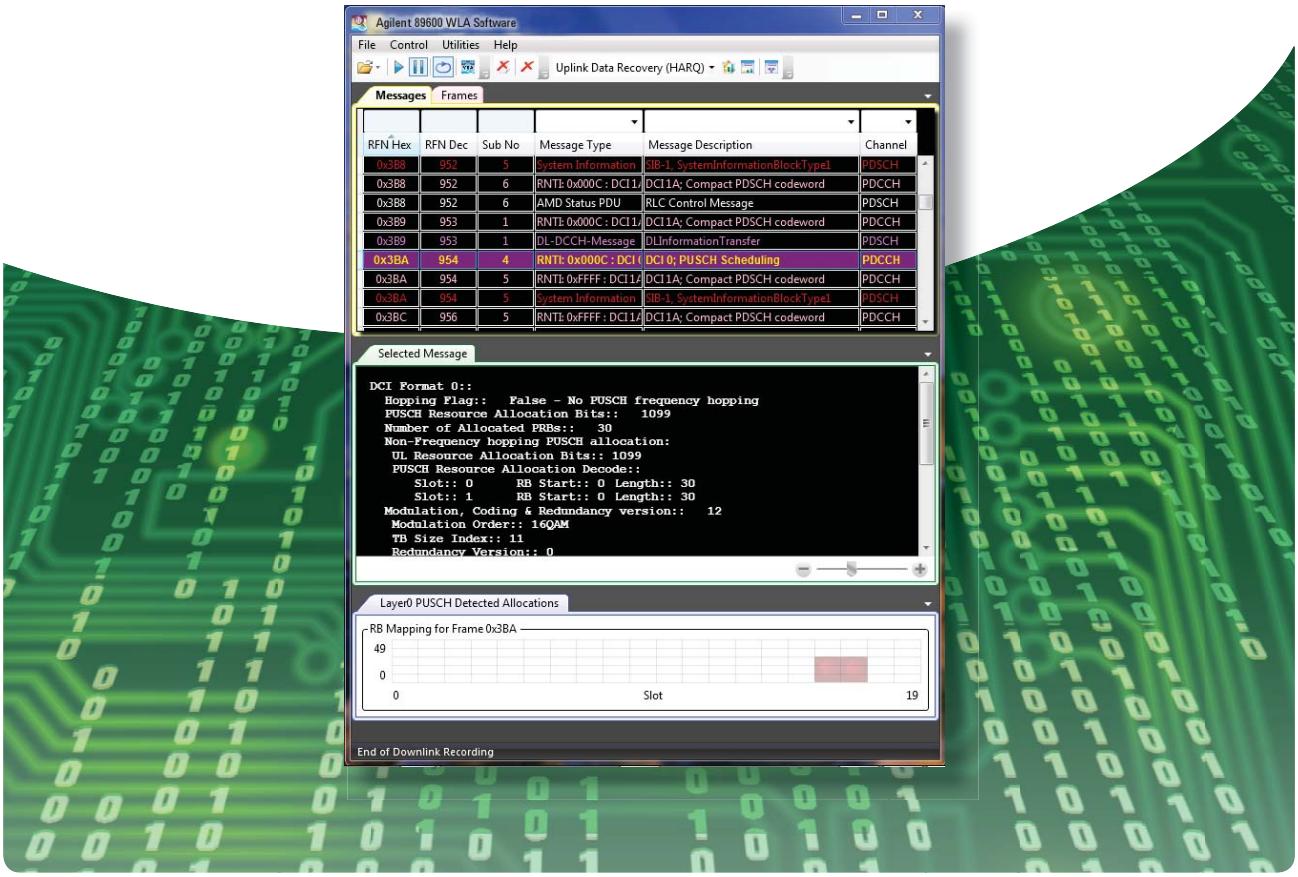
Gaining Deeper Insights into Dynamic BTS/UE Signals with Wireless Link Analysis Agilent 89600 WLA Software

Application Note



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For system-integration engineers and verification engineers, troubleshooting new BTS and UE designs will only get tougher as wireless standards become more advanced. Within standards such as LTE, the biggest challenges stem from the complex interactions between the physical (PHY) and media access control (MAC) layers during signaling operations.

Those who typically work at the PHY layer tend to rely on two tools of choice: signal analyzers such as the Agilent PXA (N9030A) and vector signal analysis software such as the Agilent 89600 VSA. As a complement to the 89600 VSA, Agilent has created the 89600 wireless link analysis (WLA) software.

Wireless link analysis correlates control messages with the wireless links they manage, giving PHY-savvy engineers greater visibility into the autonomous MAC-layer messaging that occurs between devices. In both system integration and verification the ultimate benefit is a deeper level of insight that accelerates day-to-day troubleshooting and ultimately improves time to market.

This application note provides a brief look at four key topics: link operation, wireless link analysis, a graphical approach to WLA, and dynamic measurements. It also presents an overview of additional capabilities specific to the analysis of LTE devices.

Sketching the Dynamics of Link Operation

In LTE, at least six different control loops are used to manage the radio link between a base station and a mobile device. These loops often interact as they deal with power, timing, modulation, transmission mode and retransmissions in both the downlink and uplink channels. The information needed to manage these control loops is stored in the downlink signal, starting when a connection is established between a BTS (e.g., an eNB) and a UE, and continuing while data is transferred.

During integration and verification, simultaneous testing of the RF, baseband, and control functions can be challenging due to the inherently dynamic nature of advanced wireless signals. If the processes are not fully evaluated and analyzed, the performance in a live system may be affected, resulting in unexpected variations between devices from different vendors. If problems are discovered later in the field, additional time and money will be expended as one or more engineers develops patches, workarounds or fixes as quickly as possible.

Understanding Wireless Link Analysis

As implemented in the 89600 WLA, wireless link analysis decodes control messages and correlates them with the PHY-layer signals they manage (Figure 1). This provides greater visibility into link-layer communication and leads to greater insight into unexpected behavior.

The key benefit is the ability to view and interpret RF measurements- power, modulation format, timing, and so on- in a MAC-message context, and to view and interpret MAC messages in an RF context.

For example, it's one thing to know the UE is transmitting a PUSCH signal across 15 resource blocks (RB) at +25 dBm; it's another thing altogether to match this against MAC-layer commands and then discover the device was told to transmit at only +23 dBm. This type of low-level control tends to be embedded deeply in the system and it operates with a high degree of autonomy. As a result, one of the only ways to observe and monitor link behavior is through combined PHY/MAC analysis.

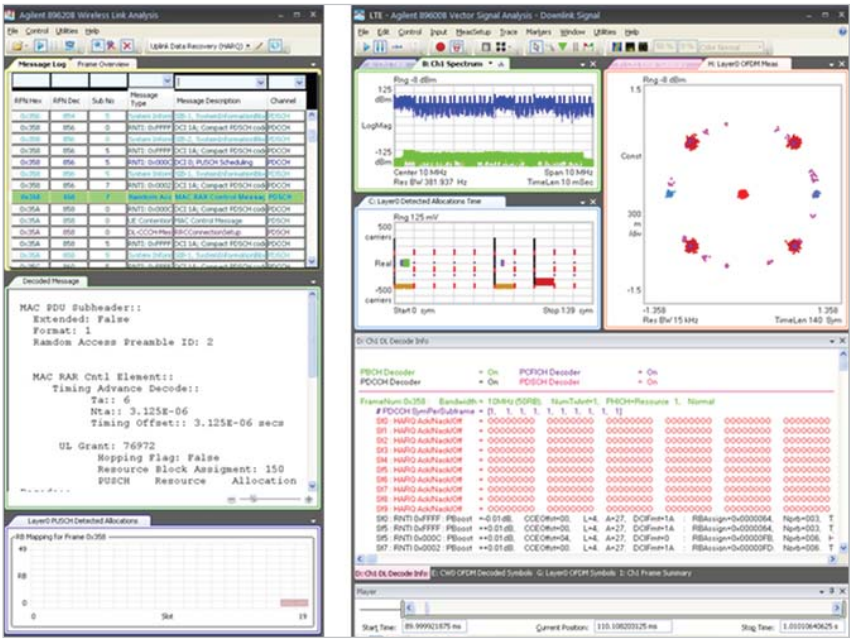

Figure 1. The decoded message in this 89600 WLA example shows a timing offset of 3.125 µs extracted from the MAC RAR control message.

Visualizing an Effective Approach

The ideal way to assess dynamic problems is to present information graphically. This approach enables fast identification of anomalies, even if you aren't expecting to see a problem—and especially if you aren't yet an expert in signaling protocols. As an example, display markers that are coupled across separate measurement traces allow immediate correlation between the timing of a problem and its location in a captured signal.

Once a problem is identified visually, detailed analysis will help reveal the cause of the suspect behavior. The debugging process is faster and more effective when you and your team members- co-located or geographically dispersed- can share the original I/Q capture and high-level data (in smaller file sizes). Issues can be logged and included in future verification tests.

Making Dynamic Measurements

Testing starts by verifying the operation of control processes, and these should be set up and running as expected when the channel is fixed and unimpaired. It's important to verify this state because the numerous options in link configuration- and their dynamic nature- can mean operating states are not reset or modified as expected.

In LTE, the radio system is designed to operate with high levels of packet error, relying on the use of multiple simultaneous low-latency retransmission processes called hybrid automatic repeat requests or HARQ. If the system is error-free, then the processes should cycle around without interruption.

Built-in tracking algorithms in the 89600 WLA allow immediate assessment of the operation of HARQ retransmission processes. Figure 2 shows data transferper HARQ process on a time (frame number) axis. The measured signal was assumed to be good; however, the various lines represent individual HARQ processes and the deviations in several of the lines would alert you to an unsuspected problem.

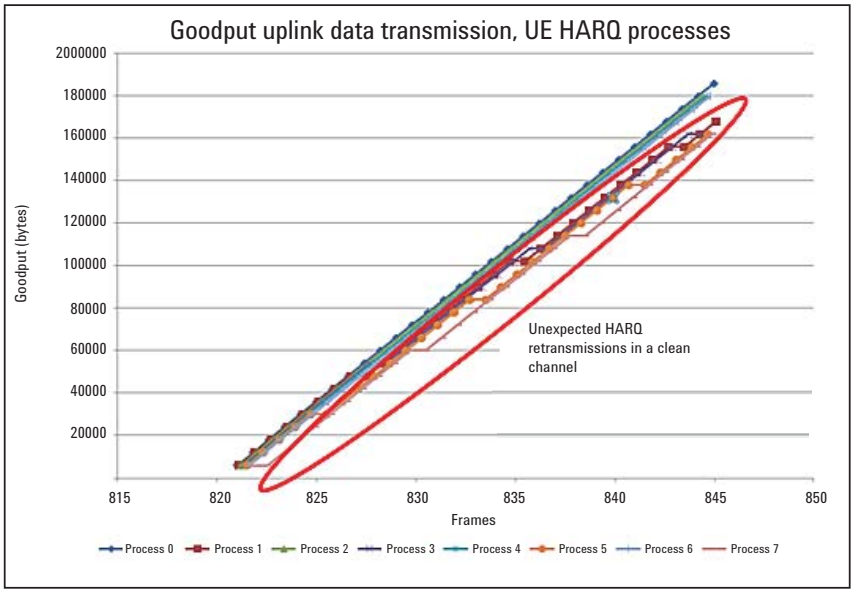

Figure 2. The 89600 WLA includes a HARQ process monitor that quickly highlights if and where retransmission processes are occurring. Markers on the trace provide immediate correlation with the original signal.

These capabilities are also relevant in 3GPP certification testing, which involves the use of randomly faded channels that approximate the various scenarios end-user customers may encounter in actual operation. Testing at this level conceals much of what is happening in the radio. Simpler tests to assess and correct the response of individual control loops will build confidence that the measured performance accurately represents what a mobile device or base station is capable of when deployed.

Exploring Additional Capabilities

Specific to LTE, the 89600 WLA includes additional capabilities that enhance the analysis of new devices:

- Extends the LTE FDD and TDD analysis capabilities of the 89600 VSA
- Performs multi-layer decoding
- Produces graphical displays of control loop activity
- Provides display and location of cyclic redundancy check (CRC) failures

Let's take a closer look at each of these.

Extending FDD and TDD analysis capabilities

The 89600 WLA builds on the hardware-connectivity and signal-capture capabilities of the 89600 VSA. As a result, new or existing I/Q signals can be immediately analyzed.

The 89600 WLA includes default configurations that enable a new user to get initial results quickly—but these don't limit the viewing options expected by an experienced user. For example, a mix of displays can be easily created: spectrum, constellation, detected allocations, decoding information, and more.

Performing multi-layer decoding

Multi-layer decoding reveals information hidden within the upper-layer messages that determine the detailed format of RF-level signals. The 89600 WLA has a built-in ANSI compiler that allows decoding and display of the information contained in base-station signaling.

The compiler also enables message filtering and tracing of essential information passed between the eNB and a UE as they try to establish a connection. This includes recovery of the settings used for uplink transmissions. As an example, capturing the RF signal around the initial synchronizing signals (e.g., the PRACHI) makes it possible to recover an ample amount of information, even when working with short time records of ten radio frames or fewer.

Visualizing control loop activity

LTE is a dynamic signal that requires equally dynamic signal analysis. For example, downlink control information and HARQ reports can change with every subframe. That's why the 89600 WLA provides user-configurable plotting of changes in the 20 or more downlink control parameters, and this allows rapid identification of slow or unexpected responses.[1]

Locating CRC failures

CRC failures provide a top-level confirmation of the makeup of an encoded signal. These are as meaningful to a baseband developer as EVM is to an RF engineer. The 89600 WLA supports direct graphical plotting of failures and uses spreadsheet filtering to locate and identify the cause.

1. *Plotting requires Microsoft® Excel 2007.*

Conclusion

Advanced wireless systems depend on efficient operation of autonomous control loops that manage BTS/UE interaction. The extraction of useful information from complex link activity is greatly simplified by the combined capabilities of the 89600 VSA and the 89600 WLA.

With its graphical approach to testing and analysis, the 89600 WLA provides views that reveal the myriad details of link operation. The net result is a quick and effective way to enhance device evaluation earlier in the development process, ultimately ensuring the creation of robust, efficient designs that get to market faster.

If you're already familiar with the 89600 VSA, you can add wireless link analysis to your existing test setup with a minimal investment of time or money. Expanding your toolkit with 89600 WLA lets you see inside the link and provides a more complete picture of MAC/PHY interaction.

Try before you buy!

Download the 89600 WLA software and use it free for 14 days to do analysis along with 89600 VSA and your analysis hardware, or explore the software in greater detail with our recorded Help signals by selecting **File > Recall > Help>** on the 89600 WLA software toolbar. Request your free trial license today:

www.agilent.com/find/89600_WLA_trial

Related Resources

Literature

Agilent 89600 WLA Software, Technical Overview
Literature number 5990-9178EN

Agilent 89600B Vector Signal Analysis Software, Brochure
Literature number 5990-6553EN

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