ASEAN 5G spectrum workshop

Roadmap for C-band in ASEAN

16 August 2019

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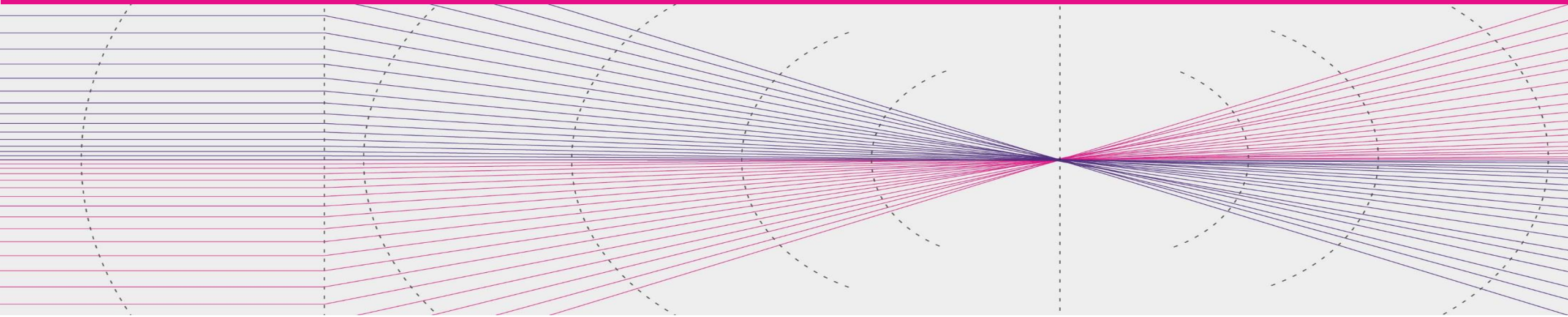


Agenda

- The importance of 3.5 GHz band
- Current services in C-band
- Options to release 3.5 GHz
- Current status in ASEAN
- Developing a roadmap for 3.5 GHz band in ASEAN

The 3.5 GHz is a key band for 5G

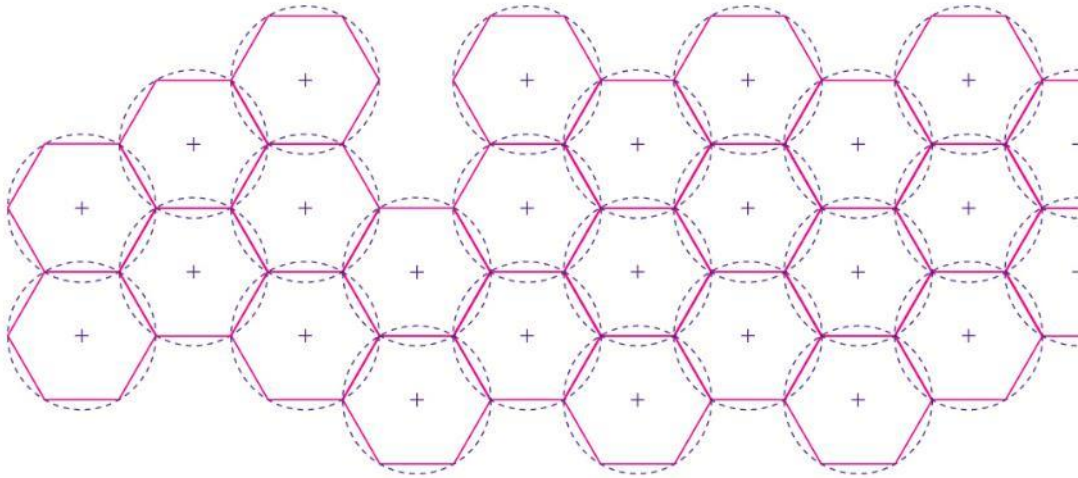
Why 3.5 GHz?

- A core 5G band in the 1-6 GHz range for enhanced mobile broadband services; identified for release by many countries globally
- Provides a good mix of capacity and coverage; requires contiguous blocks of ideally 80-100 MHz per MNO to support 5G uses cases
- Device and equipment ecosystem emerging (n78 – 3.3-3.8 GHz); commercial launches in several countries and pace will pick up in 2020

Status internationally (as of July 2019)

Assignment completed	Planned/under consultation
•Ireland (May 2017) •Czechia (July 2017) •Slovakia (October 2017) •UK (April 2018) •Spain (July 2018) •Latvia (September 2018) •Finland (October 2018) •Italy (October 2018) •UAE (November 2018) •Oman (December 2018) •Qatar (January 2019) •Switzerland (February 2019) •Saudi Arabia (March 2019) •Austria (March 2019) •Germany (June 2019) •South Korea (June 2018) •Australia (December 2018) •Japan (April 2019) •China (June 2019)	•Czechia (2019) •Estonia (2019) •Greece (2019) •Romania (2019) •Sweden (2019) •Hungary (2020) •Belgium (2019/2020) •UK (2019/2020) •Luxembourg (2020) •France (2020) •Norway (2020) •Poland (2020) •Canada (2020) •Brazil (2020) •United States (2020) •Mexico •Hong Kong (2019) •Taiwan (2019) •India (2019) •New Zealand (2020)

Current use in C-band



Frequency allocations in 3.3-4.2 GHz

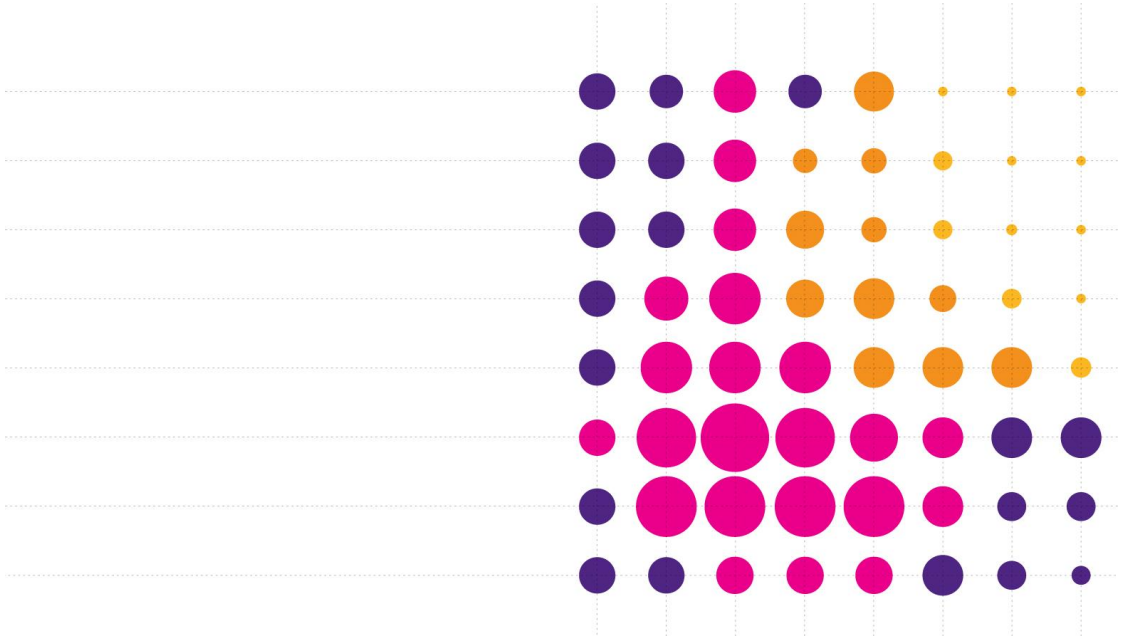
Frequency	Region 3	Footnotes (ASEAN)
3300 – 3400 MHz	RADIOLOCATION Amateur	• MOBILE/FIXED – Brunei, Cambodia, Indonesia, Malaysia • IMT identification – Cambodia, Lao PDR, Philippines, Vietnam
3400 – 3500 MHz	FIXED FIXED SATELLITE (space-to-Earth) Amateur Mobile Radiolocation	• MOBILE – Philippines, Singapore • IMT identification – Philippines, Singapore
3500 – 3600 MHz	FIXED FIXED SATELLITE (space-to-Earth) MOBILE except aeronautical mobile Radiolocation	• IMT identification – Philippines
3600 – 3700 MHz	FIXED FIXED SATELLITE (space-to-Earth) MOBILE except aeronautical mobile Radiolocation	-
3700 – 4200 MHz	FIXED FIXED SATELLITE (space-to-Earth) MOBILE except aeronautical mobile	-

Incumbent services

- In 3.4-4.2 GHz, the range of applications under FSS (space-to-Earth) include:
  - Large satellite earth stations, which serve as a gateway that carry trunk or network traffic (feeder links) to and from satellite space stations
  - Telemetry, tracking, and command (TT&C) stations, used for communication between spacecraft and the ground.
  - VSATs (which are small two-way satellite systems), primarily used by business, but also for military and government applications.
  - Satellite Master Antenna Television (SMATV), a system that uses multiple satellite and broadcast signals to create a single integrated cable signal for distribution to a cabling network within a building (e.g. apartment block, hospital etc.).
  - TV receive-only (TVRO), used for reception of broadcast signals such as free-to-air television.
- Other uses include: radiolocation (3.3-3.4 GHz) and fixed services (3.4-4.2 GHz)

Current status in ASEAN

Options to release 3.5 GHz for 5G



Is sharing feasible with incumbent services using appropriate mitigation?

- This depends on various factors
  - 5G use cases – eMBB likely to be large scale, wide area deployments; other applications (e.g. industrial uses) may be more localised
  - Incumbent uses – type of services (FSS, FS, radiolocation), the extent and location of their use
  - Type of sharing envisioned – co-channel or adjacent-channel
- Feasibility of IMT-FSS sharing was a major topic in run-up to WRC-15; considerable debate since then about FSS protection criteria and practices from individual administrations vary.

Measures to mitigate IMT-FSS interference

Interference mitigation measures	FSS (limited deployment)			FSS (ubiquitous deployment)		
	Efficiency	Time to implement	Cost	Efficiency	Time to implement	Cost
FSS earth station site shielding	✓✓✓	⏳⏳	$$	N.A.	N.A.	N.A.
Restriction zones to protect FSS	✓✓✓	⏳	$	N.A.	N.A.	N.A.
Improved FSS receivers	✓✓	⏳	$$	✓✓	⏳⏳	$$$
Addition of filters to FSS receivers	✓✓	⏳⏳	$$	✓✓	⏳⏳⏳	$$$
IMT base station location limitations	✓✓	⏳	$	✓✓	⏳⏳	$$
IMT base station antenna pointing/ down-tilt*	✓✓	⏳	$	✓✓	⏳⏳	$$
Reduce base station transmitter power	✓✓	⏳	$	✓✓	⏳⏳	$$
Detailed coordination	✓✓✓	⏳⏳⏳	$$	N.A.	N.A.	N.A.
Guard band 100 MHz	N.A.	N.A.	N.A.	✓	⏳	$$$**
Guard band < 50 MHz	N.A.	N.A.	N.A.	✓✓	⏳	$$**

Notes: ✓ to ✓✓✓ in terms of increasing efficiency and desirability; ⏳ to ⏳⏳⏳ in terms of increasing time to implement; $ to $$$ in terms of increasing cost of implementation (** based on opportunity cost)

* As part of the IMT network planned deployment, the siting of IMT base stations and pointing of sectors are determined based on the location of existing FSS receivers.

What size of guard band?

- Guard band required to mitigate adjacent channel interference from IMT into satellite receivers (e.g. TVROs, VSATs)
- A number of studies undertaken with range of conclusions

Country	Guard band	Comment
Brazil	25 MHz	Filter needed for low quality TVRO receivers
Hong Kong	100 MHz	Worst case assumptions used in analysis
Singapore	100 MHz	Ongoing studies to identify final value for guard band
Taiwan	44 MHz	Filter needed for FSS receivers in adjacent band; exclusion zone of 150m to protect receivers
US	20 MHz	Determined by satellite operators in proposed approach to undertake private auction

Measures to mitigate IMT-FS interference

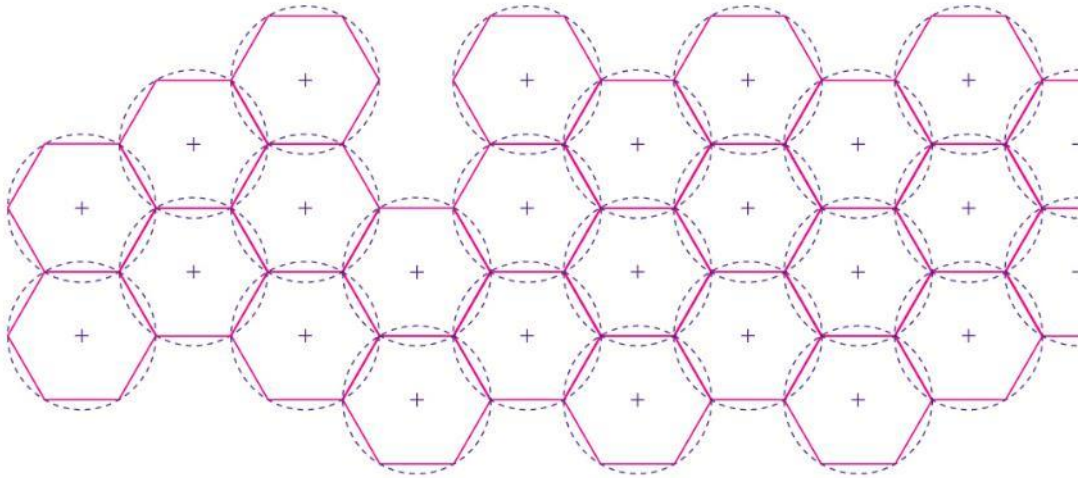
Interference mitigation measures	FS (limited deployment)			FS (ubiquitous deployment)		
	Efficiency	Time to implement	Cost	Efficiency	Time to implement	Cost
IMT base station location limitations	✓✓	⏳	$	✓✓	⏳⏳	$$
IMT base station antenna pointing/down-tilt*	✓✓	⏳	$	✓✓	⏳⏳	$$
Reduce base station transmitter power	✓✓	⏳	$	✓✓	⏳⏳	$$
Detailed coordination	✓✓✓	⏳⏳⏳	$$	N.A.	N.A.	N.A.

Notes: ✓ to ✓✓✓ in terms of increasing efficiency and desirability; ⏳ to ⏳⏳⏳ in terms of increasing time to implement; $ to $$$ in terms of increasing cost of implementation.

Is clearance feasible?

- This feasibility of band clearance and timescales involved are dependent on
  - The type of service and number of users
  - The possible impact on consumers and how this can be managed if there is a need to replace or upgrade equipment to maintain services
  - The availability of alternatives for users to maintain their current service output and associated costs
- Examples of clearance involving FSS and FS include Australia and UK; notice/transition periods range between 3 and 7 years.
- A cost benefit analysis should be undertaken to assess if clearance of the band is the optimum approach or if other mitigation options are more appropriate

Situation in ASEAN Member States



Progress in ASEAN (as of July 2019)

- The Philippines is the only ASEAN country to assign part of the band so far (3.3-3.6 GHz); many others have started planning (e.g. initial studies, consultations and 5G task forces)
- Focus is on the **3.3-3.8 GHz** range
- Ideally **80-100 MHz** per MNO is ideal to support 5G services but limited spectrum in ASEAN may mean smaller minimum allocations of 50-60 MHz
- **Size of guard bands** is a key factor affecting spectrum availability
- Other bands can serve as potential substitutes to avoid reducing spectrum per MNO in the C-band (e.g. 2.3/2.6 GHz)
- Currently **limited harmonisation** between countries
- Cross border agreements involving FSS, radar, or other fixed services may limit IMT deployment and impact 5G rollouts

ASEAN Member States

Brunei Darussalam

- Based on a study conducted in the 3.4-3.8 GHz band, not feasible to have co channel arrangement (IMT and FSS) and a guard band of 100MHz is required
- To make band available by 2022, assignment of VSAT services in 3.4-3.7 GHz bands must cease, and users must be migrated out of 3.4-3.7 GHz or mitigation techniques need to be introduced

Cambodia

- 2020 plan for medium band is to grant 100 MHz to each MNO and achieve national broadband speeds of more than 100Mbps
- Cambodia proposed a plan to revoke current wireless broadband licenses to allow for 5G use within the 3.3-3.7GHz but progress of this plan is uncertain to date
- There is some satellite usage within the 3.7-4.2 GHz band, though updated data is not available
- Cross-border coordination with Vietnam, Thailand, and Lao PDR will be crucial for 5G use in the C-band

ASEAN Member States

Indonesia

- Significant time and effort needed to optimize the use of the 3.5 GHz band for 5G due to heavy satellite usage across the Indonesian archipelago. Will be challenging
- 3.3-3.4 GHz band could be available for 5G use subject to a guard band in order to protect the 3.4-3.7 GHz FSS earth stations
- 5G indoor and outdoor trials have been on-going since 2017 and more trials are planned for 2019 including end-to-end trials.

Lao PDR

- Preparing to move forward with 5G and considering a timeline for the deployment of 5G networks and determining user demand
- Since November 2015, part of the C-band (3.4-3.7 GHz) has been used for FSS by the satellite LAOSAT-1
- 3.3-3.4 GHz and 3.7-4.2 GHz could be used for 5G if signals do interfere with the Lao Satellite network and no other solutions or any regulations for 5G use and MSS on the C-band are identified
- Operators are interested in investing in 5G networks but uncertain about demand for 5G services

ASEAN Member States

Malaysia

- National 5G task force group formed in 2018 currently aiming to identify spectrum band and bandwidth allocation required for services and use cases, and propose a 5G roadmap based on ecosystem readiness
- Preliminary recommendation was to allocate the 3.3-3.4 GHz band for limited indoor use; 3.4-3.8 GHz for 5G usage, and 3.8-4.2 GHz for satellite usage, but guard band would be needed between 5G and satellite usage
- Currently 3 cases of satellite usage within the C-band
- Some radar use in the 3.3-3.4 GHz band
- No fixed links in the 3.7-4.2 GHz band, but it is heavily used by VSATs
- Task force also planning indoor and outdoor field trials to assess coexistence interference issues and mitigation techniques between FSS and 5G (C-band and mmWave)
- Malaysia's 2.3 GHz TDD synchronization agreement with neighbouring countries may be used as model for future 5G services in the 3.5 GHz band

ASEAN Member States

Myanmar

- Myanmar has reserved the 3.4-3.6 GHz band for IMT/5G usage
- 3.3-3.4 GHz band currently being used for military radar, but could be considered for indoor usage in the future.
- PTD planning for release of 120 MHz of spectrum commencing from 3.4 GHz as part of major auction of IMT capacity spectrum in 2020
- 105 MHz guard band will be imposed from IMT services to FSS which may be reduced to 45 to 55 MHz post 2023, if demand exists and once all of the regional interference testing etc is completed.

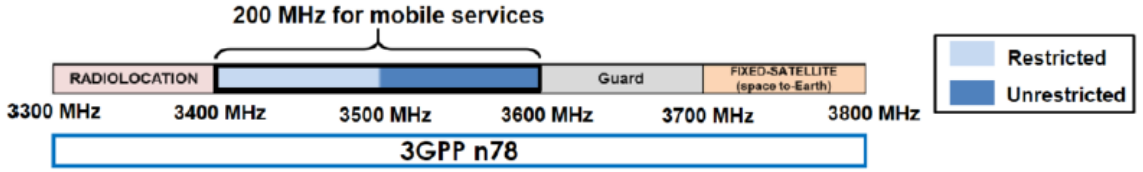
Philippines

- 3.4 to 3.6 GHz not currently being used for satellites so 200 MHz of bandwidth has been allocated to MNOs
- Mislatel (DITO Telecommunity) has 140 MHz of spectrum allocated to it in the 3.3/3.4 GHz band
- Smart and Globe Telecom have 60 MHz of 3.5 GHz each and using it to deploy 5G. Globe Telecom has already launched 5G
- 3.6-3.8 GHz and 3.8-4.2 GHz, are being extensively used by Philippine MNOs for their microwave backbones nationwide. 5G usage in these band is very unlikely and depends on MNOs' plans to fiberise backhaul/backbone networks.

ASEAN Member States

Singapore

- 3.5 GHz band is currently used extensively for satellite communications, but IMDA plans to make it available for 5G deployment in 2021 at earliest
- Most key FSS operations operate in 3.7-4.2 GHz
- 3.4-3.6 GHz is generally used for satellite signals reception for TVRO stations to individuals
- 3.4-3.7 GHz band will be changed from FSS to mobile service, and 3.7-4.2 GHz band will be retained as FSS
- 100 MHz in 3.5-3.6 GHz to be made available for 5G telecommunication systems and services, and also 100 MHz in 3.4-3.5 GHz on a "restricted" use basis, limiting deployments to indoors and underground
- IMDA will continue to engage Indonesian and Malaysian regulators for cross-border coordination and harmonisation for 5G usage in the 3.4–3.7 GHz



ASEAN Member States

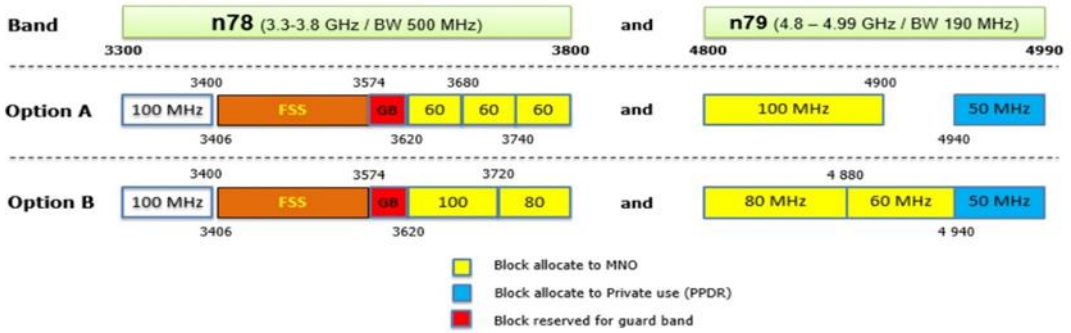
Thailand

- Only satellite operating in 3.4-3.7 GHz range is ThaiCom5
- Earliest availability for 5G use in the 3.5 GHz band likely to be in three years. ThaiCom5's licence expires in 2020, but Thaicom launched a booster and asked for a five-year extension, which the Government is currently considering
- 5G usage not possible within the 3.7-4.2 GHz band, but 3.3-3.4 GHz band is a possible given it is not being used for radar
- NBTC field trial began in early 2019 for sharing and compatibility in the 3.5 GHz band

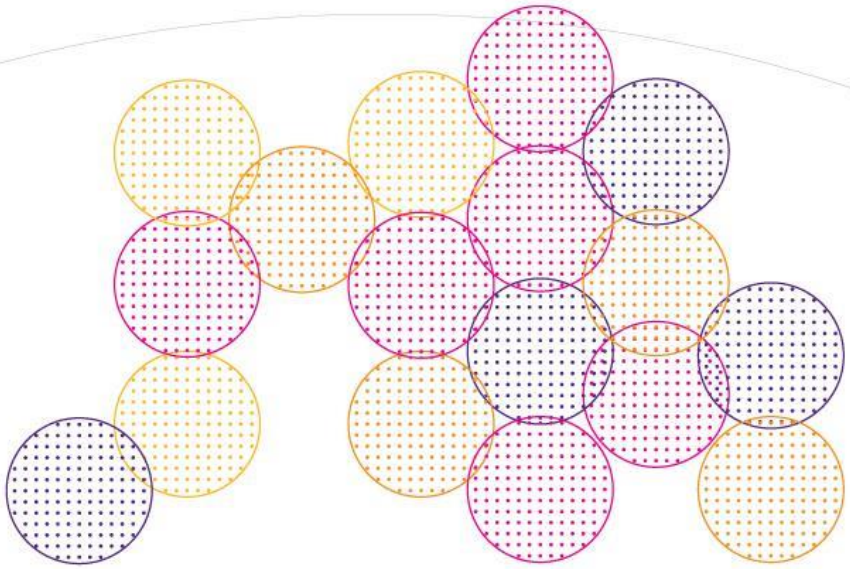
ASEAN Member States

Vietnam

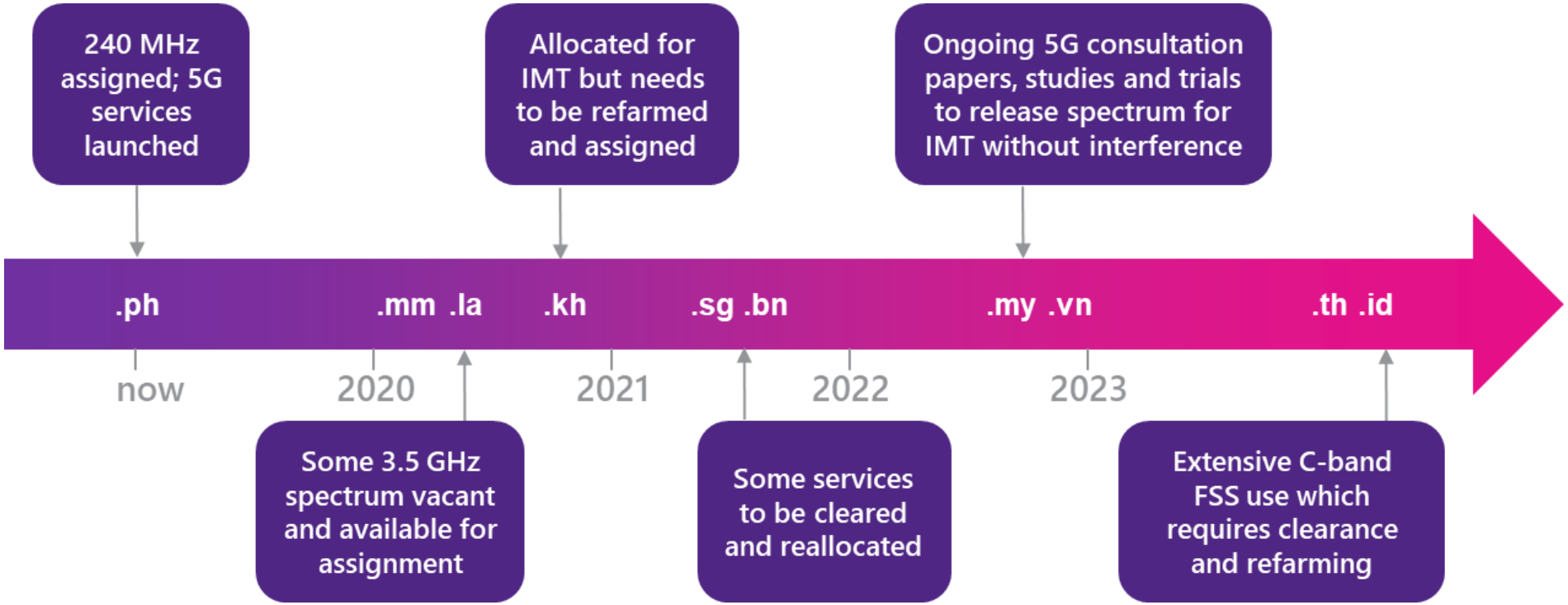
- ARFM is planning for 4G usage to continue until 2023 or 2024 before 5G usage becomes more widespread
- Early deployment of 5G planned for 2020, with focus on rolling out eMBB
- First license for 5G field trials granted in January 2019, and plans in motion to survey potential use cases, identify network rollout challenges, and determine the default protocol for 4G/5G
- ARFM trying to release spectrum of 3.3-3.4 GHz and 3.62 – 3.8 GHz in conjunction with 4.8 – 4.99 GHz for 5G with 2 options, A and B, to provide 4 spectrum blocks in mid-band range
- 3 blocks of 60 MHz OR 2 blocks of 100 MHz + 80 MHz being considered for n78 band
- 1 block of 100 MHz OR 2 blocks of 80 MHz + 60 MHz being considered for n79 band



Roadmap for 3.5 GHz in ASEAN



Possible timing for 3.5 GHz availability



Current plans (as of July 2019)

* Malaysia 3.3-3.4 GHz allocated to radar use and IMT indoor-only use
IMT assumptions are for the short/medium term and involves implementation of appropriate mitigation measures; analysis based on our understanding of current situation and subject to revision.
For Indonesia it is not possible to identify specific frequencies for IMT in C-band at present.

Key processes to releasing 3.5 GHz for 5G

Stage 1: Planning and decision (estimated 12 months)

- Review current use in 3.3-4.2 GHz
- Assess potential for coexistence (co- and adjacent-channel)
- Assess options available and conduct cost benefit analysis

Stage 2: Implementation (range from several months to years)

- Co-channel - notify incumbents on measures and implementation timescale
- Adjacent channel - notify incumbents of measures to minimise inteference
- Cross-border coordination and arrangements

Stage 3: Award spectrum (6-12 months)

- Determine technical conditions for released spectrum
- Design appropriate award taking account of national objectives
- Implementation of award

Implications on spectrum award

Providing clarity on supply and timing

- May be insufficient 3.5 GHz spectrum for all MNOs
- Governments and regulators should provide clarity on 5G spectrum availability to provide certainty for operators and potential 5G users

Facilitating contiguous assignments

- Contiguous blocks preferred as intra-band carrier aggregation can be avoided, improving spectrum efficiency and network performance
- In the case of a phased approach to spectrum release, there should be flexibility in the licensing framework and the possibility for MNOs to aggregate holdings and avoid fragmentation

Using appropriate award mechanism to meet objectives

- Auctions are an appropriate and transparent approach for assignment where demand exceeds supply; however, poorly designed auctions resulting in high spectrum fees can hinder 5G deployment
- Comparative tender can be advantageous as it can deliver contiguous spectrum of appropriate bandwidth, the process is relatively fast, obligations tend to be more palatable, and investment risks for MNOs are reduced

Conclusion: steps to secure timely release of 3.5 GHz

- Carry out a detailed review of the 3.3-4.2 GHz band and map out the current usage in terms of number of licensees and their characteristics.
- Identify and assess potential options and measures to facilitate 5G use, taking account of their feasibility in terms of effectiveness, implementation timescales and associated costs. There should be a moratorium on new C-band FSS and FS licences until a decision has been made on the future of the band.
- Develop a clear 5G spectrum roadmap and with realistic timescales for the implementation of coexistence measures or migration plans as necessary.
- Prepare for the 3.5 GHz award by consulting with all stakeholders and ensuring that adequate spectrum and conditions are in place to meet industry needs and national objectives.
- In addition, ASEAN regulators should work together to determine appropriate cross border agreements and technical coordination to ensure consistency; and at WRC-19, relevant footnotes to reflect future planned use of the 3300 – 3700 MHz for mobile (specifically IMT) should be included.

Thank you!

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