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Unified Observability: Monitoring Postgres Anywhere with OpenTelemetry

PgDay Pune 2025

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Curious One | Full Stack Developer

- Building a **Hybrid Control Plane for** managing **Postgres** across platforms
- **Focused** on observability: **collecting** & **visualizing metrics/logs** from Postgres and microservices
- Enabling a **single pane of glass** for **observability** across all deployments

Key Challenges in Monitoring Modern Apps

Modern applications span **hybrid**, **distributed** systems — from **mobile** apps to **cloud** services, containers, and even mainframes.

🚧 Common Challenges:

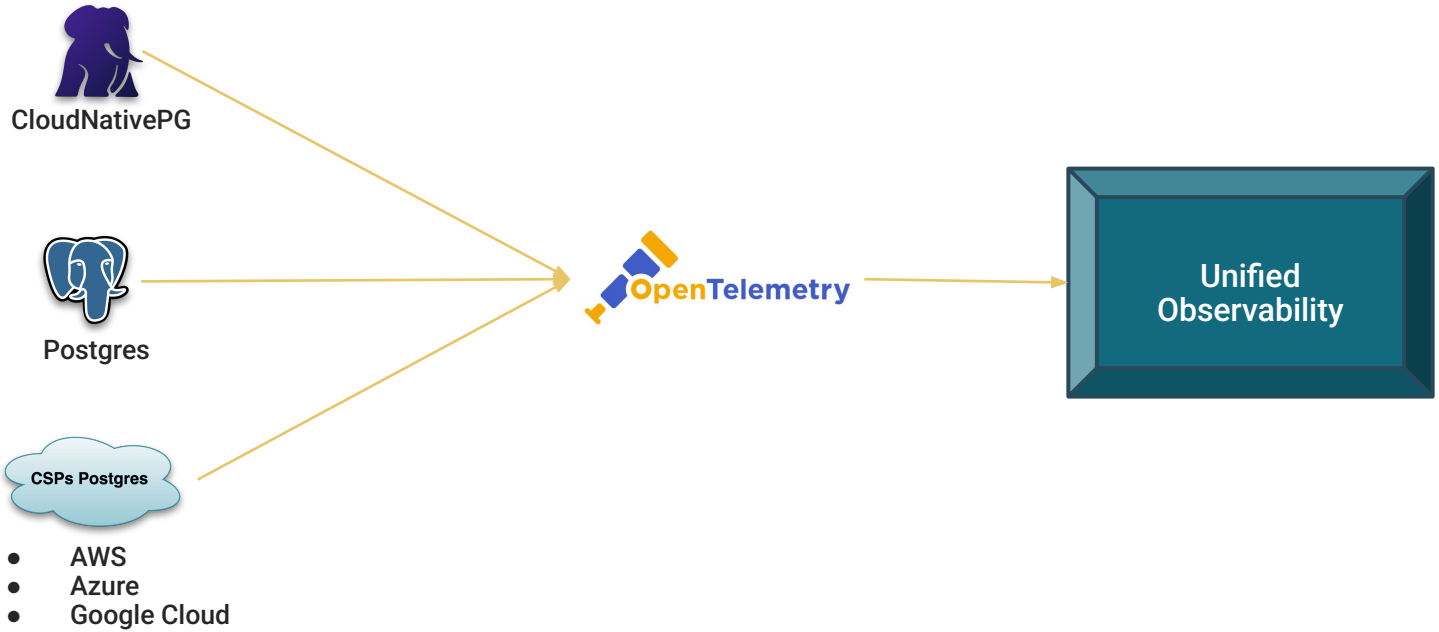
- 🌐 **No More Monoliths** - Applications are **fragmented across platforms** resulting in **lack of end-to-end visibility**
- 🧩 **Multiple Tools** - Most orgs rely on **4–7 disconnected monitoring tools**, making it **complex** to detect and **resolve** issues.
- 🔒 **Separated monitoring data** - Logs, metrics, & traces are collected separately - increasing complexity & **reducing correlations**.

💡 **Solution** - Unified frameworks like **OpenTelemetry** provide a **vendor-neutral**, open standard for collecting all telemetry signals.

Agenda

- Observability
- Monitoring PostgreSQL
- CloudNativePG
- OpenTelemetry
- Monitoring Postgres Anywhere with OpenTelemetry
- Demo

Goal



- AWS
- Azure
- Google Cloud

🔎 Observability

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Observability

Observability is the ability to understand a system's internal state by examining its external outputs – also known as telemetry data.

This includes three core pillars:

- 📊 **Metrics** – Numerical data that reflects the system's health and performance.
- 📄 **Logs** – Text records that capture events and state changes.
- 🧵 **Traces** – Detailed records of request flows across services.

Making a System Observable

- To achieve observability, a **system must be instrumented** — that means the application code must emit logs, metrics, or traces.
- Once instrumented, this telemetry data is sent to an observability backend, where it can be **analyzed** to gain insights, detect issues, and optimize performance.

Monitoring PostgreSQL

The World's Most Advanced Open Source Relational Database

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PostgreSQL - Monitoring - Metrics

We can **capture critical metrics** over time to identify trends and perform root cause analysis, for example:

💾 **Resource Usage:** Track CPU, memory, disk I/O, storage usage

🐢 **Query Performance:** Monitor slow queries, locks, & execution plans

📈 **Connections:** Track active sessions, connection limits, & idle connections

⛑️ **Database Health:** Monitor replication lag, bloat, & vacuum stats

🛑 **Errors:** Keep an eye on failure rates, & warnings

PostgreSQL - Monitoring - Logs

PostgreSQL logs provide a rich source of information to help **monitor** the **database's health, performance, and security.**

🔑 **Some Key Logs to Monitor:**

- **Error Logs:** Capture critical errors and crashes like **deadlock** detected.
- **Warning Logs:** Flag potential issues like **slow queries** or low resources.
- **Connection Logs:** Track connections and **failed login** attempts.
- **Statement Logs:** Record **SQL queries** for **auditing** and troubleshooting.

CloudNativePG

PostgreSQL Operator for Kubernetes

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CloudNativePG

CloudNativePG is a **CNCF Sandbox project** — an **open-source Kubernetes operator** for managing **PostgreSQL** workloads in **Kubernetes**.

🔧 **Kubernetes-Native by Design**

- Defines a **custom k8s resource: Cluster** – represents a PostgreSQL cluster with one primary & optional replicas.
- **Fully declarative** & integrates directly with the Kubernetes API.

🚀 **Full Lifecycle Management**

- Manages deployment, **scaling**, **failover**, and updates.
- Uses native **streaming replication** for **high availability** (primary/standby architecture)
- Does not rely on StatefulSets. Manages its own **PVCs** for storing **PGDATA**.

CloudNativePG - Monitoring

CloudNativePG integrates seamlessly with observability stacks using Prometheus and Kubernetes-native logging.

📊 **Metrics Export**

- **Exposes native Prometheus metrics**
- Each PostgreSQL instance includes a dedicated exporter
- Predefined metrics included & **Custom queries** can be added **for deeper insights**

📄 **Logging**

- **Outputs JSON**-formatted logs (including PostgreSQL logs) to stdout
- No disk persistence — improves security and statelessness

OpenTelemetry

Open Source Observability Framework

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OpenTelemetry (OTel)

OpenTelemetry is an open-source **Observability Framework** &

toolkit for: **Generating** → **Collecting** → **Processing** → **Exporting** telemetry data:

- 📊 Metrics
- 📄 Logs
- 🧵 Traces

⚠️ Important to Note:

OpenTelemetry is not an observability backend – it **does not store** or **visualize** telemetry data.

Instead, it **standardizes and transports** it to the backend of your choice.

OTel - Key Characteristics

✅ **Open Source**

🔧 **Vendor-Neutral & Tool-Agnostic**

🔄 **Pluggable** with multiple backends:

- Open source Tools (e.g., Prometheus, Loki, Jaeger)
- Commercial platforms (e.g., Grafana Cloud, Datadog, New Relic)

🎯 Built for **Easy & Consistent Instrumentation**

Works across:

👩‍💻 Multiple **Programming Language**

🏗️ Any **Infrastructure** - Kubernetes, Bare-metal, VMs

OTel - Data Pipeline

🛠️ Instrumentation

App emits telemetry data:

- 📊 Metrics
- 📄 Logs
- 🧵 Traces

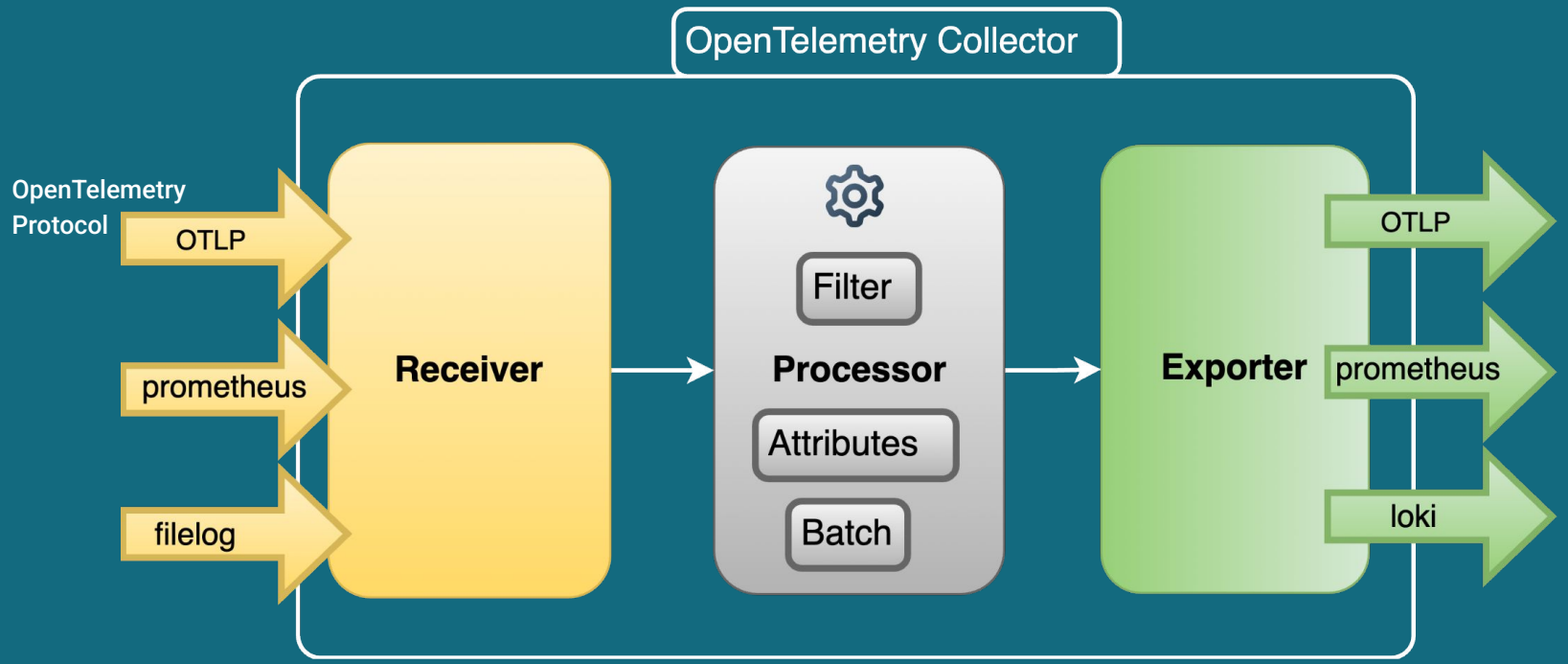
🔀 OTEL Collector

OTel Collector **Receives** → **Processes** → **Exports** telemetry data.

Data can be sent to any preferred **observability backend**:

- 📬 Prometheus, Loki
- ☁️ Datadog, Grafana Cloud, etc.

OTel Collector Design



Monitoring Postgres Anywhere with OpenTelemetry

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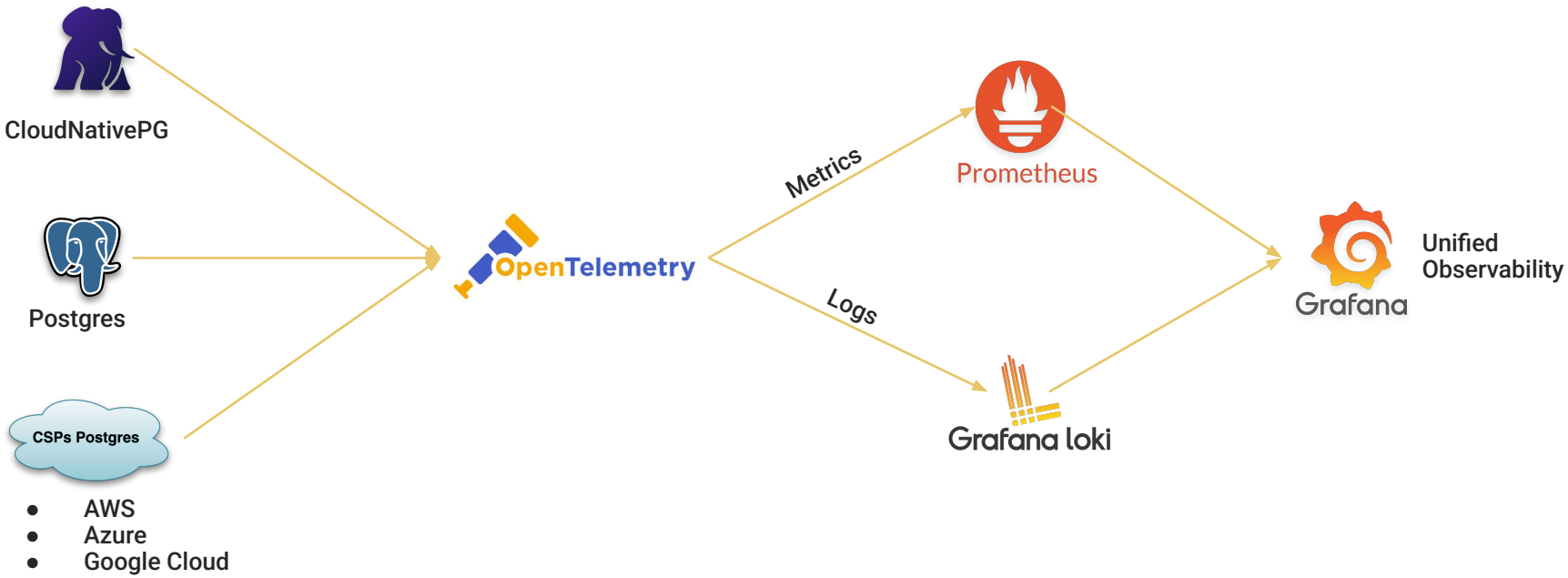
Monitoring Postgres Anywhere with OTeL



OTel - Config - Overview for Postgres

A simple pipeline to collect, process, and export PostgreSQL telemetry:

📥 Receivers

- **hostmetrics** – Gathers system-level metrics
- **postgresql** – Collects PostgreSQL metrics
- **prometheus** – Scrapes metrics from Prometheus - postgres exporters
- **filelog** – Reads PostgreSQL logs

🧹 Processors

- **attributes** – Adds, updates, deletes custom labels
- **filter** – Keeps only relevant metrics/logs (**save storage cost**)
- **batch** – Batches telemetry data for performance

📤 Exporters

- **prometheusremotewrite** – Sends metrics to Prometheus-compatible backends
- **loki** – Streams logs to Grafana Loki
- **otlp** – Exports to any OpenTelemetry-compatible observability backend

OTel - Config - Pipeline Example

```yaml
service:
  pipelines:
    metrics:
      receivers: [postgresqlreceiver, hostmetricsreceiver, prometheus]
      processors: [attributes, filter, batch]
      exporters: [prometheusremotewrite, oltp]
    logs:
      receivers: [filelogreceiver]
      processors: [filter, batch]
      exporters: [loki, oltp]
```

Unified Observability – Metrics & Logs

Home › Explore › Prometheus | Loki

Search or jump to... ⌘+k

Query history | Share

Close | Add | Go queryless

Metric: postgresql_backends

Label filters: resource_id = local-mac

+ Operations

postgresql_backends{resource_id="local-mac"}

Options | Legend: Auto | Format: Time series | Step: auto | Type: Range | Exemplars: false

+ Add query | Query inspector

Graph — Lines | Bars | Points | Stacked lines | Stacked bars

14, 12, 10, 8, 6, 4, 2

14:26:00, 14:27:00, 14:28:00, 14:29:00, 14:30:00

{__name__="postgresql_backends", resource_id="local-mac", source="external"}

Deduplication: None | Exact | Numbers | Signature

Display results: Newest first | Oldest first

Common labels: exporter=OTLP service_name=unknown_service

Line limit: 1000 (3 displayed) Total bytes processed: 2.67 kB

Download


```
> {
    "body": "2025-05-04 14:29:55.077 IST [99697] STATEMENT:  generating error
  s;",
    "attributes": {
      "log.file.name": "postgresql.log",
      "resource_id": "local-mac",
      "source": "external"
    }
  }
> {
    "body": "2025-05-04 14:29:55.077 IST [99697] ERROR:  syntax error at or n
  ear \"generating\" at character 1",
    "attributes": {
      "log.file.name": "postgresql.log",
      "resource_id": "local-mac",
      "source": "external"
    }
  }
> {
    "body": "2025-05-04 14:28:22.457 IST [98176] LOG:  checkpoint starting: t
  ime",
    "attributes": {
      "log.file.name": "postgresql.log",
      "resource_id": "local-mac",
      "source": "external"
    }
  }
```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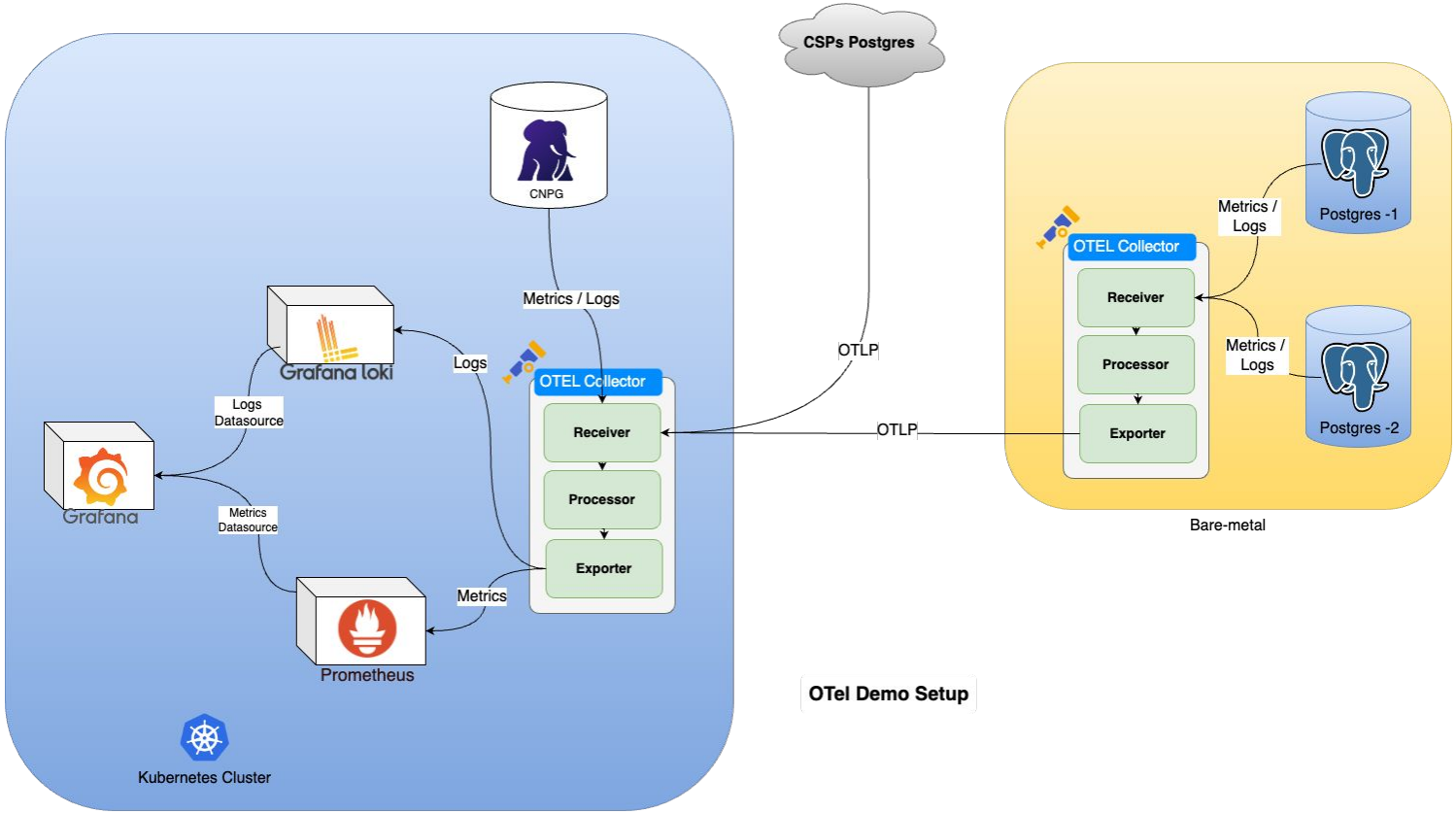
DEMO

Demo Setup Overview



OTel Demo Setup

Resources/ Useful Links

- CloudNativePG (CNCF Sandbox Project)
- CloudNativePG - Monitoring
- OpenTelemetry (CNCF Incubating Project)
  - OpenTelemetry - Receivers List
  - OpenTelemetry - Processors List
  - OpenTelemetry - Exporter List
- Prometheus (CNCF Graduated Project)
- Loki
- Grafana

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🤝Let's connect to talk about:

- Observability
- Postgres
- Kubernetes
- Conversational AI
- Open Source Softwares

🔗Contact:

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