AT&T Comments for BEREC M2M Project Team | June 2014

Introduction

Albeit at an early stage of development, machine-to-machine (M2M) communications (typically wireless) have already demonstrated the potential to massively improve efficiency, productivity and social welfare in fields as diverse as education, healthcare, transportation, energy, security, and agriculture. And M2M solutions not only create social welfare benefits within a given country, but can create economic benefits to that country's industry at large, by, for example, enabling manufacturers to have success with exports to world markets. Cisco, one of the major participants in the M2M arena, estimates that the Internet of Things (IoT) will create up to 14 trillion dollars in turnover opportunities over the next decade.[1] Therefore, in countries with regulatory policies that encourage new M2M technologies and business models, the IoT is poised to deliver significant economic and social benefits. Notably, supportive M2M policies must be based on the premise that the new business models for the IoT differ greatly from the traditional business models that have supported the cellphone and tablet industry segments in the past.

The new business models vary both in terms of the nature of the wireless connectivity provided to the end user, and the economics of providing that connectivity. For example, with most M2M devices, mobile network operators (MNOs) do not provide a communications service directly to individual end users. Rather, MNOs provide wireless connectivity to the providers of M2M devices, who distribute wirelessly-enabled products and services to end users. In turn, typically the M2M device provider does not consider itself a provider of traditional communications services. Instead, the M2M device provider manufactures a device that performs a specific function enhanced via the integration of wireless connectivity. For instance, an M2M-enabled smart meter fundamentally measures electricity usage; the M2M enhancement allows the near real-time transmission of that usage information to the electric utility company.

Because the M2M device provider usually does not provide a separate communications service to the end user, the provider generally does not charge the end user for a communications service. Rather, data transport is merely an ancillary component, not a principal feature, of the overall product or service (*e.g.*, data analytics, fleet management) sold to the end user customer. Therefore, in the M2M environment, economies of scale are essential:

- Compared to cellphones and tablets, M2M devices typically have low data consumption and very low average revenue per user (ARPU) (*e.g.*, a smart meter sending a few hundred bytes of data per day vs. a smartphone or tablet consuming tens of megabytes).

[1] J. Bradley/J. Barbier/D. Handler, *Embracing the Internet of Everything to Capture Your Share of $14.4 Trillion*, Cisco, 2013, at page 6. *See* http://www.cisco.com/web/about/ac79/innov/IoE.html. Note: in its latest Visual Networking Index, Cisco reported that there will be "7.3 billion M2M connections globally, or nearly one M2M connection per capita, based on a 7.6 billon population by 2018." *See* http://www.nasdaq.com/press-release/cisco-visual-networking-index-predicts-global-ip-traffic-to-grow-nearly-threefold-reaching-16-20140610-00298

- M2M device manufacturers typically do not sell, or charge end users separately, for wireless connectivity. Instead, wireless connectivity is often included in the overall price of the M2M solution.
- Because their devices usually have very low ARPUs, M2M device manufacturers are *extremely sensitive* to development and deployment input costs.
- To efficiently amortize their costs, M2M device manufacturers tend to develop standardized products with long useful lives that can be sold in significant volumes across many countries.
- In sum, to be economically viable, M2M device manufacturers must be able to "build it once, sell it everywhere."

AT&T is pleased to provide the following comments of the topics of interest identified by the BEREC M2M Project Team.

Topics for Discussion

1. The distinctive M2M features which assume greater importance from the point of view of the regulation.

Some of the major features that should inform regulatory policy towards M2M communications include:

a) **SIM** (*e.g.*, models, ownership, transferability): The truly global nature of M2M communications requires the use of an appropriate SIM solution. There are many such solutions, including the "global" SIM (*i.e.*, an International Mobile Subscriber Identity (IMSI) that works anywhere in the world based on roaming), a "local" IMSI (programmed according to the device's home country, but also requires individual local agreements per roaming country), and a shared Mobile Country Code (MCC) (901) or new 90X code exclusively for M2M services. There are also various M2M services for which a third-party M2M service provider may need to procure a SIM card or bandwidth from a telecom operator. Thus, the issue needs to be approached with a fresh view and from a market-appropriate perspective. (*See* Topic for Discussion 4, *The introduction of the so-called soft SIM*, and Topic for Discussion 5, *Potential problems related to the availability of resources in the medium to long term with regards to numbering*.)

b) **M2M Roaming**: Historically, MNOs have supported their customers' international wireless connectivity through roaming agreements with MNOs in other countries. To facilitate the adoption of these types of international roaming arrangements as a commercial matter, the wireless industry's leading trade association, the GSM Association (GSMA) has developed a series of roaming contract templates. These roaming templates, which are available for use by GSMA's 800+ members, contain common industry-accepted terms and conditions that expedite the negotiation of roaming agreements. Commercially negotiated roaming arrangements that enable these customers to receive service outside their home country have been in place for decades and are mutually beneficial to the MNOs: the MNOs' customers receive service in foreign countries and the MNOs receive compensation from the other party for providing the service. Moreover, building on its success in fostering traditional roaming, in 2012 GSMA adopted an "M2M Annex" template for international roaming. Among other things, the Annex mandates transparency in the provision of M2M services by requiring the parties to agree to identify their M2M traffic separately from other traffic and to exclude traditional wireless services (*e.g.*, conventional 2-way PSTN voice, Internet browsing). (*See* Topic for Discussion 5, *Potential problems related to the availability of resources in the medium to long term with regards to numbering*.)

c) **Data Privacy and Security**: Considering the proliferation of M2M services in every sector, a large volume of information will be generated, transmitted, collated and stored. Some measures to counter potential data privacy and security threats include key management, secure routing, data encryption, and Secure Multiparty Computation (SMC)-based key distribution schemes or mechanisms.[2] Critically, regulatory oversight should provide data controllers[3] with the flexibility to determine the best approach for protecting consumer privacy and should extend security measures to all players in the IoT ecosystem (*e.g.*, include hardware and software providers in any privacy or security regulatory framework).

d) **Numbering Resources**: In the case of E.164-based M2M devices, there a possibility of number exhaustion in some markets due to the significant number of connected devices and therefore a need to consider an expanded number series. (*See* Topic for Discussion 5, *Potential problems related to the availability of resources in the medium to long term with regards to numbering*.)

2. The main actors involved in the development and in the delivery of M2M services.

The M2M ecosystem incorporates many players, most notably connectivity providers (mobile and fixed network operators), hardware manufacturers (equipment manufacturers and device manufacturers), software/application service providers (telematics, data analytics, billing solutions, etc.), and system integrators. In addition, the associated vertical-market applications encompass a variety of industries, including:

- Healthcare (care provider, medical device manufacturer, health insurance);
- Logistics (asset tracking services, shipping);
- Energy/Utilities (electricity, water, waste; aggregator; meter manufacturer; pipeline/refinery management);
- Public Infrastructure (traffic control, facilities management, emergency services, security/defense);
- Building/Construction (energy management, security);
- Transportation (automotive, infotainment, hardware, services; fleet management, transportation insurance; mass transportation);
- Retail/Consumer (appliances/housewares, personal device manufacturer, signage, vending); and
- Industrial (manufacturing/fabrication, laboratory/pharmaceutical, agribusiness/farming).[4]

[2] SMC is a subfield of cryptography that enables participants to jointly compute a function using their individual inputs while keeping the individual inputs private.
[3] Data controllers may be the MNO, but could also be the device manufacturer, a third-party system integrator, a value-added reseller of ICT services, an unlicensed Wi-Fi network operator, etc.
[4] *See* IoT Vertical Markets, International M2M Council (IMC), at http://www.im2mc.org/imcmarkets.

There are also new players entering the M2M ecosystem. For example, several companies announced plans to create a network exclusively for M2M communications. One French start-up plans to develop a low-cost, energy-efficient ultra-narrowband cellular network dedicated to the IoT, and it wants to deploy in 60 countries over the next five years.[5] While such players may fall under a traditional moniker (*i.e.*, connectivity provider), their new networks may not fit neatly into traditional network concepts and regulatory frameworks. And as the industry grows, policymakers should expect and encourage further innovations that will propel the M2M ecosystem forward.

3. The main applications developed today in Europe (smart meters, smart grids, smart cities).

The IoT and its applications are particularly critical to Europe after the economic crisis and the subsequent introduction of austerity measures that influenced public investment, including public services. With pressure to reduce costs, the introduction of more efficient ways of delivering quality and sustainable public services is increasingly important. Therefore smart technologies such as M2M connectivity are being deployed. According to U.S. industrial M2M leader GE,[6] Europe is well-positioned to reap the gains from the IoT revolution, and is especially in need of doing so to restore growth and contribute to ongoing debt reduction. Indeed, Europe is advancing M2M applications with developments in smart grids/meters[7] and smart cites.[8] In Sweden, for example, the rollout of smart meters was prompted by legislation that each household should be able to accurately monitor monthly electricity consumption by July 2009. A year later, Sweden became the first European nation to achieve 100% smart meter rollout — putting that country at the forefront of demand response potential.[9]

Another major M2M application in Europe, and elsewhere, is the connected car. According to Pyramid Research, telematics is the fastest growing segment of the mobile M2M market and the firm predicts Europe will become the largest telematics market in 2016, overtaking the U.S.[10] To facilitate the expected growth relative to connected car, early this year the European Commission announced the establishment of a basic set of standards to ensure that vehicles made by different manufacturers can communicate with each other. The standards are expected to accelerate the European car industry’s development of the next generation cars.[11] The market impact promises to be significant, as Europe currently has more than 200 million vehicles in use. AT&T is also contributing to the advancement of next generation cars. We recently introduced the AT&T Drive studio, a dedicated facility for connected car innovation and research. It is a working lab where AT&T tests and develops technologies to enhance the driving experience by improving safety, convenience and entertainment. AT&T also introduced its global connected car platform called AT&T Drive. AT&T Drive allows automakers to develop the services and capabilities to differentiate their solutions in the marketplace.[12] In addition to these technical

[5] *See* http://www.lightreading.com/services-apps/m2m/metal-machine-music-dedicated-m2m-networks-on-horizon/d/d-id/708656.
[6] *See* http://www.genewscenter.com/imagelibrary/downloadmedia.ashx?MediaDetailsID=5901&SizeId=-1
[7] *See* http://ses.jrc.ec.europa.eu/smart-grids-observatory
[8] *See* http://ec.europa.eu/eip/smartcities/
[9] *See* http://www.emeter.com/smart-grid-watch/2010/sweden-at-forefront-of-demand-response-in-europe/
[10] *See* http://www.prnewswire.com/news-releases/europe-to-overtake-us-in-cellular-telematics-market-by-2016---mobile-operators-go-after-the-connected-car-opportunity-255076341.html
[11] *See* http://europa.eu/rapid/press-release_IP-14-141_en.htm
[12] *See* http://www.prnewswire.com/news-releases/att-leads-the-future-of-the-connected-car---announces-new-att-drive-studio-and-global-att-drive-platform-238904071.html

initiatives, AT&T announced several connected car agreements with automotive makers, including deals covering North America with General Motors (GM),[13] Tesla[14] and Volvo.[15]

4. The introduction of the so-called soft SIM.

The "soft" SIM,[16] more correctly referred to as an "embedded" SIM, is physically soldered into a device and therefore is intended to be in place for the duration of the life of a product. The profile of the SIM (*e.g.*, the IMSI) may be configured at the time of its manufacture or it may be deferred until a later time. This can be crucial because during the manufacturing process, it is often unknown which mobile operator will be supplying the connectivity for the M2M service. Therefore, one of the main benefits of the embedded SIM is that it can be changed over-the-air after manufacture.[17] This allows for changes to profiles of different MNOs over the life span of the product, preventing lock-in to the original MNO.[18]
The embedded SIM also supports different business models. It can be used with either the global SIM (*i.e.*, an IMSI that works anywhere in the world based on roaming) or a "local" IMSI (programmed according to the device's home country, but also requires individual local agreements per roaming country). What is important to note is no single business model will meet the needs of all manufacturers, device distributors, systems integrators, or other market participants. Thus, while the embedded SIM may enable new business models, it should not dictate them. For example, the embedded SIM (*i.e*., the ability to change the IMSI) does not solve the problem of a device manufacturer potentially needing to establish agreements with at least one MNO in each country in which it intends to offer service. In contrast, the global SIM model (*i.e.*, the ability to use a single IMSI in multiple countries) offers a superior solution to enable multi-country distribution of M2M devices.

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[13] http://www.prnewswire.com/news-releases/general-motors-selects-atts-4g-lte-network-to-deliver-enhanced-services-to-millions-of-vehicles-192939601.html

[14] *See* http://www.prnewswire.com/news-releases/tesla-and-att-enter-multi-year-exclusive-agreement-to-connect-current-and-future-models-in-north-america-239064921.html

[15] *See* http://www.prnewswire.com/news-releases/volvo-cars-and-att-enter-multi-year-agreement-to-connect-future-models-in-us-and-canada-255479991.html

[16] The soft SIM is implemented purely in software, without the operator-controlled and operator-secured hardware in the SIM. To our knowledge, there are currently no soft SIMs in production, as they are difficult, if not impossible, to fully secure.

[17] Changes to the SIM profile post-manufacture require the implementation of methods to enable re-programming of the SIM cards embedded in the M2M device. A standardized system, or infrastructure, to do that and a SIM card that is compatible with that system will likely be needed. These are in the development stages today. As a first step, the GSMA released documentation on this process in December of 2013; however, mobile operators still need to develop the capability and a measure of integration is required between MNOs to enable the functionality. To date, AT&T has developed a proprietary pre-standard capability to change the IMSI over-the-air.

[18] While number portability for handsets is important for individuals, this is not true for M2M devices, as the user of an M2M device typically does not know (or need to know) the number associated with the device. In the M2M context, the M2M manufacturer typically contracts with the MNO; the MNO does not typically contract with the consumer/end user. The MNO usually allocates a block of IMSIs to each M2M manufacturer who provisions the number in the device. The end user is likely not able to change wireless connectivity providers as they do not have a relationship with that provider. If the M2M manufacturer changes MNOs, the expectation is that the E.164 number would be changed along with the E.212 number assigned. Porting would not be required because the new MNO serving the M2M manufacturer would provide a new IMSI and a new MSISDN associated with it.

5. Potential problems related to the availability of resources in the medium to long term, with regards to numbering.

Numbering issues account for a significant share of M2M deployment concerns. From the potential of number exhaust and the necessity of E.164 numbers, to the need for extra-territorial use of numbering resources versus using a shared mobile country code based on an International Telecommunications Union (ITU) Recommendation—the issues are varied and complex. However, the complexity often can be addressed through a practical market-driven approach.

Number Exhaust

Numbering ranges may be exhausted if unique and dialable numbers are going to be assigned to individual M2M devices. The risk, of course, depends on the specificities of individual number plans and will vary by country. If there is concern about potential exhaustion of mobile numbers arising from the growth of M2M services, a special range of numbers for M2M would be appropriate since it would permit the introduction of a new number block using a longer number sequence (up to the full 15 digits) in the E.164 format. The length of E.164 numbers for mobile users was selected to balance the needs of the efficient use of numbering with the human factors of communicating and dialling a convenient length. To achieve that balance, in Europe the average length of E.164 number ranges typically do not exceed 12 digits (including trunk code). Machines, however, have no such need for convenience and so for M2M a full 15 digit number allocation, as described in ITU E.164, could be considered. One approach would be to reclaim an unused prefix.

The Necessity of E.164 Numbers

It is likely that E.164 numbers will be necessary in the long term. For many devices and applications developed today, E.164 numbers are used and will continue to be used throughout the lifecycle of the product. With many consumer and industrial products having lifetimes of 10 to 20 years, an ongoing supply of E.164 numbers will be needed. For the highly integrated nature of high-volume, low-cost, electronic modules, a retrofit or upgrade to an alternate numbering resource would be uneconomical.
After expending substantial effort and incurring considerable expense, IPv6 use has seen substantial growth over the last few years. While leading core network providers have reached IPv6 deployments in the high-teens to low-twenties—with, for example, Deutsche Telekom AG showing 21.98% IPv6 deployment and AT&T at 19.15,[19] many operators are at a very early stage of IPv6 deployment due to a variety of factors including limitations in current equipment, cost to upgrade or replace, and lack of demand. To reach a global M2M market, device manufacturers will consider the breadth of IPv6 deployment before beginning development on IPv6-only devices. This has the effect of the late movers in IPv6 deployment affecting the M2M manufactures' decision process.

There also will be a substantial overlap period where both IPv6 and E.164 numbers are in use. It is estimated it will take 5 to 10 years for IPv6 to become widely available. If the field lifecycle of a device is 20 years, E.164 numbers could be needed for the next 30 years. However, issuance of new E.164 numbers could begin to be phased out when IPv6 becomes widely available and then only for those devices that do not have any requirement for traditional PSTN-based voice or SMS[20] services.

[19] As of 20 May 2014. *See* http://www.worldipv6launch.org/measurements/
[20] SMS is commonly used to initiate action to a device, as communications to a device cannot be initiated by IPv4.

Extra-Territorial Use of Numbering Resources (Global SIM)

As noted in the *Introduction*, compared to traditional business models, the business models for the IoT typically have significantly lower ARPUs and greater input cost sensitivities. Given these realities, M2M device manufacturers would face an almost insurmountable obstacle when seeking to deploy M2M products and services on a global scale if they followed traditional handset/tablet business models. To obtain wireless connectivity under traditional business models, an M2M device manufacturer would need to contract with a separate MNO in each country into which it sells its goods, which could mean incurring transaction costs for negotiating and then implementing dozens or even hundreds of individual agreements. Moreover, for each country, the M2M device manufacturer would need a SIM card embedded with a country-specific IMSI code for each M2M device to be distributed in that particular country, leading to increased inventory management costs. In those cases where the M2M devices use E.164 numbers (*i.e.*, Mobile Subscriber ISDN (MSISDN) numbers), the M2M device manufacturer would also need country-specific E.164 numbers in each country where it seeks to distribute its products, further increasing its costs and increasing pressure on scarce numbering resources.

M2M business models also require delivery of services on a globally consistent manner, including being able to operationalize centralized manufacturing and plant resources, and establishing common management systems for consistent policy controls (*e.g.*, provisioning, customer care, cyber security, billing and reporting). A fragmented distribution model, involving a separate SIM/IMSI per country and integration with each national MNO "platform," would prohibitively raise costs and stifle M2M innovation and deployment in most markets (*e.g.*, automotive companies may not know the final destination of each vehicle at the time of manufacture, nor would a typical manufacturer of connected watches, soil moisture detectors, etc.). This will impact citizens in large and small markets, depriving them of leading edge innovation and competition. Even across the 28 European Union (EU) markets, if a nationally fragmented approach for SIM/IMSI were to occur, there is a high risk that many markets could miss out on new M2M innovations due to the added expense and risk of needing to support a distinct IMSI platform for each country. This is also true for EU device manufacturers intending to export around the world but finding their distribution model constrained by a precedent that requires a separate IMSI platform for each export market.

In essence, the new business models for M2M services necessitate innovative numbering solutions to accommodate the requirements of M2M customers and service providers. While a number of possible solutions to address the potential concerns relative to the needs of these stakeholders exist,[21] AT&T believes that the most effective solution for global M2M services is to explicitly allow the extra-territorial use of numbering resources, such as E.212 (*i.e.*, MCC plus Mobile Network Codes (MNC)) as well as E.164 number ranges—or to specifically exempt such use from any more general prohibitions that may exist on extra-territorial use of numbers. Such extra-territorial use of numbering for M2M services should not be confined to traditional roaming scenarios[22] and should work in both directions—that is, national regulators should allow use of their MCC+MNC and MSISDN numbers outside their national territories, as well as allowing the use of foreign numbering codes within their national

[21] Numbering solutions for M2M services include a shared national mobile customer number for M2M customers, a unique national MNC for each M2M customer, a unique MNC under MCC 901 for each M2M customer that requires roaming or who operates in a minimum of two different countries, and a unique MNC under a new shared MCC 90X for M2M services.
[22] According to the ITU-T E.212 Amendment 3 (06/2011), the extra-territorial use of an MCC+MNC is not intended to include roaming.

territories. In fact, this is an existing operational model already successfully in use in the incipient field of M2M, and it is enabling the goals of a digital single market in Europe. Notably, recognizing this, the CEPT/Electronic Communications Committee (ECC) Working Group on Numbering and Addressing in its final Report 212 on evolution of E.212 Mobile Network Codes[23] added a recommendation that '[t]he ECC should further analyze the concepts of roaming and extra-territorial use of E.212 resources to examine the implications of such use on national numbering plan management."[24] The inclusion of this directive recognizes the role the global SIM model contributes to the IoT.

To elaborate, there are existing, well-defined and well-established commercial models used between mobile operators that provide a practical basis for accommodating and facilitating the extra-territorial use of MCC+MNC and MSISDN numbers on a bilateral commercial basis. Foremost among these is the international M2M roaming framework that addresses and makes transparent international roaming used explicitly for M2M services. The roaming framework, currently the most efficient manner of delivering global M2M service, enables the use of the home carrier's IMSI and MSISDN to provide services on a global basis through a single SIM architecture. This architecture allows the most innovative devices, from large or small companies, to be deployed to any country in the world, thereby bringing the benefits of leading-edge technology to all countries, businesses, mobile operators and citizens. And with the business models used for M2M, where end users often pay no data transport charge, the traditional policy considerations relative to the level of roaming charges are not an issue. Under the M2M roaming framework—recognized by GSMA and endorsed through the MNOs' adoption of an M2M Annex—procedures are in place to transparently identify, measure and distinguish M2M roaming traffic from traditional handset or tablet roaming traffic. The international roaming framework has been globally adopted by hundreds of mobile network operators who today enjoy the bilateral benefits of offering these services. And this bilateral framework has enabled large and small manufacturers alike to develop and export devices around the world, and to scale their business without the upfront entry barrier of establishing a distinct platform for each country before selling a single device. Thus, global numbering use promotes robust competition, and ensures competitive telecommunications markets because MNOs will continue to compete with each other to provide an international roaming platform for M2M service providers. Meanwhile, visited network MNOs benefit from the roaming traffic on their network.

Finally, the administration and regulation of numbers remains rightly within the scope of authority and interest of national regulatory agencies. Allowing the extra-territorial use of national numbering resources does not diminish or restrict that authority. Nor are there precedential impediments on the use of global numbering resources from the either the ITU or EU. National regulators retain oversight mechanisms, and can endorse a flexible numbering policy, while addressing policy interests in other areas. Numbering policies, therefore, should embrace the global SIM approach.

Shared MCC 901 ITU Recommendation

ITU Recommendation E.212 Annex A provides for a shared country code 901 from which MNCs can be assigned by the ITU Technical Standards Bureau (TSB), after satisfying a series of criteria. Similarly, E.164.1 provides the same criteria for the use of shared E.164 codes. However, not all M2M operators may be able to satisfy the criteria for assignment. To illustrate, there are ongoing costs to obtain and

[23] ECC Report 212, *Evolution in the Use of E.212 Mobile Network Codes*, CEPT/Electronic Communications Committee (ECC) Working Group on Numbering and Addressing, (April 2014). *See* http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP212.PDF

[24] *Id.*, at page 29.

maintain membership (approximately €8,600-€25,800 annually), which may discourage small operators from participating. Applicants requesting the numbering resource also must confirm that they have overall responsibility for the management, operation, and maintenance of the network that will utilize the requested resource. Small and medium operators may use shared or virtual network elements and may not be able to make the required affirmation. Moreover, an applicant must demonstrate that its international network infrastructure will contain connecting physical nodes in two or more countries. An operator using a roaming model may only have physical nodes in its home country and therefore would not be able to satisfy this criterion. Finally, an applicant must demonstrate that other reasonable technical and operational alternatives (*e.g.*, use of national resources) are not appropriate and provide substantiating documentation to that fact. Since M2M services have been provided globally for many years using national numbering resources, an applicant may have difficulty in demonstrating why national resources are not appropriate.

Another difficulty with the shared MCC solution is that the ITU may not have sufficient numbers in the 901 code to meet demand. The pool of MNCs under the ITU shared E.212 code is limited. Since two digit MNCs are used, and 32 codes have been issued (ITU E.212 Database, 20 January 2014), fewer than 67 codes remain available for assignment which could be quickly exhausted by more than 700 existing mobile operators and a large number of commercial enterprises.

Furthermore, implementing 901 codes would cause significant delay in the provision of global M2M connectivity. This is because existing roaming agreements would have to be amended and the new SIMs would need to be tested on each roaming partner's network. It could take several years to cover several hundred operators. Network testing, functional testing, billing verification, table updates (in switches, STPs, HLRs, billing systems, etc.) would need to be performed by the operator and each of its roaming partners. It is a massive effort to launch a new code, and it would increase ongoing costs because those changes would need to be maintained. Such delay and cost could severely hamper the development and deployment of innovative M2M services.

Note: A global SIM approach using roaming can be just as efficiently implemented with the extra-territorial use of a national MCC+MNC code as it can on an MCC 901 (or a new shared MCC 90X) MNC. While the shared MCC 901 or a new 90X code may be a potential long-term solution, a global SIM approach based on a national IMSI is preferable, because the shared MCC 901 or new 90X code could involve considerable cost and time, up to 2 years, to get the necessary support structures and agreements in place, not to mention overcoming past fraudulent activities by dubious satellite operators.

6. Potential problems or barriers to the development of M2M services related to the use of spectrum.

One potential constraint relative to licensed spectrum is regulatory mandate that prescribes particular services or technologies. Instead, regulatory authorities should allow licensed mobile operators to choose the technology that is most appropriate to deploy (*i.e.*, provide for technology-neutral mobile licenses) to support the full range and capabilities of the IoT. For example, IoT devices will require operators to use licensed and unlicensed spectrum to deploy services covering short and long distances, indoor and outdoor locations, and static and mobile applications.

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