Accelerating 5G Rollout

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Since its definition by the International Mobile Telecommunications (IMT) in 2015, and the release of 3GPP's standard needed for fixed broadband and mobile services, the fifth-generation wireless system (5G) has caused waves of excitement in the mobile industry, enterprise and consumer markets. 5G wireless is expected to generate billions of dollars in revenue for equipment manufacturers, cellular operators, service providers, added value application companies and businesses through the technical advantages it provides. 5G boasts some impressive advantages for mobile operators to capitalize on. These include connection density of $10^6/km^2$ (including IoT) and the ability to offer 20 Gb/s downlink and 10 Gb/s uplink in a spot cell using millimeter wave or small cell with higher microwave. Consequently, the number of 5G cells in each geographical coverage area will drastically increase in comparison to 4G. This raises the question: how can operators efficiently roll out the Radio Access Network (RAN) services in a short timeline?

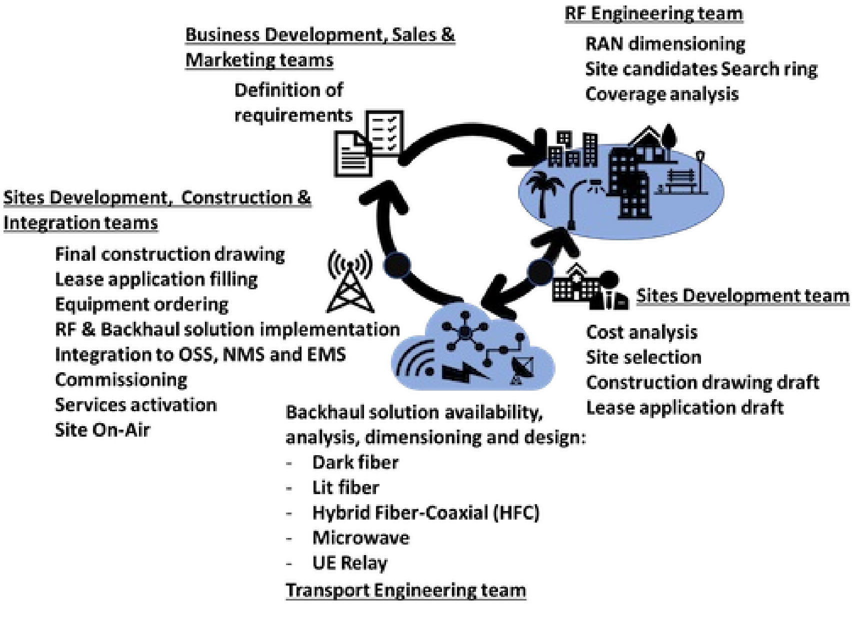

Figure 1 - Typical cellular site rollout process workflow

Usually rollout begins with the definition of requirements and proceeds to cell site services activation via a process workflow involving different teams. Though it may vary from one operator to another, the Figure 1 depicts a typical process. Here, the backhaul solution design phase contributes in the service deployment delay. When a site candidate is designated as stranded because there is no feasible backhaul solution (due to high fiber cost, blocked microwave line of sight, or another reason), RF engineering is notified for a new candidate proposal or a new search ring phase. With the volume of sites necessary to deploy across a market, today's cycle is too time-intensive.

Pre-checking backhaul availability during RF search ring phase

To minimize the number of rejection cycles, a new approach is required. RF engineering could perform a basic assessment of backhaul availability or feasibility while analyzing site candidates. The intent is not to have the RF team play the role of backhaul engineers but instead ensure the proposed candidates have less chance of rejection during the process. Of course, overloading RF engineers during the backhaul pre-check should be avoided. Using an appropriate and user-friendly tool with integrated map is necessary in this approach. The key features to look for in the application should include the following:

- Carrier routes overlay to help in locating sites closer to fiber in a search ring
- Online Lit datasets overlay to help identify which sites in a search ring host fiber
- Overlay of licensed Microwave (MW) or registered Millimeters links in regulator's database to help identifying existing LOS between sites in a search ring
- Height assessment of structures via a real cities 3D map, such as windows 10 Bing Maps App.

Would an application with these features be valuable for the RF team? Well, let start with the carrier fiber routes. One could object that, on one hand, not all carriers have their fiber footprints available for free download and that, on the other hand, commercial datasets are expensive. Worse, the free download from carrier websites are in KMZ or KML format, which can be extremely slow to navigate with Google Earth because of the large number of polylines displayed. This could be a criterion of the tool selection.

The RF supporting application for the backhaul availability pre-check must be capable of extracting the KMZ/KML data and parsing it into a relational database. The lateral distance from a site to the fiber footprint would be a metric for the site candidate selection. The tool should support other file formats such as ESRI Shapefile, generally provided by commercial fiber routes dataset vendors. Due to their low cost, an affordable alternative could be the usage of the Lit fiber dataset.

In general, Lit fiber datasets include all carriers nationwide. They offer the advantage of exactly pinpointing on a map the locations with fiber connection in service. In addition, they do not consume resources as heavily during display. When displayed, the following data attributes are provided: carrier name, fiber supplier name, On Net or Near Net, latitude and longitude, location address and datacenter. This information is very valuable in the sense that the RF engineer can now select 5G sites with the objective of minimizing carriers' network outage impact. It aids in diversifying the fiber suppliers inside a coverage cluster.

In geographic areas where neither fiber routes nor the Lit fiber dataset is available, overlaying frequencies with regulators' registered links could still be helpful in site candidate decisions. Rather than being about line of sight verification, this idea is about having a visual representation of existing links from licensees in an area of interest. Of course, some licensed or registered links could be no longer in operation because of new obstacles caused by new building construction, for example. Nevertheless, RF engineering can still locate which structure likely hosts a cellular base station. This information could be passed along with the selected site candidates to the development team.

Terrain elevation, surrounding clusters and structure height are critical pieces of information when designing cellular networks. The tool to be used for the backhaul availability pre-check would be a good asset if it offers functionalities for structural height assessment. Instead of reliance on costly commercial 3D cities datasets, the usage of free 3D maps such as Bing Maps App is preferable.

The table below shows a sample of information that RF engineers would supply in the workflow process. Engineers should also include other good candidates on coverage perspective without existing backhaul for sites so that the development team can make objective cost analyses during the decision.

Site address	Latitude	Longitude	Backhaul availability				
			Lit Fiber (Y/N)	Fiber route (Y/N)	Carrier name	Distance	Existing MW (Y/N)

Figure 2 - RF Engineer Table

Backhaul design completion phase

At this step of the adapted workflow process, the percentage of site candidates designated as stranded should be far less than using the traditional process. It’s important to remember that 5G technology operates in the lower sub-band 6 GHz, veryhigh frequency bands (24, 26, 28 GHz) and millimeter wave bands (38, 60 GHz). In the United States, the frequency bands 24, 28, 37.39 and 47 GHz have been auctioned and are considered as licensed spectrum. For cases where Microwave (MW) or Millimeter wave (MMW) radio link is the transport mean, the transport engineering team must provide innovative design guidelines for avoiding network impairments and allowing rapid design. V band (60 GHz) and E band (70/80 GHz) ultra-high capacity point-to-point radio systems may be heavily used in dense areas like city centers for accommodating 5G abundant bandwidth requirement (20 Gb/s download). These two bands are unlicensed in many countries, even if 70/80 GHz offers the advantage of being registered in some, such as the U.S. In that context, noisy channels due to interference will result in link fading, high frame loss and high delay causing a non-compliance to the IMT 2020 5G performance requirement.

Given all of this complexity, it’s important to consider solutions that are both promising and feasible. One could be the use of ultra-high capacity radios with layer 1 bonding capability. This consists of combining two enclosures with one containing millimeter wave 60/70/80 GHz diplexers, and the second containing multiple licensed frequency diplexers. The baseband traffics are carried across the different frequency carriers using the inverse-multiplexing principle, and the waves are radiated through a single multi-band antenna.

Even though it is impossible to predict the performance of unlicensed links due to uncontrolled external factors, it would be beneficial to have backhaul engineers perform an intra-network interference analysis when designing the backhaul of spot or small cells with the outlined above solution. Regarding this, RF and backhaul engineers should use the same design tool for an efficient interference analysis. The ideal design software must contain the features described above for the RF backhaul pre-check tasks.

Innovating is essential

5G will certainly revolutionize the world of communication soon across the globe. New applications beyond our imagination will be part of every human being’s daily life. Thus, mobile operators are required to innovate in their 5G network rollout process, specifically on the backhaul design.