International Conference on Recent Innovations in Science, Agriculture, Engineering and Management
University College of Computer Applications Guru Kashi University, Bathinda, Punjab (India)
20th November 2017, www.conferenceworld.in ISBN: 978-93-86171-80-1

Challenges That Square Measure Round-Faced To Form LTE Network Appropriate For (M2M) Communications

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ABSTRACT

This chapter can describes a number of the challenges that area unit long-faced to form LTE appropriate for Machine-to-machine (M2M) communications. The area is related to It manages a large number of devices, ensuring a very low power consumption low complexity protocols to reduce device costs and expand coverage to facilitate the transmission of a jump. At the other end, being technically possible, any network optimization must be approved by network operators; then, an additional technical-economic outlook is provided during this chapter. Business needs and implications from the combination of traffic (man and machine) will also be aligned, together with the quantification and preparation of value problems as well as the migration options of current solutions.

Keywords: Business roles; Heterogeneous Cellular Networks (HetNet); Low-energy and low-latency devices; technology migration

I. INTRODUCTION

The main objective of this chapter is the challenges associated with supporting M2M communication in LTE, a radio access technology designed to meet mobile broadband demand and initially seems inadequate for M2M communications with a high hardware value as a result of its quality and much more additional information measured than those specified in most M2M applications. On the other hand, 4G coverage is not wide, however, it is offered, unlike the 2G technologies that the unit of area thought of present and universal [1].

In the opposite aspect, technology attributes as greater spectral power will reduce the operator's value in providing services over technologies such as GPRS and UMTS; which could modify low incomes for M2M device units.

In addition, in some industrial segments, the unit area of the device is expected to have a prolonged lifespan of the device, with several devices that can be calculated to remain operational for more than 10 years [2]. In these cases, LTE can be considered a long-term secure alternative. In line with the OCSE [1], the 2G network drive programmed for deactivation within 5 to 15 years, the GSM forwarding modules for M2M solutions may end up in a loss of real estate services only when refocusing Spectrum or if Associate in Nursing the operator decides to

pack a gift box [3, 2]. This chapter is dedicated to gifts and describes the challenges ahead to overcome the efficient support of M2M communication in the LTE network in the technical and commercial field.

II. TECHNICAL CHALLENGES AND EXISTING SOLUTIONS

This section is specialized in technical challenges associated with a significant number of devices, low power consumption, low value LTE M2M devices and a larger coverage that the area unit faces the key challenges that need to be tackled efficiently to support M2M within the LTE System.

1. Handling a really sizable amount of devices

A huge variety of devices area unit foretold to attach to the communication networks within the predictable future, with some forecast predicting figures of fifty billion devices connected by the year 2020 [4]. This figure doesn't even think about the beingness with the present (and future) human users. Such increasing M2M traffic load could result radio network and communication congestion, which is able to inevitably increase delay and packet loss, and moreover, limit the adoption of M2M services within the market. Besides, the standard Human-to-Human (H2H) service is also affected {or even or could be or perhaps} total service outage may happen. Thus the way to support an outsized variety of devices per cell and secure the network handiness could be a key challenge the LTE system has to handle.

Access management is an efficient mean to stop the overload of networks. 3GPP unharness eight mere the Access category riddance (ACB) mechanism to perform access management [5], wherever all users area unit divided into totally different Access categories (AC). Just in case the network suffers overload, the core network will inform the eNodeB to reject some accesses from some categories of users (e.g., those users with low priority requirements). If Associate in Nursing UE intends to access the network, it should initial check if it's barred by the network. If it's not, then is ready to perform the Random Access (RA).

3GPP unharness eleven increased the ACB to a mechanism mentioned as Extended Access riddance (EAB) for M2M. In EAB, once the eNodeB receives the overload notification, it'll broadcast the condition to the M2M devices. In such cases, M2M devices won't access the network till the eNodeB inform that the network is capable to handle M2M requests. Therefore, M2M devices with EAB won't send service requests and even random access requests to the network in distinction to the ACB mechanism. Figure.1 depicts the ACB and EAB in LTE unharness 8 and 11.

 ISBN: 978-93-86171-80-1

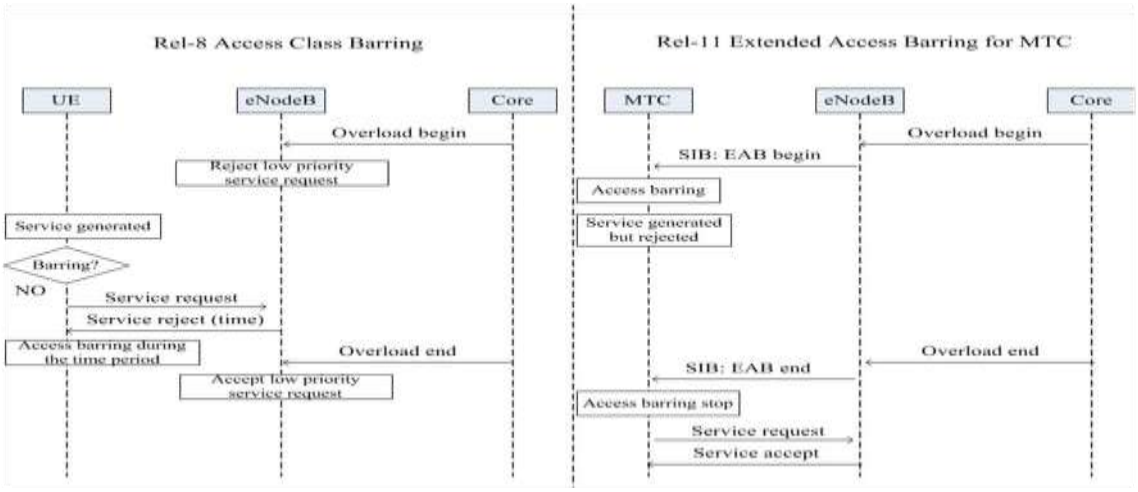

Figure 1: Access management in LTE

In addition to the EAB, alternative ways are known to deal with the Random Access Channel (RACH) congestion [6]: Separate RACH resources for M2M and H2H devices after they be within the same cell, that the congestion incurred by M2M load increase won't have an effect on the standard H2H UEs accesses. Dynamically allot extra RACH resources for the M2M devices within the case that the network will foresee the overload caused by M2M load increase ahead (e.g. within the time-controlled M2M applications).

2. Supporting low energy consumption solutions for M2M

Low energy consumption is often a fascinating demand for battery-operated devices. It's even additional crucial for M2M devices once deployed in sizable amount, in widespread areas than tough maintenance tasks associated with battery exchange or manual recharge. Therefore, high energy potency is another key challenge the LTE system has to deal with. Instead of observation the management channel unendingly, the LTE utilizes the Discontinuous Reception (DRX) theme to change off the UE's radio electronic equipment for an amount of your time, so saving power consumption [7].

3. Supporting terribly low value M2M UEs

Most operators targeting the evolution of networks to long run Evolution (LTE) own legacies like General Packet Radio Service (GPRS) and Universal Mobile Telecommunications System (UMTS) networks. So as to cut back the entire overhead of the networks, they're making an attempt to modify multiple Radio Access Technologies (RAT) into a sole LTE network.

On the opposite facet, the rising M2M is pictured to be the new revenue generation chance for the standard operators, that the 3GPP has already started the study of supporting M2M in LTE system [8]. However, as compared with the promising LTE, gift technologies still hold benefits to support some M2M applications. This can be the case for the low-end M2M, M2M devices supported LTE. Such necessities may be classified into 3 aspects:

The price of low-end M2M devices supported LTE ought to be comparable that of the devices supported the GPRS.

The performance of low-end M2M devices supported LTE ought to be above that of the devices supported the GPRS in terms of information rate, spectrum potency and power consumption.

Identifies the quality simplifying ways which can bring important UE value savings. Such ways include:

Reduction of most information measure :

A traditional UE will support a most information measure of twenty Mc and reducing the most bandwidth will considerably save the UE value consistent with the info collected from totally different firms

Reduction of peak rate:

To support the next peak rate, the UE has to support a bigger most Transport Block Sizes (TBS) for metric capacity unit and UL, a bigger most variety of at the same time assigned Physical Resource Blocks (PRB) or higher modulation orders.

Reduction of transmit power:

A traditional UE has to understand a most transmit power of twenty three dBm that is typically achieved through one more power electronic equipment stage. Thus reducing the output power or perhaps removing the ability electronic equipment stage fully could be a technique to cut back the UE value.

Half duplex operation:

Within the Frequency-division duplexing (FDD) LTE system, a traditional UE will transmit and receive knowledge at the same time that is accomplished by a duplexer.

Reduction of supported downlink transmission modes:

For the LTE metric capacity unit, a Rel-10 UE supports one layer of spatial multiplexing and up to nine varieties of transmission modes. If we have a tendency to scale back the supported transmission modes to the fundamental 2 sorts, we have a tendency to then could take away the reception Reference Signal (DMRS) primarily based channel estimation, the Pre-coding Matrix Indicator (PMI) computation and modify the Multiple Input and Multiple output (MIMO)

4. Providing increased coverage for M2M devices

The quality simplifying ways will facilitate to cut back the value of M2M devices supported LTE, however a number of them, like Single receive RF chain and Reduction of transmit power, can inevitably decrease the coverage of DLs and ULs. Moreover, some machines area unit deployed within the extreme coverage circumstances, like the basements of buildings, wherever the signals can suffer very higher attenuation than the

traditional deployments through the wireless channels. So, the way to improve the coverage in such deployments is another new challenge for the LTE system to with efficiency support the M2M. The study item in LTE Rel-12 [9] conjointly investigates the doable ways to overcome this challenge. Consistent with such characteristics, some coverage improvement ways area unit projected as follows:

HARQ retransmission:

Once the receiver cannot rewrite the received message properly, it'll not discard the message however raise the sender to convey the message once more through the HARQ mechanism. Every retransmission carries a similar knowledge info however perhaps totally different redundancy bits (different redundancy versions), that the receiver will mix {the totally different and the various} version messages from different transmissions to perform decryption incrementally, which is able to improve the chance of

TTI bundling:

UTC Interval (TTI) is that the quantity for the eNodeB to programing the UL and metric capacity unit knowledge transmissions. TTI bundling practicality permits the sender to transmit a similar knowledge through a similar radio resources on the consecutive TTIs, every TTI for one knowledge transmission with totally different redundancy versions.

Repetition:

HARQ retransmission and TTI bundling may be generalized to the repetition, wherever knowledge transmissions may be recurrent on {completely different} TTI or different frequency bands.

RLC sectionation:

The link management (RLC) will segment the massive knowledge packets into smaller packets, and every tiny packet may be coded with low rate or low modulation order. Such low rate transmission may be accustomed improve the resistance to the channel attenuation and also the coverage.

Power boosting / PSD boosting:

Power-boosting technique may be employed by the eNodeB to enhance the ability on the metric capacity unit transmissions to the M2M devices. Moreover, for the eNodeB or UEs with restricted power level,

III. GROUP ACTION M2M TRAFFIC INTO A HUMAN-CENTRIC SYSTEM: A TECHNO-ECONOMIC

Perspective

M2M traffic in essentially heterogeneous and difficult to classify in an exceedingly rough level; for this reason, there'll ne'er be a one-solution-fits-all in M2M and totally different ways ought to be thought-about looking on the service necessities and situations. Considering the ICT historical evolution from the operators' views and their revenues model, there was Associate in nursing early rating strategy for voice communications supported charging per usage.

1.The impact of a bigger variety of devices

M2M communications area unit principally associated to tiny and discontinuous knowledge transmission and predictions agree that it'll represent a density of devices orders of magnitude above H2H communications

[4][10].Besides the air interface optimizations delineated antecedently scalable property and gradable network designs area unit required so as to support the M2M traffic within the network [11].

2. The combination of LTE and capillary networks as a scalable resolution Capillary solutions for M2M seek advice from networks deployed exploitation short-range wireless communication technologies, e.g., ZigBee, WiFi, and Bluetooth. These technologies area unit use in M2M to attach devices in specific deployments. Moreover, Wi-Fi has become a wide adopted technology and also the rising low power solutions will create it appropriate for M2M communications. With IEEE

specializing in the physical and medium access management layer and IETF on the higher layers, however excluding the applying layer. The IEEE standards that area unit thought-about for M2M communications area unit IEEE.

- 802.15.4 (Which is employed by ZigBee), IEEE 802.15.11 (which is employed by WiFi) and IEEE
- 802.15.1 (Which is employed by Bluetooth). The most improvement thought-about in
- 802.15.11 and 802.15.1 is addressing power consumption and resulted in Bluetooth Low Energy, and IEEE 802.11 Low Power. On the opposite hand, IEEE 802.15.4 is split in many versions [12]:
- IEEE 802.15.4e. Extension to the initial IEEE 802.15.4 mackintosh layer, to support industrial applications, e.g. works automation, good buildings;
- IEEE 802.15.4f. Active RFID systems for bi-directional communications;
- IEEE 802.15.4g. Support for good Utility Networks.
- IEEE 802.15.4k. Crucial infrastructure observation and ultra-low power operation.
- IETF's efforts within the space of capillary M2M area unit focused on IETF 6LoWPAN (IPv6 over Low Power Wireless Personal space Networks), IETF ROLL (Routing Over Low power Lossy Networks) and IETF CoRE (Constrained reposeful Environments) [12].

Handling sizable amount of devices within the capillary domain. The IEEE 802.11 and 802.15.4 standards suffer from congestion once the quantity of devices is incredibly high. This can be as a result of the utilization of Carrier Sensing Multiple Access (CSMA) at the Medium Access Layer (MAC) that ends up in terribly unhealthy performance beneath serious traffic hundreds. Therefore, the planning of recent ways in which of handling an excellent variety of concurrent connected devices becomes necessary.

Within the EXALTED project [13], a stimulating resolution has been projected, a M2M entree as part of the LTE spec, that is capable of connecting the capillary networks with the core network. One in every of the clear advantages of those M2M Gateways is to extend the coverage of the wireless network. Associate in Nursing M2M entree has the vital role of facultative the interconnection of network in operation beneath totally different radio technologies.

IV. BUSINESS IMPLICATIONS FOR M2M IN LTE

The low traffic expected to be generated by most M2M devices can inevitably end in very low average revenues per device and also the main revenues area unit expected to come back from the applications ride high of the transmitted knowledge [14]. The main good thing about connected devices is directly associated with seamless

knowledge handiness. Moreover, in M2M applications, shoppers area unit a part of the aftermarket and deliver usage knowledge and feedback to product makers and M2M service suppliers, permitting co-creation of values [15], [16]. Therefore, once {the data and the} represents valuable information and it's processed fitly, it may be exploited as a product.

It ought to be clear at this stage that there'll not be one resolution that matches all the technology necessities obligatory by such a heterogeneous set of devices [1]. Following a similar reasoning, each the technology and economic development of M2M communications would force a fancy set of schools that area unit unlikely to be lined by one single player within the trade. As mentioned in section eight.3.3, totally different players area unit pushing their read and solutions so as to position themselves within the market [17]. Additional significantly, new players also are getting into the market and positioning themselves within the M2M system.

1. Is there a requirement for an amendment in operators' mindset?

Previous studies (presented in [18] and [19]) examined totally different cases associated with M2M-related services within the market. Findings show however it's less complicated to research the values and advantages of isolated solutions however additional significantly, it's highlighted however the implementation of fortunate services continuously incur in radical changes from ancient business thinking. Particularly in term of property services, since telecommunication suppliers couldn't realize a possible structure to come up with price from the M2M service. Therefore, various relation emerged within the market so as to with success give the services. In most cases, M2M solutions supported mobile communication area unit hampered as a result of the shortage of a correct M2M business model, since the normal vision for MNOs relies on a provider-consumer perspective just like the one shown at the left on Figure 1 (a).

M2M services area unit provided in an exceedingly advanced constellation of players and also the finish shopper isn't concerned in an exceedingly direct interaction with MNOs. The M2M system tends to be additional alike to the one shown on Figure 1 (b).

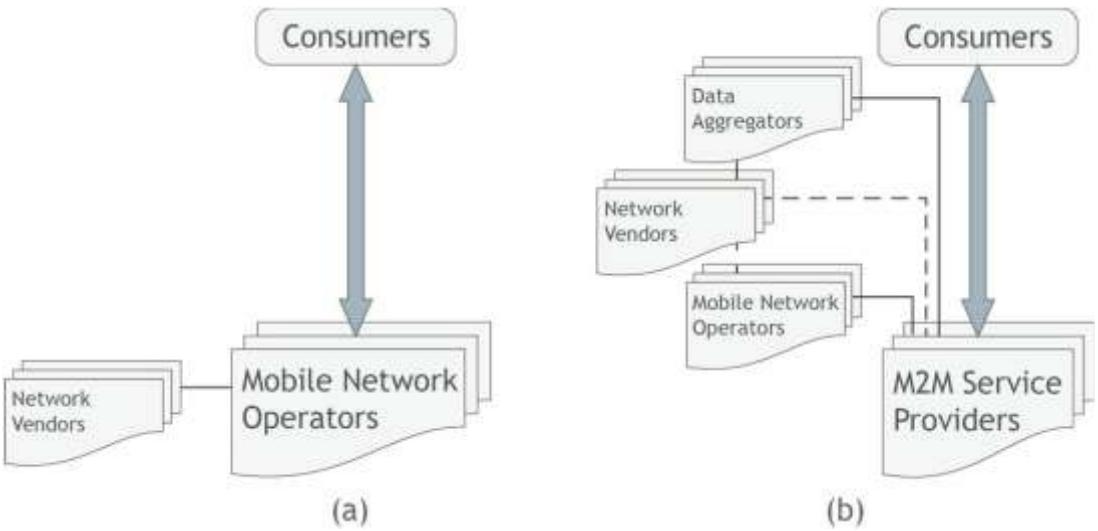

Figure 1: amendment within the position of players and also the direct relation with end-consumers.

2. The connection between business challenges and engineers

Business studies on M2M have a powerful specialize in the analysis of the roles for incumbent and new actors required so as to set-up and manage M2M services and, additional significantly, that area unit the key values that generate profits for the various stakeholders concerned in every application. There are a unit key challenges that also have to be compelled to be addressed for M2M within the business domain, as recognized by the OECD report [1]. as an example, system and network architectures projected for M2M seldom think about the role and market power of existent player within the M2M system that would definitively have an effect on the choice creating and future trends.

Specific M2M applications may be with success deployed once their price is evident and also the business thinking is customized to the new market perspective. However the combination of solutions Associate in Nursingd large-scale application stay as an open analysis challenges.

Two key challenges that directly limit any technical resolution for M2M may be highlighted at this stage:

- It is tough to alter the position of ancient players that have important market power.
- Some industrial sectors area unit dominated by players that area unit use to own the management position.

The challenge associated with the amendment of position, there are a unit lessons to be learned by engineering firms that manage to require new positions within the market. The case refers to Ericsson, originally a network vendors, that's currently succeeding in their strategic move toward support of services primarily based con connected devices. A superb example is that the “Connected Vehicle” case, given in [28], it describes the partnership between the automaker Volvo and Ericsson and it shows the new other price that concerned totally different business thinking. The answer has the subsequent price proposition:

- The automaker are able to supply price other services either themselves or through third-party actors. Moreover they will gather valuable knowledge on the operation of the automobile, which is able to improve maintenance and spare components management.
- The drivers gain access to new vary of applications and services.
- Third-party actors have one channel to achieve the end-users.

Ericsson, UN agency originally primarily based their engineering business on commercialism network instrumentality to MNOs, has began to expand the set of activities Associate in Nursing offers managed solutions to industrial actors curious about solutions supported M2M; providing an M2M service platform, on that the automaker builds its services. In figure 2, it's shown the amendment of position achieved by Ericsson, that was historically position solely as a network vendors, following the outline pictured in Figure 1 (a) and (b).

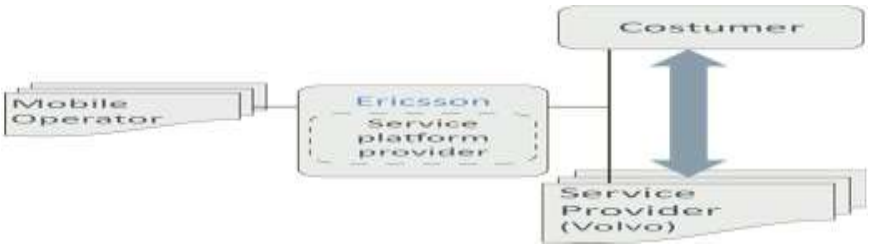

Figure 2: Redefined position for M2M service giving

3. Business models choices for M2M

It is united that M2M can expand the business potentialities in many industries, permitting new business model opportunities to require place; because it is declared on the OECD report [20], some samples of this new business models might be: Pay as you drive insurance. Permit charging drivers supported distances, location and behavior. This might considerably scale back the value associated to the insurance fee. Products as services. As explained within the report, there are a unit already firms providing lightweight as a service (charging per lumen) or energy-saving, that charging consistent with the saving they generate. It's expected that M2M solutions use this kind of business model to an outsized extend.

Nevertheless, process effective business models for M2M in several trade sectors could be a tough drawback that has not been solved within the market nonetheless [20]. In addition, M2M services area The M2M case is entirely totally different, since the agreements area unit reached between MNOs and M2M service suppliers that got to manage massive teams of devices with restricted resources. International organizations just like the 3GPP, ETSI and OECD have.

V. CONCLUSIONS

Through this chapter, technical and business aspects associated with M2M support communication on LTE networks was delineated , highlight the present it works and describes the various alternatives that are presently below consideration each within the educational world and within the industrial sector. A number of these alternatives are summarized below:

- Tiny cells could also be the most affordable in ultra-dense scenarios. However there's a general reluctance on the part of several MNOs to implement small cells or internal solutions
- The role of mobile operators isn't continuously fastened and lots of times replaceable; the emergence of "independent" internal network operators. In addition, NVs are a robust force within the market, ready to handle the device property.
- Intermediate actors have a powerful position, management the service platform and have relationships with finish users and repair suppliers.

M2M deals with communications-based services, not communication services. The heterogeneousness of the solutions interprets into a fancy scheme concerned many further players act dynamically with MNO.

In addition, the present understanding of the market is that MNO won't lead M2M scheme, however rather support the event of the answer.

VI. ACKNOWLEDGMENTS

The authors need to tell anonymous reviewers of their valuable comments and suggestions that have greatly improved the standard of the paper.

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