Northstream™

Smart Buildings: the heart of a Smart City

White Paper
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Executive summary

What is new with Smart Cities and Smart Buildings?

While for most of history, making a city "smart" has meant investing in sustainability and energy efficiency, approaches have been focusing more on ICT-enabled Smart City solutions in more recent years. Several relevant technologies such as IoT, Cloud and various kinds of connectivity have reached a maturity that **for the first time can enable many new Smart City services**. Such new smart solutions come within multiple different application areas such as Smart Buildings, Smart Energy as well as Smart Health and Well-Being, thereby providing opportunities for the stakeholders involved. Smart Buildings specifically are an attractive application area, even though most buildings in the world are not "smart" yet. They offer significant benefits to property owners and tenants alike. Moreover, we believe that **Smart Buildings form a vital component** within the overall Smart City ecosystem, connecting to and supporting many other application areas.

In order to better understand modern Smart Building solutions, we introduce a **five-layered framework** that expands the way traditional Building Automation Systems (BAS) were built and operationalized onto the new, ICT-centric environment. We argue that having **common, horizontal platforms** that enable the sharing of data across the various solutions is a major requirement to ensure that added value is created by Smart Buildings.

Why are Smart Buildings beneficial?

Currently, the advantages that Smart Buildings bring to building owners consist of **cost savings, efficiency improvements** and **overall increased sustainability levels** of their properties. Yet, we also acknowledge that, in the near future, various Smart Building solutions will also have the opportunity to become sources for **additional revenues** for real estate actors. For tenants, on the other hand, Smart Buildings help to increase the **convenience of living or working** in a building, and furthermore **improve the overall quality of living** in a city.

What does the Smart Building ecosystem look like in Sweden today and what do we anticipate for the future?

In Sweden, **classic BAS may still be the norm** for those buildings that have reached some level of "smartness", however, the level of **awareness and concrete initiatives** regarding Smart Buildings have **noticeably increased** in more recent times. Several large real estate companies have initiated their own development projects for horizontal platforms and are **actively looking for partnerships** to launch Smart Building solutions. Conversely, smaller property owners lack similar activities and have taken on a more laggard-type of position. In the future, we believe that the **Smart Building ecosystem in Sweden will develop quickly**, with the amount of solution providers increasing and system integrators becoming more important. We also expect aspects like increased personalization, the sharing economy, data trading and the readiness of buildings to accommodate Smart Health and Well-Being solutions to be among the major future demands within the ecosystem.

What should real estate owners bear in mind going forward?

Ultimately, in order for property owners to reap the benefits of Smart Buildings for their business, they need to **partner up with the right companies that can assist them** with implementing the different layers of the Smart Building framework. Among the enterprises able to support real estate owners in this area are **ICT actors** like connectivity providers and system integrators whose technical and business expertise can provide great value in making buildings smart.

1. Smart City and Smart Building

1.1 Introduction to the Smart City

Smart Cities have been the subject of governmental and municipal agendas, private initiatives, as well as a variety of large-scale discussions across different industries for many years. So far, however, the definition of "Smart City" itself has remained fuzzy, while the actual solutions have mostly been limited to off-the-shelf offerings developed by technology companies for individual use cases.

Currently, we can observe that the uptake of societal and macroeconomic concerns as well as the gradual maturing of technologies has motivated a more systematic, comprehensive and ICT-driven approach. In particular, public actors such as municipalities have taken on a more active role, trying to enable and unify solutions and services.

Previously, Smart City plans and actions around the world have primarily been focused on sustainability. Public and private initiatives have emphasized issues like energy efficiency and smart urban planning. In Sweden, this has entailed activities such as:

- National and city investments in renewable energies (e.g., the government's objective to reduce greenhouse emissions by 40% compared to 1990, Gothenburg participating in three EU-steered energy projects)
- Smart urban planning (e.g., Stockholm constructing several sustainable living districts and redesigning central city areas and squares)

While these sustainability-directed measures do not necessarily depend on ICT in order to work, ICT-based approaches to Smart Cities have gained traction in
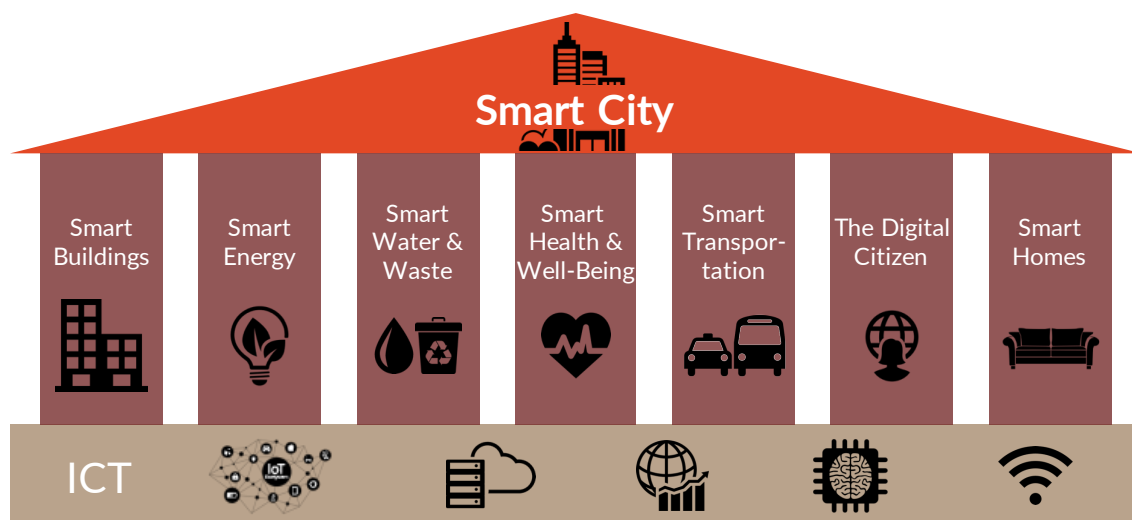

Figure 1: Overview of Smart City application areas enabled by ICT

recent years, driven by a variety of pressing external developments such as:

- The continuous **growth of the urban population** around the world
- The **increasing competition between cities** to attract private investments and talent
- The need to solve increasing and problematic **traffic congestions**
- A societal drive for **more equal access to resources**
- The general ambition to **enhance the quality of life** of urban inhabitants

Moreover, in parallel to the build-up of these macro trends, ICT has been maturing toward a level at which it can make many new Smart City solutions possible. Among the most crucial technological enablers are:

- Internet of Things (IoT)
- Cloud technologies
- Big Data and Analytics
- Artificial Intelligence (AI)
- Connectivity technologies

As a consequence of both societal and ICT developments, as depicted in figure 1, a set of application areas have become the major themes within Smart City agendas and implementations. Each Smart City application area covers a variety of different solutions and services that add value for the end user. Given these drivers and application areas, we can create this contemporary definition of a Smart City:

A Smart City uses innovation and technology to contribute to sustainability, an efficient use of resources, and a higher quality of life for its citizens.

1.2 Addressable market size for Smart Cities

According to a recent market research report[1], the global Smart City market size amounts to roughly USD 425 billion in 2017 and is projected to almost triple by the year 2022, reaching USD 1.2 trillion. Moreover, the IoT market in the Nordics, as the major ICT enabler of Smart Cities, is estimated[2] to have made up nearly EUR 7 bn in 2016. It is forecasted to grow to more than EUR 17 bn in 2021 (see figure 3). Besides the consumer domain, strong growth segments will be vehicles, infrastructure and buildings.

The illustrated market sizing and growth projections therefore validate that Smart Cities and their concrete application areas (e.g., Smart Buildings) are not just a hot topic, but that there are concrete and substantial business opportunities to be seized in this context by, e.g., property owners and smart solution providers.

1.3 Introduction to Smart Buildings

Currently, the majority of buildings in the world do not have the necessary equipment in place to be considered

"smart". What we from here on forward call Smart Buildings are buildings that encompass a set of solutions that address the needs of property owners, facility managers, and building tenants (both residential and commercial) that are not related to consumer oriented use cases (i.e., Smart Home). Rather, they are more generally related to the physical facilities and amenities of the premises. Smart Building solutions build on more traditional Building Automation Systems (BAS) that have been around for decades in order to enable the automatic control of various building facilities. On top of what "old school" BAS have been capable of doing, modern Smart Building solutions additionally leverage the newly emerging capabilities of ICT. Some of the most common smart solutions provide services within HVAC[3], electricity, lighting, safety and security, facility management and communication (e.g., house bulletin boards). In the near future, continuous innovation is expected to bring about new solutions that go beyond those mentioned here.
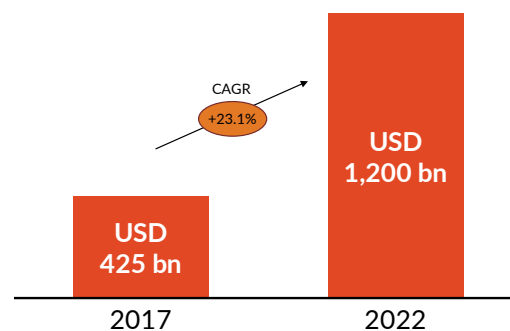
Figure 2: Estimated global market size for Smart Cities in 2017 and 2022 and corresponding CAGR

The three general types of actors within a building – **property owners**, **building tenants** and **solution providers** – have so far each sought to bring about Smart Buildings within their own silos. This has led to a heavily verticalized and fragmented environment. The eventual vision for the future is for each Smart Building to form its own ecosystem, with different actors providing different building blocks to jointly enable the various solutions. Therein, it will be the role of the property owner to cater to the physical building infrastructure and to make sure that the necessary basic ICT-capable equipment (e.g., sensors, meters, cameras) is in place so as to facilitate the subsequent deployment of smart solutions to the extent possible.

The effort required to make buildings "smart-ready" varies between new buildings and older constructions, as well as between residential homes, offices, industrial facilities and retail spaces. Yet in all these cases, the total investment required by the property owner is relatively small as the actual development, deployment and

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[1] MarketsandMarkets, "Smart Cities Market by Focus Areas," 2017
[2] Machina Research

[3] Heating, Ventilation and Air Conditioning

integration of solutions should be handled by the other actors, such as platform developers.
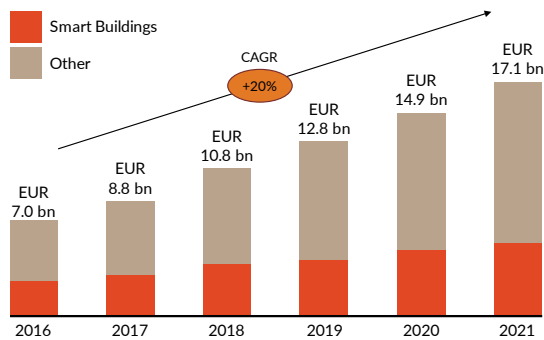

Figure 3: Estimated IoT market size in the Nordics 2016-2021

So, what are the benefits of Smart Buildings? Up until recently, the primary benefit for property owners has been cost reduction, mostly within energy. Lately, new and profitable services that Smart Buildings enable are starting to gain industry attention as well. Leading property enterprises are realizing that user demands are changing and that future tenants will expect services to come with the four walls that they buy or rent. Several large property owners in Sweden are even working on their own open Smart Building platforms.

1.4 Smart Building in the context of Smart City

Finally, considering Smart Buildings as an isolated application area within the Smart City is incorrect. There are many ways in which the Smart Building is inter-connected with other Smart City application areas. For instance, buildings are considered as a vital part of smart power grids, responsible for consuming considerable amounts of energy as well as, sometimes, producing energy (e.g., with the installation of solar panels). Therefore, the Smart Building platform could integrate smart power grid services for the buildings' tenants, in order to maximize the benefits of both solutions. Other examples are integration of Smart Transportation (e.g., car sharing between building tenants) and Smart Logistics (e.g., deliveries to buildings) with Smart Buildings. One concrete example is Helsingborg city; a Swedish municipality whose Smart City strategy ties together Smart Buildings with Smart Energy, Smart Water & Waste and Smart Health and Well-Being solutions, e.g., as part of their H+ project. Hence, it is not hard to accept that

"If you want to build a Smart City, you need to start with Smart Buildings. If the buildings cannot talk to each other, you cannot get a Smart City."

- Sören Sandell,
Head of IT at Vasakronan

2. Smart Building framework

2.1 Traditional vs. modern Smart Building systems

Among the various solutions that are offered within Smart Buildings, there is the traditional set of solutions that have been around for almost 30 years, namely BAS solutions, and a set of *new* smart solutions which depend on and benefit more from recent technology advancements. Both categories can now better utilize ICT for a more efficient use of sensors, connectivity, data collection, data analysis and even the actual implementation of services.
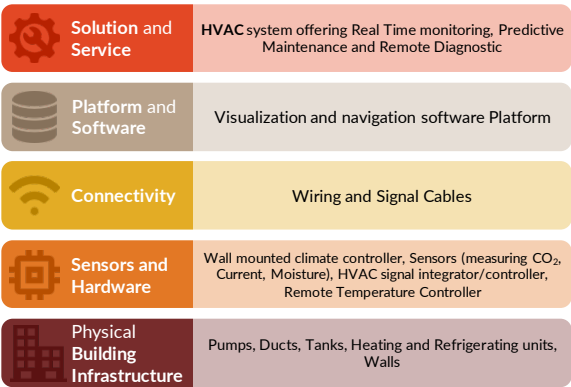
Solution and **Service**	**HVAC** system offering Real Time monitoring, Predictive Maintenance and Remote Diagnostic
Platform and **Software**	Visualization and navigation software Platform
Connectivity	Wiring and Signal Cables
Sensors and Hardware	Wall mounted climate controller, Sensors (measuring CO_2, Current, Moisture), HVAC signal integrator/controller, Remote Temperature Controller
Physical Building Infrastructure	Pumps, Ducts, Tanks, Heating and Refrigerating units, Walls

Figure 4: Components of a modern HVAC system

Most traditional BAS services are vertically designed and implemented, which means that each service focuses on solving one particular problem, usually delivered by one company, and has no communication or integration with other services in the building. One example of a BAS solution is HVAC systems. While utilizing the building infrastructure (e.g., walls, tanks, pumps), modern HVAC systems are made intelligent by utilizing real-time monitoring, predictive maintenance and remote diagnostics, etc. However, these are still vertically designed and implemented systems that only address climate control in buildings.

Different components of the HVAC system are illustrated in figure 4.

No matter if all services are implemented and designed in a coordinated fashion or separate in their own silos – every solution requires the same building blocks. Furthermore, the components of many solutions (e.g. HVAC, surveillance, etc.) could also be part of a comprehensive Smart Building solution. Considering all the sensors and components that are deployed for various vertical solutions in any building, it is clear that all smart solutions benefit from the five major building blocks.

2.2 Smart Building framework

In order to fully benefit from hardware, software and gathered data, most of the Smart Building solutions can share resources with each other. This way it becomes simpler to implement multiple solutions within the buildings by avoiding installing similar equipment for different systems. At the same time, sharing resources allows various solution providers to get access to the building and also enables creation of cumulative added value for the end user. In figure 5, we introduce the main layers of the Smart Building framework that are common among almost all solutions.

Physical Building Infrastructure. Any building requires a certain amount of internal infrastructure to function, which includes elements like HVAC appliances, power and telecommunications, water (e.g., pipes and pumps), waste collection systems, etc. The better the existing infrastructure, the easier it becomes to set up a Smart Building.

Sensors and Hardware layer. In order to make the infrastructure smart, information needs to be collected from the infrastructure through sensors. Some parts of

the infrastructure will need to be instructed on how to react to certain events, which can be achieved by using actuators (i.e., machine components that can actively execute changes to physical items, e.g., open and close doors). The data collection and reactive commands are enabled by the **sensors and hardware layer**. This layer is comprised of sensors and other devices that allow infrastructure and machines to sense the environment, collect data, react to events and be operated remotely. Some examples are:

- IoT sensors (e.g., temperature, humidity, flow, etc.)
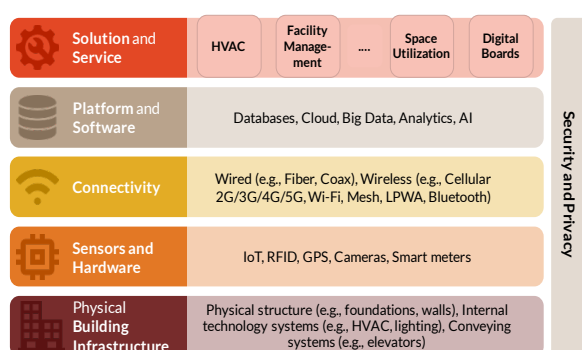- Cameras
- Smart meters
- Actuators

Figure 5: The Smart Building Framework

Connectivity layer. However, just equipping the building infrastructure with sensors and hardware, without connecting them to any intelligent systems, is not enough to make a building smart. Therefore, the next step is to connect hardware and sensors to the central analysis/monitoring systems. The **connectivity** layer can consist of different connectivity technologies, that are mainly categorized into two groups:

- **Wired.** Examples include fiber, coax, Ethernet and signal cables.
- **Wireless.** Examples include cellular (2G/3G/4G/5G), Wi-Fi, Bluetooth, as well as more recent IoT connectivity technologies such as LoRa, Sigfox, NB-IoT, LTE-M, etc.

Depending on the use cases and solutions implemented, one or more connectivity technologies may co-exist in the same building. This is because different use cases have different requirements in terms of reliability, reach and power consumption, and as a result no one technology is best suited to cater to all applications. As Smart Buildings may rely on several complimentary, co-existing technologies to meet all the requirements, it is important to make sure that different devices implemented in the building can still communicate to each other while being controlled remotely.

Platform and Software layer. The platform layer brings all the different data streams together. It also implements analytics (and Artificial intelligence) in order to get insights and make use of different types of data, leading to smart decisions. The extensive requirements for data storage and computation in this layer has recently made public clouds (or a hybrid of public and private clouds) popular with solution providers. Examples of what is generally included in this layer are:

- Databases
- Cloud technologies
- Data analytics (big data analytics)
- Artificial intelligence

Solution and Service layer. Once all the layers in the Smart Building framework are harmoniously brought together, the smart solutions and services (e.g., HVAC, facility management, space utilization, etc.) can be delivered.
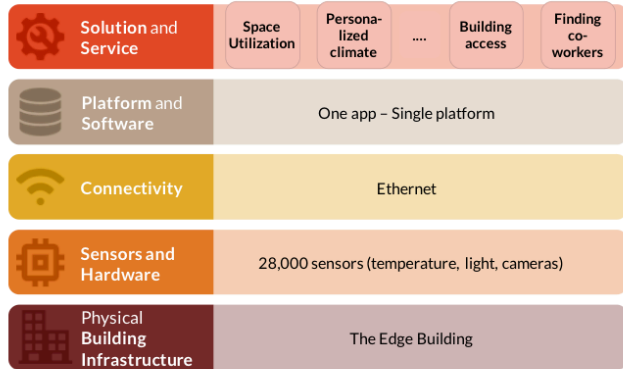
Security and privacy are an integral part of each of these layers. This is mainly to secure and protect the data of the tenants and buildings. In a building in which everything is connected and data is stored centrally, cybersecurity concerns become even more pressing. It is therefore crucial to include security and privacy components throughout the system – not as a separate layer, but as a vital part of each one.

Intel is an example of an ICT company that through its *Intel® IoT Gateway Technology* offers multi-technology connectivity gateways for use cases such as Smart Buildings.
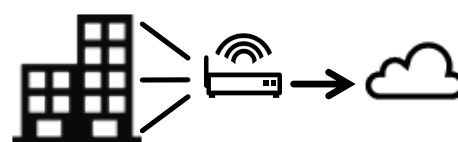
Case study #1: The Edge

The Edge, Deloitte's Dutch headquarters, is sometimes known as the smartest building* in the world. The Edge has integrated multiple different Smart Building solutions that cover both asset- and tenant-oriented solutions. The building contains 28,000 Ethernet-connected sensors that can be controlled from a single software platform, given a smartphone application as the user interface. Services offered in this building include:

Solution and **Service**	Space Utilization	Persona-lized climate	....	Building access	Finding co-workers	
Platform and **Software**	One app – Single platform					Security and Privacy
Connectivity	Ethernet					
Sensors and Hardware	28,000 sensors (temperature, light, cameras)					
Physical Building Infrastructure	The Edge Building					

- **Smart parking.** When workers arrive in their cars, cameras automatically recognize their license plates, grant them access to the garage and guide them to an available parking spot.

- **Personalization.** As they enter the building, the smartphone app gives them suggestions for different workspaces, based on their schedule. They can choose a meeting room, a quiet area or a room with a screen, and it will automatically optimize lights and temperature based on their preferences. Thanks to this innovative way of utilizing workspaces, the 2,500 workers only need 1,000 desks.

- **Space utilization.** On days when fewer people are in the building, the system reroutes people and can shut down complete floors, thus reducing the need for heating, ventilation and cleaning in those areas.

- **Finding co-workers.** Through the smartphone app, co-workers can find each other, see how to get to different rooms and book them.

- **Sustainability.** The Edge is also environmentally smart, with solar panels on the roof that produce more energy than the building consumes and power car chargers in the garage.

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* According to Bloomberg

3. Swedish Smart Building ecosystem

3.1 Traditional Smart Building solutions

While the "Smart Building" is a relatively new concept, solutions for automating the management of buildings have been around for decades. A common example would be BAS[4] which enable control of HVAC, lights, access control (e.g., tags and codes for opening doors), elevators, CCTV (surveillance cameras), etc. Typically, the motivation for implementing these solutions has been to reduce service costs.

The biggest differences between the traditional Smart Building solutions and modern ones are the extended use of sensors for data collection and the integration of different vertical solutions. At the same time, modern Smart Building solutions offer innovative services that benefit from data collected from the buildings. For example, the HVAC system normally has been separate from the access control system with very little data collected and shared between the two. With Smart Building solutions, the two systems communicate so that the HVAC can adjust the building's temperature based on the number of people that enter and exit a building, or even a room.

Traditionally, only large buildings have had the scale to justify investments in advanced and integrated smart systems. But with the advancement of solutions and with technology becoming cheaper and more mature, integrated Smart Building solutions can become a reality for almost all buildings, regardless of their size and usage.

3.2 Ongoing and future drivers for Smart Buildings

While the growth of Smart Cities is mainly driven by megatrends such as urbanization and problems like pollution and traffic congestion, during recent years efforts to increase the quality of life of citizens have also become a big part of cities' agenda. This is particularly critical for cities in order to remain attractive for private investments and the talented workforce. These drivers impact many Smart City applications, including Smart Buildings, but there are also other drivers that directly impact the development of Smart Buildings.

As an instance, for **property owners and facility managers**, the main drivers for adopting and implementing new solutions are to decrease costs, increase efficiency of the building, and simultaneously increase revenues from the building. The first two drivers can easily be satisfied by implementing Smart Building solutions. For instance, by implementing *real-time* monitoring of a building's facilities (e.g., sensors on all HVAC appliances and humidity, temperature and CO_2 sensors in all rooms) the facility manager can immediately dispatch a service team to fix any problem that might arise, and also avoid costly scheduled check-ups. At the same time, adjustments to the HVAC system can also be done remotely through real-time interaction with actuators installed on HVAC appliances, for example changing the building's climate based on tenant demands.

As it is now easier and more cost-effective to deploy these services in buildings, both large and small, the day-to-day improvements they provide increase the living standards of the building's tenants. This, in turn, increases the overall attractiveness of the building to tenants. Another important aspect is environmental considerations, where companies with sustainability goals are able to use smart solutions to reduce the environmental impact of their buildings.

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[4] Also referred to as BMS (Building Management Systems)

As with all connected "things", the data produced by Smart Building solutions enables better decision making and proactive planning of future needs and demands. With the gathered data one can answer questions such as: What are the main drivers for optimizing resource consumption? How to fully utilize rooms, areas and facilities within buildings? How to predict required maintenance for installed appliances? And many more. The more data is gathered, the better decision-making becomes. Once data gathering and processing have been optimized, property owners and facility managers can move from a reactive way of servicing their buildings to a more proactive and predictive way.

For **building tenants**, the main drivers depend largely on whether the buildings are residential, commercial or industrial. Residential tenants generally want to experience an increased quality of life through greater convenience (e.g., be informed about building malfunctions, availability and booking of common building amenities, etc.). They would also like to enjoy new services such as real-time interaction with building managers for damage reports, ordering home deliveries while not present in the building, control/access to environmental measures of the building, etc. On top of similar demands, the tenants of commercial buildings are concerned with increasing productivity. This can be achieved by implementing smart lighting solutions, analyzing space utilization, dynamic pre-planning of work space, etc. For both groups, there is a need to collect everything in one place – people are reluctant to use multiple smartphone apps to control different aspects of a Smart Building, and instead require one unified system.

3.3 Smart Building solutions are mainly twofold; Asset and tenant centric

Asset-oriented solutions tend to offer better management of the facility as a whole while lowering the costs of operation and maintenance. We categorize these solutions into the following five groups:

- **HVAC** (heating, ventilation, and air conditioning), i.e., measuring and optimizing temperature and indoor climate.
- **Electricity** includes smart meters for reading electricity consumption and learning user consumption behavior.
- **Lighting** is one of the largest areas for Smart Building solutions. Solutions mainly include automatic turn-on-turn-off for lowering consumption, but also offer adaptive lighting based on tenants' preferences and needs as well as daylight availability.
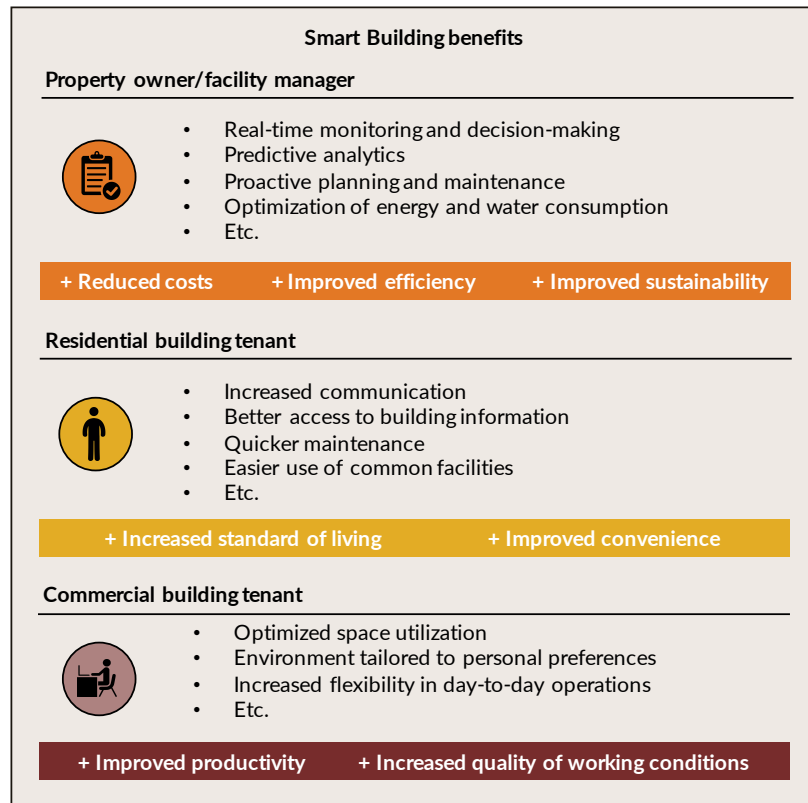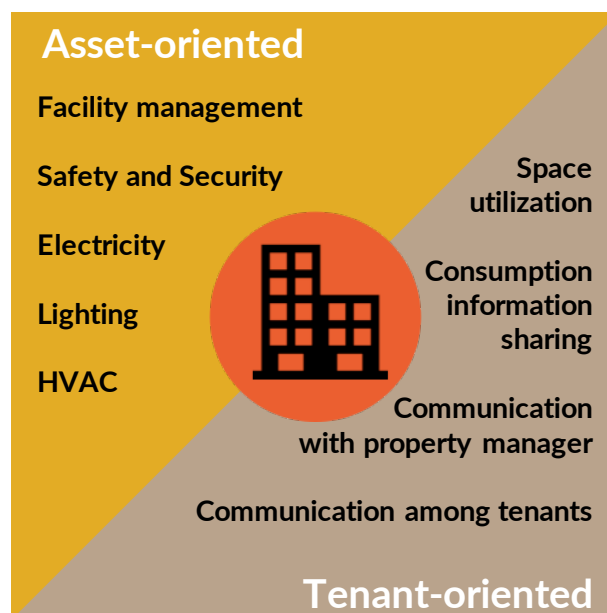

Figure 6: Benefits of Smart Buildings

Figure 7: Asset-oriented vs. Tenant-oriented Smart Building solutions

- **Safety and security** is about protecting the residents and building from both human threats (e.g., theft) and non-human threats (e.g., fire, natural disasters, etc.) through advanced security systems such as face recognition and warning systems. Building monitoring and access control are the traditional use cases in this category, and can be implemented more efficiently,
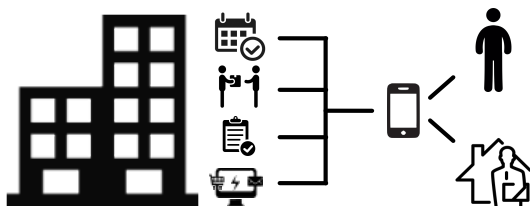
dynamically and in real-time with Smart Building solutions.

- **Facility management** includes everything related to operation and maintenance of the building, e.g., knowing when installed appliances need to be replaced or repaired. Other use cases include serving common areas (e.g., local gardens, rooms, etc.) when needed.

Tenant-oriented solutions, mainly, offer a direct increase in life quality for the tenants and increase the building's attractiveness for new tenants.

- Increased communication among tenants enables new services such as general forums for exchanging information, local marketplaces, organization of social events and sharing resources (e.g., tools, equipment, cars).
- Communication channels between residents and property owners/managers include enhanced interaction in the form of online error reporting (e.g., building malfunction) by tenants. These solutions can also incorporate informing tenants (and building guests) about building specifications, locations and common services, which can be done through multiple platforms (e.g., digital boards for common access and smartphones for individuals). Digital availability of building documentation (e.g., building user manuals) is also an increasingly popular demand that can be met by these solutions.
- **Consumption statistics** of electricity and water can make people more aware of their own usage, and by implementing gamification (e.g., competing with other tenants) one can decrease costs and lower environmental impacts.
- **Space utilization**, e.g., booking and controlling availability of common amenities and common areas, as well as dynamic planning of spaces.

While some solutions might bring more benefits to the tenants or the property owner/manager, most of the above solutions, in practice, benefit both groups. For instance, where solutions that increase communication among tenants as well as between tenants and facility managers have been implemented, building issues have been identified faster. These services ultimately result in lowered maintenance costs for the property owner and increased satisfaction levels among tenants.

3.4 Smart Building status quo in Sweden

As in many countries, most buildings in Sweden cannot be considered "smart". Within those that have some level of "smartness", traditional BAS solutions are still the norm. Other common services include smart locks, electricity measurements and communication channels for neighbors and facility managers. These solutions are mainly offered as proprietary systems; however, a few initiatives are aiming to develop and implement common platform layers for integrating vertical solutions. They are not yet widely implemented and accepted, but pilots and proofs of concept are being developed by various companies.

While most buildings in Sweden are far from smart yet, the level of awareness regarding demands and readiness of buildings among real estate ecosystem players has increased in recent years. The rise in demand from property developers, property owners, facility managers and real estate investors with regards to digitalization and Smart Building solutions has created a strong push for adopting "Proptech" (property technology). Overall, large real estate companies, who have more incentive and resources to implement smart solutions, are far ahead of the smaller ones. The activities they are already engaging in include piloting installation of sensors during the construction phase, building IoT labs, deploying pilots for Smart Buildings, and much more.

TMPL Solutions is a Swedish startup that offers mainly tenant-oriented Smart Building solutions. TMPL has created an smartphone app for tenants and the property managers in residential buildings, which allows them to communicate (among tenants and with the the property manager). This communication enables other services, such as arranging events with neighbors, having a digital marketplace, booking and sharing resources (e.g. laundry rooms, common areas, tools) and online issue reporting.
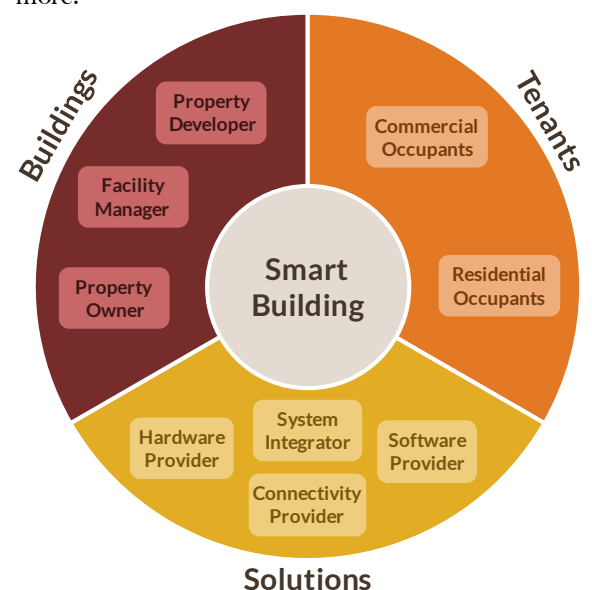

Figure 8: Smart Building Ecosystem in Sweden

At the same time, the more advanced real estate companies in Sweden are focusing on developing their own software and platform layers that can integrate different solutions (including legacy systems) into one system. These companies have mostly selected to develop open systems that work with different technologies and services. It can also be observed that in Sweden larger real estate companies have a clearer vision for developing Smart Buildings compared to the rest of the industry. Their agenda is to make their new and existing buildings smarter, mainly driven by lowering operating costs. Simultaneously, smaller property owners, while being aware of the benefits, lack active initiatives for developing Smart Buildings. However, among the smaller property owners, some have adopted the "wait-and-see" strategy for reasons such as lacking financial resources to develop their own platforms, awaiting more maturity of offered solutions, or lack of scale for benefiting from cutting costs.

The major downside of different approaches is that they have created a fragmented Smart Building ecosystem in Sweden. At the same time, most of ongoing initiatives are still in the development and proof of concept stage, which can later on be adopted for implementation in a three to five years' timeframe. Meanwhile, the need for making existing buildings smart still remains. One example of addressing this need is the Swedish company Raybased which provides a facility management platform that can integrate existing legacy systems, aiming to make old buildings smart.

Having generally accepted that innovations are mainly introduced by startups, such companies frequently lack sufficient access to end users as well as resources to address customers' needs and problems. Having said that, some advanced real estate companies have considered collaborating with startups in order to bridge the aforementioned gap.

3.5 The future of Smart Buildings in Sweden: Formation of the ecosystem

While a level of fragmentation can be observed in this ecosystem, there is a common consensus that the development of Smart Buildings in Sweden will advance quickly in the coming years. This observation is mainly based on the fast rise of awareness in the market with regards to the benefits of Proptech and demand from tenants, as well as the maturity of services and technologies. As a result, different types of Smart Building companies (e.g., investors, solution providers, technical enablers, etc.) will appear in the next few years, taking on different roles within the ecosystem. One example is companies that will take on responsibility for integrating multiple layers of the solution (illustrated in Figure 5) on behalf of smaller companies. The winning approach will then be to choose appropriate partnerships in the ecosystem, in order to fully benefit

from collaboration opportunities. But the question is how fast things will move?
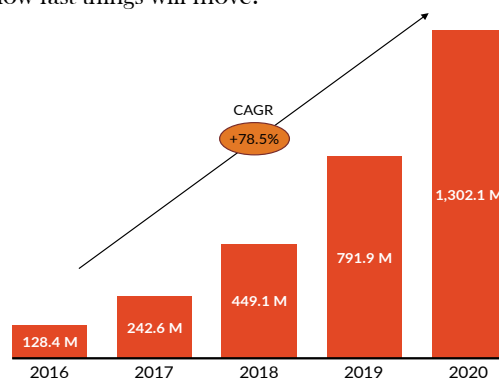
Figure 9: Estimated growth in global IoT sensor deployments in commercial real estate[5]

Rate of adoption. When it comes to adoption of Smart Building solutions, there will likely be different rates for different services, in different market segments. This is mainly because there are many different services that are covered by the term "Smart Building". However, based on the demand, asset-oriented solutions will probably grow faster compared to tenant-oriented solutions, due to more tangible savings in costs of operating buildings for property owners. Figure 9 illustrates the estimated global growth in IoT sensor deployments in commercial real estate, supporting the increasing rate of adoption globally.

Data and Analytics. One of the largest benefits of integrating Smart Building solutions is the common data that is collected, analyzed, and acted upon. Using data leads to better decision making, and with more experience of using data, one can move from simple descriptive analytics, to predictive and prescriptive. This allows property owners to shift from a reactive to a proactive way of working. One example is predicting when a building's physical infrastructure requires maintenance before equipment shutdown or malfunction. However, to get the most out of data analytics, different vertical silos need to open up and share their data freely.
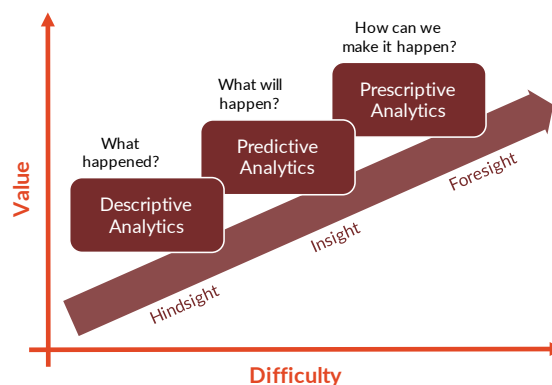
Figure 10: Data analytics levels[6]

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[5] Adapted from Deloitte, 2016

[6] Adapted from Gartner, 2012

Future solutions and services. The need to adopt horizontal approaches within buildings is increasingly becoming understood and accepted, and we are starting to witness a shift away from proprietary solutions towards integration of these solutions into coordinated systems over shared platforms. The integration of multiple services will not only make the coexisting systems more convenient and easier to use, but it will also enable the development of new services.

Future demands. The new services that will be developed will need to address the demands that tenants and property owners will have regarding Smart Buildings in the future. Therefore, such demands may include aspects such as:

- Real-time **personalization**, e.g., instantaneous integration of employees' temperature and lighting preferences with energy optimization systems in office buildings.
- **Sharing economy**, i.e., an increased supply of as-a-service products and facilities, e.g., common rooms in residential buildings.
- **Data trading**. With the massive amounts of data that will be collected in Smart Buildings in the future, real estate owners may want to monetize that data in an anonymized form by selling it to third parties. Conversely, the may also want to purchase outside data to further insights that they get from within their properties.
- **"Smart Health-ready"** buildings, i.e., the pre-installation of sensors, locks and other smart devices. Having good pre-installed in-building connectivity solutions in place may therefore also become a major future demand within Smart Buildings.

According to Storsthlm (non-profit organization formed by the 26 municipalities of greater Stockholm to drive co-operation between the municipalities in in fields like health care):

> *"An important thing in e-health in Sweden right now is to make sure that the health devices themselves are connected."*

3.6 Challenges facing Swedish Smart Buildings

The main actors of the Smart Building ecosystem in Sweden who are directly responsible for development and implementation of Smart Building solutions are property owners (including facility managers) and solution providers (including system enablers). Given the steep rise of awareness regarding the adoption of smart solutions for buildings, the main question for property owners is how to quantify the benefits of smart solutions in lowering operational costs. This means that without proper quantification, it is difficult for them to
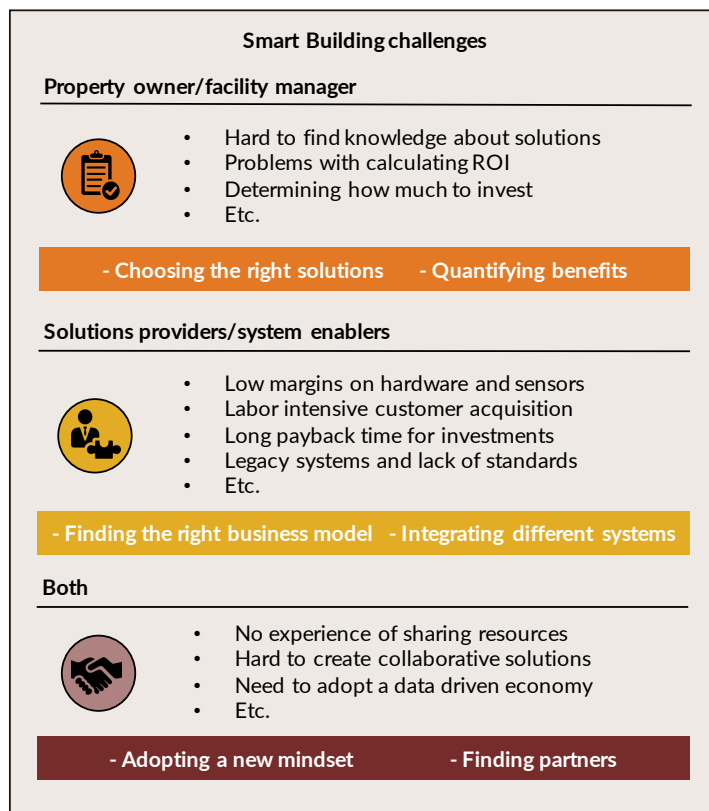
Figure 11: Challenges facing Smart Building implementations

know which specific solutions to adopt, how to implement systems, who to partner up with, how much investment is required, and finally what the return on investment will be. Apart from cost savings, property owners seem likely to consider Smart Building solutions as a potential source for additional revenue as well, although the former questions need to be answered first.

When it comes to solution providers and enablers, finding the right business model is still the largest obstacle. Also, given the low margins on hardware and sensors, the financial value for them resides in offering services with least dependency on deploying hardware, sensors, connectivity, platforms and software. However, services require reaching out to customers (i.e., property owners and facility managers), which is labor intensive for relatively small solution providers. The early adoption stage of Proptech, for smart solution providers, also means that the payback time for investments, both financially and in terms of resources, is relatively long. This creates a major barrier for startups and other small companies looking for quick returns.
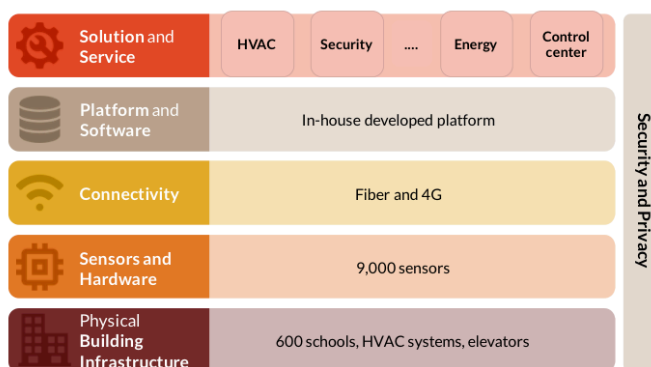
Another challenge is the complexity in developing comprehensive systems that can integrate multiple existing solution within the buildings. According to Janne Heinonen (CEO, Enermix Oy), the expertise to learn how to integrate the protocols and technologies of

different legacy systems takes years to develop[7]. This is mainly due to the existence of legacy systems in current buildings, a lack of standards in communication protocols of different existing systems, proprietary and closed solutions, as well as data ownership. Today, it takes considerable time and effort to integrate all the different systems, which makes it hard to benefit from real-time monitoring and decision-making.

While there are complexities in integrating different systems and finding the right business model, the biggest challenge is by far the mindset of the actors involved. In order to resolve this issue, a new way of thinking and working is required. This implies sharing resources, implementing collaborative systems and solutions, and adopting a data driven economy. Therefore, the first step in the right direction is to bring up and prioritize the Smart Building theme in the agenda of both property owners and other main actors of the real estate ecosystem.

Case study #2: SISAB

Skolfastigheter i Stockholm AB (SISAB) is the owner of the majority of schools in Stockholm, Sweden. The approximate 600 schools of SISAB account for 1.8 million square meters that brings a total maintenance cost of 1 billion SEK per year. In order to have a better control on heating and energy costs, as well as minimizing fire risks and damage to buildings, SISAB has started implementing Smart Building solutions. With the aid of the in-house developed facility management system, SISAB has managed to save 40 million SEK (4% of operating costs) per year. As a consequence, the energy consumption per square meter in SISAB's properties has been reduced by 26%.

Solution and Service	HVAC	Security	....	Energy	Control center
Platform and Software	In-house developed platform				
Connectivity	Fiber and 4G				
Sensors and Hardware	9,000 sensors				
Physical Building Infrastructure	600 schools, HVAC systems, elevators				

Security and Privacy

SISAB's system consists of more than 9,000 sensors that are connected through fiber and 4G to a central control room, from which all buildings can be remotely monitored and controlled, using real-time data. In the control room, visualization is used to see how the different buildings perform, which enables quick identification of buildings that perform below target. Information about the HVAC systems, elevators and security systems can be accessed in a convenient and centralized way. Energy and heating is optimized using weather forecasts and information from sensors in the buildings. There are also infrared sensors outdoors that can detect people, in order to prevent damage to buildings.

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[7] Enermix Oy is a Finnish company that offers software solutions for intelligent real estate management utilizing digitalization.

4. The way forward

4.1 Importance of finding the right partnership

Considering the progress and rise of Proptech and Smart Buildings in Sweden, finding the right partner has become more important and relevant for both property owners and Smart Building solution providers. The existing large companies that offer solutions (e.g., traditional BAS providers) still offer proprietary services, while the more innovative solution providers (often startups) lack access to buildings and struggle with limited resources. Therefore, the gap between demand, implemented solutions, and the services needs to be filled by the right partners that are willing to collaborate in order to co-create value.
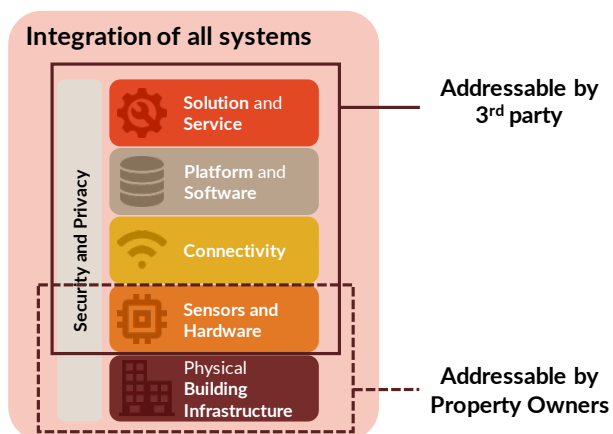

Figure 12: Smart Building layers and positioning of different actors

As discussed earlier, the enabling technologies (such as ICT) have already matured enough to start implementing modern smart solutions, i.e., solutions that can cover both asset-oriented and tenant-oriented demands simultaneously. The main concern that remains is how to integrate existing and new systems, while coordinating the innovative solutions of the startup and over-the-top solution provider community. Hence, the missing part of this puzzle tends to be the competence and knowledge necessary to integrate multiple layers of the Smart Building framework, as well as access to the various ecosystem actors.

On the plus side, there is an increased awareness and proactivity in the Swedish real estate community about new and attractive services for building tenants becoming one of the main gains from Smart Buildings in the future. A survey at a recent industry event[8] in Gothenburg showed a consensus between Swedish building owners – both residential and commercial – that attracting new tenants will be about more than just the square meters in future. As a result, these property owners are seeking suitable partners to develop, deploy and integrate smart services.

Smart Buildings represent a huge financial opportunity, both in the Nordic region and globally. As illustrated in figure 3, the Nordic Smart Building market is estimated to grow from EUR 2.5 bn in 2016 to EUR 5.4 bn in 2021, an increase of almost 108% in five years. Therefore, expertise in implementing digitalization in different industries and established client relationships with property owners are two main competences that position ICT enablers/providers to play an important role in making buildings "smart".

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[8] Fastighetsmarknadsdagen, November 2017, Gothenburg. Participating property owners included Stena Fastigheter, Akademiska Hus, Castellum, Platzer, amongst others.

4.2 How ICT actors can support Smart Buildings

As discussed earlier, ICT is one of the focal enablers of Smart Building solutions. The main role of ICT includes providing the connectivity and the platform and software layers, as well as facilitating integration of different layers of the Smart Building framework. As a result, this means that ICT is responsible for enabling intelligence and digitalization of buildings and the smart solutions therein. However, the ICT actors require a proper understanding of the real estate business to understand how to add value for property owners. In this section, we introduce where and how ICT actors can support Smart Buildings.

Connectivity is, of course, the core business of any connectivity provider. However, both fixed and mobile operators today often focus on connectivity *to* the building, e.g., through deploying fiber-to-the-home (FTTH) or wide-area cellular 4G networks that sometimes end up having poor indoor coverage. While this type of connectivity will remain crucial for providing Smart Building solutions, operators can increase the attractiveness of their existing offerings by adding connectivity *within* the building to their portfolios. Building-wide wireless access networks based on, e.g., LPWAN, Wi-Fi, Bluetooth or wireless mesh networks – or a combination of these – will become one of the major enablers of Smart Building solutions.

As for the **Platform and Software** layer, there is already a number of larger property companies working on developing their own platforms (examples in Sweden include Vasakronan and Stena Fastigheter). Since the main technology behind every platform is the Cloud, especially cloud systems that already incorporate data analytics and AI engines, ICT actors who provide public (or hybrid) clouds are well positioned to host Smart Building platforms. There is also a demand for collaboration within development and delivery, especially on the side of solution providers. Beyond this, ICT actors with the capability to provision and run software platforms that are required for Smart Buildings, can run the platform layer as a neutral player while the client owns the data.

Development and marketing of actual Smart Building **Solutions and Services** entails the creation of concrete service applications with customer interfaces. Although this may seem quite different from the current daily business of most ICT enablers, some actors, e.g., several wired and wireless operators worldwide have already launched customer-facing applications in application areas such as Smart Health and Well-Being and Smart Home. Therefore, venturing into Smart Building services could be considered as a natural progression for connectivity providers.

Finally, an **integrator** is required to actually integrate the various building blocks into a functioning Smart Building ecosystem. The integrator would also become a central partner and advisor for both property owners and solution developers. Creating a general understanding about Smart Buildings and consulting services would thus become a part of the system integrator's business model.

ABOUT THIS PAPER

This white paper was written by Northstream, commissioned by Com Hem, with the aim to provide an objective and independent view on Smart Building developments in Sweden. While Com Hem commissioned the white paper, all opinions expressed in the text are entirely Northstream's and do not necessarily represent the opinions of Com Hem.

APPROACH

This whitepaper was written during the period of November and December 2017. For this, Northstream has conducted interviews with subject matter experts in the real estate and proptech industry, consisting of property owners, property developers, property investors, solution providers, tenant associations, academia, researchers, ICT enablers, decision makers, etc. Additionally, desktop research was used to verify and complement the information gathered through the interviews, which also supported performed analyses. In order to conduct the analyses and gather more complementary input, several internal Northstream and Com Hem workshops have also been held.

ABOUT Com Hem

Com Hem Group offers broadband, TV, play and telephony services to Swedish households and companies. Their network with speeds up to 1 Gbit/s, covers half of the country's households, making the Com Hem Group an important driver of creating a digital Sweden. Com Hem Group is headquartered in Stockholm and operates through four subsidiaries; Com Hem AB, Boxer TV Access AB, Phonera Företag AB and iTUX Communication AB. Since 2014 the Com Hem share is listed on Nasdaq Stockholm.

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- Business strategy development and planning
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