



Best Practice in Mobile Spectrum Licensing

GSMA Public Policy Position

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Executive summary



Mobile services are the main means of communications for the majority of the world's population, supporting economic growth and connecting communities. Effective spectrum licensing is critical to encourage the investment required to expand mobile access, meet the increase in demand for data services and enhance the quality and range of services offered.

At its core, a licensing framework should:

- ensure operators have access to sufficient spectrum
- provide predictability to support the new network investment needed
- avoid costly restrictions on the use of spectrum beyond those needed to manage interference

This report considers major policy issues arising from spectrum management. It also looks at the advantages and disadvantages of different approaches available to address these issues.

There is no single best approach to assigning spectrum. Instead, success depends on tailored approaches which consider specific market conditions. These should consider policy objectives as well as market conditions, considering current spectrum use, the competitiveness of the market, and the promotion of investment in mobile networks.

The GSMA believes in a number of core principles in spectrum assignment:

1. Predictable and timely spectrum licensing encourages long-term network investment.

Mobile networks require predictable access to spectrum in low-, mid- and high-bands. Predictability is the result of national broadband plans and spectrum roadmaps. Broadband plans set out connectivity goals and how to achieve them, while the roadmap should provide a schedule for forthcoming spectrum releases.

2. Auctions deliver social benefits... but must be properly designed.

Auctions are a proven means of awarding spectrum to those who are most likely to put it to the best use. However, poor auction design can lead to inefficient or failed assignments that undermine competition. Administrative assignment can be considered in some circumstances.

3. A presumption of licence renewal encourages long-term network investment.

Clear and timely renewal decisions are crucial to mobile network development. They give mobile operators the certainty needed to make large long-term investments in mobile services. A decision not to automatically renew a licence should only be made in exceptional circumstances, where the benefits from reassigning spectrum would exceed the costs.

4. High spectrum prices jeopardise the effective delivery of wireless services.

Seeking to maximise state revenues from spectrum can have a negative socio-economic impact. Research shows there are strong links between high spectrum prices and slower network speeds as well as lower coverage. Licensing authorities should set reserve prices conservatively and then allow the market to determine a fair price.

5. Where spectrum is auctioned, ongoing charges should be limited to recovering the cost of spectrum management.

After auction, any other fees associated with licence continuity and renewal should not deter investment. Onerous ongoing fees can discourage technological innovation and drive consumer prices up.

6. Spectrum licences should be technology and service neutral.

Technology neutrality enables spectrum to be used efficiently by mobile operators rather than being tied to declining technologies and services. It allows consumers to get access to the most effective, spectrally efficient technologies. Charges for change of use risk delaying benefits.

7. Licence conditions should be used with caution.

Licence conditions, other than those relating to co-existence, should be kept to a minimum or removed entirely. Other objectives, including coverage requirements, can be effectively addressed through direct policy measures or by improving the conditions for offering commercial services (such as via tax benefits). Costs related to established conditions should be deducted from spectrum fees.

8. A licence duration of at least 20 years will incentivise network investment.

Just like many other measures highlighted here, a 20-year or longer license period offers the certainty mobile operators need to expand and upgrade networks. The use of indefinite licence terms can further enhance the willingness to invest.

9. Competition can be supported by licensing as much spectrum as possible while limiting charges and other barriers to services.

Specific measures to increase competition, such as spectrum caps or set-asides, are a last resort. Before implementing them, governments should assess the benefits and costs of alternative options. In many cases, additional spectrum can bring the greatest benefit to society when it is made available to existing operators for the network expansion necessary to meet demand.

10. Voluntary spectrum sharing, leasing and trading promote efficient spectrum use.

Voluntary sharing can support improved mobile services by enabling unused, or lightly-used, spectrum to be shared, transferred, or leased to operators who can use it more efficiently.

Approaches to assigning spectrum



Realising the potential of mobile broadband requires governments to release as much spectrum as possible as quickly as possible. Certainty over future rights of use drives network investment.

Licensed spectrum is required for mobile services to ensure quality of service and customer value. This, in turn, facilitates the investments needed to deploy mobile networks with wide.

The licensing of particular spectrum bands for mobile services supports international harmonisation, which delivers lower cost devices and equipment through economies of scale. Dynamic spectrum access techniques enable specific spectrum bands to be shared between multiple uses by avoiding signals being transmitted at the same time. However, exclusive licensing has been central to the success of mobile and any spectrum sharing mechanisms should be considered as a complementary possibility¹.

Overall benefits to society will be maximised where importance is attached to promoting efficient spectrum use and ensuring competitive communications markets. Using spectrum management to pursue government revenue generation can carry significant overall costs to society.

1. <https://www.gsma.com/spectrum/wp-content/uploads/2021/06/Spectrum-Sharing-Positions.pdf>

A range of objectives may be considered by authorities when assigning spectrum licences, including:

- Promoting the efficient use of spectrum
- Ensuring that the spectrum is put to its highest value use
- Supporting competition
- Ensuring service continuity for end-users
- Having a well-run, timely and legally robust process
- Achieving policy goals
- Generating revenue to government

Generally, societal benefits are maximised when policies promote efficient spectrum use. Exploiting spectrum assignments to pursue government revenue generation can carry significant overall costs to society.

For example, limiting the amount of spectrum often results in high spectrum prices and increased revenue. However, research shows this is also likely to increase the cost of mobile services and constrain the growth of sectors that rely on mobile communications. Governments have a greater revenue-generating opportunity in the long-term by supporting economy-wide growth powered by high-quality and affordable connectivity.

Competition in mobile communications markets can generally be achieved through making sufficient spectrum available to support several networks at efficient scale.

General approaches for assigning spectrum

Auctions are the main approach used for assigning the rights to use a particular spectrum band, while sometimes administrative assignments (e.g., beauty contests) are also used where demand is expected to be lower than the supply of spectrum. Sometimes, a hybrid approach may also be used where the licensing authority initially selects a shortlist of bidders based on administrative criteria and then holds an auction to assign the licence amongst the shortlisted candidates.

There is no single best assignment approach. Instead, there is a need to assess the merits of each on a case-by-case basis. Auctions remain the most common methodology around the globe and work best when there is excess demand for the

spectrum and help select those operators most likely to put it to the best use in benefitting society. Administrative assignments, on the other hand, may be suitable in certain cases where there is less demand and may allow authorities to compare the range of policy objectives offered by the candidates.

Whatever approach is chosen, it must be implemented with care. This includes identifying issues through public consultation, weighing up the trade-offs in specific design choices (noting the importance of efficient spectrum use and safeguarding competition). Sufficient time and transparency must be provided to allow potential candidates to make informed decisions.

| | Advantages | Disadvantages |
|----------------------------------|---|---|
| Auctions | <p>Well-designed auctions result in spectrum being assigned to the operators who value it most and will generally use it to improve connectivity</p> <p>Auctions seek to discover the market value of spectrum and obtain a fair return</p> <p>Outcome is typically transparent and legally robust</p> | <p>Poor auction design can lead to spectrum being assigned inefficiently or in way that harms competition in communications markets</p> <p>Inflated prices risk restricting the licensee's ability to invest in their network</p> |
| Administrative assignment | <p>Enables a range of criteria to be taken into account and for authorities to balance the trade-off between objectives</p> <p>Authorities can select the level of the licence fee, which may improve operators' ongoing financial viability and assist in raising capital for network investment</p> <p>Ability to set network investment or coverage requirements to focus on delivering high quality services rather than raising state revenues</p> <p>-Can be quick and affordable to organise</p> | <p>Licences may be assigned to the candidate that presents an attractive proposal rather than the candidate that can make best use of the spectrum</p> <p>When operators fail to meet commitments after the auction, authorities may face difficult choices as to whether to cancel the licence or otherwise penalise the operator</p> <p>Administrative assignment is vulnerable to bias or corruption. Even the perception of such issues can lead to protracted legal disputes that delay spectrum being put to good use</p> |

Auction Design

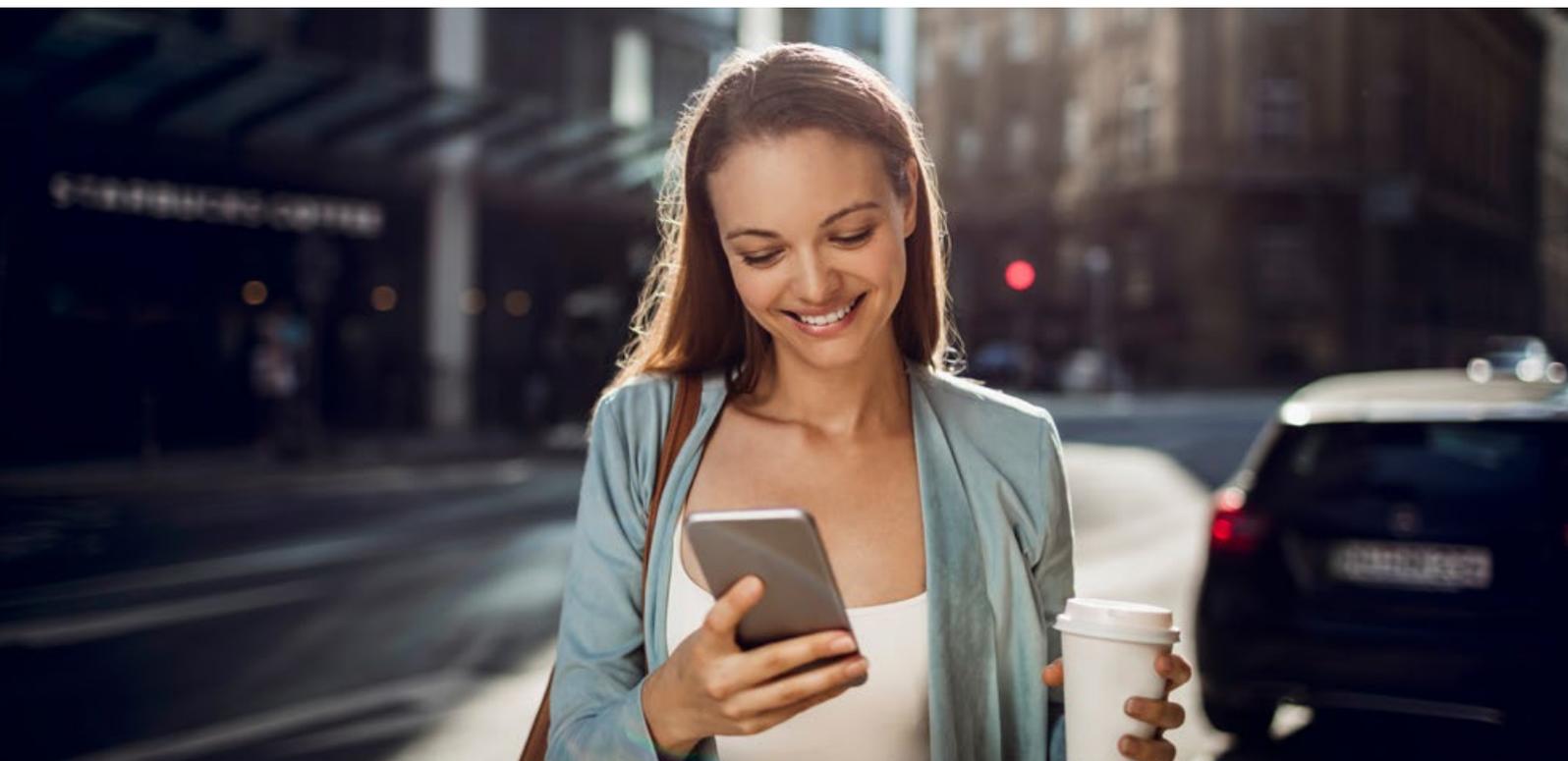
The GSMA's full positions on auction approaches can be found in its [Auctions Best Practice Public Policy Position](#).² This section includes a short overview.

Auctions have attractive properties and can lead to efficient spectrum use but their advantages can be undone by problems in the auction design and rules.

There is no single best auction format. For regulators, a challenge in auction design is managing the objectives of achieving efficient spectrum assignment while supporting competition in communications markets. Seeking to maximise auction revenues risks much greater costs to society, especially the digital economy, if competition in communications markets is undermined and network investment is limited as a result. Low participation can be a concern, especially in mature mobile markets. There are, however, a wide variety of tools available to regulators to address these issues.

When using auctions to award spectrum, major design issues that need to be addressed include:

- Avoiding coordinated or collusive outcomes in the auction:**
Participants have the incentive to limit competition in the auction and achieve lower prices. In some cases, the auction rules may enable explicit collusion and allow bidders to form joint ventures. In other cases, bidders may be able to tacitly collude, including through using their bids to signal how the bidders would like to divide up the available lots.
- Supporting price discovery and truthful bidding:**
Where the auction design enables bidders to discover information about market value based on bids by other operators, the auction can help promote efficient spectrum assignment. Effective rules can encourage truthful bidding and avoid gamesmanship. However, the price discovery function of an auction can be undermined by setting unreasonably high reserve prices (with risks of unsold spectrum and/or less funds available for investment).
- Ensuring the appropriate incentives for entry:**
Some auction designs may discourage smaller operators and entrants from bidding if they perceive they will have little chance to outbid rivals or would only win if they have overestimated value. If not prevented by auction rules, operators may also engage in predatory and entry-detering behaviour. This is more likely in auctions with high entry costs.



2. <https://www.gsma.com/spectrum/wp-content/uploads/2021/09/Auction-Best-Practice.pdf>

Main formats

Regulators have used a variety of auction formats. Those can influence outcomes as well as the resulting competition in communications markets. Other common formats apart for simple clock auctions are:

| | Benefits | Risks |
|--|---|--|
| <p>Simultaneous Multiple- Round Ascending Auction (SMRA)</p> <p>Lots are auctioned individually but simultaneously in separate bidding rounds</p> <p>Bid information is usually revealed each round allowing bidders to respond</p> <p>The auction continues until no more bids are submitted for any round</p> <p>Simultaneous stopping rule recognises that there are synergies among the licences, and a bid on one could cause another bidder to switch to a substitute</p> | <p>Efficient spectrum assignment supported by revelation of bid information during auction</p> <p>Bidders with highest spectrum valuations can outbid rivals</p> <p>Costly for dominant bidders to deter entry which makes it more likely that smaller bidders will not have to pay higher average prices</p> | <p>Bidder strategy can be complex when trying to aggregate multiple lots</p> |
| <p>Sealed bids</p> <p>Each bidder submits a single offer and the licence goes to the highest bidder</p> <p>The bidder pays either their bid or, under a second price rule, the highest losing bid</p> | <p>Low susceptibility to collusion and can attract entry</p> <p>Can raise more revenue than a multiple round auction where competition for the licence turns out to be weak</p> | <p>Limited information available to bidders as they have no insight into rivals' values</p> <p>Use of the first price rule can lead operators suffering the winner's curse, in which they have overestimated the true value of the licence</p> <p>May lead to spectrum being assigned inefficiently or left unused if winning bidder overestimates value</p> |
| <p>Combinatorial Clock Auction (CCA)</p> <p>Multiple round auction allowing bids for packages of lots, rather than for individual licences</p> <p>An initial ascending clock phase continues for each package of generic spectrum blocks until excess demand for each group is eliminated, followed by a final round of sealed bids to determine specific assignments</p> | <p>Supports flexible lot structures which help avoid aggregation risks (i.e. bidders ending up with unwanted combination of lots)</p> <p>Second price rule whereby prices paid by winners are set at the lowest hypothetical bid amount at which they could have still won encourages straightforward bidding based on own valuations</p> | <p>Less price revelation than in an SMRA</p> <p>Extremely complex to administer and participate in as it requires bidders to develop valuations for many packages before the auction</p> <p>CCA only works well if bidders can evaluate all the bidding options that are open to them</p> <p>Can give rise to strategic gaming possibilities, allowing participants to raise rivals' costs, resulting in bidders potentially paying vastly different prices for spectrum</p> <p>Limited use to date with varying degrees of success as a result of the complexity and other issues</p> |

Regulatory Tools

In addition to the choice of auction format, there are also various tools available to regulators in designing auctions to promote competition or increase the likelihood of efficient outcomes, although there are often trade-offs involved in their use.

| | Benefits | Risks |
|--------------------------------------|---|---|
| Lot sizes | Smaller lots can provide access to important spectrum for more operators than when larger lots are used | Lots that are too small increases the need for bidders to aggregate multiple lots and may lead to operators acquiring spectrum which they are unable to use. |
| Spectrum caps and set-asides | Set-asides can only be used after formal market review shows a) one player has clear market dominance and b) setting aside spectrum is then an appropriate, proportionate action | Both can distort fair market competition Set-asides may lead to spectrum being poorly used and can weaken incentives to grow customer base. Caps risk jeopardising an operator's ability to support growing consumer usage Regulators should define and set caps with care to balance, giving operators sufficient freedom to pursue their business strategies |
| Information available on bids | Providing transparent information leads to legal and regulatory certainty for the assignment process and for the full duration of the license, incentivising investments Limiting the bid progress information made available can block signalling behaviour | Limiting information weakens price discovery which may impede efficient outcomes as well as creating uncertainty for the overall process |
| Reserve prices | Reserve prices reduce gains from collusive behaviour and help governments achieve some minimum revenue for the spectrum even when demand is low They set a threshold to guarantee only bidders that can invest later can participate | If set too high can discourage marginal bidders from participating and spectrum may remain unsold |

Administrative assignments

Administrative assignments are most effectively used in cases of lower market demand. Just like auctions, administrative assignments have to be planned well to succeed. Importantly, the selection criteria and process must be clear, and the weight given to each objective should reflect its importance to society. The use of vague and subjective criteria, or a lack of transparency, increases the risk of favouritism and corruption as well as the potential for the outcome to be challenged in the courts. There may be a need to trade-off between policy objectives and the licence fee. Even where the objective is clear, estimating the appropriate price can be challenging.

Regulatory objectives which may be considered as part of an administrative assignment / beauty contest include:

- coverage,
- quality of service
- and potentially a variety of wider social and economic goals.

A particular problem of administrative assignment is the risk that successful applicants turn out to be unable to fulfil their offers, particularly if market or technology forecasts prove inaccurate. Licensing authorities should set out in advance what penalties will be imposed should commitments not be met.

Licence renewal

There are various renewal approaches available to regulators where spectrum is already licensed to an operator.

Uncertainty over future rights to use the spectrum may lead to operators ceasing investment in the development of their networks and competing less to grow their customer base until the uncertainty is resolved. Regulators thus serve consumers best by creating that certainty and a minimum period for a licence renewal decision should be five years ahead of renewal date.

Authorities should aim to minimise uncertainty by creating a presumption of renewal unless a breach of licence condition has occurred, a fundamental reallocation of spectrum to a new service is required or an overriding policy need arises.

| | Advantages | Disadvantages |
|----------------------------------|---|---|
| Presumption of renewal | <ul style="list-style-type: none"> Offers certainty for future investment in the sector Minimises customer service disruption from operators losing spectrum and needing to reconfigure networks or exit the market In conjunction with trading, supports efficient spectrum use over time | <ul style="list-style-type: none"> In extreme circumstances, spectrum may be better re-assigned (for spectrum replanning, a serious breach of conditions, or if spectrum left idle) If not set out in original licence terms, may be considered unfair to unsuccessful bidders |
| Re-auctioning | <ul style="list-style-type: none"> Auction uses market to identify the true "opportunity cost" Promotes efficient outcomes / efficient use of spectrum (i.e., those that value it most are allocated the spectrum) Outcome is transparent and legally robust | <ul style="list-style-type: none"> Discourages long-term network investment May be disruptive to existing businesses as incumbent operators risk losing critical spectrum May be subject to 'gaming', therefore auction design is critical Auction prices carry a greater risk of the licence cost undermining operators' financial viability |
| Administrative assignment | <ul style="list-style-type: none"> Quick and cheap to implement Promotes continuity of existing services Works best if benchmarks are available from local precedent or other countries | <ul style="list-style-type: none"> Government may get prices wrong Price setting may not be transparent and could be vulnerable to legal challenge |
| Hybrid solution | <ul style="list-style-type: none"> Attempts to balance achieving some predictability and some flexibility | <ul style="list-style-type: none"> Risk to investment and service continuity/QoS Potential costs associated with reconfiguring networks Trading off predictability for flexibility would only be beneficial in some circumstances |

Recommendations on licensing and renewal approaches

- Where spectrum is to be assigned for the first time, there is no single best licensing approach and authorities should make their decision considering the specific market context. Auctions tend to be the most common methodology.
- When choosing the assignment approach, licensing authorities should prioritise the objectives of promoting efficient use of spectrum and network investment while also ensuring effective competition.
- Whether an auction or administrative assignment is adopted, the details of the implementation should be transparent and focused on future certainty.
- A decision not to automatically renew a spectrum licence should only be made under certain circumstances such as for a serious breach of conditions or if spectrum left idle.
- Licensing authorities should work in close partnership with stakeholders to enable a timely, fair, and successful licensing process.

Ensuring a predictable, timely and open licensing process



A predictable and timely licensing and regulatory framework enables operators to build the business case for the long-term network investment required to support digital economies. Regulatory stability and transparency help improve the quality of licensing decisions and minimise the risk of protracted legal proceedings.

A long-term spectrum management plan

Governments can maximise the social gains from their spectrum resources by developing a spectrum management framework which supports investment, the efficient use of spectrum, and competition. The spectrum management framework should:

- Ensure that sufficient spectrum is made available for services that deliver the greatest benefits to society
- Put mechanisms in place to identify and allocate spectrum where it is idle or under-utilised
- Set out a timetable for future spectrum releases and licence renewal decisions
- Establish clear rights governing the use of bands to ensure co-existence; maintain a robust compliance regime to support this
- Follow on from a detailed cost/benefit assessment of the costs and benefits of a range of licensing options
- Take into account longer term impacts on investment incentives and sustainable competition (including recognising licensees' legitimate expectations);
- Avoid unnecessary restrictions and conditions on the use of spectrum
- Follow international harmonisation
- Assign the responsibility for licensing decisions to an independent regulator required to follow specific, transparent criteria with an independent appeals process

1. <https://www.gsma.com/spectrum/wp-content/uploads/2021/06/Spectrum-Sharing-Positions.pdf>

Many countries have recognised the importance of reforming their spectrum management policies as part of the development of national broadband plans. These plans set out targets for widespread access to broadband and how those targets will be achieved.

Making further spectrum available and liberalising its use plays a critical role in improving broadband access by extending coverage and ensuring affordable services. The strength of such

plans in promoting investment and confidence in the sector is reliant on their political support, comprehensibility, enforceability and the buy-in from stakeholders. Due to the quick moving nature of developments in the digital economy, these plans need to be reviewed and updated on a regular basis.

Spectrum management framework

Three key elements of a spectrum management framework are required to promote growth and transparency:

- A clear roadmap on both new spectrum releases and licence renewals
- Timely notice for decisions relating to licence expiry
- Consultation on key decisions

Spectrum roadmap on releases and renewals

A spectrum roadmap is an important means of ensuring there is sufficient spectrum for future demand from consumers and new technologies. Information on spectrum releases is critical for businesses to prepare investment plans, secure financing and develop arrangements for deploying particular technologies.

In particular, a spectrum roadmap should:

- Audit current spectrum use
- Schedule future spectrum releases
- Detail how spectrum will be assigned, including a framework for determining spectrum prices and other terms and conditions
- Give the timing and process for spectrum renewal decisions
- Plan for the introduction of technology neutral licensing, sharing, leasing and trading

Timely licence renewals

Authorities should provide interested parties with as much notice as possible of forthcoming assignment processes and decisions.

Timing is particularly important for spectrum renewal decisions. Early notice of renewal decisions enables operators to plan for investment and service continuity. For example, if some spectrum is not renewed, operators may be able to acquire other spectrum or make network investments that reduce the risk of service disruption to consumers.

A minimum period for a licence renewal decision should be 5 years ahead of renewal date.

Consultations

Consultations support efficient spectrum licensing by providing a forum for the perspectives of different industry stakeholders. This can allow both governments and industries the opportunity to understand the likely effects of different options.

Input from stakeholders is essential when evaluating costs and benefits and will help determine the approach taken, including the choice of licensing and renewal approach and reasonable

reserve prices. For administrative approaches, consultations can inform eventual licence fees as well as the costs and benefits of imposing certain conditions.

Detailing reasons for decisions and providing a right of appeal can also improve the quality of decisions. Taking these steps helps protect the rights of affected parties and ensure decisions are based on real-world circumstances.

Recommendations on licensing process

- Licensing authorities should ensure that the overall licensing framework offers stability and transparency to reduce regulatory risk and promote investment.
- National broadband plans and spectrum roadmaps are important ways in which governments can identify how to achieve widespread broadband access and incentivise network investment.
- Timely renewal decisions (five years in advance of licence expiry) can facilitate ongoing network investment and enable planning to provide service continuity to end- users.



Spectrum pricing



Where spectrum is auctioned, the spectrum licence price is determined by the auction itself. However, where spectrum is not auctioned, authorities will need to consider whether to charge for the use of the spectrum. In both cases, seeking to maximise state revenues risks much greater costs to society and the digital economy. If competition is undermined, network investment will be reduced.

Authorities set spectrum licence fees for three main purposes:

- To recover the administrative cost of licensing process and spectrum management
- To encourage efficient spectrum use
- To raise revenue for the government

Governments should not seek to raise higher revenues by setting licence fees that exceed the opportunity cost of the spectrum. The higher the level of licence fees, the greater the risk that no operators will acquire the spectrum, that competition will be reduced, or that final prices will be too high. It is important that spectrum charges are set conservatively to avoid spectrum being unsold.

High spectrum fees also carry risks to network investment. High charges may reduce the funds available for investment or lead to higher debt levels which increase the cost of raising additional capital.

High fees may also reduce expected future returns on investment. In the context of licence renewal, authorities should be particularly careful not to set fees that effectively seize returns. Doing so deters operators from making future investments where there are market or technology risks.

Finally, authorities should think carefully about how spectrum charges are imposed. For example, fees based on an operator's size can discourage them from competing to grow their customer base, while fees based on the size of the network may deter network investment.

For all of these issues, the balance between raising revenue and setting policies that help maximise the socio-economic benefits of mobile connectivity has to be right.

Research shows there are strong links between high spectrum prices and slower network speeds as well as worse coverage. The impact of unsold spectrum is equally serious as it impacts the ability of operators to improve coverage and performance or launch new technologies such as 5G.

What does opportunity cost mean?

Efficiency in markets is promoted where users consider the opportunity cost of a resource. The opportunity cost of spectrum is the value the spectrum would have if used in the next best alternative. Where there is no excess demand for the spectrum band, then the opportunity cost of the spectrum will be zero.

Comparative assessment of pricing approaches

There are a range of spectrum pricing approaches with different terms. Options include whether charges are levied as an upfront sum, annually or a combination of both, and whether the charge is fixed or varies with revenues. Objectives in setting prices may also vary from recovery of regulatory costs to promoting efficiency or government revenue objectives.

Auctions can directly determine market value and prices that reflect the market value of spectrum. When done correctly, they help promote efficient spectrum use. Where these market mechanisms are not used, authorities can estimate the market value of spectrum (e.g., administrative incentive prices).

One way to estimate market value is considering the costs operators avoid by gaining an additional increment of spectrum. For example, operators with more spectrum need fewer cell sites to supply the same traffic volumes. The incremental value of spectrum can be estimated on the basis of this trade-off, taking into account the network being modelled and traffic forecasts.

An alternative approach is using benchmarks based on recent auctions. The accuracy of benchmarking depends on using comparable spectrum bands, conditions, and countries. For important spectrum bands, where the cost of errors is high, the combined use of both modelling and benchmarking can further improve accuracy. Benchmarks also require normalisations, such as via ARPU or revenue, depending on market conditions.

Setting an upfront licence fee is often seen by economists as preferable to annual charges. However, upfront fees need careful consideration to be set as affordably as possible, as they carry greater risks to operators and may be harder to justify when future technological and market development is uncertain. Instalment payments can also be made available to operators, adding another possibility to their financial strategy.

Where authorities impose annual charges or new charges for licence renewal, regulatory risks to investment can be reduced by authorities following a transparent pricing framework with clear criteria.

Referencing an operator's customer base or its network size when setting prices deters both competition and investment. Such pricing may also undermine efficient spectrum use as operators with few customers would face minimal spectrum charges.

Pricing Approaches for Spectrum

| Pricing Approach | Overview | Disadvantages |
|-------------------------------|---|---|
| Administrative costs | Appropriate where there is no excess demand for spectrum | May not lead to efficient spectrum use where there is excess demand for the spectrum and where spectrum assignment is not market based |
| Share of revenue | Shares risk between government and operator | Trading off predictability for flexibility would only be beneficial in some circumstances If not paid retroactively, requires modelling based on assumptions. Runs significant risk of placing onerous, high fees and limiting investment |
| Avoided cost modelling | Provides a direct estimate of the value (cost savings) of an increment of spectrum | Requires modelling based on assumptions May overestimate or underestimate value, risking investments |
| Benchmarking | Simple and transparent where close benchmarks exist, and correct normalisations are used | Will be inaccurate if the analysis does not fully account for differences in factors impacting market value |
| Net Present Value | Provides a direct and fair estimate of the value of an increment of spectrum, based on costs and revenue Accurate to the specific market and based on historical data Considers both costs and revenues for the duration of the license | Complex and requires many different variables; requires modelling based on assumptions May overestimate value if done wrong; may be a risk to the interest for the available spectrum Hard to be implemented to new technologies when additional services may be unlocked |

Reserve prices

Reserve prices are used in auctions to help discourage uncertain bidders and ensure a floor price for spectrum in case competition for the licences is weak. However, reserve prices should be set conservatively so as not to undermine the price discovery function of the auction, which is central to the market-based approach to spectrum management.

Reserve prices may be set using any of the above pricing methodologies. If reserves are set too high, valuable spectrum may go unsold or sold at such a high price that consumers may suffer due to limited competition and high prices. Where competition is expected, reserve prices can be set as a minimum safety net as competition in the auction will ensure fair prices.

The [GSMA's Auction Best Practice policy position](#)³ outlines our guidance for auction methodology in more detail.

Recommendations on spectrum pricing and fees

- Spectrum prices should promote, and not undermine, the optimal use of spectrum for the benefit of society.
- High spectrum fees reduce the funds available for investment and will negatively impact the quality, speed and reach of mobile broadband services.
- Licensing authorities should set auction reserve prices conservatively to allow the market to determine a fair price and to reduce the risk of leaving spectrum unassigned.
- Authorities should be particularly careful not to set renewal fees that remove returns on earlier investments. Renewal fees should only recoup administrative costs.
- Costs related to conditions or obligations attached to the license should be deducted from spectrum fees.

3. <https://www.gsma.com/spectrum/wp-content/uploads/2021/09/Auction-Best-Practice.pdf>



Licence terms and conditions



Providing for flexible spectrum use by limiting licence conditions enables spectrum to be redeployed as technology and market conditions change, bringing down the cost-of-service provision. However, spectrum licences have sometimes contained terms and conditions which go beyond those necessary to guarantee co-existence amongst users.

Technology and service neutrality

Restricting spectrum use to particular technologies and services exacerbates spectrum scarcity and prevents customers from gaining access to new and better services. Removing technology-specific restrictions (beyond those needed to manage co-existence) enables a market to maximise the benefits from its spectrum resources on an ongoing basis. Operators' ability to

introduce new, more spectrally efficient mobile technologies is critical to meeting growth in demand.

Importantly, technology neutrality should also not incur the payment of fees. Charges for changing licences to be technology neutral risk delaying the benefits of new technology to end-users.

Licence obligations

Licensing authorities often impose additional obligations on licensees aimed at achieving particular policy objectives. These can include coverage and service commitments, as well as obligations meant to improve competition. Where a licence is assigned using a beauty contest, rather than an auction, commitments to meet obligations can dominate the assignment process.

In today's competitive communications markets, there is a need to regularly make sure objectives remain relevant. Licence obligations can often result in greater costs than benefits. Costs related to conditions and obligations should be deducted from spectrum costs.

Coverage and service obligations

Many licensing authorities impose obligations on licensees to provide a particular level of service coverage within a specified time frame. They also include requirements to offer certain services, or quality-of-service levels, as well as measures relating to universal access and consumer protection objectives.

In deciding whether to impose such obligations, licensing authorities should consider:

- The benefits and costs of such obligations
- Whether there are less costly means to achieve the objectives

Whether regulatory obligations are needed or not depends on the market. All governments have to carefully consider whether their approach is likely to increase the quality and reach of mobile broadband compared with the well-proven approach of mobile operator competition.

Stringent coverage or service requirements carry risks. Obligations may force operators to deploy networks and services faster than economically or commercially sensible to do so. For instance, this could arise where technology is still at an early stage with a number of technical challenges remaining or where equipment prices are relatively high before more widespread international take-up. Obligations also risk forcing operators to incur losses (e.g., by deploying networks in advance of sufficient demand for the services). This can create financial difficulties, particularly for entrants without established cash flows.

Extensive coverage obligations imposed on all licences may lead to costly duplication of network infrastructure. A number of regulators have sought alternative ways to ensure access in rural areas while avoiding inefficient network duplication e.g.:

- ‘Shared’ obligations on all operators to ensure coverage in rural areas before rolling out to urban areas
- Obligations to provide mobile broadband to locations currently lacking access to other forms of broadband.

Where obligations are imposed, they should be made clear prior to the auction or assignment process so that operators can develop a viable business case. Costly obligations can be reflected in lower auction prices. Governments should therefore assess whether the impact on auction revenue is an appropriate trade off to extend mobile coverage or whether the adoption of an alternative approach would be more efficient.

Where operators fail to meet their licence conditions regulators are confronted with the dilemma of whether to take the drastic step to revoke the licence, with potential harm to competition or postpone, or abandon the licence condition. Relaxation of licence conditions can lead to legal challenges by other operators who have met conditions or by potential new entrants who may have bid for the licence if they had known the obligations would not be enforced.

These are just some examples of why it is important to get licence obligations right from the beginning, or not use them at all.

Obligation of strenuous conditions will often not be the most beneficial approach when improved rural coverage is desired. Measures that improve the commercial viability of extending coverage are more likely to be achieved, and at lower cost, than seeking to enforce licence obligations. These include:

- Releasing spectrum in lower frequency bands
- Allowing for network and spectrum voluntary sharing
- Earmarking auction proceeds for to subsidise improved coverage
- Removing or minimising mobile-specific taxes and charges

Authorities should limit conditions on the use of spectrum to those necessary to safeguard against harmful interference. Spectrum licences should made technology and service neutral.

Minimum 20-year terms for new licences

The longer the duration of a licence, the greater the certainty provided for operators to undertake long-term investments in rolling out networks and in deploying new services. Licence terms that are shorter than the expected payback period, especially if there is uncertainty over whether the licence will be renewed, deter investment.

On the basis of the expected payback period for substantial new network investment, many countries have decided to provide for a minimum term of 20 years. Perpetual spectrum licences, with a minimum notice period for revocation, can avoid unnecessarily introducing uncertainty over renewal as a result of a fixed term.



Recommendations on licences terms and conditions

- Authorities should limit conditions on the use of spectrum to those necessary to guarantee co-existence.
- Spectrum licences should be made technology and service neutral.
- Governments with particular policy objectives should consider regulation which supports commercial provision of widespread and affordable access before imposing conditions.
- When conditions are imposed, any related costs should be deducted from spectrum costs.
- Mobile licences should have a minimum 20-year term to provide for sufficient certainty to support mobile network investment which has long pay-back periods, as well as presumption of renewal.



Promoting competition through licensing

Access to spectrum is essential for the supply of mobile services. The way spectrum is assigned and managed impacts competition.

The best way for governments to promote competition is by making as much spectrum available as possible and then limiting charges and other conditions to ensure the highest possible number of viable operators. Specific additional measures to increase competition should only be considered where it is clear that competition is not already effective.

An assessment of whether to impose additional measures to promote competition should firstly assess the level of competition in the absence of the measures. Where competition is already effective, imposing additional obligations may bring little additional benefit while risking spectrum not being assigned to its most valuable use or the market becoming excessively fragmented resulting in higher costs and prices.

Secondly, it should identify whether there are ways to achieve effective competition that do not constrain the ability of any operator to support existing and new consumer demand. For example, reducing mobile-specific taxes and licence fees and freeing additional spectrum may improve the viability of all players in the market.

It is important to evaluate each measure and check that the policy aim of any chosen measure is the least costly option.

Spectrum caps and the amount of any spectrum set-aside for new entrants and industries should be used with caution and carefully determined so that all operators can deploy networks in a technically and economically efficient manner. Before any caps and set-asides are applied, authorities should undertake a rigorous market analysis to ensure that there are entities that can make efficient use of any released spectrum.

A number of measures have been, in some cases, introduced with the aim of promoting competition. However, these have often not achieved the goals which they aimed for.

Spectrum caps and set-asides for new entrants

Spectrum caps limit the quantity of spectrum that can be held by an operator. Spectrum set-asides can reserve a particular block of spectrum for a particular bidder.

Spectrum caps and set-asides can be effective in attracting entrants to participate in licensing assignment processes and they can also limit later market consolidation leading to a loss in competition. However, these measures may lead to less efficient spectrum use as operators with larger customer bases may have greater need for additional spectrum. Additionally, fragmented spectrum holdings raise costs and lower quality of service.

Spectrum caps previously imposed in many countries have thus been modified or removed entirely as additional spectrum in new frequency bands has been made available.

Single Wholesale Networks

Open access licensing approaches, or single wholesale networks (SWNs) involve spectrum being licensed to a particular provider that will then be required to provide wholesale access to competing retail providers.

Supporters of SWNs argue they can address some concerns better than the traditional model of network competition in some markets. These concerns generally include inadequate competition or lack of coverage in rural areas, inefficient use of radio spectrum, and fears that the private sector may lack incentives to maximise coverage or investment.

While there are variations in the SWN proposals discussed and implemented by different governments, SWNs can be generally defined as government-initiated network monopolies that compel mobile operators and others to rely on wholesale services provided by the SWN as they serve and compete for retail customers.

Network competition can deliver mobile network coverage and if building networks is not economically viable there are other approaches, as highlighted in the “Coverage and service obligations” section. In order to be built, the SWN require significant public subsidies and other forms of support such as cheap/free spectrum. These support options are typically not available to competing network operators.

The ownership of the wholesale network would also be important. If owned by an operator also active at the retail level, there could be opportunities for anti-competitive behaviour. If owned by all operators, there may be difficulties in reaching agreements on investment and financing for network extensions or upgrades.

If governments retain an equity stake, there could be a risk of the operator coming under pressure to favour particular groups or businesses or to protect the operator against competition. The access price of the wholesale network is also likely to prove controversial and complex.

At present, there are no successful examples of SWNs and wholesale prices determined by government or commercial negotiation have led to untenable costs to operators and lack of investment by SWN providers.

Spectrum re-assignment in mobile mergers

Spectrum licensing has often been an issue in the assessment of proposed mobile mergers by regulators.

The likely effects of any regulatory-enforced spectrum divestment on competition and the efficient use of spectrum must be carefully considered before it is made. A merger that enables the parties to use a larger block of spectrum may enable service to be delivered at the best possible quality and

reach. Requiring the divestment of significant spectrum to a new entrant might lead to that spectrum being poorly utilised relative to a situation in which it was available to meet the needs of operators with larger customer bases. This could lead to higher prices and lower quality of service. Requiring large spectrum divestments may also deter parties from proposing mergers in the first place, even when they would bring overall social benefits.

Recommendations on promoting competition through licensing

- In competitive markets licensing spectrum to the bidder who values it the most can be expected to lead to the optimal use of a country’s spectrum.
- Spectrum caps, set-asides and single wholesale networks need careful consideration and may not bring higher costs to the society than benefits.
- Governments can best promote mobile competition by making spectrum available and limiting taxes, licence fees and other conditions that risk limiting the number of viable competing operators.

Set-asides for verticals

Verticals are companies, industries and public sector organisations operating in a specific sector.

The development of new mobile technologies alongside the cloud, big data and machine learning are transforming the connectivity requirements of vertical industries. These range from creating smart utility grids and automating manufacturing to delivering goods by drones and supporting advanced public safety and transport networks.

Policymakers play a vital role by managing the spectrum which underpins these developments and great care needs to be taken to ensure verticals are fully supported without harming other wireless users.

Verticals have historically used local private networks for their connectivity but partnering with telecom providers such as public mobile operators using licensed spectrum is increasingly popular as the capability, and flexibility, of 5G becomes clearer. Use of existing mobile assets allows vertical needs to be served by a more extensive network, more advanced network capabilities and a lower cost base.

However, some verticals may continue to operate their private networks and thus may desire access to additional spectrum to support advanced broadband capabilities. This represents a challenge for policymakers as widespread demands for additional spectrum outweigh supply. Verticals may require access to spectrum in priority 4G and 5G mobile bands (e.g. 700 MHz

and 3.5 GHz) so they can benefit from the mobile equipment ecosystem and thus lower deployment costs. Such bands are in demand.

Supporting the needs of verticals should not undermine other spectrum users or affect the fair and efficient assignment of mobile bands. A core concern is the use of dedicated set-asides for verticals as this poses significant risks to wider mobile services, most notably slower 5G networks and reduced coverage.

Setting spectrum aside can lead to insufficient spectrum to operators, which prevents the delivery of all 5G requirements and capabilities to other users. Scarcity also enlarges the prices paid for spectrum. High fees are strongly linked to reduced network investment and slower rollouts, limited coverage, and reduced data speeds.

There are alternative options to support verticals – including other ways to provide access to spectrum for these networks. Where industries require access to specific licensed bands, they can do so through the spectrum assigned to mobile operators via sharing and leasing agreements.

More information on spectrum for verticals can be found on the GSMA's [Mobile Networks for Verticals resource](https://www.gsma.com/spectrum/resources/mobile-networks-for-verticals/)⁴ page.

Recommendations on set-asides for verticals

- Commercial mobile operators support the needs of a wide variety of vertical sectors and will have added capabilities with 5G.
- Spectrum leasing or, when carefully planned, other types of spectrum sharing can be viable options for supporting verticals who want to build private networks.
- Spectrum that is set-aside exclusively for verticals in core mobile bands risks being underused and can undermine fair spectrum awards.
- Spectrum that is set-aside for mobile networks for verticals in core mobile bands can also threaten the wider success of 5G – including slower rollouts, worse performance, and reduced coverage.
- Policymakers should consider the coexistence challenges when different use cases need to be supported in the same mobile band.

4. <https://www.gsma.com/spectrum/resources/mobile-networks-for-verticals/>



Spectrum sharing, leasing and trading

Allowing spectrum to be shared, leased, or traded amongst operators can ensure that spectrum continues to be used efficiently over time. It encourages efficiency by allowing spectrum rights to be transferred to those who will make better use of them.

Benefits of voluntary spectrum sharing, leasing and trading

In helping to reduce spectrum shortages faced by some operators while ensuring valuable spectrum does not lie fallow, spectrum sharing helps more intensive spectrum use, increased service quality and lower costs of service provision.

Spectrum leasing and trading enable the parties that have the best information on the value of spectrum to determine its price. A buyer or lessee will need to create more value from the acquired spectrum than the seller to justify the sale.

Voluntary leasing and trading also reduce risks for operators as they are able to sell or lease unused spectrum while having the opportunity to acquire new capacity as they grow. The ability to trade and lease licences can ensure that spectrum is used efficiently without any need for further charges to be imposed by government.

Experience with spectrum trading and leasing shows that:

- Trading is more likely to take place where there is substantial available spectrum and where there is predictability on both future spectrum availability and the regulatory framework.
- Trading is more likely to take place where there is available spectrum and where there is a need to support network deployment by the lessee, such as for verticals.
- Long licence terms allow the buyer or lessee of the rights to undertake investments to make use of the spectrum.
- Spectrum trading and leasing are made difficult where decisions about whether licences are to be renewed and the conditions that will be attached to the new licences are made close to the expiry date of the existing licences.
- Authorities should be notified of the agreements taking place so that it is clear who holds spectrum usage rights. Notification enables authorities to assess whether a proposed trade would create any risks to competition.

Regulatory frameworks that support voluntary spectrum trading can benefit society by ensuring the ongoing efficient use of spectrum.

Issues in the implementation of spectrum trading

Authorities can support efficient spectrum trading by ensuring that rights are well specified and enforceable. Trading spectrum requires a clear definition of initial spectrum property rights or entitlements. A spectrum licence may specify the right to

exclusive usage in terms of frequency and geography (and potentially in relation to a time dimension) as well as reasonable interference levels.

| | Main issues |
|---------------------------------------|---|
| Well specified spectrum rights | <p>Defining clear, technology neutral, property rights in the context of spectrum.</p> <p>Lack of universal ITU system.</p> <p>The more flexible the property right used, the more problematic interference control.</p> <p>Defining the appropriate level of flexibility for their market. Cost-benefit analyses should be used.</p> |
| Licence renewal | <p>Uncertainty over future spectrum rights can stifle spectrum trading.</p> <p>Short licence tenures create uncertainty in a trading environment.</p> |
| Transaction costs | <p>Transactions costs affect market efficiency as well as the frequency and ease of trading.</p> <p>A secondary market, with allowance for specialised trading brokers, can reduce transaction costs and ensure that spectrum holdings are fully used.</p> |
| Competition issues | <p>Trading's impact on competition depends on the amount of spectrum available to competitors and the existing degree of competition.</p> <p>Prohibition of transactions on competition grounds may require case-by-case review.</p> |
| Taxation of gains | <p>Imposition of specific taxes on financial gains from trading will make it less likely to take place.</p> <p>A large tax on gains from spectrum sales would negatively impact efficiency.</p> |

Recommendations on sharing, leasing and trading

- Licensing authorities should allow voluntary spectrum sharing, leasing and trading amongst operators and facilitate such mechanisms through clearly defined spectrum rights, long licence terms, and limited administrative costs.
- In advance of a formal spectrum secondary market framework being established, authorities should be prepared to assess proposals for sharing, leasing and trading subject to consultation and consider risks to competition or of interference.
- Transparent and well-timed licence renewal processes, and information on spectrum availability, pricing, and conditions, facilitate sharing, leasing and trading.
- Competition issues should be assessed considering the specific circumstances of sharing, leasing and trading agreements. Certain safe harbours can be established where the spectrum represents a small share of the market capacity or where a market share is below a certain threshold.



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