TXMISSION

Smallsats with Personality
Technology White Paper

To date, every smallsat has been designed for a specific purpose, such as capturing pictures of the earth or carrying out a scientific experiment. This inflexible, siloed approach involves reinventing the wheel for every mission. The massive diversification we see in user applications, where every New Space start-up has a different vision and business model, challenges us to rethink things. In an increasingly software defined world, the smallsat user application itself is set to take center stage. Personalizing smallsats will become similar to how we personalize our phones, allowing us to run any application we want at any time. Learning from the mobile app and IT industries, we describe how to give smallsats bags of personality.

Overview

Whether we openly admit it or not, we are all fascinated by other people's personalities. We indulge in pastimes such as endless people watching or idolizing those we look up to and wish to emulate. We even have personalities (usually of the dubious variety) foisted on us, through personality cults, where extensive propaganda is used to build up the image of an individual, presenting them as the answer to everyone's problems. Similarly, in the new world of software defined everything we often see software being used to personalize every conceivable application and likewise being presented as all things to all people. In this article, we explore the role of software with respect to all things smallsat and make some predictions as to where this will lead us.

Software Defined Everything

As a society, we have developed an insatiable need for instant connectedness to everything that interests us. This primal desire is being satisfied largely through a multitude of mobile apps that can be customized to suit every conceivable need. Mobile apps have led the way in delivering a

> *'... the technology that will define the future of the New Space industry can be succinctly described as Software Defined Everything ...'*

personalized experience that is adapted to make it as relevant as possible to each user. And the tremendous diversification we see in terms of new user applications in the mobile world is starting to take root in the New Space industry. Disruptive technology combined with new business models are fuelling an unprecedented growth in space. While many innovations have come together to create and underpin this revolution, in our view the technology that is set to define its future can be succinctly described as *Software Defined Everything*.

The software-defined approach originated in the IT industry. *Software Defined Networks* (SDNs) were created to solve a growing IT network problem, namely, the management headaches created by having a plethora of different proprietary network

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technologies, and their associated management systems. By getting IT equipment vendors to support open command languages, such as OpenFlow, it allowed IT administrators to centralize and unify their network management systems, abstracting away the proprietary nature of the countless different devices in the network. In turn, this virtualisation created a flexible, scalable network architecture that could be readily changed to provision new services. **Since a satellite modem performs similar functions to an Ethernet switch or router then supporting SDN protocols on smallsat modems immediately allows them to become an intrinsic part of the wider, homogenized network covering both satellite and terrestrial resources.**

> *'... an application-aware modem can be programmed with any number of apps - (programmable software personalities) - even from an online source, similar to Google Play and the Apple App Store...'*

Software Defined Radios

Then, having standardized the command interface to network devices, *Network Function Virtualization* (NFV) migrated the device functionality from proprietary hardware to commodity server hardware, greatly simplifying the provisioning of network services in the process. The equivalent process is underway in smallsats, with dedicated communications hardware being replaced with *Software Defined Radios* (SDRs). **SDRs are satellite modems that provide programmable waveforms and transmission frequencies, meaning the hardware does not need to be changed when a different communications service is required.** They can also interface to any type of payload sensor

and transmit at any data rate. And for telecoms applications, SDRs support bidirectional communications and symmetrical data rates.

Application-specific Software

The rate at which software is entrenching itself in the smallsat arena and adding value continues to grow unabated. Ever since the world adopted TCP/IP and Ethernet as the dominant communications technologies, satellite modems have provided a generic TCP/IP communications handling capability. This suited satellite modem vendors because it meant the same modem could handle almost any market and application, from cellular backhaul to video distribution.

However, with the rapid diversification in user applications, it makes sense to revisit how these applications are supported. Most applications require customization and nuancing of the functionality and data to optimize performance and enhance and personalize the user experience. **It turns out that the best place to host the user application – in part or in full - is often on the satellite modem, changing it from a generic communications device to an application-aware modem that can be programmed with any number of apps** (perhaps even from an online source, similar to Google Play and the Apple App Store). Or, if you like, programmable *software personalities*, which brings us back to our opening remarks on

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personalities and personalization.

For example, you could create a 5G base station in space, or an IoT, cloud computing, edge computing or quantum cryptography application. All hosted on a powerful satellite processor that has plenty of spare processing power. And all that needs to be done is for the modem vendor to create a *Software Development Kit* (SDK) that allows users to port their own personal applications to the modem, which then run alongside but independently of all the modulator, demodulator, waveform, error correction and protocol handling that the modem software and hardware is providing. Or, to provide faster time to market and lower technical risk for the user, the modem vendor may decide to port the more popular types of application themselves, creating a range of application-specific modems (or modem apps) in the process.

The same SDK can be used to optimize and simplify other smallsat processing requirements. Smallsats typically have Onboard Computers (OBCs) - sometimes called flight computers – for doing housekeeping tasks such as going around all the different subassemblies and checking and reporting status. Smallsats also typically have another processing element in the mission payload, for handling all the sensor data and mass storage. The same SDK can be used to host these software applications also. This allows an all-in-one processing solution, based around the satellite modem, for all onboard smallsat needs, including the user's application. This is topped off with an in-orbit, over-the-air software upgrade capability that allows new or upgraded apps to be uploaded, maintaining the competitiveness of the user's smallsat service.

Summary

The user application is now the dominant part of the solution. This is leading to software defined satellite modems (which should really now be called *application processors* rather than satellite modems) that can be personalized to do anything the user wants, just like we do with our phones. In a software defined world there is a blurring of boundaries - the 'user' may be a products company, a services company, a satellite or terrestrial network operator or even an individual.

Old infrastructure models that have dominated the satellite industry since its inception will not be able to adapt sufficiently to meet the needs of new customers and new challenges. The flexibility introduced by software defined innovations will help open other doors, for example, for companies that wish to provide constellation as a service, ground infrastructure as a service, and so on.

And yes, it never stops until we get to software defined everything!

Software Defined Everything