Path- Dependency Analysis on New Emerging Technology: Ubisense

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With thanks . . .

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Contents

1. Origin of the Technology

The history of Ubisense begins in 1996 at the ***Oracle Research Laboratory,*** which was lead by ***Professor Andy Hopper*** (now head of computing at the University of Cambridge). The research laboratory had been going approximately six years before the founders of Ubisense, ***Paul Webster, Andy Ward, Rupert Curwen and Pete Steggles*** joined, having originally been formed as **Olivetti Research**. The remit of the research lab was "advanced industrial research with strong academic connections", connections which usually came through the sponsorship of PhD students at the University.

Even though the Lab was run by a University professor, much of the day-to-day supervision of students was done by the people working in the research Lab, most of whom had an industrial background. Therefore, it provided a good mix between practical and academic research.

Paul Webster, one of the founders of Ubisense said "*As a researcher working in this type of environment, almost from the day you started at the lab you always tended to think about whether this is something you can spin out as a company in two years, three years, or five years from now"*. As such it provided a great deal of focus and motivation for the researchers.

In addition, there were a number of PhD students who were sponsored by the University departments, with their research based on with a firm practical basis. One of these PhD students was **Andy Ward**, who later joined the laboratory and, ultimately, would become CTO of Ubisense.

The mantra of the research lab was "***Invent it, Build it and Spin it out***". There was budget available for building small and medium volumes of prototypes to try out ideas amongst the other members of the laboratory. The ultimate aim was then to use the experience to build up a business plan, and then license the technology or spin out a company. A motivation for the researchers was always that, while the funding body of Oracle had some share of its spin-outs, a significant proportion of the company would belong to the people who had worked on the project, with a smaller amount available at a preferential rate to the people who stayed within the Lab in the form of a "friends and family" round.

When the founders of Ubisense joined the Lab, there had been three successful spin-outs. These companies include (1) Advanced Telecommunication Modules Ltd (Virata), founded in 1993; the company went public on NASDAQ in 1999, raising about $81 million[1], then Virata was sold to Globespan for over $500[2] million in 2001, and then in 2004 Globespan Virata was acquired by Conexant Systems for about $969.5 million[3], (2) Adaptive Broadband; acquired by California Wireless for $11 million[4] one day after the forming the company in 1998 and (3) Telemedia Systems (TSL).

Indirectly Cambridge Broadband was founded in early 2000 by the same team who previously founded Adaptive Broadband. The company has raised over $40 million[5] in total VC funding and has operated in 33 countries since its inception.

2. The Founders and the Technology

One of the founders, Paul Webster got his PhD at the University Manchester where he had worked with Steve Furber, probably best known for his work at Acorn where he was one of the designers of the BBC Micro and one of the architects of the ARM 32-bit RISC microprocessor. Steve provided the connection with Andy Hopper and suggested Paul should apply for a job at Oracle Research Laboratory.

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[1] http://en.wikipedia.org/wiki/Virata_Corporation
[2] http://www.allbusiness.com/finance/945376-1.html
[3] http://www.wi-fiplanet.com/news/article.php/3103221
[4] http://www.theregister.co.uk/1998/09/24/california_microwave_buys_adaptive_broadband/
[5] http://cambridgebroadband.org/

Andy Ward was a PhD student sponsored at the University of Cambridge. Andy's PhD project was on the idea of "fine-grained location", based on the ideas developed from the previous room-scale Active Badge project, but using "ultrasonic" to locate objects to a few cm. During the course of next few years, the founders worked together on this "Active Bat" location system, developing the hardware and software that took it from a small prototype system, with just three sensors, to a deployed 24-7 system that would cover the entire building of Keynes House (1,000m^2). This initial test site demonstrated what could be done with accurate location technology, but was not a viable spin-out company because of the amount of infrastructure required (roughly one sensor per m^2 of coverage) and the resulting high installation cost.

However, it was still one of the flagship projects at the laboratory and generated a large amount of interest. During that time, the founders demonstrated the system to hundreds of people, ranging form local academics from other universities up to the Science Advisory of President Clinton. A number of the visitors even expressed interest in buying systems, but this could not be exploited.

Not all feedback was useful, however. One of the most famous examples was when the Lab was sold to AT&T. C. Michael Armstrong, the CEO of AT&T at the time, had the location system demonstrated to him. His conclusion: "*this is fantastic, but can't you get rid of all the rubbish from the ceiling?*"

In mid 2002, due to the economic turndown, AT&T closed down the lab claiming they could not justify the investment. Ironically within the next month around eight spin-out companies had been formed. One of them was called **Ubiquitous Systems**, which would later change its name to Ubisense.

3. Technology Pathway: From Ultrasonic to Ultra-wideband (UWB)

When the lab closed down, the founders managed to secure an internship period at Amadeus who, due to the exposure the project had generated, were interested in the possible commercial prospects for a "fine-grained location system". At that time, the technology was still planned to be based on an ultrasonic system, albeit simplified hardware designed for the mass market. ***Hermann Hauser***, the founder of Amadeus Capital Partners venture capital firm, had been an Executive Director of the original Olivetti Lab and had a strong connection with Andy Hopper from working together in many of the Cambridge spin-outs, starting back in the days of Acorn. In addition, Hermann had known the Ubisense team, and had always been a big believer in "people and recommendations", rather than just the technology proposition.

During their internship, they were hired for three months at Amadeus Capital partners to investigate the market opportunity for their "fine-grained location system". Amadeus paid the bill and was delivered a detailed report on the technology. In return, the founders could use the Amadeus resources, got a salary to keep paying their own bills, and had the opportunity to put a business plan together. Amadeus also brought in people to talk to the founding team during this process. One of the key changes during this time was to move away from ultrasonic and towards radio based location using **ultra-wideband** (UWB) technology.

Unfortunately the conclusion from the work was that the technology was extremely new, and therefore highly risky. It also proved difficult to apply a traditional valuation model, as it did not work well for this opportunity: There were no direct comparison with other companies at the time and using similar technologies, such as GPS (geographic positioning systems) or traditional RFID (radio frequency identification), skewed the valuation. From a VC perspective, even taking 1% of the market share for these technologies as a model meant that the risk was too great based on the company valuation and their resulting share. The alternative was a revenue based valuation but, as the technology didn't exist, this model tended to skew the valuation too far in the opposite direction.

A crucial turning point was when the founders met ***Hugh Burchett*** from ***Cambridge Consultants***, one of the pioneer Cambridge technology consulting firms since 1960, at a conference related to location based services. Hugh Burchett introduced the founders to the Automotive Division of Cambridge Consultants, who had developed a "Wideband Reversing

Aid" for vehicles. The founders could see that this might be quickly adapted to provide the basis for an ultra-wideband location system, thereby provided the missing link to demonstrate the technology. They licensed some design IP from Cambridge Consultants, acquiring access to a number of core patents in the process, and built an initial **Version 0 Demonstration System** that they started to show to customers in mid-2003.

4. Team Building/ Growth of the Company

One of the founders, Pete, met ***Richard Green*** at a breakfast meeting, organised by Amadeus Capital Partners in late 2002. Richard was the founder of Ten Sails, a location technology consulting firm and business angel, which had been formed following the sale of their previous company, Smallworld. Smallworld was a world leading GIS (Geographic Information Systems) company that had been sold to General Electric for over $200M[6] in 2000. Richard and his team had extensive expertise in GIS systems, which overlapped neatly with the indoor positioning systems proposed by Ubisense.

Richard, along with his team at Ten Sails, worked on business development for early and growth stage technology companies. Richard saw the potential in the technology, and his pioneer spirit in "***high risk but big rewards***" added to the founding team's aspiration in continuing Ubisense. In early 2003, Ubisense entered into a strategic partnership with Ten Sails to further develop the early stage company. Richard joined the team with a focus on business development, and Ten Sails also provided seed funding and additional head count, provided on an "as needed" basis. This had the benefit of allowing Ubisense to quickly establish a U.S presence. In later years, Ten Sails acquired two small consultancy companies, one in the US and another in Germany, which were also available when required.

Ubisense and Ten Sails merged in 2006. This boosted the headcount at Ubisense significantly, providing an established team who already had extensive experience of building and selling software systems globally in the location technology sector. Existing projects, brought by merger, would help fund the development of the new location technology, while the people would help provide the customer relations network, and additional skills required for the company to grow. It also allowed Ubisense to quickly build a strong sales presence in the U.S and European markets as the combined team could leverage their experience and knowledge about the local markets.

According to Richard Green, who moved into the role of CEO (Chief Executive Officer) of the combined company, "This merger was motivated by the tremendous upsurge in sales we have experienced in the past year since receiving FCC approval late in 2004 *(please see section 5)* for our ultra-wideband technology. In less than 12 months, we have acquired more than 80 new customers located around the globe".[7]

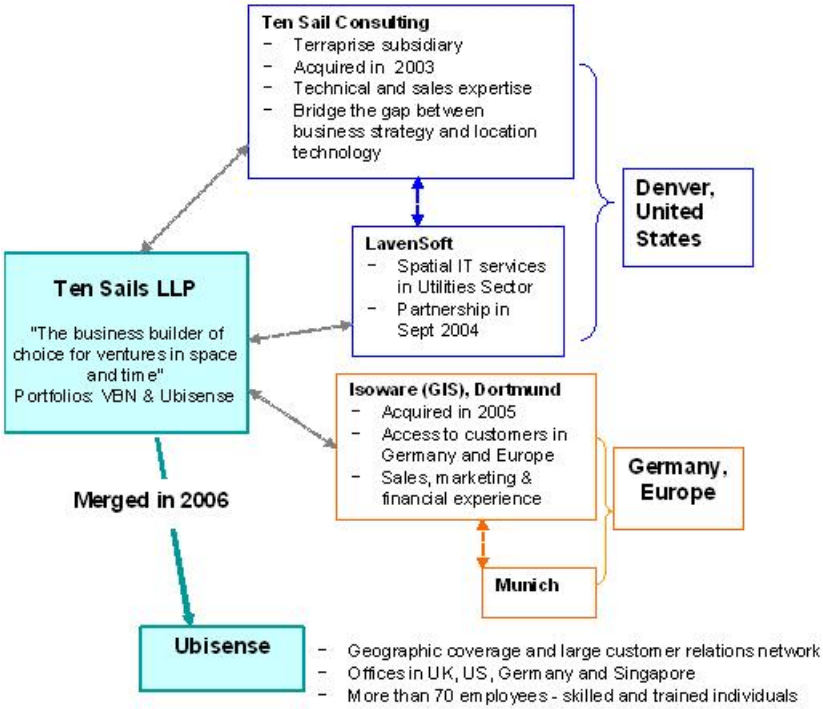
In addition to just people, the merger provided a strategic advantage to Ubisense ensuring steady growth that more than doubled the Ubisense employee headcount to more than 70, with offices located in the United Kingdom, Germany, the United States, and Singapore.

The growth of Ubisense through merger with Ten Sails is provided in Figure 1.

Along with Richard Green, ***Tom Blackie***, ex-Oracle Research Laboratory (AT&T later) and ex-Adaptive Broadband joined Ubisense as COO (Chief Operating Officer) in 2005. Tom brought with him a wealth of technical experience, with the added advantage of having worked with the original infra-red Active Badge location system.

[6] http://www.directionsmag.com/companies/Ten_Sails/
[7] http://www.gismonitor.com/news/newsletter/archive/012606.php#Ubisense

Figure 1: Growth of Ubisense through merger with Ten Sails



In order to build credibility, and to best manage this period of growth, Ubisense sought expertise from some of the most prominent industry visionaries by inviting them to become members of the Board of Directors. Firstly, ***Andy Hopper*** was appointed Chairman of the Board. He is considered one of the foremost leaders in the technology industry, having co-founded twelve successful companies including Acorn Computers Ltd., acquired by Olivetti; Adaptive Broadband Ltd., acquired by California Microwave, Inc.; Cambridge Broadband Ltd.; Level 5 Networks, etc. Other members of the board now included ***Robert Sansom***, an active angel investor and mentor to many start-up businesses, who was also co-founder and chairman of Cambridge Angels. Robert had extensive experience in the data communications industry and had co-founded FORE Systems, which had been acquired by Marconi for $4.5 billion. ***David Gammon,*** the founding member of the technology private equity advisory team and research and data services company **Library House**, contributed his more than 20 years of experience in financial investment services.

Dick Newell and ***Martin Cartwright***, both ex-Small World and ex-Ten Sails, brought with them over 20 years of experience in the technology industry, with Dick serving on the board as a Director and Martin becoming CFO (Chief Financial Officer). Finally, ***Peter Harverson,*** who has held a number of senior executive roles at Sun Microsystems, Cadence Design Systems, Intel Corporation and Texas Instruments, also joined the board to provide a sales and licensing perspective.

Ubisense has subsequently grown to over 100 employees, operating out of 7 offices based in the UK, US, Germany (three offices, providing coverage for the European market), and in Singapore and Korea for the Asian market.

5. Regulatory Requirement

The FCC (the Federal Communication Commission), the US radio regulatory authority had pioneered the regulation for UWB devices in 2002. Ubisense was only the fourth company in the world to achieve FCC certification with their **version 1.0** product in 2004; they missed out on being the third by only one day. This allowed to product to be sold freely in the U.S.

After FCC certification, Ubisense lobbied the regulatory authorities in the UK and Europe to provide similar approval mechanisms. This was essential for growth, as Europe had a much larger potential market and is generally more receptive to emerging technologies. However, the Europe regulatory framework was much more complicated than US regulatory authority.

On the one hand there were a number of member countries to convince to secure their approval. There was also much greater lobbying power by several existing groups who had invested heavily in costly radio spectrum. These groups included TV broadcasting companies, direct broadcast satellite, and mobile phone companies, all of which fiercely protected their valuable spectrum. Even the politics of influencing regulation proved complicated as there were a series of regulatory meetings where one of the core technical team members needed to be physically present, spending most of their time just waiting to see if there was someone who might have questions that needed a response.

This process took about two and half years, with a great deal of investment in time and human resources. During that period, there were other entrepreneur colleagues from the local network such as **David Cleevely**, the founder of telecom consultancy Analysys and the web based Antibody company, Abcam, who tried to help accelerate the process. Andy Hopper even spoke to the government for regulatory support on behalf of Ubisense but this did not make a significant impact on the amount of support provided.

Due to the regulatory restrictions, Ubisense had a significant barrier to sales in Europe. Essentially, any customers would need to apply to their national radio authority to get "test and development" license for their side whenever they need every single installation. This deterred many corporate customers from investing in a technology that might be later deemed illegal by the radio authorities. However, this did not delay the development of the product and the technical team upgraded the product to **version 1.1**, a much smaller version that was otherwise functionally identical to the original version.

By the end of 2006, the team had successfully achieved a framework for European regulatory approval. Within 6 months, the team redesigned the entire product range to be smaller, cheaper, longer range and – most significantly – to include European and US compliance.

In May 2007 they released the first **version 2.0** products, later rebranded as **Series 7000**, which was the world's first, and still currently the only, commercially available UWB solution that has FCC and CE approval.

6. Market Segment

Ubisense raised $3 million funding in the first quarter of 2006, to be invested in product development and marketing initiatives to allow it to expand its ability to meet the precise location tracking needs of a rapidly expanding customer base.

6.1. Initial Proposed Market Segments

UWB had been used a number of years by the military for secured communication. Early vendors continued to target this market for much of their revenue. For example **Time Domain** sells through-wall radar.

Therefore "Security and Military" was initially identified as a possible early market segment. Ubisense's technology could be applicable in an environment where there were items of a sensitive nature, for example for a company like Amersham who does nuclear medicine and therefore has access to radio isotopes that need to be moved around between secured areas. Another example was a Bank of England facility that disposed of bank notes, as they carefully needed to track the notes through the process to make sure none of them went missing on the way. Despite the perceived importance of security, there was not the budget to invest in new technology.

The military sector also provided early disappointment, as despite a series of very successful customer demonstrations at high profile events these never seemed to materialise into actual orders.

6.2. Vertical Market Development

The version 1.0 prototype had been used and evaluated at university research laboratories, by the US military, and by a number of large companies including Cisco, Accenture, Intel, HP, etc,. Ubisense received good feedback regarding the prototype system, building the confidence that there would be a huge potential market.

By the end of 2006, Ubisense had more than 100 customers worldwide. While they had not found a big vertical market quite yet a handful of customers were rapidly moving towards the stage where they wanted to deploy systems far more widely than had previously been attempted, as well as use them in mission-critical areas of their business.

A number of market sectors had been identified such as security/military, logistics and manufacturing, web-space, retail and sport/ entertainment. One challenge of Ubisense has always been that the location technology could be applied to almost any application. In order to build a business, though, the problem was finding an application where there existed a problem causing real customer pain that no other technology could solve. Based on the experience to date they decided to focus on manufacturing and logistics, with a particular emphasis on the automotive industry.

Working closely with an initial lead customer, the team spent a lot of time identifying where the pain points where and benchmarking the Ubisense solution against the other technologies available. One of the challenges car manufacturers are facing is to optimise their manufacturing processes. These days, every car produced is unique, being made to order. Once the cars go on the production line, each work station has to dynamically change their configuration for different components, different bodywork materials, etc. based on the order schedule. Existing solution are inefficient, using printed barcode technology to identify vehicles that needed manually scanning to configure the process steps.

The lead customer had two problems they needed to solve: one was reducing the number of errors caused due to incorrect configuration (e.g. if a barcode fails to scan), while another was removing the manual time that it took to scan the bar code. As the factory produced approximately 1,100 cars everyday these optimisations had the potential to save at least a million Euros a year through a combination of increased efficiency, increased quality, and reduced production costs.

Challenges to the Ubisense technology included demonstrating 99.99% reliability with the product. In total development work to bring the system to the point where this could be demonstrated, along with negotiating the sale, took nearly a year. However, in the third quarter of 2007, Ubisense managed to get its biggest single order to date, worth over US$ 1 million from the customer. The subsequent deployment has taken another 6 – 9 months, but is now nearing completion for subsequent customer sign-off. It is already in daily use.

Creating this vertical market has played a critical role in Ubisense's current success. All automotive and aircraft manufacturers have similar requirements for real-time process tracking and monitoring.

After crossing the chasm, Ubisense has received additional orders from other car and aeronautic manufacturers, and looks set to receive a number of follow-on orders from the original lead automotive customer.

7. Ubisense Beyond 2008

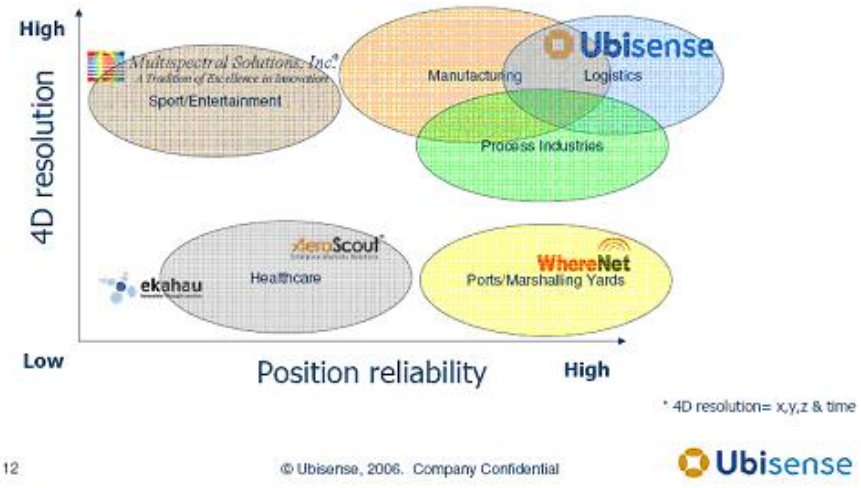
The Ubisense series 7000 product line, launched in second half of 2007 has been demonstrated to be applicable to a variety of applications in the manufacturing and logistics sectors. The accurate location information provides the end customer with greater process visibility by monitoring the flow of material both by the direct tracking of goods, and through indirectly tracking the movement of equipment used in the transportation process, e.g. ground conveyors, tools, ID scanners or fork lifts. As a result it can provide improvements in security, product quality, and process efficiency.

Similar benefits can be provided to other market segments, and Ubisense is in the process of closing final negotiations with a number of major customers in the military training, worker safety, retail, and even entertainment sectors.

However, in this competitive environment, Ubisense needs to monitor existing and new applications produced by its competitors.

The Ubisense market position is provided in Figure 2.

Figure 2: Market Position



Source: Ubisense

While Ultra-wideband (UWB) Real Time Location Systems (RTLS) offer the best accuracy and immunity to interference both indoors and outdoors this comes at the cost of requiring a networked sensor infrastructure. Price will always be an issue and, among its UWB competitors, **Time Domain** has recently announced a low cost version of its system.[8]

Considering alternative technologies, **WhereNet**, whose system is based on conventional RFID tracking technology providing 5-10 meter accuracy in outdoor environments, claims to be cheaper than those of Ubisense but cannot offer the precise accuracy and reliability. Interestingly they have recently acquired one of the original UWB providers, **Multispectral Solutions** to develop their own UWB solution.

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8 http://www.idtechex.com/research/articles/rapid_improvements_in_real_time_locating_systems_00001036.asp?rsstopicid=3

AeroScout, based on industry standard Wi-Fi technology, claims to have the advantage of being able to make use of existing infrastructure investment. Their system claims 3-5 meters accuracy, but is usually less accurate in practical deployments.

Sonitor is based on ultrasound technology, with a focus on Hospital sector. Its advantage is that its system is claimed not interfere with facilities at hospital. However, unlike the other RTLS systems, including the original prototype developed by Andy Ward during his PhD, the Sonitor system can only offer room-scale location.

Nevertheless, according to Paul Webster, 2008 and beyond should be a very exciting and interesting time for Ubisense, with many more opportunities for the product in applications across a much wider variety of industries.

In addition, they are set to deliver a Korean and Japanese-compliant UWB-based RTLS, which will strengthen the revenue-generating power in Asia.

Notes from Authors:

Path Dependency is a new economic theory paradigm. According to Path dependency the final outcome is fixed and unknown and is dependent on (a) starting Point and (b) accidental Events.

The path dependency theory of economical evolution states as **that it is impossible to plan and execute as per plan as the execution depends on the choices offered and the one selected[9].** Path dependence refers to the "lock-in" effects of choices among competing technologies. It does not discount the fact that an entrepreneur can create his own path, but it states that the path creation is again a function of the path dependency. Most of the current research only looks at these theories from a technology adaptation standpoint, i.e. why do consumers make the decisions that they do.[10] It does not explore its impact on managerial decisions inside the company. In addition, there are well developed models of entrepreneurial process such as the models of Timmons and Moore[11] and to see how well these represent the commercialisation of disruptive technology. The Ubisense case study is developed with a focus on the "path dependency" as the main underlying factor, especially analysing whether each type of disruptive technology have an 'ideal' path for commercialisation.

Questions:

- After reading Ubisense case study, what do you think are the pathways of success in commercialising its technology?
- What do you think of Ubisense funding model? If Ubisense secured the VC funding, how would Ubisense current position look like?
- How important are regulatory approvals? If Ubisense did not achieve this, what would be the choices for Ubisense for developing its technology?
- How important are the role of board, acquisitions & partnerships for Ubisense? What aspects of Cambridge phenomenon have contributed the company for future growth potential?
- What aspects did you learn from market segmentation and development?

[9] http://en.wikipedia.org/wiki/Path_dependency

[10] http://www.easst.net/review/mar2006/deus, http://www.utdallas.edu/~liebowit/paths.html

[11] http://www.babson.edu/entrep/fer/papers96/bygrave/bygrave2.htm

Appendix 1: The Founders of Ubisense

Pete Steggles, Chief Product Officer
Pete has fifteen years of experience in software engineering and consultancy. He leads Ubisense's product design and development activities. He studied at Cambridge University, where he received a BA in Philosophy, a Diploma in Computer Science, and the Olivetti Prize for excellence in computer science. He was leader of the Sentient Computing project at AT&T Laboratories Cambridge, where he designed the software for the world's first fine-grained, real-time location system to cover an entire building, and began the market involvement that lead to the formation of Ubisense in 2002.

Rupert Curwen, Lead Architect - Software Systems
Rupert has fifteen years of experience in software engineering, and leads the development of the company's innovative software platform. He studied at the University of Oxford, and received a BA in Engineering and Computer Science, and a doctorate in Computer Vision. After a postdoctoral position in Diagnostic Radiology at Yale University, he joined General Electric Corporate Research and Development, in Schenectady, NY, where he was granted two patents in cardiac MR. He then returned to England to join the Sentient Computing project at AT&T Laboratories Cambridge, implementing and supporting advanced distributed systems and novel ubiquitous applications.

Andy Ward, Chief Technology Officer
Andy is one of the world's most experienced location system engineers. He has designed, built and worked with in-building location systems for over nine years and leads technology planning and development for Ubisense. He studied at Cambridge University, and received a BA in Computer Science and a PhD in Sensor-driven Computing. He led the Location Technology project at AT&T Laboratories Cambridge, and was an early proponent of ultra wide band (UWB) radio for in-building positioning. He has experience of all levels of system design, from hardware, though embedded firmware, to software, and seven patents based on his work over the past five years have been granted.

Paul Webster, Lead Architect - Hardware Systems
Paul has over twelve years experience of hardware-based systems design, and leads hardware development for Ubisense's location system. He studied Computer Science at the University of Manchester, where he was awarded the Professor's Prize and the Kilburn Prize for outstanding academic achievement. He went on to receive a PhD in Analogue and Mixed-mode Simulation, before joining AT&T Laboratories Cambridge. There, he worked on the early systems software and middleware for the Sentient Computing project, and led a number of complex hardware projects, including the design of a complete 32-bit processor and its associated tool chain. He was also a visiting lecturer in the Engineering Department at the University of Cambridge, where he taught courses covering wireless networking and mobile computing.