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IoT and MIoT Market Analysis, Service and Application White Paper

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IoT and MIoT Market Analysis, Service and Application

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Contents

Executive Summary 6
Terminology and Abbreviation 7
1. Premium Insights 8
1.1 Worldwide IoT Forecast 8
1.2 IoT Ecosystem 9
1.3 IoT Phases 10
2. Market Analysis 12
2.1 Drivers and Constraints 13
2.2 Industry Trends 16
2.3 Market Analysis by Platform, Software Solution, Service and Application 17
2.4 Mobile IoT Market by Industry 20
2.6 Mobile IoT Market by Region 21
3. Growth Opportunities for Service Providers 22
3.1 Industry Value Chain for IoT and Mobile IoT 22
3.2 Growth Opportunities for Service Providers 24
4. IoT Use Cases 27
4.1 Connected Vehicle 27
4.2 Connected Urban Transport 28
4.3 Telematics Robotic Surgery 31
4.4 Realistic Sports Experience 33
4.5 Smart Payment 35
4.6 Smart Cargo 37
4.7 Fleet Management 38
4.8 Smart Integrated system at Airport 39
4.9 Bag Tracking 41
4.10 Smart Lighting 42

4.11 Smart Parking 44
4.12 Smart Service Vehicle 46
4.13 Connected Car 48
4.14 Smart Health Care 50
4.15 Smart Water Meter 53
4.16 Connected Cow 54
4.17 Connected Biosensor 55
5. Market Risks 57
Reference 59

Executive Summary

Digital Transformation is expected to change all aspects of our business and daily lives. The forecasts for the IoT Market demonstrate its key role in driving this significant transformation. According to estimates, there will be 29 billion connected devices by 2022 with the majority of those related to IoT.

The cellular industry is in need of new revenue prospects with current ARPU stagnant or decreasing in most regions. By embracing the opportunities presented by the tremendous growth set to occur from industry digitalization and IoT, service providers can open many exciting revenues generating business avenues.

This whitepaper outlines the worldwide forecast for IoT and provides an in-depth market analysis of all the factors that may impact the wide variety of players in this space. The growth opportunities for service providers are highlighted along with the areas that align with their current strengths. Key IoT use cases, their value proposition and realization details are described. Finally, a look at the market risks provides insights into the volatility of the market in the early growth phases.

Terminology and Abbreviation

Term	Description
AI	Artificial Intelligence
AR	Augmented Reality
ECG	Electrocardiography
eMTC	Enhanced Machine-type Communications
EMV	Europay, MasterCard, and Visa
FOTA	Firmware Over-The-Air
IATA	International Air Transport Association
IoT	Internet of Things
IR	Impulse Response
LoRa	A LPWA network
LPWA	Low-Power Wide-Area
LTE	Long-Term Evolution
M2M	Machine to Machine
MCU	Microcontroller Unit
NB	Narrow Band
NFC	Near-field Communication
OBD	On-board Diagnostics,
P2P	Point to Point
PPG	Pulse Pattern Generator
RFID	Radio-frequency Identification
RPMA	Random Phase Multiple Access
Sigfox	A LPWA network
SOTA	Software Over-The-Air
TCU	Transmission Control Unit
VR	Virtual Reality

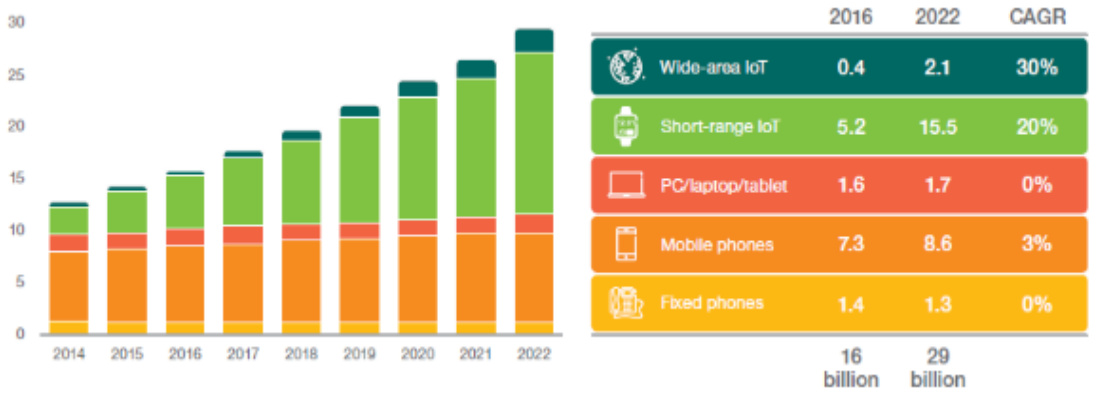
1. Premium Insights

1.1 Worldwide IoT Forecast

Internet of Things (IoT), as a key digital technology, is poised to transform the way businesses generate and consume data. Ericsson research reports that around 29 billion connected devices [1] are forecast by 2022, of which around 18 billion will be related to IoT. Connected IoT devices include connected cars, machines, meters, sensors, point-of-sales terminals, consumer electronics [2] and wearables. Between 2016 and 2022, IoT devices are expected to increase at a CAGR of 21 percent, driven by new use cases [1].

Shown in the Figure1 below, IoT is divided into short-range and wide-area segments. The short-range segment largely consists of devices connected by unlicensed radio technologies, with a typical range of up to 100 meters, such as Wi-Fi, Bluetooth, and ZigBee. This category also includes devices connected over fixed-line local area networks and powerline technologies. The wide-area segment consists of devices using cellular connections, as well as unlicensed low-power technologies, such as Sigfox, LoRa and RPMA. Presently, the dominating technology in this segment is GSM/GPRS.

Figure1: Connected devices (billions)



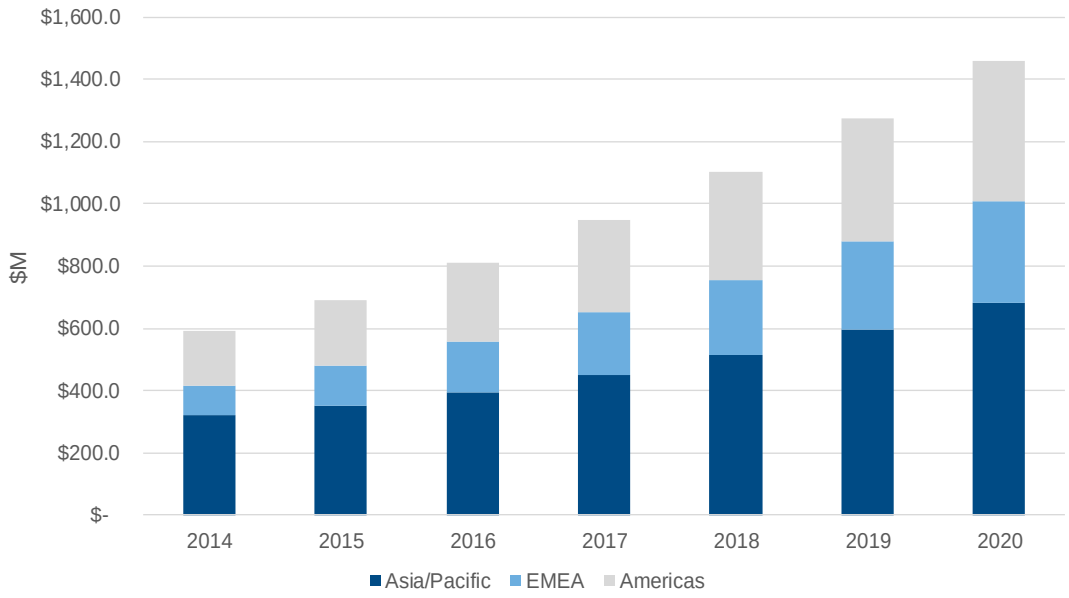
Source: Ericsson Mobility Report, June 2017

At the end of 2016, there were approximately 0.4 billion IoT devices with cellular connections. Due to increased industry focus and 3GPP standardization of Mobile IoT technologies, this number is projected to reach 1.5 billion in 2022, or around 70 percent of the wide-area category. Within the wide-area IoT segment, two distinct sub-segments with different requirements have emerged: massive and critical applications. Massive IoT connections are characterized by high connection volumes and small data traffic volumes, low-cost devices, and low energy consumption. Many things will be connected through capillary networks. Critical IoT connections place very different demands on the network: ultra-reliability, availability, low latency, and high

data throughput. Declining modem costs, evolving LTE functionality and 5G capabilities are all expected to extend the range of applications for critical IoT deployments. There are, however, many use cases between these two extremes, which today rely on 2G, 3G or 4G connectivity. The first Mobile IoT networks supporting massive IoT applications, based on Cat-M1 and Narrow Band-IoT (NB-IoT) technologies, were launched in early 2017. Several operators have deployed Mobile IoT networks in 2017.

There is another worldwide IoT forecast which indicates that IoT will grow to $1.5T in 2020, growing at a rate of 16.9%. As can be seen from following diagram, APAC would be the major IoT market with $320 billion total revenue in 2014 to $640 billion revenue forecast in 2020 [2].

Figure2: Worldwide IoT forecast, 2014 – 2020



Source: IDC #US40755516, May 2016

1.2 IoT Ecosystem

IoT has been treated as "the next Industrial Revolution" due to that the way it will change the way people live, work, entertain, and travel, as well as how governments and businesses interact with the world. The IoT ecosystem enables entities (e.g. smartphone, tablet) to connect to, and control their IoT devices over a network such as wireless and wired network. Providers in the IoT ecosystem have a tremendous unexplored opportunity to develop compelling IoT solutions that take advantage of the ability to collect and analyse IoT data in real-time. These developments will be launched within and across enterprises, offering opportunities for sustained value creation, lowered cost and bring industry revolution.

An IoT ecosystem normally consists of IoT sensors (energy, security), networks/carriers (cellular/ WiFi/ Zigbee), gateway, cloud, open data platform, IoT platform and systems integration/services as well those vendors providing the hardware or software. The picture below lists the common IoT devices or things (e.g. smart TV, smart oven, connected car and smart meters) as well as the well-known vendors (e.g. Bosch, ARM, Qualcomm, CMCC, Ericsson, SAP and IBM) in each ecosystem category [1].

Figure3: IoT ecosystem

Source: IDC #US40755516, May 2016

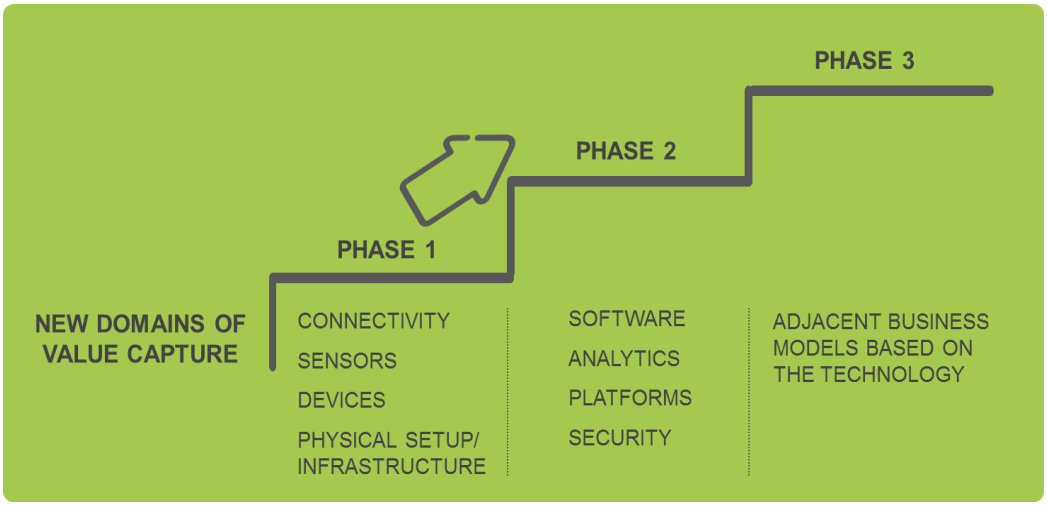
To be an active player of IoT system integration or solutions, a company needs to find the right partner, the right business model and the appropriate solution to serve its customer.

1.3 IoT Phases

Despite the big numbers and the excitement, the IoT market overall remains nascent and we are still largely in Phase 1 (see Figure 4), which is all about connecting devices and infrastructure set up. It will take us a couple more years to be at the height of Phase 2, where platforms, software and analytics take centre stage, bringing new applications and use cases, and again a couple more years to reach Phase 3, where we can expect to realize the full promise of IoT through cross-industry pollination and new business models.

As with other technology developments in the past, there are pockets of more mature markets that are already entering Phase 2, with intensifying competition in the IoT platform space. These markets include North America, Western & Northern Europe, and parts of Asia Pacific.

Figure4: IoT phases



Source: Ericsson

As the background information for Mobile IoT and IoT cloud, there are development phases as below.

- Mobile IoT equipment market
  - Expected around 10 years of high speed development

    Refer to last 30-year experience of traditional telecom equipment industry, the Mobile IoT market mode transition from monopolistic competition to oligopoly will keep 10 years of high speed development. When it reaches the “ceiling” and enters the oligopoly stage, competition will likely bring price wars and business model revolution.
  - Traditional telecom equipment supplier will maintain their dominance

    This market continues the significant barrier to entry for the newcomer. The benefits from the Mobile IoT market are based on existing telecom infrastructure, the company outside the telecom market will have to face the challenges due to this installed base.. The companies inside the market will take advantage of their experience and deployed infrastructure as leverage to obtain exclusive benefits. In general, this is a market that telecom equipment suppliers have a greater advantage.
  - Compatibility with the current generation period of telecom equipment

The standard specification freeze and industrialization can be pegged at the 4G period considering NB-IoT, eMTC, LoRa standard and devices have been released to market. Telecom operators mostly prefer the standard of NB-IoT and eMTC because they are both based on the 4G standard currently. It is expected that Mobile IoT will follow the 5G industry standardization to upgrade. In other words, Mobile IoT equipment generation period will follow telecom equipment period and it will likely delay 2 to 3 years.

- IoT cloud market rule

  IoT cloud market is at monopolistic competitive market stage, there will be many companies going to fade out. All companies will have opportunities or challenge in the same market. At present, there still isn't a unified business model and technical standard in the market. Each company can choose its strategy according to its position, strength and scale at the industry:

  – Telecom operators prefer to set up a unified cloud interface platform for IoT (PaaS)

    IoT APPs and service providers can build up their businesses by using the unified PaaS API. IoT sensors and devices are the resources delivering massive data to the platform and that data can be stored, handled and processed by the platform cost-efficiently as well, making it relatively easy and fast to develop business.

    As more companies set up business on the platform, more devices and data will access to it, the value of the PaaS platform will be increased. Therefore, the strategy of telecom operators in IoT cloud is the number of access first.

  – Many new or growing enterprises prefer to set up an E2E vertical IoT business on public cloud platform or private cloud.

    Those enterprises prefer to build an E2E solution including deploying private sensor and UE, accessing the public or private cloud business platform by Mobile IoT or internet. They handle almost all operating by themselves, e.g. Mobike. The core strategy of those enterprises is to rapidly setup strength in its vertical area by first-mover advantage, scale of entry and then become a monopoly by acquiring competitors.

  – "Internet giants" prefer the mixed mode which sets up not only IoT cloud open platform but also E2E vertical IoT cloud platform for a targeted vertical.

    For instance, Ali Cloud open API of Alibaba smart living platform to IoT service providers. Any service based on the API can access the Alibaba smart living platform and utilize it to handle business data. Meanwhile Alibaba is also applying the platform to build up their connected car portfolio.

2. Market Analysis

2.1 Drivers and Constraints

The major drivers of IoT market come from several perspectives as below [4].

- Proliferation of connected devices

  As can be seen from the previous chapter, the scale of IoT will dramatically surpass the smartphone/mobility phenomenon we have seen in the past five years. Therefore, the capacity to accommodate massive connected devices is one of the underlying baseline requirements.

- Business perception

  The world is transforming to Digitalization. Digitalization is driven by new technology capabilities being put into practice in new contexts, transforming internal business processes, business processes between telecommunications and industry and with customers/consumers. Digitalization enables industry to leap-frog legacy processes of their business, i.e. skip parts of the time-consuming process that we went through. IoT, mobility, broadband and cloud are the main technology of Digitalization.

- Maturing cloud IoT platforms and analytics

  IoT platforms, coupled with analytics, enable data analysis and management at scale, making it possible to unlock IoT transformation.

- Use cases leading the way

  Manufacturing is the most mature market, leading the way with the most use cases and the largest ecosystem. Field maintenance, food traceability, and remote health monitoring are also in the "early growth" segment.

- Growing demand for end-to-end security

  In most case, the IoT network authenticates the identity of the subscriber with a challenge-response mechanism. Such as Mobile IoT can prevent connected devices from communicating directly with each other. Preventing communications reduces the risk of a device interacting directly with another device in the IoT network and enhance overall security. Most communications in the IoT architecture are regulated from the network, thereby enhancing the overall integrity of the IoT deployment [5].

- Other business drivers

  As can be seen from below table, reducing costs and improving business processes come in highest as IoT drivers in APAC, for example, followed by increasing competitiveness. [6]

Table 1 Main goals of IoT deployment

Main goal (% responses ranked 1–3)	APAC	Australia	Japan	South Korea	China	Malaysia
Reduce overall costs	43%	45%	40%	42%	48%	42%
Improve business processes	38%	39%	44%	36%	24%	46%
Increase competitiveness	36%	26%	38%	47%	44%	28%
Improve employee productivity	33%	29%	36%	30%	35%	34%
Grow revenues from existing products / customers	31%	31%	26%	32%	29%	36%
Improve customer or citizen experience	26%	34%	21%	19%	21%	31%
Build up ongoing data collection for future use	25%	22%	33%	31%	18%	21%
n=	480	109	81	105	80	105

Note: % shows share of respondents in each country who put goal as their 'top three'

Source: Ovum

On the contrary, there are several constraints obstructing IoT development and deployment as following [4] [5].

- Standardization issue

  How to represent information, store information, interconnect, search and organize information produced by IoT will be challenging. In current Internet, application domains and business domains are separate and ultimately do not meet the goal of the IoT. Therefore, the standardization techniques to join all separated application domains in a sophisticated manner is required.

- Technology fragmentation

  The global IoT market growth faces challenges due to the fragmentation of IoT technology landscape and most IoT solutions are designed independently and separately for each application, which impact large-scale M2M deployment. In some sectors, there is technology fragmentation which limits economies of scale and the rate of growth for IoT connections. For example, the use of IoT in healthcare is restricted to some extent due to technology fragmentation and a lack of regulatory clarity.

- Lack of regulation for spectrum allocation

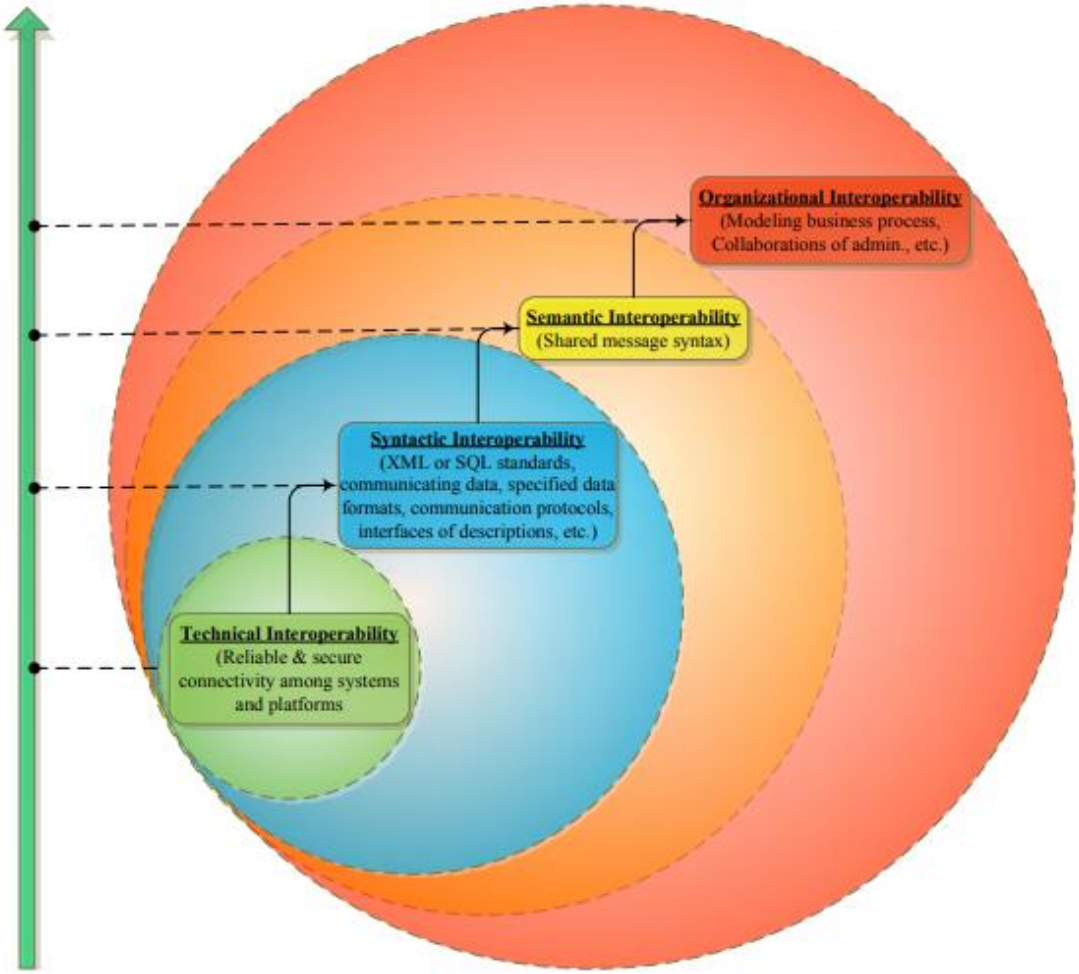
  The roadmap for a separate spectrum allocation for IoT-enabled network is not clear yet. Technologies such as LPWAN, Wi-Fi and long-range (LoRa) technology can help IoT-enabled network providers, leverage the existing spectrum to monetize their network capabilities. However, it creates collision and bottleneck in the existing network, thereby degrading the

network bandwidth and performance. Thus, the absence of separate spectrum allocation for IoT-enabled network acts as a major restraining factor for the adoption of cellular IoT.

- Interoperability

  The absence of established standards to enable the interoperability among IoT devices, applications, data collection/storage across geographies and across industry sectors is another challenge. There are many organizations such as ETSI, OMA, OneM2M, ITU-T, CCSA and others specializing in different levels of interoperability. Figure 5 describes a bottom-up approach which are technical interoperability, syntactic interoperability, sematic interoperability and organizational interoperability.

Figure 5 Bottom-up Layered approach of Interoperability



Source: Constraints in the IoT: The World in 2020 and Beyond, IJACSA

- Security and privacy [7]

  One of the biggest challenges to the broader adoption of IoT is importance of ensuring security and privacy. According to panellists from the W3C Security & privacy session, IoT devices may present a variety of potential security risks that could be exploited to harm consumers. There appeared to be widespread agreement that companies developing IoT products should implement reasonable security. The main challenges of IoT security include:

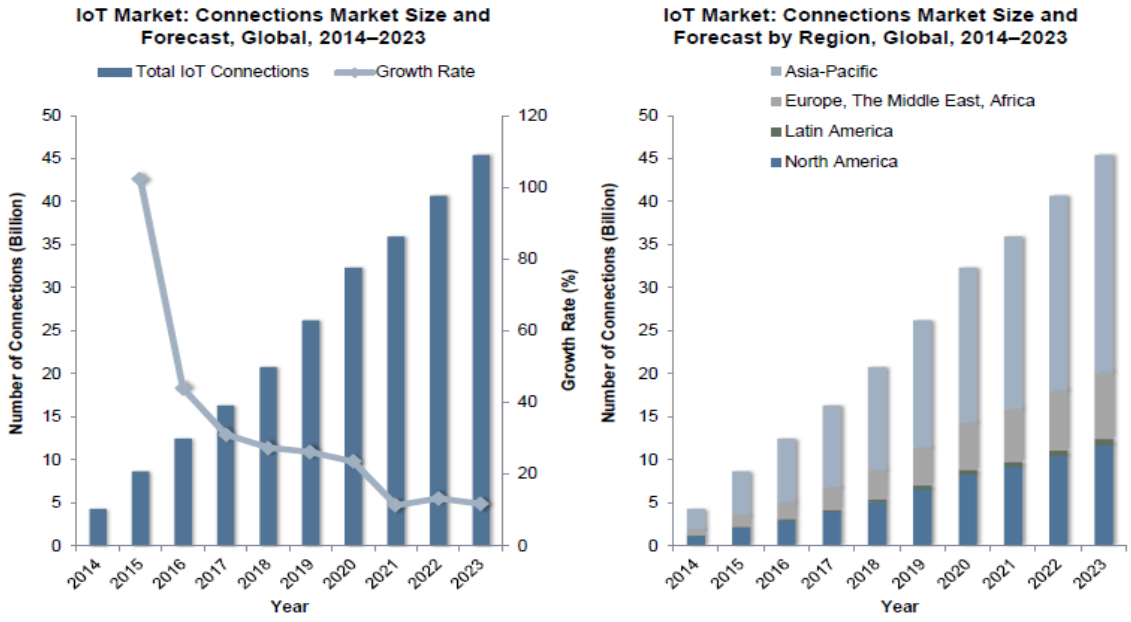
  - ✓ IoT relies on microcontrollers with limited memory and computational power
  - ✓ Threats based upon gaining physical access to IoT devices
  - ✓ How to bootstrap trust and security, and ways that this can be unravelled
  - ✓ Anything that is exposed to the Internet must be securely software upgradable
  - ✓ User experience must be good enough to avoid becoming a weak link in the chain
  - ✓ The necessity of keeping up to date with security best practices
  - ✓ The high volume of sensitive data creates a greater risk of data and identity theft, device manipulation, data falsification, IP theft, server/network manipulation etc.
  - ✓ App platforms in the cloud or at the network edge will be targets for attacks

2.2 Industry Trends

The IoT market is developing fast. The demand for connected devices and IoT solutions is increasing rapidly as IoT systems help organizations across industry verticals cut down operational costs and increase efficiencies in their processes. IoT is more than just efficient software and devices. This market incorporates components, namely platforms, systems and software and services. It is a highly competitive market with existing IoT solutions providers with greater regional reach along with niche players.

Looking around the world, European leading operators are investing in NB-IOT and LoRa networks and leading automotive OEMs are expanding availability of connected car technology. Smart metering projects have massive impact in local markets. In North America, IoT revenues of AT&T and Verizon exceeded 1 billion dollars in 2017. US operators lead the adoption of LTE for IoT and all major operators have announced plans for LWPA device launches. One in ten Americans drive a car with embedded connectivity. In Asia-Pacific, it is the largest regional market for cellular M2M connectivity in terms of volume (See Figure 6). China is the main growth engine and has seen a massive increase in domestic demand over the past years. The motorisation of China and the emerging economies in Southeast Asia is the mega trend that is driving demand for M2M/IoT in the Asia-Pacific region.

Figure 6 Total IoT Connections



Source: Frost & Sullivan

2.3 Market Analysis by Platform, Software Solution, Service and Application

IoT ecosystem consists of back-end platforms, i.e. device management, application management, and network management platforms, software solution like remote monitoring, network bandwidth management, real-time streaming analytics, security solutions and data management solutions, and professional services and managed services. The market size divided by platform, software solution and service is shown in Table 1, which shows the software solution should be the largest market size between 2015 to 2021.

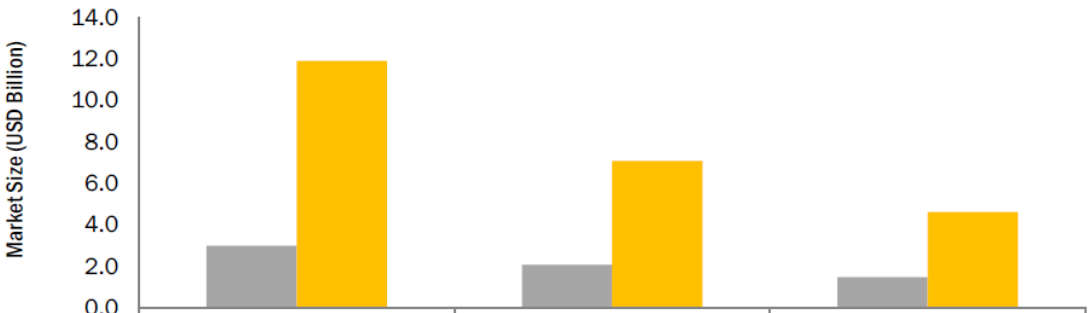
Table 2 IOT MARKET SIZE, BY COMPONENT, 2016–2021 (USD BILLION)

Component	2015	2016-e	2020-p	2021-p	CAGR (2016-2021)
Platform	5.29	6.48	17.54	23.58	29.5%
Software Solution	64.15	80.45	239.27	329.17	32.5%
Service	55.09	70.12	221.30	309.00	34.5%
Total	**124.53**	**157.05**	**478.12**	**661.74**	**33.3%**

e – Estimated; p – Projected
Source: Related Research Publications, Government Publications, Company Press Releases, Company Annual Report, Company Websites, Company Publications, and MarketsandMarkets Analysis

In terms of IoT platform (i.e. application management platform, device management platform, and network management platform), all can centrally monitor and control each activity that takes place in the organizations across industry verticals. The application management platform is highly customizable and allows any external developer to develop specialized applications using its capabilities. Among those three types of platforms, device management platform is estimated to be the largest market size during the forecast period. Figure 6 indicates the platform market size between 2016 to 2021.

Figure 7 IoT Market Size by Platform

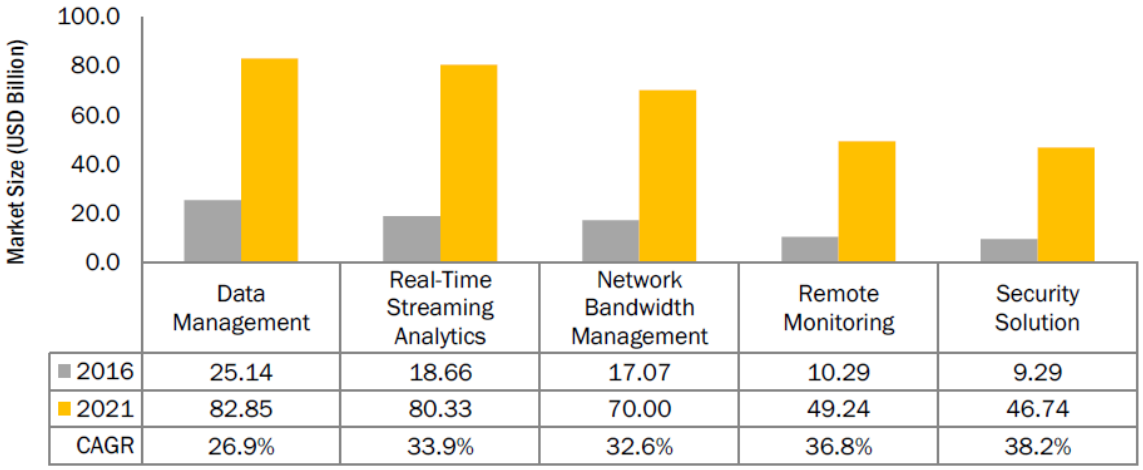


	Device Management	Application Management	Network Management
2016	2.96	2.05	1.46
2021	11.89	7.07	4.62
CAGR	32.1%	28.0%	25.8%

Source: Press Releases, Investor Presentations, Expert Interviews, and MarketsandMarkets Analysis

The overall IoT software solution segment is estimated at USD 80.45 billion in 2016 and is projected to reach USD 329.17 billion in 2021, at a CAGR of 32.5% during the forecast period. Among the software solution, the real-time streaming analytics solution enables organizations to analyse the data generated in different formats in real-time as soon as the data-set arrives. IoT security solutions include application security, device security, and network security solutions. These solutions are provided to secure the network of connected devices, such as sensors, smartphones, tablets, computers, cameras, and alarming devices. The data management solution is the most important software solution in the IoT segment as IoT devices produce enormous amounts of data that pose a challenge for the providers to deal with efficiently. The remote monitoring system is a very reliable facility that enables efficient monitoring and management of various systems. Network bandwidth management solutions check bandwidth and monitor network usage, performance, and availability for the entire network of connected devices and integrated IoT applications. From a market size perspective, data management solution would be the largest market as can be seen from Figure 7.

Figure 8 IoT Market Size by Software Solution



	Data Management	Real-Time Streaming Analytics	Network Bandwidth Management	Remote Monitoring	Security Solution
2016	25.14	18.66	17.07	10.29	9.29
2021	82.85	80.33	70.00	49.24	46.74
CAGR	26.9%	33.9%	32.6%	36.8%	38.2%

Source: Press Releases, Investor Presentations, Expert Interviews, and MarketsandMarkets Analysis

The services segment is broadly divided into professional services and managed services. Professional services include deployment and integration services, consulting services, and support & maintenance services. The figure given below highlights the overall IoT market based on services, of which the professional services is expected to be the largest market.

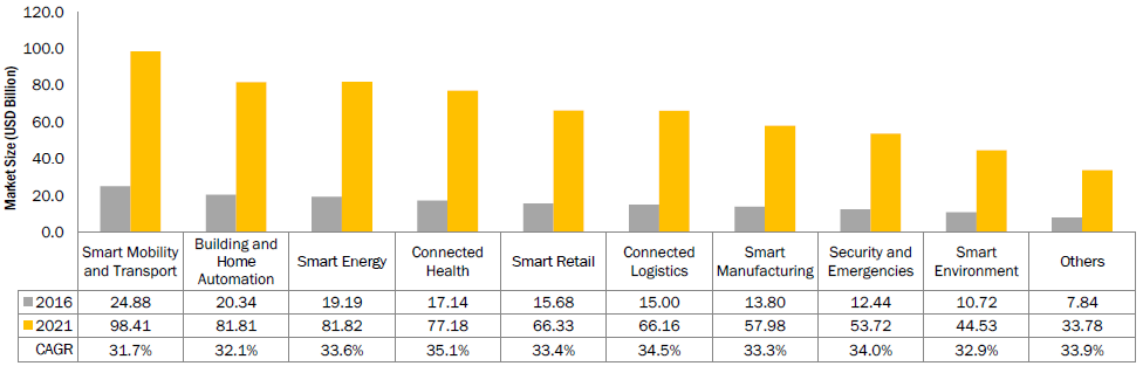
Figure 9 IoT Market Size by Service

	Professional Services	Managed Services
2016	43.46	26.65
2021	183.72	125.28
CAGR	33.4%	36.3%

Source: Press Releases, Investor Presentations, Expert Interviews, and MarketsandMarkets Analysis

The applications domain of the IoT market includes building and home automation, smart energy, smart manufacturing, connected logistics, connected health, smart retail, smart mobility and transport, security and emergencies, smart environment, and others (smart education and smart farming). Among those applications smart mobility and transport application was expected to have the largest market share of 15.8% in 2016 and is projected to grow at a CAGR of 31.7% during the forecast period while connected health is expected to grow at the highest CAGR due to the increasing need to provide efficient patient care and reduce risks. Building and home automation application segment is estimated to grow from USD 20.34 billion in 2016 to USD 81.81 billion in 2021 at a CAGR of 32.1% during the period. The figure shown below highlights the overall IoT market on the basis of application domains.

Figure 10 IoT Market Size by Application



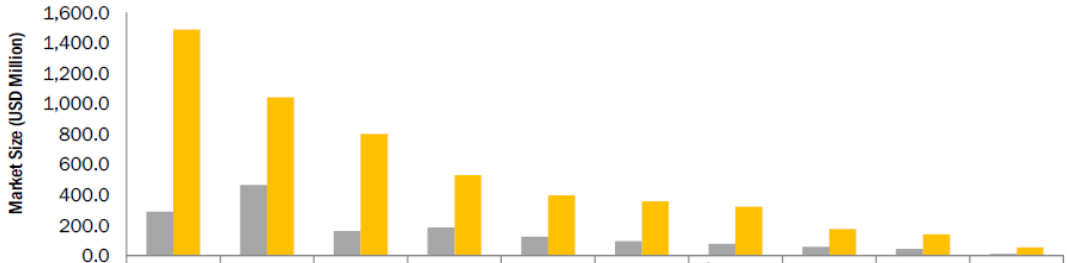
	Smart Mobility and Transport	Building and Home Automation	Smart Energy	Connected Health	Smart Retail	Connected Logistics	Smart Manufacturing	Security and Emergencies	Smart Environment	Others
2016	24.88	20.34	19.19	17.14	15.68	15.00	13.80	12.44	10.72	7.84
2021	98.41	81.81	81.82	77.18	66.33	66.16	57.98	53.72	44.53	33.78
CAGR	31.7%	32.1%	33.6%	35.1%	33.4%	34.5%	33.3%	34.0%	32.9%	33.9%

Source: Press Releases, Investor Presentations, Expert Interviews, and MarketsandMarkets Analysis

2.4 Mobile IoT Market by Industry

Compared with the existing short range wireless communication, cellular technologies, as the longer-range communications, can be broadly used in the wide area for the connectivity between mobile objects and objects to the IoT core. In lots of IoT scenarios such as Agriculture, Energy, Environmental Monitoring, Building Automation and Smart City, those types of objects are generally used to track data and thus don't transmit a large amount of data. Mobile IoT shows much more advantages e.g. low power utilization and extended coverage than the existing technologies. It can be seen from Figure 10 that building automation is expected to grow at the highest rate in the Mobile IoT market between 2016 and 2022. It also indicates the top vertical industries for the Mobile IoT market.

Figure 11 Mobile IoT market by vertical between 2016 and 2022



	Building Automation	Energy	Smart City	Manufacturing	Retail	Automotive & Transportation	Consumer Electronics	Agriculture	Environment Monitoring	HealthCare
2016	289.1	464.1	162.2	184.3	124.4	94.1	76.7	58.9	44.2	11.1
2022	1,487.4	1,041.6	800.5	529.7	396.0	356.6	320.2	175.4	139.7	54.9
CAGR (2016–2022)	31.39%	14.42%	30.49%	19.24%	21.28%	24.87%	26.90%	19.94%	21.16%	30.42%

Source: Experts, White Papers of Global Mobile Suppliers Association, White Papers of M2M Association, IoT M2M Council, and MarketandMarkets Analysis

2.6 Mobile IoT Market by Region

According to the same report of above, the Mobile IoT market based on region was valued at USD 1,265.9 million in 2015 and is expected to reach USD 5,302.0 million in 2022, with a CAGR of 23.30% during the forecast period between 2016 and 2022. The biggest market would be North America with the value of $ 450 million in 2015 and growing to $1,836 million in 2022 as Table 1 describes. The second largest market would be APAC with slightly lower total revenue forecast for Mobile IoT in 2022. Countries such as China, Japan, South Korea and India are investing heavily in infrastructure to prepare for implementation which is expected to drive the Mobile IoT market in Asia-Pacific.

Table 3 Mobile IoT market by region between 2016 and 2022

Region	2014	2015	2016	2017	2021	2022	CAGR (2016–2022)
North America	381.4	450.0	532.5	635.5	1,432.8	1,836.3	22.92%
Asia-Pacific	293.9	359.1	439.5	539.3	1,316.1	1,711.4	25.43%
Europe	332.6	389.9	458.2	543.7	1,198.5	1,533.1	22.30%
Rest of the World	56.9	66.9	78.9	92.3	177.0	221.1	18.74%
Total	**1,064.7**	**1,265.9**	**1,509.0**	**1,810.8**	**4,124.5**	**5,302.0**	**23.30%**

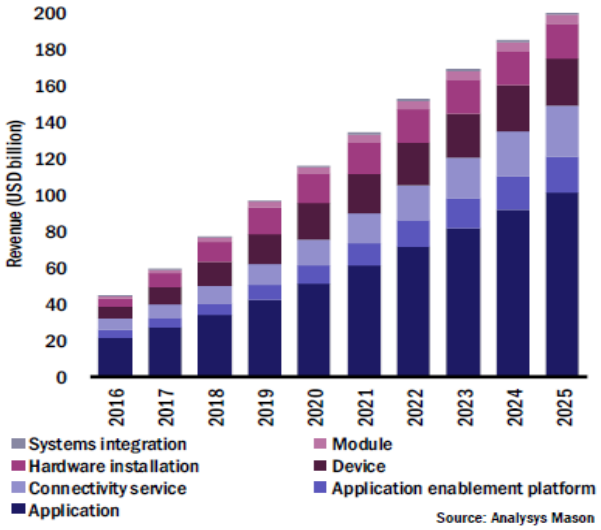
Source: Experts' Interviews, White Papers of the Global Mobile Suppliers Association, White Papers of the M2M Association, The IoT M2M Council, and MarketsandMarkets Analysis

3. Growth Opportunities for Service Providers

3.1 Industry Value Chain for IoT and Mobile IoT

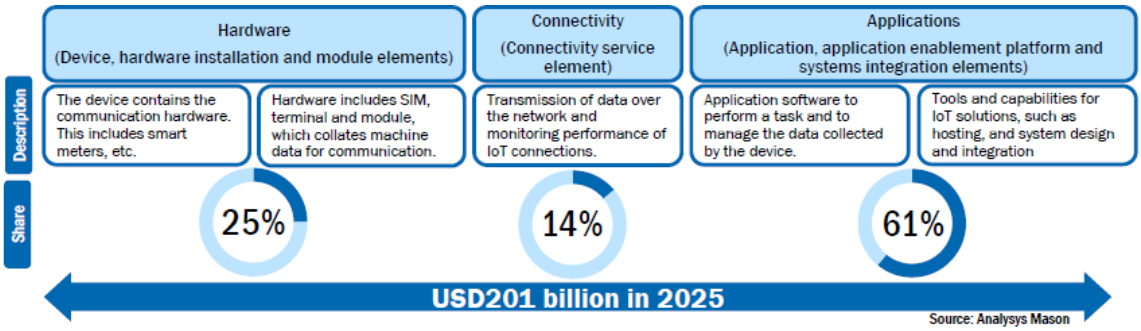
In most cases, the IoT value chain consists of the elements such as system integration, hardware installation, connectivity service, application, module, device and application enablement platform. Figure 11 shows the total revenue forecast from 2016 to 2025, when it is expected to reach $201 billion. As IoT focus moves from connectivity to application which is described in section 1.3 IoT Phases, the applications component will contribute the largest share of revenue, hitting 61% of the total by 2025.See Figure 12, hardware revenue will only occupy 14% and that of connectivity will drop down to 25% whereas that of application exceed 61% of the total. [8]

Figure 12 IoT value chain forecast between 2016 to 2025



Source: IoT value chain revenue: worldwide trends and forecast 2016-2025, Analysis Mason

Figure 13 Percentage of total value chain revenue contributed by each component, worldwide, 2025



Source: IoT value chain revenue: worldwide trends and forecast 2016-2025, Analysis Mason

Whereas in the Mobile IoT market, the value chain is somewhat different as follows:.

1) IoT network operators:

   IoT network Operator are responsible for IoT network setup and its operating. For Mobile IoT network, China Mobile, China Unicom and China Telecom are Mobile IoT network operators in China market, for example.

2) Service provider of IoT cloud platform:

   Service provider of IoT cloud platform can provide device access, security authentication, data storage and processing competence for specific APPs. The core competitiveness of IoT cloud provider is powerful cloud compute capacity.

   For example, China Mobile IoT company, a subsidiary of China Mobile is a typical IoT cloud platform provider. OneNET is the brand of the cloud platform. From internet perspective Alibaba provide Alibaba smart living platform which is another type of IoT cloud platform.

3) IoT equipment and solution provider

4) IoT network equipment suppliers:

   Which provide IoT network infrastructure for IoT network operators. In telecom market, Ericsson, Huawei, Nokia and ZTE are the major vendors in the market.

5) IoT APP solution suppliers:

   Which provide specific IoT APP solution.

6) Sensor supplier:

   Which provide IoT devices and chipset such as Qualcomm, Intel, ADI, Delphi, Mobileye and so on.

7) IoT business operators

   Which provide a specific IoT service for subscribers, for example Mobike.

8) Others: system integrator, managed service provider

Some companies cross over multi position in the industry chain, such as China Mobile who is not only a IoT network operator, but also IoT cloud provider.

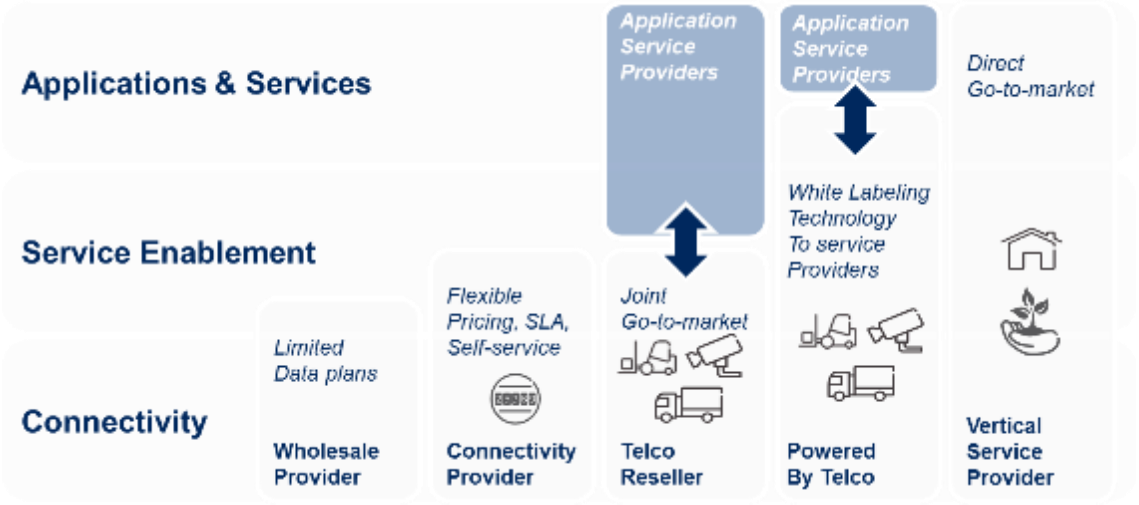
3.2 Growth Opportunities for Service Providers

Overall, the opportunities for service providers are from three perspectives i.e. things connections will be 2-4 times of that of human beings from user client perspective, applications/services revenue would be the main stream other than the pipe revenue from revenue perspective and IoT leading to other products/services e.g. IDC, cloud, big data service, security and integration will become increasingly evident from product perspective. For instance, Vodafone's IoT strategies are IoT + big data and IoT + IDC/cloud storage. AT&T's are IoT + data security service and IoT + operation. T-mobile's are IoT + integration and IoT + consulting service. [9]

We believe there are several potential roles an operator can take. Each of them has its own value associated to it in the value chain. There is no right or wrong, but the role that an operator chooses will determine what they will focus on bringing to their customers. It is expected that operator will get the full benefits as they take a bigger role and move up the value chain from just pure connectivity provider.

As shown from Figure 13 below, operators are sitting on a vast number of assets and capabilities, and this puts them in a unique position to capitalize on the IoT business. If you look at the current business landscape of M2M/IoT, many operators are struggling to get into this business fully. Many are focusing on selling more connectivity to enable M2M/IoT business for enterprises. They have very little control over what this connectivity will be used for. The scarier part is how they ensure that the new solutions and devices introduced in the network won't harm the network. Furthermore, they need resources/competences to manage the lifecycle of the complex ecosystems of partners/devices/applications and so on. Hence, just being a connectivity provider alone limits the operator's potential in reaping the full benefits from the IoT business. Furthermore, this is a volume and price business model as well as me-too type of approach: there is very little differentiation.

Figure 13 Telecom: Business roles in IoT



Source: Ericsson

On the other hand, operators have been in the enablement business for many years, many of them have been offering value-added and multimedia services to their customer through service enablement solutions. Hence, they have the experience and assets that they have built over time for the business. Can this be an evolution to support the IoT business? Absolutely. In fact, operators should devise a strategy for how to capitalize their existing investments and turn that into supporting future businesses such as IoT, bundled with the connectivity to better differentiate from the competition. Obviously, the evolution will require some thorough assessment of the impact on the existing business. However, it is worth investigating this rather than adopting an approach based on introducing silos of IoT applications into the environment, which will eventually put challenges on maintenance and management. This is also a good avenue for new revenue streams, if they become IoT platform and application service providers, to support enterprises to quickly bring their ideas to the market.

More ambitious operators will take a much more aggressive approach by going to the market addressing the enterprise customers directly. However, this requires a lot of functional knowledge in the vertical areas to be successful and make the operator relevant in the value chain.

To address operators as solution providers, the opportunities are as follows [10]:

- IoT Ecosystem

  Platforms are the engines that enable the development and integration of IoT solutions.

  Capabilities will be consolidated to allow developers to build applications for IoT.

- Market Consolidation

There is a market need for the consolidation of IoT platforms and no need for application development platforms and separate service delivery platforms. All building blocks for app development, connectivity, and integration will be consolidated within enterprise systems.

- Industry Standardization

  While it is impossible to create standards across all the industries that are part of IoT, there is need for standardization around how data is collected, stored, and communicated across different industries and applications. This provides leadership opportunities for large platform vendors.

- Capabilities Standardization

  While each platform company has certain unique capabilities, there is the need for the standardization of app development across platforms to help developers join multiple ecosystems without the cost of meeting different requirements and development capabilities.

- Modular Approach to System Integration

  Platform vendors regularly develop different applications and provide constant support for a development economy. It is critical for platform companies to help developers by making modular solutions to aid the integration of different applications for complete solutions development to meet customer requirements.

To address operators as connectivity providers, the opportunities are as follows [8]:

- Connected Cars

  Consumer telematics and vehicle diagnostics. Internet connectivity and media in vehicles

- Shipping & Logistics

  Multi-modal transportation and shipping and logistics. Asset tracking using multi-network connectivity solutions.

- Smart Grid

  Remote sensors and asset management. Monitoring pipelines and upstream, midstream, and downstream operations.

- Fleet Telematics

  Managing fleets and commercial vehicles. Automated trucks and monitoring assets for regulatory compliance and vehicle diagnostics.

- Mobile Workforce

Managing and tracking people across remote locations. Use of multi-network network connectivity solutions to improve personnel safety and security.

4. IoT Use Cases

The Internet of Things (IoT) is a conceptual framework, driven by the idea of embedding connectivity and intelligence in a broad range of devices. It will present a wide range of use cases, the most prominent of which will be home automation, connected transportation, industrial automation, smart utilities and e-health. The use cases list below are some samples of those vertical solution. It does not iterate all but it does show some typical concepts, solutions and business model of IoT use cases.

4.1 Connected Vehicle

With no doubt, the Connected Vehicle business is one of the most important IoT businesses to operators. That is why the use case of Connected Car is highlighted as the first use case shown below.

4.1.1 Use Case Description

Today, Ericsson and Volvo continue to expand upon the possibilities of cloud-based solutions to improve traffic safety and deepen driver relationships via a wide range of infotainment, telematics and safety offerings. That includes vehicles that are increasingly modified by over-the-air (OTA) software updates.

Why did Volvo want to connect their cars, in the first place? The most important reason is to secure their core business, which is their after-market sales. By offering services such as connected service booking to the end-consumer (i.e. the car owner) they will guarantee that the parts come from Volvo. The second most important reason is to build a strong, direct customer relationship, something that they don't have today. The third reason is to be able to control quality and reduce costs. By constantly having access to accurate information about each vehicle in real time Volvo knows exactly which vehicles to recall in case of a failure. Finally, Volvo also wanted to prepare for new revenue streams coming from 3rd party applications.

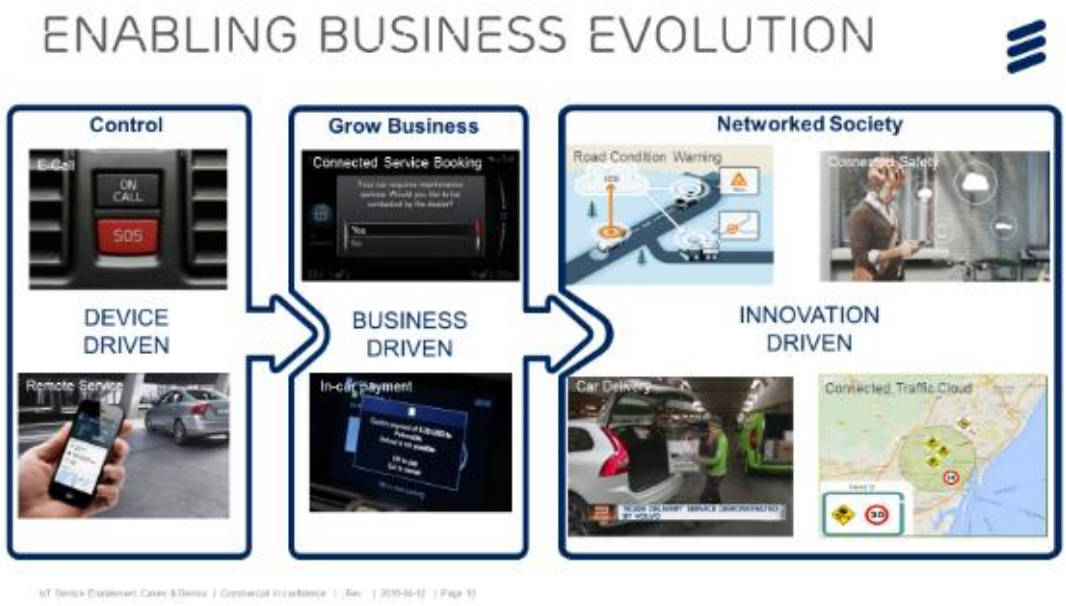
4.1.2 Value Proposition

- Transforming cars and society
- Cloud-based solutions for rapid innovation
- Safer and more efficient roads

4.1.3 Realization Details

The solution Ericsson offers in this case can be divided into a service and a technical view. The services include Telematics Service, Infotainment Service and In-car Payment. The technical view provides Vehicle Data, Connect to TCU / OBD, FOTA / SOTA and Vehicle / Road Event. With that solution, it enables the business innovation of Connected Car from device driven to business driven and finally to innovation driven as Figure 14 indicates. The Ericsson offer can also be classified as connectivity service, IoT enablement services, IoT analytics services, monetization services and security services.

Figure 14 Enabling business evolution



4.1.4 Business Model

Ericsson Connected Car solution is for the OEM with the business model divided into 3 categories as following.

- Initial setup fee
- Customization fee

  Which includes IT system integration and special request
- Connected service charge

  Which consists of connected SIM, connected service, per car, per service and B2B & B2B2C services

This is an example of a subscription business model.

4.2 Connected Urban Transport

The Connected Urban Transport is a completely new way to connect everything and everyone that moves. It is a solution that enables data sharing and takes interaction between infrastructure, traffic and all stakeholders to a new level. It is an important cornerstone in the transport industry's transition from merely being connected, to being collaborative and automated. The Connected Urban Transport gives transport authorities and cities the ability to aggregate and analyse diverse, real-time data from connected vehicles, infrastructure, and devices.

4.2.1 Use Case Description

A sleek, shiny vehicle powered by solar energy speeds across a red and rocky desert landscape. Using a connected traffic application called the Solar Navigator, this vehicle can find the most efficient path through the forbidding terrain. Named the Stella Vie, this experimental solar-powered car raced 3,000 kilometres across the Australian outback to win the World Solar Challenge in October of 2017.

Figure 15 Stella Vie

Demonstrating just how efficient the car is, at the end of the competition, Stella Vie had collected a surplus of energy that was fed into the power grid. The victory for Stella Vie demonstrates the benefits of automotive IoT and the connected vehicle ecosystem. To stay ahead of the pack, Stella Vie used the latest vehicle-to-everything (V2X) technology, including Ericsson's Solar Navigator app. This bespoke connected traffic application was designed by Ericsson to help Stella Vie move past their competition as efficiently as possible.

4.2.2 Value Proposition

- Innovation requires collaboration
- Fast is not enough, Stella Vie is smart
- Connected Urban Transport makes it easy for industries, including transport, to work with connected devices
- An easier way to drive – and park
- Breaking data out of darkened silos
- Making connected transport more profitable.

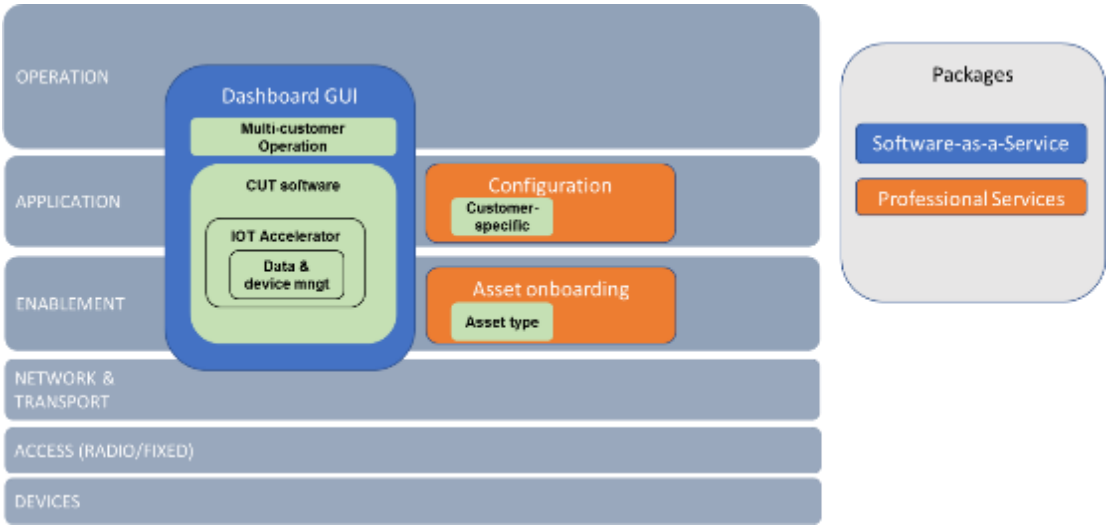
4.2.3 Realization Details

At the heart of Stella Vie is the unique Solar Navigator platform, an innovative application that uses Ericsson's Connected Urban Transport solution and is powered by Ericsson's IoT Accelerator platform. The app aggregates in-car data, traffic data and weather data, to perform in-depth analytics and optimize the route. It also takes height profile maps into account, finds the most efficient route and shows drivers how much energy is saved compared to a standard, fossil fuel-powered car. Through the Solar Parking app, which uses height maps, weather data and a parking probability map, drivers are guided to a free parking spot which yields the most solar energy. The latest vehicle-to-everything (V2X) technology to warn the driver and anticipate upcoming traffic events, allowing for safer and more efficient driving. It also encourages the user to drive as efficiently as possible by giving feedback through a built-in lighting system, warning the driver by turning red when either braking or accelerating too fiercely and using up battery life.

4.2.4 Business Model

The commercial model of Ericsson's Connected Urban Transport mainly is to sell service packages e.g. SaaS and professional services. The diagram shows the details.

Figure 15 Commercial model of Ericsson's Connected Urban Transport



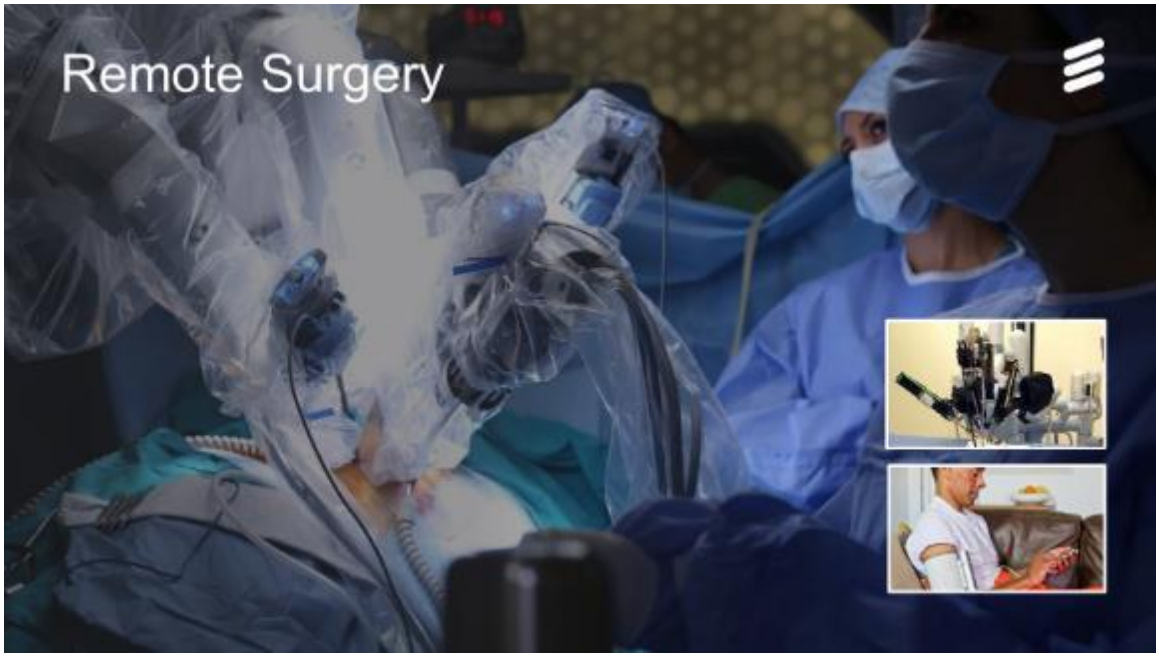
This use case also represents a subscription model.

4.3 Telematics Robotic Surgery

4.3.1 Use Case Description

The " Telematics Robotic Surgery" 5G medical use case has shown a probe as a robotic representation of a biological finger that gives the surgeon the sense of touch in minimally invasive surgery and is able to send accurate real time localization of hard nodules in soft tissue. The probe, or robotic finger, is able to identify cancer tissue and send information back to the surgeon as haptic feedback.

Figure 16 Remote machine surgery



4.3.2 Value Proposition

The industry challenge with robotic surgery is the ability to sense what the robot feels is not currently possible. Today it must be done locally and the ability to exchange the teaching skills to other surgeons takes a large amount of time. In order for top surgeons to teach a wider audience, they must move between hospitals, which is not an efficient use their skills and resource. With remotely capabilities, the transfer of the great skills can improve. The physician will not spend time traveling between hospitals, instead using the time directly towards patients or teaching.

Latency is a critical factor in the success of this use case/requirement, with requirements to provide the three senses of sight, hearing and touch. Network slicing is equally important to provide the necessary quality of service for each sense.

4.3.3 Realization Details

Ericsson provided the 5G infrastructure which included 1 Virtual Core Network, 2 Software Defined Radio and 2 Cloud-RAN & Edge Cloud and research expertise to assist with edge computing, latency reduction and network slicing.

Figure 17 5G infrastructure and remote-control terminals

Role and key dimensions of 5G

- 5G connects a surgeon in a remote location to a surgical robot
- 5G is mandatory for remote robotic surgery using mobile connection
- Most importantly 5G provides sub-1ms latency enabling haptic feedback

4.4 Realistic Sports Experience

4.4.1 Use Case Description

Ericsson-LG has delivered successful 5G trial service infrastructure with KT that was the official communications sponsor of the 2018 Winter Olympic Games. The deployment is claimed as one of the largest 5G networks operated so far. Under harsh winter environment, Ericsson-LG deployed 5G testbeds in 3 areas - PyeongChang, Gangneung and Seoul, covering 7 sites.

Omi-View service was one of the most popular use cases in the KT 5G Pavilion. It offered live athlete's position, live camera streaming and tracing, live results and 3D Maps of immersive area overview and the athlete's view.

Figure 18 Omi-View snapshots

4.4.2 Value Proposition

- Deliver the ultimate user experience for spectators in the arena or fans following the event on any device globally
    - live detailed results and statistics along with live positioning (GPS)
    - Smartphone apps (incl. VR)
- Deliver the ultimate user experience for spectators in the arena or fans following the event on any device globally
    - live detailed results and statistics along with live positioning (GPS)
    - Smartphone apps (incl. VR)
- Trigger to increase public attention of snow sports
    - Increase viewing rate as 2nd TV
    - Derive audience participation to the Olympics

4.4.3 Realization Details

The solution consists of following:

• A backend/middleware called Ericsson Networked Event (ENE). It is a platform, delivered as a service, which handles integrations of external data sources, and exposes the processed data via well-defined APIs to the client application.

• An android app, to run mainly on 5G Samsung trial devices and other Android based phones and tablets (OS version 6.0 above), that displays a 3D world, where the skiers' current positions can be seen, the results and live video streams are displayed. The app is called KT OmniView 2018.

- A VR app, to be used with Samsung Gear and corresponding phone.

- Amazon Web Service (AWS) based servers' deployment in a High Availability setup to offer redundancy and availability for the solution from both HW and SW perspectives. Servers are to be deployed in Seoul.

- Tools to manage third party provider access to the APIs.

- Integration with Swiss Timing, most likely using devices to get GPS data from the skiers.

- Exposure of the race details, including skier information, results, positions, the schedule, and similar to mobile users via the KT OmniView app on android devices.

4.5 Smart Payment

Smart payment is becoming a trend around the world and enables people to live a cashless life. It not only simplifies consumers' payment procedures, but also help traditional retailers to explore new business models and upgrade their businesses in the upcoming "new retail era".

4.5.1 Use Case Description

The smart Point of Sales (POS) devices enable the retailers a great deal of flexibility in selected application scenarios, no matter indoors or outdoors. It allows almost all mainstream payment methods such as EMV chip, swipe, QR code scanning, contactless, and NFC coupon. This will undoubtedly cater to young consumers who have formed the habit of shopping without cash, and free retailers from handling cumbersome cash.

Using an Android Operating System, the smart devices allow retailers to install a CRM system, which can easily verify membership, record consumption data, conduct scientific analysis, and manage customer information. It means that operators of shopping malls and supermarkets can conduct precision marketing activities and provide diversified and personalized products and services. That, in turn, improves customer satisfaction and operational efficiency.

Figure 18 Smart POS

4.5.2 Value Proposition

- Enabling all payment methods acceptable
- Making cashless life possible
- Faster transaction and improved efficiency
- Secure and reliable transaction
- Innovative business model for merchants
- Efficient management of customers

4.5.3 Realization Details

There is an LTE cellular module inside of each new-type POS device. Since the LTE network is stable and standardized globally, the module can send and receive transaction information reliably anytime and anywhere. The smart module, with built-in Android Operating System, supports installation of CRM system, based on which retailers can collect customer data, analyse consumers' shopping preference, and do precise marketing. The integration of online and offline business will improve customer shopping experience and enhance competitiveness of traditional retailers in the "new retail era".

4.5.4 Business Model

The ecosystem of the Smart Payment is comprised of the smart POS device providers, the financial clearing company, the operators and the merchants. Normally, the POS device providers focus on selling devices while operators charge SIM card subscriptions and the

financial clearing company charge transaction fees. However, there are some variations such as the financial clearing company paying the SIM card subscription fee for the merchants.

4.6 Smart Cargo

4.6.1 Use Case Description

Smart Cargo is Societe International De Telecommunications Aerocaptures (SITA) solution to track and monitor containers ("ULD": Unit Load Devices) in the Air cargo industry. Smart cargo is combining IoT and Mobile capabilities to ease the handling of ULD, enhance monitoring and provide valuable data analytics to improve cargo operations.

4.6.2 Value Proposition

- Supporting Digital transformation of the air freight industry
- Provide sensor- rich data from ULD and full visibility of events
- Enhance cargo handling process efficiency
- Minimize disruption impacts and improve ULD inventory & rotation

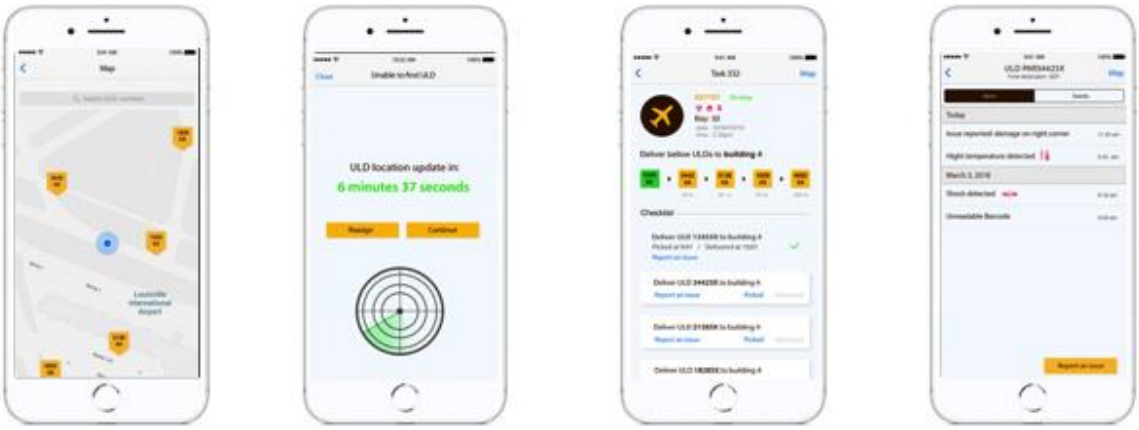
4.6.3 Realization Details

This is an end to end solution which include the component bellow:

- Aero-certified sensors to capture ULD Geo positioning data, Temperature, pressure, shock, humidity.
- LPWAN IoT network to push all data to the SITA platform using a specialized gateway.
- SITA IoT platform performs device management, business rules, data collection & analysis
- SITA mobility platform. To integrate airlines back-end system, the IoT platform data displays necessary information onto workforce mobile application
- Mobile application: Provide necessary information to workforce, such as: Flight list, task assignment, check-list, ULD alerts, ULD localization, digital report & manual, chat…

Supervisor Dashboard: Web-based console to perform: user management & ULD data analysis (Dashboard, Business Intelligence, etc.).

Figure 19 Mobile application of Smart Cargo



4.6.4 Business Model

Smart cargo is commercialized with consulting to analyse requirement and customization. It is usually priced with an on-time charge and a monthly charge per ULD to be monitored & mobile workforce involved in operations.

4.7 Fleet Management

4.7.1 Use Case Description

A multitude of vehicles are present at an airport (fuel truck, passenger buses, baggage trolley and others). It is crucial for the customer (Airlines or Airport) to have a better understanding of the geo-positioning and vehicle status (battery status, fuel levels and others) for better efficiency in the use of their equipment. SITA Fleet management solution, powered by Orange & Ocean, makes vehicles and mobile assets easy to track, manage and communicate within a complex airport environment.

4.7.2 Value Proposition

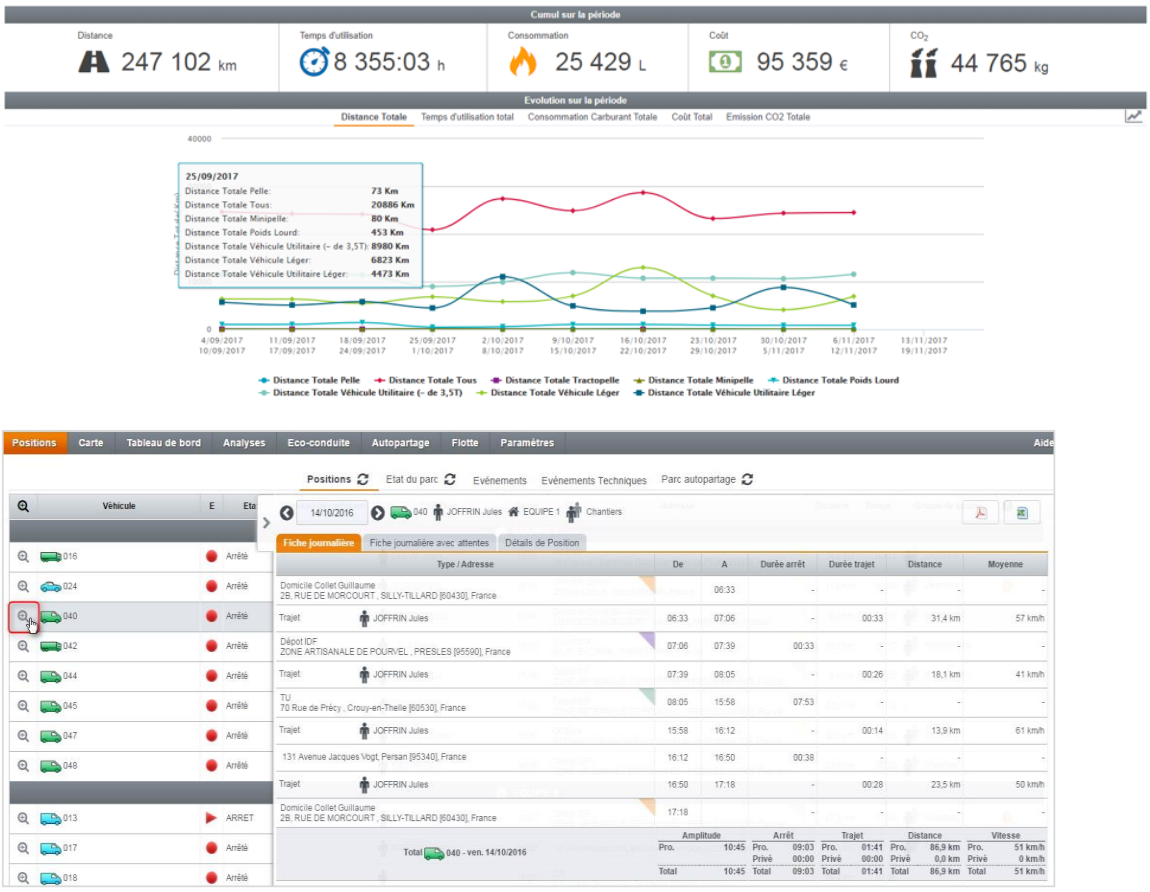
- Localize vehicles in real time at airport and benefit from historical data
- Provide full visibility of field operations to enhance business process efficiency
- Optimize fleet vehicles: cost reduction, preventive maintenance, activity follow-up
- Integration with SITA Airport Management System

4.7.3 Realization Details

A GPS box is mounted in each vehicle that needs to be tracked & monitored. The data collected from the box is sent in real time through the cellular network to SITA servers. After being

processed, the data is presented in customized reports adapted to fleet management or sent in push mail. The Fleet management solution can be sold as a bundle with the full SITA Airport Management System.

Figure 20 Sample GUI of SITA Fleet Management



4.7.4 Business Model

Fleet management for Airlines and Airport is proposed via monthly subscription model per vehicles equipped with the system.

4.8 Smart Integrated system at Airport

4.8.1 Use Case Description

Buildings and airports are built and operated in silos, which increase the complexity & data inconsistency. Examples of this are:

- Energy wastage and poor resource utilization

- Increased change orders during construction
- Increased operations and maintenance cost
- Inconsistent incident responses

SITA Smart Integrated system is helping airport facility management teams to optimize, automate and operationalize their assets, people, and purpose.

4.8.2 Value Proposition

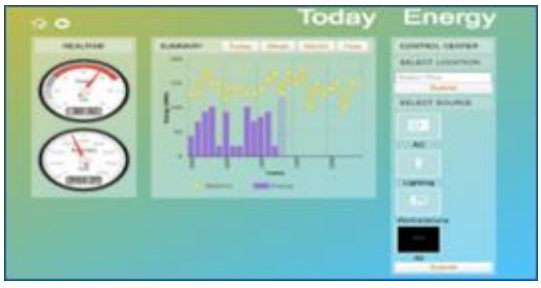
- Breach various system silos
- Improve process, automate asset & people
- Optimize Airport investment and reduce cost
- Enhance passenger experience

4.8.3 Realization Details

SITA and Orange developed a cloud-based solution which integrates and analyses the data from various sources at the airport and connects silos. It generates “Operational Intelligence” for Industrial Internet of Things (IoT) framework from data coming from connected devices, buildings systems and sensors. It enables the following use-cases. The automatization of remote data collection from a variety of sensors are linked to the LPWAN network. All data are displayed via monitoring portal in order to obtain and analyse the information and workflow.

- Work order management
- Maintenance Management
- Asset management
- Building automation
- Inventory management
- Energy management
- Commission to Operate (C2O)

Figure 21 Sample GUI of SITA Smart Integrated system



4.8.4 Business Model

The usual business model is comprised of a one-time charge (consulting, design, installation, set-up) and monthly recurring fees (service operation, support, maintenance etc.).

4.9 Bag Tracking

4.9.1 Use Case Description

The coming IATA resolution 753 in Air Transport industry requires airlines and airports to monitor and log the status of its passenger arrival bags at the airport. This resolution is scheduled to be implemented in 2018. The current solution for bag uses a legacy barcode reader, which implies expensive optical camera reading systems at the airport. The tracking ratio of arrival bags is not optimum and RFID technology is seen to improve baggage tracking on arrival at Airport.

SITA developed a project to track Bags on arrival using RFID tag & automated readers.

4.9.2 Value Proposition

- RFID infrastructure is cost effective compared to current solution
- RFID technology demonstrates significantly better bag reader rate compared to paper-based tags
- Only a simple Internet connection is required to communicate data to the back-end systems

4.9.3 Realization Details

- Selected bag tracking from airlines that include RFID tag on current label (Bag Tag)
- Install RFID reader from Lyngsoe company in current airport bag environment
- RFID readers connected through 4G to SITA back-end servers
- SITA back-end servers are used to store and filter the events:
    - The number of bags expected for a flight
    - The number of bags scanned
- The data is combined with other data sources, such as flight list (belt delivery, schedules time of arrival etc.)

Figure 21 Bag tracking

4.9.4 Business Model

Although no firm commercial model for such solution is defined yet, the potential models could be two. One of which is to sell the RFID chips and readers upfront to the customer and sell software solution. The other model is that the solution providers do not charge any hardware fees and the customer only pay the recurrent software subscription fees, normally in a SaaS model.

4.10 Smart Lighting

There is a potential for over 60% energy saving using smart lighting in cities. Smart light poles are a platform for providing local connectivity services, and innovative use cases and business models.

4.10.1 Use Case Description

Application opportunities and challenges:

- Adjust street lighting for improving security and saving energy
- Energy monitoring and dynamic control based on need
- Automatic flagging of malfunctions
- Co-location of small cells/MEC equipment for other use cases on light poles, e.g. providing local communication, information, and content services
- Visual Light Communication (VLC) for multiple use cases

4.10.2 Value Proposition

- Optimizing the electricity usage
- Ensuring the uptime of the lights in the city
- Easy and fast rectification of faulty light points
- Real time inventory management & prediction

4.10.3 Realization Details

The solution is comprised of the following components:

- Dashboard showing the location of lights on the map
- Status of the lights (On/Off) by color indication (Alternate Lights)
- Control of light operation
- Configuration page
- Configuring the Luminosity level (for LED lights)
- Naming of the light point

Figure 22 Smart Lighting architecture

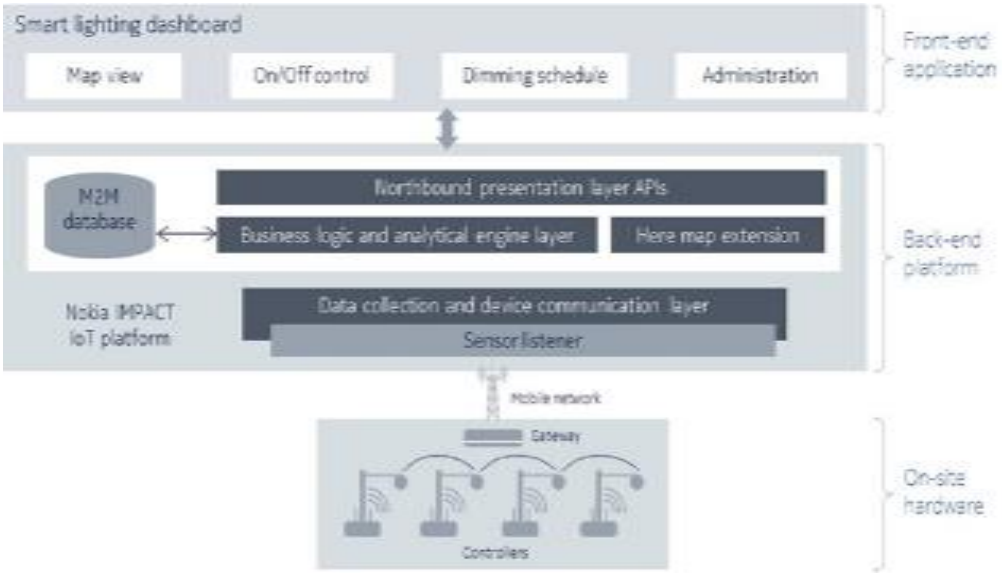


Figure 23 Smart Lighting dashboard

4.10.4 Business Model

Companies no longer compete solely on price or on new product development. IoT changes the way existing and/or the same products and services are delivered to consumers and enterprises. In the Smart Lighting dashboard solution, a new business model is to sell a project based on energy savings. For example, a customer spends $3/m2 on energy. By applying the Smart Lighting solution, the customer could pay nothing upfront and nothing for the software and hardware of the IoT solution. Instead, the solution provider could obtain its revenue from the cost saving of the energy e.g. a 10% improvement in energy efficiency saves a business $10K.

Another common commercial model is to sell the solution by device subscription. In other words, each light would be charged certain fees monthly.

4.11 Smart Parking

Smart parking solutions can help steer drivers to the most convenient parking space and enable one-click parking payment and demand-based pricing.

4.11.1 Use Case Description

Application opportunities and challenges

- In conjunction with a broader smart city opportunity;
- Free parking space detection, a selected target geography via sensors/cameras;
- Driver steering to most convenient/selected parking space;
- One-click payment and demand-based dynamic pricing.

4.11.2 Value Proposition

Nokia's solution is based upon wireless connectivity to their IMPACT IoT platform, complemented by many components, such as sensors, cameras, end-user apps, toll systems, etc. This solution assists the drivers to find the parking space and convenient online bill pay.

4.11.3 Realization Details

It is comprised of following components:

- Mobile app for drivers with real time parking lot availability
- Mobile app facilitating booking, rebooking, cashless transaction (e-wallet/credit card) and E-receipts
- Management dashboard to monitor individual parking lot status (occupied/booked/paid/unpaid/free)
- Analytics to show parking trends – utilization, occupancies, demands, violations, and enforcements
- Configuration page to create and modify parking lot listings, prices, availability and operational hours

Figure 24 Smart Parking architecture

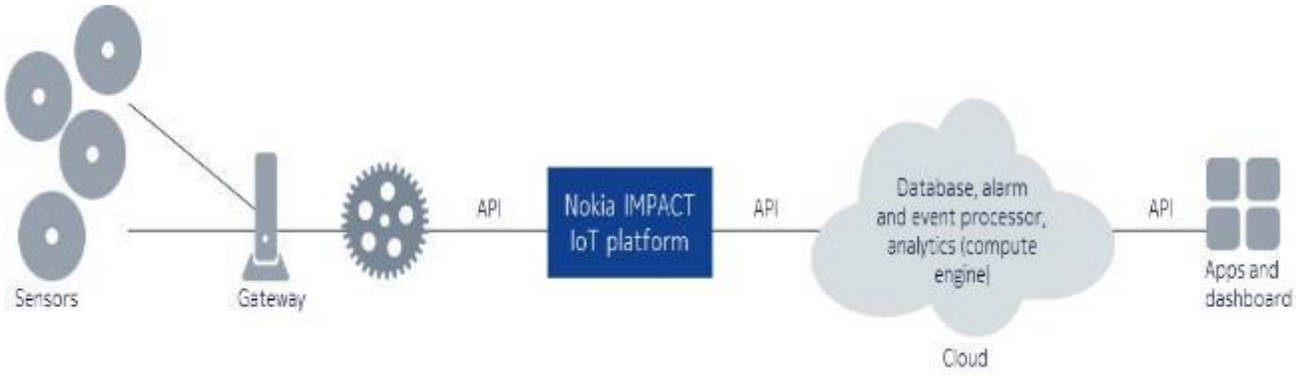
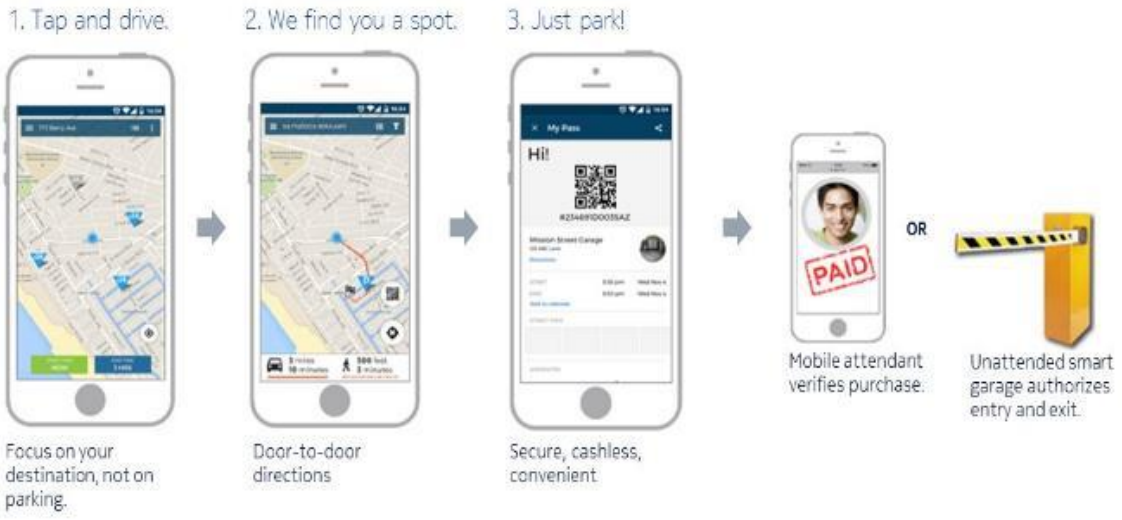


Figure 25 Smart Parking mobile application



4.11.4 Business Model

The standard charging model of this solution includes following.

- Fee for HW devices/panels
- One-time setup fee
- Monthly fee per user for basic package
- Monthly fee per user for Optional features
- Fee for optional physical installation services

However, the innovative business model can also include no upfront payment from the customer, rather the solution providers receive a revenue share of the parking fees for increasing the parking rate per day.

4.12 Smart Service Vehicle

Many enterprises depend on a field service force to set up, install, enable, and maintain their products, services, and applications. Today's widespread use of field service technicians and vehicles calls for transformational technology of field services and the supply chain.

4.12.1 Use Case Description

Almost all type of products or services, that require a reasonably complex setup and installation process on the customer's premises, will utilize a field service technician to perform the associated tasks.

The end customer experience is central to everything required to perform a successful setup or installation and to ensure that the product or service is functioning properly.

Connected service vehicle for field operations consists of:

- fleet management
- workflow management
- automated inventory tracking
- remote video supervision and support

Figure 26 Typical Smart Service vehicle

4.12.2 Value Proposition

With the right tools and applications interconnected through Smart Service Vehicle the field tasks can be performed more efficiently. Visibility to data in real time makes the process of managing the field service jobs more effective.

4.12.3 Realization Details

The solution involves an integrated platform that includes management of devices, workflow and inventory, enhanced communications, support for material delivery and management and real-time visibility to system status within the delivery chain.

Figure 27 Components of Smart Service vehicle solution

4.12.4 Business Model

For such solution, the charging model to the customer, normally, consists of three segments shown below.

- Device fees
  Which includes sensors, cameras and other IoT devices
- Software subscription fees
  SaaS model is preferred
- Professional service and maintenance fees
  Which comprises consulting service, design service, terminal software maintenance and other fees

4.13 Connected Car

4.13.1 Use Case Description

Turn the smart car into an extension of the driver's connected world. Qualcomm Technologies' suite of smart technology and automotive solutions allows car manufacturers to expand their existing accessory package offerings to include advanced on-board features, including connectivity, infotainment, navigation and driver safety. Our scalable, modular solutions, found in all global automotive brands, help carmakers integrate cutting-edge wireless and compute technologies into today's connected cars.

4.13.2 Value Proposition

- Connectivity that keeps pace with ever-evolving automobiles.

  Today's networks are 4G, but tomorrow they'll be 5G—the challenge is having a solution that meets drivers' needs today while anticipating what's next. With Qualcomm® Snapdragon™ automotive processors and modems, manufacturers of smart cars have access to superior wireless solutions, engineered to support today's technology while adapting to future wireless releases. Building on the Qualcomm Technologies' leadership in 3G/4G LTE for automotive, carmakers can further integrate additional wireless technologies including Wi-Fi, Bluetooth, and Global Navigation Satellite System (GNSS).

- Personalize the smart car driving experience with enhanced on-board connectivity.

  Smart auto manufacturers face the creative challenge of maintaining the familiarity of their brand while evolving to offer the latest wireless innovations. Qualcomm Technologies' portfolio of smart automotive technologies are engineered to allow our customers to deliver the in-demand wireless features and apps that ensure connected cars stay competitive for years to come.

4.13.3 Realization Details

- **Drive data platform**

  Our drive data platform uses cutting-edge smart technologies to intelligently collect and analyse data from different vehicle sensors, so smarter vehicles can determine their location, monitor and learn driving patterns, perceive their surroundings and share this perception with rest of the world reliably and accurately.

- **Infotainment**

  Smart cars manufactured with our integrated Snapdragon automotive processors offer an immersive infotainment experience. With support for 3D navigation, media streaming and parking assistance, as well as voice, facial and device recognition, our customers are redefining the connected smart auto landscape.

- Telematics

  We have optimized our cellular solutions for the automotive ecosystem, providing our customers with support for integrated radios, dedicated processors and advanced location engines.

- Wireless Electric Vehicle Charging (WEVC)

  Qualcomm Halo™ WEVC is a highly efficient energy charging solution that doesn't require wires or cables. Smart technologies are designed to allow electric vehicles to simply park over a designated ground-based charging pad, and power is sent to the EV—automatically and without wires.

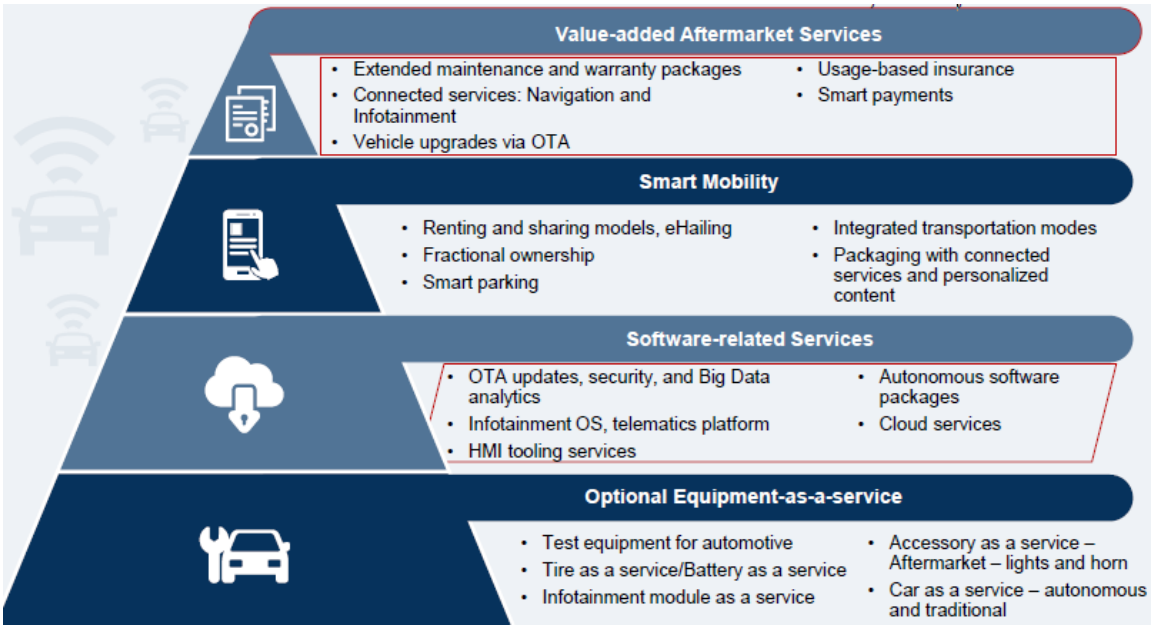
4.13.4 Business Model

According to the report from Global Connected Car Market Outlook [12], current business and revenue model of Connected Car business is divided into following:

- OEMs to follow the same suite of HMI +Connected services package
- Extension of services to home and connected office
- Freemium subscription models for Telematics

However, the future will evolve to unbundling of components to form "as-a-service" business. Mobility and software-as-a-service will account for a major part of the revenues. All those models are called Product-as-a-service. The models can be classified in 4 categories as in the figure below.

Figure 28 Connected Car Outlook: Product-as-a-Service in Connected Cars, Global



4.14 Smart Health Care

4.14.1 Use Case Description

Qualcomm Life is working to make mobile health a reality. The 2net™ suite of solutions supports end-to-end clinical connectivity that safeguards patient data, thanks to an 11-layer authentication process that meets FDA and HIPPA privacy standards. Our device-neutral architecture connects to the world's largest health care ecosystems, enabling OEMs to develop devices and systems that support a multitude of technologies.

For too long, the health care industry has lacked scalable, standardized clinical connectivity solutions to seamlessly share patient data. Patients are connected to a variety of medical devices that generate millions of data points a day, but hospitals can't leverage that data because of a lack of integration into an electronic medical record (EMR) or third-party enterprise system.

As at-home care becomes a necessity, health care providers increasingly rely on connected medical devices to remotely monitor their patients. The challenge lies in securely collecting, aggregating and analysing that data in ways that allow health care providers to monitor their patients and make informed interventions when necessary.

Figure 29 Smart Health Care

4.14.2 Value Proposition

Building on 30 years of wireless invention and innovation, Qualcomm Life is solving health care's most challenging issue yet—unlocking the value of medical device data across the care continuum. In order to ensure integration with today's leading health care offerings, we have designed an open, device-neutral platform that connects to one of the world's largest health care ecosystems

- Secure medical-grade infrastructure
  Our medical-grade 2net™ Connectivity Platform is built according to FDA quality and HIPAA privacy standards, enabling secure end-to-end clinical connectivity that protects valuable patient data from risk and exposure. And with 11 layers of authentication, encryption and access control, Qualcomm's 2net solutions further ensure the secure sharing and storage of patient data.
- Flexible, scalable connectivity solutions
  Unlock the value of medical device data through rapid and secure data management using our Capsule Medical Device Information System, which is designed to enhance clinical workflows and improve operational efficiencies across a hospital enterprise. Capsule supports over 780 medical device drivers and virtually all medical device types, models and firmware versions—providing a truly scalable enterprise system.
- Open, expansive ecosystem

Qualcomm Life's vendor-neutral architecture has enabled us to attract and build one of the world's most expansive ecosystems. Comprised of leading medical device manufacturers, pharmaceutical companies, hospitals, health care service providers, payers and more, our wide-ranging ecosystem includes more than 2,355 companies across the health care spectrum.

4.14.3 Realization Details

- Hospital connectivity and integration
- Connected hospitals empower medical staff to focus on what matters most—patient care. Qualcomm's solutions unlock the value of medical device data through rapid and secure data management that is designed to enhance clinical workflows and improve operational efficiencies across a hospital enterprise.
- Home health connectivity and integration
  Ensure an effortless patient experience during the transition from hospital to home by leveraging our medical-grade solutions, which securely transmit biometric data to enable scalable remote monitoring and informed interventions.
- On-the-go health connectivity and integration
  Qualcomm Life works with industry-leading medical device manufacturers, pharmaceutical companies, payers and health care providers to leverage medical device data to help define actionable insights. Our digital expertise supports the collection of timely, contextual data that delivers intelligent care for patients, providers and the health care ecosystem.

4.14.4 Business Model

IoT has also been changing the healthcare business. The introduction of technology companies into healthcare segment, and transformation in healthcare business model (i.e., from volume to value approach) has already happened.

In particular, the technical services in Home Healthcare consists of four types summarized by "STRATEGY INSIGHT" [13].

- Devices and Apps
  Where Consumers engage with connected devices, such as weight scales and wearables, and accompanying mobile apps to better monitor and track health and fitness. The charging model can be device selling and the subscription fees of the mobile healthcare service
- Social Media
  Where users engage with social networks for support and encouragement in meeting health related goals. Health targets can be linked with rewards programs. The social media service is commonly free but sometimes it embeds advertisements to gain profits for the provider.

- Integrated
  Where health tools are integrated with the healthcare system, linking patients directly with professionals for increased engagement, proactive care, and remote treatment. For those providers, the charging model could be a one-time service fee or monthly subscription fees or hardware & software pricing model.
- Healthcare Analytics
  Where healthcare professionals leverage advanced analytics for predictive diagnostics and can more efficiently manage specific diseases. It is primarily a subscription model mainly since the statistics of human health normally is saved in the cloud and the tools is a SaaS.

4.15 Smart Water Meter

4.15.1 Use Case Description

NB-IoT is an internet wireless narrow-band access technology standardized by the 3GPP, which has the advantages of wide area ubiquitous coverage, fast-upgrade of existing networks, low-power consumption etc. It brings great opportunity to all the terminal water meters (sensor) that need to be connected to IoT. Year 2017 is the first year of commercial application of NB-IoT. The Ningbo Water Meter (NWM) factory has been under full coverage of NB-IoT. In Ningbo, NWM and ZTE have chosen Yaojiang Huayuan community as the pilot community for automatic meter reading based on NB-IoT. The whole project planned to use the entry point of Yaojiang Huayuan community, gradually completing pilot construction and engineering application of automatic meter reading, and research of DMA (District Metering Area) technology based on NB-IoT in Ningbo city before December of 2018. During the process, by summarizing project work experience, NB-IoT technical standard system in water meter industry is developed. NB-IoT smart water meter will gradually cover Zhejiang province and even the whole country.

4.15.2 Value Proposition

- Strong links:500~100times access
- Wide coverage: Increase ability of coverage area by 100 times
- Low-power consumption: no need to rebuild network
- Easy installation
- Convenient mechanical reading
- Accurate measuring
- Convenient maintenance
- Stable and reliable signal

4.15.3 Realization Details

ZTE Smart Meter solution is formed by 5 layers; device layer, data aggregation layer, wireless network layer, IoT platform layer and application. It allows the smart meters to transmit water consumption data, through NB-IoT or 2G/3G/4G network, to its central device & data management platform to be saved, managed and monitored, and finally to publish the data to the applications e.g. consumer mobile apps. The diagram below shows the details.

4.15.4 Business Model

By the architecture defined above, the commercial model of the water meter service is another subscription model. In other words, ZTE would charge the utility operator a one-time setup fee and monthly recurrent fees whereas the operator charges no device fee from the consumer who pay the monthly water bill instead.

4.16 Connected Cow

4.16.1 Use Case Description

Farmers need to monitor the oestrus status of each cow. The tradition method is to identify it manually and the accuracy is only around 75%. Once missing the oestrus period, the cow should wait for next oestrus period to produce the milk. Alternatively, the farmers can inject medicine into the cow, moving the next oestrus period earlier. But the medicine would remain in the milk and then impact human health.

The connected cow solution leverages NB-IoT network to increase the accuracy and milk production.

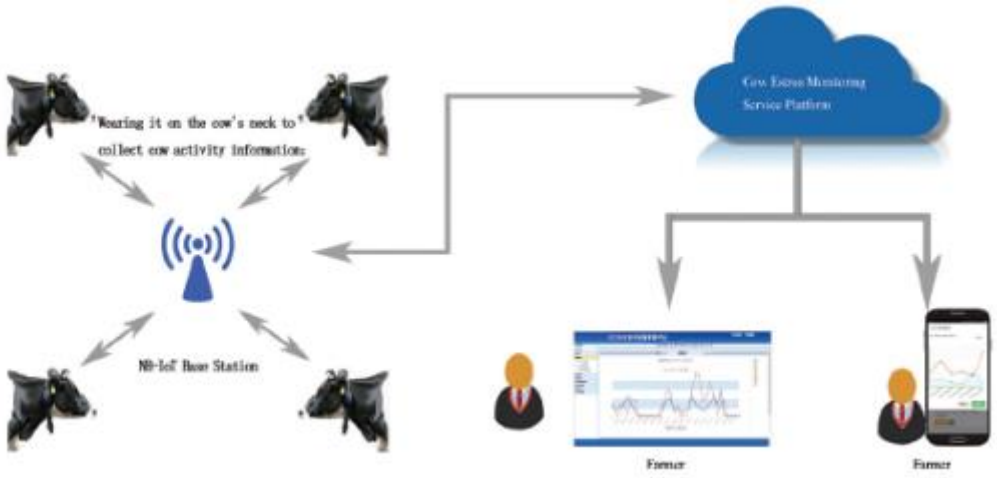
4.16.2 Value Proposition

With mobile operator's NB-IoT network, farmers do not need to deploy and maintain any communication network by themselves, which saves the farmers' costs.

Also, the low power consumption feature enables cow monitoring device to work for more than 5 years with a battery of 5400mAH only.

4.16.3 Realization Details

Figure 30 Architecture of Connected Cow



Cow Oestrus Monitoring System uses a device installed on cow's neck to collect & send cow's activity data to the cloud platform. The software in the cloud processes the data and identifies cow's oestrus status in order to help the farmer get the proper semen deposition time, and to improve the yield of milk. Currently the oestrus notification accuracy with this system is above 95%.

Meanwhile, this system also provides basic information management to the modern livestock industry, including farm management, cow management, real-time oestrus monitoring, cow positioning and tracking. All that information assists farmers to improve the farm management efficiency and increase the yield of milk.

4.16.4 Business Model

It is a device and subscription model which is made of upfront fee for the hardware device, i.e. sensor and a monthly subscription fee for the content, usage, or software that is provided as a service.

4.17 Connected Biosensor

4.17.1 Use Case Description

The popularity of sports wristbands has led people to pay attention to their own physiological health values, such as exercise, heart rate and other information. People can get their health or biological indicators by themselves without the need to go to a doctor or to the hospital.

This makes it easier for people to understand their physical changes. This type of sensor can help medical personnel, family members, etc. to better understand the physical changes of the wearer. In an abnormal situation, when it happens, more timely assistance can be given.

4.17.2 Value Proposition

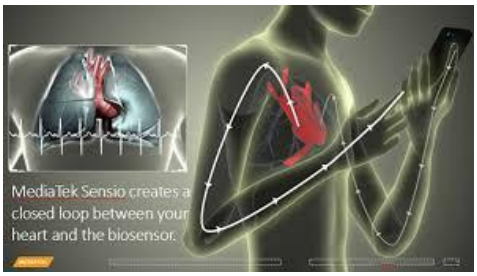
- Tracking personal health
- Observe the health trends of the population
- Improve physiological detection via reusing raw data

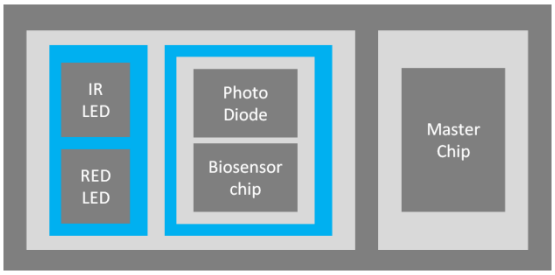
4.17.3 Realization Details

Figure 31 MediaTek Sensio

The Biosensor accessory uses light emitting diodes (LEDs) in conjunction with a light sensitive sensor to measure the absorption of red and infrared light by the user's fingertips. When the users touch a device's sensors and electrode with their fingertips, it creates a closed loop between the heart and the biosensor to measure ECG and PPG waveforms.

Figure 32 MediaTek Sensio components





From the hardware viewpoint, the biosensor sensor device consists of bio-sensor chip, IR/RED LEDs, photo diode and master MCU. From the system and software viewpoint, the biosensor chip controls LEDs and photo diode to detect the raw data signals. The master MCU analyses the raw data, converts the physiological indicators through the different algorithms, displays the

result on the device and sends the result to the phone/ cloud. From the eco-system viewpoint, these health indication values and the raw data will be saved on the cloud because the people want access to physiological data anytime, anywhere. The user can track the personal health indicator trend anywhere. In addition, it could be a great helper to the user's doctor, family etc. The SaaS companies could maintain, manage, and reprocess this data to create more useful and value add applications.

4.17.4 Business Model

For the product device manufacturers, biosensor devices allow users to constantly monitor their physical changes. Different user interface and convenient designs can allow for basic profits on the device itself. When the device can be connected to more accessories with different characteristics, such as temperature, airflow, etc. as well as other sensors, the user can also become familiar with related operations and improve the sensitivity of the product. If the bio-sensor device is equipped with a location tracking function, in addition to alerting the sudden body change, it can also provide a coordinate position to speed up the rescue time. It can be a great help for the elderly who walk alone or live alone.

For consumers to access this data anytime, anywhere, the user's measurement data and their historical results are usually stored in the cloud. This not only reduces equipment costs, but also allows SaaS companies to provide more add-on services and applications in the cloud. SaaS companies use a lot of physiological data and big data analysis, providing healthcare and other services. Consumers can track the changes in their physical indicator records and professional doctors can use the raw measurement data to further analyse the patient's bodily changes. These services can also help government agencies and companies in different jobs and industries. For example, when the fire department arranges to perform its duties, it will understand the physical changes of the firefighters and avoid the overworked body from re-entering the rescue work. Logistics and tourism can focus on the physical changes of drivers, whether they are driving tired or drunk. Insurance companies can also use this data to reduce accidents and focus on their subscriber's health to provide better security and service.

5. Market Risks

Although the document describes the IoT market, Mobile IoT market, IoT cloud market and segment market from a positive aspect, it is important to be aware that whole IoT market is still in an early growth phase. There are only few successful use cases that can set up a healthy ecosystem for replication. As such, there are risks that operators need to keep in mind as they develop their market strategies and business models:

1) Market growth lower than expectation

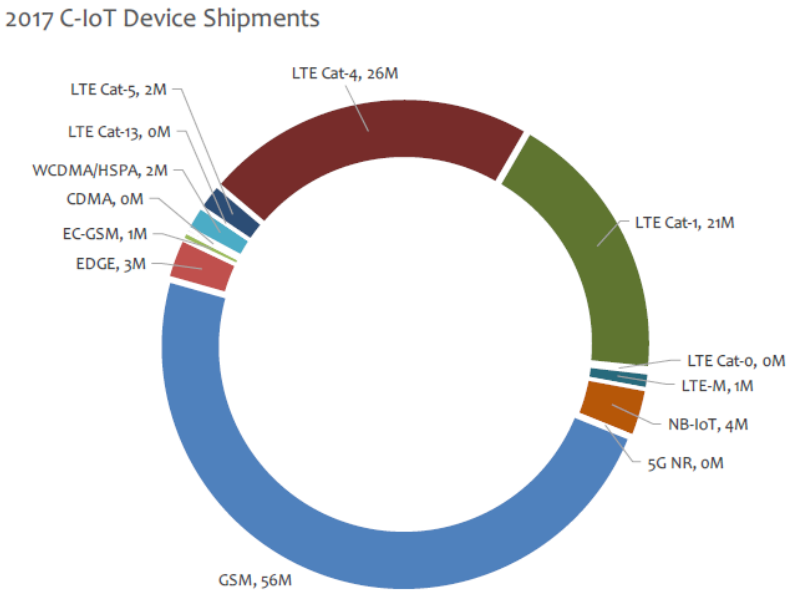
For a variety of reasons, such as industry investment lower than expected, dominate IoT players discourage technology innovation, or large and/or critical security incidents, companies may rethink their IoT strategies, which could slow down the market pace.

2) Market value smaller than expectation

The growth rate is a vital factor of the IoT market. Lower growth rate means the market will be smaller than forecast. As well, though IoT can be respected as the umbrella of diverse technology such as wired and wireless technology, device management, cloud computing, big data, AI, AR/VR and emerging technology, the market may reverse to other emerging or leading technology market treating IoT as auxiliaries only. For instance, if P2P communications among IoT devices or decentralized technology thrive more sharply than the centralized network, the connectivity revenue and the core IoT platform/application value could be dramatically reduced.

Particularly, for mobile or cellular IoT market, something interesting has been happening. The NB-IoT and LTE-M/eMTC market has not grown as expected, while the majority of the mobile IoT market is still based on GSM technology. From the diagram below, it shows that the device shipments of GSM IoT are nearly half of the total whereas that of LTE-M or NB-IoT is still a small portion in 2017. Fortunately, by 2022, it is forecast that the shipments of NB-IoT and LTE-M would take over most of the market share. [14]

Figure 33 Technology Breakdown of Cellular IoT Shipments, 2017



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