

Where the cloud meets the ground

Data centres are quickly evolving into service factories. Page 6

Creating the cumulus

Software will be transformed into a combination of services. Page 8

On the periphery

The cloud's communications with its clients will become ever more intelligent and interactive. Page 11

Highs and lows

As IT gets cloudier, the economics of the business will change. Page 13

The long nimbus

The cloud will make businesses more adaptable, interconnected and specialised—and often smaller. Page 15

Computers without borders

The cloud may be the ultimate form of globalisation. Page 17



Information technology is turning into a global "cloud" accessible from anywhere, says Ludwig Siegele. What does that mean for the way people conduct business?

IN THE beginning computers were human. Then they took the shape of metal boxes, filling entire rooms before becoming ever smaller and more widespread. Now they are evaporating altogether and becoming accessible from anywhere.

That is about as brief a history of computers as anyone can make it. The point is that they are much more than devices in a box or in a data centre. Computing has constantly changed shape and location—mainly as a result of new technology, but often also because of shifts in demand.

The first "computers" were indeed people. The word originally meant an individual who solved equations, often using a mechanical calculator. Hundreds of them were employed by big companies that needed to do a lot of number-crunching, such as aeroplane manufacturers. It was only around 1945 that the word came to describe machinery.

But even after that, computing kept undergoing mutations—or, in the jargon, platform shifts. The mainframe, the original computing platform, was dethroned by minicomputers, which in turn gave way to personal computers, which are now being pushed aside by hand-held devices and smartphones. With each step the architecture—the underlying structure of comput-

ing—became more distributed.

Now, this special report will argue, computing is taking on yet another new shape. It is becoming more centralised again as some of the activity moves into data centres. But more importantly, it is turning into what has come to be called a "cloud", or collections of clouds. Computing power will become more and more disembodied and will be consumed where and when it is needed.

The rise of the cloud is more than just another platform shift that gets geeks excited. It will undoubtedly transform the information technology (IT) industry, but it will also profoundly change the way people work and companies operate. It will allow digital technology to penetrate every nook and cranny of the economy and of society, creating some tricky political problems along the way.

Promise of heaven

Here we go again, you may think. In order to generate new demand, the maturing IT industry keeps creating new buzzwords, often with celestial connotations ("cyberspace", "blogosphere"), which suggest some kind of technological nirvana. The reality is much more down to earth.

Hype is indeed rampant in "cloud com-

Acknowledgments

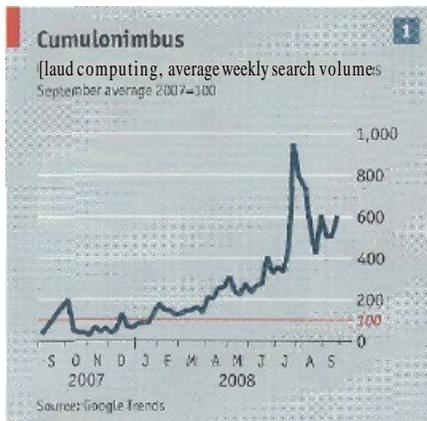
The author would like to thank many people besides those cited in the text for their time, ideas and kindness during the preparation of this report. They include Marc Andreessen of Ning, Brian Behlendorf of CollabNet, Chris Capossella and Tim O'Brien of Microsoft, Simon Crosby of Citrix, Rob Enderle of Enderle Group, Robert Hodges of Continuent, Dirk Holzwarth of Alstom, Greg Papadopoulos of Sun Microsystems, Dennis Quan of IBM, Simeon Simeonov of Polaris Venture Partners, Rahul Sood of SAP and Kishore Swaminathan of Accenture.

A list of sources is at

www.economist.com/specialreports

An audio interview with the author is at

www.economist.com/audiovideo



>puting". The term entered into iT-speak only a year ago and has spread voraciously. Cloud conferences and cloud blogs are multiplying almost as quickly as cloud start-ups. Established IT firms are slapping the new label on old gear.

In fact, the cloud craze may have peaked already, if the number of Google searches is any guide (see chart i). Cloud computing is bound to go through a "trough of disillusionment", as Gartner, a research firm, calls the phase in the hype cycle when technologies fail to meet expectations and quickly cease to be fashionable. Much still needs to be invented for the computing sky to become truly cloudy.

Yet even if the term is already passe, the cloud itself is here to stay and to grow. It follows naturally from the combination of ever cheaper and more powerful processors with ever faster and more ubiquitous networks. As a result, data centres are becoming factories for computing services on an industrial scale; software is increasingly being delivered as an online service; and wireless networks connect more and more devices to such offerings.

All this allows computing to be disaggregated into components-or "services", in IT parlance. This is why European technologists such as Lutz Heuser, head of research at SAP, a German software giant, like to refer to it as the "internet of services". The cloud metaphor seems more apt. The internet is used mainly by people with personal computers and a physical network connection. Cloud applications, on the other hand, will be used by billions of devices of all kinds, many of them untethered, but will be connected to the "internet of things".

In some ways the cloud is already hanging in the sky, especially for consumers. According to a recent study, 69% of Americans connected to the web use some kind

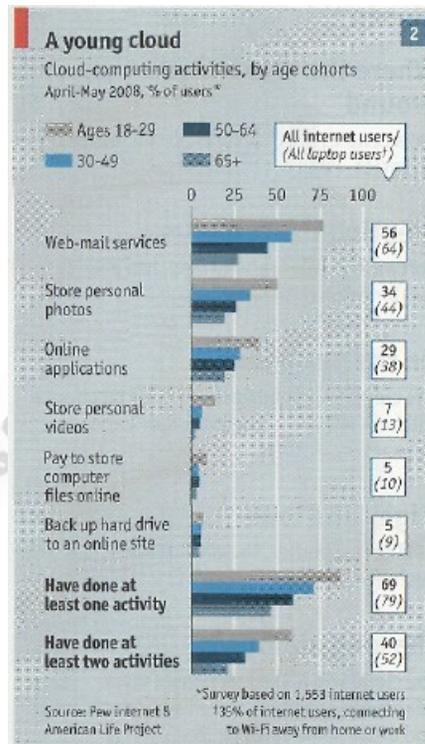
of "cloud service", including web-based e-mail or online data storage (see chart 2). The best example is Google, the biggest online search company by far, which now offers a plethora of web-based applications such as word-processing or online spreadsheets.

Learning to float

Companies, too, have been moving into the cloud, albeit much more cautiously. Financial institutions in particular have for some time been building "computing grids". Firms that provide enterprise software as a service (saas) over the internet, such as Salesforce.com and NetSuite, have been growing steadily.

In the years to come companies are likely to venture much farther. For one, operators of computing clouds such as Amazon and Google have shown that this is a far more efficient way of running IT systems. Secondly, many firms will find they have no choice. The way in which their IT infrastructure has grown is proving unsustainable. Most corporate data centres today are complex warrens of underused hardware that require more and more people, space and power to keep them going. The current economic malaise will increase the pressure on companies to become more efficient. More has to be done with less, which is cloud computing's main promise.

This special report will chronicle the rise of the cloud and try to predict where it is heading. It will start by looking at the technology. Computing clouds are immensely complex, but can be roughly divided into three layers: infrastructure, applications and the periphery where they meet the real world. These will be discussed in turn. The report will go on to consider the impact the cloud will have on the IT industry and the economy as a whole. The conclusion will look at what might stop the cloud from growing ever thicker: regu-



lation and worries about the safety of both personal and corporate data.

Irving Wladawsky-Berger, a technology visionary at IBM, compares cloud computing to the Cambrian explosion some 500m years ago when the rate of evolution speeded up, in part because the cell had been perfected and standardised, allowing evolution to build more complex organisms. Similarly, argues Mr Wladawsky-Berger, the IT industry spent much of its first few decades developing the basic components of computing. Now that these are essentially standardised, bigger and more diverse systems can emerge. "For computing to reach a higher level", he says, "its cells had to be commoditised." ■

