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Networking and wireless

Analysis: Smart grids and smart meters

At a glance

- Electricity transmission grids were designed as distribution systems and do not readily take account of variable sources of renewable energy and 'micro-generation'.
- The UK Government has sanctioned investment in 'smart meters' that show consumers the real-time cost of their electricity and gas consumption.
- Smart meters are expected to be installed in all 26 million UK households by 2020.
- Combining smart meters with real time telecommunications will allow energy suppliers to create a smart grid, providing consumers with demand-led energy pricing.
- Changes in consumer behaviour and installation of smart appliances should lead to demand smoothing, improving the efficiency of the whole network.
- A significant number of standards must be agreed or adopted to build a comprehensive smart grid infrastructure.

The smarter grid

The electricity grid originally developed as a set of regional distribution networks connected by high power transmission lines to shift surplus capacity to where it was required. The 'smart grid' concept concerns the application of much greater computer automation to the distribution networks and accommodating new, flexible power generation capacity, some of which will be owned by consumers.

The smart grid must account for a number of significant trends, including:

- More effective use of existing generation capacity through demand management.
- Reduction in national carbon emissions.
- The introduction of major new sources of supply, especially solar and wind generated electricity.
- The transfer of energy between counties in other times zones where peak demands do not coincide.
- The international potential for energy transfer from regions where (for example) solar production capacity is in excess of national needs.
- The rise of micro-generation, whereby consumers sell surplus energy back to the grid from privately owned solar and wind generators.

The demand management side of the grid will be supported by the introduction of 'smart meters' and supporting technologies. These will allow consumers to see real-time data on their energy use and automatically control home appliances to take advantage of lower price energy outside of peak periods - so-called 'demand smoothing' and 'demand-led' pricing.

Smart grids must not only be more efficient and resilient, but need to be 'hardened' against possible cyber-security attacks. Many of the features of such networks have yet to be agreed internationally, but groups like the [IEEE](#) and the US National Institute of Standards and Technology ([NIST](#)) are working on the necessary standards.

The drive towards more efficient power use and reduction in carbon emissions also encompasses gas distribution and other critical networks, such as water supply.

Smart meters

Smart meters, which show real time gas and electricity consumption in monetary units, will need to provide two-way communication between supplier and consumer:

- The supplier needs real-time data to configure the network so that energy is most efficiently routed to where it is required and (potentially) to make adjustments to pricing according to demand.
- The consumer may want to see the current cost of power in order to decide whether to use a particular appliance.

In this scenario, the energy supplier can make much more fine-grained pricing decisions than (for example) the off-peak pricing of 'Economy 7', based either on historical data, or real-time measures of demand and generation capacity. Real-time data would be much preferred, as it could account for net inflows of energy (for example) from a wind farm in blustery conditions.

Smart meters would have other benefits, not least more accurate energy bills. The suppliers would no longer need to employ meter readers and consumers would always receive up-to-date bills rather than estimates.

The Department of Energy and Climate Change (DECC) has [announced](#) that all 47 million domestic UK gas and electricity meters - in 26 million properties - are to be converted to smart meters by 2020. The meters will be standardised, so consumers will be able to change supplier, and will be fitted by the supplier. According to [BBC News](#), meters are expected to cost £340 per household, which can be added by suppliers to energy bills over a period or charged as a single fee. However, the suppliers are expected to absorb some of the outlay due to reduced meter reading costs and some estimates suggest changes in consumer behaviour resulting from better pricing information could reduce annual bills by as much as £100. Trials to date have only demonstrated household savings of £28 per year.

In a separate [report](#), BBC News states that smart meters will be fitted for all large businesses within five years (where not already present) and introduced to all small businesses by 2020. This should benefit educational establishments that have not already had such meters fitted.

Considerable detail still needs to be agreed about the meters themselves, as well as their installation. A key decision will be the radio protocol or other communications channel used to pass information back to energy suppliers. It cannot be assumed

that all consumers will have a broadband connection or that they will be happy for a small fragment of their monthly allowance (where applicable) to be used for this data.

The most viable alternative appears to be some form of Wi-Fi or low power wireless mesh network (see [TechNews 11/09](#)) that communicates with hubs installed by the suppliers, although mobile networks could also be used. In the longer term, powerline networking, which superimposes a high frequency data signal on the normal 50Hz alternating current, may be possible, but this would require all kinds of new telecommunications equipment to be installed at electricity substations and elsewhere upstream of consumers' meters. This issue will be even more acute in rural areas where landline connections are poor, mobile towers sparse and radio signals attenuated by difficult terrain. A Gartner blogger [has raised](#) the longer term implications of these decisions, as the lifespan of metering systems is expected to be much greater than that of the wireless technologies that underpin many consumer devices.

Smart consumers

Smart meters alone are quite a 'blunt instrument', as they only show gross consumption, not the contribution of each device. While some consumers may be happy to turn devices on and off to observe their net effect, others may not be willing to make this effort over the long term, especially as the motivation recedes when economic growth picks up again.

Ofgem (the UK Office of the Gas and Electricity Markets) has already been investigating smart meters as part of its [Energy Demand Research Project](#). The latest report suggests that consumer interest may not be sustained, so intelligent monitoring and control systems may be required in order to release the anticipated savings. Consumers found the presentation of data problematic, especially where gas consumption was shown in cubic meters rather than converted to the kilowatt-hours (kWh) shown on power bills. (The precise energy content of gas varies, so the conversion can only be readily carried out retrospectively.) Further, when judging the effect of changes to heating regimes, users need to take account of variable factors such as weather conditions and the number of people in the house.

A variety of home energy monitoring systems is already on the market. These gather data directly from devices, producing summaries and allowing a degree of wireless automation or remote control using the internet or text messaging. Examples include [EnergyHub](#), [Plogg](#) and [Tendril](#) systems. These integrate a range of devices, including smart meters, thermostats and heating controls, and 'smart' sockets that report energy consumption using low power [ZigBee](#) wireless networking. Google's charity arm has made its online [PowerMeter](#) energy monitoring application, which integrates with [AlertMe](#) and services from some of the UK energy suppliers, publicly available. Microsoft also has a trial [Hohm](#) service online.

Concerns have been raised by some campaigners about the privacy implications of detailed energy monitoring. (See this [article](#) on Physorg.com.)

Smart appliances

Many appliances do not need to be run on a strict schedule, so they could contribute to the smart grid. For example, a tumble dryer could be set to use energy when demand is low, even switching on and off every few seconds according to local wind generation capacity. BusinessGreen.com reports that manufacturers are already developing 'smart' [dryers](#) and [fridges](#).

There are no generally adopted standards for controlling smart appliances. A simple system could rely on slight changes in the frequency of electricity supplies, informing appliances whether prices were currently high or low. However, giving consumers greater control through inexpensive home automation systems would require widespread agreement on control and communication protocols - proprietary lock-in generally hinders the growth of such potentially large market segments.

A longer term contributor may be power storage in the batteries of electric cars. So-called vehicle-to-grid (V2G) systems charge batteries during periods of low demand, but draw this back down during peak periods, if the owner has not used the vehicle. Such distributed storage could become significant, but it is seen to be 20 or more years away from commercialisation.

Smart learners

Smart meters create a number of learning opportunities beyond environmental education and citizenship. The technologies used could provide a range of concrete examples for students to explore in regard to sensing and control systems, as well as real world problems to underpin exercises that develop understanding of modelling.

The smart future

Creating a smart grid will drive significant market growth in the relevant sectors, as nations face up to dwindling fossil fuel stocks and the effects of climate change. Many governments are already funding large development programs for smart grid technologies. Much of the investment will be in the interests of grid owners and energy suppliers, as it will reduce both capital expenditure and operating costs over the medium to longer terms. Energy is not the only resource that can benefit from smart technologies - IBM has been [reported](#) by CNET.com to be looking at improving control systems for water grids.

Considerable effort may need to be made by both government and industry to inform consumers and to sustain their interest. It might be easy to explain the benefits in pure financial terms, but the perceptions and behaviour of consumers need to be changed. Engagement is more likely to be maintained where consumers can set operating parameters but leave automated systems to make real time decisions about energy consumption.

The global economic realities mean that a 'smart energy' future is almost inevitable. However, clear standards must be agreed and many technical developments completed before most of the promised savings can be realised.

Networking and wireless news

EU telecoms reform package to be national law by May 2011

The EU has [finally agreed](#) a set of telecommunications reforms that have been subject to negotiated over the last two years. Both the European Parliament and Council have to ratify the reforms, but there should be no barriers to implementation from 2010 onwards. The 'package' covers a wide range of issues, including:

- Respect for "the fundamental rights and freedoms of citizens" in rules relating to network use. Measures to control illegal downloading (such as 'three strikes' rules leading to disconnection) "must also be appropriate, proportionate and necessary within a democratic society. In particular, they must respect the presumption of innocence and the right to privacy." Campaigners would have liked to see court proceedings specified but, due to the varied judicial systems across the EU, the statement only refers to "a right to an effective and timely judicial review".
- "An open and more 'neutral' net", referring to operators' policies of throttling certain types of traffic that they see as flooding networks and degrading service to many other users, or premium services that operators wish to prioritise. The new regulatory framework will not go as far as full 'net neutrality', under which all types of traffic should be transmitted unhindered, but instead says that "national telecoms authorities will have the powers to set minimum quality levels".
- When signing contracts, consumers must be informed of "traffic management techniques", bandwidth caps and related policies.
- Communications providers will face "mandatory notifications for personal data breaches".
- "A new European Telecoms Authority... will help ensure fair competition and more consistency of regulation on the telecoms markets." The Authority will be known as the Body of European Regulators for Electronic Communications or BEREC. Nevertheless, national telecoms regulators will gain greater independence through protections from political interference.
- Reducing the digital divide by managing radio spectrum suited to wireless broadband and allowing universal service commitments to be applied to mobile services.

The new framework for regulatory reform should be reflected in national legislation by May 2011. It aims to bring the differing national policies into line, so as to enhance the single market for telecoms networks and services across the EU. This should allow products and services, including hardware and applications designed or used for educational purposes, to operate on a common basis across the continent.

Other TechNews articles of relevance include: Digital dividend and spectrum re-allocation ([07/09](#)); EU makes GSM spectrum available for broadband ([08/09](#)); and US to consider net neutrality proposals ([10/09](#)).

Ofcom considers 'white space' mobile services

Broadcast television and many other radio-based services leave 'holes', or white space, in the usable spectrum. These may be due to legacy services that no longer use their allocation, or deliberate planning to avoid interference between stations broadcasting on the same frequency co-existing at the same location. This white space is, in a sense, wasted, but could be used for low power applications, which need not cause interference to services otherwise entitled to use those frequency bands.

Ofcom has [published](#) a discussion document that considers using white spaces in the television spectrum for new wireless services. These frequencies are lower than used for most mobile services, so they have potential to propagate further with less distortion due to landscape features. Ofcom considers hardware to be 'at least three years away from commercial production', but envisages cameras connected wirelessly back to a PC in the home, control of home heating and appliances, and mobile broadband access. One suggested measure for avoiding interference would be to use geolocation services and a geographical database of spectrum usage. Ofcom also raises the possibility that white space technologies could solve issues of rural broadband access, but it says that such claims remain 'largely unproven'.

Following Federal Communications Commission (FCC) approval for white space services in the US, the first network was [reported](#) to have been launched in Virginia in October 2009. Regulatory approval would be required for such a service to be launched in the UK.

One Voice initiative to ease introduction of LTE

LTE, along with WiMAX, is competing to be the fourth generation (4G) mobile technology of the future. 'Long term evolution' (LTE) is the moniker for the Third Generation Partnership Project's (3GPP) Release 8 specifications for mobile services that are just completing ratification for roll-out starting next year. Unlike most existing mobile technologies, which use voice-oriented switching schemes, 4G systems will be 'all-IP'. This will allow seamless inter-operation between mobile and fixed data networks, as both will then be based on the Internet Protocol (IP), which specifies how packets should be structured and routed.

Voice transmissions need to have 'quality of service' (QoS) protocols to ensure that packets are dealt with in the correct order, that late packets are dropped as required to maintain the flow and to keep latency (delay) to a minimum. On fixed networks these services are offered through voice over IP (VoIP) protocols, such as SIP, H.323 and Skype's proprietary technology. (See VoIP in [TechNews 03/09](#).) This is further complicated on mobile networks by the need for 'handover' between towers, the ability to 'fall-back' to older (3G and GSM) protocols and provision of location information for emergency services.

These issues are now being resolved for LTE through a set of protocols collectively known as 'One Voice'. (See this [press release](#) from Nokia, which has been one of the key developers behind this initiative.) The core for 4G voice communications will be handled by the IP Multimedia Subsystem (IMS). As the 3GPP outlines [here](#), IMS

has been under development since its first release in 2002, with additional improvements in the 3GPP's Release 7 in 2007. IMS is based on other standards, including SIP. One Voice also covers text (SMS) services and emergency contacts.

A wide range of industry partners have worked together on One Voice to ensure interoperability and smooth transition from 3G to LTE-based networks. However, ZDNet UK [notes](#) that doubts have been expressed about deployment by promoters of alternative approaches.

Urban businesses in Northern Ireland to get at least 10Mbps

The Department of Enterprise Trade and Investment (DETI) in Northern Ireland and BT are to spend £48 million deploying fibre connections in areas of the province that will derive 'the greatest economic benefit by receiving high speed broadband'. The [announcement](#) says that 85 per cent of businesses in urban areas will get a minimum of 10Mbps and in rural areas 2Mbps by May 2011.

BT is to invest £30 million in the project, using fibre to the cabinet (FTTC) and other technologies to link up the street-side cabinets to the core communications network. The remaining £18 million will come from European funding routed through DETI. This new 'next generation' broadband network will be available for other suppliers to run commercial services. It is not immediately clear whether the upgrades will improve residential connections or the degree to which schools and colleges may benefit.

Wi-Fi mesh network to be set up in Swindon

Swindon Borough Council has teamed up with aQovia to develop a borough-wide free wireless mesh network, to be branded 'Signal'. The [press release](#) says that the joint venture, Digital City, aims to have the infrastructure in place by the end of April 2010. The service will be funded through 'revenues from business and community services', such as home and business security CCTV coverage, air quality monitoring and managing real time electricity consumption data.

The Council says that the basic service, including connection, will be free, but that users will be able to opt for a 20Mbps service that will cost 'significantly less per month than major broadband competitors'. The council suggests that the new service will reduce the digital divide by making free broadband available to all, as well as providing other services such as free voice calls (presumably using digital VoIP technology) for remote medical consultations. The Council says that 'usage will be limited' on the free service and that there will be pay-as-you-go options for day visitors.

Beyond a cost of £1 million and that 1,400 access points will be attached to buildings, lampposts and other places, no details have been provided of the precise wireless mesh infrastructure to be installed. If the project achieves its targets for signing up residents, it will be interesting to see how well the network copes with the load imposed by people accessing video and content-rich services. Digital City intends to expand to other areas, if judged a success, but the technology is unlikely to solve the access issues encountered in rural areas. A number of US cities

installed 'municipal Wi-Fi' services two to three years back, but struggled to make them viable. Wireless mesh networks were covered in [TechNews 11/09](#).

Wi-Fi hotspots created using multiple mobile phones

Internet access is a 'given' in many homes and schools, but there are many places where access is all but impossible. Landlines may be inadequate in rural areas and satellite services still too expensive, especially in developing countries. Microsoft reports that the ratio of landline to mobile internet subscribers in India is almost one to ten. (There are 127 million wireless internet subscribers as against 14 million landline internet subscribers.)

Wireless services hold out a promise of universal access, but connections remain slow in many places. Further, 'tethering' a laptop to a phone to provide a better internet environment can rapidly drain the battery of the mobile device. (Tethering normally involves powering up the Wi-Fi or Bluetooth module in the mobile phone, or else is limited to the download speed of a single handset, which is cabled to the client device.)

Microsoft Research has been [developing](#) Cool-Tether, a 'reverse' Wi-Fi hotspot that aggregates the mobile connectivity of several phones to create an access point for a netbook or laptop. Data transfers are 'striped' (split) between the devices that create the hotspot, so that no single connection is overloaded. When receiving information, the multiple streams are recombined by the client device as though it had a normal Wi-Fi connection.

The architecture of the protocol has been optimised to limit the power drain on the devices involved, so that batteries will last longer. Cool-Tether uses 38 to 71 per cent less energy for web access using Windows Mobile smartphones compared with COMBINE, a previous 'energy agnostic' application designed for the same task. The system requires the appropriate Cool-Tether application to be installed on each device and connection to an internet-based proxy server that ensures data transmissions are delivered in an optimal 'bursty' manner.

The Microsoft Research paper gives details of a range of alternative approaches that have been previously proposed. However, other technological developments - such as WiMAX, which is a '4G' technology specifically designed to provide broadband access - could render bandwidth aggregation less important. In rural areas where connections are already sparse or in poorer urban neighbourhoods, the bottleneck may be in the infrastructure, such that network congestion arises however the signal is split between handsets. Mobile broadband services continue to be relatively costly and access may be better provided to laptops using dedicated 'dongles', as in much of the developed world.

Hardware based on new, fast NFC standard expected 2010

Sony [announced](#) the development of a new near field communications (NFC) protocol, called TransferJet, in January 2008. (See NFC article in [TechNews 01/08](#).) NFC enables devices to communicate using wireless signals at very short distances, typically under 10cm (4 inches).

Sony envisages TransferJet as a 'touch to transfer' technology, operating at speeds up to 560Mbps, for transmitting photographs, video and music files between hardware. For example, 'touching' an enabled television with a TransferJet camera would download photo files for a slideshow, or putting a music player against a mobile phone would transfer MP3 files between the two. In future, this could enable learners to download evidence from fieldwork or a design project directly from a mobile device, without having to find the correct data wire.

Like some of the wireless power delivery systems discussed in [TechNews 10/09](#), TransferJet uses inductive coupling to link devices. Unlike the charging systems, however, the technology uses coupling to transfer data rather than power. Instead of radiating power away, as a radio antenna would, the coupler 'holds' it in the near field until another device comes within range. This technology is inherently short range, so hardware has to be in close proximity, meaning that security protocols are considered irrelevant and power requirements are kept to a minimum. The protocol will determine the best transfer speed, but effective maximum speeds are expected to be around 375Mbps. The system uses radio signals centred around 4.48GHz, which is within unlicensed parts of the spectrum in the EU, US, Japan and many other markets.

A TransferJet Consortium was [formed](#) in mid-2008 and hardware was further demonstrated at the IFA trade show in September 2009. The Consortium boasted 19 member companies in November this year (including many 'big name' consumer product manufacturers), while another 22 companies had signed up as 'adopters' of the technology. The first commercial products are expected in the first quarter of next year (2010), but success will depend on wide deployment of the system.

Low power wireless networking for remote controls, lights

Low power wireless connections may soon create remote controls that have a 15-year battery life using a watch battery and lighting controls powered by energy 'harvested' purely from the user flicking the switch. These possibilities are raised in an Ars Technica [report](#) of an interview with Cees Links, the CEO of GreenPeak.

GreenPeak is a chip design company that has a focus on the IEEE's 802.15.4 standard for low power wireless communications. The standard is at the heart of a number of wireless mesh network protocols (see [TechNews 11/09](#)), enabling compact sensors to form networks by passing messages from node to node until the correct destination is reached.

The company, Links says, has reduced the power consumption of the main microcontroller on a device by moving key functions to the wireless transceiver. This allows the processor to 'sleep', while scheduling and power management logic interacts directly with the transceiver, so that minimum power is used for core networking tasks. When the device needs to respond to a network request, the microcontroller will be powered up to carry out the necessary processing. This design is said to reduce power consumption by a third.

GreenPeak, which has a range of competitors, has targeted remote controls for televisions and other hardware - wireless transmissions would remove the need for 'line of sight' communications used by infrared systems. Games would also benefit, as users generally need line of sight to the controller 'bar' to use many add-ons. The company believes that very low power sensor systems built on its technology could be used to control the lights in a room. If the controller worked on energy 'harvested' from people flicking light switches, running the sensor network would not affect to the total energy bill.

Bluetooth 4.0 to target low power devices

A new version of Bluetooth, generally used for 'personal area networks' (PANs), has been announced. Confusingly, the updated specification is termed Bluetooth v4.0 but it is not aimed at the 'traditional' uses, such as connecting accessories to mobile phones, 'tethering' (enabling laptop access via a mobile) and creating other short range wireless network connections between consumer devices. Instead, it has been designed as a low energy communication stack for sensors and other small devices. As such, v4.0 is not so much an upgrade as a new direction.

Bluetooth v4.0 will be used, according to the Bluetooth Special Interest Group's [press release](#), for applications in the sports, healthcare, security, home entertainment and other markets. At 1Mbps, this 'low energy' addition to the Bluetooth family is much slower than Bluetooth v3.0 + HS (the name for the latest 'high speed' version), which has a maximum data rate of 24Mbps. Although the maximum range of the new standard is given as 100m, transfers over that distance would tend to reduce battery life, through use of more power for the radio, and greater numbers of packets resent after transmission failures. Most applications are likely to connect devices within a 3m range.

Data packets are very small, varying from 8 to 27 bytes, and enhanced system controls ensure that the host device can remain asleep for as long as possible, reducing energy use. It is expected that most devices will use 'button' cells (watch-type batteries), which should last for a year or more. Although the quick connection and tear down could be used as a basis for mesh wireless networks, the standard is largely optimised for one-to-one connections. The new protocol stack is designed so that it can co-exist with other Bluetooth modes in the same device, so manufacturers would only need a single Bluetooth controller in their phones or other hardware.

Bluetooth v4.0 could be used to connect sensors to smartphones or laptop PCs, allowing learners to monitor their own exercise regimes, science experiments or field data collected over a longer period, without the need for cables. This could enable generic software applications running on multiple hardware platforms (perhaps enabled by Adobe Flash) to use data from a common set of sensors shared by the whole class. The protocol could also be embedded in low power remote controls, smart security tags and other hardware used in education.

Bluetooth v4.0 includes the Wibree specification, previously developed by Nokia. [TechNews 12/09](#) covered a new GreenPeak protocol that competes in a similar

application space, while the Wireless mesh networks article ([TechNews 11/09](#)) referred to other competing technologies.

Cloudlets to bring processing power nearer to mobile devices

Mobile devices tend to have lower power, inexpensive processors. Although they have come a long way in the last five years, size and power restrictions mean that mobile processors just cannot perform data-intensive tasks, such as dealing with high definition video, searching large data sets, speech recognition, augmented reality or playing graphically intensive games. These same restrictions generally apply to netbook PCs (depending how they are defined) and MIDs (mobile internet devices).

One proposed solution has been to move everything into the 'cloud' - provide remote processing power from a data centre over the internet and treat the mobile device as a thin client, sending it screen updates and using it to capture user interactions. The main problem with this approach is that the internet introduces significant delays (latency) that cripple applications that rely on almost instant responses.

The latency problem could be solved if the processor-intensive activity is hosted on local hardware moulded into a wireless 'cloudlet'. Microsoft [researchers](#) do not see latency improving in the near future, so they suggest that shops, offices and other premises could deploy a mini 'data centre in a box'. This would be a multiprocessor cluster with fast internet access and Wi-Fi connectivity for mobile devices. As devices connect, they are allocated a virtual machine that performs the processing and passes back just the essential data for screen updates and user interaction.

Although the authors say that the cloudlet will only cache data essential to operation, ensuring that critical data remains in the cloud, they give little indication of how actual applications will be provisioned within the virtual machine. It seems that the core application will come from the mobile device as an overlay that is merged with the main virtual machine to create the full operating environment. For this to happen, overlays will either need to be small, or devices with limited local storage, such as phones, precluded. Also, the size of the overlay will considerably affect the setup time, which the researchers aim to reduce to 'small tens of seconds'.

Cloudlets could be much more efficient, as they would use fast Wi-Fi connections to shift data (such as camera images from the mobile device) and take advantage of the reduced latency enabled by carrying out the processing locally. The model assumes that application efficiency will degrade as devices move out of the cloudlet's locality - processing will fall back on the device's own capabilities and other wireless connections. The authors discuss possible modes of deployment, such as coffee shops choosing to create a cloudlet as a customer benefit.

This cloudlet model, if fully developed, could prove attractive to educational establishments, where users have a heterogeneous mix of personally owned devices. So long as the mobile hardware can run the cloudlet client application, a variety of learning environments could be provided to learners without requiring high processing capabilities from such devices.

Multimedia

Analysis: Your life is online

At a glance

- Life-logging and life-streaming reflect both active and passive methods of keeping a personal digital record.
- Life-logging can be supported by devices like Microsoft's SenseCam.
- Digital persistence describes the likelihood that data will be recoverable even after it has been nominally deleted.
- Various forms of user tracking raise fundamental questions about privacy and identity, especially in an online world.
- Young people need to have some understanding of the implications of committing their data to social applications.

A digital matter of record

People are committing all kinds of personal data to online repositories, through the likes of social networks, online commercial activities and behavioural tracking systems. These collations of data can say a lot about who we are - at the time of record - or (possibly) the image we wish to project of ourselves. Employers are increasingly interested in this data to make judgements about the suitability of candidates and whether past activities might prejudice the company's own reputation if the applicant was put on the payroll.

Users may actually have less control over their data than they imagine, whether through Government communications monitoring regulations, restrictive terms of service or applications entirely out of their own control. Regarding the last of these, people are often tagged in photos on friends' social networking pages, while their images are captured and stored daily in CCTV archives.

Would a complete record of our lives actually give a truer picture of who we are and what we do? Of course, many would consider the idea ridiculously intrusive, but researchers are looking at systems to do just that.

Life-logging

Life-logging involves wearing a camera and sensor system to record the minutiae of daily life. Initially aimed at helping patients with memory dysfunction (arising from trauma or progressive disease), the Microsoft SenseCam (see below) has been developed with exactly that task in mind. A complete log can be kept of pictures, environmental information and location data to help a person recall events and rebuild memories, but many other uses have been suggested:

- The daily life of people with physical disabilities could be recorded in order to better understand their access requirements.
- Automated records could be kept of a person's food intake and exercise regime.
- Life-logging could be used as an alternative to people keeping diaries in 'mass participation' research projects.

- Life-loggers could be used for hands-free logging to provide criminal evidence, safety records and scientific results.
- Records could be used for assessment of tasks and processes, avoiding the need for an assessor to be physically present.
- A log might be helpful in understanding the triggers for stress behaviours and psychological problems.
- The same approach could help teachers understand what triggers bad behaviour for an individual or in a particular setting.

Gordon Bell, a Microsoft researcher, has been running a project called [MyLifeBits](#) for some years. He has actively collected evidence and artefacts of his daily life, such as personal notes; books read; cards received; CDs listened to; recordings of presentations made; and copies of instant messaging conversations. The SenseCam has enhanced this collection work.

European Union researchers have been working on 'pervasive awareness' - sensor systems that continually monitor the wearer's surroundings to provide a context for other activities. Hence, the [ASTRA project](#) team suggest that automatic 'status' updates would inform the user's business colleagues and social networks if she was in a meeting or cooking. Updates would be rules-based (as determined by the user), using information drawn from sensors embedded in 'smart objects' around the home and office.

SenseCam

The Microsoft [SenseCam](#) v2.3 has a fisheye lens (giving it a wide viewing angle) and a VGA resolution (640x480 pixels), the images from which are stored on a 1GB memory card. This gives a capacity of around 30,000 images, but the default setting for taking a picture every 30 seconds would produce less than 3,000 images in a 24-hour period. The image capture interval can be set by the user, or can be configured to respond to changes monitored by the sensors. For example, getting up from a chair may trigger a response through the accelerometer; a sudden increase in light may be due to going outside; or an increase in infrared may be due to someone walking in front of the wearer. The team are investigating incorporation of GPS hardware and audio recording, but these are not part of the current design.

The SenseCam can be attached to a computer via USB to download images, recharge the battery and configure settings. Even at 2 pictures per minute, large amounts of data need to be catalogued and processed over only a few days. Gordon Bell and his associates are working on software to ease these tasks and to organise playback and search.

The SenseCam design has been [licensed](#) as the Vicon Revue. New Scientist [reports](#) that it will be available for £500 (around \$820), initially to researchers, but also in a consumer version later next year.

Life-streaming and digital persistence

Data recorded by SenseCam is under the user's control and need not be posted online. However, a great deal of data is. Continued online updates - by text, image or

video - are [sometimes termed](#) 'life-streaming'. Users may feel they have control of such data, but experiments by a team from Cambridge (see [TechNews 06/09](#)) have shown that photographs can be recovered several days after having been nominally deleted from some social networking sites. Data is also available in backups and search engine caches, and it may be deliberately archived or reposted by third parties. Linda Geddes, a writer for New Scientist, took mobile phones to Disklabs to find out how much data could be recovered. [Her article](#) reveals that personal text messages, contacts and emails could be extracted from several devices, some of which did not even contain a SIM card.

The issue of 'digital persistence' can adversely affect people's careers or remind young people of incidents of cyber-bullying long after the initial event has been dealt with. Many of the issues involved are technical, but young people need to understand the realities of committing sensitive data to electronic devices, especially those that store content on the internet.

User tracking and privacy

The situation is made more complex by the considerable variation in privacy and data retention policies. There has also been a growth in user tracking applications, such as the Phorm 'behavioural' advertising system (trials of which were [recently criticised](#) by the EU) and Google's Latitude, which can record the location of mobile phone users. Many consumers already unwittingly provide all kinds of information about their households through buying habits tracked by loyalty cards, while the whereabouts of mobile phones can be roughly plotted using signal strength information and the location of base stations, so these problems are nothing particularly new.

A provocative [CNET News article](#) asks whether we can maintain our privacy and protect our identity in a world where RFID chips (that have unique codes that can be detected at short range) and CCTV cameras are becoming pervasive. Josh Harris, a digital artist and entrepreneur, [has questioned](#) whether privacy is even meaningful in a digital age: "In my experience, I think privacy is gone... The new big problem is loss of self, or loss of individuality."

An interesting lecture around the issue of identity and how digital information might be forgotten was recently given at the RSA. Viktor Mayer-Schonberger proposed the idea of 'digital rusting', with data degrading over time. He argued that information and artefacts belonged to a context that helps provide meaning, but this is inevitably lost when a digital record is created. (An audio recording is [available here](#).) [TechNews 08/09](#) covered a potential technical solution for giving information a 'best before date', although researchers have since discovered security concerns over the methods used.

Control your data

These issues need to be debated, but there is much that users can do in the short term. Young people have become more aware of the privacy settings on social networking sites like Facebook and Bebo, but they may not account properly for the damage that can be done when a 'fun' photo is copied by a third party and re-posted,

out of context and beyond their ability to delete. This is compounded where the photographer is not the individual concerned, but tags (or otherwise references) an individual in a published photograph.

Some application providers are becoming more transparent about the data they hold, while the updated EU ['Telecommunications Package'](#) will ensure that stronger measures are taken when personal data is wrongfully released, or security systems are breached. Google recently [announced](#) access to its Dashboard, where users can manage their personal data held by the company.

Users put considerable trust in many online applications and services - a trust that responsible organisations do not wish to abuse. Nevertheless, digital persistence and changes to how people view their own identity during their life need to be better understood, with some arguing that better tools should be available for controlling how personal information is stored and used.

Multimedia news

OLED-LCD hybrid may improve both types of display

Organic light emitting diodes (OLEDs) are expensive to produce in large quantities, but promise reduced energy consumption and much better colour displays. However, the chemicals and temperatures used in manufacture make it difficult to stack OLED materials in high resolution matrices or as multiple overlays to produce white light.

[Polar OLED](#), a spin-off company from research carried out at the University of Hull, [has developed](#) a system that uses ultraviolet light to 'fix' organic compounds, making it much simpler to create stacked displays. The polymers formed act like liquid crystals, in that light passing through them is polarised, but also as OLEDs, since they emit light when electrically stimulated.

The research is not nearly as close to commercialisation as other forms of OLED, but could be used to improve liquid crystal displays (LCDs). The backlight used in an LCD is one of the least energy-efficient parts of the display, but replacing standard light sources (or more recent LEDs) with a type of OLED would bring significant improvements. LCDs use two polarising screens (normally set perpendicular to each other) to block the passage of light for inactive pixels, further reducing efficiency. Because the new materials both emit light and polarise it, they have a significant potential for improving LCDs.

Quantum dots to improve liquid crystal displays

Liquid crystal displays (LCDs) are often backlit with a light emitting diode (LED) source, which is selectively blocked to create an image. This process is inefficient as it requires multiple layers of polarising filters, liquid crystals, colour filters and 'transparent' electronics, each of which reduces the light emitted. Researchers at a start-up company in the US, QD Laser, are [investigating](#) quantum dots as an alternative or supplementary light source for computer displays and lighting in rooms.

Quantum dots are nano-scale semiconductor crystals which emit light in a narrow frequency band when 'pumped' electrically or with another light source (among other properties, depending on the materials used). In general, the smaller the crystal, the higher the frequency of light emitted, so IEEE Spectrum [reports](#) that QD Laser can produce red with 6nm crystals, green at 4nm and blue at 2nm. (1nm, a nanometre, is a millionth of a millimetre.)

LEDs used in existing backlights produce a strongly blue hue, so they are used to energise phosphors which, in turn, emit a much more balanced off-white tone. This light eventually passes through colour filters to create the pixels required for a full-colour display. A quantum dot array can replace the phosphor layer and, by mixing different sizes of crystal, produce a much purer white light, considerably improving the brightness and saturation of the colours displayed.

LEDs have been used in smaller displays in the past, but energy reduction measures have meant that manufacturers are incorporating them into larger displays, as they use less power than cold-cathode fluorescent sources. Fewer quantum dot LEDs are required in a given area to produce a better image, compared with using existing LED sources, potentially reducing manufacturing costs.

Quantum dots can also be embedded in organic films, which are substantially cheaper to manufacture and more flexible than liquid crystal-based displays. Due to the conducting properties of the organic film, the quantum dots can be electrically pumped, but the efficiency is reduced from more than 90 per cent to 15 per cent. The researchers believe that careful adjustments to the properties of the molecules used for both dots and films will improve efficiency. However, all organic displays have the disadvantage that efficiency deteriorates with exposure to moisture and air, but quantum dots embedded in organic films are expected to give even better colour saturation than purely organic LEDs (OLEDs).

Displays that integrate quantum dots should be less expensive and more power efficient, as well as producing a better image, compared with existing LCDs. One of the founders of QD Laser, Seth Coe Sullivan, hopes to have products commercially available in 2011.

Sensor layer to turn LCD screen into gesture interface

Monitors with image sensors interleaved between the pixels have been prototyped before, but the image produced was poor due to lack of focus. Instead of adding lenses, which would have to be carefully aligned to avoid distorting the display, an MIT team is using the concept of a pinhole camera to produce an image.

The [BiDi Screen](#), unlike Microsoft's SecondLight (see [TechNews 11/08](#)), does not need separate cameras to track objects in front of the display. Instead, a thin sensor array is placed a small distance behind the liquid crystal mask, which is otherwise used to control the image output from the display. The system flicks extremely rapidly between display and sensing modes, so that an image is visible to the viewer but interlaced with blank frames which direct the light to the sensors. Due to the way that the sensors are arranged, opening the correct liquid crystal cells creates a whole

set of pinhole cameras. (The experimental system uses actual cameras, but the MIT Media Labs team sees no problem, in principle, for manufacturing a display in the way described.)

The focal length of each of the pinhole 'cameras' is determined by the size of the opening and the distance between the sensor array and liquid crystal layer. Because the gap is narrow, the current prototype does not have a good depth of field (about 50cm or 20 inches), but it can sense the distance of objects from the screen - a pair (or more) of pinhole apertures will allow in light from an object at a slightly different angle, which depends on the distance of the object from the screen. The controller can then use that information to calculate both the position and distance of the object.

The display operates at a fairly basic refresh rate of 30 frames per second (fps), interleaved with optical imaging at 10fps. This speed, coupled with the limited depth of field and other factors, make the sensing array a poor substitute for a webcam, but the MIT engineers hope to improve video output in future versions. Further, as [reported](#) by PhysOrg.com, changing the pattern of 'open' pixels during the imaging phase would allow in more light for a better quality image.

The BiDi Screen would allow the creation of gesture-sensing interfaces that look little different to the current range of LCD monitors. This would allow manipulation of on-screen objects using push-pull motions, as well as swipes and other 'three-dimensional' gestures. The same technique could be used to turn the screen of a mobile phone into a camera, without the need for a separate component. (However, the screen would have to be of the LCD type - not OLED - and the processor would need to be quite powerful to perform the calculations involved.)

New head-mounted systems for translation and information display

Head-mounted displays support augmented reality applications (see [TechNews 07/09](#)) and all kinds of information services. NEC has [revealed](#) a device known as the Tele Scouter, which uses a micro-projector mounted on a frame (like spectacles) to create text images on the retina of the user's eye. The system is due to go on sale in Japan next year to support sales teams by providing information about a prospect's past contacts and sales history. The company envisages an upgraded version that would provide real-time language translation, picking up the conversation on microphones, translating via a central server and providing subtitles for the user through the headset. The Daily Telegraph [suggests](#) that such a system would cost around £5 million for 30 users.

A University of Washington team [has developed](#) a prototype contact lens system based on micro-lenslets and miniature LEDs that creates images 50-100cm (16-33 inches) 'away' from the user. The circuitry has to be embedded in 'biocompatible material' and set in 'crevices' etched into the lenses, as the main polymer would be affected by the normal industrial processes used to create transparent electronics. The system includes a loop antenna that harvests energy from a custom-built radio source to power the electronics, although the designer believes it could use the output from a mobile phone in future. The current version has only been fitted to a

rabbit, but Babak Parviz sees applications in captioning the user's view, translation, gaming and military spheres. Unlike the Tele Scouter, this system would not obscure any part of the user's view.

New e-reader supports the visually impaired and learners with dyslexia

The new [Intel Reader](#) could be mistaken (in name) for an e-book reader, but it has a different mode of operation. The Reader captures an image of a page, processes the text and reads it back to the user using a text-to-speech engine. Ben Foss, the Intel researcher that proposed the idea, realised that much of the text he needed was unavailable in audio form, making it difficult for him (as a dyslexic) to access curriculum materials and professional reading matter.

[Teachers TV](#) has showcased the new product in one of its videos, demonstrating how text is reformatted and displayed in a large font on screen, as well as read back to the user. Content can be stored on the device or transferred to a computer via USB, and users are able to customise the display and reading options according to their needs. Further, text (which can be in DAISY format used for talking books) and audio content (stored as MP3 or WAV files) can be transferred from a computer for use while on the move. The hardware is somewhat smaller than a fat paperback book, contains an Intel Atom processor and 4GB flash memory (of which about 2GB is available to the user) and has a 4.3 inch (10.9cm) screen.

The Reader is available in the UK through HumanWare, Amazon and other retailers for £999. An optional Capture Station, which holds both the Reader and a publication in position for capture, is available for £249. The combination of the two devices appears similar to a visualiser, although the latter would not normally provide the same function. (See [TechNews 08/09](#) for visualisers.)

Malleable interface for tactile input

A bag filled with a viscous, magnetic compound and sensors that detect disturbance to their electric field could form the basis of new input devices. Researchers from Microsoft and Newcastle University have [developed](#) a 'tile' with embedded coils that senses a ball bearing or other metal object moving across its surface, while a bladder design allows the user to squeeze and mould a virtual object. The same coils, or other electromechanical devices, could be used to give a form of haptic (force) feedback, depending on the application.

These devices are really in the conceptual stage at present, but may have applications in design, gaming and for users who have problems controlling existing peripherals.

In related news, Cambridge Consultants has [developed](#) a 'squeezable' mouse, called Suma. The company is working with a number of equipment manufacturers to produce different versions of Suma, some of which have relatively simple touch and pressure sensors, whereas others are more sophisticated and include accelerometers that sense movement through the air. The sensors will be able to provide data from fingers moving on the surface, pressure and use of gestures, with built-in controllers interpreting some of the inputs before providing information via

USB to the computer. Cambridge Consultants envisage the product being used in applications from gaming and design through to music and the creative arts. The product is expected to be demonstrated at the Consumer Electronics Show (CES) in January 2010.

3D server takes processing load from client

Rendering three dimensional objects takes significant quantities of processing power, as the view on the object must be calculated for each viewing position, or recalculated in real time as the viewer moves around the object. 'First person shooter' (FPS) games have relied in the past on discrete graphics processing units (GPUs), which have several instruction pipelines working in parallel to render the basic shapes of objects and then add shade, lighting and other effects. Indeed, modern GPUs have multiple cores, providing 'general purpose' computing power for all types of large parallel processing task. (See [TechNews 09/08.](#))

Netbooks, smartphones and other smaller, mobile computing devices rarely have the processing capability to render 3D objects in better than the most basic resolution. NVIDIA has worked with Mental Images to produce a [new RealityServer](#) platform for rendering such images centrally to deliver to client devices via the internet. The platform uses NVIDIA's massively parallel Tesla GPUs and Mental Images' ray tracing renderer to perform 3D calculations in real time. (Ray tracing follows rays of light 'back' from the object towards light sources, including reflections of those sources, to see how any given pixel on an object should be coloured.)

The RealityServer platform is targeted at applications such as rapid (virtual) prototyping, architecture, design and interactive product configuration. These applications are used in design departments, but future iterations of the platform could create 'photorealistic' 3D environments for students to explore in real time.

ExtremeTech carries an [interview](#) with the product managers of the two companies, which outlines their vision for the product as it stands, plus their views on how this sector of the graphics market will develop in the next five to ten years. They accept that ray tracing is nowhere near ready for real time rendering, such as required by FPS games, but they suggest that the capability will be there in less than five years. The new version of RealityServer delivers progressive JPEGs (pictures that improve in detail with several 'passes') to desktop and handheld clients, including smartphones with a reasonable internet connection. The software will be free to download for non-commercial use at the end of this month, but is otherwise licensed on a per GPU basis.

A number of companies are investigating systems that use the internet to deliver graphics for games (such as OnLive, Playcast and Gaikai) and for a wide range of interactive applications (for example OTOY). One of the greatest issues is latency (delay) between user input and display response that can make games unplayable.

Streaming TV comes to more devices

Streaming television, encompassing both 'live' and 'catch-up' services, is already available through set-top boxes and online (IPTV) services. Broadcast, cable and

satellite channels can be viewed on standard television sets and digital hardware, depending on the format of the content and the subscription structure of the service. Many programmes are available for education, so long as the appropriate licensing restrictions are observed.

It was recently reported that trials are [beginning](#) for distribution of BBC iPlayer and ITV Player content through Humax freesat HD and freesat+ boxes. Techworld.com [reports](#) that the physical connection will require an Ethernet cable and a broadband modem (rather than the modems that some households still own). The connection needs to deliver an actual speed of at least 1Mbps. Freesat is the satellite service, akin to Freeview broadcast television, that requires consumers to buy and install a satellite receiver, but which is otherwise free. The service will only be available on HD (high definition) boxes and ITV content will not be available until next year. Digital Spy recently carried an [interview](#) with Freesat's managing director Emma Scott, who talks about the iPlayer initiative and future Freesat developments.

The BBC has also [launched](#) iPlayer for Nintendo's Wii games console, joining Sony's PS3 platform. However, the Telegraph [reports](#) that agreement has yet to be reached to provide iPlayer content through Microsoft's Xbox Live service. PC Advisor also [reports](#) evidence that an official BBC iPlayer application will be available for Apple's iPhone, although there has been no official confirmation that software is being developed.

The BBC, ITV, BT and Five continue to work on Project Canvas, the standard they are proposing as an open internet-connected TV platform. Although the development has yet to receive approval from the BBC Trust, the partners have launched a [website](#) as a hub for news and project information. At present the consortium is concentrating on finalising the technical standards, known as DBook 7, which they hope to publish early in 2010. Hardware designed to work with the standard will be known as 'Canvas compliant'. A senior BBC executive is [reported](#) to have said that the project may be delayed until 2011 if the BBC Trust's approval is not received soon. The partners intend the final platform to be an upgrade path for existing free-to-air services (especially Freeview and Freesat), as well as a route for other providers to offer internet TV services based around the 'shared screen'.

In the immediate future, the Freeview service is planning for an HD upgrade that will be made possible through spectrum reorganisation arising from the digital upgrade to broadcast TV. New hardware, due to become available early in 2010, will be required to receive the HD broadcasts, which will be based on the upgraded DVB-T2 standard.

In related news, the BBC has [announced](#) that it will join with a range of commercial partners to launch a new UK Radioplayer player service early next year. A console will allow users to listen to live content, search through the available genres and access additional services, such as track listings, on-demand audio, paid-for music and webcams. The console will be launched from within any participating station's website, but plans envisage future access from smartphones and internet-connected televisions. However, this project is also subject to BBC Trust approval.

BBC Trust gives provisional approval for Project Canvas

[Project Canvas](#) is a developing platform for delivering television programmes via the internet, as internet protocol television (IPTV). The project partners are the BBC, ITV, BT, Five, Channel 4 and Talk Talk. The governing body of the BBC, the BBC Trust, must approve the initiative for the platform to be completed. The Trust has now [given](#) its provisional approval to the project, subject to certain conditions.

Set-top boxes that meet the Project Canvas specification will allow users to watch television 'live', as well as pause, rewind and record programmes (depending on copyright). The hardware will also link televisions to video-on-demand services and popular social networking sites, such as YouTube and Facebook. Unlike the previously mooted Kangaroo initiative, which was blocked by the Competition Commission, the new service is based on an open platform that any provider can use to promote and deliver its content. As the BBC [notes](#), there have been objections from other broadcasters (such as BSkyB and Virgin) as well as some hardware manufacturers.

The conditions laid down by the BBC Trust are designed to ensure that all viewers can access the basic service without a subscription, that other providers can access the platform and that the core technical specification is published well in advance of project partners launching compatible services. The BBC Trust's [press release](#) gives a full summary of its conditions and outlines the results of its impact assessments. The Trust has launched a consultation (closing on 2 February 2010) and will announce a final decision later in the spring. As reported in [TechNews 12/09](#), there is a range of internet connected televisions already coming to market that will compete with hardware that adopts the Canvas standard.

If the plans for Canvas come to fruition, schools will be able to display streamed video and internet content on ordinary televisions, so long as an internet connection is available nearby. Educational providers should also be able to supply content via the internet using the Canvas platform.

Wireless HD standards agreed

[TechNews 09/08](#) reported on the emerging WHDI standard for wireless transfer of HD video data around the home, although it could equally be used for wireless projectors in schools and other short-range video transmissions. That standard has now been [released](#) by the WHDI Consortium, an industry grouping that includes Amimon, the company that developed the original idea and which hopes to sell chipsets based on the standard, Hitachi, LG, Motorola, Samsung, Sharp and Sony.

The freely-available WHDI v1 specification is based on 5GHz radio signals, which are unlicensed in most countries. The Consortium suggest that these signals, which are in the same spectrum space as 802.11n Wi-Fi, can carry data up to 30m (100 feet), as the relatively low frequency has excellent propagation characteristics within buildings. The standard can carry uncompressed, high quality 1080p HD video at 3Gbps due to a technique that is [reported](#) to prioritise the most important facets of the image. Where the signal is degraded, the more subtle visual elements, which are least important to the viewer, are dropped first. The standard includes AES

encryption, allows copyright protection (DRM) for video streams and makes provision for mesh networking. (See [TechNews 11/09](#) for details of mesh networks.) The first products that use the standard are expected to become available in the second half of next year.

The 5GHz band of the spectrum is becoming increasingly crowded, with 802.11n Wi-Fi, Wireless USB (using ultra-wideband - see [TechNews 01/09](#)) and other technologies competing in this frequency range. The Consortium says that its technology will seek out unused channels, so as to avoid other equipment.

The main alternative is to use 60GHz ('millimetre wave') frequencies, which can carry far more data due to the much faster oscillations, but which are much more readily blocked by walls and other obstacles. The Wireless Gigabit Alliance (see [TechNews 05/09](#)) has [completed](#) its wireless data transfer specification, which has been circulated to members for final comment. Known as WiGig, this new standard will support speeds up to 7Gbps at distances of 10m or more. The protocols are compatible with 802.11 standards, allowing devices to fall back to Wi-Fi links where WiGig is unavailable. The specification will permit connection of a range of devices, including HD televisions, settop boxes and computer peripherals, such as wireless hard disk drives, so it is more of a networking standard than a multimedia connection technology.

Another 60GHz standard, WirelessHD, began to appear in devices shipping during September 2009, [according](#) to its promoter group. WirelessHD aims specifically at enabling 'video area networks (VANs)'. The WirelessHD Consortium is [reported](#) to be working on a faster version of its standard.

[TechNews 03/09](#) looked at the issue of 'High definition video in networked environments' and found that no single standard prevailed. This remains true.

Hardware

Analysis: Optical computing

At a glance

- Proponents of optical computing believe it will offer high speed, low power processing that will far outstrip the limitations of electronic devices.
- The fundamental physics of light suggest these promises can be achieved if significant barriers can first be overcome.
- A range of optical components, including wave guides, optical 'transistors' and optical memory, has been developed.
- One of the greatest limitations to date has been that optical components could not be made smaller than half the wavelength of light. Plasmonics appears to be a promising route to solving this problem.
- Electronic processor technology is advancing so quickly that optical processing will have to offer considerable benefits if it is to be commercially viable.

Computing at the speed of light

Optical computing, using light instead of electrons, has been held out as a fast, low energy replacement for current chip designs. The physics underlying the current generation of processors is running up against barriers to further improvements: it is becoming increasingly difficult to etch the nanoscale designs required onto silicon wafers, while the proximity of circuits increases the likelihood of interference. With the rise of fibre optics, light has already proven to be a highly efficient communications medium, so researchers hope to find ways to use it to solve these problems.

Optical computing is sometimes referred to as photonic computing or optical processing; the latter may be confused with the use of electronics to control streams of data coded onto light. This article uses the term 'optical computing' to refer to the use of light to carry out actual computing tasks and 'optical processor' to refer to the hardware that carries out such tasks.

Optical computing offers a number of advantages:

- Light travels much more rapidly compared to electrons flowing in a conductive medium at room temperature.
- Light propagates as very high frequency 'waves' - 120THz to 790THz, including the near infrared. (This is around 100,000 times higher than the processor clock speed of modern desktop computers.) Much more data can be encoded on a faster signal, giving light a much higher potential bandwidth.
- Little light is lost when travelling through a very pure medium, allowing signals to travel long distances without significant loss of data.
- Light does not interact with matter in the same way as electricity, so it encounters negligible resistance. This means that it requires little power to transmit a signal over long distances, compared to electrical systems.
- The lack of resistance means that virtually no heat is created by signal transmission, even as power is increased. This means that waste heat will also be negligible.
- Light does not interact with light, so multiple beams can travel in the same medium without mutually interfering.
- Light is very sensitive to interference in narrow wavelength bands. This means that a single beam of light can be modulated to carry many streams of data in narrow frequency bands within its spectrum. This is known as wave division multiplexing.

Processing with light also has disadvantages:

- To be used for computing, light needs to be generated in a way that is tightly controlled. This is normally achieved with lasers, which produce 'coherent' light, where the beam is in phase. However, classical lasers cannot operate at a size less than half the wavelength of the light to be emitted - photons ('particles' of light) must bounce back and forth until they can escape at the correct frequency. A red laser would produce light with a wavelength around

700nm, so the main lasing unit must be at least 350nm. This is much larger than the 32nm features that are being etched on silicon today.

- Because light does not interact with light, it cannot be used to directly modify or control another beam.
- Light only interacts very weakly with matter, so it is difficult to detect (at low power) or use to control mechanical devices.
- Optical signal loss over short distance is worse than for an electrical signal, especially at low data rates. To be effective, optical processors must operate at much higher speeds than their electronic equivalents (which would be crippled by the excess heat generated) and the light used needs to be carefully confined to minimise such signal losses.
- The processing required to produce a given result generally involves many more steps than the output, so the processor can operate much more rapidly than attached peripherals. Nevertheless, fast optical processors, if they become a practical reality, must at some point be interfaced with slower electrical components.

The main elements needed to carry out computing tasks are wires, switches and storage. A fully optical processor needs equivalent components to communicate, process and store data.

Optical 'wires'

Fibre optic cables use the principle of total internal reflection - beams of light shone at the correct angle will bounce from wall to wall of the fibre as they pass along its length. Modern optical fibres may be 8 micrometres in diameter (without protective cladding), which is 8,000nm. Even though fibres can be made smaller, such sizes are incompatible with the nano-scale devices fabricated on silicon chips.

Optical 'waveguides' can be micro-engineered from photonic substances. These structures have regular regions that diffract different wavelengths of light, controlling and confining light within the waveguide. Nevertheless, although much smaller than fibres, these waveguides suffer the same half-wavelength limitations associated with classical lasers.

Multiplexing signals, to enable greater volumes of data to be transmitted in parallel, involves the use of ring resonators. Light is feed into the 'loop' (which may not be circular) and builds high intensity pulses through constructive interference among waves with the same wavelength, dependent on the 'diameter' of the loop. Ring resonators act as filters that can be used to multiplex and de-multiplex the frequencies of light used. Such devices create the potential for high bandwidth transmission between processing cores, but are too large for communications within a core.

Switching and processing

Interaction of signals, normally through changing the response of a transistor, controls the basic logical processing in a computer core. Optical processors have been built that use components with a non-linear refractive index to control the flow of optical signals in a way that is similar to how transistors direct electrical currents.

(The refractive index measures the speed at which light propagates through an optical medium. The non-linear nature of the photonic crystals used means that they will only emit light if 'pumped' by a strong enough input, perhaps created by combining beams to form a basic AND operation.)

An alternative approach has recently been [demonstrated](#) using the very weak 'optical force', which operates at the nanoscales, to move a switch; this pressure could redirect another beam of light. The researchers have shown that the pressure of light can be used in both attractive and repulsive modes to open and close nano-switches.

[TechNews 11/09](#) reported on the use of doping techniques in plastic optical fibre to control light. Normally, the chemical dopants serve to amplify light but, when exposed to a second laser pulse, enter a super-excited state in which they no longer emit light at all. This suggests that similar techniques could be applied in waveguides, where transmission of light from one source could be controlled by pulses from a second.

Storing light

Light must be temporarily stored - cached - in order to perform calculations, otherwise intermediate results would be lost. A range of approaches have been applied to storing light, based on particular properties of molecules. Biological approaches during the mid-1990s, for example by [researchers](#) at the Herriot Watt University in Scotland, investigated the use of light to control the photo-response of proteins. However, more recent efforts have concentrated on devices like ring lasers (the direction light propagation representing bits) and complex crystals that, [for example](#), can 'echo' a previous pulse of light when read by an appropriate laser pulse.

Over-coming the half-wavelength barrier

Alternative types of laser, known as spasers are being developed that overcome the half-wavelength limitations of existing components. (See [TechNews 09/09](#).) Surface plasmons result from optical excitation of the electrons on the surface of a metal, producing clouds of electrons that create mobile field effects that can further excite a photon source close to the metal's surface.

Researchers at Queen's University in Belfast [have shown](#) that plasmons can be routed along metal wires etched using existing lithography techniques. One of the researchers, Anatoly Zayats, suggested that an all-optical processor has been feasible for the last five years, but that it would "measure something like half a metre by half a metre and would consume enormous power". The team built demonstration components less than a fiftieth of the size of equivalents used in commercial optical communications devices.

An optical future?

The potential for optical processors is a trade-off between the size of components and the much higher potential processing speed - under current technology, a ten-fold increase in processing power would not be justified by the size of the 'chip'.

Such a chip would be constrained by the speed of numerous electronic interfaces and controllers but, if these could be removed, the potential speed of operation is at least three orders of magnitude (1,000 times) higher than existing electronic chips - without the problems of waste heat. Coupled with photonic crystals, plasmonic devices and other extremely small components, such an all-optical processor may deliver the benefits that have been anticipated for so long.

In the nearer future, companies are developing hybrid processors. For example, IBM's [silicon integrated nanophotonics](#) group is developing a three-dimensional processor with three layers: logic, memory and interconnect. The high-speed communications between the processor array and memory will be conducted via the photonic network layer, deposited on top using standard production techniques. IBM believes that such a supercomputing processor could become available in 2018. MIT researchers are also [investigating](#) the use of existing manufacturing techniques to deposit new waveguide materials within processors to provide optical interconnects. Intel is also investigating [silicon photonics](#), but with a focus on creating discrete components and connecting higher level devices.

Many problems remain for developing an all-optical processor, with [some analysts](#) suggesting that existing technology could not achieve this goal. Meanwhile, several assumed physical limitations for creating nano-scale electronic components have already been passed, while multi-core processors are achieving phenomenal combined computing power.

Further breakthroughs will be needed to achieve the same compute power in a (relatively) small all-optical processor. It is possible that quantum computing (see [TechNews 11/08](#)) will render the kind of power promised by optical processors obsolete. Ironically, one of the suggested media for carrying quantum information is the 'spin' polarisation of photons of light.

Hardware news

Processors update January 2010

Intel has [launched](#) its latest family of 32nm processors in the Core i7, i5 and i3 lines. This conforms to its (approximately) annual [tick-tock](#) policy of a new architecture followed by a reduction in size of the processor components. The tick in this cycle was the launch of the Nehalem architecture in November 2008 (see 'IDF Update' news item in [TechNews 09/08](#)). In addition to putting more processing power into a smaller space, reducing component sizes can increase processor speed while lowering the waste heat generated, as signals have to travel shorter distances.

The 2010 Intel Core family comes in a range of processor speeds, with lower power (in terms of energy consumption) mobile and 'ultra mobile' versions and embedded designs. The Core range and the latest additions to Intel's [Atom line-up](#) integrate Intel's graphics capabilities directly onto the main processor chip, rather than as a discrete graphics processing unit (GPU), although an auto-switching mode can be used on some versions that hands intensive graphics tasks (such as gaming) to a GPU. The new chips also integrate memory control functions and audio capabilities.

Intel's Atom processors (aimed at netbooks, terminals, embedded applications and other small, low power devices) are still based on its older 45nm technology. Unlike the Core range, the integrated graphics on the new Atoms does not deliver full 1080p high definition video resolutions, so supplementary GPUs will be added by manufacturers wishing to provide HD playback. Consumers wishing to view HD video will need to ensure that new netbooks have a suitable chip, such as Broadcom's new [Crystal HD](#) video decoder or the NVIDIA's Ion platform ([launched](#) in December 2008).

NVIDIA has [launched](#) its Next Generation Tegra (or 'Tegra 2') chips designed for the latest tablet PCs. Tablet (or 'slate') PCs, which have been around for more than a decade, have an 'all-in-one' touch-screen design, although earlier models used some form of pen input. Tegra 2 chips may also be found in netbooks and smartphones, but TechRadar [reports](#) that NVIDIA is championing the tablet format, to differentiate such devices from Windows-based netbooks. As a 'system-on-a-chip' (SoC) design, Tegra has supported integrated graphics, memory controller, input-output and other functions from launch.

The latest Tegra chips are based on dual-core ARM Cortex A9 processors, supporting full HD video and 3D graphics on screens that are from 5 to 15 inches (7.5 to 22.5cm) in size. Because ARM processors do not use Intel's x86 instruction codes, these tablets could not run Microsoft Windows or Apple's OS X, but they are marketed as multimedia mobile devices that have 'always-on' wireless capability. This could make them attractive devices for learners on the move, as they would be able to access the internet and upload data in the field, depending on the type of wireless connection provided. ARM processors generally operate at much lower power than Intel or AMD's equivalent chips, so they can last longer on a single battery charge.

AMD is expected to launch its Fusion range of processors, with integrated graphics, in 2011. (See [TechNews 11/09](#).)

Marvell, another ARM technology licensee, has [announced](#) the world's 'first' quad core ARM processor design. Marvell chips are found in gaming machines, printers, networking hardware and many other devices.

AMD to release Fusion processor in 2011

AMD has [announced](#) (among other news) further details of its new Fusion-branded processors, which will combine the main processor and a graphics unit within the same silicon, and will ship from 2011. Terming the combination an 'accelerated processing unit' (APU), AMD expects to continue to integrate the functions of both cores so that, in future, the operating system will see a single device rather than the central processing unit (CPU) with an attached graphics processing unit (GPU) controlled by subsidiary drivers.

Combining cores on the same silicon will make hardware faster, as they can be controlled as a single system, without the delays inherent in transferring data across

an external bus. As described by [Ars Technica](#), AMD's approach is to allow programmers to use existing code (based on OpenCL and Intel's DX drivers), rather than having to rewrite renders and other graphics routines as native x86 code - the approach favoured by Intel's forthcoming Larrabee architecture with its multiple x86 processing cores.

AMD's lower power 'Bobcat' APU designs are targeted to compete with Intel's Atom and ARM-based processors like VIA's Nano. Combined in a single package with graphics units, memory controllers and video processors, these 'system on a chip' (SoC) devices are suited for use in set-top boxes, low power internet browsing hardware and all manner of embedded applications. At the higher end, where Intel is the main competitor, the 'Bulldozer' design is aimed at servers, desktops and more powerful laptop PCs. [Ars Technica](#) gives further details of both architectures.

Bring your own computer to work

Citrix, one of the developers of virtualisation products (along with VMware, Microsoft and others), has been running a "bring your own computer" to work (BYOC) project for about a year. The company has acknowledged that employees often have a preferred platform - whether Windows, Apple or Linux - and that they would rather use their own hardware, with access to their own applications. Citrix has been actively supporting this desire by providing \$2,100 (about £1,275) towards the cost of a machine of the employee's own choosing.

The deal is made on the basis that the employee, who actually owns the machine, will purchase an extended warranty to cover hardware failures and proper malware protection, as Citrix will not give any hardware support. The business environment is created within a virtual machine, complete with operating system and applications, to ensure security and access to the workplace software platform. (Virtualisation allows a complete system to run within its own 'container' as though it had sole, direct access to the hardware.) These Citrix blog posts ([here](#) and [here](#)) give further details of the rationale behind the scheme. Around a fifth of employees now choose to use a BYOC laptop for home and work purposes.

XO laptop - v3.0 to be ultra-thin tablet

The specification of the XO laptop, designed by the [One Laptop per Child](#) (OLPC) project, is due to be updated, as available hardware has made new designs possible. The current 'Gen 1.0' laptop was expected [to be replaced](#) by the Gen 1.5 in the near future, with prototype hardware in the hands of developers in August 2009. [TechNews 04/09](#) said that Gen 2.0 (or XO-2) was two years from production.

It was [recently reported](#) that the dual-screen, clamshell design of the XO-2 is to be dropped entirely in favour of XO-3, which will be a touch-screen tablet. Nicholas Negroponte, the founder of the OLPC project, has said that the design will be 'entirely' plastic, waterproof and only 0.25 inches (0.6cm) thick. The screen will be based on reflected light, which will considerably reduce power requirements, although no further details have been given of the technology to be used. This "aspirational" device (as Negroponte refers to it) will draw only 1W of power, cost \$75 (about £47) and enter the market in 2012.

The XO laptop is intended to enhance education in developing countries by providing a computing platform that is low cost, rugged and collaborative. As [reported](#) by PC Pro, production issues, the recession and competition from Intel's competing Classmate reference design have seen it struggle to reach the original \$100 price point and production of five million units, but specific projects are continuing. (For example, in October 2009, Uruguay [completed](#) its project to provide nearly 400,000 laptops to children.)

Synaptics creates mobile for one-handed operation

Synaptics is known to many people for producing touchpads to control the mouse pointer on laptops and other devices, but it has recently been working with Texas Instruments and other partners to develop a new touch interface for mobile phones. The [Fuse](#) concept phone integrates several input and output technologies, including touch, gestures (via accelerometers), a 3D display and haptics (the use of tactile feedback).

Existing touch screen designs technologies generally require two hands to operate, so Synaptics has integrated capacitive surfaces onto the sides and back of the phone. This makes it easier to operate one handed, as fingers do not block the user's view of the screen. According to [PC Advisor](#), the pressure sensors on the side of the phone can sense a squeeze action to, for example, stop scrolling or launch an application. Concepts from the design - which is not expected to come to market in its current form - could assist users who have disabilities in one of their hands.

Fuse is expected to be on display at this month's Consumer Electronics Show (CES) in Las Vegas. Many other companies are engaged in producing competing touch products and related technologies integrated in the Fuse phone. [TechNews 01/09](#) covered a more basic prototype LucidTouch system from Microsoft, which uses a touch surface on the rear of the screen.

Liquid cooling to improve operation of 3D processors

Chip designers, like urban architects, would like to be able to build 'up' to save space on circuit boards. Packing components more closely together in three dimensions would lower the average distance for data transfers, making internal communications faster and generating less waste heat, which is proportional (among other factors) to the length of the wire. As well as protecting the electronics, reducing waste heat will also lower the total energy bill for systems using 3D processors. Initially, 3D processors are likely to be created by stacking layers of discrete cores vertically, with many short interconnects between each layer.

One of the challenges for designers of '3D' processors is to remove surplus heat - it is much easier to cool a large flat object than a more solid one. Investigators in Lausanne are [experimenting](#) with a system that operates like a fridge: a liquid coolant would be pumped into microchannels layered within the chip; waste heat evaporates the coolant, which then exits under its own pressure to pass through a condenser unit that releases the heat. A prototype system, with channels measuring 50 micrometres (50,000nm or a twentieth of a millimetre) in diameter, will be tested

under operating conditions next year. However, it has yet to be built into a 3D processor, as these are not expected to begin to appear in supercomputers before 2015.

Spintronic effects in silicon demonstrated at room temperature

All electrons carry a 'spin', which is described either as 'up' or 'down'. This binary system has been considered a potential basis for both storage (Racetrack memory and MRAM) and for quantum computing. (See 'New and high performance computing news' in [TechNews 05/08](#) and [TechNews 11/08](#), respectively.)

Controlling spin in non-metallic materials has generally required very low temperatures around 150°K (-123°C), but researchers have now [demonstrated](#) a potential approach that works at room temperature. If the effect is confirmed and can be scaled up into working components, the physics suggests a high density, low power storage medium that uses similar production techniques to existing chips.

New organic flash memory prototype revealed

Flash memory is made from silicon using industrial processes that have been refined over many years. However, the successive stages of masking and etching remain relatively expensive compared with the potential of organic electronics, which can be deposited using solvents. Researchers from Tokyo have produced a prototype organic memory that could - when commercialised - be used in disposable products with little additional cost.

Flash memory is a form of 'permanent' memory, in that it retains information when the power is switched off. This is achieved by forming a charge on an element in a transistor known as a floating gate - floating in that it is completely surrounded by an insulating material. The breakthrough, [reported](#) by the Tokyo team, is to deposit a layer that is thin enough for this charge to be transferred but robust enough not to melt during manufacture. The resulting organic circuit is not nearly as efficient or long-lasting as its silicon equivalents, but it is both inexpensive and flexible. (Data could be retained for no more than 24 hours and cells could only be re-written about a thousand times without degrading. This contrasts with around 100,000 re-write cycles for the better types of silicon based-flash.)

Disposable memory could be used in packaging to record environmental conditions over time for a food product, or in association with cheap sensors for pollution monitoring. Such memory would also likely be seen as attractive to manufacturers of greetings cards and toys.

Advanced Format finds extra space on hard drives

Western Digital and other storage manufacturers have begun to roll out a new drive formatting schema that can regain as much as ten per cent of a drive's nominal capacity. In the past, each sector (a uniquely addressed portion of the disk) held 512 bytes of data, but [Advanced Format](#) increases this to 4096 bytes.

Between each sector on a drive there are gaps which assist in synchronising drive operations and blocks that contain error correction data and other system information. Increasing the size of sectors reduces the aggregate size of these

additional blocks, releasing more space to store the user's data. Raising the sector size also increases the size of hard disk that can be accommodated by the operating system, even though the maximum number of disk sector addresses remains constant.

Advanced Format drives present themselves to the operating system as 512-byte devices, as this has been the standard for many years, but then map these smaller logical sectors to the larger 4096-byte physical sectors. Modern operating systems, such as Windows Vista, Windows 7 and more recent versions of Mac OS X, can already prepare and operate Advanced Format devices (including external USB hard drives), but utilities provided by the manufacturers are required to maximise the performance of the new drives on older platforms. Further details are given by Western Digital [here](#). Existing disk and data cloning tools may not be aware of the new format.

EU tightens requirements for battery recycling

[TechNews 09/08](#) contained an article on new rules for battery recycling across the European Union. The original implementation was delayed while precise details were redrafted and the new regulations came into force in May 2009. The requirement puts a responsibility on producers of hardware containing batteries (and replacement batteries) to register and provide collection and recycling facilities through a 'battery compliance scheme'. From 1 February 2010 most high street, mail order and online retailers will have to provide collection points or 'take-back' facilities. These must be free of charge, but will be managed by one of the battery compliance schemes.

Nearly all categories of portable battery are covered in the legislation, including rechargeable, 'button' and integrated types. However, batteries in laptops, mobile phones, cameras, power tools and similar portable items should be removed and the host hardware disposed of separately (if necessary). The latter is covered by the existing Waste Electronic and Electrical Equipment (WEEE) regulations. All types of portable battery must be collected, regardless of whether the distributor supplies that type of battery. The Department for Environment, Food and Rural Affairs (Defra) provides links to relevant documents from a [section](#) of its website, including an [FAQ](#) for distributors.

Local authorities and establishments that sell portable equipment to learners, parents or other organisations appear to be covered by these requirements. Schools and colleges should ensure that old batteries are collected and disposed of according to the appropriate regulations, rather than being put in normal waste collections. The new regulations are intended to help the UK achieve European collection targets of 25 per cent by 2012 and 45 per cent to be reached by 2016.

Software and internet

Analysis: Vital CPD

At a glance

- IT skills in the workforce are in short supply but fewer students are taking up related courses.
- Ofsted has found significant weaknesses on the teaching of ICT (as a subject) and the effective use of ICT (to support all learning) in too many schools.
- The Open University and e-skills UK have been contracted by the DCSF to develop and deliver a programme of CPD for England, aimed at teachers of ICT and all staff needing support in their use of ICT across the curriculum.
- Vital will sign-post and scaffold learning experiences from a range of providers, including courses written specifically for the programme.
- Effective CPD focuses on the context of the teacher and needs to have clear support from school leaders, based on a sound vision for ICT in learning and teaching.

Old problem, new approach

The term ICT (information and communications technology) was introduced into the curriculum more than a decade ago and has caused confusion ever since. Properly, it refers to the skills required to use technology to lead a richer and fuller life - at home, in school and at work. It is also a discrete subject in the English and Welsh national curricula and an expectation in every other curriculum area. As such, all serving teachers should have a grasp of the fundamentals of ICT and specialist teachers ought to have a deeper understanding.

A number of exam curricula use terms like 'computing' and 'information technology' to describe the deeper study of the concepts underlying ICT, including logic, programming and the operating principles of hardware. These subjects are more often available at A-level, but are introduced in most related GCSE syllabuses. However, many students can pass ICT GCSE without adequately addressing these issues and few go on to study A-level.

Ofsted has made clear that there is a significant gap between the classroom experience of many learners and the expectations of the curriculum. This gap may be explained, in part, by the lack of up-to-date knowledge of the fundamentals and applications of ICT among teachers.

ICT - future and past

We know that technology changes very rapidly and that students coming out of university will need transferable skills, as much as knowledge of current technologies. According to the [TES](#), the number of qualified IT professionals required by UK industry will increase by up to 15 per cent over the next eight years, but graduate entry to computer science courses has dropped 60 per cent since 2000. e-skills UK, the Sector Skills Council for Business and Information Technology, [reporting](#) in June 2009, said, 'almost one quarter of firms with IT/Telecoms staff stated that they were experiencing ICT-related skills gaps, whilst around one in six

firms considered the IT user skills of other staff to be at a level below that needed of them'.

[TechNews 09/08](#) reported that poor careers advice was a factor for students deciding not to take up computing-related degrees. (See 'IT careers and qualifications' article.)

[Ofsted](#) found, for the period 2004 to 2007, that 'the decline in A-level computer studies was more severe [than for A-level ICT] with a 32% drop in entries (45% drop in girls' entries and 31% for boys)'. Further, 'less than one quarter of IT graduates are women. This has serious implications for the IT industry, where just one in five workers is female.'

In secondary schools, Ofsted reported:

The Key Stage 4 curriculum was inadequate in around one fifth of the schools visited; assessment was unsatisfactory in a similar proportion, and many students were following qualifications of doubtful value... Students were spending considerable time demonstrating proficiency in what they could already do in order to meet the assessment criteria, rather than being introduced to new and more challenging material and skills... Teachers' subject knowledge was weakest in data logging, manipulating data and programming.

The root of the problem often lay in planning and teachers' subject knowledge:

Unsatisfactory achievement was due mainly to weak teaching, weaknesses in the planned provision, or both... Deficiencies in teachers' subject knowledge and expertise were more significant when non-specialists taught ICT as a specific subject, which was sometimes the case at Key Stage 3.

Ofsted also identified issues in many primary classes:

Teachers tended to give more attention to those aspects of ICT where they themselves felt confident.

A decade ago, the Government launched the New Opportunities Fund (NOF) training programme for serving teachers, funded with £230 million from the National Lottery. Evaluators, such as [MirandaNet](#), found NOF to have been a limited success, although teacher confidence and competence grew in the succeeding years.

Partners in CPD

The Open University and [e-skills UK](#) believe they have learned the lessons drawn from NOF and subsequent reports on successful continuing professional development (CPD). They have won a £5.6 million, two-year contract from the DCSF to implement a new CPD initiative, to be launched in January 2010. With the tag line 'transforming lessons, inspiring learning', [Vital](#) 'aims to share existing examples of good practice and to deliver a consistent [CPD] programme' across England. (Nevertheless, many of its services will be relevant to the whole of the UK.)

Vital will be 'targeting both those teaching IT as a specialist subject and those wanting to use ICT more effectively in teaching other subjects', including opportunities for support staff in schools and sixth form colleges to gain confidence, competence and experience. The programme will be seeking to build a large, online community of practice, in which each individual will be able to share and access advice, practical ideas, informal peer-to-peer support and CPD opportunities relevant to their needs.

Vital has already been exploring partnerships with a wide range of organisations, including CPD providers, Government agencies, examination bodies and employers willing to offer placements to teachers working with more advanced level students. The Vital website will be linked to the Training and Development Agency (TDA) CPD database and will scaffold learning experiences and opportunities.

Vital hopes to integrate initiatives like [ICT CPD 4 Free](#), developed by Naace with funding from the TDA. This set of free modules will be available online (from their launch at BETT) for teachers to increase their skills and knowledge of more recent or less well understood areas of ICT. Some teachers may find that more informal methods of developing understanding and sharing skills better fit their own needs, such as community-driven [TeachMeets](#), or 'personal learning networks' developed in an *ad hoc* way through services like Twitter. There are also many other online resources, like [Teachers TV](#) and the LTS [CPD materials](#) (also available on [iTunes U](#)).

The launch and after

The formal launch for Vital will take place at the [BETT](#) exhibition in January, but a considerable amount of development is planned to follow during 2010. Nine regional centres have been identified, with coordinators appointed to work with local authorities, schools and colleges, commercial organisations and other partners.

Vital has been mapping existing CPD provision and will be sign-posting external services, but it has also been developing new materials to fill the 'gaps'. Ten new courses will be available early in 2010, with three of these focussed on the 14-19 Diploma in IT, and there will be a route to achieving a Masters of Education through the Open University (OU) from the autumn. There will also be '15-minute' CPD events, such as keynotes, 'hotseats', 'online teachmeets' and 'talk about' sessions.

Materials will be available for third parties to use, but Vital will not dictate the delivery style. Although all will employ online elements, courses will often run as a 'blended' experience, involving varying amounts of face-to-face and online input. Vital hopes that participants will extend their studies using the resources in the OU's collaborative environment.

Teachers can pre-register their interest on the Vital [website](#).

Effective CPD

Vital may have less funding than NOF, but it is no less ambitious, hoping to use the resources it has to 'gear' other funds, including schools' CPD budgets, and to develop an effective online learning community. It will foster CPD approaches that are blended, personalised, reflective, collaborative and organic, rather than 'top down'. Vital aims to identify effective pedagogy and relevant applications of ICT to deliver curriculum aims.

Becta recently released two reports on ICT CPD written by researchers from the University of London: a [literature review](#) and a [qualitative study](#). Issues identified include (quoting selectively from the literature review):

- An over-emphasis on skills training in itself at the expense of deep understanding and application of skills to developing learning and teaching.
- The challenge of developing an appropriate 'vision' for ICT among school leaders, which is focused on pedagogy and teacher development as a priority.
- 'Policy tensions' which deflect from coherent and consistent development of pedagogy using technologies, and create conflicts over how time and resources are used to embed technologies within schools.

Two of the key recommendations from the research are:

- Teachers need to be at the centre of their own learning if they are to change their deep-seated beliefs and habits regarding the use of technology.
- CPD activities need to focus on planning for student learning, within a clear set of understandings about how learning happens.

[Ofsted](#) stated that where school leadership and management were most effective:

Training for ICT was integrated well into the school's cycle of planning and senior leaders had a good overview of what training had been completed and what was still needed. The approach to ensuring that training met the school's priorities was systematic and there was a clear evaluation of the outcomes.

The TDA has general [guidance](#) on managing effective CPD programmes.

Recognising success

Vital has agreed a series of contractual milestones and success criteria with DCSF, but it may be the 'softer' measures, such as engagement from school and college leaders, that will determine the success of the initiative. Becta's Harnessing Technology Review 2009 notes that:

CPD is a further important predictor of e-maturity. If leaders have confidence in funding for ICT CPD or CPD for teachers is in the technology strategy, schools are far more likely to have integrated technology than if this is not the case.

Uptake of computing courses at A-level and in higher education, and ICT capabilities of new entrants to the workforce in future years will be the true measure of success for initiatives like Vital.

Software and internet news

E-safety lessons become a curriculum requirement

The DCSF has [announced](#) that e-safety is to become a formal part of the curriculum for all school-age learners from September 2011. Already a part of the secondary curriculum, e-safety will be compulsory in primary schools from this date. The Government expects that e-safety issues will be raised in a wide variety of relevant curriculum areas, especially in PSHEE, not just in lessons designated as 'ICT'. (PSHE stands for personal, social, health and economic education.)

This development should be a natural progression for schools as part of the safeguarding agenda. Ofsted already requires inspectors to consider internet safety and related issues within its [Evaluation schedule of judgements](#). This states that schools should encourage learners to 'adopt safe and responsible practices and deal sensibly with risk, for example... [when] using the internet.' Schools should have policies that cover all aspects of internet safety, cyber-bullying and appropriate use of communications technologies, and these policies should be seen to be implemented.

This announcement is part of [package of measures](#) drawn up in conjunction with [UKCCIS](#) (the UK Council for Child Internet Safety), including a new campaign with the slogan '[Zip it, Block it, Flag it](#)'.

Chrome OS computers for next autumn

Google announced that it was developing a new, lightweight operating system in July this year. (See [TechNews 07/09](#).) Google has begun to give more details of how Chrome OS will work, with an expected launch date late in 2010. A [YouTube video](#) explains the concept in fairly simple terms, while [another](#) has been posted of Google staff demonstrating an early version of the software. Google stress that many changes are likely to be made before final launch.

Google Chrome OS is being developed by Google, but it is based on Linux and (like its Android operating system for mobile devices) is using an open source model. This means that programmers can freely download and modify the code (within the licence terms) and install versions of it immediately. Nevertheless, Google will remain the 'custodian' of the official build.

Google is clear (see [TechNewsWorld](#) for example) that Chrome OS is aimed at 'companion' computing devices, such as netbooks, rather than users' main desktop systems. On its [blog post](#), Google says that 'it's all about the web. All apps are web

apps. The entire experience takes place within the browser and there are no conventional desktop applications.' This means that users will be unable to install large office suites, complex photo editing applications, bulky games or utilities for grabbing data from peripherals, such as software that connects to mobile phones to manage contacts and photographs.

All hardware will be expected to have at least an 802.11n Wi-Fi connection and (in many cases) a 3G mobile data connection as well. This does not mean that the netbook must be continually connected to the web, as Google Gears will permit offline working, but the operating paradigm is primarily online. The reference hardware design, which Google is already mapping out with manufacturers, will not include a hard disk, but will use a solid state disk (SSD), and will have a simplified firmware and BIOS to enable rapid booting - the current version [is said](#) to boot in seven seconds. (See Instant-on hardware in [TechNews 07/09](#).) Cameras and other peripherals will be supported as storage devices, allowing users to retrieve pictures and video, but only the bare minimum drivers will be provided to support these functions or other services, such as printing.

Google is [reported](#) to have been working to ensure that Chrome OS will operate equally well on ARM processors as on Intel architecture devices. ARM processors have a reputation for being small and having a low power consumption compared to Intel alternatives (such as its Atom designs). This will mean that Chrome OS will work on a very wide range of hardware, from mobile internet devices (MIDs, as Intel would term its equivalent) to a range of desktop computers - people have already built versions that will run in 'virtual container' on modern Apple PCs (using tools like Parallels and VMware Fusion). At the mobile end of the market, commentators have questioned the relationship with Google Android operating system, with [reports](#) that the two could 'converge' in future as more powerful mobile processors are developed.

The 'web only' model brings considerable security advantages, as programs will not be permitted to run directly on the hardware. Instead, they will operate in the browser using a 'sandbox' that ensures they cannot interact with other parts of the system. (Google already does this with its Chrome browser, which will be tightly integrated in the new operating system.) If one of the core programs becomes corrupted in any way, the device will fail a software verification check and reboot using clean code. Of course this does not prevent other malicious attacks within the browser, such as 'phishing' scams or certain types of script-based malware.

Google's aim is to get people onto the internet as quickly as possible, using its own or alternative web applications. Once connected, Google will generate revenue from advertising and paid-for services, such as its Apps suite for businesses, although users will be able to select any other web service that better meets their requirements. Google believes that users do not need the power available in desktop applications for most of their computing tasks. If - and that is a big 'if' in many places - if wireless internet connections are fast and reliable enough to support this model, users may migrate entirely to working online. If Google succeeds, both Microsoft and Apple may see Chrome OS a real threat to their own desktop operating systems.

Due to their open source roots, other builds on the Linux platform might then see advantages in merging their code with the Google project, unless they feel able to offer something entirely different.

The always-on, always-connected model of computing that Chrome OS could deliver would be beneficial to education - learners would be able to access information, materials and learning content from 'anywhere'. The low power of Chrome OS devices should allow all-day working on a single battery charge, while the price could make it affordable to roll the hardware out to all learners in a school or college. (Although solid state disks are expensive, the price is coming down and large savings will be made as there will be no need for a proprietary operating system.) Management would also be simplified, as users could pick up any Chrome OS device and access all their applications, data and settings via the internet.

Schools choosing to go this route will need robust wireless networks able to support large numbers of mobile users and a reliable 'backhaul' internet connection. Applications could be hosted on local web servers, especially for more sensitive systems that record personal data, such as assessments. However, learning platforms and content delivery systems would be expected (in this model) to migrate to the 'cloud', where they would be hosted in remote data centres. (See Cloud computing in [TechNews 11/08](#).)

'Real time' and other search developments December 2009

Providing 'real time' results has become one of the top priorities for search engines over the last year. Although such updates can be subject to rumour, deliberate misinformation and downright malicious comment, social networking sites like Facebook and microblogging services such as Twitter have been proven to produce real news before any 'traditional' media outlet.

These companies produce application programming interfaces (APIs) that provide data for third party services and applications. However, the volume of updates can be very large, potentially overwhelming both the bandwidth of the host service and capabilities of the third party's servers, so API 'calls' are often limited. In order to grant access to the 'fire hose' of raw data, as Twitter calls it, the hosting companies are looking for something in return. This means that search engines wishing to use the data must be confident that they can add 'value' to the stream, most likely through advertising. In addition to live news, tracking updates gives an indication of 'sentiment' - the topics of immediate interest to web users and their responses to the issues of the day.

Microsoft was the first to both announce a deal with Facebook and Twitter and to have a 'beta' (trial) service for the latter running on its [Bing](#) search engine back in October. These updates have yet to be integrated into the search engine's normal results pages, but Google has [recently](#) done just that, with a box for many searches that continuously updates while you watch. These developments are just the start of what is likely to be a long series of developments and updates to incorporate a variety of 'real time' information linked to search queries. Yahoo has also begun to

[supply results](#) from Twitter for some searches, accessed from its 'News Shortcut' tabs on the US version of its search results.

Microsoft has produced a more interactive version of its Bing mapping technology using Silverlight. (Microsoft [announced](#) public access to the beta version of Silverlight v4 at its developer conference in November. Silverlight aims to compete with Adobe's Flash as a platform for delivering rich, interactive, multimedia web experiences.) Linked to Bing, the Silverlight [beta](#) version integrates weather, images, restaurants and other local information onto map pages and provides API calls for third parties to develop add-on applications.

Google has [released](#) a new 'Labs' application called Google Goggles - a mobile search tool that uses the camera and image search techniques to provide information on objects in the user's field of view. Goggles can already provide search results linked to landmarks, consumer products, works of art and other images. This developing system, which requires a smartphone with Google's Android v1.6 (or higher) operating system, could assist learners on visits and field trips.

Readers may also be interested to note that Microsoft and Yahoo have now [formalised](#) a deal that would see Microsoft supplying search data to Yahoo, while Yahoo manages 'premium' advertising relationships for both companies. The agreement is set to cover the next ten years.

In related news, researchers are investigating distributed search technology. Internet searches are generally delivered through sophisticated algorithms based on huge, centralised indices and stores of cached content. In order to deliver the performance that users have come to expect, as well as to act as a back up, this information is replicated across a few, very large data centres.

A research team from Yahoo's Labs in Barcelona, Spain, has been [describing](#) a distributed model that would deliver more locally relevant results. Parts of the global index would be held in each of the smaller local data centres, to ensure that a rapid response time could be maintained for results that might be requested in any country, whereas other parts would be more specific to that region. A new algorithm would compare page rankings between data centres and use those that provided the most relevant results. The team modelled their approach using real search data and suggest that it could make savings of as much as 15 per cent. Some searches would be delayed, but this would be balanced by faster responses to most searches and greater local relevance.

The large search providers may not see an immediate need to break up their data centres in this way, but Eric Schmidt (CEO of Google) was [recently reported](#) to have said that all the information stored by humans up to 2003 - five exabytes - is now generated every two days. (An Exabyte is a billion, billion bytes.) Indexing this quantity of data - and storing it in monolithic data centres - will become increasingly problematic.

Google brings auto-captioning to YouTube videos

Watching online video can be frustrating if you cannot hear the audio (due to background noise or physical disability), or when you do not speak the language. Google has [launched](#) a new automatic captioning service which it intends to gradually roll out across its YouTube service.

Captioning normally requires considerable human input to produce a transcription and synchronise the relevant part to each section of video. Google has had a manual captioning service available for some time, which (as a 'by-product') has helped it to index video content. The new service relies on the company's speech recognition technologies, such as used in its Google Voice telephony application. However, the quality of the captioning will depend on the clarity of the audio, as well as factors such as the speaker's accent and interference from background music or sound effects. The company readily accepts that captioning will not always be entirely accurate. (Speech recognition was covered in [TechNews 09/09](#).)

Google has added captioning to a number of YouTube academic channels, such as Stanford, MIT and National Geographic. Once captioned, Google can use its translation system to provide alternative captions for speakers of other languages.

IBM crowd-sources new language translation system

Crowdsourcing brings the 'wisdom of the crowds' to bear on a particular problem. One of the best known examples is Wikipedia, the encyclopaedia that draws on the knowledge and editing skills of tens of thousands of volunteers, to contribute to and then refine a massive range of articles.

IBM has [developed](#) the 'n.Fluent' language translation system, based on the knowledge of its 400,000 employees worldwide. The company has run a series of internal 'campaigns' to identify and translate target text, yielding an international dictionary of 40 million words and phrases. Unlike Google Translate or Yahoo's Babel Fish products, the n.Fluent application operates within the company's secure computing domain and focuses on language commonly used in a business context. The software is adaptive (like speech recognition systems), allowing it to 'learn' better translations over time. The system can translate static documents, like emails, and real time conversations in 'chat' applications. In addition to English, Japanese and Chinese, n.fluent works with a range of European and other common languages.

The product remains an internal application at present, but IBM sees potential demand from many of its business customers. The crowdsourcing approach could be used by learners to develop their own dictionaries, which they could then use and compare to automated translation tools.

Google developing new speedy web protocol

The original hypertext transfer protocol (HTTP), which controls access to much of the data now moved around the internet, was never designed for complex web pages that load multiple files. Google is running an [internal trial](#) - which it wishes to expand - for a new SPDY ('speedy') protocol to make up for some of these deficiencies.

Currently, small files required to display a page may get 'stuck' behind larger ones, or the browser on the client PC will have to negotiate separate HTTP streams for each file. SPDY creates a single, secure, SSL connection between client and server, compressing as much data as possible. The new protocol permits multiplexed data streams, so key files can be transferred at the same time as other information, allowing the browser to display the main page content much faster. Indeed, in a test of the 25 'top' websites under conditions designed to simulate a home computing environment, Google found some sites load more than twice as quickly compared to using HTTP.

However, as [Ars Technica](#) points out, this approach would add to the processor overhead for both server and client, as all information would be encrypted. This may be fine for a fast desktop system, but could actually slow down low power devices that lacked the computational power required. Further, the Internet Engineering Task Force (IETF), which is the guardian of the HTTP standard, would normally expect any new protocol to be backwardly compatible with existing equipment and software; SPDY would either need to be integrated within an update to the existing standards, or new browsers and hardware (such as routers) would be required.

New browser standard to improve file uploads

Basic browsers and early versions of the web's hypertext markup language (HTML) were only designed to link static pages of text on the internet. However, web applications have become ever more sophisticated, controlling everything from banking through to social networking. Many of these applications interact with files on the user's computer - for example, uploading photographs to share, backing up files in online repositories or downloading bank statements to the user's disk. Web applications (see [TechNews 01/09](#)) have to use add-on tools, such as Sun's Java language or Adobe Flash, to control these functions.

The Mozilla Foundation, who develop the open source Firefox Browser, has [submitted](#) a new 'File' application programming interface (API) to the World Wide Web Consortium (W3C), the web standards body. The File API, built in JavaScript, controls file access in the background, allowing the browser to process files while continuing with other tasks. This means that the user will be able to continue with other tasks in the same browser window, such as updating their status, chatting with friends or writing a blog entry, without waiting for a file upload to complete. The API also allows the browser to process the content of the file, perhaps to convert the format, before it is uploaded. However, the API must be given explicit access to the file by the user and it cannot write data back to the file or directly to the hard disk, restricting its functionality but considerably increasing machine security.

The API must be approved by W3C to become an accepted standard, but Mozilla is [reported](#) to be building it into the next release of Firefox. If adopted by Microsoft, Apple, Opera and other browser developers, it could make it much simpler to build educational web applications that handle local files, including e-portfolios, learning platforms and examination entry management systems.

UN produces guidelines on user generated content, including working with children

UNESCO, the UN's Educational, Scientific and Cultural Organisation, has [published](#) 'Guidelines for broadcasters on promoting user-generated content and media and information literacy'. It covers a wide range of topics across user-generated content, which it subdivides into:

- audience generated news content
- audience comment
- collaborative content
- interactive journalism
- other non-news content.

Specific scenarios covered include:

- partnerships with community media and other local organisations
- camera distribution projects
- community workshops
- digital storytelling
- online interactive journalism projects.

The section on skills gives basic guidelines on:

- taking (digital) photos
- filming skills
- audio and voice recording
- keeping it appropriate and legal.

The document is aimed at broadcasters, but describes how such organisations might interact with users in schools and colleges, as well as in other settings. UNESCO says that 'the mere involvement of broadcasters in MIL [media and information literacy] can give the field an authority and prestige that is often lacking'.

The document acknowledges that projects should account for the local context, including cultural differences, and refers to issues that include child protection, parental consent, moderation and project sustainability. It also promotes freedom for learners to express their own opinions, to develop content collaboratively and to be involved in the direction of the project

These guidelines may be useful to educators thinking of developing contributory projects in the wider community, or with learners from other countries, and to teachers involved in media education. While the advice is quite broad in scope, it can be seen as coming from an authoritative international body.

TechNews readers may also be interested in the 'Good Practice Note' [Taking Photographs in Schools](#) and other documents in the Information Commissioner's data protection [document library](#).

Better writing skills are developed across a range of technology and media

The Literacy Trust commissioned research on young people's attitudes to writing and the forms of media in which they expressed themselves. Some 3,000 young people aged 9 to 16 answered an online survey, with slightly fewer boys than girls responding. 43 schools participated, with the number of pupils receiving free school meals in the sample somewhat higher than the national average.

The [survey found](#) that three quarters of all pupils write 'regularly' across a range of media, including text messages and social networking sites, and for a variety of purposes, both at home and in school. Perhaps unsurprisingly, young people prefer writing for their own purposes rather than for tasks set in school. Further, girls write more frequently, across a wider range of formats, and enjoy it more than the boys in the sample.

The report identifies 'technology-based types of writing, such as text messages, instant messages and writing on social networking sites' and says that respondents engaged in these more frequently than other forms of writing. Ownership of a mobile phone was not found to be a factor, but those who had a blog or updated a social networking site wrote more and were more likely to enjoy doing so.

Nearly half of the young people used computers daily to write for social purposes, but only a fifth used them for homework. Computers were used more frequently by older pupils. In attitudinal responses, the sample suggested that the main advantages of using a computer to write include the ability to edit (89%), clarity of presentation (76%), creativity (60%) and writing more content (55%). Boys (54%) found computers much more helpful when concentrating on writing compared to girls (42%). On the down side, nearly a third of pupils (31%) suggested that computers made you write too fast and a quarter (25%) that they more likely to use bad spelling and grammar.

The authors suggest that teachers do not value technology-based writing, 'yet, much of this writing is creative, designed to entertain the intended audience, and covers many of the assessment criteria that are attached to academic writing'.

The report also contains self-reported levels of ability, details of the types of writing engaged in and young people's perceptions of professional writers. The authors are careful to avoid causal links between the respondents' perceived ability to write better and their use of technologically mediated forms.

The changing face of research in a digital age

'Generation Y' or the 'Google Generation', is considered to have been born between 1982 and 1994. (In other words, aged 15 to 27 in 2009.) JISC is undertaking a 3-year longitudinal study of 70 doctoral students born in this timeframe, supplemented by wider surveys, to see how they approach research tasks. The latest interim *Researchers of Tomorrow* report is based on responses from more than 5,400 doctoral students, with nearly two in five (38%) belonging to Generation Y.

The [summary report](#) reveals that younger researchers are most likely to be based within their own institution, compared with their older counterparts. (More than half of those aged above 35 worked largely from home.) Less than a third had received any formal training in a range of online research methodologies, including use of online datasets, access to online alert services and data mining skills; far fewer had been trained in making their own work available through open access publishing or use of tools like wikis and podcasts. (This type of training is generally provided on request, so it is quite possible that they were relying on skills gained through undergraduate years, during their schooling or through informal means.)

The doctoral students were largely (in 80% of instances) looking for secondary materials, especially published works, rather than raw data sets and archives of primary sources. Nevertheless, scientists were more likely to be seeking the latter compared to those from arts and humanities or social science disciplines. Google and Google Scholar were the starting points for nearly a third of successful searches, while one in seven used a citation database. (The use of citation databases was significantly higher among science and medical researchers.) The Generation Y researchers were somewhat more likely (75%) to find the information they required from e-journals, although a majority (69%) of all requests were fulfilled from these sources.

The majority of researchers (73%) still download or print materials (or both) for later reference, but nearly a half (48%) read or scan the information while online. Few actively use more advanced ICT tools or Web 2.0 applications, including 3D and visualisation technologies, social bookmarking, micro-blogging and e-portfolios. Patterns among Generation Y are largely the same as other age groups, but respondents from engineering and computer studies disciplines (of all ages) were more likely to use Web 2.0 tools.

This research sets a context for the skills required by students moving into and through higher education, but might also suggest that 'e-research' tools would be used more effectively if students were introduced to them earlier in their education.

TechNews Information

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