

# Analysis of 2.1 GHz Spectrum Auction in Thailand

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**Abstract**—Efficient spectrum allocation is a vital contributor to economic growth and success in telecommunications industry management of a country. Thailand's telecommunications industry is different from most cases since prior to the establishment of the telecommunications regulator, Thai telecommunications industry operated on the basis of concessionaire regime and not the licensing regime. Due to the complex nature of the concessionaire regime and the Thai legislation, supply of spectrum could not be injected into the telecommunications industry for more than a decade before spectrum allocation in October 2012. National Broadcasting and Telecommunication Organization Act (2010), Article 45 specifies that the regulator must allocate spectrum via means of spectrum auction only. Spectrum Auction is not a "one size fits all" and should be specifically designed to achieve objectives that is suitable to the country depending on telecommunications market structure and in most cases should prioritize long-term valuable economic and social benefits over short-term revenue maximization. The first part of this research provides literature on mobile broadband and spectrum auctions. The second part of this research provides an account of the Thai Telecommunications industry and specific 2.1 GHz spectrum auction objectives and outcomes. The final part of this research provides a qualitative analysis concluding that 2.1 GHz spectrum auction has fulfilled the policy objectives as prescribed by the NBTC Organization Act (2010) and is consistent with that of the international standard.

**Index Terms**—2.1 GHz band, mobile broadband, reserve price, spectrum auction, spectrum cap, spectrum management.

## I. INTRODUCTION

A myriad of studies have proven that broadband technology is a significant contributor to economic growth for several reasons. Firstly, it improves productivity by increasing the efficiency of several business processes. Secondly, deployment of broadband with extensive geographical coverage results in higher innovation through availability of new consumer applications and services to all. Lastly, broadband increases access to information by maximizing access to labor pools, raw materials and consumers etc. However, the criticality on availability of broadband bandwidth poses a challenge as exponential increase in wireless data traffic puts a critical strain on scarce spectrum resources. Numerous research have forecasted considerable increase in the demand of radio spectrum especially spectrum below 3 GHz [1]. As spectrum is a scarce resource that is highly demanded for wireless broadband that is critical to the advancement of a country's economy, "there is substantial agreement among economists that auctions are the best way to assign scarce spectrum resources" [2]. Spectrum auction ensures the most valuable use of the

spectrum as the bidder who is willing to pay the highest value for the spectrum will ensure it gets the most profitable return on investment, ensuring valuable use of spectrum. However, "policies related to pricing of radio spectrum affect how spectrum is used for wireless technologies, broadband networks and services" [3]. Therefore, spectrum auction design and outcome has to be consistent with policy objectives to ensure the desired outcome that is broader policy objectives in national broadband plans must be achieved.

National Broadcasting and Telecommunications Commission of Thailand (NBTC), has to design spectrum auction in such a way that it advances the policy objectives of the Organization Act ("Act on Organization to Assign Radio Frequency and to Regulate the Broadcasting and Telecommunications Services B.E. 2553"). The NBTC Act requires the allocation of spectrum to be a market-based approach, explicitly by spectrum auctions only. NBTC Act also authorizes NBTC to determine how the auction should be designed and run, how it will package the spectrum to be auctioned such that it meets the policy objectives required. "Valuing and auctioning radio spectrum is complex and the approach is very much depends on the policy objectives the spectrum regulator is pursuing". Therefore, this research analyzes the Thai telecommunications industry and determines whether the 2.1 GHz spectrum auction in Thailand has achieved the required policy objectives.

## II. LITERATURE REVIEW

### A. Spectrum Pricing and Allocation Methods

Valuing of spectrum is pertinent to fair and transparent allocation through auction to maximize efficiency of use and economic value of that spectrum. As spectrum is a national and public resource, it offers the chance for the public to get a fair return for private usage by operators as spectrum is a public asset and users are required to pay for telecommunications services. The main objective for determining the spectrum value and charging for the use of radio spectrum is entirely a consequence of radio spectrum being a highly demanded scarce resource.

It is significant to ensure that radio spectrum prices are set at or near the level of economic rent. What is economic rent? "Economic rent represents the surplus of the value of the public asset to the private user over the cost of maintaining and using the asset" [3].

There are two approaches to pricing spectrum to charge economic rent for the use of private use of spectrum as a public asset, namely administrative pricing and market based method. The demand for spectrum may diminish to the point that supply exceeds demand so that spectrum assignments can simply be made on administrative pricing method, i.e. first come first serve basis, beauty contest and lottery.

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Market-based approach i.e. spectrum auction is dependent on demand being higher than supply of spectrum. Where the demand for radio spectrum in a given band exceeds the available supply, feeds for the right to use the band can be used to encourage the most valuable use of the band. "Higher feeds that weed out the less valuable uses of spectrum will curtail demand to the point where it no longer exceeds supply" [3]. Therefore the highest valued use of a particular radio spectrum is one that will bid and is willing to pay the most for a frequency license in spectrum auctions.

As aforementioned, Article 45 in Organization Act of NBTC commits that spectrum allocation in Thailand must be allocated by market based approaches only i.e. Spectrum Auction. "Spectrum auction is beneficial such that it allows the bidder to estimate the commercial value of spectrum based on their own and the market's expectations around what benefits can be derived from its use" [3]. However, determination of spectrum value through market-based method depends on the following conditions [3].

- Demand for the spectrum being auctioned.
- Equitable access to the spectrum market.
- Use of a fair and transparent process.
- Auction design ensuring competitive and active bidding.
- License terms that are 'technology flexible' and 'service neutral'.
- Control over infrastructure and equipment that will use the spectrum" [3].

"One of the reasons for requiring spectrum auctions in Thailand is likely to avoid risk of weak or corrupt assignment practices by following fair and transparent assignment methods"[3]. Nevertheless, by necessitating spectrum to be allocated by market-based approach i.e. spectrum auction only, the Thai Organization Act have omitted spectrum allocation by administrative approach. According to ITU, for this reason "it appears to have removed a potentially useful means of setting economic rent where there is inadequate competition for certain radio spectrum bands. Although similar results can be achieved through setting reserve prices in auctions, this significant reduces the tools available to NBTC when licensing radio spectrum"[3].

### *B. Auction*

According to GSM Association (GSMA), "Auctions can provide an economically efficient means to allocate spectrum when there is competition for scarce spectrum resources and demand is expected to exceed supply" [4].

In assigning spectrum, regulators must take into consideration the circumstances of the market and choose which of the following objectives is appropriate objectives should be achieved to advance the telecommunications industry.

Auction is not a "one size fits all" design for all spectrum auctions. Each auction needs to be designed to meet the market circumstances and achieve specific objectives that are required by that particular country [4]. Therefore, the objectives explained below should vary by priority depending on the market conditions, competitive playing field and telecommunications industry structure of the country [4]. The following are objectives that drive auction design and should be prioritized on the outcome that should be achieved to advance that country's telecommunications

industry.

- **Economic Objective:** allocating the spectrum to the players that will use it most efficiently and effectively.
- **Social objective:** Ensuring that the maximum long-term societal value can be created from the spectrum, as opposed to seeking the short-term revenue for the government.
- **Technical Objective:** Ensuring that efficient technical implementation of services is achieved. For mobile and mobile broadband, this means the allocations should align with agreed, harmonized band plans and support contiguous allocations that enable the design and implementation of efficient and cost effective networks.
- **Investment Objective:** Use spectrum allocation process to encourage investment in deployment of networks and the implementation of new services. The greatest societal value and long-term economic value from spectrum comes from the future use of the spectrum and not from revenues generated by its initial sale [4].
- **Revenue Objective:** Many governments have a short-term revenue objective from the auction process. Valuations should not be excessive and should lead to fair competition for spectrum resources. Fees from the auction should not be excessive such that it cripples the operators and distorts the telecommunication market [4].
- **Market structure:** The outcome of the auction should be such that there is a competitive market structure from the successful allocation of the scarce spectrum resources [4].
- **Fair allocation:** The spectrum auction should ensure fair and transparent allocation process by ascertaining that potential auction bidders understand the auction roles, processes and conditions. Moreover, they should have information required to value the spectrum they are bidding for [4].

The early auction experiences in the case of 3G licenses in UK and Germany in 2000 which resulted in proceeds of over ten billion dollars has set expectations to be unrealistically high [5]-[7] and swaying the rest of the spectrum auctions towards prioritizing revenue objective over other invaluable objectives. Majority of 3G auctions that has been carried out ever since are viewed as a disappointment because large proceeds earned early on in 2000, are unrealistic and have not been possible since.

This has stirred up a discussion on policy regarding pricing radio spectrum in auctions to weigh short-term view of earning maximum fiscal revenue of the spectrum over "economic value" that could be earned for the nation. Contrary to developed countries such as UK and Germany, prioritizing revenue objectives over other valuable economic and social objectives can be extensively damaging to developing countries as this will discourage operators while auctions can motivate bidders to pay extremely high for a scarce resource such as spectrum, as argued by ITU, "It is increasingly recognized that long term fiscal benefits will be greater from a profitable ICT industry that contributes both directly through taxation of telecommunications service providers and indirectly through the economic uplift generated by employment of ICTs across all sectors of the economy. As a result, policy emphasis is less on immediate state revenue, more on generating a healthy ICT sector" [3].

Therefore, auction should be specifically designed to meet

social, market and/or economic objectives and should not prioritize short-term revenue maximization [4]. It is vital to acknowledge that excessive auction fees prices may negatively impact consumer pricing and hinder operator's financial ability to invest in network deployment, and in due course negatively impacting GDP growth and innovation in industry sectors of the economy [4]. In other words, revenue objective should not be prioritized especially in the case where, social and economic benefit is so immense that revenue received for the resource cannot exceed the long-term fiscal benefits to be achieved from allocating such resource.

### *C. Auction Rules*

As stated by the ITU report "Exploring the Value and Economic Valuation of Spectrum", that spectrum auction is an intriguing and complex process, and market value of spectrum is not static but fluctuates according to many variables. Therefore timing, auction process, regulatory rule, bidding thresholds and market structure can impact the bid amount resulting in very low or irrationally high bidding price for the spectrum [8].

Further, the critical variables that should be taken into consideration when designing the auction are the number of licenses that should be offered, whether the geographical coverage is national or regional, extent of coverage and rollout obligations required; size of spectrum lots or combination of different bands; payment obligation (license fee, royalties fees etc); access to additional spectrum and spectrum cap conditions; aspects in regards to encouraging small operators and new entrants; foreign ownership restrictions; and whether secondary trading of spectrum licenses is permitted [3].

#### *1) Number of licenses*

The number of licenses awarded in the spectrum auction can influence spectrum price and competition post auction [5]. If number of licenses awarded is higher than the number of bidders, this lessens the competition within the auction. If numbers of licenses to be award are lesser than the number of bidders such as the N-1 rule, it can create artificial scarcity leading to higher demand for spectrum thus, motivating higher bidding amounts. Therefore, numbers of licenses can a mechanism in prioritizing revenue objective. Eliminating competition through number of licenses by adoption the N-1 rule, which awards one license lesser than the number of competition, will eliminate small bidders and new entrants entering the market. Even worse, if it eliminates one strong competitor, this could lessen healthy competition and create a dominant and unhealthy competition in the telecommunication industry as an aftermath of the auction.

#### *2) Size of spectrum lots*

The size of the spectrum and the nature of the spectrum lots packaging can also influence the spectrum pricing and competitive playing field. A big block of spectrum is worth higher than a small block of spectrum and therefore a large chunk is affordable only by large players. If an objective is to increase competition in the telecommunications market after the auction has concluded, it will be wiser to auction smaller blocks of spectrum. Spectrum auctions may perhaps offer one big block of spectrum, where only one block can be assigned

to one license holder or, small blocks of spectrum where one license holder can auction for few blocks. The latter case offers more flexibility and can be controlled by spectrum cap. The latter offers a chance for small competitors to auction for the amount of spectrum they can afford, hence lessening restrictions to entry in telecommunications market, thereby promoting competition to a certain extent.

#### *3) Spectrum cap*

Spectrum caps have been introduced in several countries at various times as an ex-ante means of implementing competition policy in mobile communications markets. They have been applied to help ensure that no single mobile operator or a very small number can acquire all or almost the entire spectrum on offer at the time of initial spectrum awards or in subsequent mergers of, or, deal between operators. Therefore, spectrum cap limits the amount of spectrum that can be auctioned for.

#### *4) Reserve price*

A reserve price is used in spectrum auctions to set a floor price for each available lot. This price serves as a starting price for bids in the first round and a reserve price is imposed so as to ensure that the nation gets an economic rent that reflects the spectrum value in cases where there is less or no competition. Moreover, reserve price should be at an optimal amount so it can deter non-serious bidders from bidding for the spectrum for non-competitive purposes but not so high beyond the economic rent that it deters serious bidders from bidding for the spectrum. As the ITU states, "it must always be recognized that benchmarking the value of radio spectrum is an uncertain process, but it is not reliable in indicating the actual value of the radio spectrum" [3].

#### *5) Type of payment*

The type of payment for the spectrum auction and the license can eliminate and increase the number of players. If the payment for the spectrum is a one lump sum, only big competitors will be able to auction for the spectrum. While if there is a better payment plan, small competitors can bid for the spectrum without resulting in financial instability and inability to invest in network deployment.

#### *6) Geographical coverage*

Geography is also an institutional factor, since the regulator should decide on the license boundaries prior to auction. Whether the geographical coverage of the spectrum is regional or national, this affects both the competition and the price. Defining the geographic boundaries of licenses is necessary to conduct an auction.

#### *7) Rollout obligation*

Regulators or governments put rollout obligations as a license condition to ensure that operators do not offer services only in profitable areas and neglect remote/rural areas that could be unprofitable. However, strict rollout obligations that require too much investment in a short period of time can affect the price of spectrum as operators it could deplete operator's ability to invest. While flexible and rational coverage obligations can ease bidders and motivate them to bid for the spectrum at a price that reflects it's value. Overall, the factors explained above are mechanisms that can affect spectrum auction outcome and can be used to manipulate spectrum outcome that is consistent with the policy objectives.

#### *D. Methodology*

The research adopts qualitative case study research to explore the auction design and policy objectives of Thai 3G auction and whether the outcome complies with that of the international standard. Therefore, in order to demonstrate that the outcome of Thai 3G research is consistent with other countries and advances the policy objectives in regards to National Broadband plans, this study therefore adopts a evidence-based approach by sourcing data from secondary sources and using expert input. This research is an evidence-based research approach and is such that information within this research is sourced from variety of credible sources and further analysis is conducted [9]. Lastly, a comparative analysis is conducted to analyze whether Thai 2.1 GHz spectrum auction is consistent with that of other countries.

##### *1) Policy objectives of spectrum licensing in Thailand*

###### *a) National broadband policy*

According to NBTC statistics, Thailand has about 84 million active mobile subscriptions with a high mobile penetration rate of 123.80% in 2012. Presently Thailand's mobile subscriptions are primarily voice, however, non-voice data revenues is continuously growing and have reached 20% [3].

As aforementioned, broadband penetration is lagging behind its neighboring countries therefore, the main objective in pushing broadband penetration so Thailand can catch up with its peers is to increase spectrum availability for wireless broadband. So, maximizing economic rent to the public is neither the first priority nor is it the most important policy objective in this case, but rather a bonus. Therefore, the rationale for requiring public entities to pay for spectrum as a public asset is to secure a return on private use of public asset, which ensures efficient use by private entities, and value maximization of public scarce resource.

It is acknowledged that the national broadband policy should be the central to national ICT policy as it ensures broadband penetration and GDP growth. In Thailand just 3.5% of the population is using broadband particularly in city clusters. Therefore, the ICT policy objective is to deliver ICT infrastructure as a basic public utility with world-class quality and security standards that all citizens can access universally by year 2020.

The National Broadband Policy aims to develop broadband infrastructure and services through promotion of free and fair competition among broadband service providers, expansion of broadband services into rural areas, promotion of investment and development of a world-class network, adjustment of sector structure to achieve a level playing field. The focus on the longer term economic benefits of making the national resource of radio spectrum is clear [3].

The Thai government therefore, embraced a long-term vision of pursuing the benefits from the rollout and coverage of services that facilitate economic growth rather than a short-term focus on immediate fiscal revenues from radio spectrum auctions.

This observation is relevant to the decisions the NBTC took in carrying out its first auction of radio spectrum for broadband services, and for its future plans for further radio spectrum licensing.

##### *b) Legislation for spectrum licensing in Thailand*

The conduct of spectrum licensing, including the requirement to employ auctions to assign radio spectrum is governed by the telecommunications legislation. Thailand's telecommunication sector is subject to the Organization Act 2010. In the past, due to the complex nature of the concessionaire and Thai telecommunications legislation, supply of spectrum could not be injected into the telecommunications industry for more than a decade before 2012. Therefore, this spectrum auction marks the first milestone in transcending from concessionaire to licensing regime, and the benefits of licensing regime is substantial and is explained in [6].

In 2010, the Organization Act authorizes NBTC to regulate frequencies and broadcasting through licensing as well as to regulate the numbering, interconnection, anticompetitive conduct, unfair competition and merger controls, price regulation, universal service, customer protection and privacy. The NBTC is required to hold public hearings in connection with rule makings in order to benefit from stakeholder and public opinions.

The Organization Act 2010 does not prioritize or mention a revenue policy objective in realizing the highest economic value of radio spectrum for the state, or charging highest economic rent. Rather, it addresses where the auction proceeds should be directed. Income from spectrum auctions after deducting expenses is to be remitted to the state treasury.

Prior to 3G auction that concluded on 16th October 2012, mobile operators did not operate under telecommunication licenses under the regulatory framework of NBTC apart from TOT and CAT. The 3G auction implemented was the first milestone in transcending from concessionaire to licensing framework. Basically, these mobile operators were given the right to enter the spectrum auction regardless of their concessionaire agreements.

Therefore, NBTC's strategy to liberalize the mobile telecommunications market is therefore to auction new business licenses that are not bound by concessionaire framework. This is a form of involuntary migration from concession arrangements to licensing system, which complies with international standard.

##### *2) Auction design of 2.1 GHz spectrum in Thailand*

The 2.1 GHz band was therefore earmarked for high-speed mobile telecommunications services. In 2010, predecessor, the NTC, prepared an auction of 2.1 GHz radio spectrum which had been left unused for years as without NBC which was not formed due to a legal obstacle, NTC was not authorized to allocate or license spectrum.

In 2010, NTC devised an auction of 2x45 MHz of radio spectrum in the 2.1 GHz band. Given the strong market shares of all three operators in Thailand (AIS, DTAC, True Move), there was a high probability that such a lot size would result in a predetermined result with no meaningful competition in the auction. The NTC therefore applied N-1 rule whereby the number of licenses issued will be less than the number of qualified bidders. The spectrum lot sizes would be 2x15 MHz. if there were only three bidders, and then they would compete for two licenses. However, the third license would be re-auctioned soon thereafter with a reserve



price based on the second highest bid in the first auction.

The NBTC was not convinced that the auction design in 2010 designed by NTC its predecessor is best fitted for the current situation in the telecommunications market in Thailand in 2012.

As the spectrum auctions is two-fold, and the primary goal is efficiency while the secondary goal is revenue maximization [10]. The following are auction design factors taken into consideration by NBTC.

### *3) N-1 approach*

The 2010 NTC auction design involved creating artificial scarcity through the use of N-1 rule. The N-1 rule involves limiting the auctioned licenses to one less than the number of bidders. This approach will intensify competition within the auction but not in the market after the auction has already concluded. The outcome of N-1 risks leaving radio spectrum unused and creating a greater concentration of market power, which goes against efficient assignment of spectrum which is one of the main requirements Auction stated from the Thai Organization Act. As aforementioned, Thailand currently has three large operators equivalent to an oligopolistic market structure. Therefore, "the N-1 approach might result in excluding one of the three operators as well as other small mobile service providers that may make an entry into the Thai telecommunications industry, ending up with two licenses negative competitive consequences which go against the legislation in the Organization Act to promote free and fair competition"[3].

### *4) Number of lots and block size*

45 MHz of 2.1 GHz was available for auction as 2x45 MHz. NTC's approach in 2010 required that 45 MHz be divided into three blocks of 2x15 MHz. The public consultation conducted prior to 2.1GHz spectrum auction in 2012, revealed that it should be divided into nine blocks of 2x5 MHz. "The NBTC took a view that by making the block size smaller, new entrants and small operators might have an the opportunity and interest to participate in the bid" [3].

### *5) Coverage obligations*

Thailand is a large country in terms of the geographical areas and substantial population is concentrated in large cities, resulting incity clusters. Even more troublesome is that there is a vast difference in income levels between city dwellers and population in the rural areas. Therefore, city areas make for less expensive network coverage due to population density and greater revenue opportunity than rural areas, which make for more expensive network coverage and less revenue opportunity. Therefore, NBTC has to mitigate the risk of operators not investing in creating network in rural areas by imposing minimum network coverage [3].

For 2.1 GHz Spectrum Auction in 2012, careful consideration had to be given to coverage obligation imposed as "high coverage obligations can introduce a risk that, by imposing costs, they may reduce bidder interest" [3]. Moreover, 2.1 GHz is also not the optimal band for rural 3G services due to its propagation characteristics. To achieve extensive network coverage through 2.1 GHz spectrum band, a large number of base stations are required in comparison to number of base stations required by low frequencies. Therefore, it is not cost efficient to use 2.1 GHz to cater to

rural areas.

To mitigate the risk of discouraging bidders due to coverage obligations, NBTC decided to impose different coverage obligations depending on the number of 2.1 GHz blocks won during the auction. If the licensee only obtained 2x5 MHz, then it is obligated to provide network coverage to 20% of the population within two years, 30% within four years. On the other hand, NBTC imposed coverage obligations that required license winners that obtained 2x10 MHz spectrum block to provide network coverage to 50% of Thai population within two years after the auction and 80% within four years. "Such asymmetric obligations are an example of applying different obligations to different providers depending on their resources (in this case the bandwidth) in order to rebalance conditions and maintain level playing field – or "free and fair competition" in terms of the Thai legislation" [3].

### *6) Spectrum cap*

Initially, before the public hearing the spectrum cap was set at 2x20 which might generate more competitive bidding amongst the three strong competitors, if a new entrant is not bidding for spectrum. Therefore, the possibility of one competitor obtaining 2x20 MHz will leave only 2x25 MHz for the remaining bidders which will create a pressure for bidders and will promote increase in economic rent where small entrants will also be unable to keep up with the pressure. Nevertheless, the policy objective as clearly stated by the NBTC Organization Act is to foster competition. Therefore, the spectrum cap was changed to 2x15 MHz which decreases the barriers to entry for new entrants to a degree.

### *7) Reserve price*

One major point that had to be taken into consideration in setting the reserve price was that two of the concession agreements for two operators out of the three operating in Thailand were about to expire in less than a year after the auction. Moreover, as aforementioned, spectrum had not been injected into the telecommunications industry in Thailand for more than a decade due to the constraints posed by the concessionaires and legislations, which resulted from Broadcasting Commission not being formed. Therefore, a too high reserve price would defeat the purpose of NBTC ensuring that all spectrum bands must be assigned as soon as possible to develop broadband services as economic rent extraction is not a key and priority objective within the Thai legislation. Chulalongkorn University recommended that setting a reserve price of at least 67% of its adjusted benchmarked spectrum auction and NBTC concluded that 70% of the adjusted benchmark spectrum auction price is adopted at 4.5 billion per 5 MHz. ITU supports that "this is not an unusual level to set a reserve price. Indeed, reserve prices are often set much further below the estimated value" [3].

Raising the reserve price and promoting an extremely high economic value of the radio spectrum may risk the bidders to view the radio spectrum as being overvalued and not bidding for it. As a result, in Thailand's case, if all of the radio spectrum is assigned and licensed to develop broadband services, it could be viewed as a failed auction as it will not meet the policy objectives set by the legislations and will not feed the demand of radio spectrum that had been increasing

for more than a decade.

#### 8) *Infrastructure sharing*

NBTC is aware that at this stage in the telecommunications industry, attracting new small entrants is almost unattainable. The cost of obtaining land leases and rights of way, acquiring erecting new towers on land and buildings represent a large proportion of capital investment required to construct new mobile services network. The NBTC sought to alleviate the advantage over potential new entrants that the incumbent operators enjoyed by virtue of their existing access to CAT's and TOT's infrastructure by introducing infrastructure sharing rules to provide a level playing field for new competitors. These would require CAT and TOT to provide their infrastructure available to operators on a non-discriminatory basis. The NBTC also planned to introduce other regulations that would apply to 3G licenses, including on infrastructure sharing of mobile networks, on mobile roaming and on MVNOs.

The infrastructure sharing requirements are intended to require operators to make their excess capacity on their infrastructure available to others, and so to reduce the barrier to entry which small providers would face. One factor for NBTC to consider as it increases competition in the market in the future will be to ensure that infrastructure sharing regulation is effective, including adequate detail on technical feasibility, pricing principles, timelines for providing access and enforceability.

#### 9) *Mobile virtual network operators (MVNOs) obligations*

One way in which regulators can increase competition among service providers in the market is by introducing MVNOs. These do not have rights to use radio spectrum and usually do have their own network infrastructure. Instead, through business arrangements with traditional mobile operators, MVNOs buy capacity or minutes of use for sale to their own customers in whatever packages, or "buckets" the MVNO agrees with the network operator. MVNOs typically have full control over the SIM card, branding, marketing, billing, and customer care operations. The underlying incumbent mobile operators often keep their own operational and business support processes and procedures separate and distinct from those of MVNOs.

Therefore, MVNOs can be effective in promoting competition in areas of price, value added services and innovation. Such a system can create a form of competition, providing benefits to end users from direct spectrum licensing operators. In 2012 auction, NBTC sought to maximize the chances of increasing competition by requiring that licensees to provide telecommunications network service with minimum capacity of 10% of its networks to the MVNOs.

### *E. Discussion*

#### 1) *GHz auction process*

As a result, NBTC selected the "simultaneous multi-round" (SMR) ascending process for the 2012 auction of 2.1 GHz spectrum auction. In the case of 2012, a fourth bidder failed to deliver its bid bond leaving only three bidders. With nine blocks of 2x5 MHz and a spectrum cap of 2x15 MHz, there was equal amount of spectrum available for all bidders.

However, NBTC suspected that there would be competition, as operators will want to choose the bands since each some band may lead to high cost of investment on networks and perhaps some bands will deliver better quality data than others.

In 2012, NBTC auctioned the same frequencies 2x45 MHz of 2.1 GHz band at a reserve price of 4.5 billion baht per spectrum slot of 2x5 MHz. As the auction unfolded, it became clear that one of the operators wanted right to choose the bands it would have thus paid higher than its competitors. As the highest and leading bidder, it selected three lots of spectrum at the higher end of 2.1 GHz range being auctioned. Post auction process, the operator revealed that it preferred these bands because they are adjacent to other spectrum it uses under its concession. In the end, the three winners of the auction were Advanced Wireless Network Co. Ltd, DTAC Network Co. Ltd and Real Future Co., Ltd, which are subsidiaries of the existing large mobile operators already in the Thai telecommunications industry before the auction took place.

#### 2) *Does the 2.1 GHz Thai spectrum auction meet the policy objectives?*

Particularly in the case of Thailand where spectrum has not been injected for use in the Thai economy for more than 12 years, social, economic and technical efficiency is vital for spectrum to be allocated.

The following aspects are the main objectives in influencing the policy objectives of the Thai spectrum auction.

- **Goal:** To increase spectrum supply to meet broadband objectives.
- **Condition:** Article 45 in NBTC Organization Act, The NBTC Act requires the allocation of spectrum to be a market-based approach, explicitly by spectrum auctions only.

#### 3) *Issues*

- Broadband penetration is lagging behind neighboring countries.
- Only three competitors within the telecommunication industry
- Assigned in a way that promotes free and fair competition
- Used for efficient supply of services to consumers (social objective)
- Assigned to the interested qualified parties by means of spectrum auctions
- Assigned in a way that promotes free and fair competition, including preventing anti-competitive conduct
- Used for efficient supply of services to consumers
- Used (in addition to telecommunication services) for public goods, including education, culture, and state security – at national, regional and local levels,
- Assigned in a way that protects certain regional and local telecommunication services

As per the goal, condition and issues specified above, the policy objectives prioritized above all is economic objective to ensure that spectrum is allocated to the most efficient use as spectrum has not been allocated in this industry for more than a decade. Therefore, reserve price has to reflect the price of spectrum, such that winning bidders will make efficient

use to get a valuable return. However reserve price or auction price should not be so high that it prioritizes revenue objective over economic objective. Further, social objective is to ensure that spectrum is efficiently allocated so it can be used to achieve national broadband plan objectives, to ensure the market structure of the telecommunications industry is not damaged post auction. However, technical objective is critical, as spectrum should be used for technology that gives the most valuable return and aligns with the band plan.

In Thailand, consistent with ITU global allocations for IMT-2000 services, Band 1 (W-CDMA 2100) is allotted for 3G services in Thai National Table of Frequency Allocations. Further, The 2.1 GHz auctioned aligns with the IMT band plan, which states that it can be used for both 3G and 4G LTE. As for the market structure, while the number of competitors in telecommunications industry did not increase, it did not decrease and lead to dominant behavior. Moreover, this auction transitioned the traditional and inefficient concessionaire regime to a market-based, licensing regime. This will lead to higher market efficiency in terms of supply to fulfill the demand of spectrum.

To emphasize, neither the ICT or broadband policies nor the Organization Act identifies maximizing revenue to the state as a primary policy objective. The auction requirement appears rather to intend to set in place an allocation protocol that is fair and transparent to provide equal basis of competition for all operators in the Thai telecommunications market, which is certainly not the case with the concessionaire framework currently in place. Moreover, as the supply of spectrum has not been injected into the telecommunications market for more than a decade, the primary purpose is to allocate all spectrum bands available for the growth of the telecommunications industry at the expense of the highest revenue to the state, which could be a short-term benefit that could cripple the industry.

#### 4) Comparison of spectrum auctions around the world: pricing in Thailand too high?

In the previous section, it was concluded that the Thai 2.1 GHz spectrum auction has achieved the requirements of the NBTC Organization Act and policy objectives. Further the next step to conclude that it is successful auction, a comparative analysis with other countries should be adopted to uphold that this auction is indeed a successful one [11].

In 2000-2002, certain specific conditions existed that directly affected outcomes of spectrum auctions. In the past, 3G was equivalent to being a luxury with potential to generate tremendous revenue for the operators. At the time, securing the license was vital in order to make an entry into the telecommunications market or to secure highest market share. The telecommunications market was at an attractive stage in terms of investment, and operators had unrealistic expectations of revenue due to UK and Germany auctions. According to ITU, “3G auctions at the beginning of the millennium experienced unrealistic and economic optimism which are favorable for investment” [3]. Subsequently an economic downturn hindered the investment environment mainly for operators in Europe. The lesson learned from the spectrum auctions conducted in the millennium period was that spectrum auctions are not a matter of “one size fits all” but rather should be catered to the current market situation to

achieve wider policy objectives that materializes into economic benefits.

Moreover, in the millennium period, the first 2.1 GHz spectrum auctions for 3G was conducted mainly to introduce 3G to the market, today 3G licenses are carried out under very different market and technical conditions. The 2.1 GHz auctions conducted recently are due to extra capacity needs because these markets have operators who already have their own 3G networks. Therefore, “spectrum auction behavior can be very different when opening a new market compared with making radio spectrum available incrementally” [3]. Consequently, recent spectrum auctions have less fierce competition than the earlier auctions in year 2000-2002 [3]. Presently, regulators and stakeholders have realized that spectrum auction should be conducted to efficiently allocate spectrum to the market to alleviate bottlenecks [3] (Fig. 1 and Fig. 2).

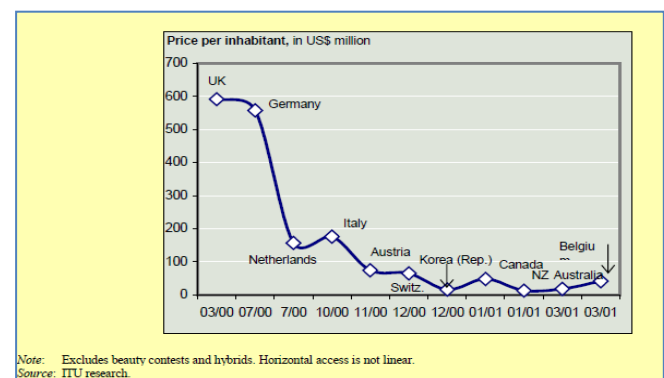


Fig. 1. 3G auctions price per capita.

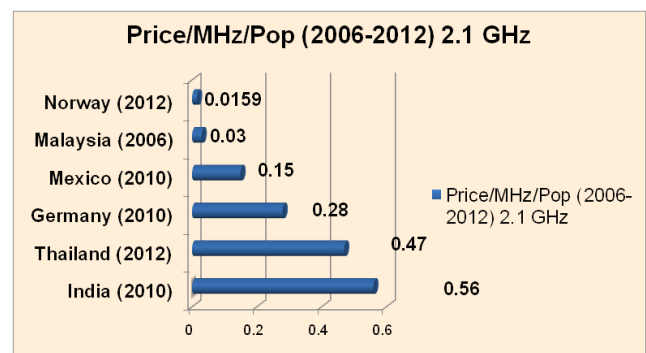


Fig. 2. Price/MHz/Pop

In cases where radio spectrum allocated when there is opportunity for large penetration in telecommunications services rather than solely just to increase capacity – it may result in higher prices. Illustrated in Figure, countries that collected highest revenue for the spectrum resource are India and Thailand. Both the countries have untapped mobile markets that are set for massive expansion and high penetration rate due to exponential rising demand in data services. In short, “India and Thailand are amongst the top countries experiencing high growth in the smart-phone market” [3]. While revenue objective should not be the primary measure for measuring the success rate of spectrum auctions, as shown in Figure, both Thailand and India are considered successful in collecting a great amount of revenue from their 3G spectrum auctions.

### III. CONCLUSION

In 2012, NBTC auctioned the same frequencies 2x45 MHz of 2.1 GHz band. The three winners were Advanced Wireless Network Co. Ltd, DTAC Network Co. Ltd and Real Future Co., Ltd which are subsidiaries of the three largest existing mobile operators i.e. AIS, DTAC and True Move. Each obtained 2x15 MHz in auction at the reserve price and one above it.

The NBTC is duty bound to promote efficient use of radio spectrum and to foster competition in the market. Although the number of competitors did not increase as a result of the auction, the auction tools created a mechanism to retain all current operators competing within the industry, hence not decreasing the competition in the Thai telecommunications market. Overall, as the entire spectrum is assigned at a reasonable economic rent, Thailand is now on its way to utilize the entire available spectrum to develop broadband services as soon as possible for the benefit of the public so, economic, social and technical objectives was prioritized over revenue objective. Moreover, this auction is a significant foundation in transcending the operators from the complex and inefficient concessionaire regime to market-based and internationally practiced licensing regime, hence taking the market structure and fair allocation into consideration. As a result, the 2.1 GHz spectrum auction achieved its goal and allocated all 45 MHz spectrum available while prioritizing economic and social objectives. As policy objectives of the legislation do not appear to require the NBTC to prioritize maximizing economic rent from use of radio spectrum in any significant way. Rather the policy objectives of NBTC is ensure all radio spectrum is assigned as soon as possible to develop broadband services as it is already lagging behind its neighboring countries and the rest of the world. Therefore, as the objectives are to ensure that spectrum licenses are assigned efficiently and fairly with minimal disruption with a price that compares reasonably to that of international benchmark for 2.1 GHz spectrum, the 2.1 GHz spectrum auction having achieved all objectives.

Moreover, after a thorough analysis of the 2.1 GHz spectrum auction, it was determined that all of the radio spectrum has been assigned at a price that is reasonable when compared to that of international benchmark as illustrated in this research. In conclusion, 2.1 GHz Spectrum Auction has achieved its goal, policy objectives, is consistent with legislation in NBTC Organization Act (2010) and lastly, as proved in this research it is also consistent with the international benchmark. All in all, having achieved and satisfied all the required objectives, it is considered a success.

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