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AU Db2 TECH CONFERENCE

Db2 for z/OS Applications Empowered with OpenTelemetry

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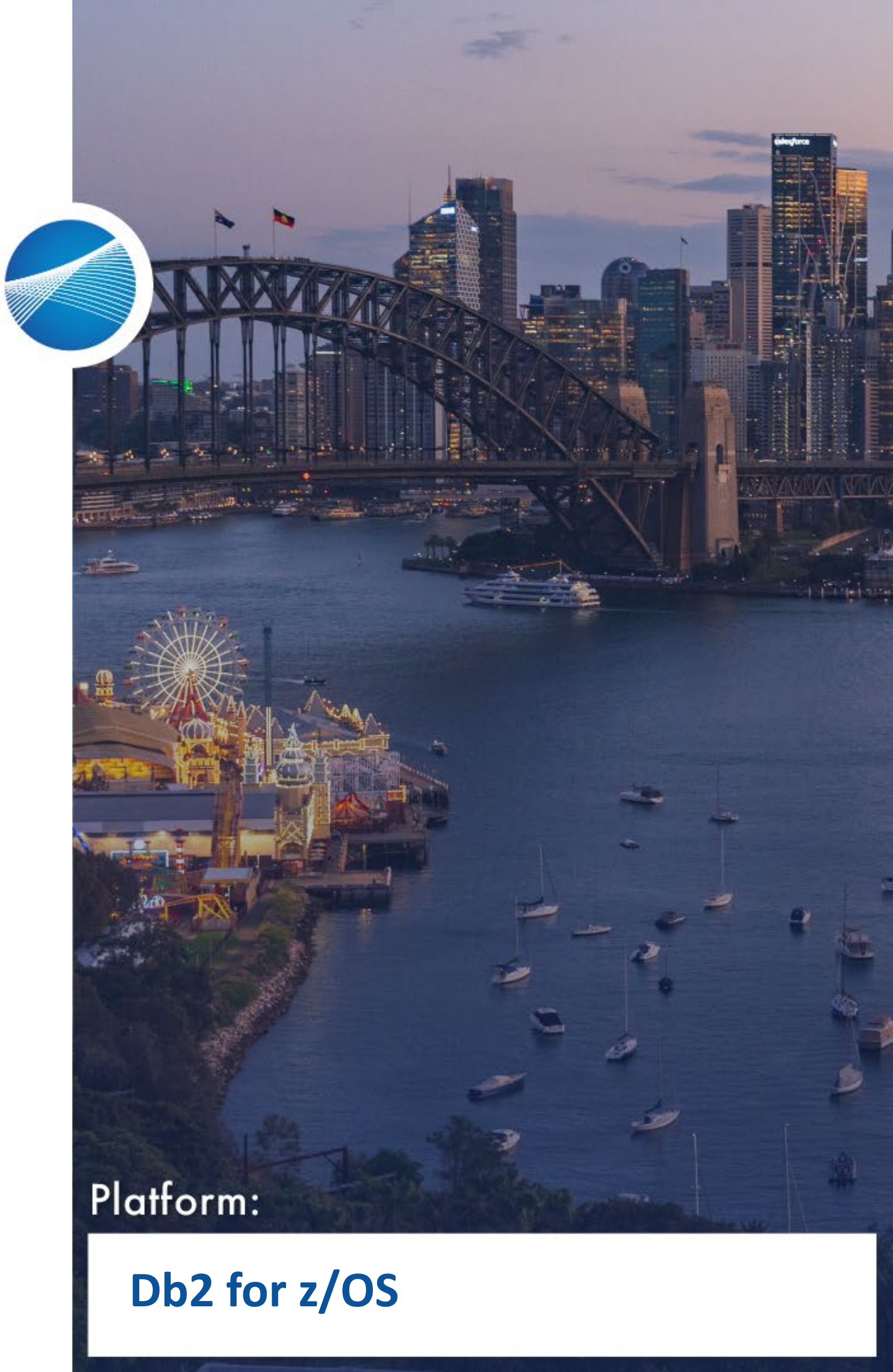
Session Code: C10



Platform:

Db2 for z/OS

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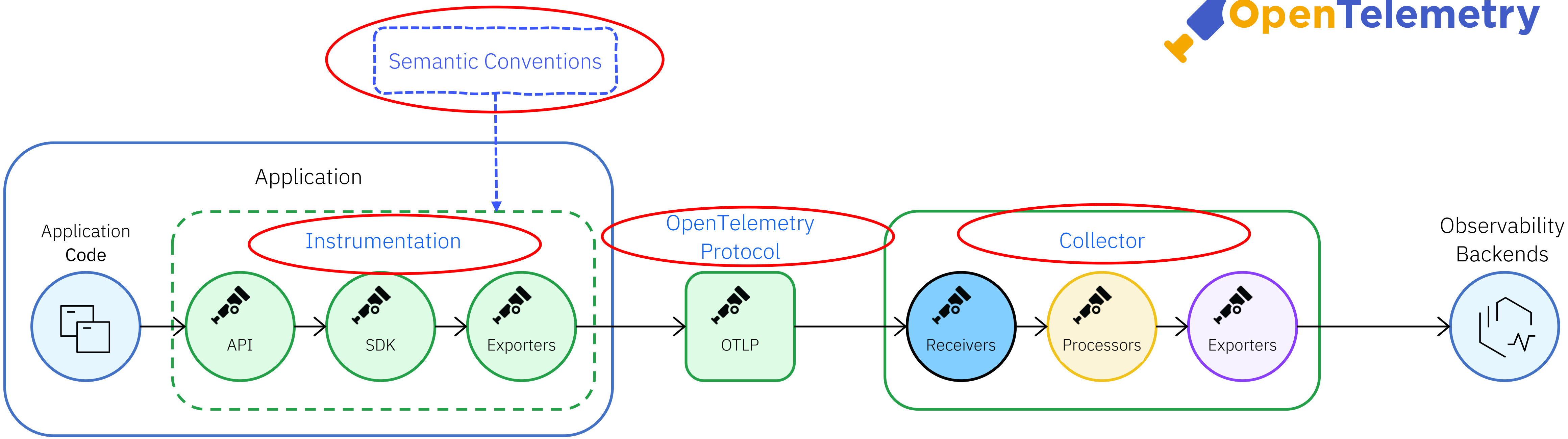
AGENDA

OpenTelemetry

- What is OpenTelemetry?
- Why implement OpenTelemetry
- OpenTelemetry trace for Db2 for z/OS
- Configuration & details
- Next Steps
- Summary & References

What is OpenTelemetry?



- OpenTelemetry is a vendor-agnostic observability framework.
  - It consists of **a collection of APIs, SDKs, and tools, which can be used to instrument, generate, collect, and export telemetry data to help site reliability engineers (SRE) analyze their software's performance and behavior.**
  - Semantic conventions that define a standard naming scheme for common telemetry data types
  - **A specification for all components**

IBM System Z Statement of Direction

OpenTelemetry

Published on 3rd June 2025

IBM intends to develop capability to support OpenTelemetry (OTel) distributed tracing in IBM CICS Transaction Server for z/OS, IBM Information Management System (IMS), IBM Db2 for z/OS, and IBM MQ for z/OS.

IBM intends that this support will include the native emission of OTel span data from IBM middleware subsystems using emitter capability provided in IBM z/OS and that the output streams will be available for consumption by any observability tooling that supports the OTel standard.

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OpenTelemetry Data

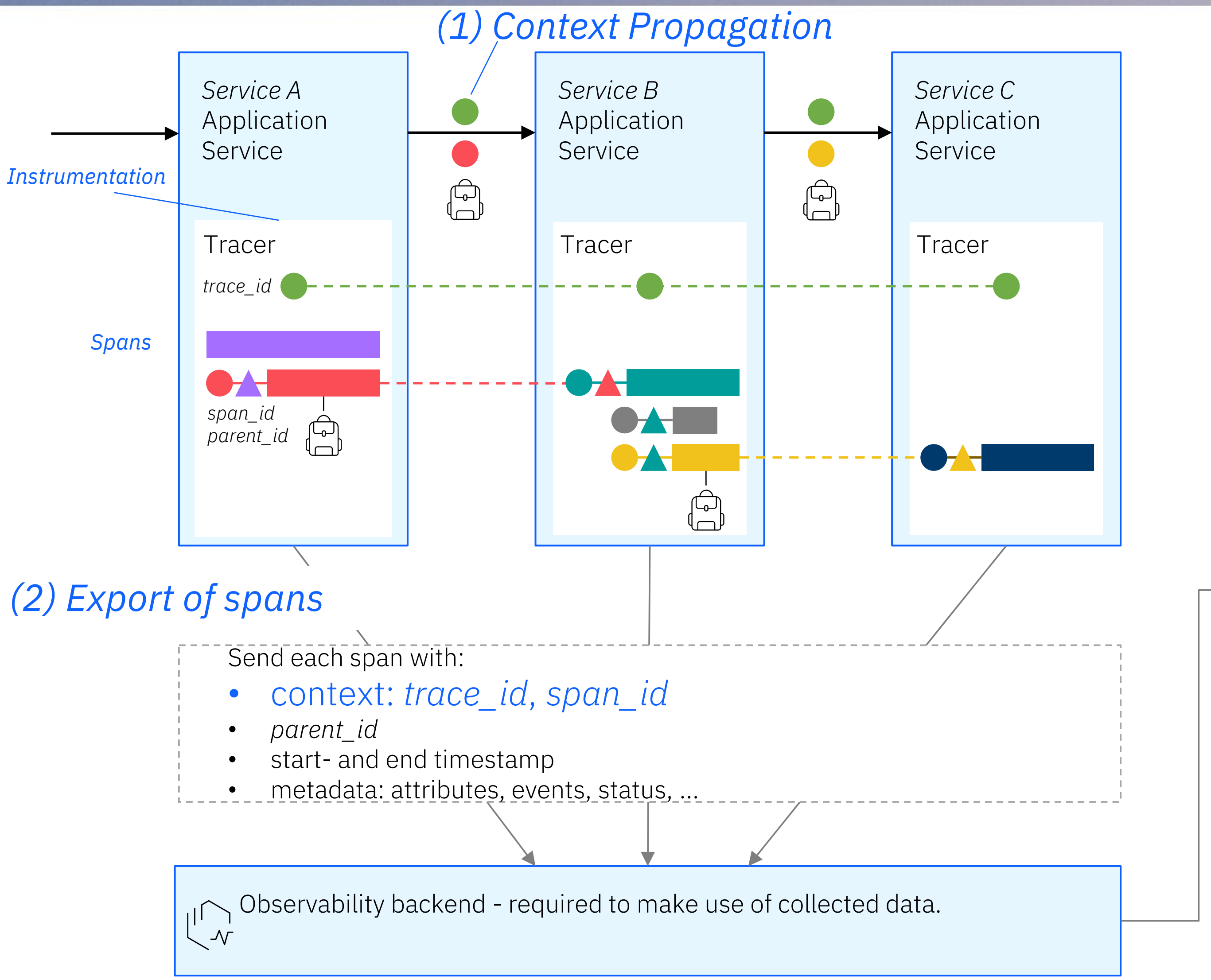
- Metrics -> provide runtime measurements of a system.
- Logs -> provide recording of events.

Current Implementation

- Traces -> track the flow of an application through a system, enabling you to observe how applications are behaving.
  - Distributed tracing is a methodology to follow a transaction across multiple software components.

IBM z/OS and its middleware implementation, enables end-to-end tracking of requests across different subsystems, making it easier to identify performance bottlenecks and failures efficiently. [W3C (World Wide Web Consortium) Trace Context Specifications]

Distributed Tracing – a conceptual view



Send each span with:

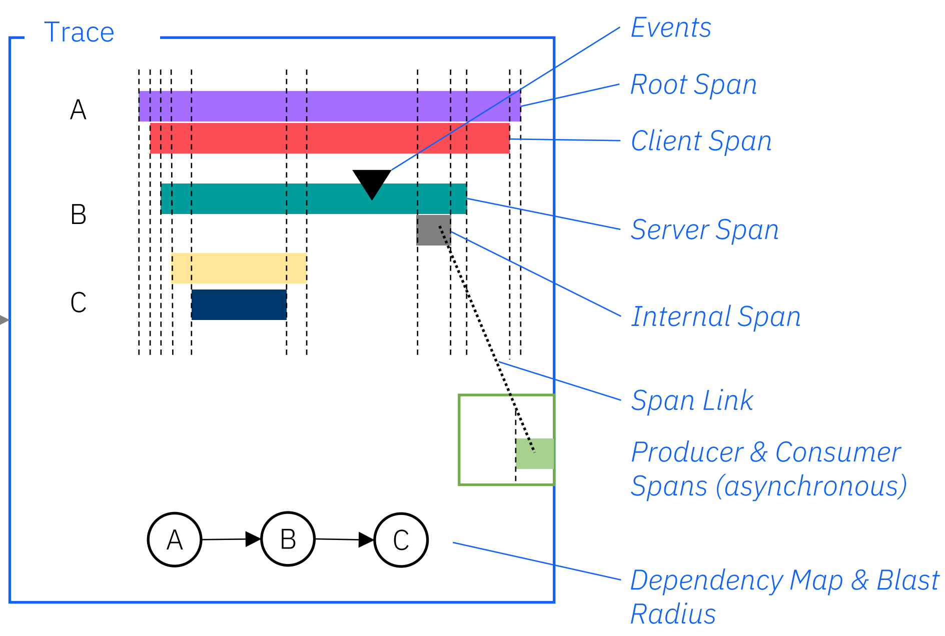
- context: *trace_id, span_id*
- *parent_id*
- start- and end timestamp
- metadata: attributes, events, status, …

Observability backend - required to make use of collected data.

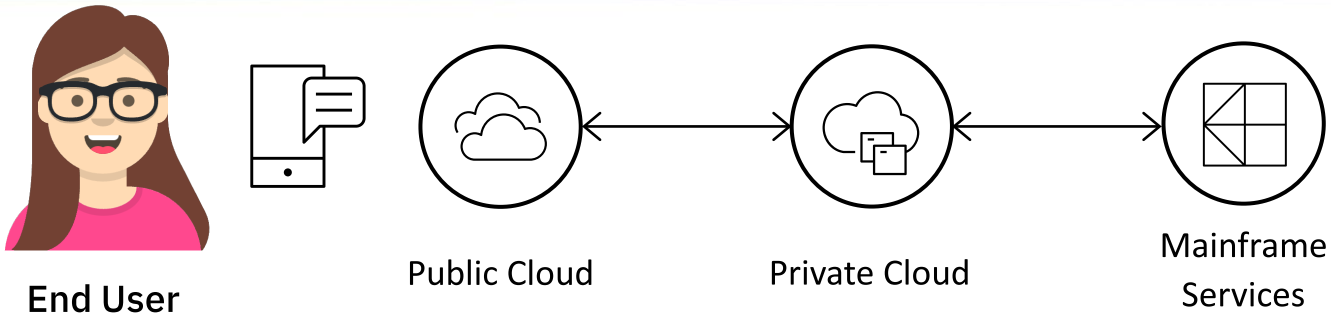
Trace: single request and its path through a system of services

Span (timespan): represents a unit of work or operation

Tracers are part of the runtime and collect data.



Why end-to-end observability for the mainframe?



End User

Public Cloud

Private Cloud

Mainframe Services

End-to-end Observability for hybrid applications and underlying infrastructure

Site Reliability Engineer

Application Developer

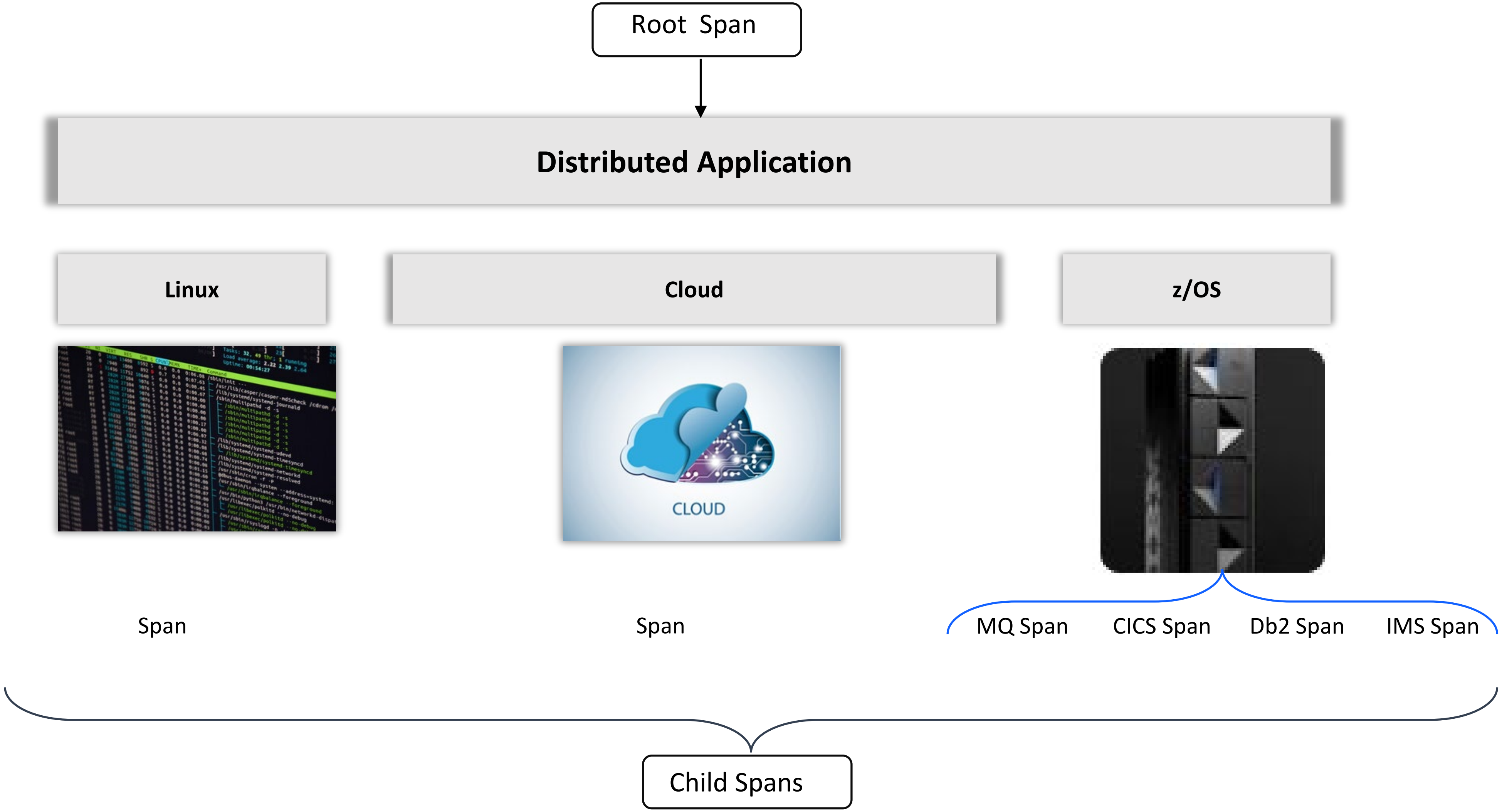
Systems Programmer

Ensuring the mainframe is at the center of an enterprise-wide observability strategy is essential for maintaining strategic application availability

Adoption of OpenTelemetry standard delivers insights in context enabling faster detection, isolation and resolution of operational issues

Understanding the concept of a trace and its spans

How the application behaves all the way through



Root Span

Distributed Application

Linux

Cloud

z/OS

Span

Span

MQ Span

CICS Span

Db2 Span

IMS Span

Child Spans

Understanding OTel Span records

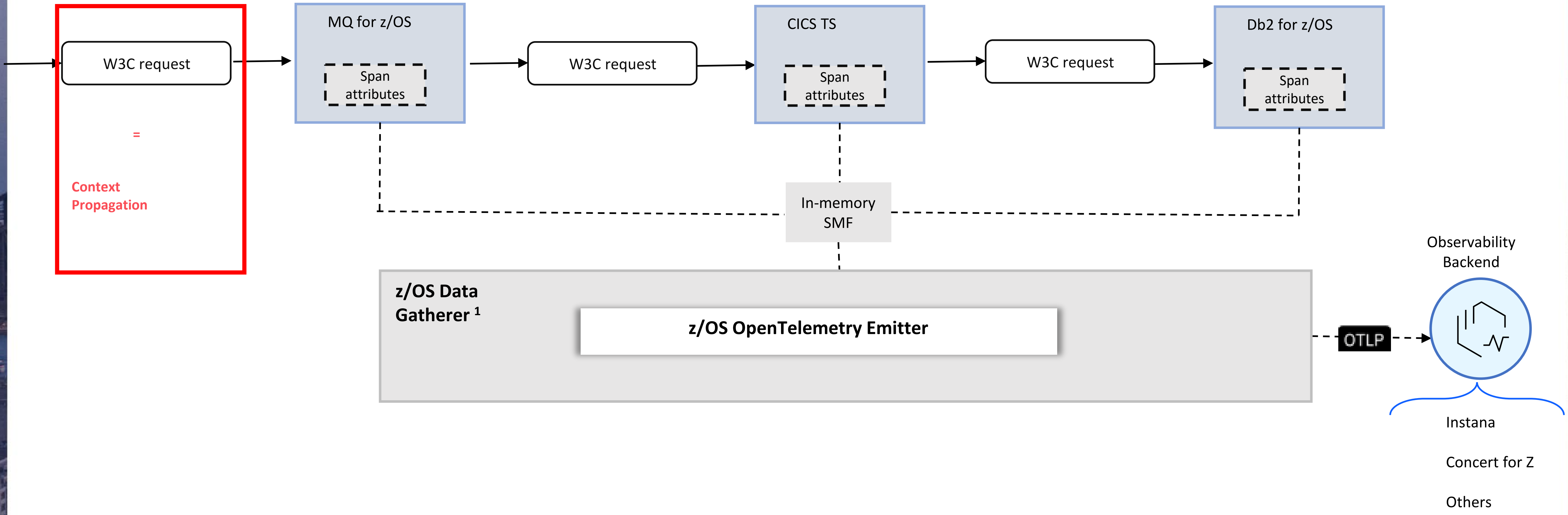
Gives you

- Spans aim to provide a way to identify where a problem is in a distributed application.
- Help to identify which team needs to be called in to resolve it.
- Spans should reduce the time to identify “in which area” when a problem arises in a complex distributed application.

Doesn’t give you

- Span data will not generally be sufficient to diagnose the root cause of a problem in most cases
- Conventional diagnostic tools will be needed as now

Distributed Tracing for z/OS System Software – Example



[1] APAR OA66345 (UJ98068 for z/OS 3.1 and UJ98067 for z/OS 3.2)

Db2 OTel Distributed Tracing Support (1|7)

- PH67971 – Db2 for z/OS OpenTelemetry Distributed Tracing Support
- PH68073 – Db2 for z/OS IMS Attach OpenTelemetry Distributed Tracing Support

Only for inbound workloads with a traceparent from:

- Db2 for z/OS native RESTful services
- JDBC Type-4/Db2 JCC type-4 Client driver [1]
- CICS-Db2 Attachment Facility
- CICS Liberty-JDBC type-2 (RRS AF) [2]
- IMS-Db2 Attachment (ESAF)
- IMS-Db2 Java Adapter-JDBC type-2 (RRS AF) [2]
- z/OS Connect-Db2 Rest service (HTTP header)

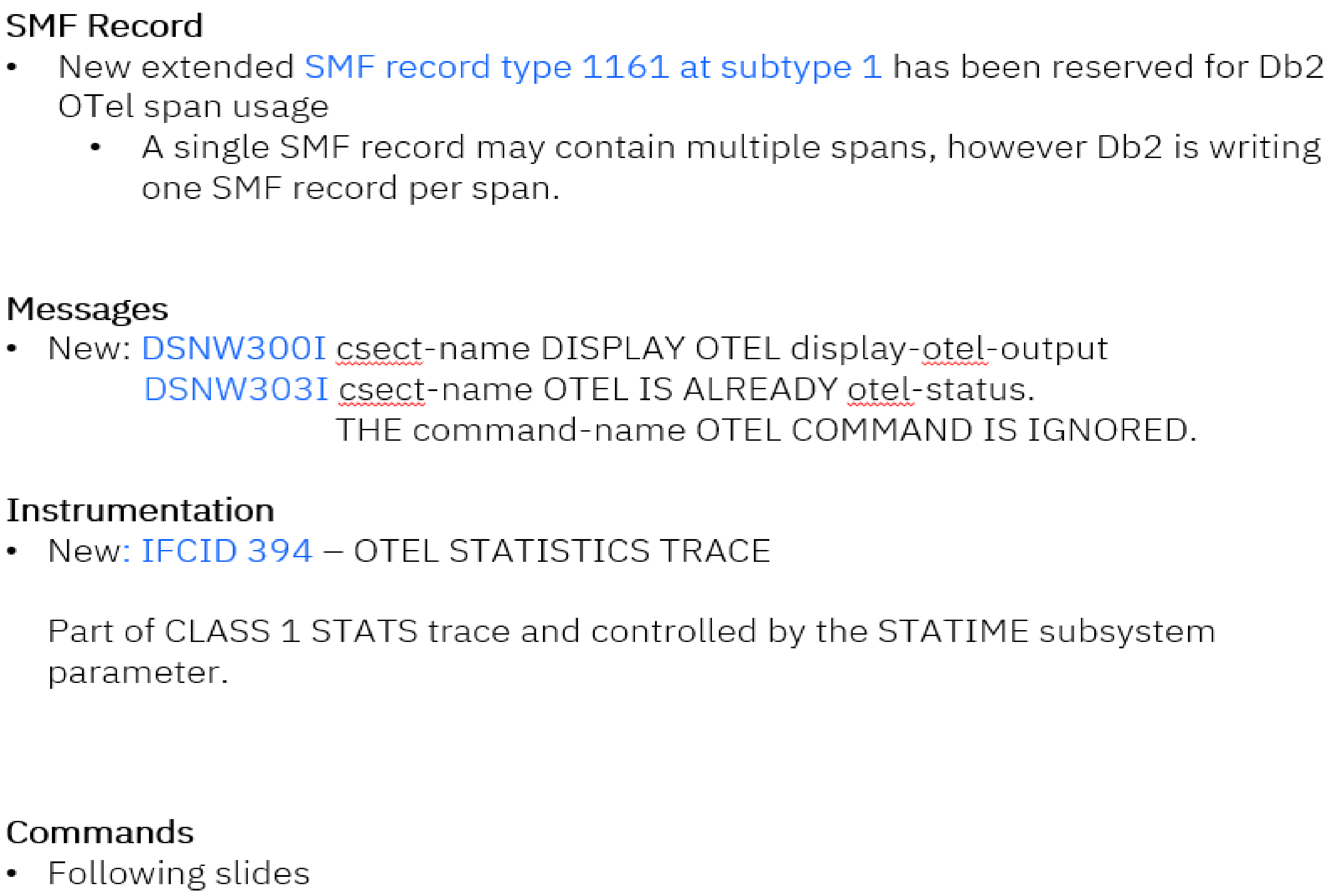
[1] JDBC Type-4 support GA with Db2 Connect 12.1.3 or a special build for Db2 Connect 12.1.2.

[2] Attachment controlled by CICS or IMS and not JDBC type-2.

- Db2 will emit an OTel span record with basic performance metrics (CPU time and elapsed time) for each unit of work.
- Environments must have IFCID 3 on to report “in Db2” timings
- Environments must be configured to enable the new SMF record 1161 subtype 1

Db2 OTel Distributed Tracing Support (2|7)

What’s new



SMF Record

- New extended SMF record type 1161 at subtype 1 has been reserved for Db2 OTel span usage
  - A single SMF record may contain multiple spans, however Db2 is writing one SMF record per span.

Messages

- New: DSNW300I csect-name DISPLAY OTEL display-otel-output
  DSNW303I csect-name OTEL IS ALREADY otel-status.
  THE command-name OTEL COMMAND IS IGNORED.

Instrumentation

- New: IFCID 394 – OTEL STATISTICS TRACE

  Part of CLASS 1 STATS trace and controlled by the STATIME subsystem parameter.

Commands

- Following slides

Db2 OTel Distributed Tracing Support (3|7)

Enablement switch, after APAR PH67971 applied

- The default behavior when Db2 starts is for the OTel traces to remain stopped.
  - No context propagation or span record emission occurs.
- The Db2 command **-START OTEL** starts OpenTelemetry (OTel) processing

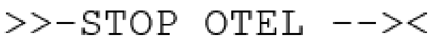
```
>>-START OTEL--+--------------------+--><
               |                    |
               |       +--YES--+    |
               |       |       |    |
               +-EMIT(-+--NO---+-)-+
```

  - EMIT YES -> OTel is started.
    Context information is propagated, and span records are written.
    A SMF type 1161, subtype 1 record will be written on commit or abort of an SQL statement (subsystem level).
  - EMIT NO -> OTel is started. Context information is propagated but span records are not written.

Db2 OTel Distributed Tracing Support (4|7)

Enablement switch, after APAR PH67971 applied

- The Db2 command **-STOP OTEL** stops all Db2 OpenTelemetry (OTel) functions, including propagation of OTel information and writing of extended SMF type 1161, subtype 1 (OTel span)



```
>>-STOP OTEL --><
```

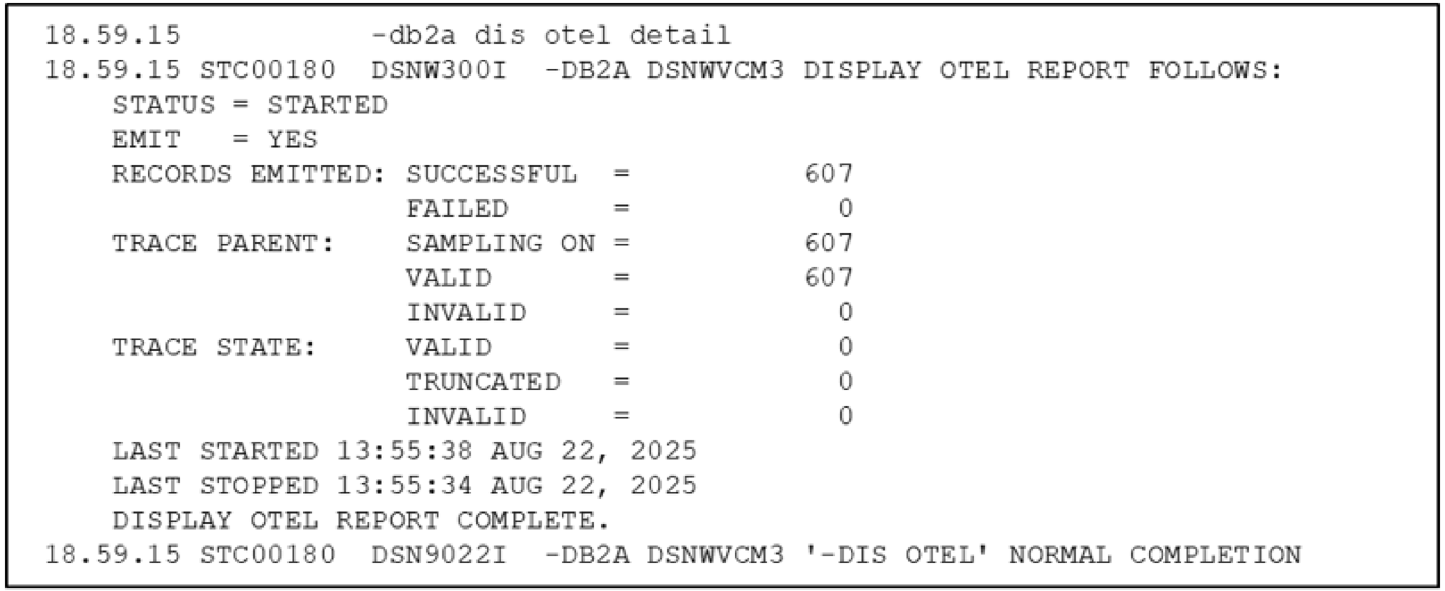
Db2 OTel Distributed Tracing Support (5|7)

Enablement switch, after APAR PH67971 applied

- The Db2 command `-DISPLAY OTEL` displays OpenTelemetry (OTel) status information.

```
>>-DISPLAY OTEL--+----------+--><
                 |          |
                 +--DETAIL--+
```

For example,



```
18.59.15           -db2a dis otel detail
18.59.15 STC00180  DSNW300I  -DB2A DSNWVCM3 DISPLAY OTEL REPORT FOLLOWS:
    STATUS = STARTED
    EMIT   = YES
    RECORDS EMITTED: SUCCESSFUL  =          607
                     FAILED      =            0
    TRACE PARENT:    SAMPLING ON =          607
                     VALID       =          607
                     INVALID     =            0
    TRACE STATE:     VALID       =            0
                     TRUNCATED   =            0
                     INVALID     =            0
    LAST STARTED 13:55:38 AUG 22, 2025
    LAST STOPPED 13:55:34 AUG 22, 2025
    DISPLAY OTEL REPORT COMPLETE.
18.59.15 STC00180  DSN9022I  -DB2A DSNWVCM3 '-DIS OTEL' NORMAL COMPLETION
```

Db2 OTel Distributed Tracing Support (6|7)

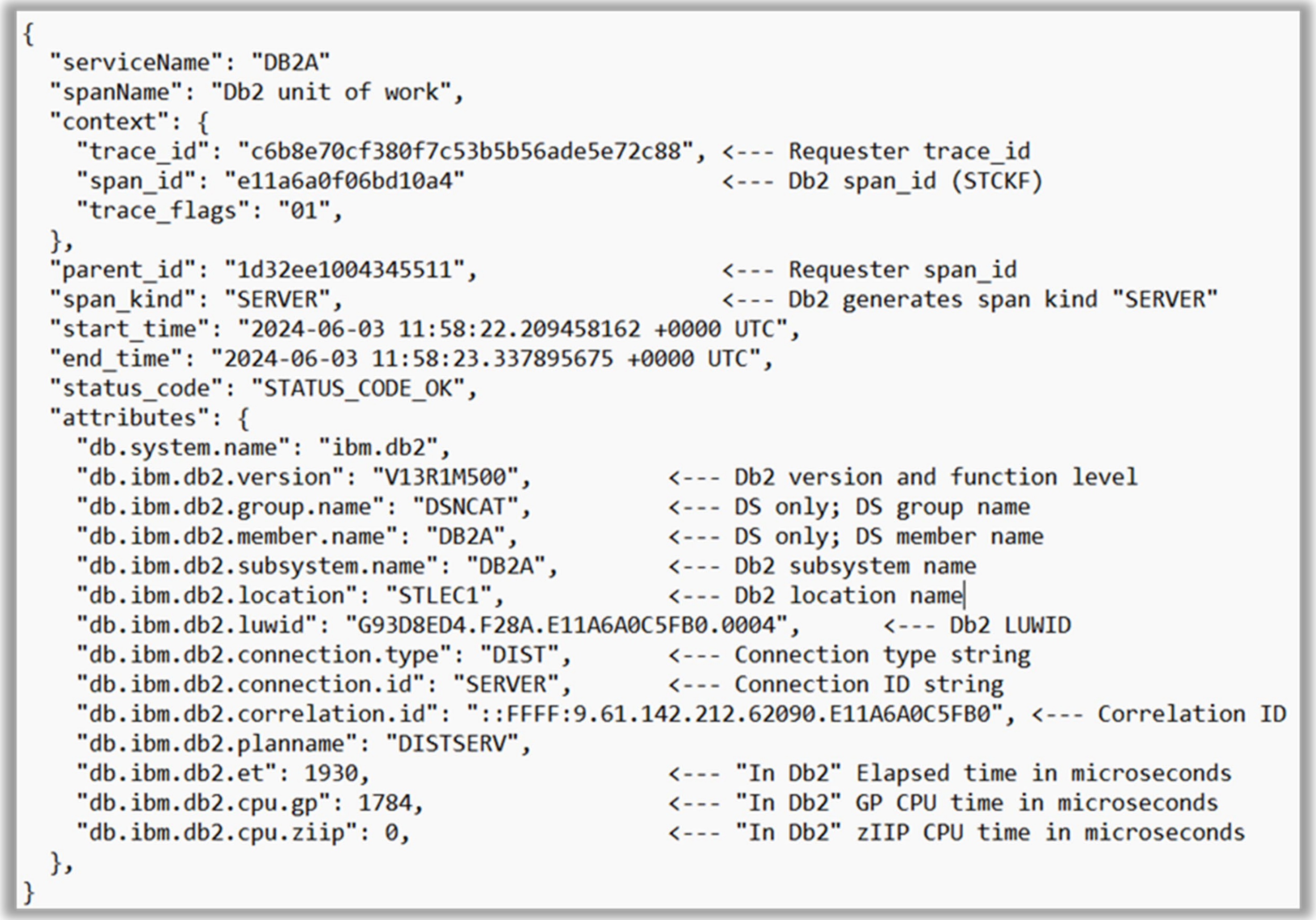
The Span record

The OTel specification for a trace span states that it must contain the following elements:

- The span name
- An immutable SpanContext which identifies the span
- A parent span or null
- A spankind
- A start timestamp
- An end timestamp
- Attributes

Db2 OTel Distributed Tracing Support (7|7)

The Span record, example

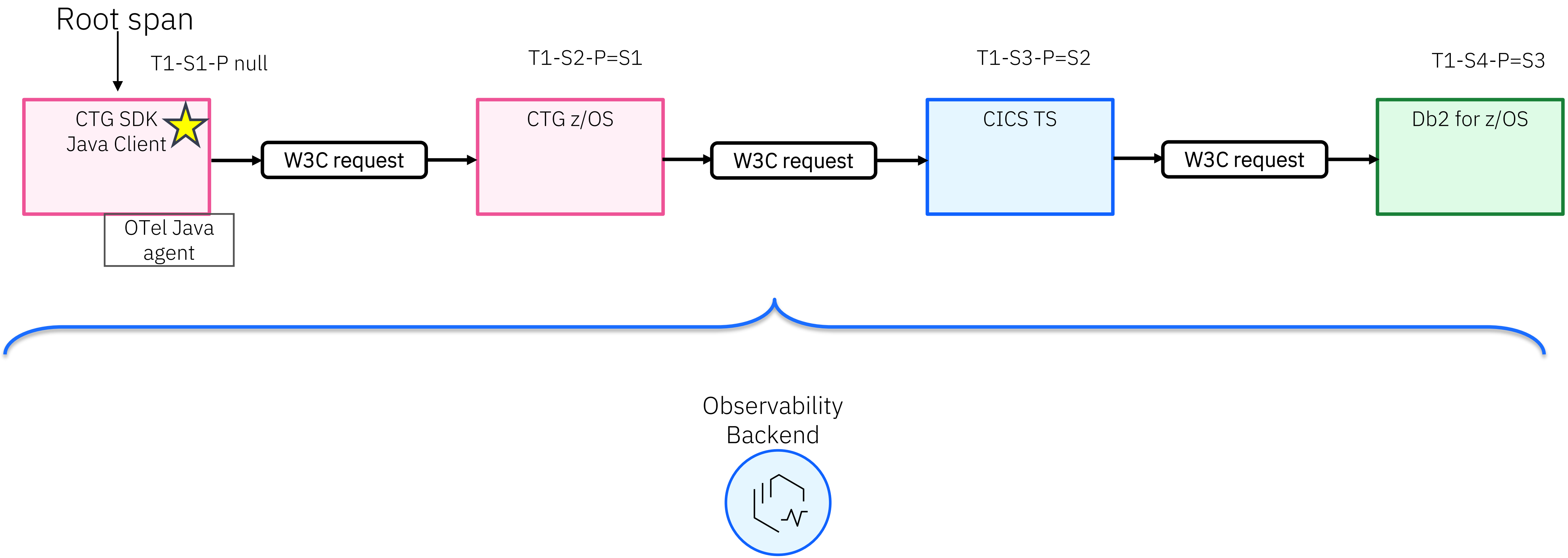


```
{
  "serviceName": "DB2A"
  "spanName": "Db2 unit of work",
  "context": {
    "trace_id": "c6b8e70cf380f7c53b5b56ade5e72c88", <--- Requester trace_id
    "span_id": "e11a6a0f06bd10a4"                   <--- Db2 span_id (STCKF)
    "trace_flags": "01",
  },
  "parent_id": "1d32ee1004345511",                  <--- Requester span_id
  "span_kind": "SERVER",                            <--- Db2 generates span kind "SERVER"
  "start_time": "2024-06-03 11:58:22.209458162 +0000 UTC",
  "end_time": "2024-06-03 11:58:23.337895675 +0000 UTC",
  "status_code": "STATUS_CODE_OK",
  "attributes": {
    "db.system.name": "ibm.db2",
    "db.ibm.db2.version": "V13R1M500",          <--- Db2 version and function level
    "db.ibm.db2.group.name": "DSNCAT",          <--- DS only; DS group name
    "db.ibm.db2.member.name": "DB2A",           <--- DS only; DS member name
    "db.ibm.db2.subsystem.name": "DB2A",        <--- Db2 subsystem name
    "db.ibm.db2.location": "STLEC1",            <--- Db2 location name
    "db.ibm.db2.luwid": "G93D8ED4.F28A.E11A6A0C5FB0.0004",      <--- Db2 LUWID
    "db.ibm.db2.connection.type": "DIST",       <--- Connection type string
    "db.ibm.db2.connection.id": "SERVER",       <--- Connection ID string
    "db.ibm.db2.correlation.id": "::FFFF:9.61.142.212.62090.E11A6A0C5FB0", <--- Correlation ID
    "db.ibm.db2.planname": "DISTSERV",
    "db.ibm.db2.et": 1930,                      <--- "In Db2" Elapsed time in microseconds
    "db.ibm.db2.cpu.gp": 1784,                  <--- "In Db2" GP CPU time in microseconds
    "db.ibm.db2.cpu.ziip": 0,                   <--- "In Db2" zIIP CPU time in microseconds
  },
}
```

An end-to-end example

Tn – trace ID
Sn – span ID
Pn – parent ID

OTel root span creation ★



Root span

T1-S1-P null

CTG SDK Java Client

OTel Java agent

W3C request

T1-S2-P=S1

CTG z/OS

W3C request

T1-S3-P=S2

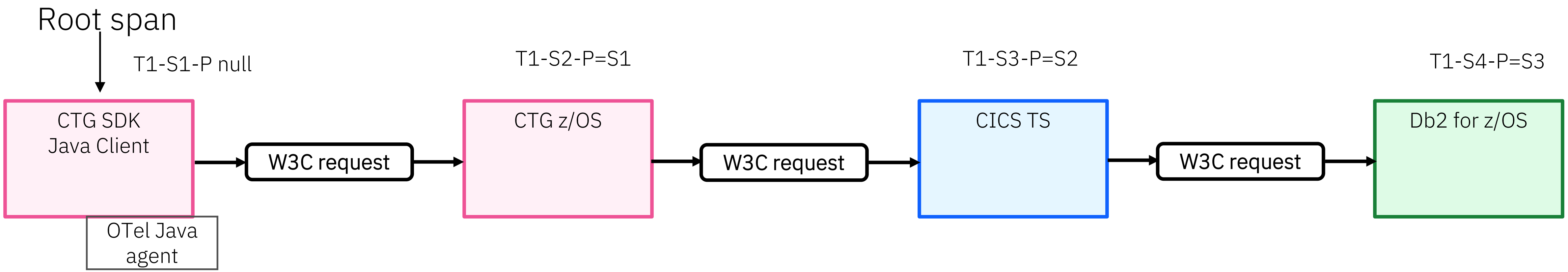
CICS TS

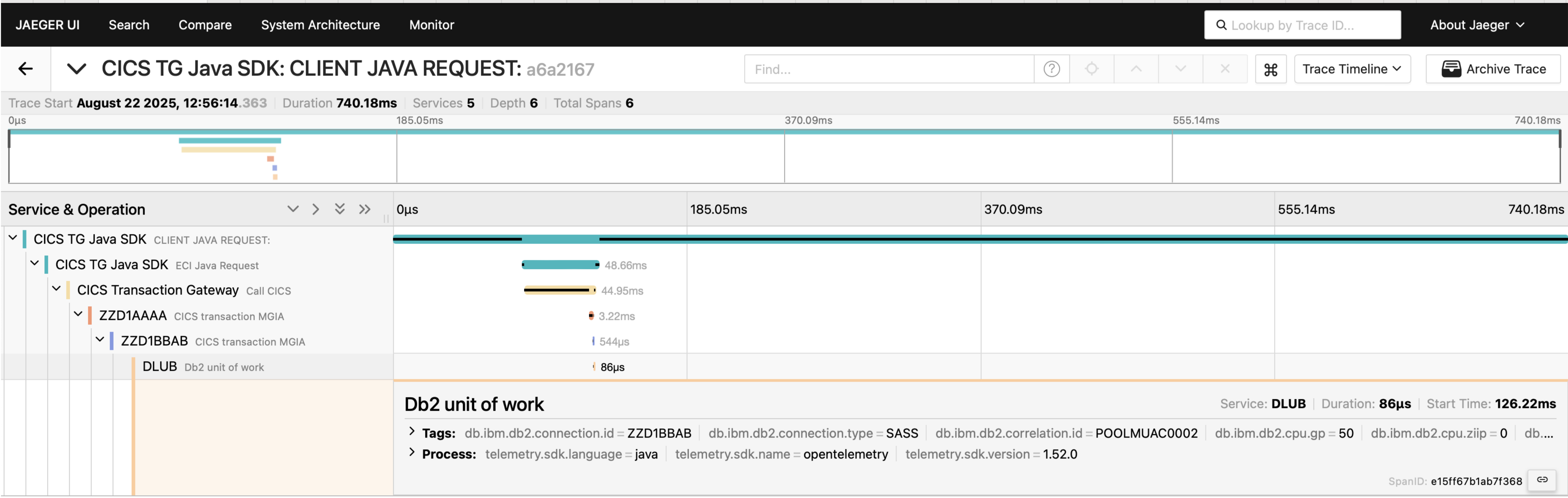
W3C request

T1-S4-P=S3

Db2 for z/OS

Observability Backend





CICS TG Java SDK: CLIENT JAVA REQUEST: a6a2167

Trace Start **August 22 2025, 12:56:14**.363 | Duration **740.18ms** | Services **5** | Depth **6** | Total Spans **6**

Service & Operation

- CICS TG Java SDK CLIENT JAVA REQUEST:
  - CICS TG Java SDK ECI Java Request — 48.66ms
    - CICS Transaction Gateway Call CICS — 44.95ms
      - ZZD1AAAA CICS transaction MGIA — 3.22ms
        - ZZD1BBAB CICS transaction MGIA — 544µs
          - DLUB Db2 unit of work — 86µs

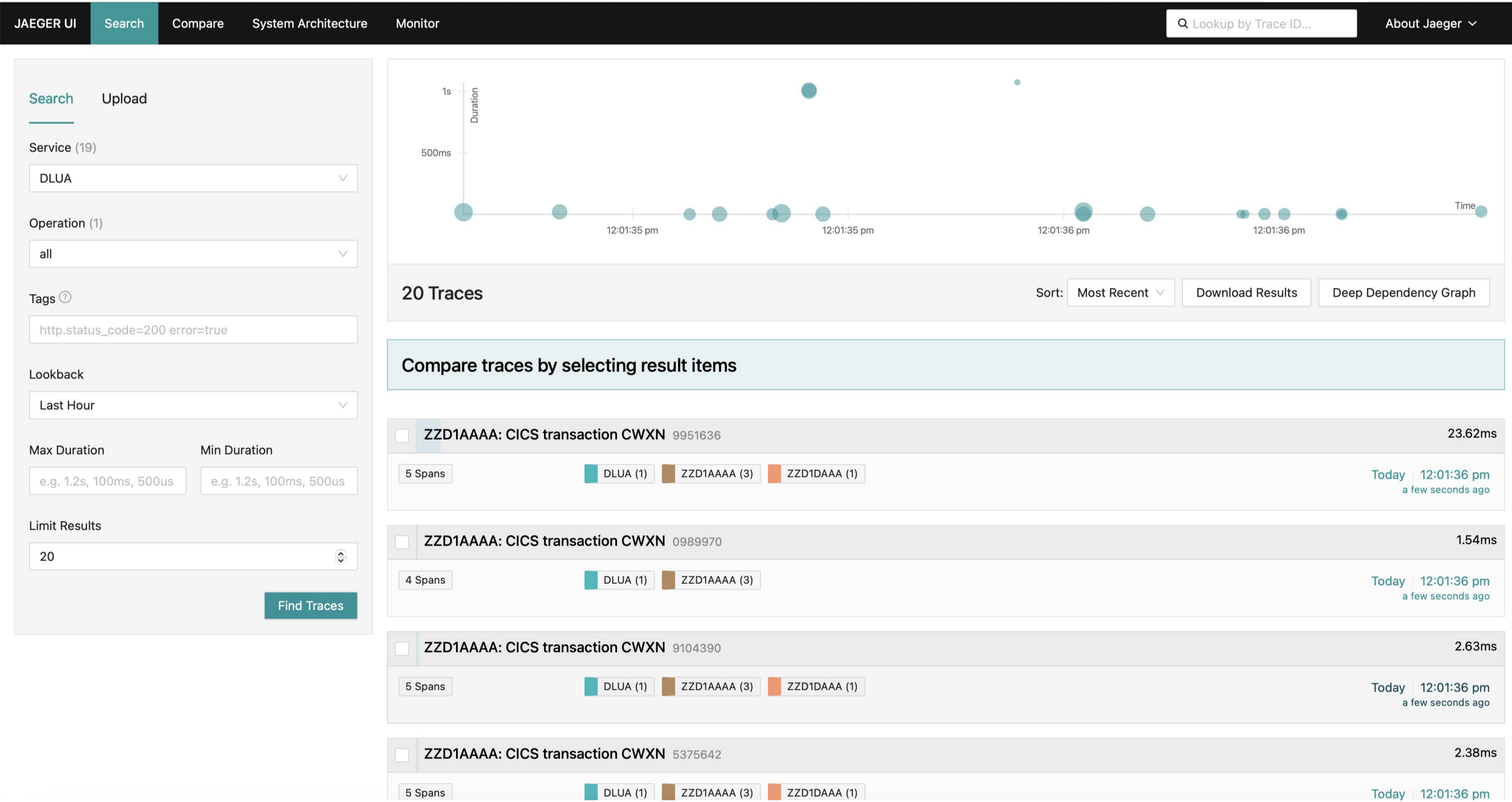
Db2 unit of work

Service: **DLUB** | Duration: **86µs** | Start Time: **126.22ms**

Tags: db.ibm.db2.connection.id = ZZD1BBAB | db.ibm.db2.connection.type = SASS | db.ibm.db2.correlation.id = POOLMUAC0002 | db.ibm.db2.cpu.gp = 50 | db.ibm.db2.cpu.ziip = 0 | db....

Process: telemetry.sdk.language = java | telemetry.sdk.name = opentelemetry | telemetry.sdk.version = 1.52.0

SpanID: e15ff67b1ab7f368



Service (19)
DLUA

Operation (1)
all

Tags
http.status_code=200 error=true

Lookback
Last Hour

Max Duration
e.g. 1.2s, 100ms, 500us

Min Duration
e.g. 1.2s, 100ms, 500us

Limit Results
20

20 Traces

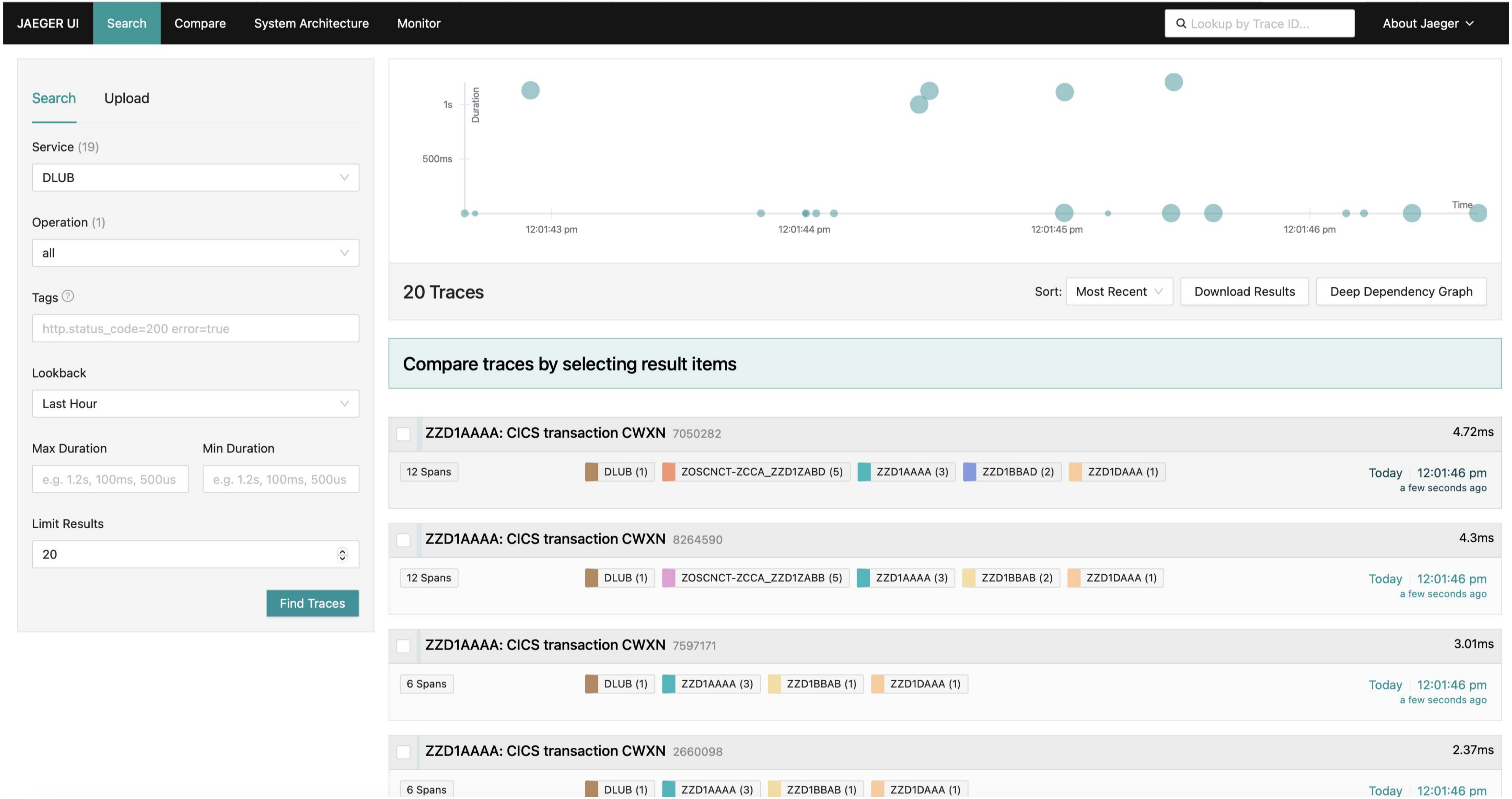
Compare traces by selecting result items

□ ZZD1AAAA: CICS transaction CWXN 9951636 23.62ms
5 Spans DLUA (1) ZZD1AAAA (3) ZZD1DAAA (1)
Today 12:01:36 pm
a few seconds ago

□ ZZD1AAAA: CICS transaction CWXN 0989970 1.54ms
4 Spans DLUA (1) ZZD1AAAA (3)
Today 12:01:36 pm
a few seconds ago

□ ZZD1AAAA: CICS transaction CWXN 9104390 2.63ms
5 Spans DLUA (1) ZZD1AAAA (3) ZZD1DAAA (1)
Today 12:01:36 pm
a few seconds ago

□ ZZD1AAAA: CICS transaction CWXN 5375642 2.38ms
5 Spans DLUA (1) ZZD1AAAA (3) ZZD1DAAA (1)
Today 12:01:36 pm



Service (19)

DLUB

Operation (1)

all

Tags

http.status_code=200 error=true

Lookback

Last Hour

Max Duration

e.g. 1.2s, 100ms, 500us

Min Duration

e.g. 1.2s, 100ms, 500us

Limit Results

20

20 Traces

Compare traces by selecting result items

□ ZZD1AAAA: CICS transaction CWXN 7050282 — 4.72ms

12 Spans · DLUB (1) · ZOSCNCT-ZCCA_ZZD1ZABD (5) · ZZD1AAAA (3) · ZZD1BBAD (2) · ZZD1DAAA (1)

Today | 12:01:46 pm
a few seconds ago

□ ZZD1AAAA: CICS transaction CWXN 8264590 — 4.3ms

12 Spans · DLUB (1) · ZOSCNCT-ZCCA_ZZD1ZABB (5) · ZZD1AAAA (3) · ZZD1BBAB (2) · ZZD1DAAA (1)

Today | 12:01:46 pm
a few seconds ago

□ ZZD1AAAA: CICS transaction CWXN 7597171 — 3.01ms

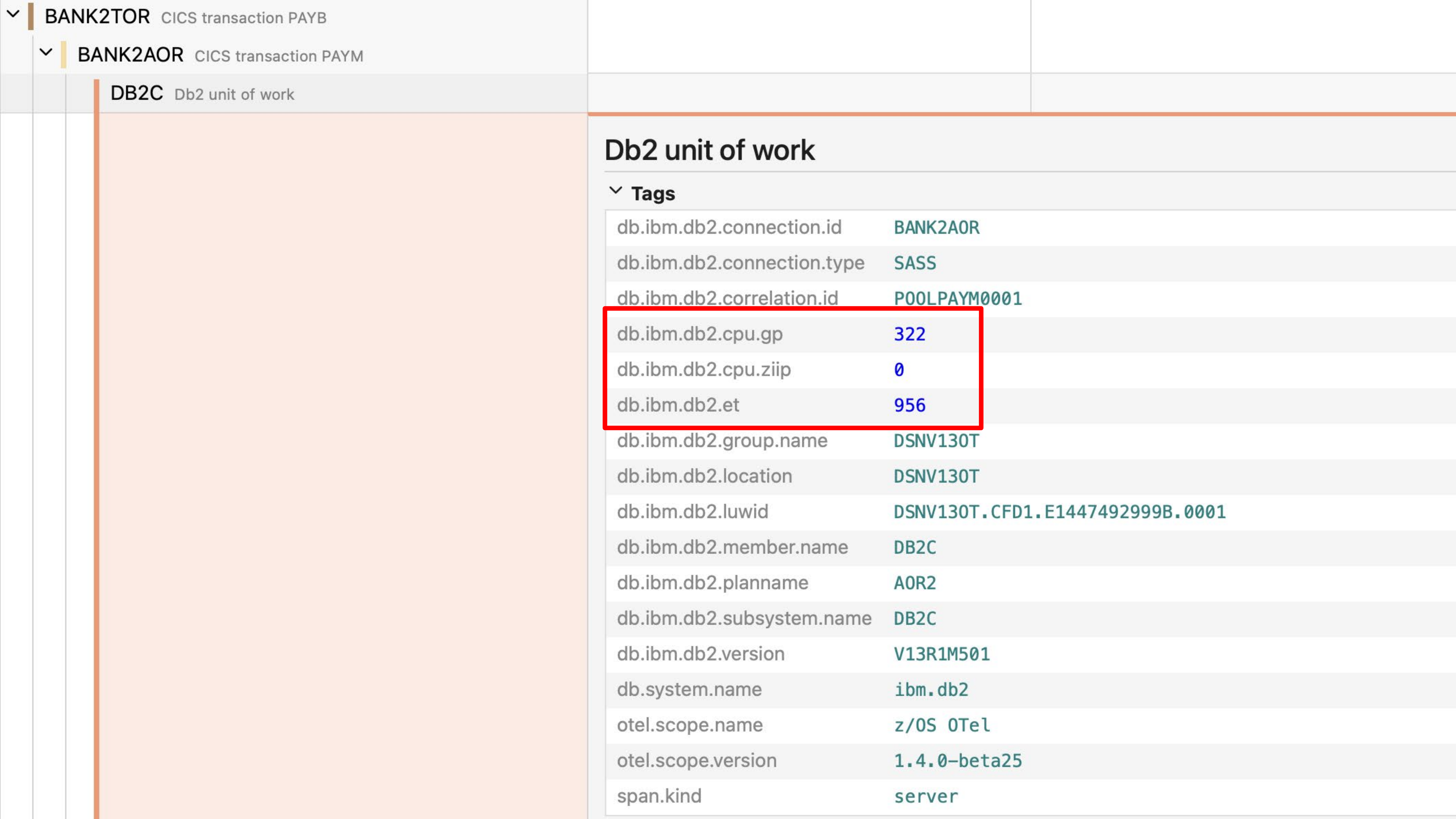
6 Spans · DLUB (1) · ZZD1AAAA (3) · ZZD1BBAB (1) · ZZD1DAAA (1)

Today | 12:01:46 pm
a few seconds ago

□ ZZD1AAAA: CICS transaction CWXN 2660098 — 2.37ms

6 Spans · DLUB (1) · ZZD1AAAA (3) · ZZD1BBAB (1) · ZZD1DAAA (1)

Today | 12:01:46 pm



BANK2TOR CICS transaction PAYB

BANK2AOR CICS transaction PAYM

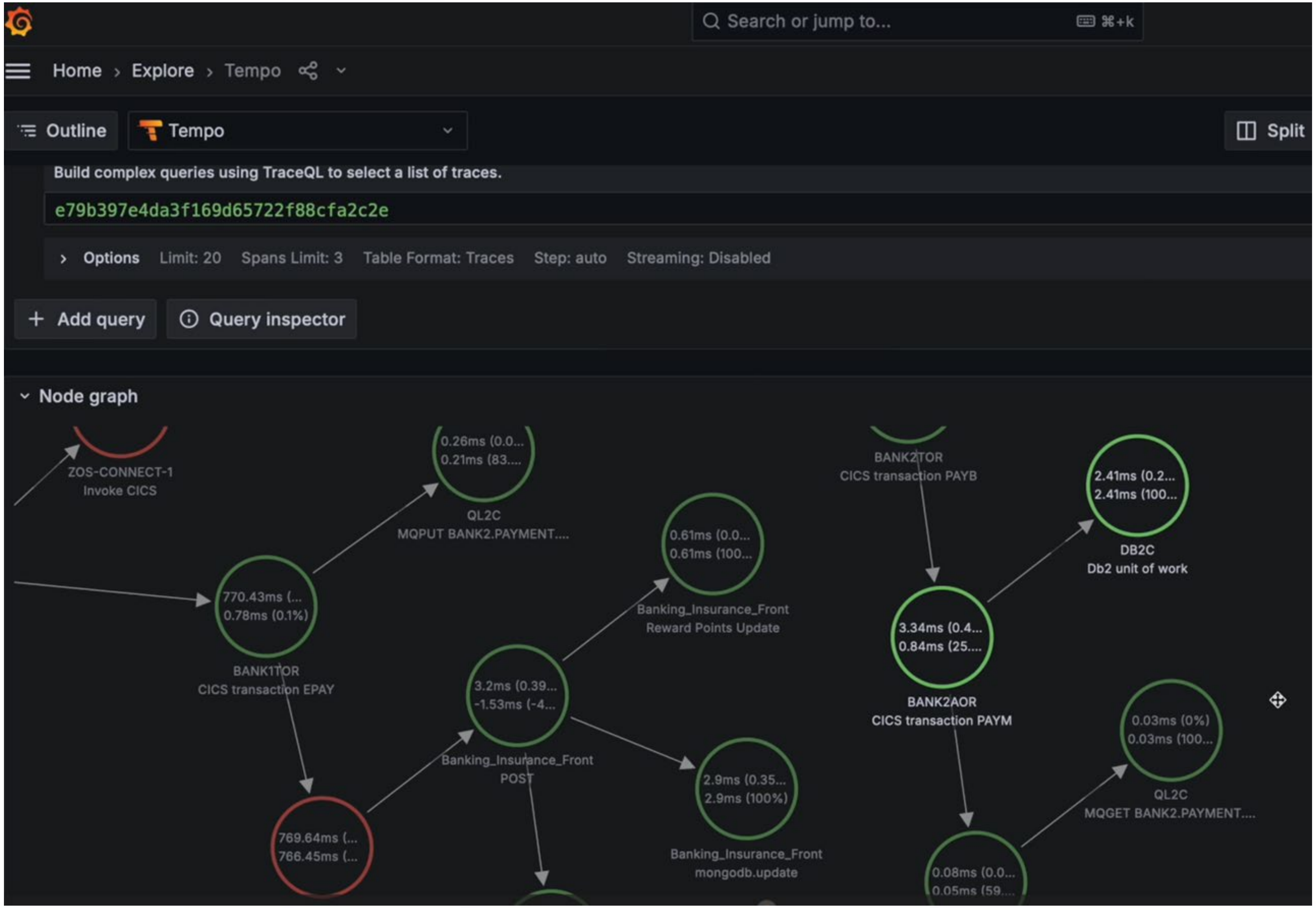
DB2C Db2 unit of work

Db2 unit of work

Tags

db.ibm.db2.connection.id	BANK2AOR
db.ibm.db2.connection.type	SASS
db.ibm.db2.correlation.id	POOLPAYM0001
db.ibm.db2.cpu.gp	322
db.ibm.db2.cpu.ziip	0
db.ibm.db2.et	956
db.ibm.db2.group.name	DSNV130T
db.ibm.db2.location	DSNV130T
db.ibm.db2.luwid	DSNV130T.CFD1.E1447492999B.0001
db.ibm.db2.member.name	DB2C
db.ibm.db2.planname	AOR2
db.ibm.db2.subsystem.name	DB2C
db.ibm.db2.version	V13R1M501
db.system.name	ibm.db2
otel.scope.name	z/OS OTel
otel.scope.version	1.4.0-beta25
span.kind	server

Graphical view example – Transaction Flow



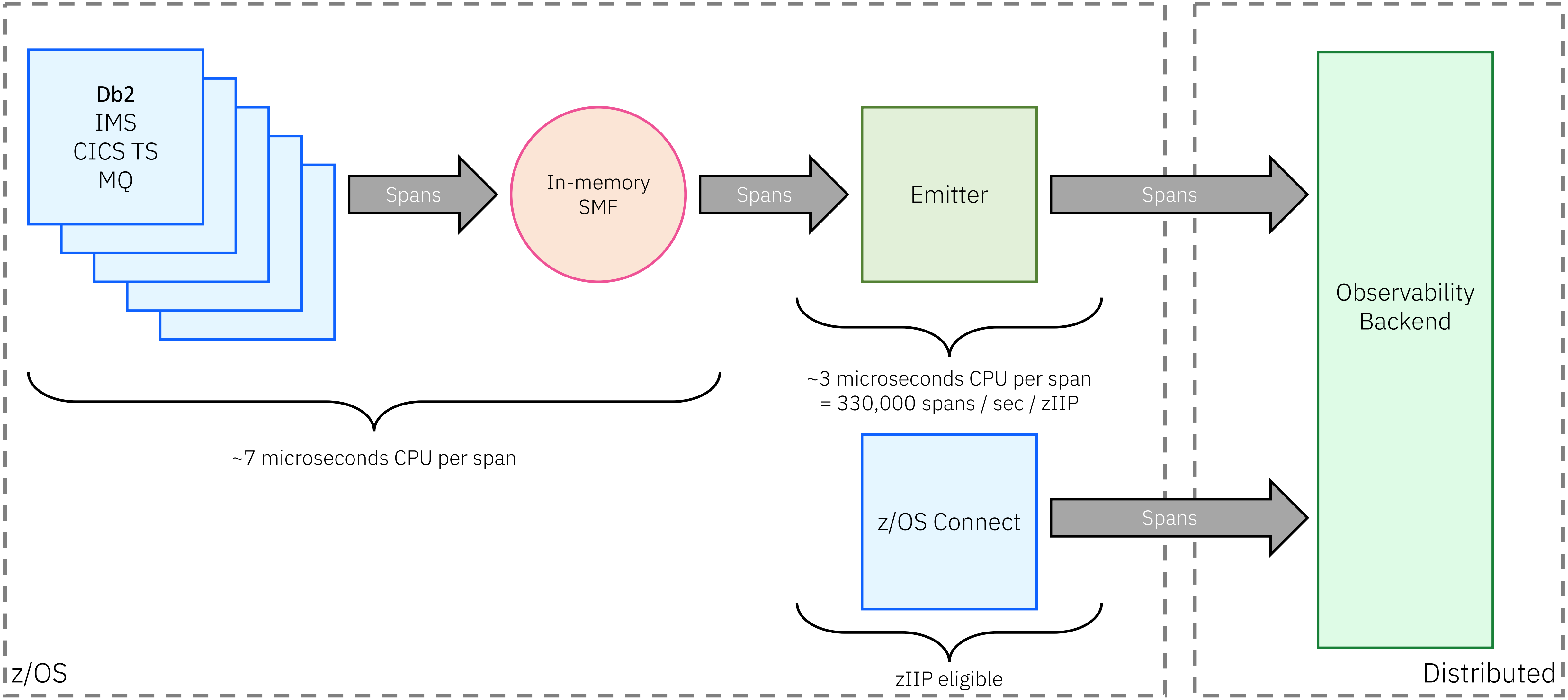
Build complex queries using TraceQL to select a list of traces.

```
e79b397e4da3f169d65722f88cfa2c2e
```

› Options Limit: 20 Spans Limit: 3 Table Format: Traces Step: auto Streaming: Disabled

CPU overview

CPU data from z16 model 7xx



~7 microseconds CPU per span

~3 microseconds CPU per span
= 330,000 spans / sec / zIIP

zIIP eligible

Note: measurements taken at pre-GA time

Next Steps

OpenTelemetry

- Add support for OTel Trace Context Propagation for Outbound DRDA connections to a remote Db2 for z/OS Server
- Enhance Db2 OTel Trace Span record
  - Adding the reporting of IDAA offload activity that occurred during the Db2 unit of work represented by a Db2 OTel Trace Span record
  - User ID for incoming DDF traffic
- Add support for JCC type-2 driver
- Add Support for ODBC/CLI driver (CLI, .Net, Python)

Summary

OpenTelemetry

- What is OpenTelemetry (OTel)
- The importance to adopt OpenTelemetry on System Z
- The System Z strategy
- OTel concepts and terms
- An end-to-end example of tracing a hybrid application
- Db2 OTel distributed tracing implementation
  - Prerequisites
  - Enablement switches
  - What is new with this support
  - Examples

References

- Db2 for z/OS Distributed Tracing and OpenTelemetry support
- Blogs:
  OpenTelemetry Support in Db2 for z/OS
  Practical guide to OpenTelemetry tracing for Java programs connecting to Db2 for z/OS – Part 1

- W3C Trace Context specification
- General OTel overview
- Open Telemetry specifications
- Semantic conventions for SQL databases client operations
- Semantic conventions for database client spans
- OTel SDK exporters (span)
- Semantic conventions for attributes
- OTEL semantic convention attribute registry

- OpenTelemetry tracing with IBM MQ on z/OS
- CICS and OpenTelemetry
- IMS and OpenTelemetry
- z/OS Connect and OpenTelemetry

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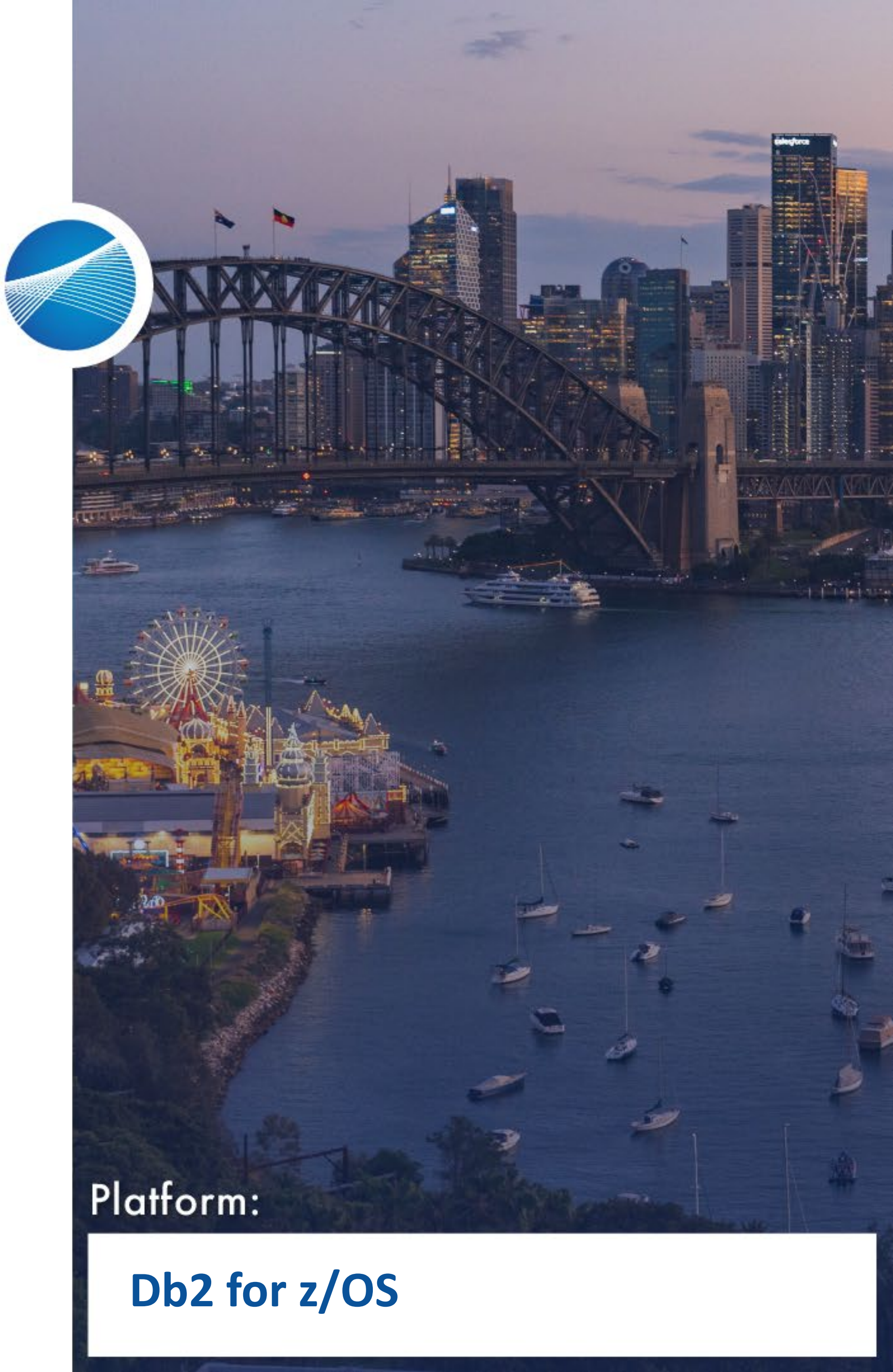
Db2 for z/OS Applications Empowered with OpenTelemetry

Sueli Almeida, IBM Silicon Valley Lab

Contact: sueli@us.ibm.com

Session Code: C10



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