statistical study of income, accounts and balances. With connected things it is possible to act on point or individual events and provide response to customers based on inbound requests. We can create targeted offers based on anticipated life and financial events predicted from spending activity and dynamically change the way a customer to be treated based on spending behavior and financial impact. This framework explores what information can be tracked by the banks that was not available in the past, what are the critical things to be tracked to keep the customer satisfied and what actions can be performed using this data.

A. Device Management Layer

The main source of data is the device management layer at the bottom. This layer consists of various types of IoT devices which must have direct (Ethernet or Wi-Fi) or indirect connection (Zig Bee gateway, mobile phone, low power radios etc.) to the internet. This layer performs various functions such as gathering data from sensing/edge devices, connection of devices and transmission of data at regular intervals. These devices interact with an intelligent gateway to perform the authentication and authorization [9], initial data aggregation, filtering, correlation, etc. For efficient identification and security, devices which support IPv6, short-range wireless technology, long-range communication and Geo-networking are recommended. The data from device management layer is then funneled through a communication layer.

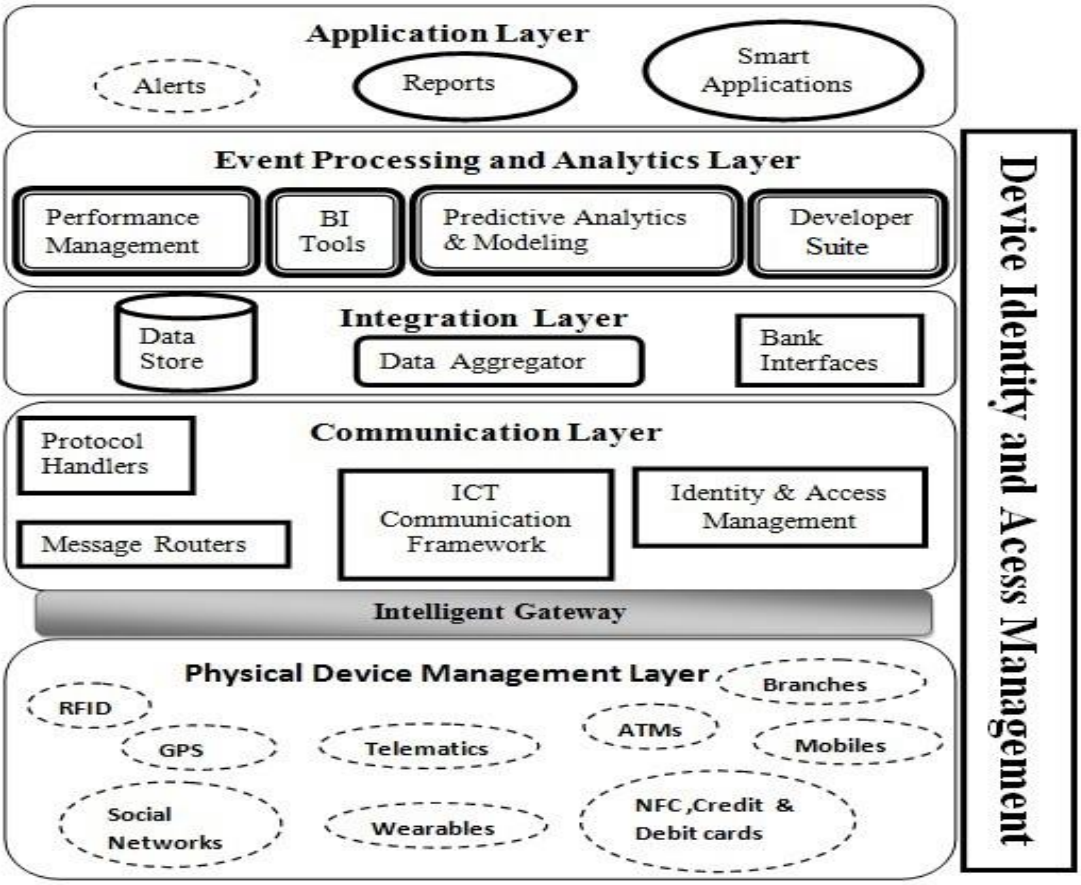

Fig. 1. IoT based framework for financial service sector

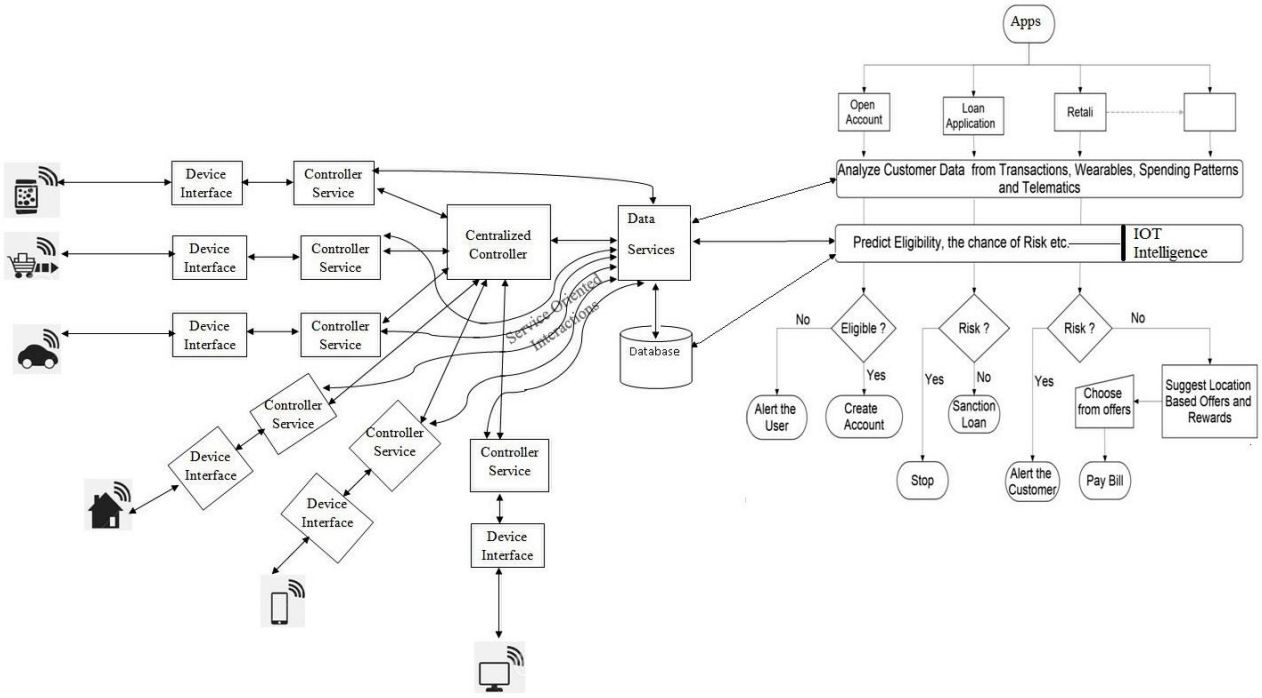

Fig. 2. Flow representation of different bank applications with IOT-intelligence

B. Communication Layer

This layer performs the functions of the networking and transport layers of traditional internet architecture. This layer

resolves the data formats of different vendors and protocols and provides an effective logical addressing with greater detail to operate with IoT applications. This layer performs data encryption, filtering and interference avoidance. The well known potential protocols are HTTP/ HTTPS, Constrained Application Protocol (CoAP) and MQTT- 3.1. This layer supports dynamic routing according to the changing network conditions. Another important action performed by this layer is changing over client characterized system execution parameters to fitting QoS policies.

C. Integration Layer

This layer performs integration of structured and unstructured data, which enables data warehouse and analytic architecture. This layer fills the gap between traditional and present processing environments with the ability to capture all of the data types and domains. Most importantly, it provides scalability, speed and value.

D. Event Processing and Analytics Layer

This layer handles the streaming events coming through and performs analytics with data being integrated. This layer act as an interface between user applications and lower modules. The Business Intelligence module is equipped with querying and reporting tools. The "reductions-results" are loaded from integration environment to a data warehouse for advanced analytics. This structure offers 'in-place' analytics, which reduces the burden of moving the data to another analytical

environment. This layer helps banks to analyze the data, takes decisions based on reduction-results and user actions, and acts on behalf of the customer using predictive analytics. The dataset is analyzed to extract knowledge and patterns to make informed decisions. This layer includes a developer suite to enable developers to build smart applications and tools using IoT services. This layer act as a middleware which provides us with the infrastructure as a service. This infrastructure is used to empower new income streams, and enhance operational efficiencies through innovations.

E. Application Layer

The application layer acts as an interface between the developed applications and underlying infrastructure. It provides services for different applications to communicate

with the shared protocols and interface methods. The application layer sends information about performance parameters to the underlying layers. Various protocols are developed and used to exchange data between versatile.

IV. Case Study

IoT for Investment Management

We consider a system for investment management that must process data from heterogeneous devices received either by streaming (sensors, trades, telematics or data from wearable) or in batches (financial statements, expenditures) and takes decisions to create, manage customer accounts and offer on the fly offers and rewards in case retail banking and loans. Data processing involves the collection, integration, analysis and complex workflows depending on external conditions or the presence/absence of other relevant data that needed to be processed. By accessing the data of customers' daily lives, this system enables banks to better understand the customer's needs, financial status, and collateral value, while automating the process of opening an account, taking loans and insurance etc.

Fig. 2 shows the functional modules of IOT based investment management systems. It consist of various devices for monitoring customer's purchasing, driving behavior, location and other activities using the sensor devices placed in wearable, mobiles, health care devices etc. The controller services shown in the figure runs the local services to continuously monitor the devices and sends data to the database (sometimes in cloud) using data services. These services utilizes the service oriented interactions to operate with cloud if needed.

In Fig. 3 we have presented the mappings of functional modules to the layers of the proposed framework. The devices such as wearable, mobiles, sensors in homes and cars etc are mapped to the physical devices management layer of the framework. The controller services plays the role of communication layer in the architecture. Interactions, databases and data services are mapped to the integration layer and also to the access management layer for security reason. All the actions like processing data and applying IOT intelligence are mapped to event processing and analytics layer.

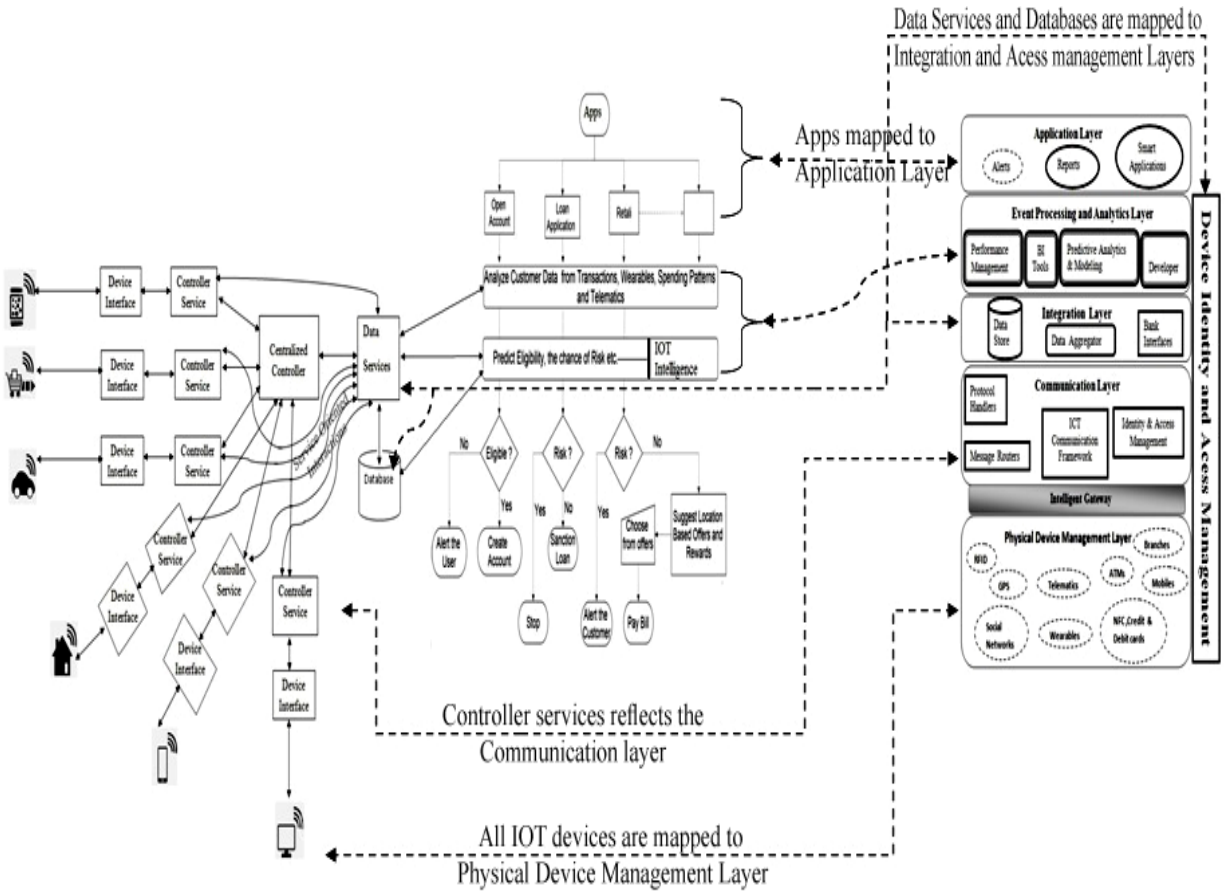

Fig. 3. Mapping of functional modules to layers of the framework

IoT for LOAN PROCESSING

In the existing systems, for taking loan, a customer starts with a formal application which requires certain basic information such as address, income, employment, educational and property details. The motivation behind the whole practice is to discover the suitability of a candidate for the credit. But verification of the income documents, statements and other will take few weeks to months and no guarantee that the customer will get the loan [10]. With IoT based system, predicting the financial health of the customers using the decision making will make banks and clients simpler to begin and keep up the advance procedure including finishing the different customs amid the whole period. This system follows the same in case of opening an account.

IoT for RISK-AWARE SHOPPING WITH CUSTOMER SPECIFIC OFFERS

Nowadays banks are going with mass messaging about their products to customers [11]. But with huge amount of granular data from connected things tomorrow's bank provide customer specific products and offers based on customer's overall financial status. The proposed system offers customers what they want. This system can analyze geographical data and identify offers and deals from other nearby sellers and alert the customer before he swipes their debit or credit card in a mall. Also, this system enables banks to provide location-based discounts on retail shopping and making customers aware of their financial position to avoid risk.

V. Conclusion

In this paper, we proposed a conceptual framework based on IoT for banking and financial services sector. We proposed the framework with heterogeneous objects interacting with the physical environment. The distinctive features of this framework are high reliability, multicast, dynamically expandable using a modular approach, efficient quality of service management with integrated analytics platforms in-place. Using a case study, this framework combined bottom-up reasoning about design guidelines and exploring the technical consequences of architectural design choices. The proposed framework permits banks to create applications in a way suitable for their own particular prerequisites such that they meet distinctive necessities for maintaining quality of service requirements.

The technology of Internet of Things is opening several possibilities for the future of banking and financial services. A major challenge in implementing IoT technology in banks is that support of legacy IT infrastructure. So, it needs to be remodeled to simplify the complex systems and to support new technologies effectively. Some of the technological issues surrounding the internet of things are identity management, energy efficient sensing, greening IoT, scalability, security and privacy, communication mechanism, integration of smart components and global co-operation. The scientific challenges include data exchange between heterogeneous elements (interoperability), effectively handling uncertain information and service adaptation in the dynamic system environment .

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