

The socio-economic impact of FTTH

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WIK-Consult GmbH
Rhöndorfer Str. 68
53604 Bad Honnef

Authors:

Dr René Arnold, Peter Kroon, Serpil Tas, Dr Sebastian Tenbrock

Executive summary

Study objective

- This study investigates the socio-economic benefits of FTTH in Sweden and the Netherlands using a representative consumer survey and case studies.

Survey results

- Consumers have been migrating to FTTH in Sweden since 2007, while the shares of subscriptions that rely on other technologies such as DSL and cable have decreased over the same period.
- In Sweden over half of the contracts signed since 2014 have involved broadband connection speeds of more than 100 Mbit/s. In 2017 more than 40% of all Internet subscribers enjoyed high-speed broadband access of more than 100 Mbit/s.
- The proportion of households in Sweden with Internet speeds of more than 100 Mbit/s has grown in rural areas in particular. The share rose from just 6% in 2014 to 47% in 2017.
- Approximately 67% of all broadband connections that provide speeds of more than 100 Mbit/s in Sweden are based on FTTH. In rural areas this share rises to 82%.
- For FTTH subscribers high bandwidth is the primary reason for purchasing an FTTH connection.

Executive summary

- On average Swedish FTTH broadband subscribers perform 11% more activities online than subscribers with other Internet access technologies, especially activities regarding entertainment or connecting with other people.
- Swedes with high-speed Internet access use music and video streaming services significantly more frequently than Germans. 30% and 35% of Swedes watch videos and listen to music solely over the Internet. Only 10% and 21% of Germans are similarly drawn to online video and music streaming.
- FTTH users are consistently more likely to own connected devices than non-FTTH users thus indicating a more progressive Internet usage pattern for FTTH users.
- 82% of FTTH customers say that they like their service very much or that it is above average. This is a substantially higher level of satisfaction than that recorded for any other Internet access technology in Sweden.
- Almost all non-FTTH subscribers (94%) would subscribe to FTTH if it was made available in their area.

Executive summary

Case study – Sweden

- 67% of municipalities in Sweden have deployed local fibre networks.
- The Stokab roll-out has an overall economic impact of almost SEK 29 billion.
- Distance learning is crucial in Sweden due to its size and low population density. FTTH enables education for all students regardless of their location. Massive open online courses (MOOCs) are very popular in Sweden.

Case study – Netherlands

- Nuenen (in the Netherlands) started rolling out FTTH in 2005. Within 3 months a 97% take-up rate had been achieved. However, there is still a lack of fast Internet access in rural and remote areas around Nuenen.
- The increasing digitalisation of the agriculture sector in Nuenen places extreme demands on broadband connections. Fast broadband is required to support several applications and to collect, save and evaluate the data that has been gathered.

Executive summary

Outlook

- Tactile Internet and immersive media are the major underlying trends that will shape future human–computer interaction and drive up bandwidth demand.
- New applications like remote medical treatment, autonomous driving or virtual and augmented reality will require the transmission of data in real time with a latency of less than 1 millisecond and high reliability and availability as well as high security standards. Fibre networks can provide these quality of service (QoS) characteristics.

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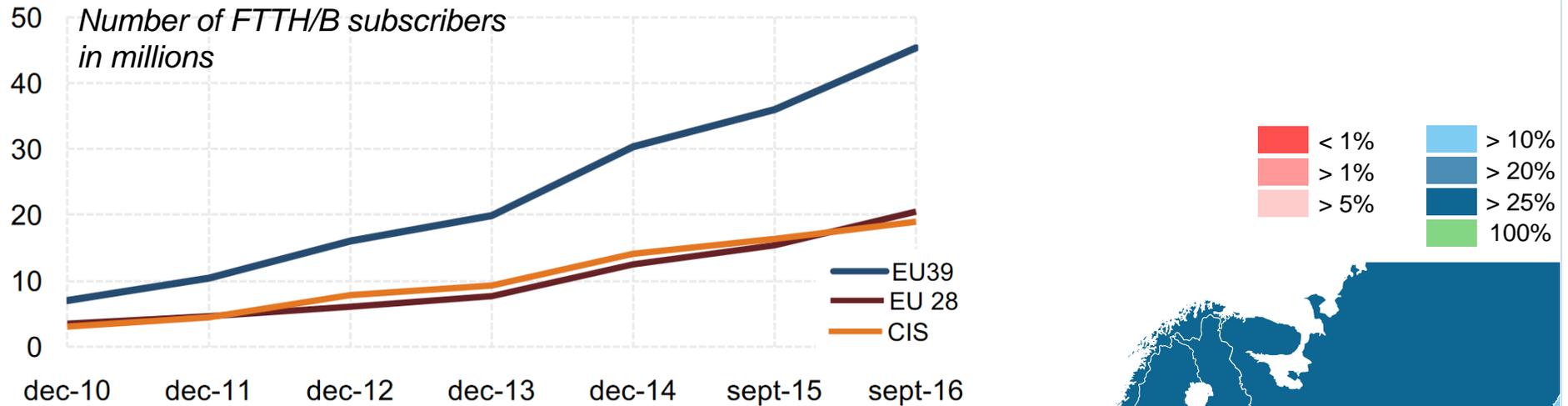
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FTTH in Europe – An overview

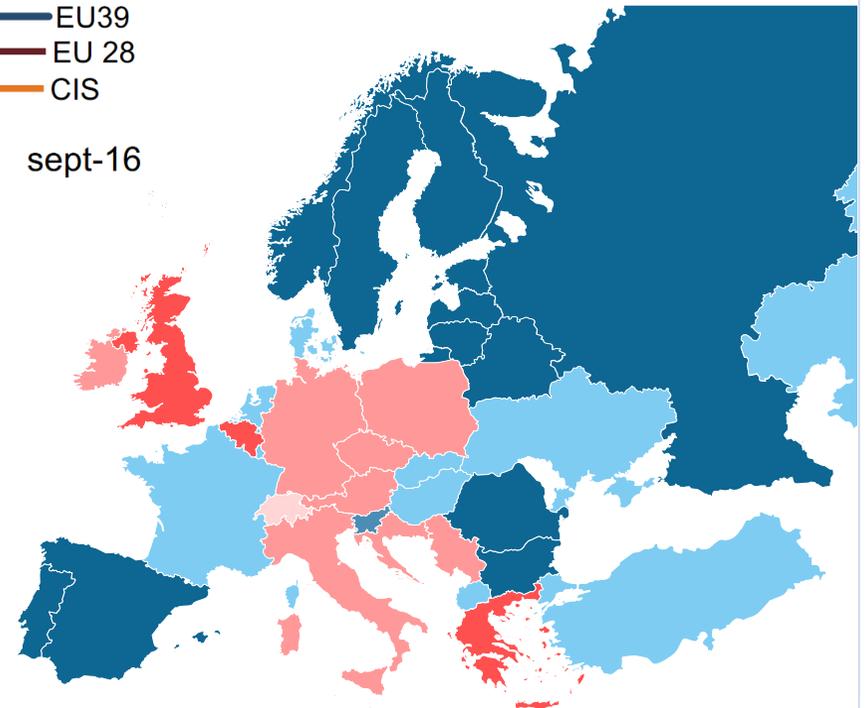
Scandinavian countries lead the way

Around 20 million FTTH/B subscribers in the EU28

Since 2010 penetration of fibre has grown more than fourfold



- The number of FTTH/B subscribers in the EU28 has grown more than fourfold since the last FTTH Council Europe study on socio-economic benefits of FTTH.
- Scandinavian and Baltic countries lead the way with regard to current penetration of FTTH/B.
- FTTH/B pioneers Sweden and the Netherlands were selected to trace the socio-economic effects of fibre in the present study.



FTTH/B penetration in Sept 2017

Socio-economic benefits of FTTH

A representative consumer survey in Sweden

Overview of the study

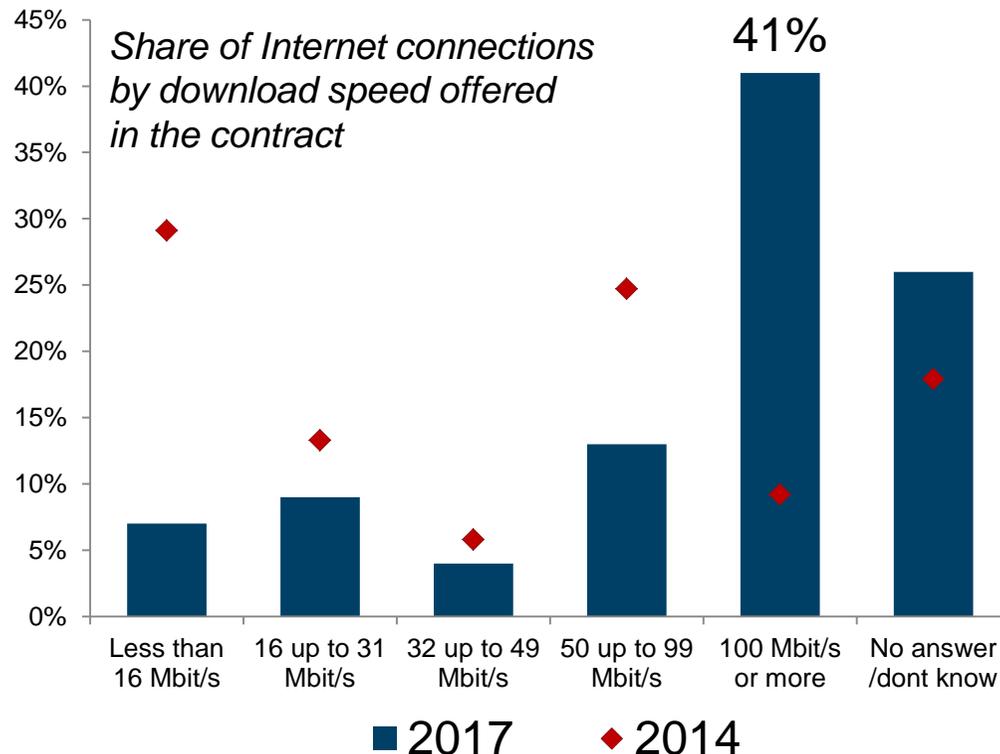
- To understand the socio-economic benefits of FTTH in Sweden a representative survey of Swedish consumers was conducted by the international market research institute YouGov between 29 September 2017 and 2 October 2017.
- The final sample size was 1018 consumers. A detailed overview of the sample is provided at the end of this report.
- Methodology: CAWI (computer-aided web interview).
- The results were weighted to draw representative conclusions for the Swedish population (age 18+).
- The questions revolved around consumers' Internet service providers (ISPs), the access technology used, their level of satisfaction, typical online activities and socio-demographics. For the purposes of comparison we draw on the data gathered for the study on the socio-economic effects of FTTH conducted in 2009 by the FTTH Council Europe (n=167) and representative data collected in Sweden in 2014 (n=1122). The latter survey was also conducted by YouGov on the same panel using the same methodology as for the present study.

Faster access in high demand

More than 40% of Swedes have Internet access of 100 Mbit/s or more

- The share of Internet subscribers with contracts that give them 100 Mbit/s or more increased by 32 percentage points from 2014 to 2017.

- Conversely, the share of broadband connections providing downloads at less than 100 Mbit/s strongly decreased between 2014 and 2017.



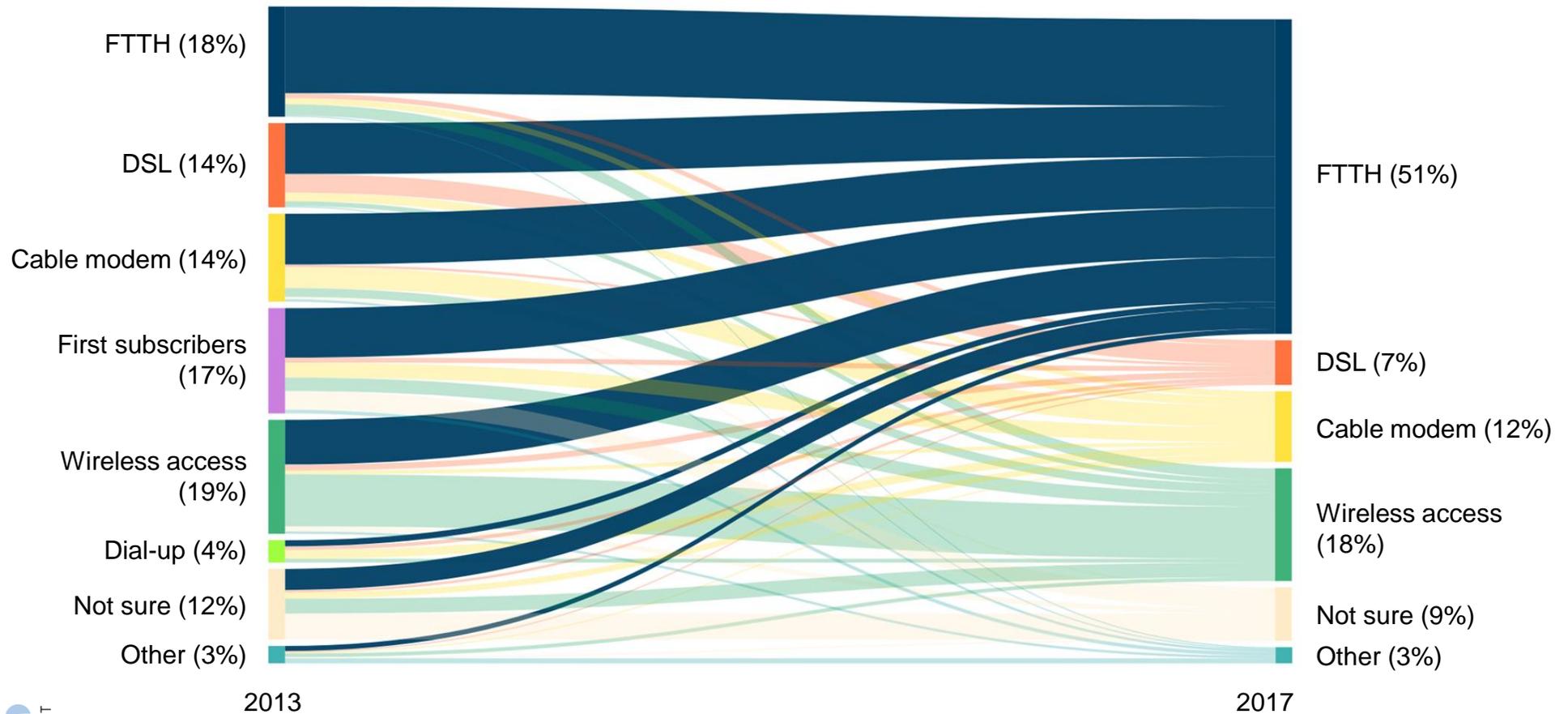
56%

of broadband contracts since 2014 have been FTTH

Fibre is attractive

Swedes migrate to FTTH

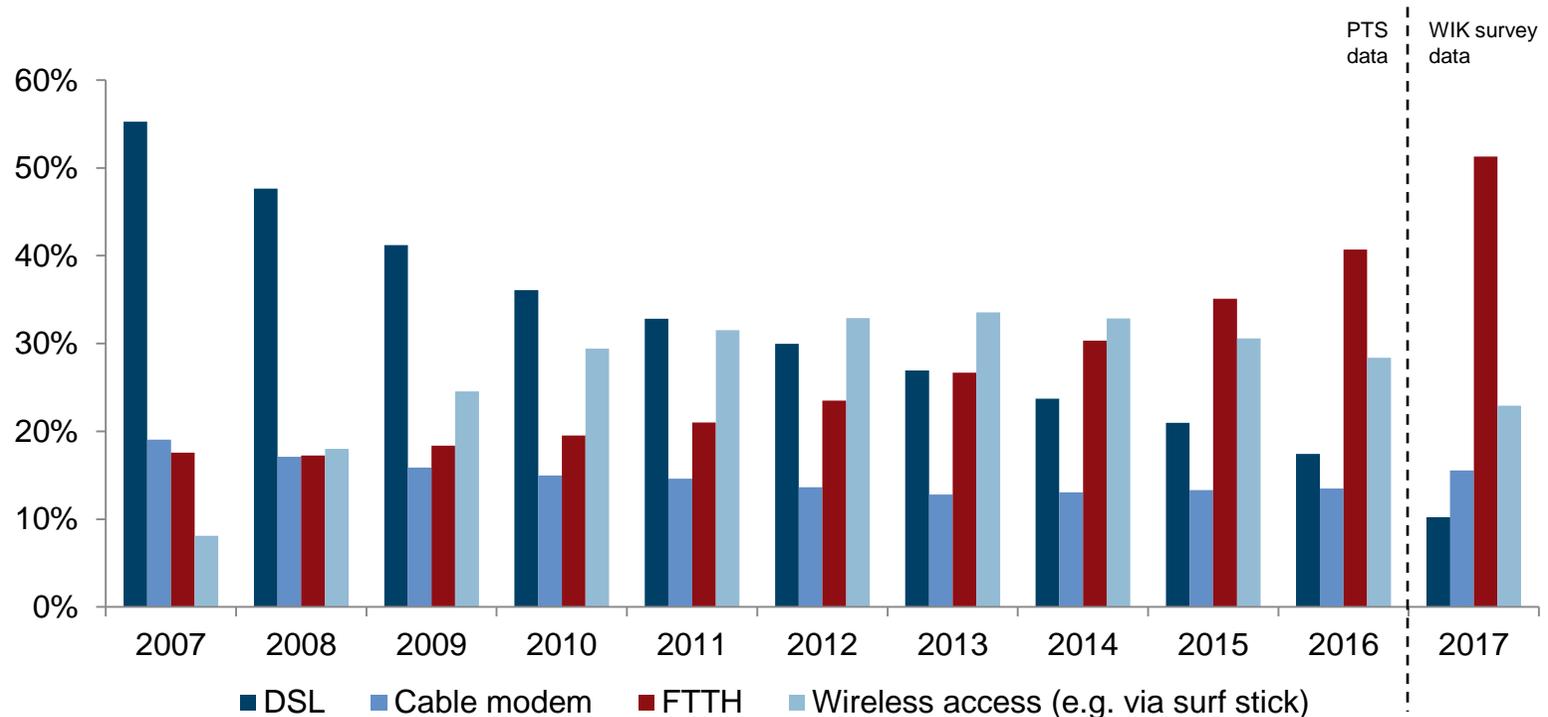
Share of Internet connections by access technology



Source: Representative consumer survey (2017), N=439.

Long-term trend of migrating to fibre

Share of FTTH subscriptions in Sweden has been increasing since 2014



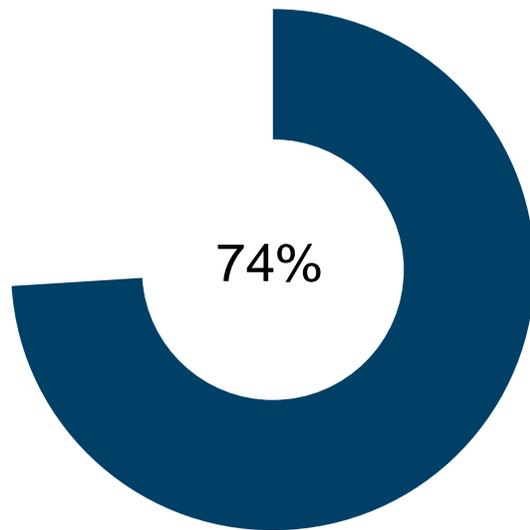
Source: Data for 2007 to 2016 was taken from the Swedish Post and Telecom Authority (2017); data for 2017 was collected via a representative consumer survey conducted for this study, N=803. To harmonise both data sets other Internet access technologies (e.g. satellite, dial-up, etc.) were not considered in the figure above.

- The share of FTTH connections has been increasing constantly for 10 years. In 2014 FTTH's share of connections exceeded that of DSL for the first time. Today more than half of all fixed broadband connections in Sweden are via FTTH.

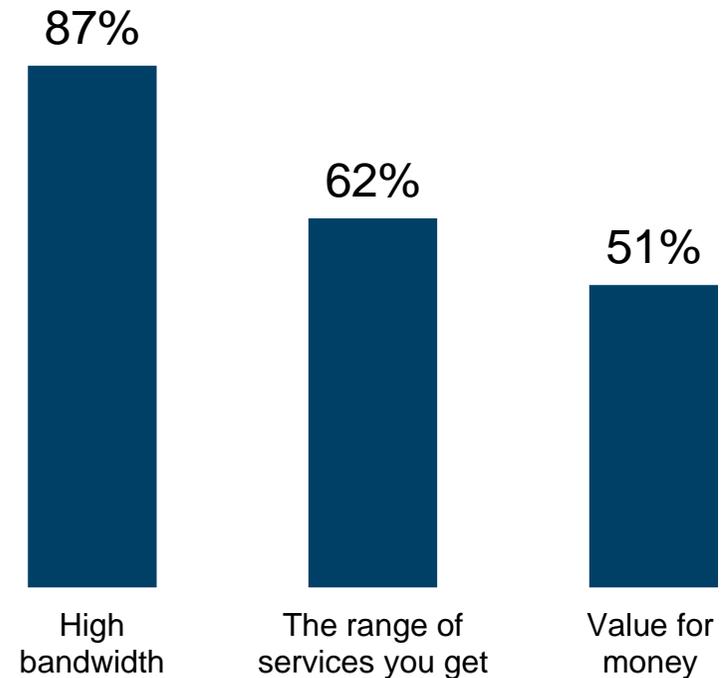
Fibre makes a difference

Consumers notice a significantly higher access speed

- More than 70% of those who made the switch to fibre noticed a difference to their previous Internet access technology.



- For the majority of FTTH users fibre is about higher speed and better value for money.*

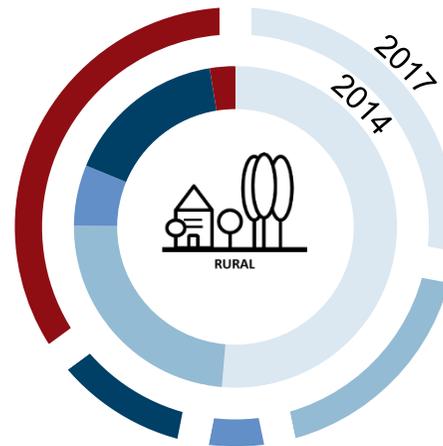
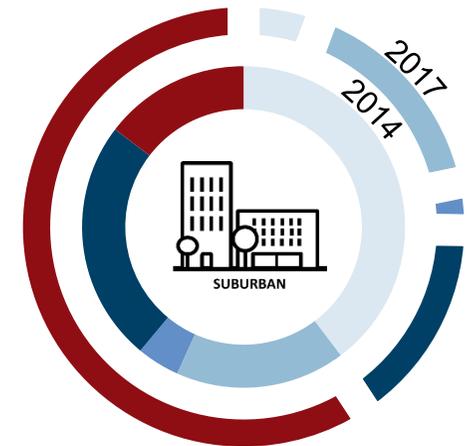
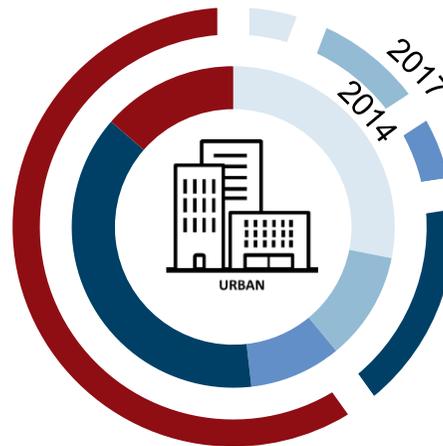


* Percentage share of the maximum available points in a ranking exercise.
Source: Representative consumer survey (2017), N=347.

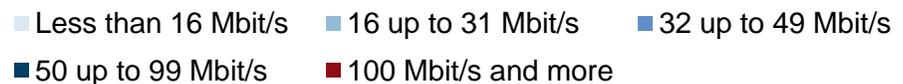
Rural areas are catching up

The share of rural households with 100 Mbit/s has grown eightfold

- The share of high-speed Internet access grew significantly from 2014 to 2017 regardless of the type of area.
- The share of households with Internet access of 100 Mbit/s or more grew in rural areas in Sweden in particular.
- Around one fourth of rural households' Internet access still offers less than 16 Mbit/s.
- In urban areas only around 5% of households are on similarly slow contracts for their Internet access.



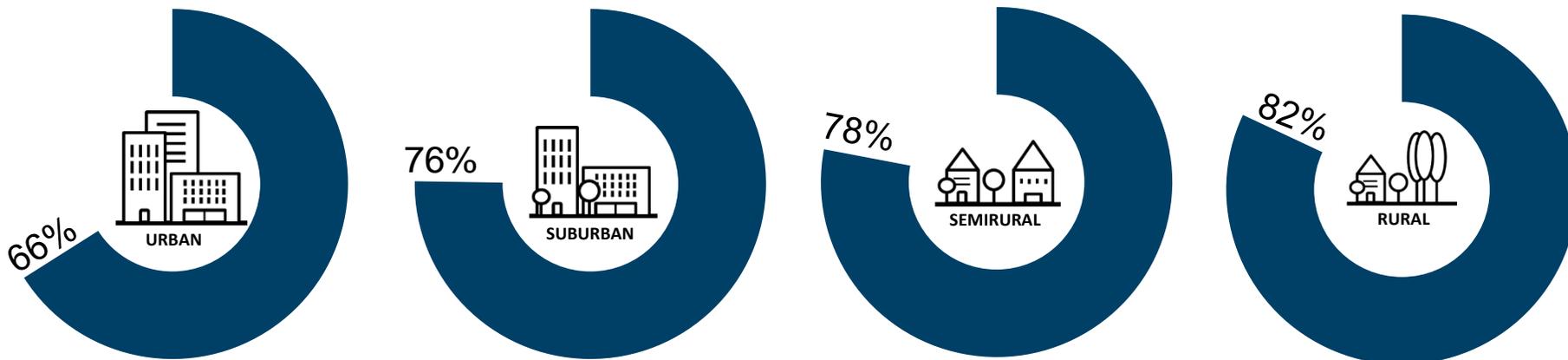
Share of Internet connections by speed and area type in 2014 and 2017



Fast broadband in rural areas

82% of households with 100 Mbit/s connect using FTTH

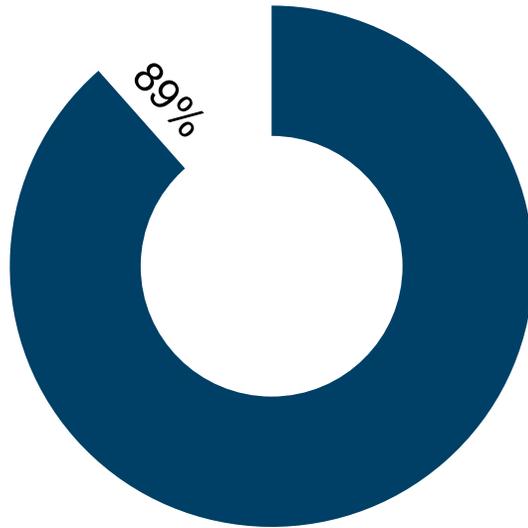
Proportion of Internet connections offering download speeds of 100 Mbit/s or more on optical fibre by area



- FTTH is clearly driving take-up rates of higher broadband usage in Sweden. Municipalities mostly choose to deploy future-proof FTTH infrastructure and a wholesale business model.
- Across all types of areas, significantly more than half of the broadband connections offering 100 Mbit/s or more are fibre based.
- In semirural and rural areas around 80% of the connections providing download speeds of 100 Mbit/s or more in 2017 were fibre based.
- In urban areas around one third of broadband connections offering 100 Mbit/s or more were not on fibre.

Always on

89% of FTTH users in Sweden are online every day



*Proportion of FTTH users
who use the Internet daily*

- FTTH users are more likely to be online daily. They can therefore gain more frequent benefits from the reduced search and transaction costs that the Internet offers.
- As the following slide illustrates, FTTH users are also more active on the Internet:
 - FTTH users access public service sites more frequently than non-FTTH users.
 - FTTH users stream music and video more frequently than non-FTTH users.
 - FTTH users employ the Internet's information resources to find the best offers as well as general information more frequently than non-users.
 - They also spend more time surfing than non-FTTH users.

FTTH users do more online

They use 15% more entertainment applications than non-FTTH users

On average
FTTH users are

11%

more active online

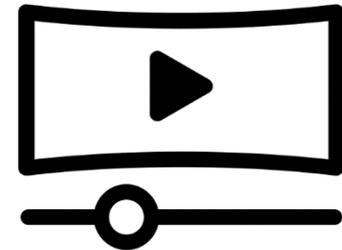
Information

+ 7%



Entertainment

+ 15%



Social interaction

+ 15%



Local services

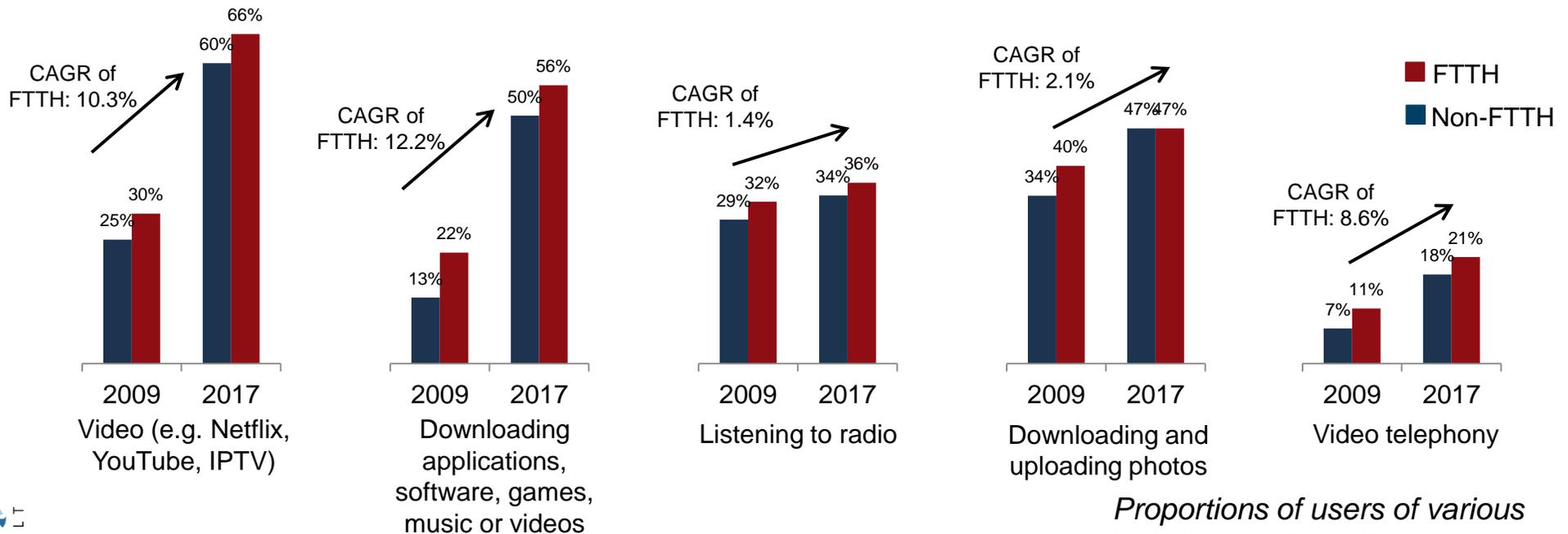
+ 10%



FTTH users still more active

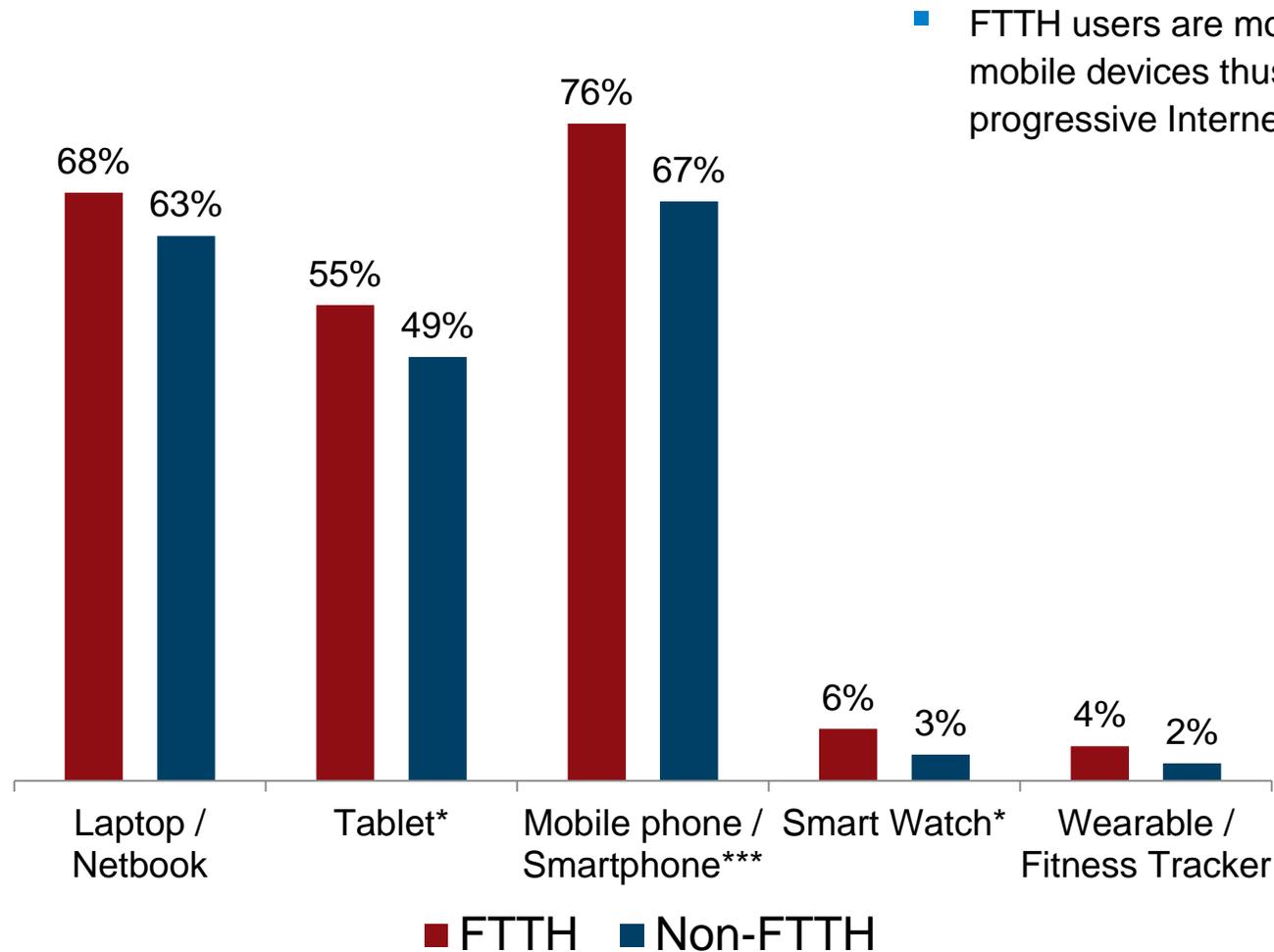
Usage of high-bandwidth online services in 2009 and 2017

- From 2009 to 2017 the usage of high-bandwidth online services increased substantially in Sweden.
- The strongest recorded growth is for downloading apps and software as well as online video consumption.
- FTTH users were more likely to use high-bandwidth online services than non-FTTH users both in 2009 and in 2017.
- The largest difference between FTTH users and non-FTTH users is in relation to downloading apps and video consumption.



Proportions of users of various high-bandwidth online services in 2009 and 2017

Connected mobile devices

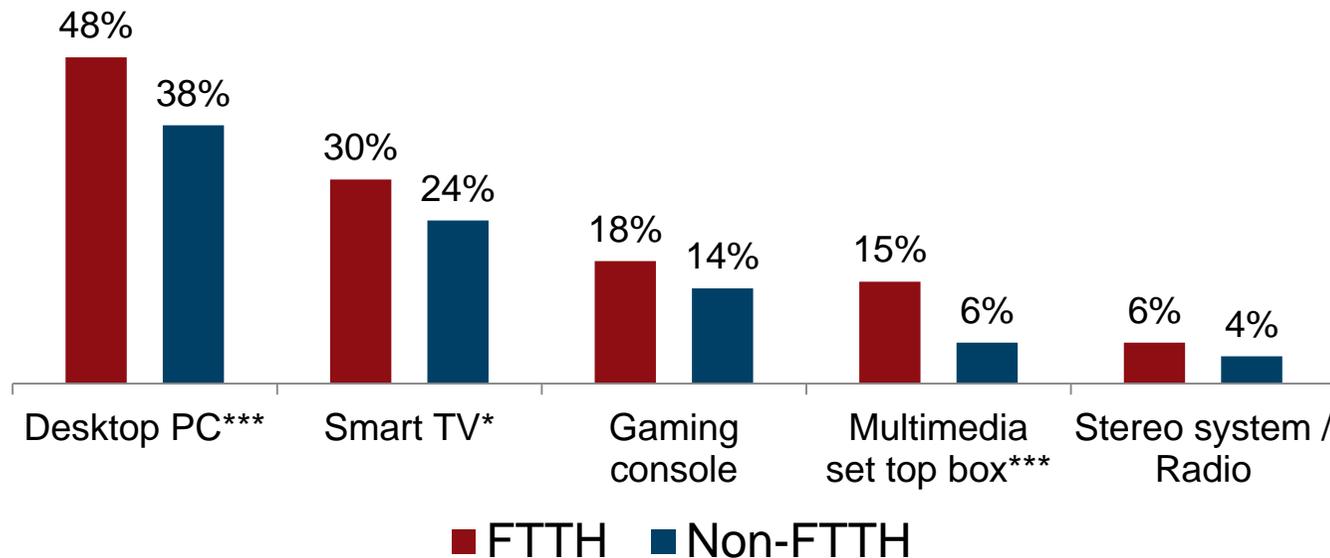


- FTTH users are more likely to own connected mobile devices thus indicating a more progressive Internet usage profile.

Proportions of users owning specific mobile devices connected to the Internet

Connected stationary devices

- FTTH users are more likely to own connected stationary devices thus indicating a more progressive Internet usage profile.
- The difference between FTTH users and non-FTTH users is particularly pronounced for multimedia set-top boxes requiring substantial bandwidth.

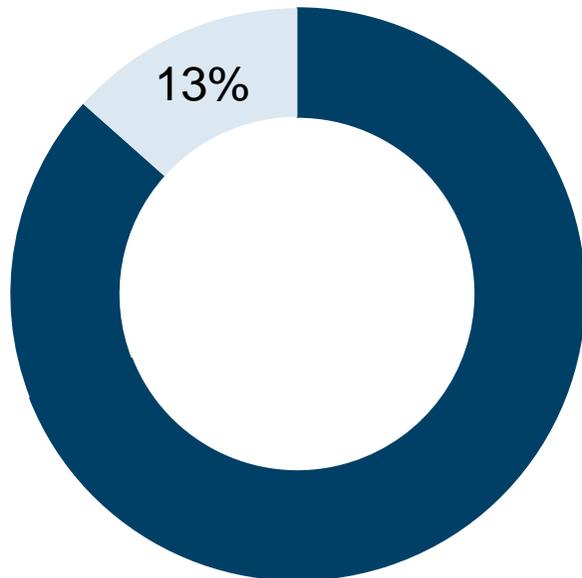


Proportions of users owning specific stationary devices connected to the Internet

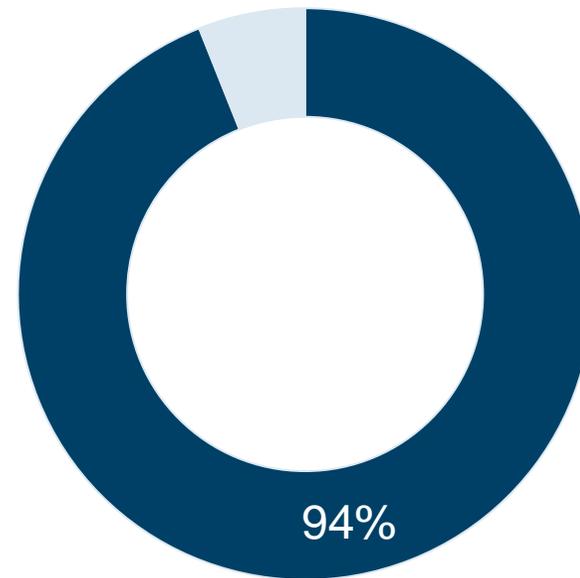
Consumers prefer fibre

Almost all non-FTTH users would like to have fibre access

- Only 13% of non-FTTH users claim that they have consciously decided against an FTTH subscription.

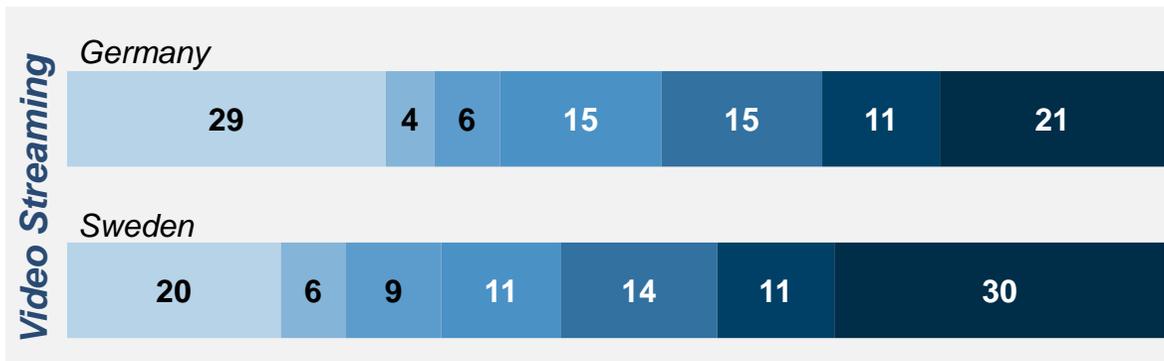
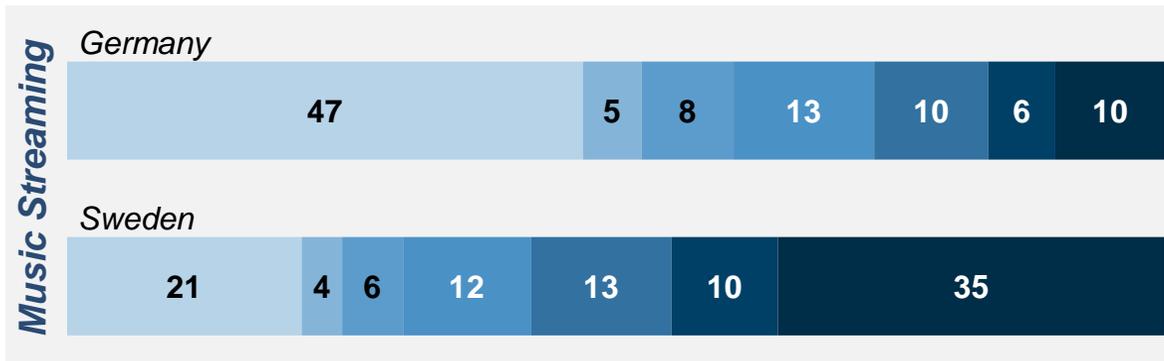


- 94% of non-FTTH users would consider subscribing to FTTH if it was made available in their area.



Swedes stream

1 in 3 Swedes gets all video content online



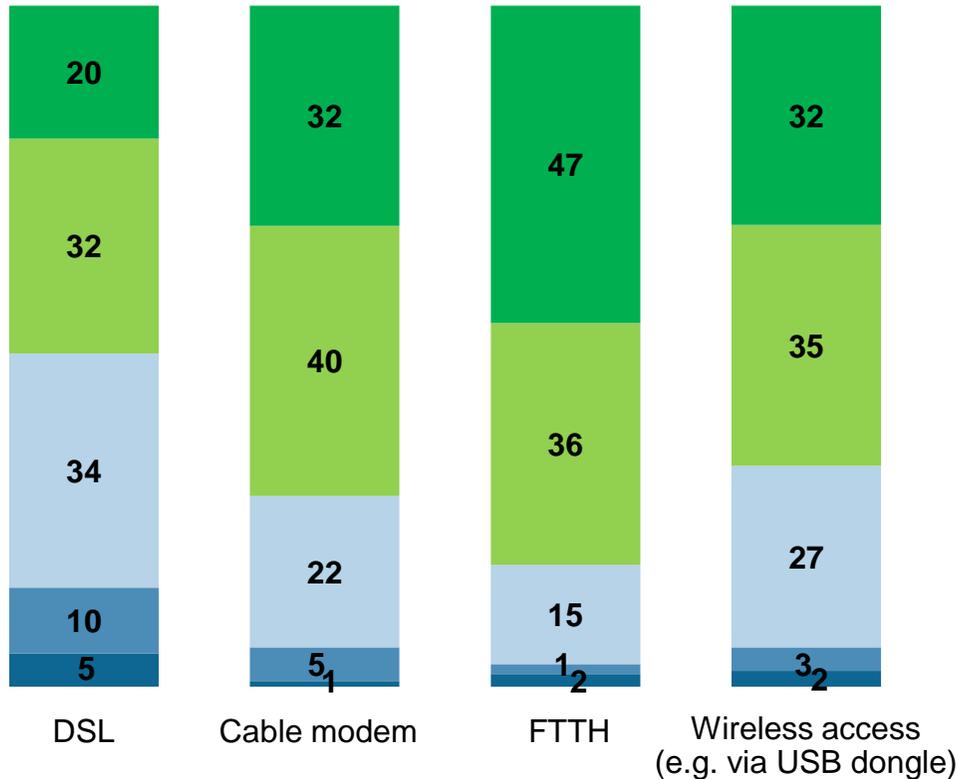
■ 0% ■ 1-20% ■ 21-40% ■ 41-60% ■ 61-80% ■ 81-99% ■ 100%

Percentage shares of OTT services used for music and video content consumption (in an average month)

- As Swedes, on average, have faster internet connections than Germans, they use music and video streaming services significantly more frequently.
- The difference is particularly pronounced for music streaming. The proportion of Swedes who listen to music solely over the Internet is about three times as large as in Germany.
- Spotify is a Swedish success story that certainly benefited from strong FTTH deployment.
- Video streaming is the only way to watch video content for around 30% of Swedes.

Satisfaction is highest with FTTH

82% of FTTH customers are happy with their service



- I don't like it at all
- It's below average
- It's average
- It's above average
- I like it very much

Percentage shares of level of satisfaction with one's Internet access service by access technology

- FTTH customers are the group that is most satisfied with its Internet access service.
- 82% of FTTH customers say that they like their service very much or that it is above average.
- DSL customers are significantly less satisfied. Only around half of them like their service or say that it is above average.
- Satisfaction with Internet access via cable and wireless connections appears to lie between that of FTTH and DSL connections.

Socio-economic benefits in other countries

Consumers and companies benefit from FTTH across the world

88% less

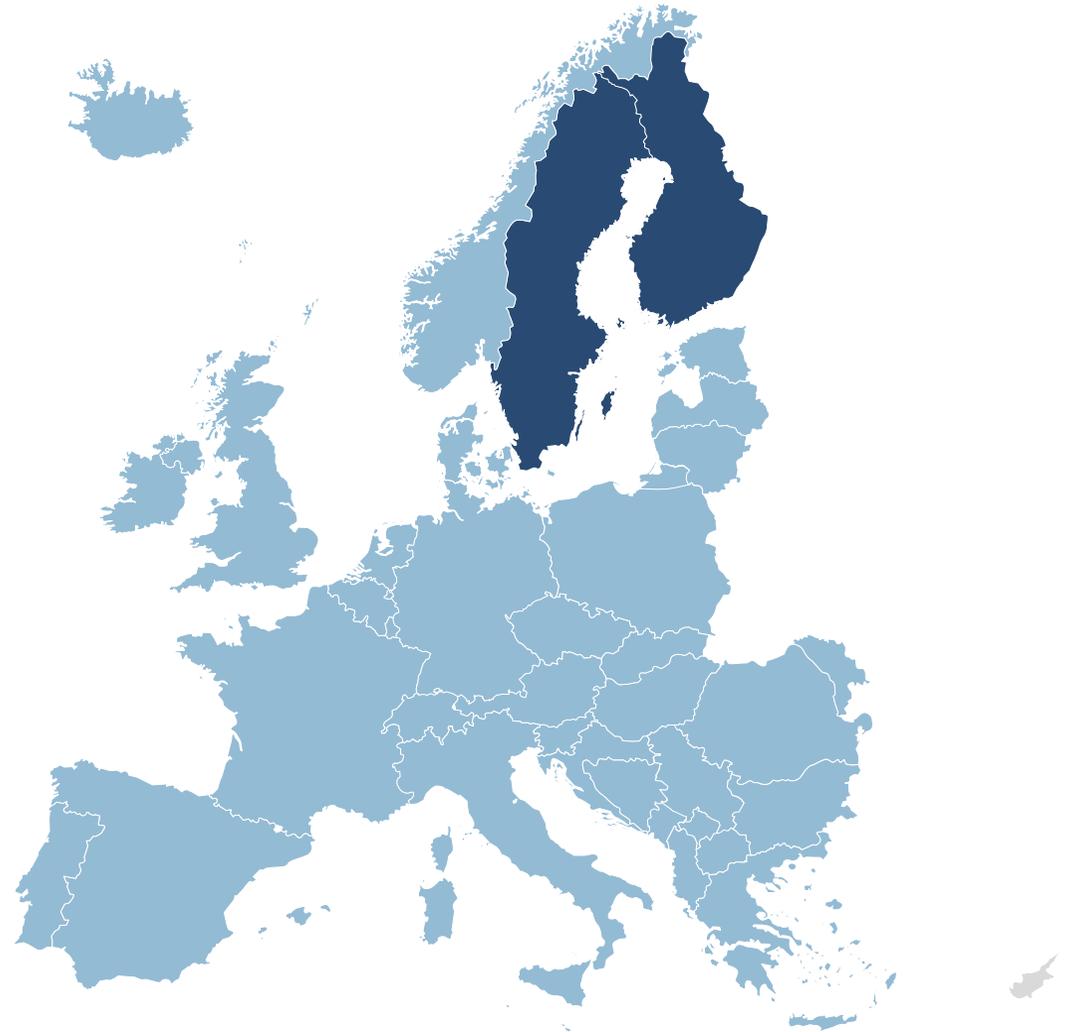
greenhouse gas
emissions per gigabit
with FTTH/B
infrastructure
compared to other
access technologies.



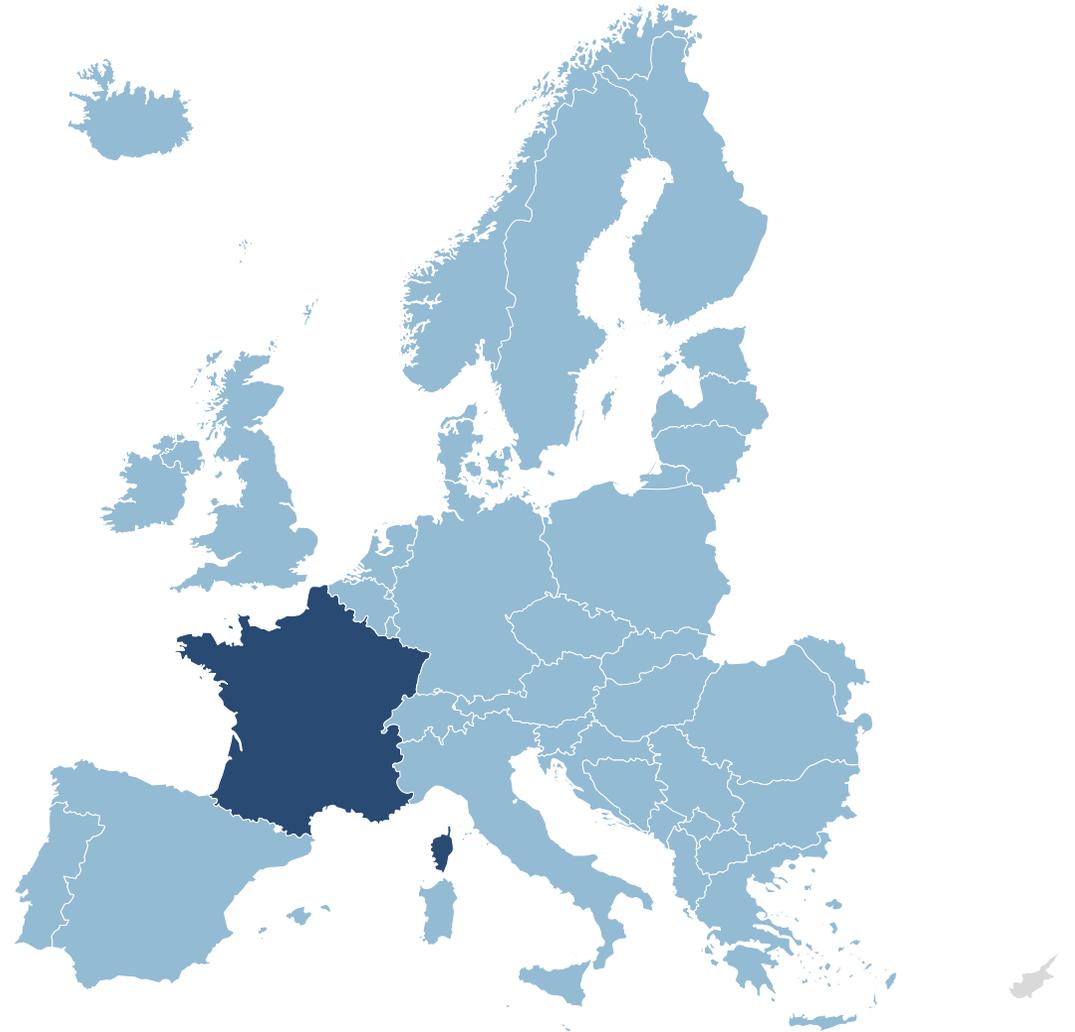
Sweden and Finland

€75 to €425

per capita can be saved annually in small municipalities depending on the take-up rate of digital home services enabled by FTTH broadband.



4.8% more
start-ups
in French
municipalities
have ultrafast
broadband than
have slower access.

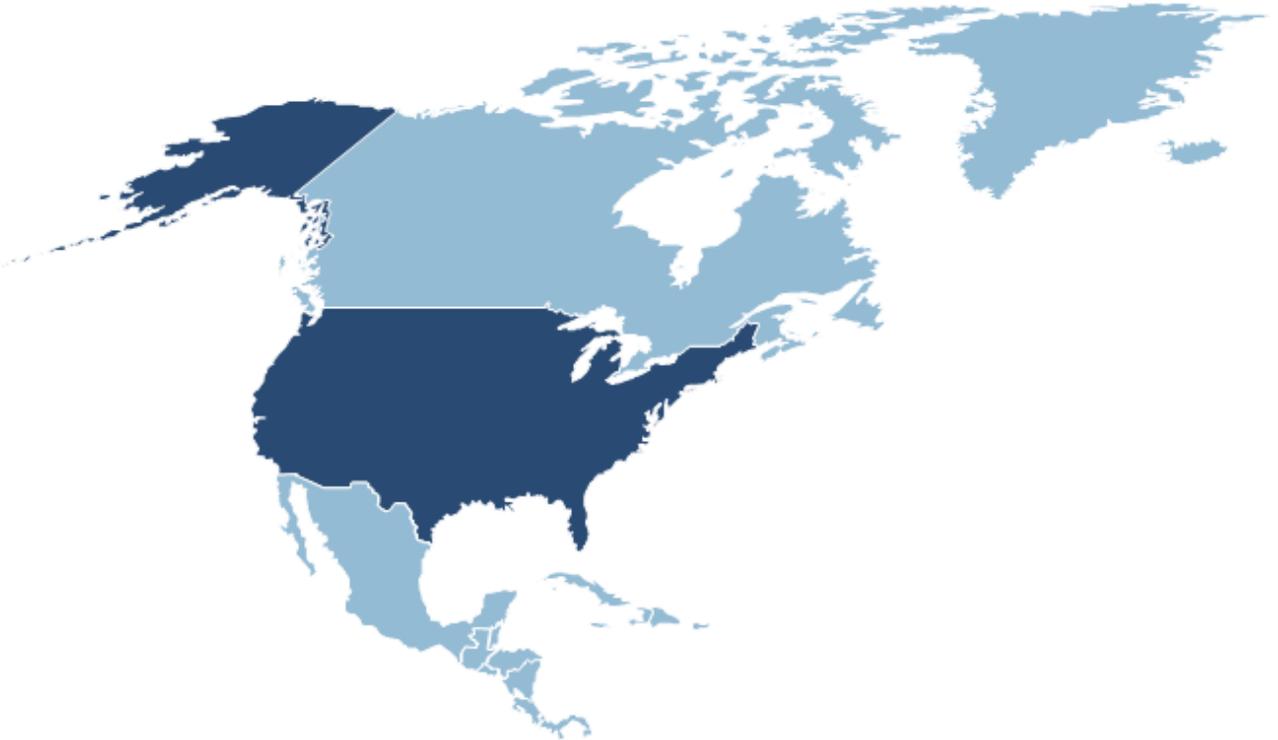


12.8 days

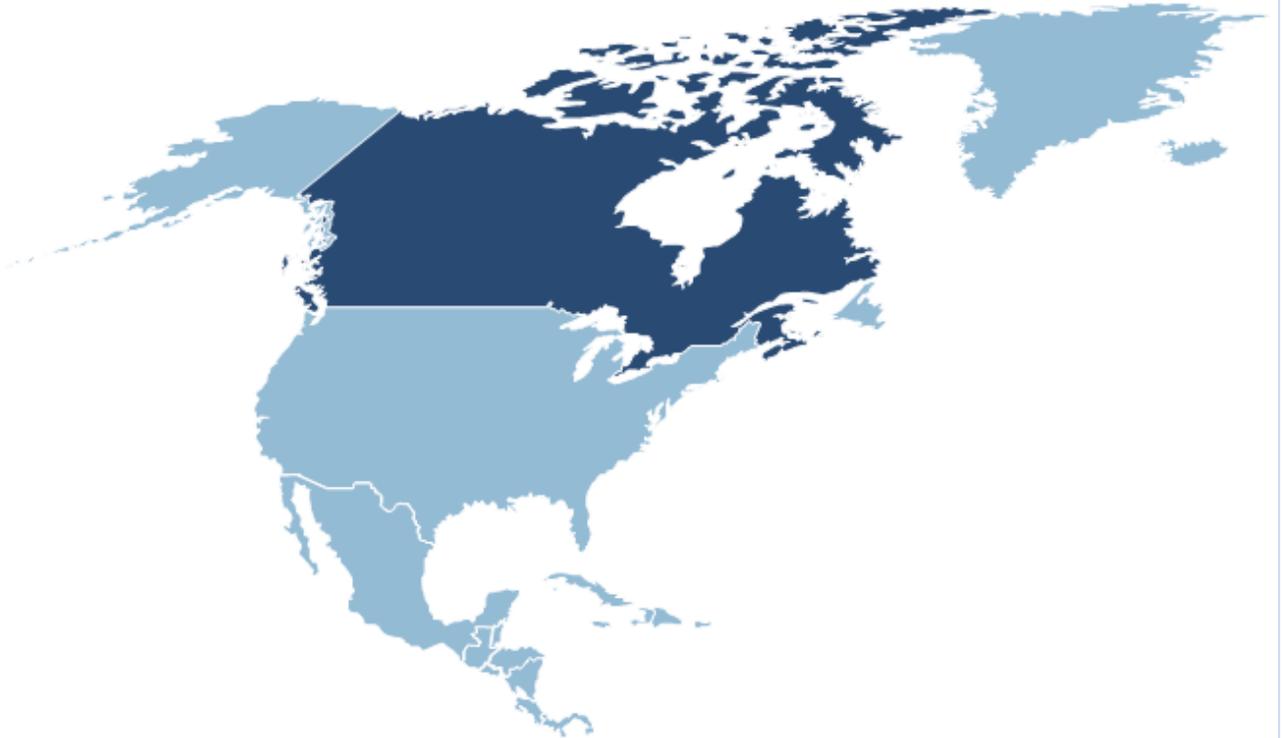
working from home per month for FTTH users compared to an average of 10.8 days for DSL and cable users.

1.1%

higher GDP per capita in communities with Gigabit broadband access than in those with slower access.



2.9%
expected
increase in
employment
from full FTTP
roll-out.



Case study 1: FTTH benefits in Sweden

Urban and rural FTTH first-movers benefit from fast broadband

Municipalities for success

Local actors have been driving fibre roll-out in Sweden

- Municipalities started as early as 20 years ago to promote the roll-out of fibre. Their rationale was to enhance welfare in their community and build a future-proof infrastructure that could retain the young affluent population.
- Existing utility infrastructure was widely used to make fibre roll-out more efficient.
- Municipal fibre infrastructure is typically open access or wholesale only, enabling competition from all providers interested in providing their own services on it.
- This leads to vibrant competition in the market and benefits consumers who in turn receive innovative, high-quality services at competitive prices.

67%

of municipalities
in Sweden
have deployed
local fibre networks¹

Stokab connects 90% of all households in the area

- Founded in 1994, Stokab belongs to the City of Stockholm.
- They provide access to physical infrastructure in the greater Stockholm area. Their wholesale-only model and market-driven roll-out have been key success factors.
- This model is used throughout Sweden to drive fibre roll-out.

Stokab in figures

400,000
buildings connected

1 Gbit/s
starts at EUR 20 monthly¹

Stokab is driving economic growth in Stockholm and related areas.

Direct economic impact¹

SEK **16** billion + SEK **5** billion

referring to direct investment and cost savings for the municipality and the national administration including benefits for private and business customers. An additional SEK 5 billion is from Stokab's procurement.

Indirect economic impact¹

SEK **7.7** billion

referring to innovative services and products being developed and used in the area due to fast broadband access as well as increased productivity and entrepreneurship.

¹ Forzati/Mattson (2013): STOKAB, a socio-economic analysis

Kista Science City in northern Stockholm

Fast broadband makes the region attractive for digital start-ups

- Kista Science City is the largest information and communication technology (ICT) cluster in Europe and the third-largest ICT cluster in the world.
- Major ICT companies have joined “Europe’s Silicon Valley”. Among them are Ericsson, IBM, Sun, Tele2 and Nokia.

Stockholm ranks

#1 in Ericsson’s Networked Society Index

#2 worldwide in SparkLabs’ start-up ecosystem monitoring

Kista Science City in figures

1,000 companies

24,000 jobs

Sense Smart Region

Fibre helps Skellefteå to innovate

- Skellefteå is a small city in the north of Sweden with a population of 33,000.
- The goal of the Sense Smart Region is to build a comprehensive network of sensors that enable various augmented reality applications. The information gathered will be used for displaying information on connected devices such as smartphones or smart glasses.
- The project is present through various seminars in the region and beyond. It drives innovation by organising hackathons and involves a number of local businesses.
- ICT innovation and fibre access have recently attracted Northvolt (Europe's largest lithium-ion battery producer) and Amazon to the area.

Digital education in Sweden

Fibre as a key success factor for excellent and fair education

- Since municipalities have been the driving force behind fibre roll-out, most schools, universities and other tertiary education institutions have FTTH Internet access.
- Furthermore, Sweden proactively promotes digital learning devices. Many schools feature “digital classrooms”.
- Given Sweden’s demographic situation, distance learning plays an important role. Fibre infrastructure enables fair participation of all youths in education regardless of where they live. Massive open online courses (MOOCs) are very popular in Sweden.¹

Digital health in Sweden

Ambient assisted living everywhere

- Ambient assisted living (AAL) is gaining importance across Europe. Sweden is one of the frontrunners in providing care to the elderly using digital technology.

Connected for Health pilot in Hudiksvall

The widespread availability of FTTH in Hudiksvall enables various new eHealth services as it offers the high reliability and low latency that the services require. That is also the reason why Hudiksvall has been selected as one of the pilot communities for the EU project Connected for Health.

The eHealth services featured as part of the pilot cover a video communication service, digital alarm and night supervision. The pilot will also deploy an open digital social care alarm platform that will integrate the services in the pilot.

The involvement of the municipality in offering fibre infrastructure as an open platform not only increased competition for broadband services, but also enabled an increase in the social benefits of the pilot as patients on homecare were offered free broadband access.

Source: Connected for Health newsletter

Case study 2: FTTH benefits in the Netherlands

The community drives the success of FTTH roll-out
and generates additional social benefits

- Nuenen was one of the first municipalities in the Netherlands to roll out FTTH. They started as early as 2005. Within 3 months a 97% take-up rate had been achieved.
- The cooperation model and strong personal involvement at the local level were the key success factors for this quick roll-out and high take-up. This strong local involvement is still part of fibre networks in the area. It also increases the social benefit of FTTH in the area above and beyond the advantages of a fast broadband connection.

OnsNet in the beginning

Initially OnsNet was a local cooperation and formed a sense of community in Nuenen that drove commitment to purchase FTTH Internet access. Reggefiber rolled out FTTH across the Netherlands in a similar manner.

Citizens in Nuenen started with 10 Mbit/s symmetric access in 2005 including telephone and email. The Dutch government subsidised each connection to the value of €800.

OnsNet today

KPN bought Reggefiber in 2014. In July 2017 KPN Reggefiber took control of the OnsNet Nuenen cooperation thus offering a more compelling and efficient service provision. Nonetheless, the cooperation still has a monitoring function. They track KPN's annual reports and have a say in management decisions. Furthermore, citizens of Nuenen can join management and engineers at meetings to bring in new ideas. Thus the community is still involved which yields additional benefits of social cohesion.

Accessing rural areas with FTTH

Nuenen is making an effort to connect rural and remote areas

- The FTTH initiative has been hugely successful in Nuenen. However, there is still a lack of fast Internet access in the surrounding rural and remote areas. Close the Gap and Mabib are addressing this issue now by involving the community and building fibre infrastructure throughout the adjoining rural and remote areas.
- A conspicuous marketing campaign uses a pink cow and Mabib flags to indicate homes already signed up for the FTTH connections to be installed in 2018.
- Data-intensive agricultural companies are signing up for FTTH as well as citizens who currently have no Internet access at all.



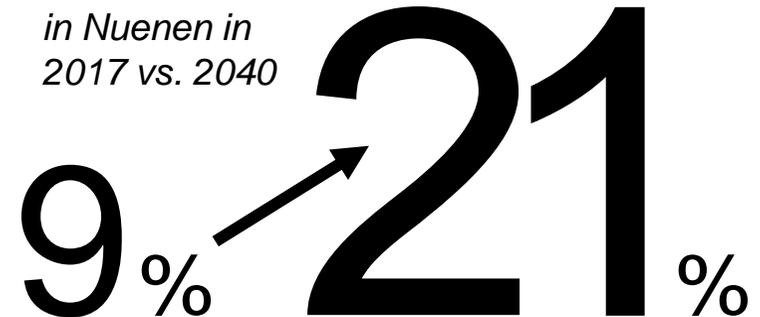
Pictures: Mabib.nl

Tackling the demographic challenge

Nuenen is well equipped to support an aging population

- Demographic change poses a challenge to all countries in Europe. Rural areas like Nuenen face an above-average demographic challenge.
- New services like home automation support elderly citizens using the FTTH network in the area.
- Nuenen was also one of the first cities to roll out a Low-Power Wide-Area Network to connect small devices. This enables the Internet of Things which in turn will create new applications for elderly citizens.

*Proportion of citizens
75 and older
in Nuenen in
2017 vs. 2040*



De Zorgboog

FTTH roll-out enables healthcare provider “de Zorgboog” to support the elderly with the latest eHealth applications. FTTH roll-out in rural areas will also enable old farmhouses to be used as homes for the elderly.



Pictures: De Zorgboog

Farming is not what it used to be

Agriculture in Nuenen on the digitisation fast track (1)

- Hardly any other sector has experienced accelerating digitisation over the last few years as intensively as agriculture. In part this is due to stricter rules for environmental emissions. Manure and fine dust emissions require continuous monitoring and reporting. However, the most relevant drivers of 'smart farming' are efficiency gains in day-to-day business and the various advantages precision farming offers. All this requires a lot of digital technology and fast broadband access even in remote areas.
- The specific applications supported by fast broadband access include cameras and sensors continuously observing livestock (often at multiple locations) or monitoring soil conditions. In addition, on a daily basis, electronic documents like load and freight letters, export documents, and required health approvals of livestock need to be generated and transmitted before the actual shipment can leave the farm.



Picture: Close the Gap/Angel Eggs, Someren

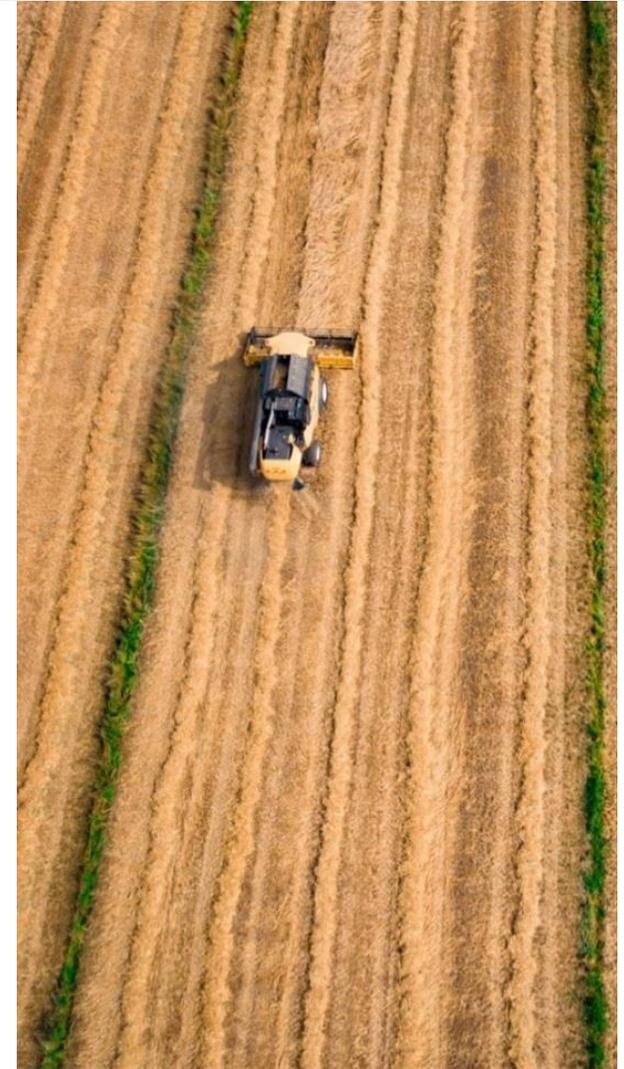


Picture: Amanda Kerr – unsplash.com

Farming is not what it used to be

Agriculture in Nuenen on the digitisation fast track (2)

- Precision farming enables all equipment to be GPS guided and responsive to the specific soil conditions. Gathered data is used to decide the right amount of water and fertiliser even accounting for shady versus sunny areas on the farmland. This results in less use of water and fertiliser while also maximising harvest yields.
- This requires collection of large amounts of data from multiple locations and then (often cloud-based) central processing to compare the specific farm with other farms.
- In the Nuenen area some farmers connected their farms already by digging their own trenches and laying fibre. The remaining farmers strongly supported the initiatives to bring FTTH to the rural and remote areas around Nuenen.
- Other applications related to fibre are semi-autonomous machines bringing in the crops and production lines having less downtime due to predictive maintenance.



Picture: Kees Streefkerk

An outlook

More hunger for bandwidth

Two trends shape future demand for bandwidth

Tactile Internet and immersive media are the ones to watch

Tactile Internet

Tactile Internet refers to a futuristic telecommunications infrastructure which will feature very low latency, ultra high reliability and availability as well as high security standards. It will facilitate the introduction of new and innovative technologies and shape the future of human–computer interaction.

Immersive media

Individuals will be able to fully immerse themselves in virtual realities in the future, so that the line between reality and fiction likely blurs. Such an experience requires humans to receive realistic feedback via all their senses. Thus latency has to match human reaction times. Immersive media is therefore subject to high broadband requirements which will only be met by Tactile Internet infrastructures.

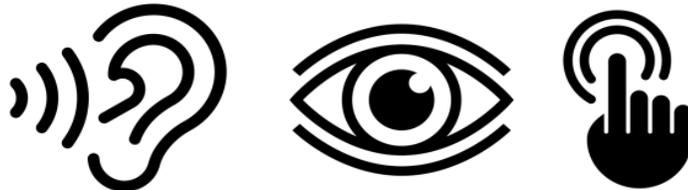
Tactile Internet

Ultra-low latency required for true human interaction

- Tactile Internet will enable real-time data transmission. Latency has therefore to resemble human reaction times:

- The auditory reaction time is 100 ms
- The visual reaction time is 10 ms
- The haptic reaction time is 1 ms

100 milliseconds 10 milliseconds 1 millisecond



Source: The figure is inspired by Fettweis, G. (2014), "The Tactile Internet – Applications and Challenges", *IEEE Vehicular Technology Magazine*, 9 (1), 140–145, p.142. Icons (from left to right): Gregor Cresnar, Carin Marzaro, Sergey Demushkin.

- New applications in sectors like healthcare, education, gaming and the automotive sector will rely on Tactile Internet:
 - Remote surgery or autonomous driving require high reliability and real-time data transmission with extremely low latency. Broadband failures or high latency might lead to severe injuries or even death.
 - Virtual and augmented reality should provide a fully immersive experience. However, delays will confuse users and disrupt the experience. They may also cause so-called “cybersickness”.¹

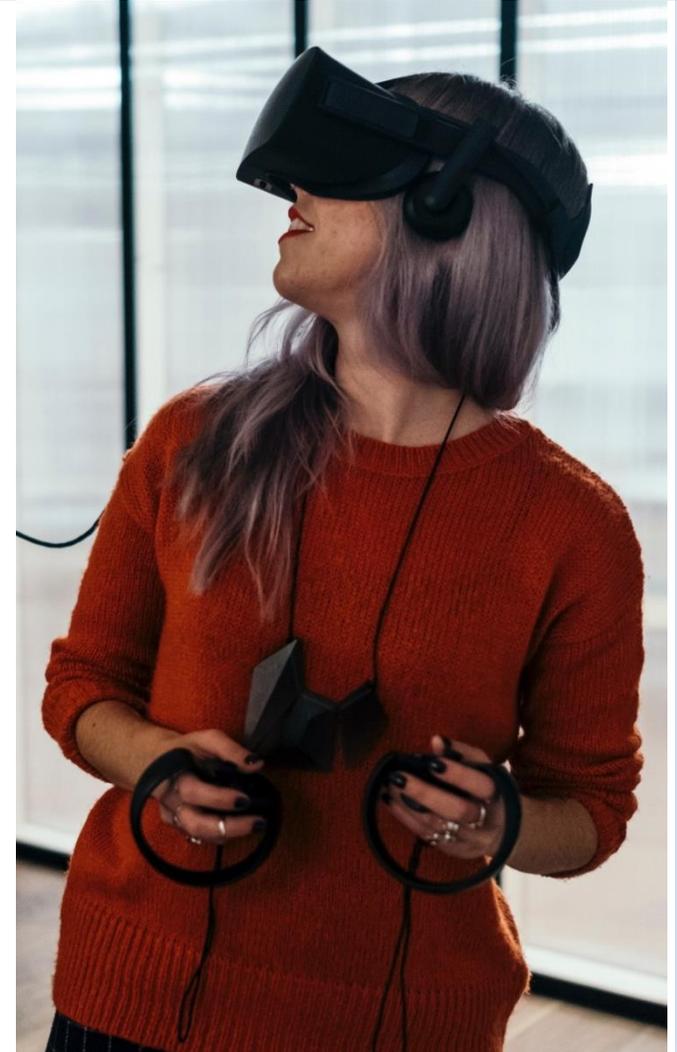
Source: The insights from this slide are from: Maier, M. et al. (2016). The Tactile Internet: Vision, Recent Progress, and Open Challenges. *IEEE Communications Magazine*, 54(5), 138–145; ITU (2014). The Tactile Internet. ITU-T Technology Watch Report, Geneva;

¹ ITU (2014). The Tactile Internet. ITU-T Technology Watch Report, Geneva, p.3.

Immersive media

A truly engaging experience requires ultra-high bandwidth

- Today's virtual and augmented reality systems require 100 to 200 Mbit/s for a one-way immersive experience. Future applications, however, will likely require fully symmetric access of more than 1 Gbit/s.
- A fully immersive experience will engage all senses. Therefore, latency of less than 1 ms is required.
- Virtual and augmented reality will provide new opportunities in multiple sectors other than entertainment:
 - Virtual and augmented reality enables students to learn together in situ no matter where they are located. It also enhances cognitive and social skills.
 - Virtual reality enables remote diagnostics, therapy and surgery, from which individuals living in rural areas can benefit the most.



Source: The insights from this slide are from: Bastug, E. et al. (2017). Towards Interconnected Virtual Reality: Opportunities, Challenges and Enablers. *IEEE Communications Magazine*, 55 (6), 110–117; ABI Research & QUALCOMM (2017). *Augmented and Virtual Reality: The First Wave of 5g Killer Apps*. NY, Oyster Bay; ITU (2014). The Tactile Internet. ITU-T Technology Watch Report, Geneva; Martín-Gutiérrez, J., Mora, C. E., Añorbe-Díaz, B. & González-Marrero, A. (2017). Virtual Technologies Trends in Education, *EURASIA Journal of Mathematics, Science and Technology Education*, 13(2), 469–486.

Appendix

Methodology

The online survey for this study was conducted with a representative sample of 1018 consumers between 29 September 2017 and 2 October 2017 by the international market research institute YouGov.

The results were weighted to draw representative conclusions for the Swedish population (age 18+). For the purposes of comparison a representative survey conducted in Sweden in 2014 by YouGov (n=1122) and a survey conducted on behalf of the FTTH Council Europe in Sweden in 2009 (n=167) were used.

The sample of the present survey comprised the following participants:

<u>Sex</u>		<u>Age</u>				
Female	Male	18–29	30–39	40–49	50–59	60+
512	506	199	162	169	161	327

<u>Technology</u>				
DSL	Cable modem	Optical fibre	Wireless access	Other/Not sure/ No answer
83	124	412	184	215

In addition, case studies were conducted for cities of various sizes in Sweden and for Nuënen in the Netherlands. For these WIK-Consult used desk research as well as telephone and personal interviews with stakeholders in the municipalities considered.