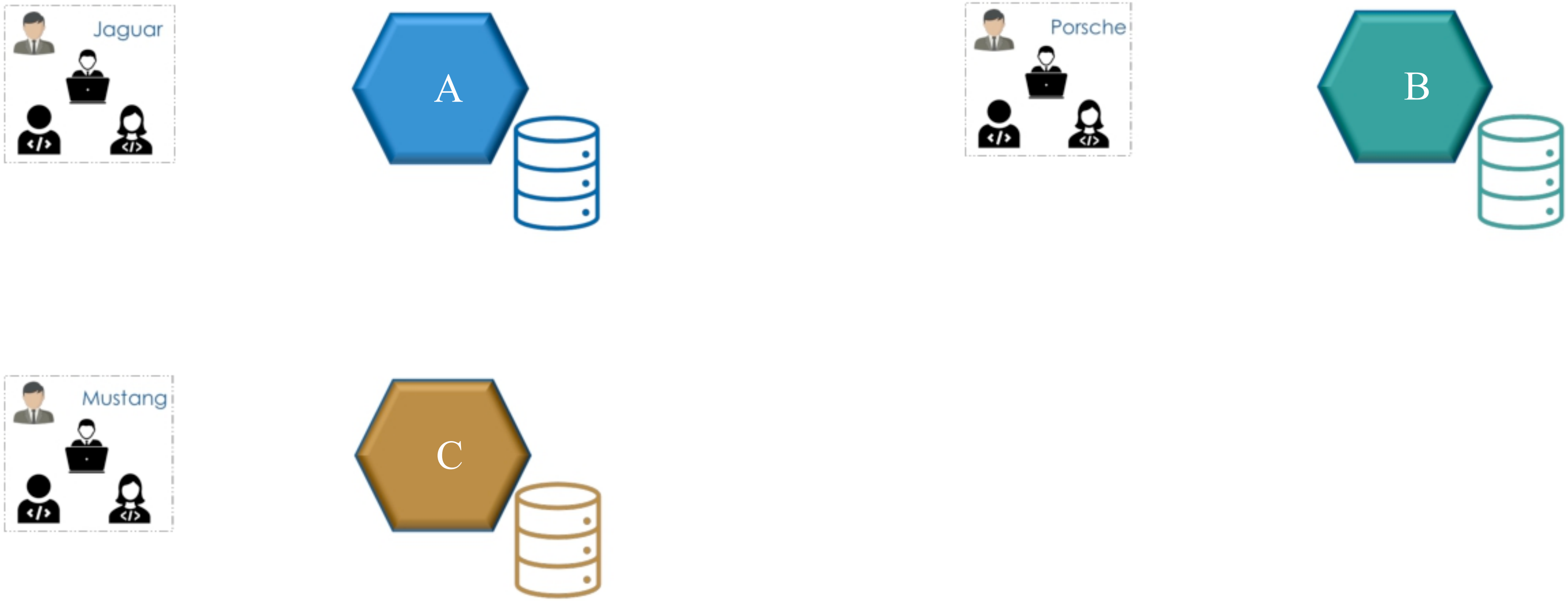
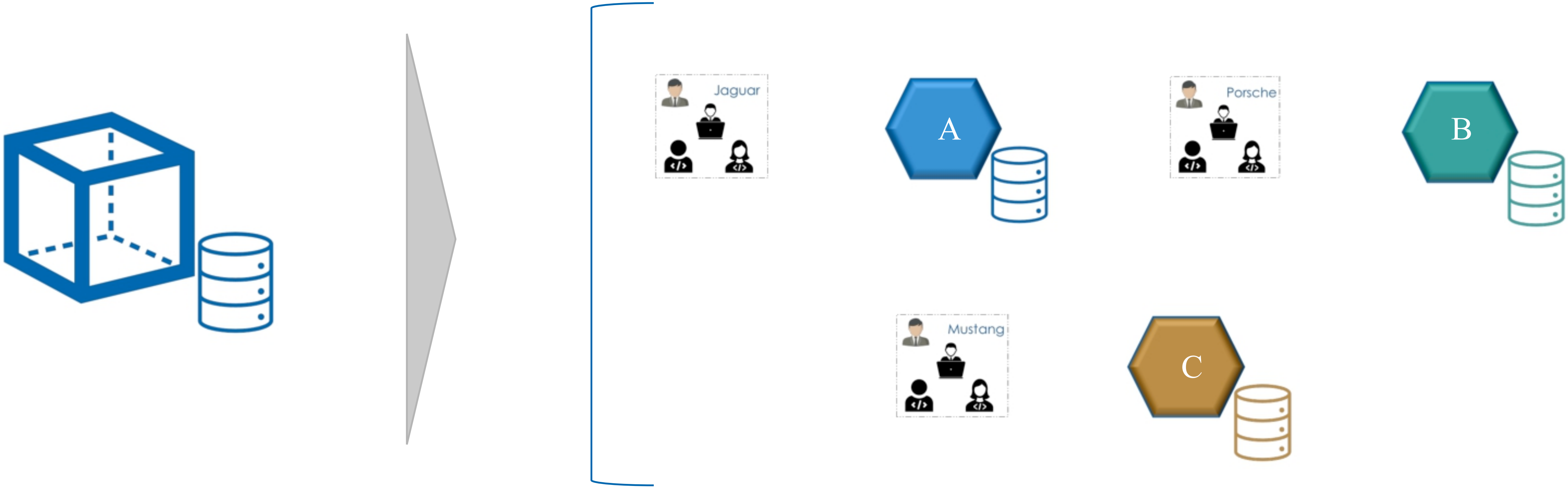
Microservices Data Patterns

Databases are an essential part of ALL applications.



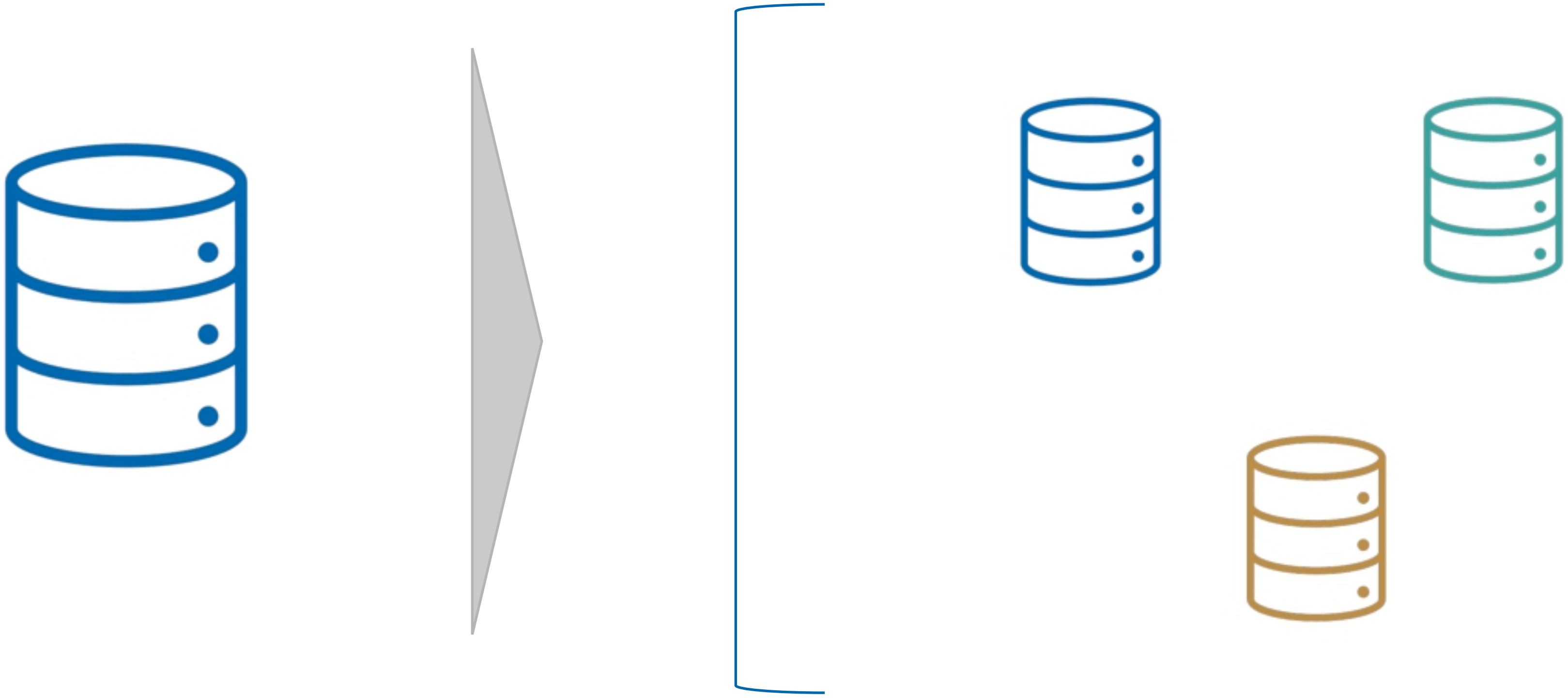
Microservices Data Patterns

Monolithic app to Microservices



Microservices Data Patterns

Breaking the Database is a CHALLENGE



Microservices Data Patterns

Data Patterns

- Used for designing the new Microservices
- Conversion of Monolithic apps to Microservices

Microservices Data Patterns

Section objective

1. Shared Database Pattern
2. Separate Database Pattern
3. Strangler Pattern
4. Converting monolith to microservices
5. Options for breaking shared DB into multiple DB instances

Persistence in Shared Databases

Data storage in legacy applications

1. Shared Database pattern
2. Pros of shared database
3. Cons of shared database

Data Storage

Persistence for application data

- Managed in raw files

- Databases

ORACLE

IBM DB2

mongoDB

CouchDB

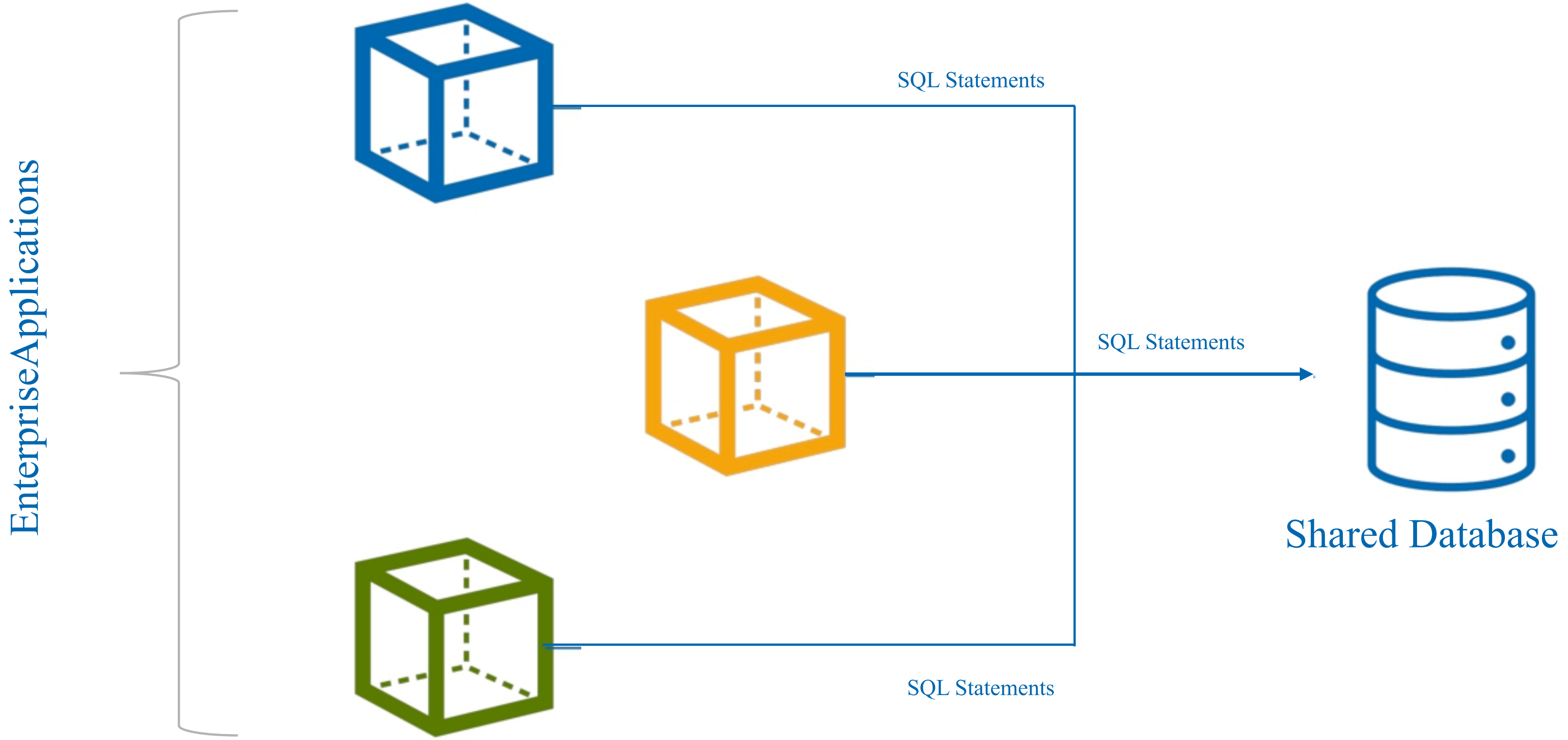
MySQL

cassandra

Relational DBs commonly used in legacy apps for all types of data !!

Use of RDBMS in Legacy Apps

Shared Database(s) for multiple applications



Shared Database - Good things

1. Simplified data management

2. Cost savings on Database (licensing, servers …)

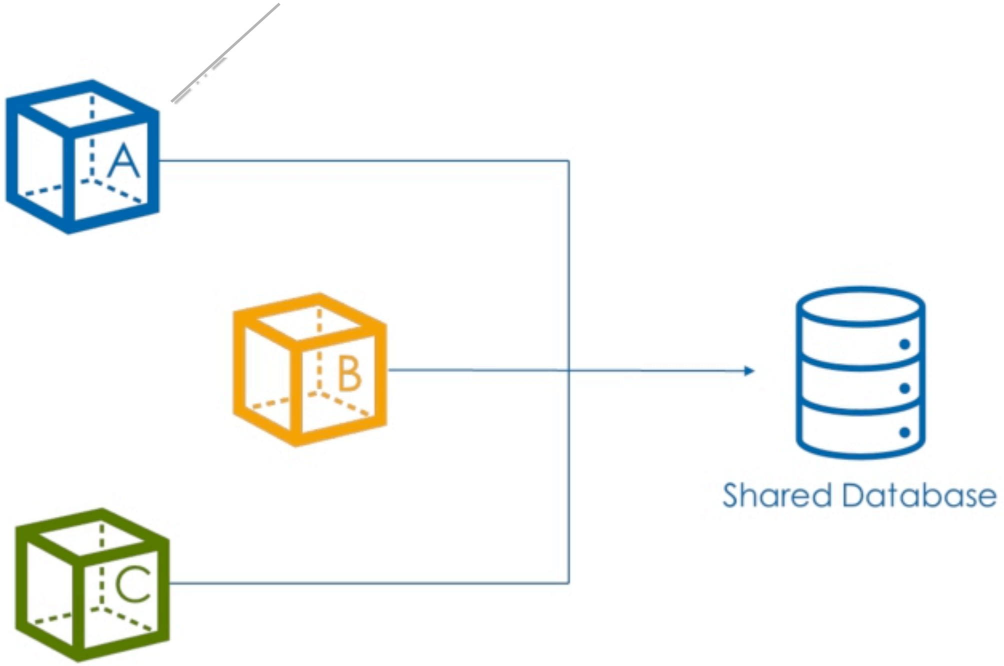
3. Centralized database administration

Challenges with Shared Database

1

DB Changes need to be managed carefully

Application **A** needs a change in Schema

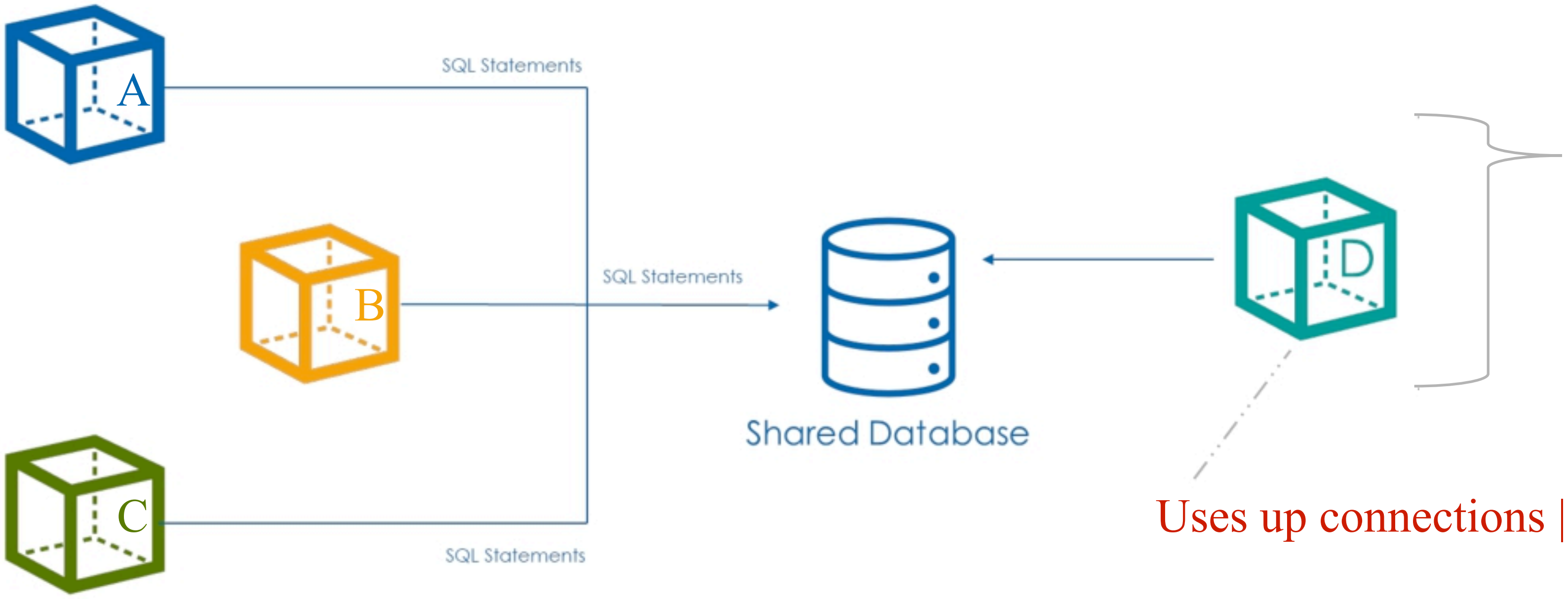


- High Cost
- High Risk
- Longer time to value

All application owners will need to assess the impact on their App !!!

Challenges with Shared Database

2 One application may negatively impact all applications



OLAP

E.g., Large Batch Job

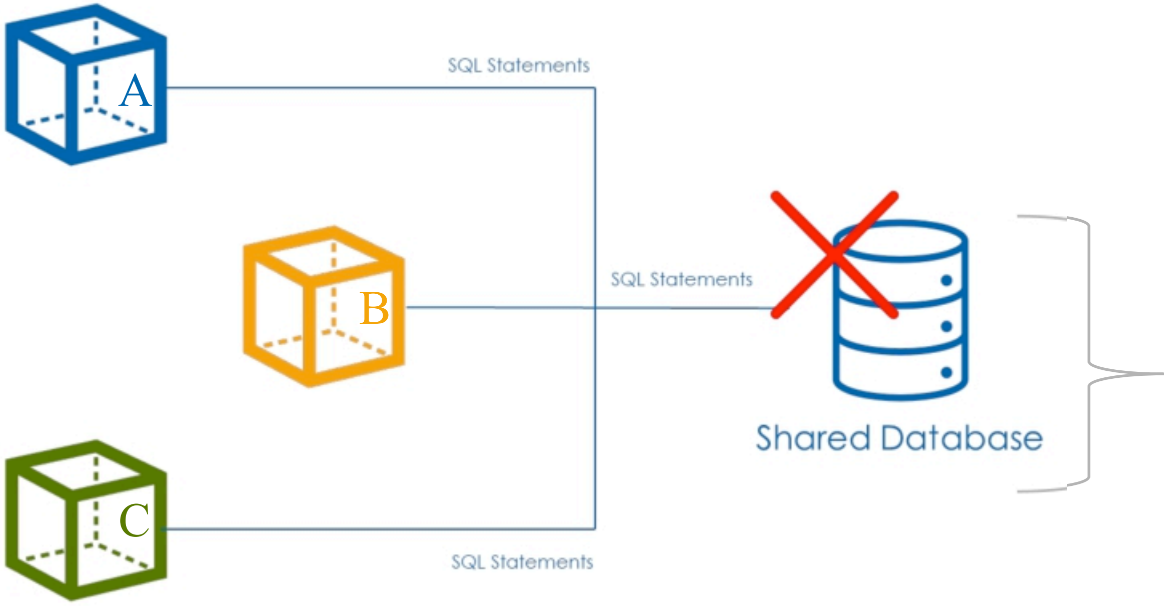
Uses up connections | resources on Database

- Impact on other applications

One App can use too much resource and impact all other Apps !!

Challenges with Shared Database

3 Single Point of Failure



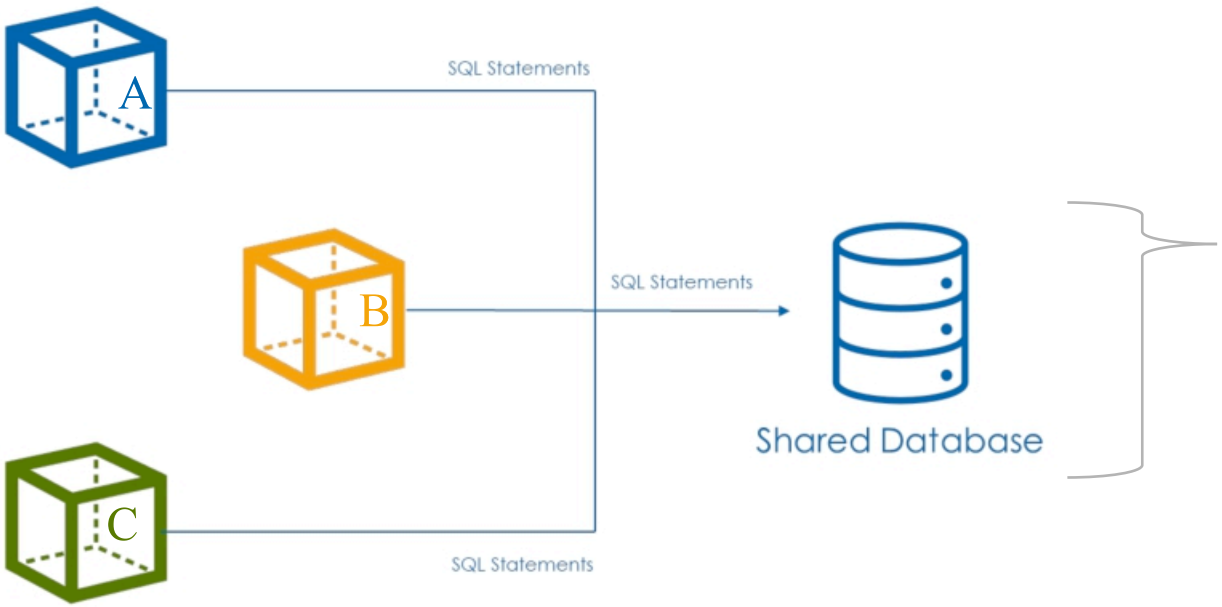
A failure here means all applications down

- Complex HA solutions → High cost

All Applications dependent on the DB will be unavailable !!!

Challenges with Shared Database

4 Capacity planning for the Database



CPU | Memory | Storage

OVER Capacity is Common !!!

ALL teams MUST provide estimates on their usage !!!

Challenges with Shared Database

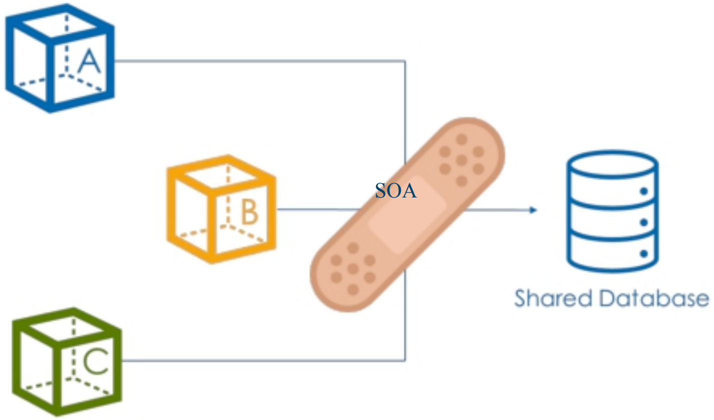
6 Same Database types for all applications

Application teams does not have a choice of DB type !!!

Monolithic applications

Shared Database(s) is an anti -pattern BUT

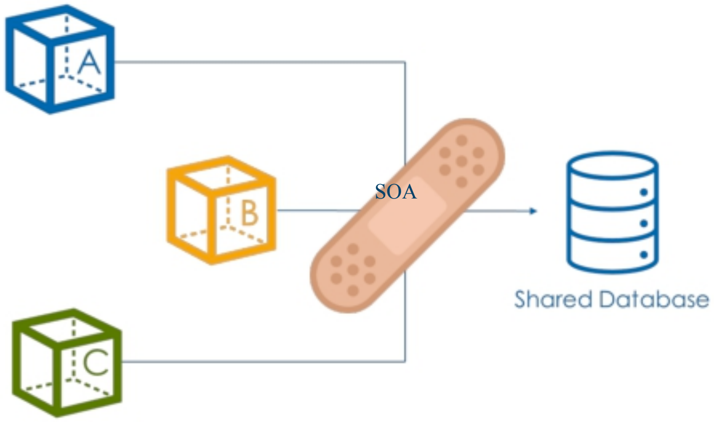
- Many enterprises are still dealing with such applications
- Service Oriented Architecture | API for rescue



Quick Review

Shared Database(s) is an anti -pattern BUT

- Many enterprises are still dealing with such applications
- Service Oriented Architecture (SOA) | API for rescue



Service Oriented Architecture (SOA)

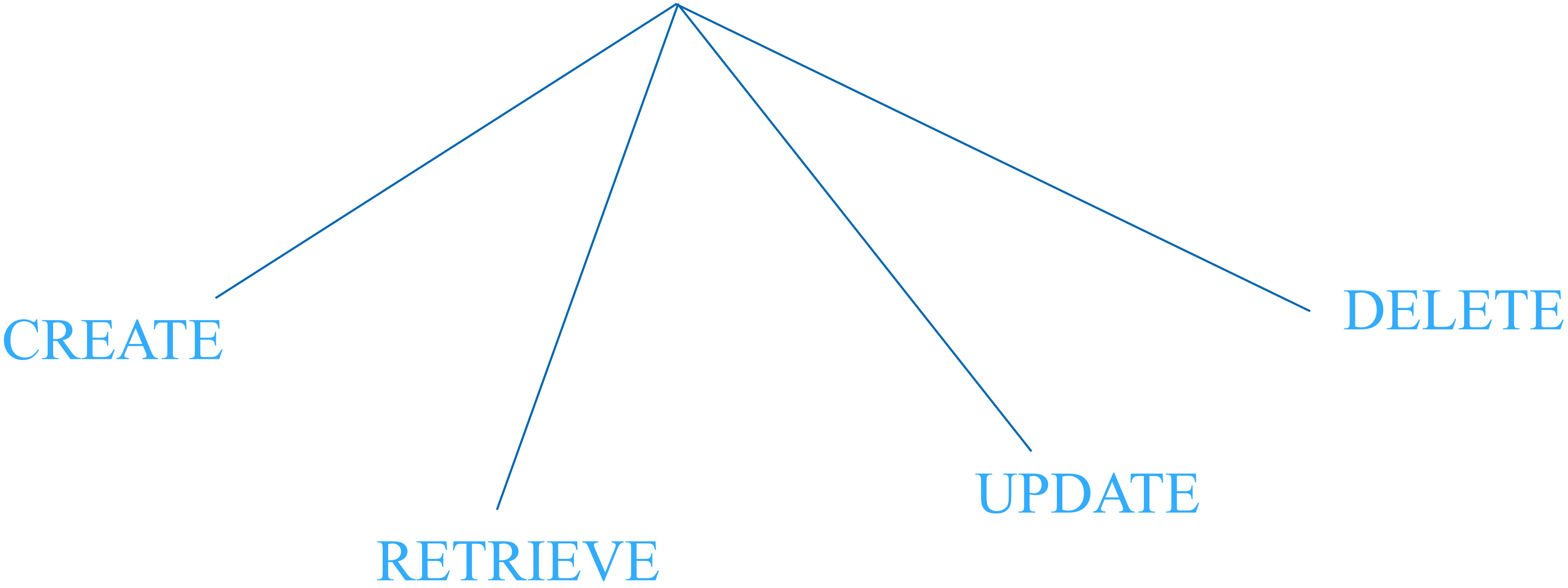
Insulated applications from underlying database(s)

1 Introduction to SOA

2 SOA & Shared Database pattern

Service Oriented Architecture

Data exposed by way of CRUD services | API



CREATE

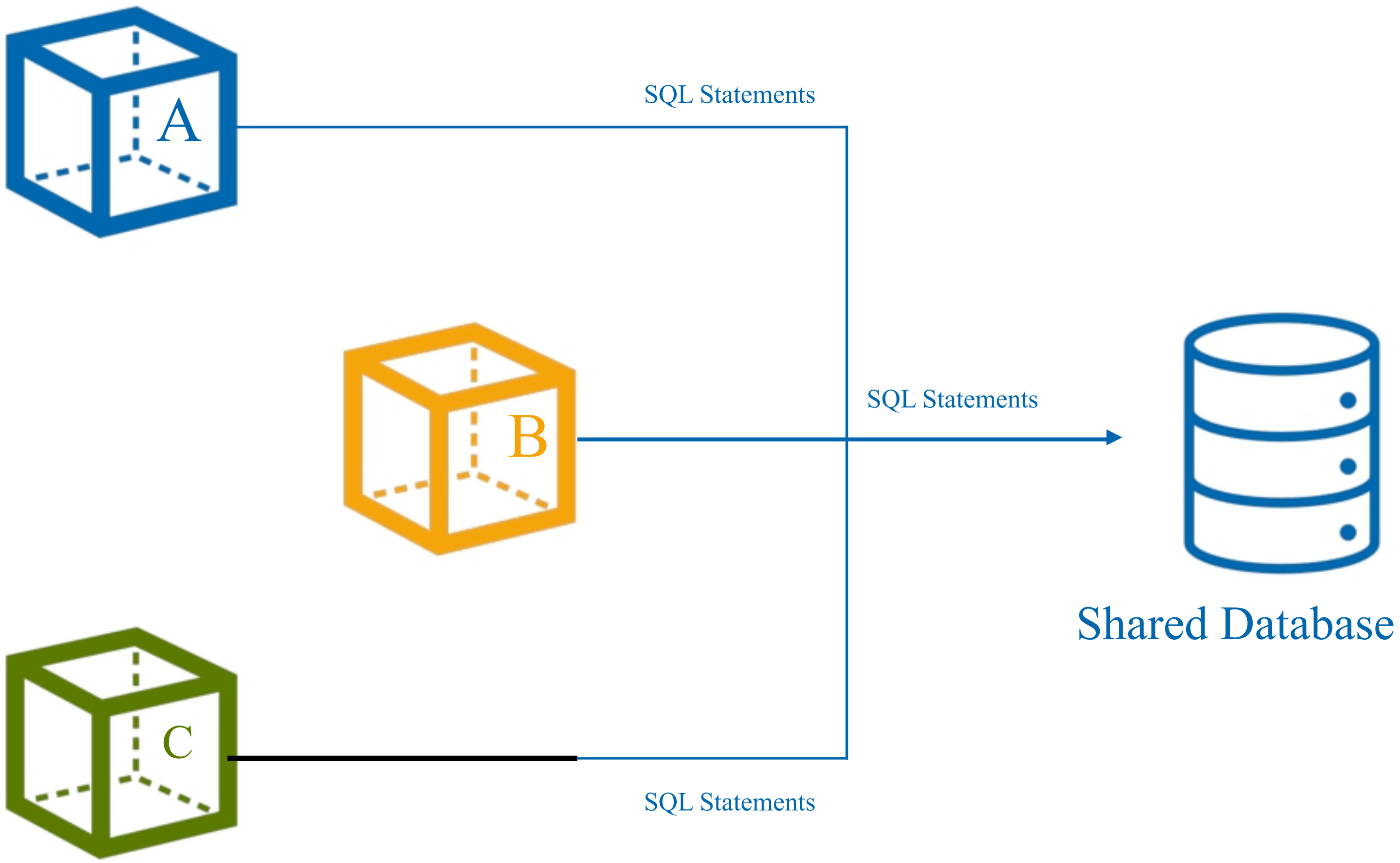
RETRIEVE

UPDATE

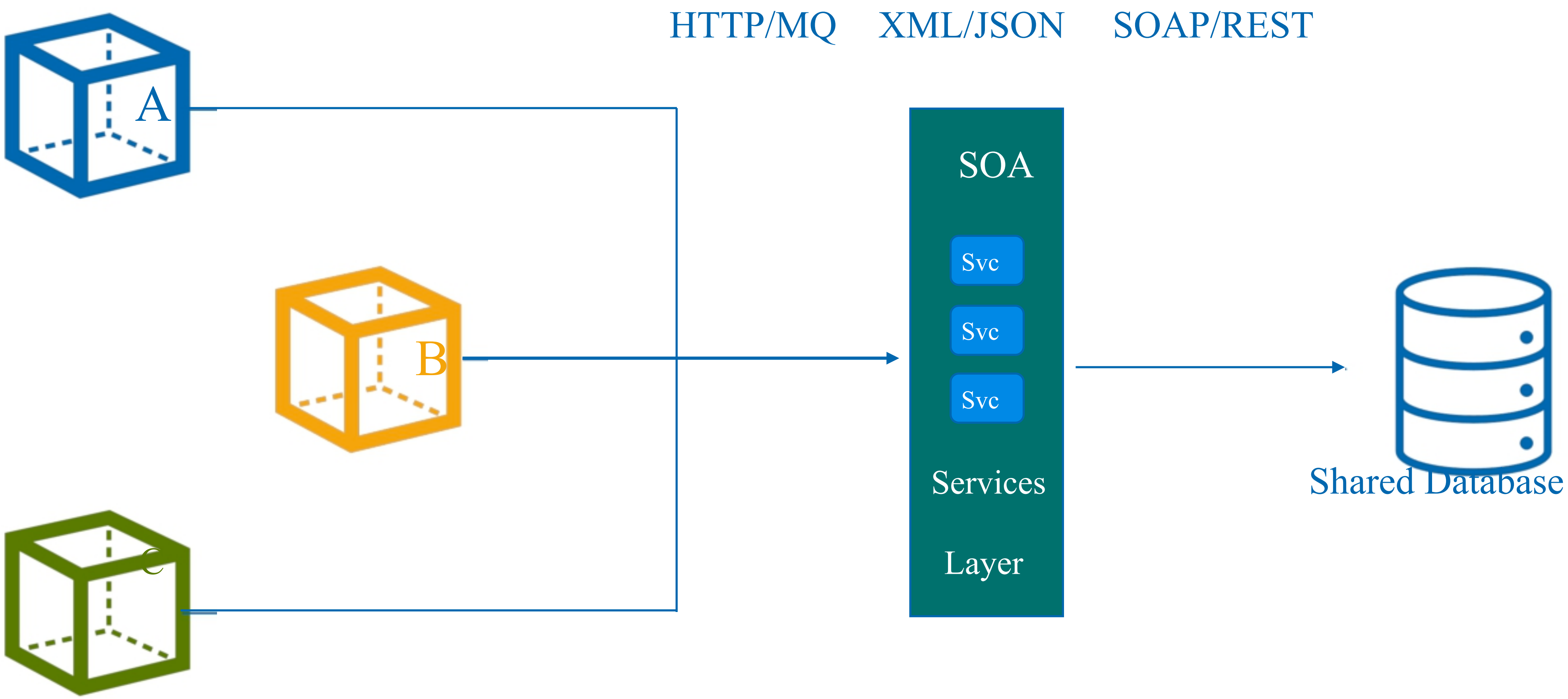
DELETE

Hides the Database structure behind services !!!

SOA Layer placed between Apps & DB



SOA Layer placed between Apps & DB



Services provided CRUD and Higher - level business operations

SOA addressed some Challenges

1. Hides the structure of DB i.e., no more SQL statements

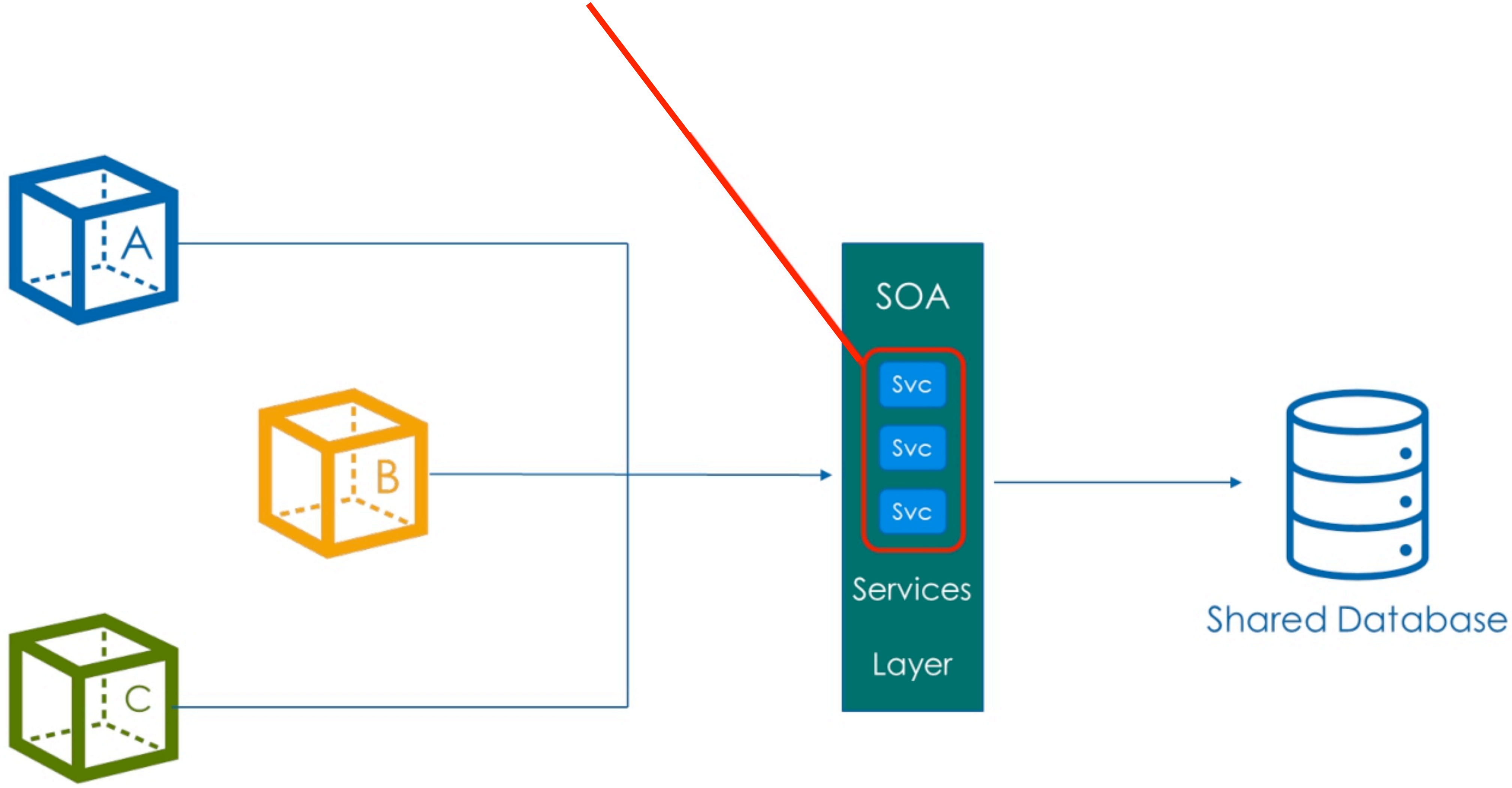
2. Services were designed to be re -usable

3. Changes to DB become manageable

Doesn't address *many* of the shared DB challenges !!

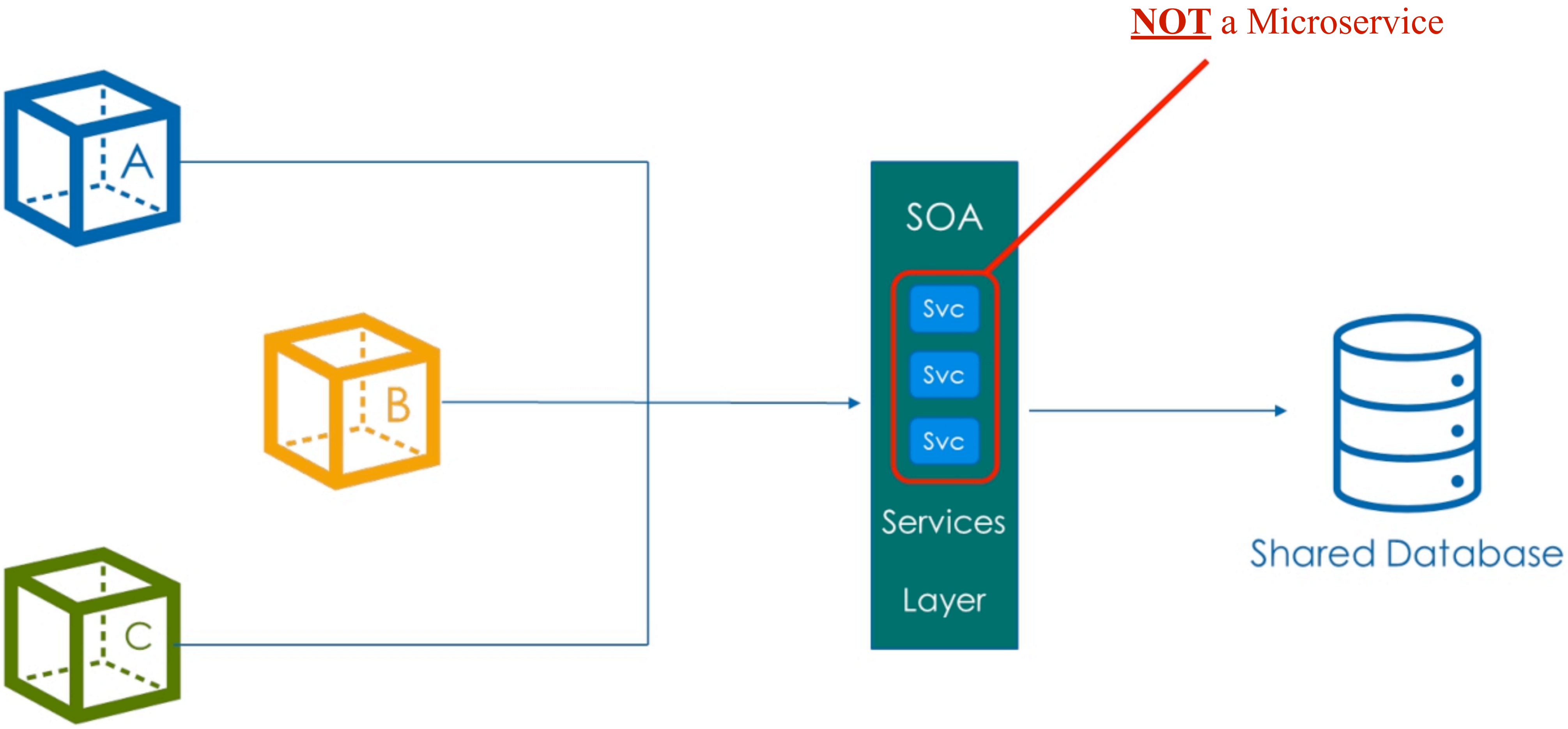
Misconception

A small SOA Service is a Microservice



Misconception

A small SOA Service is a Microservice



Quick Review

SOA services insulated the application from Database changes

- BUT did not address other challenges of Shared Database(s)

Separate Database Pattern

Recommended for Greenfield Microservices Initiative

1 Greenfield versus Brownfield

2 Separate Database Pattern

3 Advantages of separate DB

Microservices Projects

Greenfield

New application with no constraints from technical debt perspective

Brownfield

Existing monolithic app to be converted to Microservices architecture

Microservices : Recommendation

"Separate DB" recommended for Microservices

Brownfield

Is it even possible to break the existing DB?

Is it worth the effort i.e., do a Cost-Benefit Analysis?

What will be the Business benefits?

Microservices : Recommendation

"Separate DB" recommended for Microservices

Greenfield

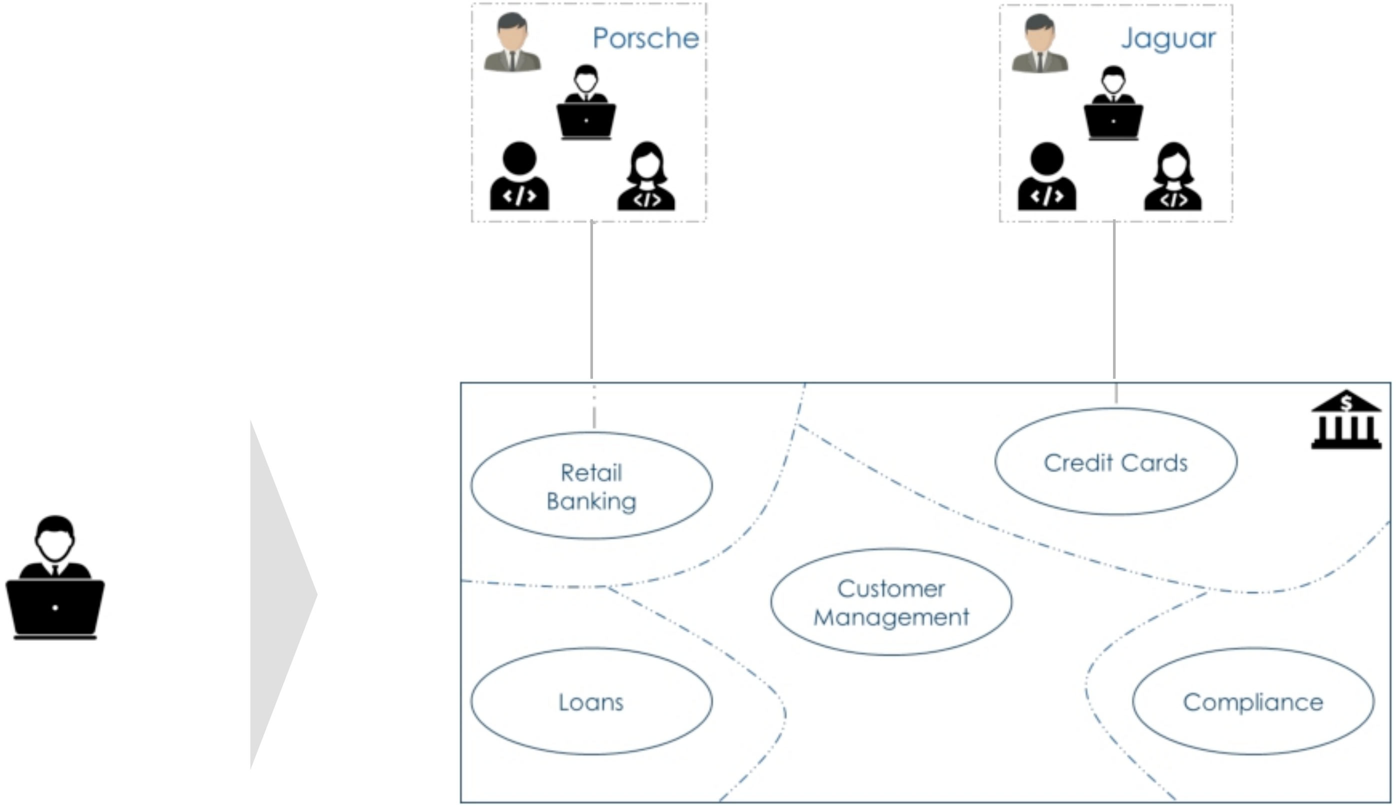
Are the teams skilled for managing their own DB?

Does the organization have tools to manage multiple database?

Are the teams ready to manage design complexities?

Microservices from ground up

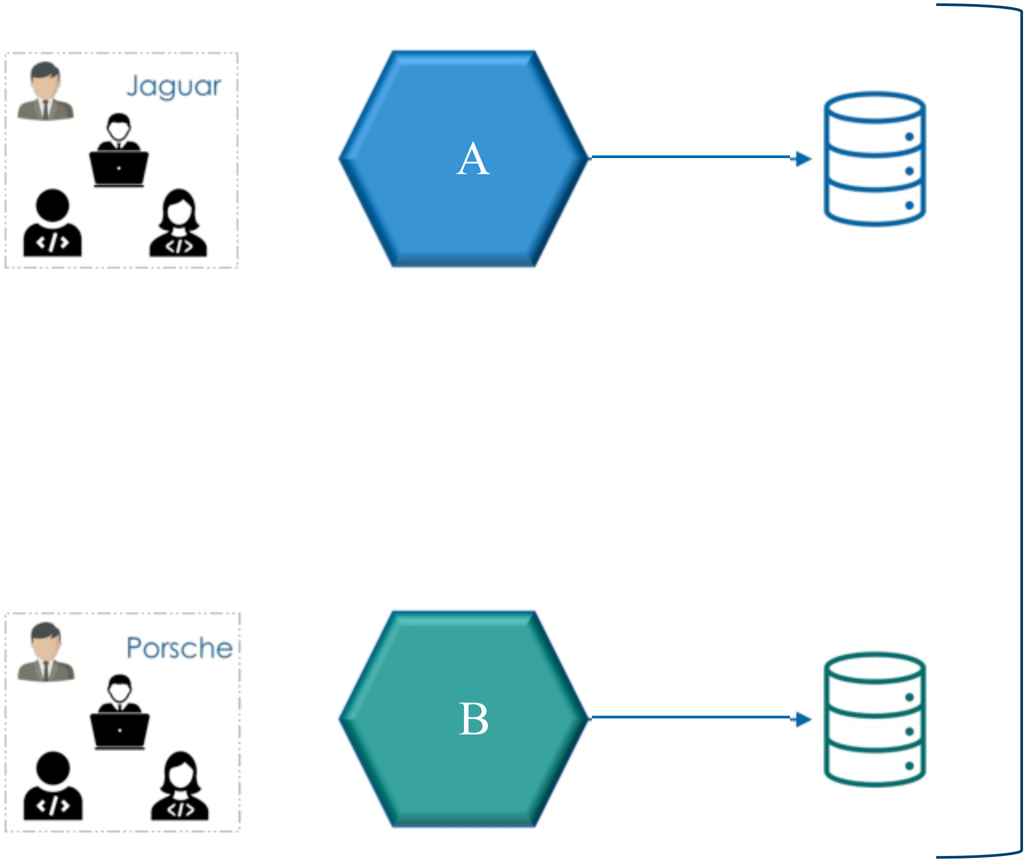
Microservices teams assigned the Bounded Context



DDD Exercise

Greenfield

Microservices from ground up

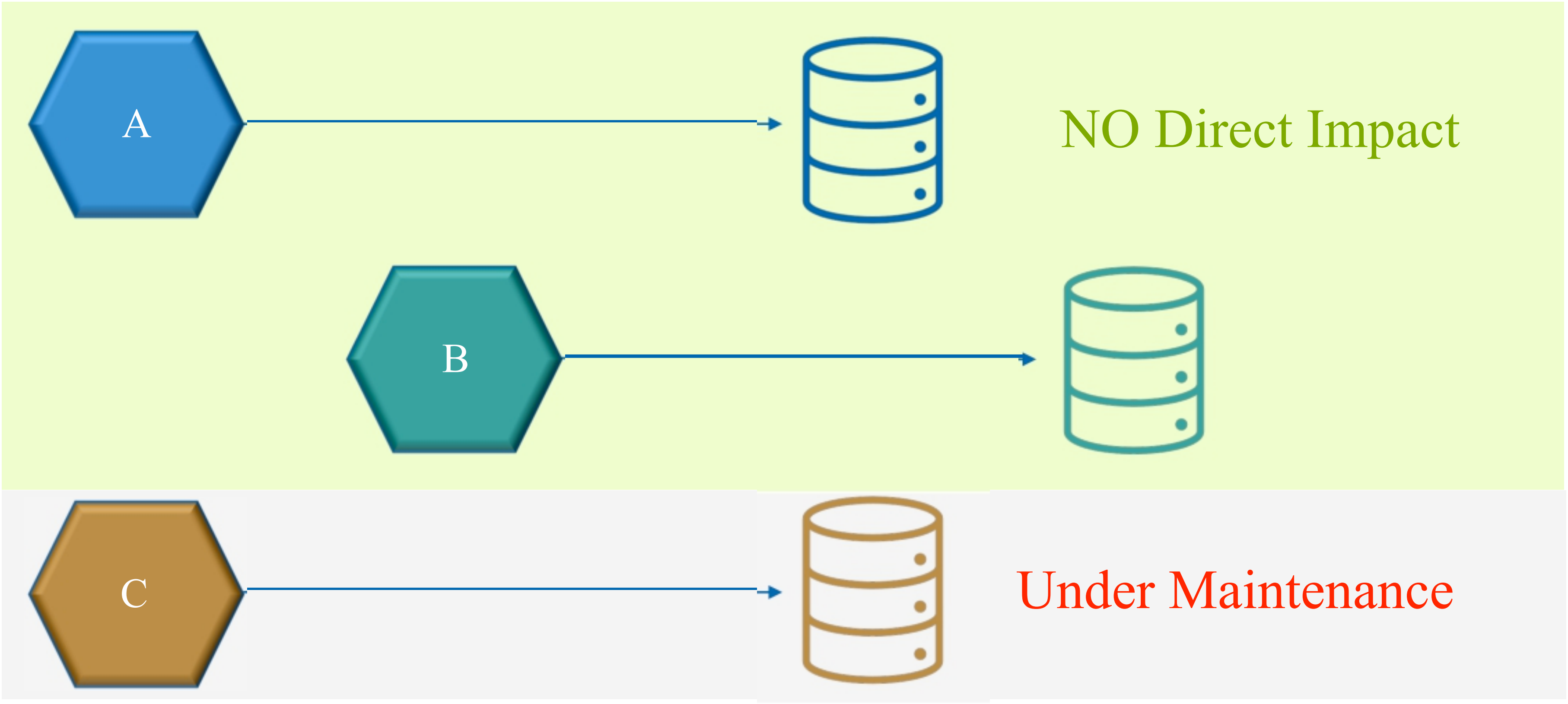


- No interdependency between teams
- Each team decide on their tech stack
- Service interactions via defined interfaces
- No direct access to data

Each microservice has its own Database !!!

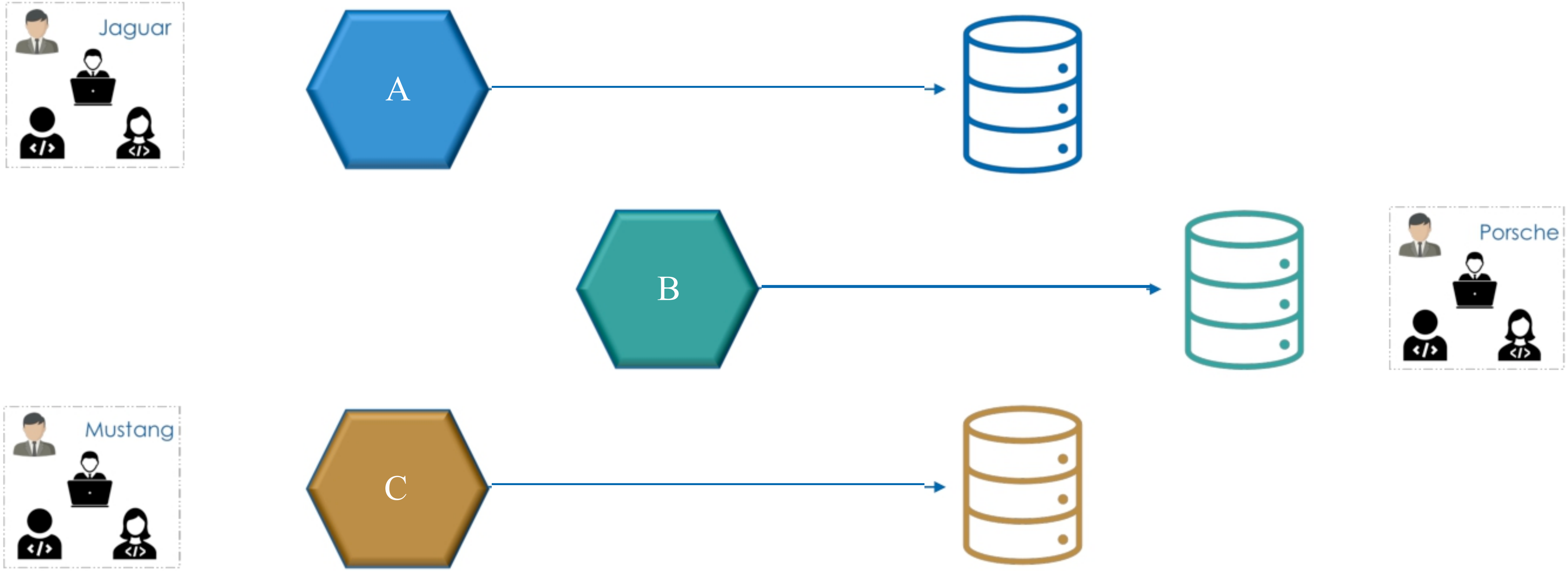
Benefits : Separate Database Pattern

Simpler change management



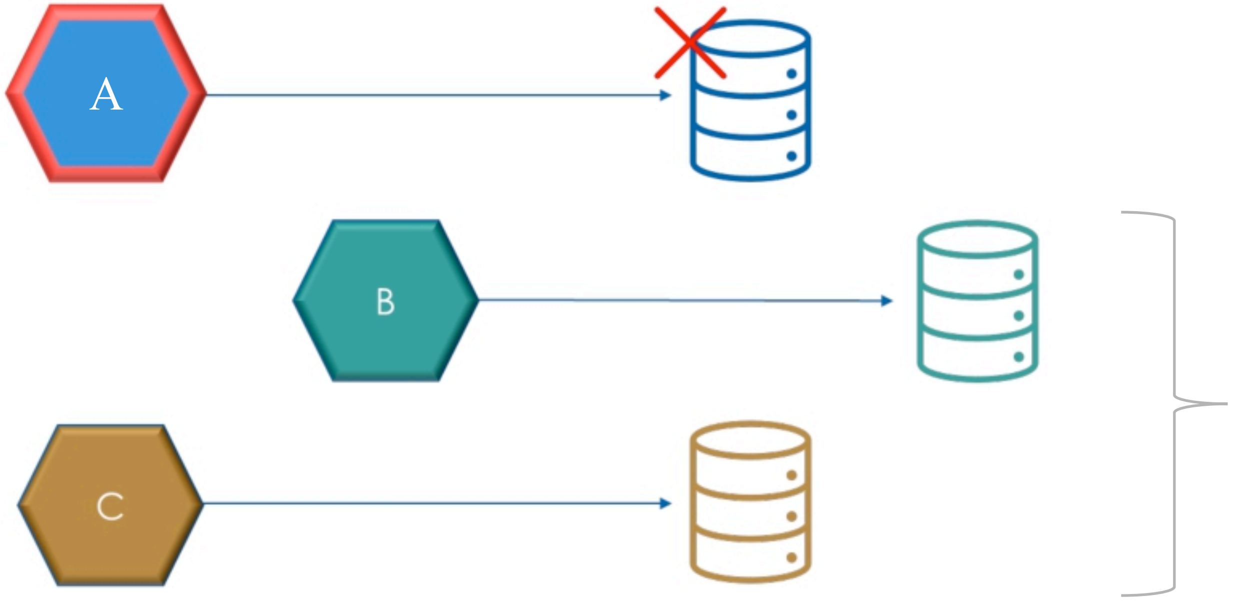
Separate Database Pattern

Each microservice team owns & manages their database



Benefits : Separate Database Pattern

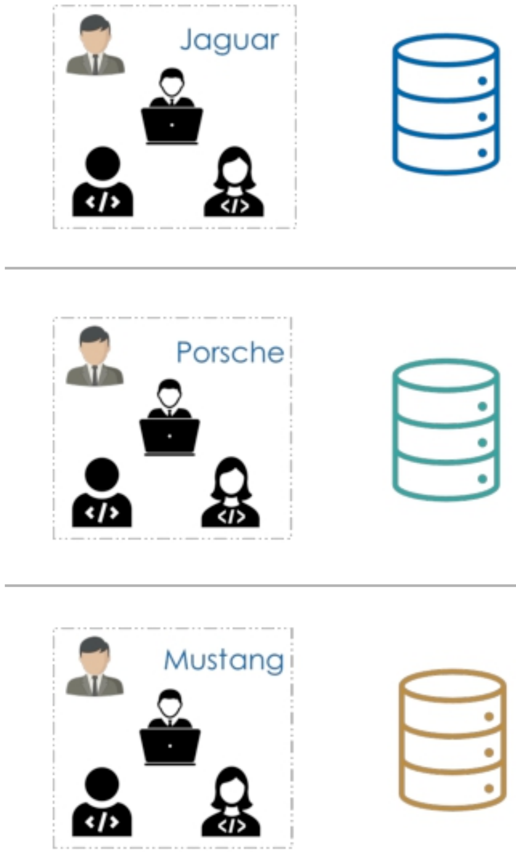
Reduced blast radius on Database Failure



NO direct impact on B & C

Benefits : Separate Database Pattern

Capacity planning | Scaling at DB level becomes simpler



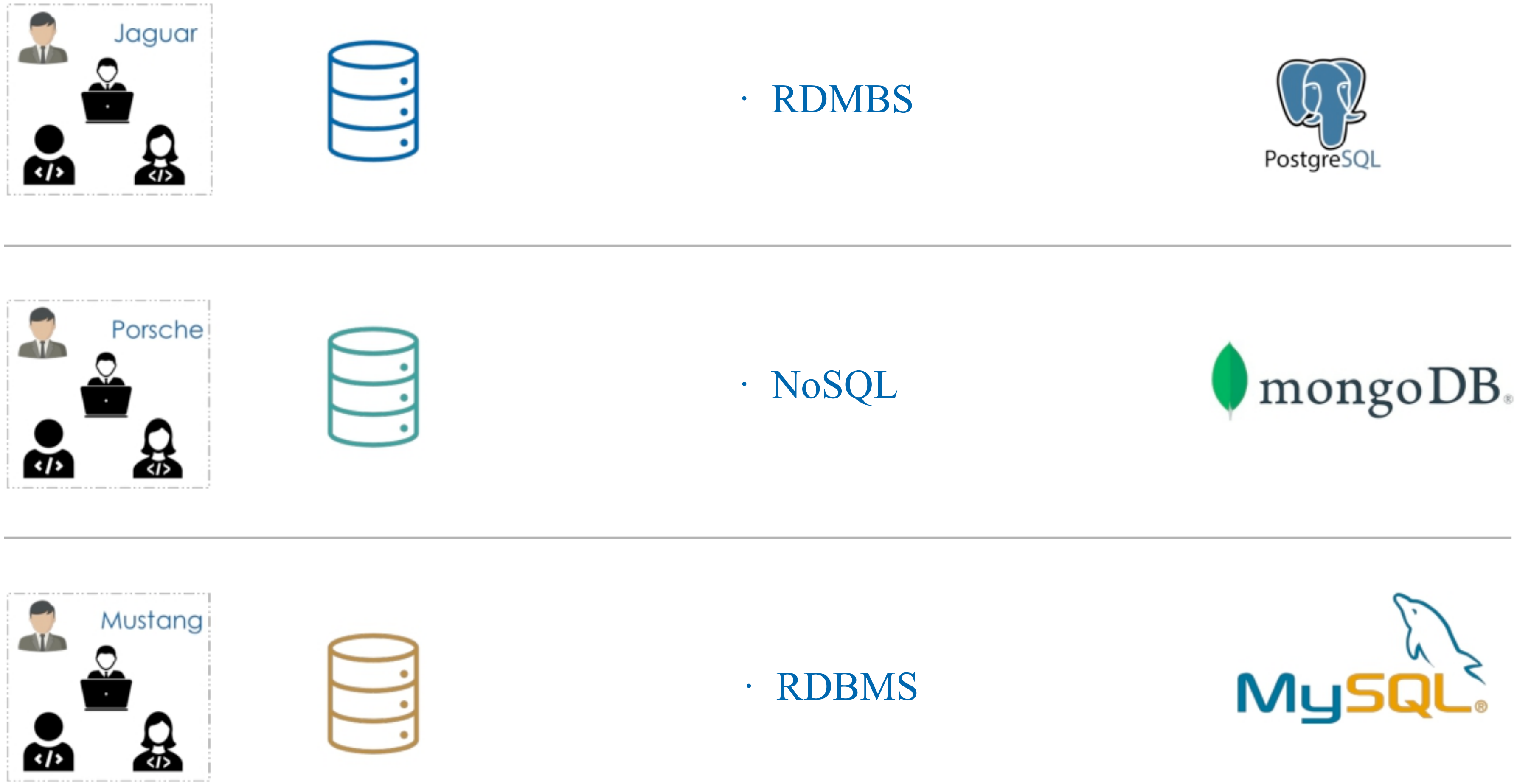
- No new capacity for next year

- Additional 5 TB for storage

- 1 TB Storage
- CPU +2 cores

Benefits : Separate Database Pattern

Each team can decide on Database i.e., doesn't have to RDBMS

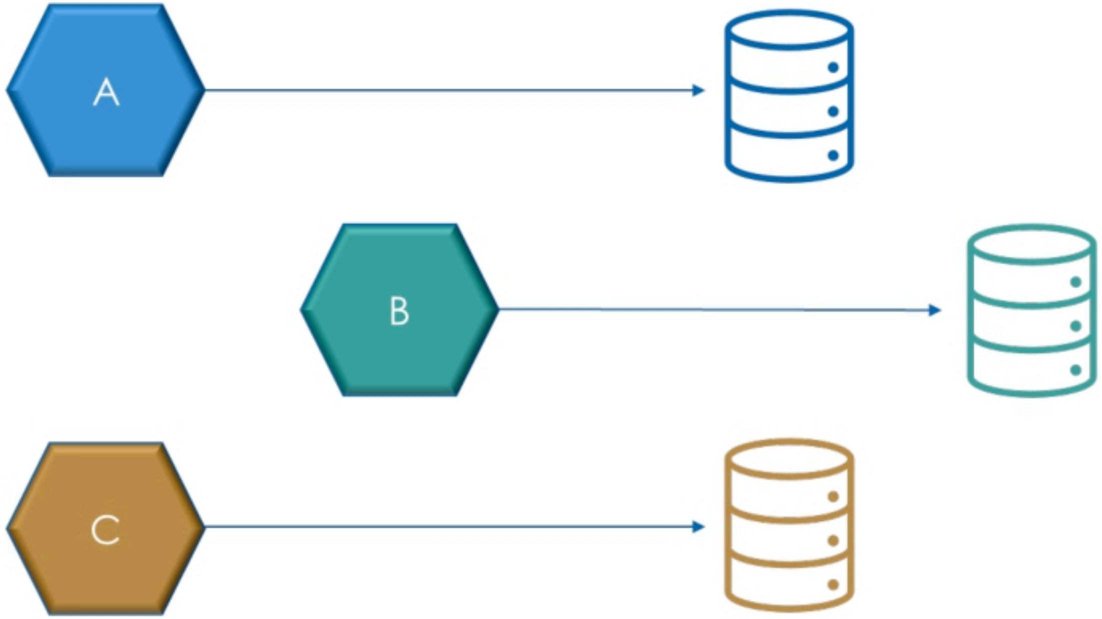


- RDMBS
- NoSQL
- RDBMS

Quick Review

Greenfield

Separate Database Pattern is recommended



Brownfield & Databases

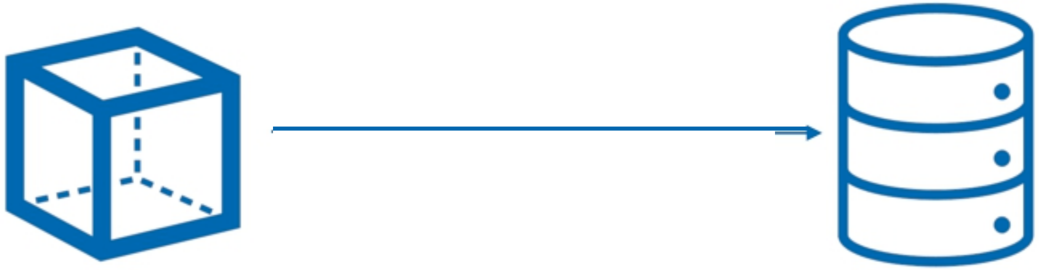
Converting a Monolith to Microservices

1. Converting Brownfield to Microservices
2. Shared Database = Anti pattern
3. Strangler pattern

Brownfield

Conversion to Microservices

A monolith is refactored to multiple microservices



1 Apply Separate DB Pattern

SharedDatabase

2 Database Refactoring

3 Logical separation of database

Conversion to Microservices

A monolith is refactored to multiple microservices

1 Apply Separate DB Pattern

Using the Strangler Pattern

Brownfield

Conversion to Microservices

A monolith is refactored to multiple microservices

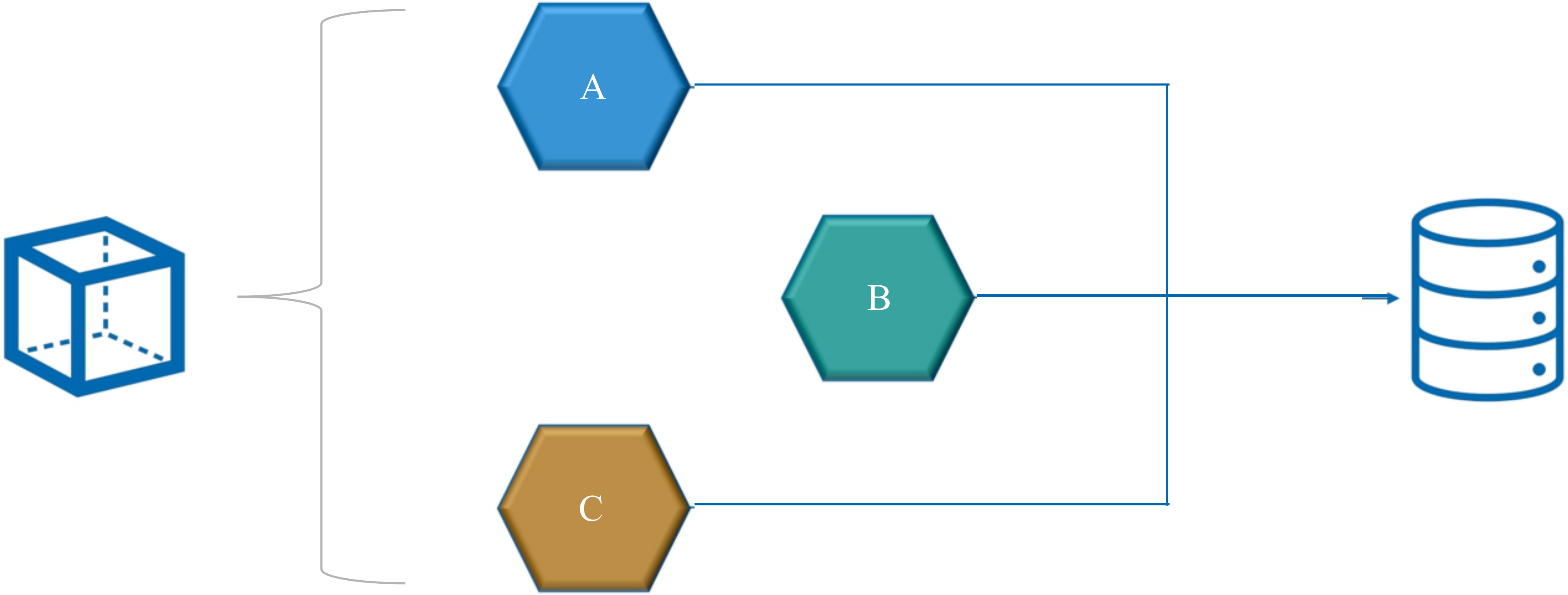
System of records in RDBMS

- Hundreds of tables
- Complex relationships
- Stored Procedures | Triggers

Brownfield

Conversion to Microservices

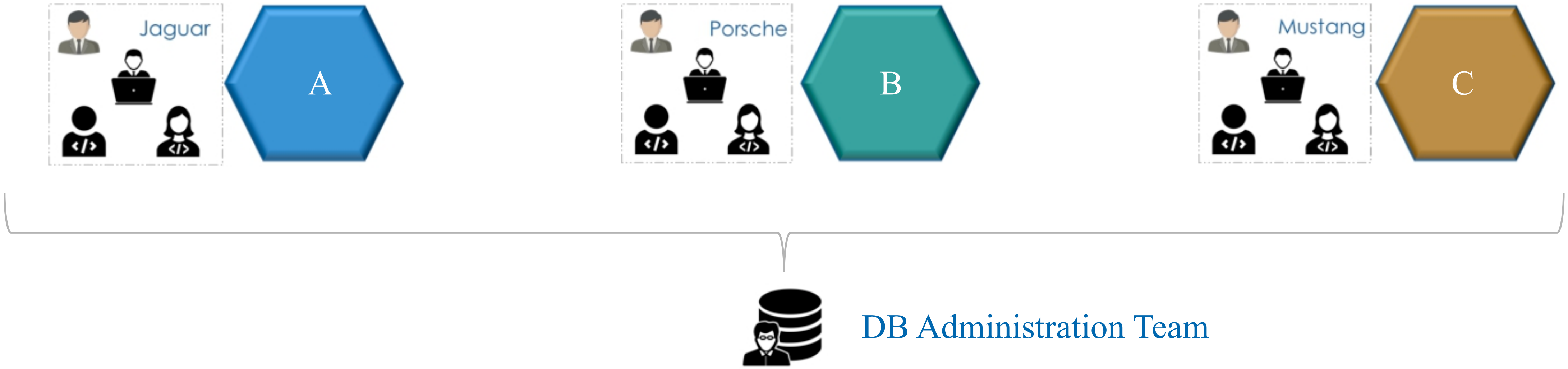
ONLY application refactored; DB stays in place



Microservices will suffer from the same challenges as applications !!!

Shared Database Pattern

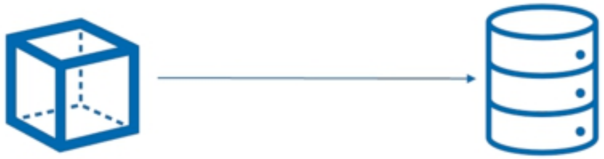
It is an Anti -Pattern as it leads to inter-dependencies



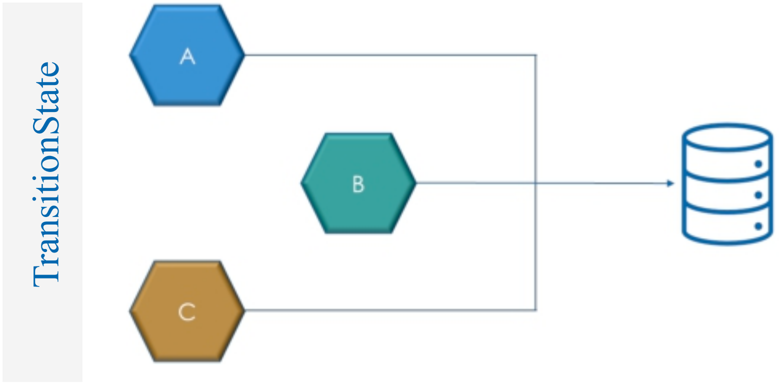
- Higher need for coordination
- Slow speed to value
- Increased testing effort
- No independent scaling

Shared DB : Transition State Architecture

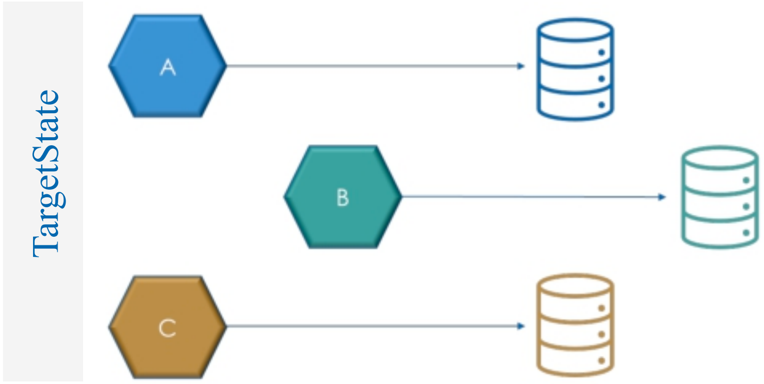
Positioning the application for Microservices architecture



- Focus on Application

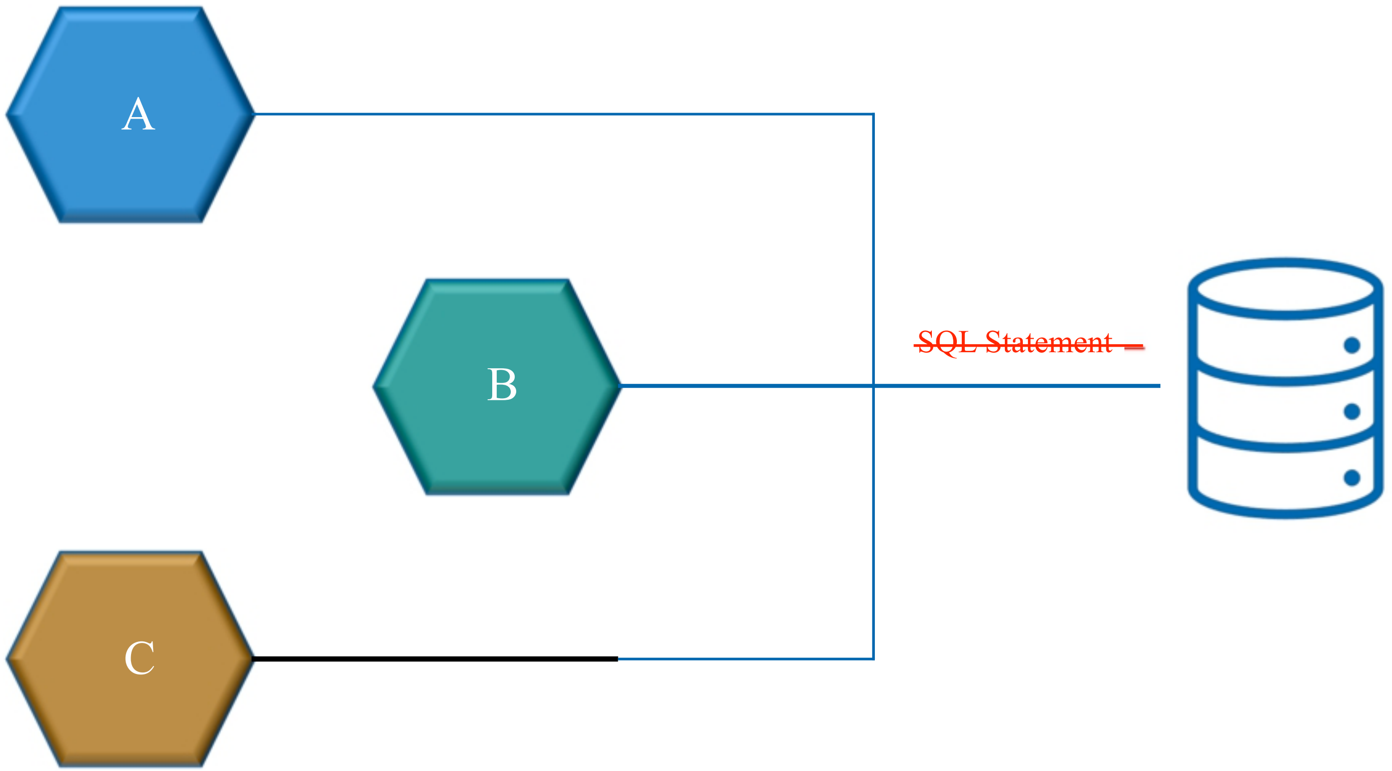


- Focus on Data



Shared DB : Transition State Architecture

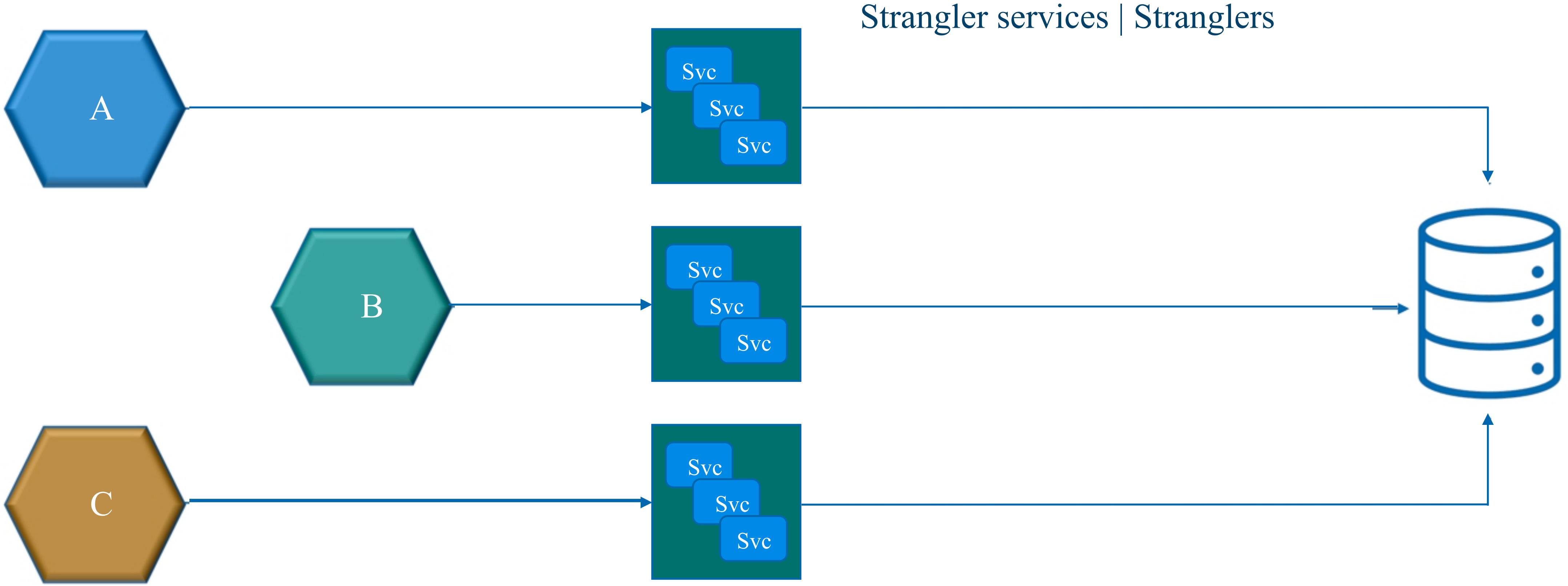
Keep the Microservices code independent of the Database



Use of SQL in code will make it difficult to switch the DB !!!

Strangler Strategy

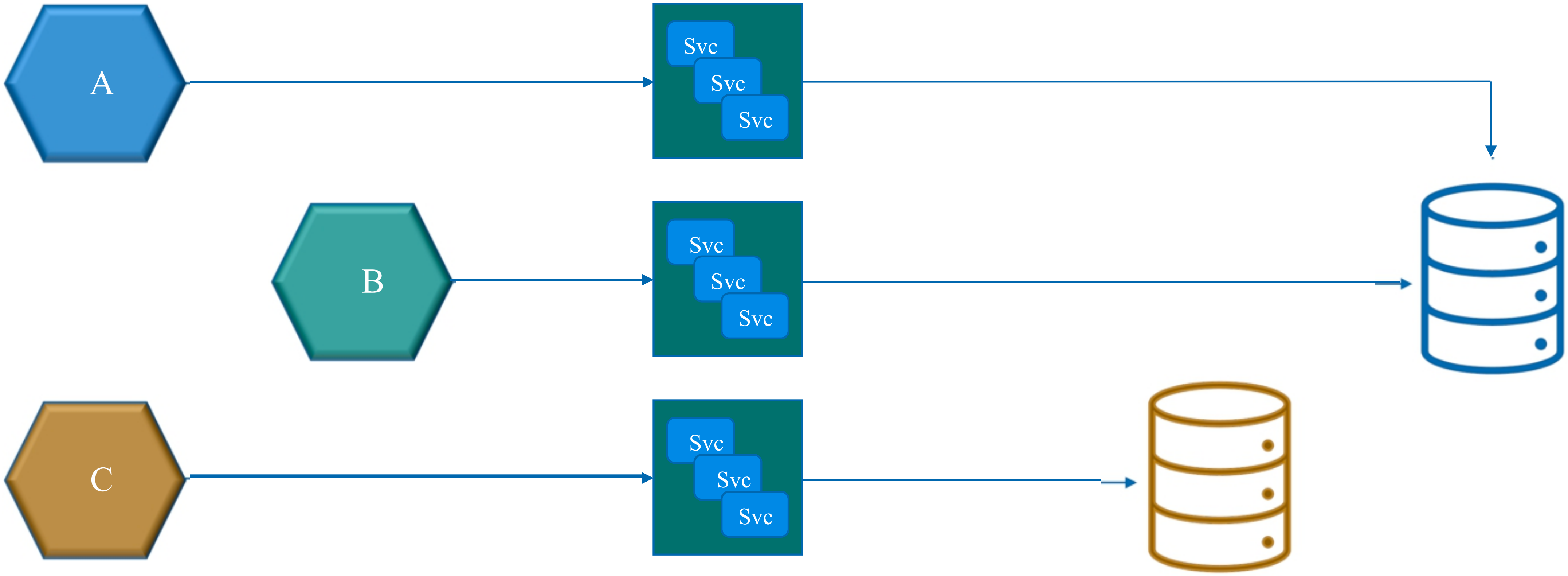
Access the data via services/API in the transition stage



Switching the DB will not affect the Microservice

Strangler Strategy

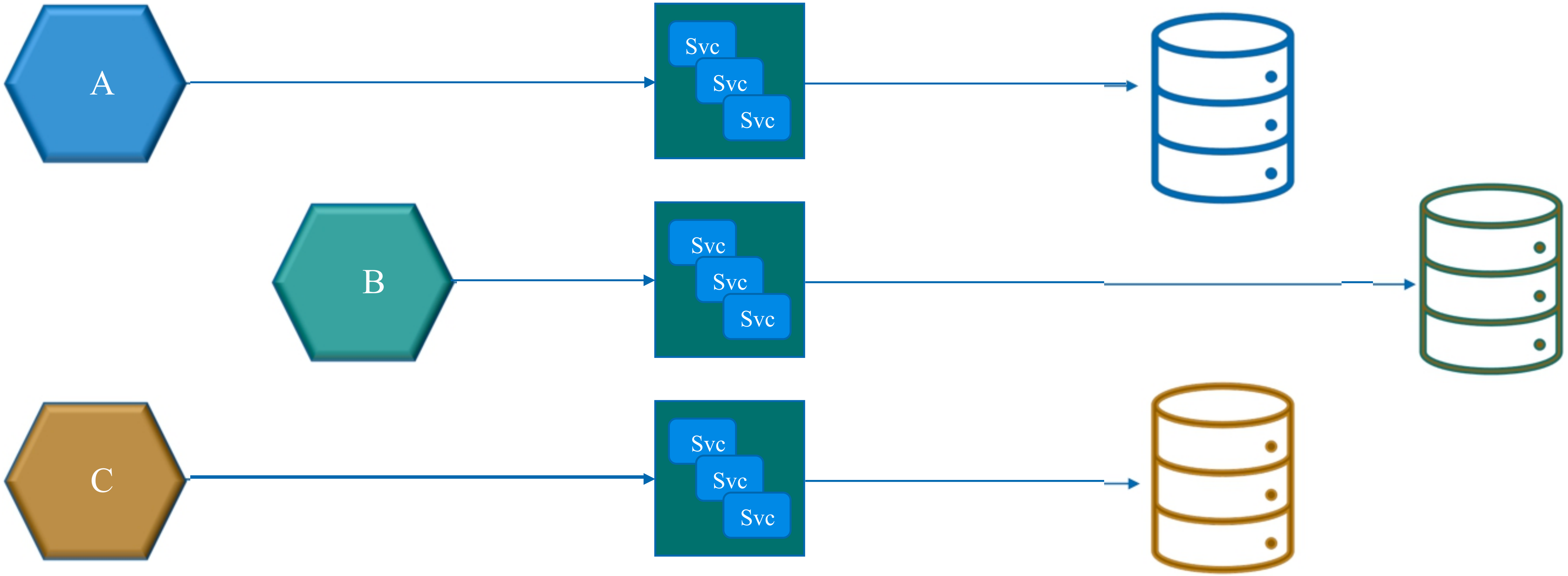
Access the data via services/API in the transition stage



Teams decide their priorities and work independently (almost)

Strangler Strategy

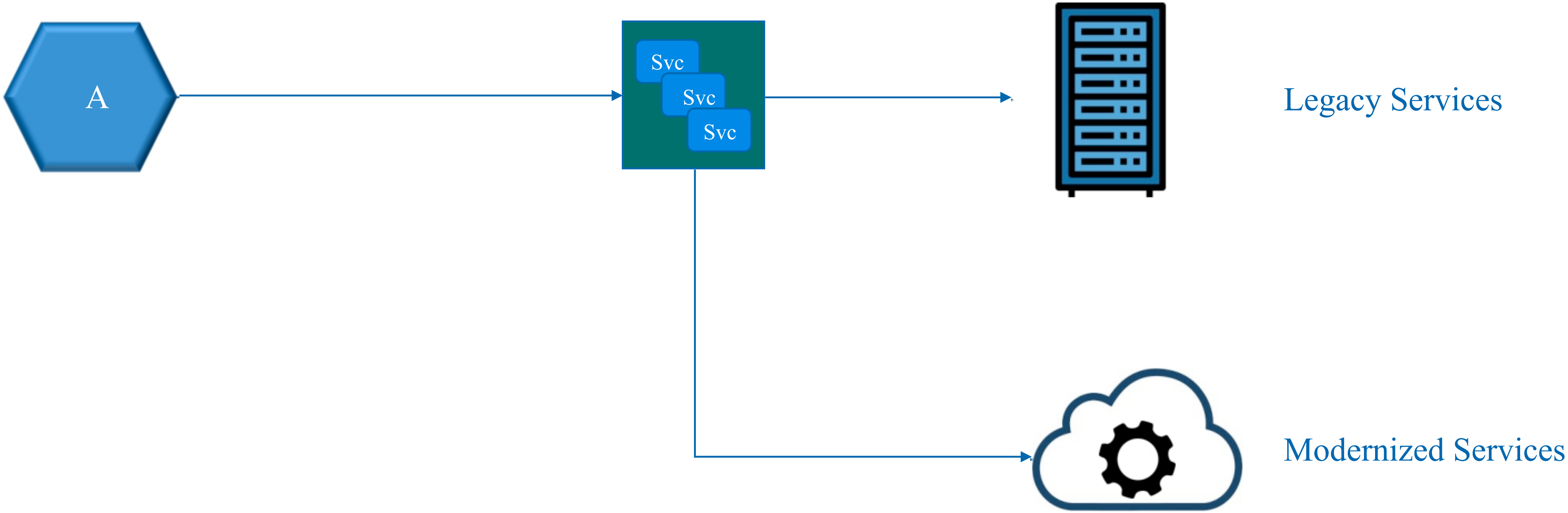
Access the data via services/API in the transition stage



Eventually the target state is achieved !!!

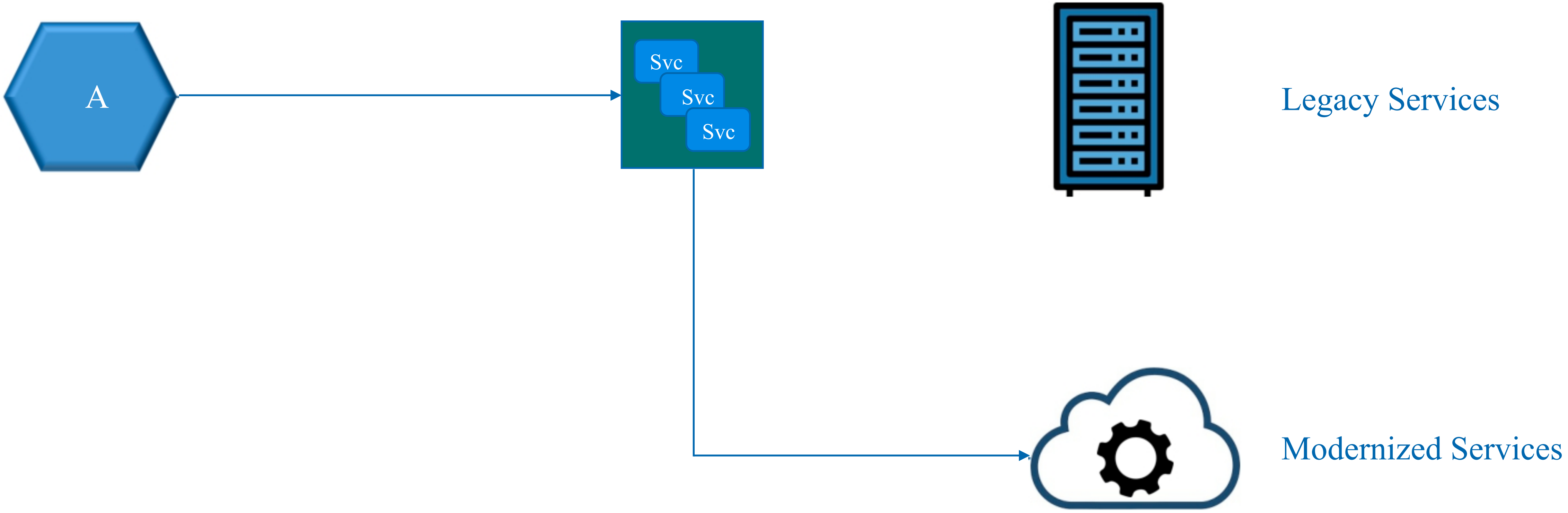
Strangler Pattern

May be used for other legacy services as well



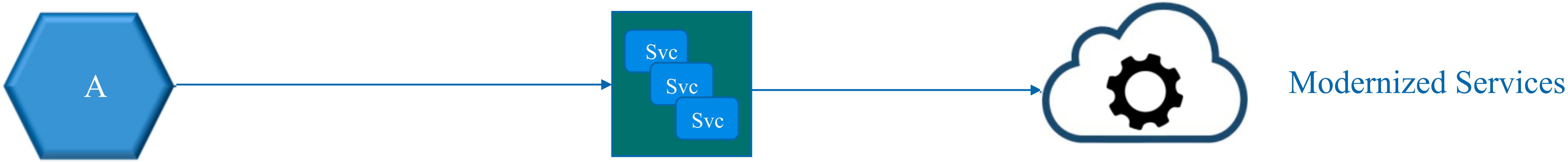
Strangler Pattern

Over a period, modernized service will replace the legacy service



Strangler Pattern

The strangler services will be changed to point to new services

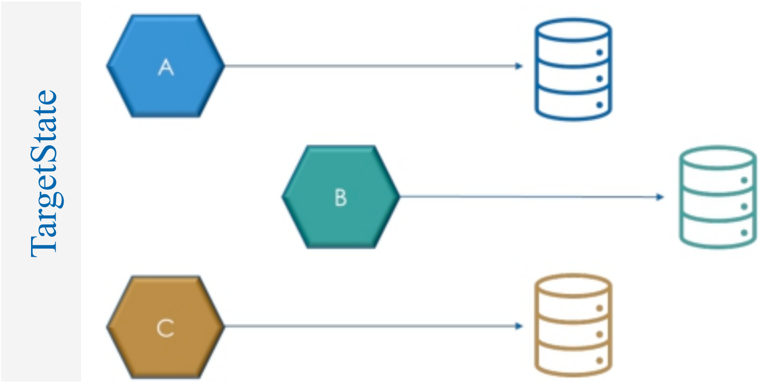


Microservice code insulated from backend changes !!!

Quick Review

Shared Database pattern = Anti pattern for Microservices

Strangler pattern used for replacing the backend | databases



Microservices : Shared DB Pattern

Converting Brownfield monolith to Microservices

1 Objective & Challenges

2 Database Refactoring

3 Logical Database Separation

Note: Discussion apply ONLY to an RDBMS

Reality check

One may not have the flexibility of using "Separate DB"

For multiple reasons:

- Time constraints
- Lack of skilled resources
- Legacy technology
- Cost | Budget constraints
- Higher risk
- …

Objective

Achieve isolation of data within the same Database instance

- Each Microservice owns part of the data in the Database

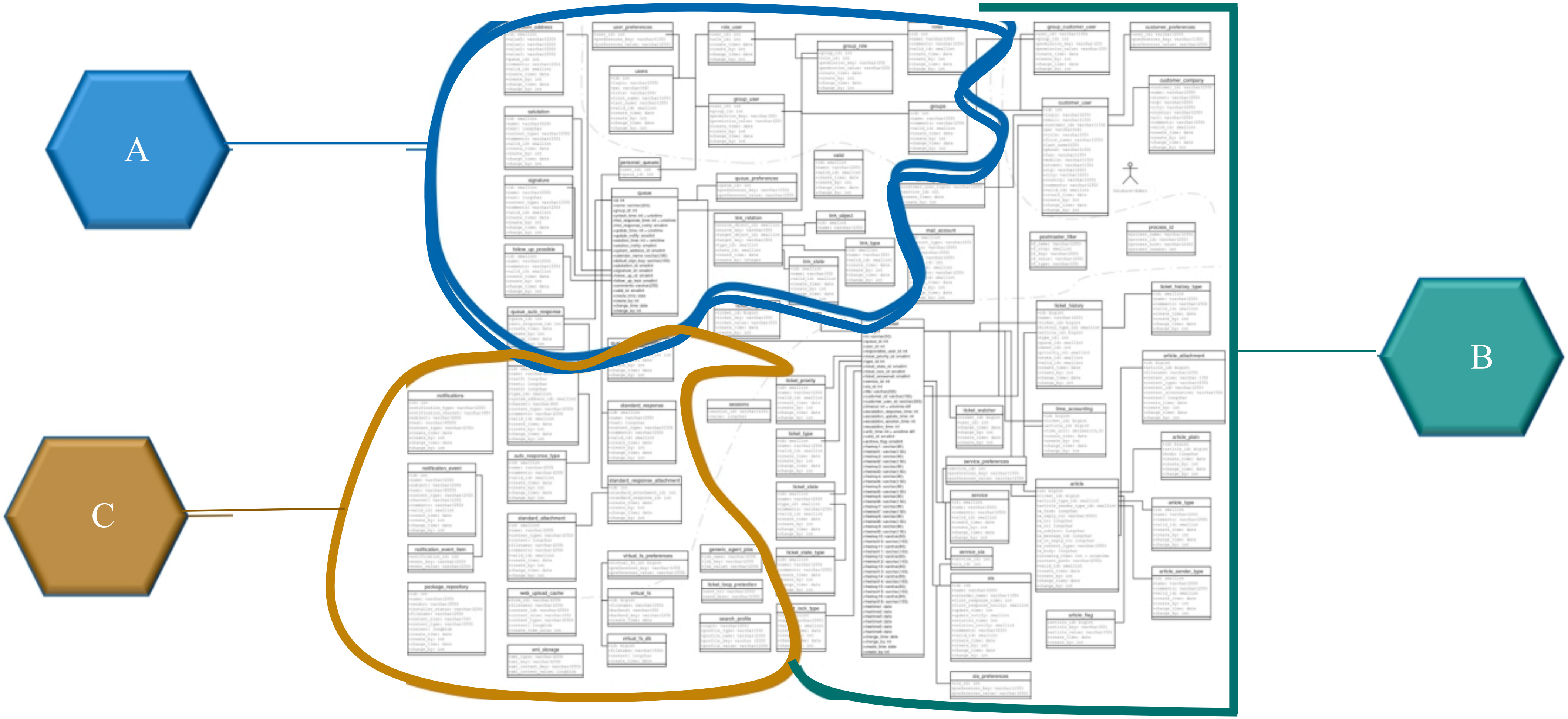
- Each Microservice have direct access to ONLY its own data

Use DB features to achieve MAXIMUM isolation between Microservices

Brownfield

Challenges with breaking the DB

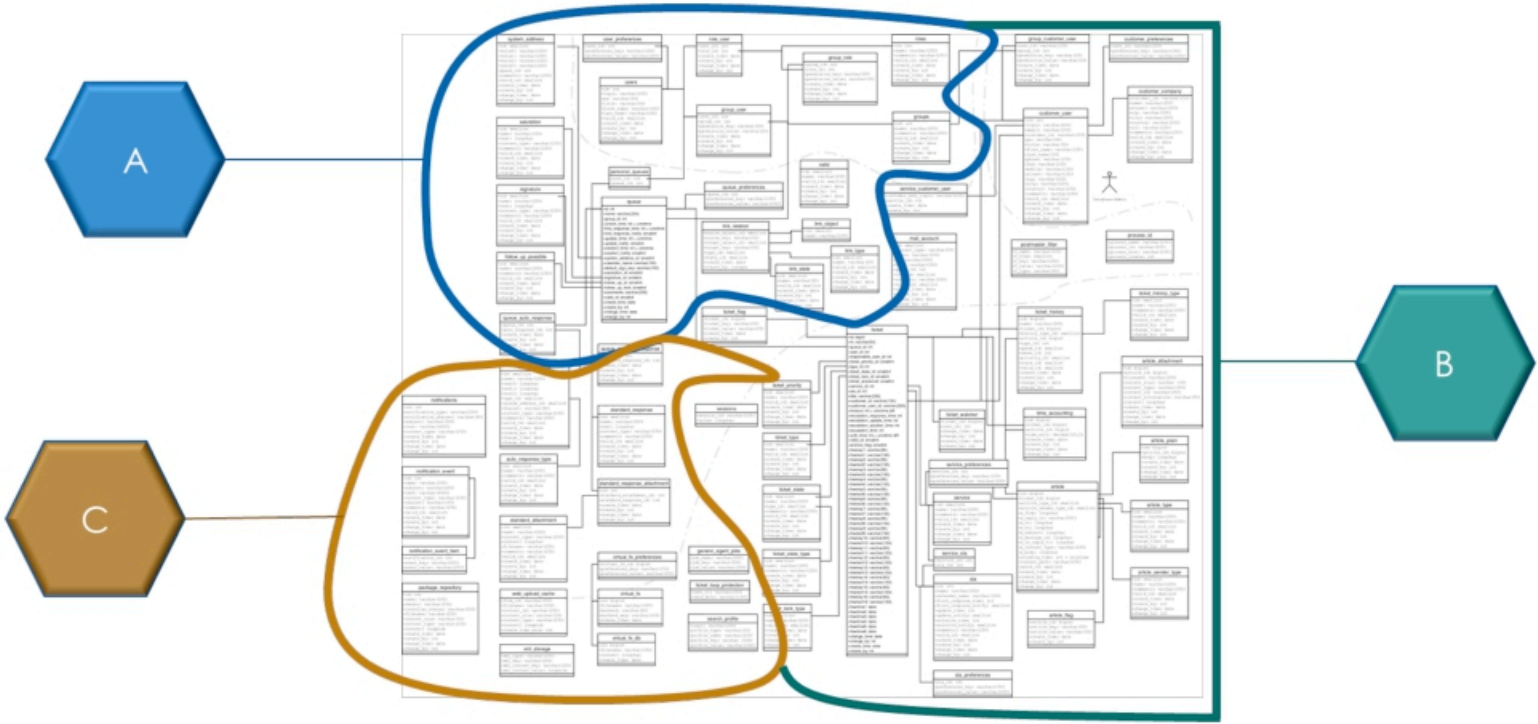
Large Databases are NOT easy to separate ☹



Challenges with breaking the DB

Separation doesn't end with segregating the tables

- Shared data across Microservices
- Relationships between tables
- Stored Procedures
- Triggers



Dealing with Shared Database

1. Database Refactoring

   - Changes to underlying database

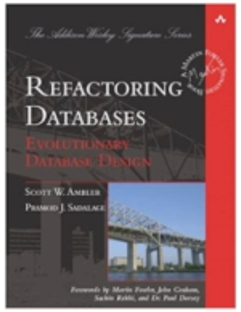
2. Logical separation of database

   - Use the database as - is

1

Database Refactoring

> “A small change to the database which improves its design without changing its semantics



by Scott W & Pramod S

1

Database Refactoring

There are 6 change categories suggested for DB Refactoring

Structural	Changes to definition of tables, views, and columns
Architectural	Changes to methodology on how apps interact with DB
Referential Integrity	Changes to the Primary Key, Foreign Keys, Triggers

1

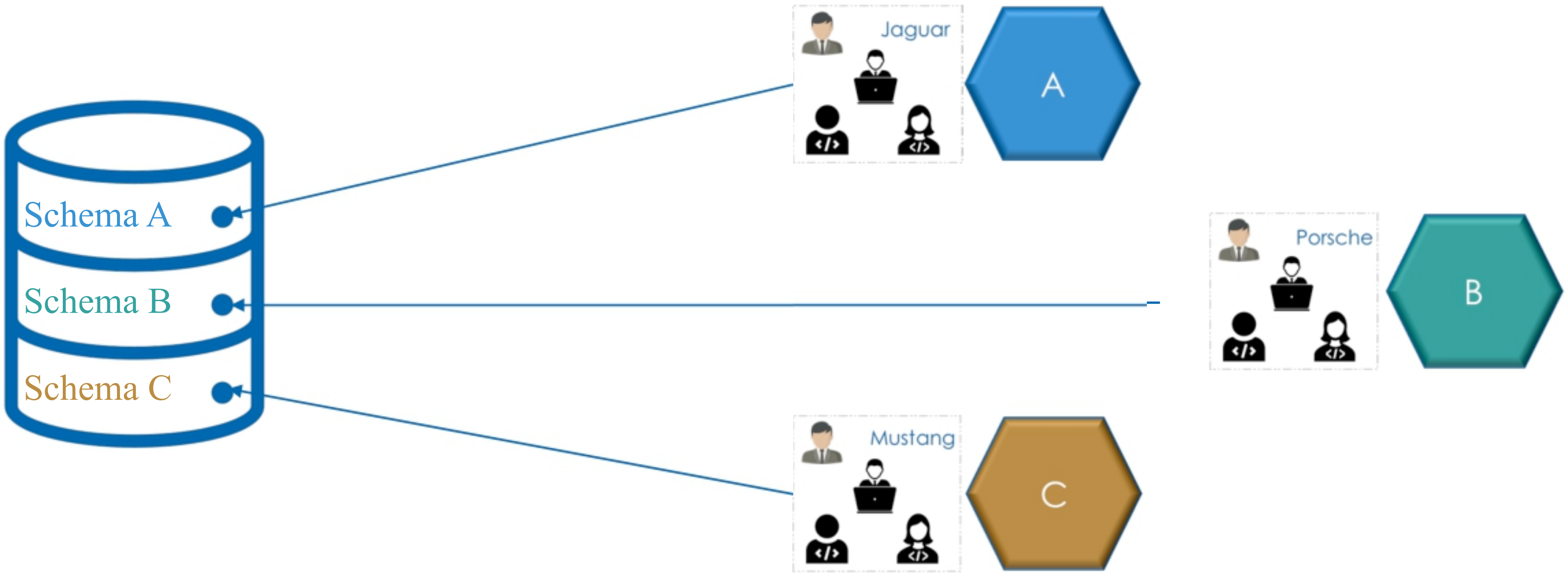
Database Refactoring : Change Categories

There are 6 categories of change suggested for DB Refactoring

Methods	Code changes to Stored Procedure like adding and removing parameters
Transformations	Changes to the database schema
Data Quality	Changes for improvement to data quality

Example : Structural Refactoring

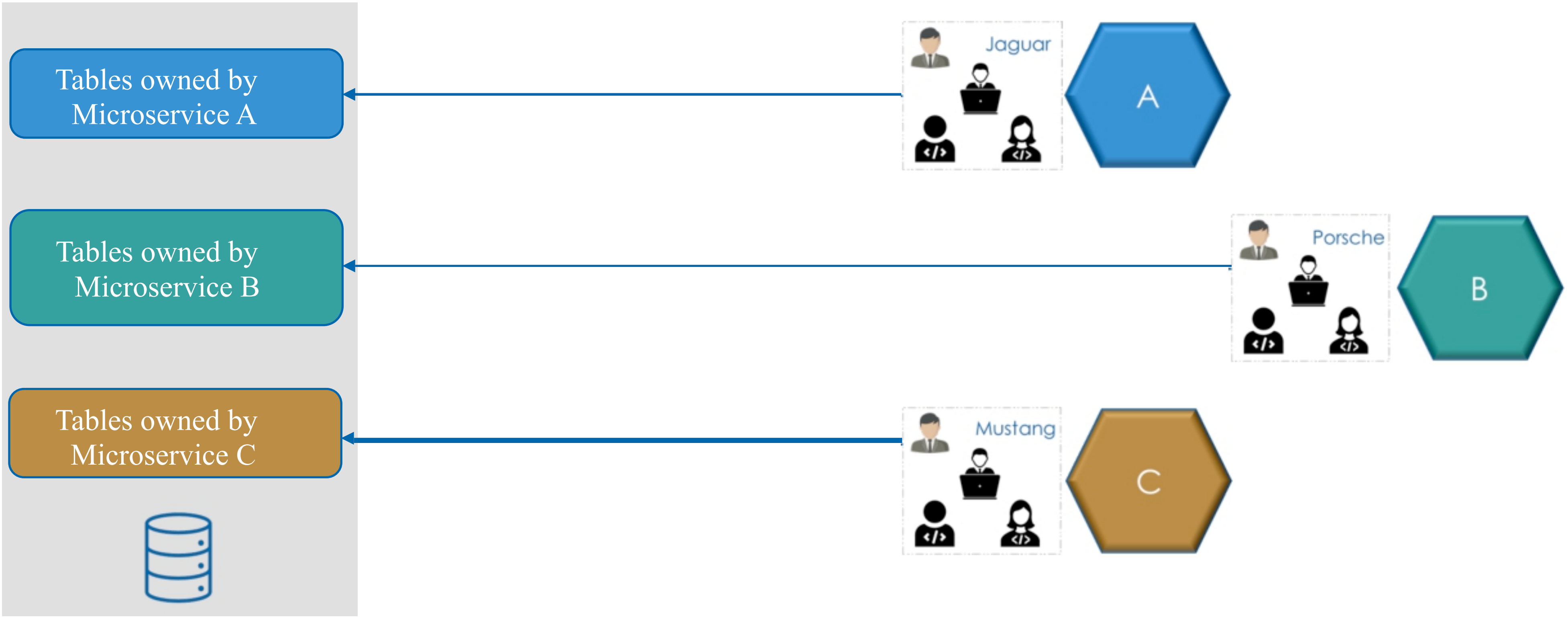
Separate schemas and put in access control for microservices



How is it done? Depends on the specific RDBMS !!!!

2 Logical separation of the Database (RDBMS)

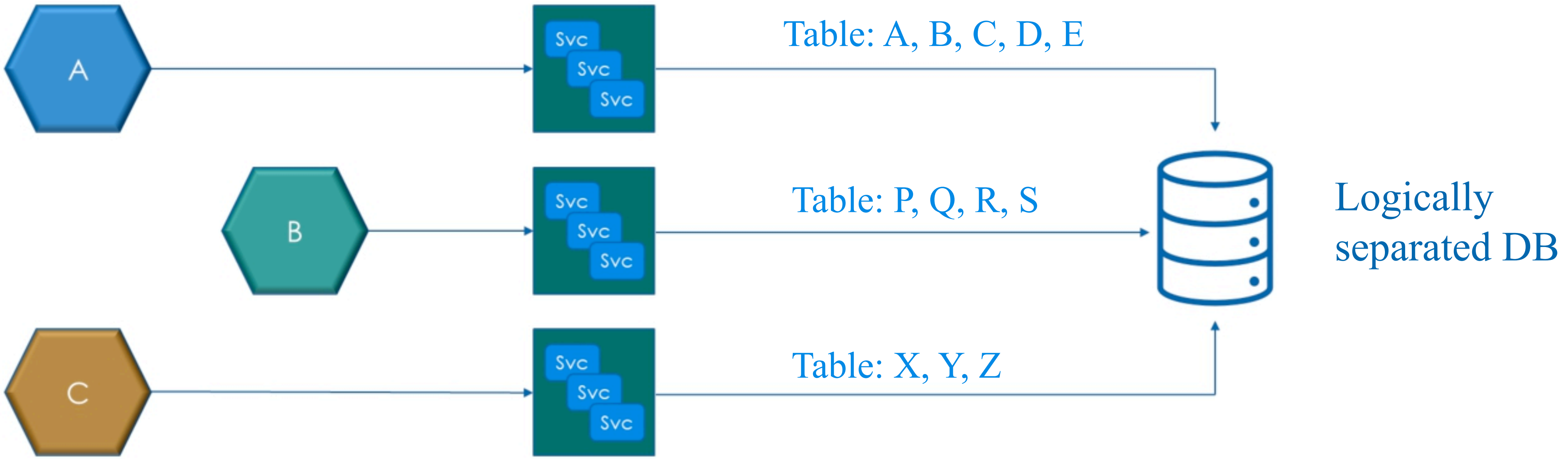
Divide the related tables among Microservices


Tables owned by Microservice A
Tables owned by Microservice B
Tables owned by Microservice C
Jaguar
A
Porsche
B
Mustang
C

Teams need to be disciplined; not to access other MS data directly

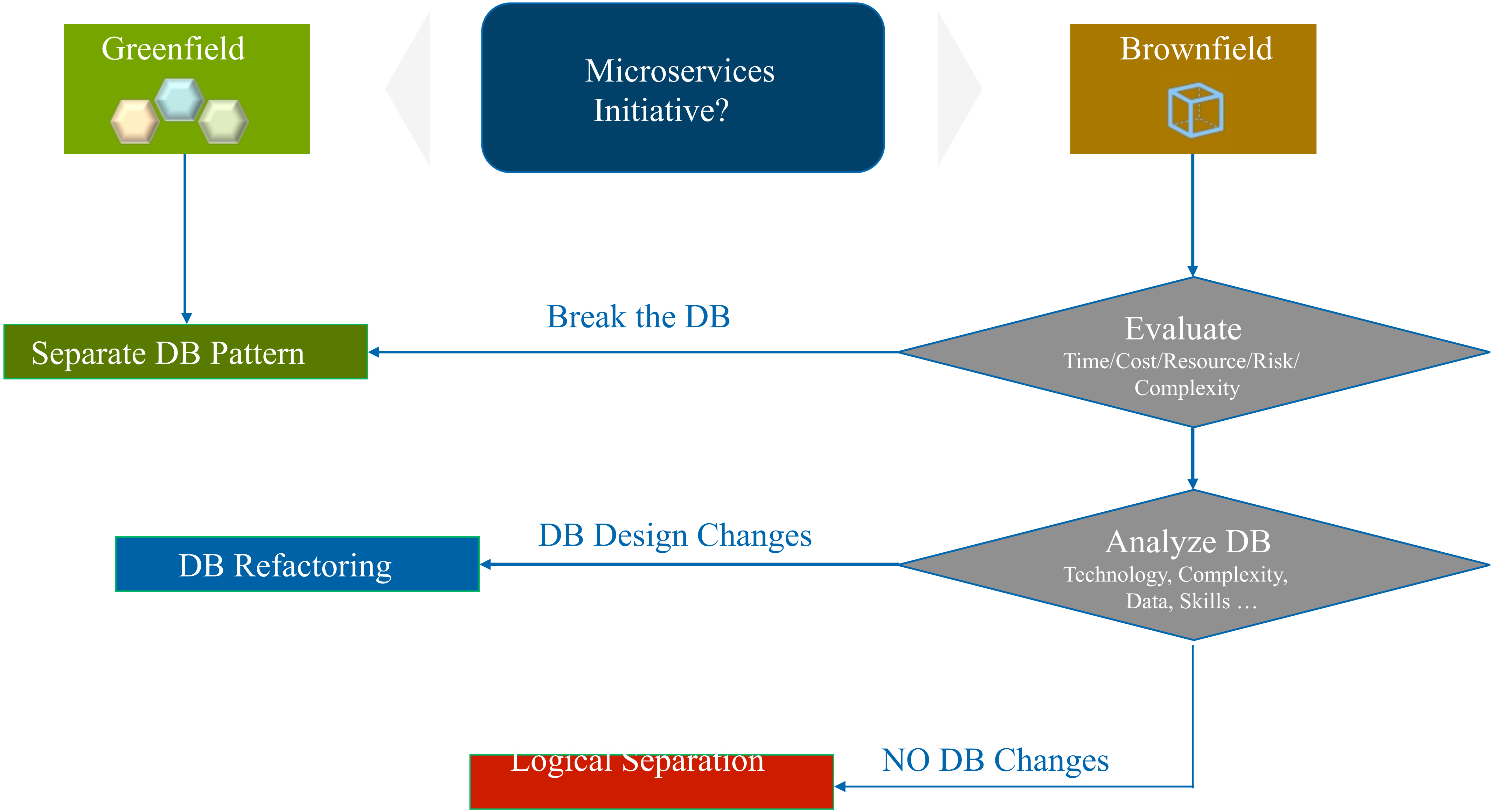
Using services for data access

All data access via services to minimize risk of direct access



- Governed services
- Provides control over only the assigned tables/data

Quick Review



Greenfield

Microservices Initiative?

Brownfield

Separate DB Pattern

Break the DB

Evaluate
Time/Cost/Resource/Risk/
Complexity

DB Refactoring

DB Design Changes

Analyze DB
Technology, Complexity,
Data, Skills …

Logical Separation

NO DB Changes

Downside of Separate Databases

But there are solutions !!!

1 Challenges

2 Solution to challenges

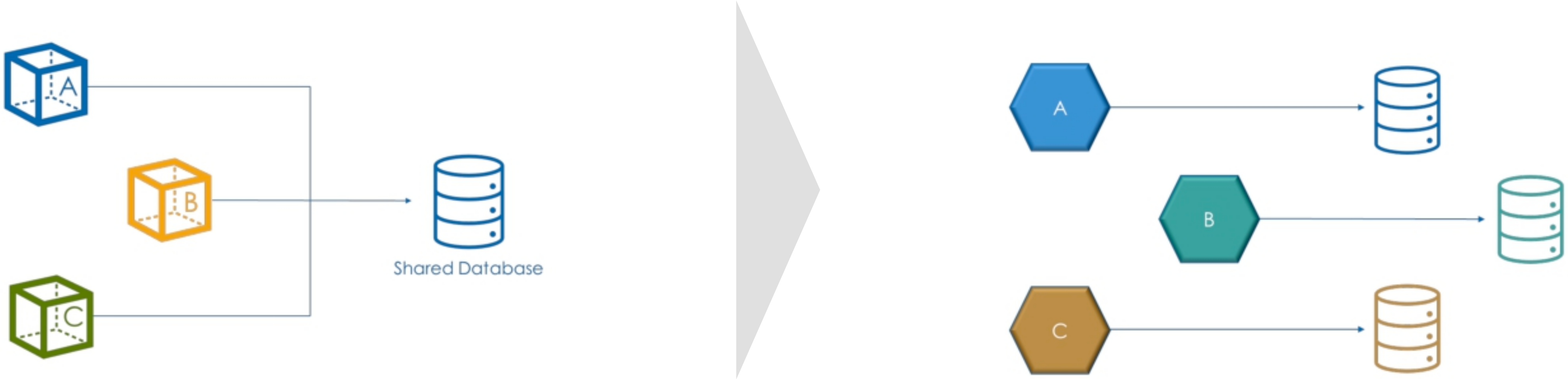
3 Introduction to CQRS, Event Sourcing & SAGA patterns

Downside : Separate Database Pattern

1 HIGHER cost of the Database for the solution

Licensing | Hardware

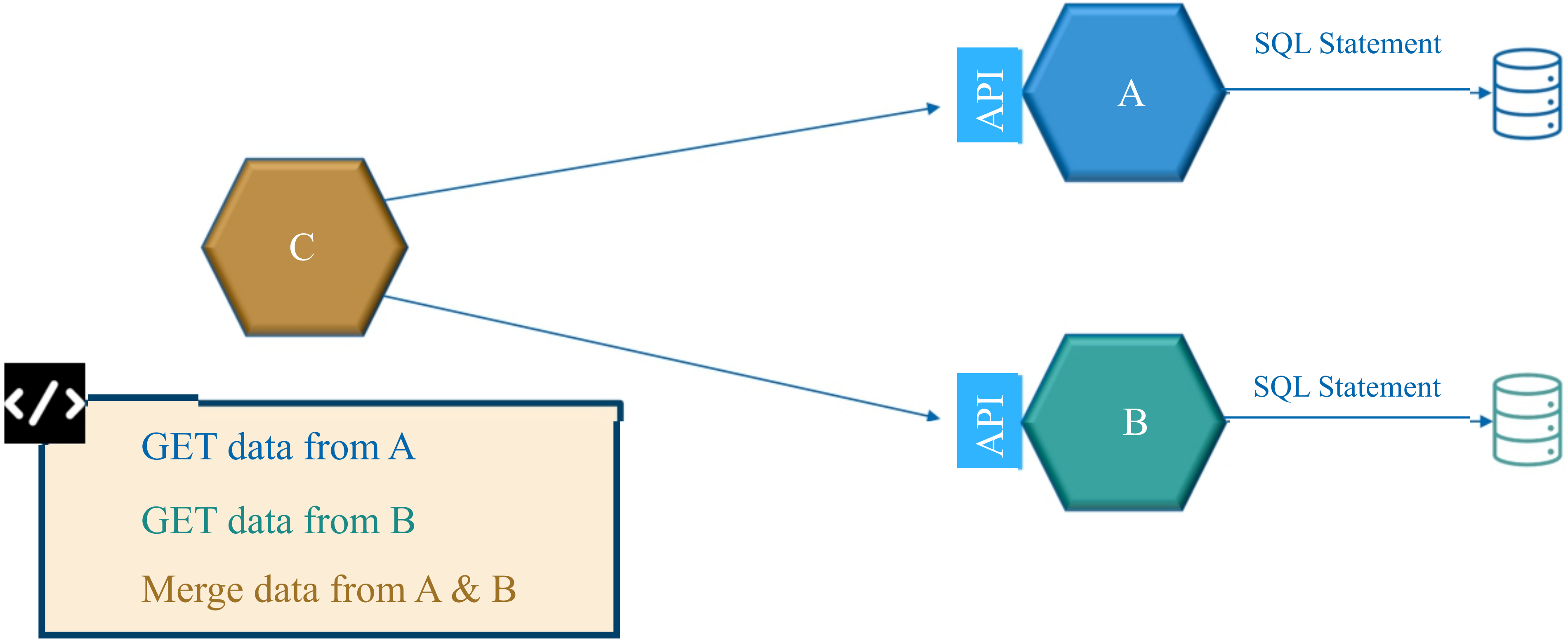
Operational | Maintenance



$$$ spent on Databases may go up by up to 3 times !!

Downside : Separate Database Pattern

2 Degraded Read Performance due to distribution of data



GET data from A

GET data from B

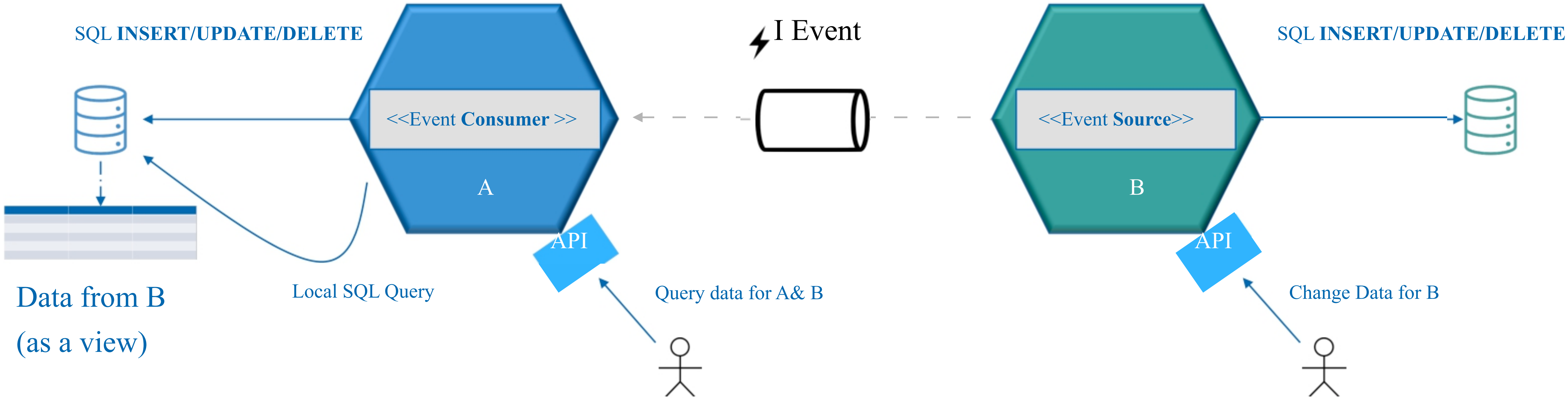
Merge data from A & B

In a Shared DB - we could have used a JOIN !!!

Addressing the challenge

2 Degraded Performance due to distribution of data

Manage local copy of the data thru asynchronous replication

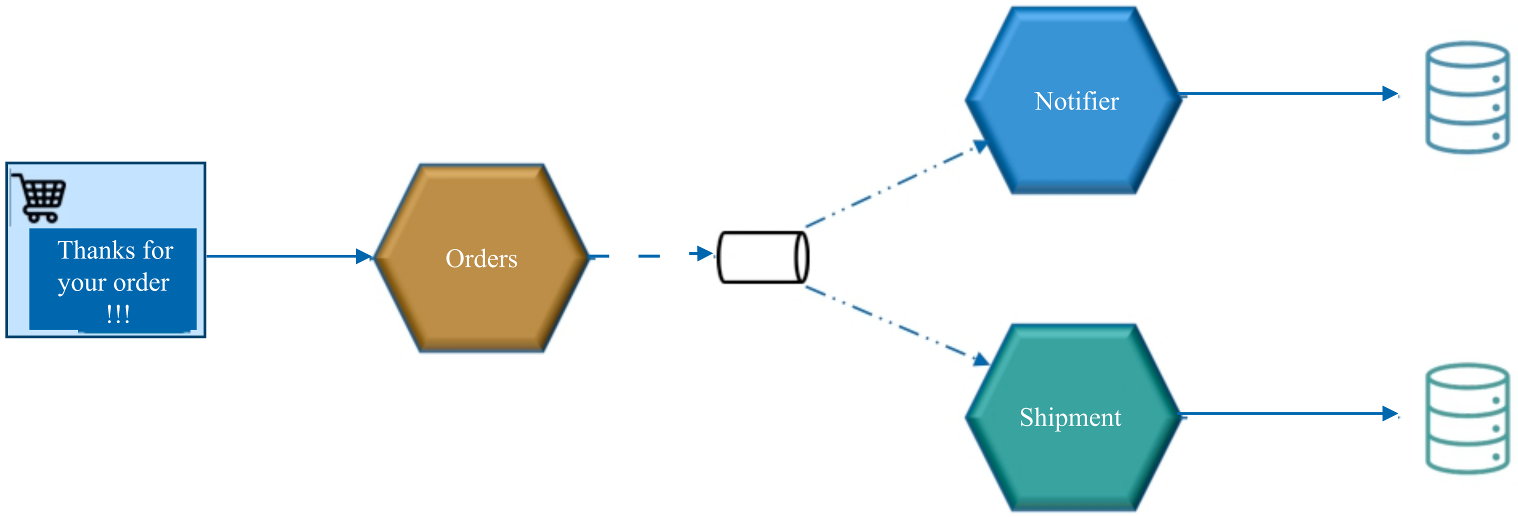


CQRS & Event Sourcing patterns

Downside : Separate Database Pattern

3 Complexity in managing Transaction | Data integrity

1. Inform Customer ✓ SUCCESS



2. Ship the Order ✗ FAILED

Customer

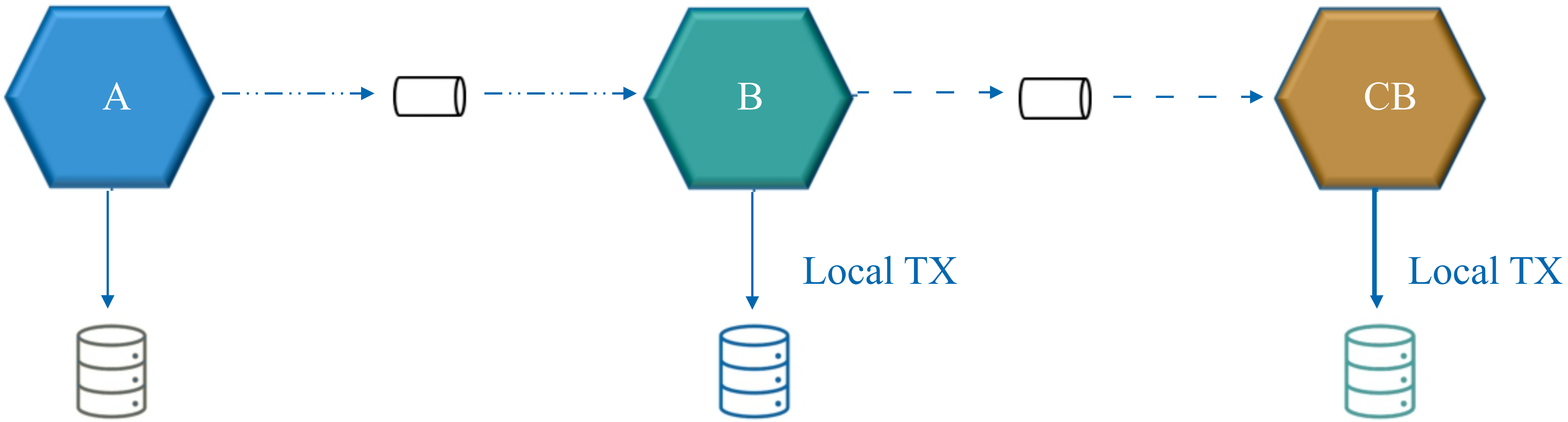
PAID + Received Email but will not receive the order ☹

Shared DB - Could have used a local Transaction !!!

Addressing the challenge

3 Complexity in Data integrity | Transaction management

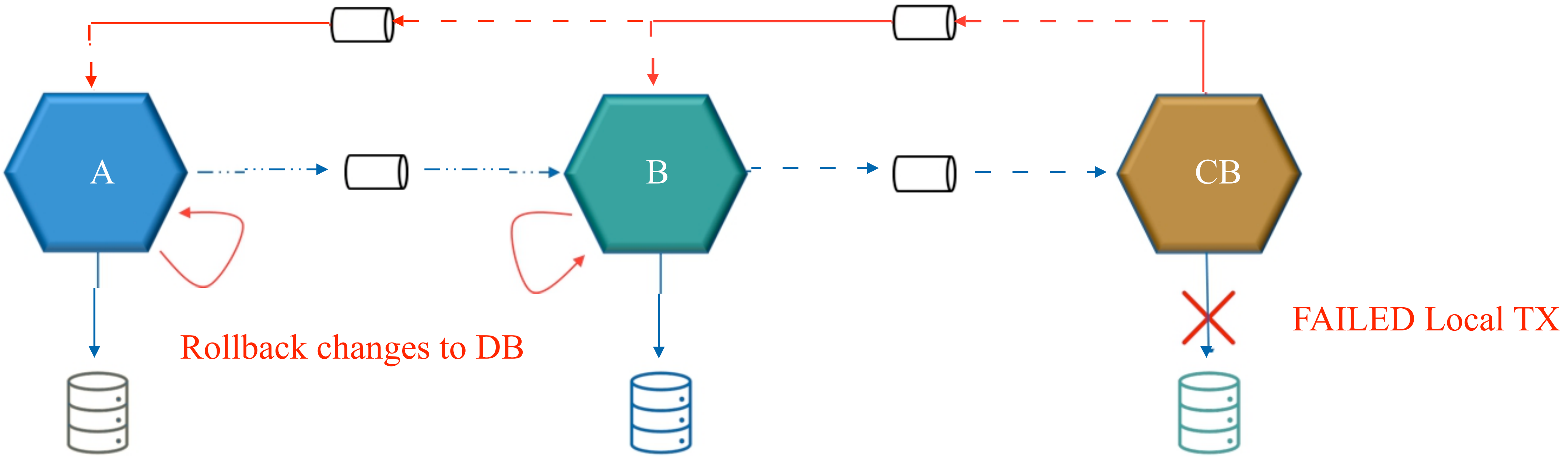
Use a sequence of local transactions with distributed rollback



Addressing the challenge

3 Complexity in Data integrity | Transaction management

Use a sequence of local transactions with distributed rollback



SAGA & Reliable messaging pattern

Quick Review

1 HIGHER cost of the Database for the solution

- Open Source, Cloud Native Databases

2 Degraded Performance due to distribution of data

- CQRS Pattern & Event Sourcing

3 Complexity in Data integrity | Transaction management

- SAGA Pattern & Reliable messaging