Plan B for National Broadband Plan

FEBRUARY 2021
VERSION 2.01

Twitter: @BforNBP
Email: PlanBforNBP@gmail.com

Plan B for National Broadband Plan

Contents

Version Log

Version	Date	Comments
1.0	3rd November 2019	Initial version
1.01	5th November 2019	Added contact details & version log
2.01	2nd February 2021	Comprehensive rewrite

1. Introduction

In May 2019, the Irish Government announced a National Broadband Plan (NBP) detailing how rural Ireland would be connected to high-speed broadband over the next six-seven years. In November of that year, it signed a contract with National Broadband Ireland (NBI) to plan, develop and operate a fibre-based broadband service within an Intervention Area (IA) embracing 544,000 rural premises. This long-term contract is valued at about €5 billion including State support of up to €2.9 billion.

A private citizen, Brian Flanagan has compiled this alternative approach to the NBP entitled **Plan B for NBP** arising from concerns about the extraordinary high cost of the NBP and lack of consideration given to emerging satellite technologies for providing high-speed broadband to rural areas.

The initial **Plan B for NBP**, published in November 2019, was primarily circulated to Government Minsters, TDs, and Senators. Its central recommendation was that preparations for the NBP should be paused briefly while an independent, expert study was conducted to assess the potential of satellites to deliver high-speed broadband to rural Ireland to complement the use of expensive fibre.

This updated version of **Plan B for NBP** is concerned with the imminent use of low-Earth orbit (LEO) satellites to provide high-speed broadband to unserved and underserved areas of the world, including potentially to rural Ireland. Data collection concluded at the end of January 2021.

Sections 3-7 introduce relevant satellite technologies; review progress and plans of major satellite operators; and discuss relevant developments within the EU and NBP.

Section 2 contains an Executive Summary of **Plan B** while Recommendation and Conclusion are presented in Sections 8-9.

***Plan B for NBP** has been compiled by Brian Flanagan out of concern about aspects of the NBP. While completely favouring the extension of broadband throughout rural Ireland he has reservations about the pre-eminent role of fibre in the NBP on cost grounds and from a technological perspective. The following letters from Brian published in the Irish Times reflected these concerns:*

- *Time to rethink National Broadband Plan – 3rd May 2019.*
- *The National Broadband Plan – 29th August 2019.*
- *Satellites and the internet – 20th January 2020.*

Brian is semi-retired having worked as a management consultant for about four decades. He is an Honorary Fellow of the Institute of Management Consultants and Advisers in Ireland. His consulting experience has embraced business planning, operational reviews, financial modelling and strategic planning with start-ups, SMEs, larger businesses, and incubators. In addition to consulting, he has operated an internet-based business developing and selling business planning and financial modelling tools to users in about 120 countries. He has no commercial links to any business interests discussed in this document.

2. Executive Summary

- **Plan B for NBP** proposes that next-generation, satellite-based broadband services be used to augment the use of fibre for Ireland's National Broadband Plan (NBP) in rural areas which will be unserved for years and/or are very costly to service.
- Up to recently, the use of satellites to deliver internet services has been constrained by the need to deploy geostationary satellites located 35,800 kms above the Equator. This has resulted in latency problems (delays) in signal transfers between users and satellites.
- New solutions based on low-Earth orbit (LEO) satellites operating in much lower orbits and in constellations of hundreds or thousands eliminate these latency problems and can bring high-speed broadband to rural areas worldwide at competitive prices.
- The leading player is SpaceX which has launched over a thousand Starlink satellites and intends to launch at least ten thousand more to complete its global network. Other key participants with definite plans to launch constellations include Amazon, OneWeb and Telesat as well countries such as Russia, India and China.
- As front runner, SpaceX currently offers a paid-for, beta service to consumers in North America with speeds of 50-150 Mbps and latency of 20-40ms.This will be extended to Europe in Spring 2021 as the precursor to launching an initial global service by the year end. Performances and coverage will continue to improve as the Starlink constellation fills out and its next generation satellites are launched.
- The EU has published periodic guidelines on the deployment of high-speed broadband. A target speed of 30 Mbps for households, first proposed in 2013, has been increased to 100+ Mbps by 2025. It has recently prioritised the delivery of high-speed broadband by satellite and has launched a major programme to establish a European-led LEO satellite service by 2025-7.
- Having been in planning since 2012, execution of the NBP finally commenced in 2020. This intends to use fibre for the vast majority of the 544,000 rural premises which are not expected to be ever served by private sector operators and are located within a defined Intervention Area. The NBP is being executed by National Broadband Ireland (NBI) which secured a 25+ year contract which incorporates an Exchequer subsidy of about €2.5 billion net of VAT.
- NBI expects to pass up to 200,000 premises a year and to complete its network construction, designed to offer speeds of 500+ Mbps, by 2026-7. As an interim solution, pending arrival of fibre, about 300 publicly accessible connection points are being developed across the Intervention Area.
- Plans by many enterprises and countries including the EU for satellite broadband are gathering momentum. Well within this decade, tens of thousands of LEO satellites could be providing high-speed, inexpensive broadband services as an alternative to fibre-based solutions especially within rural areas worldwide. These could be very disruptive to many existing rural broadband services, including the NBP.
- Against this background, **Plan B for NBP** recommends that the Government should immediately review the NBP, notwithstanding contractual and strategic commitments, and actively encourage and support the provision of high-speed broadband via low-Earth orbit satellites to premises within the Intervention Area especially where the NBP's incremental capital expenditures and waiting times for service are likely to be significant.

3. Background on Satellite Broadband Services

This section discusses existing consumer-orientated, satellite broadband services and introduces emerging new satellite-based services.

3.1. Existing Services

3.1.1. Geostationary Satellites

Receipt of internet services via satellite is well established. They are provided by commercial operators via geostationary (GEO) satellites orbiting at 35,800 kms about the equator. This altitude enables satellites to appear stationary relative to the Earth. Signals are uploaded from Earth stations and received directly by users using small external disks pointing towards the satellites' fixed positions. These satellites can cost up to a billion dollars to design, build, launch and deploy. They can be as large as small buses and take several years from design to deployment.

The main drawback with these services is latency, the time required for signals to roundtrip from/to users. This delay can frustrate real-time interactions, for example audio/video calls and gaming. In addition, services can be disrupted by heavy rain and related climatic conditions. Download and upload speeds are also factors. The former can, depending on a consumer's location, range up to about 1000 Mbps (Viasat in the USA) but is more typically about 25 Mbps (HughesNet in the USA and Eutelsat in Europe).

3.1.2. Satellite Broadband

Satellite broadband accounts for less than 1% of fixed broadband subscriptions in most countries[1]. The USA and Australia have the greatest penetration (based on subscriptions per head of population) while lesser developed regions have experienced the greatest growth rates. Overall, satellite broadband subscriptions have grown from 1.2 million in 2008 to 5.2 million in 2017.

The US Federal Communications Commission (FCC) has estimated that 26% of people in rural areas in the US are not covered by terrestrial broadband services. Only about 10-20% of the Earth's landmass is covered by terrestrial cell towers.

According to the Communications Regulator (ComReg), about four thousand people use satellite services to access the internet in Ireland. End-user charges in Ireland for access to the internet via satellite are typically about €100 to purchase the disk and about €40 per month for a domestic service offering 50 GB per month with unmetered off-peak usage. While speed is

[1] The Space Economy in Figures: How Space Contributes to the Global Economy. OECD. July 2019.

limited to approximately 25 Mbps[2] it is adequate for email, browsing, streaming etc. and meets the minimum criteria demanded under the EU's Electronics Communications Code[3].

3.2. Emerging New Services

3.2.1. LEO Satellites

To surmount latency problems linked to GEO satellites, the concept of low-Earth orbit (LEO) satellite services is being aggressively pursued to complement GEO-related services. This involves satellites orbiting as low as 300 kms. While needing much less rocket power and funding to place in orbit, satellite lives can be much shorter (at about 5+ years) than those for high orbiters.

By using such low orbits, LEO satellites can only be visible to end users for short intervals, like the 3-6 minutes per orbit for which the International Space Station at 400 kms can be seen periodically from Ireland. To provide uninterrupted service, constellations of satellites must be deployed to provide constant coverage to a given point on the Earth. Continuity is provided by adjacent satellites networking with each other, potentially via lasers, and synching with user terminals and earth stations. Most critically, they solve latency problems connected with geostationary services as signals only round trip about a thousand kms instead of seventy thousand for GEO satellites.

3.2.2. Satellite Broadband

The value of the global space economy (including satellites and ground equipment) could grow from about US$450 billion in 2019 to anywhere between US$600 billion and US$2 trillion by 2040-45. A key driver of this growth will be satellite broadband which according to UBS Bank could hit US$300 billion by 2040 from virtually nothing now. Growth will be driven by falling launch costs[4], advances in technology and increased private investment. In the same vein,

---

[2] While download speeds of 25 Mbps seem slow compared with the proposed speed of 500 Mbps for households to be serviced by the NBP, it is worth noting that the US FCC suggests that speeds in excess of 25 Mbps are only needed for households which might use four devices simultaneously including more than one very high-demand applications. It also guides that teleworking and streaming Ultra HD 4k Video may need speeds of 25 Mbps per user. This begs the question as to how and why in a short number of years, rural households would need bandwidth amounting to, say, 450 Mbps more than is currently required given that typical household bandwidth needs have only increased by about 25-50 Mbps since 14 kbps dial-up modems were first introduced in 1991. Currently, Microsoft recommends bandwidth of 15 Mbps for power users of its office products.

[3] Establishing the European Electronic Communications Code. Annex V identified this minimum set of broadband services:
E-mail, search engines enabling search and finding of all type of information, basic training and education online tools, online newspapers or news, buying or ordering goods or services online, job searching and job searching tools, professional networking, internet banking, eGovernment service use, social media and instant messaging, and calls and video calls (standard quality).

[4] Thanks to reusable components like booster stages and fairings, launch costs can be as low as US$2,500 per kilogram as compared with upwards of US$50,000 per kg a few years ago. Technological improvements include miniturisation, use of digital comms payloads, advanced modulation schemes, multi-beam steerable antennas, inter-satellite laser links, sophisticated frequency reuse schemes, and advanced and large volume manufacturing processes.
Single satellite launch costs could fall from about US$200 million to US$1 million (based on a 60-satellite payload) and satellite production costs are falling from US$500 million to well under a million. Currently, SpaceX is quoting launch costs of $1 million for a 200 kg satellite ($5,000/kg). By using SmallSat deployment systems and ridesharing, the cost of launching a 1.3 kg CubeSat could be as low as US$7,000.

Morgan Stanley has estimated that space-related internet and broadband could reach US$500 billion by 2040.

The OECD[5] identified almost twenty companies that had announced plans to launch satellite constellations to deliver broadband. These will require investments ranging from US$3 to US$12 billion. Some will deliver broadband to designated areas (India, China, Japan and Russia) while others will seek to provide broadband to the entire world. Frost & Sullivan projects "that communication satellites represent the fastest growing market segment (within the space industry), increasing demand for the manufacture of high-throughput and constellation communication satellites".

According to Euroconsult, the world will see an average of 1,250 satellites launched every year between now and 2029 by Western enterprises. That is five times the average launch rate for the 2010-19 decade. It estimated that half the market will be concentrated around a handful of mega LEO constellations. 2020 was the first year ever with more than a thousand satellites launched, of which 70% were SpaceX's Starlink LEO satellites. This compares with just 18 GEO satellite launches. The 2020 launch rate by Western enterprises could become a new standard for the next ten years with annual variations mainly driven by the replacement of the commercial constellations.

3.2.3. Issues and Alternatives

Given that tens of thousands LEO satellites could be in orbit before the end of this decade, several major issues must be addressed by space enterprises, national and international authorities in place of current ad hoc rules and procedures. These include the impact of satellite swarms on night sky brightness (albedo) and astronomical observations; space traffic management; the handling of corporate failures; satellite de-orbiting and disposal; collision avoidance (Kessler syndrome); blocking of signals by governments; and signal interference between competing systems.

Aside from LEO satellites, Very High-Throughput Satellites (VHTS) will also play increasing important roles in the delivery of high-speed internet services to remote areas and 4-5G mobile users. While these satellites will operate in geostationary orbits, latency problems will be offset by extensive use of 'spot beam' technologies to focus their significant power on specific geographic areas. Other emerging new satellite technologies include hybrid LEO satellite/5G backhaul and 'direct from space to handset' systems.

For completeness, it should be mentioned that, aside from satellites, stratospheric-based internet and mobile phone services using kites, balloons, drones and other High-Altitude Platform Systems have to date had limited technical success in providing services to rural or remote areas.

4. Key LEO Satellite Players

The four most advanced networks for LEO satellites are Starlink (targeting an initial 11,800 satellites with over 1,000 launched to date), Amazon (planned 3,236, none launched), OneWeb (planned 1,980, 74 launched) and Telesat (planned 512, one launched). These are discussed below to highlight their potential to provide high-speed broadband services over the coming years.

[5] The Space Economy in Figures: How Space Contributes to the Global Economy. OECD. July 2019.

This review excludes plans by Chinese firms[6]which are also seeking to deliver broadband from space; the Russian Space Systems Company (part of the giant Roscosmos) which plans to place 288 LEO satellites in orbit by 2025 to service 10 thousand collective outlets and 10 million subscribers; and firms such as AST SpaceMobile (backed by Vodafone and ATT) planning to offer broadband and 4G/5G mobile services via a hundred or so LEO satellites to customers using unmodified mobile phones, initially in about 49 countries in equatorial regions.

4.1. SpaceX & Starlink

This section reviews the background to SpaceX and Starlink and assesses their recent progress and plans.

4.1.1. Background

SpaceX is a privately-owned company founded by Elon Musk who is also involved with Tesla, a producer of e-vehicles, and the Boring Company which plans to link major US cities by high-speed, subterranean transport links. SpaceX is a pioneering commercial space operator and is perhaps best known for developing reusable rockets. Starlink is its LEO program. It is also engaged in cargo and crew transporting to the International Space Station, development work for trips to the Moon and Mars, launching satellites for third-parties and extensive work for US defence agencies.

Starlink's website stated in September 2019 that "SpaceX is developing a low latency, broadband internet system to meet the needs of consumers across the globe. Enabled by a constellation of low-Earth orbit satellites, Starlink will provide fast, reliable internet to populations with little or no connectivity, including those in rural communities and places where existing services are too expensive or unreliable."

To achieve this, Starlink is working to place an initial constellation of twelve thousand satellites in orbit within about five years. Based on regulatory filings[7], this constellation could be expanded to forty-two thousand satellites. By way of comparison, just ten comms satellites were launched by ten separate rockets back in 2016 and only about eight hundred comms satellites, excluding Starlink's are currently operational.

SpaceX intends to use revenues from Starlink to help fund cargo missions to the moon and Mars using its massive, 40-storey, reusable Starship rocket which is currently in development and testing. If successful, it could transform space travel and transportation costs, including for LEO satellites. To date SpaceX has raised almost US$6 billion from investors including Google and is valued at about US$46 billion. A further funding round during 2021 could double this

[6] These firms include Hongyun (planning 864 LEO satellites to provide mobile 5G connectivity to 2 million users as well as broadband directly to 200,000 in remote areas); Hongyan (320 satellites); Galaxy Space (144 satellites to provide 5G backhaul to remote areas) and GW (12,992 satellites targeting global consumer markets).

[7] The FCC has given SpaceX permission to launch 11,800 Starlink satellites to operate in the Ku-band (11-14 GHz) and Ka-band (17-31 GHz) spectrums in orbits ranging from 335 to 1,325 kilometres. Outside the US, SpaceX is working country-by-country to secure regulatory approvals. In October 2019, SpaceX filed for spectrum rights from the International Telecommunications Union for an additional tranche of 30,000 LEO satellites. If accepted, this application would give SpaceX seven years in which to bring requested frequencies into use by launching and operating at least one satellite. SpaceX stated that "as demand escalates for fast, reliable internet around the world, especially for those where connectivity is non-existent, too expensive or unreliable, SpaceX is taking steps to responsibly scale Starlink's total network capacity and data density to meet the growth in users' anticipated needs." Currently, SpaceX is negotiating with the FCC about lowering the proposed orbits of future Starlink satellites to 570 kilometres and launching some satellites at higher inclinations to service rural Alaska.

valuation. The current Starlink program (4,400 satellites) is expected to cost about US$10 billion.

SpaceX is targeting a 3% share of the projected trillion-dollar global Internet connectivity market. It is expected by analysts to achieve revenues of about US$30 billion a year once Starlink is fully operational as compared with just US$3 billion a year generated by its more mature rocket and space transport operations which have been recently boosted by major US Government and NASA contracts. Analysts suggest that SpaceX could, in the medium-term, be worth anywhere between US$5 billion and US$200 billion, depending on the degree of success or failure of Starlink.

4.1.2. Developments & Plans

4.1.2.1. Launch Plans

Following the launch of two test satellites in 2018, SpaceX orbited its first batch of 60 Version 0.9 satellites in May 2019. Since then, it has used its Falcon 9 rockets, incorporating reusable first stages and fairings, to launch a total of 963 Version 1.0 satellites[8]. Currently, it can build about 120 satellites a month in line with its launch capacity using new and recovered rocket components. In due course, its heavy lift Starship rocket could be used to deliver batches of 400+ satellites into orbit.

SpaceX plans to launch about 60 or more satellites per month into the middle of the decade with a view to having 5,900 in orbit by end 2024 and the remaining 5,900 orbiting by end 2027. Initial coverage of the populated world should be achieved when about 24 launches have deployed 1,440 satellites. A world-wide service aimed at low population densities could commence once about three thousand satellites are in orbit. All additional launches will create more capacity and facilitate customised services. Starting in 2022, all newly-launched satellites will incorporate Inter-Satellite Laser Links which greatly improve performances and even give Starlink a speed advantage over terrestrial fibre for longer distance internet links.

4.1.2.2. "Better than Nothing Beta"

SpaceX initiated private beta testing of its embryonic constellation in mid-2020 when only about 500 satellites were in orbit. It also initiated a call for expressions of interest from potential users which evoked almost a million responses. In October 2020, it launched a public beta testing programme ("Better than Nothing Beta") aimed at users predominantly in northern states of the US and southern Canadian provinces. To participate, users are being charged US$99 a month and need to purchase for US$499 ground equipment including a disk with electronic-steerable, phased-array antenna, modem and router. This disk's electronics are extremely sophisticated with over six hundred elements. It is heavily subsidised by SpaceX and reducing its cost will be a technical challenge.

Early feedback from testers has been very favourable even in adverse weather conditions. Setup and first-time connection to the internet can be done in minutes and performances, in terms of latency (typically 20-40 ms) and data speed (75-150 Mbps for downlinks) and stability (uptime), have exceeded most testers' expectations notwithstanding that only about one-third of the satellites needed for an initial full service are operational. SpaceX has indicated that

[8] In total 1,025 satellites have been launched by 19 rockets to January 2021. These include the two beta and sixty Version 0.9 satellites which have mostly de-orbited. These satellites incorporate autonomous collision avoidance and can be de-orbited remotely using on-board propulsion systems to achieve 100% demise on re-entry. All satellites launched after August 2020 incorporated visors to reduce their brightness to ground-based for ground-based astronomy.

speed, uptime will progressively improve, and that latency could decline to 16-19 ms by summer 2021.

Thus far, the only significant problem reported by users relates to the need for antennas to have unobstructed views of the northern sky – the minimum field of view requirement (and downtime) will shrink, and performances should improve as the Starlink constellation expands and more earth stations are commissioned[9]. According to a submission to the FCC, SpaceX expects to offer ultimately offer download speeds of up to 10 Gbps (upgraded from 1 Gbps).

Following receipt of licences from telecom regulators, Starlink's public "Better than Nothing Beta" service has recently commenced in Europe with reports of users in Germany and the UK[10]. Vat-inclusive prices charged to UK customers are £439 for the dish[11] and modem/router and £89 per month for ongoing service. While these prices are not competitive with fibre, they do offer high-speed broadband to users in rural or remote areas who may be waiting years, or forever, to secure an equivalent land-based service.

4.1.2.3. Expansion

In December 2020, it was announced that SpaceX had won US$888 million of the US$9.2 billion in subsidies to be awarded to suppliers of high-speed broadband under the FCC's 10-year Rural Digital Opportunity Fund. Under this scheme, SpaceX will provide service to 643,000 locations in 35 states at speeds of at least 100/20Mbps. The SpaceX award was the fourth largest amongst the 180 awardees and the only significant award to satellite-based services.

Currently, SpaceX is expanding its paid-for, beta test programme to include many European countries, New Zealand and Australia where people can access its Starlink app as a precursor to being invited to join the service.

SpaceX is in the process of securing operating licences for earth stations and user terminals from comms regulators in many countries including Canada, Australia, New Zealand, South Africa, India, Japan, Philippines, South America and Europe where it has set up a score of companies including in Ireland[12]. It expects to offer an initial global service aimed at rural, unserved/underserved areas before the end of 2021. Plans are in hand to set up earth stations at several locations within key markets including Canada, Australia, New Zealand, and Europe[13]. Thus far, SpaceX intends to sell its Starlink services directly to end users although relationships with third-parties might be considered.

SpaceX could, based on its current launch cadence, have up to 1,700 satellites in orbit by mid-2021. This would position Starlink years ahead of any competition and would make it the most immediately relevant service for rural Ireland.

---

[9] See Starlink FAQ.

[10] First Starlink user in the UK tells what it's like going from zero broadband to zippy internet speeds in rural England.

[11] While a basic ground-based disk mounting is included, specialist or DIY mountings for roofs may be needed to clear sky-line obstructions.

[12] Starlink Internet Services Limited – Company Number 677409. This company has registered with ComReg in relation to the provision of satellite internet services nationally and is seeking earth station and user terminal licences.

[13] So far earth stations have been announced for Saint-Senier-de-Beuvron, Gravelines and Villenave-d'Ornon in France to cover France, Germany, Spain, Ireland and for Goonhilly to cover the UK and possibly Ireland. Ultimately, over a hundred earth stations will be needed to provide a global service along with about 10-20 command and control stations.

4.2. Amazon, Kuiper & Blue Origin

In April 2019 Amazon announced that its Project Kuiper (no web presence) would enter the internet satellite business and in July 2019 it filed an application with the FCC to put 3,236 satellites, operating in the Ka frequency band, into low-Earth orbit to target the four billion people in the world without broadband connections. An updated application was filed in January 2021.

Based on filings, the proposed service will be confined to mid-latitudes with the satellites grouped in 98 different orbital planes within three orbital shells at 590, 610 and 630 km. Amazon expects, all going well, that it will offer services, sometime in the next few years, once it its first group of, yet to be launched, 578 satellites are in working orbits. Currently, its "constellation design and implementation plan are well-developed, and Amazon continues to mature its satellite design and operational procedures". It is actively recruiting technical staff for Kuiper. The total investment is expected to exceed US$10 billion.

It is noteworthy Jeff Bezos (CEO and founder of Amazon), through his Blue Origin space transport company, is developing New Shepard, a reusable suborbital rocket system for space tourism missions, and New Glenn[14], a reusable heavy-lift, orbital rocket which would be suitable for placing large numbers of LEO satellites in orbit. In addition, there could be strong commercial synergy between Kuiper and Amazon's subsidiary AWS which provides data storage services and has recently started offering managed ground services to satellite operators.

4.3. Telesat

Ottawa-based Telesat is mentioned specifically because it has finalised an agreement with the Canadian Government to bring high-speed broadband via LEO satellites to the country's most remote citizens. The Government will buy capacity from Telesat for ten years at a cost of CAN$600 million.

Telesat is a long-established satellite comms and broadcast operator which is planning to go public shortly. It initially planned to deploy 300 LEO satellites with optical cross links to provide a global service by 2022-3 starting with download speeds of 50 Mbps and eventually reaching gigabit speeds. Its satellites would be placed in polar and inclined orbits at a thousand kilometres from the Earth and would utilise about fifty Earth stations dispersed worldwide. Its first LEO satellite was launched in January 2018.

In 2020, Telesat expanded the proposed size of its LEO constellation to over 1,600 satellites. These will be launched by third parties, including Blue Origin with its New Glenn rocket, ULA, or even SpaceX. The immediate goal is to offer speeds of at least 50/10 Mbps with unlimited data along with enhancing LTE and 5G services by satellite using established telecom and internet operators to cover Canada's 41% of population living in rural and remote areas.

4.4. OneWeb

UK-based OneWeb was originally backed by Japan's Softbank and Branson's Virgin Group. It declared bankruptcy in late March 2020 and, notwithstanding this, applied in May 2020 to the FCC to operate 48,000 LEO satellites. It was sold in July 2020 to a consortium led by the

[14] Blue Origin hopes to start using the 310-foot New Glenn (with reusable first stage) in 2021 after spending north of $2.5 billion on the program.

UK Government and Bharti Enterprises, a major Indian conglomerate, which jointly undertook to invest US$1 billion in the 'new' OneWeb. It emerged from bankruptcy in November 2020.

The original OneWeb raised US$3.4 billion in pursuit of its objective to become a global communications business utilising LEO satellites. It aimed to provide internet services to rural and remote places as well as to a range of markets including aero, maritime and cellular backhaul. Its plans called for an initial constellation of 648 satellites by end 2022 which could ultimately grow to 7,088 with their manufacturing by Airbus switching from the US to the UK.

By the time OneWeb ran out of money (after over US$3 billion had been invested) just 74 satellites had been launched and these were kept operating throughout the restructuring. A further 36 satellites were successfully launched during December 2020 using a Soyuz rocket. This will be followed by monthly launches until 648 satellites have been launched. In January 2020, OneWeb raised a further US$400 million to complete this constellation. It hopes to start offering broadband services in northern latitudes by the end 2021 and full global services during the following year.

In February 2021 it was announced that BT and OneWeb are exploring the possibility of using the latter's satellites to reach homes in the UK that are too costly to connect using terrestrial or wireless networks.

5. EU Developments

This section describes aspects of the EU's role in promoting high-speed broadband and its emerging interest in satellite-based internet services.

5.1. Background

Major initiatives by the EU have been highly influential in dictating the pace, technologies, and direction of broadband services for Ireland and other member states.

Published in 2010, the **Europe 2020 Strategy** and its related **Digital Agenda for Europe** (DAE) initiative highlighted the importance of broadband deployment to promote competitiveness, social inclusion and employment. These set targets to bring basic broadband access to all Europeans by 2013, for all Europeans to have access to internet speeds above 30 Mbps by 2020 and for 50% or more of households to have internet connections above 100 Mbps by then.

In 2016, the Commission adopted **Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society**. It further developed the DAE and defined strategic objectives for 2025 to include (a) 100% coverage of all households with download speeds of at least 100 Mbps, upgradeable to one Gbps and (b) one Gbps symmetric speeds for all main socio-economic drivers such as schools, transport hubs and main providers of public services as well as digitally intensive enterprises.

5.2. Interest in Satellite Services

5.2.1. Historic Perspective

A key EU document giving **Guidelines for the application of State aid rules in relation to the rapid deployment of broadband networks** treated satellite systems as "basic broadband

networks" rather than **Next Generation Access** (NGA) networks[15] at which future State aid should be directed. Published in 2013 but still applicable in 2019, it viewed NGA networks as being fibre-based, advanced cable or advanced wireless and it presumed that the provision of high-speed broadband would involve very substantial and costly civil works.

Simultaneously, the EU proclaimed (in about 2014 or 2015) in a Digital Single Market policy statement (**Broadband for all via satellite**) that "satellite broadband is available to provide fast internet connectivity throughout every European Member State" at a time when GEO satellites were offering download speeds of about 20 Mbps.

In late 2019, the EU's DG Connect's team confirmed in correspondence to this document's author that low-Earth orbit satellites and Very High Throughput Satellites have not been "considered in detail so far, because they must first prove their functionality in the provision of high-speed broadband to rural and underserved semi-urban areas. But they are considered under possible upcoming future technologies". Specifically, it classified LEO satellites as a potential new technology for the delivery of broadband[16].

This view was strengthened by Internal Market Commissioner Thierry Breton in a wide-ranging introductory speech to the EU's Space Council in May 2020 when he stated that "when it comes to connectivity, we know that space is to become THE infrastructure for telecommunication, data, Internet of Things, broadband. And what we see is that these infrastructures will most likely be run mostly by the private sector."

5.2.2. LEO Satellite Plans

In November 2020, Commissioner Breton[17] indicated that the EU was committed to use some of the EU's €13 billion seven-year Space Programme to develop LEO constellations to "allow Europe to benefit from space-based, high-speed connectivity everywhere, complementary to other technologies (fibre and 5G)". A key objective would be to provide high-speed broadband to the five million households in member states which lack such a service. According to industry sources, an EU constellation might become operational between 2025-27.

To kick start this, the Commission has awarded a €7 million contract to a consortium including Airbus, Arianespace, Eutelsat and Thales Alenia Space to study the mission requirements, provide a preliminary architectural design and service provision concept, as well as associated budgetary estimates for an EU LEO constellation. Meantime, Eurospace, the trade body for the European space industry, has sought to capitalise on this interest by offering outline proposals for the development of additional satellite systems including LEO constellations for broadband.

Overall, it is evident that the EU is playing catchup given that the provision of genuinely high-speed broadband services via satellites to consumers within rural areas in many EU countries could commence as early as 2021. These services should greatly accelerate the rate at which rural households achieve the EU's performance target of 100+ Mbps for all households within member states, as per **Towards a European Gigabyte Society**.

[15] Offering speeds of at least 30/6 Mbps.

[16] Digital Single Market – Broadband Technologies.

[17] Enhancing Europe's Space Power.

6. NBP Developments

This section provides background information on the NBP; reviews aspects of its Intervention Area and contract; and discusses progress with implementation.

6.1. Background

6.1.1. Evolution

The NBP was conceived back in 2012 as a limited fibre-based rural broadband service costing about €400 million. Since then, it mushroomed into an all-compassing universal service costing about €5 billion to develop. In November 2019, the Government signed a contract with a private company, National Broadband Ireland (NBI), to plan, design, construct and operate the NBP's network. This contract has a life of at least 25 years, and it envisages that 544,000 rural premises will be passed almost exclusively with fibre by 2027.

In developing the NBP, Government planners pursued a completely fibre-based solution albeit consideration was given to 4G/5G mobile as an alternative solution as per a report **FTTP or 4G/5G for Ireland's NBP?** dated 5th December 2018. This was published by the Department of Communications, Climate Action and Environment (DCCAE) along with other background documents in May 2019.

6.1.2. Technologies

The EU's criteria for Next Generation Access networks (at least 30/6 Mbps) were carried through into the NBP's **Criteria for assessment of investment plans** (prepared in 2015 but still applicable in 2019) for which detailed technical assessments focused on wired and wireless platforms, the physical roll-out of the network and deployment of substantial managerial and contracted resources.

No consideration appears to have been given by planners to satellite broadband. In its press release dated 7th May 2019, the DCCAE referenced the need for future proofing based on the EU's strategic document **Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society** (cited above) but made no reference to satellite broadband. Also referenced in the same press release was a ComReg report entitled **Meeting Consumers' Connectivity Needs**. Dated November 2018, this report made a single reference to the 'last-generation' satellite networks which are currently available in Ireland albeit with restricted performances.

Whilst the NBP planners and its technical advisers theoretically pursued a technology-neutral approach, they focused on fibre-based solutions and did not consider emerging new satellite-based alternatives, either standalone or complementary to a fibre-based network. Only in September 2020 did the NBP's technical advisers publicly acknowledge that LEO satellites could significantly change fixed broadband services in poorly served locations.

6.1.3. Oireachtas Committee

During 2019, the Government mandated the Oireachtas Committee on Communications, Climate Action and Environment to "examine the national broadband plan process thus far, how best to proceed and the best means to roll out rural broadband".

Its report, published in August 2019 and approved by most of the committee, contained extensive criticisms of the NBP, and recommended, inter alia, that the entire plan be reviewed by independent experts before any contract should be signed. The Committee's report failed to

mention any emerging new technologies that might become viable alternatives to meet the NBP's objectives, notwithstanding that a detailed submission (Version 1.0 of **Plan B for NBP**) about the potential of satellite-based broadband had been made by the author of this document.

6.2. Intervention Area & Contract

6.2.1. Intervention Area

The NBP's Intervention Area and premises to be passed by State-supported fibre was defined by a detailed Departmental mapping exercise[18] and incorporated in the final NBP/NBI contract. Premises were excluded from the Intervention Area where service providers undertook, with a high degree of certainty, to provide broadband to premises/areas within seven years and in line with the performance criteria set out in the EU's **Digital Agenda for Europe**, namely minimum down/up speeds of 30/6 Mbps.

The departmental mapping exercise made no provision for any possible encroachment by existing broadband, WISP or mobile (5G and 4G LTE) operators or future new entrants such as satellite broadband services. However, the contract with NBI provided for compensation by taxpayers where it loses prospective customers within the IA who opt to receive broadband via other service providers.

6.2.2. Value for Money

The estimated total cost of providing fibre to pass 544,000 rural premises is about €5 billion, including an Exchequer subsidy of up to €2.5 billion net of VAT. Assuming a medium-term 30% uptake of services, the subsidy from taxpayers equates to about €15,000 per subscriber. This makes the NBP one of the most substantial investments ever made by the State notwithstanding that, under the terms of the contract, it will never own the assets being invested in. This proposed cost generated significant concerns amongst politicians and commentators[19] and led to an unprecedented public spat between senior administrators within the Departments of Public Expenditure and Communications about whether the NBP represented 'value for money' and whether its objectives could be met at lower cost to the Exchequer.

6.2.3. Contract

Nonetheless, in the end, the Government took a political decision to award the NBP contract to the sole final tenderer, NBI, in late 2019. In August 2020, the Government published portions of the contract which ran to about two thousand pages and was heavily redacted especially in relation to commercial, financial and performance issues. A detailed review (behind paywall) of the redacted contract was published by The Currency in August 2020.

The NBP is widely accepted as entailing considerable financial and operational risk given that it requires an upfront funding injection of a net €2.5 billion by the State, in addition to private funding, and appears to offer very marginal value-for-money for taxpayers based on several detailed cost-benefit analyses.

[18] NBP Mapping Consultation.

[19] Irish Times: Devil May Lie in Unknown Detail.

6.3. Progress

NBI effectively commenced operations in January 2020. Significant progress[20] has been made since then including:

- As of November 2020, it employed, directly and indirectly, about 800 personnel, a number which will rise to 1,800 in early 2022.
- NBI is offering 500 Mbps connections to households in the IA as well as business connections of up to one Gbps. It is future-proofing its network to handle 10+ Gbps withing the contract's 25-year life.
- NBI will only use eir's extensive passive assets (poles, ducts etc.) where available whereas active assets such as equipment, cabling etc. cannot be used due to contractual specifications and requirements. This approach will result in extensive duplication of cable runs etc.
- Development work to date has mainly concentrated on mobilisation, network planning and on-the-ground surveying of premises to be passed as well as detailed planning for the actual deployment of cable and equipment. By January 2021, approximately 158,000 premises have been surveyed. NBI expects that nineteen thousand premises in Cork, Galway and Cavan could become available for user connection in early 2021[21]. It plans to connect 200,000 premises (out of ultimate 544,000) in all twenty-six counties by end 2022 and to connect the balance by 2026-7[22].
- As 'wholesaler' of the NPB's fibre, NBI is working with over 30 prospective retailer service providers.
- Approximately 227 deployment areas have been identified. Working outward from exchanges, NBI will initially connect the most easily connected. However, no strategic timetable for connections over the next 6-7 years is available yet as many key decisions relating to routes, poles, ducts etc. are still outstanding.
- Initial progress has been slowed somewhat by Covid19 which has injected a new urgency into the need for broadband throughout the IA. The Government has expressed interest in seeing NBI speed up completion by up to two years provided costs and performances are not compromised. Unless there is a radical change in plans, it is likely that the final, most costly, most remote connections will not occur for several years. In partial response to this, the provision of high-speed broadband is to be accelerated to cover all 679 rural primary schools by the end of 2022.
- In advance of the roll out of fibre to individual premises, approximately 243 publicly accessible Broadband Connection Points (out of a planned 300) had, as at early January 2021, secured fibre connections. About 130 had been passed to Vodafone for the installation of indoor/outdoor Wi-Fi equipment and about 60 are currently operational.
- In November 2020, the media reported that two anti-competition complaints about the NBP had been lodged with the EU. In response, the Minister for Communications

[20] Based largely on presentations by the Minister for Communications and NBI executives to the Oireachtas Committee on Communications during November 2020.

[21] The first home connection to the NBP's network was made in Cork in early January 2021. Monthly charges are typically €45 per month for a 500 Mbps connection.

[22] NBP's Roll-out Plan.

expressed confidence that Ireland was meeting EU State Aid rules on account of the market failure to provide broadband across rural Ireland.

The most widespread concerns expressed to date by prospective customers of the NBP have been (a) the lack of any target connection dates (beyond the initial 18 months) and (b) the absence of any coherent overall plan to connect 'orphaned' premises which lie just outside the IA or in broadband 'blackspots' located well outside the IA and which have been ignored by commercial operators.

7. Role for Satellites in the NBP

According to the UN's **State of Broadband Report** for 2018, 49% of the world's population have access to reliable, affordable broadband. Regional variations range from 80% for Europe to 22% for Africa. Definitions of acceptable broadband speeds range from 25 Mbps by the FCC in the US to lower benchmarks used by the UN.

In February 2018 the OECD published **Bridging the Rural Digital Divide** which recognised satellites as "a key technology for providing rural and remote broadband access". This referenced an earlier OECD technical report entitled **The Evolving Role of Satellite Networks in Rural and Remote Broadband Access**. Although published back in December 2016, and in need of a major update, the latter delved into the potentially significant roles of low- and middle-Earth orbit satellites and referenced several proposed systems including SpaceX's Starlink.

The main targets for next generation satellite broadband services have been identified as unserved and underserved regions within both developed and underdeveloped countries as well as communities in inaccessible locations and ships, aircraft, and other mobile assets.

The imminent arrival of new technologies for broadband delivery cannot be ignored in Ireland. By the mid-2020s, the total number of fully-operational comms satellites could have increased by a multiple of the current nine hundred; many major internet, space and comms corporations will be offering competing services; billions will have been invested in satellite broadband services specifically to address unserved and underserved users worldwide; and surging satellite technology developments and breakthroughs will further enhance satellite performances and applications.

During the NBP's 25+ year operational phase, the performances of digital technologies could increase by a factor of hundreds or thousands with mobile tech entering its G7 generation. By then, many mobile phone and internet services could be delivered by satellite. This technological progression would pose major challenges to fixed fibre and land-based mobile services as has already happened in the case of traditional telephone and fax services.

Whilst it is still early days for satellite broadband, the pace of development is accelerating at the very same time that the NBP is about to roll out its fibre network and to incur major fixed costs. Meantime, satellite services are poised to offer the main benefits of the NBP to many rural users at a fraction of the NBP's cost and to a faster time scale.

8. Plan B's Recommendation

Version 1.0 of **Plan B for NBP** (November 2019) recommended that, prior to finalisation of the NBP, an expert assessment be undertaken into the potential of LEO satellites to deliver broadband to rural Ireland alongside the proposed fibre network.

Since then, this nascent space industry has made huge strides, as described in proceeding sections, and is now poised to deliver services globally, including to Ireland. Based on this research and analyses, **Plan B**'s updated recommendation to the Minister for Communications and to the Government is as follows:

> **The Government should immediately review the NBP, notwithstanding contractual and strategic commitments, and actively encourage and support the provision of high-speed broadband via low-Earth orbit satellites to premises within the Intervention Area especially where the NBP's incremental capital expenditures and waiting times for service are likely to be significant.**

This recommendation could result in up to a hundred thousand premises within the IA being offered access to high-speed broadband years earlier than anticipated by the NBP, leading to a substantial reduction in the Exchequer's contribution to the NBP[23]. In addition, there is likely to be a very substantial market amongst users enduring poor and/or erratic internet services in semi-urban and rural 'broadband blackspots' which lie outside the NBP's scope. These would include users with consistent speeds between 30 Mbps (NBP's threshold) and 100 Mbps (EU's target for 2025) and could embrace a further hundred thousand homes[24].

While acknowledging that this recommendation would require significant changes to the NBP's contract, it is consistent with the Government's stated intention to revisit the NBP, especially on account of Covid-19, to deliver high-speed broadband to rural areas within a much shorter time scale than originally envisaged and at an advantageous cost to the Exchequer.

Plan B's recommendation on the use of satellite broadband relates only to a portion of the NBP's proposed coverage and does not undermine the use of fibre to connect the great majority of premises within the Intervention Area.

9. Conclusion

This report has described the substantial progress being made towards the provision of high-speed broadband by LEO satellites and outlined likely growth trends. No Governments or internet and telecom operators can ignore the enormous energy and innovation being expended on the development of high-speed broadband services delivered by satellite. They are poised to grow exponentially and globally over the next decade thanks to major private and public investments.

LEO satellite systems will create many new opportunities based on the provision of new and enhanced services for users, especially for those in rural or unserved areas. However, they will also be significant, long-term disruptors and offer alternatives to incumbent terrestrial-based internet and telecom services as has happened with mobiles vs. landlines and satellite-based GPS vs. paper maps.

It would be entirely appropriate for Ireland, as a leading technology centre, to be at the vanguard of these developments and to be an early participant and beneficiary. Also, it makes little sense for the heavily-borrowed State to spend billions on the 25+year NBP when

[23] If the Government were to subsidise the circa €500 cost per household of an antenna etc., the once-off cost to the Exchequer would be about €10 million, based on an initial uptake by twenty thousand rural households, and pro-rate for additional households. Although only partly comparable, this cost can be contrasted with the State's total proposed expenditure of about €2.5 billion to pass 544,000 premises with fibre under the NBP.

[24] Second broadband tender may be needed as 100,000 homes left in slow lane.

emerging new solutions could undermine aspects of its finances, plans and marketplace within a matter of years.

Rural Ireland needs, arguably even more than urban Ireland, access to the benefits of high-quality, universal broadband services as soon as practicable especially in the context of Covd-19 and the ongoing revolution in remote working, education, healthcare, business etc.

Hopefully, by proposing a cost-effective solution based on satellite technologies, this **Plan B for NBP** will accelerate these developments.

Brian Flanagan Twitter: @BforNBP Email: PlanBforNBP@gmail.com