



5G spectrum pricing, make or break the 5G momentum?

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Policy makers in all countries are keen to develop mobile broadband and 5G



5G



There is an international race to become a leader in 5G; policy makers have launched initiatives towards that goal.

- *“5G will enable industrial transformation through wireless broadband services provided at Gigabit speeds”*

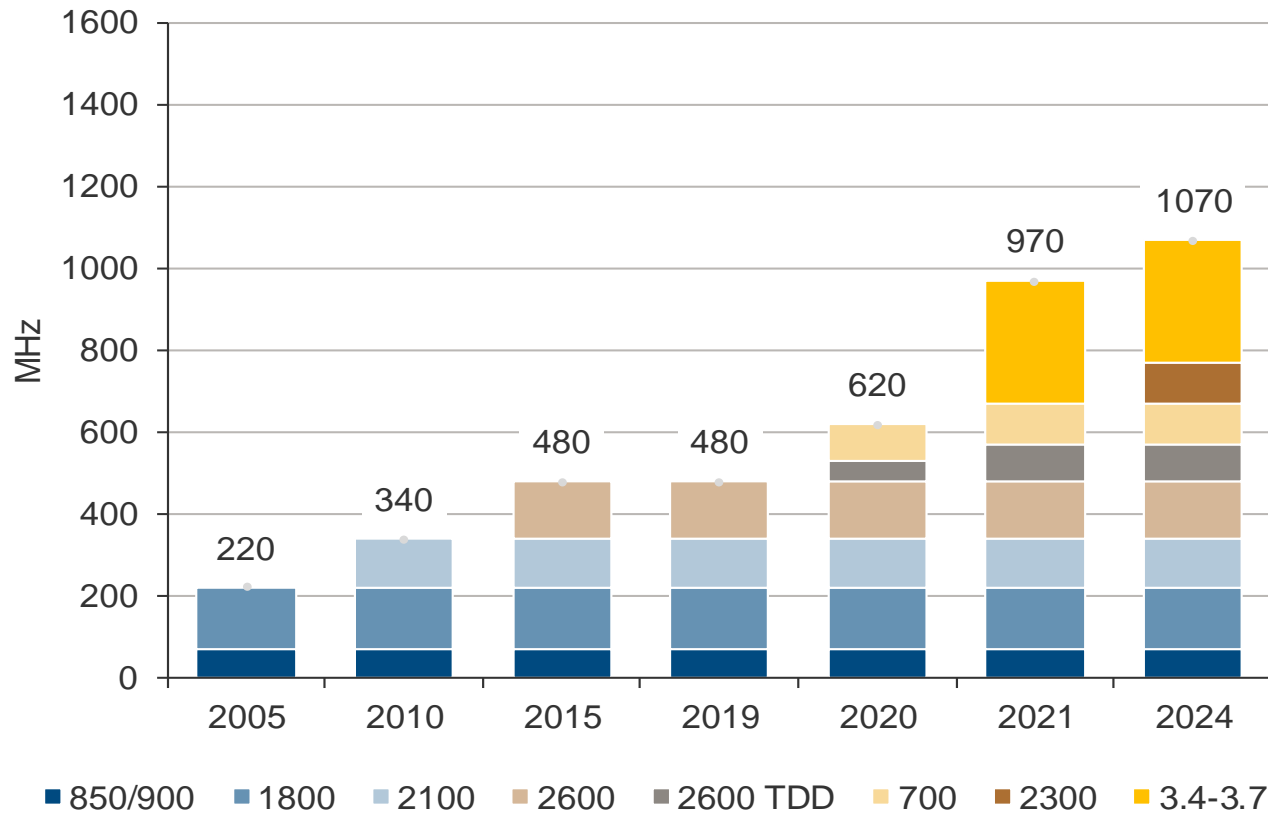
European Commission

In emerging markets a link is made between 5G and national development goals:

- *“We have missed three industrial revolutions, Bangladesh should be established as a leading country in the fourth industrial revolution. The whole world will enter into the era of 5G in 2020. The country will not be allowed to stay behind from this.”* (Bangladeshi Telecoms and IT minister Mustafa Jabbar, Speech at Junior Chamber International, 19 May 2018)

The introduction of 5G is inseparable from making large amounts of new spectrum available for mobile

Spectrum used by mobile in a typical Asian country



- A typical Region 3 country has 480MHz assigned to mobile.
- Over the next 5 years the amount used by mobile operators will more than double.
- The most important band in the context of deploying 5G is the C-Band (3.3-4.2GHz) and there are already 3GPP standardised radios and terminals available.
- Depending on the country 400MHz may be assigned to mobile operators.
- This excludes mm wave spectrum



In order to deliver 5G, mobile operators must have access more spectrum of all types of spectrum

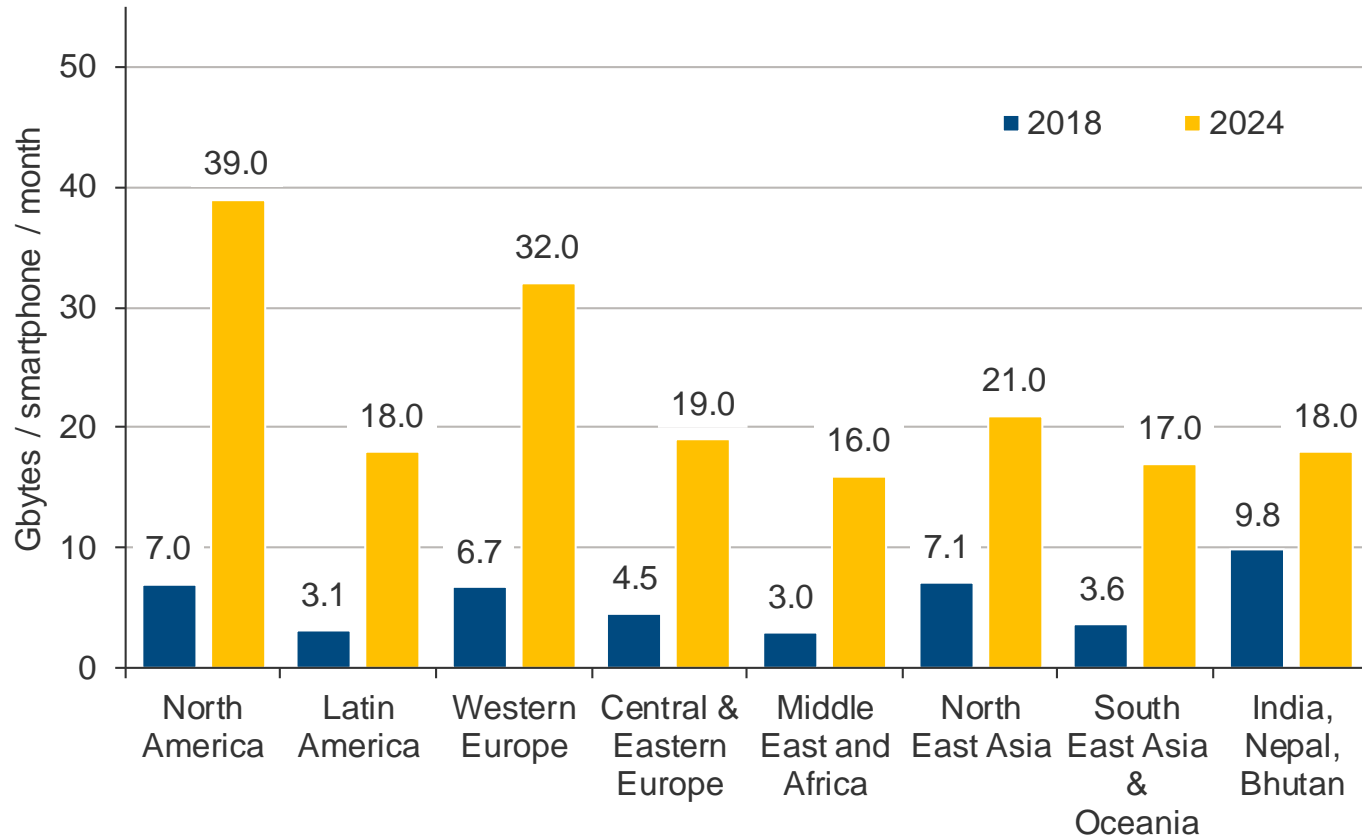
- 5G will be introduced in low (sub-1 GHz), mid (1 to 6GHz) and high frequency (24GHz and above) bands.
- Other bands are already in use for mobile but in time will be refarmed to 5G.

Type of spectrum	Coverage width	User throughput	Latency	Mobility	System capacity
Sub-1 GHz	***	*	*	***	*
Mid band: 1.5 – 5.0 GHz	**	**	**	**	**
High band: 24 – 40 GHz	*	***	***	*	***

Source: Ericsson

Per smartphone traffic is forecast to grow 3 to 6 fold between 2018 and 2024

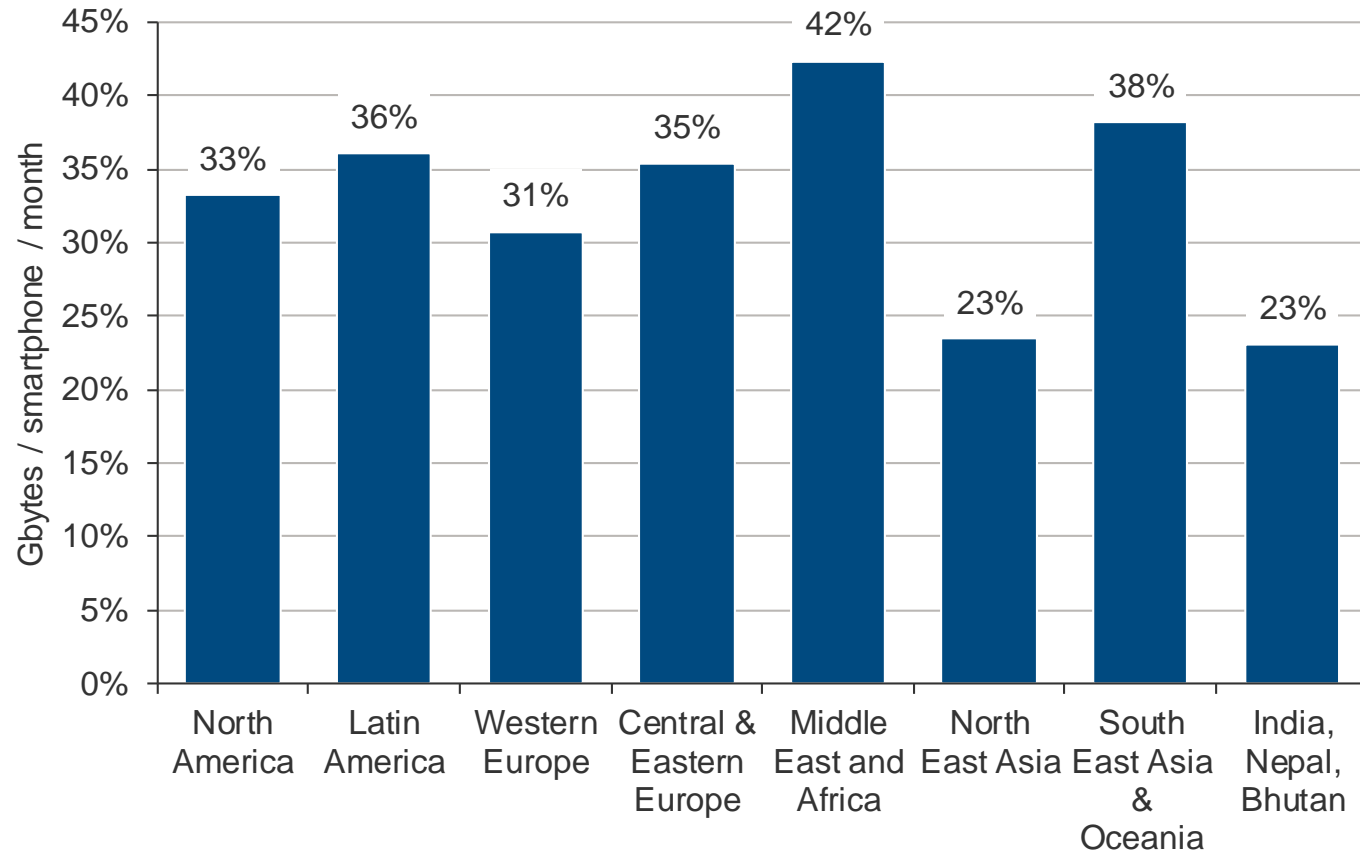
Monthly data traffic per smartphone



- Part of this traffic increase is due to the adoption of 5G but usage for 4G smartphones is also increasing.
- Per smartphone traffic will grow 3 to 6 fold between 2018 and 2024.

To cater for mobile broadband traffic, mobile operators are continuing to invest large sums in 4G and 5G radio access networks and backhaul infrastructure

Total mobile data traffic compound annual growth rate 2018-2024



- Mobile broadband traffic grew close to 88% between Q4 2017 and Q4 2018.
- This is made possible because between 2018 and 2020 mobile network operators world-wide are investing US\$ 480 billion in their 4G and 5G networks, i.e. around US\$ 160 billion per year.
- During the next 6 years traffic the CAGR estimated 23% to 42%.



Mobile operator revenues are declining in many markets and in markets where there is some growth, this tends to be below inflation

*Globally, average mobile service revenue contracted 1.0% from a year ago as Emerging Markets and Developed Markets service revenue both declined. Revenue in developed markets declined -1.3% overall, with **Asia-Pacific down 1.9%**, Developed EMEA down 1.9% and North America down 0.7%.*

*Emerging markets service revenue declined 0.7% in 4Q18 vs. last year's growth of 3.1% with **Emerging Asia declining 2.5%**, Emerging EMEA growing +3.0%, and Latin America expanding +1.6%. Bank of America Merrill Lynch, Global Wireless Matrix, 30 April 2019*

- Looking back over 10 years, in most markets there have been only small increases in mobile revenue and in some markets, revenues declined driven by competition.
 - India is an extreme example of this where revenues declined by 14% in 2017.
- History shows us that the introduction of 4G (LTE) did not increase mobile operator revenue materially and in some cases revenues declined.

Mobile data traffic increase by 23 to 42% CAGR and revenue may be flat or increase only by 1-2%

The consumer is the winner!

**Traffic
Increase**

23% to 42%

**Revenue
Increase**

0% to 2%



CAGR = Compound Annual Growth Rate

Prices for 5G packages are not higher than for 4G and also offer larger data volumes and faster download speeds

- In April 2019, mobile operators in Korea announced tariffs for 5G mobile. Depending on the tariff plan, in some instances **5G plans are cheaper than 4G plans**.
- **5G data prices are lower**. In early 2019 AT&T in the USA announced a 5G plan at rate of US\$ 4.67 per GB compared to US\$ 5 per GB for 4G.

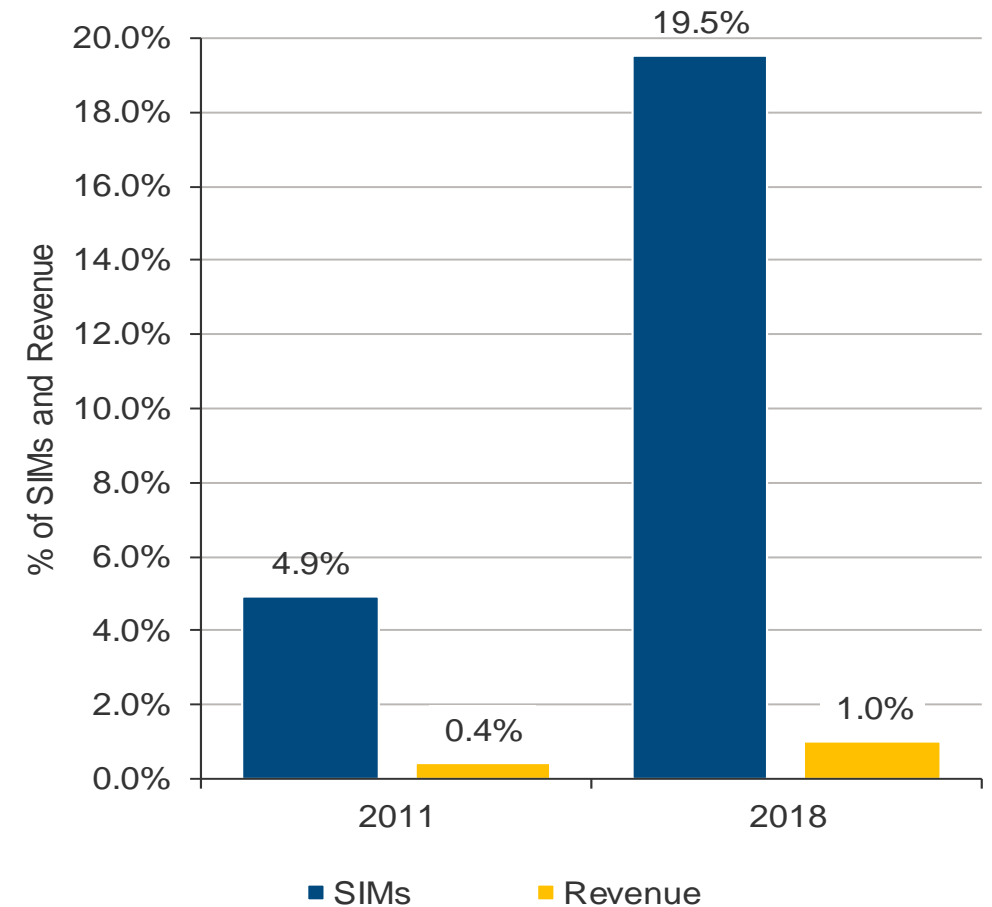
LG U+	5G			4G		
	Tariff KRW	Data pack	Limit after out of pack	Tariff KRW	Data pack	Limit after out of pack
Entrance	55,000	9GB	1Mbps	55,900	6.6GB	3Mbps
Middle	75,000	150GB	5Mbps	74,800	16GB	3Mbps
High	85,000	Unlimited	Unlimited	88,000	30GB	3Mbps
Premium	95,000	Unlimited	Unlimited	110,000	40GB	3Mbps

IoT may add some revenue but additional investment is required for IoT optimised networks such as LTE-M and NB-IoT

The IoT market is projected to grow significantly, but less than 20% will accrue to mobile operators

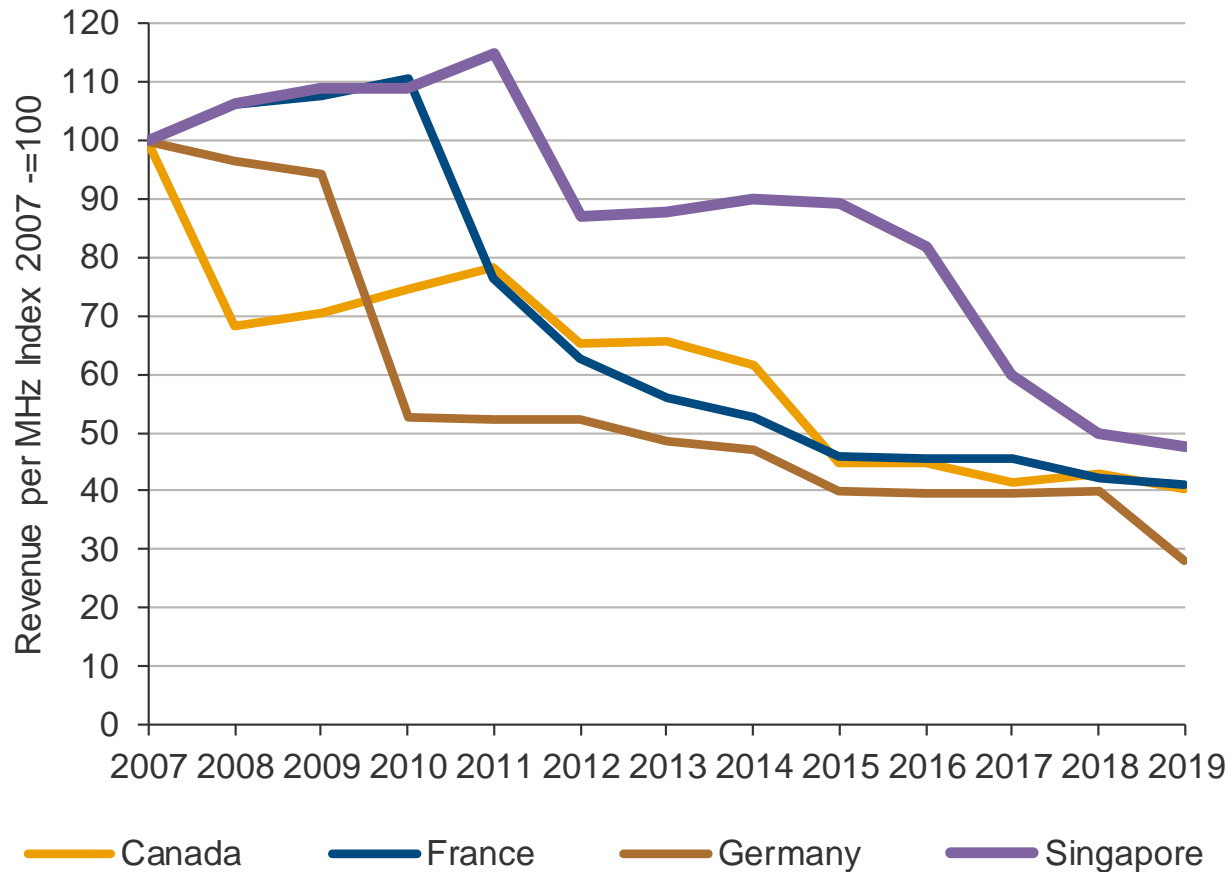
- Historically % of IoT SIMs increase rapidly but IoT revenue increased minimally.
- More than 80% of the IoT market is applications, platforms and services, and professional services.
- Connectivity, i.e. mobile data, accounts for only a small part of the IoT revenue stack. This small connectivity revenue slice will increase mobile operator service revenue only very slightly.

IoT SIMs and Revenue % of total SIMs and Revenue in France



Mobile operator revenue per MHz of spectrum has declined and will decline more rapidly when additional spectrum for 5G is added

Mobile industry revenue per MHz of spectrum deployed



Incremental spectrum does not generate incremental revenue

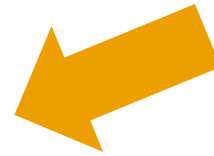
- Revenue per MHz has declined between 2007 and 2019:
 - Canada - 60% decline
 - France - 59% decline
 - Germany - 60% decline
 - Singapore - 52% decline
- With additional spectrum for 5G, the decline will accelerate.
- While additional spectrum may produce some cost savings, the effect is relatively small because mobile data traffic increases rapidly.

The return on investment in mobile operating companies has declined

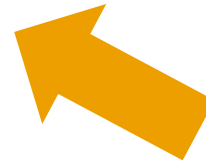
Return on
Investment

=

$$\frac{\text{Profit}}{\text{Capital Employed}}$$

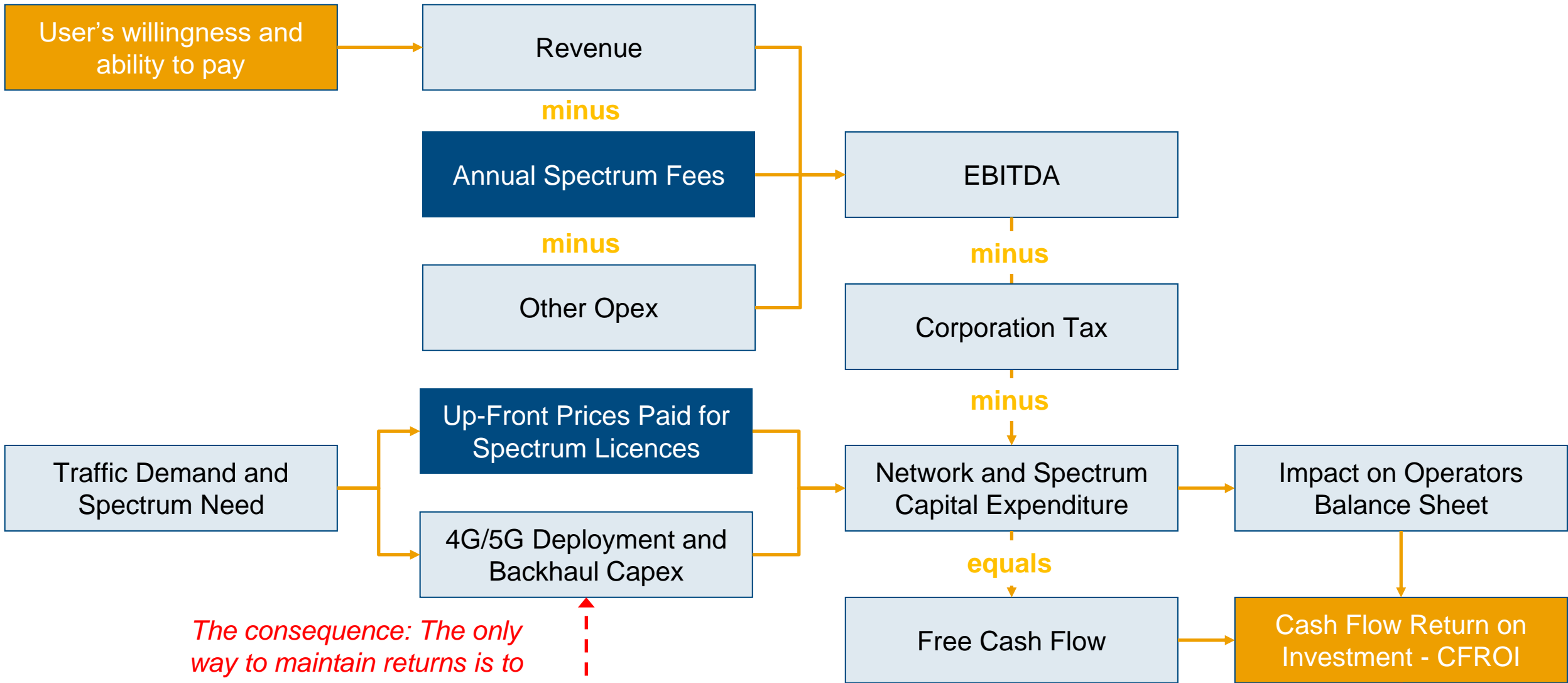


Mobile operator profit margins have declined in virtually all markets



Network investment and spectrum investment is increasing

Per MHz spectrum licence fees must decline or 5G deployment will be reduced or delayed



The consequence: The only way to maintain returns is to reduce investment

When new spectrum is assigned in a country or existing spectrum licences are renewed, the question arises of how to price the spectrum


- If there is a spectrum auction, regulators need to set the reserve price, i.e. the minimum price or opening bids.
- If spectrum is assigned administratively or licences are indefinite, then regulators have to set the price without the benefit of a market based mechanism such as an auction.





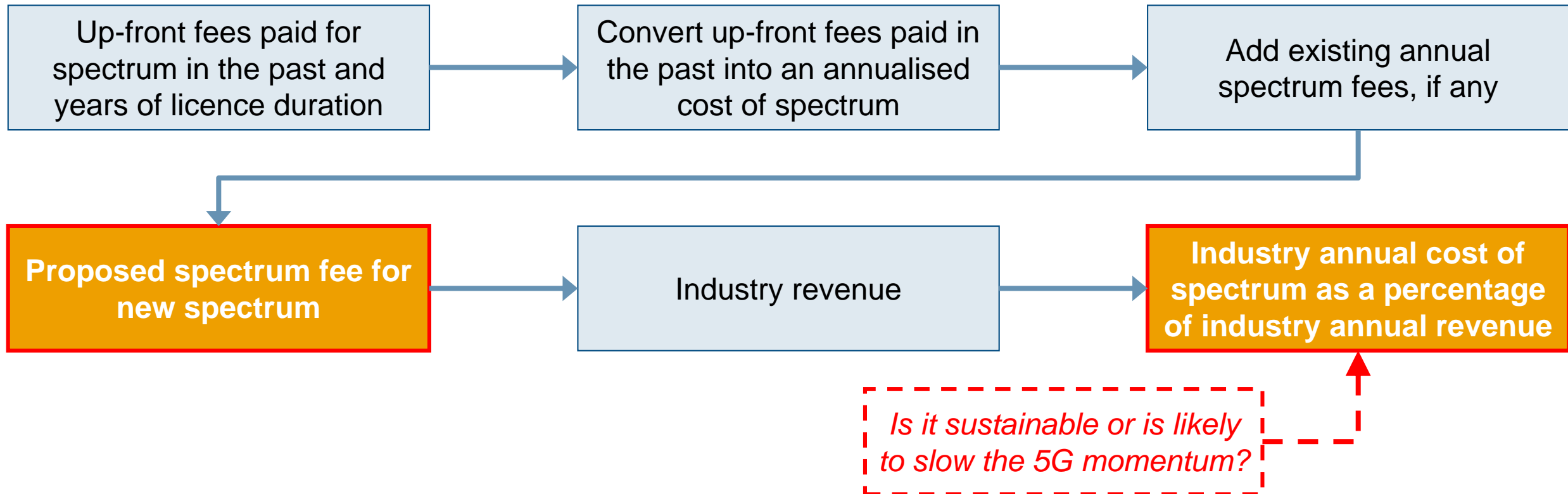
Using benchmarking to set reserve prices or set licence fees is not appropriate because it is backward looking rather than forward looking

- Mobile operator revenue per MHz of spectrum has declined by over 50% in the past.
- Adding the C-Band to an operator's network will enable operators to compete with higher data bundles. ARPU does not change.
- Revenue per MHz of spectrum deployed will continue to decline.

- 
- If each new MHz of spectrum for 5G yields little or no additional revenue, then comparisons with the past are not helpful.
 - Therefore it is fundamentally flawed to use prices paid for spectrum in the past to estimate the value of additional spectrum for 5G mobile broadband.
 - Examples of failed auctions due to setting reserve prices based on benchmarks include India, Bangladesh, and Thailand

Regulators can easily calculate the annualised cost of spectrum to ensure that spectrum pricing is sustainable and does not slow down the 5G momentum

The “annualised cost of spectrum as % of revenue” metric makes it easy to identify excessive spectrum fees and communicate this to a non-expert audience, such as the ministry of finance or politicians.



Example of annualised cost of spectrum as % revenue for Singapore

Date	Band Name	Type	Band #	MHz Sold	Price Paid SG\$ Million	Licence Duration Years	Annualised Cost SG\$ mn
Apr-01	2100	FDD&TDD	1	104	300	20	28
Oct-10	2100	FDD	1	30	60	20	6
Jun-13	1800	FDD	3	150	240	13	28
Jun-13	2600	FDD	7	120	120	15	13
Dec-16	900&2300	FDD/TDD	8&40	60	105	20	10
Apr-17	700	FDD	28	90	846	15	91
Apr-17	900	FDD	8	40	192	16	20
Apr-17	2600	TDD	38	45	107	16	11
Total				639	1,970		206

Cost of Capital (WACC) % 6.7%

Annual industry service revenue 2018 SG\$ mn 3,047

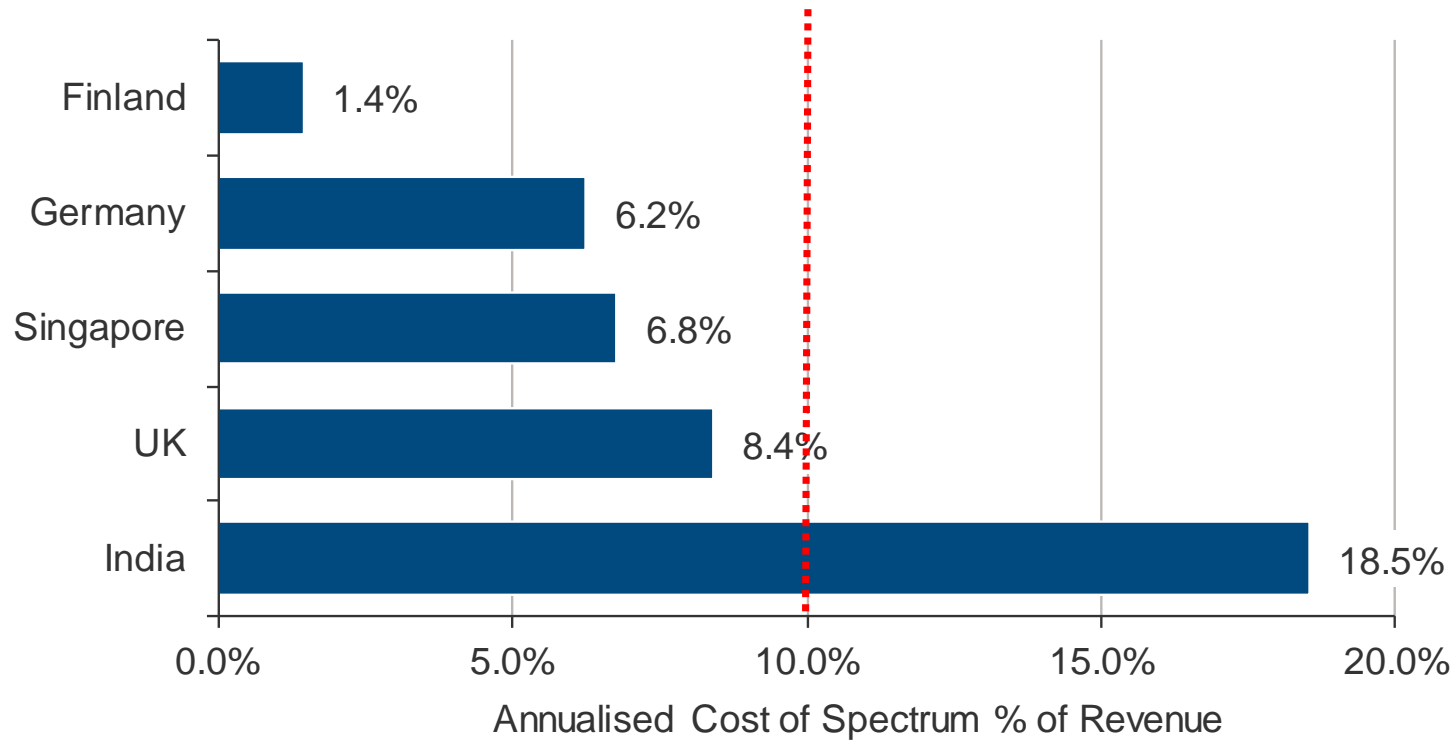
Annualised cost of spectrum % of revenue 6.8%



Annualised cost = cost of capital / (1 - (1 / (1+cost of capital)) ^ licence duration)

An annualised cost of spectrum above 10% of revenue is likely to slow the 5G momentum

Annualised cost of spectrum in selected countries



Annualised cost spectrum as a % of revenue

- Up to 5% likely to be sustainable
- 5-10% may be sustainable
- Over 10% may not be sustainable

Are there other regulatory fees?

- Where there are substantial additional regulatory fees these may need to be deducted from revenues before making the calculation.

A worked example: Calibrating spectrum licence fees for renewal and new 5G related spectrum licences

Current cost of spectrum

Auction date	Band Name	Type	Band #	MHz Sold	Price Paid \$ Million	\$ million per MMz	Licence Duration Years	Annualised Cost \$ million
2006	850/900	FDD	5/8	70	260	3.7	15	30
2007	1800	FDD	3	150	180	1.2	15	21
2010	2100	FDD	1	120	280	2.3	20	29
2016	2600	FDD	7	140	90	0.6	15	11
Total				480	810	1.7		90

Spectrum cost % of revenue 9.0%

Future cost of spectrum

Auction or renewal date	Band Name	Type	Band #	MHz	Price \$ Million	\$ million per MMz	Licence Duration Years	Annualised Cost \$ million
2016	2600	FDD	7	140	90	0.6	15	11
2020	2600	TDD	38	50	9	0.2	15	1
2020	700	FDD	28	90	170	1.9	15	20
2020	2100	FDD	1	120	113	0.9	15	13
2021	850/900	FDD	5/8	70	132	1.9	15	15
2021	3.4-3.7	TDD	n77	300	85	0.3	15	10
2023	1800	FDD	3	150	142	0.9	15	17
2024	2300	TDD	n40	100	28	0.3	15	3
Total				1,020	770	0.8		90

Spectrum cost % of revenue 9.0%

Cost of Capital (WACC) 8.0%
 Annual industry service revenue \$ mn 1,000

Spectrum licences will expire and must be renewed

- In 2020: 2100MHz
- In 2021: 850/900MHz
- In 2023: 1800MHz

The country's spectrum roadmap plans to assign new 5G related spectrum

- In 2020: 700MHz and 2600MHz TDD
- In 2021: 3400-3700MHz 2300MHz,
- In 2024: 2300MHz TDD

The regulator does not want to slow down the 5G momentum

- The price per MHz of spectrum must decline to ensure that the annualised cost does not increase above 9% of revenue.



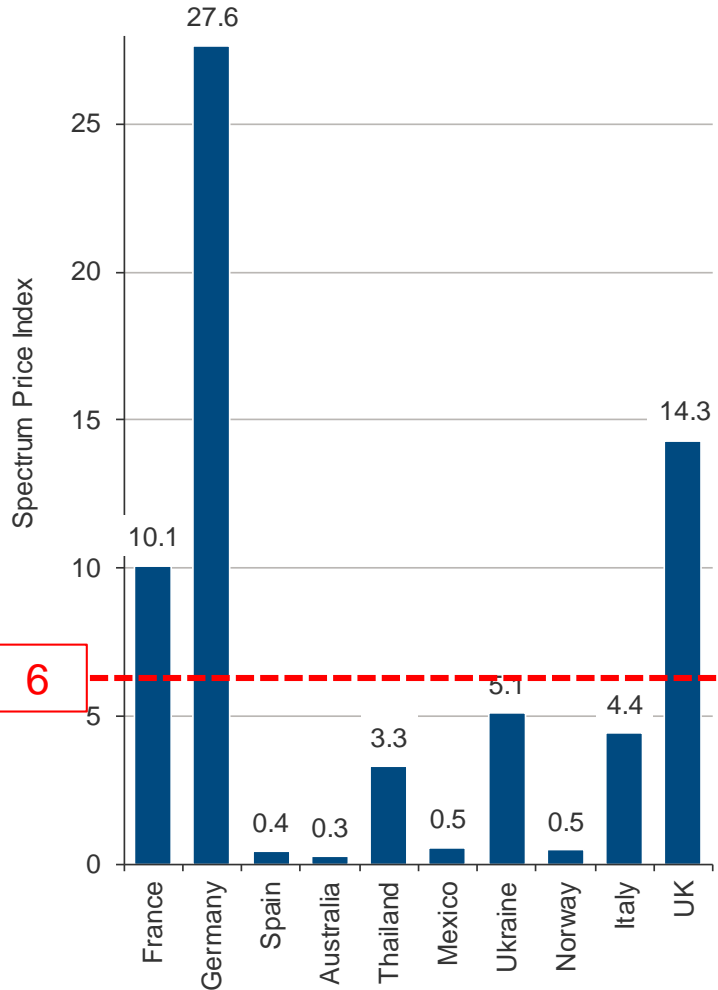
The Spectrum Price Index provides a further check on the sustainability of spectrum licence fees

$$\text{Spectrum Price Index (SPI)} = \frac{\text{Spectrum Licence Fees}}{\text{ARPU} \times \text{Subscribers}}$$

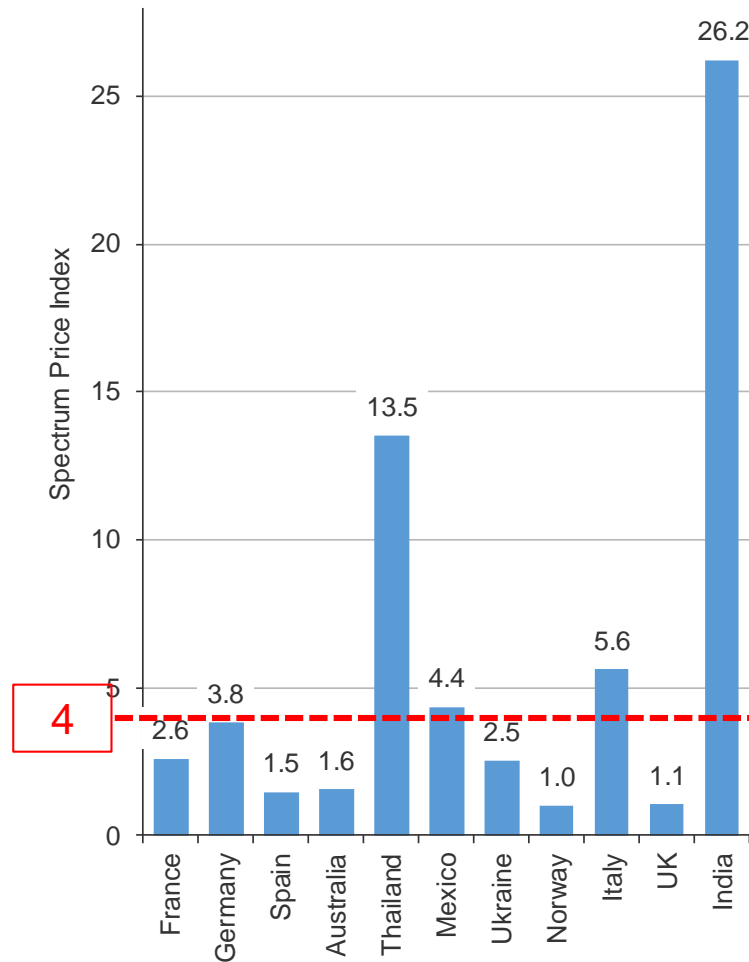
- For spectrum related to the introduction of 3G, the SPI was up to 6 in some countries which led to an industry crisis and slowed down 3G deployment.
- The SPI for 4G related spectrum tended to be below 4.
- Early indications for 5G related spectrum show that the SPI is less than 2.
- Spectrum related to the introduction of 5G includes the C-Band, potentially 700MHz, 2300MHz and 2600MHz and also mm wave spectrum. The combined cost of spectrum needs to be included in the SPI for 5G.
- **An SPI above 2 may be an indication that the proposed spectrum pricing is not sustainable.**

Spectrum Price Index 3G, 4G and 5G in selected countries

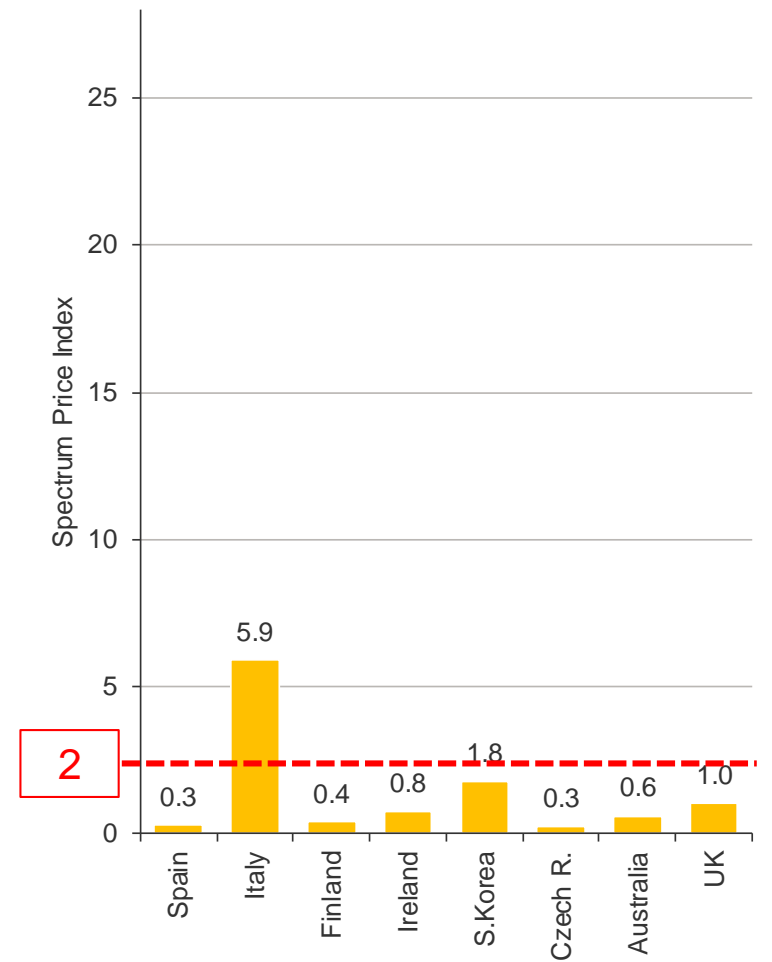
3G Spectrum Price Index < 6



3G Spectrum Price Index < 4



3G Spectrum Price Index < 2



Summary and conclusions

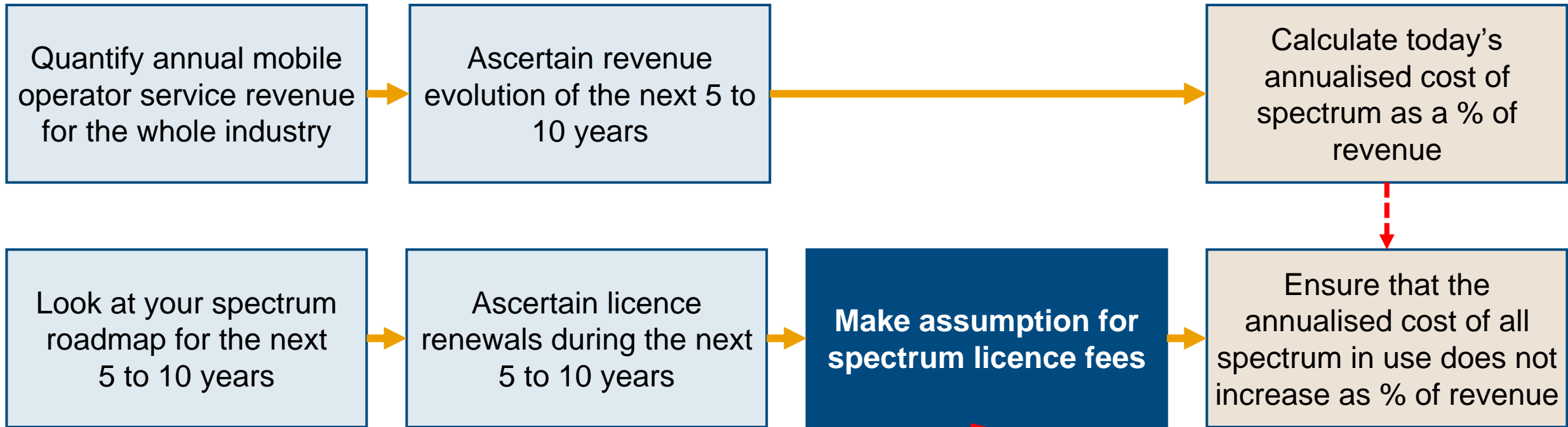
Mobile industry revenue is not increasing and 5G will not materially increase revenue

5G requires much more spectrum compared to the amount in use today

Revenue per MHz of spectrum used has declined and will decline further by over 50%

Per MHz spectrum licence fees must decline to prevent fees from becoming unsustainable

Recommendations to ensure that spectrum licences fees are sustainable



SPI: Check that licence fees for 5G related spectrum are less than 50% of 4G related spectrum fees



Questions?

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