Machina Research

White Paper

Big Data in M2M: Tipping Points and Subnets of Things

About this White Paper

This White Paper focusses on three hot topics in the TMT space currently: Big Data and the 'Internet of Things', both examined through the prism of machine-to-machine communications. We have grouped these concepts together, since Big Data analytics within M2M really only exists within the context of heterogeneous information sources which can be combined for analysis. And, in many ways, the Internet of Things can be defined in those exact same terms: as a network of heterogeneous devices.

It is clear that Big Data and the Internet of Things will have a fundamental impact on the way businesses are managed in the future, the way that we interact with our cities and urban areas, and our day-to-day life as consumers.

It is also clear that we are not going to move directly from our current, essentially unconnected and siloed world directly to a brave new world of Big Data and the Internet of Things. There must be some stepping stones along the way. The aim of this White Paper is to identify some of those stepping stones, and so to identify some of the commercial opportunities that might lie within Big Data over the short- to medium-term.

In order to write this paper, and since our analysis of the opportunities is somewhat more pragmatic than many that have gone before, Machina Research found it necessary to extend the lexicon of the industry and define some new terms that have not been used before. These include:

- **'*Subnet of Things*', by which we mean an island of interconnected devices, driven either by a single point of control, single point of data aggregation, or potentially a common cause or technology standard**

- **'*Data Community*', by which we mean a community of devices, sources of data and data owners that could potentially give rise to a Subnet of Things**

- **'*Tipping Point*', by which we mean the point where the network effects of membership of a Data Community begin to drive the development of that community.**

Six key themes within Big Data

Machina Research sees Big Data as a significant development for M2M. In the scope of this White Paper we focus our analyses in six key areas.

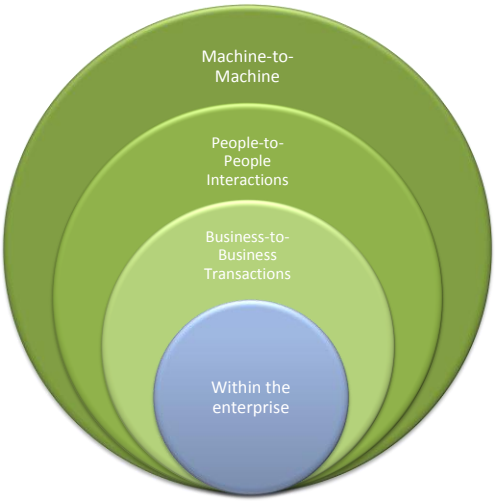
1. ***Emergence of 'Subnets of Things'***
   Islands of connected devices will emerge, driven either by a single point of control, single point of data aggregation, or potentially a common cause or technology standard. These 'Subnets of Things' will be stepping stones towards a full Internet of Things.
2. ***Tipping Points***
   Having established the concept of Subnets of Things, a critical consideration is the 'Tipping Point' where the network effects of membership of a data community begin to drive the development of that community.
3. ***The Business Case for Big Data***
   The business case for Big Data is driven by the concepts of Subnets of Things, and Tipping Points. It should also include consideration of the type of M2M connection that a connected device supports: not all M2M connections are equal.
4. ***The Qualities of Big Data – the 5 'S's***
   Five key aspects of Big Data will dictate what can be done with the data, by whom and for what purposes. The five are: Size Speed, Structure, Situation and Significance. Together, these qualities will fundamentally change the value of data.
5. ***Opportunities for Operators***
   There are many opportunities for operators, including leveraging established M2M roles, becoming a trusted third party for M2M data, driving the development of Subnets of Things, selling information, and taking on a data processing role.
6. ***Challenges for Big Data and M2M***
   There are four key challenges to be addressed in Big Data and M2M: privacy and data ownership, authenticity and security of different kinds of data, skills scarcity, and changing the attitudes of data professionals.

1 Emergence of *'Subnets of Things'*

Machina Research has identified four circles in which data is created:

- Within the enterprise
- Business-to-Business transactions
- People-to-People interactions
- Machine-to-Machine (M2M)

Machina Research's Circles of data creation
Source: Machina Research 2013



Whilst the analysis of data within each of these four circles is well established, traditional data mining has typically focussed on single sources of information, rather than cross-indexed and merged data environments incorporating data gathered from a range of disparate sources.

In particular, the current M2M environment is characterised by an increasing number of diverse connected device types, which are typically connected in vertically integrated stovepipes rather than in a horizontally integrated way. Right now, the world of connected devices could best be characterised as multiple 'Intranets of Things'. For example there are increasing numbers of connected smart meters, but the data that these produce is generally used for a single purpose (analysing, pricing and billing for power consumption).

But it would be a mistake to expect these Intranets of Things to automatically become integrated into a wider Internet of Things. The next steps of development for data analytics will see data generated, exchanged

and managed around common relationships or benefit structures, in what may be termed *'Data Communities'*.

The next step must be around integrated 'islands' of connected devices, emerging within Data Communities and for which Machina Research has coined the phrase *'Subnets of Things'*.

Subnets of Things would typically be driven either by a single point of control, single point of data aggregation, or potentially a common cause or technology standard. For example, it is not hard to envisage an emerging Subnet of Things around a smart city: local authorities would often have access to data relating to congestion charging, public transport delays and ticket machine volumes, parking space availability, traffic light phasing, air pollution and potentially a whole range of other data sources.

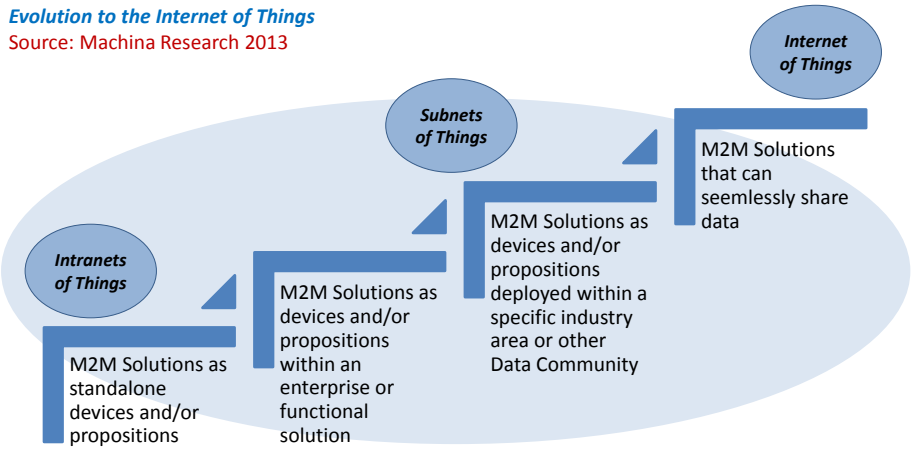
Healthcare is another front-running candidate for emerging Subnets of Things and where the Continua Health Alliance standards and Qualcomm's 2Net are both candidates for forming the kernels of connected device ecosystems.

The potential benefits of such Subnets of Things are immeasurable, including (and by no means limited to): streamlining public services; reducing carbon footprints, and; massively improving healthcare provision.

To move from these Subnets of Things to a full Internet of Things environment is a fundamentally more difficult step. It will involve aligning data points from a huge range of disparate device types, ideally at an individual user, or individual device level. In the medium-term, it will be more likely that pairs of well-integrated Subnets of Things will be connected on an ad hoc, and 'as needs' basis to support particular applications. An example might be an interface between a smart cities Subnet of Things and a healthcare Subnet of Things to support the speedy passage of an ambulance through a congested city.

The next graphic illustrates a likely development path whereby a simple M2M connection ultimately becomes part of the Internet of Things.

Evolution to the Internet of Things
Source: Machina Research 2013



Machina Research expects Subnets of Things to emerge in a range of specific niches, including:

- Smart Cities
- Healthcare
- Automotive
- Supply Chain
- Intelligent Buildings
- Consumer Electronics
- Retail
- Construction
- Emergency Service

Subnets of Things in each of these areas have the potential to massively impact efficiency, quality of service or efficacy of current processes.

2 Tipping Points

Having established the concept of Subnets of Things, a critical consideration is the *'Tipping Point'* where the network effects of participation in a Data Community begin to drive the development of that community.

While the total volume of data traffic generated by M2M connected devices will be significantly lower than that generated by personal devices (for example, mobile phones and tablets), the pervasiveness and size of M2M data is set to drive a desire to graduate from only mining isolated data-sources to extending those analyses to include a disparate range of data sources within growing Subnets of Things.

Such developments give rise to the concept of *'Tipping Points'*, which occur when Data Communities achieve significant levels of adoption and market demand. As a result they drive new patterns of adoption and market demand for M2M solutions, mainly in response to growing demand from users wanting access to the new services, but also entrepreneurs recognising emerging opportunity areas in greater numbers with lesser risk profiles.

Healthcare provides a clear example where Tipping Points could exist in the context of Subnets of Things. One example includes consumer-oriented devices, the adoption of which is driven by people's concern for their health and well-being. When a subnet of connected consumer health devices reaches a certain size, entrepreneurs will become motivated to target value added products and services at users of those connected devices, increasing the value of data community membership for all members and stimulating more members to join. Once the Tipping Point has been reached, a virtuous circle has been established that both drives growth in community membership, and the value of community membership to all members.

Tipping Points in clinical healthcare could take a very different form. Consider the example of a European local health authority that establishes a

networked health initiative. Over time, that health authority will add new M2M devices and other data sources to their own Subnet of Things. Eventually, that subnet will reach a Tipping Point, where sufficient cross-referenced data is available that data-mining is a logical next step, potentially yielding significant benefits. These could include:

- Identification of individually tailored medication and treatment programmes based on an individual's response to different types of medication, or genetic makeup, and in the context of a much more granular understanding of how other patients have reacted to such medication in the past.
- Patients judged to be at an increased risk of an adverse clinical event can be pre-emptively checked-up, potentially averting the need for an emergency admission to A&E.

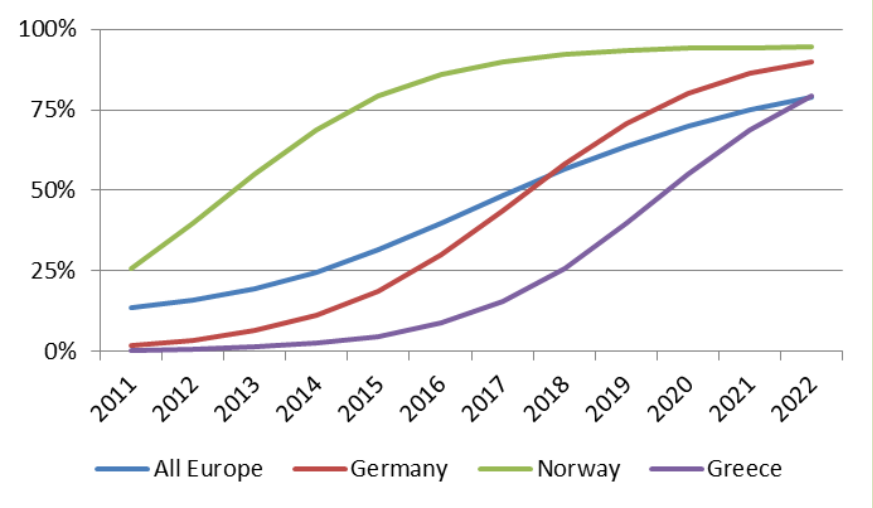
However, these two examples highlight an interesting subsequent dynamic, after the initial Tipping Point has been reached. The consumer example is likely to be played out at national level, and once one national market has reached its tipping point, then the effect is likely to snowball across different national markets, subject to consideration of external factors such as regulations, language barriers and wealth. However, the clinical example is likely to be played out at a more granular level. In Europe, the fact that a local authority has developed a Subnet of Things and reached a Tipping Point where they can profitably engage in data-mining may actually deter other local authorities from following the same path: later adopters can benefit from the findings of data-mining undertaken by earlier adopters.

And there's no point in inventing the wheel twice, other than in the case of markets where technology transfer is not efficient. For example, if it is an American health insurance company that has managed to improve the efficiency of patient care on the back of data-mining, then that company's competitors will feel compelled to develop their own Subnets of Things.

The adoption of smart meters will drive a Tipping Point for demand response in intelligent buildings

Smart electricity meters are being adopted at widely differing rates worldwide. A by-product of this trend will be a migration to more granular electricity tariff plans, as electricity providers attempt to shift consumption to off-peak periods through pricing.

Clearly, then, the adoption of smart electricity meters is a necessary precondition for the adoption of smart home technologies that support demand-response. But where are the Tipping Points? The chart below is sourced from Machina Research's forecast database, and shows the penetration over time of smart electricity meters in a range of European territories.



Whilst Norway is a clear leader in terms of adoption of smart electricity meters, the market overall lacks scale: the absolute number of smart electricity meters in Norway will probably be insufficient to kick-start a market for demand response solutions. Germany, whilst a significantly later adopter of smart electricity meters, has far greater scale and an industrial capability that may drive a market for demand response solutions which are then eagerly adopted in Norway to satisfy pent-up demand. On all counts, Greece is likely to be a follower of trends set by other markets.

3 The Business Case for Big Data

Advances in technologies have enabled the emergence of Big Data. Without the highly acclaimed Hadoop-based platforms, processing semi-structured and unstructured data would still be virtually impossible. Without reduced processing and storage costs, Big Data would remain an expensive and highly experimental endeavour for a few leading edge enterprises. Without improved networks and cheaper data traffic rates, data from individual data sources would remain isolated and unavailable for data mining.

Much the same developments are beginning to drive the implementation of machine-to-machine solutions in an ever expanding range of situations.

In short, the technological landscape has developed to the point where it is clear that Big Data presents tremendous opportunities for organisations and enterprises to develop and improve customised services and experiences delivered to customers by capturing, processing and analysing data from an increasing range of sources. Additionally, it is clear that data gleaned from M2M devices must also be incorporated into Big Data analyses.

In this White Paper, we highlight two key considerations of the business case for Big Data analyses:

- ***Firstly***, as highlighted in Sections 1 & 2 of this White Paper, we expect that Big Data analyses will take place, at least initially, primarily within the context of Subnets of Things, rather than in the context of a fully-fledged Internet of Things. In fact, we believe that the vast majority of the benefit that can be achieved through Big Data in a M2M context can be achieved at the level of linked Subnets of Things, rather than necessarily only in the context of an Internet of Things.
- ***Secondly***, it is also worth drawing attention to the fact that not all M2M is the same. In fact, there is a definite hierarchy of M2M solutions, with clear implications for the scope of Big Data analyses.

Overall, we see more basic M2M solutions as being essentially device-centric, whilst more sophisticated M2M solutions are often process-centric. Clearly the scope (and so expected benefits) of any potential Big Data analyses is very much impacted by the type of M2M devices that may contribute data to that analysis. For reference, we set out Machina Research's Hierarchy of M2M below.

Machina Research's Hierarchy of M2M

Source: Machina Research 2013

	Stage	Description	Comments
Device centric	1	Reactive information	• Devices can be polled for information, or provide information according to a set timetable
	2	Proactive information	• Devices communicate information as necessary
	3	Remotely controllable	• Devices can respond to instructions received from remote systems
	4	Remotely serviceable	• Software upgrades and patches can be remotely applied
Process centric	5	Intelligent processes	• Devices built into intelligent processes
	6	Optimised propositions	• Use of information to design new products
	7	New business models	• New revenue streams and changed concept of 'ownership'
	8	The Internet of Things	• Publishing information for third parties to incorporate in applications

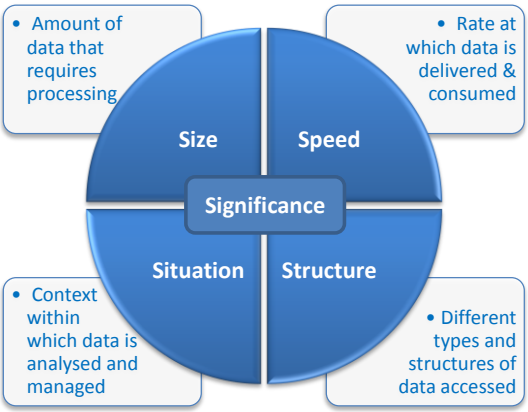
4 The qualities of Big Data

Big Data is not only about the volume of data or size of a database, although clearly ***size*** is a significant consideration. Machina Research identifies five key aspects of Big Data:

- Size
- Speed
- Structure
- Situation
- Significance

Machina Research's Five 'S's of Big Data

Source: Machina Research 2013



A major difference between traditional business intelligence and Big Data is that of ***speed***.

Data within *Intranets of Things* has traditionally been managed through fairly time-consuming processing routines with significant focus on historical analyses. In the Big Data world, much of the value of data can emerge from *real-time* data capture and processing. This does not replace historical analysis but paves the way to new ways of applying information (near) real time in such areas as fraud detection and health management.

Structure and ***Situation*** go hand-in-hand. Data may be considered structured when well-defined in content and format. This structure is further enhanced when the data has been generated within a well-defined situation, either in terms of frequency, context or terminology. Call Detail Records relating to mobile telephone calls are an example of highly structured data. In contrast, an entry on Facebook or a video-clip can contain vast amounts of unstructured data, which could have generated in a huge range of possible situations. Clearly the latter scenario requires completely different analytical techniques from traditional business

intelligence processing to yield results of any value. In this continuum, the Subnets of Things can most accurately be described as semi-structured data; not quite as organised and neat as prescribed flat-file data entries but substantially less complex than analysing the contents of a video clip.

There is a fifth 'S' in Big Data but this 'S' is the resultant ***significance*** of the other four components. Significance of the data is measured by the insights provided by them – facilitated by business analysts having framed the right questions for analysis, and data scientists having successfully matched data sources to provide suitable structures of data for enquiry and analysis. The significance of an individual data point could be intrinsic (in terms of the degree to which a particular observation is either expected, or unexpected), or conferred by analysis in association with other data points. The reality is that many data points will not have much significance, insofar as they do not vary significantly from expected values.

5 Opportunities for Operators

As enterprises explore Big Data, machine-to-machine solutions will become even more pervasive, not just as functional sensing devices but as data capture points, ultimately potentially deployed with the specific intent of providing inputs to Big Data analyses. This development will result in niche M2M markets evolving into wider Data Communities which in turn will further encourage entrepreneurs to develop M2M-related solutions and service propositions.

The incorporation of M2M information into Big Data analyses creates five distinct opportunity areas for operators, each of which we discuss in turn:

5.1 Leveraging the established M2M role of operators

Identified as a significant new revenue opportunity for communications service providers (CSPs), M2M has already become an enterprise oriented staple of many CSP product and services portfolios, and also as a key capability of a range of consumer propositions. Many leading operators have developed extensive M2M capabilities which can extend to a one-stop shop for M2M. Such operators can provide customers with reliable and experienced contacts for devices, modules, applications development, and systems integrations.

In essence, the telecoms industry already has an established M2M role which can provide a suitable entry point to introduce benefits of Big Data to their customers. In a situation where a CSP is already managing the connectivity component of an M2M solution, and potentially the management platform components, then that CSP will have already established business relationship with the customer in question. In many ways, then, offering Big Data solutions can be seen as a natural on-sell from providing M2M solutions.

In addition, many CSPs have significant experience of data mining based on the experience of running their own businesses where Big Data techniques are used to support numerous business decisions, ranging from setting pricing to managing loyalty programmes.

5.2 Becoming a Trusted Third Party for M2M data

As clearing houses are a feature of the financial industry, created to manage financial transactions between multiple financial service providers, Machina Research predicts that a similar model may emerge in data management space.

Established as an industry with a few trusted service providers, operators could extend the strengths of their brand, their embedded technology capabilities and their experience and resources in managing data by creating and offering these services to the market.

5.3 Driving the development of 'Subnets of Things'

It is clear that CSPs could be well positioned to catalyse the development of a range of potential Subnets of Things. In rapidly developing markets such as M2M and Big Data, the simple fact of being at the forefront of development can give rise to significant opportunities for new business.

5.4 Selling information

The information that CSPs (and particularly mobile operators) hold is an asset. At a basic level it can be sold to retailers to provide information as to shopper behavior whilst in shops or shopping malls, or to train operators to tell those operators how many passengers are on any given train. At a more sophisticated level, highly refined information can be made available to third parties. Such information could include identification of social influencers based on call patterns.

5.5 Taking on a data processing role

Increasing amounts of data and greater demands for real-time processing has started to raise the question as to where processing of data should take place. In this early stage, data is transferred across the network, and processed within defined processing units. Given expected advances in network analytics, operators will be in an ideal position to guide and manage alternative options of moving the processing of data onto the networks, and nearer the devices.

6 Challenges for Big Data and M2M

There are four key challenges to be addressed in Big Data and M2M: privacy and data ownership, authenticity and security of different kinds of data, skills scarcity, and changing the attitudes of data professionals.

6.1 Privacy and data ownership

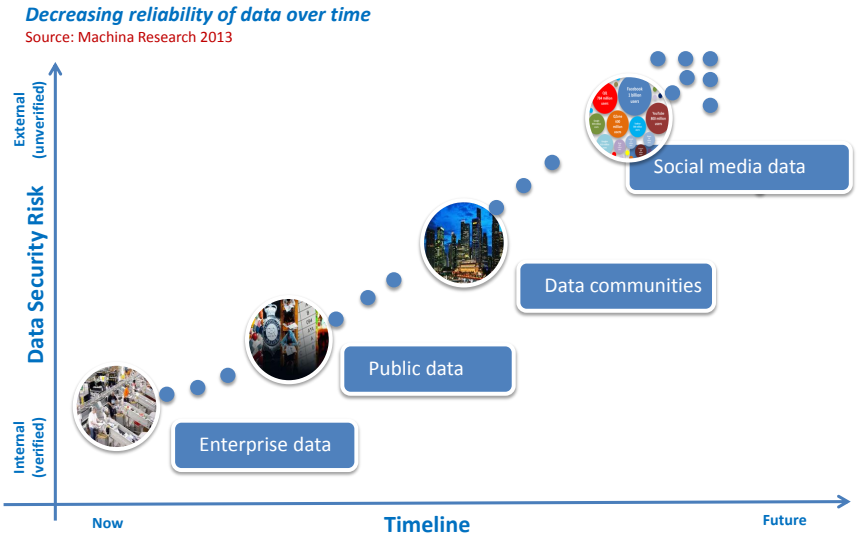
Concerns about profiling, tracking, discrimination, exclusion, government surveillance and loss of control of privacy are often associated with Big Data. More fundamentally, there is the question of who actually 'owns' data relating to people, devices or processes.

Whilst it is clear that much work remains for regulators and enterprises to determine levels of data privacy and ownership of data, it is also clear that issues of privacy and data ownership are significantly reduced in the context of a Data Community, or a Subnet of Things, where the eventual use of data is clearer and more likely to be aligned with the priorities of members of that community, or even explicitly controlled by those members.

6.2 Authenticity and Security

Big Data is about "mashing up" data from multiple sources, and delivering significant insights from the data. It is the combination of data from within the enterprise, from openly available data (for example, data made available by government agencies), from data communities, and from social media. And with every different source of data arises the issues of authenticity and security.

Machina Research predicts that as a result of the need for data verification, enterprises will have a greater inclination to process internal and open (government) data prior to mashing-up with social media. In this model, Data Communities within the Subnet of Things emerge as the 'ideal' objective in the short and medium term future of Big Data.



6.3 Skills Scarcity

Managing Big Data will require the combination and collaboration of two distinct skills sets – that of a business analyst to form the appropriate questions to be explored with available data, and that of a data scientist, able to identify the relevant data sets, manage the processing of the data, and deliver resulting insights in an easily understandable fashion.

While technologies will be scaled and made available to meet the demand, these particular skills will become a scarce resource. Enterprises and organisations are recommended to plan and address for these developments, and understand the benefits that insights can deliver.

6.4 Changing Attitudes

Recognising value from the analysis of data requires a sea-change in approach from historical, siloed, managerial tools and approaches. Improved and real-time data sets, more efficient and speedier processing capabilities, and greater insights delivered by such analysis, have and will challenge departments and management teams to explore the insights that may be achieved with data from both internal and external sources.

About Machina Research

Machina Research is the world's leading provider of strategic advice on the newly emerging opportunities in M2M, IoT and Big Data. We are staffed by mobile industry veterans with the knowledge and understanding of these new market opportunities to help your company, whatever its requirements in this space. The company is staffed by industry veterans including:

Jim Morrish (Director) is a respected telecommunications industry expert, with over 20 years' experience of strategy consulting, operations management and telecoms research. He has worked on-site in in excess of 25 countries worldwide, including in Africa, Asia-Pacific, Europe, the Middle East and North America. Previous experience includes strategy consulting for Booz&Co, project management and board membership at Cable & Wireless, Head of department at the BBC and also work as a freelance consultant and with Analysys Mason. He holds an MA in mathematics from Oxford University. Email: jim.morrish@machinaresearch.com

Matt Hatton (Director) is a hugely respected wireless industry expert with 15 years' experience at the cutting edge of telecoms research. At analyst firm Yankee Group he was Program Manager focusing on the mobile services market in EMEA and most recently at Analysys Mason he was Research Director managing all research on the telco services market, with a particular focus on mobile broadband and other new emerging services and business models. Matt holds an MSc in Telecommunications (Distinction) from University College London. Follow him on twitter at @MattyHatton. Email: matt.hatton@machinaresearch.com

Emil Berthelsen (Principal Consultant) has over 23 years' experience with management, strategic and research consulting for a number of leading consulting organisations including KPMG, BT Consulting and Analysys Mason. More recently, Emil has focused on the Technology, Media and Telecommunications industry, advising global clients on new product, service and market opportunities in mobile, identifying channels and strategic partnerships in these markets, and providing market sizing, competitor intelligence and insights around emerging market and technology trends. Email: emil.berthelsen@machinaresearch.com

Machina Research Services

Machina Research supports a blue-chip client base with an Advisory Service consisting of the following elements:

- **Forecast Database** – On-going access to this constantly updated forecast of the M2M and mobile broadband opportunity worldwide. These are the most detailed forecasts of the M2M market opportunity, including connections, traffic and detailed revenue analysis for hundreds of countries, across 61 application groups in 13 sectors (e.g. Utilities, Smart Cities, Automotive), and multiple technologies. If you need forecasts of the M2M market, Machina Research's Forecast Database will have what you need.
- **Sector Reports** – Based on the same 13 sectors covered in the Forecast Database, these reports provide qualitative and quantitative (i.e. 10 year forecasts) analysis of each sector.
- **Strategy Reports** – Reports focusing on specific issues relating to M2M cutting across multiple vertical sectors, including benchmarking communication service provider (CSP) capabilities, analysis of the big data opportunity, and in-depth analysis of M2M software platforms.
- **Research Notes** – 3 shorter reports per month examining key issues in the world of M2M such as network rationalisation, module costs, IMSI swapping/remote provisioning, alliances, and case studies of successful implementations.
- **Strategy Sessions** – On site presentations from our expert analysts to provide more detailed and tailored analysis of a particular topic.
- **Analyst Inquiry** – Direct access to our analyst team to ask the burning questions that you have about the M2M market.

The Consulting side of our business has multiple strands, including:

- **Market opportunity assessment** – Helping our clients to understand the opportunities presented by M2M, and defining how to engage with different functional, vertical and geographic markets.
- **M2M procurement assistance** – Helping our clients to procure the M2M services that they need to turn their 'connected business' ideas into a successful reality.
- **Business case development and due diligence** – drawing on our extensive experience of the M2M industry, and our benchmark forecast data, we can assist clients with key strategic decisions.

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