EDISON

Scale research report - Update

Mynaric

Technology

15 July 2021

The new space race

The US Space Development Agency (SDA) is investing in a new network of reconnaissance satellites. This will potentially have hundreds of relatively inexpensive LEO satellites, each deploying optical communications links. Mynaric has already won a contract to supply optical communications links for the first phase of this project. Its focus on design for manufacture in volume and investment in capacity, as demonstrated by the recent opening of a new production hall near Munich, places it in a good position to win follow-on business as the project ramps up.

US government upgrading satellite networks

The new SDA network was proposed because of concerns that existing government reconnaissance networks were not able to respond to threats such as missile strikes quickly enough and that networks composed of a few large and extremely expensive satellites were highly vulnerable to attack. Subject to continued funding being approved, the SDA's network will deploy several hundred low earth orbit (LEO) satellites, providing real-time global coverage from 2026 onwards. To make the project affordable, industrial partners participating in the project are required to switch to process methodologies suitable for delivery of hundreds of smaller, less expensive satellites in a short time frame.

Mynaric well positioned to take market share

Mynaric is one of only half a dozen companies globally that offers the optical communications terminals suitable for the SDA. It has already won contracts to supply terminals for both the first phase of the SDA's network and its precursor, Blackjack. Mynaric is well placed to take market share as successive phases of the NDSA network are launched. This is because it has recently opened a production hall near Munich, which has an annual production target of 2,000 terminals. In addition, while historically its competitors have been orientated towards providing expensive, one-off equipment, Mynaric is unusual in its focus on designing product for volume production.

Valuation: Analysis of potential revenue

Since consensus estimates do not expect Mynaric to generate an operating profit until FY22, we present a scenario analysis rather than a peer group comparison of multiples. This analysis shows that a constellation of 300 LEO satellites could require €150m of Mynaric's laser communications terminals and a cluster of 250 associated airborne communications platforms could require €113m of equipment.

Consensus estimates

Year end	Revenue (€m)	EBITDA (€m)	EBIT (€m)	EPS (€m)	DPS (€)	P/E (x)
12/19	0.4	(6.5)	(7.7)	(2.8)	0.0	N/A
12/20	0.7	(19.7)	(21.7)	(6.8)	0.0	N/A
12/21e	11.4	(17.6)	(22.0)	(5.4)	0.0	N/A
12/22e	108.2	12.5	5.7	0.3	0.0	312

Source: Kepler Cheuvreux, Stifel

Price	€76.40
Market cap	€313m

Share price graph

Share details

Code	M0Y
Listing	Deutsche Börse Scale
Shares in issue	4.1m
Net cash at end December 2020 (excluding €8.0m lease liabilities)	€43.2m

Business description

Mynaric designs and manufactures laser communication terminals and ground stations for airborne and spaceborne networks and applications. Its objective is to become the world's leading provider of network equipment for the aerospace communication industry using its serially produced and low-cost laser communication products.

Bull

- LEO constellations potentially give persistent global coverage for military reconnaissance.
- Wireless laser technology gives faster data rates than conventional microwave transmission.
- Tech is cost effective for mega-constellations.

Bear

- Technology not proven in complete satellite communications networks yet.
- Rate of roll-out dependent on government programmes securing funding.
- Limited number of potential networks for which Mynaric can sell equipment.

Analyst

Anne Margaret Crow +44 (0)20 3077 5700

tech@edisongroup.com

Edison profile page

Mynaric is a research client of Edison Investment Research Limited

Background to report – opening of new production hall

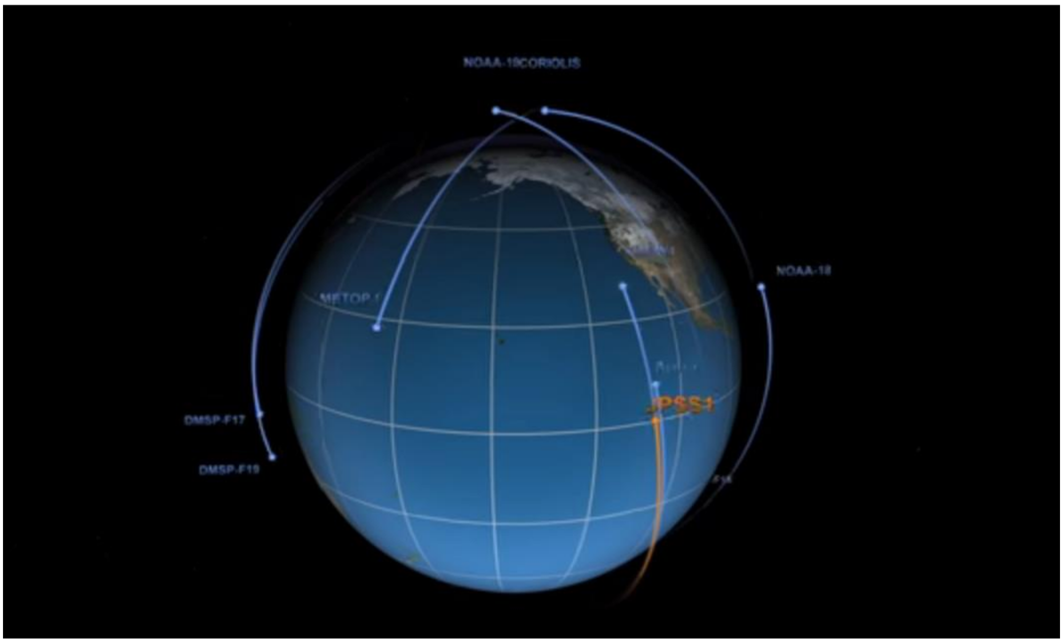
Mynaric has recently opened a new production hall at its facility in Germany, which has an annual production target of 2,000 terminals. This report explores the rationale for this investment and how the additional capacity puts Mynaric in a good position to take share as US Department of Defense (DoD) projects boost demand for free-space optical communications links.

Spy-in-the-sky

Defence organisations have used reconnaissance satellites to monitor the activity of potential enemies for several decades. While some of this activity has been taken over by drones and crewed reconnaissance aircraft, satellites are able to access areas that these vehicles are unable to do without violating the airspace of other nations. For example, the US government uses KH-11 satellites equipped with electro-optical digital imaging equipment similar to that used in the Hubble Space Telescope to obtain information on its adversaries. One of these satellites, USA-224, was probably the source of the image of an accident at an Iranian space facility which President Trump controversially tweeted in August 2019. There are two serious problems with reconnaissance systems based on these types of satellites. The first is the length of time it takes to pass the information to a decision maker. The second is vulnerability to enemy attack.

Traditional spy satellites do not provide continuous coverage

Exhibit 1: NOAA-20 earth observation satellite (details of orbit at 2.00 minutes onwards)



Source: www.jpss.noaa.gov/

The operational details of current US reconnaissance satellites are classified, but the same laws of orbital mechanicals apply whether satellites are used to collect data on weather or hostile troop movements. Earth observation satellite NOAA-20 was launched in November 2017 and forms part of the Joint Polar Satellite System. It collects information for meteorologists to enhance long-range weather forecasting. The satellite traces an orbit which circles the Earth from pole to pole, crossing the equator about 14 times daily and providing full global coverage twice a day. While data from this satellite is important, it is not time critical so it is fine to wait up to 12 hours to collect an update on the temperature at a particular spot and then have a further delay until the satellite is above a ground station to which it can download the data. The US government has multiple reconnaissance satellites in orbit so that collectively they provide full coverage of the Earth's surface much more frequently. In addition, these reconnaissance satellites immediately pass the data they collect up to relay satellites, which are in continuous communication with ground stations, so there is minimal delay in transmitting the data once it has been collected. However, the existing network does not provide continuous coverage of areas of concern so, while it can spot troops massing on a disputed border, it could miss a missile launch. The emergence of manoeuvrable hypersonic glide vehicles such as China's XINGKONG-2 (Starry Sky-2), which travel faster than the speed of sound, means the DoD needs improved tracking systems.

Traditional spy satellites vulnerable to enemy attack

KH-11 satellites range in mass from 13,500 kg to 17,000kg and typically cost at least US$1bn each to build, launch and operate. This makes the satellites attractive targets for hostile activity. A report issued by the DoD in 2020 noted that while China has not publicly acknowledged the existence of any new programmes since it confirmed that it used an anti-satellite missile to destroy a weather satellite in 2007, it currently has an operational ground-based missile intended to target LEO satellites and probably intends to develop weapons able to destroy satellites up to geosynchronous Earth orbit (GEO). In addition, in February 2020 the US Space Force revealed that a pair of Russian inspection satellites had approached within 100 miles of one of its spy satellites, behaviour which it regarded as 'unusual and disturbing'. In July 2020 the DoD accused Moscow of using the same satellite system to conduct an anti-satellite weapons test.

LEO constellations – the solution

The US government is addressing these issues by deploying a constellation of hundreds of LEO satellites orbiting at altitudes of less than 2,000km above the Earth's surface (see below). The SDA's proposed constellation, the National Defense Space Architecture (NDSA), will potentially provide the continuous coverage required, starting with coverage of sensitive regions. It will continue to operate even if several of the satellites in the network are permanently disabled by a missile or space debris, or temporarily disabled by electronic jamming. While an individual satellite will still be vulnerable to enemy attack, as the cost of each satellite falls (see below) the cost of sending a missile to deactivate a satellite will be comparable to the cost of the missile itself, potentially discouraging an enemy from launching an attack.

Improving 'lethality, manoeuvrability, and survivability' – current US government programmes

DARPA's Blackjack programme demonstrates feasibility

The Defense Advanced Research Projects Agency's (DARPA) Blackjack programme started in 2017. Its goal is the development and demonstration of the critical elements required for a global, high-speed LEO network which will provide the DoD with highly connected, resilient and persistent coverage.

One of the programme's three primary objectives is to develop payload and mission-level software to enable autonomous orbital operations including on-orbit distributed decision processors so that the network can identify a threat, calculate the appropriate fire solution and transmit it to the requisite weapons platforms. The second primary objective is to demonstrate that a network comprised of many interconnected LEO satellites can deliver the equivalent performance to a network based on larger non-GEO satellites such as the KH-11 constellation and, significantly, achieve that for a combined bus, payload and launch cost of less than $6m per satellite. DARPA aims to reach this cost point by deploying the advanced manufacturing methodologies developed in the commercial sector for LEO constellations, including those intended for broadband internet service, to the defence sector. DARPA's emphasis is on creating low-cost military payloads that will be upgraded frequently and which are carried on commercial satellite buses that can accommodate a wide range of payloads without modification. This is the third primary objective.

Since the Blackjack programme is more about proving the viability of the LEO architecture than putting actual hardware in orbit, the number of satellites involved is relatively small. The agency plans to launch up to 22 satellites by the end of 2022. The knowledge gained during the Blackjack programme will be applied to the much larger NDSA constellation being developed in parallel by the SDA as well as other US government space initiatives.

NDSA to use hundreds of LEO satellites to upgrade US missile response

The SDA was formed in March 2019 to co-ordinate the development and deployment of the DoD's NDSA. This is a proposed constellation of nearly 1,000 LEO satellites providing seven critical functions or 'layers' (see Exhibit 2) with the stated overall goal of improving US warfighters' 'lethality, manoeuvrability, and survivability'. For example, when tracking satellites in the network detect a threat such as a ballistic missile, they will send that information to the data relay satellites, which will combine the data, calculate a firing solution for disabling the threat and transmit that data directly via a tactical data link to the appropriate weapons platform.

Four test satellites will be launched in summer 2021. These will demonstrate aspects of the communications and infrared missile detection. Then the 'Tranche 0' batch of 28 satellites will be launched in September 2022 and March 2023. 20 of these will be data relay satellites providing the connectivity functionality, the other eight wide-field-of-view satellites providing tracking functionality. Tranche 1, consisting of 150 data relay satellites and around 40 tracking satellites, will be launched in 2024 and provide regional coverage for the armed forces. Tranche 2, which will consist of several hundred satellites, will be launched in 2026 and provide global coverage. This will be followed by other tranches in 2028 and 2030.

Exhibit 2: National Defense Space Architecture – capability layers

Layer	Capability
Transport	Provision of assured, resilient, low-latency military data and communications connectivity worldwide to a full range of warfighter platforms
Battle Management	Provision of architecture tasking, mission command and control, and data dissemination to support time-sensitive kill chain closure at campaign scales.
Tracking	Provision of global indications, warning, tracking, and targeting of advanced missile threats, including hypersonic missile systems.
Custody	Provision of 24/7, all-weather custody of time-sensitive, left-of-launch surface mobile targets to support targeting for advanced weapons.
Emerging Capabilities (Deterrence)	Incubation of new mission concepts. Initial focus will be to deter hostile action in deep space (beyond GEO up to lunar distances).
Navigation	Provision of alternative positioning, navigation and timing for Global Positioning System (GPS)-denied environments.
Support	Enabling ground and launch segments to support a responsive space architecture.

Source: US SDA

Tranche 0 is intended to demonstrate that the proposed architecture would be able to detect a hypersonic missile and to communicate among satellites and with the air and ground, and also to familiarise the armed forces with the system. The 28 satellites of Tranche 0 will form the initial kernel of the mesh network. Significantly, one of the stated aims of the initial phase is to demonstrate whether the proposed architecture can be manufactured at the cost points and within the compressed time schedules required for the system to provide global coverage via a network of several hundred satellites when the time the Tranche 2 satellites are launched in 2026. In April 2021, the SDA stated that the average cost of the fix-priced contracts for the Tranche 0 data relay satellites was US$14.1m and that it expected this would reduce for the Tranche 1 fleet.

‘Semper citius’ – the ‘always faster’ procurement model

As noted above, the US SDA intends to launch hundreds of satellites into space every two years through to at least 2030. The SDA has stated that to keep the pace needed to design, build, procure and launch so many satellites it is relying heavily on industrial partners. Importantly for Mynaric, the SDA wants these industrial partners to change their mindset. The SDA notes that its motto ‘Semper citius’, which translates as ‘always faster’, recognises that good enough capabilities in the hands of the joint war fighter sooner may be better than delivering the perfect solution too late. It wants its industrial partners to adapt their process methodologies from ones that were suitable for delivering small numbers of complex, individually designed satellites to methodologies suitable for delivery of hundreds of smaller, less expensive satellites in a short time frame.

Plugging into commercial networks

The SDA is relying heavily on industrial partners in another context as well. It is ensuring that the optical communications links (see below) on its own satellites are compatible with those on the emerging commercial LEO constellations such as Amazon’s Project Kuiper, SpaceX’s Starlink and Telesat’s Lightspeed. This will mean that data can be transferred easily from the DoD network to the commercial network and back, improving resilience and cutting upfront costs. We note that this shared resource approach would provide a useful source of revenue for commercial networks like Starlink and Lightspeed, subsidising the provision of broadband services to remote regions. (The Starlink and Lightspeed constellations are discussed in more depth in our sector report on the small satellite market.) According to the *Air Force Times*, a set of exercises scheduled for April 2020 involving the US military’s Advanced Battle Management System included a demonstration of elements of the US Space Command and US Strategic Command working with SpaceX’s Starlink mission.

SpaceLink is developing a constellation of relay satellites in medium earth orbit (MEO) to transmit data from LEOs owned and operated by third parties to ground stations in near real-time rather than waiting for a direct view of a ground station to transfer data. In May 2021 the company signed a framework agreement with Mynaric regarding the supply of over 40 optical communications terminals. As these will be compatible with optical terminals on the NDSA constellation (see below), this positions SpaceLink to provide supplementary data relay services for the US government’s new threat response system.

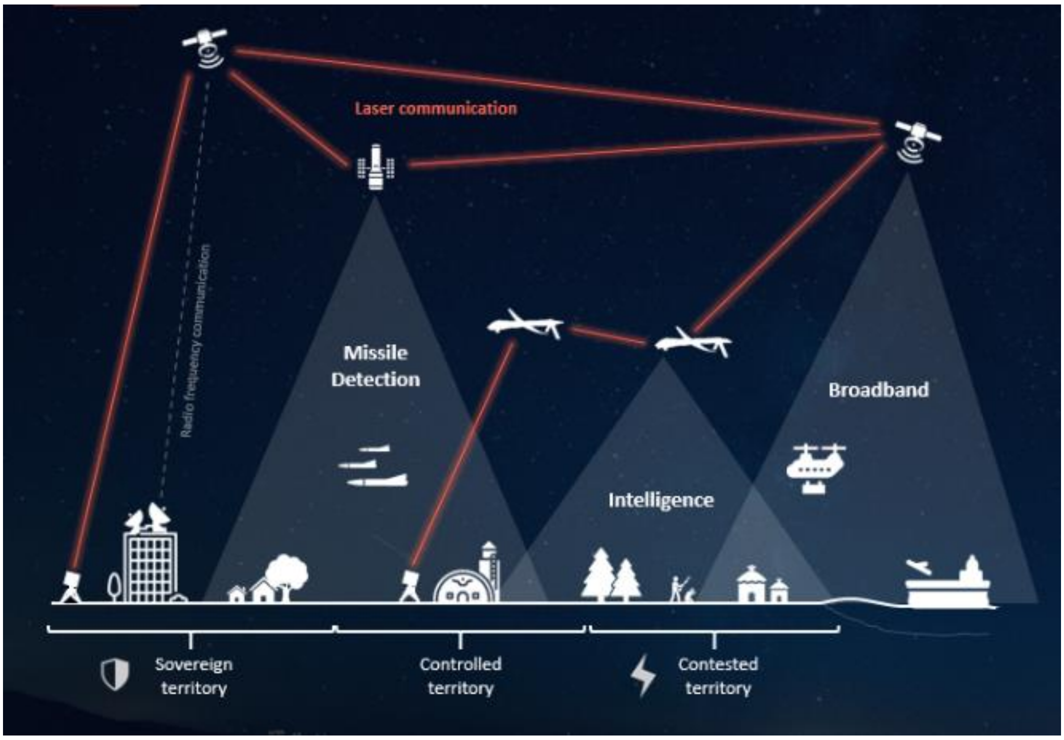
The SDA also wants to work with commercial operators of imaging satellites so they can send data directly to US government satellites in orbit without having to download it to ground stations. This would require the observation satellites to be equipped with optical links (see below) so they can pass data at speed to the SDA’s network.

Inter-satellite optical links key

Faster than traditional microwave links

Up to now, communications links on satellites have deployed microwave (radio frequency) technology. These microwave radio links typically deliver data rates that are orders of magnitude slower than optical communication links. This means that a reconnaissance satellite is not able to transmit all of the data it collects, but has to compress the information, potentially losing some of the detail in the process. The satellites being built for the Blackjack and NDSA constellations, as well as SpaceX’s and Telesat’s LEO constellations, will have optical links between the satellites, enabling them to send data to their nearest neighbours significantly faster than microwave links. Since wireless laser beams do not spread out like microwave links, they are much more difficult to intercept illegally and are thus much more secure. Additionally, laser links are significantly more power efficient than microwave links to transmit data over the same distance. This is an important advantage when transmitting from a solar powered satellite where power consumption must be kept to a minimum.

Exhibit 3: Government communications network



Source: Mynaric

The relay satellites being built for Tranche 0 of the NDSA constellation will have either two or four optical cross-links per satellite (ie forwards and backwards and optionally either right and left or up and down) that will enable satellites to communicate with their nearest neighbours. If a satellite cannot establish a contact with a ground station, perhaps because of electronic jamming, it will be able to pass data from one satellite to the next until it reaches a satellite with a connection to the ground. Tranche 1 satellites will have an additional optical link to connect the satellite to a ground station or to an airborne platform.

Mynaric has won contracts to supply optical terminals for DoD programmes

Blackjack programme

In October 2020 Mynaric announced it had been selected by Telesat to supply multiple units of its CONDOR optical inter-satellite link terminals to DARPA's Blackjack Track B programme. The terminals are scheduled to be delivered in mid-2021 to DARPA's Blackjack System Integrator, with satellites scheduled to launch in the latter part of 2021. As noted above, one of the aims of the programme is to establish the capabilities of laser communication products. This includes whether terminals from different vendors can communicate successfully with each other. As part of the deal with Telesat, Mynaric is currently in the process of setting up a laser communication link testbed at its Los Angeles facility. The testbed will replicate the existing capability facility at Mynaric's headquarters near Munich. The internal testing facilities will allow Mynaric to fully test its terminals and their compliance with the SDA OISL (optical inter-satellite link) standard in-house, further reducing development time. They will also allow third parties to test their compatibility with Mynaric's products.

National Defense Space Architecture

In August 2020 the SDA announced that it had awarded a $187m contract to build 10 satellites for Tranche 0 of its LEO communications network to Lockheed Martin and a $94m contract to build 10 satellites to York Space Systems. Established satellite builder Lockheed is purchasing optical communications equipment from an undisclosed company in Backnang, Germany, where Tesat is based. Newcomer York Space is purchasing equipment from an undisclosed company in Los Gatos, California, which is where SA Photonics is located, and from an undisclosed company in Los Angeles, which is the site of Mynaric's US operation. We have previously inferred that Mynaric is providing optical communications links for the SDA programme. This view was validated in an article from Via Satellite released in June 2021 and posted on the SDA website that noted that Mynaric had confirmed compliance with the new interoperability standard (see below). Each batch of 10 satellites must be delivered and ready for launch by September 2022.

Exhibit 4: CONDOR terminal for inter-satellite links

Source: Mynaric

Exhibit 5: Testing communications links in Germany

Source: Mynaric

The SDA has specified that optical communications equipment from any one vendor must work with equipment from the other vendors. Mynaric and other crosslink providers have worked with the SDA to develop an interoperability standard, which was approved in draft form earlier this year. In April, the Naval Research Laboratory (NRL) and Mynaric successfully connected their standard-compliant modems via optical fibre for the first time at an SDA/NRL-hosted testbed. To hear Mynaric's CEO, Bulent Altan, speak about Mynaric's involvement in these programmes, please click here.

Mynaric well-placed to win more work as the SDA's network is expanded

There are relatively few companies working on wireless laser technology. These include US-based Ball Aerospace, General Atomics, SA Photonics and Space Micro as well as Gooch & Housego, Tesat and Thales Alenia Space Switzerland, all of which are headquartered in Europe. These competitors are described in more detail in our October 2020 initiation note on Mynaric.

Capacity to manufacture in volume

Being able to manufacture terminals in volume is likely to be a key differentiator. For example, the initial phase of the NDSA constellation will have 20 data relay satellites collectively requiring 68 laser terminals. The SDA has plans to expand the number of data relay satellite to 300–500. Manufacturing optical communication terminals at these volumes is likely to present a challenge to Mynaric's competitors, which have historically produced individual bespoke items.

In contrast, after building close to a dozen terminals in FY20, primarily for in-house testing, Mynaric is preparing to construct around 50 terminals during FY21, around three-quarters of which will be available to meet customer demand. Mynaric believes that this total of 50 terminals represents a higher number than have ever been launched by all of its commercial competitors combined.

As part of getting ready for volume shipments, Mynaric has opened a new production hall at its facility in Germany, which has an annual production target of 2,000 terminals. Importantly, Mynaric has brought manufacturing of critical optical components in-house. It has also brought most of the testing in-house, significantly accelerating the development cycle. These actions put Mynaric in a good position to take market share as the SDA and others move from the pathfinder phase to full-scale deployment of hundreds of satellites.

Exhibit 6: Commencing serial production

Source: Mynaric

Exhibit 7: German facility

Source: Mynaric

Designing for manufacture in volume

As noted above, Mynaric's competitors have been orientated historically towards providing expensive, one-off equipment for governments and research institutes for space programmes. This approach is reflected in their product design. Mynaric is unusual in having been focused for several years on product that is ultimately intended for volume production. For example, it has formed an exclusive partnership with a French research institute for the supply of the next generation of avalanche photodiodes. These are expected to be around 10 times more sensitive than existing variants, enabling Mynaric to reduce the production costs, size, weight and power consumption of its laser communication units.

Valuation

Since management does not expect Mynaric to deliver meaningful numbers of commercial units until H221 and consensus estimates do not expect the company to generate operating profit until FY22, an analysis based on peer multiples is of limited use. We therefore present a scenario analysis (Exhibit 7) showing potential revenues achievable if the technology is deployed in communication systems of different sizes. We split the analysis into two types of network.

The first type is a communication network based on small LEO satellites. Putting the numbers of satellites shown into context, we note that Tranche 2 of the NDSA is scheduled for launch in 2026 and will include around 300 data relay satellites. Further tranches extending to 2030 may expand the constellation up to 1,000 satellites. As discussed in our report on the small satellite market, other constellations deploying inter-satellite optical communications links are being created, some of which may eventually contain several hundred, or in the case of Space X's Starlink several thousand, satellites.

Exhibit 8: Analysis of potential revenues

Internet LEO system				
Cost of payload* (€m)	2.0	1.5	1.0	0.75
% payload composed of Mynaric systems	50%	50%	50%	50%
Number of satellites in constellation	50	100	300	1000
Revenues attributable to Mynaric (€m)	50	75	150	375
UAV and aircraft-based system				
Cost of payload (€m)	1.00	0.90	0.68	0.51
% payload composed of Mynaric systems	50%	50%	50%	50%
Number of platforms in constellation/cluster	50	250	500	1000
Revenues attributable to Mynaric (€m)	25	113	169	253

Source: Edison Investment Research. Note: *Payload is the part carrying out communications/sensing function.

The second type is a communication network based on many more, less expensive platforms, which may be unmanned aerial vehicles or aircraft. We have not considered these so far in this note because the two government programmes we have discussed are based on tracking satellites, but it is reasonable to believe that reconnaissance data from satellites will be supplemented with data from other platforms, which could also be equipped with Mynaric's optical communications terminals. A communications satellite such as that used in the first scenario requires space-qualified terminals, which are more expensive than those on an airborne platform.

General disclaimer and copyright

Australia

New Zealand

United Kingdom

United States