LINUX VOICE TUTORIAL

PYPARTED: PYTHON DOES DISK PARTITIONING

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Build a custom, command line disk partitioning tool by joining the user-friendliness of Python and the power of C.

WHY DO THIS?
- Take complete control of your system's hard disk.
- Write a custom installer to make things easier for your users.
- Amaze your friends and family with your mastery of the libparted C library.

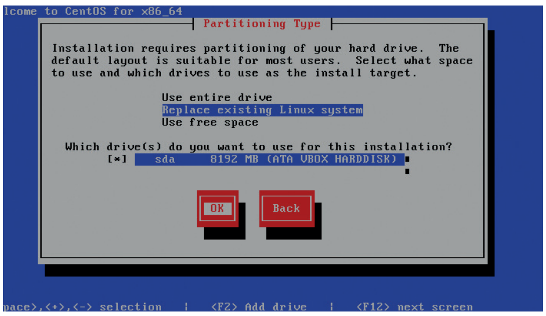
Partitioning is a traditional way to split disk drives into manageable chunks. Linux comes with variety of tools to do the job: there are fdisk, cfdisk or GNU Parted, to name a few. GNU Parted is powered by a library by the name of libparted, which also lends functionality to many graphical tools such as famous GParted. Although it's powerful, libparted is written in pure C and thus not very easy for the non-expert to tap into. If you're writing your own custom partitioner, to use libparted you're going to have to manage memory manually and do all the other elbow grease you do in C. This is where PyParted comes in – a set of Python bindings to libparted and a class library built on top of them, initially developed by Red Hat for use in the Anaconda installer.

So why would you consider writing disk partitioning software? There could be several reasons:
- You are developing a system-level component like an installer for your own custom Linux distribution
- You are automating a system administration task such as batch creation of virtual machine (VM) images. Tools like ubuntu-vm-builder are great, but they do have their limitations
- You're just having fun.

"A word of caution: partitioning may harm the data on your hard drive. Back everything up!"

PyParted hasn't made its way into the Python Package Index (PyPI) yet, but you may be lucky enough to find it in your distribution's repositories. Fedora (naturally), Ubuntu and Debian provide PyParted packages, and you can always build PyParted yourself from the sources. You will need the libparted headers (usually found in **libparted-dev** or similar package), Python development files and GCC. PyParted uses the **distutils** package, so simply enter **python setup.py install** to build and install it. It's a good idea to install PyParted you've built yourself inside the virtualenv (see **http://docs.python-guide.org/en/latest/dev/virtualenvs** for details), to keep your system directories clean. There is also a Makefile, if you wish. This article's examples use PyParted 3.10, but the concepts will stay the same regardless of the version you actually use.

Before we start, a standard caution: partitioning may harm the data on your hard drive. Back everything up before you do anything else!



PyParted was developed to facilate Red Hat's installer, Anaconda.

Basic concepts

The PyParted API has two layers. At the bottom one is the **_ped** module. Implemented entirely in C, it tries to keep as close as possible to the native libparted C API. On top of that, the 'parted' package with high-level Python classes, functions and exceptions is built. You can use **_ped** functions directly if you wish; however, the **parted** package provides a more Pythonic approach, and is the recommended way to use PyParted in your programs unless you have some special requirements. We won't go into any details of using the **_ped** module in this article.

Before you do anything useful with PyParted, you'll need a Device instance. A Device represents a piece of physical hardware in your system, and provides the means to obtain its basic properties like model, geometry (cylinders/heads/sectors – it is mostly fake for modern disks, but still used sometimes), logical and physical sector sizes and so on. The Device class also has methods to read data from the hardware and write it back. To obtain a Device instance, you call one of the global functions exported by PyParted (in the examples below, **>>>** denotes the interactive Python prompt, and **...** is an omission for readability reasons or line continuation if placed at the beginning):

```
>>> import parted
>>> # requires root privileges to communicate
... with the kernel
>>> [dev.path for dev in parted.getAllDevices()]
[u'/dev/sda', u'/dev/mapper/ubuntu--vg-swap_1',
u'/dev/mapper/ubuntu--vg-root',
u'/dev/mapper/sda5_crypt']
>>> # get Device instance by path
>>> sda = parted.getDevice('/dev/sda')
>>> sda.model
u'ATA WDC WD1002FAEX-0'
>>> sda.hardwareGeometry, sda.biosGeometry
```

```
((121601, 255, 63),
(121601, 255, 63)) # cylinders, heads, sectors
>>> sda.sectorSize, sda.physicalSectorSize
(512L, 512L)
>>> # Destroy partition table; NEVER do this on
... your computer's disk!
>>> sda.clobber()
True
```

Next comes the Disk, which is the lowest-level operating system-specific abstraction in the PyParted class hierarchy. To get a Disk instance, you'll need a Device first:

```
>>> disk = parted.newDisk(sda)
Traceback (most recent call last):
...
_ped.DiskException: /dev/sda: unrecognised disk label
```

This reads the disk label (ie the partitioning scheme) from **/dev/sda** and returns the Disk instance that represents it. If **/dev/sda** has no partitions (consider the **sda.clobber()** call before), **parted.DiskException** is raised. In this case, you can create a new disk label of your choice:

```
>>> disk = parted.freshDisk(sda, 'msdos') # or 'gpt'
```

You can do it even if the disk already has partition table on it, but again, beware of data-loss. PyParted supports many disk labels. However, traditional **'msdos'** (MBR) and newer **'gpt'** (GUID Partition Table) are probably most popular in PC world.

Disk's primary purpose is to hold partitions:

```
# Will be empty after clobber() or freshDisk()
>>> disk.partitions
[<parted.partition.Partition object at 0x1043050>, ...]
```

Each partition is represented by Partition object which provides 'type' and 'number' properties:

```
>>> existing_partition = disk.partitions[0]
>>> existing_partition.type, existing_partition.number
(0L, 1) # 0 is normal partition
>>> parted.PARTITION_NORMAL
0
```

Besides **parted.PARTITION_NORMAL**, there are other partition types (most importantly, **parted.PARTITION_EXTENDED** and **parted.PARTITION_LOGICAL**). The **'msdos'** (MBR) disk label supports all of them, however **'gpt'** can hold only normal partitions.

Partitions can also have flags like **parted.PARTITION_BOOT** or **parted.PARTITION_LVM**. Flags are set by the **Partition.setFlag()** method, and retrieved by **Partition.getFlag()**. We'll see some examples later.

The partition's position and size on the disk are defined by the **Geometry** object. Disk-related values (offsets, sizes, etc) in PyParted are expressed in sectors; this holds true for **Geometry** and other classes we'll see later. You can use the convenient function **parted.sizeToSectors(value, 'B', device.sectorSize)** to convert from bytes (denoted as **'B'**; other units such as **'MB'** are available as well). You set the Geometry when you create the partition, and access it later via the **partition.geometry** property:

```
>>> # 128 MiB partition at the very beginning of the disk
>>> geometry = parted.Geometry(start=0,
... length=parted.sizeToSectors(128, 'MiB',
... sda.sectorSize), device=sda)
>>> new_partition = parted.Partition(disk=disk,
... type=parted.PARTITION_NORMAL,
... geometry=geometry)
>>> new_partition.geometry
<parted.geometry.Geometry object at 0xdc9050>
```

Partitions (or geometries, to be more precise) may also have an associated **FileSystem** object. PyParted can't create new filesystems itself (parted can, but it is still recommended that you use special-purpose utilities like mke2fs). However, it can probe for existing filesystems:

```
>>> parted.probeFileSystem(new_partition.geometry)
Traceback (most recent call last):
...
_ped.FileSystemException: Failed to find any filesystem
in given geometry
>>> parted.probeFileSystem(existing_partition.geometry)
u'ext2'
>>> new_partition.fileSystem
<parted.filesystem.FileSystem object at 0x27a1310>
```

The names (and corresponding FileSystem objects) for filesystems recognised by PyParted are stored in **parted.fileSystemType** dictionary:

```
>>> parted.fileSystemType.keys()
[u'hfsx', u'fat32', u'linux-swap(v0)', u'affs5', u'affs2', u'ext4',
u'ext3', u'ext2', u'amufs', u'amufs0', u'amufs1', u'amufs2',
u'amufs3', u'amufs4', u'amufs5', u'btrfs', u'linux-swap(v1)',
u'swsusp', u'hfs+', u'reiserfs', u'freebsd-ufs', u'xfs', u'affs7',
```

Caution: partitioning may void your warranty

Playing with partitioning is fun but also quite dangerous: wiping the partition table on your machine's hard drive will almost certainly result in data loss. It is much safer to do your experiments in a virtual machine (like VirtualBox) with two hard drives attached. If this is not an option, you can 'fake' the hard drive with an image file (**$** is a normal user and **#** is a superuser shell prompt):

```
$ dd if=/dev/zero of=<image_file_name> \
 bs=512 count=<disk_size_in_sectors>
```

This will almost work; however, **Partition.getDeviceNodeName()** will return non-existent nodes for partitions on that device. For more accurate emulation, use **losetup** and **kpartx**:

```
# losetup -f <image_file_name>
# kpartx -a /dev/loopX
...
# losetup -d /dev/loopX
```

where **X** is the **losetup** device assigned to your image file (get it with **losetup -a**). After that, you may refer to the partitions on your image file via **/dev/loopXpY (or /dev/mapper/loopXpY**, depending on your distribution). This will require root privileges, so be careful. You can still run your partitioning scripts on an image file as an ordinary user, given that the file has sufficient permissions (ie is writable for the user that you are running scripts as). The last command removes the device when it is no longer needed.

If you feel adventurous, you can also fake your hard drive with a qcow2 (as used by Qemu), VDI, VMDK or other image directly supported by virt-manager, Oracle VirtualBox or VMware Workstation/Player. These images can be created with **qemu-img** and mounted with **qemu-nbd**:

```
$ qemu-img create -f vdi disk.vdi 10G
# modprobe nbd
# qemu-nbd -c /dev/nbd0 disk.img
```

You can then mount the partitions on **disk.img** as **/dev/nbd0pX** (where **X** is partition number), provided the label you use is supported by your OS kernel (unless you are creating something very exotic, this will be the case). When you are done, run:

```
# qemu-nbd -d /dev/nbd0
```

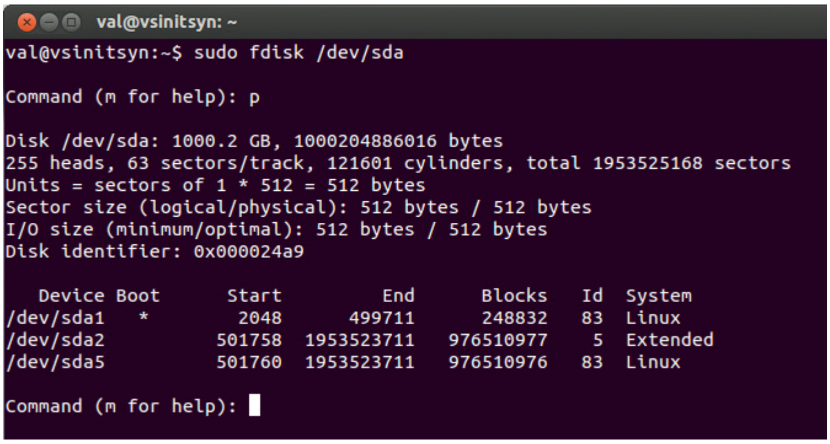
to disconnect image from the device. This way, you can create smaller images that are directly usable in virtual machines.

Sometimes, it may look like changes you make to such virtual drives via external tools (like **mkfs**) are silently ignored. If this is your case, flush the disk buffers:

```
# blockdev --flushbufs <device_node_name>
```

LV PRO TIP

Python virtual environments (virtualenvs) are a great to play with modules that you don't need on your system permanently.



```
val@vsinitsyn: ~
val@vsinitsyn:~$ sudo fdisk /dev/sda

Command (m for help): p

Disk /dev/sda: 1000.2 GB, 1000204886016 bytes
255 heads, 63 sectors/track, 121601 cylinders, total 1953525168 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000024a9

   Device Boot      Start         End      Blocks   Id  System
/dev/sda1   *        2048      499711      248832   83  Linux
/dev/sda2          501758  1953523711   976510977    5  Extended
/dev/sda5          501760  1953523711   976510976   83  Linux

Command (m for help): 
```

fdisk displays partition table on the author's computer.

```
u'ntfs', u'zfs', u'affs4', u'hfs', u'affs6', u'affs1', u'affs0',
u'affs3', u'hp-ufs', u'fat16', u'sun-ufs', u'asfs', u'jfs',
u'apfs2', u'apfs1']
```

To add a partition to the disk, use **disk.addPartition()**:

```
>>> disk.addPartition(new_partition)
Traceback (most recent call last):
...
_ped.PartitionException: Unable to satisfy all constraints
on the partition.
```

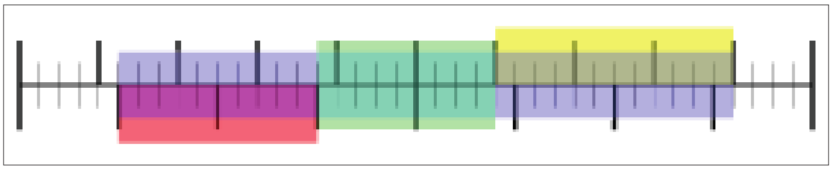
As you can see, partitions on the disk are subject to some constraints, which we've occasionally violated here. When you pass a partition to **disk.addPartition()**, its geometry may change due to constraints that you spefify via the second argument (in the example above, it defaults to **None**), and constraints imposed by libparted itself (for instance, in the MBR scheme, it won't let you start a partition at the beginning of a disk, where the partition table itself resides). This is where things start to get interesting.

"Managing constraints is probably the most complex thing PyParted does for you."

Know your limits

Managing constraints is probably the most complex and most useful part of what PyParted does for you. Partitions on a hard disk generally can't start or end where you want. There should be a gap between the beginning of a disk and your first partition to store internal partitioning data; today, many operating systems reserve 1MiB for these purposes. Partitions should be aligned to physical sector boundaries, or severe performance degradation may occur. This is not to say that partitions can't overlap; PyParted takes care of all these nuances, and **Constraint** and **Alignment** classes play a central role in this process.

A visual representation of different kwargs accepted by the Constraint constructor. Red/Yellow rectangles are **startRange**/**endRange**, blue/green are **maxGeom**/**minGeom**. Large ticks denote **startAlign** (lower) or **endAlign**(upper). Small ticks represent sectors.



Hard disk space.

Let's start with **Alignment**, which is defined by two values: offset and grain. Any sector number X with X = offset + N * grain (with N being non-negative integer) complies with Alignment. When you need to tell PyParted that your partitions should start (or end) at a 1MiB (or some other) boundary, Alignment is the way to do it. Any value satisfies Alignment(0, 1) which is equivalent to no alignment at all.

Constraint is basically a set of six conditions on **Geometry** (not a Partition!) that are wrapped together to control the following:

- How the Geometry's boundaries are aligned (**startAlign**/**endAlign** properties).
- Where the Geometry can start or end (**startRange**/**endRange**).
- What the Geometry's minimum and maximum sizes are (**minSize**/**maxSize**).

You do not always need to specify all of them. The Constraint constructor provides the shortcuts **minGeom**, **maxGeom** and **exactGeom**, which create a Constraint that fully embraces, is fully contained by, or exactly coincides with the Geometry you pass as an argument. If you use one of these, any alignment will satisfy the Constraint check. As another special case, **Constraint(device=dev)** accepts any Geometry attached to the Device **dev**.

It isn't easy to catch the meaning of all these properties at once. Have a look at the diagram below, which depicts all of them in graphical form. Both Alignment and Constraint provide the **intersect()** method, which returns the object that satisfies both requirements. You can also check that the given Geometry satisfies the Constraint with the **Constraint.isSolution(geom)** method. The **Constraint.solveMax()** method returns the maximum permitted geometry that satisfies the Constraint, and **Constraint.solveNearest(geom)** returns the permitted geometry that is nearest to the **geom** that you've specified. What's 'nearest' is up to the implementation to decide.

Partitioning on Ye Olde Windows NT

Imagine for a moment you need to create system partition for Windows NT4 prior to Service Pack 5 (remember that weird creature?). As the hardware requirements suggest (**http://en.wikipedia.org/wiki/Windows_NT#Hardware_requirements**), it must be no more than 4GB in size, contained within the first 7.8GB of the hard disk, and begin in the first 4GBs. Here's how to do this with PyParted:

```
>>> optimal = sda.optimumAlignment
>>> start = parted.Geometry(device=sda,
... start=0,
... end=parted.sizeToSectors(4, 'GB',
... sda.sectorSize))
>>> end = parted.Geometry(device=sda,
... start=0,
... end=parted.sizeToSectors(7.8, 'GB',
... sda.sectorSize))
>>> min_size = parted.sizeToSectors(124, 'MB',
... sda.sectorSize) # See [ref:4]
```

```
>>> max_size = parted.sizeToSectors(4, 'GB',
... sda.sectorSize)
>>> constraint=parted.Constraint(startAlign=optimal,
... endAlign=optimal,
... startRange=start, endRange=end,
... minSize=min_size, maxSize=max_size)
>>> disk.addPartition(partition=new_partition,
... constraint=constraint)
True
>>> print new_partition.geometry
parted.Geometry instance --
 start: 2048  end: 262144  length: 260097
 ...
```

If you want to specify **startRange** or **endRange**, you'll need to provide both alignments and size constraints as well. Now, please go back and look at the first line. As you probably guessed, **device.optimumAlignment** and its counterpart, **device.minimumAlignment**, provides optimum (or minimum) alignment accepted by the hardware device you're creating the partition on. Under Linux, in-kernel device driver-reported attributes like **alignment_offset**, **minimum_io_size** and **optimal_io_size** are generally used to determine the meaning of 'minimum' and 'optimum'. For example, an optimally aligned partition on a RAID device may start on a stripe boundary, but a fixed 1MiB-grained alignment (as in Windows 7/Vista) will usually be preferred for an ordinary hard disk. 'Minimum' is roughly equivalent to 'by physical sector size', which can be 4,096 bytes even if the device advertises traditional 512-bytes sector addressing.

Back to the **_ped.PartitionException** we saw earlier. In order to fix it, you need to specify the proper constraint:

```
>>> # Most relaxed constraint; anything on the
... device would suffice
>>> disk.addPartition(new_partition,
... parted.Constraint(device=sda))
True
>>> print new_partition.geometry
parted.Geometry instance --
 start: 32  end: 262143  length: 262112
 ...
>>> print geometry
parted.Geometry instance --
 start: 0  end: 262143  length: 262144
 ...
```

Note that the Geometry we've specified was adjusted due to constraints imposed internally by libparted for the MBR partitioning scheme.

When you're done, commit the changes you've made to the hardware. Otherwise they will remain in memory only, and the real disk won't be touched:

```
>>> disk.commit()
True
```

We've seen all the major bits that PyParted is made from. Now let's use all of them together in a bigger program – an **fdisk** clone, almost full-featured, and just a little more than 400 lines of Python code in size! Not all of these lines will be in the magazine, obviously, so I suggest you open the program code now in GitHub (**https://github.com/vsinitsyn/fdisk.py**) to follow it as you read the next section.

Each disk needs a label

Many modern operating systems enable you to assign a label to a disk, which is especially useful for removable media (**/media/BobsUSBStick** says more than **/media/sdb1**). But they are not the disk labels that libparted refers to.

When we speak of disk labels on these pages, we mean partition tables. It is very uncommon for a hard disk to not to have one (although many flash drives comes with no partitions). Linux usually sees unpartitioned devices as **/dev/sdX** (with **X** being a letter); partitions are suffixed with an integer (say, **/dev/sda1**).

There are many different partitioning schemes (or disk labels). Traditionally, the **'msdos'** (MBR) disk partitioning scheme was the most popular one for PCs. By today's standards, it's very limited: it may contain at most four partitions (called 'primary') and stores partition offsets as 32-bit integers. If you need more, one partition should be marked as 'extended', and it may contain as many logical partitions as you want. This is the reason why logical partitions are always numbered starting with 5 in Linux.

The newer GUID Partition Table (**'gpt'**) is much more flexible. It's usually mentioned in connection with UEFI, however it is self-contained and can be used on BIOS systems as well. In a **'gpt'** disk label, partitions are identified by Globally Unique Identifiers (GUID) values. Their starting and ending offsets are 64-bit, so there is some safety margin for hard disks of tomorrow's capacities.

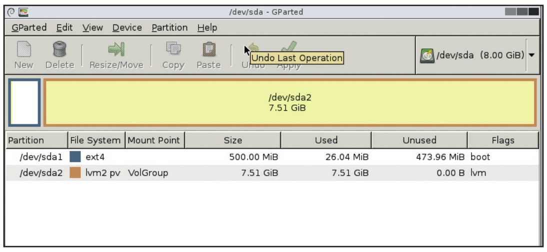
Your very own fdisk

fdisk is probably the most basic partitioning tool. It's an console program: it reads single-letter commands entered by a user and acts accordingly, printing results on the screen. Originally, it supported MBR and also BSD/SUN disk labels; we'll stick to MBR only.

Our example (let's call it **fdisk.py**) is a somewhat more elaborate version of **fdisk/fdisk.py** found in the PyParted sources **https://git.fedorahosted.org/cgit/pyparted.git/tree/src/fdisk/fdisk.py**, but it's a bit simplified compared with the real **fdisk**. Since **parted** and **fdisk** are not 100% compatible (although **parted** is more advanced in many ways), there are some discrepancies (see comments in the sources for details). However, **fdisk.py** implements all the basic functions you'd expect from the partitioning software: it can create partitions (both primary and logical), list them, delete them, and even mark them as bootable. All of these options are implemented as methods of the **Fdisk** class, which is instantiated when the program starts. In **Fdisk.__init__()**, we check whether the drive already has a partition table and create it if necessary. If the disk has any partition table other than MBR, the program exits immediately. The main loop simply dispatches commands entered by a user to Fdisk's instance methods. If any of them raise an **ExitMainLoop** exception, the program ends.

Let's start with the code that displays a partition table. In the real **fdisk**, it looks like the image at the top of page 96. And the following is the relevant part of **fdisk.py** code:

```
print """
Disk {path}: {size_mbytes:d} MB, {size:d} bytes
{heads:d} heads, {sectors:d} sectors/track, \
{cylinders:d} cylinders, total {sectors_total:d} sectors
Units = 1 * sectors of {unit:d} = {unit:d} bytes
```



libparted provides the power behind many well-known free software tools, including GParted.

```
Sector size (logical/physical): {sector_size:d} \
bytes / {physical_sector_size:d} bytes
I/O size (minimum/optimal): {minimum_io_size:d} \
bytes / {optimal_io_size:d} bytes
"".format(**data)

width = len(disk.partitions[0].path) \
 if disk.partitions else len('Device') + 1
print "{0:>{width}} Boot     Start       \
 End     Blocks  Id  System".format('Device', width)
```

The data dictionary is filled as follows:

```
unit = device.sectorSize
size = device.length * device.sectorSize
cylinders, heads, sectors = \
 device.hardwareGeometry
minGrain, optGrain = \
 device.minimumAlignment.grainSize,
 device.optimumAlignment.grainSize
data = {
 'path': device.path,
 'size': size,
 'size_mbytes': int(parted.formatBytes(size, 'MB')),
 'heads': heads,
 'sectors': sectors,
 'cylinders': cylinders,
 'sectors_total': device.length,
 'unit': unit,
 'sector_size': device.sectorSize,
 'physical_sector_size': device.physicalSectorSize,
 'minimum_io_size': minGrain * device.sectorSize,
 'optimal_io_size': optGrain * device.sectorSize,
}
```

We can deduce the maximum and optimum I/O sizes from corresponding alignment values (see the previous section). Since we don't allow our user to change units (as the real **fdisk** does), unit variable is always equal to sector size. Everything else is straightforward.

Parted has no concept of DOS disk label types such as 'Linux native', 'Linux swap', or 'Win95 FAT32'. If you were to install good old Slackware using **fdisk** back in 1999, you would almost certainly use some of these. So we emulate disk labels to some extent on top of the partition and filesystem types provided by PyParted. This is done in the **Fdisk._guess_system()** method. We recognise things like 'Linux LVM' and 'Linux RAID', **parted.PARTITION_SWAP** maps to 'Linux swap', ext2/3/4, btrfs, ReiserFS, XFS, and JFS are displayed as 'Linux native', and we even support FAT16/32 and NTFS. As a bonus, PyParted enables you to identify hidden or service partitions added by some hardware vendors (**https://git.fedorahosted.org/cgit/pyparted.git/tree/src/fdisk/fdisk.py**). If the heuristic doesn't work, we print 'unknown'.

Chinese Remainder Theorem

If you were curious enough to skim through the libparted documentation, you've probably spotted a reference to the Chinese Remainder Theorem. Despite the somewhat flippant name, it's a serious statement that comes from number theory. Basically, it lets you to find a minimum integer that yields given remainders for given divisors. If this all sounds like gibberish, think of a basket of eggs. You don't know how many of them are in it, however, if you take them out by twos or threes, you'll have one of them remaining in the bottom of the basket; to empty the basket, you'll need to take them out in batches of five. Using the Chinese Remainder Theorem, you can determine how many eggs are in the basket.

When you place a partition somewhere on a disk, libparted needs to satisfy both alignments (among other things). This is accomplished by solving a system of linear equations (see the **natmath.c** source code if you are really curious). It's amazing to realise that a 1,500-year old maths problem is useful for a free software library of the 21st century.

Creating partitions

It is also easy to delete a partition. The only thing to remember is that partitions on the disk can be out of order, so you can't use the partition number as an index in the **disk.partitions** array. Instead, we iterate over it to find the partition with the number that a user has specified:

```
for p in self.disk.partitions:
 if p.number == number:
  try:
   self.disk.deletePartition(p)
  except parted.PartitionException as e:
   print e.message
  break
```

If we try to delete an extended partition that contains logical partitions, **parted.PartitionException** will be raised. We catch it and print a friendly error message. The last **break** statement is essential. PyParted automatically renumbers the partitions when you delete any of them. So, if you have, for instance, partitions 1–4, and delete the one numbered 3, the partition that was previously number 4 will become the new 3, and will be deleted at the next iteration of the loop.

The largest method, not surprisingly, is the one that creates partitions. Let's look at it step by step. First of all, we check how many primary and extended partitions are already on the disk, and how many primary partitions are available:

```
# Primary partitions count
pri_count = len(self.disk.getPrimaryPartitions())
# HDDs may contain only one extended partition
ext_count = 1 if self.disk.getExtendedPartition() else 0
# First logical partition number
lpart_start = self.disk.maxPrimaryPartitionCount + 1
# Number of spare partitions slots
parts_avail = self.disk.maxPrimaryPartitionCount -\
 (pri_count + ext_count)
```

Then we check if the disk has some free space and return from the method if not. After this, we ask the user for the partition type. If there are no primary partitions available, and no extended partition exists, one of primary partitions needs to be deleted, so we return from the method again. Otherwise, a user can create either a primary partition, an extended partition (if there isn't one yet), or a logical partition (if an extended partition is already here). If the disk has fewer than three primary partitions, a primary partition is created by default; otherwise we default to an extended or logical one.

We also need to find a place to store the new partition. For simplicity's sake, we use the largest free region available. **Fdisk._get_largest_free_region()** is responsible for this; it's quite straightforward except one simple heuristic. It ignores regions shorter than optimum alignment grain (usually 2048 sectors): they are most likely alignment gaps.

Any logical partition created must fit inside the extended partition, and we use **Geometry.intersect()** to ensure that this is the case. On the contrary, a primary partition must lie outside the extended, so if the intersection exists, we return from the method. The code is similar in both cases; below is the former check (which is a bit shorter):

```
try:
 geometry = ext_part.geometry.intersect(geometry)
except ArithmeticError:
 print "No free sectors available"
 return
```

If there is no intersection, **Geometry.intersect()** raises **ArithmeticError**.

All the heavy lifting is done in the **Fdisk._create_partition()** method, which accepts the partition type and the region that will hold the new partition. It starts as follows:

```
alignment = self.device.optimalAlignedConstraint
constraint = parted.Constraint(maxGeom=geometry).\
 intersect(alignment)
data = {
 'start': constraint.startAlign.\
  alignUp(region, region.start),
 'end': constraint.endAlign.\
  alignDown(region, region.end),
}
```

As in the real **fdisk(1)**, we align partitions optimally by default. The partition created must be no larger than the available free space (the **region** argument), so the **maxGeom** constraint is enforced. Intersecting these gives us a Constraint that aligns partitions optimally within boundaries specified. **data['start']** and **data['end']** are used as guidelines when prompting for the partition's boundaries, and they shouldn't be misleading. Thus we perform the same calculation that libparted does internally: find start or end values that are in a specified range and aligned properly. Try to play with these; for example, change the alignment to **self.device.minimalAlignedConstraint** and see what changes when you create a partition on an empty disk.

Resources

- PyParted homepage **https://fedorahosted.org/pyparted**
- Virtual Environments guide **http://docs.python-guide.org/en/latest/dev/virtualenvs**
- Partition types: properties of partition tables **www.win.tue.nl/~aeb/partitions/partition_types-2.html**
- Windows NT4 Hardware Requirements **http://en.wikipedia.org/wiki/Windows_NT#Hardware_requirements**
- fdisk.py sources (this article's version) **https://github.com/vsinitsyn/fdisk.py**
- PyParted's fdisk.py sample code **https://git.fedorahosted.org/cgit/pyparted.git/tree/src/fdisk/fdisk.py**

After that, **Fdisk._create_partition()** asks for the beginning and the end of the partition. **Fdisk._parse_last_sector_expr()** parses expressions like **+100M**, which **fdisk(1)** uses as the last sector specifier. Then, the partition is created as usual:

```
try:
 partition = parted.Partition(
  disk=self.disk,
  type=type,
  geometry=parted.Geometry(
   device=self.device,
   start=part_start,
   end=part_end))
 self.disk.addPartition(partition=partition,
  constraint=constraint)
except (parted.PartitionException,
 parted.GeometryException,
 parted.CreateException) as e:
 raise RuntimeError(e.message)
```

If **part_start** or **part_end** are incorrect, the exception will be raised (see the comments in the source code for the details). It is caught in the **Fdisk.add_partition()** method, which displays error messages and returns.

To save the partition table on to the disk, a user enters the **w** command at the **fdisk.py** prompt. The corresponding method **(Fdisk.write())** simply calls **disk.commit()** and raises **MainLoopExit** to exit.

Afore ye go

Python is arguably the scripting language of choice in today's Linux landscape, and is widely used for various tasks including the creation of system-level components. As an interpreted language, Python is just as powerful as its bindings, which enable scripts to make use of native C libraries. In this perspective, it's nice to have tools like PyParted in our arsenal. Implementing partitioners is hardly an everyday task for most of us, but if you ever face it, the combination of an easy-to-use language and a production-grade library can greatly reduce your programming efforts and development time.

Dr Valentine Sinitsyn edited the Russian edition of O'Reilly's *Understanding the Linux Kernel*, has a PhD in physics, and is currently doing clever things with Python.