MITRE'S PHOTON
AN ACCELERATED COMPUTING RF SIGNAL PROCESSING PLATFORM

Researchers at The MITRE Corporation have developed a new software platform for processing extreme wideband spectrum applications: MITRE's Photon is a GPU-accelerated computing digital signal processing (DSP) platform for developing Python, Java, and C/C++ microservices.

Photon offers high-performance shared memory access to real-time RF sample data in cases where RF data processing can be constrained and fragmented by typical CPU limitations and CPU-GPU memory transfer latencies. Where CPU capacity restricts the ability to exploit advanced applications, Photon brings graphics processing units (GPU) technology to the table, leveraging established investments in software defined radios, high performance computing (HPC), artificial intelligence (AI) and machine learning (ML), for rapid development of efficient digital signal processing applications.

Benefits

- **On-demand data access to wideband I/Q samples.** High-speed and parallel access enables concurrent DSP applications to process massive volumes (100s to 1000s of MHz) of data without duplication, through a zero-copy, shared-memory data plane.
- **Enhanced capabilities through use of GPU technology** including wideband channelization and detection, real-time multi-mega point DFT processing, and AI/ML-enabled survey and detection processing.
- **Bridge between established and emerging platforms.** Photon leverages the powerful performance of both legacy and GPU-based platforms to free up CPU resources for other platform capabilities, and provide integrations with existing CPU-based DSP frameworks (e.g. GNU Radio Photon source and sink blocks, REDHAWK Photon FEI, and other military and intelligence tools.)
- **High-performance, parallel ingress to big data.** Access multiple segregated services running concurrently on a single common platform with industry-standard containerization techniques, microservice design patterns, Open-API and Google protocol buffer interfaces. Modular integration allows introduction and/or replacement of DSP component sub-systems for rapid deployment.

Applications

- Signals intelligence and electronic warfare systems
- Military radar and sensor systems
- Satellite communications
- 5G New Radio communications
- Space-based radio detection

Technology Details

Emerging technologies and innovations are ushering in an era of wireless communications and edge computing that offer bandwidth on demand low latency, high throughput content and AI driven network management and signaling. The impact and rate of change that these technologies have on the RF environment require a platform for signal processing that can bring wideband (100s of MHz to GHz) RF data, GPUs, and high-performance computing and networking technologies to every PC and computing device.

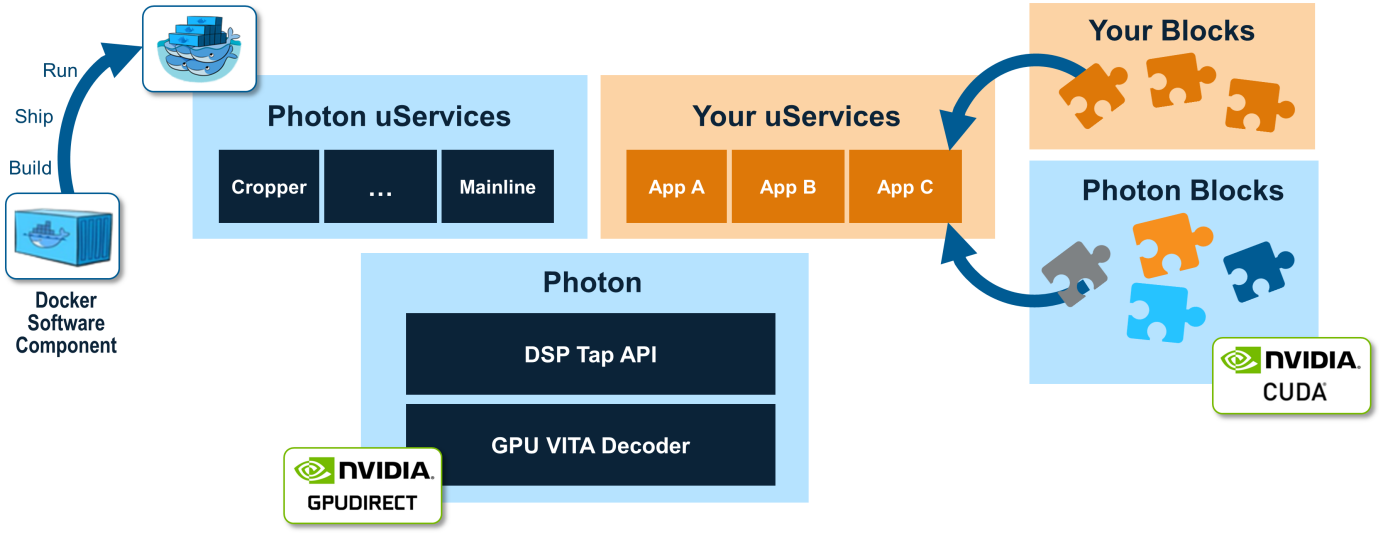
Across the wireless communications industry, demand is increasing for real-time wideband (GHz) software-based signal processing applications that take advantage of GPUs both for their ability to do massively parallel processing and for AI/ML inferencing. From 5G radio access networks, to military and government RF sensing systems, to the search for extrasolar radio phenomena, Photon offers a flexible alternative to field programmable gate array (FPGA) based solutions and existing software-based signal processing software stacks that cannot keep up to GHz sample rates.

Photon was developed to address these demands and represents a breakthrough in heterogenous processing architecture technology. Photon leverages commercially available products to transfer IQ samples into data structures for holding time aligned samples in GPU Device memory. The software makes continuous IQ samples available cross process boundaries through software APIs. A software pattern, to develop and deploy GPU-accelerated DSP Photon processing blocks that can be incorporated into a microservices architecture, is provided as a base system.

MITRE

How Photon Works:

The Photon software stack allows users to develop their own accelerated DSP blocks and microservices (uServices). Users can also leverage the blocks and microservices that are included in the Photon package. The software is designed to work on a CentOS Linux distribution. Detailed environment setup instructions are provided with the software in a containerized development environment that is OS independent.



Photon consists of:

- A direct memory address controller microservice that utilizes commercially available RDMA technology combined with commercial low-level networking libraries to transfer RF samples from a connected receiver into GPU Device Memory
- A DSPTap API that leverages shared memory data structure and cross-process boundary zero-copy sharing technology to enable time-aligned channels to be non-destructively accessed by third party applications in parallel
- A software pattern to develop and deploy GPU accelerated DSP Photon processing blocks that can be incorporated into a microservices architecture
- A set of Photon blocks and microservices for accelerated channelization, blind detection, AM/FM demodulation, VITA49 de-coding/ encoding and much more
- Templates, tutorials, example code, and videos on how to use the DSPTap API to develop new blocks and microservices
- Integrations with software defined radios, and some U.S. Government and Defense Innovation Board (DIB) software is available to system developers through access to DI2E

The MITRE Corporation is seeking licensees for commercial development of the Photon technology.
For more information, please contact: techtransfer@mitre.org

MITRE's mission-driven teams are dedicated to solving problems for a safer world. Through our public-private partnerships and federally funded R&D centers, we work across government to tackle challenges to the safety, stability, and well-being of our nation.

MITRE | SOLVING PROBLEMS FOR A SAFER WORLD