Deciphering Data Architectures: Choosing Between a Modern Data Warehouse, Data Fabric, Data Lakehouse, and Data Mesh

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About Me

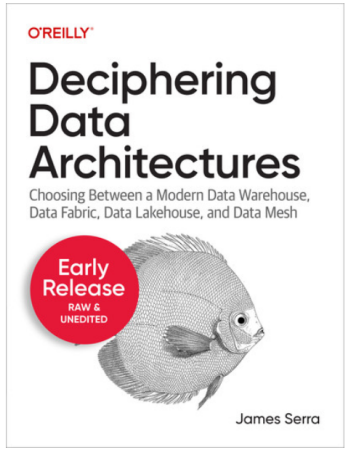
- Microsoft, Data & AI Solution Architect in Microsoft Federal Civilian
- At Microsoft for most of the last nine years as a Data & AI Architect , with a brief stop at EY
- In IT for 35 years, worked on many BI and DW projects
- Worked as desktop/web/database developer, DBA, BI and DW architect and developer, MDM architect, PDW/APS developer
- Been perm employee, contractor, consultant, business owner
- Presenter at PASS Summit, SQLBits, Enterprise Data World conference, Big Data Conference Europe, SQL Saturdays, Informatica World
- Blog at JamesSerra.com
- Former SQL Server MVP
- Author of book “Deciphering Data Architectures: Choosing Between a Modern Data Warehouse, Data Fabric, Data Lakehouse, and Data Mesh”

My upcoming book

Deciphering Data Architectures

★★★★★ 3 reviews

By James Serra



TIME TO COMPLETE:
7h 17m

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Data Lake

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Continue

Data fabric, data lakehouse, and data mesh have recently appeared as viable alternatives to the modern data warehouse. These new architectures have solid benefits, but they're also surrounded by a lot of hyperbole and confusion. This practical book provides a guided tour of each architecture to help data professionals understand its pros and cons.

In the process, James Serra, big data and data warehousing solution architect at Microsoft, examines common data architecture concepts, including how data warehouses have had to evolve to work with data lake features. You'll learn what data lakehouses can help you achieve, and how to distinguish data mesh hype from reality. Best of all, you'll be able to determine the most appropriate data architecture for your needs. By reading this book, you'll:

- Gain a working understanding of several data architectures
- Know the pros and cons of each approach
- Distinguish data architecture theory from the reality
- Learn to pick the best architecture for your use case
- Understand the differences between data warehouses and data lakes
- Learn common data architecture concepts to help you build better solutions
- Alleviate confusion by clearly defining each data architecture
- Know what architectures to use for each cloud provider

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Deciphering Data Architectures (O'Reilly.com)

- Foundation
  - 1. Big Data
  - 2. Types of Data Architectures
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- Common Data Architecture Concepts
  - 4. The Relational Data Warehouse
  - 5. Data Lake
  - 6. Data Storage Solutions and Processes
  - 7. Approaches to Design
  - 8. Approaches to Data Modeling
  - 9. Approaches to Data Ingestion
- Data Architectures
  - 10. The Modern Data Warehouse
  - 11. Data Fabric
  - 12. Data Lakehouse
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  - 14. Should You Adopt Data Mesh? Myths, Concerns, And The Future
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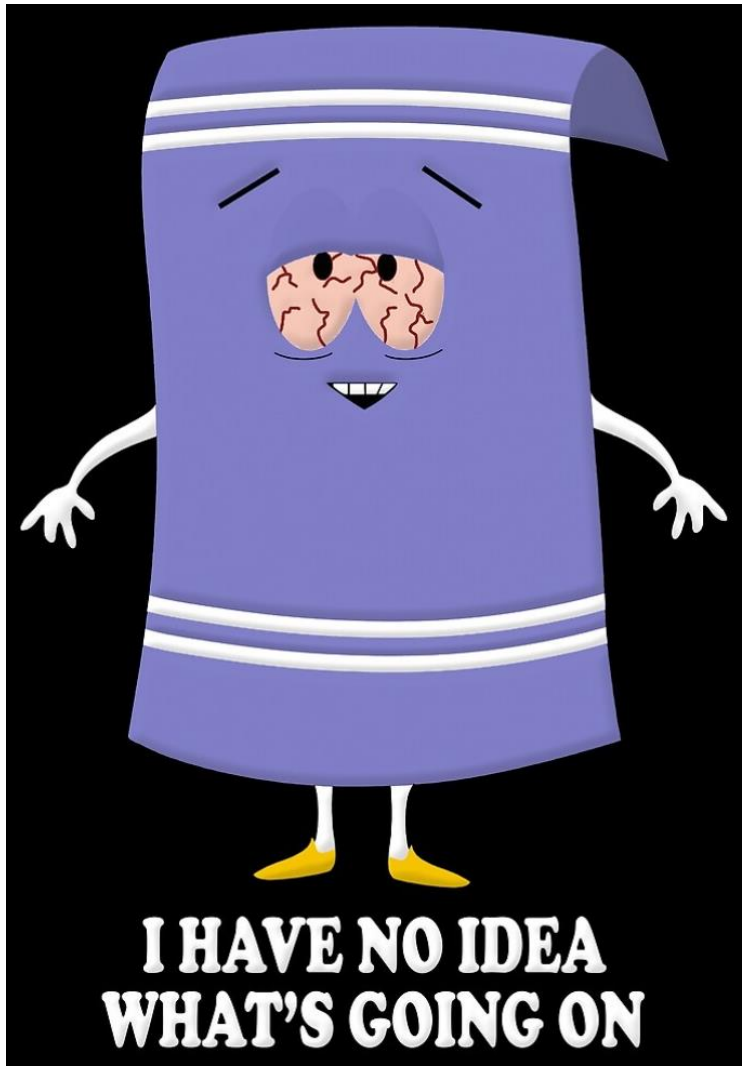
Pre-order on Amazon!

Trying to understand all this architecture stuff on your own…



Let me help!

Agenda

- Relational Data Warehouse
- Data Lake
- Modern Data Warehouse
- Data Fabric
- Data Lakehouse
- Data Mesh
- Data Mesh on Azure

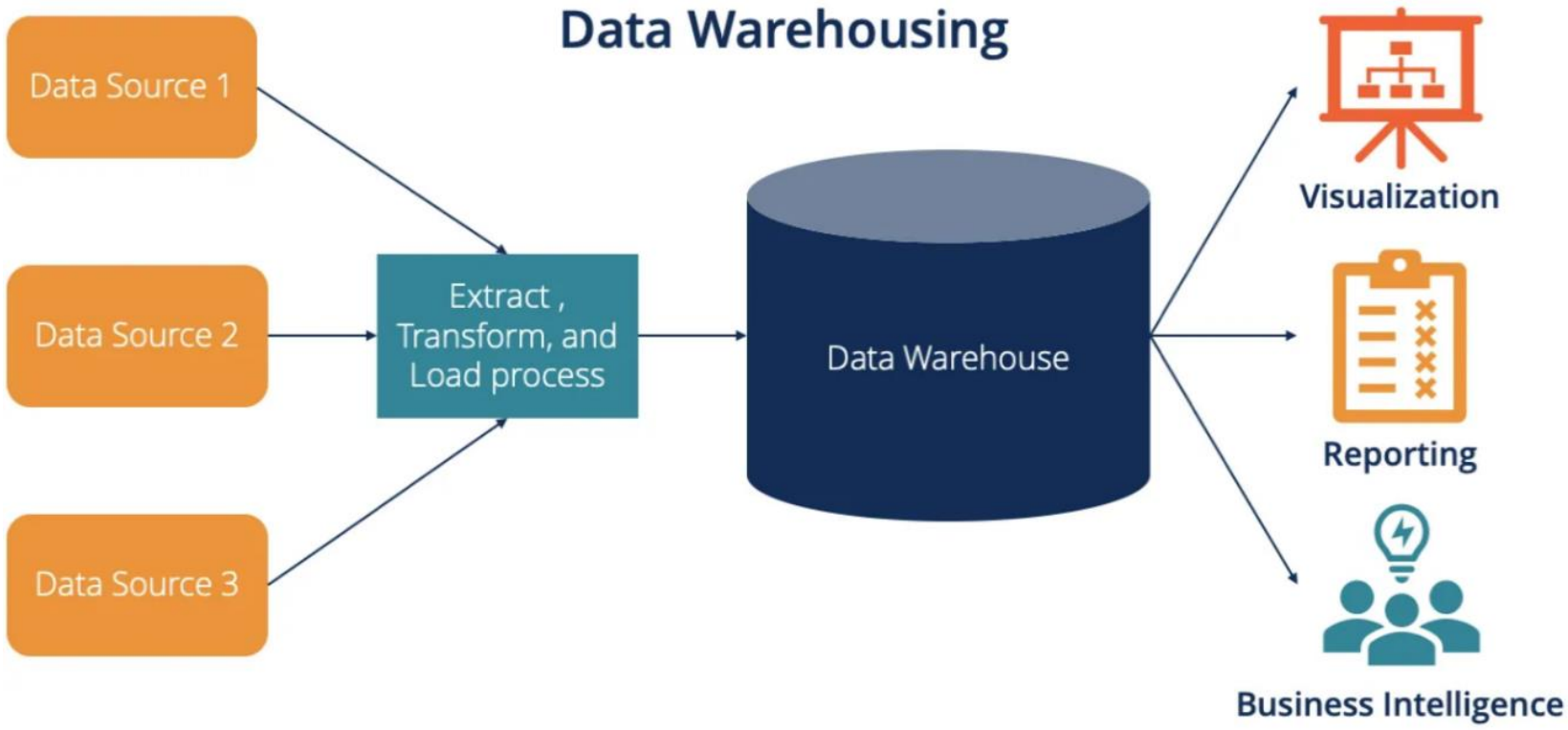
Note: These are James Serra's opinions and not that of Microsoft!

Relational Data Warehouse (RDW)

What is a Relational Data Warehouse?

(or, why do we need a copy of the source data?)

A relational data warehouse is where you store data from multiple data sources to be used for historical and trend analysis reporting to make better business decisions by getting greater insights into your company. It acts as a central repository for many subject areas and contains the "single version of truth". It is NOT to be used for OLTP applications.



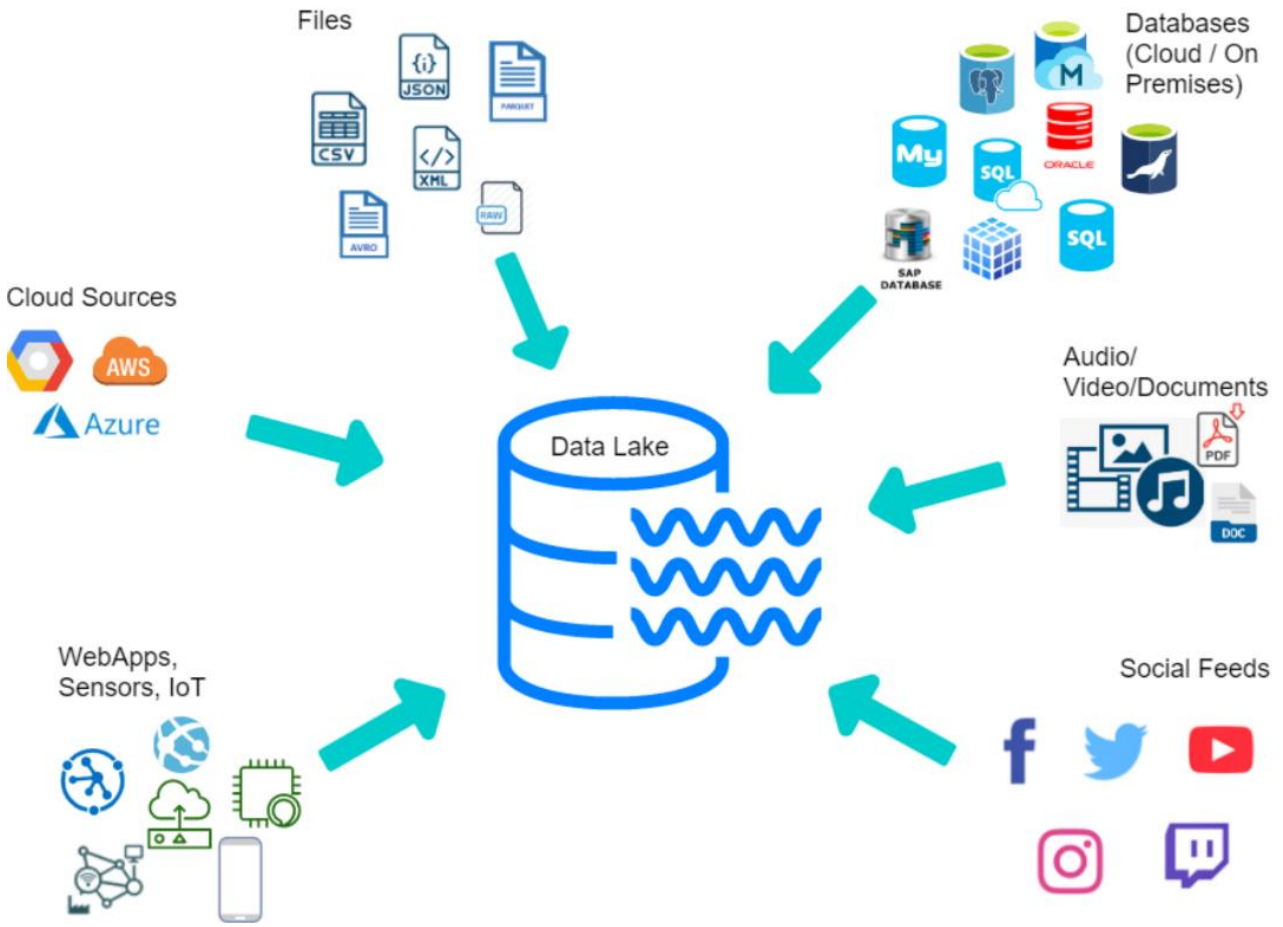
Why use a Relational Data Warehouse?

- Single version of the truth
- Reduce stress on the production system
- Optimized for read access
- Integrate multiple sources of data
- Run accurate historical reports (no need to save hardcopy reports)
- Restructure and rename tables and fields
- Protect against application upgrades
- Don’t need to provide security access to the production systems
- Keep historical data
- Use Master Data Management, including hierarchies
- Improve data quality by plugging holes in source systems
- No IT involvement needed to create reports

Data Lake

What is a Data Lake?

A schema-on-read storage repository that holds a vast amount of raw data in its native format until it is needed.



Why use a data lake?

- Store data with no modeling – “Schema on read”
- Frees up expensive enterprise data warehouse (EDW) resources for queries instead of using EDW resources for transformations. Removes need for EDW maintenance window
- Quick user access to data for power users/data scientists (allowing for faster ROI)
- Data exploration to see if data valuable before writing ETL and schema for relational database, or use for one-time report/query
- Extreme performance for transformations by having multiple compute options each accessing different folders containing data

Modern Data Warehouse (MDW)

Data Lake with Data warehouse use cases

Data Lake

Staging & preparation

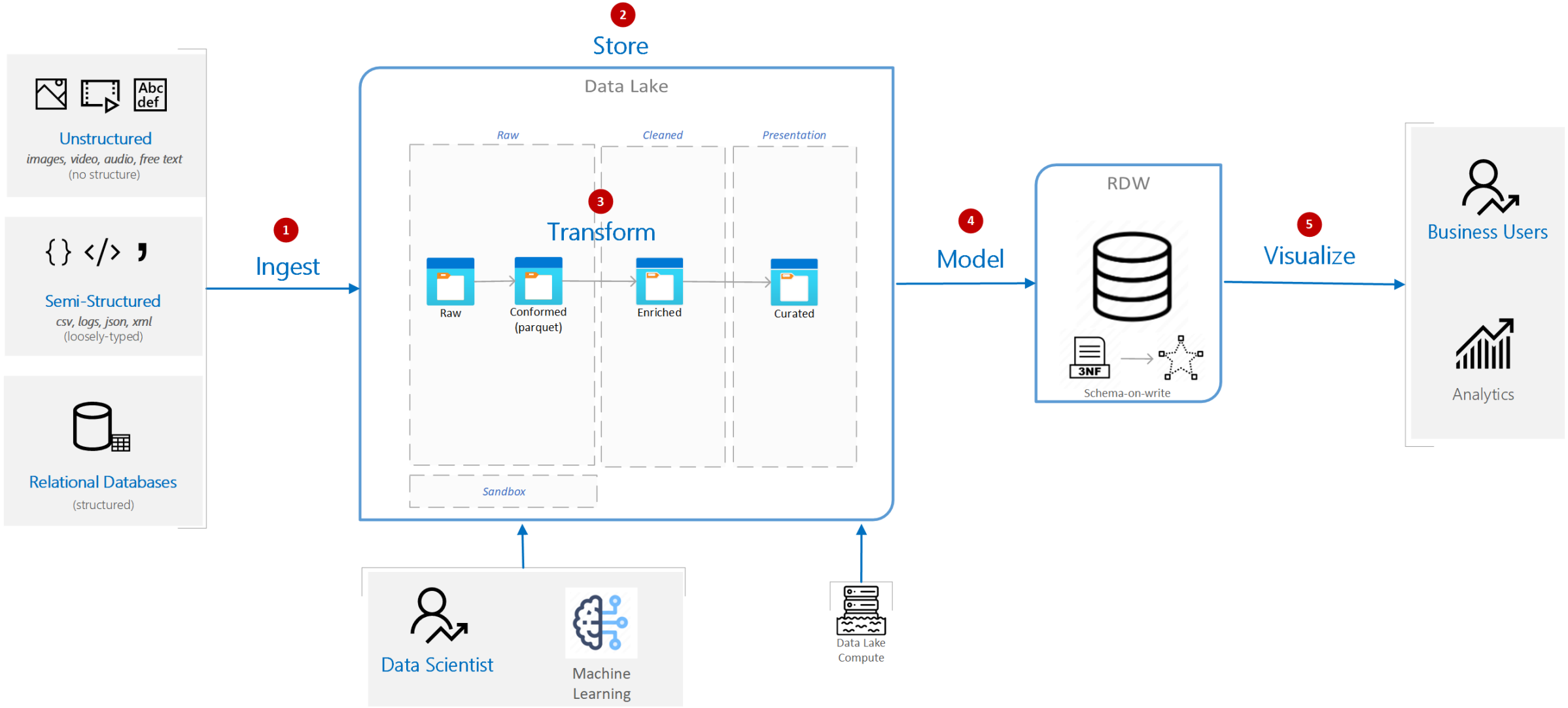
- Data scientists/Power users
- Batch processing
- Data refinement/cleaning
- ETL workloads
- Store older/backup data
- Sandbox for data exploration
- One-time reports
- Quick access to data
- Don’t know questions

Data Warehouse

Serving, Security & Compliance

- Business people
- Low latency
- Complex joins
- Interactive ad-hoc query
- High number of users
- Additional security
- Large support for tools
- Dashboards
- Easily create reports (Self-service BI)
- Know questions

Modern Data Warehouse architecture



Data Fabric

What is Data Fabric?

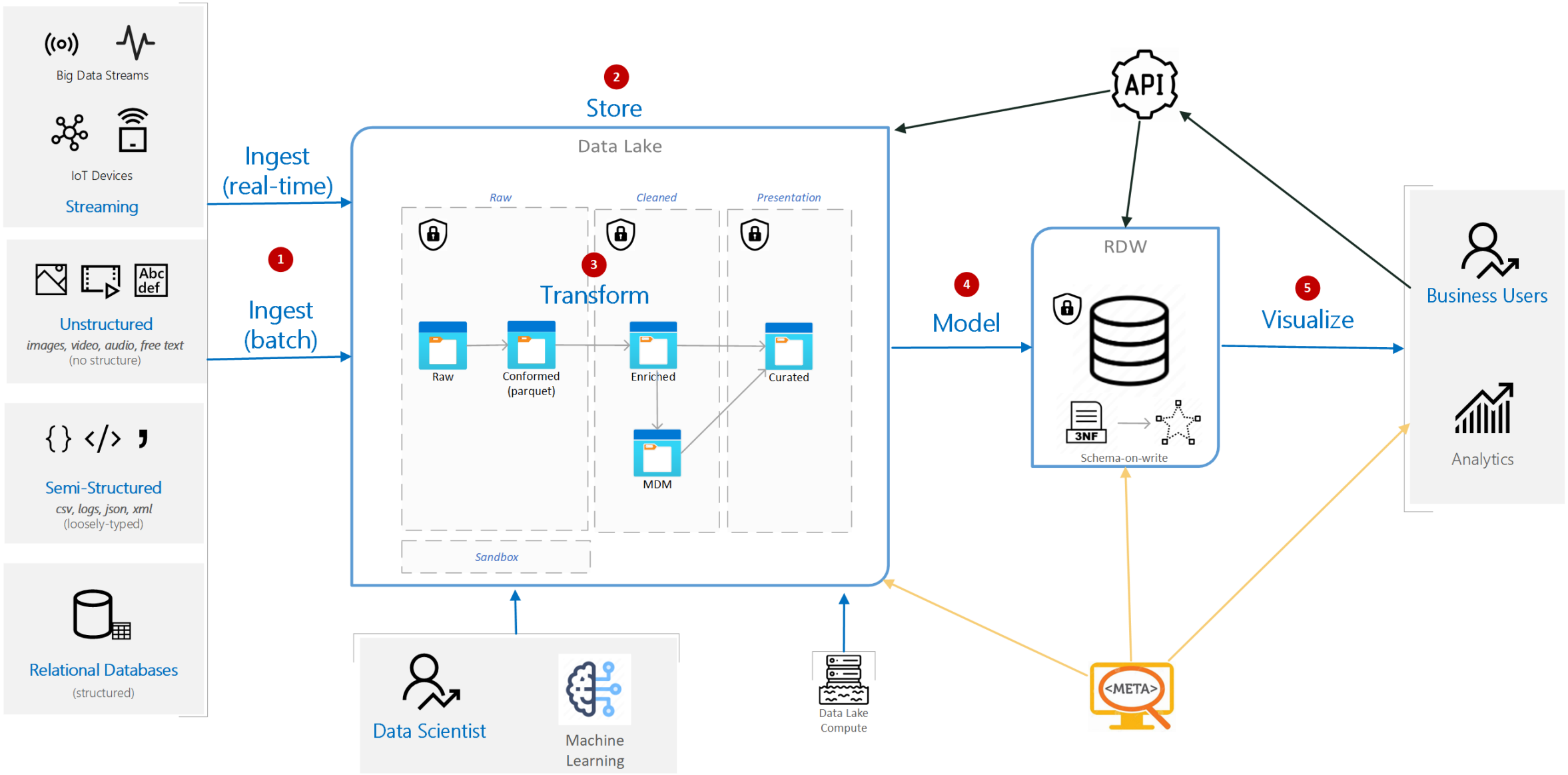
A data fabric is a term used to describe the architecture of taking disparate systems and weaving them together, like fabric, to create a consistent layer on top of an organization's data.

Data Fabric adds to a modern data warehouse:

- Data access policies
- Metadata catalog
- Master Data Management (MDM)
- Data virtualization
- Real-time processing
- APIs
- Building blocks/Services
- Products

Bottom line: Data fabric provides additional technology to source more data, secure it, and make it available. Think of it as an evolution of the MDW

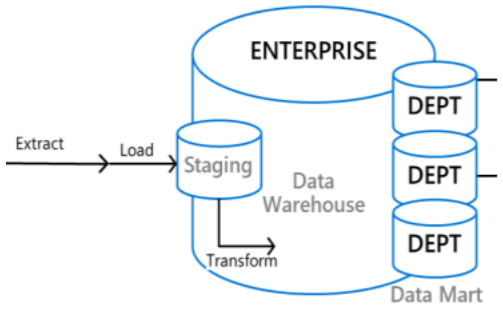
Data Fabric architecture



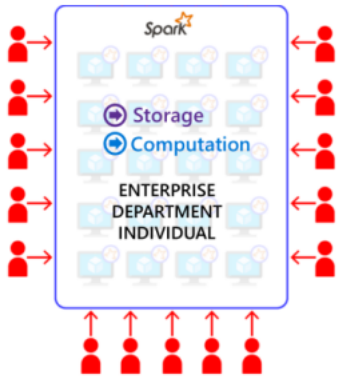
Data Lakehouse

Data Lakehouse historical timeline

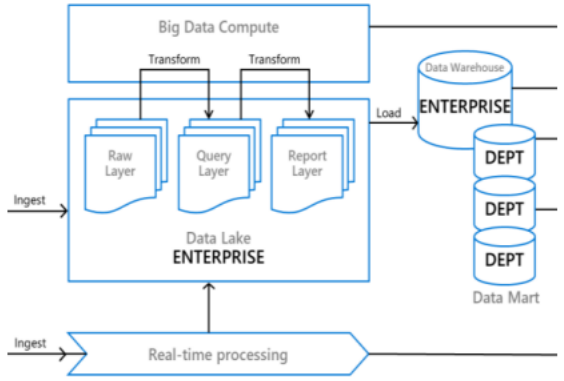
Late 1980s
Data Warehouse



Late 2000s
Data Lake

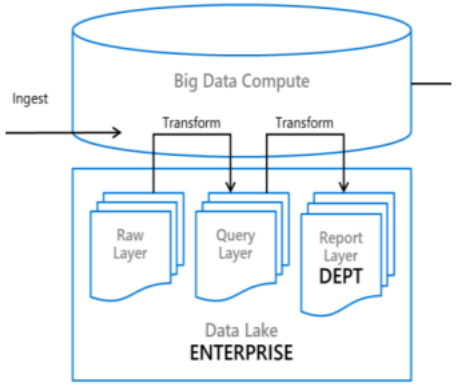


Mid 2010s
Cloud Data Platform



Modern Data Warehouse

2020
Data Lakehouse



Delta Lake

Delta Lake

A transactional storage software layer that runs on top of an existing data lake, adding RDW-like features.

Top features:

- Supports commands INSERT, DELETE, UPDATE, and MERGE
- ACID transactions for one table
- Time travel (data versioning enables rollbacks, audit trail)
- Streaming and batch unification
- Schema enforcement & schema evolution
- Performance improvements (Data skipping, caching, Z-Order, etc)
- Solve “small files” problem
  via OPTIMIZE command (compact/merge)

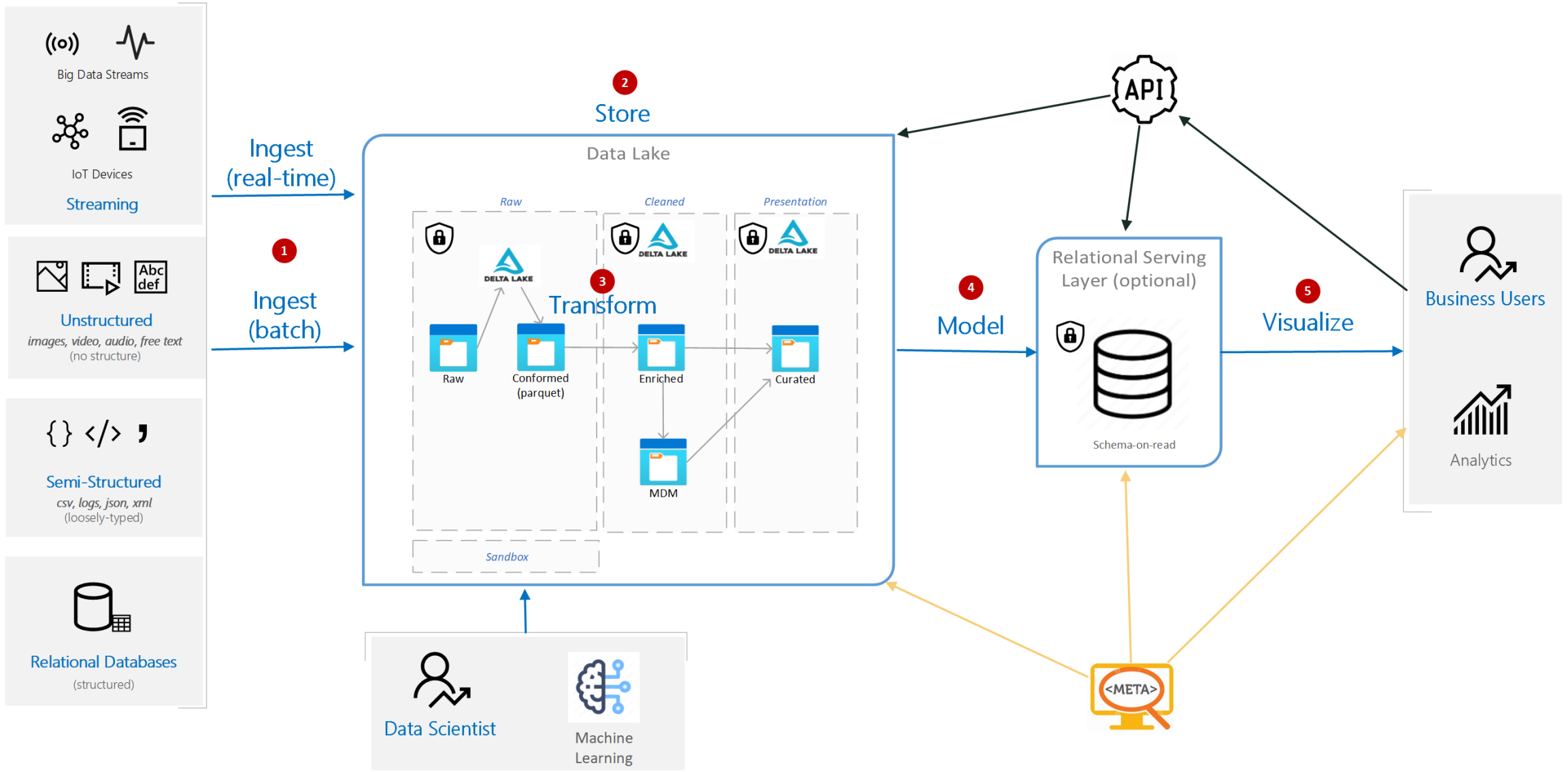
```
df.write.format("delta").save(delta_table_path)
instead of
df.write.format(“parquet").save(delta_table_path)
```

Use cases for Data Lakehouse

Today’s data architectures commonly suffer from five problems:

- Reliability: Keeping the data lake and warehouse consistent
- Data staleness: Data in warehouse is older
- Total cost of ownership: Extra cost for data copied to warehouse
- Data governance: More copies, more risk
- Complexity: More specialized skills needed for both a data lake and RDW

Data Lakehouse architecture



Opening a can of worms

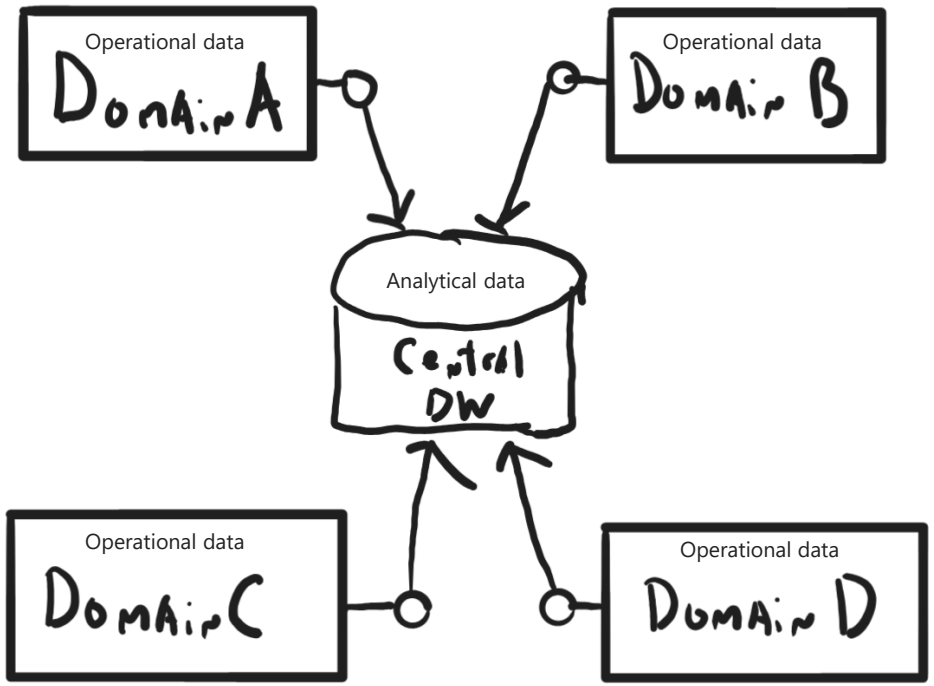
Concerns skipping relational data warehouse

- Speed: Relational database *queries* faster, especially Massively Parallel Processing (MPP) with advanced indexing, advanced statistics, caching, advanced query plan optimization, materialized views, advanced join optimization
- Security: No row-level security (RLS), column-level security, data-at-rest encryption, column-level encryption, Transparent Data Encryption (TDE), dynamic data masking
- People are used to using a relational database (forced metadata layer)
- Complexity: Metadata separate from data, file-based world
- Concurrency: Multiple reads of a file at the same time can be slow
- Missing features: SQL Views, referential integrity, workload management, advanced auditing and compliance features (such as auditing trails, data retention policies, and compliance certifications), ACID against multiple tables
- Products must add delta lake support in order to use it

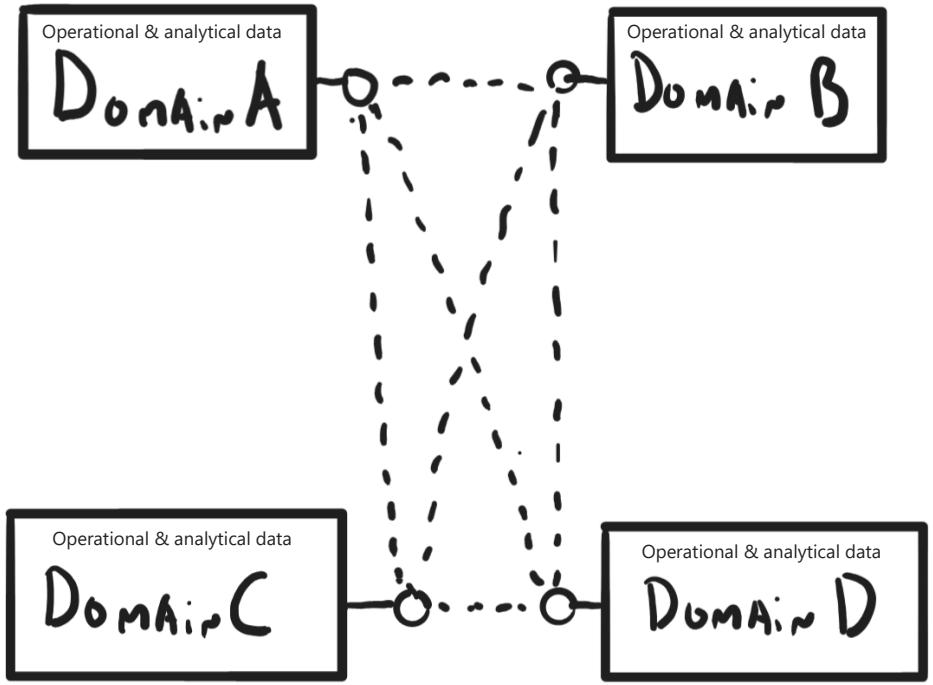
New technology addressing some of these concerns

Data Mesh

Traditional centralized vs Data Mesh decentralized



MDW, Data Fabric, Data Lakehouse



Data Mesh

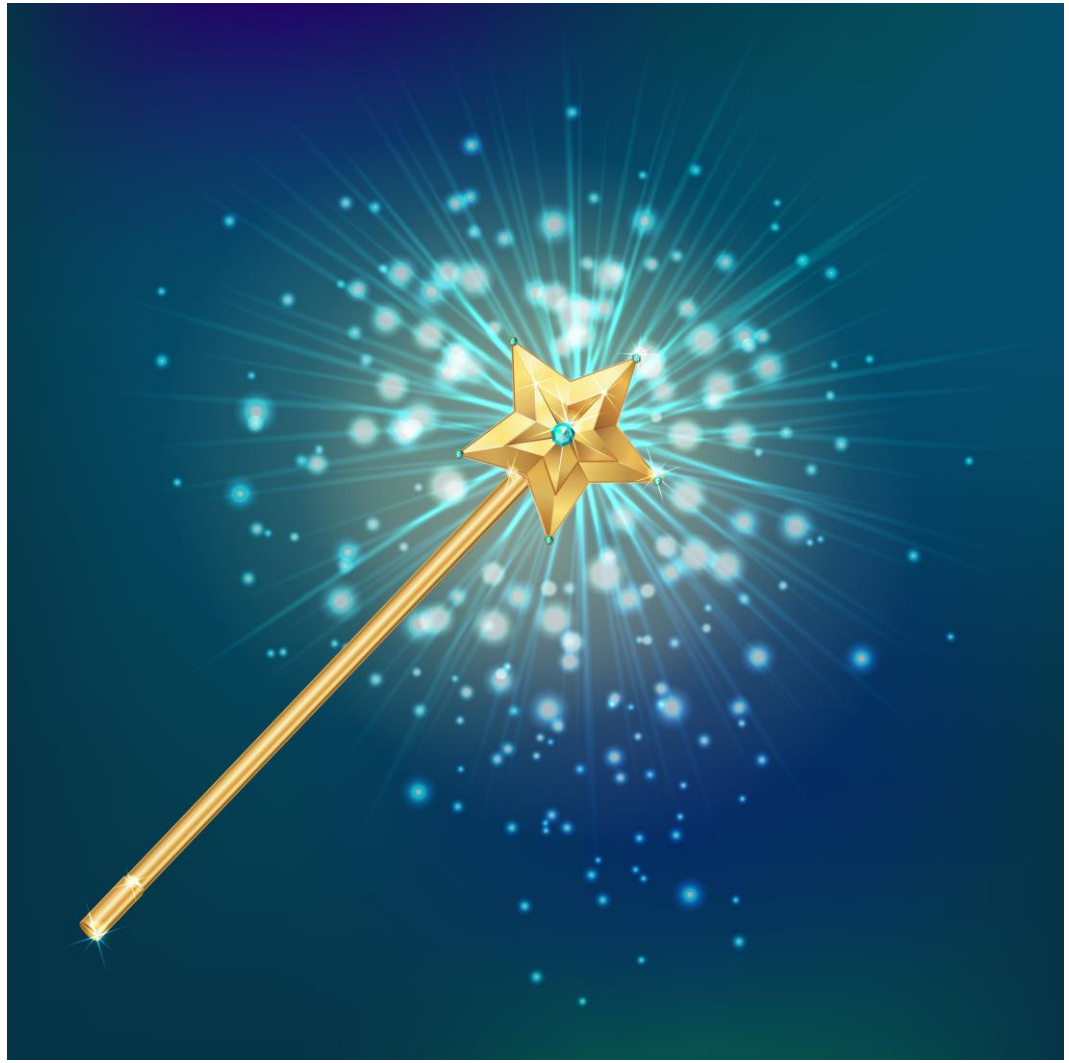
Data Mesh

Data Mesh is a concept, not technology

It is an organizational and cultural shift

Credit to Zhamak Dehghani

Data Mesh is not a magic wand that you can buy on ebay



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Data Mesh - Overview

A data mesh is a decentralized approach to managing data, where multiple teams within a company are responsible for their own data, promoting collaboration and flexibility. By implementing data mesh principles, the quality and accuracy of data can be enhanced, resulting in increased trust among businesses to utilize data more extensively for informed decision-making.

Data Mesh Principles

#1) Domain Ownership

Decentralize and distribute responsibility to people who are closest to the data in order to support continuous change and scalability (i.e. manufacturing, sales, supplier)

#2) Data as a product

Analytical data provided by the domains are treated as a product and the consumers of that data are treated as customers (domain teams, API code, data and metadata, infrastructure)

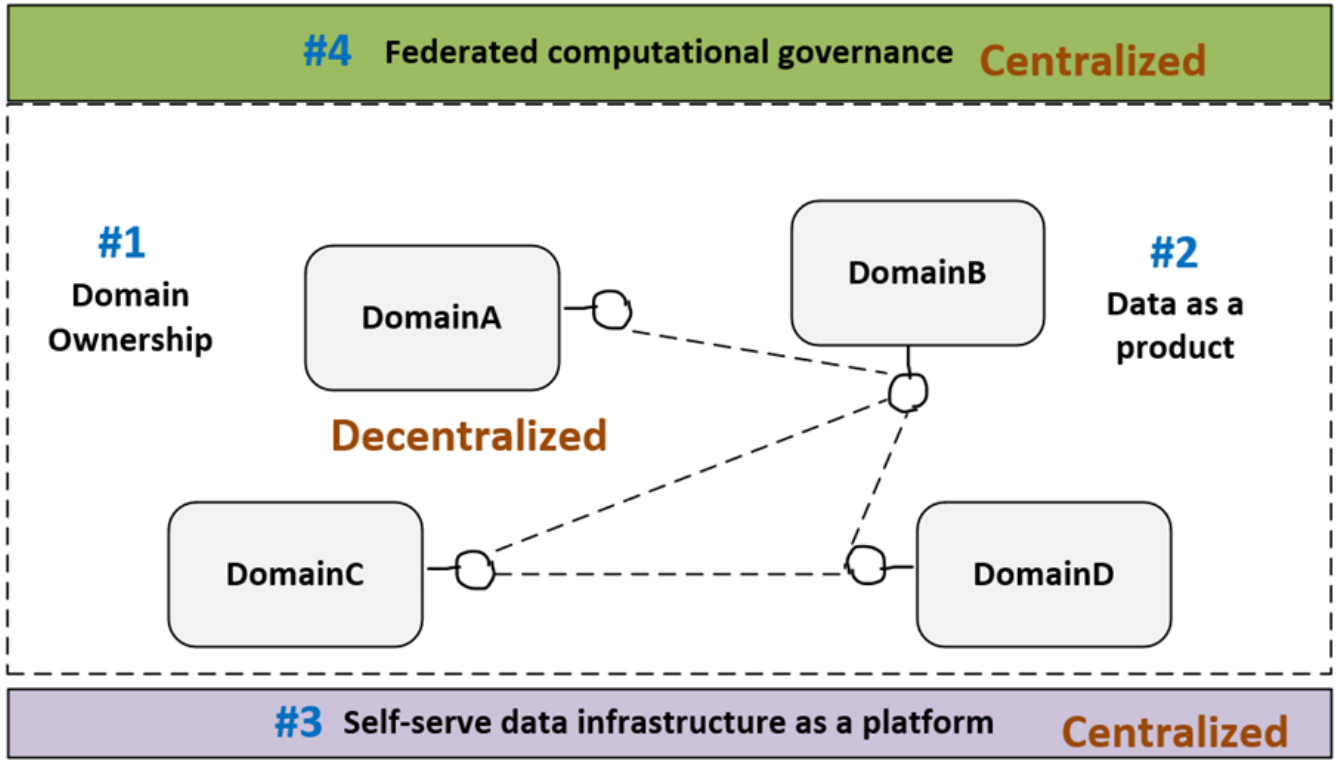
#3) Self-serve data infrastructure as a platform

Simplify data product creation and management by automating infrastructure provisioning (i.e. storage, compute, data pipeline, access control)

#4) Federated computational governance

A collaborative data governance between domains and a central data team to define, implement and monitor global rules (i.e., interoperability, data quality, data security, regulations, data modelling)

Data Mesh architecture



Use cases for Data Mesh

Data mesh tries to solve four challenges with a centralized data lake/warehouse:

- Lack of ownership: who owns the data – the data source team or the infrastructure team?
- Lack of quality: the infrastructure team is responsible for quality but does not know the data well
- Organizational scaling: the central team becomes the bottleneck, such as with an enterprise data lake/warehouse
- Technical scaling: current big data solutions can’t keep up with additional data requirements

Example healthcare domains and products within them

Patient data domain

- Patient data analytics
- Patient engagement
- Population Health Management
- Clinical decision support systems
- Patient matching and ID resolution
- Clinical research
- Patient outcome prediction
- Patient satisfaction

Clinical data domain

- Clinical research
- Clinical decision support
- Clinical analytics
- Clinical trial management
- Imaging analysis
- Disease registries
- Real-world evidence
- Clinical trial matching

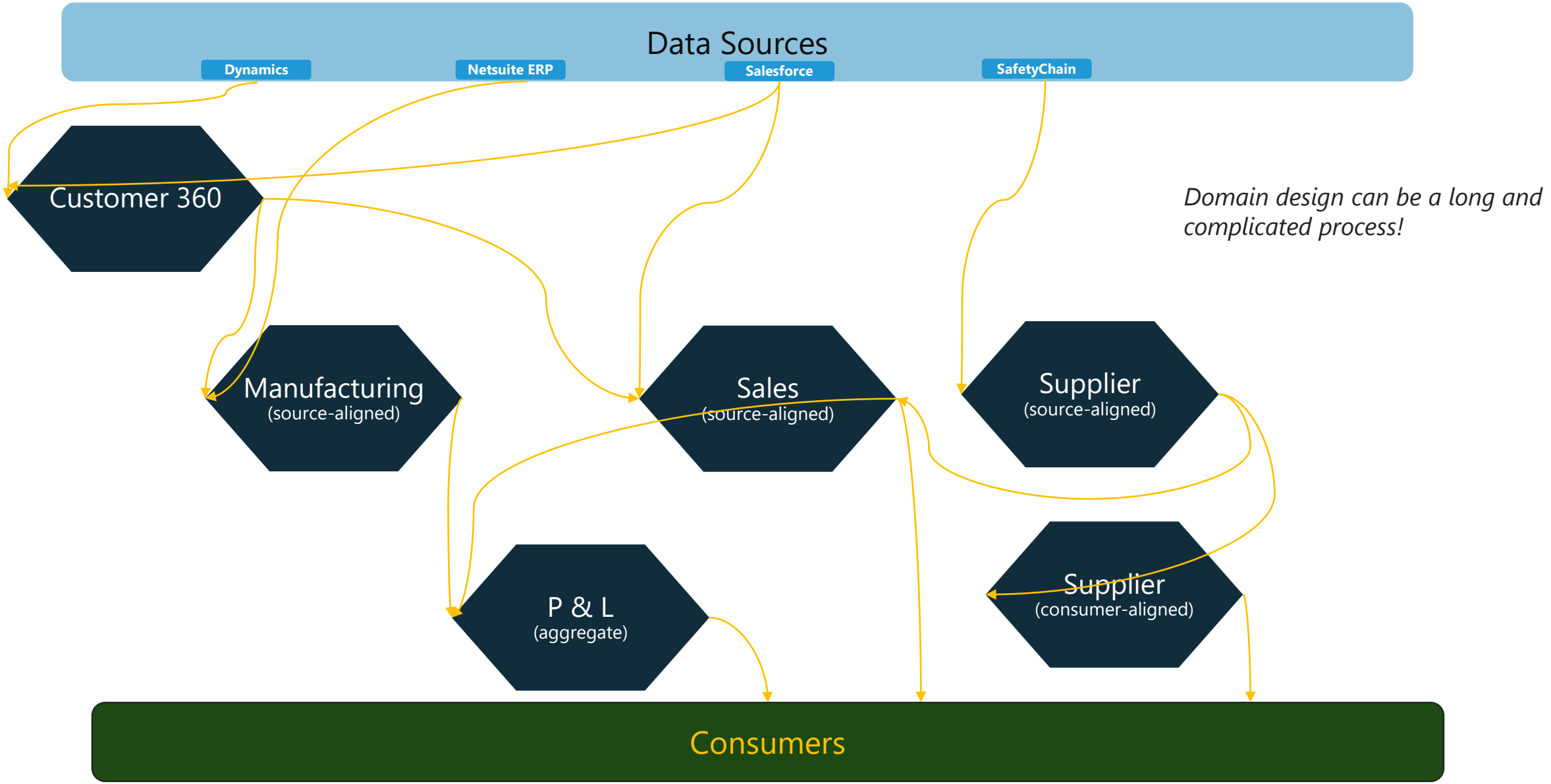
Claims data domain

- Claims analytics
- Claims management
- Fraud detection
- Payment processing
- Patient financial management
- Provider network analysis
- Claims denial management
- Health plan selection

Public health data domain

- Disease surveillance
- Health equity
- Population health management
- Environmental health tracking
- Public health research
- Infectious disease modeling
- Health behavior change
- Chronic disease management

Data Mesh – Logical Architecture



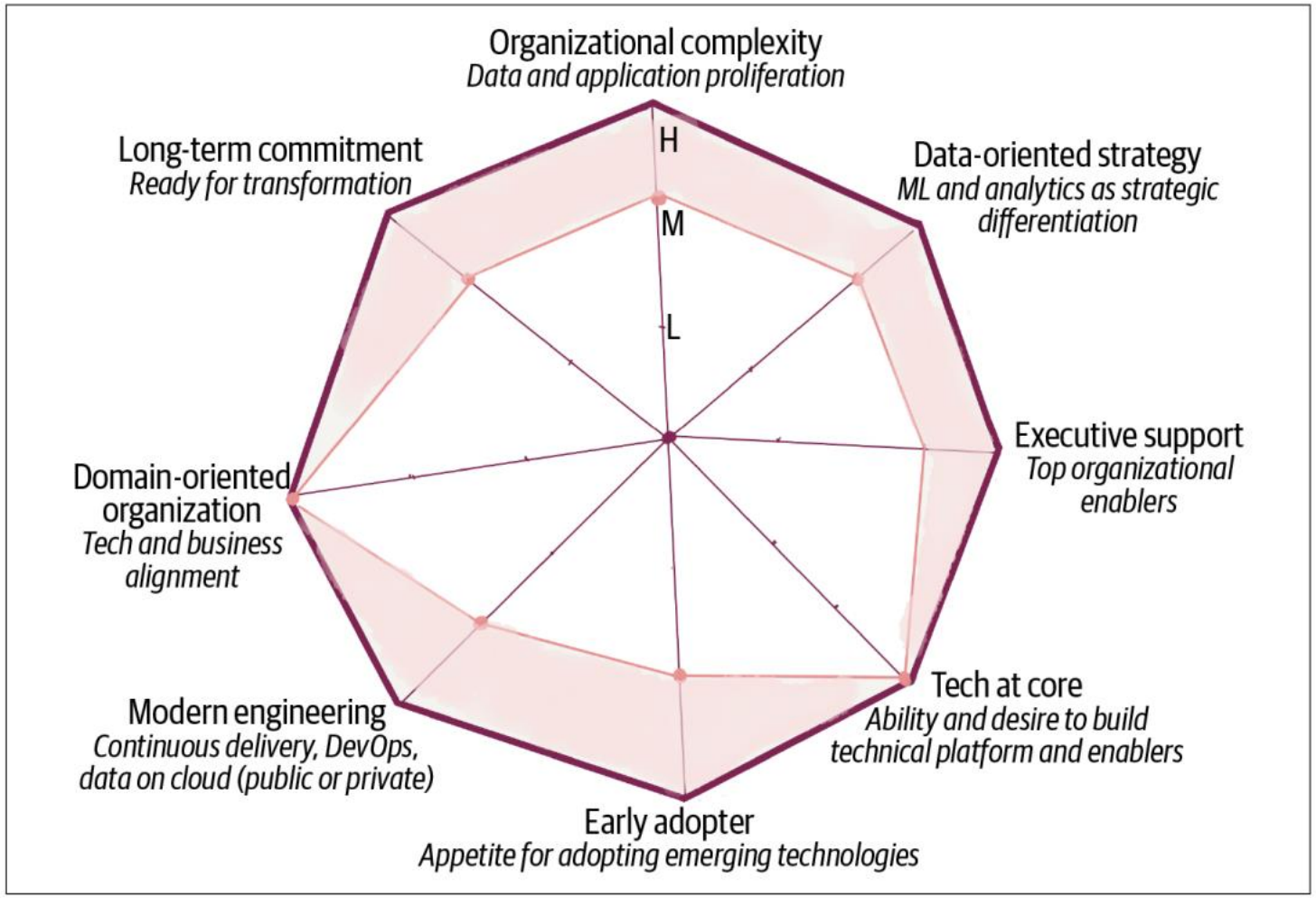
Domain design can be a long and complicated process!

Concerns with Data Mesh

- No standard definition of a data mesh
- Huge investment in organizational change and technical implementation
- Performance problem of combining data from multiple domains
- Duplication of data for performance reasons
- Getting quality engineering people for each domain
- Inconsistent technical implementations for the domains
- Domains don’t want to wait for a data mesh
- Need incentives for each domain to counter extra work
- Self-serve approach of data requests could be challenging
- Duplication of data and ingestion platform
- Creation of data silos for domains not able to join data mesh
- Not seeing the big picture for combing data

Data Mesh: Centralized vs decentralized data architecture
Data Mesh: Centralized ownership vs decentralized ownership

Should you adopt data mesh today?



Need to score medium or high in ALL categories

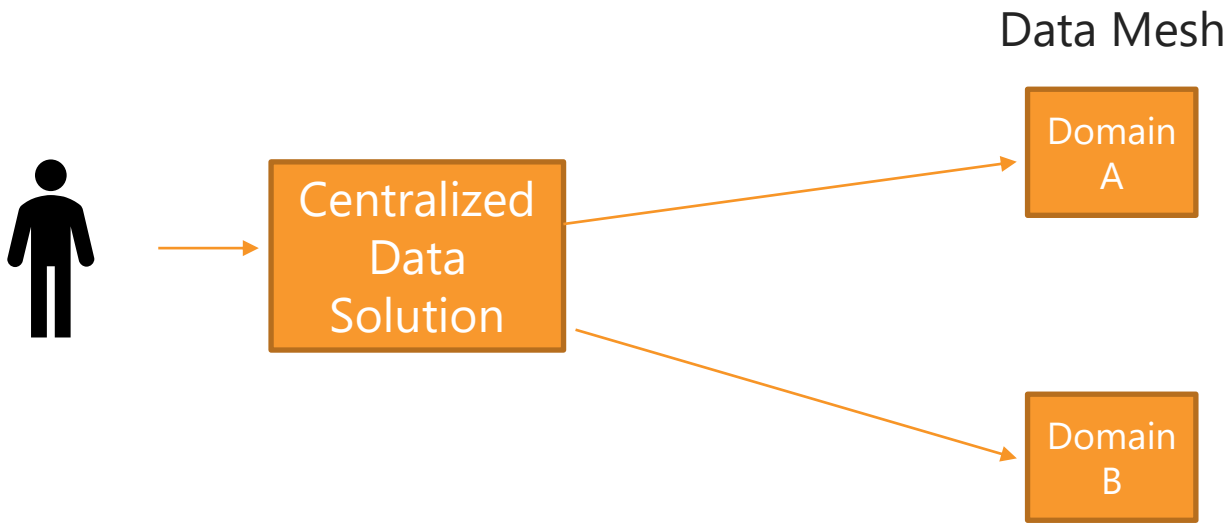
From book "Data Mesh – Delivering Data-Driven Value at Scale" by Zhamak Dehghani, Page 272

Data Mesh Future

This view is my own and not that of Microsoft!

In the end, I predict data mesh will become an extension to a centralized data solution for a small percentage of solutions via a hub-and-spoke model:

- Start by using new data to create new data mesh domains
- Supplement those domains with your current centralized data solution
- Slowly migrate your centralized data into data mesh domains over time
- Paves the way for a cultural shift over time



Data Mesh principles adoption estimate:

1) Domain ownership (90%)
2) Data as a product (70%)
3) Self-serve data infrastructure as a platform (30%)
4) Federated computational governance (50%)

Data Mesh concepts help with a better way of thinking how to get value out of data

When to use each architecture?

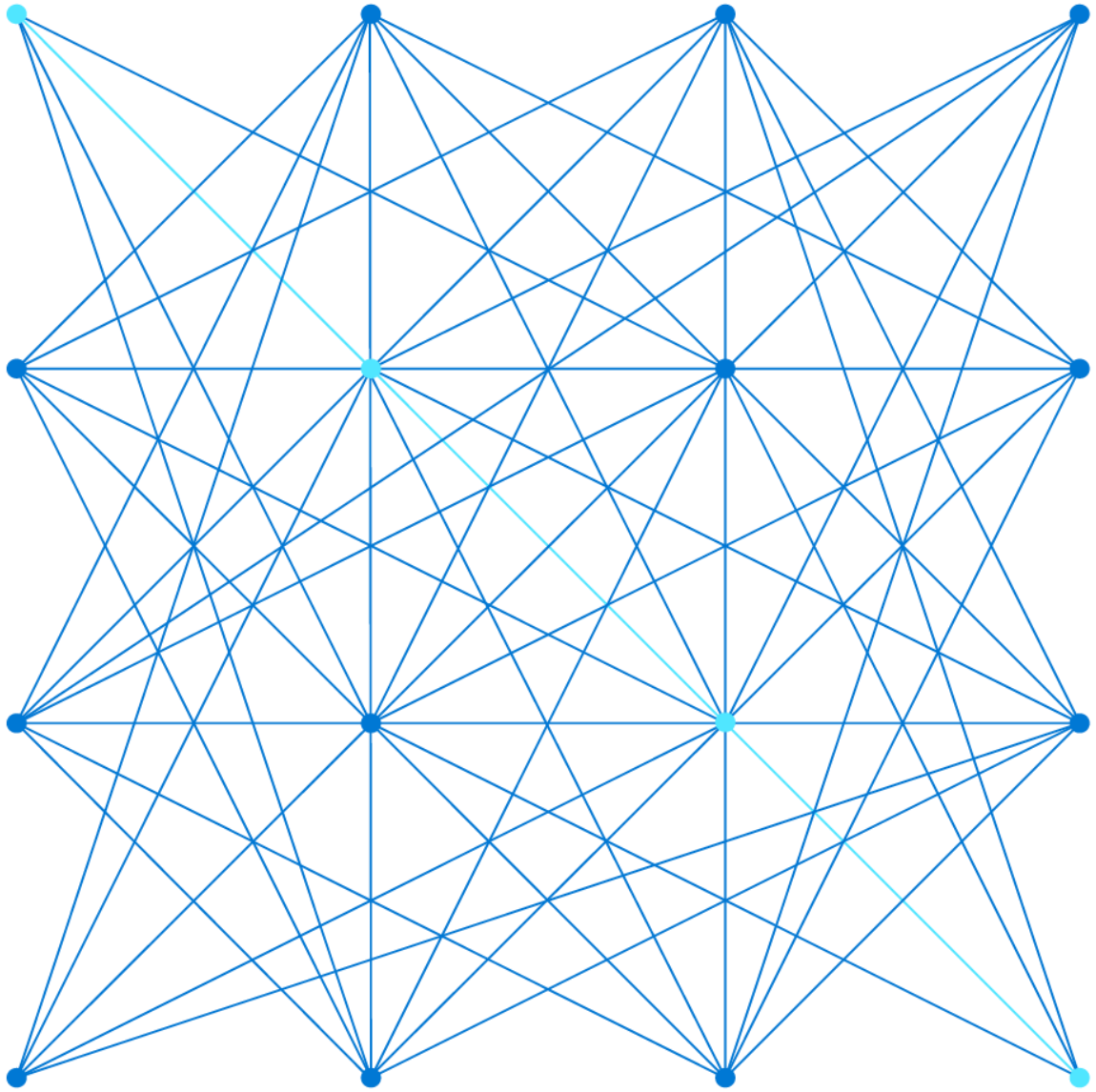
A very high-level use case for each architecture (in ascending cost and complexity):

- Modern data warehouse: Small amount of data; if used to relational data warehouses (RDW)
- Data fabric: Need to ingest many different data sources (size, speed, type)
- Data lakehouse: Use it until you can't – then copy some data to RDW
- Data mesh: Very large, domain-oriented company, that is having major paint points with scalability and can afford a long timeline

Most companies will use pieces of each architecture to build a solution adapted to their specific needs for data (use cases) and their business capabilities.

Microsoft Azure

Data Mesh on Azure



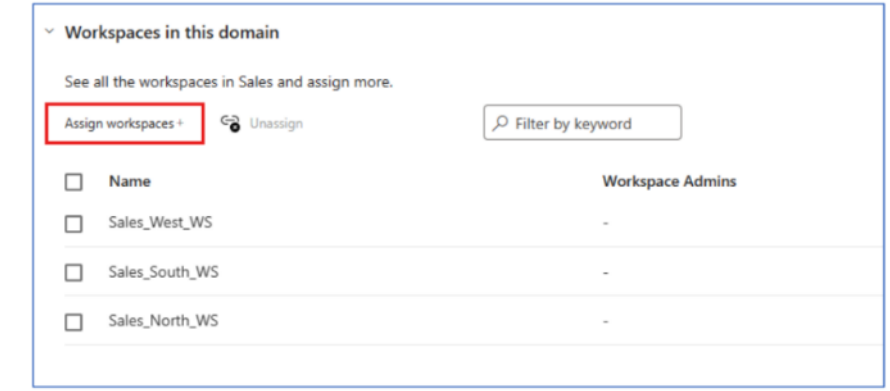
Microsoft Fabric and Data Mesh

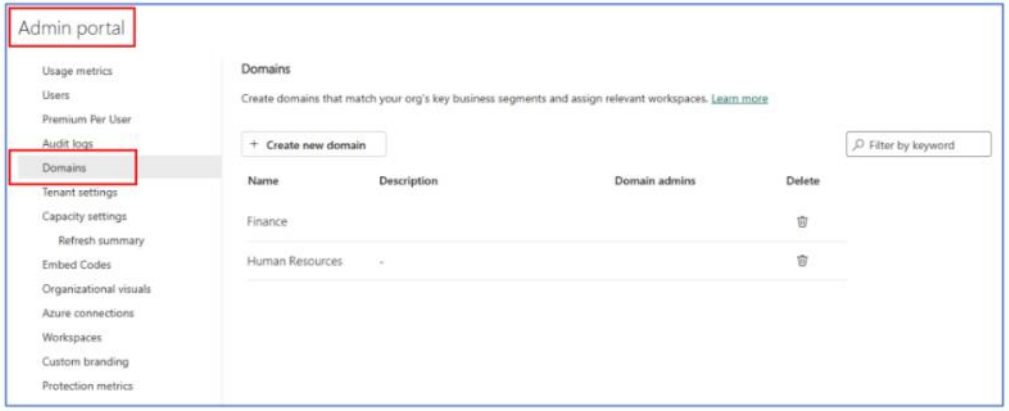
- Can logically organize data into domains
- PBI workspaces are associated with domains – all the items in the workspace become part of the domain (they receive a domain attribute as part of their metadata
- Data consumers can filter and find content by domain
- Future releases will enable federated governance, which means some of the governance currently controlled at the tenant level will move to domain-level control
- Use low-code to make it easier for domain teams to build solution
- OneLake technology to help

Data Mesh four principles:

1. Domain ownership: partial
2. Data as a product: very little
3. Self-serve data infrastructure as a platform: some
4. Federated computational governance: future

[Data Mesh with Fabric.docx (sharepoint.com)]





OneLake for all domains

OneLake gives a true data mesh as a service

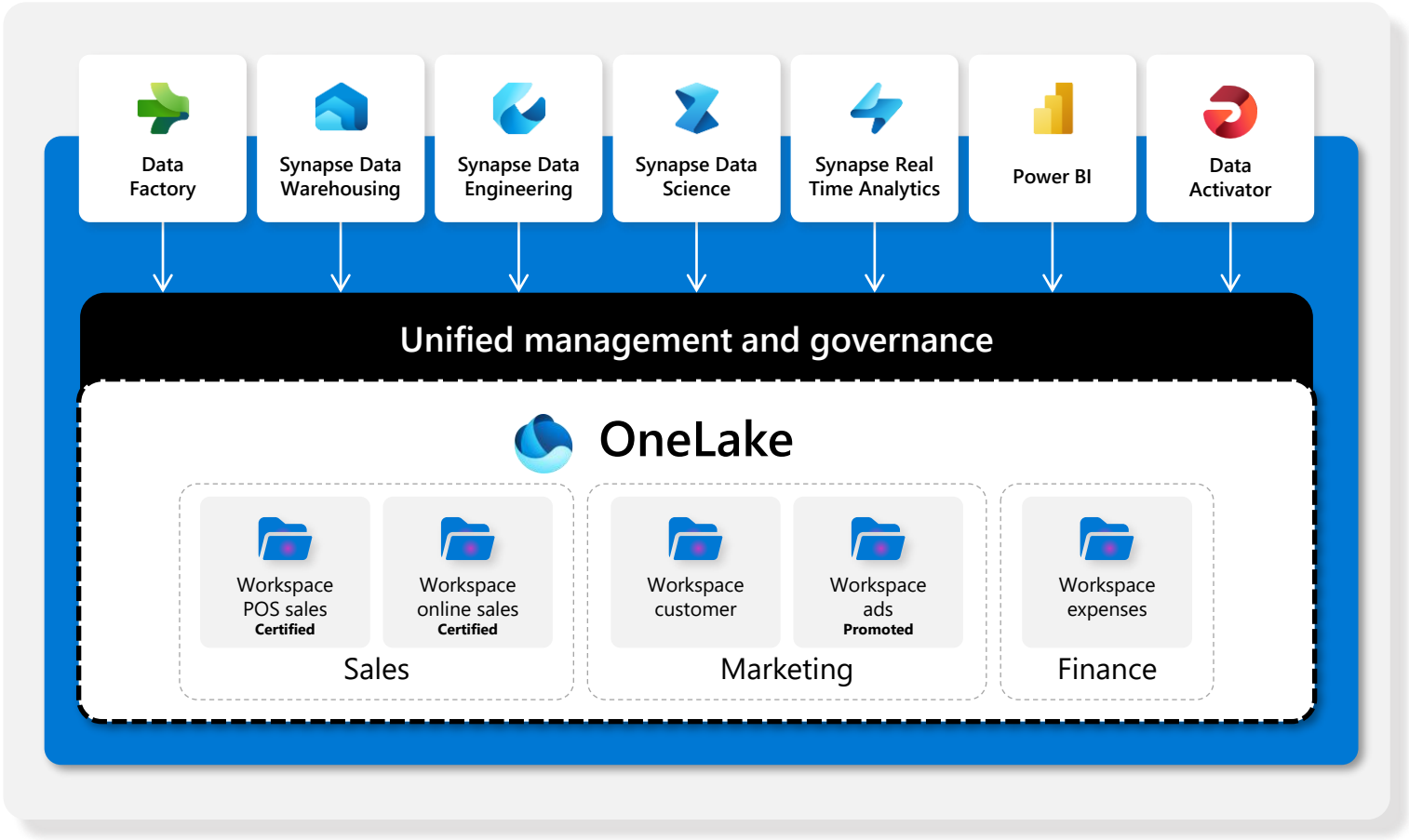
Introducing domains as an integral part of Fabric: A domain is a way to logically group together all the data in an organization relevant to an area or field, according to business needs

Domains are defined with domain admins and contributors who can associate workspaces and group them together under a relevant domain

Federated governance can be achieved by delegating settings to domain admins, thus allowing them to achieve more granular control over their business area

Domains simplify discovery and consumption of data across the organization, thus allowing business optimized consumption

Avoid data swamps by endorsing certain data as certified or promoted, thus encouraging reuse.

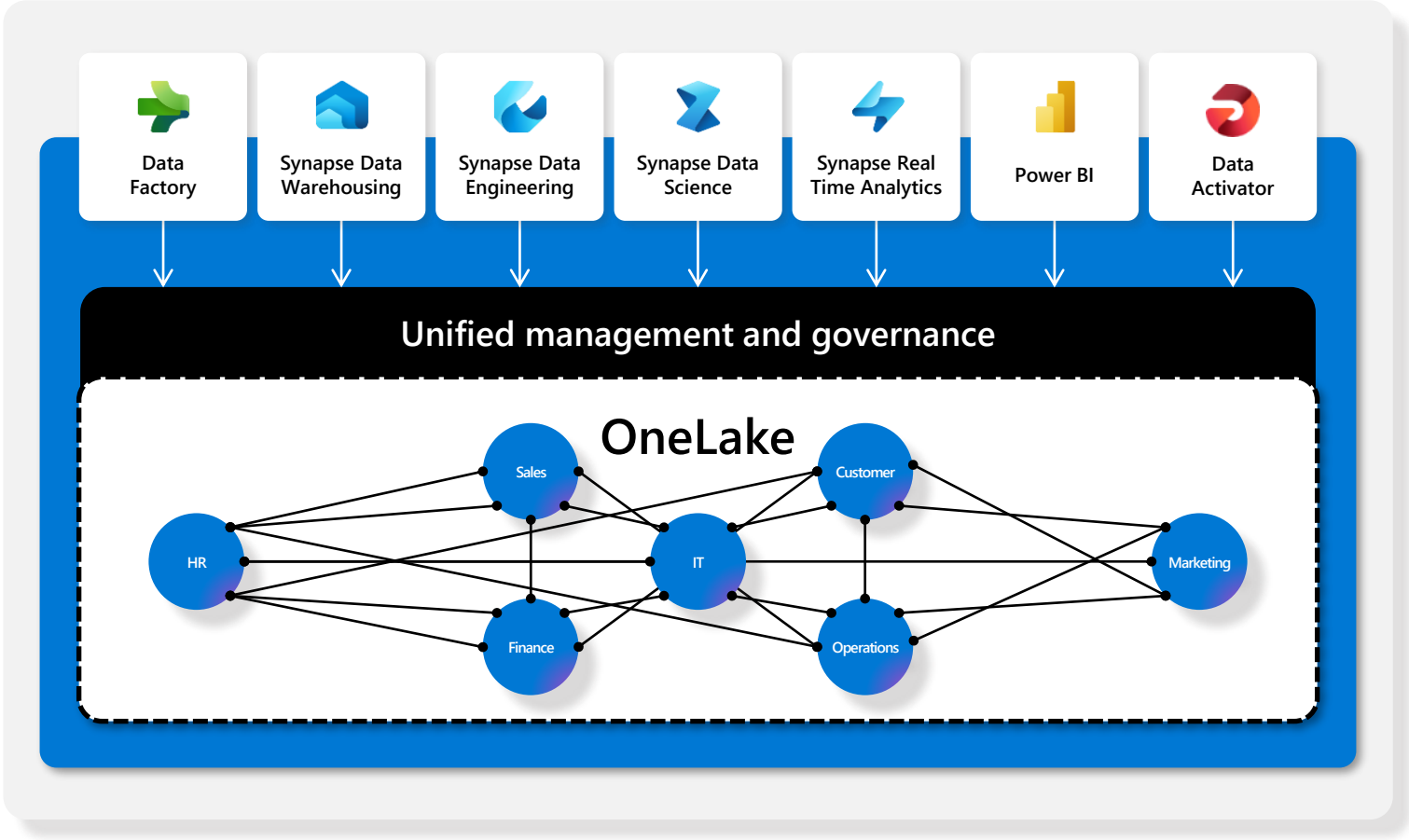


OneLake gives a true data mesh as a service

One Copy enables data to be used across domains, clouds and engines

An organization will have many data domains with many workspaces with different data owners. However, a single data product can span multiple domains.

Shortcuts provide the connections between domains so that data can be virtualized into a single data product without data movement, data duplication or changing the ownership of the data.



Data Mesh on Azure Resources

- Piethein Strengholt: Blog - Implementing Data Mesh on Azure, Blog – Data Mesh topologies, Book - Data Management at Scale: Best Practices for Enterprise Architecture
- Cloud Adoption Framework: Azure data management and analytics scenario
- Data Management & Analytics Scenario - Data Management Zone: Github
- Data Management & Analytics Scenario - Data Landing Zone: Github
- Enterprise-Scale - Reference Implementation: Github
- Microsoft doc: A financial institution scenario for data mesh
- Provision three Azure Data Lake Storage Gen2 accounts for each data landing zone
- Overview of Azure Data Lake Storage for the data management and analytics scenario
- The best practices for organizing Synapse workspaces and lakehouses

- Data Mesh, Data Fabric, Data Lakehouse – video from Toronto Data Professional Community on 2/15/23

Q & A

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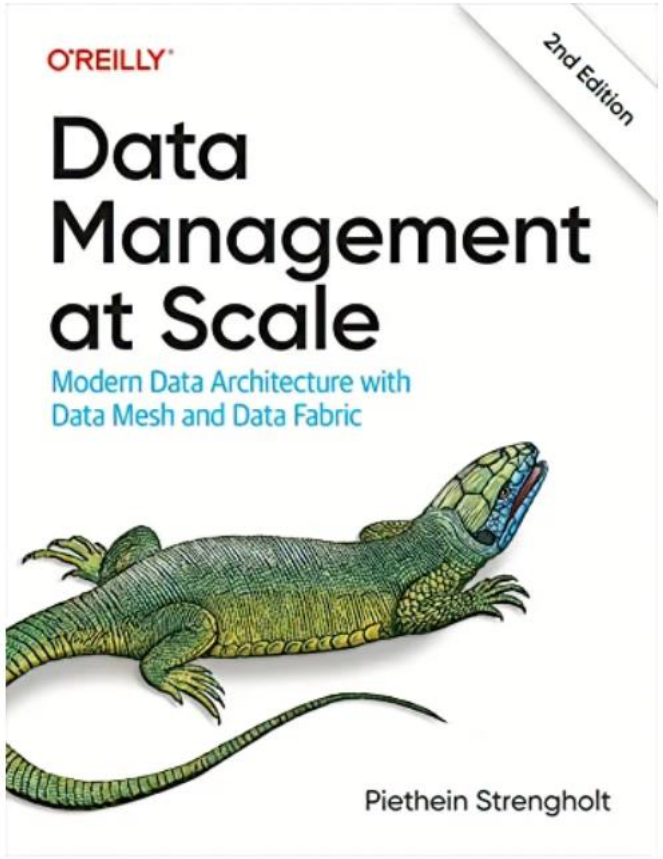
Data Management at Scale



As data management continues to evolve rapidly, managing all of your data in a central place, such as a data warehouse, is no longer scalable. Today's world is about quickly turning data into value. This requires a paradigm shift in the way we federate responsibilities, manage data, and make it available to others. With this practical book, you'll learn how to design a next-gen data architecture that takes into account the scale you need for your organization.

Executives, architects and engineers, analytics teams, and compliance and governance staff will learn how to build a next-gen data landscape. Author Piethein Strengholt provides blueprints, principles, observations, best practices, and patterns to get you up to speed.

- Examine data management trends, including regulatory requirements, privacy concerns, and new developments such as data mesh and data fabric
- Go deep into building a modern data architecture, including cloud data landing zones, domain-driven design, data product design, and more
- Explore data governance and data security, master data management, self-service data marketplaces, and the importance of metadata

http://aka.ms/datamanagementatscale (free copy)

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