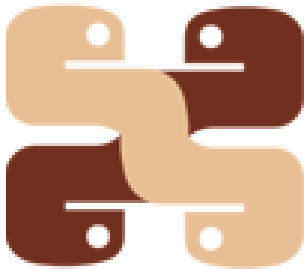
The Story of Stackless Python

Christian Tismer, Hervé Coatanhay

EuroPython 2012

July 4 2012



What is Stackless?

- *Stackless is a Python version that does not use the C stack*
  - *really? naah*
- Stackless is a Python version that does not keep state on the C stack
  - the stack *is* used but
  - cleared between function calls
- Remark:
  - theoretically. In practice...
  - ... it is reasonable 80 % of the time
  - we come back to this!

What is Stackless?

- *Stackless is a Python version that does not use the C stack*
  - *really? naah*
- Stackless is a Python version that does not keep state on the C stack
  - the stack *is* used but
  - cleared between function calls
- Remark:
  - theoretically. In practice...
  - ... it is reasonable 80 % of the time
  - we come back to this!

What is Stackless?

- *Stackless is a Python version that does not use the C stack*
  - *really? naah*
- Stackless is a Python version that does not keep state on the C stack
  - the stack *is* used but
  - cleared between function calls
- Remark:
  - theoretically. In practice...
  - ... it is reasonable 80 % of the time
  - we come back to this!

What is Stackless?

- *Stackless is a Python version that does not use the C stack*
  - *really? naah*
- Stackless is a Python version that does not keep state on the C stack
  - the stack *is* used but
  - cleared between function calls
- Remark:
  - theoretically. In practice...
  - ... it is reasonable 80 % of the time
  - we come back to this!

What is Stackless about?

- it is like CPython
- it can do a little bit more
- adds a single builtin module

```
import stackless
```

- is like an extension
  - but, sadly, not really
  - stackless **must** be builtin
  - **but:** there is a solution...

What is Stackless about?

- it is like CPython
- it can do a little bit more
- adds a single builtin module

```
import stackless
```

- is like an extension
  - but, sadly, not really
  - stackless **must** be builtin
  - **but:** there is a solution...

What is Stackless about?

- it is like CPython
- it can do a little bit more
- adds a single builtin module

```
import stackless
```

- is like an extension
  - but, sadly, not really
  - stackless **must** be builtin
  - **but:** there is a solution...

What is Stackless about?

- it is like CPython
- it can do a little bit more
- adds a single builtin module

```
import stackless
```

- is like an extension
  - but, sadly, not really
  - stackless **must** be builtin
  - **but:** there is a solution...

What is Stackless about?

- it is like CPython
- it can do a little bit more
- adds a single builtin module

```
import stackless
```

- is like an extension
  - but, sadly, not really
  - stackless **must** be builtin
  - **but:** there is a solution...

Now, what is it really about?

- have tiny little “main” programs
  - `tasklet`
- tasklets communicate via messages
  - `channel`
- tasklets are often called `microthreads`
  - but there are no threads at all
  - only one tasklets runs at any time
- *but see the PyPy STM* approach
  - this will apply to tasklets as well

Now, what is it really about?

- have tiny little “main” programs
  - `tasklet`
- tasklets communicate via messages
  - `channel`
- tasklets are often called `microthreads`
  - but there are no threads at all
  - only one tasklets runs at any time
- *but see the PyPy STM* approach
  - this will apply to tasklets as well

Now, what is it really about?

- have tiny little “main” programs
  - `tasklet`
- tasklets communicate via messages
  - `channel`
- tasklets are often called `microthreads`
  - but there are no threads at all
  - only one tasklets runs at any time
- *but see the PyPy STM* approach
  - this will apply to tasklets as well

Now, what is it really about?

- have tiny little “main” programs
  - `tasklet`
- tasklets communicate via messages
  - `channel`
- tasklets are often called `microthreads`
  - but there are no threads at all
  - only one tasklets runs at any time
- *but see the PyPy STM* approach
  - this will apply to tasklets as well

Cooperative Multitasking ...

```
>>> import stackless
>>>
>>> channel = stackless.channel()

>>> def receiving_tasklet():
...     print "Receiving tasklet started"
...     print channel.receive()
...     print "Receiving tasklet finished"
...

>>> def sending_tasklet():
...     print "Sending tasklet started"
...     channel.send("send from sending_tasklet")
...     print "sending tasklet finished"
...
```

Cooperative Multitasking ...

```
>>> import stackless
>>>
>>> channel = stackless.channel()

>>> def receiving_tasklet():
...     print "Receiving tasklet started"
...     print channel.receive()
...     print "Receiving tasklet finished"
...

>>> def sending_tasklet():
...     print "Sending tasklet started"
...     channel.send("send from sending_tasklet")
...     print "sending tasklet finished"
...
```

Cooperative Multitasking ...

```
>>> import stackless
>>>
>>> channel = stackless.channel()

>>> def receiving_tasklet():
...     print "Receiving tasklet started"
...     print channel.receive()
...     print "Receiving tasklet finished"
...

>>> def sending_tasklet():
...     print "Sending tasklet started"
...     channel.send("send from sending_tasklet")
...     print "sending tasklet finished"
...
```

... Cooperative Multitasking ...

```
>>> def another_tasklet():
...     print "Just another tasklet in the scheduler"
...

>>> stackless.tasklet(receiving_tasklet)()
<stackless.tasklet object at 0x00A45B30>
>>> stackless.tasklet(sending_tasklet)()
<stackless.tasklet object at 0x00A45B70>
>>> stackless.tasklet(another_tasklet)()
<stackless.tasklet object at 0x00A45BF0>
```

... Cooperative Multitasking ...

```
>>> def another_tasklet():
...     print "Just another tasklet in the scheduler"
...

>>> stackless.tasklet(receiving_tasklet)()
<stackless.tasklet object at 0x00A45B30>
>>> stackless.tasklet(sending_tasklet)()
<stackless.tasklet object at 0x00A45B70>
>>> stackless.tasklet(another_tasklet)()
<stackless.tasklet object at 0x00A45BF0>
```

... Cooperative Multitasking

```
<stackless.tasklet object at 0x00A45B70>
>>> stackless.tasklet(another_tasklet)()
<stackless.tasklet object at 0x00A45BF0>
>>>
>>> stackless.run()
Receiving tasklet started
Sending tasklet started
send from sending_tasklet
Receiving tasklet finished
Just another tasklet in the scheduler
sending tasklet finished
```

Why not just the greenlet ?

- greenlets are a subset of stackless
  - can partially emulate stackless
  - there is no builtin scheduler
  - technology quite close to Stackless 2.0
- greenlets are about 10x slower to switch context because using only hard-switching
  - but that's ok in most cases
- greenlets are kind-of perfect
  - near zero maintenace
  - minimal interface
- but the main difference is ...

Why not just the greenlet ?

- greenlets are a subset of stackless
  - can partially emulate stackless
  - there is no builtin scheduler
  - technology quite close to Stackless 2.0
- greenlets are about 10x slower to switch context because using only hard-switching
  - but that's ok in most cases
- greenlets are kind-of perfect
  - near zero maintenace
  - minimal interface
- but the main difference is ...

Why not just the greenlet ?

- greenlets are a subset of stackless
  - can partially emulate stackless
  - there is no builtin scheduler
  - technology quite close to Stackless 2.0
- greenlets are about 10x slower to switch context because using only hard-switching
  - but that's ok in most cases
- greenlets are kind-of perfect
  - near zero maintenace
  - minimal interface
- but the main difference is ...

Why not just the greenlet ?

- greenlets are a subset of stackless
  - can partially emulate stackless
  - there is no builtin scheduler
  - technology quite close to Stackless 2.0
- greenlets are about 10x slower to switch context because using only hard-switching
  - but that's ok in most cases
- greenlets are kind-of perfect
  - near zero maintenace
  - minimal interface
- but the main difference is ...

Pickling Program State

Example (p. 1 of 2)

```
import pickle, sys
import stackless

ch = stackless.channel()

def recurs(depth, level=1):
    print 'enter level %s%d' % (level*'  ', level)
    if level >= depth:
        ch.send('hi')
    if level < depth:
        recurs(depth, level+1)
    print 'leave level %s%d' % (level*'  ', level)
```

Pickling Program State

Example (p. 2 of 2)

```
def demo(depth):
    t = stackless.tasklet(recurs)(depth)
    print ch.receive()
    pickle.dump(t, file('tasklet.pickle', 'wb'))

if __name__ == '__main__':
    if len(sys.argv) > 1:
        t = pickle.load(file(sys.argv[1], 'rb'))
        t.insert()
    else:
        t = stackless.tasklet(demo)(9)
    stackless.run()

# remember to show it interactively
```

Greenlet vs. Stackless

- Greenlet is a pure extension module
  - performance is good enough
- Stackless can pickle program state
  - stays a replacement of Python
- Greenlet never can, as an extension
- *easy installation* lets people select greenlet over stackless
  - see for example the *eventlet* project
  - *but there is a simple work-around, we'll come to it*
- *they both have their application domains* and they will persist.

Greenlet vs. Stackless

- Greenlet is a pure extension module
  - performance is good enough
- Stackless can pickle program state
  - stays a replacement of Python
- Greenlet never can, as an extension
- *easy installation* lets people select greenlet over stackless
  - see for example the *eventlet* project
  - *but there is a simple work-around, we'll come to it*
- *they both have their application domains* and they will persist.

Greenlet vs. Stackless

- Greenlet is a pure extension module
  - performance is good enough
- Stackless can pickle program state
  - stays a replacement of Python
- Greenlet never can, as an extension
- *easy installation* lets people select greenlet over stackless
  - see for example the *eventlet* project
  - *but there is a simple work-around, we'll come to it*
- *they both have their application domains* and they will persist.

Greenlet vs. Stackless

- Greenlet is a pure extension module
  - performance is good enough
- Stackless can pickle program state
  - stays a replacement of Python
- Greenlet never can, as an extension
- *easy installation* lets people select greenlet over stackless
  - see for example the *eventlet* project
  - *but there is a simple work-around, we'll come to it*
- *they both have their application domains* and they will persist.

Greenlet vs. Stackless

- Greenlet is a pure extension module
  - performance is good enough
- Stackless can pickle program state
  - stays a replacement of Python
- Greenlet never can, as an extension
- *easy installation* lets people select greenlet over stackless
  - see for example the *eventlet* project
  - *but there is a simple work-around, we'll come to it*
- *they both have their application domains* and they will persist.

Why Stackless makes a Difference

- Microthreads ?
  - the feature where I put most effort into
    - *can be emulated: (in decreasing speed order)*
      - *generators (incomplete, “half-sided”)*
      - *greenlet*
      - *threads (even ;-)*
- Pickling program state ==
- **persistence**

Why Stackless makes a Difference

- Microthreads ?
  - the feature where I put most effort into
  - *can be emulated: (in decreasing speed order)*
    - *generators (incomplete, “half-sided”)*
    - *greenlet*
    - *threads (even ;-)*
- Pickling program state ==
- **persistence**

Why Stackless makes a Difference

- Microthreads ?
  - the feature where I put most effort into
  - *can be emulated: (in decreasing speed order)*
    - *generators (incomplete, “half-sided”)*
    - *greenlet*
    - *threads (even ;-)*
- Pickling program state ==
- persistence

Why Stackless makes a Difference

- Microthreads ?
  - the feature where I put most effort into
  - *can be emulated: (in decreasing speed order)*
    - *generators (incomplete, “half-sided”)*
    - *greenlet*
    - *threads (even ;-)*
- Pickling program state ==
- **persistence**

Persistence, Cloud Computing

- freeze your running program
- let it continue anywhere else
  - on a different computer
  - on a different operating system (!)
  - in a cloud
- migrate your running program
- save snapshots, have checkpoints
  - without doing any extra-work

Software archeology

- Around since 1998
  - version 1
    - using only soft-switching
    - continuation-based
    - *please let me skip old design errors :-)*
- Complete redesign in 2002
  - version 2
    - using only hard-switching
    - birth of tasklets and channels
- Concept merge in 2004
  - version 3
    - **80-20** rule:
    - soft-switching whenever possible
    - hard-switching if foreign code is on the stack
  - these 80 % can be *pickled*

Status of Stackless Python

- mature
- Python 2 and Python 3, all versions
- maintained by
  - Richard Tew
  - Kristjan Valur Jonsson
  - me (a bit)

The New Direction for Stackless

- `pip install stackless-python`
  - will install `slpython`
  - or even `python` (opinions?)
- drop-in replacement of CPython *(psssst)*
- `pip uninstall stackless-python`
  - Stackless is a bit cheating, as it replaces the python binary
  - but the user perception will be perfect
- *trying stackless made easy!*
- first prototype yesterday from Anselm Kruis *(applause)*

The New Direction for Stackless

- `pip install stackless-python`
  - will install `slpython`
  - or even `python` (opinions?)
- drop-in replacement of CPython *(psssst)*
- `pip uninstall stackless-python`
  - Stackless is a bit cheating, as it replaces the python binary
  - but the user perception will be perfect
- *trying stackless made easy!*
- first prototype yesterday from Anselm Kruis *(applause)*

The New Direction for Stackless

- `pip install stackless-python`
  - will install `slpython`
  - or even `python` (opinions?)
- drop-in replacement of CPython *(psssst)*
- `pip uninstall stackless-python`
  - Stackless is a bit cheating, as it replaces the python binary
  - but the user perception will be perfect
- *trying stackless made easy!*
- first prototype yesterday from Anselm Kruis *(applause)*

The New Direction for Stackless

- `pip install stackless-python`
  - will install `slpython`
  - or even `python` (opinions?)
- drop-in replacement of CPython *(psssst)*
- `pip uninstall stackless-python`
  - Stackless is a bit cheating, as it replaces the python binary
  - but the user perception will be perfect
- *trying stackless made easy!*
- first prototype yesterday from Anselm Kruis *(applause)*

Consequences of the Pseudo-Package

The technical effect is almost nothing.
The psycological impact is probably huge:

- stackless is easy to install and uninstall
- people can simply try if it fits their needs
- the never ending discussion
  - “Why is Stackless not included in the Python core?”
- **has ended**
  - hey Guido :-)
  - what a relief, for you and me

Consequences of the Pseudo-Package

The technical effect is almost nothing.
The psycological impact is probably huge:

- stackless is easy to install and uninstall
- people can simply try if it fits their needs
- the never ending discussion
  - “Why is Stackless not included in the Python core?”
- **has ended**
  - hey Guido :-)
  - what a relief, for you and me

Consequences of the Pseudo-Package

The technical effect is almost nothing.
The psycological impact is probably huge:

- stackless is easy to install and uninstall
- people can simply try if it fits their needs
- the never ending discussion
  - “Why is Stackless not included in the Python core?”
- **has ended**
  - hey Guido :-)
  - what a relief, for you and me

Consequences of the Pseudo-Package

The technical effect is almost nothing.
The psycological impact is probably huge:

- stackless is easy to install and uninstall
- people can simply try if it fits their needs
- the never ending discussion
  - “Why is Stackless not included in the Python core?”
- **has ended**
  - hey Guido :-)
  - what a relief, for you and me

Consequences of the Pseudo-Package

The technical effect is almost nothing.
The psycological impact is probably huge:

- stackless is easy to install and uninstall
- people can simply try if it fits their needs
- the never ending discussion
  - “Why is Stackless not included in the Python core?”
- **has ended**
  - hey Guido :-)
  - what a relief, for you and me

Status of Stackless PyPy

- was completely implemented before the Jit
  - together with greenlets coroutines
  - not Jit compatible
- was “too complete” with a 30% performance hit
- new approach is almost ready
  - with full Jit support
  - but needs some fixing
  - this *will* be efficient

Applications using Stackless Python

- The Eve Online MMORPG
  `http://www.eveonline.com/`
  - based their games on Stackless since 1998
- science + computing ag, Anselm Kruis
  `https://ep2012.europython.eu/conference/p/anselm-kruis`
- The Nagare Web Framework
  `http://www.nagare.org/`
  - works because of Stackless Pickling
- today's majority: persistence

Thank you

- the new Stackless Website `http://www.stackless.com/`
  - a **great** donation from Alain Pourier, *Nagare*
- You can hire me as a consultant
- Questions?