The Leading Edge

A technology scan

Information and communication technologies

- Interest in connecting normally offline devices like fridges, door locks and cars to the internet to augment their functionality, known as the Internet of Things (IoT), is growing sharply. ABI Research estimates that there are already more than 10bn wirelessly connected devices in use, and by 2020 there will be more than 30bn. However, these devices operate on many different protocols to transmit data. It is, for example, difficult for connected light switches made by one manufacturer to interact with a connected door lock made by another. A group of more than 20 technology companies including LG, Panasonic, Qualcomm, HTC and Sharp has joined forces with the Linux Foundation to develop internet-connected devices that work together regardless of the manufacturer. The AllSeen Alliance is basing its software on AllJoyn, the open-source IoT software created by smartphone chip maker Qualcomm. Allowing interoperability could be a key force in the continuous rapid growth of the IoT.

- A new smartphone operating system (OS) developed by a global collaboration will be launched in the next few months, according to Japanese mobile phone operator NTT. The OS, an open source called Tizen, is the product of a tie-up among companies from Japan, China, South Korea, Europe and the US. The Tizen Association include chipmakers Intel and Fujitsu, mobile manufacturers Samsung, LG and Huawei, and mobile carriers Vodafone and Orange. 'Unlike Android and iOS, Tizen allows us to develop freely whatever we envision because it is an open-source operating system', according to NTT spokesman Jun Otori. In spite of the big names involved, observers remain sceptical of the ability to rival Google's Android, Apple's iOS and Microsoft's Windows since the availability of mobile apps for any rival OS remains a critical part in consumers' smartphone selection process.

Medical technologies

- A material made from plastic bottles could prevent a drug-resistant fungal infection predicted to become a serious health problem. Antibiotic-resistant bacteria and fungi kill thousands of patients, often hospitalised for other reasons, each year. Research groups are exploring a variety of ways to address the problem, including new kinds of antibiotics and creating sutures coated with bacteria-killing viruses. A new approach uses biologically active materials that punch holes in the membranes surrounding each microbial cell, mimicking one of the body's natural defences, antimicrobial peptides that insert themselves into a microbe's outer membrane to break it open. A small molecule that self-assembles into a polymer-like complex capable of killing *Candida albicans* fungi infecting the eyes of mice, had been demonstrated by IBM research. The compound has not yet been tested in humans, but researchers say that it killed the fungus more effectively than a widely used antifungal drug without causing harm.

- Pacemaker surgery typically requires an incision above a patient's heart to form a cavity into which the device is implanted, before connecting it to wires delivered through a vein near the collarbone. New miniaturised wireless pacemaker technology could soon render this completely unnecessary. Doctors in Austria performed a global first by implanting such a device into the heart through a major vein in the patient's thigh. The devices are the latest effort to make heart surgery less invasive. Doctors began to widely use less invasive heart treatments in the late 1990s, when artery-unclogging balloons delivered by catheters started to replace bypass surgeries. Other cardiac technologies like stents, which prop open narrow arteries, can also be delivered through blood vessels. More recently, researchers have developed artificial valves for patients whose natural valves have become damaged. Recently a miniaturised cardiac monitor to continuously track heart activity was also developed. The monitor is inserted using a syringe-like system that places it into a small incision above the heart that is just 8mm deep. The monitor can then wirelessly transmit heartbeat data to a bedside monitor, or a smartphone.

Materials technologies

- Batteries made from pigments found in cuttlefish ink may lead to edible, dissolvable power sources for new kinds of medical devices. Researchers from the Carnegie Mellon University (CMU) demonstrated a battery that uses materials of biological origin. The prototype sodium-ion battery uses melanin from cuttlefish ink for the anode and manganese oxide as the cathode, materials that break down into nontoxic components in the body. Conventional battery materials are not safe inside the body unless they are encased in bulky protective cases that must be surgically removed. The CMU group is also working on edible electronics that can be swallowed

like pills. Electronics that can either be swallowed or implanted in the body without causing harm could monitor wound healing and disease progression, release drugs and enable more sensitive neural and cardiovascular sensors and stimulators.

Transport technologies

- In a year that many pundits started to doubt the long-term feasibility of electric vehicles (EV) when major automotive manufacturers Nissan and General Motors struggled to meet sales forecast of EVs and small players like Fisker liquidated, Tesla Motors was a shining light. Tesla impressed investors by having its first profitable quarter (link), paying off a massive US government loan a decade early (link) and meeting expectations for vehicle purchases. In addition, Tesla is making great progress in reducing the cost of batteries (link), the most expensive part of an EV and speeding up charging (link). The potential EV futures may indeed rest on a disruptive entrant and not the current global incumbents of the automotive industry.

Security technologies

- Gabriel Bestard-Ribas, founder of San Francisco start-up Goji, got tired of his house keys scratching his smartphone in his pocket, so he combined them. The result was a Goji lock, which senses when a resident's smartphone is near and unlocks the door. A free Goji application, installed on a smartphone, uses Bluetooth connectivity to let the lock know whether the holder of a 'digital key' is near to open the lock. A camera built into the lock takes a picture of whoever is arriving. Images of visitors as well as alerts regarding entry are relayed to residents' smartphones through home wireless internet connections. In addition, temporary digital keys, restricting use to specified time periods, can be e-mailed to house cleaners, dog walkers, or others who may need to visit homes. 'It is about allowing you to feel confidence and control over your home access', Bestard-Ribas said.

Agriculture technologies

- The US is facing an epidemic of herbicide-resistant superweeds that some researchers are blaming on Genetically Modified (GM) crops. 'Weeds resistant to the world's most popular herbicide, glyphosate, now grow in the vast majority of soybean, cotton and corn fields', according to a study published in *Science*. Nearly half (49%) of all US farmers said they had 'glyphosate resistant weeds' in 2012, up from 34% of farmers in 2011. Glyphosate, marketed as Roundup, was created by Monsanto in the 1970s. They also launched the first GM seeds that tolerate glyphosate in 1996. Monsanto refuses to accept any responsibility for the superweed phenomenon, stating that herbicide-resistant weeds began well before GM crops. However, the study found that 'glyphosate had been used for over 20 years prior to the introduction of glyphosate-resistant crops without any resistance issues. Eventually, resistant weeds developed, first in areas where glyphosate had been applied multiple times per season for many years.' Scientists emphasise that GM crops as such are not the source of superweeds but that it is rather the weed management tactics of farmers that increase the use of glyphosate on GM crops. Unfortunately, a vicious circle seems to have formed; the resistant weeds have become a major problem and farmers of GM crops increase the use of glyphosate driving up the volume of herbicide needed each year by about 25%.

- Australian scientists are gluing tiny sensors onto thousands of honey bees to track their movements in a trial aimed at halting the spread of diseases that have wiped out bee populations. Scientists at Australia's national science agency said the microchips could help tackle colony collapse disorder. They will glue the sensors, weighing about 5mg, onto 5 000 bees being put to sleep by refrigeration on the southern island state of Tasmania over the Australian summer. The radio frequency identification sensors work like an electronic tag for cars on a toll road, recording when insects pass a checkpoint. It will allow scientists to build a three-dimensional image of the insects' movements, a process described as swarm sensing. Scientists will examine the effectiveness of pesticides in protecting the bees from colony collapse disorder and enable fruit growers to understand and manage their crops, given the honey bee's crucial role in the pollination of crops globally.

Robotics

- A collaboration of European scientists has developed a global online platform where robots can learn new skills from each other. 'The problem right now is that robots are often developed specifically for one task', says René van de Molengraft, RoboEarth project leader. 'RoboEarth simply lets robots learn new tasks and situations from each other. All their knowledge and experience are shared worldwide on a central, online database.' In addition, some computing tasks can be carried out by the system's cloud engine so the robot does not need to have as much computing power on-board. For example, a robot can image a hospital room and upload the resulting map to RoboEarth. Another robot, which does not know the room, can use that map on RoboEarth to locate a glass of water immediately, without having to search for it. Similarly a task like opening a box of pills can be shared on RoboEarth, enabling other robots to do it without having to be programmed for that specific type of box.