SQUEEZING THE BALLOON: EFFECTIVE SDR POWER BUDGETING TO MAXIMIZE UxS RANGE & CAPABILITIES

Software Defined Radios (SDRs) are the Swiss army knives of spectrum battlefield situational awareness. Their uses range from satellite communications (SATCOM) and signals intelligence (SIGINT), to direction finding (DF), radar, jamming and many more besides. Even small drones are upgrading capabilities from only visible spectrum cameras to much more advanced capabilities using SDRs.

A common feature of all but the largest UxS platforms is that power is a premium - a scarce commodity that directly affects range or mission duration. For a given power budget, what are the variables that are typically traded off?

1. **Frequency Range** is a factor, and usually a given for the mission set - if the target is likely to include an X-band radar, then having sufficient radio coverage is a binary choice. On the other hand, for some EW applications, the answer might be to ask for as much as possible given other factors.

2. **RF Performance** has a number of factors, including dynamic range and instantaneous bandwidth (IBW). Systems used to be specified with the highest possible RF performance, causing them to be large and power hungry. More recently there has been a realization that 'good enough' might be exactly the right answer, particularly for airborne platforms that can get close to targets. As a non-scientific example, ***Figure 1*** shows how backing off on dynamic range in some of our radios can have a significant impact on power consumption - for example one exquisite channel could be traded for 4 channels of 'good enough', allowing a high quality DF capability to be added for the same power budget. This is also a factor in choice of radio architecture. Impressively capable chips have been available for a few years based on RFSoC (RF system-on-chip) architectures that provide extremely wide IBWs. However, they tend to be power hungry and require large amounts of cooling. A good alternative that Epiq employs frequently is zero IF (or homodyne) RFICs that have moderate IBWs and extremely good performance for the power they consume.

3. **Number of Channels** was mentioned before and can have a big impact on power consumption. DF can be performed adequately for many applications with just two channels, particularly when aided by AI/ML. However, accuracy and speed increase significantly with 4 or more channels. Similarly, MIMO and phased array beam forming applications benefit from more channels each driving an antenna element, with an approximate 3 dB improvement in performance for each doubling of the number of elements.

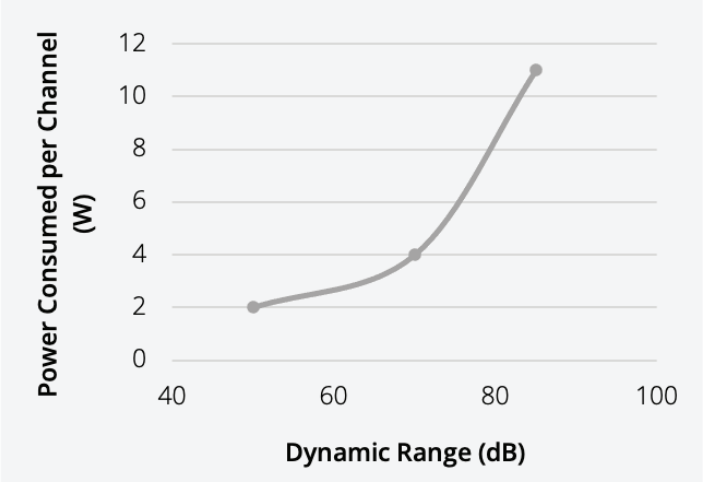

Figure 1: Trading radio dynamic range for reduced power consumption

4. **Processing Approach** has a big effect on power consumption, with trade-offs possible depending upon mission type. For the most timing-critical applications, processing performed by FPGAs such as RFSoC-based cards is essential. However, some processing techniques are able to take advantage of the latest ultra small GPU/CPUs for on board AI/ML processing that can be 2-10x more power efficient. These allow integration with the SDR such that the user is being given analyzed data for parameters like range and bearing, instead of many streams of raw time-coded data to deal with later in the system.

If the frequency range is taken as a given, power budgeting becomes an exercise in squeezing a balloon between RF performance, the number of channels, and the processing approach. The math can be pretty unforgiving, particularly on the smallest, most power and space-constrained platforms.

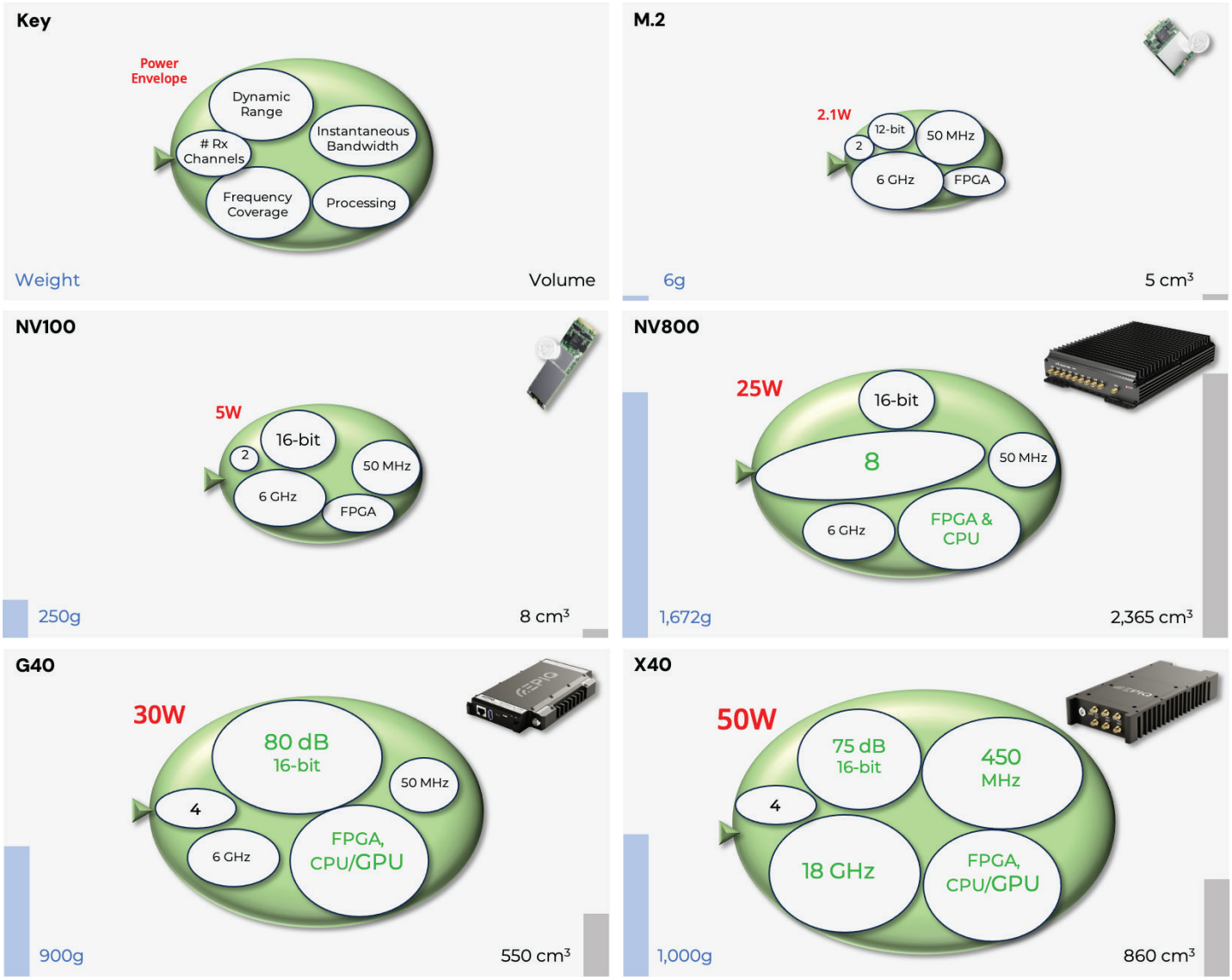

Figure 2: Example power envelopes

Figure 2 uses some small form factor (SFF) Epiq products as examples to show how factors can be traded within some different power envelopes. Even the smallest example shown is equipped with 2 channels, 50 MHz of IBW and 6 GHz coverage in a tiny package that consumes about 2W. Better RF performance costs in SWaP terms, as does increasing the channel count to 4, and in another example, 8. More processing, wider frequency coverage all have an impact. However, it should be noted that employing a high performance RFSoC might consume more than 60W for the chip alone. With power consumption, as with life, budgeting is complex.

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The interplay between these factors is obviously complex, something we have years of experience optimizing, particularly when applied to the most constrained platforms. **Contact us** for more details or visit **our website**.

ABOUT EPIQ

Epiq Solutions develops cutting edge tools for engineering teams and government-focused organizations requiring situational awareness and detailed insight into their RF environments in order to identify and act against wireless threats.

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