Bareos Python Plugins Hacking Workshop

Open Source **Backup** Conference

22 - 23 September 2014 | Cologne

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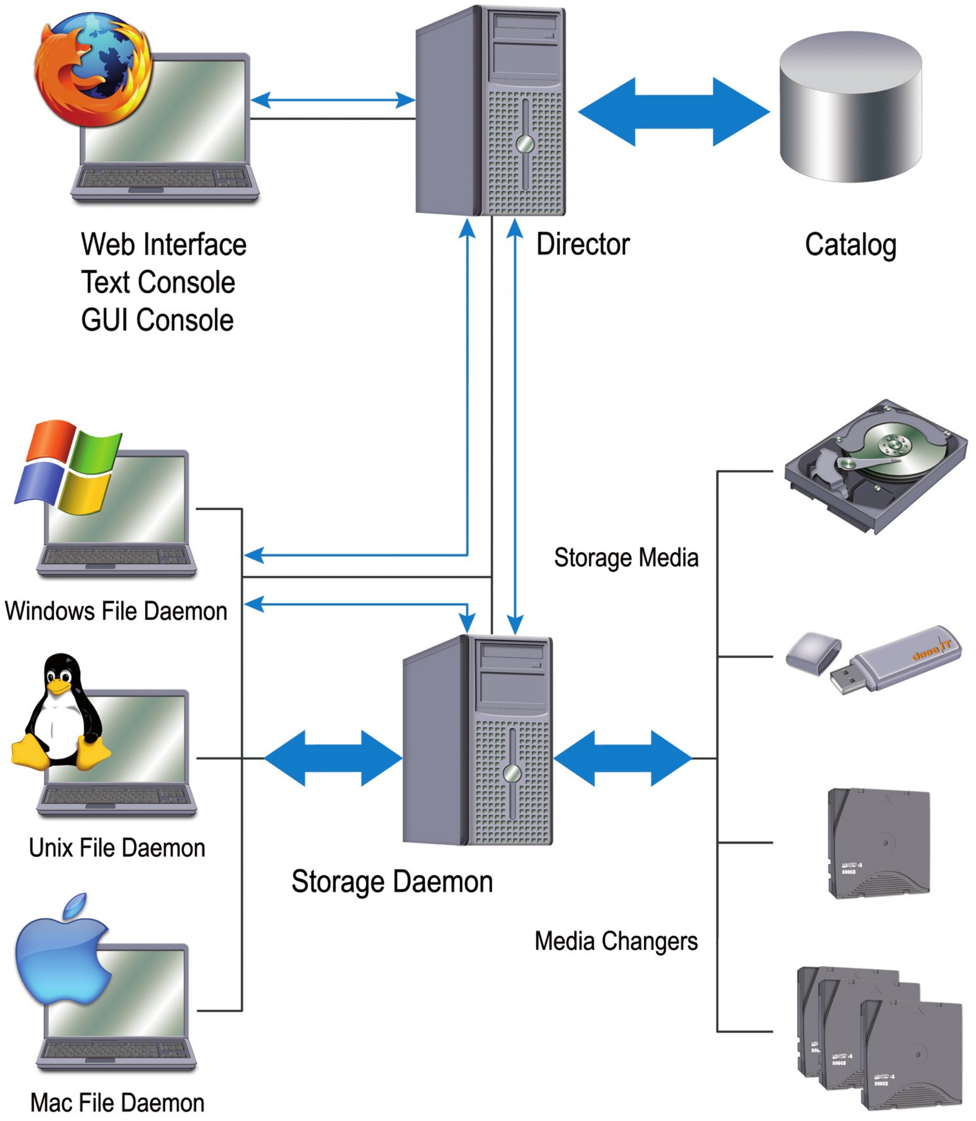
Sep 24, 2014

Agenda

- Bareos architecture and terminology
- Introduction
- Plugin overview (FD, SD, DIR)
- Detailed View at FileDaemon Plugins
- FD Plugin Examples
- Hacking: write your own plugin or extend existing ones
- Resume:
  - short description of work done
  - Feedback about plugin interface, questions, ideas...

Architecture Overview



Why Plugins?

- Extend Bareos functionality
  - Without touching the Bareos code
  - Can react on numerous events (in contrast to pre- and postscripts)
  - Modify Fileset
  - Extra treatment for files
  - Connect to other systems (Monitoring, Ticket, Hypervisors, Cloud, Logging, Indexer i.e. elasticsearch)
  - Application specific actions on backup and restore

C Plugin Interface

- C Coding knowledge needed
- Compiling / Linking to create a shared library
- rarely used (only well-known: bpipe)
- No known Bacula / Bareos C-Plugins for SD and Dir
- Incomplete implementation in Bacula / Bareos
- Near to zero documentation
- Legacy Python interface existed, removed from Bareos in favor of new designed interface

New Bareos Python Plugin interface

- Python knowledge wide spread among technical consultants, admins and devops
- Arbitrary Python modules available to handle a large numbers of application / APIs
- Plain Python script for FD / SD / DIR plugins
- For FD additional class based approach available
- Need Python version 2.6 or newer
- Uses distribution provided Python packages
- C code already prepared for Python 3.x

New Bareos Python Plugin interface

- Plugins configured via Bareos configuration
  Pass plugin options to FD plugins
- Bareos core calls functions from the plugins on defined events
- Plugins can influence the backup process and modify Bareos variables
- Plugin usage must be explicitly enabled:

```
Plugin Directory = /usr/lib/bareos/plugins
Plugin Names = python
```

Director Plugins

- One plugin, fixed name: `bareos-dir.py`
  Hint: use symbolic link from your plugin to
  `bareos-dir.py`
- Configuration snippet for director resource:

```
Director {
  ...
 Plugin Directory = /usr/lib/bareos/plugins
 Plugin Names = python
}
```

Director Plugins

- Plugin registers for events it wants to be called:

```
events = [];
events.append(bDirEventType['bDirEventJobStart']);
events.append(bDirEventType['bDirEventJobEnd']);
events.append(bDirEventType['bDirEventJobInit']);
events.append(bDirEventType['bDirEventJobRun']);
RegisterEvents(context, events);
```

- Bareos core calls function `handle_plugin_event` with event type and context
-

Director Plugins

- Context variable can be read:

```
jobId = GetValue(context, brDirVariable['bDirVarJobId']);
```

- Available variables: http://regress.bareos.org/doxygen/html/d2/d75/namespacebareos__dir__consts.html

```
bDirVarJob = 1
bDirVarLevel = 2
bDirVarType = 3
bDirVarJobId = 4
bDirVarClient = 5
bDirVarNumVols = 6
bDirVarPool = 7
bDirVarStorage = 8
bDirVarWriteStorage = 9
bDirVarReadStorage = 10
bDirVarCatalog = 11
bDirVarMediaType = 12
bDirVarJobName = 13
bDirVarJobStatus = 14
bDirVarPriority = 15,
bDirVarVolumeName = 16,
bDirVarCatalogRes = 17
bDirVarJobErrors = 18
bDirVarJobFiles = 19
bDirVarSDJobFiles = 20
bDirVarSDErrors = 21
bDirVarFDJobStatus = 22,
bDirVarSDJobStatus = 23,
bDirVarPluginDir = 24
bDirVarLastRate = 25
bDirVarJobBytes = 26,
bDirVarReadBytes = 27
```

Director Plugins

- Example: `bareos-dir-nagios.py` (stub)
  - On `bDirEventJobEnd` send job information to Nagios / Icinga
  - Evaluating `bDirVarJobStatus`
- Code excerpt:

```
def handle_plugin_event(context, event):
    ...
    elif event == bDirEventType['bDirEventJobEnd']:
        jobName = GetValue(context, brDirVariable['bDirVarJobName']);
        jobStatus = chr(GetValue(context, brDirVariable['bDirVarJobStatus']))
        ...
        if (jobStatus == 'E' or jobStatus == 'f'):
            nagiosResult = 2; # critical
            nagiosMessage = "CRITICAL: Bareos job %s on %s with id %d failed with %s errors (%s), %d jobBytes" %
(jobName,jobClient,jobId,jobErrors,jobStatus,jobBytes);
# send nagiosResult and nagiosMessage to Icinga / Nagios
```

- Send to Nagios / Icinga needs to be adapted
  https://github.com/bareos/bareos-contrib/tree/master/dir-plugins/nagios_icinga

SD Plugins

- One plugin, fixed name: `bareos-sd.py`
  Hint: use symbolic link from your plugin to
  `bareos-sd.py`
- Configuration snippet to enable plugins in Storage resource of `bareos-sd.conf`:

```
Storage {
 ...
 Plugin Directory = /usr/lib64/bareos/plugins
 Plugin Names = python
}
```

SD Plugins

- when omitting `Plugin Names`, sd will load all plugins in plugin directory matching glob `*-sd.so`
- explicitly specifying multiple plugins:
  `Plugin Names = python:autoxflate`
  will load `python-sd.so` and `autoxflate-sd.so`
- registering events and variable handling like dir plugin
- until now, only variables `bsdVarJobId`, `bsdVarJobName` and `bsdVarPluginDir` are exposed
  (`python-sd.c` still in early development state)
- future: all variables as described should be available, see http://regress.bareos.org/doxygen/html/d2/de6/namespacebareos__sd__consts.html

SD Plugins

- example: bareos-sd.py

```
from bareossd import *
from bareos_sd_consts import *

def load_bareos_plugin(context):
  DebugMessage(context, 100, "load_bareos_plugin called\n")
  events = []
  events.append(bsdEventType['bsdEventJobStart'])
  events.append(bsdEventType['bsdEventJobEnd'])
  RegisterEvents(context, events)
  return bRCs['bRC_OK']

def handle_plugin_event(context, event):
  if event == bsdEventType['bsdEventJobStart']:
    DebugMessage(context, 100, "bsdEventJobStart event triggered\n")
    jobname = GetValue(context, bsdrVariable['bsdVarJobName'])
    DebugMessage(context, 100, "Job " + jobname + " starting\n")
...
```

FD Plugins

- how to enable Python Plugins in FD?
- install `bareos-filedaemon-python-plugin`
- in `bareos-fd.conf` add or uncomment:

```
FileDaemon {
  ...
  Plugin Directory = /usr/lib64/bareos/plugins
  Plugin Names = python
  ...
}
```

- like for SD and Dir Plugins, `Plugin Names` can be omitted. Then all Plugins matching glob `*-fd.so` will be loaded

FD Plugins

- multiple plugins possible
- the `Plugin` parameter in Director's FileSet resource determines which python plugin is used with which paramters. Syntax:
  ```
  Plugin = python:module_path=<path-to-python-modules>:module_name=<python-module-to-
  load>:<custom-param1>=<custom-value1>:...
  ```
- `module_path` and `module_name` are mandatory (used by python-fd.so)
- anything else is arbitrary, the complete string is passed to the hook function parse_plugin_definitions()
- two Plugin-Types:
  Command-Plugins and Option-Plugins

How do FD Plugins work (1)

- When a Job is run, Director passes plugin definition to FD, eg. `module_path=/usr/lib64/bareos/plugins:module_name=bareos-fd`

  FD (python-fd.so) does the following:
  - instantiates new Python interpreter
  - extends the Python search path with the given module_path
  - imports the module given by module_name (for the example above, would be `bareos-fd.py`)
  - makes callback methods available for Python, use `from bareosfd import *` in Python code

How do FD Plugins work (2)

- calls `load_bareos_plugin()` in the python plugin code
- calls `parse_plugin_definition(context, plugindef)` in the python code
  - `plugindef` is the complete string as configured in Director (Plugin = ...), to be parsed by python code
- different processing loop depending on type of Plugin (Command/Option)

FD Command-Plugin Configuration

- Command Plugin Configuration in Include section of FileSet Resource in bareos-dir.conf:

```
FileSet {
  Name = "test_PyLocalFileset_Set"
  Include {
     Plugin =
"python:module_path=/usr/lib64/bareos/plugins:module_name=bareos-fd-local-fileset:filename=/tmp/datafile"
  }
}
```

FD Option-Plugin Configuration

- Option Plugin Configuration in Options section of Include Section of FileSet Resource in bareos-dir.conf:

```
FileSet {
  Name = "test_PyOptionInteract_Set"
  Include {
    File = /data/project_1
    Options {
       Plugin =
"python:module_path=/usr/lib64/bareos/plugins:module_name=bareos-
fd-file-interact"
    }
  }
}
```

- Note: for Option-Plugin must define files to backup using File = ... while for Command-Plugin need not

Difference FD Command-/Option-Plugins (1)

- Major Difference:
  - Command-Plugin determines what is being backed up, must also handle Diff/Inc itself
  - Option-Plugin gets which files to backup based on whats configured in Director, Diff/Inc handling done by FD

Difference FD Command-/Option-Plugins (2)

- Command-Plugin processing
  - `start_backup_file(context, savepkt)` must set savepkt properties for each file to back up
  - `plugin_io(context, IOP)` must handle IO Operations
    - Backup: open(r), read, close
  - `end_backup_file(context)`
    - must return bRCs['bRC_More'] if more files to backup
    - must return bRCs['bRC_OK'] to finish the looping
  - handle_backup_file() is not called

Difference FD Command-/Option-Plugins (3)

- Option-Plugin processing
  - `handle_backup_file(context, savepkt)` called for each file to be processed, savepkt defined by FD
  - `plugin_io()` handling in the same manner as for Command-Plugin
  - `start_backup_file()` and `end_backup_file()` are not called

FD Plugins – Callback Functions

- Functions provided by python-fd.so that can be called from Python code, enabled by
  `from bareosfd import *`
- Complete list: see http://regress.bareos.org/doxygen/html/d5/d0e/python-fd_8h_source.html
- Most important callback functions:
  - `JobMessage()`: Error-/Info-/Warning-Messages
    - are passed to Director, appear in messages and logs
  - `DebugMessage()`: Debug-Messages with numeric level
    - only visible when running FD in debug-mode with -d <level>
  - `GetValue()`: used to get variables from FD

FD Plugins – Class Based Approach

- Python FD Plugin can be monolithic
- Better: use classes and inheritance to reuse existing code easier and reduce code redundancy
- To support this approach, the package `bareos-filedaemon-python-plugin` package provides
  - BareosFdPluginBaseclass.py
    - Parent Class to inherit from
  - BareosFdWrapper.py
    - defines all functions a plugin needs and “wraps” them to the corresponding methods in the plugin class
  - a Plugin entry-point module glues them together

Messaging

- DebugMessage: Debug only
  - `DebugMessage(context, level, "message\n");`
    - context: used to pass information from core to plugin, don't touch
    - Level: Debug Level, use >= 100
  - Sample:

```
DebugMessage(context, 100, "handle_backup_file called with " + str(savepkt) + "\n");
```

Messaging

- JobMessage: Sent to messaging system
  - `JobMessage(context, bJobMessageType, "Message\n");`
    - Type: Controls job result, `M_INFO`, `M_ERROR`, `M_WARNING`, `M_ABORT` http://regress.bareos.org/doxygen/html/dd/dbb/namespacebareos__fd__consts.html
  - Sample:

```
JobMessage(context, bJobMessageType['M_INFO'], "Option Plugin file interact on" +
savepkt.fname + "\n");
```

Return Codes

- Return Codes control processing, no impact on overall job status.
- Depending on context / function
- Use consts:

```
return bRCs['bRC_OK'];
return bRCs['bRC_Skip']; # skips current file
return bRCs['bRC_Error']; # error but continue
return bRCs['bRC_More']; # in end_backup_file, more files to
backup
...
```

FD Plugin: bareos-fd-local-fileset.py

- Reads a local file on fd with filenames to backup
  - Demonstration / template plugin, functionality can be achieved better by fileset configuration:

    `File = "\\</localfile/on/client"`
- Configuration in fileset resource as command plugin (extends fileset):

```
Plugin = "python:module_path=/usr/lib64/bareos/plugins:module_name=bareos-fd-local-fileset:filename=/tmp/datafile"
```

- Plugin: /usr/lib64/bareos/plugins/bareos-fd-local-fileset.py
  Code excerpt:

```
from bareosfd import *
from bareos_fd_consts import *
from BareosFdWrapper import *
from BareosFdPluginLocalFileset import *
def load_bareos_plugin(context, plugindef):
    BareosFdWrapper.bareos_fd_plugin_object = BareosFdPluginLocalFileset (context, plugindef);
    return bRCs['bRC_OK'];
```

- Rest is done in class `BareosFdPluginLocalFileset`

BareosFdPluginLocalFileset

- Class inherits from BareosFdPluginBaseclass
- Method parse_plugin_definition
  Parses the options, filename is mandatory
  Reads filenames from file into array
  `self.files_to_backup`
- Method `start_backup_file` asks plugin, if there is anything to backup, sets `savepkt`:

```
file_to_backup = self.files_to_backup.pop();
savepkt.fname = file_to_backup;
savepkt.type = bFileType['FT_REG'];
return bRCs['bRC_OK'];
```

BareosFdPluginLocalFileset

- Method `end_backup_file` called to ask plugin if there is more to backup:

```
if self.files_to_backup:
    # there is more to backup, go to start_backup_file again
    return bRCs['bRC_More'];
else
    # no more to backup from this plugin, done
    return bRCs['bRC_OK'];
```

- Basic IO operations covered in base class
  - Method plugin_io handles file read / write operations

BareosFdPluginLocalFileset

- For restore: some more things to do
  - Directories have to be created

```
def create_file (self,context, restorepkt):
    FNAME = restorepkt.ofname;
    dirname = os.path.dirname (FNAME);
    if not os.path.exists(dirname):
        os.makedirs(dirname);
    open (FNAME,'wb').close();
    restorepkt.create_status = bCFs['CF_EXTRACT'];
    return bRCs['bRC_OK'];
```

  - Similar in method `plugin_io` for writing
- Overload this method in your class, if you need different handling

FD Plugin: bareos-fd-file-interact.py

- Stub / example for option plugin
- Gets called before a file is read for backup, giving the possibility to do anything with this file
- Configuration in fileset resource as option plugin in options section:
  ```
  Plugin = "python:module_path=/usr/lib64/bareos/plugins:module_name=bareos-fd-file-interact"
  ```
- Plugin: `/usr/lib64/bareos/plugins/bareos-fd-local-fileset.py`
  Uses BareosFdWrapper with class: `BareosFdPluginFileInteract`

BareosFdPluginFileInteract

- Method `handle_backup_file` called for each file to backup with param savepkt
  - Backup file with full path in `savepkt.fname`
  - File type in `savepkt.type`
- File types (selection):
  ```
  FT_REG = 3 # Regular file
  FT_LNK = 4 # Soft link
  FT_FIFO = 17 # Raw FiFo device
  ```
  Full list: http://regress.bareos.org/doxygen/html/d4/d6f/filetypes_8h.html
- `FT_RESTORE_FIRST = 25`
  Special Restore object, can contain metadata needed for restore. Needs to be created as virtual file, these objects will be restored first, handled by your plugin.

My SQL Plugin

- FD Plugin for MySQL Backup contributed by Evan Felix (https://github.com/karcaw)
- Available at https://github.com/bareos/bareos-contrib/tree/master/fd-plugins/mysql-python
- runs `mysql -B -N -e 'show databases'` to get the list of databases to back up
- runs `mysqldump %s --events --single-transaction | gzip` for each database, using `os.popen()` (pipe)
- `plugin_io()` reads the pipe, no temporary local diskspace needed for the dump

My SQL Plugin

- Possible enhancements:
  - add option to specify which DB(s) to backup
  - add option to specify compression program
    - pbzip2 or pigz may accellerate the backup, if system has multiple CPUs/Cores
    - add the ability to disable compression by pipe, to have Bareos handle compression

VMware plugin

- Work in progress to allow Snapshot based VM Backups, not yet published
- Use VMware's CBT (Changed Block Tracking) to allow space efficient Full and Incremental Backups
- Coping with the complex VMware API is not easy
- Using Java was a no-go for Bareos
- Until December 2013 several more or less useful Projects to use the API with Python were around: PySphere, Psphere, PyVISDK
- in December 2013 pyvmomi appeared on github, a Python SDK for the Vsphere API, sponsored/supported by VMware

VMware plugin

- Also requires using the Virtual Disk Development Kit (VDDK), it's a collection of C Libraries, sometimes also named vmware-vix-disklib (properity)
- No good or VMware sponsored/supported VDDK binding for Python exists
- Using https://github.com/xuru/vixDiskLib in a Python FD Plugin failed because VDDK comes with some older libs that caused unresolvable conflicts/errors
- New approach uses a separate program developed in C that handles VDDK and pipes data to the FD Plugin

VMware plugin

- What works already:
  - Creating/Removing a snapshot
  - CBT base dump (Full), CBT advantage: only active portions of virtual disks dumped
  - manual restore
- Still Missing:
  - Saving VM Metadata/Config, needed to re-create the same VM or a identically configured VM for restore
  - Creating a VM for restore and the restore process itself
    - Citation from http://pubs.vmware.com/vsphere-55/index.jsp#com.vmware.vddk.pg.doc/vddkBkupVadp.9.4.html?path=7_4_0_6_2_0#1020552 “This section shows how to create a VirtualMachine object, which is complicated but necessary so you can restore data into it.”
  - Differential/Incremental Backup/Restore

Live Hacking

- Group together (2/3 people per group)
- Get one of the existing plugins up and running
- Extend existing plugin, e.g.
  - Icinga / Director plugin: configurable interface to Nagios / Icinga (send_nsca...)
  - Mysql: make databases to backup configurable, gzip optional, restore directly to db optional
  - Local Fileset plugin: directories, optionally include / exclude files belonging to a specific user

Live Hacking

- More ideas:
  - Director plugin: connect to ticket system (otrs, rt)
  - FD option plugin: pass files to elasticsearch for indexing plus backup meta information
  - FD option plugin: create local log for every file in backup with timestamp and checksum
  - FD option plugin: gpg encrypt every file on the fly

Live Hacking

- More ideas – application specific plugins
  - IMAP / Cyrus: restore to specific mailbox directory
  - Open Xchange (backup / restore of single objects)
  - Kolab
  - other SQL or NoSQL Databases
  - oVirt/RHEV Backup (REST API now has backup functions)
  - Snapshot based KVM (some ideas next slide)
  - Other applications?

Live Hacking

- Ideas regarding KVM Backup
  - KVM/qemu has nothing like VMware CBT
  - Promising design proposals like http://wiki.qemu.org/Features/Livebackup have never been completed
  - a CBT-like approach using external QCOW2 snapshots/overlays could be derived from https://kashyapc.fedorapeople.org/virt/lc-2012/snapshots-handout.html
  - Guest-Agent quiescing actions should be looked at
  - Performance impact of overlay chaining?
  - use python libvirt bindings

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  https://github.com/bareos
- GIT Bareos contrib for plugins:
  https://github.com/bareos/bareos-contrib
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  https://bugs.bareos.org