

# Stokab Helps Build a Smarter Stockholm

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December 2015

## Executive Summary

In 1994 the City of Stockholm decided to launch a municipally owned passive fiber infrastructure provider called Stokab to lower its network costs, increase competition for telecom services in the city and minimize disruption to citizens by limiting private operators' needs for civil works to lay infrastructure in the ground.

Stokab was seen as a public infrastructure company by the City Council, much like a public organisation responsible for roads. As a consequence, Stokab was not allowed to sell active services, and was required to sell to any potential purchaser on a non-discriminatory basis. The deployment of Stokab's initial network was financed by loans backed by the City of Stockholm, and it connected mainly public institutions and universities. Soon private businesses started purchasing dark fiber circuits from Stokab and the network expanded briskly.

Around 2002, the deployment that had been mostly targeted at public and business locations was extended into residential buildings thanks to a number of deals between real estate companies and service providers. By the end of 2015, Stokab expects to be open for service for 90% of Stockholm's homes and nearly all of its business locations. 21 years after its initial launch, Stokab is a 90-employee company with a turnover in 2014 of SEK 717 million (est. €73 million), 900 customers and strong growth from the perspectives of both network expansion and revenue.

Financially, Stokab started generating positive cash flows as early as 1998 and that lasted until 2003. In 2003, overextension in network deployment combined with a contraction of demand when the IT bubble burst led to the company's first loss. Through its holding company Stadshus AB, the City of Stockholm wrote off SEK 600-million-worth of assets (est. €50 million). From then on, Stokab generated positive cash flows each year, and the overall operation started generating profit in 2008, after 13 years of operation.

On a broader scale, and although its exact effects cannot be accurately quantified, the consensus in Stockholm is that Stokab has generated significant positive benefits to the local economy that can be summarized as follows:

- **Increased attractiveness:** Stockholm's place in the international rankings of capital cities most friendly to businesses has been steadily increasing over the last decade, and its status as a tech hub and a location with state-of-the-art telecom infrastructure has often been recognized. Many technology companies have established headquarters or R&D centers in Stockholm.
- **Administrative efficiency:** The City of Stockholm has been using fiber connectivity not only to reduce its own costs, but also to launch numerous e-services to increase the efficiency of its public services and lower their costs. More recently, Stockholm launched an open data initiative to enable third-party developers to build new services using its data.

- **Innovation driver:** Stockholm has seen the birth of many tech companies that have gone on to become big players in their respective industries, Skype and Transmode being the most prominent. The mix of great infrastructure, tech talent and funding explains this success on the European scene.
- **Platform for Smart City developments:** Stockholm is now building on the common passive infrastructure layer that Stokab provides to develop its Smart City approaches. With numerous ambitious pilots in place, the City of Stockholm aims at being one of the most connected and eco-conscious cities in the world.

Stokab is seen as a model of municipal fiber deployment inasmuch as it was built with virtually no public subsidies, has led to competition in the delivery of telecom services in Stockholm, has driven adoption of superfast broadband services in the city and has helped the City administration reap significant benefits.

The following aspects are at the core of the model and have been the key to its success:

- stable political consensus on the need and form of the fiber initiative,
- a public infrastructure mindset from the City of Stockholm where the time needed to generate profit was well understood from the outset,
- a gradual deployment that allowed for cash-flow generation early on,
- a limitation on the resale of passive infrastructure to avoid competing with customers for active business, and
- non-discriminatory and transparent pricing policies.

These aspects could be replicated elsewhere, which makes Stokab a potentially interesting blueprint for fiber infrastructure deployment by local governments. Replicating the model today, however, looks more complex on the face of it: the quality of services offered on legacy copper networks today is much better than it was back in the mid-90s, and while copper is getting strained, there's no doubt that copper represents a competing platform that Stokab didn't really have to fend off in its early days. Furthermore, in large cities most of the highly profitable business contracts have already been cherry picked by service providers with bespoke fiber drops.

On the other hand, the market has evolved in positive ways as well. The technological uncertainty that prevailed around fiber access in the 90s no longer exists; deployment technologies are better understood, reliable and cheaper. Furthermore, while large businesses may already be equipped with fiber access, a much larger volume of smaller businesses are now eager for high-quality connectivity. Finally, strategies designed to aggregate demand before deployment are well understood and have a huge positive impact on the business perspective of such a project.

Furthermore, broadband considerations for end users and businesses are no longer the sole driver for infrastructure investment: building a Smart City policy on the basis of a network that is neither owned nor controlled is costly and potentially risky. The virtues of owning, or at least having some indirect control over infrastructure assets is emerging as an important factor giving municipalities a head start in the Smart City race.

We believe that the positives balance, and probably even outweigh, the negatives in making the model reproducible. However, we also believe that the model would be easier to apply today to Tier 2 cities as opposed to capital cities like Stockholm because in Tier 2 cities the demand on the corporate side is still strong and largely unmet.

# Table of Contents

Executive Summary .....	1
I. Introduction .....	4
II. History of the Project .....	5
Inception .....	5
Creation, Expansion .....	5
The Financial Story .....	6
III. Products and Customers .....	8
Service offerings.....	8
Customers .....	9
IV. Economic Impact and Innovation .....	11
Attractiveness and Economic Growth.....	11
Administrative Efficiency.....	12
Innovation .....	13
V. Smart Stockholm?.....	16
Smart City Pilot Projects in Stockholm .....	17
The Smart City Vision .....	18
The Role of Stokab in Enabling a Smarter Stockholm .....	19
VI. Conclusions and Lessons Learned.....	20

# I. Introduction

In 2012 Diffraction Analysis published a white paper entitled Stockholm's Stokab: A Blueprint for Ubiquitous Fiber Connectivity, which explored not only the history of Stockholm's fiber network but its consequences for the city itself. This was still early days, however, when it came to understanding the power of broadband to transform cities.

The question of government involvement in telecom infrastructure has been back to the forefront in the last few years as the realization that the legacy copper infrastructure that was privatized in the 1990s would not fuel growth and innovation much longer. Politically, it's a very charged debate, polarized by two radically different worldviews:

- One is that taxpayers' money shouldn't be used to pay for something that the private market can provide; and therefore government investment isn't wanted or necessary. This is the prevailing view in many US states that have barred local governments from investing.
- Another is that broadband infrastructure is a public good like roads, sewers and other shared utilities, and that taxpayer investment into broadband infrastructure is just as justified as it is in other public services. This approach is exemplified by many municipal networks around the world and is being implemented on a national level in Singapore and Australia.

These are actually two extremes of the spectrum in terms of the different options available to governments that want the infrastructure to be deployed without necessarily investing the taxpayer's money. Our 2012 paper illustrated a middle ground approach as deployed in Stockholm, Sweden, through the activity of the municipality-owned company Stokab.

Stokab has been an example for many municipalities around the world and yet for most of the political decision makers, the story is still about delivering better broadband to citizens and businesses. This much revised version of the earlier analysis is about examining how Stokab is benefiting Stockholm itself, opening up opportunities for the city to tackle its future with foresight and intelligence.

Research for this paper was done through conversations and document analysis in Stockholm, meeting all sorts of stakeholders: not only Stokab but local politicians, Stokab's customers, the municipal administration, real estate companies, the regulator, and more.

## II. History of the Project

### Inception

In 1993 the Swedish Government, following European Union policy at the time, decided to deregulate the telecom sector. Competition to incumbent operator TeliaSonera<sup>1</sup> was encouraged. The City of Stockholm welcomed the change: its own IT and connectivity bills were significant, and it was perceived that competition would lead to lower prices and better services. However, the City was also worried about a possible side effect of deregulation; it envisaged competing telecom operators digging up the streets of Stockholm massively to lay out the fiber networks they would need to offer services to their customers, generating disruption and potential chaos for the citizens of Stockholm.

The Moderaterna<sup>2</sup> party held the Mayorship at the time. Carl Cederschiöld, the Mayor, felt that the solution to avoiding the major disruptions (and associated costs) of a “fiber rush” in Stockholm would be for the city to provide the means for service providers to connect to their business customers. He approached the opposition party, the Socialdemokraterna to discuss it. In order to create a publicly-owned entity such as the one he envisaged, a broad majority was required in the City Council, and he knew that a political consensus was the only solution. His party, a conservative party leaning towards free-market policies, was not philosophically aligned with the idea of creating an additional public entity. (In fact, policy at the time leaned towards divesting the city of publicly-owned businesses as much as possible.)

However, the Moderaterna viewed this particular issue as an infrastructure issue, not as a public service issue. They felt that a municipal fiber infrastructure was comparable to a road system: asking whether it should be public or not was the wrong question. However, they were also concerned that it could grow into more than an infrastructure entity that could compete with private sector service providers. In order to avoid that, the Mayor proposed the creation of a public Stockholm dark fiber network under the following two conditions:

- The entity created would not be allowed to sell active services of any kind. It would be restricted to providing dark fiber circuits within the Stockholm region.
- The entity would be an equal opportunity provider in that a service would always have to be sold at the same price to each and every customer, no matter who they were.

The Socialdemokraterna – which was in any case less reluctant about creating a new publicly-owned entity – agreed to this compromise. The political consensus thus obtained enabled the vote to create Stokab on January 24, 1994. Soon after, the political majority changed and Mats Hulth of the Socialdemokraterna became Mayor. It was under his leadership that Stokab was effectively created.

### Creation, Expansion

One of the first actions of the newly created Stokab was to purchase an existing Stockholm duct network. Rights of way were not an issue within the City of Stockholm proper since the City owns close to 100% of the land and access conditions were already established on equal terms for all entities, public or private, requiring access. Outside of the city things were more complicated, necessitating individual negotiations with each landlord for access and rights of way. On that basis the network was deployed to business locations based on a mix of anticipated demand and customer requests.

The large public entities (the City of Stockholm, the County Council, etc.) were initial drivers for the network deployment, but quite rapidly the private market started taking advantage of the possibilities of an end-to-end dark fiber network. The first customer (KTH, Royal Institute of Technology) to be hooked up to the Stokab network went live in the summer of 1994

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<sup>1</sup> Note that the Swedish incumbent has changed names many times since the early 90s. It was called Telia at the time of Stokab’s inception, later to become TeliaSonera, and is now functionally separated into TeliaSonera (services) and Skanova (infrastructure). For simplicity’s sake, we will use the denomination TeliaSonera throughout the document.

<sup>2</sup> The Moderaterna Party (liberal-conservative) and the Socialdemokraterna Party (socialist) are the two dominant political forces in Sweden. Both parties have alternately – in coalition with small parties – governed the City of Stockholm.

(thus connecting their locations in the city center with their locations in Kista, a satellite town of Stockholm). Because Stokab's network stopped at in-building demarcation points but didn't extend inside the buildings, Stokab didn't track homes or businesses passed<sup>3</sup>, but it is estimated that, by the end of 2015, 400 000 homes (95% of the City of Stockholm) and most businesses in the City will have access to connectivity.

By 1998, Stokab as an organization was cash-flow positive and has remained so every year since with the exception of 2003 (details on the financial structure and performance are presented below). By the year 2000, Stokab was serving businesses mostly in the area of Stockholm known as the inner city but, driven by customer demand, the network footprint gradually expanded into the so-called outer city. During that period, a few pioneering private operators started looking into using Stokab's infrastructure to serve the residential market through deals with real estate companies:

- **Svenska Bredbandsbolaget** contracted with HSB<sup>4</sup>, the largest real estate company in Sweden, to fiber up all of their properties, including a significant footprint in Stockholm;
- **ViaEuropa** signed a deal with a Greenfield real estate developer, Hammarby Sjöstad, in Stockholm operating under an open access model (i.e. the tenant gets to pick his service provider).

In 2002, municipal housing company Svenska Bostäder, a public company that owns and manages around 30 000 homes in the Stockholm area, wanted to find a long-term solution to get rid of the copper cabling in its buildings. This requirement was driven by environmental concerns, increased interference from wireless signals and the recognition that the copper was inherently limited in its capacity. Svenska Bostäder deployed in-building fiber connectivity and paid for fiber to be pulled back to Stokab's nodes<sup>5</sup>. They followed the open access model pioneered by ViaEuropa and extracted a small increase in rent from the tenants (around SEK 45) and a similar amount from the service provider serving the tenant. They view this as a long-term investment aligned with real estate business concerns.

In the wake of these and other similar deals, private operators – especially Bredbandsbolaget – accelerated agreements with real estate companies to fiber up buildings in Stockholm, although not necessarily with open access provisions (Bredbandsbolaget, for example, signs five-year exclusives with real estate companies.) This trend propelled Stokab into the residential market. In 2007, they announced a broad residential deployment that would ultimately open 400 000 homes for service in Stockholm, i.e. most of the multi-tenant habitat. In 2013 Stokab started providing fiber for single households to ISPs (in units where the building owners have deployed in-building fiber connectivity).

At the end of 2014, Stokab had about 90 employees, although including sub-contractors close to 1000 people work on the project. Stokab has always made a clear distinction between the positions that were needed to operate the company in the long term (which are internal) and those that are required to deploy and expand the network (which are sub-contracted). More recently, Stokab decided to outsource network operations and maintenance as well. The turnover for 2014 was SEK 717 million (est. €73 million). The company has over 900 customers, including over 100 operators and service providers (i.e. companies that are reselling services built on the dark fiber they lease from Stokab). Altogether the network as currently deployed incorporates about 1250 000 km of fiber and 5 500 km of cable. There are 600 nodes where customers can host equipment to manage their networks.

## The Financial Story

Stokab's financial structure is interesting and is not always well understood. The company is owned directly by the City of Stockholm via a holding company, Stadshus AB, and was not originally financed with taxpayers' money beyond the SEK 50 000 (€4500) needed to incorporate the company. Stokab's initial purchase of a pre-existing municipal duct network and the operation's initial deployment were financed exclusively by loans backed by the City.

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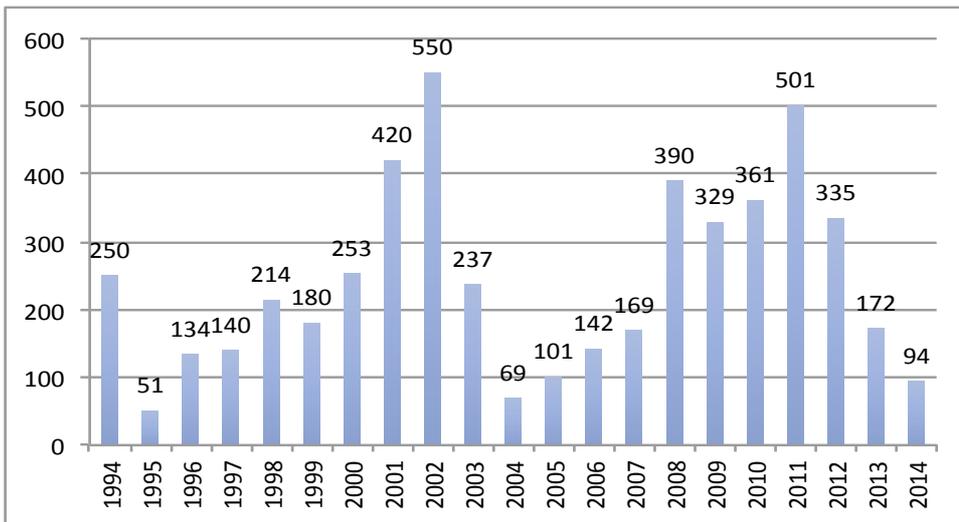
<sup>3</sup> In Sweden in-building networking must by law be owned by the landlord(s). Therefore network or service operators either connect to an existing in-building network or are paid to deploy such a network by the landlord (who will thereafter own it.)

<sup>4</sup> <http://www.fastighetsvarlden.se/notiser/bredbandsbolaget-och-hsb-gor-storsatsning/>

<sup>5</sup> <http://www.svenskabostader.se/sv/Om-oss/Pressrum/Aktuellt/SB-Bredband-nu-hemma-hos-alla/>

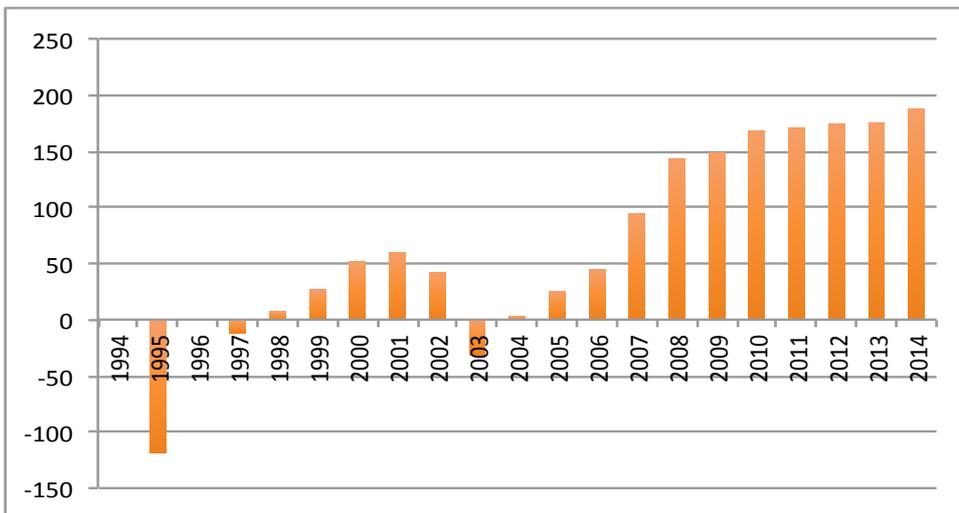
This set-up allowed Stokab to deploy its initial network and commercialize the dark fiber, and by 1998 Stokab was cash flow positive. The financial situation was stable and positive until 2003. In the wake of an over-extension into the archipelago islands, the combination of a heavy investment to deploy the network and lackluster demand in the new market inverted the financial situation and Stokab ended up SEK 32 million (€2.7 million) in the red. The ensuing loss and the generally morose business perspective led the municipality of Stockholm – through its holding structure Stadshus AB<sup>6</sup> – to write off SEK 600 million (€50 million) of assets. In 2004 Stokab was in the black again. **Exhibit 1** and **Exhibit 2** detail the levels of investment and profits of Stokab since inception.

**Exhibit 1: Stokab investment (1994–2014) (millions of SEK)**



Source: Stokab

**Exhibit 2: Stokab profit (1994–2014) (millions of SEK)**



Source: Stokab

<sup>6</sup> Stadshus AB is a holding company for around 30 business-oriented public service companies (infrastructure companies, housing companies, etc.) that is 100% owned by the City of Stockholm. As is legal in Sweden, it can mutualize profits and losses from these companies, which is what happened in 2003 with the Stokab write-off. Stockholm did not directly subsidize Stokab as part of this write-off.

## III. Products and Customers

### Service offerings

By mandate, Stokab's product portfolio is limited since it is not allowed to sell active network products and services. It can serve any customer wanting to buy point-to-point dark fiber connections, but said customer then has to light the fiber and manage the service themselves. That's an inherent limitation of Stokab's reach in the market. Their service portfolio therefore consists of one product: point-to-point dark fiber circuits.

There are two components to circuit pricing:

- Set-up fees used to be dependent on whether each end of the circuit was in the inner city or the outer city and whether the location was already on the physical network or not. Nowadays, Stokab charges identical set-up fees for inner and outer city points of connection. Multiple fibers and redundant circuits incur discounted set-up fees when purchased at the same time as the original circuit.
- Recurring fees are either based on the straight distance between the two nodes the access lines are connected to or are fixed. The recurring fees also depend on the level of service level agreement (SLA) desired by the customer (three levels are offered).

The only circumstances that automatically require a quotation for set-up fees from Stokab is when one or both end points of the circuit are outside the outer city and aren't already on the network.

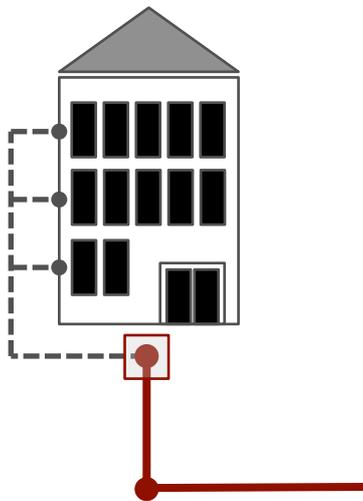
It should be noted that although Stokab will systematically apply the same price to the same purchased circuit once it has been built (although the initial purchaser will pay a higher set-up fee than subsequent buyers on the same route), that still leaves pricing flexibility for innovative uses of the fiber. Two examples of this:

- When media company SVT approached Stokab about the availability of fiber strands for very short periods of time (they use it for live broadcasts inside Stockholm as detailed below), there was no such pre-existing contract. This allowed Stokab and SVT to negotiate a fair price agreeable to both of them, which will now apply to other companies requesting the same type of access to circuits. In order to accommodate this type of 'short term' demand, Stokab has now set-up a switching robot that patches fiber between likely locations in less than two minutes. It allows SVT and other customers to rent dark fiber point to point (in pre-arranged locations) for periods as short as half a day.
- When Telenor and Tele2 decided to launch their joint venture Net4Mobility (which is effectively a Long Term Evolution (LTE) mobile aggregation network co-investment venture) they approached Stokab for a broad scale deployment in many areas of outer Stockholm in which Stokab had not yet deployed its network. By agreeing to longer term contracts than Stokab had ever signed before, Net4Mobility managed to get really good prices, and the revenue certainty allowed Stokab to finance part of its network expansion.

Stokab applies the exact same price for the same products; discounts are mechanical, and are not dependant on the customer's identity. However, when exploring new product areas, Stokab is free to determine its prices as long as they are applied equally across the board.

Since 2013, Stokab has been offering dark fiber circuits from its nodes to multi-tenant buildings to enable end-to-end fiber to the home. **Exhibit 3** shows how this differs from the legacy fiber to the building service described above. Price wise, Stokab offers discounted rates on multiple fiber pairs to the same building.

### Exhibit 3: Architecture of fiber to the home vs fiber to the building services

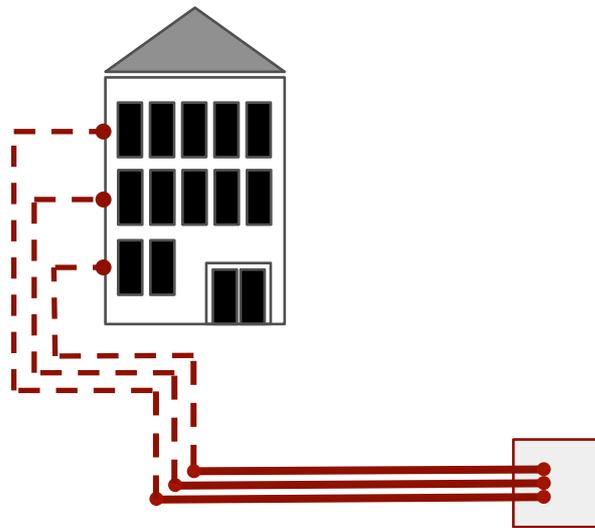


#### Fiber to the Building

Stokab delivers one pair of dark fiber from its node to the building basement.

In-building connectivity is (usually) a CAT-6 LAN owned by the landlord and connected to the ISP's active equipment.

The ISP's active equipment is hosted in the basement.



#### Fiber to the Home

Stokab delivers one pair of dark fiber from its node to the building basement for each apartment in the building.

In-building fiber is owned by the landlord and patched to Stokab's fiber.

The ISP's active equipment is hosted in Stokab's node.

Source: Diffraction Analysis

## Customers

In 2014 Stokab had over 900 customers. These fall into a number of different categories:

- **Public entities:** These were the first customers to connect to the network. The two largest are the City of Stockholm and the County Council (regional administration responsible amongst other things for the networks of schools and hospitals), but others include branches of the national government and various other public administrations. They purchase circuits from Stokab to connect the buildings where they operate and generally light the circuits themselves or turn to integrators to get this done.
- **Large private enterprises:** These are large corporations with high requirements in terms of capacity, security and resilience. The prices offered by Stokab allow them to build self-managed redundant routes between locations. The benefit is better control of their IT systems at a lower cost.

- **Business integrators:** These integrators can serve Stockholm businesses with network services (often MPLS virtual private networks or VPNs) built on top of Stokab's dark fiber or, in the case of customers with national or international locations, a mix of fiber from Stokab and other providers.
- **Real estate companies:** These companies saw the benefit for them in fiberizing up the properties they own and/or manage. They signed partnerships with so-called communications operators (see below) and leased from Stokab the dark fiber circuits they needed for their buildings to be connected to the communications operators or ISPs.
- **Service providers:** Service providers signed deals with business owners to connect whole buildings to their network through Stokab's dark fiber. This is the big driver of the network expansion post-2004 and particularly since 2009. They deliver a mix of broadband, TV and communication services.
- **Communications operators:** Communications operators (also called open exchange service operators) provide connectivity to residential homes, but not services. They operate an open access model, purchasing Stokab's dark fiber to activate a wholesale network that is then rented by service providers to serve the end customers.
- **Mobile broadband operators:** The explosion in mobile data usage has driven Stokab's expansion as well, with mobile operators connecting cell towers with fiber in Stockholm.
- **Media companies:** Near-ubiquitous fiber connectivity (at least in the inner city) has opened up interesting possibilities for media companies to use dark fiber for live editing and broadcast. This is a specific approach for this customer set since the fiber is leased for very short periods of time. An example of this is described later.

Service providers, communications operators and mobile broadband operators represent 60% of Stokab's orders by volume; public entities represent 10%. The remaining customer categories share the last 30%.

When quizzed about their relationship with Stokab, customers express their satisfaction essentially in three areas: trust, transparency and professionalism.

The trust in the relationship is perhaps the most interesting aspect, not because it's unusual per se but because it's largely connected to the specific status of Stokab as a neutral publicly-owned infrastructure provider. Service providers who also work with the incumbent point, for example, at a complete change in policy for dark fiber resale in 2009 that effectively threatened to bar them access to the incumbent's dark fiber and thus jeopardize business operations that had been built over the last decade. Working with Stokab – in its customers' perception – carries no such risk because of the public involvement of Stockholm and the fact that Stokab doesn't compete in the active retail market.

Stokab's pricing transparency is another interesting aspect of the relationship, and a number of customers mention the change in pricing approach in 2006 as a turning point in the relationship. Until 2006, Stokab's prices were difficult to figure out without getting a specific quotation for each circuit required. After 2006 Stokab started distributing to its customers prices based on a much simpler and predictable structure, thus allowing them to anticipate prices and build business models without a systematic need to refer back to Stokab's sales teams. For integrator and operator customers in particular, this transparency is very valuable. Another important related aspect is the knowledge that another company requesting the same circuit will be quoted the same price (only set-up fees are dependent on whether the circuit pre-exists or not, and even that cost can be anticipated in most cases).

Finally, Stokab's professionalism was noted by many customers. Again, customers pointed to an improvement as the company became more experienced. In the early days, provisioning and customer support weren't always optimal, but over the years Stokab has managed to acquire the know-how that now allows it to deal with international businesses in the telecom sector without blushing. Many customers pointed to a fundamental difference in this regard between Stokab and other municipal networks in Sweden, which still have approximate procedures and a lack of experience.

In the course of this study, Diffraction Analysis did not meet with any dissatisfied customers of Stokab's. That does not necessarily imply that they do not exist, of course.

## IV. Economic Impact and Innovation

When assessing the economic impact of such an infrastructure project, one longs for hard figures and econometric comparisons. Unfortunately, such studies are extremely complex to perform and usually considered inconclusive (at best) by those who doubt the impact in the first place. Stokab itself has not commissioned such an analysis.

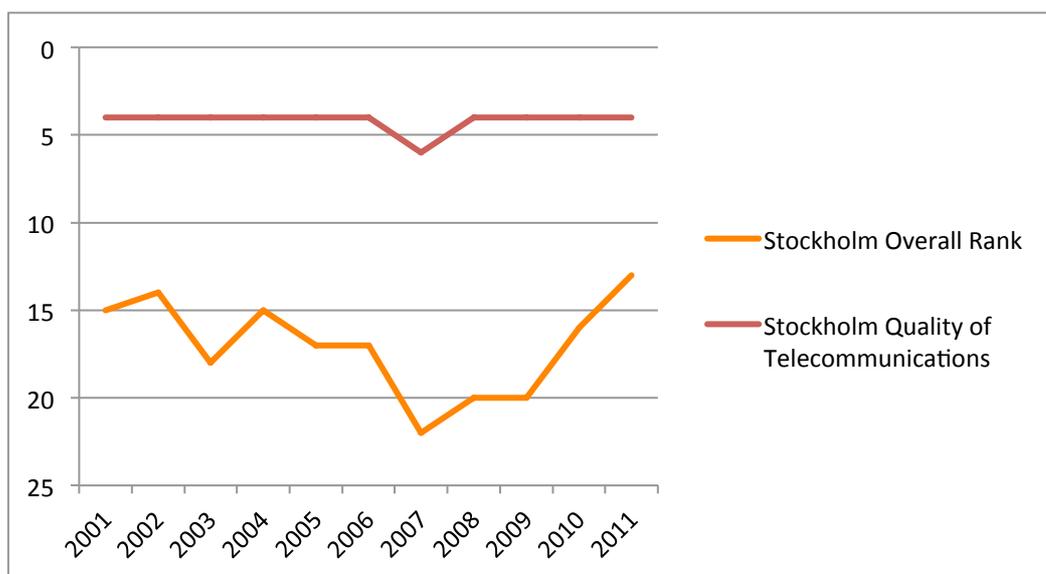
In the course of this study, we met with various organizations who have a stake in Stockholm’s economic development: the municipality and various municipal services, Kista Science City (a science hub just outside of Stockholm), and business development organizations such as Stockholm IT Region and Stockholm Business Region. Synthesizing these discussions and other researched elements allows us to highlight (but not quantify) three broad trends in terms of the impact of the Stokab infrastructure on Stockholm’s economy.

### Attractiveness and Economic Growth

Business attractiveness is obviously a key element for Stockholm, and the quality of telecommunication services is generally considered to be a key factor in business attractiveness for cities. Real estate consultancy Cushman & Wakefield has been tracking the perceived attractiveness of leading European cities since 1990. One of the criteria used to establish the attractiveness of the different cities surveyed is the quality of telecommunications. Every year since 2001 (except 2007), Stockholm has been ranked as the fourth European city in terms of the quality of telecommunications<sup>7</sup>. There’s little doubt that Stokab plays a role in that perception, especially when one considers that the top three cities in that same ranking are always London, Paris and Frankfurt, which also top the overall ranking for business attractiveness. In other words, Stockholm ranks way higher based on that one criterion than many other larger cities.

In 1990, Stockholm was considered the 19th most attractive business city in Europe. In 2011 it was placed 13th. The overall rankings for business attractiveness track many different criteria of which the quality of telecommunications is only one, but it’s quite clear that Stockholm’s high fiber connectivity has contributed to its overall rank increasing over time and enables the city to box above its weight. **Exhibit 4** presents the two indicators over time (data prior to 2001 is not publicly available).

**Exhibit 4: Stockholm’s rankings in the Cushman & Wakefield index**



Source: Cushman & Wakefield: European Cities Monitor 2001—2011

<sup>7</sup> Cushman & Wakefield: European Cities Monitor 2001—2011. No more recent study was published.

In the fourth edition of its international study *Cities of Opportunity* in 2011, global consultancy PwC examined the various services available in 26 large cities around the world. It identified Stockholm as having the best network for schools, the second best broadband quality, and the best digital economy (a factor of availability and usage of IT solutions)<sup>8</sup>. Stockholm ranked number three in Technology Readiness in that edition of the study behind New York and Seoul.

In the more recent sixth edition released in 2014, Stockholm still ranks number three in Technology Readiness (behind London and Seoul). It ranks highest in Digital Economy, taking fourth place in Broadband Quality (with Hong Kong and Seoul ahead as well as, more surprisingly, London) and fourth in networked schools.

Other studies point to the high IT literacy and maturity of the Swedish population and the high contribution of internet businesses to Swedish GDP, but while there probably is a correlation between Stockholm's own endeavors in this area and its performance, there is no Stockholm specific data to support it.

The position of Stockholm in the Technology Sector however is indisputable. In 2011 an analysis of technology sector employment across Europe showed that Stockholm was the first region in the proportion of technology employment, with 197 000 technology jobs, 18% of the overall Stockholm Region workforce<sup>9</sup>. There are currently around 25 000 technology companies in the Stockholm region<sup>10</sup>, which represents half of the total number of Swedish technology companies.

## Administrative Efficiency

In interviews with officials of the City of Stockholm, it becomes apparent that, when the original decision for the Stokab development was taken, there was only a hazy perception of the macro-economic impacts that would accrue. Stokab was originally seen as an infrastructure initiative that would mostly benefit the City of Stockholm by introducing competition in its provisioning of network connectivity.

Twenty years down the line, the consequences of Stokab are perceived as wide ranging and massively beneficial by City officials. The combination of state-of-the-art infrastructure and talent has attracted a slew of IT businesses and made Stockholm a hub for technology innovation. Not only are many of the big tech companies choosing to make Stockholm their home (IBM, Microsoft, Ericsson and many more have their European headquarters or R&D centers in Stockholm, mostly concentrated around Kista) but many successful startups are emerging as well, a virtuous circle that continues to draw more talent to Stockholm.

Beyond the innovation that has become a staple of Stockholm's economy (which will be addressed in the next section), perhaps the most unexpected impact for the city has been the acceleration of its e-services program. Stockholm currently has over 70 different e-services available to citizens through a municipal portal. Many of those are shown in **Exhibit 5**, and is in the middle of a 2013–2018 Program for Digital Renewal. This program aims not only at reinforcing the e-service strategy but at shifting the mentalities within the City administration so that digital becomes second nature.

In addition, the City of Stockholm has launched an open data initiative from which it expects another wave of privately developed services to emerge<sup>11</sup>.

The City stresses a positive impact on its effectiveness and a reduction of its costs as the result of these initiatives. When asked how Stokab has enabled widespread adoption of e-services despite the fact that not all citizens are using fiber to

<sup>8</sup> PwC, *Cities of Opportunity*, 2011: <http://www.pwc.com/us/en/cities-of-opportunity/index.jhtml>

<sup>9</sup> Discussion paper on High-Technology Employment in the European Union, 2013, KU Leuven, Vives: <http://feb.kuleuven.be/VIVES/Onderzoek/discussionpapers/DP/dp2013/final-20131223-3rd.pdf>

<sup>10</sup> Swedish Central Statistical Bureau (SCB): [http://www.scb.se/sv\\_/Vara-tjanster/Foretagsregistret/Aktuell-statistik-ur-Foretagsregistret/](http://www.scb.se/sv_/Vara-tjanster/Foretagsregistret/Aktuell-statistik-ur-Foretagsregistret/)

<sup>11</sup> Open Stockholm, <http://open.stockholm.se/>

connect to the internet<sup>12</sup>, the City points to the very high proportion of citizens that have access to the internet (estimated at around 90%) and the general high quality of internet connectivity, even over xDSL or cable.

Furthermore, the City points to the fact that most of its physical locations are fibered up as a catalyst for a slew of revised processes and approaches to delivering services and enabling internal functions. In other words, Stokab allowed the City of Stockholm to transform its internal IT operations as well as facilitate the lives of its citizens. As an example, the City explains how application maintenance on all of its fiber enabled sites is fully remote, saving considerable time and driving significant efficiency gains with less down time. In the few sites still connected by ADSL, the connectivity isn't good enough to enable remote monitoring and maintenance and still necessitates the physical intervention of a technician.

In the coming months and years, the City of Stockholm is looking at a number of possible developments, such as enhancing services for disabled citizens to minimize their need to physically come to administration centers, enabling video-communication with all citizens on certain key services, and bringing fiber connectivity to elderly care centers to facilitate medical care and social interaction.

**Exhibit 5: Sample of Stockholm's E-Services**

<p><b>PRE-SCHOOL &amp; SCHOOL</b></p> <ul style="list-style-type: none"> <li>• Childcare Application</li> <li>• Childcare Portal</li> <li>• School Application</li> <li>• Nationwide High School Application</li> <li>• Stockholm History Online Tuition</li> <li>• Preschool Web Administration Tools</li> <li>• Parent – Pre-school communication portal</li> <li>• School comparison portal</li> </ul>	<p><b>SUPPORT &amp; CARE</b></p> <ul style="list-style-type: none"> <li>• Care Diary</li> <li>• Elderly Care Request</li> <li>• Support &amp; CareApplication</li> <li>• Web-Based Parental Training</li> <li>• Online Social Counseling</li> <li>• Nursing home &amp; Assisted Living Comparison Tool</li> </ul>	<p><b>ADMIN. &amp; CITY SERVICES</b></p> <ul style="list-style-type: none"> <li>• Townhall Wedding Booking</li> <li>• Comments &amp; Complaints</li> <li>• E-Invoice &amp; Invoice Portal</li> <li>• City Archive Search Engine</li> <li>• Urban Environment Feedback Portal</li> <li>• Grave Site Search Tool</li> <li>• City Service Comparison Tool</li> <li>• Accounting Tool for Home-carers</li> <li>• Search Tool for City Administration Jobs</li> <li>• Universal Payment Platform for E-services</li> </ul>
<p><b>WORK &amp; EDUCATION</b></p> <ul style="list-style-type: none"> <li>• Unemployment Portal</li> <li>• Summer Job Application</li> <li>• Adult Education Application</li> <li>• Adult Education Workplan Tool</li> </ul>	<p><b>TRAFFIC &amp; CITY PLANNING</b></p> <ul style="list-style-type: none"> <li>• Residential Parking Application</li> <li>• Disabled Residential Parking</li> <li>• Bicycle Trip Planner</li> <li>• Navigation Support for Visually Impaired</li> <li>• Waste Disposal Services</li> <li>• Building Planification &amp; Digital Master Plan</li> <li>• Maps and Aerial Photographs</li> </ul>	<p><b>SERVICES FOR BUSINESSES</b></p> <ul style="list-style-type: none"> <li>• Food Handling Registration</li> <li>• Alcohol License Application &amp; Management</li> <li>• Refrigerant Use Reporting</li> <li>• Commercial Parking for Businesses</li> <li>• Administrative Portal for Private Pre-Schools</li> <li>• Permits Wizard</li> </ul>
<p><b>CULTURE &amp; LEASURE</b></p> <ul style="list-style-type: none"> <li>• Summer Camp Application</li> <li>• Swimming Lessons Book &amp; Pay</li> <li>• Arts School Subscription</li> <li>• Grants &amp; Scholarship Application Portal</li> <li>• Stockholm's Digital City Museum</li> <li>• City &amp; Museum Guided Tour Book &amp; Pay</li> </ul>	<p><b>CLIMATE &amp; ENVIRONMENT</b></p> <ul style="list-style-type: none"> <li>• Radon Measurements Search</li> <li>• Geothermal Drilling Application</li> <li>• Food Inspection Results</li> <li>• Environmental Issue Reporting Tool</li> <li>• Noise Level Information</li> <li>• Building Permit Tracking &amp; Monitoring Tool</li> </ul>	<p><b>INTERNAL E-SERVICES</b></p> <ul style="list-style-type: none"> <li>• Intranet &amp; Document Sharing</li> <li>• Support for Large Investment Projects</li> <li>• E-services for Trustees</li> </ul>

Source: City of Stockholm

**Innovation**

An analysis by venture-capital firm Creandum reports that between 2008 and 2013, €2.6 billion has been generated per year from Nordic tech-company exits, with more than half of this coming from Sweden alone<sup>13</sup>. According to Creandum<sup>14</sup>

<sup>12</sup> 100% of citizens have broadband available to their house, 88% have fiber available. 99,99% can get 30 Mbps in Stockholm, and 92% can get 100 Mbps (Source : PTS - <http://statistik.pts.se/bredband/>).

<sup>13</sup> European Startup Capitals, Wired UK, September 2011: <http://www.wired.co.uk/magazine/archive/2011/09/european-startups/stockholm>

Stockholm represents 33% of Europe's billion dollar exits, and 15% of European tech investment. Stockholm has been a hub for tech startups for a number of years and a number of budding businesses based in Stockholm are attracting increasing attention. Not all of these were originally founded in Stockholm, but as they grew they made Stockholm their home.

Sparklabs Global Ventures has ranked Stockholm world second<sup>15</sup> in Global Startup Ecosystems, taking into account the following criteria: Funding Ecosystem & Exits, Engineering Talent, Active Mentoring, Technical Infrastructure, Startup Culture, Legal & Policy Infrastructure, Economic Foundation, and Government Policies & Programs.

More importantly perhaps, Stockholm is the home to five Unicorns, tech companies valued at \$1 billion or more. These are:

- **Skype**, the leading peer-to-peer VoIP company (with five million daily active users in 2014)
- **Klarna**, a company working on e-payment and credit-card substitution solutions
- **Spotify**, the world's leading subscription-based music service with over 40 million users (25% paying subscribers)
- **King**, a freemium mobile game designer with 324 million monthly active users worldwide in 2014
- **Mojang**, makers of the Minecraft game, the third top-selling video game of all time (35 million copies)

Stockholm is also the home of many more successful startup companies like:

- **Transmode**, a metro DWDM company (second largest telecom exporter in Sweden, acquired by Infinera in 2015 for \$350 million)
- **Qeyton**, a privately held metro DWDM company (bought by Cisco in 2000 for \$800 million)
- **Net Insight**, a media transport over IP company
- **Global IP Sound**, a voice codec company (bought by Google in 2010 for \$68 million)
- **Rebtel**, a voice and video-over-IP company competing with Skype (with over 12 million users)
- **Bambuser**, a company that enables video broadcasting from mobile phones
- **Wrapp**, the leading social network gifting company

In the last few years, Stockholm has structured itself for technology emergence, with a network of incubators, investors, tech public relations and human resource structures covering most of the chain of needs. Furthermore, the City has established strong relations with San Francisco, London and Berlin to offer a broader outlook to its own startup ecosystem. The head of incubator Sup 46, Jessica Stark, considers that the relatively small size of the Swedish market is an opportunity for tech startups as they cannot build scale on the Swedish market alone. They are therefore forced to think "worldwide" from inception.

One challenge remaining is the relative lack of investment, and the scope of that investment interest. International investors are now looking into Stockholm but are focused mostly on Internet and media startups, whereas the needs for financing and the future opportunities are more likely in other sectors like biotechnology.

Again, Stokab cannot be considered the sole driver for tech business development, but the presence of a state-of-the-art IT infrastructure that enables competition and therefore affordable high-quality services is, alongside other factors such as available tech talent and emerging venture capital initiatives, why Stockholm has become such a hub for tech innovation.

The infrastructure initiatives driven by the City have had another interesting impact in driving more and diversified infrastructure investment. In response to Stokab's development, incumbent TeliaSonera also invested significantly in its own fiber infrastructure in Stockholm and beyond (although that does not prevent TeliaSonera from being a customer of Stokab's as well), which drove not only competition at the service layer but also at the infrastructure layer. In other leading

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<sup>14</sup> Creandum, A Nordic Perspective, 2011 (Nordic Figures)

<sup>15</sup> <http://venturebeat.com/2015/08/29/the-10-hottest-startup-ecosystems-in-the-world/>

European countries like Germany and the UK, less effective (and cheaper) copper solutions have been chosen by incumbent operators who were not facing municipal fiber competition.

Infrastructure deployment has not been restricted to wireline, however. Stockholm is now the only city in the world with four competing LTE networks<sup>16</sup>. One was deployed by incumbent TeliaSonera and two others by competitive players Telenor and Tele2. These two companies co-financed a joint-venture infrastructure company called Net4Mobility, which deploys and manages the access and aggregation parts of the LTE network for both companies. Net4Mobility clearly states that without Stokab they would not have a business: the density of cell sites for LTE is much greater than it is for 3G, and having access to affordable dark fiber to connect the cell sites has been a crucial aspect of the joint venture's viability.

Finally, although this doesn't have any direct impact on Stockholm itself, the emergence of Stokab inspired others to emulate its municipal fiber deployment model elsewhere in Sweden. There are now over 200 municipal networks in Sweden<sup>17</sup>, most of them following a model similar to Stokab's. Stokab has been seen as a blueprint even beyond Sweden, although implementation in other capital cities hasn't been attempted yet.

The existence of the dark fiber infrastructure has led to a certain number of businesses innovating around that infrastructure. Here are two examples that were highlighted to us during the course of our study:

- The first example is an illustration of how the fiber deployment itself has been used innovatively. In 2010, Stokab decided to install one of their nodes underneath a school so that the heat generated by the telecom equipment hosted there would be used to heat the school. Thus Stokab allowed the City to save money on heating and started a greener approach to urban telecom hosting in Stockholm. Stokab intends to replicate this experience in a more systematic way for public buildings near their nodes, and ultimately expects to have around half of their nodes heating other public facilities, thus driving energy efficiency and lowering operational costs.
- The second example is more emblematic of how fiber connectivity, once it is more or less ubiquitous, can allow businesses to redefine their operations. SVT, the national television company in Sweden, has started to use Stokab's dark fiber to film live events in Stockholm. For a live event (especially sports events, like the Stockholm Marathon or the Stockholm Tennis Open) SVT used to send production trucks into the field. Camera crews would film the event, the filmed content would be edited in real-time in the production trucks and then sent back to a central production studio via satellite for mixing and broadcasting. Starting with the Swedish Royal Wedding in 2010, SVT experimented with a different approach: they lease individual dark fiber strands from Stokab, which they connect directly to film cameras. The uncompressed video feed is sent back to the central production studio for editing and mixing. As a consequence, there is no need for trucks or editing teams in the field and the output quality is better. SVT estimates that the savings generated from this new technology adoption is close to 40% of the overall production costs.

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<sup>16</sup> The fourth (independent) LTE network in Stockholm operates under the brand "3", see <http://www.tre.se/>

<sup>17</sup> Svenska Stadsnätts Föreningen, the Swedish Association of Municipal Networks: <http://www.ssnf.org>.

## V. Smart Stockholm?

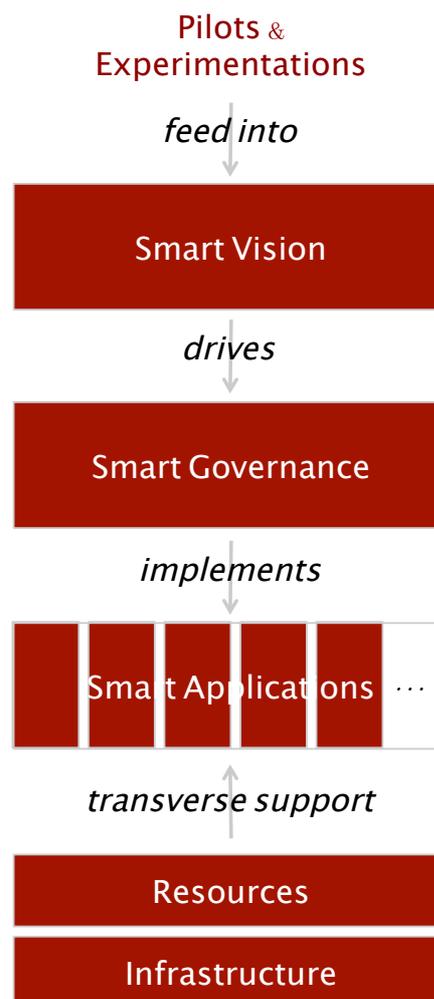
The buzz word amongst mayors all over Europe right now is “Smart City”. It’s one of those terms however that means different things to different people, and that politicians in particular have learned to use in so many contexts, relevant or irrelevant, that it hardly seems to mean anything anymore. In order to assess whether Stokab has made Stockholm smarter we need to tackle the definition.

Let’s start by distinguishing a Smart City application from a Smart City. A Smart City application is a single initiative that uses connectivity to deliver a more efficient and better service to citizens. Nice’s smart parking initiative, or Rio de Janeiro’s disaster prevention system are good examples. But one application, or even a collection of applications do not make a city smart. In fact, it’s probably a safe bet that the cities who have started tackling their issues by developing single initiatives may be the ones lagging in a decade. The reason is simple: by focusing on a single issue and building an application to address that issue, a City devotes IT and infrastructure resources to that issue alone. When the next issue comes along, it does the same, leading to asset and resource duplication, a surefire way of building a future that is financially unsustainable.

A Smart City therefore is a city that identifies its core issues, and builds a framework under which all of these issues can be addressed in time. It learns to prioritize and creates the structures internally to become smarter for the long run. In this game, short term public-relations-driven initiatives (even if they address real issues) get in the way of the long-term goal.

**Exhibit 6** is a schematic view of the framework under which a Smart City should be built:

**Exhibit 6: Path to a Smart City**



Source: Diffraction Analysis

In essence, pilots and experimentation need to be set up to evaluate the difficulties and test the emerging vision in the field. Once a vision is designed, it needs to be implemented by a governing body that oversees the various smart initiatives that parts of the city governments feel are needed to meet the vision. Their role isn't just about supervision, but also to ensure that the resources and assets put in place are reused as much as possible.

In the next few sections, we will examine how Stockholm fares when compared to this framework.

## Smart City Pilot Projects in Stockholm

There are two leading pilot programs spearheading the Smart City initiatives of Stockholm, and each is described below.

### Stockholm Royal Seaport

As part of the Stockholm Royal Seaport (SRS) urban development project, plans are underway to build about 12 000 new homes and 35 000 new office spaces. The development will largely take place in areas previously used for port operations and other industry. Stockholm Royal Seaport is part of the City's vision of a world-class Stockholm by 2030 and has been selected as one of 18 urban development projects that form part of the Clinton Climate Initiative's global Climate Positive Development Program.

The SRS project started in late 2012 and is expected to be fully completed by 2030. This pilot program is founded around seven innovation areas financed by the City and private partners. :

- C/O City is a program to promote "ecosystem services", i.e. to support the increased presence of natural ecosystems within the city. Targeted at the real-estate sector, the program aims at measuring and promoting the level of "greenness" of a given city district.
- Urban Smart Grid is a program aimed at renovating the Royal Seaport district with smart grid objectives in mind. In particular, it is expressed via the Active House pilot in which dwellings have been designed and built to take advantage of smart grid energy systems and efficient energy usage.
- The Smart Waste Collection Project aims to develop existing vacuum waste collection technology with world-class solutions for usability, function and sustainability. It offers features such as individual waste tagging (for feedback and information purposes), food waste recycling into biogas energy, waste heat to energy conversion, etc.
- Smart ICT aims at building or reusing a single infrastructure for all of the City's ICT needs in Royal Seaport (transport, logistics, healthcare and media). The goals here are to reduce the environmental cost of infrastructure duplication, enable new business opportunities targeted at residents and empower citizens.
- Smart Communications is a program aiming at delivering economic prosperity, environmental performance and social equity through a better and more comprehensive use of communications.
- SpaceTime is a smart travel program designed to help people living and working in the area to travel more efficiently and with as minimal an environmental impact as possible. It works through extensive data collection and sharing to recommend routes, facilitate shared rides and other common transportation opportunities.
- Smart City SRS will integrate and analyze data from the various city sectors, including energy, water, waste and transportation, to provide real-time feedback to city planners, industries, organisations, and citizens. It will bridge the gap between data collection and insight by developing an open data integration platform coupled with real-time analytics and feedback processes.

### Årstafältet

Årstafältet is a second, EU-funded, urban renewal project on an area of grassland in the south of Stockholm. Its goals are more focused (if possible) on sustainability than those of the Royal Seaport. It takes place within the overarching ambition

for the whole city of Stockholm to become completely fossil-fuel free by 2040, with the immediate objective of reducing carbon dioxide emissions to the equivalent of three tonnes per person by the end of 2015.

One of three so-called “Lighthouse City” locations in the “GrowSmarter” project under the EU Horizon 2020 program, the Årstafältet project has been formulated around 12 “smart solutions” for sustainable growth:

1. Efficient and smart building shell refurbishment to minimize heat loss and energy consumption.
2. Eco-conscious building logistics in the build phase through efficient transport and a dedicated logistics platform.
3. Smart energy-saving tenants, i.e. tenants who have the tools to use as little energy as possible in their daily lives.
4. Smart local electricity management with a “virtual power plant” concept for small distributed electricity generation.
5. Smart street lighting to reduce energy use, with lamp posts as sites for sensors, Wi-Fi and mobile network equipment.
6. Waste heat recovery to reuse the byproduct of heat-generating systems, such as data centers, for heating.
7. Smart waste collection, with optical sorting of waste, automatic collection, and waste statistics for residents.
8. Big data management feeding all relevant district data into an open data platform.
9. Sustainable delivery to manage up-front the delivery and distribution of goods in the district.
10. Smart traffic management to anticipate travel demand, manage traffic and prioritize certain traffic types.
11. Alternative fuel driven vehicles, integrating charging capability, refueling facilities for heavy duty vehicles and smart guiding to recharging stations.
12. Smart mobility solutions, to implement smart parking and car pooling as well as bicycle use.

#### **Other Pilots**

There are many other smaller scale pilot projects that relate to Smart City initiatives in Stockholm. Two of them deserve a quick mention since they are promising approaches:

- The Kista Science City has launched a project called Urban ICT Arena to test the potential of Internet of Things connectivity in an urban environment. This was announced in June 2015 so is very fresh, but Stokab is actively involved in providing fiber to the street furniture that will be used to host devices and sensors for this initiative.
- The Elderly Care Administration of the City of Stockholm is running a small scale pilot in the fall of 2015 to test elderly home care services to 20 fibered homes in the city. The goal is to fine tune the service proposition to be able to offer similar care services to the whole city.

## **The Smart City Vision**

Put together, these pilot projects will explore a lot of the services and applications that are considered the most interesting to deliver the potential of the Smart City. Most of these however haven't been field tested, certainly not at scale, and that is what makes these pilot projects so valuable. But how do they fit into a broader vision?

In 2010, the City of Stockholm published a document entitled Stockholm, The Walkable City. It's a long-term planning document that integrates a lot of the thinking around the city's sustainability objectives. But it was 2010, and many of the applications that are now being envisaged in Stockholm and elsewhere had not yet been imagined. In 2012 when we published our first white paper on Stokab and its contribution to the Stockholm economy, it was only the very beginning of Smart City thinking and, while the e-service program that the city had put in place was impressive, it was still “only” an e-service program.

Stockholm knows that a new vision document is needed and is working on it. That document isn't yet ready<sup>18</sup>, and so it could be said that there currently is no vision. At the same time, there are ongoing initiatives, and not just as part of the two urban redevelopment projects we have described. The risk in this case of course, as outlined above, is the potential lack of coherence and efficiency in implementation.

Stockholm however has a structure in place that avoids most of the pitfalls of letting initiatives emerge outside of the framework of a vision and appropriate governance, and Stokab plays an important role in that structure as described below.

## The Role of Stokab in Enabling a Smarter Stockholm

In 2014 Ericsson published the fifth edition of its Networked Society City Index, intended to “examine and rank 40 cities from around the world, looking at their performance, challenges and opportunities in terms of ICT, sustainability and development”. In this Index, Stockholm ranks first, thanks to (in Ericsson’s words) “its well-developed ICT infrastructure, extremely well-developed open data and e-services and high-quality access to both fixed and mobile broadband, thanks to extensive infrastructure rollouts”. This Index however, does not evaluate achievements in Smart City initiatives but rather the conditions for their emergence. Neither does it examine in-depth the connection between infrastructure and Smart City development.

One of the ways in which Stokab has contributed to a rational Smart City approach (as described in **Exhibit 6**) despite the absence of a fresh vision document is through Sankt Erik Communications. Early on in the life of Stokab, a sister to the infrastructure company called Sankt Erik Communications was created. The role of this company is to centralize all of the connectivity needs of all of the City’s entities and address them in the best possible way.

By leasing fiber from Stokab and purchasing communication solutions through Sankt Erik Communications, the City of Stockholm controls its internal IT infrastructure. Sankt Erik coordinates the technical platforms for internal communications. It should be stressed that Sankt Erik does not build *applications* for the municipal entities or city subsidiaries. These are still sourced internally (by IT) or externally as needed. But the Sankt Erik platform makes it possible for all entities and subsidiaries of the City of Stockholm to cost-efficiently purchase services from competing providers. The connectivity components of these applications however go through Sankt Erik. By mandating this process for all of the city’s IT requirements, including (but not limited to) Smart initiatives, Stockholm achieves a number of important goals:

- it ensures that Stokab’s existing assets are used whenever possible,
- it guarantees that connectivity solutions aren’t purchased redundantly by different municipal entities,
- it allows Stokab (through St. Erik) to anticipate future capacity needs and deploy additional infrastructure accordingly.

It is apparent therefore that while Stokab itself is not involved in the City’s smart initiatives (except in an advisory role), it enables most of these initiatives through the near ubiquitous connectivity it offers. And since the infrastructure deployed to offer that connectivity is not solely used for these initiatives, its unit costs are low, driving IT operational expenditures for the City that are much lower than what other cities could expect to achieve without similar infrastructure.

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<sup>18</sup> A vote on this new vision document is expected by the end of 2015.



There is potentially another risk, although one that we think remote: that regulation could interfere with the model. The need for price regulation of TeliaSonera (or its infrastructure arm Skanova), a player with significant market power at a national level, has already hindered some of Stokab's initiatives: a regulated price for dark fiber products becomes the de facto market expectation, and eliminates some of Stokab's pricing freedom. It should be noted that while regulator PTS went down this route a few years ago, it has now announced that price regulation of dark fiber would be removed from November 2016. Another issue could be around the obligation for all passive infrastructure owners to open their underlying infrastructure (ducts and poles) to competitors. Such legislation, while not implemented in Sweden, has been discussed at European level. In our view, neither of these risks would fundamentally alter the Stokab model, but they could force some changes upon the company.

There has been strong interest in the Stokab model from within Sweden and abroad, especially since the middle of the last decade. There are now over 170 municipal networks in Sweden, most of them following a model similar to Stokab's. But while it has influenced the thinking in other cities across Europe, there hasn't been any copycat deployment on the same scale. The emulation has happened mostly in Sweden and other Scandinavian countries, and even there the core components of Stokab's model haven't always been replicated.

The key elements of Stokab's success, in our analysis, are:

- A political consensus at municipal level that ensured a long-term view at the project's inception and continued support when things turned rough.
- A public shareholder that views the network as a public infrastructure rather than just a dedicated resource for its own needs, which has allowed Stokab to develop without excessive political constraints.
- A gradual deployment that focused first on revenue-generating business needs to then finance residential roll-out with the cash flow generated from the profitable and amortized business side.
- A guarantee of neutrality and non-competition with customers (by offering only passive services), which has attracted private service providers and other entities like real estate owners and managers onto the network.
- Non-discriminatory and transparent pricing as well as industry-grade processes.

Considering how early Stokab was initiated – long before the explosion in residential internet usage – it's had ample time to develop, even before traditional players in the telecom market thought that what Stokab was doing made any sense. Over the years, several layers of wholesale and retail markets have been erected on the building blocks of Stokab's dark fiber. There is therefore a legitimate question about the replicability of the Stokab model today.

A city willing to replicate the Stokab model today would face a number of specific challenges:

- First, the current level of broadband services over copper, while insufficient for future-proof residential access and current business needs, is nonetheless serving these existing businesses and would constitute competition to any municipal initiative in dark fiber. That does not in itself constitute a reason not to move forward for such a venture, but it does suggest that competition from legacy copper would be stiffer.
- Second, in most capital cities and some smaller cities as well, large businesses have already been fibered up by private operators. While this is far from the ubiquitous access enabled by Stokab, it does mean that the initial cherry picking that allowed Stokab to become cash positive fast would not necessarily be feasible.

On the other hand, the general need for bandwidth (and customer expectations in this regard) is now higher than it has ever been, and seems to be continuing to increase.

However, there are a few aspects in which it would probably be easier for a local government to launch a Stokab-like venture now as opposed to when Stokab did:

- Smaller businesses whose needs are not being addressed by private operators today and would not have been targeted by Stokab's initial run in the 90s now demand the quality of service offered by fiber connectivity and could constitute a denser customer base for an initial deployment.
- Demand aggregation has become easier to implement, either through large-scale agreements with ISPs prior to deployment or through pre-sales strategies to boost initial demand. Various public and private deployments of fiber-to-the-home around the world have successfully used these approaches to maximize initial take up and enhance their business model.
- Technological uncertainty is no longer an issue. In the 90s, there was serious doubt about the technological feasibility of fiber in the access network, both for Stokab and for its customers. All of these issues by and large have been dealt with today so that a lot of the cost associated with the uncertainty has been eliminated. It would be much cheaper to deploy such a network today than it was for Stokab some 15 years ago.

These challenges and opportunities probably cancel each other out, more or less. We also believe that the Stokab model would be easier to replicate today outside of capital cities, in so-called Tier 2 cities where the logistics are easier to manage and the demand is not currently being addressed.

The crucial change between 1995 and today is that private players understand the need and the benefits of fiber infrastructure. As such, they have become key partners in building a successful municipal operation. In Stokab's history these collaborations took longer to materialize, but they were a key element of the company's financial success. Today, Bahnhof, Bredbandsbolaget and many of the smaller retail and business communications operators use Stokab's infrastructure and drive up demand. A project initiated today using Stokab as a blueprint would be well advised to ensure the collaboration of one or several established private service providers, either as early customers or as co-investing partners in the venture.

**This research was sponsored by Stokab,  
although the opinions and views are independent and are not representative of the company's policies.**

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