iti Techmedia

Market Intelligence Report
Health

An initial study of the market for Health, defined as:
"The delivery of health services including clinical, education and administrative services through the processing, management or communication of information, including video, audio, graphics and signal data"

30 April 2004

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CONTENTS

EXECUTIVE SUMMARY

This document provides market intelligence into the sector defined as Health by the Intermediary Technology Institute (ITI) in Techmedia. The overall healthcare sector is very large; however, ITI Techmedia's interest is in the use of digital media and communications in healthcare. For the purposes of this document, the definition of Health is:

> *"The delivery of health services including clinical, education and administrative services through the processing, management or communication of information, including video, audio, graphics and signal data."*

The report describes the future market opportunities, challenges, key drivers and the potential functional needs of the Health sector.

Using this acquired knowledge as the base input, the ITI will select those functional needs that have strongest potential market 'fit', and the greatest potential to be a success when utilised within the identified target markets. The functional needs will be used to define potential technology platforms which will then be used as input to ITI Techmedia's programme selection process.

During this process, ITI Techmedia will continue to report to its Membership on progress and results. Members are encouraged to provide comment and input to this process, and to become actively involved in programmes.

Digital media and communications comprise nearly 5% of a large and expanding healthcare sector…

The overall healthcare sector comprises a significant proportion of global gross domestic product (GDP) and, with sector expenditure estimated at USD2.7 trillion in 2000, it accounted for around 9% of world GDP. The healthcare sector is forecast to grow steadily in the short to medium term, with expenditure reaching USD4 trillion by 2008. At this level of expenditure, the sector will increase in relative importance in the world economy, and is forecast to account for some 11% of global GDP by 2008. However, it is estimated that only a small proportion of the overall market (less than 5%) will fall within digital media and communications, i.e. the area of interest for ITI Techmedia.

…which exhibits a number of key trends

The healthcare sector exhibits a number of key trends, including:

- increasing costs of healthcare e.g. procedures, drug treatments
- lack of staffing with necessary training and skills
- ageing population and poorer lifestyles
- increasing litigation against healthcare organisations and individuals citing errors or misdiagnosis
- need for improved collection/collation of patient and general healthcare information
- creation and growth of intermediary services

- increasing requirement for protection, privacy and secure ownership of increasingly diverse personal data
- prevention/self-assessment healthcare driven by the desire of patients for greater empowerment and ability to take greater control of their own healthcare, e.g. regular health testing could aid prevention, or early-stage cure, of illnesses
- kiosk diagnostics that provide patients access to 24/7 healthcare, thereby supporting the prevention /self-assessment healthcare philosophy
- highly functional consumer-based devices to support the provision of simple health services, e.g. blood pressure monitoring.

These trends will create opportunities for new technology providers. However, a number of barriers to market entry exist for new technology providers. Such barriers include:

- very distinct budget boundaries, particularly in relation to primary versus secondary care
- the fragmented nature of healthcare provision makes it difficult to access the cost data required to develop robust Return On Investment (ROI) models
- inadequate management decision support infrastructure
- resistance to change to the introduction of new technologies amongst clinicians
- cost and time of training staff to utilise new solutions
- the integral importance of security and privacy of patient data to any new solutions
- heavy regulation of healthcare, and the possible need for regulatory approval of new solutions
- the lack of a well-developed information infrastructure within the healthcare sector
- lack of standards in key areas.

Despite these issues, opportunities remain for companies to develop key elements of technology which become critical to the industry, allowing rapid company growth followed by profitable returns for the original investors.

Market opportunities exist in both patient care and care setting

Two major aspects of the Health sector have been considered:

- **patient care** comprising the various activities that relate to the identification and treatment of illness
- **care setting** relating to the environment in which the various patient care activities are undertaken.

In patient care activities, a number of the identified opportunities relate to new technologies which assist with the detection, monitoring and diagnosis of illness. Imaging is a key technology that is used widely in a variety of patient care activities. Ongoing developments in this area are likely to gain acceptance where improved efficiency and improved patient outcomes can be demonstrated. Increased usage of remote detection of illnesses, and patient monitoring, will also generate new business opportunities in the future.

In care setting, the main opportunities occur in relation to an ongoing evolution of the information technology and communications requirements. The overall healthcare sector is not traditionally an intense user of IT, but demand for increased efficiency is likely to encourage increased adoption of new information management capabilities including infrastructures that enable anytime, anywhere distribution of medical information to authorised users. However, it should be recognised that the adoption of new information management techniques is likely to be a slow and extended process.

ITI Techmedia will use these key trends to identify appropriate Programmes

Using the acquired knowledge in this report as input, ITI Techmedia is undertaking further analysis of the functional needs to select those with the strongest Scottish 'fit' and the greatest potential to be a success when utilised within the identified markets. The selected functional needs will be used as input to define potential technology platforms as part of the ITI Techmedia programme selection process.

1 INTRODUCTION

1.1 Document Purpose

The purpose of this document is to provide a 'snapshot' view of the Health sector in order that the Membership:

- have visibility of the market analysis activities undertaken in this sector by ITI Techmedia

- can gain access to market information relevant to the sector

- are provided with an indication of the functional needs that ITI Techmedia will explore further to identify the technology platforms which will form the basis of ITI Techmedia research and development programmes.

This document should not be considered as providing a comprehensive analysis of the competitive environment within the Health sector. Such an analysis is beyond the scope of this document.

1.2 Structure and Content

This document provides market intelligence into the sector defined by the Intermediary Technology Institute (ITI) in Techmedia as Health (see Section 2.1 for the definition of Health). The overall healthcare sector is very large; however, ITI Techmedia's interest is in the use of digital media and communications in healthcare. The information captured within the document has been obtained following the principles of market intelligence gathering (otherwise known as foresighting) established by ITI Techmedia. This process is described in an abridged form in Appendix 1.

During the process of developing this market intelligence report, both primary and secondary market data were acquired and collated. Primary data were collected during Market Intelligence Workshops, attended by experienced individuals from industry and academia, supplemented by face-to-face interviews with key organisations in the sector. The primary data gathering process was augmented by desk research which was used to obtain secondary data from internationally recognised market analysts. Where possible, the source of any data used in this report has been identified.

Section 1: Introduction. This Section covers the background, aims and scope of the Intermediary Technology Institutes (ITIs). It also provides a high level description of the 'Techmedia' areas of focus. Further background information can be obtained on the website www.ititechmedia.com.

Section 2: Market Overview. This Section provides a working definition of the Health sector, highlights the main characteristics of the sector, identifies the main trends, drivers and barriers, and describes generic value chains representing current business practice. The Section provides a framework for the subsequent presentation and analysis of data in Sections 3 and 4.

Section 3: Market Assessment. This Section provides an assessment of the market opportunities identified during the foresighting process. Each opportunity is defined and the main characteristics described in terms of drivers, inhibitors and the functional needs to be met by any fulfilling technologies.

Section 4: Market Data. This Section contains the relevant market size data for each market opportunity identified in Section 3. This type of data is traditionally derived from historical figures, and therefore market projections are best viewed as providing a base reference level from which informed extrapolations can be drawn. Where possible and appropriate, the segments identified in this report are matched to existing market data; where a new market opportunity is identified, a potential market size has been projected.

1.3   Background: Intermediary Technology Institutes (ITIs)

1.3.1   Economic Context

A global driver for economic growth is the development and exploitation of technology both for present needs and future requirements. Successful economies are underpinned by a vibrant research base which extends from basic science through to pre-competitive research and development, with a clear focus driven by global market opportunities. Scotland has a reputation for world class research in many fields and already undertakes significant research activity in several areas which have the potential to be strong future market opportunities. In addition to the research base, most developed economies have institutes or organisations that promote knowledge generation and increase commercial exploitation capacity. The establishment of such organisations has had significant economic impact over the long term.

1.3.2   ITIs

The creation of the Scottish ITIs is aimed at increasing the effectiveness of Scottish businesses in the key global market sectors of Communications Technologies and Digital Media ('Techmedia'), Life Sciences and Energy, all targeted to address the particular (research) strengths and (company) weaknesses of the local economy. The ITIs will also interact with each other to identify potential overlap or "white space" market opportunities between Techmedia, Life Sciences and Energy. The creation and development of the Scottish ITIs is a long-term initiative, and will be supported for a significant period of time.

The ITIs are, in essence, a centre or "hub" for:

- identifying, commissioning and diffusing pre-competitive research that is driven by an analysis of emerging markets

- managing intellectual assets to maximise commercial and economic value.

An active membership is core to the proposed Institutes. The ITIs are open for membership to all companies and research institutions, and all members will be encouraged to actively participate in its activities. ITI strategy and operation will be

actively guided and supported by its members. It is essential to attract members with a broad global perspective on markets and new technology directions, as well as a local focus, to ensure that propositions will be transferred effectively into the Scottish economy.

1.4   Definition of the Techmedia Sector

ITI Techmedia is centred on the development and creation of commercial opportunities encompassing the communications technologies and digital media sectors. The activities of the ITI will bring Scotland's economy to the cutting edge of emerging markets by allowing local companies to access and build upon pre-competitive technology platforms developed by the ITI.

The term 'Techmedia' arose out of the need to reflect the market evolution of communications technologies and digital media. The overall trend in the marketplace is one governed by a value chain ranging from content/application generation through delivery to consumption. Content is no longer considered in isolation from service provision, service provision in isolation from delivery channels, or delivery channels in isolation from enabling and managing technologies.

The following elements are examples of the areas which fall within the Techmedia remit. These elements are best viewed as illustrations and represent some of the over-arching philosophies. Nevertheless, these are global drivers which help to place the output of the ITI in context:

- broadcast content: ultimately the product for which the customer is paying, either directly or indirectly
- service provision: the mechanisms for providing customer-driven content and applications
- delivery: technologies and infrastructure required to transport the digital content service to the end-user, as well as providing the feedback channels for interactivity
- enabling software and systems integration: technologies and infrastructure required to condition, control and manage the delivery of content/service to the end-customer.

One globally accepted trend is the delivery of content and services over multiple channels e.g. the provision of same (or modified) content to be received over mobile devices, through TVs or via PCs. Content consumption is the key revenue generating stream in many of the markets, and is thus central to many of the drivers that affect future market evolution in the Techmedia sector.

The Techmedia sector is potentially very broad and hence a phased approach to market foresighting has been adopted. The first phase foresighting has concentrated on five major market areas, defined as:

- **Health**: the delivery of health services including clinical, education and administrative services through the processing, management or communication of information, including video, audio, graphics and signal data.

- **Commerce and Finance**: the conducting of business transactions and the provision of financial services using electronic means, generally involving digital computers, electronic communications and the application of information technology. It includes the buying and selling of goods and services, the transfer of funds and related internal company functions.

- **Learning and Education**: the provision, delivery and administration of learning through the use of new media and network technologies

- **Communication Services**: the provision, management and delivery of voice, video, data and IT services over wired and wireless communication networks. These include consumer and business services, vertical sector industrial applications and broadcast content.

- **Entertainment and Leisure**: the delivery of on-line digital entertainment and leisure services to end-consumers. Specifically, this embraces the market for online music, games and movie services over fixed and wireless networks.

This report provides a first stage analysis of the Health sector.

1.5   Next Steps

This report describes the results of the market analysis activities undertaken by ITI Techmedia in the Health sector. As such, the report describes the future market opportunities, challenges, key drivers and functional needs in the Health sector.

Using this acquired knowledge as its base input, the ITI will select those functional needs with the strongest potential market 'fit', and the greatest potential to be a success when utilised within the identified target markets. The selected functional needs will be used as input to define potential technology platforms, and these platforms will then be used as input to the ITI Techmedia programme selection process.

During this process, ITI Techmedia will continue to report to its Membership on results and progress. Members are encouraged to provide comment and input to this process, and to become actively involved in programmes.

ITI Techmedia intends to further develop its knowledge base in this sector. In order that the Membership gain visibility to ongoing developments identified by ITI Techmedia, this report will be subject to periodic review and re-issue.

2   MARKET OVERVIEW

2.1   Market Definition

There is no universally accepted meaning for eHealth, tele-medicine or tele-health and the terms are often used interchangeably. For the purposes of this document, the definition of the Health sector is:

"The delivery of health services including clinical, education and administrative services through the processing, management or communication of information, including video, audio, graphics and signal data."

Within the European Commission's Information Society Technologies (IST) 2003-2004 work programme, the objective of the eHealth work stream is defined as:

"The development of an intelligent environment that enables ubiquitous management of citizens' health status and to assist health professionals in coping with some major challenges, risk management and the integration into clinical practice of advances in health knowledge."

The definition adopted by ITI Techmedia is complementary to the objectives defined by the European Commission.

The overall healthcare sector comprises a significant proportion of global gross domestic product (GDP) and, with overall healthcare sector expenditure estimated at USD2.7Trillion[1] in 2000, it accounted for around 9% of world GDP[2]. The healthcare sector is forecast to grow steadily in the short to medium term, with expenditure reaching USD4 trillion by 2008 as illustrated in Figure 1 below. At this level of expenditure, the healthcare sector will increase in relative importance in the world economy, and is forecast to account for some 11% of global GDP by 2008[3].

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[1] The Medical & Healthcare Marketplace Guide, 19th edition; © Dorland Healthcare Information, 2004

[2] The World Bank estimates that global GDP in 2000 was USD31.5 trillion.

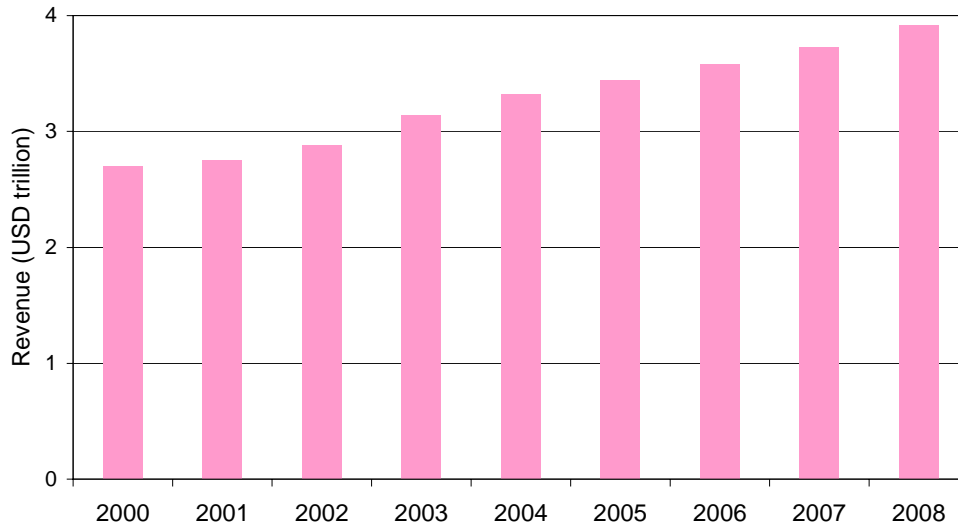[3] This analysis assumes that world GDP will grow at 3% per annum to 2008

Figure 1:   Global healthcare sector expenditure, 2000-2008 [Source: Dorland, EIU, ITI Techmedia]

The world's population is ageing as a consequence of remarkable gains in life expectancy[4], coupled with a reduction in population growth due to declines in fertility rates[5]. These trends may increase the healthcare sector spending burden on society, increasing the pressure for effective cost control whilst maintaining quality of service[6].

2.2   Market Segmentation

The market for Health services can be considered as comprising two distinct areas:

- **patient care** comprises the various activities that relate to the identification and treatment of illness

- **care setting** relates to the environment in which the various patient care activities are undertaken.

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[4] Over the past 40 years, there have been large gains in life expectancy. On average, life expectancy at birth across OECD countries increased by 8.7 years, to reach 77.2 years in 2000, up from 68.5 years in 1960, for the whole population. The gains in life expectancy were steady over the past four decades on average across countries, averaging 1.8 years from 1960 to 1970 and 2.3 years per decade since then.

[5] Fertility rate is defined as the number of children who would be born to each woman if she were to live to the end of her child-bearing years, and bear children at each age in accordance with prevailing age-specific fertility rates. The UNDP estimate that the average fertility rate in OECD countries fell from 2.2 in 1970-75 to 1.8 in 2000-05 (http://www.undp.org/hdr2003/indicator/indic_352_1_1.html)

[6] Health spending represents a growing share of GDP in OECD countries. In 2001, OECD countries devoted on average 8.4% of their GDP to health spending. This proportion varies considerably across countries, ranging from 14% in the United States to less than 6% in Luxembourg.

Whereas patient care can be considered as a set of vertical activities, care setting can be considered as a set of horizontal activities that underpin the provision of patient care activities. The relationship between patient care and care setting activities is illustrated in Figure 2 below, with the various activities considered in more detail in Section 2.3 and Section 2.4. Note that Therapy within Patient Care and Health Furniture and Consumables within Care Setting are considered to be outside of the scope of Techmedia and are not considered further in this report.
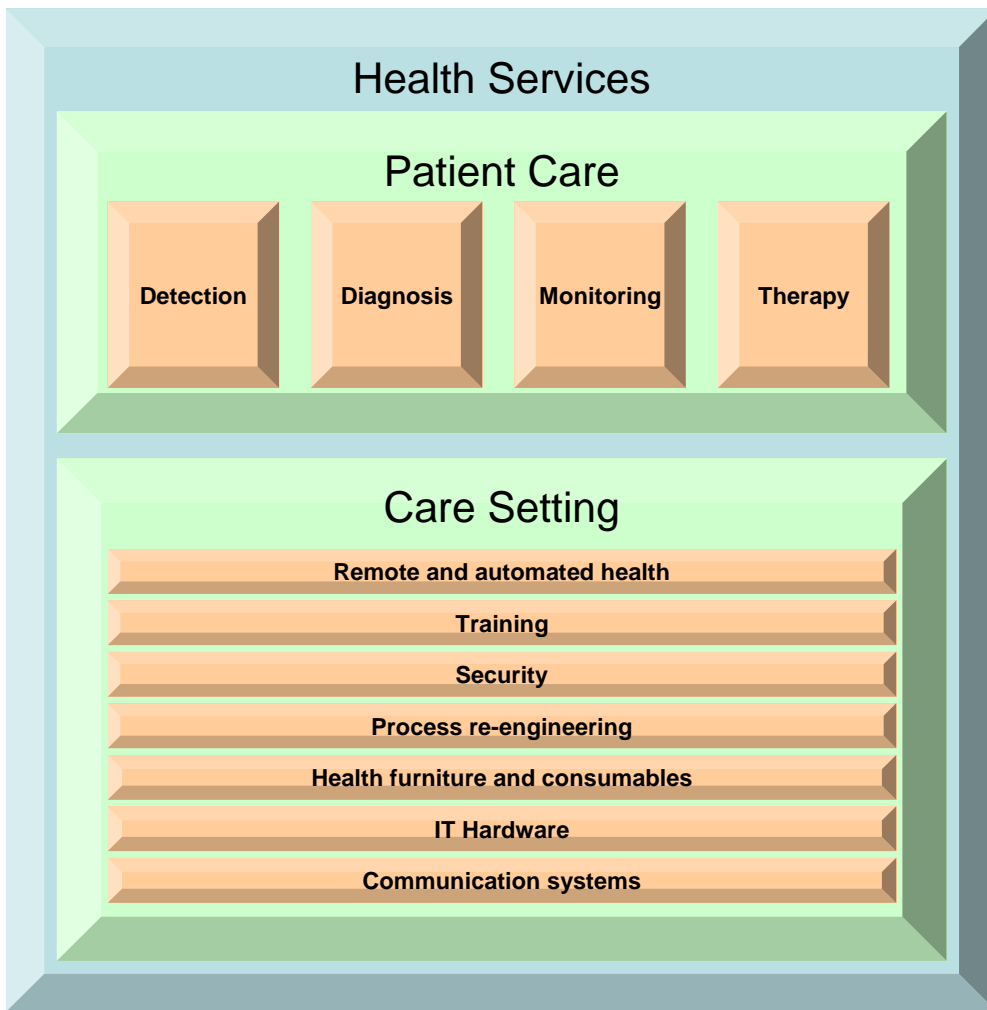

Figure 2:   Overview of Health sector activities [Source: ITI Techmedia]

2.3 Patient Care Market Description

2.3.1 Detection

Detection services, including patient screening, are used to identify the onset of illness such as cancers and heart disease. The development of new and more effective detection technologies is driven by the need to identify diseases at the earliest stages, enabling prevention and more effective treatments. When considered in the context of the overall cost of provision of patient care services, early detection can enable simpler treatments thereby reducing the cost of other patient care services.

Such savings could be significant given the cost of treatment of major illnesses. For example, cardiovascular disease affects about 120 million people in Europe and the United States (US). In the US in 2000, the cost of treatment of heart-related illness was USD200 billion, or approximately 20% of total healthcare sector costs[7].

The primary interest of this report is in relation to those areas where technology can aid the detection of medical conditions based upon input from medical samples and patient observation. In this context, areas of interest include imaging and remote health which are covered in more detail in Sections 2.3.2 and 2.4.1 below.

2.3.2 Diagnosis

Diagnosis is the process by which illness is identified from symptoms exhibited by the patient. Investment in improved diagnostic capabilities can reduce treatment costs in the longer term. However, diagnostic and treatment activities are often funded separately. The separated funding represents a significant barrier to adoption, as long-term cost savings are often not considered together with the short-term cost implications of investing in new diagnostic capabilities.

The market for diagnostic services comprises a number of areas including:

- clinical laboratory (outside the scope of this report)
- point of care
- imaging
- self/home monitoring.

Point of care (POC) testing is performed at or near the site of patient care, i.e. outside the clinical laboratory. The development and adoption of POC technologies will be an ongoing process, with hospitals considered the most amenable environment for the adoption of such technologies. In particular, critical care settings will benefit from increases in the rate of testing, enabling patients to be treated more quickly and effectively.

Advances in imaging technologies are expected to provide incremental improvements to existing methods, thereby reducing the barriers to adoption. The main impact is expected

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[7] The Medical & Healthcare Marketplace Guide, 19th edition; © Dorland Healthcare Information, 2004

to be improved and earlier diagnosis of disease leading to a decrease in admissions and length of stay in the acute care environment.

There are three basic forms of diagnostic imaging:

- transmission imaging in which the examinations are produced by generating a beam of high-energy photons passed through the body structure being examined (e.g. Computed Tomography which uses x-ray equipment to obtain cross-sectional detailed images of the body including organs, bones and other tissues)
- reflection imaging in which examinations are produced by sending high-frequency sounds to the body part or organ being studied (e.g. ultrasound)
- emission imaging in which the examinations are produced by small nuclear particles, or magnetic energy, detected by a scanner and analysed by computer to produce an image of the body structure or organ being examined (e.g. Magnetic Resonance Imaging, nuclear medicine.)

The global market for diagnostic imaging equipment is forecast to grow to over USD17 billion in 2008, up from USD10 billion in 1999 – an annual growth rate of some 6% per annum.

To date, the adoption of low technology screening products designed for home use (e.g. blood tests) has not been significant due to factors such as lack of public awareness. The widespread use of new screening technologies will not occur for some time; however, some growth is expected in low cost home products.

Together, global revenue from the in-vitro (including clinical laboratory) diagnostics and diagnostic imaging markets is forecast to exceed USD55 billion by 2008 as illustrated in Figure 3 below.

60
50
40
30
20
10
0

Revenue (USD billion)

2001 2002 2003 2004 2005 2006 2007 2008

■ In-vitro diagnostics   ■ Diagnostic imaging
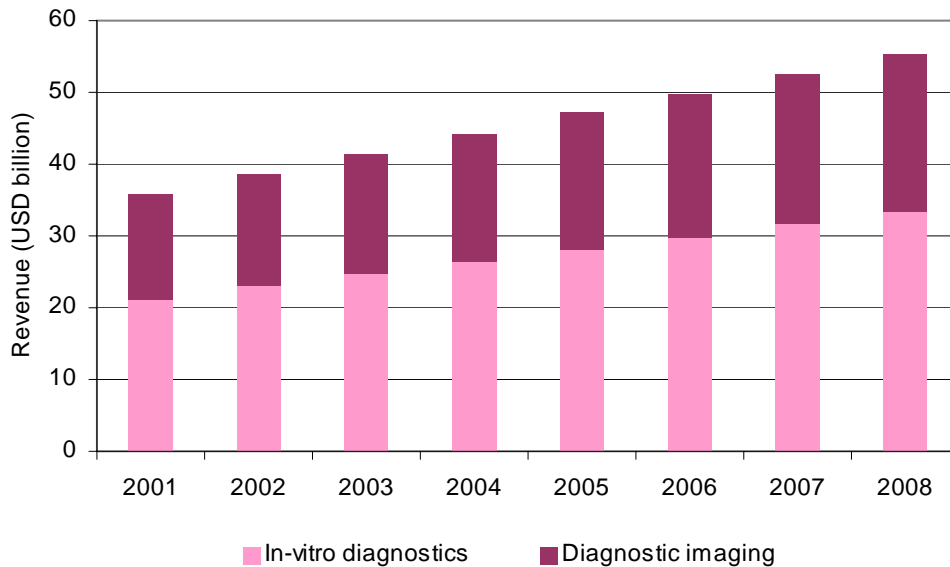
Figure 3:   Global diagnostic service revenue, 2001-2008 [Source: Dorland, ITI Techmedia]

2.3.3   Monitoring

Patient monitoring relates to the repeated or continuous observation of human function (e.g. physiological, neurological and foetal) in order to guide therapy or assist in diagnosis. Enhanced monitoring promotes improved treatment, thereby reducing the average length of patient hospital stays. Monitoring also allows systematic evidence to be incorporated into the decision-making process, and assists in the prevention of medication error.

Improvements to existing monitoring techniques are being embraced by clinicians, and rapid adoption of new technologies is common in this sector. As a result, the market for patient monitoring services is expected to exhibit a number of major shifts, including[8]:

• migration towards multi-parameter networked systems from stand-alone single parameter devices

• increased integration with information systems

• increased adoption of wireless capabilities

• increased use of non-invasive technologies.

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[8] Vital signs appear strong in competitive patient monitoring segment, Healthcare Purchasing News, December 2003

![iti Techmedia logo]

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Excluding remote monitoring (considered separately in Section 2.4.1), the global market for patient monitoring services is forecast to exceed USD15 billion in 2008, as illustrated in Figure 4 below.
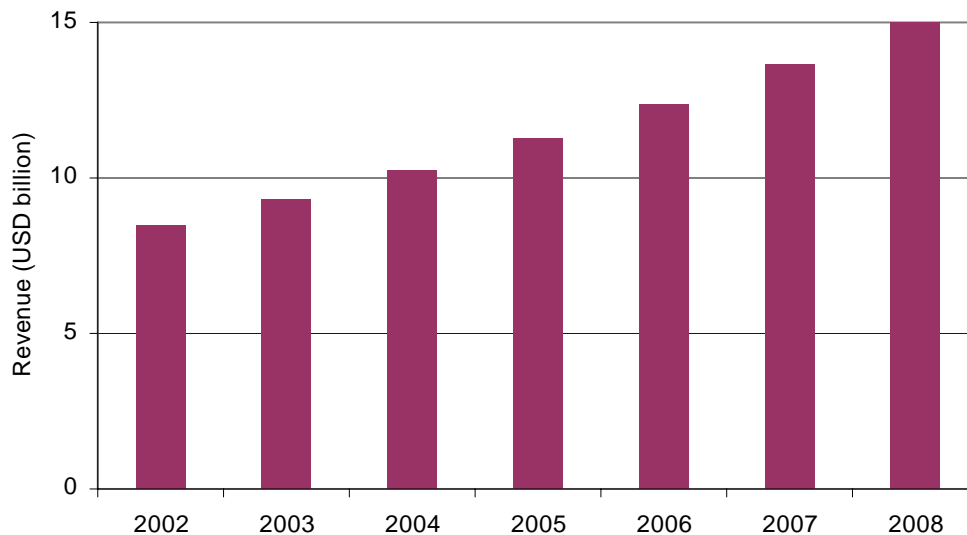
Figure 4: Global patient monitoring revenue, 2002-2008 [Source: Frost and Sullivan, ITI Techmedia]

2.4 Care Setting Market Description

2.4.1 Remote and Automated Health

From an historic perspective, the present trend towards remote and automated health services represents the second wave of telemedicine initiatives. From the late 1950s to the 1970s, a number of telemedicine applications were launched. Although these applications were partially successful from clinical and patient perspectives, many projects were discontinued for a number of reasons, including:

- high cost of complex, technically immature systems
- lack of widespread acceptance by clinicians
- lack of a pervasive, robust communications infrastructure
- high operating costs.

The resurgence of interest in alternative delivery systems, and an explosion of available applications, has been ignited by factors including:

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- the need to control healthcare costs

- the desire to increase access to healthcare facilities

- end-user desire for increased home-based care

- advances in technologies enabling the transmission and remote display of images and information.

There is a clear economic drive for migrating healthcare resources from residential to home-based care[9]. For example, in the United Kingdom, the Royal Commission on Long Term Care estimated that the cost of a week of full-time residential care is on average £454 compared to some £250 a week for private home care[10]. As the population ages, the drivers for increased home-based care will become stronger. The United Kingdom Audit Commission reported[11] that:

- some 40% of acute admissions are accounted for by people aged over 65 years

- people aged over 65 years occupy 66% of hospital beds in England and Wales.

Growth in the occurrence of diseases associated with diet and exercise levels presents one of the major healthcare challenges in developed countries. The issues are exemplified by the increasing incidence of diabetes. The World Health Organisation predicts that the number of cases of diabetes in developing countries is likely to increase more than two-fold in the next 30 years, from 115 million in 2000 to 284 million in 2030[12]. This has significant implications for the utilisation of technology solutions in the provision of healthcare: regular visits to hospital to monitor the condition of patients may be impractical and costly, which could increase the demand for remote and automated monitoring of patients.

Cost-effective and efficient medical technologies, such as clinical information systems, represent a growth market opportunity. The global market for clinical information systems, including artificial intelligence (AI) systems is forecast to reach USD40 billion by 2010[13].

Hands-on procedures provided during home nursing visits could be partially replaced by advanced remote monitoring; a study indicates that as much as 15% of all home-based procedures could be executed in this manner. Although the market is currently small, it is expected to grow rapidly within two to three years. Increased utilisation of remote health applications will result in increased healthcare efficiency as it will reduce demand for hospital beds and associated staff.

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[9] A policy goal in many OECD countries has been to shift the provision of long-term care from institutions like nursing homes towards community-based care. The objective is to allow the elderly to live independently for a longer time either in their own homes or in special housing arrangements adapted to their needs.

[10] With Respect to Old Age: Long Term Care - Rights and Responsibilities, United Kingdom Commission on Long Term Care, 1999

[11] http://bmj.bmjjournals.com/cgi/reprint/320/7251/1692/a.pdf

[12] http://66.102.11.104/u/who?q=cache:UIEW1bjzooYJ:www.who.int/mediacentre/releases/2003/pr86/en/+diabetes&hl=en&ie=UTF-8

[13] Washington Technology Centre, 2003

2.4.2 Training

This market segment covers both healthcare professional and patient training. The trend towards patient empowerment will increase; hence so will the requirement for accurate patient-targeted healthcare information, raising issues for the regulation and control of content. The rapid change in healthcare technologies, diagnosis procedures and therapies means that healthcare professionals' knowledge must be continually updated. Due to pressures on time, on-the-job training and support methodologies (utilising new tools such as internet-enabled or eLearning) will be required.

2.4.3 Security

The increased use of networked technologies poses unique opportunities and challenges for the healthcare sector. The use of networking technologies will enable lower transaction and operational costs while providing an improved service to both patients and clinicians. However leveraging such an 'open' network infrastructure also raises concerns about the privacy of individually identifiable patient information. To address these security concerns, the United States Congress passed HIPAA (Health Insurance Portability and Accountability Act), a set of standards for simplifying electronic transactions and defining minimum requirements for network security.

Services which result in improving the security of information, while ensuring ready availability of that information only to authorised parties, are expected to be an area of opportunity.

2.4.4 Process Re-Engineering

Heightened pressures on healthcare service providers to control expenditure will necessitate increased scrutiny of all areas of operation. This will result in the identification of those areas of expenditure which represent opportunities to reduce costs. To facilitate better cost control, it is expected that healthcare providers will make increasing use of integrated hospital information and enterprise resource management systems.

As processes are rationalised, increased integration of systems covering all aspects of hospital administration can be expected. This trend towards integration will encourage increased adoption of a number of applications including:

- administrative data systems, where the market is forecast to grow at around 11% per annum, reaching EUR3.4 billion by 2008[14]

- supply chain performance, where creative solutions (e.g. new collaborative partnerships in strategic sourcing, logistics and product acquisition management) are forecast to result in the value of transactions undertaken electronically reaching EUR34 billion by 2008[15].

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[14] Frost and Sullivan

[15] Frost and Sullivan

It should be noted that investment in the IT systems required to support improved cost control form a subset of the IT expenditures identified in Section 2.4.5.

2.4.5　Information Technology

Information technology infrastructure is a core enabling technology within the Health sector. If implemented correctly, an effective IT infrastructure represents a strong enabler for improved patient care through, for example, the provision of access to integrated patient data. However, it should be recognised that many clinicians remain sceptical about the role and effectiveness of IT systems within the Health sector.

The IT market has historically represented a small proportion of total healthcare expenditure, and this is not expected to change significantly in the period to 2008. Despite this, the IT sector remains a sizeable market, and is forecast to grow from around USD40 billion in 2002 to over USD60 billion as the sector expands (see Figure 5 below).
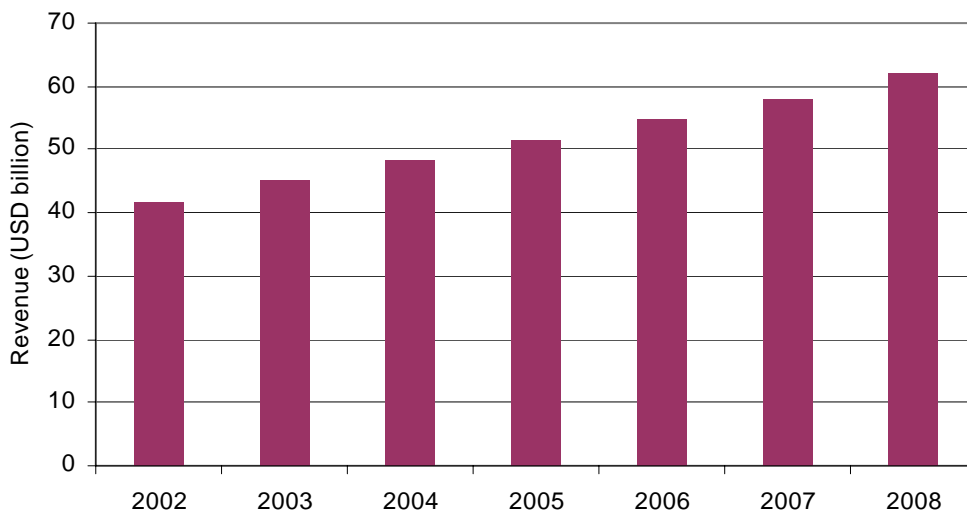
Figure 5:　　Global IT revenue in the Health sector, 2002-2008 [Source: Gartner, ITI Techmedia]

2.4.6　Communications

Communications systems are core to the efficient provision of healthcare services. Initiatives to improve the cost-effectiveness of communications systems in the healthcare environment include the development of the IEEE 1073 family of standards, which relate to the interconnection and interoperation of medical devices and computerised healthcare information systems in a manner suitable for the clinical environment.

The development of common communication protocols is slow, but once a global standard is in place, roll-out is expected to be rapid, and the market for internet protocol and IEEE 1073-based devices is expected to grow rapidly in the medium term. The

development of the market for interconnected medical devices is dependent on the creation of a heavily-networked healthcare environment. It is expected that networked healthcare environments will be more prevalent in the US than elsewhere. As a result, the US is expected to be the leading market in the development of innovative networked communications services.

As a result of the drive towards network applications, it is forecast that the global market for communications services and infrastructure will exceed USD22 billion by 2008, up from USD15 billion in 2002, as illustrated in Figure 6 below.
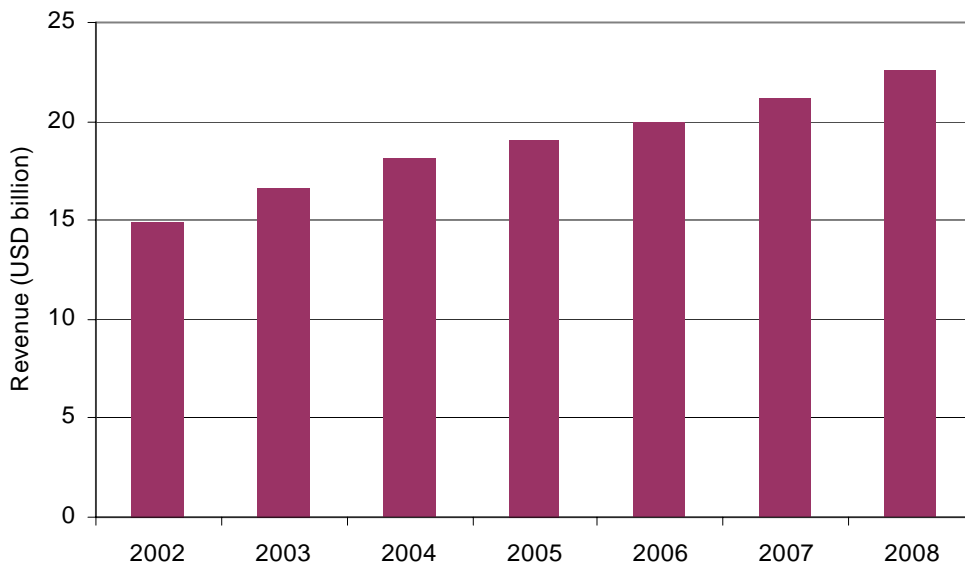
Figure 6:   Global communications revenue, 2002-2008 [Source: Gartner, ITI Techmedia]

2.5   Market Trends and Drivers

A number of trends and drivers affect, or will affect, the Health sector.

> *A **trend** is a discernible pattern of change, which can be linear, accelerating or decelerating. An example of a trend is: the average age of the UK population is increasing.*
>
> *A **driver** is a factor which directly influences or causes a change in a specific market. An example of a driver based on the above trend is: the need for easier to use interfaces in mobile phones making them accessible to the ageing population.*

The overall major trends impacting the sector are outlined below.

2.5.1 Current Trends and Drivers

Important trends in the Health sector include:

- Increasing costs of healthcare e.g. procedures, drug treatments
- Lack of staffing with necessary training and skills
- Ageing population and unhealthy lifestyles
- Increasing litigation against healthcare organisations and individuals citing errors or misdiagnosis.

Important drivers in the sector, some of which are a direct result of the trends summarised above, include:

- Control of costs is driving the use of technology and new healthcare models, e.g. technology to reduce the cost of procedures, or moving hospital patients into primary/community care
- Lack of staffing is driving use of technology, e.g. in training systems
- Need for healthcare services tailored for older people
- Need for systems to prevent medical errors
- Political and public issues e.g. pressure by Government and the Press to reduce waiting lists
- Increasing patient empowerment and more demanding "consumers".

2.5.2 Key Trends – Identified by an Expert Foresighting Group

The general sector trends identified in Section 2.5.1 above have been complemented by the opinions of an expert foresight group, convened by ITI Techmedia in January 2004. This group, which included leading organisations such as Smiths Medical, University of Edinburgh Medical School and the United Kingdom National Health Service (NHS), identified the following additional key trends likely to impact the sector:

- Need for improved collection/collation of patient and general health information
- Creation and growth of intermediary services
- Increasing requirement for protection, privacy and secure ownership of increasingly diverse personal data
- Prevention/self-assessment healthcare driven by the desire of patients for greater empowerment and ability to take greater control of their own healthcare e.g. regular health testing could aid prevention, or early-stage cure, of illnesses.
- Kiosk diagnostics offering patients access to 24/7 healthcare, thereby supporting the prevention /self-assessment healthcare philosophy
- Highly functional consumer-based devices to support the provision of simple health services e.g. blood pressure monitoring and result store.

2.5.3 Barriers to Market Entry

The healthcare sector is very large, and a complex set of inter-relationships exist between the entities involved in the provision of healthcare services. The healthcare sector is also heavily regulated, and exhibits relatively low spend on technology when compared to other industry sectors.

Barriers to market entry to the Health sector can be distinguished between non-technology and technology-related factors. Non-technology factors represent the most significant barriers to market entry, and include:

- very distinct budget boundaries, particularly in relation to primary versus secondary care. As new solutions often span these budgetary boundaries, it can be difficult to take a holistic view of the merits of any new solution
- the fragmented nature of healthcare provision makes it difficult to access the cost data required to develop robust Return On Investment (ROI) models
- inadequate management decision support infrastructure
- resistance to change to the introduction of new technologies amongst clinicians
- cost and time of training staff to utilise new solutions
- the integral importance of security and privacy of patient data to any new solutions.

From the technical perspective, predominant barriers are:

- heavy regulation of the Health sector, and the possible need for regulatory approval of new solutions. The acquisition of such approvals can be an expensive and time-consuming process
- the lack of a well-developed information infrastructure within the healthcare sector
- lack of standards in key areas. Many of the key Health sector standards are still evolving, e.g. IEEE 1073.5 is still being defined and no current agreed wireless standard exists. Standards which have become relatively mature (e.g. PACS and DICOM) are widely adopted.

2.6   Value Chain Analysis

Value chain analysis is a widely applied technique that is used to explore the specific activities through which entities can generate revenue within a particular industry sector. The techniques of value chain analysis can be applied to all sectors of the economy, although the nature of the value chain will differ between sectors. In this analysis, the value chain concept is used to illustrate the way in which:

- the introduction of new services creates opportunities across value chain elements
- functional needs can have impact across different value chain elements.

A representation of the value chain is shown in Figure 7 below. Three examples of the application of the value chain are given to illustrate how the elements of the value chain are involved for the provision of the following patient care services:

- sports injury
- heart defect
- blood screening.

	Patient Info. Gathering	Clinician Info. - Provision	Decision System Provision	Goods And Svce. Provision	Info. Infra. Provision	Clinical Intervention	User Info. Provision	Payment Provision
Sports injury	GP visit	GP notes	Physio. referral	Physio. Appointment	Paper-Based system	Physio. treatment	GP, physio.	Government
Heart defect	Vital signs monitors	Verbal system	Surgeon	Theatre, Equipment Fluids	Paper-Based system	Surgery	Surgeon	Insurance company
Blood screening	Blood test	Test Machine output	Doctor	Test kit	PC-based system	No action	Doctor	Patient Via bank

Figure 7:   Generic Health sector value chain [Source: ITI Techmedia]

The elements in the value chain are briefly described in Figure 8 below.

Patient Information Gathering	Collection of information from the patient in order to inform clinical decisions
Clinician Information Gathering	The collation of possibly disparate sources of patient information for delivery to the clinician at an appropriate place and time
Decision System Provision	The processing of information in order to formulate a clinical decision
Goods and Service Provision	Co-ordination of physical resources to enable a clinical procedures and services to be provided at appropriate times and locations
Information Infrastructure Provision	The underlying infrastructure by which the availability of information is co-ordinated between relevant parties
Clinical Intervention	The undertaking of an identified clinical procedure determined based upon clinical decisions
User information Provision	The collation of possibly disparate sources of patient information, for delivery to the patient at an appropriate place and time
Payment Provision	Entity that provides the funding for patient-related activities

Figure 8:   Elements in the Health value chain [Source: ITI Techmedia]

In order to explore the implications of new technology for the Health sector, the value chain described above has been distilled into three key segments:

- Network: elements relating to electronic communication of information
- Applications: elements relating to the provision of medical services and procedures
- Patient Services: elements relating to the interaction between clinician and healthcare user.

The mapping of these key segments to the Health value chain is illustrated in Figure 9 below. It should be noted that consideration of the Payment Provision entity is outside the scope of this report.

	Patient Info. Gathering	Clinician Info. Gathering	Decision System Provision	Physical Goods Provision	Info. Infra. Provision	Clinical Intervent.	User Info. Provision	Payment Provision
Network					✔			
Application		✔	✔	✔		✔		
Patient Services	✔						✔	

Figure 9:   Simplified value chain mapping [Source: ITI Techmedia]

This simplified value chain is explored further in Section 3.

3   MARKET ASSESSMENT

This Section summarises a number of growth areas identified through the market foresighting process, and considered to have significant market impact in the medium to long term. These market opportunities have been identified and developed based on:

- the views of experts who were asked to consider a ten-year horizon

- market research reports from 'conventional' analysts assessing a five-year horizon.

For convenience, these growth areas are described under the same market segments defined in Sections 2.3 and 2.4. For the identified growth areas, the following is described:

- brief description of the growth area

- drivers and inhibitors that will impact upon the rate of market growth

- functional needs that support market growth, together with an illustration of the area of the value chain impacted by the functional need

- for certain growth areas, roadmaps highlighting the indicative timing (i.e. when the particular need is required by the mass market) of some of the identified functional needs. Note that Roadmaps are not provided for all areas.

A brief description of the various functional needs described in this Section is provided in Appendix 3.

3.1   Detection

Improved detection capabilities offer the potential to reduce overall healthcare costs by allowing simpler treatments to be applied where illnesses are detected early. As a result of the foresighting process, two areas are considered to offer considerable potential:

- physical imaging: techniques for the development of patient images. These techniques generate personal patient data resulting in requirements for image and signal processing, including automated screening

- molecular diagnostics: methods for the identification of illness, or the predisposition towards an illness, through the analysis of DNA and protein markers. Covers tests which directly examine the genetic make-up of an individual, determine the presence or absence of certain nucleic acids, identify infectious diseases and measure the level of expression of certain proteins or RNA molecules which encode proteins. Molecular diagnostics could generate greater opportunities for patient or home-based screening, plus a requirement for online information services. Data generation from such tests will result in a requirement for storage and automated review of test results.

_____

Drivers and Inhibitors

Major drivers and inhibitors that will affect the take-up of detection applications are described in Figure 10 below.

Drivers	Inhibitors
Escalating healthcare costs	Lack of standards
Increasing demand for medical services	Medical regulations
Focus on preventative healthcare models	Lack of integrated healthcare cost models

Figure 10 :   Detection, drivers and inhibitors [Source: ITI Techmedia]

Functional Needs

Functional needs that support the development of detection applications, together with their area of application within the value chain, are illustrated in Figure 11 below.

Functional need	Network related	Application related	Patient Services related
4D (real-time 3D) cardiac ultrasound imaging		✔	✔
CT laser mammography		✔	✔
Detection of chemical indicators		✔	✔
Genetic screening		✔	
Laser surface scanning		✔	✔
Thermal imaging for mammography		✔	✔

Figure 11:   Identified functional needs, detection services [Source: ITI Techmedia]

3.2   Diagnosis

Three applications are considered to offer considerable potential:

- point of care: diagnosis performed at or near the site of patient care, i.e. outside the clinical laboratory. Some of these technologies address expanding healthcare needs while others will enable the streamlining of key healthcare processes

- physical imaging

- self/home monitoring: increased demand for home-based healthcare will drive demand for home/self monitoring systems. As a result, it can be expected that new technologies will emerge to facilitate increased patient monitoring in the home environment.

Drivers and Inhibitors

Major drivers and inhibitors that will affect the take-up of diagnosis applications are described in Figure 12 below.

Drivers	Inhibitors
Movement toward point of care diagnostics.	Cost of diagnosis equipment and services
Early diagnosis, critical for the prevention healthcare model	All new diagnosis services and techniques must have clinician approval and adhere to medical regulation
Improved techniques to reduce the number of diagnosis errors	

Figure 12 :   Diagnosis, drivers and inhibitors [Source: ITI Techmedia]

Functional Needs

Functional needs that support the development of diagnosis applications, together with their area of application within the value chain, are illustrated in Figure 13 below.

Functional need	Network related	Application related	Patient Services related
Bioinformatics		✔	
Cardiac markers for MI screening		✔	
High resolution 3D ultrasound		✔	✔
High-field MRI		✔	✔
Hyperpolarisation methods for enhancing signals		✔	✔
Inflammatory sepsis testing[16]		✔	
Laser surface scanning		✔	✔
Molecular imaging		✔	✔
MR coil technology		✔	
MR functional imaging		✔	✔
Non-invasive and non-occlusive blood pressure monitoring		✔	✔
Non-invasive continuous blood glucose testing		✔	✔
Non-invasive hematocrit (HCT) testing		✔	✔
Non-ionizing mammography		✔	✔
Novel contrast media		✔	
Prostate specific antigen testing		✔	✔
Rapid microbiological testing combined with antibiotic susceptibility testing		✔	✔
Wide range of cancer markers		✔	

Figure 13: Identified functional needs, diagnosis services [Source: ITI Techmedia]

Roadmap

Figure 14 below illustrates the timing of functional needs identified above to 2008.

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[16] Sepsis is a severe illness caused by overwhelming infection of the bloodstream by toxin-producing bacteria. It occurs in 2 of every 100 hospital admissions in the US. At present the diagnosis of infectious diseases typically requires the culturing of the organism or detection of antibodies within the patient to a particular organism. As drug resistant organisms become increasingly prevalent, it is becoming important to determine the antibiotic susceptibility of an infecting organism before commencing treatment. Hospital acquired infections with drug resistant organisms are a major cause of extended stays in hospital.
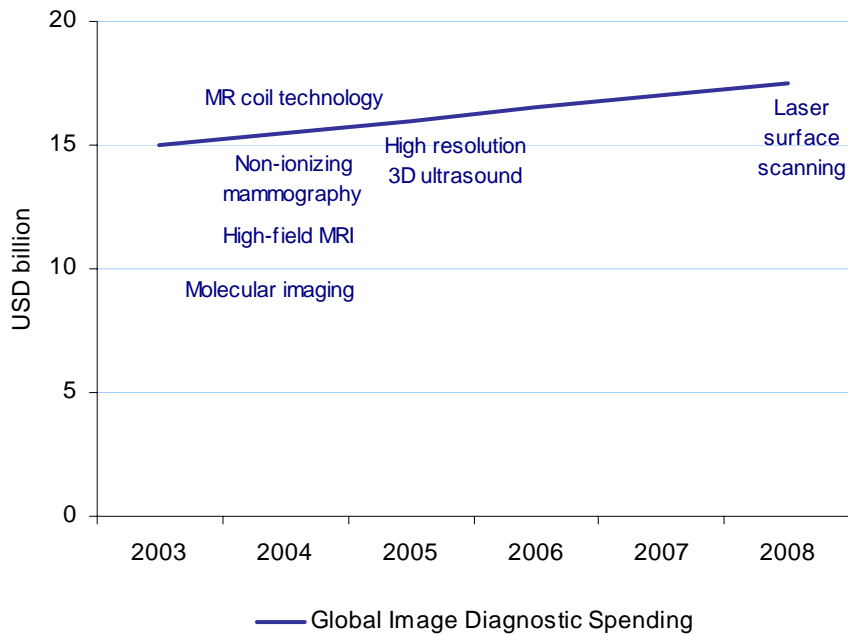
Figure 14:   Image diagnostics functional needs, 2003-2008 [Source: ITI Techmedia]

3.3   Monitoring

Monitoring applications generate significant volumes of information, requiring data analysis, transmission and processing. Three applications are considered to offer considerable potential:

- Physiological: monitoring of key bodily functions
- Neurological: monitoring of the nervous system
- Foetal/neonatal: monitoring of the mother and baby during pregnancy.

Drivers and Inhibitors

Major drivers and inhibitors that will affect the take-up of monitoring applications are described in Figure 15 below.

Drivers	Inhibitors
Movement towards preventative healthcare through non-intrusive monitoring techniques	Lack of coherent data standards and electronic patient records
Medication error prevention and litigation mitigation	
Need to reduce the requirement for intervention by staff	

Figure 15 :   Monitoring, drivers and inhibitors [Source: ITI Techmedia]

Functional Needs

Functional needs that support the development of diagnosis applications, together with their area of application within the value chain, are illustrated in Figure 16 below.

Functional need	Network related	Application related	Patient Services related
Audiological monitoring		✓	✓
Automated diagnosis	✓	✓	✓
Birth progress monitoring	✓	✓	✓
Closed-loop monitoring	✓	✓	✓
Depth of anaesthesia EEG monitoring		✓	✓
Enhanced cardiac output monitoring	✓		✓
Implantable heart rate, temperature and blood pressure monitors	✓	✓	✓
In home seizure/epilepsy prediction	✓	✓	✓
In-line real-time blood gas sensing		✓	✓
Long term EEG	✓	✓	✓
Musculo-skeletal rehabilitation monitoring	✓	✓	✓
Non-invasive continuous blood pressure monitoring	✓		✓
Novel ECG/ electrodes		✓	✓
Wireless intra-partum foetal monitoring	✓	✓	✓
Wireless monitoring devices	✓		✓
Wireless NICU monitoring devices	✓	✓	✓

Figure 16:   Identified functional needs, monitoring [Source: ITI Techmedia]

Roadmap

Figure 17 below illustrates the timing of functional needs identified above to 2008.
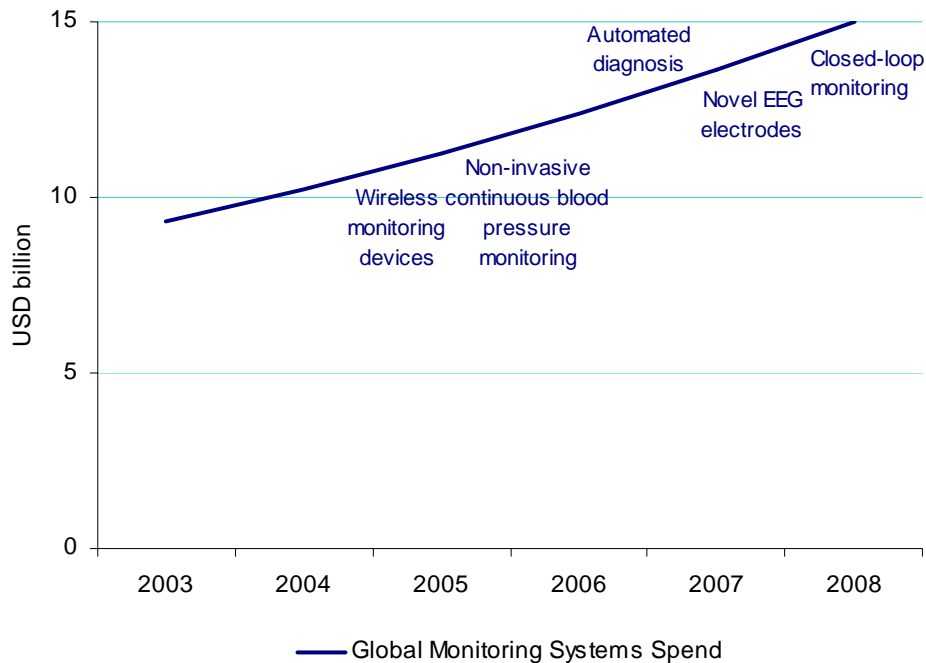
Figure 17:   Monitoring functional needs, 2003-2008 [Source: ITI Techmedia]

3.4   Remote and Automated Health

Remote and automated health refers to capabilities which enable the monitoring of patients, outside the traditional healthcare environment. Three areas are considered to offer considerable potential:

- information analysis: efficient processing of healthcare information including patient-related data. Increased demand for data analysis will increase the requirement for capabilities such as signal and image analysis and processing

- health information: traditional eHealth services such as image storage and archiving, therapy planning, contextual information

- remote health monitoring: capabilities enabling physiological, neurological and foetal/neonatal monitoring outside the traditional healthcare environment.

Drivers and Inhibitors

Major drivers and inhibitors that will affect the take-up of diagnosis applications are described in Figure 18 below.

Drivers	Inhibitors
Life style issues and ageing population driving technologies enabling at-home monitoring	Does not fit existing channels to market systems and technologies
Availability of communication systems	Difficulty in demonstrating a ROI
Increasing costs of healthcare	Inadequate heath management support and resistance to change
Miniaturisation and low cost microelectronics	Medical and privacy regulations
Patient empowerment	Lack of agreed communication standards in the health sector

Figure 18 :   Diagnosis, drivers and inhibitors [Source: ITI Techmedia]

Functional Needs

Functional needs that support the development of these applications, together with their area of application within the value chain, are illustrated in Figure 19 below.

Functional need	Network related	Application related	Patient Services related
Antennae for robust communications	✓		✓
Bayesian statistics		✓	
Edge detection & median filtering		✓	
Event, condition, action rule bases		✓	
Genetic algorithms		✓	
Intelligent agents	✓	✓	✓
Lean IP	✓	✓	
Low cost video cameras			✓
Low power systems		✓	✓
Natural language processing		✓	✓
Neural networks		✓	
Rule bases (induction)		✓	
Semantic web		✓	✓
Signal compression	✓		
Statistical interpretation		✓	
Streaming platforms	✓		✓
Video compression	✓		✓
Virtual reality		✓	
Wavelets & other transforms		✓	

Figure 19:   Identified functional needs, remote and automated health [Source: ITI Techmedia]

Roadmap

Figure 20 below illustrates the timing of functional needs identified above to 2008.
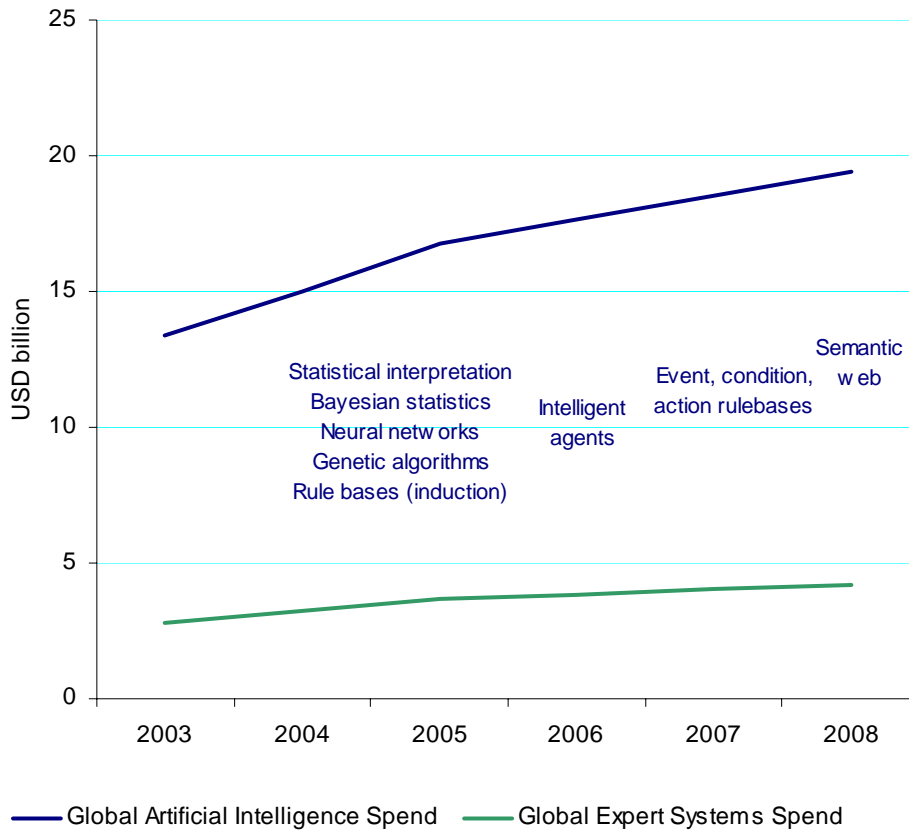
Figure 20: Remote and automated health functional needs, 2003-2008 [Source: ITI Techmedia]

3.5   Training

Training refers to services and technologies that support the cost-effective delivery of training and education to staff and patients. Education and training is central to patient empowerment, reduction of medical errors and better detection of critical diseases. Professional and patient education has been identified as an area that is considered to offer significant potential.

Drivers and Inhibitors

Major drivers and inhibitors that will affect the take-up of training applications are described in Figure 21 below.

_____

Drivers	Inhibitors
Money moving towards the patient and the expert patient; patient empowerment	Difficulty in demonstrating a ROI
More efficient training of new staff and existing staff to meet continual increase in skills and knowledge needed	Lack of current regulation on content of medical information web sites; trusted information providers
Treatment such as tailored care and independent living requiring patients to be trained	
Requirement for patient education in lifestyle for good health	

Figure 21 :   Training, drivers and inhibitors [Source: ITI Techmedia]

Functional Needs

Functional needs that support the development of this area, together with its area of application within the value chain, are illustrated in Figure 22 below.

Functional need	Network related	Application related	Patient Services related
Assessment tools		✔	
Certification validation tools		✔	
Collaborative tools	✔	✔	✔
Discovery portals	✔	✔	
Information visualization		✔	✔
Innovation management		✔	
Intelligent agents	✔	✔	✔
Interactive TV	✔		✔
Low cost video cameras	✔		✔
Natural language processing		✔	✔
Recommendation engines		✔	✔
Simulations		✔	
Streaming platforms	✔		✔
Virtual reality		✔	✔

Figure 22:   Identified functional needs, training [Source: ITI Techmedia]

3.6 Security

Security refers to physical and electronic security in healthcare. These technologies are extremely important in meeting emerging privacy regulation, and electronic data security is considered to offer considerable potential.

Drivers and Inhibitors

Major drivers and inhibitors that will affect the take-up of security applications are described in Figure 23 below.

Drivers	Inhibitors
Meeting healthcare privacy and security regulation	Cost of implementation
Increasing need to provide physically secure environment	Possible interference with medical systems
Protection of staff from increasing level of physical attack	Medical and privacy regulations
Protection of patients e.g. babies from being taken from hospital	
Need to locate equipment and prevent theft	

Figure 23 :   Security, drivers and inhibitors [Source: ITI Techmedia]

Functional Needs

Functional needs that support the development of this area, together with its area of application within the value chain, are illustrated in Figure 24 below.

Functional need	Network related	Application related	Patient Services related
Authentication (Biometrics)		✔	✔
Automated trust systems	✔	✔	
Contactless location/identification – item-level RFID	✔	✔	
Data encryption	✔		
Electronic signatures	✔	✔	✔
Low cost video cameras	✔		✔
Natural language processing		✔	✔
Network security	✔		
Unit-level bar code		✔	✔

Figure 24:   Identified functional needs, security [Source: ITI Techmedia]

3.7 Process Re-Engineering

Process re-engineering refers to capabilities which enable improvements in current healthcare management processes. Since these capabilities are important in improving efficiency, it is expected that the area of process re-engineering will experience significant growth. Three areas are considered to offer considerable potential:

- logistics and distribution: logistics and associated management systems related to the provision of goods and services
- data and process management: electronic management of process and staff resulting in efficiency improvements. Data and process management also enables the staff and patient information with eHealth systems and processes
- location and tracking systems: tools to aid asset tracking for efficiency and logistics

Drivers and Inhibitors

Major drivers and inhibitors which will affect the take-up of process re-engineering are described in Figure 25 below.

Drivers	Inhibitors
Political issues e.g. waiting lists	Clinician resistance to change
Cost; reduction of healthcare costs	Privacy regulation and security
Medical error prevention	Difficulty in demonstrating a ROI
Improving use of resources	
Improving efficiency of procurement processes and quantities; driving the price down	
More supplies required at home to support eHealth	

Figure 25 : Process re-engineering, drivers and inhibitors [Source: ITI Techmedia]

Functional Needs

Functional needs that support the development of these areas, together with their area of application within the value chain, are illustrated in Figure 26 below.

_____

Functional need	Network related	Application related	Patient Services related
Customer relationship management		✔	✔
Demand chain management	✔	✔	
Electronic patient records		✔	
Electronic prescriptions	✔	✔	✔
Electronic procurement		✔	
Electronic signatures		✔	✔
Event, condition, action rulebases		✔	
Handwriting recognition		✔	✔
Inertial system location	✔		✔
Integrated workflow		✔	
Intelligent agents	✔	✔	✔
Internet auctions	✔	✔	
Magnetic induction location	✔		✔
Mobile phone positioning systems	✔		✔
Natural language processing		✔	✔
Service management systems	✔	✔	
Supply chain management software	✔	✔	
Ultra Wide Band (UWB) location systems	✔		

Figure 26: Identified functional needs, process re-engineering [Source: ITI Techmedia]

Roadmap

Figure 27 below illustrates the timing of functional needs identified above to 2008.
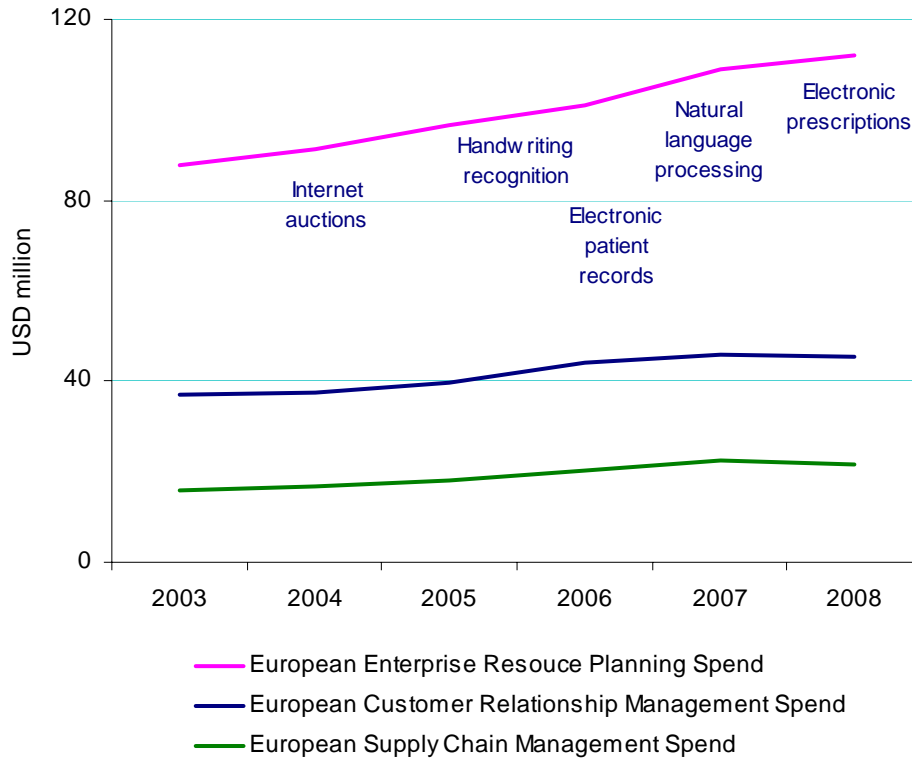
Figure 27:   Process re-engineering functional needs, 2003-2008 [Source: ITI Techmedia]

3.8   Information Technology

IT hardware refers to computer-based systems facilitating information storage, manipulation and dissemination. Strong growth is expected for the next 3-5 years, as computer-based applications are used increasingly in the healthcare environment. Two areas are considered to offer considerable potential:

- patient entertainment: systems required to support patient entertainment within and outside the healthcare setting e.g. at-bedside internet access and internet-based health information kiosks in public places

- computer systems: computer equipment used by healthcare practitioners in the support of healthcare service provision

Drivers and Inhibitors

Major drivers and inhibitors that will affect the take-up of IT are described in Figure 28 below.

Drivers	Inhibitors
Lack of underlying communications infrastructure	Cost and difficulty in demonstrating a ROI
Consumer pressure for improved healthcare environment	Clinician resistance to change
Data review and capture e.g. EPR and imaging (PACS)	
Health professional training	
Medical error prevention	

Figure 28 :   Information technology, drivers and inhibitors [Source: ITI Techmedia]

Functional Needs

Functional needs that support the development of these applications, together with their area of application within the value chain, are illustrated in Figure 29 below.

Functional need	Network related	Application related	Patient Services related
Interference-free mobile devices	✔		✔
Advanced storage media	✔		
Electronic data capture		✔	✔
Grid computing	✔	✔	
Integration brokers		✔	
Interactive TV	✔		✔
Internet access	✔		✔
Internet kiosks	✔		✔
Infotainment	✔		✔
Polymer displays			✔
Service-oriented integration architecture		✔	
Storage area networks	✔		
Voice control		✔	✔

Figure 29:   Identified functional needs, information technology [Source: ITI Techmedia]

3.9   Communications

Communications refer to products, networks and infrastructure which facilitate efficient communications and data transfer, thereby enabling new methods of health delivery. Three areas are considered to offer considerable potential:

- wireless communications: provision of radio-based communication infrastructure that does not interfere with medical equipment

- wireline communications: provision of wired communication infrastructure

- standards-based information exchange: standards are the key enabler of the electronic healthcare environment. The availability of standards will enable medical devices to communicate and transfer information in a consistent, predictable fashion.

Drivers and Inhibitors

Major drivers and inhibitors that will affect the take-up of communications are described in Figure 30 below.

Drivers	Inhibitors
Development of standard information protocols	Cost of implementation; lack of Return on Investment model.
Collation and collection of health information	Regulation and concerns that physical equipment could interfere with medical equipment (particularly wireless communications)
The growth of intermediary services	
Remote health monitoring	

Figure 30 :   Communications, drivers and inhibitors [Source: ITI Techmedia]

Functional Needs

Functional needs which support the development of these areas, together with their area of application within the value chain, are illustrated in Figure 31 below.

_____

Functional need	Network related	Application related	Patient Services related
Acoustic – psycho-acoustical masking	✔		
Campus area digital radio	✔		✔
Data communications through power lines	✔		
Fixed wireless access	✔		
High bandwidth WLAN	✔		
Lean IP	✔	✔	
Local area, robust and safe wireless technology	✔		
Medical standards-compliant systems	✔		
Optical – including diffuse IR	✔		
Third generation mobile phone systems	✔		✔
Ultra Wide Band	✔		

Figure 31:   Identified functional needs, communications [Source: ITI Techmedia]

Roadmap

Figure 32 below illustrates the timing of functional needs identified above to 2008.
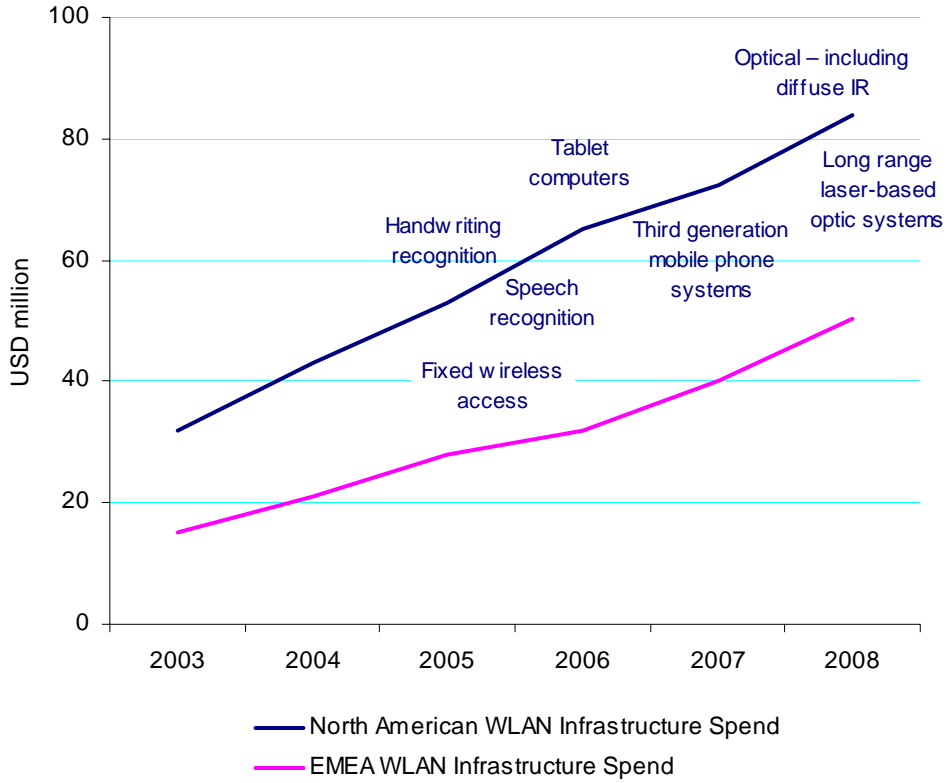
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Figure 32: Wireless communications functional needs, 2003-2008 [Source: ITI Techmedia]

4 MARKET DATA

In this Section, market data are provided for the market areas identified in Section 3.

Overall, global Health services sector revenue is forecast to reach USD3.9 trillion by 2008, as illustrated in Figure 33 below.

Revenue (USD billion)	2003	2004	2005	2006	2007	2008	CAGR %
	3,100	3,300	3,400	3,600	3,700	3,900	4.6%

Figure 33:   Global Health services revenue, 2003-2008 [Source: Dorland, EIU, ITI Techmedia]

4.1   Detection

Detection, including screening, covers new technologies used for disease detection in the general population - both molecular tests and physical-based tests.

National screening programmes focus on particular conditions such as breast cancer or deafness in childhood. For example, common screening programmes include antenatal screening, child health screening and screening for specific illnesses in adults and the elderly.

Screening programmes rely heavily on both in-vitro diagnostic tests and diagnostic imaging to provide the basis for diagnosis. Market data for these areas are provided within Section 4.2.

4.2   Diagnostics

Diagnostics data can broadly be classified into image and non-image data. Image data is generally obtained from many different imaging modalities such as X-Rays. Non-image data includes, for example, patient demographic data, clinical reports and gene expression profile data. The diagnostics sector plays an increasingly important role in the healthcare industry.

4.2.1   Non-Image Diagnostics

There is a growing trend away from central pathology laboratory testing towards a distributed model involving doctors' surgeries, pharmacies and patient homes. Ongoing reduction in the cost of testing, together with increased accuracy of test results, may underpin the emergence of the mass screening programmes of the future.

The market for in-vitro diagnostic services is forecast to reach USD33 billion by 2008, as illustrated in Figure 34 below.

![ITI Techmedia logo]

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Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
Laboratory	18,542	19,618	20,694	21,770	22,846	23,922	5.2%
Decentralised and ambulatory	1,743	1,822	1,901	1,980	2,059	2,138	4.2%
Patient self test	4,381	4,945	5,509	6,073	6,637	7,201	10.4%
Total	24,666	26,385	28,104	29,823	31,542	33,261	6.2%

Figure 34:   Global in-vitro diagnostic testing revenue, 2003-2008 [Source: Dorland, ITI Techmedia]

4.2.2   Image Diagnostics

Diagnostic imaging systems provide physicians with non-invasive methods for diagnosing diseases or injuries. There is a shift from analogue film to digital diagnostics data, and this shift is enabling "on demand" diagnostics[17] and the opportunity for a new "pay as you go" business model.

The use of diagnostic imaging systems is likely to be within the hospital setting or via independent imaging centres.

According to Frost and Sullivan, the value of the global diagnostic medical imaging market was USD13 billion in 2000. By 2008, it is forecast that the value of the market will have reached USD22 billion, as illustrated in Figure 35 below.

The link between the medical imaging equipment and services market has led to the diagnostic imaging market being dominated by the large medical imaging companies. Major vendors in this area include GE Medical Systems, Philips Medical Systems, Siemens Medical Systems and Toshiba Medical Systems.

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
	16,700	17,800	19,100	20,000	21,000	22,100	5.8%

Figure 35:   Global diagnostic imaging revenue, 2003-2008 [Source: Frost and Sullivan, ITI Techmedia]

4.3   Monitoring

Patient monitoring products measure, display and document physiological information obtained periodically from sensors attached to the patient or other input devices. An increasing amount of monitoring is taking place using telemetry to enable remote patient monitoring.

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[17] Diagnostics in Information Based Medicine, Satish Gambhir, IBM Life Sciences, 2003

According to Frost and Sullivan, the global patient monitoring market was worth some USD7 billion in 2000, and is forecast to reach USD15 billion by 2008 (see Figure 36 below).

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
	9,317	10,249	11,274	12,401	13,641	15,005	10.0%

Figure 36: Global patient monitoring revenue, 2003-2008 [Source: Frost and Sullivan, ITI Techmedia]

It is forecast that the US market for remote monitoring, comprising ambulatory and telemetry monitoring, would be worth some USD2 billion in 2008 as illustrated in Figure 37 below.

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
Ambulatory	945	1,050	1,167	1,300	1,444	1,600	11.1%
Telemetry	276	300	323	350	377	400	7.7%

Figure 37: United States ambulatory and telemetry patient monitoring system revenue, 2003-2008 [Source: Dorland, ITI Techmedia]

The patient monitoring market is highly fragmented and competitive. The major suppliers in the segment include Tyco Healthcare, GE Medical Systems, Philips Medical Systems and Instrumentarium.

4.4   Remote and Automated Health

This Section considers the following aspects of the management of health information:

- information analysis
- health information
- telemedicine.

4.4.1   Information Analysis

Interest in medical expert systems, neural networks and other artificial intelligence (AI) techniques is increasing, as more healthcare providers realise the potential to streamline areas of the healthcare process and suppliers increasingly recognise the potential offered by the Health sector.

AI's role in medicine has grown substantially in the last decade and further growth is expected given the pressure on healthcare organisations to improve efficiency and cost-effectiveness. Intelligent systems make it possible to capture expert medical knowledge and to discover new knowledge to improve in-patient monitoring, data analysis and

decision making, and hence the quality of healthcare. Within the insurance industry, there is considerable interest in AI as a predictive tool to assist in understanding claims and making reimbursement decisions.

The US AI market was worth some USD10.6 billion in 2000, and is forecast to grow to around USD19 billion by 2008 (see Figure 38 below).

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
	13,350	15,000	16,800	17,680	18,560	19,440	7.8%

Figure 38:   Global artificial intelligence revenue, 2003-2008 [Source: Dorland, ITI Techmedia]

Neural networks and expert systems represent subsets of the AI Market. The neural network market is forecast to grow from USD2.8 billion in 2003 to USD4.1 billion in 2008. The expert systems market is forecast to grow from USD2.8 billion in 2003 to USD4.2 billion in 2008 (see Figure 39 below).

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
Neural networks	2,800	3,200	3,600	3,780	3,960	4,140	8.1%
Expert systems	2,800	3,200	3,700	3,860	4,020	4,180	8.3%

Figure 39:   United States neural network and expert systems revenue, 2003-2008 [Source: Dorland, ITI Techmedia]

4.4.2   Health Information

In this Section two aspects of health information provision are considered:

- therapy planning
- picture archive and communications systems.

Therapy Planning

Therapy planning covers three main tasks in the provision of effective knowledge-based data analysis:

- selecting which therapeutic actions may improve the patient's condition
- predicting short and long term outcomes of therapeutic actions
- adopting a therapeutic plan according to some explicitly defined preferences on the predicted condition of the patient.

The US therapy planning market is forecast to exceed USD1 billion by 2008 as shown in Figure 40 below.

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
	690	800	900	960	1,020	1,080	9.4%

Figure 40:   United States therapy planning revenue, 2003-2008 [Source: Dorland, ITI Techmedia]

Picture Archive and Communications Systems (PACS)

The PACS segment is a major growth area with global revenue in excess of USD1.9 billion in 2003. It is forecast that the global PACS market, comprising hardware, software and systems integration, will grow to almost USD3 billion by 2008, as illustrated in Figure 41 below.

Major vendors in this area include GE Medical Systems, Siemens, Agfa, Fuji, Philips Medical Systems and Kodak. A number of application providers are also active, including Meditech, R2, Mirada Solutions, Medizeus, ETRAUMA and Sentillion.

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
Hardware	851	984	1,089	1,050	982	1,004	3.3%
Software	502	527	554	583	610	642	5.1%
Systems Integration	555	641	740	873	1,016	1,243	17.5%
Total	1,909	2,151	2,383	2,506	2,607	2,888	8.6%

Figure 41:   Global PACS revenue, 2003-2008 [Source: Frost and Sullivan, ITI Techmedia]

4.4.3   Telemedicine

Telemedicine is a means of transmitting medical images and other medical information. HBS Consulting considers the global telemedicine market[18] to be valued at over USD3 billion. By 2008, the market is forecast to grow to almost USD14 billion, as illustrated in Figure 42 below.

HBS Consulting considers the major market opportunities to lie in the Pacific Rim, as a number of key initiatives targeting the telehealth sector are implemented. As examples, HBS cites the recent changes in favour of telehealth solutions in the home care sector in Japan, the continued development and support of telehealth applications as part of the Multimedia Super Corridor initiative and the favourable climate for health IT applications in Australia and New Zealand.

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[18] Telehealth - A Keystone for Future Healthcare Delivery, HBS Consulting

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Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
	3,190	4,274	5,725	7,670	10,275	13,766	34.0%

Figure 42: Global telemedicine revenue, 2003-2008 [Source: HBS Consulting, ITI Techmedia]

4.5 Training

4.5.1 Professional Education

The medical education market includes:

- medical product detailing (office visits by medical product company sales people to promote products)
- other medical product company marketing activities (conferences, seminars, training)
- continuing medical education (conferences, tests, associated travel)
- medical textbooks
- medical journals

The US professional medical education market is forecast to reach USD6.5 billion in 2008, as illustrated in Figure 43 below.

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
	4,250	4,620	5,022	5,460	5,935	6,452	8.7%

Figure 43: United States professional medical education revenue, 2003-2008 [Source: Dorland, ITI Techmedia]

4.5.2 Patient Education

The trend towards patient empowerment is giving rise to patients who seek to be as well informed as the clinicians they consult. According to the Federal Trade Commission (FTC), consumer online searches for health information are increasing dramatically, and thirty million Americans are estimated to have sought health information online in 2001[19].

A September 2003 poll by the Pew Research Center in Washington, D.C., found that 67% of Americans expect to find reliable information on the Internet about health or medical

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[19] Federal Trade Commission, Protecting Consumers Online: A Federal Trade Commission Report on the First Five Years of Its Internet Law Enforcement Program, December 1999.

conditions. Among Americans as a whole, 59% indicated that they will contact a healthcare professional when requiring healthcare information. Significantly however, 46% of US Internet users indicated that they will go online the next time they need healthcare information, whilst an equal number (47%) indicated that they will consult a medical professional.

Market figures are the subject of further investigation and not included in this report.

4.6   Security

As more patient information is stored and transmitted, electronic data security is increasing in importance to both healthcare purchasers and providers.

In the United States, HIPAA governs security and patient confidentiality. Dorland Healthcare Informatics states that US health care organisations each spent around USD2.5 million to comply with security and confidentiality requirements deadlines that became effective in 2003.

Market figures are the subject of further investigation and not included in this report.

4.7   Process Re-engineering

Sometimes referred to as Enterprise Application Software, this area relates to software and tracking technology that will create a change in current healthcare management processes. As this area increases in importance in improving efficiency, it is expected to experience significant growth in the medium term.

Process re-engineering can be segmented into:

- logistics and distribution
- data and process management
- location and tracking

4.7.1   Logistics and Distribution

Supply Chain Management

Cost management is a key issue in the Health sector. Effective supply chain management is an opportunity for healthcare organisations to control costs since supplies can account for roughly 25% of an organisation's operating budget. Organisations can significantly reduce operating expense through initiatives such as:

- stricter standardisation processes
- enterprise-wide purchasing
- managing and predicting optimal inventory levels

As part of supply chain management, eProcurement is becoming more significant. Frost and Sullivan indicates that the European Health sector eProcurement market was worth around USD0.4 billion in 2002. By 2008, this value is forecast to rise to some USD34 billion.

A number of vendors are active in this segment, including i2, SAP, Aspen Technology, IBM, JDA, Retek and Intentia.

4.7.2 Data & Process Management

Enterprise Resource Planning (ERP)

Healthcare ERP applications typically comprise general ledger, accounts payable, materials management, SCM, fixed assets and human capital management. CRM systems are not as developed as in the retail sector; this is reflected in the revenue forecast for the sector as shown in Figure 44 below.

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
ERP	88	91	97	101	109	112	4.9%
CRM	37	37	40	44	46	46	4.3%

Figure 44: European resource planning and customer relationship management system revenue, 2003-2008 [Source: Gartner, ITI Techmedia]

4.7.3 Location and Tracking

No market figures are available for this segment.

4.8 Information Technology

In this Section, three specific areas are considered:

- hospital information systems
- computerised physician order entry
- hand held devices

Gartner forecasts that the US healthcare IT market will grow to USD43 billion in 2008 as illustrated in Figure 45 below. However, it should be noted that there is considerable variation in market forecasts for this segment. For example, IDC[20] forecast that the market will be worth USD26 billion by 2006.

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[20] U.S. Healthcare IT Market Forecast and Analysis, 2001-2006, IDC, June 2002

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Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
Hardware	4,027	4,019	4,055	4,179	4,268	4,350	1.6%
Software	2,276	2,479	2,733	3,038	3,125	3,380	8.2%
Services	23,390	25,549	27,746	29,963	32,508	35,322	8.6%
Total	29,693	32,047	34,534	37,180	39,900	43,052	7.7%

Figure 45: United States healthcare IT revenue, 2003-2008 [Source: Gartner Dataquest, ITI Techmedia]

The European healthcare IT market is forecast to grow to USD19 billion by 2008 as illustrated in Figure 46 below.

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
Hardware	2,273	2,457	2,648	2,768	2,889	3,015	5.8%
Software	998	1,179	1,379	1,573	1,784	2,023	15.2%
Services	5,580	6,220	6,998	7,858	8,703	9,639	11.6%
Total	8,851	9,856	11,025	12,199	13,376	14,677	10.6%

Figure 46: European healthcare IT revenues, 2003-2008 [Source: Gartner Dataquest, ITI Techmedia]

4.8.1   Hospital Information Systems (HIS) and Enterprise Scheduling Systems (ESS)

HIS and ESS are a complex mixture of software, hardware and services. A typical system comprises:

- a network connecting different hospital departments
- software package(s) enabling processing of patient and/or hospital data

Frost and Sullivan observes growing interest amongst vendors of health-related software in electronic patient records (EPR), which is widely perceived as a future revenue stream for many HIS companies and for other software vendors and service providers

By 2008, the market for HIS and ESS is forecast to reach USD27 billion and USD3.7 billion in the United States and Europe respectively (see Figure 47 below).

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Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
US	21,841	22,823	23,850	24,924	26,045	27,217	4.5%
Europe	2,938	3,070	3,208	3,352	3,503	3,661	4.5%

Figure 47:   United States and Europe HIS and ESS revenue, 2003-2008 [Source: HBS TekPlus, ITI Techmedia]

4.8.2   Computerised Physician Order Entry (CPOE)

CPOE is seen as a major factor in reducing medical error in that it allows the management of workflow within healthcare delivery organisations to be streamlined. US CPOE is expected to rise to almost USD340 million by 2008, as illustrated in Figure 48 below.

A number of major vendors are active in this segment including Eclipsys Corp., Siemens Medical Solutions, Meditech Inc., Cerner Corp. and PerSe Technologies Inc.

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
	240	270	300	312	324	336	7.0%

Figure 48:   United States CPOE revenue, 2003-2008 [Source: Dorland, ITI Techmedia]

A sub-market in CPOE is the provision of clinician information via hand-held devices. While adoption has been slow to date, health care professionals are gradually accepting the utility of hand-held devices (see Section on hand-held devices).[21]

The market for hand-held computing devices is poised for strong growth, according to Frost and Sullivan. The company estimates that the United States hand-held device market was worth some USD 70 million in 2002. The market is forecast to reach USD1.6 billion by 2008 - a compound annual growth rate of 62% over the period 2003 to 2008 (see Figure 49 below).

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
	140	280	560	896	1,232	1,568	62%

Figure 49:   United States hand-held device revenues, 2003-2008 [Source: Dorland, ITI Techmedia]

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[21] Bioinformation Market Study for Washington Technology Center, Alta Biomedical Group LLC, June 30, 2003

4.9 Communications

Like information technology, expenditure on communications infrastructure and services represents only a small proportion of overall Health sector expenditure as paper-based systems continue to predominate[22]. By 2008, it is forecast that communications expenditure will amount to around USD21 billion (or less than 1% of Health sector expenditure) in the US and Western Europe. This is illustrated in Figure 50 below.

Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
United States	8,933	9,595	10,058	10,739	11,303	11,936	6.0%
Europe	5,058	5,740	6,382	6,830	7,656	8,586	11.2%

Figure 50:   United States and Europe communication revenue, 2003-2008 [Source: Dorland, ITI Techmedia]

4.9.1   Wireline Communications

Broadband communication over fixed lines is important for inter-healthcare provider communications, where high capacity bandwidth links will increasingly be required to support the transfer of large data files and video streaming. Broadband wide area networks in hospitals and between healthcare providers will underpin the sharing of patient and clinical information between healthcare professionals.

Market figures are the subject of further investigation and not included in this report.

4.9.2   Wireless Communications

Wireless-based communications are expected to become more important to the Health sector as telemetry in monitoring equipment and hand-held devices in clinical care become more prevalent.

The deployment of wireless LANs and mobile hand-held devices has proliferated, most notably in the US, and the technology has been deployed to improve the quality of patient care and efficiency. However, as can be seen in Figure 51, the value of the WLAN infrastructure market is expected to remain limited in overall terms.

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[22] "The healthcare industry in the United States used over 25 billion pieces of paper in 2002."Ahmed Hashem, Microsoft

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Revenue (USD million)	2003	2004	2005	2006	2007	2008	CAGR %
US	32	43	53	65	72	84	21.2%
Europe	15	21	28	32	40	50	27.3%

Figure 51:   United States and Europe WLAN infrastructure revenue, 2003-2008 [Source: Dorland, ITI Techmedia]

The deployment of WLAN infrastructure will enable other markets such as wireless implementation, site survey and security requirements will increase, and will be focussed upon achieving the optimal deployment of WLAN infrastructure in the healthcare environment.

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APPENDIX 1:   THE MARKET FORESIGHTING PROCESS

The foresight process for market identification, which is at the heart of the ITI activity, has been established to meet three main objectives:

- to identify and define the potential for new and emerging global markets, over a three to ten year horizon

- to provide an objective basis for assessment and comparison of any defined markets

- to identify and define key functional needs and platforms that will support market development

A market foresight process has been created and adopted by ITI Techmedia. Using the experience and expert advice of organisations recognised as having best practice capabilities in this field, it is designed not only to meet the objectives detailed under 'market identification' above, but also to take into account other relevant factors including sector specifics, timescales and resource needs. The main elements of the process are shown in simplified format below.
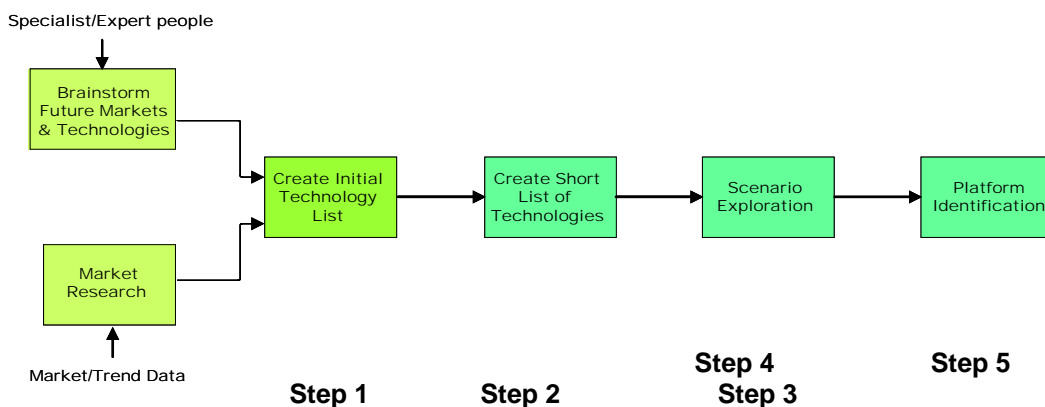
Step 1 identifies a vision for the market opportunity, the challenges, key drivers and market and technology barriers. This is achieved using specialist market knowledge, input from expert individuals in organisations across the sector, product and service companies, research organisations through to regulatory and other government offices. This is then enhanced by existing market knowledge to estimate the possible market size, timing, geographies, and demographics to create views of the value chain, the main stakeholders and resultant business models.

Step 2 creates a long technology list relevant to the individual sectors, which is in turn reduced in Step 3 to a shortlist, using input from technology experts. The process so far identifies the functional needs that best fit the market characteristics and hence highlight the most likely technology winners.

The functional needs and markets are validated in Step 4 via a process of scenario planning, a common tool used in foresighting environments. This uses example events to test if market and functional needs meet overall objectives and targets.

Step 5, the final step, identifies a resultant technology platform. A technology platform is defined as a cluster of connected technological capabilities comprising discrete technologies which together define a system with multiple potential applications.

The market foresight process and the usefulness of functions within it are subject to ongoing evaluation and refinement throughout, based on experience gained in the first phase.

APPENDIX 2:   GLOSSARY OF TERMS

AI	Artificial Intelligence
CAGR	Compound Annual Growth Rate
CPOE	Computerised Physician Order Entry
CRM	Customer Relationship Management
CT	Computed tomography (also called CT scanning, computerised tomography or computerised axial tomography (CAT)).
DICOM	Digital Imaging and Communications in Medicine
EDI	Electronic data interchange
EEG	Electroencephalogram
ERP	Enterprise Resource Planning
ESS	Enterprise Scheduling System
HIPPA	The Health Insurance Portability and Accountability Act of 1996 USA
ICU	Intensive Care Unit
IVD	In-vitro diagnostics
MR	Magnetic Resonance
NHS	National Health Service (United Kingdom)
NICU	Neonatal Intensive Care Unit
HIS	Hospital Information System
OECD	Organisation for Economic Co-operation and Development
PACS	Picture Archiving and Communication Systems
POC	Point of Care
RFID	Radio Frequency Identification Devices
ROI	Return on Investment
USD	United States Dollar

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APPENDIX 3:   FUNCTIONAL NEEDS DESCRIPTION

4D (real time 3D) cardiac ultrasound imaging	Method of high-resolution 3D ultrasound which provides real-time images of the heart enabling real-time monitoring for the detection of abnormalities
Acoustic – psycho-acoustical masking	Ability to transmit data in an audio stream in such away that it can not be heard
Interference-free mobile device	Mobile device that can be used for communications services in the healthcare environment that does interfere with medical equipment
Advanced storage media	Technology for the enhanced storage and recovery of large volumes of data
Antennae for robust communications	Novel antenna structures for the robust transmission of wireless information regardless of patient orientation
Assessment tools	Tools to allow computer aided assessment of knowledge and skills
Audiological monitoring	Technology for the measurement of the frequency response of patient hearing to assist hearing aid selection and cochlear implant monitoring
Authentication (Biometrics)	Authentication techniques that rely on measurable physical characteristics that can be electronically verified (e.g. fingerprint, iris, voice print)
Automated diagnosis	The use of AI systems for the diagnosis of simple illness
Automated trust systems	Content certification and access control technologies
Bayesian statistics	The use of accumulated knowledge and experience in probability calculations to enable more efficient patient data and knowledge mining
Bioinformatics	The application of computer technology to the management of biological information
Birth progress monitoring	Ability to monitor the status of mother and baby during the final stages of pregnancy (e.g. non-invasive foetal monitoring)
Campus area digital radio	Use of digital radio technology for communications across healthcare campuses
Cardiac markers for MI screening	Accurate and rapid diagnosis of cardiovascular disease, and in particular myocardial infarction or heart attack
Certification validation tools	Training accreditation and portfolio management
Closed-loop monitoring	Systems to enable measurement of body parameters and then delivery of drugs based on the measurement
Collaborative tools	Provide shared training/teaching environment across network
Contactless location/identification – item-level RFID	Provision of radio tags for individual items as an enabler for applications such equipment and patient tagging
CT laser mammography	Technique that enables the construction of 3D cross-Sectional images of the breast area

Customer relationship management	The application of retail customer management principles in the Health sector
Data communications through power lines	The use of standard power lines to transmit data
Data encryption	Encoding of data for to ensure confidentiality of that data
Demand chain management	Software to improve the management of logistics that satisfies individual and ad-hoc orders from the end-user e.g. prescription delivery
Depth of anesthesia EEG monitoring	Techniques to enable accurate monitoring of anaesthesia levels in patients
Detection of chemical indicators	Ability to test, possibly on an ongoing basis, for a new chemical indicators that signal the possible presence of illness
Discovery portals	Development of collaborative work environment that closely mirror work processes
Edge detection & median filtering	Mathematical technique used in image analysis and recognition as well as signal processing
Electronic data capture	Use of electronic tools to capture and record information at the point of care
Electronic patient records	Systems that utilise standardised patient records in order to facilitate electronic healthcare applications
Electronic prescriptions	Systems that utilise standardised prescription information in order to facilitate electronic healthcare applications
Electronic procurement	Electronic enablement of the procurement process
Electronic signatures	Electronic symbol or process logically associated with an electronic record that constitutes a valid certification of that record
Enhanced cardiac output monitoring	Techniques for increasing accuracy in the measurement of cardiac output
Event, condition, action rule bases	Technology with a very light processing overhead for use in networked environments to enable diagnosis and closed loop control applications
Fixed wireless access	Wireless transmission between fixed-location devices that offer both voice and broadband data services
Genetic algorithms	AI technique broadly based on the principles of Darwinism to improve performance of systems during use
Genetic screening	The testing of an individual's genetic material to predict present or future disability or disease either for oneself or one's offspring
Grid computing	Co-ordinated and secured sharing of computing resources among dynamic collections of resources
Handwriting recognition	Ability to enable human-machine interaction using handwritten inputs
High bandwidth WLAN	High-capacity, low-range radio networks for the networking of end user devices in the healthcare environment
High resolution 3D ultrasound	Development of high resolution 3D images using ultrasound techniques
High-field MRI	Technique for the development of high-quality MR images

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Hyperpolarisation methods for enhancing signals	Technique of improving the detection of bio-electrical signals from neurons through the flow of potassium ions in the human body.
Information visualization	Display of complex patterns of interaction between compounds and disease targets
Implantable heart rate, temperature and blood pressure monitors	Implant technology to enable in-situ wireless monitoring of vital signs
Inertial system location	Self-contained position sensor that utilises accelerometer and gyroscope technology to detect position
Inflammatory sepsis testing	Techniques for the early screening and monitoring of the toxin-producing criteria that results in sepsis
Infotaintment	Access to hotel-like content including pay per view TV, information and games
Innovation management	Processes for the development, identification and prioritisation of ideas and insights
In-home seizure/epilepsy prediction	Technique to enable the remote monitoring of the signs of the possible onset of epileptic seizures
In-line real-time blood gas sensing	Real-time monitoring of blood gases using micro electro-mechanical systems
Integrated workflow	Automation and tracking of healthcare business processes
Integration brokers	Systems software that resides between applications and facilitates communication between them
Intelligent agents	Ability to identify, locate and deliver relevant information from an information source to the end-user based upon such factors as context and criteria specified by the end-user
Interactive TV	End user video services and devices that may support high definition resolution capabilities
Internet access	Access to the Internet at the patients bedside in order to enable Internet browsing
Internet auctions	Internet auctions for use in the procurement process
Internet kiosks	Systems located in public places which enable the public to access the internet
Laser surface scanning	Non-invasive tool for the detection and diagnosis of internal problems by performing regular laser scans of the body and comparing these scans over time to identify any changes
Lean IP	Implementation of IP communication stacks on low cost low power processors
Local area, robust and safe wireless technology	Wireless technologies which are robust and safe enough for critical care monitoring
Long term EEG	Periodic logging of brain electrical activity of patients outside the healthcare environment
Low cost video cameras	Use of low-cost camera technologies to enable the capture and transmission of video information between locations

Low power systems	Communications systems with reduced power requirements in order to minimise interference with medical equipment
Magnetic induction location	Use of magnetic properties as an indicator of geographic position
Medical standards-compliant systems	Systems that conform to common medical communication standards including IEEE 1073 (medical device communications) and HL7 v3 (specific XML to facilitate transfer of data between systems)
Mobile phone positioning systems	Ability to locate the geographic position of end-user devices in mobile networks
Molecular imaging	Technique that goes beyond the traditional imaging of anatomic changes by allowing non-invasive characterisation of disease at the molecular level
MR coil technology	Technologies, including phased arrays and internal coils, for the development of advanced MRI examinations
MR functional imaging	Procedure that uses MRI to measure small metabolic changes that take place in an active part of the brain for the purpose of planning interventions to treat brain disorders
Musculo-skeletal rehabilitation monitoring	Wireless-based technology for physiotherapy and rehabilitation compliance that enable on-going patient monitoring
Natural language processing	Ability to enable human-machine interaction using natural language
Network security	Technology that provides a secure and robust network environment for the protection of confidential information
Neural networks	AI technologies, based around the concept of the human neuron and the ability to learn information, for signal and image analysis, compression and data mining
Non-invasive and non-occlusive blood pressure monitoring	Testing of blood pressure levels in a manner that does not restrict blood flow and does not require penetration of the skin or body cavity
Non-invasive hematocrit (HCT) testing	Techniques for the non-invasive measurement of haemoglobin in the blood stream
Non-invasive continuous blood glucose testing	Testing of blood glucose levels that does not involve penetration of the skin or body cavity
Non-invasive continuous blood pressure monitoring	Testing of blood pressure levels, on an on-going basis, that does not involve penetration of the skin or body cavity
Non-ionizing mammography	Use of non-ionizing radiation techniques for breast examination
Novel contrast media	Chemicals used to increase the contrast between target tissue and surround tissue in medical images
Novel ECG/EEG electrodes	Device contact and no-contact electrodes that are simple to use and require little or no skin preparation before use
Optical – including diffuse IR	Optical technology for the development of low-power indoor networks in the infra-red spectrum band
Polymer displays	Technology for the development of flexible and lightweight displays

Prostate specific antigen testing	Technique for prostrate cancer screening based upon the detection of prostate specific antigen
Rapid microbiological testing combined with antibiotic susceptibility testing	Image analysis based systems for automatically reading bacterial test disks used in susceptibility testing
Recommendation engines	Applications that evaluate the result of predictive models in order to reduce consumer expenditure on healthcare services
Rule bases (induction)	Standard rule base technology (forward chaining or backward chaining) which can be used to create a series of actions from a set of inputs or data for use in diagnosis and closed loop control applications
Semantic web	Ability to add context to web-based information to enable unambiguous classification of information
Service management systems	Software that enables the planning and management of services
Service-oriented integration architecture	Application interfaces that facilitate integration with other applications
Signal compression	Ability to transmit data in a compressed format using limited bandwidth
Simulations	Technologies that enable procedure simulation, modelling physical world
Statistical interpretation	Mathematical technique used in image analysis and recognition as well as signal processing
Storage area networks	Operation and management of a collection of computers and storage devices connected over a wide geographic area and dedicated to the task of storing and protecting data
Streaming platforms	Ability to deliver a continuous flow of information to an end-user device in a multi-vendor environment
Supply chain management software	Techniques for improved management of the supply chain, including logistics
Tablet PCs	End-user computing device that facilitates user input via the device display
Thermal imaging for mammography	Non-invasive investigative technique for the detection of breast cancer by identifying abnormal heat patterns in breast tissue
Third generation mobile phone systems	High capacity mobile wide area communications technology that enables both voice and data networking services
Ultra Wide Band	High-bandwidth wireless system for personal area networks
Ultra Wide Band (UWB) location systems	Use of time-difference-of-arrival (TDOA) information inherent in the UWB physical layer to identify the position of the UWB transmitter
Unit-level bar code	Bar code information that identify individual dispensed units
Video compression	Ability to transmit video data in a compressed format using limited bandwidth
Virtual reality	Technology for the 3D visual simulation of a real environment could be used for training and medical operation planning

Voice control	Ability to control equipment using voice commands
Wavelets & other transforms	Mathematical techniques used in image analysis and recognition as well as signal processing
Wide range of cancer markers	Automated detection of abnormal levels of marker proteins that may be caused by cancer cells
Wireless intra-partum foetal monitoring	Continuous in-utero foetal monitoring, both in and out of the healthcare setting, for neonatal sensing and foetal sensing during labour
Wireless monitoring devices	Devices for the wireless monitoring of key vital signs such as holter and pulse oximetry
Wireless NICU monitoring devices	Wireless-based technologies that facilitate neonatal monitoring in neo-natal intensive care units that cope with the problems caused by constant movement of the patient