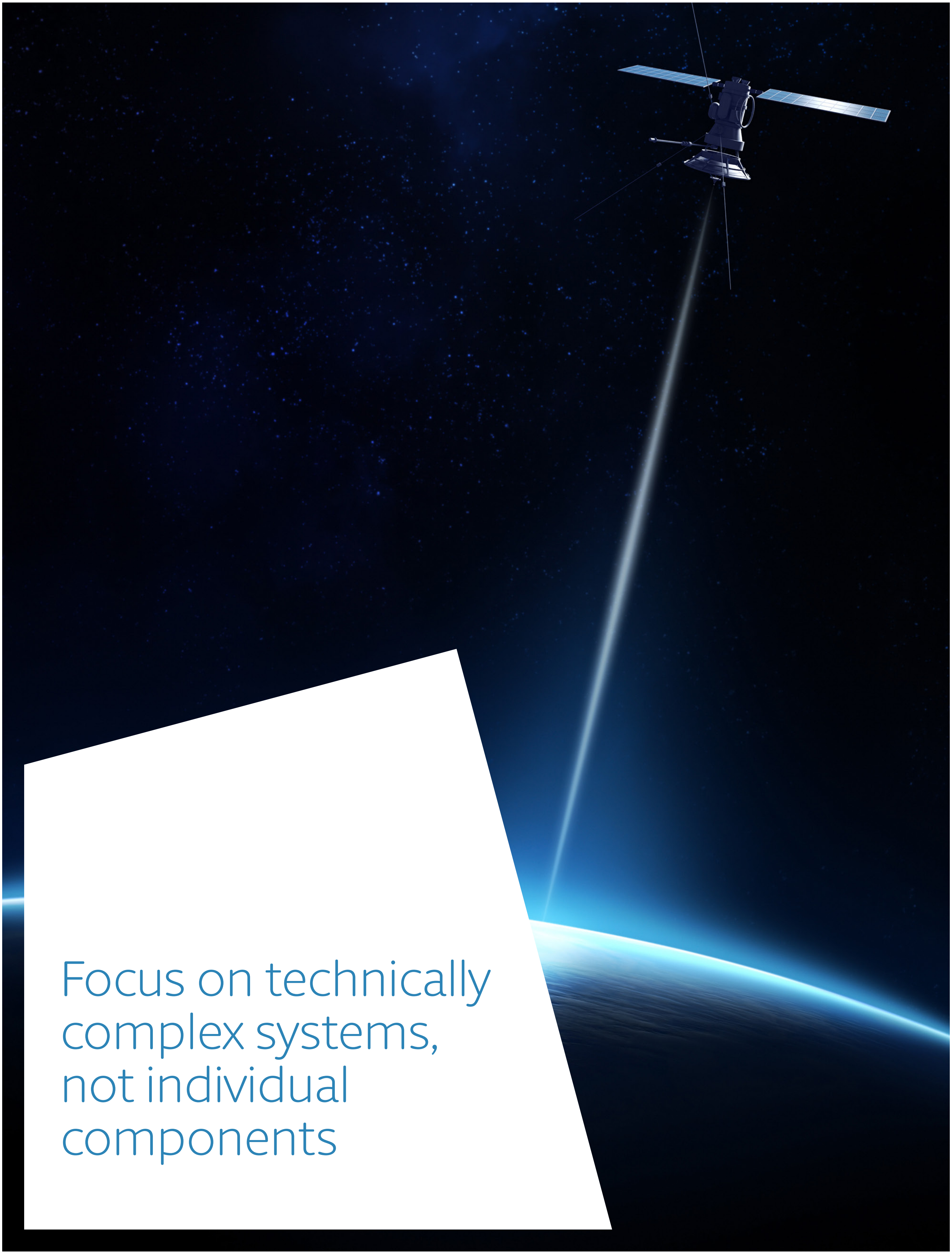
Hogan Lovells

Contracting for SmallSat mega-constellations

A brief how-to guide

Randy Segal, Steven Kaufman,

and Alexis Sáinz



Focus on technically complex systems, not individual components

Overview

Historically, commercial satellite systems have been developed and deployed on a generational basis, with geostationary satellites possessing a useful lifespan of approximately 15 years. These were launched one at a time and built for regional or country specific coverage, with sequencing limited to a small global fleet targeting land masses or ocean regions.

Beginning in the late 1990s, the satellite industry started to develop large-scale low- and mid-earth (or elliptical) mega-constellation systems. These systems faced significant technical, financial, regulatory, and market obstacles to full deployment, appearing somewhat ahead of their time.

Twenty years later, the satellite constellation era is experiencing a renaissance with several mega-constellations successfully operating and dozens on the drawing board or in process of finding funding. These operational constellations range from 40 to 200 satellites, but constellations are being developed that will have hundreds or even thousands of small satellites designed to envelop the globe. The constellations feature a range of different applications, including internet broadband, internet of things (IoT) tracking, geospatial earth observation, global imaging, air traffic control, rapid communications for large enterprises, cloud storage, and blockchain applications, with other new approaches being developed almost every month.

These constellations are more than just multiple satellites; they can perform functions on a combined basis that cannot be done by several satellites operating individually. But with these increased capabilities comes a variety of new technical challenges, including communication handoffs in space, unique operational management needs, and ground-based system developments to ensure seamless interoperability. Major new business, legal, contractual, regulatory, and risk management issues need to be overcome, and the industry is in the process of wrestling with many of those.

There is also speculation that only a portion of these constellations can be successful concurrently, as many of them compete for the same spectrum, funding, strategic partnerships, major customers, and market access.

Randy S. Segal
Partner, Northern Virginia, Washington, D.C., and Silicon Valley
T +1 703 610 6237
randy.segal@hoganlovells.com

Steven M. Kaufman
Partner, Washington, D.C.
T +1 202 637 5736
steven.kaufman@hoganlovells.com

Alexis Sáinz
Partner, Washington, D.C.
T +1 202 637 5600
alexis.sainz@hoganlovells.com

Many of the underlying issues in procuring and developing a satellite system are applicable to mega-constellations. But constellations also pose broad-ranging additional challenges. Please see our article *Satellite systems procurement: A brief how-to guide* at HoganLovells.com

Challenges arising from SmallSat mega-constellations: More than its component parts

New challenges posed by the technical system architectures , increasing developmental stages, multiple production processes, and new missions of constellations have legal, contractual, and regulatory implications.

Issues caused by technical system architectures

In a constellation, satellites need to work together as a single system, with complex handoffs, detailed coverage planning, and possibly intersatellite communications. This often means that individual satellites may have to perform different functions or reside in different orbital planes, and that the system has features that can only be tested as a full system, not on an individual satellite basis.

This poses significant technical challenges for the contracting process, where acceptance testing and remedies have to be provided on a system-wide rather than per satellite basis. It requires more technical sophistication from advisers to investors and lenders, and risk analyses that look closely at having spare satellites not just in orbit, but in specific orbital planes or that perform specific functions.

Requirements for ongoing technical reviews and processes for resolution of technical disputes among advisers and developers need to make their way into procurement contracts, investment, or loan agreements, and into insurance considerations.

System operations giving effect to sparing and redundancy

Detailed discussions need to be held and contract clauses written regarding redundancy, sparing, and restoration. Provisions in funding agreements regarding system performance may involve complex tests, since failure of one portion of the system does not necessarily mean the system itself is not commercially operational.

In addition, what constitutes a material default needs to be recast not in terms of the materiality of the damage, but in the operator's ability to restore service to acceptable levels within acceptable periods using in-orbit or even ground spares.

System assembly may not be turnkey

The need for the constellation to function as a system also extends to ground systems and software. These complex architectures require more sophisticated infrastructure, and software (always important for operations) can be a critical part of the system performance.

While this reliance on ground systems or other elements, necessitating different providers with skills unrelated to those of a satellite manufacturer, is not unique to constellations, a new issue is emerging.

The need for the ground system designer/manufacturer to play a key role in the constellation, and the cost of the ground or other system elements being as much as (or more than) the satellites themselves can undermine the turnkey nature of satellite projects. Many satellite systems are projects as understood by project finance providers, and as such need to have a certain structure and coherence.

When the satellite is by far the most expensive part of the system - with launch services being largely a stand-alone part of the puzzle - the satellite designer and the satellite manufacturer effectively function as the leads for the other system participants to work around, producing something close to a turnkey system.

How to redefine the model

Satellite constellations, by contrast, often do not follow this model. The satellites may not be the most complicated or expensive part of the system, and the satellite design may not be the primary driver of the overall system design. The role of the satellite manufacturer may be reduced so there is no natural leader or focus around which to organize the project. This creates a problem for finance providers who are looking for project coherence and a responsible party with a stellar reputation and strong balance sheet to lead the manufacturing process, and poses unique challenges for the project financing lawyers.

The problem is compounded when a good portion of a SmallSat constellation, particularly satellites, payloads, or certain ground elements, is developed in-house by the operator, with its own employees, at relatively low cost, using its own intellectual property and software. While this may be cost effective, it creates a business model previously unknown in the satellite industry where design and manufacturing risks cannot be attributed to a large player whose reputation and balance sheet can compensate for the untested nature of the system being developed.

This creates a business model previously unknown in the industry where design and manufacturing risks cannot be attributed to a large player whose reputation and balance sheet can compensate for the untested nature of the system being developed.

Major points to consider

- Issues caused by technical system architectures
- System operations giving effect to sparing and redundancy
- System assembly may not be turnkey
- How to redefine the model

The basic essence of a SmallSat constellation shifts the focus from the traditional satellite-centric and -driven model.

Issues caused by developmental stages of constellations

Long development phase timing and pricing risks

Although almost all satellite systems are custom designs, the geostationary satellite production process is well understood, with budgeted preliminary, critical design, and production phases where all cost and timing elements are defined in advance. Enter the satellite constellation, where the development timing and cost are not well known or easily budgeted, and the cost to produce individual satellites actually may not be known with any degree of certainty until close to the end of the development phase. This creates large complications for procurement processes and for financing alike, requiring creative solutions from the respective teams.

Long production phase risks caused by dynamic development process

The constellation satellites cannot all be manufactured or assembled at the same time, with some planned to be deployed over a period of more than two years. This may result in a need to contractually accommodate different versions of the same satellites as upgrades are developed and implemented during the construction process.

If the first satellites are required to meet the initial performance specification, are subsequent upgraded units held to a different specification? Do the upgrades constitute change orders that the customer must pay for? If so, on what basis given that the upgrades are planned but costs are not yet known? How do contracts handle individual satellites not meeting specification, when the design shows the system as a whole will still meet specification? And how do investors or more conservative lenders get comfortable with this type of dynamic process? These issues create challenges for legal teams on all sides, but need to be addressed in the applicable agreements.

Can operators plan for refreshing their systems?

It is understood that the new mega-constellations anticipate satellite refresh to occur in a three- to five-year period rather than the 15-year satellite lifetime for geostationary satellites. With such a short lifetime compared to the multi-year process of deploying a constellation, there can be an almost continuous process of redesign, development, and assembly. This is not easily worked into procurement contracts that must have a fixed price and duration. If the process is not continuous, the cost of stopping and re-starting the production line must also be factored in. The prospect of continuous replacement also does not yield an all-in project cost that the project finance team is looking for.

Satellite refresh, upgrades, and pricing complexities.

Challenges arising from sheer multiplicity

The satellites

While in theory a multi-satellite system can be handled with the same type of procurement contract as a single satellite, there are some unexpected issues to deal with. For example, liquidated damages become a much more complicated concept. Specific deadlines need to be met in order for satellite launches to occur on schedule, but the satellite manufacturer can argue that if the overall system is deployed on time, the customer has not suffered commercial harm.

Even storage is a more complex concept. A launch delay may require some number of satellites to be stored, but the manufacturer does not stop the production line, causing an increase in satellites that are produced and declared ready to ship. Issues with the warranty period for these satellites subject to on-ground storage are exacerbated by any miscalculations in the rapid ability to launch and/or unanticipated launch delays.

The option for a single replacement satellite from the geostationary world does not fit in the constellation world, with customers wanting options to increase and decrease the number of units coming off the production line. Since the cost per unit may depend on the volume, this option may not be easy to document, or even conceptualize.

The launch services

Single vs. multiple vendors. The main launch challenge for a constellation is how to build in both flexibility and protection against risk of delay for multiple launches. Satellites, of course, may be late in delivery, so flexibility is needed across many separate delivery cycles, and the impact of a launch provider being grounded for some months to address a launch failure issue can be problematic for multiple launches on a single vendor. On the other hand, using many different vendors also has a cost for the operator, both in terms of losing the benefits of volume pricing and the vendor being less inclined to accommodate delays in satellite delivery because they have less invested in the program as a whole. Using a single vendor (SpaceX) worked quite well for Iridium. However, other constellations may look to at least two vendors to spread some of the launch delay risk without losing all of the volume pricing benefits.

Magnified launch issues. While launch is always a key component of a satellite system, the importance and risks become magnified with the constellation. More launches bring larger risks of at least one launch failure, and delay can result in satellites piling up at the warehouse. Also, the relative cost of launches as a component of the overall system cost can be much greater for a constellation than a one or two satellite system. This becomes an issue for project financing and management of overall system cost, and puts more pressure on the provisions of the launch contracts.

New launch vehicles. With the advent of numerous and diverse new launch vehicles as well as the new launch capabilities of existing providers, launch options for both dedicated and shared launches will be available to mega-constellations. This competition may result in better pricing, more flexibility, and more ability for tailored launches with vehicles appropriate for different satellite sizes and other mission characteristics. At the time of publication, the number of choices available to constellation operators is still limited and launch demand is reasonably high relative to supply, but that may change in coming years.

Launch as a commodity. The modification (current and planned) of heavy launch vehicles to accommodate multiple SmallSat launches and the addition of satellite launch brokers to the space industry has made it increasingly possible for constellation operators to approach launches of CubeSats as something of a commodity. Launch purchases need to be planned carefully, but it is now possible to have master purchase agreements with launch providers, spreading constellations across multiple launch opportunities.

Challenges in how to build in both flexibility and protection against delay risks.

Challenges arising from new satellite system missions

Many of the new constellations focus not on the sale of satellite capacity, which perhaps is still the biggest revenue source for geostationary satellites, but on the gathering, analysis, and sale of data of various kinds such as imaging or tracking. The suite of contract documents for this type of constellation needs to be expanded to include data processing agreements, which may be part of the system architecture itself, as well as data analytics and sale agreements, which become part of customer documentation. There may also be agreements with terrestrial providers for transport of data from satellite gateways.

Additionally, sale or dedicated rights to use of satellites within a constellation for customer use over different territories is increasingly considered within the suite of revenue opportunities, and must be carefully documented and structured to reflect the range of regulatory, insurance, and liability risks in such an opportunity.

Other issues encountered with constellations

There are numerous other issues that are fundamentally different when considered in the context of a constellation. We will touch on two of them: insurance and de-orbiting/ orbital debris risks.

Different satellite constellation missions present new agreements, opportunities, and risks

Major points to consider

- Issues caused by technical system architectures
- System operations giving effect to sparing and redundancy
- System assembly may not be turnkey
- How to redefine the model

Insurance

With constellations having spare satellites in orbit, the insurance risk is quite different for operators than for a one or two geostationary satellite system. It may still make sense to insure some launches, but the economics are certainly different in a multiple-launch situation where the cost of producing extra satellites is relatively low compared to the cost of insuring a launch. Insurance brokers are developing new solutions for constellations, but the need and value proposition for the operator are not the same. This piece of the puzzle may continue to evolve in the near future.

De-orbiting/orbital debris risks

The costs of de-orbiting and risks of on-orbit failure and orbital debris are in theory cumulatively higher for mega-constellations, particularly low-earth orbiting systems which generally rely on atmospheric re-entry for post-mission disposal. Increased regulatory scrutiny regarding these risks by government agencies, including the Federal Communications Commission (FCC) and the National Oceanic and Atmospheric Administration (NOAA), and concerns regarding who should bear the burden of potential costs, means finance providers may be more interested in the views of their technical advisers regarding these matters than would be case for a geostationary system. Insurance for these risks is not yet a component of most systems, but may become one in the future if governments impose risks and costs on constellation operators.

Intellectual property for satellite systems

As already noted, mega-constellations may have customer-developed intellectual property (IP) in the satellite system, driven in part by the need to differentiate from the other mega-constellations. The customer as source of IP raises issues for financing, being untested and without the backing of a large player. However, its importance to overall system development is significant and the documents should contain provisions or separate agreements specifically addressing IP ownership, development, and exploitation. Care should also be taken as a contractual matter, beginning in initial contractual discussions, to ensure that system enhancements and operational innovation are maintained as the right of the operator, or providing for some type of joint ownership to incentivize improvements or enhancements by the satellite manufacturer.

Customer-developed IP for mega-constellations raises issues not typically encountered in geostationary satellite programs.

Global system regulatory complexities

Fundamental to the nature of a global system are the myriad regulatory and cross-border complexities (and choices) in system architecture, landing rights, government regulation, and spectrum coordination. Many of the areas of technological development for global systems include technologies (coupled with analytics) in unsettled areas of U.S. and international regulatory frameworks. Deploying global constellations raises issues of U.S. and international policy, regulation, jurisdiction, and limitations to consider in not only developing the systems but also in its operational parameters to commercial, government, or military customers in the United States and abroad.

The global nature of the system also furthers the complexity of determining the most beneficial regulatory regime for the satellite system.

Geostationary systems typically have at most three logical hosting/ licensing nations. This can be the company's own country (such as the FCC for the United States), the administration for one of the covered target countries for services in the case of a system operating outside the United States, or one of the alternative companies (with targeted country efforts) and associated administrations providing favorable terms for deploying global systems (e.g., ManSat/Isle of Man).

Global systems raise issues of other countries "flagging" based on various other considerations. These can include the country's solicitous regulatory framework for commercial space systems and support in the international regulatory community,[1] incumbents developing platforms in the same competitive market diverting (or dividing) administration support for your system, spectrum allocations and/or policy differences from jurisdiction to jurisdiction, certainty and sophistication of regulatory framework, participation in the international regulatory community (including the International Telecommunications Union), transparency, stability, cost, and timing, among others.

In addition to the regulatory issues, which are front and center in the decision, other issues including tax, financing, legal, business structure and considerations, ability (or challenges) to comply with other applicable U.S. laws, and geopolitical stability factor into the determination.

Global systems also exhibit complexities with respect to export limitations in terms of the location of the system development and regulation of the satellite system services, both of which may be regulated by a multitude of government agencies both in the United States and internationally. For example, in the United States, different elements of the satellite system development and discussions (deemed exports) are regulated by either the Commerce Department[2] or the State Department[3]. In the case of certain other elements, such as the resolution of Earth observation satellites, they're regulated by NOAA[4]. The regulatory framework for other, newer technologies and the combination of multiple innovations has not yet been fully resolved as to who would take the lead in regulation and how the technology would be regulated. Significant regulatory determinations and changes can be expected in the upcoming years as these systems are deployed.

Among the new areas that may face evolving regulation are smaller, novel launch vehicles (including those drawing on ground-based technologies and 3D printing), synthetic aperture radar (SAR) systems, artificial intelligence and big data analytics, limitations of operations and sales of raw or processed-data based on resolutions and identifications of U.S. or international military facilities.

The choice of flagging your satellite, origin of technology, geographic location of offices, and the nature of your services may affect the regulation and limitations of your product offerings in any number of international jurisdictions. Other countries have their own export and other regulatory rules, and global systems must be mindful of the interplay among the regulation and cross-border development, communications, and services.

Satellite internet broadband platforms may raise very different legal, contractual, and regulatory considerations than a geospatial, remote sensing, or IoT satellite system. Consider the different ranges of global regulation and technical limitations for compliance with global data privacy rules, cybersecurity, and compliance with both local laws and a company's governing laws in the selection of a system architecture and deployment in different jurisdictions.

The nature of the system, including its architecture and the agility of the architecture, may significantly impact the ability to coordinate spectrum and obtain landing rights for services globally.

Satellite system contracting and development often occurs simultaneously with the exploration of international landing rights, spectrum allocations, and in the context of an evolving regulatory landscape.

Significant consideration needs to be given to requirements for system architecture flexibility (or fixed option pricing) and capabilities to adjust to international regulatory requirements and maximizing spectrum opportunities as much as possible. Agility often comes with a cost, so business-technical-contractual trade-offs should be anticipated and complex decisions should be anticipated.

National and international regulatory filings

One noteworthy observation for satellite operators: From time to time (including for mega-constellations) satellite manufacturers have made filings both internationally, at the International Telecommunication Union (ITU), and domestically, such as with the FCC. In some noteworthy cases, international manufacturers seeking a negotiating advantage over competitors for potential systems have made filings at the ITU[5]. With respect to certain U.S.-based spectrum, manufacturers have also submitted filings in FCC processing rounds either based on gaining advantage for a potential (undetermined) customer(s) or based on existing customer requests[6].

Care must be taken by satellite operators to contractually pre-empt these manufacturer filings and/or obtain a strong contractual right for the filings to be assigned or used for the exclusive or partial benefit of the operator, even in the event a different manufacturer is selected[7]. Those contractual provisions may provide different economics in the event that the filing manufacturer is not selected in whole or in part for the constellation, but care should be taken to maintain control over these critical elements and dependency to the constellation.

The regulatory landscape for innovative mega-constellations is complex and evolving.

Mega-constellation financing

It goes without saying that funding a satellite constellation is an enormous undertaking, likely with tranches and possibly across multiple years.

Strategic investors

Strategic investors can bring a great deal to a constellation, including not only the provision of actual financing but also system validation, global market access, infrastructure and experience, existing customer base and relationships, and experience in system deployments. This can be key in attracting other investments and particularly for debt or project financing.

Of course, strategic investors bring complications as well. Selection of one strategic investor will make it more difficult to attract competitors as system participants or customers. This is rooted in a concern that the strategic investor will have preferred terms and that ordinary non-disclosure contracts will not adequately safeguard competitively sensitive information. Strategic investors often do seek some preferred terms, since the draw for them is commercial rather than return on investment. For the right level of investment, nature of the terms, and/or size of purchase commitment, these tradeoffs may well be reasonable and attractive for the operator.

Equity requirements for untested business models

Many constellations propose to offer new and innovative services, which may have a lot of upside but do not have a lot of evidence that customers will contract and pay for the products or services. That may require that a good portion of the financing, and certainly the initial rounds, be in the form of equity investments. Fortunately, the market today seems to have a lot of appetite, relative to historical experience, for investing equity in satellite systems.

Project financings

For high-cost constellations, it may be necessary to raise a substantial amount of debt financing, generally later in the process after initial equity investments have been funded. Since constellation operators are often start-ups which have no sources of revenue outside the constellation project itself, it may become necessary to put in place all of the building blocks for a project financing. This generally will include equity, sufficient third party contracts, demand studies to satisfy the lenders that adequate revenues will be produced once the constellation becomes operational, a solid technical design approved by the lenders' technical adviser, and performance guarantees from the major vendors.

This type of financing can take a long time to put together, consisting of many pieces that are not easy to assemble in the pre-revenue, pre-operational stage. As it is often an all-or-nothing financing, nothing can be drawn upon until everything is completed and in place.

Take or pay contracts to support debt or project financing

Like any project financing, lenders like to see take or pay contracts with creditworthy third party customers. For SmallSat constellations, some of the services offered are innovative and the systems unique, making it more challenging to line up customers ahead of system performance than would be the case for geostationary satellite systems that have well-utilized products and services.

Also, take or pay implies no exceptions to the obligation of the customer to pay for the service. That can be unrealistic for anyone except a system sponsor. A third party customer will want performance conditions tied to their receipt of a service meeting specification, rather than the project finance step of system acceptance by a lender's technical adviser.

Some flexibility and commercial understanding on the part of lenders will be needed to arrive at contracts that customers without interests in the project will actually sign. This flexibility may come with a cost in the form of higher equity or contingent equity requirements.

Financing iterative constellations

A number of SmallSat constellations are modular in nature. The entire system does not need to be launched to provide services that customers will buy, and the system can be funded, built, and launched in many pieces. It can be less challenging to finance this type of constellation, since after the first round of funding the system can actually generate revenues and, even more importantly, test the market demand for the service. This type of financing can be iterative, like the constellation itself, without the project finance-based necessity to assemble so many parts before any debt financing can be secured.

Some flexibility and commercial understanding on the part of lenders will be needed to arrive at contracts that customers without interests in the project will actually sign.

Major points to consider

- Strategic investors
- Equity requirements for untested business models
- Project financing
- Take or pay contracts to support debt or project financing
- Financing iterative constellations

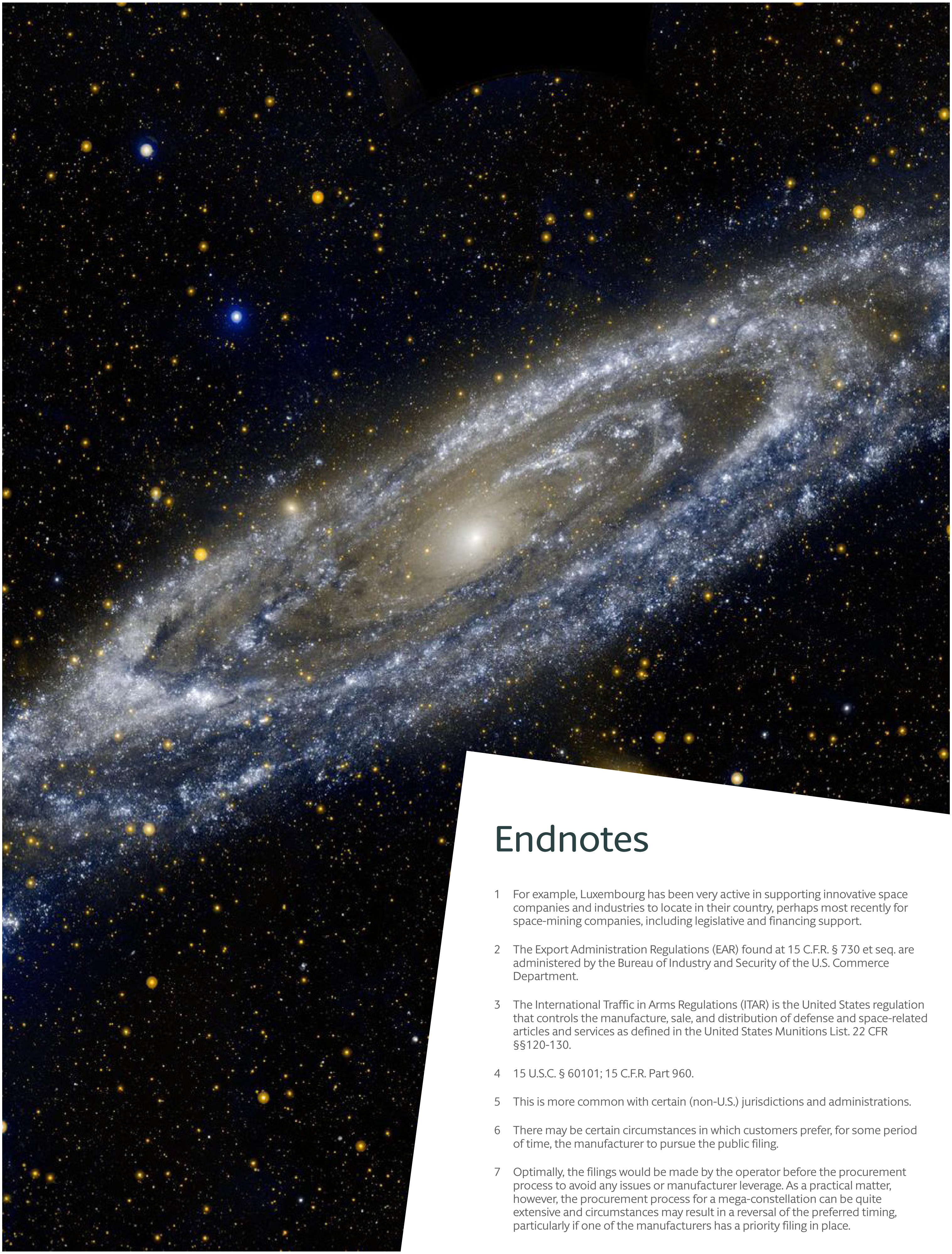
Strategic investors bring a great deal to a constellation, but bring complications as well.

Conclusion

Best practices and takeaways for SmallSat mega-constellations

The procurement, integration, and deployment of any satellite system is quite complex but can be successfully navigated with the right understanding of each of the elements and how they interreact with each other. The following are the key takeaways for constellation procurement, contracting, and financing:

- Constellation procurement is considerably more complicated than procurement of individual satellites, with a host of new issues relating to system level requirements, timing and costs, unusual option situations, and additional flexibility requirements.
- Like all satellite system procurements, constellation developments are not a series of consecutive purchases but a coherent whole, and participants need to ensure the seamless integration of all program, regulatory, and contractual elements from a technical, risk, business, and legal standpoint, all within the unique framework of satellite contracting risk-based issues.
- Launch services are a key component of SmallSat constellations, assuming relatively greater importance than in geostationary satellite procurements due to the large financial expenditure and need to manage the heightened risk of launch delay given the large number of launches.
- SmallSat mega-constellations present new issues with respect to intellectual property development and ownership, and those arise from a focus on data sales rather than sale of satellite capacity. Additional documentation is needed, and care needs to be taken, in maintaining ownership of key intellectual property elements for satellite constellation differentiation.
- Do not underestimate the importance, complexity, and evolving nature of the regulatory framework governing innovative space technologies both in the United States and internationally, as well as the multitude of layers of issues to be solved in deploying a system, obtaining landing rights, and complying with the globally evolving regulatory framework.
- Financing large constellations requires significant financial support and may present significant financing hurdles. For that reason, strategic investments come with huge potential advantages. They may also present commercial and business control risks, which the operator must carefully consider.



Endnotes

1 For example, Luxembourg has been very active in supporting innovative space companies and industries to locate in their country, perhaps most recently for space-mining companies, including legislative and financing support.

2 The Export Administration Regulations (EAR) found at 15 C.F.R. § 730 et seq. are administered by the Bureau of Industry and Security of the U.S. Commerce Department.

3 The International Traffic in Arms Regulations (ITAR) is the United States regulation that controls the manufacture, sale, and distribution of defense and space-related articles and services as defined in the United States Munitions List. 22 CFR §§120-130.

4 15 U.S.C. § 60101; 15 C.F.R. Part 960.

5 This is more common with certain (non-U.S.) jurisdictions and administrations.

6 There may be certain circumstances in which customers prefer, for some period of time, the manufacturer to pursue the public filing.

7 Optimally, the filings would be made by the operator before the procurement process to avoid any issues or manufacturer leverage. As a practical matter, however, the procurement process for a mega-constellation can be quite extensive and circumstances may result in a reversal of the preferred timing, particularly if one of the manufacturers has a priority filing in place.

Alicante
Amsterdam
Baltimore
Beijing
Birmingham
Boston
Brussels
Budapest*
Colorado Springs
Denver
Dubai
Dublin
Dusseldorf
Frankfurt
Hamburg
Hanoi
Ho Chi Minh City
Hong Kong
Houston
Jakarta*
Johannesburg
London
Los Angeles
Louisville
Luxembourg
Madrid
Mexico City
Miami
Milan
Minneapolis
Monterrey
Munich
New York
Northern Virginia
Paris
Perth
Philadelphia
Riyadh*
Rome
San Francisco
São Paulo
Shanghai
Shanghai FTZ*
Silicon Valley
Singapore
Sydney
Tokyo
Ulaanbaatar*
Warsaw
Washington, D.C.

Associated offices*

www.hoganlovells.com