CULLEN INTERNATIONAL

5G and spectrum: different approaches

ITU workshop: 5G and new technologies

September 2019

Lomé, Republic of Togo

Agenda

5G race: overview of 5G spectrum assignement

The Americas

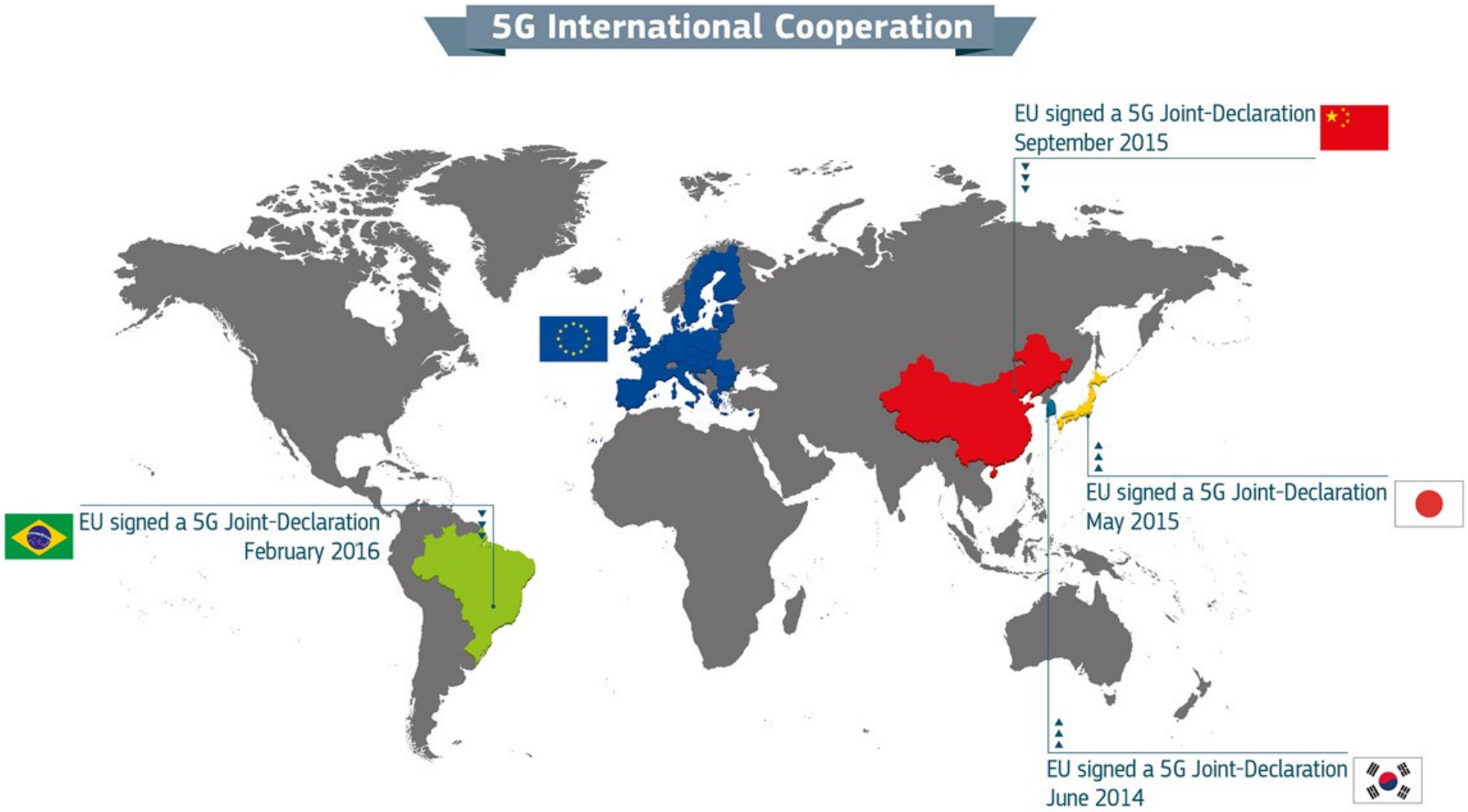
Europe

Asia-Pacific

Conclusion

CULLEN INTERNATIONAL

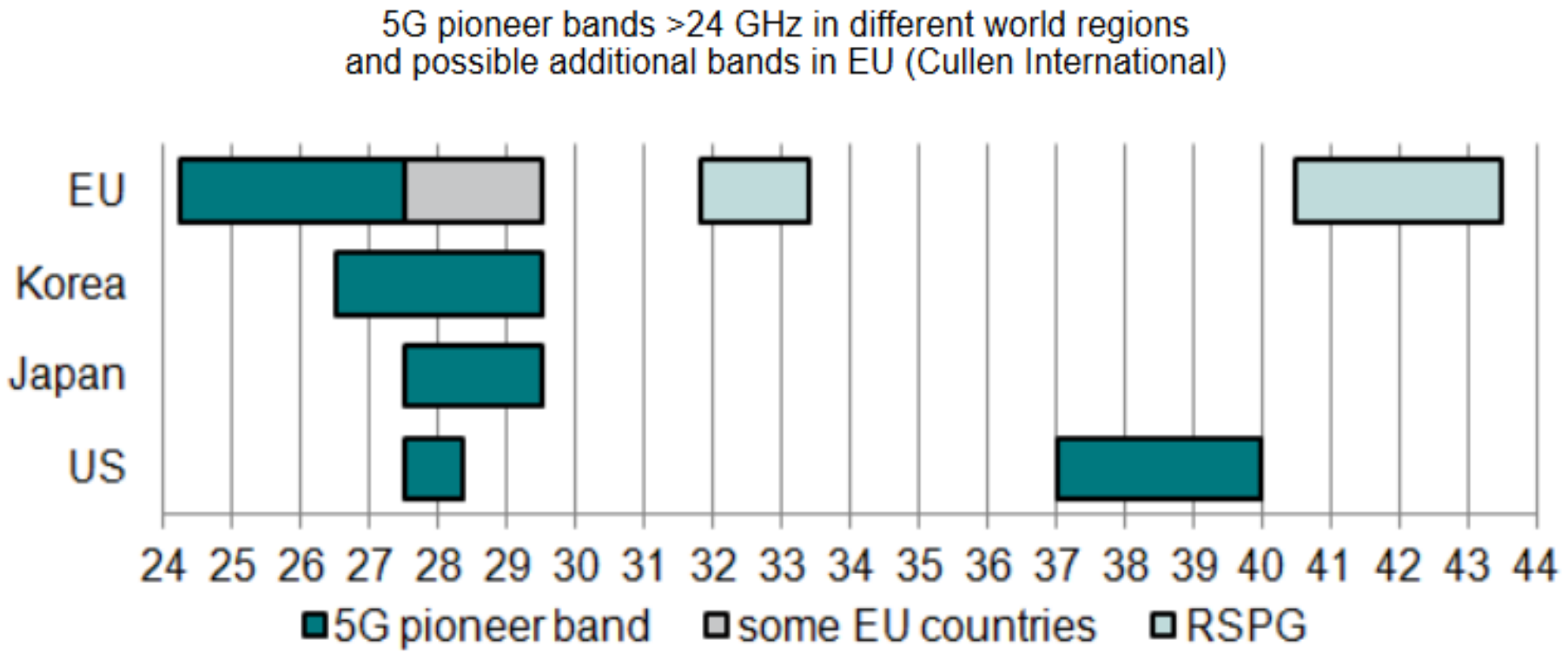
Race to 5G: cooperation…



CULLEN INTERNATIONAL

Race to 5G: …and competition

Different views on “pioneer” spectrum bands



CULLEN INTERNATIONAL

The Americas

CULLEN
INTERNATIONAL

5G bands: plans and consultations in the Americas

BR		700 MHz		2.3 GHz	3.5 GHz	24,5 - 27,5 GHz					
CA		600 MHz	700 MHz		3.45-4.2 GHz		27.5-28.35 GHz	37-40 GHz		64 to 71 GHz	
CL					3.4-3.65 GHz		28 GHz				
CO		600 MHz	700 MHz		3.3-3.7 GHz	24.25 to 86 GHz					
MX		600 MHz	700 MHz	2.5 GHz	3.3-3.6 GHz	24.25 to 52.6 GHz					
US		600 MHz			3.5 GHz	24.75–25.25 GHz	27.5-28.35 GHz	37-40 GHz	47 GHz	64 to 71 GHz	
								37-37.6 GHz			

Planned for licensed use | Planned for shared/unlicensed | awarded

CULLEN INTERNATIONAL

Main spectrum bands: release dates

600 MHz

Country	Expected award	Proposed release
Argentina	Undecided	2021
Canada	April 2019	Mid 2019
Colombia	Undecided	Undecided
Mexico	Undecided	Available
United States	March 2019	2021-2022

3.4-3.8 GHz

Country	Expected award	Proposed release
Argentina	Undecided	2022
Brazil	2H 2019	Undecided
Canada	Undecided	2020-2022
Colombia	Undecided	In process to free the band
Mexico	Undecided	Under analysis

Upper bands

Country	Expected award	Proposed release
Argentina	Undecided	2023
Canada	Undecided	Undecided
United States	28 GHz: Jan. 2019 24 GHz: April. 2019 Upper 37 GHz, 39 GHz, and 42 GH: Dec. 2019	28 GHz: Nov. 2019 24 GHz: Undecided

CULLEN INTERNATIONAL

Spectrum awards announced

AR	BR	CL	CO	EC	MX	PE	CA	US
450 MHz								
700 MHz	700 MHz	700 MHz	700 MHz	700 MHz			800 MHz	
AWS		AWS			AWS	AWS		
1900 MHz			1900 MHz					
	2.3 GHz		2.5 GHz	2.5 GHz	2.5 GHz	2.3 GHz		
	3.5 GHz	3.5 GHz		3.5 GHz			3.5 GHz	mmWave
	mmWave	mmWave					mmWave	

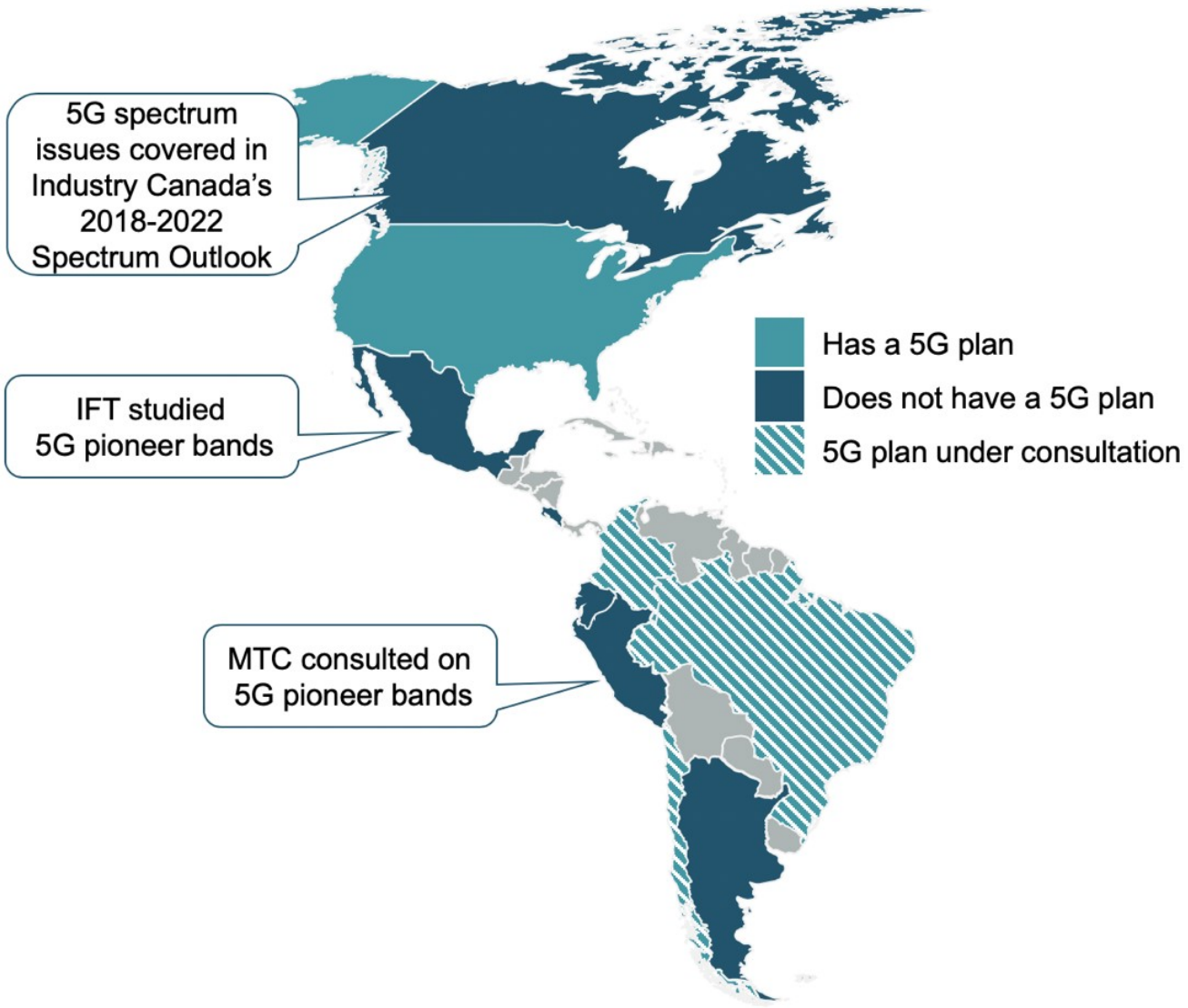
CULLEN INTERNATIONAL

Challenges on new 5G awards

- Design of the award
- Local or national licences
- Different approaches for urban and rural areas
- Detail spectrum roadmap to provide certainty

CULLEN INTERNATIONAL

5G plans in the Americas



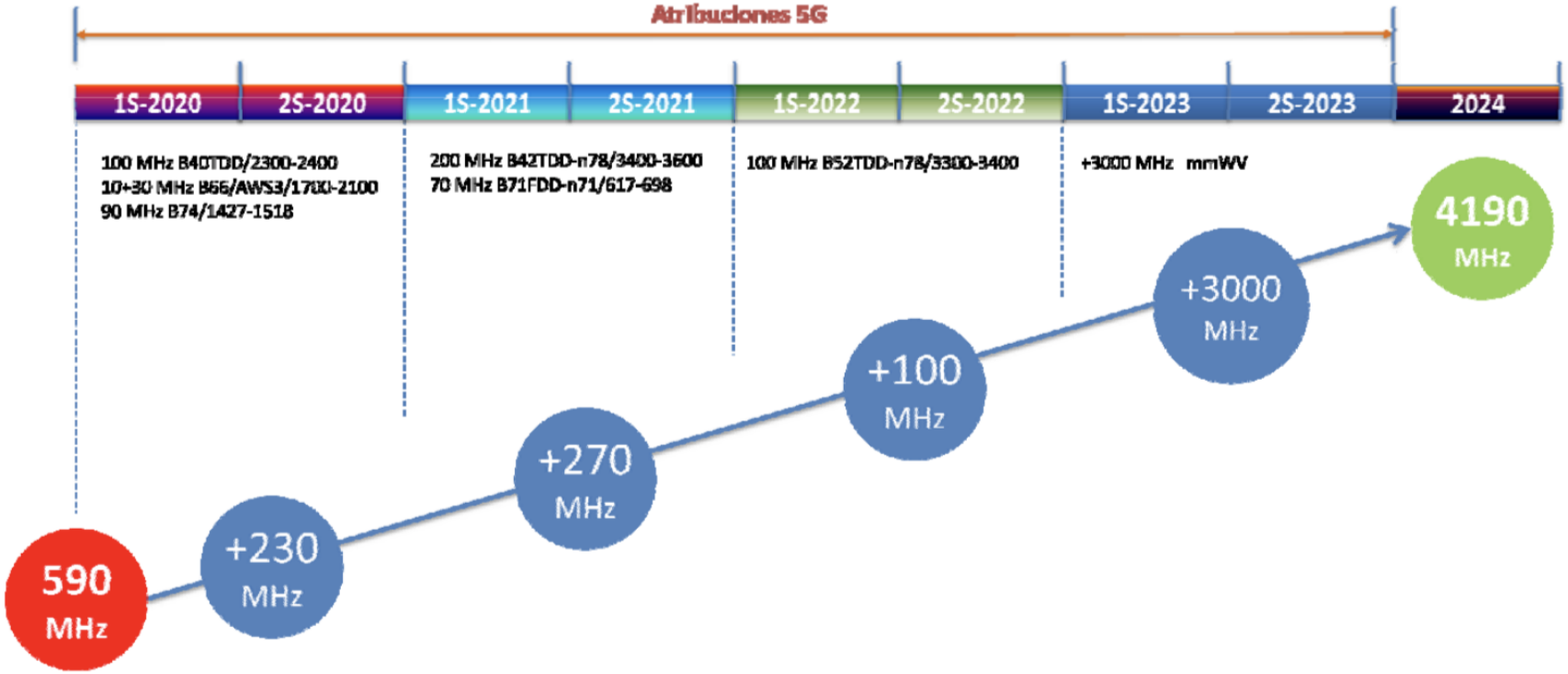
CULLEN INTERNATIONAL

Argentina

Secretaría de Modernización
Presidencia de la Nación

VII. Hoja de ruta para la disponibilización de espectro

- More spectrum: roadmap to assign spectrum by 2021



CULLEN INTERNATIONAL

Brazil

- More spectrum: Anatel consulted until 15 Sep. 2018 on allocating the 2.3 and 3.5 GHz bands for mobile services (auction by the end of 2019).
- Licensing and taxation frameworks to accelerate the adoption of 5G services
- Developing local applications and network equipment for 5G services
- promote trust and security in 5G networks and services

CULLEN INTERNATIONAL

Canada

Mainly spectrum:

- 600 MHz awarded
- Release of mmWaves:
  - 28 GHz (27.5-28.35 GHz) for flexible and mobile use
  - 64-71 GHz for licence-exempt use

CULLEN INTERNATIONAL

Colombia

- More spectrum
- Identify the technical and regulatory challenges related to the deployment of 5G
- Promote the demand of 5G-related services; and
- Simplify and update regulatory and policy frameworks.

CULLEN INTERNATIONAL

Colombia

ANE consulted on:

- low and mid bands identified for International Mobile Telecommunications (IMT – ITU's name for the 3G/4G/5G technologies) during the World Radiocommunication Conference 2015;
- high bands to be discussed for IMT identification during the next World Radiocommunication Conference (WRC-19), which will be held from 28 October to 22 November 2019; and
- the 28 GHz spectrum band.

CULLEN INTERNATIONAL

Chile

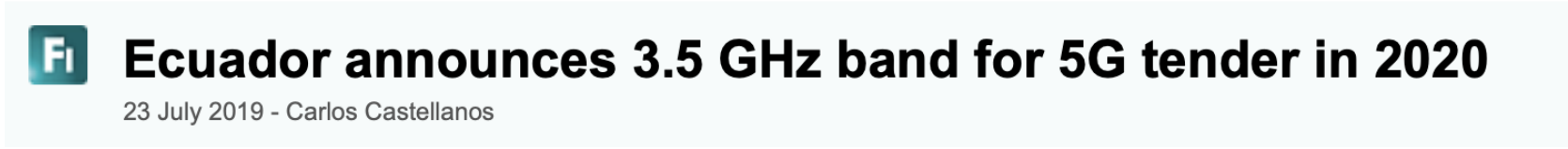
Subtel consults on draft 5G strategy

30 July 2018 - Andre Moura Gomes

- More spectrum: 150 MHz in the 3.5 GHz band and 850 MHz in the 28 GHz band
- Award design and mitigation of interference with satellite in the 3.5 GHz and 28 GHz bands
- ID services, applications and industries that will use of 5G
- Access to passive infrastructure, infrastructure sharing agreements and national roaming for 5G
- QoS and net neutrality in the context of 5G services
- Network security requirements for 5G service provision

CULLEN INTERNATIONAL

Ecuador



Mintel announced that:

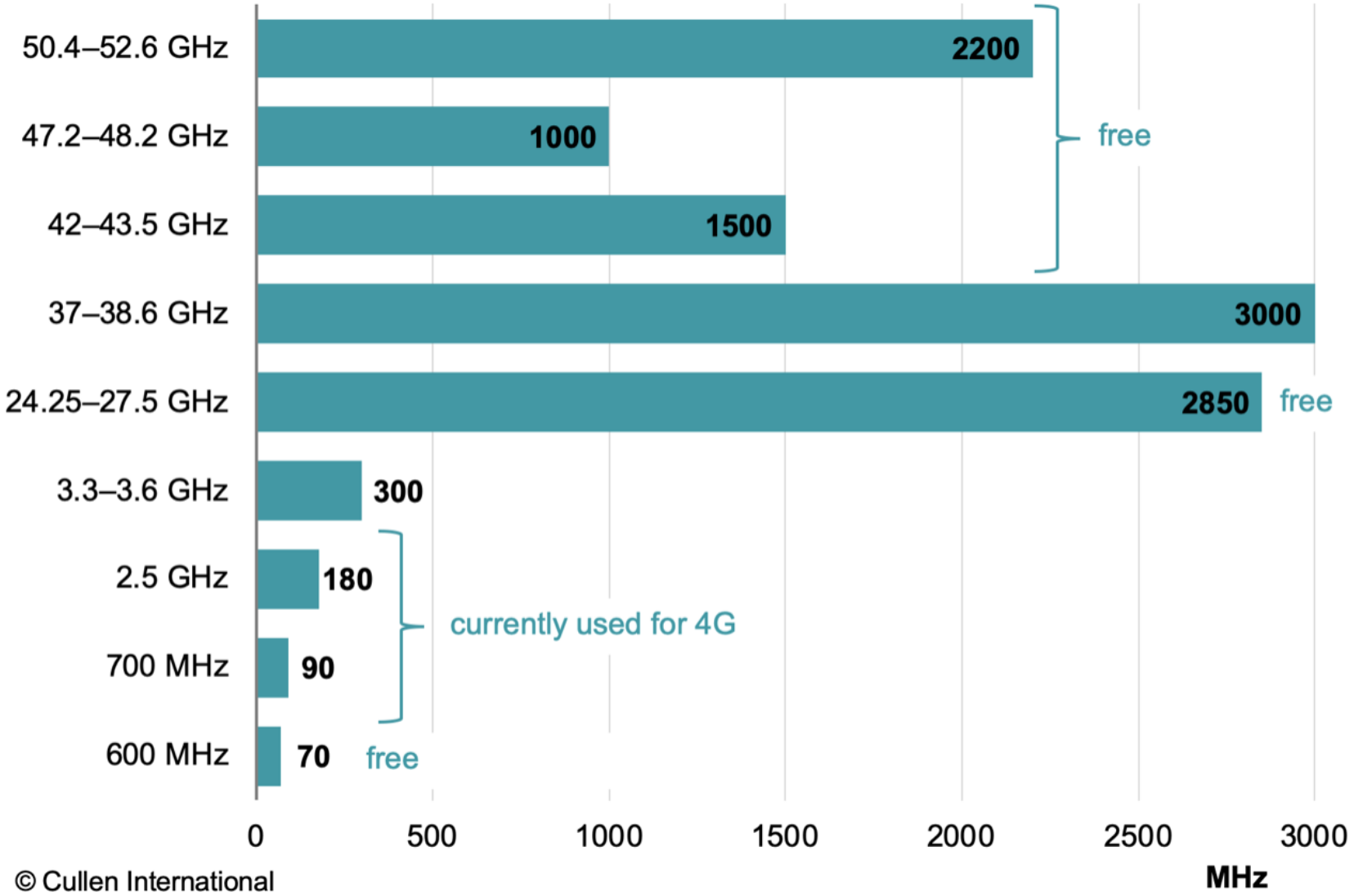
- 3.5 GHz band to be tendered in 2020
- New rules for the award of 700 MHz and 2.5 GHz bands by Nov. 2019

CULLEN INTERNATIONAL

Mexico

IFT spectrum unit identifies 5G spectrum bands for Mexico

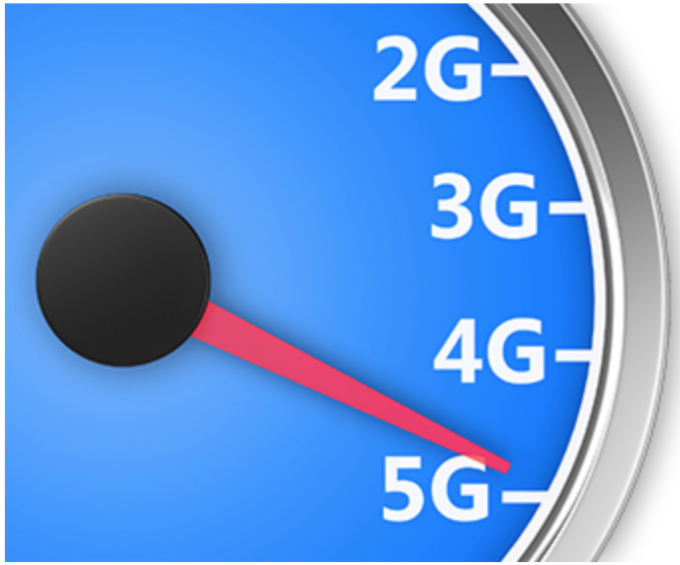
12 April 2019 - Carolina Limbatto



CULLEN INTERNATIONAL

5G in the US: first strategy adopted in the Americas

Leading the World Toward a 5G Future



The United States is moving swiftly to lead the world in the next generation of wireless connectivity—or 5G. These new networks and technologies will enable faster speeds and low-latency wireless broadband services, cultivating the Internet of Things and innovations not yet imagined.

Under Chairman Pai, the FCC is pursuing a comprehensive wireless strategy to ensure that the U.S. will lead the world in the deployment of next-generation wireless technologies.

"Forward-thinking spectrum policy, modern infrastructure policy, and market-based network regulation form the heart of our strategy for realizing the promise of the 5G future." – FCC Chairman Pai

CULLEN INTERNATIONAL

FCC 5G Fast Plan

- Low band: 600 MHz assigned (changes in 800 and 900 MHz)
- Mid band: exploring 2.5 GHz, 3.5 GHz, and 3.7-4.2 GHz
- High band: 24 and 28 GHz in 2018 | 37 GHz, 39 GHz, and 47 GHz in 2019 | 26 and 42 GHz timing undefined

Spectrum

Wireless infrastructure

- Traditional cell towers
- Small cell deployment
- Regulated fees for deployment

- Encourage investment
- One-Touch Make-Ready
- Restoring Internet Freedom order
- Supply Chain Integrity rules

Reducing regulatory barriers

CULLEN INTERNATIONAL

USA: from plan to action

- 28 GHz and 24 GHz bands awarded
- Consultation to assign spectrum for 5G services in the upper 37 GHz, 39 GHz, and 47 GHz bands.

CULLEN INTERNATIONAL

5G plans in the Americas

Spectrum is a key element

Beyond spectrum:

- Infrastructure deployment
- Use and applications of 5G
- Network and terminal equipment
- Updated policy/regulatory framework: QoS, Neutrality, Cybersecurity, Privacy
- Detail spectrum roadmap to provide certainty

CULLEN INTERNATIONAL

Europe

CULLEN
INTERNATIONAL

5G “pioneer” bands

Band	Amount	Range	Details
700 MHz	2x30 MHz	703-733 MHz 758-788 MHz	Electronic comms services **License by 30 June 2020** (possible to delay for two years)
	20 MHz	733-758 MHz	Supplemental downlink
	2x3 MHz	733-736 MHz 788-791 MHz	M2M
3.6 GHz	400 MHz	3.4-3.8 GHz	Pioneer 5G band **License by end 2020** Possible to use FDD in lower part of band (3.4-3.6 GHz) Already harmonised for mobile networks
26 GHz	3,250 MHz	24.25-27.5 GHz	Pioneer 5G band **License by end 2020 (some)**

CULLEN INTERNATIONAL

Deployment targets - 5G Action plan

Timing	Goals
2017	• Preliminary trials • March: industry to present detailed roadmaps for pre-commercial trials to be promoted at EU-level • End of March: Commission, industry and European Investment Bank (EIB) to assess the feasibility to enhance public funding, in particular through the European Fund for Strategic Investments (EFSI, Tracker) • End 2017: member states to include 5G deployments in their national broadband plans (Table)
From 2018	Pre-commercial trials "*with a clear cross-border dimension*"
End of 2020	At least one major city in every member state to be 5G-enabled
By 2025	All urban areas and "*major terrestrial transport paths*" to have uninterrupted 5G coverage

CULLEN INTERNATIONAL

700 MHz

Seven countries have awarded 700 MHz, and three more countries have set a target date for an award in 2019 or 2020

FI

- 2x30 MHz awarded in 2016 to three MNOs
- Spectrum fully available from 1 Jan. 2017
- Licences start from 1 Feb. 2017

FR

- 2x30 MHz awarded in 2015 to four MNOs
- Spectrum available gradually from April 2016
- Licences start from 8 Dec. 2015

DE

- 2x30 MHz awarded in 2015 to three MNOs
- Spectrum gradually available, mainly in 2018
- Licences start from 1 Jan. 2017

IT

- 2x30 MHz awarded in 2018 to three MNOs
- Spectrum available from 1 July 2022

CH

- 2x30 MHz awarded in 2019 to three MNOs
- 10 MHz SDL acquired by Sunnrise (5 MHz remained unsold)

SE

- 2x20 MHz awarded in 2019 to two MNOs

DK

- 2x30 MHz awarded in 2019 to three MNOs
- 20 MHz SDL acquired by TDC

Plans for award in 2019 - 2020

RO CZ UK

CULLEN INTERNATIONAL

3.6 GHz

12 countries have awarded spectrum in the band

FI

- 390 MHz awarded
- Within 3.4-3.8 GHz

CZ

- 200 MHz awarded
- 3.6-3.8 GHz

HU

- 2x30 + 20 MHz awarded
- 240 MHz not awarded
- Within 3.4-3.8 GHz

IE

- 350 MHz awarded
- Regional licences
- Within 3.4-3.8 GHz

PL

- 84 MHz awarded
- Regional licences
- Within 3.6-3.8 GHz

AT

- 300 MHz awarded to 3 MNOs
- Regional licences
- Within 3.4-3.8 GHz

IT

- 200 MHz awarded
- Within 3.6-3.8 GHz

NO

- 190 MHz awarded
- Within 3.6-3.8 GHz

RO

- 2x55 + 145 MHz awarded
- Within 3.4-3.8 GHz

SK

- 2x80 + 240 MHz awarded
- 3.4-3.8 GHz

ES

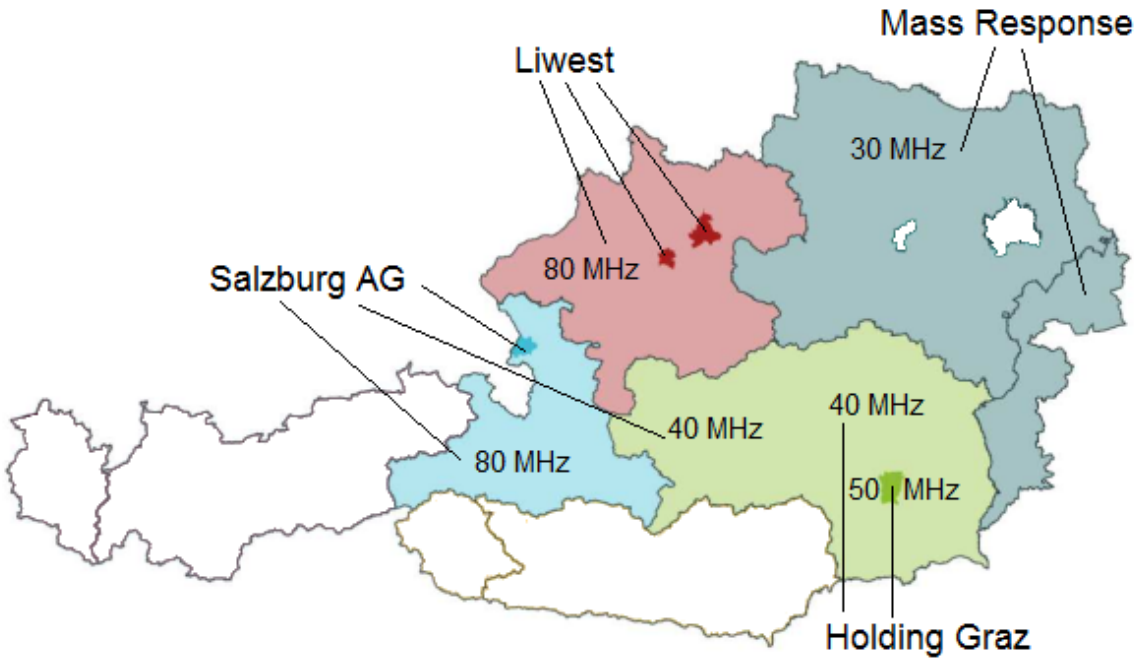
- 360 MHz awarded
- Within 3.4-3.8 GHz

UK

- 2x20 + 234 MHz awarded
- Within 3.4-3.8 GHz

CULLEN INTERNATIONAL

Austria 3.6 MHz- 4 regional operators



Operator	Regions	MHz	Price paid	Min. base stations to be built by	
				31 Dec. 2020	31 Dec. 2022
A1 Telekom Austria	All 12 regions	140 (Vienna, Lower Austria, Burgenland) 120 (Carinthia, Tyrol, Vorarlberg, city Graz) 100 (Upper Austria, Salzburg, Styria without Graz)	€64.3m	303	1000
Hutchison	All 12 regions	100	€51.9m	303	1000
T-Mobile	All 12 regions	110	€56.9m	303	1000
Holding Graz	Styria urban and rural	50 (Graz) 40 (rural)	€3.0m	15	50
Liwest	Upper Austria urban and rural	80	€5.3m	25	83
Mass Response	Lower Austria and Burgenland (without Vienna and St. Pölten)	30	€1.8m	11	35
Salzburg AG	Salzburg urban and rural Styria rural	80 (Salzburg urban and rural) 40 (Styria rural)	€4.4m	29	96

CULLEN INTERNATIONAL

26 GHz

A few countries have plans or ideas but only Italy awarded spectrum in the band

Early plans, consultations


DE


PT


RO


ES


UK


SE


FI

Awarded in 2018


IT

CULLEN INTERNATIONAL

Award conditions 700 MHz

Country	Date of award	Total paid	Price MHz/pop	Duration	Spectrum cap
Finland	Nov. 2016	€66.3m	€0.2	17 years	2x10 MHz
France	Nov. 2015	€2.8bn	€0.69	20 years	2x15 MHz (2x10 MHz for some)
Germany	June 2015	€1.0bn	€0.2	18 years	None
Italy	Oct. 2018	€2.0bn	€0.5	20 years	2x15 MHz
Sweden	End 2018	€0.27bn	€0.677	22 years	40 MHz

CULLEN INTERNATIONAL

Licence conditions 700 MHz

Country	Coverage	MVNO	Nat. roaming
Finland	99% of population within three years	No	No
France	98% of population within 12 years 60 Mbps (30 Mbps if only 2x5 MHz) + regional and transport obligations	Yes (if prev. committed)	No
Germany	98% of population within three years 50 Mbps per antenna sector + regional and transport obligations	No	No
Italy	80% within three years (also collective obligation of 99.4% within 4.5 years)	No	Yes
Sweden	Coverage bids and investment commitments	No	No

Award conditions -3.6 GHz

Country	Date of award	Total paid	Price MHz/pop	Duration	Spectrum cap
Czech	July 2017	€38.4m	€0.02	15 years	Incumbent operators: 40 MHz New entrants: 80 MHz No new entrants: 80 MHz
Finland	Oct. 2018	€77.6m	€0.04	15 years	130 MHz
Hungary	April 2016	€2.9m	€0.004	18 years	100 MHz, with sub-caps
Ireland	May 2017	€60.5m	€0.04	15 years	150 MHz per region
Italy	Oct. 2018	€6.5bn	€0.35	18 years	100 MHz
Norway	Feb. 2016	€2m	€0.002	6 years	No
Romania	Oct. 2015	€10m	€0.002	10 years	No
Slovakia	March 2015 Aug. 2015	€1.17m €2.43m	€0.002 €0.004	10 years 10 years	No No
Spain	May 2016 July 2018	€20m €437.64m	€0.01 €0.05	14 years 20 years	No 120 MHz (3.4-3.8 GHz band)
UK	April 2018	€1.33bn	€0.134	Indefinite	340 MHz on overall spectrum held
Austria	March, 2019	€188m	€0.06	20 years	National + regional

Licence conditions- 3.6 GHz

Country	Coverage	MVNO	Nat. roaming
Czech	40-50% of local regions within five years	No	No
Finland	The licensee's own network must represent 35% of the total 3410–3800 MHz network that it uses (the assessment criteria are unclear)	No	No
Hungary	None	No	No
Ireland	Rollout min. number of base stations	No	No
Italy	10% of the communes in each region not covered by ultrabroadband within six years (80 MHz licences) 5% of the population in each region within four years (20 MHz licences)	No	No
Norway	None	No	No
Romania	Rollout min. number of base stations	No	No
Slovakia	Cover each region within two years	No	No
Spain	None	No	No
UK	None	No	No
Austria	Defined as numbers of base stations per region	No	No

Asia-Pacific

CULLEN
INTERNATIONAL

South Korea

- In June 2018 the ministry of science and ICT auctioned spectrum in the 3.5GHz and 28GHz bands to support the launch of 5G mobile services
- SK Telecom, KT Corp, and LG Uplus signed a deal to launch services simultaneously (March 2019)

CULLEN INTERNATIONAL

China

- In June 2017 the ministry of industry and information technology requested comments on spectrum bands for 5G:
- mid-bands: 3.4-3.6 GHz & 4.8.-5.0 GHz
- mmWave spectrum: 24.75-27.5 GHz & 37-42.5 GHz
- Spectrum already granted in Dec. 2018

CULLEN INTERNATIONAL

Japan

- The government aims to make 5G services available for the 2020 Tokyo Olympics
- Operators DOCOMO, Softbank and KDDI have conduced tests in the 4.5 GHz, 28 GHz, 39 GHz and 90 GHz bands

CULLEN INTERNATIONAL

Taiwan

- Spectrum bands considered for 5G:
- 700 MHz (a portion is used for disaster relief systems)
- 800 MHz
- 3.4-3.6 GHz (held by Chunghwa Telecom and the military)
- 28 GHz

CULLEN INTERNATIONAL

Hong Kong

- Bands currently considered:
- 3.3 GHz
- 4.9 GHz
- 28 GHz
- Commercial launch expected by 2020

CULLEN INTERNATIONAL

Conclusion

- Asia-Pacific: early spectrum assignments + industry-government alliance
- Europe: harmonisation requires time and coordination
- The Americas: the US is leading; Latin America spectrum allocation more aligned with Europe so far

CULLEN INTERNATIONAL

Thank you!

andre.gomes@cullen-international.com