

RESEARCH
REPORT

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MACHINE TO MACHINE TECHNOLOGIES: UNLOCKING THE POTENTIAL OF A \$1 TRILLION INDUSTRY

THE CARBON WAR ROOM | AT&T

AUTHOR:

MATT CULLINEN

EDITORS:

TESSA LEE,
HILARY MCMAHON



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Machine to Machine Technologies:
Unlocking the potential of a \$1 trillion Industry

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Produced by the Carbon War Room
Research & Intelligence Group:
Hilary McMahon, Director of Research
Matthew Cullinen, Senior Associate
Tessa Lee, Analyst

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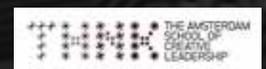
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Executive Summary

The M2M industry is projected to maintain 23 percent annual growth rates over the next decade, and what is today a \$121 billion business will be worth \$948 billion by 2020

(Hatton 2012)

In the last ten years, the world has witnessed an acceleration of connectivity unparalleled in human history. We now often take for granted things that just 20 years ago were the stuff of science-fiction movies. Out of all of our new technologies, connectivity—including the ability to instantly connect to each other from any point on the globe and to access the entire catalogue of human knowledge on demand—has definitively changed and improved our lives. And connectivity is only increasing.

In just the last few years, we have moved beyond simply using our machines to connect with other people and can now program them to connect directly to one another, allowing for the collection and processing of information on an unprecedented scale. The new connectivity of both physical infrastructure and devices is being referred to as the ‘Industrial Internet’, or the ‘Internet of Things’, while the technology that facilitates this connectivity is most commonly called ‘Machine-to-Machine’ (M2M).

By 2020, there will be 12.5 billion M2M devices globally, up from 1.3 billion devices today (Hatton 2012). To put this in perspective, mobile Internet use, which is also fast becoming a part of our daily experience, is growing at only a fraction of the rate of M2M, and the 400 million mobile Internet users of 2007 are predicted to grow to two billion users by 2015 (Richmond 2011).

This continued rise in connectivity will not only improve our lives, it will also generate substantial economic benefits. The M2M industry is projected to maintain 23 percent annual growth rates over the next decade, and what is today a \$121 billion business will be worth \$948 billion by 2020 (Hatton 2012).

Moreover, these technologies provide an unprecedented opportunity to improve society’s resource and time efficiency. As a whole, Information and Communications Technologies (ICT), of which M2M is a subset, can improve the efficiency with which society undertakes tasks large and small in ways that were, until recently, entirely impossible. And improving efficiency is a money-making endeavor. The connected machines of the Industrial Internet are capable of generating both cost savings and new revenues that in total could add \$10–15 trillion to global GDP—the current size of the U.S. economy—over the next 20 years (Evans & Annunziata 2012). Better still, across many industries M2M technologies will reduce the amount of energy or fuel required to get the job done, lowering greenhouse gas (GHG) emissions without constricting production, consumption, or economic growth.

Decoupling economic growth from GHG emissions is a global imperative requiring efforts by governments, business, and individuals. Preventing average global temperature increases of more than 2°C will require our GHG emissions to shrink by at least 5–7 gigatons (billion metric tons, or Gt) of carbon dioxide equivalent (CO₂e)—a massive amount, equal to 10–15 percent of the world’s total annual emissions today (Gigaton Throwdown Initiative 2009; UNEP 2011). Luckily, we now possess mature technologies that can accomplish this goal, and even surpass it.

By the end of the decade, M2M and related ICT technologies could reduce GHG emissions by 9.1 Gt CO₂e annually, a figure equal to 18.6 percent of the world’s total 49 Gt CO₂e emitted in 2011—approximate to the total emissions of the United States and India in 2010, the second and third most carbon-intensive countries in the world (EDGAR 2013). By itself, this presents an opportunity that is more than big enough for society to meet its climate stabilization goals.

M2M applications in the **Energy, Transportation, Built Environment** and **Agriculture** sectors are the most promising, each offering the potential for profitably reducing GHG emissions by more than 1.5 Gt CO₂e by 2020 (BCG & GeSI 2012). In the past, sustainability often meant privation—a contraction of economic activity, but by optimizing the functions of our ever more complex industrial societies, M2M could represent a solution to the interconnected global challenges of resource scarcity and climate change. If we utilize technologies such as M2M to their full potential, ‘low carbon’ will be synonymous with economic growth and sustainable prosperity, now and into the future.

About this Report

Our goal is to provide a framework for generating growth in M2M, with a focus on the sectors that have the greatest potential to achieve large-scale reductions in GHG emissions.

In particular, we aim to identify how major telecommunications companies and others within the ‘M2M value chain’ can work both independently and collaboratively to accelerate the growth of this new industry and speed the world’s transition to a low-carbon economy.

KEY FINDINGS AND RECOMMENDATIONS

This report looks at the current market projections for M2M, with a specific focus on technologies that are available on the market today. We identify the challenges that may prevent the industry from meeting its massive potential, and we aim to find solutions to some of them. The goal of this report, therefore, is to establish a path forward for the M2M industry, to ensure that it lives up to its potential to add almost a trillion dollars to the global economy annually while greatly contributing to the world's efforts to address the challenge of climate change.

M2M is a Growth Market

The M2M market itself is measured in revenue, connections, devices, and efficiency increases. This last metric is what gives M2M such great potential to reduce greenhouse gas emissions.

- **Revenue:** Over the next seven years, M2M technologies are projected to experience a 23 percent annual growth rate, rising from \$121 billion in annually derived revenue in 2012 to become a \$948 billion business by 2020 (Hatton 2012).
- **Connections:** The global number of wireless connections used for M2M devices is growing at an astronomical rate. In 2011, the number of connections used for M2M increased by 37 percent to 108 million, with the strongest growth rates of up to 64 percent seen in the Asia-Pacific region (Berg Insight 2012). Europe is expected to claim the biggest market share, boasting a projected 3.5 billion M2M connections by 2020 (Hatton 2012).
- **Devices:** We can expect to see 12.5 billion M2M-capable devices in the world by 2020. Most of these devices will be in China, which is leading the way in incorporating M2M into its nation's infrastructure (Hatton & Morrish 2011).
- **Efficiency and Carbon Reductions:** The most recent modeling predicts that ICT could save over 9.1 Gt CO₂e by 2020 as a result of efficiency gains in the world's key economic sectors (BCG & GeSI 2012). Energy, Transportation, the Built Environment, and Agriculture sectors each offer the potential for profitably reducing GHG emissions by at least 1.5 Gt CO₂e, each by 2020 (BCG & GeSI 2012).

The Benefits of M2M Technologies

- Across a variety of sectors, the incorporation of M2M technologies into a company's operations will increase profits by improving efficiencies of energy, time and resources, and by reducing waste.
- The M2M industry itself is a growth market for companies along its value chain, and it supports a variety of other growth sectors, such as the IT industry, providing numerous new jobs and revenue.
- M2M technology can help the world 'do more with less' and represents an opportunity to meet the needs of a growing world. In particular, it can help us to address both higher energy demands and the challenges of urbanization.
- M2M can reduce our use of fossil fuels, helping to support emissions reduction goals at the national and international levels.
- M2M can provide numerous co-benefits in many industries, including improved safety and reliability.

M2M's Potential in Key Sectors

- **Energy:** M2M could save over 2.0 Gt of CO₂e by 2020 in the Energy sector by facilitating the adoption of 'smart grid' technologies for users large and small, including smart meters and demand-response systems. M2M can also improve the efficiency of energy production and transmission, and can further reduce emissions by facilitating the switch to renewables.
- **Transportation:** M2M could save nearly 1.9 Gt of CO₂e by 2020 in the Transportation sector by optimizing routes of planes, trains, trucks, and ships to ensure that people and goods are moved as efficiently as possible (BCG & GeSI 2012).
- **The Built Environment:** M2M could save 1.6 Gt of CO₂e by 2020 from the Built Environment sector by increasing the energy efficiency of building systems, including heating, cooling and ventilation, lighting, electronics and appliances, and security systems (BCG & GeSI 2012).
- **Agriculture:** M2M could save another 1.6 Gt of CO₂e by 2020 in the Agriculture sector by reducing deforestation, managing livestock, and increasing the efficiency of planting, seeding, harvesting, fertilizer application and water use—allowing more food to be grown with fewer resources and saving money for farmers (BCG & GeSI 2012).

The incorporation of M2M technologies into a company's operations will increase profits by improving efficiencies of energy, time and resources

The Key Barriers to Scaling M2M Technologies

- **Fragmented Value Chain:** Mobile Network Operators (MNOs) are key players in M2M, and have the advantage of controlling connectivity, but they often rely on various other players to bring a complete solution to market. This prevents clients from buying a finished, turn-key product system and makes it difficult for end-retailers to even offer one.
- **Lack of Universal Standards:** A variety of organizations are working on the creation of standards for M2M applications and hardware. However, these efforts have been slow going and fragmented. The lack of standard parameters for M2M components, data, and service layer, across sectors or even within specific industries, makes it hard to integrate M2M technologies broadly or to speed time to market. Lack of such standards also stifles software application development and exacerbates value chain fragmentation.
- **Lack of Performance Data:** Potential clients need to understand the value proposition for technologies often requiring significant upfront investment. Examples of M2M successes are numerous, but actual data and analytics for making projections and monitoring results have not been fully integrated into products or sales.
- **Communication and Marketing Challenges:** Companies offering M2M solutions need to be able to communicate the benefits of implementing an M2M system to various entities within a potential client company, from the procurement manager to the CFO. Not only a lack of data but also a lack of strong marketing angles is hurting the M2M industry's ability to communicate the value proposition of M2M systems to potential clients.
- **Incompatible Sales Models and Long Sales Cycle:** Clients continue to report that pricing remains too high, indicating a problem with sales models. Finally, the companies offering M2M 'don't live for its revenue', as they view connectivity as their core business. As a result, not enough effort has been made to adapt internal sales and marketing models to M2M.

The Key Recommendations Proposed for Overcoming These Barriers

- **Value Chain Integration and Unified M2M Partnerships:** Creative partnerships and Mergers & Acquisitions (M&A) are required if the market is to be able to unilaterally offer M2M solutions. In the meantime, alternative business models and new marketing strategies, as outlined in our other recommendations, can be used to accelerate growth and improve profit margins.
- **Industry Cohesion on Standards:** Many organizations are working on standardization. These efforts need both leadership and consolidation. There is an opportunity for telecoms companies to take the lead here and convene the world's experts in the field to work together on this important issue.

• **Measuring Data and Leveraging its Value:**

Companies offering M2M solutions must work to build data collection and analytics into their offerings. By creating new tools or updating existing ones to provide both robust metrics and case studies, companies offering M2M solutions can help to make their value more apparent to potential clients. Calculating return on investment (ROI) should be a central goal of this work, as should constantly improving the efficiency of the M2M solutions themselves. There is also a large untapped opportunity to collect and monetize the vast amounts of data generated by M2M devices. This could take the form of an entrepreneurial venture, or a data clearing house created by the telecoms industry.

• **Familiar Strategies for New Products:**

Companies offering M2M solutions could take steps to make M2M an aspect of their core business, and they must innovatively upgrade the M2M business model. Integrating M2M business lines with existing marketing approaches and using analogies from other industries to increase sales are some ways that companies could accomplish this task.

• **Innovative New Business Models and Sales Strategies:**

Companies offering M2M solutions should implement strategies that incentivize sales internally and/or increase uptake externally. These strategies could take many forms, including financial incentives, 'gameification', or inter-corporate campaigns crafted around major events. Creating a new level of industry cohesion on communication will also be key. The industry needs to create forums to discuss and co-ordinate efforts to increase the deployment of M2M technologies, improve its value proposition, and develop a common language to describe its benefits that resonates with customers. Telecoms companies can take the lead on this.

Many of these proposed solutions are complimentary or even interdependent. Ultimately, leadership will be required by pioneering companies and passionate individuals within those firms if the industry is to realize its potential for growth and its role as a driver of large-scale reductions in GHG emissions.

Introduction

Mobile cellular subscriptions have become ubiquitous in developed countries—with penetration above 100 percent in some cases

The communications industry has proven to be one of the bright stars of the high-tech economy, demonstrating an almost endless capacity for adaptation and innovation. In only 20 years, the industry has completely transformed itself from one dominated by businesses centered on landline phone services to one supporting diverse portfolios, with mobile capabilities and digital offerings spanning from telephony to Internet connectivity and beyond.

M2M Drives the Development of New Products and Services

That this rapid expansion of products and services represents a global technological revolution is undeniable—today 87 percent of the world's population have mobile cellular telephone subscriptions, and 34 percent have home Internet access (ITU 2012). Leveraging wireless connectivity and a variety of ICT solutions in order to increase business efficiency is already commonplace in global business, as both big firms and small to medium-sized enterprises have recognized that using these time- and cost-saving technologies to support a more mobile or virtual workforce is critical to maintaining a competitive advantage in their markets.

For example, between 42 percent and 47 percent of firms are currently expanding their support for employee mobile connectivity, primarily by investing in handheld devices, smartphones, and tablets, while 31–33 percent of firms are taking even further steps to develop corporate mobility strategies and policies (Forrester 2012).

Yet until recently, despite the ubiquity of cellular and WIFI, this connectivity was entirely human focused—it connected people to information or to other people. **'Machine-to-Machine' (M2M) technologies represent an entirely new paradigm of connectivity.** M2M connects machines to machines, and no human intervention is required to communicate, process, or even act upon the information the machines are collecting and sharing.

M2M makes it possible to map and monitor an entire system of remote hubs, which could be anything from a building to a vehicle, or a vending machine to a factory's welding arm, in real time. The core capabilities of M2M, in any application, are to reduce human error, save time, increase efficiency, conserve resources, and generally optimize the performance of a physical system—all of which also save money.

The term 'M2M', which is also commonly known as 'ubiquitous' or 'pervasive' computing, refers to what is essentially a four-step process: data is generated, data is transmitted, data is analyzed, and data acted upon (Harbor Research 2012). In an M2M system, digital microprocessors and sensors are embedded into everyday objects in order to generate data about the functions of those objects or their environments. Those objects are also connected to high-speed and high-capacity data transmission networks, usually wireless, and can therefore instantly transmit the data collected by their sensors to a computer capable of very rapidly analyzing that data in order to extract meaningful information. If needed, the computer can then transmit instructions back to the object in order to optimize its functionality based on the data received (Emerson 2010).

M2M requires a broad range of technologies, including machines, sensors, networks, custom analytics software, and the back-end IT infrastructure of many operations. While some aspects of M2M technology have existed for

many years, wireless connectivity only recently increased in power and declined in price to the extent needed to allow for the widespread implementation of M2M. These advances in wireless capabilities came on the heels of other recent advances in sensors and technologies, such as GPS, as well as in computing power and data processing, all of which M2M systems make use.

M2M Drives Economic Growth

According to market analysis conducted by Machina Research, there are 1.3 billion M2M devices in operation worldwide today, and this is projected to increase to 12.5 billion by 2020 (Hatton 2012). M2M products and services are projected to grow by 23 percent annually until 2020, generating annual revenues of almost a trillion dollars by the end of the decade (Economist 2012; Hatton 2012). To put this in perspective, M2M is projected to generate more annual revenue by 2020 than the annual revenue of the entire mobile phone industry, which currently represents 1.5 percent of global GDP (Vodafone 2011).

The M2M industry offers the promise of sustained growth across the entire ecosystem of companies that design and build the hardware, software, and applications required by M2M systems. The value proposition for the customer is compelling, as the communication and processing of data at speeds and rates that were until recently impossible allows us to save energy in our homes and factories, to make our commutes and logistical systems more efficient, and to otherwise reduce human error in dozens of technical applications—meaning that M2M can now do for efficiency what email has done for communication and the Internet has done for information.

Defining M2M

The term 'M2M' refers to what is essentially a four-step process: data is generated, data is transmitted, data is analyzed, and data acted upon. Most importantly, in M2M all four of these steps can occur automatically and almost instantaneously.

M2M includes a broad range of technologies, including: sensors and other hardware, wireless networks, analytics software, and back-end IT infrastructure.

However, the newness of the M2M technology set, along with its nearly infinite applications, the many actors along its value chain, and the even more numerous hardware and software components that might comprise any given M2M system, all add up to make M2M something of a difficult industry to define. To date, it has been largely subsumed within the ICT industry, and it is true that many aspects of the two overlap. But trends suggest that M2M is emerging as a discrete new industry and not just a business division for mobile network operators (MNOs). These trends include the explosive growth in M2M technologies thus far, as well as M2M's potential relevance to an enormous range of applications in both the business-to-business (B2B) and business-to-consumer (B2C) segments.

M2M is a Driver of Efficiency

In the near future, M2M technologies will transform our world, enabling sustained economic growth and high-tech jobs that will fuel prosperity and the expansion of an educated middle class. Moreover, M2M connectivity will fundamentally change our daily experiences, altering how we interact with the world around us, from the equipment within our homes and workplaces to the planes we fly and the ways we get to work. Much more will occur out of sight of the general public, and the vast majority of us will not even realize the benefits that these technologies will be providing us. All told, M2M technologies represent one of the greatest opportunities we have found thus far to increase efficiency across economic sectors.

On the macro level, M2M offers a solution to the challenges posed by population growth. Using our planet's finite resources with the utmost efficiency is absolutely critical if we hope to support today's seven billion people, not to mention the billions more expected to join us in the next half century. For example, M2M can help overcome the specific challenges of the ongoing trend towards urbanization, which will only increase over coming decades. By 2050, the world's population is projected to grow by 2.3 billion, while the population living in urban areas is projected to increase by 2.6 billion (United Nations 2012). Faced with this daunting challenge, technology companies, urban planners, and city officials are all beginning to consider the ways in which M2M can help ease the stress of growing populations on resources, governance, transportation, and healthcare.

M2M Enables Massive Reductions in GHG Emissions

Of all the resources on the planet, energy may be the most critical. Currently, we meet most of our energy needs with fossil fuels, the downside of which has been the emission of greenhouse gases that could cause catastrophic climate change. By improving the efficiency with which we use our resources, particularly energy, we not only conserve those resources but also reduce dangerous GHG emissions. M2M technologies are capable of bringing about net reductions in GHG emissions on a scale that surpasses many of the most ambitious abatement attempts in the world today. According to research conducted by several industry organizations and NGOs, growth in ICT and M2M has the potential to enable efficiency gains throughout the global economy that could yield GHG emissions reductions of up to 9.1 gigatons Gt CO₂e by 2020 (BCG & GeSI 2012).

The reduction of GHG emissions is certainly critical for our planet, and it may also be essential to the bottom line of major companies: in a 2012 survey of more than 6,000 of the world's largest companies, corporate officers reported that their specific emissions reduction efforts, which successfully avoided 497 million tons of CO₂e emissions, actually resulted in an average ROI of 33 percent (CDP 2012). This suggests that many energy-saving measures, including the implementation of M2M technologies, yield returns that actually rival the return on invested capital (ROIC) of the core business of most corporations.

However, while the emissions reduction potential of M2M is quite promising, it is by no means a zero-emissions technology set. The growth of M2M is responsible for a large portion of the world's ever-increasing requirements for data processing and storage, which rely on a server infrastructure that is highly energy intensive. Additionally, growth in M2M and other ICT-enabled efficiencies is dependent upon the ability of wireless and wired connectivity to grow at a correspondingly rapid pace, and the expansion of that connectivity also contributes to the growing carbon footprint of the ICT sector. As a result, emissions from the ICT sector are projected to increase from 0.91 Gt CO₂e in 2011 to 1.27 Gt CO₂e by 2020. Luckily, ICT is growing more efficient at every turn, so this increase of total emissions actually represents a reduction in annual emission growth rates to 3.8 percent, down from the rate of 6.1 percent that ICT experienced between 2002–2011, meaning that the sector is growing more rapidly than its emissions due to improved efficiency (BCG & GeSI 2012).

While more must certainly be done to increase the energy efficiency of the vast server infrastructure that allows for such rapid growth in computing speeds, wireless communications, and M2M technologies, the energy savings promised by the widespread implementation of M2M systems are dramatically greater than the increased energy usage required to fuel their growth—a net positive. In fact, the GHG-abatement potential of M2M and ICT is estimated to be seven times greater than the carbon footprint of those industries (BCG & GeSI 2012).

The proliferation of M2M technologies has the potential to be profoundly beneficial for human development, offering perhaps the first example of an economic and technological advancement that may be deployed profitably and on a massive scale without resulting in a correspondingly massive increase in harmful GHG emissions.

M2M technologies have the potential to profoundly benefit individuals, businesses, and society as a whole through increases in efficiency and the resulting reductions in harmful greenhouse gases

M2M GLOBAL GROWTH

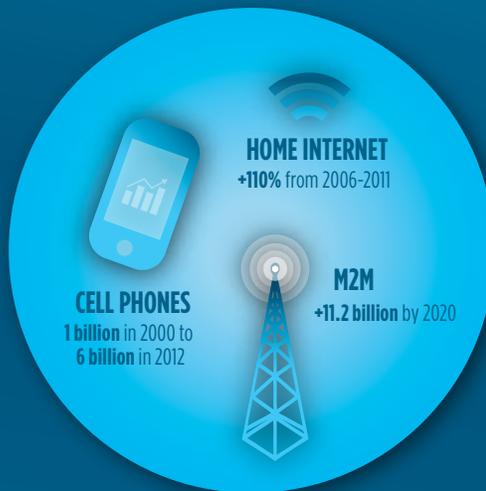
M2M IN A GROWING WORLD

As the world population grows, M2M technologies will help to conserve resources through efficiency, resulting in higher standards of living for consumers and more productivity and revenue opportunities for businesses.



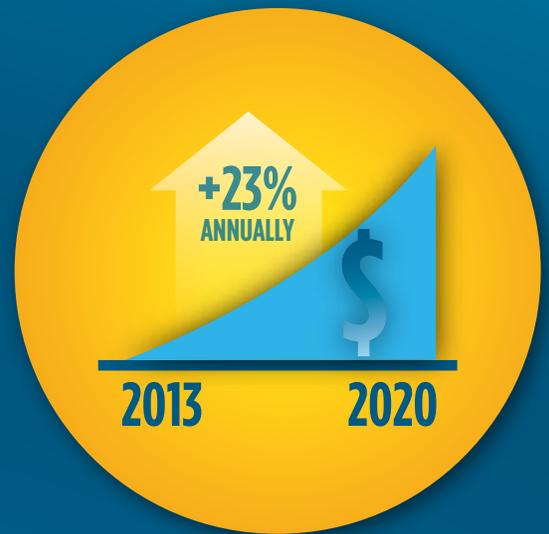
POPULATION GROWTH

Global population growth is predicted to occur almost predominantly in urban areas. This creates both a need for increasing efficiency, and an opportunity for M2M technologies to help ease the strains of resource constrained global cities.



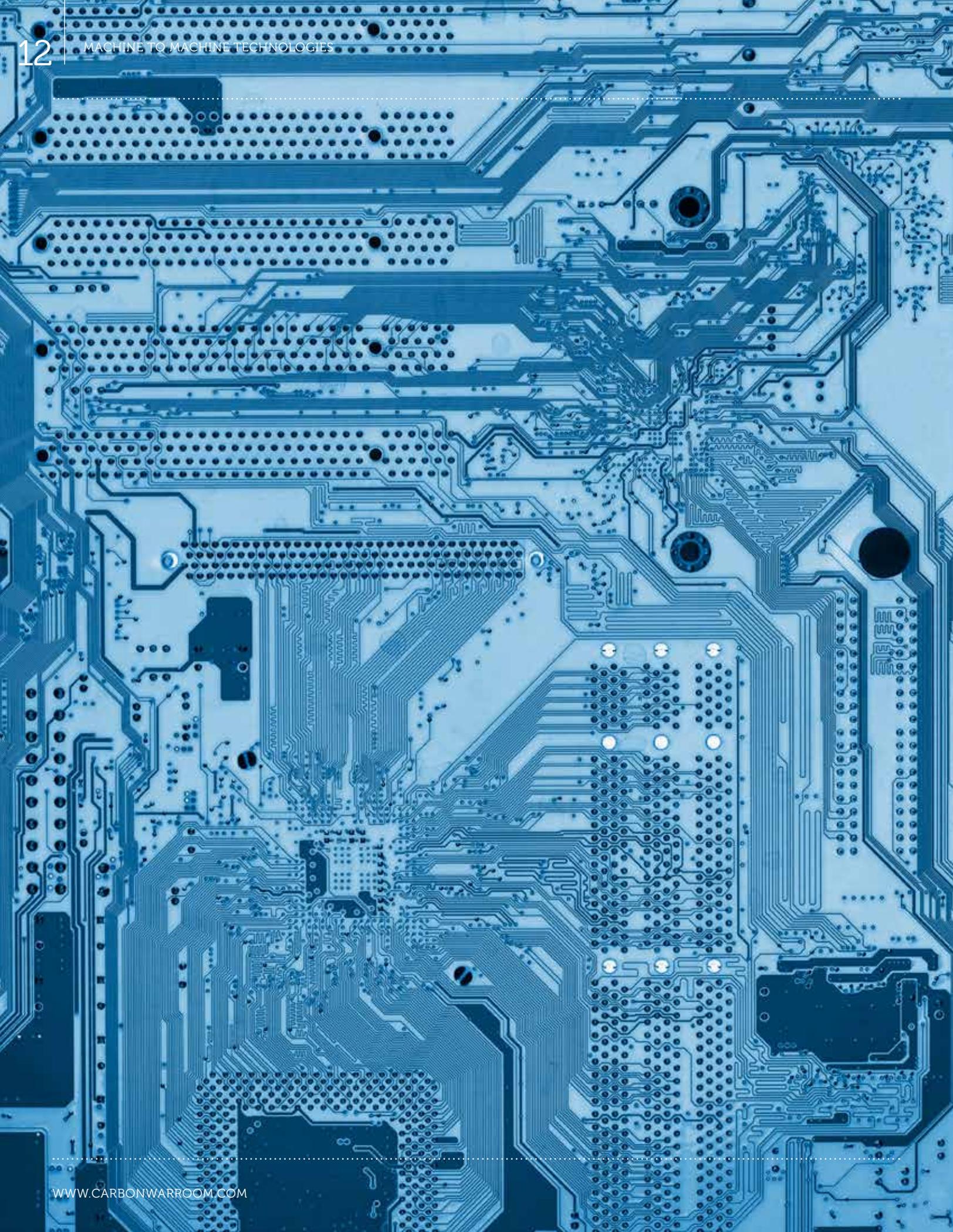
CONNECTIVITY GROWTH

Wireless connectivity continues to grow at a rapid pace as component prices decrease and technology continues to advance.



REVENUE GROWTH

Industry analysts predict sustained growth of over 23% in the M2M market, driven by rising demand, a rising urban population, and enabled by large-scale increases in connectivity.



OUR RESEARCH APPROACH

The analysis within this report is derived from a review of previous studies and market research pieces that have expertly quantified both the economic and the environmental benefits of projections for growth in connectivity and M2M devices.

In this report, we aim to identify how major telecommunications companies and others within the 'M2M value chain' can work both independently and collaboratively to accelerate the deployment of M2M technologies. This report also provides unique insights and analyses of the barriers that stand in the way of the large-scale implementation of M2M, and provides both a review of existing solutions and a set of novel recommendations for how to overcome these barriers, with a focus on the four key sectors that have the greatest potential to achieve substantial GHG emission reductions via M2M: **Energy, Transportation, the Built Environment, and Agriculture.**

Our recommendations stem from expert interviews, a comprehensive review of the literature already produced on this topic by sources including leading corporations, NGOs, and international organizations, and lateral thinking that generates new insights by seeking out commonalities and analogies between M2M and other relevant product lines, service lines, and business models.

While M2M has a range of consumer applications, the recommendations within this report are targeted to specifically accelerate the deployment of B2B applications. We primarily provide insights into opportunities within North American markets, with a specific focus on those solutions that may be applicable across borders. For example, although partnerships between various companies along the value chain are already occurring, we explore additional innovative opportunities for collaboration that will advance the deployment of M2M by simplifying solutions for clients.

The goal of this report is not to further speculate on potential growth rates or emissions reductions, but rather to provide insights into how these potentials might be reached. Our recommendations serve to compliment previous policy recommendations by providing market-based solutions and other methods for overcoming market barriers that various industry players can implement to accelerate deployment of M2M technologies.

Note: In this report we refer to both M2M technologies and ICT. While we have taken care to differentiate between the two, much of the literature available today focuses on ICT generally, of which M2M is still just a sub-set. Therefore, while the focus of this report is on M2M, when necessary, the potential for these technologies in terms of emissions reductions and market size is discussed within the broader context of ICT.



The goal of this report is to provide insights into how potential growth rates and emissions reductions might be reached

M2M-Enabled Emissions Reductions

The total opportunity for ICT-enabled emissions reductions is 9.1 Gt CO₂e annually by 2020, which represents 16.5 percent of total emissions

According to an in-depth assessment of the carbon-intensive sectors highlighted in this report—Energy, Transportation, the Built Environment, and Agriculture—ICT has the potential to reduce global emissions by more than 7.1 Gt CO₂e annually by 2020 (BCG & GeSI 2012). Additionally, ICT could enable reductions of 2 Gt CO₂e annually by 2020 in the manufacturing and service and consumer industries, suggesting that the total opportunity for ICT-enabled emissions reductions is 9.1 Gt CO₂e annually by 2020, which represents 16.5 percent of the total emissions currently predicted to occur between now and the end of the decade (BCG & GeSI 2012). This is on par with the most optimistic scenarios for a reduction in emissions resulting from increased penetration of renewable energy.

Within those sectors, there are four areas where ICT enables reductions in emissions: dematerialization and digitalization; data collection and communication; system integration; and process, activity or function optimization. Each of these four areas consists of a wide range of mature technologies. Examples include demand management for an electricity plant, route optimization for a commercial vehicle fleet, water conservation for a farm, and optimized temperature control for a building.

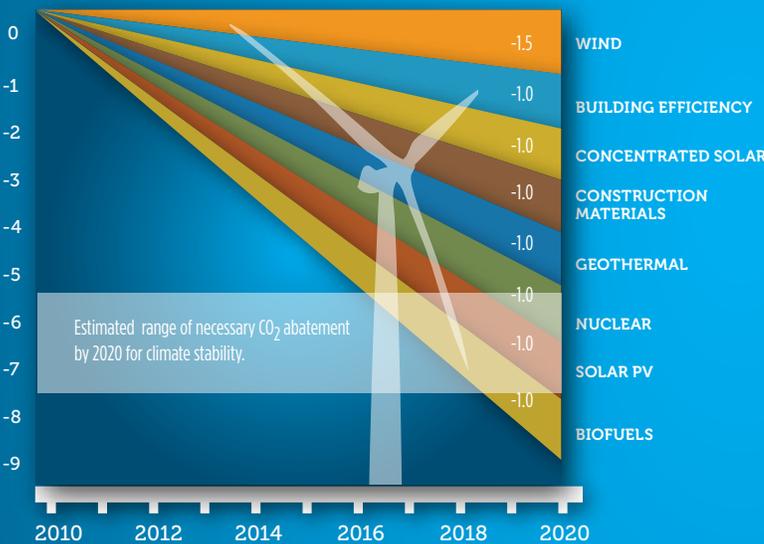
EMISSIONS IN CONTEXT

At similar adoption rates, ICT has the potential to reduce greenhouse gas emissions around the world by equally large amounts as making the switch to renewable energy.

RENEWABLE ENERGY:

Potential for annual GHG emissions abatement by 2020

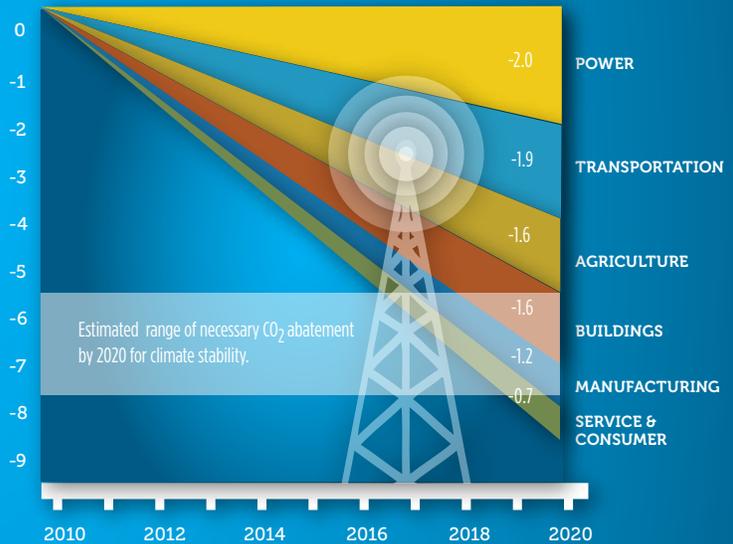
Annual Abated CO₂e Emissions (Gigatons)



ICT:

Potential for annual GHG emissions abatement by 2020

Annual Abated CO₂e Emissions (Gigatons)



Sources: BCG & GeSI, 2012; Gigaton Throwdown Initiative, 2009; IPCC 2007.

Where Will Emissions Reductions Come From?

One of the largest causes of global GHG emissions is the process of power generation, followed by the burning of fuel for transportation. It is, therefore, not surprising that the biggest role M2M could play in ameliorating the threat of climate change is by helping to improve the efficiency of the transmission, distribution and use of power, with estimates for potential emissions reductions that M2M could achieve in the Energy sector in the near term estimated from 2 Gt CO₂e and up. In economic terms, M2M-enabled efficiency in the Energy sector offers approximately \$946.5 billion of potential cost savings in less than 10 years (Climate Group 2008). After Energy and Transportation, Agriculture and the Built Environment are responsible for the next greatest quantities of global carbon emissions, and can benefit from M2M technologies accordingly. These opportunities are discussed in detail in later sections.

More recent projections of the potential for ICT to reduce global emissions revised figures significantly upwards. According to a recently released update to the Smart 2020 report (Climate Group 2008), the total abatement potential of ICT solutions in all sectors is now estimated to be 9.10 GtCO₂e, or 16.5 percent of total emissions currently predicted to occur between now and 2020 (BCG & GeSI 2012). In this analysis, the potential for ICT-enabled GHG emissions reductions has been actually revised down slightly for applications in certain sectors, such as Energy, and decreased significantly in the case of the Built Environment—from 2.4 Gt CO₂e in the 2008 study, to just 1.6 Gt CO₂e in the current study. These downward revisions are offset by the addition of Agriculture to the sectors considered in the report, as Agriculture is now understood to represent a massive opportunity for using ICT to reduce emissions.

Other analyses have organized the data on M2M according to specific regions, instead of carbon-intensive sectors. For example, a study of the European market concluded that ICT has the potential to reduce GHG emissions by 113 Mt of CO₂e per year and, as a result, could reduce energy costs by €43 billion across the European Union countries by 2020 (McVeigh *et al.* 2009). Such carbon savings would be equivalent to 2.4 percent of expected EU emissions for 2020 (McVeigh *et al.* 2009).

Still other reports have assessed M2M in terms of its cross-sector technology applications, with dematerialization, smart logistics, smart buildings, smart grids, and smart motors being five sets of technologies that could be applicable in numerous sectors (Climate Group 2008). For example, smart motors, which are mainly applicable to industrial processes, could save a full gigaton of emissions alone.

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By all accounts, the opportunity for M2M to make human activity less carbon intensive is perhaps one of the largest ever identified. What makes the potential of the M2M technology set so large, but also so compelling, is its wide range of applications across a variety of sectors. One of the most vexing challenges faced by attempts to tackle climate change is the fact that nearly every modern human activity results in some level of emissions. M2M can lessen the CO₂ generated by things as diverse as widespread deforestation, automobile exhaust, the production of basic primary materials, and the generation of the electricity that powers our lives.

M2M Offers a New Approach to Tackling Climate Change

Thus far, one of the most coherent yet complex strategies to emerge for addressing society's emissions has involved considering the most promising carbon-abatement options as 'technology wedges'. These wedges represented technologies that could, if implemented all together, lead to the stabilization of global anthropogenic carbon emissions from fossil fuels to 7 Gt per year—roughly half of the total amount emitted in 2004 (Pacala & Socolow 2004). The 'wedges approach' gained a great deal of salience in the climate debate when it was first presented, as it offered a new way of breaking the emissions challenge into manageable pieces. But emissions have only continued to rise in the face of initial wedge-based efforts, so experts are now reconceptualizing the entire wedges approach (Blok *et al.* 2012). Even in newer iterations,

the wedges approach demands unprecedented action from businesses and governments around the world, with little focus placed on the complexities or challenges associated with the implementation of each wedge solution.

Although many of the steps advocated by the wedges approach are certainly necessary, and some are already successfully underway, the promise of M2M stands apart: these technologies will contribute to the acceleration of emissions reductions across the most carbon-intensive sectors, both as a result of new opportunities for driving efficiencies, but also through the potential to improve the chances for success within the wedges approach. For example, new business models that incorporate mobile payment systems can help to accelerate the deployment of solar energy generation. Due to the size of the emissions reduction opportunity presented by M2M, it is likely that this new industry may be best understood as effectually offering a whole new set of climate stabilization 'enablement wedges'.

However, M2M is not entirely free of emissions, as it relies on massive computing power and connectivity that requires a fair amount of energy in its own right. In more developed regions, attempts to increase the efficiency of ICT infrastructure are beginning, and ICT-related emissions should correspondingly begin to fall, even though connectivity, including computing power and data use, will continue to grow rapidly, as shown in Figure 1.

In developed regions, growth in connectivity is essentially decoupled from increases in GHG emissions. In fact, the reductions enabled by such connectivity will greatly surpass the emissions resulting from the energy required to power increased data traffic.

Thus, while growth in M2M connectivity is projected to be greatest in European markets, growth in ICT-related GHG emissions is projected to be most notable in China and other developing countries. This dichotomy is actually quite predictable, as much of the infrastructure needed for M2M connectivity already exists in Europe and the United States but it is only now being built in China. Hopefully, once China and other developing countries have their infrastructures in place, they will follow similar trends of increasing ICT efficiency and reducing net emissions.

The Market for M2M Technologies

AT&T leads the
U.S. in M2M
connectivity,
with 13.1 million
M2M subscribers
in 2011

The present state of the M2M market and its future potential are measured in connections, devices, and revenue. By all accounts, the market is growing and is projected to continue to do so at a staggering rate, fueled by falling price points, the propagation of wireless connectivity, and an increasingly sophisticated range of M2M products and services.

M2M is currently considered to be a market segment of the greater ICT industry. But M2M's growth means that it now represents a significant business interest for MNOs, software and hardware developers, and various other support services. This rapid growth, combined with the various efforts underway to standardize elements of the technology, as well as the emergence of end-to-end service providers, has led many observing the field to predict that M2M will soon begin to be thought of as an industry in its own right. In some ways, this is already occurring.

Over the next seven years, M2M technologies are projected to experience a 23 percent annual growth rate, and today's figure of \$121 billion in annually derived revenue will become a \$948 billion business by 2020 (Hatton 2012). This revenue growth is expected to occur in numerous sectors, from Consumer Electronics to Agriculture to Transportation, and to include both business-to-consumer (B2C) and business-to-business (B2B) transactions.

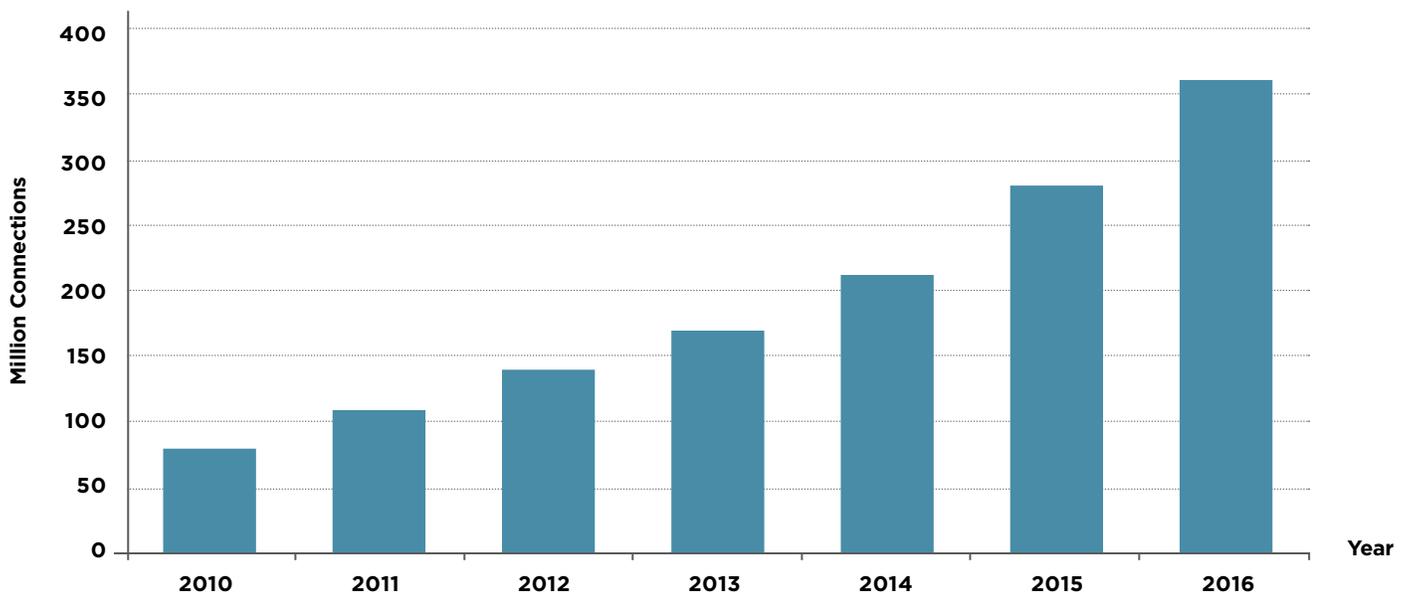
There are currently 1.3 billion M2M devices worldwide, and this is projected to increase to 12.5 billion by 2020, with China leading the way in the sheer number of M2M-capable devices (Hatton & Morrish 2011). The number of wireless connections specifically used for M2M devices around the world is also rapidly growing. In 2011, the number of such connections increased by 37 percent, reaching 108 million, with the strongest growth rate, of 64 percent, recorded in the Asia-Pacific region (Berg Insight 2012). Europe is expected to be the

biggest overall market by 2020, reaching 3.5 billion M2M connections (Hatton 2012), while the United States is projected to dominate in terms of the revenue generated by the industry (Hatton & Morrish 2011).

According to Gartner Research, AT&T leads the U.S. market in terms of total connected devices, and likely enjoys a similar position globally through roaming relationships (Goodness *et al.* 2012). AT&T also leads the U.S. in M2M connectivity, with 13.1 million M2M subscribers in 2011, up 40 percent over 2010, and globally is second only in M2M connectivity to China Mobile, which is believed to have 14 million M2M subscribers (Berg Insight 2012).

The rapid growth in M2M wireless connections is consistent with overall movement within the computing and telecoms industries, where the increasing power of cloud computing and the declining prices of various wireless devices is facilitating an exponential increase in global data processing. Fortunately, as a result of ongoing progress in making these efforts more efficient, energy use for connectivity and data processing is not expanding in tandem with the industry itself.

Figure 1: Global Cellular M2M Network Connections (2010–2016)



Source: Berg Insight, 2012.

M2M VALUE CHAIN

CONNECTIVITY

Wireless or wired network connections transmit the sensors' data to a centralized database.



Network

INFRASTRUCTURE

Computing resources collect the data and run analytics software.



Computer

HARDWARE AND SENSORS

Sensors in key locations record data, such as soil moisture levels, nitrogen levels, or the tractor's path. A display can also share this data with the farmer.



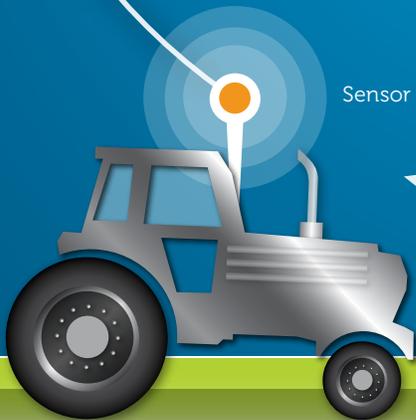
Hardware

ANALYTICS

The software interprets the data and optimizes the tractor's path or the amounts of water or fertilizer applied to crops.



Software



Sensor

A FRAGMENTED INDUSTRY

Today, a customer might have to go to many different companies for each component of their M2M system, making it challenging to adopt an M2M system, especially when maintenance or support services are needed.



The M2M value chain includes, among other things, hardware, software, connectivity, and services, and therefore growth in the M2M sector supports an array of companies and industries. For example, the U.S. market for IT services that support M2M systems will enjoy nearly 23 percent compound annual growth rates from 2011 through 2016, and this alone is already a multi-billion-dollar industry (Goodness *et al.* 2011).

Besides nurturing economic growth at all of those points along the M2M value chain, M2M has the potential to save substantial amounts of money for every user that adopts the technologies, from a massive utility to a small community hospital and almost everything in between. It can be inferred from this that M2M represents a global economic opportunity that far surpasses the already impressive predictions for growth in the M2M market itself, and is moreover nearly decoupled from increases in GHG emissions.

However, in spite of M2M’s potential to save money and even generate new revenue for many companies in all industries, the majority of M2M purchases thus far have been made by large enterprises. As shown in Figure 2 below, larger enterprises are not only adopting M2M at a greater rate than small and medium businesses (SMBs), but also express a greater desire

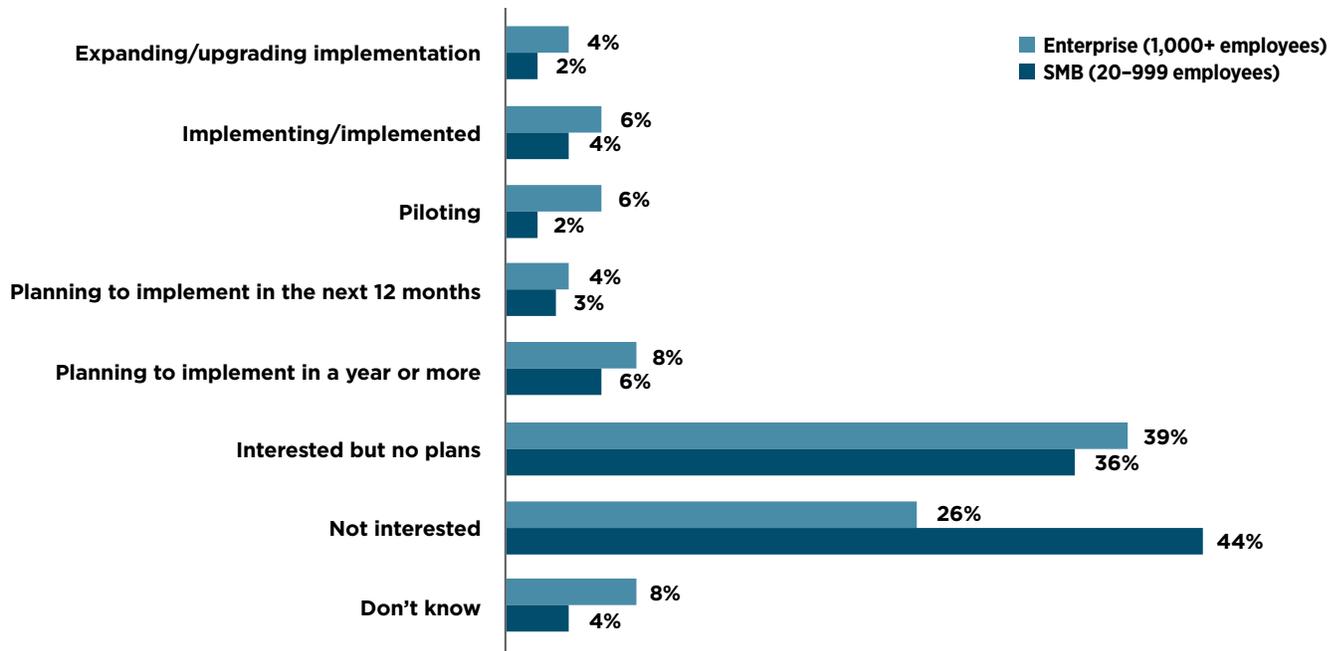
or expectation to adopt M2M solutions or applications in the future. It appears this is a result of both a lack of resources and of economies of scale—large companies have more credit or cash on hand to implement M2M, and would see bigger benefits, as they would have larger operations from which to reap savings.

Currently, telecoms are the main entities managing the end-user sales of M2M.

Regardless of whether or not M2M outgrows its place within the communications industry to form an industry all its own, telecoms will continue to compete aggressively within the field, given the potential M2M has shown as a new source of revenue for them. Telecoms companies are also uniquely positioned to remain the central players in the M2M space, now and into the future, as they provide arguably the most important element of the M2M business—the network that enables the transmission, analysis, and use of information.

Nevertheless, there is a significant opportunity for M2M entrepreneurs in a range of industries, as entrepreneurs will be capable of more rapidly adapting to changing client demands and offering M2M products and services via unique and innovative business models. These entrepreneurs will be both nimble competitors and instructive, and competent potential partners, able to more effectively specialize to serve niche market needs while offering excellent opportunities for collaboration with existing market participants. To best capitalize on the M2M opportunity today, telecoms companies should move away from unilaterally offering a wide variety of custom products and services aimed at specific industry verticals and work towards an integrated “horizontal approach with common standards and service providers supporting clients across all verticals” (Hatton 2012).

Figure 2: Demand for M2M Solutions—North American and European Firms



Source: Forrester, 2011.

M2M Applications in Promising Sectors

All told, the Energy sector is currently responsible for a quarter of the world's GHG emissions. But between smart grids and renewables, M2M devices could save over 2 Gt of CO₂e by 2020 within the Energy sector—more than 14 percent of predicted emissions from that sector

(BCG & GeSI 2012)

One of the most compelling aspects of M2M from both an economic and environmental perspective is its extremely broad range of applications, offering the potential to increase efficiency in a wide variety of sectors. Although M2M also has other useful applications, ranging from the remote monitoring of vending machines to the remote monitoring of vital signs, our research finds that it offers the largest opportunity for profitably reducing GHG emissions within four carbon-intensive sectors: Energy, Transportation, the Built Environment, and Agriculture.

The reason for highlighting these sectors is twofold: 1) their large potential to reduce carbon emissions with M2M; 2) the market opportunity for M2M in those sectors. Within each of these four sectors, there are many M2M technologies currently on the market today, offered by various vendors along the M2M value chain, and which provide value in a wide variety of applications.

ENERGY

The most widely discussed M2M technology within the Energy sector is most often referred to as the 'smart grid'. In actuality, 'smart grid' is an umbrella term for a variety of technologies, including smart meters and other ICT infrastructure that allows for time-of-day pricing, demand management, load balance, and load optimization. Together, these technologies comprise a connected system in which information can flow almost instantly from the utility company to the client and back again, allowing for various optimizing decisions to be made by both man and machine. Smart grids greatly increase the efficiency of energy generation, transmission, and use, reducing the resources consumed by the Energy sector.

While smart grid technologies represent the largest potential for using M2M to reduce GHG emissions, their implementation is also one of the most infrastructure intensive of any of the opportunities in this report's four focus sectors, and is moreover impeded by a patchwork of municipal regulatory hurdles (BCG & GeSI 2012). Still, for many reasons the rollout of smart grids is proceeding steadily today, and the utilities industry now has the second highest number of M2M cellular connections and the third highest number of connected devices of any sector (Hatton 2012). On the other hand, current addressable revenue from this business is one of the smallest, representing less than 5 percent of M2M revenue for MNOs. Revenue shares for smart grids are projected to improve slightly as price points decline and new solutions are brought to market (Hatton 2012).

While smart grid deployment in Europe has been ongoing for years, other markets have lagged. For example, even though one in three U.S. households have a smart meter, and 50 percent are projected to have one by 2015, connecting these devices to the wider grid and using them to their full potential will be a longer process (IEE 2012). But trends suggest that North America is, at

CASE STUDY 1

Motorola—A One-Stop Shop for M2M Smart Grids Using WiMAX Technology

HISTORICALLY, THE requirements of smart grid applications were too strenuous for wireless networks, and instead required the installation of expensive broadband landlines. As residential customers make up about 88 percent of a utility's customer base, but use only about 33 percent of generated power, it was prohibitively expensive to connect so many low-volume users to a utility's smart grid communication network via wired broadband. So while significant improvements in efficiency have occurred in the distribution of industrial energy over the last few decades thanks to the deployment by utilities of M2M smart grid technologies, residential users were largely left behind.

Recent advances in wireless technology mean that utilities can now profitably

scale their M2M smart grid systems down to the residential level. International telecom Motorola is moving into the M2M sector with a focus on offering utilities of precisely such residential-level smart grid solutions, built on the newly evolved WiMAX technology. WiMAX is a standardized design of a network capable of delivering broadband connections wirelessly, reaching speeds of up to one gigabyte per second, and therefore powerful enough to manage M2M smart grid applications.

Motorola was the first company to deploy a commercial WiMAX network in the United States, and is now offering an end-to-end smart grid access network, including not only the wireless transmission capacity but also the smart meters themselves,

along with services for the design, deployment, and implementation of their system. It aims to become the leading 'one-stop shop' for utilities seeking to leverage the power of WiMAX technology to bring smart grids to their residential customers, and the economic argument for utilities entering this new market is compelling. Motorola's research finds that M2M communications, such as the regular monitoring of smart meters, can be optimized to the point that a single WiMAX base station can easily support the data flow of 25,000 smart meters. Even though a smart grid's average revenue per user is relatively small—between \$0.5 and \$3 for the residential market—this translates to monthly revenues of between \$12,500 and \$75,000 from a single base station.

the least, catching up to Europe, and the U.S. can currently claim 40 million of the 200 million smart meters installed globally (Asmus *et al.* 2012). Though many actors will be a part of the smart grid technology market, it is estimated that upgrading the world's existing and future energy grids with smart grid technologies will require an investment of \$2 trillion by 2030 (Meemori 2012). The example of Case Study 1 illustrates how M2M is opening massive new markets for efficiency-improving revenue.

Unfortunately, many smart grid technologies require significant policy changes to implement at scale. One example of an M2M option facing regulatory hurdles is 'demand-response', a mechanism through which pricing for energy becomes dynamic instead of flat (the most common practice), and M2M technologies allow individual consumers or businesses to adjust their energy use in order to lower it during peak demand. In an energy system using demand-response, the utility companies could choose to reward users for not using energy in situations where load shedding (cutting off energy supply to specific areas or customers) would otherwise be required—a concept often referred to as 'negawatts'.

Some utilities are already electing to use demand-response as a way to avoid load shedding during peak demand. In what would seem to be a positive development, the U.S. regulatory body responsible for energy regulatory policy recently issued an order requiring energy wholesalers to compensate companies providing demand-response at the prevailing rate—which in theory should make it more appealing for the market to adopt demand-response technologies. However, this order has been widely criticized for overcompensating demand-response and is being challenged in court by the State of California. Other states are taking actions that would prohibit wholesale demand-response in their jurisdictions (Borlick 2011). In the end, this policy effort, while well intentioned, may end up being more of an impediment to implementation than a boon. In order for a demand-response mechanism to actually work, and in order to support the deployment of smart grids more generally, industry, consumer advocates and government regulators must work together to find more equitable and flexible solutions that encourage the adoption of the technologies.

Smart grid, demand-response, and other M2M technologies can also help to facilitate and speed the adoption of renewable sources of energy generation—another key growth market in our transition to the low-carbon economy. Reliable sources of energy are crucial to the functioning of our economy and to maintaining a modern standard of living, and renewables offer a low-carbon alternative to the fossil fuel-based sources of energy we currently rely on. Population growth and economic development mean that energy demand will grow significantly in the next decades, improving people's lives while bringing new revenue to energy service providers. While this might be good for human development, unless incremental demand is met using primarily renewable energy, it will spell disaster for the climate and expose the world to resource shortages and price fluctuations.

TRANSPORTATION

M2M, and ICT more generally, has become a commonplace technology in the Transportation sector and is employed in applications ranging from personal vehicles to heavy trucks and commercial vehicle fleets, as well as in maritime cargo shipping. In fact, aeronautical transport without advanced M2M systems is almost non-existent today.

The most ubiquitous examples of M2M technologies for ground transportation are GPS systems that adapt to changing road conditions (such as heavy traffic ahead) and suggest alternative routes. By optimizing routes for both personal and commercial vehicles, M2M prevents unnecessary driving and saves expensive fuel, not to mention the GHG emissions that result from its combustion. Other common M2M systems for road vehicles include the OnStar product, which among other things will automatically notify nearby law enforcement and emergency response units in the event of an accident, not only reducing road fatalities but also making more efficient use of emergency workers and speeding a return to normal road conditions. Finally, in the consumer sphere, various ride-sharing and personal transport optimization companies are rapidly gaining recognition and market share, reducing the total number of vehicle miles traveled while still getting people where they need to go.

Unlike OnStar or GPS for personal vehicles, which usually come pre-installed or ready to use, commercial M2M systems capable of comprehensive fleet management are far more complex to use and require custom installation. Such systems can become quite expensive, depending on the size of the fleet and other specific client requirements. The benefits of fleet management systems can also vary, leading to doubt over their value and hesitation over their purchase. When used properly, such systems provide fleet managers with useful information regarding fuel usage, routing, and vehicle diagnostics, thereby saving fuel, lengthening vehicle lifespan and otherwise increasing efficiency, all of which reduce operating expense.

More specifically, M2M can optimize the logistics of planning the routes of trucks and the different deliveries a fleet must accomplish, ensuring that all cargo is shipped in a timely fashion with the fewest miles driven. Along with optimizing routes, M2M can also be used to manage inventory, thereby both preventing loss and reducing 'deadheading'—return journeys made by empty or otherwise under-utilized vehicles. Complete M2M fleet management systems can even connect the logistics of several companies to further reduce deadhead miles in the sector. Equipped with such tools, fleet managers can monitor vehicle performance and handle vehicle maintenance scheduling, ensuring that all vehicles are being driven in good condition and reducing maintenance costs and breakdowns.

CASE STUDY 2**KORE Telematics and Navman Wireless Partner for New Hampshire Students**

KORE TELEMATICS is the world's largest wireless network provider focused exclusively on the Machine-to-Machine (M2M) communications market, while Navman Wireless provides GPS-enabled vehicle fleet tracking solutions. They were hired to develop an M2M-based efficiency upgrade for the private bus company contracted by New Hampshire public schools to safely and reliably transport more than 1,500 special needs children to 200 different schools each day.

Before seeking out an M2M solution, the 178 buses in this fleet were dispatched via radio and required many staff members and large amounts of on-the-ground employee time to ensure that the right buses with the right equipment (wheelchair lifts, etc.) were being sent where they were needed and at the correct time. Traffic, long routes, and frequent disputes over driver hours were the challenges that KORE and Navman set out to improve.

By combining Navman Wireless' cellular-based GPS tracking and messaging technology with the KORE Telematics network, the bus company was able to achieve \$400,000 in annual savings by optimizing routes and employee schedules, thereby reducing driver overtime, as well as a 50 percent reduction in bus routing time. They improved on-time performance, eliminated wasteful driving, enabled rapid response to bus breakdowns, and received high marks of satisfaction from parents, drivers, and schools alike.

As described in Case Study 2, these systems allow for improved scheduling, real-time employee time sheet monitoring, and in-the-field customer invoicing, all of which reduce miles driven. They can further save money by reducing unauthorized vehicle use, ensuring correct fuel purchase and mileage data recording, speeding truck loading times, preventing cargo and vehicle theft, curbing excessive speeding and drastically reducing driver idling.

There are some concerns, however, that M2M systems may not add value to the vehicles themselves, complicating resale or leasing deals. All of these concerns are not inherent to this set of M2M technologies or to the Transportation sector, but rather they illustrate the way in which poor models for communication, marketing and sales are a basic market barrier currently hindering growth in M2M.

Both consumers and companies feel mounting pressure to lower their gasoline or diesel consumption in the face of recent price increases and volatility. With diesel prices in the U.S. hovering at around \$4 per gallon, and gasoline prices often much lower, saving fuel makes a real difference to the wallets of consumers and the bottom lines of commercial fleets.

Similar economics and technological solutions are found in the air-, rail-, and sea-based Transportation sectors. M2M can optimize routes and manage large inventories for oceanic cargo ships, as demonstrated by Case Study 5. Cargo plane fleets are also taking advantage of M2M for logistics management services such as these. More generally, M2M technologies can replace older, weightier solutions for airplanes, and any reduction in weight saves both fuel and money. The greater sensitivity and frequency of M2M data opens up new options for adopting flight paths to changing conditions in weather and air traffic. Only in the last few years, for example, have M2M technologies made it safe and secure enough for various models of passenger planes to fly directly over the North Pole, shaving hours off many flight times and saving hundreds of gallons of fuel. Finally, M2M sensors can monitor planes "from tip to tail", greatly optimizing maintenance and improving safety for cargo and passengers alike (Principi 2011).

As a result of all these potential applications and benefits, the market for M2M Transportation technologies is expected to be by far the strongest of all M2M business segments in coming years, representing over 40 percent of expected and addressable revenue for MNOs in the M2M industry, and over 60 percent of M2M cellular connections (Hatton 2012).

THE BUILT ENVIRONMENT

Improving the energy efficiency of existing buildings has consistently been identified as one of the greatest opportunities for reducing GHG emissions while also generating significant return on investment (McKinsey & Co. 2009). Addressing energy efficiency is key to the balance sheet of a building owner, operator, or tenant, as energy is one of their largest costs. Currently, commercial real estate tenants in the United States are estimated to spend \$179 billion a year on energy (BCG & GeSI 2012). By increasing efficiency, much of that money can be directed towards more profitable pursuits, benefiting the whole economy. Many technologies that are capable of boosting a building's efficiency with very quick payback periods have been on the market for years, such as improved insulations, energy efficient lighting systems, and advanced temperature management systems. Some of these technologies are 'plug and play', but the ones that really generate substantial savings often require renovations. Thus despite the proven potential of such energy efficiency projects, the upfront capital costs and other impediments have thus far largely prevented investors, building owners, and tenants from seizing on the opportunity.

However, ICT and M2M technologies have somewhat changed this calculus by making it possible to increase energy efficiency in the Built Environment without highly capital-intensive physical retrofits and infrastructure changes. As detailed in Case Study 3, M2M technology allows for the development of very comprehensive building management systems, which monitor everything from temperature to the cars in the garage. These systems increase security and save time, turning lights and machines on and off automatically, and keeping everything from ventilation to fire systems working optimally at all times. With these technologies and more now on the market, M2M may very well revolutionize how investors and property managers think about energy efficiency in terms of the efficiency of their physical infrastructures and also of their usage of appliances and other equipment.

ICT can also greatly contribute to the design of more efficient buildings. Architects are beginning to use sensors to analyze site-specific conditions; data is transmitted back to the office, where analytic software is employed to maximize the potential efficiency of a building in blueprint drafting. While building design has limitations as an abatement pathway due to the fact that turnover in building stock is a very slow process, the sheer number of inefficient buildings still standing, along with the low cost for use of such technologies, leads the authors of the SMARTer 2020 Report to suggest that this may in fact be the largest opportunity for ICT to reduce GHG emissions in this sector.

CASE STUDY 3

Jones Lang LaSalle and Pacific Controls—IntelliCommand

IN NOVEMBER 2011, Jones Lang LaSalle (JLL) launched IntelliCommand, a real estate portfolio monitoring and control system powered by Pacific Controls technology. IntelliCommand is an end-to-end facility management solution, leveraging existing building automation systems for heating, ventilation and air conditioning (HVAC) and, in some cases, water, fire and life safety. With new technology and a cloud computing platform, IntelliCommand enables JLL to conduct real-time remote monitoring and control of buildings and portfolios worldwide.

A major feature of IntelliCommand is continual commissioning, the ability to monitor performance of building systems and equipment to ensure that buildings operate at peak efficiency. When a potential performance issue is identified, the system can often diagnose and even resolve it automatically. When an issue can't be automatically adjusted, the system alerts members of a centralized 'command center' who call on-site engineers or deploy resources to address specific problems. In many cases, the system can diagnose the problem to make resolution by facility managers easier and faster. The platform also calculates carbon footprint and can be used to provide verifiable data on carbon footprint reduction.

The data analytics also optimizes maintenance management. The platform analyzes performance curves for large equipment, such as chillers and boilers, and schedules preventive maintenance to reduce breakdowns. This prevents damage to equipment and the need for expensive repairs, and helps to optimize energy consumption.

Direct benefits of IntelliCommand include significantly reduced energy costs, lower equipment and facility management costs, decreased risk of a critical shutdown, and enhanced control over information for strategic planning purposes. As more communities implement smart grid infrastructure that allows two-way communication between utilities and buildings, the functionality of IntelliCommand will increase in a number of ways. But companies do not need motivation beyond the current energy savings and carbon reduction that can be achieved in the first year.

Most new systems have an open protocol, which means they can share information in a standard format developed by ASHRAE. These standards were in place for many years before companies that make control systems started using them; they continued to use their own proprietary systems until owners demanded they use open protocols. As a result, most existing buildings have these proprietary systems with no built-in method for cross-platform sharing. Because corporate facility portfolios are a conglomeration of properties gained in mergers or leased from third parties, there was no way for a company to operate its entire portfolio under one platform. IntelliCommand breaks through this barrier with new technology that can translate data from every major platform—BACNet, LonWorks, Modbus and others—into a common language.

In a pilot project at four large facilities owned by a global manufacturing and consumer goods company, IntelliCommand generated 24 percent energy savings at one site in just 11 months with an upfront installation that paid for itself in six weeks. With that fast payback and the promise of adding millions of dollars to its bottom line, the company is now implementing IntelliCommand across its global portfolio.

In the near term, however, there are many large commercial buildings that will stand for many decades to come with room for improvement in efficiency, providing a ripe opportunity for implementation of building management systems.

While systems such as IntelliCommand show great potential to increase building efficiency and thereby help building management companies and building tenants to save large amounts of money, smaller real estate companies and independently owned or operated facilities do not always have the resources to develop or deploy such a system. New financing options and greater investment into the 'smart buildings' sector is required for such smaller players.

Along with this lingering issue of upfront capital, installing an M2M-based comprehensive BEM system is often complicated for building owners of any size due to the fragmented value chain of the M2M market today. The issue of value chain fragmentation is a barrier to the increased adoption of M2M in nearly every sector. In this case, it means that a building owner struggles to find a turn-key solution that meets their needs. They may instead need to source and manage relationships with various vendors—some for their M2M-capable appliances, some for their sensors, another for their wireless system, another for their software, and possibly yet another to customize the whole system to their specific building and ensure that it runs properly with respect to the collection and assessment of the data generated by that building.

Faced with this barrier, some management companies have already positioned themselves as key players in the M2M market, often purchasing devices from major manufacturers and installing them on their own, or contracting installation companies. In some cases, they are already fielding their own solutions, and a few are even offering a service on the market themselves, such as IntelliCommand from Jones Lang LaSalle and Pacific Controls. However, overcoming the fragmentation barrier by 'taking matters into their own hands' is only feasible for the largest of building owners and management companies.

Other vendors are attempting to address the issue of the fragmented value chain with respect to the software behind data collection and analysis by creating a platform that is both widely accessible and open source, saving costs by allowing for the development of applications by third parties. For example, Johnson Controls has launched Panoptix, "a platform that pulls together data from disparate building systems... and offers a suite of cloud-hosted building efficiency applications that allows users to link their own building management system (BMS) to the platform and start monitoring and managing their buildings" (Bloom & Gohn 2012). The trend towards greater availability of open, cloud-based BEM systems will help overcome the market barriers of upfront costs and value chain fragmentation for all buildings, both small and large, and thereby drive solid growth. Other industry partnerships and collaborations will also be required to ensure that M2M technologies reach their full potential in the Built Environment for clients of all sizes.

Even with these barriers, the market for M2M products and services in the Built Environment, including hardware, software, and components, is projected to increase from \$1.9 billion in 2011 to \$6 billion in 2020 (Bloom & Gohn 2012). In addition, steady projected growth rates in other smart building technologies, such as demand-response systems, sub-meters, and building automation, often sold as part of comprehensive building systems, suggest that the Built Environment will be a sector where ICT and M2M can make a big impact on energy usage.

Implementation
of ICT solutions for
building efficiency could
result in GHG reductions
of 305 Mt CO₂e emissions
annually by 2020 in the
United States alone
(BCG & GeSI 2012)

AGRICULTURE

As a result of our changing climate, in recent years the world has witnessed catastrophic droughts, flooding, and temperature fluctuations. These events, coupled with our exploding global population, have meant that in order to feed itself, society has resorted to the massive overuse of agro-chemicals and unprecedented deforestation. As a result, our agricultural systems are in danger of total collapse.

Improving the way that we grow, harvest, transport, and store food has long been a concern for global businesses, national governments, and individuals, and Agriculture is a central facet of all comprehensive international plans to address climate change. But the complexity of making our agricultural systems truly sustainable—capable of producing enough food to feed the world for years to come without destroying the environment—has proven to be one of the most vexing challenges in efforts to address the interlinked challenges of climate change, poverty reduction, and food security.

While often only the most basic of changes would be required to make Agriculture more sustainable, the knowledge of how to implement them is not readily available for the farmers themselves, nor are the near-term economic incentives, and neither is sufficient upfront financing. Recognizing this fact, most projects to improve Agriculture thus far have focused on knowledge transfer, financing mechanisms (such as REDD+ and other carbon finance schemes), and various national and local initiatives to provide training and technical support to farmers. ICT solutions are poised to contribute greatly to these efforts.

Making Agriculture more sustainable will increase crop yields, save money, reduce the need for environmentally damaging fertilizers, conserve water, and reduce greenhouse gas emissions, ensuring that we can feed a growing planet now and for years to come. In a demonstration of M2M's potential, the most recent studies see Agriculture as one of the most promising applications for using ICT to reduce GHG emissions, representing an opportunity of 1.6 Gt annually by the year 2020 (BCG & GeSI 2012). Nearly half of this opportunity currently appears to lie within better livestock management systems, primarily due to the ways that M2M can reduce the methane emissions that result from cattle digestion (enteric fermentation) by monitoring cattle health and optimizing their grazing patterns. Other reductions in GHG emissions can be achieved by remotely monitoring soil conditions and weather forecasting, as well as the implementation of other 'smart farming' and 'smart watering' techniques. These last three sets of options are often grouped together under the term 'precision agriculture'.

Precision agriculture has been around for more than 40 years in the form of non-M2M technologies, such as low-till farming practices and new strains of crops. But M2M is expanding the potential of such options, and has opened up many new ones for farmers as well. Within the context of North America, precision agriculture holds great potential for reducing the use of petroleum-based chemicals, both by allowing for their accurate dispersal and by limiting the soil degradation that results from over-harvesting and necessities higher levels of fertilizers. For example, tractors can be equipped with M2M-enabled 'auto-steer' technologies that map with great precision where the machine is in the field, and can also automatically reference that data against information on crop aspects, such as soil and water quality from other sensors, in order to apply water and fertilize exactly as needed over each square foot of the field—not too much and not too little (Paarlberg 2012). M2M can also reduce the fuel

As a sector responsible for approximately a third of all anthropogenic GHG emissions, the recognition of Agriculture's importance to the climate challenge, particularly considering the complex and often unacknowledged climate impact of livestock, demonstrates an evolution in thinking on the range of applications in which ICT can reduce emissions

(Vermeulen et al. 2012)

consumption of tractors and combines by making sure that they are driven only when and where it is necessary. Such guidance systems can save approximately \$13,000 per year for a 1,000-acre farm in the United States. If guidance systems were used on just 10 percent of the planted acres in the U.S., the Agriculture sector could cut its fuel use by 16 million gallons, its herbicide use by 500,000 gallons, and its insecticide use by four million pounds per year (USDA 2006).

Additionally, systems such as John Deere's i-Solutions, as described in Case Study 4, increase yields significantly, adding new revenue for the farmers on top of the savings generated by reduced fertilizer and fuel costs. In the U.S., the introduction of these technologies has increased yields such that the annual rate of the Agriculture sector's growth in productivity has accelerated from 1.49 percent to 1.91 percent in the last few decades, allowing consumers to access cheaper food while farmers simultaneously enjoy higher revenues (Paarlberg 2012).

M2M IMPACT

M2M can save money and resources in many sectors. Here are three examples of M2M's agricultural benefits.

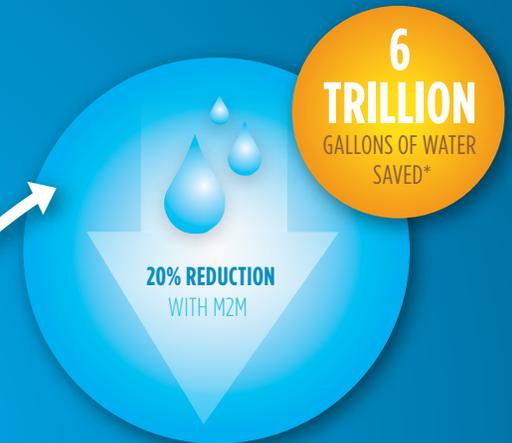
MONETARY SAVINGS

Using an M2M guidance system on a 1,000-acre corn farm in the U.S. would save approximately \$13,000 per year.



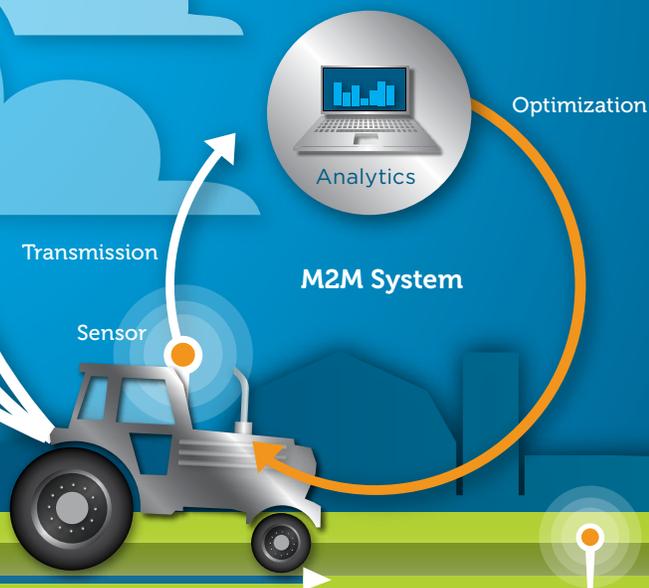
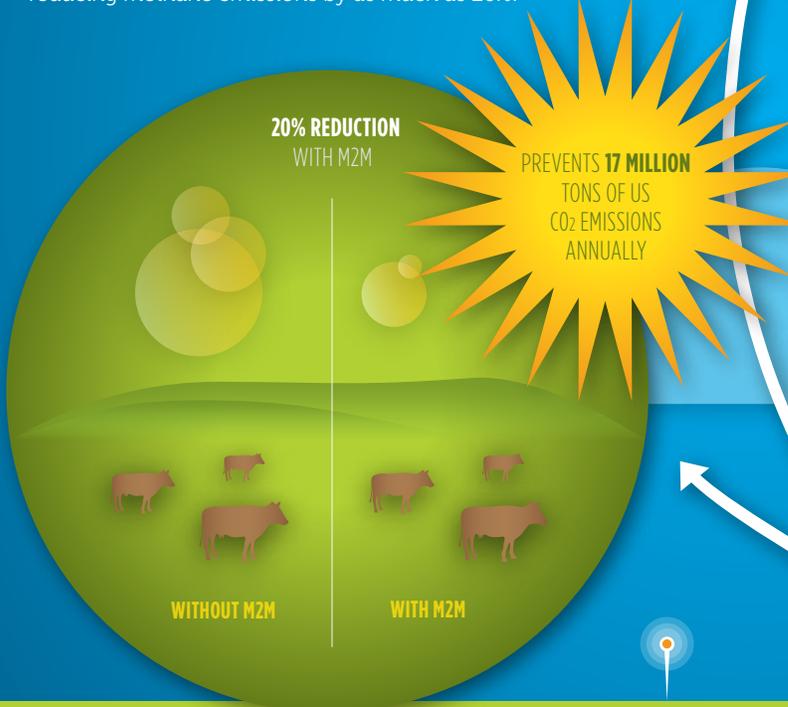
WATER CONSERVATION

M2M-enabled Soil Moisture Monitoring saves water by an average of 20%.

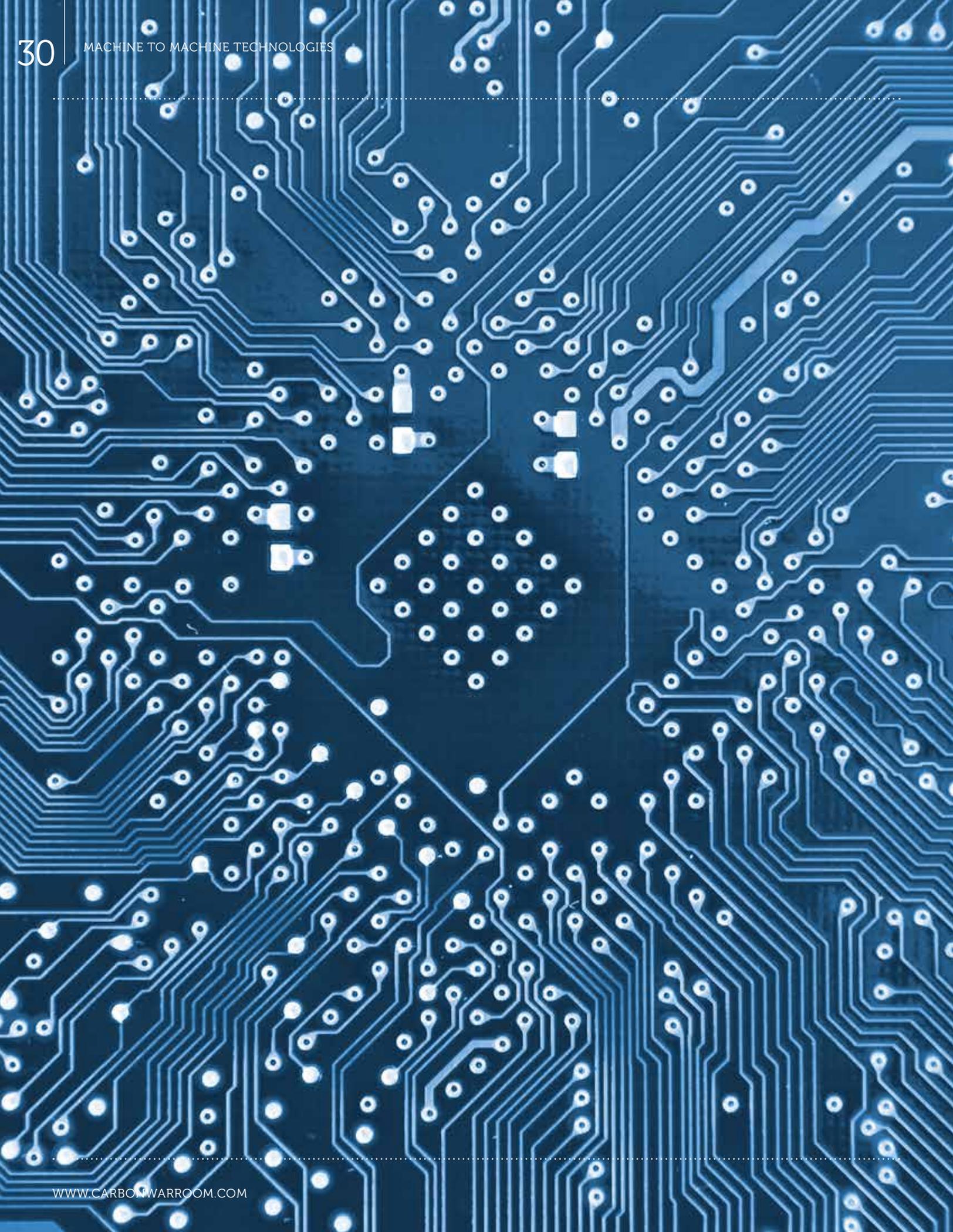


METHANE REDUCTION

M2M technologies can optimize cattle grazing, reducing methane emissions by as much as 20%.



*If adopted by all farms in the U.S.



CASE STUDY 4**John Deere i-Solutions**

JOHN DEERE, the leading manufacturer of agricultural equipment globally, has begun offering a suite of M2M products they call i-Solutions. This system uses three components—modules specifically programmed for a variety of tasks, a GPS receiver accurate to 0.78 inches, and a monitoring device that allows the user to track and control all of the modules in the system.

This system allows for a range of efficiencies in the farming process all year round. During planting, the automation of equipment allows for a reduced need for seeds, fuel, and time. Automating some aspects of seeding has yielded savings of 5 percent over average per acre costs in one case study, with additional revenue generated by the increased yields that follow (John Deere 2013). During the harvest, automation of equipment and analysis of crop rows led to reductions in fuel use of 15 percent and yielded crop increases of 50 percent in one case study (John Deere 2013).

Additionally, the M2M system can be used with other several information tools offered by the company that automatically record and map harvesting data that, after further analysis using more of their tools, can suggest more adjustments to farming procedures that will allow for even greater increases in crop yields and greater savings in fuel, seeds, and fertilizer costs, as well as lowering emissions.

Since the entire range of modules are built into and fitted to equipment by the company itself, they are fully integrated straight from the factory and are easily interchangeable and replaceable by the user, who can even use another manufacturer's components, making this a truly seamless and standardized solution for the world's farmers.

Although these are promising applications, there are several others that could markedly reduce emissions which the aforementioned report fails to consider. For example, RFID tags that allow for better management of cattle herds and grazing practices, along with other ICT tools, could together be key enabling factors in preventing the deforestation that results from cattle ranching. Ear tags containing SIM cards can provide information on cattle herd locations and movement, giving large retailers of leather and beef products a way of determining whether products they sell contribute to deforestation—and making it easier for them to choose those that do not. In the Brazilian Amazon, 70 percent of ongoing deforestation is attributable to the expansion of medium-sized to large cattle ranches, and around 80 percent of the total deforested land today is used for cattle grazing (Fearnside 2005). But analyses to date of the potential for M2M to reduce the negative environmental impacts of agricultural practises have ignored this relationship between deforestation and farming, and therefore their findings on the environmental and economic potential of M2M to optimize our agricultural systems substantially underestimate the impact such approaches could have on efforts to prevent deforestation.

Globally, improving the efficiency of our current systems with the M2M technologies that are available on the market today will have a big impact on our economy, our environment, and our world's food supply. In addition to boosting a farmers' bottom line while reducing GHG emissions, agricultural applications of M2M can reduce deforestation, prevent pollution of our fisheries and waterways caused by run-off, preserve biodiversity, and conserve water.

Improving
the efficiency of our
current systems with
M2M technologies
will have a big impact
on our economy,
our environment,
and the world's
food supply

Barriers to the Greater Adoption of M2M Technologies

While we have demonstrated that M2M is capable of reducing harmful GHG emissions while generating economic growth, there are significant challenges to realizing the technology's full potential. These challenges include structural barriers that are observable across the M2M value chain, as well as discrete, procedural barriers that are either unique to the implementation of M2M within a specific sector or sub-sector or else specific to a given company's efforts.

In this report, we focus on the structural impediments to the greater deployment of M2M, which include a litany of challenges common to many emerging industries, and also several that are unique. Furthermore, the effects of several of these impediments could be softened or lifted through actions the industry itself could take, which we discuss in the following section; others will require regulatory action and support by governments. While these issues and efforts to address them are summarized in this section, we do not seek to put forth new policy recommendations, or to assess current proposals and efforts. Furthermore, many of the issues requiring policy interventions can be categorized as discrete challenges that must be addressed on a regional or local level within the various industries and sectors where M2M could have a big impact.

By addressing the structural barriers preventing the M2M industry from reaching its potential for growth, and for enabling large-scale reductions in GHG emissions, the industry can also have an effect on alleviating some of the discrete barriers as well. For example, the landlord-tenant problem detailed in Case Study 5—using the shipping industry to illustrate the challenge—can be addressed at least in part by solving fragmentation within the value chain, particularly when companies can integrate M2M solutions into their business approach, as illustrated in Case Studies 3 and 4.

FRAGMENTED VALUE CHAIN

As shown earlier, the M2M value chain includes MNOs, a wide variety of application and hardware developers, and, importantly, a diverse customer base. While the existence of this expansive value chain is positive in that it means M2M will support economic growth for many businesses, the fragmentation that results from this diversity has had adverse effects on the ability of the various actors along the chain to bring products to market and to otherwise meet client and consumer needs. This makes it difficult for the MNOs—who are typically the retailers, but who also may serve as wholesalers for other vendors of M2M products and services—to offer complete solutions, and impedes product creation and differentiation.

M2M is also unlike other industries that have previously had, or even that continue to have, diverse value chains. The automotive industry is a good example, since, in spite of all the various parts that go into a car, the final product is straightforward and standalone for the customer. M2M solutions, on the other hand, require maintenance, data hosting, software updates, connectivity, and other ancillary services, and entail ongoing billing. For example, building managers hoping to adopt M2M systems today cannot simply research, solicit bids from, and then manage their relationship with just one supplier. Even the simplest M2M solution for a commercial building would likely cover four different systems: heating and cooling, ventilation, lights, and electronics. The building manager might find themselves searching for vendors of sensors and meters for each of those four systems, another vendor for the data transmission network, another vendor to customize the software to manage and analyze the data, and another vendor to handle data storage and hardware. Integration of these various components, tech support, and maintenance can then prove to be an ongoing challenge, dissuading building owners or smaller management companies from devoting the time and resources required.

To some extent this is an issue being addressed through mergers and acquisitions of companies that can combine their competencies and offerings to provide streamlined solutions to clients, as well as by efforts to form diverse and far-ranging partnerships, which are illustrated by Case Studies 2, 3 and 6. But much more remains to be done.

The effects of several of the impediments to greater deployment of M2M could be softened or listed through actions the industry itself could take

LACK OF UNIVERSAL STANDARDS

Standardization has consistently been highlighted as one of the greatest structural impediments to the greater deployment of M2M overall. In order for M2M to truly reach its potential, efforts currently underway to implement common standards across various business segments and industries must be co-ordinated. Just as fragmentation in the value chain poses a challenge to efforts aimed at developing and deploying turn-key solutions, it also impedes integration of various M2M components. “Various vertical M2M solutions have been designed independently and separately for different applications, which inevitably impacts or even impedes large-scale M2M deployment” (InterDigital 2012). Currently, many component-level standards exist, such as those regulating radio and cellular frequencies, interfaces, and network choices. However, the supply side of the market for M2M solutions is still quite fragmented, with a “wide range of embedded platforms, programming models, connection types, and communication protocols” (Eclipse Foundation 2012).

Lack of standardization is particularly seen as a barrier for the M2M service layer—how users interface with the M2M solution. Today, companies developing M2M applications or devices, as well as those offering M2M solutions within specific industry verticals, do so on a proprietary basis for specific clients or simply do not use a common interface. This prevents inter-operability, impeding the development of applications and devices that can be used universally. Solving this is essential for increasing the deployment and profitability of M2M.

Similarly, a lack of standardization on certain hardware parameters presents a challenge to scaling M2M technologies. While many standards exist on the component level, efforts are only now getting underway to address larger issues, such as creation of universally agreed standards for how devices communicate, taking into account different data transfer rate requirements of various applications. Implementing such standards will be necessary to optimize the telecoms networks for M2M communications.

Lack of data standardization has also proven to be a challenge. As a result of the fact that the market is fragmented and comprises a wide variety of applications in several verticals, the way in which devices connect with one another differs greatly throughout the industry. As a result, connecting devices can often be impeded by the fact that they are essentially speaking different languages.

Several organizations are working on the development of platforms and other solutions that M2M solutions providers can use to overcome some of these issues, as illustrated in the example of the Cumulocity platform given in Case Study 7. Others can sidestep the issue by offering solutions only within their industry, fully integrating them into their products and allowing for full compatibility with other hardware and applications, such as John Deere’s i-Solutions, described in Case Study 4. However, in order to tackle the systemic causes of this issue, the M2M industry will need to come together to outline universal standards or agree to a common approach.

LACK OF PERFORMANCE DATA

While there is clearly a large and growing market for M2M technologies, the inability to quantify the results of M2M systems, let alone guarantee them, has proven to be an impediment to even more rapid growth in the market. As a result, demand has remained weak in some sectors, and clients continue to express more of a theoretical interest in M2M than actual plans to purchase M2M systems, as demonstrated by Figure 2.

In order to realize the huge growth potential of M2M technologies, MNOs will have to be able to quantify the benefits of M2M solutions on a case-by-case basis, or provide the ability for clients to do so. For any product, constructing a strong value proposition is essential to engaging with potential customers and completing a sale. However, the lack of performance data currently hinders companies that offer M2M solutions from clearly and convincingly presenting the value proposition to potential clients. Companies offering M2M will need to generate performance data for M2M solutions in order to articulate not only the direct benefits of M2M, such as energy, fuel or labor savings, but also the indirect benefits relating to health, safety and GHG emissions.

The process of collecting data on M2M is difficult not only due to the custom nature of many M2M solutions today, but also because many companies lack the sort of baseline data on their operations or industries that M2M would be compared against in order to demonstrate its value. For example, in the Transportation sector, M2M technologies can allow fleets of freight-hauling trucks to save money from many aspects of their operations, as outlined in an earlier section of this report. But an M2M solutions provider requires certain information about the fleet’s current operations, such as miles driven, average speeds, fuel consumption or cargo volumes, in order to create an estimate of what savings their technology could offer. Many fleets have only estimates of such data, and in any case a vendor would need to actively seek this information out from the fleets, making it difficult to construct a comparison. In a classic ‘chicken and egg’ conundrum, the sensors used to implement an M2M solution are often the best available method for measuring the sort of operational data needed to increase their adoption.

COMMUNICATION AND MARKETING CHALLENGES

In all sectors, the lack of performance data makes M2M systems a particular challenge to 'sell' internally for large clients who have entrenched internal processes for measuring and incentivizing energy and carbon savings, and require reliable estimates for financial evaluations. While the idea of using M2M systems to reduce energy use and emissions is not hard to grasp, performance is not guaranteed, and there are often few, if any, relevant examples of expected results. All of this makes it difficult for companies offering M2M to 'check the boxes' of a large client's internal procurement process.

It is also challenging for smaller companies to understand the specific energy or efficiency savings they could enjoy with M2M due to the fact that the methodologies for quantifying this are often not in place at the company or product level. Many protocols exist to help companies undertake energy audits and GHG accounting, but implementing them requires a commitment to training staff and tracking energy. Some smaller companies cannot afford this, while others lack the time or staff resources to carry it out correctly. M2M vendors are not currently playing a role in facilitating their smaller potential clients in collecting the data they would need to adopt an M2M system.

For companies large and small, the fragmented value chain only exacerbates the difficulty of finding good performance data on M2M technologies. Even with regards to certain technology sets that are already being offered to end-users as turn-key systems, the lack of data on those systems makes it very hard for their vendors to develop a strong value propositions or for potential clients to commit to investing in M2M technologies.

Though data is certainly necessary, it is not the sole requirement for the creation of a strong value proposition. Sales rely at least partially on good marketing, and both sales and marketing rely almost entirely on communication. Today, the M2M industry has still not convincingly communicated the 'M2M story' to potential clients or even to the general public, particularly the promise these technologies hold for benefiting society, what they are, and how they work in simplistic terms.

Consistency of messaging also a major issue. The newness of these technologies and the ill-defined nature of the M2M industry itself are driving this problem. For example, the way in which this class of technologies is described is inconsistent and often vague. In many instances, M2M technologies are not properly differentiated from ICT, or are described broadly as part of the 'Internet of Things' or the 'Industrial Internet', each of which are concepts that have different connotations but that are often used interchangeably.

Sales and marketing groups for these new M2M technologies need to convincingly communicate not only their benefits, but also the fact that their adoption will be an easy process for the customer and will not interrupt their operations. For example, in the Agriculture sector, multiple investigations have found that although farmers large and small have heard about M2M technologies, they are not confident that they will be able to utilize them correctly or receive the training they might need to do so (Flaherty 2008; Winsted *et al.* 2009; Heacox 2012). Many farmers report that they trust what they hear from other farmers much more strongly than they trust information from other sources, so developing and utilizing word of mouth and testimonial marketing is essential (Winsted *et al.* 2009). So, even a strong economic argument backed by good data is often proving insufficient to create a successful marketing or sales model for these new M2M technologies.

**M2M will need to
generate performance
data for M2M
solutions in order to
articulate not only the
direct benefits of M2M
such as energy, fuel or
labor savings**

INCOMPATIBLE SALES MODELS AND LONG SALES CYCLES

Among vendors, various aspects of the M2M value proposition require an internal rethinking of current sales approaches and a refocusing on client needs. Companies offering M2M solutions are still struggling to adapt their sales cycle for such offerings, from those geared more towards consumer or commercial connectivity. Some sales units have experienced difficulties with M2M offerings due to long sales cycles and internal structures that are not optimized to the complexities of this new business line.

In some ways, the long sales cycle for M2M solutions is also an impediment to the creation of a robust and competitive market comprised of small and innovative entrepreneurial firms, as is the case for Internet start-ups, as this industry trait requires new firms to scale up quickly in order to generate revenue. Structurally, this is also an impediment for large firms, who struggle with adoption of new business model approaches in the face of changing market conditions.

Sales of M2M solutions present a challenge to traditional models for MNOs, as M2M offerings differ significantly from their core products and services: mobile connectivity, fiber-connected phone, Internet, and cable television. The lack of evolution in regard to internal sales models, at least among larger players, has been a hindrance to market growth. Structurally, the upfront and lifetime costs of M2M solutions are also both impediments to either corporate clients' or individual consumers' ability to purchase the hardware and services. Of respondents to a survey of potential M2M clients, 29 percent indicated that their top concern is the total cost of ownership (Forrester 2011). While component prices are declining, sales models need to adapt to accommodate the fact that potential clients may not be willing to pay as much upfront. Innovative pricing and financing models that are designed to address this issue have been lacking among larger companies. The principle-agent problem outlined in Case Study 5 is one example of the need for new sales models, particularly for new pricing systems within those sales models.

CASE STUDY 5

Weather Monitoring and Routing for Maritime Shipping

COMPUTER-BASED optimum routing software for containership vessels, such as that offered by Applied Weather Technology, Inc., allows either the vessel crew onboard or the ship operator onshore to select an optimum route and avoid damaging weather patterns, thereby not only improving vessel safety, but also reducing fuel consumption by between 2 percent and 9 percent (as per the Norwegian Marine Technology Research Institute, for IMO) per year. This translates into a monetary savings potential of between \$195,000 and \$975,000 per annum per vessel, which greatly surpasses both the initial cost of the M2M system and the annual service fees.

While this may seem like a compelling opportunity from both an economic and environmental perspective, there remains a persistent market perception that the master onboard and ship operators onshore can make better routing decisions than automation technologies or consulting firms, as ship routing is extremely complex and scientifically challenging. Thus far, even specialized M2M providers have struggled to overcome this perception.

Moreover, in the maritime shipping industry, one of the most difficult impediments to the greater adoption of any efficiency technology and practice is the principal-agent problem. Ship owners calculate the cost of fuel for a journey and charge this to their clients, thereby limiting incentives to cut fuel costs, as the owners would not recoup an investment into new efficiency technologies—their clients would instead enjoy the savings. The current models for selling or financing clean technologies do not take this situation into account, so the problem persists.

These informational misconceptions and poorly designed sales models are keeping adoption rates of M2M technologies low in the shipping industry, even in the face of increasing pressure to implement fuel savings measures, both from the market—in which clients are using better information to select more efficient carriers—and from governments and regulatory bodies such as the International Maritime Organization (IMO), which recently issued regulations for mandatory measures to reduce GHG emissions. To ensure that these technologies are able to meaningfully reduce the emissions of the maritime shipping industry, the value of such solutions must be clearly demonstrated to shipping operators and the market must provide incentives for their purchase through sales models that overcome the principal-agent problem.

HEALTH AND SECURITY CONCERNS

As with many new technologies, the accelerated deployment of M2M is mired in significant perceived risks. For the purposes of this report we will merely note the fact that the very idea of machines communicating automatically with other machines and taking actions in the world based on that conjures images in some people's minds of apocalyptic science fiction—quite a perceived risk indeed. The more concrete perceived risks for M2M generally fall into two categories: security concerns and health concerns.

Security risks continue to be an important concern for potential clients. In a survey of potential M2M customers, 25 percent cited integration challenges and security concerns as a major source of apprehension (Forrester 2011). While hardly good news, the reality is that all global businesses, and indeed all of us individually, rely substantially on technology already, and are therefore already exposed to many of the same risks and vulnerabilities. Although data theft is a threat felt both by individuals (credit card fraud and identity theft) and by businesses, society has generally come to the conclusion that the benefits of using related IT systems outweigh the risks.

There have been data breaches of M2M systems specifically, and though these did not receive wide media attention, fear and uncertainty are clearly stymieing the adoption of M2M (Goodness *et al.* 2012). In the face of serious risks to business systems and data, personal security, and even national security in some instances, businesses must be cognizant of the necessity of carefully evaluating network security procedures when relying on external suppliers of M2M products and services (Ruzicka 2012). IT services supporting the deployment of M2M solutions must often be maintained domestically, as outsourcing of such services, common for other telecoms offerings, raises additional security and privacy concerns. As a result, full outsourcing of such services, which could help to lower the overall price of M2M solutions, is not expected for at least 7-10 years (Goodness *et al.* 2012). While security concerns may be over-inflated, the perception among potential clients that such concerns exist remains an impediment.

Additionally, consumers continue to voice concerns about the potentially negative health effects of several components of certain M2M systems, even though strict regulations are in place for all devices that transmit radio frequencies and experts in the field conclude that such devices are safe. Recent scientific studies on the effects of such devices confirm that even at close range and under-exaggerated duty cycles, smart meters expose consumers and employees to far less radiation than other household and workplace devices, such as cellular phones (EEI 2011).

Recommendations: New Ideas for Overcoming Barriers

In this section, we propose novel ideas for how businesses can implement changes both internally and in concert with external partners to overcome the barriers outlined previously and accelerate the deployment of M2M technologies. Our aim is not to suggest that policy does not play a role, but instead to show where real progress can be made in efforts to capture the economic and environmental opportunity offered by M2M technologies through private sector ingenuity, initiative, and collaboration.

We put forth recommendations that broadly fall into two categories: 1) actions that companies can take independently, yet that in combination will serve to address financial and informational barriers; 2) actions that companies can take in partnership to implement changes, both internally and in concert with industry partners, to integrate M2M into products and services throughout the sectors where they could have the biggest impact in driving efficiency gains.

While we will endeavor to put forth recommendations for addressing the structural barriers identified in the previous section, which will allow for sustained growth of M2M throughout the sectors we have highlighted as having the greatest potential for reducing GHG emissions, in several instances it will be necessary to direct efforts towards addressing these issues within specific verticals. For example, a sustained effort on standardization within the Transportation sector for commercial vehicle fleets could greatly improve the ability of companies developing and offering M2M solutions to integrate products and services for this industry segment, while continuing to bring down costs.

MNOs leading the way in the M2M industry must continue to take innovative approaches to how such products and services are marketed, and how to adjust and improve the business model under which they are offered. This work will be best accomplished through the formation of both bilateral partnerships aimed at bringing a better product to market and of broad consortia to focus on efforts that affect the industry as a whole.

VALUE CHAIN INTEGRATION AND UNIFIED M2M PARTNERSHIPS

Further integration along the M2M value chain is essential to making M2M more attractive to clients, to creating new revenue streams for vendors, and generally to speeding M2M adoption rates in all sectors. MNOs in particular need to develop the capacity to offer unified M2M solutions. Positively, the M2M industry has begun to recognize and address this need.

For example, in July 2012, KPN, NTT DoCoMo, Rogers, SingTel, Telefonica, Telstra and Vimpelcom announced their intent to form a partnership to co-operate globally on M2M business. This partnership will give the participants the ability to seamlessly serve multinational clients “across a number of distinct high-potential industries such as consumer electronics, automotive, energy efficiency, etc., enabling the development of new business models, the creation of new products and services and a reduction in operational costs for these target industries” (NTT Docomo 2012).

The M2M industry has also seen a recent uptick in mergers and acquisitions (M&A) activity, such as Verizon’s acquisition of Hugh’s Telematics in 2012, or other smaller buy ups, such as Telit Wireless Solutions’ acquisition of Motorola M2M, Globalconect, and Navman Wireless, all within the last two years.

Both these new partnerships and recent M&As are ultimately a response to user demand for seamless global services and integrated products, and are therefore expected to continue. But many of the partnership efforts thus far have focused solely on meeting the demands of large multi-national clients. Telecoms firms should also consider partnering with specialist hardware and software firms in order to improve their M2M offerings within specific sectors by combining new system elements and new services (Harbor Research 2012). This recommendation complements the ongoing trend of multi-national partnerships between MNOs, as the formation of targeted partnerships with specialist M2M companies will increase competitiveness within specific niches. As discussed below, the creation of consortia will allow for flexibility and innovation in sales approaches, and partnerships will also help to overcome the challenge of communicating the value presented by M2M technologies in a compelling way to potential clients and the general public.

**To turn “forecasts
[for growth] into reality,
the M2M industry will need
to consolidate offerings,
standardize technologies,
convince consumers of
the benefits, and especially,
create a platform for innovation
before M2M will reach its
long-anticipated tipping point”
(The Economist 2012)**

Some MNOs have also begun collaborating with product manufacturers to integrate M2M solutions into various product lines. For example, AT&T and Ford Motor Company announced in March 2011 that they had agreed to work together to give all Ford Fusion electric vehicles wireless capabilities, allowing owners to “remotely monitor, engage and control vehicle settings via information collected over the AT&T wireless network” (Ford 2011). Another example of a successful partnership from the Energy sector is described overleaf in Case Study 6.

CASE STUDY 6**Itron and Deutsche Telekom Partner on Energy Efficiency Smart Grid Solution**

IN 2012, Deutsche Telekom, the world's fourth largest wireless service provider, partnered with Itron, a global technology company whose products "help utilities measure, manage, and analyze energy and water". The partnership will embed Deutsche Telekom SIM cards into Itron's GPRS meters, combining the telecom's wireless network capabilities with Itron's smart grid management hardware and software in order to offer a superior and complete smart metering system for utility customers in Europe.

By combining their respective assets and competencies, the two parties have simplified the process of shifting operations on to a smart grid for their utility customers, who previously would have had to choose both the smart metering system and the wireless provider. This more cumbersome multi-step process would necessitate additional set-up effort on the part of the customers, efforts that in the past were often stymied by a lack of collaboration between service provider and vendor.

This partnership allows the utility to receive a simpler, more functional and less expensive product, and a corresponding service that will allow them to save money on their operations by making remote decisions that automatically optimize their energy production and distribution based on real-time data.

These types of partnerships help to overcome the challenges of value chain fragmentation for the end-user and can help in the advancement of standardization within specific industry segments, thereby helping to overcome another key market barrier. Some companies are also taking unilateral steps to integrate M2M solutions into their products, as in the example of John Deere's i-Solutions seen in Case Study 4.

INDUSTRY COHESION ON STANDARDS

Currently, the M2M sector is witnessing a flurry of promising efforts towards standardization, both within specific sectors and industry wide. Several organizations and companies are working to identify industry gaps and to create the standards that will ensure uniformity across the range of M2M devices for various applications. These efforts are important for ensuring that components work well not only within specific applications but also together, as connecting various devices is a core value offered by M2M. Standards are also needed to ensure that the sensors used to gather data from a wide diversity of components are doing so in a way that will allow for aggregation and analysis of this information on a large scale. Finally, standards are needed for the service layer so that companies can develop applications optimized for use with a range of devices and the network that will connect them.

The European Telecommunications Standards Institute (ETSI) has formed a dedicated technical committee to develop standards for M2M communications globally. The ETSI Release 1 Standard announced in February 2012 was a large milestone, which its developers claim will "enable integration of different M2M technology choices into one managed platform", and will ultimately result in "reduced complexity of M2M deployments, reduced deployment time for new M2M services, and ultimately reduced CAPEX and OPEX" (ETSI 2012).

Meanwhile, the International Telecommunications Union has formed its own focus group on the M2M Service Layer, which is operating in collaboration with other working groups within the Union and that has been tasked with studying all ongoing efforts to develop standards for M2M service layer specifications in order to identify the key requirements of a common M2M service layer.

Finally, ZigBee, a non-profit industry association, has developed a protocol for M2M communications that has been ratified by the 300 members of the Zigbee Alliance, which includes various technology firms, original equipment manufacturers (OEMs), and service providers.

While these are all promising developments, none will likely prove sufficient for ensuring a universal set of standards for M2M communications. The Zigbee Protocol is limited in scope due to the fact that, though a public document, it is used only by members of the Alliance. Industry acceptance of the ETSI Release 1 has yet to be assessed, and the release will likely undergo several revisions before adoption of the ETSI standards reaches a level that would indicate a trend towards the creation of a globally recognized set of standards.

In the absence of universal standards, companies are beginning to offer software development platforms to bridge the gap. One example is the Cumulocity platform described in Case Study 7, which allows MNOs to expand their business beyond connectivity, as well as significantly opening up opportunities for overcoming value chain fragmentation. Companies developing and offering M2M solutions should continue to use and build innovation platforms and software-as-a-service offerings. Such efforts will help to accelerate their own learning of aspects of the M2M market beyond current core competencies such as wireless networks, add additional layers of revenue to M2M business units, and promote application development that is integrated into M2M solution development throughout the value chain. These efforts will also help to alleviate the challenge posed by the long sales cycle by creating an opportunity for speeding time to market and increasing profitability.

CASE STUDY 7**Cumulocity—Value Chain Integration**

NOKIA SIEMENS Networks began a new venture called Cumulocity in response to the need for greater horizontal integration of the M2M value chain. Cumulocity is a development platform for M2M solutions, an application platform for operators that allows them to become full M2M solution providers, and a connectivity platform, using integrated cloud computing to help bring M2M applications to scale.

Based on the assumption that devices can be decoupled from applications, allowing for the integration of devices with various applications and the development of applications for various devices, Cumulocity attempts to provide MNOs with the ability to be active in the M2M market in ways beyond just providing connectivity, while allowing developers to profitably scale their offerings beyond one vertical application.

The end goal is to allow for the greater monetization of M2M technologies, and degrees of both innovation in and the proliferation of M2M offerings that are not possible under current practices of tailoring solutions to either individual client needs or within industrial verticals. For example, this mindset envisions smart meters that not only serve as devices that transmit information back to a utility, but that also can be platforms for a variety of applications, not all of which will even necessarily be related to energy use. This, in turn, helps to overcome another barrier, in that it increases the value proposition of purchasing an M2M device by greatly increasing its potential functionality and giving the client the freedom to choose additional applications from any vendor.

Industry leadership is also essential for moving more quickly towards the creation and implementation of universal standards and open tools for innovative developers. Greater efforts are needed to bring the industry together for conferences that are more than solely academic presentations and a veritable flea market of wares—events that have real technical agendas and clear goals. Too often the telecoms industry focuses its efforts in this arena on brand management and promotion, sponsoring every event under the sun to get logos on billboards and their executives up at the podium. While such opportunities can be valuable, far too many resources are directed towards events with little or no real outcomes, and that do not move the industry forward.

MEASURING DATA AND LEVERAGING ITS VALUE

The process of collecting data, analyzing data, and automatically making decisions based on that data is the core principle of M2M communications, but too often the unparalleled ability of M2M to collect and analyze data is taken at face value. Along with being an excellent way to optimize efficiency, this data should be leveraged to improve the value proposition of M2M itself and increase adoption of the technologies. The data could also be a driver of innovation and even a commodity of intrinsic worth—improving revenue for vendors and generating savings for clients. Yet these additional values are overlooked by the market today. A tremendous opportunity is on the table for businesses to harness the value of the stockpile of data they are collecting already, and to put in place mechanisms that will let them make the most of the vast universe of data they have yet to gather.

In order to capture this opportunity, companies offering M2M solutions must work to build data collection and analytics into their offerings. By creating new tools or updating existing ones to provide both robust metrics and case studies, companies offering M2M solutions can help to make their value more apparent to potential clients. In many cases, existing products that allow clients to measure and optimize their energy use could and should be integrated into M2M solutions packages. An excellent example of an existing tool with strong potential for adaption to M2M is AT&T's Application Resource Optimizer (ARO), described in further detail in Case Study 8. Otherwise companies should engage in the development of such tools or else partner with third parties to offer them. By including such tools into a complete M2M solutions offering and addressing client concerns about the difficulty of quantifying the energy savings potential of such systems, companies will overcome one of the main barriers identified in this report—a lack of performance data. This will also improve their client-facing value proposition and thereby bolster sales and marketing models.

In addition to quantifying reductions in energy use and GHG emissions, M2M vendors should stress in their marketing and sales models how tools such as the ARO can be integrated into a client's external-facing media, providing them a way of showing stockholders and consumers the accrued savings realized through their investment in M2M systems. Such actions will likely gain positive recognition from observer groups, such as the Carbon Disclosure Project (CDP), who continue to play a major role in driving public opinion, company valuations, and sales.

**Industry leadership
is essential for
moving quickly
towards the creation
and implementation
of universal standards
and open tools
for developers**

CASE STUDY 8

Application Resource Optimizer—Quantifying Results

THE ARO is a free tool available to application developers for optimizing the energy efficiency of mobile apps. The ARO can cluster data during periodic transfers, offering energy savings of 46 percent for mobile applications that rely on large amounts of data streaming over wireless networks, or can optimize data caching to save 45 percent of energy for mobile gaming apps that rely heavily on this function (AT&T 2012). These are significant benefits not only for the consumer but also for the application developers who can improve their app offerings and become more competitive. The MNOs themselves also benefit by reducing stress on their networks.

While this tool has not yet been used specifically for measuring the energy savings or GHG emissions reductions offered by M2M products and services, adapting the ARO to such purposes should be straightforward and is a promising way to both prove and improve the value proposition and sales models of M2M. The tool also has a feature that allows users to monitor and visualize how their applications interact with the network, the frequency of such interactions, and the reason for them. That data is then compared with best practices, and the tool can even provide recommendations useful to developers and users alike interested in improving efficiency.

Research is underway to create a version specifically tuned to address common issues in the M2M space. MNOs should continue to adapt existing tools such as the ARO and use them to monitor and quantify energy savings for other product and service lines, such as their M2M offerings. They could also develop new analytic tools specifically for this purpose, or partner with third parties that currently offer such methodologies or tools. The current trend of keeping such tools open source is also an important and welcome one we hope to see continue.

Additionally, organizations such as the CDP are beginning to highlight not only the social and environmental benefits of corporate attempts at reducing GHG emissions, but also the positive effect such efforts have on the bottom line: in 2012, corporations participating in CDP's survey reported that their reductions of 497 million tons of CO₂e emissions directly resulted in an average ROI of 33 percent (CDP 2012). As company management and shareholders begin to take notice of the fact that the returns from investments in energy-saving measures actually rival return on invested capital (ROIC) in their core businesses, such activities will increase—but not without the capacity to measure and verify reductions and returns.

In the future, providers of M2M products and services will be able to go beyond simply offering widgets and applications for tracking energy savings and begin to provide ancillary services that will allow clients to track the performance of M2M technologies themselves at a company or product level, both in terms of GHG and energy savings. Doing so would not only respond to client demands, it would also expand the market and the potential client base for M2M product lines.

The positive track record generated by this data, particularly if made open source, would greatly strengthen the case for investment in M2M technologies, encouraging existing users to increase their investment while also bringing in more clients. Such data would also make it easier for companies to diversify revenue generation related to M2M business through offering software-as-a-service approaches that capture the value of the data being generated by these devices. Some providers have already begun to attempt this, as demonstrated by the Cumulocity platform described in Case Study 7.

This could be accomplished in a manner befitting of its goals—through an application of M2M technologies itself—since the devices are already self-reporting data; it is a matter now of centralizing the collection of such data and creating a scalable model for people and companies to opt in, and of providing data anonymously.

We believe there is an unrealized opportunity to develop a business model for gathering the vast amounts of data being generated by smart devices. This platform would also provide analytical tools for developers to use such data for innovating new and better M2M solutions capable of optimizing the efficiency of the devices gathering data. We believe that the creation of such an initiative will require both industry leadership and entrepreneurial passion, and will need support from civil society and governments, as much of the data generated by M2M devices is proprietary, pertains to sensitive infrastructure, or raises concerns about the security of personally identifiable information.

M2M DATA LEVERAGING

AN ENTREPRENEURIAL OPPORTUNITY

Entrepreneurs and companies offering M2M solutions can develop new businesses that gather, analyze, and distribute the vast amount of data generated by M2M in order to drive sales, investments, and innovation.



DATA-DRIVEN INVESTMENTS

Data gathered from physical infrastructure, farms, mobile resources such as vehicle fleets, and power grids can help analysts make more accurate predictions on a variety of trends. Data is also essential for unlocking investment in greater deployment of M2M.

APPLICATION DEVELOPMENT

M2M application developers can leverage data generated from M2M customers to improve their products, generate savings and improve efficiency.

DATA-DRIVEN SALES

Companies offering M2M solutions can use the data generated by existing M2M users to assess the needs of their own similar clients, and confidently recommend the best solutions for meeting those needs.

FAMILIAR STRATEGIES FOR NEW PRODUCTS

Companies offering M2M solutions must take steps to make M2M an aspect of their core business, and they must innovatively upgrade the M2M business model. In order to gain a competitive edge and capture large shares of the projected addressable revenue from global growth in M2M sales, companies offering M2M solutions must rethink how such products and services are sold. To strengthen the value proposition and develop strong marketing and sales models for these new technologies, M2M solution providers should leverage their networks of valued clients. MNOs should use their knowledge of existing clients, such as their data on the type of businesses they are currently supplying with Internet or mobile connectivity, in order to propose M2M solutions that will likely best meet individual client needs. For example, in Case Study 1 the M2M service provider plans to approach their existing clients from the utility industry with new M2M technologies, backed by data, and demonstrate to those clients the ways those technologies will benefit them. Similarly, in Case Study 4 the M2M technologies are not only being offered as total package turn-key solutions, they are being marketed to the clients by a company with whom they are already likely quite familiar.

Furthermore, integrating M2M business lines with existing marketing approaches and adopting analogous successes from other industries are both strategies that should be pursued to increase sales. MNOs should start by considering how to employ marketing strategies that have proven successful for them in the past, including things as simple as offering existing clients of their M2M systems the opportunity to appear in mutually beneficial advertising that highlights the client's business, in the course of their discussing the benefits they have enjoyed from M2M.

Major telecoms companies could consider further integrating M2M with their existing product lines and sales models by offering free M2M assessments to clients who purchase another service that requires on-site installation, such as phone, Internet, or cable. This strategy represents a low-cost way to make the case for purchasing M2M solutions to existing clients. In any case, M2M sales pitches should include in-person presentations or other tutorials on M2M products, particularly ones that use the client's own experience or resources as illustrative examples. There is a strong need for this particularly in the Agriculture sector, where there also an opportunity for working more closely with the Department of Agriculture, which is responsible for providing farmers with information on best practices.

Another of the most successful sales and marketing approaches already employed by the telecoms industry is the concept of service bundling—30 percent of U.K. consumers now purchase phone, Internet, and cable television as a package at discounted rates when compared to the combined cost of the individual services, with an additional 45 percent planning to do so (Booz and Co. 2009). In appropriate instances, MNOs should consider offering M2M as part of a customized, bundled service, and marketing this to existing and potential clients about whom they already possess data showing that such services would be beneficial. As is a common approach for so called 'triple play' offers that inform consumers and business how much they could save through bundling, offers that include M2M in such packages should not only show the discounted rate for M2M, offsetting some of the upfront-cost barrier, but should also show the projected savings accrued from the implementation of the product, improving the value proposition.

Finally, MNOs can look for market and sales strategies from other industries and adopt them to their M2M products. For example, the M2M industry could consider implementing loyalty and incentive program models, under which companies offering M2M solutions would offer discounts on other items from their product or service lines to their clients that save the most energy with M2M, or else partner with third parties to offer freebies or discounts tailored to their client's essential business needs. This has proven to be a very successful approach to differentiation for airlines and credit card companies, and could produce similar success within the M2M market.



Companies offering M2M solutions must take steps to make M2M an aspect of their core business, and they must innovatively upgrade the M2M business model

INNOVATIVE NEW BUSINESS MODELS AND SALES STRATEGIES

Companies offering M2M solutions should implement strategies that incentivize sales internally and/or increase uptake externally. These strategies could take many forms, including financial incentives, ‘gameification’, or inter-corporate campaigns crafted around major events.

MNOs must consider reshaping their sales model to lower the upfront cost of M2M. This can be accomplished through the implementation of a model in which MNOs are paid over time for their M2M products and services through a percentage share of the savings derived from the reduced energy and fuel consumption enjoyed by their clients. Such savings can be measured with tools such as the ARO—another example of how overcoming the barrier of marketing and sales models will require first overcoming the barrier of a lack of performance data.

Internal efforts to simplify sales models and otherwise incentivize sales will be critical to successfully exploit the M2M market opportunity. ‘Gameification’ on an internal level within a company, or between companies, is an idea that shows great promise. This model has proven successful in other applications and analogous industries, though examples to date have mainly involved behavioral experiments or small-scale pilot projects. For example, a new company called Greenbean Recycle piloted a reverse vending machine on the Massachusetts Institute of Technology’s campus that allows people who deposit recyclables to receive direct deposit payments and track their efforts in real time. The company’s software is flexible, and allows for the creation of contests between groups, such as departments or student clubs, the winners of which receive prizes from the company, such as gift cards or tickets to a Red Sox game. The company claims that, since 2010, its machines have collected 131,299 containers, representing 24,246 pounds of garbage diverted from a landfill and 21,771 kWh of energy saved (Greenbean Recycle 2013). The success of this program cannot be attributed to economics alone, as bottle deposit payments are both relatively small and already technically accessible to anyone anyway. This program made recycling not only easy but also fun, social, and even competitive, with the added bonus of generating monetary rewards for participants.

A similar set of circumstances may be at work in the M2M sector. Companies are aware that they could save some money by investing in M2M, but they find it both difficult and, for lack of a better word, boring. Companies offering M2M solutions can take inspiration from examples such as Greenbean Recycle and combine it with marketing strategies that include thematic elements of cause marketing, interactive digital approaches, and targeted marketing to create strong new customer-facing strategies.

For example, two U.S.-based MNOs could join forces to create a contest between their sales teams around the deployment of M2M solutions into a specific target geography or industry. This would be particularly powerful if done as part of a marketing campaign highlighting how the contest represents an effort to increase sustainability. Both companies would benefit from the joint publicity of their efforts through increased sales and image building. Such a marketing campaign could surround the World Series or other top-tier sporting event sponsorship, with the home cities or states of the teams serving as the zones for the sales teams to compete in.

This approach would also work for MNOs who partner with other firms to offer fully integrated M2M solutions. The firms in the partnership could engage consumers in participating in a demonstration of an M2M consumer application that the two companies are jointly offering. This could be encouraged through a contest promoted during a high-profile event or occasion. Under this model, for example, during the World Series, individuals who are fans of either of the two teams, or businesses based in either city, would be encouraged to trial M2M solutions over the course of the week. At the end of the sporting event, the winning city would be announced, and the prize might be an incentive such as a giveaway to the host city, perhaps in the form of the implementation of an M2M building management system for their home stadium.

Such gamification and incentive programs work equally well when conducted by a company internally. For example, the use of incentives on an internal level for reducing energy and fuel consumption is quickly becoming a trend within global Fortune 500 firms. Today, 95 percent of major telecoms firms have internal incentives that reward efforts leading to reductions in GHG emissions, of which 75 percent are monetary incentives—more than any other industry (CDP 2012a). These same programs could be applied to a sales team to boost sales of an M2M product line, perhaps with one region competing against another.

But for any of these new strategies to work, the M2M industry will have to first generate some cohesion on their telling of ‘the M2M story’. In order to accomplish this, the industry needs to create forums in which they can discuss and co-ordinate efforts to increase the deployment of M2M technology, improve its value proposition, calculate ROI, and develop a common language to describe its benefits that resonates with customers. The industry needs to foster a wider understanding of what M2M technologies are and begin a concerted effort to communicate this both within the telecoms industry and to the general public. Major industry players should work together to create a centralized source of information on M2M and the various applications for the technology set, as well as to provide a comprehensive overview of the value chain and the entities within it. This information source should be both external facing, for potential clients and consumers, but also industry facing, so practitioners can stay up to date on developments, and put forth a unified message on what these technologies are and how they hold the potential to greatly improve our world.

Concluding Thoughts

The emerging M2M industry appears poised for rapid growth, providing a beacon of hope for telecoms companies seeking new revenue sources and business lines in the face of mobile and Internet saturation, and indeed for the global economy, which could stand to benefit greatly from both the almost \$1 trillion in potential activity projected for the M2M industry and from the massive efficiency gains that would accompany wide-scale deployment.

However, there are several major impediments to achieving a future characterized by the connectivity promised by M2M technologies and encapsulated in the grand vision of concepts such as the 'Industrial Internet'. While reaching such a future will most certainly require governments to send the right policy signals and support, it will undoubtedly require industry leadership and innovation. While many recommendations within the literature focus on ways to stimulate the creation of the regulatory framework deemed necessary by observers for consumers and businesses to invest in M2M, many of these steps are already either under consideration or in the process of being implemented. Others are hopelessly ensnared in bureaucratic gridlock, or slowly moving through the processes of international negotiations whose outcomes often lack the force of law.

For the MNOs and the rest of the M2M industry, the single overriding message of this report is: Act Now. The technologies are mature and the economics are favorable. Now is time to create partnerships, develop standards, leverage data, and rev up sales. There is no need to wait for new policies in order to realize the growth projections summarized in this report.

In this report, we have focused on proposing strategies for industry leadership for increasing B2B sales of M2M within North America. While the vast majority of growth in M2M is now occurring in the United States, Europe, and China—a trend projected to continue—more thought should be given to how M2M can be applied in the developing world. In addition to offering significant savings to clients and consumers in mature markets, M2M has the potential to transform the developing world by offering new business models for energy, bringing domestic electricity to the hundreds of millions who still lack this basic resource, and by preventing food and medicine spoilage, thereby reducing malnutrition, starvation, and death from infectious diseases. These regions often represent entirely new markets for MNOs, who may find that M2M is a key entry point for sales of their other products and services in developing regions, opening up opportunities for expansion of other business lines. Such efforts will also necessitate partnerships with smaller regional telecommunications companies, a positive trend highlighted by many of the case studies presented here and one likely to lead to additional profit opportunities.

For the MNOs and the rest of the M2M industry, the single overriding message is: Act Now. The technologies are mature and the economics are favorable. Now is the time to create partnerships, develop standards, leverage data and rev up sales.

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GLOSSARY

ARO	Application Resource Optimizer
BAU	Business as Usual
BEM	Building Energy Management
CAPEX	Capital Expenditure
CO ₂ e	Carbon Dioxide Equivalent
GDP	Gross Domestic Product
B2B	Business-to-Business
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HVAC	Heating, Ventilation, and Air-Conditioning
ICT	Information & Communication Technology
M2M	Machine-to-Machine
M&A	Mergers & Acquisitions
MNO	Mobile Network Operator
NGO	Not-for-Profit Organization
OEM	Original Equipment Manufacturer
OPEX	Operating Expenditures
ROI	Return on Investment
ROIC	Return on Invested Capital
TCO	Total Cost of Ownership

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NOTES

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VP of Business Development, Milsoft Utility Systems

David Gilford

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Jeff Hamilton

Director of Strategic Partnership, Trimble

Svetlana Grant

Director, Smart Cities, Connected Living Programme, GSMA

Michael Troiano

Executive Sales Director, AT&T

Bruce Thompson

Senior Product Manager, AT&T

David Kalb

Application Sales Director, M2M, AT&T

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ABOUT THNK:

THNK: The Amsterdam School of Creative Leadership is an international non-profit educational foundation, founded in 2010. The mission of THNK is to catalyze breakthrough societal innovation and accelerate future generations of creative leaders. THNK has three core activities: innovation challenge projects (4 per year), creative leadership executive program (2 classes per year), and a research program.

ABOUT AT&T:

AT&T Inc. (NYSE:T) is a premier communications holding company and one of the most honored companies in the world. Its subsidiaries and affiliates – AT&T operating companies – are the providers of AT&T services in the United States and internationally. With a powerful array of network resources that includes the nation's largest 4G network, AT&T is a leading provider of wireless, Wi-Fi, high speed Internet, voice and cloud-based services.

ABOUT CWR:

The Carbon War Room is a global entrepreneurial initiative set up by Sir Richard Branson that accelerates entrepreneurial solutions to deploy profitable, scalable clean technologies across industry sectors; and is a registered US non-profit.

Research Conducted In Partnership with:



Contributing Partner:





Carbon War Room
1150 Connecticut Ave., NW, Suite 620
Washington, DC 20036

P / 202.717.8448
F / 202.318.4770

Web: www.carbonwarroom.com

Twitter: www.twitter.com/cwarroom

Carbon War Room – LinkedIn Group: <http://linkd.in/f3Zu1G>