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White Paper

Sharing an antenna doesn't mean giving up control

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Sharing an antenna doesn't mean giving up control

The practice of network sharing has been a recurring topic of interest since it was introduced in the early 2000s. The first network sharing agreements, introduced in Germany, Australia, the Netherlands and the U.K., were conceived as a way to help wireless operators offset the high cost of launching 3G service in hard-to-cover areas. Despite the potential for CapEx and OpEx savings, the initial surge in interest in network sharing quickly declined as most operators opted to build their own 3G networks.[1]

Fast forward to 2015 and network sharing is once again a common topic of conversation as operators look for more cost-effective methods to transition to 4G services including long-term evolution (LTE) and long-term evolution advanced (LTE-A). Once again, cost pressures are driving many operators to enter network-sharing talks with competitors.

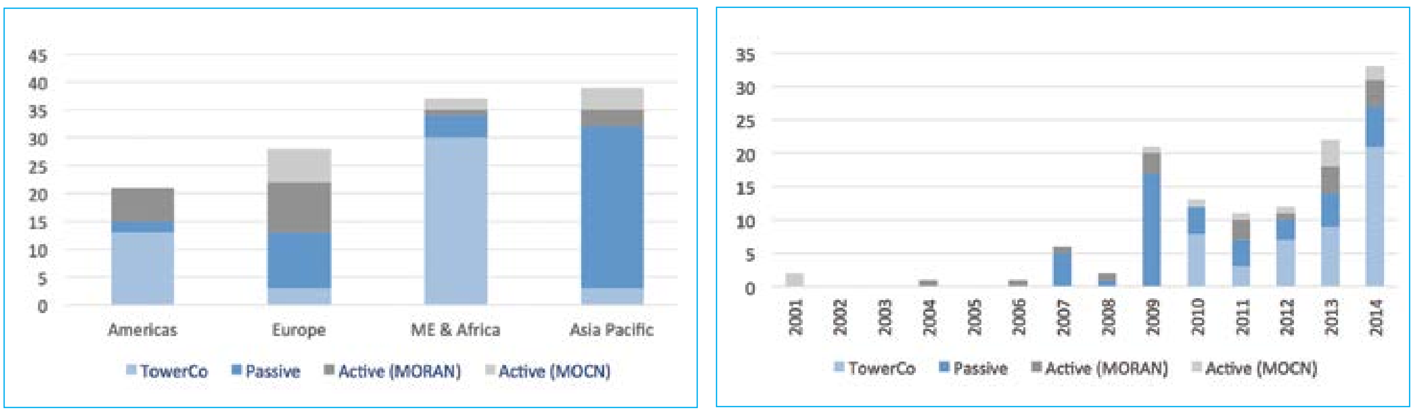

Figure 1: MNO network infrastructure sharing deals 2001-2014
Source: Coleago Mobile Network Sharing Database (based on public announcements by MNOs. Excludes M&A, national roaming and informal or unannounced site sharing.)

According to consulting firm Coleago, "Network sharing Joint Ventures ("JVs") between Mobile Network Operators ("MNOs") have more than doubled in the last five years and active sharing has increased significantly as a proportion."

As more equipment is developed to support active and passive network sharing, the options available to operators grow—increasing the complexity of the decision. This is especially true regarding the base station antenna, which is somewhat unique in that it can play a role in either passive or active network sharing arrangements.

Because a shared antenna potentially interacts with so many different RF elements—TMAs, SBTs, radios and RRHs—it presents a variety of technical challenges and trade-offs that must be carefully weighed by any operator considering a network sharing arrangement. This paper has been developed to provide a brief overview of the various network sharing models and discuss some of the key technical issues regarding antenna sharing that must be addressed.

Network sharing models

Ultimately, network sharing is driven by the need to maximize enterprise value. The major benefit from network sharing is a net reduction in network CapEx and OpEx, usually in the range from 10—40% of the in-scope costs dependent on the sharing option.

– Coleago Consulting, February. 2015

The major driver of network sharing continues to be the potential for cost savings. The amount an operator can save depends upon the depth of the sharing arrangement. Options range from passive forms (such as site sharing) to active forms in which a common RAN network, spectrum resources and core networks may be shared among MNOs. The potential cost savings and benefits increase as the depth of the sharing increases, but so do the risks. An overview of the most common network sharing models is illustrated in Table 1.

Passive sharing	Site sharing	Civil infrastructure
	Transport	Backhaul
Active sharing	RAN sharing, MOCN, MORAN	Base station
		Antennas
		Controllers
		Spectrum
	GWCN	Core network

Table 1: Popular network sharing models

Despite some 3GPP efforts, there are no standard sharing terminologies, architectures or classifications in the industry. Even the term "sharing" itself is referred to as "colocation" in some markets. However, all terminologies pour into three main sharing categories: passive sharing, active sharing, and national roaming.

Passive sharing

Passive network sharing refers to the sharing of passive non-electronic infrastructure and facilities. Shared assets can include the real estate on which a cell site is located, tower space, equipment cabinets or buildings at the base of the tower, as well as power, lighting and air conditioning systems that support the equipment.

Passive infrastructure sharing is a common practice around the world and—in some markets—has become a regulatory mandate, depending on the specific site location. Whether voluntary or mandatory, passive sharing can save MNOs up to 5 percent on CapEx and as much as 10 percent on OpEx over a five-year span. In North America, tower companies such as American Tower, Crown Castle, Global Tower Partners and SBA Communications have invested billions of dollars to acquire passive infrastructure from operators in the hopes of brokering passive sharing agreements with MNOs.

Active sharing

Active RAN sharing is likely to be the next significant evolutionary step in infrastructure sharing, unlocking even greater CapEx and OpEx efficiencies than passive RAN sharing.

– Analysys Mason, Oct.ober 13, 2014

Active network sharing refers to the sharing of active electronic infrastructure and radio spectrum. Within active sharing, there are a number of models involving elements in the RF path: antennas, base station equipment, transmission lines, base station operations and maintenance, and radio design and planning.

There are also sharing strategies that take the partnership between MNOs deeper. In these models, operators can share radio spectrum, core network, infrastructure management systems, content platforms, and administrative resources like billing systems and even customer service platforms.

In the past, active infrastructure sharing has been less commonly supported, but is becoming more widely considered—especially because of its potential benefits for rural broadband.[2] The high cost to deploy LTE is also expected to increase the number of active RAN sharing joint ventures between operators.

National roaming

National roaming allows roaming between operators inside the same country. This can reduce investments by geographically dividing the cost of the necessary infrastructure between operators. It can also allow new operators without physical radio access networks to completely roam on other existing operators (MVNO). Guest operators can then provide services in new markets without having to deploy additional infrastructure.

While national roaming is the easiest and least costly model of network sharing, it provides the least amount of control and flexibility for the guest operator. It also consolidates the overall number of mobile networks and homogenizes retail offerings and quality of service, making it harder for an operator within a market to differentiate itself from the competition. In addition, price competition may be restricted, since the retail tariffs charged by the roaming operator will be based, to a large extent, on the wholesale charges paid to the visited operator.[3]

A closer look at active sharing

Given the high cost to deploy LTE RAN components and the need to conserve spectrum wherever possible, active sharing is getting more attention now than in the past. MNOs are experimenting—albeit on a limited basis—with a variety of active sharing arrangements that involve different RAN elements, spectrum assets and core network components.

The landscape of active sharing models can be viewed as a continuum that goes from the least involved to the most involved. As the degree of sharing increases, so do the cost benefits—but the flexibility and operator control decreases.

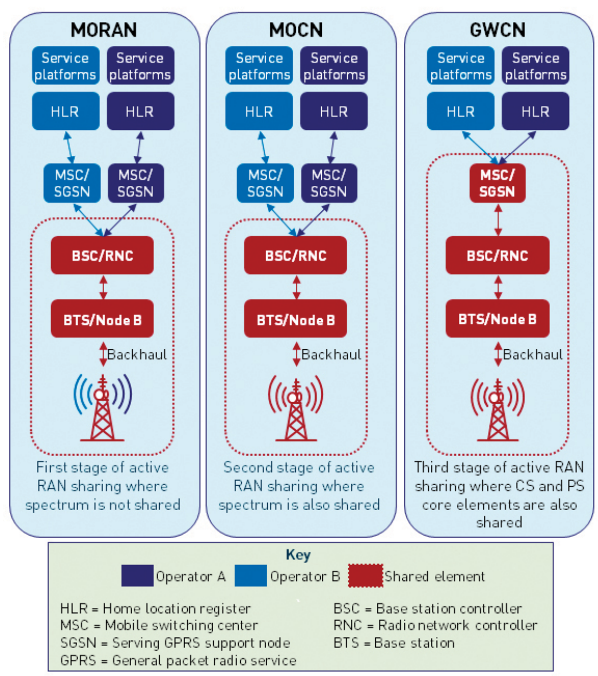

Figure 2: Active sharing models

Source: Analysys Mason, newsletter; October 2014

Multi-operator RAN (MORAN)

In the MORAN model, only the RAN elements are shared. Specifically, the base transceiver station (BTS), base station controller (BSC), node B and radio network controller (RNC) are split into multiple virtual radio access networks, each connected to the core network of the respective operator. Operators continue to use their own dedicated frequency bands.

Multi-operator core network (MOCN)

"The benefits of spectrum consolidation are becoming increasingly apparent, as availability of large contiguous bands of spectrum can significantly increase performance capabilities of modern mobile broadband networks in terms of peak data rates and capacity."

– Next Generation Network Sharing; Webb Henderson, February 2014

MOCN is similar to the MORAN in that the operators' core networks remain separate while the RAN elements are shared. In addition, MOCN shares the same base station radios and uses spectrum pooling, which increases the number of usable frequency blocks. 3GPP Rel6 TR 23.851 has enabled BTS radio sharing. It allows each cell in the shared RAN to broadcast all sharing operators' identities and other relevant information, including their NMO (network mode of operation) and common T3212 (location update timer). This, of course, requires Rel6 terminals/UEs to fully function. Participating operators in this arrangement tend to be similar in terms of market presence and spectrum assets in order to create an equitable arrangement.

Gateway core network (GWCN)

The GWCN model takes MOCN sharing a step further; not only do the operators share a common RAN, but elements of the core network are also shared. These include the mobile switching center (MSC), serving GPRS support node (SGSN) and—in some cases—the mobility management entity (MME). This configuration enables the operators to realize additional cost savings compared to the MOCN model. However, it is a little less flexible and regulators may be concerned that it reduces the level of differentiation between operators.

Of the three active models outlined here, two—MOCN and GWCN—are addressed in the TS 23.251 3GPP network sharing standards. Yet, while active sharing has an attractive up side, it has yet to catch on. In the Asia-Pacific region, for example, there were 64 total network sharing arrangements as of April 2014.[4] Active network sharing accounted for just 14 percent (nine) of these.

According to Nipun Jaiswal, with industry analyst Analysys Mason, "It's not that operators in the region are averse to working together, but the complexities of sharing active components of the network remains an insurmountable barrier for many."[5] Much of the complexity is in the technical details of deployment—a prime example of which is the base station antenna.

The unique role of the antenna in a shared network

A site's antennas are unique in that they are key considerations in both passive and active network sharing agreements. The variety of network sharing scenarios in which they are used has led to manufacturers engineering a high degree of versatility into the antenna's architecture. Therefore, base station antennas have evolved to become highly complex—and their proper use in network sharing arrangements can appear enigmatic.

Antenna sharing between multiple operators, for example, is often seen as being restrictive in terms of optimization—and costly when compared to adding another regular antenna. A regional market survey conducted by CommScope sales teams in August 2015 estimated the instances of antenna site sharing to be approximately 100 or fewer per operator in the Middle East and Africa, while similar scenarios in North America and Europe were practically nonexistent. On the other hand, antenna co-siting sharing, using multitechnology cabinets, is in high demand across North America and Europe and is expected to grow in popularity as 4G LTE continues to spread into emerging markets.

Potential challenges

Because it interacts with so many different RF elements—TMAs, SBTs, radios, RRHs, etc.—a shared antenna presents a variety of technical challenges and trade-offs that must be thoughtfully considered. For example, there are a number of limitations within the 3GPP-defined MOCN architecture.

Non-antenna issues include capacity limitations and the risk of network congestion and reduced data throughput in areas with high traffic. The MOCN model also has limited carrier separation between operator bands (IBW) and requires all sharing operators to use RAN components from the same OEM vendors.

The MOCN sharing model also presents a variety of questions and issues specific to the shared antenna and RF path. For starters, operators sharing a common radio, RF path and antenna must adapt to fixed azimuth, height and gain settings. So optimizing the RF pattern envelope for each operator is challenging.

To overcome some of these issues, the operators may consider switching to the MORAN model. This would limit sharing to the baseband units and backhaul—eliminating the issues of independent antenna optimization, capacity and IBW limitations. Each operator would maintain their own radio, RF paths, antenna ports, frequency bands and technologies.

Another option would involve deploying a common multiport antenna with separate RET controls linked to individual radios. This configuration would provide a good balance between independent pattern control and cost savings. The MOCN example is just one of many that may be involved in any network sharing arrangement that includes a shared antenna. The following are other common issues operators will have to consider when deploying antennas in support of a shared network.

Forced antenna sharing

Sometimes, on sites with space limitations—or health and safety regulations—operators are forced to share the same antenna. Alternatively, to reduce power usage, emissions and aesthetic impact, many countries like Brazil, Canada and Jordan are stipulating that operators seeking to deploy new services must be willing to share passive and/or active elements within the networks, including antennas. There are two basic solutions to antenna sharing: use of multiport antennas or deployment of low-loss combiners.

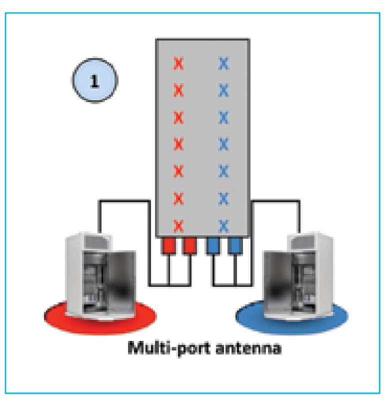

Figure 3

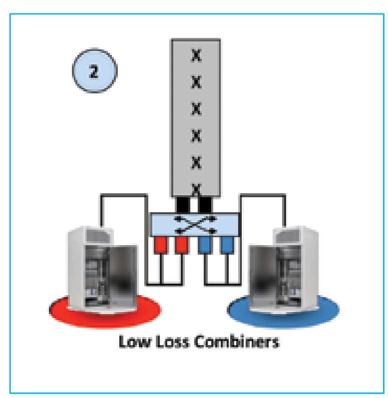

Figure 4

	Multi-port antennas sharing	Low loss combiners sharing
PROS	• Multi BTS RET control after mods • Normal PIM and VSWR risk • Lower RF path losses • Can re-allocate bands in future	Normal antenna size and tower load for all bands
CONS	Increased antenna size and tower loading for low bands	• Higher PIM and VSWR risk • Increased RF path losses • Does not support multi-BTS RET control • LLC fixed for existing bands

Table 2

Today's multiport antennas provide an excellent opportunity for MNOs to take advantage of antenna sharing while retaining control of their individual antenna elements and coverage patterns. Some multiport antennas are able to support multiple RET controllers, feature low-loss RF performance and enable mobile operators to change their frequency band allocation without physically modifying the antenna.

The biggest challenge when deploying multiport antennas in support of a shared network is the larger physical size of the antenna and the resulting increase in tower loading. This is especially problematic across multiple ports in the lower frequency bands where the antenna array is larger to begin with.

Or, MNOs can deploy low-loss combiners in place of multiport antennas. This reduces the number of antenna arrays required and enables the operator to minimize the antenna size and tower loading. This type of solution is often used to deploy an LTE overlay onto a network's legacy services. However, it too, has drawbacks. Operators give up independent RET control and risk higher incidences of passive intermodulation (PIM) and VSWR. There is also greater RF path loss—and adding or changing frequency bands means replacing combiners.

While either multiport antennas or low-loss combiners can be used to enable antenna sharing, the best solution may be a combination of both. Using a low-loss combiner for the low bands and a multi-port antenna for the high bands takes advantage of the strengths of both technologies while minimizing the weaknesses.

Ensuring independent operator control with a shared antenna

In most RAN sharing scenarios, multiport BTS antennas will provide each operator better flexibility, RF performance and pattern control. However, to realize these benefits, the antenna must provide independent RET control for each operator—a capability not inherently available with all antennas.

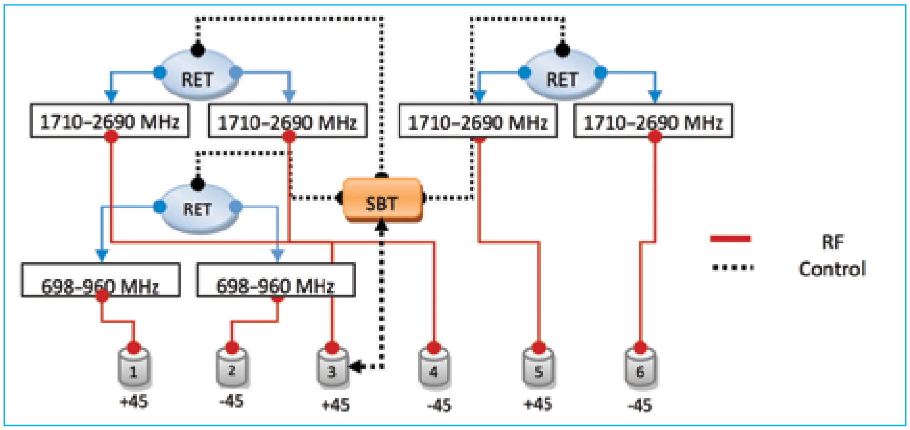

Figure 5: External RET control on port #3

In a some RET-controlled antennas, the actuators are internally connected to a built-in bias tee, which is connected to a single RF port. As a result, all antenna ports are controlled by one RET unit. To add this independent RET control, operators must either purchase new antennas equipped with multiport independent RET control or re-fit their current antennas with this capability.

While purchasing all-new multiport antennas with integrated independent RET controllers would appear to ensure the most advanced—and thereby the best-performing—solution, this is not always the case. The major benefit to buying new antennas is that it ensures all RET electronics are integrated into the antenna's internal architecture. This provides for a slight decrease in weight and tower loading and helps further protect the RET controller.

Recommendations for successful RET antenna sharing

Employing the latest best practices can help ensure a smooth antenna sharing agreement that is equally productive and beneficial for all operators involved. The following describes recommended characteristics for a shared antenna RET solution.

Verify the ability to upgrade existing multiport antennas with independent RET control for each operator.

Ensure scalability of the RET retrofit solution. To avoid unnecessary future CapEx and limitations on network growth, operators should understand how the solution under consideration will scale and if there are limits to the number of antenna ports that can be supported.

Make sure the RET can be accessed and controlled directly from within the BTS radio and management software.

On the horizon: RET multiplexing

Another approach to enabling independent RET control on a shared BTS antenna is by using new techniques such as RET multiplexing. By leveraging the AISG communications protocol, operators can multiplex RET signals from different sources to a single antenna AISG input port. Developed on the RS485 protocol, the AISG standard inherently supports 254 devices on the same bus, reaching 1220 meters.

RS485 Communications

Modes of operation	half duplex
Network topology	multipoint
Max distance (acc. standard)	1220 m
Max speed at 12 m	35 Mbs
Max speed at 1200 m	100 kbs

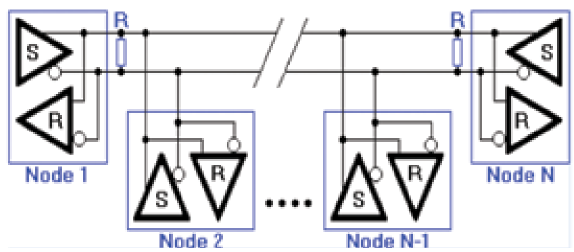

Figure 6

The AISG/3GPP standardizes three data rates:[5] 9.6 kbps (default), 38.4 kbps (optional) and 115.2 kbps (optional). Typically, antenna line devices (ALDs) only support the required 9.6 kbps today. Future systems may evolve to support multiple data rates.

The AISG uses standard HDLC (high level data link control) frames for command messages, enclosed between two flags[6], as shown in Figure 7.

Flag	ADDR	Control	Info	FCS	Flag
1x Octet	1x Octet	1x Octet	Nx Octet	2x Octet	1x Octet
0x7E	Secondary	I/S/U	Variable Length	CRC	0x7E

Figure 7: Format of an HDLC frame, used for AISG signaling

Source: TS 25.462 v.10.0.1 Release 10; 3GPP; April, 2011

ADDRess field:

- If primary stations is originator, secondary address is included as destination
- If secondary station is originator, secondary address is included as source
- Secondary-to-secondary communication is not allowed

Using this method, it is possible to multiplex more than one command message over a single AISG line.

Conclusion

Interest in network sharing is somewhat cyclical; as each new generation of wireless technology is introduced, operators look at the added cost to upgrade and evolve their networks. Over the years, the number of models for sharing network infrastructure and services has grown while the components involved have become more diverse. A critical constant during this time has been the role of the shared antenna—common to both passive and active network sharing scenarios.

As operators look to ramp up deployment of 4G services, the technical challenges of antenna sharing become more complex. Highly sensitive to interference, services such as LTE and LTE-A require precise antenna positioning for each operator. With advances in multiport antenna and external RET control design, this is possible.

To leverage the potential benefits of RET- and antenna sharing, wireless operators must have an understanding of the opportunities and challenges—current and future—involved.

Sources

[1] Global Experience of Infrastructure Sharing by Mobile Network Operators; April 2013

[2] Trends in mobile infrastructure sharing; Analysys Mason, presentation; January 2010

[3] Mobile Sharing, GSR 2008 discussion paper; International Telecommunications Union; March 2008

[4] Active network sharing fails to gain traction; telecomasia.com; April 2014

[5] 3GPP TS 25.461

[6] 3GPP TS 25.462

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