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Lessons learnt re-writing a PubSub system

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About

- **Founded in 2000**
- **Located in Stoke-on-Trent**
- **The largest online sports betting company**
- **Over 19 million customers**
- **One of the largest private companies in the UK**
- **Employs more than 2,000 people**
- **2013-2014: Over £26 billion was staked**
  - **Last year is likely to be around 25% up**
    - **Business growing very rapidly!**
- **Very technology focused company**

History of Erlang use

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- Started experimenting with Erlang/OTP circa 2011
- 3 major systems written in Erlang
- 4th one in progress
- Code base of varied quality

Publisher

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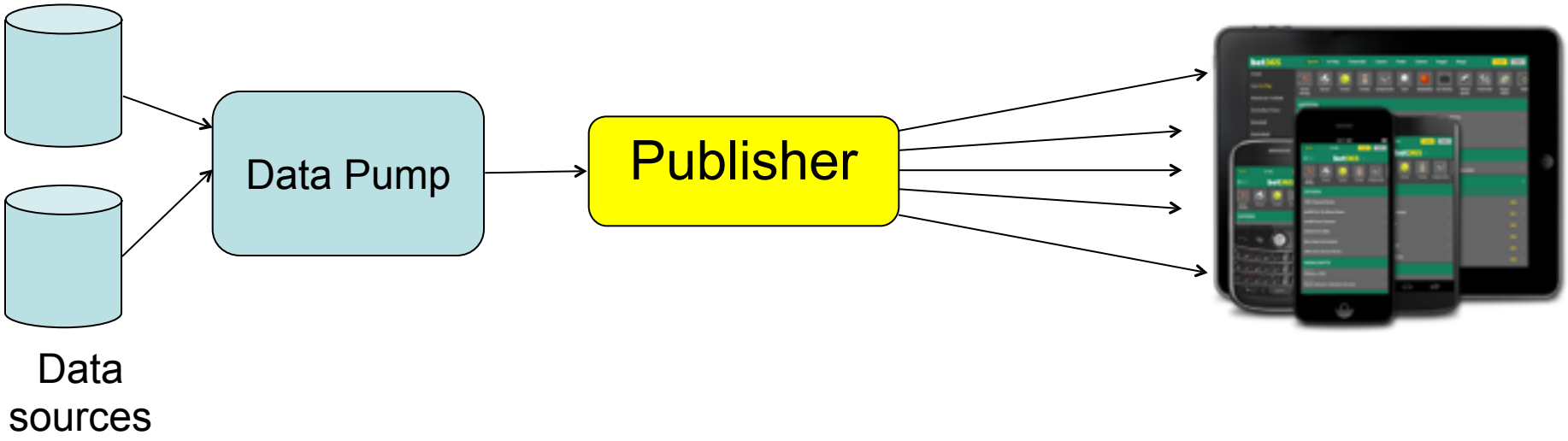

Why rewrite?

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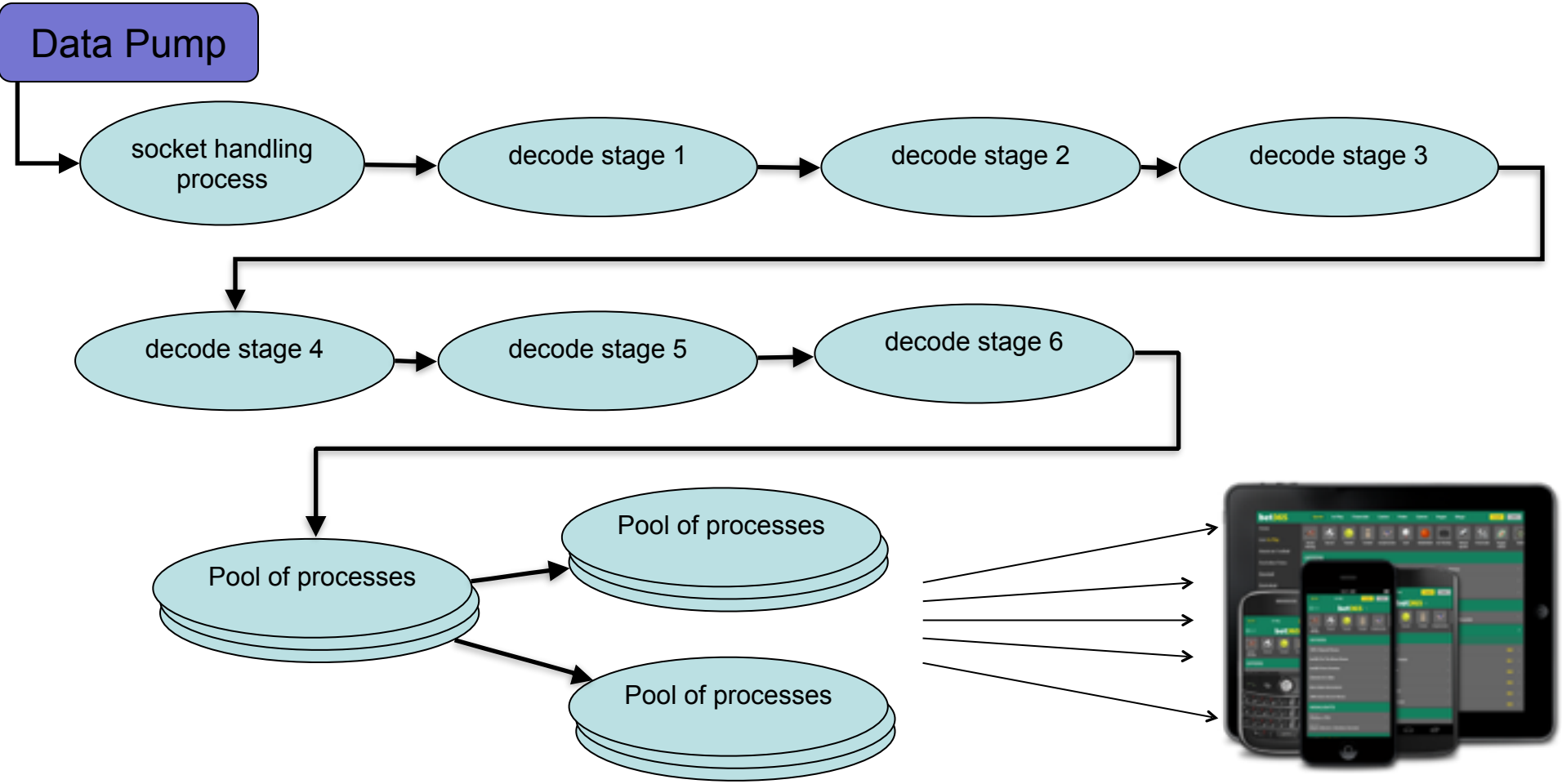
Complicated process structure

Message queue hotspots



New architecture

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- Exploits tree structure of data shipped to clients
- Total number of nodes in the tree ~2.2million
- Approx 130K top level nodes just below root

1st attempt

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- One process to take a message off the socket
- Decode
- Update global-state ETS table
- Send message to one of 130K top level procs

New architecture

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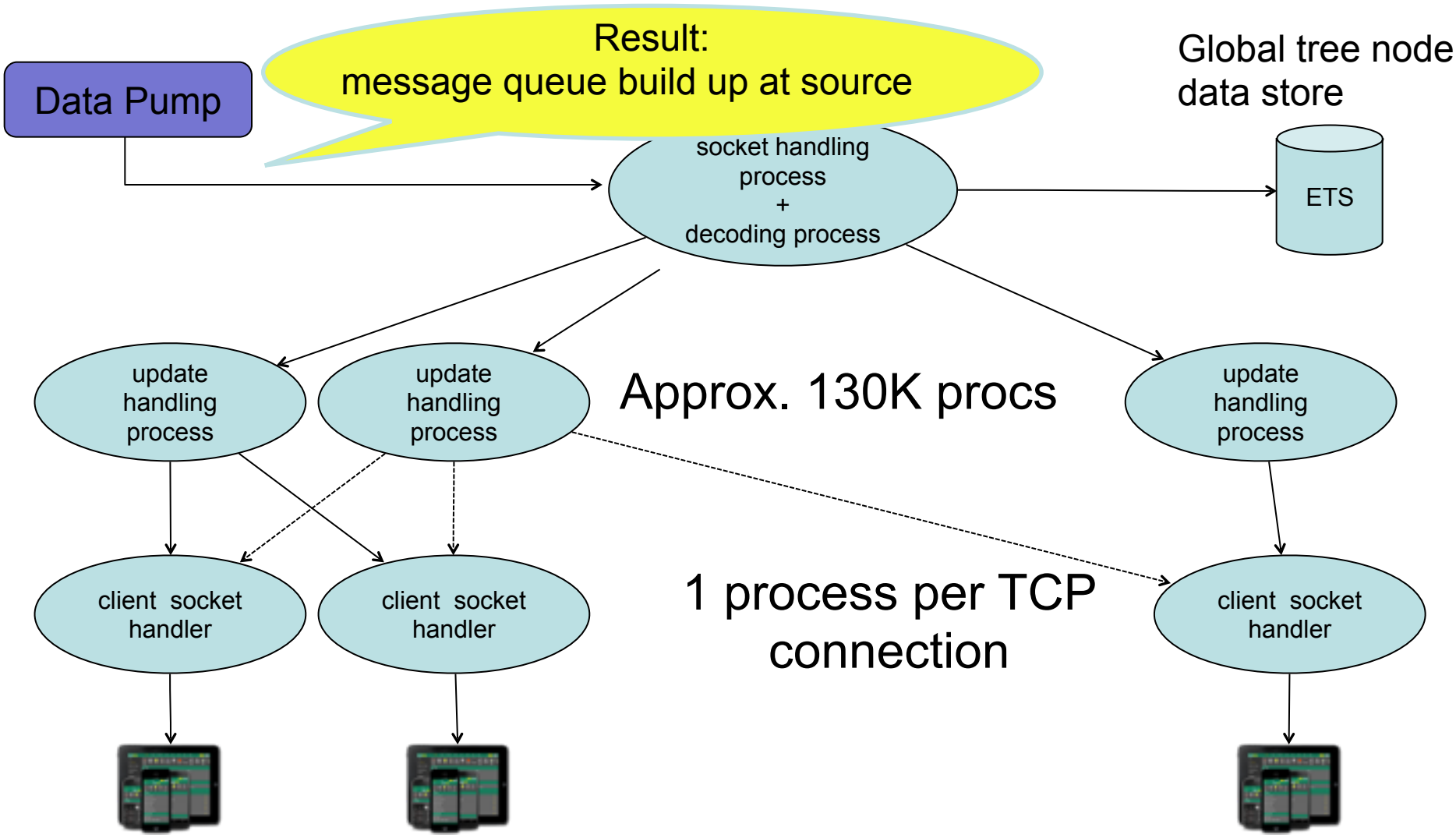

2nd attempt

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- One process to take a message off the socket
- Decoding 1st stage
- Insert into ETS table
- Another process pops message off ETS table
- Update ETS table
- Send message to one of 130K top level procs

New architecture

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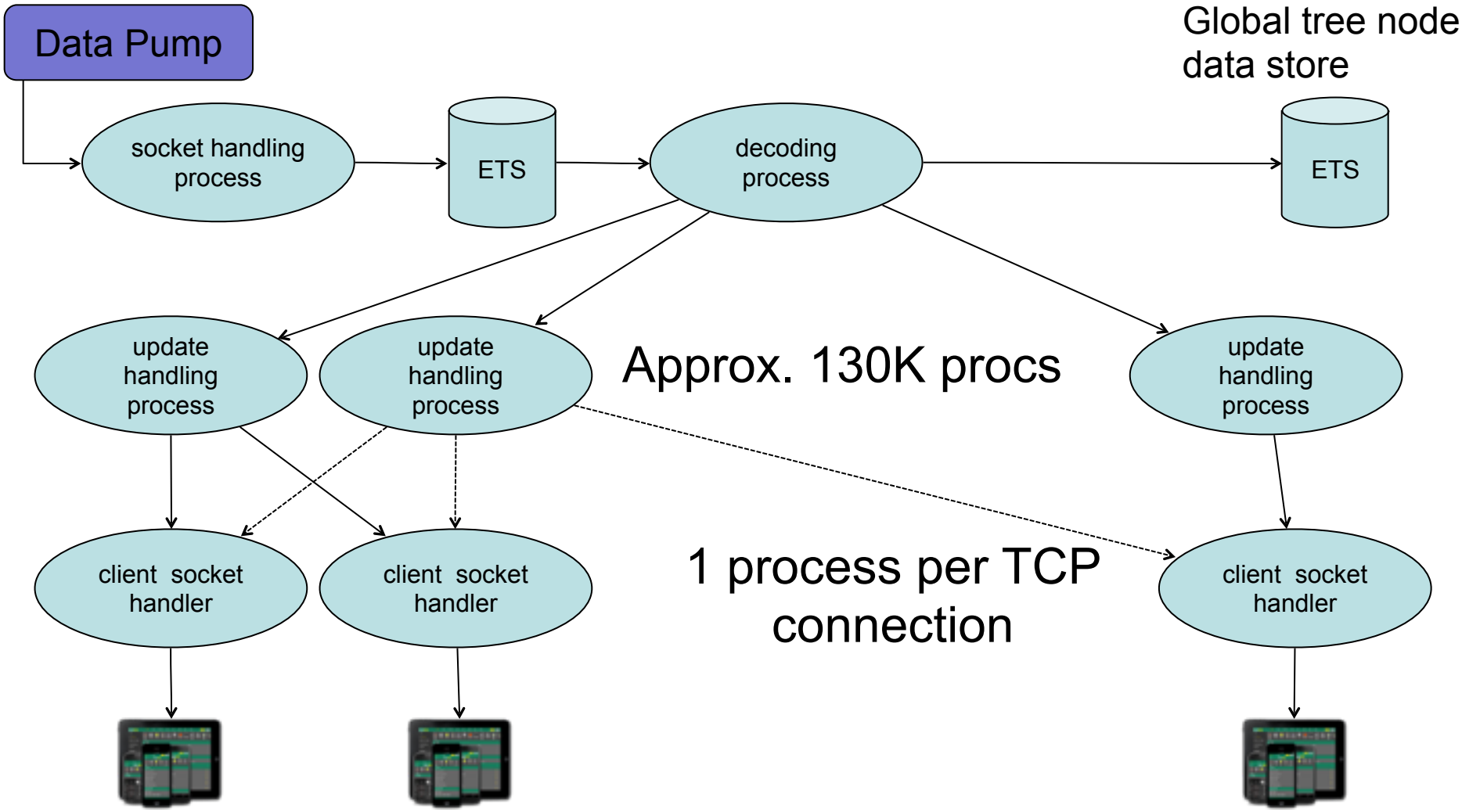

Results

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It worked well with 1.8 million nodes in the tree

BUT

throughput fell and latency increased for 2.2m nodes in the tree

Garbage collection

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- GC is per process
- Regular GC of a process is “generational”. Data that survives at least one GC will be put on the old heap
- When there is no space on the old heap, a “fullsweep” is performed

GC continued

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- The time taken to GC eats into the 2000 reductions available for a process
- So a “busy process” (with lots of incoming messages) with lots of garbage produced will quickly spiral out of control

Reduction count penalty

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- Sending message to a process with a “large” message queue
- Long GC
- Proportional to size of message sent to another node
- Proportional to size of binaries created
- …

Nice to have
Better documentation about reduction count consumption and “penalties”

Process priority flag

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- process_flag(priority, high) does NOT mean more reductions are available

- It just means it gets scheduled before others, if it has messages in its queue

Nice to have
Support for processes which have a dedicated execution thread may be useful?

Diagnosis

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```
[root@publisher ~]#
for x in $(seq 10000); \
   do ps -eo ppid,pid,user,stat,pcpu,comm,wchan:32 | \
      grep D | \
      egrep -v "\-|WCHAN"; \
   done;
```

-e : Select all processes
-o : user defined format

ppid : parent process id
pid : process id
stat : process state
pcpu : CPU utilisation
comm : command name
wchan : kernel function name where process is sleeping

```
2   263 root     DN    0.0 khugepaged      call_rwsem_down_write_failed
2   263 root     DN    0.0 khugepaged      call_rwsem_down_write_failed
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2   263 root     DN    0.0 khugepaged      call_rwsem_down_write_failed
2   263 root     DN    0.0 khugepaged      call_rwsem_down_write_failed
```

THP

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- Transparent Huge Pages are a feature in 64-bit RHEL
- Enabled by default for all applications
- Abstraction over “huge page” support in Linux
- Most database vendors recommend turning this off

What are huge pages?

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- Typical size of page in memory is 4KB
- 20GB of memory equates to 5,242,880 pages and that many entries in the page table.
- RHEL kernel allows page sizes of 2MB and 1GB on x86_64

How does THP work?

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- Using the huge page feature requires explicit code change to the application (in this case ‘beam’)
- THP aims to make it “just happen”
- It also does some memory defragmentation which seems to be the root cause of the issue

Disabling THP

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```
echo never > /sys/kernel/mm/redhat_transparent_hugepage/enabled
echo never > /sys/kernel/mm/redhat_transparent_hugepage/defrag
echo no > /sys/kernel/mm/redhat_transparent_hugepage/khugepaged/defrag
```

Permanently disable THP

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```
#!/bin/sh

if [[ $EUID -ne 0 ]]; then
   echo "This script must be run as root" 1>&2
   exit 1
fi

for KERNEL in /boot/vmlinuz-*; do
    grubby --update-kernel="$KERNEL" --args='transparent_hugepage=never'
done
```

source: http://unix.stackexchange.com/questions/99154/disable-transparent-hugepages

Message passing

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- Double edged sword
  - Easy to write reasonably complex code, quickly
  - Enough rope to hang yourself easily
- Developed a process message queue with {active, once} semantics
- No improvement in performance, but no noticeable degradation either!

Message queue

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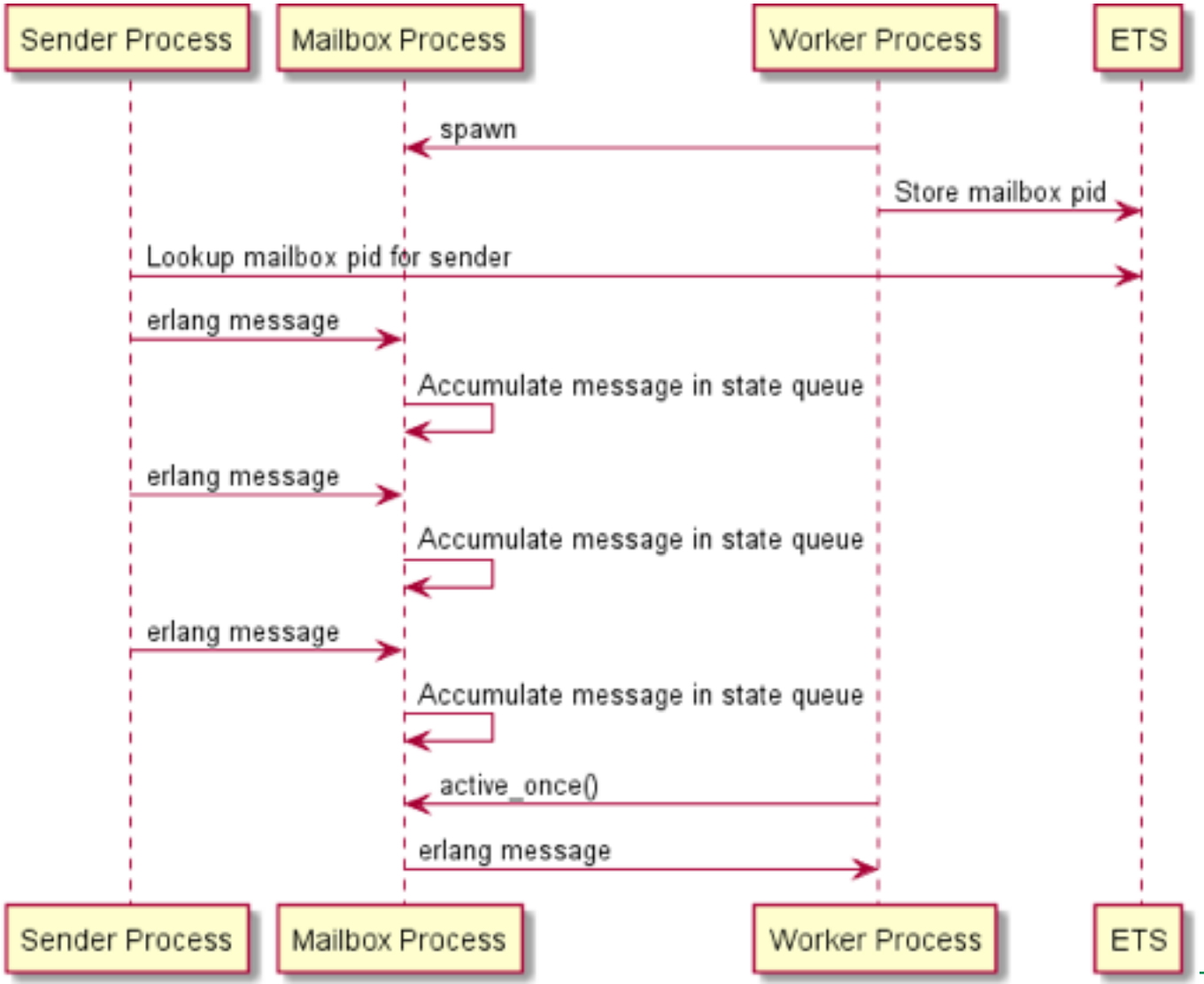

Results

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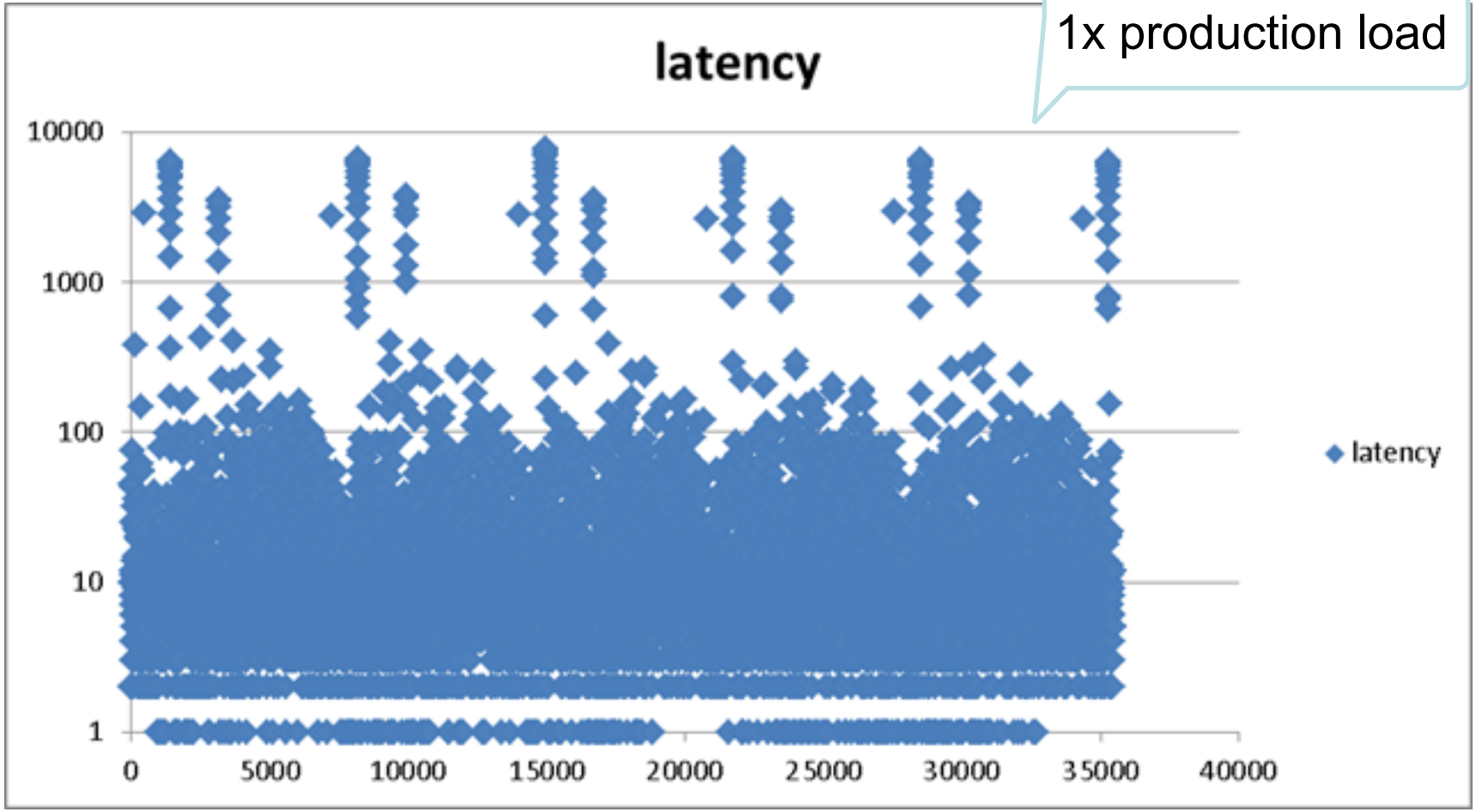

Results

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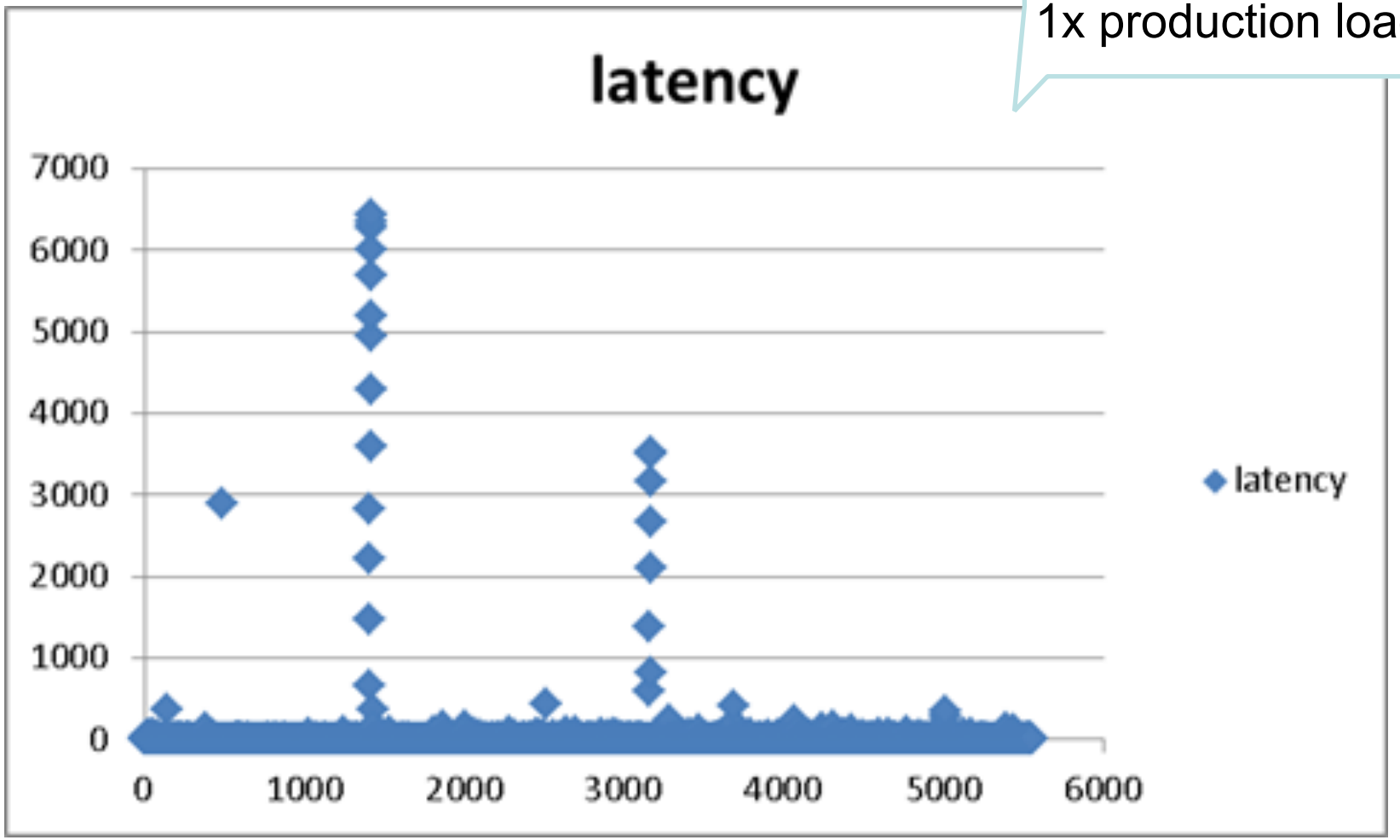
100K clients
1x production load



Results

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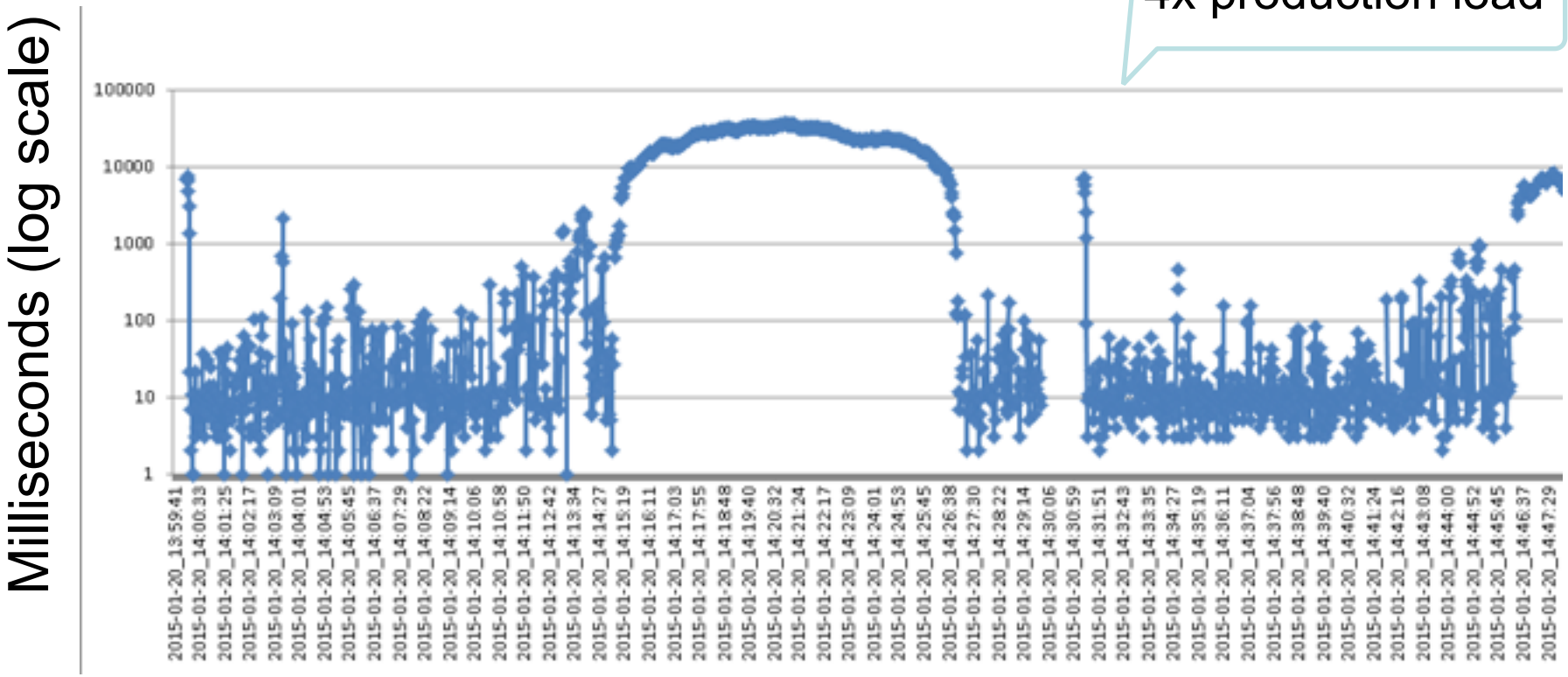
100K clients
4x production load



Bottlenecks

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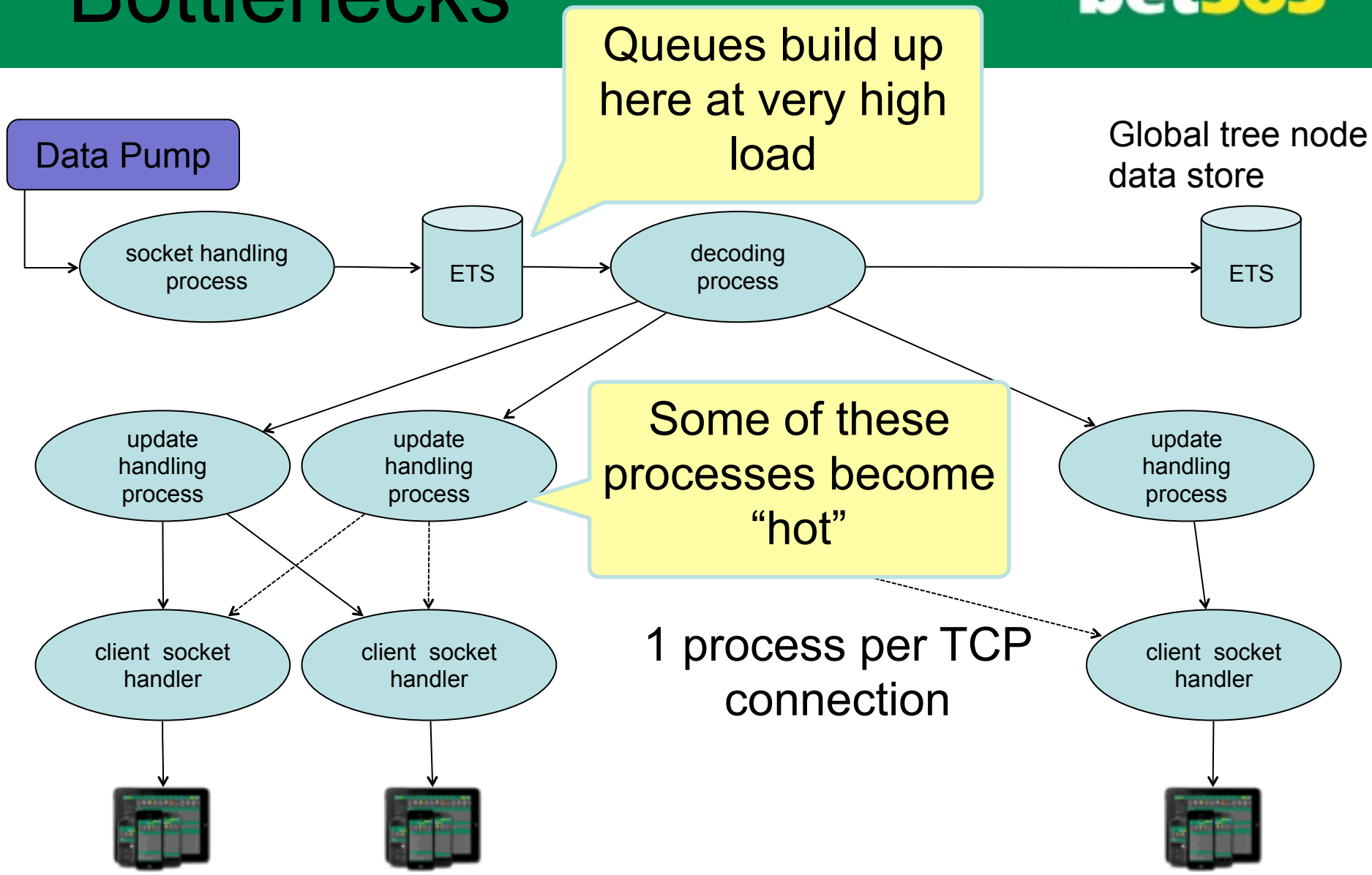

Work in progress

Distributed Data Grid

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- An mnesia like database
- Without the storage backend issues
- And without the “partitioned network” problems with mnesia
- Something similar to Infinispan

Bounded message q

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- Long term itch

- Seems fairly straightforward to achieve
  - Additional option max_msg_q_length in process_flag/2 BIF
  - Modify process_info/2 BIF
  - Kill process if message queue length exceeds configured limit

Deep packet inspection

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- Analyse traffic patterns in real-time
- Proof of concept being worked on using Erlang
- Speed will be an issue here so an interesting challenge

COME WORK WITH US!