MOBILE EXPERTS

ACCURATE RAN PLANNING SAVES BILLIONS

JOE MADDEN

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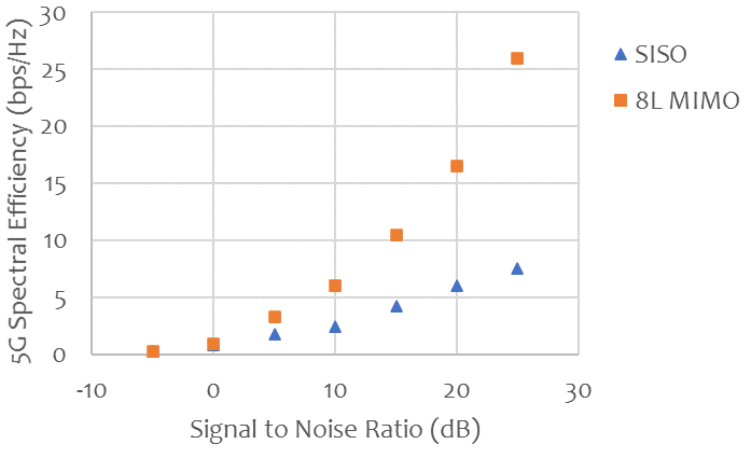
Background

During the 1990's, RAN planning was a simple affair of drawing circles on a map, then choosing the site for a tower or a rooftop installation. With only one or two frequency bands, the tools for maximizing coverage were fairly simple. But anybody that still thinks about RAN planning tools in that way needs an update.

Today, RAN planning tools are very complex, with multiple bands to consider in both coverage and capacity planning. High resolution 3D map data are used to precisely predict wireless coverage in multiple generations. In-building models are merged with outdoor models to reflect the impact of indoor small cells or DASs. Artificial Intelligence has come into play recently, as the number of optimization dimensions has grown beyond the ability of human users to achieve the best results.

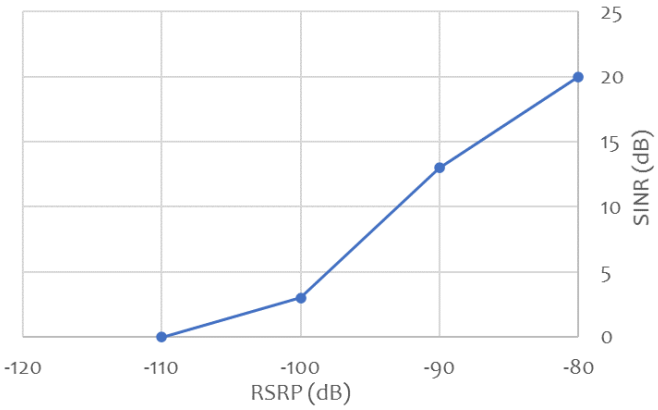
With 5G network slicing, a new requirement is coming into the market: Operators need to model the implementation of a network slice, with dedicated resources for specific customers or applications. The challenge here is to assess the network's ability to support a network slice within minutes, to be able to respond quickly to a customer request.

Accuracy creates more capacity



The use of massive MIMO has made accurate RAN modeling extremely important. During the days of SISO mobile links, every 1 dB of SNR improvement could result in 0.1 to 0.2 bps/Hz in improved spectral efficiency. But we have improved our mobile links. Today, as the signal-to-noise ratio improves, we can scale up to higher QAM levels and higher order MIMO, achieving much higher spectral efficiency. In a massive MIMO system with 4-layer multi-user MIMO in the downlink, a 1 dB improvement in SNR yields 0.5 bps/Hz of additional spectral efficiency (for users in the typical range of 0 to 10 dB SINR). That means that today's RAN planning tools have a much bigger impact on capacity performance than ever before.

The SINR achieved by each user depends directly on the RAN planning tools and their use. When the network is set up, a sophisticated 3D model is used to predict the RSRP (reference signal received power) at each location. After network deployment, drive testing is used to



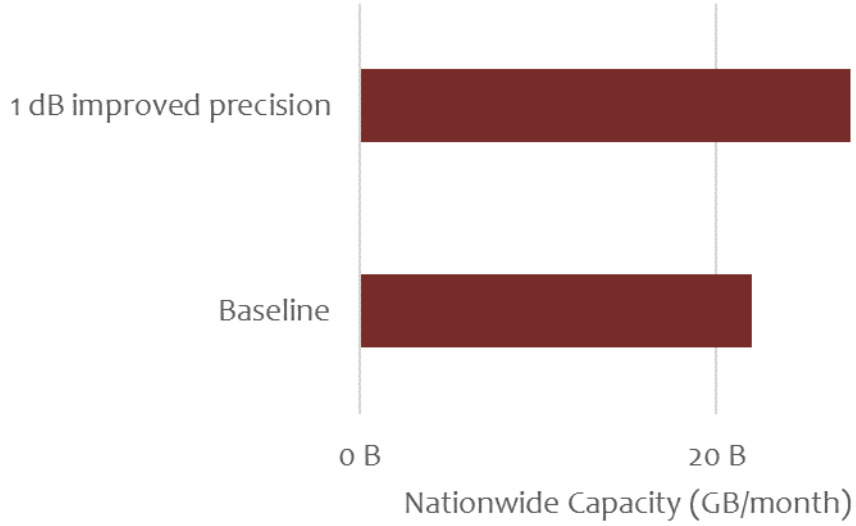
validate the actual RSRP in each location. Any error between these RSRP values will translate directly into lower SINR for users, either due to higher path loss than predicted or higher interference than predicted.

Looking at some results from the field, we estimate that when actual RSRP is 1 dB lower than desired, for typical users this can result in 0.5 to 0.9 dB in lower SINR. If actual RSRP is 1 dB higher than anticipated, many users would lose capacity due to higher interference. (The amount of capacity lost is more difficult to quantify in the case of high power/interference.)

We calculated the business impact of a 1 dB improvement in RSRP precision by:

1. Converting the RSRP error into SINR impact;
2. Translating SINR impact into spectral efficiency impact;
3. Estimating the capacity and cost of network deployment over five frequency bands, including macro, massive MIMO, and small cells. (See the Mobile Experts *Business Case* model)

Our modeling showed that 1 dB improvement in RSRP precision can make a huge difference in capacity for the mobile operator. In a nationwide network, 1 dB higher precision in RSRP leads to roughly 0.4 bps/Hz overall improvement in spectral efficiency. With the same numbers of radios and the same antennas, that's a 24% increase of capacity!



Accuracy reduces CAPEX spending

Of course, the operator can choose to use their improved modeling precision for higher capacity, or they can simply defer the investment in additional spectrum and radio equipment. In the same nationwide network model, we calculated the CAPEX savings from reduced numbers of base stations and small cells. In the case with 1 dB RSRP precision, we found that the nationwide network could save about $2 billion over a 10-year period…mainly by deferring capacity investments to a later date. The table shown below illustrates that thousands of gNodeB deployments can be deferred every year, with significant savings over time.

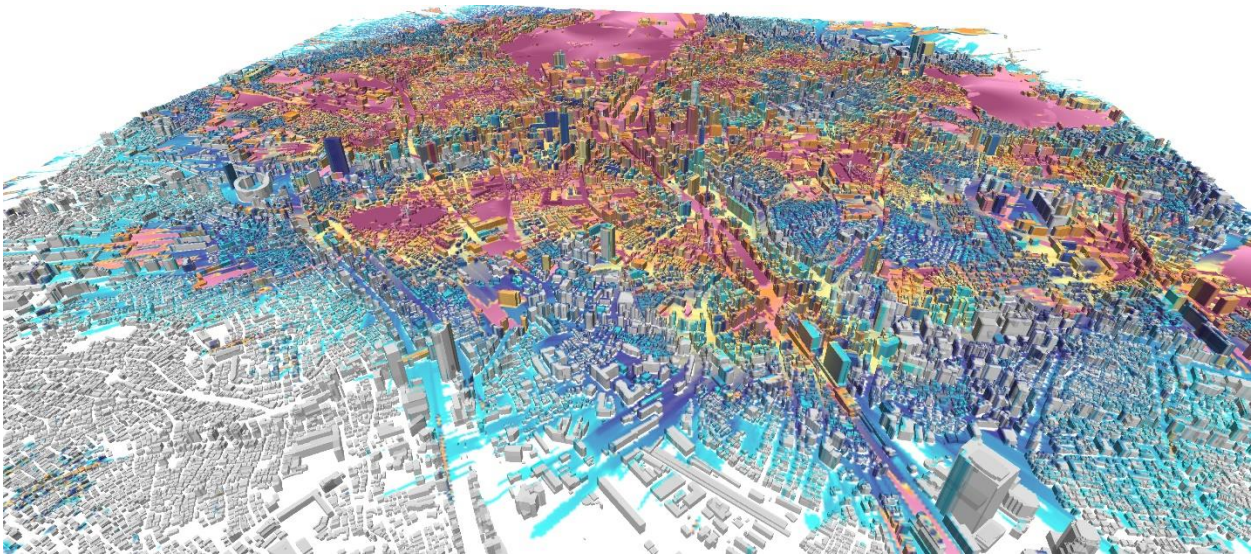
gNodeB installed base (number of sites x number of bands)									
	2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Baseline	112,160	126,160	150,280	174,200	210,120	245,250	277,640	317,680	366,720
1 dB improved	104,860	119,560	143,080	166,850	203,470	236,800	268,240	307,180	352,720
Sites saved	**7,300**	**6,600**	**7,200**	**7,350**	**6,650**	**8,450**	**9,400**	**10,500**	**14,000**

In fact, in the case with improved RSRP prediction, the operator may be able to delay the introduction of a mmWave network by as much as three years. Eventually, the operator will need to make most of the investments for capacity, but delaying deployment of difficult new radio bands can make them significantly less expensive.

Accuracy reduces churn

Looking at the options, it's clear that the operators can use improved RSRP predictions in two different ways: 1) to boost capacity or 2) to save money. They can't get the full benefit of both improvements at the same time, but they can choose a position that takes advantage of both benefits to some degree. We believe that most operators will choose to focus on improved RSRP precision for higher capacity, at least in the urban areas. The reason is that peak capacity limitations are an issue in LTE and 5G networks, and capacity limits can lead to dissatisfied customers.

In this way, Quality of Service (QoS) also carries a significant financial incentive, as customer churn ties directly to lost revenue. Another way of saying this is that better RAN planning is an inexpensive way to boost capacity and QoS to reduce churn.



Planet RF coverage image courtesy of Infovista

Continuous RAN Planning enables new revenue

RAN planning tools are evolving into RAN optimization tools, that use a continuous cycle to determine the optimal network configuration based on constantly updated map data and capacity/demand data. The idea is to use AI and Machine Learning to create a digital representation of the network, so that the operators can quickly consider changes.

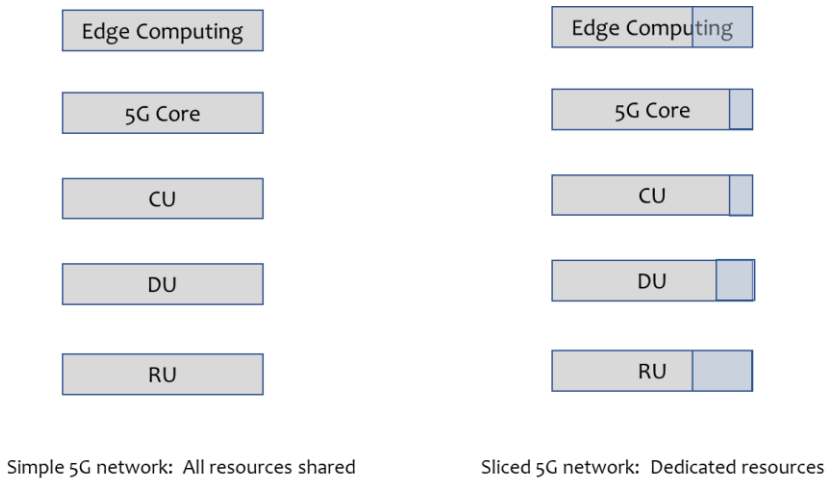
One example of a high-impact network change is the Network Slice. Consider an enterprise that wants to buy a Network Slice from a mobile operator, with guaranteed reliability and latency for their own private network. The process of setting up a Network Slice is not well automated today, and the operator could spend weeks investigating the resource allocations that would be necessary in processors, memory, radio resource blocks, and other aspects of the network. A sophisticated model could simulate a network slice within minutes, and then drive a re-provisioning sequence that sets aside resources throughout the end-to-end network.

To reduce slice assessment times from potentially weeks down to hours, or even minutes, will require a planning tool that is tightly integrated into the network. Automation workflows to constantly update the planning tool with the latest network data and orchestration API's to implement the relevant network changes will be key components. The speed and tight integration to the network required to fulfil this use case means a cloud-native planning tool is the best approach.

As an example of this, Rakuten is implementing a cloud-native "on-demand" radio network planning solution with Infovista that allows its engineering teams to utilize advanced planning and design features devised to efficiently reduce the time and cost of network

planning and deployment, through extensive automation and full integration with other applications within Symworld.

To further reduce network planning decision time requires planning to move even closer to the network, with ability to consume various (including near real time) network data in the decision process. Building planning algorithms into an rApp on a non-real-time RAN Intelligent Controller (RIC) provides the framework that can potentially enable fast planning decisions and actions We expect this kind of platform to become the basis for automation of Network Slicing throughout the network.



When Network Slicing becomes easy enough that the operators can set up a Slice in less than an hour, we expect a rush of customer demand to follow. The market for private wireless networks is hot today, with 90% CAGR in 5G private network growth expected through 2026. Many companies are implementing their own radio and core networks today because guarantees for reliability/latency/bandwidth are not available from the public mobile network yet. Based on our forecasting, we believe that a significant pent-up market is building for private networks "as a service".

Top 5 prerequisites for effective 5G RAN planning

Analysis of our financial modeling and investigation into available planning solutions has led us to a short list of 'must-have' capabilities to ensure effective 5G RAN planning:

1. Accuracy: Accurate network modeling across not only coverage, but also interference and throughput is critical. As outlined earlier, this ensures the design delivers maximum return on the CAPEX invested and exceptional quality of experience, which minimizes churn. AI/ML-based prediction engines are becoming the de-facto standard to deliver the accuracy required and ensure the optimal network design is arrived at.

2. Efficiency: The productivity of engineering resources is key to shortening the deployment times of 5G networks. A planning tool needs to be efficient to use, whether that be managing complexity though automation or increasing engineer productivity with efficient workflows and faster computational cycles.
3. Data-driven: Population density maps and clutter rasters are no longer fit for purpose when planning a best-in-class network. The best plan can only be determined by leveraging multiple input data sources including crowdsourced, social media, drive test, geolocated call trace and performance management data.
4. Integrated: A stand-alone planning tool no longer delivers the value expected. Integration of network planning into network lifecycle automation (NLA) processes such as testing, assurance and operations can significantly reduce operational costs. Take for example the ability to leverage planning data to inform where to focus your drive testing and reduce the time, scope and cost of the drive testing effort by over 70%.
5. Cloud-native: A cloud-native architecture is rapidly becoming the approach of choice when it comes to planning tools. It provides the high availability and disaster recovery required in a business-critical solution. On-demand compute resources and elastic horizontal scalability enables new capabilities such as nationwide predictions at any resolution and faster computation times, which are cost-prohibitive with a traditional hardware approach. And it delivers the many other business benefits associated with a cloud architecture such as automation and integration with other stages of the network lifecycle, all in a cost-effective package.

In other words, RAN planning is now much more than a one-time best-effort decision to place the radio sites in the right locations. Having the right capabilities within your planning tool will ensure you can deliver a 5G network plan that meets the QoE expectations of your customers and the ROI expectations of your management.

Conclusion

In our years of experience with mobile radio networks, we have rarely seen any product that has such a big impact on the performance of the network. Any mobile network deployment will benefit from the capabilities highlighted above whether they are launching a brand new 5G network or preparing for new Network Slicing business offerings on the existing network.

Overall, RAN planning and optimization is taking a key role in 5G deployment. We expect mobile operators to increase their investment in these tools, as the operations team and the CFO can both agree that this is an effective way to guide the investment in the field.