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Networking and wireless

Analysis: Power line networks

At a glance

- The electricity grid infrastructure, as a widely distributed network of copper wiring, seems an obvious candidate for use as a data network.
- A high-frequency data signal can be imposed on the normal alternating current, which will propagate between the phases in a building but not through power transformers in substations or connected to consumer hardware.
- Modern digital signal processing equipment can drive data at 200Mbps on household mains and as fast as 2.5Mbps on higher voltage distribution cabling.
- Mains interference from switching and high power equipment can also propagate through buildings and local electricity networks, hampering transmissions.
- A number of power line communication specifications are competing for adoption as the 'de facto' standard, but they also have to prove their advantages compared to other wired and wireless technologies.
- Monitoring and control of 'smart grid' meters and devices may prove to be suited to power line networking.

Network power

The electrical grid has long held out a promise of pervasive networking based on widely installed infrastructure, but the associated practical limitations have hindered implementation. Mains electricity comes to almost every building in the country and is wired through every room, but the grid was never designed with data transmission in mind.

The public's perception is largely governed by an understanding that mains electricity is dangerous. Such a perception may suggest to people that they should never connect networking equipment, let alone expensive audiovisual (AV) devices, to the mains to transfer data. However, the electrical theory underpinning such connections is perfectly valid and can be safely implemented. 'Baby monitors' plugged into mains sockets generally use this method of communication with little immediate risk.

Many power companies exploit the grid infrastructure for signalling and telemetry. Relatively low frequencies are used (in the kilohertz range), so only limited data can be carried, but this is adequate for network monitoring and control. Historically, these systems have used analogue signalling equipment, but modern high-speed analogue to digital converters and inexpensive digital signal processors have opened up opportunities for broadband communications in the home and over the grid.

The mains solution

Power line communications (PLC) is being promoted as a solution for home media networking. [According](#) to PC Advisor, ABI Research predicts that revenue from networked home media devices will more than double to \$243 billion (about £160 billion) in the three-year period to 2012.

Household wiring can be used to create a data network by overlaying a data signal on the alternating current waveform of the electrical mains. (This [description and diagram](#) from HD-PLC illustrates the point.) In practice, mains wiring often transmits significant interference caused by devices turning on and off and harmonics (a kind of resonance) generated by connected equipment. Some sensitive hardware, such as computers, need surge protection and filtered supplies to operate reliably, but most appliances, such as washing machines, are not affected by 'dirty' mains supplies.

A further problem for all levels of power line communications is that high-frequency signals are effectively filtered out by power transformers, whether on the mains lead for an LCD monitor or at a local electricity substation. This means that home devices that use PLC must either be directly connected to the full 240V supply or via an Ethernet or USB lead that 'bridges' across any transformer.

A variety of industry groupings, including the [HD-PLC Alliance](#), the [HomePlug Powerline Alliance](#) and the [Universal Powerline Association](#), are promoting a range of related power line technologies. Taking [HomePlug AV](#) as an example, the system delivers 200Mbps at the physical level, although error correction, 128-bit AES security and other overheads reduce the effective data rate to 150Mbps. In the US domestic market, as in many UK educational establishments, two or three phases of the electricity supply are connected to a single building. This [HomePlug whitepaper](#) explains how parallel supply wiring and a common bus permit the relatively high the frequency (2-28MHz) signals to cross between phases.

HomePlug AV was one of a number of technologies examined in the initial stages of developing a draft PLC standard, known as [IEEE P1901](#). This standard is intended to specify systems that can deliver 100Mbps or more using frequencies up to 100Mhz, whether in a building (transmission distances under 100m) or 'last mile' connections to buildings (under 1,500m). The standard should ensure 'fair coexistence' between devices, but the draft specifies two alternative physical layers based on incompatible modulation techniques, which would limit full interoperability unless devices support both. (Modulation affects the way that digital data is represented as an analogue signal.)

Home alternatives

Power line networks are competing with a mature Wi-Fi ecosystem, a range of wired technologies and specific wireless standards for networked media devices. Many consumers have broadband routers with 802.11g or 802.11n built in, [capable of](#) maximum (theoretical) throughputs of 54Mbps and 450Mbps respectively. The latest wired [HDMI v1.4](#) specification supports video resolutions above full 1080p HD at over 8Gbps, while the current [WirelessHD](#) and the forthcoming [WiGig](#) standards have maximum throughput of 4Gbps and 7Gbps respectively. However, these HD standards are all relatively short range due to the cabling used or high (60GHz) frequencies chosen.

Many homes, especially in the US and newer developments in Europe, already have co-axial cabling installed in every room for distribution of television signals. The

Multimedia over Coax Alliance ([MoCA](#)) has a proprietary standard that currently delivers 175Mbps and promises 400Mbps to come. Meanwhile, the [HomePNA](#) Alliance's latest specification delivers up to 320Mbps across telephone wiring and coaxial cabling.

The [HomeGrid Forum](#) aims to unite these cabled infrastructures (but not necessarily all the groupings) into a single G.hn specification, which is currently being ratified by the International Telecommunications Union (ITU) as 'Recommendation G.9960'. Covering co-axial, telephone and power line cabling, the G.hn standard is [effectively complete](#), with devices expected later this year. As reported in [TechNews 01/09](#), G.hn is designed to deliver 400Mbps over co-axial cables and 200Mbps on power lines.

[Tom's Hardware](#), a respected online publication, compared the performance of 802.11n wireless, a HomePlug AV compatible device and a MoCA unit in a typical house. The review concluded that power line technology had the lowest throughput figures and that it was not "suitable for anything beyond a single HD video stream". The hardware was all sourced from the same manufacturer, so it is possible that other units would compare differently. Also, building materials in other dwellings might adversely affect Wi-Fi, which came second in their tests.

The last mile and beyond

Broadband over power lines (BPL) aims to apply similar principles for connecting homes back to internet service providers (ISPs). Due to the structure of local power networks connected through transformers at substations, each network would operate independently and would need to be bridged together at substations and elsewhere in the grid. Each local network would need an addressing structure that accounted for both buildings and the devices within those buildings, since they all share what is effectively a single data bus. In the UK such a local network might cover 200 to 300 houses and interference from appliances in any of those properties would be transmitted across the whole network. Such issues have limited the development of BPL in the UK.

High voltage overhead power cables, which could be used for the 'backhaul' between a local network and an ISP, effectively act as large antennae, so a number of pilot schemes in the US and elsewhere have been criticised for generating radio frequency interference. (Typical data transmission frequencies range from 1.6 to 80MHz, potentially affecting shortwave and FM transmissions.) Both BPL and home PLC modems can use protocols that 'notch' transmission frequencies, either according to fixed lookup tables or by sensing radio transmissions in the area, to avoid interfering with broadcast signals.

The electrical grid could provide 'last mile' connectivity between premises and high bandwidth copper or fibre optic connection points. However, depending on the transmission frequency used, BPL currently offers up to 2.5Mbps, which is hardly competitive in areas where standard ADSL or cable services are available and often packaged as part of a phone deal. In the US, where local substations serving only a

few buildings are mounted on the poles for power lines, BPL could provide backhaul for 'metro' Wi-Fi networks. (See [Wireless mesh networks in TechNews 11/09.](#))

A new discovery, if its promise is fulfilled, could provide last mile access in areas with overhead power distribution cables. A transverse-magnetic surface wave can be generated in the field lines around an unshielded cable, which, with regular amplification, can propagate over significant distances. The developers of the new '[E-Line](#)' system claim that the hardware is relatively simple and inexpensive to install, and could be combined with 'nano-cells' to provide mobile phone access. Their test system used 2GHz frequencies, although they suggest anything from 200MHz to 20GHz will work. The [white paper](#) states that "practical systems have been built with five to ten amplifiers per mile of line which have supported more than 2Gbps information capacity".

Connecting the smart grid

To deliver significant energy efficiencies, smart grids will require two-way communication between consumers and power supply companies. (See [TechNews 01/10.](#)) Standards bodies, such as US National Institute of Standards and Technology ([NIST](#)), are investigating a variety of connectivity options, including power line technologies, to transmit data and control commands both within and between buildings and grids. This type of data is suited to PLC as it generally comprises many small packets from a large number of sources, rather than the large video streams increasingly being viewed by consumers.

Network ready?

Both power line communications and home media networking are beset with a large number of standards, many of which are not interoperable. Existing PLC implementations do not offer the speed of most consumer alternatives, let alone meet the requirements of large educational establishments. However, they can provide low cost, point-to-point connections in situations where aggregate data does not exceed the demands of a single HD video stream and where technical limitations might make the alternatives unattractive. (Such limitations might include radiofrequency interference, the cost of running new cables or aesthetic concerns regarding surface cabling.)

There may be potential for some form of BPL to deliver 'last mile' internet connectivity. This may be of particular relevance in rural areas where telephone lines are too long for ADSL connections. However, the most likely application for power line networking appears to be to provide the physical channel to connect smart devices to meters and to form the local backbone for developing smart energy grids.

Networking and wireless news

First long-haul 100Gbps fibre internet connection

Despite the vast quantities of data that are served to internet-connected households and businesses, the internet backbone is not as fast as one might expect, with single links offering up to 10Gbps. (1 gigabit is 1000 megabits.) Fibre connections are often 1 'gig', even in fairly modest local networks. Delivering such data over the wider

internet is solved by multiplexing signals in cables, offering multiple routes for packets to travel and utilising considerable quantities of cache, so that data can be held closer to where it is required. However, as the quantity of data served increases, especially with greater demand for streaming video, bottlenecks are bound to increase. (At a recent event, a Cisco executive was [reported](#) to have said that internet traffic will have increased fivefold by 2013 and that video will account for 90 per cent of traffic by 2019.)

Raising data rates in a single fibre channel above 10Gbps is tricky; the digital pulses representing individual 0s and 1s begin to merge together in ways that electronic equipment cannot readily disentangle at the far end of the fibre. More recent modulation techniques for encoding data adjust the phase of the light, so that waveforms are either shifted ahead or behind the default pattern. (This shift is measured in degrees, so 'quadrature phase-shift keying', can adjust the phase by +135, +45, -45 or -135 degrees.) This system can give stable data rates of 50Gbps, but multiplexing in a second polarised signal, with the wave pattern rotated by 90 degrees from the first, can produce 100Gbps.

Nortel has installed a new 100Gbps network segment for Verizon, covering the 900km from Paris to Frankfurt. This is the same partnership that has been working to trial 100Gbps connections for JISC. (See [TechNews 06/09](#).) A New Scientist [report](#) states that Nortel has proven the technology over a 2000km test link in Australia.

Virgin Media starts rollout of 100Mbps fibre service

In 2009, Virgin Media commenced a trial of 200Mbps broadband provision over its fibre network in Ashford, Kent. (See [TechNews 05/09](#).) It has now [announced](#) that the pilot will be extended to Coventry and that a new 100Mbps service will be available nationally to its cable customers. Compared to an average 'received' speed of around 4Mbps for customers on standard ADSL connections, Virgin states that its new service will cut the download time for a full HD movie from 1 hour 44minutes to just over 7 minutes. Virgin gave no indication of pricing or how rollout would proceed.

BT, Virgin's largest competitor, is experimenting with fast 'fibre to the premises' (FTTP) for speeds of at least 100Mbps; it already offers maximum speeds of 40Mbps in some areas and is in process of rolling out 24Mbps across its network. (See [TechNews 10/09](#).) Steve Robertson, CEO of Openreach (BT's wholesale and infrastructure division), [discussed](#) future developments with PC Pro, including 'gigabit' (1,000Mbps) broadband. He said, "There is no piece of CPE [computer premises equipment] that is even remotely on the drawing board that could even begin to consume a Gigabit." He also pointed out that download 'access' speeds are not the only factor affecting the customer experience, as upload speeds and the capabilities of the 'backhaul' network to the wider internet must also be considered.

Many other companies offer broadband services, generally by leasing the infrastructure from Openreach and installing their own equipment to serve customer lines in local exchanges. (So-called 'local loop unbundling'.) An entirely different approach, last reported on in TechNews 07/08, has been taken by H2O networks. Its associate company, [FibreCity](#), is installing fibre in the sewers of two UK locations,

Dundee and Bournemouth. [Three alternative](#) service providers will offer Bournemouth residents broadband, television and telephone packages from £9.99 per month. Speeds offered will range from 25 to 100Mbps, although Fibrecity claims a UK 'first', suggesting that its service can 'burst' up to 1Gbps on some packages.

Fast broadband services allow learners to remotely access materials on learning platforms, use videoconferencing and engage in interactive experiences. Although this is possible on many existing ADSL connections, users may experience audio dropouts and jittery pictures on video streams. Improving connection speeds will remove one set of bottlenecks, but server and software capabilities, and the internet connections to schools and colleges may still affect performance. In addition to supporting faster connections, establishments will also have to consider the implications of mobile access on their infrastructure and services.

In related news, the UK Department for Business, Innovation and Skills has [announced](#) the next step in its commitment to offering a 2Mbps service across the country by 2012. This universal service commitment (USC) will be overseen by Broadband Delivery UK (BDUK), who will also be charged with managing the £1 billion set aside to develop 'next generation access' (NGA) for 90% of the population by 2017.

Visible light communication demonstrated at 500Mbps

Visible light communication (VLC) superimposes a data signal onto the input voltage of LED lights. (Light-emitting diodes are low energy light sources based on silicon electronics. As production costs come down and light quality improves, they are increasingly being used as replacements for incandescent and fluorescent bulbs in commercial and domestic settings.)

Researchers from Siemens [have shown](#) that rapid but imperceptible variations can be used to transmit data at up to 500Mbps over a distance of five meters (about 16 feet) using a single LED light source. Connecting several LED sources to the same controller reduced data rates to around 100Mbps, but improved the range of the system. The technology is essentially one way, with a data stream available to any capable receiving device. Such 'broadcast' data could be used in a variety of settings to transmit information to be put on public displays, to contribute to vehicle guidance systems via LED-powered traffic lights, or as an alternative to radio-based transmission in 'noisy' industrial environments.

[TechNews 11/08](#) reported on similar technology being developed at Boston University.

In related [research](#), engineers from Penn State University have used a laser diode source to create infrared data streams that do not require line of sight between the source and sensors. The detector array is very sensitive, so it can pick relatively faint signals reflected from painted walls and other objects. The researchers argue that it could form the basis of secure wireless networks, as it would be impossible to eavesdrop through solid walls. Also, nodes in separate rooms would be (literally) invisible to each other and would not interfere with radio-based wireless networks.

Using gigahertz frequencies, the team have demonstrated data rates exceeding 1Gbps. They see no theoretical barrier to applying the same approach using light in the visible spectrum.

'Network coding' could increase data throughput threefold

Data travels around networks in packets - chunks of data that contain additional information about source and destination, as well as codes for error correction. These are generally routed to the destination by equipment that stores a routing table that describes paths towards the intended destination, if not directly connected to the receiving computer. Although data may be multiplexed (logically combined into larger units) on more capable network connections, traffic is essentially one-to-one - a source computer creates packets for a single destination.

This schema may be inefficient when two computers are exchanging information (for example a voice conversation) that involves considerable two-way traffic, as each packet has to be uniquely routed to the destination along with all the necessary control information. A long-standing technique, known as network coding, can reduce the number of packets by combining them and broadcasting them. If a packet is travelling from A to B at the same time as one is travelling in the opposite direction, a router connected to both computers could combine the information into a single packet and pass it to both A and B simultaneously. The receiving computer knows what it sent, so it 'subtracts' this from the combined packet to find the information it needs to receive.

A team working at MIT [has developed](#) a network coding scheme that uses these principles to improve data transmission, testing it on equipment in their own building. However, rather than defining how packets are 'hybridised' according to known routes, they 'randomised' the selection and combination of data. Counter-intuitively, this improved the throughput of their wireless network because, although more processing is involved in extracting the data, the same packets passed through several routers, meaning that dropped packets did not have to be resent. Further, due to reducing the overheads involved in creating control frames around the 'payload' in multiple non-hybrid packets, the hybrid coding structure generated no greater network traffic. Precise improvement figures varied with the number of wireless devices included, but the transfer of actual payload data increased around threefold.

The researchers are looking at further aspects of network coding, to improve the protocols for particular applications and to extend it to the natural mixing of analogue radio signals in a location with multiple wireless transmitters of different types. A number of defence and industrial partners have either used versions of the coding scheme, or are involved in further research.

Researchers produce tool for troubleshooting small networks

Microsoft researchers [have found](#) that troubleshooting small business and home networks is actually more difficult than tracing problems on large corporate systems. This counterintuitive conclusion stems from the fact that larger networks often have servers dedicated to particular processes and that it is easier to correlate symptoms

across multiple users to identify common elements. Due to their scale, smaller businesses often run multiple applications on a single server, the interactions of any of which could create a particular fault.

The Microsoft team has developed a prototype application, NetMedic, to help administrators of small networks. Such people often work alone and have limited diagnostic tools to aid investigations, so automated problem-solving tools can give significant help. However, the multiplicity and diversity of applications and hardware frequently means that it is not obvious as to which tool should be used or what the results actually mean. There is certainly no single tool that would reference the knowledge required to support the typical school or college network, though forums and informal personal networks often offer technicians answers to the most obscure problems.

NetMedic is based on an entirely different methodology, tracking key network metrics and recording typical system behaviour in order to spot anomalies. This approach is underpinned by a mathematical construct known as dependency graphs, which 'map' the strength of the interactions of each key element in the system. When a fault occurs, the system ranks the components most likely to have caused the symptoms, so an engineer can focus standard troubleshooting techniques on the areas with the highest probabilities.

The research team suggest that only 30 to 60 minutes of system 'history' are required to create NetMedic's dependency graphs. Once 'trained', the offending component was given top rank in tests on four out of five occasions and was 'almost always' ranked among the top five. Clearly, to be of any use, NetMedic must be actively monitoring a system before a fault actually occurs.

The article gives no indication of plans to commercialise NetMedic. Although diagnostic tools can be helpful, structured approaches to system administration, documentation and diagnostics, are essential to the identification and resolution of issues. These techniques are embodied in Becta's [FITS](#) best practice guidance.

Proprietary protocol to improve wireless transfers

A new fasp-AIR protocol from Aspera is designed to improve transfer of larger files over wireless networks. Most file transfers use TCP, the internet's transmission control protocol, which slows down when it detects packet loss in order to reduce network congestion. However, the same symptoms can be generated through interference or weak signals on a wireless network, but TCP's speed reduction algorithm may result in data rates that are well below those that the wireless link is capable of supporting. Video streams are often transmitted using UDP, the user datagram protocol, but this leads to packet loss as the primary objective is smooth streaming rather than accurate transmission of every packet.

Fasp-AIR is [set to appear](#) first as an iPhone application, although its developers claim that it will eventually be supported across a range of wireless hardware using Wi-Fi (802.11g or n) and mobile (3G and the upcoming LTE specification) connections. However, service providers will have to install the protocol on their

servers before consumers will benefit. Technology Review [states that](#) Amazon and a number of other large internet companies have licensed fasp-AIR, and indicates that other wireless developers, such as Meraki, are producing alternative approaches based on transfer speeds measured by routers on the wireless network.

Early LTE-connected netbook revealed

The next '4G' iteration of mobile phone technology will be based on 'IP' data transfer protocols for voice, web and other services. Strictly, neither of the leading technologies (WiMAX and LTE) has yet to meet the 100Mbps minimum transmission speed in practice, but both promise this in the near future.

Mobile WiMAX was first to be approved by the IEEE in 2005 (as the 802.16e-2005 standard), while 'Release 8' LTE (Long Term Evolution) was largely frozen in December 2008 but potentially remains subject to minor amendments. As [reported](#) by ABI Research, this means that the number of WiMAX installations considerably outstrips those for LTE, with 164 networks already offering a WiMAX service or trialling adoption. WiMAX is supported by Intel, which is among the manufacturers producing WiMAX chipsets for laptops, mobile phones and other devices.

Samsung [demonstrated](#) an N150 netbook with an embedded LTE chipset during February's Mobile World Congress. This hardware is already available with HSPA (an upgraded form of 3G). As [reported](#) by Techworld.com, many other manufacturers are involved in developing LTE-compliant chipsets for laptops, dongles, phones and other mobile devices. The first commercial LTE network was launched in Sweden by TeliaSonera, but the substantial European rollout is not expected until late next year and into 2012.

WiMAX is seen as the better option in many areas where there is no existing mobile data network. However, LTE is expected to be the natural upgrade path for operators across most of Europe and other regions where 3rd Generation Project Partnership (3GPP) 3G technology has already been deployed. Although only theoretical maxima, which will be reduced by network overheads and operating conditions, the current specifications for LTE will deliver download speeds of up to 360Mbps, as against WiMAX's 144Mbps. These '4G' technologies were last covered in [TechNews 09/09](#).

Mobile wireless data to more than double annually

Cisco has released its latest 'Visual Networking Index' forecast, which predicts an ever-growing consumption of data through mobile devices. (See [TechNews 01/09](#) for last year's forecasts.)

In the 5-year period 2009 to 2014, Cisco calculates the mobile data consumption will grow globally at a compound annual rate of 108 per cent - that is more than doubling every year. The highest growth rates are expected to be in India and China. At the end of this time, mobile networks will be moving more than 40 exabytes of data each year. (An exabyte is a billion gigabytes.) The company ascribes this growth to a combination of increased ownership of mobile devices and greater consumption of video data across mobile connections. Video will account for two thirds of all traffic in

2014. At present, Cisco says that the average monthly traffic is 1.3GB per device, but it expects this to rise to 7GB by the end of 2014.

The [full report](#) contains considerably more detail, such as regional variations, proportions of smartphones, use at home and work, and migration from fixed line to mobile.

If Cisco's predictions are correct, mobile networks (and 'backhaul' connections from wireless access points to the internet) will come under great pressure in the coming years. This suggests that system managers will need to review their infrastructure to ensure it is capable of meeting anticipated demand.

Over half people in developing world have mobiles

The International Telecommunication Union (ITU) has [released](#) its latest report on global uptake of communication technologies, *Measuring the Information Society 2010*.

The United Nations agency estimates that mobile subscriptions passed 50 per cent in developing nations by the end of last year, giving a total of 4.6 billion subscribers globally. This is in stark contrast to numbers using the internet, where just over a quarter (26%) are connected. The global figure hides a significant disparity between populations in developed and developing countries using the internet, at 64 per cent and 18 per cent respectively. Further, the number of internet users includes those subscribing to fixed and mobile services as well as those accessing from elsewhere.

The trend in the developing world has clearly been for growth in mobile communications, due to the expense of deploying the infrastructure necessary for fixed line services. Developments in basic mobile services, such as finance, information and education, are being driven by this rapid uptake of mobile communications. (See the Mobile payments article in [TechNews 03/10](#) and this [BBC News article](#) on learning English in Bangladesh.)

The report also provides a country-by-country set of 'ICT Development Index' (IDI) values, based on eleven indicators of ICT access, use and skills. The UK was ranked 10 internationally in 2008, up from 12 the previous year; Europe dominates the top ten nations, while Africa accounts for the majority of the bottom twenty. Compared to Sweden, the group of 'developing countries' is about a decade behind in its ICT adoption. While this reflects a significant, continuing digital divide, it also shows much more rapid improvement than measures of health. Analysing the IDI components, the ITU suggests that ICT use is intensifying.

The report compiles an ICT 'price basket' for each country. The ITU found that people in developed countries spent, on average, under two per cent of gross national income (GNI) per capita on ICT services, whereas in developing countries it was over a sixth of GNI (17.5%) per capita. These ICT service costs are further broken down by country and type of access.

The ITU also attempts to measure the impact of ICT on national economies and citizens, such as the association between high levels of access and educational attainment, and between ICT use and participation of women in the labour force. The summary does not ascribe causation to these trends, but suggests that they are worthy of further investigation.

Analysts predict 802.11n Wi-Fi in 87% of mobile in 4 years

Smartphones are designed primarily to use 3G services for speech and data at present, but many owners switch to Wi-Fi for data intensive tasks, such as downloading applications, web browsing and updating their status on social networks. Those handsets that support Wi-Fi generally use the older 802.11g standard, which gives a theoretical maximum throughput of 54Mbps, but the recently ratified 802.11n (see [TechNews 8/09](#)) is just beginning to appear on smartphones. 802.11n has a maximum throughput of 600Mbps, although this will be affected by the number of users sharing the connection, distance from the wireless access point, the quality of the signal and other factors.

Analysts ABI are [reported](#) to have predicted that more than five out of every six smartphones (87 per cent) will have 802.11n capability by the end of 2014. However, to achieve maximum performance, 802.11n needs at least two antennae to provide the 'multiple input, multiple output' (MIMO) required for beam forming. (Beam forming creates a stronger, more focussed signal - allowing greater data throughput - by using multiple antennae to create constructive interference patterns directed towards the receiving device.) In the short term, manufacturers are unlikely to give up the extra space required in handsets for this, or to provide for the additional power consumption that would be necessary. Nevertheless, 802.11n chipsets will soon reach price parity with those that only support the older protocols, so manufacturers are expected to install them as a matter of course.

Learners will increasingly own devices with 802.11n chipsets, so schools providing access to learning materials through students' own smartphones will need to prepare for widespread adoption. In addition to upgraded access points, the cabled 'backhaul' connections will need to supply data fast enough (especially where video is commonly used) to fulfil users' expectations.

Multimedia

Analysis: Motion tracking

At a glance

- Motion capture ('mocap') is widely used to create special effects in the film industry.
- Older systems used markers that could be more readily tracked and analysed by computer systems. Such markers may be passive (reflective) or actively broadcast a signal.
- Markerless systems are more complex and computationally more intensive.
- Developments in depth-sensing cameras have opened up the possibility of a relatively low cost peripheral for the consumer market.

- Technology from new game controllers, such as Microsoft's 'Project Natal', could be used or adapted to create new interactive learning environments, as well as adding more accessible methods for controlling hardware.

We know where you are!

Motion tracking is the ability to follow objects in 3 dimensions (3D). This article will focus particularly on tracking the human body, although similar techniques could be applied to a whole host of objects.

Applications of motion tracking include:

- Capturing movement as the basis for animation and CGI (computer generated imagery) in films and computer games
- An alternative means of input and control for computer programs and consumer devices
- Hands-free operation of medical devices in sterile environments
- Interaction with training simulators in military and other contexts
- Control of personal avatars (on-screen representations) in virtual worlds
- First-person 'experience' of proposed architectural and environmental projects
- Immersive gaming environments where the player's movements directly control the action
- Tracking people in buildings for security purposes
- Interactive response systems for advertising hoardings, which may detect passing viewers and react to their emotional state
- Adding a layer of engagement to videoconferencing systems, such as IBM's augmented collaboration in mixed environments system (see [TechNews 11/09](#)).

Motion tracking systems are about to move from a specialist product, often costing £50,000 or more, to a consumer peripheral that may cost less than £100. The capabilities of such low-end systems will not be as refined as the more expensive ones (which may provide sub-millimetre accuracy), but reports suggest that they will be perfectly acceptable to many consumers.

Marker systems

Automated image recognition has long been a complex and processor-intensive operation. Our native optical system handles it without much conscious thought, but picking out shapes from an unknown background and matching them to libraries of similar shapes has taken much research effort, which is considerably compounded when the object is in motion.

Motion capture (or 'mocap') has been used as the basis for CGI effects in many recent films. For example, the actions of Andy Serkis were captured and digitally reprocessed to produce the character of Gollum in the *Lord of the Rings* trilogy. Motion capture has generally relied on placing markers on a suit that the actor wears while moving against a plain background in a known space. The use of markers

considerably simplifies the image processing requirements, producing a wireframe or volumetric digital model that the animator can then enhance to produce the desired character. Once the character has been digitised, it can be merged with footage filmed using normal equipment.

Markers can be of two types: passive, which do not emit any kind of signal, and active. The latter have traditionally been heavier and more cumbersome, due to inbuilt electronics and wires connected back to the control system. While restricting the actor's movement, such hardware can provide more accurate positional information. The type of system chosen will also affect the speed of capture (essentially frame rate); the capture 'volume' (the area within which the actor can work); and the price.

Passive markers include:

- Reflective plates, such as the yellow-black quartered disks on crash-test dummies
- Reflective balls attached to the face or other parts of the body.

Active systems make use of:

- Light emitting diodes (LEDs) remotely controlled to emit light at known intervals
- Potentiometers and accelerometers that determine relative motion, either by measuring the movements of an exoskeleton attached to the body or sensing inertial changes in gyroscopic devices
- Electromagnets, which disturb magnetic field lines generated in a limited capture volume
- Radio transponders that emit a coded signal.

Active systems may use coding patterns to identify individual markers attached to different parts of the body. Many controllers for many gaming platforms, such as Nintendo's Wii, use a combination of active markers.

Miniaturisation and increased use of wireless signalling has considerably improved the capabilities of active Technologies. Some systems are known as 'semi-passive imperceptible', combining the advantages of several approaches. Infrared LED projectors are used to 'light' the space with encoded signals, whilst photo sensors attached to the actor record both the coded infrared and ambient optical lighting levels. 'Time of flight' techniques are used to calculate where the sensors are within the capture space, depending on the minute delays in receiving the coded infrared data from the projectors. The ambient light data can be used by the digital artist to ensure that the CGI character is correctly lit.

Motion capture systems often employ upwards of eight cameras to give the animator a 3D representation of the actor's movements, which can then be combined with data from active sensors (if used). The system may need to be calibrated to account for video distortion, wireless interference and other technical issues. Further,

markers may be occluded by the actor's body (especially in optical systems), must be aligned between shots and alternative camera views, and may become detached from the actor's clothing or face.

The amount of data captured gives rise to a significant processing load, so applications that require high spatial resolution or fast frame rates generally produce data that must be processed after capture. Lack of real time graphics need not present a problem for digital animators, who often add significant items and effects to the image, but directors may want to see an immediate approximation in order to judge the success of the shot. Creating real time footage adds considerably to the expense of the system.

Companies involved in this type of CGI work include [4D View Solutions](#), [ImageMovers Digital](#), George Lucas's [Industrial Light and Magic](#) (ILM) and [Weta Digital](#).

An MIT project, known as Wear ur World, uses 'Sixth Sense' technology that (at present) relies on optical markers on the user's fingers to capture gestures to control the interface. (See [TechNews 03/09](#).)

Markerless systems

With the announcement of Microsoft's '[Project Natal](#)' game controller (see [TechNews 06/09](#)), depth-sensing cameras have recently come to the attention of a wider audience. These cameras contain a solid-state sensor array that captures data coded in reflected light. Project Natal projects an infrared signal, but other systems use wavelengths at the extremes of the visible spectrum.

The simplest approaches use 'time of flight' techniques to calculate the distance of each part of a scene, whereas others use distortions in the coded data (also produced by the distance that reflected light has travelled) to generate a 'pseudo' 3D image. (It is not a true 3D representation as it can only provide the distance to the object nearest to the camera along any given path. Software then interpolates changes in this data and maps it to some internal model to create a 3D object.)

Various hardware and software companies are involved in developing consumer and specialist systems. These include partnerships between [Optrima](#), [Softkinetic](#) and Texas Instruments (see [TechCrunch](#)); between [Atracsys](#) and Sony (see [New Scientist](#)); and between [PrimeSense](#), [GestureTek](#) and Microsoft (as reported by [VentureBeat](#)). Other companies in the market include [Canesta](#), [MESA Imaging](#), [Organic Motion](#) and [PMDTec](#). Some of these systems use pairs of stereoscopic cameras to gather 3D data.

Generating a computer model

In addition to distinguishing the object of capture from the background environment, the success of a system is in large measure determined by the underlying computer model. Scientific American has [outlined](#) the process used by the Project Natal engineers. The team started by collecting digital video clips of people moving, which they manually marked as a basis for a purpose-written machine learning algorithm.

This analysed the video segments to produce digital representations, which were refined using an iterative process until they had 12 models that represented broad combinations of body type, age and gender.

Natal's lead developer, Alex Kipman, is [reported](#) to have said that Natal will use 10 to 15 per cent of the Xbox 360's processing power to run the software that maps the captured image onto the 3D model. Body parts can be located to within 4cm (under 2 inches) accuracy in three dimensional space and poses are recognised in less than 10 milliseconds. These metrics are vital to effective game play, as latency (delay) or inaccurate placement could significantly degrade the gaming experience.

Educational possibilities

If Microsoft, or one of the other companies, opens up the application programming interface (API) for its hardware, a range of educational applications could be built. Systems could be used directly in media studies, IT or built environment courses, but also for a wide variety of immersive, virtual worlds that could be explored by learners of all ages. Before moving to Microsoft, [Johnny Chung Lee](#) showed how the 'Wiimote' controller could be modified for other applications. Depth-sensing cameras could be harnessed for innovative applications that are yet to be envisaged.

Motion sensing is already coming to the attention of educators, with companies like RM demonstrating [MyTobii](#) eye-tracking technology and an interactive video 'room' in its 'Shaping Education for the Future' display during January's BETT exhibition. [OM Interactive](#) had several interactive 'water' displays around the main exhibition space, which 'rippled' as you stepped on the projected image.

Motion tracking technologies can be built into sensory environments for profoundly impaired people, as well as used as accessible interfaces for common hardware. [TechNews 11/08](#) reported that Toshiba was among a number of companies developing gestural interfaces for televisions, while integration of sensors within displays could become viable, as covered in [TechNews 12/09](#).

These developments in the consumer sector are being driven by the gaming industry, but the possibilities for educational spin-offs are significant. Project Natal will not be launched until the autumn, so it cannot be said for certain that it will deliver its promise in diverse domestic and educational settings. However, if the hardware becomes a standard feature of displays or is released as an affordable peripheral device, it could change our approach to immersive and virtual reality environments, as well as opening up more technologies to learners with physical disabilities.

Multimedia news

Apple launches media tablet

Late in January Apple introduced the [iPad](#), a device that it [suggested](#) will be a new class of hardware sitting between a smartphone and a laptop. Others may consider a whole range of categories as potential contenders, including netbooks, e-readers, Intel's MIDs (mobile Internet devices) and ARM's Smartbooks. Analysts, such as

ABI, are [reported](#) to be referring to it as a 'media tablet' and, following the launch, predicting sales of 4 million similar devices this year and 57 million per year by 2015.

The iPad hardware includes a 9.7 inch (nearly 25cm) LCD touch screen, a solid state disk drive of at least 16GB, 802.11n Wi-Fi, Bluetooth and a battery that Apple claims will last for 10 hours of active use. (Although termed IPS by Apple, the 'in-plane switching' screen is another form of liquid crystal display. IPS gives a brighter display for the power used and has a wider viewing angle compared to other LCD technologies.)

The iPad runs on a '1GHz Apple A4 custom-designed' processor, which most (such as [CrunchGear](#)) assume will be based on technology licensed from ARM, rather than the Atom chip that Intel is promoting for mobile devices. This move was essential as Apple decided to use its iPhone mobile operating system, which doesn't run on x86 code used by most processors from Intel and AMD. It also gives Apple a much greater degree of control over the hardware platform, including power management.

Many have pointed out that the hardware is constrained by the absence of direct USB connections for external devices, an SD memory card slot or a camera. The last of these may seem unimportant, but would prevent using the iPad for video chat or casual photography. While commentators have suggested that users would not want to hold up the hardware to use a camera - likely using a laptop or mobile phone instead - it does beg the question about how people will use such hardware. Most learners and teachers already carry a mobile phone (often a smartphone) and own a laptop, so why would large numbers make this additional investment in a device that replicates functions they already have covered? Perhaps the answer to that will be the convenience of an 'all-in-one' device, especially if the missing features are released in future iterations.

The touch screen design may prove uncomfortable for typing longer articles, risking repetitive strain injuries (RSI), and may prove difficult for students who need to use assistive technologies. (Apple does allow a number of customisations to improve accessibility, but the whole design may be limiting for many. This [blog post](#) shows how one user has adapted to touch screen technologies.)

By using the iPhone OS, Apple has brought all the applications from its App Store within reach of iPad owners, although the company has updated the software development kit (SDK) to allow developers to accommodate future products to the larger screen. Apple will be launching a new iBooks store to run alongside its iTunes music store, allowing users to purchase and download content over the air (using Wi-Fi or, on the more expensive models, 3G).

Books will be available in the widely supported ePub format, although [questions](#) have been raised over whether digital rights management (DRM) techniques will preclude use on otherwise compatible devices. (Amazon's Kindle e-reader is one of the few devices not to support ePub.) Other inbuilt applications include the Safari web browser, a mail client, maps from Google, a photo browser, a video player, a calendar and contacts management software. Apple has also re-engineered its

iWorks suite (which includes a presentation tool, word processor and spreadsheet) for the iPad, although this will not be provided in the standard pricing.

Another omission, common to the iPhone and iPod range, is Adobe's Flash technology. While proprietary and potentially to be replaced by the video 'tags' and other features of HTML5, it is undeniably the main platform used to download video from the internet and to deliver much other content, such as games. (Gizmodo discusses HTML 5 in [this article](#), while the Adobe's defence of Flash is discussed [here](#) on TechCrunch.) Lack of Flash could be a fundamental problem to delivering certain types of educational content which, otherwise, run across a very wide range of hardware, using a Flash plug-in on whichever browser has been installed.

The regular versions of the iPad will arrive in the UK at the end of March followed by 3G devices sometime in April, according to [Apple](#). The more expensive 3G versions will be able to download content over the mobile phone network, although Apple has yet to say whether its new iBooks store will be available in the UK. Further, Apple has given no indication of UK pricing, but has said the base model will be \$499 (around £320), rising to \$829 (£535) for the 64GB 3G version. However, UK pricing for most technology products is generally higher than direct currency conversions might suggest.

The launch followed considerable hype in the technology and general media, with much speculation around its features and pricing. Commentators were surprised at the 'low' \$499 price point, but this is still (for example) two and a half times above the price for Apple's 8GB iPod Touch. This should raise the question about whether investment in the iPad would bring additional educational benefits that could be justified by the extra cost, since most functions that will run on an iPad already appear on the iPod Touch.

It is probable that students, especially in colleges and HE, will soon arrive with iPads and other media tablets. Institutions providing access must be prepared for a likely ramp in the quantity of video consumed across their networks.

A wide variety of competing media devices, netbooks and tablet PCs is available. Many dedicated e-book readers, such as the Kindle, use E Ink's monochrome display system. This produces an image that does not need to be constantly refreshed, considerably reducing power consumption. However, it is slow to update, so it does not support video, and cannot display colour.

TechNews has previously reported on a number of display systems and device manufacturers that are seeking to enter the e-reader and low power display markets. (For examples, see TechNews [11/08](#), [03/09](#), [05/09](#) and [05/09](#) again.) New entrants are expected include the [QUE](#) from Plastic Logic and [JooJoo](#) from Fusion Garage. How the iPad will affect this market has yet to be seen - its price may prove attractive compared to 'single-function' e-readers, but whether it manages to sustain the claimed 10-hour battery life over several months of use remains unproven.

Large format, flexible e-reader screen announced

LG Display [announced](#) that it has developed a flexible e-paper panel that is nearly as large as a sheet of A3 paper, or a tabloid newspaper. The monochrome display is 250x400mm (approximately 10x16 inches), based on metal foil, and only 0.3mm thick. Because the company used 'GIP (gate-in-panel)' techniques, which integrate the control circuitry within the panel, there is no need for a frame housing additional electronics, so the whole device remains quite flexible.

No details are given about how images are loaded onto the panel, or how power is supplied. The system appears to use pixels formed from liquid crystals, based on stand thin film transistors (TFT), although another display medium may be in use. A liquid crystal display (LCD) normally uses a backlight, with the liquid crystals selectively blocking light to create the picture. A monochrome LCD (such as found in many small alarm clocks or other simple display units) can create a clear enough image from light reflected from a mirrored rear panel, but it must remain continuously powered to prevent the crystals returning to the 'blank' state. The foil backing to the LG device could form the mirror, but the requirement for continuous power would limit battery life of any finished product.

E-paper is the basic component for an e-book reader, or future electronic 'newspapers', so it must create a clearly defined image, be light and consume little power. Many readers have E Ink displays, which use electric fields to manipulate black and white particles in micro-capsules. These remain in place without regular refreshing, so power consumption is minimal, but displaying a new image takes a significant amount of time compared to liquid crystal devices. Manufacturers are competing to produce full-colour e-paper panels that are capable of displaying simple moving images, if not true video. A number of systems have been demonstrated, but none has achieved widespread commercial adoption.

LG Display suggests that its system would be suited to advertising, as panels could be mounted on curved surfaces, such as pillars. The company says that it will begin mass production of a smaller, 11.9-inch diagonal, flexible panel in the first half of this year.

Switchable graphics to reduce notebook power consumption

Graphics processors integrated onto a computer's motherboard may be limited in the level of support they provide for heavy graphical loads, such as high definition (HD) video and computer games. On the other hand, separate graphics cards take significantly more power and can generate a lot of waste heat when operating at fairly modest levels. Many notebook computer purchasers are quite happy with integrated graphics, as they keep the cost and weight down, but those who need more graphics capability may not be able to avoid a separate graphics card.

Some manufacturers have offered the option at boot time to use a separate card (where installed) or the integrated hardware, depending on the anticipated workload. More recently, some have made it possible to unload one set of drivers and load another while the computer is running, in order to optimise power or graphics

capability. But this remains far from seamless, with the user having to interrupt her workflow and initiate the change.

NVIDIA has [announced](#) a new graphics technology, which it has named Optimus, that allows the computer to switch without user intervention. In its [whitepaper](#), the company describes how all display output is rendered by the integrated graphics processor (IGP). However, when a graphically intensive application is used, the discrete graphics processing unit (GPU) is enabled and takes over the actual graphics calculation tasks before pushing the required image to the IGP to render. This approach removes the need for separate sets of drivers for the IGP and GPU, and eliminates the delay involved in switching between the two.

Certain types of graphics calls (such as Direct X requests) will automatically invoke the GPU, whereas other applications are given profiles which the driver uses to determine which graphics subsystem to select. NVIDIA will send online profile updates for applications that it has tested to machines using Optimus, while users will be able to create their own profiles where necessary. The system also supports highly parallel processing tasks optimised to run on the GPU. (See GPU Computing in [TechNews 09/08](#).)

NVIDIA claims that notebook battery life can be doubled using this technique compared with a similar machine that uses a discrete graphics processor alone. Optimus technology is initially available on selected models from the ASUS range, but is expected to be supported by other manufacturers who use Intel's IGP's. TechNewsWorld [reports](#) that Optimus is only available for Windows 7, although there is no technological reason preventing it from being integrated in future versions of the Mac platform.

Laser phosphor displays

Laser phosphor displays (LPDs) are being promoted by [Prysm](#) as an alternative to LCD and other types of display. The system uses techniques related to those in cathode ray tube (CRT) monitors and televisions. These went out of fashion during the 1990s and early 2000s, as sharper, more space efficient liquid crystal displays (LCDs) dropped in price. Because they are 'emissive', producing a picture by generating rather than blocking light, CRTs can show a brighter, fuller range of colours than LCDs and also have a wider viewing angle.

Laser phosphor displays are similar to CRTs in that a scanning beam is used to energise a phosphor array to form a picture. However, instead of using a set of electron guns that produce beams steered by magnets in a vacuum tube, LPDs use solid-state ultraviolet lasers and mirrors to scan the phosphor grid. Such lasers are already mass produced for DVD players and all kinds of consumer applications, so the hardware components should be relatively inexpensive. Unlike an LCD, which has a backlight that is continually powered, LPDs do not need to have the lasers constantly emitting light, depending on the picture. Modern phosphors are also highly responsive, so the image can be refreshed extremely rapidly to cope with fast moving, high definition graphics.

The image on an LPD screen can be generated close to the surface, depending on how phosphors are layered onto the glass or polymer substrate. This produces a wide viewing angle and creates the opportunity for irregularly shaped and curved displays, as the laser control engine need only be reprogrammed to take account of the new output area. Use of mirrors to direct light means that the beams need not come from directly behind phosphor screen, so displays should not be nearly as bulky as large CRTs. However, to produce a display that exceeds the quality of LCD and plasma systems, the alignment of the control system will need to be extremely accurate.

Prysm intends to enter the consumer market with hardware that is 'priced competitively' against existing displays, according to a [report](#) in Technology Review. Prysm hopes to produce public information and advertising displays in future. LPDs would cost less to run than plasma screens, which use considerable energy to ionise the gas in each pixel. They would also be less expensive than the very large displays used at sporting venues, made up of large numbers of individually placed LEDs, as relatively few lasers can be used to scan a large surface.

Projectors without bulbs launched

Replacement bulbs are an expensive component in the total cost of ownership (TCO) for data projectors, so affordable, 'bulbless' projectors would be welcomed by schools and colleges. Casio has [launched](#) a laser-based, hybrid, bulbless projection system capable of more than 2,000 ANSI lumens, which it suggests is a 'world first'.

Modern lasers can readily produce red and blue light, but scientists have long been seeking a commercially viable, high power green light source. (See [TechNews 05/09](#) and [10/09](#) for recent reports of research into methods for producing green laser light using frequency conversion techniques.) Casio has solved this problem by using a blue laser source to energise green phosphors; red light is generated by a high energy light-emitting diode (LED) and blue comes directly from the laser. The image is generated using Texas Instruments' DLP system, in which an array of micro-mirrors mounted on a chip deflects the light to the correct location on the screen. Because the system removes the need for a high-pressure mercury lamp, it warms up very quickly, needs no cool-down period and has no need for replacement bulbs. Casio estimates that the light source will last 'up to' 20,000 hours. (Standard bulbs may last 500 to 2,000 hours and cost upward of £200. Due to their mercury content, they must be disposed of according to the relevant rules.)

Casio [lists](#) the price of the lower power, 2,000 lumens projector at just under \$800 (about £500). Other options will be available up to 3,000 lumens brightness, which should be adequate for most smaller lecture theatres and school halls.

Lasers are used for some large back-projection television screens and in a number of ultra-portable 'pico' projectors.

New chipset for pico projectors in phones and cameras

Texas Instruments (TI) has [announced](#) a new chipset for its DLP technology that should be sufficiently compact to fit within a mobile phone. (Digital Light Processing

chips are covered in an array of tiny mirrors that can be flipped to reflect coloured light sources through a lens system onto a screen.) The nHD chipset provides 640x360 resolution, which is well below the SVGA (800x600) found in the most affordable 'desktop' projection units.

The TI [press release](#) gives no indication of the unit's brightness or size of projected image, but users should not expect a good image in bright light or one which is larger than a metre across. TI says that production quantities of the chipset will be available by the summer. Engadget [reports](#) on a forthcoming Samsung smartphone that has just such a DLP projector embedded, although not stating that the nHD chipset will be used.

In related news, Acer is [launching](#) a stand alone pico projector that has an HDMI port, enabling it to connect directly to HD video sources, although the display can only produce 858x600 pixels. (The lower 720p HD resolution is 1280x720.) The unit measures less than 5 inches square (122x116mm), weighs a little over half a kilogram (610g or 1.34 lbs), contains an SD memory card reader, has an output brightness of 200 ANSI lumens (about a tenth of a lower specification desktop unit) and a 20,000 hour lamp life. The light source uses LEDs, so it requires less power than metal halide-based alternatives and needs no cooling off period when powered down. PC Advisor [reports](#) that the unit can display a diagonal image up to 2.54m (100 inches), although brightness will be reduced at this maximum size.

Pico and other pocket projectors were previously covered in [TechNews 01/09](#). Several manufacturers have licensed the TI DLP system for desktop and Pico projectors, but others use liquid crystal panels to create an image. (Strictly, 'Pico Projector' is a Texas Instruments trade mark.) These small projectors could be extremely useful for learners to display images captured on mobile phones, cameras and other handheld devices to small groups. A reporter for the New York Times [recently wrote](#) about his experience of a 'clip-on' projector for an LG phone and a standalone pocket laser projection unit.

Piezoelectric materials enable 'high-definition' touch feedback

TechNews reported [01/09](#) and [02/10](#) on ways in which piezoelectric materials can be used to generate power, but they can also be used 'in reverse' to exert a force on another object. Technology Review [reports](#) that piezoelectric actuators can respond much more rapidly and more sensitively than many mechanical devices, such as motors, designed to provide haptic (force feedback) responses.

Immersion, a company working on a range of haptic technologies, is working on research carried out at the University of Pierre and Marie Curie in Paris. A screen is suspended and attached it to a piezoelectric strip within a frame of a mobile device, so that rapid vibrations can provide user feedback. Normal motors oscillate about 20 times per second, whereas this piezoelectric system can move a tenth of a millimetre a thousand times per second. Although the movement is in the horizontal plane, it is so small that the nerves in a human finger can be fooled into interpreting it as a vertical edge.

A demonstration system gives the user the impression that the central key of an on-screen numeric keypad is raised above the rest. This would assist a user who needed to look elsewhere, or a person with visual impairment, locate the correct regions of the screen to tap so as to dial a number. Further research is expected to produce the feel of 'real' buttons, enabling a user to be sure that the 'press' has been acknowledged by the hardware. Immersion [expects](#) that the first devices incorporating their technology will appear later this year.

Sensor system offers lip reading support for mobile devices

Researchers from the Karlsruhe Institute of Technology recently [demonstrated](#) a 'lip-reading' system that senses muscle movements rather than interpreting visual cues. Electromyography is used to measure electrical signals in the muscles and this information is passed back to a central processor via wires attached to the sensors.

The prototype hardware would not rate highly on ergonomic or aesthetic indices, as nine sensors must be attached to the face, but it could permit a person working in a noisy environment, or who had lost the ability to verbalise, to communicate with friends and colleagues. [According to](#) CNET.com, the system could be enhanced by adding language translation and, potentially, could be associated with applications on a mobile phone using a Bluetooth connection. No indication is given of the accuracy of the device, but (as human lip-readers know), speech is modulated by the vocal chords, tongue and other parts of the mouth, which may not be picked up by the sensor array used.

Eye tracking improves reading experience

What if reading were a two-way process? Words on an e-book reader's screen could be highlighted or magnified as the user scanned across the text, dictionary definitions pop up on the fly, or the text read back to the user. Such a system could be used to support young readers, those developing new language skills, students studying technical papers or for people with visual and other impairments. Appropriate 'mark-up' would be required for referenced texts, but the hardware could also be used to highlight the point where you left off reading, or dim out all but the most significant phrases when you were skim-reading.

[Text 2.0](#) is designed to support exactly these types of task. Developed by the German Research Centre for Artificial Intelligence, it uses eye-tracking hardware to pinpoint the target of the user's gaze and highlight that part of the text, or respond in other ways determined by the mark-up. A PC Pro reporter was given an 'augmented reading' [demonstration](#), in which sound effects were played back as he read the text of Dracula.

Eye tracking has been used for a number of years in projects seeking to determine the extent of infants' cognition and mental development, as well as in a variety of computer interfaces for military systems and other interactive displays. However, neither the hardware nor appropriate software has been generally available. This project shows how the technologies might be used to enhance reading, but commercially viable applications have yet to emerge. The researchers report that, to

date, two thirds of their demonstrations for one system have achieved a 'good' response from participants.

Using your skin as an input device

Researchers from Microsoft's Computational User Experiences (CUE) group are [investigating](#) ways to use your own skin as a 'sounding board' for touch input. Sensors mounted in an armband pick up the minute vibrations caused by a user tapping on the forearm.

The Skininput system, developed in association with Carnegie Mellon University, combines a projector into the armband to highlight the correct place to tap to create a particular input. [According to](#) Technology Review, the team could distinguish five areas of the arm with better than 95 per cent accuracy. The idea is fascinating, although there is no indication that Microsoft will turn it into a commercial product. Further, if a projector is needed to create the 'keyboard', it might be simpler to use a system that senses scattered light to locate the user's fingers. This team's research is associated with the muscle input system reported in [TechNews 11/09](#).

Hardware

Analysis: Multi-core processors

At a glance

- Improved processing capacity is now being delivered by adding cores to systems, as driving chips faster generates too much heat and reducing component sizes becomes limited by the laws of physics.
- Problems must be split into separate tasks to take advantage of multiple cores, but parallelisation may produce deadlocks and race conditions.
- Increasing the number of cores exacerbates issues such as cache coherency, inter-core communication and chip size.
- Stacking chips as '3D' processors may alleviate some problems, but brings challenges of its own.
- Multi-core processors will give no advantages where operating systems and applications are not written to take advantage of the extra capacity.

The core issue

Processor designers are constantly improving their products, yet the computer you are using never seems to be as fast as you want! While waiting a couple of seconds for a program to load may not be a real hindrance, tying up your machine for an hour while video from the school's most recent field trip is encoded is more of a problem. The same is true for businesses, whether searching a large database or rendering a 3D version of an architectural drawing.

Improved processing speed has been delivered through a combination of increasing clock speed and the addition of more physical logic to chips. However, both of these create problems - driving chips faster produces more waste heat and additional components require space on silicon wafers. Reducing the size of components has been a core design goal, enabling more logic on the same area of silicon and reducing waste heat, as electrical signals encounter less resistance, having less

distance to travel. Nevertheless, there are physical limits and additional production costs involved in reducing component sizes.

The seemingly obvious solution is to put two 'workers' on the job - two processors can surely achieve twice the throughput of one? But, extending the analogy, it must be possible to deliver sufficient raw materials, channel them to the production lines, collect the waste and distribute the output. Where one part of the manufacturing process relies on output from several others, the whole process control system becomes more complex to manage.

Multiplying the number of cores in the processor 'package' seems attractive - little new design work needs to be done and the technology is already proven in the single-core design. Nevertheless, each core becomes more expensive to produce, as failures during quality assurance mean that at least two cores may have to be scrapped simultaneously. Further, feeding the cores so that they run as close as possible to maximum capacity is no simple task - algorithms must be developed that manage shared resources and split jobs into separate components.

The race for cores

Tasks in servers are often duplicated or readily run in parallel, allowing programmers to reap the benefits of splitting processes between cores. All the major manufacturers have multi-core server products. For example, IBM's [recently released](#) POWER7 has eight cores, AMD's next generation of Opteron [will come](#) in both 8 and 12-core versions and Intel's [forthcoming](#) Nehalem EX processors will contain up to eight cores.

Multi-core competition has also come to the desktop, with Intel [promising](#) six cores in its Core i7- 980X Extreme Edition (focused on gamers) and AMD [expected](#) to release competing products soon after. This proliferation of cores is extending 'down' through notebook and netbooks, and is expected to arrive soon in smartphones - PC Advisor [suggested](#) that quad-core ARM processors will be shipped during 2011.

Following another course

Building fast computers from multiple processors is nothing new, as many generations of 'supercomputers' demonstrate. The Cray Jaguar - which is the world's [fastest](#) - has [been upgraded](#) to contain nearly a quarter of a million cores. Such machines are used for tasks like nuclear research and climate modelling that require the same calculations to be processed across many data points.

Telecommunications systems also have a requirement for high throughput parallel processing structures, to route millions of packets and to de-multiplex combined data streams carried by optical fibres. Hardware from companies like Alcatel and Cisco contains specialised embedded processors to perform these tasks, while Tileria is [expects to launch](#) a 100-core processor next year.

Many graphics tasks can be split into highly parallel streams, but the graphics processing unit (GPU) often remains relatively idle. [TechNews 09/08](#) discussed use

of GPUs for completion of general computing tasks, such as analysis of data from oil exploration and searching for trends in retail data.

Grid computing ([TechNews 09/09](#)) takes a different approach, breaking problems into discrete 'work units' that are independent of other tasks. These units can be allocated to computing centres with unused capacity or parcelled out to consumers willing to 'donate' spare processor time. On-going projects include research into cosmology, pharmacology and climatology.

Hardware parallelism

Tasks like rendering graphics are sometimes referred to as 'embarrassingly parallel', as it takes little effort to divide the problem into discrete components. The situation becomes more complex when one process requires resources used by, or the results from another process. Memory locking is generally implemented to prevent problems such as:

- Race conditions. Two processes generate results to be stored at a given location, so the content at that address will depend on which process 'wins'.
- Deadlocks. Two processes produce interim results that are required for the other to be completed, such that neither can progress.

Due to the (relatively) slow speed of communicating with main memory, portions are kept in cache, 'nearer' to the cores. However, as each core generally has its own 'level 1' cache, this raises questions of coherency - if cache is a copy of portions of the main memory, then it must be consistent across all the caches in the system. These problems increase dramatically with the addition of new cores.

One response to this is to implement transactional memory. Processor operations generate memory transactions, in a similar way to multiple operators manipulating the contents of a database. Although not widely used, this may be a solution that grows in importance.

The number of cores significantly affects the amount of traffic across chip interconnects, since coordinating a shared workload requires constant 'snoops' into cache elsewhere, control commands and so forth. A 16-core chip ([TechNews 01/09](#)) may only be as efficient as one with two cores, due to waiting for access to main memory and operations designed to ensure cache coherence.

Intel's prototype 48-core 'Single-chip Cloud Computer' ([TechNews 02/10](#)) implements hardware routing, rather than a shared memory bus, in order to reduce contention on interconnects. Intel researchers ([TechNews 11/09](#)) are also analysing alternative on-chip networking topologies for many-core communication.

However, routing comes at a cost, as each communication must be analysed and sent along the appropriate interconnect. Researchers from Georgia Tech in Atlanta [found](#) that, on a 12x12 core processor grid, routing operations could take 20 clock cycles, demonstrating a need for simpler routers.

Building up

Multiplying cores in the horizontal plane increases the physical area of silicon used and the distance between processors. This in turn introduces messaging delays and generates waste heat as communications travel further.

One solution is to build 'up' - literally stacking cores on top of each other. 3D processors can be assembled from cores already proven to work, but all the cores must be interlinked in some way. Through silicon vias (TSVs) provide vertical communication channels anywhere the chip designer chooses, not just on the edge where it is relatively simple to add connections.

Despite their advantages, 3D processor packages are more costly to build, due to additional manufacturing stages. Further, as they have less surface area, they are more difficult to cool - researchers in Lausanne ([TechNews 12/09](#)) are investigating the use of liquid cooling techniques to deal with heat dissipation.

Way to go

Multiplying the number of cores available seems the obvious route to improving processor efficiency. However, as we have seen, it raises many issues, including:

- Coherency of memory caches
- Increased distances between the more 'remote' cores
- Efficiency of on-chip communication networks
- Wastage during manufacture
- Complexity where 3D structures are implemented.

One issue receiving little public attention has been the inherent randomness of multi-core systems, such as varying distances between cores that happen to be chosen to process a task, the effects of heating within the processor and unpredictable radiative events. Engineers at University of Washington [are seeking to](#) model and reproduce such errors to help developers write robust code for multi-core environments.

Hardware parallelism is not restricted to cores in a single 'package', but to processors in separate sockets on a motherboard and different nodes working on the same task in a distributed processing structure. Indeed, core architectures often allow for internal parallelism, with separate software threads being processed simultaneously. The issues raised in this article are common at nearly every level, although their relative importance will vary.

Programming in a multi-core era presents its own challenges, not addressed in this article. Some tasks are readily divided into threads, while others are very demanding. Desktop operating systems have only recently brought support for multiple cores into the mainstream, but keeping each core operating at optimum efficiency remains problematic - just having a six-core gaming platform by no means results in games running six times as fast. Unless tasks (such as artificial

intelligence, user communications, graphics modelling and so forth) are programmed to run independently, the game may show no speed increase at all.

Collapsing multiple physical servers into just a few units running several virtual 'machines' has reduced hardware requirements and - where properly managed - improved efficiency. However, with multi-core becoming the norm, a reverse trend of 'physicalisation' is emerging, with separate cores dedicated to each virtual machine. (This does not represent a return to dedicated servers - machines may be moved between cores as demand and efficiency dictate.)

A specific issue to consider during software procurement is whether licenses are written on a 'per-core' basis. If installed on a single computer workstation, this may not arise, but it may be relevant for server-based tasks and complex applications (such as computer aided design).

Multi-core is likely to be the processing paradigm for the medium term future. Its success will depend on the degree to which the opportunities and challenges presented can be met in order to deliver genuine performance and energy-efficiency gains.

Hardware news

Intel tweaks 48-core research chip for data centre use

Intel has [reported](#) on its 48-core research processor, designed with cloud computing applications in mind. 'Utility computing' - offered through the internet - requires the availability of a large number of general-purpose processors that can be segmented according to the needs of each application. If these processors are in separate sockets, or on different boards, delays are introduced in transferring data and overall power consumption is increased. (Utility computing is part of the more general approach to cloud computing. See [TechNews 11/08](#).)

The chips have been optimised for complex data mining tasks, where large data sets are being searched for specific information or common patterns. Cores are paired together with a router that controls data flow to other parts of the processor. When working on highly parallel tasks, like search or video encoding, a newly written message-passing algorithm guarantees that data passed between cores only has a single owner, ensuring data integrity and improving inter-core communications. Because the cores communicate directly with each other, message passing is fifteen times faster than having to pass data out to the main memory before it can be accessed by another core.

Application developers can directly control power 'islands' on the chip. Normally, this is done by the operating system, but that relies on power and thermal measurements, and general assumptions about workload. In the new model, a complex task could be set to run overnight in a power-efficient manner, rather than having to complete in the shortest time.

The Intel team is partnering with academic and industrial researchers to further improve the architecture. If launched commercially, the processor would compete against products from companies like Tiler, who [announced](#) a 100-core TILE-Gx chip in October 2009. Samples of the smaller, 36-core TILE-Gx36 will be shipped to partners later this year, with other models to follow in 2011.

Intel integrates storage management functions on new processors

Intel has [announced](#) the availability of its latest Xeon chips (code named 'Jasper Forest'), aimed at high workload embedded applications, such as network addressed storage (NAS), voice over IP (VoIP), streaming video and controllers for wireless networks. The new processor series can have from one to four cores, depending on the model selected, and be mounted in single or dual-socket configurations.

The new processors embed input-output (IO) functions into the same chip to reduce the number of chips required and increase performance. In particular, the PCI Express (PCIe) controller has been brought into the main package, providing integrated access to high speed peripherals, such as graphics processors and storage devices. The processor also has embedded RAID functions, removing the need for another chip in many applications. (RAID - a redundant array of independent disks - is a storage structure that protects data by providing the means to reconstruct information from damaged or inaccessible media.) Intel's [figures](#) suggest that the new processors provide nearly double the performance per watt, compared with earlier models.

TechWorld [reports](#) that the new chips will be beneficial to designers of storage systems, as more functions are already provided within the main processor, while the fail-safe features built into the chip will help to protect data.

Near-threshold computing could double battery life

Transistors operate as switches because there is a threshold value at which the voltage applied between the gate terminal and the source terminal causes a conducting channel to open between the source and the drain. Most transistors are operated significantly above this level (which, depending on the materials used, is just below 0.5V) in order to prevent processing errors. Near-threshold computing reduces the voltage as close to this level as possible, but there is a danger that natural leakage between source and drain is mistaken for the 'positive' output that should be generated when the switching voltage is applied.

Reducing the operating voltage of processors would lead to increased battery life in mobile devices and cut the amount of waste heat generated in all kinds of hardware. As more transistors are packed onto the processor die, heating and power management problems only increase, leading to a reduction in the operating efficiency of those devices. A point could come where further miniaturisation becomes less efficient, because fewer transistors are being used than are being added to a particular portion of silicon due to power constraints.

Transistors can actually operate below the threshold level, through deliberately accounting for leakage in the processor's design, but it considerably reduces the

speed at which the chip can operate. Researchers from Michigan are [drawing together](#) existing work on near-threshold computing to see whether solutions can be devised to mitigate reduced operating speeds and markedly increased component failure rates, so as to reduce power consumption to a tenth (or less) compared with normal operating levels.

Data centres, which place a heavy load on central processing units (CPUs), would benefit more from success in this field than mobile phones, as the latter consume greater energy in components like the screen and radio than the CPU. Improved processing efficiency would also benefit distributed sensor networks, which would more readily operate on low levels of free energy 'harvested' from ambient light, radio waves or vibrations.

Graphene transistors could operate above 100GHz

Transistors are the main components of silicon chips, providing switching and signal amplification functions. Nearly all modern processors are derived from silicon, a material that conducts charge poorly (because it is a semiconductor), but which can be enhanced by adding impurities (dopants).

Graphene - a sheet of carbon arranged in a lattice one atom thick - is also semiconducting, but doping it to create a transistor that switches has proven difficult. Instead, an electric field can be used to control graphene's ability to conduct, creating a field effect transistor (FET). Graphene conducts charge much faster than silicon (because it has higher electron mobility), so it is seen as a potential replacement for silicon-based transistors.

Scientists from IBM have [demonstrated](#) a field effect transistor that has the potential to operate at 100GHz. The graphene was 'grown' on a silicon-carbide wafer, which was then coated with an extremely thin polymer layer before deposition of the oxide gate layer. (The gate controls the electric field which, in turn, controls the current that flows through the transistor.) The smallest gate [produced](#) was 240nm - poor in comparison with silicon, which is already being manufactured with features as small as 22nm.

The researchers proved that the transistor operated at a frequency of 26GHz and extrapolated their data to suggest that it could work as fast as 100GHz. Similarly-sized silicon transistors have only been shown to operate at 30-40GHz at best.

This type of field effect transistor conducts in proportion to the strength of the electric field applied to it. This is useful for amplifying other signals, but does not readily form a switch. The silicon transistors used in processors have a 'band gap', or threshold, at which conductivity suddenly increases, allowing the controlling gate to switch the current on or off.

Researchers from the Georgia Institute of Technology have [demonstrated](#) that a switching structure could be introduced into graphene using a new method for 'doping'. (Most transistors are formed from silicon that has been 'doped' with impurities to make it carry positive (p-type) or negative (n-type) charge. Creating a

sandwich of p-type and n-type semiconductor materials produces a region that can be switched by a gate.)

Tiny flakes of graphene were coated with a doping material and exposed to an electron beam. Both p-type and n-type regions can be produced using the same process, depending on length of exposure. (Other approaches to doping have been shown to produce only one type of doped graphene.) The team believes that the process could be replicated using a conventional lithography process, leading to commercial applications in future years.

IEEE Spectrum [reports](#) on other research by IBM scientists to create the necessary band gap in a graphene transistor.

If these processes (or some combination) can be scaled to produce small components operating at much higher frequencies than silicon, this may lead to a new generation of chips that could operate as fast as 1,000GHz (or 1 terahertz). Few processors are currently operated above 5GHz due to the amount of waste heat that would be generated.

New flexible energy harvesting material demonstrated

Piezoelectric materials generate electricity when subjected to mechanical stress. Piezoelectric crystals can be found in gas lighters, which produce a spark without the need for a battery, and in many other applications.

Researchers from Princeton [have found](#) a way to embed lead zirconate titanate (also known as PZT) as tiny nanoribbons into a flexible silicon polymer substrate. The ribbons are manufactured from the source crystal, which is formed at a very high temperature, and then layered into the silicone at densities of up to 100 per millimetre (measured across the ribbons). The resulting piezoelectric structure is 80 per cent efficient, so the majority of the force applied to it is converted into electricity.

Energy-harvesting devices produce electricity from movement, vibration, ambient radio signals, temperature changes and other physical effects. These nanoribbons could one day be embedded in the soles of shoes or clothes so that the energy produced would help charge a mobile phone or other device. Because the silicone, into which the ribbons are implanted, is 'biocompatible', chargers could be designed for medical devices that use energy derived from breathing. Such applications are quite some way into the future, so alternative technologies (such as solar power) could prove more suitable for some purposes.

Force-sensitive resistance ink underpins new multi-touch technology

A new system, termed interpolating force-sensitive resistance (IFSR) technology, has been developed for touch screens and other applications. Most resistive touch technologies, which operate by sensing the contact of intersecting wires on a grid, cannot tell which of the pairs of opposite corners of a rectangle have been pressed when there are two simultaneous touches. The IFSR approach uses scanning, so that different wires are 'live' at any time, ensuring that the correct touch locations are identified.

Force-sensitive resistance (FSR) 'ink' is sandwiched between the layers of perpendicular wires that make up the sensing grid. The resistance of this ink is reduced as more pressure is applied, so the current that flows is a measure of the force that has been applied.

The PhysOrg.com [report](#) refers to a new company, Touchco, which developed this technology. The company's website showed in January 2010 that it had ceased to trade, but others (such as [SiMa Systems](#)) are working on related technologies.

Mobile SIM with processor, programs and 1GB memory

A South Korean company, SK Telecom, has [shown](#) a normal-sized mobile phone SIM card that contains an ARM processor, the Android operating system (OS) and a gigabyte of memory for the OS, user applications and data. Although only a prototype, such a system could form the basis of a highly 'portable' computing environment that could be plugged into any compatible dumb terminal - in essence, the SIM card would become its processor. A user would be able to use any such terminal - whether in an office, an airport or a school - as their personal PC.

New 'SmartSIM' cards, which [have been developed](#) under the auspices of the GSM Association, have the potential for storing more applications and data. SK Telecom plans to launch branded SIMs in April that contain music videos or stock monitoring applications.

Smartphones could be made for less than \$100

Inexpensive smartphones could put advanced mobile technologies into the hands of many more learners across the world. Smartphones generally include a web browser, the capability to download applications, Wi-Fi connectivity and other substantial functions beyond making voice calls, but they are much more expensive than the 'headline' price, which normally includes an operator subsidy. These subsidies are mainly recouped through monthly charges across a fixed term contract, rather than through the call charges of 'pay as you go' deals offered with less expensive 'feature phones'.

Many smartphones run on processors designed on the ARM architecture, but built by companies like Qualcomm and Texas Instruments. Another ARM licensee, Marvell, has [announced](#) its Pantheon platform - a complete set of chips that covers the main modem that handles voice and data traffic, wireless connectivity, the lower specification '720p' HD video playback and other graphics and multimedia functions. Ms. Weili Dai, Marvell's Co-founder, claimed, "Marvell is delivering the platform for a \$99 smartphone that provides instant access, live content, high performance 3D mobile gaming, rich HD media and a wealth of applications". If Marvell manages to deliver the production volumes required to achieve that price point (about £65), it would enable more learners to benefit from web browsing and downloadable educational applications.

Marvell is providing its major handset manufacturers with samples of the chipset, although no further details of pricing or availability have been given. Pantheon will

work with Android, Windows Mobile and other major mobile operating systems. Intel is seeking a greater share in this market with its Atom processors.

In related news, Vodafone has [announced](#) a \$15 (just under £10) VF 150 basic mobile phone aimed at 'emerging markets'. It will be launched initially in Turkey and eight African nations, with voice, SMS (text) and basic money transfer capabilities. Although money transfer has driven significant take up of mobile services in developing nations, as well as basic health and agricultural advice by SMS, blogger Ken Banks [argues](#) that such phones are inadequate for delivering further advances. Mr Banks, a respected commentator on mobile technologies in emerging economies, suggests that the inability of such phones to download new applications limits their potential for delivering financial, health and other services to remote communities.

Mobile phone could be hub for virtual desktop

Citrix is developing a 'use case' for a mobile phone as the replacement for the main processing unit in a workstation environment. The model relies on thin client computing (see [TechNews 01/09](#)), whereby the main processing is carried out at a server and screen updates are delivered to a device linked to a monitor and keyboard. Although the desktop environment can be displayed on a normal PC (or 'rich client'), thin client devices usually have limited processing capacity.

Some smartphones have sufficient graphics capability to drive an LCD monitor at a resolution of 1024 x 768 pixels, while Bluetooth would enable the connection of a keyboard and mouse. Citrix has dubbed such a device the '[Nirvana Smartphone](#)'. Ideally, this would attach to a docking station (which could be a small dongle device), to charge it and link to the monitor, while the phone would act as a USB 'host' so that it could control devices like keyboards and mice.

The Nirvana Smartphone, which was [first mooted](#) in 2008, would enable users to keep all their settings on either the phone or on the virtual desktop hosted on a server. Travelling workers could 'hot desk' at a docking station when in the office or use a remote connection to access their desktop while on the move; teachers could project video from the device; and consumers could bring the mobile web to their television via the docking station. If all phones and handheld devices had such a system as standard, learners could carry their computing environment with them and just 'plug in' when they needed to use a complex applications, a projector or other larger hardware. While Citrix is developing the concept around its own desktop virtualisation technologies, the same approach could be delivered using applications from other vendors (such as VMware and Microsoft), or from phone-specific software uploaded to a mobile applications store.

A prototype was [demonstrated](#) by Citrix and Open Kernel Labs at the Mobile World Congress in February, with the suggestion that systems may become available during 2011.

Intel introduces convertible classmate PC reference design

Intel has updated its Classmate PC reference designs to enable children to use it as an e-book reader. Available in the UK, the main Classmate market has been the

developing world, where Intel has worked with national governments and hardware manufacturers to deliver low cost laptops suited to education.

The latest [Classmate](#) iteration, [according](#) to Intel, 'can convert instantly from a clamshell design to a tablet PC, allowing students to naturally change form factors as they move about between activities and locations in the classroom'. Like many smartphones, it has a touch screen and the orientation of the display automatically adjusts from landscape to portrait as the user turns the hardware.

The operating system supports publications in PDF and ePub formats, among others, providing access to a large range of books and other material. PC Advisor [reports](#) further on the device's capabilities as an e-book reader and says that the latest Atom processor in the design should make the unit 20 per cent more power efficient. Intel emphasises collaboration, with learners able to rotate the screen a full 180 degrees horizontally and able to work in pairs on tasks with audio using the dual headphone sockets.

The Classmate is often linked as a competitor to the XO PC, from the One Laptop per Child (OLPC) project. As reported in [TechNews 11/09](#), Nicholas Negroponte outlined an updated vision for the XO as an ultra-slim, lightweight, tablet PC.

Software and internet

Analysis: Mobile payments

At a glance

- Cash is expensive to handle and cheques are due to be phased out in the UK in 2018.
- Individuals and organisations need electronic methods of payment, some of which will necessarily involve mobile technology.
- Smartphones will be able to transact most of the payment services offered online, but they provide an opportunity to support new methods as well.
- A number of small card readers and associated applications are being developed for smartphones.
- Contactless payment systems based on near field communication (NFC) offer a viable alternative for low value transactions in developed countries.
- Effective payment systems based on SMS technology, such as M-PESA, are being developed in emerging markets.
- Schools and colleges will need to provide alternative payments technologies if cheques are phased out. Increasing numbers of students and parents will expect such technologies to be available.

Going mobile

Electronic payments services and online banking considerably reduce costs over a period of years, decreasing the number of staff needed to handle cash and cheques, while increasing accuracy of transactions. For both businesses and consumers, many transactions are carried out faster and account information is available much

more readily than in the past. However, these advantages have to be balanced against people's fears about security and the privacy of their financial data.

Much of the growth in online commerce is heading to mobile devices, with ABI Research [estimating](#) that mobile purchases of goods and services will reach \$119 billion (around £77 billion) globally by 2015. The UK Payments Administration [reports](#) that more than half of UK bank customers use online services, often in preference to phone banking.

Many schools and colleges already receive electronic payments or have cashless payment systems for canteens, libraries and other functions. Payment cards can be 'loaded' with cash through 'vending' machines, removing the need for lunch supervisors to handle money and lessening the temptation of pupils trying to steal cash from fellow learners. As electronic payment systems grow, parents are likely to press for schools to accept money through these new services and technologies, some of which are bound to be facilitated through mobile phones. Indeed, increasing numbers of adults may have no other means to make payments.

The UK Payments Council [announced](#) in December 2009 that it intends phasing out cheques by 2018, on the basis that 'cheque use is in long-term, terminal decline'. Many smaller transactions are carried out by cheque, for example sending presents to relatives, making payments to sole traders and funding school trips. There is little scope at present for electronic payment to (say) a plumber that has just repaired a pipe, but other cash alternatives will need to be found before cheques are phased out.

Traditional transactions using phones

The rise of telephone banking has roughly coincided with the general availability of mobile phones, so basic transactions, such as checking balances and making transfers to previously authorised recipients, have likewise been available to people on the move. As smartphones take a greater share of the market, it is inevitable that people will use mobile web browsers to carry out the same processes that they already perform on a desktop computer. The very existence of mobile technologies has created new opportunities for commerce, such as paying for services using premium rate numbers, charging ringtones and other downloads against the owner's pre-paid credit or billing account, or paying parking fees by SMS.

Phone operators and third parties have developed an extremely successful model of charging for services and electronic goods through premium rate SMS (text) messages. This was recently used to great effect following the disastrous earthquake in Haiti. It was recently [reported](#) that a US campaign to donate \$10 (about £6.50) to the Red Cross by SMS had raised over \$8 million (£5.2 million) for the relief effort - nearly double all charity donations made by text in 2009.

One of the most recent developments has been the design of card readers for smartphones. [Square](#) is a hardware add-on for more recent models of the Apple iPhone. The trader selling the goods or service has a 'merchant account' with a bank to handle transactions made through debit and credit cards. When a consumer

makes a purchase, the retailer swipes the user's card through an attachment connected via the audio jack of the phone (as shown on this [TechCrunch video](#)). The hardware is basically a magnetic stripe reader that encrypts the relevant data, so it is never stored in 'plain text' on the phone, and passes it through to an application that handles the transaction. The user is able to 'sign' on the phone's touch screen to validate the payment and an email receipt can be sent to the purchaser.

This type of hardware could be very useful for tradespeople and for small retailers at exhibitions, markets and craft fairs. Similar systems are being developed by Mophie (the '[marketplace](#)') and VeriFone ([PAYware Mobile](#)). These are both targeted at the iPhone, whereas Square could more readily be adapted to other platforms as it only requires an audio socket. Without Chip and PIN, none of the solutions are likely to be accepted by financial institutions in the UK, but Barclaycard has [announced](#) that it will pilot a Chip and PIN system in the second half of this year.

Contactless payments

Contactless payments, using near field communication (NFC) to gather information from an RFID tag or a low power transmitter, have been enabling small payments for some time. (NFC was covered by [TechNews 01/08](#).) The Transport for London [Oyster card](#) uses this system to deduct the cost of fares for the London Underground and bus services from preloaded credit. Other uses, as outlined in this [electronic book](#) on NFC pilots in the EU, include payment for parking, as an alternative to cash when making small purchases and as a means to purchase electronic tickets.

O2 was [reported](#) to have successfully completed a trial of contactless payments eighteen months ago, with a view to embedding the hardware in future mobile phones. This would require a relatively inexpensive antenna to be added to the user's mobile and changes to SIM cards to secure payments, but large numbers of contactless point of sale terminals would also have to be installed. Retailers are interested in processing small transactions in this way, as it would reduce queuing at checkouts, but it remains unclear whether enough would choose to make this investment without subsidy.

[According](#) to Silicon.com, just last year a Vice President from mobile manufacturer Ericsson predicted that RFID would be embedded in all new phones by the coming summer. However, just recently it was [reported](#) that Nokia had abandoned development of its 6216 Classic phone, which supports NFC directly on the SIM card. The company says that it remains committed to other phones that support NFC in less integrated ways. Nevertheless, PC Advisor [drew attention to](#) a recent survey that suggested considerable consumer resistance to the idea of committing further payment data to phones as 'mobile wallets'. There are plenty of alternative means of payment and consumers are [fearful](#) of losing vital information.

Consumers in the Japan and other parts of the Far East may be more open to novel uses of mobile phones, but Europeans seem to be electing for evolution of existing methodologies. Some of the large credit companies are piloting NFC for lower value transactions - generally under £10 - using their cards. For example, Visa has rolled out over 750 of its payWave terminals in retail outlets in [central London](#), while

Barclaycard and Orange have [announced](#) an NFC-enabled credit card with transactions reported to the owner by SMS.

Simpler solutions in emerging markets

The most significant advance in payment technologies may be occurring beyond the 'developed' nations. Adoption of mobile technologies in so-called emerging markets has been growing very rapidly - both topography and the necessary capital investment make landlines unattractive compared with mobile phones in these countries, while inexpensive phones (now including a Vodafone [handset for \\$15](#)) put the technology within reach of many poorer people.

Basic mobile money transfers were pioneered by Kenya's Safaricom in association with Vodafone and the UK Department for International Development. Small retailers become [M-PESA](#) agents, who accept cash from individuals wishing to transfer money to relatives, pay bills or reduce the balance on a loan. This cash is added to the payer's e-money account; they then uses a simple application on the phone to transfer it to the recipient. Both parties get an SMS confirming the transaction and the recipient can then pick up the cash at their local agent.

The agents take a small commission, but this is generally lower than would be charged by a bank for similar services. Although it can be used with traditional banking services, M-PESA supports users who have neither an account nor a Safaricom phone. It can now be used by expatriates wishing to send 'remittances' to families back home. ([Kenyatopup](#) is one of the companies providing the service from the UK.)

M-PESA relies on signalling channels associated with the standard GSM service structure to deliver secure messages that authorise the transactions. The user interface in Kenya is based on the SIM Application Toolkit, whereas more recent services have employed unstructured supplementary service data (USSD).

Vodafone recently [announced](#) the extension of M-PESA to a fourth country, South Africa, while Visa [is seeking](#) to reach out with its services to a market that it estimates comprises four billion mobile devices. Nokia has formed an alliance with [Obopay](#) to deliver similar services under its [Nokia Money](#) banner and the GSM Association (representing network operators and manufacturers) has created an initiative called [Mobile Money for the Unbanked](#).

Juniper Research put out two press releases covering the findings of its *Mobile Money Transfer & Remittances* report. The [first](#) states that the company expects mobile payment service to reach more than 500 million users globally by 2014, while the [second](#) suggests the market will be worth over \$65 billion by that date. New Scientist [reports](#) that daily transactions are already worth \$13 million (£8.4 million) in Kenya alone.

Researchers from Oxford University recently [announced](#) that had developed a new security protocol that could underpin transactions using mobile phones. The payer would compare a number (normally 4-8 digits) generated on their local handset with

that provided by the payee - whether a retailer, a sole trader, a friend, a website or even a vending machine. The transaction could be backed by credit 'loaded' on the phone, a credit card, or a regular bank account.

Farewell cash?

Not only are cheques due to be phased out, but cash is considered by some likely to follow soon after. (MasterCard recently promoted its [Maestro](#) products with the slogan 'cash is dead'.) Many people already have [PayPal](#) accounts for online transactions and some young people use these to receive birthday gifts and payment for second-hand goods. The latest developments in mobile technology could support a movement towards the cashless society.

Many colleges have already implemented a variety of cashless systems. However, some approaches are backed through credit agreements, which cannot be directly contracted with under-18s in the UK. (Debit cards, such as [Solo](#), may be available to users aged 11 or over.) This would limit the usefulness of mobile payment technologies, especially in primary schools, unless a parent or other adult were available to carry out the transaction.

Pre-paid credit, based on contactless payment cards or systems similar to M-PESA, could provide a viable way forward for many schools. Nevertheless, the wider market is in state of flux and rapid development - it is quite possible that the replacement for cash and cheques will arise from the developing world rather than Western economies.

Software and internet news

Mobile application platforms update

Developing mobile applications has become a big market, with Apple (who are the front-runner just now) [reported](#) to be hosting over 150,000 applications in its [App Store](#) and having delivered a total of 3 billion downloads by the end of January 2010. While many of these applications are either free or 'trial' versions, some developers have derived significant revenue from their software. (The Times [reports](#) Gartner's prediction that applications will deliver \$6.2 billion (about £4 billion) of revenue during 2010, rising to \$30 billion in 2013.) Many of the mobile operators see applications as a threat, as users may no longer be interested in 'added value' utilities that the manufacturer or operator have installed on the handset, while data generated by some applications is putting considerable stress on the whole network infrastructure.

The App Store is integrated into several of Apple's hardware platforms (the iPod Touch, iPhone and forthcoming iPad), providing applications that only operate under Apple's iPhone operating system. Programmers would generally prefer to create software that runs on multiple platforms, as that reduces the development costs while increasing the potential audience. (See Web Applications in [TechNews 01/09](#).) Although handset manufacturers and operators delayed entering this market, many are now trying to take some share away from Apple. (For example, Nokia's [Ovi store](#); Microsoft's Windows Phone [Marketplace](#); BlackBerry [App World](#); Sony Ericsson's

[PlayNow](#); O2's [Litmus](#) store; and Orange's [Application Shop](#).) For consumers, this produces fragmentation and confusion.

A consortium of 24 carriers and three hardware manufacturers has now emerged from the GSM Association to develop a unified [applications initiative](#), to be known as the [Wholesale Applications Community](#). The alliance has big ambitions, but has provided little detail on how its 'open' platform will be created. Some of the carriers have already partnered to develop [OneAPI](#), a generic application programming interface (API) for access to network services, such as SMS (text), location and payments. The first main draft of the OneAPI specification is [due](#) in March. The new initiative will start with the [JIL](#) (Joint Innovation Lab widget specification) and [OMTP BONDI](#) to create a programming interface, which they intend to submit eventually to the World Wide Web Consortium (W3C) as an open standard. (BONDI was mentioned in [TechNews 03/09](#).)

The alliance aims to create a new open market for applications that can run on multiple operating systems using services from the carriers. However, agreeing standards has often proven to be a drawn out process (for example in the case of 802.11n Wi-Fi) and does not necessarily guarantee that programs will work on handsets from all the carriers - functionality may depend on screen size and resolution, keyboard availability and layout, integration of multi-touch or location awareness, embedded support for digital rights management (DRM) for multimedia content, and other factors specific to the network or hardware.

There are two other approaches to delivering software that operates on a greater variety of devices: create web applications that work in the phone's browser or use some form of 'middleware' that sits between the application and the phone's operating system. Adobe's [AIR](#) provides the latter as a cross-platform runtime environment, which already delivers 'rich internet applications' to the desktop of machines running recent versions of Linux, Mac OS X and Windows.

Adobe recently [announced](#) that AIR will become available for some of the major mobile operating systems, starting with Google's Android during 2010. This release is part of Adobe's wider Open Screen Project (OSP), which will also bring its Flash multimedia environment to many mobiles during the first half of this year. The OSP aims to create versions of AIR and Flash for internet tablets, smartbooks and many other types of mobile and desktop hardware. (Smartbooks are a category of ARM-powered devices which, like Microsoft's MID concept, falls somewhere between smartphones and netbooks.) Although AIR is growing in popularity, with support for many web standards, it remains largely proprietary, not least through support for Flash. Apple has no immediate plans to provide access to native Flash or AIR applications on its iPhone OS.

Many applications are marketed as 'educational', although some might question the merits of that description in certain cases. Other applications, such as photo editing and posting, voice recording, strategy games and web browsers can be used for educational ends. A number of learning platforms have mobile applications that

interface with their product, while a few schools (such as [Porchester Junior](#)) have developed their own mobile information applications.

Mobile OS update

The operating system (OS) for any device provides controlled access to the hardware, key services and aspects of the generic user interface. At the recent Mobile World Congress event (MWC), a number of manufacturers took the opportunity to talk about significant developments for their mobile operating systems.

Microsoft [announced](#) Windows Phone 7 as a replacement for its most recent, modest upgrade, Windows Mobile 6.5. (See end of the update in [TechNews 11/09](#).) The interface has become much more graphical, with touch-screen, gestural input and support for real time updates from social networking applications. In what has been seen as a challenge to Apple's iPhone, the new OS also has links to Microsoft's Zune music and its Xbox LIVE gaming services, plus support to view and edit documents from a number of Microsoft's Office applications. New phones based on Windows Phone 7 are expected in the run-up to Christmas this year.

CNET News [reports](#) that the OS will be based on Microsoft's Windows CE embedded OS, but [information](#) available to Ars Technica "suggests that backwards compatibility is almost entirely sacrificed". Programmers will either have to write applications in Microsoft's cross-platform Silverlight tool, or they will use XNA code that currently works on the Xbox. This may mean that many developers will have re-design applications from the bottom up. Further details are expected at [MIX10](#), Microsoft's developer conference later in March.

Intel and Nokia have previously been working on separate implementations of the Linux OS for mobile applications - Moblin and Maemo respectively. In the face of significant adoption of Google's Android (which is also based on a managed Linux implementation), it appears that they have decided that merging their endeavours under MeeGo is more likely to produce a credible alternative. The [press release](#) says that MeeGo will be designed to operate across a large variety of mobile devices, including netbooks, smartphones, televisions and in-car 'infotainment' systems.

Applications will largely be developed using Nokia's existing Qt ('cute') toolkit and run (when compiled) on either Intel's x86 processor architecture or on the ARM-designed chips found in most phones from Nokia and other manufacturers. Although the merged OS will have a degree of backward compatibility to its parent systems, specific limitations of the two hardware platforms may prevent code to be fully compatible due to hardware dependencies. This will also mean that software will be downloaded from at least two different locations - depending on the hardware - Intel's AppUp Center and Nokia's Ovi Store. Devices based on MeeGo are expected to start appearing this summer.

The Symbian Foundation has, somewhat earlier than expected, [announced](#) the full, open source version of the operating system that was previously a proprietary product, largely under the control of Nokia. (Again, see [TechNews 11/09](#).) Symbian^3 (or just S^3) will be 'feature complete' by the end of the month, although

its open source development model will mean that it is never truly 'finished' and a further release, S^4, is slated to appear at the end of the year. S^3 will enable users to watch HD video content from the phone on a television connected via an HDMI cable (where supported in hardware), provides interface elements to control connection to online music stores and has improved graphical support for fast 2D and 3D interfaces and games. S^3 also uses Nokia's Qt toolkit for application development.

Samsung has opted to develop yet another new operating system for its smartphones, called Bada. [Launched](#) in January, it supports all the features of modern hardware, such as touch screens, accelerometers (indicating movement) and GPS (for location). The first phone to use Bada will be Samsung's Wave, [slated for launch](#) in April 2010.

The profusion of operating systems and application development platforms could confuse consumers and make some reluctant to invest in devices without a significant track record. Apple's tight control and integration of its iPhone platform has proven extremely successful, taking a [reported](#) 14.4 per cent market share in the final quarter of 2009. Although a long way behind Symbian's 46.9 per cent share, both the iPhone OS and Google's Android are showing significant growth at the expense of Symbian and the existing Windows Mobile platforms. Nokia remains the worldwide leader (in terms of shipments), but many developers and commentators see the iPhone as the device to beat. Arguably, its success has been built as much on its web applications as the user interface. If downloadable software can run on multiple platforms, users may have less loyalty to particular hardware or operating systems. As covered in [TechNews 02/10](#), the mobile applications market is also in a state of flux, with the launch of a new Wholesale Applications Community and the imminent release of Flash 10 for many of the smartphone operating systems.

Mobile to overtake PC as browsers by 2013

CNET News [reports](#) on Gartner research that predicts that smartphones will become the most common browsing platform, with nearly two billion connected devices, by the end of 2013. Although PCs will still dominate total traffic at this stage, many more learners will be used to browsing the internet using mobile phones. This means that schools and colleges may need to provide for learners to use these devices as their preferred means of access to the internet. Further, education developers in industry and the public sector should consider whether their websites and applications will work on the wide variety of mobile platforms that may be found in the home as well as in educational establishments at that date.

Gartner analysts also expect there to be a total of 6.5 billion mobile connections by 2014 and that more than 3 billion users will routinely carry out shopping, banking and similar tasks online. In the face of outsourcing, cloud computing and increasing support for employee-owned devices, same report suggests that a fifth of firms will own no IT assets at all in 2012.

CNET News also [reports](#) that smartphones are taking an increasing share of the mobile phone market. Enthusiasm for new devices, or categories of hardware, often

falls off after the first year. However, smartphone ownership (somewhat broadly defined) increased from 11 per cent of subscribers at the end of 2008 to 17 per cent in 2009.

Microsoft launches tailored thin client OS for education

Hardware is costly, so a number of systems have been developed to deliver thin client computing. (See [TechNews 01/09](#).) One approach, developed by NComputing and others, has been to install cards in a PC that connect to additional monitors, mice and keyboards, so that several learners can share one main processor. (See [TechNews 11/08](#).) This was previously supported by proprietary hardware drivers, but Microsoft has now [launched](#) Windows MultiPoint Server 2010, embedding the necessary functions within the operating system itself.

MultiPoint Server may not be considered by some as a thin client system, as the server is not connected to remote clients via a network. Nevertheless, it supports several users on a single operating system instance. Each user can be working on the same or disparate applications, on independent or collaborative tasks. This type of setup may be particularly suited to schools in developing countries, since the aim is to reduce the cost of hardware, but multiple licensing costs must be considered for all applications used. Each station (a separate screen/keyboard combination) attached to the main machine needs to have a client access licence.

Microsoft is working with a range of hardware manufacturers (such as HP, NComputing and Wyse), as well as application vendors. It has [produced](#) a software development kit (SDK) to support programmers who want to implement their own ideas. Specifically designed software includes Microsoft's own free [Mouse Mischief](#) application. The MultiPoint concept was previously covered in [TechNews 04/09](#).

Common cloud, services and hardware for government

The Government has [launched](#) its new ICT Strategy, which relates to central and local government, and to the wider public sector. The Strategy is designed to improve delivery of, access to and efficiency in public sector services over the period to 2020. It has 14 strands spread across three broad themes:

- *Common infrastructure*, including a unified telecommunications infrastructure for voice and data; data centre rationalisation; provision of internet-based processing and storage capacity through a new 'G-Cloud', available to public sector organisations; a government 'application store' (G-AS), or common repository of applications, enabling government bodies to reuse previous code; and greater sharing of ICT services and desktop components.
- *Common standards*, covering use of open source software and protocols; data security; and architectural, infrastructure and environmental standards.
- *Common capability*, highlighting staff development, project management, procurement and 'international alignment'.

A prototype application store, which will contain software for functions such as human resources (HR), enterprise resource planning (ERP), email and finance, was launched at the start of February. The Silicon [report](#) says that four platforms will be used to host the G-Cloud across twelve data centres, with local authorities and government departments able to host their own functions on the service. Not only would children's services be able to host software on this new 'private' cloud, but it seems likely that individual institutions will be able to access applications and use its resources. Martin Bellamy, director of the office of the government CIO, expects it to take "four to five years" to develop the services and infrastructure, followed by a similar period to achieve widespread adoption.

The Strategy has an aspirational target for delivering 'savings of over £3.2 billion per year', although the systemic changes required will delay some of the cost savings envisaged. As suggested in this Gartner [blog post](#), delivering this transformation will require extensive changes in the processes and culture of government.

An important element that has been integrated into the strategy is the *Open Source, Open Standards and Re-Use: Government Action Plan* (found [here](#)). Although this emphasis has been welcomed by open source suppliers, TechWord [reports](#) that they are concerned that there is little in the Strategy to drive open source procurement.

Blogs wane for teens

The Pew Internet & American Life Project undertakes regular research 'exploring the impact of the internet on families, communities, work and home, daily life, education, health care, and civic and political life'. Its most recent report, [Social Media and Young Adults](#), looks at the attitudes and behaviours of the 'Millennial generation', a cohort that it defines as adults now aged 18 to 29.

The survey finds that both blogging and the practice of commenting on blog posts have declined among teens and young adults since 2006. Only 14% (or one in seven) US teens blogged in 2009, which is exactly half the number compared with three years before. In contrast, nearly three quarters of teens (73%) use social networks, compared with a little over half (55%) in 2006. There is a marked jump between 12 and 13 year olds (46% to 62%), suggesting many adhere to social networking sites' age policies. The number of people aged 30 and over who maintain a blog has increased to 11%.

Use of social networks has increased across the board, with nearly three quarters of teens and young adults, and 40% of older adults using such sites. Use of microblogging services, like Twitter, increases with age, from one in twelve (8%) of young teens to nearly one in five (19%) of adult internet users.

Choice of hardware also varies. Young adults are more likely than any other generation to own a laptop compared with a desktop computer (66% and 53% respectively). Half (51%) of adults aged 30 to 49 owned a games console, whereas four in five teens (80%) did so. Mobile phone ownership has risen dramatically among younger respondents, with the number of 12 year olds possessing a mobile tripling to nearly three in five (18% to 58%) in the past five years.

These trends from the States are consistent with the findings of most UK reports and show that young people's expectations for using online communications continue to grow. A large number of learners - even more so from Key Stage 4 and above - will be familiar with sharing information and commenting on other people's posts. (More than four in five teens will have commented on a friend's picture or wall post.) This indicates a depth of knowledge for teachers to draw on when designing collaborative learning experiences.

Children want simple involvement in developing primary ICT

Research to be featured in a forthcoming book outlines the changes that primary pupils would like to see made in schools' ICT. One of the authors, Dr Neil Selwyn, was surprised to find that learners were not looking for "virtual classes or robot teachers"; rather they wanted more opportunity to bring in their own devices and "a greater say in the rules and regulations that surround ICT use in schools".

The research team found that the 600 pupils interviewed were quite realistic about the limitations on school ICT. Their educational experience often centred on word processing or internet searching, whereas more than four out of five used ICT for gaming at home. Nevertheless, Merlin John's ICT in education news site [reports](#), 'there were few instances of creative and/or collaborative uses of Web 2.0 applications' in the home. Dr Selwyn found that the clearest request was for "a moderate 'loosening' of the restrictions on their ICT use". The University of London Institute of Education [press release](#) contained few further details of what that might entail, but suggests the main conclusion is that schools should take greater account of 'pupil voice' when making decisions about ICT use and development, and give greater guidance on e-safety.

Ofsted: pupils need to grow into e-safety; staff need training

Ofsted has released an important report on the use of ICT in schools: [The safe use of new technologies](#). This report was a follow up to the Byron review, involving inspectors visiting 35 schools from a range of settings in the first half of last year. The focus of the report was to 'to evaluate the extent to which schools teach pupils to adopt safe and responsible practices in using new technologies'.

The report can be summarised under five themes:

- **Internet filtering.** Inspectors were clear that 'managed' systems are much more effective in the long term in developing e-safe behaviour than filters that 'locked down' access. This aspect received significant media attention. (For example, this BBC News [report](#).) Quoting Ofsted:

Although the 13 schools which used 'locked down' systems kept their pupils safe while in school, such systems were less effective in helping them to learn how to use new technologies safely... Pupils in the schools that had 'managed' systems had better knowledge and understanding of how to stay safe than those in schools with 'locked down' systems.

- **Curriculum.** The report commended an approach to e-safety that 'builds on what pupils have learnt before and which reflects their age and stage of development'. Further,

The schools where the provision for e-safety was good or better recognised the potential dangers of new technologies, but tried to equip their pupils to deal with them... In the best practice seen, pupils were helped, from a very early age, to assess the risk of accessing sites and therefore gradually to acquire skills which would help them adopt safe practices even when they were not supervised.

- **Staff training and engagement.** Inspectors judged this area to be 'the weakest aspect of provision in the schools visited'. In particular, they found that training was too often 'one size fits all', did not involve support staff and did not focus on how to develop e-safe behaviour among learners. The report also noted that staff training audits were rarely carried out.
- **Policy.** To be effective, policy needs to be appropriate to the context and regularly reviewed:

In the outstanding schools, senior leaders, governors, staff and families worked together to develop a clear strategy for e-safety. Policies were reviewed regularly in the light of technological developments... Few of the schools visited made good use of the views of pupils and their parents to develop their e-safety provision.

- **Beyond the school gate.** Inspectors emphasise the need to account for learners' use of ICT (broadly defined) in a wider range of settings, including arrangements for work experience, courses shared with colleges and in pupils' homes. The report suggests a number of measures for engaging with parents and outlined content that Inspectors would expect to see in a school's acceptable use policy (AUP).

Support for developing effective approaches to e-safety is available from Becta's [safeguarding web pages](#), including the helpful [Safeguarding children online](#) poster. The new [21st century teacher](#) information provides a more general self-evaluation for teachers concerning their use of ICT. [TechNews 12/09](#) covered the DCSF [announcement](#) that e-safety is to become a formal part of the curriculum for all school-age learners from September 2011.

Help in the home from i2home project

An EU-funded [I2HOME](#) project is being used to demonstrate how new interfaces can be used by older and disabled people to control domestic appliances and systems. The interaction is governed by Universal Remote Console (URC) - an [ISO/IEC 24752](#) standards family, which ' facilitates operation of information and electronic products through remote and alternative interfaces and intelligent agents'. A Universal Control Hub forms the 'middleware' core, interpreting user requests and

interacting with controllers for televisions, media centres, washing machines, lighting and other domestic systems. The researchers intend plug-in user interface modules for the hub to be available as downloads from the internet.

User control is provided through touch screens, mobile phones, speech recognition systems and simplified remote controls. A video, embedded on this BBC News [web page](#), shows a door entry system, heating and lighting controls, monitoring of a gas hob and support for users on prescribed medications. The interface can be personalised through profiles and output provided through synthesised speech and clear on-screen graphics.

Researchers hope that manufacturers will add the necessary control interfaces to their hardware, enabling people with cognitive and other disabilities to live more independent lives. Siemens was among the companies supporting the project, which has now been completed, while the BBC News page suggests that more than 100 research groups and commercial organisations were involved or interested in the outcomes.

Potential fines of £500,000 for data breaches

The Information Commissioner's Office (ICO) [can issue](#) fines of up to £500,000 for data security breaches from 6 April 2010 onwards. In order to exact any monetary penalty, the Information Commissioner 'must be satisfied that there has been a serious breach that was likely to cause damage or distress and it was either deliberate or negligent and the organisation failed to take reasonable steps to prevent it.' The precise fine levied would depend on the severity of the offence and the nature of the organisation involved.

The Information Commissioner is clear about the purpose of the new maximum fine, saying, "These penalties are designed to act as a deterrent and to promote compliance with the Data Protection Act." Such fines could be applied to schools and colleges.

TechNews Information

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