Technique For Reducing Mobile Device Transmitter And Receiver Test Time

This article is first in a series of quarterly guest columns by Justin Panzer, manager of product marketing, Rohde & Schwarz.

The cellular phone has increased dramatically in terms of complexity, from its origin as a device that transmitted and received signals by employing a single analog modulation technique over a single range of frequencies. While phone features and capabilities have grown exponentially since then, the price consumers expect to pay for a basic phone has remained the same, and the cost of even the most feature-intensive devices must remain affordable. Faced with this situation, carriers turn to phone manufacturers to reduce cost, and they in turn place increasing pressure on component suppliers. The cost of testing each phone remains problematic, since the RF performance of every phone must be checked and the transmitter and receiver must be calibrated. Reductions in the time required for calibration have been steadily achieved over the years, but a new approach, known as Smart Alignment, can reduce the time required to calibrate a quad-band GSM phone from thousands of seconds (using commonly-accepted methods) to a few hundred seconds, while simultaneously increasing the points at which measurements are made.

Reductions in device test time that are significant to a mobile phone manufacturer would probably seem miniscule to someone outside the industry. This is because a complete set of transmitter alignment tests, for example, requires less than 4 seconds to complete. However, reductions in test time are like compounding of interest: a little adds up to a lot over time. For example, a mobile phone manufacturer might typically send 5,000 phones (in board form) through this test in a given day, so a savings of 1 second per phone yields a daily test time reduction of more than 83 minutes, in which time more than 1,200 additional phones could be tested. In addition, a phone receiver must be tested, and Smart Alignment produces even greater test time reductions for receiver testing. This article will describe the Smart Alignment approach and compare it with traditional mobile device test methods, in order to see how its benefits are derived.

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Traditional Test Techniques

Devices destined for networks that employ a specific standard such as GSM, UMTS, or CDMA2000 must meet a wide array of technical specifications before they reach the consumer. The specifications governing each wireless standard set forth a comprehensive series of tests that cover how phones perform under a variety of operating conditions. Phones must meet the specifications dictated by a network standard and must be compatible with other devices used on the network. They must also meet criteria established by the carriers themselves, which adds another level of complexity. Most of these criteria are satisfied during development of the product through verification testing, which is the most complex type of test procedure and covers all aspects of phone operation. Fortunately, verification testing is not performed on every phone, but rather on a select sampling of phones in production. However, the transmit and receive functions of every phone must still be evaluated through a series of tests of various types.

The classic method in which these alignment tests are performed requires a large amount of communication between the device under test (DUT), a controller (usually a PC), and the test equipment, which typically consists of a vector signal analyzer and vector signal generator or a “single-box” solution, in which both instruments are combined. The described method for adjusting transmitter power is shown in *Figures 1* and *2*. In this approach, the controller sets the phone and instrument to a specific transmit channel, the phone is commanded to transmit power at a specific level, and the power level is measured by the test equipment. This procedure is repeated on numerous channels at numerous power levels for each device.

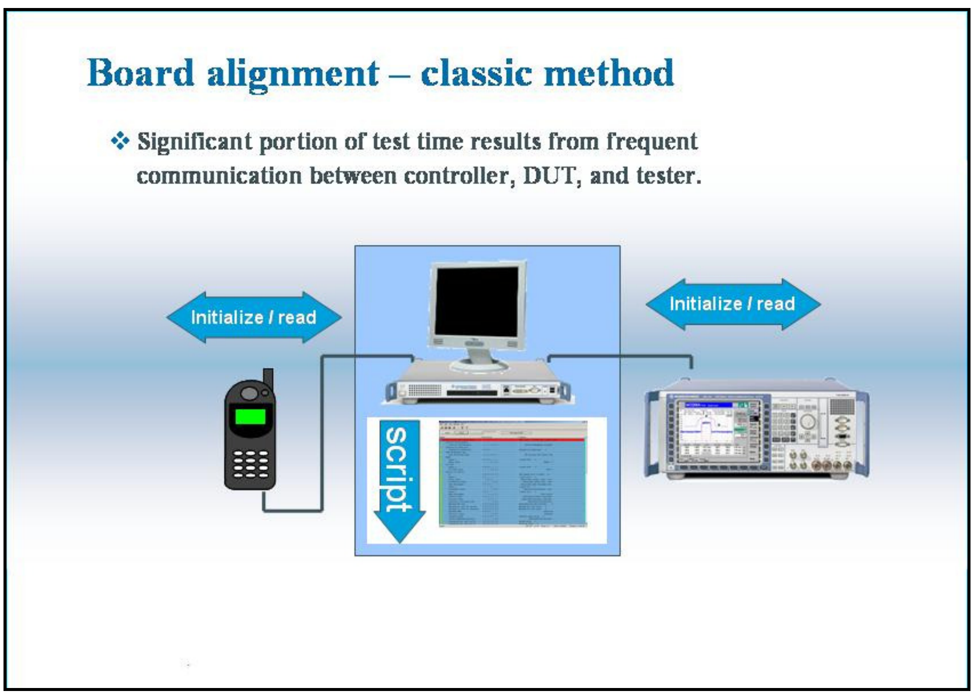

Figure 1: *The classic approach to transmitter alignment requires the most communication between the phone, controller, and test equipment.*

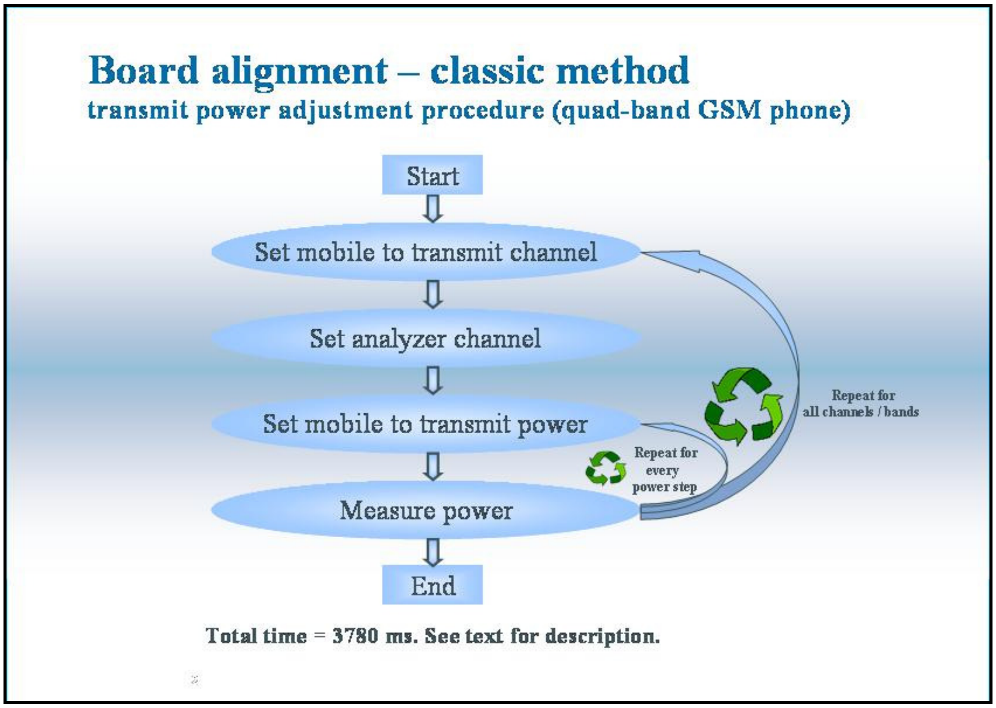

Figure 2: *The many steps required by the classic approach result in its long test times.*

An alternative procedure for adjusting transmitter power, called power versus frame, reduces test time considerably by limiting the amount of communication between the phone, controller, and instrument, and by altering the way the test is performed (see *Figure 3*). In this case, the phone and analyzer are set to a specific channel, and a *sequence* of power levels is transmitted and measured. In another alternative, called power versus slot, the channel is set by the controller in both the phone and the analyzer, and a power sequence is performed in various slots (see *Figure 4*). This approach also substantially reduces test time. Again, the process is repeated for a set of channels, bands, and power levels defined by the phone manufacturer and applicable standards. All three methods require a significant amount of communication between phone, controller, and instrument, which adds in series to produce a specific test time per phone.

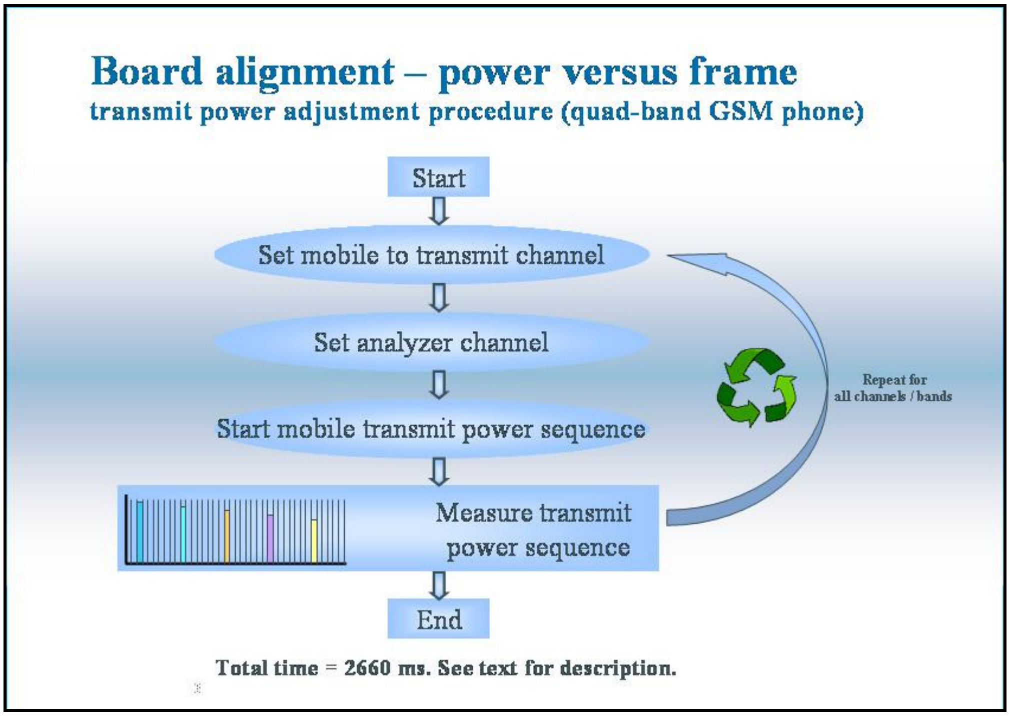

Figure 3: *The power versus frame technique reduces test time compared to the classic method.*

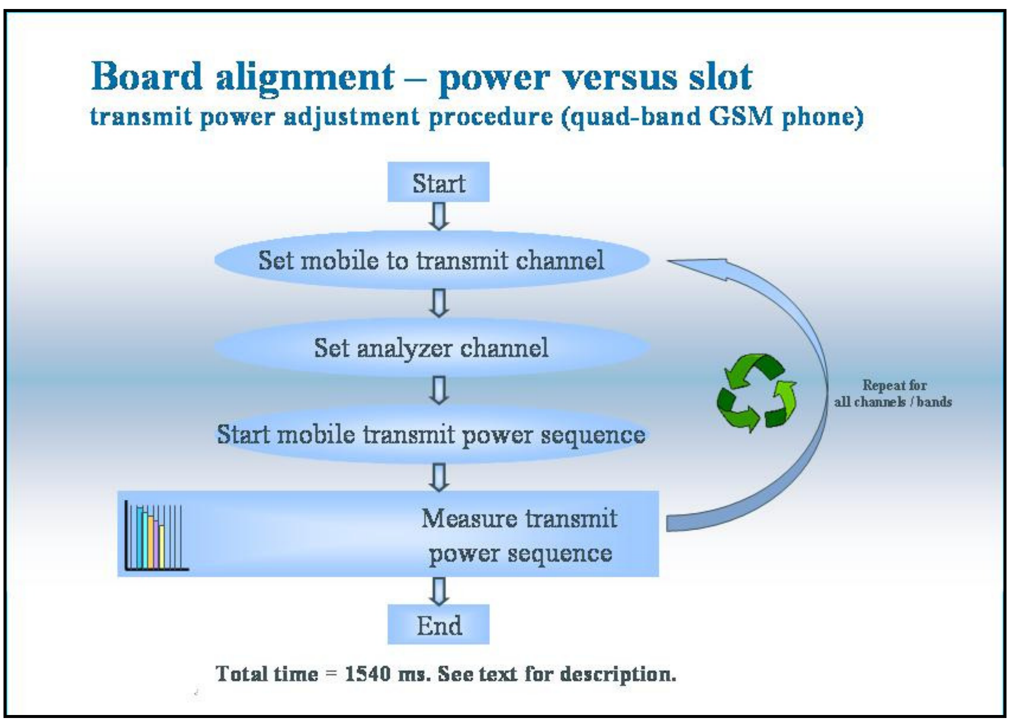

Figure 4: *The power versus slot technique is the fastest of the three traditional methods.*

The Smart Alignment Approach

The Smart Alignment technique (Figure 5), developed by Rohde & Schwarz, achieves massive reduction in test time not through any particular breakthrough in test equipment performance but by reducing, and ideally eliminating, nearly all of the set-up steps required by the other methods. The test routine is stored in the firmware of the phone and in the instruments, so that once the test sequence is initiated, the procedure is simply performed automatically by the phone in synchronization with the test equipment, eliminating the need for any setup-related communication. All that remains is simply to run the tests and send the results to the instruments. No additional equipment is required to implement Smart Alignment.

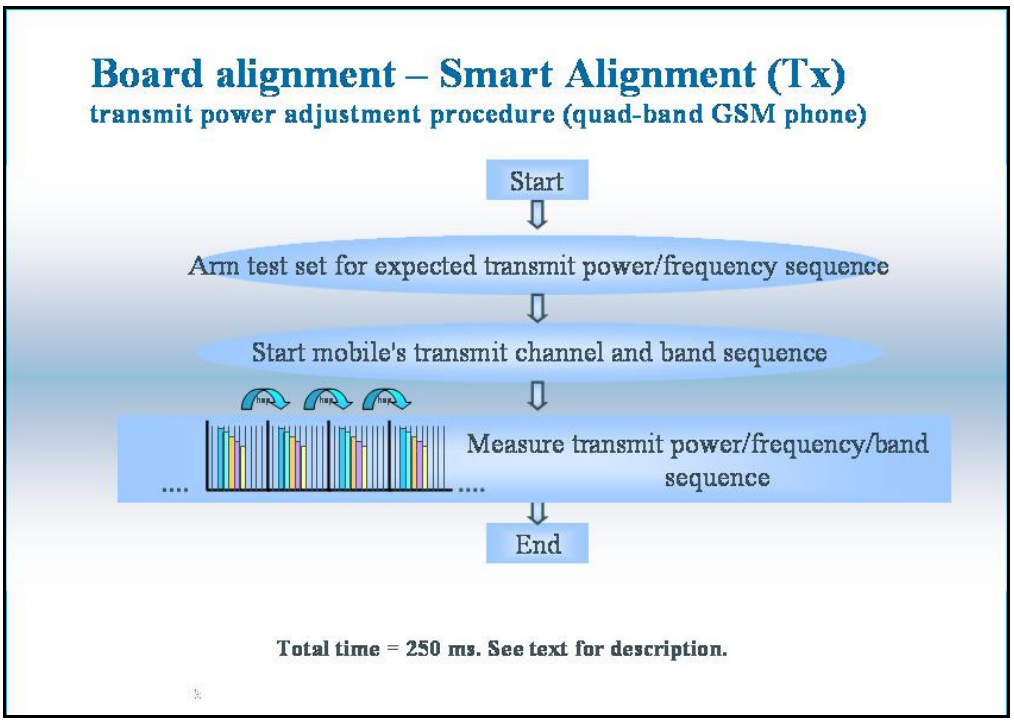

Figure 5: *Smart Alignment dramatically reduces test time by virtually eliminating setup-related communication between the phone, controller, and test equipment.*

Comparing The Methods

For a transmitter alignment made on a quad-band GSM phone using the classic method, configuration of the channel and power requires about 15 ms, and the power measurement requires about 12 ms, including data transfer between the instrument and controller. Changing the channel requires about 18 ms. Measurements at five power levels in one channel requires about 135 ms. All tests over seven channels and four bands per phone and, including communication time, collectively takes about 3780 ms (3.78 seconds).

If the power versus frame technique is employed, setting the channel/power combination requires the same 15 ms, and the power versus frame test itself requires 80 ms for five power levels and the time required to transmit the data to the controller. Performing measurements at five power levels requires about 95 ms. The entire process (95 ms per channel over seven channels per band and four bands per phone) yields a total test time of 2660 ms (2.66 seconds). Using the power versus slot technique requires 15 ms for power/channel configuration, 40 ms for up to eight power levels, and 55 ms to measure five power steps in one channel. Complete alignment time over seven channels per band and four bands per phone yields a significantly faster 1540 ms (1.54 seconds).

In the Smart Alignment technique, the channel/power configuration requires the standard 15 ms, and the measurement process for seven power levels over *100 channels* requires 250 ms (0.25 seconds) for a complete alignment time including initialization, measurements, and data transfer. Thus, the time savings over the next-fastest technique is about 1.29 seconds. Again, using our example of a production run of 5,000 phones per day, the reduction in transmitter alignment time alone is 107.5 minutes.

This means that transmitter alignment could potentially be performed on nearly 1,500 additional phones during a single day, tens of thousands more phones being tested in a week, and hundreds of thousands during a month. Receiver tests, which typically require much more time than transmitter tests, consume about 6360 ms (6.36 seconds) for the device characterized above. Using Smart Alignment, this time is reduced to 300 ms (0.30 seconds), providing an even greater advantage. All of the times presented here are representative of what phone manufacturers achieve in actual production testing. However, since the measurement times shown were made with a specific test setup on a quad-band GSM phone, performance will obviously vary somewhat depending on the device being tested and the instruments used.

Of course, test time alone is hardly the only indicator of how many phones can be produced during a day, since there are many more variables that must be considered. However, by any standard of measure, the savings resulting from use of the Smart Alignment technique yield dramatic improvements in throughput and a commensurate reduction in the cost of test.

Creating and refining a production line requires enormous amounts of work over a long period of time, and changes as revolutionary as Smart Alignment are not made on a whim. Smart Alignment requires adoption by both the phone manufacturer and the chipset vendor, and the chipset manufacturer must modify device firmware to implement it. Nevertheless, Smart Alignment’s benefits make a compelling argument for taking the steps required to use it.

Conclusion

While the wireless marketplace is volatile by nature, there are two constants. First, the complexity of wireless-enabled devices will continue to increase to accommodate new features. Second, phone prices will not markedly increase because customers will simply not buy them. As a result, the need for faster test methods will only increase with time. Smart Alignment is already being implemented in production lines throughout the world, and may very well become the industry standard in years to come.

About The Author

Justin Panzer is manager of product marketing for Rohde & Schwarz in North America. His background includes more than 14 years of test and measurement and mobile communications marketing experience. He has been with Rohde & Schwarz since 2003, with previous responsibility for mobile communications test products serving 2G and 3G technology markets. Panzer holds a B.S. in marketing from Drexel University and an MBA from Auburn University.

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