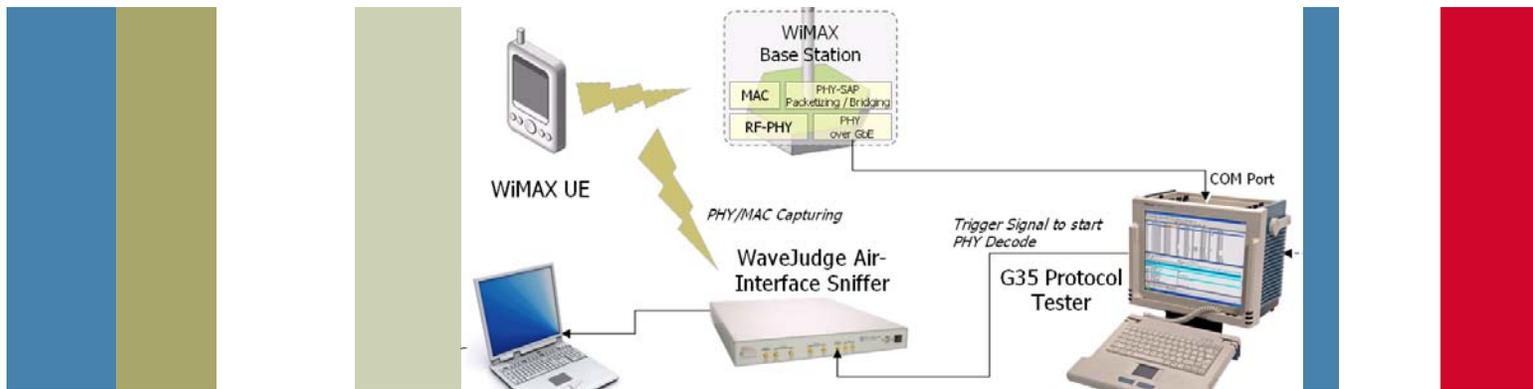


# Multi-Interface WiMAX R1 Protocol Analysis with Tektronix G35 and WaveJudge 4800



## Decoding R1 Traffic with a Multi-Interface Approach

Verifying the correct function of the air-interface is a key issue in any type of Base Station (BS) testing. In the case of Mobile WiMAX, test engineers must not only be able to analyze the Physical (PHY) and Medium Access Control (MAC) layers of the R1 interface, but also all MAC Management messages specified in IEEE 802.16e, that is, the control-plane messages exchanged between the Mobile Station (MS) and the BS.

Test engineers are able to analyze multiple layers of the air-interface by using appropriate monitoring devices such as the WaveJudge from Sanjole. However, real-time monitoring is not available yet in the market due to the large gap between capturing traffic and actually decoding it. Since storage space for captured I/Q samples is also limited, it is a challenge for test engineers to trigger the R1 I/Q sample processing for just the WiMAX procedure of interest.

As outlined in this solution note, combining the G35 protocol analyzer with the WaveJudge air-interface sniffer provides the ideal solution to solve this “synchronization” issue. Additionally, by decoding air-interface traffic provided via a BS mirror port, the G35 is able to compare traffic decoded by the air-interface sniffer with traffic actually received at the BS and may detect PHY layer issues which would go undetected when using only a BS mirror port for monitoring.

### Issue:

The failure of a particular WiMAX procedure over the R1 interface may be caused by PHY layer issues. Current air-interface monitoring tools limit the number of physical layer frames that can be decoded at any time. Therefore, a key issue is:

- How can the PHY layer be decoded for exactly the WiMAX procedure of interest?

### Solution:

- The G35 monitors R1 traffic over a BS mirror port or traffic over any other WiMAX interface (e.g. R6).
- G35 provides a trigger to the WaveJudge when a procedure of interest occurs.
- After reception of the trigger signal, the WaveJudge starts processing the I/Q samples.

### Merits:

- Air-interface decoding can be performed for the WiMAX procedures of interest, e.g. for the handover procedure.
- BS R1 traffic processing issues can be detected by comparing air-interface traffic from the sniffer device with traffic received via a BS mirror port.

## Combining the G35 with the WaveJudge for Deep-Level R1 Protocol Analysis

One method for monitoring the traffic on the R1 interface is to use a mirror port on the BS. Some BS chipsets have the ability to duplicate any inbound and outbound MAC-layer traffic from the R1 interface onto a dedicated Ethernet port (for example, Gigabit Ethernet). This traffic can then be decoded by an external protocol tester, such as the Tektronix G35 (Functional Tester) and the Tektronix NSA (Monitor). This requires, however, a well-specified PHY Service Access Point (SAP) which describes in detail the interface for transporting the MAC-layer information onto the Ethernet transport.

Even though this approach provides visibility into R1 procedures at a level that would be difficult to achieve otherwise, not all error cases can be covered by this solution. Many errors may occur, for example, at the PHY layer. As an example, only a portion of a more or less large number of MS may be able to complete the ranging procedure with a WiMAX BS, due to physical layer issues. In other words, scenarios could occur whereby the WiMAX BS would not detect the presence of MS requesting to 'range', and thus, related MAC management messages would not be visible on the protocol tester. The test engineer would not see that PHY layer errors occurred. Therefore, a comprehensive test solution needs to also provide visibility into the physical layer aspects of the R1 interface, in addition to the MAC management messages being exchanged between MS and BS.

The full PHY/MAC layer can be captured "Over The Air" by using dedicated monitoring devices, for example, an air-interface sniffer such as the WaveJudge 4800 from Sanjole. Air-interface sniffers have the ability to capture RF and therefore provide PHY layer information as well as provide visibility into upper layer MAC and IP protocols. This is done by down-converting the RF signals to baseband I/Q samples and forwarding these to a client running the WaveJudge application. In this case, the decoding of the PHY, MAC and IP layers are possible along with the ability to correlate any eventual lower layer anomalies with potential upper-layer connection issues.

The decoding of the PHY layer is a computationally intensive task. This is the reason why air-interface sniffers are typically able to decode a limited number of physical layer frames, for example, in the range of 3 to 10 seconds. While 'raw' air-interface related data is constantly being written into the sniffer's internal buffer memory, actual captures of the PHY layer takes place once specific triggers have been activated. In today's WiMAX market for air-interface sniffers, a real-time chipset which can support sophisticated triggering related to upper layer message content is not available. Instead, only simple triggers such as power level and CDMA code recognition are available. Procedures such as network entry can be captured provided that such a CDMA code is sent prior to ranging.

Since over-the-air sniffers cannot detect upper layer messages in real time, a more sophisticated approach is required in order to capture critical PHY layer data during upper layer events such as BS-BS handover, ranging success messages, HCS or CRC errors. A solution can be provided by combining the usage of the WaveJudge 4800 with the G35 protocol tester. This combination is highlighted in Figure 1 (on page 3).

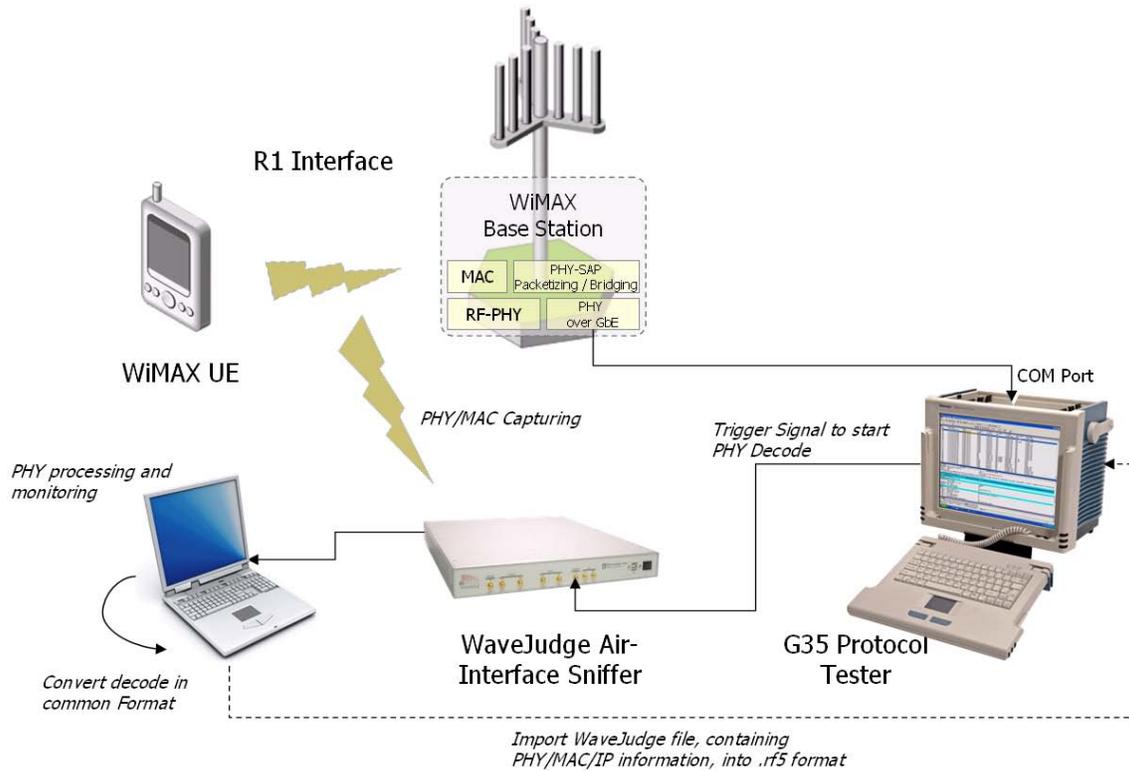


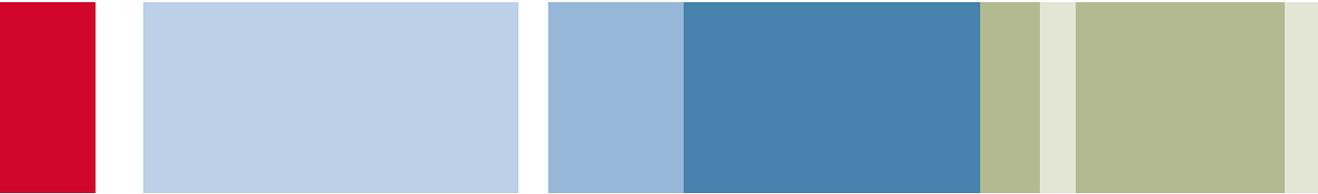
Figure 1 – Combining Air-interface sniffer with G35 protocol tester

Here, the G35 takes over the task of decoding the MAC layer, and particularly the MAC management messages. The protocol tester itself is connected to the WaveJudge sniffer via a dedicated cable, which enables the G35 to connect via a RJ-45 serial port to an SMB connector on the sniffer device. Based on the test engineer's configuration, the G35 can detect the MAC management message of interest via the BS's mirror port, and issue a trigger to the sniffer which would notify the WaveJudge to start capture of RF traffic. This would allow capturing of traffic at the correct time and thereby allow PHY/MAC and IP layer decoding.

Various types of triggers can be configured on the G35; these can be certain PHY or MAC management messages or certain parameters and parameter values within messages (e.g. RNG-REQ->Ranging Status=Success). A particularly useful approach is to define a trigger based on MAC header checksum errors, which presumes that some transmission errors occurred over the air-interface.

G35 can read the traces created by the WaveJudge. This way, the traffic decoded by the sniffer can be compared with the traffic decoded by the G35, and any discrepancies, such as certain ranging messages not being decoded by the BS, can be detected.

An issue that obviously needs to be resolved is the timing delay between a MAC management messages being received by the G35 from the BS until the sniffer starts decoding these messages. The WaveJudge internally buffers the incoming raw PHY data, and the user can determine, taking the trigger signal as reference, how many milliseconds before this reception the sniffer should start with the decoding operation. This timing delay can easily be determined by comparing the timestamps of messages decoded by the G35 with the timestamps of equivalent messages which have been decoded by the air-interface sniffer.



In addition to triggers for the R1 interface, the G35 can also provide triggers based on events occurring on any other WiMAX interface, for example, the R6 interface. This allows this concept to be used also in cases when a mirror port is not available on the WiMAX Base Station.

The innovative approach described in this paper, which combines the strengths of a protocol analyzer such as the G35 with the RF processing capabilities of the Wavejudge air-interface sniffer, allows BS vendors to easily detect PHY layer processing issues at the base station that would otherwise go undetected.

#### About Sanjole

Sanjole is a leader in LTE and WiMAX testing with expertise in innovative wireless technology. Sanjole provides problem solving capabilities from inside the wireless network through over the air analysis tools that provide visibility into events spanning multiple layers. Sanjole has been involved from the very beginning of WiMAX as a test vendor in the first plugfests for both fixed and wireless devices. Our work with the WiMAX Forum, 3GPP and extensive experience in interoperability trials gives Sanjole deep insight into the complex technical issues specific to the LTE community.

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#### About Tektronix:

Tektronix has more than 60 years of experience in providing network operators and equipment manufacturers a comprehensive and unparalleled suite of network diagnostics and management solutions for fixed, mobile, IP and converged multi-service networks.

These solutions support such architectures and applications as 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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