

# Spectrum Refarming

## Benefits, challenges, and solutions

Mobile radio communications have evolved from analog systems in the late 80s, carrying only voice, to more robust GSM/GPRS voice systems, enabling the boom in text messaging, to the latest advances in mobile broadband brought by UMTS, HSDPA, and LTE. All radio communications make use of a highly regulated resource: a limited portion of the electromagnetic spectrum. Specific portions of that spectrum are allocated for use by particular technologies. Agencies typically allocate GSM bands in 800 – 900 MHz and 1800 – 1900 MHz frequencies; UMTS bands are typically within the 1900/2100 MHz frequencies; and, LTE is found at 700/1900/2100/2400 MHz in the spectrum. It is a scarce and expensive resource.

To deal with this scarcity, some countries have changed legislation so that other services can use portions of the spectrum initially allocated to a different service/technology. This is called refarming: repurposing a frequency that was initially allocated to one technology for another one. For example, an operator may have a license to operate on the 900 MHz spectrum for GSM. To better deploy UMTS or LTE, the operator could potentially free some of the GSM capacity and allocate it to LTE or UMTS.

### Benefits of Refarming

Refarming is a cost-effective way to increase capacity for UMTS/LTE without the need to bid for new spectrum. Refarming is not limited to GSM, since UMTS spectrum can also be refarmed to increase LTE capacity. Another interesting benefit for operators is that lower frequencies (usually allocated to GSM networks) provide much better coverage. Lower frequencies reach farther and have less penetration loss than higher frequencies, enabling better rural coverage and improved indoor urban coverage. Higher frequencies typically deliver greater capacity, rather than coverage, in urban areas.

As an example of better coverage, UMTS900 can increase areas served per Node-B between 44% (in urban areas) and 119% (rural areas) when compared with UMTS2100. This difference in performance lets operators economically provide 3G applications over much greater areas.

In terms of cost, the lower propagation loss at 900 MHz means fewer base stations. Compared to networks using the 2100 MHz core-band 3G spectrum, costs can be 50 to 70% less. Operators can provide less densely populated areas with 3G services more cost-effectively.

Quality of service (QoS) is enhanced because fewer base stations means fewer handovers. Considering that the vast majority of phone calls are initiated indoors, the higher in-building penetration afforded by lower-frequency bands is a significant factor.

## Challenges

As with any technical solution, spectrum refarming presents challenges. The first and most obvious are meeting the prerequisites for it:

- Operators must have sufficient contiguous spectrum to support the simultaneous operation of two or three technologies in a frequency band
- Simultaneous, mixed use of frequency bands presents challenges regarding bandwidth allocation across bands
- The same operator should be using both sides of the spectrum adjacent to the dividing point
- Adjacent channel interference must be dealt with using guard bands

Other challenges include avoiding disruption to existing users on the band/technology that will be refarmed and encouraging them to migrate to new services. The operator needs to maintain GSM quality as the process takes place, not compromising customer satisfaction and experience. Avoiding service degradation means understanding traffic patterns and managing how traffic will be served.

Spectrum may be interleaved between operators, requiring reconfiguration to avoid fragmentation. This can require considerable coordination and cooperation. After reconfiguration, a full site/cluster audit needs to be carried out to understand new coverage, traffic distribution, and interference/quality.

Some handsets and machine-to-machine devices cannot work with multiple bands or must remain on the old technology. This can be a big challenge when discontinuing the use of a legacy network—any interruption in services can significantly affect roaming revenues. Fortunately, the rate-of-change in consumer mobile devices is quite rapid.

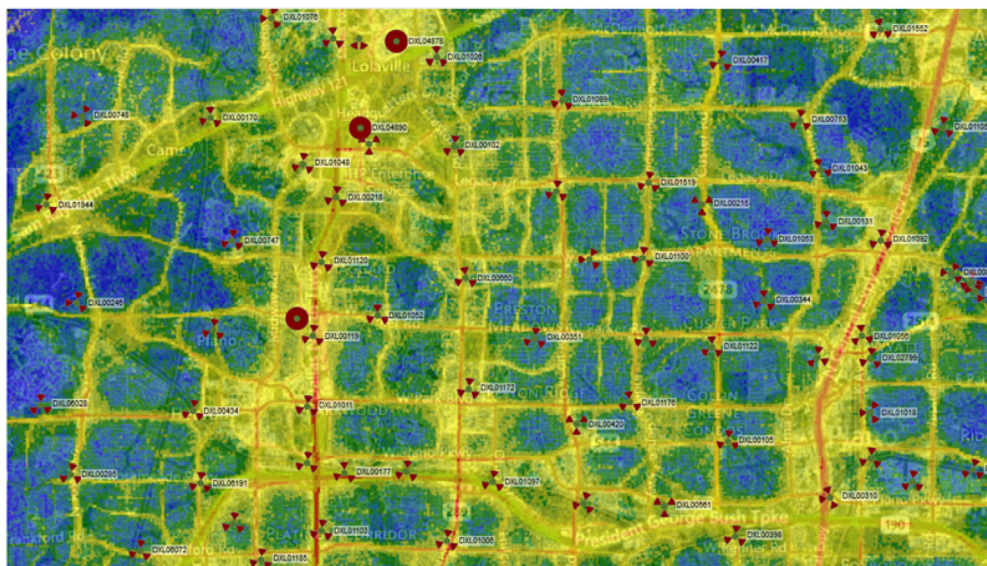
Once the spectrum is made available for use with the target technology, for example, refarming GSM to LTE, the spectrum needs to be cleaned up of external interference often caused by legacy signals left behind.

## Solutions

Location intelligence and RAN solutions play a crucial role in several key areas of the planning, implementation, and troubleshooting of a network going through spectrum refarming.

Geolocated information allows for the quick identification of areas where LTE/UMTS traffic is growing, where coverage is poor, and where refarming can help improve capacity and/or coverage. During and after refarming, customer-centric, location-aware data enables a near-real time assessment of how changes have impacted performance. This kind of data can best perform the post-implementation validations needed to check for coverage, quality, and capacity. The traffic can be monitored in the refarmed band to better understand user behavior and validate usage, and the refarmed spectrum can be monitored on newly coexisting services (for example, GSM and UMST) to truly understand the impact of the changes.

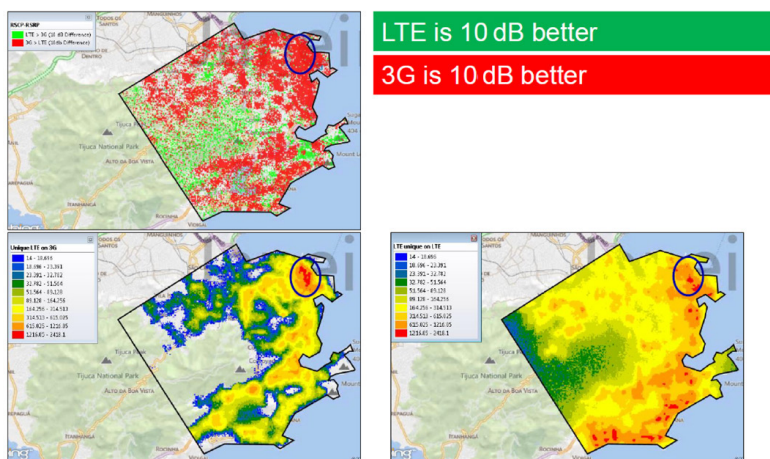
Specific areas that a customer-centric, location-aware approach can help include network capacity analysis by frequency layer, and understanding and visualizing network usage by frequency band. For example, an operator can prioritize refarming areas using VIAVI Solutions™ ariesoGEO™ to identify high traffic clusters, consistent hotspots, and key locations.



Example of traffic clusters, hotspots, and patterns

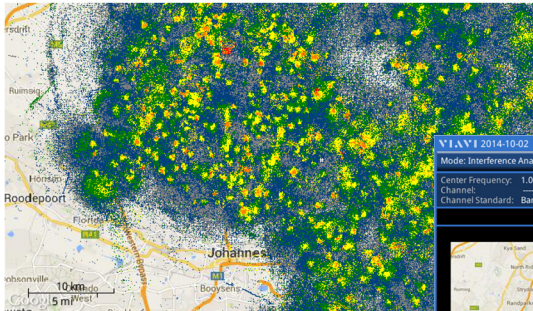
The approach also better reveals handset migration and usage impact. It can identify the number of customers needing to migrate to a 3G/4G device and the number of LTE devices that cannot connect to the LTE network. This can be due to the mobile network mode not being set to the 4G network, the device software not being updated to an LTE-compatible version, or handsets not supporting the correct frequency band.

Another benefit of an ariesoGEO-like solution is the RF optimization of network frequencies. Operators can better understand cell borders; they can compare the new service coverage and create equal boundaries between different technologies (for example, 700 vs. 1900). The approach optimizes inter radio access technology (IRAT) and inter frequency handover (IFHO) and enables a before-and-after comparison of GSM vs LTE in terms of KPIs for coverage, drops, blocks, and traffic utilization.



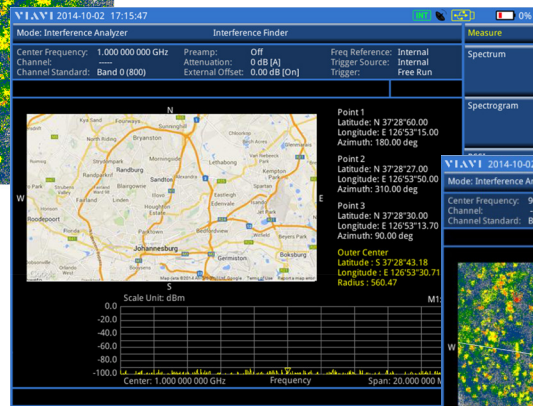
ariesoGEO lets operators perform cross-technology analysis before and after refarming to better plan it and understand impact

Other RAN solutions such as the VIAVI Rubix™ and TrueSite™ can be used in conjunction with location-aware information to audit guard bands and the entire refarmed layer to identify and pinpoint sources of interferences between services (for example, GSM and LTE) or other external sources.



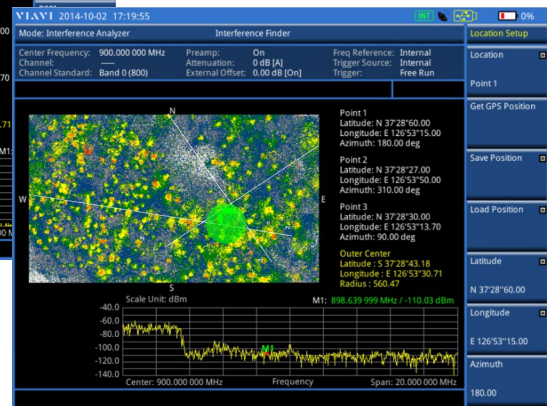
**Work Order**

Raster map export and downloading via e-mail or cloud server



**Sizable Map**

Seamless map capture and downloading with mobile terminal



**Interference Hunting**

Direction finding with direction finding handle using triangulation

## Conclusion

In terms of spectrum usage, the benefits of spectrum refarming for improved quality of service and coverage are well understood. However, these benefits need to be weighed against the challenges faced by each mobile operator during the planning and execution of a spectrum refarming activity. The ariesoGEO platform offers the multi-technology and multi-vendor, subscriber-based measurements that let operators address many of the challenges outlined in this document. Furthermore, by taking a systematic approach with ariesoGEO, CellAdvisor, and RANAdvisor, operators can quickly resolve interference issues, minimize service disruptions, and maximize customer QoE.



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