Forsway 5G

Forsway White Paper

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FORSWAY™

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1 Introduction

Billions of people cannot access Internet due to infrastructure deficiencies, mainly in emerging markets but also rural areas in Europe and USA. To reduce the digital divide and to increase prosperity globally new low-cost broadband solutions are needed. Cellular technologies such as 3G and 4G are not cost- effective to provide broadband in areas with low population density or low ARPU. Satellite and DVB-T2 technology has for a long time been the most cost-effective technology to provide TV broadcast services. This paper will describe a hybrid satellite/DVB-T2 – cellular/xDSL solution combining the ubiquitous downlink coverage of satellite/DVB-T2 and low-cost uplink of terrestrial technology to provide broadband to all. We call it 5G.

2 Forsway deploys 5G today

For a new generation of mobile telephony to become successful it should fulfil an urgent need. 1G (NMT) gave us the possibility to communicate wirelessly. 2G (GSM) gave encrypted and secure communication as well as the possibility of international roaming. 3G (HSPA) allowed us to access the Internet via our mobile phones. 4G (LTE) allows us to watch video with high quality. What other needs will 5G fulfil?

According to the report “Digital Dividends” from the World Bank 2016[1] more than half the population of the world lacks access to broadband Internet, mainly in emerging markets in Africa and South-East Asia. However, also in rural areas in Europe, USA and South-America 100s of millions of people lack fast (10 Mbps) broadband. Facebook and Google are two companies that for many years have talked about providing broadband anywhere using drones and balloons. Not much has happened.

Forsway Scandinavia AB is a Swedish company from Skövde, Sweden which has developed a hybrid modem for combining transmission from TV satellites/TV towers with terrestrial technologies such as 2G/3G/4G (xG) and xDSL to be able to deliver broadband at very competitive prices anywhere in the world. Forsway has delivered more than 50 000 modems to all continents except Australia and Antarctica. Right now, there are trials ongoing with Indian government agencies and private companies, as well as commercial deployments in e.g. Congo (DRC), Nigeria and Senegal.

India is potentially the most interesting market for the Forsway solution. In India, there is very good and reliable GSM coverage to about 900 million people while only about 100 million people, mostly in the cities, have access to broadband Internet. Forsway is today fulfilling an

[1] http://documents.worldbank.org/curated/en/896971468194972881/pdf/102725- PUB-Replacement-PUBLIC.pdf

urgent need, i.e. broadband anywhere, which has not been fulfilled by 2G, 3G or 4G. Therefore, we call the Forsway solution 5G.

According to many researchers, telecom companies (Ericsson, Huawei, Nokia) 5G is about much higher data speeds than 4G, lower latency, and the ability to handle many billions of IoT. Are they right? Below are some arguments why they are probably wrong. Already today 4G can deliver 1 Gbps wirelessly with technologies such as Carrier Aggregation (CA) and 4x4, 8x8 MIMO (Multiple Input Multiple Output).

It is hard to see use cases for the average user when you need or is willing to pay for 1 Gbps. And the 5G advocates talk about the need for 10 Gbps. Most people will probably agree that it would be better to have 10 Mbps available everywhere, than data speeds of only 10 kbps – 1 Mbps in rural areas and 10 Gbps in urban areas. Data speeds of 10 Mbps everywhere will not be solved by millimetre wave technology, small cells or new radio technology providing latencies of less than 1 ms. Forsway has a solution where the ubiquitous coverage from TV satellites/TV towers is used in downlink and combined with terrestrial technologies in the uplink. Forsway is the only company in the world that today deploys 5G, i.e. broadband anywhere.

3 Which are the key benefits of 5G?

Some scientists and operators are beginning to question if 4G is not enough for most of the needs of an average user, at least in our cities. Let us in briefly discuss and refute some of the proposals from e.g. Ericsson why we need 5G. Ericsson writes in a White Paper "5G Radio Acess" from April 2016:

"The capabilities of 5G wireless access must extend far beyond previous generations of mobile communication. Examples of these capabilities include very high data rates, very low latency, ultra-high reliability, energy efficiency and extreme device densities, and will be realized by the development of LTE in combination with new radio-access technologies. Key technology components include extension to higher frequency bands, access/backhaul integration, device-to-device communication, flexible duplex, flexible spectrum usage, multi-antenna transmission, ultra-lean design, and user/ control separation."[2]

In this White Paper from Ericsson, there is not a single word about the challenge to provide "Radio Access" to the more than 4 billion people who lacks it. The focus is completely on new technologies which hardly solve any problems the average user has today, nor will have in the future. Has Ericsson completely misunderstood what 5G should be? Below there will be some brief arguments about Ericsson´s views and why they seem to be mistaken based on many of

[2] https://www.ericsson.com/res/docs/whitepapers/wp-5g.pdf

the ideas in William Webb´s provocative and interesting book *"The 5G Myth: When vision decoupled from reality"*[3].

3.1 The need for higher data speed

The driver for higher data speeds has been and is video. 4G has more than sufficient capacity for video. In most cities with good 4G infrastructure about 40 Mbps is readily available. If you are watching a video in your mobile 10 Mbps is more than enough for good quality. Even if you were to have 10 Gpbs you wouldn´t watch the video any faster. Downloads of large files will of course work better with higher data speeds. However, how often do we download large files to our phones. And if we were to download a large file of e.g. 10 Gbyte is it not be better to do over WiFi at home? And how much are we prepared to pay extra to download large files when outside of WiFi coverage? The business case for 10 Gbps data speed seems dubious.

3.2 Fixed Wireless Access (FWA)

FWA is promoted as a wireless alternative to fibre at millimetre wave frequencies at e.g. 28 and 39 GHz. Many, especially in the USA, say that this will be the first use of 5G. Others call it LMDS (Local Multipoint Distribution System) 2.0 and question why it will succeed when LMDS 1.0 was a failure about 17 years ago. It is difficult to use millimetre wave technology to homes in an urban environment and achieve high speed and good quality. There is the need for Line-Of Sight (LOS) or base stations with at the most a few hundred meters from the home. The base station will have to be connected via fibre. Why not then deploy the fibre to the home? It seems that fibre is best for fixed broadband access in cities and that wireless technologies should be used for mobility or where there are too large distances to make fibre a feasible option.

3.3 IoT

There is no doubt that more and more things are being connected to the Internet and companies connecting things wirelessly will be busy. Most of these sensors, household appliances, "things" etc., will be connected with low bit speeds over e.g. 2G, Bluetooth, NB-IoT, LoRa and Sigfox. Some will use high bit speeds over LTE and WiFi (802.11ac and 802.11ad) but likely none of these need Gbps speeds. The capacity in today´s networks is more than sufficient to handle tens of billions of things.

[3] Webb, W. The 5G Myth: When vision decoupled from reality, Kindle Edition (2016)

3.4 1 ms latency

No people, i.e. the normal user paying for mobile services, need such short latencies. Possibly there is a limited market for M2M communications. However, such communications must be between machines at the most of a distance of 150 km from each other, because at longer distances the latency of 1 ms will be exceeded because of the limited speed of light.

3.5 Rural broadband

William Webb writes “A great road system is no longer one with unlimited maximum speed, but one with minimal congestion and excellent safety. A great communications system is one available everywhere, all the time with minimal congestion and at low cost. If the focus of 5G could be switched toward this direction that would provide a new generation worth having.” [3] Most people will probably agree. The need is huge.
In India, there are more than a million schools and more than1 billion people which lack broadband in rural areas. To fulfil this need with a mobile network would entail astronomical costs since high speed in a mobile network can only be achieved at a limited distance from the cellular tower. To cover the whole of India or Africa with cellular broadband would require an immense number of base stations. Another solution is obviously required to provide everyone with broadband in rural areas. One of the key technologies to provide broadband to everyone, not mentioned in the Ericsson “5G Radio Access” White Paper, is satellite technology. Let us therefore call communication solutions where satellite technology is included 5G if such solutions fulfil a concrete and urgent need 4G has failed to fulfil.

3.6 Communications to cars, buses and trains

This is an area under strong growth. Passengers will in vehicles want access to fast and reliable broadband. In cities, there is usually enough capacity over 4G but not in rural areas. Outside urban areas satellite companies see a possibility to complement 4G and already plan for connecting cars with small, highly integrated antennas. Besides the already existing area of GPS navigation the satellites will provide entertainment and data communications to the cars. It is very likely that we will see solutions were different wireless technologies such as e.g. cellular, satellite and WiFi will complement each other for the next generation connected cars.

4 Forsway's 5G solution

4.1 With GEO (Geostationary Earth Orbit) satellites

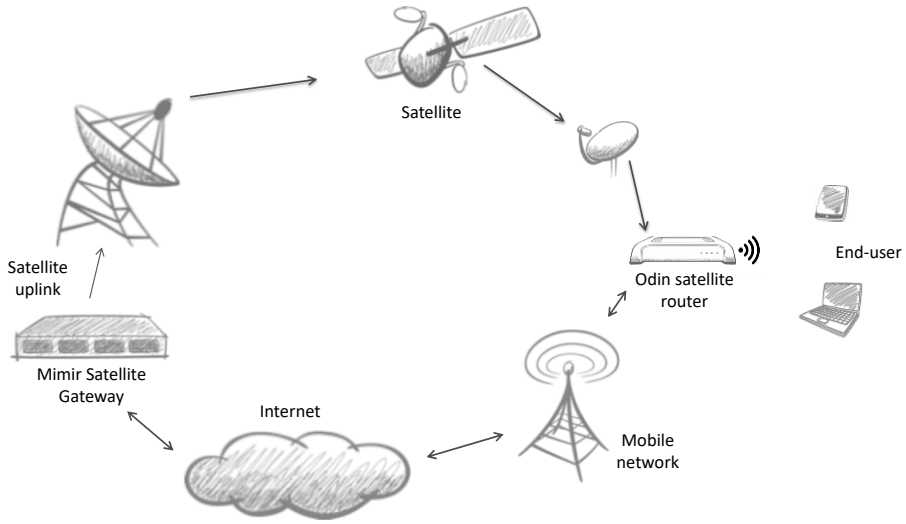
Geostationary (GEO) satellites has for many years been the most cost-effective way to broadcast TV to almost all parts of the world (except around the North and South poles). Today many new GEO satellites have capacities of 100s of Gbps and in a few years the first satellites with Tbps will be launched. These satellites will not be used to broadcast thousands of additional TV channels but to provide broadband to areas where there is a lack of 3G/4G/xDSL/fibre.

Satellite terminals used for Internet access at oil platforms, mines, ships etc. where there is no terrestrial broadband available are called Very Small Aperture Terminals (VSAT). A VSAT terminal is much more expensive than a TV satellite dish. The reasons are mainly 1) the need to both receive and transmit to the satellite. This requires 2) a larger antenna, at least about 1 m in diameter compared to the 0,7 m of a typical TV satellite dish. A larger antenna has a narrower antenna beam why it is usually necessary to have 3) a more stable and expensive tripod as well as a professional installer. VSAT has because of e.g. these reasons been manufactured in much smaller volumes, a few millions, compared to TV satellite dishes, many 100s of millions.

VSAT is today the most common way to get broadband access where there is no 3G/4G/xDSL /fibre. In rural USA and Europe, VSAT is for many the only way to have a broadband Internet connection. For the overwhelming majority of people in rural Africa or South East Asia the cost of a VSAT terminal is too high and a more cost-effective solution is needed. For many years, the cost of satellite capacity has been high. New technology has, however, lowered the cost of satellite capacity with about a factor of 10 in the last 10 years. Most satellite companies have a surplus capacity in their new satellites and the bottle neck to be able to sell capacity to the average person in emerging markets have become the expensive VSAT terminals. On the other hand, most people in these countries have 2G coverage and a TV dish.

Forsway´s solution is to use a hybrid broadband modem, Odin, connected to a low- cost TV satellite dish that anyone can install. The TV dish is used to receive Internet traffic (downlink) within the very large coverage of a GEO satellite (e.g. the whole of India, China or a quarter of Africa).

Instead of transmitting the uplink Internet traffic back to the satellite as with VSAT, the Forsway modem uses a USB dongle with 2G/3G/4G for uplink. If there is xDSL with low speed it can also be used for uplink via an Ethernet port at Odin. This combination of satellite and terrestrial technologies means that the Forsway solution can be used almost anywhere where there is at least GSM (2G) coverage, and that is almost everywhere. About 97% of the world´s population is within 2G coverage [1].



Overview of the Forsway solution. The Mimir server routes the Internet traffic over the satellite or cellular/terrestrial network, depending on traffic type, to the end-user equipment Odin.

Under a contract from the Indian IT Ministry, Forsway connected village offices (CSC = Common Service Centers) with broadband in 5 states. They were all within GSM coverage of 10 – 100 Kbps. The Forsway solution was very quick to set up and more or less immediately the CSC´s had about 3 Mbps download speed. This allowed them to access web sites or look at video clips without any problems. The upload speed was limited but sufficient for keyboard commands or commands via the mouse. Forsway is at the moment discussing the next phase to connect 5000 CSC. There are about 240 000 villages without broadband in India.

The satellite dish on the picture is connected to the hybrid modem Odin. About 3 Mbps downlink capacity was achieved were there previously only had been about 20 – 40 Kbps.

4.2 With LEO (Low Earth Orbit) satellites

Oneweb and SpaceX are two companies which has proposed to launch 100s or 1000s of small satellites in LEO constellations to provide broadband to everyone. Investors in these projects are e.g. Google, Softbank (Japanese mobile operator), Elon Musk (Tesla) and Richard Branson (Virgin).

The major advantage with LEO satellites compared to GEO satellites is that they orbit the Earth at much lower height, about 1000 km compared to 36 000 km. This means much less latency. The latency over GEO satellites make them more or less useless for on-line gaming. Another advantage is that the LEO systems cover the whole globe with satellite to satellite communication while a GEO satellite typically covers a continent. The first broadband LEO systems are planned to be in use around 2020.

The large drawbacks with the LEO systems are 1) the cost to launch and replace (satellites which fall down due to atmospheric drag) a very large number of satellites, 2) that about 70% of the Earth´s surface is water where there are few paying customers, and 3) the satellite terminals will be complex and probably too expensive for the majority of the potential customers. Oneweb will therefore in the beginning address business customers when they start their service.

One of the early LEO systems with global coverage for speech was Iridium. However, it soon became bankrupt after its launch partly because of the high investment costs and especially because the limited number of customers. Most people preferred the much cheaper 2G system which at this time (1998) had very good coverage.

A LEO broadband terminal will have to track satellites from horizon to horizon over a time period of 5 - 10 minutes. This will use complex and costly hardware, especially for sending to the LEO satellite. A LEO receive only terminal will be much simpler and lower cost.

Forsway has therefore applied for a patent using a hybrid modem for receiving (downlink) from a LEO satellite and uplink via 2G/3G/4G/xDSL. This will be a much cheaper LEO satellite terminal than the LEO terminal that also will have to send to the satellites. However, the cost of a Forsway GEO hybrid modem terminal, i.e. a TV dish with a fixed pointing direction, will be the absolutely lowest cost solution for broadband via satellite.

4.3 With DVB-T2

Forsway has shown that it is possible to have 2 Mbps via a common TV antenna at trials in e.g. India, Chad and Rwanda. A standard Yagi TV antenna (indoor or outdoor) is connected to the hybrid modem Odin for downlink from TV towers at frequencies between 400 – 700 MHz. In the uplink 2G/3G is used via USB dongle in the same way as in the satellite solution described above.

In India there are 1416 TV towers covering about 90% of India´s population. This hybrid DVB-T2 solution is, as is the Forsway satellite solution, something that can be deployed immediately to provide broadband to schools, small business, village offices, and households in rural areas. This is the lowest cost and best (low latency) hybrid solution for countries with available TV spectrum and good TV and 2G coverage.

Internet over DVB-T2. The white box to the left in the picture is the hybrid modem Odin with a WiFi hotspot. The modem is connected to a low cost indoor TV antenna. 2 Mbps was measured about 7 km from the TV tower. Higher downlink speeds can be achieved with additional DVB-T2 channels.