Application Note

AEROFLEX
A passion for performance.

A test lab based solution to optimize 3G networks to maximize revenue for data services through good end user Quality of Experience

While voice minutes are predicted to increase, current competitive pressure within the mobile communications market is resulting in a decrease in ARPU. If 3G is to succeed commercially, then network operators have to successfully exploit the capability to deliver data services; itself an important differentiator from GSM networks.

Market analysts predict that an increase in ARPU is possible; this being achieved through the successful deployment of data services. While message based services will

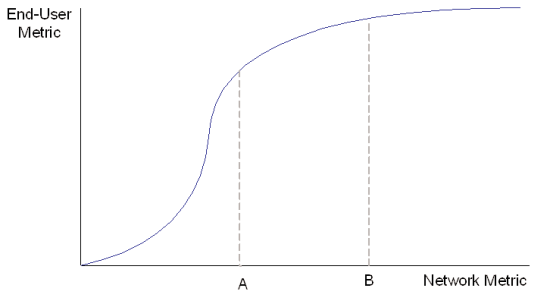
continue to be successful and the ARPU attributable to them will increase, they alone will not make up for the shortfall caused by the erosion of voice margins.

It is unlikely that there will be a single killer application for data services. What is more likely is a wide variety of services, each targeted at specific market segments. Interactive services in particular are believed to be likely to prove attractive to consumers, with the potential to significantly enhance ARPU. However, these will only be successful if the usability and the performance of the service meets a level of acceptability from the consumers' perspective, the 'Quality of Experience'.

However, it is a multivariable problem that must be solved. The different services place a range of different requirements on the network: average data rate, peak data rate, latency and residual error rates. Aeroflex has developed a method to optimize the 3G network to ensure that the network delivers the optimum service performance for the traffic and service mix, thus maximizing the ARPU.

Measuring End User Satisfaction - Quality of Experience

While it is relatively easy to measure the Quality of Service (QoS) within the network, the QoS can provide misleading information. It can be that even though the QoS is 'acceptable', the end user Quality of Experience is actually unacceptable; there exists a non-linear relationship between the network parameters and the user perception of service delivery quality.



Showing the non-linear relationship between network metrics and the end user metric

A more accurate measure of user satisfaction is to measure the end user's Quality of Experience. The ITU has established a precedent where the end user's perceived quality is measured as a 'Mean Opinion Score' or MOS. This was a technique first applied to listening tests used to evaluate voice codecs. Tests were arranged where a number of pre-recorded phrases or sentences were played to individual subjects and they marked them from 1 - 5 for intelligibility. The Mean Opinion Score is quite simply the average of the individual scores.

The advantage of using a simplistic metric such as a MOS is that it is easy to interpret.

The MOS method has also been applied in ITU standards for video and Aeroflex now has a technique that applies it to interactive data services, such as web browsing.

Specifically the technique allows a MOS to be generated automatically on test equipment, without the need for a test subject. Hence it creates a performance metric that is in the perception plane of the user, not a network QoS measure.

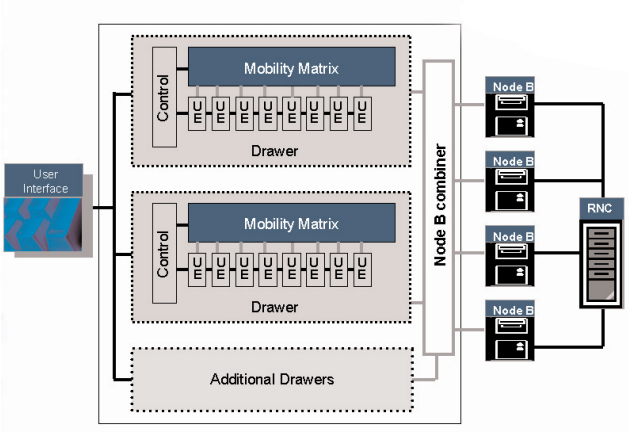
Using the MOS generated for each service and application, an overall Figure of Merit may be derived for the specific scenario. The Figure of Merit is programmable; typically it is used to reflect the revenue that the scenario would generate, or the ARPU. This allows the relative revenue that can be earned from voice and data services to be assessed. There is a danger that an increase in voice minutes as a result of lower prices could lead to packet data services not realizing their revenue potentials on networks that favor circuit switched calls such as voice.

Both the MOS for interactive services and the Figure of Merit can be used within the test laboratory.

Network Optimization by Replicating Real-World Scenarios in a Test Laboratory

Central to our approach for network optimization is the use of the SystemAT. The SystemAT is designed to incorporate commercial mobile phones within an automated test environment. The SystemAT automates voice and data call generation by controlling the mobile phones using AT commands. The SystemAT monitors the test progress and collects comprehensive test log files. The comprehensive logging and data analysis capability provides the information required to make rapid and highly accurate decisions regarding network and user equipment quality of service.

The SystemAT allows multiple calls, of different types, to be made simultaneously. SystemAT has a modular architecture, with 8 mobile phones per drawer and as many drawers as required.



Typical Arrangement of SystemAT

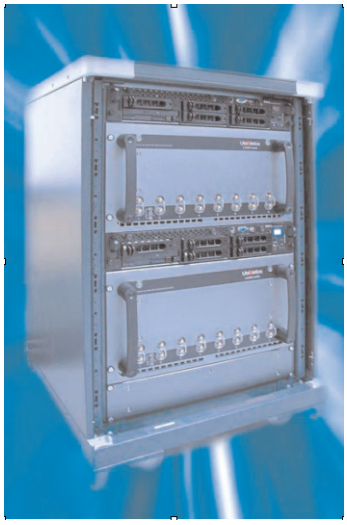
(Note: UE= User Equipment = Mobile phone)

The R.F. attenuators within the mobility matrix are used to control the channel conditions between the mobile phones and the net-

works. The relative locations of the Node Bs are modelled within the SystemAT to create a 'virtual world'. By controlling the attenuators in real-time, the test script for each mobile phone implements a mobility model thus allowing handover to be tested. With the capability of supporting up to 4 Node B's, one or more can be replaced with a GSM BTS thus allowing 2G to 3G and 3G to 2G handover to be tested.

The mobile phones are contained within specially designed drawers that provide power, RF isolation and the centralized control of each mobile phone. As WCDMA networks are performance limited by interference, the RF isolation is critical in accurately evaluating their performance. The mobile phones are controlled using the AT command set: calls can be set up and cleared down, and data transferred under the control of test scripts. SystemAT uses the industry standard test scripting language, TTCN-3.

Being a script controlled test equipment it provides the benefits of being ideally suited to benchmark or regression testing as the test conditions are controlled and therefore repeatable. It also has the advantage that it can be used for testing 24 hours per day, 7 days a week, using a test scheduler to determine which tests are run.



The multi-terminal drawer variant of the SystemAT supports a range of mobile phones. This allows the network to be tested using a representative mixture of mobile phones.

SystemAT supports both circuit switched and packet switched calls. Packet switched calls utilize a packet profiler, which generates the packet data according to the data service (application) profile. The packet and circuit switched calls are controlled by a top-level script that determines the traffic scenario. The traffic scenario can be generated either from traffic models, such as those used to prepare the 3GPP specifications, or from real traffic data gathered from the network. SystemAT will have the capability to generate control scripts derived from live network probe data to reproduce real traffic scenarios in the lab. As signal strength data is available from the Iub data, these scenarios will include full simulation of the actual phone mobility recorded in the probe data log.

The test output from the SystemAT can be configured to provide a range of outputs: simple pass/fail indications for functional testing, network performance KPIs and an end user Mean Opinion Score reflecting the Quality of Experience. A Figure of Merit is generated to determine the overall network performance for the scenario based on the Quality of Experience and hence the usage of the services. This Figure of Merit can be programmed to reflect the business priorities of the network, so that it correlates to ARPU.

The Radio Resource Management (RRM) parameters of the Radio Network Controller (RNC) determine the network's performance for a particular traffic loading. The values of these parameters are easily programmed in software, being accessible via the Operations Management Subsystem or Engineering Terminal for the RNC. Using SystemAT to measure the network Figure of Merit for the specific traffic scenario allows the optimum RRM values to be determined for that scenario. Once the RRM parameters have been determined, they can then be deployed on the network just by updating the RNC database used within the live network.

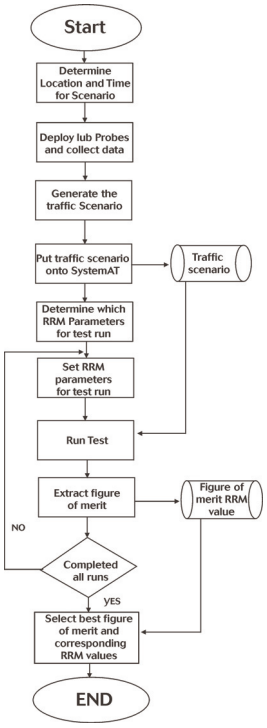
The laboratory based approach is seen as an appropriate means for network optimization:

- SystemAT uses real equipment and scenarios based on live network data and so minimizes any simulation inaccuracies. This is particularly important for a system as complex as a 3G network.
- Experimentation on a live network is risky and results can be difficult to interpret as the traffic mix varies from day to day. Thus a change in network performance that is observed may be attributable to either the change in the RRM parameters or a change in the traffic mix, or a combination of both.

The optimization process will involve the following steps, for each scenario:

- Using Iub probes, the real traffic pattern for the selected location and time of day is captured
- The scenario traffic data is analyzed and a model is generated for SystemAT
- Based on experience, the RRM parameters to be adjusted and their likely range of values are identified.
- The Figure of Merit regime for the network is programmed into the SystemAT
- The traffic scenario is then run for the default settings of the RRM within the RNC and the Figure of Merit value is determined.
- The traffic scenario is then repeated for the different RRM values and the Figure of Merit value recorded.
- The optimum reflects the RRM values for the best Figure of Merit

This approach is summarized in the flowchart that follows:



Aeroflex proposed optimization process

This Approach Has Significant Benefits

By adopting the Aeroflex methodology, operators will:

- Be assured that the service delivery meets the expectations of the end users, that the Quality of Experience meets expectations for all applications and services
- Be assured that the network is delivering the service to the best possible Quality as experienced by customers which will:
  - Increase ARPU as customers will only use services which provide a good Quality of Experience
  - Reduce churn as the network will be providing a higher quality of service than the competitors' nrtworks
  - Allow new services to be launched with the confidence that they can be delivered to meet user expectations. New services can both increase ARPU and reduce churn
- Reduce network optimization costs as drive test can now be specifically targeted at troubleshooting coverage issues and not as the only means of assessing service delivery performance
- Explore trade-offs between network capacity and quality
- Determine the effect on end user Quality of Experience as a result of 3G to 2G handover
- Be able to re-optimize the network as new services are added
- Be able to re-optimize the network to reflect changes in traffic
- Be able to determine optimization settings to ensure network stability and operation during emergencies
- Be able to test graceful degradation strategies to deal with congestion
- Be able to determine and test fallback scenarios to deal with fault conditions
- Gain the assurance that the network equipment and its setup is stable under a variety of real equipment load conditions
- Be able to assess the impact that a different mix of mobile phones will have on optimum system operation

Aeroflex - leaders in 3G network test

Aeroflex is acknowledged as a world leader in 3G network test equipment; the test mobile products being the de-facto standard for the air interface testing of Node Bs supporting both WCDMA and HSDPA. A HSUPA variant is currently under development. This knowledge has been applied in the wider network to provide SystemAT for extensive network performance and functional testing, which was specifically developed using the experience gained from testing new UMTS products.

Customers are supported by a dedicated team of Field Applications Engineers, who are experts with both test equipment and the 3GPP UTRAN specifications. The Field Applications Engineers are able to call upon additional expertise within the engineering development teams if needed.

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AEROFLEX
A passion for performance.

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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.

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