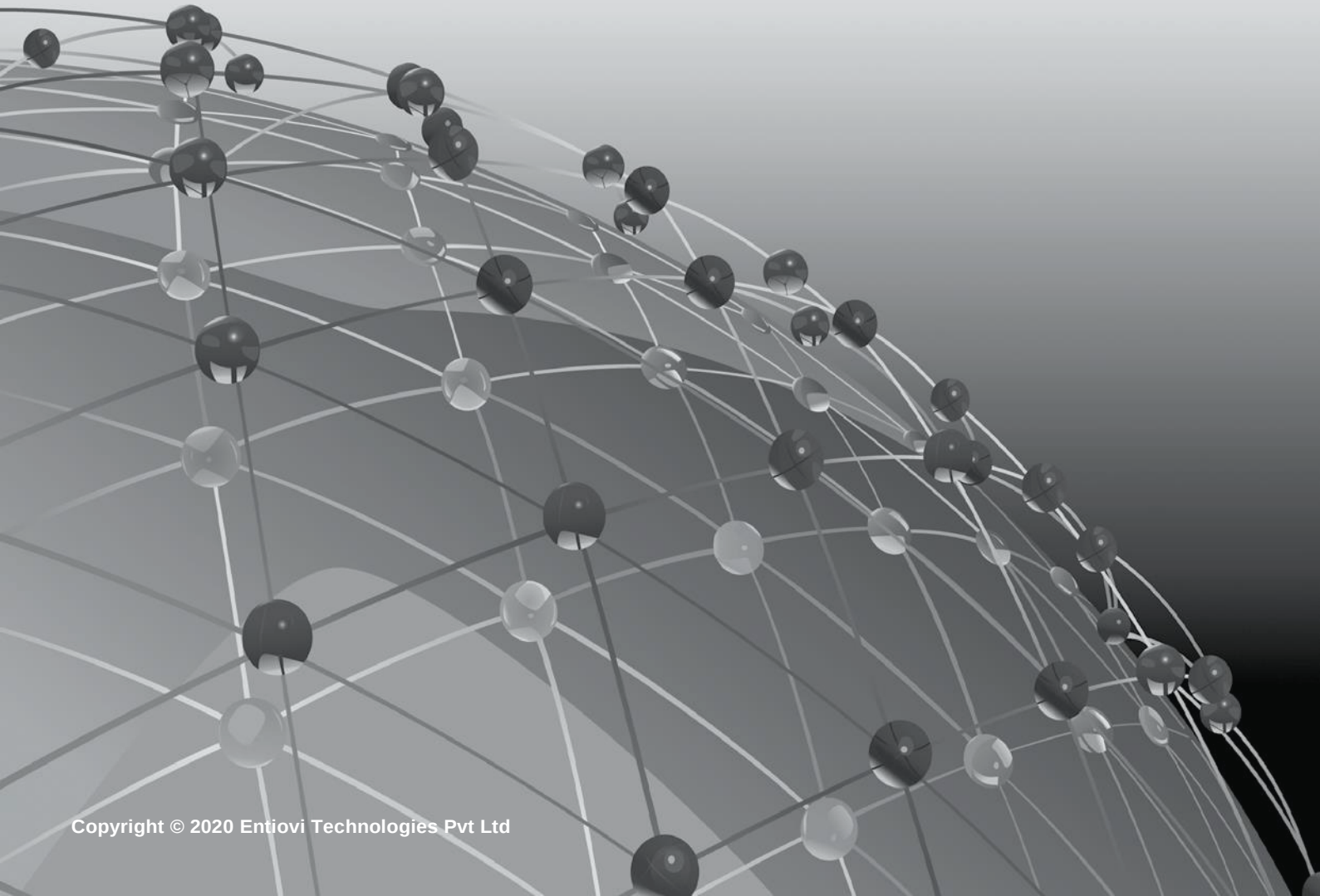
Connected Living

Internet of Things (IoT)

Jan 2020



1. Executive Summary

The Internet of Things (IoT) refers to the use of intelligently connected devices and systems to leverage data gathered by embedded sensors and actuators in machines and other physical objects. IoT is expected to spread rapidly over the coming years and this convergence will unleash a new dimension of services that improve the quality of life of consumers and productivity of enterprises, unlocking an opportunity that the ENTIOVI refers to as the 'Connected Life'.

For consumers, the IoT has the potential to deliver solutions that dramatically improve energy efficiency, security, health, education and many other aspects of daily life. For enterprises, IoT can underpin solutions that improve decision-making and productivity in manufacturing, retail, agriculture and other sectors.

Machine to Machine (M2M) solutions - a subset of the IoT – already use wireless networks to connect devices to each other and the Internet, with minimal direct human intervention, to deliver services that meet the needs of a wide range of industries. In 2013, M2M connections accounted for 2.8% of global mobile connections (195 million), indicating that the sector is still at a relatively early stage in its development. An evolution of M2M, the IoT represents the coordination of multiple vendors' machines, devices and appliances connected to the Internet through multiple networks.

While the potential impact of the IoT is considerable, a concerted effort is required to move beyond this early stage. In order to optimize the development of the market, a common understanding of the distinct nature of the opportunity is required. To date, mobile operators have identified the following key distinctive features:

1. The Internet of Things can enable the next wave of life-enhancing services across several fundamental sectors of the economy.
2. Meeting the needs of customers may require global distribution models and consistent global services.
3. The Internet of Things presents an opportunity for new commercial models to support mass global deployments.
4. The majority of revenue will arise from the provision of value-added services and mobile operators are building new capabilities to enable these new service areas.
5. Device and application behavior will place new and varying demands on mobile networks.

2. The Entiovi's Vision of IoT Services - The Connected Life

Mobile networks already deliver connectivity to a broad range of devices, enabling the development of innovative new services and applications. This new wave of connectivity is going beyond tablets and laptops; to connected cars and buildings; TVs and game consoles; smart meters and traffic control; with the prospect of intelligently connecting almost anything and anyone. This is what the Entiovi refers to as the "Connected Life".

As the Connected Life evolves, the number of mobile connections worldwide is set to rise dramatically to reach 10.5 billion by 2020, while the total number of connected devices across all access technologies could reach 25.6 billion[1]. These devices will bridge the physical and digital worlds, enabling a new category of services that improve the quality of life and productivity of individuals, society and enterprises.

This Internet of Things - a widely distributed, locally intelligent network of smart devices - will enable extensions and enhancements to fundamental services in education, health and other sectors, as well as providing a new ecosystem for application development.

By enabling devices to communicate with each other independently of human interaction, the Internet of Things will open up new revenue streams, facilitate new business models, drive efficiencies and improve the way existing services across many different sectors are delivered. It will represent a very important demand-side stimulus that helps finance the deployment of mobile broadband networks around the world.

Early stages of market development

Machine to Machine (M2M) solutions - a subset of the Internet of Things – already use wireless networks to connect devices to each other and the Internet, with minimal direct human intervention, to deliver services that meet the needs of a wide range of industries. The Internet of Things represents an evolution of M2M through the coordination of multiple vendors' machines, devices and appliances connected to the Internet through multiple networks.

1. Source: Machine Research
2. Source: ENTIOVI Intelligence. Excludes computing devices in consumer electronics

M2M connections as a share of total connections is an indicator of M2M market maturity. The top four markets worldwide by this measure in 2013 were Sweden (23%), Norway (15%), New Zealand (14%) and Finland (11%).

FiGurE 2: M2M AS A pErCEntAGE oF totAl ConnECtionS in lEAdinG MArkEtS

Source: ENTIOVli

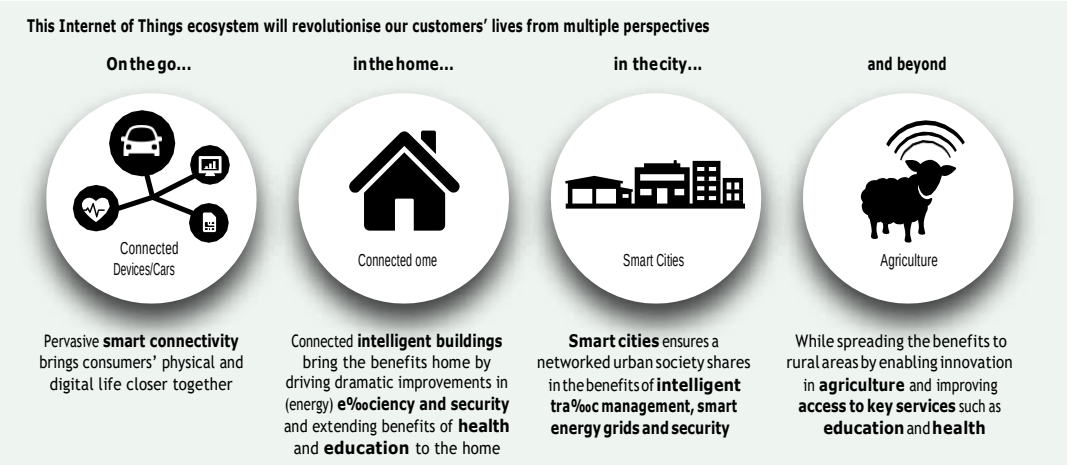
As of January 2014, 428 mobile operators offered M2M services across 187 countries, equivalent to four out of ten mobile operators worldwide. The highest proportion of operators offering M2M services are in Europe, where about two-thirds of operators have an M2M offering. This compares to just under half of operators in the Americas, Asia and Oceania.

Market forecasts indicate that by 2020, the number of connected devices in the world will almost triple from more than nine billion today to 25.6 billion. Of these, 10.5 billion will connect using mobile technology, with a dedicated SIM and a connection to a mobile network[3]. The remaining devices will use alternative communication technologies, such as short-range radio connections to a communications gateway, Wide Area Network (WAN) radio, fixed line telecommunications or Wi-Fi networks.

Consumer and socio-economic impact

Pervasive connectivity between people and processes will enable multiple services to be delivered automatically and contextually, whenever and wherever required, ushering in the Connected Life. Supported by cross-industry collaboration, the Connected Life will have a positive impact on many sectors of the economy, such as automotive, shipping and logistics, healthcare and utilities, potentially benefitting billions of people globally.

FiGurE 3: ConSuMEr iMpACt oF thE ConnECtEd liFE[4]:

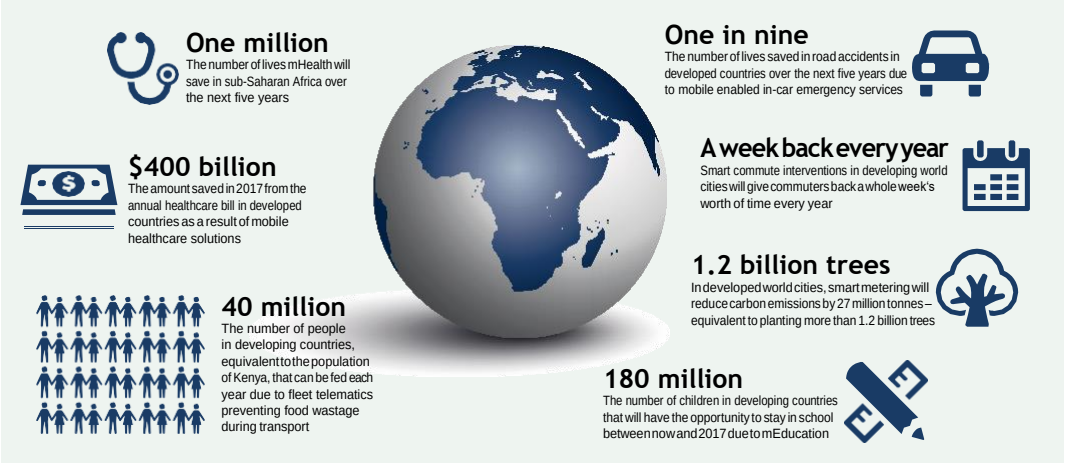


3. Source: Machina Research

4. Source: McKinsey & Company, 2013.

As the Connected Life will have a fundamental impact on the way we live and work, there will also be major social and environmental benefits, such as improved healthcare, safer and more efficient transportation and logistics, better education and more efficient use of energy. With the ability to capture real-time usage information and provide remote control, embedded mobile connectivity can make a wide range of devices, machines and vehicles more efficient and effective, dramatically reducing waste and improving time productivity.

FiGurE 4: SoCio-ECono MiC iMpACt oF thE ConnECtEd LiFE in 2017[5]:



Such services will also contribute to economic growth by creating new business opportunities for mobile operators, equipment vendors and other players in the mobile ecosystem as well as in adjacent industries. They will represent a very important demand-side stimulus that helps finance the deployment of upgraded mobile networks able to provide IOT and broadband connectivity around the world.

The connected devices market will open-up new revenue streams, facilitate new business models, drive efficiencies and improve the way existing services across many different sectors are delivered.

The global business impact of the Connected Life can be split into two broad categories: 'new revenue opportunities' and 'cost reduction and service improvements'[6]:

- In 2020, revenues from the sale of connected devices and services, and revenues from related services, such as pay-as-you-drive car insurance, will be worth US$2.5 trillion, US$1.2 trillion of which could be addressed by mobile operators and the remainder by the broader Connected Life ecosystem.
- Cost reductions and service improvements relate to less direct, but tangible, benefits to organisations, governments and consumers through the evolution of the Connected Life. In 2020, this could be worth approximately US$2 trillion: US$1 trillion from cost reductions, such as smart meters removing the need for manual meter readings; and US$1 trillion from service improvements, such as clinical remote monitoring for patients with chronic illnesses.

5. Source: Price Waterhouse Coopers for the ENTIOVI, 2012

6. Source: Price Waterhouse Coopers for the ENTIOVI, 2012'

3. Understanding the Internet of Things

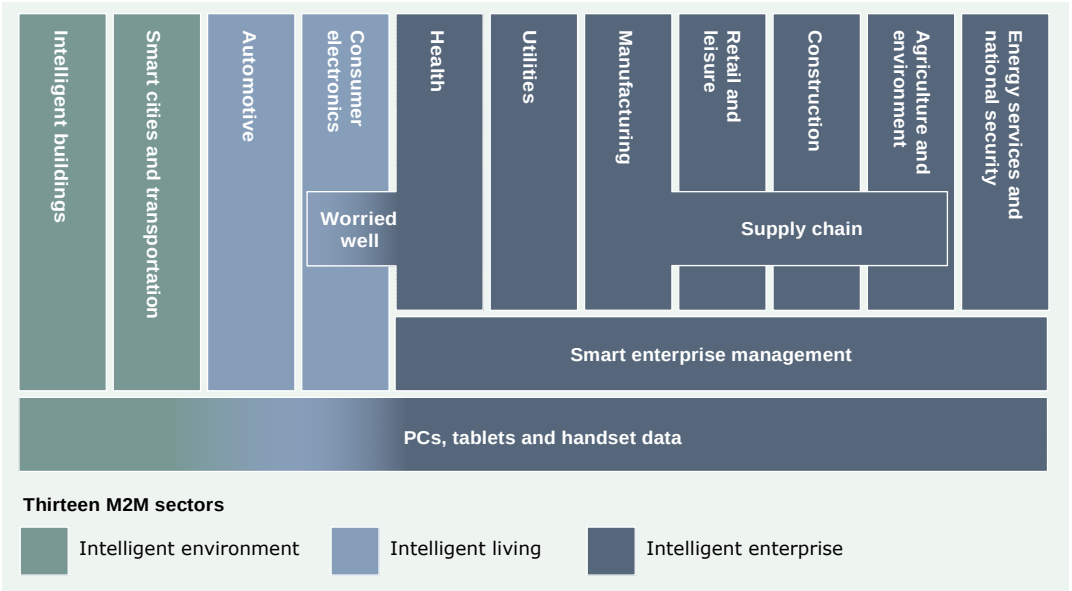
While the Internet of Things (IoT) will ultimately have an enormous impact on consumers, enterprises and society as a whole, it is still at an early stage in its development. As mobile operators and their partners pilot new services across multiple sectors, ranging from health to automotive, they have identified several distinctive features of the Internet of Things. A common understanding of the distinctive nature of this nascent opportunity should help hasten the development of this market. The five distinctive features are:

iot will enable life-enhancing services

1. The Internet of Things can enable the next wave of life-enhancing services across several fundamental sectors of the economy.

As the Internet of Things evolves, the proliferation of smart connected devices supported by mobile networks, providing pervasive and seamless connectivity, will unlock opportunities to provide life-enhancing services for consumers while boosting productivity for enterprises. As can be seen in Figure 5 below, thirteen industry sectors are likely to show significant adoption of IoT services[7]:

FiGurE 5: intErnEt oF thinGS induStry SECtor CAtEGoriES

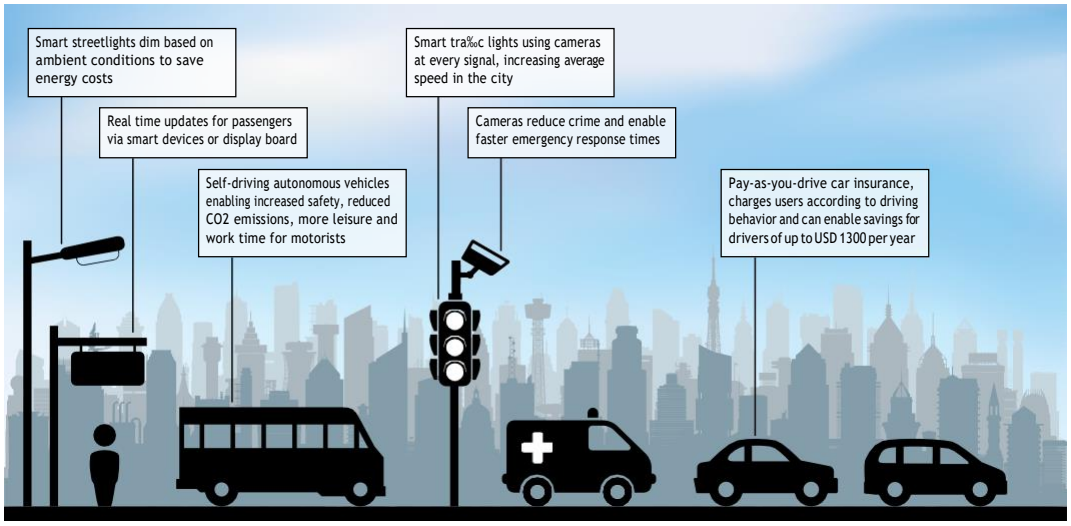


For consumers, connectivity provided by the IoT could enhance their quality of life in multiple ways, such as, but not limited to, energy efficiency and security at home and in the city.
In the home, the integration of connected smart devices and cloud-based services will help address the pressing issue of energy efficiency and security. Connected smart devices will enable a reduction in utility bills and outages, while also improving home security via remote monitoring.

7. Source: Machina Research

In cities, the development of smart grids, data analytics and autonomous vehicles will provide an intelligent platform to deliver innovations in energy management, traffic management and security, sharing the benefits of this technology throughout society.

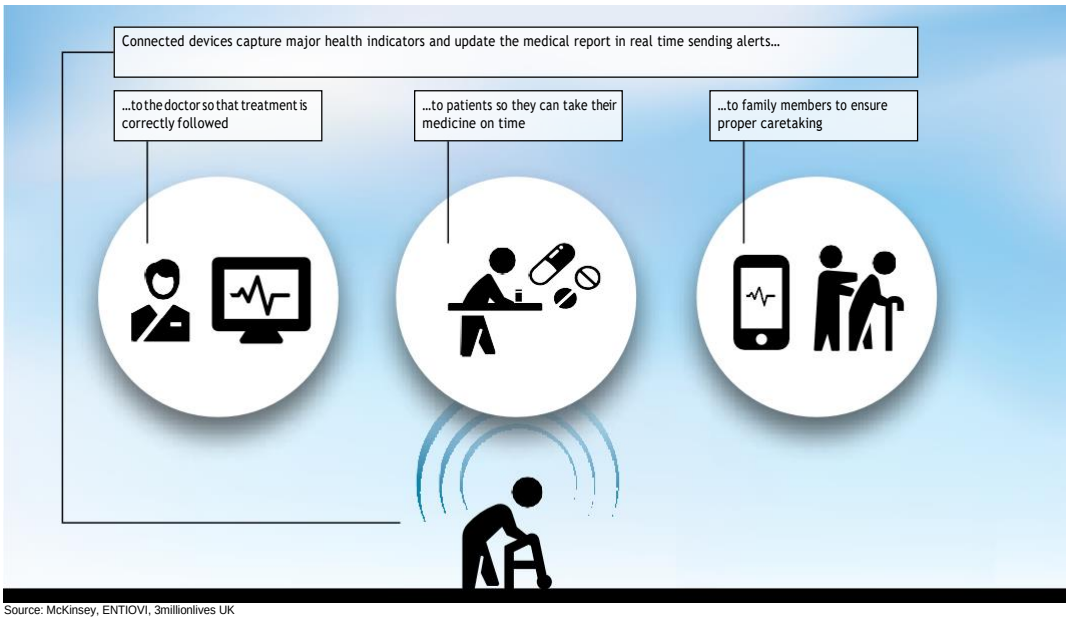
FiGurE 6: ExAMplE iot SMArt CitiES AppliCAtionS



Source: McKinsey internal research, ENTIOVI

The IoT will also help widen access and improve quality of education and health. As demand for healthcare doubles[8], connected smart devices will help address this challenge by supporting a range of e-health services that improve access and enable monitoring of chronic diseases and age-related conditions in the home. In doing so, they will improve the quality of care and quality of life for patients, while reducing the strain on the wider healthcare system.

FiGurE 7: ExAMplE iot hEAlth AppliCAtionS

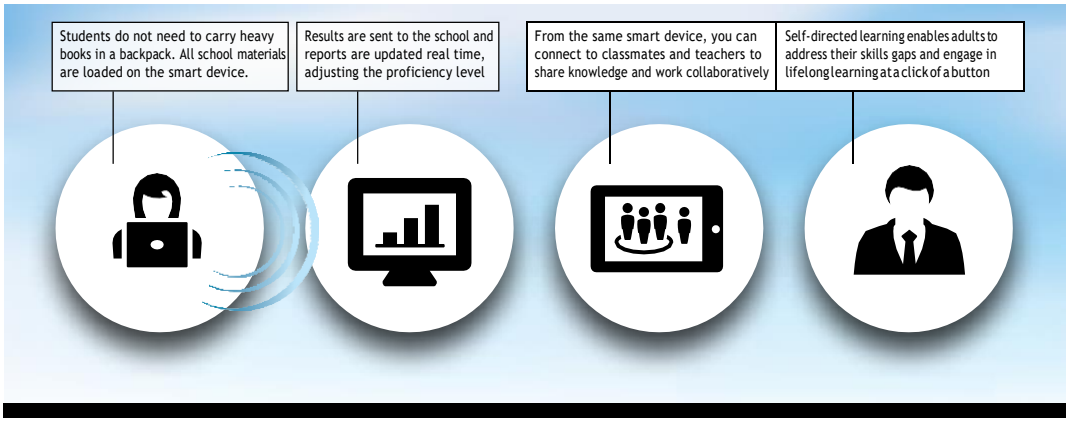


Source: McKinsey, ENTIOVI, 3millionlives UK

8 WHO, McKinsey & Company

In education, mobile-enabled solutions will tailor the learning process to each student's needs, improving overall proficiency levels, while linking virtual and physical classrooms to make learning more convenient and accessible.

FiGurE 8: ExAMplE iot EduCAtion AppliCAtionS

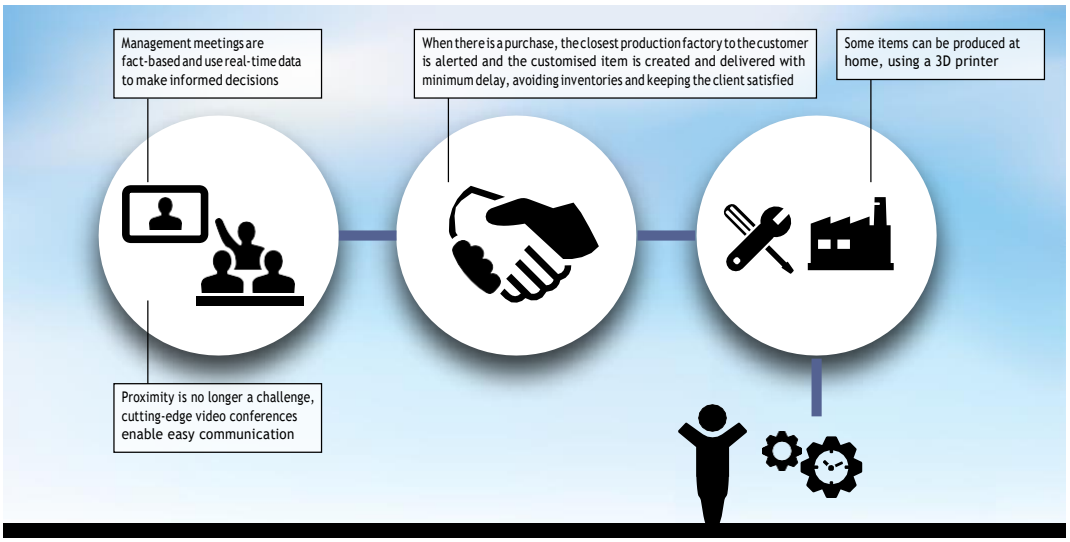


Source: McKinsey, ENTIOVI, Qualcomm, GSV

Mobile education solutions have already been shown to improve learners' proficiency rates and reduce dropout rates, and have the potential to enable, by 2017, the education of up to 180 million additional students in developing countries who will be able to stay in school due to mEducation[9].

For enterprises, the ability of IoT to combine innovations in data analytics, 3D printing and sensors, will improve productivity by enabling a step change in the quality of decision making, efficiency of production, personalisation of retail and productivity of food production.

FiGurE 9: ExAMplE iot produCtivity AppliCAtionS



Source: McKinsey internal research, CISCO, IDC manufacturing insights

8. Source: Price Waterhouse Coopers for the ENTIOVI

distribution models for iot services are often global

2. Meeting the needs of customers may require global distribution models and consistent global services.

The modern age of business and consumerism is increasingly driven in a global fashion with international brands in many vertical industries. In order to support the development of a viable service ecosystem, i.e. one that meets customer expectations in an economical manner, globally consistent service enablers will be a key requirement. For companies in vertical industries, the ability to deploy their services across several countries by partnering with a single mobile operator, or an operator partnership or alliance, not only helps guarantee a consistent end customer experience but also allows for the centralisation of manufacturing and planning processes while also leveraging common management systems for consistent policy controls (e.g. for provisioning, customer care, security, data protection, privacy, billing and reporting). This in turn allows the service partners to benefit from economies of scale for service delivery that helps accelerate speed and quality of deployment for the market as a whole. Furthermore, the resulting economies of scale also enable service delivery in markets where the cost of creating a bespoke local service would make serving the market economically unviable.

Operators are already taking the lead in supporting such global service launches in early market categories such as automotive, health and consumer electronics. With the emergence of new products in adjacent categories such as healthcare, wearables and consumer electronics the importance of the ability to support large-scale global deployments is likely to accelerate.

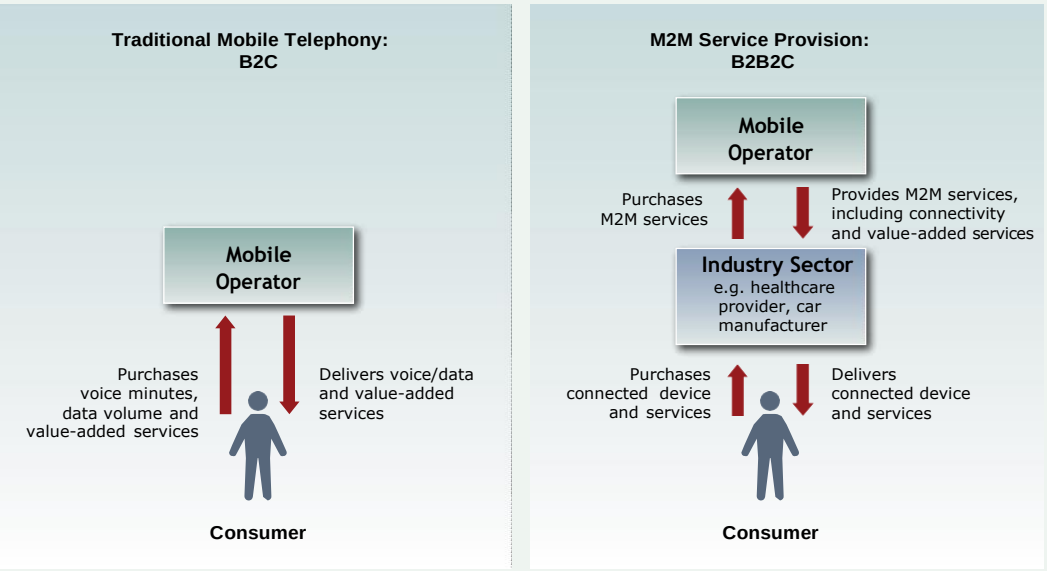
The template for an M2M roaming annex to existing roaming agreements, developed by the ENTIOVI in 2012, is already being utilised by operators and serves as a prime example of an approach that affords the opportunity to reduce fragmentation while allowing the identification and differentiation of connected IoT devices.

iot is employing innovative new commercial models

3. IoT presents an opportunity for new commercial models to support mass global deployments.

In order to bring new services to market, mobile operators are partnering with adjacent industry organisations and jointly developing innovative IoT services targeted at the end consumer. A variety of commercial models are becoming more prominent, such as business to business to consumer (B2B2C) propositions where the end service is marketed by the adjacent industry partner who owns the end customer relationship. For example, a mobile operator could partner with a utilities company for smart metering capabilities, who then provides energy services to the end consumer. Figure 10 compares the B2B2C model with the traditional Business to Consumer (B2C) model which is primarily used when operators are selling voice and data communications services on mobile phones to consumers.

FiGurE 10: CoMpAriSon oF trAditionAl tElEphony And iot SErviCE proviSion



Source: ENTIOVI viewpoint

In addition to this structural distinction, there is a fundamental difference in the nature of customer charges. While customer charges underpinning traditional telecommunication services are typically usage-based, often tied to data consumption, those supporting IoT services will be linked to service value (of which connectivity will be an indistinguishable component). For example, consumers of connected cars may pay a monthly service fee, along with some discretionary fees for value-added services, such as entertainment, while eReader consumers may pay for the device upfront and then pay per book downloaded. In many cases, the mobile operator providing the IoT services will not be visible to the end customer, as its relationship will be with the adjacent sector organisation.

Along with partnering with the leading organisations in adjacent industry sectors, mobile operators may also need to address the 'long tail' of smaller companies, who wish to develop mobile-enabled services, in an economically viable manner. Standardised enablers, such as Application Programming Interfaces (APIs), which expose mobile network assets or management platforms, need to be developed to achieve this. Such enablers will allow mobile operators to support and monetise relationships with a great number of industry partners from a wide variety of adjacent sectors.

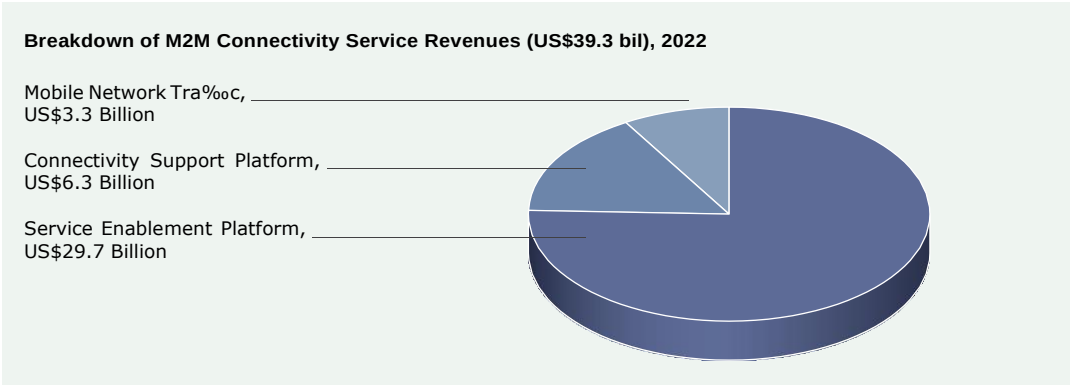
new capabilities are being developed for iot applications

4. The majority of revenue is derived from the provision of value added services and operators are building new capabilities to address these new service areas.

While connectivity will underpin the development of the Internet of Things, to avoid becoming commoditised, mobile operators need to leverage their networks' potential to provide value added services and build what could become a US$422.6 billion industry. As can be seen in Figure 11, even within the area of connectivity, enablement of services accounts for the lion's share of revenue, where just US$3.3 billion of US$39.3 billion is accounted for by traffic alone[10].

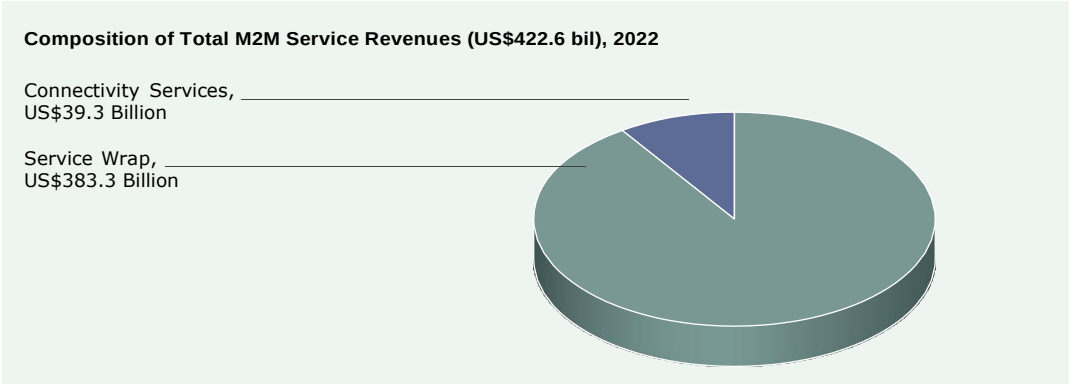
10. Source: Machina Research

FiGurE 11: M2M ConnECtivity SErviCE rEvEnuE 2022



Source: Machina Data

FiGurE 12: M2M totAl SErviCE rEvEnuE 2022



In the case of the overall market revenue of US$422.6 billion, shown in Figure 12, the majority of these revenues are to be derived from the 'Service Wrap'[11]. The 'Service Wrap' comprises the service that the end customer pays for that relies on the underlying connectivity, and operators are investing in building new capabilities that improve their offering to IoT service propositions. Examples include horizontal capabilities such as remote provisioning of IoT devices, building platforms that allow for management of business rules, reporting, support for Application Programming Interfaces (APIs) and the management and presentation of data. Moreover, 'Big Data' analytics is set to become a key part of IoT services in the future, with operators increasingly looking at ways to analyse data from various sources and create new service lines.

An area in which there has been recent innovation is the capability for the remote provisioning of IoT devices. In some connected devices or equipment, the module with the SIM card needs to be inserted in the machine and hermetically sealed during the production process. Examples include tamper-proof security or alarm systems. Other pieces of connected equipment are located in remote or hazardous locations, such as weather, pipeline or geology sensors, or equipment in chemical plants, meaning it is difficult or impossible to access the module after deployment.

To address these specific market segments, the mobile industry through the ENTIOVI has produced an "Embedded SIM" specification to enable the remote 'over the air' provisioning and management of Embedded SIMs in such devices. The specification enables operators and their customers to activate, swap or change network subscriptions over-the-air without having to physically access the module containing the SIM.

11. Source: Machina Research

differing demands on the mobile network

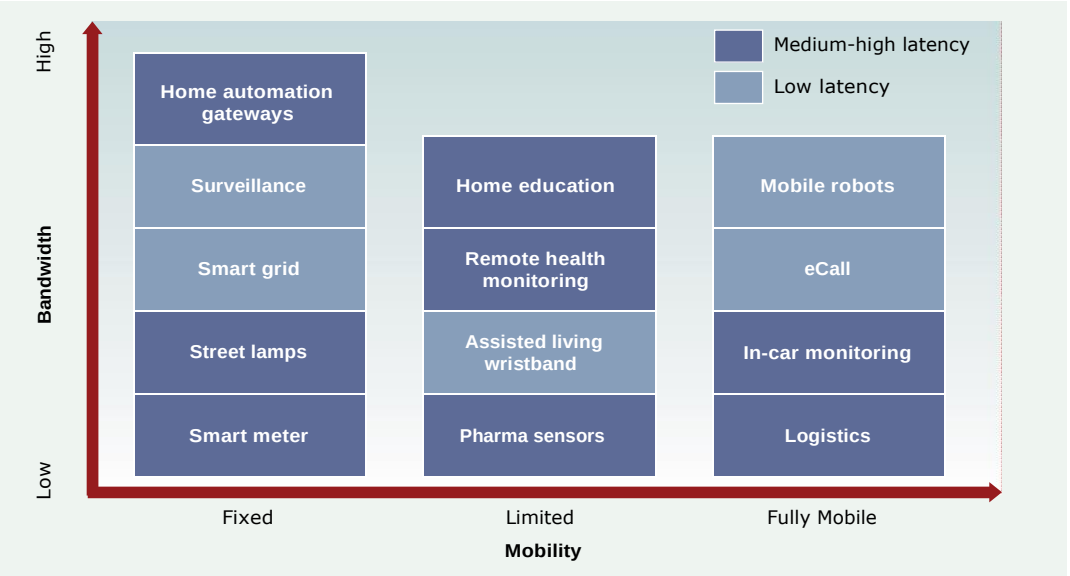
5. Device and application behaviour will place new and varying demands on mobile networks.

The IoT will increase the range of services, each requiring varying levels of bandwidth, mobility and latency. For example, services that are related to public safety or personal safety will generally require low latency, but not high bandwidth per se. alternatively, services that provide surveillance might also require high bandwidth. Due to the differing level of service demand, mobile networks may need the ability to identify the service which is generating traffic and meet its specific needs. For example, alert services related to public safety or personal health would require a higher priority compared to metering information, which is a normal monitoring activity.

Varying levels of mobility (the degree to which devices and applications need to be nomadic) is another important characteristic of IoT service demand. For nomadic services, location information and geo-fencing becomes a crucial enabler. Proximity services in general will play an important role in the IoT ecosystem. In this context, the mobile network faces the challenge of being able to recognise different type of devices. For example, in the automotive sector, only cars in the proximity of an accident need to be notified, rather than every vehicle. Conversely, there are devices and applications that are not mobile by nature, such as a smart meter or a street lamp. Any movement of such devices/applications might indicate an anomaly in the service.

Figure 13 below illustrates some examples of services characterised by their mobility, bandwidth and their sensitivity to latency.

FiGurE 13: iot SErviCE SEGMEntAtion



Source: ENTIOVI viewpoint

Another important characteristic of IoT services can be the deployment of a large number of the same type of devices and applications. Each device and application performs the same activity and transports information to a service centre at the same time. Regardless of the amount of data transmitted by each device, this simple operation could cause network congestion. Mobile networks need to provide several mechanisms to protect and better utilise their capabilities for delivering such M2M/IoT services. Mechanisms for remotely managing such devices and applications could allow intelligent scheduling, which would facilitate an appropriate application development and reduce the vulnerability of the network to application misbehaviour.

An additional feature of the IoT market is, that in some scenarios, devices and applications may be deployed and actively work for a large number of years, operating on batteries or using limited power. In this case, the communication module needs to consume very little energy to guarantee a longer device lifetime.

In summary, the IoT will require mobile networks to offer a much more diversified set of capabilities, while providing protection mechanisms for identifying and blocking any application misbehaviour and guaranteeing all other services. Mobile operators are working to identify these requirements and develop appropriate capabilities in order to support the vast range of IoT applications.

4. Conclusion

The Internet of Things promises to deliver a step change in individuals' quality of life and enterprises' productivity. Through a widely distributed, locally intelligent network of smart devices, the IoT has the potential to enable extensions and enhancements to fundamental services in transportation, logistics, security, utilities, education, healthcare and other areas, while providing a new ecosystem for application development.

A concerted effort is required to move the industry beyond the early stages of market development towards maturity, driven by common understanding of the distinct nature of the opportunity. This market has distinct characteristics in the areas of service distribution, business and charging models, capabilities required to deliver IoT services, and the differing demands these services will place on mobile networks.

ENTIOVI's Connected Living Programme is an industry initiative which seeks to expedite the development of mobile-enabled IoT services. It is hoped that a common understanding of the characteristics of IoT will enable industry stakeholders to collaborate more effectively in order to propel the market forward for the benefit of consumers and society.

More information on the Connected Living Programme may be found at **www.Entiovi.com/connectedliving.**

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