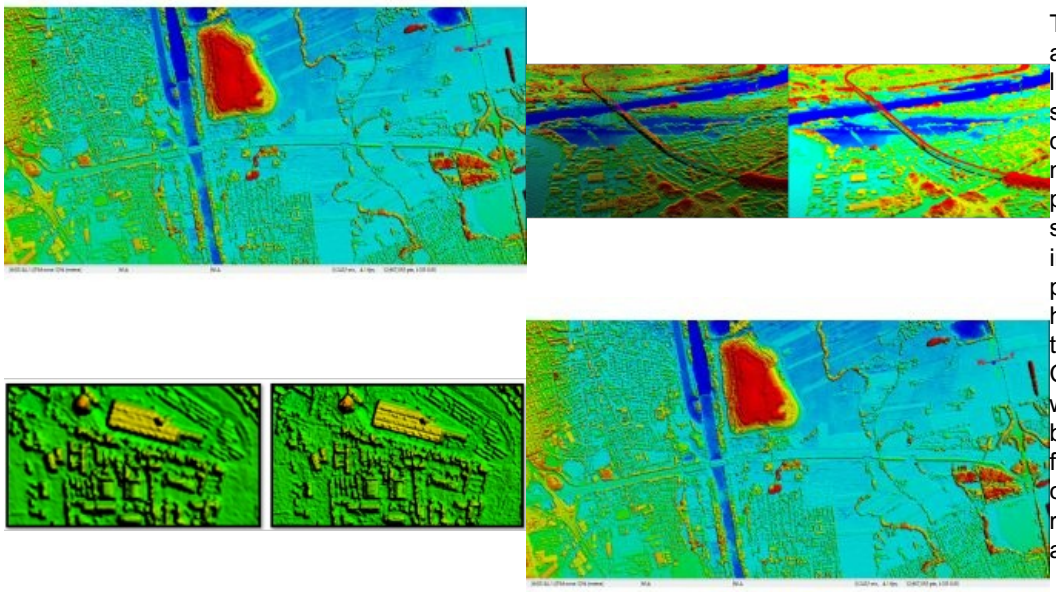
High-quality Aerial Imagery Helps to Unlock 5G Networks



Telecommunication operators are working at full speed to bring the 5G network to life. Most operators are currently at the signal propagation planning stage and are defining optimal locations for the network nodes. Although widely used for the planning of 3G/4G networks, digital surface models generated from satellite images are insufficient for 5G antenna positioning. Another source, with required high-resolution data, is now available for the USA and large parts of Europe and Canada. 5G is the next generation of wireless network technologies. For 5G to become reality, however, significant and fundamental changes need to be made to current network architecture, and that requires digital surface models (DSMs) and digital terrain models (DTMs).

Presently, most telecom operators are therefore preparing their signal propagation planning. This cannot be done effectively without high-resolution spatial data. The vital importance of high-resolution geographical 3D datasets is due to the characteristics of 5G (for the basics, see below). To realize the benefits of the new network, it is necessary to amplify the spectrum and to operate primarily in the less occupied high- to very-high-frequency domains. However, operating in high-frequency bands, especially when it comes to signal propagation, can pose the following challenges: 1) high-frequency signals are easily blocked by obstacles, especially (reinforced) concrete, and 2) high-frequency signals attenuate faster over distance (attenuation proportional to the square of signal frequency). A new network architecture forms the heart of a successful signal propagation setup, and it requires digital surface models (DSMs) and digital terrain models (DTMs).

5G Antenna Poles Everywhere

Instead of centralized and expensive ‘station-like’ antennas, scattered and agile antenna poles will be used to ‘guide’ signal waves around obstacles and act as signal ‘pit stops’ to decrease attenuation. These active antennas will be much smaller than current antennas and will outnumber them several hundred times. We will see 5G antenna poles being installed everywhere – on buildings, at bus stations and even in shops.

In order to optimize signal propagation performance of this vast network of small antennas, a current and detailed overview is needed of the ground surface and terrain. This means the use of DSMs (as-built surface information with buildings and vegetation) and DTMs (processed surface information with all vegetation and structures removed). So far, 3G/4G network operators have planned and implemented their network using relatively rough and simple DSMs, generated from satellite data with a spatial resolution of 5 x 5 metres or worse. This is simply insufficient for the planning of a 5G network. In most countries, however, better datasets are only available ‘in pieces’, with inconsistent accuracy and specifications. Network providers would have to acquire a patchwork of non-homogeneous and expensive existing data, or be confronted with costly data acquisition. Additionally, access to better datasets is often restricted and administratively complex. It is therefore perhaps interesting to know that there is an alternative approach in many regions of the world.

Figure 1: Comparison of 5m (left) and 80cm (right) DSMs.

Regionwide 3D Imagery

For the USA and large parts of Canada and Europe, the Hexagon (HxGN) Content Program provides seamless 15-30cm resolution orthophotomosaics and elevation data, as well as an 80cm-resolution DSM. In its work to acquire Europe-wide homogeneous aerial imagery coverage since 2014, COWI has discovered the benefit of the HxGN Content Program compared to traditional satellite imagery for professional use. The solution has brought radical improvements to the aerial imagery industry thanks to its high geometric accuracy, radiometric consistency and its ability to capture images in areas with difficult weather conditions, covering entire countries and regions. The Leica cameras used within the programme capture light in four bands: three visible bands for a colour image and the invisible near-infrared, which can be used later to detect vegetation automatically. This combination makes it very suitable for a wide-area semi-

automatic mapping task at high speed. Due to the continuous capture of the data in stereo models, high-resolution terrain models can be calculated and all important obstacles mapped in 3D. The digital surface models have a spatial resolution of 80cm, which is an order of magnitude better than almost any satellite dataset used today for radio propagation. The HxGN DSM can be further improved by combining mapping with the height model and adding land cover information, e.g. the discrimination between buildings, building types and vegetation such as forest and agriculture. The DSM will inherently contain the information about the height of buildings and vegetation, both of which are crucial for 5G antenna planning. If the resulting high-resolution datasets would pose challenges for local data storage and management of large-area coverage, that can be addressed through easy and secure cloud-based storage and access.

Figure 2a (left): 5m-resolution DTM. Detailed structures are generalized and disappear in the surroundings. Figure 2b (right): 80cm-resolution DTM. Detailed structures are clearly visible.

Basic characteristics of 5G

5G is the next generation of wireless network technologies that will revolutionize mobile communication systems, raising the norm for wireless network speed to 10Gb/s. 5G also means a revolutionary change to the entire architecture of cellular networks. The network will have none of the 'blind spots' currently experienced, e.g. in tunnels or inside elevators. A better network architecture not only means much lower latency (fewer delays and lags), but also creates better communication paths. The previously centralized communication (with everything passing through base stations) will be scattered, allowing direct device-to-device communication. More devices can be connected without interfering with central data traffic, which will be a significant step towards advancing the Internet of Things (IoT) and cyber-physical systems. In another major improvement, 5G networks are expected to decouple energy consumption from data volume/traffic thanks to higher signal transmission efficiency and lower signal attenuation.

Further information
The Hexagon Content Program

Figure 3: HxGN DSM at 40cm resolution.