UMTS Network Sharing: Wideband PAs allow true infrastructure sharing

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As mobile communications transitions from second-generation voice services to third-generation data networks, the investment required to deploy hardware has become a daunting challenge. Many network operators have spent huge sums of money in order to secure spectrum for upcoming 3G services, and recently they have found that financial markets no longer have an unlimited appetite for investing related to telecommunications services. For these reasons and other technical reasons, 3G deployment has been delayed.
Several European governments have now announced a partial solution to this dilemma. Sweden, Germany, France, Portugal, Spain, Ireland, and the Netherlands have announced various levels of approval for 3G network sharing. As an example, the German government has authorized 3G network operators to share antennas, base stations, and even radio network controllers, as long as the individual networks are logically (and legally) controlled separately. Obviously, this will help financially strapped operators to reduce the overall cost of entering the 3G market.
Examples of operators which have announced plans to share infrastructure include:
&#149British Telecom (through the German unit VIAG Interkom) and Deutsche Telekom AG have agreed to share network infrastructure. DT expects to save approximately 30% of the expected $7.8 billion it had forecasted to spend on 3G network deployment.
&#149E-Plus, Group 3G, and MobilCom plan to also share 3G network infrastructure in Germany. In this scenario, the consortium has publicly stated that they plan to use common sites, base stations, and radio network controllers.
&#149Finnish operators Telia and Tele-2 plan to share infrastructure via a joint venture, with each service provider operating as an MVNO.

There are at least three ways in which network operators may share 3G infrastructure. Because of the overall tightening experienced recently in financial markets, many analysts expect that some form of all three arrangements will take place for 2003 network deployments:
&#149Operators can agree to share common infrastructure, including core and radio network equipment such as base stations, sites, mobile switching centers, VLRs, and other core network resources. Each operator would maintain its own billing, data servers, and subscriber data services. Essentially the network hardware would be largely shared, but each operator would have its own websites and customer interface.
&#149A second option involves a geographical split in coverage by the operators, with roaming agreements between them. In this concept, each operator would simply agree to a coverage and quality of service level for a given region, then each operator would agree to pay roaming charges to the other operators for traffic within other regions. This scenario will require "hard handoffs" to occur at the geographical boundary.

&#149Thirdly, operators may choose to use common hardware such as base stations, antennas, or even radio network controllers, but would have "ownership" over individual logical areas such as a set of frequency assignments or CDMA codes. This arrangement could allow for individual operators to fund capacity upgrades related only to the frequency assignments or codes that they have allocated to them.

All three of these scenarios allow for the network operators to compete at a consumer level, with varying degrees of differentiation at the network level in terms of quality of service and capacity. The first and third scenario create some unexpected requirements for the RF hardware, especially with regards to bandwidth-sensitive subassemblies such as filters and power amplifiers. Some of the major OEM base station suppliers have published concepts for the use of shared sites, but few of these concepts have included the sharing of significant radio infrastructure, due to limitations in the components that these OEM suppliers normally use.

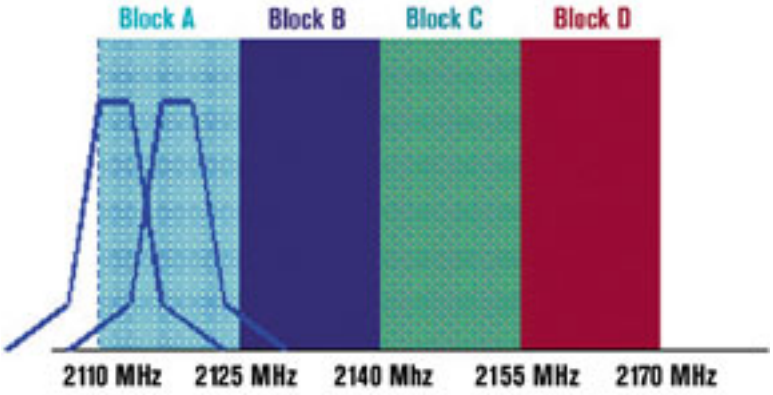

Figure 1. Frequency assignments for 3G operator A.

In particular, the multicarrier power amplifiers that are currently designed into most 3G Node B solutions are limited in instantaneous bandwidth to about 20 MHz. Feed-forward amplifier designs are typically used in most "production" Node B equipment today, with the feed-forward linearization assembly optimized to work over narrow bandwidths. New 3G amplifier designs make use of new digital predistortion techniques, which are even more limited in bandwidth. A state-of-the-art digital predistorter handles 15 MHz to 20 MHz bandwidth today. Because of these limitations, most Node B suppliers have not offered true infrastructure sharing.

The Multicarrier Power Amplifier

Dozens of countries have licensed UMTS spectrum, and each country has its own unique strategy in terms of the number of operators desired for competition at the consumer level. Worldwide, UMTS service is fairly universal in adopting a pair of 60 MHz frequency bands. (For frequency duplexed systems, uplink frequencies are at 1920 to 1980 MHz, and the downlink frequencies range from 2110 MHz to 2170 MHz.) Many European countries have licensed paired blocks of 10 MHz to 15 MHz to each operator, resulting in four to five operators in each country. On the other hand, some Asian governments have licensed three carriers, allowing for paired 20 MHz frequency blocks.

Third-generation network operators that plan to share network infrastructure equipment cannot use narrowband amplifiers without making some major compromises. Figure 2 illustrates a preferred assignment of frequency channels in a two-way network sharing example. It quickly becomes clear that a limitation of 15

to 20 MHz in bandwidth forces the operator to deploy two distinct amplifiers for site sharing. Other components such as transceivers, antennas, and filters are fairly flexible in frequency and bandwidth availability. In order to achieve the desired sharing of costs shown in Figure 2C, a wideband amplifier is important.

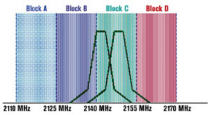

Figure 2. Frequency assignments for 3G operator C.

It is also possible to design a multicarrier RF power amplifier and other components to handle the wider bandwidth required for infrastructure sharing scenarios. This can be achieved over as much as 45 MHz instantaneous bandwidth for 3G applications.

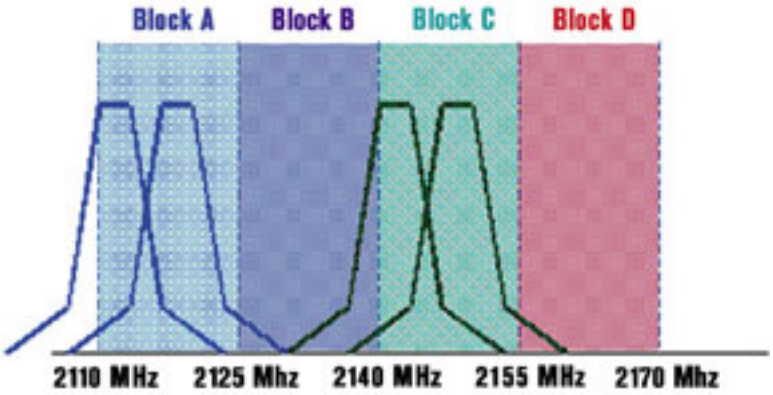

Figure 3. Frequency assignments for a shared network including both operators.

What if the operators consolidate carriers into one band?
One way to avoid a wider bandwidth requirement for the RF components is to force the frequency assignments for all operators into one relatively narrow band. This idea may work fairly well during the early days of the network operation, since the capacity required by initial consumer demand should be relatively light. However, the arrangement of all frequency assignments within the spectrum of one carrier poses some interesting upgrade and growth challenges:
&#149What happens when the operators need more capacity? If the shared network is continually upgraded through the addition of frequency assignments, then soon the capacity requirements of two or three operating companies will outstrip the available capacity for three W-CDMA carriers in a 15 MHz band. At that point, the operators would be forced to add new base stations and/or retrofit the amplifiers in order to add a fourth carrier.
&#149What happens when one of the operators decides to roll out a network of their own? As they deploy the initial base stations on their own, the frequency assignments that they add within their own frequency allocation will not be at the same frequency as their existing service. Handoffs from one base station to another will involve a handoff from one frequency to another.

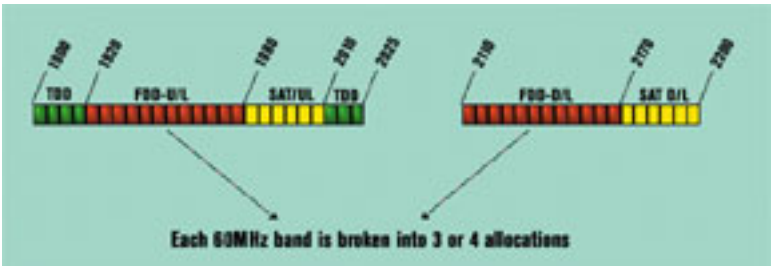

Figure 4. UMTS frequency allocations.

Conclusion
Network sharing is a relatively new development in the concept of 3G infrastructure deployment. OEM vendors that are launching new base station products will be well served by examining the power amplifiers specified in their systems, and ensuring that the amplifiers can handle the higher bandwidth required for shared systems.

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