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Spectrum Auction Risks Leaving Thailand Stranded in a Mobile Data Slow Lane

By **Richard Marsden**
and **Hans-Martin Ihle**

The Thai communications regulator, NBTC, plans to sell spectrum in the 900 MHz and 1800 MHz bands in 2018. This is spectrum already used by dtac to provide 2G and 4G services, under a concession from CAT expiring in 2018. Dtac has no right of renewal and must compete in the auction if it wants to win back some or all of the spectrum.

NBTC's initial design of the award includes two proposals that we consider controversial because they may not support an efficient award process:

- to withhold some spectrum from the award in case of low participation in the auction (the so-called "N-1 rule"); and
- to adopt exceptionally high prices from a similar auction in 2015 as reserve prices.

These rules appear designed to maximise revenues from the auction. However, the unintended consequences may be lower auction revenue, unsold spectrum, an inefficient market outcome and mobile operators burdened with financial obligations that depress their incentives to invest and compete in providing next-generation mobile data services to consumers. In this paper, we highlight research that suggests that enforcing such rules could leave Thailand stranded in a mobile data slow lane, constraining scope for future economic growth and putting at risk the government's vision for Thailand 4.0. The ultimate losers would be Thai taxpayers, subscribers and businesses.

The N-1 rule may lead to valuable spectrum going unsold

In an apparent effort to spur competition within the auction, NBTC plans to offer one fewer 2x15 block at 1800 MHz than the number of qualified bidders in the auction. Thus, in the likely scenario that only AIS, dtac and True participate, only two of three available blocks would be offered. In the case that only dtac participated, the rule implies that only 2x15 MHz of spectrum would be offered.

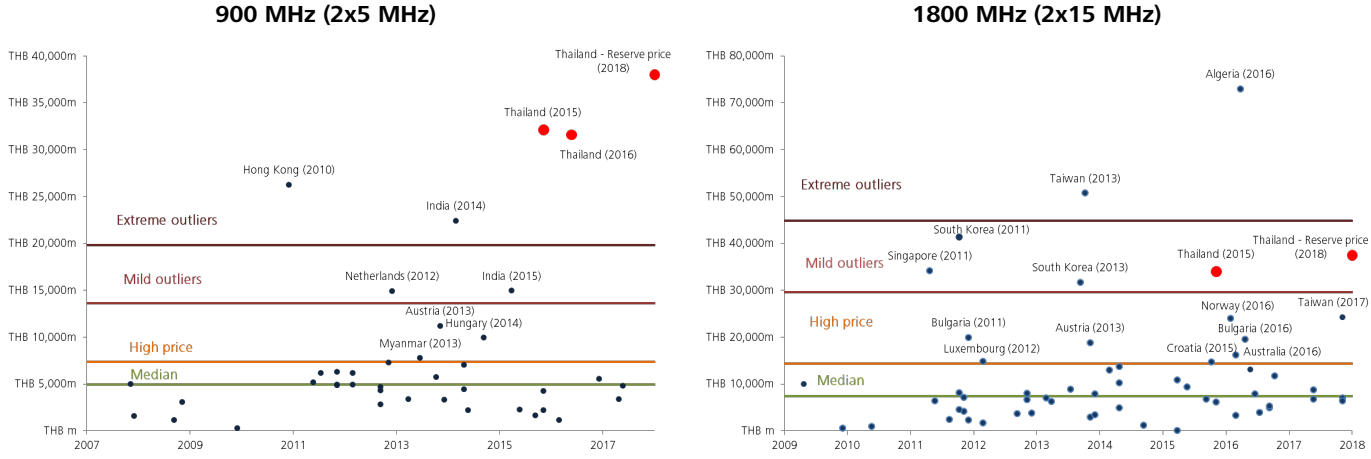
This means that spectrum currently being used to provide valuable mobile services to Thai consumers could be taken away from the market and warehoused for an indefinite period. The proposals also fail to consider the potential impact on downstream competition from withholding spectrum. In the 2015 auction, AIS and True secured access to spectrum which they likely view as a crucial to their ability to provide 4G services. In this auction, it is the other operator, dtac, that may be in a "must buy" situation. Taking spectrum away from the market inevitably increases competition in the auction above market-clearing levels. It also increases the risk that dtac might fail to win spectrum, which could raise concerns about future competition in the Thai mobile market given poor availability of spectrum for 4G.

Proposed reserve prices are amongst the highest in the world

In Figure 1, we compare the reserve prices set by NBTC for the available spectrum with prices paid for the same spectrum in other countries. We make a number of adjustments to prices, including using purchasing power (PPP) exchange rates to allow fair comparison across countries. The proposed Thai 900 MHz price is the highest in the world (some six times the global median for actual prices), and the price for 1800 MHz (three times the global median) has only been exceeded in three countries.

The NBTC apparently bases its reserve prices on the previous Thai auction in 2015. However, this is a poor benchmark for market value, which should be set by a marginal loser not based on the willingness to pay of a winning bidder. The original price was set by a new entrant bidder, Jasmine, which defaulted on its winning bids, implying it was bidding beyond its means. [1] Ultimately, AIS stepped in to buy the licences that Jasmine could not afford but had to pay Jasmine's inflated price, a price level it has rejected in the auction. Based on available data, it seems clear that AIS and True (the other winner) paid a significant premium over the real market price. A possible explanation is that these operators were concerned that, if they did not re-acquire sufficient spectrum they would have insufficient capacity to support their customer base.

Figure 1: **Thai reserve prices versus actual prices in other countries worldwide** [2]



The N-1 rule could prevent Thailand from catching up with other economies in release of spectrum for 4G

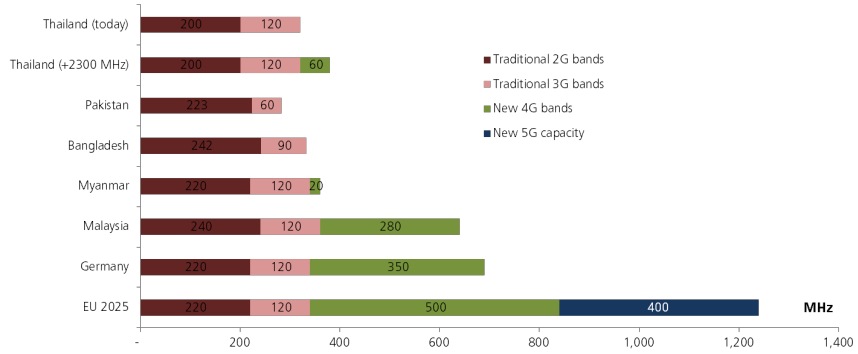
Owing to the success of 4G mobile broadband, mobile operators worldwide are experiencing unprecedented demand on their networks. While there are many ways that operators can increase and manage network capacity, ultimately more demand can only be serviced with more bandwidth … and that means more spectrum. Supported by the ITU (the United Nations specialised agency for information and communication technologies), spectrum regulators worldwide have anticipated this demand by identifying and releasing new frequency bands for mobile, and supporting refarming of existing bands, such as 900 MHz and 1800 MHz, for 4G use.

To date, Thailand has been one of the slower countries in responding to this new demand for spectrum. As illustrated in Figure 2, the 320 MHz of spectrum released for mobile in Thailand is: comparable to Bangladesh and Pakistan, and behind Myanmar, all countries with much lower per capita incomes; and only about half the volume of spectrum being deployed to provide mobile broadband in Malaysia and in most EU countries.

The forthcoming award of 900 MHz and 1800 MHz in Thailand is needed to support the future expansion of mobile data services for Thai consumers. Further releases, such as the 2300 MHz and 2600 MHz band, are also required. Given the 4G footprint that mobile operators have already established, additional spectrum could be put to use almost immediately to provide essential capacity, improve reliability, and increase both peak and average data speeds. Simply put, if Thai mobile operators had access to twice as much

spectrum than they have now, they could deploy this spectrum to double capacity at high-use base stations.

Figure 2: **Spectrum availability in Thailand vs other countries**



Source: NERA analysis based on data provided by dtac.

The N-1 rule is particularly harmful because it threatens to delay the deployment of spectrum. For example, if application of the rule required the regulator to "warehouse" 2x15 MHz of spectrum, that would be a roughly 10% reduction in capacity for Thai consumers in a country already lagging in the global league table for mobile spectrum release.

Such a bad outcome is likely if this rule is not changed as Thailand already has three established mobile operators, which is the structure in many mobile markets worldwide. In such markets, it is unrealistic for any regulator to assume that it can attract a viable entrant bidder, and this may be particularly true in Thailand given the track record of pricing spectrum above market levels.

Much like unused farmland, the loss to society from unused spectrum accrues continuously and can never be recovered. There is a well-established economic literature on this topic highlighting the potential huge scale of losses to consumers. For example, Hausman (1997) calculated the loss in consumer welfare associated with the 7-10 year regulatory delay in approving the widespread availability of mobile telephones in the United States at up to $24.3bn a year in 1983 dollars. [3] The risk of welfare losses in Thailand is magnified owing to the slow pace in release of new spectrum for mobile use.

No other leading regulator uses the N-1 rule; indeed, within Europe, our understanding is that such a rule may be interpreted as illegal given EU policy requiring regulators to release spectrum in a timely manner. A better approach may be to sell spectrum in base units of 2x5 MHz (paired) or 5 MHz (unpaired), rather than large blocks as proposed by the NBTC, and use auction formats that allow bidders to aggregate spectrum on a contiguous basis. This approach, which is now used by many regulators worldwide, gives operators maximum flexibility to target different amounts of spectrum, and allows for competition for incremental spectrum even in low participation scenarios.

The N-1 rule may not even be effective in increasing revenues. Although artificially restricting the availability of spectrum does typically increase prices paid for spectrum, the price premium may not be enough to offset the lost revenues from leaving spectrum unsold. Even if there was a short-term revenue upside, this may be outweighed by the long-term losses to the economy via reduced economic activity.

Inflated spectrum prices depress investment in 4G and discourage price competition for mobile data services

The most direct impact of inflated reserve prices is that they may lead to unsold spectrum. In this case, the government may be able to increase direct revenues by lowering reserve prices to ensure that all available spectrum is sold.

But are there further effects beyond this? Historically, many mobile industry observers argued that because upfront spectrum prices are 'sunk' (i.e. irrecoverable) they will not influence future investment and retail pricing decisions. However, such arguments are not supported by the latest theoretical and empirical work, as highlighted in NERA's 2017 global study on effective spectrum pricing for the GSMA. [4]

The GSMA study establishes a number of links between high spectrum costs, lower network quality and higher retail prices:

1. Hold-up. Spectrum awards are recurring transactions. The traditional sunk cost argument does not fully apply in this case because it ignores the repeated nature of auctions and network investments. When spectrum is priced above true market value, it reduces an operator's profits, which, to a large extent, are the returns on the investments that it has already made. In the short run, operators that need more spectrum may decide that they have little choice but to accept high prices. This may have been the case in 2015 for True and AIS, and may be the case for dtac in the upcoming auction. In the longer term, however, operators will respond by lowering their expected returns on future investments, which will reduce their overall investment and may even lead to market exit or consolidation. In the economic literature, this phenomenon is referred to as the "hold-up problem". [5]
2. Crowding out. Spectrum acquisitions are usually financed with internal funds, so high prices may result in other mobile investment projects being crowded out. Internal funding is cheaper than external funding, as external providers of finance have less information about the riskiness of investment plans. Other projects that rely on internal funding may be crowded out as their returns are insufficient to cover the higher risk premium of external financing. [6]
3. Lower investment. Many mobile operators are owned by multinational corporations or local conglomerates. Extorting returns on sunk investments through excessive spectrum prices lowers the expected returns on future investments. Investment by parent companies may then be redirected towards more profitable markets or ventures. Artificially high spectrum costs may therefore lead parent companies to allocate less investment funding to operators in high spectrum-cost markets. [7]
4. Higher consumer prices. Recent research in the field of behavioural economics demonstrates that firms do consider sunk costs when making pricing decisions. In particular, in sectors with imperfect competition in which firms have some degree of flexibility over the prices they set, researchers have observed a tendency for prices to inflate over the theoretically efficient level if sunk costs are increased. [8]

Fees for spectrum licences are therefore not a risk-free way for governments to raise revenues. The GSMA study highlights a number of countries – including Ghana, India, Jordan, Mozambique and Senegal – whose 4G ambitions have been set back as a result of spectrum going unsold and some operators failing to buy essential spectrum owing to high reserve prices. These examples are contrasted with the relative success of Morocco's 4G auction in January 2015, which allocated 4G spectrum to the country's three mobile operators at prices commensurate with the development of the local mobile market. Thai consumers will be the ultimate bearer of the costs of current policies and will pay in the form of lower quality mobile services at higher prices.

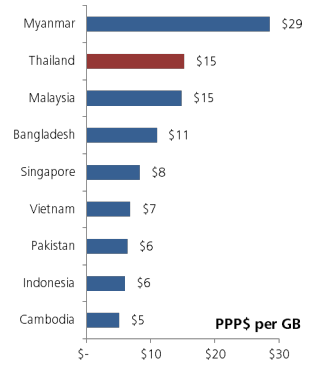
Removal of N-1 rule and lower reserve prices could lead to lower retail prices

Our understanding is that Thai consumers already pay more for mobile data than their peers in many other Asian countries. This is apparent from both ITU data and our own research for this paper, as illustrated in Figure 3.

Thai operators may be more reluctant to reduce data prices and/or increase data allowances than operators in other countries where spectrum costs are expected to be lower. AIS and True paid a combined THB 3,300 per subscriber, equivalent to THB 25 per subscriber per month over the course of their 15-year licences. [9] At least some of this will need to be recouped from consumers, presumably in the form of a lower quality experience and/or higher prices per GB than might otherwise have been the case. If similarly high prices are realised in this auction, whether because spectrum is withdrawn under the N-1 rule or reserve prices are set above the market level, the situation will only be made worse.

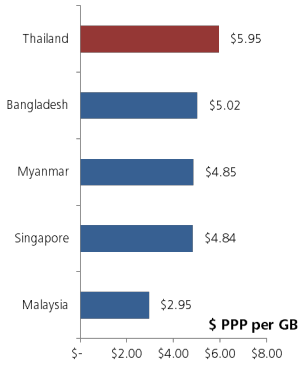
Figure 3: **Retail price comparison with neighbouring countries** [10]

ITU – price per GB of data



Source: ITU, 2016

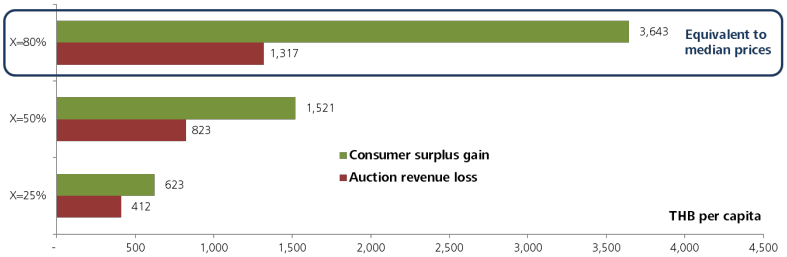
NERA – price of packages with ≥ 5GB of data



Source: NERA analysis, December 2017

In a recent paper, the authors used global data to estimate the relationship between higher spectrum prices and retail prices. [11] In Figure 4, we apply the relationship to Thailand. The results indicate that if prices for 900 MHz and 1800 MHz spectrum were reduced to median levels, Thais could gain THB 3,643 per person in consumer surplus over the 15-year licence term. [12] Consumer surplus measures the gain from lower data prices and associated increase in consumption. These gains are nearly three times the associated loss in auction revenues per capita of THB 1,317. The estimated benefits are also conservative, as we do not consider the wider impact on the economy.

Figure 4: **Indicative consumer surplus gain if spectrum prices are reduced by X%** [13]



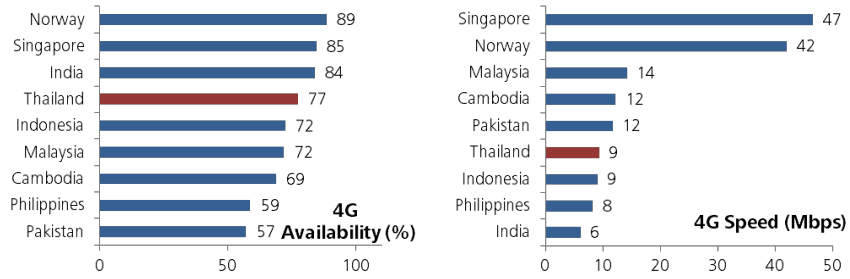
Source: NERA analysis.

Removal of N-1 rule and lower reserve prices could increase network quality

In our study on effective spectrum pricing for the GSMA, we also found empirical evidence for a link between high spectrum prices and lower network quality. This suggests that, consistent with the evidence highlighted above, higher input prices (for spectrum) discourage investments in infrastructure (mobile networks). Given the key role of mobile broadband as an enabler of economic growth, any underinvestment poses a risk to the Government's vision of Thailand 4.0.

The latest report from OpenSignal suggests that Thailand is already starting to fall behind its peers in terms of 4G network speed and quality, which may be the result of lower or inefficient investment. [14] Figure 5 shows that although 4G availability in Thailand is comparable to neighbouring countries, 4G download speeds lag behind. It appears that although Thai operators have invested heavily in availability, they have not been able to keep pace with the capacity expansion needed to support higher average data rates. [15]

Figure 5: **4G network quality in Thailand compared to other countries**



Source: Open Signal, 2017, State of the LTE network

If we apply the same high-level relationship between spectrum prices and investment that we identified in our GSMA work, we estimate that, all else equal, a reduction in spectrum prices for this auction to the global median price level could lead to a 13% increase in 4G speed. Such an increase would move Thailand up the Asian league table, ahead of Pakistan and Cambodia, but still behind Malaysia (see Figure 5). This estimated increase would have been much greater if Thai operators were not already burdened by the exceptionally high prices from the 2015 auction. [16]

The right way forward

Two immediate actions that the NBTC could take to greatly improve the likelihood of an auction outcome that is beneficial for Thai consumers are to:

- **Abandon the N-1 rule.** Without this rule, the risk that valuable spectrum goes unsold is greatly diminished, enabling a greater amount of 4G capacity to be rolled out in 2018 and beyond; and
- **Set reasonable reserve prices.** Best practice is to set reserve prices at modest levels, ideally below a conservative estimate of market value, and let the auction determine final prices. If the auction is well designed, this should ensure an efficient allocation and a fair return to the state, while avoiding inflated price outcomes that damage the industry and discourage investment and consumer price competition. For the forthcoming auction, we recommend prices are set no higher than the 2015 reserve prices, and ideally at a lower level.

Looking forward, the NBTC should consider two further measures:

- **Offer spectrum in smaller units.** In future auctions, such as the upcoming 2600 MHz auction, spectrum should be offered in smaller units that can be aggregated to form contiguous blocks. This facilitates competition for incremental spectrum instead and reduces the risk that an incumbent operator could leave the auction empty handed.
- **Commit to a roadmap for future spectrum release.** Thai mobile operators will need a lot more spectrum in the coming years to meet the demands of data-hungry consumers. Currently, Thailand is lagging behind many other countries in transitioning to advanced 4G and 5G. To avoid leaving the country stranded in a mobile data slow lane, a binding medium-to-long term roadmap is urgently needed to enable Thai mobile operators to access large volumes of spectrum at affordable prices.

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Authors

Richard Marsden is a Managing Director and leader of NERA's Radio Spectrum Practice, which focuses on the design of allocation mechanisms, including auctions and trading, bidding strategy, and related competition, pricing, regulatory, and public policy issues. Based in NERA's New York City and London offices, Mr. Marsden has 20 years of experience in microeconomics, political economy, and business consulting. He has worked for regulators and private companies in more than 40 countries across the Americas, Africa, Asia Pacific, and Europe. He has particular expertise in auction design and in applying economics to the telecommunications and media sectors.

Hans-Martin Ihle is a Senior Consultant in NERA's Tokyo office, specialising in auctions and spectrum policy. Mr. Ihle has nearly 10 years of experience in the design and implementation of spectrum auctions. As a member of NERA's global Auctions Practice, he advises clients on auctions and regulatory issues in communications, energy, and other sectors worldwide, with a focus on the Asia Pacific region.

Contact

For further information and questions please contact the authors:

Richard Marsden
Managing Director
New York: +1 212 345 2981
richard.marsden@nera.com

Hans-Martin Ihle
Senior Consultant
Tokyo: +81 3 3500 3784
hans.ihle@nera.com

Notes

[1] *Siong, 2016, Thai-break? Lessons from the 900MHz and 1800MHz auctions, DotEcon Discussion Paper 16/01*; and *Ihle, 2016, Spectrum license assignment in the Asia-Pacific region, presentation at the 2nd Annual Asia-Pacific Spectrum Management Conference*.

[2] Licence prices converted to USD using IMF PPP exchange rates, adjusted for inflation using US CPI and adjusted for comparable licence duration (15 years) using standard discounting techniques and a WACC of 5%. Prices are for a comparable licence of 2x15 MHz in 1800 and 2x5 MHz in 900 MHz covering the Thai population.
In order to identify outliers we used a standard statistical technique. The IQR is defined as the observations between the 1st and 3rd quartile. Outliers are classified as being above an "inner fence", and extreme outliers are classified as being above the "outer fence." Inner fence = 3rd quartile + 1.5*IQR. Outer fence = 3rd quartile + 3*IQR. High price = 3rd quartile.

[3] *Hausman, J. (1997), Valuing the effect of regulation on new services in telecommunications, Brookings Paper on Economic Activity, Microeconomics, 1-38*, available at: http://www.brookings.edu/~/media/Projects/BPEA/1997%20micro/1997_bpeamicro_hausman.PDF

[4] *GSMA, February 2017, Effective Spectrum Pricing*, available at: gsma.com/spectrum/wp-content/uploads/2017/02/Effective-Spectrum-Pricing-Full-Web.pdf

[5] Hold-up occurs when the return on one party's sunk investments can be expropriated *ex post* by another party. In the case of spectrum licences, the government can expropriate the returns on other sunk investments (such as in network infrastructure) made by a mobile operator by overcharging for access to spectrum. The hold-up problem has played an important role as a foundation of modern contract and organisation theory. The associated inefficiencies have justified many prominent organisational and contractual practices. See for example, *William P. Rogerson, "Contractual Solutions to the Hold-Up Problem", Review of Economic Studies, Vol 59, 1992, p. 777-794*.

[6] This is referred to as the pecking-order theory and was developed by Myers and Mailuf (1984). *Stewart C.* Myers and *Nicholas S. Majluf, "Corporate financing and investment decisions when firms have information that investors do not have", Journal of Financial Economics, 13 (2): 187–221.*

[7] McAfee, Mialon, and Mialon (2010) refer to this effect as "de-escalation" or "reverse sunk-cost effect" owing to financial constraints. *McAfee, Mialon, and Mialon, "Do Sunk Costs Matter?", Economic Inquiry, Vol. 48, No.2, 2010, p. 323-336.*

[8] Relevant references include: *Offerman and Potters, "Does Auctioning of Entry Licences Induce Collusion? An Experimental Study", Review of Economic Studies, Vol. 73, 2006, p. 769-791*; and *Buchheit and Feltovich, "Experimental Evidence of a Sunk-Cost Paradox: A study of Pricing Behaivor in Bertrand—Edgeworth Duopoly", International Economic Review, Vol. 52, 2001, p. 317-347.*

[9] The net present value of THB 25 every month for 15 years at a 5% discount rate is equal to THB 3,300.

[10] The first chart is from *ITU, 2016, Measuring the Information Society.* The second chart is compiled based on NERA's analysis of retail prices for mobile data plans with 300+ minutes, 300+ SMS and at least 5GB of data as a typical package for a "data-hungry" subscriber.

[11] *NERA, May 2017, The Impact of High Spectrum Costs on Mobile Network Investment and Consumer Prices*, available at: http://www.nera.com/content/dam/nera/publications2017/PUB_High_Spectrum_Costs_0517.pdf

[12] This assumes that reserve prices effectively set the final price. Consumer surplus is discounted using a 5% discount factor.

[13] We use the demand curve estimated in NERA, May 2017, p.12, to derive the estimates provided here. We assume that only the three established operators participate in the auction which, under the N-1 rule, would mean that only 2x30 MHz of 1800 MHz would be available.

[14] The Open Signal report is available at: https://opensignal.com/reports/2017/11/thailand/state-of-the-mobile-network.

[15] Thai mobile operators have apparently attempted to compensate for lack of spectrum availability by investing heavily in their networks. Dtac tell us that, in total, the three operators have raised the number of base stations by more than 35% in the last three years, from approximately 55,000 in 2015 to approximately 75,000 in 2017. Although such densification is very costly it has not been sufficient to enable Thai operators to grow capacity fast enough to keep pace with the rapid growth in demand for mobile data.

[16] The empirical model developed for the GSMA report takes into account all outlays for spectrum since 2008. Past mistakes such as the 2015 auction have tied up significant capital and cannot be corrected by a single well-run auction in the future. The model predicts that if the 2015 auction had ended at half the price, a reduction of current reserve prices by 80% could improve network quality by 38%.