Indoor Coverage

The Risk of Skipping Model Calibration

Radio design and simulation tools are essential elements during planning however, they can't take into consideration all the parameters of each specific site. In several cases, the financial and technical risks are significant if this adaptation is ignored. And this gave rise to the need for real field measurement in order to optimize the design and infrastructure cost.

Model calibration has been the safety net of coverage simulation, and hence a standard function in any reliable indoor or outdoor planning software in order to achieve reliable coverage and decent KPI's. However, with the new higher bands it is becoming a more critical step to take into account the effect of the actual wall materials on signal strength and reveal any complex propagation mechanisms. So, this article sheds light and analyzes case studies that depict the technical & business impact of skipping this step.

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Introduction

Mobile operators always need to deliver greater capacity while keeping minimum financial and technical risks. And obviously the cost and network complexity of indoor communications systems are functions of the number of small cells or RF node required to achieve the coverage objectives.

Outdoor model calibration used to be a standard step for macro network planning and bypassing it causes major deficiencies in coverage. The vital benefits of such step are well known to planning professionals. Hence, in this article we give much attention to indoor networks (while extra readings are available for outdoor concerned people)

Radio propagation in indoor environment differs greatly from outdoor, not only because of wall losses but also due to many other factors such as close proximity of reflecting structures (walls, floors …etc.) introducing different fading profiles. And all are resulting in a totally different RF behavior that varies greatly even from one place to another within the same building.

Factors such as Penetration loss, Reflection, Diffraction and Scattering influence the propagation of electromagnetic waves. During indoor network planning, CW testing should be conducted to examine how these mechanisms aggregate at every venue type. And this is the only method to collect true information about the structure, examine the effect of wall materials on signal strength and reveal any complex propagation mechanisms.

Nevertheless, in addition to indoor model calibration which is the main topic of this article, CW Testing used to be vital for indoor network commissioning due to the following reasons:

- Verify zone and sector boundaries
- Show attenuation between adjacent levels
- Explore places where zoning framework is liable to fail
- Study the propagation characteristics of each antenna type per particular venue
- Analyze the prospect antenna locations including back-lobes and side-lobes
- Test sector-to-sector RF leakage
- Verify sector/zone seams, propagation overlaps and power deltas.

Indoor coverage: why is it so critical

“80 percent of mobile traffic originates or terminates within a building”

“>70% of commercial buildings & hospitals have insufficient mobile coverage indoors”

“49% of architects see that the cost of provisioning of IBS is the greatest challenge”

“77% increase in enterprise workforce productivity due to better connectivity”

“28% average increase in property’s value in case of reliable indoor coverage”

“83% of healthcare workers claim poor cellular coverage at least some of the time”

“40% of warehouse distribution workers blame the carrier when they had a call trouble”

“32% of cases warehouse distribution workers have to go outside to make calls”

The VIRTUAL and The REALITY

While leading vendors of indoor planning tools work hardly to make sure materials in their database are as accurate as possible, in fact, the prediction is not always accurate due to the following factors:

1. Database/Reality dissimilarities
2. Missing inputs
3. Wrong material selection
4. Material is not in DB
5. Other hidden materials on-site

We summarize in this section 2 different case studies explaining the significant effect of ignoring field measurements.

1) Wall type mix-up

There are over 70 wall types to choose from. And Many of the wall types look similar by name while it can be hard -especially for a non-construction RF engineer- to select the correct type. Additionally, custom walls can be defined with varying loss parameters. These custom walls might have similar names bult greatly different loss figures.

The examples here address a typical case of Drywall and Sheetrock - Light. Most of planning engineers consider Drywall and Sheetrock to mean roughly the same thing. The first heatmap below is for correct value of Drywall to produce the proper passing scenario using 2* 20 W Remotes and 25 Antennas.

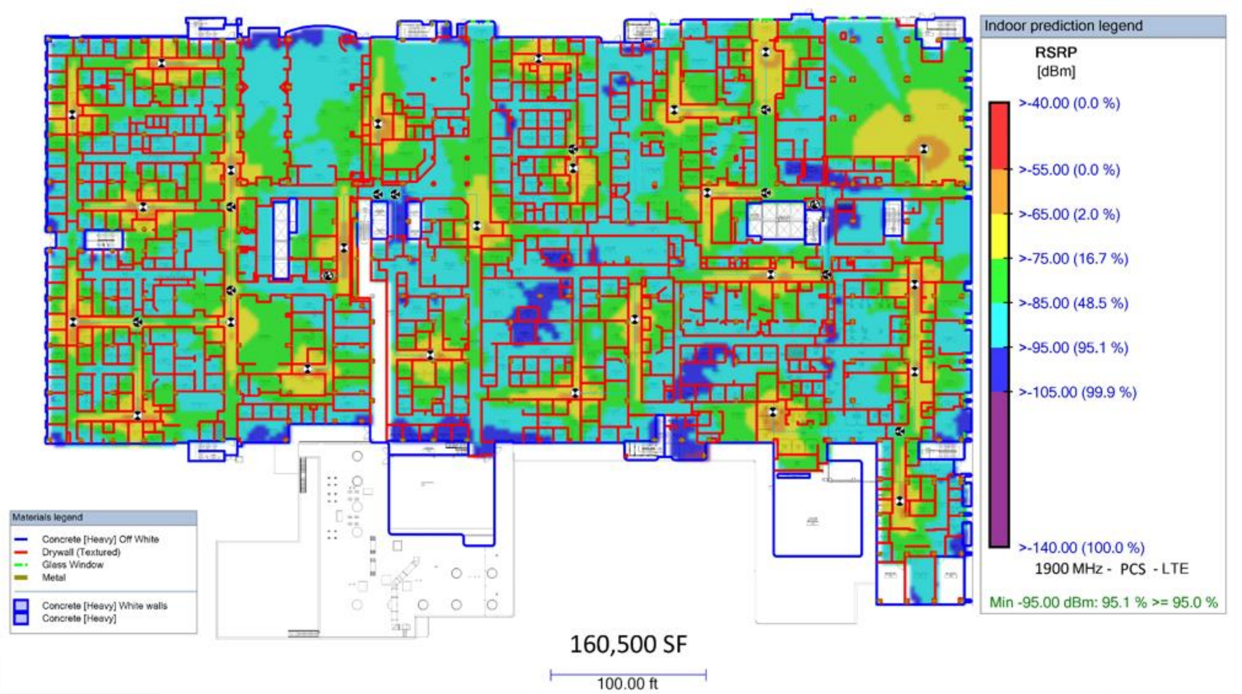


Figure 1. Selected wall type Drywall (correct Passing)

Instead, if the wall type is mistakenly selected to be Sheet rock Light, then the coverage only requires 2* 2 Watt Remotes and 12 antennas. And this will result in a fake passing heatmap as shown in figure 2 here. If that flawed design is installed, later the customer will have to choose either to pay a significantly higher price (more than what's required in the proper case above) or to leave a poor performing system in place as per the actual coverage illustrated in the next figure below.

Figure 2. Wall type Sheet rock-Light (incorrect Passing)

If we take the previous incorrect design then correct the selection of wall type from Sheet Rock - Light to be the actual Drywall, we will recognize the dramatic impact it has on performance. Figure 3 here shows the actual failing coverage and KPI's that will take place based on the wrong selected wall type. In other words, the price/performance impacts are extremely out of alignment.

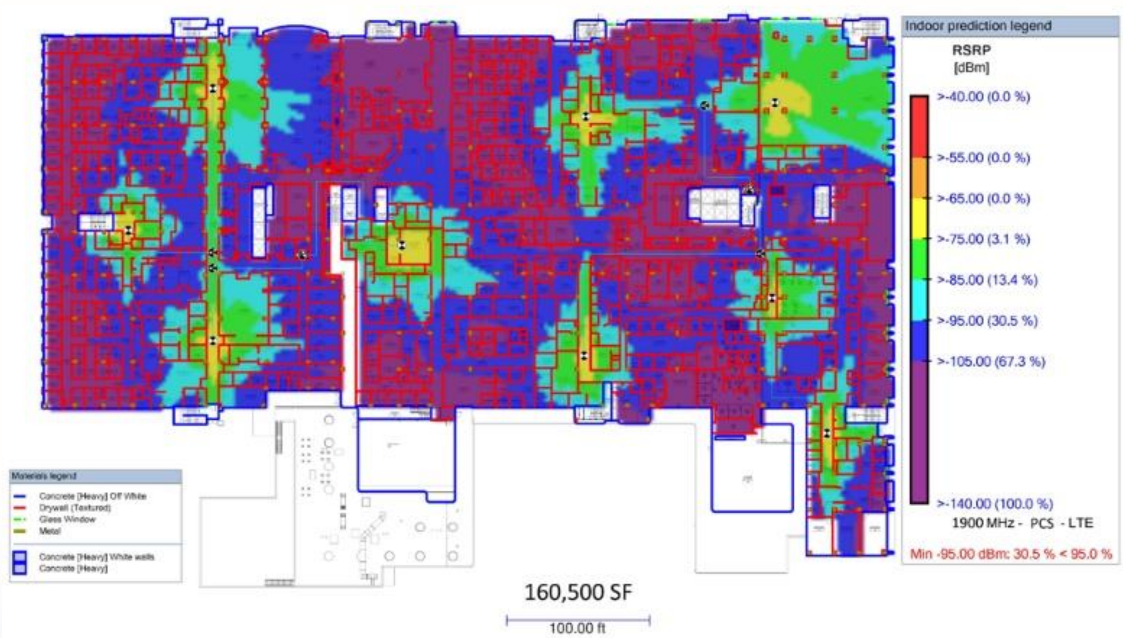


Figure 3. Wall type Dry Wall (Correct failing)

2) No model calibration

Another case study is illustrated here where prediction accuracy is compared to reality in both cases of calibration and no calibration.

Figure 4 below shows non-calibrated prediction compared to actual field measurements

Figure 4. Non calibrated prediction vs. field measurement

On the other side, Figure 5 below illustrates the case of calibrated prediction compared to actual field measurements

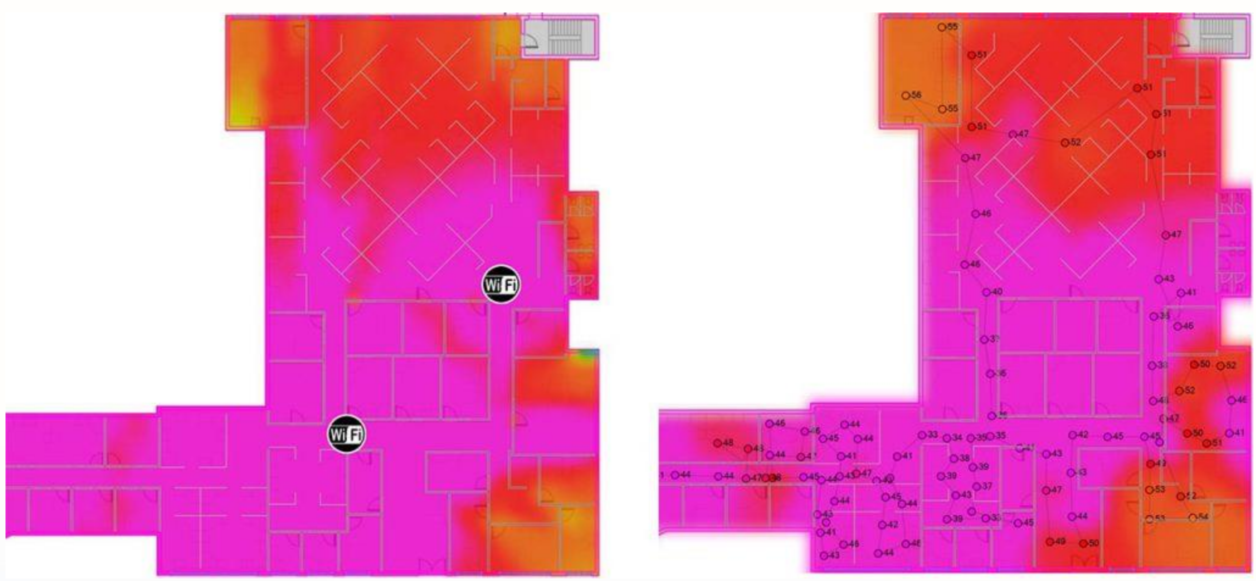
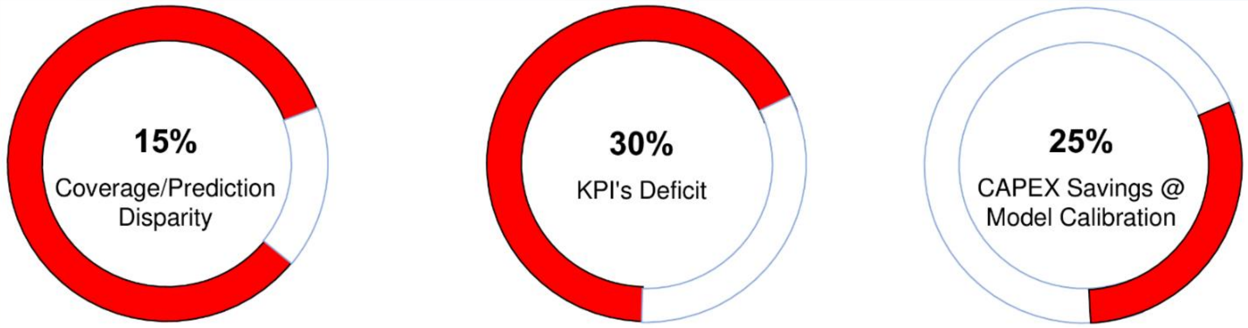


Figure 5. Calibrated prediction vs. field measurement

The Business Case

Post deployment analysis of several projects showed 3 typical numbers sorting out coverage and KPI's deficiencies in case of prediction-only scenarios and the cases of CW-augmented modelling.



This summarizes the financial and technical risks and implications when ignoring to fine tune propagation models to each specific venue.

Worth mentioning, the price increase illustrated in the last section is the baseline -in case the error is recognized before construction works- however, typically you will realize that in a later phase. That's why accurate predictions require true CW testing in various building morphologies which can then be used to modify prediction parameters. Otherwise, this will eventually lead to a scenario where everybody is blamed!

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About Consultix

Consultix is a leading vendor of portable RF test equipment. The company is remarkably known for its comprehensive portfolio of RF analyzers, CW equipment and monitoring solutions serving the Small cells and DAS market worldwide

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