

## # 🕒 Spans & Distributed Tracing Fundamentals

> **Series:** SPANS | **Notebook:** 1 of 8 | **Created:** December 2025

### ## Understanding the Building Blocks of Observability

This notebook introduces distributed tracing concepts and demonstrates how to query span data in Dynatrace using DQL. You'll learn what spans are, how they form traces, and how to explore your distributed systems.

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### ## Prerequisites

Before starting this notebook, ensure you have:

- ✅ Access to a Dynatrace environment with span data
- ✅ DQL query permissions (viewer role minimum)
- ✅ Basic understanding of microservices architecture

### ## 1. What is Distributed Tracing?

In modern microservices architectures, a single user request often travels through dozens of services. **Distributed tracing** captures this journey, showing:

- The **path** a request takes through your system
- **Timing** of each operation along the way
- **Dependencies** between services
- Where **errors** and **latency** occur

![Distributed Tracing Flow]

(

[illegible]

RcvdykiLz4KICA8dGV4dCB4PSIz0DAiIHk9IjIwNSIGZm9udC1mYw1pbHk9IkFyaWFsLCBzYW5zLXNlcmMlIiBmb250LXNpemU9IjEyIiBmb250LXdlaWdodD0iYm9sZCIgZmlsbD0id2hpdGUiIHRleHQtYW5jaG9yPSJtaWRkbGUiPkIudmVudG9yeTwvdGV4dD4KICA8dGV4dCB4PSIz0DAiIHk9IjIyMCIGZm9udC1mYw1pbHk9IkFyaWFsLCBzYW5zLXNlcmMlIiBmb250LXNpemU9IjEyIiBmb250LXdlaWdodD0iYm9sZCIgZmlsbD0id2hpdGUiIHRleHQtYW5jaG9yPSJtaWRkbGUiP'NlcnZpY2U8L3RleHQ+CgoGIDwhLS0gQXJyb3dzIC0tPgogIDxsaW5lIHGxPSIxMzAiIHkxPSIxMDAiIHgyPSIxNzUiIHkyPSIxMDAiIHN0cm9rZT0iIzY0NzQ4YiIgc3Ryb2tLLXdpZHRoPSIyIiBtYXJrZXItZW5kPSJ1cmwoI2Fycm93aGVhZCkiLz4KICA8bGluZSB4MT0iMjgwIiB5MT0iMTAwIiB4Mj0iMzIiIiB5Mj0iMTAwIiBzdHJva2U9IiM2NDc0G0IiIHN0cm9rZS13aWR0aD0iMiIgbWfya2VyLWVuZD0idXJsKCNhcnJvd2hlyWQpIi8+CiAgPGxpbmUgeDE9IjQzMCIGeTE9IjEwMCIGeDI9IjQ3NSIGeTI9IjEwMCIGc3Ryb2tLPSIjNjQ3NDhiIiBzdHJva2Utd2lkdGg9IjIiIG1hcmtdci1lbmQ9InVybgGjYXJyb3doZWFKKSIVPgogIDxsaW5lIHGxPSIyMzAiIHkxPSIxMzAiIHgyPSIyMzAiIHkyPSIxNzUiIHN0cm9rZT0iIzY0NzQ4YiIgc3Ryb2tLLXdpZHRoPSIyIiBtYXJrZXItZW5kPSJ1cmwoI2Fycm93aGVhZCkiLz4KICA8bGluZSB4MT0iMjgwIiB5MT0iMTMwIiB4Mj0iMzgwIiB5Mj0iMTc1IiBzdHJva2U9IiM2NDc0G0IiIHN0cm9rZS13aWR0aD0iMiIgbWfya2VyLWVuZD0idXJsKCNhcnJvd2hlyWQpIi8+CgogIDwhLS0gVHJhY2UgSUQgbGFzIiwWgLS0+CiAgPHJlY3QgeD0iNjAwIiB5PSI2MCIGd2lkdGg9IjE3MCIGaGVPZ2h0PSIxMDAiIHJ4PSI2IiBmaWxsPSIjZmZmIiBzdHJva2U9IiNlMmU4ZjAiIHN0cm9rZS13aWR0aD0iMiIvPgoGIDx0ZXh0IHg9IjY4NSIGeT0iODUiIGZvbnQtZmFtaWx5PSJBcmllhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMiIgZm9udC13ZWlnaHQ9ImJvbGQIiIGZpbGw9ImZmZmIiHRleHQtYW5jaG9yPSJtaWRkbGUiP'LRyYWNlIENvbnRleHQ8L3RleHQ+CiAgPHRleHQgeD0iNjg1IiB5PSIxMTAiIGZvbnQtZmFtaWx5PSJBcmllhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIGZmlsbD0iIzY2NiIgdGV4dC1hbmNob3I9Im1pZGRsZSI+dHJhY2UuaWQ6IGFiYzEyMzwvdGV4dD4KICA8dGV4dCB4PSI2ODUiIHk9IjEzMCIGZm9udC1mYw1pbHk9IkFyaWFsLCBzYW5zLXNlcmMlIiBmb250LXNpemU9IjExIiBmaWxsPSIjNjY2IiB0ZXh0LWFuY2hvcj0ibWlkZGxlIj50cm9wYWdhdGVkIHRocm91Z2g8L3RleHQ+CiAgPHRleHQgeD0iNjg1IiB5PSIxNDgiIGZvbnQtZmFtaWx5PSJBcmllhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMSIGZmlsbD0iIzY2NiIgdGV4dC1hbmNob3I9Im1pZGRsZSI+YWxsIHNlcnZpY2VzPC90ZXh0PgoKICA8IS0tIExlZ2VuZCAtLT4KICA8cmVjdCB4PSIzMCIGeT0iMjcwIiB3aWR0aD0iNzQwIiBoZWlnaHQ9IjQwIiByeD0iNiIgZmlsbD0iI2YxZjVm0SIgc3Ryb2tLPSIjZTJlOGYwIiBzdHJva2Utd2lkdGg9IjEiLz4KICA8dGV4dCB4PSI1MCIGeT0iMjk1IiBmb250LWZhbWlseT0iQXJpYWxsIHhbnMtc2VyaWYiIGZvbnQtcl2L6ZT0iMTIiIGZpbGw9Im2NDc0G0IiPkVhY2ggc2VydmljZSBjcmVhdGVzIGEgU1BBTIB3aXRoIHRpbWluZywg3RhdHVzLCBhbmQy9udGV4dC4gQWxsIHNwYW5zIHNoYXJlIHRoZSBzYW1lIHRyYWNlMlkiHRvIGZvc0gYSBjb21wbGV0ZSBUUKFDRS48L3RleHQ+Cjwvc3ZnPg==)

Without distributed tracing, debugging issues in this flow would require correlating logs from each service manually—an error-prone and time-consuming process.

## ## 2. Understanding Spans

A **span** represents a single unit of work in a distributed system. Think of it as a timer that captures:

- **What** operation was performed
- **When** it started and ended
- **How long** it took

- **Whether** it succeeded or failed
- **Context** about the operation (HTTP method, database query, etc.)

### Key Span Concepts

Concept	Description	Example
<b>Trace</b>	Collection of spans forming a request flow	Checkout transaction
<b>Span</b>	Single operation within a trace	Database query
<b>Root Span</b>	First span in a trace (no parent)	HTTP request to frontend
<b>Child Span</b>	Span triggered by another span	Service calling database

## ## 3. Span Anatomy

Every span contains these essential fields:

! [Span Anatomy]

( dD0iYm9sZCIgZmlsbD0id2hpdGUiIHRleHQTYW5jaG9yPSJtaWRkbGUipLNQUU48L3RleHQ+CgogIDwhLS0gSWRlbnRpdHkgU2VjdGlvbIatLT4KICA8dGV4dCB4PSI2MCIgeT0iMTIWIiBmb250LWZhbw lseT0iQXJpYWsIHNBnbMtc2VyayWiIGZvbnQtcl6ZT0iMTMiIGZvbnQt2VpZ2h0PSJib2xiIB maWxsPSIJMTQ5NmZmIj5JZGVudGloTWvdGV4dD4KICA8bGluZSB4MT0iNjAiIHkxPSIXMjgiIHgy PSIZMDAlIHKyPSIXMjgiIHNOcm9rZT0iI2UyZThmMCIgc3Ryb2tLLXdpZHRoPSIXIi8+CgogIDx0 ZXh0IHg9IjcwIiB5PSIXNTAiIGZvbnQtZmFtaWx5PSJBcmLhbCwgcz2Fucy1zZXJpZiIgZm9udC1za XplPSIXMiIgZmlsbD0iIzZmYy+dHJhY2UuaWQ8L3RleHQ+CIAgPHRleHQgeD0iMTgwIiB5PSIXNTA iIGZvbnQtZmFtaWx5PSJBcmLhbCwgcz2Fucy1zZXJpZiIgZm9udC1zaXplPSIXMSIgmZmlsbD0iIz Y2NiI+TGLua3Mgc3BhbIB0byBWYXJlbQgdHJhY2U8L3RleHQ+CgogIDx0ZXh0IHg9IjcwIiB5PSIXN

[illegible]

jY2Ij5FcnJvciBkZXRhaWxzPC90ZXh0PgoKICA8IS0tIEF0dHJpYnV0ZXMGU2VjdGlvbiAtLT4KIC  
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dGV4dD4KICA8bGluZSB4MT0iMzgwIiB5MT0iMzI2IiB4Mj0iNjQwIiB5Mj0iMzI2IiBzdHJva2U9I  
iNlMmU4ZjAiIHN0cm9rZS13aWR0aD0iMSIvPgoKICA8dGV4dCB4PSIz0TAiIHk9IjM0OCIGZm9udC  
1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmImIiBmb250LXNpemU9IjEyIiBmaWxsPSIjMzMzIj5odHR  
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XR0cmliXRLczwvdGV4dD4KICAgPCEtLSBEeXJhdGlvbiB2aXN1YWwGLS0+CiAgPHJlY3QgeD0iNz  
AiIHk9IjMyMCIGd2lkdGg9IjIwMCIGaGVhZD0iPSIyNSIgcng9IjQyIGZpbGw9IiNmZWYzYzciIHN  
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### Core Span Attributes

Attribute	Type	Description
`trace.id`	string	Unique identifier linking all spans in a trace
`span.id`	string	Unique identifier for this specific span
`span.parent_id`	string	ID of parent span (null for root spans)
`span.name`	string	Operation name (e.g., "GET /api/products")
`start_time`	timestamp	When the span started
`end_time`	timestamp	When the span ended
`duration`	long	Duration in nanoseconds

### Service Context Attributes

Attribute	Type	Description
`service.name`	string	Name of the service
`dt.entity.service`	string	Dynatrace entity ID (reliable for joins)
`service.namespace`	string	Namespace or environment

### Status Attributes

Attribute	Type	Description
`span.status_code`	string	Status: `ok`, `error`, or `unset`
`span.status_message`	string	Error message when status is error

## 4. Span Kinds

The `span.kind` attribute indicates the span's role in the distributed transaction:

(

02XdlawDdD0iYm9sZCIgZmlsbD0id2hpdGUiIHRleHQtYW5jaG9yPSJtaWRkbGUiPkL0VEVSTKFM  
PC90ZXh0PgogIDx0ZXh0IHg9IjIzMCIGeT0iMTMwIiBmb250LWZhbWlseT0iQXJpYWwsIHNhbnMtc  
2VyaWYiIGZvbnQtc2l6ZT0iMTAiIGZpbGw9InJnYmEoMjU1LDI1NSwyNTUsMCM45KSIGdGV4dC1hbm  
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tLT4KICA8cmVjdCB4PSI2MCIGeT0iMTU1IiB3aWR0aD0iMTAwIiBoZWlnaHQ9IjQ1IiByeD0iNiIg  
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mFtaWx5PSJBcmllhCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSiXMSIgZm9udC13ZWlnaHQ9ImJvbG  
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lNlbnQgTWVzc2FnZTwdGV4dD4KCIaGPEtLSBTZXJ2aWNLIEIgQm94IC0tPgogIDxyZWNOIHg9Ij  
QzMCIGeT0iNTU1IHdpZHRoPSiY0DAiIGhlaWdodD0iMTYwIiByeD0i0CIgZmlsbD0iI2ZmZiIgc3R  
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JtaWRkbGUiPlNlcnZpY2UgQjwvdGV4dD4KCIaGPEtLSBTZXJ2ZXIuU3BhbiAtLT4KICA8cmVjdCB  
4PSI0NTAiIHK9Ijk1IiB3aWR0aD0iMTAwIiBoZWlnaHQ9IjQ1IiByeD0iNiIgZmlsbD0idXJsKCNz  
ZXJ2ZXJHcmFkKSivPgogIDx0ZXh0IHg9IjUwMCIGeT0iMTE1IiBmb250LWZhbWlseT0iQXJpYWwsI  
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YWwsIHNhbnMtc2VyaWYiIGZvbnQtc2l6ZT0iMTEiIGZpbGw9Im2NDc00GIiPlNlcnZlcjwvdGV4d  
D4KICA8Y2lyY2xlIGN4PSiXNTAiIGN5PSiYnJiAiIHI9IjgiIGZpbGw9InVybGcgY2xpZW50R3JhZC  
kiLz4KICA8dGV4dCB4PSiXNjUiIHK9IjI2NCIgZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmll  
mIiBmb250LXNpemU9IjExIiBmaWxsPSIjNjQ3NDhiIj5DbGllbnQ8L3RleHQ+CiaGPGNpcMNsZSBj  
eD0iMjMwIiBjeT0imjYwIiByPSi4IiBmaWxsPSJ1cmwoI2ludGVybMfR3JhZCkiLz4KICA8dGV4d  
CB4PSiYNDU1IiHK9IjI2NCIgZm9udC1mYW1pbHk9IkFyaWFsLCBzYW5zLXNlcmllIiBmb250LXNpem  
U9IjExIiBmaWxsPSIjNjQ3NDhiIj5JbnRlcm5hbDwdGV4dD4KICA8Y2lyY2xlIGN4PSiZmZmZmIiAIGN

```
5PSIyNjAiIHI9IjgiIGZpbGw9InVybcGjchJvZHVjZXJHcmFkKSIVPgogIDx0ZXh0IHg9IjMzNSIg
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BzYW1lIHRyYWwNLmlkPC90ZXh0Pgo8L3N2Zz4K)
```

> 💡 **\*\*Tip:\*\*** When a service calls another service, you'll see a CLIENT span on the caller and a SERVER span on the receiver. Both spans share the same `trace.id`.

## ## 5. Trace Structure

A **\*\*trace\*\*** is a tree of spans connected by parent-child relationships:

![Trace Tree]

```
()
```

mImIiBmb250LXNpemU9IjEyIiBmb250LXdlaWdodD0iYm9sZCIgZmlsbD0id2hpdGUiPltGcm9udG  
VuZF0gUE9TVCAvY2hly2tvdXQ8L3RleHQ+CiAgPHRleHQgeD0iNzAwIiB5PSIxMDAiIGZvbnQtZmF  
taWx5PSJBcmLhbCwgc2Fucy1zZXJpZiIgZm9udC1zaXplPSIxMiIgZmlsbD0iIzYzNjZmMSIgdGV4  
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W5lIHgxPSI3MCIgeTE9IjExMCIgeDI9IjcwIiB5Mj0iMTMwIiBzdHJva2U9IiNjYmQ1ZTEiIHNoCm  
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Qtc2l6ZT0iMTAiIGZpbGw9IiMyMmM1NWUiIHRleHQtYW5jaG9yPSJlbmQiPjVtczwvdGV4dD4KCiA  
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XNpemU9IjExIiBmb250LXdlaWdodD0iYm9sZCIgZmlsbD0id2hpdGUiPltQYXltZW50IFNlcnZpY2  
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YW5jaG9yPSJlbmQiPjI4MG1zPC90ZXh0PgoKICA8IS0tIEZyYXVkiENoZWNRIC0tPgogIDxsaW5lI  
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I0IiBmaWxsPSJ1cmwoI2x1YWZHcmFkKSIGZmlsdGVyPSJ1cmwoI3RyZWVtaGFkb3cpIi8+CiAgPHR  
leHQgeD0iMTQ1IiB5PSIyNjQiIGZvbnQtZmFtaWx5PSJBcmLhbCwgc2Fucy1zZXJpZiIgZm9udC1z  
aXplPSIxMCIGZm9udC13ZWlnaHQ9ImJvbGQiIGZpbGw9IndoaXRlIj5bUGF5bWVudCBHYXRld2F5X



progressively add complexity.

> ⚠️ **\*\*Important:\*\*** Always use `limit` when exploring data to avoid processing millions of spans.

```
```dql
// Basic span query – fetch all spans from the last 2 hours
fetch spans
| limit 100
```
```

### ### Selecting Specific Fields

Instead of retrieving all span attributes, select only the fields you need for better performance and readability:

```
```dql
// Select specific span fields for analysis
fetch spans
| fields start_time,
         trace.id,
         span.id,
         span.name,
         span.kind,
         service.name,
         duration,
         span.status_code
| sort start_time desc
| limit 50
```
```

### ### Understanding Duration

Span duration in Dynatrace is stored in **\*\*nanoseconds\*\***. Here's how to convert to more readable formats:

> 💡 **\*\*Tip:\*\*** 1 millisecond = 1,000,000 nanoseconds

```
```dql
// Convert duration from nanoseconds to milliseconds and seconds
fetch spans
| fields start_time,
         span.name,
         service.name,
         duration,
         duration_ms = duration / 1000000.0,    // Convert to milliseconds
         duration_sec = duration / 1000000000.0 // Convert to seconds
| sort duration desc
```
```

```
| limit 20
```
```

### ### Filtering Spans

Use filters to focus on specific spans. Filter early in your query for better performance:

```
```dql
// Filter spans by service and span kind
fetch spans
| filter span.kind == "server"
| filter duration > 100ms
| fields start_time,
         service.name,
         span.name,
         duration_ms = duration / 1000000.0,
         span.status_code
| sort duration_ms desc
| limit 50
```
```

### ### Discovering Services in Your Environment

Find all services that are generating span data:

```
```dql
// Discover all services with span data
fetch spans
| filter span.kind == "server"
| summarize {span_count = count()}, by:{service.name}
| sort span_count desc
| limit 50
```
```

---

## ## Summary

In this notebook, you learned:

- ✅ **What distributed tracing is** and why it's essential for modern architectures
- ✅ **What spans are** and their core attributes
- ✅ **Span anatomy** including trace.id, span.id, duration, and status
- ✅ **Span kinds** (server, client, internal, producer, consumer)
- ✅ **Trace structure** with parent-child relationships
- ✅ **Basic DQL queries** to fetch and explore span data

✅ **\*\*Duration conversion\*\*** from nanoseconds to human-readable formats

---

## ## Next Steps

Continue to **\*\*SPANS-02: Querying Spans with DQL\*\*** to learn:

- Filtering spans by service, operation, and attributes
- Finding specific traces by trace.id
- Querying HTTP and database spans
- Combining multiple filters for precise analysis