



GROUNDSPACE High-Performance DIFI Router

Context

Groundspace provides RF spectrum monitoring and SIGINT solutions consisting of networks of intelligent sensors. Each sensor comprises an antenna, a digitizer, and a computer with limited computational power, all integrated within a virtualized ground segment architecture. When signals of interest are detected, raw I/Q data is often transferred to a central processing node for archiving and advanced analysis. Users can also initiate on-demand real-time data streams if needed.

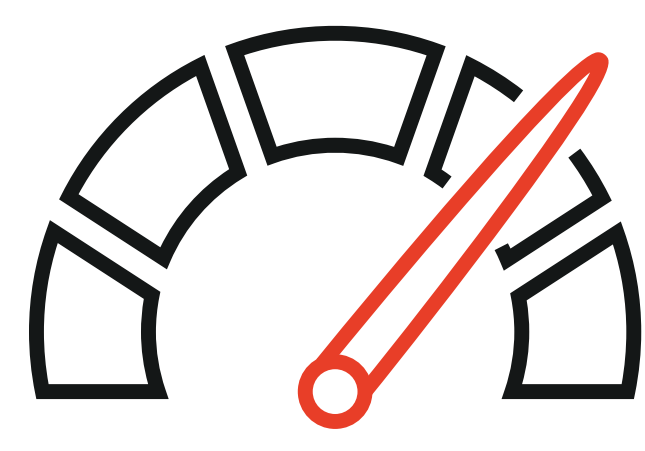
The sensor nodes are interconnected using various communication technologies, from dedicated high-speed fiber to commercial 5G networks. Despite potential network diversity, the system is designed to deliver a seamless and responsive experience. A critical component of this architecture is our high-speed DIFI router, which plays a central role in enabling efficient, virtualized RF distribution.



Goals



Establish secure links in a zero-trust environment



Route DIFI streams of up to 200 Gbps



Buffer streams transiting through low-bandwidth links

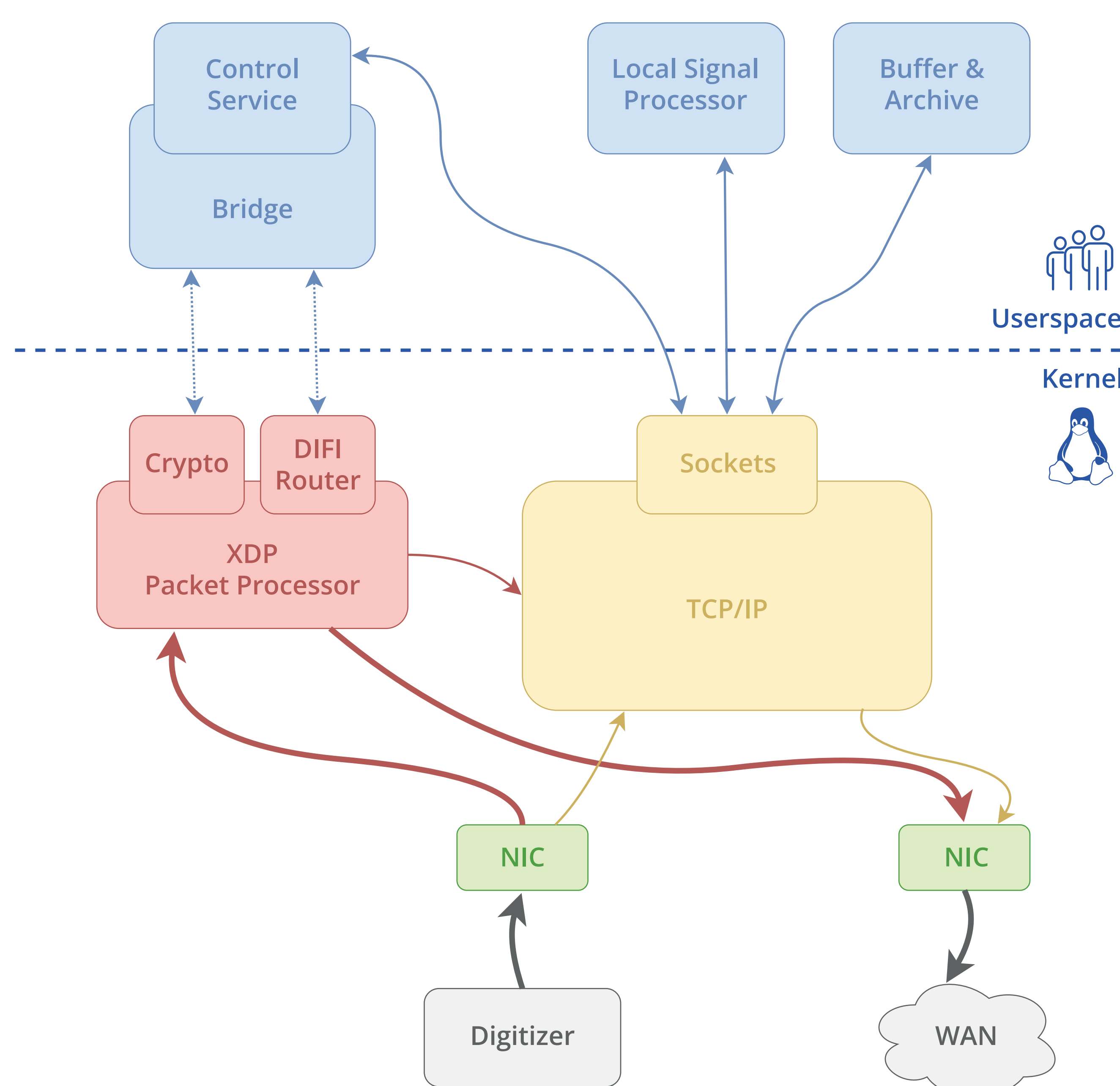


Support on-demand links and scalable networks

Workflow



Architecture



Technology

XDP (eXpress Data Path) is a high-performance, in-kernel packet processing framework in Linux designed for ultra-low latency data handling. By running custom packet processing programs directly in the network driver, XDP allows packets to be processed at the earliest possible stage in the network stack, even before they enter the kernel. This approach minimizes latency and enhances throughput.

Results

A proof-of-concept of an XDP-based virtual IF router, encompassing both in-kernel and userspace components, has been developed and tested using a native DIFI digitizer alongside simulated workloads. Offloading the processing and encryption of DIFI packets to the kernel shows strong potential, particularly for embedded systems with limited computing power. Performance evaluation is ongoing, with initial tests of 40 Gbps streams successfully conducted on commodity hardware. Additionally, a prototype for an in-kernel DIFI translator has been developed, demonstrating further functional possibilities.

