WCDMA versus GSM: handset performance testing

While WCDMA technology may be on the brink of widespread rollout, its successful commercial deployment is gated upon the availability of wireless handsets that can provide a user experience that exceeds current GSM products. WCDMA test solutions must characterize the performance breakpoints of the all-new air interface technology, as well as evaluate the device's performance over a wide range of representative scenarios.

By Rob VanBrunt

Wideband Code Division Multiple Access (WCDMA) technology is on the brink of widespread rollout. This technology will initially complement and then eventually replace current Global System for Mobile Communications (GSM) systems as the mostly widely deployed air interface technology in the world. The successful widespread commercial deployment of WCDMA is gated upon the availability of wireless handsets that can provide a user experience that exceeds what is currently offered on the GSM networks. Legacy GSM handset test methodology was focused on conformance tests used to validate the underlying components of the air interface technology. However, the successful launch of WCDMA services will require a more progressive, integrated approach to evaluating the performance of WCDMA user equipment (UE). WCDMA UE test solutions must characterize the performance breakpoints of the all-new air interface technology, as well as evaluate the device's performance over a wide range of scenarios representative of the user's experience. Using the proper performance analysis solutions can reduce time to market and ensure customer satisfaction.

As was the case with GSM, the rollout of the WCDMA air interface technology is gated upon the availability of handsets that both interoperate with network infrastructure and provide a level of performance that ensures a satisfactory user-experience. In addition, the deployment bar has been set higher for WCDMA, as an abundance of mature GSM user services and third-generation (3G) hype have raised the market's expectations. Couple these factors with a more complex UE development process and increased pressure to shrink time to market and it becomes apparent that UE developers and network operators must look for new, innovative ways to optimize product development and launch.

Handset development phases

Over the last 10 years, wireless handsets have evolved from voice-only telephony devices on proprietary platforms to voice and data-capable devices implemented on open mobile computing platforms possessing high-speed wireless connectivity. The development process used to realize and launch wireless devices has also grown more complex and distributed.

As shown in Figure 1, the development of a mobile device undergoes many overlapping stages.

Each stage has unique requirements for design verification and performance analysis tools. At a high level, these stages can be grouped into four phases: core platform development, product realization, product deployment and optimization, and application development.

Core platform development: This phase is either executed in-house from the ground up by a handset manufacturer or is performed by a third party technology provider that supplies turn-key reference designs. In either case, this phase includes the specification and implementation of the handset's physical layer (Layer 1) transmission scheme and access stratum call processing stacks (Layer 2 and Layer 3). The core platform development does not usually include the handset's final physical form factor or the user interface.

Product realization: Regardless of whether the core platform development was home grown or outsourced, handset manufacturers build a wide product portfolio of handset models leveraged on this underlying platform.

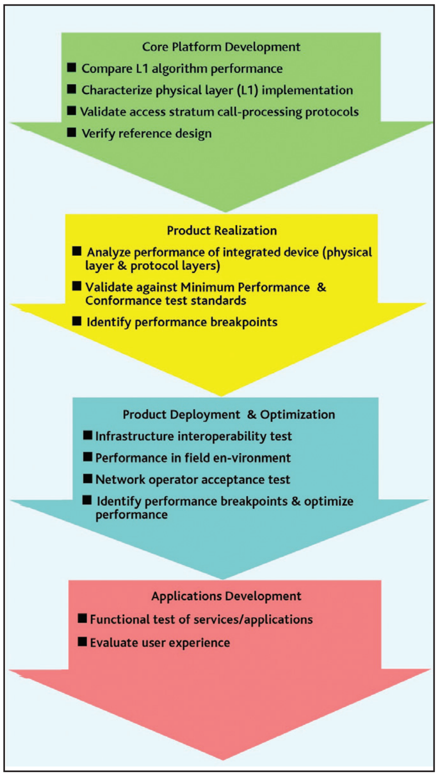

Figure 1. Performance analysis phases during UE product development.

Thus, the core platform undergoes a one-to-many transformation as it is used as the basis for a range of low to high-end devices, as well as devices targeted at specific geographic markets. The final form factor and specific user interface is implemented in this phase. During this phase handset manufacturers perform lab-based parametric and functional verification of the integrated handset to internal specifications and self-testing to industry minimum performance/conformance standards.

Product deployment and optimization: As a specific handset model approaches its launch date, a large suite of tests is performed both in the field and by third parties. This includes interoperability tests with infrastructure manufacturers, conformance validation to 3GPP specifications by independent test labs, and acceptance tests by network operators. During this phase, handset manufacturers optimize the performance of the device by adjusting physical and signaling layer characteristics based on analysis of the handset's performance in various test and user scenarios.

Application development: This is a relatively new phase in the handset product life cycle as mobile devices now feature an open platform on which third party applications, such as interactive gaming, can run. This phase plays a prominent role in the end-user's satisfaction with the handset as applications and user services are a key differentiator for manufacturers and network operators. This phase typically runs in parallel with the earlier three phases. Applications are developed and evaluated by original equipment manufacturers, third-party software application developers, and network operators.

WCDMA versus GSM

Although the GSM mobile development process has evolved over the past decade, it is important to compare the processes at the inception of each technology to have an appreciation of the challenges facing WCDMA deployment today. When the initial wave of GSM handsets appeared in the early 1990s, the product realization and performance analysis requirements were much different than today's WCDMA UE product development cycle.

Initially, underlying GSM handset hardware and software was developed for specific handset models rather than for generic platforms and, thus, the end-to-end product development process was much simpler and more centralized. A far smaller range of models was expected in the market.

Today's network operators demand a wide range of models to address markets spanning from the adolescent to high-end corporate user. There is a strong focus on accelerating time to market as devices have a much shorter shelf life since handset styles and features change as quickly as fashion trends.

The GSM air interface standard was created with voice as the primary application. WCDMA, on the other hand, includes support for voice, high-speed packet data, and multimedia applications. These applications are employed on a wideband-CDMA-based air interface and a completely different radio network. The UMTS specifications are orders of magnitude more complex than the GSM standard with the support of new applications and a new WCDMA radio network engineered for 3G.

The underlying WCDMA air interface is much more performance sensitive and its operation shares many more similarities with its rival CDMA2000 than its predecessor GSM. To achieve link-level performance gains over GSM's equalization and frequency hopping techniques, WCDMA uses rake receiver technology for diversity gain. The ability of the rake receiver to mitigate multipath interference and to perform soft-handovers must be evaluated over a variety of real-world conditions.

Overall WCDMA system capacity, a critical metric for network operators, has a soft limit dependent on interference levels and interference mitigation. WCDMA employs a fast power control scheme — 1500 Hz on both up and downlink — to deal with CDMA's inherent near-far interference issues. GSM, which features a hard capacity due to its fixed frequency reuse scheme, employs a very slow (2 Hz) power control scheme. Thus, finding the key performance breakpoints of the WCDMA air interface implementation has a direct correlation to WCDMA system capacity and network operator revenue.

With fewer features and a smaller number of infrastructure vendors, initial GSM interoperability tests required a smaller scale of test scenarios prior to launch. WCDMA's complex "future-proof" air interface standard allows many different ways to perform similar mobile functions, greatly increasing the change for signaling interoperability mismatches between handset and infrastructure.

Finally, early GSM handsets were built on a closed platform that did not allow the range of complex, high-bandwidth services and applications expected to be deployed on today's multimedia mobile devices. But over the years, a wide variety of mature user services have been deployed on GSM networks. WCDMA must initially, at least, equal and eventually exceed the services and performance available on GSM networks to accelerate subscriber adoption.

While the respective initials launches of GSM and WCDMA share common trials and tribulations, the WCDMA design verification and performance analysis process must evolve to meet today's market requirements.

WCDMA performance analysis evolution

To meet the complex challenges associated with the deployment of WCDMA services, the development and design verification process for WCDMA UE's must evolve in several key ways.

Integrated test approach

Given that today's more complex handsets must reach the market faster with fewer issues, it is critical to employ an integrated approach to device verification during the product development lifecycle. It is highly desirable to push design verification as far back into product development as possible. This way design issues can be uncovered earlier and with less negative impact.

Since the overall design process has become more distributed across geographic locations, it is highly desirable to share common test tools between development and deployment stages and user groups to align test plans and results analysis. This also enables product evaluators further downstream in the cycle, such as network operators, to share test conditions and results with design engineers looking to recreate problems and to optimize product performance.

Commercial test solutions offer significant

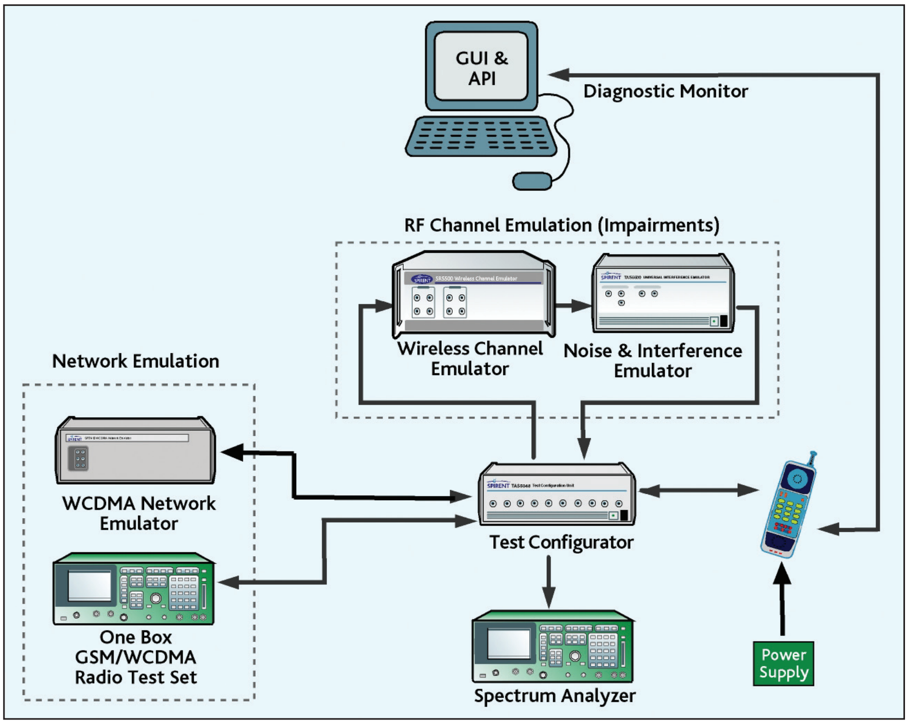

Figure 2. WCDMA integrated test system configuration.

advantages over unique, home-brew solutions. Commercial solutions can be easily replicated across development sites and between companies. To be effective, integrated test systems must include the key components shown Figure 2, enable manufacturers and network operators to focus their attention on analyzing product performance rather than developing unique custom test solutions.

Complementary mobile diagnostic monitoring tools are also useful to capture a handset's detailed performance metrics during both lab and field tests simplifying the comparison of test results.

Inherent to utilizing common solutions across the product development cycle is that a wide range of users with unique areas of expertise will need to be able to operate the tools. Legacy GSM conformance test systems based on complex scripts require extensive protocol knowledge to operate and create new test scenarios.

These systems typically only address one phase (such as the signaling protocol test) of the overall test requirement, making them inefficient and expensive. Next-generation WCDMA test systems address parametric physical layer performance analysis, as well as functional performance analysis of signaling protocols and user services.

Performance analysis

As discussed earlier, the WCDMA air interface is a much closer relative of CDMA2000 than it is to GSM. Both CDMA2000 and WCDMA employ CDMA technology that is highly performance sensitive. The evaluation handset characteristics such as rake receiver performance in the presence of dynamically changing multipath delay spread, or the transmitter's ability to respond rapidly to power control messages, is critical to predicting real-world performance. The ability to pass the minimum performance criteria outlined in conformance standards merely serves as a common baseline for qualifying potential handsets.

Network operators are concerned with predicting the quality of the end user's experience and with overall network capacity. These metrics require the handset to be evaluated past the specifications found in conformance standards to identify performance breakpoints under representative real-world conditions.

While systematic evaluation of each layer of the handset implementation is part of a structured test methodology, the functional performance of a handset must be analyzed, as well.

While voluminous, WCDMA conformance test specifications do not specify how the user interface of the handset should react to a call-waiting event, or how to display an incoming SMS message. Conformance test specifications cannot predict the latency of interactive gaming conditions under harsh mobile environments. However, these are critical elements of user/handset interaction that directly affect subscriber satisfaction.

Once the WCDMA industry is able to achieve basic interoperability and the air interface begins to mature, the focus will quickly shift to more extensive test methods to evaluate the functional performance of handsets from a user's perspective.

Test automation

More thorough testing prior to deployment, and a reduced time to market, are competing objectives that handset manufacturers must try to optimize in union with one another. Analyzing each of the individual layers of a handset implementation past minimum performance requirements generates a multitude of test scenarios. Functional testing is essential to verifying how the layers interact in user scenarios, but also makes the required test campaign grow even larger.

As handset model turnover rate increases, the market window for a given handset design is shrinking. A handset launched several weeks late can have a negative impact on the handset manufacturer in the order of millions of dollars or Euros. To accelerate the launch of new handsets, manufacturers and network operators must take advantage of the tremendous efficiencies made possible through the use of test automation.

Test automation enables tests to be launched and executed without the need for user intervention. This enables efficient use of valuable test equipment and human resources. Tests can be run 24 hours a day, seven days a week, to ensure maximum test coverage.

In addition to automating test execution, next-generation, integrated test systems automatically handle the translation of test settings into instrument settings, calibration and verification execution, and report generation and analysis.

To fully benefit from the gains possible through automation, the burden of handset control must also be removed from the user and be performed by the host system controller. Test platforms that enable flexible and powerful handset interfacing, also know as an *application programming interface* (API), enable keystrokes to be automatically emulated to initiate mobile-originated actions while simultaneously monitoring handset performance.

Conclusion

Given market expectations and the sophistication of the technology, WCDMA manufacturers and network operators are facing challenges much greater than experienced during the initial rollout of GSM service.

WCDMA handsets and their associated product development processes have increased in complexity and product launch windows are shrinking. In addition, advanced multimedia services have created an enhanced expectation of user experiences. To optimize the product realization process and to accelerate deployment, manufacturers and network operators must evolve their test methodology.

Using integrated, automated test solutions focused on performance analysis will enable more comprehensive evaluation of the end user's experience while still meeting time to market expectations.

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ABOUT THE AUTHOR

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VanBrunt joined the company in 1990. During his tenure with Spirent, VanBrunt has held several positions within the organization, including director of business development, and product development manager. Van Brunt has written numerous trade articles on the advancement of wireless technology, including 3G technologies such and CDMA2000, and WCDMA.

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