<https://thingspeak.com/channels/54792/api_keys>

Dr. Aung Win Htut test channel 'field1': cpu\_pc, 'field2': mem\_avail\_mb,

write

UVSEK1MB57YHIBFW

read

RUDTAHF3T4UFLJCY

<https://api.thingspeak.com/update>

<https://api.thingspeak.com/update?key=UVSEK1MB57YHIBFW&cpu_pc=22&mem_avail_mb=22>

အင္ဂ်င္နီယာ ပညာေရးတြင္ အိုင္တီနည္းပညာ၏ အခန္းက႑

အိုင္တီနည္းပညာ ေပါင္းကူး

embedded system

stand alone ထက္ ခ်ိတ္ဆက္ထားတာ ပိုအစြမ္းထက္တယ္

Data loging

Remote Control and Monitoring

Input Sesor reading

တင္း ရည္ လုပ္ အုပ္ ဆက္

အင္ ေက်ာင္းသားမ်ားအေနျဖင္႔ ကိုယ္တိုင္ေလ႔လာရန္လို

ကြန္ပ်ဴတာ တစ္လံုး ဘယ္လို အလုပ္လုပ္လဲ

ဘယ္လို တည္ေဆာက္မလဲ

EC ေက်ာင္းသားမ်ားအတြက္ assembly language

IoT

Internet of Things(IoT) ကို Internet of Everything သို႔မဟုတ္ Network of Everything ဟုလည္း ေခၚဆိုၾကပါသည္။ သာမန္ ေန႔စဥ္သံုး လူသံုးပစၥည္းမ်ားတြင္ အီလက္ထေရာနစ္ပစၥည္းမ်ား၊ ေဆာ႔ဖ္ဝဲမ်ား၊ အာရံုခံ ကိရိယာမ်ားႏွင္႔ ကြန္ယက္ခ်ိတ္ဆက္သည္႔ ပစၥည္းမ်ား (embedded) ျမွပ္ႏွံထည္႔သြင္းထားကာ သတင္းအခ်က္အလက္မ်ား ဖလွယ္ႏိုင္ရန္ အခ်င္းခ်င္း (သို႔) အင္တာနက္ျဖင္႔ ကြန္ယက္ခ်ိတ္ဆက္ထားျခင္း ျဖစ္သည္။ ဤနည္းျဖင္႔ အရာဝတၳဳမ်ားကို ကြန္ယက္မွတဆင္႔ အေဝးမွ ခ်ိတ္ဆက္ကာ ထိန္းခ်ဳပ္ႏိုင္မည္ျဖစ္သည္။ ထို႔ေၾကာင္႔ လူသံုးကုန္ ပစၥည္းမ်ားႏွင္႔ ကြန္ပ်ဴတာ အေျချပဳ စနစ္မ်ားအၾကား တိုက္ရိုက္ ခ်ိတ္ဆက္ ေပါင္းစည္းေပးႏိုင္ၿပီး အရည္အေသြးႏွင္႔ စြမ္းေဆာင္မႈ၊ တိက်မႈ ႏွင္႔ စီးပြားေရးတြက္ေျခကိုက္မႈ စေသာ အက်ိဳးေက်းဇူးမ်ား ရရွိခံစားႏိုင္မည္ ျဖစ္ပါသည္။ IoT မ်ားတြင္ ပါဝင္ေသာ embedded computing system မ်ားမွတဆင္႔ ခြဲျခား သတ္မွတ္ႏိုင္မည္ ျဖစ္ၿပီး အင္တာနက္ႏွင္႔ အျပန္အလွန္ခ်ိတ္ဆက္ႏိုင္စြမ္း ရွိပါသည္။ ကၽြမ္းက်င္သူမ်ား၏ ခန္႔မွန္းခ်က္အရ ၂၀၂၀ ခုႏွစ္တြင္ IoT ေပါင္း ဘီလီယံ ၅၀ ခန္႔ ရွိလာမည္ ျဖစ္ပါသည္။ IoT ဟူေသာ စကားလံုးကို ၿဗီတိသွ် စြန္႔ဦးတီထြင္ ပညာရွင္တစ္ဦးျဖစ္သူ Kevin Ashton က ၁၉၉၉ ခုႏွစ္တြင္ တီထြင္ေခၚဆိုခဲ႔ျခင္း ျဖစ္သည္။ IoT တြင္ အဆင္႔ျမင္႔ ကြန္ယက္ နည္းပညာသံုး ပစၥည္းမ်ား၊ စနစ္မ်ားႏွင္႔ ဆားဗစ္မ်ား ပါဝင္ၿပီး machine-to-machine communications (M2M) ထက္ ပိုမိုအဆင္႔ျမင္႔မားပါသည္။ ပရိုတိုေကာမ်ားစြာကို ကိုင္တြယ္လုပ္ေဆာင္ႏိုင္ၿပီး နယ္ပယ္အသီးသီးႏွင္႔ အသံုးခ်ႏိုင္စြမ္း က်ယ္ျပန္႔လွေပသည္။

အဆိုပါ embedded devices မ်ား အခ်င္းခ်င္း ခ်ိတ္ဆက္ထားျခင္းျဖင္႔ နယ္ပယ္အမ်ားစုတြင္ အလိုအေလ်ာက္ လုပ္ကိုင္ႏိုင္စြမ္း ရွိလာမည္ဟု ေမွ်ာ္လင္႔ထားၾကသည္။ အထူးသျဖင္႔ စြမ္းအင္တိုင္းတာျခင္းႏွင္႔ စြမ္းအင္ထုတ္လုပ္ ထိန္းခ်ဳပ္သံုးစြဲမႈမ်ားတြင္ smart meters, smart appliances, renewable energy resources ႏွင္႔ energy efficiency resources မ်ား အသံုးခ်ႏိုင္သည္႔ Smart Grid မွ အစိုးရ၏ စီမံခန္႔ခြဲမႈႏွင္႔ အုပ္ခ်ဳပ္မႈ လုပ္ငန္းမ်ား၊ သယ္ယူပို႔ေဆာင္ေရးႏွင္႔ ယာဥ္ေၾကာထိန္းသိမ္းေရးလုပ္ငန္းမ်ား၊ စြမ္းအင္က႑၊ က်န္းမာေရး ျပဳစုေစာင္႔ေရွာက္မႈ၊ ေရႏွင္႔ ေရဆိုး ဆိုင္ရာ စီမံခန္႔ခြဲမႈမ်ား ပါဝင္သည္႔ Smart City အသံုးခ်မႈမ်ားအထိ က်ယ္ျပန္႔လာႏိုင္ေပသည္။ ဤသို႔ျဖင္႔ အနာဂတ္တြင္ ဒီဂ်စ္တယ္ၿမိဳ႕ျပ စီမံကိန္းမ်ား ေပၚထြန္းလာႏိုင္ေပသည္။ IoT တြင္ ေမြးျမဴထားေသာ တိရိစာၦန္မ်ားအတြင္း ျမွပ္ႏွံ ထည္႔သြင္းေပးထားသည္႔ တည္ေနရာညႊန္ျပေပးႏိုင္ေသာ biochip transponders မ်ား အပူအာရံုခံကိရိယာမ်ားမွ ေနာက္ဆံုးေပၚ အပူေပးစက္၊ အဝတ္ေလွ်ာ္စက္၊ ေရခဲေသတၱာ၊ အေျခာက္ခံစက္မ်ား၏ ဝါယာလက္ ကြန္ယက္ ပါဝင္ေသာ smart thermostat စနစ္မ်ား အထိ ေစ်းကြက္က်ယ္ျပန္႔စြာ ေပၚေပါက္လာေပသည္။

သမိုင္း

၂၀၁၄ ခန္႔မွာ ဝါယာလက္ ဆက္သြယ္ေရးႏွင္႔ အင္တာနက္အပါအဝင္ embedded system မ်ားႏွင္႔ micro-electromechanical systems (MEMS) နည္းပညာမ်ား အလြန္လွ်င္ျမန္စြာ ထြန္းကားလာျခင္းႏွင္႔ အတူ Internet of Things အတြက္ လမ္းစမ်ား ေပၚေပါက္လာခဲ႔သည္။ ထို႔ေၾကာင္႔ သမားရိုးက် embedded system နည္းပညာမ်ား၊

//////////////

ကၽြန္ေတာ္တို႔ ဘဝမွာ အခ်ိန္ေတြက တျဖည္းျဖည္း ရွားပါးလာေနပါတယ္။ အမ်ားစုအေနနဲ႔ Social Media ေတြျဖစ္တဲ႔ Facebook နဲ႔ Twitter ေတြမွာ အခ်ိန္အမ်ားအျပား သံုးစြဲလာေနၾကပါတယ္။ ကၽြန္ေတာ္တို႔ ဘဝကို ပိုမို စမတ္က်ေအာင္ျပဳလုပ္ႏိုင္ဖို႔ Gadgets ေတြ Wearables ေတြ အသံုးျပဳလာၾကပါတယ္။ ဆက္သြယ္ေရး နည္းလမ္းေပါင္းစံုနဲ႔ ကိရိယာေပါင္းစံုကို အသံုးျပဳလာၾကပါတယ္။

အဲဒီ IoT ေလးေတြဟာ အင္တာနက္ထဲမွာ အခ်င္းခ်င္း ခ်ိတ္ဆက္ထားၾကပါတယ္။ ကမာၻႀကီးရဲ႕ အာရံုေၾကာ စနစ္လိုမ်ိဳး အားလံုး တစ္ခုနဲ႔ တစ္ခု ဆက္စပ္တည္ရွိေနၾကတာ ျဖစ္ပါတယ္။ အာရံုခံ ကိရိယာေတြ ေနရာအႏွံ႔အျပားမွာ တပ္ဆင္ထားၾကၿပီး Real-Time data ေတြကို အခ်ိန္နဲ႔ တေျပးညီ ရယူေနၾကတာ ျဖစ္ပါတယ္။ IoT ကိရိယာ တစ္ခုခ်င္းစီမွာ သီးသန္႔ ID တစ္ခုစီ သတ္မွတ္ေပးထားတာျဖစ္လို႔ အခုလို ခ်ိတ္ဆက္ႏိုင္တာ ျဖစ္ၿပီး Machine to Machine (M2M) commutication လို႔လဲ သတ္မွတ္ႏိုင္ပါတယ္။ ဒါေၾကာင္႔ IoT ကိရိယာ တစ္ခုနဲ႔ တစ္ခုအၾကား သတင္းအခ်က္အလက္ေတြ ဖလွယ္ႏိုင္လာတာ ျဖစ္ပါတယ္။ ကမာၻႀကီးေပၚက မေရမတြက္ႏိုင္ေအာင္ မ်ားျပားလြန္းလွတဲ႔ ကိရိယာေတြကို သီးသန္႔လိပ္စာေတြ သတ္မွတ္ေပးဖို႔ရာ အခက္အခဲရွိႏိုင္မလားလို႔ စဥ္းစားစရာ ျဖစ္လာပါတယ္။ IPv6 ကို အသံုးျပဳျခင္းအားျဖင္႔ လိပ္စာေပါင္း 2^128 = 340282366920938463463374607431768211456 ကို ဖန္တီးေပးမွာျဖစ္တဲ႔အတြက္ ေကာင္းေကာင္းႀကီး လံုေလာက္မွာ ျဖစ္ပါတယ္။ ေနာက္ထပ္ ျပႆနာ တစ္ခုကေတာ႔ အဲဒီလို မ်ားျပားလြန္းလွတဲ႔ ကိရိယာေတြက ေပးပို႔လိုက္တဲ႔ အခ်က္အလက္ေတြကို ဘယ္လို ကိုင္တြယ္ေျဖရွင္းမလဲ၊ analyze လုပ္ၿပီး သိမ္းဆည္းမလဲ ဆိုတာပါပဲ။ သာမန္ USB stick ေတြ HardDisk ေတြနဲ႔ သိမ္းလို႔ေတာ႔ ဘယ္လိုမွ မျဖစ္ႏိုင္ပါဘူး။ တစ္ခုတည္းေသာ နည္းလမ္းက Cloud ကို အသံုးျပဳဖို႔ပါပဲ။ ဒါေၾကာင္႔လဲ Dropbox, pcloud google drive skydrive အစရွိတဲ႔ ကုမၸဏီ အေတာ္မ်ားမ်ားက cloud space အခ်ိဳ႕ကို ကန္႔သတ္ၿပီး အခမဲ႔ ေပးထားျခင္းျဖင္႔ အသံုးျပဳသူေတြကို ဆြဲေဆာင္ စုစည္းထားရွိပါတယ္။ မၾကာခင္မွာပဲ အခမဲ႔သံုးေနသူေတြအေနနဲ႔ သူတို႔ ရရွိေနတဲ႔ အခမဲ႔ cloud space ေတြ မလံုေလာက္ေတာ႔တာေၾကာင္႔ ပိုက္ဆံေပးၿပီး သံုးရတဲ႔အျပင္ အဲဒီ ကုမၸဏီေတြကို မွီခိုလာရေတာ႔မွာ ျဖစ္ပါတယ္။ ေနာက္တစ္ဆင္႔က အဲဒီ အခ်က္အလက္အေျမာက္အမ်ားကို analytics ျပဳလုပ္ၿပီး Solution နဲ႔ ထိုးထြင္းသိလိုက္ရတဲ႔ အသိဥာဏ္ေတြကို ရရွိႏိုင္မွာ ျဖစ္ပါတယ္။ ဒါေၾကာင္႔ ကၽြန္ေတာ္တို႔ရဲ႕ လူေနမႈ ဘဝ ေျပာင္းလဲလာႏိုင္ပါတယ္။ ကၽြန္ေတာ္တို႔ အသံုးျပဳေနတဲ႔ စနစ္ေတြ ပိုၿပီး ထိေရာက္လာသလို စမတ္က်လာမွာ ျဖစ္ပါတယ္။ ခက္ခဲနက္နဲတဲ႔ အသိဥာဏ္သံုးရတဲ႔ ဆံုးျဖတ္ခ်က္ေတြကို လူသားေတြက ခ်မွတ္ေပးစရာ မလိုေတာ႔ဘဲ စက္ကိရိယာေတြက အလိုအေလ်ာက္ ျပဳလုပ္ေပးႏိုင္မွာပဲ ျဖစ္ပါတယ္။ အေလအလြင္႔ေတြ၊ မလိုလားအပ္တဲ႔ ျပႆနာေတြလဲ ျဖစ္လာမွာ မဟုတ္ေတာ႔ပါဘူး။ လူသားေတြ ရဲ႕ တီထြင္မႈဟာ လူသားေတြကို ပိုမိုအားေကာင္းၿပီး စမတ္က်ေအာင္ ျပဳလုပ္ေပးမွာပဲ ျဖစ္ပါတယ္။ IoT ေတြက ကၽြန္ေတာ္တို႔ လူ႔အဖြဲ႕အစည္းေတြကို ႀကီးမားတဲ႔ ရိုက္ခတ္မႈ ျဖစ္လာေစမွာ ေသခ်ာပါတယ္။ ဒါေၾကာင္႔ အဲဒီအတြက္ ႀကိဳတင္ျပင္ဆင္ထားဖို႔ လိုအပ္လာမွာ ျဖစ္ပါတယ္။

စြမ္းအင္ ေခၽြတာ

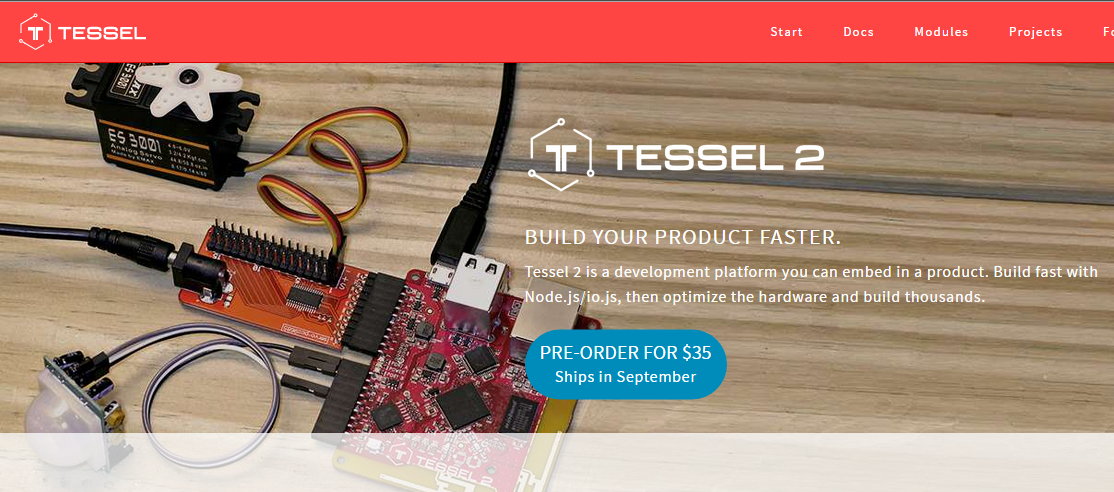
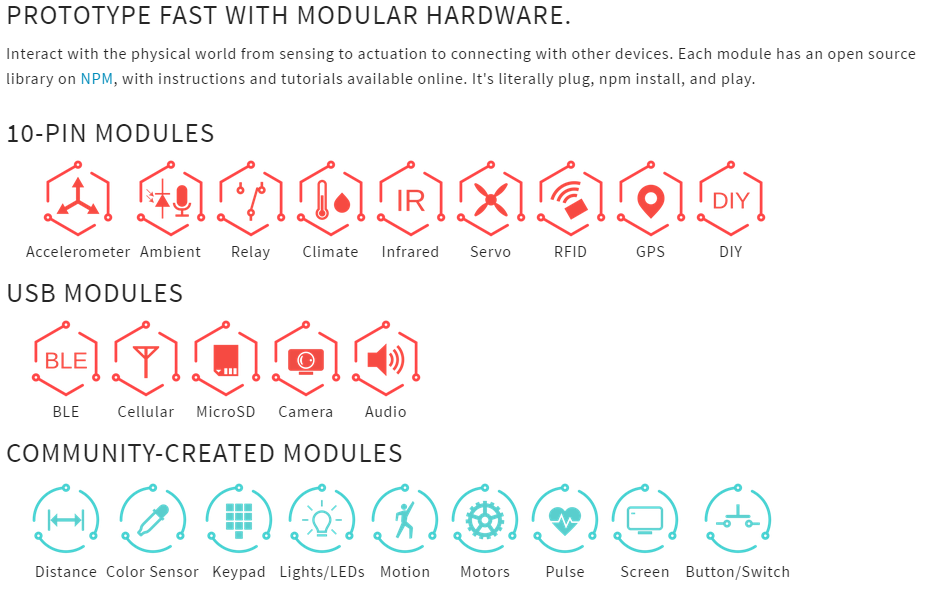
လယ္သမား

ကား

တာမီေနတာလိုမ်ိဳး ျဖစ္လာႏိုင္မွာလား

**လိုအပ္ခ်က္မ်ား**

Hardware

1. Raspberry Pi
2. Arduino
3. Wireless and other communication Devices
4. 
5. 

Software

1. IoT framework (Windows 10)
2. Open source Hardware
3. **ThingSpeak**
4. ThingSpeak is an open source “Internet of Things” application and API to store and retrieve data from things using HTTP over the Internet or via a Local Area Network. With ThingSpeak, you can create sensor logging applications, location tracking applications, and a social network of things with status updates.
5. https://thingspeak.com/

Thing ဆိုတာ အာရံုခံ ကိရိယာ သို႔မဟုတ္ actuator ေတြကို ဆိုတာတာ။ Thermometer, Thermostat

IoT က အားလံုးကို စုစည္းထားတာေၾကာင္႔ အျပန္အလွန္ ဆက္သြယ္လို႔ရတယ္။ Thing က app အခ်ိဳ႕နဲ႔ ခ်ိတ္ဆက္ စကားေျပာ ဆက္သြယ္

ThingSpeack က data collection engine

အိမ္မွာ မီးမပိတ္ဘဲ ထားခဲ႔မိတာကိုလည္း ျပေပးမယ္။

API ေတြကို အိမ္သံုး PC သို႔ ကိုယ္ပိုင္ ဆာဗာေပၚတင္ၿပီး data processing ျပဳလုပ္ႏိုင္တယ္

ဒီနည္းနဲ႔ အာရံုခံ ကိရိယာေတြက ရတဲ႔ raw data ေတြအစား ပိုမို အဓိပၸါယ္ျပည္႔စံုတဲ႔ သတင္းအခ်က္အလက္ေတြ အျဖစ္ ရရွိမယ္။ Data visualization

Open data platform for the internet of things

ta platform for the Internet of Things

1. Structure : includes sensors, actuators , controls, nodes , connected media, host, apps, data, data-set and frameworks. It is a group of hardware, software, software frameworks and communication technology
2. for sensors, control and node, Arduino is the first step to learn, it can done from simple to complex system due to skills
3. Next step is Pi, linux of windows 10 IOT core is base OS, python is a recommended programming language for this. scope is not limited and PHP, java and other serverside prog like node.js are also a good choice for programming
4. 3) the communication method can be started from simple P2P PAN like bluetooth and also WiFi. Then extended to use interconnection like 2G/3G or relay from wifi connection.
5. 4) when system is connected to internet, we need a server host to relay our data to everywhere. The hardest part is most hardware engineer don't know web/network programming and most software programmer don't know how to setup hardware. But no problem at all, there are complete frame works to use. Example iot websites : <https://thingspeak.com/> [www.nimbits.com/](http://www.nimbits.com/) <http://www.smartliving.io/><http://www.thingworx.com/>
6. 5) There will be a control+monitor program for your devices, the control app for your in hand monitoring and control. Android is the best. Try to learn Android programming and build your self. If you dont want to reinvent the wheel, there are many ready made apps. You can also check abobe web sites for this.
7. For a simple system without connecting interent, Android phone + Arduino and some sensors, actuatorsand some programming will do the job.<http://www.buildinginternetofthings.com/list-of-projects/>
8. After this, try connect your devices to internet with wifi modules or 2G/3G modem board. There are many example here. <http://postscapes.com/internet-of-things-award/open-source/>
9. then, switch to resberry Pi. Android + Arduino + Pi will give you a real complete IoT system. check here <https://microsoft.hackster.io/en-US>
10. the real world problem of IoT is security. The problem for us is infrastructure and budgets. How a hobbyist or student can expenses cozy devices (really these devices are not expensive, our stupid import rule, tax and pure logistics system added extra cost for this ) and pricey internet fee.

For the last several years, I have been collecting data with ThingSpeak from devices all around my house. I have been tracking temperature, humidity, light levels, outside weather data, my deep freezer’s temperature, the state of [My Toaster](https://twitter.com/mytoaster), and air quality metrics. I just recently started to think about what all of this data really means to me and if it’s good data to begin with. Wouldn’t it be great if I could explore my data in ThingSpeak?  Well, I am happy to say that with the latest upgrade to ThingSpeak, you can do just that.

We have been working with the MATLAB team at MathWorks to provide two new[ThingSpeak Apps](https://thingspeak.com/apps): MATLAB Analysis and MATLAB Visualizations. With these new built-in Apps, the ThingSpeak web service can automatically run MATLAB code. That makes it easier to gain insight into your data.

Without question, the Internet of Things presents a huge opportunity – and with every great opportunity comes challenges. One needs to consider connectivity, application development, hardware compatibility, and many more facets in order to get a successful IoT solution.

## Early history[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=1" \o "Edit section: Early history)]

As of 2014, the vision of the Internet of Things has evolved due to a convergence of multiple technologies, ranging from wireless communication to the Internet and from [embedded systems](https://en.wikipedia.org/wiki/Embedded_system) to [micro-electromechanical systems](https://en.wikipedia.org/wiki/Microelectromechanical_systems) (MEMS).[[16]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Definition-IoT-16) This means that the traditional fields of embedded systems, [wireless sensor networks](https://en.wikipedia.org/wiki/Wireless_sensor_network), [control systems](https://en.wikipedia.org/wiki/Control_system), [automation](https://en.wikipedia.org/wiki/Automation) (including [home](https://en.wikipedia.org/wiki/Home_automation) and [building automation](https://en.wikipedia.org/wiki/Building_automation)), and others all contribute to enabling the Internet of Things (IoT).

The concept of a network of smart devices was discussed as early as 1982, with a modified Coke machine at [Carnegie Mellon University](https://en.wikipedia.org/wiki/Carnegie_Mellon_University)becoming the first internet-connected appliance,[[21]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-21) able to report its inventory and whether newly loaded drinks were cold.[[22]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-22) [Mark Weiser](https://en.wikipedia.org/wiki/Mark_Weiser)'s seminal 1991 paper on ubiquitous computing, "The Computer of the 21st Century", as well as academic venues such as UbiComp and PerCom produced the contemporary vision of IoT.[[17]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-IoT-17)[[23]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-UbiquitiousComputing-23) In 1994 Reza Raji described the concept in [*IEEE Spectrum*](https://en.wikipedia.org/wiki/IEEE_Spectrum) as "[moving] small packets of data to a large set of nodes, so as to integrate and automate everything from home appliances to entire factories".[[24]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-24) Between 1993 and 1996 several companies proposed solutions like [Microsoft](https://en.wikipedia.org/wiki/Microsoft)'s [at Work](https://en.wikipedia.org/wiki/At_Work) or [Novell](https://en.wikipedia.org/wiki/Novell)'s [NEST](https://en.wikipedia.org/wiki/Novell_Embedded_Systems_Technology). However, only in 1999 did the field start gathering momentum. [Bill Joy](https://en.wikipedia.org/wiki/Bill_Joy) envisioned Device to Device (D2D) communication as part of his "Six Webs" framework, presented at the World Economic Forum at Davos in 1999.[[25]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-ETC:_Bill_Joy.27s_Six_Webs-25)

The concept of the Internet of Things first became popular in 1999, through the [Auto-ID Center](https://en.wikipedia.org/wiki/Auto-ID_Labs) at [MIT](https://en.wikipedia.org/wiki/Massachusetts_Institute_of_Technology) and related market-analysis publications.[[26]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-26) Radio-frequency identification ([RFID](https://en.wikipedia.org/wiki/RFID)) was seen[[*by whom?*](https://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style/Words_to_watch#Unsupported_attributions)] as a prerequisite for the Internet of Things in the early days[[*when?*](https://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style/Dates_and_numbers#Chronological_items)]. If all objects and people in daily life were equipped with identifiers, computers could manage and inventory them.[[27]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-gartner.com-27)[[28]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-EC.2C_Action_plan_for_Europe-28)Besides using RFID, the [*tagging*](https://en.wikipedia.org/wiki/Tag_(metadata)) of things may be achieved through such technologies as [near field communication](https://en.wikipedia.org/wiki/Near_field_communication), [barcodes](https://en.wikipedia.org/wiki/Barcodes), [QR codes](https://en.wikipedia.org/wiki/QR_codes)and [digital watermarking](https://en.wikipedia.org/wiki/Digital_watermarking).[[29]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-29)[[30]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-30)

In its original interpretation,[[*when?*](https://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style/Dates_and_numbers#Chronological_items)] one of the first consequences of implementing the Internet of Things by equipping all objects in the world with minuscule identifying devices or machine-readable identifiers would be to transform daily life.[[31]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-31)[[32]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-casal-32) For instance, instant and ceaseless [inventory control](https://en.wikipedia.org/wiki/Inventory_control) would become ubiquitous.[[32]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-casal-32) A person's ability to interact with objects could be altered remotely based on immediate or present needs, in accordance with existing [end-user](https://en.wikipedia.org/wiki/End-user) agreements.[[27]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-gartner.com-27) For example, such technology could grant motion-picture publishers much more control over end-user private devices by remotely enforcing [copyright restrictions](https://en.wikipedia.org/wiki/Copyright) and [digital restrictions management](https://en.wikipedia.org/wiki/Digital_restrictions_management), so the ability of a customer who bought a [Blu-ray disc](https://en.wikipedia.org/wiki/Blu-ray_disc) to watch the movie becomes dependent on so-called "copyright holder's" decision, similar to Circuit City's failed [DIVX](https://en.wikipedia.org/wiki/DIVX).

## Applications[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=2" \o "Edit section: Applications)]

According to [Gartner, Inc.](https://en.wikipedia.org/wiki/Gartner) (a technology research and advisory corporation), there will be nearly 26 billion devices on the Internet of Things by 2020.[[33]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-33) [ABI Research](https://en.wikipedia.org/w/index.php?title=ABI_Research&action=edit&redlink=1) estimates that more than 30 billion devices will be wirelessly connected to the Internet of Things by 2020.[[34]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-34) As per a recent survey and study done by [Pew Research](https://en.wikipedia.org/wiki/Pew_Research_Center) Internet Project, a large majority of the technology experts and engaged Internet users who responded—83 percent—agreed with the notion that the Internet/Cloud of Things, embedded and [wearable computing](https://en.wikipedia.org/wiki/Wearable_computing) (and the corresponding dynamic systems[[35]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-35)) will have widespread and beneficial effects by 2025.[[36]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-36) It is, as such, clear that the IoT will consist of a very large number of devices being connected to the Internet.[[37]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-How_Fast_Is_The_Internet_Growing-37) In an active move to accommodate new and emerging technological innovation, the UK Government, in their 2015 budget, allocated £40,000,000 towards research into the Internet of Things. The Chancellor, Rt Hon [George Osborne](https://en.wikipedia.org/wiki/George_Osborne), posited that the Internet of Things is the next stage of the [information revolution](https://en.wikipedia.org/wiki/Information_revolution) and referenced the inter-connectivity of everything from urban transport to medical devices to household appliances.[[38]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-38)

Integration with the Internet implies that devices will utilize an [IP address](https://en.wikipedia.org/wiki/IP_address) as a unique identifier. However, due to the [limited address space](https://en.wikipedia.org/wiki/IPv4_address_exhaustion) of [IPv4](https://en.wikipedia.org/wiki/IPv4) (which allows for 4.3 billion unique addresses), objects in the IoT will have to use [IPv6](https://en.wikipedia.org/wiki/IPv6) to accommodate the extremely large address space required. [[39]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-6LoWPAN-39) [[40]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-computerworld.com-40) [[41]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-cio.com-41) [[42]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-infoworld.com-42) [[43]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-idgnews.in-43) Objects in the IoT will not only be devices with sensory capabilities, but also provide actuation capabilities (e.g., bulbs or locks controlled over the Internet).[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44) To a large extent, the future of the Internet of Things will not be possible without the support of IPv6; and consequently the global adoption of IPv6 in the coming years will be critical for the successful development of the IoT in the future. [[40]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-computerworld.com-40) [[41]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-cio.com-41) [[42]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-infoworld.com-42) [[43]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-idgnews.in-43)

The ability to network embedded devices with limited CPU, memory and power resources means that IoT finds applications in nearly every field.[[45]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-45) Such systems could be in charge of collecting information in settings ranging from natural ecosystems to buildings and factories,[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44) thereby finding applications in fields of [environmental sensing](https://en.wikipedia.org/wiki/Environmental_monitoring) and [urban planning](https://en.wikipedia.org/wiki/Urban_planning).[[46]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Cisco-SmartCity-46)  
On the other hand, IoT systems could also be responsible for performing actions, not just sensing things. [Intelligent shopping systems](https://en.wikipedia.org/wiki/Retail_Intelligence), for example, could monitor specific users' purchasing habits in a store by tracking their specific mobile phones. These users could then be provided with special offers on their favorite products, or even location of items that they need, which their fridge has automatically conveyed to the phone.[[47]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-PCQuest-Retail-47)[[48]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-IoT-Butler-Shopping-48) Additional examples of sensing and actuating are reflected in applications that deal with heat, electricity and [energy management](https://en.wikipedia.org/wiki/Energy_management), as well as cruise-assisting [transportation systems](https://en.wikipedia.org/wiki/Intelligent_Transportation_Systems).[[49]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-49) Another excellent application that the Internet of Things brings to the picture is home security solutions. Home automation is also a major step forward when it comes to applying IoT. All these advances add to the numerous list of IoT applications. Now with IoT, you can control the electrical devices installed in your house while you are sorting out your files in office. Your water will be warm as soon as you get up in the morning for the shower. All credit goes to smart devices which make up the smart home. Everything connected with the help of Internet.[[50]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-50)

However, the application of the IoT is not only restricted to these areas. Other specialized use cases of the IoT may also exist. An overview of some of the most prominent application areas is provided here. Based on the application domain, IoT products can be classified broadly into five different categories: smart wearable, smart home, smart city, smart environment, and smart enterprise. The IoT products and solutions in each of these markets have different characteristics.[[51]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-TETCIOT-51)

### Media**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=3" \o "Edit section: Media)]**

In order to hone the manner in which the Internet of Things (IoT), the Media and Big Data are interconnected, it is first necessary to provide some context into the mechanism used for media process. It has been suggested by Nick Couldry and Joseph Turow that[Practitioners](https://en.wiktionary.org/wiki/practitioner) in Media approach [Big Data](https://en.wikipedia.org/wiki/Big_Data) as many actionable points of information about millions of individuals. The industry appears to be moving away from the traditional approach of using specific media environments such as newspapers, magazines, or television shows and instead tap into consumers with technologies that reach targeted people at optimal times in optimal locations. The ultimate aim is of course to serve, or convey, a message or content that is (statistically speaking) in line with the consumer's mindset. For example, publishing environments are increasingly tailoring messages (advertisements) and content (articles) to appeal to consumers that have been exclusively gleaned through various data-mining activities.[[52]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-52)

The media industries process Big Data in a dual, interconnected manner:

* Targeting of consumers (for advertising by marketers)
* Data-capture

Thus, the internet of things creates an opportunity to measure, collect and analyse an ever-increasing variety of behavioural statistics. Cross-correlation of this data could revolutionise the targeted marketing of products and services.[[53]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-53) For example, as noted by Danny Meadows-Klue, the combination of [analytics](https://en.wikipedia.org/wiki/Analytics) for [conversion tracking](https://en.wikipedia.org/wiki/Conversion_tracking), with [behavioural targeting](https://en.wikipedia.org/wiki/Behavioural_targeting" \o "Behavioural targeting) and [programmatic media](https://en.wikipedia.org/wiki/Programmatic_media) has unlocked a new level of precision that enables [display advertising](https://en.wikipedia.org/wiki/Display_advertising) to be focused on the devices of people with relevant interests.[[54]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-54) Big Data and the IoT work in conjunction. From a media perspective, Data is the key derivative of device inter connectivity, whilst being pivotal in allowing clearer accuracy in targeting. The Internet of Things therefore transforms the media industry, companies and even governments, opening up a new era of economic growth and competitiveness. The wealth of data generated by this industry (i.e. Big Data) will allow Practitioners in Advertising and Media to gain an elaborate layer on the present targeting mechanisms utilised by the industry.

### Environmental monitoring**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=4" \o "Edit section: Environmental monitoring)]**

[Environmental monitoring](https://en.wikipedia.org/wiki/Environmental_monitoring) applications of the IoT typically utilize sensors to assist in environmental protection[[55]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-How_the_Internet_of_Things_will_enable_.E2.80.98smart_buildings.E2.80.99-55) by monitoring air or[water quality](https://en.wikipedia.org/wiki/Water_quality),[[15]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-MolluSCAN_eye-15) [atmospheric](https://en.wikipedia.org/wiki/Air_pollution) or [soil conditions](https://en.wikipedia.org/wiki/Soil_pollution),[[56]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-IoT-EnvProt-56) and can even include areas like monitoring the [movements of wildlife](https://en.wikipedia.org/wiki/Animal_migration_tracking) and their[habitats](https://en.wikipedia.org/wiki/Habitat).[[57]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-FIT-57) Development of resource[[58]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-58) constrained devices connected to the Internet also means that other applications like[earthquake](https://en.wikipedia.org/wiki/Earthquake_warning_system) or [tsunami early-warning systems](https://en.wikipedia.org/wiki/Tsunami_warning_system) can also be used by emergency services to provide more effective aid. IoT devices in this application typically span a large geographic area and can also be mobile.[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44)

### Infrastructure management**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=5" \o "Edit section: Infrastructure management)]**

Monitoring and controlling operations of [urban](https://en.wikipedia.org/wiki/Sustainable_urban_infrastructure) and rural [infrastructures](https://en.wikipedia.org/wiki/Infrastructure) like bridges, railway tracks, on- and offshore- wind-farms is a key application of the IoT.[[59]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-IoT-Survey-59) The IoT infrastructure can be used for monitoring any events or changes in structural conditions that can compromise safety and increase risk. It can also be utilized for scheduling repair and maintenance activities in an efficient manner, by coordinating tasks between different service providers and users of these facilities.[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44) IoT devices can also be used to control critical infrastructure like bridges to provide access to ships. Usage of IoT devices for monitoring and operating infrastructure is likely to improve incident management and emergency response coordination, and quality of service, up-times and reduce costs of operation in all infrastructure related areas.[[60]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-IoT-McKinsey-60) Even areas such as waste management stand to benefit from automation and optimization that could be brought in by the IoT.[[61]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-SmartTrash-61)

### Manufacturing**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=6" \o "Edit section: Manufacturing)]**

Network control and management of [manufacturing equipment](https://en.wikipedia.org/wiki/Reconfigurable_Manufacturing_System), [asset](https://en.wikipedia.org/wiki/Asset_management) and situation management, or manufacturing [process control](https://en.wikipedia.org/wiki/Process_control) bring the IoT within the realm on industrial applications and smart manufacturing as well.[[62]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Butler-M2M-62) The IoT intelligent systems enable rapid manufacturing of new products, dynamic response to product demands, and real-time optimization of manufacturing production and[supply chain networks](https://en.wikipedia.org/wiki/Supply_chain_network), by networking machinery, sensors and control systems together.[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44)

[Digital control systems](https://en.wikipedia.org/wiki/Digital_control) to automate process controls, operator tools and service information systems to optimize plant safety and security are within the purview of the IoT.[[59]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-IoT-Survey-59) But it also extends itself to asset management via [predictive maintenance](https://en.wikipedia.org/wiki/Predictive_maintenance), [statistical evaluation](https://en.wikipedia.org/wiki/Statistical_model), and measurements to maximize reliability.[[63]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Future-IoT-63) Smart industrial management systems can also be integrated with the [Smart Grid](https://en.wikipedia.org/wiki/Smart_Grid), thereby enabling real-time energy optimization. Measurements, automated controls, plant optimization, health and safety management, and other functions are provided by a large number of networked sensors.[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44)

### Energy management**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=7" \o "Edit section: Energy management)]**

Integration of [sensing](https://en.wikipedia.org/wiki/Sensor) and [actuation](https://en.wikipedia.org/wiki/Actuator) systems, connected to the Internet, is likely to optimize energy consumption as a whole.[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44) It is expected that IoT devices will be integrated into all forms of energy consuming devices (switches, power outlets, bulbs, televisions, etc.) and be able to communicate with the utility supply company in order to effectively balance [power generation](https://en.wikipedia.org/wiki/Electricity_generation) and energy usage.[[64]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-EMAN-64) Such devices would also offer the opportunity for users to remotely control their devices, or centrally manage them via a [cloud](https://en.wikipedia.org/wiki/Cloud_computing) based interface, and enable advanced functions like scheduling (e.g., remotely powering on or off heating systems, controlling ovens, changing lighting conditions etc.).[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44) In fact, a few systems that allow remote control of electric outlets are already available in the market, e.g., Belkin's WeMo,[[65]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-65) Ambery Remote Power Switch,[[66]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-66) Budderfly,[[67]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-67) Telkonet's EcoGuard[[68]](https://en.wikipedia.org/wiki/Internet_of_Things" \l "cite_note-68) etc.

Besides home based [energy management](https://en.wikipedia.org/wiki/Energy_management), the IoT is especially relevant to the Smart Grid since it provides systems to gather and act on energy and power-related information in an automated fashion with the goal to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity.[[64]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-EMAN-64) Using [Advanced Metering Infrastructure (AMI)](https://en.wikipedia.org/wiki/Smart_meter) devices connected to the Internet backbone, electric utilities can not only collect data from end-user connections, but also manage other distribution automation devices like transformers and reclosers.[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44)

### Medical and healthcare systems**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=8" \o "Edit section: Medical and healthcare systems)]**

IoT devices can be used to enable [remote health monitoring](https://en.wikipedia.org/wiki/Remote_patient_monitoring) and [emergency notification systems](https://en.wikipedia.org/wiki/Emergency_notification_system). These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized implants, such as pacemakers or advanced hearing aids.[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44) Specialized sensors can also be equipped within living spaces to monitor the health and general well-being of senior citizens, while also ensuring that proper treatment is being administered and assisting people regain lost mobility via therapy as well.[[69]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-mHealth-69) Other consumer devices to encourage healthy living, such as, connected scales or [wearable heart monitors](https://en.wikipedia.org/wiki/Wearable_technology), are also a possibility with the IoT.[[70]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-SensorMania-70) More and more end-to-end health monitoring IoT platform are coming up for antenatal and chronic patients, helping one manage health vitals and recurring medication requirements. Distinct advantages over similar products from the US and Europe are cost-effectiveness and personalisation for chronic patients. Doctors can monitor the health of their patients on their smartphones after the patient gets discharged from the hospital.[[71]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-71)

### Building and home automation**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=9" \o "Edit section: Building and home automation)]**

IoT devices can be used to monitor and control the mechanical, electrical and electronic systems used in various types of buildings (e.g., public and private, industrial, institutions, or residential).[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44) [Home automation](https://en.wikipedia.org/wiki/Home_automation) systems, like other [building automation](https://en.wikipedia.org/wiki/Building_automation) systems, are typically used to control lighting, heating, ventilation, air conditioning, appliances, communication systems, entertainment and home security devices to improve convenience, comfort, energy efficiency, and security.[[72]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-72)

### Transportation**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=10" \o "Edit section: Transportation)]**

The IoT can assist in integration of communications, control, and information processing across various [transportation systems](https://en.wikipedia.org/wiki/Intelligent_Transportation_Systems). Application of the IoT extends to all aspects of transportation systems, i.e. the vehicle, the infrastructure, and the driver or user. Dynamic interaction between these components of a transport system enables inter and intra vehicular communication, [smart traffic control](https://en.wikipedia.org/wiki/Smart_traffic_light), smart parking, [electronic toll collection systems](https://en.wikipedia.org/wiki/Electronic_toll_collection), [logistic](https://en.wikipedia.org/wiki/Logistics_management) and [fleet management](https://en.wikipedia.org/wiki/Fleet_management), [vehicle control](https://en.wikipedia.org/wiki/Autonomous_cruise_control_system), and safety and road assistance.[[44]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-CoMAN-44)

### Large scale deployments**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=11" \o "Edit section: Large scale deployments)]**

There are several planned or ongoing large-scale deployments of the IoT, to enable better management of cities and systems. For example, [Songdo](https://en.wikipedia.org/wiki/Songdo_International_Business_District" \o "Songdo International Business District), South Korea, the first of its kind fully equipped and wired [smart city](https://en.wikipedia.org/wiki/Smart_city), is near completion. Nearly everything in this city is planned to be wired, connected and turned into a constant stream of [data](https://en.wikipedia.org/wiki/Data) that would be monitored and analyzed by an array of computers with little, or no human intervention.[*[citation needed](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*]

Another application is a currently undergoing project in [Santander](https://en.wikipedia.org/wiki/Santander,_Spain), Spain. For this deployment, two approaches have been adopted. This city of 180000 inhabitants, has already seen 18000 city application downloads for their smartphones. This application is connected to 10000 sensors that enable services like parking search, environmental monitoring, digital city agenda among others. City context information is utilized in this deployment so as to benefit merchants through a spark deals mechanism based on city behavior that aims at maximizing the impact of each notification.[[73]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-73)

Other examples of large-scale deployments underway include the Sino-Singapore Guangzhou Knowledge City;[[74]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-74) work on improving air and water quality, reducing noise pollution, and increasing transportation efficiency in San Jose, California;[[75]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-75) and smart traffic management in western Singapore.[[76]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-76) French company, [Sigfox](https://en.wikipedia.org/wiki/Sigfox" \o "Sigfox), commenced building an ultra-[narrowband](https://en.wikipedia.org/wiki/Narrowband) wireless data network in the[San Francisco Bay Area](https://en.wikipedia.org/wiki/San_Francisco_Bay_Area) in 2014, the first business to achieve such a deployment in the U.S.[[77]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-EETimes-77)[[78]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Fierce_Wireless_Tech-78) It subsequently announced it would set up a total of 4000 [base stations](https://en.wikipedia.org/wiki/Base_station) to cover a total of 30 cities in the U.S. by the end of the 2016, making it the largest IoT network coverage provider in the country thus far.[[79]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-EETimes2-79)[[80]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Gigaom2-80)

Another example of a large deployment is the one completed by New York Waterways in New York City to connect all their vessels and being able to monitor them live 24/7. The network was designed and engineered by [Fluidmesh](https://en.wikipedia.org/wiki/Fluidmesh" \o "Fluidmesh) Networks, a Chicago-based company developing wireless networks for critical applications. The NYWW network is currently providing coverage on the Hudson River, East River, and Upper New York Bay. With the wireless network in place, NY Waterway is able to take control of its fleet and passengers in a way that was not previously possible. New applications can include security, energy and fleet management, digital signage, public Wi-Fi, paperless ticketing and others.[[81]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-81)

## Unique addressability of things[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=12" \o "Edit section: Unique addressability of things)]

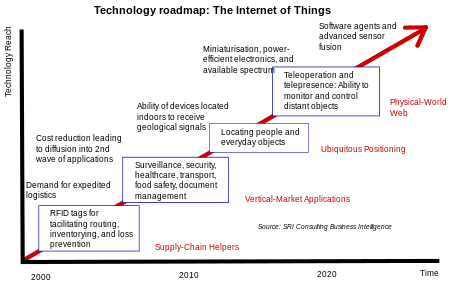
The original idea of the [Auto-ID Center](https://en.wikipedia.org/wiki/Auto-ID_Labs) is based on RFID-tags and unique identification through the [Electronic Product Code](https://en.wikipedia.org/wiki/Electronic_Product_Code) however this has evolved into objects having an IP address or [URI](https://en.wikipedia.org/wiki/Uniform_resource_identifier).

An alternative view, from the world of the [Semantic Web](https://en.wikipedia.org/wiki/Semantic_Web)[[82]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Brickley_et_al.2C_2001-82) focuses instead on making all things (not just those electronic, smart, or RFID-enabled) addressable by the existing naming protocols, such as [URI](https://en.wikipedia.org/wiki/URI). The objects themselves do not converse, but they may now be referred to by other agents, such as powerful centralized servers acting for their human owners.

The next generation of Internet applications using [Internet Protocol Version 6](https://en.wikipedia.org/wiki/IPv6) (IPv6) would be able to communicate with devices attached to virtually all human-made objects because of the extremely large address space of the IPv6 protocol. This system would therefore be able to scale to the large numbers of objects envisaged.[[83]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Waldner.2C_2008-83)

A combination of these ideas can be found in the current [GS1](https://en.wikipedia.org/wiki/GS1)/[EPCglobal](https://en.wikipedia.org/wiki/EPCglobal" \o "EPCglobal) EPC Information Services[[84]](https://en.wikipedia.org/wiki/Internet_of_Things" \l "cite_note-84) ([EPCIS](https://en.wikipedia.org/wiki/EPCglobal#EPCIS)) specifications. This system is being used to identify objects in industries ranging from aerospace to fast moving consumer products and transportation logistics.[[85]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Miles.2C_2011-85)

## Trends and characteristics[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=13" \o "Edit section: Trends and characteristics)]

[](https://en.wikipedia.org/wiki/File:Internet_of_Things.svg)

Technology Roadmap: Internet of Things

### Intelligence**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=14" \o "Edit section: Intelligence)]**

[Ambient intelligence](https://en.wikipedia.org/wiki/Ambient_intelligence) and [autonomous control](https://en.wikipedia.org/w/index.php?title=Autonomous_control&action=edit&redlink=1) are not part of the original concept of the Internet of Things. Ambient intelligence and autonomous control do not necessarily require Internet structures, either. However, there is a shift in research to integrate the concepts of the Internet of Things and autonomous control, with initial outcomes towards this direction considering objects as the driving force for autonomous IoT.

In the future the Internet of Things may be a non-deterministic and open network in which auto-organized or intelligent entities ([Web services](https://en.wikipedia.org/wiki/Web_service), [SOA](https://en.wikipedia.org/wiki/Service-oriented_architecture) components), virtual objects (avatars) will be interoperable and able to act independently (pursuing their own objectives or shared ones) depending on the context, circumstances or environments. Autonomous behavior through collecting and reasoning context information plays a significant role in IoT. Modern IoT products and solutions in the marketplace use variety of different technologies to support such context-aware automation.

### Architecture**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=15" \o "Edit section: Architecture)]**

The system will likely be an example of [event-driven architecture](https://en.wikipedia.org/wiki/Event-driven_architecture),[[86]](https://en.wikipedia.org/wiki/Internet_of_Things" \l "cite_note-Gautier.2C_2007-86) *bottom-up* made (based on the context of processes and operations, in real-time) and will consider any subsidiary level. Therefore, model driven and functional approaches will coexist with new ones able to treat exceptions and unusual evolution of processes ([Multi-agent systems](https://en.wikipedia.org/wiki/Multi-agent_system), B-ADSc, etc.).

In an Internet of Things, the meaning of an event will not necessarily be based on a deterministic or syntactic model but would instead be based on the context of the event itself: this will also be a [semantic web](https://en.wikipedia.org/wiki/Semantic_web).[[87]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Gautier.2C_2010-87) Consequently, it will not necessarily need common standards that would not be able to address every context or use: some actors (services, components, avatars) will accordingly be self-referenced and, if ever needed, adaptive to existing common standards (*predicting everything* would be no more than defining a "global finality" for everything that is just not possible with any of the current *top-down* approaches and standardizations). Some researchers argue that sensor networks are the most essential components of the Internet of Things.[[88]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Perera7-88)

Building on top of the Internet of Things, the [Web of Things](https://en.wikipedia.org/wiki/Web_of_Things) is an architecture for the application layer of the Internet of Things looking at the convergence of data from IoT devices into Web applications to create innovative use-cases.

### Complex system**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=16" \o "Edit section: Complex system)]**

In semi-open or closed loops (i.e. value chains, whenever a global finality can be settled) it will therefore be considered and studied as a[Complex system](https://en.wikipedia.org/wiki/Complex_system)[[89]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Gautier_2011-89) due to the huge number of different links and interactions between autonomous actors, and its capacity to integrate new actors. At the overall stage (full open loop) it will likely be seen as a [chaotic](https://en.wikipedia.org/wiki/Chaos_theory) environment (since [systems](https://en.wikipedia.org/wiki/System) have always finality).

### Size considerations**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=17" \o "Edit section: Size considerations)]**

The Internet of objects would encode 50 to 100 trillion objects, and be able to follow the movement of those objects. Human beings in surveyed urban environments are each surrounded by 1000 to 5000 trackable objects.[[90]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-Waldner.2C_2007-90)

### Space considerations**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=18" \o "Edit section: Space considerations)]**

In an Internet of Things, the precise geographic location of a thing—and also the precise geographic dimensions of a thing—will be critical. Open Geospatial Consortium, ["OGC Abstract Specification"](http://www.opengeospatial.org/standards/as) Currently, the Internet has been primarily used to manage information processed by people. Therefore, facts about a thing, such as its location in time and space, have been less critical to track because the person processing the information can decide whether or not that information was important to the action being taken, and if so, add the missing information (or decide to not take the action). (Note that some things in the Internet of Things will be sensors, and sensor location is usually important. Mike Botts et al., ["OGC Sensor Web Enablement: Overview And High Level Architecture"](http://portal.opengeospatial.org/files/?artifact_id=25562)) The[GeoWeb](https://en.wikipedia.org/wiki/GeoWeb) and [Digital Earth](https://en.wikipedia.org/wiki/Digital_Earth) are promising applications that become possible when things can become organized and connected by location. However, challenges that remain include the constraints of variable spatial scales, the need to handle massive amounts of data, and an indexing for fast search and neighbour operations. If in the Internet of Things, things are able to take actions on their own initiative, this human-centric mediation role is eliminated, and the time-space context that we as humans take for granted must be given a central role in this information ecosystem. Just as standards play a key role in the Internet and the Web, geospatial standards will play a key role in the Internet of Things.

### Sectors**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=19" \o "Edit section: Sectors)]**

There are three core sectors of the IoT: enterprise, home, and government, with the Enterprise Internet of Things (EIoT) being the largest of the three. By 2019, the EIoT sector is estimated to account for nearly 40% or 9.1 billion devices.[[91]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-91)

### A Basket of Remotes**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=20" \o "Edit section: A Basket of Remotes)]**

According to the CEO of [Cisco](https://en.wikipedia.org/wiki/Cisco), the remote control market is expected to be a $USD 19 trillion market.[[92]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-92) Many IoT devices have a potential to take a piece of this market. [Jean-Louis Gassée](https://en.wikipedia.org/wiki/Jean-Louis_Gass%C3%A9e) (Apple initial alumni team, and BeOS co-founder) has addressed this topic in an article on [Monday Note](https://en.wikipedia.org/w/index.php?title=Monday_Note&action=edit&redlink=1),[[93]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-93) where he predicts that the most likely problem will be what he calls the "Basket of remotes" problem, where we'll have hundreds of applications to interface with hundreds of devices that don't share protocols for speaking with one another.

There are multiple approaches to solve this problem, one of them called the "[predictive interaction](https://en.wikipedia.org/w/index.php?title=Predictive_interaction&action=edit&redlink=1)",[[94]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-94) where cloud or fog based decision makers [[*clarification needed*](https://en.wikipedia.org/wiki/Wikipedia:Please_clarify)] will predict the user's next action and trigger some reaction.

For user interaction, new technology leaders are joining forces to create standards for communication between devices. While [AllJoyn](https://en.wikipedia.org/wiki/AllJoyn" \o "AllJoyn)alliance is composed the top 20 World technology leaders, there are also big companies that promote their own protocol like CCF from[Intel](https://en.wikipedia.org/wiki/Intel).

This problem is also a competitive advantage for some very technical startup companies with fast capabilities.

* [AT&T](https://en.wikipedia.org/wiki/AT%26T) Digital Life provides one solution for the "basket of remotes" problem. This product features home-automation and digital-life experiences. It provides a mobile application to control their closed ecosystem of branded devices;
* [Nuve](https://en.wikipedia.org/w/index.php?title=Nuve&action=edit&redlink=1) has developed a new technology based on sensors, a cloud-based platform and a mobile application that allows the asset management industry to better protect, control and monitor their property.[[95]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-95)

Manufacturers are becoming more conscious of this problem, and many companies have begun releasing their devices with open APIs. Many of these APIs are used by smaller companies looking to take advantage of quick integration.[*[citation needed](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*]

## Sub systems[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=21" \o "Edit section: Sub systems)]

Not all elements in an Internet of Things will necessarily run in a global space. [Domotics](https://en.wikipedia.org/wiki/Domotics" \o "Domotics) running inside a [Smart House](https://en.wikipedia.org/wiki/Home_automation), for example, might only run and be available via a local network.

## Frameworks[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=22" \o "Edit section: Frameworks)]

Internet of Things frameworks might help support the interaction between "things" and allow for more complex structures like [Distributed computing](https://en.wikipedia.org/wiki/Distributed_computing) and the development of [Distributed applications](https://en.wikipedia.org/wiki/Distributed_application). Currently, some Internet of Things frameworks seem to focus on real time data logging solutions like [Jasper Technologies, Inc.](https://en.wikipedia.org/wiki/Jasper_Technologies,_Inc.) and [Xively](https://en.wikipedia.org/wiki/Xively" \o "Xively) (formerly Cosm and before that Pachube): offering some basis to work with many "things" and have them interact. Future developments might lead to specific [Software development environments](https://en.wikipedia.org/wiki/Software_development_environment) to create the software to work with the hardware used in the Internet of Things. Companies such as Tibbo Systems - [AggreGate Platform](https://en.wikipedia.org/wiki/AggreGate_Platform" \o "AggreGate Platform),[[96]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-96)[[97]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-97)[[98]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-98) [Arrayent](https://en.wikipedia.org/wiki/Arrayent),[[99]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-99)[[100]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-100)[[101]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-101) [B-Scada](https://en.wikipedia.org/w/index.php?title=B-Scada&action=edit&redlink=1),[[102]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-102)[[103]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-103) [Carriots](https://en.wikipedia.org/wiki/Carriots),[[104]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-104)[[105]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-105) [EVRYTHNG](https://en.wikipedia.org/wiki/EVRYTHNG),[[106]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-106) [Exosite](https://en.wikipedia.org/wiki/Exosite_(company)),[[107]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-businessjournal-107)[[108]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-cioreview-108)[[109]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-electronicdesign-109) [IoT-Ticket.com](https://en.wikipedia.org/w/index.php?title=IoT-Ticket.com&action=edit&redlink=1), nPhase,[[110]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-110) Raco Wireless[[111]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-111)[[112]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-112) and [ThingWorx](https://en.wikipedia.org/w/index.php?title=ThingWorx&action=edit&redlink=1" \o "ThingWorx (page does not exist))[[113]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-113)[[114]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-114)[[115]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-115) are developing technology platforms to provide this type of functionality for the Internet of Things.

The XMPP standards foundation XSF is creating such a framework in a fully open standard that isn't tied to any company and not connected to any cloud services. This XMPP initiative is called [Chatty Things](https://en.wikipedia.org/w/index.php?title=Chatty_Things&action=edit&redlink=1).[[116]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-116) XMPP provides a set of needed building blocks and a proven distributed solution that can scale with high security levels. The extensions are published at [XMPP/extensions](http://xmpp.org/extensions/)

The independently developed MASH IoT Platform was presented at the 2013 IEEE IoT conference in Mountain View, CA. MASH’s focus is asset management (assets=people/property/information, management=monitoring/control/configuration). Support is provided for design thru deployment with an included IDE, Android client and runtime. Based on a component modeling approach MASH includes support for user defined things and is completely data-driven.[[117]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-117)

[REST](https://en.wikipedia.org/wiki/REST) is a scalable architecture which allows for things to communicate over Hypertext Transfer Protocol and is easily adopted for IoT applications to provide communication from a thing to a central web server. [MQTT](https://en.wikipedia.org/wiki/MQTT) is a publish-subscribe architecture on top of TCP/IP which allows for bi-directional communication between a thing and a MQTT broker.

## Simulation[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=23" \o "Edit section: Simulation)]

IOT modeling and simulation (and emulation) is typically carried out at the design stage before deployment of the network. Network simulators like [OPNET](https://en.wikipedia.org/wiki/OPNET), [NetSim](https://en.wikipedia.org/wiki/NetSim" \o "NetSim) and [NS2](https://en.wikipedia.org/wiki/NS2) can be used to simulate IOT networks

## Criticism and controversies[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=24" \o "Edit section: Criticism and controversies)]

While many technologists tout the Internet of Things as a step towards a better world, scholars and social observers have doubts about the promises of the [ubiquitous computing](https://en.wikipedia.org/wiki/Ubiquitous_computing) revolution.

### Privacy, autonomy and control**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=25" \o "Edit section: Privacy, autonomy and control)]**

Peter-Paul Verbeek, a professor of philosophy of technology at the [University of Twente](https://en.wikipedia.org/wiki/University_of_Twente), Netherlands, writes that technology already influences our moral decision making, which in turns affects human agency, privacy and autonomy. He cautions against viewing technology merely as a human tool and advocates instead to consider it as an active agent.[[118]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-118)

Justin Brookman, of the [Center for Democracy and Technology](https://en.wikipedia.org/wiki/Center_for_Democracy_and_Technology), expressed concern regarding the impact of IoT on consumer privacy, saying that "There are some people in the commercial space who say, ‘Oh, big data — well, let’s collect everything, keep it around forever, we’ll pay for somebody to think about security later.’ The question is whether we want to have some sort of policy framework in place to limit that."[[119]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-119)

[Tim O’Reilly](https://en.wikipedia.org/w/index.php?title=Tim_O%E2%80%99Reilly&action=edit&redlink=1) believes that the way companies sell the IoT devices on consumers are misplaced, disputing the notion that the IoT is about gaining efficiency from putting all kinds of devices online and postulating that "IoT is really about human augmentation. The applications are profoundly different when you have sensors and data driving the decision-making.".[[120]](https://en.wikipedia.org/wiki/Internet_of_Things" \l "cite_note-120)

Editorials at [WIRED](https://en.wikipedia.org/wiki/WIRED) have also expressed concern, one stating 'What you’re about to lose is your privacy. Actually, it’s worse than that. You aren’t just going to lose your privacy, you’re going to have to watch the very concept of privacy be rewritten under your nose.'[[121]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-121)

The [American Civil Liberties Union](https://en.wikipedia.org/wiki/American_Civil_Liberties_Union) (ACLU) expressed concern regarding the ability of IoT to erode people's control over their own lives. The ACLU wrote that "There’s simply no way to forecast how these immense powers -- disproportionately accumulating in the hands of corporations seeking financial advantage and governments craving ever more control -- will be used. Chances are Big Data and the Internet of Things will make it harder for us to control our own lives, as we grow increasingly transparent to powerful corporations and government institutions that are becoming more opaque to us."[[122]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-122)

Researchers have identified privacy challenges faced by all stakeholders in IoT domain, from the manufacturers and app developers to the consumers themselves, and examined the responsibility of each party in order to ensure user privacy at all times. Problems highlighted by the report[[123]](https://en.wikipedia.org/wiki/Internet_of_Things" \l "cite_note-ITPIOT-123) include:

* User consent – somehow, the report says, users need to be able to give informed consent to data collection. Users, however, have limited time and technical knowledge.
* Freedom of choice – both privacy protections and underlying standards should promote freedom of choice.
* Anonymity – IoT platforms pay scant attention to user anonymity when transmitting data, the researchers note. Future platforms could, for example, use TOR or similar technologies so that users can't be too deeply profiled based on the behaviors of their "things".

### Security**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=26" \o "Edit section: Security)]**

Concerns have been raised that the Internet of Things is being developed rapidly without appropriate consideration of the profound security challenges involved and the regulatory changes that might be necessary.[[124]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-124) According to the BI (Business Insider) Intelligence Survey conducted in the last quarter of 2014, 39% of the respondents said that security is the biggest concern in adopting Internet of Things technology.[[125]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-125) In particular, as the Internet of Things spreads widely, cyber attacks are likely to become an increasingly physical (rather than simply virtual) threat.[[126]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-126) In a January 2014 article in [*Forbes*](https://en.wikipedia.org/wiki/Forbes), cybersecurity columnist [Joseph Steinberg](https://en.wikipedia.org/wiki/Joseph_Steinberg) listed many Internet-connected appliances that can already "spy on people in their own homes" including televisions, kitchen appliances, cameras, and thermostats.[[127]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-127) Computer-controlled devices in automobiles such as brakes, engine, locks, hood and truck releases, horn, heat, and dashboard have been shown to be vulnerable to attackers who have access to the onboard network. In some cases, vehicle computer systems are internet-connected, allowing them to be exploited remotely.[[128]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-128)

The U.S. [National Intelligence Council](https://en.wikipedia.org/wiki/National_Intelligence_Council) in an unclassified report maintains that it would be hard to deny "access to networks of sensors and remotely-controlled objects by enemies of the United States, criminals, and mischief makers… An open market for aggregated sensor data could serve the interests of commerce and security no less than it helps criminals and spies identify vulnerable targets. Thus, massively parallel [sensor fusion](https://en.wikipedia.org/wiki/Sensor_fusion) may undermine social cohesion, if it proves to be fundamentally incompatible with Fourth-Amendment guarantees against unreasonable search."[[129]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-129) In general, the intelligence community views Internet of Things as a rich source of data.[[130]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-130)

### Children and the Internet of Things**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=27" \o "Edit section: Children and the Internet of Things)]**

It has been suggested by Sonia Livingstone OBE that young people are the target of a range of policy initiatives designed to realise the benefits of new developments in the internet while minimising the potential risks. These are often developed, of necessity, in the absence of rigorous empirical data, making an informed assessment of access, attitudes, skills and uses essential. The key ideas that reveal the complex dynamic between online opportunities and online risks include:

* Digital in/exclusion
* Learning and literacy
* Peer networking and privacy
* Civic participation
* Risk and harm

This research raises key questions regarding identity, literacy, privacy, participation and risk which are all key issues in relation to IoT developments.[[131]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-131)

Data capture, or [Big Data](https://en.wikipedia.org/wiki/Big_Data), is a key starting point whilst considering the effects of the IoT on young people.

### Design**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=28" \o "Edit section: Design)]**

Given widespread recognition of the evolving nature of the design and management of the Internet of Things, sustainable and secure deployment of Internet of Things solutions must design for "anarchic scalability."[[132]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-132) Application of the concept of anarchic scalability can be extended to physical systems (i.e. controlled real-world objects), by virtue of those systems being designed to account for uncertain management futures. This "hard anarchic scalabilty" thus provides a pathway forward to fully realize the potential of Internet of Things solutions by selectively constraining physical systems to allow for all management regimes without risking physical failure.

Brown University computer scientist [Michael Littman](https://en.wikipedia.org/wiki/Michael_Littman) has argued that successful execution of the Internet of Things requires consideration of the interface's usability as well as the technology itself. These interfaces need to be not only more user friendly but also better integrated: "If users need to learn different interfaces for their vacuums, their locks, their sprinklers, their lights, and their coffeemakers, it’s tough to say that their lives have been made any easier."[[133]](https://en.wikipedia.org/wiki/Internet_of_Things#cite_note-133)

### Environmental impact**[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=29" \o "Edit section: Environmental impact)]**

A concern regarding IoT technologies pertains to the environmental impacts of the manufacture, use, and eventual disposal of all these semiconductor-rich devices. Modern electronics are replete with a wide variety of heavy metals and rare-earth metals, as well as highly toxic synthetic chemicals. This makes them extremely difficult to properly recycle. Electronic components are often simply incinerated or dumped in regular landfills, thereby polluting soil, groundwater, surface water, and air. Such contamination also translates into chronic human-health concerns. Furthermore, the environmental cost of mining the rare-earth metals that are integral to modern electronic components continues to grow. With production of electronic equipment growing globally yet little of the metals (from end-of-life equipment) being recovered for reuse, the environmental impacts can be expected to increase.

Also, because the concept of IoT entails adding electronics to mundane devices (for example, simple light switches), and because the major driver for replacement of electronic components is often technological obsolescence rather than actual failure to function, it is reasonable to expect that items that previously were kept in service for many decades would see an accelerated replacement cycle, if they were part of the IoT. For example, a traditional house built with 30 light switches and 30 electrical outlets might stand for 50 years, with all those components still being original at the end of that period. But a modern house built with the same number of switches and outlets set up for IoT might see each switch and outlet replaced at five-year intervals, in order to keep up-to-date with technological changes. This translates into a ten-fold increase in waste requiring disposal.

While IoT devices can serve as energy-conservation equipment, it is important to keep in mind that everyday good habits can bring the same benefits[*[citation needed](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*]. Practical, fundamental considerations such as these are often overlooked by marketers eager to induce consumers to purchase IoT items that may never have been needed in the first place[*[citation needed](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*].

## See also[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=30" \o "Edit section: See also)]

* [Web of Things](https://en.wikipedia.org/wiki/Web_of_Things)
* [Algorithmic Regulation](https://en.wikipedia.org/wiki/Algorithmic_Regulation)
* [Cloud manufacturing](https://en.wikipedia.org/wiki/Cloud_manufacturing)
* [Connected Revolution](https://en.wikipedia.org/wiki/Connected_Revolution)
* [Data Distribution Service](https://en.wikipedia.org/wiki/Data_Distribution_Service)
* [Digital Object Memory](https://en.wikipedia.org/wiki/Digital_Object_Memory)
* [Open Interconnect Consortium](https://en.wikipedia.org/wiki/Open_Interconnect_Consortium)

## References[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=31" \o "Edit section: References)]

* 1. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-1) ["Network of Everything"](http://openinterconnect.org/join/).
  2. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-2) ["Internet of Things Global Standards Initiative"](http://www.itu.int/en/ITU-T/gsi/iot/Pages/default.aspx). *ITU*. Retrieved26 June 2015.
  3. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-3)<https://hbr.org/resources/pdfs/comm/verizon/18980_HBR_Verizon_IoT_Nov_14.pdf>
  4. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-4) <http://www.internet-of-things-research.eu/pdf/Converging_Technologies_for_Smart_Environments_and_Integrated_Ecosystems_IERC_Book_Open_Access_2013.pdf>
  5. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-5)<http://www.cisco.com/web/solutions/trends/iot/introduction_to_IoT_november.pdf>
  6. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-6) <http://cordis.europa.eu/fp7/ict/enet/documents/publications/iot-between-the-internet-revolution.pdf>
  7. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-7) <http://www.vs.inf.ethz.ch/publ/papers/Internet-of-things.pdf>
  8. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-8) <http://www.cognizant.com/InsightsWhitepapers/Reaping-the-Benefits-of-the-Internet-of-Things.pdf>
  9. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-9) Dave Evans (April 2011). ["The Internet of Things: How the Next Evolution of the Internet Is Changing Everything"](http://www.iotsworldcongress.com/documents/4643185/0/IoT_IBSG_0411FINAL+Cisco.pdf) (PDF). *Cisco*. Retrieved 4 September 2015.
  10. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-10) Wood, Alex. ["The internet of things is revolutionizing our lives, but standards are a must"](http://www.theguardian.com/media-network/2015/mar/31/the-internet-of-things-is-revolutionising-our-lives-but-standards-are-a-must). *theguardian.com*. The Guardian. Retrieved 31 March 2015.
  11. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-M2M-IoT_11-0) J. Höller, V. Tsiatsis, C. Mulligan, S. Karnouskos, S. Avesand, D. Boyle: [*From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*](http://store.elsevier.com/product.jsp?isbn=9780124076846)*.* Elsevier, 2014, [ISBN 978-0-12-407684-6](https://en.wikipedia.org/wiki/Special:BookSources/9780124076846).
  12. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Smart-IoT_12-0) O. Monnier: [*A smarter grid with the Internet of Things*](http://e2e.ti.com/blogs_/b/smartgrid/archive/2014/05/08/a-smarter-grid-with-the-internet-of-things.aspx)*.* Texas Instruments, 2013.
  13. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-13) <https://www.itu.int/dms_pub/itu-t/oth/0b/15/T0B150000153301PDFE.pdf>
  14. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-14) ["IEEE Xplore Full-Text PDF:"](http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6740844). Retrieved 26 June 2015.
  15. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-MolluSCAN_eye_15-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-MolluSCAN_eye_15-1) ["Molluscan eye"](http://molluscan-eye.epoc.u-bordeaux1.fr/index.php?rubrique=accueil&lang=en/). Retrieved 26 June 2015.
  16. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Definition-IoT_16-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Definition-IoT_16-1) I. Wigmore: ["Internet of Things (IoT)"](http://whatis.techtarget.com/definition/Internet-of-Things). TechTarget, June 2014.
  17. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-IoT_17-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-IoT_17-1) Farooq, M.U.; Waseem, Muhammad; Khairi, Anjum; Mazhar, Sadia (2015). ["A Critical Analysis on the Security Concerns of Internet of Things (IoT)"](http://dx.doi.org/10.5120/19547-1280). *International Journal of Computer Applications (IJCA)* **11**. Retrieved 18 February 2015.
  18. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-18) Hendricks, Drew. ["The Trouble with the Internet of Things"](http://data.london.gov.uk/blog/the-trouble-with-the-internet-of-things/).*London Datastore*. Greater London Authority. Retrieved 10 August2015.
  19. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-InfoWorld-BigData_19-0) Violino, Bob. ["The 'Internet of things' will mean really, really big data"](http://www.infoworld.com/d/big-data/the-internet-of-things-will-mean-really-really-big-data-223314). *InfoWorld*. Retrieved 9 July 2014.
  20. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Internet_of_Things_Database_20-0) Hogan, Michael. ["The 'The Internet of Things Database' Data Management Requirements"](http://www.scaledb.com/internet-things-database.php). *ScaleDB*. Retrieved 15 July 2014.
  21. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-21) ["The "Only" Coke Machine on the Internet"](https://www.cs.cmu.edu/~coke/history_long.txt). [Carnegie Mellon University](https://en.wikipedia.org/wiki/Carnegie_Mellon_University). Retrieved 10 November 2014.
  22. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-22) ["Internet of Things Done Wrong Stifles Innovation"](http://www.informationweek.com/strategic-cio/executive-insights-and-innovation/internet-of-things-done-wrong-stifles-innovation/a/d-id/1279157).[InformationWeek](https://en.wikipedia.org/wiki/InformationWeek). 7 July 2014. Retrieved 10 November 2014.
  23. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-UbiquitiousComputing_23-0) Weiser, Mark (1991). ["The Computer for the 21st Century"](http://web.media.mit.edu/~anjchang/ti01/weiser-sciam91-ubicomp.pdf)(PDF). *Scientific American* **265** (3): 94–104.[doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.1038/scientificamerican0991-94](https://dx.doi.org/10.1038%2Fscientificamerican0991-94). Retrieved 5 November2014.
  24. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-24) Raji, RS (June 1994). ["Smart networks for control"](http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=284793&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D284793). *IEEE Spectrum*.
  25. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-ETC:_Bill_Joy.27s_Six_Webs_25-0) Jason Pontin: [ETC: Bill Joy's Six Webs](http://www.technologyreview.com/view/404694/etc-bill-joys-six-webs/). In: *MIT Technology Review*, 29 September 2005. Retrieved 17 November 2013.
  26. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-26) Analyst Anish Gaddam interviewed by Sue Bushell in*Computerworld*, on 24 July 2000 ("M-commerce key to ubiquitous internet")
  27. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-gartner.com_27-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-gartner.com_27-1) [P. Magrassi](https://en.wikipedia.org/wiki/Paolo_Magrassi), T. Berg, *A World of Smart Objects*, Gartner research report R-17-2243, 12 August 2002 [[1]](http://www.gartner.com/DisplayDocument?id=366151)
  28. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-EC.2C_Action_plan_for_Europe_28-0) Commission of the European Communities (18 June 2009).["Internet of Things — An action plan for Europe"](http://ec.europa.eu/information_society/policy/rfid/documents/commiot2009.pdf) (PDF). COM(2009) 278 final.
  29. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-29) Techvibes [*From M2M to The Internet of Things: Viewpoints From Europe*](http://www.techvibes.com/blog/from-m2m-to-the-internet-of-things-viewpoints-from-europe-2011-07-07) 7 July 2011
  30. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-30) Dr. Lara Sristava, European Commission Internet of Things Conference in Budapest, 16 May 2011 [*The Internet of Things - Back to the Future (Presentation)*](http://www.youtube.com/watch?v=CJdNq7uSddM)
  31. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-31) P. Magrassi, A. Panarella, N. Deighton, G. Johnson, *Computers to Acquire Control of the Physical World*, Gartner research report T-14-0301, 28 September 2001[[*need quotation to verify*](https://en.wikipedia.org/wiki/Wikipedia:Verifiability)]
  32. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-casal_32-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-casal_32-1) Casaleggio Associati [*The Evolution of Internet of Things*](http://www.slideshare.net/casaleggioassociati/the-evolution-of-internet-of-things)February 2011[[*need quotation to verify*](https://en.wikipedia.org/wiki/Wikipedia:Verifiability)]
  33. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-33) ["Gartner Says the Internet of Things Installed Base Will Grow to 26 Billion Units By 2020"](http://www.gartner.com/newsroom/id/2636073). [Gartner](https://en.wikipedia.org/wiki/Gartner). 12 December 2013. Retrieved2 January 2014.
  34. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-34) [More Than 30 Billion Devices Will Wirelessly Connect to the Internet of Everything in 2020](http://www.abiresearch.com/press/more-than-30-billion-devices-will-wirelessly-conne), ABI Research
  35. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-35) Fickas, S.; Kortuem, G.; Segall, Z. (13–14 Oct 1997). "Software organization for dynamic and adaptable wearable systems".*International Symposium on Wearable Computers*: 56–63.[doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.1109/ISWC.1997.629920](https://dx.doi.org/10.1109%2FISWC.1997.629920).
  36. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-36) ["Main Report: An In-depth Look at Expert Responses"](http://www.pewinternet.org/2014/05/14/main-report-an-in-depth-look-at-expert-responses/). *Pew Research Center: Internet, Science & Tech*. 14 May 2014. Retrieved26 June 2015.
  37. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-How_Fast_Is_The_Internet_Growing_37-0) ["Behind The Numbers: Growth in the Internet of Things"](http://www.theconnectivist.com/2014/05/infographic-the-growth-of-the-internet-of-things/).*platform*. Retrieved 26 June 2015.
  38. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-38) ["Budget 2015: some of the things we've announced"](https://www.gov.uk/government/news/budget-2015-some-of-the-things-weve-announced). *gov.uk*. GOV.UK. Retrieved 31 March 2015.
  39. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-6LoWPAN_39-0) Kushalnagar, N; Montenegro, G; Schumacher, C (August 2007). "IPv6 over Low-Power Wireless Personal Area Networks (6LoWPANs): Overview, Assumptions, Problem Statement, and Goals". *IETF*[*RFC 4919*](https://tools.ietf.org/html/rfc4919).
  40. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-computerworld.com_40-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-computerworld.com_40-1) Sun, Charles C. (1 May 2014). ["Stop using Internet Protocol Version 4!"](http://www.computerworld.com/article/2488886/networking/stop-using-internet-protocol-version-4-.html). *Computerworld*.
  41. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-cio.com_41-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-cio.com_41-1) Sun, Charles C. (2014-05-01). ["Stop Using Internet Protocol Version 4!"](http://www.cio.com/article/752252/Stop_Using_Internet_Protocol_Version_4). CIO. Retrieved 2015-01-28.
  42. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-infoworld.com_42-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-infoworld.com_42-1) Sun, Charles C. (2 May 2014). ["Stop using Internet Protocol Version 4!"](http://www.infoworld.com/article/2607476/networking/stop-using-internet-protocol-version-4-.html). *InfoWorld*.
  43. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-idgnews.in_43-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-idgnews.in_43-1) Sun, Charles C. (1 May 2014). ["Stop using Internet Protocol Version 4!"](http://www.idgnews.in/content/stop-using-internet-protocol-version-4). *IDG News India*.
  44. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-1) [***c***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-2) [***d***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-3) [***e***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-4) [***f***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-5) [***g***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-6) [***h***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-7) ***[i](https://en.wikipedia.org/wiki/Internet_of_Things" \l "cite_ref-CoMAN_44-8)*** [***j***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-9) [***k***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-10) [***l***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-CoMAN_44-11) Ersue, M; Romascanu, D; Schoenwaelder, J; Sehgal, A (4 July 2014). "Management of Networks with Constrained Devices: Use Cases". *IETF Internet Draft < draft-ietf-opsawg-coman-use-cases>*.
  45. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-45) Vongsingthong, S.; Smanchat, S. (2014). ["Internet of Things: A review of applications & technologies"](http://ird.sut.ac.th/e-journal/Journal/suwimonv/1403739/1403739.pdf) (PDF). *Suranaree Journal of Science and Technology*.
  46. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Cisco-SmartCity_46-0) Mitchell, Shane; Villa, Nicola; Stewart-Weeks, Martin; Lange, Anne. ["The Internet of Everything for Cities: Connecting People, Process, Data, and Things To Improve the ‘Livability’ of Cities and Communities"](http://www.cisco.com/web/about/ac79/docs/ps/motm/IoE-Smart-City_PoV.pdf) (PDF). Cisco Systems. Retrieved 10 July 2014.
  47. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-PCQuest-Retail_47-0) Narayanan, Ajit. ["Impact of Internet of Things on the Retail Industry"](http://www.pcquest.com/pcquest/feature/214876/impact-internet-things-retail-industry). *PCQuest*. Cyber Media Ltd. Retrieved 20 May 2014.
  48. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-IoT-Butler-Shopping_48-0) CasCard; Gemalto; Ericsson. ["Smart Shopping: spark deals"](http://www.iot-butler.eu/wp-content/uploads/2011/10/BUTLER_PoC_SmartShopping_Poster_CasC.pdf)(PDF). *EU FP7 BUTLER Project*.
  49. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-49) Kyriazis, D.; Varvarigou, T.; Rossi, A.; White, D.; Cooper, J. (4–7 June 2013). "Sustainable smart city IoT applications: Heat and electricity management & Eco-conscious cruise control for public transportation". *IEEE International Symposium and Workshops on a World of Wireless, Mobile and Multimedia Networks (WoWMoM)*.[doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.1109/WoWMoM.2013.6583500](https://dx.doi.org/10.1109%2FWoWMoM.2013.6583500).
  50. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-50) ["Making your home 'smart', the Indian way"](http://timesofindia.indiatimes.com/tech/tech-news/Making-your-home-smart-the-Indian-way/articleshow/46311492.cms). *The Times of India*. Retrieved 26 June 2015.
  51. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-TETCIOT_51-0) Perera, Charith; Liu, Harold; Jayawardena, Srimal. ["The Emerging Internet of Things Marketplace From an Industrial Perspective: A Survey"](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=7004800). *Emerging Topics in Computing, IEEE Transactions on*. PrePrint. [doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.1109/TETC.2015.2390034](https://dx.doi.org/10.1109%2FTETC.2015.2390034). Retrieved 1 February2015.
  52. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-52) Couldry, Nick; Turow, Joseph (2014). "Advertising, Big Data, and the Clearance of the Public Realm: Marketers’ New Approaches to the Content Subsidy". *International Journal of Communication* **8**: 1710–1726.
  53. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-53) Moss, Jamie. ["The internet of things: unlocking the marketing potential"](http://www.theguardian.com/media-network/media-network-blog/2014/jun/20/internet-things-marketing-potential-data). *theguardian.com*. The Guardian. Retrieved 31 March2015.
  54. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-54) Meadows-Klue, Danny. ["A new era of personal data unlocked in an "Internet of Things""](http://www.digitalstrategyconsulting.com/articles/2014/10/a_new_era_of_personal_data_unlocked_in_an_internet_of_things.php).[*http://www.digitalstrategyconsulting.com*](http://www.digitalstrategyconsulting.com/). Digital Strategy Consulting. Retrieved 26 January 2015.
  55. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-How_the_Internet_of_Things_will_enable_.E2.80.98smart_buildings.E2.80.99_55-0) ["How the Internet of Things will enable ‘smart buildings’"](http://www.extremetech.com/extreme/209715-how-the-internet-of-things-will-enable-smart-buildings).
  56. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-IoT-EnvProt_56-0) Li, Shixing; Wang, Hong; Xu, Tao; Zhou, Guiping (2011). "Application Study on Internet of Things in Environment Protection Field". *Lecture Notes in Electrical Engineering Volume* **133**: 99–106.[doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.1007/978-3-642-25992-0\_13](https://dx.doi.org/10.1007%2F978-3-642-25992-0_13).
  57. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-FIT_57-0) FIT French Project. ["Use case: Sensitive wildlife monitoring"](http://fit-equipex.fr/use-cases/23-use-case-sensitive-wildlife-monitoring). Retrieved 10 July 2014.
  58. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-58) [Resource](https://en.wikipedia.org/wiki/Resource)
  59. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-IoT-Survey_59-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-IoT-Survey_59-1) Gubbi, Jayavardhana; Buyya, Rajkumar; Marusic, Slaven; Palaniswami, Marimuthu (24 February 2013). "Internet of Things (IoT): A vision, architectural elements, and future directions".*Future Generation Computer Systems* **29** (7): 1645–1660.[doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.1016/j.future.2013.01.010](https://dx.doi.org/10.1016%2Fj.future.2013.01.010).
  60. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-IoT-McKinsey_60-0) Chui, Michael; Löffler, Markus; Roberts, Roger. ["The Internet of Things"](http://www.mckinsey.com/insights/high_tech_telecoms_internet/the_internet_of_things). *McKinsey Quarterly*. McKinsey & Company. Retrieved10 July 2014.
  61. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-SmartTrash_61-0) Postscapes. ["Smart Trash"](http://postscapes.com/smart-trash). Retrieved 10 July 2014.
  62. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Butler-M2M_62-0) Severi, S.; Abreu, G.; Sottile, F.; Pastrone, C.; Spirito, M.; Berens, F. (23–26 June 2014). ["M2M Technologies: Enablers for a Pervasive Internet of Things"](https://www.academia.edu/6866526/M2M_Technologies_Enablers_for_a_Pervasive_Internet_of_Things). *The European Conference on Networks and Communications (EUCNC2014)*.
  63. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Future-IoT_63-0) Tan, Lu; Wang, Neng (20–22 August 2010). "Future Internet: The Internet of Things". *3rd International Conference on Advanced Computer Theory and Engineering (ICACTE)* **5**: 376–380.[doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.1109/ICACTE.2010.5579543](https://dx.doi.org/10.1109%2FICACTE.2010.5579543).
  64. ^ [Jump up to:***a***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-EMAN_64-0) [***b***](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-EMAN_64-1) Parello, J.; Claise, B.; Schoening, B.; Quittek, J. (28 April 2014). ["Energy Management Framework"](http://tools.ietf.org/html/draft-ietf-eman-framework-19). *IETF Internet Draft <draft-ietf-eman-framework-19>*.
  65. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-65) ["Why Wemo?"](http://www.belkin.com/us/Products/home-automation/c/wemo-home-automation/). Belkin. Retrieved 30 January 2015.
  66. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-66) ["Professional 4-Port Remote Power Switch - Phone Control + Web Control"](http://www.ambery.com/prreposwphco.html). Ambery.
  67. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-67) ["Budderfly - The Power to Manage ALL YOUR ENERGY"](http://www.budderfly.com/).
  68. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-68) ["EcoSmart - Where Energy Matters"](http://www.telkonet.com/).
  69. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-mHealth_69-0) Istepanian, R.; Hu, S.; Philip, N.; Sungoor, A. (30 August – 3 September 2011). "The potential of Internet of m-health Things "m-IoT" for non-invasive glucose level sensing". *Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*. [doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.1109/IEMBS.2011.6091302](https://dx.doi.org/10.1109%2FIEMBS.2011.6091302).
  70. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-SensorMania_70-0) Swan, Melanie (8 November 2012). ["Sensor Mania! The Internet of Things, Wearable Computing, Objective Metrics, and the Quantified Self 2.0"](http://www.mdpi.com/2224-2708/1/3/217/htm). *Sensor and Actuator Networks* **1** (3): 217–253. [doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.3390/jsan1030217](https://dx.doi.org/10.3390%2Fjsan1030217).
  71. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-71) ["Bangalore Crowd Pitch 2015: Check out these fresh startups!"](http://yourstory.com/2015/03/crowd-pitch-2015/).*YourStory.com*. Retrieved 26 June 2015.
  72. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-72) <http://asia.nikkei.com/print/article/77022>
  73. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-73) Rico, Juan (22–24 April 2014). "Going beyond monitoring and actuating in large scale smart cities". *NFC & Proximity Solutions - WIMA Monaco*.
  74. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-74) ["Sino-Singapore Guangzhou Knowledge City: A vision for a city today, a city of vision tomorrow"](http://www.ssgkc.com/). Retrieved 11 July 2014.
  75. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-75) ["San Jose Implements Intel Technology for a Smarter City"](http://newsroom.intel.com/community/intel_newsroom/blog/2014/06/11/san-jose-implements-intel-technology-for-a-smarter-city). Retrieved 11 July 2014.
  76. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-76) Coconuts Singapore. ["Western Singapore becomes test-bed for smart city solutions"](http://singapore.coconuts.co/2014/06/19/western-singapore-becomes-test-bed-smart-city-solutions). Retrieved 11 July 2014.
  77. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-EETimes_77-0) Lipsky, Jessica. ["IoT Clash Over 900 MHz Options"](http://www.eetimes.com/document.asp?doc_id=1326599). *EETimes*. EETimes. Retrieved 15 May 2015.
  78. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Fierce_Wireless_Tech_78-0) Alleven, Monica. ["Sigfox launches IoT network in 10 UK cities"](http://www.fiercewireless.com/tech/story/sigfox-launches-iot-network-10-uk-cities/2014-12-13).*Fierce Wireless Tech*. Fierce Wireless Tech. Retrieved 13 May 2015.
  79. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-EETimes2_79-0) Merritt, Rick. ["13 Views of IoT World"](http://www.eetimes.com/document.asp?doc_id=1326596). *EETimes*. EETimes. Retrieved 15 May 2015.
  80. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Gigaom2_80-0) Fitchard, Kevin. ["Sigfox brings its internet of things network to San Francisco"](https://gigaom.com/2014/05/20/sigfox-brings-its-internet-of-things-network-to-san-francisco/). *Gigaom*. Gigaom. Retrieved 15 May 2015.
  81. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-81) ["STE Security Innovation Awards Honorable Mention: The End of the Disconnect"](http://www.securityinfowatch.com/article/10840006/ste-security-innovation-awards-honorable-mention-the-end-of-the-disconnect). Retrieved 12 August 2015.
  82. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Brickley_et_al.2C_2001_82-0) Dan Brickley et al., c. 2001
  83. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Waldner.2C_2008_83-0) [Waldner, Jean-Baptiste](https://en.wikipedia.org/wiki/Jean-Baptiste_Waldner" \o "Jean-Baptiste Waldner) (2008). *Nanocomputers and Swarm Intelligence*. London: ISTE. pp. 227–231. [ISBN](https://en.wikipedia.org/wiki/International_Standard_Book_Number) [1-84704-002-0](https://en.wikipedia.org/wiki/Special:BookSources/1-84704-002-0).
  84. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-84) ["EPCIS - EPC Information Services Standard"](http://www.gs1.org/gsmp/kc/epcglobal/epcis). [GS1](https://en.wikipedia.org/wiki/GS1). Retrieved2 January 2014.
  85. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Miles.2C_2011_85-0) [Miles, Stephen B.](https://en.wikipedia.org/w/index.php?title=Stephen_Miles&action=edit&redlink=1) (2011). *RFID Technology and Applications*. London: Cambridge University Press. pp. 6–8. [ISBN](https://en.wikipedia.org/wiki/International_Standard_Book_Number) [978-0-521-16961-5](https://en.wikipedia.org/wiki/Special:BookSources/978-0-521-16961-5).
  86. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Gautier.2C_2007_86-0) Philippe Gautier, « RFID et acquisition de données évènementielles : retours d'expérience chez Bénédicta », pages 94 à 96, Systèmes d'Information et Management - revue trimestrielle N°2 Vol. 12, 2007, ISSN 1260-4984 / [ISBN 978-2-7472-1290-8](https://en.wikipedia.org/wiki/Special:BookSources/9782747212908), éditions ESKA. [[2]](http://revuesim.free.fr/index.php?page=detail&num_article=259&search=ok)
  87. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Gautier.2C_2010_87-0) Philippe GAUTIER (17 April 2010). ["3 questions to Philippe GAUTIER, by David Fayon (from the original interview by David Fayon, in French : http://david.fayon.free.fr/interview/philippe-gautier.htm) - I-O-T : INTERNET Of THINGS / Internet des Objets"](http://www.i-o-t.org/post/3questionstoPhilippeGAUTIERbyDavidFayon). Retrieved 26 June 2015.
  88. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Perera7_88-0) Charith Perera; Arkady Zaslavsky; Peter Christen & Dimitrios Georgakopoulos (2013). ["Context Aware Computing for The Internet of Things: A Survey"](http://dx.doi.org/10.1109/SURV.2013.042313.00197). *Communications Surveys Tutorials, IEEE* **PP** (n/a): 1–44. [doi](https://en.wikipedia.org/wiki/Digital_object_identifier):[10.1109/SURV.2013.042313.00197](https://dx.doi.org/10.1109%2FSURV.2013.042313.00197).
  89. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Gautier_2011_89-0) Gautier, Philippe; Gonzalez, Laurent (2011). *[L'Internet des Objets… Internet, mais en mieux](http://excerpts.numilog.com/books/9782124653164.pdf)* (PDF). foreword by Gérald Santucci (European commission), postword by [Daniel Kaplan (FING)](https://en.wikipedia.org/w/index.php?title=Daniel_Kaplan_(FING)&action=edit&redlink=1)and [Michel Volle](https://en.wikipedia.org/w/index.php?title=Michel_Volle&action=edit&redlink=1). Paris: [AFNOR](https://en.wikipedia.org/wiki/AFNOR) editions. [ISBN](https://en.wikipedia.org/wiki/International_Standard_Book_Number) [978-2-12-465316-4](https://en.wikipedia.org/wiki/Special:BookSources/978-2-12-465316-4).
  90. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-Waldner.2C_2007_90-0) [Waldner, Jean-Baptiste](https://en.wikipedia.org/wiki/Jean-Baptiste_Waldner" \o "Jean-Baptiste Waldner) (2007). *Nanoinformatique et intelligence ambiante. Inventer l'Ordinateur du XXIeme Siècle*. London: [Hermes Science](https://en.wikipedia.org/w/index.php?title=Hermes_Science&action=edit&redlink=1). p. 254. [ISBN](https://en.wikipedia.org/wiki/International_Standard_Book_Number) [2-7462-1516-0](https://en.wikipedia.org/wiki/Special:BookSources/2-7462-1516-0).
  91. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-91) ["The Enterprise Internet of Things Market - Business Insider"](http://www.businessinsider.com/the-enterprise-internet-of-things-market-2014-12).*Business Insider*. 25 February 2015. Retrieved 26 June 2015.
  92. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-92) Olga Kharif (8 January 2014). ["Cisco CEO Pegs Internet of Things as $19 Trillion Market"](http://www.bloomberg.com/news/2014-01-08/cisco-ceo-pegs-internet-of-things-as-19-trillion-market.html). *Bloomberg.com*. Retrieved 26 June 2015.
  93. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-93) ["Internet of Things: The "Basket of Remotes" Problem"](http://www.mondaynote.com/2014/01/12/internet-of-things-the-basket-of-remotes-problem/).*Monday Note*. Retrieved 26 June 2015.
  94. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-94) ["Better Business Decisions with Advanced Predictive Analytics"](http://www.intel.com/content/www/us/en/it-management/intel-it-best-practices/better-business-decisions-with-advanced-predictive-analytics-video.html).*Intel*. Retrieved 26 June 2015.
  95. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-95) ["Nuve - Asset Management and Fraud Prevention"](http://www.nuve.us/). *Nuve - Asset Management and Fraud Prevention*. Retrieved 26 June 2015.
  96. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-96) ["Tibbo now is a member of the Internet of Things Council"](http://www.theinternetofthings.eu/victor-polyakov).
  97. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-97) ["Tibbo Systems has become an official member of StarNet Alliance"](http://starnetalliance.com/news/7). Retrieved 23 July 2015.
  98. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-98) ["A list of IoT and M2M platforms"](http://monblocnotes.com/node/1979).
  99. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-99) Maxine Bingham (10 January 2015). ["IoT startups (A-F)"](http://www.iotperspectives.com/iot-startups-a-f.html). IoT Perspectives. Retrieved 30 March 2015.
  100. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-100) ["Number One Consumer Brands are Selecting the Arrayent Connect(TM) Platform to Power Their Connected Product Initiatives"](http://www.marketwatch.com/story/number-one-consumer-brands-are-selecting-the-arrayent-connecttm-platform-to-power-their-connected-product-initiatives-2012-12-19). Market Watch. 19 December 2012. Retrieved30 March 2015.
  101. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-101) ["Arrayent Brings the Internet of Things to Life with New Products at CES 2014"](http://www.businesswire.com/news/home/20140102005921/en/Arrayent-Brings-Internet-Life-Products-CES-2014#.VQNV9zHF-b4). Business Wire. 2 January 2014. Retrieved 30 March2015.
  102. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-102) Boccamazzo, Allison (28 January 2015). ["B-Scada Launches New IoT Initiative at ITEXPO 2015"](http://www.m2mevolution.com/topics/m2mevolution/articles/397213-b-scada-launches-new-iot-initiative-itexpo-2015.htm). *TMCnet*.
  103. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-103) ["B-Scada Takes SCADA to the Cloud"](http://www.automation.com/product-showcase/b-scada-takes-scada-to-the-cloud). *Automation.com*. Retrieved 13 February 2015.
  104. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-104) ["What is Carriots"](https://www.carriots.com/what-is-carriots). *Carriots official site*. Retrieved 10 October2013.
  105. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-105) Higginbotham, Stacey. ["Carriots is building a PaaS for the Internet of Things"](http://gigaom.com/2013/04/26/carriots-is-building-a-paas-for-the-internet-of-things/). *GigaOM*. Retrieved 26 April 2013.
  106. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-106) ["IoT Startup EVRYTHNG Secures $7M Series A From Atomico, BHLP, Cisco And Dawn"](http://techcrunch.com/2014/04/30/iot-startup-evrythng-secures-7m-series-a-from-atomico-bhlp-cisco-and-dawn/). *Techcrunch*.
  107. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-businessjournal_107-0) Katharine Greyson (22 October 2013). ["Is Minn.'s next big thing the Internet of Things?"](http://www.bizjournals.com/twincities/blog/in_private/2013/10/is-internet-of-things-minns-next.html?page=all). Minneapolis-Saint Paul Business Journal.
  108. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-cioreview_108-0) ["Exosite: Extending Big Data to Next Generation Of Cloud Solutions"](http://www.cioreview.com/company/exosite-extending-big-data-to-next-generation-of-cloud-solutions-cid-677-rntid-1.html). CIOReview.
  109. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-electronicdesign_109-0) Bill Wong (1 May 2014). "Dev Kits Light Up The Internet Of Things". Electronic Design.
  110. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-110) Bowen, Suzanne. ["Interview with nPhase (Qualcomm - Verizon) Steve Pazol on M2M"](http://www.didx.net/podcast/?p=episode&name=2010-09-22_nphasesept132010.mp3). *DIDX Audio Podcast Newspaper*. Retrieved9 April 2013.
  111. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-111) Bowen, Suzanne. ["Raco Wireless John Horn on the Connected World and M2M"](http://www.didx.net/podcast/?p=episode&name=2012-06-14_racowireless_connectedworld_johnhorn.mp3). *DIDX Audio Podcast Newspaper*. Retrieved9 April 2013.
  112. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-112) Fitchard, Kevin (26 February 2013). ["T-Mobile’s M2M provider Raco goes international with Sprint, Telefónica deals"](http://gigaom.com/2013/02/26/t-mobiles-m2m-provider-raco-goes-international-with-sprint-telefonica-deals/). *GigaOm*.
  113. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-113) Rizzo, Tony (12 March 2013). ["ThingWorx Drives M2M and IoT Developer Efficiency with New Platform Release"](http://www.m2mevolution.com/topics/m2mevolution/articles/330202-thingworx-drives-m2m-iot-developer-efficiency-with-new.htm). *TMCnet*.
  114. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-114) Bowen, Suzanne. ["ThingWorx CEO Russell Fadel on M2M and the Connected World"](http://www.didx.net/podcast/?p=episode&name=2013-02-07_thingworx_machine2machine.mp3). *DIDX Audio Podcast Newspaper*. Retrieved9 April 2013.
  115. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-115) ["ThingWorx"](http://www.ptc.com/product/thingworx).
  116. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-116) ["Tech pages/IoT systems"](http://wiki.xmpp.org/web/Tech_pages/IoT_systems). Retrieved 26 June 2015.
  117. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-117) <http://www.youtube.com/user/MASHPlatform> "YouTube channel"
  118. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-118) Verbeek, Peter-Paul. "Moralizing Technology: Understanding and Designing the Morality of Things." Chicago: *The University of Chicago Press,* 2011.
  119. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-119) Diane Cardwell, [At Newark Airport, the Lights Are On, and They’re Watching You](http://www.nytimes.com/2014/02/18/business/at-newark-airport-the-lights-are-on-and-theyre-watching-you.html?_r=0), [*The New York Times*](https://en.wikipedia.org/wiki/The_New_York_Times)*,* 2014.02.17
  120. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-120) Hardy, Quentin (4 February 2015). ["Tim O’Reilly Explains the Internet of Things"](http://bits.blogs.nytimes.com/2015/02/04/tim-oreilly-explains-the-internet-of-things/). *The New York Times Bits* (The New York Times). Retrieved 18 May 2015.
  121. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-121) Webb, Geoff (5 February 2015). ["Say Goodbye to Privacy"](http://www.wired.com/2015/02/say-goodbye-to-privacy/).[WIRED](https://en.wikipedia.org/wiki/WIRED). Retrieved 15 February 2015.
  122. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-122) Catherine Crump and Matthew Harwood, [The Net Closes Around Us](http://www.tomdispatch.com/post/175822/tomgram%3A_crump_and_harwood%2C_the_net_closes_around_us/), *[TomDispatch](https://en.wikipedia.org/wiki/Tom_Engelhardt" \o "Tom Engelhardt)*, 25 March 2014
  123. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-ITPIOT_123-0) Perera, Charith; Ranjan, Rajiv; Wang, Lizhe; Khan, Samee; Zomaya, Albert (2015). ["Privacy of Big Data in the Internet of Things Era"](http://arxiv.org/abs/1412.8339). *IEEE IT Professional Magazine*. PrePrint (Internet of Anything). Retrieved 1 February 2015.
  124. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-124) Chris Clearfield. ["Why The FTC Can't Regulate The Internet Of Things"](http://www.forbes.com/sites/chrisclearfield/2013/09/18/why-the-ftc-cant-regulate-the-internet-of-things/). *Forbes*. Retrieved 26 June 2015.
  125. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-125) ["We Asked Executives About The Internet Of Things And Their Answers Reveal That Security Remains A Huge Concern"](http://www.businessinsider.in/We-Asked-Executives-About-The-Internet-Of-Things-And-Their-Answers-Reveal-That-Security-Remains-A-Huge-Concern/articleshow/45959921.cms).*Business Insider*. Retrieved 26 June 2015.
  126. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-126) [Christopher Clearfield "Rethinking Security for the Internet of Things" Harvard Business Review Blog, 26 June 2013](http://blogs.hbr.org/2013/06/rethinking-security-for-the-in)/
  127. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-127) [Joseph Steinberg](https://en.wikipedia.org/wiki/Joseph_Steinberg) (27 January 2014). ["These Devices May Be Spying On You (Even In Your Own Home)"](http://www.forbes.com/sites/josephsteinberg/2014/01/27/these-devices-may-be-spying-on-you-even-in-your-own-home/). Forbes. Retrieved27 May 2014.
  128. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-128) [Andy Greenberg](https://en.wikipedia.org/wiki/Andy_Greenberg) (21 July 2015). ["Hackers Remotely Kill a Jeep on the Highway—With Me in It"](http://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/). Wired. Retrieved 21 July 2015.
  129. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-129) [Disruptive Technologies Global Trends 2025. National Intelligence Council (NIC), April 2008, P. 27.](http://www.fas.org/irp/nic/disruptive.pdf)
  130. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-130) Ackerman, Spencer (15 March 2012). ["CIA Chief: We'll Spy on You Through Your Dishwasher"](http://www.wired.com/dangerroom/2012/03/petraeus-tv-remote/). *WIRED*. Retrieved 26 June 2015.
  131. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-131) Livingstone, Sonia (2009). *Children and the Internet* (1st ed.). London: Polity. [ISBN](https://en.wikipedia.org/wiki/International_Standard_Book_Number) [978-0-7456-3194-3](https://en.wikipedia.org/wiki/Special:BookSources/978-0-7456-3194-3).
  132. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-132) [Roy Thomas Fielding, Architectural Styles and the Design of Network-based Software Architectures (2000), Dissertation - Doctor of Philosophy in Information and Computer Science](https://www.ics.uci.edu/~fielding/pubs/dissertation/fielding_dissertation.pdf)
  133. [**Jump up^**](https://en.wikipedia.org/wiki/Internet_of_Things#cite_ref-133) Littman, Michael and Samuel Kortchmar. ["The Path To A Programmable World"](http://footnote1.com/the-path-to-a-programmable-world/). *Footnote*. Retrieved 14 June 2014.

## Further reading[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=32" \o "Edit section: Further reading)]

* Zanella, Andrea; Bui, Nicola; Castellani, Angelo; Vangelista, Lorenzo & Zorzi, Michele. ["Internet of Things for Smart Cities"](http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6740844). IEEE Internet of Things Journal, VOL. 1, NO. 1, FEBRUARY 2014.
* Atzori, Luigi; Iera, Antonio & Morabito, Giacomo. ["The internet of things: A survey"](http://www.inf.ufpr.br/rtv06/iot/IoT%20-%20A%20survey.pdf) (PDF). Computer Networks, Elsevier, The Netherlands, 2010.
* Carsten, Paul (2015). ["Lenovo to stop pre-installing controversial software"](http://www.reuters.com/article/2015/02/19/us-lenovo-cybersecurity-idUSKBN0LN0XI20150219). Reuters.
* Chaouchi, Hakima. The Internet of Things. London: Wiley-ISTE, 2010.
* Chabanne, Herve, Pascal Urien, and Jean-Ferdinand Susini. RFID and the Internet of Things. London: ISTE, 2011.
* ["Disruptive Technologies Global Trends 2025"](http://www.fas.org/irp/nic/disruptive.pdf) (PDF). U.S. National Intelligence Council (NIC).
* Fell, Mark (2014). ["Roadmap for the Emerging Internet of Things - Its Impact, Architecture and Future Governance"](http://carre-strauss.com/documents/IoT_Roadmap.pdf) (PDF). Carré & Strauss, United Kingdom.
* Fell, Mark (2013). ["Manifesto for Smarter Intervention in Complex Systems"](http://carre-strauss.com/documents/Smarter_Intervention_In_Complex_Systems.pdf) (PDF). Carré & Strauss, United Kingdom.
* Jayavardhana Gubbi; Rajkumar Buyya; Slaven Marusic; Marimuthu Palaniswami (September 2013). ["Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions"](http://www.buyya.com/papers/Internet-of-Things-Vision-Future2013.pdf) (PDF). Future Generation Computer Systems, Elsevier, The Netherlands.
* Hersent, Olivier, David Boswarthick and Omar Elloumi. The Internet of Things: Key Applications and Protocols. Chichester, West Sussex: Wiley, 2012.
* Howard, Philip. ["Pax Technica: Will The Internet of Things Lock Us Up or Set Us Free?"](http://www.paxtechnica.org/). Yale University Press, New Haven CT, 2015.
* ["Internet of Things in 2020: A Roadmap for the future"](http://www.smart-systems-integration.org/public/documents/publications/Internet-of-Things_in_2020_EC-EPoSS_Workshop_Report_2008_v3.pdf) (PDF). EPoSS.
* Ishaq, Isam; Carels, David; Teklemariam ,Girum K.; Hoebeke, Jeroen; Van den Abeele, Floris; De Poorter, Eli; Moerman, Ingrid & Demeester, Piet (2013). ["IETF Standardization in the Field of the Internet of Things (IoT): A Survey"](http://www.mdpi.com/2224-2708/2/2/235/htm). Journal of Sensor and Actuator Networks, Multidisciplinary Digital Publishing Institute.
* [IERC - European Research Cluster on the Internet of Things: Documents and Publications](http://www.internet-of-things-research.eu/documents.htm)
* Michahelles, Florian, et al. Proceedings of 2012 International Conference on the Internet of Things (IOT) : 24–26 October 2012 : Wuxi, China. Piscataway, N.J.: IEEE, 2012.
* ["What is the Internet of Things? An Economic Perspective"](http://www.autoidlabs.org/uploads/media/AUTOIDLABS-WP-BIZAPP-53.pdf) (PDF). Auto-ID Labs.
* Pfister, Cuno. Getting Started with the Internet of Things. Sebastapool, Calif: O'Reilly Media, Inc., 2011.
* Uckelmann, Dieter, Mark Harrison and Florian Michahelles. Architecting the Internet of Things. Berlin: Springer, 2011.
* Weber, Rolf H., and Romana Weber. Internet of Things: Legal Perspectives. Berlin: Springer, 2010.
* Zhou, Honbo. The Internet of Things in the Cloud: A Middleware Perspective. Boca Raton: CRC Press, Taylor & Francis Group, 2013.

## External links[[edit](https://en.wikipedia.org/w/index.php?title=Internet_of_Things&action=edit&section=33" \o "Edit section: External links)]

* ["A New Economic Vision for Addressing Climate Change (Internet of things - part II)"](http://www.huffingtonpost.com/jeremy-rifkin/obamas-climate-change-plan_b_5427656.html). *Huffington Post*. 2 June 2014. (2014-06-02) and ["Monopoly Capitalism vs. Collaborative Commons (Internet of things - part I)"](http://www.huffingtonpost.com/jeremy-rifkin/internet-of-things_b_5104072.html). *Huffington Post*. 7 April 2014. (2014-04-07)
* [Pew Internet canvas of experts](http://www.pewinternet.org/2014/05/14/internet-of-things/), prognosticating on the nature, application, and impact of the Internet of Things in 2025
* ["The Creepy New Wave of the Internet (Internet of things)"](http://www.nybooks.com/articles/archives/2014/nov/20/creepy-new-wave-internet/). (2014-11-02), [*New York Review of Books*](https://en.wikipedia.org/wiki/New_York_Review_of_Books)
* [The IoT Council](http://www.theinternetofthings.eu/)
* [Internet of Things and People research center at Malmö University, Sweden](http://iotap.mah.se/)

IoT မ်ားအေနျဖင္႔ အခြင္႔အလမ္း

<http://store.electronfun.space/product/tower-pro-sg90-micro-servo/>

ဆာဗိုေမာ္တာ ၂ လံုး

Female to Female jumper ႀကိဳး အေခ်ာင္း ၂၀

Male to Male jumper ႀကိဳး အေခ်ာင္း ၂၀

Male to Female juper ႀကိဳး အေခ်ာင္း ၂၀

ဝါယာလက္ adapter for raspberry pi

Jitsi