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Největší česko-slovenská

konference o IT

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Logování, metriky a tracing v .NET s OpenTelemetry v 2025

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What's Wrong with Observability?

- Vendor lock-in
  - Proprietary tools and instrumentation libraries
  - Switching is expensive and painful
  - Every tool requires custom SDKs and configuration
- Tools fragmentation
  - Different tools, formats, protocols → no standardization
- Lack of clear best practices
  - No clear guidelines → Every team does observability differently
  - Inconsistent telemetry data structure

What is OpenTelemetry?

- Semantic rules – naming (log severity, exporters, etc.)
- Protocol – serialization and transport
- APIs & SDKs – C++, .NET, Go, Java, PHP, Python, Rust, Swift, JavaScript, …
- OpenTelemetry Collector – receive, process and export telemetry data
- Massive industry support – https://opentelemetry.io/ecosystem/vendors/

OpenTelemetry Protocol (OTLP)

- OTLP/gRPC (Protobuf) or OTLP/HTTP (Protobuf or JSON)
- Protocol specs and protobuf definitions at https://github.com/open-telemetry/opentelemetry-proto
- Defines services:
  - Logs collector
  - Metrics collector
  - Trace collector

OpenTelemetry Protocol (OTLP) Design Goals

- All signal types over single protocol
- For instrumented apps, telemetry backends and proxies
- Reliable, low CPU and memory usage
- High throughput, backpressure signalling
- Load-balancer friendly

.NET Aspire Dashboard

- Part of the .NET Aspire project
- Receives OpenTelemetry data via the OTLP protocol
- Has a standalone mode

DEMO

Examples of Backends Supporting OpenTelemetry Protocol (OTLP)

OpenTelemetry Signals

- Logs
- Tracing
- Metrics

Observability Signals – Logs

```
03 Mar 2024 17:21:29.094 OTelDemo.Web Privacy page visited
03 Mar 2024 17:21:28.550 OTelDemo.Web Executed DbCommand (1ms) [Parameters=[], CommandType='Text', CommandTimeout='30'] SEL...
03 Mar 2024 17:21:28.550 OTelDemo.Web received-first-response
03 Mar 2024 17:21:28.548 OTelDemo.Web End processing HTTP request after 64.2179ms - 200
03 Mar 2024 17:21:28.548 OTelDemo.Web Received HTTP response headers after 64.0337ms - 200
03 Mar 2024 17:21:28.537 OtelDemo.Backend Got weather forecast
03 Mar 2024 17:21:28.484 OTelDemo.Web Sending HTTP request GET http://localhost:4006/WeatherForecast
03 Mar 2024 17:21:28.484 OTelDemo.Web Start processing HTTP request GET http://localhost:4006/WeatherForecast
03 Mar 2024 17:21:28.484 OTelDemo.Web Done
03 Mar 2024 17:21:28.477 OtelDemo.Backend Getting weather forecast
03 Mar 2024 17:21:28.437 OTelDemo.Web Part way there
03 Mar 2024 17:21:28.381 OTelDemo.Web Index page visited
```

OpenTelemetry Log Record

- Timespan → When?
- Resource attributes → Who?
- Tracing → Trace Id, Span Id
- Severity → Trace, Debug, Info, Warn, Error, Fatal
- Structured Content → `"Order 32 has been Delivered"`

```
Message = "Order {OrderId} has been {State}"
OrderId = "32"
State   = "Delivered"
```

- Additional Attributes → Scope, Client IP, Identity, …

Resource represents the **entity** producing **telemetry**.

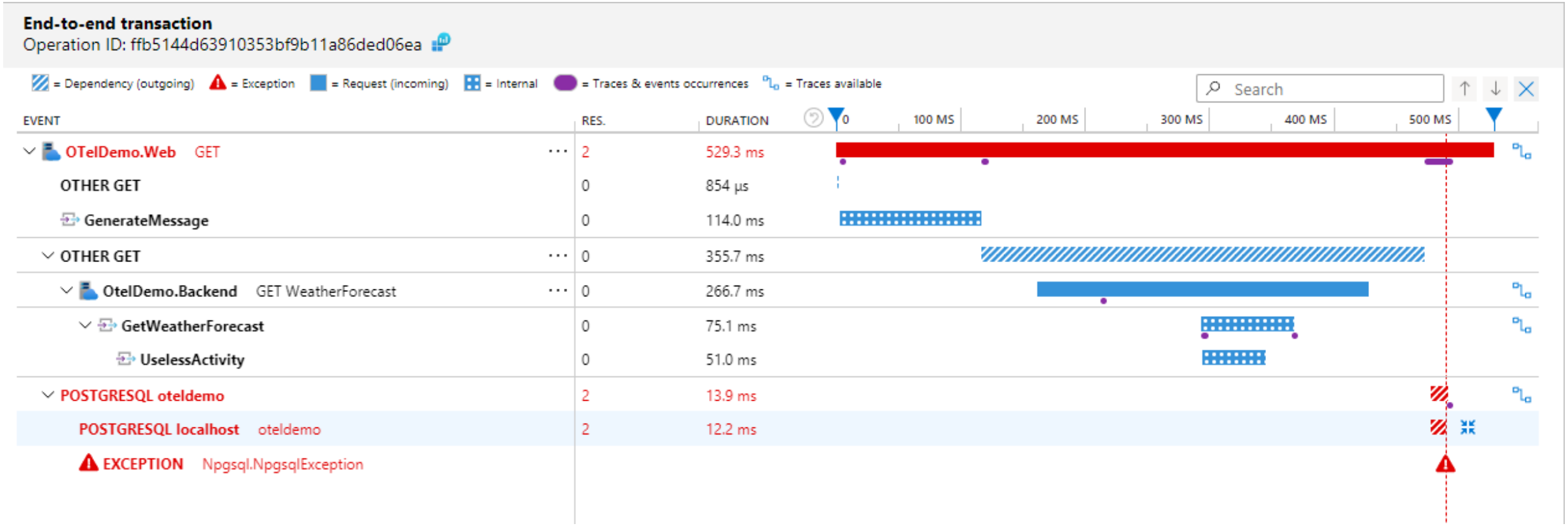
- Windows IIS AppPool
- Process inside Kubernetes pod
- Linux daemon
- …

- Logs
- Metrics
- Tracing

Resource Attributes – Examples

```
service.name=ShoppingCart
service.instance.id=627cc493-f310-47de-96bd-71410b7dec09
service.version=3.4.5; a01dbef8a
deployment.environment.name=staging
…
telemetry.sdk.language=dotnet
telemetry.sdk.name=opentelemetry
telemetry.sdk.version=1.2.3
…
process.pid=1234
process.executable.path=D:\apps\ShoppingCart\ShoppingCart.exe
os.type=windows
cloud.platform=azure_container_apps
k8s.pod.name=kubernetes-pod-name
…
```

Observability Signals – Tracing



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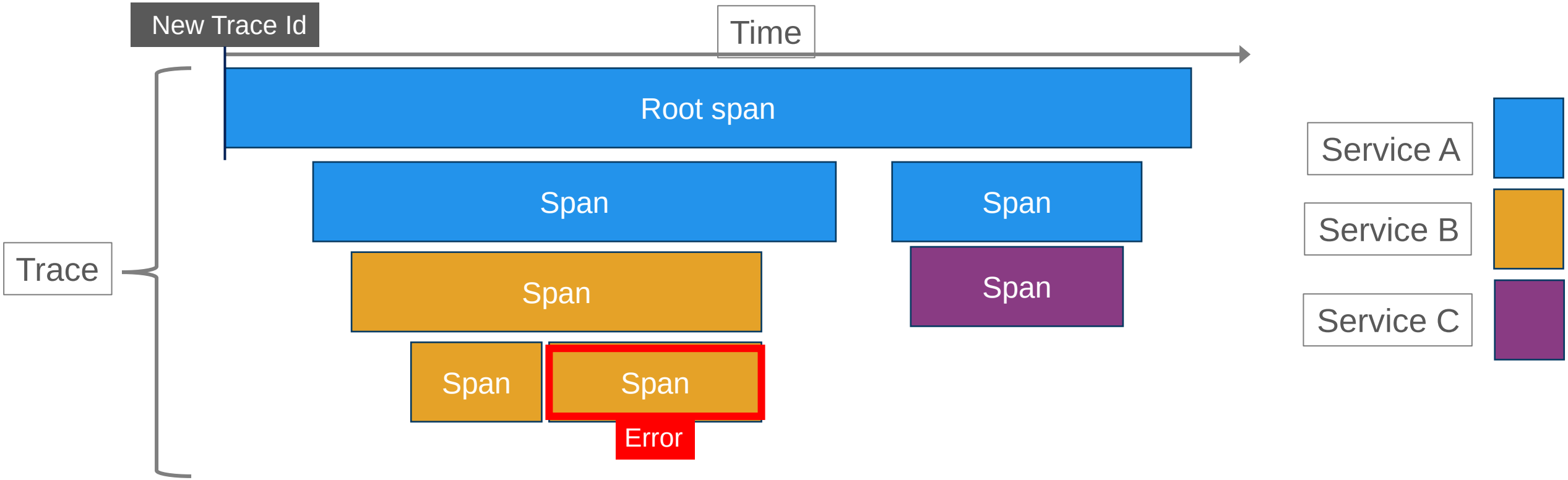
Observability Signals – Tracing

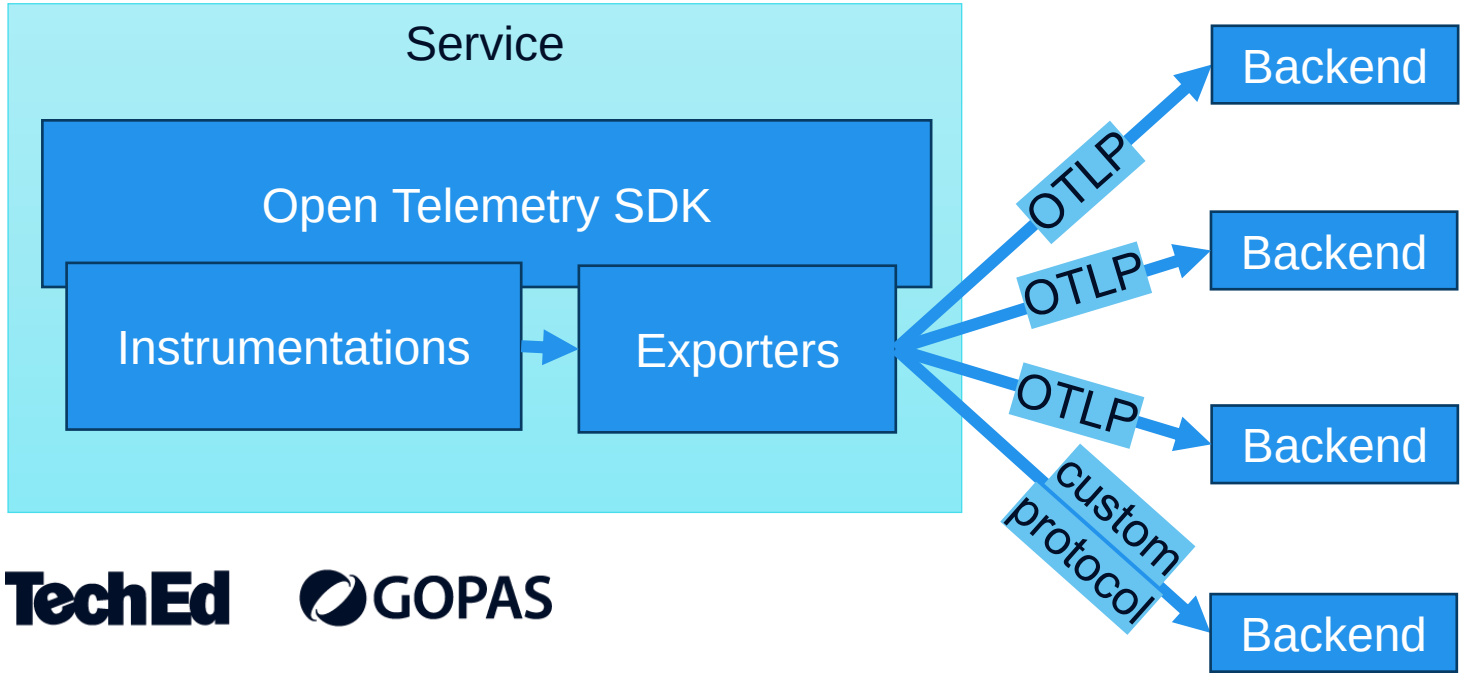


How tracing works?

- Span = .NET System.Diagnostics.Activity
- W3C Trace Context HTTP headers
- TraceId, SpanId, ParentSpanId
- .NET distributed tracing concepts: https://learn.microsoft.com/en-us/dotnet/core/diagnostics/distributed-tracing-concepts

OpenTelemetry Libraries

- Registry: https://opentelemetry.io/ecosystem/registry
- Instrumentation libraries – generates relevant telemetry data
- Exporter libraries – sends telemetry (via OTLP or other protocols)



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OpenTelemetry .NET SDK – Logs, Traces

Observability Signals – Metrics

- .NET: System.Diagnostics.Metrics
  - .NET6+, designed to integrate well with OpenTelemetry
  - Replaces EventCounters (.NET Core 3+) and PerformanceCounters (Win only) – see https://learn.microsoft.com/en-us/dotnet/core/diagnostics/compare-metric-apis

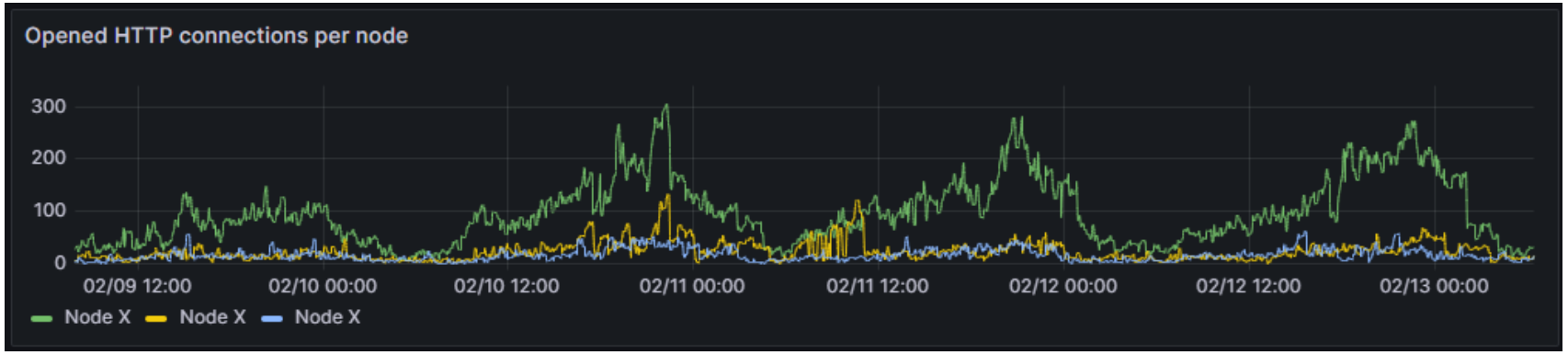
OpenTelemetry Metric Types

- Gauge
- Counter
- Histogram

Metric Types - Gauge

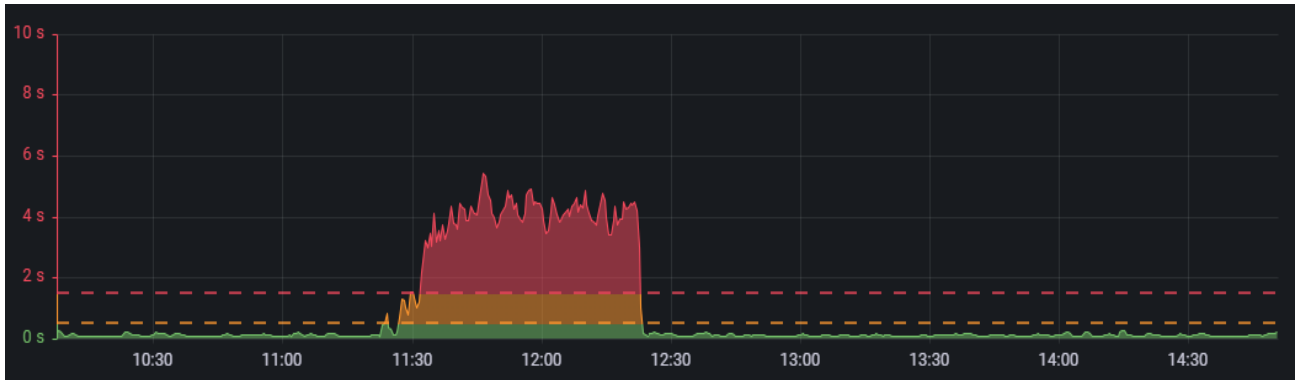
- Usage: Set instant value
- Examples:
  - CPU usage
  - Allocated threads
  - Open connections
  - Longest running task
  - Timespan of last backup
  - Free disk space
  - Queue length
  - ….

Metric Types - Gauge



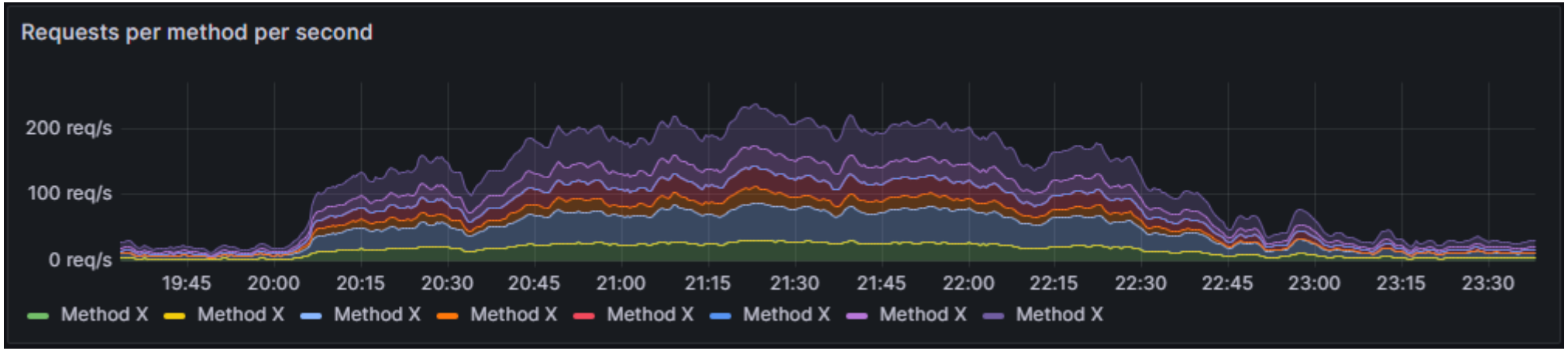
Metric Types – Counter (Sum)

- Usage: Increment +1
  - Examples: Counter of HTTP requests, executions, cache hit/miss, …
- Usage: Add +delta
  - Examples: Bytes transferred, rows processed, request duration, …



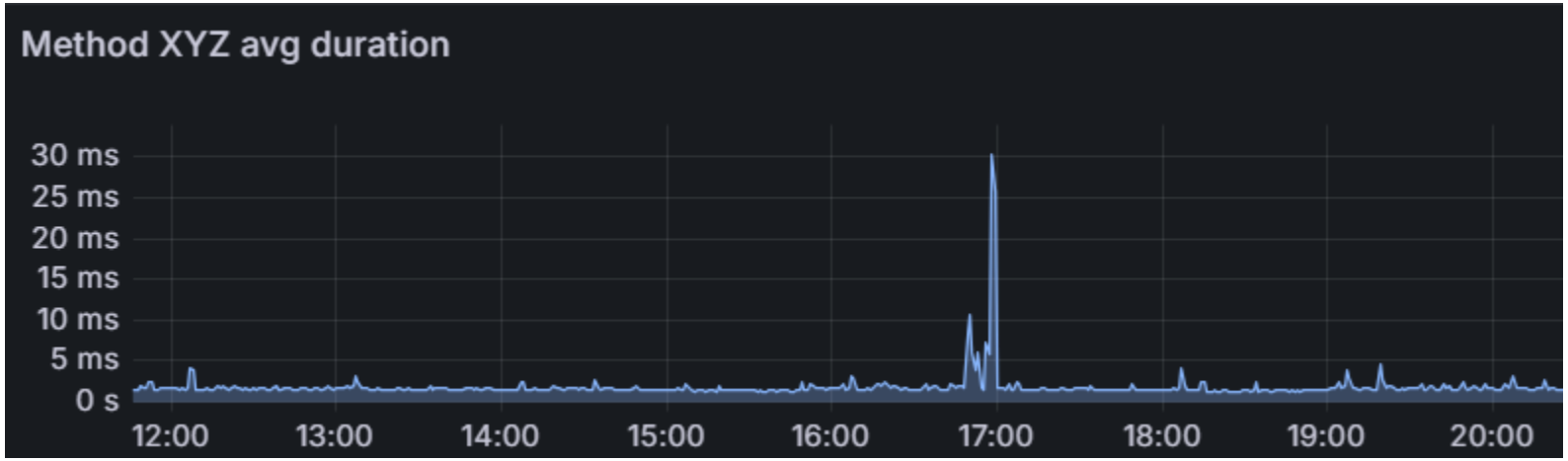
Metric Types – Counter (Sum)

- Visualize **rate**
- Examples: Requests/second, MB/s bandwidth, orders per hour, …



Metric Types – Counter (Sum)

- Visualize **average**
- Examples: average duration/size
  - From Requests counter / Requests total duration

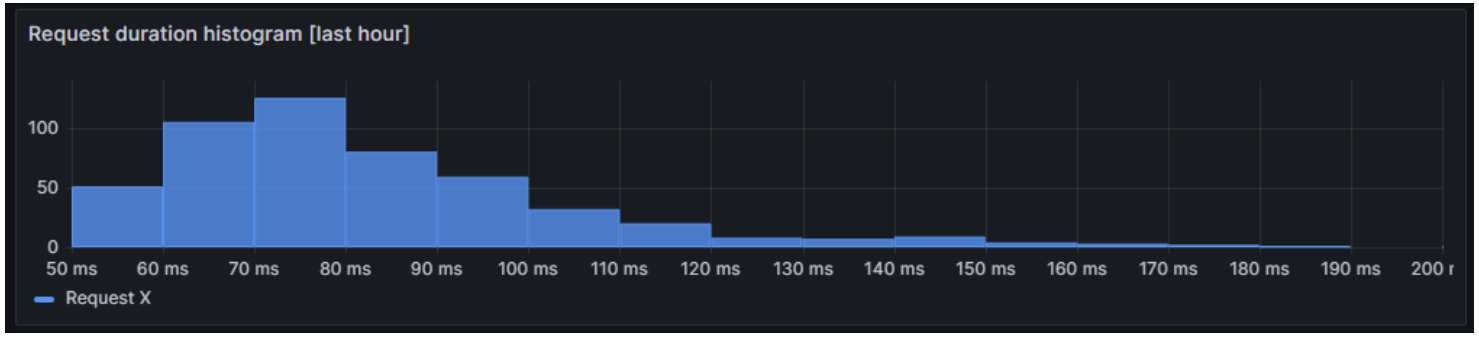


Metric Types – Counter (Sum)

- Visualize **ratios**
- Examples: cache hit/miss ratio, success/failure rate, …

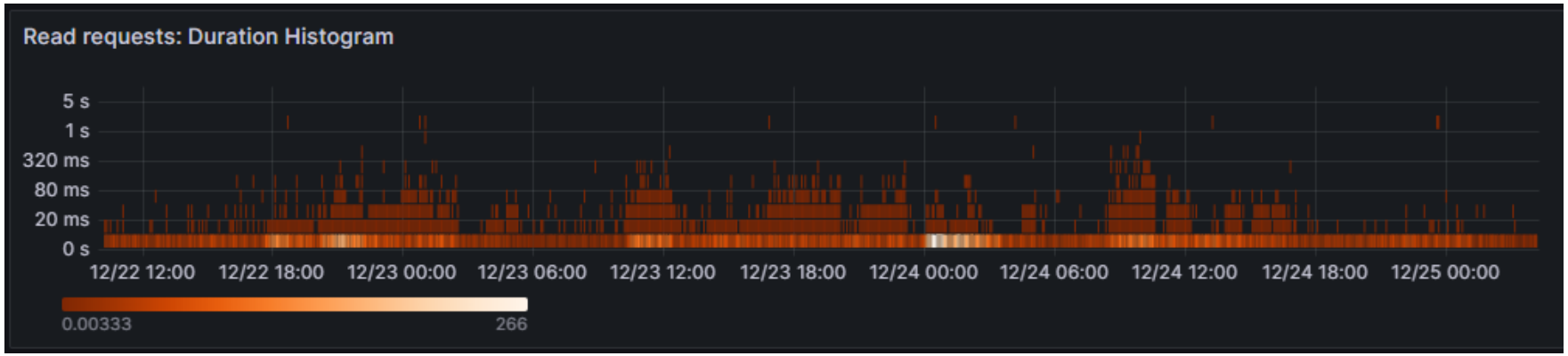
Metric Types – Histogram

- Usage: Record frequency of value (buckets)
- Examples: Request duration, message size, quantity per order
- Visualized as: Histogram, heatmap, percentile, average
- Default buckets for OpenTelemetry:
  [0, 5, 10, 25, 50, 75, 100, 250, 500, 750, 1000, 2500, 5000, 7500, 10000]



Metric Types – Histogram

- **Heatmap** visualization example (histogram over time)



DEMO

Metrics

OpenTelemetry Collector

- Receive, process and export telemetry data
- https://opentelemetry.io/docs/collector/
- Alternatives: Logstash, Fluentd, Telegraf (InfluxDB), …
- Registry: https://opentelemetry.io/ecosystem/registry/?language=collector

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OpenTelemetry Collector

Zero-code Instrumentation for .NET

- https://opentelemetry.io/docs/languages/net/automatic/
- Steps:
  1. Install auto-instrumentation (once)
  2. Run `.otel-dotnet-auto/instrument.sh`
  3. Configure with env variables (OTEL_EXPORTER_OTLP_ENDPOINT, etc.)
  4. Run your app/service

- Works like *magic** 🦄 🌈

**magic* is limited to .NET 6+, .NET 4.6.2+

https://github.com/jechtom/demo-open-telemetry

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Děkuji za pozornost