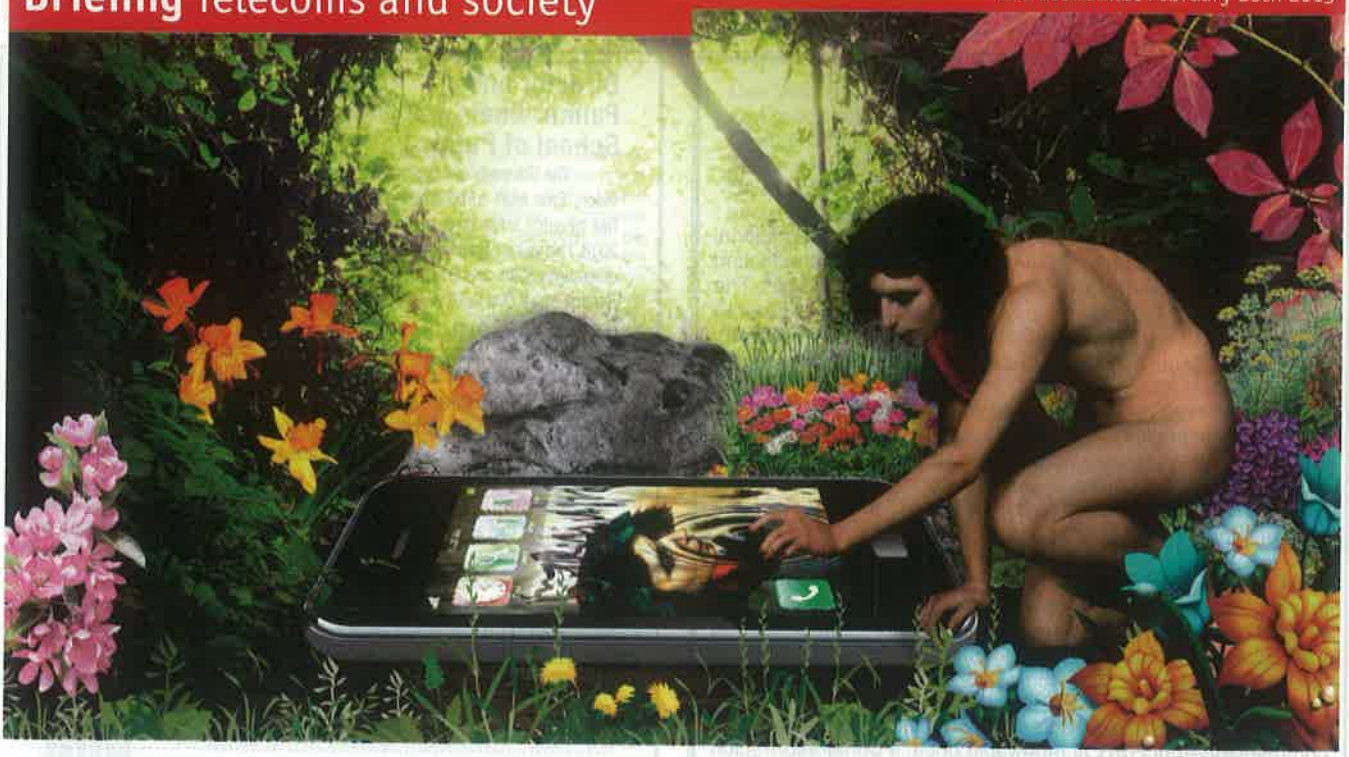


The truly personal computer

Also in this section

20 SIM cards and security fears

The smartphone is the defining technology of the age

THE Ood are an odd bunch. Among the more enigmatic of the aliens regularly encountered in "Doctor Who", a television series about a traveller in time and space, they are mostly silent—though sometimes given to song—and disconcertingly squid-like. What is more, evolution has equipped them with two brains—one in their heads, the other carried around in their hand.

Put an Ood onto public transport anywhere in the developed world, though, and—tentacles apart—he would barely raise a questioning eyebrow. The other passengers would be too busy paying attention to the parts of their brain that they now carry in their hands to notice anything particularly odd about an alien doing something very similar.

There are 2 billion people around the world using smartphones that have an internet connection and a touchscreen or something similar as an interface. By the end of the decade that number looks set to double to just over 4 billion, according to Benedict Evans of Andreessen Horowitz, a venture-capital firm. Already hugely attractive—an estimated 500m will be sold in China this year—smartphones are getting both more useful at the top end and much cheaper at the bottom. The most popular brand in India, Micromax, sells basic models for under $40. Once phones are established in a market the expectation that everyone will have one—what Rich Ling of the Nanyang Technological University in Singapore calls the "mobile logic"—forces them even into initially reluctant hands, making them end up ubiquitous.

The success is not a story of phones alone. From 2009 to 2013 the mobile industry invested $1.8 trillion on improving its infrastructure around the world, according to the Boston Consulting Group. Download speeds have increased by a factor of 12,000 and data rates have dropped to a few cents per megabyte (see chart 2 on next page). Along with Wi-Fi in homes and offices this has made it feasible to add to the phones' own computing power that of data-centres far away. Amazon Web Services, the world's biggest provider of such cloud computing, says it is now adding as much server capacity every day as its e-commerce parent required to run its entire global infrastructure ten years ago.

Let it ring a little longer

By 2020, something like 80% of adults will own a smartphone connected to this remarkable global resource. If they are anything like today's Europeans and Americans, who are leading in these matters, they will use them for about two hours a day; if they are like today's European and American teenagers they will use them more than that. The idea that the natural place to find a computer is on a desk—let alone, before that, in a basement—will be long forgotten.

Like the book, the clock and the internal combustion engine before it, the smartphone is changing the way people relate to each other and the world around them. By making the online world more relevant, and more applicable, to every task from getting from A to B to finding a date to watching over a child to checking the thermostat it is adding all sorts of convenience. Beyond convenience, though, a computer ▸▸

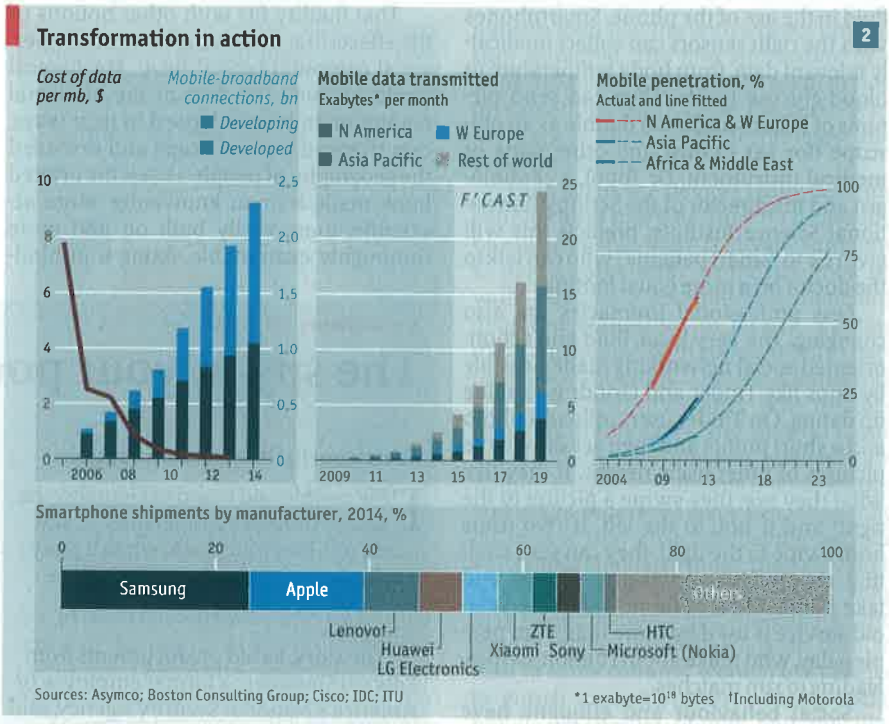
that is always with you removes many previous constraints on what can be done when and where, and undermines old certainties about what was what and who was who. Distinctions that were previously clear—the differences between a product and a service, between a car owner and a taxi driver, between a city square and a political movement—blur into each other. The world is becoming more fluid.

These changes and the tools driving them have refocused the computer industry. Thanks mostly to the iPhone, Apple—not so long ago a maker of niche desktops and laptops—is now worth more than any other company in the world and just had the most profitable quarter in history. Mr Evans reckons that its revenues are now greater than those of the whole personal computer (PC) business. Xiaomi, a fast-growing Chinese maker of smartphones, has become the world's most valuable startup (see page 56). The smartphone has become information technology's key product. It generates the most profits; it attracts the most capital and the brightest brains.

Apple's App Store and Google Play, the equivalent for the Android operating system—which runs on 82% of the world's smartphones, as opposed to Apple's 15%—now offer users more than 3m apps. Apple alone sold apps worth more than $14 billion in 2014. Phones which start off identical—much more so, say, than cars—can thus be customised to meet an almost infinite range of needs and enthusiasms. Cry Translator purports to interpret your baby's mood; RunPee tells you when best to take a toilet break in any film (and fills you in on what you missed).

The fact that they can see and hear, that they know where they are and how fast they are being moved and can sense or infer all sorts of other goings-on increases the advantages that smartphones enjoy over boxes which sit on desks. When's the next bus; what's that not-quite-recognised tune; how much would that conveniently barcoded product cost somewhere else; is that really horse on the menu: the combination of local data and cloud computing answers questions in any circumstance a user might find himself.

As well as letting people do ever more on their phones, apps let them do ever more things off their phones, too. If something can be connected to the internet—be it a door or a fridge or a thermostat—it can be accessed by an app. The phone is thus central to the success of the "internet of things". Wearable technology products—fitness trackers, smart watches, clip-on cameras and the like—will mostly work through the wearer's phone in a similar way. In part this is because giving wearables short-range wireless links to a phone, rather than their own connection to the internet, means that they can be built with smaller batteries and simpler circuits. In part it is because the phone is already a great way of reading, caching and acting on all sorts of data. The phone can be turned into a remote control for almost anything; you can even add a dog-whistle app to send commands to your pet.



Please check the number

The most famous app-based company, Uber, is valued at $41 billion because of the success it has had in turning the smartphone into a remote control for taxis. The smartphone gives the company's two categories of user—drivers and passengers—the control that they need. And it gives the company's algorithms the data they need, from car positions to customer feedback.

Similar service providers are using smartphones to rejigger local logistics. Over the years many firms have tried to turn the delivery of groceries and other goods into a big business. The latest generation is much more likely to succeed thanks to the smartphones of freelance personal shoppers ready to jump into action should something need to be picked up. Instacart, one of the biggest such services, has contracts with more than 4,000 of them in 15 American cities. It has grown from $1m in revenues in 2012 to $100m last year. Such business models are not without critics; the way that "*Plattform-Kapitalismus*" integrates people's lives and livelihoods ever more thoroughly into a network of market transactions is an increasing concern on the European left.

The new businesses that smartphones and apps allow are not merely extending the internet; they are also reshaping it in a way that some of its current denizens may find hard to live with. One reason Google got itself into the smartphone world with the acquisition and development of Android was to adapt its business to a world of smartphones dominated by another company. When people access the internet with apps on a phone, rather than with a browser on a PC, they experience it differently. The internet looks a lot less like a set of connected pages, and that makes a business that depends on helping people find the page they want—and seeing ads in the process—look less compelling. Smartphone users mostly buy things through apps, not through searches or ads.

If moving to phoneworld has been a challenge for companies born on the web—though Facebook offers an example of doing it successfully—it can be harder still for companies which had only just caught up with the web in the first place. Media companies used to rely on their users going to their websites (though getting them to pay to do so has always been tricky). But people are now finding stuff they want to read or watch through Facebook, Twitter and, increasingly, messaging services. Snapchat, hugely popular among teenagers because it allows them to send pictures that fade away after a few seconds, recently introduced a service called "Discover". It offers articles and videos from CNN, *National Geographic* and others, which disappear after 24 hours. Some publications have already concluded that websites have had their day and are now planning to distribute their wares only directly.

Other disruptions are more personal. As Eric Topol argues in his recent book "The Patient Will See You Now" the relationship between a doctor and a patient is another of the things that becomes more

fluid in the age of the phone. Smartphones with the right sensors can collect medically relevant data, from body temperature to blood-glucose levels. They can send pictures of lesions and even double as an otoscope (for ear exams) and other sorts of medical instrument. Dr Topol, a cardiologist and the director of the Scripps Translational Science Institute, predicts this will give rise to "smart patients" who can talk to the doctor on a more equal footing.

Less professional intimacies are also changing. The very local, fluid and action-oriented social networking made possible by apps like Tinder and Grindr is shaking up dating. On Tinder users upload a photo and a short profile and then get shown the pictures of other users nearby. If they like what they see, they swipe a picture to the right—and if not, to the left. If two users both swipe to the right, they can start chatting on Tinder's messaging service and take it from there. The not-yet-three-year-old service is used by more than 30m people a day, who make about 1 billion swipes, leading to 13m matches.

Social behaviour and etiquette have adapted to new technology in the past; they will do so again. At the unconscious level of habit smartphones are already oddly integrated into people's lives. Particular spatial cues—getting into a lift or onto a train, for example—can reliably trigger a check of the screen. A similar effect in toilets is said to be the reason Samsung started making more models waterproof.

A strange sensation

Protecting users may not always be as easy as protecting their phones. Physiotherapists warn of "text neck"; unlike the Ood, humans evolved to keep all their brains balanced on top of their spines, and constantly hunching forward leads to stress and strain. Some psychologists warn of the danger of slipping past habit to addiction. They are warning not just of gambling apps, but of the more general way in which checking a phone, like gambling, is a search for an elusive reward in which every disappointment reinforces the desire to try again. David Greenfield, a psychologist and founder of the Centre for Internet and Technology Addiction, calls them "the world's smallest slot machines".

Teenagers, whose time on phones dwarfs that of their elders (see chart 3 on next page), are developing a social life in which face-to-face and digital forms of contact are used interchangeably and often simultaneously. Manuel Castells of the University of Southern California talks of their phone-based lives playing out in a "timeless time" in which activities and exchanges happen in parallel or even backwards (when people's lives come with timelines, it is a common experience to find out what they said first only after you know what they said next).

That fluidity fits with other notions of the effects that the smartphone's truly personal computing could have. Mechanical clocks allowed the days of the industrial revolution to be regularised in new ways; cars changed the landscape and extended the geography of people's lives; the printed book made human knowledge more accessible, more easily built on and more thoroughly examinable, fixing it in bindings onto shelves. In its present, admittedly early, days the phone seems to permit earlier regimentation to relax. It encourages renting over buying, trying out over tying yourself down, co-ordinating things on the fly rather than in advance.

Recent political protests have taken advantage of the new fluidity. Smartphones have not caused uprisings or revolutions, but they have affected their dynamics: mo-

Smartphone security

The spy in your pocket

Watch out for hackers—and spooks

FEW people had heard of Gemalto, the world's largest manufacturer of SIM cards, until February 19th, when a story on the *Intercept*, a website, put it at the centre of the latest internet-security scandal.

The story, based on documents from Edward Snowden, a former employee of America's National Security Agency, said that spies at GCHQ, Britain's equivalent to the NSA, had stolen hundreds of thousands of the encryption keys hard-coded into Gemalto's SIM cards, which are specialised chips that identify phones to phone networks. Armed with the keys, decrypting conversations and data from the phones in which they were installed would be trivial.

In an announcement made on February 25th Gemalto said that spies probably had tried to penetrate its systems but that there had been no "massive theft of SIM encryption keys". Security experts were sceptical, for a number of reasons: less than a week seems rather quick for such an investigation; government hackers are pretty good at this sort of stuff; and the GCHQ documents provided by Mr Snowden explicitly talk of a "vast quantity of product".

Regardless of its scope, the Gemalto incident is a reminder that security has mostly been an afterthought in a booming industry that has always seen market share as the priority. (The PC industry was just the same in its early days.) The NSA and its counterparts have entire departments thinking up creative ways to break into phones. Fake base stations, which trick nearby phones into connecting to them, are a popular tool with the FBI and other law-enforcement agencies.

Criminals are getting in on the act, too. Despite attempts by Google and Apple to check the bona fides of the apps their stores sell, mobile malware is a growing industry. Last summer security researchers warned about "Simplelocker", a piece of "ransomware" for Google's Android operating system that encrypts users' data and then demands payment to unscramble it—a tactic copied from malware targeted at PCs. Many legitimate apps transmit their data without encrypting it first, allowing anyone so inclined to pluck it from the air and read it.

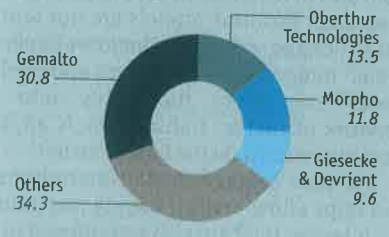
Consumers have learned the hard way that their PCs are vulnerable, but that realisation has not yet sunk in for their phones. Smartphones use a single cable to charge their batteries and to transfer data. That means that plugging in to unfamiliar charging points can be a security risk. In 2011 pranksters used a gimmicked charger to gain access to 350 people's phones at a conference—which was particularly embarrassing for the victims, as the event they were at was DefCon, the premier meeting for hackers and security professionals.

More esoteric attacks are possible, too: a recent paper showed that the motion sensing gyroscopes in phones can be used to record speech even when the phone's microphone is switched off.

Some consumers are aware of the risks. Last summer a firm called Blackphone began shipping an Android handset specifically designed to be as secure as possible. Its initial production run sold out within days. But the Gemalto story, and the fact that security was not built into the system of smartphones from day one, suggest that there is still a lot for the industry and its users to learn.

Tempting targets

SIM card market share
% of total shipments, Jan-Jun 2014



Source: ABI Research

bilising has become much cheaper, centralised organisation less necessary. During recent protests in Ferguson, a suburb of St Louis, Missouri, and Hong Kong, messaging apps were used to co-ordinate activities on the ground in real-time.

A fixed sense of place has still mattered a lot to these movements—witness Kiev's Maidan, Cairo's Tahrir Square, New York's Zuccotti Park, Hong Kong's Civic Square. Protest-movement metonymy of this sort reflects the way that physical space is becoming "a function of the virtual world", in the words of Thomas Sevcik of Arthesia, which provides advice to city governments. The refiguring of public spaces as political platforms reflects the way that the purpose of physical places, be they roads or rooms or buildings, now depends less on where they are and what they were designed for, and more on what is being done with the screens that they contain or that people have brought into them.

Such changes will prove fascinating to social scientists, for some of whom the smartphone has become both telescope and microscope, allowing them to see social phenomena both more precisely and on a grander scale than ever before. Optimists, such as Alex Pentland of MIT's Media Lab, argue that the vast amounts of data phones can provide could underpin a new, predictive "social physics". This new science might be capable of modelling, and thus helping to alleviate, many of the world's problems, from epidemics to violence (and, indeed, epidemics of violence).

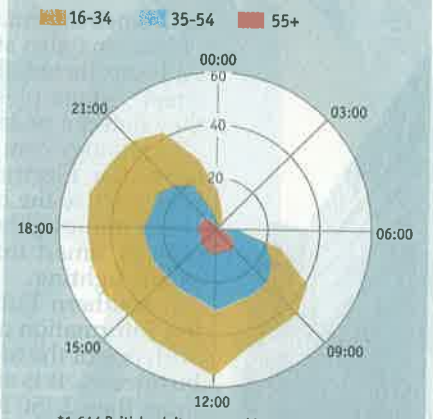
Wild time has just begun

For pessimists, however, smartphones are miniature versions of the "telescreens" in George Orwell's "1984", omnipresent tools which allow the thought police to identify enemies of the state. The security services in democracies have shown a keen interest in the ability to get into as many smartphones as possible (see box on previous page). Those in autocracies are doubtless doing the same. Around the world people are rushing to buy machines through which they can be monitored at previously impossible levels of intimacy—monitored by the state, by companies entrusted with their data, by hackers who steal their information, and by peers who just see what has been posted.

Phone-based social media, messaging services and other apps already make people's lives more public. Hacks into the cloud have been exposing parts of people's phone-based lives they would rather have kept private. Democracies may be able to find acceptable solutions to some of the problems posed. Mr Pentland calls for a "new deal on data", which would include giving individuals clear rights on their personal data and allow them to better control how the information is used. In "The Black Box Society" Frank Pasquale of the University of Maryland argues for more transparency in the use of data both by governments and companies—and limits on the uses to which they are put.

Never gonna put you down 3

Use of smartphones by age group
% reporting use by hour of the day, over a week*



*1,644 British adults surveyed between Feb-Apr 2014
Source: Ofcom

There are technical fixes to some problems. California now insists that smartphones have "kill switches" that allow their owners to lock their devices from afar if they get stolen, thus reducing their value to thieves and protecting the data they could be used to access. The latest versions of both Apple's iOS and Google's Android automatically encrypt user data on smartphones in such a way that only the user can decrypt them.

Perhaps the most fundamental question about the fluid world of the smartphone is whether its currents will, in general, bring people together or move them apart. The Ood-ignoring, text-neck-risking screen-focused commuters on trains and buses seem even more isolated from each other than they used to be. In 2013 security footage on a San Francisco Muni train showed a number of passengers failing to notice a man playing with a pistol until he shot someone. The title and tagline of a book by Sherry Turkle of MIT seem to sum up something real: "Alone Together—Why We Expect More From Technology and Less From Each Other".

Then again, the devices really do bring people closer together. They do it casually, by ensuring that there is always someone to play a game with, or indeed hook up with. They do it commercially, matching people needing jobs to people wanting them and people with goods to sell to people who want to buy. They do it impersonally, with celebrity selfies sent to huge numbers of followers, and they do it intimately, with near-constant conversation within families and lifelong links to friends you might otherwise have lost. They may do it in a way that lets people exclude voices that challenge them; they may do it in ways that are unutterably banal. They may do it differently according to age and gender—some research suggests that, at least in some cultures, women use phones to enrich and strengthen existing social bonds by sharing photos and the like, while men use them to create new, weaker bonds based on shared interest. But they do it nonetheless.

The new computing's tendency to the fluid will, in all likelihood, mean that the current form of the phone will not last forever. The truly personal computing phones make possible, though—the sort which adapts you to your surroundings and vice versa—seems sure to persist. People will live in perpetual contact both with each other and with the computational power of the cloud.

The Ood, it is worth remembering, did not just have two brains, one in the head and one in the hand—they had a third, planetary brain, telepathically shared by all. It may yet be to such a world that, with phones in hand, pocket and purse, humanity makes its way. ■