Kashima Flexible Correlator (KFC) – A next generation VLBI software correlator

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Abstract:

Next generation VLBI technology (VLBI2010) will increase the amount of digital sampled data by at least two orders of magnitude compared to currently operational geodetic VLBI equipment. Thus, a flexible, scalable and high-performing correlator is needed to handle the large data-streams in (near) real-time. The Kashima Flexible Correletor (KFC) will follow and potentially outperform new generation software based VLBI correlators which are capable to handle current und upcoming VLBI data-streams.

KFC concept:

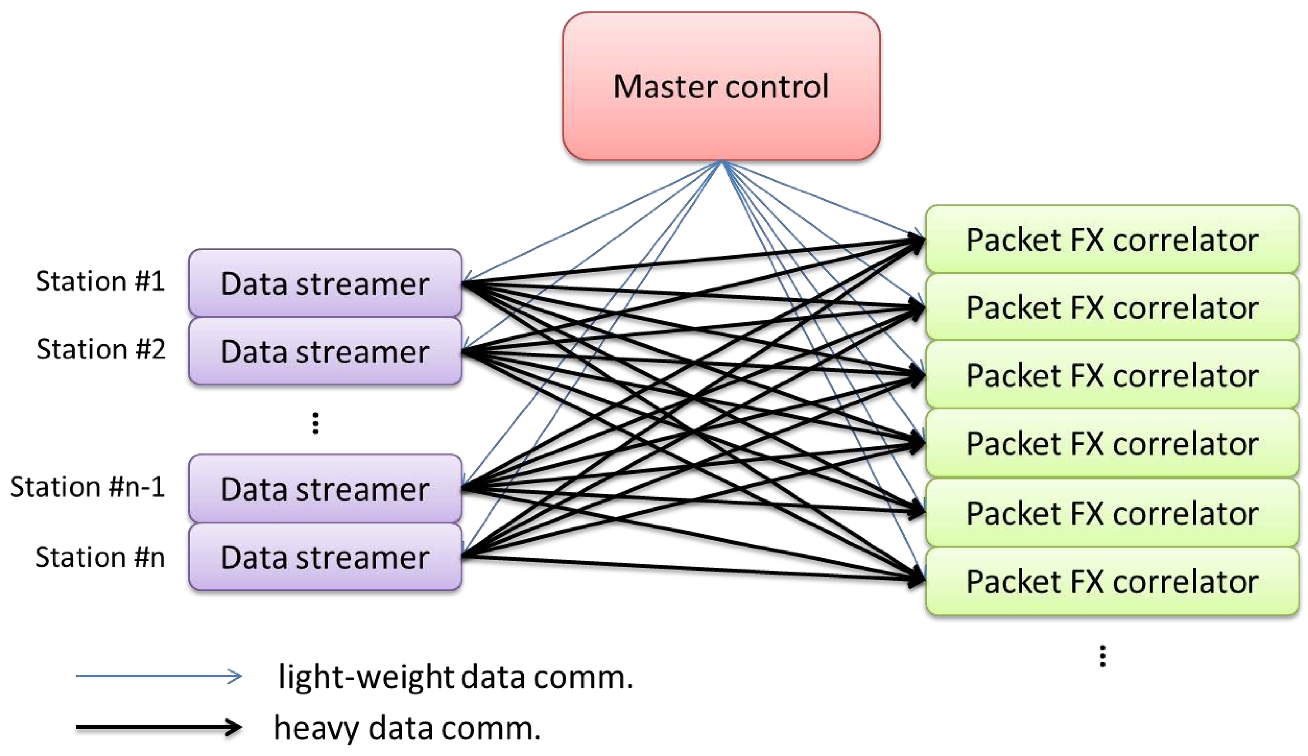

Figure 1: Outline of the KFC concept. Communication between master control, data streamers and correlator nodes is done vie the Message Passing interface (MPI) which ensures good scalability from single CPU PCs up to high-end computing cluster and super computing platforms .

Data streamer:

The data streamer (figure 2) provides packetized raw-data to the correlator nodes. Thereby, high data-throughput towards the correlation must be ensured for (near) real-time operation. Additionally, data-streamers will extract phase-cal signals and check the raw-data for I/O errors.

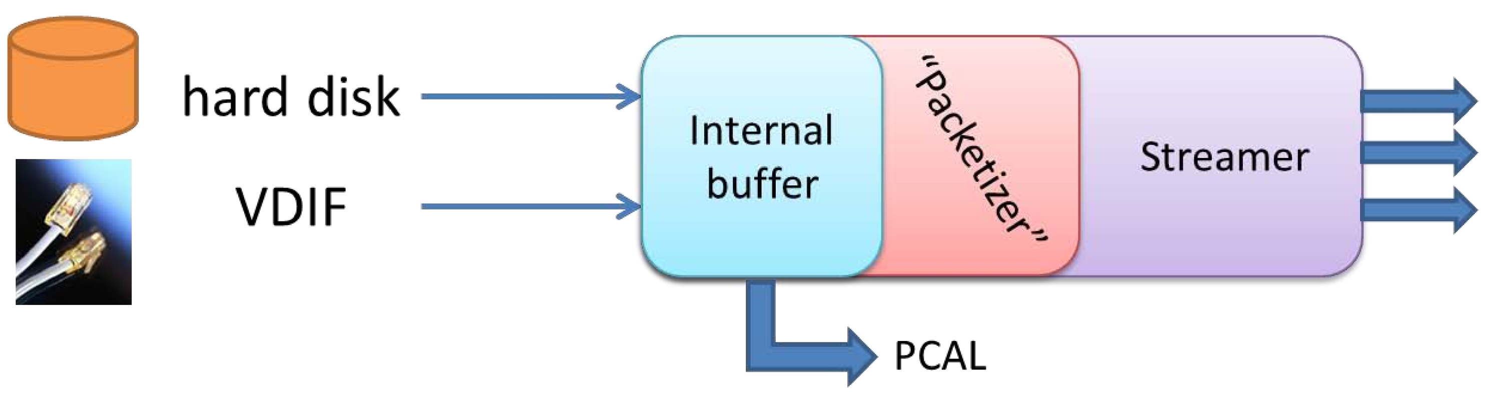

Figure 2: Operating mode of a data-streamer.

Correlator node(CPU):

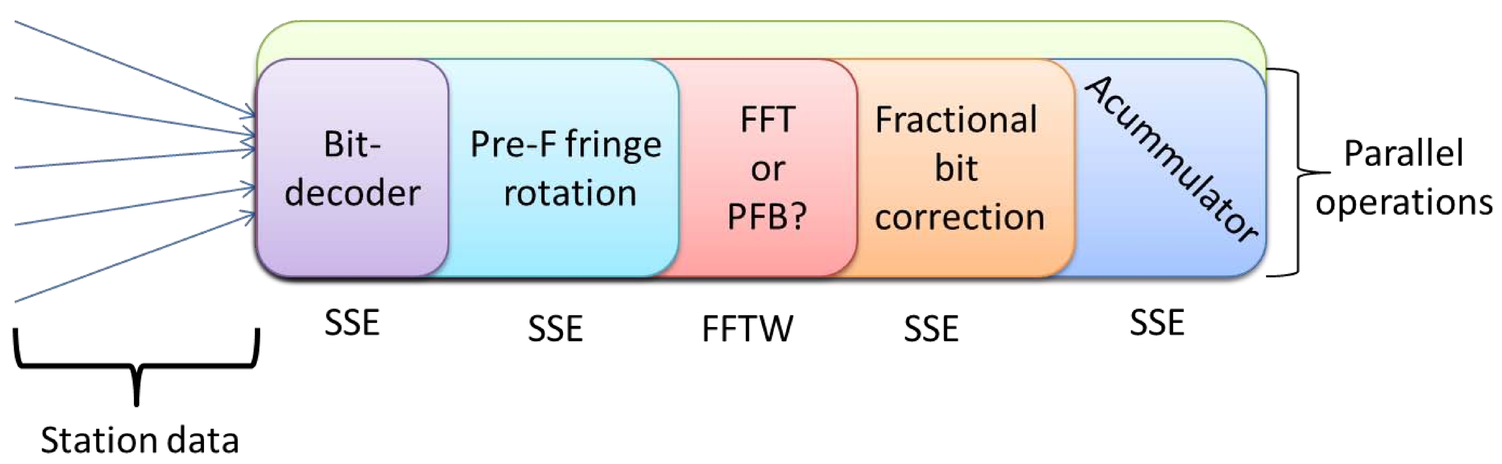

Figure 3: Functions of a CPU based correlator node.

Correlator node(GPU):

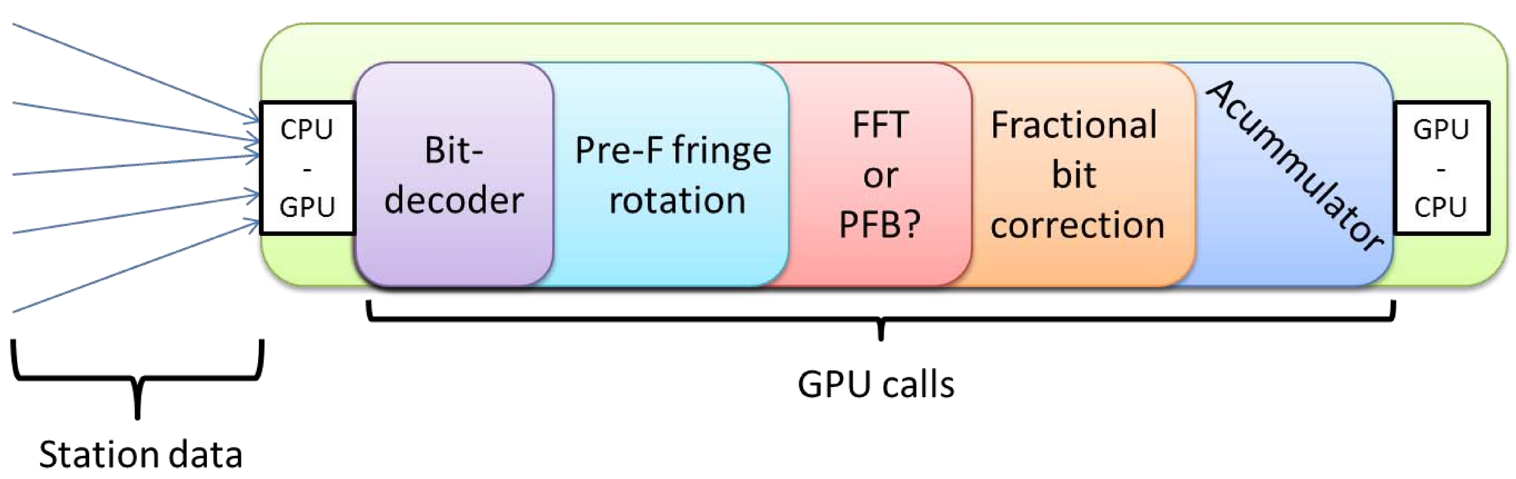

Figure 4: Functions of a GPU based correlator node.

Operations modes:

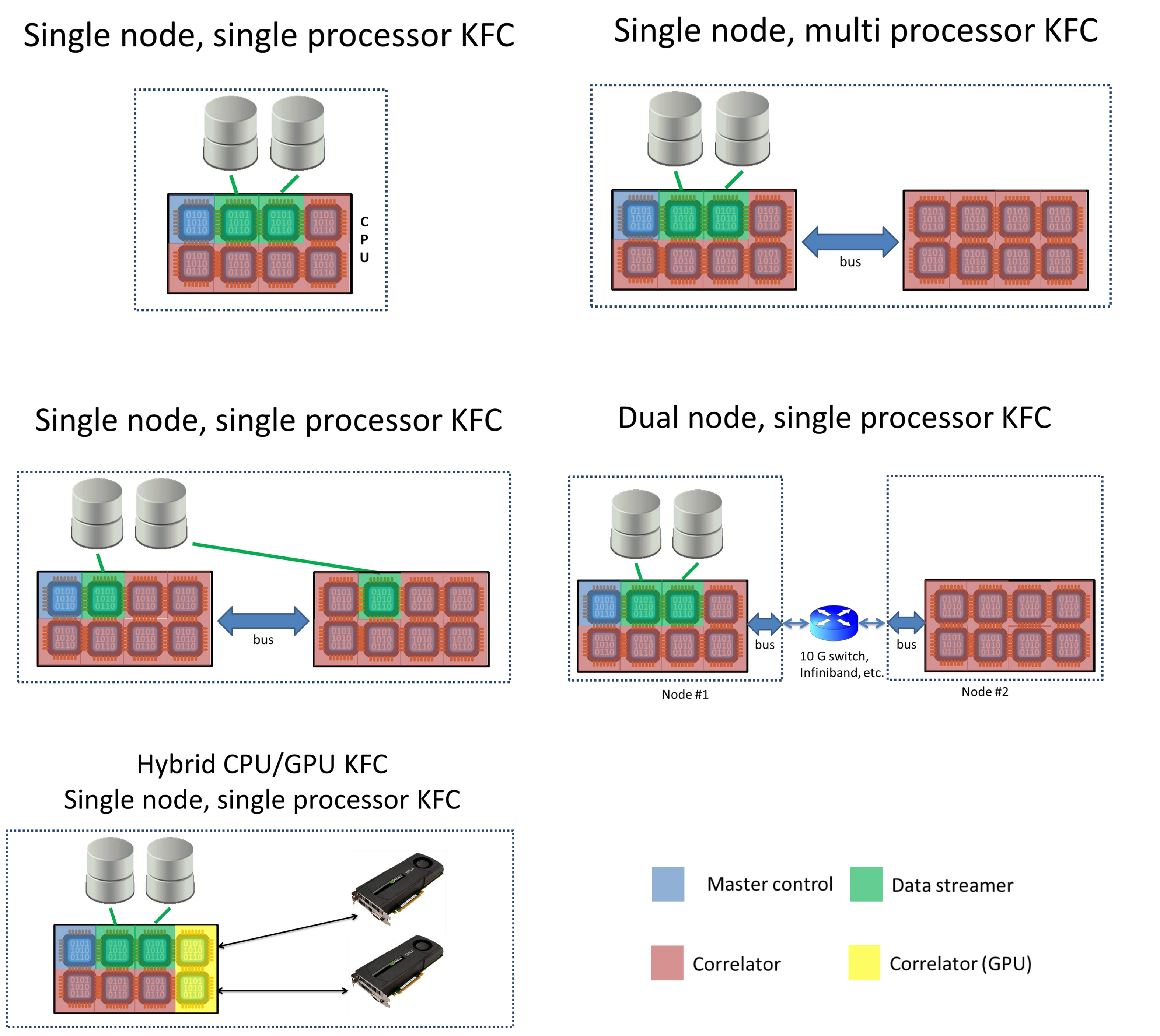

Figure 5: Five examples of how possible computing environments on which the KFC is expected to run. Beside pure single- and multi-CPU machines, the software correlator can be installed on multi-node and hybrid CPU/GPU environments.

Possible bottle-necks:

Even sophisticated hardware and network topologies are posing the risk of hampering or stopping the scalability of software correlators. Possible bottlenecks have been identified as

- **Inter-node bandwidth: Data-transfer from the streamers to the correlator might be limited by the bandwidth of the inter-node communication. 10 GbE might not be sufficient for operating in full VLBI2010 mode with data-rates of several 10s of Gsps. InfiniBand technolgy, 40 GbE or even 100 GbE might be necessary for high-end correlation tasks.**
- **Hard-disk I/O: VLBI2010 data will be recorded on hard-disks (HD) and must be played back for correlation processing. Thus, HD read performance must ensure data-rates of several 100 MB/sec in order to operate as clock as possible to real-time. This requires sophisticated file-systems, top-edge RAID cards and fast and reliable hard-disks.**
- **Hybrid-architectures: GPUs are expected to perform well for larger data-sizes, whereas CPUs are expected run faster correlators with smaller data sizes. Thus, KFC must be capable to schedule the streamers dynamically feeding data to the correlators in a way to keep both computing platforms of a hybrid system at optimum occupancy.**

Advances of soft- and hardware components are expected to help overcoming most of the bottle-necks.

Road-map for the FY2012:

Figure 6: depitcs the current development status and an outlook how far the implementation of KFC will proceed within the FY2012.

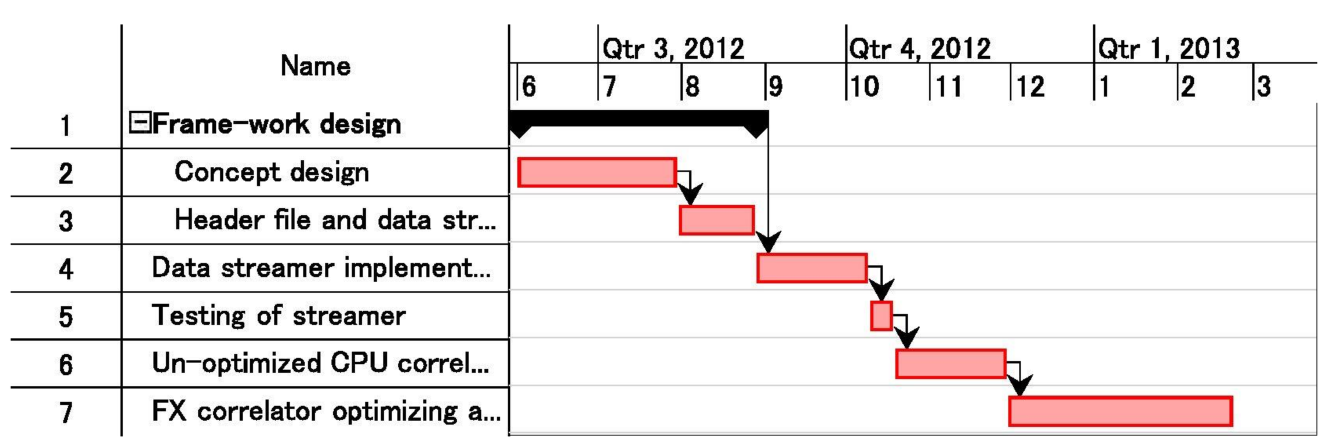

Figure 6: KFC development road-map for the FY2012.