

The Radio Spectrum Ladder of Investment to promote Innovation and Competition in Mobile Markets

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Abstract: How can innovation and competition be sustained in closed tight oligopolistic market structures? This question will be crucial in the next years for an appropriate regulation of mobile markets. The regulatory framework era of the postulate of infrastructure based competition seems behind us. It is time now to re-open the regulatory tool box to renew a service based competition approach with good incentives for all players: the incumbents with their own mobile infrastructure and potential entrants with innovative propositions for services in the emergent era of Internet of Things. This paper proposes to revisit the concept of the "ladder of investment" and to apply this approach to the mobile specific context where operators need an access to frequencies to maintain and develop their businesses. Our radio spectrum ladder of investment is structured by six rungs. Each of them supposes an appropriate technical and pricing access to the operators' networks infrastructure. Opening access to the mobile networks will be sensitive. A general scheme based on incentives for the network operators rather than on obligations and constraints is certainly more appropriate. Proposals are suggested in this article to pursue this objective.

Key words: Regulation, tight oligopolies, mobile market, MVNO, radio license assignment, infrastructure competition, service competition.

When competition in mobile infrastructure was opened between 1995 and 2010, the number of mobile operators rose thirty-fold. This trend has since slowed down, and in some countries has even reversed. On saturated markets, the conquest of new subscribers is difficult and costly. Promoting data services requires constant investments in

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new infrastructure. In this context and with intensive price competition, market structures with four or five infrastructure operators become unsustainable in the long run.

Ultimately, economic fundamentals reappear. In capitalistic sectors with low product and service differentiation and intensive price competition, economies of scale create a crucial cost advantage; hence reaching a large size on the market becomes a strategic imperative for operators¹. Building on critical size to lower costs and boost operating margins drives operators to merge or cooperate via mutualization and Ran-sharing agreements. More, the Internet Protocol has pushed transportation and treatment of all types of signals to converge, regardless of their origin or destination. The core of fixed and mobile networks, distribution networks, billing systems, and platform services, as well as others, can be mutualized between fixed and mobile activities to foster the economies of scope only benefiting integrated operators. These integrated operators in fixed and mobile networks have a competitive cost and marketing advantage over mobile-only operators, which also spurs concentration deals.

Competition in infrastructures was the cornerstone for telecommunications regulation, especially in mobile services. This context has led to very closed oligopolistic market structures and these oligopolies are entering in a concentration era to become triopolies and even duopolies. Contrary to monopolies, the regulation of oligopolies cannot be based on general results of economic theory². In the past three decades, research in the New Industrial Organization³ has pointed to the interdependence among oligopoly members which leads to multiple equilibriums with very contrasted effects on consumers and social welfare and which can be positive or negative⁴. Given this backdrop, questions regarding market performance can lead to use *ex post* interventions and to let competition authorities handle tight oligopolistic markets, which mobile markets are.

This orientation does not necessarily provide sufficient and appropriate answers for future challenges which networks and mobile services

¹ L. BENZONI & *al.*, "Optimal Mobile Telephony Market Structure in Europe: Two are few and four are too many", in, *Infrastructure vs Service-Based Competition: The Case of Mobile Telecommunications*, Quantifica Publishing, 2008, 167 p.

² BEREC, *Report on Oligopoly analysis and Regulation*, December, 2015, 121 p.

³ A. JACQUEMIN, *The new Industrial Organization*, MIT Press, 1987.

⁴ J. TIROLE, *The theory of Industrial Organization*, The MIT Press, 1998; M. MOTTA, *Competition Policy: Theory and Practice*, Cambridge University Press, 2004.

encompass, especially since the ubiquity of service offers is key to competition. When competition in infrastructures is softened, or even compromised, service based competition needs to be activated. This solution was backed by regulatory authorities when they encouraged the emergence of Mobile Virtual Network Operators (MVNO).

Until today, the emergence of MVNOs did not foster anticipated competitive effects. There were two obstacles. Regulatory authorities have a limited power to impose a regulated access to competing infrastructure operators. In an oligopoly, no single operator is *per se* a bottleneck monopoly, since the infrastructure has been duplicated. For competition authorities, requiring competitive conditions for access to the mobile network supposed proving a collective dominant position by these operators: a complex endeavor and one doomed to fail if one of the market's operators had contracted with at least one MVNO, even when the MVNO's economic conditions to this host operator's access did not truly give the MVNO the means to compete with full-fledged infrastructure operators.

We need to recall the relationship between infrastructure competition and competition in services, and between competition law and regulatory law in this area.

We, therefore, suggest starting from the Ladder of Investment. This concept was introduced by M. CAVE to illustrate the progressive network entry of new fixed telecommunications service operators⁵. M. BOURREAU *et al.*, have already extended this approach to communications with mobiles⁶. As for fixed networks, mobile competitors could enter the market progressively⁷. In this article, the authors underline that one of the essential specificities of mobile networks is access to radio spectrum and consequently, the need to obtain licenses from the competent authorities to be able to enter the market.

⁵ Martin CAVE, "Encouraging infrastructure competition via the ladder of investment", *Telecommunications Policy*, Volume 30, N° 3-4, 2006, pp. 223-237; M. CAVE & I. VOGELSANG, "How access pricing and entry interact", *Telecommunications Policy*, 27, 2003, pp. 717-727

⁶ M. BOURREAU, "Ladder of investment in Mobile", in L. BENZONI *et al.*, *Infrastructure vs Service-Based Competition: The Case of Mobile Telecommunications*, Editions Quantifica Publishing, 2008, 167 pages.

⁷ R. CAVES & M. PORTER, "From Entry Barriers to Mobility Barriers: Conjectural Decisions and Contrived Deterrence to New Competition", *The Quarterly Journal of Economics*, Vol. 91, No. 2 (May, 1977), pp. 241-262.

Licenses to access radio spectrum are the means to steer competition on mobile markets towards service based competition, especially in a market context where infrastructure competition is weak. It is worth noting that in mergers between mobile operators on national markets, Europe's competition authorities have preferred activating service based competition over lesser infrastructure based competition. These decisions offer new pathways to review mobile assignment policies and provide a real change in competition in services to promote innovation (and not merely lower retail tariffs).

In this article, the first section provides a Ladder of Investment model which enriches the standard MVNO model by introducing additional rungs. In section two, we review how mobile licenses are assigned. Auctions remain the most frequently used method, but procedures are becoming more and more complex. To foster competition in services in the mobile market, auctions need to move away from the price-only focus and become multi-criteria. Criteria can include control mechanisms, with progressive and proportionate sanctions to compensate for the well-known weaknesses of a system where pledges are only made for those who listen.

■ Definition of a Radio Spectrum Ladder of Investment

In mobile markets with very few mobile operators, and where only one or two operators can provide fixed line services, the market structure does not *a priori* offer a positive context for investors to take risks and/or innovate. Disruptive innovations generally come from new market entrants rather than from established market operators, especially when major capital outlay is invested in existing network technologies⁸. For an established operator to adopt a new technology, the operator must not only invest in a new technology, but also write-off existing obsolete infrastructure (dismantling costs may as well be high). So, it may be more worthwhile to continue amortizing current investments, rather than take on new risks and invest in a new technology. New market entrants are not confronted with these types of arbitration.

⁸ Clayton M. CHRISTENSEN, *The Innovator's Dilemma*, Harvard Business School Press, 1997; or P. AGHION, R. BLUNDELL & alii, *Firm Entry, Innovation and Growth: Theory and Micro Evidence*, August 20, 2004.

We are putting forth an original approach that accounts for the relative rigidity of the market structure, yet fosters innovation, especially given the promising growth this sector offers. The regulatory framework of Europe's fixed telecoms, called the Ladder of Investment, can also be transposed to radio communications. In fixed high speed broadband networks, the Ladder of Investment generally refers to five ladder rungs:

1. Resale of operator services purchased wholesale (the new market entrant does not have to have its own network),
2. Purchase of bitstream-related services (the new market entrant owns the basic network elements for web connections),
3. Purchase of partial unbundling services (the market entrant has its own infrastructure and rents only part of the bandwidth on the local loop)
4. Purchase of full unbundling services (end-to-end subscriber handling, by renting the local loop),
5. Deploying the operator's own local loop infrastructure (the alternative operator controls the infrastructure from end to end).

This framework incites market entrance at the lower rungs of the ladder of investment since the initial capital outlay is significantly lower, and thereby lowers the overall risk. The risk is lower because market entrance is gradual: the operator can stop at any rung. This approach has allowed a number of new Internet service providers to become market players, considerably speeding up high speed broadband Internet diffusion.

More, this approach has facilitated market entrance without destabilizing incumbents with infrastructure, including in the many countries where there was a duopoly due to two local loop infrastructure, the telcos and cable companies. New Internet service providers have not reached the fifth ladder rung, to build alternative copper or coaxial local loop, but they have developed durable business models, providing diverse enough offers to spark innovations in services and in content (higher bandwidth, triple play set-top boxes, VoD, etc.).

Transposing this approach to the mobile sector is a means to change tight oligopolistic *status quo* without destabilizing the market and the incumbents. Entrance is not only "soft" for possible new entrants (having to cope with limited risk and capital outlay), but also for incumbents already active in the market (which could find a new stream of wholesale revenues).

This transposition is not a leap into the unknown since all of the ladder rungs presented below have already been tested in one way or another in Europe and the United States through the concept of Mobile Virtual Network Operators. But MVNO experiences have been implemented erratically, based on the context at the time, instead of being part of a coherently planned regulatory framework. They nevertheless provide good building blocks.

Our spectrum ladder of investment includes six rungs (cf. Diagram 3) which, based on the fixed telephony experience, allows for a progressive market entrance from the first to sixth rung, when an operator has gained enough financial backing to become a full-fledged operator and be granted a license, which is the same for the duopolistic incumbents. Reaching the sixth rung, however, is not a requirement, as Europe counts many broadband markets where operators are at lower rungs on the ladder of investment.

Figure 1 - The radio Ladder of investment



Source: TERA Consultants

Level one: Service reselling

The first rung is the pure "resale" activity of the services offered by the existing mobile operators, where market players sell volume of data to the market entrant at wholesale prices, or below retail prices (in exchange, the "reseller" commits to a given volume). The first rung has been experimented across Europe, under the generic term of service provider. In the United Kingdom, when the four digital licenses (2G) were granted in 1995, resale became mandatory for the two operators with analog radio licenses (1G), British Telecom and Vodafone. British Telecom and Vodafone had to provide their 2G radio communication offers to resellers. The same was implemented in mainland Europe where service provision spurred many market entrances. Operators ended up buying resellers, while others prospered and moved up the rungs (Hutchinson Whampoa, the brand Three, Freenet, 1&1, Coriolis, etc.).

Resellers bill the subscribers they acquire and are therefore legally responsible, when problems arise, including network problems. To ensure that players opting for a "first rung entrance" can move up the ladder and are not blocked, the regulator must guarantee that new entrants:

- Can resell packages under their own brand name, and not under the hosting operator's name,
- The resale package cannot be exclusive for either party. An MNO cannot grant a resale exclusivity to a reseller, and a reseller cannot require an exclusivity from an MNO,
- The acquired subscriber base can be carried over to another MNO at a reasonable cost, or even for free, especially if the reseller wants to climb new rungs on the same host MNO.

For the market, the reseller provides a greater diversity in offers (brand and customer services), by developing new differentiating and additional "off-network" services for end-consumers, households and/or businesses: a greater variety of cell phone offerings with purchase, phone rental, special insurances, concierge services, repairs, special maintenance, more diversified distribution canals (stores), etc.

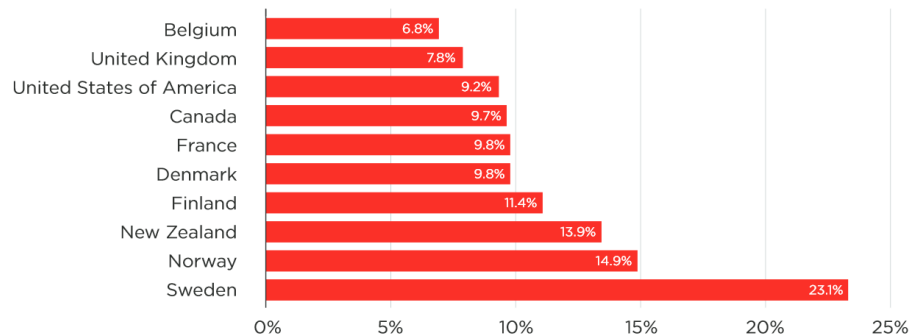
In a market where Mobile to Mobile communication, connected objects and Internet of things is poised to grow, if MNOs want to provide new specific services, a dynamic market for these new services will be very positive. If, for example, the MNO provides a remote alarm system based on its radio frequencies, having multiple users and resellers of this service

under different brand names and with different off-network service offerings is a means to ensure faster diffusion and greater service penetration.

Turnkey service offers for Machine to Machine (M2M) or Internet of Things (IoT), have seen the day without requiring regulatory intervention, as underlined by the number of connections registered by M2M SIM cards of mobile operators in overall connections (cf. figure 2).

The number of connections, however, is linked to players who internalize the M2M function in their systems and do not directly resell on the market via an operator plan. M2M market players generally buy M2M plans provided by the operator and implement them directly in their service offering. A photocopier manufacturer, for example, can include a SIM card in its products so that remote maintenance sends the appropriate preventive or curative messages. The photocopier client who has subscribed to a maintenance contract may not even know that the alarms are sent via mobile frequencies and/or that a SIM card is inside the photocopier installed in its building. The company installing the photocopier is not on the first rung of the investment ladder, since sales for M2M subscriptions are carried out through a direct distribution system.

Figure 2 - Share of M2M connections in overall mobile connections (2013)



Source: GSMA Intelligence ⁹

In practise, the resale approach of the first rung of the spectrum ladder of investment approach implies that a reseller can buy the M2M plan from an operator at a wholesale price, so that the reseller can sell the M2M plan to installers who include M2M SIM cards in their systems. M2M subscription

⁹ <https://gsmaintelligence.com/research/?file=140217-m2m.pdf&download>.

sales by resellers are an indirect distribution channel in competition with the direct distribution channel of the MNOs. M2M subscription resellers will seek out clients across all sectors where M2M and the Internet of Things are both useful and financially rewarding. New technologies with almost infinite applications and with many players providing offers are the best means to develop the market.

Regulating wholesale prices as of the first rung may be necessary if operators do not spontaneously offer reasonable tariffs to resellers to ensure a profitable business model. Regulated wholesale tariffs for resale can be set out using retail minus pricing that consists in subtracting the operator's retail tariffs from the network elements of the service's commercialization costs: distribution, billing, unpaid bills, etc.

Level two: Light MVNO

This second level is very common in OECD countries. At this level, market entrants can issue their own SIM cards to subscribers, allowing the entrants to package offers based on targeted client needs. On this second rung, MNOs must provide originating call offers to interested players. As second-rung market entrants can buy traffic from MNOs, they can also provide differentiated plans from the MNOs. Consumers, households or businesses, can perceive a real difference between the MNO and the MVNOs plans, with consumers viewing the MVNOs as MNOs, even though these market players do not own a network. Typically, the term "MVNO" is used to designate players established on this second rung. However, at this rung, players do not own any elements of the mobile network they control, in particular the HLR ¹⁰ so, the term MVNO Light is used to distinguish these MVNOs from those owning this type of equipment ¹¹.

Most of today's MVNOs operating across the OECD are light MVNOs. This new player's entrance on the mobile market was backed by regulators who felt that the natural oligopolistic structure of mobile markets did not provide sufficient market competition. Regulators considered that MVNO's could stimulate competition on the mobile concentrated markets. In Europe, incumbent MNOs accepted MVNO's entrance because regulators threatened to open up their network and set up a mandatory originating call

¹⁰ HLR : Home Local Register.

¹¹ L. BENZONI, *Rapport sur les opérateurs mobiles virtuels*, C.C.R., ARCEP, 2002.

tariff for MVNOs - which operators should have done spontaneously. The threat sufficed to make operators bend under regulatory pressure, albeit not always willingly.

At the time, operators' licenses did not include these types of obligations, and imposing changes had to be carried out without modifying regulation, which would have implied changing the licenses. The scheme developed to legally constrain operators into negotiating with MVNOs was either by dispute settlement at the regulator level, or by antitrust litigation before national competition authorities. The litigation would rely on a "refusal to sell" and be sanctioned as an abuse of a collective dominant position. In Europe, Spain was the exception to the rule, when the national regulator, the CMT, tried to impose MVNOs on the mobile operators refusing to yield to regulatory pressure.

In all other European countries, and even elsewhere, MVNOs were able to negotiate originating call tariffs allowing them to start at the second rung. For brand MVNOs, the offers and the commercial service quality provided such differentiation that consumers often designated MVNOs as offering the best network quality (coverage, quality of communications, etc.), even though these players do not own their own network. This point shows that for a consumer, network service quality is often confused or seen as the overall quality of the service rendered.

In a context where data services and data traffic will largely dominate the market, it is crucial that light MVNOs obtain terminating call tariffs that can only include data traffic origination. If the additional maneuvering margin for IoT services or mobile Internet access provides the possibility of providing brand-name tariff plans, market offerings in diversity and quantity, will consequently increase. Data only wholesale offers to MVNOs can be designed for specific clients or to diversify IoT offers. An MVNO, for example, can offer an anti-intrusion alarm with a basic service that sounds the alarm remotely, and a premium service that sends real time video surveillance camera images of the premises to the one or more smartphones of the persons to be alerted, be they the premise occupants or a surveillance company. But the guarantee of a high quality level of the service for the end users, especially in the above example where the service requires delivering a high quality real-time video, can require prioritizing traffic within the MNO's network. Traffic prioritization supposes that a managed service can be implemented by the MNO in its network and sold to the MVNO. This managed service can imply specific costs for the MNO if it has to maintain a constant quality of its network for all services and users.

Could MNOs offer MVNOs differentiated tariffs based on different quality levels to answer specific requests from MVNOs? If we take the above example of the anti-intrusion alarm, it is clear that quality real time transmission of video in color, with the highest definition possible provided by the camera, at the source of the signal, should be an MVNO request. A number of other cases could be cited as an example of MVNOs providing interactive multi-player online games for tablets and smartphones, requiring both available bandwidth (transmitting high definition and animated color images) and the lowest latency possible (real time response for players in action games). Here too, the MVNO offering drastically depends on the quality that the MNO host can provide, hence the need to calibrate an offer with special needs to meet the MVNOs specific requirements. Differentiating service qualities should logically mean different MVNO tariffs when they purchase traffic from MNOs. This leads us to question a strict net neutrality approach across mobile networks at wholesale levels, and therefore at retail levels.

Regulating wholesale prices should only be envisaged if operators do not spontaneously provide reasonable tariff offers for originating calls, so that MVNOs can benefit from a sustainable business model. Regulated wholesale tariffs for call origination can be established on a retail minus (cf. supra) or cost plus logic. In the latter case, the cost of network elements¹² that are required to provide an offer are assessed and a markup is added. Further, originating call tariffs must be included in a catalogue for MVNOs acquiring voice services independent of data services.

Level three: full MVNO

Certain players, especially those with successful businesses at the second rung, can decide to invest in network elements and have their own HLR, or even transmission equipment. As such, these players can own their network to fully control their subscribers. They buy originating call traffic from operators, but they can also generate revenues from call termination to their subscribers, which is not true for an MVNO Light. At level three, subscribers acquired by the MVNO are fully controlled by the MVNO and the MVNO can switch its subscriber base from one operator to another at any moment. If an

¹² Network elements are generally referred to as reasonably sized logical entity bringing together one or more devices. Devices can consequently be managed coherently with the same system.

MVNO has agreements with several operators, the dynamic management of interconnecting SIM cards means this MVNO can provide its subscribers with a better network service quality than the operators providing this service can offer to their subscribers. This situation is paradoxical since the operator that doesn't own a radio local loop, objectively has a better network service quality than the operators who own this local loop.

There are Full MVNOs, although across the OECD, the Light MVNO is more common. Full MVNOs have acquired a significant subscriber base. They have climbed an extra rung in the radio ladder of investment since the breadth of their subscriber base means they can risk investing in network equipment (fixed costs). A few players have entered the mobile market at the third rung, generally as a joint-venture with a mobile operator. Examples are Virgin Mobile in the United Kingdom: it entered the market as a Full MVNO on the basis of a joint-venture between T-Mobile, the hosting MNO, and the Virgin Group Holding, which provided the Virgin brand name reputation.

One of the difficulties that Light MVNOs face to move from the second to third rung is the cost of subscriber portability to their network elements. The experience acquired in this domain suggests that contracts between Light MVNOs and MNOs should at least include sharing portability costs, this cost could be nil if Light MVNOs become Full MVNOs by staying with the same host MNO.

Like the previous levels, the regulatory question for wholesale prices must be foreseen at this level, if operators do not spontaneously make reasonable tariff offers for originating and terminating traffic, so that MVNOs can have a sustainable business model. A retail minus (cf. supra) or cost plus approach can be contemplated. Asymmetric termination traffic favoring the Full MVNO can be seen as a temporary incitation to facilitate the move to the third rung. A tariff integrating traffic criteria (prioritization or other) acquired by the MVNO has to be addressed once again.

If the regulatory body accepts and provides the framework for the MNOs to prioritize traffic within their network (regulation of net neutrality), it seems logical, that to avoid anticompetitive practices, the quality level and prioritization implemented by the MNO has to be offered to MVNOs on the wholesale market on a transparent and non-discriminatory basis.

Level four: quasi MNO

The three previous levels include a number of antecedents in many countries, the fourth level proposed here appeared in a concentration case on the German market when Telefonica operated under the brand name O2 and wanted to buy out its competitor E Plus, owned by KPN. The merger reduced the number of MNOs from 4 to 3 on the German mobile market, a market structure which the European Commission deemed too small to maintain an adequate competition level. More, the German market counted the highest mobile tariffs, higher than in many other European Union countries.

To accept this concentration deal, Telefónica suggested a certain number of commitments to the European Commission¹³. Telefónica's first commitment was original and served as the basis for a new rung. The following is a long citation from the European Commission on this point.

"First, Telefónica offered a package of commitments aimed at ensuring the short-term entry or expansion of one or several MVNOs which will compete with the merged entity. MVNOs offer mobile telecoms services to consumers through access to the network of MNOs. Telefónica commits to sell, before the acquisition is completed, up to 30% of the merged company's network capacity to one or several (up to three) MVNO(s) in Germany at fixed payments. The capacity is measured in terms of bandwidth and the MVNO entrants will obtain a dedicated "pipe" from the merged entity's network for voice and data traffic. This model is more effective than the typical pay-as-you-go model that MVNOs and Service Providers currently use in Germany - and more generally in Europe - and under which they pay for network access on a per usage basis. The Commission's investigation in this case also showed that the model is viable for the German telecoms market. Indeed, with a fixed capacity that they committed to pay upfront at their disposal, the MVNOs will have increased incentives to fill the capacity they have committed to purchase by offering attractive prices and innovative services".

Via this agreement, MVNOs have a direct access to a set of reserved frequencies amongst the host operator's own frequencies. This refers to the purchase of exclusive capacity rather than selling of traffic as exposed above. The contract between an MVNO and the MNO aims to obtain an exclusive right of use of the reserved frequencies. It is comparable to a "Spectral Infeasible Right of Use" (S-IRU), since for all MVNOs part of this

¹³ For a summary of this deal, cf. http://europa.eu/rapid/press-release_IP-14-771_en.htm.

type of contract engages purchasing capacity with a single payment at the beginning of the contract ¹⁴.

Using an operator's local loop via an IRU is actually an original regulation element for FTTH deployment on the French market. When an operator ensures FTTH deployment across a specific geographic zone, the operator is obliged to meet another operator's request to acquire an IRU with a commercial lifespan of 20 years for a certain number of FTTH plugs in the zone. The range is delimited by 5% steps for plugs of the considered zone. The price for a plug (Orange offer) is 500€. If, for example, an operator wants to acquire an IRU for 10,000 plugs in a given zone, the operator has to pay a one-time settlement fee, or 5 million euros, to the operator who owns the FTTH network, and can sell up to 10,000 plugs in the deemed zone. The operator who has not acquired an IRU in the zone, can always rent FTTH subscriber lines, plug by plug, from the operator who deployed the network. In addition to the IRU offer obligation, there is a regulatory obligation to propose a rental offer per plug at a non-excessive price for all operators. The price of renting an FTTH plug is of course much costlier over the long term than paying for an IRU.

The FTTH regulatory mechanism set up in France was fully approved in its principle by the European Commission, which even used it as an example to follow in other countries, as it did for the above presented O2-E PLUS case. They allow operators who have an established business as an Internet Service Provider in broadband, but do not have their own local loop infrastructure, to fully benefit from a local loop, when there is a network generation change and broadband market developments to compete better against the incumbent.

The ability for MVNOs to acquire spectrum capacity as an IRU is the fourth level. Frequencies are owned over periods of time lasting as long as an operator's license, but the MVNOs don't operate these frequencies, since the operations are handled by the host MNO as a form of network sharing. The MVNO can install or have installed active equipment that is dedicated to

¹⁴ As a reminder, an IRU in the telecommunication sector means an effective long-term lease (temporary ownership) of a portion of the capacity of a network. The most common IRU concerns agreement for the access to international cable. IRUs are specified in terms of a certain number of channels of a given bandwidth. IRU is granted by the company or consortium of companies that built the leased network. Some IRU legal agreements forbid resale of the capacity ownership. The IRU ownership period is generally granted for 20 years. For further details cf. http://www.arcep.fr/uploads/tx_gspublication/etude-IRU-baker-et-mckenzie-030311.pdf.

the MVNO by the host MNO and which the MNO will exploit with technologies to produce the services decided by the MVNO. The MVNO can therefore offer different technologies and services from the host MNO. But these MVNOs have reduced spectral capacity compared to the full MNOs, and they do not have the same obligations, specifically in terms of coverage. Having full control of a spectral capacity enables these MVNOs to act as quasi-MNOs. They can deploy innovative radio technologies and services with a major differentiation with their host MNO. For example, a quasi-MNO can operate 5G or LoRa¹⁵ protocol technologies and services on the host MNO's frequencies whereas the host MNO has not yet deployed these technologies.

Like the previous rungs, wholesale regulation must be envisaged if operators do not spontaneously offer capacity-driven tariffs so that MVNOs have a sustainable business model. Capacity granularity must also be defined, and possibly include a geographic dimension. In the German O2-E Plus case, the sale of bandwidth capacity covered the entire national German market. An MVNO had to buy a capacity of at least 5 MHz. The number of MVNOs that could benefit from this mechanism was limited by the quantity of frequencies held by the host operator, and in Germany the host operator could only host up to three MVNOs or service providers. In the French FTTH case, the IRU is available at a geographic level (a number of cities grouped together). Applied to Qatar, capacity does not have to include all of the host operator's capacity or network, as is the case in Germany, but is limited to a geographic scope, as is the case in France for FTTH.

As a matter of principle, the capacity purchased through an IRU shall not be sold to a third party operator. However, this reselling possibility could be studied on a case-by-case basis. If, for example, a player decides to purchase spectral capacity to be used only for the development of IoT services, this player could be authorized to resell capacity to other players on rungs 1 and 2, and maybe rung 3 as well.

Level five: Roamer MNO

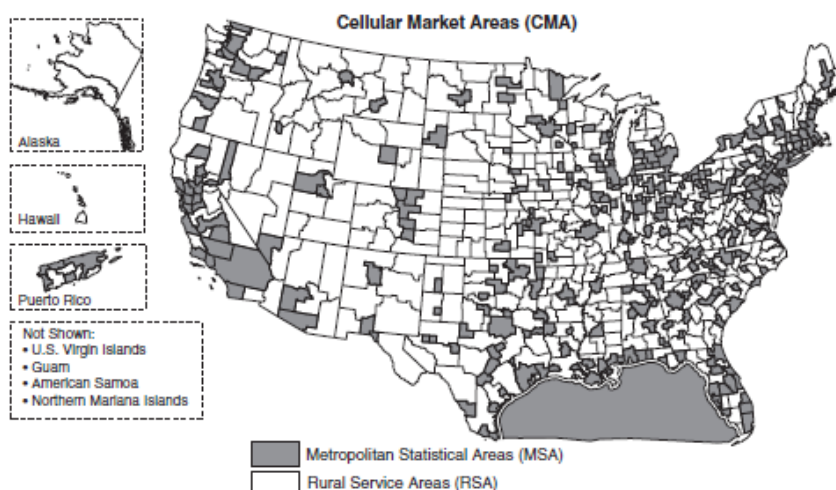
This fifth level of the spectrum ladder of investment is already present in a number of countries where coverage obligations do not entail the entire national territory, such as the United States. When networks do not cover

¹⁵ "Long Range Wide-area network".

the entire national territory, either transitorily, or due to license conditions, the number of operators required to increase coverage beyond the licensed zone, entails national roaming agreements. In the US, where there are more than 100 operators, only four operators state having their own quasi-national coverage¹⁶. For other operators, coverage beyond their licensed zone requires roaming agreements with one or more operators, and these agreements are key to their livelihood, because the smallest operators sometimes have only 1 of the 732 types of "Cellular Market Area" licenses, which are either Metropolitan or Rural (cf. map below). Therefore, these operators must have a roaming agreement beyond their license coverage zone, so that their subscribers can benefit from the mobile service. This is called national roaming. The twelve licenses ensuring the greatest coverage are "Regional Economic Areas" and include obligations to sign roaming contracts with Cellular Market Area operators. This organization stems from the geography of licenses. Over the long term, it has led to the coexistence of several market players of different sizes, since the four biggest operators (Verizon, ATT, Sprint, T Mobile) hold more than 80% of the market, while the next top 100 operators have a market share slightly above 10%, and MVNOs have an 8% market share. National roaming is regulated by the obligation to grant all reasonable requests, and the FCC has the power to resolve any disputes that arise.

¹⁶ Source: FCC, *Sixteenth Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services*, FCC 13-34, released March 21, 2013, pages 37-38, https://apps.fcc.gov/edocs_public/attachmatch/FCC-13-34A1.doc

Figure 3 - Map of coverage of the 732 Cellular Market Areas in USA (2013)



Source: FCC

In Europe, the operators also use national roaming agreements to round out their coverage, much as in the United States. In Europe, however, these agreements have less importance.

National roaming agreements should not be assimilated to Ran Sharing agreements, where operators mutualize equipment, but do not pool the use of their frequencies. In a national roaming agreement, like in international roaming, a host operator owns the network equipment, and operates using its license frequencies, and bills the roaming partner operator for use of its network (used by the roaming partner's subscribers).

National roaming agreements also qualify the fifth level of the radio ladder of investment. The idea here is to provide a new market player with an operator's license with lower coverage obligations compared to established operators. This operator must have access to a national roaming agreement to provide a service equivalent to the incumbent's. This explains the fifth rung's name, Roamer MNO. The national roaming agreement can be temporary or permanent for a third party. National roaming possibilities have often been granted to Europe's last market entrants, as a means to help them get started in a market where established operators' advantages seem impossible for newcomers to overcome (Three in Italy, (is something missing here?) the United Kingdom, or Free in France).

The scope and length of national roaming agreements considerably impact an operator's entrance costs, especially since they now have a license with assigned frequencies.

Like the previous rungs, regulating the price of national roaming must be called for, if operators do not spontaneously provide offers, providing new MNOs with a sustainable business model. These types of agreements can include a fixed part for a one-off payment at signature to cover the investments of the additional capacity that the hosting operator bears. The deal may also include a variable factor, and the MNO may pay a variable sum linked to traffic.

Level six: Full MNO

If an operator climbs all the rungs of the spectral Ladder of Investment, this operator will be on the same footing as the mobile network operators. This perspective is by far hypothetical, but shouldn't be considered impossible.

■ Implementing the Radio Spectrum Ladder of Investment: A Regulatory framework

As stated above, the measures to create rungs for the radio spectrum Ladder of Investment are progressive and heuristic, and do not mirror the planned regulatory framework presented, when competition was opened in fixed networks which was more or less the case. Initially, regulatory authorities thought that infrastructure competition, at the very basis of mobile regulation, was a sufficient means to guarantee competition. However, translated into business plans, infrastructure competition is by nature capital intensive. Therefore, it translates either into soft competition to allow all operators to amortize their infrastructure or by cut throat competition which ultimately leads to market concentration. The European mobile market is in the concentration phase.

In the soft competition phase, regulatory authorities have put the emphasis on the need to help MVNOs enter the market, to spur competition for services, in addition to infrastructure competition, which is insufficient.

When operators hold individual licenses, regulators are seldom in a position to make significant changes without the operators' approval. There are, however, two means to impact operator's behavior, used either tacitly or explicitly by regulators so that mobile operators accommodate service operators, like MVNOs: (i) the threat to use antitrust and competition law to sanction abusive behavior and impose injunctions to re-establish competitive order, including injunctions which are not compatible with license conditions, (ii) new conditions introduced during the renewal or allocation of new licenses/spectrum. The second approach based on regulation tools is described below.

Using the leverage effect of assigning new frequencies to incite incumbent operators to host MVNOs

This approach is based on the principle that licenses are renewable and new frequencies can be assigned for the 5G generation. The current and future volume of available frequencies to assign for mobile services could be used as an incentive for incumbents accepting new clauses and benefit from these frequencies in counterpart. The catalogue dedicated to wholesale offers will be designed by operators, who are candidates for licenses proposed with a call for tender and not with auctions.

Which assignment procedure can be chosen?

Two approaches are proposed here:

- A competitive tender at a fixed date: The regulator can organize a tender at a set date and assign frequency bands to each mobile operator depending on their bid for frequency bands and their commitments relative to the quality of their wholesale catalog.
- An ongoing process, for which the operator obtains additional frequencies or advantages in exchange for the publication of a wholesale catalog for MVNOs, and which is approved by the regulator.

The first approach seems appropriate to encourage mobile operators to make additional efforts to invest in new network technologies based on new frequencies and new licenses (e.g. 5G).

An assignment procedure for the frequencies must be selected. In light of the retained objective, the beauty contest procedure should be favored over an auction-based procedure.

If the auction process will be retained, the regulator would have to define standard specifications of the radio spectrum ladder of investment, providing specific indicators for the types of contracts and processes that operators would have to abide by. Drawing up these types of specifications means that the regulator knows the mobile operators' capacities to open their networks to new market entrants better than the mobile operators themselves do. The regulator must also know the costs that operators will bear for each opening level on each operator's network. The operators' costs have to be challenged with a bottom-up model of an average efficient mobile operator conducted by the regulator.

In a beauty contest procedure, each competing mobile operator defines its own specifications. Competition is consequently based on how operators define their best efforts in exchange for a greater or lesser opening of their networks, and consequently, service-based competition. Competition based on specifications meets the objective for optimal network opening.

We further detail hereafter how this regulatory approach can be implemented on a practical level.

The regulators would rank mobile operators' proposals and each operator would receive a given amount of frequency based on their rank. Criteria used to rank operators would be chosen by the regulator to make sure that the mobile operators' wholesale catalog facilitates the entry of new players. The regulators would weigh each criterion, and the final rank would be a weighted sum of the criteria grades. The regulators may oblige mobile operators to respect minimum standards for each criterion. Like the minimal clauses in the beauty contest procedure specifications, the regulators could provide a list of minimal commitments to be accepted by operators in the catalogue framework. This framework would impede mobile operators from focusing on specific criteria and neglecting others. Hereafter is a list of criteria that the regulators could use to calculate final grades:

- *The bid*: each mobile operator would bid a certain monetary amount based on the total discounted sum of expected private benefits directly linked to the new frequency bands.
- *The level of the radio ladder of investment selected by the mobile operator*: The competitive tender would be on condition of the bidding

operators' acceptance that other firms enter the market via the spectral ladder of investment (see Figure 4). Each mobile operator would select one or more successive ladder levels and commit to give access to new players under the conditions imposed by the chosen level of the spectral ladder of investment. For example, the mobile operator can select the first ladder rung, thereby, committing to sell retail packages to service providers at wholesale prices, and also offer access at the second rung with a call origination rate, and so on for the other rungs. The operator could choose to open either specific rungs or the entire ladder.

- *The proposed price of access given the selected level of radio ladder of investment:* each mobile operator would commit to offer access at certain rates (see Figure 4). If a mobile operator has selected the third rung, the MNO accepts to give access to a full MVNO. In this example, the call termination rate can be asymmetric, with a tariff premium for the new player. Rates can be transitory with regulatory control, helping entrants increase their market share to drive service-based competition.
- *The guaranteed QoS offered to entrants:* ensure that the mobile operator does not degrade the QoS for access seekers.
- *The committing date to give access:* the mobile operator can also commit to pay financial compensation in case of delay.

Figure 4 - Radio spectrum ladder of investment and condition of access to the rungs

	Rungs of the ladder	Condition of access to the rungs
⑥	Full MNO	No specific access is required but ran sharing conditions can be proposed
⑤	Roamer MNO	Access conditions for national roaming
④	Quasi MNO	Access conditions and rate proposals for Spectral-IRU
③	Full MVNO	Call originating rate + asymmetric termination rate
②	Light MVNO	Call originating rate
①	Brand license	Wholesale price of retail packages

Source: Tera consultants

(above) RAN sharing

Inciting operators to participate and compete with each other

In tight oligopolies, operators have no incitation to spontaneously open their networks to service operators who compete on their markets. The incumbents can tacitly collude to avoid providing a wholesale offer. This blockage has been noted in numerous national markets when regulatory authorities tried to force MNVO entrance onto the mobile markets. With competing operators, history shows that the operators participating in the bids for tender have always accepted to open their networks to future service operators. This point can be modeled using the prisoner's dilemma. Let's suppose a national market with two mobile operators. Each of the two operators can refuse or accept to bid for frequencies. This first situation corresponds to square *A* in the figure 5 below, when the two operators refuse to bid. This case is a *status quo* of the present market situation. Profit levels remain stable for example at a level of 2, and are considered similar for the two operators. In an opposite situation, they both accept to bid, as in square *D*. Since the two operators compete against each other, they promote the entrance of MVNOs. The two operators therefore anticipate either a drop in their profits at level 1, or a drop compared to situation *A*.

Figure 5 - Share of M2M connections in total mobile connections (2013)

		Operator 1	
		Accept	Refuse
Operator 2	Accept	1 <i>D</i> 1	- 1 <i>C</i> 3
	Refuse	3 <i>B</i> - 1	2 <i>A</i> 2

Source: TERA Consultants

In a dynamic vision of the mobile service market, and in light of the rebound effect¹⁷, systematically observed in over half a century of information technologies, the operators can nevertheless anticipate higher market volume with new market channels, namely on the data market, while the drop in short-term profitability will be offset by higher volumes over the long term. In this way, profits could grow despite the new entrants on the mobile service market.

In the third situation, an operator bids while the other does not. This is the situation presented in square *B* in figure 6, whereby operator 1 accepts and operator 2 refuses. Operator 1 will be the host operator and benefit from the dynamics of the MVNOs by receiving wholesale revenues generated by MVNO activity, whereas operator 2 will not receive any of these MVNO-linked revenues. Operator 1 can even increase this effect by establishing a wholesale catalogue that specifically targets its competitor's client segments: business clients, specific data plans, international roaming, etc. In this instance, MVNOs compete less with their host operator than with the other operator. MVNO subscribers come from the non-host operator. The non-host operator loses clients and these clients now provide wholesale revenues to the host operator. Furthermore, the acquired additional frequencies imply that the host operator can also handle the extra MVNO-related traffic on its network without bearing high incremental costs. Given this situation, operator 1 can anticipate high growth in its profits and move to square 3, which is the best situation for this operator. *Mutatis mutandis*, will be the reverse situation where operator 2 accepts to bid and operator 1 refuses (square *C* in figure 6). This time the roles will be switched for the same reasons as mentioned above for square *B*. The perspective that either of the two operators ends up in square *B* or *C* incites them to participate in the bid rather than sit out.

The logic in this bid for competition should lead to square *D*, the most desired from a competitive standpoint, notwithstanding the possibility of an explicit or tacit collusion between the operators, whereby both operators would refuse to participate, or a *status quo* situation.

This competition logic can push the operators to outbid one another and offer opening levels which they will not be able to realistically provide later.

¹⁷ S. JEVONS, *The Coal Question; An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal Mines*, 1865.

Credible commitments require a precise and detailed access calendar for interested parties. Letters of intent from the operators may be required.

One of the beauty contest's weak points lies in not respecting previous commitments. Only credible and automatic, and thus non-negotiable, threats can be used to impose operators to fulfill their previous commitments.

Progressive and significant fines could be automatically applied if commitments are not respected. To lend credibility to these commitments, sanctions could be applied in solidarity to the interested third-parties who accompanied the operator in the bid.

All of these proposals provide possible tracks for reflection, and need to be detailed, amended or rejected if the radio spectrum ladder of investment were to be implemented with a beauty contest procedure.

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