RESEARCH STRATEGY REPORT

LTE IN UNLICENSED SPECTRUM AND LTE/WI-FI AGGREGATION: TECHNICAL OPTIONS AND BUSINESS MODELS

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About this report

This report considers the options available to operators for providing improved capacity and high peak speeds using unlicensed spectrum. We consider the utilisation of two basic sets of technologies:

- both LTE and Wi-Fi through aggregation (where LTE and Wi-Fi flows are combined), or Wi-Fi for the downlink and LTE for the uplink
- LTE in unlicensed spectrum, most likely in the 5GHz band initially.

The report provides an overview of the technical capabilities for the different technology options, and assesses the hardware requirements for each. Finally, the report considers possible business models and what will be required in order for operators to successfully deploy these technologies.

We provide recommendations for operators and independent players that are rolling out these technologies, and examine how vendors should position these technologies in the market place.

The report is based on several sources, including:

- Analysys Mason's internal research
- interviews with stakeholders in markets for LTE in unlicensed spectrum, as well as LTE Wi-Fi aggregation equipment.

KEY QUESTIONS ANSWERED IN THIS REPORT

- What are the technical capabilities for systems that use LTE in unlicensed spectrum, compared with those that combine LTE and Wi-Fi?
- What are the hardware requirements for systems that use LTE in unlicensed spectrum, compared with those that combine LTE and Wi-Fi, and what implications will this have for the equipment's time to market?
- How can operators best monetise the launch of LTE in unlicensed spectrum, as well as systems that combine LTE with Wi-Fi?
- Which technology option should vendors target primarily?

WHO NEEDS TO READ THIS REPORT

- Operator marketing teams that need information on how best to launch commercial offers that use LTE in unlicensed spectrum, or combine LTE and Wi-Fi.
- Operator strategy teams that want to understand the potential of each technology option and the ease with which they can be launched.
- Vendor strategy teams that require guidance on which of the technology options seem most promising for attracting new operator customers.
- Device manufacturers that want to identify the potential features and technologies that their latest products can support.

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Executive summary

Operators can provide increased capacity and speed to localised sites where there is a high level of traffic and limited spectrum availability by using either LTE in unlicensed spectrum or a combination of LTE and Wi-Fi.

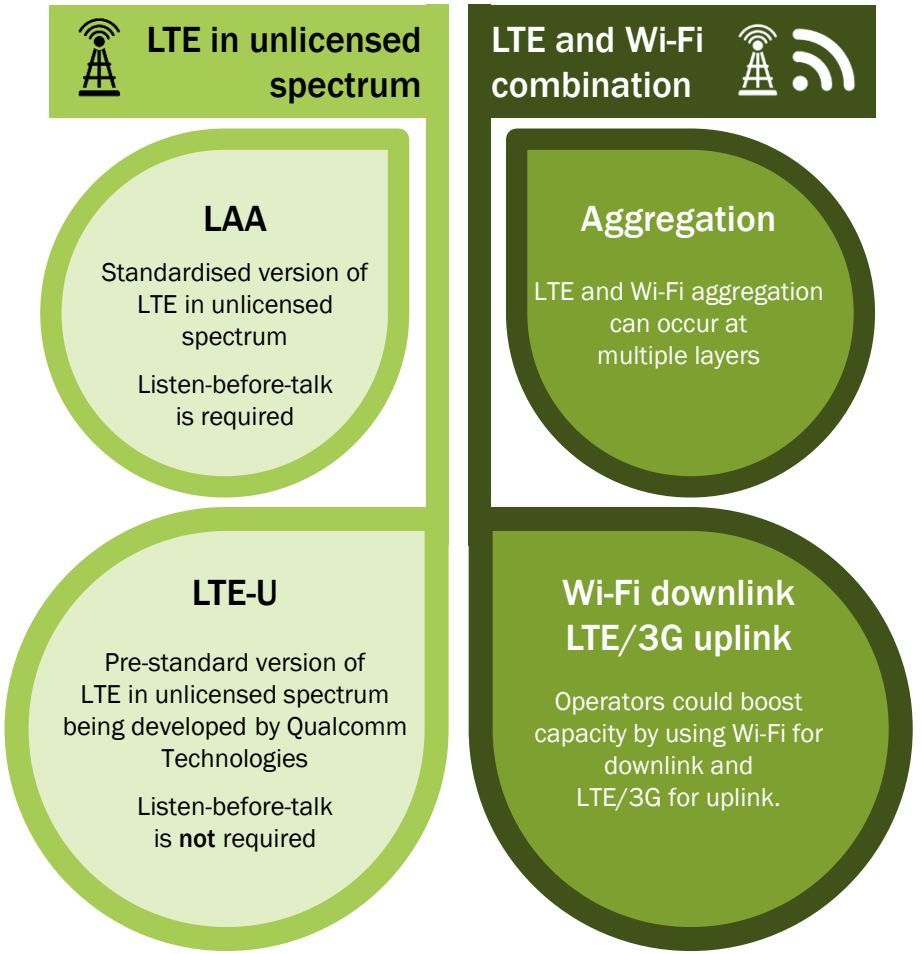
Each of these technologies offers different technical characteristics and performance benefits.

- Operators could deploy LTE-U – the pre-standard version of LTE in unlicensed spectrum that has been developed by Qualcomm Technologies. Alternatively, operators can wait until Licensed Assisted Access (LAA) is standardised to use LTE in unlicensed spectrum.
- LTE and Wi-Fi aggregation could also provide increased capacity. To achieve this, operators can take several approaches. For example, KT Corp deployed MPTCP. Operators can also combine LTE (or 3G) with Wi-Fi to boost capacity by using LTE for the uplink and Wi-Fi for the downlink.

Hardware support for these technologies is essential, and there are constraints for all technology variants, even where LTE Wi-Fi aggregation uses PDCP modem-level or MPTCP-based aggregation.

Operators have the potential to directly monetise deployments using one of the technologies mentioned above, but they will be constrained by free public Wi-Fi.

Figure 1: Technology options for unlicensed spectrum



Source: Analysys Mason

Spectrum availability may fail to keep pace with mobile traffic growth

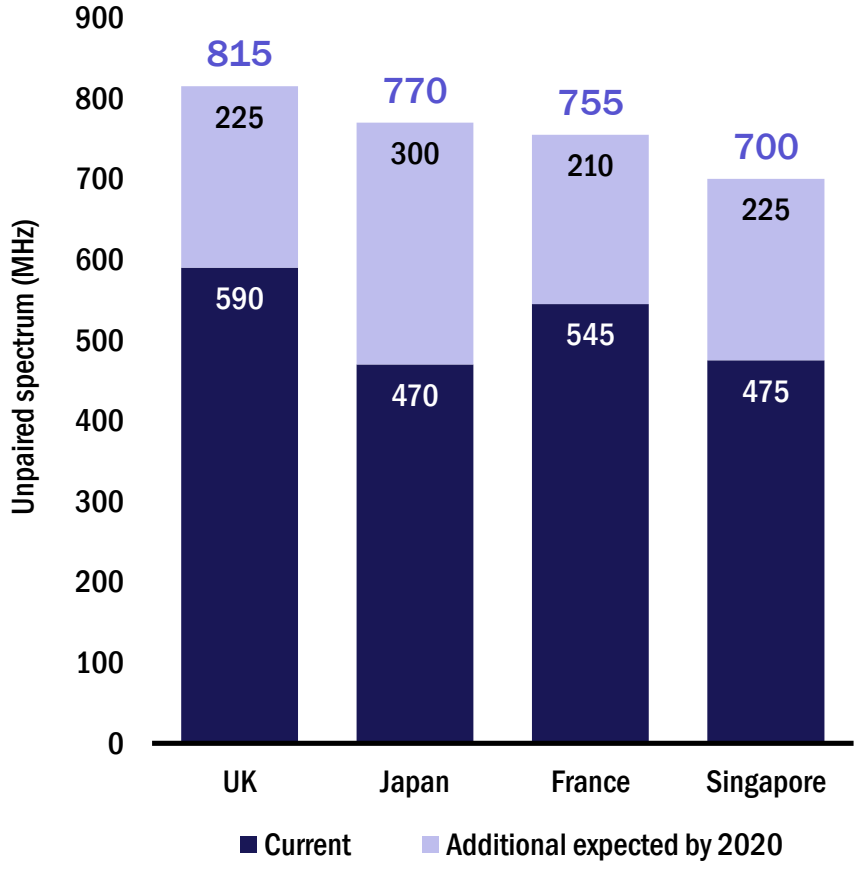
Future spectrum availability may fail to keep pace with growing mobile data traffic levels. However, operators could make use of unlicensed spectrum to deliver improved capacity.

The future availability of spectrum is likely to vary significantly by market, although frequencies in the 700MHz and 2.3GHz bands may become available in a number of countries by 2020. LTE in unlicensed spectrum, as well as the combination of LTE and Wi-Fi, could compensate for slow growth in licensed spectrum availability by using significant amounts of spectrum in the 5GHz band.

Systems that use LTE in unlicensed spectrum, as well as systems that combine LTE and Wi-Fi, are suitable for small-cell deployments when Wi-Fi uses higher frequency bands such as 5GHz. Such localised small cell and hotspot deployments can provide operators with a further way to increase capacity through improved density.

Both LTE in unlicensed spectrum and the combination of LTE and Wi-Fi will be useful for providing increased capacity in indoor locations that experience high traffic. These technologies could ease performance limitations that affect the uplink of legacy Wi-Fi networks. Public spaces such as shopping centres and enterprises are likely targets for these deployments, as are high-demand outdoor locations such as stadiums.

Figure 2: Current available spectrum and expected additional spectrum in 2020, selected countries



Source: Analysys Mason

LTE in unlicensed spectrum, and the combination of LTE and Wi-Fi, have several advantages and disadvantages

LTE in unlicensed spectrum is an attractive option compared with licensed spectrum, which is constrained by limited availability and higher costs. Unlicensed spectrum in higher frequency bands, such as the 5GHz band, provides operators with a way to increase capacity – particularly for indoor environments.

This report examines the technical capabilities of systems that use LTE in unlicensed spectrum, and those that use LTE and Wi-Fi together to optimise speed and capacity.

In order to use LTE in unlicensed spectrum, hardware must be deployed to base stations, as well as to end users' devices. This increases costs, and handset vendors may not immediately support the technology. We also consider the equipment requirements for deploying systems that combine LTE and Wi-Fi.

We also consider the potential monetisation strategies for using LTE in unlicensed spectrum, as well as combined LTE and Wi-Fi. Operators and small-cells-as-a-service (SCaaS) providers will need to consider how best to incentivise venue owners to deploy the necessary equipment. Operators will also need to consider how, and whether, end users can be charged for traffic delivered over unlicensed spectrum. Free-to-end-user (FTEU) public Wi-Fi deployments also present a challenge to the commercial viability for operators' deployments of LTE in unlicensed spectrum and combined LTE and Wi-Fi.

Figure 3: Advantages and disadvantages of LTE in unlicensed spectrum and combining LTE and Wi-Fi

Factor	LTE in unlicensed spectrum	LTE and Wi-Fi combination
Time to market	LTE-U pre-standard version available by mid-2016. LAA standardised version at earliest by mid-2017.	Pre-standard systems that use MPTCP or IP layer aggregation already exist (KT Corp has already launched MPTCP aggregation). LWA standards should be complete by 1H 2016.
Applicability for multi-operator deployments	Multiple operators could share spectrum via Multi-Operator Core Network (MOCN), although not all vendors support this in small cells.	Multiple operators can easily be supported with partitioned Wi-Fi.
Need for end-user device alternations	Both LTE-U and LAA require new end-user device (and small-cell) chipsets. More complex changes may be required with LAA.	Application for http aggregation, OS update for MPTCP and IP layer aggregation. Modem-level aggregation requires new end-user devices.
Charging issues	Consumers are unlikely to be concerned that the service is partly delivered via unlicensed spectrum.	Consumers are accustomed to Wi-Fi services being offered freely, which could present a challenge to imposing extra charges for these technologies.

Source: Analysys Mason

Recommendations

1

Operators need to concentrate their efforts on explaining the benefits of deploying LTE in unlicensed spectrum, as well as LTE Wi-Fi aggregation, to venue owners.

A primary target market for LTE in unlicensed spectrum and combined LTE Wi-Fi is indoor public and enterprise locations, where Wi-Fi is likely to already be freely available. Therefore, the performance benefits of the new technologies must be clearly articulated. Operators must also convince venue owners that existing Wi-Fi deployments will not be negatively impacted by LTE in unlicensed spectrum.

2

Vendors should not overly focus their attention on either using LTE in the unlicensed spectrum or using LTE Wi-Fi aggregation. Both LTE in the unlicensed spectrum and LTE Wi-Fi aggregation have advantages and disadvantages for operators. Operators that have deployed public Wi-Fi are likely to want to maximise their investment further by deploying LTE Wi-Fi aggregation. Other operators have a less urgent need to increase capacity in dense, predominantly indoor, areas and may favour the improved spectral efficiency of LTE using unlicensed spectrum.

3

Vendors should consider becoming SCaaS providers, and integrate LTE in unlicensed spectrum into their small-cell hardware.

Venue owners may also be interested in systems that can support multiple operators – for example, to reduce the clutter associated with separate small cells for each individual operator. LTE in unlicensed spectrum is compatible with multi-operator deployments that use a single small cell through MOCN-based sharing. Vendors could become SCaaS players by using a single small cell for LTE in unlicensed spectrum and every relevant regional LTE band.

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About the authors

Stephen Wilson (Senior Analyst) contributes research to our *Fixed Networks* research programme. He joined Analysys Mason as a Senior Analyst in November 2012, having previously worked for Informa Telecoms & Media. Stephen has more than 5 years of experience covering the telecoms industry and specialises in analysing fixed broadband access technologies and strategies, as well as developments in European telecoms markets across fixed and mobile sectors. He has produced reports on DSL acceleration technologies as well as regular updates on European markets, notably in Central and Eastern Europe. Stephen is a graduate in Politics, Philosophy and Economics from St Catherine's College, Oxford University.

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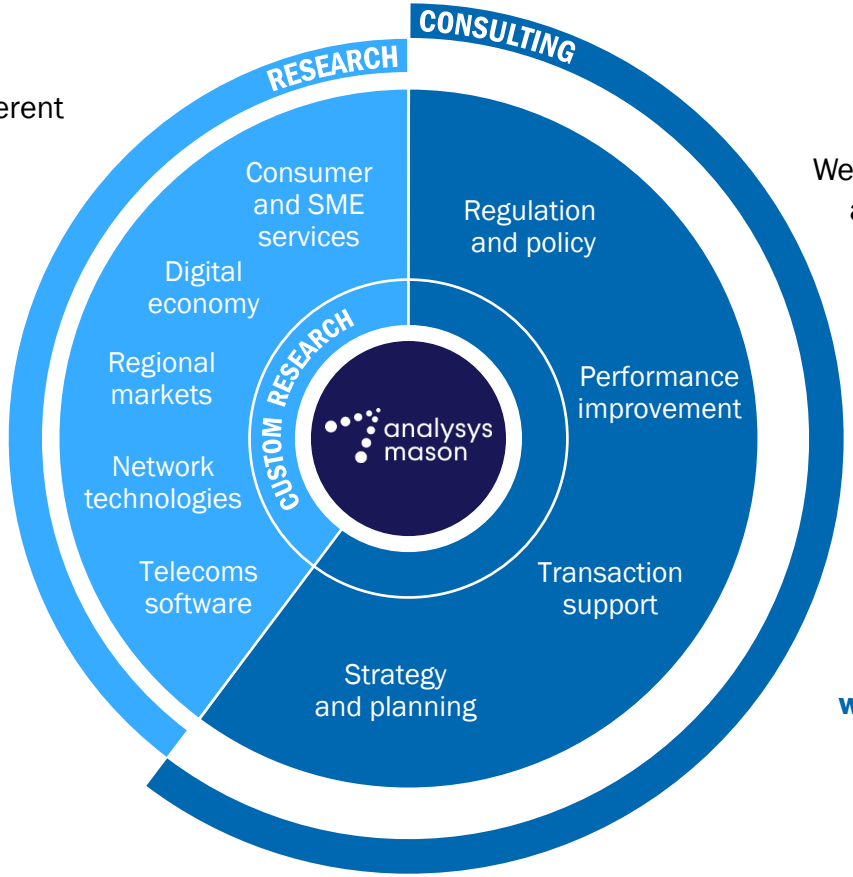

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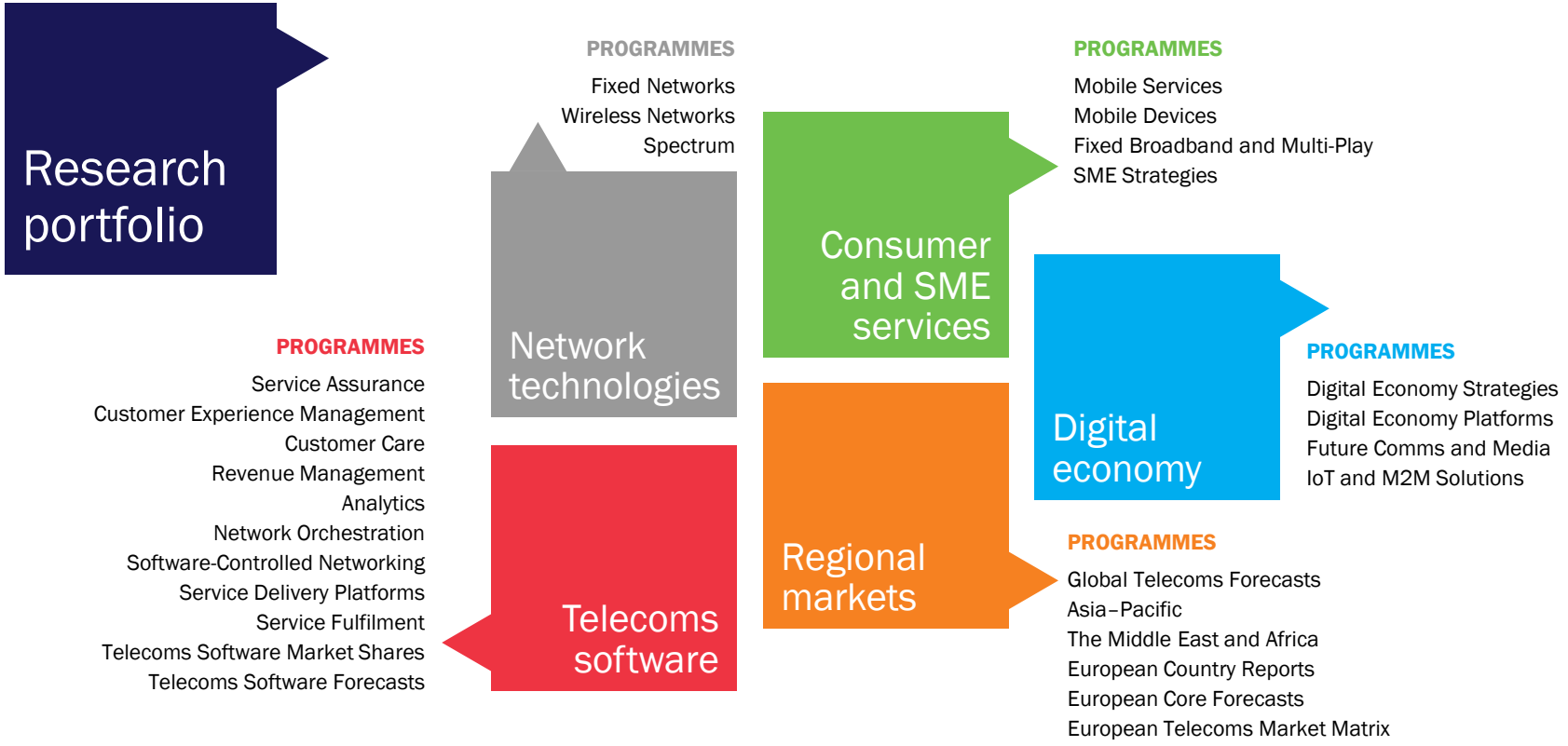

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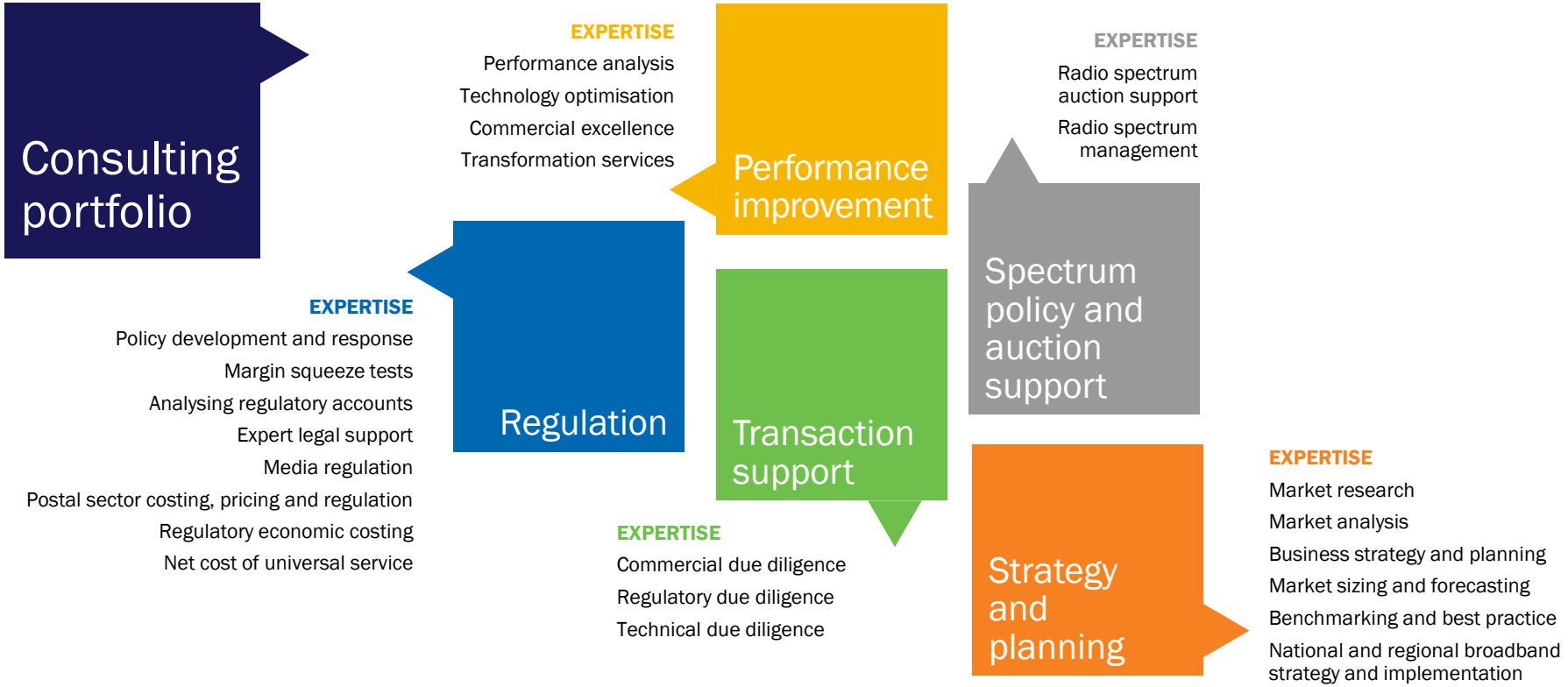

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