PaRC

PortAble Rasbperry pi Cluster

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September 27, 2020

Contents

Chapter 1

Introduction

The aim of this project was to create a portable cluster for doing on premise parallel computing. It consists of 6 raspberry pi's in a rugged waterproof case connected to a wifi router.

This report is printed, bound and placed in the top of the box for the cluster. It is to serve as a primary source of information about how the cluster is to be used, how to interact with it, and how it works.

All of the information regarding the parts can be found in Appendix A. For information regarding the hardware, see Chapter 2, and for the software is in Chapter 3.

Chapter 2

Hardware

The device, named PaRC (PortAble Raspberry Pi Cluster) is a rugged box holding 6 raspberry pi's, a WiFi router, 8 port switch, two fans, and accompanying power supplies. The complete parts-list can be found in Appendix A, but can be summarized by:

1. 6 Raspberry Pi 4B's with 2GB or RAM.
2. 2 100W 5V power supplies for the Raspberry Pi's and the switch.
3. 1 10W 9V power supply for the router.
4. 1 TP Link TL-WR841N router.
5. 1 generic 8 port gigabit switch.
6. 1 SERPAC SE630 rugged box.
7. 2 12V 2.9W fans

2.1 Wooden structure

Not included in the appendix, nor the list above, is the wooden structure. PaRC is built inside of a wooden structure sitting inside the SE630, which can be easily removed for easy access to all the components. The box is made using 12mm plywood for the structural elements and 3mm plywood for the top panel. No glue is used, only screws, so that it can be completely disassembled. Wood was chosen for its low price and easy availability both itself and the tools and consumables required to make it into the necessary shape.

2.2 Power supplies

To power the Raspberry Pi's, 5V power is required. However, the recommended power supplies are not cost effective. Hence, 100W 5V Mean Well power supplies were purchased, to supply the required $6 * 15W = 90W$ for the Raspberry Pi's. Two of these power supplies were ordered for redundancy. This was deemed necessary because the internal fuses for these power supplies cannot be replaced in the field as they are soldered on.

The 8 port switch takes a 5V power input and can hence be connected directly to the power supplies for the raspberry pi's rather than requiring their own power supply.

The router however, requires 9V to operate. Rather than reusing the power supply it came with, providing 6W, a 10W power supply was used, to offer expandability.

The fans are currently running on the 5V rail, and are hence providing much less cooling than at the spec 12V. However, cooling hasn't yet been an issue. Nevertheless, a 15W 12V power supply is on the list for future upgrades.

With all this excess power, another item on the upgrade list is a set of terminals (most likely using banana jacks) to provide the excess 12V, 9V, 5V and (after installation of a 5V to 3.3V DC to DC converter) 3.3V. In the toolset will then also be a set of banana plugs.

2.3 Toolset

In the bottom of the box (the largest portion), the wooden structure with all the electronics resides, but in the lid holds other useful tools:

1. A Philips screwdriver to take the box apart,
2. 3.15A fuses for the power entry module,
3. The power cable,
4. A copy of this document,
5. Banana plugs, and
6. The WiFi antennas

These are all placed in a canvas fabric attached to the lid with velcro (so that the fabric can be changed).

2.4 Top panels

The 3mm plywood was used to form the top panels. The left panel holds:

1. 2 Neutrik Ethernet connectors. One of them is connected to the WAN port of the router, and the other to on of the LAN ports. This enables, without disassembling anything, the router to provide an internet connection to cluster nodes and also an outside device (such as a laptop).
2. The power entry module with a receptacle for the IEC-320 C-14 power cable, a 10A switch, and a fuse drawer.

The right panel, being the largest, is reserved for the possible future addition of a touchscreen, to control and provide data about the status of the cluster.

Chapter 3

Software

PaRC is programmed in Python. All of the nodes run raspbian, a Raspberry Pi optimized version of Ubuntu. The software is structured such that there is one main node, and the rest are worker nodes.

3.1 Main Node

The main node, being either a laptop connected to the network, or one of the Raspberry Pi's (for stand-alone operation) is the one controlling all the others. Startup of the main node is roughly as follows:

1. The Main Node creates instance of the WorkerNode class such that it has a representation of all the nodes it found from the node_list.csv file.

2. Then a network speed test is performed. This includes both ping and upload and download speeds to each node.

3. The code in for the Worker Nodes is zipped up and sent to all the nodes and unzipped there. The nodes are then started.

4. The main node starts a webserver that is both a webapp for users to see that status of the machine, and an API for nodes to: 1) Check for work, 2) Download projects, and 3) Send the results back.

Once startup is done, the webserver add the tasks to its get_work endpoint, and the worker nodes execute it. Depending on the project, the new tasks handed out may or may not depend on past results. This will be the case for a function optimizer (a system that tries to find the input that yields the highest output for a function).

The endpoints of the web server that are user facing provide information about the nodes (number of processes, gpu and cpu temperature, ping time and network speed) and also about the results that these nodes have returned.

When the cluster is used in stand-alone operation, the main node will also run up to 2 processes (rather than the 4 as the others). This is to maximize the computing power of the cluser while also ensuring enough remains for the webserver operation.

3.2 Worker Nodes

After the worker nodes are initialized by the main node, they start a loop:

1. If there are less than the maximum number of processes running, the node will try and get more. This is done by sending an HTTP GET request to the get_work endpoint. If a task is returned then:

   If the task corresponds to a project that has not yet run, that project will be downloaded and the dependencies installed.

   The task is then run in a separate process. This means that rest of the loop will continue running from here.

   When the task finishes, it calls the post_answer endpoint (HTTP POST request).

2. The status is posted. This is the main tool for getting information from the worker nodes to the main node. This also enables the main node to update its information about the worker nodes in the corresponding instance of the WorkerNode class.

The number of processes in each node is limited to 4 (= the number of core in the Raspberry Pi). The loop will shut down when a stop file is placed in the right directory by the main node. This enables a soft kill process.

Appendix A

Parts lists

The following chapter contains the order summary of all the parts that were purchased online.

Other purchases include:

1. 1m by 0.5m 12mm plywood and 1m by 0.5m plywood for 13 euros,
2. 4 3.15A fuses for 4.5 euros.

Customer Service Office
ESP 222
5633 AC Eindhoven
The Netherlands
+31 88 1300 700

Sales Order No: -
Web Order No: 19341546
Order Date: 05-Jul-20
Order Status: Pending

Detailed Order Receipt

Billing Information

Joe Verbist
Multatuliweg 91
Delft, 2624 CG
Netherlands
0032471604984

Dispatch Information

Joe Verbist
Kollegestraat 38
Geel, 2440
Belgium
0032471604984

Delivery Method

Shipment: FedEx International Priority

Payment Method

Payment Type: Credit Card - Mastercard ending in 6868

Item	Product Detail		Qty.	Availability	Price	Ext Total
1	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	SERPAC SE630,BK 635-SE630-BK	1	1 Dispatches Now	€ 74,86	**€ 74,86**
2	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	Seeed Studio 110990048 713-110990048	6	6 Dispatches Now	€ 2,61	**€ 15,66**
3	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	SanDisk SDSDQAD-016G 467-SDSDQAD-016G	5	5 Dispatches Now	€ 10,43	**€ 52,15**
4	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	Neutrik NE8FDV-TOP 568-NE8FDV-TOP	1	1 Dispatches Now	€ 6,78	**€ 6,78**
5	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	Wurth Elektronik 971450155 710-971450155	10	10 Dispatches Now	€ 1,50	**€ 15,00**
6	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	Neutrik B-SCREW-1-8 568-B-SCREW-1-8	20	20 Dispatches Now	€ 0,133	**€ 2,66**
7	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	Essentra 04M025045HN 144-04M025045HN	20	20 Dispatches Now	€ 0,075	**€ 1,50**

Item	Product Detail		Qty.	Availability	Price	Ext Total
8	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	MEAN WELL LRS-100-5 709-LRS100-5	2	2 Dispatches Now	€ 16,02	**€ 32,04**
9	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	Sunon MEC0381V3-000U-A99 369-MEC0381V3000UA99	2	2 Dispatches Now	€ 9,75	**€ 19,50**
10	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	FCI / Amphenol 10133475-10001LF 649-10133475-10001LF	1	1 Dispatches Now	€ 2,30	**€ 2,30**
11	**Mfr.:** **Mfr. No:** **Mouser No:** **Desc.:**	JAE Electronics DX07P022AA6R2000 656-DX07P022AA6R2000	1	1 Dispatches Now	€ 1,49	**€ 1,49**

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nl.mouser.com/saleterms/

Merchandise Total: **€ 223,94**
Shipping Total: **€ 0,00**
VAT Total: **€ 47,03**

Order Total: € 270,97

Print

Customer Service Office
ESP 222
5633 AC Eindhoven
The Netherlands
+31 88 1300 700

Sales Order No: 251468101
Web Order No: 19640715
Order Date: 16-Aug-20
Order Status: In Shipping

Billing Address

VERBIST, JOE

RETIESEWEG 170
2440 GEEL
Belgium

Delivery Address

JOE VERBIST

KOLLEGESTRAAT 38
2440 GEEL
Belgium

Payment Method

PayPal

PO Number: 19640715

Delivery Method

Delivery Method: FedEx International Priority

Product Detail	Customer No	Order Qty.	Price (EUR)	Ext. (EUR)	Status	Date	Invoice No.
Mouser No: 710-971450155 **Mfr. No:** 971450155 **Desc.:** Standoffs & Spacers Standoffs & Spacers WA-SPaIE Spacer Stud M2.5x45mm SW5		14	1,41 €	19,74 €	14 Pending	Pending	-
Mouser No: 485-743 **Mfr. No:** 743 **Desc.:** Adafruit Accessories Adafruit Accessories Waterproof DC Power Cable Set		5	2,12 €	10,60 €	5 Pending	Pending	-
Mouser No: 650-400R0111-10-9 **Mfr. No:** 400R0111-10-9 **Desc.:** Hook-up Wire Hook-up Wire 400R0111-10-9 Price Per Foot		8	0,889 €	7,11 €	8 Pending	Pending	-
Mouser No: 693-KM00.1205.11 **Mfr. No:** KM00.1205.11 **Desc.:** AC Power Entry Modules AC Power Entry Modules 1P FUSE/2P SWITCH 10A 250VAC NO Drawer		1	6,45 €	6,45 €	1 Pending	Pending	-
Mouser No: 356-ESP32-S2-SAOLA-M **Mfr. No:** ESP32-S2-Saola-1M **Desc.:** WiFi Development Tools (802.11) WiFi Development Tools (802.11) ESP32-S2 general-purpose development board, embeds ESP32-S2-WROOM, 4 MB flash, with pin header		1	6,78 €	6,78 €	1 Pending	Pending	-

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MERCHANDISE TOTAL: 50,68 €
VAT TOTAL: 10,64 €
ORDER TOTAL: 61,32 €

Gmail **Joe Verbist <joe.verbist@gmail.com>**

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Antwoorden op: commande@mchobby.be
Aan: Joe Verbist <joe.verbist@gmail.com>

18 juni 2020 om 09:49

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Commande : 26168 passée le 18/06/2020 09:49:32

Paiement : Paiement par carte bancaire Ultr

Référence	Produit	Prix unitaire	Quantité	Prix total
RASPBERRY-PI-4-2Go	**Raspberry Pi 4 - 2 Go de RAM !! DISPO EN STOCK !!**	39,95 €	5	199,75 €
			Produits	199,77 €
			Réductions	0,00 €
			Paquet cadeau	0,00 €
			Livraison	0,00 €
			TVA totale	34,67 €

Total payé	199,77 €

LIVRAISON

Transporteur : Home delivery / Livraison à domicile / Thuislevering

Paiement : Paiement par carte bancaire Ultr

ADRESSE DE LIVRAISON

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