Parallel Data Streaming with GStreamer and MPI

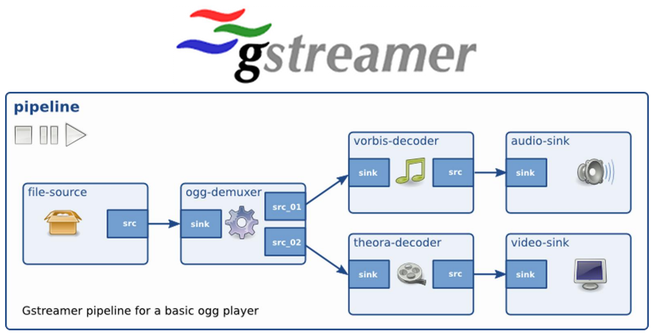
Garrett Roberts: Brigham Young University—Idaho
Jian Tao: Louisiana State University

Abstract

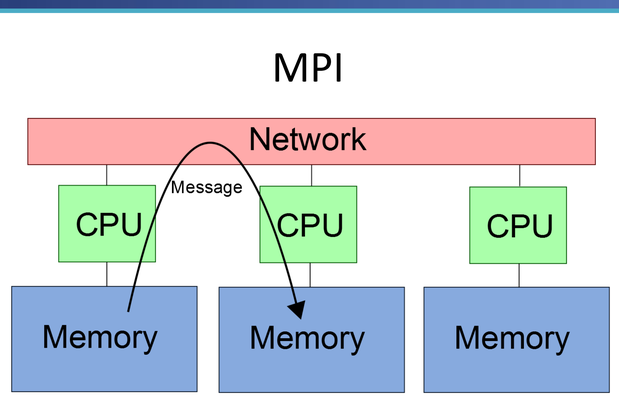
Data streaming is the movement of data from one place to another. To accomplish more in the same time, we use parallel processing, which uses multiple processors simultaneously. Depending on the methods used, this can improve both latency, the delay between input and results, and bandwidth, the amount of data that can be processed simultaneously. This project uses a data streaming framework, GStreamer, and a parallel processing framework, MPI, to achieve parallel data streaming and processing.

The Parallel Streaming Plugin

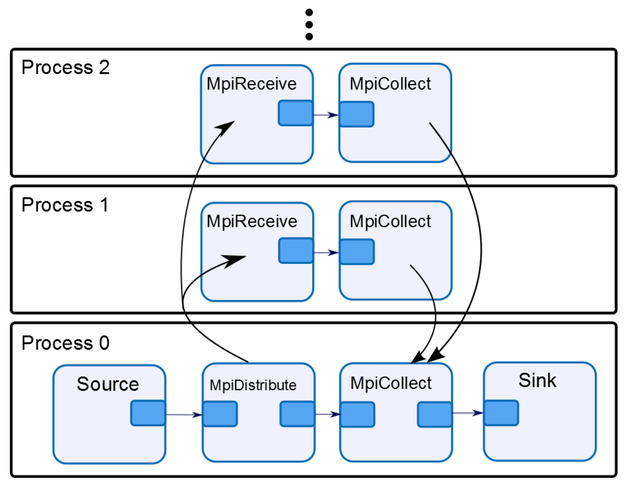
The result of the project was a collection of new elements for GStreamer, or a plugin, called "GstMPI." These elements use MPI functions to communicate with pipelines on other processes. Thus, each process can run its own pipeline independently, using MPI functions to coordinate as necessary, for example, sending data to analyze or returning the results of number crunching.



GStreamer is a multimedia streaming framework. It links individual **elements** together to create **pipelines**.



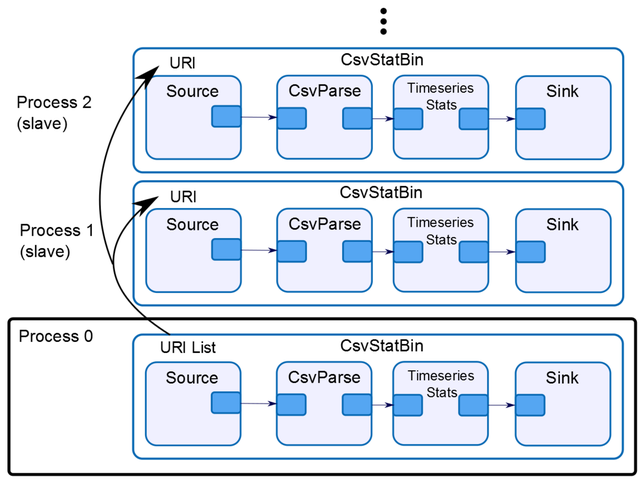
The Message Passing Interface (MPI) is a standard for a distributed memory parallel computation framework. It is designed for systems whose CPUs do not share the same memory, hence "distributed memory." It provides an API filled with functions to pass data among many processes over a network.



This figure shows how these elements can be used. An MPI programmer can construct one pipeline for the root process (0), and another pipeline for the other processes (1 and up). The MpiDistribute element splits its data between itself and the other processes, and the MpiCollect elements perform a reducing operation to bring the relevant information back to the root.

Time Series Analysis

A time series is any set of data points collected on a scale of time. These types of datasets have applications in signal processing, coastal modeling, financial data analysis, gravitational wave analysis, etc.



This figure shows the time series analysis elements. A higher-level element, CsvStatBin, allows the user program to only worry about one process with one pipeline and no MPI calls. Provided with a list of stream identifiers, or URIs, this element creates its own child processes, essentially duplicating the pipeline for each additional data stream. This is enabled by a slave program included in the plugin. The pipelines then analyze their separate time series independently, potentially sending relevant statistics back to the root process.

Future Work

While the framework developed in this project is in need of further development and extension, it can be used directly in time series analysis applications. Specifically, it may prove to be a useful tool in future coastal modeling projects.

References
http://gstreamer.freedesktop.org/ (Images)

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