PyPy: current status and GIL-less future

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EuroPython 2012

July 2 2012

PyPy at EuroPython

```
fijal:~/extradoc/talk$ cd ep20
ep2004-pypy/ ep2006/ ep2008/ ep2010/
ep2005/ ep2007/ ep2009/ ep2011/
ep2012/
```

- for those who missed previous EPs, PyPy is a Python interpreter with a JIT.

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Software archeology

“single functions doing integer arithmetic get great speed-ups; about anything else will be a bit slower with the JIT than without. We are working on this - you can even expect quick progress, because it is mostly a matter of adding a few careful hints in the source code of the Python interpreter of PyPy.”

(status of the JIT of PyPy as of March 2007)

Software archeology

- Around since 2003
- (advertised as) production ready since December 2010
  - release 1.4
- Funding
  - EU FP6 programme
  - Eurostars programme
  - donations
  - ...

PyPy 1.9: current status

- Faster
  - **1.7x** than 1.5 (a year ago)
  - **2.2x** than 1.4
  - **5.5x** than CPython
- Implements Python 2.7.2
- Many more “PyPy-friendly” programs
- Packaging
  - Debian, Ubuntu, Fedora, Homebrew, Gentoo, ArchLinux, ...
  - Windows (32bit only), OS X
- C extension compatibility
  - runs (big part of) **PyOpenSSL** and **lxml**

PyPy organization

- Part of Software Freedom Conservancy
  - Bradley successfully fighting U.S. bureaucracy
  - we are happy about it
- Funding model
  - py3k, numpy, STM
  - more than 100'000$ in donations
  - from individuals, large companies and the PSF
  - **thank to all**

Let's talk about Python

- Rapid prototyping
  - run your web server in 3 seconds
  - run your script in 0.1s
- Glue language
  - integrating with C is "easy"

Let's talk about PyPy

- JIT warmup time
  - significant
  - rapid prototyping is harder
- no good way to call C from PyPy (yet)

JIT warmup times

- JIT-ted code: very fast
- Everything else: slow
- JIT-ting one piece at a time
- “takes a while”
- **Cannot** cache JIT-ted code between runs

- We did not spend much time on this
- **PyPy JIT Under the hood**
  - July 4 2012

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Py3k

- `py3k` branch in mercurial
  - developed in parallel
- Focus on correctness
- Dropped some interpreter optimizations for now
- Work in progress

Py3k status

- Directly from the “What’s new in Python 3.x”:
  - string vs unicode, int/long unification
  - syntactic changes (`print()`, `except`, ...)
  - set, oct, binary, bytes literals
  - view and iterators instead of lists
  - function annotations, keyword only arguments
  - `nonlocal`
  - extended iterable unpacking
  - dictionary comprehensions
  - `raise ... from ...`, lexical exception handling
  - `__pycache__`
- Most features are already there
  - major exception: unicode identifiers

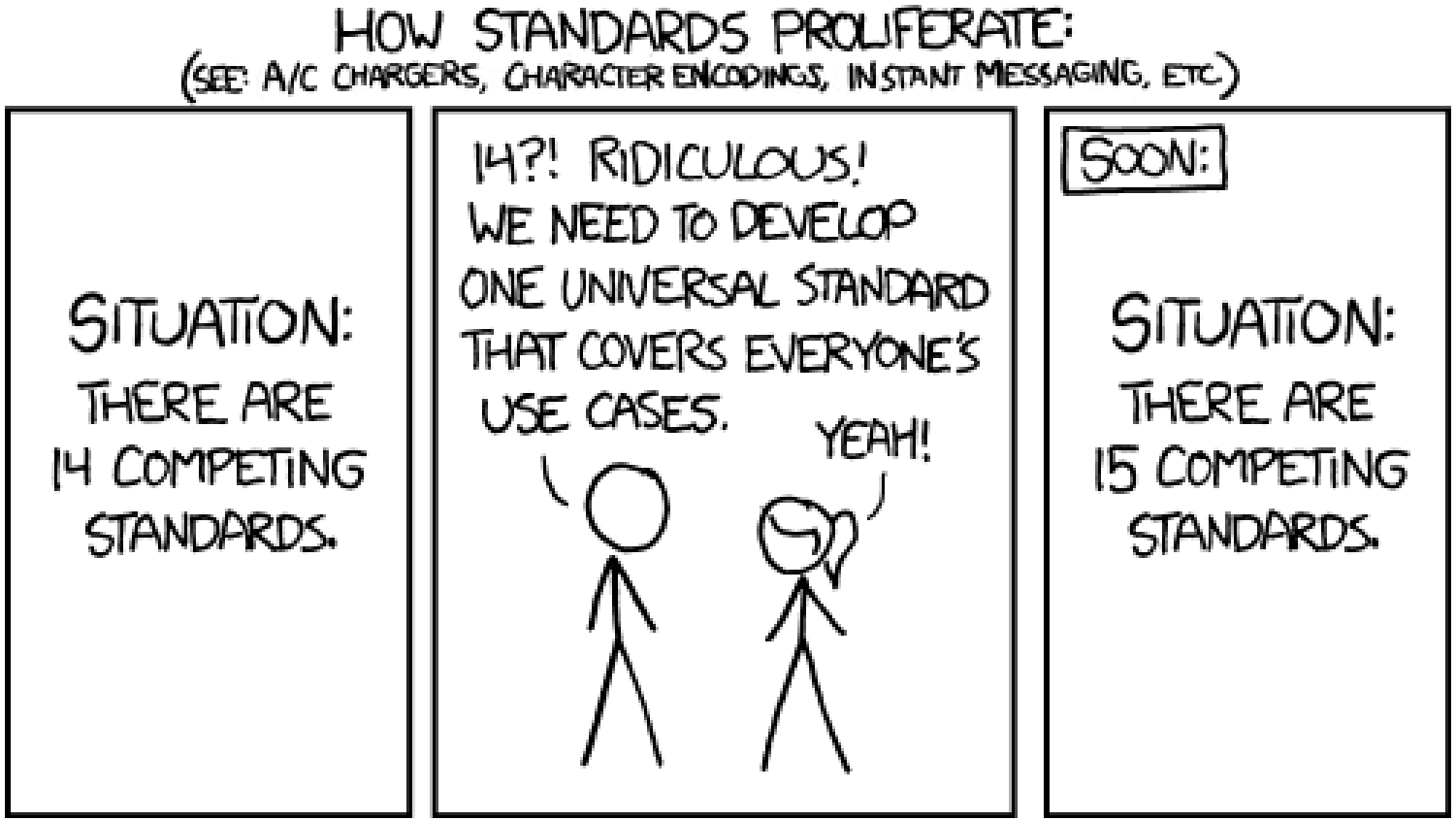
Py3k: what's left?

- First 90% done, remaining 90% not done
- Tons of small issues
- Extension modules / stdlib
- In January:
  - PyPy "own" tests: 1621 failures
  - CPython tests: N/A (did not compile)
- Now:
  - PyPy "own" tests: 83 failures
  - CPython tests: "lots"
- Most are shallow failures

NumPy

- progress going slowly
- multi dimensional arrays, broadcasting, fancy indexing
- all dtypes, except complex, strings and objects
- tons of functions missing
- you can help!

Calling C


HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC)
SITUATION:
THERE ARE
14 COMPETING
STANDARDS.
14?! RIDICULOUS!
WE NEED TO DEVELOP
ONE UNIVERSAL STANDARD
THAT COVERS EVERYONE'S
USE CASES.
YEAH!
SOON:
SITUATION:
THERE ARE
15 COMPETING
STANDARDS.

Calling C landscape

- CPython C extensions
- SWIG, SIP, wrapper generators
- ctypes
- Cython
- CFFI (our new thing)

CFFI

Example

```
>>> from cffi import FFI
>>> ffi = FFI()
>>> ffi.cdef("""
...     int printf(const char *format, ...);
... """)
>>> C = ffi.dlopen(None)
>>> arg = ffi.new("char[]", "world")
>>> C.printf("hi there, %s!\n", arg)
hi there, world!
```

CFFI

- Many more examples
- Including macro calls and most subtleties of C
- `http://cffi.readthedocs.org`

STM

- Software Transactional Memory
- “Remove the GIL”

Problem

- One Python program == one core
- Even with threads

Does it matter?

- “My script runs anyway in 0.1 seconds”
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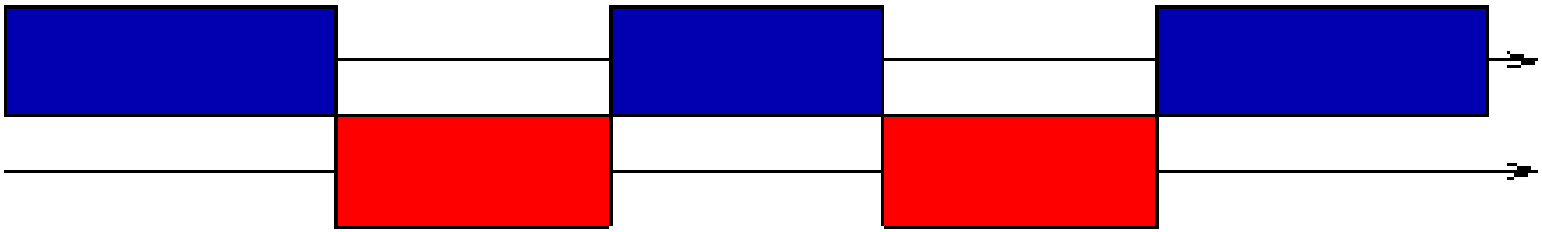
pypy-stm

- A Python without the GIL
- not the first one:
  - Python 1.4 patch (Greg Stein, 1996)
  - Jython
  - IronPython
- Demo

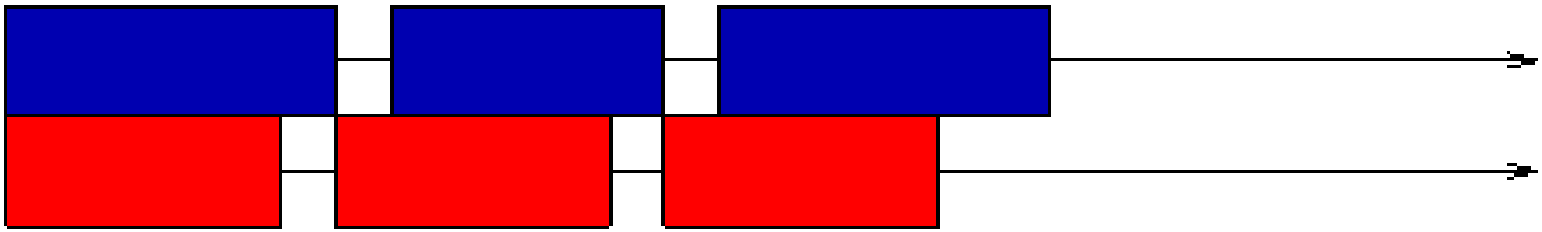
STM

Transactions, similar to database transactions

- GIL

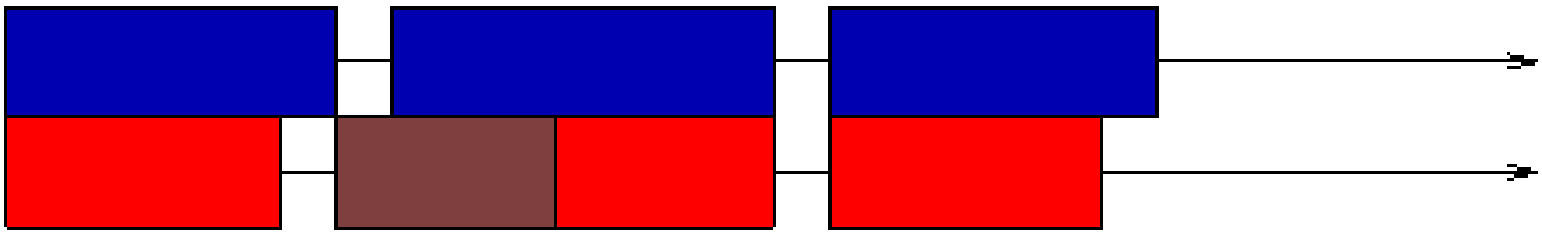


- STM



Conflicts

Occasional conflict:



HTM

- Hardware support: Intel Haswell, 2013
- “CPython-htm”?
- Removing the GIL: suddenly around the corner

The catch

You have to use threads

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Threads

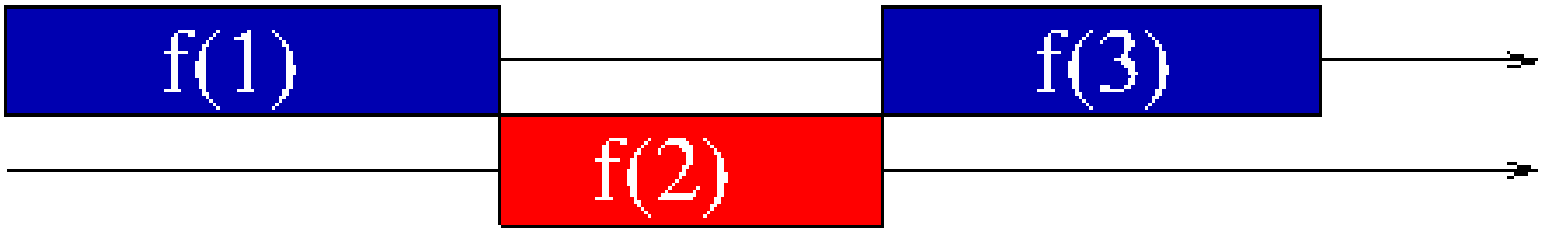
- Messy
- Hard to debug, non-reproductible
- Parallel with Explicit Memory Management:
  - messy, hard to debug rare leaks or corruptions
  - automatic GC solves it
  - (like in Python)

This talk is really about...

- Multicore usage **without using threads**
- Demo with the “transaction” module

How?

- Longer, controlled transactions
- GIL



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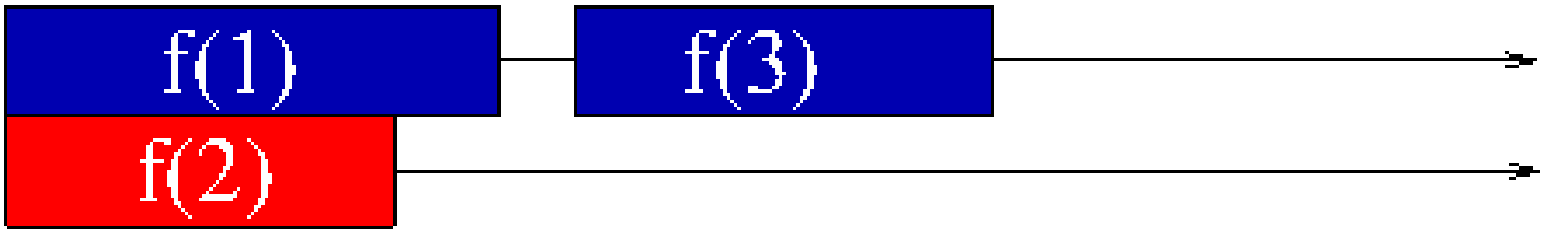

Results

- Same results in both cases
- i.e. can pretend it is one-core

The opposite catch

- Always gives correct results...
- But maybe too many conflicts
  - up to: systematic conflicts
- This still approaches the issue from “the right side”

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About CPython

- Long transactions: HTM too limited
- At least for the next 10-15 years
- On CPython we are stuck with threads
  - for the next 10-15 years

Summary

- STM fine with PyPy, but HTM required for CPython
- HTM too limited for long transactions
- Long transactions give a better programming model
- For years to come, only in PyPy
  - Unless major effort from CPython devs

Conclusion

- The GIL will be removed soon
- But for the foreseeable future, Python programmers stuck with using threads

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  - My own point of view only
  - Or maybe everybody will switch to PyPy

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Thank you

- `http://pypy.org/`
- You can hire Antonio
- Questions?