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Where's the "Auto" in Auto-Instrumentation?

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Questions about Auto-Instrumentation

Do I need to modify my application code?

Do I need to use specific libraries?

Will it work without Kubernetes?

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It depends…

01 — What are we trying to do with instrumentation?
What is “auto-instrumentation”?
Hint: there is more than one right answer

02 — Different kinds of auto-instrumentation
The Kubernetes Operator

03 — When is Auto-Instrumentation not enough?

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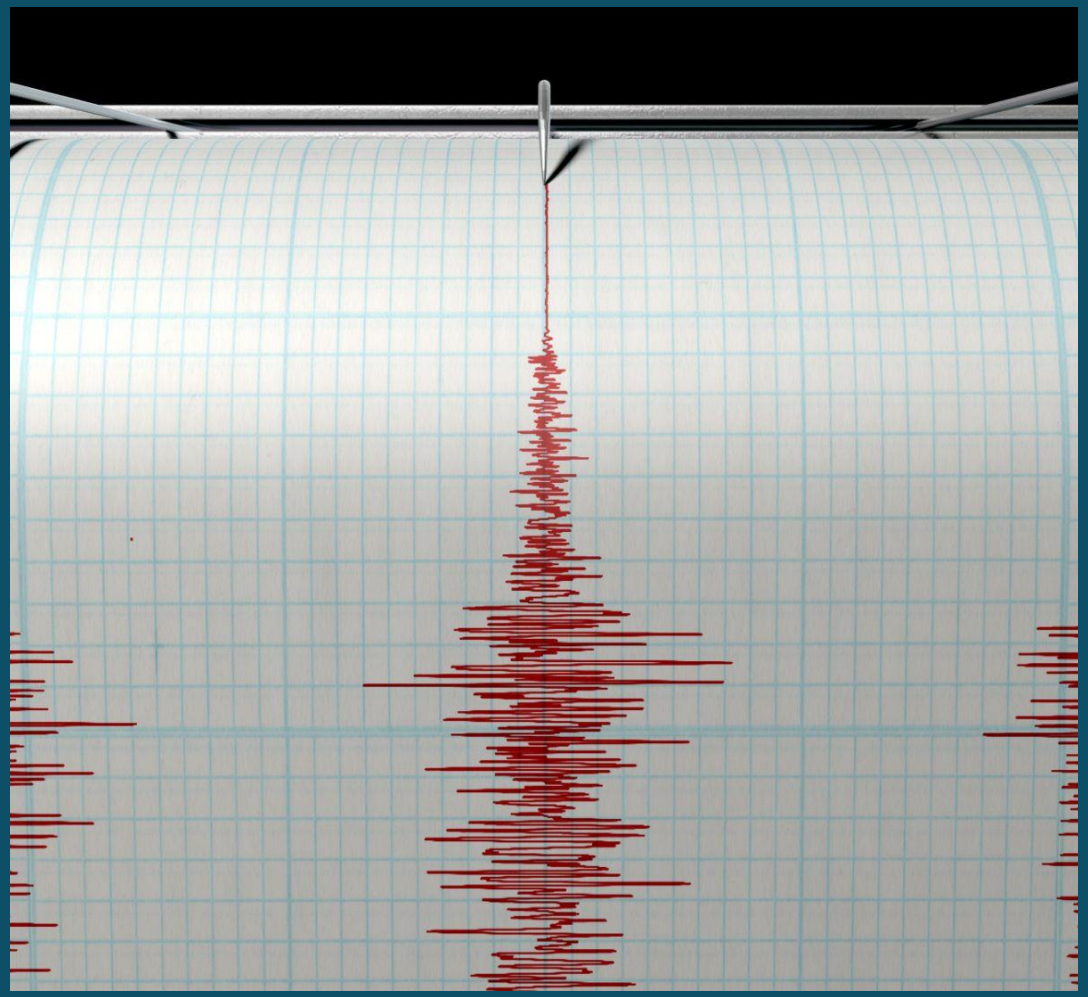
Instrumentation is the process of translating *interesting things* into telemetry signals



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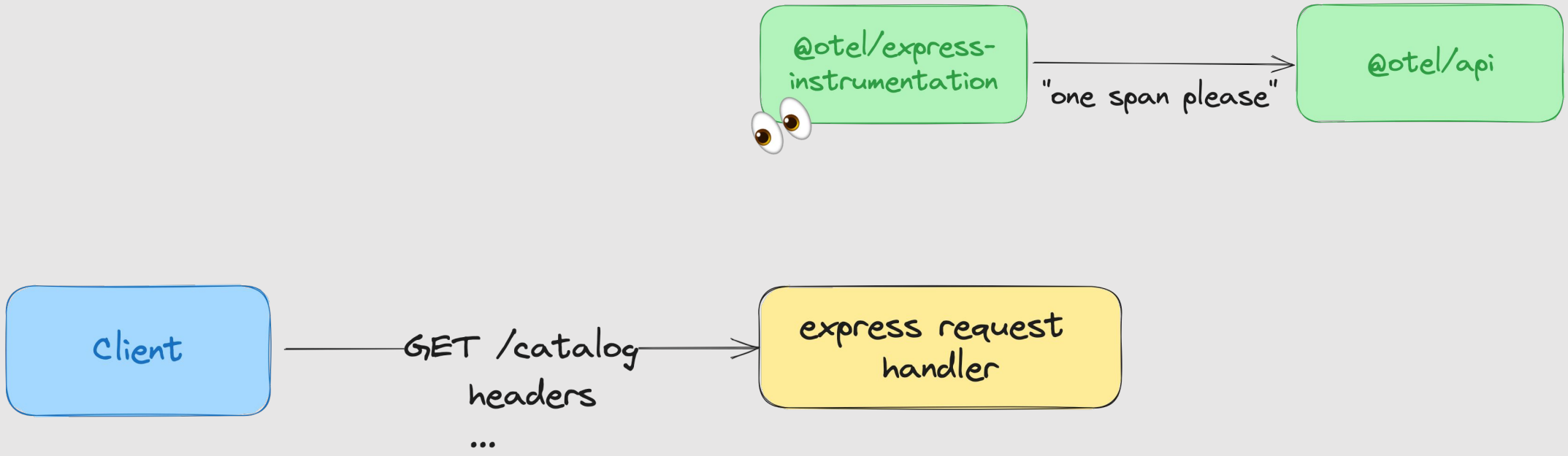

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Interesting events

Requests,
Queries,
& Messages

Errors,
Exceptions,
& Events

Function Calls
(with arguments)

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Contextualizing metadata

User Context

Who are they and what are they trying to do?

Infrastructure Context

What is the state of the resources?

Organizational Context

Who is responsible?

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```
// Copyright The OpenTelemetry Authors
// SPDX-License-Identifier: Apache-2.0

const opentelemetry = require('@opentelemetry/sdk-node');
const {getNodeAutoInstrumentations} = require('@opentelemetry/auto-instrumentations-node');
const {OTLPTraceExporter} = require('@opentelemetry/exporter-trace-otlp-grpc');
const {OTLPMetricExporter} = require('@opentelemetry/exporter-metrics-otlp-grpc');
const {PeriodicExportingMetricReader} = require('@opentelemetry/sdk-metrics');
...

const sdk = new opentelemetry.NodeSDK({
  traceExporter: new OTLPTraceExporter(),
  instrumentations: [
    getNodeAutoInstrumentations(...)
  ],
  metricReader: new PeriodicExportingMetricReader({
    exporter: new OTLPMetricExporter(),
  }),
  resourceDetectors: [
    ...
  ],
});

sdk.start();
```

Instrumentation in OpenTelemetry

- OpenTelemetry SDK
- OpenTelemetry API
- Instrumentation Libraries

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    exporter: new OTLPMetricExporter(),
  }),
  resourceDetectors: [
    ...
  ],
});

sdk.start();
```

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… Isn't that Auto-Instrumentation?

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Instrumentation Libraries *target specific libraries* and modify them (or observe them) to call the OTel APIs, creating telemetry

opentelemetry-instrumentation-bunyan	chore: release main (#2497)
opentelemetry-instrumentation-cassandra	chore: release main (#2497)
opentelemetry-instrumentation-connect	chore: release main (#2497)
opentelemetry-instrumentation-dns	chore: release main (#2497)
opentelemetry-instrumentation-express	chore: release main (#2497)
opentelemetry-instrumentation-fastify	chore: release main (#2497)
opentelemetry-instrumentation-generic-p...	chore: release main (#2497)
opentelemetry-instrumentation-graphql	chore: release main (#2497)
opentelemetry-instrumentation-hapi	chore: release main (#2497)
opentelemetry-instrumentation-ioredis	chore: release main (#2497)
opentelemetry-instrumentation-knex	chore: release main (#2497)
opentelemetry-instrumentation-koa	chore: release main (#2497)
opentelemetry-instrumentation-memcached	chore: release main (#2497)
opentelemetry-instrumentation-mongodb	chore: release main (#2497)
opentelemetry-instrumentation-mysql	chore: release main (#2497)
opentelemetry-instrumentation-mysql2	chore: release main (#2497)

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What is Auto-Instrumentation?

"Auto-Instrumentation" Meta Packages

Packages that can be configured to automatically include relevant instrumentation libraries based on the presence of other libraries.

No-Code Instrumentation Agents + Extensions

Mechanisms for adding instrumentation to an application package after it has already been compiled or bundled.

Instrumentation-Injection (w/ Kubernetes Operator)

The Kubernetes Operator can automatically inject no-code instrumentation into matching workloads.

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Mechanisms

Code-based Library-Instrumentation

Observe other modules in the same process without directly modifying their source, and emit telemetry*

No-Code Instrumentation

Modify or observe another program (binary, bytecode, etc.) and emit telemetry*

Code-based Library-instrumentation
Monkey Patching
Function Wrapping
Middleware Injection
Event Observation

No-Code Instrumentation Mechanisms
Monkey Patching (JS, Python)
Runtime Agent (Java, .NET)
Interpreter Extension (PHP)
eBPF (Go)

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Monkey Patching

```
new InstrumentationNodeModuleDefinition(
    'express',
    ['>=4.0.0 <5'],
    moduleExports => {
      const routerProto = moduleExports.Router as unknown as express.Router;
      // patch express.Router.route
      if (isWrapped(routerProto.route)) {
       this._unwrap(routerProto, 'route');
      }
      this._wrap(routerProto, 'route', this._getRoutePatch());
      ...
      return moduleExports;
    },
    moduleExports => {
      if (moduleExports === undefined) return;
      const routerProto = moduleExports.Router as unknown as express.Router;
      this._unwrap(routerProto, 'route');
      this._unwrap(routerProto, 'use');
      this._unwrap(moduleExports.application, 'use');
    }
  ),
];
```

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Function Wrapping

```php
private static function _hook(..., ?string $class, string $function, string $name, int $spanKind = SpanKind::KIND_SERVER): void
{
    hook(
        class: $class,
        function: $function,
        pre: static function ($object, ?array $params, ?string $class, ?string $function, ?string $filename, ?int $lineno) use ($instrumentation, $name, $spanKind) {
            $span = self::builder($instrumentation, $name, $function, $class, $filename, $lineno)
                ->setSpanKind($spanKind)
                ->startSpan();
            Context::storage()->attach($span->storeInContext(Context::getCurrent()));
        },
        post: static function ($object, ?array $params, mixed $return, ?Throwable $exception) {
            self::end($exception);
        }
    );
}
```

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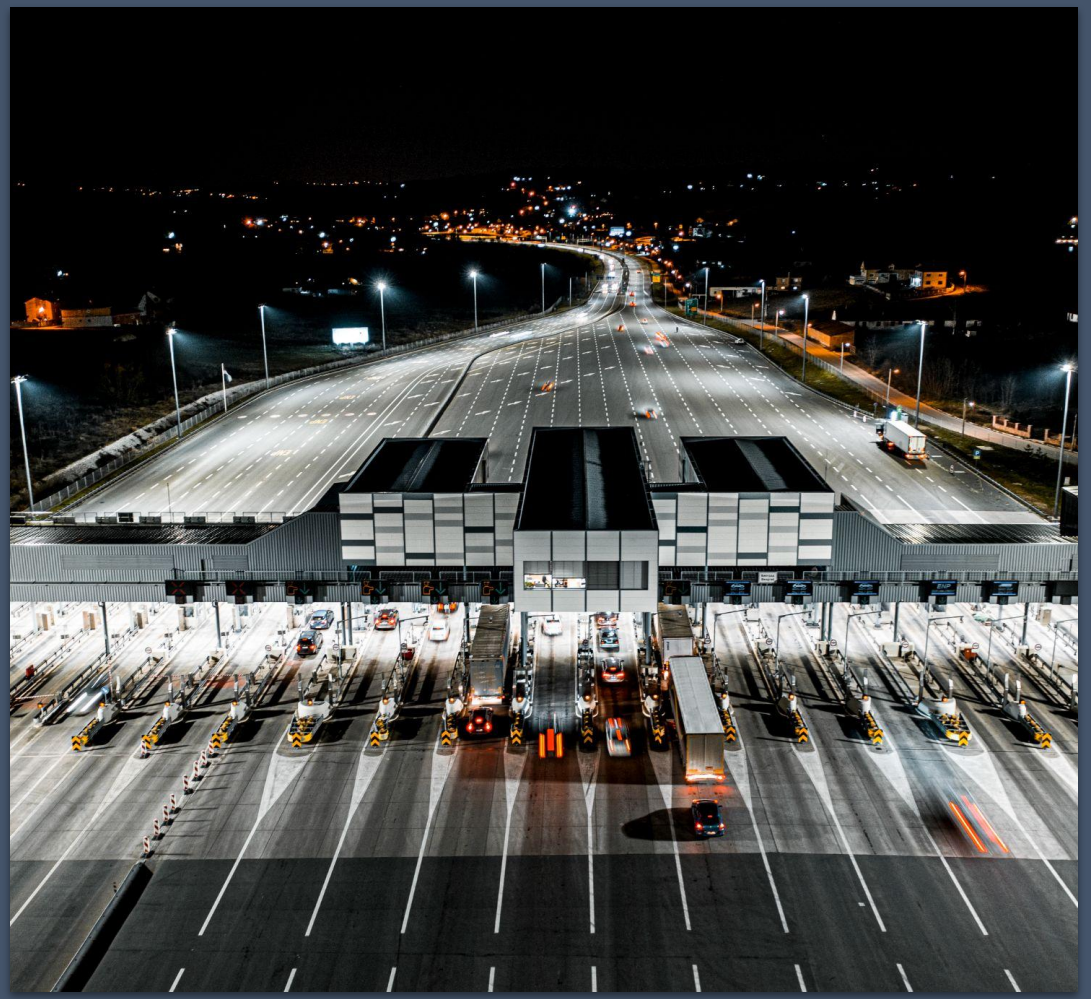
Middleware Injection



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Event Observation

```elixir
@doc false
def attach_router_start_handler(_opts) do
  :telemetry.attach(
    {__MODULE__, :router_dispatch_start},
    [:phoenix, :router_dispatch, :start],
    &__MODULE__.handle_router_dispatch_start/4,
    %{}
  )
end
```

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No-Code Instrumentation Mechanisms

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	Instrumentation Libraries	No-Code Instrumentation	Mechanism
Java	✅	✅	Java Agent + Bytecode Injection
Python	✅	✅	Python Agent + Monkey patching
JavaScript	✅	✅	Monkey patching
.NET	✅	✅	.NET Profiler + Bytecode Injection
Go	✅	✅*	eBPF
PHP	✅	✅	Interpreter Extension + Autoloading
Erlang / Elixir	✅		
Ruby	✅		

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Bytecode Injection

Runtime agents can inject OpenTelemetry SDKs and library instrumentation at the bytecode level.

Functions can also be wrapped and/or monkey patched.

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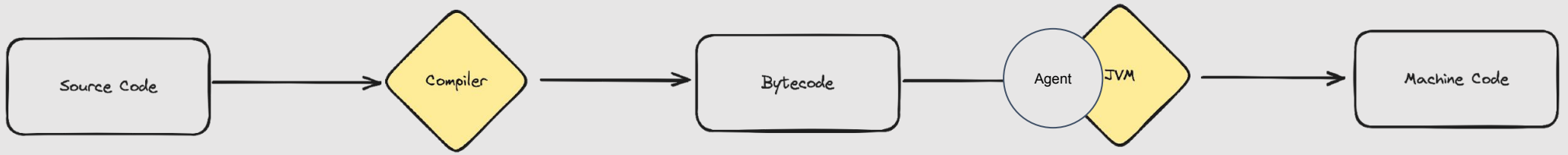

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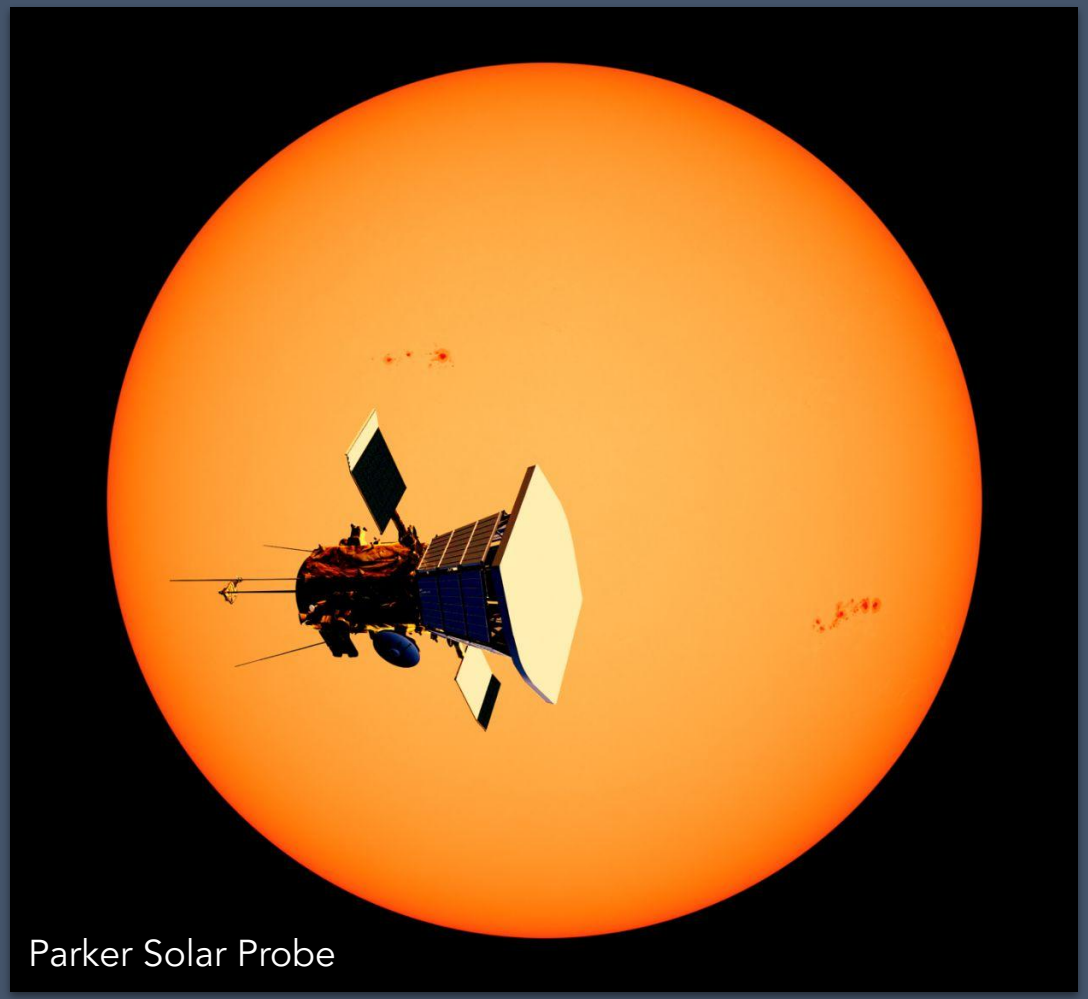
eBPF

Compiled binaries can't be modified with instrumentation.

eBPF + uProbes offer visibility.



Parker Solar Probe

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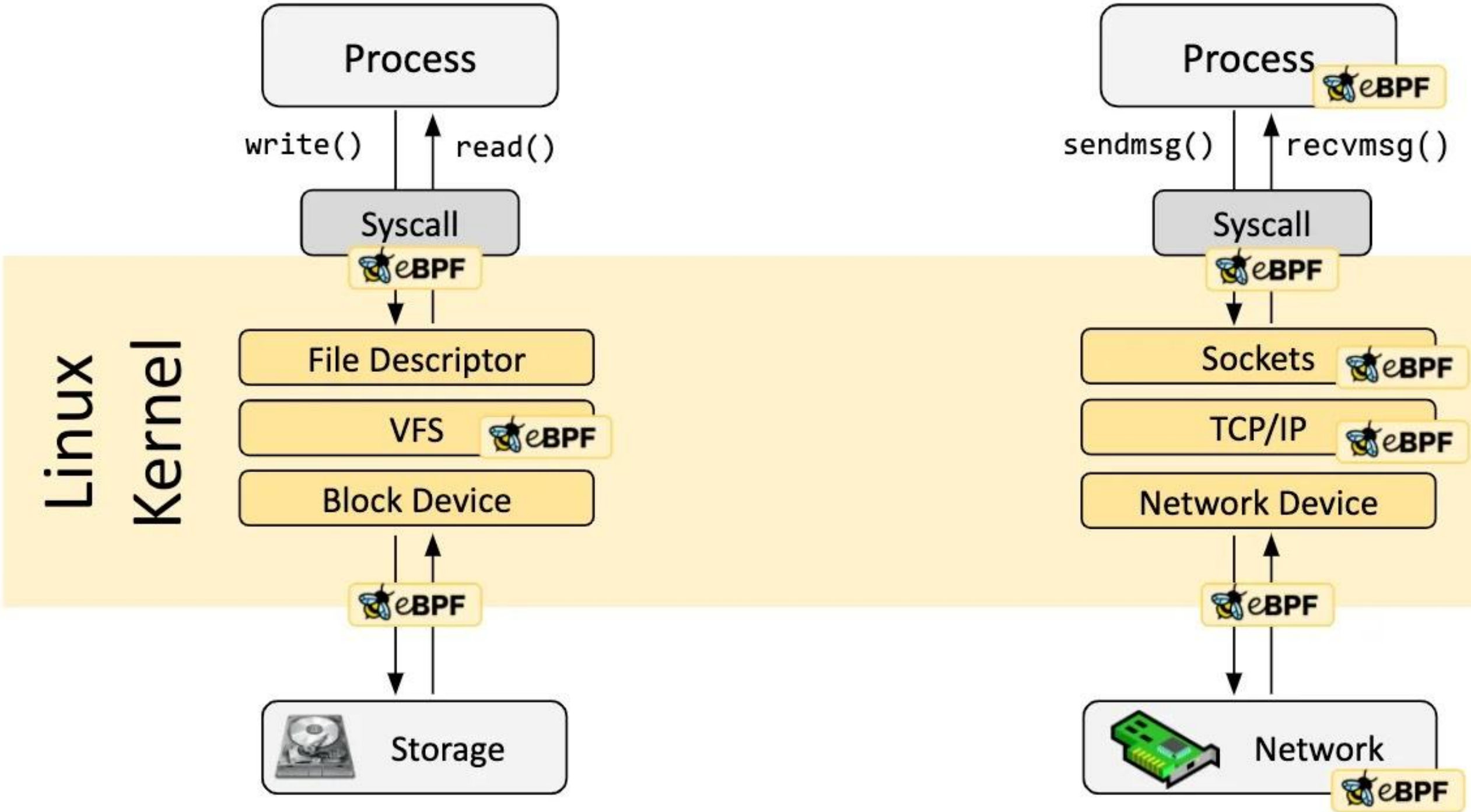
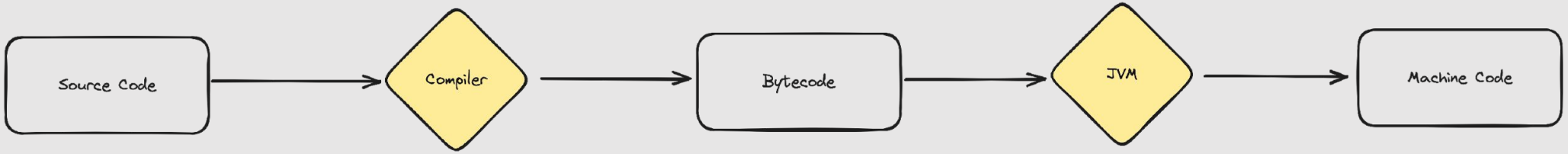

Process
write()
read()
Syscall
eBPF
File Descriptor
VFS
eBPF
Block Device
eBPF
Storage
Linux
Kernel
Process
eBPF
sendmsg()
recvmsg()
Syscall
eBPF
Sockets
eBPF
TCP/IP
eBPF
Network Device
eBPF
Network
eBPF



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Injecting Instrumentation

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Kubernetes Operator

```
kubectl apply -f - <<EOF
apiVersion: opentelemetry.io/v1alpha1
kind: Instrumentation
metadata:
  name: demo-instrumentation
spec:
  exporter:
    endpoint: http://demo-collector:4318
  propagators:
    - tracecontext
    - baggage
  sampler:
    type: parentbased_traceidratio
    argument: "1"
EOF
```

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What have we learned?

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Questions about Auto-Instrumentation

Do I need to modify my application code?

Do I need to use specific libraries?

Will it work without Kubernetes?

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When is Auto-instrumentation *not enough*

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Essential Custom Spans

"Stack" trace information

Incompatible frameworks or libraries

Especially for monolithic services

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Essential Manual Annotation

User Experience & Client Details

Details about the user (who they are or what they are trying to do) from the Application or Client contexts.

Business Metrics & Dimensions

Runtime details about business operations (e.g. regions, departments, revenue, cost)

Team / Business Unit Ownership

Especially if it isn't defined by infrastructure context.

Extra useful in monolith-like services.

Incompatible or Bespoke System Architecture

Heavy use of non-HTTP messaging, IPC, RPC *

Compiled languages (besides Go)

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When is Auto-Instrumentation *awesome*

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When is Auto-Instrumentation *awesome*

Combined with Manual Annotation

Reduce toil with a consistent starting point for customization

Fill Gaps in E2E Distributed Tracing

Legacy services

Skill-gap on central observability team

Quickly Understand System Topology

Complete tracing can reveal architecture details

Cannot modify original source code

Auto-instrumentation is the only option here

Off-the-shelf OSS components can be deployed as-is

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Include Auto-Instrumentation *early**

* especially for http-based apps

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Thank You

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OTel Observatory

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