The Challenge
In the process of rolling out 4G service, a Tier 1 Mobile Operator was interested in situations where 4G devices were being inappropriately passed to the existing 3G network layer. The operator sought guidance regarding the priorities for future site deployment and identification of sub-optimal 4G infrastructure behavior. They turned to the Viavi Solutions™ ariesoGEO to provide detailed intelligence on the performance of the new 4G service and on 4G-on-3G hotspots within their network.

4G and 3G Interactions
Generally, 4G-capable devices can utilize 3G and even 2G network services. The intention is that such devices should use the 4G layer as far as possible, deferring to lower specification layers only when the higher layer cannot sustain the service required. While on lower layers, devices should return to the 4G layer as soon as conditions permit.

The ariesoGEO solution was used to generate maps showing the density of usage that 4G devices were making on the 3G layer. The representation in Figure 1 was achieved by tracking 3G activity and filtering to include usage only from 4G-capable devices. The dots identify the operators’ sites, while sector symbols identify operational 4G infrastructure. Clearly some 4G-on-3G usage occurs in areas where the operator has yet to roll out 4G service.
There are three reasons why devices may pass from 4G down to other technologies:

1. Where users request services such as voice that are not offered by the 4G network
2. Where devices that have roamed from elsewhere cannot access to the 4G network
3. Where 4G services are unavailable or 4G connectivity cannot be sustained

The first two reasons have to be accepted within any network. They can be accounted for through additional filtering of the usage maps by service type and by device capability. Figure 2 shows remaining data usage that could be handled by a 4G network.

**4G Deployment and Optimization**

In addition to roll-out issues, ariesoGEO also revealed cases where 4G service should have been expected, yet 4G devices appeared en-masse on the 3G layer. For example, Figure 2 shows heavy usage to the south of the area close to sites that Figure 4 reveals to offer high data throughput.

Analysis of events captured by ariesoGEO in these areas revealed that much of this 3G usage stemmed from a reluctance of the network to return devices to the 4G layer after use of 3G. Figure 1 shows that data connections make up only a part of the total set of 4G-on-3G connections in this area. ariesoGEO found that, following circuit-switched fallbacks (handovers to 3G to establish voice calls), subsequent data transfers were kept on the 3G layer rather than being passed back to 4G.

**Cross-Technology Insight**

The third reason whereby 4G devices were passed down to lower layers because the device was unable to access 4G provided the source of the issues that the operator aimed to investigate. Clearly, the center and the northwest corner of Figure 2 show high 3G data usage from 4G devices in the vicinity of sites without 4G deployed. Devices in those areas may find the more distant 4G sites do not provide coverage, or the data rates available from such sites are substantially poorer than those offered by the 3G sites.
Figure 3 shows maps generated by ariesoGEO that reveal the peak data rates reported by devices connecting to the 3G layer (bottom-left) and the 4G layer (top-right). The 3G service is consistent across the map at around 5 Mbps, dropping to 1 Mbps in some places and rising to 10 Mbps in others. The 4G service, however, is less consistent with some areas reaching up to 50 Mbps and others falling to 100kbps or less. This analysis was taken a step further in ariesoGEO by generating a Delta map showing the differences between the peak rates reported by the two networks, as shown in Figure 4.

Blue areas indicate that 4G is measured to be faster than 3G, and red areas show that 3G was the faster service. As expected, 4G service is stronger near operational sites, while 3G service prevails elsewhere.