KerrisdaleCapital

June 2018

Intelsat S.A. & SES S.A.

To The Moon

We are long shares of Intelsat and SES, two large satellite operators with significant and underappreciated 5G spectrum assets. For us, this is an unusual position to be in. For years, with our reports on Globalstar (2014), Straight Path (2015) and DISH (2016), we have publicly railed against the excesses of spectrum hype. Time and again, we have argued, equity investors have gotten carried away with their enthusiasm about offbeat frequencies and futuristic technologies, ignoring inconvenient details and weak business cases. But this time, it's different. Intelsat and SES hold the keys to the right frequencies, in the right way, at the right time, without the irreconcilable interference issues that have beset other spectrum stories. The value they stand to reap is staggering: ~$60 billion. Intelsat is worth $151 per share, and SES, €51.

The spectrum in question is called the C band. This set of frequencies, used by certain geostationary satellite systems operated in the US almost entirely by Intelsat and SES, consists of two pieces: 3.7-4.2 GHz (for transmission from space to earth) and 5.925-6.425 GHz (for transmission from earth to space). The former band, 3.7-4.2 GHz, is now under consideration by the FCC for allocation to mobile use in addition to satellite use. Around the globe, spectrum in and around this range is emerging as the primary domain of 5G. With an ideal mix of ample bandwidth, good coverage (especially using the 5G technology known as massive MIMO), and international harmonization, the C band has been described as the spectral "sweet spot" for widespread 5G deployment. Whoever gets their hands on the spectrum first will immediately obtain a massive leg up on the competition.

Today, however, the C band isn't just lying fallow: it's a critical conduit between the creators of TV content, like Disney and Fox, and the distributors of TV content, like Comcast and DirecTV. To optimize the difficult transition from primarily satellite use to primarily mobile use, Intelsat and SES have proposed a clever and elegant solution: let the market decide. US C-band satellite operators, acting as a consortium, will effectively auction off portions of the band to mobile carriers like Verizon and AT&T; if the price is right, Intelsat, SES, and perhaps a few much smaller peers will roll up their sleeves and work with incumbent users to free up the spectrum. This market-based approach not only appeals to the FCC's ideological bent; it's also eminently practical, liberating meaningful amounts of bandwidth in a short period of time and helping the US win the so-called race to 5G. In our view, the Intelsat/SES proposal is by far the leading contender for C-band reform – a high-probability base case, not a longshot.

Based on recent international and domestic comps, we believe US C-band spectrum is worth at least $0.50/MHz-pop – valuing the entire band at roughly $75 billion. To seize an opportunity of this magnitude, Intelsat and SES would move heaven and earth. But they won't have to. Based on realistic assumptions, we show that they can monetize roughly 400 MHz over 5-10 years, chiefly by rearranging channels across satellites and using up-to-date video encodings, all at a reasonable cost. It's not rocket science, but shares in Intelsat and SES are set to launch.

Table of Contents

I. Executive Summary

Kerrisdale Valuations of Intelsat and SES

	Consortium	Intelsat	SES ($)	SES (€)
C-band spectrum				
Valuation ($/MHz-pop)	$ 0.50			
Monetized bandwidth (MHz)	400			
Population (mm)	300			
Gross spectrum value ($mm)	$ 60,000			
Share of proceeds (%)	100%	45%	45%	
Share of proceeds ($mm)	$ 60,000	$ 27,000	$ 27,000	
Gross income tax		(5,670)	(5,670)	
Benefit of net DTAs		3,262	-	
After-tax spectrum gain		$ 24,592	$ 21,330	€ 18,278
Clearing costs (after-tax)	$ (675)	(304)	(304)	(260)
Core business value		13,476	12,672	10,858
Impairment of C-band sat. biz	$ (1,088)	(490)	(490)	(420)
Fair enterprise value		$ 37,275	$ 33,208	€ 28,456
Net debt*		(13,364)		(5,103)
Fair market cap		$ 23,910		€ 23,353
Diluted shares O/S*		158		460
Fair value per share		**$ 151**		**€ 51**
% upside		770%		229%

Source: Kerrisdale analysis
**Intelsat net debt and diluted shares are pro forma for the recent capital raise. The diluted share count incorporates the assumed conversion of the convertible notes. We assume the exercise of the underwriters' overallotment options for both the equity and convertible-note issuances.*

The Intelsat/SES plan for the C band will prevail. It's abundantly clear that the FCC, in alignment with the Trump administration and the cellular industry, wants to see a material portion of the C band repurposed for 5G – and fast. Byzantine auction rules hammered out through round after round of lawyerly debate aren't going to cut it. Only Intelsat and SES are in the right position to understand the nuances of current C-band usage and cost-effectively manage the transition to 5G; without their cooperation, the process will bog down. That's why last week's first step in the rulemaking process prominently featured the Intelsat/SES proposal and former opponents to the consortium's plan keep preemptively modifying their own schemes to more closely resemble it: everyone can sense which way the wind is blowing.

While commentators often treat the Intelsat/SES plan as shockingly novel and thus unlikely to sail through, the history of FCC policymaking clearly indicates otherwise. Time and again, reformers have proposed reallocating underutilized spectrum to its highest and best use by simply giving incumbent licensees flexibility to sell off their rights and keep *all* of the proceeds.

These reformers are now in charge. In fact, they've been gaining influence for many years, even under Democratic administrations: the recent 600MHz incentive auction, for instance, was another product of the same underlying philosophy. From the perspective of mainstream market-oriented spectrum wonks, the Intelsat/SES proposal is just common sense.

The C band is extremely valuable. Armed with 5G technology and ~160 MHz of Sprint's 2.5-2.7GHz spectrum, T-Mobile believes it can increase its users' average download speeds by a factor of 15 over the next several years, creating a "world-leading, nationwide 5G network with more capacity than any network in existence today." Intelsat and SES's similar C-band spectrum offers the exact same potential but with even more bandwidth – a king-making asset that will be in high demand.

Recent auctions of C-band and adjacent spectrum in the UK, South Korea, and Australia have garnered intense interest from large carriers and valued the spectrum at $0.17-0.38 per MHz-pop. Notably, C-band prices have often *exceeded* prices for more familiar, lower-frequency cellular spectrum in the ~2GHz range. Since spectrum prices in the US have always been *multiples* of those in other developed countries, and since C-band spectrum using 5G massive MIMO can likely perform about as well *using conventional cell towers* as, say, Sprint's spectrum, it's easy to argue that the US C band should trade at or above $1/MHz-pop. Such a price is probably too high for the carriers to afford, but, even after applying a large discount, the C band will still generate tens of billions of dollars for Intelsat and SES – a valuation range that T-Mobile, for one, has directly endorsed.

Extensively repacking the C band is operationally and economically feasible. Is it actually possible for incumbent C-band users to condense themselves into just ~100 MHz of spectrum over time? We undertake a detailed satellite- and transponder-level analysis of current C-band activity to show that Intelsat and SES have many opportunities (given the right incentives) to do more with less spectrum. At a high level, for instance, fully upgrading to the latest compression techniques would ultimately enable all existing C-band video channels to coexist using less than 20% of aggregate satellite capacity. While extensively rearranging the mapping of video channels to satellite transponders will take time, effort, and negotiation, it's clearly within the realm of possibility. Nor will the costs be astronomical: we estimate that even generous forecasts for installing improved receiver equipment and interference-mitigating filters will come in at less than a billion dollars.

Intelsat and SES are dramatically undervalued. With enormous embedded spectrum value than can be extracted at a reasonable cost and in reasonable time, Intelsat and SES should trade toward their fair values of $151 and €51 per share, respectively, over the next few years.

II. Company Overviews

Intelsat and SES are two of the world's largest satellite service providers, with 30% combined market share in the commercial Fixed Satellite Services (FSS) sector (based on total 2018E FSS-sector revenue). The companies each own and operate fleets of over 50 geosynchronous equatorial orbit (GEO) satellites, primarily using frequencies in the ranges known as C band, Ku band, and Ka band. (SES's wholly owned subsidiary, O3b Networks, also owns 16 medium-earth-orbit satellites.) Intelsat and SES use their satellites to provide a wide range of communications solutions to media companies, telecom operators, multinational corporations, and government agencies.

In areas where terrestrial telecommunications are unavailable or not cost-effective, satellite data networks form a critical layer of communications infrastructure – especially in emerging markets, the source of roughly a third of Intelsat and SES's revenue (*source: 2017 annual reports*) and the target of 54% of Intelsat's current capacity. Another key use case for GEO satellites is media (particularly TV) distribution, which accounts for 40% of Intelsat's and 68% of SES's revenue. GEO satellites allow video programming transmitted from a single point in space to blanket large coverage areas on earth, thereby simultaneously reaching multiple distributors, including cable companies and over-the-air broadcasters, which then re-transmit the signals out to consumers. Beyond emerging markets and media, mobile use cases – like providing broadband connectivity to cruise ships and commercial aircraft – have recently emerged as key sources of industry growth.

Historically, the FSS business was financially attractive, enjoying long-term contracts, high renewal rates, stable pricing, high EBITDA margins (75%+), mid-single-digit growth rates, and robust returns. This financial profile is what gave SES its traditional reputation as a "defensive growth" stock and what enticed private-equity sponsors to execute a leveraged buyout of Intelsat in 2008, saddling the company with high debt levels.

Over the last 3-4 years, however, the competitive landscape has transformed. First, the proliferation of new high-throughput satellites (HTS) has created excess capacity in some regions, leading to price declines for traditional data services. (Unfortunately, Intelsat's own HTS fleet got off to a disappointing start because of these trends.) Second, as fiber-based terrestrial connectivity has become more common and less expensive, it has reduced demand for satellite-based connectivity. Third, the growth of "over the top" internet video services like Netflix has eroded the value of traditional linear TV, a major source of satellite-industry revenue. This confluence of pressures has led to higher customer churn, lower prices, and lower volumes.

These problems are well documented and widely discussed. The tide may be turning, however. In Intelsat and SES's core businesses, there are early signs of improvement. Intelsat's free cash flow is set to increase as the company reduces capital expenditures while still maintaining its launch schedule; meanwhile, the company's revenue trends are improving thanks to industry-wide pricing stabilization and the benefit of newly deployed satellites. For SES, underlying revenue growth already returned to positive territory in the first quarter of 2018, setting the stage for further improvement as more satellites enter service this year and next.

But, while we believe that investors do tend to undervalue Intelsat and SES's core businesses, any upside from positive surprises on that front will be dwarfed by the upside from a source that, just six months ago, few market participants had ever considered: terrestrial use of the C band.

III. The Intelsat/SES Plan for the C Band Will Prevail

Although the specific proposal that has breathed new life into Intelsat and SES began to take shape in October, it represents only the latest phase of a longer history – both of market-oriented FCC reform and of attempted terrestrial use of the C band, which runs from 3.7 to 4.2 GHz. The global cellular industry has lusted after this spectrum for over a decade. Leading up to the 2007 World Radiocommunication Conference (WRC), an important international regulatory event held every three to four years, cellular interests pushed for shared access to the band but were rebuffed when studies showed that satellite and cellular users couldn't peacefully coexist. Undaunted, the carriers kept lobbying, and, leading up to WRC-15, they came close to getting their way, until a satellite-industry counter-offensive – "The Fight to Save C-Band" – turned the tide. Still, the industry's grip was already beginning to weaken, as many countries reallocated at least some of the adjacent spectrum (3400-3700 MHz) to mobile use. In the US, for instance, the 3550-3700MHz band became the home of the Obama-era experiment known as Citizens Broadband Radio Service (CBRS), a complex and still unproven arrangement in which low-powered terrestrial wireless networks are supposed to share spectrum seamlessly with incumbent users, including naval radar systems and a small number of satellite earth stations.

Mobile carriers are not the only interest group salivating over the C band; companies involved in *fixed* wireless service, especially as an alternative to cable- or fiber-based home internet access, have also sought to get their hands on the spectrum. In October 2016, a group called the Fixed Wireless Communications Coalition petitioned the FCC to make it easier for terrestrial point-to-point fixed services to share bands primarily used by the satellite industry, including the C band. Then, last June, an overlapping group, the Broadband Access Coalition (whose membership includes fixed-wireless providers as well as several nonprofit organizations), filed a separate petition asking the FCC to allow point-to-multipoint systems in the band, on the theory that such systems could be engineered to steer clear of satellite users (a theory that the satellite industry and its customers contest).

With so much in-bound interest in the C band, the FCC began to consider its options for change, establishing a new docket last July to gather information. An *ad hoc* coalition including Verizon, AT&T, T-Mobile, Ericsson, Intel, and Apple soon presented its own proposal, including, in part, "adding a mobile allocation to the 3.7-4.2 GHz band" to open it up for "5G use," consistent with "efforts underway around the world" to repurpose the same band. FCC Commissioner Michael O'Rielly wrote in a blog post that he believed this was "the best option," as long as incumbent users could be protected – or "compensated to leave these bands." In particular, he cited as a possible template the overhaul of the 28 and 39GHz millimeter-wave bands, where incumbents were simply gifted with mobile use rights on top of their existing point-to-point licenses, allowing Straight Path, for instance, to sell itself for $3.1 billion to Verizon. (A far less incumbent-friendly option – letting incumbents keep point-to-point rights but auctioning off mobile rights to new entrants – was briefly considered but rejected as impractical.) O'Rielly also mentioned the precedent of the recent 600MHz incentive auction, in which the FCC funneled money from carriers to incumbent TV broadcasters in exchange for vacating spectrum they neither paid for nor legally owned; at one point, at least one set of industry participants expected that these broadcasters would collectively walk away with $80 billion (though the final tally ended up being "only" $10 billion).

Given the unique characteristics of the C band, neither the mmWave nor the 600MHz template would directly apply, but O'Rielly reflected that "[i]t's easy to imagine that a suitable market-based arrangement could be fashioned." Importantly, then, the basic notion of a "market-based" way of paying off incumbent C-band licensees (primarily Intelsat and SES) for freeing up spectrum for terrestrial use originated with the FCC, not with the satellite operators. Sure enough, when the FCC put out its official Notice of Inquiry regarding mid-band spectrum (including the C band) last August, it specifically sought comment on "large-scale incentives for non-federal users [of mid-band spectrum] that could be used to increase the flexibility of existing non-federal allocations," including potential incentive auctions or other "market-based relocation approaches" designed to "encourage incumbent non-federal licensees to relinquish their licenses in exchange for incentive payments."

At first, however, the satellite industry viewed this as yet another "fight to save C band," emphasizing the importance of existing uses of the band and all the practical challenges of altering them or accommodating them by different means. The basic narrative was familiar from what had happened in other struggles over other satellite bands: terrestrial operators would try to grab every attractive bit of spectrum they could, and satellite companies would do everything in their power to obstruct change. Frustrated by this dynamic, former FCC Chairman Tom Wheeler had issued a barely veiled threat to the satellite industry in 2016 (emphasis added):

> Industry-driven win-win solutions that protect your existing and contemplated satellite services, while also enabling new terrestrial offerings – are likely to find regulatory favor. Claims that sharing is impossible are not.
>
> …As someone who has spent decades practicing before the Commission [as a lobbyist], and now finds himself on the other side of the table, I offer a bit of hard-earned experience: **it is far more practical to get on the train than to be run over by it.**

While Wheeler has since departed the FCC, the spirit of his comments lives on; the current FCC under Chairman Ajit Pai is also keen to see satellite interests cooperate rather than clash with terrestrial players.

In October 2017, Intelsat got on the train. In collaboration with the chip maker Intel (likely seeking to establish its own credibility as a major player in 5G), Intelsat began to set out a clever and elegant plan to free up major portions of the C band *quickly,* allowing market forces to sort out the details and dispensing with unnecessary formality and bureaucracy. Under the proposal, the FCC would allow incumbent satellite operators, acting together as a consortium, to put access to the C band up for sale. (Spectrum leasing would also be possible, but we focus on a lump-sum sale for the sake of simplicity; after all, any lease is always financially equivalent to a lump sum equaling its present value.) If the best bid for a given amount of spectrum in a given geographic area is high enough, the satellite consortium would roll up its sleeves and work to free up that bandwidth, using a variety of techniques to accommodate existing customers in other ways (primarily by "repacking" them into the remaining, uncleared portion of the same band). Economic forces would determine how much spectrum was transferred from satellite to terrestrial (mobile or fixed) usage and at what pace; economic forces would likewise determine the most efficient way of rearranging satellite systems to make do with less spectrum, since the satellite operators would be responsible for carrying out the transition and would be incented to minimize disruption and expense.

Commissioner O'Rielly quickly expressed tentative support for the idea at the Americas Spectrum Management Conference:

> I'm trying to figure out what's the best mechanism to provide mobile service in this band, whether it be protection of incumbent uses in earth stations, or whether it be market mechanisms, and when I see Intel coordinate and combine with Intelsat, a large satellite provider, or at least today, I think that that's very beneficial and provides one mechanism to look at closely.

In subsequent refinements and clarifications, the plan evolved to include an explicit near-term target of freeing up 100 MHz nationwide (with the exception of a small number of designated exclusion zones) within 18 to 36 months of an FCC order. The expected timeline for this first phase would break down as follows:

- *3-8 months:* the consortium negotiates agreements with potential buyers
- *2-7 months:* buyers apply to the FCC for terrestrial licenses to the spectrum, and the FCC, after following its usual procedures (including soliciting public comment), grants them
    - At that point, the buyers put the purchase price into escrow
- *12-20 months:* the consortium clears the spectrum. When the job is done, the payment comes out of escrow, and the buyers may begin transmitting on the band. (Ideally, the buyers can build out the necessary network assets in parallel with the clearing process, thereby allowing them to "light up" the spectrum on day one.)

While many industry analysts have focused primarily on this approach to the first 100 MHz, it has been clear from the start that the process wouldn't stop there. Again, economics would dictate the outcome: if bids for terrestrial use of additional spectrum beyond the first 100 MHz sufficiently outstripped the cost of clearing it and moving incumbent users elsewhere in the band or to alternative facilities – including the cost of potentially impairing the satellite operators' future business prospects – then the operators would have every reason to agree to the deal and free up more spectrum. Without heavy-handed regulatory intervention, spectrum would naturally migrate to its highest and best use.

Initially, the Intelsat/Intel plan had a severe flaw: SES, the number-two satellite operator both worldwide and in the US C band, had not yet signed on. (This flaw was especially important because, in the C band, no licensee has exclusive rights to a particular piece of spectrum; each licensee can use the *entire* band, albeit only within its own orbital locations. Even if Intelsat theoretically relinquished all of *its* rights to the band, the entire thing would remain fully encumbered, because SES's rights would remain.) But in February, SES too got on the train, announcing it was jointly developing the proposal with Intelsat. It was now clear beyond a shadow of a doubt that the plan was serious, not just a Hail Mary play on the part of Intelsat.

Indeed, with the Notice of Inquiry phase complete and a Notice of Proposed Rulemaking (the first step in crafting a finished rule) imminent (a draft NPRM has already been released), we believe, based on our interpretation of the available FCC filings as well as our discussions with industry participants and telecom lawyers, that the Intelsat/SES concept is highly likely to form the core of the FCC's final order, expected to arrive in the second half of 2019. While the FCC will continue to entertain alternative proposals, and debate will rage about precise details of implementation, the Intelsat/SES proposal is, by design, the most attractive option available on both ideological and practical grounds – consistent with the prevailing regulatory philosophy *and* well suited to deliver real-world results.

The Intelsat/SES Proposal Embodies the Principles of Market-Oriented FCC Reform

Investors tend to view the Intelsat/SES proposal in isolation, as a one-off effort tied to the concerns of the day, like 5G. But it can more profitably be seen as part of a much deeper tradition of market-oriented FCC reform, one near and dear to the heart of Chairman Pai, who espouses as one of his basic regulatory principles that "[f]ree markets have delivered more value to American consumers than highly regulated ones…[T]he FCC should do everything it can to ensure that its rules reflect the realities of the current marketplace and basic principles of economics."

According to the market-oriented perspective on spectrum regulation – as articulated, for instance, by the recently published book *The Political Spectrum* by former FCC chief economist Thomas Winslow Hazlett – the original sin of the FCC was attempting to dictate from on high what licensees should or shouldn't do with their spectrum. By locking certain bands into certain uses, with no simple mechanism for change or renegotiation, the agency guaranteed that, as soon as technological and commercial realities shifted – as they do constantly – spectrum use would become inefficient. The classic example is over-the-air TV broadcasting: dozens of channels went unused for decades, while others garnered few viewers and generated little value. But the rules didn't permit welfare-enhancing transactions between, say, mobile carriers, who could make better use of the spectrum, and broadcasters, so spectrum went to waste.

Over time, FCC rulemaking under both Democrats and Republicans has shifted away from the old prescriptive approach, giving rise to what the telecom economist and policymaker Jeffrey Eisenach has called "the spectrum reform movement" and "the modern consensus." (Eisenach led the Trump administration's telecom transition team, helped select Pai as FCC chairman, and was reportedly considered for the chairman role himself.) That consensus has led to *flexible* licensing, under which licensees are free to do what they wish with their spectrum, including selling it, leasing it, and subdividing it, as long as they comply with certain basic rules intended to protect other entities from harmful interference. Most cellular spectrum rights in the US today are based on such flexible licenses.

But a thorny problem remains: what is to be done with legacy licenses from the command-and-control era? How can the underlying spectrum be put to better use? According to Eisenach – again, a key figure in the formation of the Trump administration's telecom team – "the modern consensus" has a straightforward answer: "providing incentives for incumbent to reallocate their spectrum." In his words:

> From the perspective of the modern consensus, allowing license holders to share in the value creation associated with spectrum reallocation goes hand in hand with the concept of spectrum flexibility and tradable rights, the very purpose of which is to provide incentives for licensees to increase the value associated with their spectrum, or to lease or sell it to someone who can. The political perception, however, has been that such gains constitute inequitable windfalls, which should be taxed away, or not permitted at all. Spectrum reform proponents have responded to the "windfall" argument in a variety of ways, including noting that virtually all current spectrum licensees paid for their spectrum, that increases in the value of the spectrum resulting from private investment properly belong to those making the investments, that windfalls are inherent in many beneficial government activities (e.g., building interstate highways benefits those who own land nearby), and that, in any case, the broad-based application of spectrum flexibility would dramatically increase the supply of spectrum in the market, and thus limit or even potentially eliminate any windfalls. Most importantly, it is noted, letting incumbents profit from reallocation is what makes flexibility work: it creates the incentive for change, which is the whole idea.

In short, the core idea of the Intelsat/SES proposal – give the incumbent licensees the right to repurpose the band, sell some or all of it, and pocket all of the proceeds – is exactly what Eisenach describes as the "modern consensus" approach to fixing the policy errors of the past.

Similarly, a 2002 FCC working paper suggested achieving large-scale spectrum reallocation by offering flexibility to many kinds of legacy incumbents in one fell swoop and then conducting a giant auction. This paper planted the seed that ultimately grew into the 2016-17 incentive auction, but it also foreshadowed the Intelsat/SES proposal. Addressing the challenges posed by shared bands like the C band (Intelsat and SES have monopolies over specific orbital slots within the geostationary arc, but each of their satellites can and does operate across the entire 3.7-4.2GHz frequency range), the paper noted, "One possible solution…may be to select a single entity to serve as an auction agent to participate on behalf of all incumbents in the band" – in other words, a consortium. The paper also made clear that, "[t]o encourage [incumbent] participation, we propose that incumbents be allowed to keep all proceeds from the sale of encumbered spectrum" – an outcome viewed as "fair to incumbents as well as the general public" because "incumbents would gain from the increased value of their spectrum as a result of flexibility, and the public would gain from a rapid and efficient restructuring of the spectrum." Interestingly, one of the co-authors of this paper, Evan Kwerel, still works at the FCC as a senior economist in the Office of Plans and Policy and has participated in multiple meetings with Intelsat and SES to discuss their proposal. In essence, what the companies are pitching to Kwerel is *his own idea.*

These market-oriented spectrum reform concepts are not just ancient history; they have also influenced recent FCC policymaking. In May, for instance, the FCC adopted a Notice of Proposed Rulemaking regarding portions of the 2.5GHz band allocated to the Educational Broadband Service (EBS). Originally, EBS spectrum was supposed to be used by educational institutions for instructional TV, but that use case never got very far, so, once more, useful spectrum has gone to waste. Eventually the FCC did allow EBS licensees to lease spectrum to commercial users (like Sprint today), but they couldn't lease *all* of it, let alone sell it, and they were required to use the retained portion for ongoing educational broadcasts, despite changes in technology and society that have rendered such broadcasts largely irrelevant. After years of inaction, the Pai FCC has now proposed to largely deregulate the band: let educational institutions sell or lease their spectrum as they wish (even to commercial entities previously barred from owning EBS spectrum), stop forcing them to use it for educational TV, and even grant them (for free) rights to larger geographic areas to make the licenses more similar to typical commercial licenses. Importantly, the FCC justified these radical changes by invoking the laissez-faire spectrum-reform philosophy of giving incumbent licensees flexibility and then letting them decide for themselves what to do with it:

> We note that the existing licensees have built out their systems since 2011 and understand how they use their EBS licenses as well as the availability of wireless broadband in their area. Under this proposal, the decision whether to lease or transfer a license would rest with the EBS licensee. There is little reason to think that, at this point in time, the Commission is better positioned than licensees themselves to determine how to maximize the use of 2.5 GHz spectrum for licensees and their communities. And there is little reason to think that licensees should not be allowed to decide for themselves whether to continue to hold their licenses or to transfer their licenses to a third party in the secondary market.

The same logic of regulatory humility – allowing market forces and incumbent self-interest to decide spectrum allocation instead of imposing it by fiat – applies beyond EBS to the C band.

From the perspective of recent FCC history, the Intelsat/SES proposal is just the front line in the steady advance of the spectrum-reform consensus – something the commissioners, especially the Republican ones, will find easy to cheer on.

The Intelsat/SES Proposal Is the FCC's Best Option to Promote 5G Deployment

The FCC is not just a creature of ideology; it also has practical goals in mind. At the moment, that means 5G. Indeed, even Commerce Secretary Wilbur Ross recently said, "Whoever pursues it, whoever does it, we're very much in support of 5G. We need it. We need it for defense purposes, we need it for commercial purposes." FCC Commissioner O'Rielly echoed these remarks at an event hosted by the aforementioned Jeffrey Eisenach in April, describing 5G as "one of the highest priorities for the Commission." In O'Rielly's words, winning "the global race to be the first among many competing nations to 5G… will allow U.S. companies to help shape its future growth, standards, and capabilities – all of which have a tremendous impact on our future economic success. The alternative means that we would be dictated to by other regimes, many of which can't be fully trusted, don't believe in capitalism, don't believe in freedom, don't believe in fair play, don't believe in the role of the individual over the government, and rebuke American leadership." In short, the perceived stakes are high – not just economic but geopolitical – and the US government wants to see significant 5G deployments *soon.*

It should come as no surprise, then, that in the same speech O'Rielly again tentatively endorsed the Intelsat/SES proposal as "an attractive option that should be thoroughly considered, particularly because of the speed in which it could bring the spectrum to market." At bottom, what makes the Intelsat/SES proposal the fastest and most practical option for bringing 5G to the C band is the fact that it ensures the cooperation of the satellite operators themselves, who can then bring their customers along for the ride; it's a win-win that can bear fruit both in the short term (100 MHz within 18-36 months) and the longer term (at least 300 additional megahertz, we believe, over time).

By contrast, alternative approaches are all highly likely to bog down. As FCC policymakers well know, reallocating spectrum by regulatory fiat may sound easy, given the FCC's expansive legal powers, but the reality has been quite different. As documented by the National Broadband Plan created under the Obama administration, "The process of revisiting or revising spectrum allocations has historically taken 6-13 years…Deploying networks adds still more time….In general, a voluntary approach that minimizes delays is preferable to an antagonistic process that stretches on for years." Ironically, the 600MHz incentive auction, originally intended to circumvent any "antagonistic process" by paying off broadcasters rather than trying to force them out, also ended up dragging on far longer than planned, in part because of broadcaster litigation targeted at aspects of the auction rules they disliked and in part because of the enormous complexity and novelty of the auction itself. First proposed in the National Broadband Plan in 2010, the auction concluded in 2017, and the spectrum remains mostly unused today – all consistent with the usual molasses-slow 6-13-year timeline.

If the government wants to see widespread 5G using mid-band spectrum any time soon, repeating the mistakes of the past won't work. What's needed is the simplicity and clarity of the Intelsat/SES approach, which obviates the need for extensive FCC rule-writing and all of its attendant politicking, delay, and substitution of bureaucratic judgement for market outcomes. Intel put it well in February:

> As set out in the Intelsat/Intel joint pleadings in this proceeding, the current use by thousands of customers and the alternative possible means of accommodating them makes efficient clearing of this band complex. The Intelsat/Intel proposal represents the best means of using available information and incentives to enable terrestrial use where and when it [is] efficient, while protecting the legitimate interests of the existing users at the lowest possible cost. The alternative approaches put forward in the record would require more difficult FCC determinations as to what use exists, the relative value of competing uses of the band, and which means of accommodating existing users, if any, would be cost-effective. These top-down approaches are much [more] likely to result in delays.

Indeed, even the proponents of the major competing approaches to the C band have modified their proposals over time to more closely resemble Intelsat and SES's. The Broadband Access Coalition, for instance, began by seeking shared access to the entire band for fixed point-to-multipoint systems. Its early response to the Intelsat/SES proposal was at times caustic: it expressed "strong opposition to the…private auction concept," calling it "absurd." Within weeks, however, the tune changed: now the Coalition advocated "combining the BAC proposal with the Intelsat/SES/Intel proposal" by "using a private or public auction to make available the lower 100 megahertz of the band for mobile service" but allowing fixed P2MP to share the upper 400 MHz with satellite services. While this sudden about-face demonstrates the rapidly growing mindshare of the Intelsat/SES proposal – going from "absurd" to base case in a matter of days – we believe even the revised BAC proposal is a non-starter because it would tie up too much spectrum that could otherwise be used for 5G. While a version of the proposal was incorporated in the FCC's recently released draft Notice of Proposed Rulemaking, the FCC shows little signs of reserving any large piece of the C band for fixed point-to-multipoint use. Instead, the FCC's intention appears to be to allow such use to coexist with any residual satellite operations in the band. If hundreds of megahertz can be freed up in the lower part of the band for 5G, with satellite operations remaining in a smaller piece of spectrum at the upper part of the band, then fixed point-to-multipoint systems will likely be allowed to operate in that remaining portion, as long as they avoid interfering with earth stations. In other words, while C-band satellite operations will have to share their spectrum with fixed point-to-multipoint, this arrangement will not stop satellite operators from repurposing as much spectrum for mobile use as they can profitably achieve.

The only other detailed proposal besides the satellite operators' and the Broadband Access Coalition's is T-Mobile's. As with the BAC, as Intelsat and SES have gained traction, T-Mobile's tone has dramatically changed. At first, though expressing strong interest in C-band spectrum, T-Mobile urged that "the Commission should specifically reject any proposals to use experimental market-based mechanisms, such as those suggested by Intel and Intelsat, to merely give existing licensees flexible rights to provide terrestrial services," decrying a possible "give-away of spectrum rights worth tens of billions of dollars to companies that are not fully utilizing spectrum today." Instead, T-Mobile called for a more traditional FCC-run auction, though it glossed over the difficulties of handling incumbent users or Intelsat and SES's legal rights. Soon, however, T-Mobile begin to advocate a "hybrid approach": forcing the satellite operators to vacate the first 100 MHz of the band but, *if* they cooperated in clearing it, granting them the right to sell access to the remaining 400 MHz.

More recently, however, the T-Mobile plan has changed again to become even more favorable to the satellite operators. Instead of dismissing "experimental market-based mechanisms" out of hand, T-Mobile now generally supports them, saying that "[t]he SES, Intel, and Intelsat proposal, which would use market-based approaches to incentivize relocation, is a step in the right direction." In place of those companies' relatively simple plan, though, T-Mobile proposes a complex, multi-stage FCC-led auction, in which the satellite consortium would theoretically sell 500 MHz in most urban areas and progressively smaller amounts of spectrum in rural areas and anywhere else C-band satellite use was concentrated. The more spectrum the consortium sold, the more of the auction proceeds it would retain, with T-Mobile suggesting 100% for 500 MHz and 80% for 400 MHz. Far from complaining about the "give-away of spectrum rights worth tens of billions of dollars," T-Mobile is now arguing in favor of it – another sign that the Intelsat/SES proposal has already become the mainstream approach, with alternatives presented as mere variations on the same core themes.

Again, however, the alternative seems unworkable. The multi-stage auction structure proposed by T-Mobile has never been used (let alone suggested) before, and the sketchy description of it breezes through crucial issues – like how incumbent users, including TV broadcasters and cable companies, would be treated. (For example, what would be the timeline for them to move out of their current portion of the band? Any answer will be controversial, with carriers demanding speed and incumbents demanding flexibility.) Moreover, T-Mobile appears to assume that there are large swathes of the country, especially urban areas, with minimal use of the C band, but other FCC filings and our own direct discussions with industry participants suggest otherwise: earth stations are distributed far and wide. The T-Mobile auction structure would also require that the satellite consortium settle on a precise estimate of the cost of clearing large amounts of spectrum all at once, instead of gradually refining that estimate over time through practical experience. This would likely lead the consortium to be overly conservative, unnecessarily widening the bid/ask spread. While the T-Mobile proposal would likely lead to significant upside for Intelsat and SES – after all, it would allow them to sell access to the vast majority of the highly valuable C band and retain the vast majority of the proceeds – it seems far too cumbersome to align with the FCC's overriding priority of near-term 5G deployment. Only the Intelsat/SES proposal can unleash the C band *quickly.*

It's no surprise, then, that the proposal appears to have so much momentum. Tellingly, incumbent satellite users, like Comcast and Viacom – who are happy with the inefficient spectrum utilization of the status quo and would like to preserve it for as long as possible, other things being equal – have taken to pleading with the FCC to "avoid prematurely endorsing any particular proposal until it develops a comprehensive record." We are confident that the "particular proposal" they have in mind – the one that they fear the FCC will "prematurely" endorse and codify – is Intelsat and SES's. And they're right to be concerned: the proposal is the single best way for the FCC to achieve its goals in a manner consistent with its worldview. The details may change at the margin, but Intelsat and SES's vision will prevail.

IV. The C Band Is Extremely Valuable

The C Band Is the Ideal Choice for Nationwide 5G

> *The Nokia Executives stressed the urgency to make spectrum available in the 3.7 to 4.2 GHz band for terrestrial use as the centerpiece for nationwide 5G deployment in the U.S.*
>
> —Nokia

> *Verizon agrees with Nokia's assessment that the 3.7-4.2 GHz band is "the most favorable mid-band spectrum range to introduce 5G services in the U.S." Given this underutilized band's unique value and potential to quickly provide a mid-band foothold for 5G, the record demonstrates that the Commission should move swiftly to ensure that the 3.7-4.2 GHz band is available for wireless broadband as soon as possible.*
>
> —Verizon

> [*I*]*nternational efforts are well underway to make mid-band spectrum available for 5G operations, and the United States must do the same to ensure its continued leadership in mobile wireless broadband. The 3.7-4.2 GHz band is particularly well-suited to meet those needs. It provides a balance of capacity and coverage and has the potential to accommodate the wide bandwidths associated with 5G technology.*
>
> —T-Mobile

> *The 3.7-4.2 GHz band is ideally suited to address the United States' need for additional mid-band spectrum. It is immediately adjacent to the 3.5 GHz band, has favorable propagation characteristics and can also potentially be globally harmonized.*
>
> —the GSM Association

> *Mid-band spectrum offers something of a "sweet-spot" because large channel bandwidths can be available, so allowing high data rate services to be offered to the end user. Meanwhile the propagation characteristics result in the potential for large coverage areas…*
>
> —Cambridge Broadband Networks

> *In our view, at least 100 MHz* [*of C-band spectrum*] *is **needed on a per carrier basis** to fulfill mobile broadband use cases*

—Ericsson (emphasis added)

Given the high demand for and high-value of mid-band spectrum, we should strive to adopt a mechanism that will repurpose a socially efficient amount of spectrum in the band.

—FCC draft Notice of Proposed Rulemaking

As the quotations above indicate, the important players across the US wireless industry concur: the C band is critical spectrum for 5G, and especially for *widespread* 5G. This view may come as a surprise to market participants more familiar with the potential use of very high-frequency millimeter-wave spectrum for 5G, but, even with the most cutting-edge technologies, that spectrum still requires extremely dense and costly network buildouts and will likely be relegated to urban hot spots, at least for mobile service. By contrast, C-band spectrum, with the use of a 5G technique called massive MIMO (discussed in greater detail below), much more closely resembles conventional cellular spectrum and can work not just with densely deployed small cells but with traditional macro cell sites, like towers. By combining large bandwidths (hundreds of megahertz), 5G spectral efficiency (which allows that bandwidth to carry large amounts of data traffic), and healthy propagation, C-band spectrum can enable radical improvements in network quality – not just in mmWave-style small-cell hot spots but across the country. Moreover, because many other developed countries are at various stages of repurposing portions of the C band (and the adjacent extended C band) as prime spectrum for 5G, there will be a rich, global ecosystem of network equipment and user devices available from the start.

What could a large, 100+ MHz contiguous swath of virgin mid-band spectrum do for a carrier's competitive position? T-Mobile's plans for Sprint's 2.5GHz spectrum – a different band, but one with similar potential for 5G massive MIMO – shed some interesting light on this question. In recently released FCC filings made in support of T-Mobile's proposed acquisition of Sprint, the company describes in great detail how exploiting Sprint's underutilized mid-band spectrum (averaging 160 MHz in the top 100 geographic markets) will allow it to leapfrog over the "big two":

> [T]he combined spectrum assets acquired through the proposed transaction will allow New T-Mobile to deploy a broad, deep nationwide layer of 5G years before AT&T and Verizon could do, which is something neither Sprint nor T-Mobile could otherwise achieve alone.

Accessing a "world-leading, nationwide 5G network with more capacity than any network in existence today, or currently planned for the future," New T-Mobile customers would enjoy a *15x increase in average download speed* over the next several years – thanks primarily to Sprint's mid-band, 5G-ready spectrum. Without a large slug of new mid-band spectrum, though, T-Mobile says it would be stuck:

> On a standalone basis, we will deploy a nationwide 5G network, but will lack the bandwidth to deliver upon the full data rate and capacity gains possible for 5G. Our lack

> of access to significant amounts of available mid-band spectrum that is not encumbered with LTE subscribers (as well as a lack of large amounts of high-band spectrum nationally) will significantly limit our ability to provide a nationwide 5G system that can handle the most demanding high capacity 5G applications.

What the C band provides is an alternative source of "significant amounts of available mid-band spectrum that is not encumbered with LTE subscribers"; it can enable the same "revolutionary capacity and speed" that T-Mobile expects to get from Sprint's spectrum. Perhaps the T-Mobile/Sprint deal will be approved, and Verizon, AT&T, and new entrants like Comcast and Charter will have to ask themselves how they can compete in the long run against a 15x superior competitor. Perhaps the deal will not be approved, but every wireless player and potential wireless player is now on notice that, with 5G, 100-200 MHz of clean mid-band spectrum can be a genuine competitive game-changer, catapulting them ahead of their peers. Either way, the C band is a jump ball; everyone will want to be the first to grab it.

And what if, as T-Mobile suggests, 5G massive MIMO using mid-band spectrum can support not just vastly improved *mobile* performance but also robust fixed wireless access that can compete with cable and other wireline broadband service? The cable companies themselves must then consider whether they want such an important spectrum asset to fall into the hands of potential new entrants into their own market.

Verizon will launch 5G residential broadband later this year with a target addressable market of 30 million homes, a seemingly large number but one that reflects deployment in only the densest parts of the largest cities using mmWave spectrum. We believe with large nationwide swathes of mid-band spectrum, Verizon could dramatically increase that addressable market.

In short, we agree with the FCC that the C band has high value and will enjoy high demand from many different deep-pocketed bidders in many different scenarios.

International C-Band Prices Imply Dramatic Upside for Intelsat and SES

Over the past year or so, the global mobile industry has started to put its money where its mouth is – not just lobbying for access to the C band but plunking down billions of dollars for exclusive bandwidth. Applying foreign prices to US spectrum is often a waste of time because US prices tend to be so much higher that the comparison is irrelevant; for the C band, however, even low foreign comps already translate to enormous upside for Intelsat and SES.

United Kingdom

In April 2018, Ofcom, the British equivalent of the FCC, auctioned off 150 MHz of spectrum lying between 3410 and 3580 MHz at a clearing price of $0.17 per MHz-pop – an "eye watering" figure, in the words of one European telecom consultancy, which noted that the auction results “raised many eyebrows in the industry.” (“MHz-pop” is a commonly used unit of spectrum. The number of MHz-pops associated with a spectrum license equals the bandwidth measured in megahertz multiplied by the population living in the license area.) All four nationwide British operators – EE (now owned by BT), O2, Vodafone, and Three – participated in the auction and ended up buying spectrum, underscoring the band’s wide appeal. Interestingly, the $0.17 price emerged in the face of three headwinds that would each tend to suppress demand:

- Three, the smallest nationwide operator (a unit of the Hong Kong-based conglomerate CK Hutchison), front-ran the auction by snapping up a small fixed-wireless provider called UK Broadband in February 2017. UK Broadband’s main assets were a set of C-band spectrum holdings, including 3480-3500 MHz, 3580-3600 MHz, 3605-3689 MHz, and 3925-4009 MHz (208 MHz in total, though much of that spectrum will require regulatory changes before it can accommodate 5G mobile use). Notwithstanding these extensive holdings, Three still purchased an additional 20 MHz in the auction.
- To promote competition, Ofcom barred BT, the largest nationwide operator, from buying more than 85 MHz of the 150 MHz auctioned, a factor that not only affected its own bidding but made the auction less competitive overall.
- The spectrum up for sale was just the first installment: before the auction, Ofcom clearly stated its intention to auction off another 116 MHz in the adjacent 3.6-3.8GHz range during 2019, while also reiterating that it continued to pursue earlier-stage plans to free up the 3.8-4.2GHz band as well.

Had similar spectrum not been available outside of the auction, and had the deepest-pocketed buyer not been constrained, the $0.17 price would presumably have been even higher.

How do spectrum prices in the UK compare to those in the US? While every spectrum transaction has its own idiosyncrasies, looking at past UK auctions of mid-band spectrum highlights the strong likelihood that US C-band prices will be substantially higher than $0.17.

- In February 2013, Ofcom sold the 190 MHz of spectrum between 2500 and 2690 MHz in two pieces: a paired 2x70MHz piece and an unpaired 50 MHz piece. The paired piece went for ~$0.12/MHz-pop, while the unpaired piece went for just ~$0.03 (*source: Aetha valuation report for Sprint, October 2016, p. 33*), for a weighted average of $0.10.
    - Meanwhile, at around the same time (July 2013) in the US, Sprint was acquiring 49% of Clearwire, which held a large amount of spectrum in essentially the same frequency range. Adjusting for a variety of deal-specific factors, Sprint paid $0.41/MHz-pop (on a nationwide-average basis) (*source: Aetha valuation report for Sprint, October 2016, p. 25*). In other words, *the US price for 2.5GHz spectrum was 4x higher than the UK price.*
    - **This ratio implies a $0.68/MHz-pop valuation for the US C band.**
- In April 2018, alongside the 3.4GHz spectrum, Ofcom also auctioned off 40 MHz of 2.3GHz spectrum; the carrier O2 was the winning bidder at a price of $0.11/MHz-pop. (Intriguingly, then, the 3.4GHz spectrum actually fetched a *higher* price than the 2.3GHz spectrum – a reversal of the longstanding relation between high- and low-frequency

spectrum prices.) Again, a bidding restriction suppressed the price – EE wasn't allowed to bid at all – so it's a somewhat flawed benchmark. Still, it seems likely that the underlying market price of similar ~2GHz spectrum hasn't changed much since 2013.

- Meanwhile, in the US, sell-side analysts valued Sprint's 2.5GHz spectrum at $0.45-0.80/MHz-pop before the announcement of the company's sale to T-Mobile, while a bottoms-up NPV analysis commissioned by Sprint to support its 2016 spectrum securitization valued a portion of its mid-band spectrum at $1.50-2.80/MHz-pop, depending on the buyer.
  - An updated appraisal a few months ago reduced the valuation to ~$1.40/MHz-pop. Perhaps more importantly, though, this appraisal accompanied an increase in the size of Sprint's securitization, meaning that the credit market has now lent $7 billion against 8.9 billion MHz-pops of Sprint's spectrum (87% of which is in the 2.5GHz band, the remainder in the 1.9GHz band), implying a *floor* valuation of $0.79/MHz-pop. (It's a floor because the credit market, charging Sprint a low interest rate for the securitization, clearly believes it's lending the company less than the full value of the underlying asset, even if it doesn't fully believe in the Sprint-commissioned appraisal.)

In short, while ~2.5GHz spectrum prices in the UK apparently haven't changed much over the past few years, comparable prices in the US appear to have roughly doubled (from ~$0.40 to >$0.80), suggesting that the 4-to-1 valuation ratio from 2013 may now be 8-to-1 or higher. By that logic, the US C band could be worth *well over $1/MHz-pop* (8 x $0.17 = $1.36).

Australia

In December 2017, Australia's telecom regulator, the Australian Communications and Media Authority (ACMA), concluded a "multiband residual lots auction" in which it sold vacant spectrum in a variety of geographic areas across the 1800MHz, 2GHz, 2.3GHz, and 3.4GHz bands – assorted bits and pieces left over from prior auctions. Among the 14 lots of 3.4GHz spectrum, all but one offered very little bandwidth (~3.5 MHz on average) and generally low-population geographies, but the one reasonably large lot – 32.5 MHz in the Brisbane region – inspired fierce bidding, driving the price up from the reserve level of AUD 1mm up to the winning price of AUD 50mm, equating to **USD 0.38/MHz-pop**. The winner was Telstra, the largest mobile operator in the country. Interestingly, the 3.4GHz price in Brisbane was *3x higher* than price of 2GHz spectrum in the same geographic area in the same auction – another sign that C-band spectrum may actually be *more* valuable than lower frequencies.

How do Australian spectrum prices compare to American ones? As with the UK, we compare past Australian auctions with American transactions involving similar spectrum at similar times, showing clearly that American prices tend to be much higher.

- For instance, in May 2013, Australia sold 2.6GHz spectrum for ~$0.03/MHz-pop (*source: Aetha*). At around the same time, as already mentioned, Sprint purchased half of Clearwire at an implied spectrum price of $0.41/MHz-pop – almost 14x higher.
- In 2016, Australia sold 1.8GHz spectrum for ~$0.65/MHz-pop. Relatively similar paired AWS-3 spectrum in the US sold in early 2015 for $2.71/MHz-pop, more than 4x higher than in Australia. (While we and others have argued in the past that the AWS-3 auction was distorted by DISH's unusual bidding practices, US prices would have been substantially higher than Australian prices even after applying a large discount.)

While it's difficult to be certain that Brisbane prices represent a fair proxy for the whole of Australia (and past auctions provide little guidance, since many involved nationwide licenses), we believe that they represent a reasonable estimate, especially because the bulk of Australia's population lives in similarly urban areas. Applying a 4-14x multiplier to the Brisbane 3.4GHz price, we arrive at a range of $1.52 to $5.32/MHz-pop for the US C band. While we certainly don't view $5.32 as a realistic expectation, it's striking just how easy it is generate such staggering estimates just by extrapolating from international comps.

South Korea

Earlier this month, South Korea auctioned off a large amount of spectrum intended for 5G usage: 280 MHz in the 3.5GHz band and 2,400 MHz in the mmWave 28GHz band, with total proceeds of $3.3 billion (in US terms). The 3.5GHz spectrum (running from 3.42 to 3.70 GHz) cleared at $0.19/MHz-pop. Previous South Korean spectrum auctions have often seen spectrum blocks clearing right at their reserve prices, with the national regulator actively *discouraging* competition (partially on the theory that expensive spectrum makes network buildouts too costly). Ahead of this auction as well, the Korean news agency Yonhap reported that "the government plans to limit [the three Korean carriers'] bidding amount to stop the auction from becoming too competitive."

Notwithstanding the artificially muted competition, though, the 3.5GHz spectrum – but *not* the mmWave spectrum – actually did spark a mild bidding war, with the clearing price ultimately rising above the reserve level. All three national carriers participated in the auction and purchased some spectrum, though the smallest, LG U+, only managed to walk away with 80 MHz, not the 100 MHz purchased by its larger competitors.

How might this Korean benchmark translate to the US? Once again, looking at history, we find that non-American spectrum prices tend to be far lower than American ones. In Korea, the last major spectrum auction took place in spring 2016 and included 1.8 and 2.1GHz (similar to AWS-3) and 2.6GHz (similar to Sprint/Clearwire). Comparing the average 1.8/2.1GHz Korean price of $0.37/MHz-pop (*source: New Street Research*) to the AWS-3 paired-spectrum price of $2.71, the multiplier to go from Korean to American is ~7x. Comparing the average 2.6GHz Korean price of $0.36/MHz-pop to the ~$1.80 valuation used in Sprint's 2016 spectrum securitization yields a multiplier of ~5x. The implied range of American C-band pricing is then $0.94-$1.32.

KerrisdaleCapital

Summary

The table below summarizes the recent foreign C-band (or extended C-band) transactions just discussed, along with their implications for C-band prices in the US. While the range of possible US values is clearly quite wide, three basic points stand out:

1. spectrum is worth much more – *multiples* more – in the US than in other countries, even relatively similar countries;
2. in very recent overseas auctions, bidders have valued C-band spectrum *more highly* than lower-frequency spectrum; and
3. it's not a stretch to get to a price of >$1/MHz-pop. Applied to the full 500 MHz of the C band, this price implies a minimum aggregate value of $153 billion – ~5x higher than the combined enterprise values of Intelsat and SES. (While we don't view this as a realistic estimate – it's likely just too much for the US telecom industry to pay – it goes to illustrate the sheer magnitude of the potential upside.)

C-Band Valuation: International Pricing and Readacross to the US

Note: all prices expressed in USD/MHz-pop.

	2017-18 auction prices				Implied US C-band value, based on…			
						Ratio of US to local values		
Country	C band	~2.5GHz	Ratio of C band to ~2.5 GHz	Historical ratio of US to local spectrum values	Ratio of C band to ~2.5 GHz†	Low	High	Mid
United Kingdom	$ 0.17	$ 0.11	1.5x	4-13x	$ 1.19	$ 0.67	$ 2.19	$ 1.43
Australia*	$ 0.38	$ 0.13	3.0x	4-14x	$ 2.38	$ 1.53	$ 5.34	$ 3.43
South Korea	$ 0.19	n/a		5-7x		$ 0.94	$ 1.32	$ 1.13

Source: Kerrisdale analysis

**Brisbane only.*

†Assumed US price for 2.5GHz spectrum is $0.79 (floor valuation for Sprint's spectrum based on $7 billion in outstanding securitization debt backed by 8.9 billion MHz-pops).

Based Solely on the Fundamentals, the C Band Is Likely as Valuable as Conventional Mid-Band Spectrum

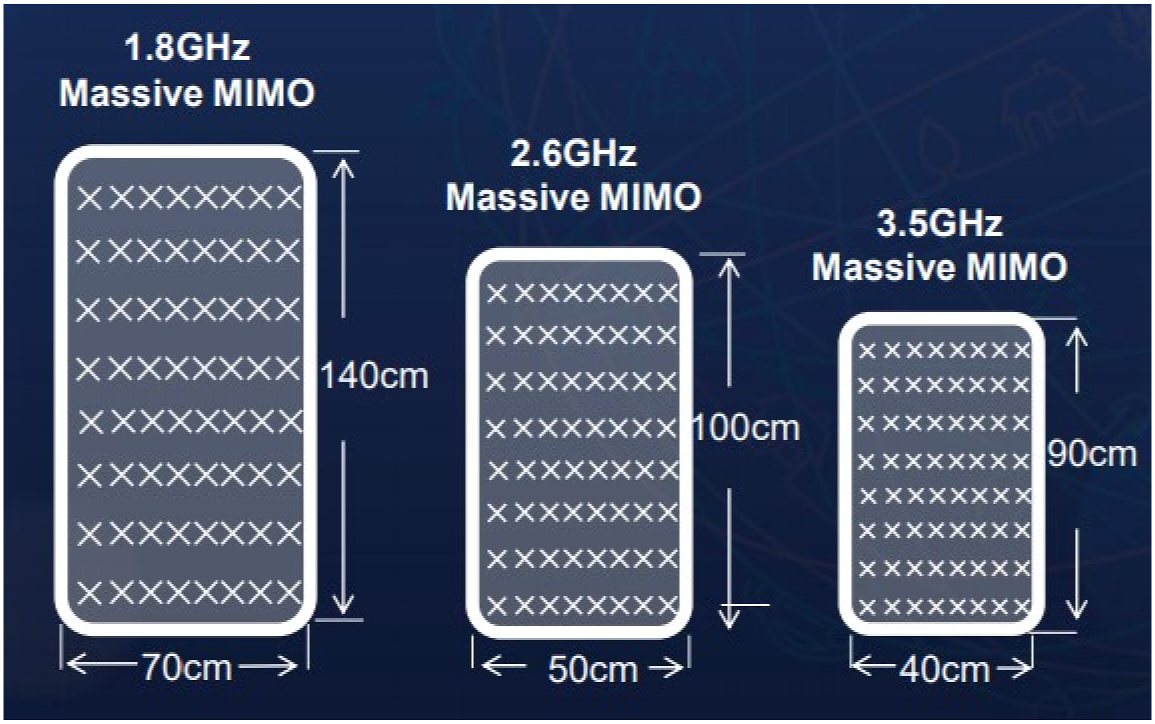
Setting aside foreign comps, where *should* US C-band spectrum trade relative to established mid-band spectrum like AWS or 2.5GHz – bands widely used today for LTE service? Traditionally, high-frequency cellular spectrum always commanded lower prices than low-frequency spectrum, for a relatively simple reason: low-frequency spectrum enjoys better overall propagation and in-building penetration than high-frequency spectrum, so carriers can build out their networks using far fewer nodes at far lower cost. Today, however, the existing national networks already enjoy good coverage; at the margin, additional low-frequency spectrum adds less value than it used to, a fact many have pointed to in explaining the surprisingly low clearing price of the 600MHz low-band spectrum auctioned off in early 2017.

With 5G, the high-vs.-low-frequency calculus has begun to shift even further thanks to a transformational technology called massive MIMO. In simple terms, massive MIMO allows operators to multiply the data-trafficking capacity of a given unit of spectrum several-fold by using a large number of antennas (e.g. 64) at the same time in a precisely coordinated fashion. Massive MIMO not only enables higher throughput; it also enhances coverage, because the antenna arrays located on cell towers and other macro sites can better "hear" faint signals from faraway user devices. While the use of very high-frequency *millimeter-wave* spectrum (like Straight Path's) for 5G mobile service will require extremely dense deployments – think a small cell on every corner – massive MIMO in mid-band frequencies can provide huge increases in capacity while largely relying on the *existing* "grid" of towers. Qualcomm, for instance, has said that, with massive MIMO, "it is possible to reuse existing macro cell sites (e.g., at 2 GHz) for new 5G NR [New Radio] deployments that operate in mid-bands between 3 GHz and 5 GHz." One of the most prominent massive-MIMO researchers has likewise written that the intended "deployment scenario" for massive MIMO in sub-6 GHz spectrum is "macro cells with support for higher user mobility," as opposed to mmWave spectrum restricted to "small cells with low user mobility."

Until recently, then, frequencies as high as 4 GHz would have suffered from such poor propagation that they too would have required dense, expensive small-cell deployments. With massive MIMO, however, increased antenna counts can compensate for this propagation deficit (while greatly improving speeds and capacity) *without* demanding much higher cell density.

But massive MIMO poses a major practical challenge: arrays of many antennas can be so large and heavy that they can't easily or safely fit on top of already heavily loaded towers. This problem is most acute at lower frequencies, because physics dictates that optimal antenna size is inversely related to frequency (low-frequency spectrum, like the 700MHz band, requires large antennas). Indeed, the CEO of SBA Communications, one of the largest owners of cell towers in America, has reportedly said that "in early deployments, the weight of Massive MIMO antennas [using carriers' existing spectrum] have been double that of existing antennas." Even if these large, heavy structures *can* fit on existing towers, they will cost more because tower owners will charge higher rent. Now, C band's relatively high frequency becomes an advantage, because multi-antenna arrays at ~4 GHz are simply not as bulky as those at ~2 GHz. In an example provided by the equipment vendor Huawei, for instance, we see that massive-MIMO antenna arrays using 3.5GHz spectrum can be 36% shorter and 43% narrower than comparable arrays using 1.8GHz spectrum (a band commonly used overseas, similar to PCS or AWS in the US):

C-Band Spectrum Enables Smaller, Lower-Cost Massive-MIMO Equipment



Source: Huawei 5G marketing presentation, slide 10

Massive MIMO will thus allow C-band spectrum to "match" the coverage of ~2GHz spectrum – Nokia says it will enable reuse of the "1800 MHz grid" (slide 6), while Qualcomm says it will work well with relatively large inter-site distances of ~1 mile (slide 23) – without the use of burdensome, impractical equipment. At the same time, it will increase spectral efficiency, allowing carriers to do more with a given amount of bandwidth. (Interestingly, the spectrum valuation report commissioned by Sprint in 2016 explicitly considered the use of massive MIMO at 2.5 GHz as a separate scenario outside of the base case; the report concluded that the technology could increase the value of the spectrum to T-Mobile, AT&T, or Verizon by ~30-60% relative to the base-case NPV.)

If C-band spectrum can achieve coverage similar to conventional cellular bands while using 5G massive-MIMO equipment that will likely be cheaper and more practical than in lower frequencies, there's little fundamental reason to assign it a lower value than, say, Sprint's 2.5GHz spectrum. (The FCC itself, in its recent draft NPRM, refers to "the similarity in propagation characteristics for the [C-band] spectrum band and AWS bands"; the AWS bands are lower-frequency than 2.5 GHz and are typically viewed as even more valuable.) Indeed, as we already saw, UK and Australian auctions suggest that the C band can actually be substantially *more* valuable than such spectrum; in our view, those data points were no flukes. In the US, as previously discussed, Sprint's spectrum securitization has established an approximate floor on the market value of 2.5GHz spectrum at ~$0.79/MHz-pop. Based purely on its technical merits, why should the C band trade any lower?

The trouble becomes the sheer size of the check that the telecom industry would have to write. At some point, the carriers (or potential new entrants) won't have the financial wherewithal to pay what comparative and fundamental analysis suggest the spectrum is worth. However, it's important to remember that this constraint still sets a relatively high ceiling on the valuation. In the past five years, for instance, FCC auctions raised $66 billion in gross proceeds, mmWave acquisitions cost Verizon and AT&T another ~$4 billion, and acquiring the other half of Clearwire cost Sprint ~$7 billion (including assumed debt), for a rough total spectrum bill of $77 billion since early 2013. In addition, the four national carriers shelled out $244 billion in total capital expenditures from 2013 to 2017; while some of that pertained to non-wireless business units, the majority served to improve wireless network performance and capacity – the same ends achieved by investing in additional spectrum. Overall, then, the aggregate "budget" for wireless network improvement in the US over the last five years has easily exceeded $100 billion.

Looking forward to the *next* 5-10 years, though, there won't be much high-value spectrum for sale besides the C band. The FCC will auction off large amounts of bandwidth in multiple mmWave bands, including 24 GHz, 28 GHz, 37 GHz, 39 GHz, and 48 GHz, but even at the high price paid by Verizon to acquire Straight Path, total spending will remain closer to $10 billion than $100 billion. Meanwhile, policymakers continue to pursue the reallocation of lower-frequency, more readily usable spectrum that is currently monopolized by the federal government, but this process has always been extremely slow, and currently no new federal bands have taken even their first significant steps toward commercialization, let alone approached the finish lane. In the absence of other major spectrum-related demands on carrier budgets, we believe the likes of Verizon and AT&T will be willing and able to pay tens of billions of dollars for the C band – over time, as the satellite operators work to clear more and more spectrum.

Thus, while our analysis of international auctions values the US C band at at least $0.67/MHz-pop and easily more than $1, and our comparison of the massive-MIMO-empowered C band to conventional mid-band spectrum suggests it's worth at least $0.79/MHz-pop, we opt to be conservative – but not gratuitously conservative – and use an artificially reduced point estimate of **$0.50/MHz-pop**. At this price, with ~400 MHz of spectrum eventually put up for sale (as discussed in further detail below), the total gross value accruing to the C-band satellite operators over the next 5-10 years will be $60 billion – a tremendous amount, to be sure, but one that we believe is realistic in light of historical spectrum spending and capex, along with the critical importance of mid-band massive MIMO to widespread 5G. As the CEO of SBA Communications said in May, "[O]nce you get outside the high-density urban markets…this massive MIMO architecture is what's necessary to provide true 5G services" (*source: Capital IQ transcript*) – and the C band is ideal for massive MIMO.

How Much Spectrum Will Be Cleared?

With a valuation of $0.50/MHz-pop in hand, we must now determine the right number of MHz and the right number of "pops." The latter is relatively easy: under the Intelsat/SES proposal, C-band spectrum would be cleared throughout the lower 48 states, which have a combined population (as of the last census) of 306.7 million people. (Alaska and Hawaii pose unique problems, which is why they're excluded: Alaska currently relies on C-band transmissions for basic connectivity, not just video distribution, while Hawaii is so far out in the Pacific that repacking the C band in its vicinity would require changes to many satellites designed to serve e.g. Asia, not just the US.) However, in a small number of locations within the contiguous US – Intelsat, SES, and Intel refer to "a couple of dozen sites nationwide" – use of the C band, especially for controlling and tracking the satellites themselves, is so intense that any terrestrial use of the band nearby would risk harmful interference. One problem location, for instance, is near Atlanta, which has an overall metro-area population of 5 million. To conservatively account for this set of potential exclusion areas, we round the population down from 306.7 million to 300 million.

That leaves the more difficult question: how much spectrum can ultimately be cleared and sold? Much of the existing discussion of the Intelsat/SES proposal has focused on the stated *initial* clearing target of 100 MHz, to be achieved within 18-36 months of an FCC order. But it's been obvious from the start that the process won't stop there. Indeed, why would it? The FCC would like to see more spectrum cleared, to make way for 5G deployments; carriers would like to see more spectrum cleared; and the C-band satellite operators, inasmuch as they're financially incented, would also like to see more spectrum cleared. As Intelsat, SES, and Intel put it in an April FCC filing:

> The Parties stated that if the terrestrial demand for mid-band spectrum is as robust as claimed, their market-based approach could result in additional spectrum being cleared in the future – but in a manner and timeframe that protects Intelsat's and SES's customers and their businesses.

At a high level, the math is simple. C-band operations in the US currently generate $340 million of annual revenue, according to the Satellite Industry Association; assuming an 80% EBITDA margin and an 8x EV/EBITDA multiple, that in turn implies that the market value of the US C band in its current uses is ~$2 billion. By contrast, valuing the full 500 MHz in the band at $0.50/MHz-pop and using a 300mm population figure, potential cellular usage of the entire band would be worth $75 billion (setting aside clearing costs for the moment). $2 billion vs. $75 billion: the arbitrage is just too attractive. By hook or by crook, the satellite operators will do everything in their power to move from one state of the world to the other. Why would they just stop at the first 100 MHz?

"Protect[ing] Intelsat's and SES's customers and their businesses" is an important and difficult constraint, of course; satisfying it is going to take a great deal of time, effort, and money. Were Intelsat and SES to simply abandon politically and economically important customers like

Disney, Fox, and local TV broadcasters, the FCC would likely frown upon their proposal; ensuring a rapid yet orderly transition from the C-band status quo to the 5G future is the responsibility Intelsat and SES are undertaking in exchange for their potential multi-billion-dollar windfall.

But it's important to remember that, in the final analysis, the satellite operators hold all the cards. In a sense, clearing the band is easy: all Intelsat and SES need to do is let their current customer contracts expire. No one can compel them to lease their transponders if they don't want to, and, once their transponders stop transmitting, the path is clear for the carriers to build out cellular networks in the freed-up band. In a less extreme scenario, Intelsat and SES could simply hike the price of C-band capacity. If the entire pay-TV industry, with roughly $175 billion in annual revenue, rests on the foundation of C-band distribution, as its representatives constantly insist to the FCC, then surely it can afford to pay more than $340 million a year (~0.2% of revenue) for the service. At a high enough price, though, companies like Disney and Fox will prefer to find another way to distribute their content and will give up on the C band, again leaving it free for Intelsat and SES to sell. (Or, if they're willing to pay more than the mobile carriers, Intelsat and SES can opt to clear a smaller amount of spectrum over time; economic forces will dictate the final amount.) In reality, we don't think it will come to such coercive measures. Intelsat and SES will diligently work with their customers to accommodate their core business needs using less spectrum, rather than just unceremoniously evicting them – but the satellite operators' *ability* to go down that route, if necessary, gives them leverage over any potential intransigent customers.

Assuming a deliberate, cooperative process between the satellite operators and their customers, how much spectrum can plausibly be cleared while still leaving adequate capacity for existing uses? The answer is, of course, uncertain, but we believe a total of **400 MHz**, leaving the remaining 100 MHz for conventional satellite uses, is quite feasible over the next 5-10 years. In the next section, we offer a detailed analysis of the kinds of operational steps that Intelsat and SES are likely to undertake to achieve this goal; some constitute low-hanging fruit, while others demand a higher reach.

Abstracting from the step-by-step mechanics, though, consider the following basic framework: today, the C band houses approximately 2,000 video feeds (see e.g. the American Cable Association's reference to "almost 2,000" channels) across ~24 satellites that cover the entire contiguous US. Over time, video utilization of the band has tended to concentrate among an even smaller subset of those satellites, because the owners of second-tier channels are willing to pay a premium to operate on the same satellite as a top-tier channel like HBO; this co-location makes it easy for a cable company or other distributor to receive the channel without having to re-point an existing antenna or buy a new one. As a result, usage has narrowed down to a handful of heavily loaded satellites operating across a wide stretch of the 500MHz band; other satellites, by contrast, are far less crowded. In short, existing incentives have led the industry to rely on more spectrum but fewer satellites. Under the Intelsat/SES proposal, this dynamic will reverse: channels will spread out across a wider range of satellites but use fewer transponders – effectively, a smaller fraction of the available band – and thereby make room for terrestrial usage.

How far can this process go? Currently, without strong incentives to economize on spectrum usage, many C-band video feeds are spectrally inefficient. For example, they use outdated compression algorithms and other technical standards. Using the best existing technology, however – a transmission standard called DVB-S2X and a codec called HEVC – a single C-band transponder can handle ~20 high-definition channels. (One source says 17-22; another says 19-24. In general, newer and higher-powered satellites will be able to get to the high end of the range, but stuffing more channels onto one transponder will eventually affect video quality.) ~2,000 channels allocated across transponders that can accommodate ~20 channels each will thus require, in the long term, only 100 transponders. But the full fleet of 24 contiguous-US-covering satellites, if fully operational, boasts 576 total transponders (24 x 24). 100 required transponders out of 576 available could, in principle, be spread out evenly across the available satellites, thereby using only 100/576 = 17% of the total band, or 87 MHz, leaving 413 MHz available for other uses. Since most non-video uses of the band generate little revenue and require little spectrum – many audio feeds for radio broadcast, for instance, can fit on a single transponder – that would leave space for at least 400 MHz of terrestrial cellular usage.

Of course, all of this is much easier said than done. Every channel can't switch to DVB-S2X and HEVC overnight, nor is every customer going to be happy to change satellites. Some cable head ends today aren't set up to pull feeds from a large number of satellites, although many are: Comcast, for example, uses 20 different satellites, and SES has estimated that "a typical cable head end [already] has 11-15 antennas pointed at different satellites in order to receive a robust package of programming." But the simple calculation above, showing that 400 MHz of C-band spectrum can, over time, be cleared for terrestrial use while still preserving the ability to distribute video over the remaining 100 MHz, neglects a key degree of freedom: the number of channels. Why must there be 2,000? From the perspective of a cable subscriber, the typical number of channels is more like 200, not 2,000. What inflates the count from a satellite perspective is, in part, redundancy. For example, there may be both high-definition and low-definition version of a single channel, or east-coast and west-coast versions to address time-zone differences. Such arrangements may be convenient when spectrum is abundant, but they can be replaced at low cost when it isn't: cable companies interested in offering standard-definition channels can easily down-convert high-definition signals on their end, while west-coast users can simply record east-coast feeds and then retransmit them to their subscribers when the appropriate time comes. As redundant channels are squeezed out, Intelsat and SES will be in an even better position to make room for cellular.

Moreover, at a high level, most industry observers believe that linear TV is a mature or declining business. As viewership declines over time due to cord-cutting, the least valuable channels will eventually become unprofitable and disappear. One doesn't have to believe the industry is doomed to expect a gradual pruning away of marginal channels over time – another tailwind in Intelsat and SES's favor, giving them more flexibility to free up spectrum. 1,000 channels, for instance, could eventually fit on ~50 transponders, potentially requiring only ~40 MHz of bandwidth.

To reiterate, it won't be fast or easy to clear 400 MHz; that's why Intelsat and SES are targeting only 100 MHz to start. But it's clearly feasible. There's no need to invoke hypothetical future improvements in video compression, nationwide fiber availability, or major transformations in the TV industry; current technology can ultimately handle current use cases with much less spectrum. But it will take the operational and commercial skill of Intelsat and SES to execute on this conceptually simple strategy; no one is better positioned to reorganize the band with a minimum of friction.

How Much Will Intelsat and SES Benefit?

Under Intelsat and SES's proposal, proceeds from the sale of C-band spectrum would be shared among a "consortium…open to all C-band satellite operators providing service to all or a portion of the lower 48 states pursuant to FCC-issued licenses or grants of market access." The allocation of proceeds "would be based on an equitable predetermined metric reflecting the U.S. C-band operations of each Consortium member." While the nature of this "equitable predetermined metric" has been left undefined, at least in the companies' public comments, we believe the simplest and fairest such metric is revenue generated in the US by C-band service.

As previously noted, the Satellite Industry Association has estimated that "current annual revenue from C-band satellite services alone is $340 million," and it's clear from our discussions with industry participants, as well as the public comments of Intelsat and SES, that the "big two" account for almost all of this total – 90-95%, according to Intelsat management during the company's fourth-quarter 2017 earnings call. We also know from Intelsat's quarterly commentary that "[i]n 2017, continental U.S. media distribution services represented 7 percent of total company revenue," or $150 million – 44.2% of the SIA's $340mm industry total. Though the vast majority of US C-band revenue does pertain to media distribution, a small amount involves other use cases; we thus round up from 44.2% to 45%. Using the low end of the 90-95% range of combined Intelsat/SES market share, we then conclude that SES has roughly the same 45% share as Intelsat, leaving 10% to account for other operators, primarily Eutelsat and Telesat.

While some industry observers have wondered about the potential for these second-tier operators to shake down the "big two" in exchange for cooperation, we see little reason to worry. Eutelsat answered "yes" in February when asked if it intended to join the Intelsat/SES consortium, noting that "we control only a small portion of the C-band in North America. We have around 5% of the C-band, meaning that we are a minor player." Telesat, a small Canadian company, also reportedly "has only a single-digit percentage of the C-band covering the U.S." Though Telesat's CEO complained in May about the risk of unfairness in the consortium's notion of "equitable" sharing and claimed he would oppose the Intelsat/SES proposal – even while Telesat has remained almost totally silent in the relevant FCC proceedings – we believe the company has no meaningful ability to derail the process in the hopes of a better deal. With very little US-based C-band business – we highly doubt there are many American viewers of channels like the Saskatchewan Legislative Network, hosted on Telesat's Anik F2, or Legislative Assembly TV Nunavut, hosted on Anik F1R – Telesat can largely be ignored. To the extent there are earth stations of any value communicating via C-band with Telesat satellites whose signals cover the contiguous US, the consortium can, if necessary, negotiate with their owners directly, potentially moving their business to Intelsat or SES satellites or just getting rid of the problem channels. In the end, for a "minor player" in the US C band, joining the consortium and sharing in the proceeds of any deal looks like a much wiser course of action than bluffing about holding out.

Using reasonable values for price per MHz-pop, population, bandwidth, and the split of proceeds by participant, we can now carry out the arithmetic and compute the gross value of the repurposed US C band to Intelsat and SES. However, this is the *pretax* value. SES will likely face a full tax bill on its share, but Intelsat can offset a portion of its gains against almost $4 billion of net-operating-loss carryforwards (less a smaller net deferred tax liability). All in, we believe Intelsat will walk away with $24.6 billion and SES $21.3 billion.

Estimated After-Tax Value of US C-Band Proceeds to Intelsat and SES

Valuation ($/MHz-pop)	$ 0.50	
Bandwidth (MHz)	400	
Population (mm)	300	
Gross spectrum value ($mm)	$ 60,000	
	Intelsat	SES
Company share of proceeds (%)	45%	45%
Company share of proceeds ($mm)	$ 27,000	$ 27,000
Gross income tax	(5,670)	(5,670)
Benefit of net deferred tax assets	3,262	-
Net gain	$ 24,592	$ 21,330

Source: Kerrisdale analysis

Of course, the proceeds are the fun part. To earn those proceeds, Intelsat and SES will have to put in a great deal of work over a period of years – reconfiguring earth stations, rearranging transponder lists, renegotiating customer contracts, and more. All of this will cost money. But *how much* might it reasonably cost, and what concrete steps might the satellite operators take? We now turn to these questions.

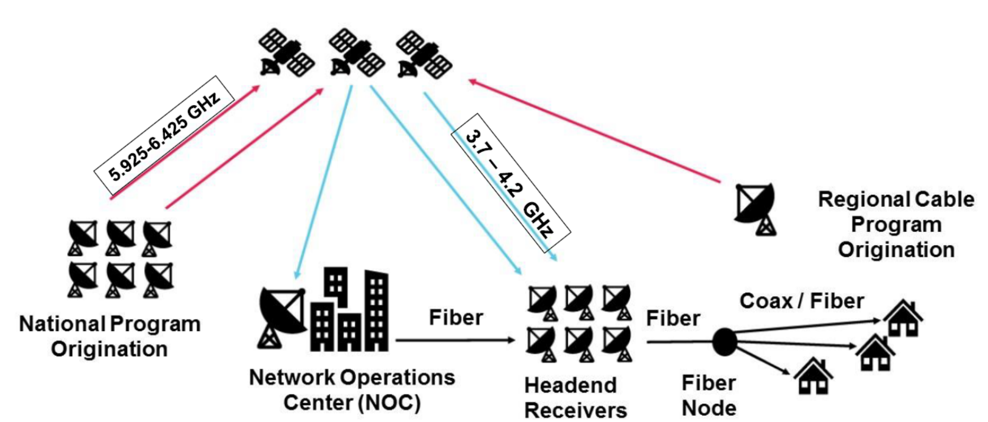
V. Extensively Repacking the C Band Is Operationally and Economically Feasible

Before considering in greater detail how Intelsat and SES might reconfigure US C-band operations to use less spectrum, we begin by reviewing how the C band works today. Based on discussions with Intelsat, we believe there are over 50 satellites with C-band transponders authorized to downlink into the US, of which Intelsat and SES account for almost all. (A transponder is the basic unit of satellite capacity – a device that receives signals centered on a given uplink frequency, converts them into signals centered on a given downlink frequency, amplifies them, and re-transmits them.) The vast majority of the revenue generated by North American C-band transponders (>90%, according to Northern Sky Research) comes from distributing video and audio programming. That distribution activity is in turn highly concentrated among an even smaller number of satellites – roughly two dozen that cover the entire contiguous US.

For TV in particular, these C-band satellites are crucial. According to the American Cable Association (ACA), "virtually all" pay-TV providers receive programming via C-band satellite links in order to then deliver it to more than 90 million subscriber households. Similarly, the National Association of Broadcasters says that "[v]irtually every U.S. television and radio household relies on C-band satellite operations for content distribution in some manner." According to Comcast, 84% of the primary signals for the cable channels it offers to its customers are received via C-band satellites.

The diagram below illustrates how content providers such as broadcasters (CBS, NBC, ABC, and their local affiliates) and cable networks (Discovery, Viacom, Disney, etc.) use C-band satellite links to transport video from origination points (production studios, local news/event sites) to operational hubs and head-ends for cable and other pay-TV systems, after which they make their way to viewers' homes.

An Overview of C-Band Video Distribution



Source: Roberson and Associates, T-Mobile ex parte, June 15, 2018

The key C-band satellites are arrayed in geosynchronous orbit above the equator from 139°W longitude to 87°W longitude in what are commonly referred to as the cable and broadcast arc. With the exception of the satellite Eutelsat-115 West B, which only covers the western third of the country, all the satellites within this arc cover all or substantially all of the US (*source: Satbeams*). Below we enumerate those satellites. Overall, excluding two older and less capable satellites, we find that 23 satellites with a combined 540 C-band transponders handle core US media distribution today.

A Snapshot of the Primary US C-Band Satellites Today

Intelsat[1]			**SES[2]**		**Eutelsat**		**Telesat**	
	Name	C-Band TPs	Name	C-Band TPs	Name	C-Band TPs	Name	C-Band TPs
1.	Galaxy-15	24	1. AMC-10	24	1. 117 West A	24	1. Anik-F3	24
2.	Galaxy-12	24	2. AMC-11	24	2. 115 West B	12	2. Anik-F2	24
3.	Galaxy-13	24	3. AMC-15	24	3. 113 West A	24	3. Anik-F1R	24
4.	Galaxy-14	24	4. SES-3	24				
5.	Galaxy-18	24	5. SES-1	24				
6.	Galaxy-23	24	6. SES-2	24				
7.	Galaxy-16	24						
8.	Galaxy-19	24						
9.	Galaxy-3C	24						
10.	Galaxy-17	24						
11.	Galaxy-28	24						
	Subtotal	**264**		**144**		**60**		**72**

Grand totals:

Satellites	23
TPs	540

Source: ACA Exhibit 3, SES website, Intelsat website, Gunter's Space Page, Kerrisdale analysis
Note: "TP" = transponder.
1. Excludes Galaxy-25 given estimated end of service life next year and limited transponder usage. Galaxy-12 serves as designated in-orbit back-up.
2. Excludes AMC-8 which is beyond planned design life and is used primarily for Alaskan data service.

There Are Many Opportunities to Accommodate Incumbent Use of the C Band with Less Spectrum

The opportunity to optimize use of C-band spectrum in the US while still meeting the needs of the incumbents is substantial. Transponder usage varies widely among satellites, and there is a broad mix of legacy and more advanced compression formats carried by each transponder. We believe in time this will change. Properly incentivized by the value of the spectrum, operators will shift from trying to sell the maximum number of transponders (for a US media business that isn't growing) to using as few transponders as possible while harvesting the spectrum for cash.

Some satellites in the fleet are workhorses, such as Galaxy-17, with 23 out of 24 C-band transponders in use. Others are not, such as Galaxy-23, with only 12 out of 24 transponders in use.[1] In aggregate, across the fleet we counted 309 C-band transponders being used for media delivery. Viewed in this high-level manner, C-band transponder utilization across the cable/broadcast arc is less than 60% (309 transponders out of a total of 540). Theoretically, if one could evenly spread transponder usage across the fleet, even without the benefit of higher compression ratios and new satellites, one could immediately free up the lower ~10 transponders, enough to clear 200 MHz of spectrum.[2]

Analyzing transponder usage like this only tells part of the story. We count a transponder as "used" in the above analysis regardless of whether it has one MPEG-2 channel (Galaxy-13, transponder 10), 30 MPEG-2 channels (Galaxy-17, transponder 24), or 15 MPEG-4 HD channels (SES-1, transponder 16). To gauge utilization in a more nuanced way, one must examine what's actually being transmitted.

In our review of each satellite's transponder list we counted 1,757 total video feeds and 231 radio feeds (closely matching ACA's tabulation as shown in Exhibit 3 of comments filed with the FCC in the mid-band proceeding). A little over 700 (41%) still use MPEG-2 encoding, a format that is over 20 years old. Despite the excitement surrounding ultra-high definition 4K programming, we found only nine 4K channels (four of which apparently exist only to promote 4K technology – see transponder 4 on SES-1). We believe the modest level of 4K penetration to date reflects in part the limited incremental benefit that 4K resolution delivers relative to HD for average TV sizes and viewing distances. (It also serves to debunk the notion advanced by some incumbent users that the "inexorable" rise of 4K will make it impossible to free up much C-band spectrum because that capacity will be badly needed.) According to AsiaSat, using DVB-S2 8-PSK satellite transmission (a standard modulation scheme used to carry HD feeds) and MPEG-4 compression, a single transponder can accommodate over 24 SD channels, 7-9 HD channels (14-18 using HEVC), and 2-5 UHD (i.e. 4K) channels. These figures are consistent with those used in a presentation filed with the FCC by Comcast.

Using these estimates of the reasonable number of channels than can fit on a single transponder, we can then calculate the minimum number of transponders that could theoretically handle *all* existing US C-band video and audio feeds. We summarize our analysis in the table below. We find that, **even without resorting to improved compression** (e.g. going

[1] All transponder-list data presented in this section comes from LyngSat, a third-party website that compiles information on satellite channels globally. LyngSat data is cited in filings with the FCC made by the ACA and by the communications-equipment provider Ericsson. Multiple satellite experts have confirmed for us that data from LyngSat is typically up to date and is often referred to by professionals in the satellite industry.

[2] Technically, 5 transponder pairs. Transponders operate in two frequency polarizations, vertical and horizontal, within a single 40MHz channel block (36 MHz plus a 4MHz guard band). Each polarized transponder takes up 20 MHz of spectrum. Clearing 10 transponders therefore frees up approximately 200 MHz of spectrum. More simplistically, 10 transponders are the equivalent of 40% of total transponder capacity on a 24-transponder satellite, and 40% of 500 MHz of C-band spectrum is 200 MHz.

from MPEG-2 to MPEG-4 or from MPEG-4 to HEVC), every feed could fit on just 146 transponders. Recall that 540 transponders are available, of which 309 are currently used for media delivery. In principle, then, all the existing feeds require only 146/540 = 27% of the available collective C-band capacity, which, if properly distributed across the satellites, would require only roughly 27% x 500 MHz = 135 MHz of spectrum, leaving the other 500 – 135 = 365 MHz free for mobile use.

US C-Band Transponder Utilization

Channel type	Number	% of total video	Max channels per TP	Min required TPs
MPEG-2 SD[1]	627	36%	18	35
MPEG-2 HD	81	5%	16	5
MPEG-4 SD	368	21%	24	15
MPEG-4 HD	662	38%	8	83
4K HEVC	9	1%	4	2
Other video[2]	11		10	1
Radio[3]	231		50	5
Total	1,989			146

Source: LyngSat (last visited June 12, 2018); AsiaSat presentation, slide 16; Kerrisdale analysis
Note: "TP" = transponder.
1. Max channels per TP = Kerrisdale estimate based on "How many SD/HD channels can we get from one transponder?"
2. Primarily NTSC channels.
3. Conservatively assumes a max radio channel per transponder similar to MPEG-2 video. For reference, SES's AMC-15, transponder 2 which carries 41 radio feeds.

The implication is that, while there is undeniably significant usage of the C band today, there remains a tremendous opportunity for optimization. Of course, rearranging channels on transponders is far easier to do in a spreadsheet than in real life, but the potential is very real. In addition, the above analysis does not factor in efficiency gains provided by a more aggressive transition of MPEG-2 channels to MPEG-4. This would result in incremental topline headwinds, but media revenue is already under pressure from compression changes. Intelsat has guided to pressure in North American media in 2018 and 2019 due to the implementation of compression technologies (*source: Intelsat 2017 annual report*). Using the latest satellite and compression technology, a transponder can accommodate a mix of over 20 MPEG-4 and MPEG-4 HD channels with HEVC encoding (*based on data from AsiaSat*). With this more advanced scheme, the total number of transponders needed to serve current video and audio feeds would fall further still, to fewer than 100 transponders, potentially freeing up nearly 400 MHz of spectrum while retaining all existing feeds.

We acknowledge that the above analyses are abstract representations of aggregate capacity, neglecting nuances like the differences in different satellites' coverage areas and power levels. In the real world, C-band transponders are not actually fungible commodities. But these quibbles miss the bigger picture. Satellite service providers have spent 50 years operating in the C band – but only in the last 9 months have they been presented with the possibility of strong financial incentives to be efficient users of the spectrum. It thus stands to reason that there will be low-hanging fruit for the picking. Furthermore, for the sake of conservatism, our analyses do not assume the availability of any new satellites (which would increase capacity) or the application of novel technologies like better compression or satellite-transmission standards. The point is not that we know the exact optimal way to free up C-band spectrum; the point is that it's perfectly realistic to expect far more than 100 MHz over time, as long as the key players have the right incentives.

Playing Tetris: A Case Study

We've heretofore focused on clearing C-band spectrum by rearranging and reconfiguring transponder use. Intelsat and other industry participants have sometimes referred to this exercise as Tetris – a game of moving blocks to the right locations to form a coherent pattern with no gaps.

At a high level, C-band Tetris will involve identifying customers who are using transponders in the lower portion of the frequency range across the fleet, working with them to potentially use better compression schemes, and relocating them to available transponders in the upper portion of the frequency range – preferably on the same satellite, to minimize disruption. According to an Intelsat investor-relations representative, C-band contracts typically give satellite operators the flexibility to move customers to different transponders, provided the orbital location and performance standards remain the same.

There have been discussions of C-band repacking that, in contrast, have focused on more terrestrial approaches to the problem, like physically moving C-band receivers out of urban centers and into more remote areas, then constructing fiber links back to their original locations. In our view, this bias is misguided. Engaging in potentially tens of thousands of construction projects will likely cost far more money and take far more time than achieving the same goal by more ethereal means.

As with the classic puzzle game, C-band Tetris is relatively easy at first. As the targeted amount of cleared spectrum increases, however, the number of available vacant and underutilized transponders declines, and the game becomes more difficult. In the words of one of our sources – an engineer and former industry executive with over 15 years of corporate-development experience – "I don't see this as overly complicated, and, again, the smaller amount of capacity that you're trying to clear out, the easier it is. I'm sure that the ultimate end goal would be to clear out at least 200 or 300 MHz and would expect the first 100 MHz to be a lot easier than the last 100 MHz." Still, based on the patterns of C-band transponder usage we examined above, we believe Intelsat and SES can ultimately manage through the complexity; they have enough flexibility to make Tetris an eminently winnable game.

To make the problem more concrete, we consider how the game might unfold on one specific satellite: Intelsat's Galaxy-17. (In reality, the game would involve every major C-band satellite.) We deliberately chose Galaxy-17 for this exercise to show how, even for one of the most heavily utilized satellites in the fleet, migrating customers to free up 200 MHz is well within the realm of possibility, without requiring heroic measures.

Galaxy-17 C-Band Transponder List

TP	Provider name	# of feeds	Feed type
1	The CW Plus	4	MPEG-4 HD
2	Fox Networks Group	4	MPEG-2 HD
3	NBC Sports Chicago	3	MPEG-4 HD
	SportsNet New York	2	MPEG-4 HD
4	MLB Network	2	MPEG-2 HD
5	Fox Networks Group	2	MPEG-2 HD
6	Fox Networks Group	10	MPEG-2 SD
7	Comcast Entertainment Group	6	MPEG-2 SD
8	Fox Sports Networks	2	MPEG-2 HD
		2	unknown
9	Kroenke Sports	5	MPEG-4 HD
	The Word Network	1	MPEG-2 SD
	910 AM Superstation	1	radio
10			
11	Comcast / NBC Sports	6	MPEG-4 HD
12	BYU TV / Univision / Roberts	2	MPEG-4 HD
		1	MPEG-2 HD
		4	MPEG-2 SD
13	Digital Media Centers	5	MPEG-2 SD
14	TCT	1	MPEG-4 HD
		2	MPEG-4 SD
15	Spectrum Networks	8	MPEG-4 HD
16	Fox Networks Group	4	MPEG-2 HD
17	Fox Sports Networks	4	MPEG-2 HD
18	Classic Arts Showcase	1	MPEG-4 HD
		1	MPEG-2 SD
19	Comcast SportsNet	7	MPEG-4 HD
20	AT&T SportsNet	10	MPEG-4 HD
21	Crawford Cablestar	7	MPEG-2 SD
		1	unknown
22	Fox Sports Networks	4	MPEG-2 SD
23	Fox Sports Networks	2	MPEG-4 HD
24	Intl. Media Distribution	30	MPEG-2 SD

Source: LyngSat (last visited June 16, 2018), Kerrisdale analysis.

Above is a diagram of the satellite's current C-band transponder usage. Nearly all 24 C-band transponders on Galaxy-17 are currently being used. Intelsat bills the satellite as part of its "Premier Regional & League Sports Neighborhood," and customers include regional sports networks like AT&T SportsNet, SportsNet New York, and Fox College Sports. We have highlighted the customers that Intelsat would need to migrate to clear the lower 10 transponders.

There are numerous potential scenarios, but here is one way Tetris might be played on Galaxy-17 in five steps:

1. The diversified media giant 21st Century Fox uses 8 transponders (highlighted in gold), but not one is used to its fullest potential. We believe all of Fox's 34 channels (including 2 feeds for live "occasional use") could fit within 2 of its transponders; we moved them to transponders 22 and 23. (Note that this might require an upgrade to HEVC compression.) This frees up 6 transponders: 2, 5, 6, 8, 16, and 17.
2. Comcast Entertainment (highlighted in pink) can then move to the newly vacated transponder 16.
3. NBC Sports and MLB Network (highlighted in green and light blue, respectively) can move to the vacated transponder 17.
4. The CW Plus channels (highlighted in grey) move to transponder 18, which currently holds just 2 feeds, both from Classic Arts Showcase (a channel that promotes fine arts and is now also available via the internet 24 hours a day).
5. Kroenke Sports / Other channels (outdoor living entertainment plus The Word Network) move to transponder 13, which currently has a hodgepodge of MPEG-2 content (Logo East, BET Jams, TV One, etc.).

Below we show the transformation from "before" to "after" – freeing up the first ~200 MHz currently used by the satellite *without forcing any customers onto different satellites.*

Before & After:
One Way to Clear 200 MHz on Galaxy-17

TP	Provider name
1	The CW Plus
2	Fox Networks Group
3	NBC Sports Chicago SportsNet New York
4	MLB Network
5	Fox Networks Group
6	Fox Networks Group
7	Comcast Entertainment Group
8	Fox Sports Networks
9	Kroenke Sports / Other
10	
11	Comcast / NBC Sports
12	BYU TV / Univision / Roberts
13	Digital Media Centers
14	TCT
15	Spectrum Networks
16	Fox Networks Group
17	Fox Sports Networks
18	Classic Arts Showcase
19	Comcast SportsNet
20	AT&T SportsNet
21	Crawford Cablestar
22	Fox Sports Networks
23	Fox Sports Networks
24	Intl. Media Distribution

TP	Provider name
1	Cleared
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	Comcast / NBC Sports
12	BYU TV / Univision / Roberts
13	Digital Media Centers Kroenke Sports / Other
14	TCT
15	Spectrum Networks
16	Comcast Entertainment Group
17	NBC Sports Chicago SportsNet New York MLB Network
18	Classic Arts Showcase The CW Plus
19	Comcast SportsNet
20	AT&T SportsNet
21	Crawford Cablestar
22	Fox Networks Group 1
23	Fox Networks Group 2
24	Intl. Media Distribution

Source: LyngSat (last visited June 16, 2018), Kerrisdale analysis

To actually execute such a strategy, Intelsat would formulate a migration plan for each customer, and concessions would likely be made on contract terms in order to secure agreement. In the case of Fox, there would be lost revenue as the number of transponders used went from 8 to 2. Intelsat has stated that it has already begun discussions with certain customers as part of media contract renewals for 2018 and 2019 (*source: Goldman Sachs Leveraged Finance Conference transcript, May 10, 2018*). According to a former Intelsat network engineer with whom we spoke, once permission is granted by the customer, the actual process of rearranging channels is easy. Migration would take perhaps 1-2 weeks per satellite once contracts have been signed.

For the purposes of this exercise, we have made minimal use of the benefit of more advanced compression methods, such as HEVC, though Intelsat has clearly acknowledged that, as customers move to higher compression rates, relocating them to the upper portion of the C band will become easier (*source: JP Morgan Global Technology, Media and Communications Conference transcript, May 17, 2018*). Again, we also didn't resort to moving any customers to other satellites. As a result, at least with respect to Galaxy-17, there would be no need for earth stations to re-point their dishes; they would keep using the same orbital slot. TV providers like cable companies would have to reconfigure their receive equipment to account for the new channel placements, likely in early morning hours to avoid potential viewer disruption, but, according to the previously mentioned former Intelsat network engineer, this sort of adjustment is routine: "cable guys do it all the time."

Even if Tetris does eventually require moving channels to different satellites, it still wouldn't necessarily call for the cumbersome or costly manipulation of ground equipment. To be sure, for a hypothetical cable head-end that currently receives all of its programming from a single satellite at a single orbital location, starting to receive programming from a different satellite at a different orbital location would indeed require a new dish. But this hypothetical scenario represents an unrealistic extreme. The large TV providers that collectively account for over 96% of the US pay-TV market already receive programming from many different satellites. Comcast, for example, uses 20 satellites – so many that it's unlikely it would have to receive channels from additional satellites, even if many channels ultimately move around. SES has stated that many head-ends have "triple-feed" antennas that can receive programming from all the satellites it has in the "central arc neighborhood" (SES-1, SES-3, and AMC-18). If programming on SES-1 had to move to, say, SES-3 to free up spectrum, Comcast and other large providers wouldn't have to do much; their triple-feed antennas would stay exactly where they were

The C Band Can Be Cleared at a Reasonable Cost

Given all the uncertainties surrounding the details of the C-band clearing process, it's impossible, especially for an outside observer, to get the overall cost precisely right. Nonetheless, making our best guesses and using what we believe are conservative assumptions, we estimate that the total pretax cost to clear 400 MHz over time will be approximately $855 million, split between two main components:

1. Installing filters to protect earth-station receivers from terrestrial 5G interference
2. Ensuring that TV-related head ends can still receive the same channels they do today even if those channels move to transponders on different satellites

Below we summarize our estimates.

Kerrisdale-Estimated C-Band Clearing Costs for 400 MHz of Spectrum		
Filtering		
Total earth stations		30,000
Hardware cost per filter	$	4,000
Labor cost per installation	$	500
Installation passes		3x
Total filter cost ($mm)	$	405
Head-end upgrades		
Total MVPD head-ends		5,000
Of which: rural		4,500
Ground equip. cost per rural HE	$	100,000
Total ground equipment cost ($mm)	$	450
Grand total ($mm)	**$**	**855**

Source: Kerrisdale analysis

Filtering: Radio-frequency filters are devices that, in simple terms, allow certain frequencies to pass through but block others. Filtering will be necessary because even when, say, the lower 100 MHz of the C band is cleared, the proliferation of terrestrial 5G base stations and user devices will still threaten to interfere with the satellite earth stations operating in the neighboring portion of the band. These earth stations are highly sensitive, designed to "hear" faint signals from 22,236 miles above the equator; while 5G systems aren't *supposed* to leak energy outside of their defined channels, real-world transmitters always do. Installing filters will keep 5G noise from overwhelming satellite signals. This process isn't especially difficult – one veteran satellite network engineer told us he could do it in five minutes – but will still require significant planning, coordination, and cost.

How many filters will the satellite operators have to install? The Satellite Industry Association has estimated that "over 33,000" C-band earth stations may exist nationwide. The methodology behind this estimate, however, is difficult to fully credit: the SIA took the number of *registered* C-band earth stations in the official FCC database, adjusted it for the number of registered yet currently nonexistent antennas identified by Google in its review of the database, and then scaled the total up by a factor of 10 based on feedback from its members that only 1 in 10 of their earth stations are registered. (Under FCC rules, receive-only earth stations have no obligation to register, and satellite operators themselves have no direct way of knowing how many earth stations their wide-coverage signals are reaching – hence all the uncertainty.)

A second source, a company called LinkUp Communications that helps clients design and install satellite uplink and downlink networks, has estimated that there are "27,000 C-band downlink locations nationally," though its methodology also seems questionable: it's extrapolating from its examination of Bay County, Florida, which it asserts is "typical." According to LinkUp, Bay County, with a population of only 183,563 people, contains "9 radio groups with C-band downlinks, 4 TV groups with multiple C-band downlinks each and 2 cable headend locations with multiple downlinks. That is nearly one C-band downlink site for every 12,000 people."

Arguably, both SIA and LinkUp have an incentive to exaggerate their estimates when communicating with the FCC, on the theory that the more incumbent C-band users there are, the less likely the FCC is to make any rash changes to the status quo. By contrast, at one recent investor conference, Intelsat suggested that there were only 10-15,000 C-band earth stations in the US (*source: JP Morgan Global Technology, Media and Communications Conference transcript, May 17, 2018*). Nonetheless, in our cost analysis we use the average of the SIA and LinkUp estimates: 30,000 earth stations.

Each will need a new filter, but how much does a filter cost? In our discussions with industry participants, we encountered a wide range of estimates, ranging from $500 to $5,000. We have assumed a figure at the high end of the range, $4,000 per device, despite the potential for the satellite consortium to obtain volume discounts over time. For associated labor costs, we assume 5 hours of work (travel time, prep work, installation) per earth station at $100 per hour. Finally, we assume this exercise must be repeated three times in order to free up 400 MHz over time. As more spectrum is gradually cleared and the portion of the C band remaining for satellite use shrinks, new filters with different so-called passbands will be needed. (First, for instance, the passband might be 3.8 to 4.2 GHz; then, 4.0 to 4.2 GHz; then, 4.1 to 4.2 GHz.) Ideally, of course, the operators could clear the maximum amount of spectrum all at once, but, because of the increasing difficulty of the aforementioned "Tetris" over time, it's more realistic to expect clearing to be meted out in several discrete chunks. Bringing together our estimates for the number of earth stations, the cost of a filter, the cost of filter-installation labor, and the number of times new filters will have to be installed, we arrive at a total cumulative filter cost of $405 million.

<u>Head-end upgrades</u>: As explained above, rearranging the mapping of channels to transponders in order to free up spectrum is not an inherently expensive process. To liberate increasing amounts of spectrum, though, satellite operators will ultimately have to move channels from heavily loaded work-horse satellites like Galaxy-17 to their less utilized counterparts at other orbital locations; that way, channels will be spread across more satellites but use less bandwidth. For large MVPDs – "multichannel video programming distributors," industry jargon for pay-TV providers like cable companies and satellite-TV companies – these changes may not make much of a difference, because they already draw programming from so many satellites already.

For smaller, more rural MVPDs, however, the story might be different. Today, these companies tend to receive (and offer to their subscribers) fewer channels and thus make use of fewer satellites. If a high-value channel moves from a transponder on, say, Galaxy-17 at 91°W to one on Galaxy-23 at 121°W, a small MVPD without a receive antenna in place that already points at Galaxy-23 won't be able to get the channel anymore. To prevent this or remedy it, Intelsat and

SES will have to either compensate the small MVPDs for their lost value or supply them with the necessary equipment to receive those relocated channels.

Unfortunately, the precise number of MVPD head-ends operated by small operators or located in small markets is difficult to know. Intelsat has stated "5,000, 6,000 [are] in remote and rural areas" (*source: JP Morgan Global Technology, Media and Communications Conference transcript, May 17, 2018*), but this figure is somewhat at odds with comments from content companies putting the number of all MVPD head-ends at "nearly 5,000." Nevertheless, the big picture is relatively clear: a handful of well known MVPDs operate a minority of powerful head-ends that reach ~96% of the total subscribers, while rural America is served by thousands of less well equipped head-ends operated by many obscure companies. (The American Cable Association claims to represent "nearly 800 small and medium-sized independent operators.")

In our estimate, we assume that 90% of the ~5,000 total head-ends (4,500) are in rural markets and may require new and improved ground equipment to cope with the outcomes of "Tetris." While it seems highly unlikely that every one of these head-ends would be forced to upgrade – recall that, according to SES, "a typical cable head end [already] has 11-15 antennas pointed at different satellites" – we conservatively assume that they would. According to a former satellite-industry executive to whom we spoke, the all-in cost of a new C-band antenna, including other associated ground equipment, is roughly $50,000. However, if small head-ends need to receive channels from *many* more satellites than they currently do, it may be more cost-effective to install an even larger, more sophisticated antenna called a Simulsat, capable of receiving up to 35 satellite signals simultaneously. These structures don't come cheap: their manufacturer indicates that they are "approximately equivalent in cost to three C-Band parabolic antennas." Assuming a 50/50 split between ~$50k conventional antennas and ~$150k Simulsats, we arrive at a conservative estimate of $100k for new equipment at each of the ~4,500 rural head-ends. Such expenditures are unlikely to come into play during the earliest phases of band-clearing, but, because we believe that at least 400 MHz can ultimately be freed up, which will require extensive transponder rearrangement, we must make some allowance for MVPDs that might otherwise be left behind. (Viewed more cynically, small MVPDs likely wield enough political influence that it makes more sense to make them happy with generous support than to stint on equipment and risk their wrath.)

Overall, we estimate total clearing costs of $855 million, to be incurred by the satellite consortium over multiple years. As a sanity check for this figure, consider the following statement from the SIA back in October, when the satellite industry was still stressing the importance of incumbent C-band use rather than supporting market-based reallocation:

> The total investment in C-band earth station antennas is substantial. SIA estimates that considering current cable headends alone, the sunk cost of these facilities represents roughly $135 million.

Our estimate of the total C-band clearing cost is thus more than 6x what SIA believes is the "sunk cost" of all cable headends in the country. This is somewhat analogous to renovating a home using a budget of 6x the home's price – perhaps realistic, but more likely overkill. Relative to the tremendous value of C-band spectrum for flexible terrestrial use, the cost of clearing 400 MHz pales in comparison.

VI. Valuation Summary

Our analysis has focused on the C band because it has become by far the largest factor affecting the value of Intelsat and SES. Of course, both companies also run real businesses, but our assessment of their core operations doesn't differ materially from market consensus. To value SES, we simply use its enterprise value as of February 8, 2018 – one day before it announced that it was joining forces with Intelsat on the US C-band proposal. (In our experience, though, market participants are far less aware of the importance of the C band to SES than they are of its importance to Intelsat, and we doubt that all of SES's appreciation since early February actually stemmed from spectrum speculation.) At that time, SES traded at 8.6x forward EBITDA.

For Intelsat, it's difficult to pinpoint an exact date when a positive outlook on C-band monetization began to creep in, and recent developments in the core business, in particular a reduction in expected near-term capex, make more of a difference. We thus use our own DCF model of Intelsat's unlevered cash flows to calculate its fair enterprise value, excluding C-band upside. Assuming (among other things) a 0% terminal growth rate, 9.5% WACC, and terminal capex of 25% of revenue, we arrive at a valuation of $13.5 billion, which works out to 8x 2018E EBITDA and 11x unlevered free cash flow – unremarkable multiples for this sector. (Note that, in May 2017, the SoftBank-backed satellite startup OneWeb attempted to acquire Intelsat in a complex deal that, by our calculations, implied a $12.6 billion enterprise value for Intelsat – similar to our DCF output. Though the acquisition ultimately fell apart because of bondholder resistance, we regard it as establishing a floor on Intelsat's core business value, especially because the strategic imperatives that drove OneWeb to seek Intelsat as a partner remain pressing.)

From our core business valuations we deduct 50% of the implied value of current C-band operations, using the previously mentioned SIA estimate of $340mm of total revenue across all operators, an assumed 80% incremental EBITDA margin, and an 8x EBITDA multiple. As satellite use of the C band decreases to make way for terrestrial 5G, it's likely that revenue from C-band transponders will fall, at least initially. However, we expect a countervailing trend to also emerge over time: higher prices for C-band capacity. In microeconomic terms, the supply curve of C-band transponders will shift leftward, which will tend to reduce quantity but also increase price; the net effect on revenue is unclear. (Apparently beginning to notice this possibility, a group representing cable operators, content companies, and broadcasters recently began asking the FCC if C-band reallocation proposals would "result in higher prices for C-band users.") Even so, and despite our belief that the vast majority of existing incumbent use can eventually fit into 100 MHz of spectrum, we conservatively assume that profits will be cut in half.

Bringing it all together, we arrive at our three-to-five-year price targets for Intelsat and SES in the table below.

Kerrisdale Valuations of Intelsat and SES

C-band spectrum				
Valuation ($/MHz-pop)	$ 0.50			
Monetized bandwidth (MHz)	400			
Population (mm)	300			
Gross spectrum value ($mm)	$ 60,000			
	Consortium	Intelsat	SES ($)	SES (€)
Share of proceeds (%)	100%	45%	45%	
Share of proceeds ($mm)	$ 60,000	$ 27,000	$ 27,000	
Gross income tax		(5,670)	(5,670)	
Benefit of net DTAs		3,262	-	
After-tax spectrum gain		$ 24,592	$ 21,330	€ 18,278
Clearing costs (after-tax)	$ (675)	(304)	(304)	(260)
Core business value		13,476	12,672	10,858
Impairment of C-band sat. biz	$ (1,088)	(490)	(490)	(420)
Fair enterprise value		$ 37,275	$ 33,208	€ 28,456
Net debt*		(13,364)		(5,103)
Fair market cap		$ 23,910		€ 23,353
Diluted shares O/S*		158		460
Fair value per share		**$ 151**		**€ 51**
% upside		770%		229%

Source: Kerrisdale analysis

**Intelsat net debt and diluted shares are pro forma for the recent capital raise. The diluted share count incorporates the assumed conversion of the convertible notes. We assume the exercise of the underwriters' overallotment options for both the equity and convertible-note issuances.*

Clearly the upside for both stocks is extremely large. In the case of SES, it's not quite as extreme primarily because of SES's more modest financial leverage. As previously mentioned, a 2008 LBO left Intelsat heavily indebted, and satellite-industry headwinds since then have made its financial position even more precarious. Today, however, most of Intelsat's bonds trade at or near par. Based on our discussions with market participants, we believe that credit investors attribute enough value to Intelsat's spectrum to feel comfortable refinancing the company's existing capital structure, buying the company time as it waits for a final FCC order and perhaps even initial clarity on monetization of the first 100 MHz of the C band as early as next year. With so much embedded value likely to be crystallized in the next several years and the nearest-term debt maturities arriving only in October 2020, Intelsat should have the financial flexibility to stay the course until its windfall is in view – at which point its strained balance sheet will finally heal.

We find both risk/reward propositions highly attractive and thus own shares in both companies.

VII. Conclusion

Over the years, there have been many failed and underwhelming efforts to extract value from underutilized spectrum. One common theme uniting these flops is that they were primarily driven from the start by the *incumbents,* looking to profit off of assets that otherwise weren't doing much. No one clamored to gain access to, say, Globalstar's spectrum, nor would many people notice if Globalstar simply winked out of existence. By contrast, mobile operators worldwide have clamored to gain access to the C band, but companies like Intelsat and SES truly are using the spectrum every day to serve as a logistical linchpin of a hundred-billion-dollar industry. They are not struggling to drum up or fabricate interest in some hare-brained scheme; the demand is real, and the scheme makes sense. That's why the C-band process keeps gathering momentum, in stark contrast to situations like LightSquared/Ligado and Globalstar that repeatedly got stuck. Instead of fighting this momentum, Intelsat and SES have successfully channeled it to their benefit. Overcoming the strongly ingrained habit of resisting any policy shake-up and resenting the cellular industry's designs on their spectrum, the satellite operators are building tens of billions of dollars of upside by adopting a simple policy: if you can't beat 'em, join 'em.

Full Legal Disclaimer

As of the publication date of this report, Kerrisdale Capital Management LLC and its affiliates (collectively "Kerrisdale") have long positions in equity and debt securities of Intelsat S.A. (“Intelsat”) and SES S.A. (“SES”). In addition, others that contributed research to this report and others that we have shared our research with (collectively with Kerrisdale, the “Authors”) likewise may have long positions in the securities of Intelsat and SES. The Authors stand to realize gains in the event that the prices of the securities increase. Following publication of the report, the Authors may transact in the securities of the company covered herein, including selling or buying the securities. All content in this report represent the opinions of Kerrisdale. The Authors have obtained all information herein from sources they believe to be accurate and reliable. However, such information is presented “as is,” without warranty of any kind – whether express or implied. The Authors make no representation, express or implied, as to the accuracy, timeliness, or completeness of any such information or with regard to the results obtained from its use. All expressions of opinion are subject to change without notice, and the Authors do not undertake to update or supplement this report or any information contained herein. This report is not a recommendation to purchase the securities of any company, including Intelsat and SES, and is only a discussion of why Kerrisdale is long equity and debt securities of Intelsat and SES.

This document is for informational purposes only and it is not intended as an official confirmation of any transaction. All market prices, data and other information are not warranted as to completeness or accuracy and are subject to change without notice. The information included in this document is based upon selected public market data and reflects prevailing conditions and the Authors’ views as of this date, all of which are accordingly subject to change. The Authors’ opinions and estimates constitute a best efforts judgment and should be regarded as indicative, preliminary and for illustrative purposes only.

Any investment involves substantial risks, including, but not limited to, pricing volatility, inadequate liquidity, and the potential complete loss of principal. This report’s estimated fundamental value only represents a best efforts estimate of the potential fundamental valuation of a specific security, and is not expressed as, or implied as, assessments of the quality of a security, a summary of past performance, or an actionable investment strategy for an investor.

This document does not in any way constitute an offer or solicitation of an offer to buy or sell any investment, security, or commodity discussed herein or of any of the affiliates of the Authors. Also, this document does not in any way constitute an offer or solicitation of an offer to buy or sell any security in any jurisdiction in which such an offer would be unlawful under the securities laws of such jurisdiction. To the best of the Authors’ abilities and beliefs, all information contained herein is accurate and reliable. The Authors reserve the rights for their affiliates, officers, and employees to hold cash or derivative positions in any company discussed in this document at any time. As of the original publication date of this document, investors should assume that the Authors are long equity and debt securities of Intelsat and SES and stand to potentially realize gains in the event that the market valuations of the companies’ securities is higher than prior to the original publication date. These affiliates, officers, and individuals shall have no obligation to inform any investor or viewer of this report about their historical, current, and future trading activities. In addition, the Authors may benefit from any change in the valuation of any other companies, securities, or commodities discussed in this document. Analysts who prepared this report are compensated based upon (among other factors) the overall profitability of the Authors' operations and their affiliates. The compensation structure for the Authors' analysts is generally a derivative of their effectiveness in generating and communicating new investment ideas and the performance of recommended strategies for the Authors. This could represent a potential conflict of interest in the statements and opinions in the Authors' documents.

The information contained in this document may include, or incorporate by reference, forward-looking statements, which would include any statements that are not statements of historical fact. Any or all of the Authors' forward-looking assumptions, expectations, projections, intentions or beliefs about future events may turn out to be wrong. These forward-looking statements can be affected by inaccurate assumptions or by known or unknown risks, uncertainties and other factors, most of which are beyond the Authors' control. Investors should conduct independent due diligence, with assistance from professional financial, legal and tax experts, on all securities, companies, and commodities discussed in this document and develop a stand-alone judgment of the relevant markets prior to making any investment decision.