▶ BEYOND THE PC

Mobile digital gadgets are overshadowing the personal computer, says Martin Giles. Their impact will be far-reaching

IF YOU HAVE a phone, these days even space is within reach. Last year Luke Geissbühler and his son, who live in Brooklyn, popped a high-definition video camera and an Apple iPhone into a sturdy protective box with a hole for the camera's lens. They attached the box to a weather balloon, which they released about 50 miles (80km) outside New York City, after getting the approval of the authorities. The balloon soared into the stratosphere and eventually burst. A parachute brought it to the ground. By tracking the iPhone's inbuilt global positioning system, the Geissbühlers were able to retrieve the box and the video of their "mission", which shows the curvature of the planet clearly. The results can be seen at www.brooklynspaceprogram.org.

The iPhone and other smartphones are proving extremely useful on Earth too. These devices, which let people download and install applications, or "apps", from online stores run by phonemakers, telecoms companies and others, are starting to displace ordinary mobile phones in many countries. Ofcom, Britain's telecoms regulator, recently reported that more than one in four adults there uses a smartphone. Nielsen, a market-research firm, reckons the devices make up the majority of mobile-phone purchases in America. Emerging markets are embracing them as well: in Indonesia, BlackBerry handsets made by Canada's Research in Motion (RIM) have become a status symbol among the country's fast-growing middle class.

Sales of tablet computers, though still small, are also growing rapidly. Since Apple's iPad arrived last year, a host of rivals have appeared, such as RIM's Playbook, Samsung's Galaxy Tab and Sony's Tablet. All eyes are now on Amazon's Kindle Fire. With smartphones, which seem to be surgically attached to the hand of every teenager and many an adult, tablets have opened up a new dimension to mobile computing that is seducing consumers. Morgan Stanley, an investment bank, believes that in 2011 combined shipments of smartphones and tablets will overtake those of personal computers (PCs).

The revolution is mobile

This marks a turning-point in the world of personal technology. For around 30 years PCs in various forms have been people's main computing devices. Indeed, they were the first machines truly to democratise computing power, boosting personal productivity and giving people access, via the internet, to a host of services from their homes and offices. Now the rise of smartphones and tablet computers threatens to erode the PC's dominance, prompting talk that a "post-PC" era is finally dawning.
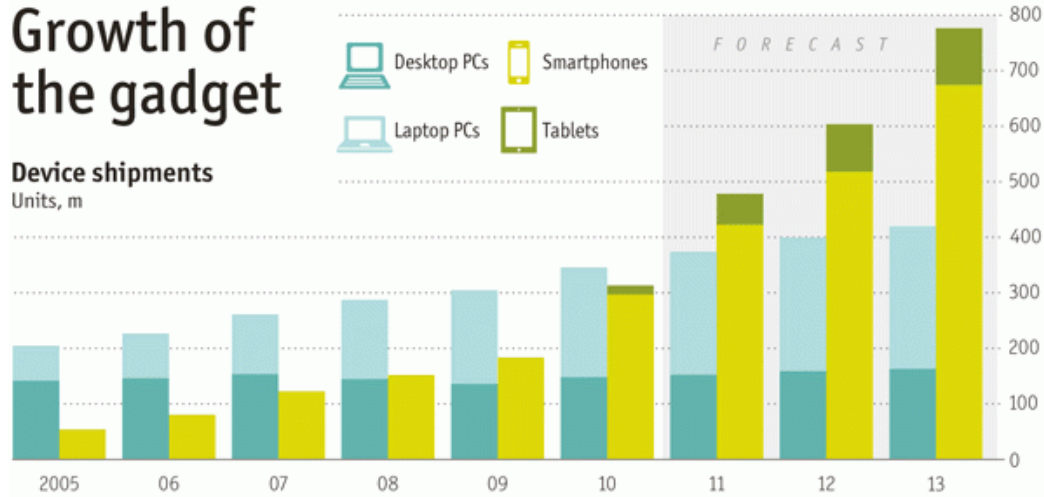
PCs are not about to disappear. Forecasters expect 350m-360m of them to be sold this year and the market is likely to keep growing, if slowly. With their keyboards, big screens and connectivity to the web, PCs are still ideal for many tasks, including the writing of this article. And they continue to evolve, cheap, light "ultrabooks" being the latest in a long line of innovations. Even so, the Wintel era—dominated by PCs using Microsoft's Windows operating system and Intel's microchips—is drawing to a close. The recent news that HP, the world's largest computer-maker, is thinking of spinning off its PC business to focus on.

A new tech landscape is taking shape that offers consumers access to computing almost anywhere and on many different kinds of device. Smartphones are at the forefront of this change. The Yankee Group, a research firm, thinks that sales of these phones will overtake those of ordinary "feature" phones in many more countries in the next few years. But other kinds of machine, from Microsoft's Xbox 360 gaming console, which allows gamers to contact friends while they play, to web-enabled television sets, are also helping people stay connected.

In part, this emerging array of devices reflects changes in society. As people come to rely more heavily on the web for everything from shopping to social networking, they need access to computing power in many more places. And as the line between their personal and their work lives has blurred, so demand has grown for devices that can be used seamlessly in both.
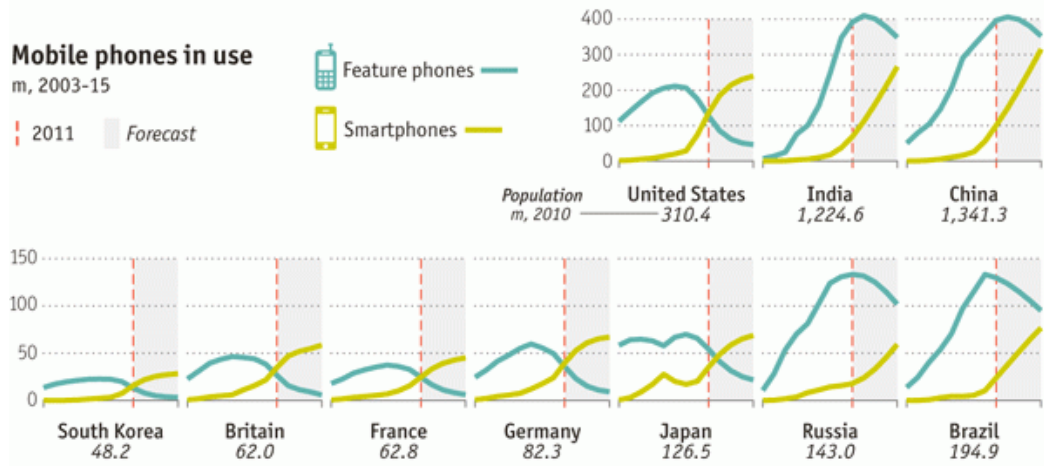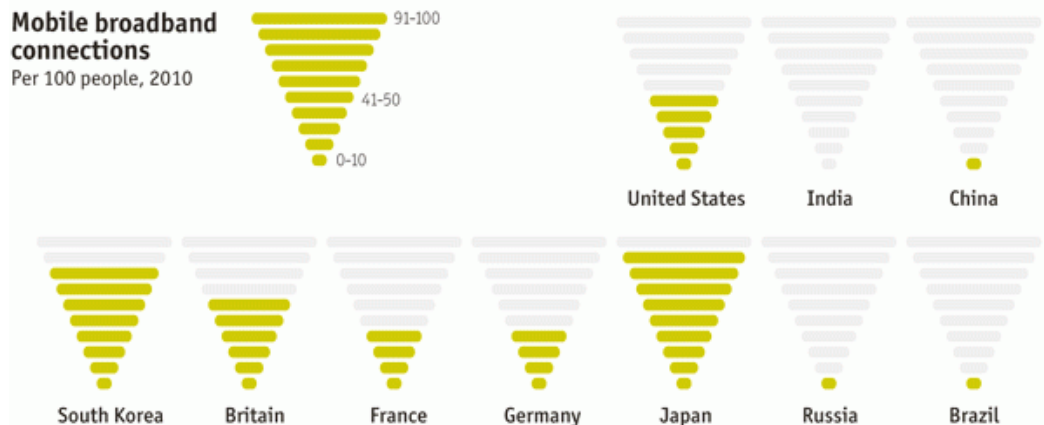
1

Growth of the gadget

Desktop PCs Smartphones

Laptop PCs Tablets

FORECAST

Device shipments
Units, m

800
700
600
500
400
300
200
100
0

2005 06 07 08 09 10 11 12 13

Devices in use:

100m PCs in **1993**

1bn PCs in **2008**

10bn Mobile connected devices by **2020***

Mobile phones in use
m, 2003-15

Feature phones
Smartphones

2011 Forecast

400
300
200
100
0

Population m, 2010 — 310.4

United States	India	China
	1,224.6	1,341.3

150
100
50
0

| South Korea 48.2 | Britain 62.0 | France 62.8 | Germany 82.3 | Japan 126.5 | Russia 143.0 | Brazil 194.9 |

Mobile broadband connections
Per 100 people, 2010

91-100
41-50
0-10

United States India China

South Korea Britain France Germany Japan Russia Brazil

The consumer is king

The rise of tablets and smartphones also reflects a big shift in the world of technology itself. For years many of the most exciting advances in personal computing have come from the armed forces, large research centres or big businesses that focused mainly on corporate customers. Sometimes these breakthroughs found their way to consumers after being modified for mass consumption. The internet, for instance, was inspired by technology first developed by America's defence establishment.

Over the past ten years or so, however, the consumer market has become a hotbed of innovation in its own right. "The polarity has reversed in the technology industry," claims Marc Andreessen, a prominent Silicon Valley venture capitalist whose firm, Andreessen Horowitz, has invested in several consumer companies, including Facebook and Twitter. Now, he says, many exciting developments in information technology (IT) are appearing in the hands of consumers first and only then making their way into other arenas—a trend that tech types refer to as the "consumerisation" of IT.

The transformation may not be quite as dramatic as Mr Andreessen's remark implies. Armies, universities and other institutions still spend vast sums on research, the fruit of which will continue to nourish personal technology. Moreover, this is not the first time that individuals have taken the lead in using new gadgets: the first PCs were often sneaked into firms by a few geeky employees.

Nevertheless there are good reasons for thinking that the latest round of consumerisation is going to have a far bigger impact than its predecessors. One is that rising incomes have created a vast, global audience of early adopters for gadgets. Around 8m units of the Kinect, a Microsoft device that attaches to the Xbox and lets people control on-screen action with their body movements, were sold within 60 days of its launch in November 2010. No consumer-electronics device has ever sold so fast, according to Guinness World Records. "These people will absorb new technology on a scale that is simply quite stunning," says Craig Mundie, Microsoft's head of research and strategy.

The cost of many gadgets is falling fast, giving another fillip to consumption. Smartphones priced at around $100—after a subsidy from telecoms companies, which make money on associated data plans—are starting to appear in America. The cheapest Kindle, an e-reader from Amazon, sells for $79, against $399 for the first version launched in 2007. The cost of digital storage has also fallen dramatically. A gigabyte (GB) of storage, which is roughly enough to hold a two-hour film after compression, cost around $200,000 in 1980; today a disk drive holding a terabyte, or 1,024GB, costs around $100.

The growth of the internet and the rapid spread of fast broadband connectivity have also transformed the landscape. So has the rise of companies such as Apple, Google and Amazon, whose main aim is to delight individuals rather than businesses or governments. Apple, in particular, has been to the fore in the democratisation of IT, creating a host of impressive devices such as the iPhone and the iPad. Much of the credit for its success goes to Steve Jobs, who stood down in August as its chief executive.

Techtonic shifts

This special report will examine in more detail the forces underlying the reversal in polarity to which Mr Andreessen refers and how they are affecting individuals, businesses and governments. The combination of new devices with pervasive connectivity and plentiful online content is raising citizens' expectations of what personal technology can achieve. And it is leading them to bring their own devices into the workplace, where some of the technology they are expected to use now seems antediluvian by comparison. This trend is challenging companies to rethink their IT departments' habit of treating employees as digital serfs who must do as they are told.

The burgeoning global market for smart consumer technology is also inspiring an outpouring of entrepreneurial energy that will create many more remarkable products. And it is encouraging organisations of all kinds to adapt innovations from the consumer world for their own ends. Companies are setting up online app stores for their employees; hospitals are handing out specially modified smartphones to nurses; soldiers are trying out tablet computers to control drones and experimenting with "battlefield apps". Many more such opportunities are likely to emerge as the technological and economic forces behind this popular computing revolution gather steam.

Consumerisation

▶THE POWER OF MANY

The shift from personal to personalised computing

ANYONE WANTING TO get a better idea of the scale of the changes taking place in the world of consumer electronics should take a look at Foxconn's giant factory complex in Shenzhen, in southern China. Known as Foxconn City, it covers an entire square mile and is crammed with manufacturing operations and company-managed housing, medical facilities and educational centres. About 400,000 people work there, roughly as many as live in Oakland, California.

Matt Herring

Like several other Taiwanese firms that operate factories at home and in China, Foxconn churns out electronic devices on behalf of a number of Western companies. By tapping into cheap Asian labour, Apple, Samsung and other consumer-electronics giants have been able to drive down the prices of their phones and other gadgets, broadening their appeal to consumers. A handful of insurgent Asian firms, including China's Huawei and Taiwan's HTC, which make devices that run on Google's Android mobile operating system, are using their cost advantage to build their own global brands.

A globalised supply chain is not the only thing helping consumer-electronics companies to cut costs. They are also benefiting from economies of scale as the incomes of more and more people in more and more countries rise to the point at which gadgets are affordable. Erik Brynjolfsson of the MIT Sloan School of Management points out that because of this, manufacturers of consumer electronics are now moving down production learning curves faster than more specialised tech firms.

HTC is a case in point. The company shipped over 22m phones in the first half of this year, more than twice as many as in the first half of 2010. As it has grown, it has been constantly tweaking the integration between product development and manufacturing. Matthew Costello, the firm's chief operating officer, says that it now takes six to 12 months for the Taiwanese company to get a product from the conceptual stage to a consumer's hand, compared with 12 to 18 months only two years ago.

Power surge

The ability to amortise spending over a fast-growing audience is also encouraging tech firms to pour more money into consumer-focused research and development (R&D). Asked what is driving consumerisation, Jen-Hsun Huang, the boss of NVIDIA, an American firm that makes graphic chips for everything from gaming consoles to smartphones and supercomputers, whizzes through a quick calculation. There are about 200m PCs sold every year that contain the kind of chips that NVIDIA produces, he says. Assuming an average sales price of $20 per chip, that makes a potential market today of $4 billion for the firm's products. Sales of the types of PC that NVIDIA targets are likely to grow, so this number could increase.

However, Mr Huang expects the market for smartphones to grow far faster, with around 2 billion ultimately being sold each year. Given that the average sales price of NVIDIA's chips for these devices is $20 too, the potential market is $40 billion, ten times as big as that in PCs. Other forecasters also expect demand for smartphones to soar. Gartner, a research firm, estimates that 1 billion will be sold in 2015, up from 468m this year. "R&D is shifting to consumer-focused markets simply because we have more hope that it will be monetised there," explains Mr Huang.

These economic trends are being reinforced by several technological ones. Arguably the most important has been the ability of microchip-makers to squeeze ever more computing power onto their products, as Moore's law (which holds that the number of transistors on a single chip doubles roughly every two years) has continued to operate. James Bruce of ARM, a British company that designs chips for the iPhone and other portable devices, reckons today's versions are 40 times more powerful than those around in 2000.

One of the most important leaps has been the introduction of "multi-core" processors, tiny chips with two or more processors, or "cores", on them. Often, smartphones are used only for simple stuff such as calls and e-mail, which do

not require all of their computing potential. By using multi-core chips and smart software, phonemakers can shut down one or more of the processors, reducing the drain on phones' batteries. "We have become experts at the art of doing nothing," jokes Mr Bruce.

Other advances have also contributed to the personal-computing revolution. Lithium-ion polymer batteries, which can be easily moulded to fit different shapes, have made possible ultra-slim devices. Developments in "flash" memory technology have made it possible to store more data in devices. Advances in screen know-how have begotten super-sharp displays. Photos and videos can be shot and shared on the move. Some phones even allow video calls.
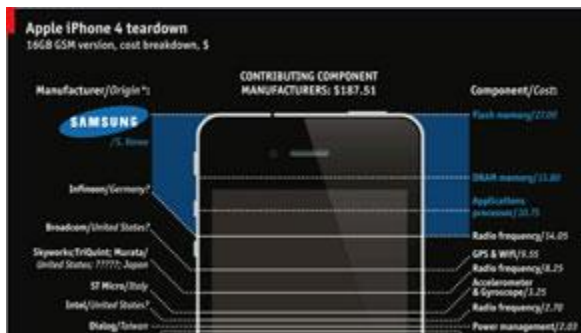
Find out how much of an Apple iPhone is actually a Samsung with our "teardown" infographic. (Placed at end of this report.)

Technologically impressive as all this is, the biggest change that the new devices have wrought is to transform many people's experience of computing. The PC may have been personal; a smartphone or tablet, held in your hand rather than perched on your desk, is almost intimate, and you can take it almost anywhere. This shift has been driven by Apple, which likes to boast that most of its revenue now comes from "post-PC" devices such as iPods and iPhones rather than from its Macintosh computers. This is partly marketing talk: crack open an iPhone and you will find many of the paraphernalia—including a motherboard and microchips—that make up the guts of a PC too.

The Gucci of gadgets

Yet Apple has indeed ushered in a new era in which personal technology is finally living up to its name. That is because the technology is starting to adapt to the people who use it rather than forcing them to adapt to it. The most obvious manifestations of this are the touch-screens and intuitive operating systems on many tablets and smartphones that have allowed even toddlers to take to them with gusto. It is also reflected in the way that phones can now be tweaked to reflect people's increasingly connected lives by, say, bringing up a friend's latest Facebook posts when he calls. "The PC is personal but nowhere near as customisable as the smartphone," says Tim Bajarin of Creative Strategies, a consultancy.

The marketing of this new generation of mobile devices has also reinforced the notion of technology as something personal. Again, Apple has led the way, encasing the mass of electronics that make up iPhones and iPads in elegant cases and churning out its iPods in a range of different colours. "Consumer technology is becoming fashion," says Paul Saffo, a veteran Silicon Valley tech-watcher who works for Discern Analytics. "And Apple is now the world's biggest fashion company."

The PC may have been personal; a smartphone or tablet, held in your hand rather than perched on your desk, is almost intimate, and you can take it almost anywhere

Still, no matter how good a gadget looks, utility counts. This is where smartphones excel. Many now contain sensors such as accelerometers (which detect whether a gadget is being held vertically or horizontally), gyroscopes and compasses. More and more employ global positioning system (GPS) technology, which let the Geissbühlers find their iPhone when it returned from its space mission. Soon this sensor technology will become widespread too: ABI Research forecasts that by 2013 85% of smartphones will be shipped with GPS systems and around half will contain accelerometers and gyroscopes.

Thanks to these sensors and the apps that tap data from them (see article), smartphones are being used for all sorts of things, such as navigation and video-recording, that used to require dedicated devices. Some in the industry call the smartphone the Swiss Army knife of consumer electronics. HTC's Mr Costello says it is more like a black hole "because it is swallowing so many other gadgets".

Another big driver of mobile-device usage—and thus of consumerisation—has been the rise of cloud computing. For much of the personal-computing era, the content that people needed for work or entertainment had to be stored on PCs' hard disks, or on external hard drives and USB keys. But now data and content often reside in the "cloud": large

server farms, run by Amazon, Google and others, where huge amounts of data are stored for retrieval from almost anywhere in the world.

Pioneers such as Amazon have built cloud-based "ecosystems" that make content such as its electronic books widely available. Even though the firm has its own e-reader, the Kindle, and has hatched a tablet computer too, it has also created apps and other software that let people get at their digital stuff on all sorts of devices, including PCs. Other companies are developing their own ecosystems in a bid to make people's mobile-computing experience even more seamless. Google's recent $12.5 billion acquisition of Motorola Mobility, which makes smartphones, tablets and other gadgets, will enable it to produce a new crop of devices to show off its cloud services, such as Gmail and Google Docs, to best effect. And Apple is stepping up its integration efforts, rolling out an "iCloud" in which people can store up to 5GB of content for nothing, and more if they pay.

Heads in the cloud

The rise of the cloud has also created an explosion of other consumer-focused web services. These include the big social networks such as Facebook, which has over 800m users, and a host of smaller firms such as Foursquare, which was created specifically to let people tell their pals where they are. This combination of social networking, location-signalling and mobile computing—nicknamed "SoLoMo" by John Doerr, a prominent venture capitalist—has given birth to outfits such as Badoo, a site for people wanting to chat, flirt and date. Mobile computing is also encouraging people to use web services more often than they would on a PC. Facebook reports that people who visit its network via mobile devices are twice as active on it as those who tap into it via other means.

Other small software companies are also placing powerful tech tools in people's hands. Dropbox lets users upload photos, documents and other content via a simple interface and then retrieve them from many different devices. SlideShare allows people to share presentations and other stuff via the cloud. Many of these companies offer a free basic service: Dropbox lets users store up to 2GB of data for nothing, then charges for more.

Amazingly capable mobile devices and oodles of cloud-based content are two of the three pillars on which the personalised computing revolution is being built. But it is the third pillar—the proliferation of broadband connections—that has turbocharged it. In many rich countries fixed-line broadband connections are now commonplace, often with a Wi-Fi link at the end of them to allow people to use their devices wherever they are in homes or offices. And a variety of wireless technologies including "third-generation", or 3G, networks, Wi-Fi and Bluetooth have made it possible for people to stay connected to the internet almost everywhere.

Skype, which claims to have about 170m monthly active users, is one of the services that has flourished as all sorts of devices have become more powerful and connected. "It's amazing how many things you can now use Skype on," says Tony Bates, the firm's boss, who points out that many of the innovative uses of the online phone and video-calling service have been inspired by consumers. For instance, when teachers began using Skype to swap advice on classes, the firm added features that made it easier for them to collaborate using its technology.

Like many other technology executives, Mr Bates is convinced that consumerisation is an unstoppable force and that it has raised people's expectations hugely. "It used to be that the best IT experiences people had were in the office," he says. "Now that technology has been democratised, they have become used to doing new and exciting things themselves." For their employers, this is creating both opportunities and headaches.

▶ APPS ON TAP

The beauty of bite-sized software

ASKED WHAT MAKES mobile apps so special, Bart Decrem, a co-founder of Tapulous, gives a reply that could have come straight out of the mouth of Steve Jobs. "Apps are nuggets of magic," he says. "They very elegantly address the strengths and weaknesses of the mobile internet." Mr Decrem knows the app economy well. After building a number of successful gaming apps at Tapulous, including "Tap Tap Revenge", which involves tapping on coloured balls as they move down a phone's screen, he sold his company last year to Disney, where he is now an executive.

Hordes of other developers have piled into the app business, creating hundreds of thousands of offerings for online stores run by Apple and Google, by telecoms firms such as South Korea's SK Telecom, and by independent app stores such as GetJar. The appetite for apps appears insatiable: Gartner, a research firm, estimates that almost 18 billion have been downloaded since the first app store was opened by Apple in 2008. By 2013, it thinks, the number will have risen to 49 billion. Many are games such as "Tap Tap Revenge" and "Angry Birds", in which a bunch of enraged digital fowl wage war against evil pigs that have pinched their eggs. But there are also plenty with a more serious purpose, such as the Federal Bureau of Investigation's Child ID iPhone app, which lets parents store information about their kids and send it to the authorities if a child goes missing.

In many ways, apps are representative of the changes taking place in personal technology. Small, downloadable chunks of software, they give people access to information in a neatly packaged format and most have one or more of the following attributes: simplicity, cheapness and instant gratification.

They have caught on partly because many websites do not look good when viewed on phones' tiny screens. Apps do a much better job of making the best of the space available. Using them is intuitive, by and large. Many are free; many others cost no more than a fancy cup of coffee. Some of the most creative apps make the most of phones' sensors. Gaming ones use accelerometers and gyroscopes to track users' motions, while mobile-navigation apps rely on inbuilt GPS systems.

Another reason why apps have proved popular is that, unlike websites, they do not need a constant connection to the internet. Instead, they are stored in mobile gadgets' silicon memories and refreshed when a new connection is available. This also explains why they launch so much faster than software on PCs. "Apps mean that people are no longer going to be satisfied waiting for spinning hard disks on PCs to deliver what they want," says Tim Bajarin of Creative Strategies, a consultancy.

There has been speculation that apps may fade when new websites designed to work better on mobile devices appear. But that is unlikely to happen while mobile-internet connectivity remains patchy. Fans also point out that apps are easy to create.

Most, however, are destined for obscurity. Today there are more than 425,000 apps in Apple's online store and more than 250,000 in Google's Android Market. Yet in a recent survey of Android-phone users in America, Nielsen, another research firm, discovered that the ten most popular apps accounted for 43% of usage and the top 50 for a whopping 61%. Admittedly, these statistics may be influenced by the pre-loading of apps for services such as Facebook and Google Maps onto many phones. But the results are still telling. Part of the problem is that there is still no reliable search engine for discovering outstanding apps. No doubt there will soon be an app for that too.
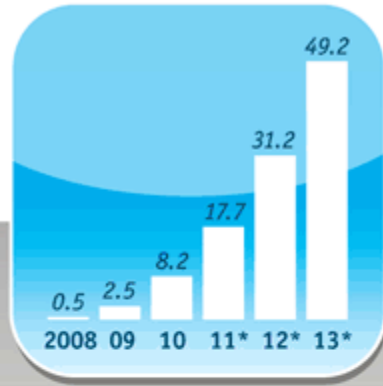
(See Figure on next page.)

STORE	NO. OF APPS
Apple App Store	414,852
Android Market	237,199
GetJar	160,296
MobiHand	158,301
PocketGear	91,144
Mobango	82,936
Handango	44,685
SK Telecom T Store	37,629
BlackBerry App World	36,781
Handster	31,042

Biggest app stores
Q2 2011

No. of app downloads graph:
- 2008: 0.5
- 09: 2.5
- 10: 8.2
- 11*: 17.7
- 12*: 31.2
- 13*: 49.2

No. of app downloads
Worldwide, bn

Games	64
Weather	60
Social networks	56
Maps/search	51
Music	44
News	39

Most popular categories
% of users†, Q2 2011

Most popular:

1. Hair Plucker
2. Temple Run
3. Draw 'n' Go: Awesomeness!
4. Office Zombie
5. Google+

1. Facebook
2. Google Maps
3. Talking Tom Cat 2
4. YouTube
5. MP3 Music Download Pro

Top free apps‡
September 27th 2011

*Forecast †US
‡Apple: iPhone only; Android: all devices

Personal technology at work

▶ IT's Arab Spring

People are demanding to use their own gadgets in their jobs. Trying to thwart them is futile

WILLEM EELMAN, the chief information officer (CIO) of Unilever, an Anglo-Dutch consumer-goods giant, recounts the reaction of young employees when they first come across the complicated and often confusing ways in which many big corporate IT systems still present information to staff. "They take a look at a business-application screen and they scream in horror," he says. The youngsters are even more horrified when presented with tomes of instructions through which they must plough before getting down to work.

Like many other companies, Unilever is recruiting from a generation whose expectations of technology have been profoundly shaped by Facebook, mobile apps and other innovations. But it isn't just "digital natives" who are shocked by the state of some of the technology in their workplaces. The rapid spread of tablets and smartphones, and the magnetic attraction of social networks and other online tools such as Twitter, mean that people of all ages have grown accustomed to having powerful yet easy-to-use technologies at their fingertips. Many of them want the same stuff at work too.

Their demands are also being fuelled by changes in society. Among these is the increasing mobility of the workforce, whether commuting or visiting clients, which has made smartphones and tablets especially popular with corporate road-warriors. There has also been a gradual blurring of the lines between personal and business lives, which means that people rely on technology much more to allow them to work or play anywhere at any time.

The effects of these changes are being widely felt. A survey of 3,000 workers in nine countries carried out by IDC, a research firm, for Unisys, an IT company, and published in July found that their use of personal devices to access business information had grown sharply, partly because of the arrival of tablets (see chart 1). The study also noted that IT departments often greatly underestimate how much employees are using their own technology, including social networks and other web services, for work. And it accused internal tech teams of frequently using security concerns as a "figleaf" to justify keeping tight control of decisions about which devices workers may and may not use.

How far firms are affected by all this will largely depend on the nature of their business. Those with a highly mobile workforce are already seeing swift changes. Accenture, a consulting firm whose staff often work at clients' offices, is a case in point. Frank Modruson, the CIO of the company, which has 223,000 employees, says that less than two years ago 30,000 smartphones and other mobile devices were connected to its network, most of them bought by the firm. Today there are 85,000, less than a third of which were provided by the company.

Other companies are seeing a more gradual influx of employee-owned gadgets. At Unilever, Mr Eelman says that of the 90,000 employees who use a computer for their jobs (out of a total of 160,000 staff) about 5,000 have so far brought in a mobile gadget of their own. But he expects that number to grow as the company rolls out a new IT infrastructure that will allow people to work more easily from different places.

War of the IT worlds

The arrival en masse of personal technology in the workplace is causing waves. "Historically many IT departments have treated people as tech automatons who should do what they are told," says Bob Tinker, the boss of MobileIron, which helps firms manage mobile devices. For years that has involved restricting people's choice of mobile gadgets to a few devices such as the BlackBerry smartphones made by Canada's RIM.
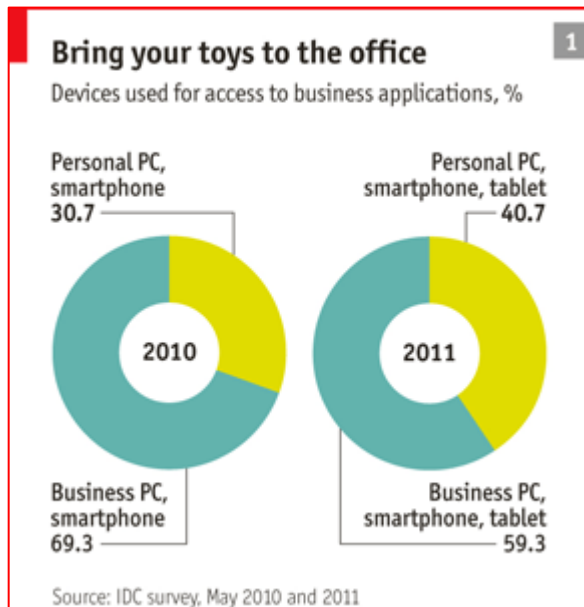
One rationale for this was that strict standardisation saved money. By limiting choice to a few gadgets, companies could buy them in bulk and streamline their maintenance in much the same way that, say, budget airlines reap big savings by buying just one or two types of aeroplane. At the same time, standardisation made it easier to ensure

security. A big reason why BlackBerrys have proved so popular with companies has been that RIM also provides software that lets IT departments maintain a firm grip on the way the devices are used. Now, however, IT teams are facing a challenge to their authority. Much of what workers are demanding, including the right to use their own smartphones and tablets for work, to mix business and personal data on them, and to personalise them with their own apps, is anathema to IT departments used to running digital dictatorships. Often it is senior executives who insist on being allowed to use their own technology for work, which makes it hard for IT folk to say no. "This really is the end of the nanny state of IT," says Doug Neal of CSC, a consultancy.

> Rather than a few geeky rebels, there are now entire armies of employees equipped with smart mobile devices
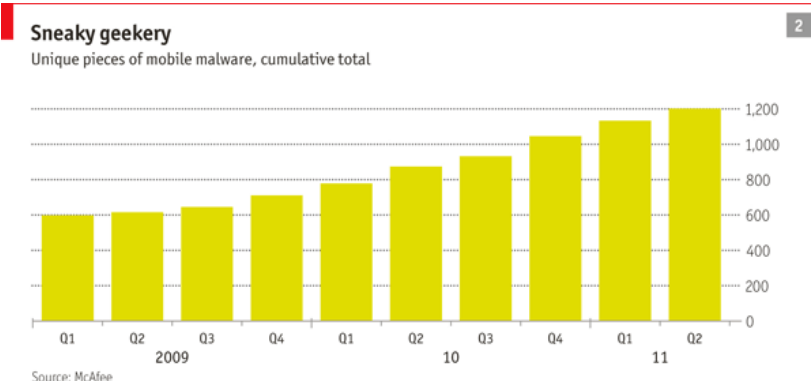
CIOs who try to ban the use of personal technology at work risk a proliferation of "shadow IT", which arises when employees surreptitiously use their own devices and software to get things done. This is not new, as the example of the people who sneaked the first PCs into offices shows. What is different is the sheer scale of the consumerisation movement this time. Rather than a few geeky rebels, there are now entire armies of employees equipped with smart mobile devices. Left undetected, their do-it-yourself efforts could cause sensitive corporate data to leak and open digital doors to hackers.

Bring your toys to the office
Devices used for access to business applications, %

Personal PC, smartphone 30.7 — 2010 — Business PC, smartphone 69.3

Personal PC, smartphone, tablet — 40.7 — 2011 — Business PC, smartphone, tablet 59.3

Source: IDC survey, May 2010 and 2011

There is some debate about just how big a threat this is. Earlier this year Verizon, an American telecoms firm, published a report that reviewed numerous corporate data breaches that had occurred in 2010. It concluded that most of these were due to direct attacks on corporate servers, not to mobile devices being compromised. Moreover, many smartphones and tablets now include features such as the ability to erase, or "wipe", the content on them remotely and to track their location using their inbuilt GPS systems. The same cannot be said of most PCs. And some operating systems such as later versions of Apple's iOS include ready-made encryption capabilities that protect data on devices. This helps explain why so many companies are embracing iPads. Apple has said that most members of the Fortune 100 list of America's largest firms are either buying the gadgets or running trials with them.

Nevertheless there are grounds for concern. The Verizon report predicts that threats to mobile devices will grow as more are sold. And another study published in August by McAfee, an IT-security firm, found there had been a steady increase in mobile "malware"—software such as viruses and "Trojans" designed to disrupt or steal data (see chart 2). Google's Android system is an especially popular target. One piece of malware disguised as an Android calendar app sent SMS messages to a premium-rate number without users' knowledge. Another, masquerading as an update for "Angry Birds", a mobile game, deleted browser histories and bookmarks on phones.

Sneaky geekery
Unique pieces of mobile malware, cumulative total

Q1 Q2 Q3 Q4 2009 | Q1 Q2 Q3 Q4 10 | Q1 Q2 11

Source: McAfee

Popular web services have also had security hiccups. In June a software update at Dropbox caused a temporary security breach that allowed unauthorised access to data held by the online-storage service for about four hours. According to the company's blog, fewer than 100 accounts were compromised, but the episode nevertheless shocked those who had assumed that the service was perfectly secure. The firm has since taken steps to prevent a recurrence.

Lock up your devices

Perhaps the biggest risk of all, though, is employees themselves. Numerous studies have shown that although people lock their cars and their homes, many do not secure their mobile devices. A report in March by the Ponemon Institute, a research group, for AVG, a security firm, found that less than half of the 734 Americans surveyed had set up passwords on their smartphones, even though most had used them for work. Other studies have found that when people do protect their phones, they often choose codes that can be cracked easily, such as "password" or "12345", rather than more secure combinations of letters, numbers and other symbols.

Many CIOs recognise that trying to stamp out the use of personal gadgets at work is not only futile but also risky. "I'd rather know about a device and put reasonable security on it than stick my head in the sand and pretend it's not there," says Accenture's Mr Modruson. To manage the risks, companies have been installing systems from firms, such as MobileIron and Zenprise, whose software lets IT departments manage a wide range of mobile devices. These can detect the kinds of gadgets that are gaining access to a firm's network and wipe data from those that are lost. "Virtual desktops" from companies like VMware and Citrix that let people use devices but keep data on a remote server behind a firewall are another popular means of limiting risks.

All this costs money. So there is much debate in the IT world about whether or not consumerisation leads to savings too. Mr Modruson says that Accenture's employees have spent $4.25m of their own money on tablet computers that they use for work. But Cesare Garlati of Trend Micro, an IT-security company, gives warning that companies also need to take into account the cost of managing many different kinds of devices running on various telecoms networks. "It's a nightmare of complexity," he says.

Yet even if IT perestroika is pricey, the investment may still be worth it—and not just because it minimises the risk of a disaster caused by shadow IT. For a start, firms that embrace consumerisation are more likely to attract technologically minded workers at a time when IT is becoming ever more crucial to corporate success. Those people are also more likely to give their employers early warning of innovations in the personal-technology world that could affect their business. And they are probably better at conversing with customers who are themselves adopting many of the same technologies.

Such considerations help explain why even companies in heavily regulated industries are letting people bring their own gadgets to work. "Previously we just said no to people using non-standard devices," says Robert Cockerill of Thames River Capital, a British fund-management company. Now the firm lets employees use a range of phones and tablets as long as sensitive data on them are encrypted and activity is logged in order to comply with regulations.

Pfizer, a big pharmaceuticals company, is also embracing consumerisation cautiously. "We have to find a balance between flexibility and protecting the intellectual assets that are the lifeblood of the company," says Jeff Keisling, the firm's CIO. The company allows workers to use various kinds of devices and operating systems, but to get access to its network they must agree to load an encryption agent on their gadgets and to allow Pfizer to wipe part or all of the information on them if necessary.

At the other end of the spectrum, some companies are giving their employees stipends to encourage them to buy their own devices. One of these is Citrix, which requires staff to use its own virtual-desktop product on the gadgets they purchase and to install antivirus software prescribed by the company. The firm says that about a fifth of its 6,500 employees have taken advantage of the policy.

Mr Eelman of Unilever sees consumerisation as part of a broader shift in what companies expect of their IT departments. Not so long ago, he says, many internal tech teams were focused on installing gigantic software systems to handle such things as accounting and human resources. Most of these are now in place, though they require maintenance. This means IT now has more time to be a partner supporting firms' business divisions. Enabling workers to use the gadgets they consider best for their jobs is part of this strategic realignment. Wise companies are not just embracing the consumerisation of IT. They are also turning innovations from personal technology to their advantage.

Ubiquitous computing

▶ UP CLOSE

Technology will become even more personal

GENEVIEVE BELL HAS spent the past few months travelling to several different countries, rummaging in people's cars, and photographing and logging what she found in them. Ms Bell is neither a private investigator nor a spy. Instead she works for Intel, the world's biggest maker of semiconductors, where she runs a team that helps the company analyse how people interact with technology.

An anthropologist by training, Ms Bell says her interest in cars and their contents—which were unpacked with their owners' permission—is a reflection of the fact that vehicles have become places where people use a great deal of personal gadgetry. Her photos often reveal what she calls "a wasteland of electrical detritus" inside vehicles: everything from multiple chargers for different kinds of electronic devices to music CDs and other artefacts of people's digital lives. "Cars are a perfect proxy for mobile phones," she says, "because people load lots of stuff into them to be prepared for every eventuality and then rarely chuck anything out."

Intel's curiosity about how people use technology in cars is hardly surprising. Carmakers are keen to install extra computing power in their vehicles in order to impress customers with a taste for technology, and Intel hopes that this will translate into a big new market for its chips. Ford, for instance, has already developed a service called SYNC, based on a Microsoft operating system. SYNC allows drivers to make calls, play music and do other things using voice commands. The car company has also created AppLink, a feature that lets people link their smartphones to a vehicle's voice-control system and operate their apps with it. For now the system works with only a handful of apps, such as Pandora, an internet-radio service, but Ford is hoping to expand that number rapidly.

Japan's Toyota has also been working on an in-car system, called Entune, to which drivers will be able to connect their smartphones via Bluetooth wireless links and other means. And it plans to make driving even more personal by helping people's cars "talk" to them. The firm has announced plans for a Twitter-like private social network, called Toyota Friend, which will be integrated into some electric and hybrid vehicles in Japan next year. Based on software from Salesforce.com and Microsoft, this will enable a car to send a tweet-like message to its owner telling him that, say, its battery is running low or a maintenance check is due. Mr Benioff, Salesforce.com's boss, says he foresees many more "product social networks" that will create more intimate relationships between people and the devices they own.

It is not just vehicles that are becoming more connected. So are homes, public places like sports stadiums and even aircraft, where passengers are now sometimes offered in-flight Wi-Fi services for an extra charge. Cisco, a big IT firm, reckons that there could be almost 15 billion devices linked to the internet in circulation by 2015, up from 7.5 billion last year. These will include everything from televisions and gaming consoles (see chart 3) to coffee machines and cookers.

This has led researchers such as Ms Bell to conclude that ubiquitous computing, or "ubicomp" to its fans, is no longer the realm of science fiction. In a series of articles in the 1990s Mark Weiser, the chief technologist at Xerox's Palo Alto Research Centre (PARC), laid out a vision of a world in which computers would be everywhere yet all but invisible. Instead of the conventional desktop or laptop, Mr Weiser (who died in 1999) and one of his colleagues, John Seely Brown, predicted that in this new era of "calm technology" gadgets would adapt to people rather than vice versa.

Everything online
Internet-connected TVs and games consoles, global forecast, bn

Games consoles   TVs

2011   12   13   14   15   16

Source: Informa Telecoms & Media
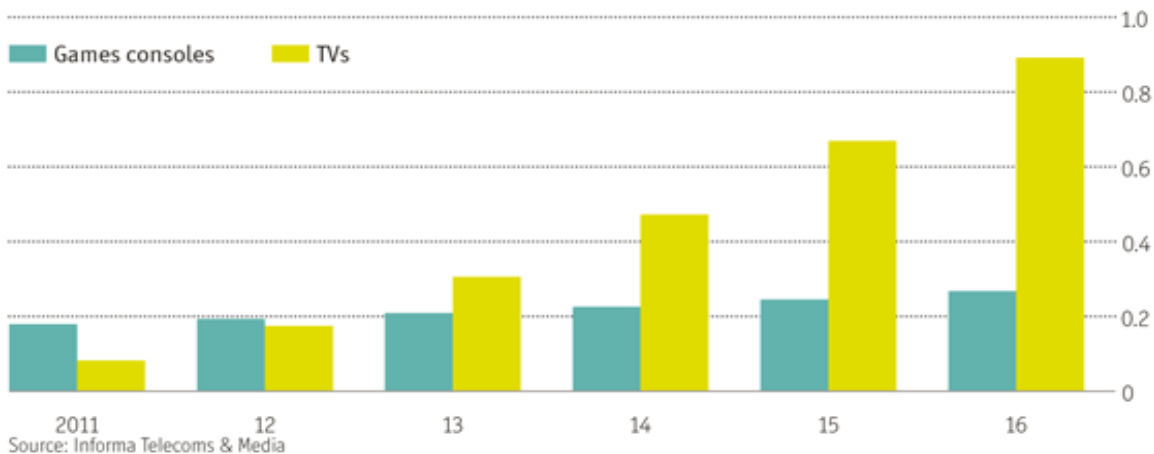
Still a wired world

"Calm" is not a word typically associated with most personal technology today. Just trying to get various gadgets to work together is often enough to send blood pressures soaring. Moreover, the spaghetti of wires, the chargers and the other paraphernalia of digital life are hardly unobtrusive. And although wireless broadband connectivity is widespread, it can still be patchy and unreliable. All this is a far cry from the kind of seamless interaction between humans and connected devices depicted in futuristic films beloved of ubicomp enthusiasts, such as Steven Spielberg's "Minority Report".

Ms Bell acknowledges that the infrastructure of computing is still "messy", but argues this should not be allowed to obscure the fact that it has become much more widely accessible. Bo Begole, a ubicomp expert at Xerox PARC, echoes that view. "We already have a critical mass of devices and wireless networks," he explains. "The next step is to make those devices aware of how humans work and to get them to adapt to their habits."

If there is one part of the world where personal technology is on its way towards becoming ubiquitous it is Asia, where several richer countries have created impressive infrastructures on which all sorts of personal technologies can work. South Korea, for instance, plans that every home in the country should have an internet connection with a speed of up to one gigabit per second (fast enough to download a full-length feature film in a matter of seconds). And it also intends greatly to increase the capacity of the country's wireless-broadband networks.

Singapore has set itself a goal of creating an ultra-fast broadband infrastructure and sees this as the foundation of a wealth of new digital services that will be delivered to its citizens. These include "telemedicine", which allows doctors to monitor people's health remotely using devices in patients' homes, and high-definition videoconferencing services so that Singaporeans can keep in touch with relatives, friends and colleagues. Canalys, a research firm, reckons that almost two-thirds of the phones sold in Singapore last year were smartphones. The same gadgets are also plentiful in Japan, where many of them contain near-field communication (NFC) chips, which in effect turn them into mobile wallets that can be used to pay for groceries, trips on public transport and more.

America, Britain and other countries are also experimenting with various mobile-payment technologies, including NFC-enabled phones. Fans of these envisage a future in which people's wallets and purses will get sucked into smartphones too. Google, for instance, has already endorsed NFC technology and Apple is likely to include some form of mobile-payment capability in future versions of its iPhone.

A new reality show

Other novel services are giving people far more data about the world around them. There is much excitement in tech circles about augmented-reality apps. The Golfscape GPS Rangefinder allows golfers to see a picture of the course in front of them and have it overlaid with useful data, such as the distance to various bunkers and the green. Other

apps, for example Layar and Google Goggles, combine visual images with data gleaned from web browsers and other software. This enables them to overlay the images with information from many different sources. Someone using Layar can point his phone's camera at a street in Paris and see information about, say, well-known restaurants in it and call up pictures showing what they looked like in the past.

The ability to capture video and audio easily on smartphones has also given a boost to fans of "lifelogging"—recording your life via electronic media—which was popularised by Gordon Bell and Jim Gemmell, two Microsoft executives, in "Your Life, Uploaded". For some time people have been immortalising their thoughts and deeds on Facebook and other social networks from PCs. More and more often, they are doing so on the move, from smartphones with apps such as Instagram. A photograph is taken, the time and place are noted automatically, and with a few taps the image can be uploaded. "More of people's lives will be captured in future," says Mr Bell, "simply because more bits and bytes are flowing out of these devices."

In their book Messrs Bell and Gemmell predict that people with chronic ailments will one day have sensors embedded directly in their bodies that can transmit data about their vital signs wirelessly to other devices such as their phones. This forecast, which would give a new spin to the slogan "Intel Inside", may seem far-fetched, yet some cardiac devices are already equipped with wireless connectivity that allows them to send data to doctors. And gadgets such as a bathroom scale made by Withings, a French company, can transmit a person's weight to a digital health-log on a computer or smartphone.

Rather than have sensors lodged inside their bodies, many people may prefer to have them woven into their clothing, or placed next to rather than under their skin. Some venture capitalists such as Mr Andreessen of Andreessen Horowitz believe that "wearable computing" will be the next big thing in personal technology, though the companies that have set their sights on this area face a difficult task. History is littered with examples, such as the Seiko Ruputer wristwatch computer, that sounded great in theory but turned out to be lemons in practice.

This has not dissuaded Nike, which has produced a range of wearable devices that allow people to track their fitness as they exercise. Nor has it put off Jawbone, which has won a reputation for itself by making Bluetooth-equipped headsets and smart, portable speakers. The company has created a slim bracelet, the UP band, that contains a wealth of sensors and a rechargeable battery all attached to a flexible steel frame enclosed in a special, rubber-like coating. Among other things, the band can record how much distance the wearer has covered in a day and how many calories he has burned, and can even monitor his sleep patterns. Data from the device can be uploaded to an app on a smartphone and then shared with the wearer's friends on various social networks.

Dressed in devices

Hosain Rahman, Jawbone's boss, foresees many more devices like the UP band creating what he calls "everywhere computing", with microprocessors and sensors embedded in all sorts of things, from shirts to jewellery, and linked by a "body-area network". Other companies such as Looxcie, which makes cheap, wearable video cameras, are also hoping to profit from a more transparent world.

These devices may remain minority tastes for a while, if they ever catch on at all. But smartphones, tablets and other mobile digital devices are likely to keep the consumer-electronics industry busy for some time to come. The ability of these gadgets to deliver the mobile internet to millions—and ultimately billions—of people is going to have a profound impact on the world. "We're really at a very nascent stage of this revolution," says Vijay Gurbaxani, a professor of information systems at the University of California, Irvine. Mr Gurbaxani is right, but some of its implications are already becoming clear.

Apple and Samsung's symbiotic relationship

▶SLICING AN APPLE

Aug 10th 2011, 15:04 by P.K.

How much of an iPhone is made by Samsung?

APPLE doesn't make the iPhone itself. It neither manufactures the components nor assembles them into a finished product. The components come from a variety of suppliers and the assembly is done by Foxconn, a Taiwanese firm, at its plant in Shenzhen, China. The "teardown" graphic below, based on data from iSuppli, a market-research firm, shows who makes what inside the iPhone, and how much the various bits cost. Samsung turns out to be a particularly important supplier. It provides some of the phone's most important components: the flash memory that holds the phone's apps, music and operating software; the working memory, or DRAM; and the applications processor that makes the whole thing work. Together these account for 26% of the component cost of an iPhone.

This puts Samsung in the somewhat unusual position of supplying a significant proportion of one of its main rival's products, since Samsung also makes smartphones and tablet computers of its own. Apple is one of Samsung's largest customers, and Samsung is one of Apple's biggest suppliers. This is actually part of Samsung's business model: acting as a supplier of components for others gives it the scale to produce its own products more cheaply. For its part, Apple is happy to let other firms handle component production and assembly, because that leaves it free to concentrate on its strengths: designing elegant, easy-to-use combinations of hardware, software and services.

Stranger still, Apple sued Samsung in April over the design of its Galaxy S handset (a smartphone that bears a strong resemblance to an iPhone) and its Galaxy Tab tablet computer (which looks rather like an iPad), claiming that they copied hardware and design features from Apple products. Samsung retaliated by counter-suing. In the latest twist, Apple has just gained injunctions to prevent the sale of Samsung's Galaxy Tab in Europe and Australia. But the two firms' mutually beneficial trading relationship continues.

The second part of the graphic shows that, beyond manufacturing and component charges, the lion's share of the iPhone's $560 price tag goes to Apple, though just how much it spends on software development, R&D, marketing, shipping, packaging and so forth is unclear. But Apple now commands the largest slice of the handset industry's profit share, so its margins are still impressive even when these costs have been taken in account. Apple also became the world's largest supplier of smartphones in the second quarter (see chart), with Samsung in second place. And on August 9th, the same day as its victory over Samsung in the European courts, Apple even briefly surpassed Exxon Mobil to become the world's largest company by market capitalisation. So although Apple does not actually make the iPhone, it certainly makes a lot of money from it.

Apple iPhone 4 teardown
16GB GSM version, cost breakdown, $

CONTRIBUTING COMPONENT MANUFACTURERS

Manufacturer/*Origin* *:

SAMSUNG /*S. Korea*

Infineon/*Taiwan*

Murata/*Japan & Taiwan*

Skyworks; TriQuint/*United States*

Micron/*United States*

ST Microelectronics/*Italy*

Dialog Semiconductor/*Taiwan*

Texas Instruments/*United States*

Cirrus Logic/*United States*

AKM Semiconductor/*Japan*

Unknown manufacturers

Others

Component/*Cost*:

Flash memory/*26.00*

DRAM memory/*11.60*

Applications processor/*8.08*

Baseband/*10.25*

Bluetooth & Wi-fi/*8.00*

Baseband/*6.20*

Flash memory/*2.50*

Accel. & gyroscope/*2.25*

Power management/*1.51*

Audio/*0.98*

Touchscreen control/*0.90*

E-compass/*0.70*

Display & touchscreen/*38.50*

Mechanicals & electro-mechanicals/*19.97*

Camera/*13.70*

Battery/*6.00*

Accessories/*5.67*

Other parts/15.19

0.0

Total components: *178.00*

TOTAL COSTS†
Average sale price: **$560.00‡**

APPLE'S SLICE: *368.00*

Manufacturing by Foxconn (Shenzhen, China): *7.00*

Foxconn's margin: *7.00*

GLOBAL SMARTPHONE UNIT MARKET SHARE
By company, second quarter, %

	0	*2010*				100
	13.0	5.6	37.3	17.4	6.8	19.9
	Apple	**Samsung**	**Nokia**	**RIM****	**HTC††**	**Other**
	19.1	*16.2*	*15.7*	*11.6*	*11.0*	*26.4*

2011