# THE MARKET POTENTIAL OF M2M COMMUNICATIONS FOR TELECOMMUNICATIONS OPERATORS

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**Abstract:** M2M (Machine-to-Machine) communication represents the exchange of data between remote devices using wired and/or wireless communication network for telemetry and remote control. M2M services provide exchange of information without human intervention, thus making it possible to reduce costs, improve efficiency and reduce risk. Predictions show that M2M communication is having accelerated development and long-term growth prospects. Great application of M2M services is visible in the field of Inteligent transportation systems (ITS) through segments such as traffic management, navigation of traffic, the impact of traffic on the environment, cargo management and logistics and traffic safety. Technological progress and potential of M2M services represents a significant opportunity in revenue growth for telecommunication operators. Accordingly, logical is the fact that telecommunications operators are introducing new tariff models that are aligned with specificities of M2M communication.

**Keywords**: M2M, ITS, Telecommunication operator, Tariffs

## 1. Introduction

The use of new communication services entails a series of changes that affect all segments of the value chain of precisely these services. M2M communication represents a new challenge and a great opportunity in a variety of application areas such as intelligent transport systems, with a tendency of significant growth. One of the segments of the value chain of M2M services represent telecommunication operators. Given the nature of M2M communication and the trends of its greater use, it is necessary adjustment to these services for all segments involved in the chain, primarily by telecom operators. Potential, which is visible in the M2M communication, refers mostly to the increasing amount of traffic and the number of devices that are becoming part of the system. Since telecom operators have seen their ability to earn and business improvement through M2M communication services, it is not surprising that there are visible changes in the offer of tariff models. Given the specificity of M2M communication it is given an adaptation of tariff models, in order to increase the use of M2M communication and creation of additional profit.

## 2. Machine-to-Machine (M2M) communication

Machine-to-Machine (M2M) communication is a form of communication that involves one or more entities that do not necessarily require human interaction or intervention in the communication process. M2M communication can take place via a mobile network, such as GSM or UMTS. In M2M communication the role of mobile network is largely determined as a transport network service.

M2M communication is different from the current communication models in the ways that it includes (Government of India, 2011):

- lower costs and effort,
- a potentially very large number of communicationg terminals,
- little traffic per terminal, in general
- new or different market scenarios

There are four basic stages that are common to just about every M2M application. Those components are (M2M Communications, 2012):

1. Collection of data
2. Transmission of selected data through a communication network
3. Assessment of the data
4. Response to the available information

Data collection begins with downloading data from the device, so these data can be analyzed and sent through a network.

As for the data transmission through a communication network, there are multiple options for data transmission from the remote device to the center of the network; like mobile communication networks, fixed communication networks, satellite communications etc., and they all are common solutions.

M2M communication is based on the idea that machines are more valuable when they are networked and network becomes more valuable with addition of more machines to it. In order to implement M2M system it is necessary to combine a variety of electronic, communications and software technologies.

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### 2.1. Elements of M2M architecture

Architecture of M2M communication system consists of:

- M2M Device
- M2M Access network
- M2M Gateway
- M2M Core Network
- M2M Applications

M2M Device is a device capable of replying to request for data contained within those devices or capable of transmitting data autonomously. Sensors and communication devices are the endpoints of M2M applications. M2M Access network provides connectivity between M2M devices and M2M Gateways. M2M Gateway is a equipment that uses M2M capabilities to ensure M2M devices inter-working and interconnection to the communication network. Gateways and routers are the endpoints of the operator's network in scenarios where sensors and M2M devices do not connect directly to the network. M2M Core Network covers the communications between the M2M Gateway(s) and M2M Application(s), and includes technologies like Digital Subscriber Line (xDSL), Long Term Evolution (LTE), WiMAX, WLAN etc. M2M Applications can be targeted to end-users or service providers which may arise sophisticated M2M solutions and services. Such services can be designed and offered by the service provider, but also they may be offered by telecommunications operator through its independent platform (Fig. 1).

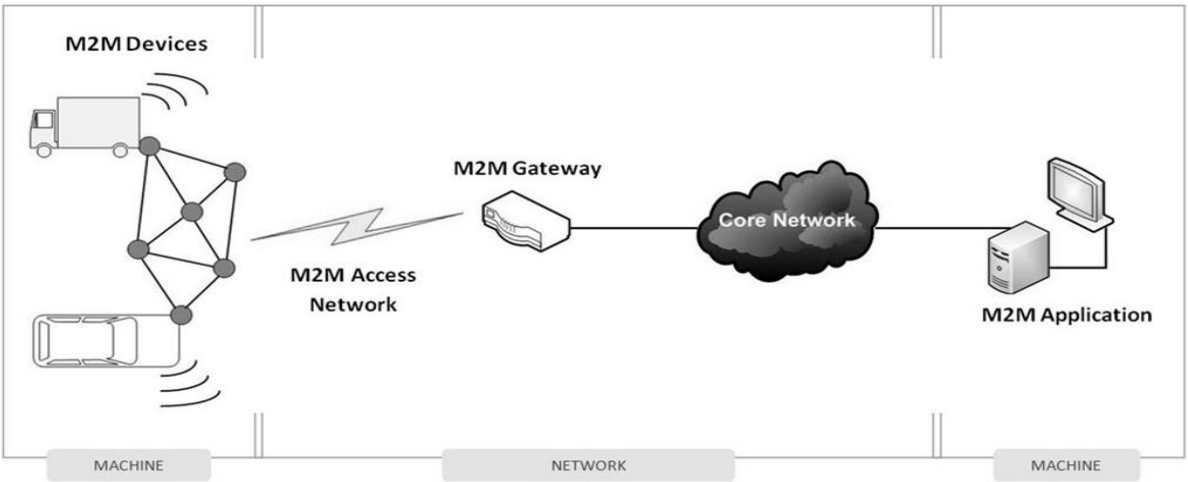


**Fig. 1.** *M2M communication system architecture*

### 2.2. Key features of M2M communication

The most important features of M2M communication system are (Government of India, 2011):

- Time controlled – send or receive data only at certain pre-defined periods
- Low mobility – M2M Devices do not move, move infrequently, or move only within a certain region
- Time Tolerant – data transfer can be delayed
- Packet Switched – network operator to provide packet switched service
- Online small Data Transmissions – MTM Devices frequently send or receive small amounts of data.
- Location Specific Trigger – intending to trigger M2M device in a particular area (e.g. wake up the device)
- Monitoring – not intend to prevent theft or vandalism but provide functionality to detect the events
- Low Power Consumption – to improve the ability of the system to efficiently service M2M applications

M2M solutions are typically developed for sending indications of unusual situations, collecting information or setting parameters according to business needs. New M2M applications are contionuously emerging to serve rather comprehensively all business areas – monitoring elevators in shopping centres, downloading new games into amusement machines, checking the temperature of swimming pools, locating trucks on the highways, tracking the use of office photocopiers, etc. (Table 1) (Nokia Corporation, 2004).

**Table 1**
*Application examples of M2M communication*

| Sector | Example applications | Effects |
|---|---|---|
| Smart buildings | Automated monitoring of heating, ventilation and cooling | Reduced energy costs |
| Smart cities | Street lights that dim when roads are empty | Cost savings |
| Automotive | Emergency calling and accident alerts | Regulatory reqiurements |
| Consumer electronics | Connected satelite navigation devices to monitor traffic jams | Product inovation |
| Health | Remote monitoring of patients and personal health monitoring | Cheaper, home-based care |
| Transport and logistics | Fleet optimisation and supply-chain tracking and tracing | Cost savings |
| Emergency services and national security | Disaster response and critical infrastructure protection | Proactive maintenance |
| Retail | Wireless payments | Retail inovation |

*Source: Machina Research; Economist Intelligence Unit.*

## 3. Trends in M2M services

With a potential market of probably 50 million connected devices, M2M offers tremendous opportunities as well as unique challenges. These devices vary from highly-mobile vehicles communicating in real-time, to immobile meter-reading appliances that send small amounts of data sporadically (Government of India, 2011).

From the perspective of telecom operators, M2M communication solutions meet customer needs for IT applications in processes of monitoring, controlling, planning, remote measuring, collecting data and remote diagnostics of the data. M2M traffic growth trends have strong growth, with increasing annual growth.

Globally, M2M traffic will increase 22-fold between the 2011 and 2016, and the amount of M2M traffic in 2016 will be 508 petabytes per month (Fig. 2).

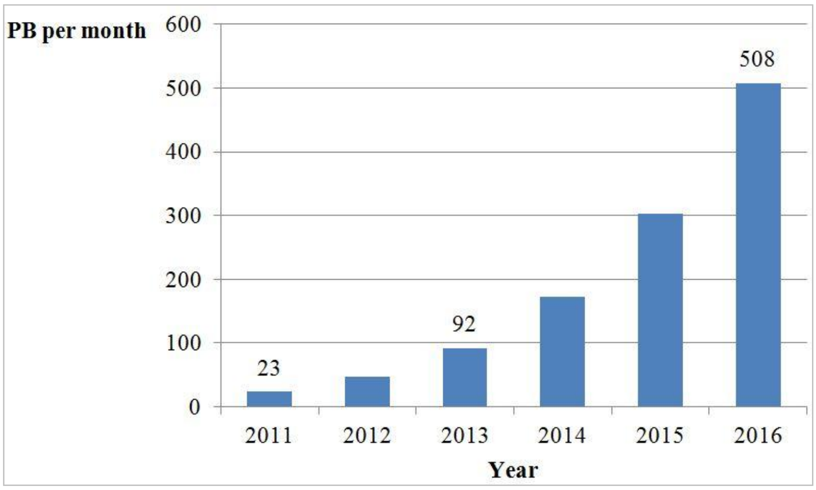


**Fig. 2.**
*M2M traffic growth between 2011 and 2016*
*Source: Cisco VNI Mobile, 2012*

Compound Annual Growth Rate (CAGR) of M2M mobile data traffic between 2011 and 2016 will be 86%, while the increase in the number of M2M devices at the same period will be 42% (Table 2).

**Table 2**
*Comparison of Global Device Unit Growth and Global Mobile Data Traffic Growth*

| Device | Growth in users, 2011-2016 CAGR[1] | Growth in Mobile Data Traffic, 2011-2016 CAGR |
|---|---|---|
| M2M module | 42% | 86% |

*Source: Cisco VNI Mobile, 2012*

[1] Compound Annual Growth Rate

M2M communication represents a significant and growing opportunity for telecom operators to increase their revenue. Technological progress and the potential of M2M applications across numerous markets will bring a huge number of transactions. Investing in M2M communication is the key of further success of telecom operators.

Some of the opportunities of M2M communication that telecom operators can take advantage are:
- New revenue stream
- Ensuring customer satisfaction
- Improving the use of the existing infrastructure
- Inovative user's terminal equipment
- Increase in the number of users

**4. M2M and Intelligent Transportation Systems**

One of the functions of Intelligent Transportation Systems is to optimize the flow of vehicles and their cargo, streamline their management and reduce costs, and with potential dependence of intelligent M2M communication. M2M technology has the potential to improve transport systems in five major areas: traffic management, navigation of traffic, the impact of traffic on the environment, cargo management and logistics and traffic safety. This offers convenience, simplicity and safety of Intelligent Transportation System that provides real-time information, such as the weather and road conditions and automatically warns travelers to hazards such as slippery roads or accidents (Fig. 3).

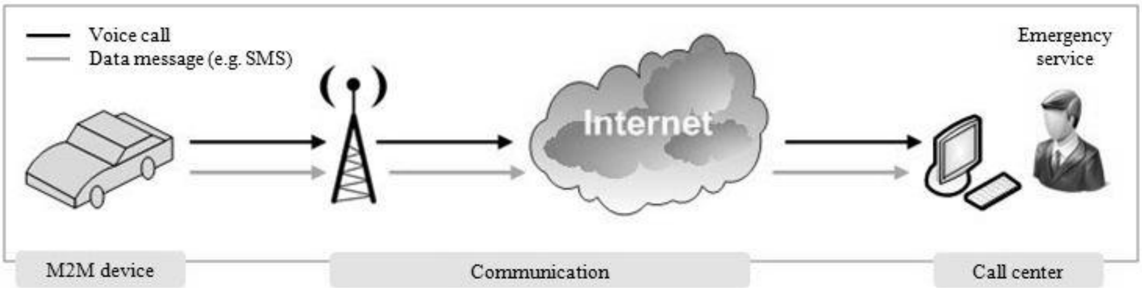


**Fig. 3.**
*Architecture of an emergency call system*

Governments, car manufactures and consumers are realizing that wireless technology holds the key to changing travel lifestyles and cleaning up, greening up and optimizing modern transportation systems. Of course, machine-to-machine vehicle telematics on its own cannot fully mitigate the global challenges of automotive traffic. Wireless Intelligent Transportation Systems (ITS) work in conjunction with telematics transmitting real-time data about traffic and the environment (i.e. the networked interconnection of cars, busses, traffic lights, roads with embedded sensors and emergency road crews) (Cinterion, 2012).

The role of M2M communication in vehicle telematics and applications is evident through (Smith, 2012):
- Stolen vehicle tracking (theft protection)
- Remote ignition disablement
- In-vehicle emergency call services
- Live traffic reporting and rerouting around road congestion
- Fleet management
- Cargo monitoring
- Remote diagnostics and maintenance
- Onboard entertainment

The automotive sector represents one of the greatest opportunities for machine-to-machine. From less than 90 million connections globally in 2010 the automotive M2M market will grow to almost 1.4 billion connections by the end of 2020 (Fig. 4). There are numerous vehicle-related applications that would benefit from being connected. By 2020 the emergency assistance device will be the dominant type of M2M connection (Machina Research, 2011).

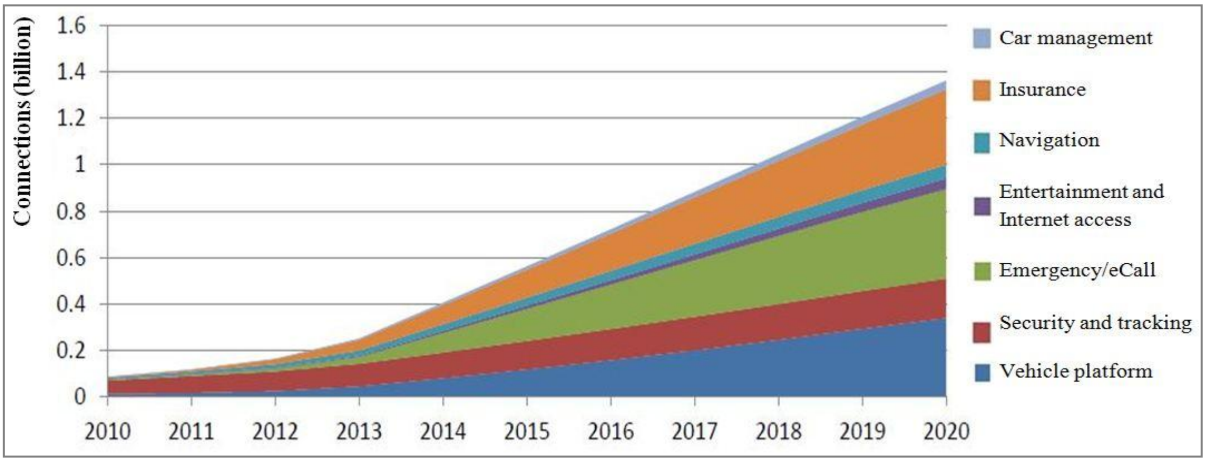


**Fig. 4.**
*Global automotive M2M connections 2010 – 2020*
*Source: Machina Research, 2011*

## 5. Tariff systems

### 5.1 The structure of the tariff models

M2M market requires a completely different structure of tariff models in relation to any of the traditional models, for either residential or business customers, and telecommunication operators yet need to respond to this kind of requests by offering new tariff M2M models. In Republic of Croatia existing operators (T-Mobile and Vipnet) offer four tariff models related to M2M communication. As already mentioned, only two operators in Republic of Croatia offer packages for M2M communication as a part of tariff models for business users. Basic packages are (at the time of writing paper): M2M Total (T-mobile), M2M Ideal (T-mobile), Data Profi (Vipnet) and Smart Data (Vipnet). It is possible, in particular packages, to activate various options like cheaper communication while roaming, data transfer etc. Also, as with the tariff models for residential users, there are two types, depending on the method of payment: proactive and retroactive payment.

When talking about the structure of the tariff models, an important factor are the services for which the user is required to pay. For example, for the package for residential users of mobile communication network, there are three basic services: calls, messages and data. In M2M communication core services are: transfer of data (service that involves the transmission of data using GPRS/EDGE/UMTS/HSDPA technology), messages (textual and multimedia, i.e. SMS and MMS), data calls (Circuit Switched Data Call, CSD), fax messages and voice services (optional).

### 5.2 Creating a mathematical model

Getting insight to the M2M communication services, it can be concluded that there is a whole range of factors that can affect the final cost. Based on this, it is necessary to measure some sort of quantification of the total cost of ownership, called TCO (Total Cost of Ownership). The main factors that largely affect the costs are:

a) Call (data and voice) and call billing unit
b) Messages
c) Data Transfer
d) The amount of the monthly subscription

The basic model for calculating the cost of ownership for a specific period *t* in months of use is (Eq. (1)):

$$\text{Total Cost of Ownership (t)} = (\text{Average monthly fee} + \text{Average cost of data transfer} + \text{Average cost of data calls} + \text{Average cost of messages} + \text{Average cost of voice calls}) \cdot t \qquad (1)$$

The mathematical model includes only the retroactive tariff models. As the cost of data transfer depends on the quantity and price (per data unit) of transferred data, a cost of data calls depends on the duration of CSD calls, time required to send fax messages and price (per time unit), the cost of messages depends on the number of messages and the cost of messages (per message) and the cost of voice calls depends on the duration of the call, the price of one call (per time unit), the number of calls and call set-up fee, it can be easier to write (Eq. (2)):

$$TCO\ (t) = (M + TC_{DATA\text{-}TRANSFER} + TC_{DATA\text{-}CALLS} + TC_{MESSAGES} + TC_{VOICE\text{-}CALLS}) \cdot t \qquad (2)$$

Where it is:

TCO ≡ Total Cost of Ownership [KUNA]
M ≡ The amount of monthly fee [KUNA]
TC ≡ Total cost for a particular service
t ≡ Time period [months]

It should be mentioned that the above model is valid only for national traffic.

The formula for calculating the cost of data transfer (Eq. (3)):

$$TC_{DATA\text{-}TRANSFER} = N_{DATA\text{-}TRANSFER} \cdot R_{DATA\text{-}TRANSFER} \tag{3}$$

Where it is:

$N_{DATA\text{-}TRANSFER}$ ≡ Amount of data transferred (Data unit - MB)
$R_{DATA\text{-}TRANSFER}$ ≡ Price of transferred data [KUNA/MB]

If there is a certain amount that is subsidized, it enters into a monthly package, the following is valid (Eq. (4)):

$$TC_{DATA\text{-}TRANSFER} = (N_{DATA\text{-}TRANSFER} - N_{DATA\text{-}TRANSFER\ \text{-}SUB}) \cdot R_{PP} \tag{4}$$

Where already existing labels are valid and $N_{DATA\text{-}TRANSFER\ \text{-}SUB}$ denotes the number of subsidized units of information. The expression in brackets is used for checking whether the subsidized amount was spent.

Cost of data calls is calculated by the formula (Eq. (5)):

$$TC_{DATA-CALLS} = TC_{FAX} + TC_{CSD} \tag{5}$$

Where it is:

$TC_{FAX}$ ≡ Cost of fax calls [KUNA]
$TC_{CSD}$ ≡ Cost of data calls (Circuit Switched Data Call) [KUNA]

Cost of fax traffic is (Eq. (6)):

$$TC_{FAX} = T_{FAX} \cdot (1+y) \cdot R_{FAX} \tag{6}$$

Where it is:

$T_{FAX}$ ≡ Duration of all fax calls [min]
y ≡ Average increase of duration of fax calls depending on the billing unit
$R_{FAX}$ ≡ Price of one fax call [KUNA/min]

Regarding the calculation of the cost for data calls, the formula is similar as for calculating the cost of fax traffic, but different access numbers for achieving CSD connection and different pricing should be taken into account, i.e. the price depending on the number which is dialled, e.g. if access number of the parent operator has been dialled, then one price is valid, and in case of dialling another operator, another prices are valid (this is the case of so-called selective billing). Therefore, it is necessary to introduce the concept of zones[1]. Let *m* be the total number of *zones*, then the following applies (Eq. (7)):

$$\sum_{k=1}^{m} \quad = \quad (T_{CSD} \cdot X_k \cdot (1 + y) \cdot R_{CSD\text{-}k}) \tag{7}$$

Where it is:

$T_{CSD\text{-}k}$ ≡ Length of CSD calls to the zone [min]
$X_k$ ≡ Proportion of calls to a particular zone
y ≡ Average increase in the CSD call duration depending on the billing
$R_{CSD\text{-}k}$ ≡ Price of CSD calls for zone k [KUNA/min]
m ≡ Total number of zones

The cost of messaging consists of two parts: the cost of text messages (SMS) and the cost of multimedia messaging service (MMS) (Eq. (8)):

$$TC_{MESSAGES} = TC_{SMS} + TC_{MMS} \tag{8}$$

[1] The term zone is used for a call destination - a specific network, networks, or even an individual user for whom selective billing and various benefits when making calls to a particular zone are valid.

Where it is:

$TC_{SMS}$ ≡ Cost of text messages (KUNA)
$TC_{MMS}$ ≡ Cost of multimedia messages (KUNA)

The cost of the text messages and multimedia messages is calculated using the following formulas (Eq. (9) and Eq. (10)):

$$TC_{SMS} = N_{SMS} \cdot R_{SMS} \quad (9)$$

$$TC_{MMS} = N_{MMS} \cdot R_{MMS} \quad (10)$$

Where it is:

$N_{SMS}$ ≡ Number of sent SMS messages
$R_{SMS}$ ≡ Price of text message [KUNA/message]
$N_{MMS}$ ≡ Number of sent MMS messages
$R_{MMS}$ ≡ Price of multimedia message [KUNA/message]

If there is certain number of text messages, which is subsidized, that enters into a monthly package, then the following is valid (Eq. (11)):

$$TC_{SMS} = (N_{SMS} - N_{SMS\text{-}SUB}) \cdot R_{SMS} \quad (11)$$

The cost of voice calls is optional for certain models and several factors should be taken into account: the price of calls (may vary for calls made towards certain operators or individual users. If this is the case, the so-called zones should be introduced), call duration, billing unit, the number of calls and the fee for setting up a call.
Taking into account the specified items, the cost of voice calls can be calculated by the following formula (Eq. (12)):

$$TC_{VO}\sum_{k=1}^{m}{}_{LLS} = \quad T_{VOICE\text{-}CALLS} \cdot X_k \cdot (1 + y) \cdot R_{VOICE\text{-}CALLS\text{-}k} + N_{VOICE\text{-}CALL} \cdot F \quad (12)$$

Where it is:

$T_{VOICE\text{-}CALLS}$ ≡ Duration of all calls [min]
$X_k$ ≡ Proportion of calls to a particular zone
y ≡ Average increase in call duration depending on the billing
$R_{VOICE\text{-}CALLS\text{-}k}$ ≡ Call price per minute for a given zone (KUNA/min)
$N_{VOICE\text{-}CALLS}$ ≡ Number of calls
F ≡ Set-up call fee
m ≡ Total number of zones

When calculating the cost of voice calls, data calls and fax messaging, it is necessary to take into account the amount of the call billing unit – $T_{OBR}$. An amount of billing unit may directly affect the actual time that is used for billing and calculation of call cost. If the billing unit is greater than one second, actual call duration gets increased for a certain amount that is equal to the billing unit's remaining time, in which the current call has stepped into (i.e. it has finished).

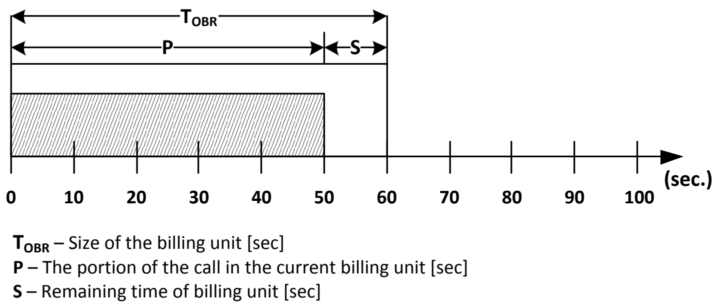


**Fig. 5.**
*Call billing unit*

According to Fig. 5 there are three variables (size of the billing unit – $T_{OBR}$, the proportion of the call in the current billing unit – P, the remaining time of billing unit – S) and every call's duration P gets increased by S.

## 6. Conclusion

M2M communication systems opens up new and great opportunities for telecommunication operators. Wholesale market and easy implementation of such services is a major factor in their significant growth. M2M communication can be utilized in various fields, and especially in the field of intelligent transportation systems, offering additional features and improvements to existing systems. The fact that M2M communication system in their work does not require human intervention allows it to work every day without stopping. This means that this system allows generating traffic all day, therefore it is not surprising such a large growth of M2M traffic. In all of that essential is adaptation of telecommunication operators to new services and tariff plans. Improved tariff models provide new market opportunities and increase the number of users and their satisfaction. M2M communication systems and services enable the increase of customer satisfaction as well as satisfaction of telecommunication operators. Users often receive a quality service that ensures their needs, while telecommunication operators are increasing their profits thanks to the increasing number of users and devices.

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