IT Reference Architecture for Healthcare

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The vast number of changes in healthcare arising from trends and developments within the market, as well as from legislation and regulations, is increasingly obliging healthcare facilities to take a critical look at their own processes. Exchange and availability of information for healthcare processes takes a central position within this context. The purpose of the ICT landscape which supports these processes is to make this information available to the right people, at the right time, in the right place. The ICT organization within healthcare facilities is currently facing a fragmented system landscape which has undergone evolutionary growth. This landscape stands in the way of optimal information services, and therefore has significant consequences for the quality of the delivered care. In addition, this problem also has negative consequences for the operating costs of ICT. Working under an ICT reference architecture, in order to organize the present landscape and make it transparent, can change this. Specifically aimed at the healthcare situation, the ITAH model provides this reference and is furthermore able to assist in creating the desired situation – the Digital Hospital.

Today's Challenges

The Dutch healthcare environment is in significant flux. The double increase of the ageing population, in terms of the increasing number of elderly people as well as the higher age they are reaching, is causing a steep rise in the demand for healthcare, while at the same time the supply is suffering from the same demographic trend. Patients are seeing healthcare becoming more costly and in some cases even less accessible (waiting lists)[1] .

Healthcare facilities are not only facing a changing environment, but the rules of the game are also changing. New players are for instance appearing in the market. They specialize in standardized treatments which in the past could only be provided within a hospital. In general, it can be said that there is a growing necessity for further specialization, amongst others due to the increasing complexity of technology as well as rising treatment costs. In some cases, this is forcing clustering of healthcare providers, both horizontally (mergers) and vertically (chain integration)[2] . At the same time, patients are increasingly getting a better grip and control over their own healthcare process.

Current situation in healthcare

- **Increasing demand (amongst other reasons due to ageing population)**
- **Increasing effects of market forces**
- **Patient empowerment**
- **Patient orientation**
- **Besides cure, increasing focus on prevention and care**
- **Need for measurable results**
- **Creating greater insight within healthcare supply**
- **Pressure on labor market**

In addition, the national system of diagnosis treatment combinations ('DBC') introduced in the Netherlands not so long ago demands a different administrative organization, and sometimes a different organization in terms of healthcare itself. As a result, insight into activities and their associated costs within treatment routes is becoming more and more important.

Moreover, legislation requires medical records to be exchanged digitally. Every healthcare provider must have 24/7 access to all information necessary for treating a patient safely. This is putting great pressure on hospitals to have this information digitally in order at the organization level.

Within this changing environment, an increasing prerequisite for hospitals to survive is to scrutinize and improve their own processes and performance. Not only in terms of the quality of healthcare, but also in terms of the quality of the working environment for personnel and in relation to reducing operating costs. This is only possible if insight can be gained into internal processes and their outcome and, where possible, if these can be measured. Only then can processes be improved and resources employed efficiently and effectively. This also allows optimal use of information within these processes. Such focus on processes and information is relevant to all healthcare sectors.

The Hospital Processes

Figure 1 illustrates the dependence of and the distinction between the different components of patient care in a hospital which integrally result in, amongst other things, an improved patient's state of health. Each process tier has its own characteristics and its own resources for supporting the activities. At the same time, the different tiers cannot be approached separately.

Healthcare facilities, including hospitals, within the Netherlands are grappling with these previously described problems. The following questions are amongst others relevant within this context:

- How can I organize my core processes and supporting processes in such a way that I can operate more (cost) efficiently and effectively, while optimizing the quality of healthcare delivered?
- How do I concretize the concept of putting the patient centrally within my processes?
- How do I organize access to, modification of and routing of information within these processes in relation to the various stakeholders?
- How do I make my performance transparent and measurable?
- How can I influence this performance in such a way that an improvement in outcome takes place?
- Which resources do I need to use or employ differently for this?
- As a hospital, how can I flexibly and adequately deal with trends and changes in my ecosystem with support from ICT?

Operating more efficiently allows the hospital to meet the demand more adequately, while reducing the costs per treatment, without loss of quality of care. Operating more efficiently means a focus on activities that produce added value in predefined desired results, whilst simultaneously reducing obstructive situations. This means that

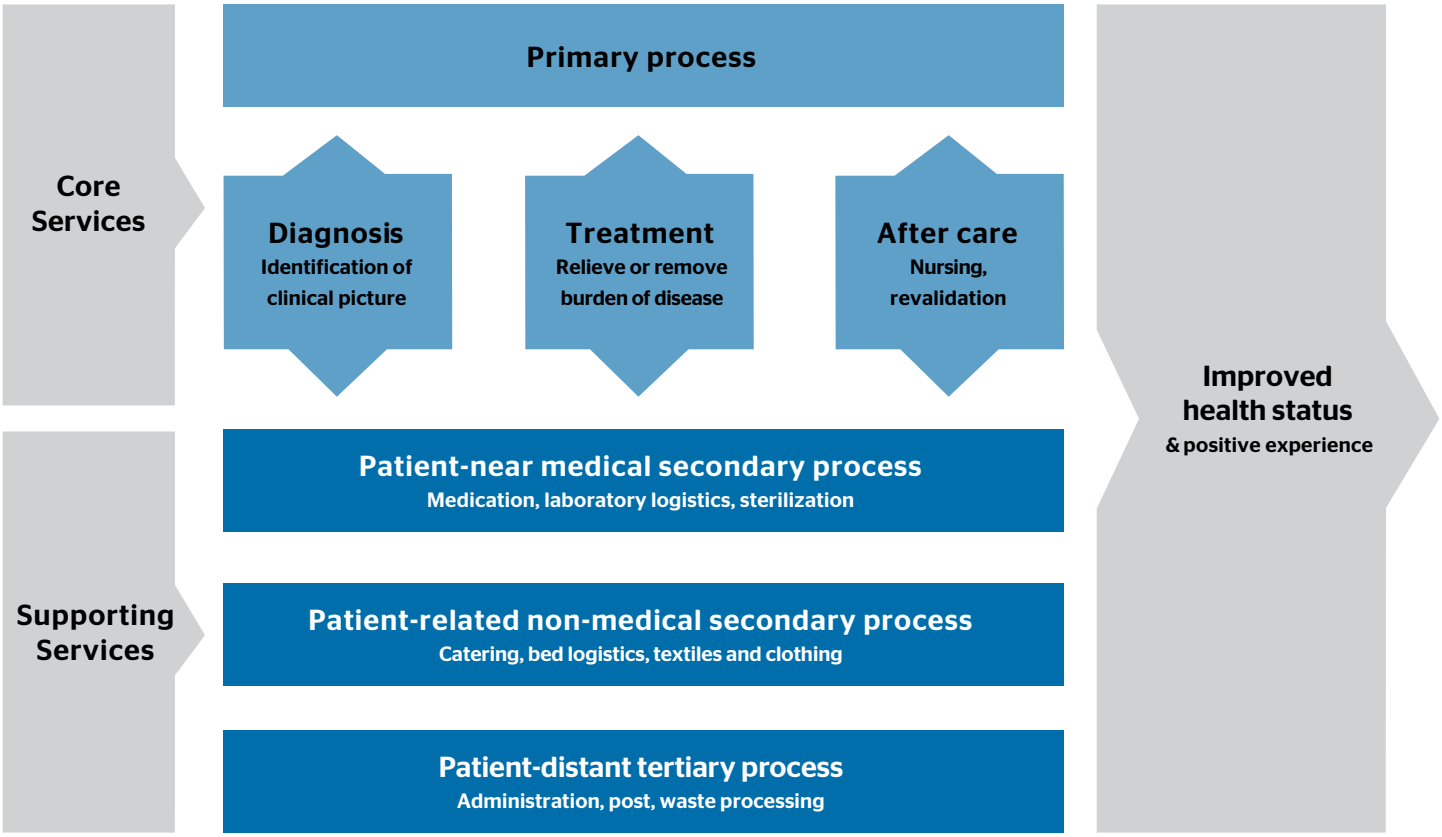
1 *Kommer, G.J., L.C.J. Slobbe, et al. (2007). Trends en verkenningen van kosten van ziekten. Zorg voor euro's-2, Rijksinstituut voor Volksgezondheid en Milieu RIVM.*

RVZ (2007). "Briefadvies: De strategische beleidsagenda zorg 2007 - 2010."

Kasten, G., Kruijff, G. de , Verbrugge, C. (2006). Sectorstudie Ziekenhuizen; trends en ontwikkelingen in de sector ziekenhuizen., ING: 47.

2 *Putters, K., & Frissen, P. (2006). Zorg om vernieuwing. Tilburg: Tilburg School voor Politiek en Bestuur.*

Figure 1: Overview of the Hierarchical Processes within the Hospital from the Patient Perspective



the costs and time spent on activities that are not essential must be reduced, without loss in quality of result. It may also mean that by reconfiguring activities, the same result can be achieved in another way with a fraction of the resources. Yet another option is for example outsourcing (a part of) certain activities to third parties.

Availability of the right information in the right place can facilitate this considerably. This requires clear insight into (necessary) process information and therefore also a holistic vision of the infrastructure.

This is the only way in which activities can take place within the process which allows them to be executed the most efficiently. Therefore, this also means that the right information needs to be made available in the right place and to the right person, i.e. an optimal organization of information and knowledge. The possibilities which information systems can offer within healthcare are often considered within this context. In short, the pressure of having adequate organization of information is larger than ever, partially due to the aforementioned problems.

For a variety of reasons, hospitals are facing a system landscape which has grown highly fragmentarily and evolutionarily, consisting of a large number of badly integrated ICT solutions. These singular solutions, usually selected and acquired by the healthcare facilities themselves, often provide the desired functionality on the specialization level (e.g., like a PACS system for radiology images, or an echographical system for cardiological or gynecological images). However, on a cross-specialization level, these systems often create problems, both in terms of processes and functionality as well as in terms of technology.

Often, there is no insight into the organization of the information exchange between these different singular solutions and the conditions to achieve this. Moreover, these systems are technically not uniform (different phase within the lifecycle, interoperability, etc.)[3].
As a result, one cannot always have the right information at the right time, with all consequences for the quality of healthcare and operating costs. This also often implies data redundancy; duplicate records are made of entities at different times and in different contexts. Moreover, this fragmented landscape hinders the ability to get a complete overview of processes and performance. The limited interoperability also prevents information exchange, which will soon be a legal obligation. As a result of these as well as other reasons, choices for new investments within this landscape are a highly complex issue.

This fragmentation of the ICT landscape imposes a huge burden within the primary process on healthcare providers, amongst others due to the fact that they must assess and organize information from the different systems themselves, with considerable uncertainty in terms of reliability and completeness of this information. In the light of developments related to increasing demand, in particular due to comorbidity as well as balanced care paths partially arising from this, these singular solutions form a potential obstacle to process efficiency. After all, the chain is only as strong as its weakest link.

Enhancing insight into a hospital's own system landscape, amongst others by structuring and analyzing it according to the methodology as proposed within this whitepaper, makes it possible to optimize the total configuration and integration of systems, thereby enabling growth towards the Digital Hospital.

3 *Avison D E, Young T. Time to rethink health care and ICT? Communications of the Association for Computing Machinery 2007; 50 (6): 69-74.*

The Digital Hospital – Dream or Reality?

A lot is said nowadays about 'the digital hospital'. This mainly focuses on the new possibilities which ICT offers within the execution of the medical process. But what is a digital hospital? There is an urgent need for a clear-cut definition which unambiguously describes what a digital hospital is. It is both surprising with respect to its content and far-reaching in its consequences:

A Digital Hospital is a hospital which depends on ICT systems for executing the medical process. This means that without adequate ICT support, the hospital is unable to function properly, if at all. This is why the Digital Hospital possesses very high requirements for the non-functional aspects of the ICT facilities such as availability, reliability, performance and security.

In the Digital Hospital, everyone has the right information at the right time. Information is exchanged between those systems for which (and users for whom) this is necessary for related activities, while of course respecting the necessary authorization and privacy[4] protocols. For instance, a nurse knows exactly what has been agreed between practitioner and patient and which issues need to be taken into consideration within the treatment plan, as already partially proposed by the system.

These harmonized communication flows not only take place within the hospital walls, but between all parties who play a role for the patient within the healthcare route, such as pharmacies, general practitioners, rehabilitation centers, mental healthcare institutes and of course the patient itself. There is far-reaching chain integration: the Digital Hospital is closely interwoven with referrers and after-care partners, and exactly the right information is available in the right form, matching the information needs[5] .

The different management levels are aware of the performance of their domains of responsibility. They are able to see actual waiting times and treatment times right down to the individual level. Within the Digital Hospital, there is therefore a continuous and integral insight regarding the status of processes and their key figures. This makes healthcare more tangible, for the patient as well. It also allows bottlenecks to be identified at an earlier stage, allowing action to be taken sooner, in those places where it is necessary.

The different treatment routes are optimized coherently for both patient and healthcare provider. Patients and healthcare providers alike know what is going to happen and appointments are scheduled according to patients' wishes as much as possible. Within the context of medical information such as medical files, (laboratory) results and photos, this means that ease of understanding and completeness are focused on the target group. To a certain extent, the patient too has insight into this information, possibly from home and possibly complemented from external sources such as informative websites or patient forums.

In terms of comfort and safety this means, amongst other things, having bedside terminals and comfort systems during a patient's clinical admission, as well as complication registration, real-time vital values, laboratory results and prospective risk analyses for the healthcare provider. All information is available immediately, on condition that it has been released and that one is authorized. With respect to treatment, the Digital Hospital has surgical robotics, e-learning and simulations are used as training aids for personnel, and workstations and terminals are secure.

Planning software and terminals support all secondary and tertiary processes such as bed logistics, appointment scheduling and catering. Centralized planning through the use of ICT enables optimal use of available

space and manpower, and enables physical logistics to be controlled digitally, amongst others with support from robotics and track & trace solutions using RFID.

In short, the core and supporting processes within (and partially beyond) the Digital Hospital are supported with optimal deployment and configuration of ICT.

The Digital Hospital – Working under Architecture

One of the main technological bottlenecks in the traditional hospital concerns the so-called Manhattan Effect. This effect relates to the aforementioned singular solutions, where various components function adequately at the individual level, but fundamental problems occur when these separate components are placed within a greater framework and need to collaborate with each other. Within the traditional hospital, we often see that the focus lies on these individual components, and not on their mutual integration.

The ICT landscape within hospitals and other healthcare facilities, organizations which make intensive use of Information and Communication Technology (ICT), has in practice more often than not undergone organic growth, resulting in an entanglement of non-integrated systems, services and processes - an analogy is a jigsaw puzzle in which the individual pieces do not fit.

Processes do not match adequately, systems are not capable of communicating optimally with each other, and as a result, in many cases a 'gap' arises between the business on one hand and the underlying technology which should enable this business' vision on the other.

4 *For detailed scenarios, also refer to:*
Ministerie van Volksgezondheid, Welzijn en Sport. (2007a). Niet van later zorg.
Edwards, N., Wyatt, S., & McKee, M. (2004). Configuring the hospital in the 21st century, Policy brief. Copenhagen: European Observatory.

5 *B.G. Celler, N.H. Lovell, and J. Basilakis, "Using Information Technology*

Manhattan Effect

One of the main conditions to be able to realize the Digital Hospital is a focus on optimally functioning individual components (at both the functional and non-functional level) on the one hand, and a focus on optimal integration between this high number of components on the other, so that processes and underlying (supporting) systems interconnect seamlessly and reinforce one another – the whole must be more than the sum of its parts, in order to be able to achieve synergy between business and ICT.

In order to be able to realize this fundamental precondition for the Digital Hospital, it is essential that those components are not only regarded as individual building blocks, but mainly as a coherent, unified system in itself.

An integrated, well thought-out architecture, acting as a blueprint for the entirety of the components (in the widest sense of the word) within a hospital, forms the essential basis for this. Within this context, architecture means: the fundamental organization of components, the relationships between these components and with the environment in which they exist, as well as the principles underlying those components and their evolution.

Working with such architecture, including any relevant standards and principles underlying its individual components and mutual relationships, i.e. by working under architecture, enables the vision of an integrated Digital Hospital. Working under architecture prevents the aforementioned Manhattan Effect and lays the fundamental, concrete foundation for the Digital Hospital, where business and ICT are optimally harmonized.

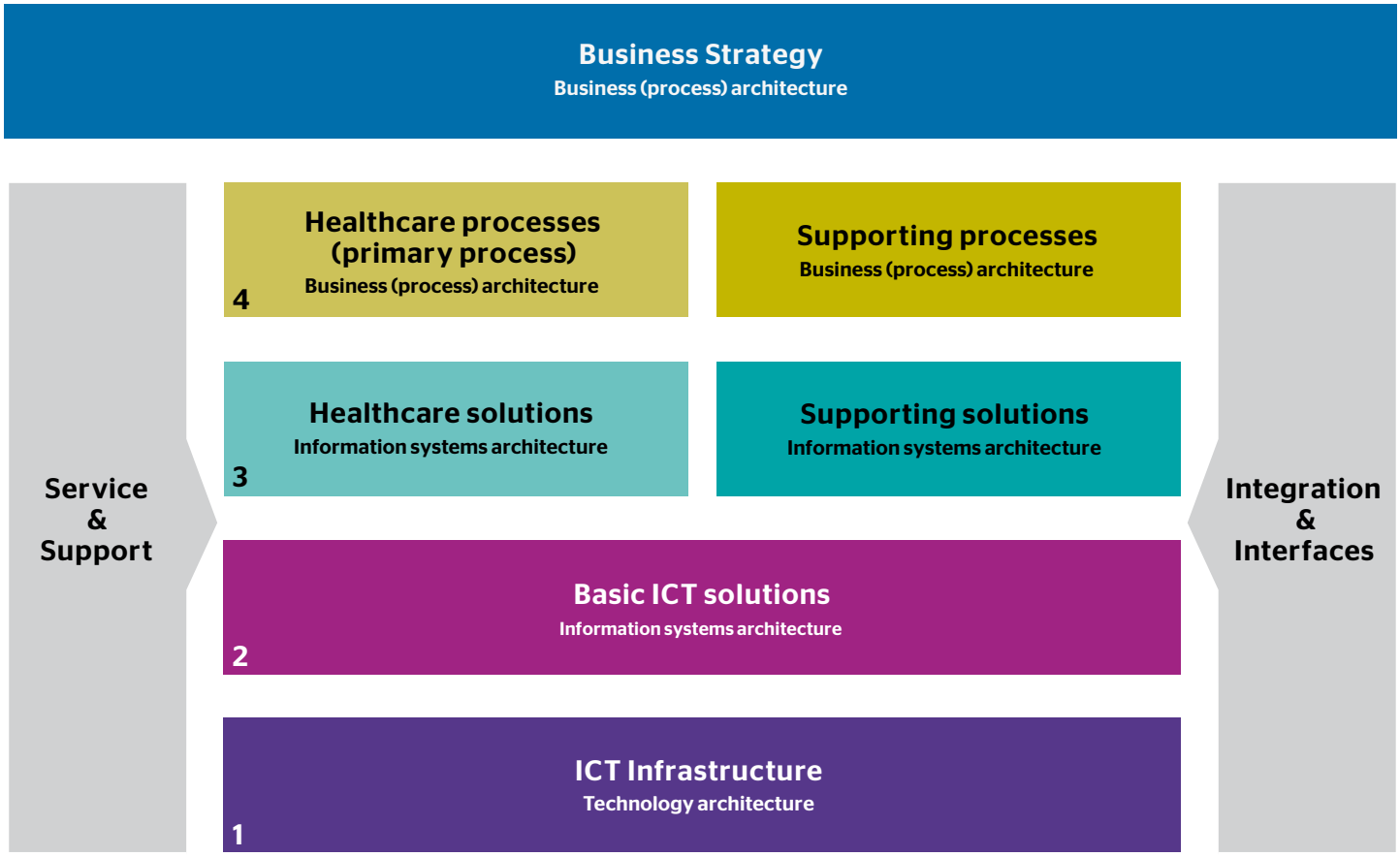
It also enables an architecture to be managed and to grow along with changes in both business and ICT itself. When existing components need to be modified as a result of such changes or when new components need to be added, this can be done relatively simply ('plug and play'), with the entirety of components and their interaction not being threatened, provided that the aforementioned architecture and associated standards and principles are adhered to.

Working under architecture enables optimal integration of components, so that for example a patient is able to use all of the services relevant to him or her from a patient comfort system (bedside terminal) next to his or her bed. From a bedside terminal or a central dashboard, a patient can control room functions, order meals (adjusted to the patient's diet as recorded in his or her EPD), call nursing personnel, telephone, use the Internet and intranet, use multimedia applications like video-on-demand, and much more. It is for example also possible to integrate a billing component within the above-mentioned configuration, which makes it possible to charge (prepaid or postpaid) patients for certain services.

At the same time, a doctor or specialist can use the same terminal for viewing the patient's EPD and discuss it with the patient at the bed. Important aspects within this context are security and Identity & Access Management (IAM), so that users of the system (patients and medical specialists) only have access to those services and information which are applicable to them. This can be realized by using a separate IAM component, which in its turn uses patient and personnel passes (smartcards) with which those users can log on to the mentioned bedside terminal. This IAM component will therefore also be integrated with the other components.

The above-mentioned is possible due to the use of one central architecture in which all components form a synergetic whole. ITAH – the IT Reference Architecture for Healthcare architecture model – describes such a model, and forms a reference architecture which can be tailored to the specific requirements and wishes of a hospital.

Figure 2: ITAH Tier Model



The ITAH Reference Architecture

The ITAH reference architecture comprises a model composed of abstraction layers. It is an ICT- focused Enterprise Architecture. The architecture relies heavily on the domain model, where in particular the business processes and the ICT systems are arranged in domains. Domains provide services to other domains or externally. Within the context of domains relating to collections of ICT systems, we speak of ICT services.

Each tier within the ITAH reference architecture represents a cohesive collection of ICT services. Each tier can have its own norms and standards described and set up in respect of non-functional properties (for example, high availability for the network). It is also possible to specify and implement ICT management standards and procedures for each tier in the model. The architecture as presented here can be used for the whole healthcare chain. This whitepaper however focuses on the applicability within a hospital. Figure 2 visualizes this.

The Business Strategy tier models the organization's ambitions and context. Matters relating to the hospital's core operation are contained in the Healthcare Processes tier. Examples are the consultation center, screening and diagnostics, and the treatment and nursing center. Components that support the hospital's core operation are modeled in the Supporting Processes tier. Examples are the center for logistics and the back-office (Administration, HRM, etc.).

The three tiers below the hospital's process tier form the ICT architecture. These tiers are described in further detail within the context of this reference architecture.

The location of ICT services in the tier model is not clear-cut. It is often possible to place an ICT service in several tiers. It is a choice that needs to arise from decision-making with respect to standardization per tier in terms of functional and non-functional properties. When developing the reference model into a more specific specialization, it is possible to subdivide tiers in terms of functionality, ICT management method, degree of coherence and non-functional properties. The figure at the end of this section illustrates this.

Healthcare Solutions

The services positioned in this tier are those that directly support the primary medical process. These are therefore primarily applications which are essential for the execution of the core activities of medical professionals. Examples include:

- Electronic Patient Database
- Electronic Nursing Database
- Electronic Prescription System

Supporting Solutions

This tier, positioned at the same level as the Healthcare Solutions tier, contains (often applicative) systems which specifically support the enterprise processes, i.e. which do not directly concern the primary medical activities. Examples are:

- Accounting system
- Stock control system
- Tracking & Tracing

Basic ICT Solutions

This tier represents the information systems. It contains the ICT systems which do not directly support the hospital processes, but which are essential for supporting all higher ICT services. The services positioned here are to be found in any modern business.

Examples include:
- Office automation
- Services for access control and authorization management
- Services for digital archiving

ICT Infrastructure
This tier represents the Technical Infrastructure tier in which the 'hard' systems of the ICT set-up are positioned. These are mainly hardware platforms and the 'harder' and/or more technically oriented systems (e.g., databases, technical administration platforms, backup systems, etc.). Consequently, these are the technical systems which enable the deployment of information systems and communication systems. Examples are:
- Server platform
- Network
- Printers / scanners

Figure 3 illustrates the aforementioned ITAH reference architecture in greater detail. This is an actual example of how ITAH is applied within hospitals, including the components which apply to a specific hospital. The black arrows shown at the top of the figure depict the ambitions as discussed in the first paragraph. These ambitions are decisive for the implementation of architecture. Within this context, it is important to state that ITAH is a generic reference architecture which is tailored to the hospital's requirements and wishes.

Dependency Model

An important property of current ICT landscapes is that a particular form of ICT support is not provided by one information system alone. Often it is the combined action of several ICT services, which in a collaboration model provide the support required for executing processes or transactions. For example: making an appointment using the Internet takes places via the ICT service Online Appointments as part of the ICT service Multi-Channel Appointments System service, while the underlying information is stored in the SAP-ISH calendar system. This service, in its turn, uses the ICT service Server Platform, which in turn has a dependency on the services Network and Storage Platform.

As a result, ICT services have a high degree of mutual dependence. This dependence can be defined vertically and/or horizontally. A complex network of dependencies exists across the entire architecture. If, within this chain of dependencies, an ICT service in an underlying tier does not have the right quality, this will propagate to all services which depend on this ICT service. For example: if the network has inadequate performance or insufficient availability, all of the ICT services above it, such as the Electronic Patient Database, will be directly affected by this.

In general, the quality of the ICT services in the higher tiers of the model is fully dependent on the quality of the configuration of the ICT services in the lower tiers. This dependence and the propagation of deficiencies in the ICT set-up towards the ICT systems is illustrated in figure 4 on page 8.

ICT Services

As described above, ICT systems which are positioned within the ITAH tier model can be defined as ICT services. An ICT service is a coherent entity of ICT systems, in which one ICT service can of course consist of one ICT system, although this does not always have to be the case. In general, ICT services can be decomposed into sub-services. For example: the ICT service Network consists of a wired network and a wireless network. In addition, in its turn the network also has a logical subdivision into so-called network zones which are related to the different security levels.

Figure 3: ITAH Reference Architecture

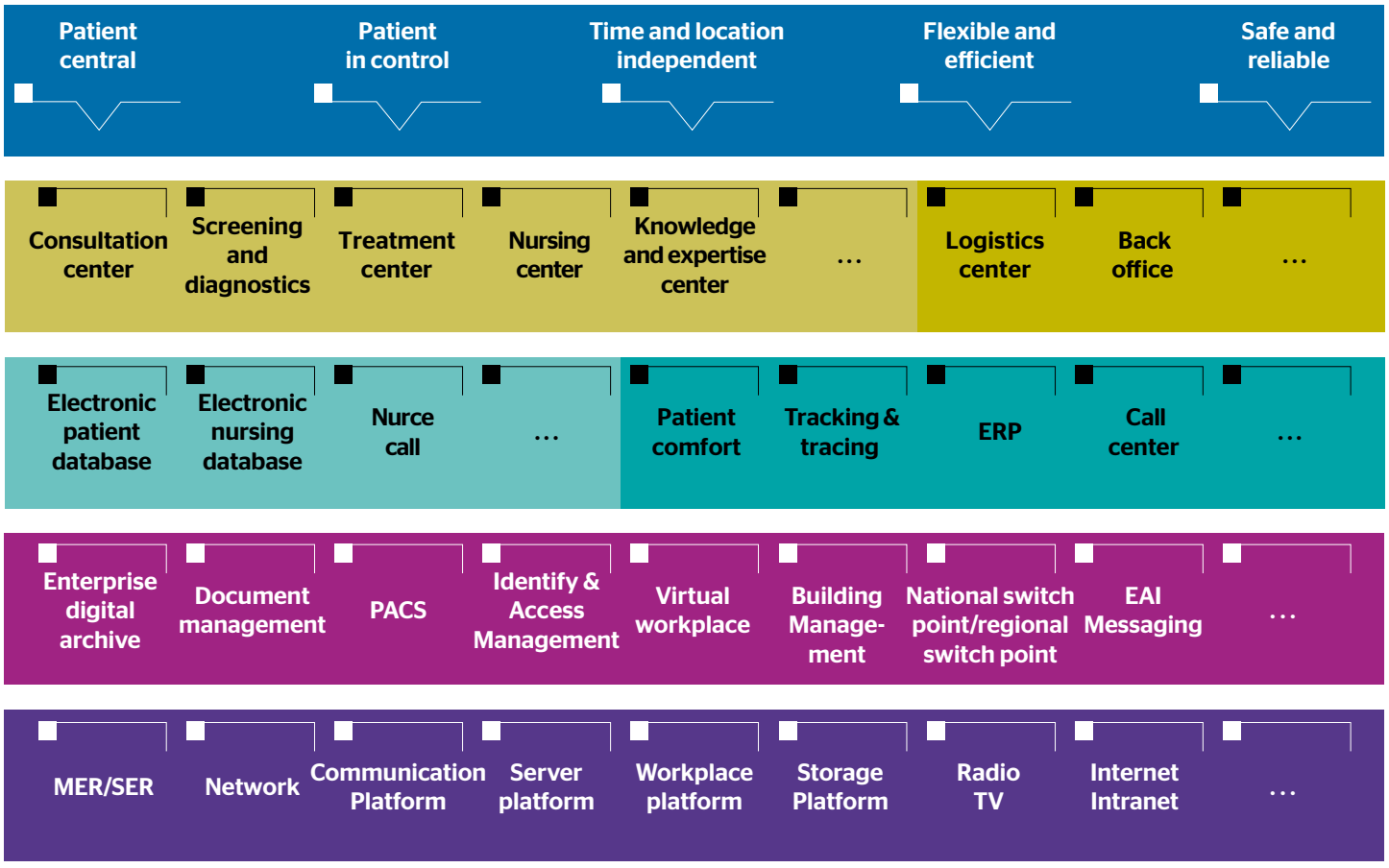
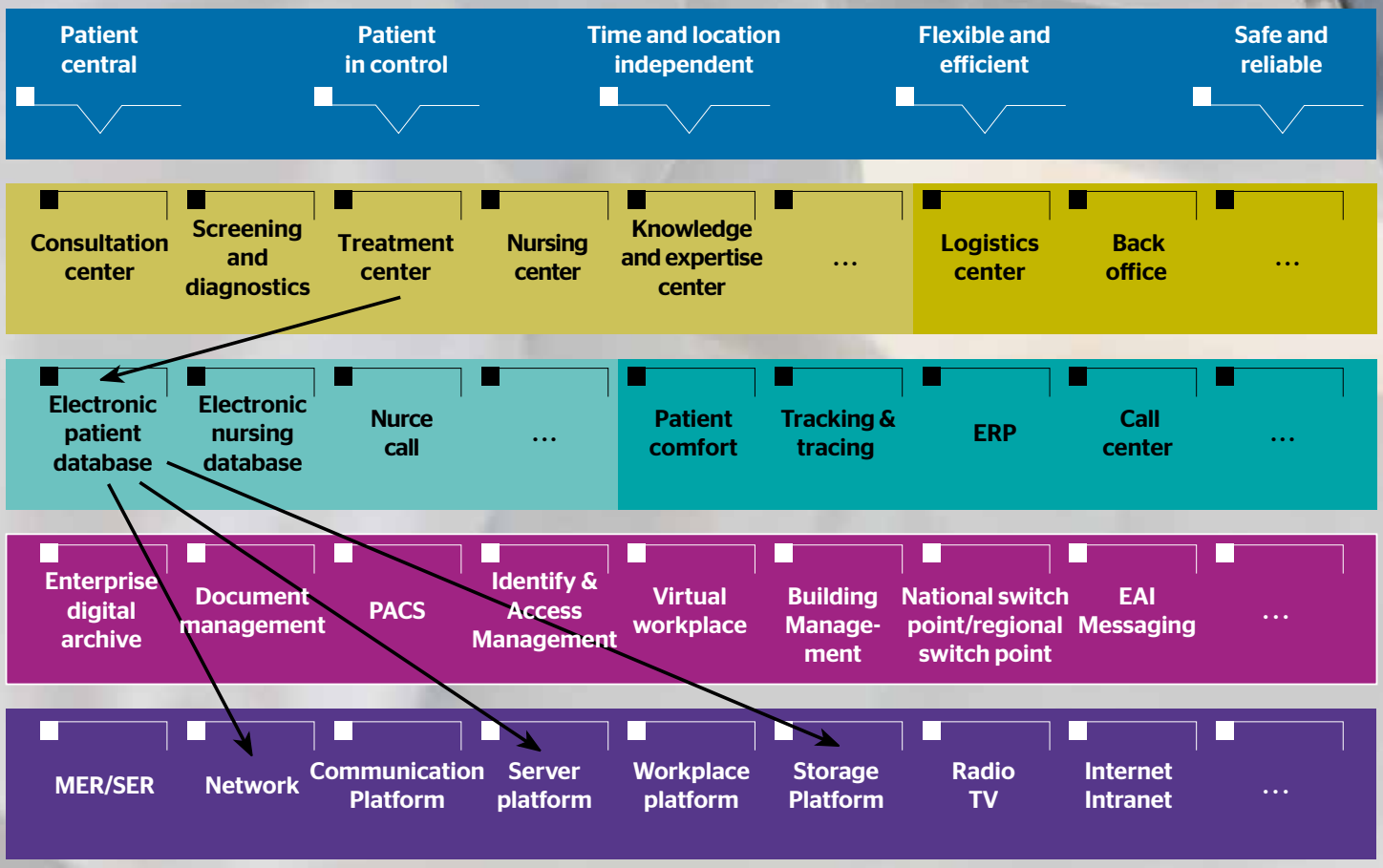


Figure 4: Dependency Model



In a well designed ICT architecture, the ICT services are therefore decomposed into individual elements and the dependencies are established on the lowest possible level of the decomposition.

Non-Functional Requirements

Non-functional requirements are the preconditions which the systems must fulfill. A system's architecture determines to a significant extent whether the system is able to meet non-functional requirements. Examples of non-functional requirements are availability, reliability, performance and security.

If the hospital's primary process is dependent on ICT, this has far-reaching consequences for the non-functional requirements. For example, if the processes in the operating room are supported by ICT systems, it is essential to have a high degree of availability, reliability and performance. The following explains the non-functional requirements in further detail.

Availability
This term indicates the extent to which an ICT system is accessible for the processes in the hospital. Availability is indicated as a percentage, where a higher value indicates a higher availability.

Some processes in the hospital require a high availability. Analyzing a process enables the required percentage availability to be established. This percentage can subsequently serve as a 'key performance indicator' (KPI) for the underlying ICT systems.

The availability of an ICT system depends on different factors. The main factor is system outage, wherein a distinction can be made between scheduled and unscheduled outage. In general, scheduled outage is not considered when determining availability. This means that maintenance does not have an effect on the availability that is established and guaranteed.

Security
A hospital is basically an open and freely accessible environment. This open architecture forms a potential security risk. Combined with the high level of integration of hospital processes and ICT systems and the fact that there is privacy-sensitive information, this requires a powerful security system and security policy.

The more information is stored digitally, the more an organization's vulnerability to improper use and breaches of privacy legislation increases. This means that far more attention than previously must be paid to aspects related to information security and access control.

Essentially, a good security policy should be based on the following two principles:

- *need-to-know* – access to information, only if explicitly authorized based on function
- *need-to-access* – access to locations and systems, only if explicitly authorized based on function.

With respect to security, several standards are relevant for hospitals. The most important ones are NEN 7510/7512 and Well Managed Care System. The next two paragraphs briefly describe these standards.

NEN 7510/7512

These quality requirements in the field of information security, imposed by the national government, have already applied to hospitals for some considerable time. Yet, it is not a straight-forward matter for hospitals to meet these requirements. This is mainly because the set-up of many ICT systems does not make efficient security easily possible.

Well Managed Care System

The National Switch Point (LSP) is the central node for national exchange of medical records between healthcare providers within the Netherlands. The LSP is developed by the National ICT Institute for Healthcare (NICTIZ). Within the context of the Electronic Patient Database, a connection to the LSP is essential. An important precondition for this is that the hospital must meet the quality criteria for a Well Managed Care System (GBZ). Within the GBZ, high requirements are imposed on the reliability of ICT facilities. SMART requirements are defined with respect to the availability, reliability and performance of a connection with the EPD. In order to be able to meet these requirements, the basic ICT infrastructure must enable these requirements to be realized.

Data security is an important aspect of the ITAH reference architecture. However, the hospital must also be able to adequately guarantee patients' safety. An important aspect within this context is the identification of patients in both the clinical and out-patient process, as well as reducing avoidable errors in the treatment process by having the right information in the right place. ICT must provide the necessary facilities for this.

Performance

The necessity for performance is two-fold. In the first place, certain processes within the hospital will require a certain reaction speed of ICT systems in order to be able to be executed correctly. Not only does a slow response time or lack of speed in general result in inefficiency, but it can also be a cause of potentially life-threatening situations.

Performance is also necessary for the users. A system's speed is after all also determined by user perception. This perception often varies per user group within the organization. Due to these differences in perception within the organization, it is necessary to determine beforehand what the expectations of the various user groups are with respect to the performance of ICT systems. Poor system performance can lead to frustration and lack of user acceptance, and it undermines the organization's operation.

As discussed within the section on availability, the fact that the speed of a chain of systems is determined by the speed of the slowest system within that chain also applies here. It is important that all systems in the chain conform to the required performance.

For many ICT services, performance can be expressed in terms of Quality of Service properties. For instance, a logical segmentation can be applied to the network in such a way that the performance properties for each logical network can be set up and measured individually.

Scalability
Scalability is the possibility to change the scope of ICT systems, without having to replace the hardware and software platform which are used. In fact, it is a response to an (often in time) changing demand from the environment. In practice, this means for example that for data storage, additional space will probably be required in the future. A properly scalable ICT system is able to comply with this with a relatively minor intervention (e.g., adding servers).

Adaptability
The requirements for adaptability of ICT systems are formed by the relatively long lifecycle of ICT infrastructure (10-15 years). In order to meet these requirements, it is necessary that all preconditions for adequate future adaptability are in place beforehand. The application architecture can be built in tiers. By separating presentation, control, business processes and data within the application, process operation and business functionality are individually adaptable and replaceable.

For example, data structures used within the ICT systems must be data oriented. The data is then independent from specific business processes, thus enhancing flexibility and adaptability.

Maintainability
ICT facilities must be set up in such a way that they can be easily maintained. This is a requirement that is directly related to the availability and reliability criteria. A system which has to be available 24/7 cannot be shut down for maintenance activities. Provisions need to be made within the set-up which make it possible to perform maintenance safely, without such systems being unavailable to the organization. Good examples are the telephony environment and the network. These need to be available at all times.

Standards regarding the ICT Support Organization
Building an ICT infrastructure which complies with the aforementioned standards is only worthwhile, if at the same time a maintenance organization exists which is capable of managing the ICT facilities according to the quality properties which form the foundation of the ICT architecture. In general, the ICT maintenance organization must fulfill (and possibly also be certified for) the standards and guidelines as described in:

- ITIL (Information Technology Infrastructure Library)
- ASL (Application Service Library)
- COBIT (Control Objectives for Information and related Technology)

ITAH – Compliance with International Standards

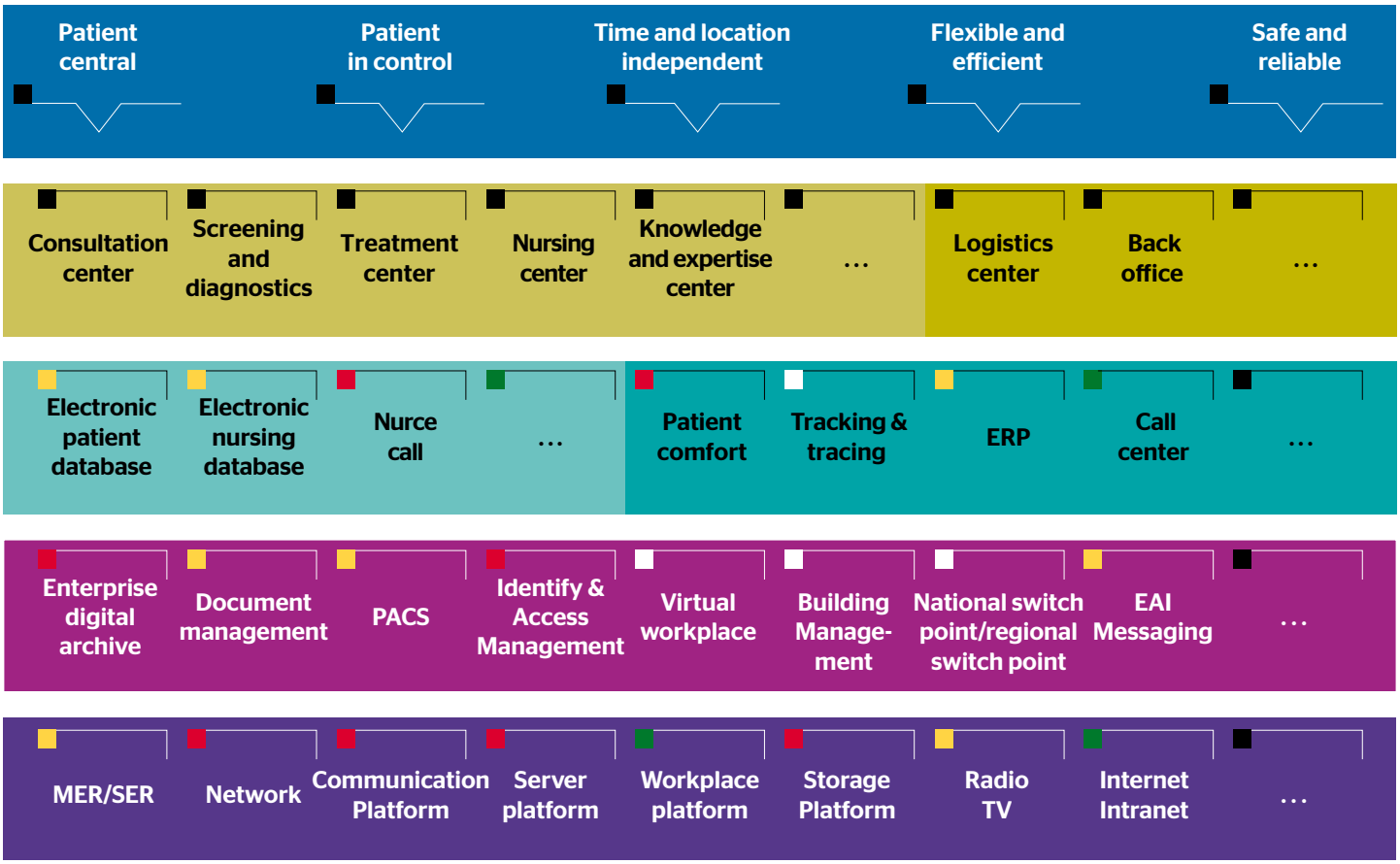
ITAH describes and structures Healthcare IT architecture from a holistic perspective, not only in terms of the IT tier within such an architecture, but also in terms of the business, process and underlying infrastructure tiers. As a result, ITAH forms an integral Enterprise Architecture model.

Within this context, ITAH closely matches the international standard for defining and working with Enterprise Architectures – TOGAF (The Open Group Architecture Framework). This is a standardized framework, based on best practices, created by a large number of organizations worldwide, which forms the basis for many Enterprise Architectures set up in the past few years, both within (semi) governmental bodies and commercial businesses. Compliance with TOGAF means that ITAH uses best practices as developed worldwide over the years within this field, which increases the efficiency and results of projects to be carried out within the hospital. It also ensures that the IT architecture is developed and specified according to an international standard, including standardized terminology - a solid basis for the future.

In terms of subject matter, Atos is an active member of the IHE community. IHE (Integrating the Healthcare Enterprise) is an international initiative of healthcare professionals, responsible for many healthcare standards such as HL7 and DICOM. ITAH is an IHE compliant model, which guarantees flexible integration between healthcare systems according to a worldwide standard.

For ITAH compliant hospitals, conformity with international standards also means increased interconnectivity with the world outside their own hospital walls – after all, a hospital is not a fortress. Modern patients are increasingly making use of the 'global village' effect which has also made its entry within the healthcare industry, and an ITAH compliant, transparent hospital will facilitate – not hinder - the patient in this respect, with all the resulting benefits for both patients and the hospital itself.

Figure 5: Gap Analysis



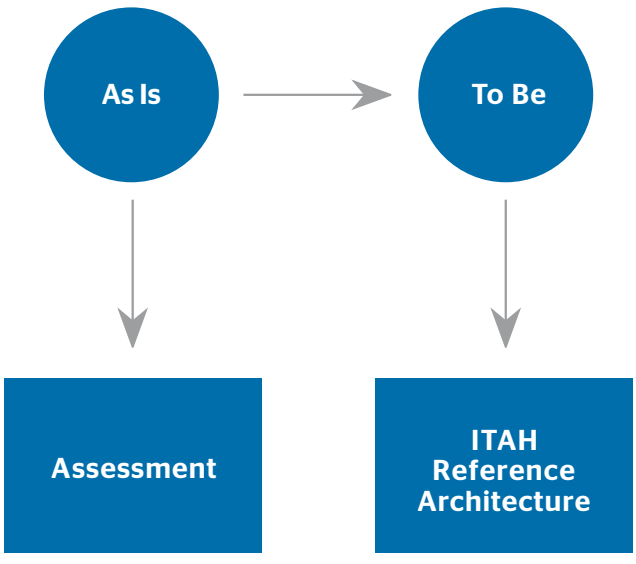
ITAH Assessment

The path to the Digital Hospital is not an easy one for traditional hospitals. The great diversity of areas that require attention represents a serious obstacle for implementation. The ITAH assessment helps in mapping these areas. Based on interviews and available documentation, the hospital's ambitions and current functionality of ICT services are made transparent (the 'as is' situation). Subsequently, the assessment gives answers regarding how well the current ICT services match with the ICT services as specified within the ITAH reference architecture (the 'to be' situation). Figure 6 gives a schematic illustration of the essence of this process.

The results of the assessment are presented in a document which, for each ICT service, details the extent to which the dimensions of the ICT service meet the requirements as defined in terms of the To Be situation. These dimensions consist of functional and non-functional properties as described in the ITAH reference architecture.
The document also contains a dashboard-style overview which shows the status (the size of the 'gap') of the various ICT services in comparison with the ITAH reference architecture. Figure 5 gives an example of such a dashboard.

The red blocks indicate that the basic set-up of the current ICT service does not match the functional and non-functional requirements of the ITAH reference architecture, which is therefore not reusable for the future. The yellow blocks indicate that the 'gap' between To Be and As Is is smaller, but adjustments are necessary. Green blocks indicate that no adjustments are required to the basic set-up of the ICT service. White blocks indicate that the ICT service is not implemented in the current situation.

Figure 6: From As Is to To Be



ITAH Roadmap

The ITAH reference architecture and the ITAH assessment make it possible to draw up a roadmap. This roadmap gives an overview of the ICT projects that need to be executed, in order to realize the ambitions in terms of ICT modernization, as described within the ITAH reference architecture. The roadmap is drawn up as a document which also pays attention to the risks associated with, for example, time constraints or dependencies with other projects within the hospital.

The roadmap does not present a detailed planning of the projects to be carried out. The ITAH reference architecture contains a high-level design of the ICT services, which is to be defined in further detail within a next phase, in terms of concrete design documents. Product selection forms an important starting point within this next phase. The document describes the strategy with which the ICT modernization program must be executed, as well as an outline of the stage planning.

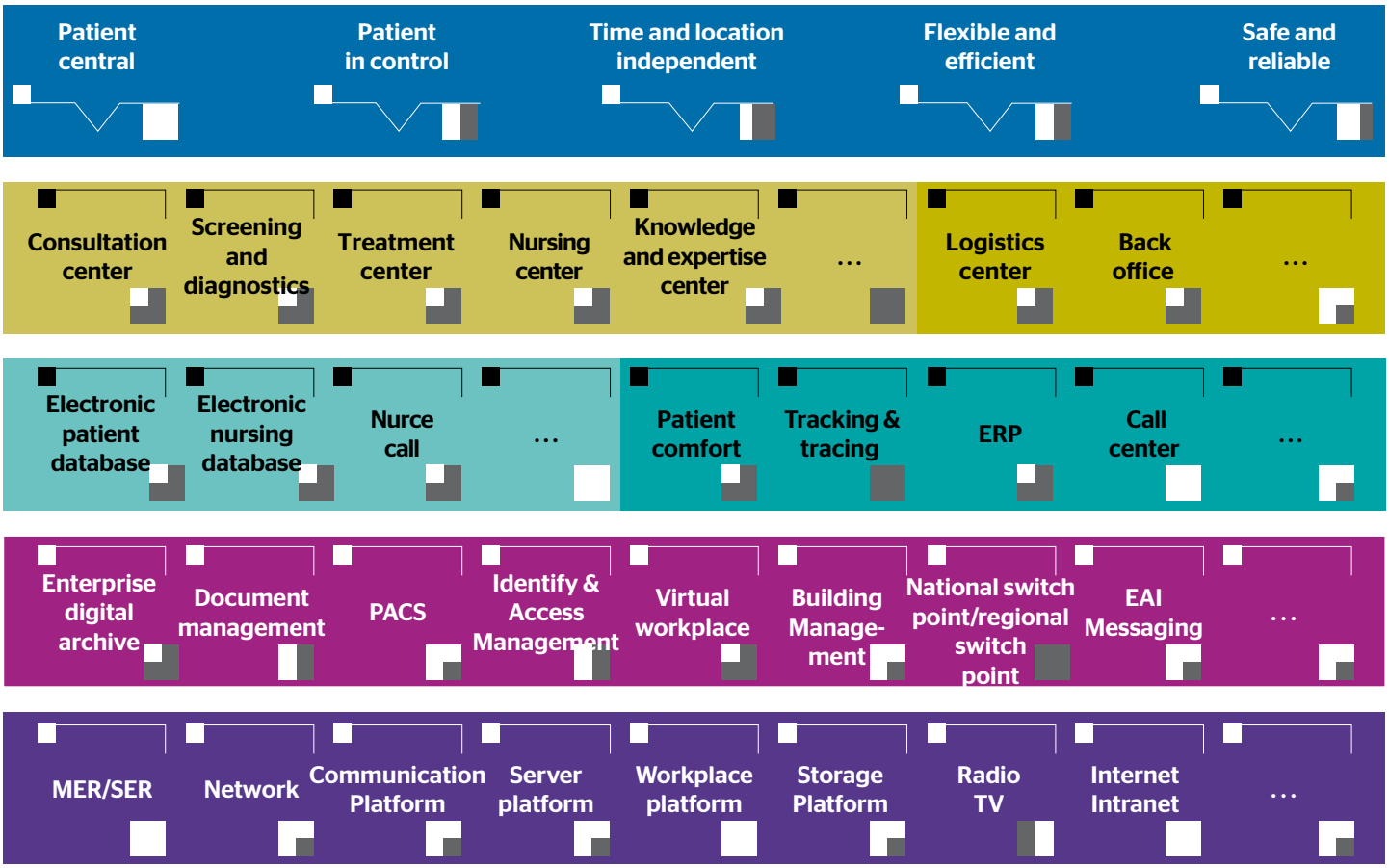
Logical stages can be defined based on the dependencies between the ICT services. The ITAH reference architecture contains a generic stage model, based on bottom-up development of ICT services according to the different tiers in the model. This means that an initial focus is put on the ICT services in the ICT Infrastructure tier, and that subsequently, the services in the higher tiers are attended to successively. Below is an example of how a stage plan can be drawn up for the ICT modernization program, based on the generic stage model of the ITAH reference architecture:

- **Stage I: ICT foundation**
  The first stage consists of reorganizing and modernizing the ICT Infrastructure tier.
- **Stage II: En route to a secure and paperless environment**
  In this stage, two projects which are conditional for a hospital to be able to work in a flexible, efficient, secure and low-paper way are carried out in parallel:
  - **Stage IIa: Middleware and Enterprise environment**
    Building on the foundation of the ICT Infrastructure tier, the modernizations or adjustments can be pushed towards the ICT services Virtual Workplace, Identity & Access Management and Office Automation.
  - **Stage IIb: Enterprise Content Management**
    Implementing different digitization projects, resulting in the introduction or modernization of the ICT services Digital Archive, Document Management, Medical Imaging Management and Record-keeping.
- **Stage III: Care and support processes**
  Building on the facilities as realized in the previous stage, the modernized working processes take shape and are implemented within this stage. Within this context, ICT modernizations which go hand in hand with process modernizations are carried out per functional unit within the hospital:
  - Appointments center
  - Screening and diagnostics
  - Treatment center
  - Knowledge and expertise center
  - Back-office

When defining the stage plan, attention will also need to be paid to dependencies with other projects within the hospital. Compliance with the framework of standards that the government has made compulsory for hospitals plays a role as well (GBZ, NEN7510/12). For each ICT service, it is possible to indicate what the necessity is as seen from the perspective of other projects or preconditions. The so-called MoSCoW method is used for this.

Because the ICT modernizations are often large in scale, they are structured in program lines, each of which has its own deliverables structure and planning within the different stages of the overall program.

Figure 7: First Steps towards Roadmap



The following considerations form the basis for defining these program lines:

- A program must consist of one or more ICT services with related functionality
- A program preferably consists of ICT services which are positioned in the same architecture tier. The grounds for this are that the quality and maintenance characteristics are analogous, so that it is possible to work towards a standardized implementation of these aspects.

For example, a program line "ICT Foundation" can be defined within the ICT modernization program. This focuses on a number of ICT services within the infrastructure tier of the architecture model:

- MER / SER
- Network
- Communication Platform
- Server Platform
- Storage Platform
- Internet / Intranet
- Radio / TV

As a visual aid, the stage plan is projected onto the architecture model, in which the gray facets indicate which parts of the ICT services are to be realized in which stage. The significance of a gray facet is that on completion of a particular stage, those parts are realized that are not covered by a gray facet. This projection is done for each individual stage. The ICT architecture unveils itself incrementally when viewing all of the projections, with the curtain opening up more each time.

Figure 7 gives an example of a stage projected onto the architecture model.

After completion of the various stages, implementation of the ICT management organization remains, if not included within the stage plan. Its purpose is to manage the realized architecture and to deal flexibly with changes within the hospital or ICT services.

ICT Management

Realization of the roadmap has an impact on, amongst other things, the organization's primary and secondary processes. Other requirements will be imposed on the ICT elements resulting from the roadmap. The hospital's ICT organization faces the challenge of 'managing' this emerging environment. This focuses on ICT management of applications and infrastructure, but also on direction from and to the hospital's own organization. Managing suppliers is an important aspect as well. In sync with the implementation of the roadmap, the hospital needs to evolve in terms of, for example, knowledge, organization, communication and possibly culture as well. This change process requires a lot of attention.

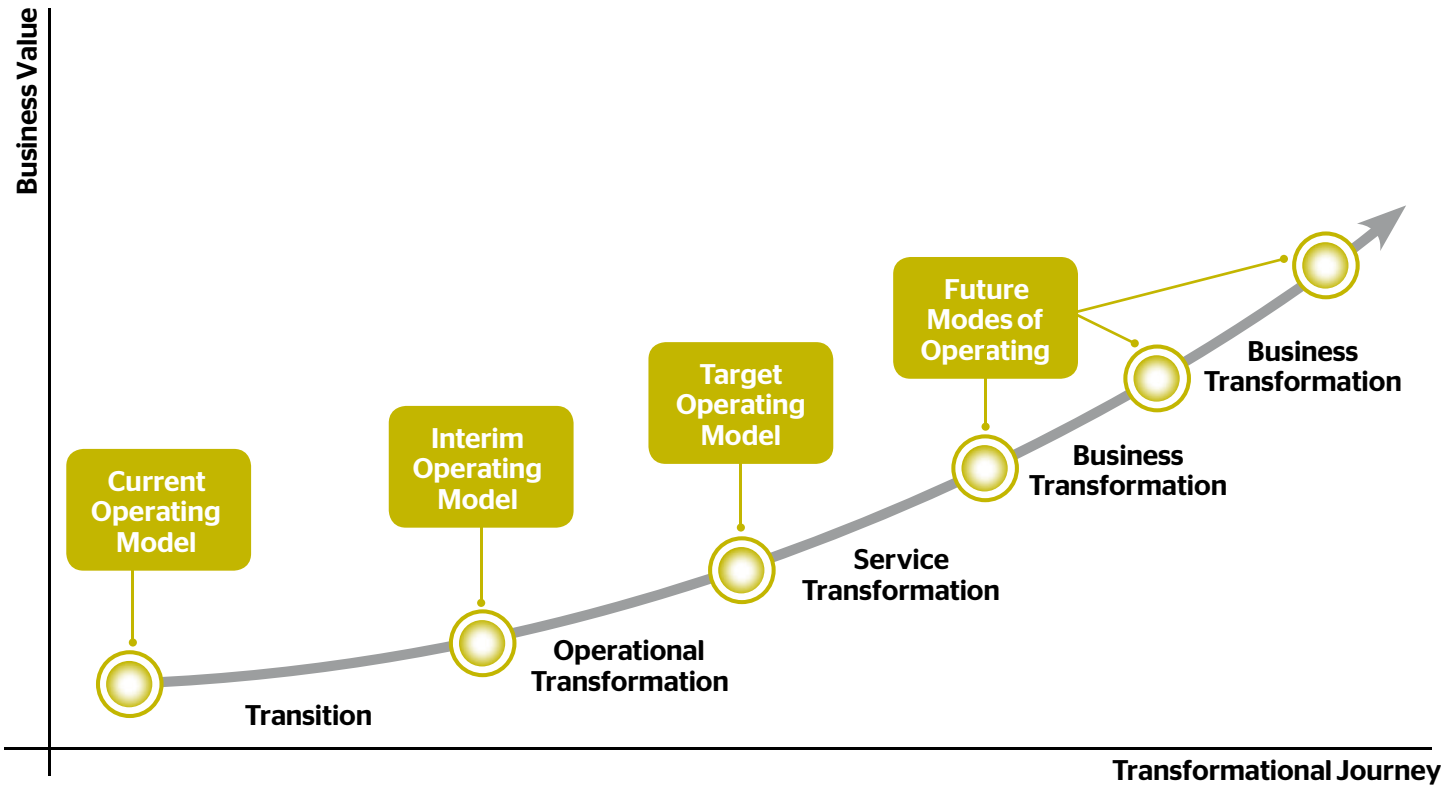
Setting up the ICT organization in such a way that it is able to shape the changing requirements and wishes, both during and after completion of the roadmap projects, towards the executing organization is crucial within this context. The question whether the available ICT services suffice and whether adjustment or perhaps more significant change is required needs to be asked on a constant basis. It is impossible to obtain properly functioning ICT for the longer term, if this part of the ICT organization does not function properly.

In addition, the appropriate conditions must be fulfilled within the executing organization with respect to the day-to-day management of the ICT services. This is where the knowledge of all the new technology needs to be absorbed. Moreover, a professional organization with well implemented ICT management processes (ITIL, ASL) needs to be in place. This is necessary for managing the hospital's own organization, but also for directing external parties in accordance to this. After all, the sum of the performance delivered by all parties determines the final result.

Stage Planning

In essence, the ICT management organization needs to evolve with the ambitions as defined within the reference architecture. Experience shows that this takes place via a number of intermediate steps, which run parallel to the roadmap for introducing the new ICT services.
The first step is the transition to a new ICT management organization, which is at least capable of managing the hospital's own organization on one hand and the executing ICT organization on the other. In this step, this executing ICT organization prepares itself for managing the new services. The challenge is of course that the old environment also needs to be managed in parallel. The actual transformation of technology and

Figure 8: The Transformation Process in Terms of ICT Management



services takes place within the second step. The goal is an operational model capable of properly managing the new basic ICT tier, as well as the new ICT services as completed in this stage. Just as in the first stage, this requires attention and preparation from both the managing and executing part of the ICT organization.

In the third step, the 'new' services form the basis for day-to-day ICT management. More services from the roadmap are possibly added step by step. The basic tier can constantly be adjusted within the context of this development. At the same time, requests for change may originate from the hospital itself. With the new services being taken into use, and under pressure from possible external developments, new requirements and wishes may arise, which must be implemented within the then existing environment. Heavy requirements are thus imposed on the 'capacity for change' of the hospital's own ICT organization. Here as well, this again concerns the managing side of the ICT organization as well as the executing side of the ICT organization. In the subsequent steps, supporting the hospital's primary and secondary processes through ICT in an increasingly improving fashion has become a 'normal' ICT management process. Not only is the 'digital hospital' designed upon strong architecture and built upon professional program management, but the ICT management organization has changed in such a way that ICT is constantly adding more value. As a result, the whole organization's capacity for innovation has increased enormously.

Outsourcing
It is quite possible to purchase services within the market which take over the daily ICT management. This may be a possible solution for facing the many changes that come within the hospital's own organization with the introduction of 'the roadmap'. Building the 'target operating model' for the executing ICT management organization can be assigned to an external party, i.e. outsourced. One of the distinct benefits of outsourcing is the clearly defined responsibility residing with the supplier. Another way of arriving at outsourcing, is by first going through the transition and transformation with the hospital's own organization (both the managing and executing part) and, when reaching the 'target operating model', to select a party which adopts the executing part. The disadvantage of the latter option is that a second transition needs to take place.

The advantage is that there might be a more stable situation. In practice, the latter is only partially true within significantly changing environments. In general, hospitals must be considered as environments which will face many significant changes in and dependence on ICT within the years to come.

Atos is a professional partner within every stage of this overall change process, both in the fields of advice and implementation as well as in the field of ICT management. Various hospitals in the Netherlands have led the way.

About Atos

Atos is an international information technology services company with annual revenues of EUR 8.7 billion and 78,500 employees in 42 countries. Serving a global client base, it delivers hi-tech transactional services, consulting, systems integration and managed services. Atos is focused on business technology that powers progress and helps organizations to create their firm of the future. It is the Worldwide Information Technology Partner for the Olympic Games and is quoted on the Paris Eurolist Market. Atos operates under the brands Atos, Atos Consulting, Atos Worldline and Atos WorldGrid.

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