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**Application Visions and Business Opportunities of Bluetooth**  
**– A Wireless Technology for Local Data Transfer**

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## **1 INTRODUCTION**

The development in telecommunications and computing sectors has been rapid in recent years. New products and services – both product upgrades and more innovative concepts - come out at an increasing pace to compete for market positions. The telecommunications and computing sectors are converging to form a new industry that may be called multimedia or infocom industry, while new innovations are transforming current business structures. One of the most promising new innovations today is Bluetooth, a wireless technology for data transfer, which allows devices such as portable computers, mobile phones, household appliances and other electronic devices to communicate with each other at short distances without the burden of cables. In addition to replacing the cords and offering convenience, Bluetooth enables the forming of ad hoc networks and supports automatic data updating between devices. Bluetooth is a low-cost technology and it is therefore predicted to be attached to most electronic devices in a few years. If these predictions come true and Bluetooth becomes ubiquitous it may cause some major changes in the value chains and business models of the multimedia industry of the future.

This working paper is an exploratory study of the application visions and general business opportunities of Bluetooth technology. The paper first presents the technical and network characteristics of the technology in general to clarify its possibilities and limitations. Competitive technologies are introduced briefly to give a more exact idea of the future market situation of Bluetooth. Then the application visions of Bluetooth are discussed and classified. The technology is examined from a strategic perspective with regard to its nature as an enabling technology and as a value innovation, and from the perspective of customer needs. Factors affecting the diffusion of Bluetooth technology in the marketplace are contemplated, and the position of Bluetooth in relation to future trends in the field of communications is discussed. Finally, issues related to business models and value networks and their further research are brought up.

## **2 BLUETOOTH TECHNOLOGY**

Bluetooth is the official name for a specification of wireless technology that lets devices communicate in short distance with each other by using a secure radio frequency. The name was given to this new radio technology after the 10<sup>th</sup> century Danish Viking King Harald Blåtand (Bluetooth), because the technology has been developed in collaboration of the computing and telecommunications industries and it was originally aimed at unifying them, like King Harald once unified Scandinavia. Actually, the new technology may do much more than that: it is predicted that it will grow to influence nearly all areas where cable replacement is needed. (www.bluetooth.com 2000) Bluetooth-enabled portable computers, mobile phones, office equipment, household appliances and other electronic devices can communicate at short ranges without cumbersome cable connections. In addition to easy connectivity with Bluetooth, communication is secure and inexpensive, and happens at a fairly high data transmission rate without line-of-sight requirements, which all are characteristics that make it suitable for multiple situations. (Frazier 2000, 43)

Bluetooth technology has been developed and promoted by the Bluetooth Special Interest Group (SIG), which was founded in 1998 by Ericsson, Nokia, IBM, Intel and Toshiba Corporations. Four other companies, Lucent Technologies, Motorola Inc, Microsoft and 3Com Corporation joined the Promoter Group in December 1999. Bluetooth SIG is an open industry group, which any company can join with no cost as an adopter company. The group has currently about 1900 associate members, who are allowed to use the specification for developing and manufacturing products and software. Bluetooth SIG's purpose is to promote Bluetooth and ensure that the devices being developed will be compatible with each other. SIG also sees to that the products allowed to use the trademark comply with the specifications and meet the required qualifications. (Bluetooth SIG)

### **2.1 Technical characteristics**

Bluetooth creates ad hoc wireless networks among just about any devices with the necessary logic. The Bluetooth device itself is a small, low-powered radio on a chip

that operates in the 2,45 GHz radio band, which is unlicensed and available almost worldwide (Frazier 2000, 43). The Bluetooth radio link should be able to transmit through non-metal solid objects and therefore allow data transmission through thin walls and briefcases. As a short-range radio link Bluetooth operates in all directions and carries from 10 centimeters to 10 meters, but it is possible to extend the transmitting range up to 100 meters by increasing the transmitting power. (Hill 2000, 16)

The technology unites circuit and packet switching and uses a frequency hopping technique, which means that it changes the frequency it is using to send data packets 1600 times per second. It is designed to operate in a noisy radio frequency environment and to avoid interference from other signals by hopping to a new frequency after transmitting or receiving a packet of data. By shifting between different radio channels within the band range the Bluetooth radio finds the frequency with the least interference and noise. (Karlstedt 1999b) The maximum throughput of a radio is 1 Mbit/sec, but at the moment the speed of only 721 Kbit/sec is reached, which is still about 13 times faster than a modern modem. (Klopp 2000, 117, 126)

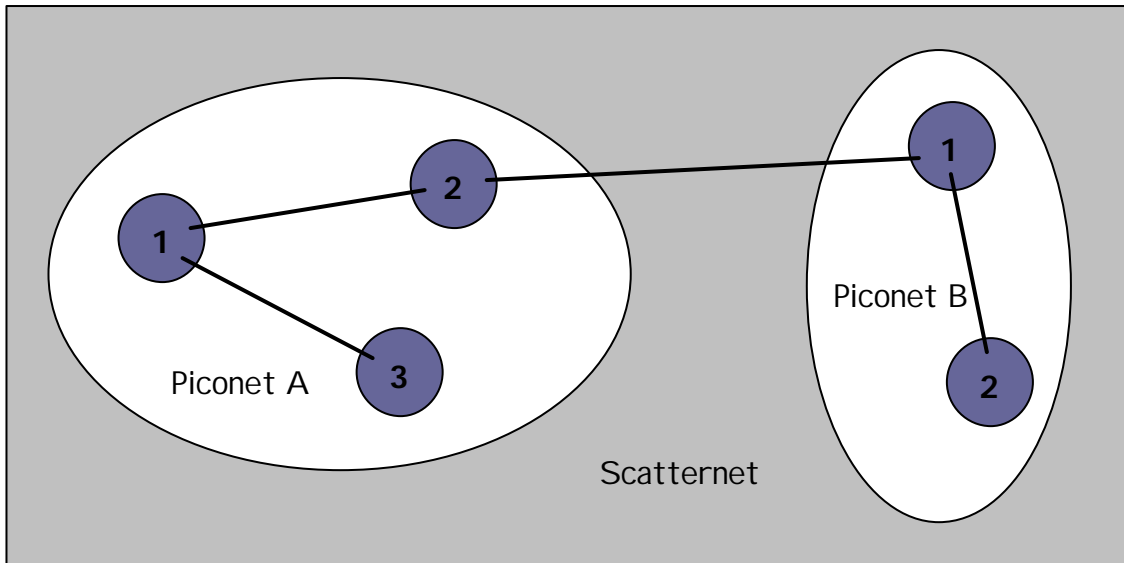
Since Bluetooth is designed for portable devices to be used anywhere, it must be small in size and in power consumption. The early implementations of Bluetooth electronics use multichip modules consisting of a microchip, an antenna and software. They are also bigger than the desired 9x9 mm chip. (Piven 1999, 1) The producers are trying to reduce the number of modules to two or ideally to just one. This will reduce the size of the chip, cut the manufacturing and assembly costs, and improve reliability. (Zeichick 2000, 242) At 0,1 W power consumption and the potential cost of \$5 or less per device in the mass market volume the chip will be both low-powered and relatively low-priced, which are qualities that make it ideal for mobile appliances. However, a Bluetooth chip still costs about \$20-\$30, but the price of a chip system is estimated to fall down to \$5 within about three years. (Deckmyn 2000, 73; Sabatini 2000, 63)

The Bluetooth capability can be attached to devices in several ways. It can be either integrated or added to products, and the integration may be done by several industry players. It is likely that the Bluetooth capability is first added with adapters and PC-cards, but later on as it becomes cheaper it will be integrated into all devices. It is yet to

be seen who will eventually take over the task of adding Bluetooth, because several players could be interested in it. Right now it seems that device manufacturers are the ones adding or integrating it to devices they develop. The microcircuit can also be added to computers by using a card or via a Universal Serial Bus (USB) connection, which creates opportunities for card manufacturers once they get their cards ready. In mobile phones the chip can be integrated into the mobile phone's circuit board, SIM-card or attached as an external card, which can make it an interesting business opportunity for both phone manufacturers and operators. (Karlstedt 1999a) In order to become a built-in feature, Bluetooth devices need to be fully interoperable. The interoperability of devices from different manufacturers is enabled by a shared Bluetooth-defined profile specification. For consumers, interoperability will mean the cross-compatibility of devices and accessories. (Karlstedt 1999b) For example, a mobile phone with a headset profile will support any Bluetooth enabled headset. This also means that new Bluetooth products entering the market will be fully interoperable with their older counterparts.

## **2.2 Network characteristics**

Bluetooth supports point-to-point and point-to-multipoint connections. The connection can be formed between two or up to eight devices within the radio range. A group of devices forming an ad hoc connection is called a piconet: it starts with two devices, such as a laptop and a mobile phone, and may grow to eight connected devices. All Bluetooth devices are peer units and have identical implementations. However, the device that initiates the connection acts as a master and the other devices function as slaves for the duration of the piconet connection. The master controls the slaves and ensures that the slaves continue hopping on the same frequency as the master. (Piven 1999, 24) The configuration of a Bluetooth system is highly adaptable, allowing a Bluetooth unit to simultaneously act as a master in one piconet and as a slave in another. Within the piconet, slaves communicate only with the master but they can be connected to devices in other piconets. That way they create multiple connected piconets, called scatternet, where each piconet has an individual hopping frequency. Ten of these piconets can coexist in the same coverage range of the Bluetooth radio. (Zeichick 2000, 242)



**Figure 1** Ad hoc networks

The master/slave relationship in a piconet is handled by a link processor that also converts voice to digital data, splits it into packets and performs error correction. The link processors have to be functionally identical on all Bluetooth-compliant devices for the devices to be able to communicate with each other. Communication between devices happens automatically and transparently when the device is turned on. Each device in a piconet has its own address, on the basis of which the devices are able to identify themselves to each other. The identification includes a description of the type of the device, the functions it supports and which devices are authorized to access those functions. (Zeichick 2000, 242) Proper identification is essential, because without it the devices would try to contact every Bluetooth device around, which would considerably slow down the data traffic and cause security problems.

### 2.3 Competitive technologies

Bluetooth is not the only technology enabling wireless connections and local networks. Point-to-point connections can also be formed with IrDA, an infrared technology provided by Infrared Data Association, whereas wireless local area networks (WLAN) can be built up using either HomeRF or the 802.11 standard. Both network technologies use the same ISM-frequency area as Bluetooth, so there might be problems when using them at the same time in the same area (Pönkänen et al 1999). All

these technologies are partly overlapping and partly suitable for different kinds of purposes because of their special features (Diehl 2000), so each of them could fill a specific niche in the future marketplace of wireless communications.

### 2.3.1 IrDA

Infrared technology transfers data at short, line-of-sight distances, replacing cables. At first glance, Bluetooth and IrDA seem to compete with each other since they both provide short-range wireless connectivity. However, each of the technologies has its advantages and drawbacks, and neither of them can meet all users' needs properly in every usage situation. Data transfer with IrDA is possible at 4 Mbps over a distance up to 1 meter and it requires the devices to be pointed at each other allowing a narrow angle of 30 degrees. IrDA is already much faster than Bluetooth and it will become even faster when the planned transfer rate of 16 Mbps is reached. Where IrDA falls short of Bluetooth is in the considerably shorter distance over which it carries and in the fact that it needs a line-of-sight connection. IrDA is best suitable for focused point-to-point connections, and data exchange is considered its fundamental function. Many of the applications defined for IrDA are also defined for Bluetooth and it may seem that they could support the same applications. However, the scenarios where IrDA falls short are the ones in which Bluetooth excels and vice versa. (Suvak 2000)

In a common data exchange scenario, two people meet face to face and wish to exchange business cards in a conference room. Several other people carrying wireless devices are also present in the large room and possibly attempt to exchange cards as well. With IrDA, these people can simply aim their devices at the intended recipient device and make the exchange without interfering other exchange situations. The exchange is secure and easy to use because of the short-range and narrow angle of the technology. With Bluetooth, the same situation becomes more complicated and time consuming because close proximity to the intended recipient does not help. A Bluetooth device has to first discover the right device among many other devices in the same room and then execute security measures to prevent unauthorized access. (Suvak 2000)

In the above situation Bluetooth has some drawbacks but in some other exchange situations it excels. Bluetooth allows data exchange when real mobility is required and when line-of-sight connection is not possible, whereas when using IrDA the devices need to be placed properly and remain stationary during the data transfer. IrDA can provide only point-to-point connections between two devices, whereas with Bluetooth the forming of ad hoc networks among multiple devices is possible. In addition, Bluetooth is better for the synchronization of data between devices because it can happen automatically and when moving around. Wireless connectivity to a wired network such as LAN is an important feature in both technologies, but Bluetooth is better suited for it because there are no line-of-sight requirements and it is capable of efficiently sharing the media, even though its performance is weaker. The price of an IrDA solution is about \$2, whereas the cost of integrating Bluetooth into first generation products is initially projected to be around \$20 and within a few years it is estimated to fall to \$5. (Suvak 2000)

### 2.3.2 HomeRF and 802.11

HomeRF and 802.11 are Wireless Local Area Network (WLAN) technologies for networking and therefore overlap Bluetooth with different features than IrDA. They function in the same frequency band with Bluetooth, but they are heavier and more expensive solutions. (Diehl 2000) They currently provide higher speeds at data transfer, as the data speed with HomeRF is 1-2 Mbps (HomeRF WG) and 1-11 Mbps with 802.11. 802.11 actually refers to a family of specifications, which include three specifications with different features and capabilities. (Whatis?com)

802.11 products can establish ad hoc networks or link to wired networks. 802.11 is a heavy business solution and is mostly used in offices, whereas HomeRF is more inexpensive because of less overhead capacity and is therefore more suitable for homes. (Diehl 2000) HomeRF has some similarities to Bluetooth, but it also differs from it. The maximum amount of devices in a HomeRF network is 127, the operating distance maximum is 100 meters, and the technology consumes more power and is more expensive. Due to these reasons, HomeRF is more suitable to heavier use and not usable in mobile phones, and thus it is not a direct substitute for Bluetooth. (Pönkänen et al.1999)

Interference between all these 2.4 GHz standards has been debated. Some experts are certain that Bluetooth will interfere with HomeRF and 802.11, whereas others disagree. Although Bluetooth can co-exist with 802.11 or HomeRF over a wider area, they are unlikely to work together in close proximity (Hunn 2000). Tests have shown that Bluetooth devices may slow down the traffic in WLANs by tens of percents (Leino 2000b, 13). Another concern is the possible wide-band noise interference by cellular systems such as GSM or CDMA, which may even block Bluetooth signals. It will be up to engineers to implement effective filtering strategies to reduce interference across all these technologies. (Diehl 2000)

An important issue is whether there is room for all these standards in the market. They all have some similarities but also differing features, which make them better suitable for some specific area of use, and they are thus not direct substitutes. WLAN technologies can basically be used to form networks over a wider area, and connections with Bluetooth at considerably shorter distances. Therefore, 802.11 and HomeRF may be better suitable for networking in a house but Bluetooth works best as an enabler of Personal Area Network (PAN) and mobile connectivity. IrDA, on the other hand, is at its best when focused point-to-point connections are needed. (Diehl 2000) 802.11 and HomeRF may well be faster at data transfer and thus better at wireless networking but Bluetooth is more versatile. It can be used wherever the user is – at home, in the office or on the move. It may not perform as well as specialized devices in every usage situation, but its overall ubiquity makes it very useful. Bluetooth has also better cost reduction opportunities and breadth of usage applications to drive the price down, which can facilitate its becoming a leading standard. (Hunn 2000) It is still too early to say which one of the technologies will survive and dominate the others, or if there is a commercial niche for all of them. It is likely, however, that there will be a dominant standard for wireless LAN in five or ten years. (Diehl 2000)

## **2.4 Problems and delays in Bluetooth development**

Bluetooth is going to add many fascinating features into devices and to enable easier communication between them. It promises to do a lot and much is also expected from it, but it is still far from fulfilling these expectations. The development of the standard has been more complicated than anticipated, and thus it has taken more time than was estimated. The first Bluetooth applications were promised to enter the market already last year, but the launching point has been postponed several times so that the first products are currently expected to arrive at the market at the end of this year. (Leino 2000, 13) The problem is that there are not enough chips available even for development purposes, and the chip modules available at the moment are still in the beta phase and cost as much as \$100. There are also problems with several features of the technology and all the promised functions do not work yet. Bluetooth has still problems with transmitting through even some of the thinnest materials and the operating range is currently under 10 meters. The chips that are available at the moment also support only point-to-point connections, and the achieved data speed still falls short of the speed in the standard. In addition, the interference problems with other technologies remain unsolved as well. (Bluetooth Research Group)

Problems in developing standards are quite normal but they can become fatal if solving them takes too much time and other technologies gain market share in applications critical to successful diffusion. In the case of Bluetooth, other wireless technologies may become widely adopted before the problems with the standard are overcome, which can then considerably threaten the diffusion and adoption of Bluetooth. If the expectations cannot be fulfilled in due time, the expectations toward Bluetooth may start declining and threaten the success of the whole technology. Therefore, it is important to have some proof of the capabilities of the technology and its upcoming features in the near future.

## **3 BLUETOOTH APPLICATIONS**

In this chapter Bluetooth applications are divided into products and services. The difference between a product and a service is not clear, however, in all the applications

in information technology and telecommunications industry. For the purposes of this working paper, it can be said that a Bluetooth product refers to a device containing a Bluetooth chip with the basic characteristics that Bluetooth offers. A Bluetooth-enabled service, on the other hand, refers to activities that add value to the basic usage of Bluetooth products. The term Bluetooth application refers to both Bluetooth products and Bluetooth-enabled services. In this chapter, the application visions of Bluetooth will be presented, discussed and classified, the benefits of Bluetooth and the service visions analyzed, and some marketing-related themes debated.

### **3.1 Products**

The current market for portable devices is segmented into entertainment, mobile connectivity and professional devices. New types of devices integrate these classes and call for connectivity that is easy to deploy. (Moloney 2000, 113) Bluetooth offers this easy and convenient connectivity: with a single, small radio chip Bluetooth technology can replace cable connections in all sorts of devices. Early products will focus on point-to-point connectivity because of the current focus on mobile phone applications (Aliwella, Wight & Paillard 1999, 106). A list of Bluetooth products already under development is presented in Appendix I.

According to Joyce Putscher, an analyst at Cahners In-Stat Group Inc., Bluetooth will roll out in three waves: in the first wave Bluetooth will be attached to high-end cellular phones and through PC cards to notebooks, and it will be offered as an option on some laptops. The first set of Bluetooth products will be targeted for business professionals who use wireless data to increase their productivity. In the second wave, the Bluetooth-enabled device collection will diversify, with the technology serving consumers in everyday situations. The second wave will engulf lower-cost mobile phones and portable devices, digital cameras, printers, automotive systems, home networking and a variety of vertical markets. In the third wave, the technology will be ubiquitous and appear in all kinds of devices to make their use more convenient. (Karlstedt 1999a; Menezes 1999; Ohr 1999b) In general, the terminals that are planned to contain a Bluetooth chip in the near future are small and relatively simple, like mobile phones and Personal Digital Assistants. The basic features of these terminals, such as memory

capacity and energy usage, should be taken into consideration when planning the Bluetooth applications and services.

Cahners In-Stat Group forecasted in December 1999 that by 2005 there would be 672 million Bluetooth units and the semiconductor market itself would be worth \$3.2 billion. Dataquest has presented similar projections, and according to them there would be 572 million Bluetooth units in 2004, and two-thirds of all new mobile phone handsets would make use of Bluetooth. All the forecasts start from zero point this year and explode upward with compound annual growth rates of 100 % or more. Table 1 presents the annual projections of Dataquest. (Hogan 2000, 118)

**Table 1** Bluetooth mobile handsets: sales, penetration and growth rates  
(Dataquest Inc. in Hogan 2000)

|                                                     | 2000  | 2001   | 2002   | 2003   | 2004   |
|-----------------------------------------------------|-------|--------|--------|--------|--------|
| Number of Bluetooth handsets<br>(millions of units) | 1,2   | 28,8   | 123,7  | 318    | 572    |
| Percentage of all new handsets                      | 0,3 % | 5,3 %  | 18,5 % | 40,8 % | 65,4 % |
| Growth rate                                         |       | 2329 % | 330 %  | 157 %  | 80 %   |

Bluetooth can do more than just replace point-to-point cables. It supports point-to-multipoint connections as well, which enables connection of multiple devices into instant, ad hoc networks. Some people envision executives in a meeting linking their handheld computers to compare agendas or to exchange virtual business cards or other files. A speaker could also send slides wirelessly to an overhead projector. Another advanced use of Bluetooth technology would be an Internet or LAN access point, which could be used just by standing nearby, and the cell phone or handheld could log on at a quite respectable speed of 721 Kbit/sec. (Deckmyn 2000, 73)



**Figure 2** Typical devices containing a Bluetooth chip

### 3.2 Classification of Bluetooth visions and benefits of Bluetooth

Bluetooth applications can be classified by several criteria, for example by the type of application, its expected rollout time or the value it offers. Due to the enabling nature of the technology the value added by the application is used as a criteria in this paper. Bluetooth brings new features to current devices and its contribution to them can be seen best by looking at the additional benefits. Table 2 shows the visions collected from current literature (a detailed list of different visions is presented in Appendix II), classifying them according to the characteristics of Bluetooth they are based on, the benefit they offer to the user, the possibilities of corporate use and the service attachment. Corporate use refers to application visions that can be marketed to companies to bring them improvements in productivity and efficiency, and enabling cost savings. As can be seen in the Table 2, some applications use only certain characteristics of Bluetooth – for instance the headset is based on wirelessness – while other concepts like the cordless office are based on a wider use of Bluetooth characteristics, and therefore the added value through Bluetooth usage is greater.

**Table 2** Classification of Bluetooth applications

| Vision                                        | Bluetooth characteristics |                    |                                 |                         | Benefit/ value added                                      | Corporate use | Service attachment possibilities | Issues to take into consideration                                | Examples                                                           |
|-----------------------------------------------|---------------------------|--------------------|---------------------------------|-------------------------|-----------------------------------------------------------|---------------|----------------------------------|------------------------------------------------------------------|--------------------------------------------------------------------|
|                                               | Wirelessness              | Local area network | Internet/ intranet connectivity | Automatic data updating |                                                           |               |                                  |                                                                  |                                                                    |
| Headset                                       | x                         |                    |                                 |                         | Convenience, safety                                       | x             | Listening to music in trains.    |                                                                  |                                                                    |
| Game network                                  | x                         | x                  |                                 |                         | Entertainment, convenience, several players               |               | Game ordering/ updating          |                                                                  |                                                                    |
| Multiparty data exchange                      | x                         | x                  |                                 |                         | Convenience                                               | x             |                                  |                                                                  | Conference material, slides, business cards                        |
| Recognition                                   | x                         | x                  |                                 |                         | Convenience, security                                     | x             |                                  |                                                                  | Access supervision in buildings, personal adjustments to one's car |
| Advertisement push                            | x                         | x                  |                                 |                         | Convenience, special offers                               |               | Service packaging                | Is the customer willing to receive ads?                          | Shopping centers, amusement parks                                  |
| 3 function phone                              | x                         | x                  | x                               |                         | Convenience, cheapest possible calls, one phone is enough | x             |                                  | Acceptance of operator?                                          |                                                                    |
| Long distance remote control box              | x                         | x                  | x                               |                         | Convenience                                               |               |                                  |                                                                  |                                                                    |
| Data transfer                                 | x                         | x                  | x                               |                         | Convenience, security, entertainment, productivity, speed | x             |                                  |                                                                  | Digital camera, MP3, safety bracelet, car alarm etc.               |
| Smart navigation systems                      | x                         | x                  | x                               |                         | Convenience, security                                     |               | Maps, traffic info               |                                                                  |                                                                    |
| Electronic wallet/ ID/ key                    | x                         | x                  | x                               |                         | Convenience                                               |               |                                  | Cooperation with a financial company? Transaction security?      |                                                                    |
| Wearable intelligence                         | x                         | x                  | x                               |                         | Convenience, security                                     |               | Health care services             |                                                                  |                                                                    |
| Interest recognition                          | x                         | x                  | (x)                             |                         | Convenience, entertainment, right contacts easily         |               | Preference registration          | Intelligence of the device? Where are the preferences specified? | Trade fair, Lovebeeper                                             |
| Cordless office                               | x                         | x                  | x                               | x                       | Convenience, no wires, easily adjustable, inexpensive     | x             | Service packages                 |                                                                  |                                                                    |
| Cordless home entertainment center & security | x                         | x                  | x                               | x                       | Convenience                                               |               |                                  |                                                                  |                                                                    |
| Process control                               | x                         | x                  |                                 | x                       | Efficiency, quick response, quality                       | x             |                                  |                                                                  |                                                                    |
| Public Internet port                          | x                         |                    | x                               |                         | Convenience, high-speed connection                        |               |                                  | Who pays?                                                        | E.g. at the airport                                                |
| Internet anywhere                             | x                         |                    | x                               | x                       | Convenience, latest information, productivity             | x             |                                  |                                                                  |                                                                    |
| Email anywhere                                | x                         |                    | x                               | x                       | Convenience, always within reach, productivity            | x             |                                  |                                                                  |                                                                    |

Bluetooth enables the creation of some new applications and services, but mostly it offers convenience of use to current devices. The use of Bluetooth-enabled devices is easy because connections can be formed automatically and wirelessly, and the devices can be used to multiple purposes. Convenience is provided by applications that have such features as automatic personal adjustability, remote control or electronic cash capabilities. Besides convenience, Bluetooth also offers improved efficiency and productivity to business users and results in greater accessibility and better responsiveness. It enables more convenient access to the Internet and email, and as well as data transfer between parties in wireless ad hoc networks. The forming of Personal Area Networks between personal devices provides better working conditions when on the move.

Public Internet-ports offer convenience of use and faster connections but they may offer cost savings to users as well, depending on how the service is paid for. Many other Bluetooth solutions can also provide an inexpensive alternative to current technologies when the mass-market volume is reached. Setting up local area networks with Bluetooth technology is cheaper than setting up physical networks, and in addition they are highly adaptable. Bluetooth can thus provide a reasonable network solution for homes and smaller firms as well. In some cases it will help save money because one device is appropriate for multiple purposes. An example of this is a three-function-phone that functions as a fixed network phone when at home or in the office, as a mobile phone when on the move and as a walkie talkie when within the reach of another Bluetooth phone. The phone then selects automatically the cheapest way to connect.

Bluetooth can also provide safety and security. Safety can be improved with such a simple solution as a wireless headset. When driving a car, the wires of the headset will not get tangled, and even more importantly, calls can be taken simply by pressing the earpiece, or even better, by voice commands, and the driver can look at the road all the time. Smart navigation systems can offer, besides maps, information on traffic and weather conditions and thus warn about accidents and other imminent factors. Security is offered by alarm systems, which can be applied to cars as well as to buildings, and which can automatically give an alarm to the police or security service when the car or house is broken in. The same kinds of alarm systems could be attached to safety

bracelets or intelligent pieces of clothing, which could then for example call an ambulance if the pulse becomes too slow, or tell when the child leaves the yard. It is also easy to figure the value brought by applications in the fitness sector, where sensors in one's clothes could transmit the heart rate and other relevant information to the home computer, which could then make suggestions on how to improve the exercise. An example would be an exercise bike that would automatically tune the resistance according to the signals of the body, and adapt "the terrain and the track" accordingly.

In many industry sectors Bluetooth can be used in the controlling of processes. It can forward control information from process indicators to the supervisor who then can immediately take action when required. This way costs can be cut and quality improved at the same time. The value added by Bluetooth increases in almost all usage situations as the number of devices grows, since the applications are inter-connectible and thus offer more and more convenience of use and wider areas of benefit as more of them are employed. In addition to the benefits that the devices offer, more value can be added with services: Bluetooth is likely to generate various new business opportunities and new services.

### **3.3 Critique on Bluetooth visions**

Wireless local area networks are already being implemented in many places and usage situations. While Bluetooth technology is still under construction, these other – already several times faster – techniques are gaining positions in the marketplace. Once consumers have invested and adopted fast and reliable connections, it is not easy to see that they would switch to possibly slower and still evolving Bluetooth technology. Keeping this in mind it could be even speculated that Bluetooth might be fighting a losing battle in some application visions.

The three-in-one phone presented in Chapter 3.2 is a common application vision of Bluetooth. The same idea was also behind the DECT (Digitally Enhanced Cordless Telephone) phones, but the actual result of their market launch was not a great success. The idea with the DECT phone was that the same communication terminal could have been used as a wireless home/ office phone using the system's own, low powered

transmitter while at home or at office facilities. After leaving the premises, the same terminal was meant to roam to the GSM network and operate as a GSM phone. Unfortunately, this idea never took off. Probably one of the reasons for the failure of DECT phones was the reluctance of national GSM operators: they would have lost a large number of phone calls from their network if they had allowed the roaming. However, in the future the situation in the telecommunication markets may evolve in the direction of free voice communication. Voice communication may become such a bulk product even in the near future that it will no longer attract operators, and the voice service will be given as a free gift to data connection users. In this situation, the roaming described above might become viable and therefore offer an implementation point for Bluetooth.

In short, it may be said that the application visions of Bluetooth should be carefully examined. There are many visions that can be executed more easily and even more cheaply or conveniently with existing technologies. Yet another question is whether true customer needs relating to the usage visions have been investigated and whether it is even possible to do this before some concrete applications can be introduced. Telecommunications and computing industries have been, in general, quite technology-push-oriented, but in the future this is bound to change. It would be better to anticipate the change to market-pull orientation and focus on application visions having real potential in the marketplace.

### **3.4 Bluetooth service visions**

It is relatively easy to think of possible products using Bluetooth technology. However, imagining and evaluating services that Bluetooth enables raises more open questions – at least momentarily when no Bluetooth products are available at the marketplace. In this section, three service scenarios are presented in greater detail to illustrate some possible options of business models in the future. The service visions presented here are local advertising, game networks and lovebeeper. The aspects of marketing affecting the emergence and success of Bluetooth-related services are discussed in chapter 3.4.5.

### 3.4.1 Local advertising

Local advertising is one example of location-based services that for example Nokia is interested in. The system can be built around a Personal Area Network like Bluetooth communicating through a Local Area Network over to a Wide Area Network (WAN). When a customer enters a shopping centre, for example, and comes into the local network area, s/he may receive advertisements from local retailers, if s/he has accepted the service. These advertisements can be personalized if the consumer has given information on his/her preferences beforehand or if the advertiser has got a detailed database. The consumer can even receive individualized offers of special discounts. (Tulensalo 2000) It is not self-evident that a consumer is willing to accept advertising in his/her mobile device, and therefore there has to be a compensation for the consumer. A basic compensation model is the one where a subscriber uses a certain value-added service and gets the service for free in exchange to his/her permission to receive ads on the handset (Paananen 2000). Another way of compensation is to give special offers in the stores. Either way, the consumer must value the benefit given in return for receiving the advertisements. In addition to local advertising, Bluetooth opens up new opportunities for mobile commerce services as it enables ordering and paying for the products and services with the handset. In this case, Bluetooth technology acts as a method to trigger an action paid via globally accessible technology – like the mobile phone network. For example, a person can access the ticket sales system of a railroad operator or an airliner through his/her WAP service and reserve and pay for the trip. When the user then arrives at the station or the airport, the Bluetooth device can act as the actual ticket or as a means to recognize the passenger.

### 3.4.2 Game network

Bluetooth enables up to eight players playing a multi-party game with their own devices simultaneously, which has not been possible before without heavy network systems. The value-added entertainment service opportunities may come from ordering new games, upgrades or score tables from the Internet or from a service provider's platform. The games could be billed per hour, per game or with a monthly fee, and the fee would be considerably cheaper than buying the game in a CD-ROM. The question is, who is the service provider: is it a game manufacturer or game device manufacturer

such as Nintendo or Sega? Alternatively, could it be an operator who offers a game selection? Another open question concerns the distribution channel: will Internet be dominating once the characteristics of devices develop further, or will there exist a WAP-based or similar, less open portal for distribution? The game segment will form a considerable part of the entertainment service sector in the future of wireless telecommunications, and it will offer interesting business opportunities. It is estimated that the wireless entertainment business – games, icons and ringing tones – will be worth 40 billion FIM in 2004. (Laatikainen 2000, 11) The portion of Bluetooth-enabled game networks of this business depends not only on the development of the technology and its integration to mobile devices and game devices, but also on the development of a new, wireless game culture.

The game and device manufacturers could benefit the most from Bluetooth by distributing the device-specific games through stores or special Bluetooth-distribution-booths, while the operators and other portal companies could focus on the creation of game-playing communities and keeping up the scoreboards. However, these operations could actually be implemented more easily through more widely useable access technologies. Another interesting idea is broadcasting a tournament or series of locally played games in a game portal. With Bluetooth, these tournaments or local games could be played in the Bluetooth network and relayed from this small user group by the portal keeper to the Internet for larger audiences to see.

### 3.4.3 Lovebeeper

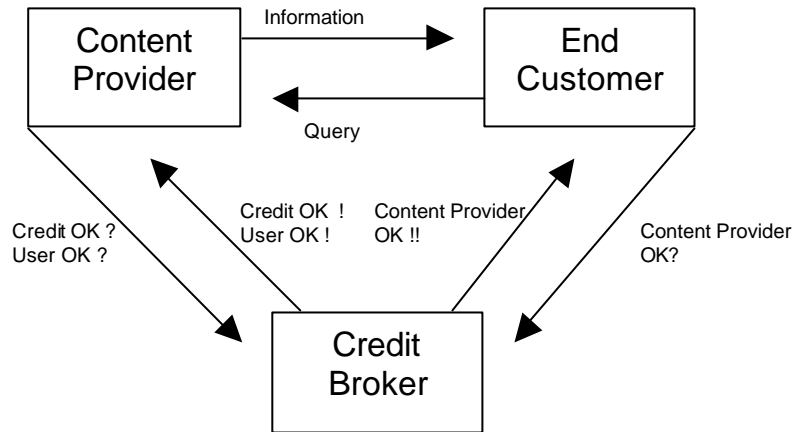
The third service opportunity that uses the characteristics of Bluetooth is lovebeeper. The basic idea is that a user lists his or her preferences of an interesting person in an Internet-database or to a smart device, and the device signals when a suitable person is in the personal network area. This idea of interest recognition may be expanded to other areas, too: a person could, for instance, program his handset to notify when a person wishing to buy a used couch is around, or the system could be used in trade fairs to match buyers and sellers with similar interests. Another question is whether there exists a need for this kind of service.

#### 3.4.4 Service application integration vs. local Bluetooth services

The services enabled by Bluetooth may come to the market slightly later than the product applications, since consumers obviously need devices containing a Bluetooth chip before the use of services is even possible. Then again, it seems that a critical mass of Bluetooth-users is needed before the services can be created profitably. A key theme in the diffusion of all digital services is *service application integration*: for the system to work, there has to be an organization that can integrate the whole process of bringing different contents together with different technologies to various platforms accessible to customers from their devices. This is very challenging to execute in practice and may be a bottleneck for the development of the whole content industry. (Tulensalo 2000) Who this integrator will be in tomorrow's business context, is yet an open question.

Some Bluetooth services will differ from digital services in general, because the contents distributed via Bluetooth are very local by nature. Since the transmitting range is mere 10 meters, integration with mobile phone networks is not necessary. Therefore, with localized Bluetooth services, a general content distribution tool is needed instead of service application integration. The general content distribution tool refers to how different kinds of Bluetooth terminals display different kinds of local services provided by separate content providers in numerous different places. For example, a gift shop, hospital or car-dealer could be the content provider in this case. The general content distribution tool could be a browser-like multipurpose software in the communication terminal.

Direct communication between the actual content provider and the end-customer is a likely option. In Bluetooth service terminals this could even be the main course of the development. When the service is intended for an extremely local audience and a general content distribution tool is implemented, the communication can become very direct and a third party is needed only in some situations. For instance, a credit broker is required when the service situation involves paying. The communication paths are shown in Figure 3.



**Figure 3** Local service, local audience

### 3.4.5 Marketing communications and Bluetooth-related services

A common theme in any of the service scenarios' success is *marketing communications*: the service provider must have enough resources to market the services cost-effectively with a wide reach. The question of effective marketing communications may be decisive especially for smaller, innovative service companies, and it may lead them to ally with bigger players to gain market reach. On the other hand, the Internet may work as a powerful extension of word-of-mouth for a very innovative and interesting service, and awareness and use of a service may grow very rapidly without great marketing investments. However, these cases are exceptions.

Existing customer databases may also form a decisive competitive edge for marketing Bluetooth-related services. Reaching the right customer segments is crucial, and building a database may be time-consuming in the fast moving Internet Economy. Assisted with existing and suitable databases, the competitors may be surprising: big retailers with their large bonus databases, credit card companies, banks, operators or any other company with a suitable customer database. Finally, customers' trust on the service provider may be crucial.

## 4 STRATEGIC PERSPECTIVES ON BLUETOOTH

Bluetooth has inspired many writers to vision the usage possibilities and evaluate the technological aspects of the standard. Strategic aspects concerning Bluetooth have been less common issues in the discussion around Bluetooth technology. The strategic issues presented in this chapter include the customer perspective, factors affecting the diffusion of Bluetooth products and services, and the effects of Bluetooth on business models and value networks. In addition, the nature of Bluetooth as an enabling technology and as a value innovation is discussed. Furthermore, future scenarios of the development of the communications industry are presented and the role of Bluetooth from the viewpoint of content providers, network operators and device manufacturers evaluated.

### 4.1 Nature of Bluetooth technology

Bluetooth is by nature *an enabling technology*, which means that it brings new features into existing devices and may give rise to a multitude of services. Since the product standard is open, producers across the field of telecommunications, information technology and consumer electronics are developing their own applications utilizing the characteristics of Bluetooth technology. Bluetooth is a major shift from premise-based to person-based communications (Carrier in Scheiderman 2000, 9), because it enables even greater mobility and access to different services in different platforms. Bluetooth has the potential to change both the way people use mobile devices and the future terminal design (Reeves 1999, 30). The technology's greatest synergy is with established wireless communications products. In addition, coupled with WAP or a more developed mobile Internet connection, Bluetooth provides a local link that opens up new e-commerce or mobile-commerce potential (Bickers 2000, 54), as the Bluetooth-terminal acts as an electronic wallet in various situations.

Bluetooth technology also contains features of *a disruptive technology* or *a discontinuous innovation*. Disruptive technology refers to an indirect substitute for an industry providing different product-market paradigms, while discontinuous innovations are technologically and/or commercially discontinuous. (Walsh & Linton

2000, 24) The definitions hold different perspectives especially concerning discontinuous innovation, and no single definition is yet widely accepted. However, disruptive technologies bring a very different value proposition to the market when compared to choices previously available. For example, Christensen sees mobile telephony as a disruptive technology to wireline telephony, and hand-held digital appliances as disruptive to notebook computers. (Christensen 2000, xxix) Bluetooth may enable some current devices that have not yet made a true commercial breakthrough, such as the Personal Digital Assistant, to become disruptive technologies substituting some parts of both mobile phone and laptop markets.

Bluetooth technology may be considered as a potential value innovation. Kim and Mauborgne define value innovation as something that focuses on redefining the problem the product solves and shifting the performance criteria that matter to customers. Value innovation thus offers the customers radically superior value with a price acceptable to large-volume market. (Kim & Mauborgne 1999, 46) The characteristics of Bluetooth are likely to elevate the performance criteria: when customers get used to wireless products, traditional solutions will seem obsolete. The visions of Bluetooth devices have also brought up critique: for instance the Bluetooth-smartphone that talks to cars and domestic appliances is likely to remain as a prototype, unless customer needs concerning the product and access to services are carefully examined. A simple and convenient user interface, strong Web-usability and easily customizable operating system will be essential topics prior to a breakthrough in the marketplace (Hughes 2000, 48).

## **4.2 Customer perspective**

With regard to customer needs and benefits, there are two perspectives: the perspective of an individual user and the perspective of an organization. Bluetooth responds to many individual users' needs, such as the convenience of use, easiness and even freedom. These needs may also be associated with mobile communications devices where Bluetooth may likely be a standard or an easily added optional feature. Examining these customer needs, however, is not an easy task: the more innovative and radical a product is, the more likely the potential customers will not self-evidently see

its practicality and benefits (Shanklin & Ryans 1987, 41). In addition, when it comes to disruptive technologies, customer need analyses may even provide misleading data, since customers may not see the usefulness of the disruptive technology today. (Christensen 2000, 258) Wireless technologies in general provide several key advantages for users, including greater accessibility, better responsiveness and improved productivity. For organizations the same advantages remain, and additionally wireless technologies may bring about strategic and even competitive advantage over competitors. (MultiMedia Telecommunications Association 2000) In fact, wireless technologies may pave the way for truly virtual teams and organizations.

The emergence of person-based communications enabled by Bluetooth and other wireless technologies means that employees are no longer dependent on the physical office. Instead, the office becomes virtual and it can be taken anywhere. The work can be done where it best suits the person and schedule, which makes working more productive and the use of time more efficient. Bluetooth enables easy interconnectivity of all the appliances required for working just about anywhere. Bluetooth may be beneficial also inside the organization: in-building wireless telephone systems enable workers to move freely in the workplace, using portable handsets to place and receive calls like using a regular desk set. Industries such as health care, retailing, manufacturing, distribution and warehousing are among the early adopters of portable telephony supported by wireless LAN, for example Bluetooth. (MultiMedia Telecommunications Association, 2000) The characteristics of different local area network solutions, for instance price, power consumption or number of connectible devices will determine which solutions will become most common in organizations. In addition to network characteristics, also organizational characteristics, such as the size of the organization and the strategic role of network connections, affect the suitability of different local area network solutions to each organization.

### **4.3 Factors affecting the diffusion of Bluetooth applications**

The development of the whole telecommunications sector appears to be quite scattered for the next few years: the third generation wireless and fixed broadband networks will become more common but a global standard does not yet exist. There will be a

multitude of devices and services with different characteristics: some devices play music, some show films, some act more as computers and some devices are primarily phones. The combinations of characteristics may differ greatly from today's situation, and only the best will survive in the marketplace. (Leino 2000a, 16) The scattered market may actually work for the benefit of the diffusion of Bluetooth products: during the next few years, it will be essential that enterprises and individuals have access to dual-mode handsets and intelligent network links that facilitate the switching between fixed and wireless networks and route voice and data correctly (MultiMedia Telecommunications Association 2000). Bluetooth products are one answer to this need, since Bluetooth may be a part of both wireless and fixed broadband networks, increasing the versatility of devices: the technology makes it easy to move from one network to another, and devices with a Bluetooth radio chip talk to each other without the user's initiative. Therefore, Bluetooth increases flexibility and interoperability by giving more choices to the user. In addition to being an enabling technology, Bluetooth could thus be called *a linking technology* enabling the mobility of information users.

There are four key features that enhance the rapid diffusion of Bluetooth-enabled products in the marketplace: a high level of integration to different devices, very low power consumption, support for both multipoint and piconet connectivity and ease of integration into an end-user application (Aliwella et al. 1999, 106). The keen interest among manufacturers is likely to make Bluetooth one of the fastest and most-widely adopted new standards the consumer-electronics industry has ever seen: in any area where cords or cables are used today, manufacturers are asking "Could we use Bluetooth?" (Bickers 2000, 54) The diffusion of Bluetooth products may enjoy network externalities: there is a snowball effect meaning that the greater the number of people using the products the more valuable they become, and therefore the greater the number of people who are motivated to use them (Evans and Wurster 1999, 35).

How well Bluetooth is accepted depends on how well it incorporates network security and user authentication. Some of the necessary security will be applied as encryption at the application level, but the technology still lends itself to easy eavesdropping, and so the users need to ensure their security needs and use them appropriately. It must be remembered that often the idea is to implement the Bluetooth chip to small, light and inexpensive tools and devices. In such devices, there will not be much extra calculation

power to be used for encryption. This makes the usage of the technology even more challenging and emphasizes Bluetooth's nature as an enabling and linking technology.

#### 4.4 Bluetooth and scenarios for the future field of communications

Ericsson Ab has constructed scenarios concerning the general field of communications of tomorrow. The views of experts have been summarized in three scenario models, each having one of the players of the value chain as the leader of the development and others in the role of a subcontractor (Kurki 1999, 9):

- 1) **Service Mania** refers to a scenario led by the *content provider*, for example a media house. It buys the distribution network from teleoperators through bidding and assumes that consumers' devices develop to fit the contents they provide.
- 2) **Gran Tradizione** is a scenario where the company providing network distribution – *the operator* - is central to the whole process: it buys contents to its portals from content providers and the characteristics of the network affect the device development and consumer tastes and needs.
- 3) **Up'n Away** scenario is led by *devices used by consumers*. Consumers program their own personal tastes and needs to their devices that can be called "smart clients", and collect the contents and services they need from different networks.

How does Bluetooth stand in the light of these three scenarios? What is the role and importance of Bluetooth from the viewpoint of content providers, network operators or device manufacturers? Considering the first scenario, the interest of media companies is to bring their contents through all large-volume networks to large volumes of consumers. To the media companies, Bluetooth may appear as just one extension of mobile devices' characteristics that does not at first affect the content provision. However, if Bluetooth becomes a widespread feature in mobile devices, the media companies will surely be interested in service provision, such as the interest recognition concept, but the media companies may not have a direct interest in Bluetooth technology's diffusion. The operators in scenario two may see Bluetooth as a threat that excludes the need for network use in local areas, or as one additional way to access their network. However, a great possibility for operators could be the concept of

location-based services, such as local advertising presented in chapter 3.4.1. If the operators are interested in offering total service packages including both the hardware and the software to shopping centers, museums, big corporations, amusement parks and other similar places where the service concept could be applied, it might become a considerable business.

In the light of current knowledge, it seems that scenario three is the most promising to a widespread use of Bluetooth: the instant benefits of Bluetooth – convenience, security and fun – materialize in the use of the devices possessed by consumers. Therefore, in the launch phase of the technology, the manufacturers of mobile phones, other mobile terminals and consumer electronics are in the key position. User-friendliness of the products and clear demonstration of the benefits of Bluetooth technology are the messages that should be transmitted to the marketplace. Even more important is to develop the products containing a Bluetooth chip in close contact with potential customers to avoid launching products with no real value for the customers.

#### **4.5 Business models and value networks**

There exists some confusion on the business models of tomorrow in the entire telecommunications industry: all the modern innovations in communications and information technologies may enable changes in organizational structures and business processes and thus affect the competitive advantage of companies. Therefore, it is beneficial to try to envision these possible changes in business models in advance. The effects of Bluetooth technology on business models will be a subject of further research along with the effects Bluetooth may have on the value chains and value networks of tomorrow.

A business model or business concept forms the core of a business: what is produced and sold, how and to whom? How does the value of the product or service materialize? What is the earning logic behind profit making? The business models based on traditional value chain thinking do not fit well to global information infrastructure, where the logic of action and the relationships between players are in constant change (Tuunainen 1999, 52). Hamel (1998, 7-14) and other leading strategy researchers

therefore call for the development of new business models and a new concept of the firm instead of mere business process reengineering. One possible research method concerning business models is to build different business model scenarios showing the possible effects of Bluetooth technology, and then test these scenarios with experts representing different players in the telecommunications industry.

With regard to digital contents and content services, it is essential to bear in mind that a company with direct contact to customers will lead the development and the whole business. Other players in the value network are more or less in the role of a subcontractor (Kurki 1999, 9), as was shown in the future scenarios of the communications industry in Chapter 4.4. As the value chains transform into value networks, customer management becomes even more complicated and it is not evident which player in the network actually owns the customer. The customer relationship must be shared within the network along with the profits of the business. How this is done is a central question concerning the earning logic of Bluetooth products and related services.

Bluetooth will certainly add value to customers and bring attractive features to devices. The added value can be for instance in the form of increased convenience of use or availability of new valuable services. It is unclear, however, what the value adding businesses will be. Bluetooth will provide many kinds of opportunities, and it is to be seen which player performs which tasks in the value chain. Since there is not yet any experience of the usage of Bluetooth products, and even less knowledge of its effects on the value chains or networks, visioning new value networks is very challenging. Emerging new business opportunities may bring new players to the sector: some of them may perform new tasks but some of them may take over tasks that are traditionally performed by others. In other words, the roles of the businesses may change as the effects of the technology spread and offer new opportunities to profit.

## **5 CONCLUSIONS**

Bluetooth technology is certainly intriguing with its characteristics and considerable business potential. However, at the moment there are no Bluetooth products at the

marketplace, and the technical development still faces many problems of large scale. The future will show which path the development of the whole field of wireless communications will take and what will be the role of Bluetooth in this development. The characteristics of Bluetooth imply that the standard has got at least some aspects of a disruptive technology that could change some parts of the current business structure and the way people use their mobile devices. Ultimately, the markets will decide which application visions and services become commercial success stories.

The strengths of Bluetooth compared to its competitors include convenience, versatility and possibly cheap price in the future. It seems that the importance of these characteristics should dominate in the likely-to-be-success Bluetooth applications from the customer perspective. In addition to conquering the technical obstacles, the success of Bluetooth depends on the continuing of efficient cooperation of Bluetooth Special Interest Group and effective marketing research on real customer needs concerning Bluetooth. Once the mobile terminals containing a Bluetooth chip become more common, the utility and network externalities of Bluetooth devices will increase and service offerings will become more versatile.

Bluetooth may become one case example of how a new innovation may transform business models. The roles of current players in the field of telecommunications – infrastructure providers, device manufacturers, software developers, content providers and service providers – may change: the field may see both vertical integration up or down the current value chain, concentration on more focused activities or the rise of new players acting as integrators or navigators. Analyzing and anticipating these new business models is a challenging task for research.

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Below is a list presenting such Bluetooth application visions that can be connected to some companies and can thus be considered to be under development. The list is by no means complete, and it is unclear how advanced the development is in each company. In some cases it may still be on the level of talk only. The information has been collected from various sources including articles and company web pages. The related company is mentioned in the parenthesis together with a reference to an article if there is one where the company is mentioned.

### **PC-cards, adaptors, handheld computers, notebooks**

- Handheld computer able to send and receive electronic mail, contact information and appointments; Internet access in future applications (WidComm)
- Bluetooth-adaptors for laptops, desktops and PDA's as well as a range of access points for LAN and telephone line connection (TDK)
- ThinkPad (notebook ® laptop) and WorkPad for quick access to your address book, calendar, to do lists and downloaded e-mails (IBM: Menezes 2000)
- Bluetooth-enabled PC-cards, later integration of the technology into notebooks (Toshiba: O'Brien)
- Modem card, PC-card for notebook computers, Bluetooth-equipped Palm Pilot (3Com: Ohr 1999b, Bickers 2000)
- Bluetooth-enabled PC-cards for PDA devices (Xircom Inc.: Stirpe 2000)
- Bluetooth adapter (Acer NeWeb Corp.: Trembly 1999)

### **Hands-free sets**

- Wireless headset (Ericsson; Stirpe 1999, 2; Wireless Review 2000)
- Hands-free headset (Jabra: Shaffer 2000)

### **Phones**

- Three-function phone: phone that functions as a landline phone, cellular phone and walkie-talkie (Ericsson: Sabatini) In office: internal extension line (Bickers 2000)
- Cordless screen phone: combines cordless Internet access with telephony and e-mail, Communicator platform: communication, organizing, GPS, (Ericsson)

### **Car applications**

- Hands-free Car Kit (Motorola)
- Telematics Control Unit in the trunk of your car: Cellular phone service, Internet access, GPS, mapping functionality, address book and calendar, (Motorola: Carnoy 2000)
- Application (Internet access, GPS) for trucks (Mecel and Scania: Haataja & Helttunen)
- Car alarm, car infotainment (Ericsson & Mannesman VDO: Makundi et al. 2000)

## **Electronic wallet**

- Electronic wallet (Visa & Ericsson: Wireless Review 2000)
- Wireless Bluetooth payment system for WAP-phones in the Internet and stores (Nokia, MeritaNordbanken and Visa: Tietokone Weblina)

## **Consumer electronics**

- Digital camera sending images wirelessly to a nearby hard disk for storage (EastmanKodak: Shaffer 2000)
- Laptops, walkmans, digital cameras, electronic toys (Robot dog Aibo) (Sony: WOW!)
- Bluetooth to wireless MP3 players, surround sound speakers, headphones, multi-purpose remote controls and wireless game consoles (Philips)
- HomePilot + SmartHome, TV and Internet access, control of lighting and electrical appliances in the house (PCTVnet: Makundi et al. 2000)

## **Security of use**

- Virtual tunnel provides secured communications when the user is remotely using Bluetooth capabilities (Internet Appliances Inc.: Stirpe 1999)
- Bluetooth-compatible smart cards "XyLoc" for security: authorized user will be automatically logged on (XyLoc ID badge) (Ensure Technologies: Tremblay 1999, Stirpe 1999)

## **Further**

- Display on eyeglasses (MicroOptical: Nass 2000)
- Mobile phone in a wrist watch (Philips, Haataja & Helttunen)
- Digital pen with handwriting reading capability (Ericsson & Anoto AB)
- Wearable intelligence (Elisa Communications, TTKK, Nokia: Prossori)

Below is a list presenting Bluetooth application visions collected from various sources. The list is by no means complete, but gives an idea of the versatility of ideas of Bluetooth usage classified roughly to nine groups.

### **E-mail / Internet- / LAN-access**

- E-mail written and sent on the move (Karlstedt 1999a)
- Web to go: Internet access anywhere (Carnoy 2000)
- While stepping out of a meeting your notebook computer automatically dials into the Internet via a cellular phone to synchronize your e-mail or calendar
- Mobile phone communicating with the LAN in wireless office environment (or rather as a walkietalkie), replacing the cordless phone at home and functioning as a mobile phone elsewhere (Karlstedt 1999a)
- Bluetooth-enabled Internet-ports at airport waiting lounges (Motorola visions)

### **Wireless networks**

- Wireless computer networking: cheap to set up (Carnoy 2000)
- Game network
- Advertisements sent to by-passers in a shopping centre
- Using Bluetooth to reach a wireless hub in the room that could connect to the wireline corporate LAN (Hamblen 1999)

### **Meetings / conferences**

- Bluetooth enabled printers installed in conference rooms (Frazier 2000)
- Wireless connection to the projector and afterwards a copy of the presentation (or recorded presentation) sent wirelessly to all participants (Hill 2000)
- Printing by sending the file through mobile phone to the printer (Makundi et al. 2000)
- Preloading preferences to PDA (Personal Digital Assistant) before going to a trade show and detecting people with common interests and receiving information (Motorola visions)

### **Synchronization**

- Convergence of clocks, telephones (numbers), cell phone and organizer (updating information) (Shaffer 2000)
- Updating telephone numbers on your desktop PC without taking palmtop out of your briefcase (Doan 1999)
- Automatic synchronization when entering the room: PDA transferring files, e-mails and schedule information with PC (O'Brien 2000)
- Bluetooth phone delivering voice commands to your PC (Isenberg 1999)
- A factory supervisor checking the status of processes while walking through the factory and giving new instructions via a Bluetooth link (Motorola visions)

## **Car applications**

- Handsfree telecommunications in a car; a voice recorder in the headliner of the vehicle (Sabatini 2000)
- Headset; using cell phone is safer while driving a car, allows listening to Internet MP3 music via the phone (Robertson 2000)
- Music in MP3 format sent via a Bluetooth radio (Shaffer 2000)
- When receiving a message en route it is verbally transmitted via the speakerphone in the vehicle (Motorola visions)
- Phone flipping caller ID to your PC for a screen pop, car reporting mileage, gas level and other stats when coming home (Isenberg 1999)
- A Web-enabled phone displaying the content on a screen in a vehicle, or a computer in a briefcase using a cell phone in a pocket to connect to the Internet and displaying the information on the same screen (Sabatini 2000)
- Smart navigation systems, traffic information broadcast to the dashboard, in-vehicle e-mail, remote diagnostics (Internet-enabled electronics) (Sabatini 2000)
- GPS in cellular phones: navigation and local-area information through wireless Internet links (Robertson 2000)
- A map, instructions, weather information, distance to go, traffic jams, accident alerts (Makundi et al. 2000)
- As entering a national park receiving a park map and schedule of activities on the display in car (Motorola visions)
- Car alarm
- Automatic unlocking of the car doors when approaching it, radio tuning into favorite station, seat adjusting to preferred settings (Motorola visions)
- Handset in your car opening garage door, activating the house's alarm system, turning the lights on before entering the house, Bluetooth-enabled gas station (Carnoy 2000)
- As entering the car receiving a reminder of the items on the daily calendar (Motorola visions)

## **Communicating presence / supervision**

- Bluetooth-enabled PDA automatically communicating your presence to the Bluetooth-enabled device at your flights gate
- A safety bracelet for the elderly, help instrument for the blind: messages from the environment (Makundi et al. 2000)
- A chip in children's clothes: supervision (Motorola visions)
- Access supervision in corporate buildings

## **Electronic wallet and services**

- Electronic wallet or phone communicating directly with a store's cash register (Bickers 2000)
- Charging train tickets or sodas to wireless bills using Bluetooth, electronic wallet (Kridel 1999, 33)
- Device as a combination of credit card, bus ticket and personal ID (Makundi et al. 2000)

- Electronic tickets to airplanes, movies etc.: buying and confirming your arrival and automatically selecting the seat (Motorola visions)
- When arriving at a hotel checking in, getting an electronic key and opening of the door when approaching it (PDA) (Motorola visions)
- At a racetrack downloading information on selected horses, placing bets, requesting slow-motion replays and ordering food and beverages (Motorola visions)
- Sending messages and communicating with others in a bar and participating in games, ordering and paying for the food in a restaurant (Motorola visions)

### **House**

- Wireless buzzer for a building
- Electric company reaching through your PC to your appliances for so-called demand-side energy management (Isenberg 1999)
- Home security system (Motorola visions)
- Upon arriving at home the door automatically unlocks, the entry way lights come on and the heat is adjusted to pre-set preferences (Motorola visions)
- PDA automatically updating the family calendar when coming home and alerting of any conflicts (Motorola visions)
- Wireless home theater (Makundi et al. 2000)

### **Consumer electronics**

- An image shot with your digital camera and wirelessly transferred onto the laptop or cellular phone (Hill 2000)
- TV set and digital camera (Trembly 1999)
- Lovebeeper (Makundi et al. 2000)
- Speedometer for bicycle (wire replacement)
- MP3 player in backbag (Sabatini 2000)