The Tanzania Communication Regulatory Authority Multi-Band Spectrum Auction

A review of the TCRA's multi-band spectrum auction and the learning for other regulators seeking to award spectrum to support the development of mobile broadband and 5G

July 2023

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Insights from the TCRA's multi-band spectrum auction

Introduction

The TCRA's recent spectrum auction met the government's objectives but this was due to luck rather than judgement

In October 2022, the Tanzania Communications Regulatory Authority (TCRA) announced the results of its multi-band spectrum auction for spectrum in the frequency ranges 700 MHz, 2300 MHz, 2600 MHz and 3500 MHz bands. The auction raised a total of US$ 187 million and the results were broadly consistent with the levels indicated by benchmarks. Whilst there were a number of positive features of the award process, the choice of auction design, a series of sequential, first-price, sealed bid auctions, would have created significant challenges for bidders and risked the economic efficiency of the outcome. The TCRA appears to have been successful in achieving its auction objectives, but this is more likely to be due to luck, rather than judgement.

In this paper we describe the key features of the award process and highlight some of the positive features, as well as several flaws in the auction design.

Auction objectives

Generating revenue was the primary objective for the award process

The National Information Communications and Technology Policy, 2016 (National ICT Policy) of Tanzania sets out the primary objectives of telecoms policy and spectrum management. One objective pertinent to the auction was as follows:

"To strengthen management and promote efficiency in spectrum allocation and utilisation that guarantees its availability and competition in both urban and rural areas."

When regulators discuss "efficiency" this is usually defined in economic terms and implies that spectrum should be assigned to the operators that will generate the greatest socio-economic value from the use of the spectrum. We will see later in this paper that the objective of efficiency was put at risk by the auction design. However, the published Information Memorandum also stated:

"…the general objective of the auction is to obtain the optimal value of scarce radio frequency spectrum resource."

This suggests that revenue raising was the primary objective and that economic efficiency was a secondary consideration.

Spectrum to be auctioned

The blocks (lots) available in the auction comprised:

- one block of 2 × 10 MHz of spectrum in the 700 MHz band;
- two blocks of 1 × 35 MHz spectrum in the 2300 MHz band;
- three blocks of 2 × 15 MHz in the 2600 MHz band;
- one block of 1 × 20 MHz of spectrum in the 2600 MHz band; and
- four blocks of 1 × 40 MHz spectrum in the 3500 MHz band.

Successful bidders would be awarded contiguous spectrum subject to a number of caps. The caps were such that bidders could not hold more than:

- 2 × 35 MHz of sub 1 GHz spectrum after the conclusion of the auction;
- two blocks of 1 × 35 MHz spectrum in 2300 MHz band after conclusion of the primary stage of the auction;

- two blocks of 2 × 15 MHz FDD spectrum in 2600 MHz band after conclusion of the primary stage;
- two blocks of 1 × 40 MHz of 3500 MHz spectrum after conclusion of the primary stage; and
- three blocks after secondary stage of the auction.

However, bidders could apply for more spectrum above the cap and they would potentially receive some or all of these additional requests if there was any unsold spectrum from the first round. In addition, bidders could acquire a 1 × 20 MHz TDD block in addition to the FDD spectrum cap imposed in 2600 MHz.

Reserve price levels

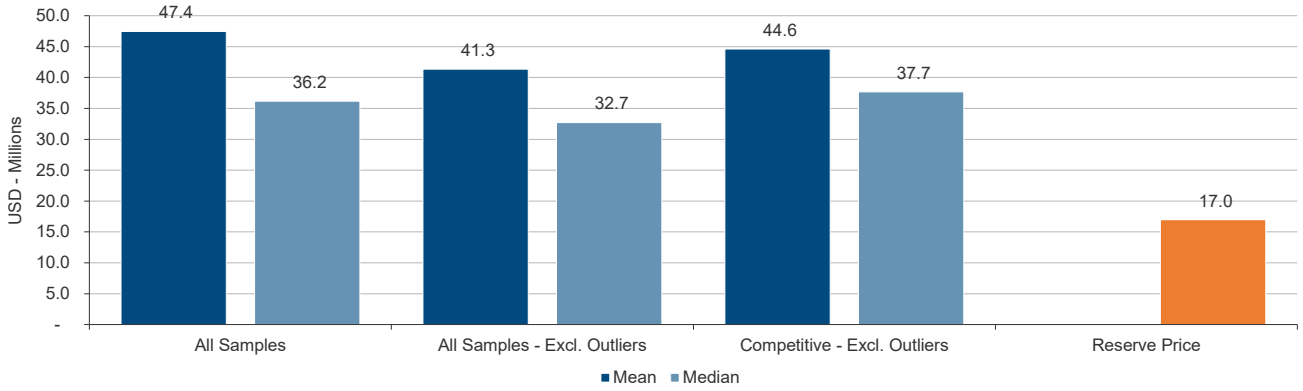
Reserve price levels were generally reasonable

The reserve price defines the minimum bid a bidder must be prepared to make in the auction. Until relatively recently, African regulators had sometimes set unrealistically high reserve prices that often resulted in partial or full auction failure. However, in recent years, reserve price levels have been set at more sensible levels.

Regulators often use spectrum auction benchmarking to provide a guide to the market value of spectrum. Best practice is generally to set a low but non-trivial reserve price, as the risks of setting the price too high are significantly greater than setting the price too low. As a rule of thumb, we typically recommend that the reserve price is set at 25 to 50% of the estimated market value.

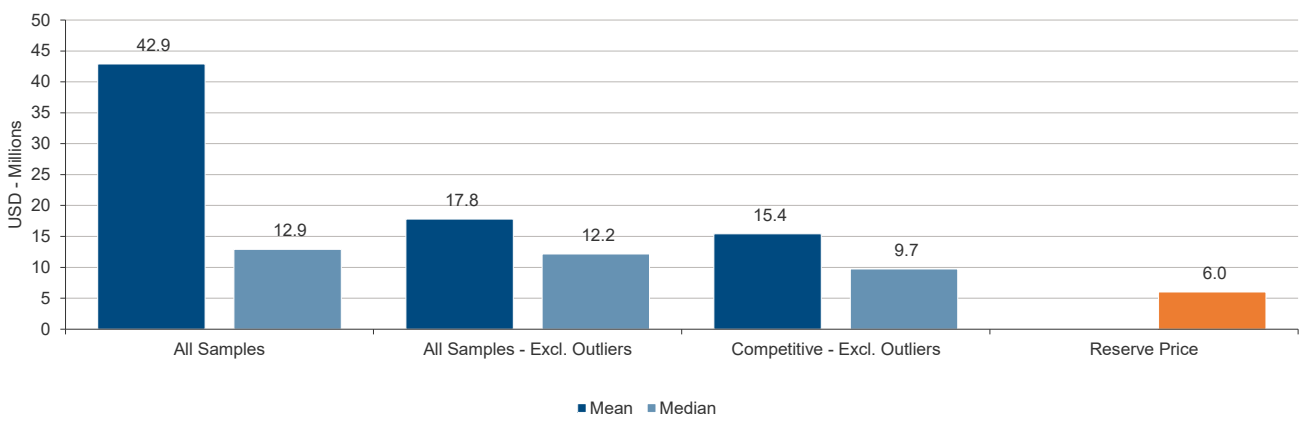
The exhibits below compare the reserve price levels with the results of an auction benchmarking study based on Coleago's spectrum auction database. As the charts show, the TCRA generally set the reserve price at a reasonable discount to market values, with the exception of 3.5 GHz spectrum which was fully priced. The TCRA should be congratulated on taking a sensible approach to reserve price levels.

Exhibit 1: 700 MHz



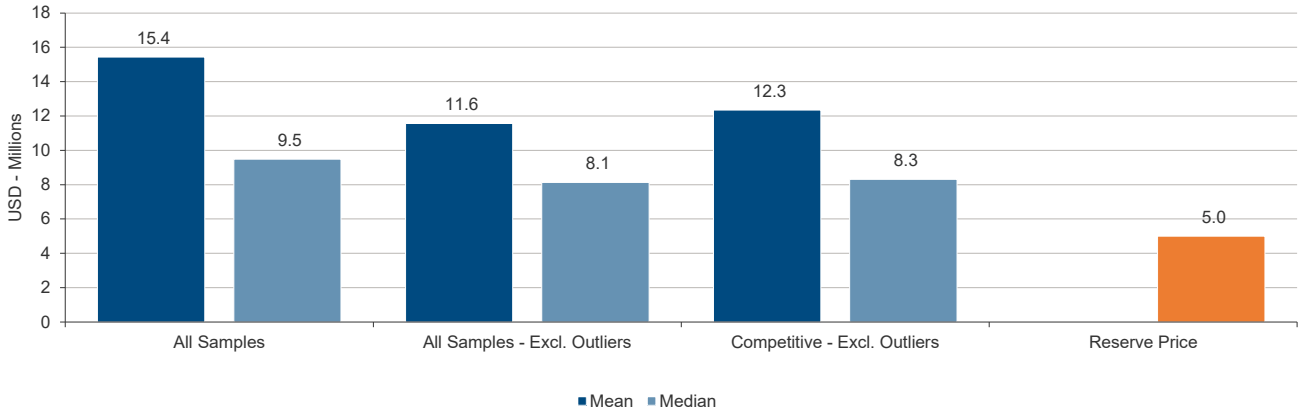
Source: Coleago spectrum auction database

Exhibit 2: 2300 MHz



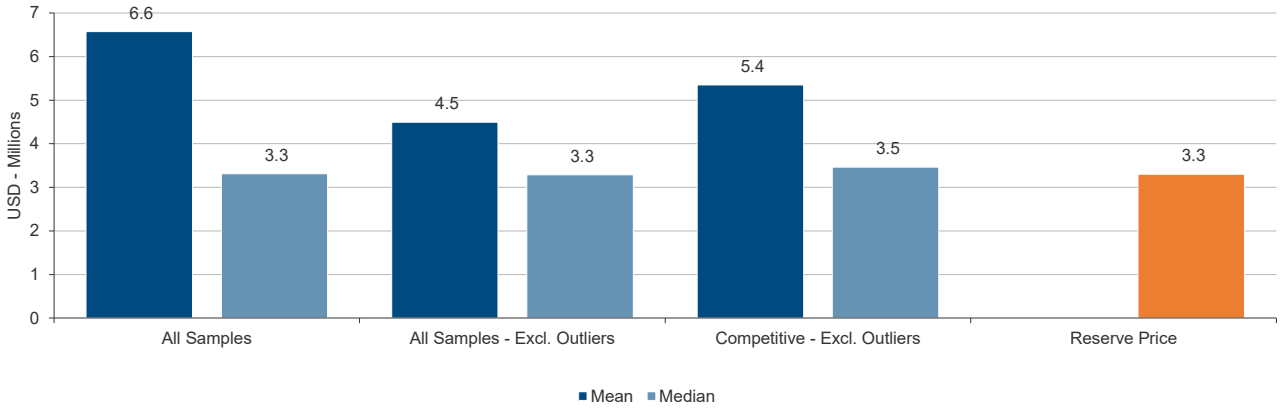
Source: Coleago spectrum auction database

Exhibit 3: 2600 MHz FDD



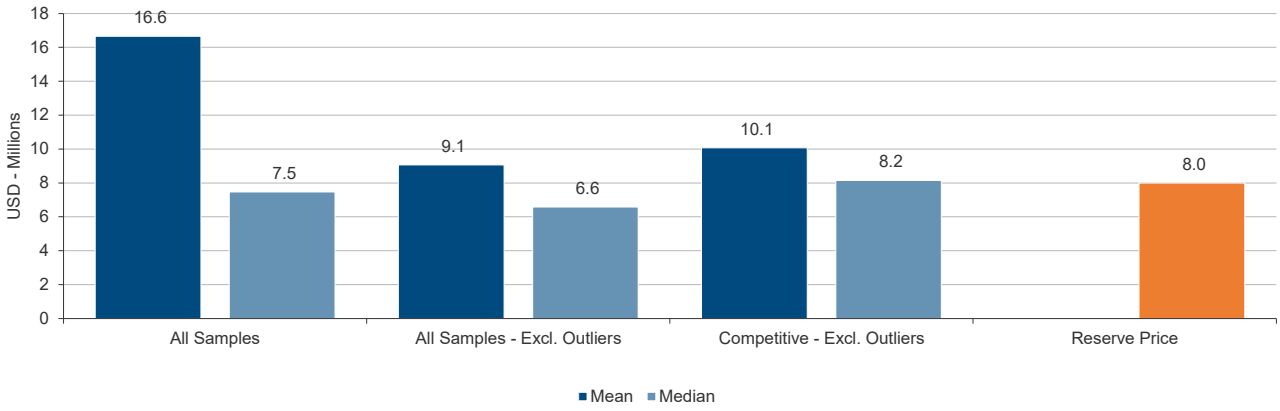
Source: Coleago spectrum auction database

Exhibit 4: 2600 MHz TDD



Source: Coleago spectrum auction database

Exhibit 5: 3500 MHz



Source: Coleago spectrum auction database

Coverage obligations

Coverage obligations were not particularly demanding

A regulator seeking to maximise the revenue generated from an auction faces a trade-off when setting coverage obligations. Demanding obligations which seek to expand mobile broadband into increasingly rural areas generate significant socio-economic benefits, but they also reduce the value of the spectrum to the operator and the potential revenue that can be raised through the award process.

The TCRA imposed an obligation of 90% population coverage by the end of 2028 and 95% by the end of 2033. Given that operators had more than 10 years to meet this obligation, it was not particularly demanding. The obligation was technology neutral which is consistent with best practice. No obligations were attached to the 2300 and 2600 MHz bands as these were seen as capacity bands, and the requirement to have a 3.5 GHz presence in at least six different administrative regions by 2025, and all regional headquarters by the end of 2032, was also not particularly challenging.

Very demanding obligations can result in spectrum being unsold, as was the case in the recent ICASA spectrum auction in South Africa. The 700 MHz obligations set by the TCRA were designed to promote higher levels of coverage as they were more demanding than the obligations imposed in the 2018 award, but generally the obligations would have supported reasonably high valuations for the operators.

Licence term and renewal

The licence duration was sufficiently long to encourage investment

The licence duration was set at 15 years from the issuance date which was reasonable (longer is generally preferred) as long licence durations promote higher levels of investment. A regime of renewal in favour of the licensee (subject to efficiency, market competition, technological developments) is also positive for investment and should be applauded.

Timings

Bidders were not allowed sufficient time in which to prepare

The Information Memorandum was published on the 15th August 2022 and the application deadline was set for the 28th September of the same year. This gave operators just over six weeks in which to review the IM, raise questions, await the publication of answers to the questions and publication of the final IM, develop their spectrum valuations and auction bidding strategies, arrange financing and seek the required approvals at the local and group level boards.

Six weeks is too short to complete these tasks well. A valuation exercise typically takes at least six to eight weeks and approvals often require an additional two weeks. We

generally recommend that a minimum of two months is allowed and ideally three months or more.

Auction design

The choice of auction format was the weakest aspect of the award process

Academics often refer to the revenue equivalence theorem (RET)[1] when considering auction design. The theorem states that, under certain conditions, any auction format that awards the item to the bidder with the highest valuation (an efficient outcome) and induces truthful bidding will yield the same expected revenue for the auctioneer. Therefore, in theory at least, the TCRA could have chosen from a range of efficient auction designs and achieved the same level of auction proceeds. Different levels of auction revenues can be obtained, but often they can only be achieved by compromising on the efficiency of the auction.

The TCRA selected a sequential series of first-price, sealed bid auctions to assign the different spectrum bands at the generic level. A sequential series of auctions means that each band was auctioned in turn, one after the other. This meant that when bidding in an earlier auction, a bidder would not know whether they would be successful in future auctions. A first-price, sealed bid auction requires bidders to (secretly) write their bid in an envelope and then the highest bidder wins and if there are blocks remaining, the second highest bidder wins some or all of its requested spectrum and so on until all the spectrum is assigned. The winners pay the amount they bid. An administered process would then determine the specific blocks allocated to bidders.

For participants in the auction, this was potentially one of the worst possible auction designs that could have been chosen as it would have presented them with significant risks. In the remainder of this section, we highlight some of the key risks facing bidders.

Exposure risk

Spectrum blocks can be complementary or substitutes.

Bidders faced exposure risk when bidding

Complementary spectrum blocks are blocks where the value of the combined blocks is greater than the sum of the value of the individual blocks. For example, the value of adding a second block of 3500 MHz spectrum to an existing block will result in a much higher valuation for the two blocks as the second block will double the capacity but will require minimal additional investment to deploy it.

In the TCRA auction, bidders faced exposure risk. A bidder might have bid for two blocks based on their combined, synergistic valuation. However, they face the risk that they would only be awarded one block which would have a lower valuation. They would have to pay a price that assumed they won two blocks but they only receive one block which would have a value below the price they had to pay for it resulting in the destruction of value. Bidders therefore might decide to reduce their bids in order to lower the loss they face if they were only to win one block. The result might be an inefficient auction outcome and lower auction proceeds.

It is worth noting however that the large block sizes for spectrum in the 2300 and 3500 MHz are likely to have been sufficiently large to create positive value for winners. Our work with mobile operators indicates that a minimum of around 40 MHz is required to justify the investment required to deploy the spectrum. The TCRA's choice of block sizes would therefore have mitigated against the risk of paying for a small allocation with a negative valuation but exposure risk would have remained.

[1] Vickrey (1961) and Myerson (1981)

Substitution risk

Bidders also faced substitution risk when bidding

Some spectrum bands are substitutes for each other. For example, 2300 and 2600 MHz bands offer similar benefits in terms of capacity. A bidder seeking to add capacity spectrum to its portfolio may want either 2300 or 2600 MHz but not both. The problem with a sequential series of auctions is that a bidder bidding in the first auction does not know the price it might have to pay for substitute spectrum in a later auction. A bidder may decide to bid in the first auction and win and then learn that it could have won substitute spectrum at a lower price in the later auction and would then regret not having waited until the later auction. Alternatively, a bidder might wait for the second auction and end up paying a higher price than the price achieved in the first auction and then regret not having bid in the first auction. Bidders have to guess what they think the likely outcome in future auctions will be and then bid in the earlier auctions based on those guesses. If the guesses are incorrect this can result in bidding errors which can lead to inefficient auction outcomes.

Inefficient outcomes

A first-price, sealed bid auction is not efficient

First-price, sealed-bid auctions can generate inefficient outcomes. Suppose two bidders are bidding for one block of spectrum. Bidder A values it at 100 and Bidder B values it at 110. An efficient outcome would see the block awarded to Bidder B and the price would be determined by the value of the block to the strongest, losing bidder, i.e., 100.

In a first-price, sealed-bid auction it never makes sense to bid more than your value as if you win you lose money. It also does not make sense to bid your value because if you win you have neither made or lost money, so there is no point in bidding your value. It therefore only makes sense to bid less than your valuation. The problem is that it is impossible to determine with confidence how much less to bid than your value. Suppose Bidder B decides to bid 80 and Bidder A decides to bid 90 (both bids are below their respective values), then Bidder A will win but from an efficiency perspective, Bidder B should have been awarded the spectrum. Also note that Bidder B would have been prepared to pay more than 90 and could still have created value.

Regret risk

Bidders paid different amounts for similar spectrum which is not equitable

If you went to the supermarket to buy a loaf of bread and you paid US$ 1 and then learnt that someone else had only paid US$ 0.50 for an identical loaf, it may leave you feeling unhappy because this would not be equitable. In a first-price, sealed bid auction, bidders can end up paying very different amounts for identical spectrum. This is exactly what happened in the Tanzanian auction. The results of the auction are shown in the table below.

Exhibit 6: Auction results

Bidder	Band	No. of blocks	Total USD millions	Per block USD millions
Vodacom	700 MHz (FDD)	1	25.6	25.6
	2300 MHz (TDD)	2	34.4	17.2
	2600 MHz (TDD)	1	3.3	3.3
Airtel	3500 MHz (TDD)	2	21.1	10.6
	2600 MHz (FDD)	2	39.0	19.5
MIC (Tigo)	3500 MHz (TDD)	2	34.0	17.0
Viettel (Halotel)	2600 MHz (FDD)	1	30.2	15.1
Total auction proceeds			187.5	

Source: TCRA

Airtel paid US$ 10.6 million per block for 3.5 GHz whilst MIC paid US$ 17.0 million, a premium of over 60%. Airtel paid US$ 19.5 million for 2.6 GHz FDD and Viettel paid US$ 15.1 million, a premium of nearly 30%.

Coleago has worked alongside many mobile CEOs in auctions. CEOs are generally competitive individuals and do not like to be seen to have overpaid. Whilst it should not matter if you paid more than a competitor provided you paid less than your valuation, it does matter to CEOs, and they will often bid to try and minimise the risk of regretting having paid more than they needed to. This can also give rise to inefficient auction outcomes.

Furthermore, auction outcomes where different bidders pay dramatically different amounts for essentially the same thing are often regarded as inequitable and unfair. Many regulators prefer auction outcomes that are perceived as being reasonable and fair by the public.

Results of the Tanzanian auction

The TCRA achieved its objectives but more as a result of luck than judgement

All the spectrum was sold and the Tanzanian auction raised US$ 187.5 million overall, which is broadly consistent with the proceeds indicated by auction benchmarks and therefore suggests that the auction achieved the goal of raising a significant amount of revenue. Whether an efficient auction design, such as a simultaneous multi-round ascending auction, would have generated higher levels of revenue is impossible to determine. However, the three largest players, Vodacom, Airtel and MIC secured the majority of the spectrum and so the outcome is likely to have been broadly efficient. The auction appears to have broadly met the TCRA's objectives but as we have argued above, this is more likely due to luck than judgement given the major risks that the chosen auction format created.

Summary of key insights

The TCRA should be applauded for a number of aspects of the award process:

- making spectrum available in a timely manner;
- setting (on the whole) reasonable reserve prices;
- setting sensible coverage obligations which were consistent with their auction objectives and which were technology neutral; and
- adopting a reasonably long licence duration of 15 years and providing confidence that winners would be able renew their spectrum.
- However, there were several key issues with the TCRA award process:
- insufficient time was available for operators to comfortably prepare for the auction;
- the sequential nature of the auction created significant risks for bidders and compromised the efficiency of the auction; and
- the use of a first price, sealed bid auction format also compromised efficiency and resulted in bidders paying materially different amounts for similar spectrum which may not be regarded as equitable.
- Some form of a simultaneous, multi-round ascending auction format would not have entirely eliminated all the risks that bidders would have faced, but it would have reduced them considerably compared to the chosen design. Such a design is likely to have raised similar levels of revenue, reduced the risk of bidding errors and, as a result, would have increased the chances of an efficient assignment.

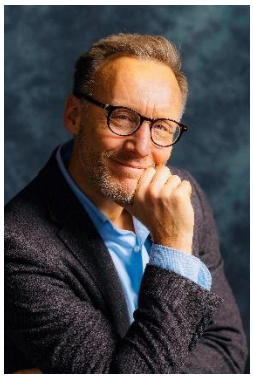
How Coleago can help

An understanding of spectrum from an operator's perspective is key to developing appropriate spectrum management strategies

Coleago has over 20 years of experience in advising both operators and regulators on issues related to spectrum including spectrum management strategies, roadmaps, pricing and award process design and implementation, including auctions. We can provide regulators with the "operators' perspective" to ensure that our recommendations take account of the practical real-world realities faced by mobile operators to ensure that our regulatory advice will achieve the regulator's objectives.

About Coleago Consulting Ltd

Graham Friend, M.A., M.Phil., (Cantab), ACA, is an economist, an award-winning author and the Managing Director and co-founder of Coleago Consulting. Coleago is a specialist telecoms strategy consulting firm and advises regulators and operators on issues relating to spectrum, regulation and network strategy. If you would like to discuss any of the issues raised in this paper, then please contact Graham.



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