TOPIC: Internet of Things
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SUBJECT: Overview of a market that offers new opportunities to startups.

1 Definitions

The Internet of Things (IoT) refers to the expansion of the Internet to things/objects and places in the physical world.

The connected objects are physical objects that include technologies enabling communication, sensing the environment and performing various actions.

The Internet of Things is a network of networks which allows, through unified and standardized electronic identification systems and mobile wireless devices, to identify directly and without ambiguity digital entities and physical objects and thus to recover, transfer, store, and process without interruption between the physical and virtual worlds, data related thereto[1].

The IoT is driven by a combination of sensors, connectivity, people and processes (outline and examples of applications at http://www.visualcapitalist.com/what-is-internet-things/).

- *Sensors:* Everything in the environment can be measured, from temperature to pressure changes: position, presence, motion, velocity, humidity, sound, vibration, gas, chemical, flow, force, leaks, levels, magnetic…
- *Connectivity:* Inputs from sensors are digitized and placed onto networks : WiFi, Bluetooth, Zigbee, NFC, RFID, 4G, LTE, Ethernet, Wan, Lan…
- *People and processes:* Networked inputs are combined into bi-directional systems that integrate data, people, processes and systems for better decision making : CRM, analytics, upgrades and configurations, remote monitoring, maintenance, control & automation, security, supply chain management, mobile devices & apps…

These interactions between entities are creating new types of smart applications and services.

2 Global market – figures and trends

To date, the market is still in its early days. Currently, only very few people own connected objects, other than computers, printers, smartphones and tablets. The figures below show the percentage of US adopters for the main connected objects[2]:

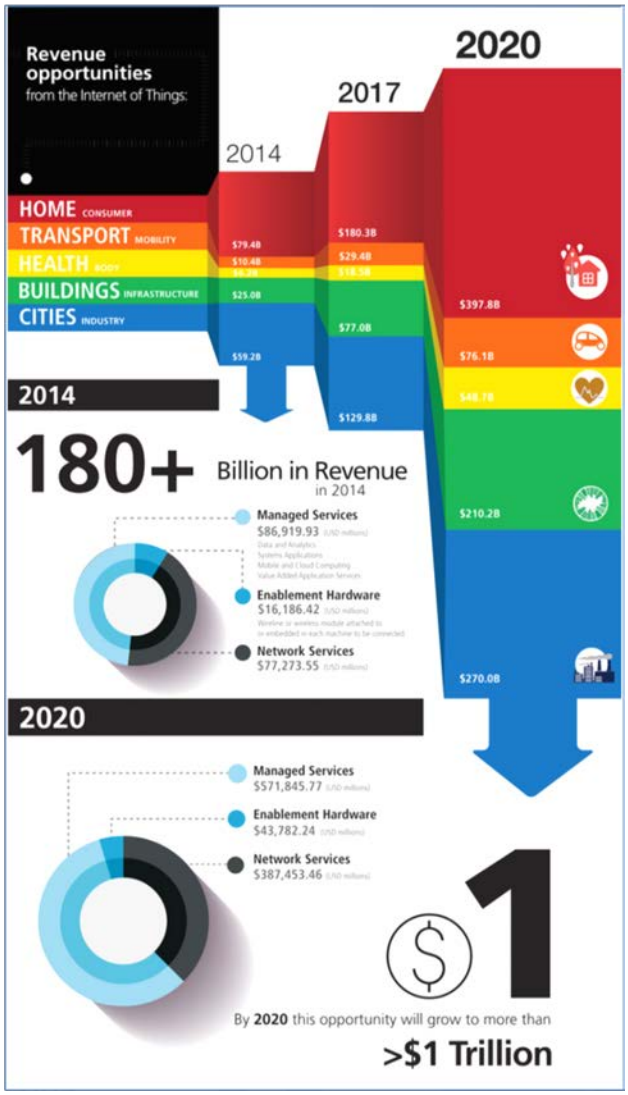
			% Users
1	Fitbit	Personal Health	0.59
2	Samsung	Smart TVs	0.503
3	LG	Smart TV's, lights and smart fridges	0.502
4	Nest	Thermostat	0.447
5	MaaS360	Air control mobile devices	0.080
6	Control4	Keypad locks, lighting, more	0.065
7	Belkin	WeMo home automation includes power, cooking, coffee pots	0.045
8	Radio Thermostat	Thermostat	0.033
9	Cereson	Vending machine on steroids	0.012
10	Screenfeed	Digital signs	0.011

[1] BENGHOZI P-J, BUREAU S., MASSIT-FOLLEA F. The Internet of Things | What Challenges for Europe? Paris : Editions de la Maison des sciences de l'homme, 2009.
[2] https://gigaom.com/2014/06/19/despite-major-growth-the-internet-of-things-is-still-the-wild-west/

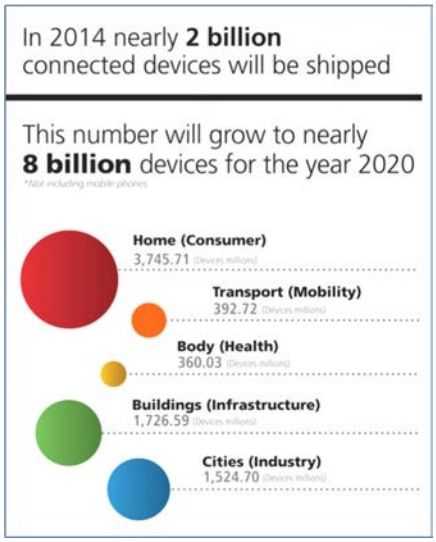
Cisco envisions a market of **50 billion objects**. The **economic value** generated by this market would be **$19,000 billion** by 2020[1], but this figure **includes cost reductions** due to **productivity increase**… Therefore, it is not solely based on additional sales of products and services.

This is what Cisco calls **Value at Stake** (this notion will come back later in this report). Value at Stake is the **potential bottom-line value (higher revenues and lower costs) that can be created or will migrate among companies and industries based on their ability to harness IoE (Internet of Everything)**[2].

According to Visualcapitalist.com[3], the number of new connected devices (except smartphones) could reach 8 billion per year, to reach an installed base of **28 billion connected devices at that time**.



According to this article, **revenues** estimated to **$180 billion in 2014 could reach $1,003 billion by 2020**, i.e. **$959 billion for services** and **$44 billion for hardware**.

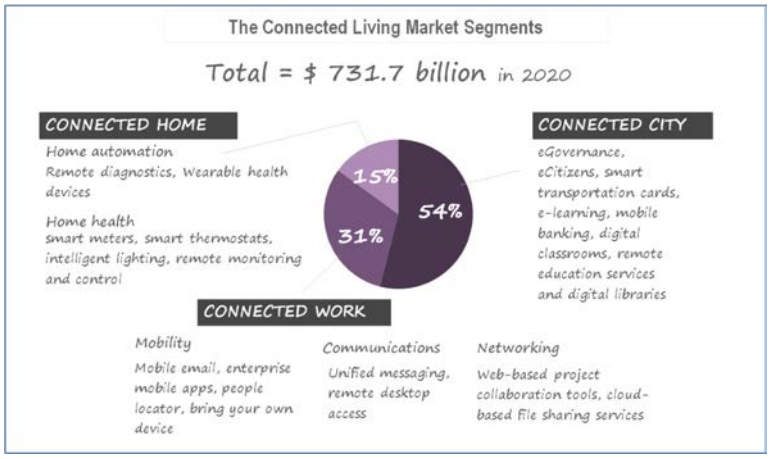


[1] http://www.bloomberg.com/news/2014-01-08/cisco-ceo-pegs-internet-of-things-as-19-trillion-market.html
[2] http://www.cisco.com/web/about/ac79/docs/innov/IoE_Economy.pdf
[3] http://www.visualcapitalist.com/what-is-internet-things/

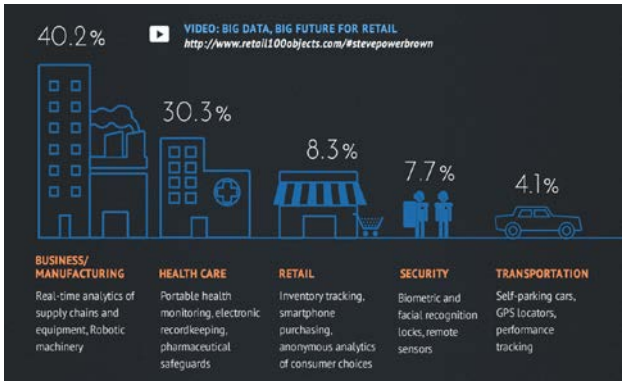
Yole Development figures[1] are in line with what is mentioned above, as they assume the **IoT devices market** will be worth **$46 billion in 2024** ($70 billion in 2018 and then decline).

In the same study, they estimate the **global IoT market in 2024 to $400 billion**, split into **$59 billion for cloud services** and **$296 billion for data processing**.

According to a study by Frost & Sullivan, the market for **Connected Living**, as they call it, is estimated at **$732 billion by 2020**. Connected Living will see hundreds of companies from a host of verticals - namely service providers, manufacturers, software providers, IT and cloud services companies and system integrators working hand-in-hand to bring connectedness to homes, schools, offices, factories, public places, vehicles and probably every place there is[2].



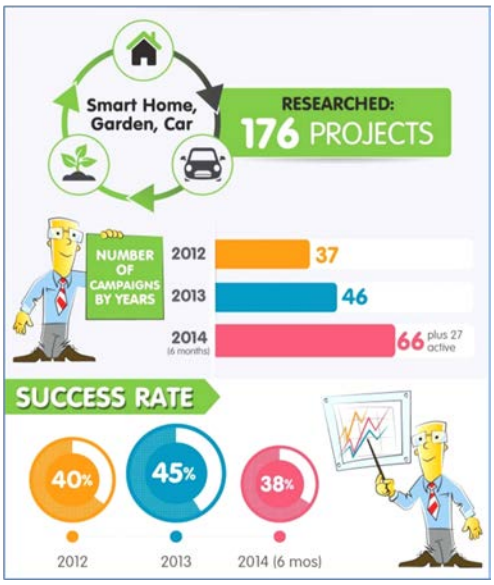
In updating its 2014-2020 outlook on IoT, IDC predicts much higher amounts (and therefore probably include other elements, but it is not detailed): $1,900 billion in 2013 and $7,100 billion in 2020[3]. Growth will focus on products to the general public as well as infrastructure. The IoT is expected to reach 212 billion objects by the end of 2020, including 30 billion autonomous objects[4].



Most objects will not address the home (currently the most visible part for the general public), but **industries and health care**[5].

[1] http://electroiq.com/blog/2014/06/iot-devices-offer-huge-potential-for-components-manufacturers/
[2] http://www.policychargingcontrol.com/technology-and-solution-trends/1907-how-connected-will-we-be-in-future-frost-predicts-731-7-billion-iot-market-for-2020
[3] http://www.idc.com/getdoc.jsp?containerId=prUS24903114
[4] http://machine-to-machine-solutions.tmcnet.com/topics/machine-to-machine-solutions/articles/355763-idc-forecasts-89-trillion-internet-things-market-2020.htm
[5] http://blog.infochimps.com/2014/04/28/guide-internet-of-things-infographic/

Here are recent figures on Kickstarter projects related to the IoT[1]:



Since this is a hot topic, the IoT is also whetting the investors' appetite:

"More than $1 billion flowed into 153 venture deals for companies creating products and services in the "IOT" space for the full year 2013", according to CB Insights, a venture capital and angel investment research company[2].

3 Market challenges

3.1 Security and access to data

More and more criticism is directed at the poor protection level of connected objects and associated data. It is usually possible for anyone expert in IT to connect to these objects, take control over them and divert some supposedly confidential information.

The public French television broadcasted an interesting TV reporting on that topic in June 2014: https://www.youtube.com/watch?v=AwipasrZ7ko

HP conducted a study[3] published in July 2014 and analyzed 10 of the most used objects in this new world and discovered **25 vulnerabilities per item**, totaling some 250 security problems. Tested objects are components of televisions, cameras, thermostats, sprinkler controllers, various control equipment modules, as well as doors opening and closing, alarms…

The most common issues are:

- *Privacy concern:* 8 objects out of 10 (both cloud and mobile application modules) have had problems related to personal consumer data (names, addresses, dates of birth, credit card data, health information…).

[1] http://connected-objects.fr/2014/07/infographie-objets-connectes/
[2] http://www.inc.com/jeremy-quittner/venture-capital-flows-to-gadget-and-hardware.html
[3] http://fortifyprotect.com/HP_IoT_Research_Study.pdf

- *Insufficient authentication:* 80% failed to require passwords of sufficient complexity and length (1234 is a fairly common example). And these deficient passwords can also be found on websites and mobile applications.
- *No encryption:* 70% of the objects do not encrypt the data before transmitting them via the Internet to the control or steering system. Encryption of data in transit on the network is an essential element of security.
- *Insecure Web Interface:* 6 items out of 10 had security problems about their user interface, such as cross-site scripting, poor session management and weak default credentials.
- *Insecure software:* 60% of the objects do not use encryption during software update, which is quite worrying when you consider that these software supports objects.

According to Symantec[1]:

- All activity trackers using the Bluetooth 4.0 Low Energy can be easily geo-located and they all use it.
- At least 20% of mobile applications used with connected objects would not be properly encrypting their data and more than half of the applications would not even post their privacy policy.
- When transmitting data, exchanges can be easily intercepted and the data can then be used for commercial purposes.

3.2 New products to create, changes in habits – startups vs. giants

Needless to say, connecting objects must bring real added value to the user. Some items are unsuccessful because, after the enthusiasm of the first trials, the user fails to feel a real benefit in the connection. Some manufacturers tend to forget it and just content themselves with surfing the wave of the IoT.

However, many connected objects deliver new capabilities, allow new usages, sometimes constitute radically new product categories. Most of these innovations come from startups that have the flexibility to create and promote new brands into our habits. The IoT is a significant field of opportunities for these startups, but they must not waste time, considering the rapid adoption of this market (just have a look on Kickstarter at the dozens of connected tags allowing you to track your keys, bags…).

Major players are also beginning to enter the game. They may bring more confidence than smaller structures in areas where security, maintenance and after-sales service are important in the long term.

3.3 Energy challenge

Connected objects need regular battery recharges or remain AC-powered. The International Energy Agency (IEA) is concerned about excessive consumption and possible electricity production shortages.

According to the IEA, the **cost of consumption** of connected objects was **€59 billion** for the year **2013** and the bill is likely to rise in 2020, reaching €120 billion. In 2013 the **overall consumption** of

[1] http://connected-objects.fr/2014/07/symantec/

these items totaled **616 terawatt-hour** (more than Canada's electricity consumption). They consumed **400 terawatt-hour** just to remain connected in a **standby mode**[1].

An estimated 80% of the electricity consumed by the connected devices is used just to maintain an active Internet connection. This is one of the main conclusions reached by the IEA in its report « More Data : Less Energy » (176 pages, PDF). Overall consumption of connected objects could be reduced by 65% by implementing adequate measures. The future therefore depends on the implementation of energy saving devices throughout the value chain[2].

3.4 Lack of standardization (connections, platforms)

Given the growing number of objects, manufacturers and communication standards that exist in the market, interoperability between devices becomes a real problem. This is particularly true in the market of the connected home where more and more objects of different brands are found, with numerous applications and interfaces to control them.

Recently, the main stakeholders involved in this market created consortia to establish interoperability standards to enable smooth communication among IoT objects[3].

4 Different types of players in the market

4.1 Manufacturers

We will not cite a list of IoT players as they are numerous and there is room for startups.

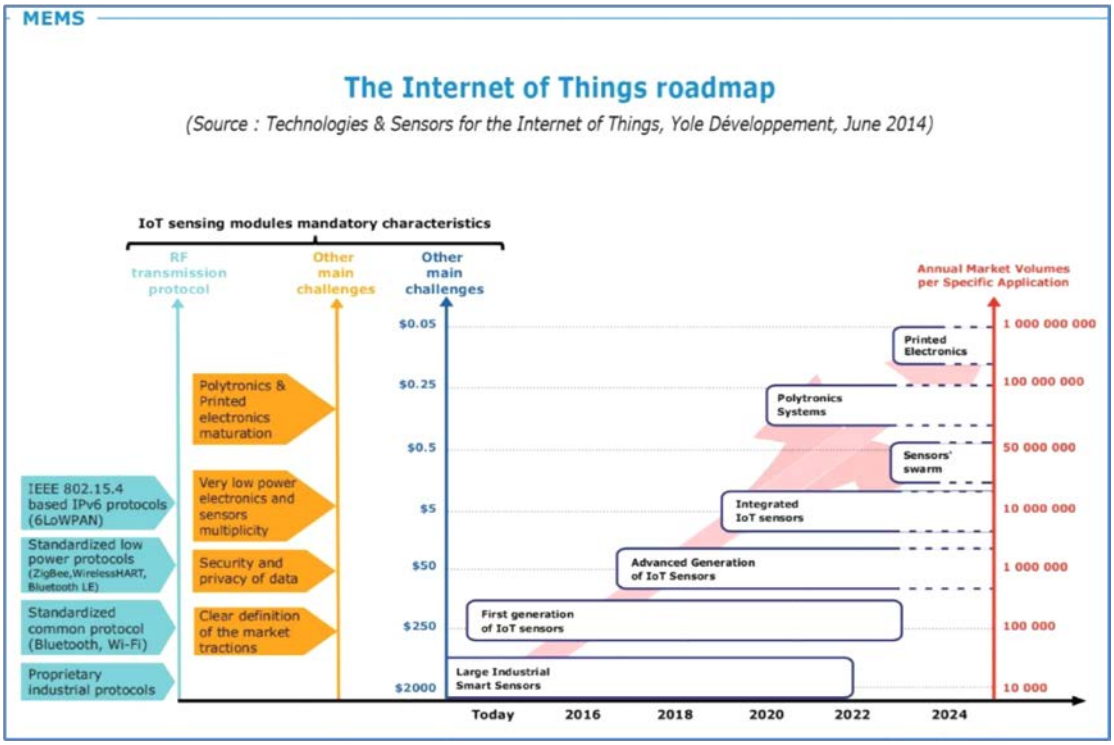
France is a relatively significant player in this field, with companies such as Parrot or Netatmo. At CES 2014, there were more than 30 French companies in the startup village (out of a total of 200 companies).

4.2 Component suppliers

The short-term opportunity lies in the electronics industry. Indeed, very **strong price pressure is expected for IoT devices, and large volumes are expected** but at very **low cost**. Even though the general electronics market will experience a significant growth, it will be through decreased costs, increased manufacturing capabilities and reduced margins. This trend has already been observed in the MEMS field over the past few years, and will repeat in the future (reference here).

According to the above-listed studies, revenues for **devices**, including their components, would be worth **tens of billions of dollars by 2020**.

[1] http://www.objetconnecte.net/objets-connectes-consomment-ils-trop-electricite/
[2] http://connected-objects.fr/2014/07/objets-connectes-electricite/
[3] http://www.forbes.com/sites/amitchowdhry/2014/07/09/samsung-intel-and-dell-launch-internet-of-things-consortium/



With a significant growth, Qualcomm is the leading global supplier of Systems on Chip (SoC) for smartphones in terms of value, while Intel is stagnating. They have strong ambitions in TV, automobiles and connected objects.

Bosch has created a specific company for the IoT: Bosch Connected Devices and Solutions (http://www.bosch-connectivity.com/)

4.3 Companies active in telecommunications and data storage

Large investments in terms of data storage will be needed, but strong price pressure is expected, and an overall low value will be attributed to the physical data. Actually, the war on price has already begun between the major cloud computing companies, which are cutting data storage prices while growing their capabilities (reference here).

4.4 Service companies which value data

On the data processing side, more and more information will be available, and at low cost. Larger the data volume, higher the value, and all this with low overall infrastructural investment. **"Service companies will be the big winners in this field"**. In order to secure some of this value, hardware and cloud companies will have no other choice than trying to integrate vertically in order to valorize themselves and the data they'll be responsible for! (reference here).

According to most studies above, this market segment represents the **largest share** of income of the IoT, valued at **several hundred billion dollars by 2020.**

A typical example, although still relatively taboo today, is the use of data by insurance companies, whether in health (variable premiums based on data provided by the activity trackers of the customers) or vehicle insurance (based on data provided by the vehicle reporting driving style,

distance travelled…). Indeed, some insurers or employers start to offer activity trackers to their subscribers/employees[1].

"There is a Chinese saying that a very good doctor is someone whose patients never get sick in the first place," said Craig Beattie, an analyst in Celent's insurance practice. "That's the opportunity for the IoT. It allows us to monitor data in real time, such that we can prepare for a loss and in some cases prevent it as well," he added[2].

Prevention can of course be valued in the fields of health or agriculture, in our homes (to avoid theft, pipe breaks, reduce consumption…) and much more.

While major players are present (especially with Google Fit, Apple HealthKit), it is possible for a startup to have access to a share of this huge market.

[1] http://www.forbes.com/sites/parmyolson/2014/06/19/wearable-tech-health-insurance/
[2] http://finchannel.com/index.php/business/item/38480-smart-devices-real-time-data-meet-the-future

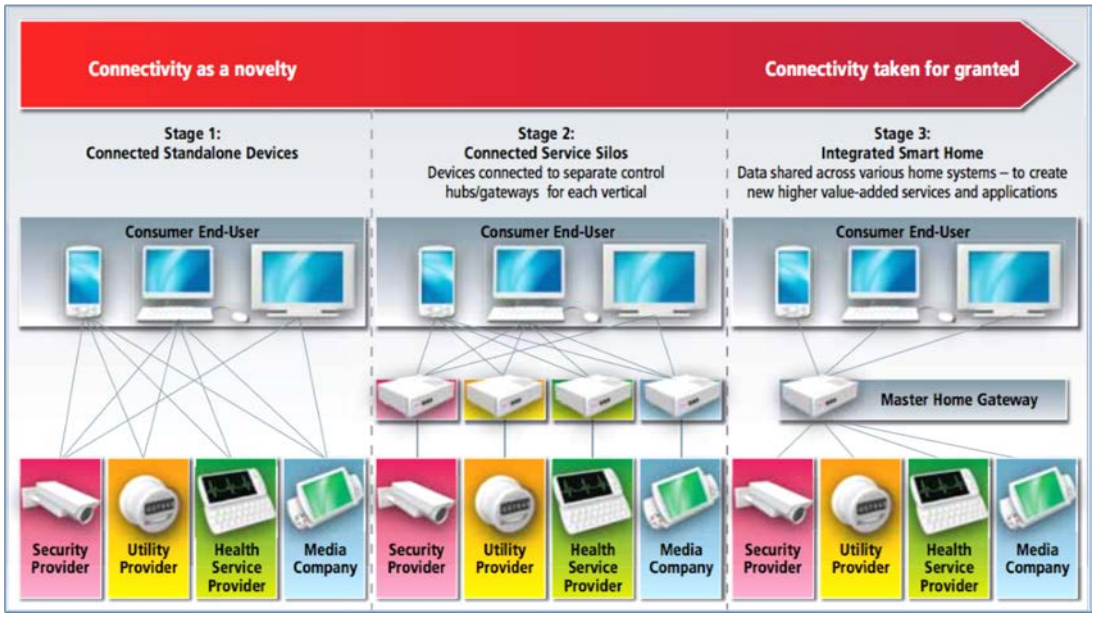
5 Main markets often mentioned

5.1 Home automation / Smart Home

As mentioned in section 3.4, the lack of standard connections and the inability to consistently control all devices is currently a major problem for a simple and effective use in the field of "Smart Home". This problem is limited to date because there are few users owning many connected objects, but the lack of a uniform framework could slow down the development of IoT at home. Initiatives such as the Apple HomeKit could change this trend[1].

GSM Association's prediction[2] is that the connected **home sector** will be a **$44-billion-a-year industry by 2017.**
The long-term direction of the smart home involves numerous connected devices– as many as 30 smart sensors and devices by some estimates – which share a common information highway. This would enable the delivery of a range of value added services to meet consumer lifestyle needs (home energy management, allows security, assisted living etc.).

Smart Home evolution:



Smart meter technology is a strong candidate to initiate the smart home services for the mass-market. This is because regulatory directives in Europe and North America have given smart metering rollouts significant momentum: **72% EU electricity consumers with a smart meter by 2020**[3].

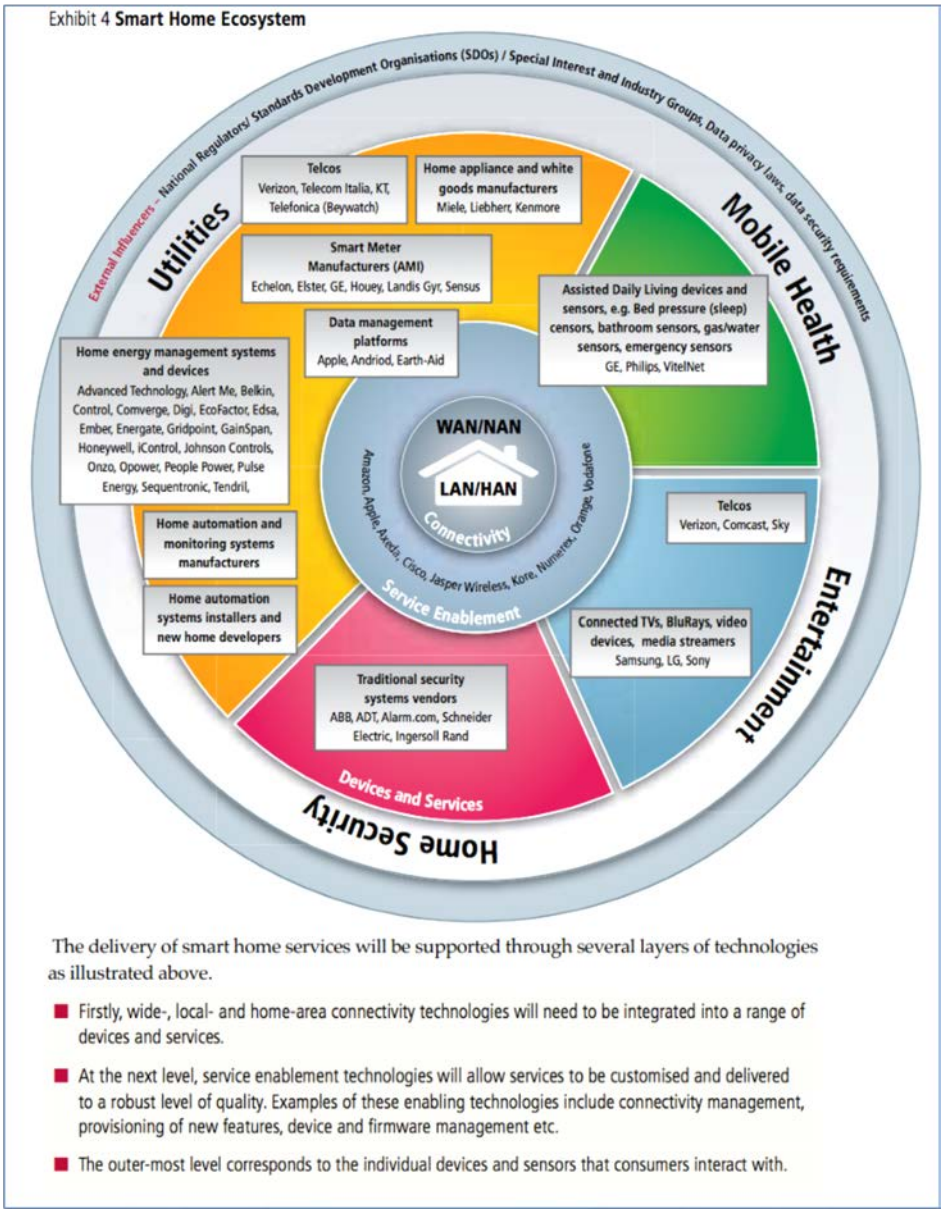
Home energy management (HEM) presents an attractive new growth opportunity for the established security products and services sector. Most home energy management providers offer complete solutions, consisting of connected devices, such as thermostats, smart plugs, in-home

[1] http://www.fastcolabs.com/3034919/how-apple-thinks-about-smart-homes
[2] http://www.gsma.com/connectedliving/wp-content/uploads/2012/03/vision20of20smart20home20report.pdf
[3] http://ec.europa.eu/energy/gas_electricity/smartgrids/smartgrids_fr.htm

displays (IHDs) and energy control hubs, backend systems and end-user portal software. Some of these companies sell directly to consumers, while others sell exclusively to the utilities. No dominant player has emerged in this sector to date.

The telecommunications sector has also begun to address the smart homes opportunity. Many of the early service launches have been based on fixed-line access, taking advantage of telcos' existing base of home broadband gateways and IP TV set top boxes to add home control and monitoring tools. Smart home services have been dubbed the "fifth play", added to telco service portfolios alongside voice, data, TV and mobility.

Smart Home ecosystem :

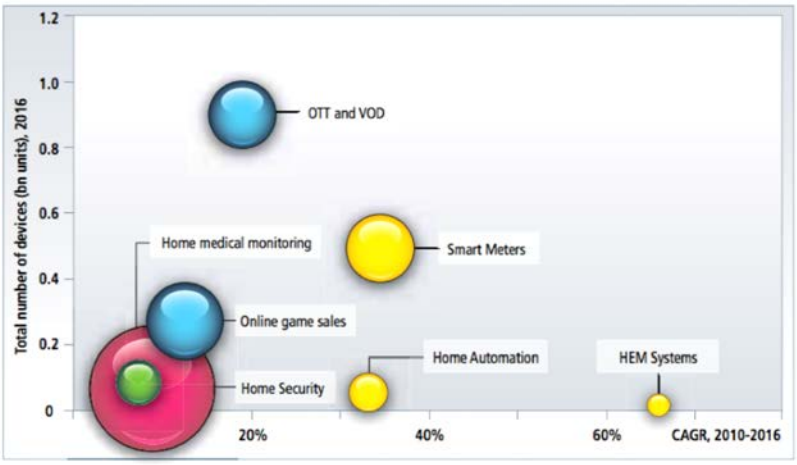


The delivery of smart home services will be supported through several layers of technologies as illustrated above.

- Firstly, wide-, local- and home-area connectivity technologies will need to be integrated into a range of devices and services.
- At the next level, service enablement technologies will allow services to be customised and delivered to a robust level of quality. Examples of these enabling technologies include connectivity management, provisioning of new features, device and firmware management etc.
- The outer-most level corresponds to the individual devices and sensors that consumers interact with.

Revenues and key drivers (including services and communications):

Exhibit 8 **Connected Home Devices and Revenue, 2016**



Smart Metering	Smart Metering	Home Automation	HEM	Home medical monitoring	Home Security	OTT & VOD	Online game sales
CAGR, 2010-2016	34%	33%	65%	7%	8%	20%	12%
Revenue, USD$, 2016	$33bn	$9.50bn	$2bn	$12.4bn	$110bn	$31bn	$37.9bn
Units, 2016	490mn	~50mn systems	12mn home systems	2mn connected home monitoring systems	60mn units	900mn connected TVs	260mn connected consoles

Exhibit 9 **Smart Home: Major Segments, Key Drivers and Value Proposition**

Segment	Sub-Segment	Key Drivers	Key Value Proposition for End-users
Smart Utilities	Smart metering	Regulatory initiatives Drive for efficiency Incorporation of electric vehicles and renewables into the smart grid	Access to historical and current energy and utilities service consumption; Financial incentives
	Home energy management	Regulatory initiatives Growing consumer interest in energy efficiency New interfaces for energy consumption tracking	Life-style improvement, convenience Ability to remotely manage home devices; Energy efficiency
Security and safety	Home alarm and monitoring systems	New functionality: wireless/ M2M capabilities	Increased safety and security; Remote monitoring of the home
Audio-visual and entertainment	Connected TVs, Blu-rays, game consoles, media players	Supply-side push: broadband penetration; new IP-based/OTT media services; viewing devices (smart phones, tablets)	Content packaging and bundling
Healthcare	Assisted Living	Aging population, growing cost of healthcare, need to improve healthcare industry	Access to remotely monitored physiological statistics Life-style improvement, safety and security

A few opportunity ideas (examples here):

- **Energy and Water Use**
  Monitoring energy and water supply consumption to obtain advice on how to save cost and resources.
- **Remote Control Appliances**
  Remotely switching appliances on and off to avoid accidents and save energy.
- **Intrusion Detection Systems**
  Detection of windows and doors openings and violations to prevent intruders.
- **Art and Goods Preservation**
  Monitoring of conditions inside museums and art warehouses.

5.2 Wearables

According to Credit Suisse[1], the market for **wearables** would be so far between $3 and 5 billion and could be worth 10 times more in the next 2 to 3 years, **up to $50 billion**.

The challenge of this market, which includes activities trackers, watches, is that these products are too quickly disregarded because they do not finally meet their use, particularly due to battery issues. Classic watches do not face these problems. These new connected wearables must add such a real value to the user so that he can accept the disadvantage of battery-related restrictions.

A sine qua non for the success of these wearables is the delivery of a real experience for the user, including allowing access to **third party apps**.

According to Crédit Suisse[2], the most likely near-term opportunities will be for corporate marketers and in creating medical and athletic applications that allow people to easily monitor their health. "Say the sensors in your smart sneakers detect that you've nearly worn them out. What if the sneaker brand could send you a coupon the next time you walk by a shoe store?" Marketers could ultimately target individual users based on real-time movements and preferences.

More than in other fields, data confidentiality is of course problematic in the market for wearables and legal and regulatory frameworks are by no means defined.

The full study from Credit Suisse on wearables, dated May 2013, is available here.

Olivier Ezratty indicates in its 2014 CES report[3] that the sales of **smart watches** were 1 million worldwide in 2013, half in the USA. They should reach **four million units in 2017**, two-thirds in the USA. It's probably a too much American-centric vision of the market. It is not clear why the US share would increase over time. History shows that it decreases with every technology, as with smartphones and tablets where growth comes from emerging markets and China. But these data are only predictions and do **not** anticipate **exponential boosting sales** of these watches unlike those tablets.

Nick Hunn[4] thinks that the substitutes of smart watches will be earbuds and headsets. Indeed, the general public already accepts these devices and, as the main usage of smartphones is phone calls

[1] http://www.forbes.com/sites/danmunro/2013/05/19/credit-suisse-says-wearable-tech-the-next-big-thing/
[2] https://www.credit-suisse.com/ch/en/news-and-expertise/news/economy/sectors-and-companies.article.html/article/pwp/news-and-expertise/2013/07/en/the-future-of-wearable-technology.html
[3] http://www.oezratty.net/wordpress/2014/rapport-ces-2014/
[4] https://www.linkedin.com/in/nickhunn

and music listening. This vision could be one of the reasons for Apple's acquisition of Beats Electronics [1] for $3 billion.

> "As well as voice, hundreds of millions of people use their phones for music, as evidenced by the ubiquitous cables trailing from ears. Sound drives the bulk of our technology use and earbuds are the only piece of wearable tech to have gained ubiquity and social acceptance. These devices are about to undergo a revolution in capability, getting rid of their cables and giving them the opportunity to be the standard bearer for wearable technology.
>
> I'm currently writing a new market forecast report for connected consumer wearable technology. It argues that **the biggest potential market for connected wearables will not be for devices we put on our wrists, but the ones we put in our ears.** By 2018 it suggests that we'll be spending over **$5 billion on Hearables**[2]."

Few people realize that the ear is a remarkably good place to measure many vital signs. Unlike the wrist, the ear doesn't move around much while you're taking measurements, which can make it more reliable for things like heart rate, blood pressure, temperature and pulse oximetry. It can even provide a useful site for ECG (electrocardiography) measurement.

Some products have already been demonstrated that take advantage of this. At the Consumer Electronics Show in January, Intel showed some prototype earbuds which incorporate sensors from InvenSense which detect your mood and help select your music based on that. Since then, InvenSense has signed a partnership deal with Sonin – a leader in sub-miniature hearing aid microphone which will leverage InvenSense's MEMS technology. Dublin-based Zinc Software have raised just under $1 million for a heart rate variability (HRV) device for biofeedback, InnerBalance have a similar clip-on. iRiver have a neat set of wired earbuds which include a heart rate sensor using sensor technology from Valencell, and even Apple have jumped into the field with a recent patent application.

Bragi, a German company, has just succeeded in funding their Dash earbuds through a Kickstarter campaign. They've managed to raise over $3.3M.

The founders of Siri are currently working on the VIV project to create artificial intelligence allowing voice to control your smartphone in a much more flexible way than it currently does[3] [4].

5.3 Health

With the emergence of Quantified Self, the boundary between wellness and health will fade.

See the full report of the CNIL (Commission Nationale Informatique et Libertés) at
http://www.cnil.fr/fileadmin/documents/La_CNIL/publications/DEIP/CNIL_CAHIERS_IP2_WEB.pdf

According to the study published by Research2guidance in March 2013: "The market for **mobile health** (mHealth) should represent **$26 billion by 2017** and involve nearly **1.7 billion users**".

[1] http://fortune.com/2014/05/14/a-beats-acquisition-could-be-big-for-apple-hearables/
[2] http://www.nickhunn.com/hearables-the-new-wearables/
[3] http://www.wired.com/2014/08/viv/
[4] http://www.wired.com/2014/09/hearables-needed-to-realize-wearables-nearables/

The potential market of mHealth users will increase from 1 billion in 2012 to 3.4 billion in 2017. The **sale of connected devices or sensors** should represent the second largest source of income with nearly **$5 billion while services will account for more than two-thirds** of those $26 billion[1].

According to McKinsey, connected objects in the field of health could lead to savings of 10-20% in health spending [2].

The questions of data security as well as standards to be met are even more crucial in this sector.

If the application is considered as a medical device, developers will then apply the standards of quality, security and confidentiality of personal health data (e.g. FDA).

In Europe, the general laws of data protection classify health data as "sensitive" information. Using these data is impossible, except in specific cases to save or protect lives for example. In 2008, the Council of EU Telecom Ministers affirmed the need to recognize a "right to silence of the RFID chips". Now they are talking of "right to control".

In England, the National Health Service has opened a portal of applications that offers a selection of apps that are trusted, valued and sorted out by medical relevance.

In Europe, there is unfortunately no official definition of health data.

According to a French study[3], **6 out of 10 health professionals report using mobile applications for their practice**. 35% downloaded these apps because they used them on other media (web, paper, etc.), 24% by searching randomly, 18% because the application had been recommended, 13% because they knew the publisher or the author and 10% because they had seen ads.

Nearly two-thirds (64%) of respondents believe that mobile health applications have become "a must" for their practice (including 24% who believe they are "absolutely" essential and 40% "probably"). The **drug databases are the most downloaded and used apps** (32% and 38%). Continuous education apps are not so much downloaded (1.6%) but are among the most used ones (14%).

In contrast, **only 2% of health professionals have downloaded an application for doctor-patient relationship and only 1% use it**. 60% have never downloaded any application for patients, and only 9% did so to be able to advise them.

According to Cisco, **$106 billion of total Value at Stake**. IoE will enable better-connected devices and data-driven patient management, resulting in improved healthcare effectiveness and efficiencies. Many of the inefficiencies in healthcare today are the result of siloed sources of knowledge and information — it is difficult to access all of the relevant knowledge available at the point of care. In addition, many measurements and tests are administered manually. The greater number of sensors and connections in IoE will allow for shorter hospital stays due to smarter home monitoring systems and improved care from standardized treatments that conform to all known best practices.

[1] http://webdesobjets.fr/les-objets-connectes-quantified-self-prospective/
[2] http://rue89.nouvelobs.com/2014/05/18/encore-gadgets-les-objets-connectes-sauveront-peut-etre-vie-252127
[3] http://www.ticsante.com/story.php?story=1954

IoE value created	Continuous monitoring of health conditions in a less-expensive home setting; all care aspects consolidated and coordinated
Main IoE driver(s)	Asset utilization, supply chain and logistics, and customer experience
Type of IoE connection(s)	Machine-to-machine and machine-to-people
IoE technology enabler(s)	Medical devices, home IT connections, security
Value created or migrated	Both

Connected healthcare and patient monitoring involve a fundamental shift in how healthcare providers deliver their services. Billing and insurance processes will also have to change for this Value at Stake to come to fruition. Given these changes, business leaders will need to focus on both new technology-driven initiatives and change management, while addressing patients' privacy concerns.

Connected objects will allow patients to collect data (blood pressure, digital images) that they can pass on to their physician. Otoscope and dermascope to connect to the smartphone are well underway[1]. This allows patients to examine themselves and notify their doctor for a remote diagnosis that can be better understood by the patient.

See also the publication in French from APSSIS: "Le vademecum des objets connectés dans le domaine de la santé": http://www.apssis.com/#/publications-apssis/4395697

A few opportunity ideas (examples here);

- **Detection**
  Assistance for elderly or disabled people living independent.
- **Medical Fridges**
  Control of conditions inside freezers storing vaccines, medicines and organic elements.
- **Sportsmen Care**
  Vital signs monitoring in high performance centers and fields.
- **Patients Surveillance**
  Monitoring of conditions of patients inside hospitals and in old people's home.
- **Ultraviolet Radiation**
  Measurement of UV sun rays to warn people not to be exposed in certain hours.

In the area of health, we can imagine that implants or patches (such as the solution of medical monitoring Electronic Tattoos[2]) could replace wearables.

5.4 Cars/transport

One counts 35 million commercial vehicles in Europe. By **2016**, there should be **210 million connected vehicles in the world** and **60 billion trips on public transport** each year in **Europe**[3].

The GE approach in the field of railway transport: by making smarter and communicating trains, more trains could run at the same time, increasing the average speed of 15 to 20%[4].

[1] http://www.atelier.net/trends/articles/faire-smartphone-un-kit-aide-medicale_430442
[2] http://www.netexplo.org/media/2013-63-electonictattoos-1.pdf
[3] http://www.itproportal.com/2014/06/07/a-closer-look-at-the-internet-of-things-a-new-industrial-revolution/
[4] http://www.fastcompany.com/3031272/can-jeff-immelt-really-make-the-world-1-better

According to Cisco: **$347 billion of total Value at Stake.**

This use case is based on commercial fleet (ground) vehicles that use an integrated platform of control systems to automate tasks such as navigation, path optimization, and logistics improvements. As vehicles become more connected with their environment (road, signals, toll booths, other vehicles, air quality reports, and inventory systems), efficiencies and safety greatly increase. For example, the driver of a vending-machine truck will be able to look at a panel on the dashboard to see exactly which locations need to be replenished. This scenario saves time and reduces costs.

IoE value created	Reduced time lost in congestion, lower accident rates, lower fuel and repair costs
Main IoE driver(s)	Supply chain and logistics, asset utilization
Type of IoE connection(s)	Machine-to-machine
IoE technology enabler(s)	Telematics, sensors, cloud computing, security
Value created or migrated	Both

5.5 Industrial IoT / M2M

According to Cisco, **$1.95 trillion of total Value at Stake**.

Adding connectivity to manufacturing processes and applications increases factory productivity, reduces inventories with real-time inventory supplies, and cuts average production and supply-chain costs. Smart factories represent one of the two largest use cases in terms of Value at Stake. The value is largely derived from more intelligent machines that incorporate better sensors, improved connectivity to other machines, and more intuitive interfaces with people.

IoE value created	More intelligent design of machines; greater control of instrumentation and production conditions
Main IoE driver(s)	Asset utilization, supply chain and logistics
Type of IoE connection(s)	Machine-to-machine
IoE technology enabler(s)	Machine design tools, production sensors, employee training
Value created or migrated	Migrated from inefficient producers and countries

A few opportunity ideas (examples here):

- **M2M Applications**
  Machine auto-diagnosis and assets control.
- **Indoor Air Quality**
  Monitoring of toxic gas and oxygen levels inside chemical plants to ensure workers and goods safety.

- **Temperature Monitoring**
  Control of temperature inside industrial and medical fridges with sensitive merchandise.
- **Ozone Presence**
  Monitoring of ozone levels during the drying meat process in food factories.
- **Indoor Location**
  Asset indoor location by using active (ZigBee) and passive tags (RFID/NFC).
- **Vehicle Auto-diagnosis**
  Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.
- **Quality of Shipment Conditions**
  Monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes.
- **Item Location**
  Search of individual items in big surfaces like warehouses or harbors.
- **Storage Incompatibility Detection**
  Warning emission on containers storing inflammable goods closed to others containing explosive material.
- **Fleet Tracking**
  Control of routes followed for delicate goods like medical drugs, jewels or dangerous merchandises.
- **Tank level**
  Monitoring of water, oil and gas levels in storage tanks and cisterns.
- **Photovoltaic Installations**
  Monitoring and optimization of performance in solar energy plants.
- **Water Flow**
  Measurement of water pressure in water transportation systems.
- **Silos Stock Calculation**
  Measurement of emptiness level and weight of the goods.

5.6 Smart cities

As more people choose to dwell in urban areas, governments and municipalities will be faced with infrastructural challenges such as creating more cities for residents, as well as being able to equip said cities with the utilities needed to thrive. Aside from the creation of new cities, existing cities should be upgraded in order to accommodate the growing population as well as the need to provide solutions for intelligent transportation, security, energy management, CO_2 emissions, and sustainability or use of renewable energy[1].

This report stated that the global smart cities market is expected to grow **from $654.57 billion in 2014 to $1,266.58 billion by 2019**.

Smart city technologies are being developed to address a range of issues, including energy management, water management, urban mobility, street lighting, and public safety, for example. These innovations are underpinned by general developments in areas such as wireless communications, sensor networks, data analytics, and cloud computing. The smart city concept is

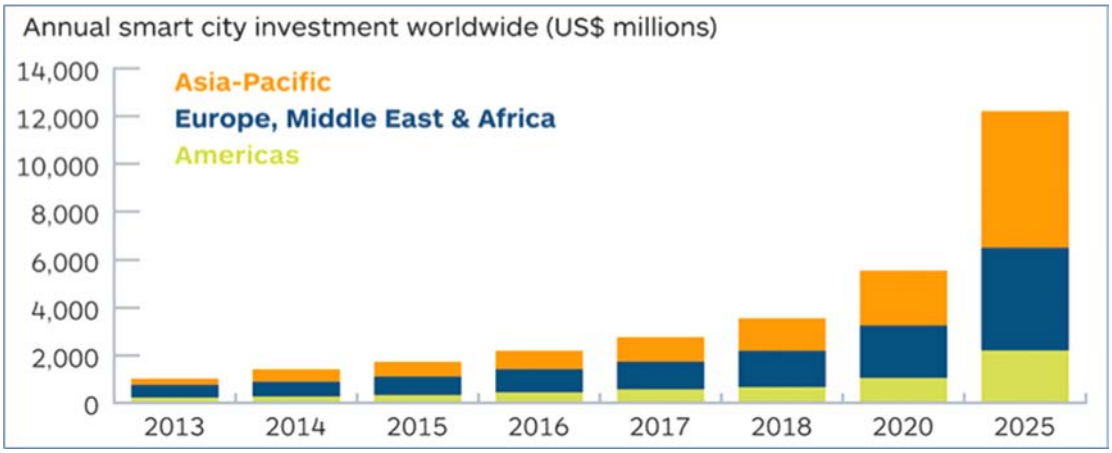
[1] http://siliconangle.com/blog/2014/06/05/smart-city-market-to-reach-1266-58-billion-by-2019-despite-risks/?angle=silicon

also driving new integrated approaches to city operations. Navigant Research forecasts[1] that **global smart city technology revenue will grow from $8.8 billion annually in 2014 to $27.5 billion in 2023**.

There will be at least **88 smart cities all over the world by 2025**, up from 21 in 2013, based on the IHS' definition of a smart city[2]. While the Europe, Middle East and Africa region represented the largest number of smart cities last year, the Asia-Pacific will take over the lead in 2025. In all, the Asia-Pacific will account for 32 smart cities of the total in nine years' time, **Europe will have 31**, and the Americas will contribute 25.

City projects in the Americas are typically somewhat narrower in scope than those found in Europe. Unlike broad projects underway in cities like Vienna or Amsterdam, US projects will often focus on a single functional area, such as mobility and transport.

By 2025, total annual investment is projected to be US$12.2 billion—representing a compound annual growth rate of 23% from 2013 to 2025[3].

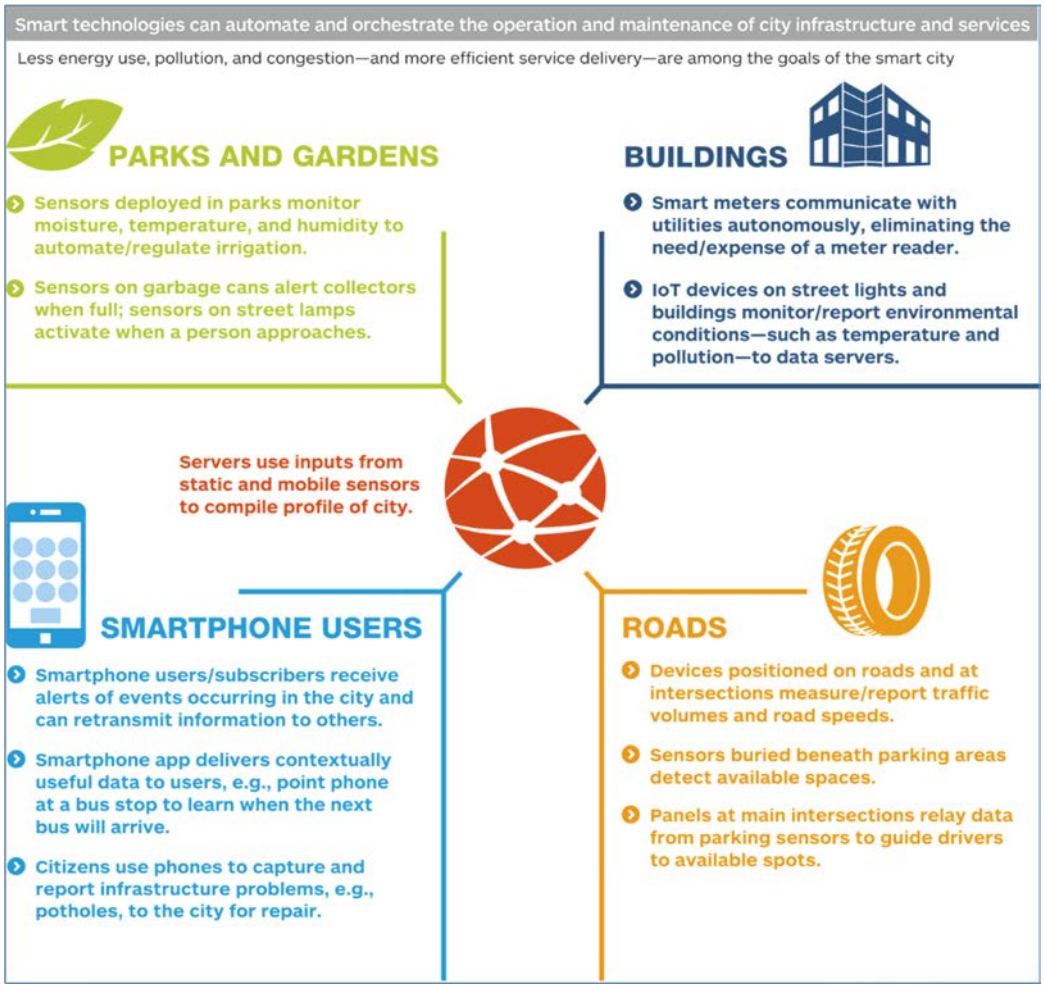


Intelligence is typically evidenced by the ability to integrate information from a variety of sources and make decisions. So far, smart cities are monitoring and automating discrete functions, but none has yet reached the level of integrating these disparate sources of information to such a degree. There are several reasons for this. First is the organizational structure of city governments. Municipalities traditionally operate in silos, with departments overseeing such areas as transportation and public safety that typically don't communicate with each other. Second, private companies involved with smart city projects are often focused on only one piece of technology or service—the one that will produce commercial profits.

As the burgeoning Internet of Things increases the capacity to make cities smart, the **challenge** will be to bridge those gaps and **form a single platform across all services and departments**. Without it, smart cities may see improvements in individual sectors, but will struggle to attain the overall efficiency, cost reductions, and other benefits they seek. For example, reducing energy consumption and improving overall sustainability requires data from many sectors. The system

[1] http://www.marketwatch.com/story/smart-cities-2014-08-19
[2] http://www.khaleejtimes.com/kt-article-display-1.asp?section=uaebusiness&xfile=data/uaebusiness/2014/august/uaebusiness_august13.xml
[3] http://www.ihs.com/tl/quarterly/features/connecting-tomorrow-cities.aspx

needs to collect and integrate data from utilities, physical infrastructure (both public and private), and transportation (such as buses and subways as well as privately owned cars and bicycles).



A challenge that smart city planners face is determining the long-term business model. Most projects are public-private collaborations involving hardware and software vendors, telecommunications carriers, and local, regional, and national governments. While integration is key, it's not likely to happen unless business models are clarified. Who will own the data? How will it be monetized?

IHS divides the **business models for smart cities into three categories: build-operate-transfer (BOT), build-operate-comply (BOC), and municipal-owned-deployment (MOD).** The most common is BOT, in which the city works with an external private partner. The partner develops the services, deploys the infrastructure, and handles all operations, at least until such time that they are transferred back to the city.

In the BOC model, the city provides a more open environment, creating a platform for development and allowing private entities to build services atop it as long as they agree to certain regulations and funding levels. The third parties are entirely responsible for deploying infrastructure and operating the services.

Under MOD, which is rarely used, the city takes responsibility for the entire project, deploying infrastructure and developing and operating services.

In terms of smart cities, **India** is certainly one of the most ambitious countries[1]. A significant portion of Google alerts on smart cities refers to Indian news!

The garbage bin sensor firm Enevo gives away connected "ONe" sensor units to waste management firms, so they can measure volume, temperature and so on. Enevo then manages the resulting data for them, so they can optimize waste collection routes and intervals[2].

A few opportunity ideas (examples here):

- **Smart Parking**
  Monitoring of parking spaces availability in the city.
- **Structural health**
  Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.
- **Noise Urban Maps**
  Sound monitoring in bar areas and centric zones in real time.
- **Smartphone Detection**
  Detect iPhone and Android devices and in general any device which works with WiFi or Bluetooth interfaces.
- **Electromagnetic Field Levels**
  Measurement of the energy radiated by cell stations and and WiFi routers.
- **Traffic Congestion**
  Monitoring of vehicles and pedestrian levels to optimize driving and walking routes.
- **Smart Lighting**
  Intelligent and weather adaptive lighting in street lights.
- **Waste Management**
  Detection of rubbish levels in containers to optimize the trash collection routes.
- **Smart Roads**
  Intelligent Highways with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

Of course, one of the challenges for startups in the field of smart cities is the heaviness of **public procurement**. But being a subcontractor of private partners involved in this sector could offer interesting opportunities given the **size of the market**.

5.7 Agriculture/environment

Through a subsidiary, agribusiness giant Monsanto uses internet-connected sensors to capture everything from meteorological information and the size of crop yields to the water-holding capacity of soil. It can then draw on this big data to offer farmers targeted insurance policies – and to determine whether they're likely to have experienced a loss and settle a claim. In fact, the Kenyan microinsurance scheme, Kilimo Salama, is turning your typical claims process on its head by

[1] http://www.forbes.com/sites/girijapande/2014/08/26/building-100-smart-cities-in-india-can-singapore-seize-this-once-in-a-lifetime-opportunity/
[2] http://gigaom.com/2014/08/28/garbage-measuring-sensor-firm-enevo-pulls-in-another-8m-in-funding/?utm_source=GeneralUsers&utm_campaign=c2a4f829c4-c:sci,mob,tec,cld,dta,mda,socd:08-28&utm_medium=email&utm_term=0_1dd83065c6-c2a4f829c4-99685697

embracing "connected" agriculture. Really, there is no "claims" process. Automated, IP-based weather sensors record if, for example, rainfall is 15% below the average, a payout is calculated, and the amount owed to farmers is then sent to their mobile phones, according to Lloyd's (see here).

While the impact in this area is less quantified (or included in M2M or industrial IoT), it is nevertheless very important, especially with the weather impact on crops and therefore on revenue. Information gathering is crucial for agriculture.

A few opportunity ideas (examples here):

- **Forest Fire Detection**
  Monitoring of combustion gases and preemptive fire conditions to define alert zones.
- **Air Pollution**
  Control of CO_2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.
- **Snow Level Monitoring**
  Snow level measurement to know in real time the quality of ski tracks and allow security corps avalanche prevention.
- **Landslide and Avalanche Prevention**
  Monitoring of soil moisture, vibrations and earth density to detect dangerous patterns in land conditions.
- **Earthquake Early Detection**
  Distributed control in specific places of tremors.
- **Potable water monitoring**
  Monitor the quality of tap water in cities.
- **Chemical leakage detection in rivers**
  Detect leakages and wastes of factories in rivers.
- **Swimming pool remote measurement**
  Control remotely the swimming pool conditions.
- **Pollution levels in the sea**
  Control real-time leakages and wastes in the sea.
- **Water Leakages**
  Detection of liquid presence outside tanks and pressure variations along pipes.
- **River Floods**
  Monitoring of water level variations in rivers, dams and reservoirs.
- **Wine Quality Enhancing**
  Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.
- **Green Houses**
  Control microclimate conditions to maximize the production of fruits and vegetables and its quality.
- **Golf Courses**
  Selective irrigation in dry zones to reduce the water resources required in the green.
- **Meteorological Station Network**
  Study of weather conditions in fields to forecast ice formation, rain, drought, snow or wind changes.
- **Compost**
  Control of humidity and temperature levels in alfalfa, hay, straw, etc. to prevent fungus and other microbial contaminants.

6 Possible business models in the IoT

6.1 Change of mindset

THE INTERNET OF THINGS REQUIRES A MINDSET SHIFT
Because you'll create and capture value differently.

		TRADITIONAL PRODUCT MINDSET	INTERNET OF THINGS MINDSET
VALUE CREATION	Customer needs	Solve for existing needs and lifestyle in a reactive manner	Address real-time and emergent needs in a predictive manner
	Offering	Stand alone product that becomes obsolete over time	Product refreshes through over-the-air updates and has synergy value
	Role of data	Single point data is used for future product requirements	Information convergence creates the experience for current products and enables services
VALUE CAPTURE	Path to profit	Sell the next product or device	Enable recurring revenue
	Control points	Potentially includes commodity advantages, IP ownership, & brand	Adds personalization and context; network effects between products
	Capability development	Leverage core competencies, existing resources & processes	Understand how other ecosystem partners make money

SOURCE SMART DESIGN HBR.ORG

6.2 4 examples of business models[1] [2].

6.2.1 Hardware as a Service (HaaS)

Revenue model based on a subscription.

[1] http://connected-objects.fr/2014/07/business-modeles/
[2] http://fr.slideshare.net/elephantsandventures/hardware-startup-financing

6.2.2 Hardmium

*Software service where a **hardware device** is the **premium feature**.*

The customer purchases a device but the value comes from the hardware-service combination.

Another example is the Amazon Dash scanner solution to scan your shopping and have it shipped by Amazon. You buy the scanner in order to receive the delivery.

6.2.3 Hardware as a Platform

Model based on hardware-derived revenues generated by apps.

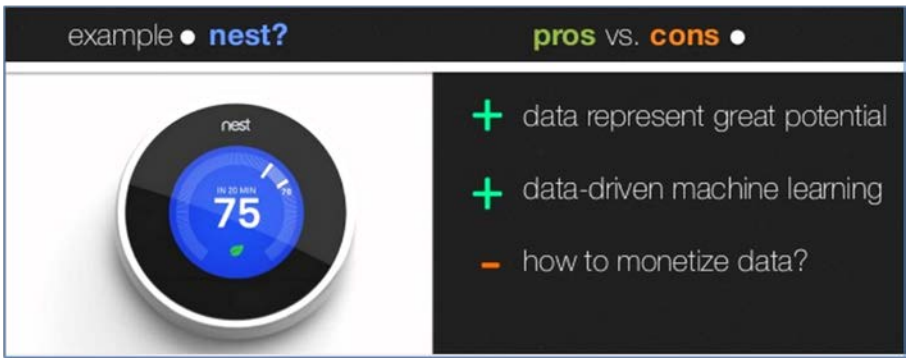
The connected object is intended to provide a new functionality or technical capacity in order to create an ecosystem of users and developers. The creation of such a community often leads to a platform allowing developers to meet and create applications for users, who buy them to improve the product acquired in the first place. In HAAP business model, revenues are generated by the ecosystem around the product.

Leap Motion is a small box with gesture control capabilities for your electronics. With Leap Motion you can control your devices using movements, and there are many applications available for the user community who acquired the sensor for $89 initially.

6.2.4 Hardata

Monetization of data collected by a hardware device.

This model is usually very profitable given the quantity and value of the data, but it is also the most controversial.



7 Conclusions

Although some amounts mentioned in this report are very different from each other, it is however clear that the IoT will be an important market, probably the next revolution after the personal computer and the mobile phones. The IoT market is emerging, with a bright future, but is still in its very early stages.

Many companies enter the market every day, from startups to giants. It is therefore probably easier for startups to take a position now than in a few years. The future is getting ready today!

The big market is linked to the **use of data**. This is where the added value is the most important.

It is clearly in the **industrial sector** that the expected revenues are the most substantial. The **smart cities** should not be overlooked although more difficult to access (heavy and slow public procurement). Finally, health is a very important market too but quite complex due to the regulation and the risk of privacy issues.

For the general public, one can also think that, given the flood of objects currently available (and that's just the beginning) with a unique function, the most **generic products** may be the ones that will survive in the future if they manage to concentrate more utility and value.

If you need to remember a few words only, focus your startup on:

- the most generic products
- that collect a maximum of data,
- and provide a service with real value (do not connect any object to follow the trend)
- in markets where the savings will be significant (industries, cities, health, agriculture…).