



# The World Economic Forum's Technology Pioneers 2006



**Pathways  
to success:  
a taxonomy  
of innovation**

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## Preface

The World Economic Forum recognises that part of the answer to many of the challenges facing the world today lies in the development of novel and innovative technologies. Technology Pioneers are companies that develop and apply cutting-edge transformational technologies in the fields of information technology, renewable energy, biotechnology and health.

The Forum launched the Technology Pioneers programme in 2000 with the aim of identifying 30 to 50 companies with outstanding and innovative technologies every year. Since the launch of the programme, the number of companies nominated for this prestigious award has increased significantly. Thirty-six companies were selected as Technology Pioneers this year. We warmly congratulate them on their outstanding achievements.

We wish to express our thanks and appreciation to the members of the Selection Advisory Committee whose expertise and enthusiasm were critical in selecting the new class of Technology Pioneers. The Forum would also like to express its thanks and gratitude to Apax Partners for the content and publication of this report and for its strong ongoing commitment to the Technology Pioneers programme.

The World Economic Forum



## Pathways to success

**There is no right way to innovate — just many different, equally valid, approaches**

Innovation, for all the attempts to explain and understand it, remains as much an art as a science. Like any creative process, there is no right way to do it. Just as there can be many routes to the summit of a mountain, there are also many different, but equally valid, pathways to successful innovation. And just as the many routes up a mountain can be charted on a map, so too can the various kinds of innovation.

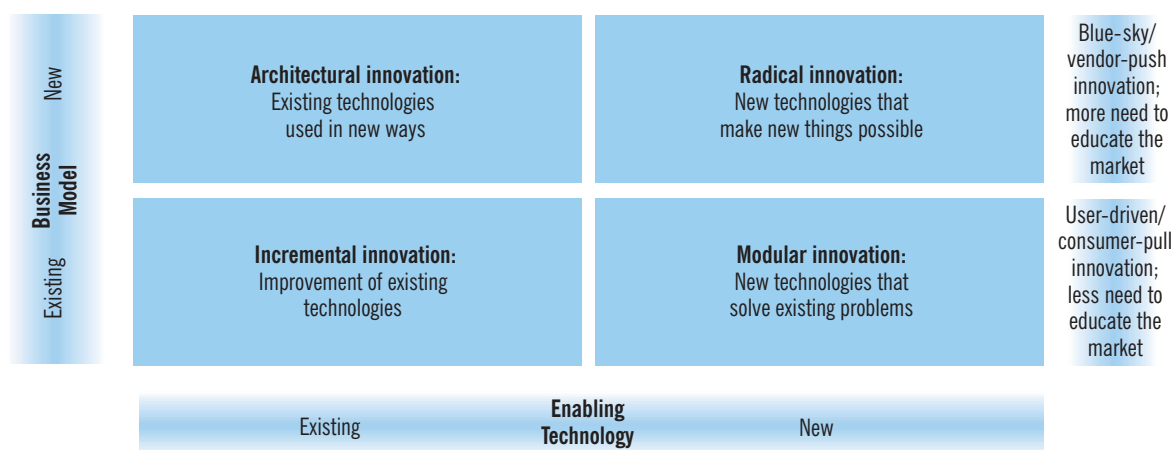
Perhaps the most common form of innovation involves the gradual improvement of existing technologies. Consider microchips, for example. It is only because of many separate, incremental improvements to design and manufacturing processes that chips have continued to improve in performance and fall in price over the past few decades. Most people have never heard of these individual innovations (such as silicon-on-insulator, or copper interconnect), but collectively they have made computing power cheap and small enough to incorporate into all kinds of devices. Such “incremental” innovation may be regarded as less exciting than other kinds, but it is just as important.

Another form of innovation involves finding a new way to solve an existing problem. The recent development of high-brightness light-emitting diodes (LEDs), for example, has made possible low-power illumination. The new technology meets an existing need, but in a new and more efficient way. Domestic lighting based on white LEDs is ideal for use in parts of the developing world where no mains power is available. The low power consumption of LEDs means they can be powered at night by a battery pack that is recharged by solar power during the day. Using solar

energy to power conventional high-power, high-voltage light bulbs, in contrast, would be impractical. This approach, in which a new technology replaces a previous, inferior way of meeting an existing need or market, can be termed “modular” innovation, since the new technology simply slots in, replacing an older one.

Yet another style of innovation involves the use of an existing discovery or technology to do something new. Hard disks were invented in the 1950s, and their storage capacity has improved steadily ever since, through a series of incremental improvements. As a result, it has recently become possible to use this familiar technology to do entirely new things: the hard disk built into a TiVo personal video-recorder, for example, is what makes it possible to pause and rewind live television. And music players based on hard disks enable people to carry their entire music collections with them wherever they go. In such “architectural” innovations, the underlying technology is an existing one, but the uses to which it is put are new.

Then there are the most daring innovations of all, in which new technologies are used to solve problems and do things that are fundamentally different to the capabilities of previous technologies: using stem cells, a promising new therapeutic approach, to treat previously incurable diseases, for example. Radical innovations often have a whiff of science-fiction about them, since they postulate not just a new technology, but entirely new markets or applications for it. Using sponges made of carbon nanotubes to build stronger, lighter tennis rackets, a modular innovation, is easy enough to imagine; using carbon nanotubes to build a “space elevator” capable of lifting things into orbit, in contrast, is rather more difficult to envisage, since nei-



ther the technology nor the application is familiar. Such innovations can be termed “radical” innovations.

The boundaries between these four categories can be blurry but all innovations can be placed in one of them. To determine which category a particular innovation belongs in, ask yourself the following: does the innovation depend on an existing or a new technology? And is that technology being applied in an existing or a new market or application? The four possible answers to these two questions determine which of the four categories the innovation falls into. They can be represented as a two-by-two grid (see diagram). And as this year's selection of Technology Pioneers demonstrates, innovations in each of the four categories have the potential to change the world.



## Building a better mousetrap

Build a better mousetrap, goes the old saying, and the world will beat a path to your door. Why? Because people already know what a mousetrap is, and why they need one; so the appeal of a better one is straightforward. Hence the appeal of incremental innovations, which do not do anything new, but involve improvements to existing products or ways of doing things. The notion of continuous improvement is most

familiar in the field of information technology, which is driven by Moore's Law, the self-fulfilling rule of thumb which states that the amount of computing power available at a given price doubles every 18 months or so. Other, similar laws apply to improvements in storage density and network capacity. Most people simply take it for granted that computers will continue to become faster, cheaper and more capable. But such progress requires a steady stream of innovations.

Matrix Semiconductor, for example, based in Santa Clara, California, is one of the pioneers of “three-dimensional” computer chips, in which multiple layers of components and circuitry are stacked vertically. Just as high-rise buildings can pack more homes or offices into a city lot, this makes possible memory chips that combine high storage density with low cost. Matrix® 3DM chips are ideal for storing pre-programmed content, such as music, games and video, in small cartridges that can be slotted into portable devices. In October 2005, the company was acquired by SanDisk, the leading supplier of flash-memory products.

BitBand, a company based in Netanya, Israel, has developed technology that improves the smoothness and efficiency of the delivery of video content across Internet protocol (IP) networks. Delivering video across the Internet has been possible for years, but as tele-



coms operators around the world start to diversify into television services delivered over broadband internet links, doing so reliably has assumed sudden importance. BitBand's technology has already been deployed by operators in Italy, Sweden, Ireland and India.

Constant improvement is also vital in information security, a field in which an arms race is underway between those trying to attack and defend data stored on computer networks. Fortinet, based in Sunnyvale, California, has developed security systems based on hardware, rather than software. Using an appliance built around dedicated chips that scan for viruses, worms and attempted intrusions is far faster than using software. It ensures that legitimate traffic can still flow, and users do not suffer from a loss of network performance.

Incremental improvements need not be limited to underlying technology, of course. Telmap, based in Herzliya, Israel, is one of several companies working in the field of mobile mapping and navigation. What sets its technology apart, however, is the sleek design and ease of use of its user interface. For no matter how advanced the underlying technology, a navigation system is no use if users find it complicated or confusing to use.

Nor are incremental improvements limited to the field of information technology. Energy Innovations, based in Pasadena, California, has devised a clever but powerful improvement to the design of solar concentrators. These are arrays of mirrors that concentrate sunlight on to a photovoltaic cell in order to generate electricity; rather than boosting output by increasing the number of cells, they boost output by, in effect, increasing the amount of sunlight falling on to a single cell. To do this, however, each of the mirrors in the array must be moved so that it tracks the sun. Solar concentrators are only economic if the increase in power output more than offsets the increased cost and complexity of the tracking system. Energy Innovations' Sunflower 250 concentrator uses an array of mirrors that are cleverly interconnected to a single undercarriage so that all of them can be steered using just two motors. This could make solar concentrators far more affordable and attractive.



## Many ways to skin a cat

Build a better mousetrap using an entirely new technology—a laser beam rather than a mechanical spring, perhaps—and you still don't need to explain its purpose. Instead it is enough to demonstrate that the new technology is superior in some way. This opens the door to modular innovations, in which a new technology substitutes for an old one in an existing market or application. Examples abound in the field of energy, where innovators are searching for new, more compact and less polluting ways to meet existing energy needs. In particular, many firms are pursuing the development of fuel cells, electrochemical devices that combine a fuel (usually hydrogen, methanol or methane) with an oxidant to produce electricity far more efficiently than internal-combustion engines do. Fuel cells could be used in place of existing engines and generators to power cars, houses and factories, while producing far less pollution; they could also replace batteries in portable electronic devices, where they offer the promise of longer running times.

Intelligent Energy, based in London, England, is one of several firms developing fuel cells for a range of commercial applications. But it is best known for the development of the "emissions-neutral vehicle", or ENV, the first fuel-cell-powered motorcycle. It can run for up to four hours on a full tank of hydrogen and has a top speed of 50mph. Its purpose is to demonstrate that fuel-cell vehicles can be built today, and can be stylish and fun. The ENV was designed from scratch around Intelligent Energy's fuel-cell design, known as Core; it is not simply an existing motorcycle into which a fuel-cell has been retrofitted. It is a reminder to existing vehicle manufacturers that if they do not embrace fuel-cell technology, they could be challenged by upstarts that do.

CMR Fuel Cells of Cambridge, England, takes its name from its new "compact mixed reactant" design for fuel cells. It simplifies the design of the fuel cell to eliminate flow-field plates, which are normally used to guide the flow of fuel and oxidant to the appropri-





ate parts of the fuel cell. In CMR's design, the fuel and oxidant are simply mixed together and passed through the cell, which is porous. This could reduce the cost of a stack of fuel cells by 80% and its size by 90%, according to the company, so leaving more room for fuel and increasing the running time available from a power pack of a given size. Accordingly, CMR plans to focus on making fuel cells to power portable electronic devices.

While fuel cells provide a new way to generate electricity, Innovalight, based in Santa Clara, California, is working on a more efficient way to turn electricity into light, using silicon nanocrystals or "quantum dots". When connected to an electrical supply, these tiny structures emit light, the colour of which depends on their size and structure. Compared with conventional lightbulbs, and even with light-emitting diodes, they are far more energy efficient, and can be easily "tuned" to produce light of a particular colour without requiring changes to the manufacturing process. (Different coloured LEDs, in contrast, must be made from different materials.) Proponents of quantum dots believe that they will eventually replace today's light bulbs, as well as making possible entirely new forms of illumination, such as light-emitting wallpaper.

Innovations in biotechnology can also be modular in nature, as new, high-tech approaches are used to meet existing needs in novel ways. Amyris Biotechnologies, for example, based in Emeryville, California, is applying new techniques from the field of synthetic biology to address an age-old problem that persists across the developing world: malaria. One of the most effective treatments for malaria, long used in Chinese medicine, is a herb called Artemisia, the active ingredient of which is an isoprenoid compound called artemisinin. But the herb is in short supply and the price has recently soared. Amyris' approach is to take plant genes and insert them into *E. coli*, thus converting the bacterium into a factory that can produce any given isoprenoid in large quantities. While its initial focus is on anti-malarials, the company plans to move on to other isoprenoids which are effective treatments for cancer and viral infections, but must currently be

laboriously extracted from natural sources.

Similarly, NitroMed, based in Lexington, Massachusetts, has added a novel twist to the treatment of cardiovascular disease. It has devised a way to attach nitric-oxide molecules to existing drugs, so that they are released when the drug is metabolised. Nitric oxide is known to play a role in many cellular functions, and has an anti-inflammatory effect, among other things. But in some circumstances it can also be toxic. By piggybacking on other drugs, it can be precisely targeted at a particular site of action. BiDil, a treatment for heart disease developed by NitroMed, has proved to be particularly effective among African-American men, and made medical history in June 2005 when it became the first drug to be approved by America's Food and Drug Administration for a specific racial group. It is a step towards a future in which medical treatments will be precisely matched to particular patients, overturning today's "one size fits all" approach.



## Teaching an old dog new tricks

Where modular innovations meet old needs in new ways, architectural innovations do the opposite: they repackage existing technologies to meet new needs or address new markets. This means that, unlike incremental and modular innovations, they may address needs that people do not yet realise they have, and must often convince a sceptical marketplace that they are worthwhile. A good example is the TiVo personal video-recorder, which records television on to a hard disk. This enables the pausing and rewinding of live TV, but even more importantly, makes it possible to record dozens of favourite programs and call them up when needed. At first, the technology was a hard sell, since its benefits are not obvious and are difficult to explain without a demonstration. But once the TiVo began to change the way people watch television—it abolishes schedules, in effect—the benefits of the device began to spread by word of mouth, and it went



on to become an iconic, category-defining and industry-changing product. To be successful, architectural innovations must demonstrate that they are more than just a gratuitous recombination of existing ideas, but are instead applying familiar technologies in new and useful ways.

An inspiring example comes from Ossur, a firm based in Reykjavik, Iceland. It has combined computer technology with materials from the aerospace industry and smart-fluid technology from the car industry to produce a range of advanced prosthetics. These “bionic” systems can adapt themselves both to the user’s gait and the circumstances, from walking on flat terrain to navigating stairs and ramps or crossing uneven ground. Sensors inside the prosthetic Rheo Knee™, for example, detect the knee position and applied load, and a small computer then varies the stiffness of the knee joint when needed by applying a magnetic field to a magnetorheologic fluid, which increases the fluid’s viscosity. The Power Knee™ goes further: rather than merely assuring that the prosthetic lower leg is in the correct position and providing an appropriate degree of resistance, it can also do the work of missing knee muscles, to assist the user in walking up stairs, for example.

Another novel combination of existing technologies comes from MBA Polymers of Richmond, California. It has devised an elaborate system for reclaiming plastic and other materials from electronic devices, computers, appliances and even cars. The raw material is first ground and shredded, and various devices (such as spectrometers, densometers, magnetometers) and techniques are used to sort the resulting fragments by colour, type of plastic or metal, and so forth. The sorted material can then be recycled and reused. Just as minimills revolutionised the steel industry by enabling scrap metal to be easily recycled, this technique could do the same for the plastics business. MBA Polymers has already set up a plant in China, now the electronic-waste dump of the world. The potential to turn mountains of waste material from a liability to an asset is particularly attractive given the introduction of new rules around the world that make manufacturers responsible for

disposal of their products.

Architectural innovation can also involve taking technology from one field and applying it in another, apparently unrelated one. Ahura, based in Wilmington, Massachusetts, is doing just that. The company originally intended to apply its expertise in miniaturised laser technology in the telecommunications market, but had to think again when the telecoms bubble burst in 2001. Instead, the same technology can now be found inside a range of portable devices that shine laser light at a substance and determine its composition based on the reflected light, using a technique called Raman spectroscopy. The ability to determine the chemical composition of an unknown sample using a handheld device has obvious applications in homeland security, but can also be applied in medicine, for tumour analysis and drug discovery.

Another firm deploying an existing technology in a new way is AgION Technologies of Wakefield, Massachusetts. The effectiveness of silver as an antimicrobial has been known since antiquity; it was used by the Greeks and Romans to disinfect contaminated water, for example. More recently, silver has been incorporated into medical devices and dressings to reduce the risk of infection. AgION has gone a step further: it has developed a way to bond silver ions to an inert ceramic so that the rate of release of silver ions increases with the humidity (and hence with the likelihood of bacterial activity). The resulting material enables antimicrobial silver to be incorporated into all kinds of new devices, including pens, household fridges and even mobile phones. The idea is centuries old, but the method of application is entirely new.



## Backing the right horse?

Architectural innovations can be a tough sell, but when it comes to attracting investors and customers, radical innovations present the greatest challenge of all. By definition, introducing a new technology that opens up or addresses a new market is a risky business. In the early stages, it is not clear whether, or how quickly, the technology will live up to its prom-



ise; nor is it certain that the intended market will turn out to be an important one. Videotelephony, for example, now works well after years of development, but there does not seem to be any real demand for it. But while the risks associated with radical innovations are higher, so are the rewards: such innovations provide the opportunity to seize a leadership position in potentially lucrative new markets.

EnOcean, based in Oberhaching, Germany, has developed a unique technology that could put it at the forefront of the “smart dust” revolution, should it ever occur. Smart dust, which is still science fiction, is the computational equivalent of fairy dust; the idea is that it can be added to any product to give it computational smarts. Once everything is a wirelessly networked computer, all sorts of things will become possible: you will never be able to lose anything again, for example, since you will just be able to query the network to find out where it is. But while computing and networking components continue to shrink, a big obstacle remains: power. EnOcean’s “ambient energy harvesting” technology gets around this problem by gathering energy from the environment, much as a self-winding watch does. This energy can be derived from temperature changes, vibration, pressure, light or motion. It can then be used to power a tiny radio-enabled sensor that sends out regular readings over a distance of 300 metres or so. To date, EnOcean’s technology has found use in building automation and logistics. But if smart dust ever becomes a reality, with computers embedded into even the smallest and most mundane everyday objects, ambient energy harvesting could prove to be a technology of fundamental importance.

Holografika, based in Budapest, Hungary, has also devised a new technology with a mind-boggling range of potential uses. Its HoloVizio™ three-dimensional display presents lifelike 3D images that can be seen without the use of special glasses or head-tracking equipment. The display has a wide field of view, and different users can see different details depending on their position. The company is now participating in the development of a format for 3D image compression and transmission. A true-3D display could trans-

form entertainment, communications, marketing and design, and could prove to be as significant a step forward as the original introduction of television. But it could also, like videotelephony, prove to be a niche application that fails to achieve broad adoption.

Perhaps the most difficult field in which to introduce a radical innovation is biotechnology, due to the regulatory and ethical obstacles that must be navigated. The development of new therapies based on stem cells provides a vivid illustration of the potential and the pitfalls associated with radical biotech innovations. Unlike most cells in the human body, which are of particular and fixed types, stem cells can be coaxed into turning into a wide range of cell types, and are also able to divide to make copies of themselves. This allows them to act as a repair mechanism for the body, since they can take the place of cells that are missing or damaged. The most versatile stem cells, capable of transforming into any type of cell, are those found in human embryos. In many parts of the world, however, there are restrictions on the type of experiments that can be carried out using human embryonic stem cells, for ethical and religious reasons. Adult stem cells, which are found in adults, can only transform into a more limited number of cell types, but still have great therapeutic potential.

Stem Cell Sciences, based in Edinburgh, Scotland, is one of many firms pursuing the new opportunities presented by stem cells. It has developed techniques to separate stem cells from other cells, to derive and grow neural stem cells (an alternative to embryonic stem cells in many areas of research), and to monitor gene expression within cells. It licenses these technologies to other firms for use in research and drug discovery. TheraVitae, based in Rehovot, Israel, is developing an experimental therapy for heart disorders in patients who cannot be treated using bypass surgery. Stem cells are derived from the patient’s own blood and are then reimplanted into regions of the heart suffering from reduced blood supply, to promote blood-vessel formation. Since the stem cells come from the patient’s own body, this type of therapy sidesteps complications associated with rejection, or with the origin of the cells. But while the potential is clear,



the use of stem cells in therapy is clearly still many years from becoming mainstream.



## Reading the map

As these examples demonstrate, the four categories of innovation present varying degrees of risk and reward. Incremental innovations are the safest bets, modular and architectural innovations are slightly more risky, and radical innovation is the riskiest of all. Indeed, radical innovation is often very difficult to distinguish from basic scientific research, which is generally funded by governments (via research centres or universities) or charitable organisations; only later do private investors step in.

Investors' appetite for risk is cyclical in nature, and the past few years since the tech boom and bust have witnessed a greater emphasis on investment in incremental, late-stage technologies at the expense of radical, blue-sky innovations, particularly in biotechnology, a field which is taking far longer than expected to fulfil its potential. But there are some notable exceptions: there is currently a boom underway in private space companies, for example, many of which are funded by the winners from the dotcom boom. Now that computers and the internet have become so pervasive, technology entrepreneurs are looking for new challenges.

That highlights a second point about the nature of innovation: that technologies move around the grid, from one category to another, as they mature. The computer, for example, was originally a radical innovation: it was a new technology that made new things (weapons modelling and weather forecasting, for example) possible. Computers then spread through

modular innovation, as the new technology was slotted in as a better way of solving existing problems, such as running accounting systems or controlling aircraft. As the technology matured, it settled into a long period of incremental improvement. From time to time, the process of incremental improvement produces sudden offshoots of architectural innovation, as novel combinations of computer technology make new uses possible. By and large, more mature technologies (such as information technology) are to be found on the right of the grid, while less mature and more speculative technologies (such as leading-edge biotechnology or nanotechnology) can be found on the left.

But the most important point is that no single one of these categories is more important than any other. All technologies have a life-cycle, starting off as glamorous radical innovations and ending up as mundane, incrementally improving ones. Some innovators prefer to be present at the creation, getting new ideas off the ground; others prefer to take existing technologies and find new ways to use them, improve them, or make them more widely available.

Mobile phones are now spreading rapidly in the developing world, for example, thanks to incremental innovations that have brought down the price of handsets, and architectural innovations (pre-paid billing and microfinance) that make access affordable even in the poorest parts of the world. Which innovators are more important: those who made mobile telephony possible in the first place, those who made it reliable and widespread, or those who are now making this vital tool of economic development available to the people who need it most? Answer: All have played an equally important role. There is no right way or wrong way to innovate; what really matters is that people continue to do so.

## Technology Pioneer profiles

Thirty-six companies have been chosen as Technology Pioneers in 2006. They come from three categories—biotechnology, energy/environmental technology and information technology. Candidates are nominated by members, constituents and collaborators of the World Economic Forum. Candidates are reviewed by an external Selection Advisory Committee comprising technology experts in a variety of fields; the World Economic Forum takes the final decision.

The pioneers are chosen on the basis of six selection criteria:

- **Innovation.** The company must be truly innovative. A new version or repackaging of an already well-accepted technological solution does not qualify as an innovation. The innovation and commercialisation should be recent. The company should invest significantly in R&D.
- **Potential impact.** The company must have the potential to have a substantial long-term impact on business and society.
- **Growth and sustainability.** The company should have all the signs of a long-term market leader and should have well-formulated plans for future development and growth.
- **Proof of concept.** The company must have a product on the market or have proven practical applications of the technology. Companies in “stealth” mode and those with untested ideas or models do not qualify.
- **Leadership.** The company must have visionary leadership that plays a critical role in driving it towards its goals.
- **Status.** The company must not currently be a Member of the World Economic Forum.

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**BIOTECHNOLOGY**

**AglION Technologies Inc**

Jeffrey Trogolo, *chief technology officer*

**LOCATION:** Massachusetts, USA

**NUMBER OF EMPLOYEES:** 30

**YEAR FOUNDED:** 1997

**ORIGINS:** Entrepreneurial start-up

AglION Technologies develops and markets silver-based antimicrobial technologies. Silver has been used for thousands of years to treat disease and preserve food and water freshness, but common silver compounds cannot provide long-term protection as they release silver in an uncontrolled way. The AglION compound enables the controlled release of silver, the pace of which can be varied in response to the potential for bacterial growth.

The AglION compound is now being used across a wide range of applications. These include water purification and indoor air handling systems, footwear, mobile phones, pens, and the coating of medical catheters. AglION has also developed products to combat bacteria on already installed equipment, such as surfaces in food-processing plants. The healthcare sector is a particularly strong future growth market, as AglION-treated surfaces have shown resistance to viruses and "super-bugs" such as MRSA.

**Why the company is a pioneer**

AglION Technologies has pioneered the development of products that control problematic microbes in critical applications without compromising safety or harming the environment. Whether it is incorporated as an additive or applied as a coating, the AglION compound can increase a product's lifetime and its performance.

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**BIOTECHNOLOGY**

**Ahura Corporation**

Daryoosh Vakhshoori, *founder and president*

**LOCATION:** Massachusetts, USA

**NUMBER OF EMPLOYEES:** 45

**YEAR FOUNDED:** 2002

**ORIGINS:** Entrepreneurial start-up

Ahura makes First Defender™, a hand-held instrument that allows rapid identification of thousands of chemicals. It does this through the use of lasers and Raman spectroscopy optical analysis, and can identify chemical weapons, toxic chemicals, explosives and narcotics. First Defender™ has already been sold to emergency-response teams in North America and Europe, who have to identify unknown substances quickly—for example, following a terrorist incident or a spillage of hazardous materials.

Chemical identification by First Defender™ is instantaneous, and its "point and shoot" approach does not require the sample to be touched. (It can also be used through plastic and coloured glass.) Results are checked against a large sample library, and a chemometric algorithm allows mixture analysis.

**Why the company is a pioneer**

First Defender™ is the fruit of a variety of technological advances by Ahura—including the design of high-performance semi-conductor lasers and novel spectroscopic techniques. Tiny "optical engines" allow the device to be hand-held, making it easier to use on-site. Expert software makes it possible for non-chemist users to get correct results. In addition to First Defender's™ obvious counter-terrorism and hazardous materials uses, there are possible future applications in food and drug inspection, as well as in remote medical diagnostics.

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## BIOTECHNOLOGY

## Amyris Biotechnologies Inc

Jay D Keasling, *co-founder***LOCATION:** California, USA**NUMBER OF EMPLOYEES:** 25**YEAR FOUNDED:** 2003**ORIGINS:** Entrepreneurial start-up

Amyris engineers microbes that are capable of cost-effectively producing large volumes of high-value complex molecules that until now have only been available in small quantities through extraction from natural resources. These microbial chemical factories can be used to produce new pharmaceuticals and fine chemicals.

Such bio-active compounds are currently very underdeveloped, largely as a result of supply limitations. By developing production processes that link microbe-based manufacturing processes to novel chemistry, Amyris aims to develop therapeutic drugs that are currently stalled in clinical investigation—as well as to expand markets for fine chemicals, currently constrained by existing synthesis techniques.

Amyris's first project is to construct a synthetic microbe for use in the production of the anti-malarial drug artemisinin. This drug, which can currently only be obtained from a herb, would constitute an effective weapon in the global fight against the disease.

**Why the company is a pioneer**

The company's innovative production technology may make it possible to reduce the cost of, and thus improve access to, economically and socially important chemicals and pharmaceuticals. By using optimised microbes and rapid enzymatic pathway construction techniques, Amyris aims to build cells eventually capable of producing any class of chemical. As well as reproducing natural bioactive compounds, the production of novel derivatives could be possible.

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## BIOTECHNOLOGY

## DNA Genotek Inc

Ian Curry, *president and chief executive officer***LOCATION:** Ontario, Canada**NUMBER OF EMPLOYEES:** 24**YEAR FOUNDED:** 1998**ORIGINS:** Entrepreneurial start-up

DNA Genotek's Oragene™ self-collection kit provides an easy, reliable and cost-effective way of collecting DNA. The kit works as follows: an individual leaves a saliva deposit in a plastic collection device; when the device's lid is closed, the saliva is mixed with a chemical solution that stabilises the DNA until it can be extracted and analysed.

Most DNA collection methods in use today suffer from significant problems. Blood-based DNA collection is invasive, can hurt, incurs costs in handling and processing the blood, and requires trained operators to take the sample. An alternative—buccal swabs—may not provide enough DNA for genetic research and can also be unreliable.

So far, the company has focused on promoting Oragene™ to researchers conducting large-scale population studies. The product is now being used in a number of the world's leading research institutions.

**Why the company is a pioneer**

Advances in genetic research and testing are expected to continue improving the way health conditions and diseases are diagnosed, treated and prevented, resulting in major improvements to global healthcare. All genetic findings start with the collection and analysis of one essential resource—DNA. The Oragene™ self-collection kit makes this significantly easier.

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**BIOTECHNOLOGY**

**NitroMed Inc**

Michael D Loberg, *president and chief executive officer*

**LOCATION:** Massachusetts, USA

**NUMBER OF EMPLOYEES:** 92

**YEAR FOUNDED:** 1992

**ORIGINS:** Entrepreneurial start-up

NitroMed is a research-based pharmaceutical company. Its first drug to market, BiDil, was approved this year in the United States for black patients diagnosed with heart failure. African Americans are 2.5 times more likely than the general population in the USA to die prematurely from heart failure. BiDil was initially rejected by the US's Food and Drug Administration before being shown by NitroMed to be especially useful in treating black patients.

NitroMed is researching why BiDil provides a disproportionate clinical benefit to black patients, and is beginning to isolate specific bio-markers that can more precisely identify for whom the drug is most likely to be effective. The company is currently developing "second generation" derivatives as well as other complimentary products.

**Why the company is a pioneer**

BiDil may encourage an increased focus on the delivery of "personalised medicines" and the healthcare needs of minority populations. This market is at present underserved by large pharmaceutical companies, but is extensive: in cash terms, the medical needs of black patients in the US are greater than the entire German pharmaceutical market. BiDil may also encourage a different approach to pharmaceutical research, with more racially diverse drug testing.

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**BIOTECHNOLOGY**

**Optos plc**

Douglas Anderson, *founder and director*

**LOCATION:** Dunfermline, UK

**NUMBER OF EMPLOYEES:** 183

**YEAR FOUNDED:** 1992

**ORIGINS:** Entrepreneurial start-up

Optos is a leading medical technology company that designs, develops, manufactures and markets retinal imaging devices. Retinal imaging is used by optometrists, ophthalmologists and retinal specialists for the screening and diagnosis of eye and non-eye, or systemic, diseases.

The company's platform technology is the Panoramic200™ Scanning Laser Ophthalmoscope (P200™) device. The P200™ is the world's first and only ophthalmic device capable of producing a high resolution, digital wide-field image of up to 200° of the retina in a single capture. The image, branded as the optomap® Retinal Examination, provides eye-care practitioners with clinically useful information that facilitates the early detection of disorders and diseases evidenced in the retina.

Over 2000 P200™ devices have been installed in eye-care practices in the company's current markets to date—USA, Canada, UK, Germany—and over 5 million optomap® retinal examinations have been performed.

**Why the company is a pioneer**

The P200™ device affords the following advantages over conventional retinal examination methods: approximately 80% of the patient's retina is captured in a single image; image capture takes a quarter of a second; the device is designed to take an image through a 2mm aperture, and therefore the decision to dilate is a purely clinical one rather than being mandated by device requirements; and the P200™ employs two independent low-powered laser light sources operating at discrete wavelengths and do not suffer the same degree of diffraction as white light.

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## BIOTECHNOLOGY

## Ossur

Jon Sigurdsson, *president and chief executive officer*

**LOCATION:** Reykjavik, Iceland

**NUMBER OF EMPLOYEES:** 900

**YEAR FOUNDED:** 1971

**ORIGINS:** Entrepreneurial start-up

Ossur develops sophisticated orthopaedics. Recently launched products include RHEO KNEE™, the world's first artificially intelligent knee system that learns from and adapts to its user's movements.

The company's latest product, the POWER KNEE™, is the first powered prosthesis that replaces true muscle activity. By gathering sensory information one step ahead of the prosthesis, the POWER KNEE™ anticipates functions and lifts and propels its user up stairs and inclines. Other products include Flex-Foot® a carbon-fibre artificial foot, braces, supports, and products for sprains, strains, fractures and post-operative care.

In 2003, the firm introduced new carbon-fibre and silicon technology. Future developments will focus on drawing out the full benefits of bionic technologies in a wide range of orthopaedics. The RHEO KNEE™ combines a number of technologies: electronic sensors to monitor the knee's position, a dynamic matrix learning algorithm (DMLM) to make the knee "intelligent," and magnetorheologic fluid to deliver the proper amount of resistance during each step.

#### Why the company is a pioneer

The increasing use of electronics and artificial intelligence has far-reaching implications for orthopaedics. Ossur has been innovative in its incorporation of new technologies into its products, with the company's POWER KNEE™ at the forefront of developments in this sector.

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## BIOTECHNOLOGY

## Stem Cell Sciences plc

Peter Mountford, *president and chief executive officer*

**LOCATION:** Edinburgh, UK

**NUMBER OF EMPLOYEES:** 47

**YEAR FOUNDED:** 1994

**ORIGINS:** Entrepreneurial start-up

Stem Cell Sciences (SCS) co-ordinates intellectual property development, protection and commercialisation in a network of SCS companies and collaborating academic centres in Edinburgh, Kobe and Melbourne.

The key patented technology behind SCS is stem cell selection. (Stem cells are unspecialised cells in the body that can divide and renew themselves, and that can turn into specialised cells.) The company is based around proprietary technology that allows the isolation, growth and manipulation of stem cells. Recent advances include a technique for growing pure brain cells from neural stem cells, invented by researchers at Edinburgh and Milan Universities.

The company's business model combines short-term revenue-generating activities, through licensing or other methods, with the development of a pipeline of cell-based therapeutic treatments. Existing SCS products include serum-free media for both mouse and human embryonic stem cells and neural stem cells, episomal transfection kit systems and cell plates containing neural cells for drug screening. The award of extended US patent claims for SCS should facilitate further licensing deals.

#### Why the company is a pioneer

SCS's technology is the only one able to purify any human stem cell on the basis of any differentially expressed gene. Patients stand to benefit directly from the application of SCS technologies to drug discovery and, possibly, cell-based therapeutic treatments.

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**BIOTECHNOLOGY**

**TheraVitaе Ltd**

Valentin Fulga, *co-founder and chief executive officer*

**LOCATION:** Ness Ziona, Israel; Bangkok, Thailand

**NUMBER OF EMPLOYEES:** 40

**YEAR FOUNDED:** 2003

**ORIGINS:** Entrepreneurial start-up

TheraVitaе aims to offer effective and safe stem-cell therapies, derived from the patient's own blood. VesCell™, its first product, is intended for ischemic heart disease or heart failure patients who have no other option for treatment. Because VesCell™ is created from the patient's own blood, there are no immunological problems associated with donor stem cells, patients do not receive any foreign molecules or drugs, and the ethical problems associated with use of embryonic stem cells are avoided.

VesCell™ is now offered to patients at a number of Thai hospitals for severe angina pectoris and congestive heart failure. The procedure is simple, and relatively painless. Patients have a small amount of their blood collected. Cells are isolated, grown and differentiated outside of the body. The differentiated cells are then injected using a catheter system into the patient's heart vessels or directly into the heart muscle.

**Why the company is a pioneer**

By using the patient's own blood as the basis for cell development, VesCell™ sidesteps a number of problems associated with stem-cell based therapies. If the company can develop large quantities of other cells in this way, many new therapies should be possible.

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**BIOTECHNOLOGY**

**XDx**

Jay Wohlgenuth, *co-founder and vice-president of clinical development*

**LOCATION:** California, USA

**NUMBER OF EMPLOYEES:** 65

**YEAR FOUNDED:** 2000

**ORIGINS:** Entrepreneurial start-up

At present, the standard procedure for determining whether a patient is rejecting a transplanted heart is endomyocardial biopsy. This is an invasive and expensive procedure—which also risks adverse effects to the patient and new heart. The AlloMap™ molecular expression test, the first commercial offering from XDx, monitors for the absence of rejection through a simple blood sample. This test translates the complex signals provided by the immune system's genes and pathways into an objective, actionable score that enables physicians to assess a patient's risk of rejection.

AlloMap™ testing also provides information that may help physicians to make decisions on immunosuppressant treatment—drugs used for this purpose can have serious adverse effects, and balancing the immunosuppressive effect versus the risk of rejection is very important. The company has also begun work on an autoimmune disease application, aimed at allowing better identification and treatment of such conditions.

**Why the company is a pioneer**

XDx's technology is a foundation stone for personalised medicine. The AlloMap™ test is already enabling the monitoring of transplant patients utilising their individual gene expression. It could also provide the basis for the development of personalised medicine in lung transplant cases, as well as for patients suffering from immune-mediated diseases such as Lupus, Crohn's disease and Multiple Sclerosis.

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## ENERGY/ENVIRONMENTAL TECHNOLOGY

## CMR Fuel Cells Ltd

John Halfpenny, *chief executive officer***LOCATION:** Cambridge, UK**NUMBER OF EMPLOYEES:** 14**YEAR FOUNDED:** 2003**ORIGINS:** Entrepreneurial start-up

CMR Fuel Cells develops fuel cell stacks for portable and small stationary power generating activities. The company's success in simplifying the design of fuel cells, and in the process reducing their size by 90%, allows for much easier manufacture of fuel cells, with cost savings projected at around 80%.

Conventional fuel cells generate electricity through chemical reactions stimulated by electrocatalysts. To maximise electricity (rather than heat) generation they need to keep fuel and oxidants physically separate. The CMR fuel cell takes quite a different approach, by allowing fuel and air to mix together in the fuel stack but preventing direct reaction by use of selective electrocatalysts. This allows a much smaller and simpler fuel cell stack—as impermeable membranes, separators, seals and manifolds are no longer required.

**Why the company is a pioneer**

CMR's radically different approach to fuel cell manufacture will enable the manufacture of much more resilient units, as well as ones that are smaller, lighter and cheaper. This could open up enormous new areas for fuel cell use, including the replacement of batteries in small appliances. One initial target market is the portable electronics sector, which urgently needs longer run-time and smaller energy sources.

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## ENERGY/ENVIRONMENTAL TECHNOLOGY

## Ecology Coatings

Richard Stromback, *chief executive officer***LOCATION:** Ohio, USA**NUMBER OF EMPLOYEES:** 2**YEAR FOUNDED:** 1990**ORIGINS:** Entrepreneurial founder

Ecology Coatings uses nano-material technologies to create proprietary coatings with unique performance attributes. These coatings require only a few seconds of ultraviolet (UV) exposure to form a durable barrier, and can be applied via conventional techniques to a wide range of surfaces.

Coating has traditionally been a tricky stage in the manufacturing process: one that requires time, energy and large amounts of space. Traditional coatings have also been based around solvents, which can be highly polluting. Ecology Coatings has developed a much more efficient and environmentally sustainable approach. The firm now has 12 products on the market, selling to the automotive, medical, electronics, plastics, paper and metal industries. The products' formulation means that they can be applied along with other nano-technology products, without fear of agglomeration and resultant loss of characteristics. They are non-polluting, have no volatile organic compounds (VOCs) or hazardous air-polluting agents (HAPs) and use less energy to apply. The firm has concluded contracts with DuPont and Red Spot.

**Why the company is a pioneer**

Ecology Coatings appears to have outpaced the research and development (R&D) efforts of the world's biggest chemical companies. Its technologies could have a big impact on existing coatings industries, as well as emerging industries that cannot use conventional coating technologies.

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**ENERGY/ENVIRONMENTAL TECHNOLOGY**

**Energy Innovations Inc**

Bill Gross, *founder and chief executive officer*

**LOCATION:** California, USA

**NUMBER OF EMPLOYEES:** 35

**YEAR FOUNDED:** 2000

**ORIGINS:** Entrepreneurial founder

Energy Innovations is developing the world's first mass-produced photovoltaic (PV) tracking concentrator system, called the Sunflower. This can be used to increase solar yield captured by solar panels and hence the volume of electricity they can produce.

Traditional PV systems do not provide a sufficiently high return on investment to make them viable without government or utility-sponsored incentives. However, the Sunflower technology could reduce the cost of solar energy below that of electricity supplied by power utilities relying on coal and gas-fired power stations, prompting mass take-up of the technology.

The firm installed its first prototype Sunflower in 2004; more than a dozen further units have been constructed for testing and a commercial launch is imminent. Energy Innovations is primarily targeting the commercial and institutional rooftop solar generation segment, which has been growing rapidly in recent years.

**Why the company is a pioneer**

Energy Innovations believes that its Sunflower systems can have a payback period of 3-5 years in many locations—enough to tempt many commercial operators to invest. Low-cost, reliable solar energy supplies will allow firms to reduce energy expenses and protect themselves from possible price surcharges or supply failures.

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**ENERGY/ENVIRONMENTAL TECHNOLOGY**

**EnOcean GmbH**

Markus Brehler, *chief executive officer*

**LOCATION:** Oberhaching (Munich), Germany

**NUMBER OF EMPLOYEES:** 25

**YEAR FOUNDED:** 2001

**ORIGINS:** Spin-off from Siemens Technology Accelerator

EnOcean technology enables what might seem a physical impossibility: battery-less, wireless and maintenance-free electronic sensors. The technology works by, first, harvesting locally available ambient energy—which might be provided by the press of a switch, or changing light or temperature. Second, extremely energy-efficient electronics process sensor signals and send them to receiving units.

At present, the company offers six different radio modules, and about 100,000 of these modules have been sold to building automation projects. Numerous potential applications for the technology—for example in manufacturing production lines, logistics, automotive and medical systems—are being developed. The sensors can be used as limit switches for production systems, or as temperature sensors for industrial processes. A tyre-pressure monitoring sensor is being developed. So far more than 20 companies have launched more than 70 different products using EnOcean modules.

**Why the company is a pioneer**

The technology promises significant cost savings—partly through cutting out wiring and maintenance and thus extending the life of sensors. The sensors' small size can make it easier to meet existing product needs, and also make possible new ones—for example, remote medical monitoring of patients. As technological advance allows further reductions in the size and cost of sensors, new mass-market consumer applications will become possible.

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## ENERGY/ENVIRONMENTAL TECHNOLOGY

**InnovaLight Inc**

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*Conrad Burke, president and chief executive officer*

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**LOCATION:** California, USA**NUMBER OF EMPLOYEES:** 12**YEAR FOUNDED:** 2002**ORIGINS:** Entrepreneurial start-up

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Silicon, when made in thicknesses of one-to-four nanometres, can do some very interesting things. InnovaLight has found a way to make it this thin, using the world's first solvent-based processing technology for silicon nano-crystals. This "silicon ink" technology will make it dramatically cheaper to manufacture solar panels, and will also considerably improve their performance. As the size of the silicon nano-crystal determines the colour of light absorbed, using a selection of crystals in the solar panel can also allow it to harvest much more energy from the sun.

The company aims to start production of its silicon nano-technology panels in 2007. These could be used in many applications—from very small portable chargers to large-scale low-cost rooftop solar panels. These panels might also be incorporated into flexible, roll-up packages that could be applied to many different sorts of surfaces—so redefining the way that we think about portable power.

**Why the company is a pioneer**

More efficient, flexible and portable power sources could reduce power consumption from existing sources, reducing carbon emissions from conventional generation. In the future, the technology might have other uses, such as flat-panel lightings, silicon lasers and biotechnology applications.

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## ENERGY/ENVIRONMENTAL TECHNOLOGY

**Intelligent Energy**

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*Mark Lawson-Statham, chief operating officer*

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**LOCATION:** London, UK**NUMBER OF EMPLOYEES:** 75**YEAR FOUNDED:** 2001**ORIGINS:** Entrepreneurial start-up

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Intelligent Energy develops fuel cells. Its key technology is the proton exchange membrane (PEM) fuel cell, which uses pure hydrogen to deliver cleaner electricity. The PEM cell is ground-breaking in terms of power density and low parasitic losses. The cells' use of metal (rather than graphite) plates makes them smaller, more robust and, crucially, easier to manufacture.

Intelligent Energy has developed the world's first fuel cell motorbike—able to reach speeds of up to 50mph, and to run for up to four hours between refuelling. The technology could also be used for auxiliary power uses in the automotive and aerospace industries. The company's combined heat and power (CHP) technology is intended for residential and industrial buildings, and is already being tested in the UK and South Africa. The company is also working on a range of hydrogen-reforming technologies, which will enable the production of hydrogen from fuels such as diesel, propane, ammonia and bio-ethanol.

**Why the company is a pioneer**

The company's twin-pronged approach to improving hydrogen generation and fuel cell design offers the prospect of detachable, multi-source fuel-cell power generation. The company's portfolio of energy solutions could help to make the "hydrogen economy" a reality.

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**ENERGY/ENVIRONMENTAL TECHNOLOGY**

**MBA Polymers Inc**

Michael Biddle, *chief executive officer*

**LOCATION:** California, USA

**NUMBER OF EMPLOYEES:** 50+

**YEAR FOUNDED:** 1994

**ORIGINS:** Entrepreneurial start-up

Over the past twelve years MBA Polymers has developed technology to recycle plastic from end-of-life durable goods. Such products—and their “waste streams”—are difficult to recycle because they include a wide range of materials.

MBA has built a completely automated process, comprising more than 30 individual stages. Completely mixed waste streams from shredded end-of-life equipment are broken down into ferrous and non-ferrous metals, and various types of plastics. A large-scale pilot plant in California has already recycled over 20m pounds of plastics, and two commercial recycling plants, in China and Austria, are just coming online. Recycled plastics are already sold to a number of clients.

**Why the company is a pioneer**

MBA processes create new plastic materials with comparable properties to virgin plastics from highly complicated waste streams. MBA is able to produce these plastics at lower cost because waste by-products are cheaper than petrochemicals; because the company's process requires only about 5% of the energy needed for traditional manufacturing techniques; and because plant capital costs are also much lower. The process also avoids the environmental and economic costs associated with burning or burying mixed plastics-rich waste streams. All these benefits are especially relevant to developing countries such as China and India that need to expand plastics output without boosting energy consumption and pollution.

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**INFORMATION TECHNOLOGY**

**Altiris Inc**

Greg Butterfield, *president and chief executive officer*

**LOCATION:** Utah, USA

**NUMBER OF EMPLOYEES:** 863

**YEAR FOUNDED:** 1998

**ORIGINS:** Spin-off from KeyLabs Corporation

It is generally estimated that only 20% of IT costs are on equipment purchase; equipment management accounts for the remaining 80%. Even so, relatively few companies currently have an integrated enterprise-wide IT lifecycle asset management programme.

Altiris provides a set of products that allows customers to automate, simplify and reduce the cost and complexity of IT management. The emphasis is on product integration, and on providing full management over an IT asset's entire lifecycle—from acquisition to disposal. Products are ordered into four “suites”: client and mobile management, server management, asset management and security management. The “suites” are easy to use and innovative in numerous ways, for example by employing highly intuitive user visual interfaces as well as being modular and quick to deploy. Rapid organic growth at Altiris in recent years has been accompanied by a number of strategic acquisitions.

**Why the company is a pioneer**

Companies that can implement an enterprise-wide lifecycle asset management programme should be able to reduce the cost of IT assets significantly, as well as improve general operational efficiency. The highly integrated nature of Altiris's products makes it much easier for clients to realise major potential savings.

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## INFORMATION TECHNOLOGY

**BitBand Technologies Ltd**Ervin Leibovici, *chief executive officer***LOCATION:** Netanya, Israel**NUMBER OF EMPLOYEES:** 50+**YEAR FOUNDED:** 1999**ORIGINS:** Entrepreneurial start-up

BitBand provides a platform for video distribution over Internet protocol (IP) broadband networks. The company primarily targets telecommunications firms and "new generation" service providers who supply "triple-play" (IP voice, data and video) services to metropolitan centres and other residential communities.

IPTV video-on-demand (VOD) allows individuals to decide exactly what they want to see, and when. But to make this possible, secure and reliable systems are needed to deliver the content. Broadcasters also have to be convinced that their chosen system can grow to meet future demands.

BitBand's technical approach is three-pronged: it offers a Vision™ family of appliance-servers, Maestro™ content distribution and server management technology, and SecureStream™ content protection. The company now serves over 500,000 subscribers in several European countries and BitBand technology runs Italy's FastWeb, the largest IPTV VOD deployment to date.

**Why the company is a pioneer**

BitBand's focus on IP networks (rather than cable or satellite) has allowed it to develop specialised client-server architecture and a sophisticated management system. This helps to create systems that are more reliable and quicker to set up. Unique media streaming protocols also ensure higher quality and more reliable service. BitBand's technology will allow individuals easier and more personalised navigation through home-entertainment networks.

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## INFORMATION TECHNOLOGY

**Fortinet Inc**Ken Xie, *founder, president and chief executive officer***LOCATION:** California, USA**NUMBER OF EMPLOYEES:** 600+**YEAR FOUNDED:** 2000**ORIGINS:** Entrepreneurial founder

Security threats to today's computer networks are different from a decade ago. Network-level, connection-based attacks have been replaced by application-based, agent-level attacks. Current threats, such as viruses and worms, may be embedded in the application-level contents of ordinary Internet traffic packet streams. Previously, analysing and reconstructing such packet streams required enormous processing power, but Fortinet's technology now allows the easy deployment of real-time, application-specific services such as virus elimination and content filtering. This has been made possible by the company's development of application-specific integrated circuits (ASICs).

Fortinet's FortiGate™ family of products gives a wide range of businesses an integrated solution to computer security. These hardware-based, ASIC-accelerated security appliances can be installed at various points within customers' networks, and can co-exist with existing security systems. The company's product line has tripled in size and more than 100,000 FortiGate™ systems have now been sold.

**Why the company is a pioneer**

Fortinet has built rapidly on its early understanding of changing network security needs and its FortiGate™ systems are currently the only ASIC-accelerated antivirus gateway products in the world. FortiASIC™ chips, available exclusively in the company's products, accelerate firewall, VPN encryption, malicious code signature matching and traffic-shaping functions.

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**INFORMATION TECHNOLOGY**

**Holografika Kft**

Tibor Balogh, *chief executive officer*

**LOCATION:** Budapest, Hungary

**NUMBER OF EMPLOYEES:** 20

**YEAR FOUNDED:** 1996

**ORIGINS:** Entrepreneurial founder

Holografika designs and sells 3-D display systems. It started selling its 26" and 32" HoloVizio™ 3-D displays in 2004, and plans to offer larger-scale holographic screens soon. Second-generation displays, a 3-D camera system and a full 3-D software environment are all under development.

Traditional approaches to simulating 3-D vision—by, for example, requiring the viewer to wear special glasses—have not gained long-term acceptance, as they restrain the viewer or cause discomfort.

Holografika takes a different approach, by using a holographic screen in which the pixels (dubbed "voxels") emit light of different intensity and colour in different directions. Hologram geometry principles then allow the reconstruction of key elements of spatial vision.

HoloVizio™ screens are viewable from different angles, without the need for special positioning or tracking equipment. Monitor products have already been sold for medical applications, and for scientific visualisation. An automotive computer-aided design (CAD) application is being developed, and telepresence and virtual theatre applications are also under consideration.

**Why the company is a pioneer**

The company's long experience with 3-D imaging has enabled it to construct a high-end system that works. There are numerous possible professional future applications—from CAD to medical imagery—as well as an obvious eventual consumer application, through 3-D TV.

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**INFORMATION TECHNOLOGY**

**Icera**

Stan Boland, *founder, president and chief executive officer*

**LOCATION:** Bristol, UK

**NUMBER OF EMPLOYEES:** 105

**YEAR FOUNDED:** 2002

**ORIGINS:** Entrepreneurial start-up

Icera is a leader in the field of cellular broadband—a new capability that provides high speed Internet access, fast file download, such as full-track MP3 audio, and full email access to mobile devices. Icera's wireless soft modem IC, the Livanto ICE8020™, and Adaptive Wireless™ software deliver the industry's highest performance HSDPA solution—the global standard for broadband cellular wireless on next-generation mobile phones and wireless devices.

Founded in 2002, Icera's team brings together globally recognised expertise in three distinct development fields: custom microprocessors, wireless algorithms and handset platform integration. The result is a complete terminal platform solution that delivers performance, low power consumption and an unprecedented level of flexibility all enabled by a new wireless soft modem architecture.

**Why the company is a pioneer**

Utilising Icera's breakthrough Deep eXecution Processor™ technology, Icera has developed Livanto ICE8020™, the world's first wireless soft modem for mobile handsets that fully meets the strict power and cost constraints of this demanding application.

With Livanto™ and Adaptive Wireless™ software, Icera provides handset manufacturers with the fastest time-to-market in cellular broadband (HSDPA) plus a clear roadmap to future wireless standards.

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## INFORMATION TECHNOLOGY

**Matrix Semiconductor Inc**


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 Michael Farmwald, *co-founder*


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**LOCATION:** California, USA
 

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**NUMBER OF EMPLOYEES:** 100
 

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**YEAR FOUNDED:** 1998
 

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**ORIGINS:** Entrepreneurial start-up
 

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Matrix is the first company to commercialise 3-D integrated circuits. The company's first product, Matrix® 3-D Memory, is a one-time programmable, permanent and non-volatile memory for publishing content to portable electronic devices.

Matrix has managed to achieve 3-D circuitry while using conventional materials and manufacturing techniques. This enabled the company to lower costs, and means that it does not always have to use the most cutting-edge manufacturing technologies. As a result, Matrix® 3DM is currently the world's lowest cost-per-bit semiconductor memory.

Companies such as Disney, Mattel and Sharp are now using Matrix® 3DM and the company's chips are being used in a wide range of portable consumer electronics products.

**Why the company is a pioneer**

Many worry that the development limits of conventional 2-D chips are fast approaching, so 3-D chips could become increasingly important to the future of the semiconductor industry. Matrix's leveraging of proven manufacturing techniques has allowed it to achieve high production volume and high reliability more quickly. As high-volume products such as mobile telephones and hand-held games demand ever-increasing amounts of memory, Matrix technology will help to keep down costs and enable new opportunities for growth.

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## INFORMATION TECHNOLOGY

**mobileATM Ltd**


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 Steven Atkinson, *chief technical officer*


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**LOCATION:** London, UK
 

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**NUMBER OF EMPLOYEES:** 60
 

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**YEAR FOUNDED:** 2003
 

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**ORIGINS:** Joint venture between LINK and Morse plc
 

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mobileATM provides a resilient, robust and secure platform that allows customers to access their financial information using their mobile phone handsets. Based on the simplicity and ubiquity of the Automated Teller Machine (ATM), the service allows customers to exercise greater control over their finances in the context of an increasingly digital world.

For such a service to gain acceptance it needs to be both secure and cheap for all parties involved. It also needs to be modular, so that it can adapt to future developments in transaction types or access methods. mobileATM's security credentials are already accepted: the company is a joint-venture between Morse plc and LINK Interchange Network, which provides the bulk of conventional ATMs in the UK. A number of global banks have already agreed to use the system.

**Why the company is a pioneer**

mobileATM's service is initially focused on offering greater convenience, but may have more profound implications. In the developed world, mobileATM may facilitate the collection of new sorts of taxation, notably those centred on a "pay per" basis (for example, vehicle usage charges). It may also allow governments to improve monitoring of the collection of certain sorts of existing taxation. In developing countries, the technology should also facilitate secure access by individuals to financial systems, reducing scope for corruption.

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**INFORMATION TECHNOLOGY**

**Navio Systems Inc**

Stefan Roever, *president and chief executive officer*

**LOCATION:** California, USA

**NUMBER OF EMPLOYEES:** 50+

**YEAR FOUNDED:** 2002

**ORIGINS:** Entrepreneurial founder

Navio aims to provide a new rights-based approach to electronic commerce. Rather than require transactions to be made through the conventional file-based approach, Navio's system involves the circulation of "digital bearer instruments". These instruments give the holder the rights to, for example, 1,000 songs, or a promotional offer, or loyalty points, or any other digital asset. Navio allows these assets to be published, accessed, managed, traded, shared, transferred and redeemed just like real world assets.

With current technology, which relies on copy-protection, this approach is impossible—as digital documents can be easily copied. With Navio's approach, the "rights" to content are managed separately from the content itself, enabling legal file sharing while protecting the rights of the content owner.

Using Navio's service, rights issues are created for each digital product, which are catalogued and offered for sale through web and mobile storefronts. Upon purchase, buyers receive an electronic voucher with their digital rights—for example, the "download" right, or the "share 10 times" right. The right is then used to secure delivery of the digital files. This approach removes the incentive for a rights-holder to copy or share his rights. Navio is initially targeting the entertainment sector, and has already secured deals with a number of companies including FOX Music and TVT Records.

**Why the company is a pioneer**

The company's rights-based approach could ultimately be applied to any digital commerce transaction and should make it possible to run decentralised electronic commerce networks. Navio's technology therefore has the potential to boost electronic commerce significantly.

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**INFORMATION TECHNOLOGY**

**Rosum Corporation**

Howard Speaks, *chief executive officer*

**LOCATION:** California, USA

**NUMBER OF EMPLOYEES:** 27

**YEAR FOUNDED:** 2000

**ORIGINS:** Entrepreneurial start-up

Rosum has developed a technology, using broadcast TV signals, for mobile positioning that is particularly effective in rural and urban areas. This system is cost-effective, uses a reliable infrastructure and can work indoors.

Electronic positioning is important in a number of sectors. Emergency services need accurate positioning for effective first response. Firms may want to track the position of individual physical assets; law-enforcement agencies will want to follow the movements of those on parole. A number of technologies already exist to do this, but each has its limitations. Satellite-based methods such as the Global Positioning System (GPS) do not work indoors; Wireless Local Area Network (WLAN) approaches do not have a reliable infrastructure and others (such as Global System for Mobile Communications/GSM network location) are not cost-effective over wide areas. Rosum's use of TV signals solves many of these problems. TV signals are more powerful than GPS signals and their lower frequency allows better penetration of buildings. Their wider bandwidth also allows for greater accuracy.

**Why the company is a pioneer**

Rosum is the only company successfully to use TV signals in tracking technology, and could reduce overdependence on GPS. The company designs and builds its own hardware and software and has already begun trials of its TrimTrac-TV™, an asset-tracking device.

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## INFORMATION TECHNOLOGY

**Silicon Optix Inc**

Paul Russo, *founder, president, chairman and chief executive officer*

**LOCATION:** California, USA

**NUMBER OF EMPLOYEES:** 160

**YEAR FOUNDED:** 2000

**ORIGINS:** Entrepreneurial start-up

Silicon Optix develops and sells video-processing chips and broadcast/post-production systems based on patented array processing and Hollywood-proven algorithms (collectively Hollywood Quality Video or HQV).

The Silicon Optix approach—as exemplified by the company's REALTA™ chip—requires a combination of three different proprietary technologies. Real-time geometry processing enables optical elements and image processing to work together, and a new digital signal processor (DSP) structure capable of one trillion operations per second allows very rapid pixel-by-pixel software processing. This works with specially developed video-processing algorithms, built on a long working relationship with (and now ownership of) Teranex, which produces video-processing equipment for the professional market.

**Why the company is a pioneer**

The coming wave of video everywhere, from handheld devices and HD video consumer products to IPTV and large-screen flat displays for home theatres, will drive demand for the creation, distribution, storage and display of high-quality video. The REALTA™ chip in effect moves the digital system onto a software platform, so that different algorithms can be applied to different applications, and at different times. The chip can make regular video appear high-definition: Denon (DVD), Yamaha (projection), NEC and JVC recently launched REALTA™-based products that sport the HQV logo, and others will be announced shortly. The company is currently developing a new chip that should retail at a lower cost, encouraging widespread adoption.

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## INFORMATION TECHNOLOGY

**Tao Group Ltd**

Francis Charig, *co-founder and chairman*

**LOCATION:** Reading, UK

**NUMBER OF EMPLOYEES:** 60

**YEAR FOUNDED:** 1992

**ORIGINS:** Entrepreneurial founder

Tao has developed intent® (short for Interactive Entertainment), an integrated, high-performance multimedia software platform for mobile, consumer electronics and automotive devices. intent® is independent of operating system, processor and programming language, making it ideal for the rapidly converging markets of mobile, handheld and home-based electronics. It facilitates the development, interaction and execution of services and applications over any intent®-enabled device. Consumers can therefore have the same rich experience irrespective of the number of devices they own or where they are.

Companies such as Philips, Sony, NEC and Panasonic now license intent® technology.

Approximately 15m intent® units have already been shipped by device manufacturers, and the software can be found in a range of devices from telephones to TVs and even Japanese pachinko machines. intent's® capabilities are unleashed by an innovative graphics engine, and by an award-winning audio product line.

**Why the company is a pioneer**

intent® enables consumers to have a common and appealing experience on any connected digital device, removing the barriers of technological complexity for ordinary consumers. The design of the intent® technology also enables manufacturers to bring new generation devices to the market more quickly and cheaply than has previously been possible.

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**INFORMATION TECHNOLOGY**

**Telmap Ltd**

Oren Nissim, *chief executive officer*

**LOCATION:** Herzlia, Israel

**NUMBER OF EMPLOYEES:** 80+

**YEAR FOUNDED:** 2000

**ORIGINS:** Entrepreneurial founder

Telmap is a leading developer of mobile mapping and navigation solutions. It is dedicated to making mobile navigation available across the full range of cellular platforms so that many more people worldwide can more easily find their way during the course of their daily lives.

Telmap's flagship server-based navigation solution is unique in offering a complete worldwide mapping and navigation experience on any mobile platform. It provides accurate turn-by-turn navigation with text, voice and map directions for in-car or pedestrian navigation. The solution also includes real-time traffic and weather updates, address book, millions of SMS-sharable Points of Interest (POI), and premium content.

The power behind Telmap's solutions is its Andromeda™ Mapping and Location GIS Platform, which enables rapid design of an unlimited range of sophisticated mobile mapping applications.

**Why the company is a pioneer**

Telmap is the first company to provide a comprehensive cross-platform solution for mobile phones, for the first time enabling mobile navigation on any platform, any device, for any content, anywhere. This innovative cross-platform approach provides operators and other mobile industry players with an unprecedented opportunity to reach to new markets and customers, and enables a wider variety of people to benefit from mobile mapping and navigation.

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**INFORMATION TECHNOLOGY**

**The Cloud Networks Ltd**

George Polk, *founder and chief executive officer*

**LOCATION:** London, UK

**NUMBER OF EMPLOYEES:** 80+

**YEAR FOUNDED:** 2002

**ORIGINS:** Entrepreneurial start-up

The Cloud Networks operates the largest public-access Wireless Local Area Network (WLAN) in Europe. This is an "open" network, enabling access by any service provider—the key factor that differentiates The Cloud from competing European WLAN networks run by Swisscom or Deutsche Telekom.

The Cloud provides "carrier-grade" access to all service providers, and does this invisibly to all users. This means that, say, a user of British Telecom (BT) can access all their BT services over The Cloud network: to the user, the network appears to be a BT network. The Cloud therefore allows carriers to offer WLAN services as part of a package of home or enterprise-based fixed broadband services. Such services can also be offered to complement slower Universal Mobile Telecommunications System (UMTS) or third-generation (3G) mobile telephone-based connections: a deal to this effect has recently been concluded with Vodafone.

**Why the company is a pioneer**

By reducing barriers to entry in mobile communications, The Cloud has already stimulated competition and innovation. A recent deal with Skype—and new WLAN/UMTS handsets—will usher in a new challenger to the established mobile networks. Another new service will provide mobility to Sony's PSP games machines. Cloud Carrier Services help new entrants with service creation and platform development, thus lowering barriers to entry.

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## INFORMATION TECHNOLOGY

**Transmode Systems AB**

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*Magnus Oberg, chief technical officer*

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**LOCATION:** Hägersten, Sweden**NUMBER OF EMPLOYEES:** 90**YEAR FOUNDED:** 2000**ORIGINS:** Entrepreneurial start-up

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Transmode develops, markets and supplies optic-fibre networking systems used for carrying voice, data and video traffic within and beyond metropolitan networks. The company's Wave Division Multiplexing (WDM) technology allows a greater volume of traffic to be carried over existing optic-fibre networks. The company supplies a range of WDM products, aimed at different levels of customer. The aim has been to provide simple to use, yet highly flexible and scalable, "plug and forget" systems.

Network efficiencies are gained through a range of technologies. Central to the proposition is Transmode's Intelligent Wave Division Multiplexing (iWDM) technology. This removes the need for complex installation, commissioning and provisioning procedures, because the system can automatically recognise and respond to the signal coming from the client. A single network card can also be used for all network services. As a result, the system can be operational within a few minutes of unpacking.

**Why the company is a pioneer**

Transmode's ability to simplify WDM systems has made the technology much easier to use—and made it possible for relatively small-scale users to implement optical networks themselves. Also, the company's innovative higher-end products are well-suited for maintaining new-generation high-capacity networks at lower cost.

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## INFORMATION TECHNOLOGY

**UPEK Inc**

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*Alan Kramer, founder and chief executive officer*

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**LOCATION:** California, USA**NUMBER OF EMPLOYEES:** 100**YEAR FOUNDED:** 2004**ORIGINS:** Spin-off from STMicroelectronics

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UPEK produces and markets a range of biometric authentication products including fingerprint sensors, biometric algorithms and software. The company's products are used to provide secure access to consumer and commercial products such as laptop computers, portable storage drives, door entry systems and safes.

UPEK's TouchChip® and TouchStrip™ fingerprint sensors provide one-touch positive user identification by employing a finger image capture technique that senses an electrical charge when a finger is placed on the surface of a sensor. This system allows processing of a wider range of fingerprints than alternative approaches.

UPEK provides a fully integrated "finger to server" security chain. The host processor is not used during user authentication, enabling a very high level of security. Complementary UPEK software allows user enrolment and authentication.

**Why the company is a pioneer**

Identity and data theft are likely to become an even greater problem than they are today. Biometric identification is inherently more secure than alternative approaches based on passwords or Personal Identification Numbers (PINs), and UPEK is the only company to provide fully integrated biometric solutions.

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**INFORMATION TECHNOLOGY**

**Varioptic SA**

Bruno Berge, *founder and president*

**LOCATION:** Lyon, France

**NUMBER OF EMPLOYEES:** 50

**YEAR FOUNDED:** 2002

**ORIGINS:** Entrepreneurial start-up

Varioptic has designed liquid lenses that act similarly to the human eye, in that they can change focus by changing shape without mechanical intervention. They can also be used to zoom. The company's electrowetting technology uses electricity to distend or flatten two drops of liquid, in order to alter the border between the two liquids, and thus focus the lens. Multiple liquid lenses can be combined with a driver, sensor and image processor to change magnification and focus, and also control optical aberrations.

Varioptic's success in developing a liquid lens depends on the effective combination of four technologies. High-quality electrowetting is necessary, to achieve the high accuracy required for optical standards. The liquid drops must also remain centred on the optical axis. The chemistry of the liquids used ensures consistent performance of the lens, across a wide temperature range. Finally, all these elements are brought together into a package that can be made at an attractive cost.

**Why the company is a pioneer**

Liquid lenses have the potential to replace conventional lenses in a wide range of products—including mobile telephones and digital cameras. Varioptic's technology allows them to be manufactured more cheaply than conventional focus-control systems, and they are also durable, fast and power-efficient.

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**INFORMATION TECHNOLOGY**

**VoiceObjects AG**

Karl-Heinz Land, *founder and chief executive officer*

**LOCATION:** Bergisch Gladbach, Germany

**NUMBER OF EMPLOYEES:** 90

**YEAR FOUNDED:** 2001

**ORIGINS:** Entrepreneurial start-up

VoiceObjects X5, the company's software platform, is a voice application management system (VAMS) that allows fast and easy provision of voice-controlled telephone services. It consists of a server, user development and management interfaces and associated programs to allow firms to analyse the system's usage.

Voice-operated systems are one way of helping firms to handle customer transactions more efficiently. But installing and maintaining sufficiently sophisticated systems can be expensive—so undermining the case for automation. VoiceObjects X5 allows business experts—rather than computer programmers—to manage, control and maintain such systems. The system is highly flexible: the VoiceObjects server can handle calls from thousands of different customers at once, using a range of different languages, and is already used by a number of major German companies.

**Why the company is a pioneer**

An effective VAMS could, through reducing costs and improving service levels, permit new types of business model. In the future VAMS usage could move beyond customer self-service functions to the use of voice portals for applications such as voice commerce and mobile business. Just as there will be no website development without web application servers, so there will be no voice application development without the use of VAMS. Networking of these voice portals would create a voice-based Internet, allowing access to anyone with a telephone, and would constitute one way of bridging the "digital divide" caused by unequal access to computers.

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## INFORMATION TECHNOLOGY

## VOICE.TRUST AG

Michael Kramer, *founder and chief executive officer*

**LOCATION:** Munich, Germany

**NUMBER OF EMPLOYEES:** 20

**YEAR FOUNDED:** 2000

**ORIGINS:** Entrepreneurial start-up

The company's Trusted Voice ID services are based around the company's VOICE.TRUST server. This uses a voiceprint recorded during the initial user enrolment to verify the user's identity during subsequent dialogues. Unlike other security systems, the user needs only a conventional telephone in order to confirm identification.

Standard biometric identification processes such as fingerprint or iris-scan clearly have an advantage over passwords, smartcards or other means of security clearance, in that they rely on properties that are not easily forged, lost or forgotten. However, VOICE.TRUST argues that such static biometric systems may suffer from security weaknesses and believes that the use of dynamic biometric processes such as voice scanning are inherently more secure. The company's system uses a unique multilevel analysis of the voice, and also permits a challenge/response dialogue using random words, intended to fend off the threat posed by recorded voices.

#### Why the company is a pioneer

VOICE.TRUST provides an integrated hardware and software solution, currently used mainly in corporate environments within closed user groups. It can be rapidly deployed, using standard telephone systems. Use of voice-based security systems is likely to increase as computer interaction moves away from the keyboard/mouse model. In future, VOICE.TRUST technology could be extended to cover paid services and transaction authentication.

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## INFORMATION TECHNOLOGY

## Voltage Security Inc

Dr Guido Appenzeller, *co-founder and chief technology officer*

**LOCATION:** California, USA

**NUMBER OF EMPLOYEES:** 93

**YEAR FOUNDED:** 2002

**ORIGINS:** Entrepreneurial start-up

Only around 0.1% of e-mail on the Internet is secured through encryption or digital signatures, largely as a result of the difficulties of managing traditional encryption keys. Because these keys are too long for humans to remember, a management infrastructure, based on certificates, is required to look up, revoke and manage these keys. This infrastructure, often referred to as Public Key Infrastructure (PKI), is expensive and difficult to set up and deploy.

Voltage Security has developed solutions for securing business communication based on a breakthrough technology, developed at Stanford University, called Identity-Based Encryption (IBE). IBE allows a well-known identity, such as an email address, to be used directly as a public key. IBE, based on powerful mathematics, provides an elegant approach to securing online and offline business communication, without the need to pre-register recipients or manage a cumbersome certificate infrastructure.

The company has already launched several products using the Voltage IBE Enterprise Privacy Management platform, and has a number of large customers in the healthcare and financial services industry. Voltage IBE-based protocols for a range of new applications such as Internet telephone services (VOIP) and smart cards are being developed.

#### Why the company is a pioneer

Voltage IBE revolutionises how privacy and security are managed in the enterprise. The system's simplicity means that technically unsophisticated users can easily use powerful encryption to protect private information and confidential business communications.

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