Healthcare provider implementation

State-of-the-art hospital relies on GS1 standards for highly efficient and safe ways to work and care for patients

Constructing one of the largest hospitals in northern Europe has required a new approach to support process improvements and traceability. State-of-the-art technology has been a requirement for this transformation that has been more than ten years in the making. But how should a hospital plan for technology that might not have been invented yet? Following are the methods facilitated by Aarhus University Hospital and Central Denmark Region to create a foundation of global GS1 standards for innovation and technology adaption in a modern hospital. With standards in place, including EPCIS, the hospital can now easily locate the people and assets it needs to provide patients with timely and safe care.

By Henrik Stilling

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Merging for modern care

Aarhus is the largest city in one of the five regions in Denmark named the Central Denmark Region, which provides healthcare for 1.2 million citizens. Aarhus University Hospital is the main hospital in the Region, providing services to patients in need of special treatments that require the highest level of expertise like heart transplants and advanced neurosurgery.

Originally, Aarhus University Hospital consisted of five hospitals. The process to merge the five hospitals into one organisation started in 2002 as part of the transformation of the entire Danish healthcare sector.

Looking back, small, local hospitals were quite common in Denmark at the turn of the century. In 2005, national and local governments decided that a structural change was needed to improve quality in healthcare services. The vision: to create fewer, more efficient hospitals with a greater level of expertise in each hospital. Another purpose was to mitigate the increasing cost of healthcare technology (and healthcare in general) due to demographic developments caused by increased life expectancy.

As a result, the governance structure of healthcare changed from small counties to larger regions in 2007. Today, each Region's government is responsible for its healthcare system and the quality of care.

To achieve the full effect of the merger, it was decided to expand Skejby Hospital to accommodate all activities from the original hospitals. Aarhus University Hospital thus became the largest hospital complex in Denmark, covering nearly 500,000 squre metres, with 10,000 employees treating about one million patients each year.

Creating the future, today

The actual building of the hospital broke ground in 2009 with planned completion in no less than eight years. Since Aarhus University Hospital aimed to be a leading hospital in research, education and innovation, this posed a great challenge when it came to implementing the latest in technology. Aarhus University Hospital realised early on that it had to be able to use new concepts, developed years in advance of the actual construction, to be incorporated into the physical structure of the buildings.

"One design requirement says a concept has to be outlined four years prior to implementation," advises Henrik Stilling, IT Architect with Central Demark Region. "However, this does not match the requirement for state-of-the-art technology. For example, when construction began, examples of the latest technology included the Apple iPod, mp3 digital audio players and mobile phones with keyboards. This was two years prior to the release of the first Apple iPad."

Great fluctuations in available devices were to be expected during the construction period. Focusing on current technology or trying to foresee what kind of technology would be available in 8 to 10 years was not a viable solution.

Making the business case

Early in the design phase, Aarhus University Hospital decided to increase the use of information technology and aim for the introduction of automation in new and existing processes. A project was initiated to gain experience from other industries and identify focus areas for investments. Secondly, a baseline was needed in order to turn the anticipated benefits into a valid business case.

> "One key strategy for the new hospital was the just-in-time delivery of goods. The goal was to decrease the amount of inventory in stock and to minimise storage requirements throughout the hospital. Other key concepts were to attain a high level of accountability and traceability to ensure high quality, efficiency and patient safety."
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> **Henrik Stilling,** Information Technology Architect, Central Denmark Region

While a hospital can be a very specialised business, much of a hospital's operations are similar to any business in any industry. Building and running a large hospital requires a focus on supply chain efficiency and a just-in-time delivery model. Analysis of the just-in-time delivery concept showed a general mistrust among staff that goods would truly be available on time—an issue that the science of logistics management addresses. Creating transparency in the supply chain allowing access to information on goods in transit and showing the whereabouts of goods reassures staff that supplies will be ready on time. This mitigates the mistrust.

Furthermore, the transportation industry has started to prove that global supply lines could be just as cost effective as local supply methods. Efficient delivery of goods had also shown to coexist well with traceability.

Research into potential focus areas produced different results. Some of the significant outcomes included:

- Every person in patient wards, surgery and outpatient clinics were, on average, using at least 12 minutes a day searching for items or personnel.
- The time needed to order new hospital beds and clean beds in patient wards put a heavy load on both nurses and service personnel.
- Several transports were made without goods due to a tight split between responsibilities and organisation of service personnel.
- Much of the medical technical equipment appeared to have a very low utilisation rate.

The baseline indicated that time spent "searching" as well as "registering where items were used" took an unnecessarily high toll on staff when compared to similar use cases from the logistics industry or in production scenarios with the same requirements for traceability as a hospital.

To turn the findings into future systems, obvious gaps had to be bridged, to include:

- A shared digital model describing the locations in the hospital was needed; at minimum, identities for locations would be shared.
- Events in the supply chain had to be shared between systems that were not necessarily compatible.
- A common dataset identifying items and actors needed to be introduced.

Information is available both on mobile devices and on overview touch screens.

Laying the foundation

The solution introduced a method to integrate systems that would automatically register the location and identity of a mobile object at a known time—in other words, the "what", "where" and "when."

The foundation for the method included a number of elements:

- The hospital layout was a given.
- The supply strategy would need to be designed along with the infrastructure.
- Objects like medicines, sterile goods, single-use items and reusable items would change rapidly. New objects should be easily introduced in numerous systems.
- Overview of staff and supplies would need to be made available as well as information on inventory.
- Autonomous vehicles and robots would be able to play a vital part in the daily production of the hospital.
- Major changes in the business model were expected, but only gradually introduced in its business processes.

Forty-four use cases with potential efficiency gains were identified and analysed such as automated locating and standardised object identification. Use cases helped to create a reference architecture for locating and identifying objects. [1]

GS1 standards were found to be the best fit for many of the requirements of the reference architecture: GS1 identification keys like the Global Location Number (GLN) to identify locations and the Global Trade Item Number® (GTIN®), Global Individual Asset Identifier (GIAI) and Global Returnable Asset Identifier (GRAI) to identify objects were used along with EPCIS for sharing data about the physical movement and status of objects and products as they travel throughout the hospital and supply chain.

The relationship between objects and their locations could have been handled within dedicated business applications. However, this approach was not economically acceptable. Building a new system to register the location of an object based on each specific business need would be costly. The hospital struggled with different location models in different applications. It was also not technically possible to introduce numerous wireless tracking technologies side-by-side without creating electronic interference that could jeopardise the functionality of medical technical devices and, therefore, patient safety.

Hospital Services was selected to test the feasibility of all these concepts. The applications included patient transportation, trolley delivery, bed management, service task management (in general), a search application and methods to support patients in finding their way around the hospital. At this time, all applications were being put into full production.

A location database containing all relevant locations was also needed: Locations with a broad number of functions like bed locations, patient rooms, nurse call locations, patient reception areas and the placement of hardware needed to create real-time location data.

Streamlining processes and care

Today, each location in the hospital is identified by a GLN. A minimum level of usage is the exchange of GLN information between systems, yet a high level of metadata and location context information is available for systems. On top of the location database, a wayfinding system adds

1 *Read more about the development of the Danish Reference Architecture in the case study, "Reference Architecture enables locating objects for Danish hospitals," page 74.*

routes, making it possible to be guided to a location based on its identifier. Wayfinding guides are made available to patients before their arrival at the hospital to ensure a positive experience.

EPCIS in combination with the Core Business Vocabulary (CBV) has enabled the creation of an event-based infrastructure. An EPCIS integration system has been implemented where event data is made available to multiple actors, at the same time. Business applications subscribe to events through EPCIS query interfaces and handle the supplied information to cover the needs of the individual processes supported by the applications.

Multiple locating technologies are also being used. These technologies supply tracking information through an EPCIS-capture interface in the integration system. Wi-Fi is used for devices like smartphones and computers while EPC-enabled RFID is applied for more accurate, low-cost tracking applications.

A hospital-wide EPC/RFID infrastructure with more than 1,800 gates has been placed in doorways of both existing and new buildings. This investment has reduced the cost of adding traceability to an object since EPC/RFID tags can be very cost-effective and durable. More than 20 different types of tags are in use with plans to tag more than 250,000 objects over the next two years.

Currently, the focus is locating sterile goods trolleys, trolleys in general, medical technical devices, beds and staff with more than 20,000 tagged objects in use. Locating staff is accomplished using strict terms of privacy with only a person's current position made available. The EPCIS-capture interface allows for new technologies like Bluetooth® beacons or ultrasound exciters to be added seamlessly.

All captured data is filtered and delivered to business intelligence applications in order to monitor a single application and be aggregated into overall production data for more in-depth reports.

Mobility is made possible by publishing standardised services. Multiple applications interact with the same set of data in multiple locations simultaneously.

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Significant gains in productivity and efficiency

Aarhus University Hospital has realised multiple benefits from its GS1 standards-based solutions and systems, to include:

- ✓ Quality assurance: By aggregating items with relevant data of applied maintenance and service, staff members can ensure equipment is "fit" for use and can easily manage maintenance schedules.
- ✓ Search time reduction: As much as 50 percent of the time used to search for personnel and items can be cut; on average five to six minutes per employee per day.
- ✓ Usage and capacity management: The potential for sharing equipment between units can be identified. Due to better utilisation, the number of beds is expected to be cut by at least 200.
- ✓ Transit time: The time used moving from point of origin to destination is automatically calculated with optimal transport routes and risk of congestion identified.
- ✓ Nearest employee handles task: Unproductive time is reduced when the nearest qualified employee handles a task. Time saved often exceeds 10 minutes per task.

Looking ahead

Aarhus University Hospital's decision to select GS1 standards prior to technology has enhanced the agility of the solution. "Multiple vendors have been able to provide or subscribe to data from the EPCIS platform with little or no help from Systematic, the supplier of the platform," advises Stilling.

The hospital's next priority is to expand beyond the domain of logistics by establishing the location database with GLNs as an interconnected master data system, providing location information to all lines of business within the Central Denmark Region.

An additional priority is the use of GS1 standards to support the information lifecycle for goods consumed in all hospitals in Central Denmark Region, creating a standardised information flow throughout the entire supply chain.

Finally, standardised data made available to systems on all levels has shown to support innovation and coherence. A practical next step is to make location data and relevant business events available outside Aarhus University Hospital—initially to actors within the healthcare domain and secondly for public use.

"GS1 standards is the basis for new use of existing information, and data will therefore be published through the Global Data Synchronisation Network™ (GDSN®) to ensure general availability," concludes Stilling.

Staff using the overview of people and items in OR recovery.

About the Author

Henrik Stilling *is the Information Technology (IT) Architect with Central Denmark Region. He is the Lead Architect for item identification and tracking. An engineer by trade, Henrik specialises in IT design focused on process management and technology adaption. He has worked in the healthcare industry since 2008. Henrik is assigned to the Service Logistics Programme at Aarhus University Hospital and is part of the Danish national initiative on identification and traceability in healthcare.*

About Aarhus University Hospital

Aarhus University Hospital *is a fusion of Aarhus Municipal Hospital, Aarhus County Hospital, Skejby Hospital, Marselisborg Hospital and Risskov Psychiatric Hospital. It is built as an extension af Skejby Hospital to a size of approximately 500,000 square metres and includes the new Danish Centre for Particle Therapy. The hospital consists of 10,000 employees, 1,000 students, has 100,000 admissions per year, 850,000 outpatients per year and up to 35,000 daily transportations.*

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