# INFOLINE

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## DEPARTMENT OF COMPUTER TECHNOLOGY AND INFORMATION TECHNOLOGY

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# INFOLINE

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## INTERNET OF THINGS (IoT)

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an IP address and is able to transfer data over a network. Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.

### History of IoT

Kevin Ashton, co-founder of the Auto-ID Center at MIT, first mentioned the internet of things in a presentation he made to Procter & Gamble (P&G) in 1999. Wanting to bring radio frequency ID (RFID) to the attention of P&G's senior management, Ashton called his presentation "Internet of Things" to incorporate the cool new trend of 1999: the internet. IoT has evolved from the convergence of wireless technologies, micro electromechanical systems (MEMS), micro services and the internet. The convergence has helped tear down the silos between operational technologies (OT) and information technology (IT), enabling unstructured machine-generated data to be analyzed for insights to drive improvements.

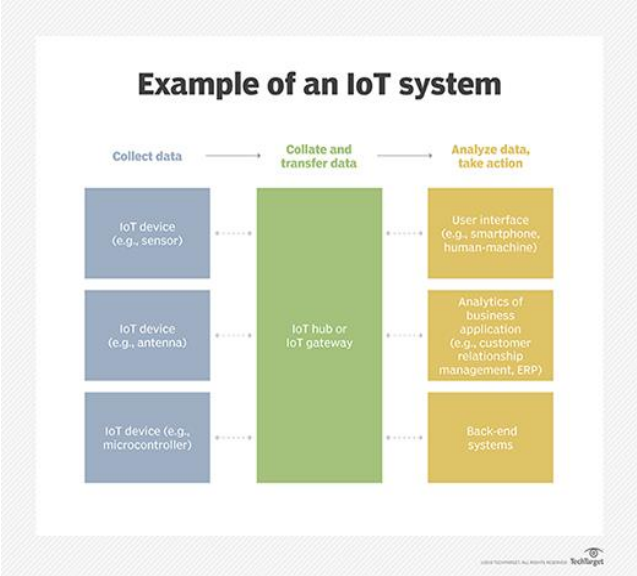
Ashton's was the first mention of the internet of things, the idea of connected devices has been around since the 1970s, under the monikers embedded internet and pervasive computing. The first internet appliance, for example, was a Coke machine at Carnegie Mellon University in the early 1980s. Using the web, programmers could check the status of the machine and determine whether there would be a cold drink awaiting them, should they decide to make the trip to the machine.

IoT evolved from machine-to-machine (M2M) communication, i.e., machines connecting to each other via a network without human interaction. M2M refers to connecting a device to the cloud, managing it and collecting data. Taking M2M to the next level, IoT is a sensor network of billions of smart devices that connect people, systems and other applications to collect and share data. As its foundation, M2M offers the connectivity that enables IoT. The internet of things is also a natural extension of SCADA (supervisory control and data acquisition), a category of software application program for process control, the gathering of data in real time from remote locations to control equipment and conditions. SCADA systems include hardware and software components. The hardware gathers

and feeds data into a computer that has SCADA software installed, where it is then processed and presented it in a timely manner. The evolution of SCADA is such that late-generation SCADA systems developed into first-generation IoT systems. The concept of the IoT ecosystem, however, didn't really come into its own until the middle of 2010 when, in part, the government of China said it would make IoT a strategic priority in its five-year plan.

**How IoT works**

An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors and communication hardware to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices for instance, to set them up, give them instructions or access the data. The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.




**Benefits of IoT**

The internet of things offers a number of benefits to organizations, enabling them to:

- Monitor their overall business processes
- Improve the customer experience
- Save time and money
- Enhance employee productivity
- Integrate and adapt business models
- Make better business decisions
- Generate more revenue.

IoT encourages companies to rethink the ways they approach their businesses, industries and markets and gives them the tools to improve their business strategies.

**Consumer and enterprise IoT applications**

There are numerous real-world applications of the internet of things, ranging from consumer IoT and enterprise IoT to manufacturing and industrial IoT (IIoT). IoT applications span numerous verticals, including automotive, telco, energy and more. In the

consumer segment, for example, smart homes that are equipped with smart thermostats, smart appliances and connected heating, lighting and electronic devices can be controlled remotely via computers, smartphones or other mobile devices. Wearable devices with sensors and software can collect and analyze user data, sending messages to other technologies about the users with the aim of making users' lives easier and more comfortable. Wearable devices are also used for public safety  for example, improving first responders' response times during emergencies by providing optimized routes to a location or by tracking construction workers' or firefighters' vital signs at life-threatening sites.

In healthcare, IoT offers many benefits, including the ability to monitor patients more closely to use the data that's generated and analyze it. Hospitals often use IoT systems to complete tasks such as inventory management, for both pharmaceuticals and medical instruments.


Smart buildings can, for instance, reduce energy costs using sensors that detect how many occupants are in a room. The temperature can adjust automatically for example, turning the air conditioner on if sensors detect a conference room is full or turning the heat down if everyone in the office has gone home. In agriculture, IoT based smart farming systems can help monitor, for instance, light, temperature, humidity and soil moisture of crop fields using connected sensors. IoT is also instrumental in automating irrigation systems.

In a smart city, IoT sensors and deployments, such as smart streetlights and smart meters, can help alleviate traffic, conserve energy, monitor and address environmental concerns, and improve sanitation.

**The future of IoT**

There is no shortage of IoT market estimations. For example:

- Bain & Company expects annual IoT revenue of hardware and software to exceed $450 billion by 2020.
- McKinsey & Company estimates IoT will have an $11.1 trillion impact by 2025.
- IHS Markit believes the number of connected IoT devices will increase 12% annually to reach 125 billion in 2030.
- Gartner assesses that 20.8 billion connected things will be in use by 2020, with total spend on IoT devices and services to reach $3.7 trillion in 2018.

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## AUGMENTED REALITY

**Augmented reality** (**AR**) is an interactive experience of a real-world environment where the objects that reside in the real-world are "augmented" by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory. The overlaid sensory information can be constructive (i.e. additive to the natural environment) or destructive (i.e. masking of the natural environment) and is seamlessly interwoven with the physical world such that it is perceived as an immersive aspect of the real environment. In this way, augmented reality alters one's ongoing perception of a real-world environment, whereas virtual reality completely replaces the user's real-world environment with a simulated one. Augmented reality is related to two largely synonymous terms: mixed reality and computer-mediated reality.

The primary value of augmented reality is that it brings components of the digital world into a person's perception of the real world, and does so not as a simple display of data, but through the integration of immersive sensations that are perceived as natural parts of an environment. The first functional AR systems that provided immersive mixed reality experiences for users were invented in the early 1990s, starting with the Virtual Fixtures system developed at the U.S. Air Force's Armstrong Laboratory in 1992. The first commercial augmented reality experiences were used largely in the entertainment and gaming businesses, but now other industries are also getting interested about AR's possibilities for example in knowledge sharing, educating, managing the information flood and organizing distant meetings. Augmented reality is also transforming the world of education, where content may be accessed by scanning or viewing an image with a mobile device or by bringing immersive, markerless AR experiences to the classroom. Another example is an AR helmet for construction workers which display information about the construction sites.

Augmented reality is used to enhance natural environments or situations and offer perceptually enriched experiences. With the help of advanced AR technologies (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally manipulable. Information about the environment and its objects is overlaid on the real world. This information can be virtual or real, e.g. seeing other real sensed or measured information such as electromagnetic radio waves overlaid in exact alignment with where they actually are in space. Augmented reality also has a lot of potential in the gathering and sharing of tacit knowledge. Augmentation techniques are typically performed in real time and in semantic context with environmental elements. Immersive perceptual information is sometimes combined with supplemental information like scores over a live video feed of a sporting event. This combines the benefits of both augmented reality technology and heads up display technology (HUD).

## Technology

### Hardware

Hardware components for augmented reality are: processor, display, sensors and input devices. Modern mobile computing devices like smart phones and tablet computers contain these elements which often include a camera and MEMS sensors such as accelerometer, GPS, and solid state compass, making them suitable AR platforms. There are 2 technologies: diffractive waveguides and reflective waveguides. Augmented reality systems guru Karl Guttag compared the optics of diffractive waveguides against the competing technology, reflective waveguides.

### Display

Various technologies are used in augmented reality rendering, including optical projection systems, monitors, handheld devices, and display systems worn on the human body. A head-mounted display (HMD) is a display device worn on the forehead, such as a harness or helmet. HMDs place images of both the physical world and virtual objects over the user's field of view. Modern HMDs often employ sensors for six degrees of freedom monitoring that allow the system to align virtual information to the physical world and adjust accordingly with the user's head movements. HMDs can provide VR users with mobile and collaborative experiences Specific providers, such as uSens and Gestigon, include gesture controls for full virtual immersion. AR displays can be rendered on devices resembling eyeglasses. Versions include eyewear that employs cameras to intercept the real world view and re-display its augmented view through the eyepieces and devices in which the AR imagery is projected through or reflected off the surfaces of the eyewear's lens pieces.

**Headset computer**

A head-up display (HUD) is a transparent display that presents data without requiring users to look away from their usual viewpoints. A precursor technology to augmented reality, heads-up displays were first developed for pilots in the 1950s, projecting simple flight data into their line of sight, thereby enabling them to keep their "heads up" and not look down at the instruments. Near-eye augmented reality devices can be used as portable head-up displays as they can show data, information, and images while the user views the real world. Many definitions of augmented reality only define it as overlaying the information. This is basically what a head-up display does; however, practically speaking, augmented reality is expected to include registration and tracking between the superimposed perceptions, sensations, information, data, and images and some portion of the real world.

A number of smartglasses have been launched for augmented reality. Due to encumbered control, smartglasses are primarily designed for micro-interaction like reading a text message but still far from more well-rounded applications of augmented reality.

**Contact Lenses**

Contact lenses that display AR imaging are in development. These bionic contact lenses might contain the elements for display embedded into the lens including integrated circuitry, LEDs and an antenna for wireless communication. The first contact lens display was reported in 1999, then 11 years later in 2010-2011. Another version of contact lenses, in development for the U.S. military, is designed to function with AR spectacles, allowing soldiers to focus on close-to-the-eye AR images on the spectacles and distant real world objects at the same time.

Many scientists have been working on contact lenses capable of many different technological feats. The company Samsung has been working on a contact lens as well. This lens, when finished, is meant to have a built-in camera on the lens itself. The design is intended to have you blink to control its interface for recording purposes. It is also intended to be linked with your smartphone to review footage, and control it separately. When successful, the lens would feature a camera, or sensor inside of it. It is said that it could be anything from a light sensor, to a temperature sensor.

In Augmented Reality, the distinction is made between two distinct modes of tracking, known as marker and markerless. Markers are visual cues which trigger the display of the virtual information. A piece of paper with some distinct geometries can be used. The camera recognizes the geometries by identifying specific points in the drawing. Markerless tracking, also called instant tracking, does not

use markers. Instead the user positions the object in the camera view preferably in a horizontal plane. It uses sensors in mobile devices to accurately detect the real-world environment, such as the locations of walls and points of intersection.

A virtual retinal display (VRD) is a personal display device under development at the University of Washington's Human Interface Technology Laboratory under Dr. Thomas A. Furness III.[56] With this technology, a display is scanned directly onto the retina of a viewer's eye. This results in bright images with high resolution and high contrast. The viewer sees what appears to be a conventional display floating in space.

Several of tests were done in order to analyze the safety of the VRD. In one test, patients with partial loss of vision were selected to view images using the technology having either macular degeneration (a disease that degenerates the retina) or keratoconus. In the macular degeneration group, 5 out of 8 subjects preferred the VRD images to the CRT or paper images and thought they were better and brighter and were able to see equal or better resolution levels. The Kerocunus patients could all resolve smaller lines in several line tests using the VDR as opposed to their own correction. They also found the VDR images to be easier to view and sharper. As a result of these several tests, virtual retinal display is considered safe technology.

Virtual retinal display creates images that can be seen in ambient daylight and ambient roomlight. The VRD is considered a preferred candidate to use in a surgical display due to its combination of high resolution and high contrast and brightness. Additional tests show high potential for VRD to be used as a display technology for patients that have low vision.

**Eyetap**

The EyeTap (also known as Generation-2 Glass) captures rays of light that would otherwise pass through the center of the lens of the eye of the wearer, and substitutes synthetic computer-controlled light for each ray of real light.

The Generation-4 Glass (Laser EyeTap) is similar to the VRD (i.e. it uses a computer-controlled laser light source) except that it also has infinite depth of focus and causes the eye itself to, in effect, function as both a camera and a display by way of exact alignment with the eye and resynthesis (in laser light) of rays of light entering the eye.

**Spatial**

Spatial augmented reality (SAR) augments real-world objects and scenes without the use of special displays such as monitors, head-mounted displays or hand-held devices. SAR makes use of digital projectors to display graphical information onto physical objects. The key difference in SAR is that the

display is separated from the users of the system. Because the displays are not associated with each user, SAR scales naturally up to groups of users, thus allowing for collocated collaboration between users. Examples include shader lamps, mobile projectors, virtual tables, and smart projectors. Shader lamps mimic and augment reality by projecting imagery onto neutral objects, providing the opportunity to enhance the object's appearance with materials of a simple unit a projector, camera, and sensor.

Other applications include table and wall projections. One innovation, the Extended Virtual Table, separates the virtual from the real by including beam-splitter mirrors attached to the ceiling at an adjustable angle. Virtual showcases, which employ beam-splitter mirrors together with multiple graphics displays, provide an interactive means of simultaneously engaging with the virtual and the real. Many more implementations and configurations make spatial augmented reality display an increasingly attractive interactive alternative. A SAR system can display on any number of surfaces of an indoor setting at once. SAR supports both a graphical visualization and passive haptic sensation for the end users. Users are able to touch physical objects in a process that provides passive haptic sensation.

**Tracking**

Modern mobile augmented-reality systems use one or more of the following motion tracking technologies: digital cameras and/or other optical sensors, accelerometers, GPS, gyroscopes, solid state compasses, RFID. These technologies offer varying levels of accuracy and precision. The most important is the position and orientation of the user's head. Tracking the user's hand(s) or a handheld input device can provide a 6DOF interaction technique.

**Networking**

Mobile augmented reality applications are gaining popularity due to the wide adoption of mobile and especially wearable devices. However, they often rely on computationally intensive computer vision algorithms with extreme latency requirements. To compensate for the lack of computing power, offloading data processing to a distant machine is often desired. Computation offloading introduces new constraints in applications, especially in terms of latency and bandwidth. Although there are a plethora of real-time multimedia transport protocols, there is a need for support from network infrastructure as well.

**Input devices**

Techniques include speech recognition systems that translate a user's spoken words into computer instructions, and gesture

recognition systems that interpret a user's body movements by visual detection or from sensors embedded in a peripheral device such as a wand, stylus, pointer, glove or other body wear. Products which are trying to serve as a controller of AR headsets include Wave by Seebright Inc. and Nimble by Intugine Technologies.

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## FOLDABLE SMART PHONES IN 2019

### Samsung Galaxy Fold

At Unpacked 2019 Samsung revealed more details about the Galaxy Fold, which goes on sale on 3 May at a staggering 2000 Euros (26 April at $1980 in the US). In the UK you can pre-register your interest now, and pre-order from Samsung or EE from 26 April. There's a 4.6in HD+ Super AMOLED screen on the outside of the device, which can be unfolded to reveal a larger 7.3in QXGA+ Dynamic AMOLED display that can display three apps at once. The exterior screen is not usable in this position, but App Continuity allows you to continue what you were doing on the smaller screen on the larger display.

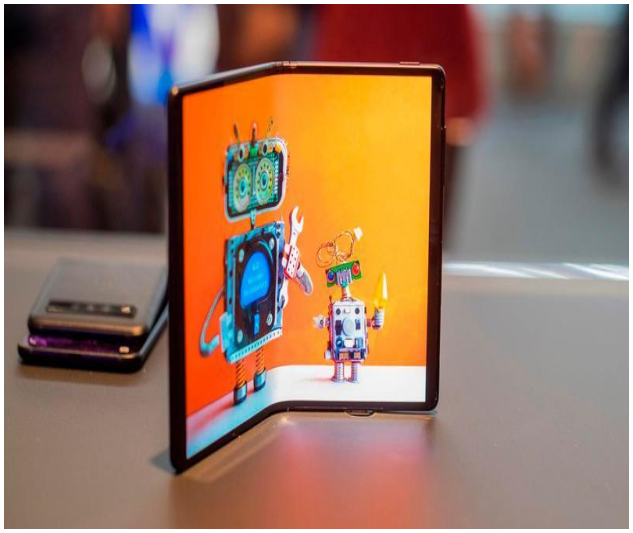
Galaxy Fold has a total of six cameras, with three (16Mp + 12Mp + 12Mp) on the back, two inside (10Mp + 8Mp) and one (10Mp) on the front in its folded position. The new Samsung phone features 12GB of RAM, 512GB of storage and a fast 7nm 64-bit octa-core processor. The battery is rated at 4,380mAh.

The phone uses a new custom operating system called One UI, which is much more simplified than what we are used to seeing on Samsung devices, and optimised for one-handed use. Samsung reportedly has two more foldable phones in the planning stages, with Bloomberg reporting that two very different designs see one phone much more like the Huawei Mate X below, with a large outer wraparound screen, and the other a vertically oriented clamshell with a small external display.

### Huawei Mate X

Huawei may well have outdone Samsung just four days after Unpacked when it announced the Mate X at MWC 2019. It folds the opposite way to the Galaxy Fold and has a more expansive near bezel-less display. Unfolded it's 8in but fold it outwards and that one display becomes a front display of 6.6in and a rear one of 6.38in. It's pretty special at this stage, and the most ready-for-market foldable at the time of writing.

**TCL DragonHinge**



At MWC 2019 TCL and sister company CSOT showed off a foldable phone prototype using its patented DragonHinge tech. We saw them behind glass and they are a compact take on foldables that are less flashy than Huawei or Samsung's.

**Xiaomi Foldable Phone**

Xiaomi president Lin Bin earlier this year posted a video to Weibo that shows him using a Xiaomi folding device running MIUI software. The phone in the video is revealed to have two folds, which allows a quarter of the display at either end to be folded back and wrapped around the device. The screen appears to remain active when folded.

Xiaomi reportedly told LetsGoDigital: The double folding phone is the latest innovation by Xiaomi. One of the key components of the phone, the flexible folding screen, is co-developed by Xiaomi and its supply chain partner. Aside from the screen, its design, folding mechanism and MIUI adaptation are independently developed by us. Xiaomi is first in the world to present a double folding smartphone and has conquered the technical challenges posed in its three different form factors - double folded, single folded, and tablet form. Prior to finding the best solution,

Xiaomi has conducted extensive research and experiments to develop a robust folding mechanism that will allow the flexible screen to withstand mechanical stress.

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## ARTIFICIAL INTELLIGENCE WILL RESHAPE BUSINESS STRATEGIES

Nowadays, AI brings enormous changes to the business, reshaping the entire industries with the power of advanced technologies and software. Some companies have acknowledged that it is time to implement an AI strategy for their businesses; however, the main part is still on the way. The large companies are more likely to have an AI strategy is with at least 100,000 employees, but for them, this process is especially intimidating. 2018 will be the year when the best firms will incorporate AI applications into strategic and organizational development. There is a potential for algorithms marketplaces, where the best ones created by engineers or companies can be shared, bought, and deployed for organization's personal use.

Moreover, the constant development of machine learning and AI technologies promises that every business will be data-driven and every industry will be smart. With years of background work on prototypes and ideas, the changes now will be breathtaking. From healthcare to construction, banking and finance to manufacturing, almost every industry will be reshaped. Things that were hard to believe in are now becoming a reality. Virtual assistance for patients, computational drug discovery, genetics research, can give you a glimpse of the amazing use cases in medicine. There are many more applications for automation, robotization, data management and more in different industries that will bring significant changes.

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## PROGRESSIVE WEB APPS (PWA)

Progressive web apps is the next big thing for sure in mobile apps industry. It was initially proposed by Google in 2015. In less than two years, it is already very popular among masses specially because of its ease of use and user experience.

### Websites v/s Smartphone Apps

We all have used Different platforms to access contents, like a Web Browser on Desktop & Mobile Applications on our Smartphone and we all are completely comfortable using them. According to Global Web Index (the largest firm that provides data regarding digital consumers to advertisers) around 80% of the internet users own a Smartphone that means they must be using native apps for different needs. In case you

don’t know, Native Apps in your Smartphone are like Application softwares on PC. They are developed to do a specific task on a particular platform. But that’s where the problem comes up, it runs on a “PARTICULAR PLATFORM”. That means an android application or an APK that was developed using, let’s say Java or C# won’t run on iOS but can run on Android

The Technology was supposed to make our lives easier but was not supposed to make developer’s life tough right? It should work both ways, For Users and Makers both. But if we put applications aside and talk about websites made by technologies like HTML, CSS & JavaScript, then we know that they need Web Browsers to work also they need an internet connection and major advantage is that they do not depend on what OS you have? whereas Smartphone applications can access API(s) , Storage, Camera, GPS easily and may provide a lot of information offline like any news application, an E-Book reader or new YouTube offline video feature that allows you to save videos for offline use, they necessarily do not require internet access, But websites do! Websites also require a mobile friendly interface, so that it can be completely used on mobile devices .For this purpose we can use BootStrap which is a mobile first front-end framework used to make websites mobile friendly.

But Websites also has more internet consumption and may be slow depending on that, even to show basic information they depend on your Network speed. But in terms of accessing information, websites can be considered better, as Let’s say you are on your computer, then you may just fire your browser and open up Zomato to order dinner and simultaneously access Flipkart to order new Dress and play video on YouTube and access all 3 tabs easily, or even use them in a stacked window mode and enjoy multitasking! But in Smartphone you need to have these 3 Apps! This takes more RAM and Storage space etc. It is also true that changes in websites can be done easily and the user is not required to download any update.

So, we need something which is not entirely internet dependent like Smartphone apps and saves resources like RAM & Storage just like Websites. Also, they should provide smooth working, multitasking and fast access, consumes less internet bandwidth, and has offline access if possible.

**What are Progressive Web Apps**

Progressive means advanced or gradually advancing in extent, so now you may have framed an idea about Progressive Web Apps (PWA).

PWA is a software dev methodology. For better understanding, we can say they mix up the best of Mobile Apps and Websites.

Experience is as smooth as it is on mobile. Progressive Web Apps work regardless of your Browser (like any website), fits on any screen size (like BootStrap Websites), Works offline (like Mobile Apps), and are always up-to-date because of Service Workers.

**Service Workers**

What Progressive apps basically do is that they provide mobile like experience to the user by using modern web capabilities. The technology used in making these Progressive web apps is Service Workers. It is powerful enough to power offline functionality, content caching, push notifications and several things. They work independent of your app, they are basically some JavaScript file that runs in the background (like Services do in Android) that is triggered via events.

Service Worker works between Network and Device to supplement the content. They use caching mechanism efficiently. They can handle Push notifications easily and are event driven. They make PWA efficient, and also PWA require no installation and can be accessed using your web browser. Chrome on Android allows installing web apps to the home screen, and for developers to tell Chrome that their web app is installable, manifest. JSON file is created. Web App manifest is a W3C specification that defines JSON-based manifest. In short, Service Workers are like a client-side proxy, written in JS that can fire PWA from Home Screen regardless of network state and by pre-caching resources, network dependency is not a problem, making Progressive Web Apps reliable!

**Design Approach App Shell**

Progress Web Apps are faster as they use App Shell, a model where an initial load of mobile web app provides a basic shell of the App's Interface and content of that application is loaded after this. It is not a framework itself but a Design approach. In this model, the basic UI of the app and its content is kept separate. You can relate it to Model View Controller (MVC) design pattern. The Shell is basically a code bundle stored locally in browser cache of your Smartphone.

**Current Scenario of Progressive Web Apps**

**According to Google**

1. Service workers enabled Konga(Nigeria's Largest online Mall) to send 63% fewer data for initial page loads, and 84% fewer data to complete the first transaction!
2. Because of Web Push notifications, eXtra Electronics (Saudi Arabia's leading and fastest growing consumer electronics retailer) saw 4 times growth in terms of engagement of user and 100% more sales from users arriving via web push.

3. Flipkart (Indian e-commerce Company) also triples their time-on-site with the help of PWA, they call it Flipkart Lite.

**Why to use Progressive Web App?**

Progressive Web Apps do not require us to write codes again and again for different platforms that mean no more building of native apps for all platforms and making of web apps. Progressive Web apps are not exactly a new thing out there but many companies are yet to switch to it, they are not buggy like Hybrid apps as they do not depend on any other middleware like PhoneGap and can have HTTPS to provide transaction security etc. that means they are more secure. Without installing these apps they can be kept on the home screen and from there they can be accessed in a browser.

**Progressive Web Apps Features**

- Reliable (Works offline, can be launched from User's home screen)
- Fast (App Shell makes it fast, and respond quickly to User Interactions with smooth animations)
- Engaging (Silky smooth UI and App-Like Experience)
- Secure (HTTPS prevents snooping etc.)

**EVENT-DRIVEN APPLICATIONS**

Gartner predicts that by 2020 a real-time, event-based approach will be a core required demand for 80% of all digital solutions. It's crucial for business application development companies to apply "event thinking" to their solution strategy.

Event programming is not a type of technology or programming language. It represents an approach that should be implemented in a product development process. An event-driven application responds to actions generated by the user or the system, for example, mouse clicks or loading a program. From a programming point of view, it's important to separate event-processing logic from the rest of the coding work. Technologies like AI or IoT speed up event-driven coding as a useful product development strategy. In general, event-driven apps can improve responsiveness, flexibility and give better understanding of user experience.

## RIOT (OPERATING SYSTEM)

RIOT is a small operating system for networked, memory-constrained systems with a focus on low-power wireless Internet of Things (IoT) devices. It is open-source software, released under the GNU Lesser General Public License (LGPL). Due to this unclonable license and its large independent community RIOT is often referred to as the Linux of the Internet of Things.

Background

It was initially developed by Freie Universität Berlin (FU Berlin), Institut national de recherche en informatique et en automatique (INRIA) and the Hochschule für Angewandte Wissenschaften Hamburg (HAW Hamburg). RIOT's kernel is mostly inherited from FireKernel, which was originally developed for sensor networks.

**Technical aspects**

RIOT is based on a microkernel architecture. In contrast to other operating systems with similarly low memory use (such as TinyOS or Contiki), RIOT allows application programming with the programming languages C and C++, and provides full multithreading and real-time abilities. It is supported by popular SSL/TLS libraries such as wolfSSL.

RIOT runs on 8-bit (such as AVR Atmega), 16-bit (such as TI MSP430) and 32-bit (such as ARM Cortex) processors. A native port also enables RIOT to run as a Linux or macOS process, enabling use of standard development and debugging tools such as GNU Compiler Collection (GCC), GNU Debugger, Valgrind, Wireshark etc. RIOT is partly Portable Operating System Interface (POSIX) compliant.

RIOT provides multiple network stacks, including IPv6, 6LoWPAN, or Content centric networking and standard protocols such as RPL, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), and CoAP.

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## NEW ALGORITHM OPTIMIZES QUANTUM COMPUTING PROBLEM SOLVING

Tohoku University researchers have developed an algorithm that enhances the ability of a Canadian-designed quantum computer to more efficiently find the best solution for complicated problems, according to a study published in the journal Scientific Reports.Quantum computing takes advantage of the ability of subatomic particles to exist in more than one state at the same time. It is expected to take modern-day computing to the next level by enabling the processing of more information in less time.

The D-Wave quantum annealer, developed by a Canadian company that claims it sells the world's first commercially available quantum computers, employs the concepts of quantum physics to solve 'combinatorial optimization problems. A typical example of this sort of problem asks the question: "Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city and returns to the origin city?" Businesses and industries face a large range of similarly complex problems in which they want to find the optimal solution among many possible ones using the least amount of resources.

PhD candidate Shuntaro Okada and information scientist Masayuki Ohzeki of Japan's Tohoku University collaborated with global automotive components manufacturer Denso Corporation and other colleagues to develop an algorithm that improves the D-Wave quantum annealer's ability to solve combinatorial optimization problems.

The algorithm works by partitioning an original large problem into a group of sub problems. The D-Wave annealer then iteratively optimizes each sub problem to eventually solve the original larger one. The Tohoku University algorithm improves on another algorithm using the same concept by allowing the use of larger sub problems, ultimately leading to the arrival at more optimal solutions more efficiently.

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## PIN-SIZED SENSOR COULD BRING CHEMICAL ID TO SMARTPHONE SIZED DEVICES

Devices called spectrometers can detect dangerous chemicals based on a unique "fingerprint" of absorbed and emitted light. But these light-splitting instruments have long been both bulky and expensive, preventing their use outside the lab until now. Engineers at the University of Wisconsin-Madison have developed a spectrometer so small and simple that it could integrate with the camera of a typical cell phone without sacrificing accuracy. "This is a compact, single-shot spectrometer that offers high resolution with low fabrication costs," says Zhu Wang, who was among the team of electrical engineers that created the device.

The researchers published a description of the devices recently in the journal Nature Communications. The team's devices also have an advanced capability called hyperspectral imaging, which collects information about each individual pixel in an image order to identify materials or detect specific objects amidst a complicated background.

Hyperspectral sensing, for example, could be used to detect seams of valuable minerals within rock faces or to identify

specific plants in a highly vegetated area. Every element's spectral fingerprint includes unique emitted or absorbed wavelengths of light and the spectrometer's ability to sense that light is what has enabled researchers to do everything from analyze the composition of unknown compounds to reveal the makeup of distant stars.

Spectrometers usually rely on prisms or gratings to split light emitted from an object into discrete bands each corresponding to a different wavelength. A camera's photo detector can capture and analyze those bands. The spectral fingerprint of the element sodium, for example, consists of two bands with wavelengths of 589 and 590 nanometers. Human eyes see 590-nanometer wavelength light as a yellowish-orange shade. Shorter wavelengths correspond to blues and purples, whereas longer wavelengths appear red. Sunlight contains a complete rainbow mixed together, which we see as white.

To resolve the difference among a mixture of different colors, spectrometers usually must be relatively large with a long path length for light beams to travel and separate.Yet the team created tiny spectrometers, measuring just 200 micrometers on each side (roughly one-20th the area of a ballpoint pen tip) and delicate enough to lie directly on a sensor from a typical digital camera. That small size was possible because the researchers based their device on specially designed materials that forced incoming light to bounce back and forth several times before reaching the sensor. Those internal reflections elongated the path along which light travelled without adding bulk, boosting the devices' resolution.

The devices performed hyperspectral imaging, resolving two distinct images (of the numbers 5 and 9) from a snapshot of an overlaid projection that combined the pair into something indistinguishable to the naked eye.

Now the team hopes to boost the device's spectral resolution as well as the clarity and crispness of the images it captures. Those improvements could pave the way for even more enhanced sensors.

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## ADVANCE BOOSTS EFFICIENCY OF FLASH STORAGE IN DATA CENTERS

Data centres are server farms that facilitate communication between users and web services, and are some of the most energy-consuming facilities in the world. In them, thousands of power-hungry servers store user data, and separate servers run app services that access that data. Other servers sometimes facilitate the computation between those two server clusters.

Most storage servers today use solid-state drives (SSDs), which use flash storage electronically programmable and erasable memory microchips with no moving parts to handle high-throughput data requests at high speeds. In a paper being presented at the ACM International Conference on Architectural Support for Programming Languages and Operating Systems, the researchers describe a new system called LightStore that modifies SSDs to connect directly to a data center's network without needing any other components and to support computationally simpler and more efficient data-storage operations. Further software and hardware innovations seamlessly integrate the system into existing data center infrastructure.

In experiments, the researchers found a cluster of four LightStore units, called storage nodes, ran twice as efficiently as traditional storage servers, measured by the power consumption needed to field data requests. The cluster also required less than half the physical space occupied by existing servers.

The researchers broke down energy savings by individual data storage operations, as a way to better capture the systems full energy savings. In "random writing" data, for instance, which is the most computationally intensive operation in flash memory, LightStore operated nearly eight times more efficiently than traditional servers.

**Adding "value" to flash**

A major efficiency issue with today's data centres is that the architecture hasn't changed to accommodate flash storage. Years ago, data-storage servers consisted of relatively slow hard disks, along with lots of dynamic random-access memory circuits (DRAM) and central processing units (CPU) that help quickly process all the data pouring in from the app servers.

Today, however, hard disks have mostly been replaced with much faster flash drives. "People just plugged flash into where the hard disks used to be, without changing anything else," Chung says. If you can just connect flash drives directly to a network, you won't need these expensive storage servers at all.

For LightStore, the researchers first modified SSDs to be accessed in terms of "key-value pairs," a very simple and efficient protocol for retrieving data. Basically, user requests appear as keys, like a string of numbers. Keys are sent to a server, which releases the data (value) associated with that key. The concept is simple, but keys can be extremely large, so computing (searching and inserting) them solely in SSD requires a lot of computation power, which is used up by traditional "flash translation layer." This fairly complex software runs on a separate module on a flash drive to manage and move around data.

The researchers used certain data-structuring techniques to run this flash management software using only a fraction of computing power. In doing so, they offloaded the software entirely onto a tiny circuit in the flash drive that runs far more efficiently.

That offloading frees up separate CPUs already on the drive which are designed to simplify and more quickly execute computation to run custom LightStore software. This software uses data-structuring techniques to efficiently process key-value pair requests. Essentially, without changing the architecture, the researchers converted a traditional flash drive into a key-value drive.

**Adapting and scaling**

The challenge was then ensuring app servers could access data in LightStore nodes. In data centers, apps access data through a variety of structural protocols, such as file systems, databases, and other formats. Traditional storage servers run sophisticated software that provides the app servers access via all of these protocols. But this uses a good amount of computation energy and isn't suitable to run on LightStore, which relies on limited computational resources.

The researchers designed very computationally light software, called an "adapter," which translates all user requests from app services into key-value pairs. The adapters use mathematical functions to convert information about the requested data such as commands from the specific protocols and identification numbers of the app server into a key. It then sends that key to the appropriate LightStore node, which finds and releases the paired data. Because this software is computationally simpler, it can be installed directly onto app servers.

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## NEW ALGORITHM KEEPS DATA FRESH IN WIRELESS NETWORKS

For wireless networks that share time-sensitive information on the fly, it's not enough to transmit data quickly. That data also need to be fresh. Consider the many sensors in your car. While it may take less than a second for most sensors to transmit a data packet to a central processor, the age of that data may vary, depending on how frequently a sensor is relaying readings.

In an ideal network, these sensors should be able to transmit updates constantly, providing the freshest, most current status for every measurable feature, from tire pressure to the proximity of obstacles. But there's only so much data that a wireless channel can transmit without completely overwhelming the network.

Constantly updating network of sensors, drones, or data-sharing vehicles minimize the age of the information that it receives at any moment, while at the same time avoiding data congestion. Engineers in MIT's Laboratory for Information and Decision Systems are tackling this question and have come up with a way to provide the freshest possible data for a simple wireless network.

The researchers say their method may be applied to simple networks, such as multiple drones that transmit position coordinates to a single control station, or sensors in an industrial plant that relay status updates to a central monitor. Eventually, the team hopes to tackle even more complex systems, such as networks of vehicles that wirelessly share traffic data.

"If you are exchanging congestion information, you would want that information to be as fresh as possible," says Eytan Modiano, professor of aeronautics and astronautics and a member of MIT's Laboratory for Information and Decision Systems. If it's dated, you might make the wrong decision. That's why the age of information is important.

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## PROTECTING COMMUNICATIONS FROM HACKERS

Securing highly sensitive information, such as hospital records and bank details, is a major challenge faced by companies and organisation throughout the world. Standard communication systems are vulnerable to hacks, where encrypted information can be intercepted and copied. It is currently possible for hackers to make a copy of transmitted information, but it would not be possible to read it without a method of breaking the encryption that protects it. This means that information might be secure for a period of time, but there is no guarantee that it would be secure forever, as supercomputers in development could potentially decipher

particular encryptions in the future. Researchers at York investigated a prototype, based on the principles of quantum mechanics, that has the potential to side-step the vulnerabilities of current communications, but also allow information to be secure in the future.

Dr Cosmo Lupo, from the University of York's Department of Computer Science, said: Quantum mechanics has come a long way, but we are still faced with significant problems that have to be overcome with further experimentation. One such problem is that a hacker can attack the electronic devices used for information transmission by jamming the detectors that are used to collect and measure the photons that carries information. Such an attack is powerful because we assume that a given device works according to its technical specifications and will therefore perform its job. If a hacker is able to attack a detector and change the way it works, then the security is unavoidably compromised.

The principles of quantum mechanics, however, allows for communication security even without making assumptions on how the electronic devices will work. By removing these assumptions we pay the price of lowering the communication rate, but gain in improving the security standard. Instead of relying on possibly compromised electronic components at the point at which information needs to be detected and read, the researchers found that if the untrusted detectors existed at a separate point in the communications somewhere between the sender and receiver the communication was far more secure. The detector would receive a combination of two signals, one from the sender and one from the receiver. The detector would only be able to read the result of this combined signal, but not its component parts.

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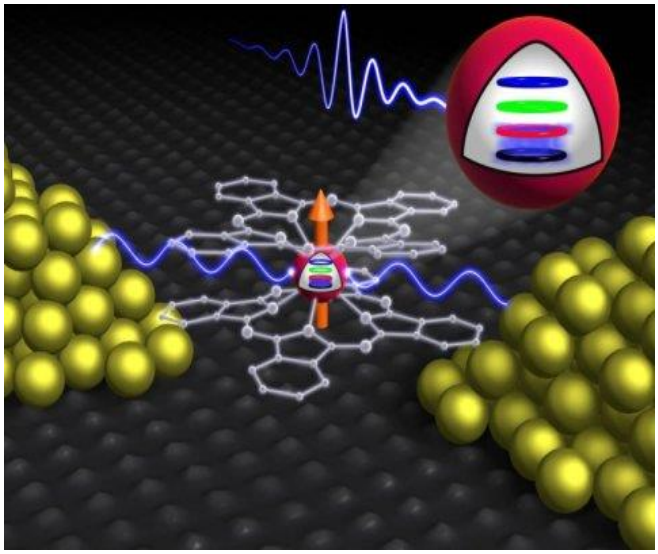
## QUANTUM SPEED SEARCH OF UNSORTED DATABASES



Scrapbooks or social networks are collections of mostly unsorted data. The search for single elements in very large data volumes, i.e. for the needle in the data haystack, is extremely complex for classical computers. Scientists of Karlsruhe Institute of Technology (KIT) have now quantum mechanically

implemented and successfully executed Grover's algorithm, a process for the quick finding of a search element in unsorted databases. A universal quantum computer still is a vision. Special quantum systems that promise to solve certain tasks more quickly than a classical computer, however, are already playing an important role in science. To reliably find a certain element in unsorted data, a conventional computer has to run through all search elements successively in the most unfavourable case. A quantum system with an implemented Grover's search algorithm quadratically accelerates search.

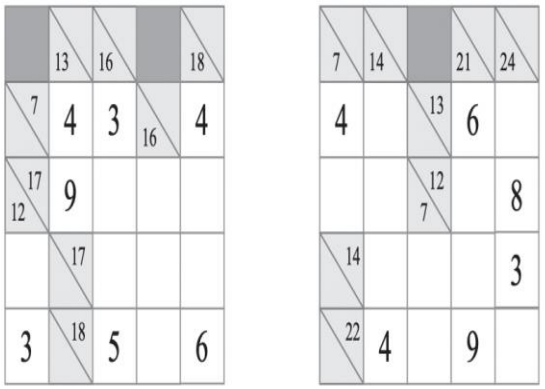
Research teams headed by Professors Wolfgang Wernsdorfer and Mario Ruben of KIT, together with scientists of the Institute Néel (Grenoble), have succeeded in doing this: The scientists applied Grover's algorithm to a molecular magnet and, thus, created a quantum system, whose task is the rapid finding of search elements in unsorted data. In their latest research project, they demonstrated feasibility of a quick search for a small database of four elements. "But this method can be implemented in any quantum system with many, non-equidistant energy levels, which opens up the way towards a universal quantum search algorithm," Professor Ruben says.

The scientists implemented Grover's algorithm in a molecular magnet that was subjected to superposition with specially designed microwaves. Superposition is a quantum effect, in which a particle assumes different states at the same time. Upon execution of the quantum operations, a single-molecule transistor read out the search results. An animation illustrates this process.

Wolfgang Wernsdorfer, Professor of KIT's Physikalisches Institute and Institute of Nanotechnology (INT), emphasizes that the quantum states were manipulated at very low temperatures using electric fields exclusively. "That is why we hope that this technology can be integrated into current electronic devices," Wernsdorfer adds. The customized molecule transistor was synthesized by Mario Ruben's team at INT and KIT's Institute for Inorganic Chemistry. In its centre, a terbium atom with a pronounced magnetic moment, a spin, is located. The terbium is surrounded by organic molecules that shield it against external impacts.

**PUZZLES**

**Kakuro** also called “Cross Sums,” is another mathematical crossword puzzle. Players must use the numbers one through nine to reach “clues” on the outside of the row. Decrease the size of the grid to make it easier for younger players, or keep it as is for students who need a challenge. Students can combine addition and critical thinking and develop multiple skills with one fun challenge.

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## RIDDLES

1. I have forests but no trees.
   I have lakes but no water.
   I have roads but no cars.

   What Am I?

   Answer: The answer is MAP.

2. I have keys without key locks.
   I have space without rooms.
   You can enter but you cannot go outside.

   What am I?

   Answer: The answer is KEYBOARD.

3. Which seven-letter word contains dozens of letters?

   Answer: The answer is MAILBOX.

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The Economy of Human Time is the Next Advantage of Machinery in Manufactures.

- Charles Babbage