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Innovation Services

· Network Infrastructure Sharing

Operations and Technology Management

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What's it all about?

The traditional and still prevailing mobile network operator business model is based on the carrier's full ownership of the physical network assets. However, rapid and complex technology migration, regulatory requirements and increasing capital expenditures on the one hand, and competitive environments, saturated markets and pressure on margins on the other hand, advocate a new paradigm, with the focus being on "critical success factors" and "key assets". Simultaneously, telecommunications equipment is being commoditized. These trends are paving the way for network infrastructure in core and radio access networks to be shared among multiple operators. Challenges arise not only with regard to technical solutions to enable such business models in a multi-vendor landscape, but also in the context of the principal-agent problem accompanying the re-allocation of assets and operational duties.

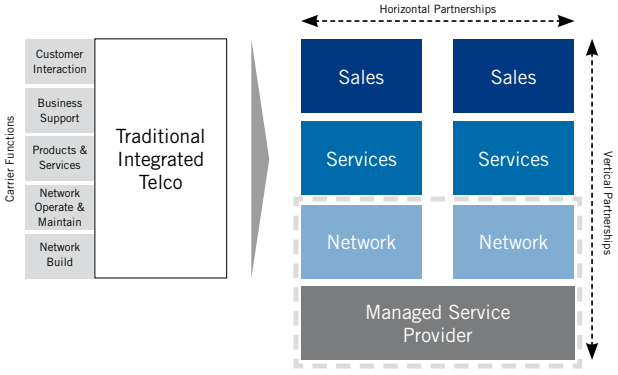
We advise operators on the technological, regulatory and business aspects of sharing network resources, as well as helping them to evaluate the various approaches and technical solutions. On the commercial side, we have a comprehensive model that estimates reductions in capital and operating expenses for the various scenarios. Finally, we assess the benefits of outsourcing and managed services for a shared network, a highly attractive option to overcome some of the challenges posed by infrastructure sharing and harvest additional operational synergies.

Our Approach

- **Concept and Business Model:**
  Current incumbent mobile network operators (MNO) are still characterized by a high degree of vertical integration: The MNO plans the network architecture and topology, acquires (buys or leases) and develops (in terms of civil engineering) the sites needed to roll out the network, oversees the network implementation by suppliers and subcontractors, operates and maintains the network, creates, markets and provides services to its end users, and manages customer relations. However, technology migration is becoming increasingly rapid and complex, and regulatory requirements could mandate the coverage of areas that are unattractive from a business perspective. At the same time, markets are highly competitive and increasingly saturated, meaning that operators have to be cost-aware in order to protect their profits.

  Operators need to focus on activities that really differentiate them in the marketplace, and the mere provision of coverage and capacity is gradually being viewed less as such a key success factor. Specialized providers may be more competitive in running a particular part of the business – such as the network – leading to a vertical disaggregation of the value chain. Operations outsourcing and out-tasking are typical examples, as is the network provider business model, where the operating party also owns the network assets.

  Considering multiple operators rather than just one single operator in a market, sharing certain, non-strategic platforms and assets, and operating them together or having them operated by a third party become viable options, with horizontal partnerships emerging as a result. In this context, infrastructure sharing is an important topic in both growth or new roll-out (e.g. new technology or additional coverage) and in consolidation (e.g. phase-out of old technology, relocation) scenarios. It is relevant both to emerging/developing market operators looking at inexpensive options for coverage and capacity growth and to operators in mature markets seeking cost optimization and technology refresh. The starting point for network sharing was traditionally the sharing of sites, including passive infrastructure (towers, shelters, air conditioning and cooling systems, power supply, diesel generators), but current technical solutions allow for much more radical approaches. Infrastructure sharing transactions can be characterized by three dimensions:



Evolution of the operator business model

- Business model – describing the parties involved and their contractual relationship

- Geographic model – describing each operator's physical footprint

- Technology model – describing the technical solution used

The three dimensions are interrelated, since the choice of a certain option regarding one dimension will limit the degrees of freedom for reasonable choices in the other dimensions.

The decision on business model and geographic model largely depends on the involved operators' relative conditions, installed bases and future roll-out plans. Incumbents with similar roll-out cycles would probably prefer mutual service provisioning agreements, or would establish a joint venture to run the shared network. If both incumbent and new entrant operators are involved, unilateral service provisioning would be an appropriate choice. If operators want to focus on service development and sales, the delegation of the network provision to a third-party network provider holding the assets and operating them would be an interesting alternative.

Operations outsourcing and out-tasking are options that can deliver cost reductions to operators in any constellation: standalone, unilateral and mutual service provisioning agreements, as well as joint ventures. For the collaboration schemes mentioned, however, outsourcing becomes especially interesting because, on the one hand, the outsourcing provider accomplishes higher synergies out of the alignment of the services for the combined scope and, on the other hand, this external partner facilitates the sharing process, providing neutral governance models (solving the principal-agent dilemma) and guaranteeing the confidentiality of each operator's data, such as customer-specific traffic data and service-specific configuration settings.

- **Geographic Dimension:**
  In the standalone base case, each operator provides full service coverage for the complete geography in scope (a country, or a large country's region or province) by operating a dedicated own network. Departing from this structure, various options are available.

  - Full split:
    In the full split case, the operators cover disjointed, complementary areas. This approach is interesting for operators of comparable strength wanting to enter a mutual service (roaming) agreement. In a growth scenario, it allows extended coverage or introduction of new technology at the lowest combined cost; in a consolidation scenario, it requires discretionary phase-out to be coordinated between the operators, but no relocation of equipment.

  - Unilateral shared region:
    Unilateral sharing is a model particularly aimed at combining incumbents' and new entrants' roll-out requirements, because it allows the operator holding a large installed base to leverage it in order to generate additional volume and revenues, while relieving the "greenfield" operator from the burden of investing in an own full-coverage infrastructure that may be incommensurate compared to a small subscriber base. Again, roaming would be the corresponding technical solution.

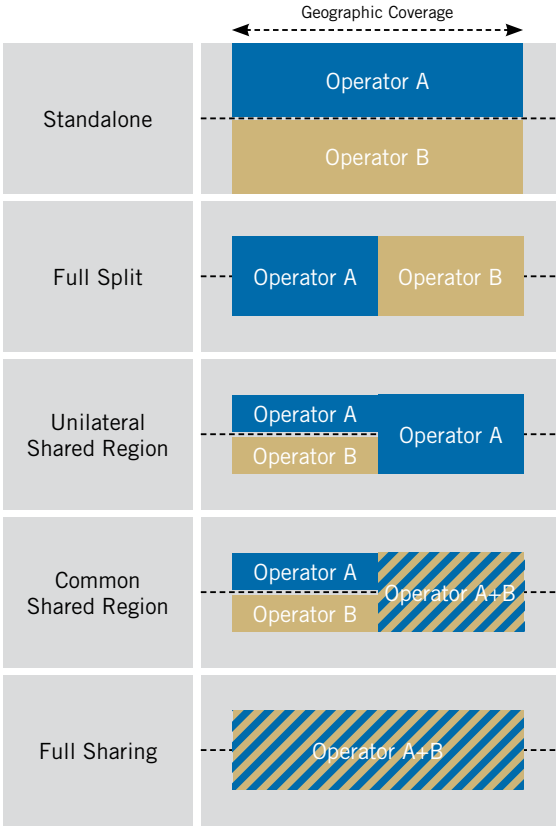
  - Common shared region:
    Similar scale operators will establish a common shared region, if they all want to be physically present in an area (i.e. expanding into that area in the growth case, refraining from moving out of that area in the consolidation case), but still want to share infrastructure, or at least sites, in order to reduce capital and operating expenditures. Since no roaming is required and new technical features – such as use of individual network identifiers – have recently been added by infrastructure vendors, the subscribers will not necessarily even notice that infrastructure is being shared (as would be the case with roaming).

  - Full sharing:
    With full sharing, operators combine all sites, their entire radio access networks (RAN) and, potentially, even portions of their core networks. Of course, a geographical full sharing implementation

is always more efficient than a partially sharing implementation with the same technical approach. For a roaming-based solution, the only difference between full split and full sharing is the regional selection criterion for the former (i.e. one operator rolls out or concentrates in one area), while the latter means a case-by-case decision on the roll-out or phase-out with no regional decision criterion. In a growth environment, full sharing mandates an optimal joint network planning ex-ante; in a consolidation environment, operating costs are reduced by concentrating sites (relocation costs apply though), and by retiring equipment no longer needed from a capacity point of view.

- **Technical Approaches:**
  The technical approaches can largely be allocated to three clusters, depending on the depth of sharing and the location of sharing features control:

  - Passive RAN sharing – essentially a quite common, feature-poor site-based sharing, even when including electrical components



Geographic options for infrastructure sharing

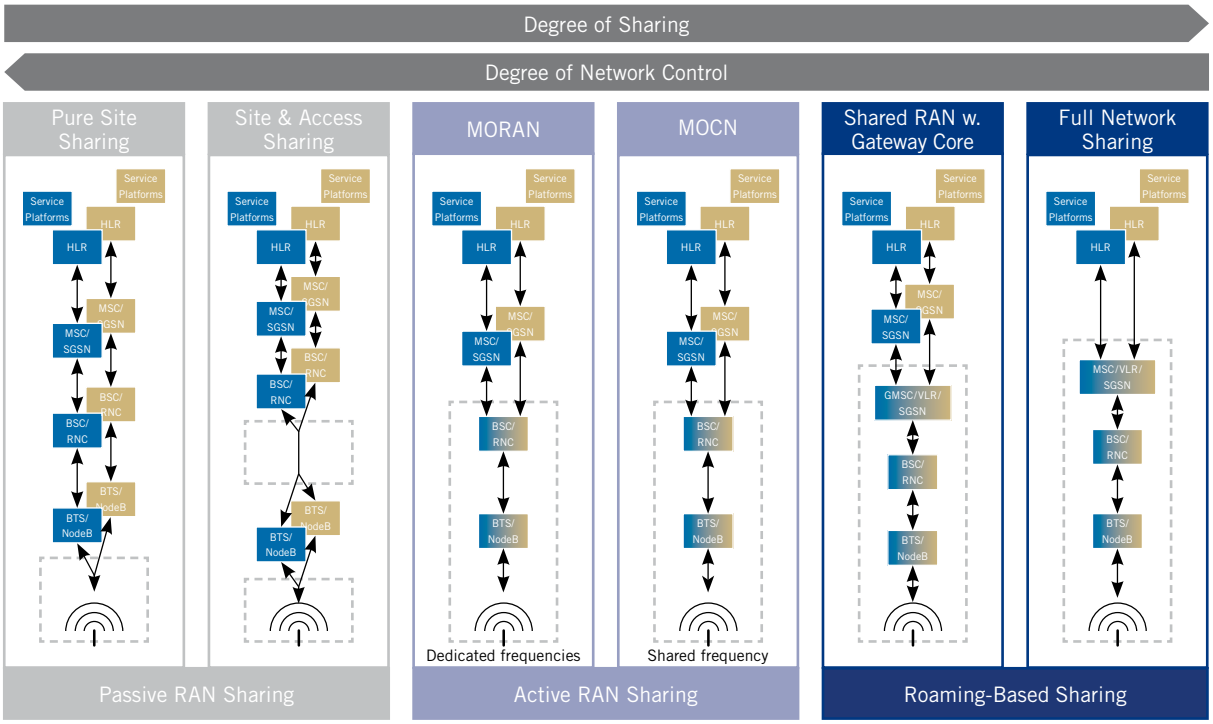
  - Active RAN sharing – a novel sharing of active network equipment with the features implemented in the radio access network

  - Roaming-based sharing – a sharing approach with features residing in the core network, in some form already known for traditional roaming applications

Along with the prerequisite that the technical solution must match the geographic concept, strategic issues should be considered. While infrastructure sharing is, by definition, the most cost-efficient design principle for any new roll-out and the recurring-cost-optimizing approach for consolidation (although some one-time costs arise from potential relocation), its greatest benefits can be experienced in the coverage-driven domain, i.e. areas where the number of network elements is driven by coverage needs (rural areas), as opposed to the capacity-driven domain ("hotspots", urban and suburban areas), where the number of users dictates the network dimensioning. Apart from the addressable market resident in the rural areas, coverage requirements might be set by the regulator, or demanded by highly mobile customers residing in covered areas, but travelling to or through remote areas.

At the same time, cost cutbacks from infrastructure sharing are earned by sacrificing some of the control that the standalone operator has over the network. This is why, considering both economic and strategic aspects, the stronger forms of infrastructure sharing are usually recommended for coverage-driven roll-outs in rural areas with limited business potential and where differentiation (which requires autonomy) is less important. This leads to a differentiated approach, where the generally beneficial and uncritical site sharing would be adequate for focus areas with high business volume, heavy competition, as well as the need for service and performance differentiation; active RAN sharing could cater to zones with moderate business potential and average competitive impact; and roaming-based solutions would be chosen for low business potential areas, possibly with regulatory coverage requirements.

Other regulatory policies than just coverage-requirement related ones need to be taken into consideration, especially those regarding "frequency pooling":



Technical solutions for infrastructure sharing

If permitted, operators can even share the same frequency carrier on one base station; if forbidden, multiple carrier units need to be deployed. Complex situations can be addressed by our licensing and regulatory affairs consulting services.

- **Passive RAN Sharing – Site Sharing and Co-Location:** Exploiting opportunities for sharing the radio sites – the locations of base transceiver stations (BTS) for 2G and Node B for 3G networks – has been popular since around the year 2000. Operators can directly enter into an agreement to share sites, but more commonly an "enabling third party" is involved; in fact, providing "towers" to telecommunications operators has become a standalone business in many markets, run by so-called "tower companies". While these initially established a footprint in rather mature markets, such as the USA or the UK, the phenomenon can also be observed in emerging markets. Regulators encourage site sharing, because it means that fewer sites will be needed overall, which is desirable when one considers the environmental and aesthetic concerns currently prevalent among the population. Traditional site sharing, or co-location, usually comprises the shared use of the site itself, the mast, shelters and cabinets, the power supply including backup batteries, air conditioning and diesel generators (if present); depending on the frequency spectra used, antennas may also be shared. Both capital expenditures (CAPEX) and operating expenses (OPEX) are significantly reduced when sharing sites among multiple "tenants", by addressing upfront site acquisition costs and expenses for civil works, as well as recurring site-related costs. Besides cost considerations, the process of acquiring (buying or leasing) sites and obtaining all the necessary permits and clearance can be very lengthy and time-consuming, and these efforts are also shared. The sharing of some electrical equipment, such as air conditioning, also reduces power consumption.

- **Passive RAN Sharing – Access Transmission Sharing:** Access transmission sharing incrementally includes sharing the transmission network between BTS and base station controller (BSC) for 2G and between Node B and radio network controller (RNC) for 3G networks. The transmission network can be implemented as leased lines (LL) or microwave (MW) links. Further saving results from fewer field services and network operations centre (NOC) efforts, as well as fewer spares and logistics and technical assistance centre (TAC) costs due to the lower number of network elements (LL and MW links).

- **Active RAN Sharing – Multi-Operator RAN (MORAN):** Additional CAPEX and OPEX discounts can be realized by also sharing the active RAN infrastructure, i.e. BTS and BSC in 2G or Node B and RNC in 3G networks. MORAN is a technical solution where operators maintain a maximum level of independent control over their traffic quality and capacity, e.g. each operator maintains its own set of cell-level parameters and only site-level parameters are shared. In principle, multiple virtual radio access network instances are implemented by splitting the BTS, BSC, Node B and RNC into logically independent units realized by a single physical instance. These virtual radio access networks are then connected to the respective operator core network – mobile switching centre (MSC) and serving GPRS support node (SGSN) for circuit- and packet-switched traffic, respectively. Operators continue to use the dedicated frequency ranges that they were awarded by the licensing bodies and broadcast their own individual network identifiers, so that they maintain full independence in their roaming agreements and the sharing is not visible to their subscribers. With MORAN, all previously mentioned cost items are again addressable, but larger discounts are obtained in various categories, such as electrical power and maintenance, because the number of elements is further reduced. Additionally, network planning and optimization can be shared

- **Active RAN Sharing – 3G Multi-Operator Core Network (3GPP MOCN):** MOCN is another active RAN sharing solution, which has been defined in 3GPP Release 6 for 3G networks, where Node B and RNC are shared among multiple operators and frequencies are pooled. Addressable cost items are identical to MORAN but, while frequency pooling results in further marginal reductions of equipment investment and equipment-related costs – field services and network operations centre, spares, logistics and electricity – due to a lower number of carrier units in extremely low-traffic areas, operators have to give up their independent control on traffic quality and capacity to a large extent. Subscribers using "pre" 3GPP Release 6 mobile terminals may realize that the network is shared. Under regulatory aspects, the 3GPP MOCN frequency pooling feature may exclude the MOCN solution from being used in certain markets.

- **Roaming-Based Sharing – Shared RAN with Gateway Core and Full Network Sharing:** From the beginning of second-generation (2G) digital mobile telephony, roaming has always been employed as a means of virtually extending the geographic coverage of an operator, by allowing its subscribers to use another operator's network. International roaming is the natural solution for serving one's customers abroad, where the operator has no license and no business. Roaming is also used on a domestic basis – as national roaming – typically to grant a new entrant ("greenfield") operator nationwide coverage right from the start, when initial rollout focuses on urban and suburban areas, and rural areas are not served yet. The regulator often forces incumbent operators into such a temporary national roaming agreement with the new entrant. However, in the traditional MNO business model, such national roaming is always temporary. Roaming-based options in the context of network sharing, on the other hand, mean that one operator relies on another operator's coverage for a certain, defined footprint on a permanent basis. As already mentioned, such dependence can be either unilateral or mutual, regionally split or for the network as a whole. If operators decide to generally retain dedicated independent core networks, or to share the radio access network in only one certain region, the "shared RAN with gateway core" solution can be deployed. Similar to the active RAN sharing solutions from a point of view of addressable cost items, this approach does not require specific features in the RAN equipment, however, as the sharing is fully based on roaming features implemented in the core network. The shared RAN is connected to the core networks of the sharing partners via a so-called gateway core consisting of gateway MSC (GMSC), SGSN and visitor location register (VLR). In this solution, frequencies are either pooled, or the frequency spectrum of only one partnering operator is used, meaning that there is no independent control of the traffic quality and capacity for the operators. If only one spectrum is used, capacity is substantially reduced; otherwise, the pooling of frequencies is again subject to potentially restrictive regulatory policies. Unless mobile terminals are equipped with specially configured SIM cards, the network sharing is visible to the subscribers, because only a single common network identifier is broadcast in the shared region.

In the full sharing case, the operators separately retain only that portion of the core network a mobile virtual network operator (MVNO) would also own, i.e. home location register (HLR) and authentication and billing system. In this case, all network OPEX are shared.

- **Network Deployment:**
  After choosing the business model, geographic sharing scheme and technical solution, the partnering operators need to agree to what extent legacy equipment and future roll-out are to be included. Implementation then starts by transferring the involved assets into the new, shared network structure. They are subsequently subjected to an optimization process, involving network planning, consolidation of sites and network elements, as well as potential substitution of concurring technologies (such as leased lines and microwave transmission links, if access transmission sharing is within the scope). The joint network planning exercise will usually flag the need for some site relocation or decommissioning. Circumstances to be considered are equipment-driven differences in grids – such as between 900 MHz and 1800 MHz networks, where the 1800 MHz network will have a considerably higher number of radio sites in the coverage-driven domain, due to the smaller maximum cell radius. Next, the future roll-out plan is determined. Joint network planning is required for the shared network portions, as well as close alignment with the (operator-individual) network planning for the standalone portions. In principle, the operators have the choice of purchasing the equipment "bare bones" and performing the necessary deployment services themselves or of subcontracting them to another party, as is typically the case with the civil works at least. This procedure will, however, leave some CAPEX cutback potential from network sharing unexploited, as the design, planning, installation and commissioning processes are less efficient when performed by different teams. Therefore, the alternative of purchasing "full-turnkey" services from the equipment suppliers definitely makes sense in a network sharing environment, even if the operators are experienced and not lacking in the required deployment skills.

- **Network Operations:**
  Network OPEX items can be roughly grouped into site-related and operations-related costs. Site-related costs are attached to the existence of the site itself and include site rental, power consumption, line leasing, microwave frequency fees and site infrastructure management. Depending on the sharing scenario chosen, operators can make immediate savings in this cost category, by requiring fewer sites, installing less equipment and sharing transmission links. Operations-related costs are all other costs directly driven by network operation, comprising network operations centre (NOC) and field service activities, operations support, network equipment maintenance and repair, plus associated logistics, ongoing planning and optimization. Process optimization is crucial in order to reap increased efficiency in this cost class. The sharing of active equipment involves a far more complex and mission-critical degree of operations and maintenance aimed at shared resources than passive site sharing does. It can therefore be much more effectively and efficiently accomplished by one single party in charge, which then owes fiduciary duties to the partner. This entity will then achieve economies of scale, higher utilization of field resources and less coordination efforts. The inherent principal-agent dilemma is solved if the operating body reports equally to all partners, i.e. carves out the relevant resources, by setting up a joint venture for example. Outsourcing to a third-party provider becomes a very attractive option, because it combines joint operations with a sound, neutral governance model, thereby addressing both strategic and economic aspects.

Client Benefits

Operators benefit from a thorough, holistic evaluation of their various options for infrastructure sharing, considering strategic, financial, technical and regulatory aspects. Besides modelling economic benefits, we always keep our eye on potential risks. Where beneficial, we advise our clients on outsourcing and out-tasking certain activities.

During implementation, we make sure that our clients get maximum advantage out of all the benefits each chosen option has to offer. We help them to avoid pitfalls by assisting them in negotiating with partnering operators and third-party equipment and service providers, as well as with regulators, if required.

Our Services

We offer a broad range of advisory services, as presented in our portfolio matrix.
We position our individual solutions alongside services practices and service clusters.

	Strategy and Marketing	Corporate Finance and M&A	Operations and Technology Management
Transaction Services	Strategic Investment Management · Feasibility Study	Commercial and Financial Due Diligence · Business Plan Analysis and Benchmarking · Asset Valuation	Network Infrastructure and Operations Due Diligence
	Strategic Due Diligence · Management Assessment	Investor Business Plan Development	Roll Out Plan Review and Benchmarking
	Licensing and Regulatory Affairs	Bankable Business Plan Negotiation · Project Finance	Operations Plan Review and Benchmarking
Optimization Services	Going-to-Market Strategy · Segmentation · Target Marketing · Product · Pricing · Promotion · Sales Channels · Customer Care	Financial Performance Measurement and Benchmarking	Network and Process Performance Measurement and Benchmarking
	Organization Development	Forecasting and Budgeting	Business Process Reengineering · Process Audit and Improvement
	Partner Selection and Sourcing	Service and Process Costing	Shared Delivery · Regionalization and Centralization · Outsourcing and Managed Services
Innovation Services	Business Development · Growth and Transformation		Technology Appraisal and Roadmapping
	Mobile Virtual Network Operator · Mobile Virtual Network Enabler	Financial Modelling and Financial Engineering	Network Planning and Migration
	Value Added Services		Network Infrastructure Sharing

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