

Internet of Things with Wearable Devices at Enterprise Radar

Raghvendra Singh Dikhit

Abstract: *Internet of Things and wearable devices at Enterprise has a long way to go with unexplored and untapped areas. And its market is too big to ignore. Ubiquitous mobile, gadgets and internet usage have transported enterprise towards ocean of opportunities. A massive growth have been observed in the sale of wearable devices, smartphones and tablets. With capabilities beside quad core processor, decent memory and bigger screen size, smart devices are ideal for personal and professional use. Gadgets owned by the target user – employees, partners, distributors, contractors and customers – are smarter than the technology options provided by the enterprises, which is a huge challenge for the enterprises. Organizations are trying hard to come up with an efficient, secure, and usable catalyst across multiple platforms to meet the expectations and demands of the target users. In this paper, we will understand the enterprise ecosystem, IoT, wearable devices, their classifications, applications along with feasibility and possibility of IoT with wearable devices at enterprises.*

Keywords: *Enterprise, IoT, Wearable devices*

I. Introduction

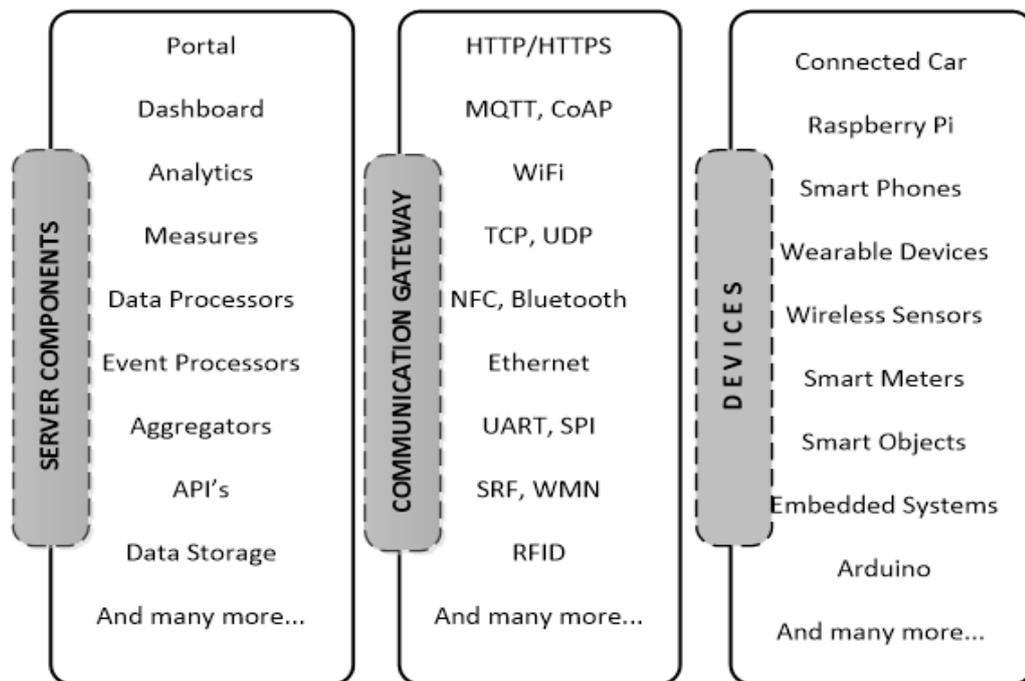
Enterprises stress at gaining competitive advantage, user delight, efficient / productive workforce and resource optimization, leads them to versatile challenges for enterprise solutions. They can be like:

- **Data Security:** Enterprise solution requires enterprise data access. And in cases, application saves enterprise data locally at user's personal device. Security mechanism for data on the move as well as data- at-rest is one of the crucial concern for enterprises.
 - Data on move: Data security while network communication for client server interaction
 - Data at rest: Data security while storage at client device (Required for offline data support from enterprise client application)
- **Enterprise Data Gateway:** Access of enterprise data over generic Wi-Fi or operator's network is core requirement of modern enterprise solutions. These gateways should have intelligence to offer enterprise data at registered device only. However, these data sources may be standard or custom data sources.
- **Device / Platform Diversity:** Multiplatform supported applications for supporting BYOD (Bring Your Own Device) or CYOD (Choose Your Own Device) policy is unavoidable need for enterprises. COPE (Corporate Owned Personally Enabled) devices can be a mode of delivery. Selection of appropriate development strategy, to deal with platform diversity and device diversity is one of the important decision. It can significantly affect TCO (Total Cost of Ownership). Applications in-house distribution and admin desk to manage user devices in remote fashion also adds to TCO.
- **Manageability (Application distribution and data management):** Data management and applications management in remote manner is another expensive dimension of enterprise ecosystem.
- **User Experience:** Customer / User delight is the way to engage them with offerings / services. Enterprise solutions comes with diverse platform specific guidelines and user interaction models like Windows metro guidelines, iOS (Mobile Operating System by Apple) Human Interface Guidelines, Android UX guidelines etc. Enterprise client applications can be designed with app-centric design or adaptive design.
 - App-centric design: Client application designed with common guidelines and used across the multiple platform devices.
 - Adaptive design: Client applications designed with respective platform specific guidelines for desired cross platforms.

Considering the difficulties and challenges with device strategies, enterprises are looking for a unique and cost effective catalyst solution that reduces the time to arrive at market and offers high maintainability. Enterprise solutions are emerged over-the-time as per the transformations introduced via society, technology, revolution or invention. Popularity of wearable devices and scope of IoT postulates enterprises to look over on their solution offerings. With time, enterprises are looking forward for new strategies and future aspects. Needlessly, the cause is very simple because innovative gadgets grows virally in the society.

II. IoT Classification and Applications

IoT which stands for Internet of things is an umbrella consisting of uniquely identifiable network connected embedded devices, supported communication protocols, relevant technologies and server components. These network connected embedded devices are often connected with sensors or data gathering systems likewise internet connected cars, wearable devices, smart phones etc. These IoT devices with or without UI are basically used for collecting and processing the data of everyday usage. Broadly IoT can be classified in three layers consisting of Server components, Communication gateway and Devices. Figure below illustrates classification in three layers.



Server Components are required for assorted analytics, measures, processing, and storage by system. Communication channels are identified and designed as per device and solution expectations. Some of the communication protocols are MQTT (Message Queuing Telemetry Transport), CoAP (Constrained Application Protocol), NFC (Near Field Communication), UART (Universal Asynchronous Receiver Transmitter), SPI (Serial Peripheral Interface), SRF (Shaped Radio Frequency Signal), WMN (Wireless Mesh Network), and RFID (Radio Frequency Identification) etc.

IoT devices are also identified and designed as per solution statement. Some of the devices are Raspberry Pi (Small size single board computer), Smart Object (An object with own possible interactions), Wireless Sensors, Embedded Systems and Connected Cars etc.

IoT solution or system expects attention to cater respective challenges associated with devices, likewise:

- Identity and access control
- Security of private data (secure credentials and other personal data)
- Authenticated channel of communication
- Automatic updates (data wipe, data backup, suspend / resume, enable / disable features, & preferred communication networks and settings etc.)
- Remote management (monitor, locate, and block device)
- Limited power, memory and processing capability
- Device risk management (handle reverse engineering and other attacks)

Proliferating and emerging IoT solutions can be integrated with any domain, sector or business statements. Following can be some of the IoT solutions:

- Home / hotel or building automation with various sensors, and managed by single device. For example, home appliances (refrigerator, TV, AC, washing machine and lighting etc.) are managed by mobile phone
- Health monitoring automated systems via sensors, and communication to relevant devices

- Real-time communication among driver, vehicle, traffic and other entities in transport systems
- Electronic devices automation and management over the air for effective usage of power or energy
- Enterprise departments process optimization via automated sensors. For example supply chain management process optimization while manufacturing, transportation etc.
- Monitoring and controlling of various bridges, railway tracks, hospital etc. for Infrastructure management via IoT devices
- Emergency services automation with sensors to track environmental factors as earthquake, storm etc.
- Monitoring and analysis of wildlife movements for required management and wild life security
- Tracking and analysis of user likes and locations for smart shopping solution

III. Wearable Devices

Initially mobile phones were used for audio calling and text messaging. It was not expected to manage personal and professional work from mobile phone. Though, over-the-time mobile devices have emerged as an importunity for personal and professional work life management.

Wearable devices may repeat the history. Proliferating and emerging wearable devices are at experimental state, for various domains, sectors, and segments. Following can be some of the feasible wearable devices, with focus on usability perspective:

- Cloths (shirt / trouser): Conductive thread manufactured cloths can power and communicate with other wearable devices.
- Shoes: Integrated sensors and GPS (Global Positioning System) with shoes can be used for generating power with movement, health monitoring, tracking kids or people, navigation to destination etc.
- Glasses: Internet connected glasses with computing power can be utilized for important notifications, navigation with distance and direction, internet browsing, over the voice command, music player, radio, audio / video call, camera picture, audio / video recording etc.
- Wristband / Bracelet: Integrated sensors with wristband / bracelet can be used for health monitoring (body movement, sleeping habits etc.), communication with other gadgets, notifications / alerts etc.
- Ring: Personalized ring with storage / computing power can be used as identify proof and storing valuable details, likewise passport, license, credit card details etc.
- Wristwatch: Integration of computing power and storage capability can make wristwatch as mini mobile with versatile features, likewise vibrate on messages / notifications, send and receive voice calls, install and use apps, monitor health, use as a storage device, work as camera for pictures and audio / video recording, make dinner reservation etc.
- There can be many other wearable devices (earrings, necklet, and belt etc.).

For consumer market, wearable devices (smart Watch, wristband, and glasses etc.) can be a part of luxury life style. Either, they can also be an importunity, if designed and marketed attractively. Here, mobile can be a good example.

Following can be some of the feasible use cases for wearable devices:

- Health Sector: Wristband for patients at hospital, giving alarm to doctor (cabin / mobile) in case of health issues, which are measured through various sensors.
- Ecommerce: Wrist watch for customer with payment feature. This wearable device can verify user identity and process payment, via vendor devices.
- Access Authentication: Wearable device (wristband / bracelet / ring / wrist watch etc.) can be used as identify proof asset, while entry of office gate or authentic place. It can display user's personal details on gate glass / monitor, and gate would open only for authorized person.
- There can be many other similar use cases.

For enterprises, business objective association is mandate for any entity, to be a part of enterprise ecosystem. Mobile offering contributes to enterprises, in the form of increased and efficient productivity. Similarly, if wearable devices use case can be accommodated to enterprise ecosystem, with measurable ROI (Return on Investment), then soon it can be a part of enterprise radar.

IV. Enterprise Solution Objective

Over the period of time, versatile technologies have emerged. However, irrespective of emerging technology or market trend, enterprises possess their own needs and challenges. They are data security, manageability, scalability, reliability, development / support cost, user experience, cross platform support etc. with enterprises. The chief focus areas of enterprises as:

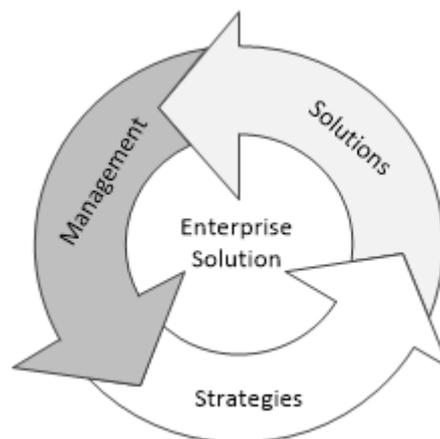
- Gain competitive advantage
- User delight
- Efficient / Productive workforce
- Resource optimization

In order to breakthrough challenges, and fulfill the need of desired focus areas, enterprise solutions have also emerged with time. IoT devices (mobile, wearable) as a mandatory gadget for users has given a new direction to enterprise solutions. Device centric solutions and services have emerged as an essential for enterprise due to target user dependency on gadgets. Enterprise users are willing to access everything from everywhere, either it's for personal or professional use. It is also an untapped opportunity for business.

The objective for enterprise solution can be defined as "Enhancements in productivity with measurable ROI using strategies, solutions and management for enterprise users and business flows is the principal focus of enterprise solution".

Enterprise solutions would require well defined services, consulting and respective management from SME (Subject Matter Expert). Broadly enterprise solution can be classified in three stages.

- **Strategies:** Well-defined enterprise policies are required for identification of any strategy. Enterprise policies are important in view of security and management perspective. Also, it gives direction for solutions design and their offerings. IoT device offering is a part of overall enterprise strategies, which is required to be identified and well-defined before planning further actions. These strategies are the enablers for transforming enterprise, to exploit market business opportunities. IoT device strategies would drive the path for enterprise solution.
- **Solutions:** Enterprise would necessitate different catalysts as per business flow and execution cycle. These catalysts may or may not possess IoT offering. However, in today's era, it can be an innovative way to plan solution with IoT, wearable devices and latest popular gadgets.
- **Management:** Designed and implemented solution's management emphasize on certain aspects. They are infrastructure requirement, their setup, processes & resources for execution etc. Client devices can be one of the cause for security menace which requires concentrated approaches and catalysts to maintain enterprise data secure and manageable.



The diagram above, illustrates the three distinctive stages of enterprise solution in circular direction. These three classified stages work in a circular way in enterprise while execution. Strategies are built over the time. They get mature with end user feedbacks, results and business oriented reports. Solutions are also updated over the period with versatile innovations, emerging technologies and market trends. Management feature and support are outcome of emerging and evolving essentials from strategies and solutions.

V. Enterprise Systems

An enterprise has several business units and systems at execution level. This section covers some of the popular acronyms used for enterprise segments or systems. It's difficult to exist in isolation for any system at

enterprise. Hence, it is very obvious to embrace some overlap of features, solutions and services within the system.

- **Field Service Management (FSM):** Field service jobs are the area of complexity for enterprise, as well as individuals. Field service schedule management, client interaction, and real-time task management are hectic and demanding. Field service life cycle can be defined as:
 - New Appointment
 - Assign resource
 - Process / Execute with resource tracking
 - Review / Assess / Feedback
 - Close / Complete flow
 - Analytics / ReportsFSM is the solution or catalyst to entertain objective of workforce optimizations for any enterprise. FSM solutions can affirm introductory features as:
 - Work force management
 - Schedule management
 - Support data on move (online / offline)
 - Real-time statistics
 - Location tracking
 - Business intelligence
 - Social network collaboration
 - Payment gateway integrationMobile can be a facilitator for data collection, user feedback, and schedule, etc., as per desired FSM solution. These solutions inherit benefits likewise increased efficiency, time based routing, real-time analysis and optimized cost / time.
- **Customer Relationship Management (CRM):** One of the imperative need for any enterprise is an efficient CRM. It is the system for enterprise customer's management. CRM system plays an important role to feed enterprise core motives. Basic objectives behind CRM systems are customer acquisition, retention, and migration with increased profitability. It primarily deals with sales, marketing and customer which are important entities for any business. CRM solution possess following features, but doesn't limit to:
 - Contact and account management
 - Communication tracking
 - Scheduling
 - Sales automation, tracking and forecasting
 - Marketing automation
 - Customer service
 - Knowledge managementCustomer engagement can be defined in three steps as 'Lead', 'Opportunity', and 'Account'. Here, "Lead" is a new identified person or company and that can have potential to be an opportunity. "Opportunity" is the potential lead. It goes through versatile sales stages (proposal, quote etc.) for selling product or service. "Account" is engaged lead with business relationship. Though, it's not necessary to initiate purchase of any service or product.
- **Supply Chain Management (SCM):** Enterprises manufacturing system require solution to deal with end-to-end cycle from supplier to consumer. SCM is all about managing life cycle from supplier to consumer as per enterprise need. Goods supplier, product manufacturing, warehouses, transportation / distribution, customers are the entities / parties involved with any supply chain management system. SCM have introduced versatile changes and innovations time-to-time, as per emerging technologies. Following are some of the features offered by SCM, but not limited to:
 - Inventory management
 - Worker management
 - Controlling and tracking data, flow and locations
 - Real-time schedule, notifications and alerts
 - Real-time information at different levels
 - Logistics and reports

Innovative SCM system provide reduced employee downtime, responsiveness to customers, control and tracking of overall system. Mobile applications with location, map and adequate information helps to optimize frequently changing time critical supply chain ecosystem.

- **Enterprise Resource Planning (ERP):** ERP is an acronym for Enterprise Resource Planning which focuses on enterprise business process integration, automation and management. It can be used by small, mid or

large enterprises. Though, earlier it was implied to be used by mid or large enterprises only, due to cost over heads. ERP system comprises of several modules also known as “ERP Modules” and each module can sustain separate solution or software for particular purpose likewise payroll. Following are some of the imperative features of ERP, but not limited to:

- Manage project planning, cost and development
- Payroll, account and finance process automation
- Data protection via well-defined role based data access
- Document management
- Workflow management
- Employee life cycle management
- Manufacturing process automation
- Human resource process automation
- Sales and marketing process management
- Collaboration management
- Messaging / chat support
- Inventory, procurement management
- Reports and performance monitoring for optimizations

It is very common to compare ERP with CRM due to overlap of assorted features. However, broadly CRM deals with front office management (sales, marketing, business contacts / profiles, accounts etc.). Whereas, ERP focuses on back office business process integrations (payroll, account, finance, employee management, workflow management, project management etc.). Though, some system integrates both CRM and ERP to prevent data isolation. ERP systems help enterprises to improve operation efficiency, integrate all business processes and manage back-office activities.

- Enterprise Social Platform (ESP): ESP is an acronym for Enterprise Social Platform, which is one of the must have solution for enterprises with principal focus on collaboration, communication and coordination among different business units and members. ESP system need secure and robust system with portal. It can hold topic, activity stream or group oriented sub communities. And there can be internal, as well as external platforms for engagement in enterprise social community. ESP focuses on management of following features, but doesn't limit to:
 - WiKi, Forums, Calendar, Polls, Messenger
 - Unified search, Collaboration FAQ's
 - Documents, Email notifications
 - Product or service promotion
 - User profile, Connections, Localization
 - Web content management

ESS (Enterprise Social Software) is also coined acronym in enterprise ecosystem. It also focuses on enhancing communication, collaboration and coordination among business units, employees and processes. There are some other acronyms, which are in use with similar features, like SEP (Social Enterprise Platform) and SCS (Social Collaboration Software).

- Enterprise Content Management (ECM): Enterprise Content Management is a combination of methods, strategies and tools, with systematic ways to capture, store, manage, preserve and access information, content and document related to enterprise. It governs the life cycle of information, from its creation to publication, through archival and later on its disposal. ECM system includes following features, but doesn't limit to:
 - Document management
 - Web content management
 - Records management
 - Digital asset Management
 - Workflow / process management
 - Security, Search, Localization
 - Archive, backup & recovery management
 - Version control

EIM (Enterprise Information Management) is one of the acronym used in enterprise ecosystem for similar kind of features.

VI. Enterprise Use Case

Enterprise solution blueprint is expected for hassle-free footprint while execution with real systems. It is challenging to identify applications first version features, with consideration of scalability, expandability, and flexibility. Minimum Viable Product (MVP) is the term coined for such scenarios. Where enterprises can plan first version of application with minimum required features for target users. Features of the solution can be limited down. However, architecture and design should be scalable, expandable, and flexible. Enterprise solution with IoT and wearable devices design and architecture requires precise consideration of factors likewise:

- Type of applications
- Target user segments
- Target platforms and devices
- Features of applications
- Communication channels
- Middleware support and services (cloud hosted or on-premise)
- Security mechanism
- Enterprise device support environment (BYOD, COPE, CYOD)
- Device platform customization
- Solution/Application distribution channel (enterprise stores or consumer stores)

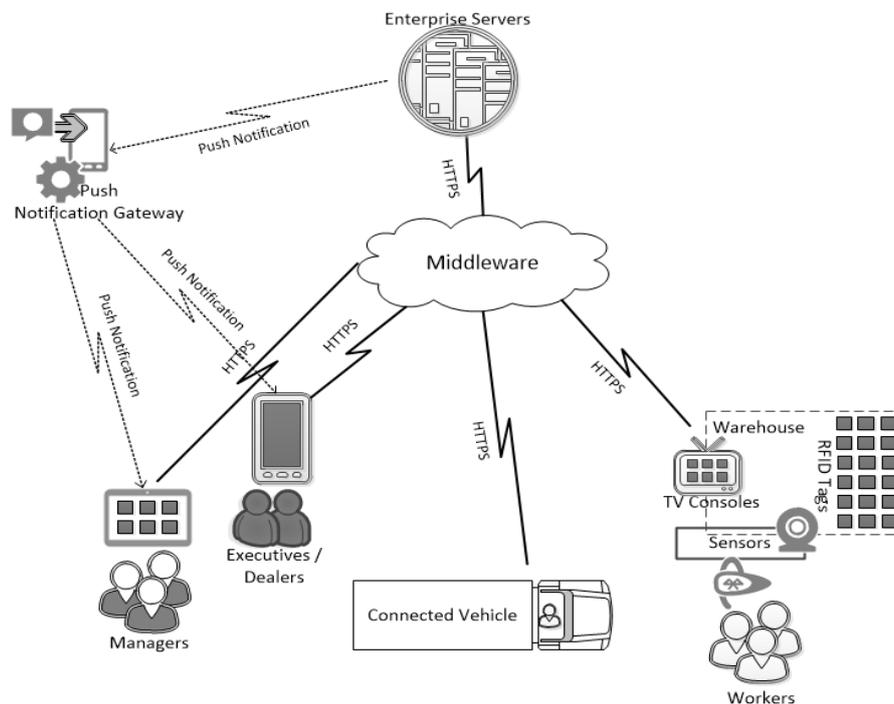
There can be many other major or minor entities, which can influence overall application architecture and design as per enterprise ecosystem and target use case.

This use case covers 'Supply Chain Management' system of enterprise for IoT and wearable devices solution with focus on enterprise objectives and processes. Following are the solution summary points:

- Target enterprise system : Supply chain management
- Devices :
 - Worker Bluetooth badges for authentication and attendance
 - Driver wristband for location tracking and health monitoring (body movement, sleeping habits etc.)
 - RFID tags and readers for inventory management
 - Sensors at warehouses for workers authentication and attendance over Bluetooth
 - TV consoles for work allocation and information communication
 - Vehicle connected device for navigation, location tracking and communication to middleware
 - Tablet phone for managers
 - Smart phones for executives and dealers
- Communication channels / protocols : HTTPS, Bluetooth, RFID, Push Notification
- Applications :
 - Executive mobile (smart phone) application
 - Target platforms : Android & iOS
 - Application type : Mobile hybrid application
 - Device strategy : BYOD
 - Distribution channel : Enterprise app store
 - Security mechanism : Mobile application management
 - Features :
 - Inventory summary
 - Reports
 - Real time statistics
 - Dealer mobile (smart phone) application
 - Target platforms : Android & iOS
 - Application type : Mobile hybrid application
 - Device strategy : BYOD
 - Distribution channel : Enterprise app store
 - Security mechanism : Mobile application management
 - Features :
 - Order / Supply form
 - Order / Supply details and real time tracking
 - Reports
 - Payment gateway integration
 - Managers mobile (tablet) application

- Target platform : Android
- Application type : Customized Android applications
- Device strategy : COPE
- Distribution channel : Enterprise app store
- Security mechanism : Mobile device management
- Features :
 - Order / Supply list
 - Workers list with attendance
 - Live vehicle tracking
 - Work allocation
 - Inventory details

Below diagram illustrates the infrastructural components for enterprise supply chain management with participating entities:



VII. Conclusion

An enterprise has many business departments, employees and stakeholders.

- Business departments: marketing, sales, finance, human resource, inventory, payroll, transportation, and administration etc.
- Employees: executives, managers, SME's (Subject Matter Expert), workers / engineers / labors etc.
- Stakeholders: investors, partners, distributors, vendors, OEMs (Original Equipment Manufacturer), ISVs (Independent Software Vendors), and SI (Systems Integrators) etc.

An enterprise can be of small, mid or large size. Earlier, only large enterprise were considered to embrace well defined catalysts in their execution cycle, due to cost and infrastructure overheads. However, over-the-time thought process and enterprise objective have been evolved and now business software systems are also used by SMEs (Small Medium-sized Enterprises). Though, the primary reasons might be a competition, customer satisfaction, popularity of smart devices or cost effective technology. IoT and wearable device offerings as a part of business roots have given innovative direction for effective and efficient execution at enterprise work place.

References

Books:

- [1] Raghvendra Singh Dikhit, Enterprise mobility breakthrough the beginners guide (Partridge Pub, 2015).