Lua as a business logic language in high load application

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IPONWEB

Company background

- Ad industry
- Custom development
- Technical platform with multiple components

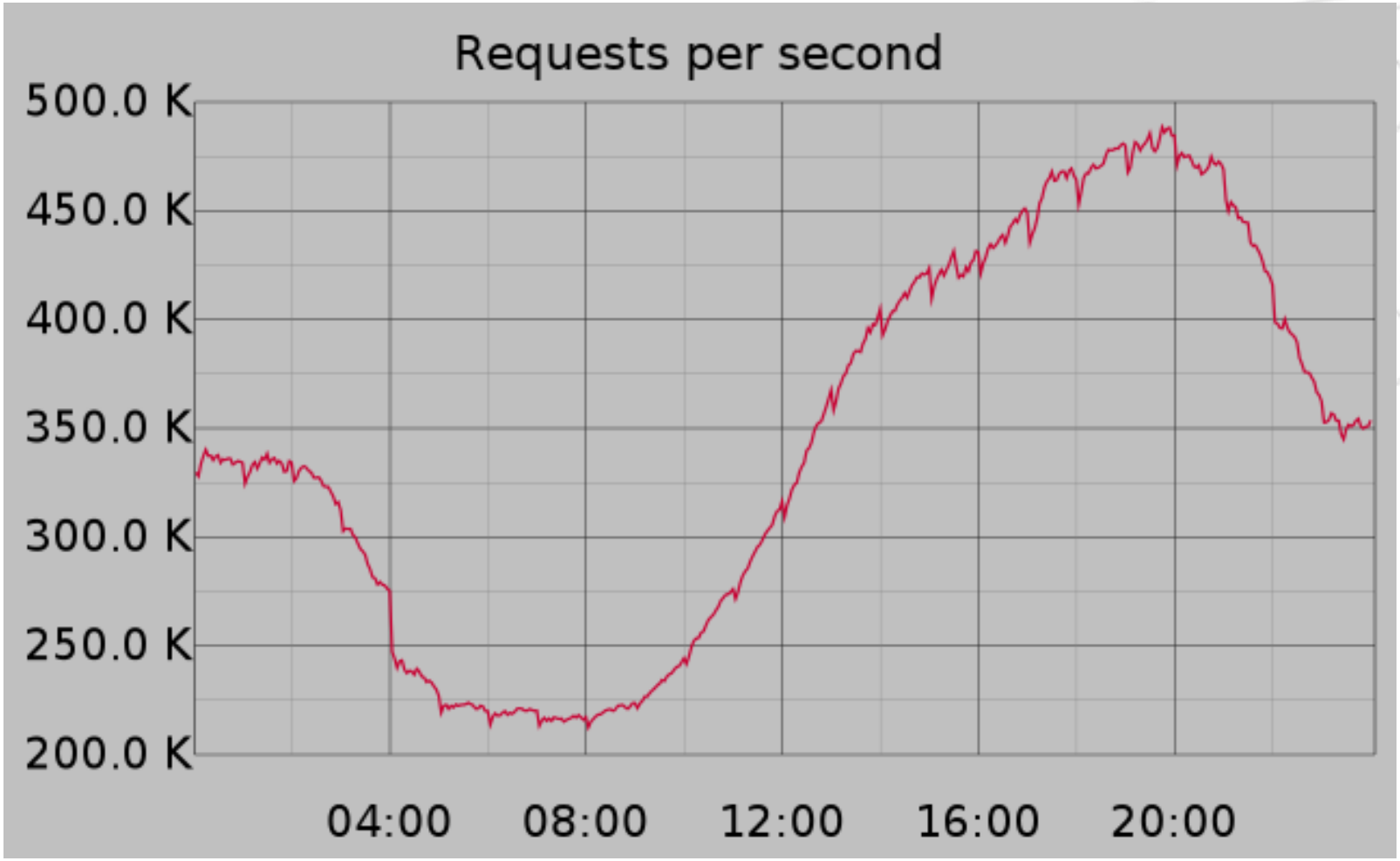
Custom web server

- One of the components of our technology stack
- Written in C++
- Uses Lua as an embeded scripting language

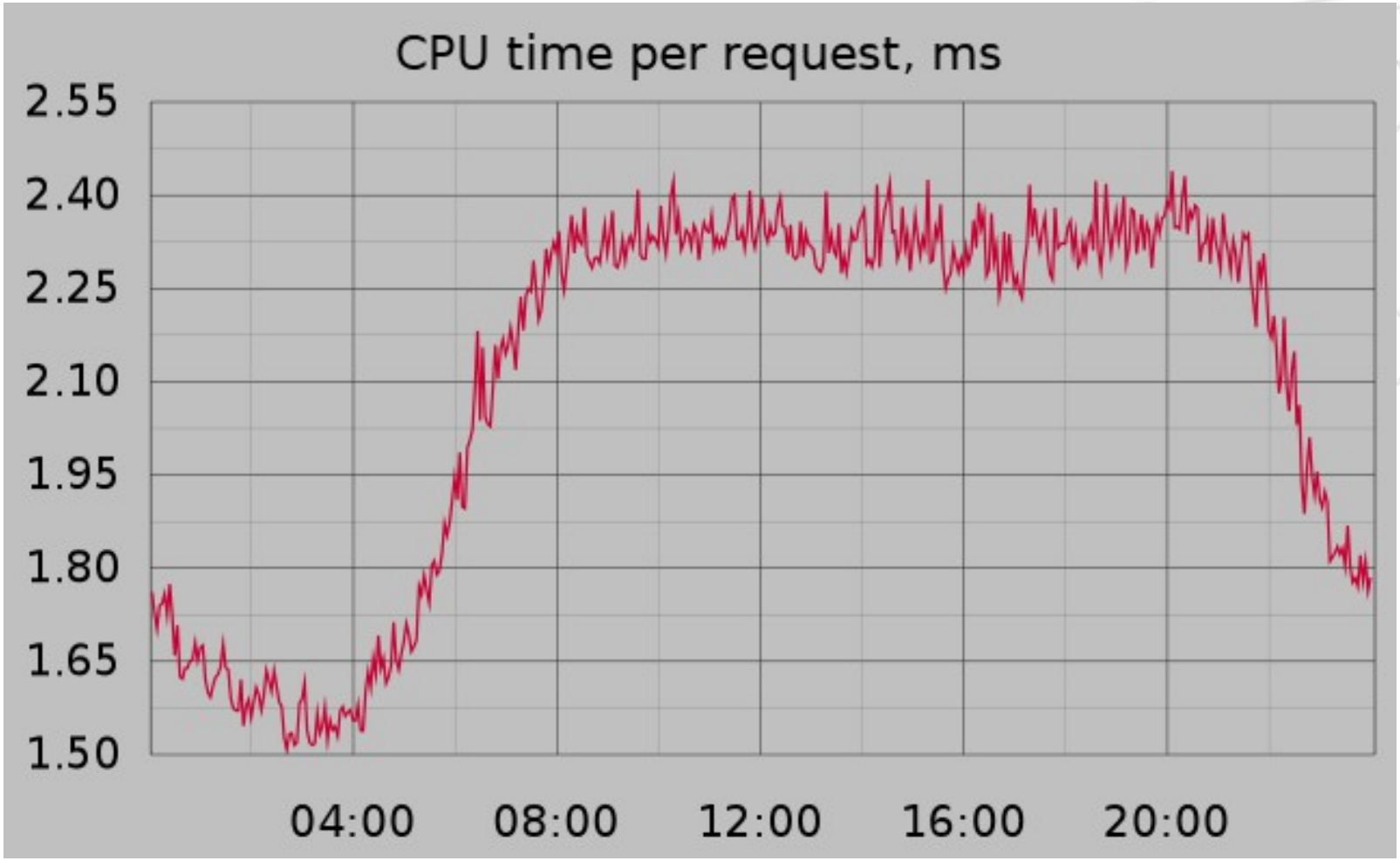
Adserving requirements

- High load
- Complex logic about what ads to show and how to track them
- Hardware is not always cheaper than developer's time

What is high load



What is high load



How do we come to use Lua?

- First version of adserver is pure C++
- Runs fast
- Development is slow

How do we come to use Lua?

- Developers who can write low level code and can write business logic code are rare animals
- Operational costs: there is a better balance between cost to run and cost to develop

How do we come to use Lua?

- Separation of church and state
- C++ for low level and performance critical bits
- Scripting language for business logic

So what do we use as a scripting language?

Why Lua?

- So that I can attend Lua workshop as a speaker!

Why Lua?

Game developers like Lua for good reasons

- Fastest scripting language
- Easiest to embed scripting language
- Simple but expressive
- Can be sandboxed

Why NOT Lua

- Poor libraries (compared to competition)
- But this is NOT as big deal for development in special domain (advertising)

Architecture

Multithreaded C++ server

- Worker thread per CPU core
- One Lua interpreter state per worker

Multithreaded C++ server

- Multiple coroutines in each Lua interpreter state
- New HTTP request → new coroutine in idle Lua interpreter state

Sandbox environment

- Only safe subset of Lua standard library available
- Special high level IO APIs to access external world
- Only allow what is really required

Why coroutines

- Networking IO APIs mean Lua code may wait for responses
- Coroutines can be paused until response so that we can process other requests meanwhile in worker thread

API design

- Hide as much complexity from Lua developers as possible

API design example

- Networking APIs: Allow parallel requests without async or multithreading programming model
- Separate operations to create requests and to wait for results

API design example

HTTP client API example

```
local requests = {}
for _, url in ipairs(urls) do
  local request = http_request({url = url, …})
  table.insert(requests, request)
end
...
local responses = {}
for _, request in ipairs(requests) do
  local response = request.get()
  table.insert(responses, response)
end
```

Business logic

- Select ad creative (banner) to show from all ad campaigns
- Track important evens for ad creative like clicks

Selecting ad creative

- Complex targeting rules
- Ad campaign delivery optimization
- Money calculations

Selecting ad creative

```
local creatives = {}
for _, campaign in ipairs(data.campaigns) do
  if campaign_passes_targeting(campaign, request) then
    for _, creative in ipairs(campaign.creatives) do
      if creative_passes_targeting(creative, request) then
        table.insert(creatives, creative)
      end
    end
  end
end
local winner_creative = run_auction(creatives)
return winner_creative
```

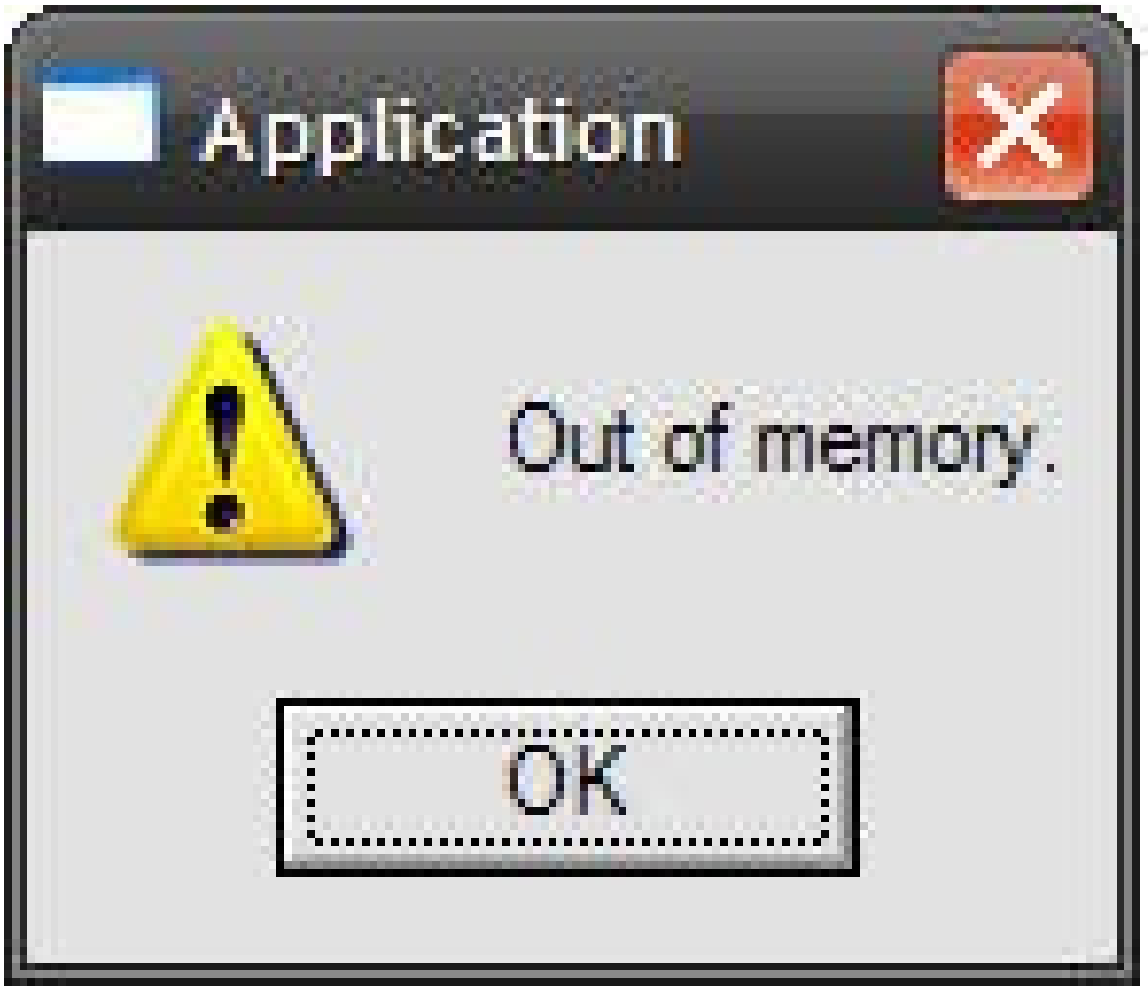
Business data as native Lua data

- Most of data our business logic works with is read-only
- Amount of data required in real-time is relatively low
- Solution: use Lua data structures as in-memory storage

Business data as native Lua data

- Very natural Lua code – it is all just iterations over Lua data structures
- Very fast – you cannot beat in-memory data

Problem with data



Out of memory

- You cannot share Lua data between Lua interpreter states
- More CPU cores → higher memory usage
- Projects became bigger too → more data

Out of memory: LuaJIT

32 bit Linux	32 bit application	3 GB of RAM
64 bit Linux	32 bit application	4 GB of RAM
64 bit Linux	64 bit application	all RAM available but LuaJIT can use only 1GB

Memory problem solution

- Switch to stock Lua?
- Not as fast as LuaJIT
- Fixes immediate problem but with higher memory usage breaks due to GC

Memory problem solution

- Move business data out of Lua
- But we need backward compatibility with existing Lua codebases

Attempt #1: userdata

- userdata + metatables to expose C++ managed data storage as “fake” Lua tables
- Each field access via userdata is C function call → slow compared to native Lua data

Attempt #2: FFI cdata

- FFI – alternative interface to C code from Lua available in LuaJIT
- FFI is designed to be LuaJIT friendly
- cdata is sort of like userdata for FFI – also can use metatables to “fake” Lua tables

How does LuaJIT work?

- Runs parts of your code as interpreted and parts of it as JIT compiled
- As long as hot spots are covered you are good
- If code not written with LuaJIT in mind then most of it will not be compiled

FFI: leap of faith

FFI: leap of faith

	FFI	Lua 1	Lua 2
jit	1.57	1.87	2.00
nojit	55.1	5.05	5.95

3rd party benchmark – source at

https://github.com/client9/ipcat/tree/master/lua

FFI: leap of faith

- If you introduce FFI in your application it will run slower
- Until you manage to get LuaJIT to JIT compile enough parts of it

How to make LuaJIT happy

- Use compilation traces to find why code doesn't compile
- Unfortunately for uninitiated they look like gibberish

Compilation trace

```
---- TRACE 19 start history.lua:307
0001  MOV      4   0
0002  TGETS    3   0   0  ; "parse"
0003  ISTC     5   1
0004  JMP      5 => 0006
0005  KSTR     5   1      ; ""
0006  CALL     3   2   3
0000  . FUNCF   23          ; history.lua:62
0001  . KSHORT   2   1
0002  . KPRI     3   0
0003  . TGETS    4   0   0  ; "fields"
0004  . TNEW     5   0
0005  . KNIL     6   8
0006  . ISF          2
0007  . JMP      9 => 0089
0008  . LOOP     9 => 0089
---- TRACE 19 abort history.lua:72 -- inner loop in root trace
```

LuaJIT challenge

- Requires special low level knowledge to make code run fast
- Sometimes leads to non-intuitive Lua code

LuaJIT quiz

```
return tonumber(var)
```

vs

```
return (tonumber(var))
```

LuaJIT challenge

- Breaks our abstractions – Lua developers forced to work on lower level than normally needed

Wraping up

- Lua: unique challenges
- Lua: despite everything very powerful and successful technology


THE END