Born2beroot 01: Creating a Debian Virtual Machine

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In 42 School Projects
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The 42 project Born2beroot explores the fundamentals of system administration by inviting us to install a virtual machine with VirtualBox. The server we will be creating must have the partition scheme defined in the subject as well as the Linux operating system of our choosing : CentOS or Debian. These are the topics we will examine in this article. Two future articles will tackle the configuration of Born2beroot and its bonuses.

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What is a Virtual Machine?

In many ways, a **virtual machine** (**VM** for short) is practically identical to a regular physical computer. Both have a CPU, some RAM, a hard drive and an internet connection if needed, and various operating systems and software can be installed within them. The only difference is that a physical computer uses its own hardware, whereas a virtual machine borrows the physical resources of its host. A virtual machine is therefore only code, a virtual computer within a physical server.

The software called hypervisor or virtual machine monitor (VMM) is responsible for creating and running virtual machines, as well as managing resources — like CPU, memory, and storage — among them.

Advantages of a Virtual Machine

There are several benefits to a virtual machine:

- Running a different operating system than the physical computer without having to partition its hard drive or restart it.
- Installing old operating systems like DOS, even if the hardware is no longer compatible.
- Carrying an entire OS on a USB key for example, or transferring an entire machine from one computer to the next easily.
- Developing a program intended for a different OS and using software never intended to run on the physical machine's OS.
- Isolating a program of dubious origin, or even a virus, to handle it without risk to the physical computer. As a matter of fact, a virtual machine and its hard drives can easily be frozen, restarted, copied, transferred from one computer to the other, and deleted. Besides, it is possible to take a snapshot of the VM's state in order to restore it as it was at that moment.
- Installing several virtual machines on a limited number of physical computers, instead of having to multiply the number of physical machines. This saves on spending, on electricity and on maintenance time.

Drawbacks of Virtual Machines

However, a virtual machine does have its drawbacks, especially concerning security and performance:

- The host computer must be able to handle virtualization: too little RAM leads to slowness and latency.
- If the host computer breaks down, the virtual machines might no longer be accessible unless there are backups on another physical machine.
- A physical computer is also more vulnerable to attacks if it runs several virtual machines rather than a single operating system.

CentOS vs Debian for Born2beroot

For the Born2beroot project, we have a choice between two operating systems for our virtual machine: CentOS or

Debian. These two GNU/Linux distributions are community-supported and open source. Both are well known for their stability and security.

Debian

Launched in 1993, **Debian** is the oldest and most robust Linux distribution. Developed and maintained by a large community, it supports a wide variety of architectures and offers are large selection of packets. This OS is easy to update and its minimal installation saves on server ressources and increases its security. Debian is a common operating system, whether it be for network servers or personal computers. However, Debian is not particularly user-friendly and requires interacting with the terminal. Moreover, it does not offer an Enterprise version.

CentOS

CentOS on the other hand is specifically aimed at enterprise servers. Launched in 2004, CentOS (***C**ommunity **ent**erprise **O**perating **S**ystem*) is the free, open-source version of RHEL (***R**ed **H**at **E**nterprise **L**inux*). Nearly identical and 100% compatible with RHEL Quasiment identique et 100% compatible avec RHEL from a binary perspective, CentOS is widely used in the IT world. Indeed, it meets company requirements for security and stability and offers 10 year support for each of its versions. Updating from one version to the next remains difficult however: a full installation of the new version is recommended.

In december 2020, the community put an end to the development of CentOS in favor of CentOS Stream. CentOS Stream is a more experimental and less stable version that precedes RHEL, whereas CentOS used to follow RHEL version releases closely.

For our Born2beroot project, CentOS is the one that interests us, not CentOS Stream. Despite the fact that CentOS is no longer being developed, it is still a good option to consider in order to explore enterprise-specific Linux distributions, RHEL in particular.

Which OS to choose for Born2beroot?

There is no real “best” choice for Born2beroot. The rest of this article series will concentrate on Debian simply because it seems that it is more widely used on internet servers in general. For anyone curious about CentOS, Carol Daniel’s guide on Github is a great resource.

Below is a summary table of the major differences between CentOS and Debian:

	CentOS	Debian
Launch	2004	1993
Community	Red Hat Enterprise and community	Debian project community
Release Cycle	2 – 5 years (10 years support per version)	2 years (5 years support per version)
Update	Difficult. Full install of new major version recommended.	Easy. No need for reinstallation.
Supported Architectures	x86_64/AMD64, AArch64/ARM64 et ppc64el/ppc64le. (CentOS 7 : armhf/armhfp, i386, POWER9.)	x86_64/AMD64, AArch64/ARM64, armhf/armhfp, i386, ppc64el/ppc64le, MIPSel, MIPS64el et s390x.
Packet Manager	RPM, YUM/DNF	DEB, dpkg/APT
Number of Packets	Limited.	Large choice of packets.
Percentage of Servers [source]	9,7%	15,6%
State of the Project	Terminated December 2021.	In development.
Download	CentOS ISO images	Debian ISO images

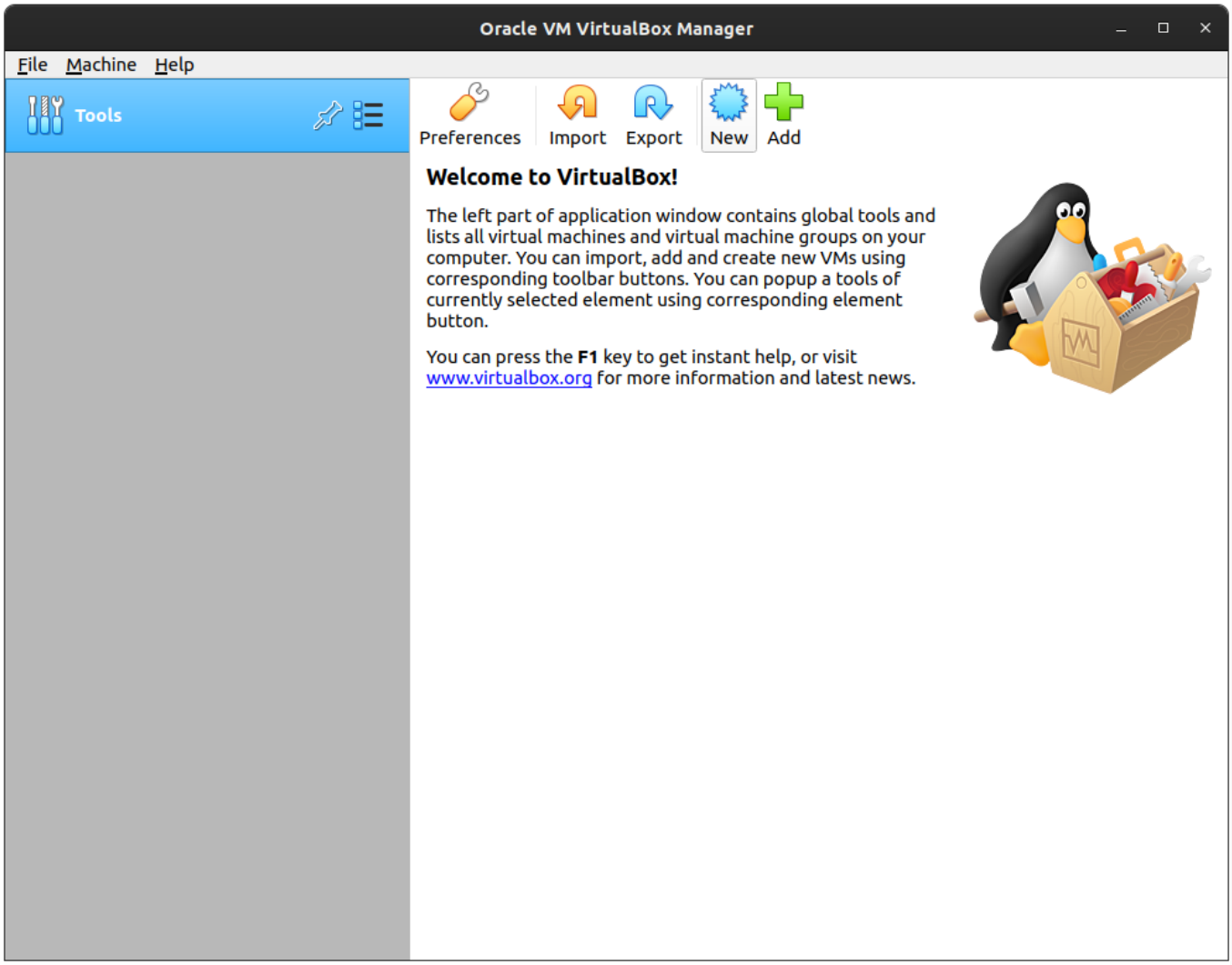
Creating a Born2beroot Virtual Machine

In order to create our Born2beroot virtual machine, we will need two things:

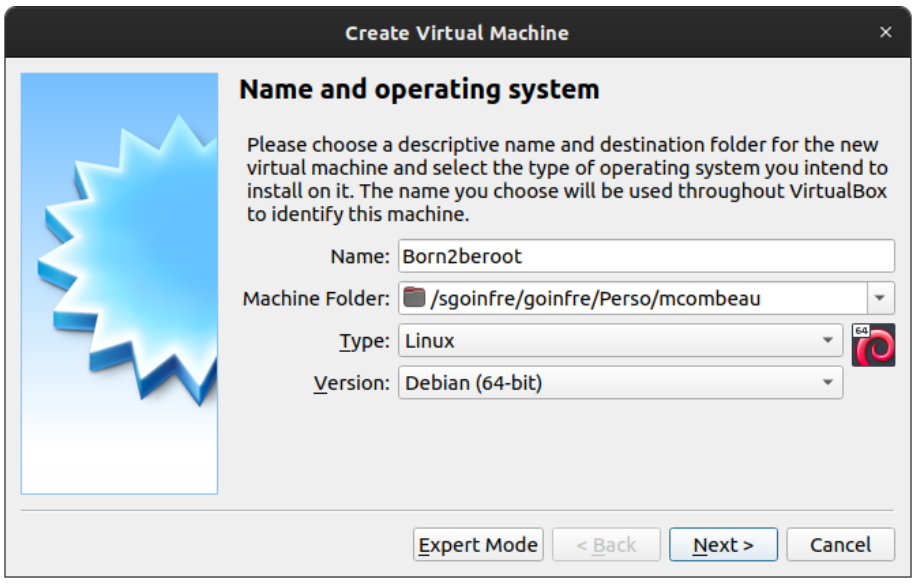
- **Oracle VirtualBox** which is already installed on the computers at 42. Otherwise, we can download it from

the official website. At the time of this writing, it is version 6.1.
- The **Debian disk image**, which we can download from the official website. At the time of this writing, it is version 11.2.0. The ISO ending in “amd64-netinst.iso” is good enough.

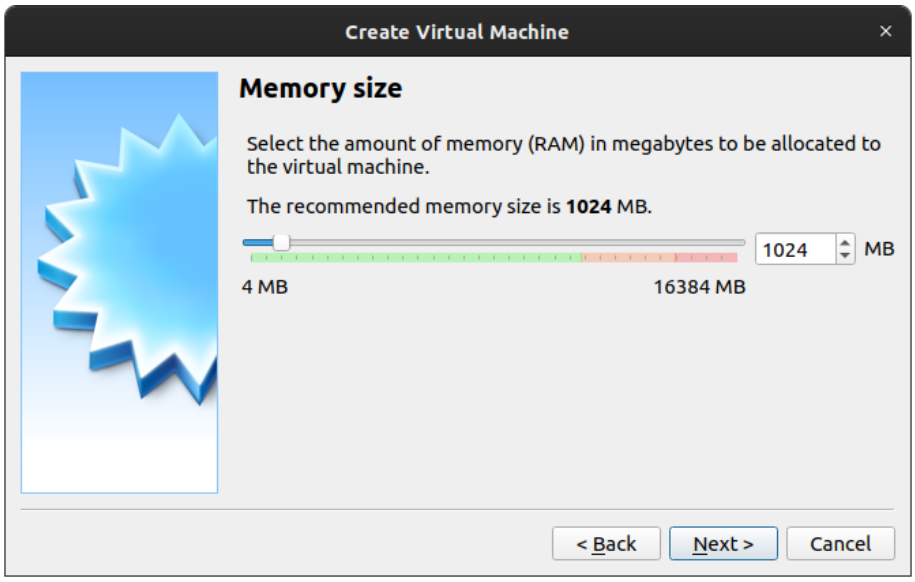
Once VirtualBox is installed, we can start setting up our virtual machine.



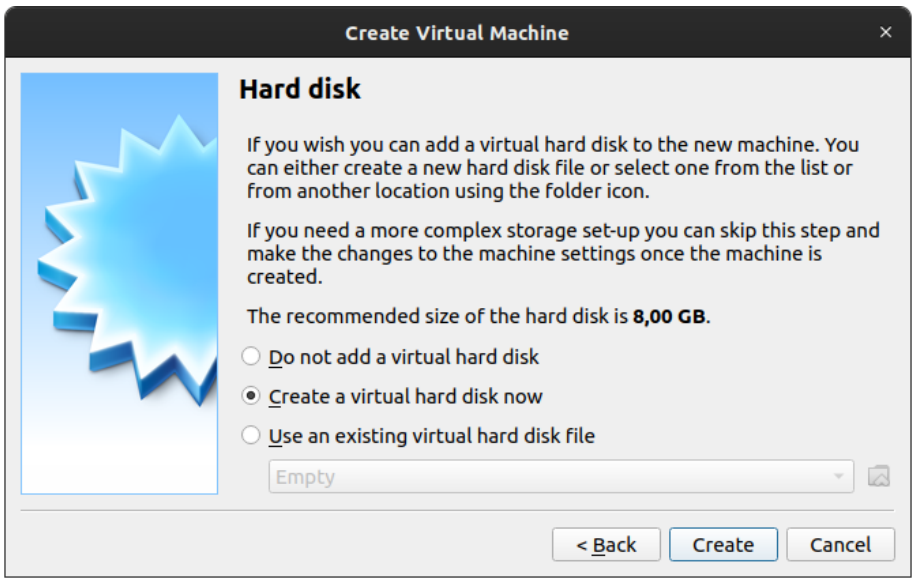
At the top of the VirtualBox main window, click on **New** to start.



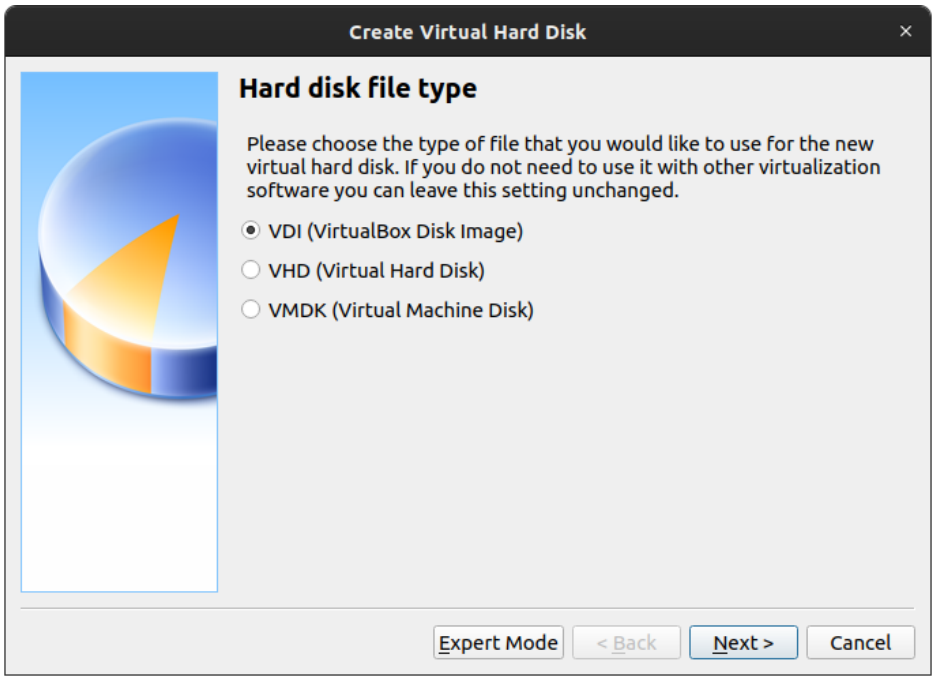
Let's name the machine and decide where to install it. On the 42 computers, we should create the virtual machine in the **`/sgoinfre/goinfre/Perso/my_login`** folder for space concerns. Otherwise, we can put it on a large enough USB key or an external hard drive to be able to move it later.



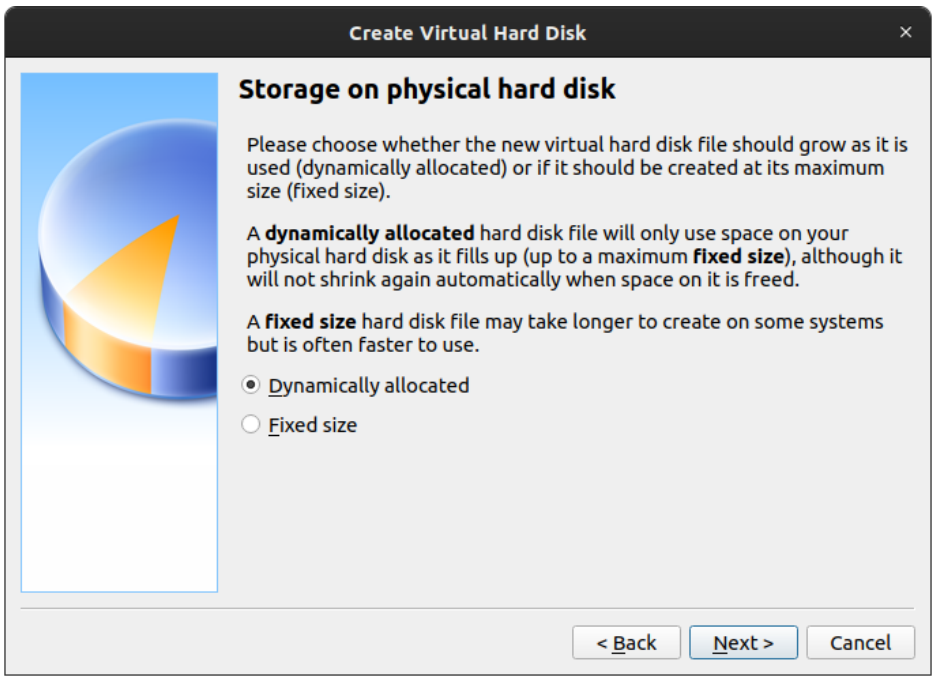
As far as the memory size goes, we can leave the default value, **1024** MB.



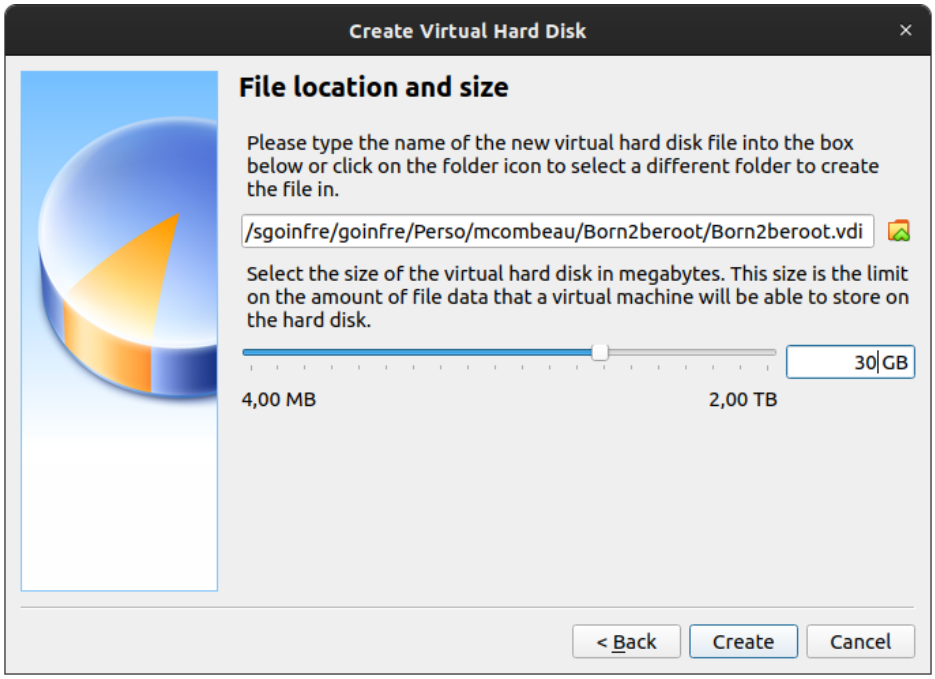
Now, we'd like to **create a new virtual hard disk**.



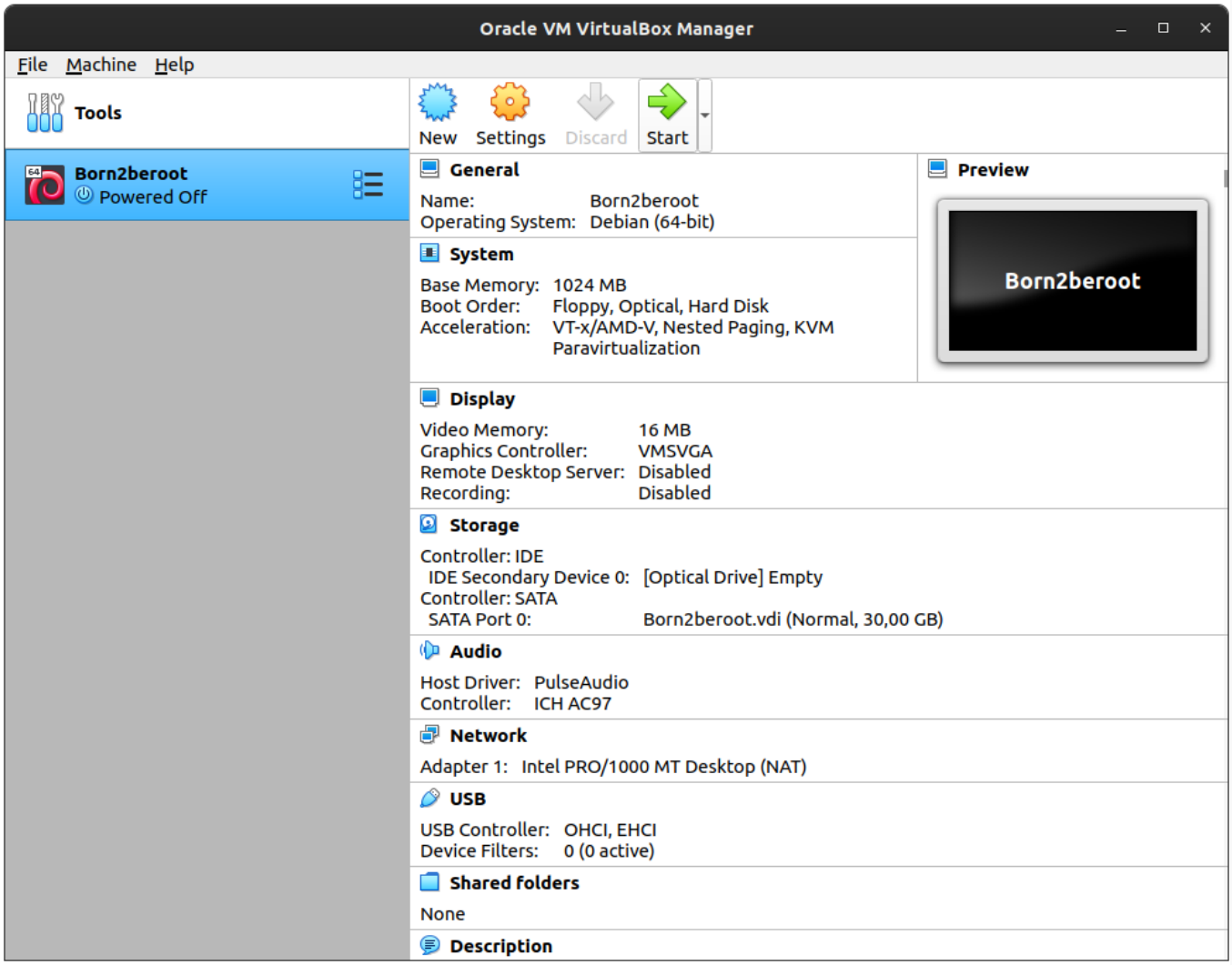
A **VirtualBox Disk Image** is perfect for our purposes.



We can let the hard disk be **dynamically allocated**.



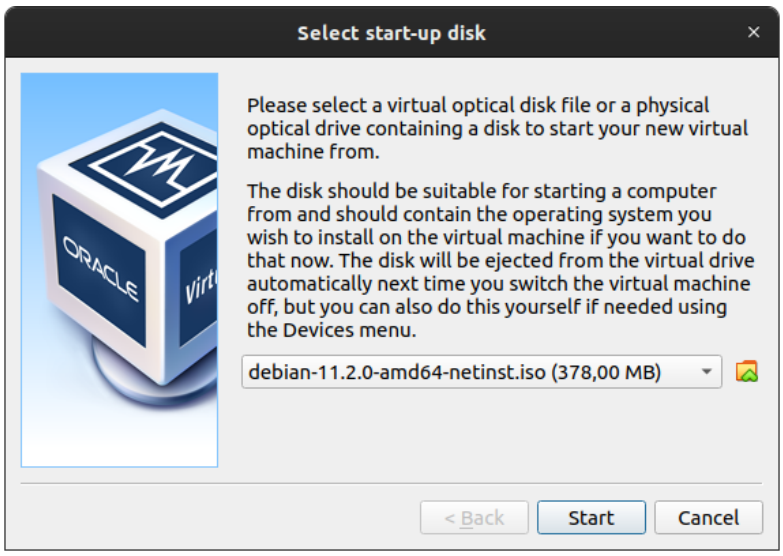
For the size of the hard disk, **12 GB is enough**, unless we wish to do the bonuses, in which case we'd better ask for **30 GB**.



There! Our Born2beroot virtual machine has been created!

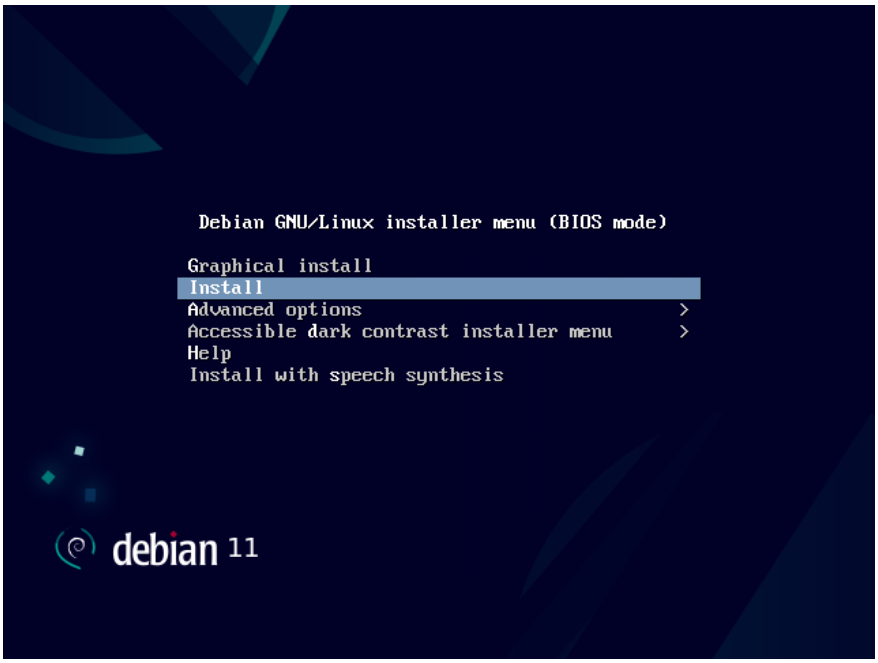
Installing Debian on Born2beroot

Since the virtual machine has no operating system, VirtualBox will ask us to choose a disk to boot from when we start it up for the first time.

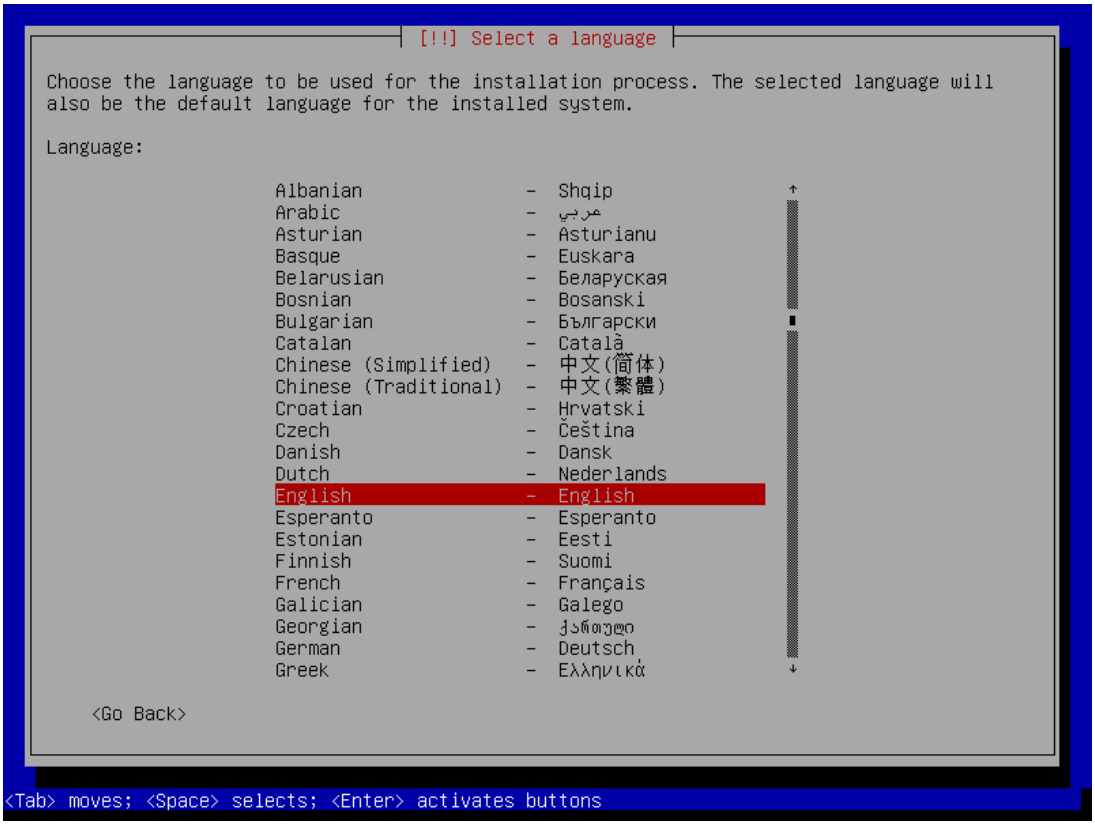


Here, we must choose the **.iso** file that we've previously downloaded, which contains all the necessary files to install Debian.

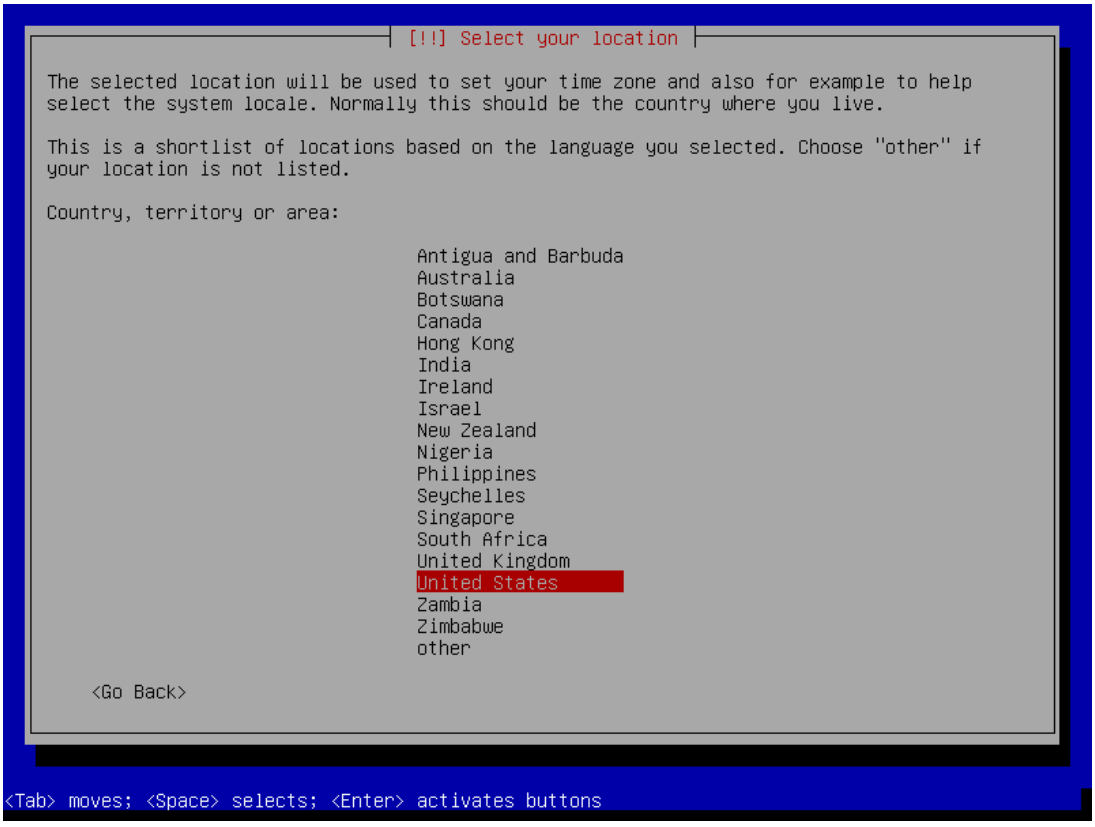
The machine will boot from that disk and a graphical interface will guide us through the Debian installation.



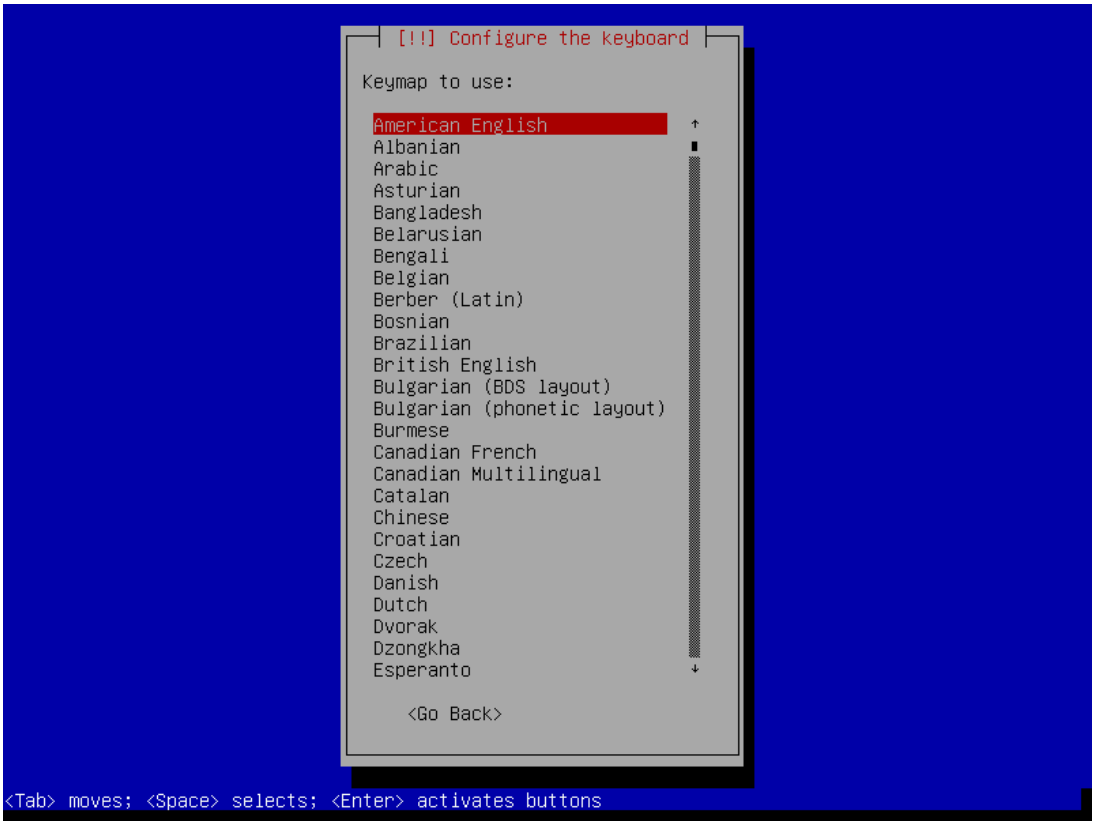
We must choose **Install**. A graphical interface is explicitly forbidden in the Born2beroot subject, we can therefore not choose "Graphical Install".



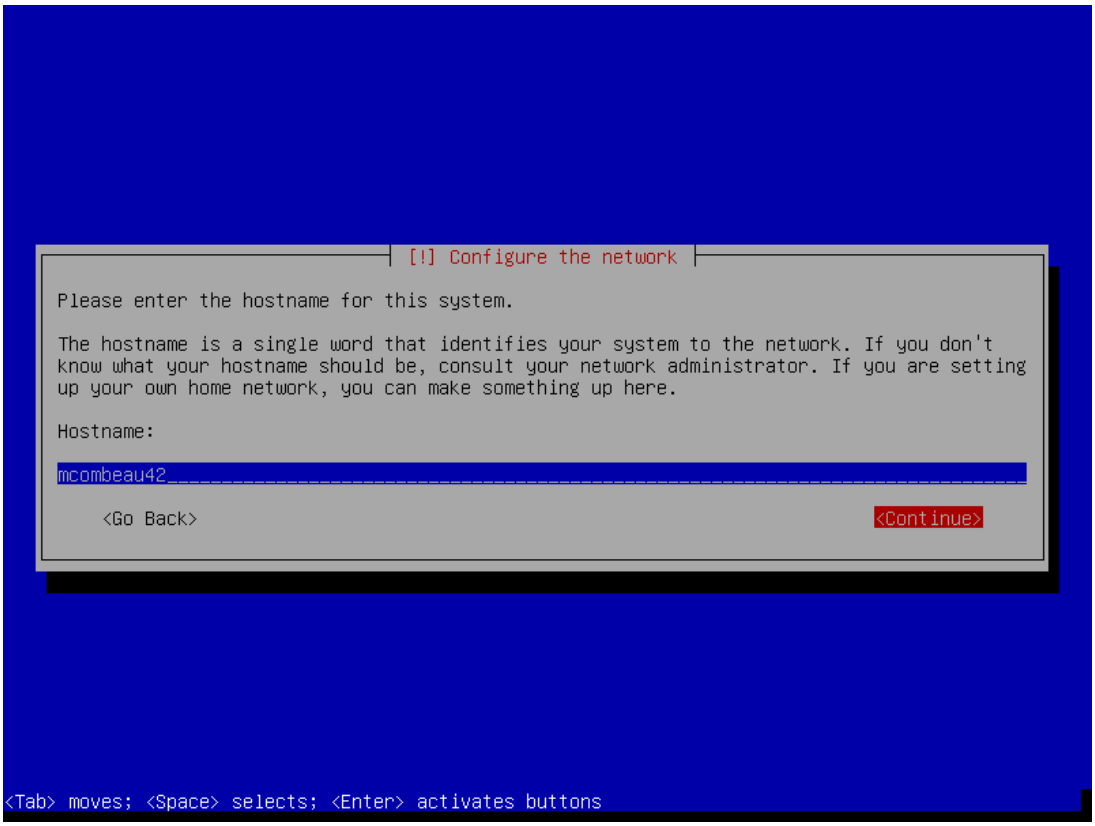
Let's choose the language that suits us best. In this case, **English**.



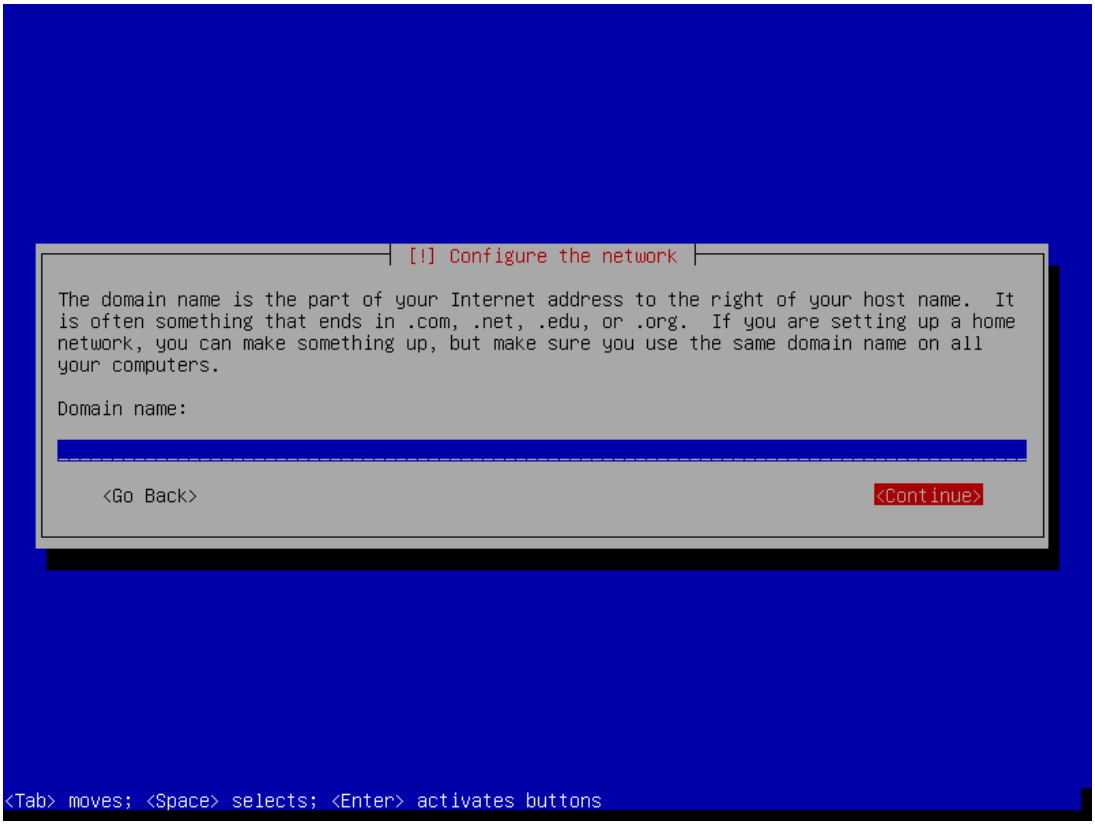
Then we will have to chose our geographic region. For some reason, choosing "other > France" results in an error after choosing English so let's just go with **United States**, even though the time zone will be wrong. The time zone doesn't really matter for Born2beroot.



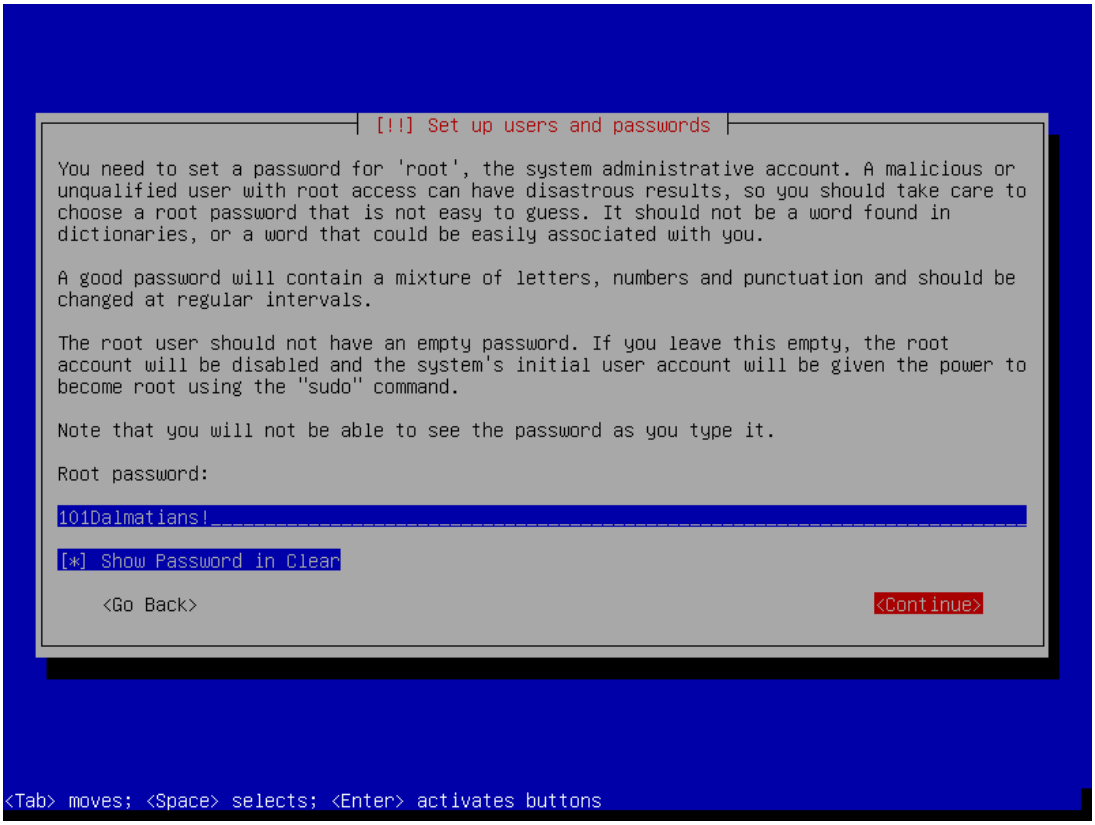
Here we will choose the keyboard configuration. For a QWERTY keyboard, choose **American English** at the top of the list.



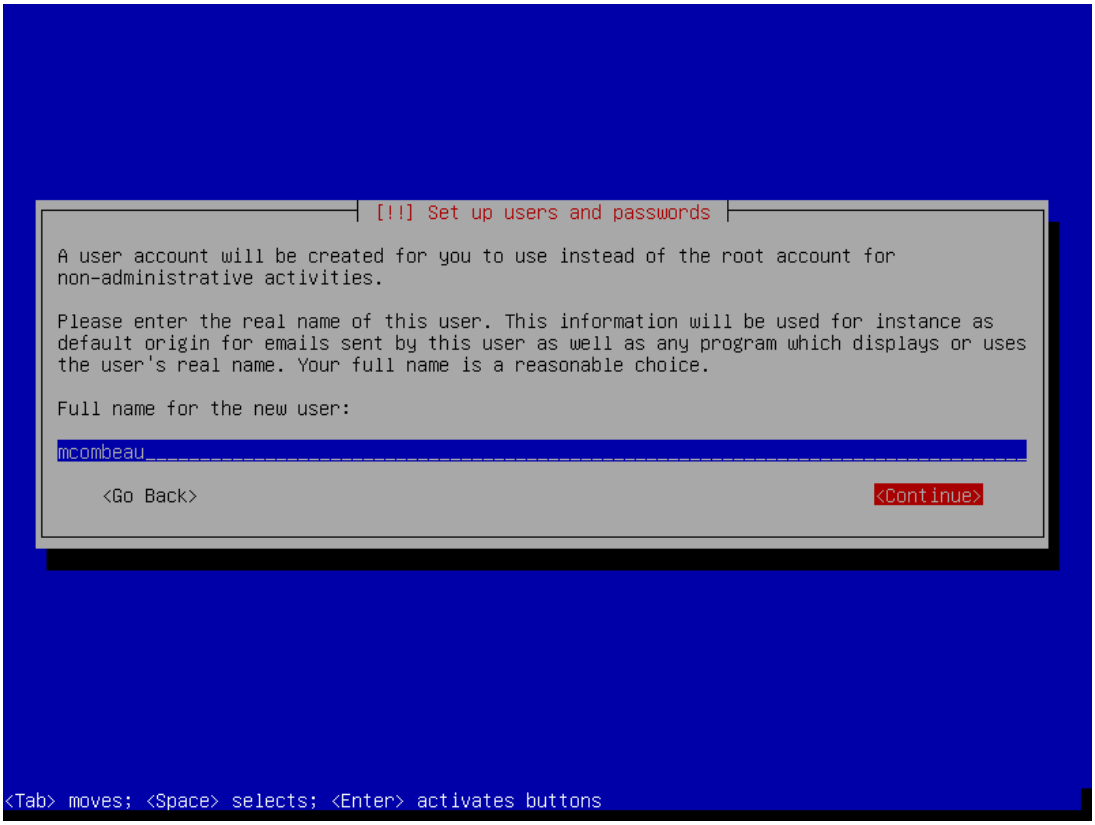
As instructed in the Born2beroot subject, the hostname must be our **intra login followed by 42** (i.e. mcombeau42).



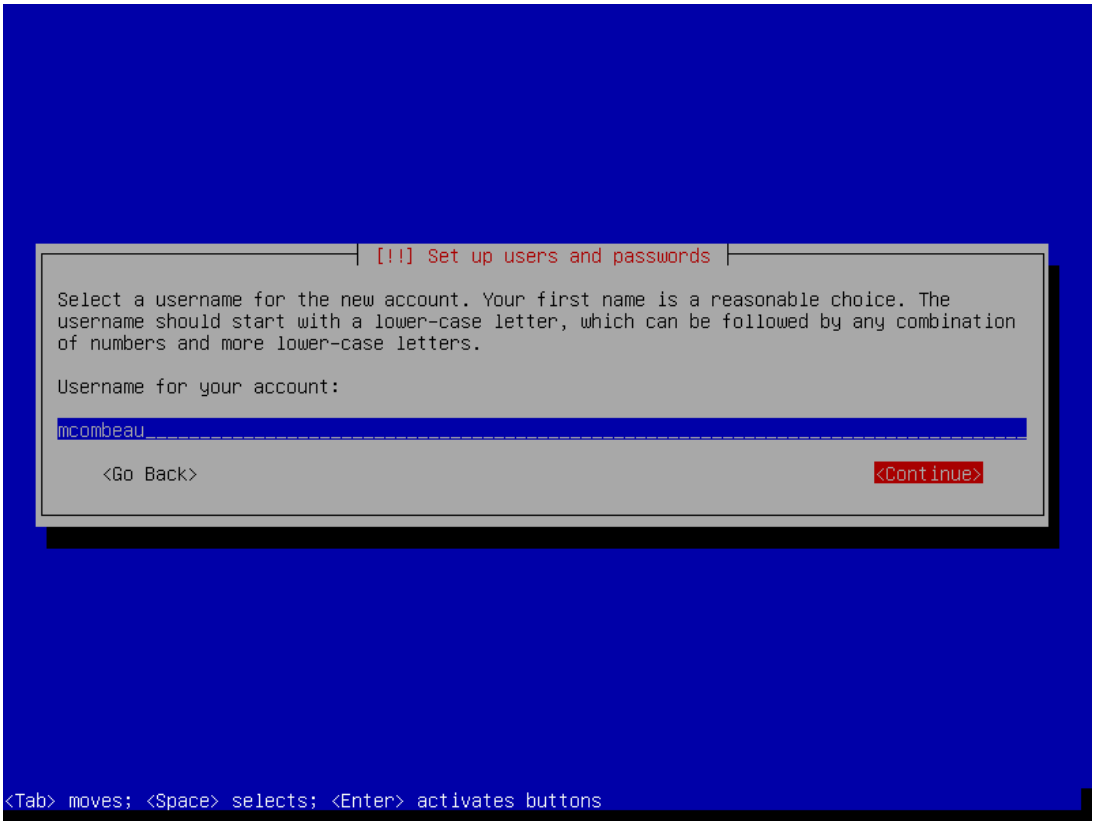
We don't need to worry about any domain name, leave this field **blank**.



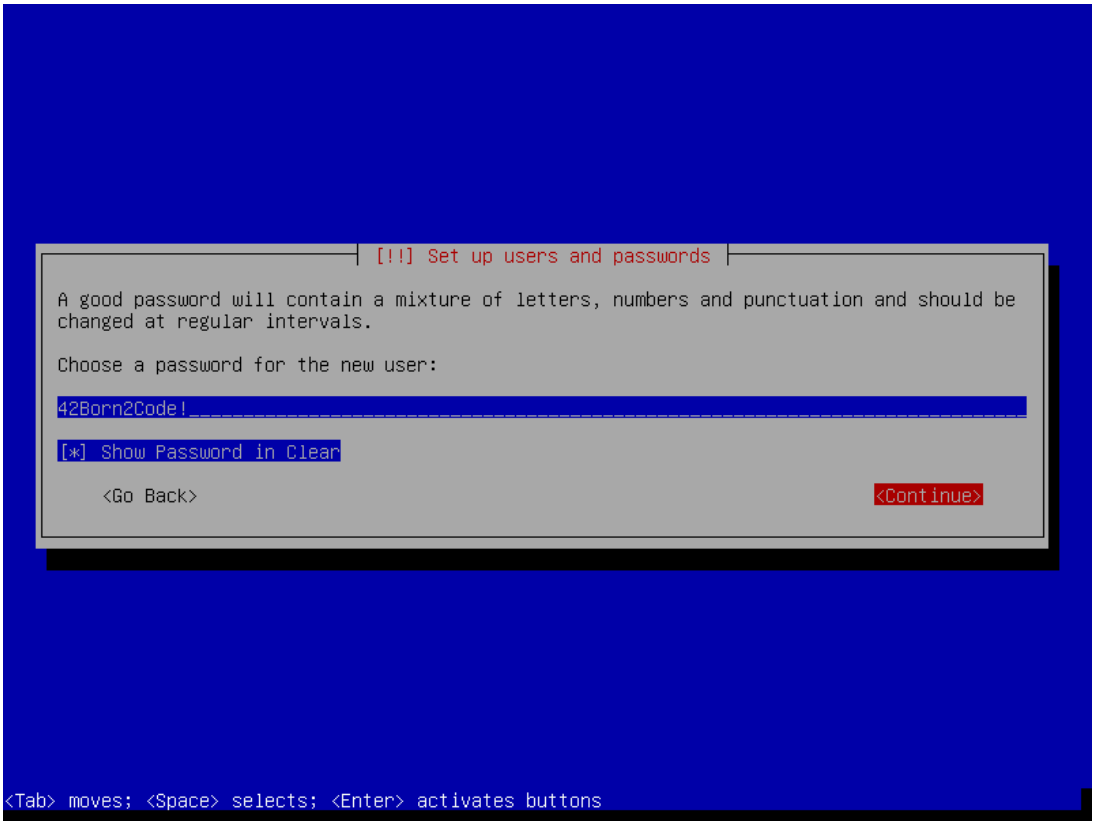
For the super-user root, it's very important to define a strong password. To show the password in clear, select that option and press the space-bar. The next screen will of course ask us to confirm the password. Do not forget it!



Then we must create a new user, other than root. With a name ...



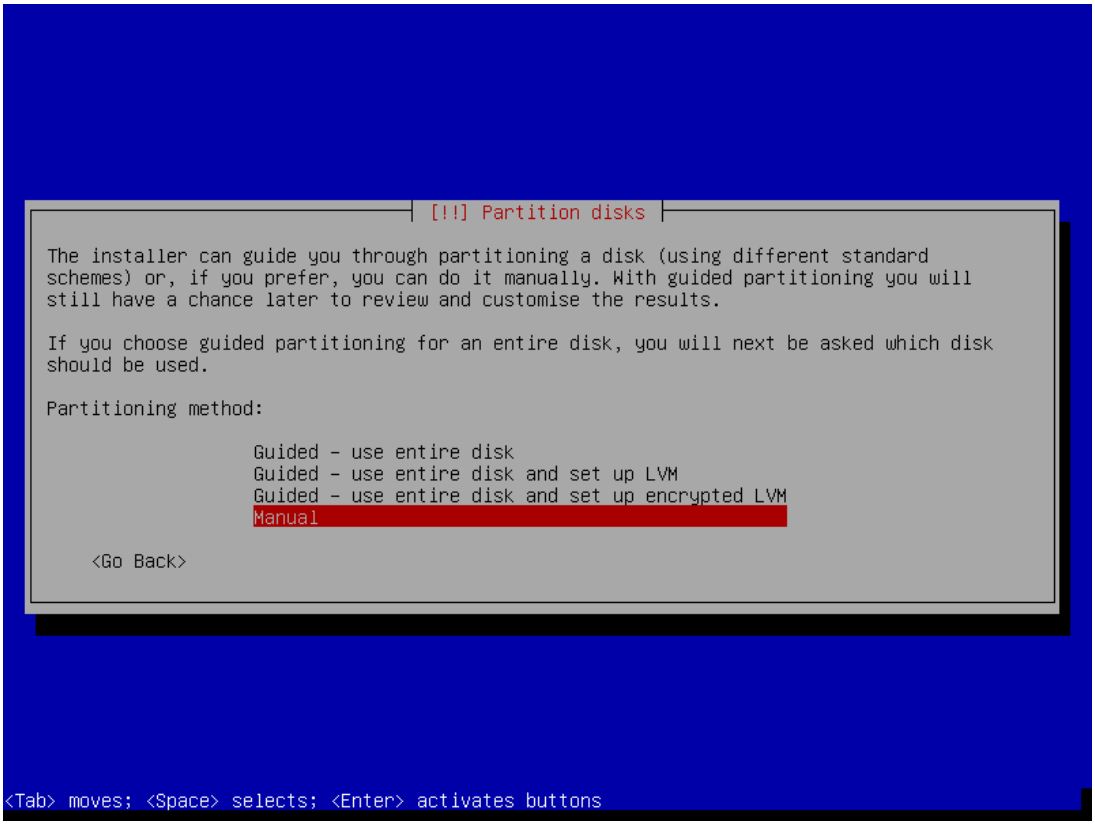
... a username (we will have to have a user with our **intra login** as username for our Born2beroot evaluation, so we might as well do that now) ...



... and a strong password (preferably different from the root password) ... which we must confirm on the next screen.

Partitions, LVM and Encryption

This is the moment when we have to decide how to partition our virtual hard drive. The partitions for the bonuses are different from the partitions of the mandatory part, but in both cases, we can't count on the guided partition methods. Let's do it **manually**.



Why Have Several Partitions?

We could very well have a single partition to contain all of the operating system's data, all of the software and all of the personal user files. The purpose of having several distinct partitions is to not put all our eggs in the same basket. If one file system becomes corrupted for example, only one of the partitions would be affected instead of the entire system.

The partitions we must have on our Born2beroot virtual machine are as follows:

- **boot**, containing the static files of the boot loader.
- **root**, containing the home directory for the root user.
- **home**, containing the user home directories.
- **swap**, a special partition that serves as a "workspace" for the operating system. It allows the OS to use this space as RAM overflow, which increases the system's efficiency.

For the bonus part, we must also have the following partitions:

- **var**, containing variable data.
- **srv**, containing data for services provided by the system.
- **tmp**, containing temporary files.
- **var/log**, containing log files.

In the example shown in Born2beroot's subject, we will notice three partitions, `sda1`, `sda2` and `sda5`. The latter has the type "crypt" and contains several other partitions such as root, swap and home, of "LVM" type. Of course, crypt indicates that the partition is encrypted, as per the subject requirements. (Let's also notice that the `sda1 /boot` partition is not encrypted!) But what does "LVM" mean?

What is LVM ?

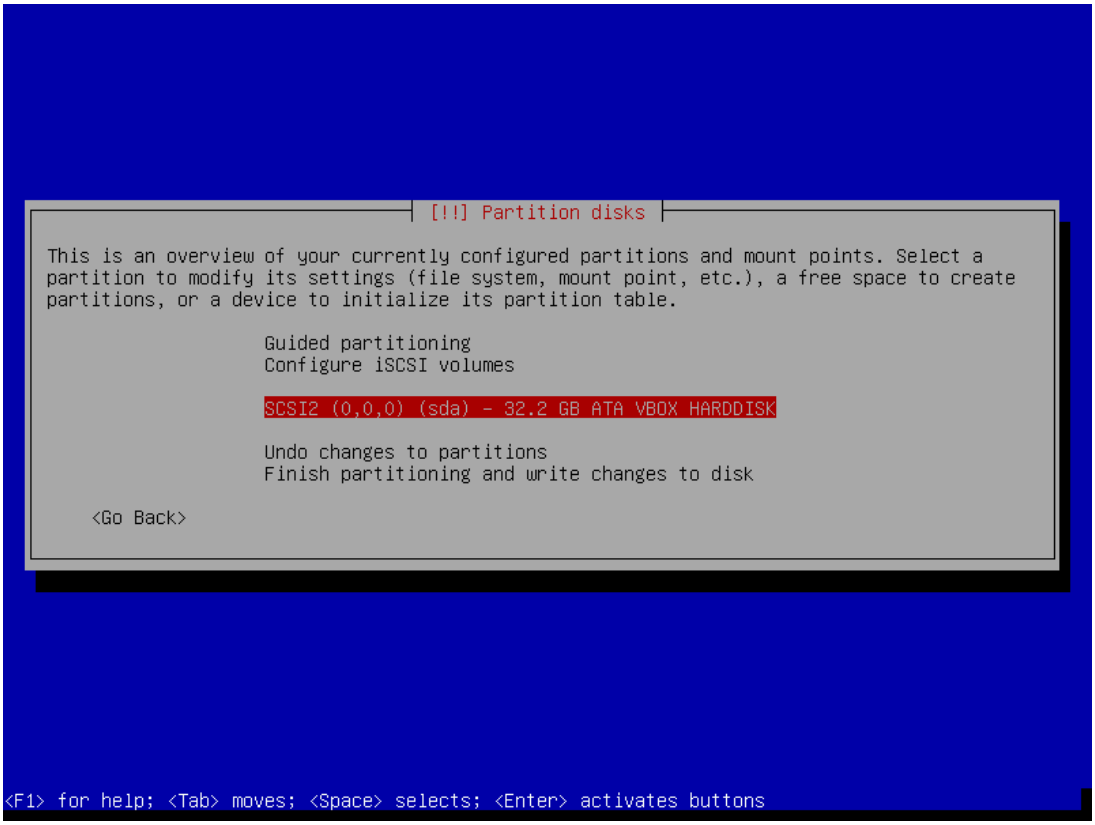
The **Logical Volume Manager** (LVM for short) is a flexible and dynamic management system for Linux hard disk memory. It allows us to have as many partitions as necessary, and to resize, move and even freeze them, without having to restart the machine. This "virtual partitioning" system is very useful on a server, which must preserve stability and rapid management of its memory resources.

With LVM, a physical partition is assigned to a logical volume group and is then "partitioned" into several logical volumes. This is the case of the `sda5` partition in the Born2beroot subject example.

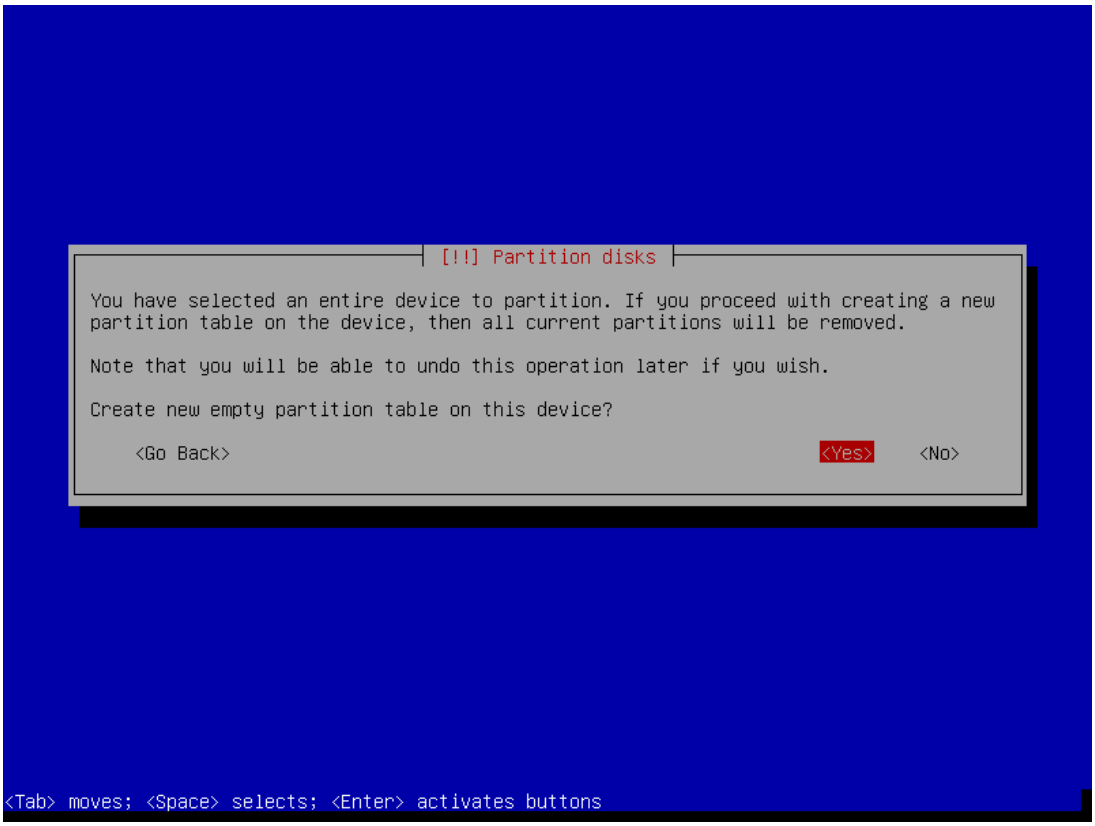
The `sda2` partition will automatically be created when we define an LVM partition. It is an extended partition which serves only as a container for the logical volumes and doesn't contain any other data.

Manual Partitioning

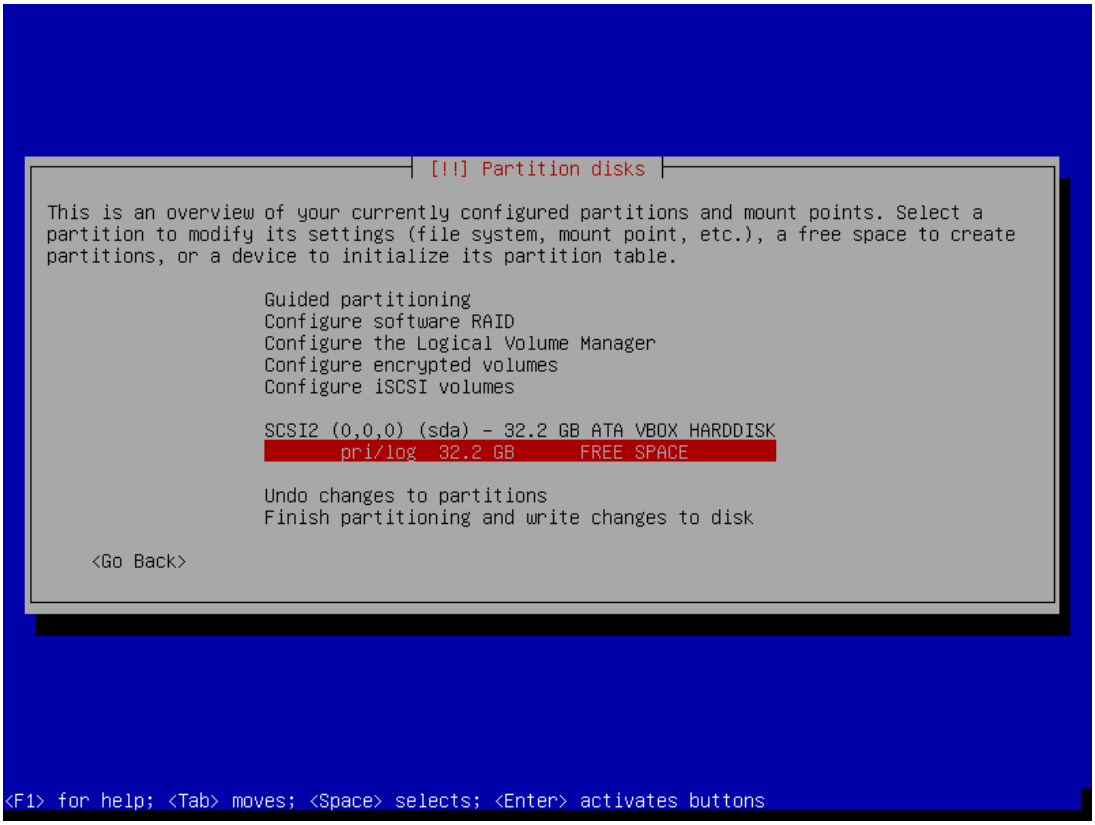
For Born2beroot, we will have to create two partitions: a primary partition for the Debian boot loader files, and an encrypted logical partition to contain the LVM logical volumes.



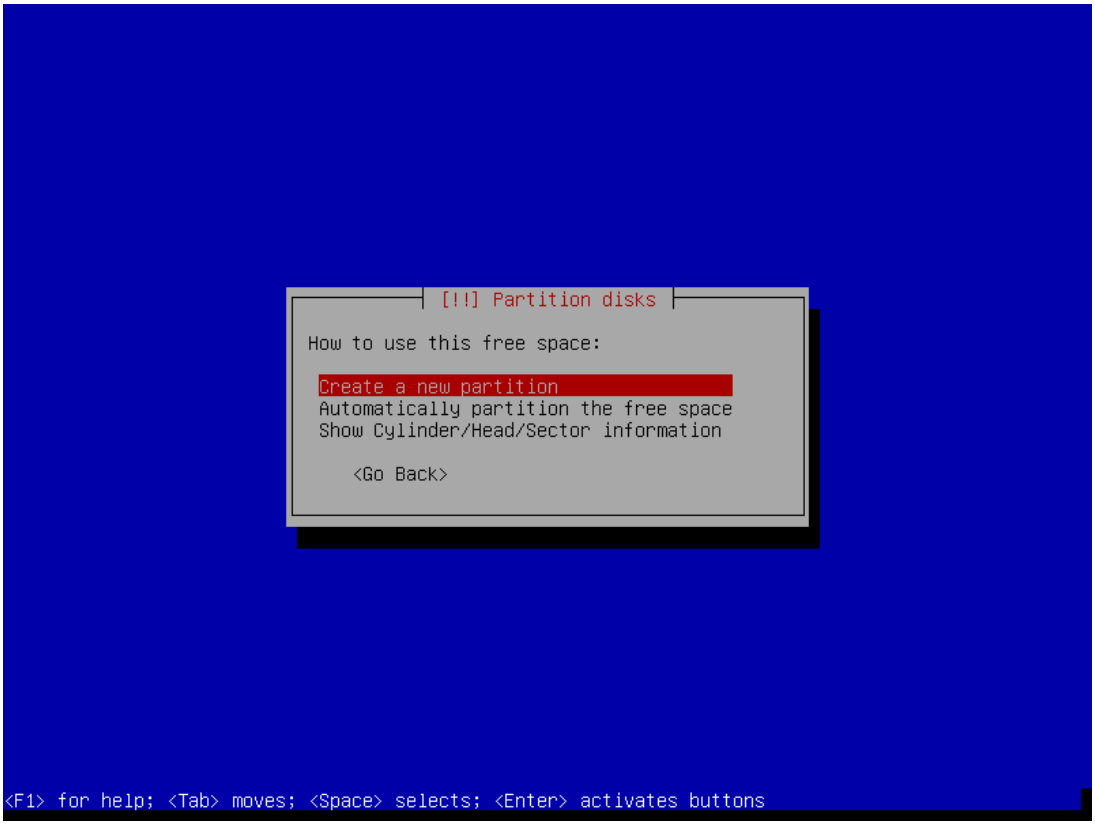
Here we must choose the disk we'd like to partition. There should only be one: **`SCSI (0, 0, 0) sda ... HARDDISK`**.



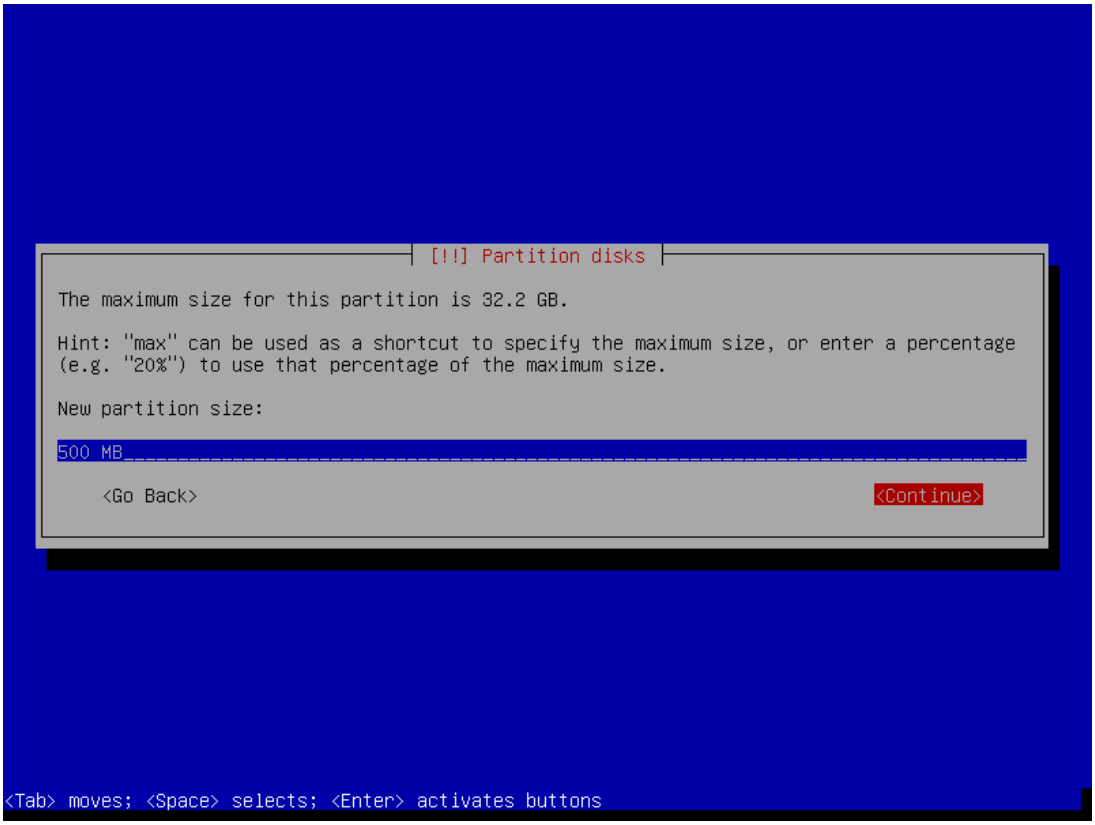
Then we will confirm that **yes**, we want to create a new empty partition table on this device.



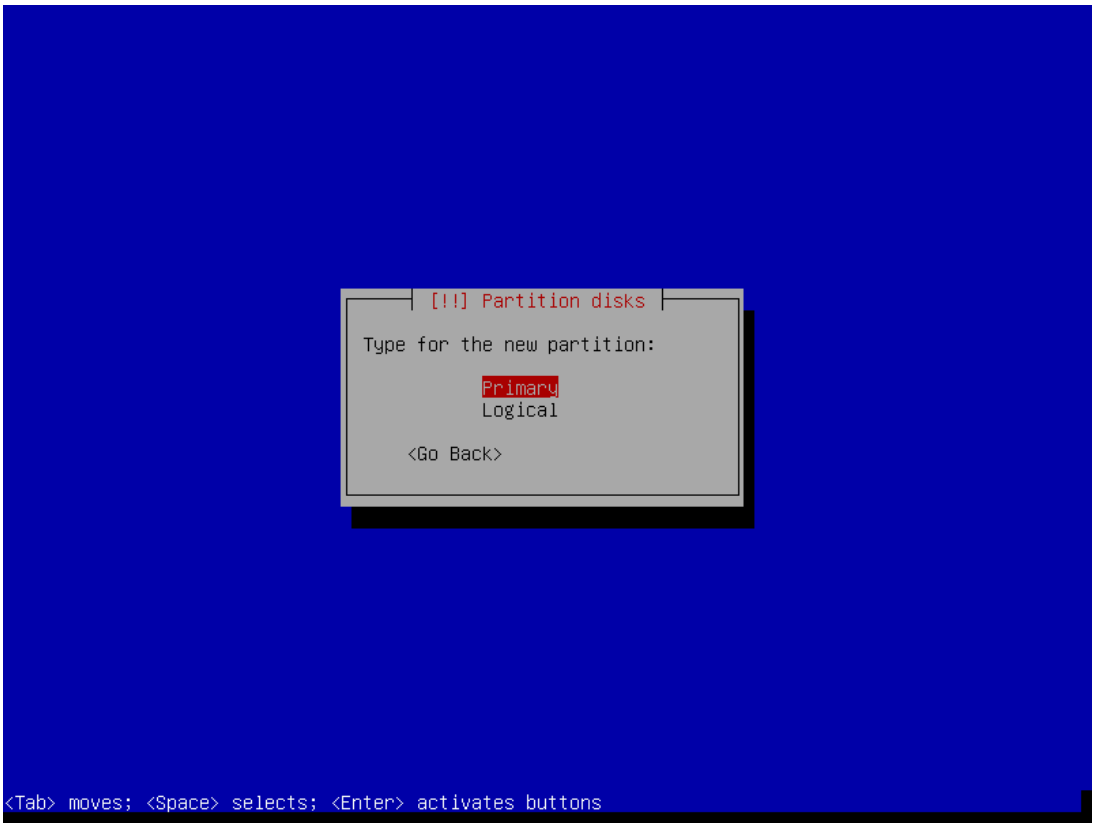
With the partition table created, we can now add the partitions we want. The first will be the `/boot` partition which should not be encrypted because it is required to start up the OS. Let's select the **free space**.



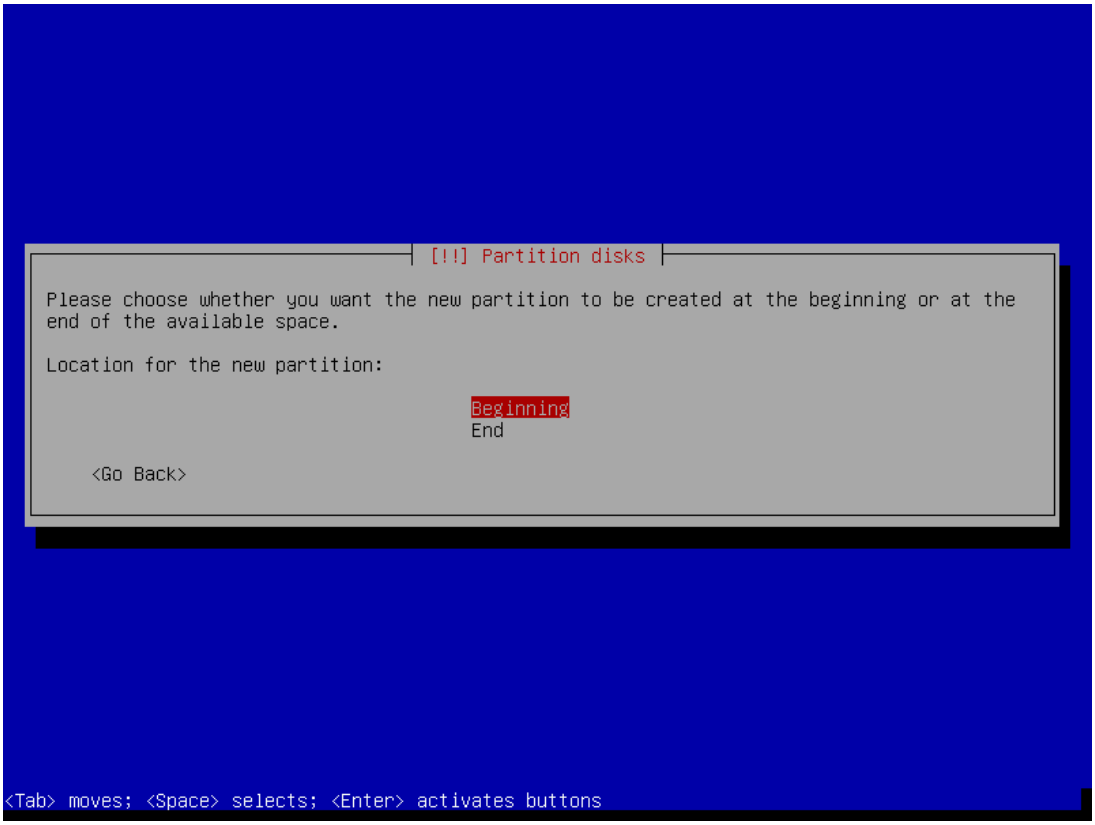
We will **create a new partition** in this free space.



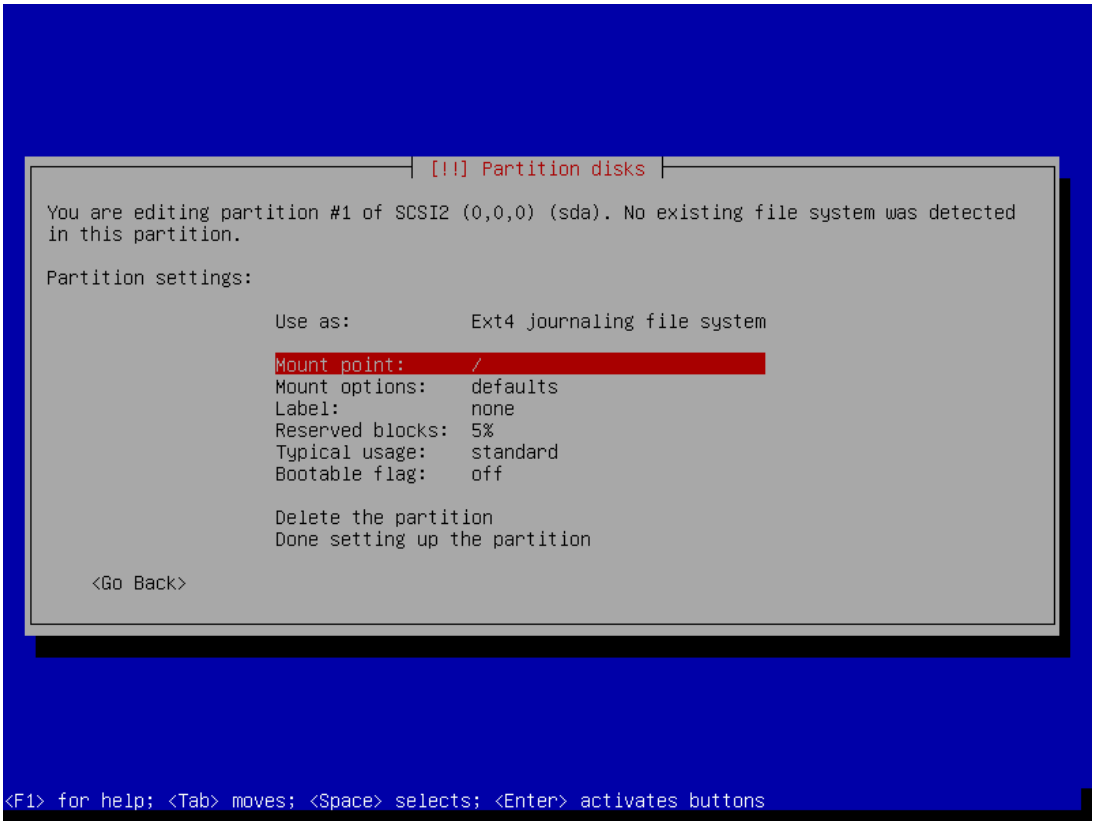
500 MB is enough for the `/boot` partition.



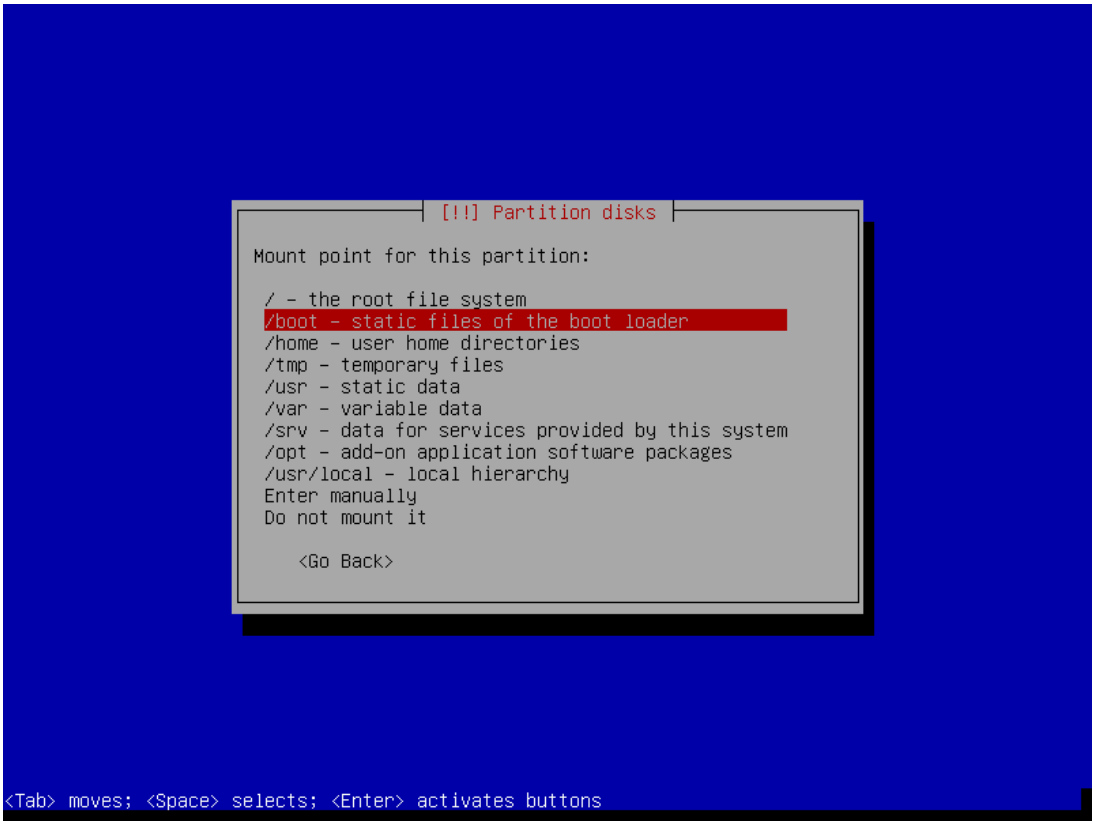
This partition will be **primary**, not logical.



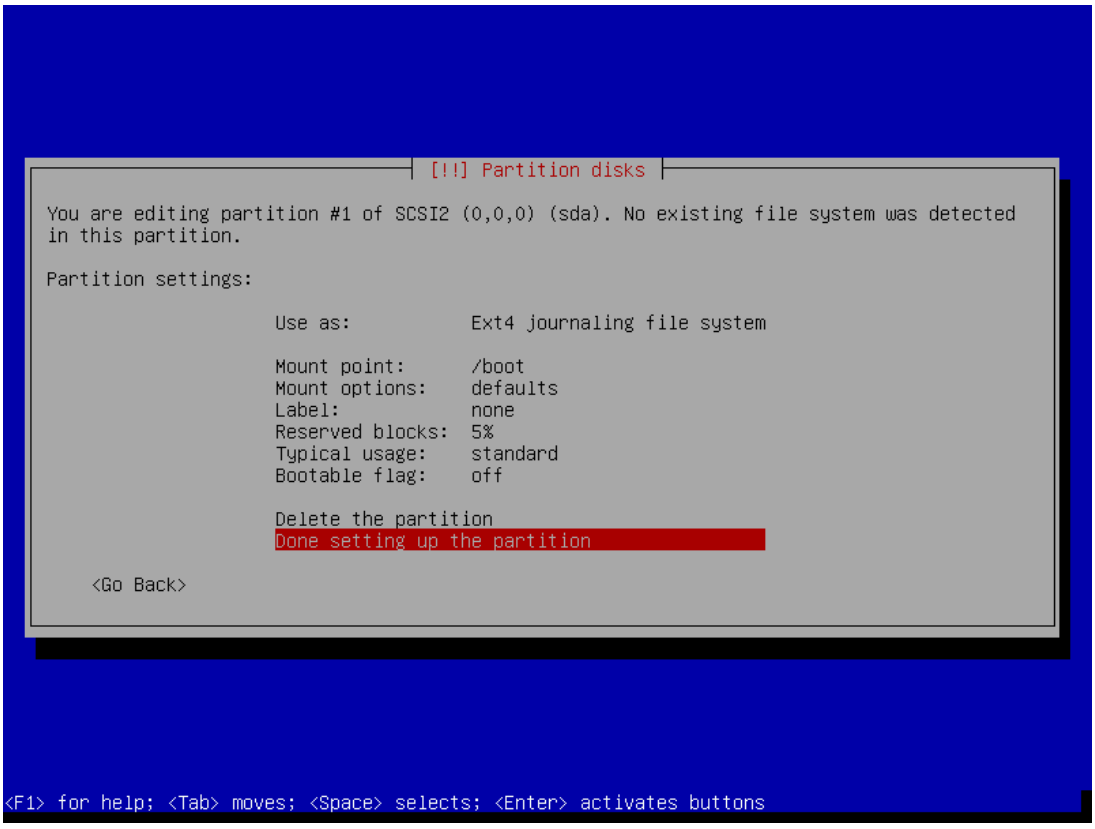
We want to put it at the **beginning** of the available space.



Here, we need to indicate that this partition will be used as `/boot`, which means we must change its **mount point**.

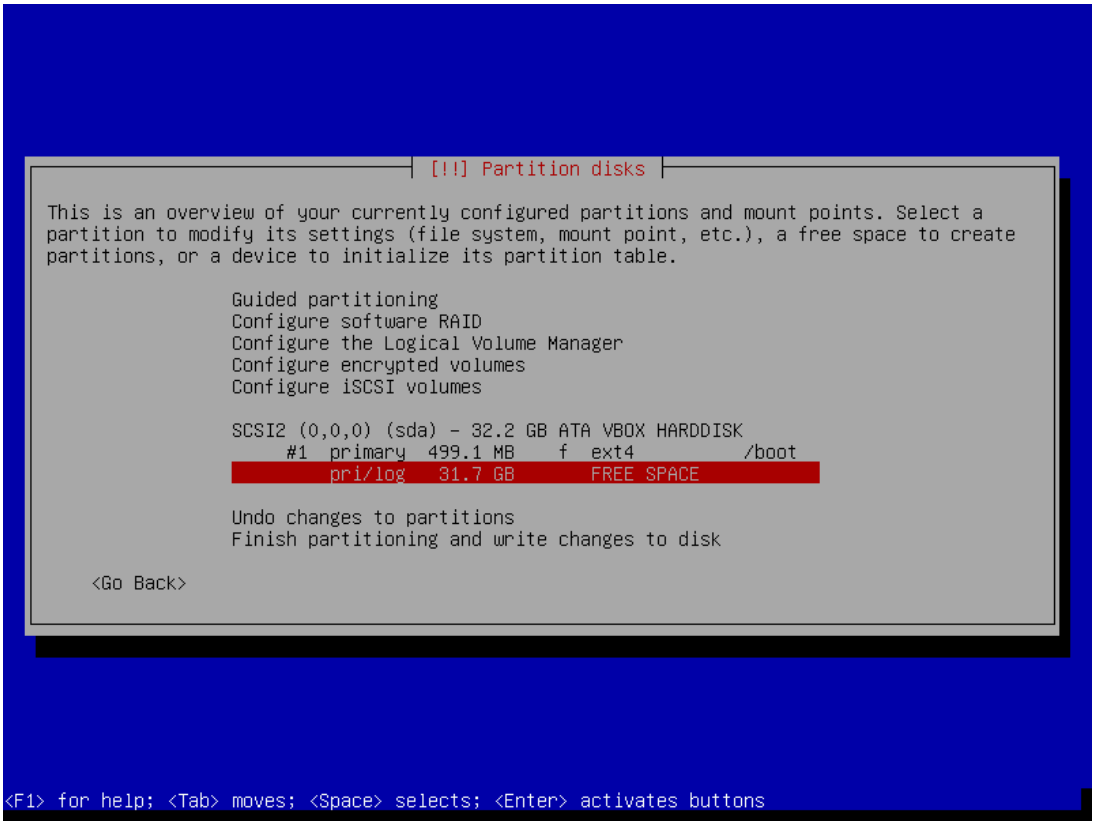


Let's select **/boot**, static files of the boot loader.

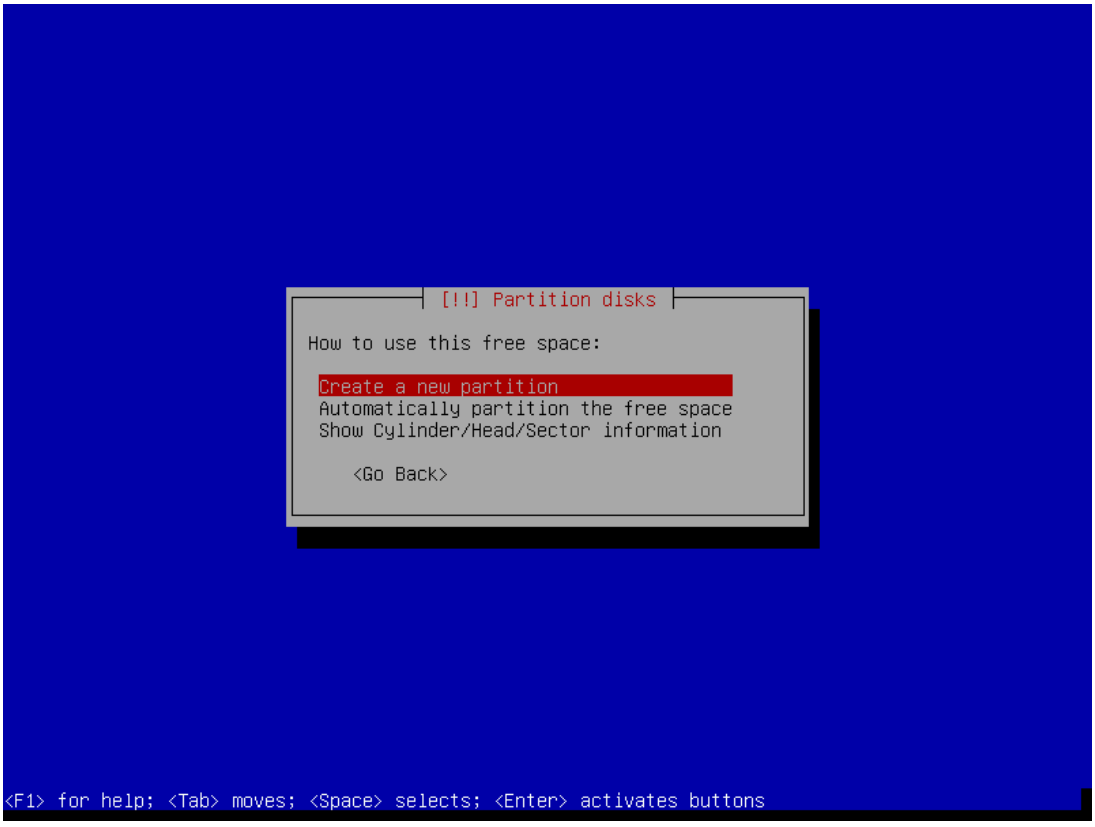


We are now **done setting up the partition**.

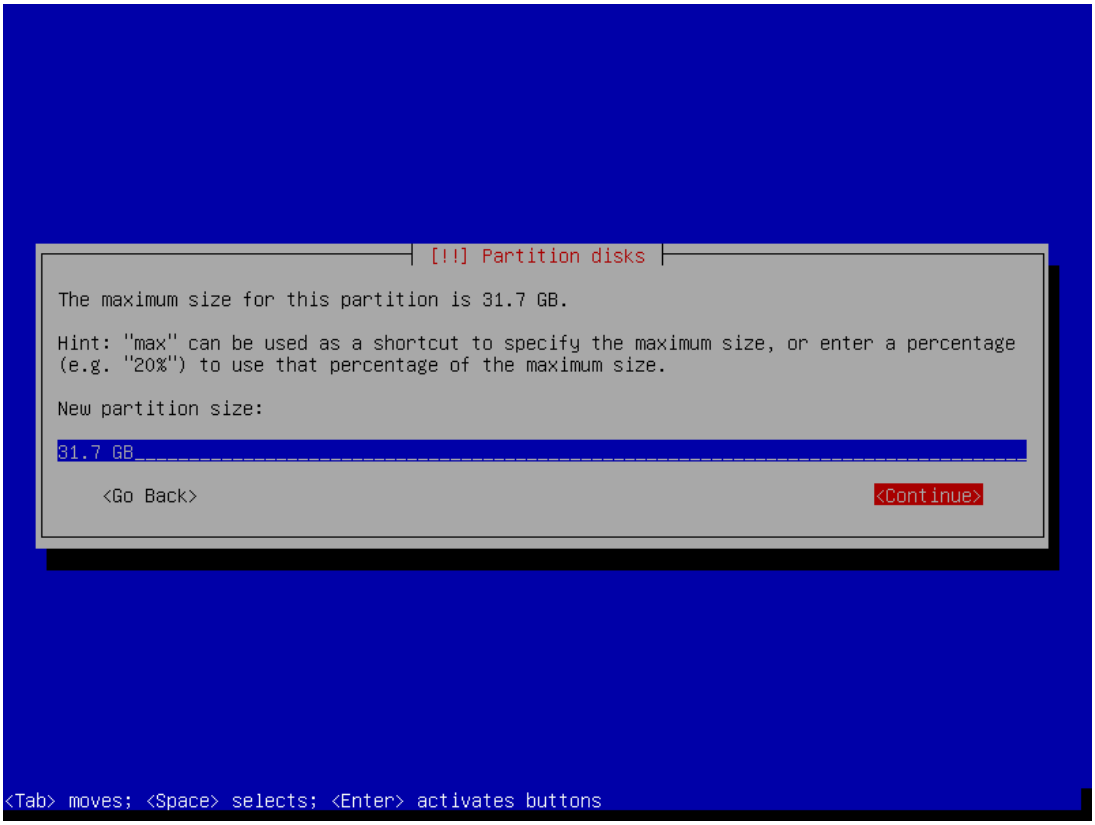
Now that our `/boot` partition has been created, we need another partition to contain our LVM logcial volumes.



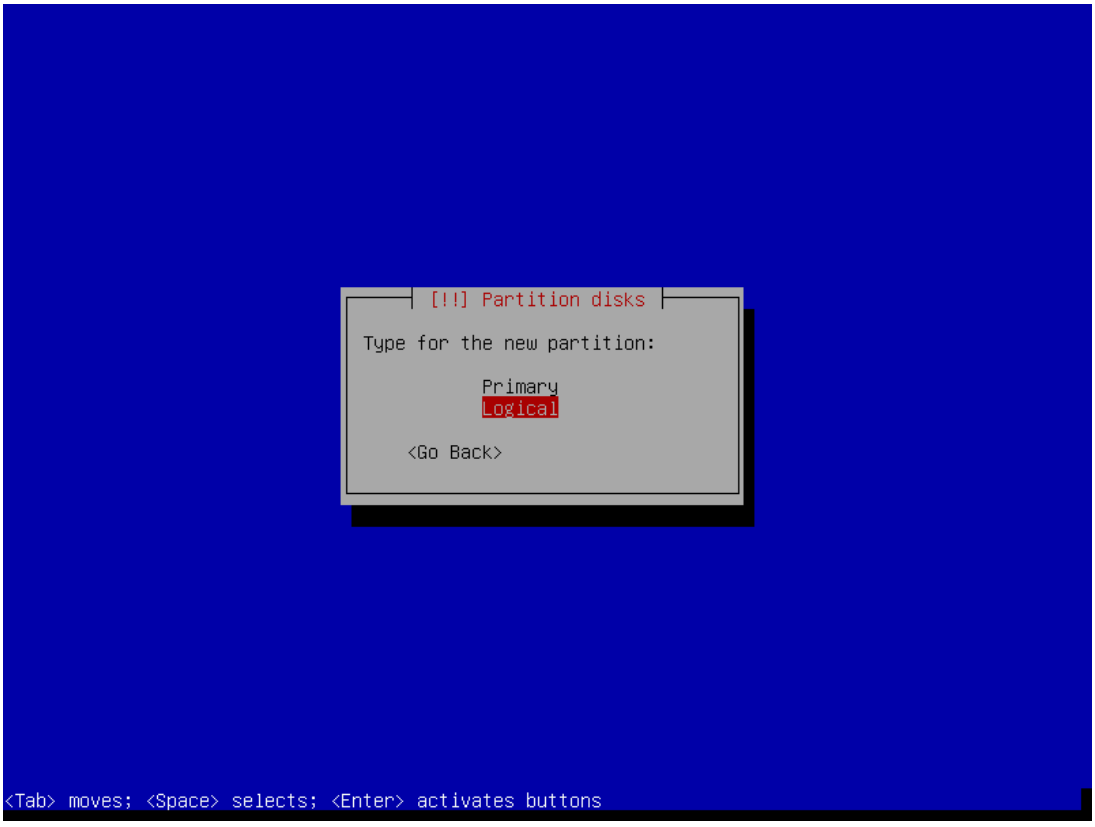
Let's select the **free space** once more.



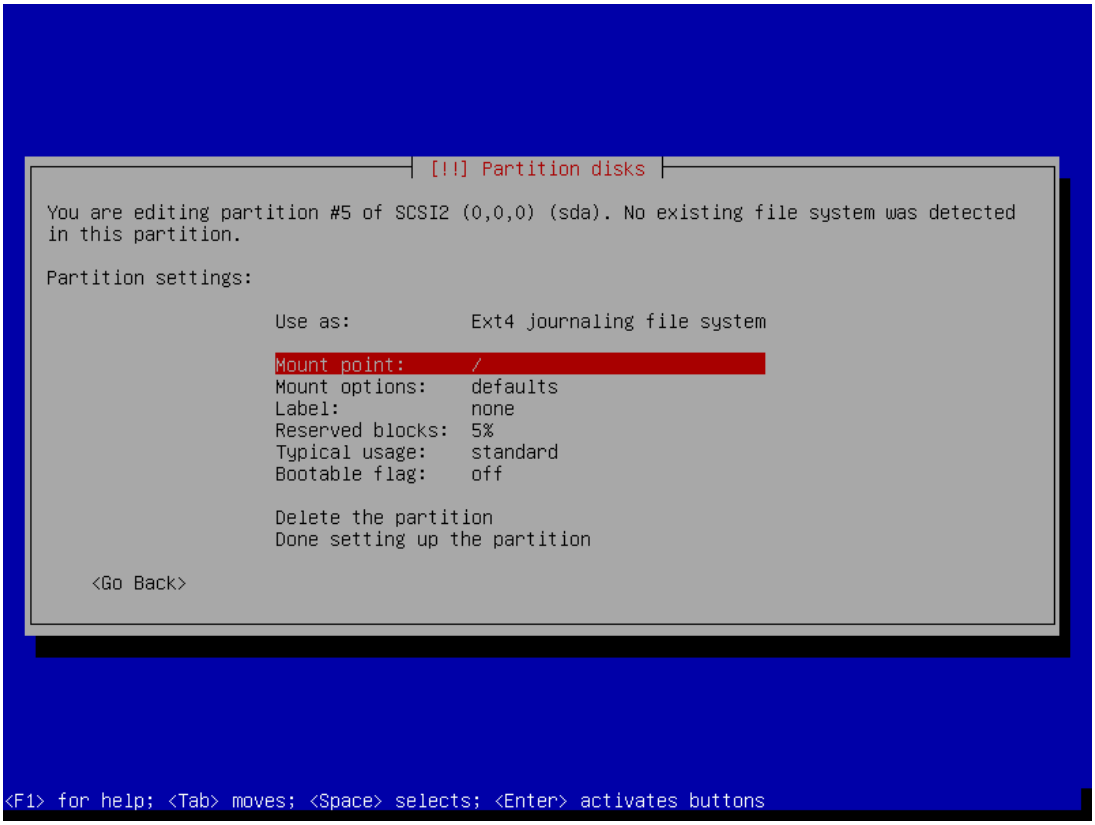
Once more, we will **create a new partition**.



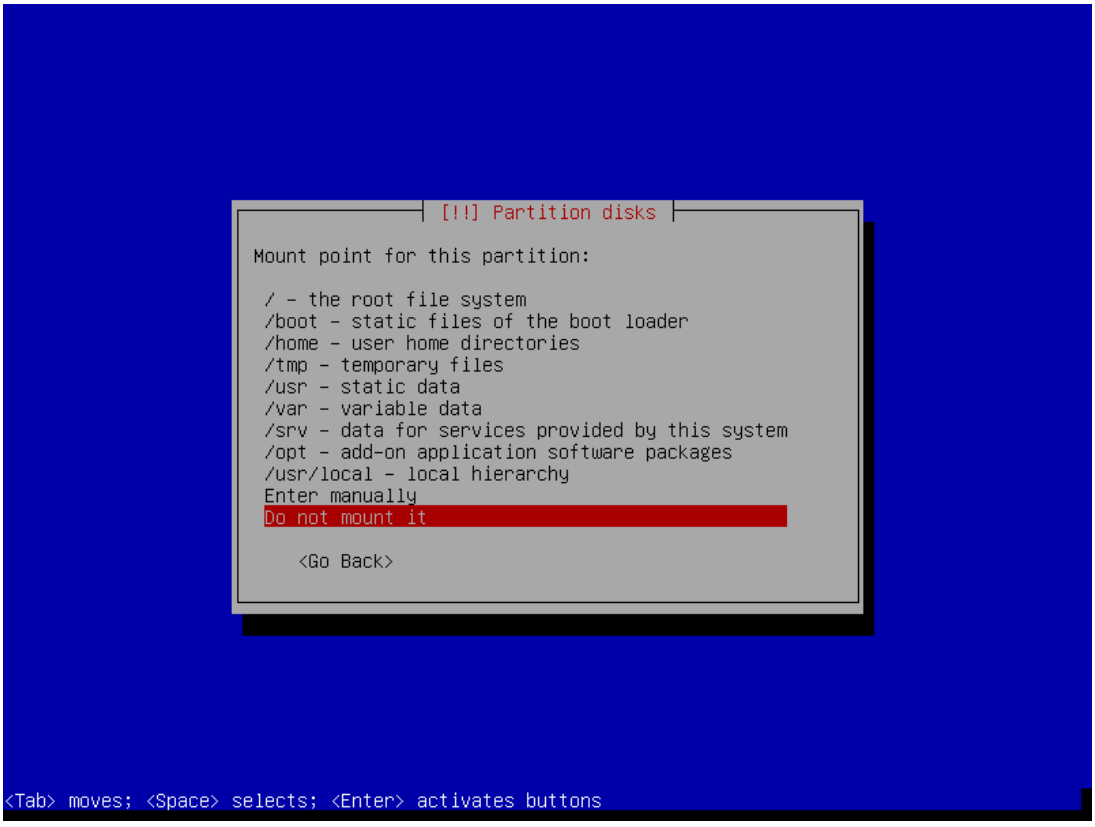
It will be the size of all the rest of the free space we have.
We can simply **continue**.



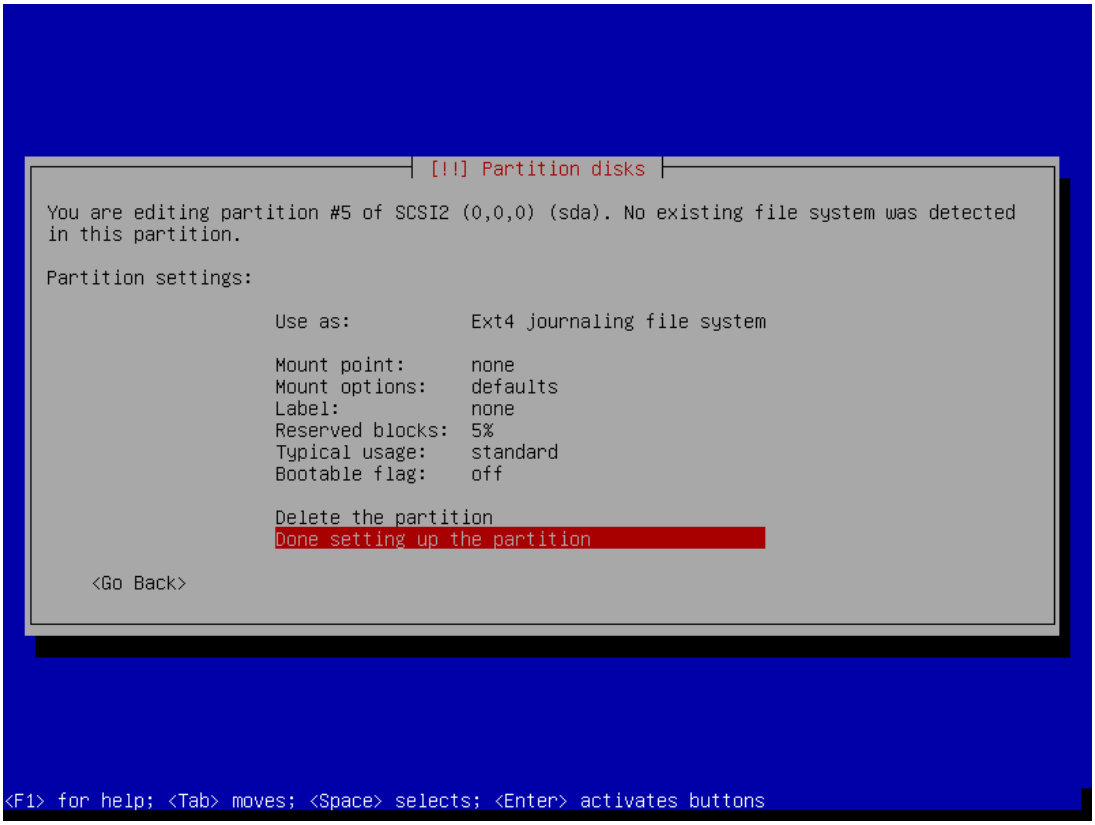
This time, it will be a **logical** partition, since we want logical volumes inside.



For this LVM partition, we don't want any **mount point**.
Let's modify that.



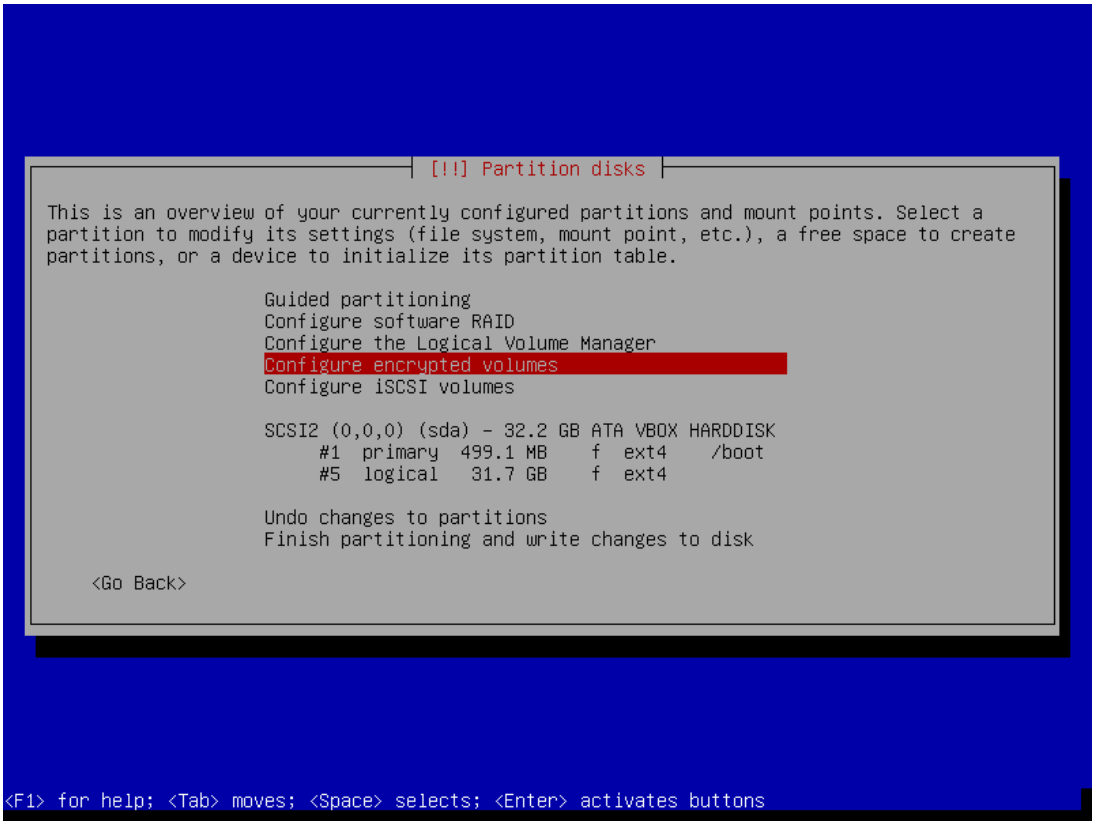
We will tell the system **not to mount** this partition.



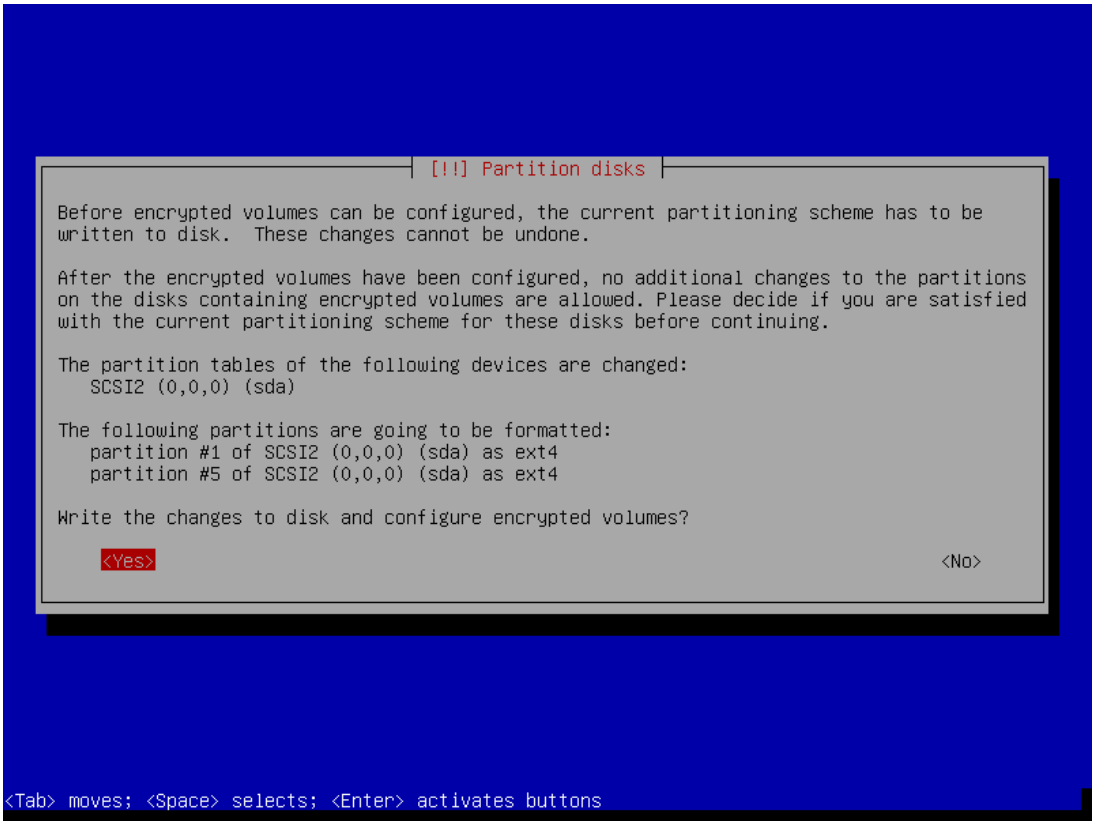
We are **done setting up the partition**, for now, but we will have to manipulate it more before it is ready to use.

Encrypting the Partition

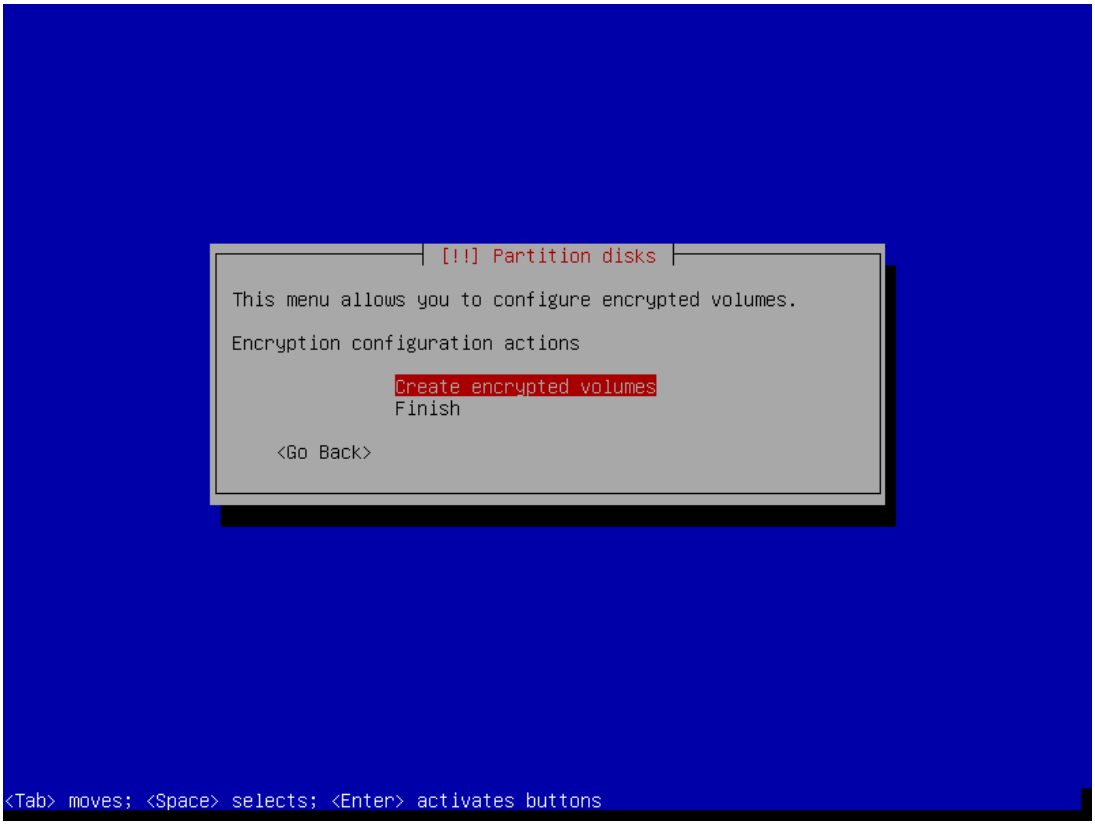
The Born2beroot subject specifies that we must encrypt our partition, and that's a good practice. Careful, however, our partition `sda1` which contains the boot loader files, must not be encrypted!



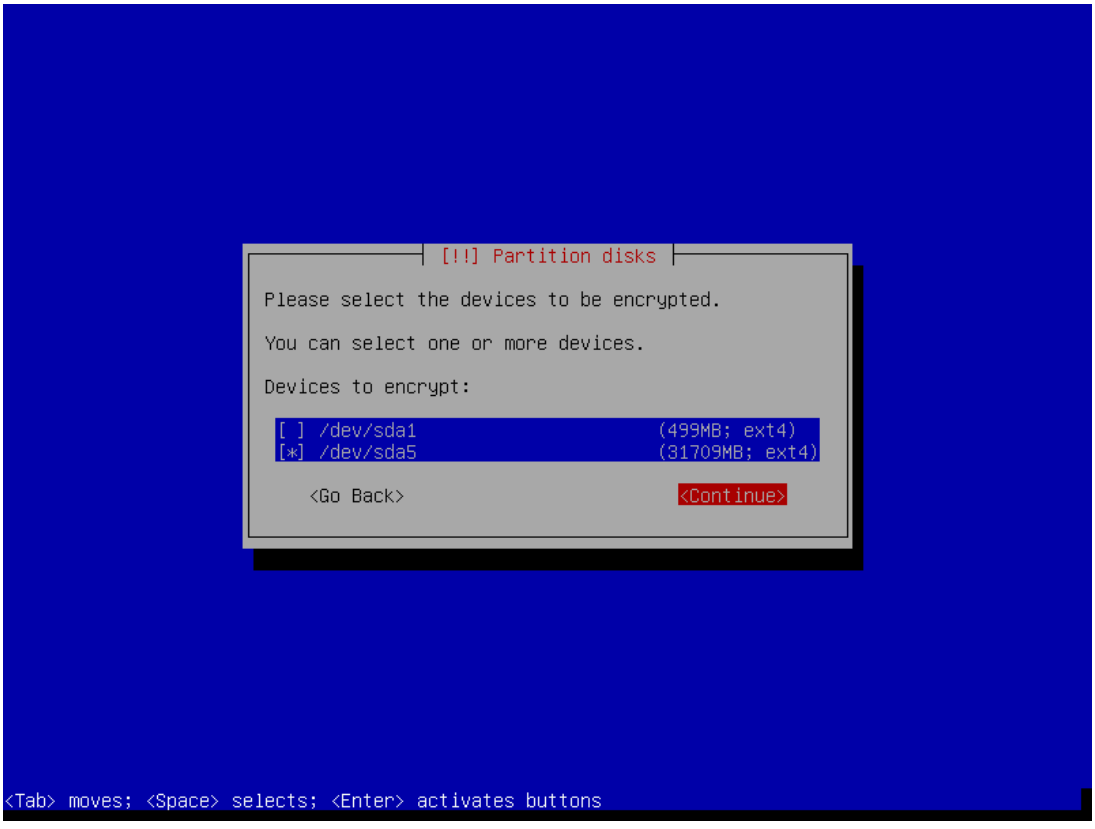
Let's **configure encrypted volumes**.



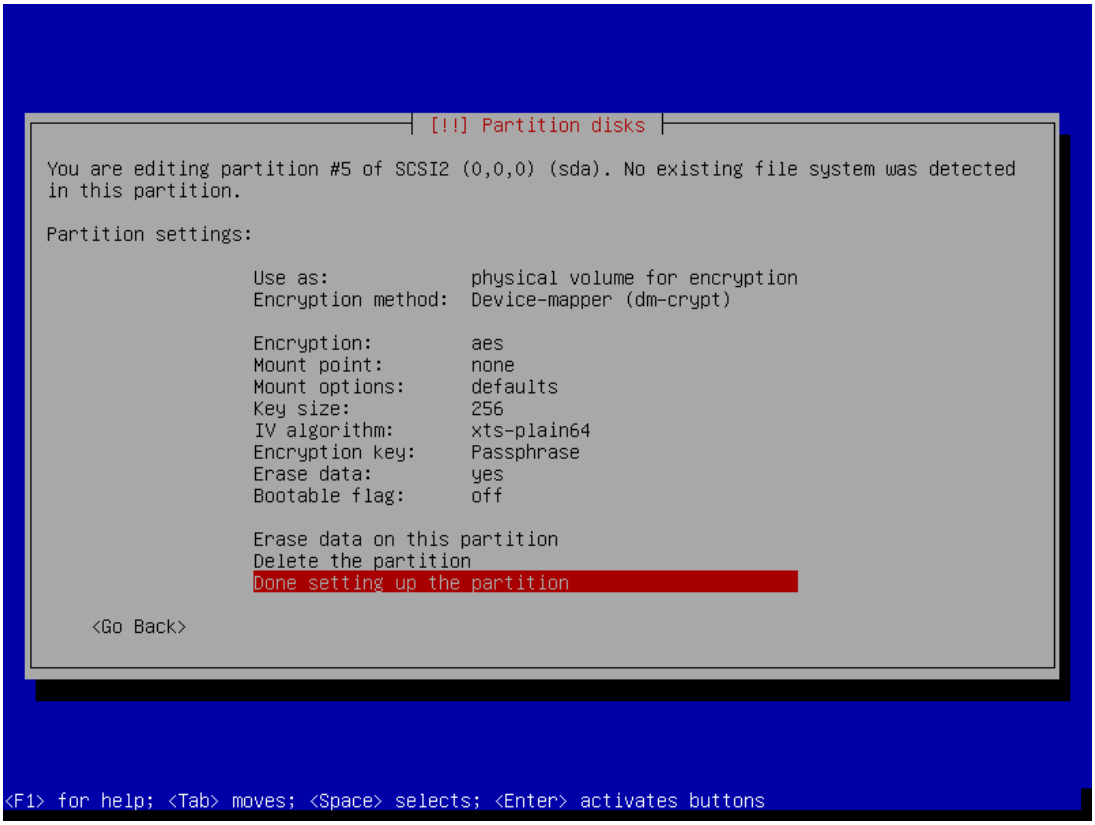
Yes, we will confirm the partition scheme. As in the image above, we should have two partitions so far: partition #1 and #5.



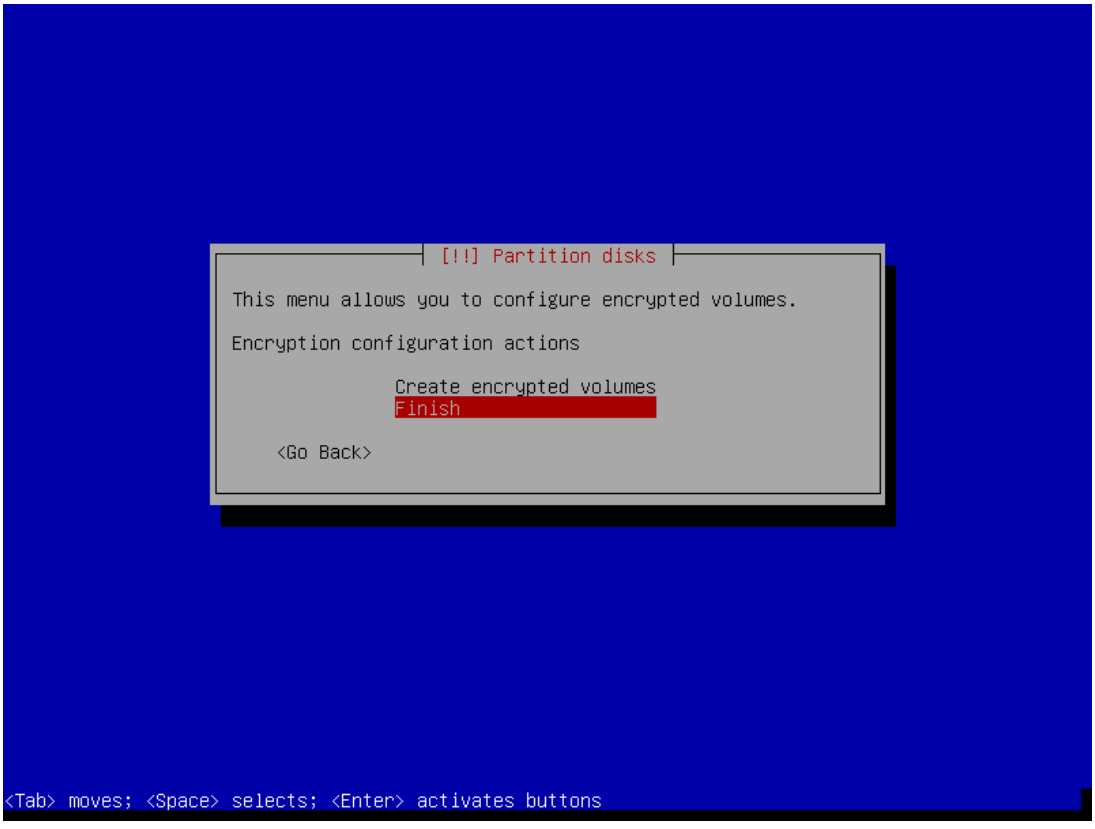
Let's **create encrypted volumes**.



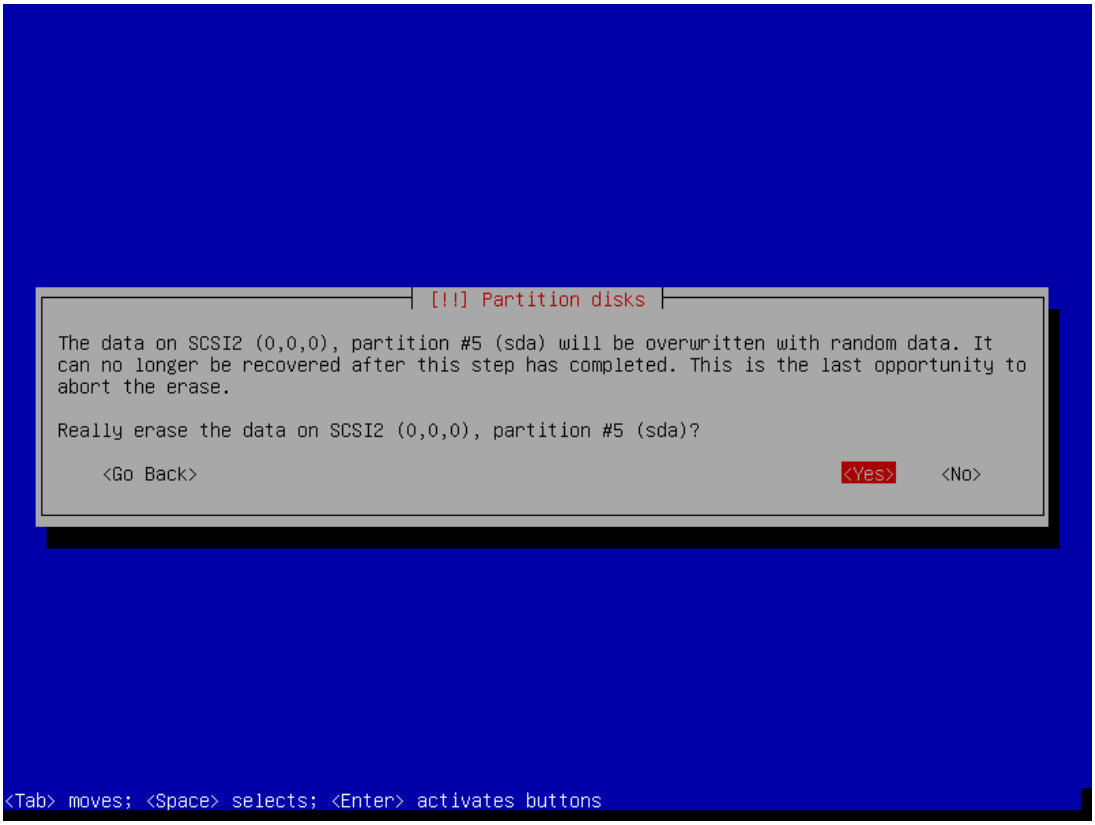
Here we **ONLY want to choose `/dev/sda5`** to encrypt (select that disk and press space so that a star appears near it).



We're now **done setting up the partition** (for now....).



And we are **finished** configuring encrypted volumes.

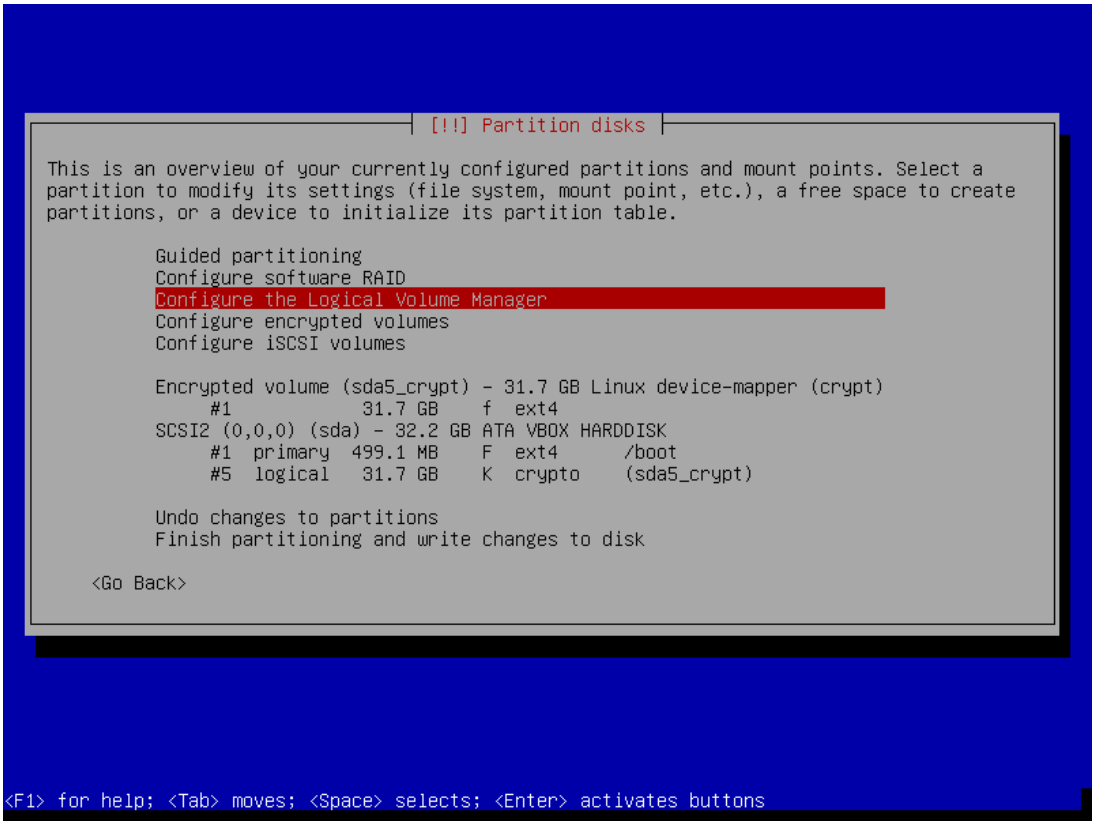


Yes, we will format the `sda5` partition that we just encrypted. Now we must wait a while until `sda5` is ready.

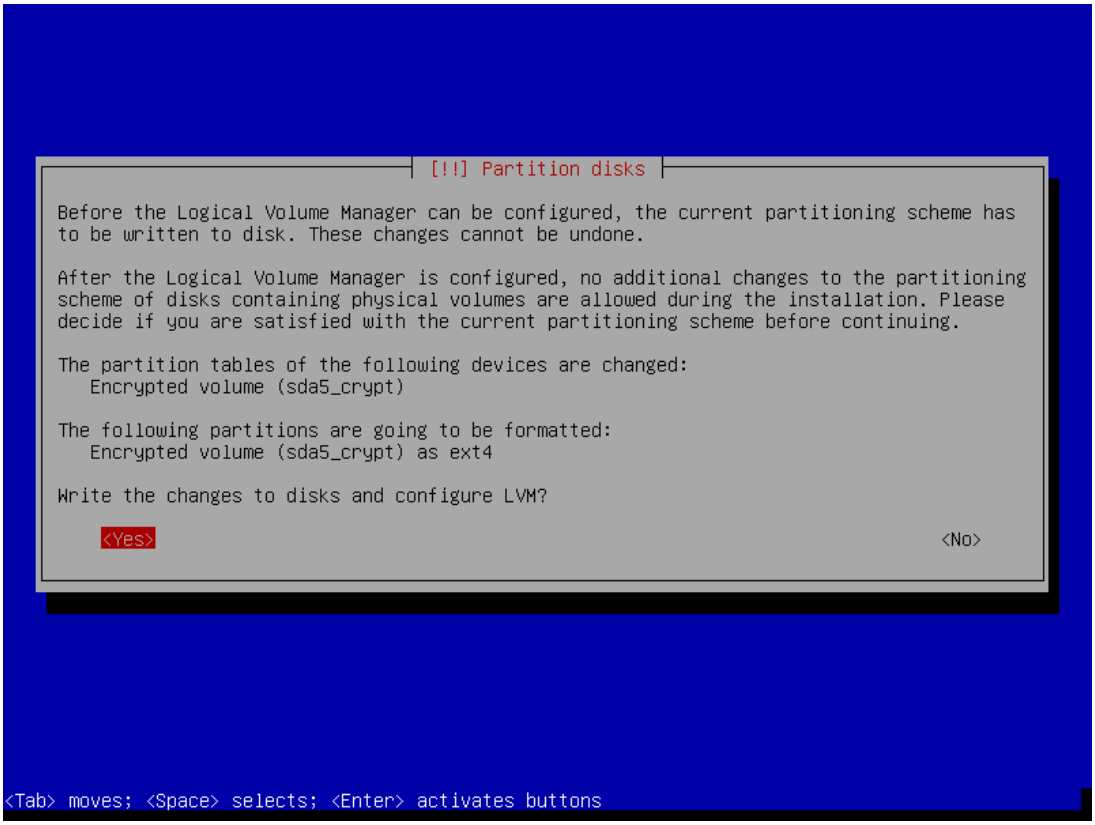
Once the installer is done erasing data on our encrypted partition, we must choose an **encryption password**. This password should be strong and we cannot forget it, otherwise we won't be able to access our Born2beroot machine! Then, of course, we have to confirm this password.

Configuring LVM

Now that our `sda5` partition is nicely encrypted, it is time to create our logical volumes inside it. For the mandatory part of Born2beroot, we need three logical volumes: root, swap and home. If we want to do the bonuses, we need seven of them: root, swap, home, var, srv, tmp and var/log.

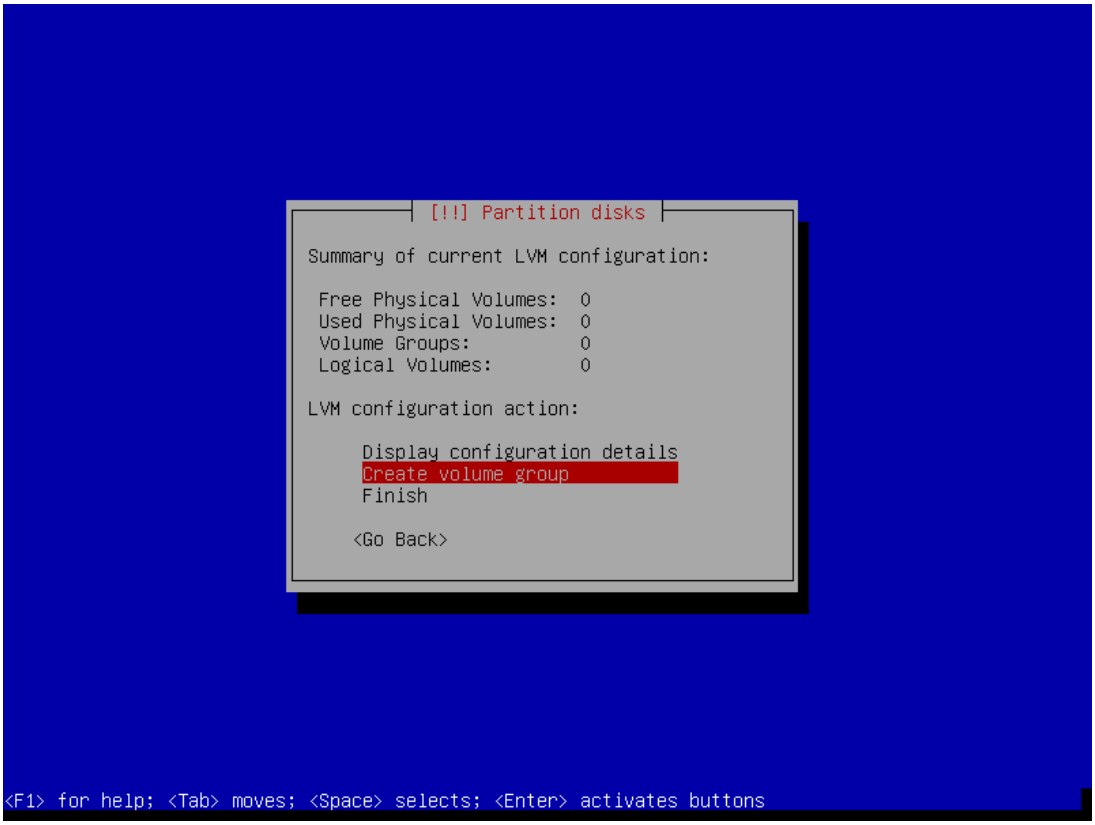


Let's **configure the Logical Volume Manager**.

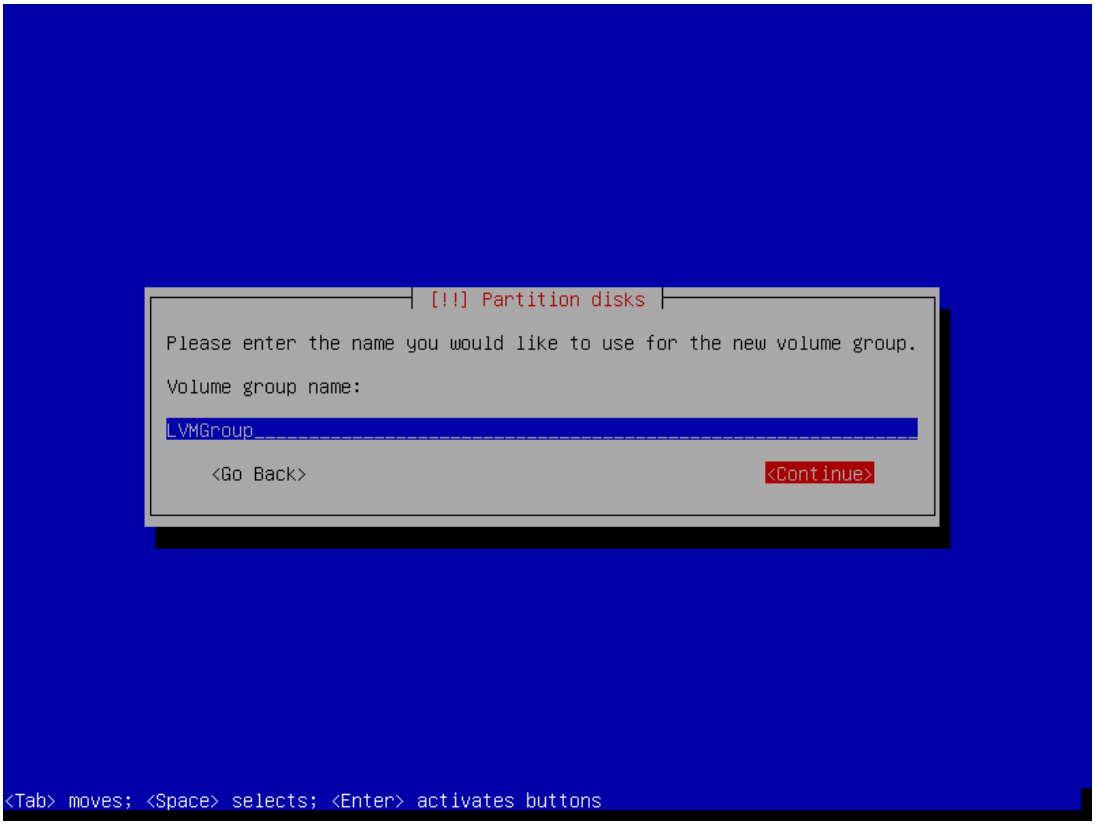


Yes, of course, we want to apply the changes and configure LVM.

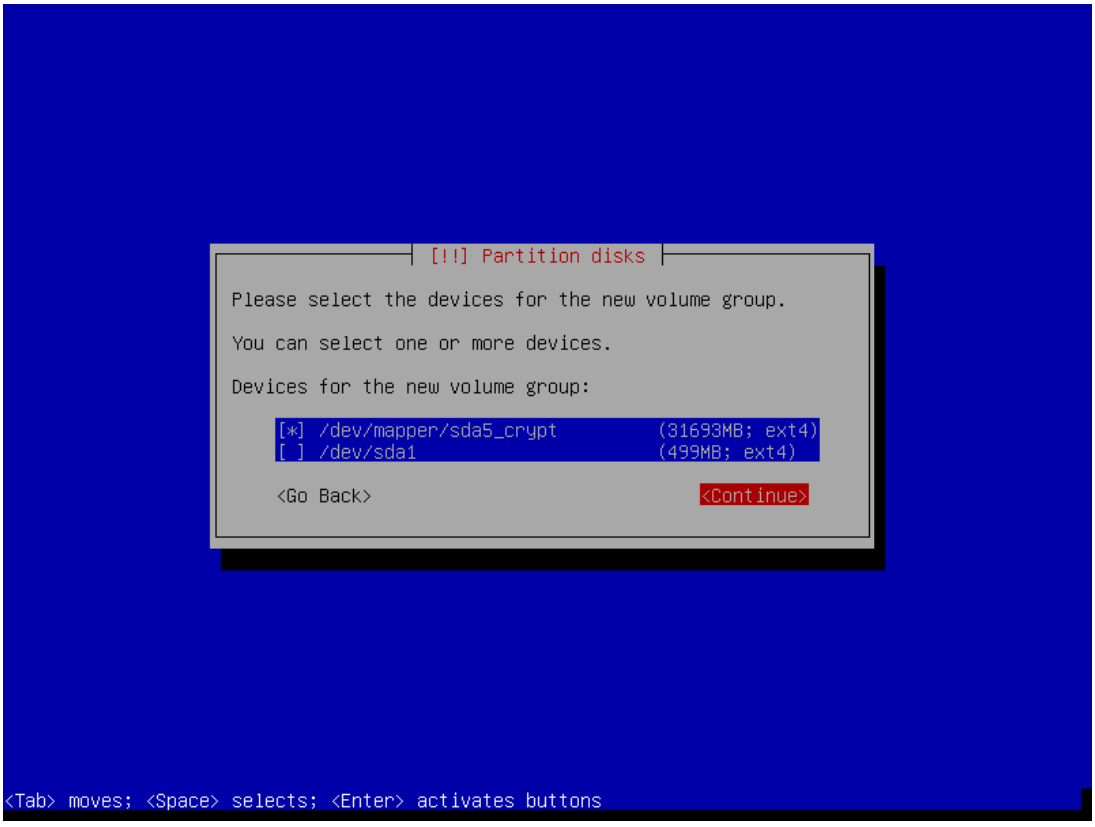
Creating a Volume Group



In order for LVM to be able to manage our logical volumes, we first have to **create a volume group**.



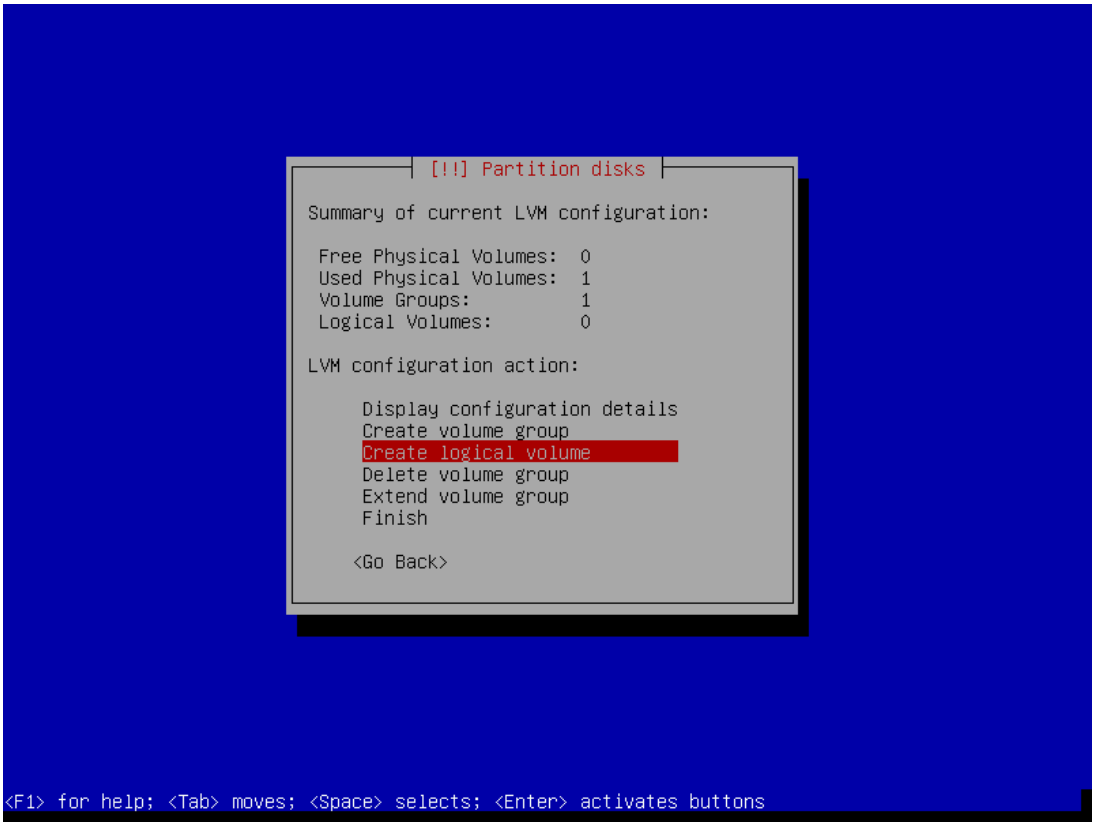
We will call the group **LVMGroup**, just like in the Born2beroot subject.



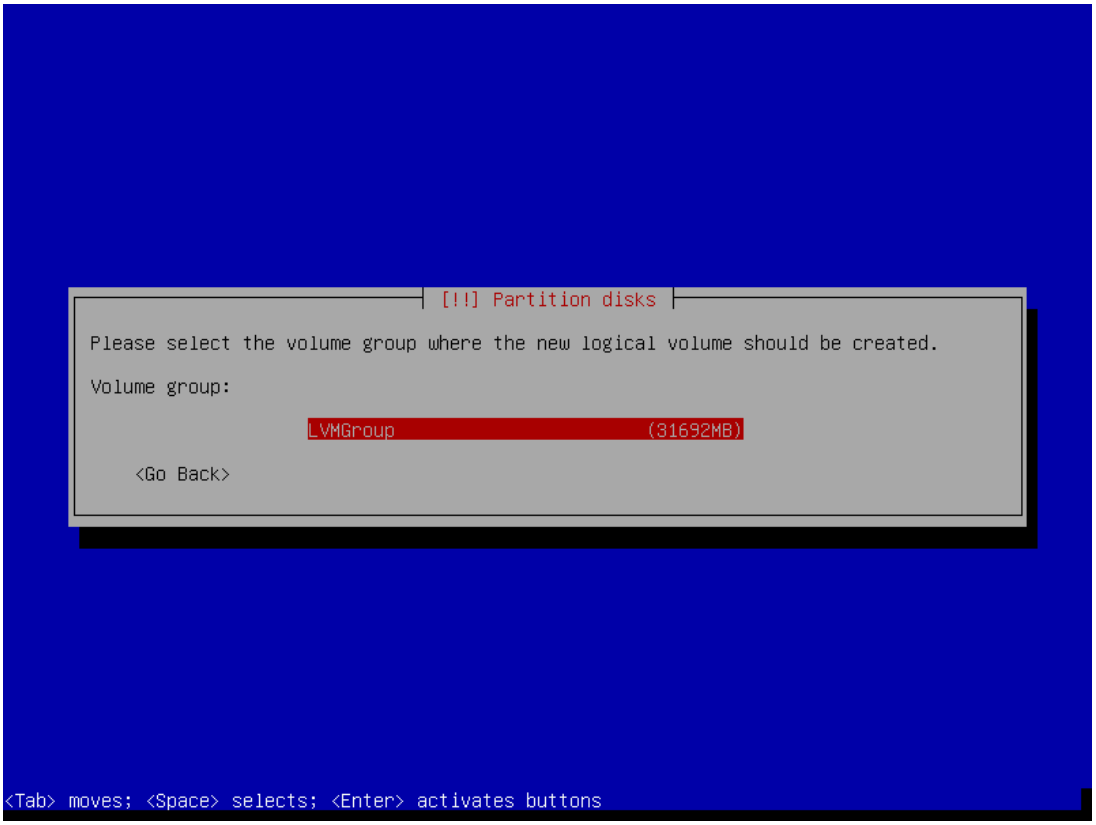
Now, we should **assign our encrypted logical partition** to this volume group (select `sda5` and press space-bar so the star appears). Careful not to assign `sda1`!

Create Logical Volumes

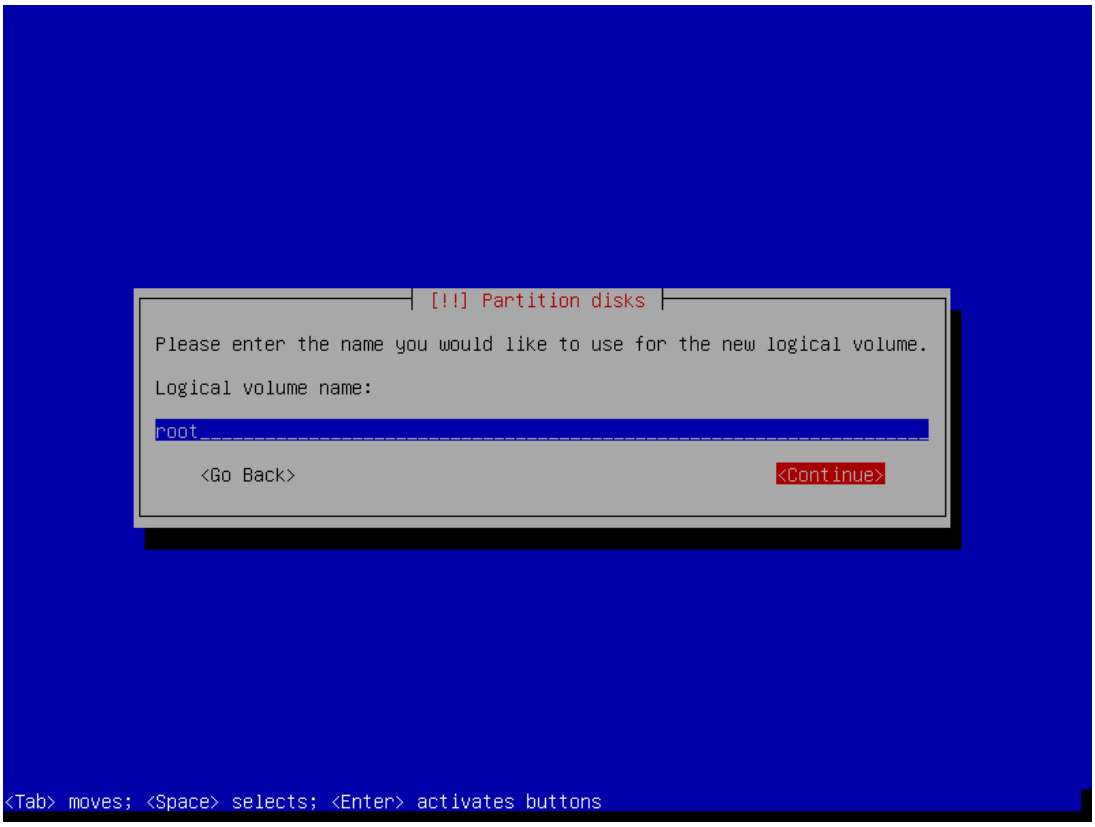
Now that we have out volume group and that our encrypted logical partition is assigned to it, we want to create our logical volumes one by one. Let's start with root, which must be present for both the mandatory and bonus parts.



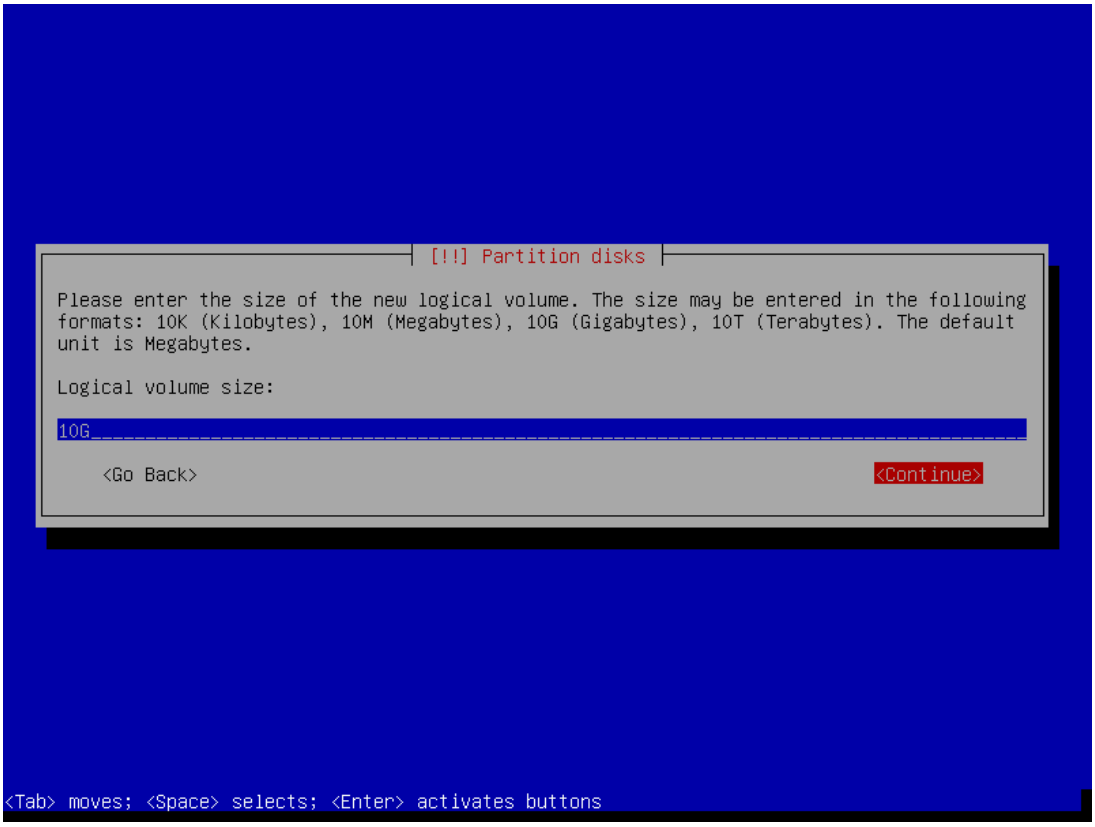
Let's **create our first logical volume**.



The new logical volume will be created in the volume group that we just made, **LVMGroup**.



Let's give it a descriptive name. In this case, **root**.



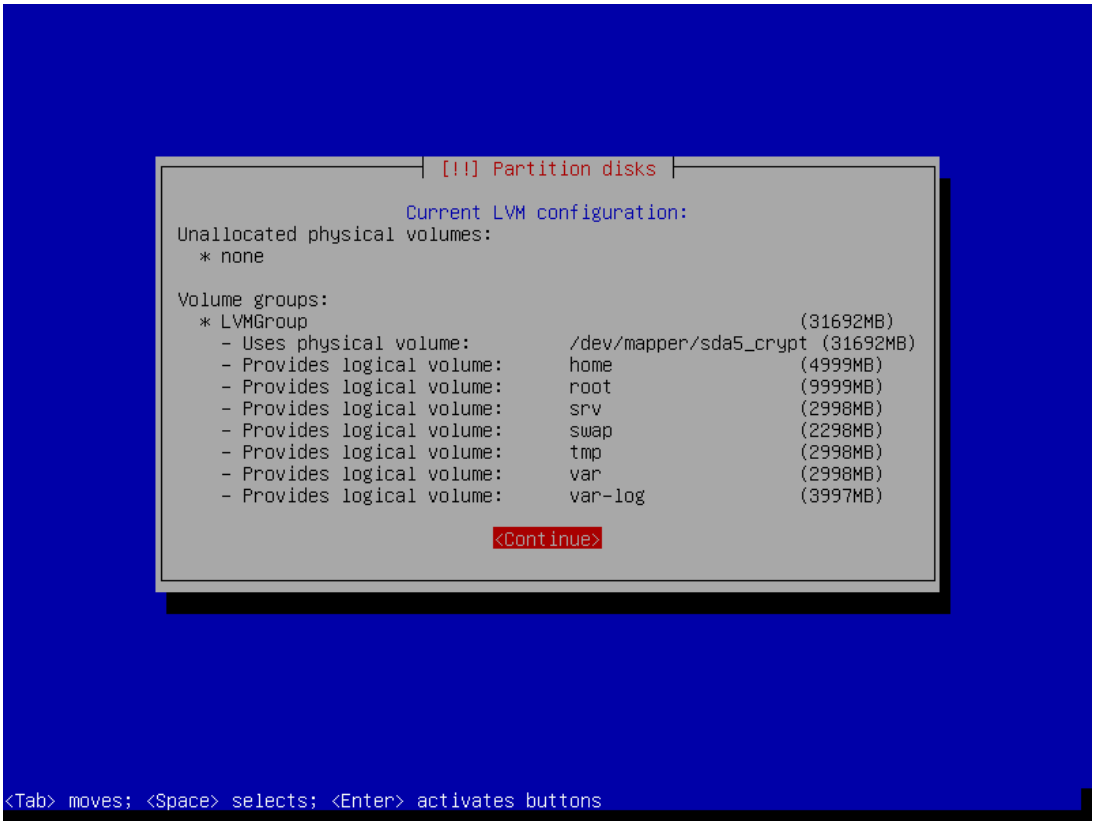
And we will give it a **size**. Here, 10 GB as in the Born2beroot subject example. For the mandatory part only, we can ask for 2.8 GB instead. However, it is possible

to change the size of these partitions later, since they are logical volumes.

We now have our first logical volume! Now we must continue to create our logical volumes until we have all the ones we need. There should be 3 for the mandatory part, 7 for the bonuses. These are the four steps:

- Create a logical volume
- Choose the group LVMGroup
- Name the volume
- Choose a size (check the subject examples)

We can check where we are in the list by **Displaying the configuration details** if we get lost. In the end, it should show something like this:

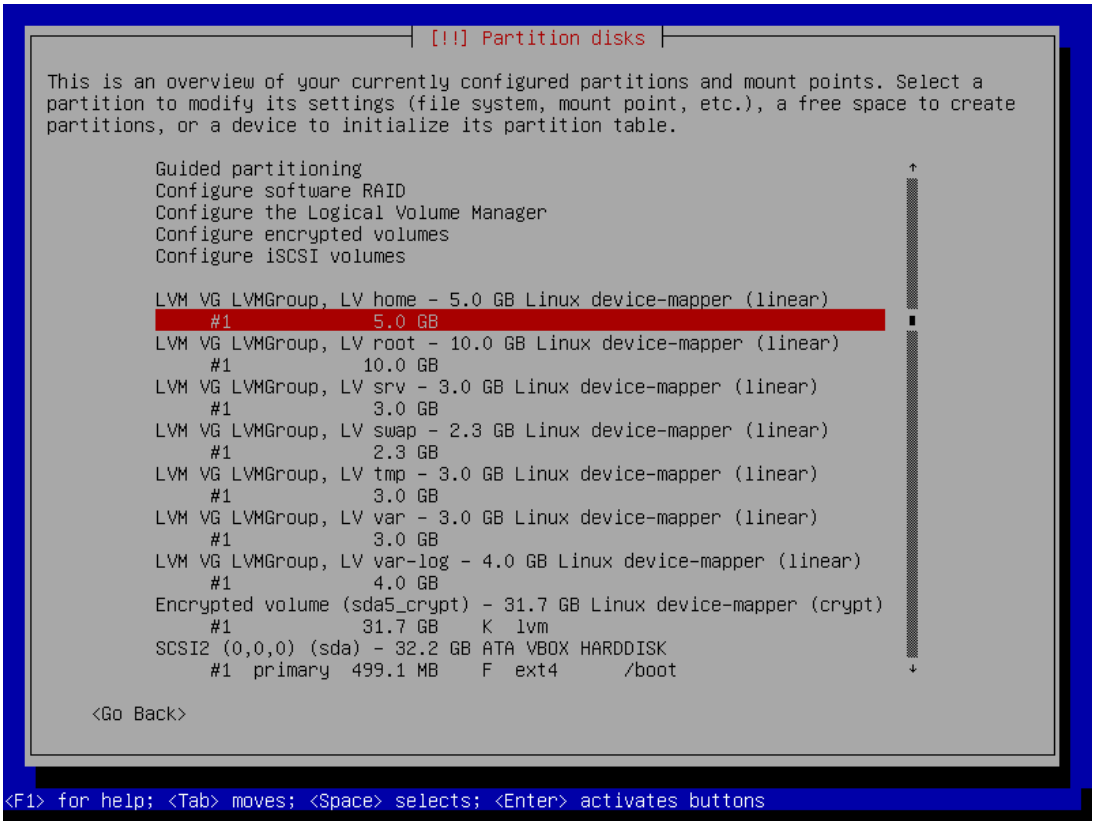


This is what the final LVM configuration for the bonus part of Born2beroot looks like. Note that the last one is named “var-log” (for some obscure reason, it will appear later as in the subject: var–log)

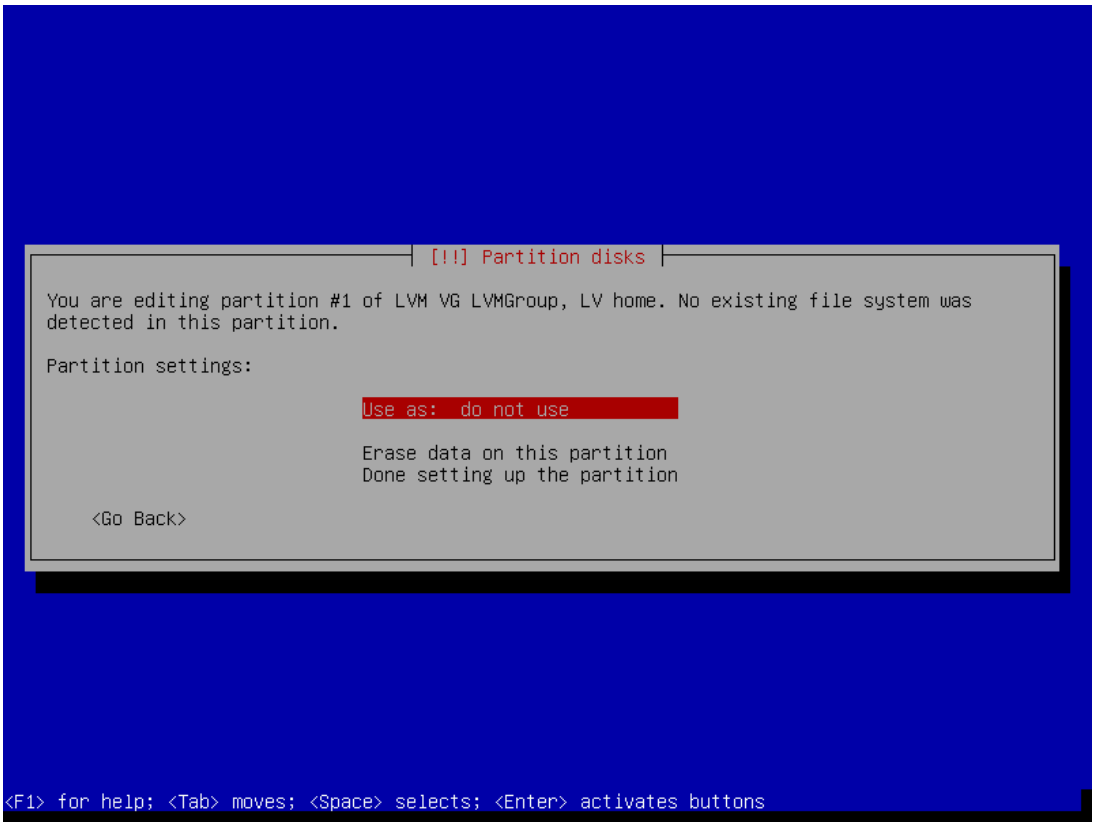
Once all the volumes are configured, we can choose to **finish** in the main menu.

Configuring Logical Volumes

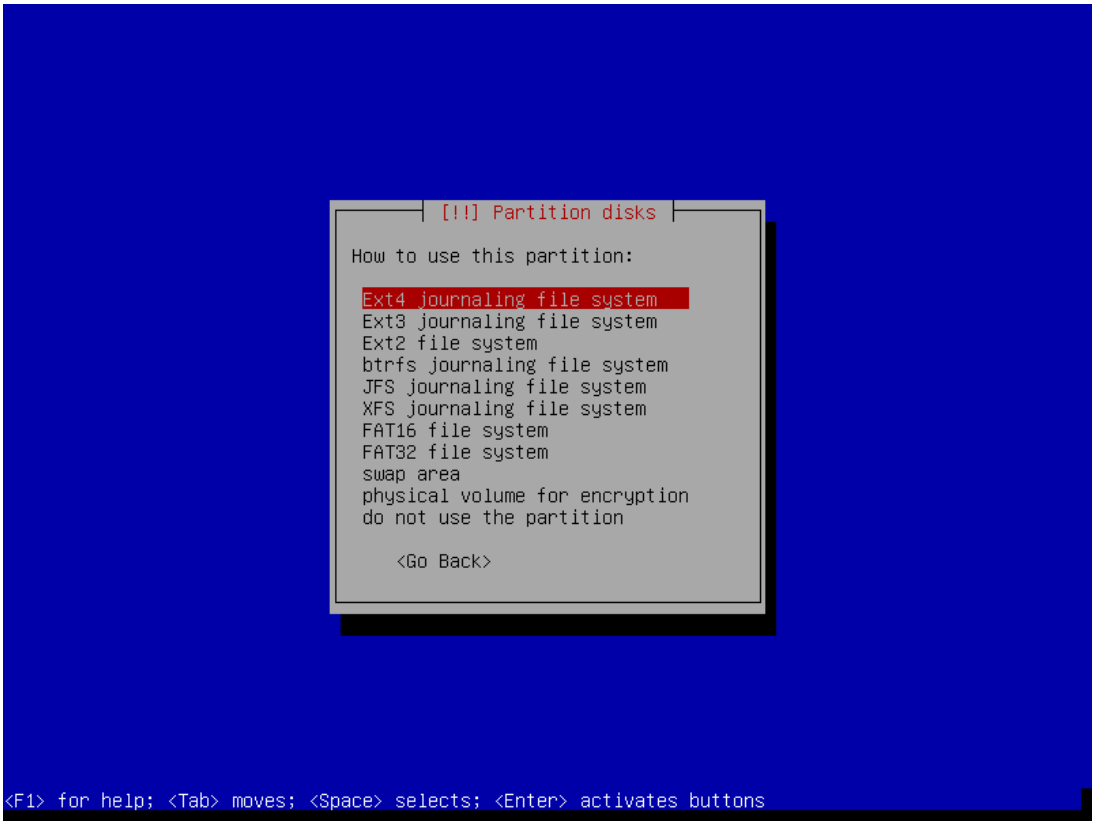
But it is not really finished! We now have to explain to Debian how to actually use each logical volume: which file system and which mount point to use.



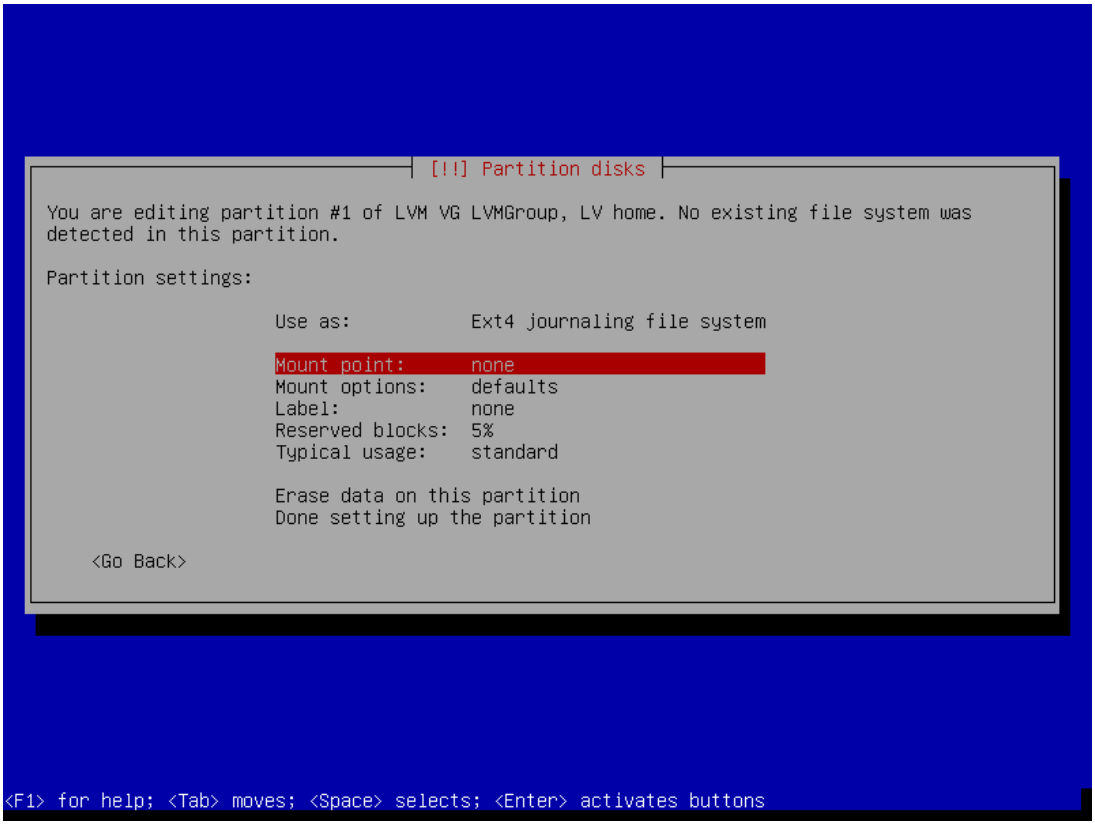
Let's select the first logical volume, **#1**, right under the line displaying its group and name. The first one will be "home".



We want to tell the system how to use this logical volume, so select **Use as:**...



We will give it the **ext4 journaling file system**.



Then, we will change it **mount point**. Let's note that the name of the logical volume is displayed for reference at the top of the screen. In this case, it's still "home".

Finally, we will tell the system to use this logical volume for the /**home** user directories. Then, we are **done** setting up this logical volume.

It is the same procedure for all the rest of the logical volumes:

- Choose the volume
- Change “Use as”
- Choose ext4 (Except **swap**, where we should instead choose “swap” and finish right away)
- Change the mount point
- Choose the corresponding mount point depending on the volume name (for **root**, choose “/ – the root file system” and for **var-log**, choose “Enter manually” and type `/var/log`)

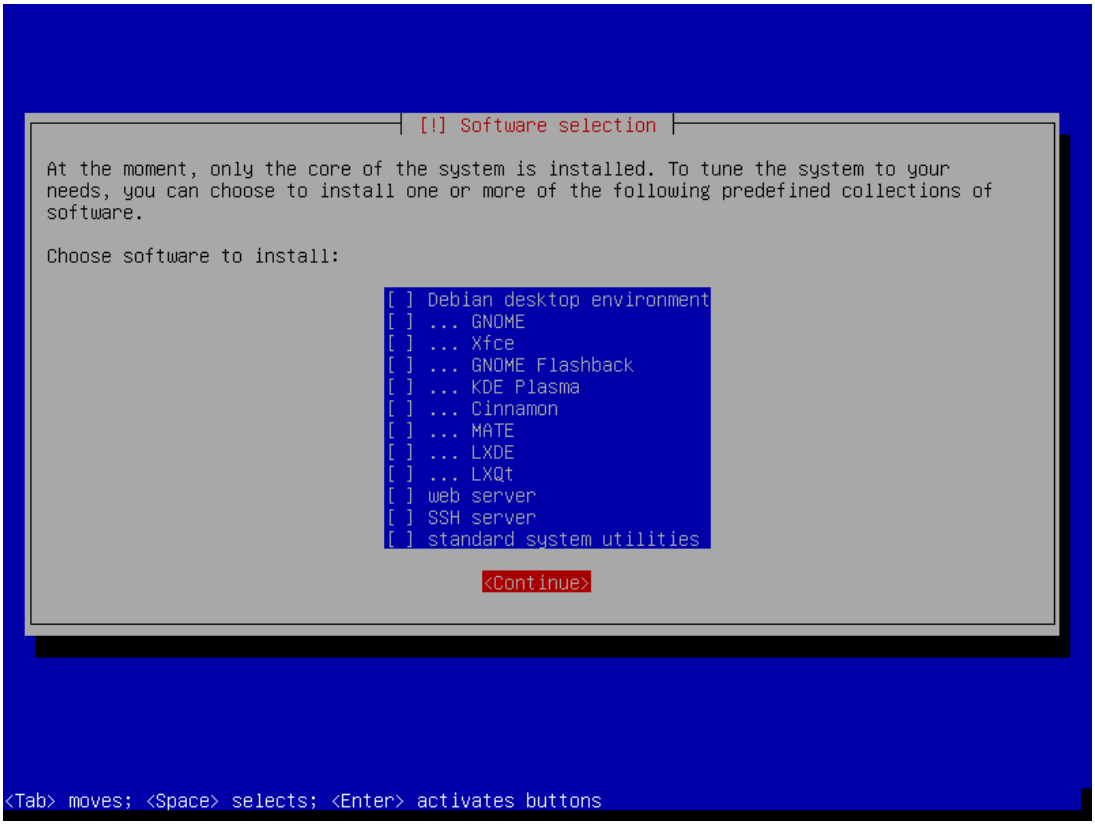
Finally, once we are certain that every volume is set up correctly, we can navigate all the way down the main page and select **Finish partitioning and write changes to disk**. Then **yes** on the next screen to confirm.

Finishing the Debian Installation

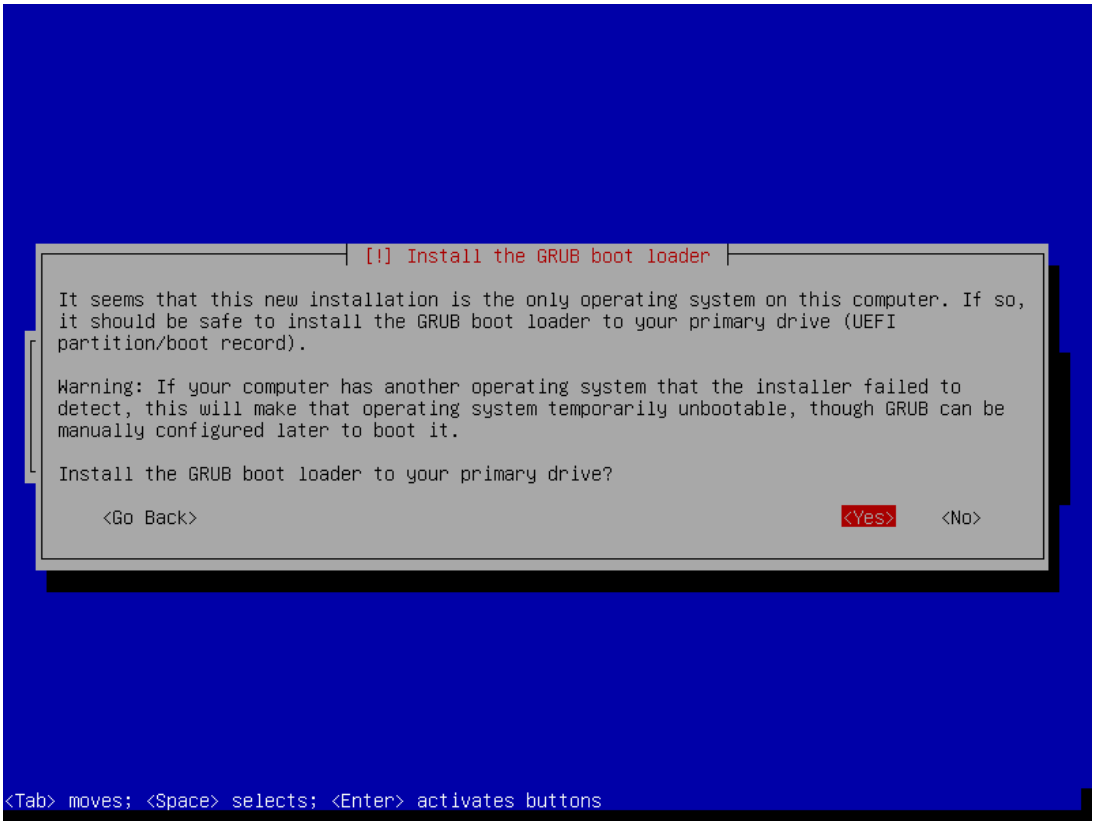
The base system will now install, which means we will have to wait some more. There are still a few things to settle:

- We can say **no** to the scan.

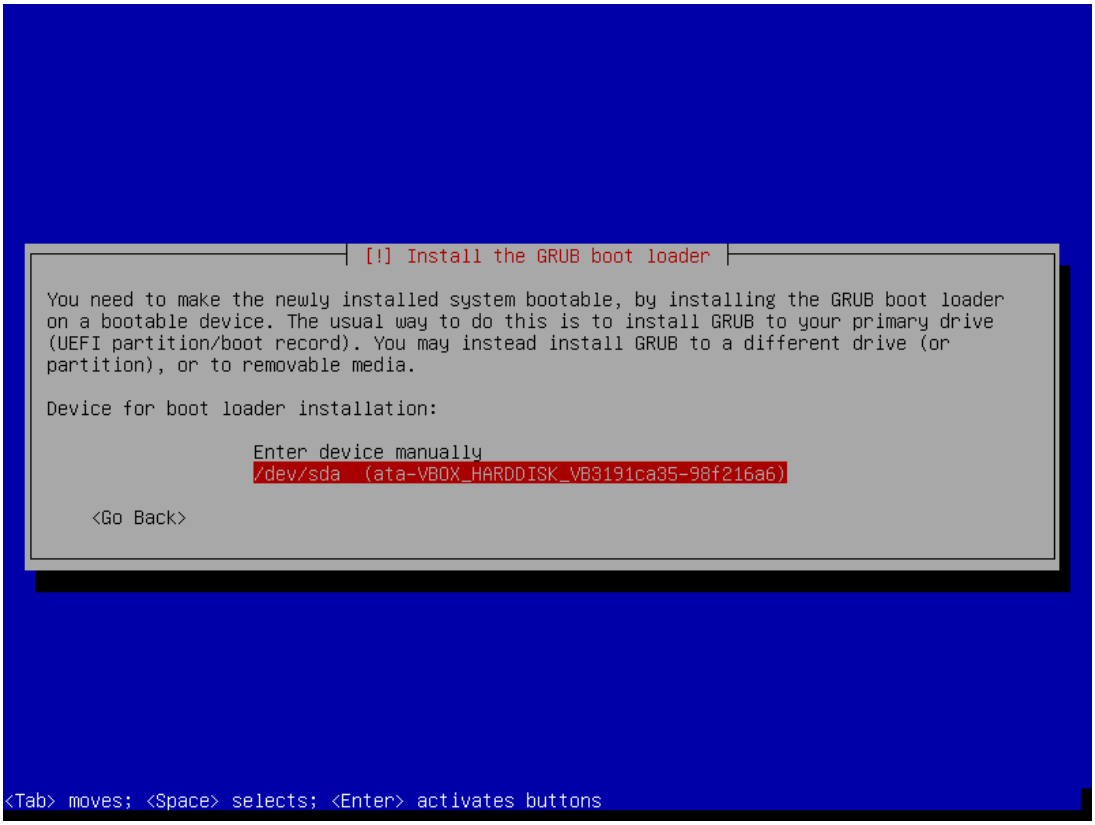
- Then we must choose a **country** and a **mirror** to download Debian packages from. (i.e. France and deb.debian.org)
- We can leave the proxy field **blank**.
- And we don't need to participate in the statistical study, so **no**.



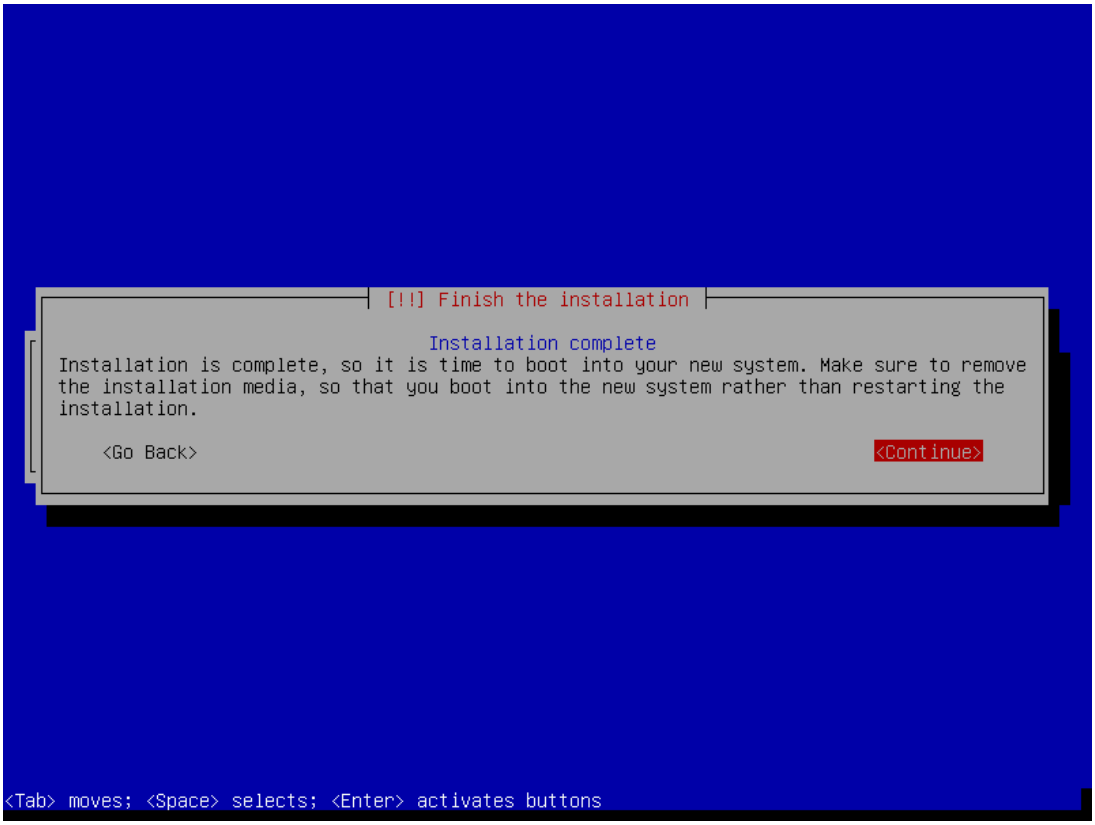
For the software selection, we don't want **any**. We will install what we need very soon. **Uncheck all the starred options** by selecting the option and pressing space before continuing.



However, **yes**, we do want to install GRUB (**Gr**and **U**nified **B**ootloader).



And we will install it on **`/dev/sda`**.



After all our effots, Debian is installed on our virtual machine, Born2beroot!

Logging into Born2beroot

Now, we can restart the virtual machine. On boot, it will ask us for the password to decrypt the encrypted partition, and then the credentials of the user we created at the beginning of the installation process.

To verify that the installation was correct, we will want to immediately try a few commands:

- **`cat /etc/os-release`** to check the OS information,
- **`lsblk`** to check our partitions,
- **`apt --version`** to check if the packet manager is installed by default,
- **`date`** to check the time zone. If the time zone is incorrect, it's not very important for Born2beroot.

Now that our partitions are correct, we can focus on the various configurations that the Born2beroot subject requires, like the sudo installation, the password policy and the monitoring.sh script. All that and more will be in the next article!

Born2beroot : **Installation** | Configuration | Bonus | Subject [pdf]

Sources and Further Reading

- VirtualBox User Manual [VirtualBox]
- Michael Klein, *What is a Virtual Machine?* [codecademy]
- W3Techs, *Usage statistics of Linux for websites* [W3Techs]
- Rich Alloway, *CentOS vs. Debian: Key Similarities and Differences* [OpenLogic]
- Nisal N, *Debian vs CentOS: Differences You Should Know* [1Gbits]
- Rich Bowen, *CentOS Project shifts focus to CentOS Stream* [CentOS]
- Karim Buzdar, *What is LVM (Logical Volume Management), and what are its Benefits?* [LinuxHint]
- Ubuntu Wiki, *LVM* [Ubuntu Wiki]
- Debian, *Appendix C. Partitioning for Debian* [Debian]

- Bertel King, *What Is a Linux Swap Partition? Everything You Need to Know* [MakeUseOf]

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Student at 42Paris, digital world explorer. I code to the 42 school norm, which means for loops, switches, ternary operators and all kinds of other things are out of reach... for now!

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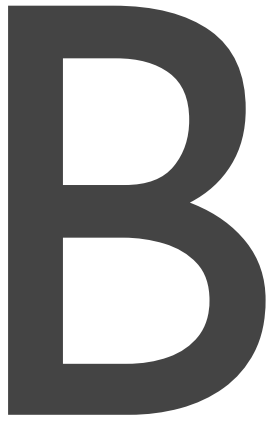

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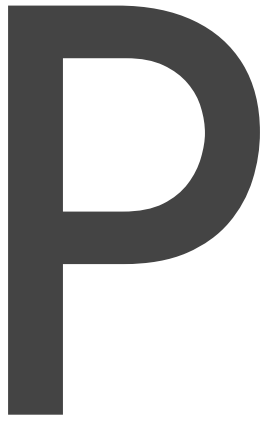

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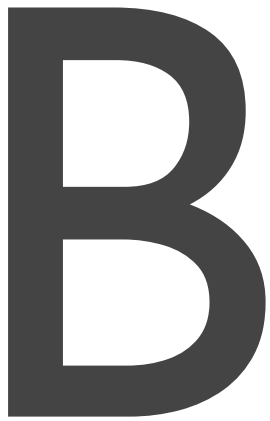

Born2beroot 02: Configuring a Debian Virtual Server

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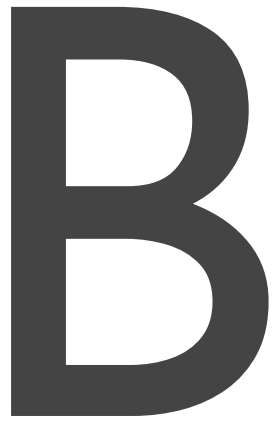

By Mia Combeau March 9, 2022

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