Building a Web-Scale Search Engine with Perl

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Waah

- This is my first YAPC
- They scheduled me against Rick?!

Agenda

- Personal histories
- The Search Business in 3 minutes
- Why we chose Perl
- Writing NoSQL in Perl
- The search engine app – event-driven progr.
- Continuous Everything
- Updating perl (and CentOS)
- Open Data / Open Source
- Our secret sauce

Personal Histories

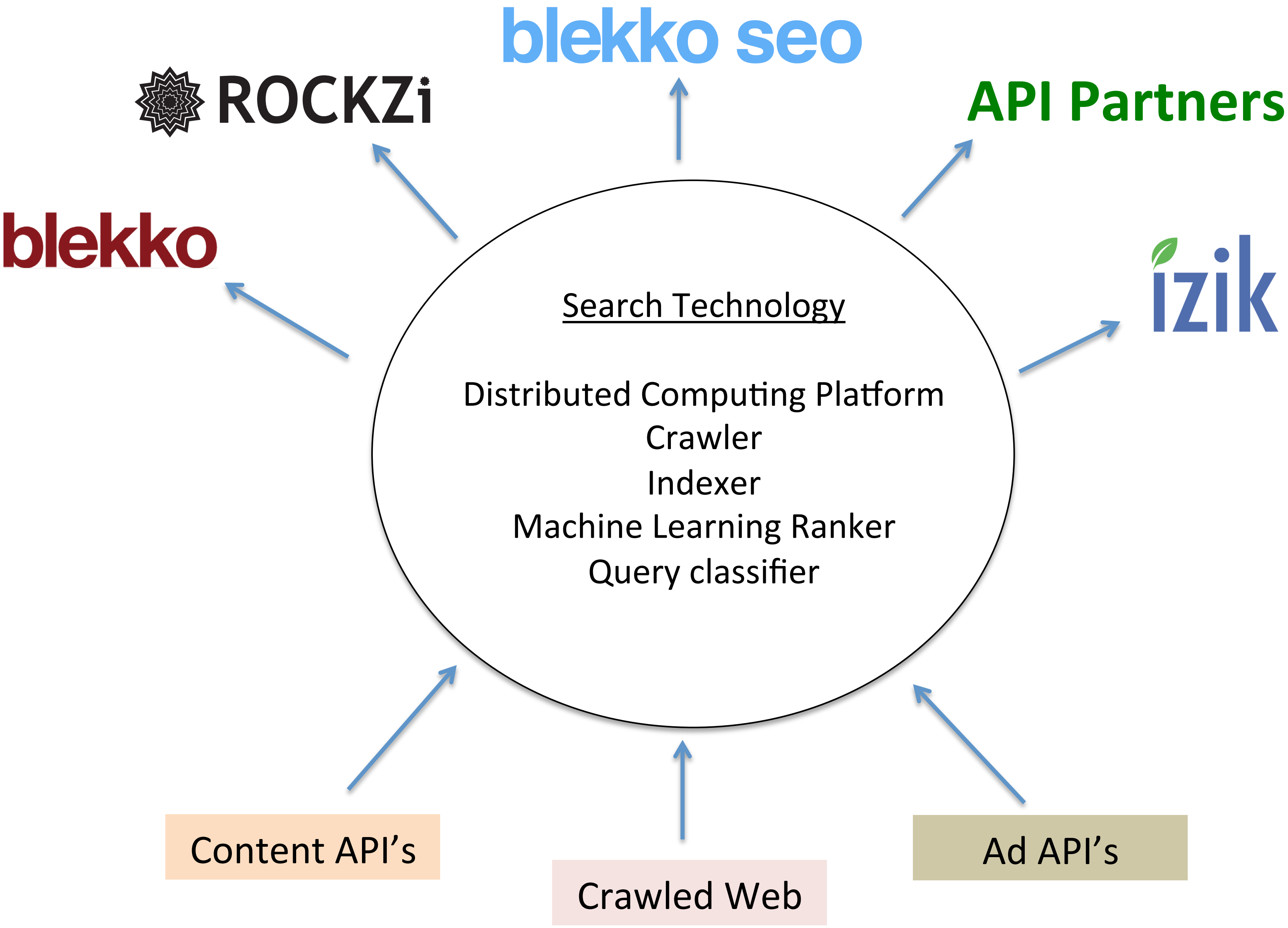
- me: icon, usenet? or irc?, merlyn, camel book
- http://www.pbm.com/~lindahl/
- really a supercomputing guy: Fortran, MPI
- Contrib to ircd (founded efnet), binutils, emacs

- others: GnuHoo => NewHoo => ODP / dmoz
- Netscape => AOL => AOL-TimeWarnerMegaCorp
- Popular open data dataset, inspired Wikipedia
- All of us know a lot of other languages

The Search Business in 3 minutes

- Some people say building a real search engine costs $1 billion
  - and by real, I mean multi-billion-page crawl and index, not using Google/bing’s index
- Recent “real” failures: cuil, SearchMe; they raised ~ $30-40 million, hire 80-100 people
- The only successful new “real” engine since Google is the bing re-write! ($1B loss/year)
- We felt real innovation was possible only if we had our own crawl and index

What our marketing team says we built



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API Partners

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Search Technology

Distributed Computing Platform
Crawler
Indexer
Machine Learning Ranker
Query classifier

Content API’s

Crawled Web

Ad API’s

Our plan

- Build the basics of a search engine
- Try some innovations, most of which will fail
- Don't die on launch day, have a long runway
- Try some innovations, most of which will fail
- …
- Profit!

- (we didn't really have a plan)
- Keep the team small: build an environment that makes programmers efficient

Choosing perl

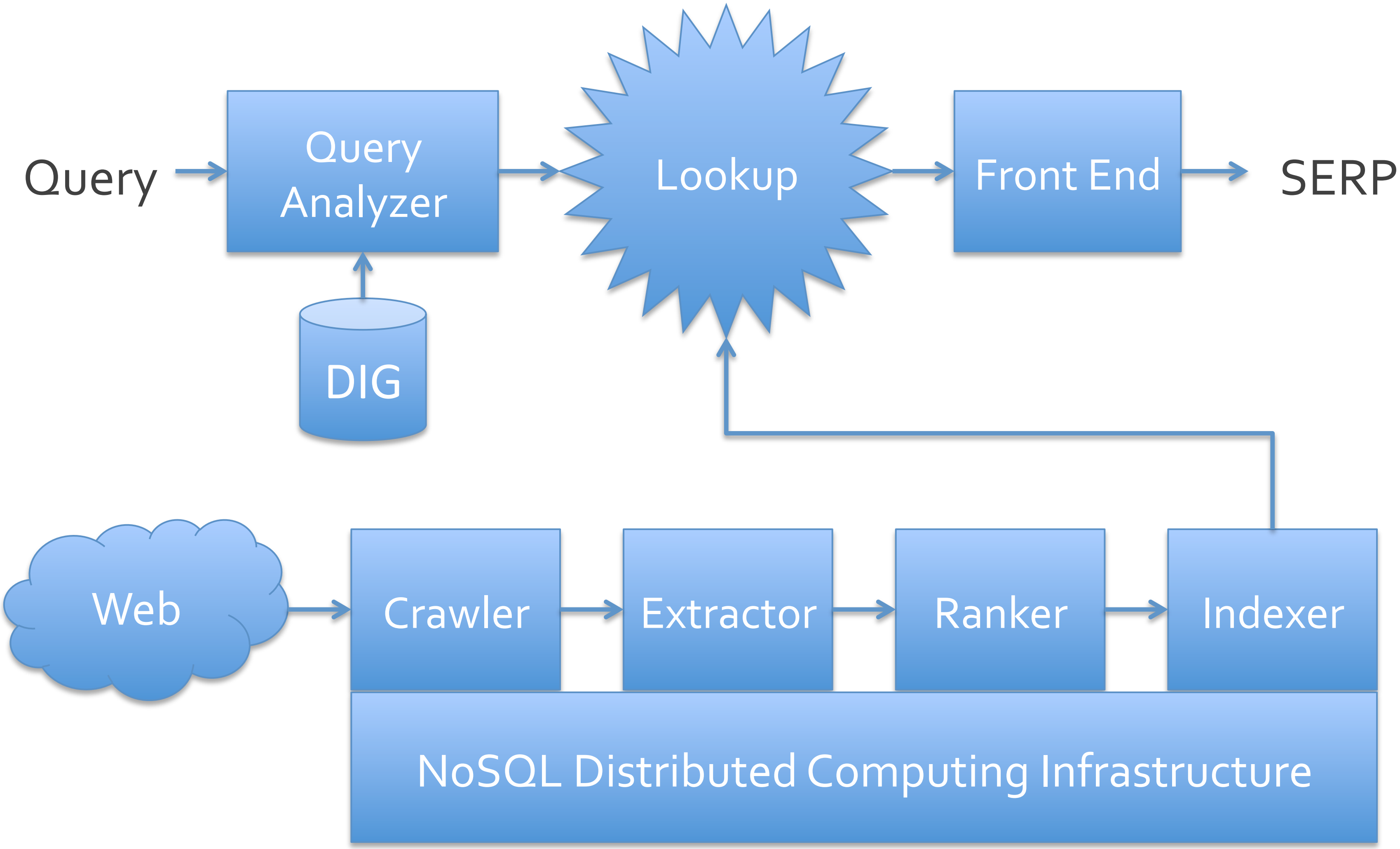
- “Maybe we should switch to Python
  - basically the same language
  - easier to hire”
- Went and bought Python books
- 1 week later: “Anyone read their book?”

- Allrighty, Perl it is.

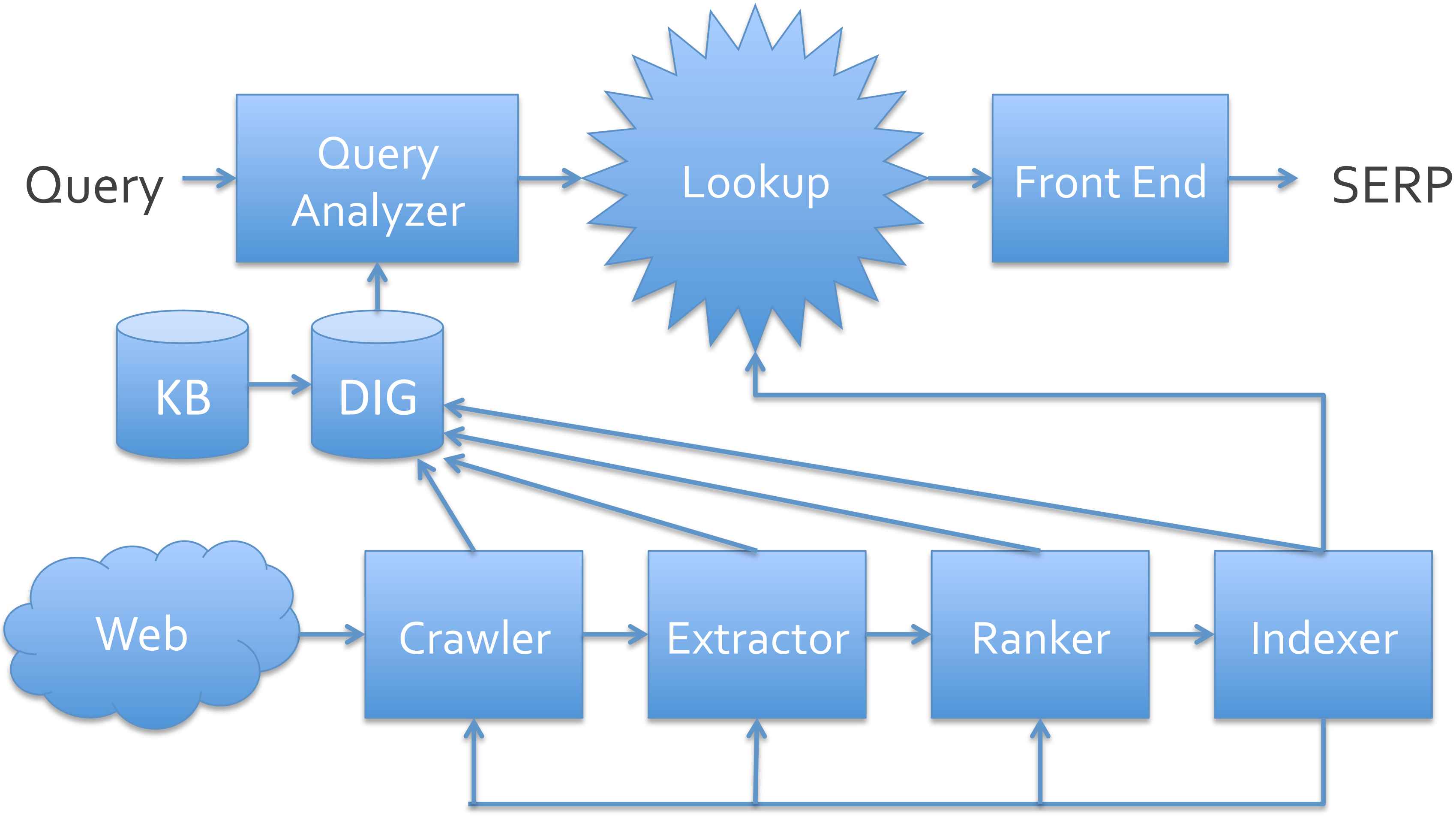
How did that work out?

- Hired some people who loved perl and wanted to work for an awesome startup
- Hired lots of smart people who didn’t know perl, but knew Python/Ruby or Java
- No complaints about “resume damage”
- No problem hiring during the Silicon Valley hiring crunch
- We succeeded in making our programmers very productive

A Search Engine



The Real Diagram – lots of feedback



NoSQL

- “Let me explain. No, there’s not time. Let me sum up.”
- …
- Lots of existing NoSQL alternatives, but
  - We want a bunch of unusual features that other people wouldn’t care about – and we’d be extreme users overall
  - Choice: understand all the code, or write all the code
  - Plus, all that existing stuff is in Java. Screw that.

NoSQL in Perl

- Lots of great building blocks
  - IO::AIO
  - JSON::XS – hacked into our own solution
  - AnyEvent
  - … 397 more CPAN distributions
- Need: Map/Reduce
- Need: a way of expressing efficient transactions

Map/Reduce without the Reduce

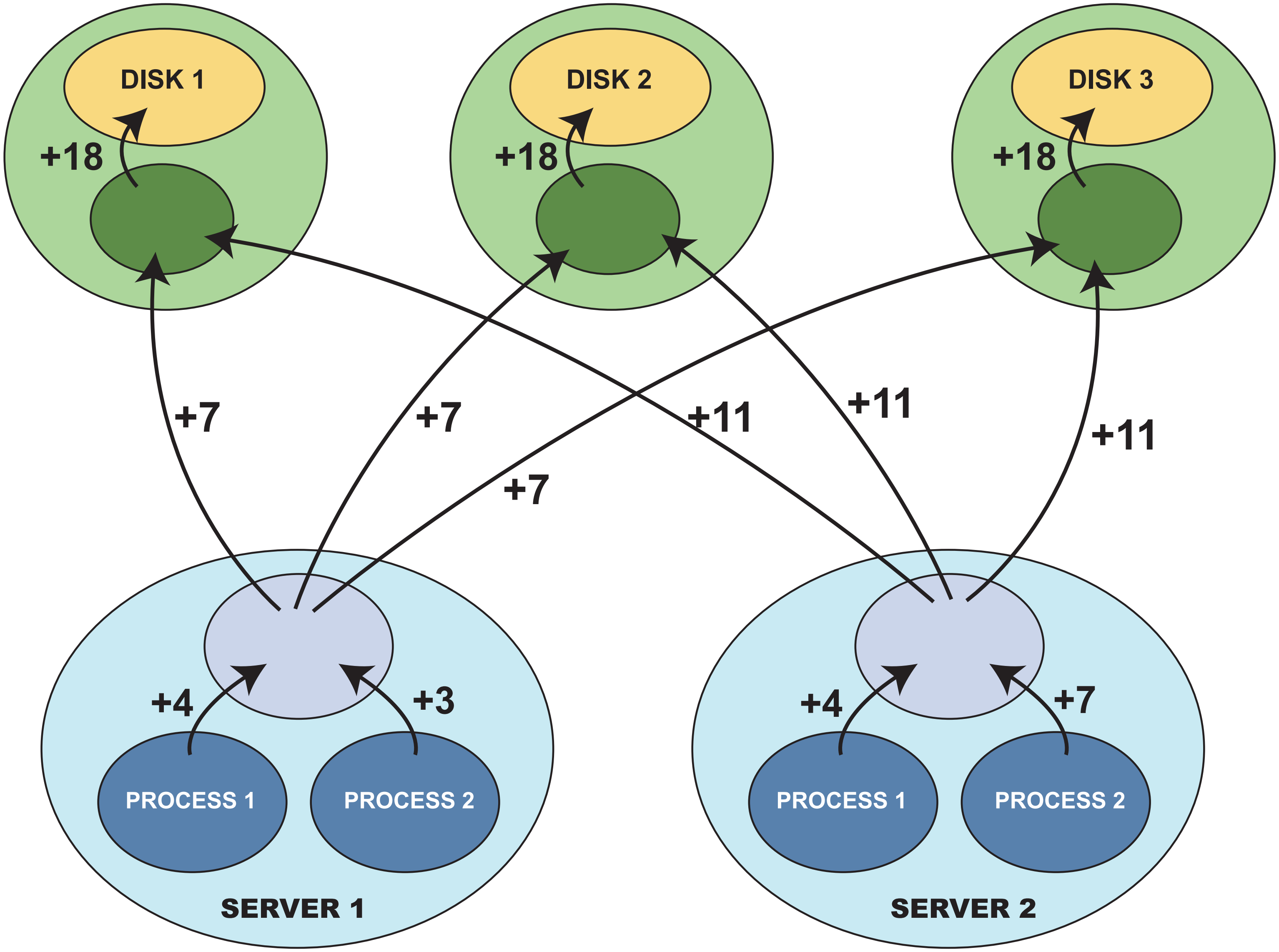
```
sub foo {
  return if $pm->MAPJOB();
  while ( ($url, $doc) =
           $pm->nextrow('/crawl', $url) ) {
      foreach word in doc
        $pm->add("/wc", $word,{ count=>1 } );
  }
}
```

- No reduce phase
- Writes to the database are made through combinators (comb_add in this case)

Combinators?

- Transactional data structures
  - add, min, max, delete, average, …
- Associative: Can combine before delivery
  - In process, before they’re sent to the local write daemon
  - Writer daemon, before delivery to buckets
  - Bucket daemon, before delivery to disk
- Preferably commutative
  - who’s first in a cluster?
- They allow sub-cell atomic updates
- Minimizes operations at the disk

Combinators reduce the total work



TopN combinator

- table: /crawl/32/url
- row: blekko.com/, column: inlinks

rank	key	anchortext
900	nytimes.com	new search engine blekko
540	techcrunch.com	blekko removes spam
1	www.ehow.com/blekko	our enemy

Writing the search engine app

- Sits on top of the NoSQL stuff
- crawl => extract => index
- Needs a lot of event-driven programming
  - because we aren’t using threads, no way
- Needs to be integrated with the NoSQL stuff, network outcalls
- Must allow pretty code

Expressing Dataflow

```
my @work = generate_work();
PM::FrameWork::do_work( \@work, \& first,
                        ( framecount => 5, fps => 1 ) );
sub first {
   my ( $frame, $work ) = @_;
   get_page( $work, $frame->{page} );
   return \& second;
}
sub second {
   my ( $frame ) = @_;
   … do something with $frame->{page} …
   return undef;
}
```

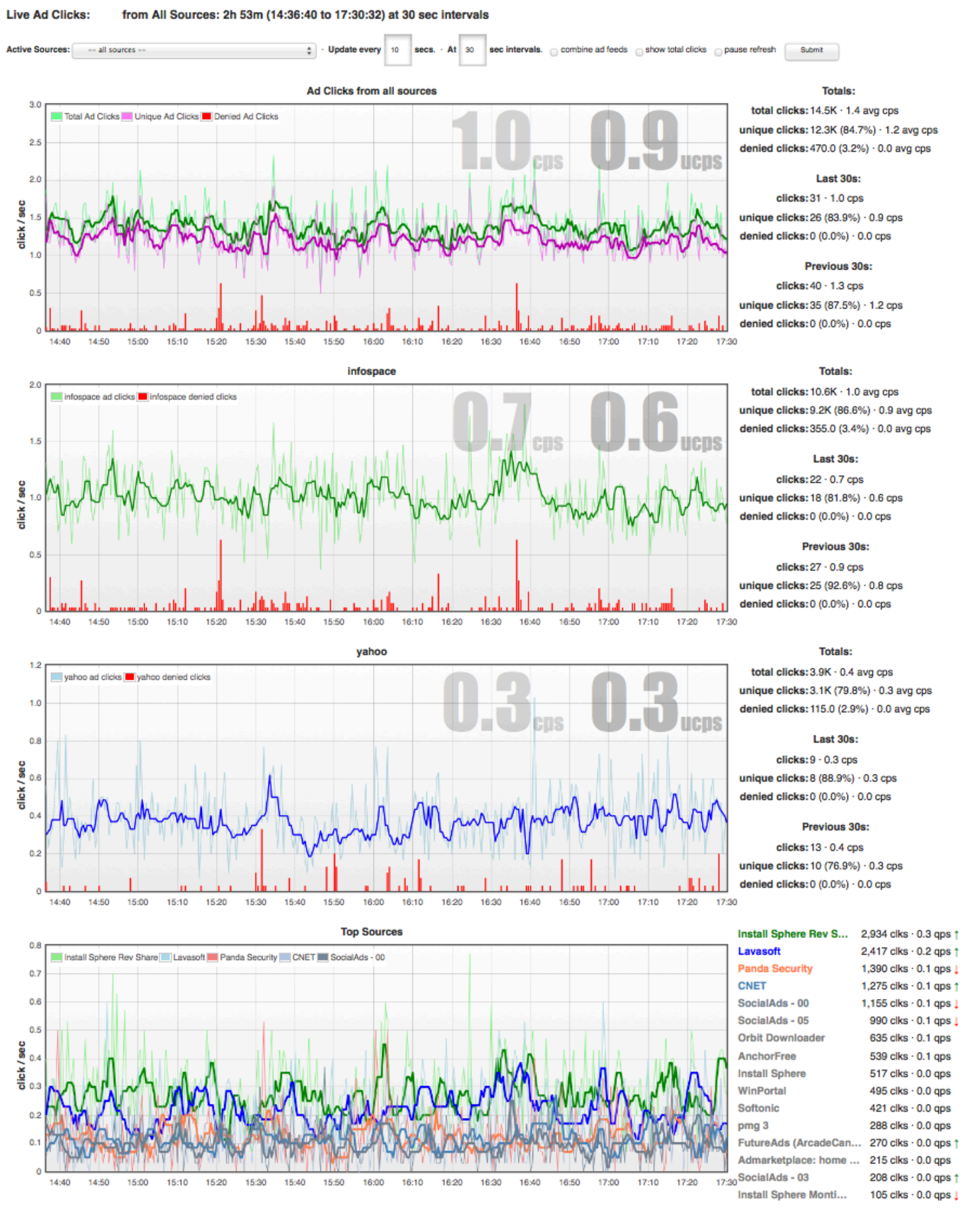
Dataflow good and bad

- Good: very efficient, great cache patterns
  - our crawlers frequently have 1000 active frames per single-threaded process
- Slightly bad: have to run multiple heavy-weight processes to use multiple cores
  - because perl is single-threaded
  - not a big deal for us, all of our daemons are parallel
  - multiple crawlers/box, 1 set of disk daemons for every disk etc.

Continuous Everything

- Continuous Integration
  - was Jenkins, now homegrown
  - end-to-end testing catches most disasters
- Continuous Deployment
  - want to push the webserver multiple times a day
  - want to push the NoSQL daemons every few months
  - no downtime for search users
- Continuous monitoring
  - Nagios and status displays

Show me the money: ad clicks



Live Ad Clicks: **from All Sources: 2h 53m (14:36:40 to 17:30:32) at 30 sec intervals**

Active Sources: -- all sources -- · **Update every** 10 **secs.** · **At** 30 **sec intervals.** □ combine ad feeds □ show total clicks □ pause refresh

Ad Clicks from all sources

Totals:

total clicks: 14.5K · 1.4 avg cps

unique clicks: 12.3K (84.7%) · 1.2 avg cps

denied clicks: 470.0 (3.2%) · 0.0 avg cps

Last 30s:

clicks: 31 · 1.0 cps

unique clicks: 26 (83.9%) · 0.9 cps

denied clicks: 0 (0.0%) · 0.0 cps

Previous 30s:

clicks: 40 · 1.3 cps

unique clicks: 35 (87.5%) · 1.2 cps

denied clicks: 0 (0.0%) · 0.0 cps

infospace

Totals:

total clicks: 10.6K · 1.0 avg cps

unique clicks: 9.2K (86.6%) · 0.9 avg cps

denied clicks: 355.0 (3.4%) · 0.0 avg cps

Last 30s:

clicks: 22 · 0.7 cps

unique clicks: 18 (81.8%) · 0.6 cps

denied clicks: 0 (0.0%) · 0.0 cps

Previous 30s:

clicks: 27 · 0.9 cps

unique clicks: 25 (92.6%) · 0.8 cps

denied clicks: 0 (0.0%) · 0.0 cps

yahoo

Totals:

total clicks: 3.9K · 0.4 avg cps

unique clicks: 3.1K (79.8%) · 0.3 avg cps

denied clicks: 115.0 (2.9%) · 0.0 avg cps

Last 30s:

clicks: 9 · 0.3 cps

unique clicks: 8 (88.9%) · 0.3 cps

denied clicks: 0 (0.0%) · 0.0 cps

Previous 30s:

clicks: 13 · 0.4 cps

unique clicks: 10 (76.9%) · 0.3 cps

denied clicks: 0 (0.0%) · 0.0 cps

Top Sources

Install Sphere Rev S...	2,934 clks · 0.3 qps ↑
Lavasoft	2,417 clks · 0.2 qps ↑
Panda Security	1,390 clks · 0.1 qps ↓
CNET	1,275 clks · 0.1 qps ↑
SocialAds - 00	1,155 clks · 0.1 qps ↓
SocialAds - 05	990 clks · 0.1 qps ↓
Orbit Downloader	635 clks · 0.1 qps
AnchorFree	539 clks · 0.1 qps
Install Sphere	517 clks · 0.0 qps
WinPortal	495 clks · 0.0 qps
Softonic	421 clks · 0.0 qps
pmg 3	288 clks · 0.0 qps
FutureAds (ArcadeCan...	270 clks · 0.0 qps ↑
Admarketplace: home ...	215 clks · 0.0 qps
SocialAds - 03	208 clks · 0.0 qps ↑
Install Sphere Monti...	105 clks · 0.0 qps ↓

What we've got

- Each of our daemons has its own complete set of perl libraries, independently updatable
- Bittorrent-like thingie that manages millions of objects (files)
  - one file changed in 1 snapshot deployed in a few seconds
- build <changeset> && badm restart fe
- Works great! A few rollbacks, but most outages affect a subset of users and we just fix the bug

Updating to 5.16

- First step was hard, because we stopped using the system perl & CPAN from rpms
  - Was needed to facilitate changing out Linux
  - Which we did, CentOS 5 => 6
- We have a lot of XS. Numerous minor changes. Some Cargo Cult in our XS.

- 5.18: a few days work. Bug #118159

  $a = dualvar 1, “”; print $a ? “true” : “false”

  Change was reverted! Our first perl bug ever!

Advice for updating

- Watch out for dual-life modules: upgrades turn into downgrades when you rev Perl
- Yes, updating 400 cpan modules will introduce bugs
  - BSD::Resource::getrlimit stopped returning a hashref in scalar context between 1.28 and 1.2904
- Rerun all your XS memory leak tests
- Read the release notes
  - sv_upgrade => SvUPGRADE
- All your hacks will haunt you
  - failed requires stay in %INC in 5.16, wuh?
- Send out advice to your colleagues
  - "don't use given/when & smartmatch"

Blaming the Bystander

- We're still on IO::AIO 3.3, tip is 4.18
- All of our disk I/O goes through it, even logs
- Significant bug: double-close
  - if you reuse fds fast enough, it closes something
  - our daemons would run for 2 weeks and then close their TCP accept socket, or their UDP socket
- Never reported to author ☹
- Upgraded to CentOS 6: OMG !!! load doubled, disks are 100% busy !!! Our old IO::AIO is incompatible with new kenel ?!?!
- Solved a week later: IO::AIO a bystander

Challenges with perl

- Memory leaks
  - Surprised that a tool to monitor object leaks is not common
  - Built one; turns out almost all of our leaks were actually busted XS
- Crashes in 5.8.8
  - Built an industrial strength stack dumper: C then ugly Perl then pretty Perl
  - Woah. 5.16 got rid of all of our mystery crashes

The Dien Bien Phu of logfile analysis

- perl spews shit to stderr all the time
- Hard to split our warns from perl complaints formatted like warns ("at line N, file foo")
- In order to summarize all those damn warns, I thought I wanted to know the difference
- I wrote a routine with a 720 line regex of messages culled from perldiag
- Also needed to make a list of non-warn-like things perl printed: /^panic:/
- And glibc: /^\Q*** stack smashing detected/

Please

- Someone (with more brain than I) please invent a better methodology for classifying lines in logfiles from long running daemons
- I’ll toss in the “get some backtrace info even if the stack is corrupt” stuff

The body count

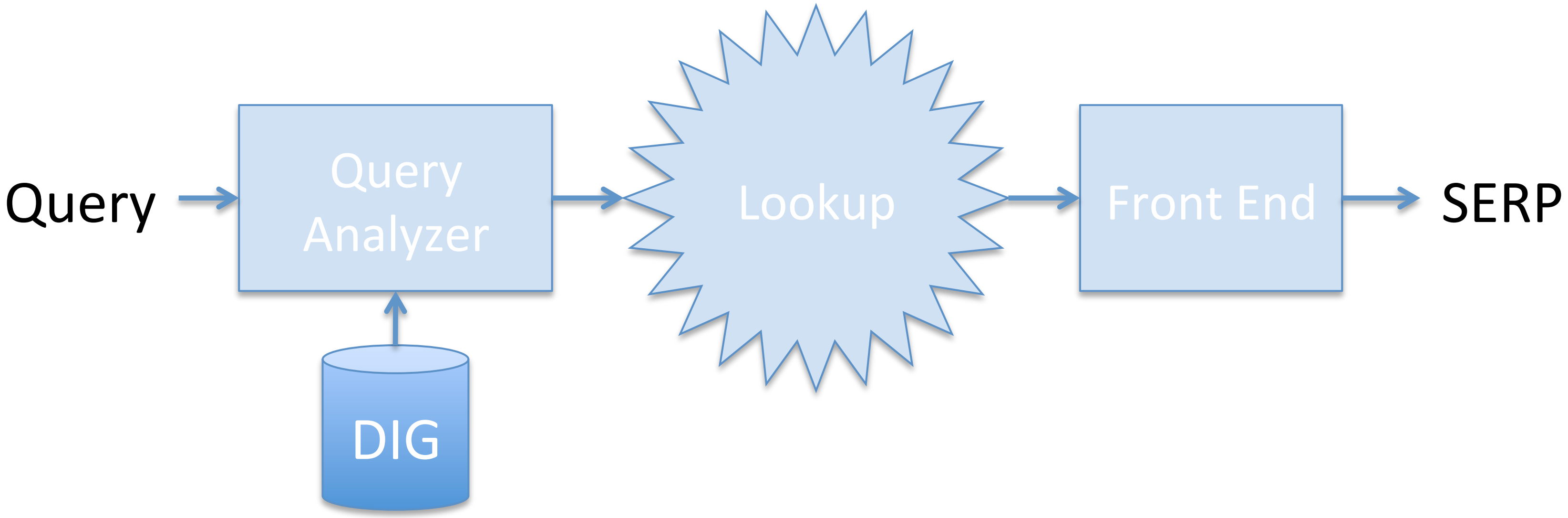
- total perl: 3,500 files, 1.07 million lines
  - NoSQL: 135,000 lines
  - Search engine: 872,000 lines
- total XS: 152 files, 82,000 lines
- total C/C++: 380 files, 326,000 lines

- $53 million, nearly 6 years of our lives, 5 babies, 5 million daily searches, a few gray hairs, our CEO has a tonsure now

Open Data and Open Source

- ODP got a lot of interest in the open source community, & inspired Wikipedia
  - (that was us, yo)
- We’ve gotten little attention for giving away both our curation data (github.com/blekko) and our crawl ranking data (via the Common Crawl Foundation)
- We’re open to Open Sourcing a bunch of our code, but our resources to do it are zilch.

p.s. this is the secret sauce



- 2,000 vertical categories built by our librarians
- Non-keyword-based classification using the web as a dataset
- Runs in ~0.01 seconds
- Many accurate categories for ambiguous queries
- Additional word-based "afterburner" to split big categories like "programming"

Thank you! For more info

- http://bit.ly/yapcna_blekko_2013

- These slides
- High Scalability blog series
- Videos of conference talks
- A few blekko blog postings