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Why Node.js needs an application server

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Hello, I'm **Paolo**!

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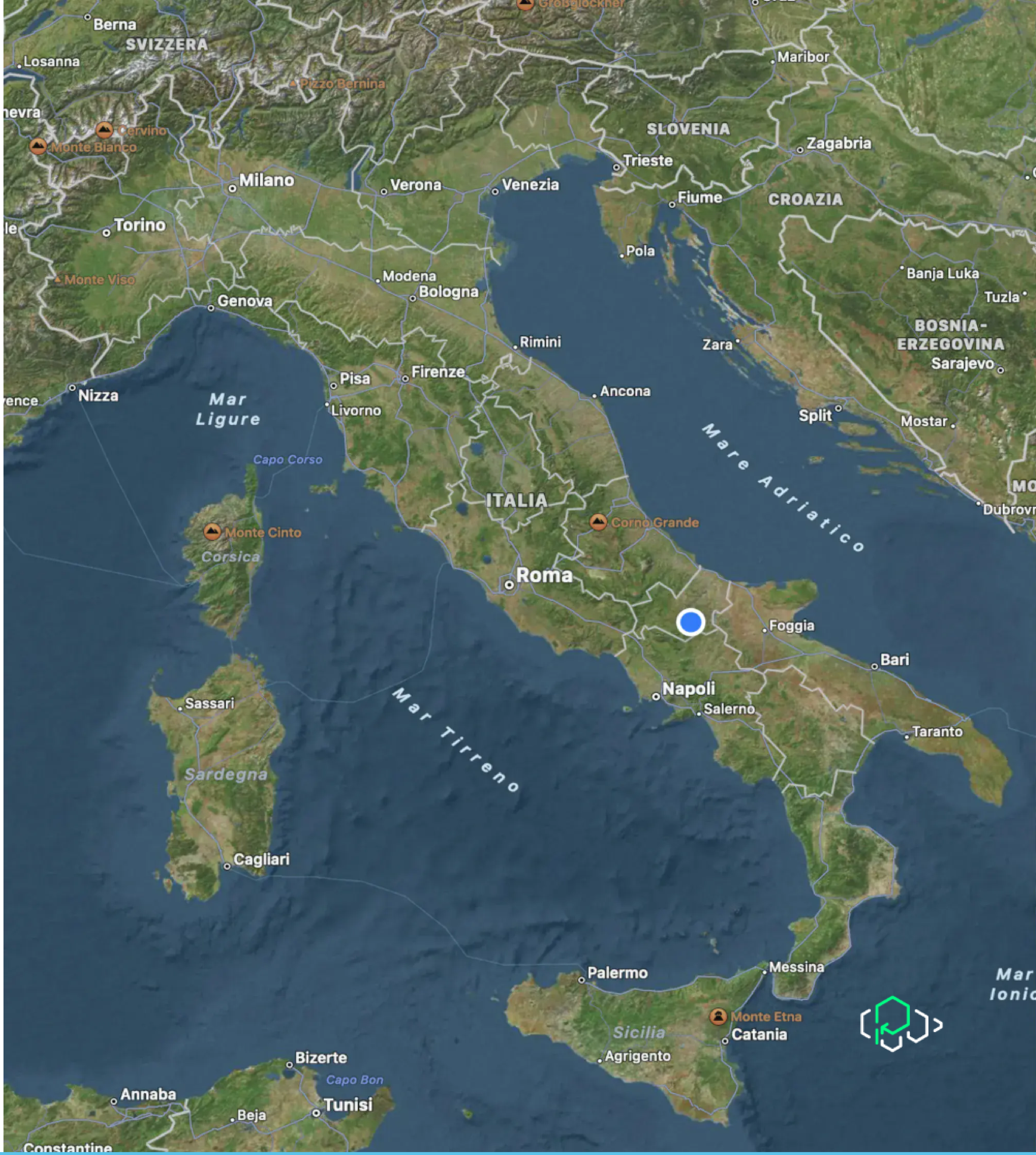


Node.js is everywhere

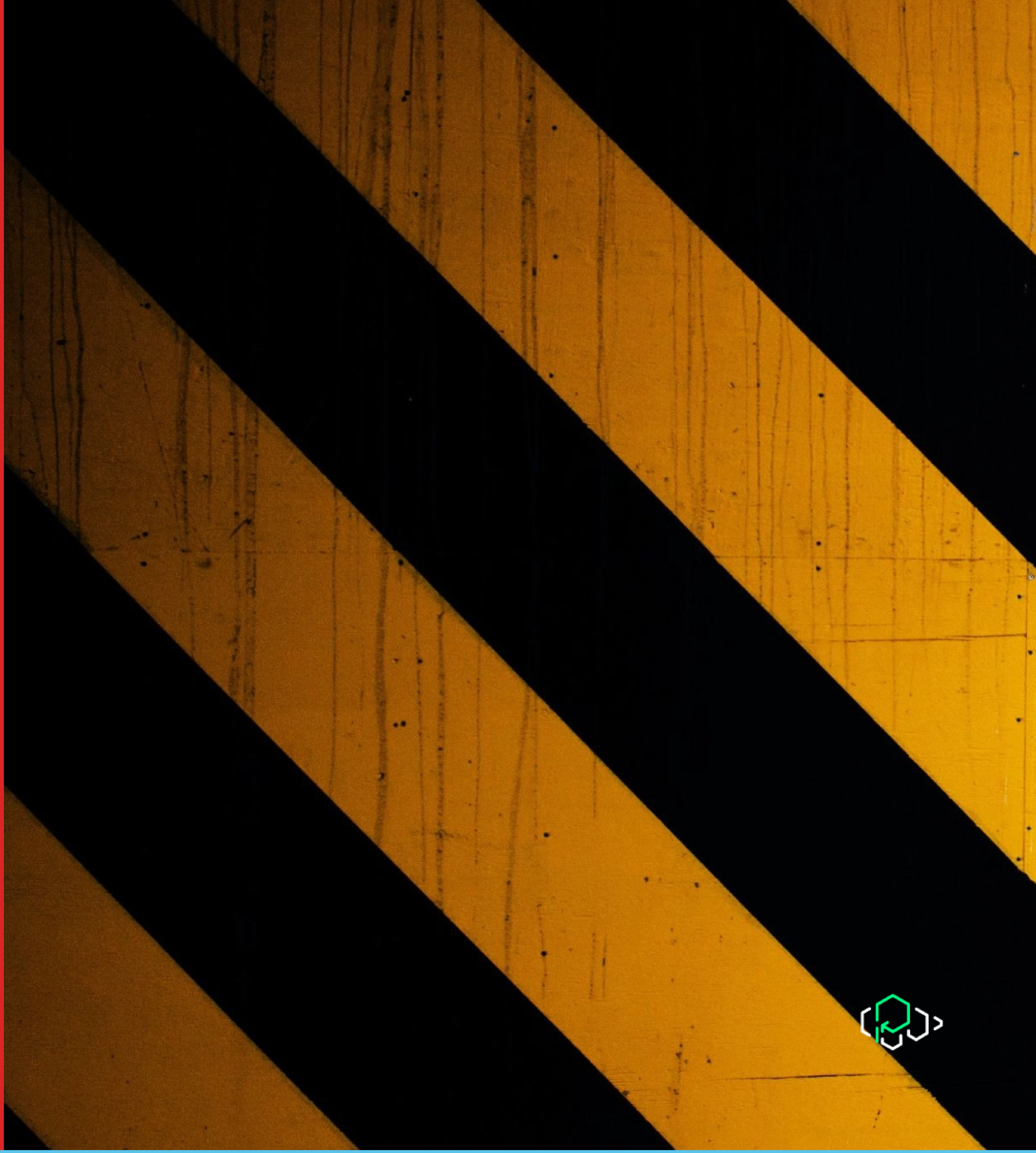
The numbers speak for themselves

2+ billion downloads annually
Node.js is one of the most popular web development tools in the world.

Powers millions of applications
From startups to Fortune 500 companies, Node.js runs critical infrastructure.

Fast and efficient
Built on V8, it delivers excellent performance for I/O-bound applications.

But there's a catch...



Single-threaded by design

One thread per process
By default, it runs JavaScript on a single event loop.

Non-blocking I/O
It's the perfect fit for web servers and APIs.

Limited for CPU-intensive tasks
Heavy computation can block the entire application.

Is this still true?

Did you hide in a cave?

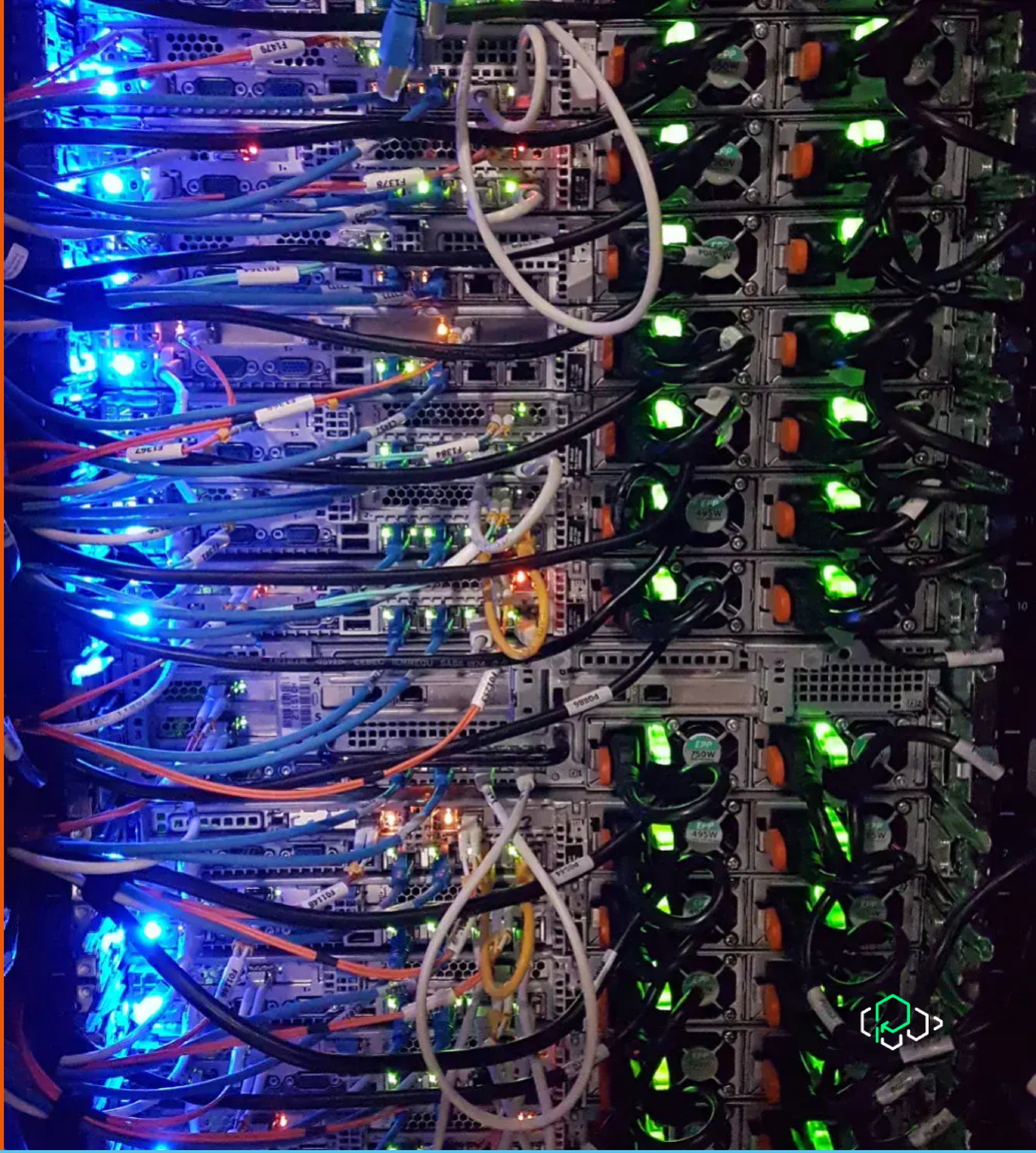
Worker Threads have existed since 2018

Introduced in Node.js 10.5.0
The Worker Threads API was added in June 2018 and has been stable since Node.js 12.

True parallelism
Run JavaScript in multiple threads, each with its own V8 instance and event loop.

Not widely adopted
Way too many applications still don't leverage them, missing out on multi-core performance.

Running Node.js in production



The three pillars

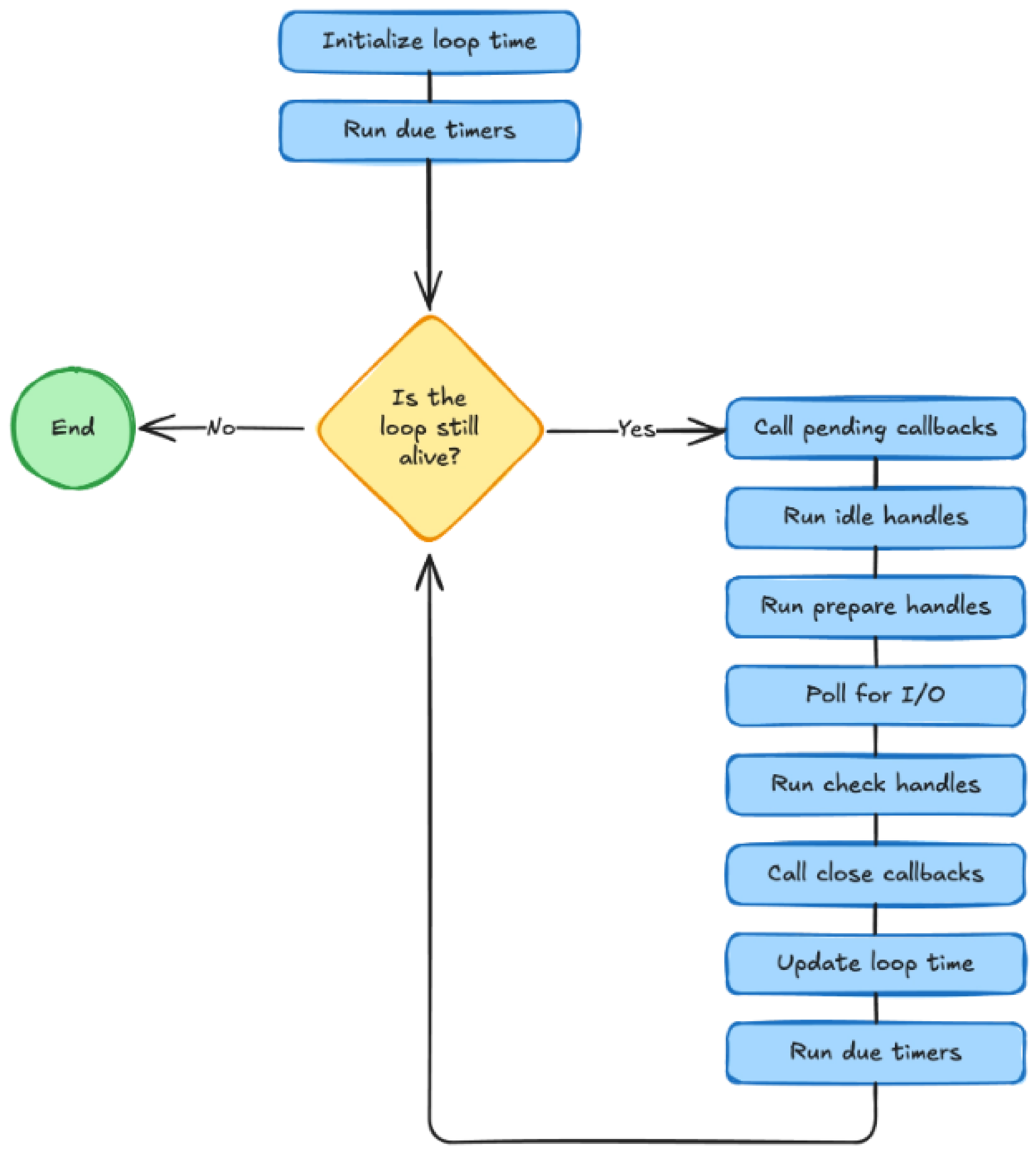
Monitoring
Track application health and detect issues before they become critical.

Metrics
Collect and expose performance data for observability platforms.

Fault tolerance
Handle failures gracefully and recover quickly from errors.

How do we monitor health?

The Node.js event loop



The event loop observation problem

The paradox
A busy event loop
cannot observe itself.

Monitoring gets blocked too
If your application is overloaded,
the monitoring code is also blocked.

Backpressure management loses effectiveness

Resource waste is "suboptimal"
You must set low thresholds
to allow monitoring to run.

Ineffective under load
If the thread is truly stuck,
no monitoring code runs.

We need a better architecture!

Introducing Watt

A Node.js application server, done the right way!

https://www.platformatichq.com/watt

Here's our secret sauce!

Move applications to threads
Each gets its own separate worker thread.

Main thread as coordinator
The main thread manages workers and routes requests.

External observation
The coordinator can monitor worker health from outside.

How does it work?

Main thread (coordinator)
Monitors workers
and handles their lifecycle.

Worker threads
Run applications, report health status,
and support independent restart and scaling.

What about metrics?

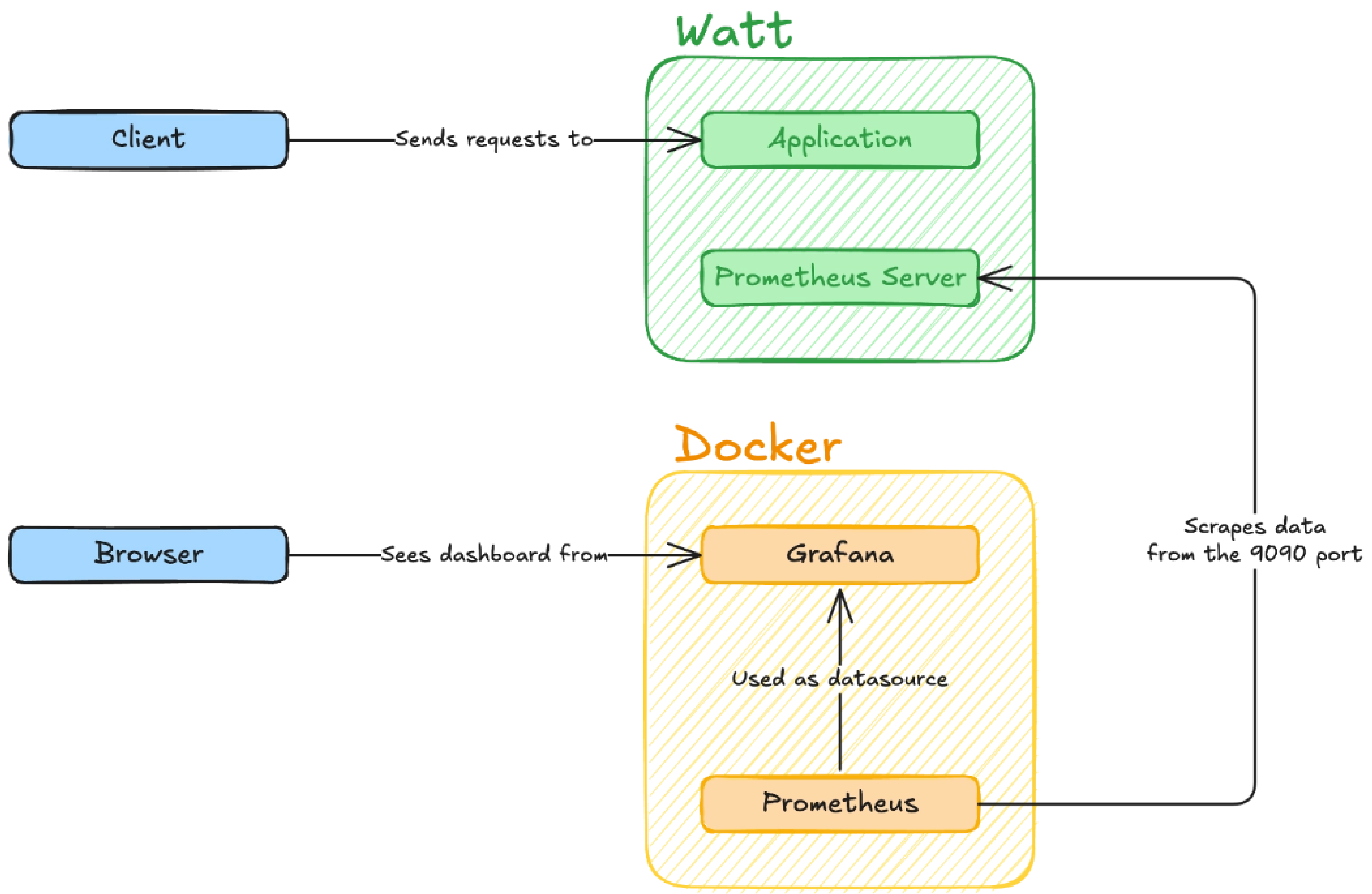
Prometheus server on the main thread

Dedicated metrics server
Prometheus metrics are exposed from the main thread, not from worker threads.

Avoid the paradox
A blocked worker cannot report its own metrics reliably.

Always available
The metrics endpoint always responds, regardless of worker state.

Monitoring architecture



Kubernetes probes benefit too

Reliable readiness probes
Report as ready only when workers are actually available.

Reliable liveness probes
Always respond to liveness checks, even under heavy load.

True health visibility
Kubernetes sees the real application health, not just thread responsiveness.

Handling failures

The traditional single-threaded scenario

Degradation goes unnoticed
Health checks stop responding when the thread is busy, hiding the real problem.

Critical failures are catastrophic
Memory exhaustion, a crash, or an unhandled exception takes down the entire application.

Long recovery time
During process restart, there might be downtime or performance loss due to fewer replicas.

The innovative Watt multi-threaded approach

Let it fail
If a worker thread crashes, restart it immediately.

Proactive approach
If health metrics degrade, terminate and restart the worker.

Replace before restart
Start a new thread before stopping unhealthy ones.

Why is this approach better?

Because I'm telling you!

Don't you just trust me? 😭

Seriously, why is this approach better?

Much faster recovery
Restarting a single thread is orders of magnitude faster than restarting the entire process.

Replace, don't restart
New workers start before unhealthy ones stop, ensuring zero wait time.

No request loss
Traffic seamlessly shifts to healthy workers with no dropped connections or failed requests.

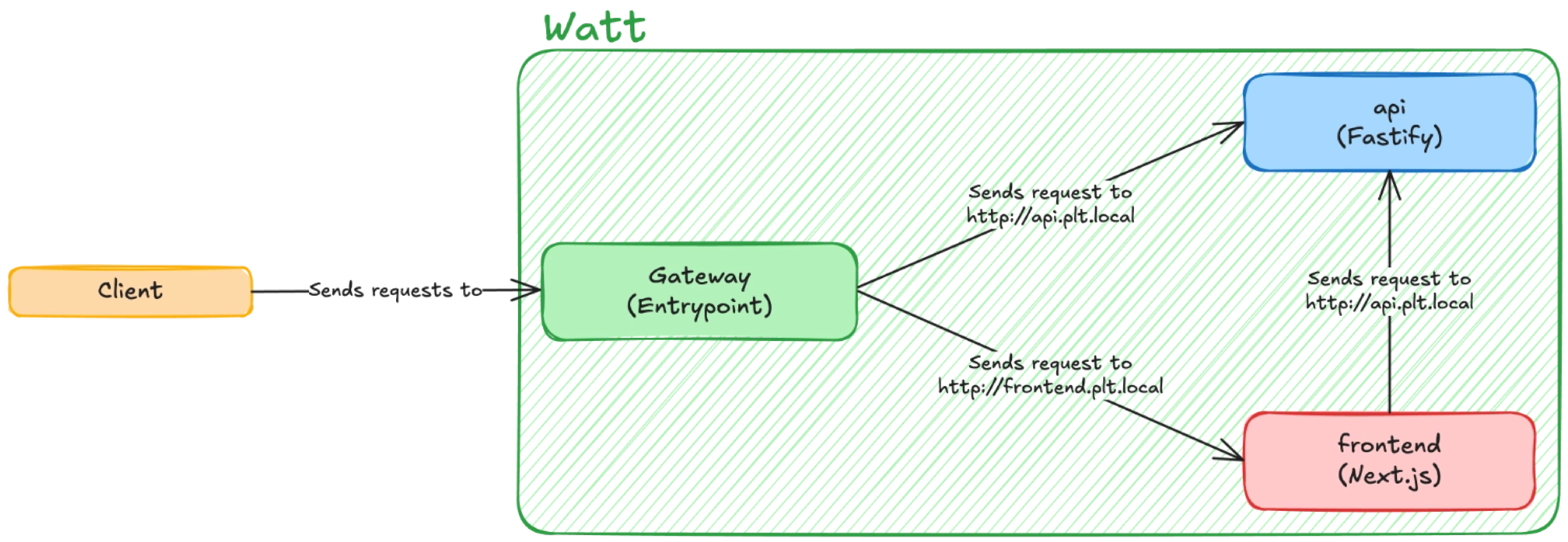
Not convinced yet?

Multiple applications, one process

Run multiple applications
They all run in the same Node.js process, each isolated in its own worker thread.

Independent scaling
Scale each application independently based on its own load and resource requirements.

Watt in action: the mesh network


Watt
Client
Sends requests to
Gateway (Entrypoint)
Sends request to http://api.plt.local
Sends request to http://frontend.plt.local
api (Fastify)
Sends request to http://api.plt.local
frontend (Next.js)

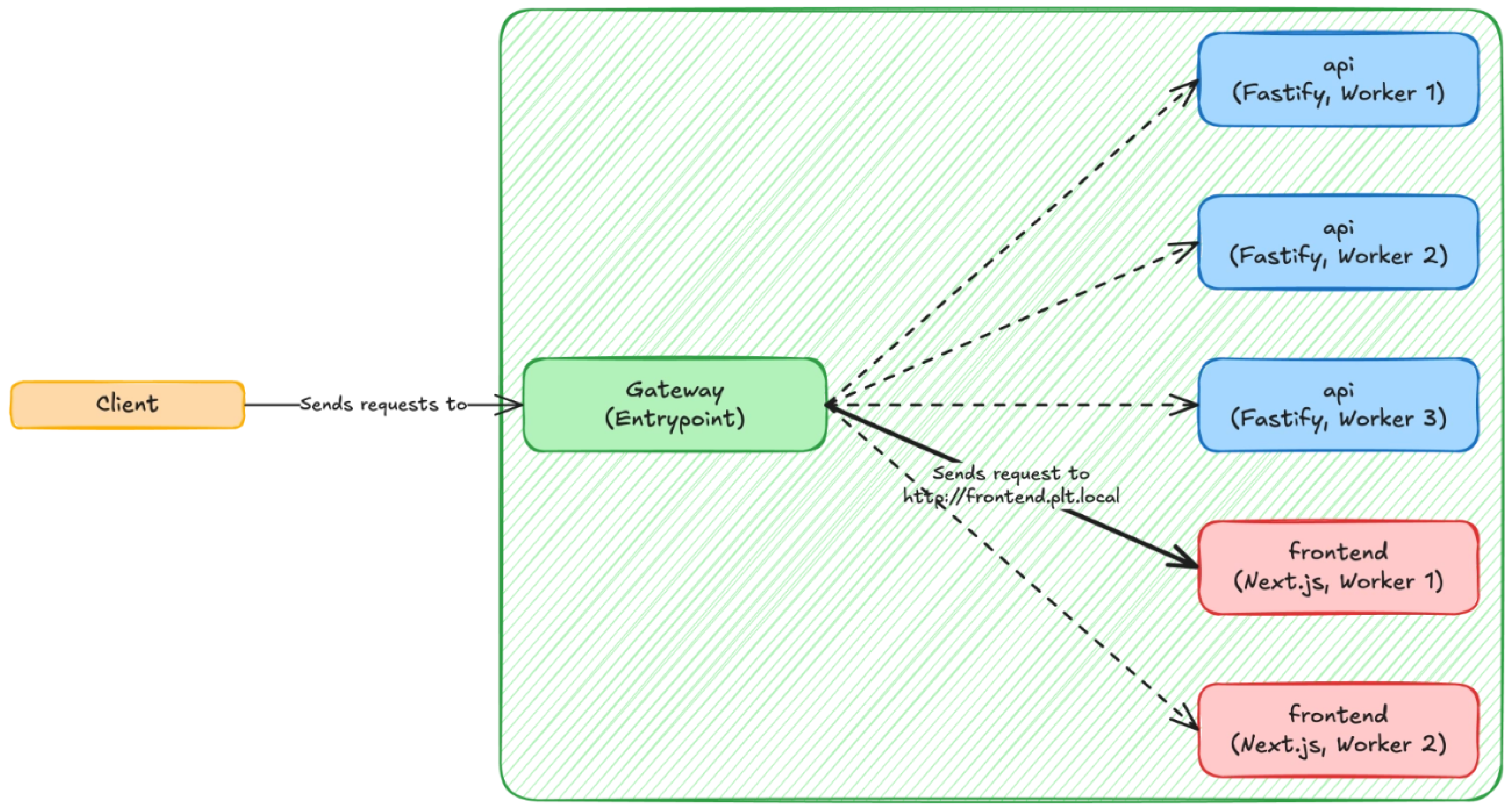
Intelligent dynamic in-process scaling

Use all available cores
Spawn workers to match available CPU cores.

Dynamic worker count
Scale workers up or down dynamically based on load and performance.

Better resource utilization
Get more from your existing infrastructure before scaling horizontally.

Watt in action: multiple workers



Dynamic applications

Hot-swap made easy
Add or remove applications from a running process with zero downtime.

Movable and flexible
Redistribute applications for load balancing or resource optimization without interruption.

Please, just let me go!

I promise I understood everything! 🙏

Take-home lessons

The monitoring paradox
Self-monitoring on a single thread is fundamentally flawed.

Separation of concerns
Application logic, coordination, and monitoring should be isolated.

Let it fail
Fast restarts are better than trying to recover unhealthy processes.

One last thing™

"Success is often achieved by those who don't know that failure is inevitable."

Coco Chanel

Thank you!

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