Memory-based API for real-time processing of high-data rate satellites

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ABSTRACT

Real-time processing of satellite data necessitates pipelined parallelism wherein a block of raw-data is transformed into final-processed data block as it moves from one stage of pipeline to another. For high-data rate satellites (like Cartosat-3 with 2.88 Gbps), the rate at which the blocks-of-data is generated is very high. Hence, efficient inter-process communication (IPC) for seamless data exchange between parallel processes is necessary for real-time processing. Shared memory and memory-mapped files are the fastest IPC mechanisms but often introduce complexity due to their intricate nature. Their direct use can be challenging for developers to learn and use effectively, leading to errors and time-consuming debugging. This paper addresses this challenge by proposing a novel, memory-based read-write API specifically designed for real-time processing of satellite data. This API offers a developer-friendly, file-like interface that abstracts complex IPC mechanisms, enabling efficient data exchange. It provides flexible data-exchange between processes like that achieved using a file with comprehensive features for robust data handling such as blocking reads, timed-reading, unblocking writes to accommodate growing-satellite data acquired during ground station visibility. The API also simplifies IPC resource management with a well-defined interface and offers multiple debug modes for streamlined development. It implements abstraction for both forms of IPCs viz., shared-memory and memory-maps by handling buffer-overflow for shared-memory and dynamic-stretching of memory-maps for growing satellite data thereby enhancing reliability and improving flexibility respectively. By streamlining complex IPC tasks, this API significantly reduces development time and effort enabling developers to focus on core-algorithms while improving the overall processing efficiency of real-time satellite data systems and making it an invaluable tool for real-time processing application.

Keywords: API, Abstraction, Real-time Processing, IPC, Shared Memory, Memory-Maps