

Conceptual analysis of Internet of Things use cases in Banking domain

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Abstract— Internet of Things (IoT) is an element of smart infrastructure and banking is one of the potential domains which can leverage a huge opportunity from IoT technology. Currently Automated Teller Machine (ATM), Point of service (POS) terminal, mobile banking acts as the edge for banking infrastructure. These digital edge systems in banking bring in one on one interactions with customers and their requirements which opens up opportunities for data acquisition, processing, analytics and decision making on that data. In this paper, banking, financial services and insurance (BFSI) based IoT application usage / use cases with concepts, current trends, opportunities and challenges will be discussed. Smart banking edge systems are needed to address the growing demands on BFSI requirements and IoT is one of the elements for Digital banking infrastructure that will meet the expectations.

Keywords—Internet of Things, Business Intelligence, edge data analytics, banking, SoA, ATM, POS.

I. INTRODUCTION

Banking and financial services organization is backbone for many countries economic development and Information technology (IT) helps to manage the services and eases the operations for Banking institutions to scale [1]. The banking business is driven by knowledge and information processing. Using IT systems and applications the products are developed, marketed and distributed. IT drives banking for all economic activity and hence an efficient banking system will make the money move faster resulting in increased growth and increased balance sheets, leading to economic growth. Banking has adopted technology for its fast growth and current technology adoptions include Service oriented architecture (SOA), Master Data management (MDM), Customer relationship management (CRM), Business Process Management (BPM), Web Content Management System (WCM), Document Management Systems (DMS) etc. Banking services are broadly categorized into three areas such as retail banking, Business and corporate banking and Investment banking.

- Retail banking - Serving retail customers, offering savings, deposits and loans.
- Business and corporate banking - Serving small, medium and large enterprises, offering current accounts, payments, cash management, trade finance, guarantees and foreign exchange (FOREX) services.
- Investment banking - Capital market related service like advisory, investment research, brokerage, mergers and acquisitions and wealth management.

Retail banking is about relationships with customer and offers opportunity to tap large amount of data. Customer satisfaction is the key parameter to be managed and can result in lifetime business and many opportunities to cross sell banking products. IT plays a major role in achieving these objectives and executes for the usage of banking products as per business strategy. The below Table 1 highlights the customer usage of banking touch points in Europe, US [5] and India [6] & [7].

TABLE I. BANKING TOUCHPOINT ACTIVITY IN EUROPE, US AND INDIA - PERCENTAGE OF ONLINE ADULTS, AT LEAST ONCE MONTHLY

Countries	Banking in person	Banking via ATM	Banking Online	Banking via mobile
Europe	22%	65%	70%	55%
US	43%	47%	73%	69%
INDIA	94%	94%	48%	48%

Based on the data with reference to Table I., online banking is picking up compared to in person banking. The usage trends for Mobile and ATM are better compared to in person banking.

II. INFORMATION TECHNOLOGY INFRASTRUCTURE FOR BANKS

Banks are powered by Information Technology (IT) infrastructure for handling their own data processing and connecting to their respective branches, ATM/POS terminals. Retail banks have customer facing ATM/POS terminals and acts as the edge data interfaces to capture various types of banking customer data. Figure I. below highlight the Bank IT infrastructure which has a combination of hardware and software-based systems which stores, processes and communicates the banking related data. Connectivity to branches are 24 x 7 and cannot afford any down time. Large data centers can host variety of database, software applications for banking related products. On which service-based software application are interfaced to offer various services to customers. Many banking functions will benefit with this back-end data processing in the data centers. Operations such as HR, Payment processing, Call center operations, back office operations will function.

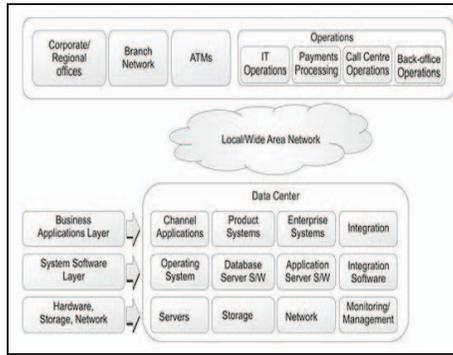


FIGURE I. BANK IT INFRASTRUCTURE

New age Digital banking extends the above infrastructure closer to capturing customer data and ATM/POS terminals/mobile banking are transforming with power of Internet of things. For example, IoT based video capturing devices to get data about customer experience in retail banking and create new opportunities for improvement. Table II. offers the data from current popular ATM manufacturers who offers smart services via ATM/ POS terminals.

TABLE II. ATM/POS MACHINES FROM MANUFACTURERS WITH ADDED SMART SERVICES

ATM / POS Manf.	Cash with drawal / deposit	Utility payment	Mobile pairing / Self service	POS with added smart service	Comments
Diebold	Yes	Yes	Yes	Yes	Diebold NixDorf Irving terminal offers smart POS services. [2]
NCR	Yes	Yes	Yes	Yes	NCRs SelfServ 80 Series offers smart ATM services [3]
Hyosung	Yes	Yes	Yes	Yes	Hyosung offers Moni mobile ISO for ATM maintenance using Mobile APP. [4]

III. INTERNET OF THINGS - TECHNOLOGY AND APPLICATIONS

Internet of things (IoT) system is a combination of variety of sensing device nodes as referred in Figure II. to capture data from physical world and Customers, gateway to process data from the IoT devices and send it over internet to remote

servers / cloud/ data centers for software applications [5]. These software applications are designed based on services as required by customers from retail to enterprise and resides in data centers which hosts software applications.

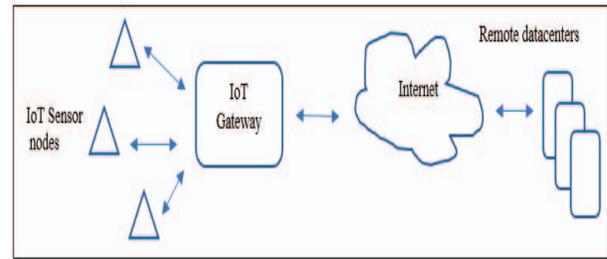


FIGURE II. IOT SYSTEM

With reference to Figure III., typical IoT architecture includes

- Perception layer - The layer which interfaces with the physical world to accommodate the information from source. All kinds of information are collected in this layer. Sensors and wireless communication devices are the key components of this layer.
- Network Layer - This layer facilitates the transparent data transmission using the existing communication medium such as mobile, Wireless sensor nodes (WSN), Radio access network and other communication devices.
- Service Layer - This layer hosts critical function such as data management, application support, security and execution.

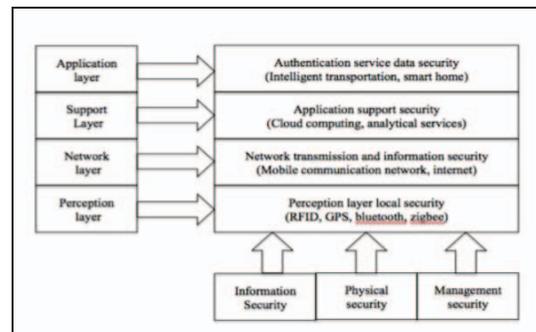


FIGURE III. INTERNET OF THINGS – LAYERED ARCHITECTURE

For deployment of IoT, there are topology recommendations with applications are highlighted below

- Point to Point (P2P) - Communication can only happen between 2 nodes using Bluetooth wireless communication protocol. One side is the gateway that connects to internet and the other one is IoT sensor node which connects to physical world for data. Example for P2P IoT is bluetooth device that works between earpiece and mobile phone. Another example is personalized interactive customer kiosk in banks.
- Star - Here Gateway device (connected to internet) acts as a central hub where the IoT sensor nodes

interfacing for various physical parameters are connected to Gateway using WiFi communication protocol. Example of Star configuration has Wifi enabled Gateway devices connected to various IoT based sensor nodes in a smart home environment.

- Mesh - Here there are three types of devices, i.e. IoT sensor nodes, IoT router/sensor node and Gateway which connects to internet. The IoT router/sensor nodes connects to the sensor nodes and routes the data to Gateway. This allows more distance coverage for the IoT system deployment. This typically uses Zigbee wireless communication protocol for connectivity. Examples are building automation/ Smart infrastructure.

IV. CURRENT TRENDS OF IOT USE CASES IN BANKING

The opportunity for IoT in banking will be looked upon with reference to the Banking IT infrastructure. Given the scope of IoT as connect point to power up the edge data transactions, ATM/POS terminals can leverage the potential of IoT for sourcing the data related to customer in many aspects. Some of the IoT application are

- Banking on Wearables- Wearables such as apple watch, Samsung gear, Fit pay are already in the market where consumers can pay using the wearables. The bank Barclays is unveiling bPay wearable contactless payment solution [8].
- Connected Automotive as banking branches - Connected cars one of the major consumers of IoT devices has enough infrastructure to host ATMs. The fleet of cars run by Idea bank has been customized with integrated security deposit box and ATM and can reach to customers rather the other way. Based on transactions, it has been found that the average deposit on one of the car-based ATM is thrice that of standalone branch [8].
- Block chain with IoT - Blockchain is a technology adopted by banks towards the Digital banking framework. Block chain [4] is a Peer to Peer ledger which offers decentralized framework with data intensive applications running on billions of devices and preserving the privacy of users. IoT offers the connected experience with various sensor nodes does have the challenges of security or data privacy, block chain can be used as a solution to this challenge. The services offered from banks allow lot of sensor data from IoT devices to be managed and here the demand for privacy is high and block chain-based applications can ensure there is no tampering of data.
- Smart branches - Retails bank branches interfaces with customer with traditional teller-based interaction, ATMs etc. Basically, converting a retail bank branch into a smarter one by using video analytics and sensors can allow customer data to be captured for understanding customer interactions with banks. Customer facial expression can be used for judging the retail banking experience. The same can be used for monitoring threats [6].
- Personalization - Bluetooth based beacons (IoT devices) can be used for creating personalization for customers. Chase bank is validating a proactive

service platform for retail banking customers before they approach a human bank teller or ATM. At Barclays beacon technology is used for helping disabled passengers to navigate branches [8].

- Home Banking - Enabling smart devices at homes makes home infrastructure smart to handle different services and close to customer. IoT powered devices integrated with Alexa (Voice based AI assistant from Amazon) or Google home (voice-based AI assistant from Google) can open up services for banking customers. US based Capital one is allowing customers to pay their bills via Amazon Alexa, similarly UK's challenger bank Starling is using Google home integrated with the API allows their customer to check their balances and make payments using voice commands [8].
- Customer experience - To improve the customer experience IoT can be used. Digitalization of retail banking can be enabled using IoT connectivity. This also will lead to opening up new channels using technology. Self-service ATMs [8], Screen less banking, voice-based devices (Amazon echo devices) can improve experiences with banking customers. The operational time for customer during banking is significantly reduced.
- Artificial intelligence (AI) for insurance Industry - Insurance industry is regarded as one of the oldest industries to use modeling and statistics. IoT can be a tool for capturing customer data such as locations, Automotive driving patterns for the insurance industry to use the data understanding the customers and their risks. With AI deployed above the IoT data stack, it allows and enables smart decisions towards insurance products for many customers. Predictive alerts to customer on maintenance towards wear and tear of machines is possible using IoT and AI combination [14]. Ant financial uses AI for intelligent insurance claim by processing real time customer data and their behaviors [11].
- Electronic Surveillance system for banks - Banks can equip themselves from intruders by installing electronic surveillance system. Zicom, an electronics surveillance security provider has installed many surveillance systems in ATMs for ICICI Bank. This surveillance system has IOT and AI for alerting about the intruders by sensing and analyzing data [15].
- Leasing finance automation - Real time monitoring of assets can be enabled using IoT, this makes the asset digitally enabled. Metrics such as asset usage and idle time could add to data points for pricing of leased assets. This enables other financial models such as daily leasing for wide variety of digitally enabled assets [16].

V. CHALLENGES

IoT for banking has challenges such as data privacy, data density, security and the need to safeguard customer information while ensuring privacy standards are met as compliance [12].

- Data Privacy - Typically banks host all the customer data and information sent through smart devices, wearables which are available for the bank and

financial institutions. Here along with data banks also have customer location data which has potential breach of privacy. Today's insurance company want to have customer location as a parameter mapped to their applications this could lead to privacy concerns.

- Data security risk - As a basic business engagement banks collect lots of data from customers through various channels and use it for their banking records and processing. Data breach is a potential issue if occurs and could leads to potential damage to customer relationship. Data infringement and data hacking could impact the customer relationship with bank severely.
- Data density - Data from IoT is expected to flow higher, now processing all the data and giving more choices to customers can lead to over loading information to customers. Psychologists have theorized and gathered evidence that increasing level of choice can contribute to anxiety, confusion, and inability to choose [17].

VI. CONCEPT AND MODELS FOR SMART BANKING IOT USE CASES

Smartness in banking is driven by digitalization of traditional banking infrastructure. This concept is already gaining momentum based on current banks investing in IT infrastructure for benefiting on scaling themselves in introducing banking products, increased customer service and improved customer experience. Inclusion of IoT technology enables the traditional banks to work in a better operational model and scale with efficiency. Figure IV. shows the IoT use case framework in banking to enable banks to offer services.

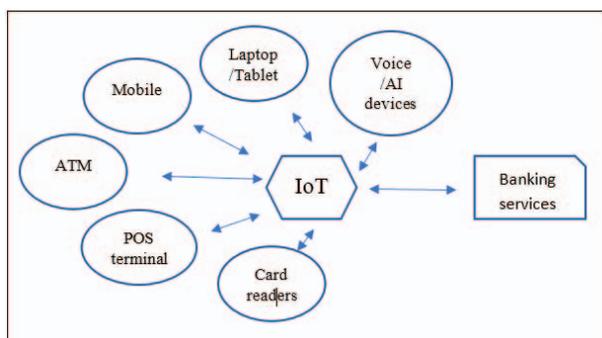


FIGURE IV. INTERNET OF THINGS USE CASE FRAMEWORK

Retail and investment smart banking models will be highlighted with IoT use cases

A. Retail banking

ATM 2.0

Mobile technology offers opportunity for next generation ATM services. Account holders can log into bank's mobile app at the ATM, using geo location and API mobile banking app can recognize account holders at the ATM [10]. The mobile app can mirror the ATM screen and account holder can then complete the transaction from his or her phone. This enables faster transaction as account holders don't have to take their

debit card to complete the withdrawal. Here security methods such as bio metric authenticity in mobile can be used for verifying the identity. Similarly, QR code can be used for enabling a third party to withdraw cash from ATM on behalf the Account holder. This could be used for payment purpose or cash transactions. Potential use cases of IoT are

1. IoT can offer video-based surveillance to ensure the identity of the customer.
2. IoT can offer digital pairing with customer mobile with ATM. This allows the identity confirmation for more services to get enabled for customers.

Mobile banking

Mobile banking apps are used today for payment, cash transfer to other bank accounts, insurance payments, utility payment etc. APIs play a major role for mobile banking to enable a broad eco system of integrated services and functionality to develop. With IoT integration the benefit of real time data feeds into services for customers. Potential uses case of IoT are

- Enabling services in utility outlets for interactive customer experience and to promote new products based on credibility of customer. IoT allows the physical objects to communicate with customer's mobile offering services.
- Risk assessment based on data from IoT in an automotive paired with the Mobile app allows the insurance companies to decide on risk levels and assess insurance premium accordingly.

B. Screenless banking

Technology has opened by possibility for more interaction between customers and banks. It also removes the hurdles such as physical location or even interact directly with the bank. The concept of screenless banking was motivated by smart phones and smart watches which delivers more secure retail transactions. The next step is to have a screenless user experience by using voice as a new platform for interacting with technology. Using voice-based AI devices such as Alexa or Google home customer access bank accounts using voice recognition as authentication. Potential use cases for IoT are

- Enabling IoT based devices that are connected to voice-based AI devices to offer services. These IoT devices can be directly managed by third party authorized by banks for maintenance.

C. Investment banking

- Client centricity [18] - Provide personalized experiences by transforming customer data into next best actions and ensuring long term relationship. Getting a 360-degree perspective of customer experience. Potential use cases of IoT are
 - Enabling IoT based video monitoring devices to get data on customer experience while visiting a retail outlet.
 - Customer interactive IoT based banking kiosk to get real time feedback from customer.
- Banker productivity - Offload manual survey and leverage IoT based real time data from operational

functions and link it to machine learning technologies to improve productivity on staff hours.

- Advanced risk analytics - Based on data different IoT based sense point evaluate the overall risk on the portfolio of investments. Integrate with cloud for leveraging modelling accuracy based on updated software applications.
- Regulatory compliance - IoT sense points to provide data on most vulnerable threats which can be bridged to analytics for evaluating compliance and predictive maintenance. This also reduces the compliance burden when linked to analytics for identifying fraud patterns, market data and offer enhanced security through real time fraud analytics.

VII. EDGE DATA ANALYTICS

Data processing in the edge with reference to incoming data from the sensor nodes has growing opportunities for localized decisions based on application. In remote deployments of IoT system the support for edge data processing, localized decisions and managing latency [20] on the network is a significant feature for IoT based systems. Applying analytics in the edge on the real time raw data brings in meaningful information for the applications to process. In a typical banking scenario edge data analytics support can clear the validity of customer credibility validation in the local retail banks itself instead of validating every time with Core banking infrastructure. Similar operational parameters which govern the performance of retail banking infrastructure can be improved using edge data analytics supported IoT system.

VIII. BUSINESS INTELLIGENCE (BI) – EDGE DATA ANALYTICS SUPPORT VERSUS EXACT BI APPLICATION IN REMOTE DATA CENTERS

Banking and trade organizations use business intelligence (BI) based software to manage operations and business continuity. Table III. below highlights a comparison between the current software with exact BI support versus a BI based software with edge data processing support. Considering the following characteristics in a BI package, a comparison with edge data processing and current datacenter-based application processing is mentioned below

1. Reporting and Analysis
2. Analytics
3. Data warehousing
4. Workflow
5. Data integration

TABLE III. COMPARISON OF BI CHARACTERISTICS WITH CURRENT BI SOFTWARE WITHOUT EDGE DATA PROCESSING VERSUS WITH EDGE PROCESSING FUNCTIONALITY

S.No	BI characteristics	Current Software solution offerings in the market	BI Solutions with Edge processing & data analytics
1	Reporting and Analysis [21]	Data storage and processing with latency challenges the real time reporting and	Reports data with better accuracy and real time with reduced latency. Further

		analysis	can add to analysis.
2	Analytics [21]	Storage data or real time data still lacks the performance. Has huge data processing capability for large volume of data.	Limits to volume of data processing however excels in real time data processing and analytics.
3	Data ware housing [21]	Conventional data ware housing techniques used	Score remarkable higher in Data ware housing
4	Workflow [21]	Limited when compared to off the shelf workflow capabilities.	Score better with off the shelf workflow capabilities.
5	Data integration [21]	Good performance Data integration with large volume of data however limits to stored data versus real time.	Supports real time data integration.

IX. FUTURE SCOPE & RESEARCH OPPORTUNITIES

With current IT infrastructure in a changing landscape the future of banking is to embrace the digital technology which offers scalability with quality. More applications or Apps in Financial technologies or FinTech can become vital for the services offered to the customers and make personalized banking products more adapted to personality of customers and their lifestyle choices removing the barriers. Data source fetched by IoT for back end processing will drive more opportunities for Service based integration. Following are the research opportunities

- Quality of Service (QoS) in Software as Service (SaaS) – Service oriented architecture (SoA) will play a key role in the drive for software services based on customer data and for the banks to expand their business. IoT based services using SoA can offer Software as Service (SaaS) to customers using cloud service providers / Internet service providers (ISPs). Handling QoS in SaaS with IoT sense points is a research area.
- Context aware banking - Predictive algorithms can help customers to alert or trigger payments based on patterns. For example, IoT powered thermostat can alert the estimated payment for the winter season based on the climate data. Banks can offer such services to customer as insurance products. IoT based sensors can capture real time data on seismic impacts and send the data to market analyst for balancing the investments in that zone. Context aware computing applied to banking is open for research and has huge potential for banking related algorithms.
- Intelligent banking – Artificial Intelligence (AI) deployed on banking digital infrastructure can help to manage regular operation workloads and increase the operational efficiency in the floor. Interfacing IoT, big data analytics, Deep learning and AI is research topic based on different banking requirements. Yoshua Bengio, Aaron Courville and Pascal Vincent's

Representative learning can open new AI based opportunities [22].

- Security & Compliance - Intelligent intruders doesn't have to be a physical person, it could also be botnets to hack into the banking infrastructure and ransack the system. Downtime for banking IT infrastructure cost huge loss to the banks. Today's hackers are much equipped with tools and smart algorithms to hack into complicated IT systems, data centers. Security and Compliance is a research area which needs more inputs from research minds to close the gap of vulnerabilities [23].
- Quick response times - Current IoT systems are mostly connected to cloud for processing and most of the work loads are processed in the cloud based on data provided by IoT devices. This causes latency issues and if there is a network down time, the functionality is a challenge. Edge analytics is demanded more in such situation where the IoT systems which are front facing data capturing units should be able to process the data immediately in the edge and respond to it. Edge computing is a research area of interest to improve the response time. Opportunity for heuristic based algorithms can be recommended research area to resolve optimization challenges [24].
- Enhancements in Current BI Software solutions – Traditional BI based solution lacks real time data and heterogenous data enhancements, this gap can be supported using edge data processing and has research scope identify physical parameters that can build more accuracy and application domains for BI software.

X. CONCLUSION

The foundation for digital era in commerce/businesses are powered by digital banking and adding the sense points such as IoT based devices gives better quality of data in real time for processing and making decisions for scaling up. Banking products, retail/branches are increasing based on the increase in customers, financial institutions, services etc. To provide seamless service and real time data for the digital banking infrastructure IoT acts as the key element to interface in the edge [17] and enable banks to scale customer services. Future banking will have IoT as the backbone for all related services and products.

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