Advantages of Using MRAM with FPGA

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Abstract:
Connecting MRAM as the nonvolatile memory to an FPGA device can create new opportunities for a wide variety of applications. System designers can take advantage of MRAM's faster write capabilities and easier software programmability, which can lead to lower energy usage due to the faster write speeds and lower energy profiles of MRAM.

Field-programmable gate arrays (FGPAs) are finding their way into many different applications as 5G technology, and other LPWAN connectivity solutions roll out. Automotive, IoT operations, and 5G edge applications are implementing FPGA chips due to their fast time-to-market and their ability to be reprogrammed. In many cases, the FPGA is installed in applications where frequent system updates are needed. Often these bitstream updates are made over the air (OTA), an FPGA with a magnetoresistive random-access memory (MRAM) is a desirable choice due to its ability to simplify the software complexity associated with the management process of updating new bitstreams into memory. (see Figure 1).

Electric vehicles are prime example of such an application. OTA upgrades for battery performance or system security are common occurrences. Others include remote video cameras and battery powered IoT applications, which may need errors fixed or updated new algorithms for artificial intelligence (AI) installed. Each of these applications can require frequent OTA updates to keep the software current and to ensure that the security and feature sets of the system is kept intact. Battery-operated systems need a low-power memory solution to enable either a long life between battery changes or system swap-outs.

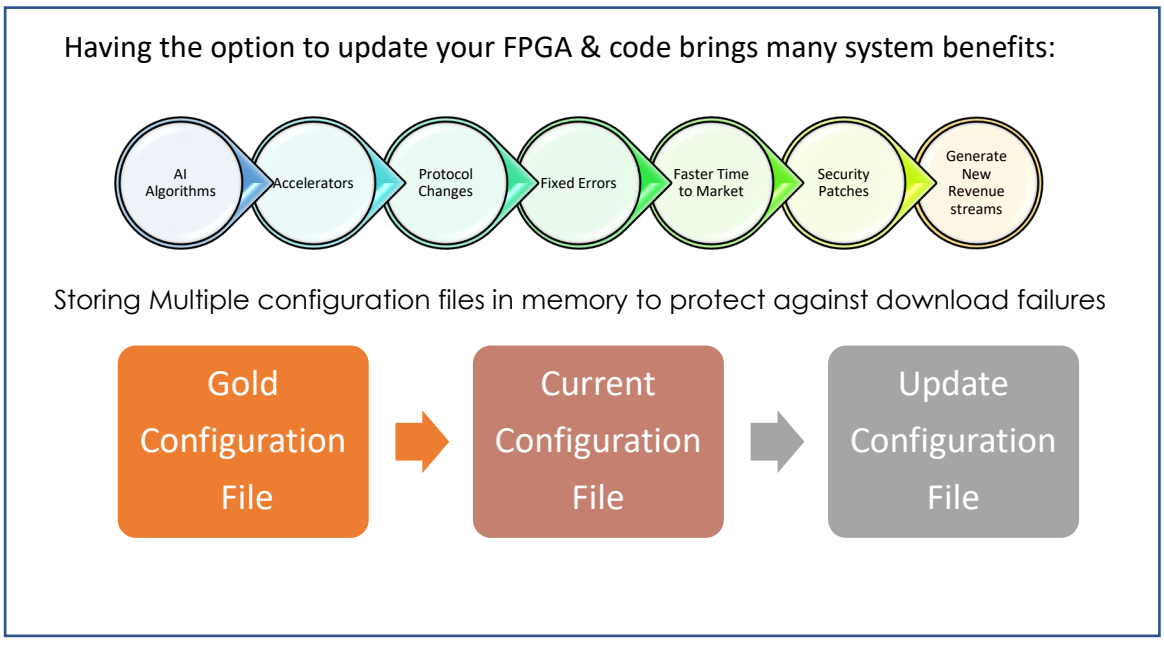

Figure 1. Factors driving the need for OTA updates of FPGAs.

One of the semiconductor industry's most flexible chips, the FPGA is employed in many different applications across the microelectronics industry. One of the advantages of FPGAs is that, as the name indicates, they are programmable after being installed, unlike ASICs. Once deployed, this capability allows for on-the-fly reprogramming in the field, enabling updates after the system with the FPGA has been installed or initially programmed. This provides optimum flexibility for developers designing FPGA chips for future applications needs with existing hardware.

Nonvolatile Memory Makes a Difference

A key component of an FPGA's programmability is the non-volatile memory (NVM) used to store the FPGA's bitstreams and firmware for any integrated processor cores used inside it. Everspin's MRAM technology is best positioned to improve FPGA performance as shown in *Figure 2*, a representation of the superior write speed and endurance of MRAM. MRAM can bring other benefits to an FPGA system such as the ability to be the system fast data logger. Key data that needs to be stored and protected during any power loss or power down sequence can use the MRAM persistent RAM feature.

The use of LPWAN communications networks enable a faster data pipeline, and using MRAM to download data will be much faster than NOR flash memory –literally in milliseconds rather than minutes. This reduces energy consumption considerably and minimizes the opportunity for any security attacks when the data pipeline is open.

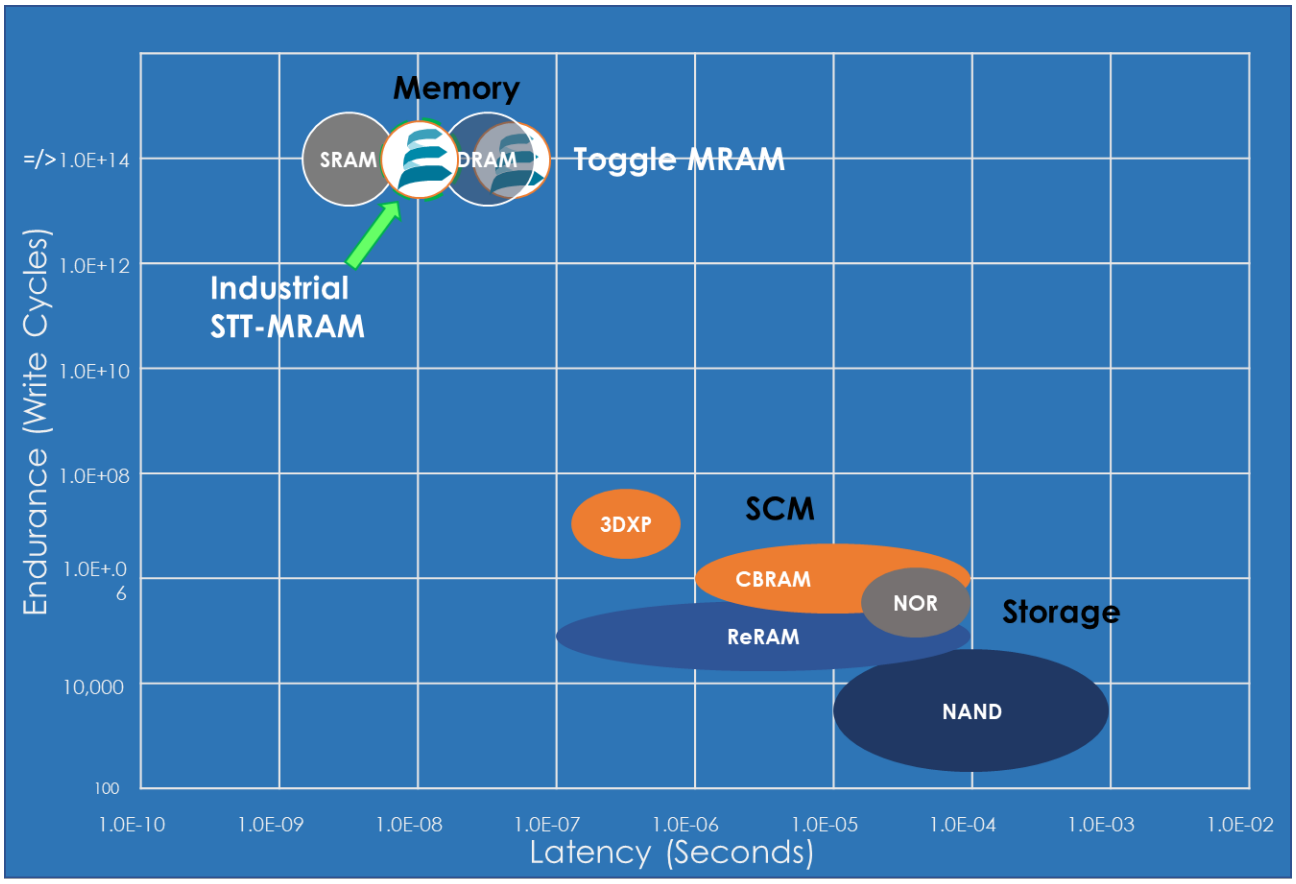

Figure 2. MRAM Write Endurance and Latency far exceeds other Non-Volatile Memory types .

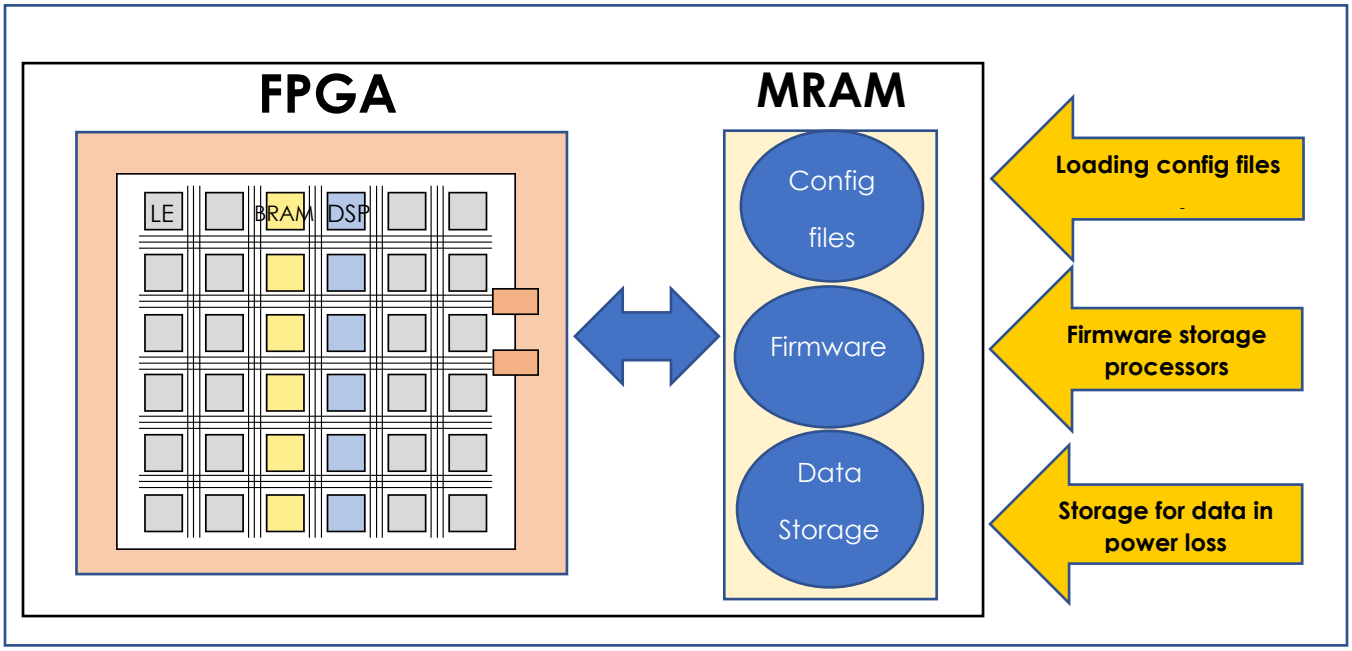

Figure 3. STT-MRAM offers great value for FPGA platforms.

The Everspin MRAM has an xSPI interface, based on the Expanded Serial Peripheral Interface JEDEC standard for NVM devices, and standard packaging to ease the transition from NOR to MRAM technology. The software management and file structure enable simpler file management with better system performance. Software engineers don't need to be concerned about wear leveling, bad block management and the process of having to do background erasing of flash blocks. With MRAM, engineers can just write to the block, with no erase required, simplifying the coding process. The simpler file management also makes MRAM more power efficient, as software blocks don't need to be moved around to achieve the desired FPGA performance. Memory capacity from 4Mb up to 128Mb is available now and higher capacity, enhanced NOR-like memories are on the roadmap.

In summary, designing STT-MRAM into FPGA systems gives the user a high-utility memory for more platform functionality. Using MRAM enables lightning-fast loading of bitstream files for rapid reconfiguration, excellent firmware storage for soft and hard processor cores, and storage of data in case of a power loss or if with a remote application, the system occasionally either gets turned off or goes into power lost mode. The higher capacity of storage available with Everspin's MRAM devices enables the storage of multiple FPGA bitstreams for protection against system lock ups, always having one fully downloaded bitstream to fall back on in case of a download malfunction.

MRAM-FPGA Benefits Multiple Applications

Another advantage of using Everspin MRAM technology with FPGA is that it can be adapted for use in radiation-hardened (rad-hard) FPGA applications. STT-MRAM technology is an ideal candidate for rad-hard FPGA devices due to its persistence and inherent radiation immunity. Everspin is working with partners on a program to develop reconfigurable FPGA technology for use in harsh environments. The rad-hard aspect pushes FPGA using MRAM into aerospace, and other applications where the potential for radiation exposure would compromise system performance.

To assist in making the transition from other non-volatile memories to MRAM, Everspin offers an FPGA evaluation platform. Using a Trenz CRUVI FPGA board with an MRAM daughter card, the evaluation board provides a ready to use tool for developing FPGA+MRAM designs.

An exciting Future

Developments underway will make it possible for MRAM technology to be further integrated within FPGA based systems. As chiplet technology continues to emerge, Everspin MRAM sitting alongside the FPGA in a single package can bring even more performance benefits while reducing the footprint of the system. Using MRAM as a configuration element within the FPGA fabric is yet another way to enhance performance via persistence of the configuration, i.e., instant-on capability combined with extremely fast reconfiguration as needed.