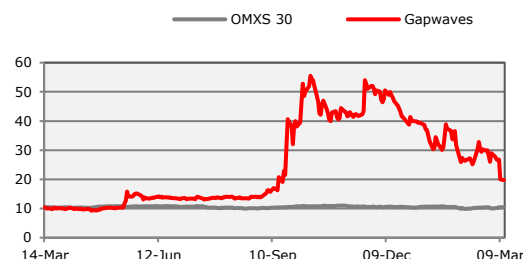


Summary
Gapwaves (GAPWB.ST)
Connecting the future

- Gapwaves potential is found in the offering of antennas built on the Gap waveguide technology, allowing for more efficient wireless connectivity than alternative existing technology.
- The company's great opportunities arise with the development of next-gen telecommunications network 5G and automotive radar applications, opening up for significant revenues if Gapwaves succeeds in attracting large clients within the segments.
- We initiate coverage of Gapwaves with a fair value of SEK 19 per share in base case. Our fair value range is between SEK 6.5 per share in bear case and SEK 43 per share in our positive bull case.

List: First North
 Market Cap: 406 MSEK
 Industry: Telecommunication Equipment
 CEO: Lars-Inge Sjöqvist
 Chairman: Lars Granbom

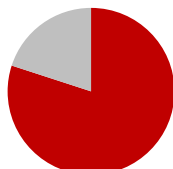

Redeye Rating (0 – 10 points)

Management



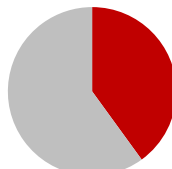
5.0 points

Ownership



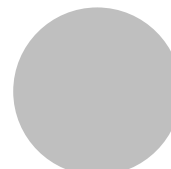
8.0 points

Profit outlook



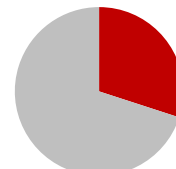
4.0 points

Profitability



0.0 points

Financial strength



3.0 points

Key Financials

	2016	2017	2018E	2019E	2020E
Revenue, MSEK	2	1	9	29	74
Growth	0%	-43%	973%	207%	158%
EBITDA	-3	-24	-31	-21	2
EBITDA margin	-168%	-2,736%	-329%	-73%	3%
EBIT	-4	-27	-35	-25	-4
EBIT margin	-239%	-3,097%	-372%	-87%	-5%
Pre-tax earnings	-4	-27	-35	-25	-4
Net earnings	-4	-27	-35	-25	-4
Net margin	-242%	-3,132%	-375%	-87%	-5%
Dividend/Share	0.00	0.00	0.00	0.00	0.00
EPS adj.	-2363.93	-1.53	-1.31	-0.93	-0.14
P/E adj.	0.0	-26.3	-15.4	-21.5	-143.5
EV/S	-13.6	805.9	46.4	16.5	6.8
EV/EBITDA	8.1	-29.5	-14.1	-22.8	244.9

Share information

Share price (SEK)	22.7
Number of shares (m)	26.9*
Market Cap (MSEK)	609*
Net cash (MSEK)	15
Free float (%)	62 %
Daily turnover ('000)	100
*based on full subscription of rights issue	

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Important information: All information regarding limitation of liability and potential conflicts of interest can be found at the end of the report.

Redeye Rating: Background and definitions

The aim of a Redeye Rating is to help investors identify high-quality companies with attractive valuation.

Company Qualities

The aim of Company Qualities is to provide a well-structured and clear profile of a company's qualities (or operating risk) – its chances of surviving and its potential for achieving long-term stable profit growth.

We categorize a company's qualities on a ten-point scale based on five valuation keys; 1 – Management, 2 – Ownership, 3 – Profit Outlook, 4 – Profitability and 5 – Financial Strength.

Each valuation key is assessed based a number of quantitative and qualitative key factors that are weighted differently according to how important they are deemed to be. Each key factor is allocated a number of points based on its rating. The assessment of each valuation key is based on the total number of points for these individual factors. The rating scale ranges from 0 to +10 points.

The overall rating for each valuation key is indicated by the size of the bar shown in the chart. The relative size of the bars therefore reflects the rating distribution between the different valuation keys.

Management

Our Management rating represents an assessment of the ability of the board of directors and management to manage the company in the best interests of the shareholders. A good board and management can make a mediocre business concept profitable, while a poor board and management can even lead a strong company into crisis. The factors used to assess a company's management are: 1 – Execution, 2 – Capital allocation, 3 – Communication, 4 – Experience, 5 – Leadership and 6 – Integrity.

Ownership

Our Ownership rating represents an assessment of the ownership exercised for longer-term value creation. Owner commitment and expertise are key to a company's stability and the board's ability to take action. Companies with a dispersed ownership structure without a clear controlling shareholder have historically performed worse than the market index over time. The factors used to assess Ownership are: 1 – Ownership structure, 2 – Owner commitment, 3 – Institutional ownership, 4 – Abuse of power, 5 – Reputation, and 6 – Financial sustainability.

Profit Outlook

Our Profit Outlook rating represents an assessment of a company's potential to achieve long-term stable profit growth. Over the long-term, the share price roughly mirrors the company's earnings trend. A company that does not grow may be a good short-term investment, but is usually unwise in the long term. The factors used to assess Profit Outlook are: 1 – Business model, 2 – Sale potential, 3 – Market growth, 4 – Market position, and 5 – Competitiveness.

Profitability

Our Profitability rating represents an assessment of how effective a company has historically utilised its capital to generate profit. Companies cannot survive if they are not profitable. The assessment of how profitable a company has been is based on a number of key ratios and criteria over a period of up to the past five years: 1 – Return on total assets (ROA), 2 – Return on equity (ROE), 3 – Net profit margin, 4 – Free cash flow, and 5 – Operating profit margin or EBIT.

Financial Strength

Our Financial Strength rating represents an assessment of a company's ability to pay in the short and long term. The core of a company's financial strength is its balance sheet and cash flow. Even the greatest potential is of no benefit unless the balance sheet can cope with funding growth. The assessment of a company's financial strength is based on a number of key ratios and criteria: 1 – Times-interest-coverage ratio, 2 – Debt-to-equity ratio, 3 – Quick ratio, 4 – Current ratio, 5 – Sales turnover, 6 – Capital needs, 7 – Cyclicity, and 8 – Forthcoming binary events.

Investment case

- Technology improving power efficiency
- 5G brings significant opportunities
- Yet, an uncertain value proposition

Technology improving power efficiency. Gapwaves has a first mover advantage in its antennas that are 4-10x more power efficient in an active setting than other existing technology (depending on configuration and setup). The antenna is expected to incur substantial advantages in communication and automotive radar applications by improving power efficiency and the possibility for production at lower cost. It is, however, of significant importance to show that there is a commercial interest in the company's antennas. We, therefore, regard a potential non-recurring engineering (NRE) agreement with a telco or an automotive radar supplier to be the most likely important catalyst that could drive the stock within the coming year, as it would indicate that clients truly are willing to pay to access the technology.

Supportive analysis:

The efficiency of the company's solution is shown in a case study where Gapwaves antenna is compared to current State-of-the-art technology. The simulations show that Gapwaves solution incur higher output power of the transmitter, due to better cooling, and higher antenna directivity (the concentrated radiation in a single direction) while reducing the power losses. These three factors finally results in a higher equivalent isotropic radiated power (EIRP), a measure undertaken to compare the concentrated signal output power, than the state-of-the-art solution. The theoretical implication of this is that the alternative solution must increase the power consumption by a factor 10 in order to achieve the same EIRP. The practical meaning is that Gapwaves antennas could be used in longer distances, which will be a very important factor in upcoming 5G networks operating on higher frequencies. The antenna has further characteristics that makes it possible to produce at lower cost, which is another critical factor as 5G solutions must be commercially viable.

5G brings significant opportunities. There is no lack of opportunities as the company is targeting sizeable markets with a technology shown to be more efficient than alternative solutions. The greatest potential arises with the upcoming 5G roll-out, which is expected to bring substantial network investments. Although several vendors and operators already have initiated 5G trials, the greatest infrastructure investments are expected to take off beyond 2021. There will be a need of antennas in upcoming macro base stations, small cells and radio remote heads (RRH).

SNS research estimates more than 4.3m RRHs, macro and small cells to be shipped in 2025, which implies an addressable antenna market worth about USD 1bn during the same year. The communications market is further highly concentrated, implying that an agreement with one key vendor would generate significant revenues for Gapwaves. We, therefore, believe that it is of the highest importance to exploit the company's current first mover advantage by becoming the antenna provider in a telco's 5G deployments. Gapwaves could thereby become part of the client's system, supporting the company's ability to achieve long-run growth.

Yet, an uncertain value proposition. It is possible that Gapwaves, with complex products and strong technological expertise, will be able to fend off competition for a longer period of time. But technology improves rapidly and we are not convinced that Gapwaves offering will face a long-term demand. It is currently difficult to assess whether the technology will be indispensable to the customers, as we yet cannot see if there is a demand from the customers. If the company would succeed in delivering an active antenna solution solving genuine needs, we would be convinced that it implies a solid market opportunity - reflected by our bull case. This especially holds as there, as of today, is no commercially viable technology with the same promising characteristics. Until we see a deal with a key vendor, it is difficult to assess whether the product really should be regarded as a 5G enabler. If Gapwaves offering truly is crucial to the customers by improving the customer's ability to rapidly gain market share, we also believe that this might as well constitute an acquisition case. If the product, however, regards a nice to have feature, we believe that Gapwaves should be considered an actor with weak bargain and pricing power, which is captured in our bear case.

Bear-points (counter-thesis)

- **Targeting markets that are tough to penetrate**

The company is targeting markets that offer enormous opportunities. This implies that there will be more than one actor trying to reap from the arising opportunities. This further points to another challenge for the company, namely that potential customers develop alternative solutions in-house. These actors have established research organizations and the capital needed to pursue R&D activity and could thereby reduce their dependency of external component suppliers.

- **Small player with limited organizational abilities**

We are not convinced that the company's current organization would be able to serve several demanding clients simultaneously. The recent recruitments of senior staff are, however, bringing extensive telecommunications experience and improves the company's possibilities to run parallel projects (and further adds some validity to the company's technology).

- **Uncertainties regarding next-gen networks**

There are yet several uncertainties regarding the specifications of next-gen networks and which equipment that will be used. This may impose that clients are more reluctant to invest in new technology and equipment. The uncertainties are, on the other hand, nothing that hinders clients from testing new equipment.

Catalysts

- **NRE agreement (0-12 months)**

An NRE-agreement (where clients' bear one-time costs related to R&D project) signed with either a telco or automotive radar supplier would indicate that there truly is a commercial interest for Gapwaves technology. We would especially like to see an agreement with a telco given the financial opportunities arising with the introduction of 5G. It is furthermore important that such an agreement is signed within the coming year to utilize the first-mover advantage and integrating the antenna components with clients' systems – which potentially could protect the company from being substituted in the long run.

About Gapwaves

Gapwaves, founded in 2011, offers wireless communication products based on the GAP waveguide technology, which stems from the research of the late founder Professor Per-Simon Kildal at Chalmers University of Technology. The company's potential is found in millimeter wave antennas, built on the patented gap waveguide technology, that can be applied in radio links and eventually in active (software steered) antennas, automotive radars and smartphones. The company is also providing antennas and waveguides for niche segments such as military defense industry and scientific laboratories.

Today

Gapwaves was listed on Nasdaq First North the 11th of November 2016, where the company issued units, consisting of one B-class share and one option, at SEK 5.95 per unit. The company raised SEK 23.8m before transaction costs at a pre-money valuation about SEK 50m. The share price has increased substantially since then and is currently trading around SEK 22.7 per share.

*Promising technology
opens up large
opportunities*

The company is in possession of a unique waveguide technology allowing for high-speed communication transfers with lower losses compared to alternative existing technologies. Gapwaves antennas thereby open up for great opportunities during the extension of sub-6, 4.5G, and, subsequently, the build-up of 5G networks. The current level of net sales is still low and amounted to SEK 0.9m during FY 2017. Focus during the previous year has been on initializing sales discussions with the largest telco's and automotive radar suppliers, staffing the organization and signing a memorandum of understanding regarding the development of active antennas with Jarjet Technologies. The company is now entering 2018 with a focus on selling gap antennas (E-band) for radio link applications before increasing the efforts in delivering antennas for applications within 5G and automotive radar.

Gapwaves' organization has grown rapidly during the recent year, from 3 employees in 2016 to enter 2018 with 17 employees and additional consultants. Interesting is that the company has recruited several employees with substantial experience from the telecommunications industry after working at Ericsson.

Gapwaves has recently announced that the company is conducting a rights issue that will bring SEK 152m (before transaction costs) at full subscription, where 8.96m new shares are offered at a price of SEK 17 per share. There is further an overallotment option that could bring an additional SEK 30.6m before transaction costs. Full subscription of the issue and the overallotment option would thereby increase the number of shares by 10.76m, corresponding to a dilution about 38%.

Management

Lars-Inge Sjöqvist holds the CEO position since 2014. Before joining Gapwaves, Lars-Inge has held several management positions at the tech company Semcon AB, where he also held the CEO position for a short period. Lars-Inge has further been chairman of the board in Trebax (today owned by Sivers IMA) and board member in Bluetest (reverberation chamber). All other management positions have, however, been appointed during 2017 and 2018, implying that Gapwaves' management team is a relatively new constellation.

Gapwaves: Management			
Name	Position	Joined	Ownership
Lars-Inge Sjöqvist	CEO	2014	888 900 shares, 100 000 options
Per Andersson	CFO	2017	2 000 shares, 50 000 options
Johan Andrén	COO	2017	7 500 shares, 50 000 options
Thomas Emanuelsson	CTO	2017	50 000 options
Martin Lundkvist	Sales & Marketing Director	2018	50 000 options
Charlotte Elmquist	VP Supply	2017	50 000 options

Source: Gapwaves

Numerous employees with experience from the telecommunication industry

Our view is that the company has strengthened their organization in order to benefit from the upcoming opportunities, where we especially value that several recent recruits have strong experience from the telecommunications sector after working at Ericsson, which we believe will be vital to capitalize on the 5G opportunity. As an effect of that several members joined in 2017, the shareholding among the management team is not as high as we ideally would have wished for. Please see the appendix for more information about the management members.

Board of Directors

The position as Chairman of the board (CoB) is held by Lars Granbom since 2016. Granbom has vast experience in the sector after working for companies such as Sivers IMA, Trebax and SAF Tehnika. Granbom has also held the position as CEO at Raybased. Jan Wäreby adds significant telecommunication industry experience after holding several management positions at Ericsson. Olle Axelsson is another important board member with experience from the automotive industry.

Gapwaves: Board of Directors			
Name	Position	Joined	Ownership ¹
Lars Granbom	Chairman of the board	2016	159 000 shares, 50 000 options
Cécile Schilliger	Member of the board	2016	5 618 000 shares
Lars-Inge Sjöqvist	Member of the board	2014	888 900 shares, 100 000 options
Jan Wäreby	Member of the board	2017	50 000 options
Olle Axelsson	Member of the board	2017	50 000 options

¹ Private and through company holdings

We like that three of the company's board member possess large holdings of Gapwaves shares, where Cécile Schilliger stands out as the biggest owner of 5 618 000 shares (about 60% of the votes) in Gapwaves. Cécile Schilliger is a representative of the majority owner Kildal Antenn.

Apart from large holdings, we find it crucial that the board members have experience from the telecommunication and automotive markets. See the appendix for more details about the board members.

Ownership

Gapwaves: Ownership			
Rank	Owner	Capital (%)	Votes (%)
1	Kildal Antenn AB	31.3%	60.1%
2	Avanza Pension	5.1%	1.0%
3	Nordnet Pensionsförsäkring	4.7%	0.9%
4	Actionstep AB	4.7%	9.1%
5	Leif Hagne	4.5%	0.9%
6	Jian Yang	3.4%	6.5%
7	Bright Peter Leo Ebenezer	2.9%	0.5%
8	Ashraf Uz Zaman	1.5%	2.8%
9	Sjoerd Haasl	1.0%	2.0%
10	Peter Enoksson	1.0%	2.0%

Source: Holdings per 2017-12-31

Large CEO ownership

The company's largest owner is Kildal Antenn, which is controlled by the family of the late Per-Simon Kildal. CEO Lars-Inge Sjöqvist is holding 9.1% of the votes through the company Actionstep, which we find positive. It is also noteworthy that several researchers from Chalmers Institute of Technology that has been involved in research connected to Gapwaves is present among the largest owners.

Options

Gapwaves has so far issued two option programs. The first program, TO1, was issued during the IPO. 6.4m of the outstanding options were exercised, which generated SEK 23.5m in cash and increased the number of outstanding shares to 17.9m. The second program, TO2, was issued in April 2017 towards management and employees. The number of outstanding options is 582 000, which can be converted into 582 000 shares at a price of SEK 13 per share and are thus in-the-money at today's share price of SEK 22.7 per share. The TO2 options were issued at a price of 1.9 SEK per option.

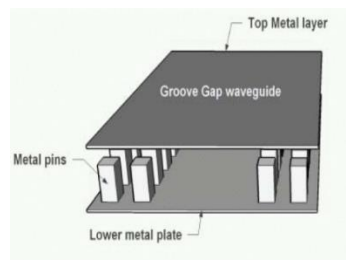
Gapwaves: Options				
Issued	No of options	Last exercise date	Strike price	No of shares
April 2017	582 000	29th of May 2020	13	582 000

Source: Gapwaves

Product and technology

Gapwaves offering consists of products derived from the research of Professor Per-Simon Kildal and his research group, active at Chalmers University of Technology. Per-Simon was a distinguished researcher within antenna theory and electromagnetics and is the founder of the **Gap waveguide technology**.

The gap waveguide is a technique of constructing waveguides within the millimeter wave (mmwave) spectrum. The waveguide is, somewhat simplified, consisting of a flat metal surface with a pattern of spikes/pins guiding the signals and another flat metal surface on top of the spikes, sealing the waveguide. The technology is promising as it reduces power losses, enables for high antenna efficiency and the possibility to produce components at low cost. The technology further enables integration of component for steerability (active antennas), which has potential to establish more reliable high-speed networks. The gap waveguide technology has gained interest as the above features open up opportunities in the coming 5G development as well as in automotive radars.



Millimeter waves

The mmwave spectrum is between the frequencies 30 GHz to 300 GHz, where the length of the radiowaves range from 1 to 10 millimeters. The advantage of the mmwave technology is that it operates on high frequencies and thereby allows for high-speed data connectivity with potential transfer speeds towards 10Gbps. The downside of using mmwave is that the short waves have problems in transmitting through physical objects, for example walls, and is further sensitive to certain weather conditions such as rain and fog (due to high atmospheric attenuation). It is therefore important that the antennas are steerable to make more efficient use of the radiated power, and consume little power to be installed in a network of densely built base stations.

Gapwaves offering is not limited to mmwave products, but also offers antennas for applications high demanding communication niches. The company's current offering consists of three categories: GAP antennas, wideband antennas and the gap flange adapter.

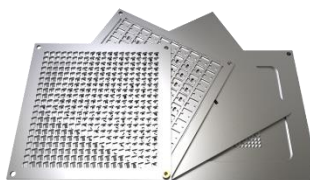


The products that are expected to generate revenues in the short-run are gap antennas for point-to-point, wideband antennas and the gap flange adapter. We believe that revenues from automotive radar applications could arise in 2019 at earliest while expecting greatest financial potential in 5G applications beyond 2020.

GAP antennas

The antenna is an important component addressing what distance and noise a communication system can handle. The gap waveguide technology opens up great opportunities in mmwave applications by allowing for highly energy efficient antennas. The antennas further have physical advantages as they are flat and of small size. The GAP antennas are constructed to operate in communication in frequencies exceeding 30 GHz as well as in the coming 5G network (the technology works in frequencies between approximately 15 – 200 GHz). There are currently antennas of different sizes for the E-band (range of frequencies between 71-86 GHz) and V-band (57 – 71 GHz).

The GAP antennas can be used in both passive and active settings (more on this under the active antenna section). The planar antennas are advantageous as they enable for high transfer speeds, are small, can be produced at relatively low costs and the fact that it enables for steerability. The GAP antenna is not only promising in an active setting, as it initially opens up opportunities during the extension of current radio links networks. One example is the build-out of Massive MIMO (setting with multiple transmitting and receiving antennas) networks, which is expected before the introduction of a 5G network based on mmwaves. These installations will require high data bandwidth radio links to transport data back to the core network. This bandwidth is available in the mmwave bands and initial deployments of the gap antennas will thus be in point-to-point setups supporting the build-out of Massive MIMO networks.

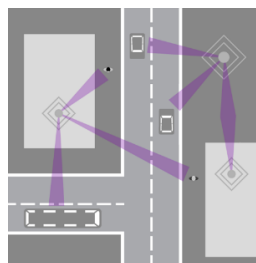


The GAP antenna is deployable in different setups and will, therefore, be tailored depending on the needs of specific clients. Areas of application are found in communication networks (radio fronthaul networks, 5G backhaul networks and fixed wireless access) and in automotive radars.

5G & Active antennas

The gap antenna has been proven to open up opportunities in the coming 5G development as it is efficient at high frequencies and enables for steerability. This implies that the antennas could be digitally steered by integrating active components in the antenna, meaning that the antennas could change transmitting direction without being physically moved. The concept is called beamsteering and is promising as it enables for point-to-multipoint communication, meaning that one antenna could reach several receiving units instead of being limited to one fixed unit.

This is advantageous as it is possible to optimize the data traffic by opening up for mesh networks of small cells where the data traffic is directed depending on the network usage in order to avoid overload.



By the introduction of 5G, the access network (the connection between base stations and end users) is expected to expand with millions of new cells built closer to the end users. An increased density of the base stations will be required to transfer data in higher frequencies and active antennas could thereby help to overcome problems of path loss and line-of-sight by steering the antenna towards the groups of users that are actively using the network.

There is, however, a need for development of a radio chip that enables the concept of active antennas. Gapwaves is currently working on showing proof-of-concept of an active antenna together with the American company Jarjet Technologies, a manufacturer of digital microwave integrated circuits. Gapwaves announced that the parties had signed a Memorandum of Understanding regarding the development of an active antenna at the beginning of November 2017 and further demonstrated the way of constructing the active antenna during Mobile World Congress at the end of February.

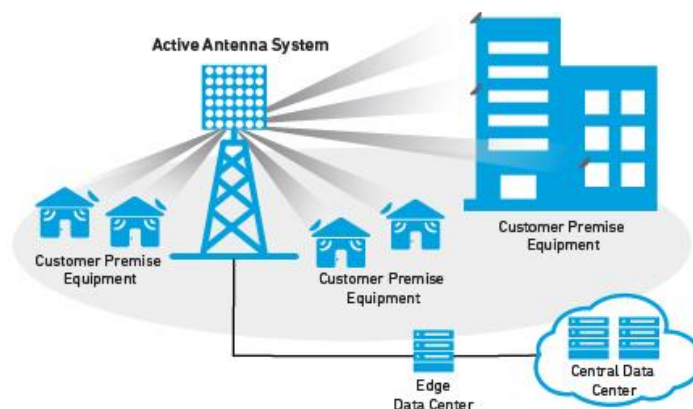
There is yet a great deal of uncertainty regarding the upcoming 5G development as there is no exact standardization and requirements set for the upcoming standalone 5G network. Standards will be set by ITU (International Telecommunication Union) and the industry organization 3GPP. An initial step will most likely be an increased efficiency of the existing LTE networks before implementing a standalone 5G network. The new access network is called 5G NR (New Radio), which initially is expected to operate together with existing LTE Networks (non-standalone).

Actively working to demonstrate concept of active antennas

The standards for the standalone 5G NR is expected to be finished during the summer of 2018.¹ As there will be a need of using higher frequency bands due to requirements of higher data transfer speed and low capacity in existing frequency bands (low mobile cellular spectrums are occasionally congested), there will be a need of using new spectrums in the upcoming 5G network. It is yet unknown which specific bands that will be used in the next generation telecommunications network. Although the spectrum most likely will be 24 – 42 GHz depending on geographical location, there are some mmwave spectrums will be allocated first during WRC-19, held in 2019.

Fixed wireless access (FWA)

One of the initial use cases driving the 5G development is fixed wireless access, where broadband is provided to households by wireless networks instead of delivering wired solutions such as fiber or copper. Operators would thus set up new base stations which will communicate to households wirelessly instead of providing optical fiber all the way to the home (FTTH). FWA is not a new concept but has lately gained an increased attention as 5G is expected to generate about 10 to 100 times the capacity of 4G and would thus work as both a substitute or complement to the FTTH solution. This opens up an opportunity for Gapwaves as it would require that the base stations and households are equipped with high-speed antennas (such as the gap antenna) in order to deliver high-speed connectivity to the end-users. Although all 5G standards are not fully defined, there are vendors that have invested in 5G networks and initiated 5G FWA trials.



Source: Qorvo, Inc.

¹ <https://www.sdxcentral.com/articles/news/3gpp-approves-first-5g-specification/2017/12/>

*FWA enables quicker
installment at lower costs*

Optical fiber imposes higher data transfer speeds but does require a physical connection (cable) between the communication points. The advantage of using FWA is that it is not as expensive to set up compared to FTTH as it does not require the operator to dig and lay fiber or copper cables all the way to the end users, significantly reducing the installment costs. The market intelligence firm SNS expect that FWA could lower the initial connectivity installment costs with up to 40% compared to FTTH². Apart from lowering installment costs, FWA is also advantageous in terms of roll-out speed as the installment process is not as time-consuming. Finally, FWA is expected to also be cost beneficial in terms of operational costs due to the eliminated requirement of last-mile cables. FWA might thus be a good solution in areas where it is difficult to dig ditches and lay new cables, such as densely built areas.

Automotive radar

The third relevant area of application of the GAP antenna is found within automotive radars. Automotive radars are used to detect objects such as other vehicles or persons by the use of a transmitter and a receiver. The transmitter is thereby transmitting signals that bounce upon hitting a target, which then will be read by the receiving unit. It is thus possible to detect and read the distance, speed and directions between the vehicle and the object. Other technologies, such as the use of laser (LiDAR) or camera, have some drawbacks compared to a radar. The radar is, for example, able to detect objects in bad weather conditions (such as fog) where both laser and camera might have difficulties in reading objects.

The most common radar segment by band is UWB³. 77GHz (71-86 GHz) and 24GHz radio chips are, however, beneficial due to its broad functionality where the radars could be used for different distances ranging from 5cm to over 100m depending on the antenna setup. This would be advantageous for the automotive producers as the same radar could be applied in applications that require short distance sensors as well as long-distance sensors. Increased sensor precision will be required for usage of various proactive safety functions, which is why it is beneficial to use systems on high frequencies and bandwidth as it increases the range and velocity resolution.

*GAP antenna could
disrupt existing radar
antennas*

Higher frequencies would further incur that it is possible to reduce the size of the components and would further be beneficial in terms of production costs. Automotive applications are further interesting as the GAP antenna could replace existing antennas without too demanding modification processes. It is yet important to emphasize that there to date is no gap antenna that has been applied in automotive radars.

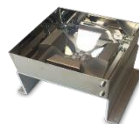
² SNS Research, "5G for FWA (Fixed Wireless Access): 2017-2030"

³ Accuracy Research, "Global Automotive Radar Market Analysis & Trends"

The company has, however, announced that a pre-study regarding an automotive radar prototype has been initiated together with MobilityXlab. MobilityXlab is a cooperation founded by Autoliv, Ericsson, Volvo and Zenuity with the intention to develop solutions for future automotive applications. The study is expected to last for one month before a decision regarding further development of a radar with Gapwaves antenna is taken.

Bowtie

Another antenna offered by Gapwaves is the Bowtie antenna. The bowtie antenna comes in two forms; standalone (700 MHz-6 GHz) and Smart-Bowtie. The Bowtie is an ultra-wideband (UWB) antenna, meaning that the antenna serves in an extremely wide band, which is advantageous as one can use the same antenna to cover different frequencies. Gapwaves' bowtie antenna is of compact size and has been shown to incur low transmission losses.



The standalone Bowtie is relevant for application within communication (in sub-6 Massive MIMO networks) and scientific laboratories. The antenna will be delivered in different settings depending on clients' demand, where it could be offered just as a separate antenna or in an array of antenna elements (with potential to integrate up to 64 antenna elements in an array). It can further be delivered together with the Gap waveguide technology (to solve integration with the electronics).

It is important to emphasize that there is no standard set for the upcoming 5G network and that the development of 5G will be based on a variety of spectrum bands. Introduction of sub-6 GHz (technology making use of frequencies below 6 GHz) is important to open up for flexible 5G use cases as various spectrums impose different pros and cons. In short, the sub-6 GHz is advantageous in terms of lower path loss and less line-of-sight dependency and could thus be employed as a stable base while the mmwave spectrum is useful for transmitting connectivity at higher data rates. The antenna is also currently being used in the Gothenburg based company Bluetest's reverberation chamber testing antenna's efficiency and diversity gain.

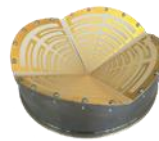
Bowtie could also be advantageous in smartphones

The Bowtie antenna, then referred to **smart-bowtie**, has also been shown to have potential mobile phone applications (where the antenna is integrated in circuit boards) as it simultaneously covers different spectrums and frequencies to achieve high efficiency. Different from the standalone bowtie, this would primarily be interesting for frequencies above 20 GHz. The antenna is promising as 5G networks are expected to operate on the frequencies between 24 – 42 GHz (depending on geographical location), where a single smart bowtie antenna thus would be able to cover the entire range of frequencies.

The antenna will most likely need integration with the gap waveguide technology operating at frequencies above 28 GHz. This is a potential application which currently is being examined in a research project held at Chalmers together with Ericsson, Sony and Leax Arkivator, expected to be completed in 2019. We thus regard this as a long-run opportunity which would be relevant first as 5G subscriptions take-off, which should be around 2022-2023 according to Ericsson⁴.

Eleven feed

The second UWB antenna offered by Gapwaves is the Eleven feed antenna. The technology is employed when there is a need for high bandwidth communication over a broad spectrum with a high antenna sensitivity. The eleven feed antenna is not as compact as the bowtie, but serves a wider band which makes it suitable for application areas with high demanding niches such as radio astronomy, military surveillance systems and EMC test chambers. Gapwaves Eleven feed is advantageous as it operates over a very wide band, is of small and compact size and thereby easy to move. The antenna is made on request and designed/modified according to clients' need and is not a product sold in greater volumes given its niche applications.



Gap flange adapters

Gapwaves first commercially available product is the gap flange adapter, which is used to connect waveguide components. The application areas are assembly of measurement circuits in laboratory and industrial applications. The benefits of using Gapwaves flange adapter is that it eliminates the requirement of assembling waveguides and components with screws as no electrical contact is required. The adapter further incurs low losses in high-frequency circuits. The gap flange adapters will mainly be sold through distribution partners but are also retailed in the company's online sales platform at € 500 per adapter.

Intellectual property

Gapwaves has about 22 different patents covering the Gap waveguide technology, the Eleven feed antenna and well as the Bowtie antenna. All of the company's current offerings is thereby covered by the patents. The base patent for the gap waveguide technology was registered in China, Japan and the US in 2008 and will thus hold for about 10 other years. Gapwaves is further owners of a patented technology called Comhat (a compact parabolic antenna), which generated license revenues about SEK 0.6m in 2017.

⁴ Ericsson, "Mobility Report" (November 2017)

Business model & strategy

Strategy

The company's business model is built on sales of antennas and gap flange adapters. There is no general pricing strategy applied to all products, but the pricing will rather depend on technology, application and clients. As an example, the eleven feed antenna is offered towards high demanding clients at a price up to 0.3m per antenna, while the gap antenna for automotive applications is expected to be sold at a price around SEK 70-100 per antenna in greater volumes.

Gapwaves is targeting sizeable markets dominated by a few large actors. The company has stated that it initially has no intentions of establishing a partnership with a large telco that would give the counterparty exclusive rights to Gapwaves' antenna. We, however, believe that giving one client exclusive rights to the technology could become relevant if the company succeeds in signing partnerships with one actor within each of the communications & automotive markets.

The company's focus in near-time is to sign NRE's (joint development projects) where Gapwaves is paid to design their antenna to fit in clients' systems and thereby becoming a part of the clients' system. Gapwaves will further focus on selling antennas for point-to-point application in extensions of the current radio link network while demonstrating proof-of-concept of active antennas together with Jarjet. If successful, the final offering will either be combined (with Jarjet's chip and Gapwaves antenna) or individually (where the companies target telco's with their respective offerings). We believe the demonstrator to be of uttermost importance given that the company's greatest financial potential arise with the 5G opportunity where the GAP antenna imposes several advantageous properties.

Important to demonstrate the concept of active antennas

If the development of the smart Bowtie antenna succeeds, we believe that the most likely outcome would be that Gapwaves license out the technology due to the competitiveness of the smartphone market.

Gapwaves has grown its organization rapidly during the recent year and increased its sales efforts towards large telecommunication vendors. We find this necessary for the company to succeed in delivering antennas for both 5G and automotive applications, given that the company is targeting markets and companies that generally are difficult to penetrate.

The company's primary focus is to go from being an engineering company to actually produce commercially viable products. This is important to both materialize on the 5G opportunities in time but also not to lose the value of the company's intellectual property.

Research and Development

R&D is performed in-house, together with scientists at Chalmers as well as with partners such as Jariet. The company's current offering is built on the research of Per-Simon Kildal which was active at Chalmers. Gapwaves has since then remained its close contacts with several researchers, which still is performing research that is important for the company. Several scientists are further found among the top 10 shareholders and the company's CTO is an adjunct professor at Chalmers, which clearly illustrates the company's close-knit to Chalmers.

An example of the company's rather dynamic R&D environment is found in the project concerning Smart-bowtie which is held together with Chalmers, Ericsson, Sony and Leax Arkivator Telecom. This illustrates how the R&D is performed depending on potential use case and stakeholders.

Sales strategy

Gapwaves sales strategy involves direct sales towards large potential clients and the use of sales partners for other clients. The company currently has three sales partners that cover distribution of its products in Asia together with Cornes Technology, Dymstec and Electronic Scientific. Our perception is that Gapwaves strategy with the sales partners is to benefit from the companies established relationship with potential clients within telecom and automotive that are of large interest for Gapwaves. The distribution agreements cover all Gapwaves products that have been developed to date (i.e. flange adapters, point-to-point, eleven feed and bowtie antennas).

We find the increased emphasis on showing proof-of-concept of active antennas to be of uttermost importance in the company's current phase. We furthermore believe it has been necessary for the company to staff the organization and put specific value in that several recent recruits have a background from working at one of the largest potential clients (Ericsson). This is especially important in Gapwaves' stage of going from being a small research company to becoming a potential supplier of components to significant markets.

The company has a technological advantage in its offering and aims to become a part of potential clients' systems. We have, however, not identified any other factors that will constitute long-term competitive advantages protecting Gapwaves long-run growth.

Market

The following section covers summaries of the markets that we find most important for Gapwaves. The following section thus discusses the 5G, FWA and automotive radar markets.

5G

5G opens up an enormous financial opportunity

Gapwaves financially most promising opportunity is rising with the development and roll-out of coming 5G networks driven by significant increases in data usage. The increasing data usage implies requirements of a next-generation network with higher capacity, data rates and latency to support both the current usage and future use cases that is expected to increase the data traffic additionally. Apart from increased capacity, 5G will also require broad coverage. One can thus state that there is and will be a need of a 5G network, but there is still a great deal of uncertainty concerning the network setup, its development and launch as there currently is contingency regarding standards as well as the timing of expected large-scale commercial roll-outs. Use cases that drive the development of the 5G technology are found in areas such as eMBB (enhanced mobile broadband), fixed wireless access, massive and critical IoT as well as several new industrial use cases.

Data traffic

Ericsson has stated that the total data traffic grew by an astonishing 65% between Q3'16 and Q3'17⁵. The company further estimates that the total worldwide mobile data traffic will grow at a CAGR of 42% between 2017 and 2023, to reach 100 ExaBytes on a monthly basis in 2023 (compared to today's level of 14 EB) and thereby illustrating the need of a network with greater capacity. There is yet a great variability among the expected timing of 5G deployments. Several sources indicate that 5G will be launched in 2020, but it is important to point out that this usually refers to initial 5G deployments. Common for all industry reports is that the development is expected to be gradual just as with the previous 3G and 4G networks. An interesting notion is, however, that the total 5G roll-out time is expected to be shorter compared to the roll-out of 3G and 4G networks.

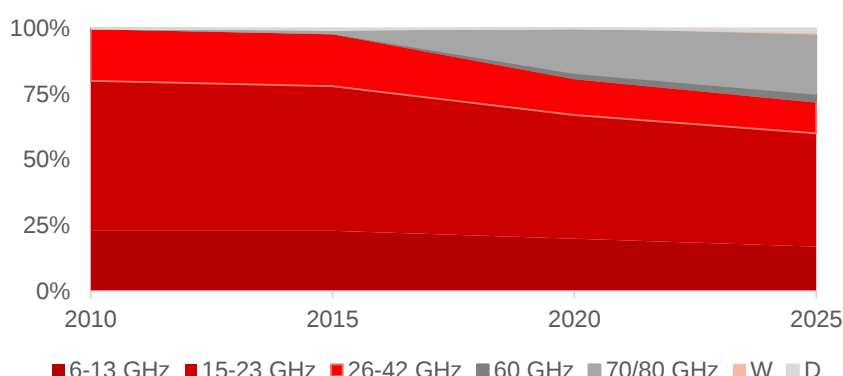
The Swedish consultancy firm Northstream estimates that the 5G currently will be in a stage of trial, where new technology is being developed and tested while new network standards are being set, until 2020 where initial deployments are expected⁶. The consultancy firm expects that a mass adoption will not happen before 2023.

⁵ Ericsson, "Mobility Report" (November 2017)

⁶ Northstream, "How will 5G happen" (September 2017)

Ericsson estimates that initial commercial standalone 5G NR deployments will occur in 2019 followed by major deployments the following years. GSMA intelligence estimates that the global 5G coverage will be 34% by 2025⁷. The same report further entails a CEO survey indicating that 38% of telco CEO's are planning a commercial roll-out between 2020 and 2025, whereas 36% have planned to start before 2020. The research company SNS estimates that 5G will bring annual infrastructure investments around USD 28bn by 2025.⁸ More interesting is the estimated shipments of macro base stations, small cells and remote radio head which together is expected to exceed 4.3m units in 2025.

New deployments by frequency



Source: Ericsson, Microwave outlook report 2017

There will also be a difference in timing of roll-out between frequencies, where the 28 GHz frequency band most likely will be used in early roll-outs for FWA applications. E-band deployments (70/80 GHz) is, however, expected to grow at the highest CAGR during the coming years before accounting for approximately 20% of new deployments by 2025 according to Ericsson. The timing of deployment of higher spectrums is, as mentioned, dependent on the allocation decisions that will be taken during WRC-19.

Region

There is further a variation between geographical regions where Asia and North America currently are in the 5G deployment forefront, while EU is struggling with fragmentation that lumbers the development. Asia's strong position is proved by trials that already has been initiated in Japan and South Korea (where KT has stated that 5G will be launched commercially already in 2019⁹), whereas 5G deployment in North America is expected to be driven by domestic competition, especially regarding setting up fixed wireless access networks.

⁷ GSMA Intelligence, "The 5G era: Age of boundless connectivity and intelligent automation"

⁸ SNS Research, "5G for FWA (Fixed Wireless Access)"

⁹ <https://www.rcrwireless.com/20170525/5g/south-korea-launch-first-commercial-5g-network-2019>

Ericsson estimates that this pattern will prevail during the roll-out, where 5G is expected to make up for about 37% of all mobile subscriptions in North America, whereas the corresponding statistic for North East Asia is 34% and Western Europe is 16% by 2023. 5G is further, just as with 3G and 4G, estimated to initially be deployed in urban areas before increasing the coverage during the later roll-out phase.

Challenges

Building a new network come at a significant cost, which is why there is a need of clear business cases with large revenue streams for the large telco's to undertake the investments needed to launch a large scale roll-out. High CAPEX limitations imply constraints on the investments that telco's are willing to make and the potential return on 5G investments will, therefore, be crucial in determining the speed of the development and roll-out. This is important as operators want to achieve return on the investments already made in 3G and 4G before investing substantial amounts into new networks.

It is furthermore important to avoid technology fragmentation leading to different network setups driven by actors desire to rapidly deploy the next-gen mobile network. It is thus desirable that various market actors adopt a common infrastructure standard concerning technology and spectrums to avoid problems of interoperability. The 5G development is heavily dependent on industry standards and regulations. It is, therefore, of uttermost importance that policymakers are open and accommodating regarding spectrum licensing to avoid technology fragmentation.

Apart from the above mentioned challenges, it important to emphasize that 5G impose great opportunities for operators to turn the ongoing downward trend in revenue growth, which is why 5G attracts such immense interest¹⁰.

Fixed wireless access

One of the initial 5G use cases is FWA, which currently is a strong driver of 5G investments. FWA is a strong driver of the North American 5G deployment where operators have identified potential for great revenues, where small-scale roll-outs are expected to occur already in 2018 before a large scale launch is expected after 2020 according to SNS Research.

FWA is a strong driver of initial 5G deployments

FWA is expected to ramp up the 5G development in North America due to the rather low FTTH-penetration where approximately 11.2% of the total broadband subscriptions are based on fiber connections in the US (compared to the OECD average of 21% and Sweden 55%)¹¹.

¹⁰ Northstream, "How will 5G happen" (September 2017)

¹¹ OECD Broadband Statistics, "BB via Fibre" (December 2016)

SNS Research estimates that the global FWA market is expected to grow rapidly, corresponding at a CAGR about 84% between 2019 and 2025 to generate more than USD 40bn in revenues after 2025¹². Most relevant for Gapwaves is the estimates concerning FWA CPE (consumer premises equipment) unit shipments, which is expected to reach 25m in 2025.

Automotive radar

Automotive radar has gone from being a niche technology for application within luxury cars to become a standard solution in midrange cars. The entire market of automotive radars is expected to experience strong growth related to increased automation (such as autonomous cars) and safety requirements which will spur an increased usage of sensors. An example of the increased focus on safety is found in the Euro-NCAP classification which has started to evaluate vehicles' autonomous emergency breaking systems.

Market for automotive mmwave radars expected to grow rapidly beyond 2020

The research firm Accuray¹³ estimates that the global automotive mmwave radar market is expected to grow from USD 220m in 2015 to reach USD 1.2bn by 2025. Most notably is that the mmwave radar market is expected to grow at the highest growth rate, amounting to 18.9%. The largest geographical automotive radar market is North America, expected to generate about USD 0.9bn in total revenues by 2020. The second largest market is Europe, estimated to reach about USD 0.66bn in 2020. Research and Markets states that the global shipments of automotive mmwave radar grew by 27.5% in 2016 to reach 31.5m units and further estimates that 84m units is expected to be shipped in 2021.¹⁴

Drivers for high mmwave radar growth are primarily found in the broad distance applications and its low-cost implementation. The latter is especially important as it currently is costly to integrate high performing radar sensors. As safety requirements increase, so will the demand of a commercially viable high-resolution radar systems. The radar market is further expected to bolster following the introduction of autonomous vehicles as they are expected to require numerous different sensor systems in order to fulfill safety requirements.

¹² SNS Research, "5G for FWA (Fixed Wireless Access)"

¹³ Accuracy Research, "Global Automotive Market Radar Analysis and Trends"

¹⁴ Research and Markets, "The Global and China Automotive Millimeter Wave (MMW) Radar Industry Report, 2016-2021"

Customers and prospects

Gapwaves existing and potential clients could be divided by products and areas of application.

GAP antenna

The GAP antenna is Gapwaves most financially promising product as it serves several different application areas. The greatest opportunity lies within telecommunication, where the gap antenna could be integrated in upcoming 5G deployments. The telco's are not only interesting due to potential 5G deployments but also fixed beam antennas for point-to-point deployments in the short term.

Gapwaves has mentioned that the company has "more than one" existing clients within the telecom segment which have not been disclosed. The company has also announced that the company has signed NDA's (non-disclosure agreements) with three large telco's. Potential clients are found among large vendors such as Ericsson, Huawei, Nokia and NEC.

Ericsson clearly an important stakeholder

Ericsson is an important stakeholder for Gapwaves, not only as a potential client but also as it also could be regarded as a competitor of Gapwaves due to in-house R&D. Several employees of Gapwaves further have connections to Ericsson after working there for several years. Ericsson is interesting for Gapwaves as the company is regarded to be at the forefront of the development of digital beamforming technology. Ericsson is an active actor within FWA (5G based) development and has undertaken projects with giants such as AT&T and Verizon.

Nokia is also an interesting potential client as Nokia actively has increased its efforts in developing 5G solutions and shown great interest in new frequency bands and advanced antenna technologies. The company is currently engaged in over 30 5G trials worldwide¹⁵ and engaged in 28 GHz and 39 GHz spectrum deployments in American FWA deployments.

Huawei is another interesting vendor placing great efforts in 5G investments with a large focus on mmwave radio, exemplified by an FWA trial with the Canadian operator Telus operating at 28 GHz involving a point-to-multipoint setup. Huawei is the largest provider of telecom equipment, but there are currently uncertainties regarding whether the Chinese giant will succeed to address the American market due to U.S. security fears¹⁶.

¹⁵ SNS Research, "5G for FWA (Fixed Wireless Access)"

¹⁶ <https://www.reuters.com/article/us-telecoms-mobileworld-huawei-tech/huawei-in-early-5g-trials-with-30-telcos-ceo-rejects-u-s-security-fears-idUSKCN1GA1B0>

NEC Corporation is a Japanese provider of wireless network solutions. NEC is interesting due to its strong position in the development of advanced antenna technologies and has, for example, developed a massive element active antenna system for 5G application on the 28 GHz band. The company is currently active with initial 5G trials together with NTT DOCOMO and KT.

Gapwaves is also targeting **radio link providers** such as **SAF Tehnika, Vubiq Networks, Sivers IMA and Leax Arkivator** with its gap antenna offering. These potential clients are companies that provide wireless radio link solutions to service providers. Common for potential clients within this segment is that the companies are focusing on sub-6 GHz and high-frequency spectrum bands.

Apart from targeting vendors and radio link providers, potential clients are further found among **automotive radar providers** as the gap antenna has shown to exhibit characteristics that are promising for application within automotive radar providers. Example of possible clients is found among companies such as Autoliv, Bosch (world's largest automotive industry supplier), Continental and Denso. **Autoliv** is a Swedish supplier to the automotive industry with a strong focus on safety systems, which is promising given that these systems incur a need for reliable radar solutions. Autoliv is further interesting as the company is spending a large share of revenues on R&D. **Continental** is a German supplier with a strong focus on autonomous driving, which will require the use of high-precision antennas. **Denso** is a Japanese supplier of advanced automotive technology with a worldwide network of clients. Denso has, for example, developed LiDAR which is used in vehicles¹⁷. Another actor is found in the company **ZF**, which is actively working with automotive mmwave radar technology.

Apart from only targeting traditional telecommunication vendors, the gap antennas may also be interesting for providers of **over-the-top (OTT)** providers, which are actors that are delivering data outside traditional telecom networks. Examples of such OTTs are found in **Google** and **Facebook**. Google has, for example, been pushing its Google Fiber (FTTP provider) efforts where the company has stated that they are interested in wireless solutions for delivering broadband services.

¹⁷ Accuracy Research, "Global Automotive Market Radar Analysis and Trends"

Bowtie

The standalone bowtie is targeted towards the telecommunication system providers mentioned above (for sub-6 applications) as well as scientific laboratories. If Smart-bowtie would show to be an efficient antenna to use in smartphones, one could find potential clients in the large smartphone producers or, more likely, suppliers of chipsets for mobile applications (for example Qualcomm).

Gap flange adapter

Potential clients of the gap flange adapter are found among microwave laboratories (academia and industrial) and suppliers of electrical instruments such as Rohde&Schwarz and Anritsu. Examples of clients are found in Ericsson, Leax Arkivator and Rose Telecom. Sales are, as mentioned, primarily through the use of distributors.

This review highlights that the majority, and most important, potential clients of Gapwaves are found within large companies operating in sizable markets. The most promising clients are found among large global telco's, where we believe the earlier presented companies Ericsson, Huawei, NEC and Nokia to be important stakeholders for multiple reasons. These are near-time potential clients of gap antennas for point-to-point fixed beam applications and later active antennas for applications in 5G deployments. Our interpretation is that it is difficult to get inside the large telco's that are both developing in-house solutions and evaluating other alternatives, especially for a company of Gapwaves size. We, therefore, believe that it is reasonable to expect demanding sales processes and long sales cycles. We are, however, convinced that the payoff will be significant if Gapwaves succeeds in becoming a large telco's antenna provider during 5G deployments.

*Tough markets to
penetrate with long sales
cycles*

The automotive radar industry is also interesting as potential payoffs could be substantial thanks to the sizable and growing market. Just as with the telco's, we believe that one should expect long sales cycles with companies of these sizes.

Current clients are found within smaller niche segments such as test chambers and laboratories. These are, however, not the clients that we believe to make Gapwaves future interesting. As noticeable, we have put less emphasis on Bowtie's potential application within smartphones as we interpret this to be somewhat unexplored and therefore more of a long-run possibility.

Competitive market

There is no competitor offering antennas based on the gap waveguide technology, but competitors could instead be segmented by area of application and between technologies within each application area. An example is the market for radio links, where there is no actor offering the same antenna type (GAP) as Gapwaves. There is, however, competitors offering alternative solutions for high-frequency applications. Such an alternative technology is the patch (microstrip) antenna which is advantageous in terms of costs, size and ease of production. This is explained by the patch antenna's low profile and that it can be printed on a circuit board. The microstrip antenna is attracting interest as it opens up for electronic beamforming. A disadvantage with the patch antennas is high losses and problems of increasing the effect due to heating problems.

Another antenna type is the parabolic antenna which traditionally has been the go-to for point-to-point applications. Although parabolic antennas have characteristics opening up for high gain in point-to-point connections, it is not suitable in an electronically steerable setting due to its form and size.

As mentioned, Gapwaves competitors are not only solely providers of antenna solutions but also telco vendors that develop substituting technologies in-house. An example of that is **Ericsson's** project together with IBM, where the companies have developed a phased-array-antenna-module to operate on 28 GHz¹⁸ in a 5G setting, indicating the company's strong position in antenna technology.

Telco's in-house development one of the greatest technological threats

Huawei is conducting 5G trials at 28 GHz and 39 GHz together with the Japanese operator NTT DOCOMO. **NEC** has a strong offering through its mmwave transmission products. **Nokia** is also an interesting stakeholder that possess strong R&D capabilities and has further shown great interest in mmwave solutions for 5G¹⁹.

Apart from in-house development among the largest telco's, there are also other companies that are focused on developing active antenna systems based on new technology such as **Metawave** (based on AI-technology) and **Pivotal Commware** (offers a solution based on Holographic beam forming).

Competitors within the radio link market are found among antenna providers and large telco's (presented in the previous segment) that develop antennas in-house. One of the largest competitors is **HUBER+SUHNER** which provides fiber optics, radio and low-frequency products.

¹⁸ Elektroniktidningen (11/17), November 2017

¹⁹ <https://insight.nokia.com/new-spectrum-5g-one-step-closer-mmwaves>

The radio frequency division generated sales of CHF 219.7m with an EBIT-margin of 12.5% in 2016 (total group generated revenues of CHF 737m). The company is offering a flat mmwave antenna (SENCITY Matrix) for V- and E-band applications. Other companies offering flat mmwave antennas for point-to-point applications at the E-band (71-86 GHz) is the American company **ThinKom Solutions** and the Israeli company **Wireless Edge Ltd** (with revenues exceeding USD 23m, whereof 51% stems from the antenna segment). There are also multiple companies offering other antenna types which not should be regarded as direct competitors of Gapwaves offering due to the differences in antenna characteristics.

Automotive

Competitors within the automotive sector are found among providers of alternative technologies (for example LiDAR, radar and camera). The dynamics of this segment is somewhat similar to the telecom as some potential clients also develop alternative solutions in-house. Such examples are found in Denso who have developed in-house LiDAR solutions. Other LiDAR providers are found in companies such as **LeddarTech** and **Quanergy**. **Delphi Automotive** is another provider of alternative technology, which has developed a “RACam” (combination of radar sensor and camera in the same module). **Mitsubishi Electric** is also an interesting actor within this space given its offering of a mmwave radar.

Comparing different technologies is not a straightforward task given the uncertainties regarding the upcoming 5G network and its standards. The intention with the above section is to illustrate the current market and its important actors. Gapwaves will be unique in its gap antenna offering, given that the company succeed in developing an active antenna with the expected properties that opens up for interesting applications due to the antennas high gain, ease of production, the possibility for electrical beam steering, size and form.

Important key takeaways are that the communications market is dominated by the largest telco's which spend significant amounts on their internal R&D, but also competitors supplying alternative antenna technologies for high-frequency applications with an established worldwide sales network, such as HUBER+SUHNER, as well as start-ups focused on developing active antenna systems based on new technologies.

The automotive market has similar characteristics, where various competitors offer different technologies. Interesting is that potential clients of Gapwaves also are found among actors that currently supply different solutions to automotive manufacturers. There are several companies of significant size such as Denso, Delphi and Mitsubishi supplying solutions for the automotive industry.

Opportunities and challenges

Gapwaves greatest financial opportunity arises with the upcoming 5G deployment where the company's technology has several promising characteristics in an active setting. Another great opportunity lies within the automotive sector which is driven by the increased use of radars for safety and automation systems. Both of the markets are of significant sizes and expected to experience strong growth during the coming years, which thereby opens up for great revenues if Gapwaves succeeds in becoming the antenna provider for one or few potential clients.

It will further be important to not only show that the antennas show outstanding performance, but also to prove that the antennas are commercially viable by being able to produce at low cost. The latter is very important for both markets, telco's are already facing large capex in 5G deployments while automotive producers are interested in implementing efficient radars in cars of all prices. To summarize, there is no lack of opportunities as the company is facing large markets with a technology that is more efficient than current solutions.

Challenges

The above also highlights what we perceive to be one of the company's greatest challenge. Gapwaves is not only going from being in a research/engineering stage to start producing and selling a product, but it is doing so in markets that are dominated by large players and generally difficult to penetrate.

It does thus require Gapwaves to take strategically sound decisions and prioritize its efforts in targeting different markets. The company is further rather small, which limits the possibilities of running several parallel projects with demanding clients.

Apart from organizational challenges, it is further important to stress that Gapwaves also will be affected by the markets' technology challenges. As emphasized in the market section, the market will face standardization challenges arising from the involvement of numerous stakeholders as well as spectrum regulation and complexity. The company is furthermore dependent on other active components (chip) to prove the GAP antennas advantageous characteristics in an active setting.

*Dependent on
development of active
electronic components*

Financial estimates

Estimating revenues for a company in Gapwaves phase is not a straightforward procedure. This is a long-term case where the company's great sales potential arises first beyond 2021. Our estimates are based on estimated market sizes, growth, prices, margins among other parameters for each product and respective area of application. We have further assumed potential revenues arising from NRE-agreements, which would cover some of the development costs that Gapwaves will face during integration projects.

Gapwaves revenues during FY 2017 amounted to SEK 0.9m, which mainly consist of contributions arising from the Comhat license. The revenues within the coming two years are primarily expected to be driven by NRE-revenues, sales of P2P antennas, bowtie for sub-6 applications, gap flange adapters, eleven feed antenna as well as minor contributions from funding programs (like the announced Marie Curie program). Point-to-point antenna sales will most likely take-off during the end of 2018, where we expect Gapwaves to sell about 500 units at a price around SEK 1500. We further assume the company to sell gap flange adapters and an Eleven feed antenna during 2018.

We believe that one NRE agreement could bring about SEK 6-10m, depending on partner and project and assume that the first such agreement would be signed during 2018 – yielding about SEK 5m this year. Other revenue includes the Marie-Curie funding of SEK 1.8m and estimated income from the Comhat licenses.

Gapwaves: Base case - net sales by product								
(SEKm)	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E
Gap antenna	0.8	6.9	37.6	123.1	208.6	388.6	548.9	749.2
5G (NR & FWA)	0.0	0.0	13.5	76.5	140.3	281.6	386.1	514.1
Point-to-point	0.8	2.0	2.4	2.7	3.4	4.0	5.5	7.4
Automotive	0.0	4.9	21.7	43.9	65.0	103.0	157.3	227.7
Bowtie	0.0	4.5	15.0	15.0	8.5	0.0	0.0	0.0
Eleven feed	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2
Gap flange adapter	0.8	1.6	2.0	2.3	2.5	2.4	2.4	2.3
Net sales	1.8	13.2	54.8	140.7	219.8	391.2	551.4	751.7
NRE-revenues	5.0	14.0	18.0	15.0	8.0	6.0	0.0	0.0
Other revenue	2.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5
Capitalization of R&D	9.0	12.0	14.0	8.0	6.0	4.0	3.0	3.0
Total revenues	18.4	40.8	88.3	165.2	235.3	402.7	555.9	756.2

Source: Redeye Research

We have included revenues from the automotive segment in 2019 following successful completion of a development project during 2018/2019. We believe that the MobilityXlab is such a project that could generate NRE-revenues upon a successful pre-study and subsequently generate sales. Our estimates beyond 2020 are based on assumptions of different average selling prices depending on the area of application.

We believe that the lowest price charged will be within automotive applications, where we expect the company to initially receive around SEK 100 per antenna before decreasing over time. We find this reasonable as the GAP antenna is not expected to require as much modification for application within automotive radars and is furthermore cheap to produce. We expect that the company initially will be able to achieve a gross margin around 80% for this radar and argue that this will be possible given that the company's offering is more efficient than other existing solutions but also able to produce at cheaper cost. We are, however, assuming a price decline during the subsequent years as competitors' solutions catches up.

*5G deployments
financially most
promising*

As illustrated in our sales estimates above, we find the 5G market to be the financially most promising area of application for Gapwaves given the enormous 5G investments that are expected during the coming years. To illustrate the potential revenues of the markets Gapwaves is targeting, we have constructed a table of market shares and potential revenues below. It is yet important to remember that the estimates are heavily affected by the industry estimates and assumptions regarding prices of full systems, antennas, revenues per sold antenna among other things. It is further important to mention that the 5G NR estimate contains antennas in macro base stations, small cells and remote radio units.

Gapwaves: Market share & potential revenue by 2025

(SEKm)	5%	10%	15%	20%
5G NR	320	640	960	1280
Automotive	57	114	171	228
FWA	75	150	225	300

Source: SNS Research, Accuracy Research, Redeye Research

As noticeable, we have not included Smart-bowtie applications in our base case valuation as it currently is under research. Instead, we argue that potential smartphone antenna applications should be regarded as an option for the company's shareholders. Concerning sales of gap antennas in an active setting, we expect that the selling price will depend on whether the antenna components are sold separately or in a system (together with the chip from Jariet).

Gapwaves: Estimates in Base case

(SEKm)	2016	2017	2018E	2019E	2020E	2021E	2022E	2023E	2024E
Net sales	1.5	0.9	1.8	13.2	54.8	140.7	219.8	391.2	551.4
Other rev (incl. NRE)	0.7	0.5	7.6	15.6	19.5	16.5	9.5	7.5	1.5
Capitalized dev. costs	1.4	7.2	9.0	12.0	14.0	8.0	6.0	4.0	3.0
CoGS	-0.8	-6.8	-1.4	-3.4	-20.3	-53.5	-87.9	-176.0	-264.7
Gross margin (%)	-	-681%	23%	74%	63%	62%	60%	55%	52%
Staff costs	-1.2	-10.2	-23.7	-31.8	-35.9	-39.2	-42.3	-44.8	-48.0
External costs	-4.2	-15.4	-24.2	-26.6	-30.1	-32.8	-35.4	-37.9	-40.5
EBITDA	-2.6	-23.9	-30.9	-21.0	2.1	39.8	69.7	143.9	202.8
D&A	-1.1	-3.2	-4.0	-4.6	-5.8	-8.5	-9.2	-9.2	-9.0
EBIT	-3.7	-27.1	-34.9	-25.0	-3.7	31.3	60.5	134.8	193.7
Sales growth (%)	150%	-	150%	645%	315%	157%	56%	78%	41%
EBIT Margin (%)	-239%	-3097%	-1965%	-189%	-7%	22%	28%	34%	35%

Source: Redeye Research

We expect to see a significant increase in both external and staff costs due to the increased organization and believe that the company will continue growing its organization going forward. This is based on the assumption that the company will need to at least double its development team if it succeeds in signing NRE-agreements with one telco and one automotive client. We further assume that capitalized development costs will increase slightly during 2018-2020 before declining as sales of antennas take off.

We estimate that Gapwaves initially will exhibit great gross margins about 60-65% before declining beyond 2022. This will obviously differ between products, client and requested volumes. We are also assuming that the above implies that the company will be able to reach an average EBIT-margin about 33% during 2022-2025.

This section clarifies that Gapwaves great prospects are expected to materialize first during 2021 and subsequent years. It further illustrates that the company will achieve substantial revenues if the company succeeds in penetrating large markets with high market concentration and thus grabbing large market shares.

Bull case

Our bull case is constructed like our base case with estimates based on potential market sizes, market shares, revenue per antenna among other parameters. The difference to our base case is that the bull case entails greater market shares as well as revenues arising from a successful smart-bowtie application in 2023 and beyond. Apart from that, we are also expecting greater revenues arising from NRE-agreements already during 2018 where we assume that Gapwaves will be able to sign one contract with a large telco and another contract with an automotive supplier.

Gapwaves: Bull case - net sales by product								
(SEKm)	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E
Gap antenna	0.9	18.3	79.8	158.9	312.1	618.9	960.2	1336.6
5G (NR & FWA)	0.0	0.0	49.8	104.9	229.7	506.4	760.5	1042.0
Point-to-point	0.9	2.0	3.0	3.4	4.4	6.0	7.3	10.0
Automotive	0.0	16.3	27.1	50.7	78.0	106.5	192.4	284.6
Bowtie	0.0	5.4	18.0	17.0	10.0	22.5	78.8	135.0
Eleven feed	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
Gap flange adapter	0.8	2.0	3.0	3.2	3.6	3.2	3.2	3.2
Net sales	2.0	25.9	101.1	179.4	325.9	644.8	1042.4	1475.0
NRE-revenues	8.0	18.0	22.0	17.0	15.0	10.0	0.0	0.0
Other revenues	2.8	2.0	2.0	1.8	1.8	1.5	1.5	1.5
Capitalization of R&D	9.0	12.0	14.0	8.0	6.0	4.0	3.0	3.0
Total revenues	21.8	57.9	139.1	206.2	348.7	660.3	1046.9	1479.5

Source: Redeye Research

A substantial difference is found in our 5G market share assumption as the bull case is based on the outcome where Gapwaves succeeds in delivering an active antenna system that is several times more efficient than alternative solutions as well as cheaper to produce. Thus fulfilling a true need for vendors that competitors does not manage to match, leading to substantially greater market shares.

We estimate the company to grab up towards 20% of the addressable market (small cells, macro cells, remote radio units as well as FWA applications). We have also included smart-bowtie revenues based on a license model where Gapwaves receives revenues based on a license price about SEK 10 per sold phone.

We have further assumed a greater penetration of the automotive radar market. We are like in our base case assuming that Gapwaves will gain large market shares, but this case entails the scenario where prices decline at a slower rate. The bull case incorporates the scenario where break-even is reached in 2020 when revenues exceed SEK 100m. This bull case would thus also imply greater gross margins for the company as we have assumed a slower decline in prices compared to our base case based on the reasoning that the company will have greater pricing power, particularly within 5G applications.

The estimation period ends in 2026 where the above assumptions results in revenues about SEK 1.5bn and this case thus clearly illustrates the enormous possibilities that arise within the industries Gapwaves is targeting.

Bear case

Our pessimistic bear case reflects the scenario where Gapwaves grabs substantially lower market shares compared to our two previous cases. We are also expecting lower gross margins than in our base case due to lower pricing power. The estimates are further based on lower NRE contributions during the coming four years, where we assume that Gapwaves manage to secure one deal regarding automotive radar in 2018/2019 as well as one agreement with a telecom company during 2019/2020.

The bear case also entails lower costs compared to our two previous cases due to the delayed development projects, implying that the company would not need to increase the organization in the same rapid pace.

We still assume that Gapwaves will take-part of 5G roll-outs and successfully close deals within automotive but at lower market shares compared to previous cases. We are further incorporating more conservative market size estimates in the bear scenario arising from slower 5G development. The assumptions of lower market shares and slower market growth result in sales estimates that are below 50% of our base case estimates.

This case thus incorporates the scenario where the active antenna concept offers better efficiency than alternative solutions, but that it is not regarded as a crucial solution for vendors, leading to less areas of applications. This makes the greatest assumption difference to the other two scenarios, reflected by substantially lower sales arising from the 5G opportunity.

Gapwaves: Bear case - net sales by product								
(SEKm)	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E
Gap antenna	0.5	1.0	11.9	68.1	91.8	141.1	279.2	392.6
5G (NR & FWA)	0.0	0.0	2.9	49.5	64.1	97.2	207.5	286.9
Point-to-point	0.5	1.0	1.5	2.5	3.4	3.7	4.8	6.4
Automotive	0.0	0.0	7.5	16.0	24.4	40.3	66.9	99.4
Bowtie	0.0	2.3	8.3	8.5	4.3	0.0	0.0	0.0
Eleven feed	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Gap flange adapter	0.5	1.0	1.3	1.6	1.7	1.7	1.6	1.5
Net sales	1.2	4.4	21.6	78.4	97.9	143.0	281.0	394.3
NRE-revenues	4.5	8.0	10.0	8.0	0.0	0.0	0.0	0.0
Other revenues	2.3	1.4	1.3	1.3	1.0	1.0	1.0	1.0
Capitalization of R&D	9.0	12.0	14.0	8.0	6.0	4.0	3.0	3.0
Total revenues	17.0	25.8	46.9	95.7	104.9	148.0	285.0	398.3

Source: Redeye Research

We are, like in our base case, not assuming any revenues arising from smart-bowtie smartphone applications and rather regard this as an option with substantial payoff if proven to be interesting for a smartphone chipset manufacturer. The above assumptions ultimately result in an outcome where break-even is not reached until 2023 when sales exceed SEK 125m.

Valuation

Our valuation is based on a discounted cash flow (DCF) model, in which we have used a discount rate (WACC) of 15.1% for valuation purposes. The discount rate we use is based on a number of different parameters that together form Redeye's rating model. The underlying factors aim at capturing the company-specific risk and take into account everything from management and owners to market position and the balance sheet.

Our valuation is based on three scenarios: a most likely base case, a pessimistic bear case and a positive bull case. The bear case represents the lower end and the bull case represent the upper end of the valuation range.

Gapwaves held SEK 20.5m in cash per year-end 2017, while the level of interest-bearing debt amounted to SEK 6m. The company's current quarterly burn-rate is around SEK -10m. Gapwaves has further recently announced that the company is conducting a rights issue, which at full subscription would yield about SEK 137m after transaction costs. Our valuation is based on the assumption that the issue will be fully subscribed, increasing the number of shares to 26.9m (from 17.9m) and bringing SEK 137m in cash. We have not included the effect of a potential exercise of the overallotment option, which could increase the number of shares by an additional 1.8m and yield SEK 30.6m before transaction costs.

Base case

We expect that the company will take part of the arising 5G opportunities given the antennas promising characteristics in 5G NR and FWA applications. There will be a need of a commercially viable antenna system able to deliver according to the 5G requirement standards, but we believe that there currently are several uncertainties. The company has to succeed in demonstrating the active antenna concept and further show that the outcome yields a substantially better value proposition than the solutions that competitors and potential clients (for example Ericsson) develop in-house.

Our estimates entail a sales CAGR of approximately 340% during 2018-2020, with SEK 0.9m sales in 2017 as the base for calculation. Sales during the period is expected to primarily be driven by sales of antennas for automotive radar and point-to-point applications as well as revenues arising from NRE-projects.

This case incorporates the scenario where Gapwaves reaches an agreement with a large telco, leading to that the company's solution is applied in several 5G applications. This is illustrated in our expectations of substantial revenue growth beyond 2021 (at a CAGR of 61.3%).

We are also assuming that Gapwaves will succeed in delivering antennas for automotive applications where Gapwaves offers a technology that is more efficient than current solutions and possible to produce at lower cost.

We therefore believe that the company has the ability to rapidly gain market shares by offering a better product at lower price, but that it will be difficult to retain high gross margins over time. In comparison to the 5G opportunity, Gapwaves has shown that there is interest from the automotive segment through the recently announced project with MobilityXlab. If successful, we believe that revenues from this segment would be visible already during 2019.

Our base case entails the scenario where the company exhibits gross margins between 50-70% (depending on area of application and year), which results in an average EBIT-margin of 28.7% beyond 2021.

Gapwaves: Base case assumptions			
Assumptions	2018-2020	2021- DCF valuation	
CAGR Sales	339.8%	61.3% WACC	15.1%
EBIT margin (avg.)	-154.6%	28.7% NPV of FCF 2018-2027	151
ROE (avg.)	-23.4%	31.5% NPV of terminal value	208
			EV
			359
			Net cash
			15
			Share issue proceeds
			137
Terminal		DCF value	511
Terminal growth rate	2.0%	Fair value per share	19.0
EBIT margin	18.0%	Current share price	22.7
			Potential/Risk
			-16%

Source: Redeye Research

Fair value of SEK 19 per share in base case

We assume a terminal EBIT-margin of 18%, which together with the above assumptions result in a **fair value of SEK 19** per share. The valuation is, as mentioned, based on the assumption of a successful share issue yielding about SEK 137m and increasing the total amount of shares to 26.9m.

It is important to note that the valuation is heavily dependent on the assumptions above as well as the discount rate (WACC) used for valuation purposes. As noticeable in the table below, a 1% decrease in the applied discount rate (WACC) would have increased the fair value with approximately SEK 2 per share. The valuation is further affected by the terminal EBIT-margin assumption, where a 1% increase would increase the fair value with approximately SEK 0.5 per share.

Gapwaves: Sensitivity analysis					
% change	-2%	-1%	0%	1%	2%
Term EBIT-margin	18	18	19	19	20
WACC	23	21	19	17	16

Source: Redeye Research

Bull case

Our positive bull case entails the scenario where Gapwaves succeeds in becoming the antenna provider for one key telco vendor and gains larger market shares within the automotive radar market. The scenario incorporates greater NRE-revenues during 2018-2020, leading to lower negative cash flows during the period. We have also included revenues arising from potential smart-Bowtie applications from 2023. Altogether, this case reflects significantly higher revenues as well as a slower decline in prices, thus yielding higher margins compared to the base scenario. We assume an average EBIT-margin about 34% beyond 2021- and use a terminal margin of 24% in our bull case.

Gapwaves: Bull case assumptions			
Assumptions	2018-2020	2021- DCF valuation	
CAGR Sales	423.1%	65.3% WACC	15.1%
EBIT margin (avg.)	-134.0%	34.3% NPV of FCF 2018-2027	506
ROE (avg.)	-20.8%	40.9% NPV of terminal value	500
Terminal		EV	1 006
		Net cash	15
		Share issue proceeds	137
		DCF value	1 157
		Fair value per share	43.0
Terminal growth rate	2.0%	Current share price	22.7
EBIT margin	24.0%	Potential/Risk	90%

Source: Redeye Research

Bull case based on large market shares imply fair value of SEK 43 per share

Our bull case assumptions **imply a fair value of SEK 43 per share**, illustrating that there is potential for a significant upside if Gapwaves succeeds in grabbing a larger share of 5G deployments and further succeed in signing several automotive mmwave radar suppliers.

As pointed out in our investment case, if Gapwaves succeeds in delivering a product that is several times more efficient than alternative solutions at lower cost of production, thus showing that the product truly is indispensable to the customers – this could as well be an acquisition case as it would give the buyer control of Gapwaves technology.

Bear case

The negative bear case is constructed to capture the scenario where Gapwaves does not succeed to monetize on the arising 5G opportunity in the same levels as in the previous case. This is mainly based on the assumption that Gapwaves active antenna offering will incur characteristics that are better than existing alternatives, but not truly fulfill a need for vendors. This implies that we have assumed that the company's antennas will be applied in specific 5G applications and we are still, as illustrated in our estimate section, expecting Gapwaves to exhibit large revenues beyond 2023. We are further assuming a lower market share within the automotive market and neither including any revenues arising from smart-Bowtie applications in smartphones. We have also assumed lower NRE-revenues during 2018-2020.

The above assumptions imply that the company achieves a sales growth of 67% beyond 2021, where the sales used as basis for calculation is substantially lower compared to our two previous cases. Our estimation period ends in 2027 where we estimate the company to generate revenues about SEK 420m.

As this case incorporates the scenario where the company's product is not regarded to be indispensable to the customers, we have further assumed that the company will have lower pricing power which will affect both revenues and gross margins. We are, however, assuming lower external- and personnel costs compared to the previous case. This is ultimately reflected in the average EBIT-margin about 14.5% beyond 2021. We are further assuming a terminal EBIT-margin of 10%.

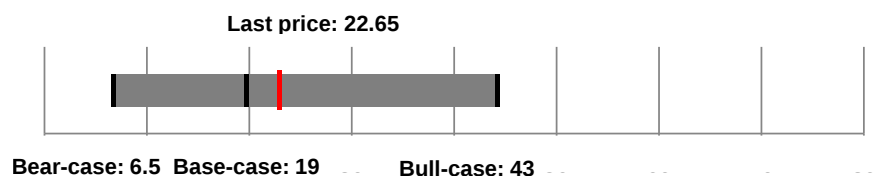
Gapwaves: Bear case assumptions			
Assumptions	2018-2020	2021- DCF valuation	
CAGR Sales	235.0%	66.6% WACC	15.1%
EBIT margin (avg.)	-183.3%	14.5% NPV of FCF 2018-2027	-38
ROE (avg.)	-29.3%	21.8% NPV of terminal value	62
		EV	24
		Net cash	15
		Share issue proceeds	137
Terminal		DCF value	175
Terminal growth rate	2.0%	Fair value per share	6.5
EBIT margin	10.0%	Current share price	22.7
		Potential/Risk	-71%

Source: Redeye Research

*Bear case assumptions
result in fair value of SEK
6.5 per share*

The above assumptions results in a **fair value of SEK 6.5 per share** in our bear case, thus illustrating a risk if the company does not succeed in demonstrating that its solution adds substantial value by solving actual needs for its potential clients.

Gapwaves: Fair value range



Source: Redeye Research

Our three different scenarios thereby result in a fair value range from SEK 6.5 per share in bear case to SEK 43 per share in bull case. We believe that this range clearly illustrates that an investment in Gapwaves is associated with great potential if the company succeeds in grabbing a substantial share of the 5G deployments. It also illustrates that an investment comes with a risk as the company is facing several challenges and that there are many uncertainties related to the upcoming 5G deployments, especially whether Gapwaves will be able to deliver a solution that will be crucial for telco's.

Appendix: Management & Board

Management

Lars-Inge Sjöqvist – CEO & Member of the Board (Since 2014)

Prior to taking on the role as CEO for Gapwaves, Sjöqvist has held various management and product development positions. Lars-Inge has, for example, held the CEO position at the tech company Semcon. Sjöqvist holds an M. Sc. in Engineering from Chalmers University of Technology.

Johan Andrén – COO (Since 2017)

Andrén has experience from the microwave industry after holding management positions such as Product Manager and head of system management & radio link at Ericsson. Johan holds an M. Sc. in Electrical Engineering from Chalmers University of Technology.

Thomas Emanuelsson – CTO (Since 2017)

Thomas has vast experience of microwave technology after working with research, product and technology development at Ericsson. Apart from holding the CTO position at Gapwaves, Emanuelsson is also an adjunct professor at Chalmers University. Thomas holds a M. Sc. from Chalmers University of Technology.

Per Andersson – CFO (Since 2017)

Andersson has previously worked as a senior manager in the area of M&A at KPMG. Apart from KPMG, Per has worked as Business Controller for Mondelēz. Per holds an M. Sc. in Finance from University of Gothenburg.

Charlotte Elmquist – VP Supply (Since 2017)

Charlotte Elmquist is another management member with strong experience from the microwave technology area after working at Ericsson for 15 years, where she held the position as Head of Production Microwave. Charlotte holds an M. Sc. in Mechanical Engineering from the University of Borås.

Martin Lundkvist – Sales and marketing (Since 2018)

Martin Lundkvist joined Gapwaves during Q1 2018. Martin has previously worked with business development and sales of microwave products at Ericsson. Before joining Gapwaves, Martin held the position as Head of Transport Solutions Northern Europe and Central Asia at Ericsson.

Board of Directors**Lars Granbom – Chairman of the Board (Since 2016)**

The position as the Chairman of the board (CoB) is held by Lars Granbom. Granbom has extensive experience of wireless technologies after working at firms such as SAF Tehnika, Sivers IMA and Trebax (owner and CEO). Granbom further held the CEO position at Raybased. Lars holds an M. Sc. in Electrical Engineering from Chalmers University of Technology.

Olle Axelsson – Member of the Board (Since 2017)

Olle Axelsson has extensive experience from various management positions after holding positions such as Executive Director for GM Europe and Senior Vice President for Volvo Cars. Apart from management positions, Axelsson has also held communication roles, including Head of Group Communications for Svenska Spel, Coop and Volvo Cars. Olle Axelsson holds a BA. in Behavioral Finance, Communication and Journalism from Karlstad University.

Jan Wäreby – Member of the Board (Since 2017)

Wäreby is another member with strong management experience from the telecommunications sector after holding positions as senior vice president of sales, sales and marketing and multimedia at Ericsson for several years. Jan is further chairman of the board of Fingerprint Cards and RISE (Research Institutes of Sweden), board member in Tobii and has previously also been chairman of SonyEricsson. Wäreby holds an M. Sc. in Engineering from Chalmers University of Technology.

Cécile Schilliger – Member of the Board (Since 2016)

Representative for the majority owner Kildal Antenn AB.

Lars-Inge Sjöqvist – Member of the Board (Since 2014)

See previous page.

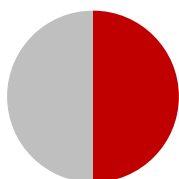
Summary Redeye Rating

The rating consists of five valuation keys, each constituting an overall assessment of several factors that are rated on a scale of 0 to 2 points. The maximum score for a valuation key is 10 points.

Rating changes in the report

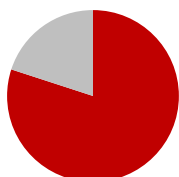
First rating of Gapwaves.

Management 5.0p



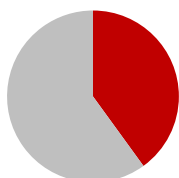
Gapwaves management team comprises members with experience from the telecommunication segment and especially working with microwave technology. Approximately half of the management team has previously worked at Ericsson, which is an important stakeholder for Gapwaves. Our belief is that management is focused on preparing the company to benefit from the opportunities arising with the upcoming 5G networks and the automotive industry.

Ownership 8.0p



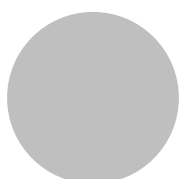
Gapwaves is awarded a high ownership rating based on large holdings among the board of directors. CEO Sjöqvist holds a large share of the shares (4.7% of the capital). The major owner is Kildal antenn, represented by Cecile Schilliger, holding 60% of the voting rights.

Profit outlook 4.0p



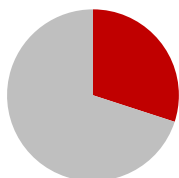
The opportunities arising with the 5G development and automotive industry is expected to be significant for Gapwaves. The company currently has a temporary competitive advantage in its technology and it is important to show that the Gapwaves technology is commercially viable and better than the solutions that potential clients could develop in-house.

Profitability 0.0p



Gapwaves is currently exhibiting losses, which are expected to increase further during 2018. Although we believe revenues to also increase during the period, we require to see positive earnings before increasing our rating.

Financial strength 3.0p



Gapwaves current level of net cash is SEK 15m. The company has, however, recently announced a rights issue, which would bring about SEK 137m (after transaction costs) at full subscription. We believe that the cash position, at full subscription, would be sufficient to cover the losses and investments needed until break-even is reached.

Income statement	2016	2017	2018E	2019E	2020E
Net sales	2	1	9	29	74
Total operating costs	-4	-25	-40	-50	-72
EBITDA	-3	-24	-31	-21	2
Depreciation	0	0	0	-1	-2
Amortization	-1	-3	-4	-3	-4
Impairment charges	0	0	0	0	0
EBIT	-4	-27	-35	-25	-4
Share in profits	0	0	0	0	0
Net financial items	0	0	0	0	0
Exchange rate dif.	0	0	0	0	0
Pre-tax profit	-4	-27	-35	-25	-4
Tax	0	0	0	0	0
Net earnings	-4	-27	-35	-25	-4

Balance	2016	2017	2018E	2019E	2020E
Assets					
<i>Current assets</i>					
Cash in banks	27	21	111	70	37
Receivables	2	4	6	7	13
Inventories	0	0	1	2	6
Other current assets	0	0	0	0	0
Current assets	29	25	118	79	56
<i>Fixed assets</i>					
Tangible assets	0	3	9	17	29
Associated comp.	0	0	0	0	0
Investments	0	0	0	0	0
Goodwill	0	0	0	0	0
Cap. exp. for dev.	0	0	0	0	0
O intangible rights	9	14	19	27	37
O non-current assets	0	0	0	0	0
Total fixed assets	9	17	28	44	66
Deferred tax assets	0	0	0	0	0
Total (assets)	38	42	146	123	123

Liabilities					
<i>Current liabilities</i>					
Short-term debt	0	0	0	0	0
Accounts payable	2	9	10	13	22
O current liabilities	0	0	0	0	0
Current liabilities	2	9	10	13	22
Long-term debt	6	6	6	6	0
O long-term liabilities	0	0	0	0	0
Convertibles	0	0	0	0	0
Total Liabilities	8	15	16	19	22
Deferred tax liab	0	0	0	0	0
Provisions	0	0	0	0	0
Shareholders' equity	30	27	129	104	100
Minority interest (BS)	0	0	0	0	0
Minority & equity	30	27	129	104	100
Total liab & SE	38	42	146	123	123

Free cash flow	2016	2017	2018E	2019E	2020E
Net sales	2	1	9	29	74
Total operating costs	-4	-25	-40	-50	-72
Depreciations total	-1	-3	-4	-4	-6
EBIT	-4	-27	-35	-25	-4
Taxes on EBIT	0	0	0	0	0
NOPLAT	-4	-27	-35	-25	-4
Depreciation	1	3	4	4	6
Gross cash flow	-3	-24	-31	-21	2
Change in WC	0	4	-1	-1	-1
Gross CAPEX	-6	-11	-15	-20	-28
Free cash flow	-8	-31	-46	-42	-26

Capital structure	2016	2017	2018E	2019E	2020E
Equity ratio	78%	64%	89%	84%	82%
Debt/equity ratio	20%	22%	5%	6%	0%
Net debt	-21	-15	-105	-64	-37
Capital employed	9	12	24	41	63
Capital turnover rate	0.0	0.0	0.1	0.2	0.6

Growth	2016	2017	2018E	2019E	2020E
Sales growth	0%	-43%	973%	207%	158%
EPS growth (adj)	83%	-100%	-14%	-29%	-85%

DCF valuation		Cash flow, MSEK	
WACC (%)	15.1 %	NPV FCF (2018-2020)	-106
		NPV FCF (2021-2027)	257
		NPV FCF (2028-)	208
		Non-operating assets	21
		Share issue proceeds	137*
		Interest-bearing debt	-6
		Fair value estimate MSEK	511
Assumptions 2017-2023 (%)		Fair value e. per share, SEK	19.0
Average sales growth	97.2 %	Share price, SEK	22.7
EBIT margin	-49.2		

Profitability	2016	2017	2018E	2019E	2020E
ROE	-22%	-97%	-45%	-22%	-4%
ROCE	-18%	-79%	-42%	-20%	-4%
ROIC	-95%	-318%	-287%	-106%	-9%
EBITDA margin	-168%	-2736%	-329%	-73%	3%
EBIT margin	-239%	-3097%	-372%	-87%	-5%
Net margin	-242%	-3132%	-375%	-87%	-5%

Data per share	2016	2017	2018E	2019E	2020E
EPS	-	-1.53	-1.31	-0.93	-0.14
	2363.93				
EPS adj	-	-1.53	-1.31	-0.93	-0.14
	2363.93				
Dividend	0.00	0.00	0.00	0.00	0.00

Valuation	2016	2017	2018E	2019E	2020E
EV	-21.0	704.4	435.1	477.0	503.5
P/E	0.0	-26.3	-15.4	-21.5	-143.5
P/E diluted	0.0	-26.3	-15.4	-21.5	-143.5
P/Sales	0.0	822.6	57.7	18.8	7.3
EV/Sales	-13.6	805.9	46.4	16.5	6.8
EV/EBITDA	8.1	-29.5	-14.1	-22.8	244.9
EV/EBIT	5.7	-26.0	-12.5	-19.1	-135.3
P/BV	0.0	26.9	4.2	5.2	5.4

Share performance		Growth/year	15/17e
1 month	-23.6 %	Net sales	146.3 %
3 month	-58.2 %	Operating profit adj	207.5 %
12 month	93.3 %	EPS, just	-97.7 %
Since start of the year	-49.9 %	Equity	109.0 %

Shareholder structure %	Capital	Votes
Kildal Antenn AB	31.3 %	60.1 %
Avanza Pension	5.1 %	1.0 %
Nordnet Pensionsförsäkring	4.7 %	0.9 %
Actionstep AB	4.7 %	9.1 %
Leif Hagne	4.5 %	0.9 %
Jian Yang	3.4 %	6.5 %
Bright Peter Leo Ebenezer	2.9 %	0.6 %
Ashraf Uz Zaman	1.5 %	2.8 %
Peter Enoksson	1.0 %	2.0 %
Sjoerd Haasl	1.0 %	2.0 %

Share information	
Reuters code	GAPWB.ST
List	First North
Share price	22.7
Total shares, million	26.9*
Market Cap, MSEK	609*

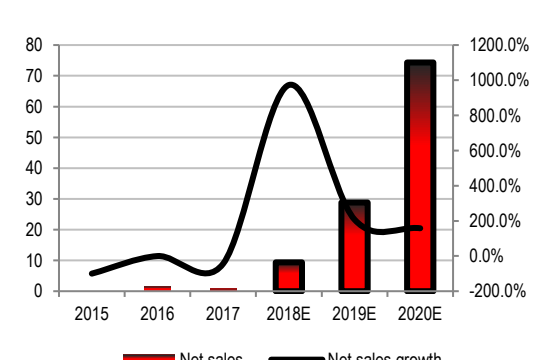
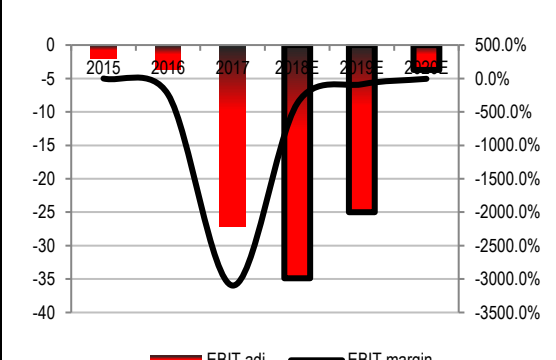
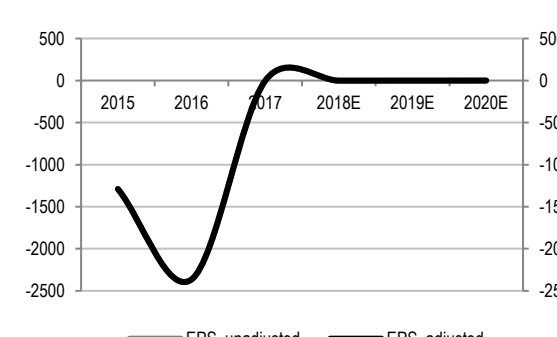
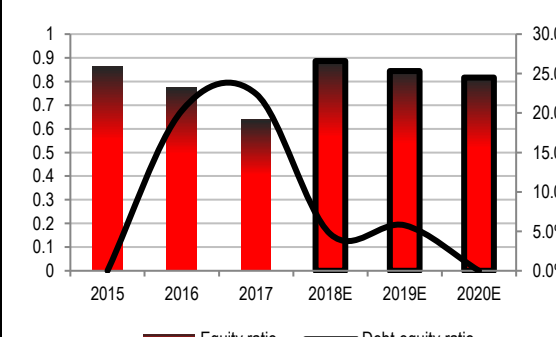
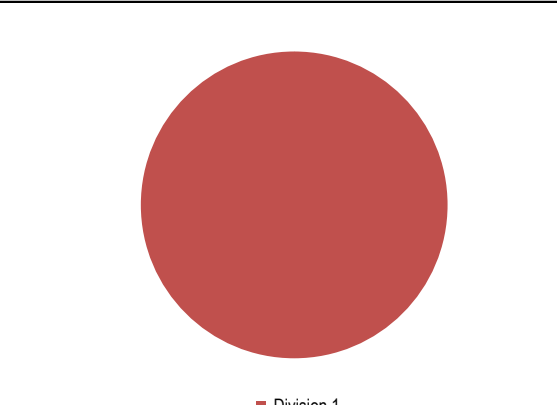
Management & board	
CEO	Lars-Inge Sjöqvist
CFO	Per Andersson
IR	Lars-Inge Sjöqvist
Chairman	Lars Granbom

Financial information	
Q1 report	May 23, 2018
Q2 report	August 22, 2018

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*based on full subscription of rights issue

Revenue & Growth (%)	EBIT (adjusted) & Margin (%)
 Net sales (red bars), Net sales growth (black line)	 EBIT adj (red bars), EBIT margin (black line)
Earnings per share	Equity & debt-equity ratio (%)
 EPS, unadjusted (grey line), EPS, adjusted (black line)	 Equity ratio (red bars), Debt-equity ratio (black line)
Sales division	Geographical areas
 Division 1 (red)	
Conflict of interests	Company description
Dennis Berggren owns shares in the company: No Anton Wester owns shares in the company: No Redeye performs/have performed services for the Company and receives/have received compensation from the Company in connection with this.	Gapwaves is a company offering wireless communication solutions based on the GAP waveguide technology, which stems from the research of the late founder Per-Simon Kildal. The company's great potential is found in the millimeter wave antennas that can be applied in expansions of current radio link networks, automotive radars and eventually 5G networks.

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Redeye Rating (2018-03-14)

Rating	Management	Ownership	Profit outlook	Profitability	Financial Strength
7,5p - 10,0p	45	41	17	10	20
3,5p - 7,0p	73	68	103	35	47
0,0p - 3,0p	13	22	11	86	64
Company N	131	131	131	131	131

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