Partitioning and Formating

Carving up the disk

Entire disk

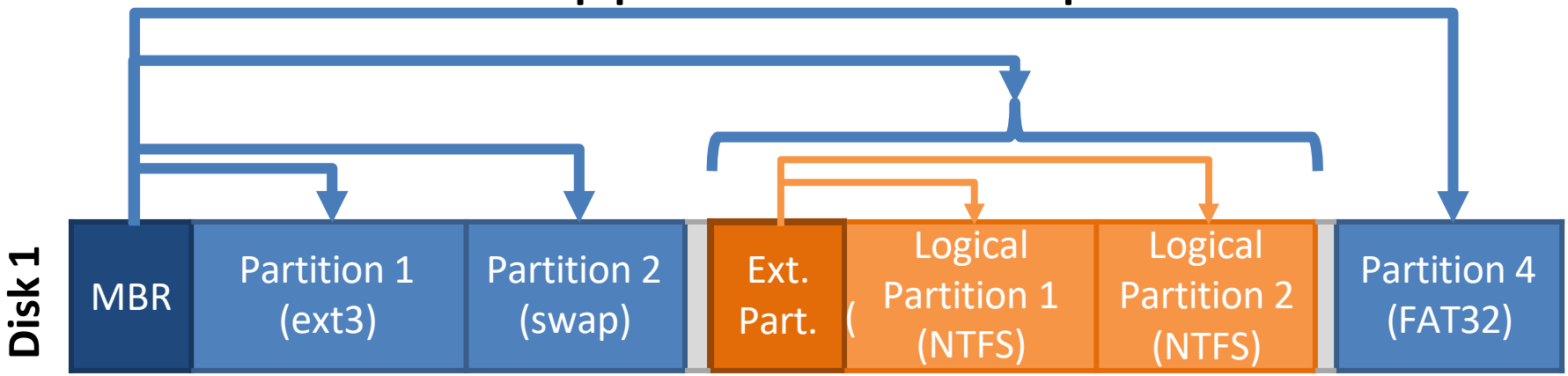
Partition table

Master boot record		Partition 1	Partition 2	Partition 3	Partition 4

Boot block	Super block	Free space management	Index nodes	Files & directories

Extended Partitions

- In some cases, you may want >4 partitions
- Modern OSes support extended partitions



- Extended partitions may use OS-specific partition table formats (meta-data)
  - Thus, other OSes may not be able to read the logical partitions

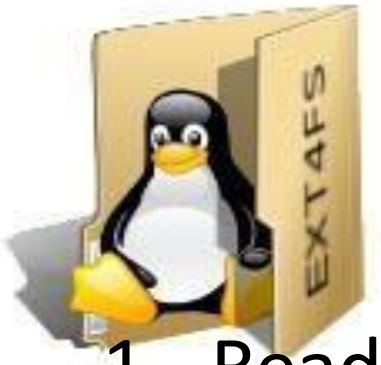
Types of Root File Systems

```
[cbw@ativ9 ~] df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/sda7        39G   14G   23G  38% /
/dev/sda2       296M   48M  249M  16% /boot/efi
/dev/sda5       127G   86G   42G  68% /media/cbw/Data
/dev/sda4        61G   34G   27G  57% /media/cbw/Windows
/dev/sdb1       1.9G  352K  1.9G   1% /media/cbw/NDSS-2013
```

1 drive, 4 partitions

1drive, 1 partition

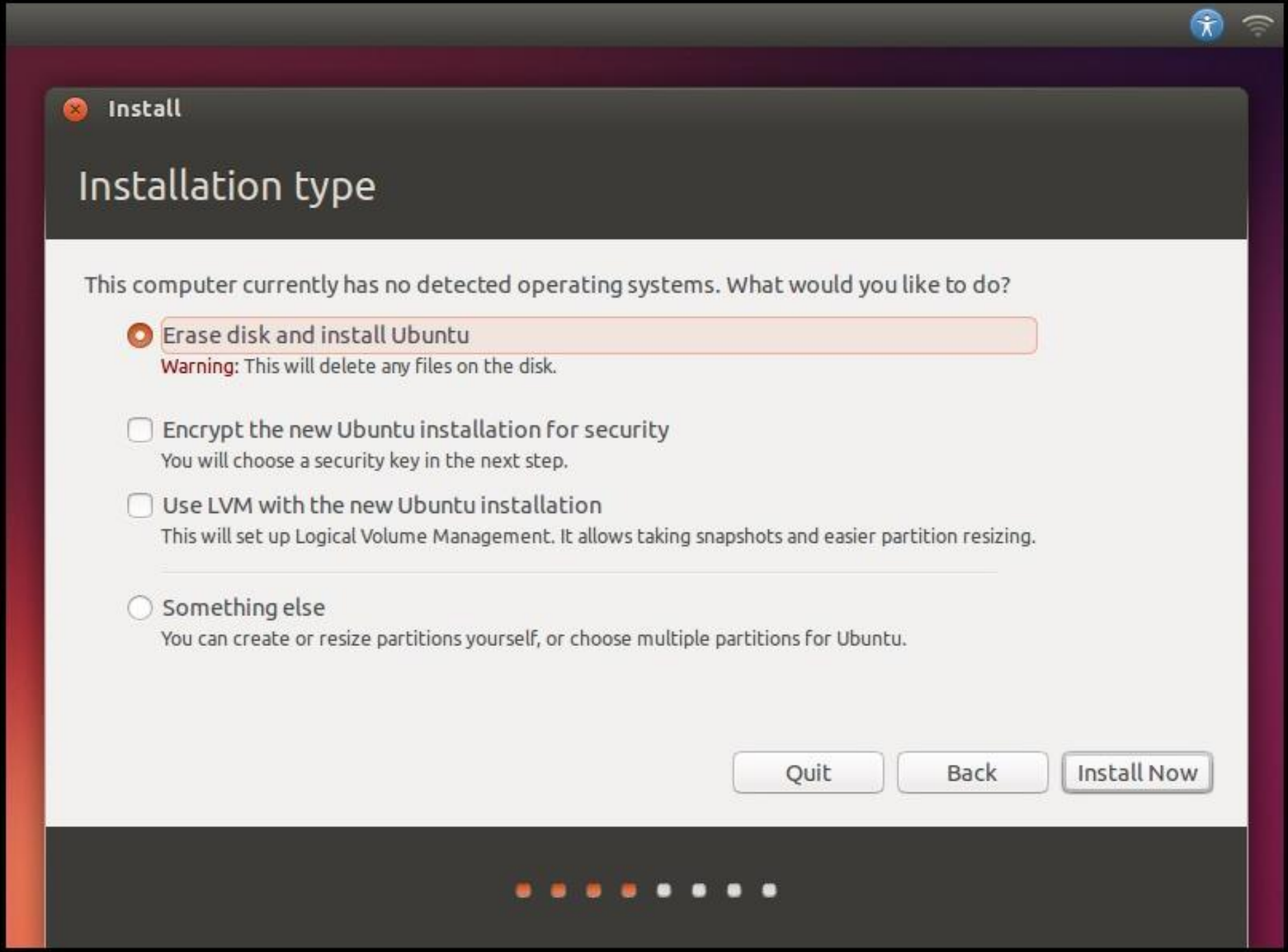
- Linux has a single root
  - One partition is mounted as /
  - All other partitions are mounted somewhere under /
- Typically, the partition containing the kernel is mounted as / or C:

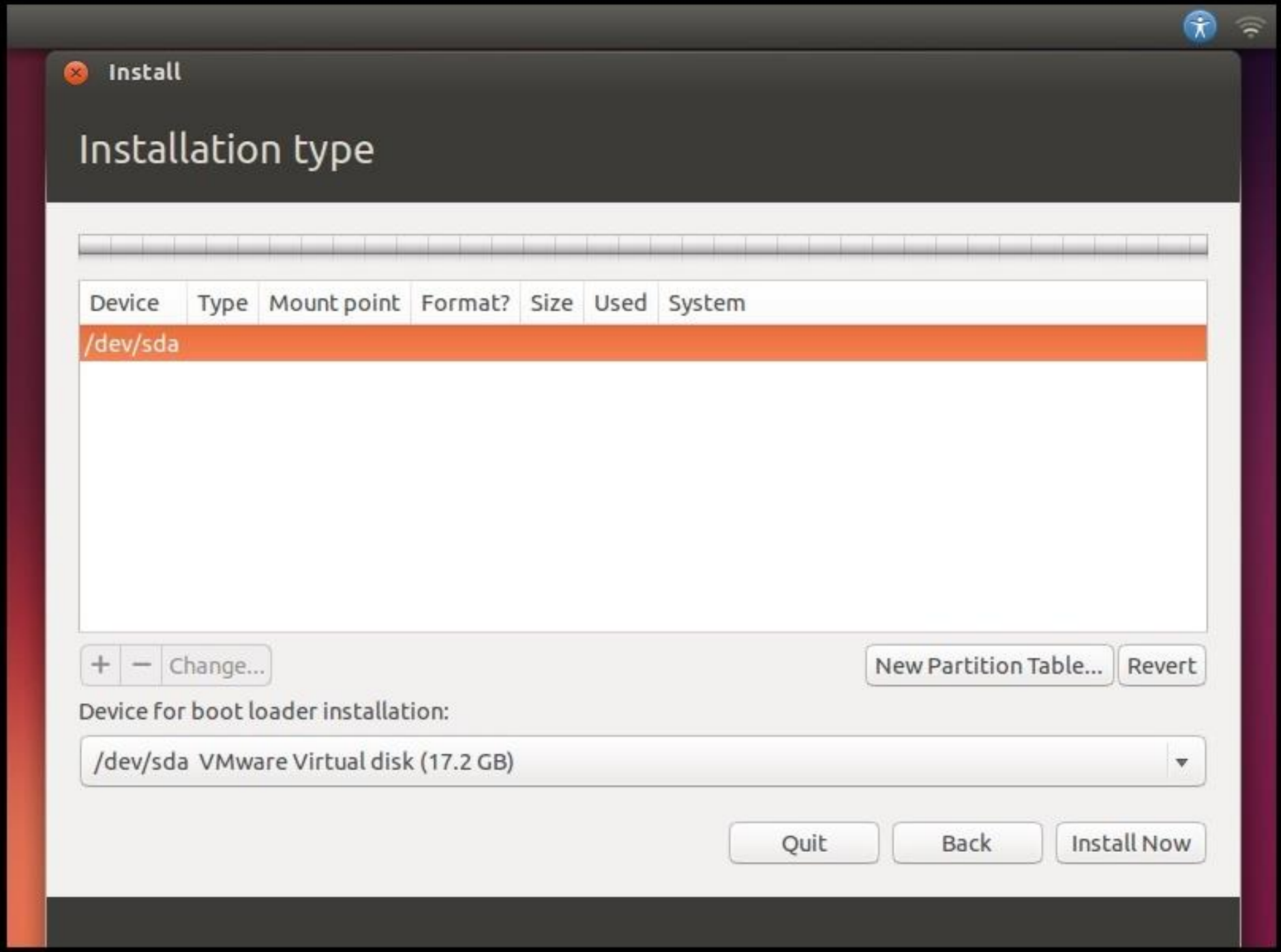


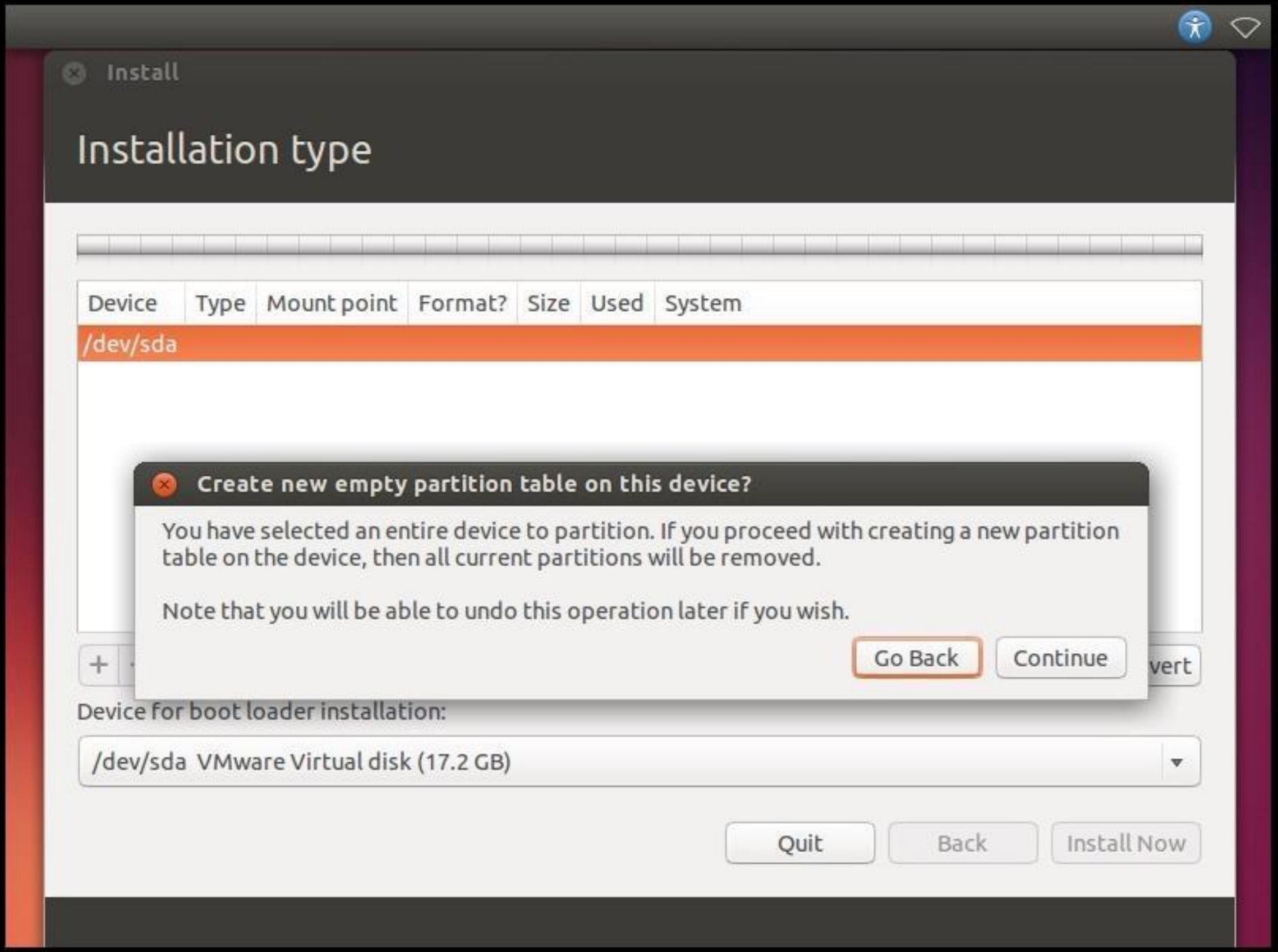
Mounting a File System

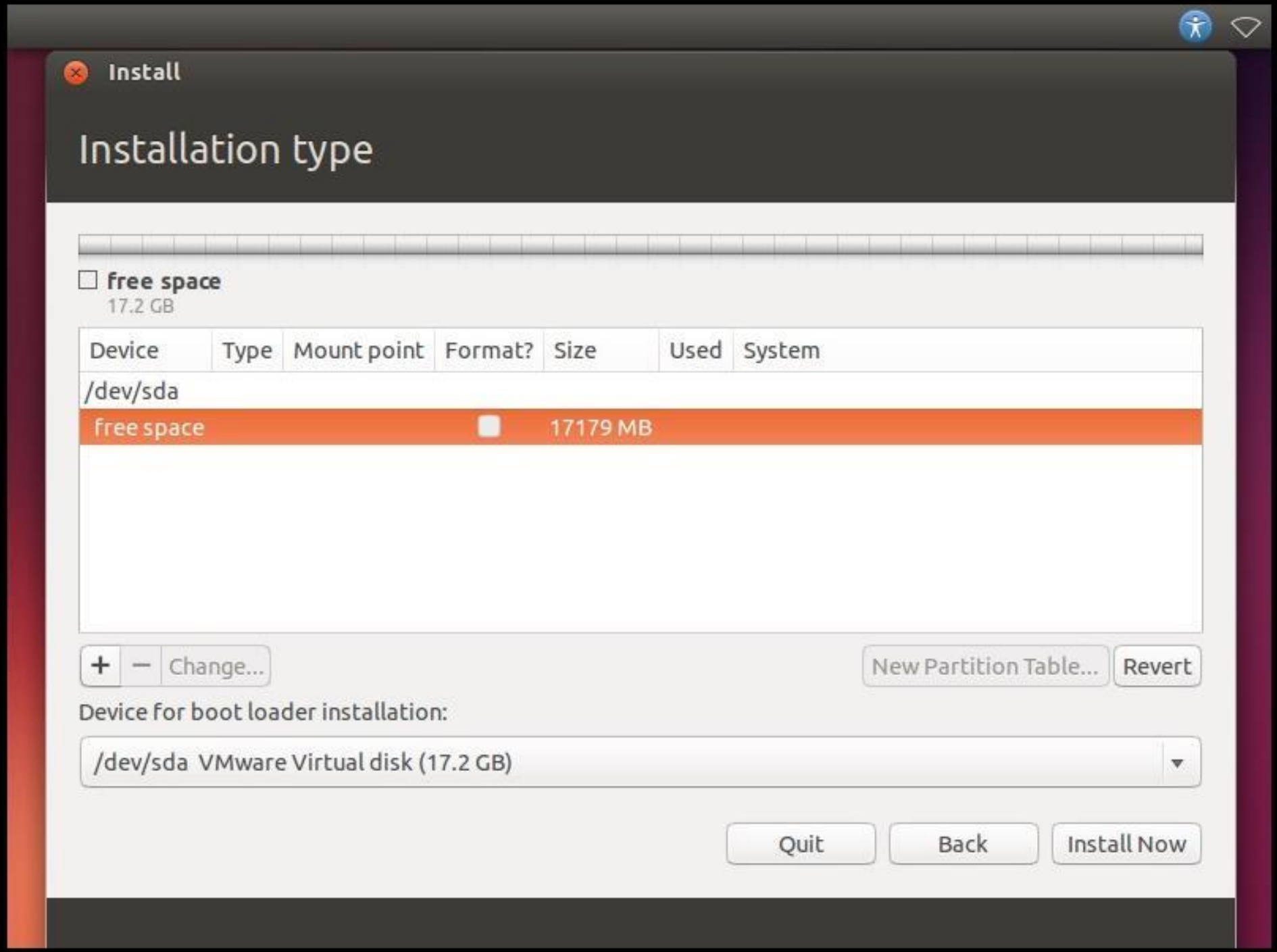
1. Read the super block for the target file system
   - Contains meta-data about the file system
   - Version, size, locations of key structures on disk, etc.
2. Determine the mount point
   - On Windows: pick a drive letter

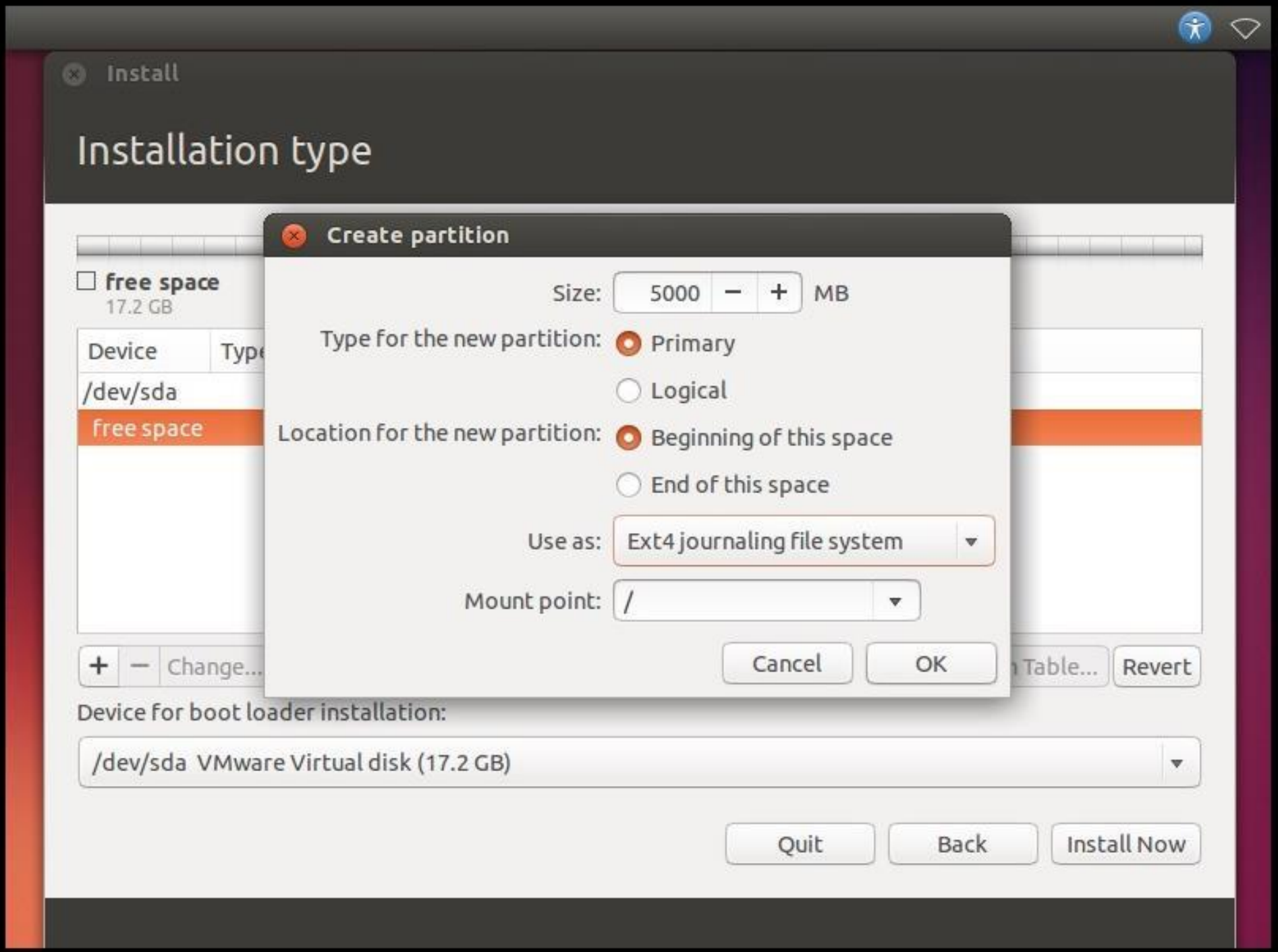
Filesystem	Size	Used	Avail	Use%	Mounted on
/dev/sda5	127G	86G	42G	68%	/media/cbw/Data
/dev/sda4	61G	34G	27G	57%	/media/cbw/Windows
/dev/sdb1	1.9G	352K	1.9G	1%	/media/cbw/NDSS-2013

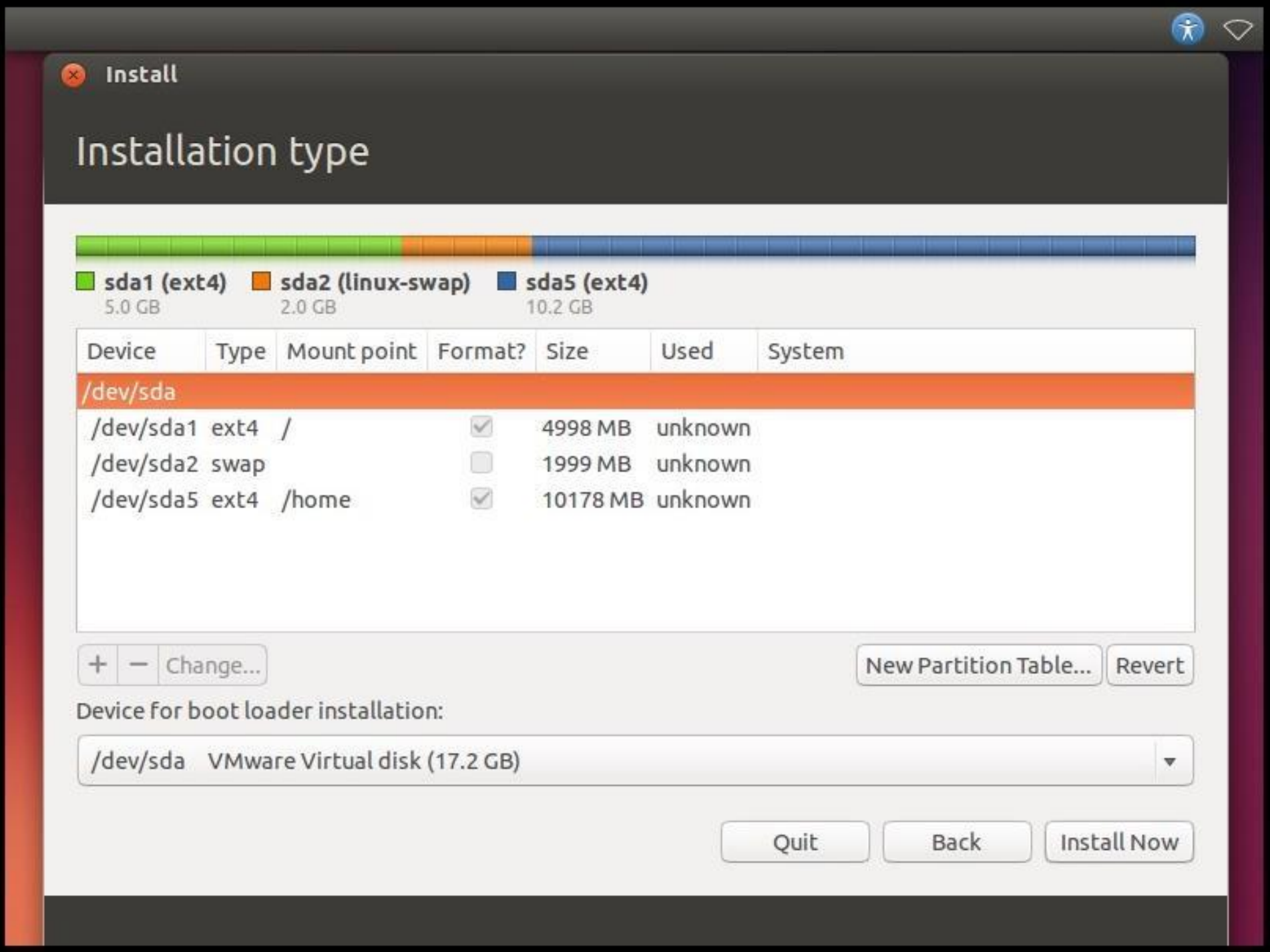

Install
Installation type
This computer currently has no detected operating systems. What would you like to do?
Erase disk and install Ubuntu
Warning: This will delete any files on the disk.
Encrypt the new Ubuntu installation for security
You will choose a security key in the next step.
Use LVM with the new Ubuntu installation
This will set up Logical Volume Management. It allows taking snapshots and easier partition resizing.
Something else
You can create or resize partitions yourself, or choose multiple partitions for Ubuntu.
Quit
Back
Install Now


Install
Installation type
Device
Type
Mount point
Format?
Size
Used
System
/dev/sda
+
−
Change...
New Partition Table...
Revert
Device for boot loader installation:
/dev/sda VMware Virtual disk (17.2 GB)
Quit
Back
Install Now


Install
Installation type
Device
Type
Mount point
Format?
Size
Used
System
/dev/sda
Create new empty partition table on this device?
You have selected an entire device to partition. If you proceed with creating a new partition table on the device, then all current partitions will be removed.
Note that you will be able to undo this operation later if you wish.
Go Back
Continue
vert
Device for boot loader installation:
/dev/sda VMware Virtual disk (17.2 GB)
Quit
Back
Install Now

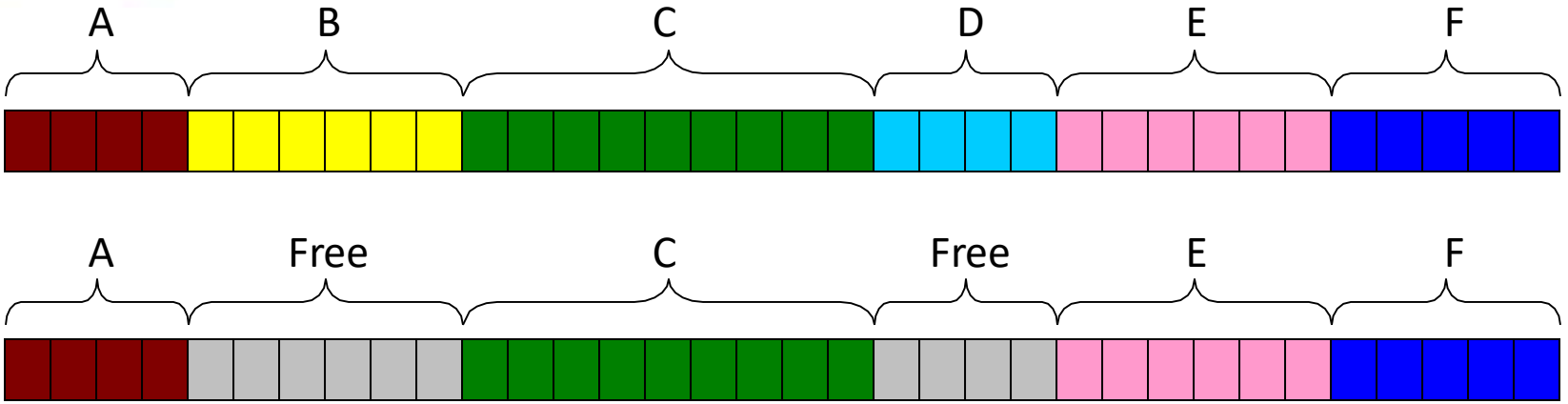

Install
Installation type
free space
17.2 GB
Device
Type
Mount point
Format?
Size
Used
System
/dev/sda
free space
17179 MB
+
−
Change...
New Partition Table...
Revert
Device for boot loader installation:
/dev/sda VMware Virtual disk (17.2 GB)
Quit
Back
Install Now


Install
Installation type
free space
17.2 GB
Device
Type
/dev/sda
free space
Create partition
Size:
5000
MB
Type for the new partition:
Primary
Logical
Location for the new partition:
Beginning of this space
End of this space
Use as:
Ext4 journaling file system
Mount point:
/
Cancel
OK
Change...
Table...
Revert
Device for boot loader installation:
/dev/sda VMware Virtual disk (17.2 GB)
Quit
Back
Install Now


Install
Installation type
sda1 (ext4)
5.0 GB
sda2 (linux-swap)
2.0 GB
sda5 (ext4)
10.2 GB
Device Type Mount point Format? Size Used System
/dev/sda
/dev/sda1 ext4 / 4998 MB unknown
/dev/sda2 swap 1999 MB unknown
/dev/sda5 ext4 /home 10178 MB unknown
+ − Change...
New Partition Table... Revert
Device for boot loader installation:
/dev/sda VMware Virtual disk (17.2 GB)
Quit Back Install Now

Linux Filesystem

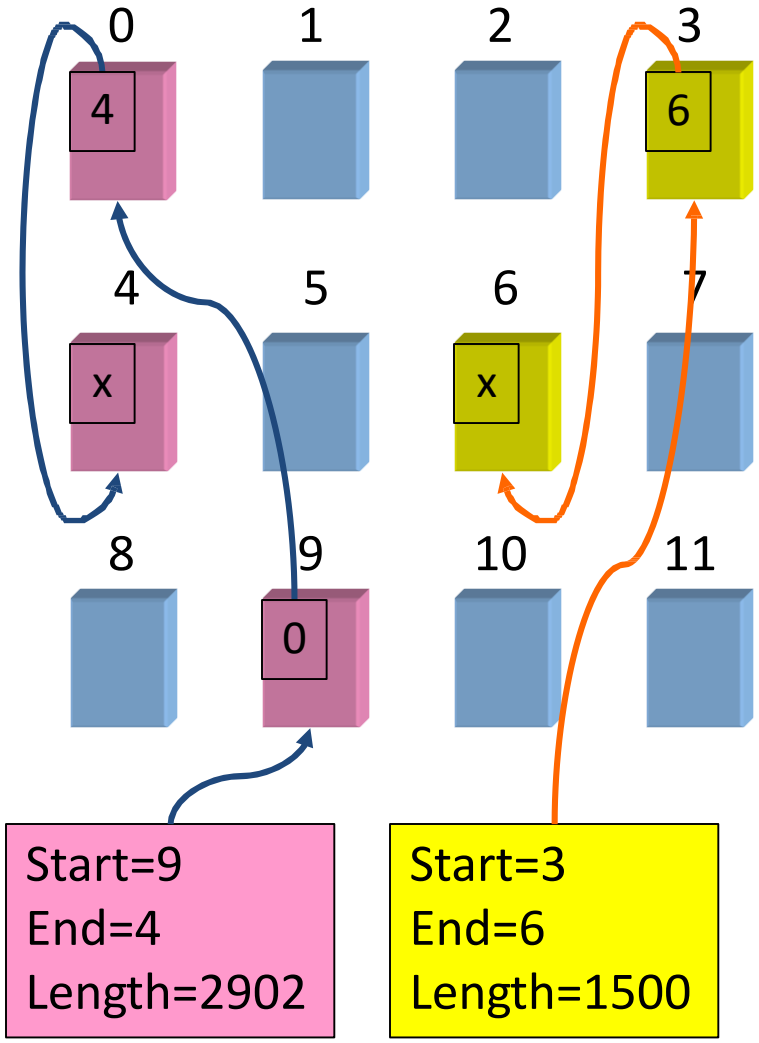
Contiguous allocation for file blocks



- Contiguous allocation requires all blocks of a file to be consecutive on disk
- Problem: deleting files leaves “holes”
  - Compacting the disk can be a very slow procedure…

Linked allocation

- File is a linked list of disk blocks
  - Blocks may be scattered around the disk drive
    - Block contains both pointer to next block and data
    - Files may be as long as needed
- New blocks are allocated as needed
  - Linked into list of blocks in file
  - Removed from list (bitmap) of free blocks



Beginnings and Ext2

- EXT: Extended File System
- First one created in 1992 for Linux
- EXT2 created one year after EXT
- XIAFS also created at the time, but lost to EXT2 due to EXT2's better longevity and flexibility.
- EXT2 expanded the maximum filesystem size from 2 GB to 32 TB.

EXT3

- In 2001 EXT3 was created to enable journaling within the filesystem.
- Maximum file size is 16GB-2TB
- Maximum file system size is 2TB-32TB
- The max number of blocks for ext3 is 2^32
- **Journaling**: writing all filesystem changes to a temporary location, or journal, before writing permanently to the filesystem.
  - Allows for better recovery.

EXT4

- Not an entirely new filesystem, but rather a fork of EXT3.
- Main improvements: Journal Checksums and delayed allocation of memory
- This meant the system waits until right before it writes the file permanently to allocate memory. This allows for better decision making.
- EXT4 is backwards compatible with all other versions of EXT.

Ext4

- It supports 48-bit block addressing, so it will have 1 EB of maximum filesystem size and 16 TB of maximum file size.
- 1 EB = 1,048,576 TB (1 EB = 1024 PB, 1 PB = 1024 TB, 1 TB = 1024 GB)
- Ext4 allows an unlimited number of sub directories

Features of Ext4(cont.)

- Journal Checksumming
  - Ext4 uses checksumming to make sure that the journal blocks are not failing or corrupting.
  - The journal blocks are some of the most used on the disk which means that they are more prone to hardware failures.
- “No Journaling” Mode
  - Ext4 allows for the disabling of the journal to remove the little of overhead that it takes

Features of Ext4(cont.)

- Online Defragmentation
  - Allows for defragmentation while a filesystem is still in use
- Inodes
  - Ext4 has a larger default inode size, allowing for more information about each file
  - Ext4 will automatically reserve several inodes when a directory is created in anticipation of the directory holding files
  - Ext4 uses nanosecond resolution timestamps over Ext3 use of second resolution timestamps

Difference between ext versions

Point	ext2	ext3	ext4
Maximum individual file size	16GB – 2TB	16GB – 2TB	16GB – 16TB
Maximum file system size	2TB – 32TB	2TB – 32TB	1EB
Journalling	Not available	Available	Available and can be turned "off" too
Number of directories	31998	31998	Unlimited
Journal checksum	No	No	Yes
Multi-block allocation and delayed allocation	No	No	Yes

Compatibility with Windows

- It is possible to use software to allow certain operations in an Ext4 system from Windows, however there are no drivers available yet that allow all features of Ext4 to be used
  - Ext2Fsd is a driver that will allow write operations
    - Extents must be turned off
  - Ext2Read will allow read operations in Windows with extents enabled

Compatibility with OS X

- OS X has full compatibility with Ext4 filesystems through the use of Paragon ExtFS.
  - This is a commercial software and must be purchased.
- Free solutions are extremely limited
  - ext4fuse is a free solution but is limited to read only

Getting Ext4

- Once you have upgraded to e2fsprogs 1.41 or later. Simply type:

  # mke2fs -t ext4 /dev/*DEV* or

  # mkfs.ext4 /dev/*DEV*

- Once the filesystem is created, it can be mounted as follows:

  # mount -t ext4 /dev/*DEV* /wherever

ext4 features on ext3

- To enable the ext4 features on an existing ext3 filesystem, use the command:

  # tune2fs -O extents,uninit_bg,dir_index /dev/*DEV*

- WARNING: Once you run this command, the filesystem will no longer be mountable using the ext3 filesystem!

Sources

- http://kernelnewbies.org/Ext4
- https://ext4.wiki.kernel.org/index.php/Ext4_Howto