

# Supporting Mexican digitisation

Effective mobile spectrum management and pricing

24 June 2017

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# 1 Summary and recommendations

In 2016 in Mexico a 404 MHz were assigned for mobile use. The IFT's spectrum roadmap shows that by 2022 a total of 1,007 MHz will be used by mobile operators, i.e. 2.5 times more. Mobile operators invest and use more spectrum to serve the exponential increase in data traffic. While spectrum use and data traffic is increasing rapidly, mobile operator revenue is not increasing. Between 2013 and 2016 mobile revenue declined by 17% whereas mobile data traffic increased 6.7 times.

There are four major problems with the annual spectrum fees "derechos" in Mexico. First, annual fees are very high relative to mobile service revenue. Second, annual fees increase not only with inflation, but also by Congressional discretion, whereas mobile service revenue has not increased. Third, annual fees for regional licences do not reflect population density. Fourth, the fee for high band spectrum is set too high compared to sub-1 GHz spectrum.

Ultimately the cost of spectrum must be reasonable in the context of revenue generated. All costs must be paid for by the users of mobile services. A simple metric to measure the cost of spectrum is to calculate the annualised cost of spectrum as a percentage of mobile industry revenue. In 2016, the cost of spectrum amounted to 12.8% of mobile service revenue which is around twice the level seen in the US and other developed markets.

Mexico is now adding more spectrum for mobile use. The 2500MHz band (130MHz) will be used by mobile operators. The annual fee for 140 MHz of 2500 MHz spectrum amounts to MXN 2,430 million. But in 2016, the entire industry Free Cash Flow was MXN 1,103 million. With these fees, the mobile industry annual cash flow would become a negative MXN 1,327 million.

In 2018, 67.8 MHz of 1900MHz on which currently annual fees are not charged is due for renewal. At the present level of annual fees, this will add MXN 3,148 million to spectrum fees paid by mobile operators resulting in an annual negative mobile industry cash flow of MXN 4,475 million. Clearly, this is not sustainable and the per MHz annual fee for spectrum must be reduced significantly.

After 2018, the IFT plans to assign a further 463 MHz of spectrum to mobile while revenues are not expected to increase or increase only slightly. If the annual spectrum fees are not reduced dramatically, mobile operators will not have a business case to acquire and deploy the spectrum. This would be a severe set-back for Mexico's digitisation objectives and have a negative impact on socio-economic development.

To eliminate the risk of such a negative outcome, we recommend to set the annual spectrum fee as follows:

- Reduce annual fees across all bands,
- set substantially lower fees for high band spectrum,
- keep annual fees constant over time, i.e. do not index with inflation,
- do not increase the reserve price for the up-front fee, and
- rely on competitive bidding in the auction to determine the price of spectrum.

Using this approach has the following benefits:

- More cash will be raised up-front relative to annual fees,
- the risk of unsold spectrum disappears,
- mobile operators can invest more in mobile broadband,
- Mexico achieves its digitisation goals.

## 2 Developing spectrum for mobile use

Wireless communications make use of radio waves which are a scarce resource. Getting the best use out of the scarce resource is one of the key objectives of spectrum management. There are many users and uses of radio spectrum, this paper focuses on mobile use.

To extract mobile communications value from spectrum must be allocated to mobile and brought to use. This is a process which can stretch out over many years. The uses of spectrum within particular frequency bands are agreed globally under auspices of the International Telecommunications Union (ITU). ITU is the United Nations specialized agency for information and communication technologies – ICTs. The global harmonised approach is required to ensure non-interference and secondly to enable economies of scale to materialise as equipment manufacturers build devices which world around the world.

The first step in the process is for spectrum to be allocated for mobile services at the World Radiocommunication Conference, an international meeting that takes place every three to four years. The mobile allocation becomes part of a treaty that governs international interference management. Next, band plans must be specified, often beginning with defining a technical specification through the international 3GPP standard setting body. Once the technical specifications are published, radios and handsets can be produced.

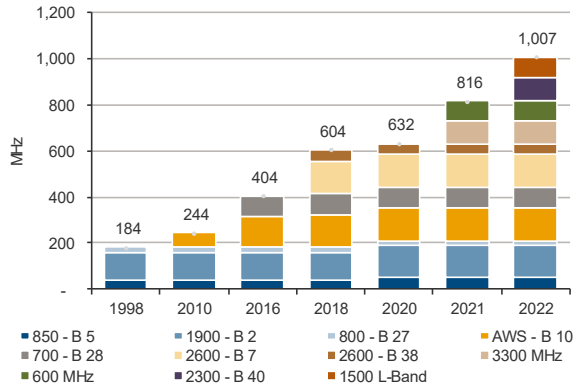
The next step happens at the national level. Governments must assign spectrum to mobile operators that will then invest in building mobile networks. The quicker the assignment process, the faster spectrum can be put to use – then, and only then, can the socio-economic benefit of spectrum be extracted.

The exponential growth in 3G and 4G mobile broadband traffic is driving an increased need for spectrum for mobile services. While new technology enables higher data speeds and allows more traffic to pass through a given amount of spectrum, in cities the mobile broadband traffic density is such that operators cannot deliver good data speeds without access to more spectrum.

Mobile operators seek to ensure a good user experience in urban environments with high traffic volumes per square kilometre. The most demanding and high-spending users will migrate to the operator which has the least congested network and hence offers the best user experience. Spectrum is a key ingredient in delivering the LTE capacity required to keep data traffic moving in a high traffic density environment.

Globally, including in Mexico, the amount of spectrum and number of bands for mobile are growing. The IFT has published a spectrum roadmap for Mexico (IMT en Mexico, IFT, Febrero 2017). In the short term the 2500MHz band will add a substantial 190 MHz to spectrum used by mobile operators in Mexico. IFT plans to assign a further 603 MHz to mobile by 2022, bringing the total spectrum used by mobile to 1,007 MHz, i.e. a 2.5 times increase.

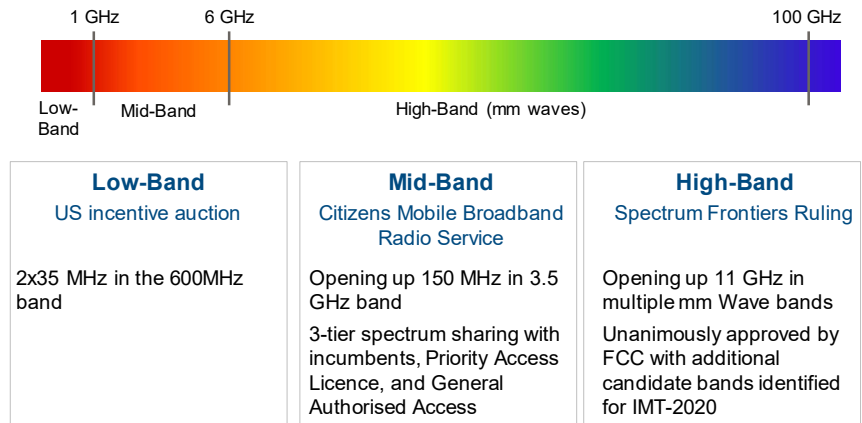
Exhibit 1: Spectrum used by mobile in Mexico



Source: IMT en Mexico, IFT, Febrero 2017

The next mobile standard, 5G, will become a commercial reality in 2020. The requirements for 5G enhanced mobile broadband (eMBB) drive the need for spectrum from 3 GHz to 80 GHz. In the Americas, the FCC is driving key spectrum initiatives to enable 5G.

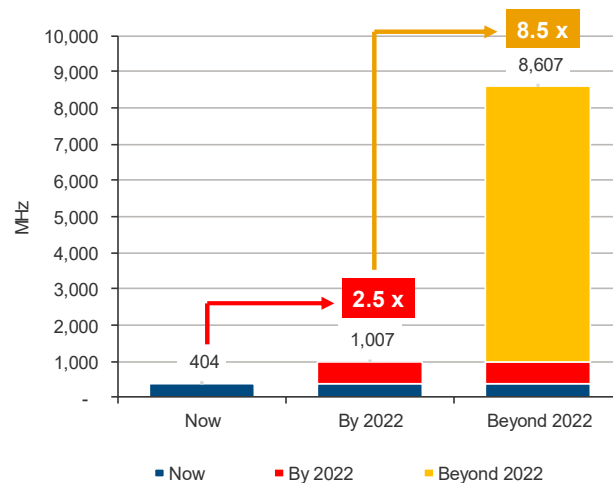
Exhibit 2: The FCC is driving key spectrum initiatives to enable 5G in the Americas



Source: Coleago Consulting

Over time Mexico will follow the global trend. This means beyond 2022 the assignments of high bands, including mm wave spectrum, will increase the amount of spectrum used from 1,007 MHz to around 8,607 MHz, an 8.5 times increase in the amount of spectrum used to deliver 4G and 5G mobile broadband in Mexico.

Exhibit 3: Mobile spectrum - MHz



Source: Coleago Consulting

### 3 How do mobile operators value spectrum?

Spectrum has no intrinsic value, value is only created through the use of spectrum. Spectrum which is unused has no value. If operators invest and build networks which are used, consumer value is created. However, the investment only takes place if producer value is created, i.e. there has to be a return on investment. The return on investment needs to be at least as high as that in an alternative investment of similar risk.

The value of spectrum to an operator is the net present value of incremental cash flows that can be generated from the spectrum. Initially mobile operators experience negative cash flows due to the investment required:

- Amount paid for the acquisition of spectrum
- Deployment of technology in the new spectrum

Subsequent ongoing negative cash flows include:

- Annual spectrum licence fees
- Additional network operating costs

Subsequent positive cash flows consists of:

- Additional revenue
- Cost savings

Operators calculate the value of spectrum using Discounted Cash Flow analysis which produces the Net Present Value for two separate business cases – one where the business acquires spectrum and another where the business does not acquire spectrum. The difference in the value of the business with and without the spectrum is the maximum that the business would be prepared to pay for the spectrum.

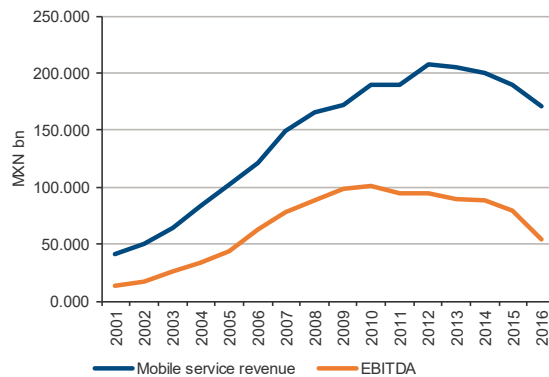
Additional spectrum adds to operators' costs. Some regulators wrongly assume that spectrum, particularly low band spectrum, saves money. As explained above, there is substantial capital expenditure associated with the deployment of new spectrum:

- Radios and antennae have to installed
- Additional backhaul capacity needs to be added
- However, it is less costly to increase capacity by adding spectrum rather than building more cell towers.

Additional costs would not matter if mobile operator revenue kept growing. However, this is not the case. The growth in data traffic far outpaces growth in revenue; there is little incremental revenue from data. Revenue growth - if any - is minimal compared to the growth in data volume. The notion that investment in LTE generates much additional revenue is erroneous.

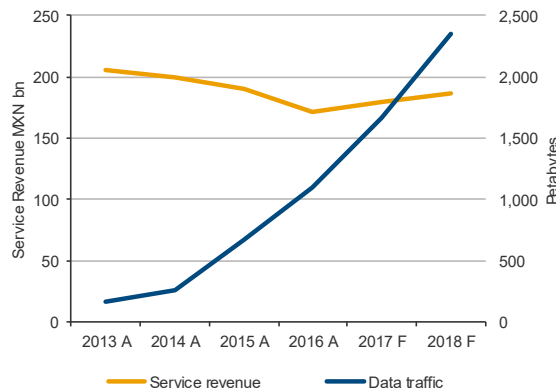
As shown in Exhibit 4, In Mexico mobile service revenue and EBITDA have declined and prospects for growth are slim. Mexico is no exception when looking at traffic growth, mobile data traffic growth far outpaces revenue growth. Exhibit 5 shows that between 2013 and 2016 mobile service revenue declined by 17% whereas mobile data traffic increased 6.7 times.

Exhibit 4: Mobile revenue and EBITDA, Mexico



Source: Bank of America Merrill Lynch Global Wireless Matrix

Exhibit 5: Mobile service revenue and traffic in Mexico

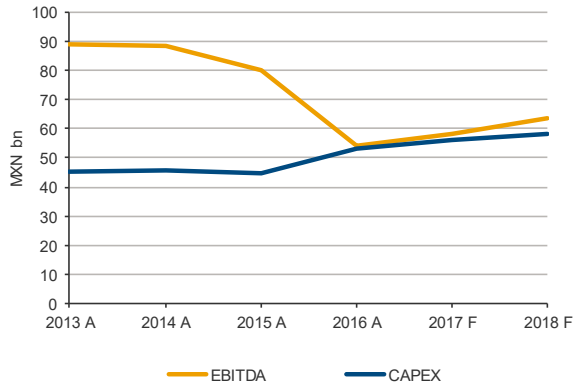


Source: Coleago Consulting

While mobile industry margins in Mexico are declining capital expenditure (CAPEX) is increasing. As a result the mobile industry is no longer generating any cash flow (EBITDA minus CAPEX) to pay investors, see Exhibit 6 and Exhibit 7.

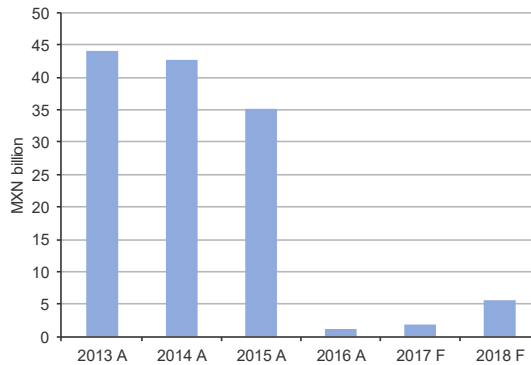


Exhibit 6: EBITDA and CAPEX in Mexico



Source: Bank of America Merrill Lynch Global Wireless Matrix

Exhibit 7: Cash Flow in Mexico



Source: Coleago Consulting

As we explained above, there are unlikely to be much additional revenues whereas costs will increase. Nevertheless operators around the world are investing in spectrum and LTE deployment.

The business case for investment in mobile broadband is driven by preventing losing revenue market share. Operators that deliver a relatively better mobile broadband experience could attract high ARPU smartphone users. Innovation, such as investment in new spectrum and deployment of LTE is driven by competition. If an operator expects that a competitor will move on to the next technology investment cycle, they will follow in order to stay competitive. The business case is not driven by additional revenue generation but by preventing the loss of revenue. Investment by all operators maintains the competitive equilibrium, but does not generate additional cash flows.

5G Enhanced Mobile Broadband (eMBB) is likely deliver some additional revenue, but not much. eMBB will deliver what people do today with their smartphones, only better:

- Larger data volumes
- Greater speeds

- Lower latency for gaming and similar applications
- Consistent user experience outdoors and indoors

Moving from 4G to 5G is similar to moving from 2G to 3G to 4G. Consumers and businesses may pay a little bit more, say, 10%, but not massively more. However in Mexico the amount of spectrum used to deliver the service will increase by 2.5 times to 2022 and a further 8.5x beyond 2022. The increase in spectrum used is will be around 20 times greater than the increase in mobile operator revenue.

The business case for IoT / M2M is highly uncertain. Evidence from France shows that while M2M SIMs have increased to 14% of all SIMs, revenue account for less than 1% of total revenue. The same evidence from France also shows that while the number of M2M SIMs is growing, M2M revenue growth has stalled.

Pricing spectrum must take account of the economics of the mobile industry; the starting point is how much users will pay. The cost spectrum to operators cannot increase faster than revenue or the business case becomes unsustainable.

## 4 Setting prices for spectrum

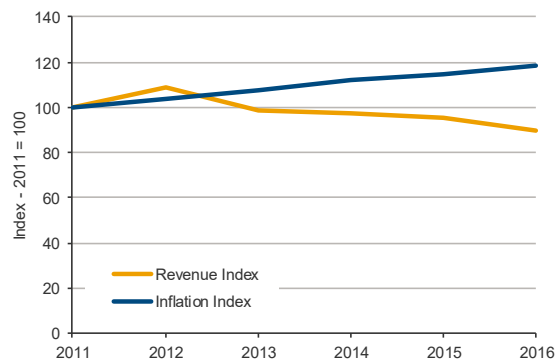
In Mexico the cost of spectrum to mobile operators consists for spectrum licensees comprise two parts:

- An upfront auction fee “guante”
- Annual fee per MHz “derechos”

The annual fees are stipulated in the “Ley Federal de Derechos” (LFD), CAPITULO XI, Espacio Aéreo. The fees for the 800MHz, 850MHz, 1900MHz and AWS band are the same. The fees for 700MHz is 90% lower and 2500MHz is 59% lower. Mexico is unusual in that the annual spectrum are very high relative to mobile service revenue compared to the vast majority of other countries.

Furthermore, the annual fee increases based on inflation (Índice Nacional de Precios al Consumidor) and Congressional discretion. Due to indexing with inflation, the annual spectrum fees per MHz are increasing relative to revenue. For the annual fee to remain a constant % of revenue, revenue must increase at least in line with inflation. This has not been the case for the past few years.

Exhibit 8: Ingresos vs. inflación



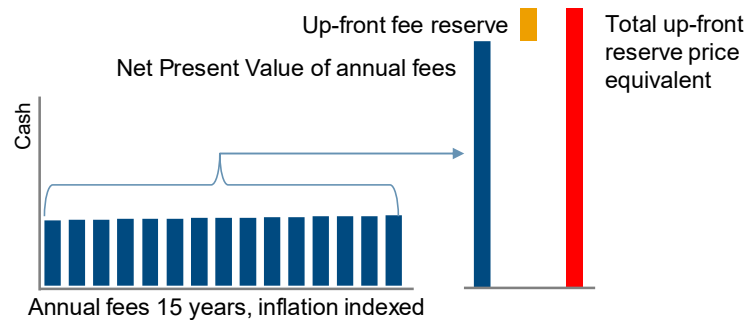
Source: Coleago Consulting

Aside from the amount of annual fee, there are problems setting annual fees the way is done in Mexico.

- There is uncertainty over the change in annual fees in future years. This uncertainty can be eliminated if the annual fee remain constant over the term or alternatively if there is no (or only a small administrative) annual fee and only an up-front fee.
- The annual fees for regional licences are calculated on a per capita basis, which does not take account of population density. The solution would be to substantially reduce the annual fees and allow regional differences in spectrum value to be determined by competitive bidding.
- The fee for high band spectrum is too high compared to sub-1 GHz spectrum. It is necessary to substantially reduce the fees for high band spectrum (1900MHz, AWS, 2500MHz, etc) compared to 850MHz.

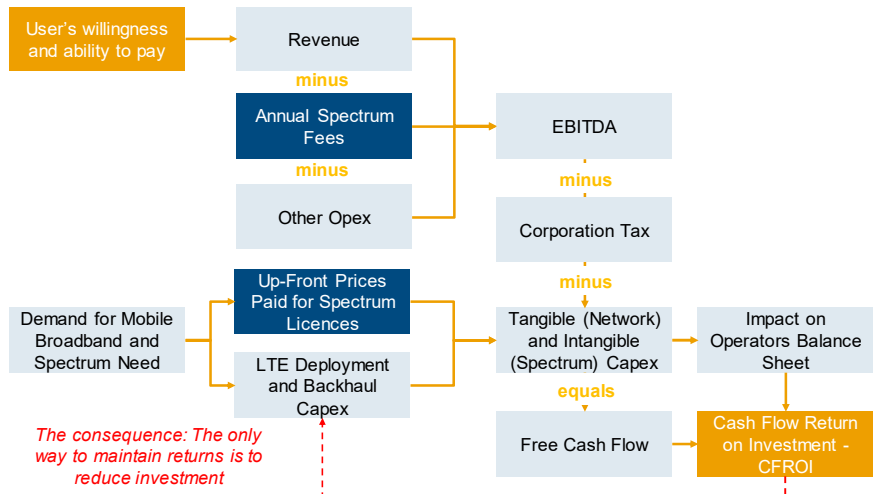
When an operator acquires spectrum at auction and deploys the spectrum, the operator is committed to paying the annual fees during the term of the licence. This means that the Net Present Value (NPV) of the annual fees for spectrum plus the upfront reserve constitute the total reserve price for spectrum in Mexico.

Exhibit 9: The reserve price = Up-front price + annual spectrum fees



Source: Coleago Consulting

Exhibit 10: The cost of spectrum must take account of the financial reality of mobile network operators



Source: Coleago Consulting

The biggest problem in Mexico is the size of the annual spectrum fee relative to the value of spectrum to operators. There is an aspect to be considered:

- Spectrum fees must make sense in the context of the economics of the mobile industry so as not to run the risk of unsold spectrum.

Let's focus on the first aspect and examine whether spectrum fees make sense in the context of the revenue generated by mobile operators in Mexico. We do this by investigating whether annual spectrum fees in Mexico make sense in the context of the economics of the mobile industry.

Ultimately the cost of spectrum must be reasonable in the context of revenue generated. All costs, including the cost of capital – i.e. returns to investors - must be paid for by the users of mobile services. A simple metric to measure the cost of spectrum to mobile operators is to calculate the annualised cost of spectrum as a percentage of mobile industry revenue. An annuity calculation formula to convert up-front spectrum fees into an annualised cost of spectrum. We then add the annual spectrum fees to obtain the annualised cost of spectrum.

#### Exhibit 11: Annualisation formula

##### **The annuity calculation formula to convert up-front spectrum fees into an annualised cost of spectrum**

Annualised cost =

cost of capital / (1 - (1 / (1 + cost of capital)) ^ years of licence)

Source: Coleago Consulting

In Mexico, currently 404 MHz of spectrum is assigned to mobile. Operators paid around MXN 70,302 million in up-front fees for this spectrum. The annualised equivalent of this is MXN 11,271 million. Annual spectrum fees amount to MXN 10,524 million. Therefore the total annual cost of spectrum is MXN 21,794 million. In 2016, mobile industry service revenue amounted to MXN 169,971 as shown in Exhibit 12.

Exhibit 12: Cost of spectrum as a percentage of revenue

Band Name	Band #	MHz Sold	Price Paid MXN mn	Licence Duration Years	Annual Fee per		Annual Fee MXN million
					MHz	MXN mn	
850	5	42	10,642	15	42.3		1,778
800	27	22	440	15	42.3		931
1900	2	120	10,271	20	42.3		1,932
700	28	90	0	20	4.2		378
AWS	10	130	48,948	15	42.3		5,504
-				15			
-				15			
-				15			
-				15			
-				15			
-				15			
<b>Total</b>		<b>404</b>	<b>70,302</b>	<b>16</b>	<b>33.8</b>		<b>10,524</b>

1900MHz spectrum up for renewal in 2018 currently has no annual fee

Annual licence fee payments for all spectrum

Amount paid up-front by all operators for all spectrum licences currently in force

Up-front spectrum licence fee paid	MXN million	70,302
Cost of Capital (WACC)	%	14.0%
Average licence duration	years	16
Annualised up-front cost of spectrum	MXN million	11,271
Amount of spectrum used	MHz	274
Total annual spectrum fees	MXN million	10,524
Total annualised and annual cost of spectrum	MXN million	21,794
Annual industry service revenue	MXN million	169,971
Spectrum cost % of revenue	%	12.8%

Source: Coleago Consulting

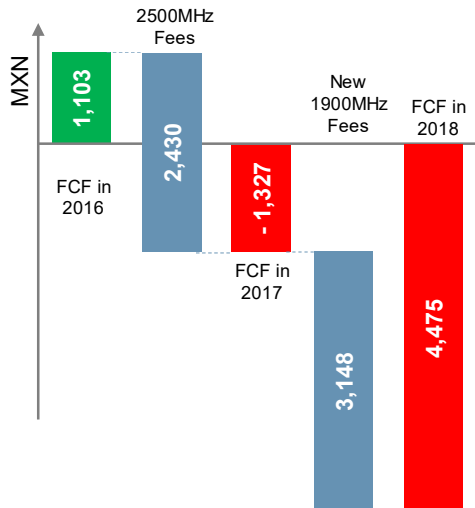
The cost of spectrum amounts to 12.8% of industry revenue. This is high compared for example to the USA, where it is less than 8% but with much more spectrum is used by the industry. The calculation can be made for other countries, for example in Germany the cost of spectrum is estimated at 6.1% of mobile industry revenue.

2017 IFT plans to auction 2500MHz spectrum (some spectrum has already been acquired in the secondary market) and we can see that the annual fees for the 2500MHz spectrum are too high relative to mobile industry cash flow. The annual licence fee for 2500MHz spectrum is MXN 17.4 million per MHz. The annual fee for 140 MHz amounts to MXN 2,430 million. In 2016 the entire mobile industry Cash Flow in Mexico was MXN 1,103 million. Simple maths show that the additional spectrum fees would reduce the annual cash flow to a negative 1,327 million. And this is before we take account of the fact that operators have to deploy new LTE radios @ MXN 0.5 million per unit resulting in significant incremental CAPEX.

In 2018, 67.8 MHz of 1900MHz on which currently annual fees are not charged is due for renewal. The annual licence fee for 1900MHz spectrum is MXN 42.3 million per MHz nationally. If this fee is applied, at national level the annual spectrum fee for the 67.8 MHz to be renewed will amount to MXN 3,148 million. This additional spectrum cost would result in an annual negative mobile industry cash flow of MXN 4,475 million.

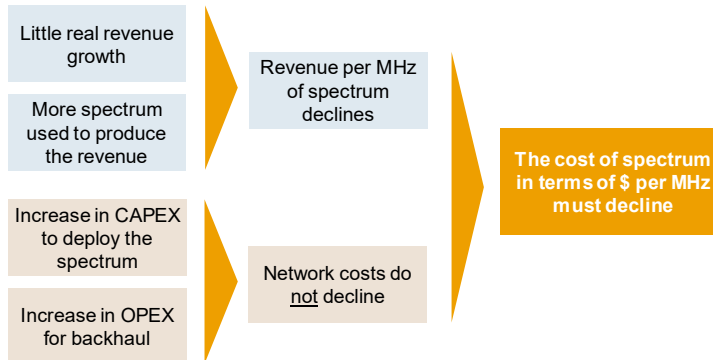
Clearly charging the additional spectrum fees for 2500MHz and 1900MHz spectrum is not sustainable. The government must align its expectations of revenue from spectrum sales with the economic reality of the mobile business. The cost of spectrum in terms of MXN per MHz must decline substantially.

Exhibit 13: Impact of derechos for 2500MHz and 1900MHz spectrum



Source: Coleago Consulting

Exhibit 14: Implications for setting spectrum fees



Source: Coleago Consulting

## 5 An increased risk of spectrum auction failure

For operators the risk of paying too much for spectrum is compounded by the investment for 5G and uncertain revenue growth. Spectrum accounts for an ever larger proportion of operator costs. Furthermore, while new network investment is required for 5G the business case for 5G and IoT is highly uncertain, i.e. the risk to investors is increasing.

The risk to investors translates into a risk to the Mexican Government: Spectrum auctions may fail to achieve their objectives. The higher the annual licence fees the higher the risk of auction failure. A failed spectrum auction will impact negatively on Mexico’s digitisation objectives.

The societal value of assigning spectrum to operators should be taken into account when determining spectrum pricing. The return to the community from spectrum auctions goes well beyond any direct payment made to government for spectrum. Implicitly all governments recognise the trade-off between spectrum fees and wider

goals. Otherwise they would simply auction off monopolies which would undoubtedly bring the highest direct receipts.

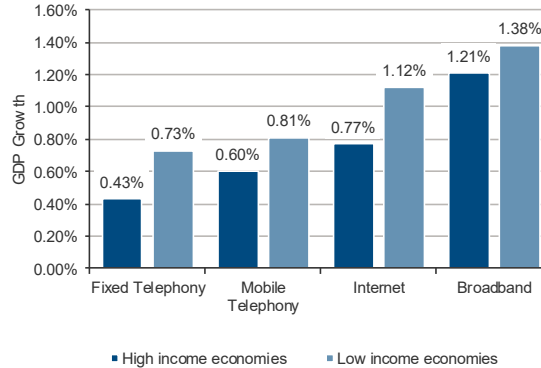
Policy objectives for the assignment of mobile spectrum are wider than maximising revenue from the sale of spectrum:

- Promote the highest value use of spectrum
- Ensure spectrum is deployed rapidly and widely and the maximum spectral efficiency is extracted
- Promote investment and innovation
- Promote rural broadband access and increase digital participation rates
- Promote competition
- Promote customer convenience
- Provide a high net economic return to the public

Mobile broadband is a key ingredient for the development of the digital economy:

- A 10% increase in broadband penetration leads on average to an additional GDP growth of by 0.81% overall, and 1.4% in low income economies (World Bank, 2009).
- For a given level of total mobile penetration, a 10% substitution from 2G to 3G increases GDP per capita growth by 0.15 % points (Deloitte, 2012)
- Doubling broadband speeds for an economy can add 0.3% to GDP growth (Arthur D. Little, 2011)

Exhibit 15: GDP increase resulting from a 10% increase in service penetration



Source: World Bank

There are tangible benefits to society which illustrate the impact of mobile data:

- A 12% increase in financial inclusion in countries such as India and Bangladesh
- Healthcare: up to 70% improved compliance for TB
- 10-15% increase in farmer income
- mEducation solutions can improve the affordability of education by up to 65%

In their excellent research paper, “What Really Matters in Spectrum Allocation Design”, (2010) Hazlett and Munoz found that setting high prices for spectrum is problematic and is inconsistent with development policy objectives.

*“[T]he ratio of social gains [is of] the order of 240-to-1 in favour of services over licence revenues...Delicate adjustments that seek to juice auction receipts but which also alter*

*competitive forces in wireless operating markets are inherently risky. A policy that has an enormous impact in increasing licence revenues need impose only tiny proportional costs in output markets to undermine its social utility. ... In short, to maximise consumer welfare, spectrum allocation should avoid being distracted by side issues like government licence revenues.”*

If annual spectrum fees in Mexico are not reduced substantially, Mexico runs the risk of operators not acquiring the spectrum necessary to deliver Mexico's digitisation goals. The loss of socio-economic benefits would far outweigh lower receipts for annual spectrum fees.

## 6 Conclusions and recommendations

Mexico has taken a step in the right direction in setting prices for future spectrum awards. The annual fees for 2500MHz spectrum are 59% lower than for 850MHz, 1900MHz and AWS spectrum. But this adjustment is insufficient for several reasons:

- the cost of spectrum as a percentage of revenue is already high,
- the annual fee increases with inflation and Congressional discretion,
- in addition to 130 MHz of 2500MHz FDD spectrum a further 463 MHz needs to be assigned by 2022, and
- operators have to make large investments to deploy the spectrum.

The solution is to set the annual fee as follows:

- Reduce annual fees across all bands,
- set substantially lower fees for high band spectrum,
- keep annual fees constant over time, i.e. do not index with inflation,
- do not increase the reserve price for the up-front fee, and
- rely on competitive bidding in the auction to determine the price of spectrum.

Using this approach has the following benefits:

- More cash will be raised up-front relative to annual fees,
- the risk of unsold spectrum disappears,
- mobile operators can invest more in mobile broadband,
- Mexico achieves its digitisation goals.

If these recommendations are implemented a potential scenario after in 2022 with 1,007 MHz assigned to the mobile industry, but with lower annual fees is shown:

- A reduction in the annual fees across all bands, including the 850MHz band
- Lower annual fees for future spectrum bands
- Competitive bidding will determine the up-front fee for new spectrum

With these changes the cost of spectrum would still be at 12.8% of industry revenue as is the case to today, and could be higher due to competitive bidding.



Exhibit 16: A potential scenario after in 2022, with 1,007 MHz assigned to the mobile industry, but with lower annual fees

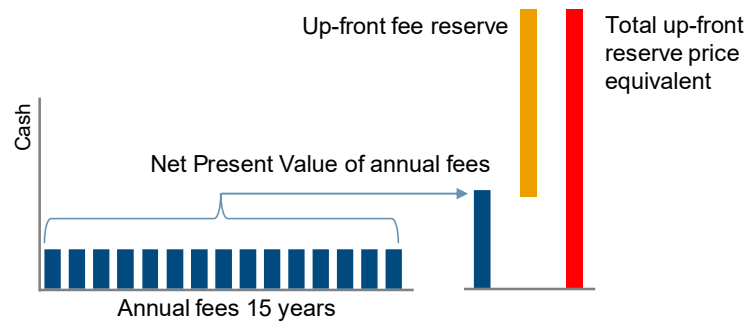
Band Name	Band #	MHz Sold	Price Paid MXN mn	Licence Duration Years	Annual Fee per		Annual Fee MXN million
					MHz	MXN mn	
850	5	50	12,669	15	21.2	1,058	A reduction in the annual fees
800	27	22	440	15	21.2	466	
1900	2	140	11,983	20	8.5	1,185	Lower annual fees for future spectrum
700	28	90	0	20	4.2	378	
AWS	10	140	48,948	15	10.6	1,482	Annual licence fee payments for all spectrum
2500	7	140	15,876	15	5.3	741	
2500	38	50	15,876	15	5.3	265	Competitive bidding will determine the up-front fee
3300		100	794	15	0.3	26	
600		84	3,175	15	1.1	89	Annual licence fee payments for all spectrum
1500	L	91	3,175	15	1.1	96	
2300	40	100	3,175	15	1.1	106	Annual licence fee payments for all spectrum
<b>Total</b>		<b>1,007</b>	<b>116,113</b>	<b>16</b>	<b>5.9</b>	<b>5,893</b>	

**Annualised cost of spectrum**

Up-front spectrum licence fee paid	MXN million	116,113
Cost of Capital (WACC)	%	14.0%
Average licence duration	years	16
Annualised cost of spectrum	MXN million	18,660
Spectrum used	MHz	1,007
Total annual fees	MXN million	5,893
Grand total	MHz	24,553
Annual industry service revenue	MXN million	192,307
Spectrum cost % of revenue	%	12.8%

Source: Coleago Consulting

Exhibit 17: With lower annual fees the price of spectrum will be determined by the market



Source: Coleago Consulting