GE-International Journal of Management Research
ISSN (O): (2321-1709), ISSN (P): (2394-4226)
Vol. 10, Issue 10, October 2022 Impact Factor: 7.466

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Emerging Trends in Entrepreneurship—IoT and Data Analytics

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Introduction and Purpose of Study

We need to make a research on the emerging trends in computational technologies in entrepreneurship, that need to be of relevance to a wide range of applications of supply-chain management. Block chain technologies are complemented by these technologies, and provide ways for improvement of efficiency and tracking of the operations of supply-chain management.
Keywords : emerging, computational, entrepreneurship, blockchain and tracking

Design of Study.

a) The Internet of Things (IoT)

A diverse set of technologies that operate together and provide actuation capabilities, with networked sensing, for applications that span the physical and cyber worlds, is known as The Internet of Things (IoT). The traditional end-to-end internet applications, whether it be websites, or social media or email, have only humans, generating and consuming data. Hence the primary purpose of the internet is to connect humans to each other. On the other hand, live

measurements from digital electronic sensors, are read by embedded microcontrollers, that are deployed for various uses, as well as generation of data, that could be useful to certain applications. If the internet is connected to embedded actuators, an action is initiated remotely on the physical world, like operating a cooling fan, or causing the movement of a robot. Hence, smart 'things', whether these be electronic devices, or actuators or sensors, could be operated remotely, after connecting to the internet. With the increase in the number of embedded controllers, the usage involving internet on one hand, and communication between people and things, as well as, things and other things, on the other hand, machine to machine (M2M) communication of the internet, are outnumbering person-to-person communication uses of the internet. This feature is known as

the phrase 'the Internet of Things'. The Internet of Things is viewed architecturally, as seen in Figure-1.

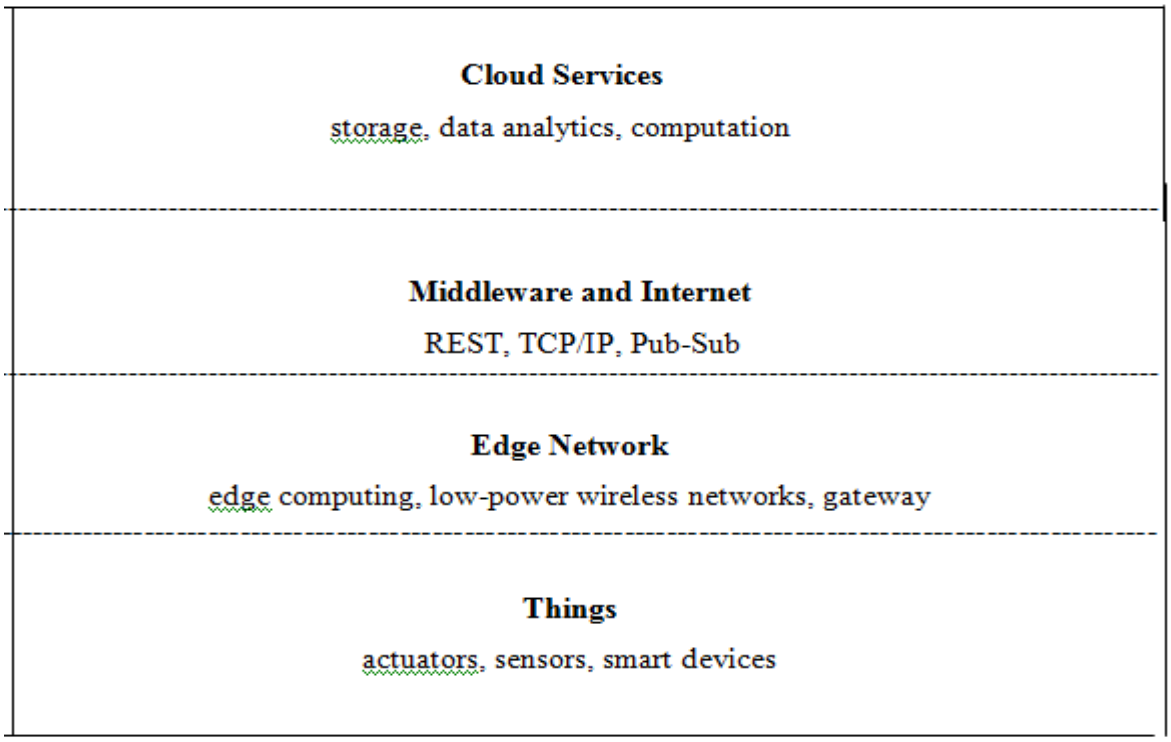

Figure-1 : The architecture of Internet of Things

The layer of 'things' could also include mobile applications or similar human input sources, that could be connected to a mesh wireless network. The next layer of 'edge network' could have a gateway node, providing necessary access to the wider internet, including some computation capabilities, that could be substantial to the environment, that is resource-constrained due to unavailability of energy and limitations of form factor. The performance of each individualsensor could be limited due to energy-driven constraints, and the rate of communication could be at the rate of a few bytes per second.

b) Data Analytics

A number of algorithms have now emerged in the context of big data systems, for data analytics, prediction and learning. There are different types of machine learning solutions, and the capabilities vary, as these are maturing rapidly in the recent years. We would make discussion regarding representation of data, compression of data, cleaning of data, clustering of data and unsupervised machine learning, statistical inference and estimation using Bayesian techniques, classification and prediction by supervised machine learning, speech processing and natural language, learning reinforcement and visualization of data.

Major Findings and Trends

We would now make discussion regarding the emerging trends of IoT sensors that could be useful in the management of supply chain applications.

a) Tracking of location using passive radio frequency identification (RFID) devices : Electromagnetic radio-frequency signals from a reader, are reflected in a uniquely identifiable way, by passive RFID tags. Due to limitations of energy on RFID readers, these are read and detected over a short range. For reading over a short range of about 10 (ten only) metres, ultra high frequency tags are used on pallets of applications of supply-chain management.

b) Tracking of location using global positioning systems (GPS) : These systems infer the positions of objects by collection and processing of signals from geo-positioning satellites. Due to limitations of the power of transmission, and the long distance of satellites, GPS systems receive weak signals, and as such, remain effective in outdoor.

c) Tracking location using radio frequency (RF) beacon : These device are more sophisticated, and could measure upto a distance of 100 (one hundred only) metres, with high powered batteries. For localization in large indoor spaces, RF-based location algorithms, could be used with less expensive and potentially mobile readers.

d) Accelerometers : These sensors provide acceleration in three dimensions. In a nine-axis inertial motion unit (IMU), it combines 3-axis accelerometer, with 3-axis gyroscope and 3-axis magnetometer readings. It provides an accurate angle and position information about tracked objects.

We could now explore some emerging wireless technologies for the links of the sensor devices.

a) Long Range Radio (LoRA) : It is for allowing communication at low power with wireless sensors of IoT over very long distance. It is a new proprietary standard, used for long range wireless communication at low power, with IoT devices.

b) RFID : In this case, the reader emits and reads RF electromagnetic signals that are scattered from the device, and measures as well as collects the data. A wired LAN connection or cellular connectivity is used to connect the reader to the internet.

c) Narrowband IoT : It is a wide area network standard of low power, recently developed by 3 GPP cellular standards body. The cellular providers deploy the same.

d) Cellular Data : A cellular data connection of traditional nature, is suited for sensors, Having adequate power supply, and has a higher energy cost.

e) Bluetooth Low Energy (BLE) : These are new standards, having very low power consumption, and are used to communicate data from other low-power active sensors. These are easily paired with smartphones, but could be connected directly with hubs that could communicate with multiple devices simultaneously.

The five main layers on the internet, application, transport, network, data link and physical, are illustrated in Figure 2.

Number	Name	Protocols	Data Unit	Addressing
1	Physical	802.15.4, 802.11…	Bits	-
2	Data Link	Zigbee, WiFi	Frames	MAC address
3	Network	Internet Protocol	Packets	IP address
4	Transport	TCP, UDP	Datagrams Segments	Port Number
5	Application	MQTT, HTTP	Messages	-

Figure 2 : The Internet Layers

There are several mechanisms and protocols at the application layer, that are used to communicate IoT data across the internet. These are discussed briefly :

a) REST based applications of IoT : Representational State Transfer signifies an architecture, utilized in end-to-end web services applications on the internet, using a client-server model. It is the generalization of HTTP, that is the standard protocol for web-browsing. In the case of HTTP, the client is the browser, and the server is the associated software. An illustration is made in Figure-3.

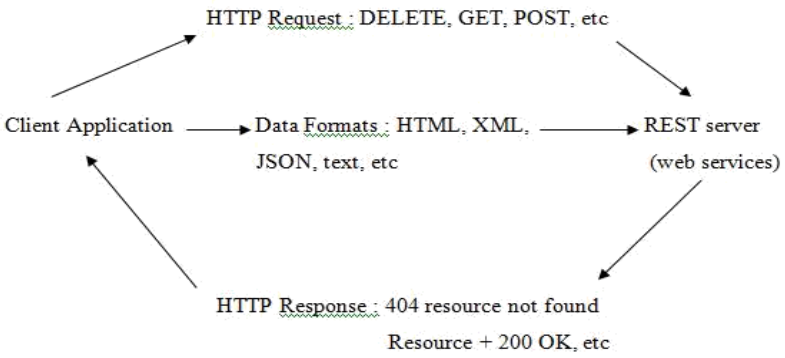

Figure 3 : Web Services Based on REST

b) Publish-Subscribe Middleware for applications of IoT : The applications of IoT are often built using Publish-Subscribe Middleware, like message queue telemetry transport (MQTT), to cater to data emanating from several sensor devices, and are intended for a large number of end consumption points. An illustration is made in Figure-4.

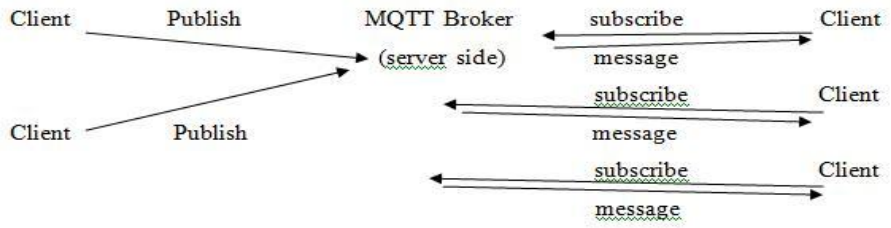

Figure-4 : A Publish-Subscribe Protocol (MQTT)

The end devices, in these protocols, consuming or producing information, act as clients, that connect to a server, acting as a broker of message. Devices, like sensors, that produce information, 'publish' or send messages to the broker on a given topic. Devices could connect to the broker, and 'subscribe' to those topics, if required. Hence each topic could have one or more publishers. Sending streams of messages. So there could be one or more subscribers, receiving those streams.

A few emerging techniques of data analytics and machine learning, being adopted in the recent innovation of entrepreneurship, are being discussed briefly.

a) Representation of data : Sensor data could be represented as text, like Javascript Object Notation (JSON), and data is represented in the form of name-value pairs in a human readable and lightweight format. IoT data is represented in non-human-readable representations of binary, like Concise Binary Object Representation (CBOR).

b) Compression of data : Compression is made due to resource limitation, with respect to bandwidth and storage. Lossless compression is known as 'zip' and is applicable to digital data. Lossy compression is made in the form of Joint Photographic Experts Group (JPEG) that represents images with a tradeoff between the quality of the image and the efficiency of compression.

c) Cleaning of Data : Cleaning is made of raw data that is available for analytics and processing. The emerging techniques are the use of digital filters for de-noising audio data, and interpolation approaches for missing data.

d) Clustering of data and unsupervised machine learning : Some algorithms automatically cluster the data points and detect the categories they fall into. These do not require any human annotation or prior domain knowledge, and the technique is categorized as unsupervised machine learning.

e) Statistical inference and estimation using Bayesian techniques : Certain inferences and estimations based on data-driven observations, could be made using Bayern techniques, for applications, that involve random variables, linked in ways that could be modelled, using conditional probabilities and prior probabilities.

f) Speech processing and natural language : There is advancement in certain features, as text to speech conversion, speech to text recognition and voice imitation that are readily available as offerings from cloud providers, as Amazon, Google and Oracle. Chatbot systems are emerging for automated conversations with humans.

g) Learning reinforcement : The introduction of deep reinforcement learning algorithms, that use neural networks for approximating the optimized high dimensional mapping of states to actions have broad applicability. These systems operate robotics and industrial machinery as well, and also make online decisions in trading. This system is the best hope for the vision of AI for autonomous systems, that operate automatically and adapt to environmental changes.

h) Visualization of data : The visualization of multiple relevant metrics over time, for monitoring and identifying trends, using tools like Grafana, help build dashboards for real-time data. These work in conjunction with the improvement of User Interface/User Experience

(UI/UX) for decision makers and data consumers. The use of increased reality techniques to overlay IoT system inferences and data, from the locations of the data, is another emerging trend.

Summary

When blockchain technologies are utilized for applications of supply-chain management, there is seamless integration with IoT and data analytics. The two examples consider, a) IoT-based Publish-Subscribe systems combination, and b) IoT data decentralization base.

a) IoT based Publish-Subscribe systems combination is implemented by using the client-server approach. Publish and subscribe clients communicate with a broker, hosted on a server. A centralized approach might not be prudent as there could be several IoT and other data streaming devices, deployed in several organizations, and it is essential to share the streams in a trusted manner. The emerging trend is to maintain a consistent state by a consensus process, by the replacement of the single central broker, with a collection of distributed brokers.

b) The emerging trend is the exchange of data between consumers and providers, in a supply-chain consortium, using blockchain technologies. Here, the data might cross the trust boundaries in a seamless fashion. A few elements of IoT data decentralization base include token-curated registries and dynamic pricing. The emerging Streaming Data Payment Protocol (SDPP), as shown in Figure-5, allows the seller and buyer to transact comprehensively over that data, that includes micro-payments using traditional electronic payment rails or cryptocurrencies, allowing Blockchain-based storage of orders, invoices and receipts.

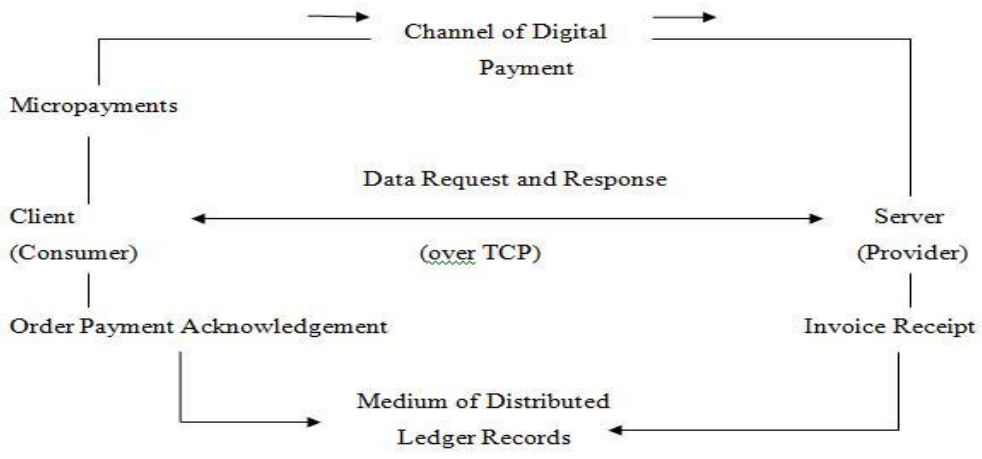

Figure-5 : Streaming Data Payment Protocol

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