



Mobile and the Internet of Things:

Unanimity Around Fragmentation, Surprises in Connectivity and Geography

A survey and analysis of how the mobile industry views the IoT opportunity

Executive summary

To research the future of the Internet of Things (IoT), Mobile World Live conducted an online survey of 393 people in the mobile industry – one of the largest IoT surveys to date – on behalf of InterDigital. The survey yielded a wealth of data, some of it confirming views and some challenging accepted views. That fragmentation and interoperability is a major issue is no surprise, and the industry is turning to four clear early standards leaders to provide a foundation. Perhaps in the same vein, and despite early indications that much of the IoT would be non-cellular, the ease of use and global nature of cellular is galvanizing attention. Finally, and surprisingly given the early talk of the tremendous benefits of IoT to primarily industrial economies, global respondents look to America as the early leader.

KEY FINDINGS INCLUDE:

Rapid growth ahead: Today, almost half (48%) of mobile operators earn less than 1% of their revenues from the IoT. But, by 2023, almost 40% of the operator respondents believe the IoT will account for more than 20% of their revenues, compared with 6% today (see Figure 1). The survey found that the mobile industry expects the consumer/smart home market to generate the most revenues by 2023, closely followed by the local government/smart cities segment (Figure 2). Within the smart cities market, respondents regard smart lighting, video surveillance and traffic control systems as the three most promising sectors from a revenue perspective (Figure 3).



“North America dominates the global software industry and is at the forefront of the development of artificial intelligence (AI), which will underpin self-driving cars, autonomous drones, robots and many other products and services of the future.”

The challenges facing the IoT: Half the respondents chose the development of sustainable business models as the first or second biggest challenge facing the IoT. The availability of connectivity, security fears and technical incompatibility are also seen as significant hurdles faced by the IoT (Figure 4). When asked what customers care about most with IoT connectivity, almost half of the respondents chose cost as the number one consideration, while the vast majority put coverage/reliability in their top three (Figure 6).

Cellular is the key to connectivity: Looking ahead to 2020, respondents identified cellular technologies - LTE, NB-IoT, GSM and 5G - as the most important connectivity options, well ahead of Wi-Fi variants. Developed specifically for the IoT and using operators' licensed spectrum, NB-IoT was the number one choice for 66 respondents, ahead of 5G and LTE (Figure 7). However, by 2023, 5G is likely to become the most important connectivity technology for the IoT, with 127 respondents making it their top choice (Figure 9). By contrast, most respondents see proprietary technologies playing a relatively minor role.

Fragmentation abounds: The IoT is being developed by a huge number of companies using a wide range of technologies, which are not necessarily compatible. The survey highlighted the high level of fragmentation in the IoT, with 92% of respondents describing this as "a major issue" or a "moderate issue" (Figure 11). Drilling down, the survey found that the mobile industry regards connectivity technologies and connectivity management as the areas in greatest need of more standardisation (Figure 12), with the Open Connectivity Foundation, the Open Mobile Alliance and OneM2M attracting strong support (Figure 13).

Diverse group of drivers: Respondents were divided on which organisations will drive the adoption of the IoT going forward. Although one third opted for mobile operators, one fifth selected application developers and another fifth, systems integrators (Figure 15). At the same time, the survey found that well-established players may not shape the future of the IoT. Some 39% of respondents believe new players will have the most influence over this market in the next decade, while one quarter reckon yet-to-emerge companies will play this role (Figure 18).

Action in North America and AI: Although respondents from North America made up just 15% of the sample, the survey clearly identified that region as the most likely to lead the adoption of the IoT going forward (Figure 19). Thanks in part to Silicon Valley, North America dominates the global software industry and is at the forefront of the development of artificial intelligence (AI), which will underpin self-driving cars, autonomous drones, robots and many other products and services of the future. A majority of respondents in the survey believe demand for data to develop machine learning and AI will be a major driver in the growth of the IoT in the next decade (Figure 20).



Introduction and Methodology



As the cost of computing and connectivity falls, a vast array of devices, appliances, equipment, vehicles and machinery are coming online. This emerging Internet of Things (IoT) is enabling consumers and companies to capture much more information about their assets, while allowing the remote control of everything from simple thermostats to complex traffic management systems.

As the Internet of Things expands and evolves, this report paper explores the growth drivers and dynamics underpinning this new market from the perspective of the mobile industry. It begins by outlining the growth of the IoT, before identifying the main challenges and then identifying likely future trends. It seeks to answer key questions, such as what proportion of mobile operators' revenues will be generated by the IoT and what kinds of companies are set to shape the future of this market.

To inform the analysis, the paper draws on an online survey of 393 people in the mobile industry conducted by Mobile World Live on behalf of InterDigital. Some 34% of the respondents were

from mobile operators (including mobile virtual network operators), 24% were from software developers and 14% were from hardware vendors. The remaining respondents were from other players within the mobile ecosystem, including systems integrators, testing providers, industry bodies and consultants.

Just over 46% of the respondents were from organisations with their headquarters in Europe, 15% were from North America, 9% from East Asia, 8% from Africa and 5% from South Asia, South East Asia and South America respectively.

“This emerging Internet of Things (IoT) is enabling consumers and companies to capture much more information about their assets”

How fast will the IoT grow?

The anticipated growth in IoT revenues

Approximately half the mobile operators participating in the survey said that they earn less than 1% of their revenues from the IoT and/or M2M (machine-to-machine services) today (see Figure 1). However, the respondents see that changing rapidly. By 2020, more than two-thirds of the operator respondents expect at least 4% of their revenues to be generated by this market. By 2023, almost 40% of the operator respondents believe the IoT will account for more than 20% of their revenues: five years from now, connecting machines will be a big part of many operators' businesses.

Figure 1: What proportion of your revenues are generated by the Internet of Things/M2M? (Mobile operator respondents, 133)

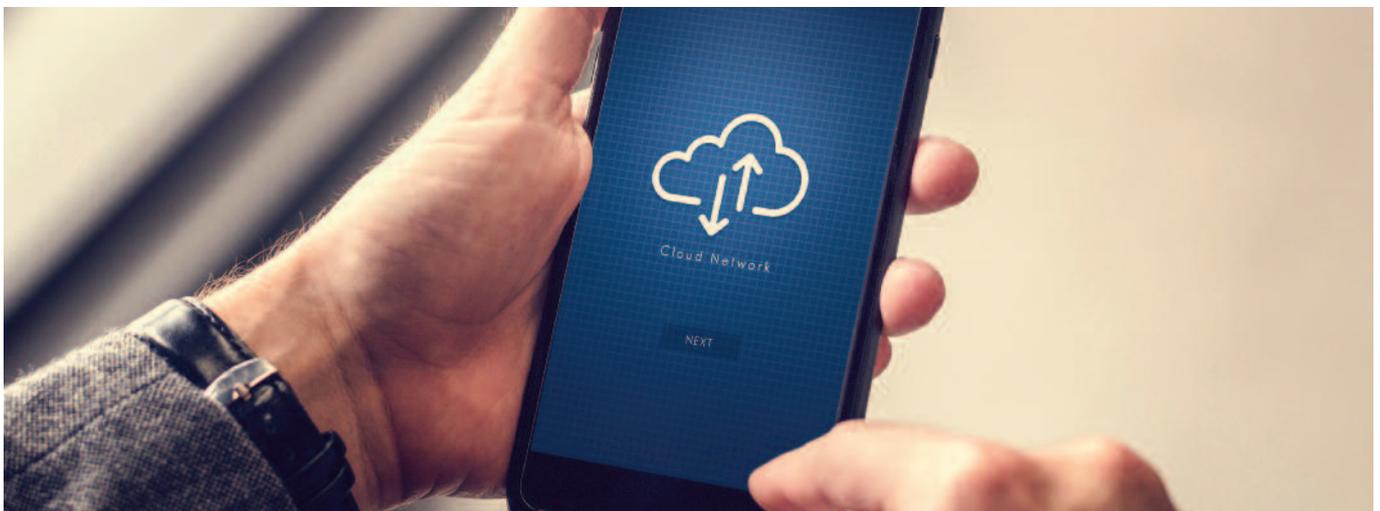
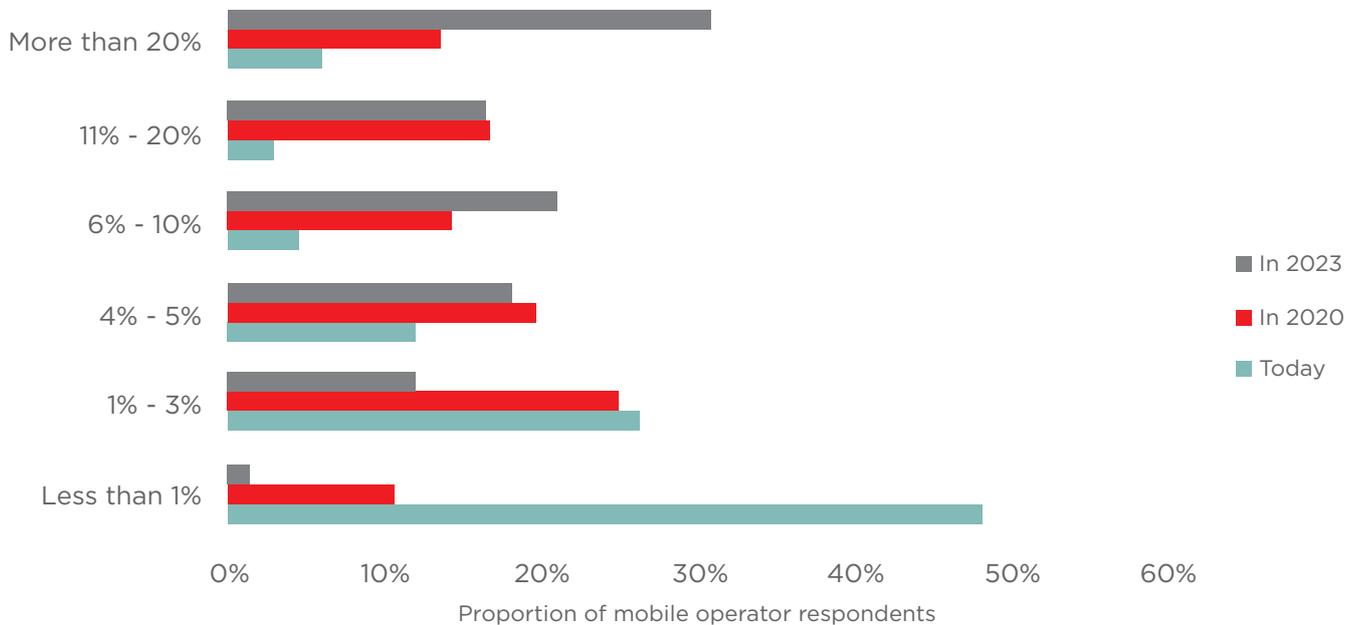
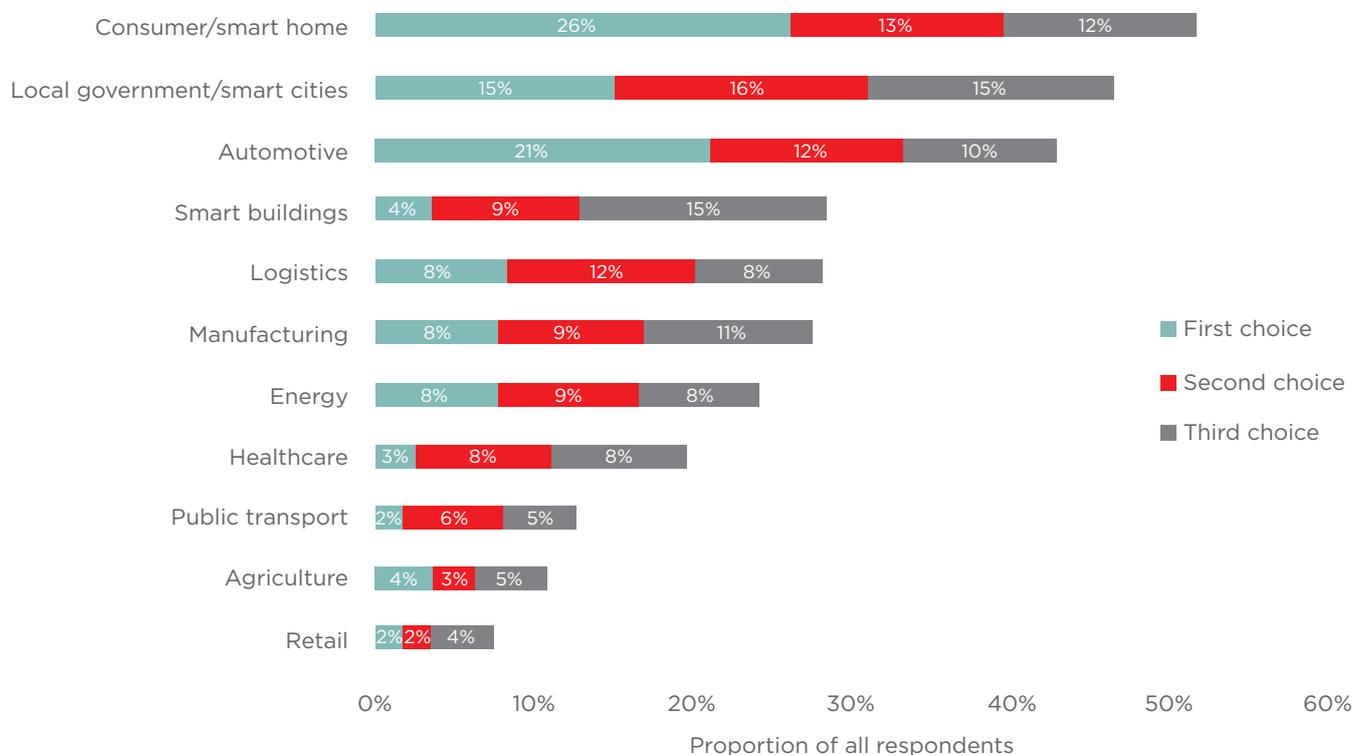


Figure 2: How do you expect the following market segments to rank in terms of the Internet of Things/M2M revenues in 2023? (please rank the top 3 in order of importance) (All respondents, base 331)



Today, operators in North America are the most likely to have a significant IoT business – approximately half of the operators from this region are generating more than 3% of their revenues from the IoT, compared with about one quarter in Europe and just 14% in Asia.

The sectors that will drive growth

The Internet of Things encompasses a vast range of both business and consumer applications, spanning everything from heavy industrial equipment to tiny wearable devices for people and animals. Which segments of the IoT will drive the growth that respondents are anticipating?

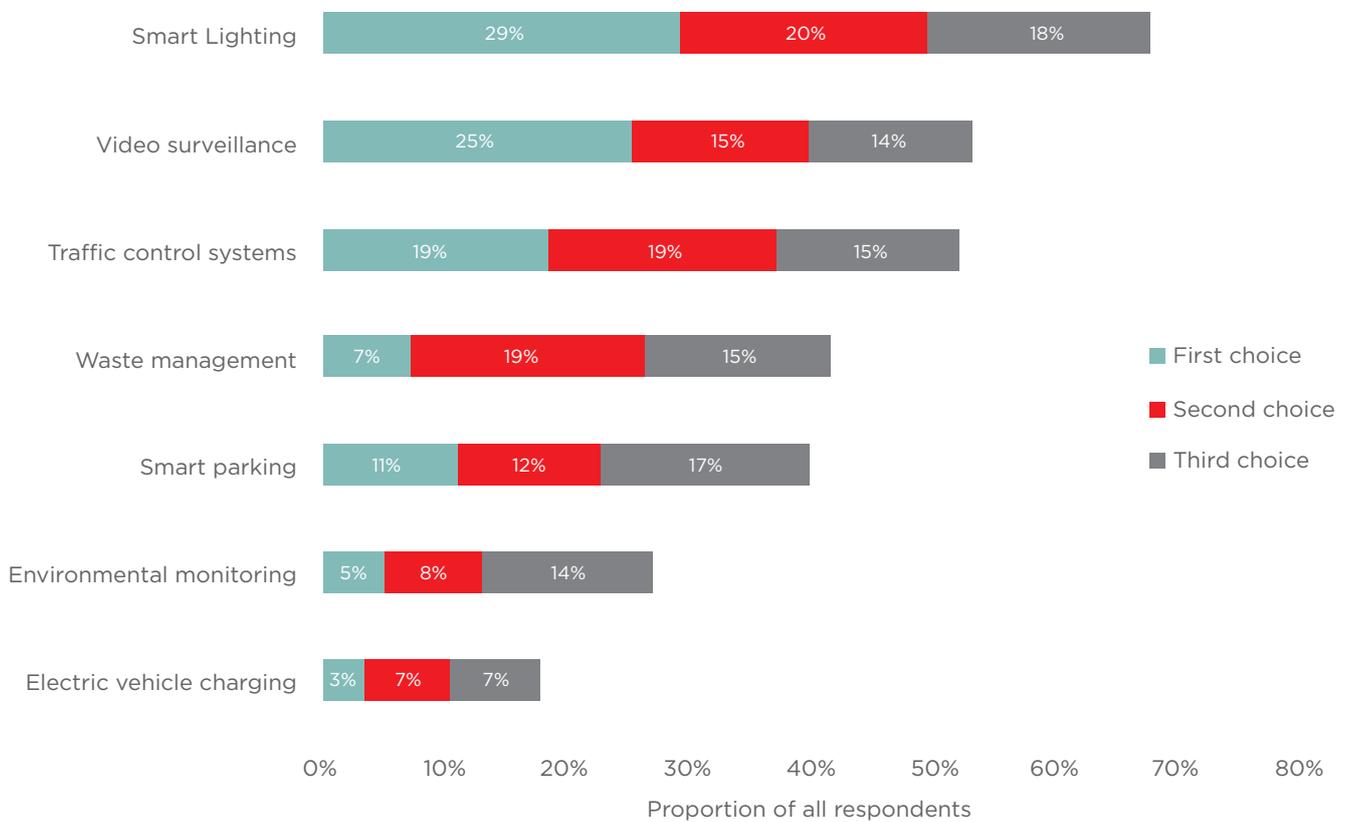
The survey found that the mobile industry expects the consumer/smart home market to generate the most revenues by 2023, closely followed by the local government/smart cities segment. The automotive sector is also regarded as having major potential, in contrast to the public transport, retail and agriculture sectors, which were nominated by few respondents (see Figure 2).

However, there are significant regional differences. Organisations in East Asia and South East Asia tend to see the local government/smart city market as the top IoT opportunity. By contrast, respondents from North America and Europe tended to identify the automotive sector as the business sector with the largest revenue potential (after the consumer/smart home market), significantly ahead of the local government/smart city segment.

In the smart cities market, respondents regard smart lighting, video surveillance and traffic control systems as the three most promising sectors from a revenue perspective (see Figure 3). Again, there are some regional differences. Among respondents from East Asia and South America, video surveillance is seen as the number one smart city application from a revenue perspective. By contrast, in the North American mobile industry, both smart lighting and traffic control systems are regarded as a bigger opportunity than video surveillance.



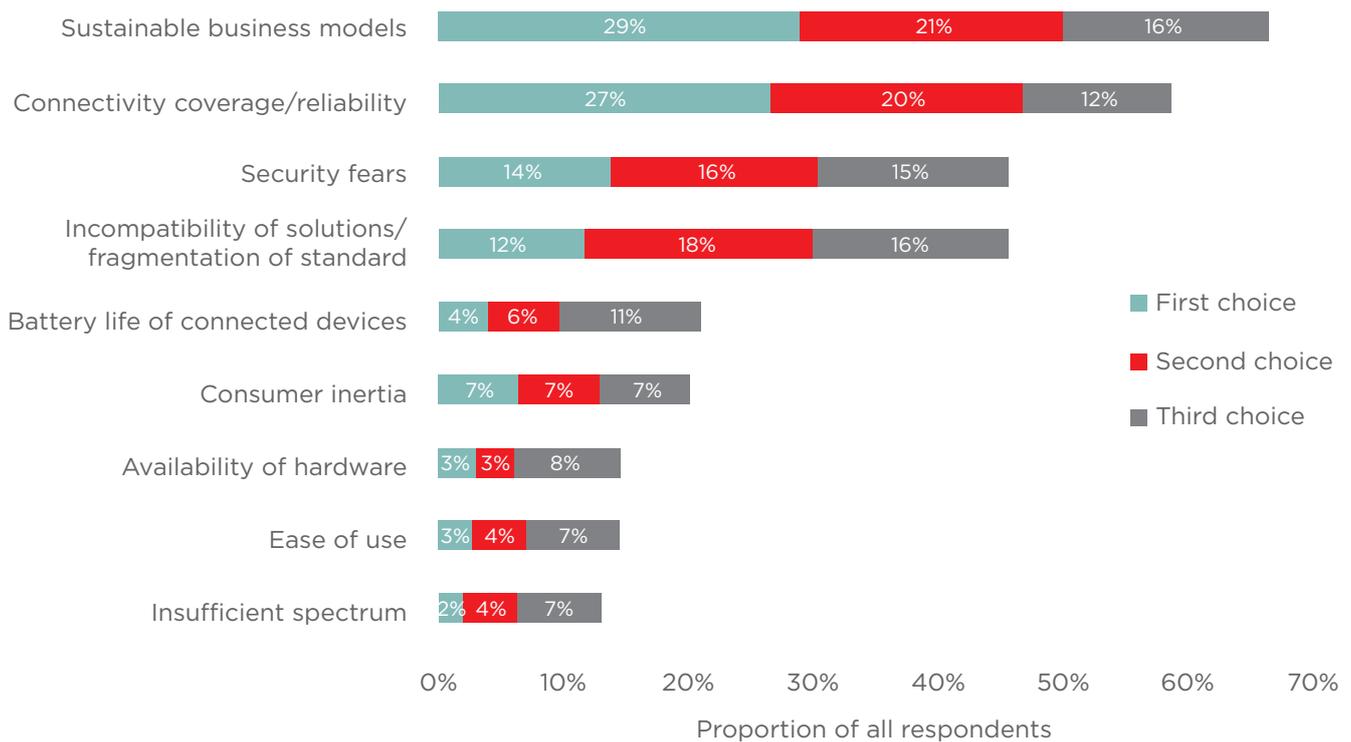
Figure 3: In the smart cities market, please rank the top 3 sectors in order of importance from a revenue perspective (All respondents, base 324)



The challenges facing the IoT

Although advances in connectivity and sensing technology are fuelling a rapid expansion in the Internet of Things, the market continues to face some significant challenges. Given the large number of players in the typical IoT value chain, it is not surprising that many respondents identified the development of sustainable business models as the biggest challenge (see Figure 4) – in some segments, there may not be enough revenue to sustain all the players involved in providing an IoT solution. The availability of connectivity, security fears and technical incompatibility are also seen by many industry participants as significant hurdles faced by the IoT.

Figure 4: What do you regard as the main challenges facing the IoT? (please rank the top three in order of importance) (All respondents, base 322)



Looking solely at the mobile operator respondents, the main challenges they identified generally mirror those of the broader ecosystem. However, operators place even greater emphasis on the challenge of creating sustainable business models, while tending to be less concerned about battery life and more concerned about the availability of hardware (see Figure 5). These findings reflect many mobile operators' faith in

new low power wide area technologies, such as NB-IoT (Narrowband-IoT) and LTE-M, which are designed to support long device battery lives. Although these technologies are being deployed commercially, some operators have complained about a shortage of compatible modules.

The mobile industry's concerns about business models, reliability and security were also

apparent in the responses to a further question about what customers regard as the most important attributes of IoT connectivity. Almost half of the respondents chose cost as the number one consideration, while the vast majority put coverage/reliability in their top

three (see Figure 6). Security was also identified as a key factor, while more than one quarter of the respondents put “standards-based/availability from multiple vendors” in their top three factors.

Figure 5: What do you regard as the main challenges facing the IoT? (please rank the top three in order of importance) (Operator respondents, base 114)

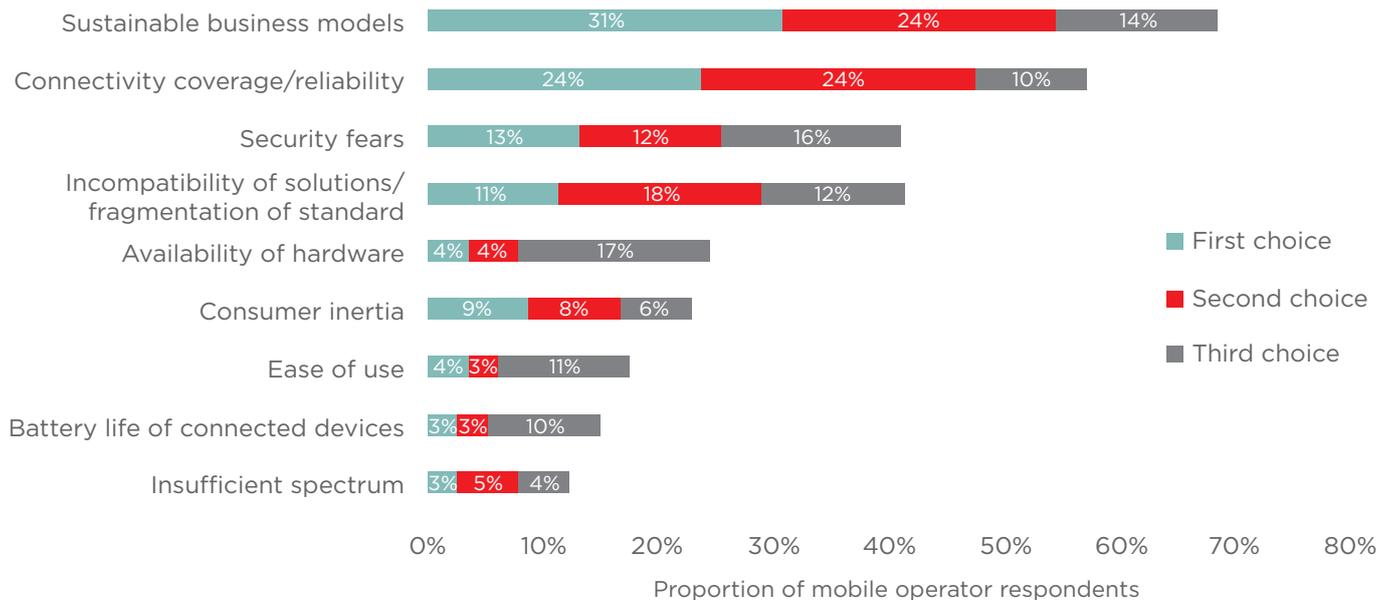
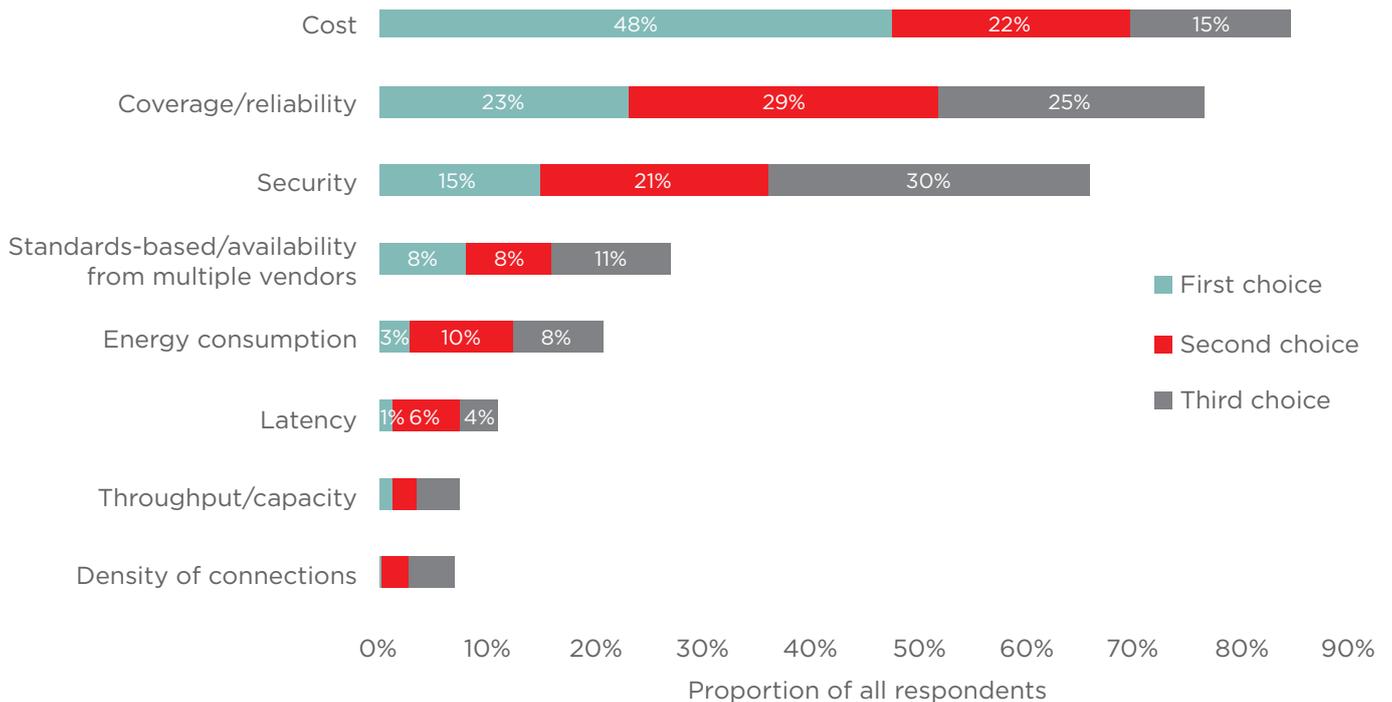


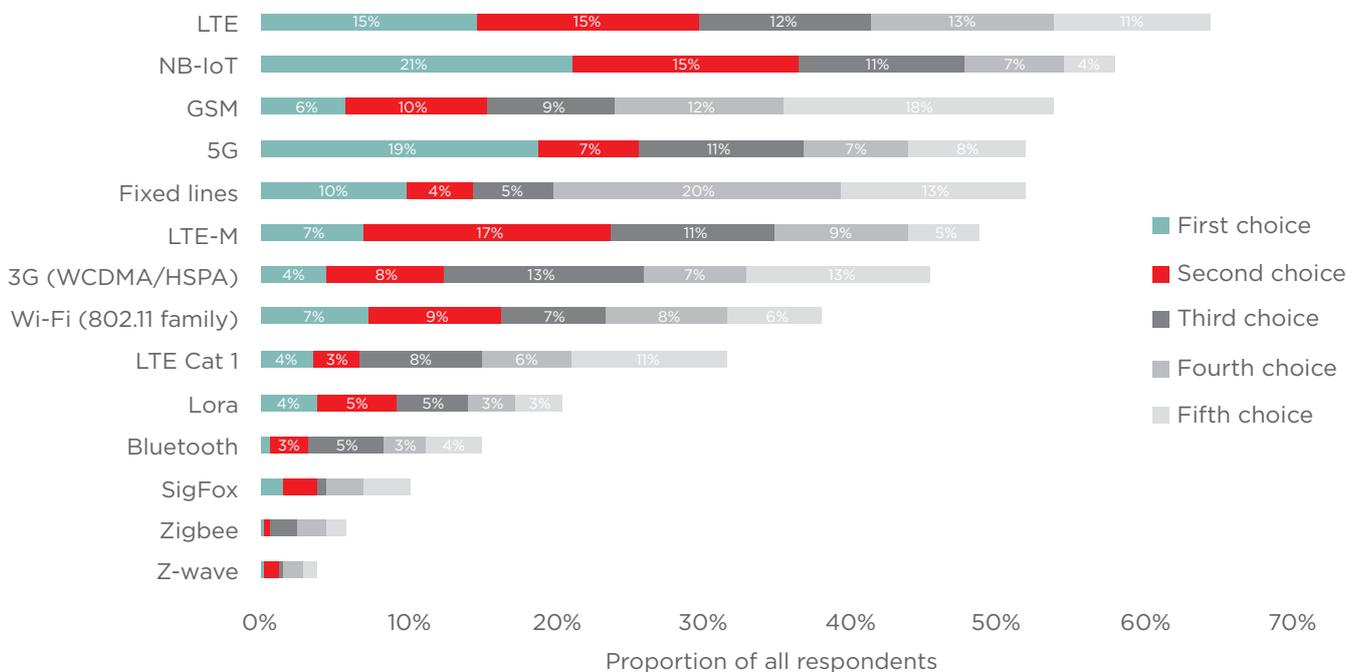
Figure 6: Thinking about IoT connectivity, which of these factors do you regard as most important to your customers? (please rank the top three in order of importance) (All respondents, base 280)



The key connectivity technologies

The availability of cost-effective, reliable and widespread connectivity is clearly crucial to the development of the Internet of Things. Which technologies can meet that requirement? Looking ahead to 2020, respondents identified LTE, NB-IoT, GSM, 5G and fixed-lines as the connectivity technologies that will be most important to their IoT propositions (see Figure 7). Developed specifically for the IoT and using operators' licensed spectrum, NB-IoT was the number one choice for 66 respondents, ahead of 5G with 59 and LTE with 46. Forthcoming 5G networks will be designed to support both mission-critical IoT solutions, requiring ultra-reliable connectivity, and IoT solutions that require a high density of connections, such as sensor networks in farms or factories. Although the first 5G networks will be live by 2020, NB-IoT coverage will be far more widespread. Moreover, as NB-IoT is designed to provide low cost coverage over large geographic areas with low power requirements, it is likely to co-exist with 5G and other cellular technologies for many years to come.

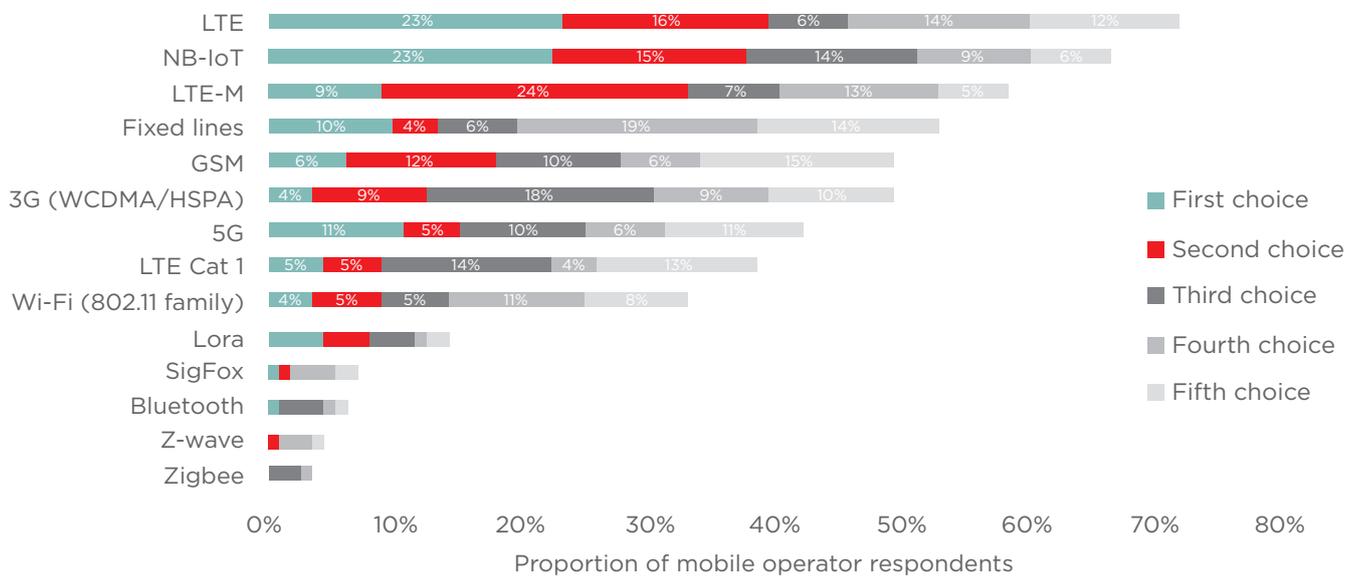
Figure 7: Which of these connectivity technologies will be most important to your IoT proposition in 2020? (please rank the top five in order of importance) (All respondents, base 312)



In many cases, mobile operators will be providing the connectivity underpinning the IoT. Respondents from mobile operators identified LTE and NB-IoT as very important, but interestingly, they were more cautious about 5G, attaching greater weight to LTE-M (see Figure 8). Like NB-IoT, LTE-M is a low power wide area technology designed specifically for IoT solutions. It can support higher data rates and lower latency than NB-IoT, making it suitable for solutions with more demanding connectivity requirements.

However, by 2023, 5G is likely to become the most important connectivity technology, ahead of LTE and NB-IoT, for the IoT. The survey respondents made 5G a clear leader in that timeframe, with 127 respondents making it their top choice (see Figure 9). Still, there was also considerable support for NB-IoT and LTE, potentially reflecting the view that these technologies will be integrated with operators' 5G networks, enabling them to provide connectivity carefully tailored to specific IoT applications.

Figure 8: Which of these connectivity technologies will be most important to your IoT proposition in 2020? (please rank the top five in order of importance) (Operator respondents, base 111)



Although the mobile operators responding to the survey also ranked 5G as the number one connectivity technology for the IoT in 2025, they again tended to attach more importance to NB-IoT, LTE and LTE-M than the wider ecosystem (see Figure 10).



Figure 9: Which of these connectivity technologies will be most important to your IoT proposition in 2023? (please rank the top five in order of importance) (All respondents, base 303)

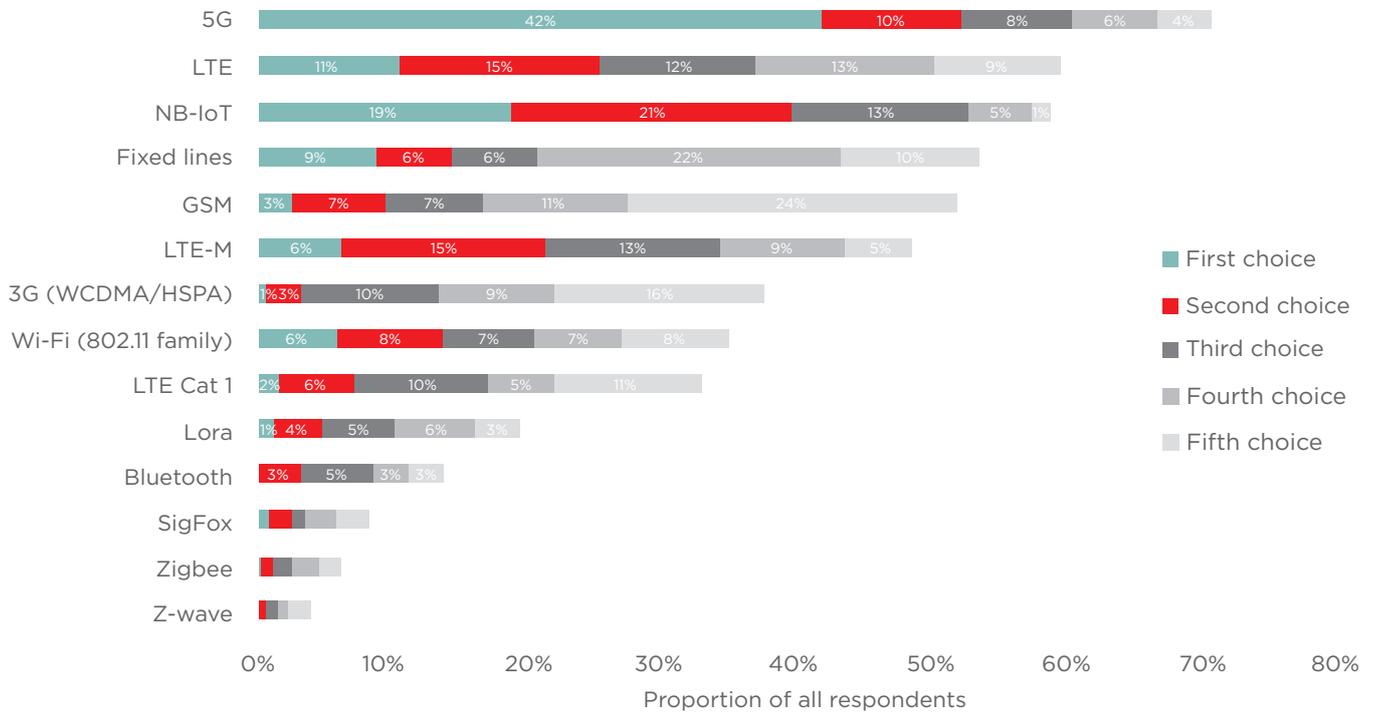
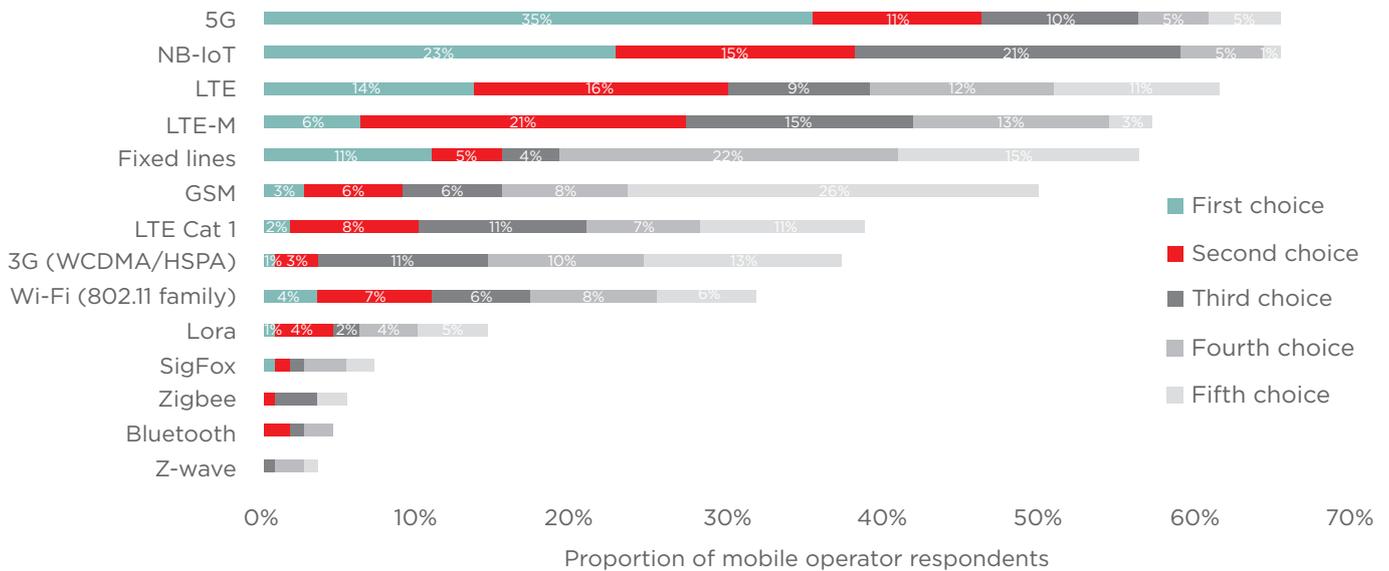


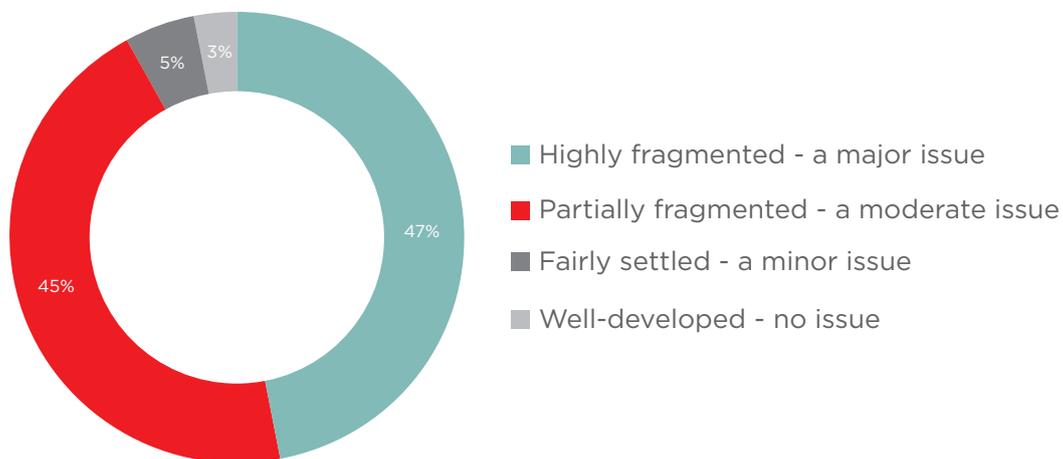
Figure 10: Which of these connectivity technologies will be most important to your IoT proposition in 2023? (please rank the top five in order of importance) (Operator respondents, 110)



Standardisation versus fragmentation

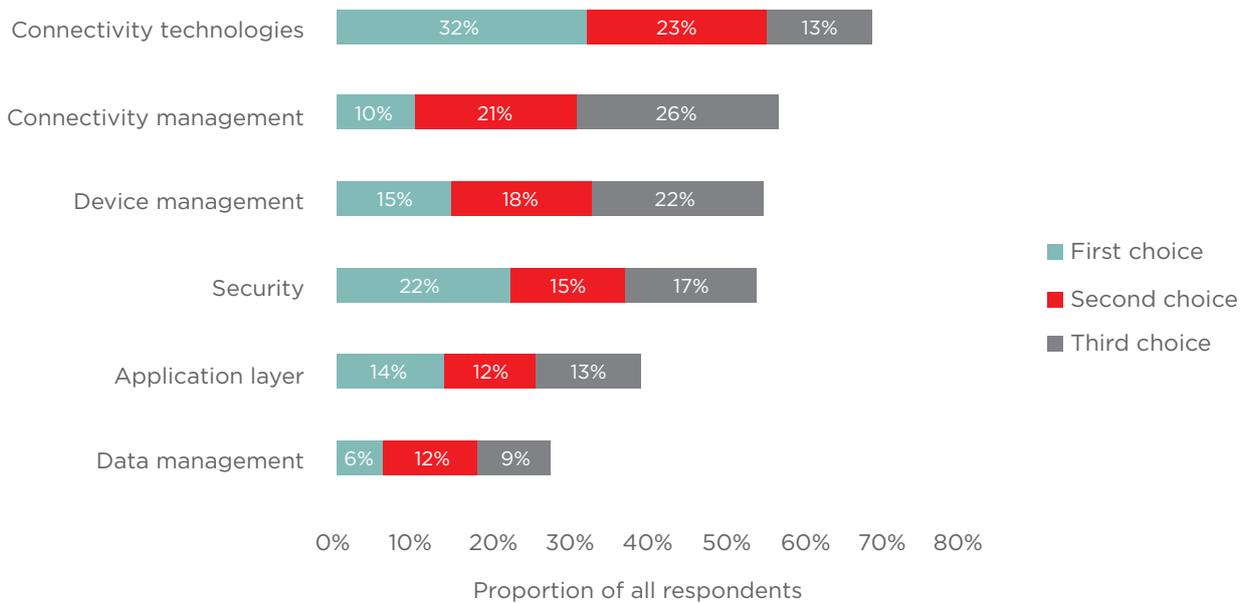
As a relatively new concept spanning many sectors of the economy, the IoT is being developed by a huge number of companies using a wide range of technologies, which are not necessarily compatible. The survey highlighted the high level of fragmentation in the IoT, with 47% of respondents describing this as “a major issue” and a further 45% seeing it as a “moderate issue” (see Figure 11).

Figure 11: How would you characterise standardisation in the IoT market? (All respondents 308)



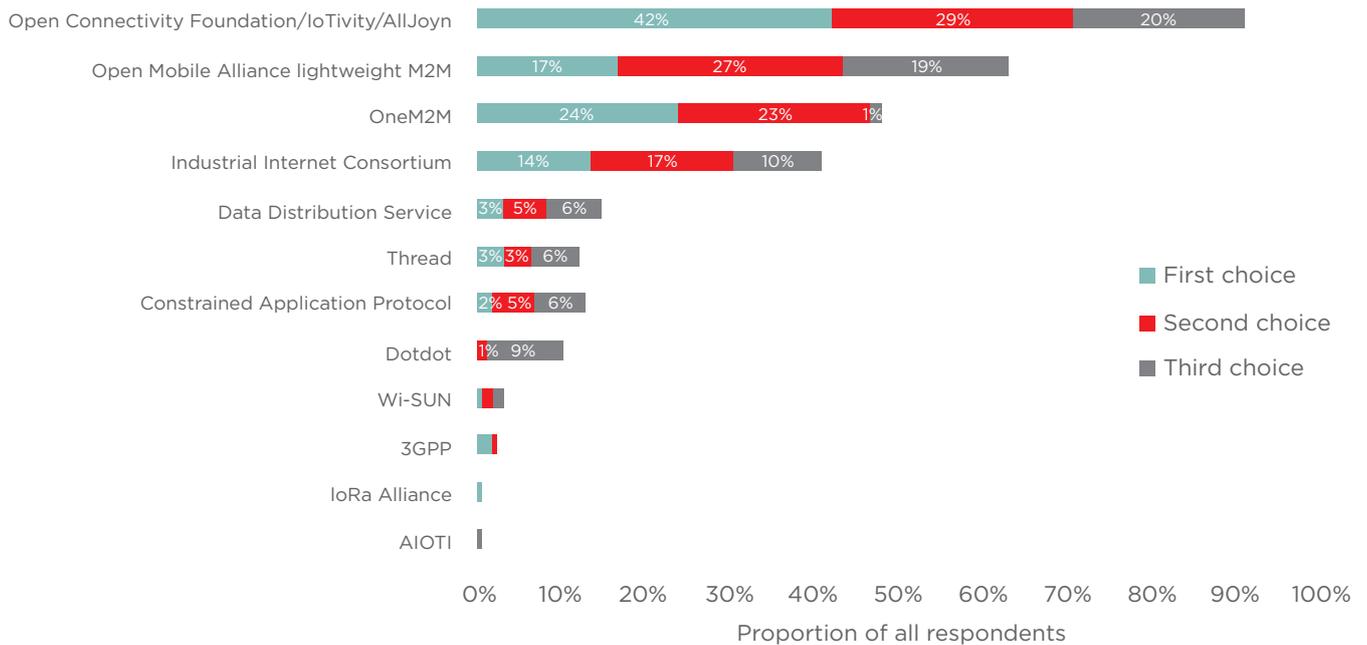
Drilling down on the fragmentation issue, the survey found that the mobile industry regards connectivity technologies and connectivity management as the areas in greatest need of more standardisation (see Figure 12).

Figure 12: In which segments of the IoT value chain do you see the need for greater standardisation? (please rank the top three in order of importance) (All respondents, 272)



The survey also found that four sets of IoT standards have significant support in the mobile industry (see Figure 13).

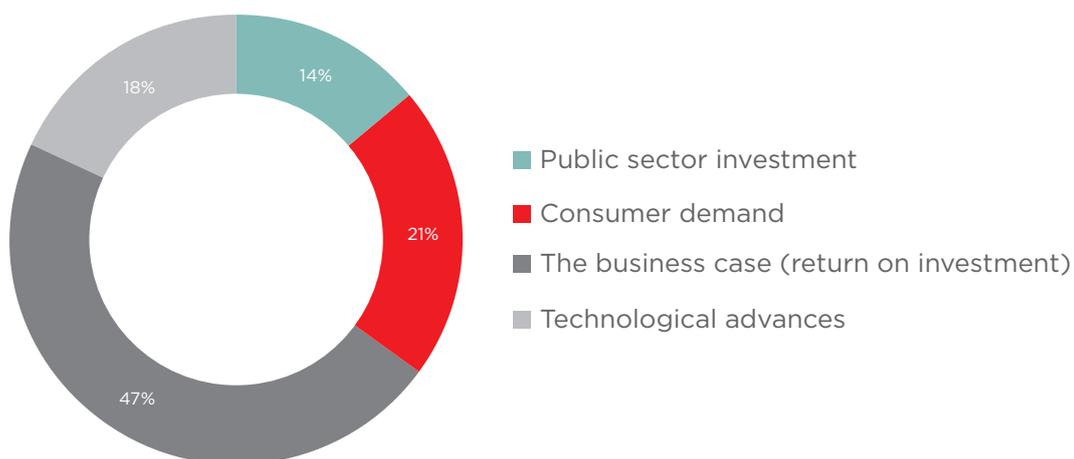
Figure 13: How important are the following standards/protocol/initiatives to your IoT services/solutions? (please rank the top three in order of importance) (All respondents, 154)



Future drivers and trends

The expansion of the Internet of Things is being driven by many factors ranging from consumer demand for convenience to concern about climate change and intense competition between companies. Asked to identify the biggest driver for the next decade, almost half of the respondents in the survey chose the business case - the return on investment (see Figure 14). However, there were some regional variations – respondents in Africa and South America believe consumer demand will play an equally important role.

Figure 14: Which of the following factors do you think will play the largest role in driving the growth of the IoT over the next 10 years in your region? (All respondents, 299)



Although IoT solutions are generally delivered by partnerships of companies, one organisation tends to lead the sale and the deployment. Respondents were divided on which organisations will drive the adoption of the IoT going forward. Although one third opted for mobile operators, one fifth selected application developers and another fifth, systems integrators (see Figure 15).

Naturally, the operator respondents were more inclined to believe their companies will drive adoption, but more than half chose other players (see Figure 16). That finding may reflect the fact that many IoT solutions need to be integrated into existing ICT systems, requiring systems integration and software development capabilities.

Figure 15: Which companies do you expect to drive adoption of the IoT? (All respondents, 298)

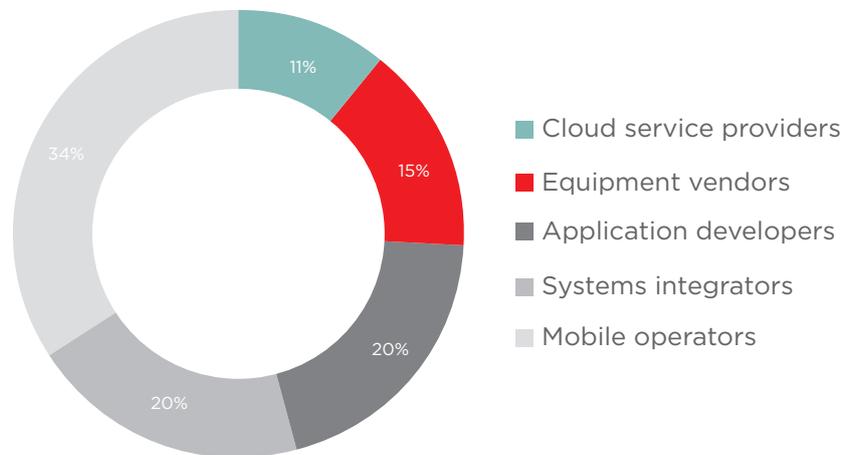


Figure 16: Which companies do you expect to drive adoption of the IoT? (Operator respondents, 107)

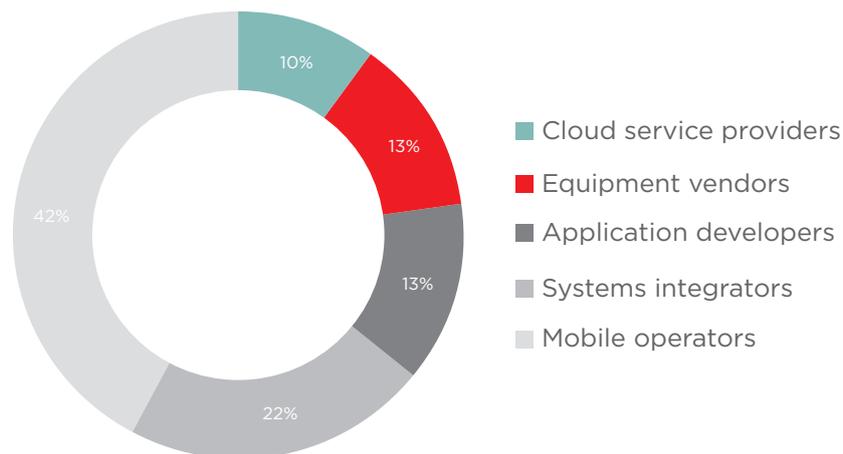
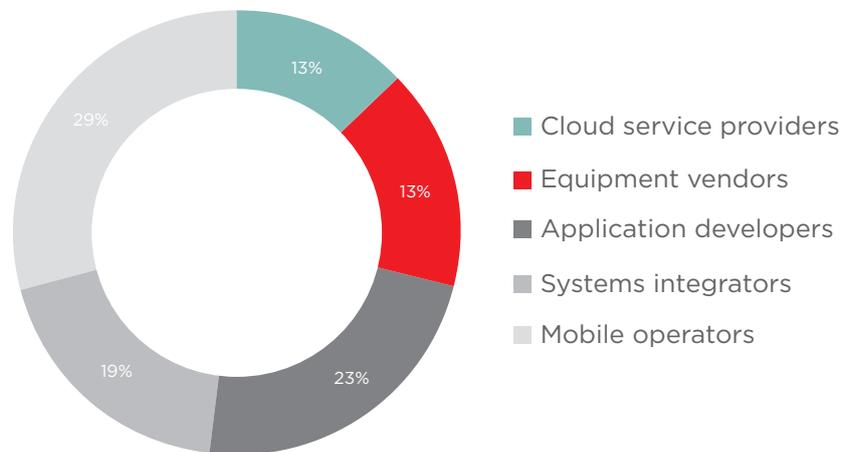


Figure 17: Which companies do you expect to drive adoption of the IoT? (Non-operator respondents, 191)



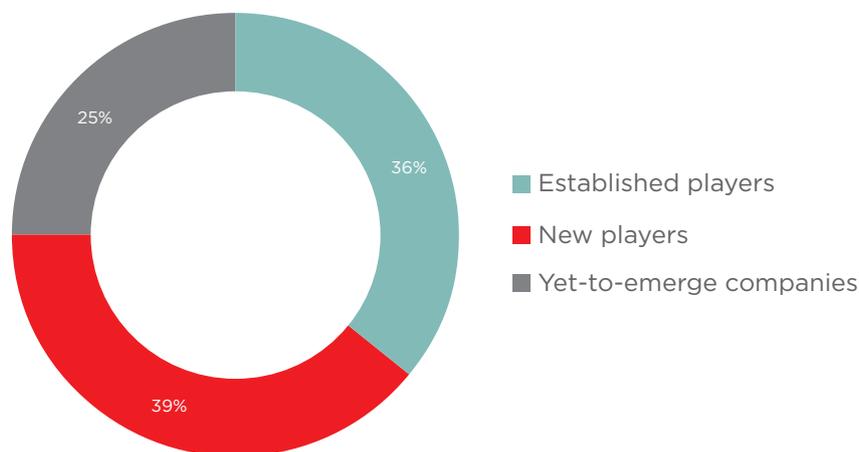
Moreover, only 29% of the non-operator respondents selected mobile operators as the companies they expect to drive the development of the IoT, not that far ahead of application developers (see Figure 17).

At the same time, the survey uncovered a widely held belief in the mobile industry that well established players won't necessarily shape the future of the IoT. Some 39% of respondents believe new players will have the most influence over this market in the next decade, while one quarter reckon yet-to-emerge companies will play this role (see Figure 18). This pattern is

consistent across the regions, except in the Middle East, where a majority of respondents believe established players will exert the most influence over the next decade.

Although respondents from North America made up just 15% of the sample, the survey clearly identified that region as the most likely to lead the adoption of the IoT going forward. Some 125 respondents made North America their number one choice, while 69 opted for East Asia, 44 for South East Asia and 32 for Europe (see Figure 19).

Figure 18: Which of the following do you think will have the most influence over the development of the IoT over the next 10 years? (All respondents, 300)



Thanks in part to Silicon Valley, North America dominates the global software industry and is at the forefront of the development of artificial intelligence (AI), which will underpin self-driving cars, autonomous drones, robots and many other products and services of the future. Developed by training software with vast amounts of data, AI systems are increasingly drawing on the information collected from connected vehicles, machines, appliances and other IoT solutions. Indeed, a majority of respondents in the survey believe demand for data to develop machine learning and AI will be an important driver in the growth of the IoT in the next decade (see Figure 20). Interestingly, respondents from East Asia attached even greater importance to this factor, with 27% saying AI will be the main driver and a further

43% responding that growth in the IoT will be driven "to a large extent" by AI and machine learning. That finding is consistent with China's ambition to lead the world in the development of machine learning and AI.

"By 2023, almost 40% of the operator respondents believe the IoT will account for more than 20% of their revenues"

Figure 19: Which regions do you expect to be the earliest adopters/beneficiaries of large-scale IoT? (please rank the top three in order of importance) (All respondents, 291)

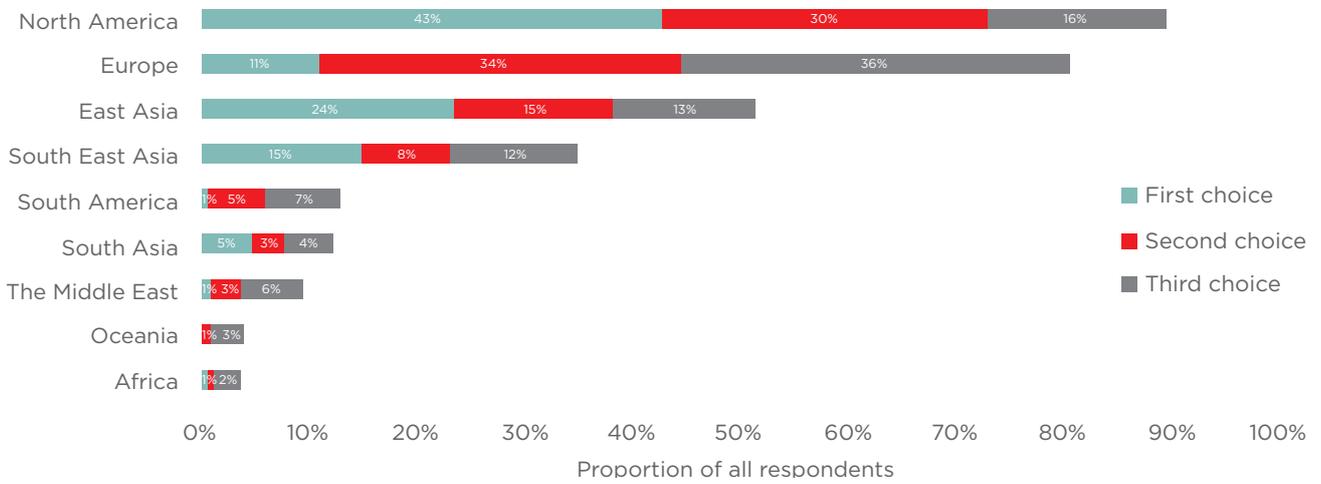
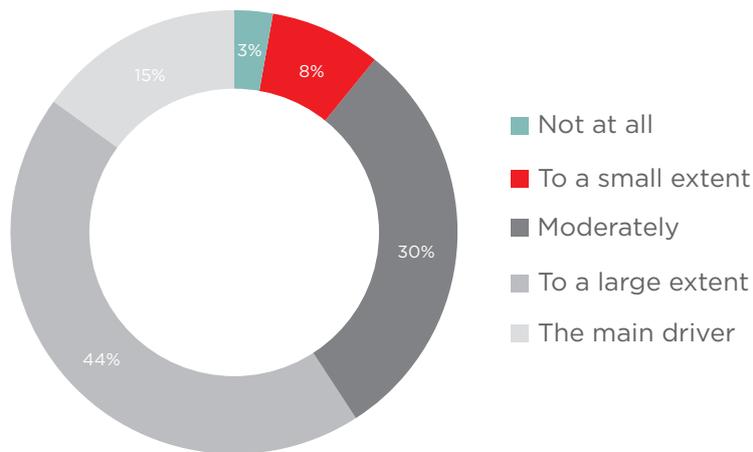


Figure 20: To what extent do you think the growth of the IoT over the next 10 years will be driven by demand for data to develop machine learning and artificial intelligence? (All respondents, 302)



Conclusion

The mobile industry believes the Internet of Things will become a major source of revenue over the next five years despite a number of commercial and technical challenges. Although industry participants are clearly concerned about business models, the availability of connectivity, technical fragmentation and security, the survey doesn't suggest any of these will be a major brake on the growth of the IoT.

Some of these challenges are being addressed by technological advances. Newly standardised connectivity technologies, notably NB-IoT and 5G, are set to have a major impact on the evolution of the IoT, with most mobile operators particularly enthusiastic about the former. However, the industry still sees the need for more standardisation in the connectivity space.

Looking ahead to the next decade, the industry is expecting significant disruption by both new players and companies that haven't even been created yet. North America is widely regarded as being at the forefront of the development of the IoT, reflecting the view that its formidable software industry will harness widespread connectivity to develop advanced artificial intelligence that will give machines, robots, drones and vehicles much greater autonomy: many players in the mobile industry believe the IoT will play a pivotal role in the next technological revolution.



For more than four decades, InterDigital has pioneered research and development of future generations of wireless capability, driving digital communications and mobile broadband many years ahead of market deployment. For successive generations of cellular wireless, InterDigital has been one of a handful of leaders advancing standards, and those efforts continue through 5G. In IoT, InterDigital's standards-based research dates back to the earliest days of IoT interoperability research.

In addition to the efforts of our own engineers in nine R&D offices around the world, InterDigital works hand-in-hand with research institutions, universities, small- and medium-sized companies, and market leaders to develop and define the wireless future. Together, we're Creating the Living Network.

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