Whitepaper

Developing Purpose-Built & Turnkey RF Applications

How System Integrators Can Deliver Better RF Solutions for End-Users

thinkRF

Introduction

The spectrum analysis market has changed significantly in recent years, and these trends have created new opportunities for system integrators (SIs) developing purpose-built and turnkey RF applications for end-users. The widespread use of mobile devices, Internet of Things (IoT) sensors, and wireless communications technology has made reliable spectrum access a necessity for users in a variety of industries, including those which have never needed a spectrum analysis solution until now.

For example, retailers and consumer goods companies are incorporating IoT sensors into their logistic facilities and vehicles to improve efficiency. Public safety agencies are increasingly turning to wireless devices and IoT sensors, and recent research has shown that they were projected to spend $2.772 billion by 2025 on IoT devices.[1] Similarly, intelligence agencies and military users are facing new threats due to the availability of low cost devices used for communication or surveillance.

Even device manufacturers, who have traditionally used spectrum analysis solutions for test and measurement applications, are designing and building devices which include new wireless signal standards, such as 5G, that use frequencies well above what was previously required.

This dependence on the RF spectrum has made the need to isolate and measure RF signals, detect and mitigate RF interference, and ensure network coverage more urgent, and more challenging, than ever before.

Unfortunately for end-users, many of the existing commercial-off-the-shelf (COTS) software solutions for spectrum monitoring and signal analysis do not adequately address their requirements. End-users, who are not necessarily familiar with signal analysis, need to be able to measure the wireless spectrum to get the benefits of the wireless devices they've implemented into their business. Put simply, they do not have the expertise or time required to build an RF application on their own, but they need a solution that is easy to use, cost-effective, and designed around their unique requirements to ensure spectrum access.

This represents a significant opportunity for SIs who have experience developing purpose-built, turnkey RF applications for specific niches and use cases.

This whitepaper will examine how SIs can develop a purpose-built software application designed for the end-user by leveraging open, high performance, and versatile spectrum analysis hardware. It will present questions that RF Application Developers at SIs need to ask prior to initiating a new project and discuss the common challenges SIs face when developing an application for their customers. Finally, it will provide recommendations on the types of hardware SIs should use to build their solution to ensure end-users get the flexibility and performance they need for their business.

1. https://www.globenewswire.com/news-release/2019/08/14/1901740/0/en/Global-IoT-For-Public-Safety-Market-Will-Reach-USD-2-772-Million-By-2025-Zion-Market-Research.html

Develop vs. Integrate – When Does Building a Purpose-built RF Application Make Sense?

The question of whether to build or buy is not unique to the RF industry, nor is it one that has a clear answer. Each approach offers its own benefits and limitations that need to be evaluated on a project by project basis. Depending on your customer and their requirements, there may be times when either option makes the most sense. So how can you determine which is the best approach?

When it comes to RF software, there are many COTS applications available, and there are times when these will meet the needs of your customers without any modifications. For example, there may be times when a software solution exists from a market leader for your user's application. Specialized software designed for vector signal analysis (VSA) or technical surveillance countermeasures (TSCM), or generalized software that provides standardized measurement capabilities, such as 3G/4G/LTE monitoring or RF testing for low frequency signals, may already provide the right capabilities for users in these fields.

Because it is already developed, COTS software is easier and faster to deploy, proven in the field, and potentially less expensive depending on the types and number of licenses required. However, these standard software applications have several limitations depending on the requirements of the user.

First, many software applications are closed, proprietary and vertically integrated, or they only integrate with a limited number of hardware vendors. This drastically reduces flexibility for end-users who may not want to use a specific vendor's hardware for a variety of reasons, including cost, performance, or form-factor.

Additionally, COTS software often prevents end-users from accessing raw IQ data, or forces them to pay an additional fee for access. This limits the measurement capabilities of the solution, especially if the user is in a relatively small, unique, or niche market that requires custom measurement sets.

For example, some end-users may need to decode or demodulate signal standards that are not included in the software, such as new 5G waveforms and proprietary signals. Similarly, customers may want to fuse data from multiple sources, such as GPS and RF signal data, which many COTS solutions do not support.

Finally, end-users are increasingly demanding custom interfaces that show the most relevant data in a clean and easy to use format. In COTS software, specific views of the data are not always possible, and the interface may be designed for an application that is different than the end-users. This lack of flexibility can be frustrating for end-users who are not necessarily experts in RF and are primarily interested in specific results that are most important to their business.

In these cases, building a purpose-built RF application allows SIs to meet end-user requirements and provide them with the capabilities, measurement sets, outputs and interfaces they need for their business. In the end, a purpose-built application increases flexibility, and allows you to sell to a larger number of end-users in a variety of use cases.

That said, it's not necessarily an either/or decision. You may determine that COTS software will be good enough in the short term and integrate it with your chosen hardware platform while developing a turnkey application for the long term. It all depends on your customer and their needs.

SIs who can identify the right solutions and deliver them to customers in a timely manner add more value and gain a considerable advantage over competitors.

Advantages of Integrating with COTS Software

- Proven application designed for a specific use case
- Minimal development and integration work required to use with supported hardware
- Potentially lower cost depending on licensing requirements

Limitations of Integrating with COTS Software

- May lack critical capabilities for end-user
- Unable to access raw data, customize measurement sets, or decode/demodulate unsupported signal standards
- Ongoing licensing and support costs
- Typically vertically integrated or limited to specific hardware, reducing flexibility

Advantages of Developing a Purpose-Built, Turnkey Application

- Purpose-built turnkey solution that meets all the customer's requirements
- Provides access to raw measurement data and increases flexibility around signal standards, measurement sets, interfaces, and capabilities
- Minimal ongoing costs for licensing or support
- Increased flexibility to choose hardware platforms that are best suited for the end-user

Limitations of Developing a Purpose-Built, Turnkey Application

- Potential for bugs or unexpected issues in development
- Longer time to market and more development effort
- Potential for higher cost depending on development resources required

What to Ask Before Building a Purpose-built, Turnkey RF Application

If you've decided that developing a turnkey RF application is the best choice for your end-users, there are a number of questions you need to be asking before getting started. Many companies run into common challenges or delays, in part due to a lack of planning, that end up costing significant time and resources and reduce the profitability of the project.

Understanding the risks that come with designing a purpose-built application and being prepared to address them in advance will not only make the project run more smoothly, but also improve customer satisfaction and ensure they get what they need, when they need it for their business. Here are three questions to ask before you begin development.

How Will the End-User's Needs Evolve Over Time?

As with any project, you need to have a strong understanding of the scope well before you start the actual development work. Make sure you have fully identified the customer's requirements, what types of signals they plan on measuring, what features they require, and how they intend to use the application you develop in the field.

You should also be considering how these needs will evolve over time so that you can extend the life of the solution by building in additional features and selecting the right hardware platforms that meet these future requirements.

For example, while many devices operate at below 6 GHz today, mobile devices will soon be available which transmit and receive signals up to 40 GHz. SIs developing solutions for end-users to identify unknown signals of interest should consider these new signal standards when selecting hardware to ensure that the solution will be viable as the new standards are released.

What Hardware Capabilities Are Required?

While you'll be developing the software application, it is likely that you'll be building it on an existing hardware platform. Before selecting this platform, identify the customer's requirements and determine a short list of equipment to choose from.

Capabilities such as frequency and bandwidth performance or sweep rate are typically non-negotiable when determining which platform to use, so start with these features when evaluating your options. Once you've selected a shortlist, you can start to look at other important factors, such as cost, portability, connectivity, networkability, APIs and development languages, or whether the platform is able to integrate with other third-party hardware.

If, for example, your customer intends to monitor mid-band and high-band 5G signals from inside a vehicle, the equipment you choose must be able to capture these frequencies and be easily deployed and powered by a vehicle at an acceptable cost to the end-user. Otherwise, it doesn't matter how good the software you develop is as the hardware capabilities will not be good enough.

What Programming Language or Environment Do I Want to Use?

Despite the diversity of the available programming languages, each candidate programming language must be examined for its strengths and limitations. For instance, from a usability standpoint, when using a high-level language such as MATLAB, the final application is not as portable as the one developed from scratch in a general-purpose programming language such as C. On the other hand, C lacks readymade functions, particularly in signal processing. Therefore, more effort and developer skills are required to write the proper code to implement such functions.

Additionally, some software environments are very expensive with single-use licenses costing thousands of dollars. Moreover, if an application developer wanted to distribute a standalone executable, then typically additional software modules are required to generate this executable at additional cost.

Understanding which programming language or environment is best suited to your application enables you to choose a hardware platform that supports this language. Using APIs with strong supporting documentation improves the development process and reduces the time it takes to build a purpose-built application when compared to developing and coding everything from scratch.

Choosing the Right Hardware Platform to Develop On

There are numerous RF equipment providers, and each have their own strengths and weaknesses depending on the type of solution you are building. The platform is one of the key components of the solution you provide to end users, and what you choose to develop on will have a significant influence on the success of the project.

Certain hardware platforms will be easier to develop on than others, and there are some common requirements you should look for when selecting equipment. Before deciding, ask yourself the following questions to ensure you will be able to build the solution your customers need.

Does the Platform Provide Access to Raw IQ Data?

Raw measurement data is a necessity for developing a purpose-built, turnkey RF application for customers. It allows SIs to include custom measurement sets, capture, decode, and demodulate signal standards outside of what is available in existing COTS software, or fuse multiple types of measurements together, such as GPS and signal data, depending on the application.

Most traditional, hardware-based spectrum analysis platforms do not provide end-users with visibility or access to the raw IQ data, while others will charge an additional fee. This limits the flexibility for SIs, adds costs for end-users, and makes it impossible to develop an application that depends on these measurements. For these reasons, the ability to access, manipulate, and analyze raw measurement data should be a requirement when selecting an RF platform.

Which APIs and Development Environments Are Supported?

Open APIs and development environments are crucial to developing a purpose-built RF application. While it is possible to code an entire application from scratch, it's far easier, and less expensive, to take advantage of APIs to speed up and simplify development.

As mentioned above, the language or environment you choose to use will depend on the type of application you are developing. The hardware you select should support the language or environment you need, such as MATLAB, LabVIEW, C/C++ or Python, and provide clear and accessible supporting documentation.

Finally, you should be able to use standard configuration protocols via SCPI commands or VITA VRT. By removing the heavy lifting of coding standard and repetitive functions, you can focus your efforts and development resources on creating the features and capabilities your end-users require.

Can the Hardware Be Deployed in the Environment Your End-Users Need It?

This is where understanding the intended use case is extremely important. You need to ensure that the hardware you select meets the size, weight, and power requirements of the user, and that it can be deployed in the environments that your customer intends to use it in.

For example, some customers may require multiple units to be networked together and connected to a central location to conduct analysis such as direction finding and location analysis. Others may require units be placed outdoors in challenging environments for continuous monitoring applications, while some may need the unit to be easily deployed in a vehicle for mobile analysis applications.

Regardless of how your customer intends to use the solution, the way the platform is deployed will have a significant impact on which hardware you choose to develop on.

The Advantages of Developing on a Software-Defined Spectrum Analyzer

To achieve the frequency, bandwidth performance and flexibility required for today's RF applications, traditional, hardware-based spectrum analysis platforms are often expensive, heavy, and difficult to use. SIs must then make a sacrifice and choose between price, performance, and portability.

Alternatively, you can develop on a software-defined spectrum analyzer that uses software-defined radio technologies. Software-defined radio (SDR) is a class of radios that can be reprogrammed and reconfigured through software rather than hardware. Basically, it takes some of what used to be done in dedicated hardware components, such as tuning, demodulation and signal processing and moves them to software functions instead.

In a software-defined spectrum analyzer, the software runs over top of a thin, broad layer of hardware to provide greater flexibility and versatility. The hardware components tend to make up only the RF to IF to digital conversion. An inexpensive standard PC can then be connected to provide the necessary computing power for digital signal processing, signal analysis, and other capabilities. As a result, software-defined spectrum analyzers achieve high frequency and bandwidth performance at a significantly lower cost and smaller form-factor than traditional, hardware-based equipment.

Additionally, by taking an open, interoperable approach to spectrum analysis, these platforms offer open APIs and programming environments and can integrate with leading third-party hardware and software so that SIs can build the right solution for customers.

For SIs, this approach means that end-users get the performance they need at a lower cost, while allowing you to choose the right third-party hardware components to build a complete solution without being tied to a specific vendor. A software-defined spectrum analyzer provides additional flexibility and versatility, making it well suited to the needs of SIs developing applications for today's wide variety of spectrum analysis applications.

Build an RF Solution That Lets Your Customers Improve Their Business

Today's customers are not the traditional users of spectrum analysis equipment and RF software. The rise of wireless signals means that today's end-users come from a variety of industries and have a wide range of use cases and requirements. No COTS software can possibly be expected to address all these use cases effectively.

As a result, SIs will be asked to develop purpose-built, turnkey applications that are easy for end-users to utilize and implement into their business. SIs with the ability to build these applications and meet these requirements will gain a significant competitive advantage over companies who are unwilling or unable to do the development work.

The platform you choose to develop a turnkey RF application on will have a significant impact on the success of your project. A software-defined spectrum analysis solution provides the best mix of performance, price, and flexibility while providing SIs with access to raw measurement data and a suite of APIs and programming environments. And by taking an open, interoperable approach, SIs can integrate third-party hardware components to build the right solution for end-users.

The future of spectrum analysis will be with purpose-built RF applications designed around the needs of the end-user. The SIs who capitalize on this opportunity and develop the right process for building these applications will survive and thrive in this new future, while the companies that fail to do so risk being left behind.

ABOUT THINKRF

ThinkRF delivers a new category of Software-Defined Spectrum Analysis solutions that monitor, detect, and analyze complex waveforms in today's rapidly evolving wireless landscape.

Remotely deployable, PC-driven and easily-upgraded, the ThinkRF platforms offer greater versatility, better performance, and additional capabilities for monitoring, signals intelligence (SIGINT), technical surveillance counter measures (TCSM), test and measurement, and 5G applications.

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