

Best Practices for Testing Customer-Premises Equipment (CPE)

A Valid8 Whitepaper



Challenges of Testing CPEs

Customer Premises Equipment (CPE) represents those equipment devices provided to consumers for use in their home office or other workspaces, including routers and set-top boxes. The devices historically have connected directly to the carrier's equipment but are becoming smarter to include backhaul access to 3G 4G and 5G over-the-Air (OTA) networks.

Testing CPE devices that have cellular capabilities can be a costly and often frustrating exercise. Often, the test lab does not have clear access to wireless network connectivity, so the test results are less than optimal. In many cases, the costs to connect to cellular service providers' networks to perform testing becomes very expensive as the number of tests required increases.

Problems Using the Public Network to test UE include:

- Pay per use – multiple SIM cards and data overages
- Not deterministic – network conditions may change randomly
- Difficult or impossible to set certain scenarios including Dual-SIM, IPv6
- Cannot isolate the device and network away from other interference
- Cannot emulate specific PLMNs and LTE bands
- Cannot select specific IMSIs you want to enable/disable on the fly

Test operators need a solution that is reliable, cost-effective, and eliminates the need to use the carrier's network.

Examples of CPE devices with cellular modem built in:



Introducing the M5 Mobile UE Tester

Valid8 is singularly focused on Mobile Testing. With the introduction of the Valid8 M5 Mobile UE Tester for embedded device testing, Valid8 has delivered a significant upgrade to its already broad suite of mobile products for device testing.

The M5 UE Tester represents a significant step forward for testing a variety of data-centric CPE devices including embedded modem & router. Widely used by the world's leading organizations and labs to help reduce the complexity of device testing through the quick isolation and presentation of issues, the M5 UE Tester is saving test engineers valuable support time and costs.

The M5 UE Tester builds on the proven Valid8 platform for Security, performance, and mobility. By delivering a comprehensive network emulation solution that can be flexibly deployed, Valid8 allows companies to test mobile technology, such as embedded 4G LTE, without the high costs of testing on a commercial network. The simulated environment gives operators full control to best fit the testing scenarios.

Valid8.com's M5 Mobile UE Tester provides businesses with a comprehensive network emulation solution with flexible deployment options and a low total cost of ownership

Built to Meet Current and Future Mobile Testing Needs

The Valid8 M5 Mobile UE adds and improves on the already significant capabilities in mobile UE testing.

Some of the key capabilities introduced with the M5 Mobile UE Tester Include:

Lower Cost Per Test: Valid8 has continued to add automation and simplicity to their technology, driving down the cost per test.

Increased Test Environment Flexibility: By allowing the ability to configure the simulated environment to meet specific testing needs, users can safely perform penetration tests and other security tests that could not typically be performed on a public network.

Comprehensive Test Menu: Enables testing of a variety of data-centric cellular devices including IoT, embedded, modems, routers & hotspots.

Actionable/Collaborative Reports: From a user-friendly interface screen user can quickly see test results, uncover any issues, and drill-down as needed. Historical tracking allows for trend analysis and reports. Reports can be easily shared with the rest of the team or integrated into a 3rd party reporting tool.

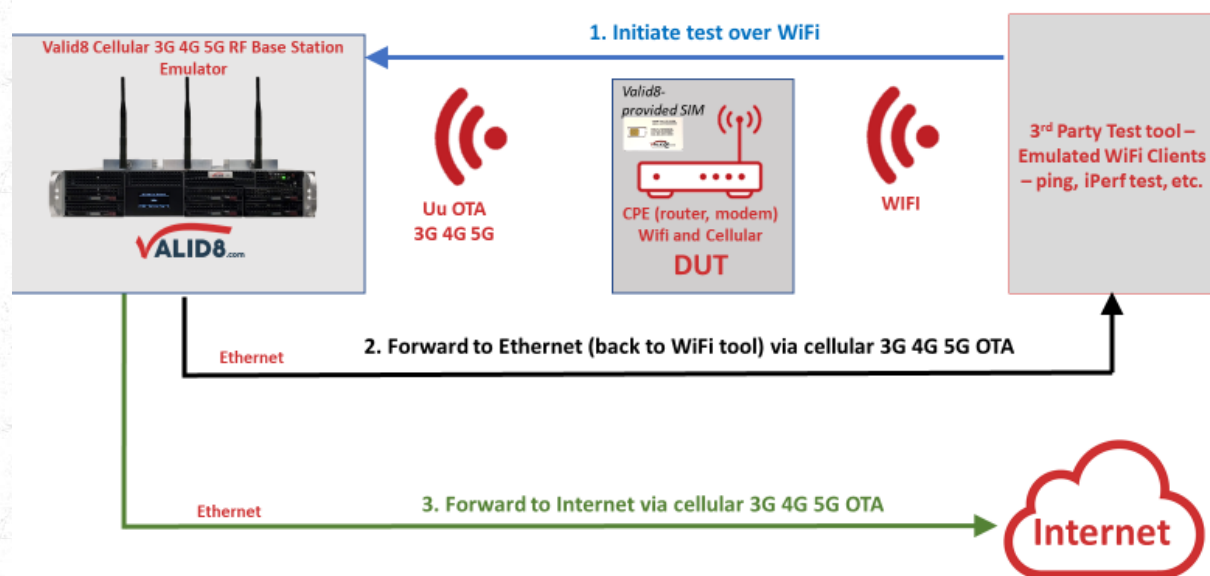
An example testing scenario:

For businesses that need to test CPEs, and already have a 3rd party testing tool that emulates WiFi clients, as the image below illustrates, there are several test scenarios that are enabled with the addition of Valid8's Cellular 3G 4G 5G RF Base Station Emulator.

Step 1: Initiate Test over WiFi from incumbent 3rd-party WiFi tester

Step 2: Forward to Ethernet back to WiFi tool via cellular 3G 4G 5G OTA

Step 3: Forward to Internet via Cellular 3G 4G 5G OTA



The flexibility of Valid8's cellular network emulation simplifies and streamlines the testing process, saving time and money, while allowing for a broader range of tests without incurring the high costs of cellular network time.

The solution includes:

- Deterministic – repeatable network conditions
- Configure specific test scenarios – e.g. no response from network, handover
- Isolate the device away from other interference
- Emulate specific PLMNs & multiple cells (requires one RF card per cell)

Select specific LTE bands you want to allow/disallow on the fly up to 6GHz, including CBRS and FirstNet B14

- Run signaling feature, data throughput, sensitivity, security, battery life, emergency call tests
- LTE 4G, 5G NR 2Q1g (NSA & SA Modes). UMTS 3G option available
- BW: 20/10/5MHz, NB-IoT, Cat-M1

Results report include the following metrics for the UE device:

- Network Attach attempts/successes/fails
- Detach attempts/successes/fails & Detach reason (e.g. UE context release)
- Tracking Area Update attempts/successes/fails
- Protocol Errors
- Message Timeouts
- Message request/response time (min/average/max)

Results from iPerf include packet loss metrics:

```
[protocolEngine@yaanatest1 ~]$ iperf -su -i 1
-----
Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size: 208 KByte (default)
-----
[ 3] local 192.168.2.10 port 5001 connected with 192.168.15.181 port 56639
[ ID] Interval      Transfer      Bandwidth      Jitter    Lost/Total Datagrams
[ 3] 0.0- 1.0 sec   131 KBytes    1.07 Mbits/sec  0.221 ms   0/ 91 (0%)
[ 3] 1.0- 2.0 sec   128 KBytes    1.05 Mbits/sec  1.900 ms   0/ 89 (0%)
[ 3] 2.0- 3.0 sec   128 KBytes    1.05 Mbits/sec  0.751 ms   0/ 89 (0%)
[ 3] 3.0- 4.0 sec   128 KBytes    1.05 Mbits/sec  1.707 ms   0/ 89 (0%)
[ 3] 4.0- 5.0 sec   128 KBytes    1.05 Mbits/sec  0.149 ms   0/ 89 (0%)
[ 3] 5.0- 6.0 sec   128 KBytes    1.05 Mbits/sec  0.889 ms   0/ 89 (0%)
[ 3] 6.0- 7.0 sec   129 KBytes    1.06 Mbits/sec  0.192 ms   0/ 90 (0%)
[ 3] 7.0- 8.0 sec   128 KBytes    1.05 Mbits/sec  1.080 ms   0/ 89 (0%)
[ 3] 8.0- 9.0 sec   128 KBytes    1.05 Mbits/sec  0.750 ms   0/ 89 (0%)
[ 3] 9.0-10.0 sec   128 KBytes    1.05 Mbits/sec  0.520 ms   0/ 89 (0%)
[ 3] 0.0-10.0 sec   1.25 MBytes    1.05 Mbits/sec  0.520 ms   0/ 893 (0%)
[ 4] local 192.168.2.10 port 5001 connected with 192.168.15.181 port 45113
[ 4] 0.0- 1.0 sec   129 KBytes    1.06 Mbits/sec  1.040 ms   0/ 90 (0%)
[ 4] 1.0- 2.0 sec   128 KBytes    1.05 Mbits/sec  0.189 ms   0/ 89 (0%)
[ 4] 2.0- 3.0 sec   128 KBytes    1.05 Mbits/sec  0.716 ms   0/ 89 (0%)
[ 4] 3.0- 4.0 sec   128 KBytes    1.05 Mbits/sec  0.202 ms   0/ 89 (0%)
[ 4] 4.0- 5.0 sec   128 KBytes    1.05 Mbits/sec  0.675 ms   0/ 89 (0%)
[ 4] 5.0- 6.0 sec   129 KBytes    1.06 Mbits/sec  0.191 ms   0/ 90 (0%)
[ 4] 6.0- 7.0 sec   128 KBytes    1.05 Mbits/sec  0.482 ms   0/ 89 (0%)
[ 4] 7.0- 8.0 sec   128 KBytes    1.05 Mbits/sec  0.230 ms   0/ 89 (0%)
[ 4] 8.0- 9.0 sec   128 KBytes    1.05 Mbits/sec  0.397 ms   0/ 89 (0%)
[ 4] 9.0-10.0 sec   128 KBytes    1.05 Mbits/sec  0.470 ms   0/ 89 (0%)
[ 4] 0.0-10.0 sec   1.25 MBytes    1.05 Mbits/sec  0.441 ms   0/ 893 (0%)
```

Summary

Mobile UE testing has continued to increase in complexity as technologies have innovated and become more ubiquitous. With Valid8's M5 UE Tester, test engineers have the luxury of a platform that is user-friendly, comprehensive, and flexible. With extensive support available, and a clear upgrade path through Valid8, businesses can be confident in their current and future testing.

About Valid8:

Valid8 helps the world's networks operate by providing the best methods to simulate & test any network equipment and communication protocol. With 17 years of proven results, Valid8 believes that testing tools should start with a flexible and affordable base with the ability to customize solutions to needs. Clients should only pay for what they need. Valid8 is dedicated to customer success with a comprehensive support program providing direct access to engineers to assist with training, integration, and problem-solving. Over 90% of customer feedback points to Valid8's flexibility and service as the reason they have chosen to partner with the company. Valid8 has succeeded in giving clients a refreshing change from the testing status quo.

www.valid8.com

