JUC memo #15

Some simple calculations regarding the power consumption and price of possible future JIVE correlators.

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1. Introduction

In this memo a brief overview is given of the power budgets of the correlators currently at use and under development at JIVE. As both correlators make use of playback units like the Mark5 or the FlexBuff recorders, these do not feature in the calculations. An extrapolation is made to a "next generation" EVN correlator, including the financial investment needed.

2. SFXC

The EVN software correlator at JIVE (SFXC) is currently used for all EVN operations. It boasts many improvements over the (recently retired) MarkIV hardware correlator, is very flexible, with many new features being developed and offered to the scientific community.

The software runs on a commodity cluster, which has an Ubuntu Linux operating system, and makes use of MPI and Infiniband.

The hardware was purchased in three steps.

data of purchase	Processor	nr CPU	nr cores	processor speed (GHz)	power at full load (kW)
Jan 2010	Intel Xeon E5520	32	4	2.27	4
Jun 2011	Intel Xeon E5620	32	4	2.4	4
Nov 2012	Intel Xeon E5-2670	16	8	2.6	2

Clearly processing power has gone up with the years, as has power efficiency. Note however that the last tranche has as many cores as the others, and was only slightly cheaper than the first two. The power consumption when idle is roughly one quarter of the full load.

3. UniBoard

The EC-funded UniBoard project had as aim the development of a generic high-performance computing platform using state-of-the-art FPGAs. Part of JIVE's task in this project was the design of a VLBI correlator personality.

This correlator personality is now loaded onto two UniBoards, each equipped with 8 Altera Stratix IV FPGAs, 16 DDR3 memory banks and a total of 16 times 10-Gbps ports in and out.

Power consumption per UniBoard:

- Idle: 163 Watt
- full load: 230 Watt

4. Comparison

For this comparison, we will assume that we wish to accommodate "standard" operations in the EVN at 4 Gbps per telescope (made possible by the new DBBCs in the EVN), from 16 telescopes, in real time.

In its current configuration, SFXC can just about handle the data from 13 telescopes running at 1 Gbps in real time. Although the computing power needed for correlation in principle increases quadratically with the number of stations, a considerable part of the total computation scales linearly. We estimate that going to 16 stations will require a factor of 1.4 more computing power, from 1 to 4 Gbps another factor of 4, in all 5.2 more computing than currently available. The price of the complete cluster is of the order of 130 keuro.

Two UniBoards can do 16 stations at 2 Gbps. Going to 4 Gbps will require an additional 2 boards. These are about 10 keuro/piece.

platform	**power consumption (kW)**	**investment (keuro)**
SFXC	31.2	546
UniBoard	1	20

5. Considerations

This is of course a simple and somewhat crude comparison. In many ways a software correlator is far more flexible than a firmware-based correlator. Very high-spectral resolution will always have to be done on a software correlator, and wide-field observations will be more limited on the UniBoard. Commodity hardware will continue to decrease in price and become more power efficient. And one could argue that a software correlator is perfectly capable of correlating any number of stations at any bandwidth, given enough time; real-time operations are not always a necessity.

On the other hand, the numbers above are rather compelling, and show the UniBoard correlator can be a fantastic complement to the SFXC, useful for the heavy lifting which will not be feasible for some time on commodity hardware. Add to this the life time expectancy of commodity hardware: failures of the SFXC hardware are quite common, maintenance contracts expensive and life time limited, which necessitates regular replacements of components. FPGA-based hardware is far more robust and much cheaper to replace.