paexec – distributes tasks over network or CPUs

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Problem

- Huge amount of data to process
- Typical desktop machines have more than one CPU
- Unlimited resources are available on the Internet
- Heterogeneous environment (*BSD, Linux, Windows...)

Solution

Usage

```
paexec [OPTIONS] \
  -n 'machines or CPUs' \
  -t 'transport program' \
  -c 'calculator' < tasks
```

example

```
ls -1 *.wav | \
paexec -x -c 'flac -s' -n +4 > /dev/null
```

example

```
paexec \
  -n 'host1 host2 host3' \
  -t /usr/bin/ssh \
  -c ~/bin/toupper < tasks
```

Example 1: toupper

Our goal is to convert strings to upper case in parallel

~/bin/toupper

```
#!/usr/bin/awk -f
{
   print " ", toupper($0)
   print ""  # empty line -- end-of-task marker!
   fflush()  # We must flush stdout!
}
```

~/tmp/tasks

```
apple
bananas
orange
```

Example 1: toupper

`~/bin/toupper` script will be run only once on remote servers "server1" and "server2". It takes tasks from stdin (one task per line). Transport program is `ssh(1)`.

paexec invocation

```
$ paexec -t ssh -c ~/bin/toupper \
   -n 'server1 server2' < tasks > results
$ cat results
 BANANAS
 ORANGE
 APPLE
$
```

Example 1: toupper

Options **-l** and **-r** add the task number and server where this task is processed to stdout.

paexec -lr invocation

```
$ paexec -lr -t ssh -c ~/bin/toupper \
   -n 'server1 server2' < tasks > results
$ cat results
server2 2  BANANAS
server2 3  ORANGE
server1 1  APPLE
$
```

Example 1: toupper

The same as above but four instances of `~/bin/toupper` are ran locally.

paexec invocation

```
$ paexec -n +4 -c ~/bin/toupper
   < tasks > results
$ cat results
BANANAS
ORANGE
APPLE
$
```

Example 1: toupper

The same as above but without `~/bin/toupper`. In this example we run AWK program for each individual task. At the same time we still make only one ssh connection to each server regardless of a number of tasks given on input.

paexec invocation

```
$ paexec -x -t ssh -n 'server1 server2' \
-c "awk 'BEGIN {print toupper(ARGV[1])}' " \
    < tasks > results
$ cat results
ORANGE
BANANAS
APPLE
$
```

Example 1: toupper

If we want to "shquate" less one can use option **-C** instead of **-c** and specify command after options.

paexec invocation

```
$ paexec -x -C -t ssh -n 'server1 server2' \
awk 'BEGIN {print toupper(ARGV[1])}' \
    < tasks > results
$ cat results
ORANGE
BANANAS
APPLE
$
```

Example 1: toupper

With options -**z** or -**Z** we can easily run our tasks on unreliable hosts. If we cannot connect or lost connection to the server, paexec will redistribute failed tasks to another server.

paexec invocation

```
$ paexec -Z240 -x -t ssh \
-n 'server1 badhostname server2' \
-c "awk 'BEGIN {print toupper(ARGV[1])}' " \
    < tasks > results
 ssh: Could not resolve hostname badhostname:
  No address associated with hostname
  badhostname 1 fatal
$ cat results
ORANGE
BANANAS
APPLE
$
```

Example 2: parallel banner(1)

what is banner(1)?

```
$ banner -f @ NetBSD

@      @                      @@@@@@    @@@@@  @@@@@@
@@     @   @@@@@@    @@@@@ @      @ @      @ @      @
@ @    @   @           @   @      @ @        @      @
@  @   @   @@@@@         @   @@@@@@   @@@@@  @      @
@   @  @   @             @   @      @        @ @      @
@    @@   @             @   @      @ @      @ @      @
@     @   @@@@@@        @   @@@@@@   @@@@@  @@@@@@

$
```

Example 2: parallel banner(1)

`~/bin/pbanner` is wrapper for `banner(1)` for reading tasks line by line. Magic line is used instead empty line as an end-of-task marker.

~/bin/pbanner

```
#!/usr/bin/env sh

while read task; do
   banner -f M "$task" |
   echo "$PAEXEC_EOT" # end-of-task marker
done
```

tasks

```
pae
xec
```

paexec invocation

```
$ paexec -l -mt='SE@X-L0S0!&' -c ~/bin/pbanner \
   -n +2 < tasks > result
$
```

Example 2: parallel banner(1)

`paexec(1)` reads calculator's output asynchronously. So, its output is sliced.

Sliced result

```
$ cat result
2
2
2  M     M   MMMMMM    MMMM
2   M   M    M         M     M
1
1
1  MMMMM       MM      MMMMMM
1  M     M    M  M     M
1  M     M   M     M   MMMMM
1  MMMMM    MMMMMM    M
2     MM    MMMMM     M
2     MM    M         M
2   M   M   M         M     M
2  M     M  MMMMMM    MMMM
2
1  M        M     M   M
1  M        M     M   MMMMMM
1
$
```

Example 2: parallel banner(1)

`paexec_reorder(1)` normalizes `paexec(1)`'s output.

Ordered result

```
$ paexec_reorder -mt='SE@X-L0S0!&' results

MMMMM      MM     MMMMMM
M     M    M  M    M
M     M   M    M   MMMMM
MMMMM    MMMMMM   M
M        M    M   M
M        M    M   MMMMMM


M     M   MMMMMM    MMMM
 M   M    M        M    M
  MM     MMMMM    M
  MM     M        M
 M  M    M        M    M
M    M   MMMMMM    MMMM

$
```

Example 2: parallel banner(1)

The same as above but using magic end-of-task marker provided by `paexec(1)`.

Ordered result

```
$ paexec -y -lc ~/bin/pbanner -n+2 < tasks | paexec_reorder -y

MMMMM      MM     MMMMMMM
M    M    M  M    M
M    M   M    M   MMMMM
MMMMM    MMMMMM   M
M        M    M   M
M        M    M   MMMMMM


M    M   MMMMMM    MMMM
 M  M    M        M    M
  MM     MMMMM    M
  MM     M        M
 M  M    M        M    M
M    M   MMMMMM    MMMM

$
```

Example 2: parallel banner(1)

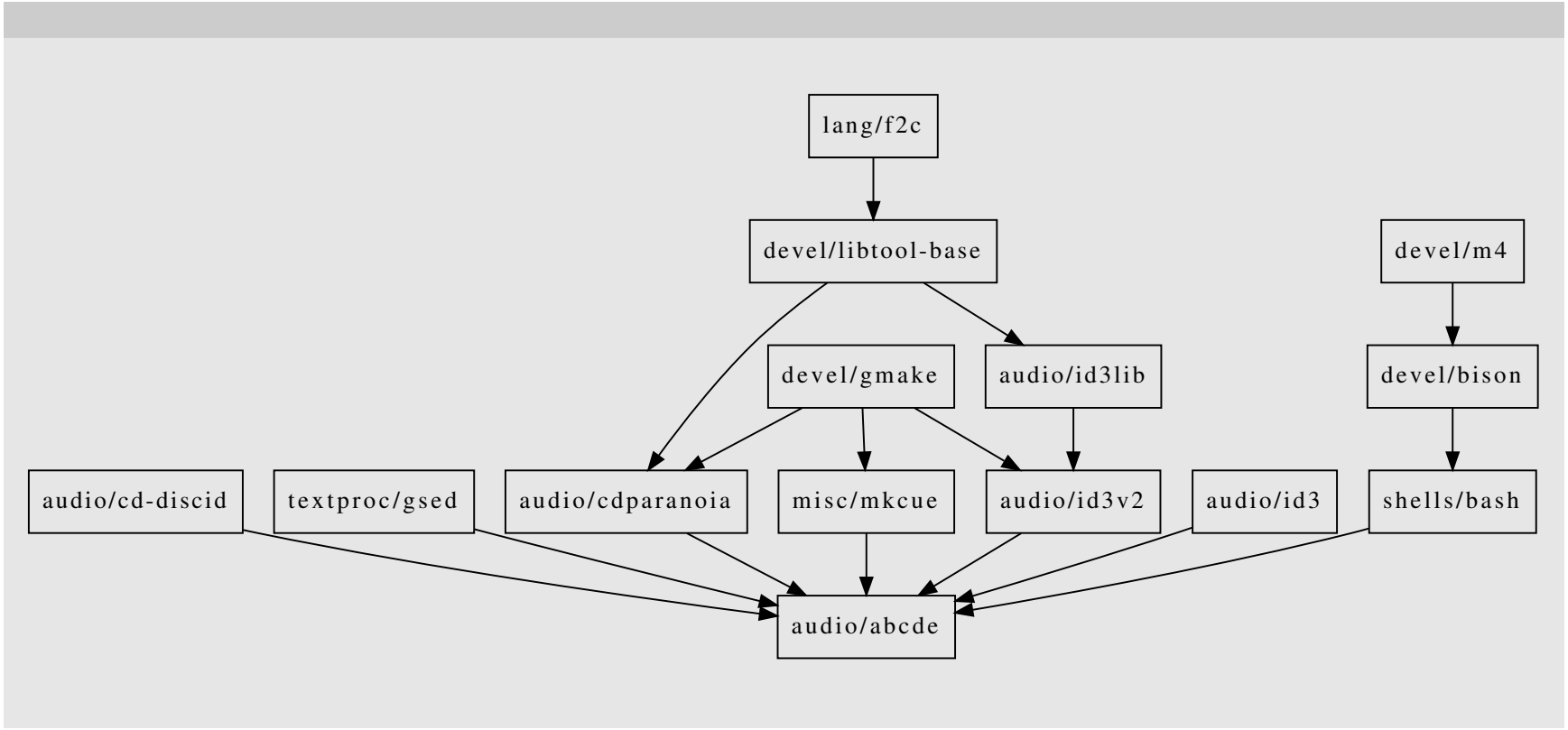
For this trivial task wrapper like `~/bin/pbanner` is not needed.
We can easily run `banner(1)` directly.

Sliced result

```
$ paexec -l -x -c banner -n+2 < tasks
2
2
2  M     M   MMMMMM    MMMM
2   M   M    M         M     M
2    MM     MMMMM     M
2    MM     M         M
2   M  M    M         M     M
1
1
1  MMMMM       MM     MMMMMM
1  M    M     M  M    M
1  M    M    M    M   MMMMM
1  MMMMM    MMMMMM   M
2  M    M   MMMMMM    MMMM
2
1  M        M    M   M
1  M        M    M   MMMMMM
1
$
```

Example 3: dependency graph of tasks

`paexec(1)` is able to build tasks taking into account their "dependencies". Here "devel/gmake" and others are pkgsrc packages. Our goal in this example is to build pkgsrc package audio/abcde and all its build-time and compile-time dependencies.



Example 3: dependency graph of tasks

‘‘`paexec -g`’’ takes a dependency graph on input (in `tsort(1)` format). Tasks are separated by space (`paexec -md=`).

~/tmp/packages_to_build

```
audio/cd-discid audio/abcde
textproc/gsed audio/abcde
audio/cdparanoia audio/abcde
audio/id3v2 audio/abcde
audio/id3 audio/abcde
misc/mkcue audio/abcde
shells/bash audio/abcde
devel/libtool-base audio/cdparanoia
devel/gmake audio/cdparanoia
devel/libtool-base audio/id3lib
devel/gmake audio/id3v2
audio/id3lib audio/id3v2
devel/m4 devel/bison
lang/f2c devel/libtool-base
devel/gmake misc/mkcue
devel/bison shells/bash
```

Example 3: dependency graph of tasks

If option -g is applied, every task may succeed or fail. In case of failure all dependants fail recursively. For this to work we have to slightly adapt "calculator".

~/bin/pkg_builder

```
#!/usr/bin/awk -f

{
   print "build " $0
   print "success" # build succeeded! (paexec -ms=)
   print ""         # end-of-task marker
   fflush()         # we must flush stdout
}
```

Example 3: dependency graph of tasks

paexec -g invocation (no failures)

```
$ paexec -g -l -c ~/bin/pkg_builder -n 'server2 server1' \
    -t ssh < ~/tmp/packages_to_build | paexec_reorder > result
$ cat result
build textproc/gsed
success
build devel/gmake
success
build misc/mkcue
success
build devel/m4
success
build devel/bison
success
...
build audio/id3v2
success
build audio/abcde
success
$
```

Example 3: dependency graph of tasks

Let's suppose that "devel/gmake" fails to build.

~/bin/pkg_builder

```
#!/usr/bin/awk -f

{
   print "build " $0
   if ($0 == "devel/gmake")
      print "failure" # Oh no...
   else
      print "success" # build succeeded!

   print ""         # end-of-task marker
   fflush()         # we must flush stdout
}
```

Example 3: dependency graph of tasks

Package “devel/gmake” and all dependants are marked as failed.
Even if failures happen, the build continues.

paexec -g invocation (with failures)

```
$ paexec -gl -c ~/bin/pkg_builder -n 'server2 server1' \
    -t ssh < ~/tmp/packages_to_build | paexec_reorder > result
$ cat result
build audio/cd-discid
success
build audio/id3
success
build devel/gmake
failure
devel/gmake audio/cdparanoia audio/abcde audio/id3v2 misc/mkcue
build devel/m4
success
build textproc/gsed
success
...
$
```

Example 3: dependency graph of tasks

paexec is resistant not only to network failures but also to **unexpected** calculator **exits or crashes**.

~/bin/pkg_builder

```
#!/usr/bin/awk -f

{
   "hostname -s" | getline hostname
   print "build " $0 " on " hostname

   if (hostname == "server1" && $0 == "textproc/gsed")
      exit 139
      # Damn it, I'm dying...
      # Take a note that exit status doesn't matter.
   else
      print "success" # Yes! :-)

   print ""         # end-of-task marker
   fflush()         # we must flush stdout
}
```

Example 3: dependency graph of tasks

"textproc/gsed" failed on "server1" but then succeeded on "server2". Every 300 seconds we try to reconnect to "server1". Keywords "success", "failure" and "fatal" may be changed with a help of -ms=, -mf= and -mF= options respectively.

paexec -Z300 invocation (with failure)

```
$ paexec -gl -Z300 -t ssh -c ~/bin/pkg_builder \
      -n 'server2 server1' < ~/tmp/packages_to_build \
      | paexec_reorder > result
$ cat result
build audio/cd-discid on server2
success
build textproc/gsed on server1
fatal
build textproc/gsed on server2
success
build audio/id3 on server2
success
...
$
```

Example 4: Converting .wav files to .flac or .ogg

In trivial cases we don't need relatively complex "calculator". Running a trivial command may be enough. Below we run three .wav to .flac/.ogg convertors in parallel. If **-x** is applied, task is passed to calculator as an argument.

paexec -x invocation

```
$ ls -1 *.wav | paexec -x -c 'flac -s' -n+3 >/dev/null
$
```

paexec -x invocation

```
$ ls -1 *.wav | paexec -ixC -n+3 oggenc -Q | grep .
01-Crying_Wolf.wav
02-Autumn.wav
03-Time_Heals.wav
04-Alice_(Letting_Go).wav
05-This_Side_Of_The_Looking_Glass.wav
...
$
```

Example 5: paexec -W

If different tasks take different amount of time to process, than it makes sense to process "heavier" ones earlier in order to minimize total calculation time. For this to work one can weigh each tasks. Note that this mode enables "graph" mode automatically.

~/bin/calc

```
#!/bin/sh
# $1 -- task given on input
if test $1 = huge; then
    sleep 6
else
    sleep 1
fi

echo "task $1 done"
```

Example 5: paexec -W

This is how we run unweighted tasks. The whole process takes 8 seconds.

paexec invocation

```
$ printf 'small1\nsmall2\nsmall3\nsmall4\nsmall5\nhuge\n' |
time -p paexec -c ~/bin/calc -n +2 -xg | grep -v success
task small2 done
task small1 done
task small3 done
task small4 done
task small5 done
task huge done
real         8.04
user         0.03
sys          0.03
$
```

Example 5: paexec -W

If we say paexec that the task “huge” is performed 6 times longer than others, it starts“huge” first and then others. In total we spend 6 seconds for all tasks.

paexec -W1 invocation

```
$ printf 'small1\nsmall2\nsmall3\nsmall4\nweight: huge 6\n' |
time -p paexec -c ~/bin/calc -n +2 -x -W1 | grep -v success
task small1 done
task small2 done
task small3 done
task small4 done
task small5 done
task huge done
real         6.02
user         0.03
sys          0.02
$
```

For details see the manual page.

The End