

The NXP Applications Solution Kit: Reducing Risk Through Testing and Experience

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I once had a friend in IT who would email several hundred engineers whenever IT released a new CAD software version. The problem with these announcements was my friend's definition of "ready." To him, it meant that the program worked at least once on his personal workstation. His customers had a different standard for "ready" software in mind.

Fortunately, the NXP Applications Solution Kit (ASK), adheres to readiness standards that are significantly different from my old friend's concept of the term.

What is the NXP ASK?

The ASK is an intelligent or smart embedded high OSI layer routing and switching platform where all customers need to do is to add their branding, skinning, and differentiating control and management applications.

In short, the ASK programs utilize an NXP Layerscape® LS104xA device and squeeze 10s of 1000s of simultaneous packet streams through the LS1043A networking hardware while the general-purpose (GPP) processors can do something more fun such as billing applications or TV over IP, for example. All this capability for a surprisingly few watts.

ASK Components

The ASK has, at the highest level, the following key components:

- ▶ OpenWRT distribution
- ▶ A specialty microcode that works with the OpenWRT distribution so that routine traffic never has to be handled by the GPP
- ▶ OpenWRT/kernel modifications that allow programmers to control high-speed hardware-assisted networking via Linux® networking functions like iptables
- ▶ Incomparable intangibles
 - Experience—NXP has been bypassing Linux stacks with hardware and software fast paths (an industry-standard term for a high speed path for ethernet packets) for many, many years.
 - Field hardened—The NXP ASK is deployed in millions of customer premise equipment (CPE). NXP has received valuable feedback from CPE OEM customers over long periods of time and many units. The CPE OEM feedback incorporates the unique stresses of deployed units in large networks.
 - Extensively tested: Testing is what binds everything together. One of the unique aspects of testing is the idea that the tests grow over time as new feedback from the field gets incorporated. So testing isn't just testing your current work, but instead is one of the primary methods of injecting field feedback and experience into the product.



ASK Incomparable Intangibles

Downloading OpenWRT yourself and expecting NXP level results is not reasonable

The NXP ASK test environment is a reasonable place to start discussing intangibles because this behind-the-scenes part of the ASK development is the lightning rod for capturing experience, field hardening information and years of test creation and improvements.

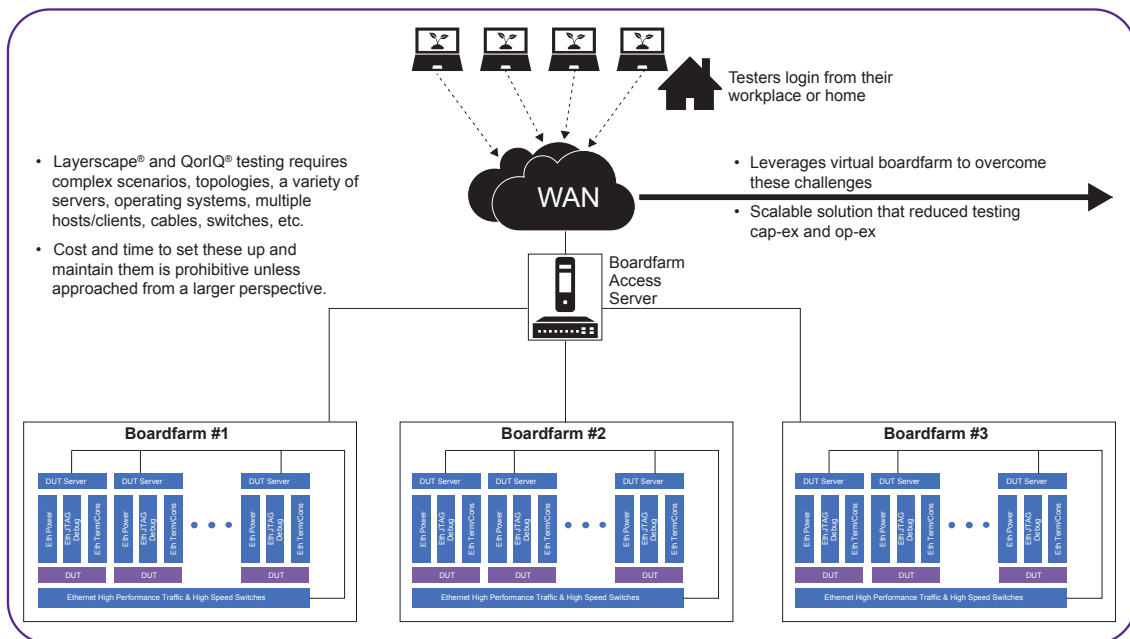
The NXP ASK test environment isn't something that NXP normally licenses or provides externally to customers or partners. This embedded networking software testing system is a part of the NXP test discipline that NXP uses internally to test NXP networking boards and software. As a general statement, the NXP maturity level for our software and testing is now predictive in terms of understanding where our software is relative to release readiness.

NXP Test Methodology

The major components of the NXP test methodology, which will be described in more detail later, are:

- ▶ Multiple test topologies and environments
- ▶ Production-level network test equipment from companies like IXIA and Spirent
- ▶ Large library of tests, both open-source tests and NXP-authored tests that test very different items
- ▶ A structured environment for 24/7 automation and engineer access to source code (test and product), boards, test equipment, traffic, networked UART/consoles, networked debug JTAG debug software and much more (e.g., Jenkins is one component NXP uses)
- ▶ Test reporting—comes from the structured environment
- ▶ Committed engineering teams engaged in software testing

Multiple Test Topologies and Environments



As depicted in the figure, NXP has several facilities worldwide that we call “test farms” or “board farms.” These farms are large environmentally controlled rooms with racks and racks of NXP development boards.

Each board has networked reset, power, JTAG debug, and UART console as a minimum. For NXP networking, high-performance crossbar switches and expensive network test equipment can be connected to the board, also called a DUT. As time, space, and equipment allow, additional connections can be added based on the SoC and its target application.

In the NXP board farm co-located with our networking software developers, additional capabilities for testing routers and other networking equipment are added.

For example, several networks are connected to the DUT. One network is an isolated network to test the device under test (DUT) pretty much like a person would expect. NXP also connects the DUT to a public network for providing the epitome of randomness to our DUTs, including attacks that NXP might not provide otherwise.

A test environment described here is difficult to setup and maintain and would be prohibitively expensive for all but the most serious networking customers to maintain.

This is one example of the environment that the ASK and all of its integrated software are tested which customers cannot match by “just downloading an OpenWRT” even if they didn’t care about enabling the packet processing system in NXP SoC.

Production-Level Network Test Equipment

Many customers attempt to save money by skimping on the test equipment they use to stimulate the products they test, even if they have access to the tests, network topologies and other items outlined here.

In the NXP networking labs, we are fortunate to have test equipment that can generate the tests that exercise our devices at their maximum capability. We use this equipment to test our SoC products, as our customers would expect, but we get the additional benefit of stressing the software and development boards to their maximum capabilities, too. If someone from NXP tells you that we can route 64 K NAT’d streams of Ethernet traffic at 10 Gbit/s with less than 5 percent CPU loading, it’s because we’ve done it. Even better, we do it regularly as part of our ASK software testing. The testers are in an environment where we can make their traffic streams available to any board in the board farm. This is an example of what isn’t the same as “just downloading OpenWRT” when you use our ASK. It takes time and effort to download, port, integrate, compile, optimize and test open-source software; that’s precisely what NXP has done.

Library of Multi-Level, Multi-Discipline Tests

As of mid-2017, the ASK builds upon the NXP SDK for Linux (<https://nxp.com/lSDK>). The LSDK has a sophisticated test system comprising of thousands of tests targeted towards testing NXP software running on QorIQ® P, T, LS, and LX series SoCs.

The ASK itself, an OpenWRT-based embedded networking open-source software package with various high-performance optimizations, also has hundreds of purpose-built, NXP-authored, tests that stress the ASK function with traffic on the NXP SoC (LS1043A, LS1046A, etc.).

NXP tests have different goals in mind. We create tests for functionality, stress, and system performance.

- ▶ For functionality, we focus on the completeness of our software and do all the features work, the API’s work as advertised, etc.
- ▶ For stress, we’re looking to see if we can overrun buffers, find memory leaks and more by simply taking the system to the most ludicrous level of stimulus and see what it would do.
- ▶ Finally, we have performance tests. On one hand these look like stress tests, but, more realistically, these are tests that ensure that our stated goals are achieved as software is modified and re-released.

Recently a customer had a test that sent a packet into our ASK setting up the hardware-enabled fast path packet flow and then the next packet terminated the flow. This is not a real-world situation and we never once thought of a test like that, but we added it to our library.

This is another example of why “just downloading OpenWRT” isn’t the same as getting the ASK from NXP. Unless customers are willing to collect years of feedback generating new tests and commit to making a test library, they aren’t going to match this level of testing. Of course, other tech companies similar to NXP probably have large libraries of tests, too, but each of them has spent considerable financial resources over a long period of time to acquire these valuable assets.

Structured Test System and Environment

Inside NXP we have slide presentations, papers, and internal web sites that extensively discuss how to use our internal structured test system. It would be impossible to give a complete depiction of these interactions and resources in a whitepaper. It is possible, however, to discuss a few of the software components we use as well as some of the more interesting features of our NXP test system that the ASK utilizes in its product lifecycle.

NXP employs a well-known industry System V model-quality framework that leverages many tools and frameworks for engineering quality assurance support. The following list is a cursory glance at the typical processes and tools in use for NXP ASK testing:

- ▶ Git and Stash are used for code review and patch generation and maintenance
- ▶ Jira is used for defect and new requirement tracking
- ▶ Coverity is used for static code analysis
- ▶ Supergit and Repo are used for software integration
- ▶ Blackduck is used for legal review in concert with a process for incoming and outgoing software source
- ▶ Linaro, Yocto, Bamboo and Jenkins are used for patches integration, incremental and regression build and release, as well as codifying a uniform and repeatable method to access our DUTs and system infrastructure
- ▶ LARS, LAVA, cloudy Boardfarm, Testlink, PAT (performance analysis tool) and test maturity model (productivity, automation percentage, test cases pool, metrics shows below) are used for automation testing, test management, performance benchmark and testing improvement.
- ▶ Performance analysis for benchmark and analysis optimization for Core (LmBench, CoreMark®, Dhrystone, SpecINT, EEMBC), Networking (IPfwd, ODP, HTTP), Security (IPsec, HTTPs, VPN, SSL), storage (NAS, lozone, RAID), Realtime (life3, threading), virtualization (LXC, KVM, Docker)
- ▶ Industrial standard networking load generators
 - MuStudio
 - Recreate mixes of application traffic to mimic production network, Generate multiple forms of “bad” traffic, including: malware, known attacks, exploits, threats, and malformed traffic, around 3000 application patterns, over 1,300 known attacks
 - IXIA and Spirent
 - Helps in hardening the device for the real world, high data rates and loads; supported protocols include HTTP, HTTPS/SSL, FTP, SIP, SMTP, RTSP, DNS, MGCP, POP3, IMAP, TCP/IP

Setting up a single tool would be prohibitively expensive for many organizations. Customers using the ASK inherit the benefits of this testing without the matching multi-million dollar investment in creating this infrastructure, let alone filling it with tests, equipment and DUTs.

Test Reporting

During the ASK lifecycle, the culmination of all this technology is delivering quantitative data into reports. NXP has reports for all the tests that run regularly and check for regressions, performance drop-offs and so much more.

Just for customers to spend time creating a single report could be quite expensive; this is yet another example of the NXP ASK's value.

Vibrant, Active and Engaged Test Engineering

Picture this: a customer has called the manufacturer of an older and perhaps unavailable product, only to find that the manufacturer is unable to answer the most basic questions about it. This situation can be commonplace in modern technical corporations, but it isn't the case with NXP ASK.

NXP has a very large, well-trained engineering staff dedicated to supporting the NXP packet management systems (PFE, DPAA 1, DPAA 2, etc.). This staff possesses deep expertise in how Linux manages and processes packetized protocols, and this level of support means that you'll get to engage with knowledgeable, current experts when you need a special mod or an answer regarding the NXP ASK. Having this large, competent and engaged deep networking SW team is simply not plausible for most of our business clients, but it is one of the incomparable benefits that come with the NXP ASK.

Consider how long it would take to get to a similar quality level or think of the cost of delayed revenue or a catastrophic field problem NXP conquered years ago. Ask yourself—can you afford not to use the NXP ASK in your embedded networking product?

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