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The Economics of Network Elasticity

Julie Bradford and Simon Fletcher
Real Wireless
Pulborough,
West Sussex, UK

***Abstract*[1]— This short paper considers some of the economic drivers and considerations for elasticity as proposed in virtualised 5G network architectures such as under the 5G MoNArch project. The current commercial challenges faced in today's mobile networks are first introduced, and how network slicing and improved network flexibility and elasticity promises to go some way to addressing these. An evolved mobile ecosystem enabled by network slicing and virtualisation is applied to an example use cases to understand how network elasticity may drive better cost efficiencies within this framework.**

Keywords— techno-economics, 5G business case, network elasticity

I. INTRODUCTION

5G networks promise to introduce a radical change in how mobile networks are deployed. While many 5G research projects focus on air interface developments, changes in the network architecture and in particular the move to virtualised networks promises to add a new capability of flexibility and configurability to mobile networks. This will pave the way for an evolution of the mobile ecosystem and new value creation to stakeholders. Today's mobile networks contain a tight coupling between network functionality and the hardware. This means that today's mobile network operators (MNOs) are vertically integrated and required in most cases to have ownership of their network equipment and sites and to dimension these in line with peak demand levels. Virtualisation in 5G networks decouples network functionality from hardware so that the party implementing the network functionality can do so by chaining together virtualised network functions on infrastructure that can be more dynamically acquired, potentially from external parties, as and when demand requires it. This leads to the possibility of greater efficiencies in network costs for addressing today's use cases of mobile services, and opens the opportunity for some less commercially attractive use cases to become viable.

II. COMMERCIAL CHALLENGES IN TODAY'S MOBILE NETWORKS

Fig. 1 from [1] presents the existing cost and revenue trends over time as can be seen in the mobile industry today. This shows there is significant risk to the business case for enhanced Mobile Broadband (eMBB) only mobile services as provided in today's networks due to:

- Having reached the limits on willingness to pay by consumers for mobile subscriptions despite growing demand and traffic volumes. This creates a downward trend in the revenue per GB over time.
- Growing traffic volumes making it difficult for MNOs to reduce network costs.

While the cost per GB on mobile networks is generally reducing, competitive dynamics between service providers drive an increasing reduction in revenue per GB; the consequent reduction in margin reduces the potential for profitability.

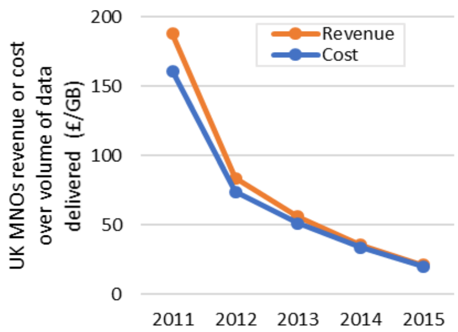

Fig. 1. UK MNO revenue vs. costs per GB trends based on UK traffic volumes from [2] and revenue and spend reported by [3]

The trend of ever increasing data traffic, whilst MNOs are unable to keep their pricing in line with these increases in demand, requires a continual improvement in the cost efficiency of mobile networks. Elasticity in 5G virtualised networks, and 5G-MoNArch [4] in particular, promises to assist with this by:

- Allocating ideally no more than sufficient resource to provide the required mix of services or slices.
- Reducing over-dimensioning in the network to deal with localised peak demand points.
- Ensuring network functions are implemented at the most cost-effective locations feasible.

Looking at revenue, the opportunity presented by multi-service 5G networks to MNOs, based on their use case interest, is to establish greater value for their services alongside these greater cost efficiencies. This combination of delivering new higher revenues per GB services alongside greater cost efficiencies should overall de-risk and strengthen the long-term business case for mobile networks.

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III. Tiered 5G Ecosystem and Depth of Network Slicing

Network slicing in 5G networks provides guarantees of service (with an appropriate choice of quality, availability, performance) that can be tailored to a client of mobile services' individual requirements. This generates a new stakeholder group in the mobile ecosystem known as tenants who may be an organization or vertical with a particular set of service requirements and service level agreements with the mobile service provider. As illustrated in Fig. 2 some tenants may request to control part of the network implementation. An extreme example of this would be two network operators sharing infrastructure and potentially spectrum to save costs in a multi-tenancy arrangement. Another example might be an industrial user keen to maintain the higher layers of the protocol stack on their own sites and equipment for security reasons. Giving tenants more control and configurability over their network slice may change the value to the tenant and hence revenue derived from that slice.

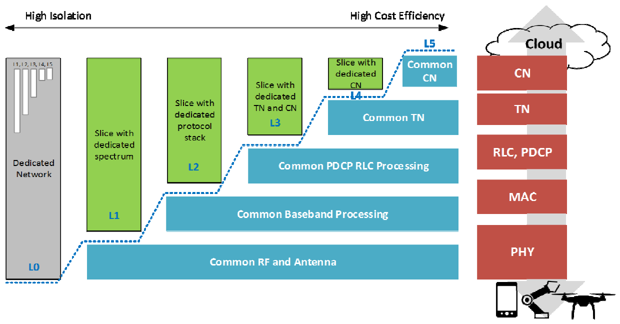

Fig. 2. Depth of slicing and trade off with elasticity and cost efficiency

However, decoupling the network functions from the hardware in a virtualised network also opens up the possibility of separation of infrastructure providers (in terms of antenna sites, data center providers and transport providers) from the mobile service providers. Overall this creates a multi-tiered ecosystem with mobile service providers chaining virtual network functions on a potentially dynamic infrastructure set to deliver against tenant requirements. Theoretically the more tenants and range of services that a mobile service provider can attract the more diversity of traffic will be present on the network allowing elasticity functions to optimize resources and make the most of these economies of scale and scope. Fig 2 however, also illustrates the trade off between the cost efficiencies of combining services on a shared dynamic infrastructure, for the case where the tenants do not require a high level of control, compared with the case where tenants maintain a high level of control over the provisioning of their slice. Higher levels of control reduce the degrees of freedom in the cloudified systems and effect elasticity strategies of the service provider.

IV. Use Cases Potentially enabled by Network Elasticty

Finally, Fig. 3 illustrates an example use case where network elasticity may make some of today's challenging mobile scenarios more commercially viable to address. The example shown is that of a stadium with today's distributed radio access network (D-RAN) type network implementation. This requires base station equipment to be co-located with the antenna at the existing macrocell site. The existing macrocell network tends to perform poorly for large stadiums at maximum capacity on an event day. Some venues install neutral host distributed antenna systems to attract MNOs to provide better service at their venues. However, the MNO will still need to install and maintain a base station hotel on the venue's site which is costly and may not merit the investment particularly as consumers tend to select a mobile service provider based on the experienced service level at home, their route to work and workplace rather than at occasional events. The lower part of Fig. 3 shows the situation with a flexible virtualised network architecture. In this case the base station functionality is performed in an edge cloud site (which could be a local fixed telecoms exchange). If the venue were to provide a neutral host set of antennas and RF front ends within the stadium and connectivity to a local fixed telecoms exchange then the MNO could potentially use space in this exchange to install servers that could be dynamically configured to carry out the processing for a number of macrocells in the area on non-event days and then be re-assigned towards the stadium network on event days. The macrocells that normally use this data center can be served by more centralized cloud sites temporarily, at least for latency tolerant services. This would remove the cost of an on-site base station hotel at the venue and potentially make this use case more attractive for MNOs.

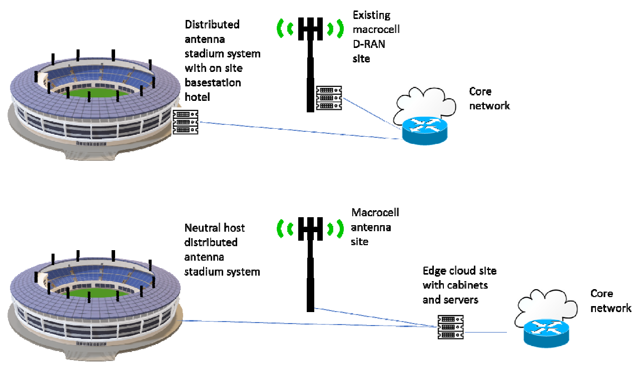

Fig. 3. Depth of slicing and trade off with elasticity and cost efficiency

Acknowledgment

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