eSIM on IoT : An Innovative Approach Towards Connectivity

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Abstract— **This paper consists of a brief introduction about eSIM; the basis on which it is build, its architecture and technologies. This paper covers the use and benefits of eSIM on various levels and its impacts on human life and machines. Today's world is surrounded with AI and IoT. Many IoT devices are everlasting, changing the world of ICT. Hence eSIM can be considered a breakthrough in IoT providing wireless communication between the devices. Major uses of eSIM with respect to IoT are analyzed in this paper. Through this paper we are emphasizing on role of eSIM with IoT and along with exploring various possibilities for revolutionary approach in eSIM Technology.**

Keywords— eSIM, Internet Of Things (IoT) and Artificial Intelligence(AI)

INTRODUCTION TO eSIM TECHNOLOGY

eSIM (also called as eUICC) or embedded SIM is not a traditional SIM card, instead it is programmable SIM card which can be reprogrammed over the air (OTA). eSIM and eUICC together form an architecture which is securely downloaded in the device and is fixed in the device permanently providing the facility of changing the network operator at any instance without physically removing the card. eSIM basically is not tied to a specific Mobile Network Operator(MNO). It is embedded directly in the mobile device and no physical swapping of SIM is required to change the operator [1]. Users can switch between the operators remotely on one device and can have multiple network operators. The eSIM technology can be widely applied to various IoT frameworks. It provides the remote provisioning capabilities. eSIM can be used for both the consumer solution and M2M solution as more compatible devices are entering the market. It is next big thing in the telecommunication world which allows remotely the deployment of network details and connectivity on the phone containing embedded SIM.

eSIM ARCHITECTURE

The eSIM specifications provided by GSMA revolves around elements such as: eUICC (embedded Universal Integrated Circuit Card) and Subscription Management platform.

The subscription Management Platform mainly comprises of: SM-DP(Subscription Manager-Data Preparation) and SM-SR(Subscription Manager-Secure Routing).
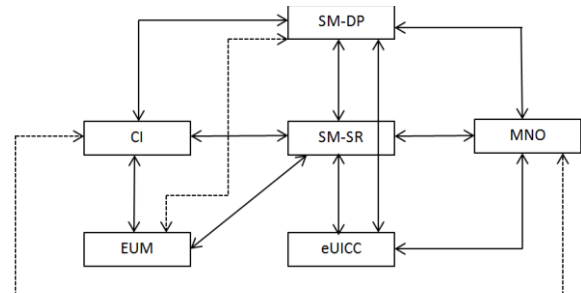

Figure1: eSIM Architecture

- eUICC: eUICC is the next evolutionary step for connectivity of devices. It mainly contains the Subscription Profiles. eUICC is a secure element which enables changing of Subscriptions. This is not easily replaceable or changeable. It covers all the functionalities that were present in the removable SIM.

- SM-DP: The SM-DP (Subscription Manager-Data Preparation) is mainly responsible for securely storing the operator profile and credentials on eUICC. It is provisioned on eUICC for over the air installation of operator profiles.

- SM-SR: The SM-SR (Subscription Manager-Secure Routing) is responsible for managing the SIM once the operator credentials and profile are securely installed. It mainly deletes, enables and disables the credentials whenever necessary. There is sharing of operator profiles between SM-DP and eUICC where the security is maintained by SM-SR.

- EUM (eUICC Manufacturer): EUM is certificate for a single eUICC.

- CI (Certificate Issuer).

CONSUMER eSIM VS. eSIM FOR IoT/M2M

The eSIM is basically designed to improve user experience. The consumer solution began with consumer perspective, where the end user can remotely provision multiple profiles Over the Air (OTA) .This offers customers flexibility of choosing the operators when in different geographical regions. The users or consumers can connect to the network available in that country or area by requesting and downloading the profile details.
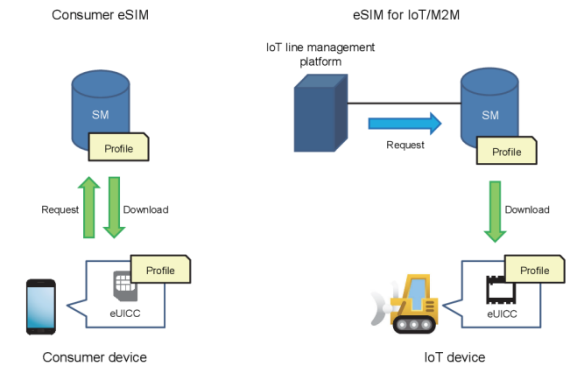

Figure 2: eSIM consumer v/s M2M

Machine-to-Machine (M2M) is a technology that enables machines/devices to communicate with each other without human intervention. This is possible because of several Artificial Intelligence algorithms and Machine Learning. The data that are fetched with the IoT devices are fetched and analyzed with the preexisting data models. After processing, these devices communicate within themselves and make their own autonomous decisions. IoT devices are generally connected through wireless mediums which are prone to any unexpected circumstances like unfavorable weather conditions, network unavailability etc. The incorporation of eSIM with M2M/IoT can help to eliminate these problems. As it will be pre embedded there will be no dependencies on any environmental or other factors as well as no manual human interference.

INTRODUCTION TO IoT.[1]

IoT or Internet of Things is a giant network of connected devices which caught attention these days across industries. The typical motive of IoT is to enhance user experiences in day to day life for common people, industries and enterprises. Any IoT device works basically by creating a digital identity of a device, reading and analyzing data from it and its surroundings. There are some key elements that are responsible for functioning of IoT.

- Sensors and Actuators: These components are responsible for gathering and analyzing information from their surroundings at times. They reside in home appliances, wearables, smartphones, machines, environmental sensors and in a lot of other devices.

- Communication Channel: IoT is a network of devices, to connect these devices and share information between them comes in picture the Communication Channel. This communication channel is responsible to connect the devices and the cloud-based service for frequent processing of information.

- Cloud Storage: Data and information that is gathered from devices are cleansed, combined, stored, transformed and modelled with past existing data. This is where the final processing is done and results are generated for the end user.

- Information Delivery: The last step in this IoT chain is the delivery and consumption of these generated results to the end users or devices, and on the basis of that decisions making takes place.

The characteristics that make IoT different from traditional technologies are listed below:

- Enormous Scale
- Platform Diversity
- Software/ Hardware Interconnection
- Connectivity
- Rate of Changes
- Security
- Privacy
- Analytics Challenges
- Regulation.

eSIM- A GATEWAY OF OPPORTUNITIES IN IoT DEVICES.[2]

Every new origin in technology opens up doors for new opportunities. Here comes the origin of cellular technology with IoT in the form of eSIM. After years of work on cellular IoT, eSIM became live globally. There was a continuous need of scalability in IoT solutions which led to the development of eSIM technology. There exists two major uses of eSIM typically for Consumers and Machines(M2M) both serving "pull" and "push" requests respectively.

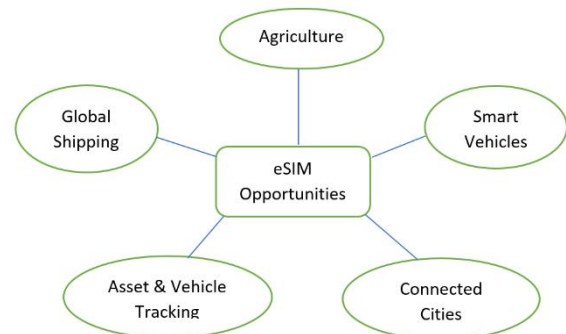IoT Sectors where Opportunities emerged with the help of eSIM.[3]

Figure3: Opportunities in eSIM.

A. Smart Agriculture:

The agriculture industry faces many challenges like scarcity of cultivable land, climate uncertainty, scarcity of water, improper use of fertilizers, uncertainty in availability of

energy and price. To overcome these problems, precision agriculture methodology is adopted which is based on real time monitoring of crops and their predictive models through sensors. With these sensors we can easily determine what kind of crops are to be cultivated at ncertain conditions. As sensors can also determine velocity of wind and its direction, temperature of the environment, solar radiation, amount of moisture in the soil etc. The IoT devices which contains these sensors can be connected with eSIM's which will work on M2M model [4]. A major providers of Precision agriculture solutions are namely, Deere & Company, Trimble, Topcon Positioning Systems and Raven Industries. Other significant vendors include AGCO, Ag Leader Technology, DICKEY-john and Hexagon.[5]

B. Smart Vehicles:

Traditional SIM's are already existing in some vehicles specially cars but there are limitations with respect to many things such as high and low temperatures, exposure to different whether conditions, corrosion issues, friction from engine and road conditions. One more limitation is they can connect to only one network at a time. eSIM's are now utilized in AIS-140 (Automotive Industry Standard) for commercial vehicles This standard provides real time vehicle tracking, camera surveillance, emergency notification buttons, autodetect vehicle health and maintenance monitoring. Currently MG Hector and Hyundai Venue are equipped with eSIM.
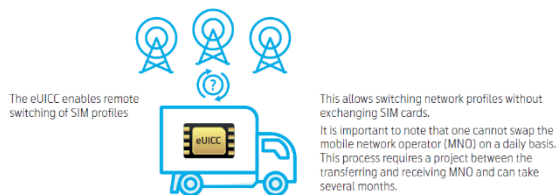

Image Courtesy: Telenor

Today, connected cars are the major place holders of eSIM's. Connectivity in vehicles emerged with emergency calling systems. And now it supports a lot of applications like analytic based solution like controlling temperature inside car, fuel alerts, alternative route navigations, vehicle tracking assistance, security alarm, geofence, speed alert, driving information etc. [6]

Users can now simultaneously use voice and data services, allowing one user to do something online while second user initiates a call to someone. eSIM's have its own unique identity for individual vehicles which helps them to encrypt communication and ensure security in global connectivity for smart vehicle systems.[7]

C. Asset tracking and tracing:

Many heavy machinery manufacturers, construction equipment manufacturers or vehicles manufacturers are connected with other assets globally. They have to perform global operations and distribute their products to geographically dispersed areas anywhere in the world. If traditional provisioning is done for their shipment on cellular networks it can create a lot of business challenges. Some of them are:

- Unknown Asset Destination:
- Complex Logistical Processes
- Regulatory Compilance.

With eSIM solution global manufacturers can use single integrated module to all connected devices without keeping in mind where they are to be deployed. Once that device reaches its destination, according to the carrier profile of that location it can be provisioned. If the device moves to a new destination it can again be re-provisioned using specific locations profile. eSIM provides some benefits such as:

- Optimized Network Connectivity:
- Streamlined Operations
- Enhanced Control

Optimized network connectivity: It enables the organizations to provision the equipment's remotely according to their location and they also take care that they are connected to the optimal reginal network. Along with this they also check whether the equipment is in accordance within country regulatory policies.

Streamlined Operations: This simplifies inventory management, procurement, manufacturing, and logistics processes associated with eSIM with all necessary regional networks.
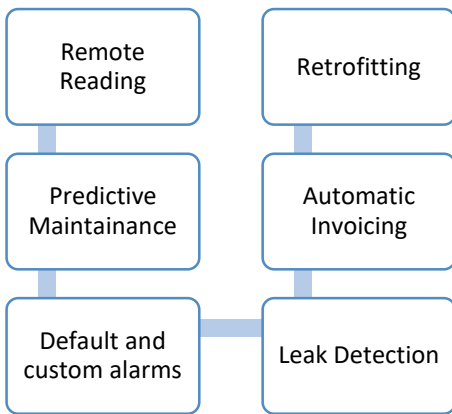
Enhanced Control: It standardize connectivity services that are managed centrally in all geographic regions. It also enables heightened control over networks, resulting in optimizing network availability. [8]

Compared to cell phones SIM cards, IoT eSIM cards are more durable and can withstand adverse weather conditions. They ensure that there is a continous connection between eSIM and the cloud allowing a constant flow of data. While in transit if the assets are damaged or they are in an area with poor coverage, the eSIM will still be capable enough to notify the logistics manager of the situation, with data integrity sustained even when assets are underground.[9]

D. Energy Management:

One of he applications of IoT in energy management is Smart Metering. Smart metering enables remote reading of electricity, gas, water meters etc. Smart meters can reduce operational cost and automate service and network maintenance. The data collected from these smart meters are periodically collected and sent to the IoT cloud platform using standardized protocols.

Benefits of Smart Metering

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- Remote Reading: No manual intervention needed; consumption data can be directly sent to cloud.

- Predictive maintenance: Based on historical data, predictions can be done.

- Default and custom alarms: Several alerts can be generated like over consumption of energy, voltage fluctuations, pressure management etc.

- Leak Detection: It can verify if there is a leak or other infrastructure issues by crosschecking the amount of energy released and energy consumed.

- Automatic Invoicing: Smart metering enables to generate bills on the basis of energy consumption without any human efforts and it is secure.

- Retrofitting: Smart metering can be installed on any preinstalled systems.

If we embed eSIM technology with these smart meters which are currently working on LTE Cat M1 and Narrowband IoT, there will be no dependencies of networking as eSIM technology can directly connect to cloud technologies.[10]

CONCLUSION

Today, in this ever-changing environment of technologies, a major inclination is towards IoT devices. Dependency of connectivity in IoT is majorly ruled by connected network, it may be wired or wireless. Both these type of connectivity dependencies can cover shorter range of connections. We propose if eSIM technology is embedded in every IoT device the major dependency of network will be eliminated. Smart Assistants can eliminate the dependency of WiFi, Smart vehicles can perform diagnostics and manage itself without the need of manual intervention, for connectivity in battery enabled IoT devices continuous power supply is required; which can be omitted if connectivity is provided through eSIM can be eliminated if eSIM is embedded. Therefore, we conclude eSIM technology on IoT devices can turn the tables in terms of connectivity, monitoring, security, traceability, agriculture, smart metering and a lot more.

REFERENCES

[1] eSIM Whitepaper- The what and how of Remote SIM Provisioning, March 2018 https://www.gsma.com/esim/wp-content/uploads/2018/12/esim-whitepaper.pdf

[2] Embedded SIM Remote Provisioning Architecture Version 1.1, 17 December 2013 https://www.gsma.com/iot/wp-content/uploads/2014/01/1.-GSMA-Embedded-SIM-Remote-Provisioning-Architecture-Version-1.1.pdf

[3] K.Makino, D.Kishi, J.Bian - Building GSMA3.1- Compilant eSIM Commercial System for IoT /M2M, NTT DOCOMO Technical Journal, Jul 2018. https://www.nttdocomo.co.jp/english/binary/pdf/corporate/technology /rd/technical_journal/bn/vol20_1/vol20_1_005en.pdf

[4] Whitepaper An Introduction to IoT, Thinxtream https://www.thinxtream.com/whitepapers/thinxtream-introduction-to-iot-wp-001.pdf

[5] M.Sharma - Senior Product Manager, Secure Identity, Arm, eSIM and a trillion device opportunity, June 2019. https://www.arm.com/blogs/blueprint/esim-trillion-device-opportunity

[6] R.Kawamura - Future Of eSIM, August 14, 2019 https://www.soracom.io/blog/the-future-of-esim/

[7] White Paper: Enabling the Smart Agriculture Revolution http://www.libelium.com/white-paper-enabling-the-smart-agriculture-revolution/

[8] F.Stålbrand - M2M/IoT Applications in the Agricultural Industry, Berg Insight. http://www.berginsight.com/ReportPDF/ProductSheet/bi-agriculture-ps.pdf

[9] A.Raheja - Connecting Seamlessly With e-SIMs for Future Mobility,Auto Tech Review, January 2020. https://autotechreview.com/technology/connecting-seamlessly-with-esims

[10] A.Jakhar - All about eSIM, News18 Editor, May 2019. https://www.news18.com/news/auto/connected-cars-with-esim-set-to-jazz-up-your-weekend-road-trips-2131453.html

[11] Unlocking the Hidden Value of eSIM: Emerging Use Cases, Kore Wireless. https://eu.korewireless.com/resources/white-papers/esim-technology-emerging-use-cases/Bigmate-Case-Study-Asset-Management-and-Location-Tracking

[12] How IoT Enables Mobile Asset Tracking Throughout the Supply Chain, Seiraa Wireless Whitepaper http://www.iotforassettracking.com/wp-content/uploads/2018/07/WP_Tracking_180524.pdf

[13] Smart Metering https://www.comarch.com/iot-ecosystem/case-study-smart-metering/

[14] A.Rehak, I.Freire - eSIM Solutions Drive New Opportunities for Global IoT Services, February 2019 https://gsma.force.com/mwcoem/servlet/servlet.FileDownload?file=0 0P1r000026IMF7EAO

[15] P.Sealy -The true value proposition of eSIM, ABI Research, Tata Communicatons, September 2019 https://www.tatacommunications.com/wp-content/uploads/2019/09/The-True-Value-Proposition-of-the-eSIM-3Q-2019-1.pdf

[16] The eUICC Opportunity: How to harness the power of eSIMs in IoT, SIERRA Wireless Whitepaper. https://www.sierrawireless.com/resources/white-paper/euicc/

[17] Understanding the eUICC, Whitepaper, Telenor Connexion. https://www.telenorconnexion.com/