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Lustre-OpenStack integration

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Interests

- Access data that resides in your Lustre filesystem securely from the Internet

  ➔ **Connect your HPC storage infrastructure to the rest of the world**

- Use Lustre as a common storage backend for various purposes

  ➔ **Save money & reduce maintenance effort**

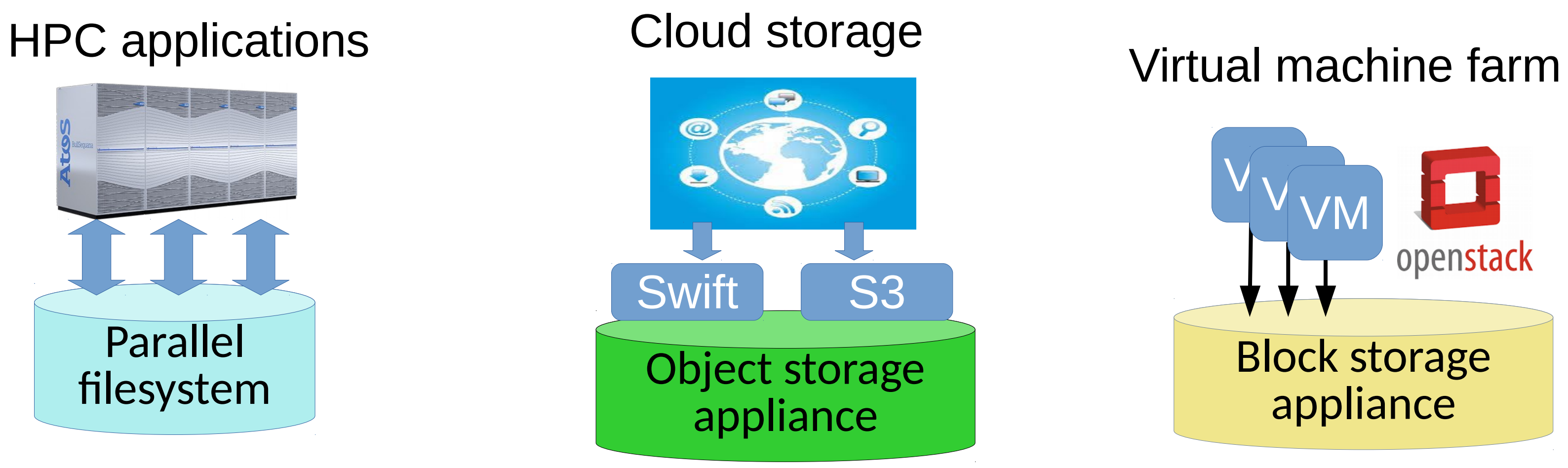
Accessing Lustre over the Internet: security concerns

Issues with public sharing of Lustre over the internet

- Clients must run Lustre client (compatible) software
- Clients needs to be trusted
- Fine control of access rights of any client
- Authentication mechanism needs to be configured on client and server side
- Clients can make the filesystem unstable (wrong behavior, taking ldlm lock and disappear, exploiting known bugs…)
- Can Lustre support millions of clients?

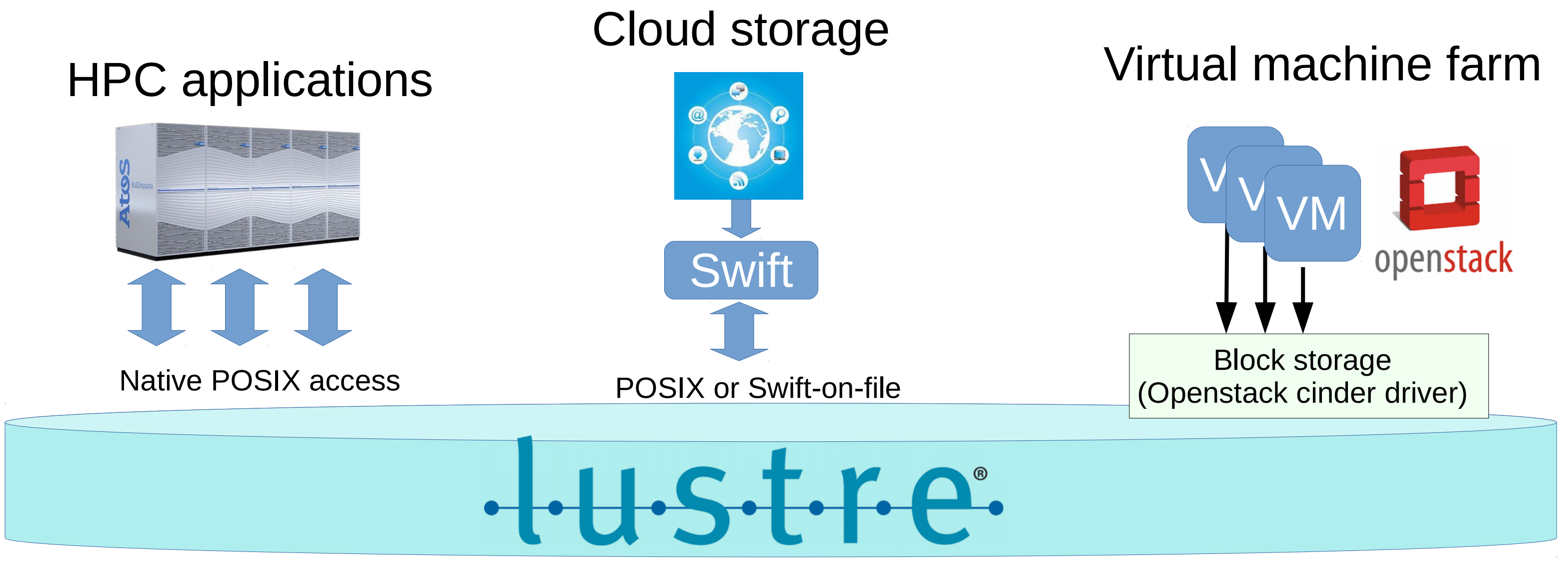
➔ **Obviously not a good idea!**

Fragmentation of resources in compute centers and data centers

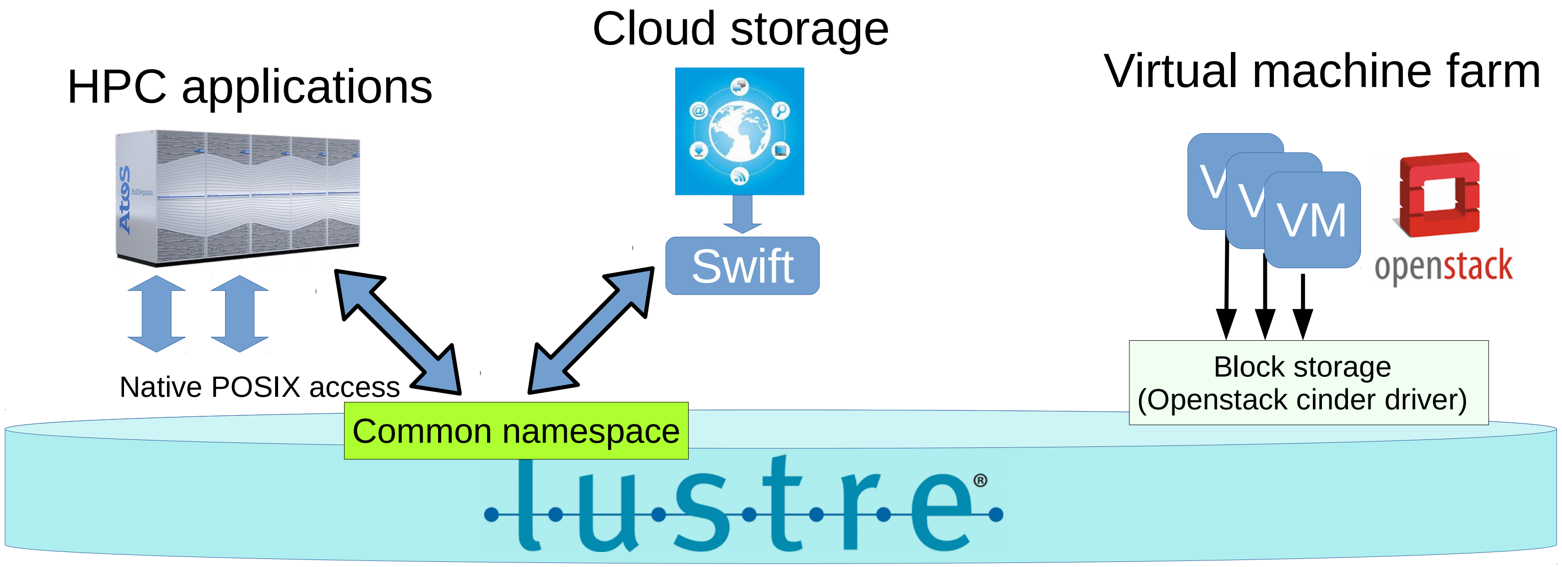


- ➔ Not flexible: fragmented resources can't be allocated as needed
- ➔ No data sharing between the systems
- ➔ Requires many fields of expertise: Lustre, CEPH, SAN, NAS, object store…

Using Lustre as a single storage backend for all purposes



Icing on the cake: unified view between Swift and POSIX



Bi-directional namespace synchronization:
Data pushed through Swift can be accessed by HPC application and vice versa

A little background

- The **ICEI** project (European H2020 project) aims to implement a federated infrastructure across European HPC sites, called **FENIX**
- It includes funding for the implementation of new services required in this project
  - “Swift-over-Lustre” is one of the identified required features
- Due to its long experience with Lustre, CEA was designated to lead the RFP to develop it
- The company selected at the end of the tender procedure is LINAGORA

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LUSTRE AND OPENSTACK INTEGRATION

30 September 2021

SOMMAIRE

0. INTRODUCTION
1. LUSTRE AND CINDER INTEGRATION
2. LUSTRE AND SWIFT BASIC INTEGRATION
3. LUSTRE AND SWIFT DEEP INTEGRATION
4. CONCLUSION

Introduction / Presenter

Jean-Sébastien BEVILACQUA

Technical Manager

Work with CEA in order to integrate OpenStack and Lustre

lustre®

openstack®

LINAGORA

INTRODUCTION / PURPOSE OF THIS INTEGRATION

Lustre and Cinder integration

- Store Cinder volumes directly in a Lustre FS
- Attach these volumes to a VM with Nova

Lustre and Swift integration (basic)

- Write a guide in order to deploy Swift on a Lustre FS

Lustre and Swift integration (deep)

- Integrate deeper with SwiftOnFile

PART 1

LUSTRE AND CINDER INTEGRATION

Automatic mounting by Cinder of the remote Lustre FS

- At launch, the Cinder service has to take care of the availability of the Lustre FS (Cinder manages the mount)

Volume management in Lustre FS

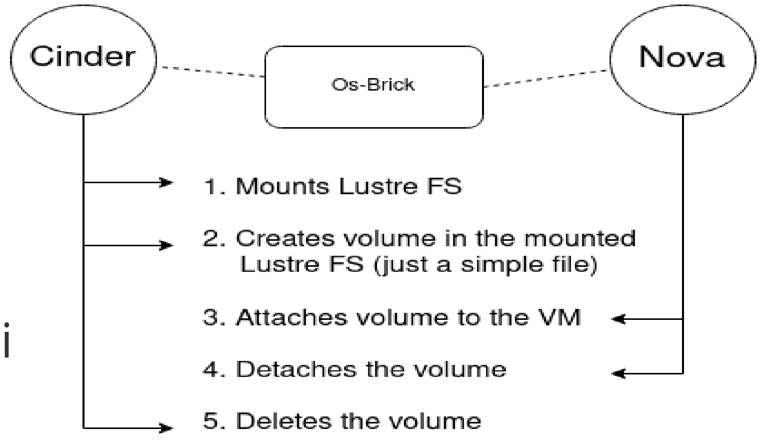
- Cinder has to be able to create, delete and manage disks in the Lustre FS

Attaching volumes to a VM via Nova

- Nova has to be able to attach disks stored in Lustre FS

Development should be done in multiple modules

- Cinder: disk management
- Nova: attachment and detachment of di
- os-brick: underlying library launching mount operations

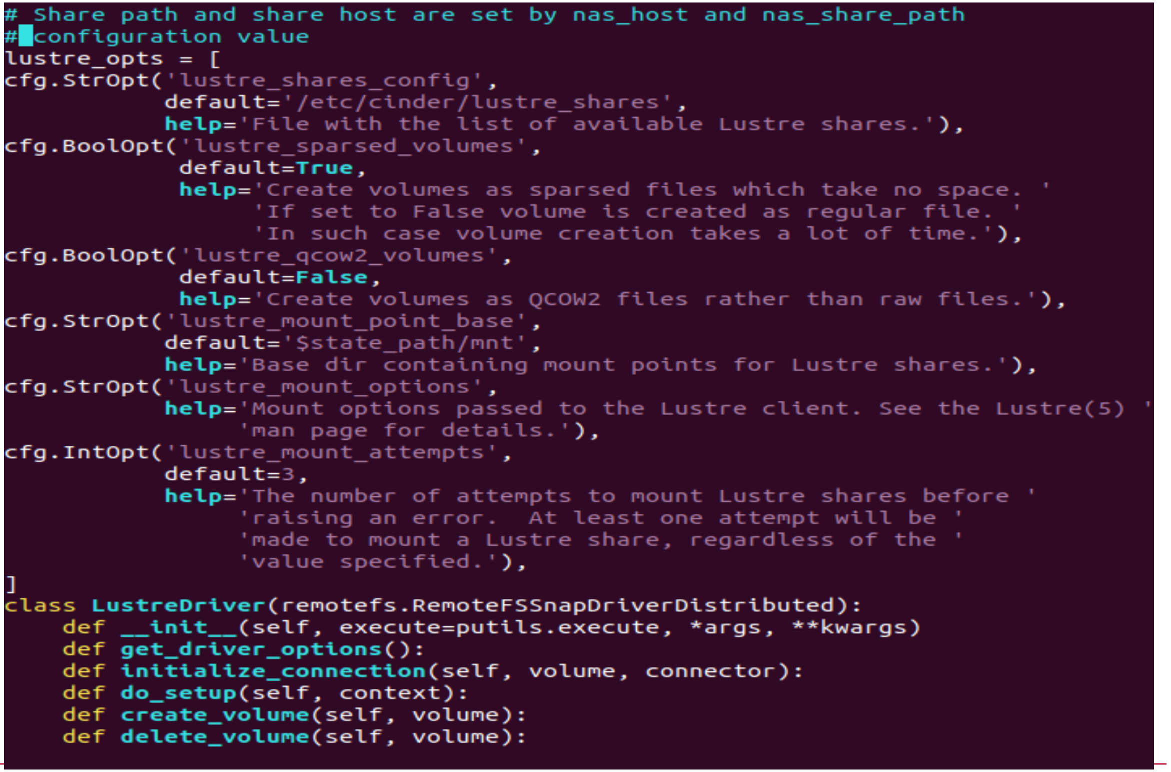

Cinder
Os-Brick
Nova
1. Mounts Lustre FS
2. Creates volume in the mounted Lustre FS (just a simple file)
3. Attaches volume to the VM
4. Detaches the volume
5. Deletes the volume

Operations performed by Cinder:

- When starting the service, mounting the Lustre FS configured in /etc/cinder/cinder.conf (nas_host, nas_share_path)
- Mounting of the FS in a directory directly managed by Cinder
- Volume creation and deletion = Creation and deletion of a file

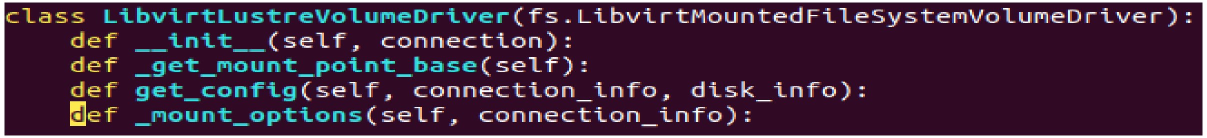
Note : A volume corresponds to a file in the FS

Development of a new driver: cinder/volume/drivers/lustre.py



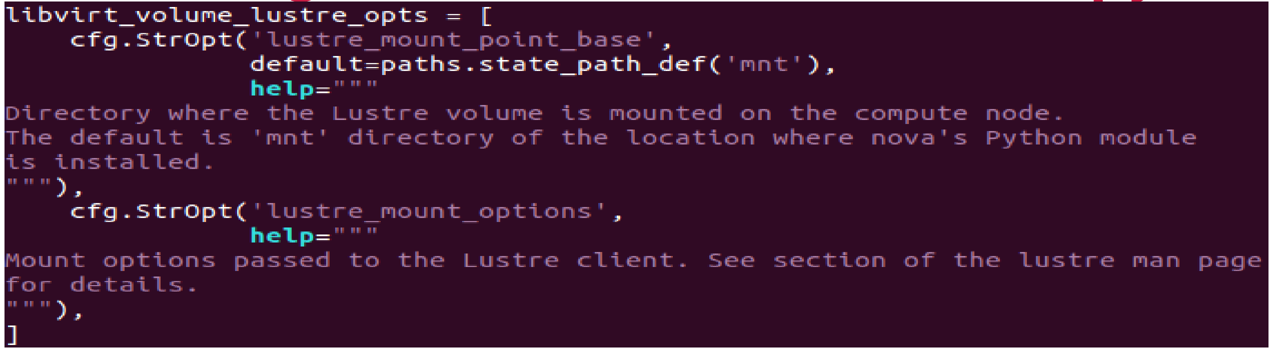
```
# Share path and share host are set by nas_host and nas_share_path
# configuration value
lustre_opts = [
cfg.StrOpt('lustre_shares_config',
           default='/etc/cinder/lustre_shares',
           help='File with the list of available Lustre shares.'),
cfg.BoolOpt('lustre_sparsed_volumes',
            default=True,
            help='Create volumes as sparsed files which take no space. '
                 'If set to False volume is created as regular file. '
                 'In such case volume creation takes a lot of time.'),
cfg.BoolOpt('lustre_qcow2_volumes',
            default=False,
            help='Create volumes as QCOW2 files rather than raw files.'),
cfg.StrOpt('lustre_mount_point_base',
           default='$state_path/mnt',
           help='Base dir containing mount points for Lustre shares.'),
cfg.StrOpt('lustre_mount_options',
           help='Mount options passed to the Lustre client. See the Lustre(5) '
                'man page for details.'),
cfg.IntOpt('lustre_mount_attempts',
           default=3,
           help='The number of attempts to mount Lustre shares before '
                'raising an error.  At least one attempt will be '
                'made to mount a Lustre share, regardless of the '
                'value specified.'),
]
class LustreDriver(remotefs.RemoteFSSnapDriverDistributed):
    def __init__(self, execute=putils.execute, *args, **kwargs)
    def get_driver_options():
    def initialize_connection(self, volume, connector):
    def do_setup(self, context):
    def create_volume(self, volume):
    def delete_volume(self, volume):
```

Development of a new driver : nova/virt/libvirt/volume/lustre.py



```
class LibvirtLustreVolumeDriver(fs.LibvirtMountedFileSystemVolumeDriver):
    def __init__(self, connection):
    def _get_mount_point_base(self):
    def get_config(self, connection_info, disk_info):
    def _mount_options(self, connection_info):
```

With custom configuration : nova/conf/libvirt.py



```
libvirt_volume_lustre_opts = [
    cfg.StrOpt('lustre_mount_point_base',
               default=paths.state_path_def('mnt'),
               help="""
Directory where the Lustre volume is mounted on the compute node.
The default is 'mnt' directory of the location where nova's Python module
is installed.
"""),
    cfg.StrOpt('lustre_mount_options',
               help="""
Mount options passed to the Lustre client. See section of the lustre man page
for details.
"""),
]
```

PART 2

LUSTRE AND SWIFT BASIC INTEGRATION

PART 2 / LUSTRE AND SWIFT BASIC INTEGRATION

Simple installation of Swift with slight modifications

- Only one device, the Lustre FS (normally you need several devices to manage the distribution of data)
- Lustre takes care of replication
- Very small Swift Ring because only one device
- All Swift features are supported → Utilization of Lustre is transparent
- Lustre striping optimisation may be required

Note : The Ring is a file allowing to all service to know where others service are located.

PART 3

LUSTRE AND SWIFT DEEP INTEGRATION

PART 3 / LUSTRE AND SWIFT DEEP INTEGRATION / GOALS

To be able to access files stored in Swift directly through the FS

- Swift uses its own unreadable storage architecture

Swift: `/mnt/sdb1/2/node/sdb2/objects/981/f79/f566bd022b9285b05e665fd7b843bf79/1401254393.89313.data`

To be able to recover a file via Swift which has been set up in the FS

- Swift has to know the new added file

Partial solution : SwiftOnFile

x / swiftonfile

PART 3 / SWIFTONFILE / OVERVIEW

Pros of SwiftOnFile

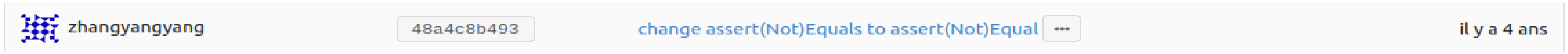
- Implemented as a storage policy → No need to modify the Swift code
- SwiftOnFile allows files to be stored on the FS in a readable way

Swift: `/mnt/sdb1/2/node/sdb2/objects/981/f79/f566bd022b9285b05e665fd7b843bf79/1401254393.89313.data`
SoF: `/mnt/swiftonfile/acct/cont/obj`

Cons of SwiftOnFile

- Not compatible with Python 3
- Not compatible with the last Swift API
- Can't synchronize file from Lustre to Swift

And the most important : Sof is no longer maintained


zhangyangyang 48a4c8b493 change assert(Not)Equals to assert(Not)Equal ··· il y a 4 ans

PART 3 / SWIFTONFILE / CON 1 : PYTHON 3 SUPPORT

Python 3 support is mandatory

- Swift no longer supports Python 2 but only Python 3
- OS Victoria version (last stable) targets Python 3

Difficult migration

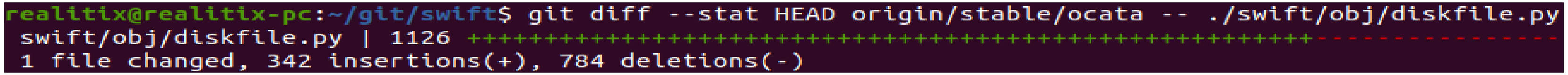
- SwiftOnFile communicates a lot with the outside world (IO)
- Major breaking change with string IO when passing from Python 2 to Python 3

PART 3 / SWIFTONFILE / CON 2 : NEW SWIFT API

SwiftOnFile is based on the Swift API to implement the storage policy

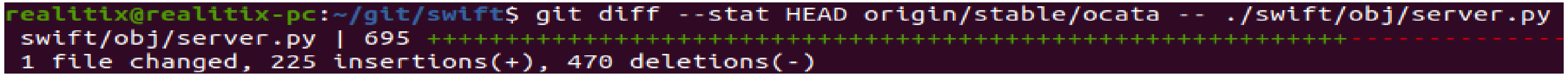
- Lots of API changes in the two code areas used by SwiftOnFile

swift/obj/diskfile.py



```
realitix@realitix-pc:~/git/swift$ git diff --stat HEAD origin/stable/ocata -- ./swift/obj/diskfile.py
 swift/obj/diskfile.py | 1126 +++++++++++++++++++++++++++++++++++++++++++++++++++++++----------------
 1 file changed, 342 insertions(+), 784 deletions(-)
```

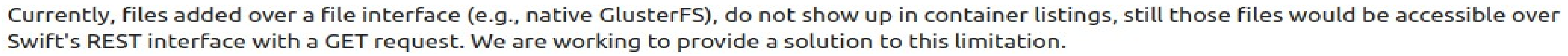
swift/obj/server.py



```
realitix@realitix-pc:~/git/swift$ git diff --stat HEAD origin/stable/ocata -- ./swift/obj/server.py
 swift/obj/server.py | 695 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++--------------
 1 file changed, 225 insertions(+), 470 deletions(-)
```

PART 3 / SWIFTONFILE / CON 3 : TWO-WAY SYNCHRONIZATION

SwiftOnFile does not support synchronization from FS to Swift


Currently, files added over a file interface (e.g., native GlusterFS), do not show up in container listings, still those files would be accessible over Swift's REST interface with a GET request. We are working to provide a solution to this limitation.

New service to be implemented

- Must run alone and listen to the fs → daemon
- Must perform well with Lustre → use of changelog
- Should also offer a generic version → Ideal to be contributed: open-source software!

PART 3 / SWIFTONFILE / TEST COVERAGE

SwiftOnFile's current test coverage : 60 %

- Increase test coverage to its maximum
  - → 100% test coverage on new developments
  - → Increase the test coverage to 100% on the existing code too

Goal :

PART 4

CONCLUSION

PART 4 / CONCLUSION

A lot of work to do

- Part 1 : Cinder part currently under development
- Part 2 : Swift and Lustre quickstart guide already completed
- Part 3 : SwiftOnFile under study

Work in progress

- Provisional schedule for part 1 : Start of the contribution Q1 2022
- Provisional schedule for part 3 : Start of the contribution Q2 2022
- It may take several months to be integrated into master and available for everyone

THANK YOU FOR YOUR ATTENTION