FROM THE DIGITAL HOSPITAL TO THE SMART HOSPITAL

SBA
théma 6

The Smart Hospital Commission

In late 2017, Assistance publique-Hôpitaux de Paris (AP-HP) and the Nantes University Hospital issued a call for expressions of interest which led to the creation of the Smart Hospital Commission in June 2018.
This Commission is fully in keeping with the SBA's ideals. It brings together some fifty experts (project owners, project management assistants, consultants, engineers, architects, installers and integrators, manufacturers, editors and associations) who are all participants in the hospital construction ecosystem. It was formed with the purpose of helping hospitals and healthcare facilities fulfil their goals based on an innovative Smart Hospital approach. Over the past 18 months, interspersed with informative and animated discussions, the Commission has developed a service matrix and compiled this Thema before turning to a R2S for Care reference framework.

Contributions

We would especially like to thank the members of the Commission without whose help this handbook would not have been possible:

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EDITORIAL

UNLOCKING THE **POTENTIAL OF DIGITAL TECHNOLOGY** FOR HOSPITALS

Very often, efforts to bring about a digital transformation in hospitals are focused on patient records and the provision of healthcare. However, the potential of pooling and sharing the uses and interactions with the data produced by the hospital building itself is still quite neglected. A holistic view is necessary to unlock this potential of digital technology.

The intrinsic value does not lie in the technologies implemented but rather the benefit provided by their use.

We the members of the Commission consider the Smart Hospital to be a communicating, flexible healthcare facility, which can be galvanised in the face of a current event as was the case during the pandemic at the start of 2020. Since the onset of the coronavirus pandemic, awareness has rapidly grown that the health system must, now more than ever, be resilient and operate in real time.

With that being said, how can we structure the digital transformation of the hospital, when the vocabulary, concerns and needs of patients, the healthcare community, operators and managers are so broad and diverse? How can we identify the possible interactions between each stakeholder; how can we highlight the possibilities for pooling and sharing and achieve greater benefits?

In the following pages, the Smart Hospital Commission shares its vision, practical use cases, and feedback. In addition, it sheds light on the focal points to be taken into consideration when implementing a Smart Hospital process. This work will provide the players involved in the digital transformation of healthcare, decision makers and managers, proponents of Hospital of the future projects and their service providers with a reliable method for making the best use of the innovations at their disposal while controlling the risks and building a tool that will stand the test of time.

Marie-Paule DAYER
ABB France Business Developer, Chair of the Smart Hospital Commission

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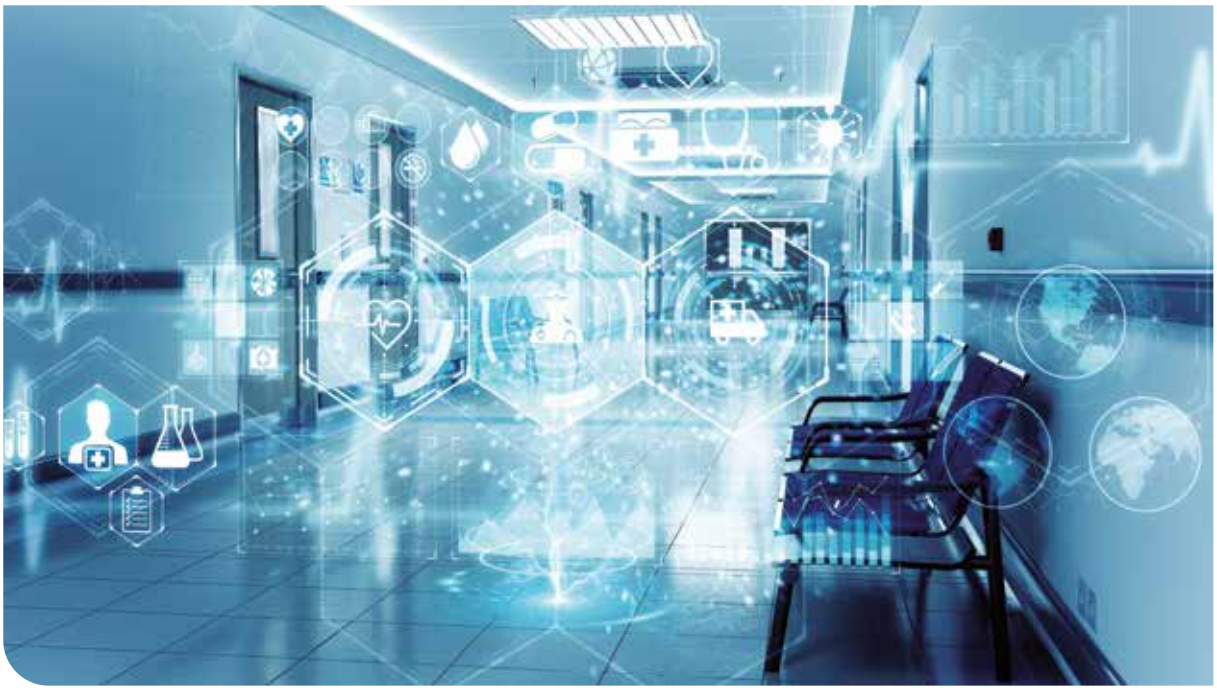


THE **ISSUES** AT STAKE

With some 70 million m² of healthcare buildings to be transformed in the upcoming years, there are many imperative issues at stake: patient experience, improving the quality of work life for healthcare providers, fostering easier access to healthcare, optimising the operating costs of healthcare facilities, prevention as well as support for the elderly and the increase of chronic illnesses.

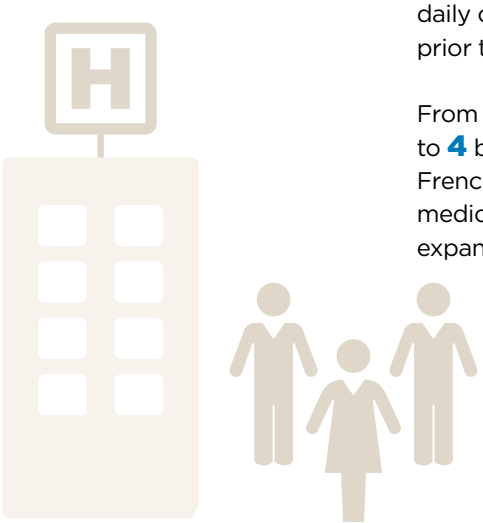
DATA AND STATISTICS

CONTEXT

12.8 million patients were hospitalised in 2018.

25 million consultations and outpatient visits per year.

21.4 million emergency room admissions in 2017.



ORGANISATION OF HEALTHCARE

70,000,000 m² of buildings in widely varying conditions to be maintained and adapted.

1.2 million persons are employed by hospitals.

100,000 teleconsultations[1] daily compared with **1,000** prior to the Covid-19 pandemic.

From **2.7** billion euros in 2014 to **4** billion euros in 2020: the French market of connected medical objects[2] is constantly expanding.

OPERATIONS

84.2 billion euros planned in the draft social security[3] financing bill (PLFSS - Projet de Loi de financement de la Sécurité sociale) for the operation of hospitals.

12% of energy consumption of the services market in France.

2 to 5% of the operating budget dedicated to energy purchases.

4/5 of the total cost of a hospital building is associated with its operation.

Energy consumption reduction goal of **40%** in 2030, **50%** in 2040, **60%** in 2050, dictated by the tertiary decree of the ELAN[4] Act.

1. https://www.monde-diplomatique.fr/2020/06/BRYGO/61870
2. https://experiences.microsoft.fr/business/intelligence-artificielle-ia-business/sante-connectee-chiffres
3. https://www.gouvernement.fr/projet-de-loi-de-financement-de-la-securite-sociale-plfss
4. Evolution of housing, special planning and digital technology – Évolution du logement, de l'aménagement et du numérique.

Sources: Insee - French national institute for statistics and economic research - La dépendance des personnes âgées: une projection en 2040 (The dependency of the elderly: a projection for 2040). The French Agency supporting the performance of healthcare and medical-social facilities (Anap). Xerfi study. Les chiffres clés de l'hospitalisation - Key hospitalisation figures.

NEED TO ACCELERATE THE DIGITAL TRANSFORMATION OF HOSPITALS

When the Ma santé 2022 (My health 2022) plan was launched in September 2018 by the Government, its purpose was to undertake a profound transformation of the healthcare system in France and to fulfil the hopes of the digital transformation of hospitals.

De-compartmentalising the hospital

Digital technology has been described as one cornerstone of a "target overall architectural design for the healthcare information system[1]" in France. More broadly, the My health 2022 plan highlights the goal of de-compartmentalising the organisation of healthcare, professional practice and training, between hospital and medical-social structures. Therefore, it involves improving access to and strengthening the quality of healthcare, wining back the trust of staff and healthcare providers as well as making the patient the core focus of the healthcare system.

Using a hub and satellites to coordinate the continuity of healthcare in an organisation

Already as early as April 2016, the establishment of regional hospital groupings[2] (GHT - Groupements hospitaliers de territoire) via a decree had sought to transform the hospital system to achieve better coordination and sharing of patient care between healthcare facilities.
These GHTs initiated the pooling of support functions and planned the roll out of a standardised or alternatively, interconnected, hospital information system with financial support from the Digital Hospital and HOP'EN[3] programmes.
In our minds, this is a system organised much like a hub surrounded by its satellites. At the core of this system, patients must be guaranteed continuity of care (between the prevention, consultation, treatment and support initiatives) within their homes, wherever they are in the region. The support facility – the hub – therefore plays a pivotal role in the hospital information system.

Bridging the gap in the digital transformation of hospitals

On this basis, many facilities have begun their digital transformation and their efforts must be supported. "France is lagging behind due to the lack

1. https://solidarites-sante.gouv.fr/IMG/pdf/masante2022_rapport_virage_numerique.pdf
2. https://solidarites-sante.gouv.fr/IMG/pdf/fiche_34.pdf
3. Hôpital numérique ouvert sur son environnement (The digital hospital: open to its environment).

of interoperability between healthcare information systems and needs to play catch up, stated Enguerrand Habran, Head of Research and Innovation at the French Federation of Hospitals[4]. As a result, there are very few smart hospitals, very little coordination of the medical and energy activities, no data management... and yet the transformation is underway."

Seizing on digital technology for greater agility

Furthermore, the pandemic served as a catalyst, bringing about new uses of digital technology in hospitals in relation to teleconsultations, training, prevention, teleworking, etc. "In just a short space of time, many healthcare professionals had to be trained in response to the specific requirements involved in caring for Covid-19 patients", noted Enguerrand Habran. This skills development was achieved through new approaches such as serious games, MOOCs[5] or webinars." The telemedicine sector has also taken off. The technologies already existed, however they were hardly being put to use. Lastly, the human resources sector in hospitals was already using digital technology but this trend increased during the pandemic.

Improving the dissemination of healthcare services in the region

In addition to the digital technology consideration, the Smart Hospital should be integrated within the city, with several independent buildings, and should also be interconnected with its local ecosystem. "The Smart Hospital is a facility that can analyse the health of the populations in its region, added Enguerrand Habran, in order to open the most appropriate prevention and healthcare services which meet the real local needs. **This is called population-based responsibility."**

4. The research and innovation funds of the FHF establish innovative collaborative programmes between the 4,800 hospitals and healthcare facilities in France
5. Massive Open Online Course

THE **EXPECTATIONS**

The benefits of digitising patient records: continuity of care and patient experience, safe and high quality healthcare, optimisation of medical procedures, prevention tools, biomedical research, epidemiological statistics

THE HEALTHCARE INFORMATION SYSTEM

The Smart Hospital ensures better care for hospitalised patients.

The Hospital Information System and its mainstay, **the Electronic Patient Record** (EPR) are a digital ecosystem where the core focus is placed on the patient as a means of monitoring the healthcare provided and the contributions of the support activities.

The **Electronic Medical Record**[1] (EMR) which is also called the electronic health record is another system which has been put in place by the Health Insurance Fund in France since 2018. Data is input from the digital tools of medical professionals whether they work in hospitals, in private practices or in medical-social structures.

The digital roadmap of the My health 2022 initiative sets forth the foundations of this ecosystem with:
– The use of a **national health identifier**[2] (INS), mandatory as of 1 January 2021, in order to avoid identification errors of people being treated and to ensure easier communication and sharing of health data.
– The opening of an **E-health space**[3] (ENS) which will provide a package of digital services to each citizen, including the consultation of the EMR.
– Compliance with an interoperability framework, which is the basis for certification of health information systems, which will take effect as of 1 January 2022.

The EPR, including all other electronic records (such as that of the pharmacy), must be compatible with the EMR in order to guarantee consistency in the patient's journey.

The **Hospital Technical Information System** (SITH) is the last element of the proposed measures. The ENS can provide the SITH with patient data in order to, for instance, adapt the environment of the room to the patient's specific needs, or to provide dedicated services as well as to ensure that the technical resources are suited to the hospital activity. All of this will take place in real time.

1. https://www.dmp.fr
2. https://esante.gouv.fr/securite/identifiant-national-de-sante
3. https://solidarites-sante.gouv.fr/IMG/pdf/masante2022_rapport_virage_numerique.pdf
4. Electrocardiogram.
5. https://actualiteinformatique.fr/non-classe/iomt-internet-des-choses-medicales-ou-iot-des-soins-de-sante

EXAMPLE: A CYCLIST IS KNOCKED DOWN BY A CAR

1 As soon as the cyclist is treated by the paramedics and the decision is made to transport the cyclist to the emergency room, his or her arrival at the hospital is organised: the EPR 2 is created via the data collected and sent by the paramedics, outlining the circumstances of the accident, the doctor's diagnosis, the treatment underway and any allergies. 3 Upon the cyclist's arrival at the hospital, the receiving hospital staff has gathered together the necessary equipment (bed, wheelchair, ECG[4], etc.). 4 Each examination and each report is then added to the EPR 5 and shared with the entire care team thereby guaranteeing the continuity of care. 6 After leaving the emergency room, the patient will have access to all the digitised data sent to the EMR and an electronic prescription 7 which will allow the patient to go to the pharmacy without a written prescription. The patient will have consented to this data being sent to his or her attending physician and the other health workers who will provide care during the patient's recovery.

WHAT IS THE INTERNET OF MEDICAL THINGS?

A wave of technological advances has broken over all our environments including the hospital. IoT (Internet of Things) sensors affect information systems (SIH and SITH) through the massification of available data and the decentralisation of connectivity to the object via networks, particularly through Wi-Fi:
– The sensors of the building and the technical equipment are used to monitor and control the spaces, manage access and security and implement predictive maintenance on critical facilities.
– The Internet of Medical Things4 (IoMT) relates to all medical devices which connect to the health information systems.
IoMT is especially useful in the remote monitoring of patients suffering from chronic illnesses. Other examples of IoMT technology include the IV pumps connected to analytic dashboards and hospital beds equipped with sensors to measure the patient's vital signs. Lastly, sensors can also be placed on the medical equipment and supplies for stock management purposes.

The benefits of digital technology on the quality of work life: geolocation of equipment and people, management of logistics flows, comfort control, optimisation of information and easier integration upon taking out a new position

SOCIAL AND ENVIRONMENTAL RESPONSIBILITY

Amongst its goals, the Smart Hospital aims to improve the quality of work life. The quality of work life is based on many criteria which involve the organisation and environmental quality of buildings as well as the resources provided to the medical staff and the recognition that they are likely to gain from their job.

In terms of organisation, optimising the distances to be travelled in the hallways of the ward, between the floors of the hospital and within the hospital campus is a major issue which affects all staff.
Did you know that a healthcare provider walks up to 10 km daily in the hallways of a hospital?

In terms of environmental quality, the dilapidated condition of some buildings, as well as the failure to take comfort into consideration, stemming from the lighting, sound installation, thermal conditions as well as air quality at the time of construction are some factors of stress which affect healthcare providers and influence the behaviour of patients and their families. Extended waiting times in "inhospitable" places during their search for information has led to an upsurge in aggressive behaviours.
Did you know that attacks on medical personnel have increased by 18% in the last 2 years?

THE CHANGEABILITY OF BUILDINGS

Hospitals are covered by the ÉLAN Act adopted on 16 October 2018, and by its energy efficiency requirements. The "tertiary sector buildings" decree which seeks to reduce the final energy consumption of commercial real estate by 40%, 50% and 60% respectively by 2030, 2040 and 2050, stems from this Act.

FINDING SUSTAINABLE SOLUTIONS TO MEET THE ENERGY CONSUMPTION REDUCTION OBLIGATIONS ARISING FROM THE "TERTIARY SECTOR BUILDINGS" DECREE

– By promoting energy renovation solutions which are eligible for the Energy Saving Certificate scheme (CEE).
– By adopting an overall energy optimisation approach with a commitment to the results.
– By initiating a renovation of lighting to provide a better working environment and foster better patient recovery.
– By reinvesting energy savings into the renovation and upgrading of the digital infrastructure.

The benefits of the changeability of buildings: cost savings, adaptation depending on developments in therapy and treatments, the appeal of the facility

Accordingly, the ELAN Act provides healthcare facilities with the opportunity to lessen their expenses and to modernise the 70 million m^2 of medical activities, with many additional benefits such as reducing the arduousness of work, improving the quality of accommodation and lessening waste.

INNOVATION AND DIVISION PATIENT EXPERIENCE

The Brest Regional University Hospital set up an Innovation and Patient Experience Division as a means of developing its appeal in the current competitive environment and improving the experience of its patients. The initial goal of this division is to improve accessibility to the hospital's historic site.

"We took a cross-functional approach to the project, confided Christelle Collec, Head of the Division, and we studied other buildings receiving the public such as airports. In addition, we noted that over half of the patients enter the hospitals via the emergency rooms, making them the main entrance to the hospital. The interior design that we chose is as welcoming as a hotel in terms of the colours and the furniture. We also installed Wi-Fi and a smartphone charging terminal for patients' companions. Accordingly, with these reassurance solutions we help patients deal with their stress and anxiety and the building is an active participant in this process." Five years later, we have had extremely positive feedback from emergency staff and patients.
Innovation and Patient Experience Division of the Brest Regional University Hospital is currently working on the introduction of digital services (appointments, health record, geolocation, etc.)

THE MAIN **STAKEHOLDERS** OF THE ECOSYSTEM

It is with good reason that the hospital is often compared to a "city within the city" given the many different stakeholders of a healthcare facility. For that matter, the Smart Hospital Commission has identified all the stakeholders of the hospital ecosystem. The aim was to study their uses, their needs, and their interactions in order to provide the most helpful and appropriate solutions.

THE PUBLIC

The core purpose of a hospital is to receive and provide care to all patients and to ensure that they, their companions and visitors, all have the best possible experience.

HEALTHCARE PROFESSIONALS

Healthcare professionals including doctors, nurses, nursing assistants, senior medical officers and hospital porters, are on the front lines in the hospitals and healthcare facilities, both in the urban and rural areas.

TECHNICAL AND CLINICAL SUPPORT BLOCK

This is the core of the hospital: it brings together the medical imagery, nuclear medicine, operating theatres, sterilisation, biology laboratory, the pharmacy, emergency rooms, outpatient care services as well as the dialysis clinic.

RESOURCE SERVICES

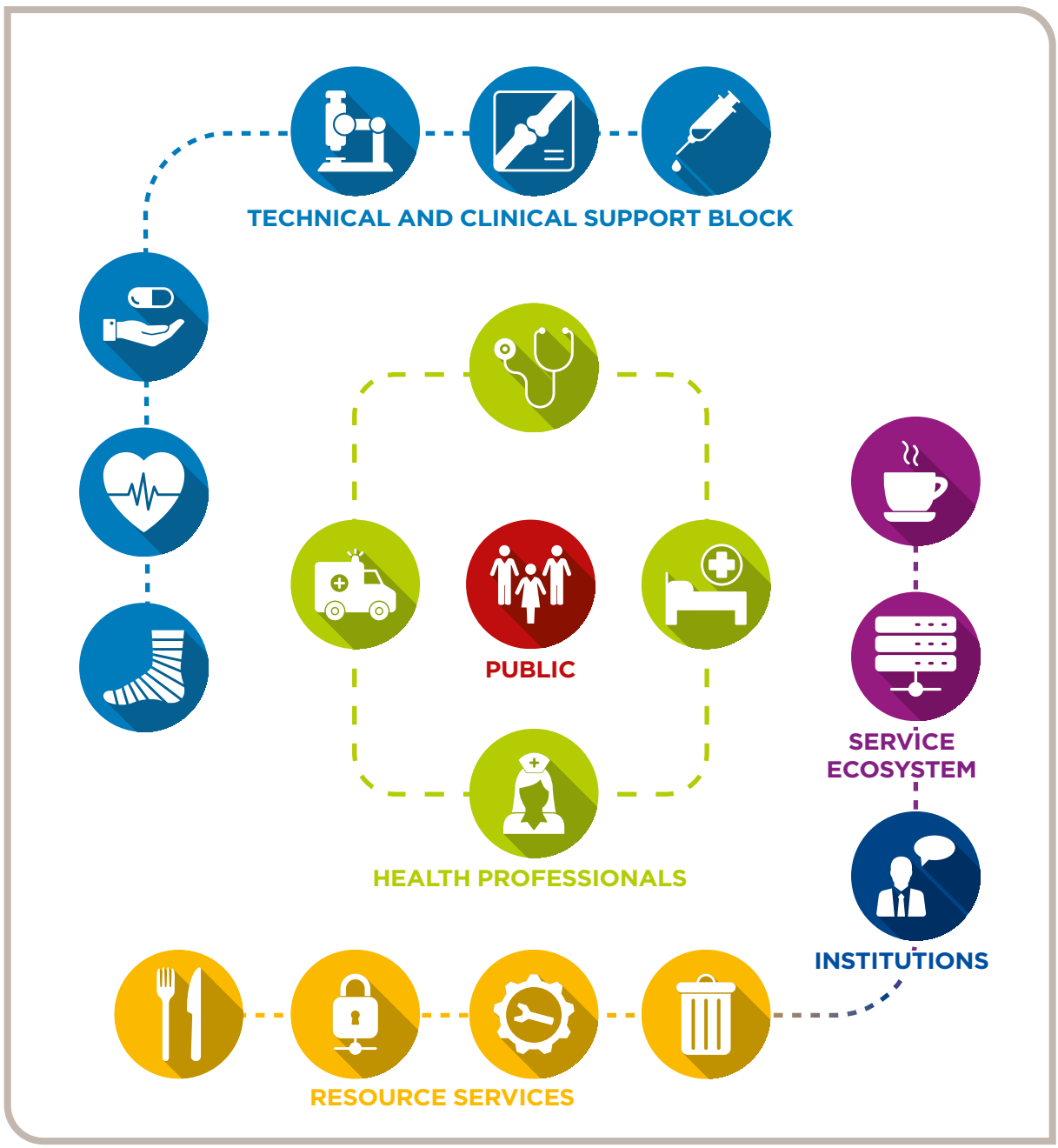
Resource services include technical maintenance and servicing, biomedical equipment and logistics, the information and security system, catering, laundry service, energy distribution and cleaning services.

THE SERVICES ECOSYSTEM

The hospital, just like a real city, also needs services: proximity and business services, network connectivity, transportation, parking and accessibility.

THE INSTITUTIONS

The leadership of the hospital works in conjunction with other institutions such as the Regional Hospital Groups (GHT) and local representatives.



A FEW PRACTICAL **USE CASES**

Based on its identification of the hospital stakeholders, the Smart Hospital Commission has designed and implemented a service matrix to examine the range of possible options for pooling resources and solutions between the various hospital units, which to date have been siloed off from each other.

In the following pages, the Smart Hospital Commission has outlined a few concrete cases of the deployment of digital technologies as a means of illustrating the merits of this service matrix. These cases relate to:
– **The patient** (dynamic navigation and assessment of the patient's experience).
– **Healthcare personnel** (geolocation of patients, equipment traceability, mobile collaborative robot).
– **Asset Management Department** (parking, digital twin).

The Georges Pompidou European Hospital.

THE PATIENT'S JOURNEY

PRACTICAL USE CASE 1
DYNAMIC NAVIGATION INDOOR AND OUTDOOR

STAKEHOLDER	USE	BENEFITS
PATIENT	**ACCESS AND NAVIGATE**	**PERSONALISED RECEPTION - RESERVATION OF SERVICES**
Companion. Visitor. Healthcare provider. Medical transportation. Management. Service provider.	Flow management. Location of services and access paths. Improvement plan.	Reduced waiting times. Maximised parking areas. Optimised administrative services. Fewer missed appointments and optimised schedules. Better patient experience.

DYNAMIC SYSTEM TO MONITOR THE PATIENT'S JOURNEY

1. A patient goes to the hospital for various examinations, hoping not to have to wait a long time in the various successive units.

2. At the admissions department, the patient receives a single ticket which mentions the patient's first appointment. The ticket features a barcode which must be scanned on the reader provided as the patient progresses on the journey.

3. The system offers the patient useful information at each step and directs the patient to the different units. Patient calls show up on displays located at various areas of the hospital.

4. With the complete management of the patient's journey from admission to discharge, the patient had to wait very little. The patient always receives information about the care and progress of his or her treatment with a maximum amount of confidentiality.

PRACTICAL USE CASE 2
ASSESSMENT OF THE PATIENT'S EXPERIENCE

STAKEHOLDER	USE	BENEFITS
PATIENT	**SELECTING THE FACILITY AND THE SPECIALIST BASED ON THE PATIENT'S OWN CRITERIA**	**PERSONALISED RECEPTION - RESERVATION OF SERVICES**
✚ Companion. Healthcare provider. Management. Institution.	✚ Generate satisfaction indicators. Identify points for improvement. Adapt the service to the patient's expectations.	✚ Improved quality of care and professional practices. Strategy guided by the assessments. Communication of the results and indicators, management of e-reputation. Improved attractiveness. Market share increased.

We created an innovation department in 2019, led by a two-person team of a director and a doctor in order to steer this strategy, stated **Christelle Collec**, Head of the Innovation Division at the Brest Regional University Hospital. Our division reports to an innovation council. Accordingly, we have carried out several projects, such as the improvement of patient experience, the accessibility of the hospital and the provision of services dedicated to the patient's companions. Did you know that 85% of patients are accompanied by someone when they visit the hospital?

THE INDICATORS FOR IMPROVING THE QUALITY AND SAFETY OF HEALTHCARE

1. The IHAS are indicators developed by **the French National Authority for Health** to improve the service provided to patients. They measure the quality and safety of care in French hospitals and clinics (IPAQS).

2. The IQSS, indicators of healthcare quality and safety measure the patient's health status, a professional practice or the occurrence of an event to be investigated. The Scope1 santé website gives access to all the results of the indicators[1].

3. Online surveys serve to measure the satisfaction of hospitalised persons as demonstrated by the email survey[2] common to the AP-HP hospitals and the online satisfaction survey[3] of the French National Authority for Health (Haute autorité de santé, HAS) introduced in 2015 (e-satis3).

4. The Hospitalidée[4] tool is a platform which collects patients' views about their hospital stay and is compatible with e-satis satisfaction surveys. The hospital has an integrated dashboard which displays the results in the aim of improving its e-reputation.

1. Source: Les indicateurs en bref (A brief summary of indicators), HAS article, 24 February 2020. www.scopesante.fr
2. https://www.aphp.fr/satisfaction-des-patients
3. https://cas.atih.sante.fr/cas/login?service=https%3A%2F%2Fe-satis.atih.sante.fr%2F
4. https://www.hospitalidee.fr

THE HEALTHCARE PERSONNEL'S JOURNEY

PRACTICAL USE CASE 3
GEOLOCATION OF PATIENTS

STAKEHOLDER	USE	BENEFITS
HEALTHCARE PROVIDER	**DETERMINE THE PATIENT'S POSITION IN HIS OR HER JOURNEY**	**MONITORING AND LOCATION OF FRAGILE PATIENTS TIME SAVING**
✚ Companion. Visitor. Medical transport. Management. Service provider.	✚ Streamline the sequence of examinations. Adapt the schedules of personnel or rooms. Anticipate material healthcare needs in real time. Optimise external services. Adapt the level of safety.	✚ Better communication with the companion. Better coordination with service providers. Improvement of overall performance.

TRACKING OF OUTPATIENT FLOW AT THE COURLANCY REIMS-BEZANNES CLINIC

The Reims-Bezannes clinic has 22 operating rooms which receive 15 to 20 patients per day and per room. One third of the procedures performed are endoscopy procedures

1. Upon arriving to the outpatient care unit, the patient receives a **wristband, equipped with an active tag**, which the patient wears during the entire hospital stay. The patient's treatment, appointments and journey are loaded via a dedicated application.

2. The tag emits signals captured by the wall terminals which are processed and then sent to the servers which **calculate in real time the position and movement of the patient. It notably tracks when the patient enters and exits the areas**.

3. **Each step is automatically completed** in the application and a notification is sent to the medical staff so that the patient is moved on to the next step.

4. Badges have also been installed on the lockers where the patient's personal belongings are stored upon arrival. The sensor is easily identifiable and confidential and helps to **save a valuable amount of time for the healthcare providers** when a patient leaves.

> Courlancy Santé has adopted an outpatient flow tracking tool which secures and streamlines our outpatient care, disclosed **Élien Meynard**, Director of the clinic. Our medical staff loves it!

PRACTICAL USE CASE 4
TRACKING OF MEDICAL EQUIPMENT

STAKEHOLDER	USE	BENEFITS
HEALTHCARE PROVIDER	**AVAILABILITY OF MEDICAL EQUIPMENT**	**REDUCED SEARCH TIME – USE OF EQUIPMENT IN GOOD WORKING ORDER**
✚ Patient. Management. Service provider. Facilities management company.	✚ Organise servicing and maintenance. Optimise purchases.	✚ Decreased loss or misuse of biomedical equipment. Optimised number of equipment items and scheduling of medical personnel flows. Improved maintenance of equipment via the organisation of rounds and the traceability of equipment.

“With the introduction of a PCA1 pump geolocation system, spearheaded by our Project manager **Farid Annabi**, our ward went from 50% of pumps being found to 95%, explained **Damien Gobel**, Head of the Biomedical Department at the Robert Schuman Hospital of the Hôpitaux privés de Metz. This was done in record time and cut the maintenance times of technicians in half. Better yet, the risk of using a PCA pump that has not been serviced has been completely eliminated thereby strengthening the safety of both the patient and staff .”

1. Patient-controlled analgesia.

SMART INDOOR TRACKING OF MEDICAL EQUIPMENT AT THE GRENOBLE-ALPES UNIVERSITY HOSPITAL

The initial goal was to reduce the time spent looking for stretchers and wheelchairs at the emergency rooms of the hôpital Couple-enfant (child and family hospital) and within the Michallon IGH[2] building of the Grenoble-Alpes University Hospital.

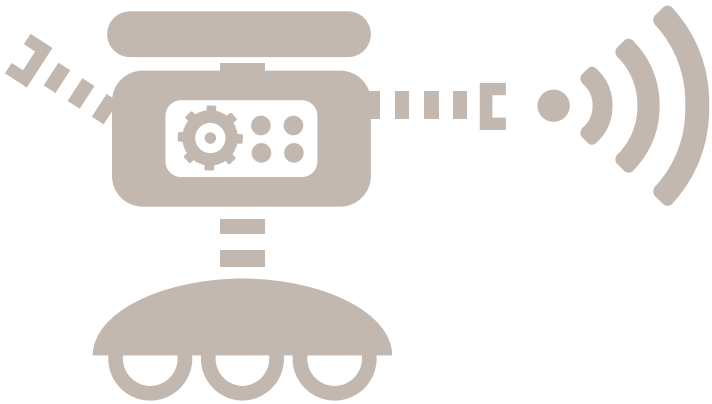
1. Time saving: By equipping 60 stretchers and wheelchairs with a tracking system, the management of the Technical Departments alongside the management of the Digital Services Department enabled hospital porters to save 4 hours per day looking for equipment.

2. A cost effective investment: The roll-out of the system was designed to optimise costs, by using the 1,500 Wi-Fi terminals already in place. The tracking conducted via a user interface and a geolocation engine, provides a 3D view with an accuracy to within 2 m.

3. An innovative system: The location of the Wi Fi terminals was configured by pairing the technical equipment referencing and geolocation application with the site’s CAMM[3] system.

4. Fewer equipment items lost: The tracking system could also be installed on carts (with the aim of preventing the loss of 70 carts per year, syringe pumps, cardiac monitors as well as oxygen tanks thereby minimising the loss and misuse of equipment.

2 . Immeuble Grande Hauteur – High rise building
3. Computer-aided maintenance management



PRACTICAL USE CASE 5
MOBILE COLLABORATIVE ROBOT

STAKEHOLDER	USE	BENEFITS
HEALTHCARE PROVIDER	**STANDALONE DELIVERY SERVICES**	**REFOCUSING THE PRIORITY ON HEALTHCARE – INCREASED SAFETY AND TRACEABILITY**
✚ Patient. Support services. Management. Service provider.	✚ Improve the quality of care. Secure deliveries. Optimise the number of trips, based on real time requirements. Reduce healthcare-associated infections.	✚ Improved quality of services. Improved quality of work life. Increased safety and traceability.

THE MESSENGER ROBOTS AT THE NANTES UNIVERSITY HOSPITAL

The Nantes University Hospital has been using mobile robots for the past 6 years.

1. The endoscopy unit manages the **messenger robots** and is very satisfied with their performance. The robots make 50 trips back and forth per day upon request, traveling 1,400 km per year. They help staff save 2 hours per day.

2. In full compliance with **safety standards and conditions**, the mobile robots seamlessly travel the hallways of the hospital without risk.

3. **They connect to the hospital's technical information system** to communicate with the lifts while taking into account cyber security. They blend into the existing buildings without the need to change the existing infrastructure.

4. To optimise costs and increase productivity, mobile robots can perform **autoconfiguration based on actual logistical needs** (day, night, high influx of visitors). The Nantes University Hospital is considering other applications that could be covered by the robots in the future: transportation of medication, night time cleaning of the floors, etc.

> These robots can be considered as the vehicles of the last few meters, explains **Tony Perlemoine**, Logistics Project Manager at the Nantes University Hospital. As opposed to Automated Guided Vehicles (AGVs), these robots do not stop at the door of the unit; they go right up to the users in an environment that is open to the public. This technology is still uncommon in hospitals but should expand in the upcoming years as it eliminates tasks that have no added value and is available at all times.

THE JOURNEY OF THE ASSET MANAGEMENT DEPARTMENT

PRACTICAL USE CASE 6
MANAGEMENT OF PARKING

STAKEHOLDER	USE	BENEFITS
ASSET MANAGEMENT DEPARTMENT	**MANAGEMENT OF PARKING**	**MONITORING AND TRACKING OF FRAGILE PATIENTS TIME SAVING**
✚ Patient. Companion. Visitor. Local community. Logistics. Service provider	✚ Pooling of parking spaces with local residents, shops and businesses. Possible coverage of expenses. Organisational plan of carparks and traffic.	✚ Improvement of patient, companion and visitor experience. Improved quality of work life. Introduction of a virtuous approach in its ecosystem. Increase in revenue.

ORGANISATIONAL PLAN OF PARKING SPACES

1. **The financing of building costs and the annual management of parking spaces** is a key challenge. Although the staff is generally exempted from payment, the rates for users must not prevent access to healthcare and call into question the benefit of the available spaces.

2. Therefore, **a simple and clear organisational plan of the parking spaces is necessary** including licence plate recognition, a pay-on-exit system through a subscription, parking meter, smartphone or prior online payment

3. Another possible approach is **the pooling of carparks** with the dwellings, offices or stores within the vicinity of the hospital in order to generate additional revenue or share costs

4. Other possible avenues worth exploring include the optimisation of existing land development, the use of parking spaces in nearby carparks, the request for parking contributions or financial incentives for car sharing and the use of public transportation. The introduction of such measures helps to **initiate a virtuous cycle** without having to build new carparks. Therefore, at the Rouen hospital, the percentage of employees who come to work alone in their car has been reduced to 53%.

PRACTICAL USE CASE 7
DIGITAL TWIN

STAKEHOLDER	USE	BENEFITS
ASSET MANAGEMENT DEPARTMENT	**BUILDING PERFORMANCE**	**OPERATIONAL UPKEEP OF SYSTEMS**
✚ Patient. Companion. Healthcare provider. Visitor. Service provider. Institutional body.	✚ Control and reduce the heavy maintenance and upkeep budgets. Simulate renovation projects. Determine the potential changeability of areas. Improve the quality of how visitors are received. Improve the quality of services performed by third parties. Reduced energy expenditure.	✚ Better budget allocation. Better surface use. Asset enhancement. Improved quality of work life.

EUREKA EUROSTARS EUROPEAN PROGRAMME

The aim of the SB4D Viewer project is to create a digital twin and to develop a platform which promotes interoperability between the building software applications. It processes the data from the connected medical objects for easier use and maintenance of the hospital without altering existing technologies.

1. The goal is to display the data generated by the hospital in 2D or 3D **BIM1 digital models** via colour codes and icons. The use of the existing software without altering the equipment and the collection, processing and interpretation of the data in a visual and educational format lessens the training costs, expedites analyses and optimises the responsiveness of building operators.

2. The SB4D Viewer solution provides a digital platform which **consolidates all the building data** to easily identify on the various floors the equipment in need of repair or to connect the sensors to the data generated on the plans and thereby improve energy efficiency and preventive maintenance in the facility.

3. The SB4D Viewer can be used for a large variety of applications: accurate location of a warning emitted by control software, identification of the rooms and equipment controlled by a system, marking off of the areas affected by service interruption.

4. As a result, the hospital operator can **continuously update the information** in the software, improve the location of defective equipment or the management of alarms, optimise the effectiveness of operation and the independence of service providers through a shared identification and repository of the connected equipment and spaces.

1. Building Information Modeling

> The digital twin of a hospital simulates the infrastructure as well as its human and material resources. It makes it possible to test various construction and layout solutions, before the plans of a new facility or unit are validated, explained **Sandra Bertezène**, professor and hospital services management Chair at the CNAM. During operation, it serves to test alternative uses of material and equipment to improve their performance. It also helps to anticipate shortcomings in the quality of care and quality of work life. Lastly, on a more systemic level, it provides input for the Health Data Hub to bring about overall improvement in the management of healthcare organisations.

THE **IMPACT** ON BUILDINGS AND ORGANISATIONS

The introduction of digital solutions will of course have an impact on the existing infrastructure and equipment as well as on the organisation of the hospital. In general, this impact will be minor but in some specific cases it will be significant so much so that this deployment can only be carried out in new facilities where the digital solutions have been taken into consideration at a very early stage during the programming process, combined with change and organisational support.

ANTICIPATING THE CHANGES IN FUNCTION OF THE INFRASTRUCTURE AND EQUIPMENT

If services are to be cost-effectively added to the health building, then, as new uses are developed, the infrastructure and equipment inside the hospital must be pre-installed and pooled. A good example of this is the case of geolocation in the healthcare facility, given its positive influence on enhancing the patient's journey, optimising patient flow, dynamic monitoring of people and tracking of mobile medical equipment. Therefore, the necessary components for geolocation (Wi-Fi, telecommunication network, multi sensors, lighting, etc.) must be integrated within the infrastructure and equipment.

COORDINATE THE HOSPITAL ORGANISATION

The digital transition of hospital facilities primarily affects the clinical or medical and technical support divisions which little by little are replacing the wards and the departments. To successfully implement a digital transformation plan, it is vital that the organisation responsible for coordinating all activity divisions be determined so as to enable them to pool their requirements and implement facility-wide solutions.

FUNDING THROUGH AN OVERALL PERFORMANCE CONTRACT

Where the funding of the Smart Hospital is concerned, the vision of the OPEX[1] cannot be dissociated from that of the CAPEX[2] and the return on investment must be examined as a whole to ensure that the right decisions are being made. In fact, as things currently stand, the party funding the investment is not the one who will benefit from the returns on investment, which may result in a fragmentation of responsibilities. Moreover,

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The new Lens hospital.

technological generations exist together in the facility often without real benefit and without being perceived by patients.

The success of any Smart Hospital solution therefore depends largely on having access to all investments and budgets. One serious avenue to be explored is the establishment of an **overall performance contract in relation to the provided use** instead of a description of the technical resources, especially in connection with a transformation project that does not include new-build projects.

A FEW KEY POINTS TO BE KEPT IN MIND WHEN DEVELOPING THE SMART HOSPITAL

Control cyber risks

In today's world, almost all activities carried out at the hospital rely on digital technology. The medical equipment market is constantly growing, reporting revenues of 4 billion euros in 2020. The digital transformation of the healthcare sector must go in hand with optimum security.

Did you know that healthcare facilities have suffered cyber-attacks[3] in recent times? In 2019 in France, some 400 incidents were reported to the French Ministry of Health and Social Care and 70 applications for support were made to the medical cyber security division within the Agence du numérique en santé (Agency for digital technology in health). To make matters worse, in 2017, dozens of hospitals in Great Britain were paralysed by the Wanacry virus. This cost 115 million euros to resolve and resulted in 19,000 appointments being cancelled. These incidents endanger the lives of patients.

1. Operational expenditures.
2. Capital expenditure.
3. https://www.lemondeinformatique.fr/actualites/lire-l-ap-hp-touchee-par-une-attaque-en-deni-de-service-78531.html

Complying with the GDPR and personal data protection

The General Data Protection Regulation (GDPR) is a European regulation which governs data processing on an equal basis throughout the entire European Union. The GDPR took effect on 25 May 2018 and champions the same principles laid down in the French Data Protection Act of 1978 establishing rules on the collection and use of data in France. The CNIL[1] provides guidelines on its website to help healthcare facilities comply with the regulation.

Personal health data is data relating to the past, present or future physical or mental health of a natural person. The CNIL gives a definition of this health data on its website. Access to personal health data is regulated by law in order to protect people's rights. As a result, this data must be hosted under secure conditions suited to its level of criticality. The regulation sets out the expected terms and conditions.
With a Smart Hospital solution, there is no concern about compliance with the regulation or any new risk. It will only be necessary to fill out the processing registers as defined by the regulation with the new processing operations implemented.

CYBER SECURITY IN THE SMART HOSPITAL

Maître Omar Yahia (Omar Yahia, Esq.) is a senior partner at the Yahia Avocats law firm who specialises in health law. He outlines the risks of the information system in a hospital and recommends some precautionary measures that should be taken. "According to the ANSSI[2], cyber-attackers are becoming increasingly interested in vital sectors of activity and specific critical infrastructure such as the defence, research and health sectors, stated Omar Yahia. As a means of supporting hospitals, the Order of 14 September 2018 lays down security rules (Appendix I) that ESOs[3] must apply to the computer systems and networks used to supply their essential services and establishes the deadlines (Appendix II) within which the ESOs must apply these safety rules. To secure the data flows transiting within the mobile applications on personal equipment, I would recommend installing mechanisms to filter the flow of data transiting through the information systems, in order to block the flow of data that is not necessary for the operation of these systems and which may make it easier to carry a computer attack. Furthermore, the traceability of the actions performed by healthcare personnel must be ensured via a logging system which records any events related to user authentication, the management of accounts and access rights, access to resources, changes to the security rules of the information system as well as its operation."

1. Commission nationale de l'informatique et des libertés (French Data Protection Authority).
2. Agence nationale de la sécurité des systèmes d'information (French agency for the security of information systems).
3. Essential services operator.

A **DIGITAL TRUST** FRAMEWORK

AN OVERALL APPROACH FOR THE SMART HOSPITAL

Even more so than a conventional hospital project, the creation of a Smart Hospital must be based on an overall collaborative approach involving all stakeholders of the healthcare facility. The main difference resides in the data produced and used by the Smart Hospital, which requires the establishment of a digital trust framework, in like manner as the digital transition of the health sector spearheaded by the DNS1, a division of the French Ministry of Health and Social Care. The DNS relies on the ANS2 to support the digital transformation of our health system.

“The State must accept to build foundations so that the public/private ecosystem, the start-ups, health professionals and industrial manufacturers do not work in silos, and to greatly increase opportunities for use of digital technology during a crisis, pointed out Dominique Pon, General Director of Clinique Pasteur in Toulouse and head of the DNS. Digital technology can enhance the daily lives of people, healthcare professionals and patients3.”

With the aim of building digital trust, and ensuring the implementation of the expected digital solutions, the SBA proposes to rely on R2S (Ready2Services), the reference framework that is has established and which has received a label issued by Certivéa, a certifying body. This label is intended for tertiary, residential or mixed-use structures (see pages 28-29).

1. Délégation numérique en santé (Delegation for digital technology in the health sector).
2. Agence numérique en santé (Agency for digital technology in the health sector).
3. Sources: Le concours médical, April 2020; and SANTEXPO Focus Covid-19: zoom sur Dominique Pon, May 2020.

A SERVICE MATRIX IN SUPPORT OF DECISION MAKERS

However, the R2S does not cover the specific characteristics of the hospital ecosystem which is much more akin to the constraints of an industrial site rather than a tertiary site in terms of the processes and machines specific to this sector. The Smart Hospital Commission was created within the SBA with the aim of devising a dedicated tool to support decision makers, operators and project engineers in bringing their smart hospital project to fruition. This tool is a service matrix which identifies all the stakeholders and users of the hospital and classifies their needs into categories. The matrix links uses to these needs. It is a collaborative tool that serves as a basis for discussion and brainstorming from the start of a renovation or construction project.

This tool has the following benefits:

– It provides a common frame of reference for all stakeholders of the hospital.

– It serves to identify the potentials and interdependencies of the solutions dedicated to the Smart Hospital.

Therefore, the hospital project team singles out in this matrix the uses that are considered important. In this way, the matrix reflects the facility's strategic expectations. The hospital construction stakeholders could use the matrix to match the hospital with a service offering that can be implemented from solutions or a family of appropriate technological and digital solutions.

The development of these uses within a cross-cutting package (Smart) will have impacts on all parties involved in a project.

– **Impacts on its architectural design**. Therefore, the uses should be integrated within a systematic approach from the initial design phase in order to achieve a fair technological design.

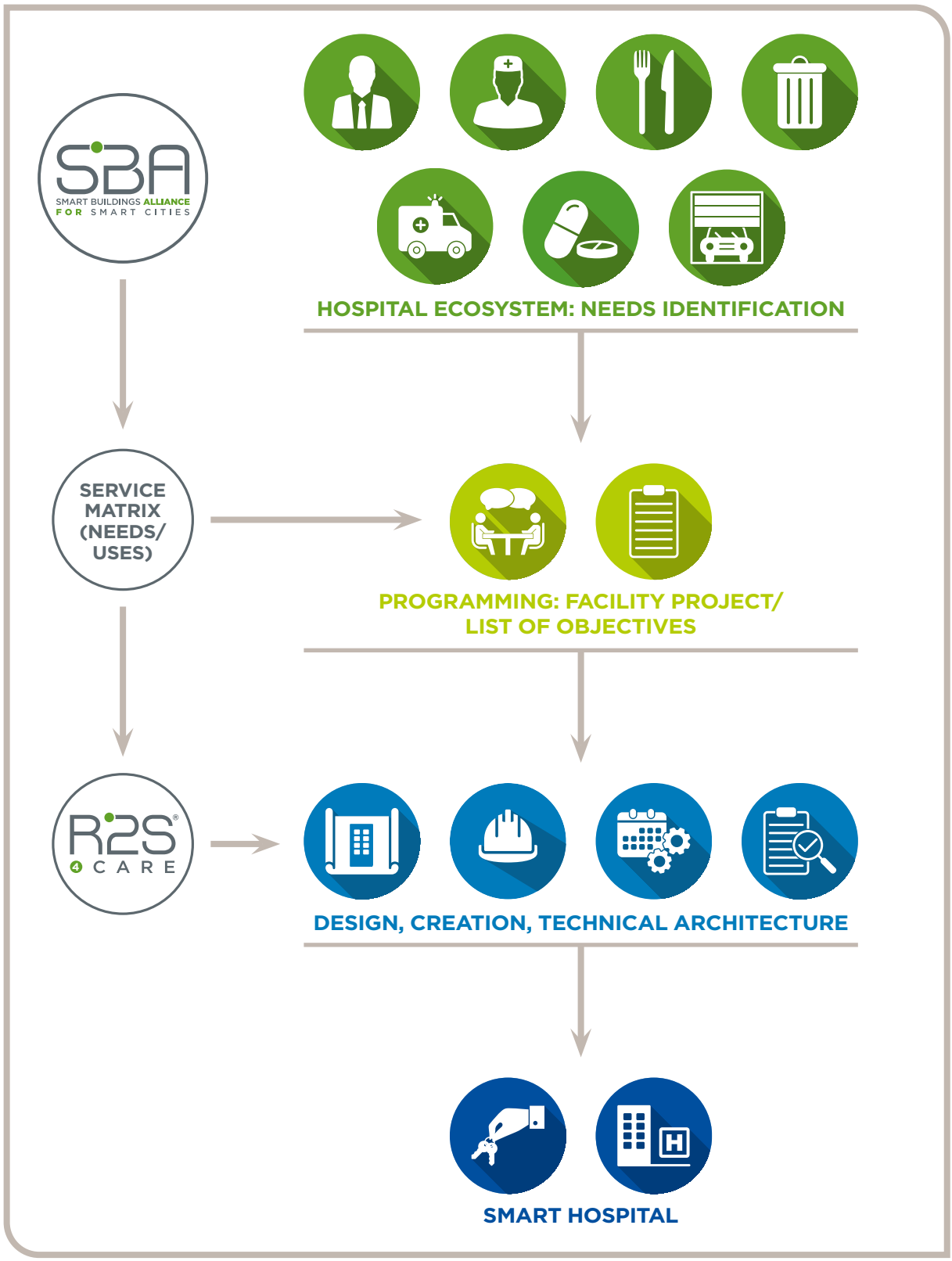
– **Impacts on the deployment of technologies**. The tool helps to choose the right technologies depending on the requirements by retaining an overall and evolving vision.

– **Impacts on the operation of the building**. The matrix ensures convergence between the actual operation and the digital twin in order to optimise its overall cost.

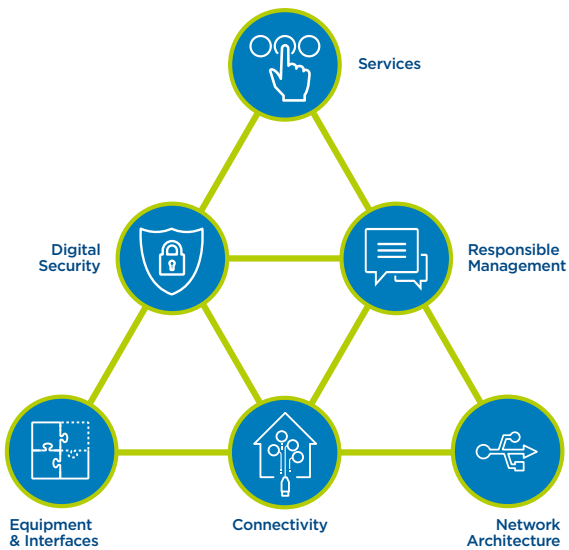
In consistency with the work of the SBA's cross-cutting commissions such as the BIS Commission, the Smart Hospital work group has embarked on the production and provision of the R2S for Care label. The aim of this reference framework is to help designers and engineers of the hospital of the future to introduce the digital strategy into the healthcare facility as it defines the prerequisites in terms of the techniques, infrastructure and services.

> With the many existing communication protocols, the Smart Building can quickly become a true Tower of Babel where each system uses a different language, points out **Blaise Sola**, president of the SBA's Building Information System Commission. The first step for the SBA was to establish a framework, based on the R2S frame of reference. We would now like to take things further on a more detailed level. Our goal is to create a link between these batches of applications so that they operate together in the context of a Building Information System (BIS), made up of a layer of equipment, a central software platform or Building Operating System (BOS), and a layer of service applications.

Toolbox


SBA
SMART BUILDINGS ALLIANCE FOR SMART CITIES
HOSPITAL ECOSYSTEM: NEEDS IDENTIFICATION
SERVICE MATRIX (NEEDS/ USES)
PROGRAMMING: FACILITY PROJECT/ LIST OF OBJECTIVES
R2S 4 CARE
DESIGN, CREATION, TECHNICAL ARCHITECTURE
SMART HOSPITAL

THE **R2S** (READY2SERVICES) REFERENCE FRAMEWORK



R2S diagram.

Breakdown of R2S services.

The digital revolution is a challenge for many economic sectors and marks a major shift. For example, the building sector has to reinvent a new way of designing, executing and operating buildings which means that trades must work closer together in a cross-cutting manner and acquire new expertise in information technologies.

As a result, the SBA is offering a new concept for buildings: a communicating and connected building, compatible with a wide range of services and able to interact with its environment. It also forms part of the sustainable and smart city of the future; a more efficient building whose value-in-use contributes to the well-being of its occupants and its value on the property market. To meet these requirements, the SBA has developed the R2S (Ready2Services) reference framework for a building which becomes a genuine "service platform" organised around its living spaces and activities.

The SBA R2S (Ready2Services) approach forms part of an overall approach that encompasses the connectivity of the building and the services for different stakeholders. The R2S reference framework describes the key requirements for communication between the building systems and services that will enable the building to provide a wide and scalable range of services by relying on a common federating base, i.e. the network infrastructure of the building and the connected equipment related thereto.

R2S is therefore a new generation reference framework which applies to all buildings, including hospitals. As such, it enables the deployment of a vast and diverse range of services, including the specific healthcare and medical services described in this Thema.

THE PRINCIPLES

A connectivity base of the communicating building

The ability to route wired and/or radio connections to and inside the building is the first link in the chain of connected building services. The implementation of a robust, secure and scalable building network infrastructure (smart network) is the second link. By relying on international Ethernet-IP (Internet Protocol) standards, this infrastructure dedicated to the technical systems of the building makes it possible to converge all communicating systems of the building towards a federating network and hence promote the pooling of the network infrastructure to ensure optimum efficiency.

A technical architecture separated into 3 layers

This architecture, with its three independent levels, provides a solution to the problem of communication between the systems and the lifecycle of the building. It provides the building with greater flexibility and scalability by separating the applications layer (services), the communication layer (network infrastructure) and the field layer (connected equipment). The model lays down the standard for interchangeability of each level, without modifying the other two levels so that a service does not require an equipment ecosystem or dedicated network infrastructure and vice versa.

Interoperability between heterogeneous systems

With the generalisation of open APIs (Application Programming Interface), the connected equipment will be able to expose the data necessary for the operation and services of the building and enable the various building services to communicate with each other. These APIs which are broken down between field APIs (governing the interfaces between the field layer and the infrastructure layer) and central APIs (governing the interfaces between the infrastructure layer and the services layer) are all covered by documentation and user licences which are accessible to the project manager and/or the owner of the building.

Secure design, protected data

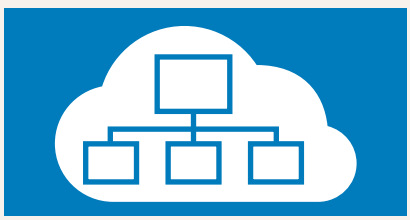
Making the equipment ecosystem and the functions of the building accessible and controllable from the communication networks, implies taking into account cyber security rules for access to the systems at all levels (field equipment, network infrastructure, services), as well as data protection procedures in compliance with the Rules of the General Data Protection Regulation (GDPR).

THE THREE LAYERS OF THE CONNECTED AND COMMUNICATING BUILDING

"APPLICATIONS/SERVICES" LAYER

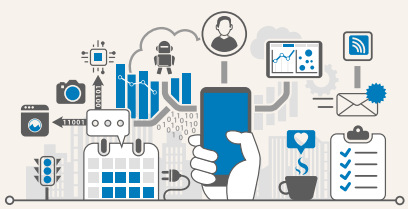
These are all the service applications intended for the managers, operators or occupants of the building.

"COMMUNICATION INFRASTRUCTURE" LAYER

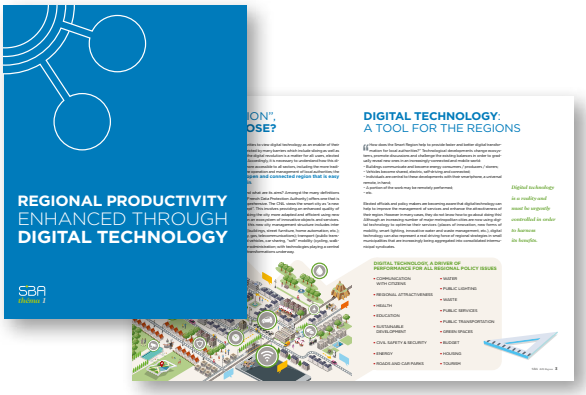


This is the infrastructure dedicated to the network of the building. Based on the Ethernet-IP (Internet Protocol) standard, it brings together all connected systems and field buses of the building.

"FIELD" LAYER



These are all the sensors, actuators and equipment which enable them to be connected to the Ethernet – IP network.



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EN ACT ARCHITECTURE • ENERBEE • ÉNERGIE IP • ENERGISME • E'NERGYS • ENGIE SOLUTIONS • ENLESS WIRELESS • ENLIGHTED • ENOCEAN • ENSI POITIERS • F2A SYSTÈMES • FAUCHÉ • FEDENE • FFIE • FG • FLEXY MOOV • FLOW • FORMAPELEC • FSIF • GA SMART BUILDING • GA2B • G-ACTIV • GADS • GARCIA INGÉNIERIE • GBMP • GCC • GETEO • GIESPER • GIMELEC • GIZMO IMMO • GLI • GOOGLE CLOUD • GPMSE-TN • GREEN SOLUCE • GREENFLEX • GROUPE ALARME SERVICES • GROUPE HBF • GROUPE VIVALYS • HABITAT 76 • HABITATIQUE • HAGER • HAVR • HEINRICH ÉCLAIRAGE • HELINK • HENT CONSULTING • HERVÉ THERMIQUE • HONEYWELL • HSBC • HUB ONE • HXPERIENCE • HYDRAO • HYDRELIS • IBM • ICADE • ICONICS • IDEX • IDTIQUE • IGNES • IMA PROTECT • IMMOBILIÈRE 3F • INGÉROP CONSEIL ET INDUSTRIE • INGETEL BET • INNES • INNOVATION PLASTURGIE COMPOSITES • INSITEO • INSTALLUX • INTENT TECHNOLOGIES • INTERALU • IOT FLOWERS • IOT'ERA • IPORTA • ISTA • J2INNOVATION • JEEDOM • JIP CORPORATION • JOOXTER • JVD • KALIMA DB • KARDHAM DIGITAL • KÉO FLUIDES • 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