



ANALYTICS AND DATA

TechCasts

Temporal Data Lineage and Impact Analysis in Oracle Database: Evolution to Oracle Graph Architecture with Time-Travel Capabilities

Karin Patenge, Senior Principal Product Manager, Oracle Spatial & Graph
Tomislav Zarkovic, Business Intelligence Consultant, Koios Consulting

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June 25th

Our New Favorite Features of OAC – March & May 2026 Releases

Presented by Carter Beaton, Taiwo Ajayi & Gautam Pisharam



July 23rd

Temporal Data Lineage and Impact Analysis in Oracle Database: Evolution to Oracle Graph Architecture with Time-Travel Capabilities

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August 20th

How and Where Oracle 26ai Beats Python for Data Preparation

Presented by Dr. Holger Freidrich

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<https://www.linkedin.com/company/analytics-and-data-oracle-user-community>

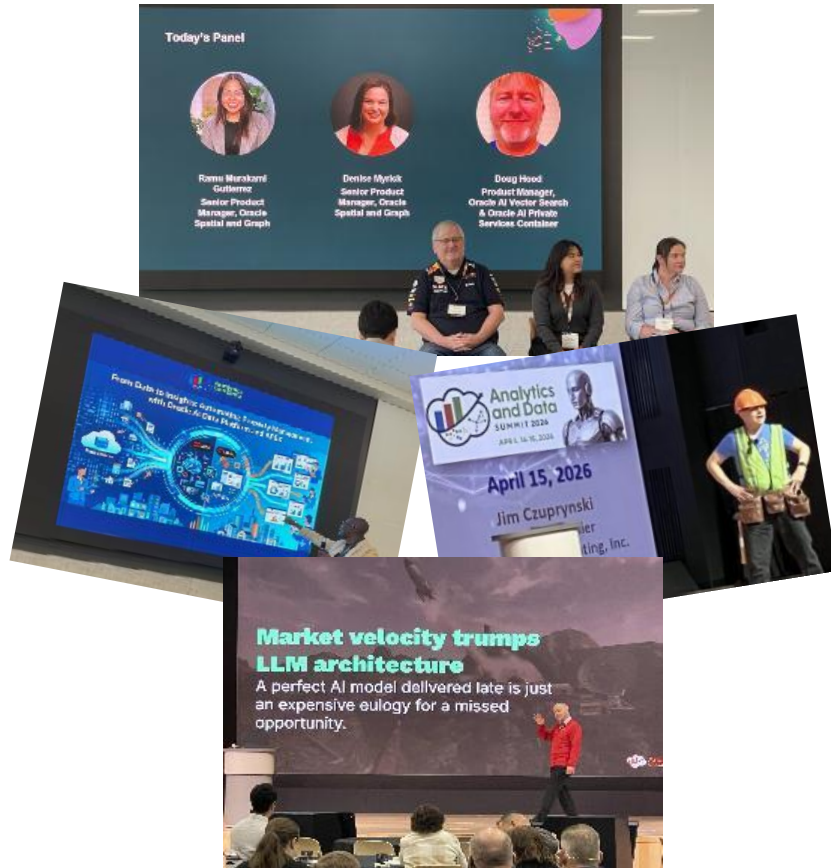


Spatial + Graph SIG

bit.ly/Spatial-Graph-LinkedIn



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bsky.social**



**Analytics
and Data**
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is OPEN!!***



Operational (SQL) Property Graphs in the Oracle AI Database



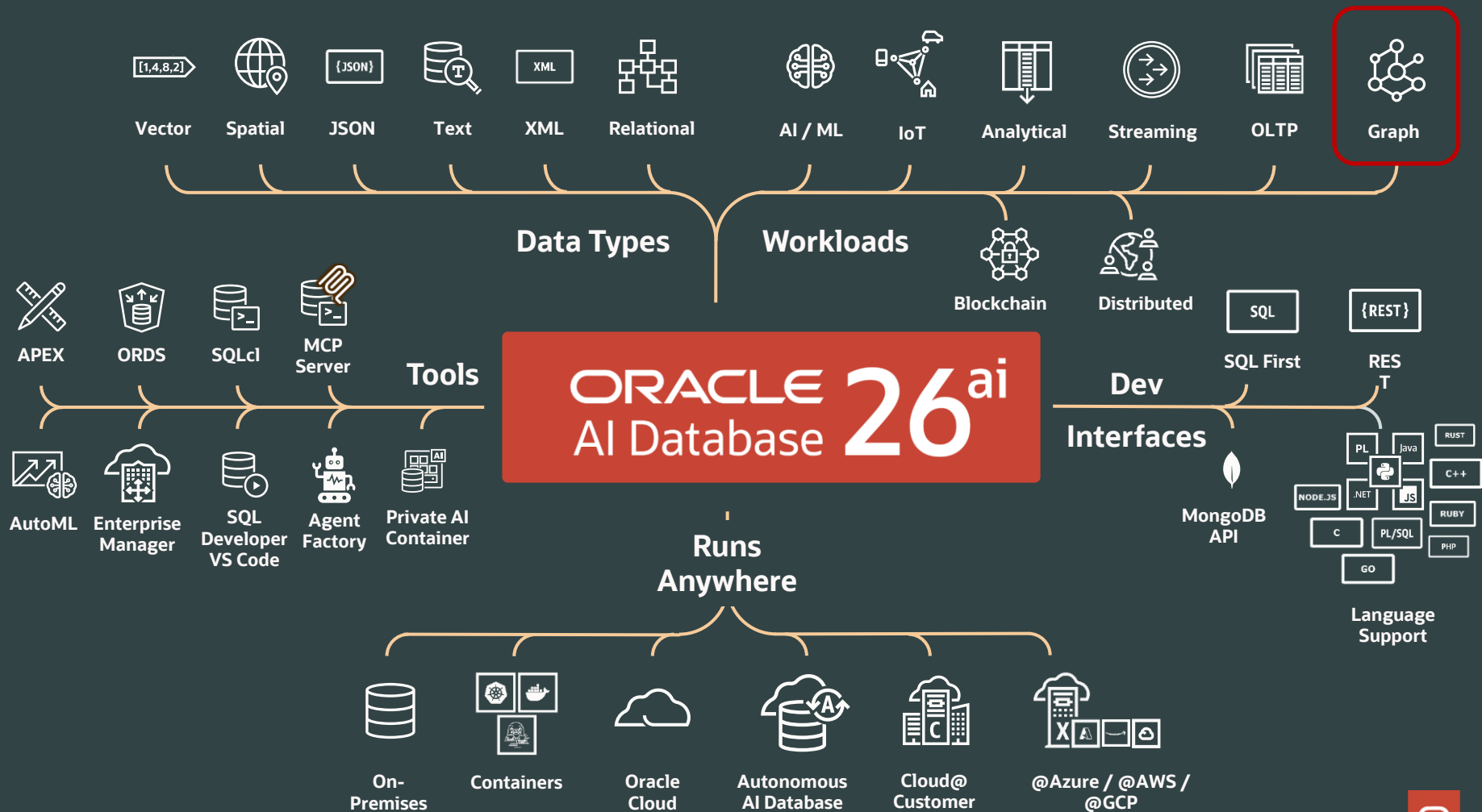
Analytics and Data
ORACLE USER COMMUNITY

Karin Patenge | karin.patenge@oracle.com

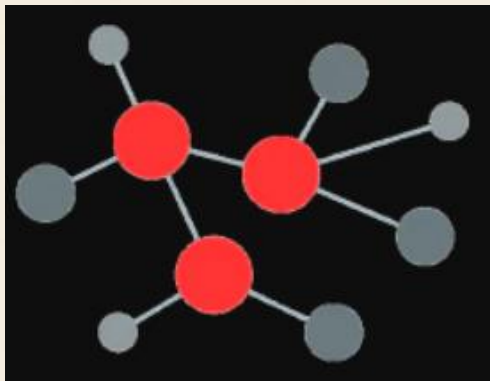
Oracle Database Product Management

Spatial & Graph Technologies

Oracle Corporation

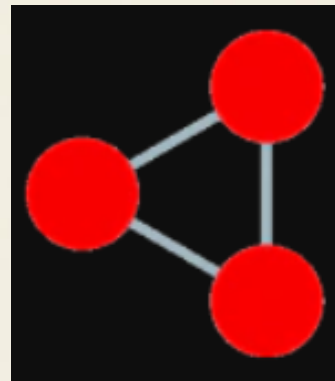


Graph Support in the Oracle Database



(Labeled) Property Graphs

- Since Oracle Database version 11.2
- Generic graph model
- Keywords: Graph Pattern-Matching, Graph Algorithms, Graph Machine Learning, PGQL, SQL/PGQ



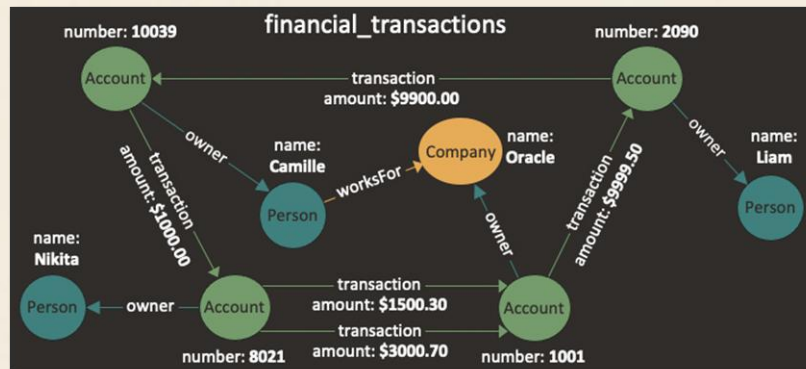
RDF Knowledge Graphs

- Since Oracle Database version 10.2
- Specialized, standards-based graph model
- Keywords: Semantic technologies, Linked Data, SPARQL, RDF, RDF-S, OWL, Ontologies, Inferencing

No additional license costs
All editions of the Oracle DB
All Oracle DB Cloud Services



Brief recap: The Property Graph Data Model



Source: pgql-lang.org

A representation of the real world, focusing on relationships using

- **Vertices** (nodes)
representing a *Thing*
- **Edges**
representing connections between vertices
- **Properties**
expressed as key-value pairs attached to vertices and/or edges
- **Labels**
representing the type of a vertex or edge

Create and Analyze Property Graphs using SQL



Prerequisite: Oracle Database 23ai or higher

- **Operational (SQL) Property Graphs** using **SQL/PGQ**
- SQL/PGQ is an extension to SQL:2023 (ISO/IEC 9075-16)

Step 1: Create a graph

CREATE PROPERTY GRAPH to build graphs as **metadata objects** over the original data

- Work with data where it lives ➡ No data copy or move

Step 2: Analyze the graph

MATCH clause inside the **GRAPH_TABLE** function to run **Pattern-Matching Queries**

New: DBMS_OGA to run **Graph Algorithms** (PageRank and variants, Bellman-Ford, Weakly Connected Components)

Schema flexibility through JSON

- JSON document as a property
- JSON element as a property

Combines all converged DB features using SQL

See also:

www.oracle.com/a/ocom/docs/database/operational_property_graph_with_23c.pdf
blogs.oracle.com/database/post/property-graphs-in-oracle-database-26ai-the-sql-pgq-standard



Tools



Tools to work with SQL Property Graphs in 26ai



All your existing SQL tools work with graphs

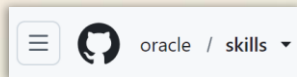
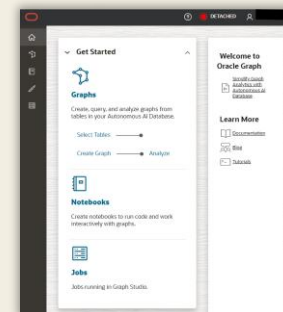
- SQL Developer (**New: 26.2**), SQLcl
- VSCode
 - SQL Developer Extension
 - SQL Developer Graph Visualization Extension
- Graph Visualization JavaScript Library
- APEX (Plug-in, Sample Graph Viz app)
- Advanced queries, graph algorithms

Graph Server and its clients add additional capabilities

- APIs and CLIs
- Graph Algorithms
- Graph Machine Learning
- Graph Visualization Web App
- Graph Visualization JavaScript Library
- Integration with Jupyter Notebook/Lab

Graph Studio

- Integrated tool of the Autonomous AI Database
 - Automated and AI-supported graph modeling
 - Built-in notebook support including visualization tools



github.com/oracle/skills > db > appdev > sql-property-graph.md



Graph-enabled low-code app dev

Property Graphs with
Oracle Application Express (APEX)



Sample Graph Viz app



Sample Graph Visualizations kpatenge ▾

Sample Graph Visualizations

This is a sample application that showcases the features of the **Oracle Graph Visualization Toolkit (GVT)** APEX plugin. Click on the different features below to explore them in depth.

Basic Graph

Styling

Interaction

Selection

Network Evolution

Saving Graph State

ORA_SQLGRAPH_TO_JSON Function

Keyboard Navigation Shortcuts



Getting started

Try it out yourself



Livelabs.oracle.com

The screenshot displays the Livelabs.oracle.com interface. At the top, there's a navigation bar with the Livelabs logo, a search bar containing "Property Graph", and links for "Event Code" and "Sign In". Below the navigation bar, the main content area is divided into a left sidebar and a main grid.

Left Sidebar:

- Run on Your Environment:** (12) Run on Your Environment, (1) Sprints
- Product:** Filter Product
 - Oracle Graph (10)
 - Custom Image (9)
 - Oracle AI Database (5)
 - Autonomous AI Database (4)
 - Autonomous AI Lakehouse (3)
 - Show All
- Workshop Series:**
 - Autonomous DB Serverless (4)
 - MovieStream Series (1)
- Focus Area:** Filter Focus Area
 - Database (19)
 - Development (8)
 - Analytics (7)
 - AI/Machine Learning (6)
 - Data Warehouse/Lakehouse (5)
 - Show All
- Role:**
 - Application Developer (14)
 - Business Analyst (7)
 - Business User (5)
 - Data Engineer (3)

Main Grid:

industries.

More LiveStacks, workshops, and sprints are available in the other region below.

- Explore Operational Property Graphs in Oracle AI Database**
 - This workshop focuses on working with Property Graphs in Oracle AI Database. You will create a (...)
 - 2 hrs, 30 mins | 15855 Views
- Gain a competitive edge with Generative AI, use AI to generate the Edge and Vertices that make Property Graph data structures**
 - This workshop will show users how to extract relational data from a vectorized text file and use (...)
 - 3 hrs | 2854 Views
- Use of Graph RAG and Vector Search for Enhanced User Prompt to LLMs**
 - This workshop focuses on working with Property Graphs in Oracle AI Database. You will create a (...)
 - 2 hrs | 8495 Views
- Build Energy & Utilities Intelligence on One Governed Oracle Data Platform** (LiveStack)
 - Explore how Oracle AI Database 26ai helps energy and utility organizations connect grid operations, (...)
 - 7 Steps
- Autonomous AI Lakehouse - The PeakGear LiveStack** (LiveStack)
 - The PeakGear Autonomous AI Lakehouse LiveStack uses a modern retail scenario to demonstrate how (...)
 - 7 Steps
- Build Higher Education Intelligence on One Governed Oracle Data Platform** (LiveStack)
 - Explore how Oracle AI Database 26ai helps higher education institutions connect student success, (...)
 - 6 Steps

Show less ^

Workshops, Sprints, and LiveStacks



Summary



Graphs offer a different view on your data

With Oracle 26ai you can use your existing tools to work with graphs

Oracle Graph is the graph database for the enterprise



More information



Useful Resources (1/2)

General information

- www.oracle.com/database/graph/
- Graph Size Estimator
www.oracle.com/webfolder/assets/graph-size-estimator/index.html
- PGQL Spec 2.1 pgql-lang.org/spec/2.1/

Documentation Release 26.2

- Oracle Property Graph Developer's Guide
docs.oracle.com/en/database/oracle/property-graph/26.2/index.html
- Property Graph Visualization Developer's Guide and Reference
docs.oracle.com/en/database/oracle/property-graph/26.2/pgvtr/graph-visualization-library-reference.html
- Python API
docs.oracle.com/en/database/oracle/property-graph/26.2/pypgx/pypgx/api.html
- Java API
<https://docs.oracle.com/en/database/oracle/property-graph/26.2/spgjav/index.html>
- Graph Server REST API
docs.oracle.com/en/database/oracle/property-graph/26.2/spgdg/graph-server-rest-api-version-2.html

GitHub

- Machine Learning Workshop with Oracle Property Graph
github.com/operard/mlgraph
- github.com/oracle-samples/oracle-graph

Oracle Cloud MarketPlace

- Graph Server and Client – Image
cloud.oracle.com/marketplace/application/74883066

YouTube

- youtube.com/@oraclespatialandoraclegraph
- Analytics and Data Techcasts: youtube.com/@analyticsanddatatechcasts90

Blogs

- Oracle Database Insider – Graph: blogs.oracle.com/database/category/db-graph
- Medium: medium.com/tag/oracle-graph
- Database & Cloud Technology: blogs.oracle.com/coretec/

LinkedIn

- Oracle Spatial and Oracle Graph group: www.linkedin.com/groups/1848520/

Useful Resources (2/2)

- Oracle SQL Developer for VSCode
marketplace.visualstudio.com/items?itemName=Oracle.sql-developer
- Oracle SQL Developer Graph Visualization for VSCode
marketplace.visualstudio.com/items?itemName=Oracle.sql-developer-graph-visualization
- Graph Server and Clients downloads
oracle.com/database/technologies/spatialandgraph/property-graph-features/graph-server-and-client/graph-server-and-client-downloads.html
- APEX
 - Sample Graph App
github.com/oracle/apex/tree/26.1/sample-apps/sample-graph-visualizations
 - Graph Visualization Plugin
github.com/oracle/apex/tree/26.1/plugins/region/graph-visualization
- Oracle Graph Visualization Library JavaScript API
docs.oracle.com/en/database/oracle/property-graph/26.2/pgisd/index.html
- Get Started with APEX Graph Visualization Plug-in
docs.oracle.com/en/cloud/paas/autonomous-database/csgu/get-started-apex-graph-visualization-plug.html
- Oracle Graph samples on GitHub
github.com/oracle-samples/oracle-graph
- Linkurious Ogma integration with Oracle SQL Property Graphs
linkurious.github.io/ogma-oracle-parser/getting-started.html

— KOIOS · ORACLE STACK

via

Visual
Interactive
Analysis

Column-level lineage, forward impact analysis, and time-travel across your entire db — interactive, and 100% Oracle-native.

LINEAGE

IMPACT

TIME-TRAVEL

MOTIVATION

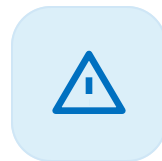
Why We Built VIA



No Column-Level Lineage

Tracing a column through many layers was manual, slow and error-prone — only senior developers could do it.

ODI / METADATA



No Impact Analysis

Source column changes broke things downstream — and the failures were silent, discovered only after the fact.

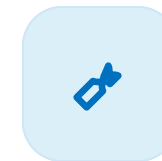
IMPACT / NO ALERTS



No Historical View

Once a mapping was overwritten, the previous version was gone forever — no way to look back in time.

SCD2 / NO VERSIONS



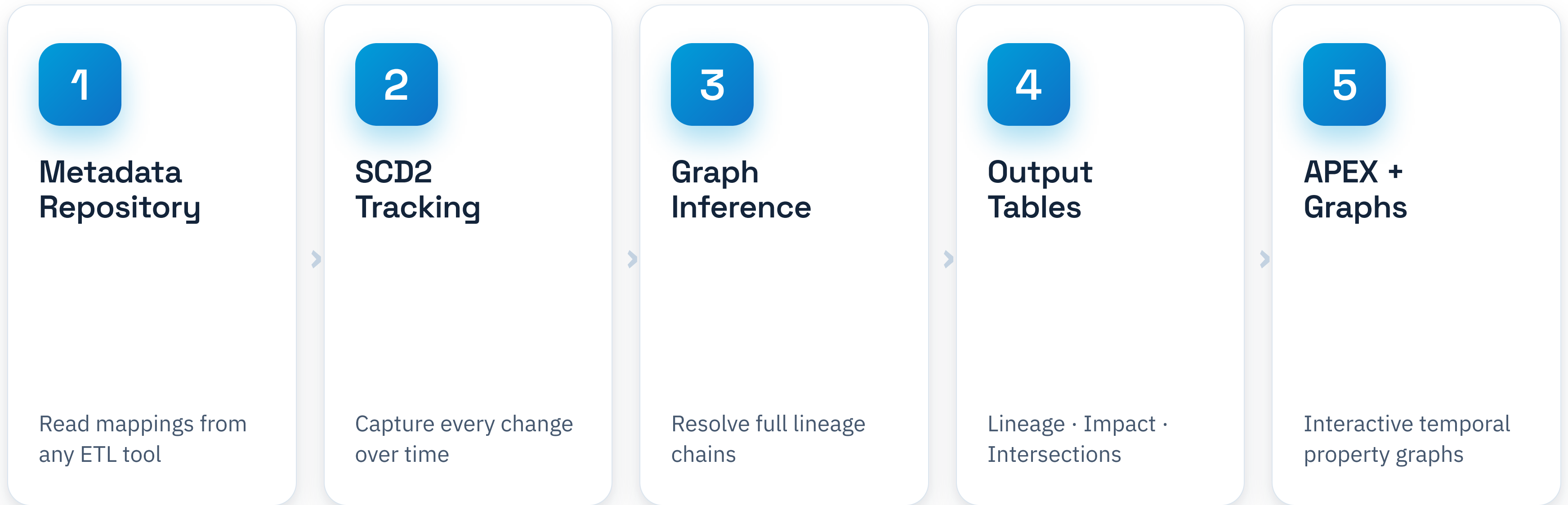
Manual Maintenance

Thousands of ODI mappings tracked entirely by hand. Zero automation, and endless, repetitive upkeep.

MANUAL / MAPPINGS

— SYSTEM WALKTHROUGH

How VIA Works — Step by Step



100% ORACLE-NATIVE

No external tooling · no additional licensing

1

— SYSTEM WALKTHROUGH

Metadata Repository

- Metadata Sources**

Any ETL / EL-T tool with accessible metadata is supported.
- Column Expressions**

Transformation logic — joins, filters and derivations per column.

- ETL TOOL**

Any ETL / EL-T
- METADATA**

Column mappings
- COLUMNS**

All attributes

COLUMNS NEEDED — THE BARE MINIMUM

1 • MAPPINGS & FOLDERS

FOLDER_NAME EXECUTION_NAME MAPPING_NAME

2 • MAPPING TABLES

SCHEMA_NAME TABLE_NAME TABLE_TYPE TABLE_NAME_IN_MAPPING
DIRECTION

3 • COLUMN EXPRESSIONS

OBJECT_TYPE COLUMN_NAME EXPRESSION

4 • JOINS

JOIN_NAME JOIN_TYPE JOIN_POSITION

5 • PHYSICAL COLUMN CATALOG

REFERENCE_NAME

5 simple extracts, ~15 columns — all VIA needs. That's exactly why any ETL / EL-T tool's metadata plugs straight in.

2

— SYSTEM WALKTHROUGH

SCD2 Tracking

-  **Temporal Tracking**
Full history preserved — nothing is ever deleted, only added and closed.
-  **Loads From One Source**
The same SCD2 tables feed both the initial load and incremental loads.

-  **SCD2**
Type 2 dimension
-  **TRACKING**
Historic versions
-  **HISTORY**
Time-travel

HISTORIC TABLE — ONE ROW PER VERSION			
VERSION	VALID_FROM	VALID_TO	IS_CURRENT
v1	2024-01-01	2025-03-10	N
v2	2025-03-10	2026-02-01	N
v3	2026-02-01	—	Y

3 — SYSTEM WALKTHROUGH

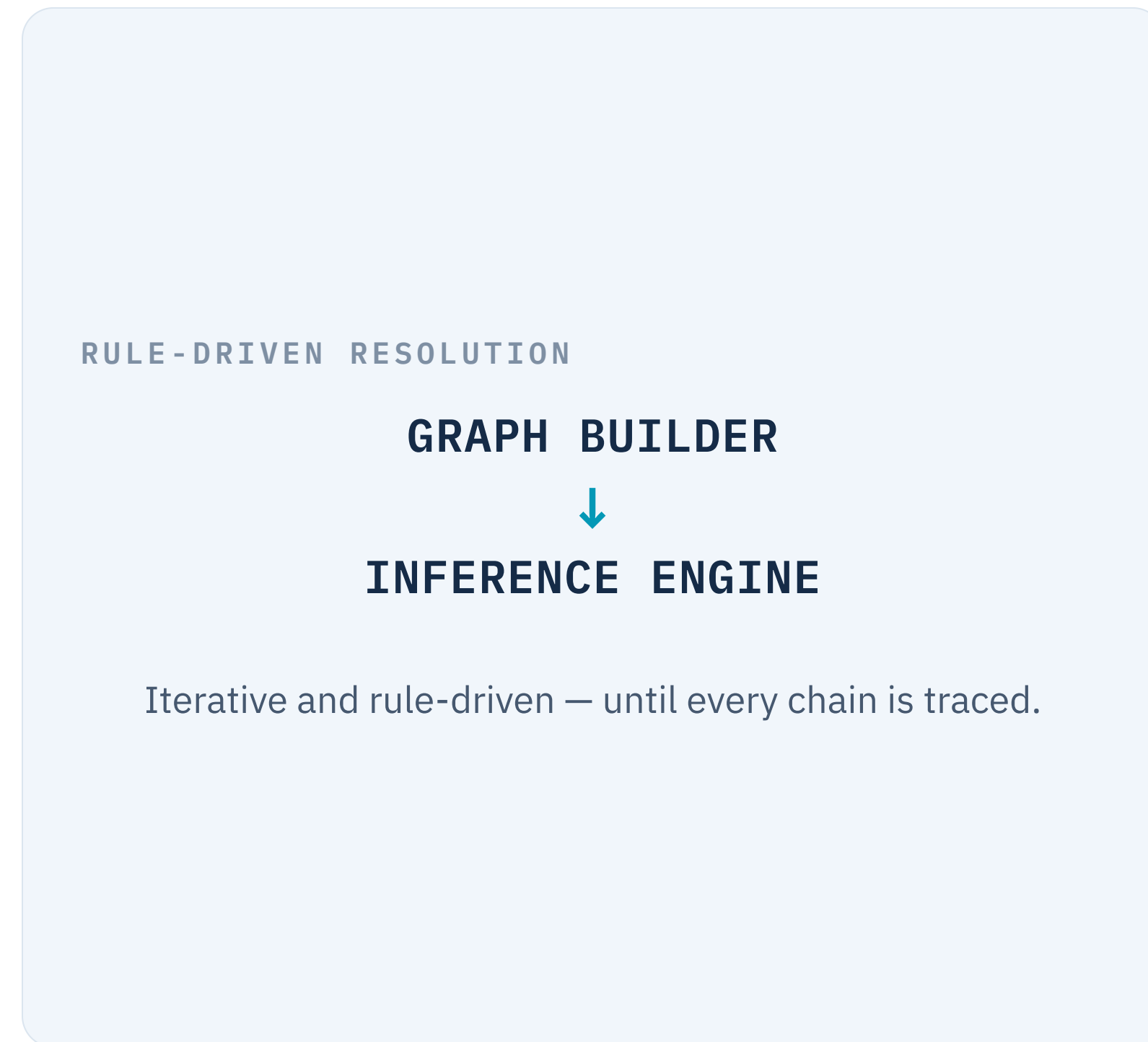
Graph Inference

- Graph Builder**
Turns metadata into nodes & edges — one node per column.
- Inference Engine**
Rule-driven traversal that resolves every dependency.

GRAPH
Node network

INFERENCE
Rule-driven

RESOLVE
Full chain



4 — SYSTEM WALKTHROUGH

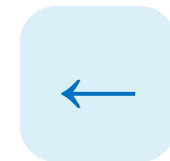
Output Tables



Three SCD2 Tables

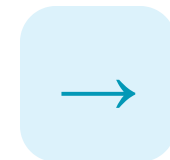
Each output is itself fully SCD2-tracked and historised.

Lineage, Impact and Intersections — together they give both the detail and the big picture.



LINEAGE

Detailed **backward** trace — column to raw source.



IMPACT

Detailed **forward** trace — what each column feeds.



INTERSECTIONS

Bi-directional **big picture** across the db.

5 — SYSTEM WALKTHROUGH

APEX & Graphs



APEX Interface

Interactive UI — the explorer you'll see live in a few minutes.



Property Graphs

Temporal graphs queried via `GRAPH_TABLE()`, rendered with Cytoscape.js — Oracle's GVL plug-in is also supported.



Offline Export

One-click download of the current graph — any view, filters and as-of date — as a self-contained interactive HTML file that opens anywhere.



APEX

Oracle APEX



CYTOSCAPE

Rendering

```

QUERY · GRAPH_TABLE ( )

SELECT * FROM GRAPH_TABLE (
  via_lineage
  MATCH (c) -[:FEEDS]-> (t)
  WHERE c.column = :selected
  COLUMNS ( t.schema, t.table,
             t.column, t.layer )
)
AS OF '2026-02-01';

```

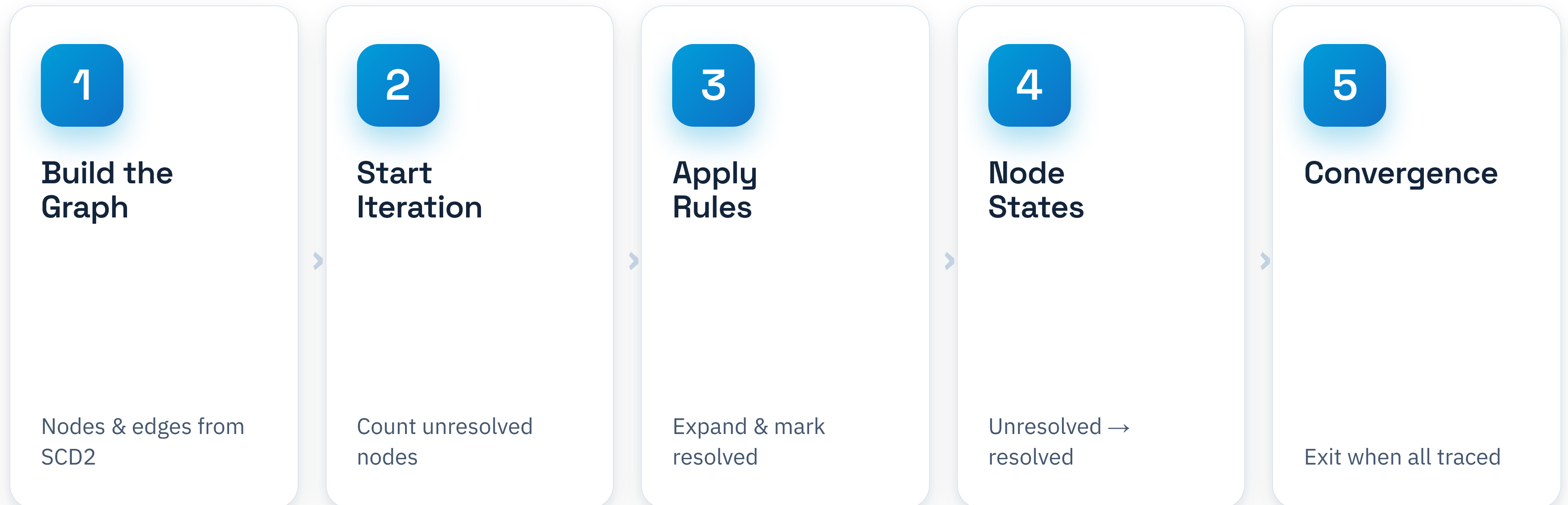
SQL/PGQ

Cytoscape.js

APEX plug-in

— SYSTEM WALKTHROUGH

How the Inference Engine Works



1 — INFERENCE ENGINE

Build the Graph



Graph Structure

1 node = 1 column · 1 edge = 1 dependency



Dependencies

Edges encode the transformation dependencies between columns.



NODES

Column nodes



EDGES

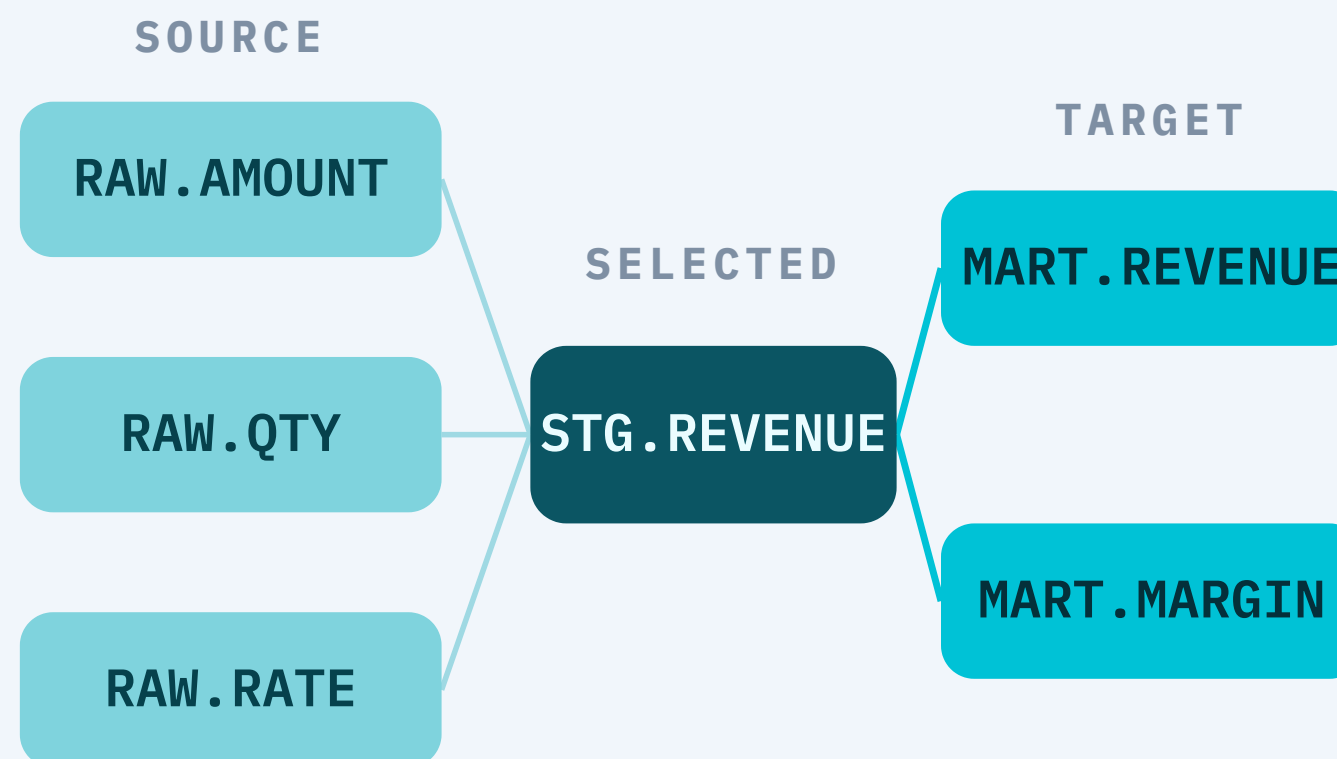
Dependencies



SCD2

Source tables

ONE NODE PER COLUMN, WIRED BY DEPENDENCY



2 — INFERENCE ENGINE

Start Iteration



Start the Loop

Begin a fresh iteration over the unresolved graph.



Count Nodes

Track progress each pass to know when to stop.



ITERATE

Fresh pass



COUNT

Unresolved & partial



RULES

Priority order

EACH PASS

- ✓ Start a **fresh pass** over the graph
- ✓ Count **UNRESOLVED** and **PARTIAL** nodes
- ✓ Run resolution rules in **priority order**

3 — INFERENCE ENGINE Apply Rules

- Expand Transformations**
 Traverse the dependency chain — resolve column references, expand transformation values.
- Mark Resolved**
 Tag **SOURCE** nodes once their chain is fully explained.

- EXPAND**
 Transformations
- RESOLVE**
 Column refs
- RULES**
 Priority order

TWO RULES, APPLIED IN PRIORITY ORDER — EVERY PASS

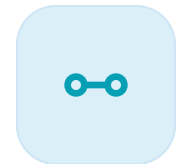
R1 Expand
 Substitute each column reference with its defining expression; strip aliases to physical **schema.table.column**; walk through views and pass-through layers, pass after pass.

R2 Mark Resolved
 A chain terminates at a physical source column, a named terminal (constant, variable, sequence), or a null reference.

Filters and joins are resolved the same way — down to physical columns, not just the select-list expressions.

4 — INFERENCE ENGINE

Node States



State Machine

Three states drive every column from raw input to a fully traced chain.

Only **TARGET** nodes are driven all the way to RESOLVED.



UNRESOLVED

Not yet visited — no expression traced.



PARTIAL

Expansion started — references still unexplained.



RESOLVED

Every reference explained down to a terminal.

5 — INFERENCE ENGINE

Convergence

✓ **Inference Complete**
 Done successfully when all **target nodes = RESOLVED**.

In practice, 99%+ of columns resolve in under 10 iterations.

COMPLETE
 All resolved

EXIT
 Loop ends

SUCCESS
 Converged

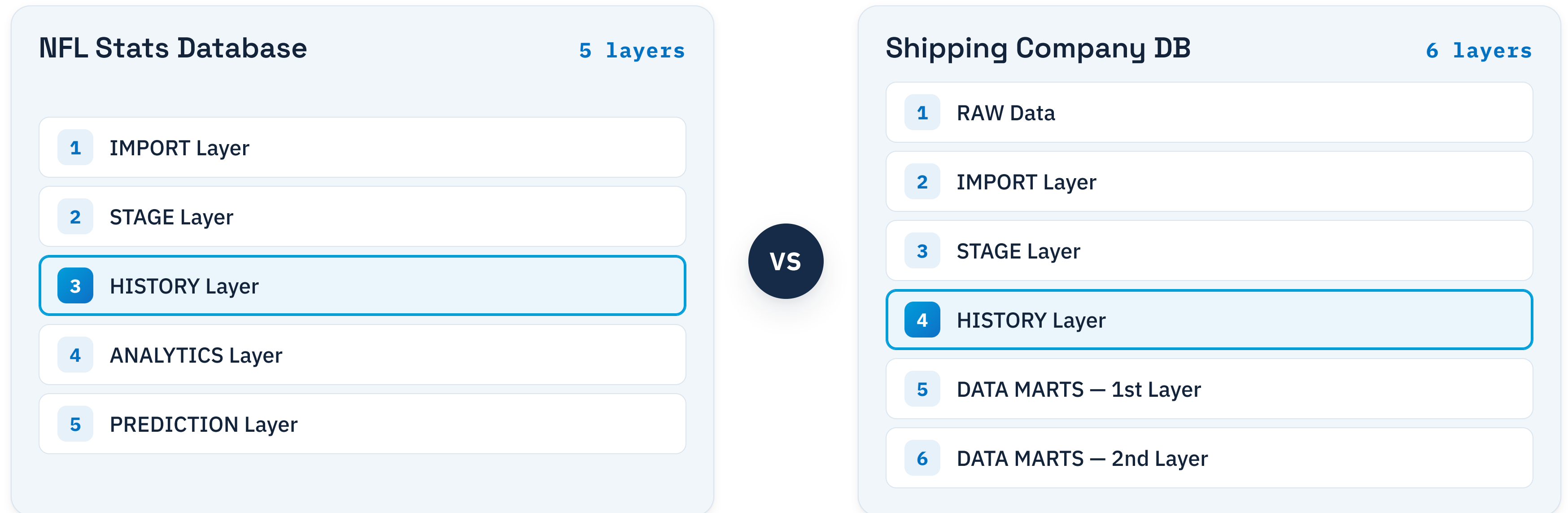
LOOP EXITS WHEN ANY IS TRUE

- ✓ **UNRESOLVED = 0** — all targets fully traced
- ✓ **No progress** — count before = count after
- ✓ **100 iterations** reached

— DATA SOURCES UNDER ANALYSIS

Two Datasets, One VIA

VIA tracks metadata, lineage, and impact across both data domains.



— FROM THE FIELD — ORACLE PROPERTY GRAPHS

Best Practices — Making Property Graphs Fast

01 — INDEXING

Index the columns the graph walks on

A graph over MVs full-scans on **every hop** (one hop = following a single edge, column → its source).
Index the **node & edge keys**, the schema.table.column **identity**, and the **validity dates** — on the graph MVs *and* the fact tables.

FULL SCAN → INDEX **~1,200 ms → ~20 ms**
EVERY GRAPH HOP AS-OF DATE LIST

02 — LEAN GRAPH

Keep heavy payloads out of the graph

Vertices & edges carry **identity + validity dates, nothing else**.
Transformation / filter / join CLOBs stay in indexed fact tables, fetched on node-click — the walk never drags CLOBs along.

10–30 ms
CLOB FETCH ON DEMAND

AND THIS IS ALL ON THE OCI FREE TIER Column-level, time-travel lineage over ~80k edges — renders 25,000–32,000 ms → ~300 ms (~100×).		MAPPINGS	COLUMN NODES	LINEAGE EDGES
	Shipping db	3,300	35,607	77,532
	NFL stats db	72	1,503	2,250
	Whole graph	3,403	37,233	79,964

— KEY CAPABILITIES

What You Just Saw

SCD2 • HISTORY

Column-Level Lineage

Trace any column up to its raw source.

METADATA • TRUTH

Forward Impact Analysis

Instant downstream impact view.

SQL/PGQ • GRAPHS

Temporal Snapshots

Query any date — SCD2 + property graphs.

INSIGHT • OVERVIEW

Interactive Graph

Live graph, instant database overview — downloadable as offline interactive HTML.

— RESULTS

What VIA Delivers in Practice

SPEED

1h→5min

Scale & Speed

Automatic tracking, end to end.

CLARITY

Raw→Mart

Transparency & Clarity

Every layer, fully visible.

RESILIENCE

Any date

Resilience & Diagnosis

Complete history, instant queries.

FLEXIBILITY

Any ETL

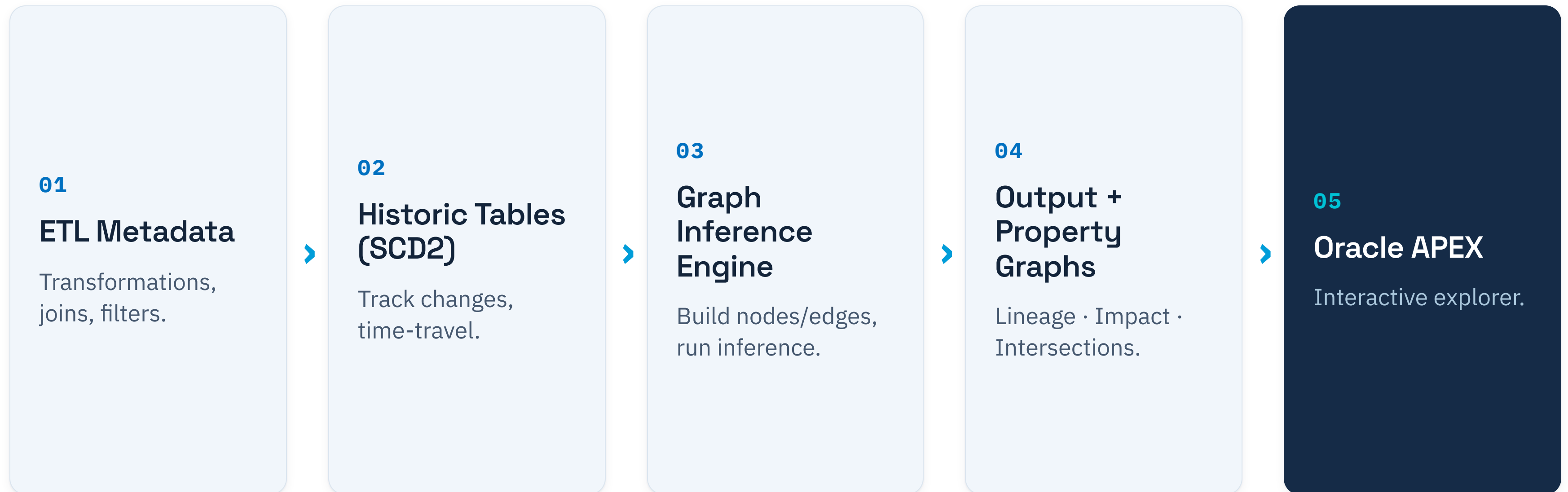
Flexibility & Automation

Zero manual work, any tool.

— SOLUTION ARCHITECTURE

Metadata to Interactive Graph — Fully on the Oracle Stack

Works with any ETL / EL-T tool.



— WHAT'S NEXT

VIA Is Actively Evolving

AI

AI-Assisted Explanations

LLM pseudocode for non-developers.

CONNECTORS

Broader ETL Support

dbt, Informatica, PL/SQL, and more.

MULTI

Multi-Workspace

Multiple schemas and teams.

OPEN

Open for Collaboration

Bring us your metadata challenge.

— KOIOS

Thank you for your time

info@koios.hr

tomislav.zarkovic@koios.hr

koio2.

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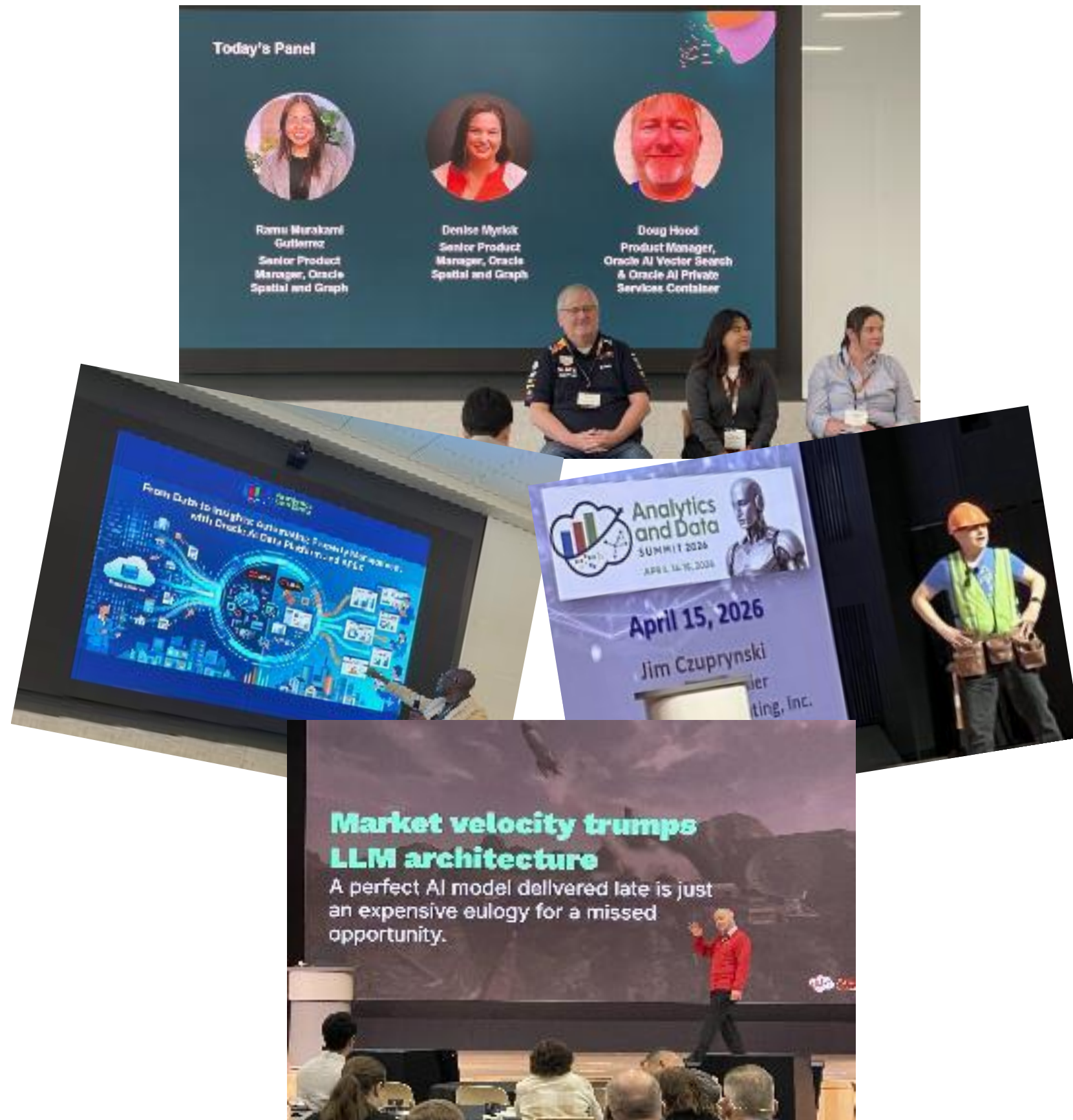
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[www.andouc.org](https://andouc.org)





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***Call for Papers
is OPEN!!***

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ORACLE ANALYTICS VIDEOS:

<https://www.youtube.com/@OracleAnalytics/videos>

OAC MARCH AND MAY 2026 NEW FEATURES VIDEOS BY ORACLE:

<https://bit.ly/OACMar26Features>

<https://bit.ly/OACMay26Features>

OAC NEW FEATURES DOCUMENTATION BY ORACLE:

<https://docs.oracle.com/en/cloud/paas/analytics-cloud/acswm/index.html#GUID-CFF90F44-BCEB-49EE-B40B-8D040F02D476>

ORACLE ANALYTICS COMMUNITY:

<https://community.oracle.com/products/oracleanalytics>

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<https://www.oracle.com/business-analytics/data-visualization/examples/>

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