Reduce Drive Test Costs and Increase Effectiveness of 3G Network Optimization

Abstract

It is critical for today's 3G network operators to change their approach to network optimization if they want to remain competitive and profitable. What was effective and acceptable with 2G and 2.5G networks is no longer getting the job done. If network operators want to create a competitive edge while rolling out new services, they must deploy smarter tools and strategies that allow for significant OPEX savings and optimize internal resources.

This application note will describe how modern wireless operators can achieve increased network optimization efficiency by overcoming some of the typical shortcomings of a dated optimization strategy inherited from the 2G world. These shortcomings are a result of drive test campaigns and network element counts. They include lack of visibility on uplink activity, poor statistical relevance of data gathered and the high operating costs associated for each campaign.

Tektronix has demonstrated time and time again the benefits of implementing a new approach to network optimization – one that integrates the use of protocol-based information with on-demand drive test campaigns. Carriers have the ability to not only to resolve non-effective 3G optimization, but also to realize significant OPEX savings of up to 60 percent. Ultimately, operators are able to successfully roll out new services without quality degradation.

Top 10 Issues Identified by Radio Engineers that are Resolved by OptiMon

1. Ability to clean neighboring cell list
   - Over-provisioned neighbors
   - Missing neighbors
2. Ping Pong Handover Detection
3. Propagation Delay
4. Handover Relations
5. Ec/No Analysis
6. RAB Usage and Distribution
7. HSDPA/HSUPA Throughput
8. UE Distance for Services
9. Pilot Pollution
10. Geo-localization of Problems

Introduction

Today's wireless communications environment is unlike any we've ever experienced. It is also putting operators in a confusing and difficult situation.

There are numerous factors that are occurring and driving the need for more and more optimization activities. These factors include:

- The increasing number of 3G subscribers (ultimately a goal for all carriers).
- An increase in network traffic due to the concurrent availability of high speed data services, Smart Phones (including iPhone applications driving the use of data services beyond just business users), and PC cards. These new technology options are pushing networks to the limit in terms of capacity and resource utilization.
- The deployment of new network elements in the RAN. Examples may include HSPA NodeBs, MIMO antenna, or the need to increase the capacity of the backhaul infrastructure with the provisioning of additional NodeB E1s.
- Continuous changes in the surrounding radio environment due to the frequent deployment of new radio sources or changes to city landscapes.
- Changes to subscribers' demographic and usage profiles resulting in an increased need for capacity to cope with the consumption of data-intensive services.

But despite these compelling trigger factors, network operators' Radio Engineering teams must still contend with 2G/2.5G networks. So, in order to cut the time-to-revenues for new 3G infrastructure while simultaneously attending to existing networks, more wireless carriers rely on vendor professional services teams for network tuning and resources optimization. Unfortunately, by doing this, operators are missing an opportunity to build competences on the more complex 3G radio environment.

Yet another dilemma is the concurrent need to increase the perceived quality of the new services, while being faced with the constant pressure to reduce operations costs to maximize ROI.

Using the same approach that worked for 2G and 2.5G networks is simply not effective. But because operators have not had the time to build new competencies, they have no choice but to have their KPIs monitored by professional services. As a result, data may suit the perspective of the infrastructure vendor, but may mislead the operator regarding final user experience.

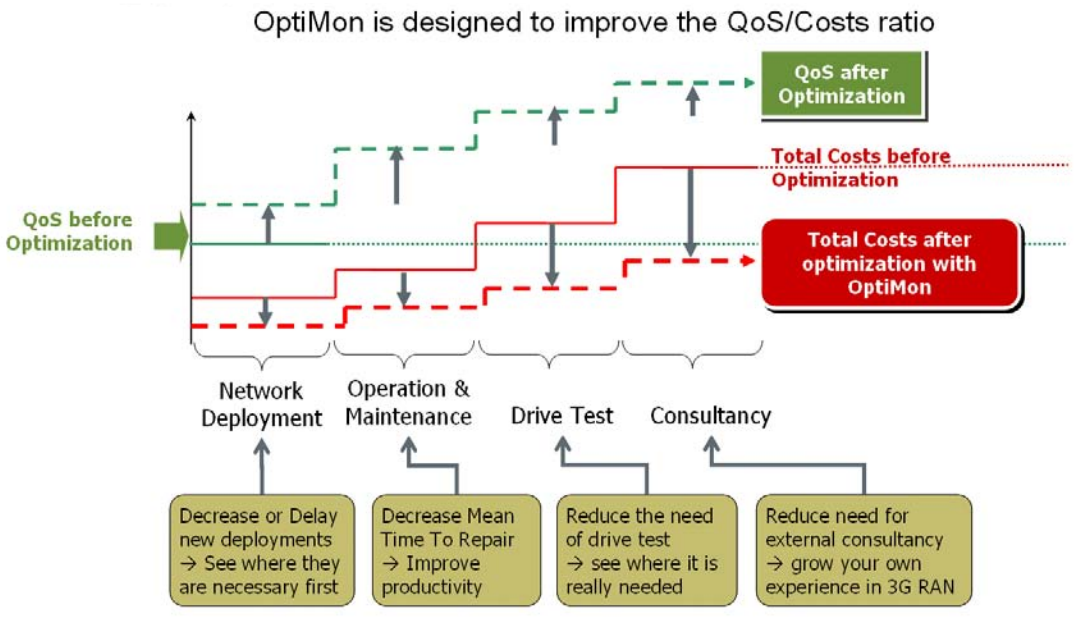
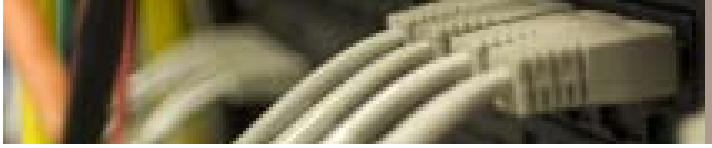


Figure 1. *Increase QoS/QoE & Cut Costs*



By Nature and Design, 2G is Different than 3G

What follows are a few examples of just how different these networks are:

- In a GSM/GPRS network, it is easy to get a complete view of performance (call drops, attachment failures, etc.) from the core network (MSC, SGSN).
- In 3G, the MSC is no longer the central point of decision for mobility management, call management, etc. Most of these functions have been transferred to the RNC and they play a central role in the UMTS access network.
- 3G Radio Access is far more complicated than GSM/GPRS technology. As a result, 80 percent of the problems faced by operators in 3G networks are located in the RAN, not in the Mobile Core Network.

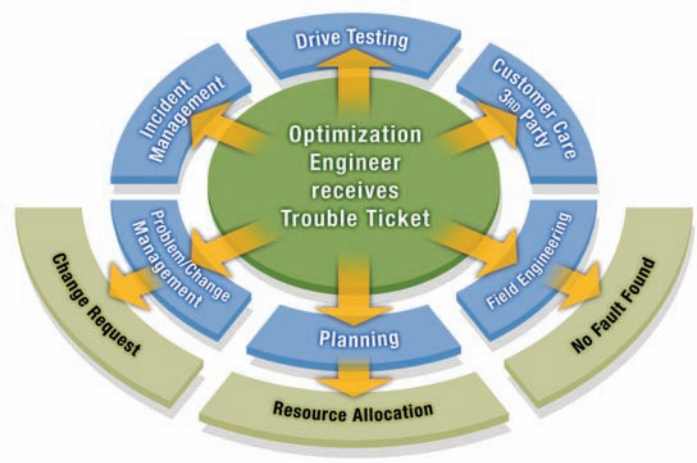


Figure 2. *Typical Optimization tasks at RNC level*

It is important to note that just because a wireless service provider has operated its 2G network for quite some time and has established troubleshooting processes, doesn't mean that the same process will work well for a 3G network.

In reality, after analyzing the typical optimization process primarily being used today (i.e. at the RNC level, as represented by Figure 2 above), operators may find that there is lots of room for improvement in terms of effectiveness and efficiency.

With the right approach, significant savings and efficiencies can be achieved in each of the tasks represented by blocks in figure 2. But the most compelling business case can be made for Drive Testing. Drive testing is a good example of what worked well with 2G, but not so well for 3G. It is also (ironically) the most used type of 3G optimization test (see figure below).

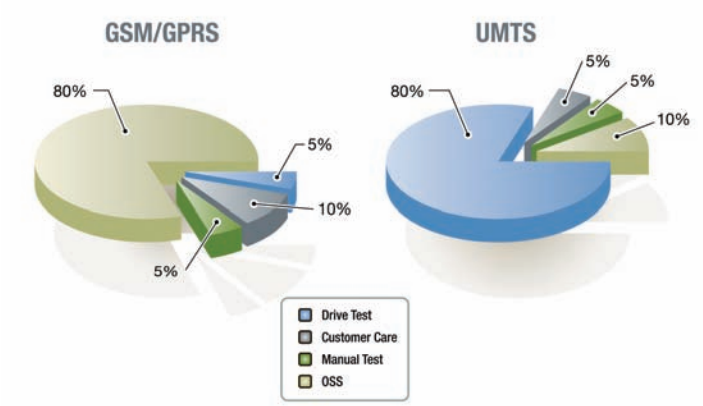


Figure 3. *Sources of Input Data for Optimization: GSM vs. UMTS*

The end-to-end performance is very sensible to the radio quality

- Start investigation in the RAN
  - Where most problems arise
  - Where the best chance of finding the root cause is possible
- OptiMon narrows down the possible sources of performance issues:

Interface	Ranking Criteria	Probablye cause of the problem
Iub	per IMSI	Specific Subscriber issue
Iub	per Handset Type	Handset Model issue
Iub	per Cell	Radio issue
Iub	per NodeB	E1 link issue
IuPS	per RNC	PS Core issue
IuPS	per Application Service	Application server issue

Why Drive Testing is not Effective

Drive Testing in UMTS networks

As discussed earlier, drive tests are still widely used by 3G UMTS optimization engineers for the following tasks:

- Network performance assessment
- Identification of network problems
- Validation of the effects of applied optimization changes
- Root problem cause analysis

But in fact, the only activities for which drive testing is well suited for is Problem Root Causes Analysis and Competitive Benchmarking. The reason lies mainly in the following characteristics of drive test vs. other test methods:

Drive Test data is severely under-sampled
This under-sampling occurs both in spatial and time domains. Even in most detailed drive testing scenario, the data is collected only from a small fraction of the system coverage area. In the time domain, the data is only collected in a small time interval that usually does not correspond to the system busy hour. This severe under-sampling raises issues regarding statistical validity and repeatability. For example, if a problem is detected, how certain is the operator that this problem will also occur for other mobile phones? Likewise, it is quite possible that many mobiles may experience a problem that is not sampled during the drive test.

Drive test data only monitors the Uu interface
Therefore, all network problems that manifest themselves on other interfaces are usually not visible from the drive test data. For example, it is impossible to detect radio coverage problems due to interference in the UL.

Drive testing is very expensive and time consuming
In fact, drive testing is the most expensive test method available for optimization. Although automated drive test systems were introduced to reduce the operating cost of drive testing, their practical value is limited. This is because their operation in public transportation vehicles is usually constrained by very limited geographic areas (e.g. bus routes). Also, compared to other test methods, the total cost of ownership is still high.

Drive testing can only use limited types of mobiles
There are only a few mobile terminals (ME) that are available and compatible with drive test systems. The consequence of this limitation is that drive test measurements can only apply to a few types of mobiles, subsequently ignoring the performance of all the other models that subscribers really do use. When we consider that end-to-end service performance (end user perceived performance) will vary with each terminal module, it is easy to understand why drive testing is not relevant when measuring end-to-end performance-of-services.

Drive testing in 3G networks cannot properly cover new usage profiles
In-building (office and home) usage is growing dramatically due the availability of new services and the success of wireless broadband bundles.

The Unnecessary Deployment and Costs of Drive Test

What follows are three specific situations in which the use of drive testing can be misleading, if not useless. These are based on standard routine activities and typical issues.

Reproducing customer complaints

Many trouble tickets assigned to an optimization department today require drive testing to reproduce a specific behavior or condition related to customer complaints. The typical wireless operator receives approximately 20 trouble tickets per 100,000 subscribers each month. The first metric to determine is whether or not the time and effort required to investigate trouble tickets are producing any results. A significant example is when the operator must investigate complaints related to frequently dropped calls with large gaps between access areas – probably overshooting. This issue is very hard to detect because of the low statistical sampling that is provided. Drive testing (and in this case the entire campaign) will be not only OPEX-intensive, but also useless when compared with the information that could be gathered using a solution that provides full visibility of network data. With complete visibility, the operator will be able to measure the performance of each call from every mobile at the NodeB level. The operator will also have the ability to spot events, performance indicators and trends.

Figure 4. *Access Distance Analysis Report*

- *The availability of detailed reports and data aggregations allows for faster and more accurate analysis and resolution of customer complaint tickets.*
- *In this example – frequent drop calls with large gaps between access areas – the Access Distance statistics indicate that it is possible to quickly isolate those over-shooting instances that would have been otherwise difficult to spot with a methodology based on Drive Test.*
- *The report can demonstrate at a glance the distribution of calls by distance. A significant 15% of calls can be highlighted as potential overshooting.*

Reducing QoE issues due to Pilot Pollution

With the increased availability of HSDPA networks, DL interference is becoming a significant topic with a negative impact on overall QoE of HSDPA traffic. This is significant because the majority of this traffic is business users, normally the first set of customers operators want to keep satisfied. The use of the drive test limits the reach of the optimization department to only those areas that are “drive test-accessible”, providing very limited statistical aid.

Let’s consider the example below. The left side of the graph represents a small group of users that do not warrant registration on a cell, but do not yet qualify for cell reselection. In this case, the recommended course of action would be to find a good compromise between both access areas (good/bad). Experience has shown that decreasing tilt could be an option. But because of ever-changing radio conditions, the operator would be lucky to identify this problem within a typical two-hour drive test session.

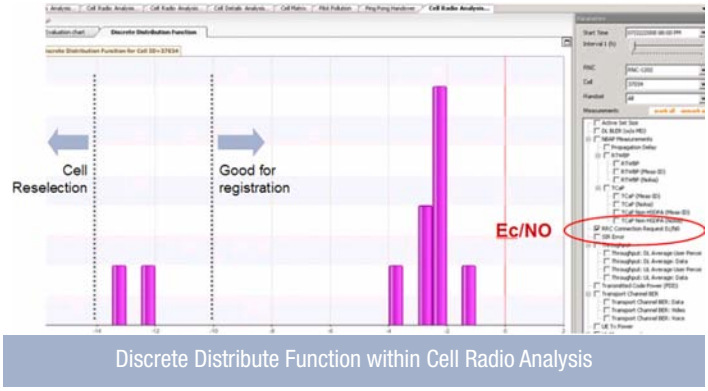


Figure 5. *Discrete Distribute Function within Cell Radio Analysis*

- *Typically, a value of -14dB is sufficient for cell reselection. But for the start of initial registration procedures, values of -10 dB are required.*
- *A histogram that shows distribution of Ec/N0 values will provide the best graphical tool for Down Link quality analysis at cell level.*
- *OptiMon’s Cell Radio Analysis application allows for the creation of histograms based on a large base of data. This functionality helps optimization engineers solve issues that might be difficult to identify with only a two-hour Drive Test campaign.*
- *The Discrete Distribution Function shown in the picture demonstrates how a protocol analysis-based solution can help fill the gaps of Drive Test-based analysis and reduce the time to problem resolution.*

Up-Link Interference Issues

As demonstrated in earlier examples, drive test systems simply cannot measure uplink radio performance. Some operators realize this but choose to ignore the problem because they feel only a small portion of their cells are affected by up-link interference. While the total number of affected cell may only be between 0.5%-1%, the impact could in fact be quite painful. QoS issues due to call drops, voice quality problems and throughput problems can result in additional trouble tickets costs and an increasing number of potential dissatisfied customers.

It has been reported that with the launch of new high speed data services in 3G, the QoE perceived by the end user during the first attempts to access the services will almost always determine the attitude of that customer when using or buying that service in the future. In other words, first impressions matter. So in the end, optimization engineers that are exclusively relying on drive test should quickly consider alternative approaches to prevent quality degradation and revenue loss.

The 3G Approach to Network Optimization

For modern 3G wireless communications, protocol-based optimization tools are the ideal choice for assessing network performance and identifying potential network problems. Larger traffic areas can be monitored with one system. Each UE literally becomes a 'probe', delivering measurement data to the protocol-based optimization system.

Protocol-based optimization tools have the following important advantages:

Test results are statistically valid. Typically all calls from a larger area (i.e., a cluster of NodeBs in one RNC) are monitored and analyzed. This method is very effective for both detecting and troubleshooting network problems.

Multiple interfaces that are not visible from the mobiles can be monitored. Protocol-based optimization solutions (monitoring traffic on Iub, IuCP/PS, Iur) are able to obtain a more complete picture of the overall radio access network.

Once installed, few resources are required. This is completely unlike drive test, which demands extensive time and resources.

Traffic can be stored for further analysis. By recording the data, root cause analysis is very straight forward and time-to-investigate is decreased.

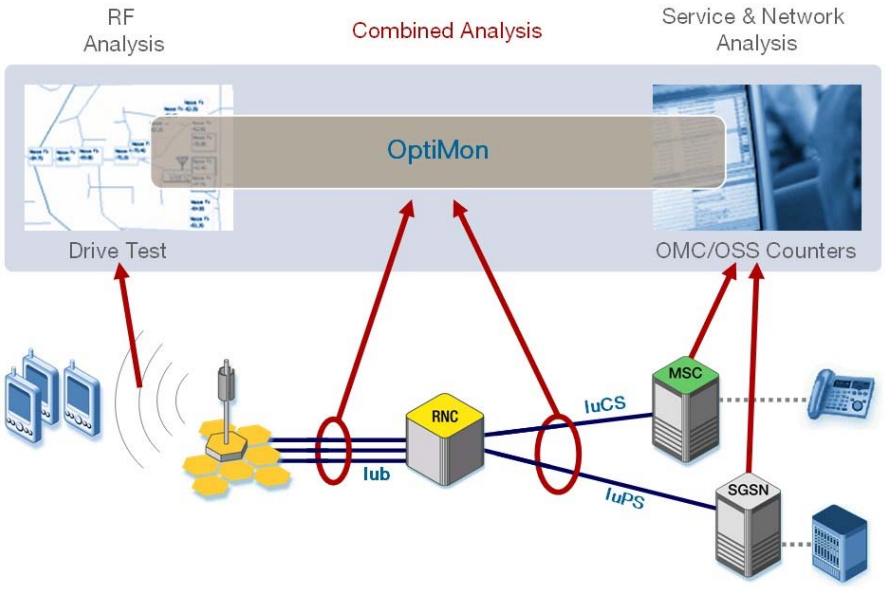


Figure 6. *Extending Network visibility with Protocol Analysis-based intelligence*

Case Study: Drive testing can be reduced by 60%

Despite all the limitations of drive test methodology discussed in this application note, wireless operators still rely on it for these two features:

- All measurements gathered by drive test are geographically referenced.
- The end user experience can be assessed by measuring on the Uu interface.

Network operators can instead gain significant efficiency by focusing the use of drive testing only on those areas where it can play off its strengths. For example, the drive test system can generate calibrated application-level traffic that can be then analyzed by protocol analysis-based solutions on Iub and Iu interfaces. As a result, an effective approach to troubleshooting of data throughput issues has been created.

But for network performance assessments or problem identification, protocol-based optimization solutions are the efficient and effective choice.

In an optimization field trial with a European mobile network operator, the following process was implemented:

- Tektronix' OptiMon, a protocol-based optimization solution, was installed to observe and analyze a larger geographic area.
- The network engineers used this solution to identify and investigate potential problems.
- Drive testing was performed only in cases where the network engineers could not determine the root cause with the protocol-based solution and additional data from the site was required.

The findings from this trial project were very impressive:

Prior to the start of the trial, drive testing was performed regularly according to a predefined schedule. Additionally, on-demand drive testing was done when needed for troubleshooting.

During the project, not only was the regularly scheduled drive testing reduced to (almost) zero, but additionally, the number of on-demand test cases was reduced due to the troubleshooting capabilities provided by OptiMon.

In summary, overall team productivity increased (with faster time to trouble resolution), and drive testing was reduced by almost 65 percent.

Conclusion

Although very effective and widely adopted for 2G/2.5G optimization, drive test is no longer the “all-in-one” answer to 3G optimization challenges. Drive testing is not effective due to its high operating costs, as well as its limiting campaign-based approach – its inability to address all the issues that are generated in 3G radio access network. Wireless operators must redesign their Network Optimization process, relying on protocol-based network optimization solutions for most of the activities and reducing the use of drive test only to specific troubleshooting campaigns and for competitive benchmarking. By doing this, OPEX costs are reduced dramatically, and the QoS “traps” created by misleading optimization techniques are avoided.

Tektronix’ experts are available to demonstrate how OptiMon can increase the efficiency and productivity of network optimization departments while simultaneously reducing drive test costs and improving the end user’s Quality of Experience. In addition, Tektronix provides high-level consulting services to assist network operation and engineering departments in the implementation of test method change, new test tools, and to the organization itself.

About Tektronix Communications:

Tektronix Communications provides network operators and equipment manufacturers around the world an unparalleled suite of network diagnostics and management solutions for fixed, mobile, IP and converged multi-service networks.

This comprehensive set of solutions support a range of architectures and applications such as LTE, fixed mobile convergence, IMS, broadband wireless access, WiMAX, VoIP and triple play, including IPTV.

For Further Information:

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology.

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