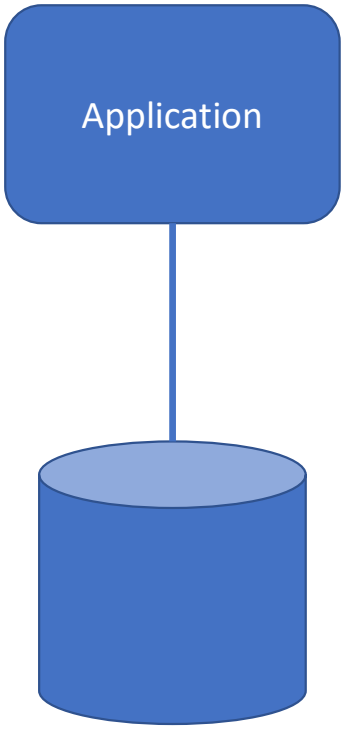

Data Patterns
for Successful Applications

So, what we going to do?

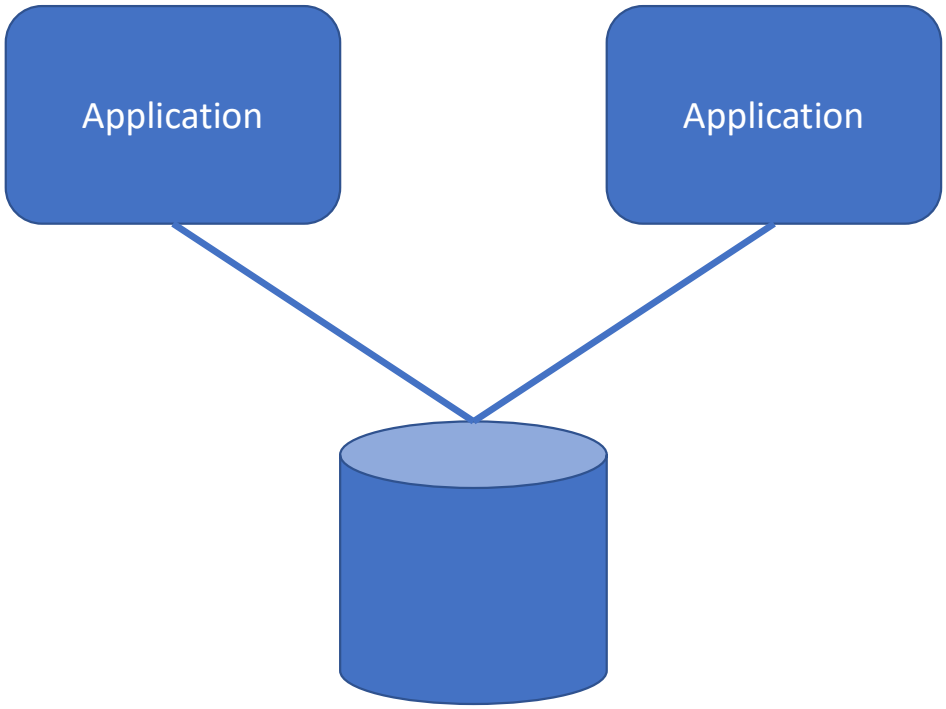
Agenda:

- Common Architecture
- Data Model
- CQS
- CQRS
- Eventual Consistency
- Views
- Event Sourcing
- CQRS + Event Sourcing

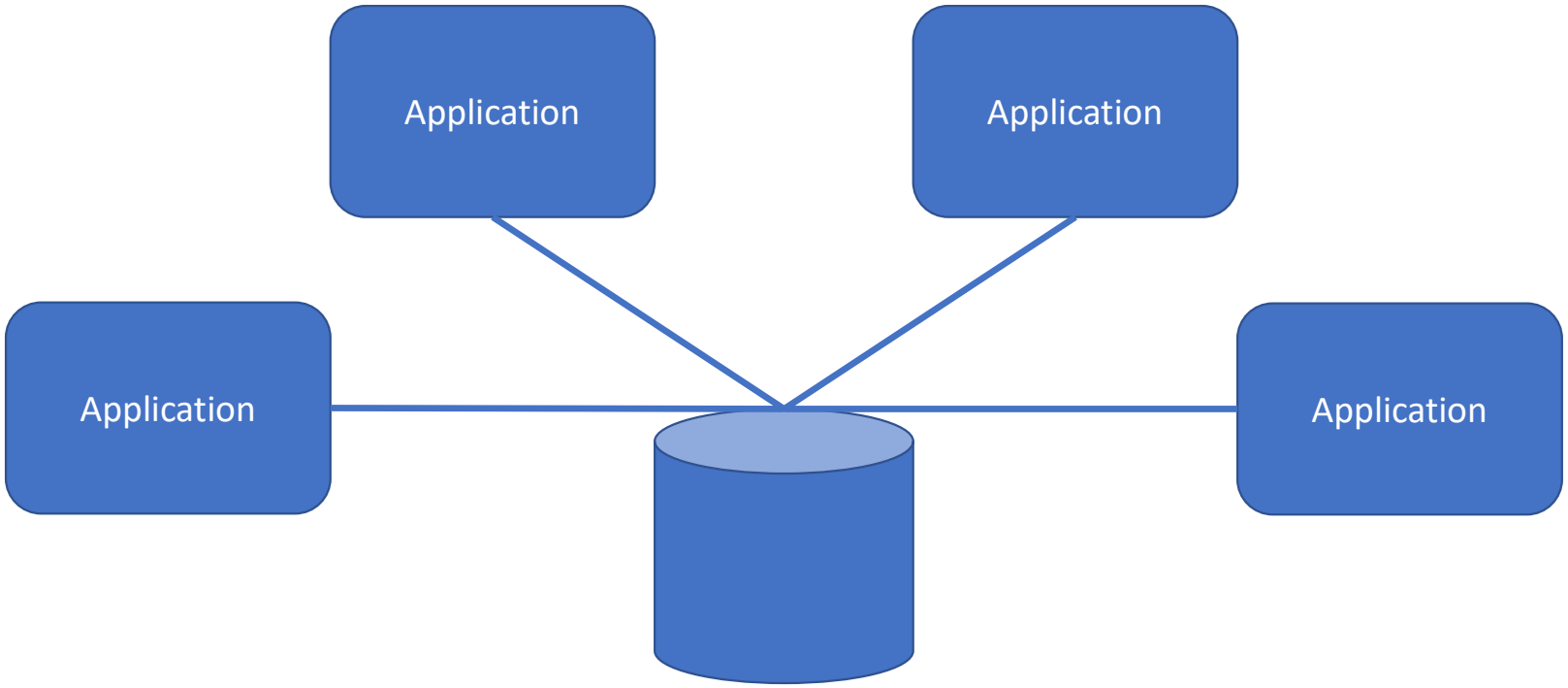
Common Architecture



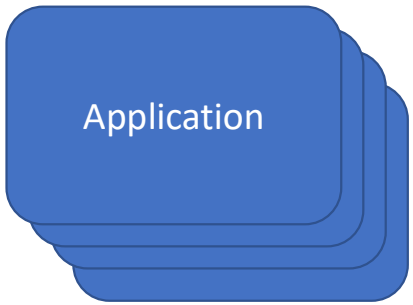
Common Architecture

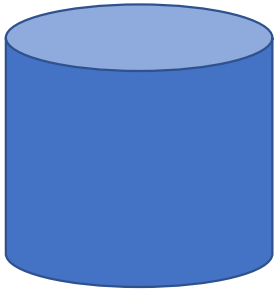


Common Architecture

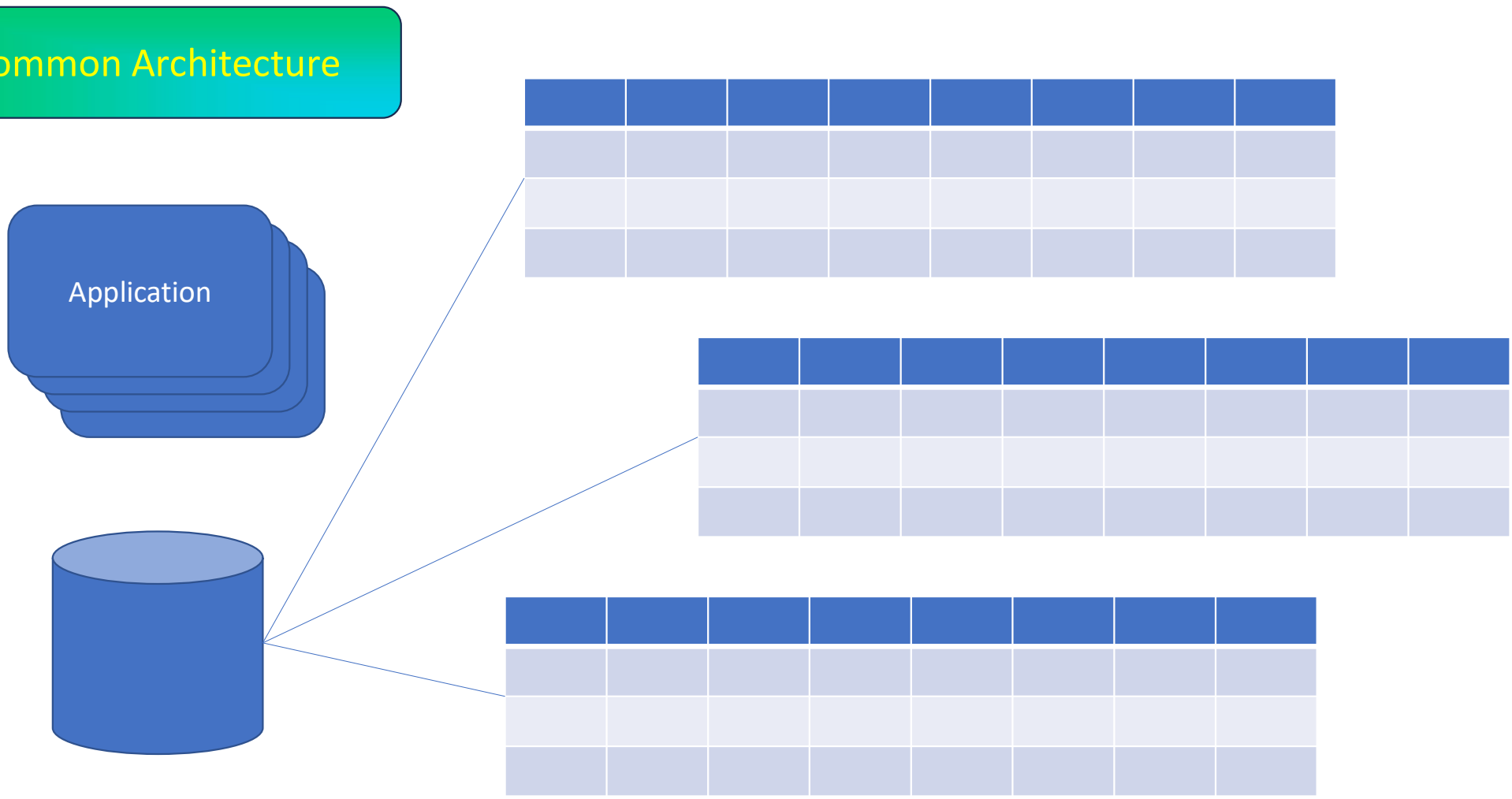


Common Architecture



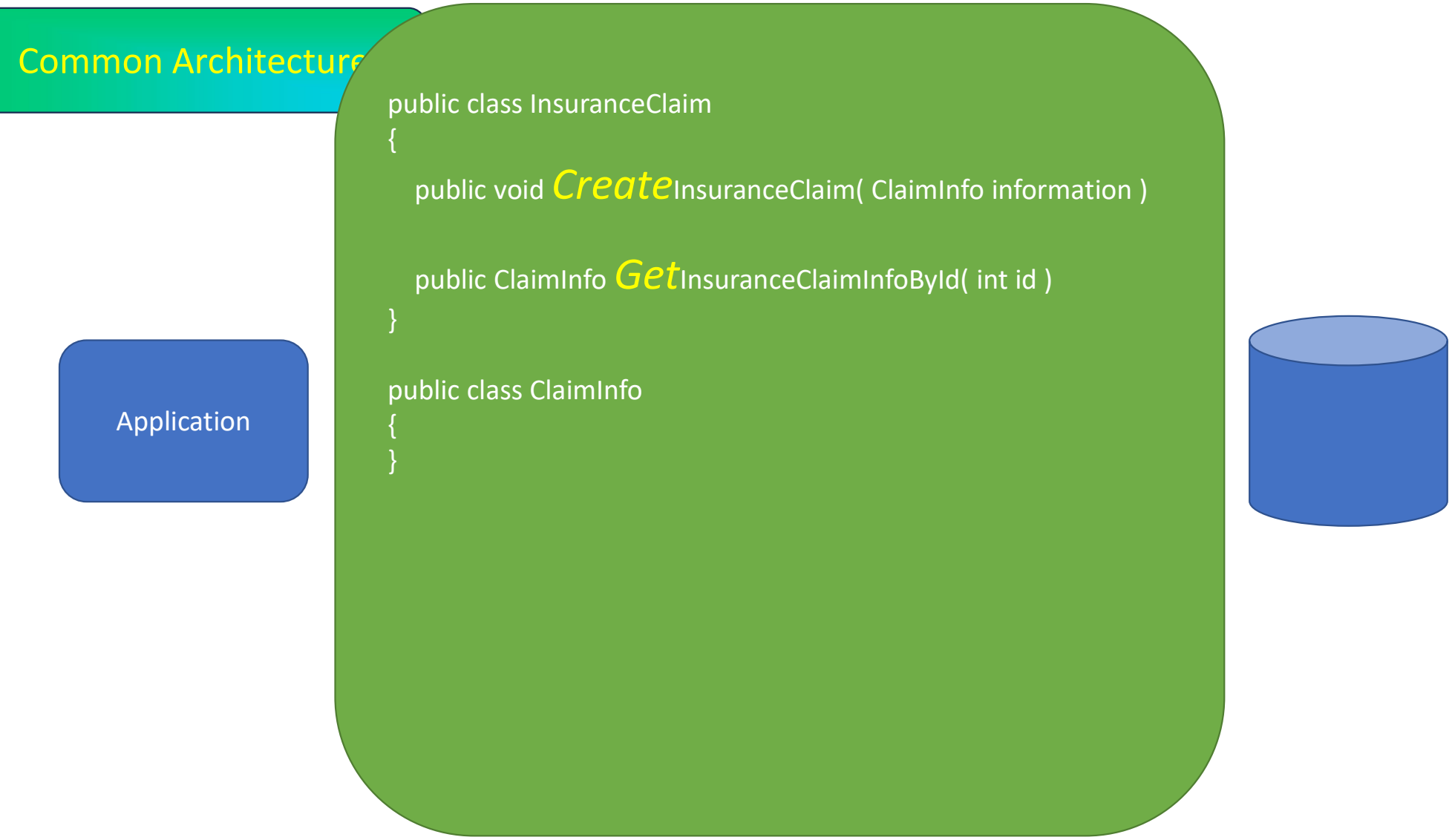


Common Architecture



Common Architecture

Could be inside the app or in a DLL/package.


Common Architecture
public class InsuranceClaim
{
public void CreateInsuranceClaim(ClaimInfo information)
public ClaimInfo GetInsuranceClaimInfoById(int id)
}
public class ClaimInfo
{
}
Application

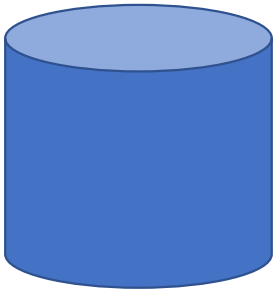
Common Architecture

Application

```
public class InsuranceClaim
{
    PayInsuranceClaim( ClaimInfo information )
    ApproveInsuranceClaim( ClaimInfo information )
    RejectInsuranceClaim( ClaimInfo information )

    public ClaimInfo GetInsuranceClaimInfoById( int id )
}

public class ClaimInfo
{
}
```



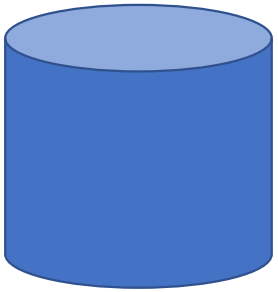
Common Architecture

Application

```
public class InsuranceClaim
{
    PayInsuranceClaim( ClaimInfo information )
    ApproveInsuranceClaim( ClaimInfo information )
    RejectInsuranceClaim( ClaimInfo information )

    public ClaimInfo GetInsuranceClaimInfoById( int id )
}

public class ClaimInfo
{
}
```

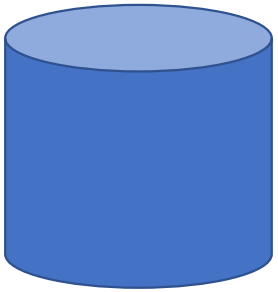


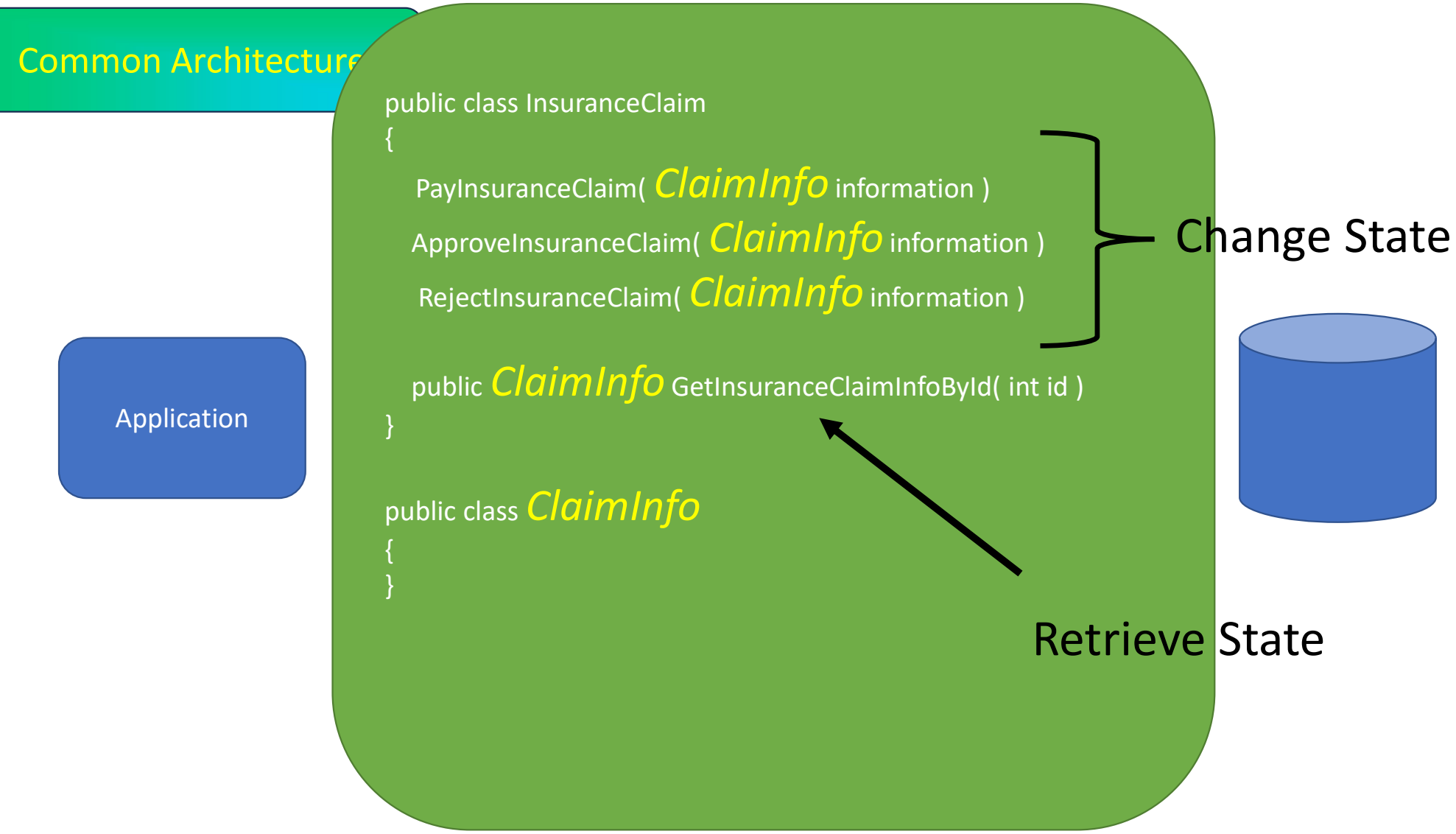
Common Architecture

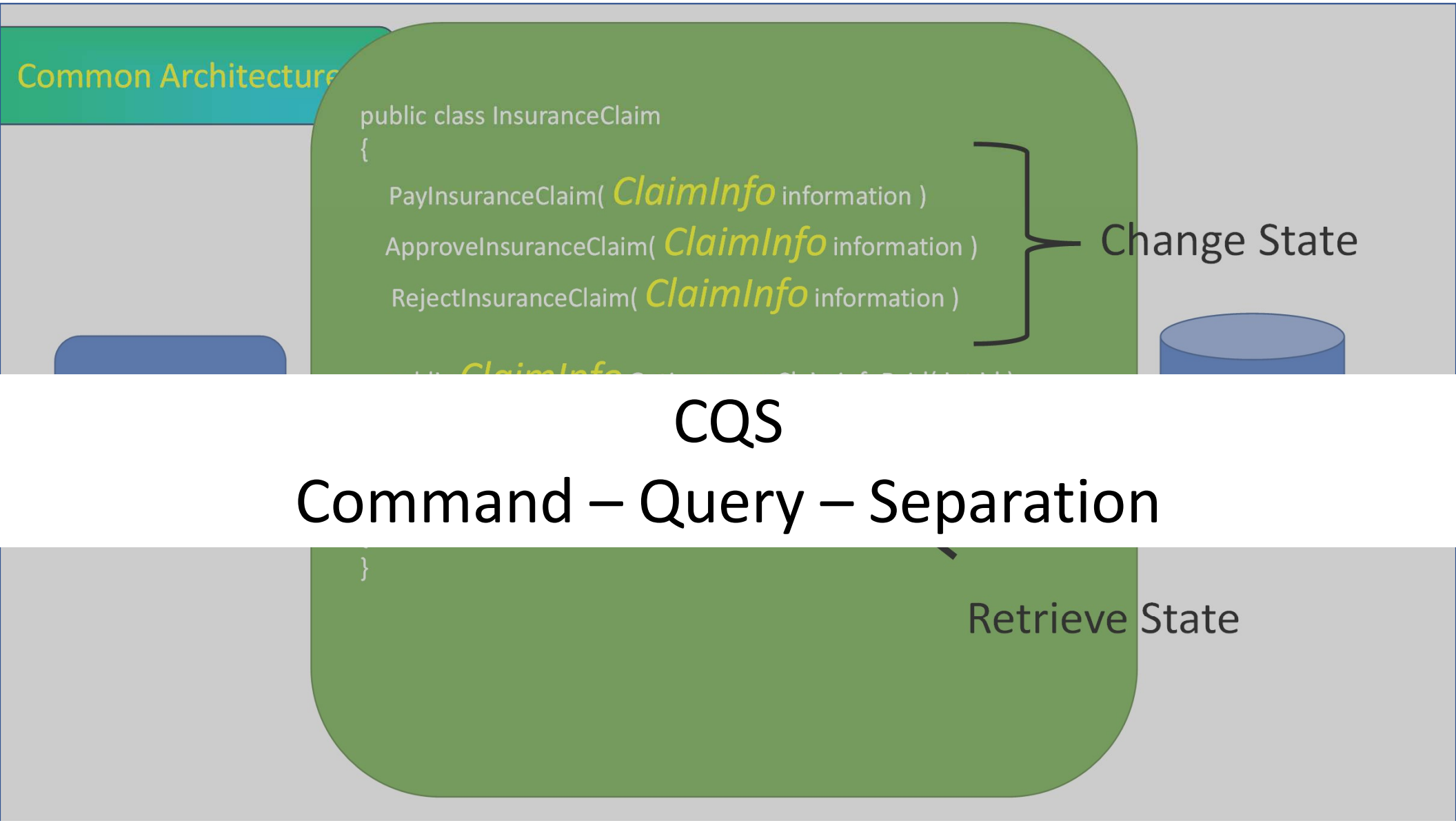
Application

ClaimInfo

Id
Carrier Id
Policy Id
Claimant Info
Claim Date
Loss Date
Loss Description
Claim Status
Claim Type
Claim Amount
Supporting Documents
Investigation Details
Payments
Resolution Details
Create Date
Create User
Update Date
Update User

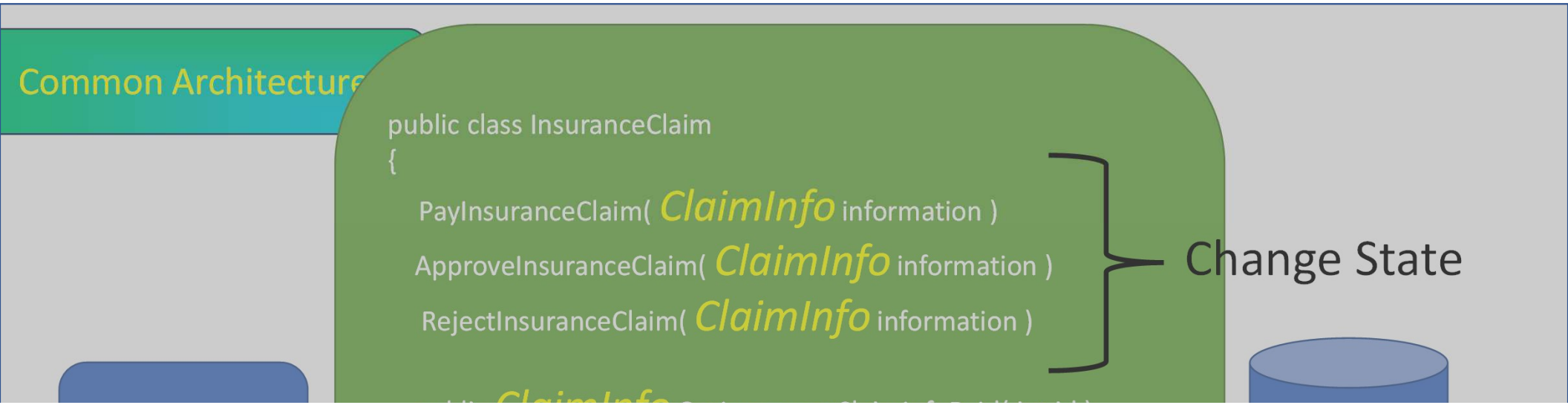



Common Architecture
public class InsuranceClaim
{
PayInsuranceClaim(ClaimInfo information)
ApproveInsuranceClaim(ClaimInfo information)
RejectInsuranceClaim(ClaimInfo information)
public ClaimInfo GetInsuranceClaimInfoById(int id)
}
public class ClaimInfo
{
}
Change State
Application
Retrieve State



CQS

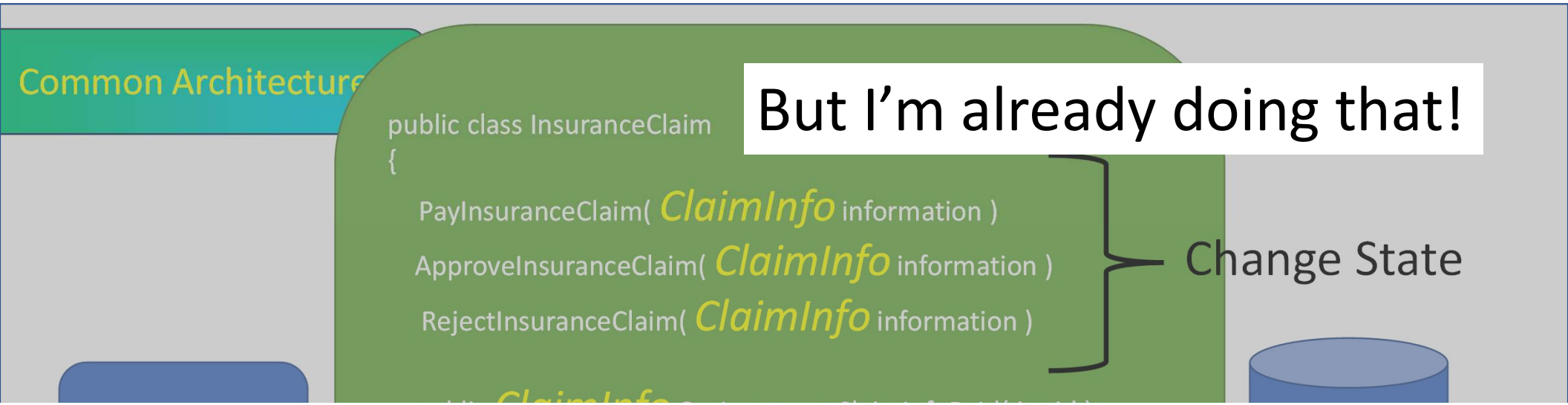
Command – Query – Separation



CQS

Command – Query – Separation

Retrieving data should not cause data to be changed.

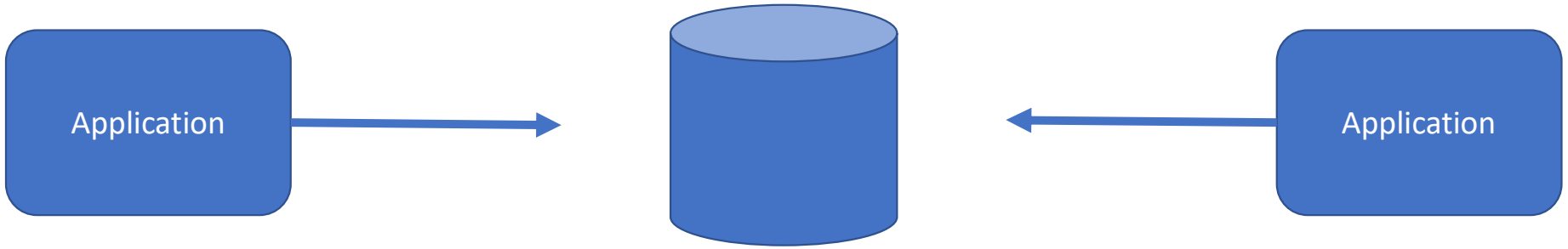


CQS

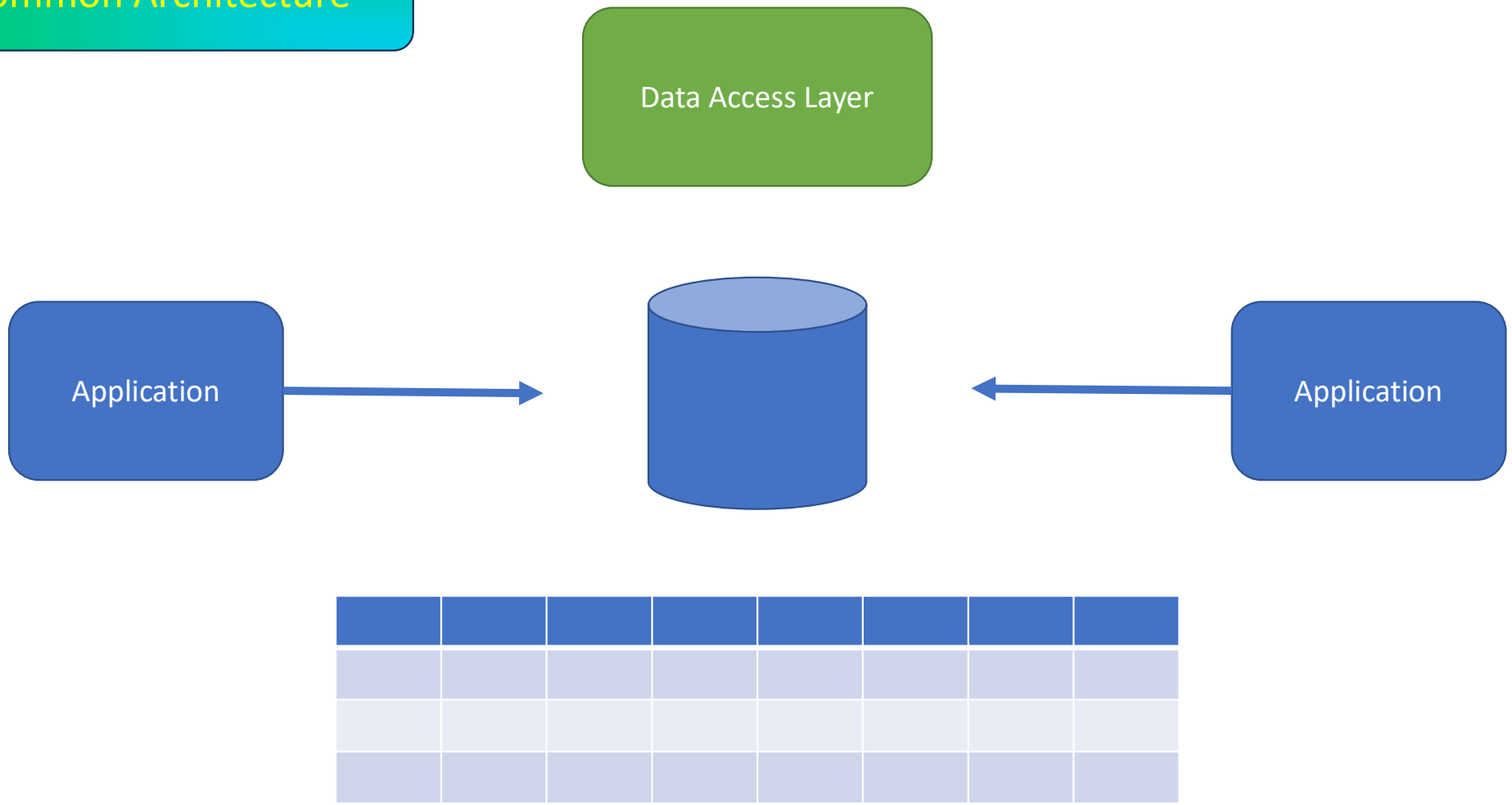
Command – Query – Separation

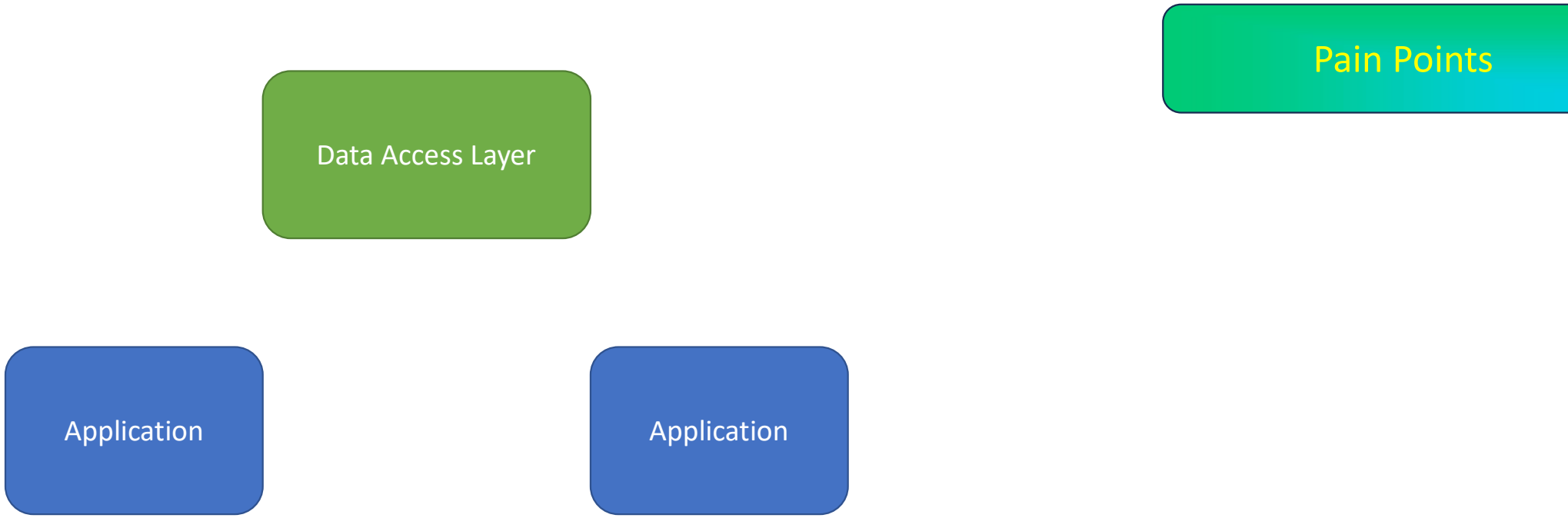
Retrieving data should not cause data to be changed.

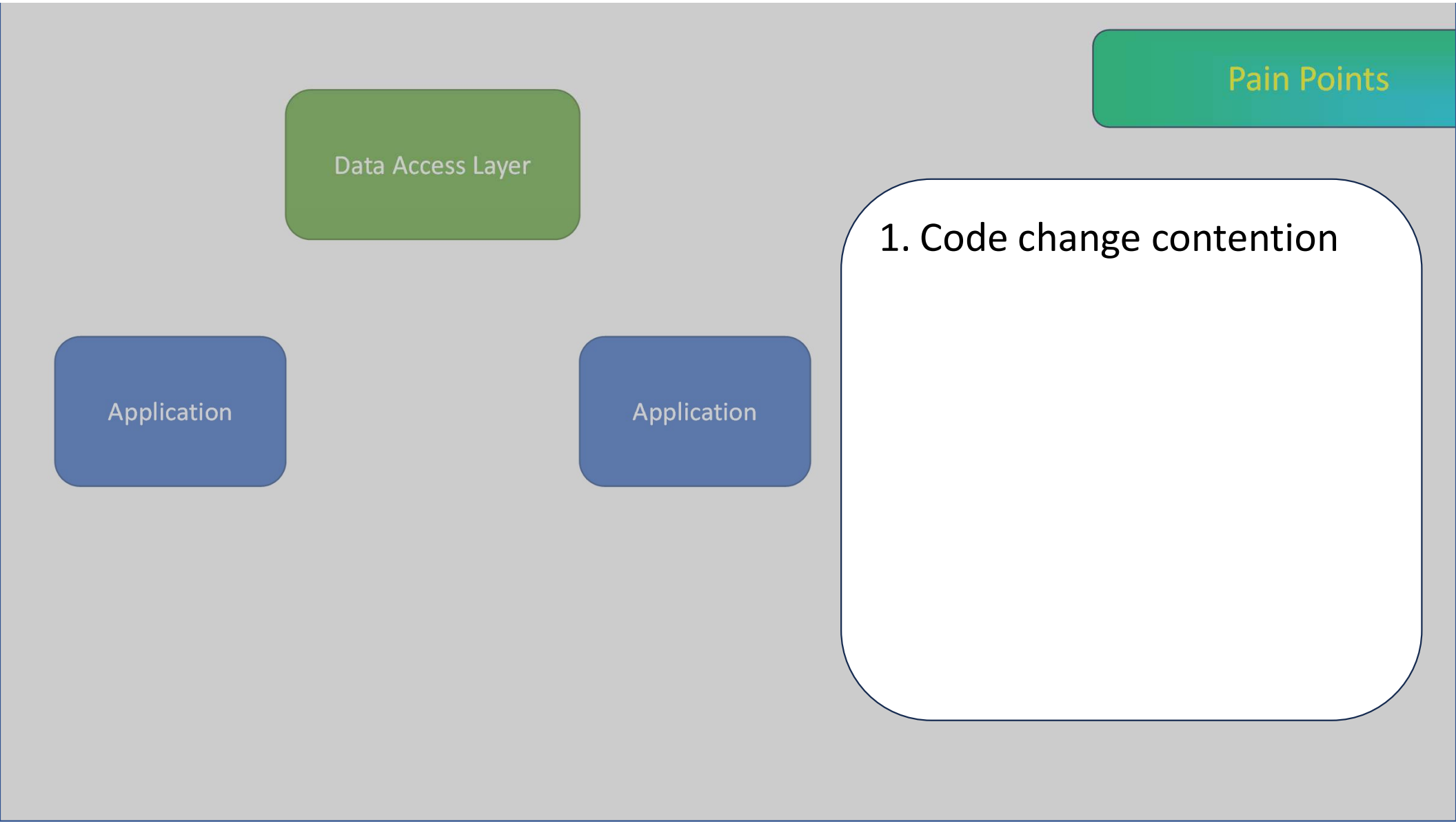
Common Architecture

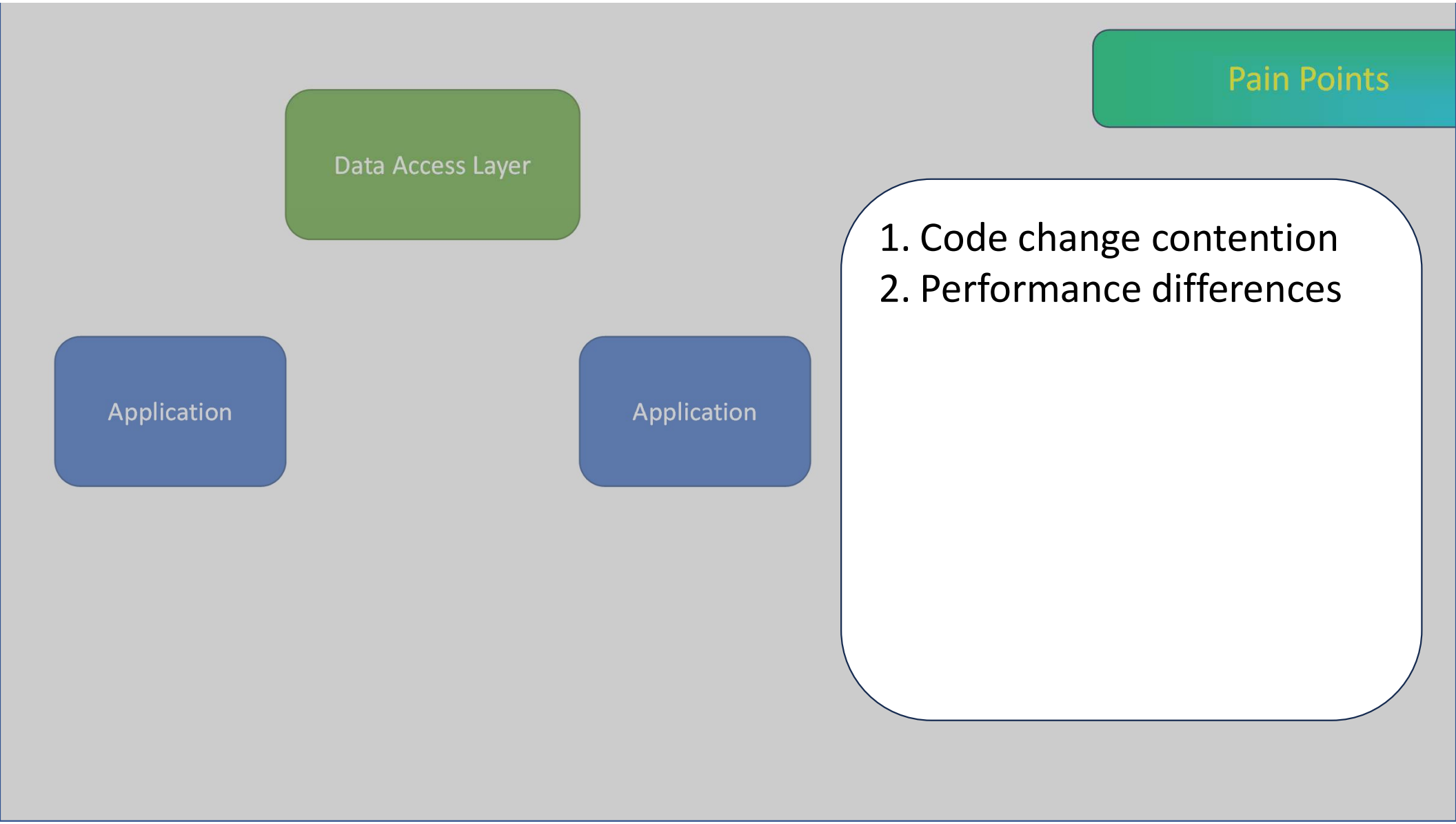


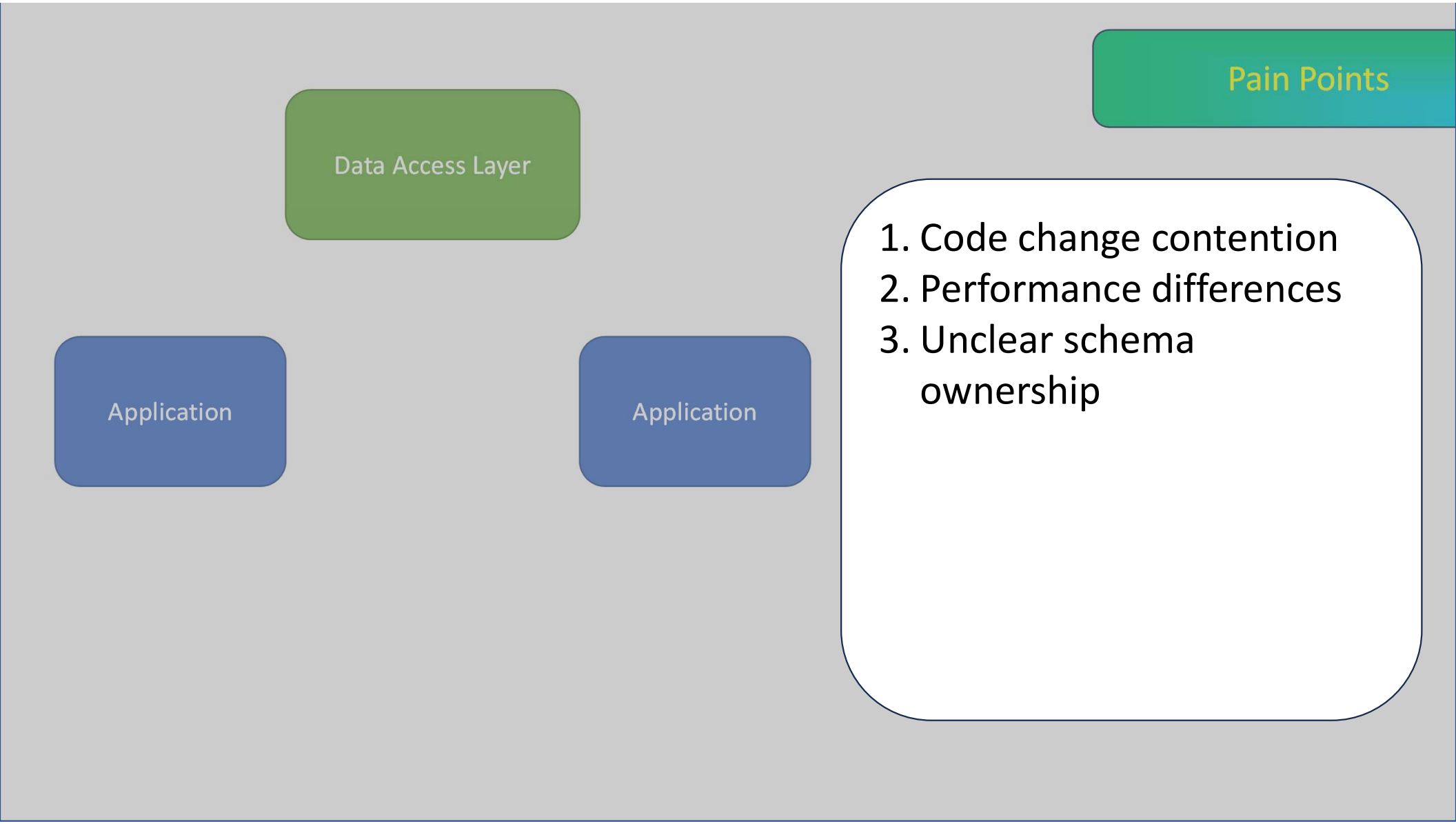
Common Architecture

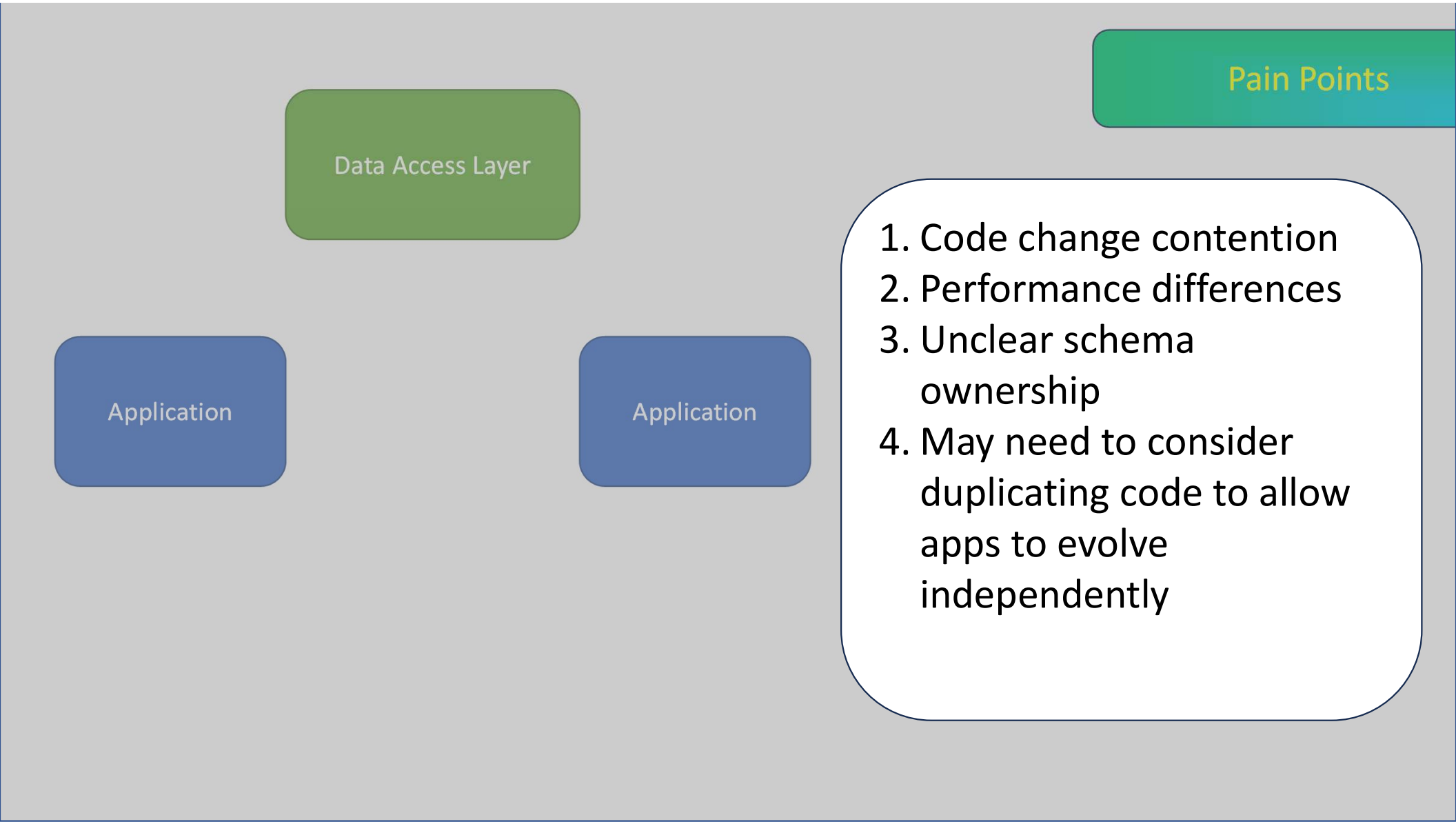


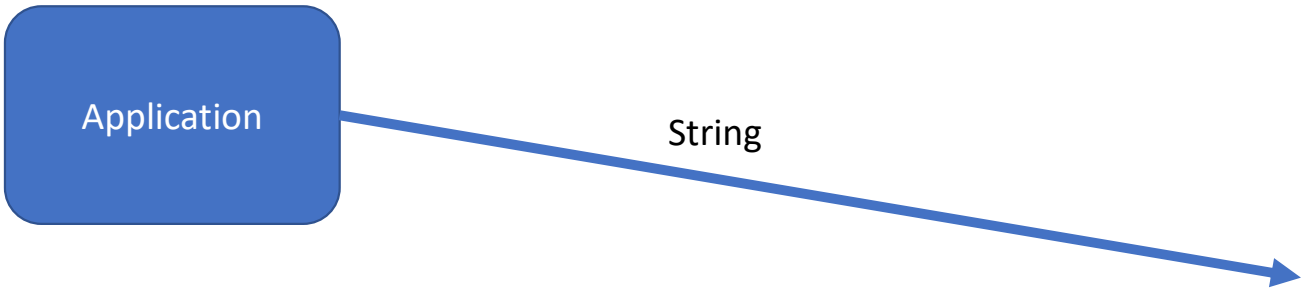

Pain Points
Data Access Layer
Application
Application


Pain Points
Data Access Layer
1. Code change contention
Application
Application


Pain Points
Data Access Layer
1. Code change contention
2. Performance differences
Application
Application

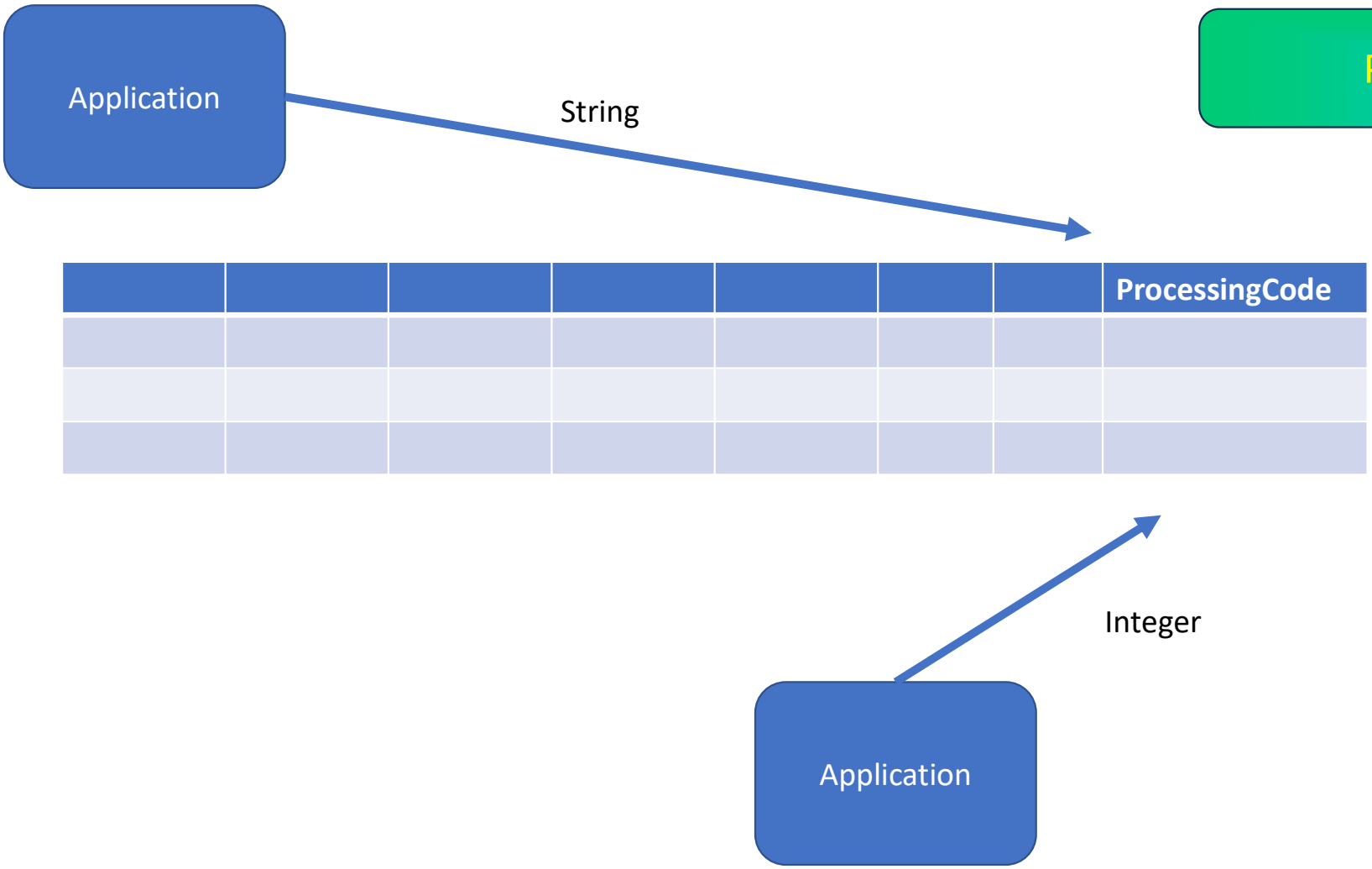

Pain Points
Data Access Layer
Application
Application
1. Code change contention
2. Performance differences
3. Unclear schema ownership

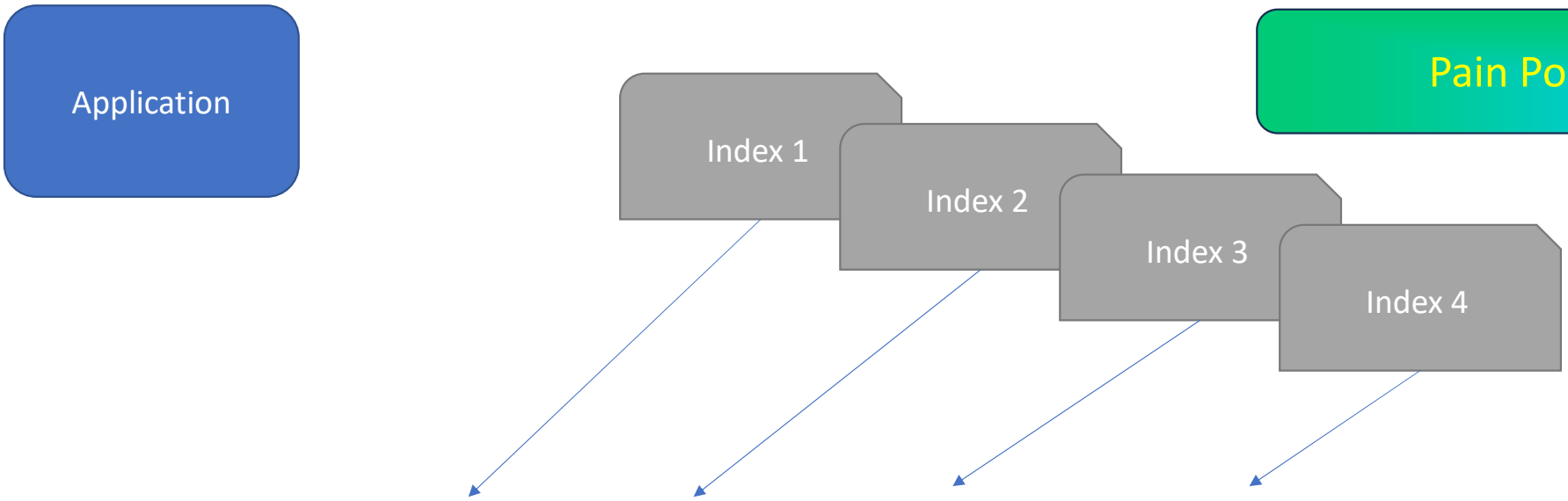

Data Access Layer
Application
Application
Pain Points
1. Code change contention
2. Performance differences
3. Unclear schema ownership
4. May need to consider duplicating code to allow apps to evolve independently



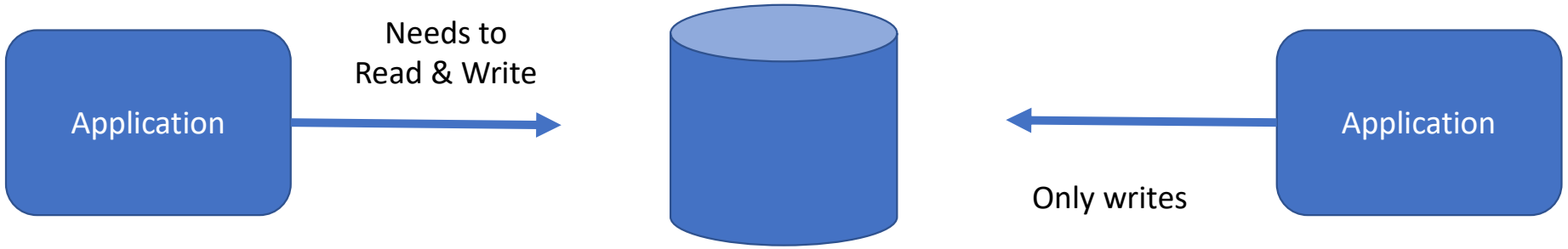
Pain Points

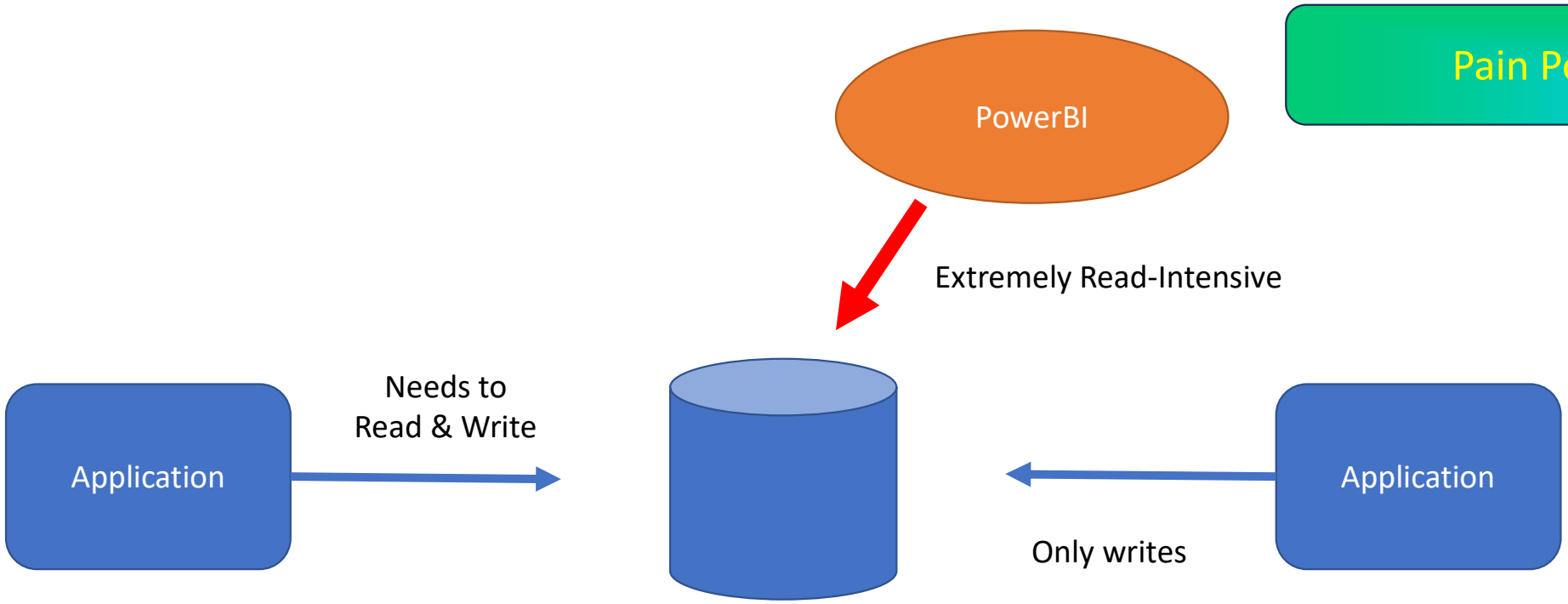
							ProcessingCode


Application
String
Pain Points
ProcessingCode
Integer
Application


Application
Index 1
Index 2
Index 3
Index 4
Pain Points

Pain Points




Pain Points
PowerBI
Extremely Read-Intensive
Application
Needs to
Read & Write
Application
Only writes

What is this “Data Store” of which you speak?

A database is a data store. But a data store is not necessarily a database.

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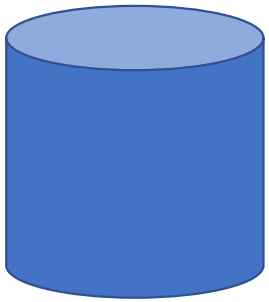
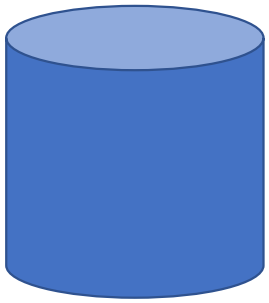


A database has an “engine” that maintains data integrity among many other functions.

A database is a data store. But a data store is not necessarily a database.



A database has an “engine” that maintains data integrity among many other functions.

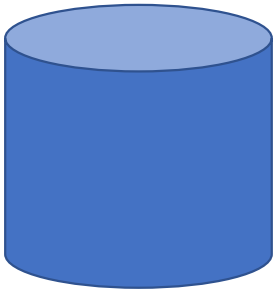
A data store could be a database but could also be a File, Excel File, Azure File Share, Azure Table Storage, Azure Blob Account, AWS S3 Bucket, …….

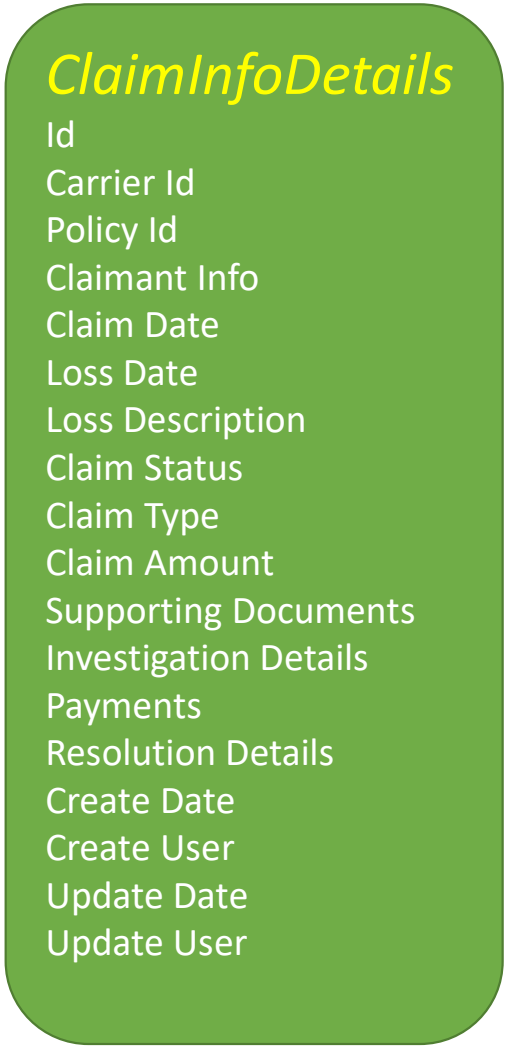
Common Architecture

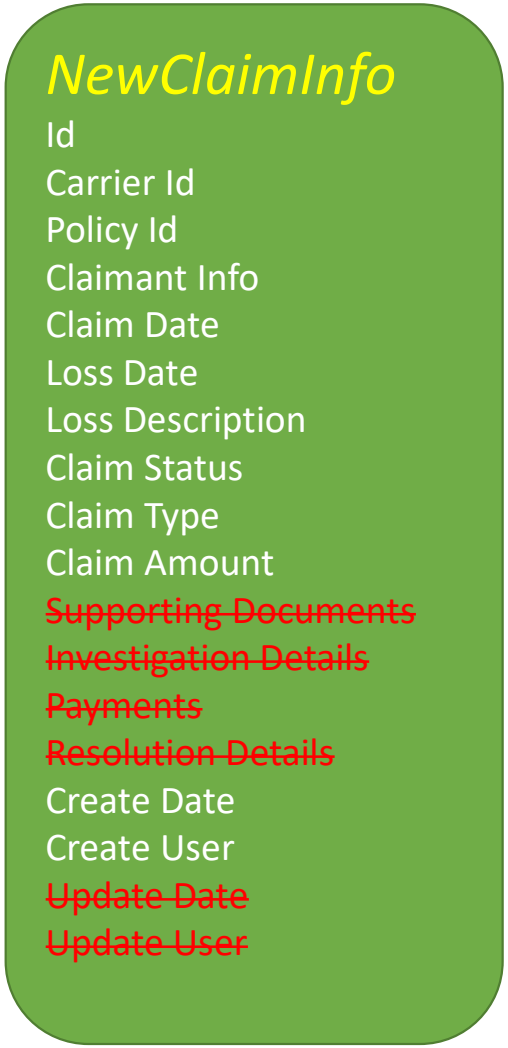
Application

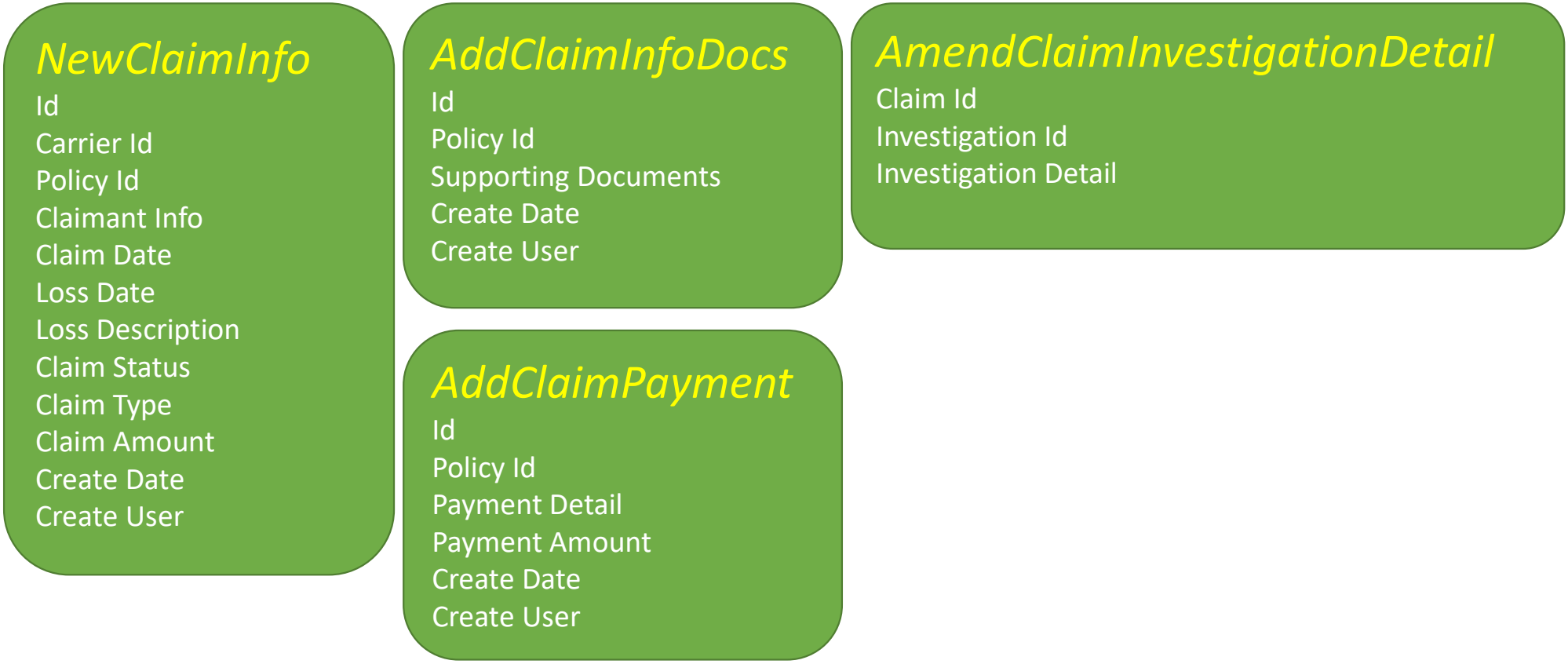
ClaimInfo

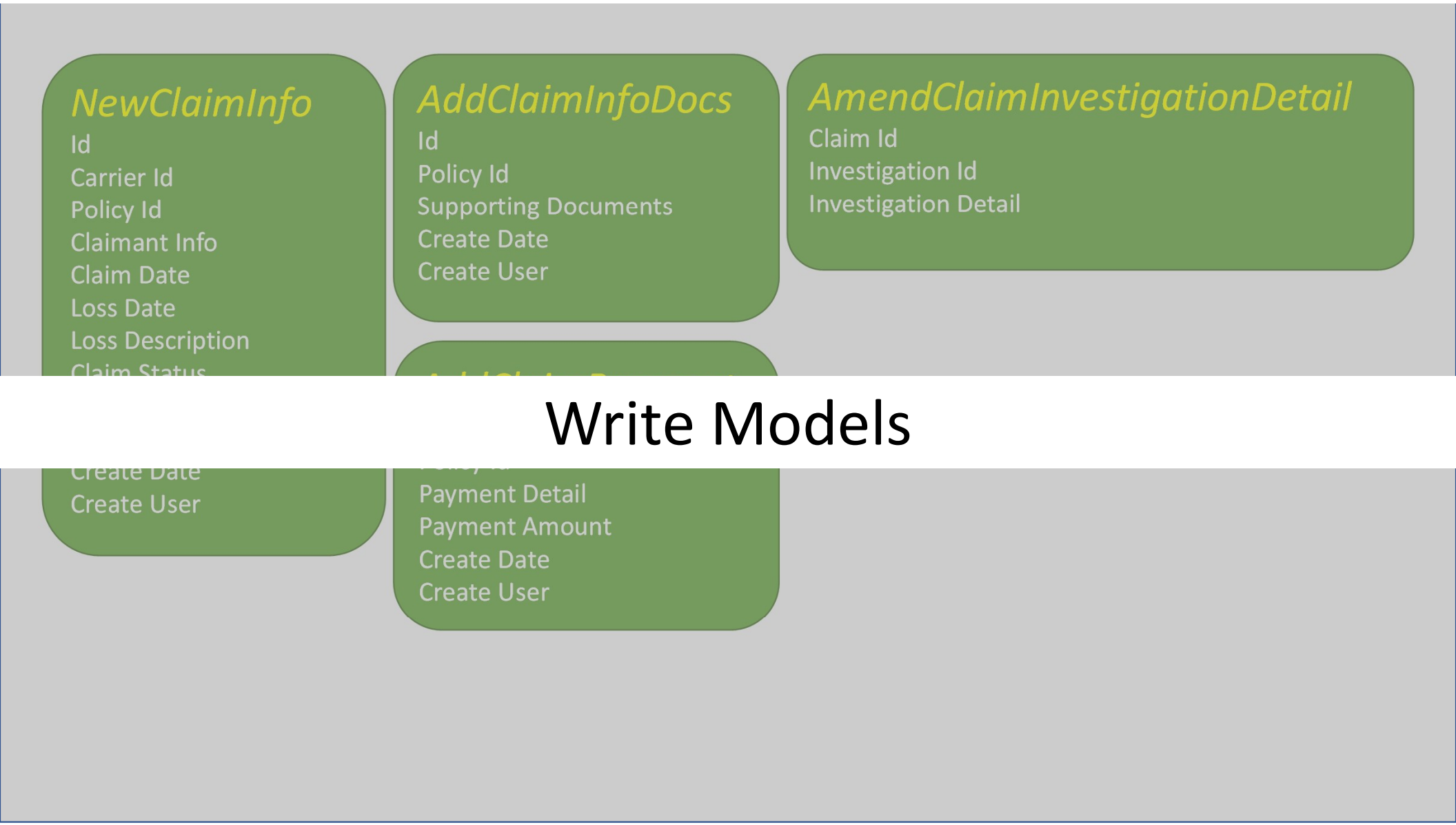
Id
Carrier Id
Policy Id
Claimant Info
Claim Date
Loss Date
Loss Description
Claim Status
Claim Type
Claim Amount
Supporting Documents
Investigation Details
Payments
Resolution Details
Create Date
Create User
Update Date
Update User




ClaimInfoDetails
Id
Carrier Id
Policy Id
Claimant Info
Claim Date
Loss Date
Loss Description
Claim Status
Claim Type
Claim Amount
Supporting Documents
Investigation Details
Payments
Resolution Details
Create Date
Create User
Update Date
Update User


NewClaimInfo
Id
Carrier Id
Policy Id
Claimant Info
Claim Date
Loss Date
Loss Description
Claim Status
Claim Type
Claim Amount
Supporting Documents
Investigation Details
Payments
Resolution Details
Create Date
Create User
Update Date
Update User

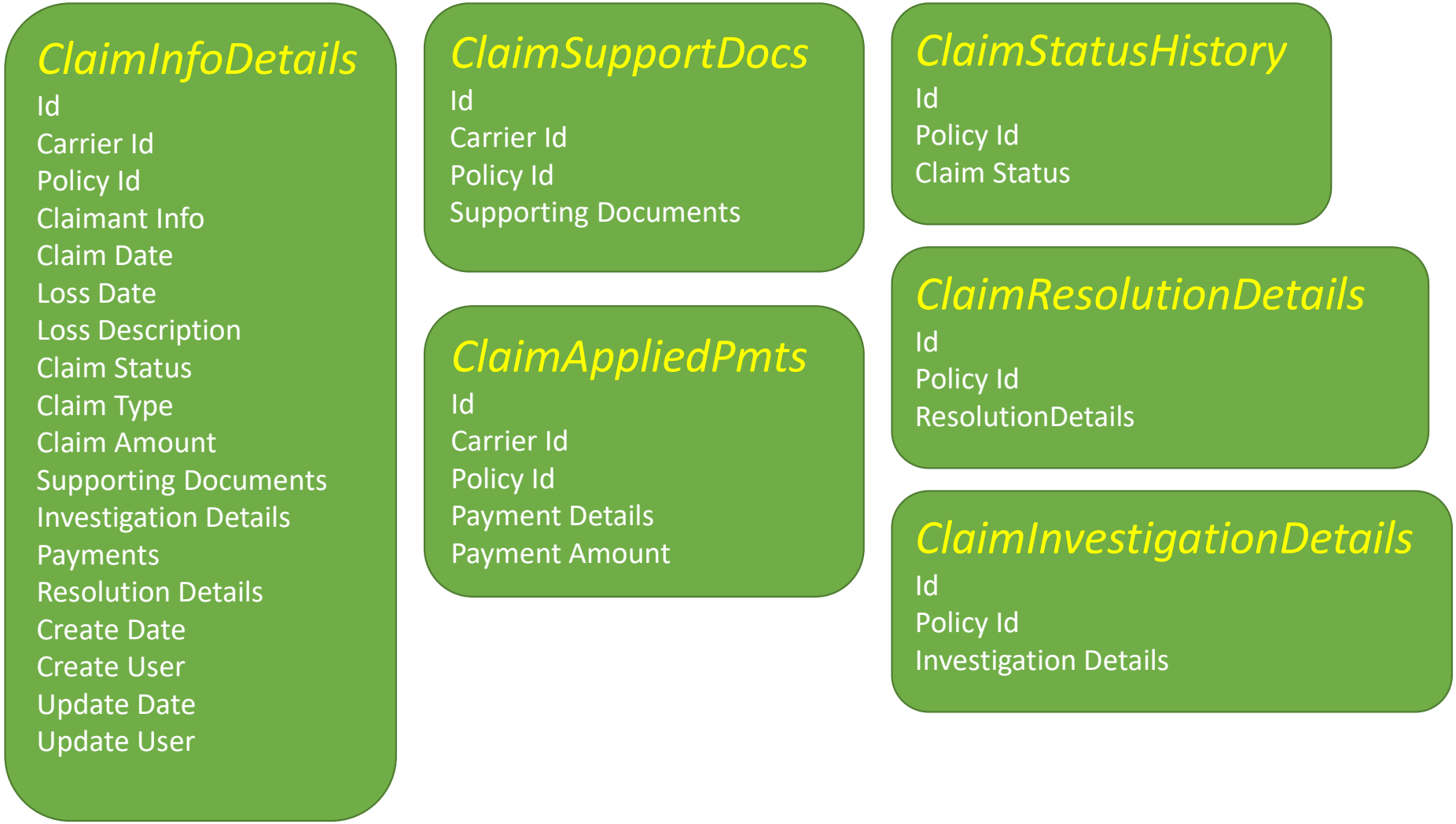

NewClaimInfo
Id
Carrier Id
Policy Id
Claimant Info
Claim Date
Loss Date
Loss Description
Claim Status
Claim Type
Claim Amount
Create Date
Create User
AddClaimInfoDocs
Id
Policy Id
Supporting Documents
Create Date
Create User
AddClaimPayment
Id
Policy Id
Payment Detail
Payment Amount
Create Date
Create User
AmendClaimInvestigationDetail
Claim Id
Investigation Id
Investigation Detail

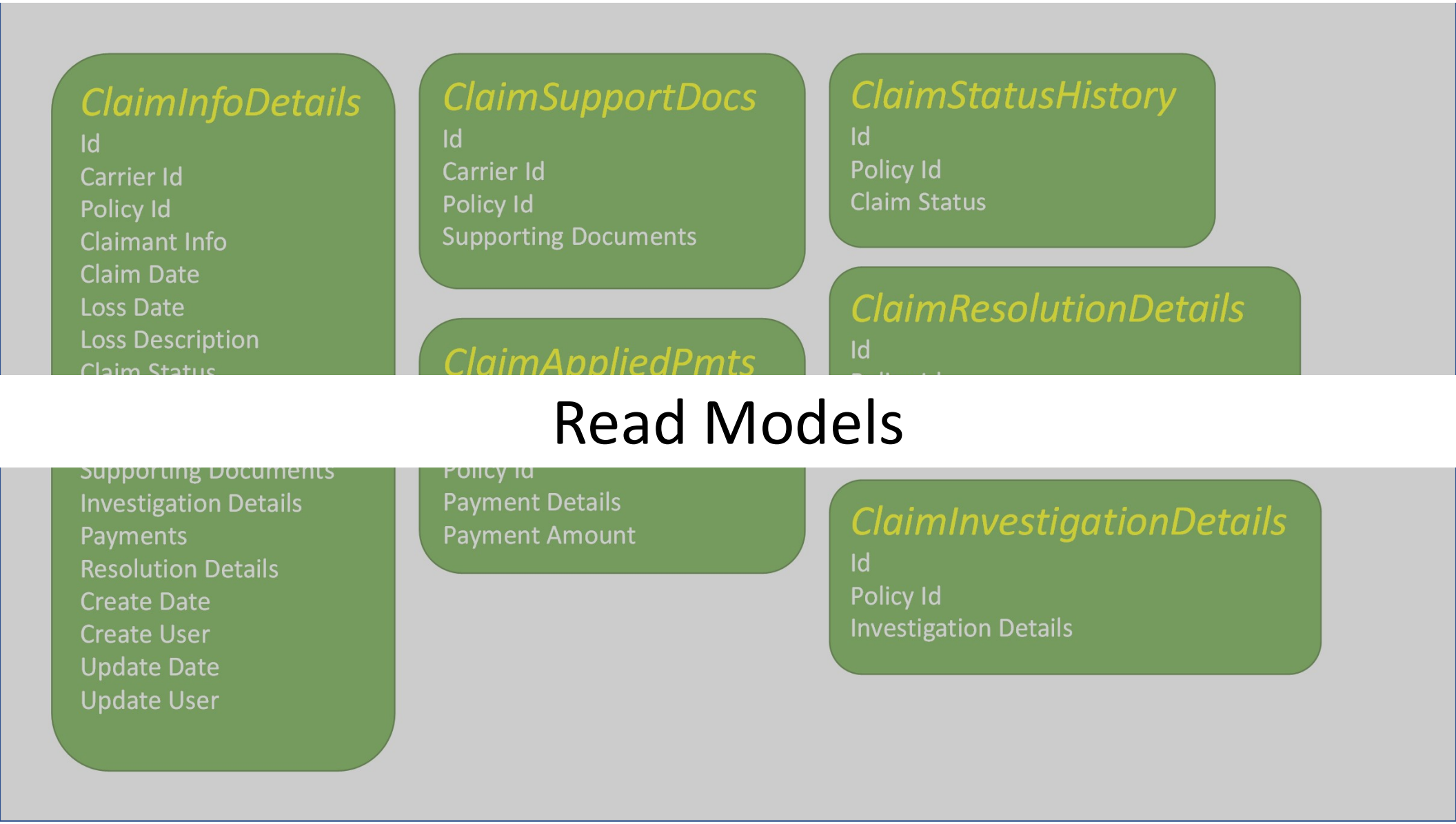


Write Models

ClaimInfoDetails

Id
Carrier Id
Policy Id
Claimant Info
Claim Date
Loss Date
Loss Description
Claim Status
Claim Type
Claim Amount
Supporting Documents
Investigation Details
Payments
Resolution Details
Create Date
Create User
Update Date
Update User


ClaimInfoDetails
Id
Carrier Id
Policy Id
Claimant Info
Claim Date
Loss Date
Loss Description
Claim Status
Claim Type
Claim Amount
Supporting Documents
Investigation Details
Payments
Resolution Details
Create Date
Create User
Update Date
Update User
ClaimSupportDocs
Id
Carrier Id
Policy Id
Supporting Documents
ClaimAppliedPmts
Id
Carrier Id
Policy Id
Payment Details
Payment Amount
ClaimStatusHistory
Id
Policy Id
Claim Status
ClaimResolutionDetails
Id
Policy Id
ResolutionDetails
ClaimInvestigationDetails
Id
Policy Id
Investigation Details


ClaimInfoDetails
Id
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Policy Id
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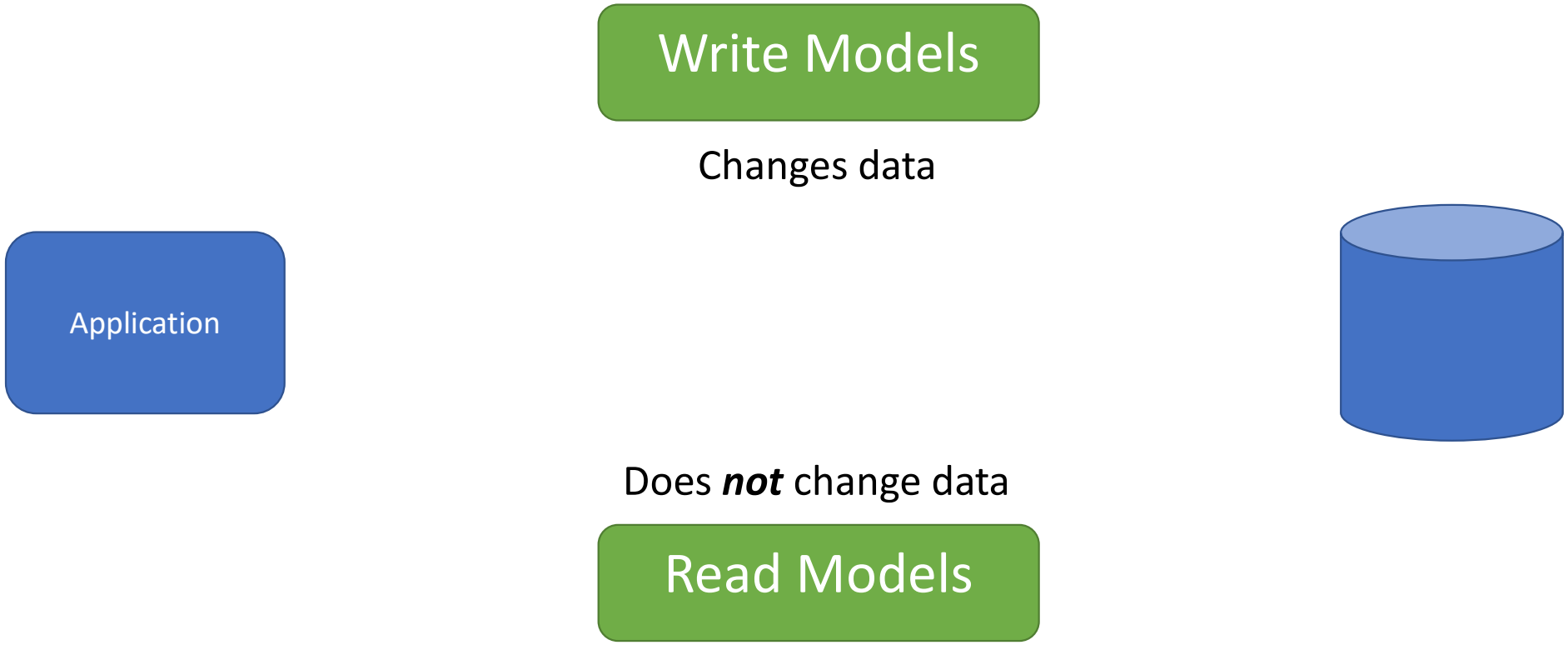
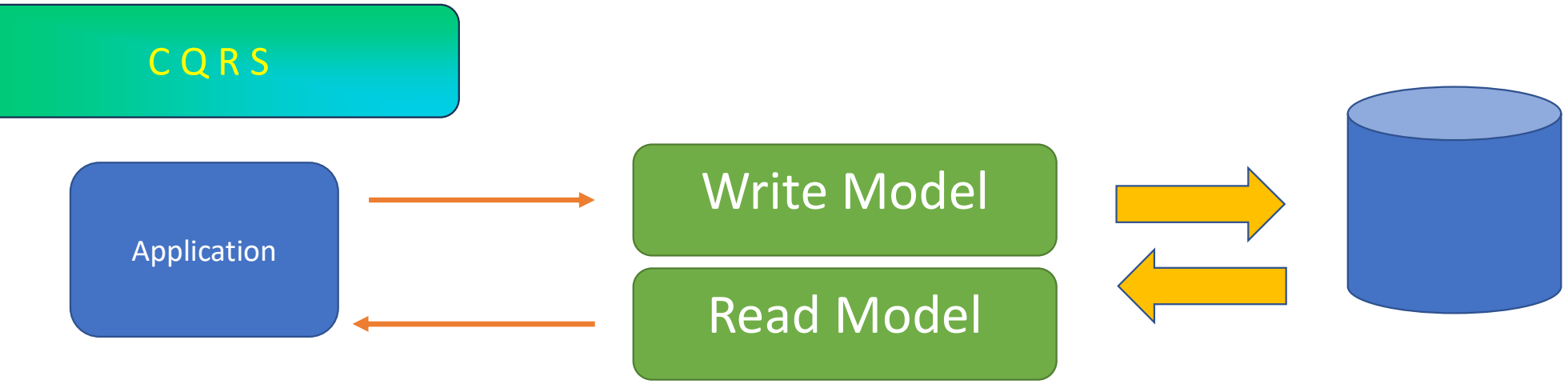
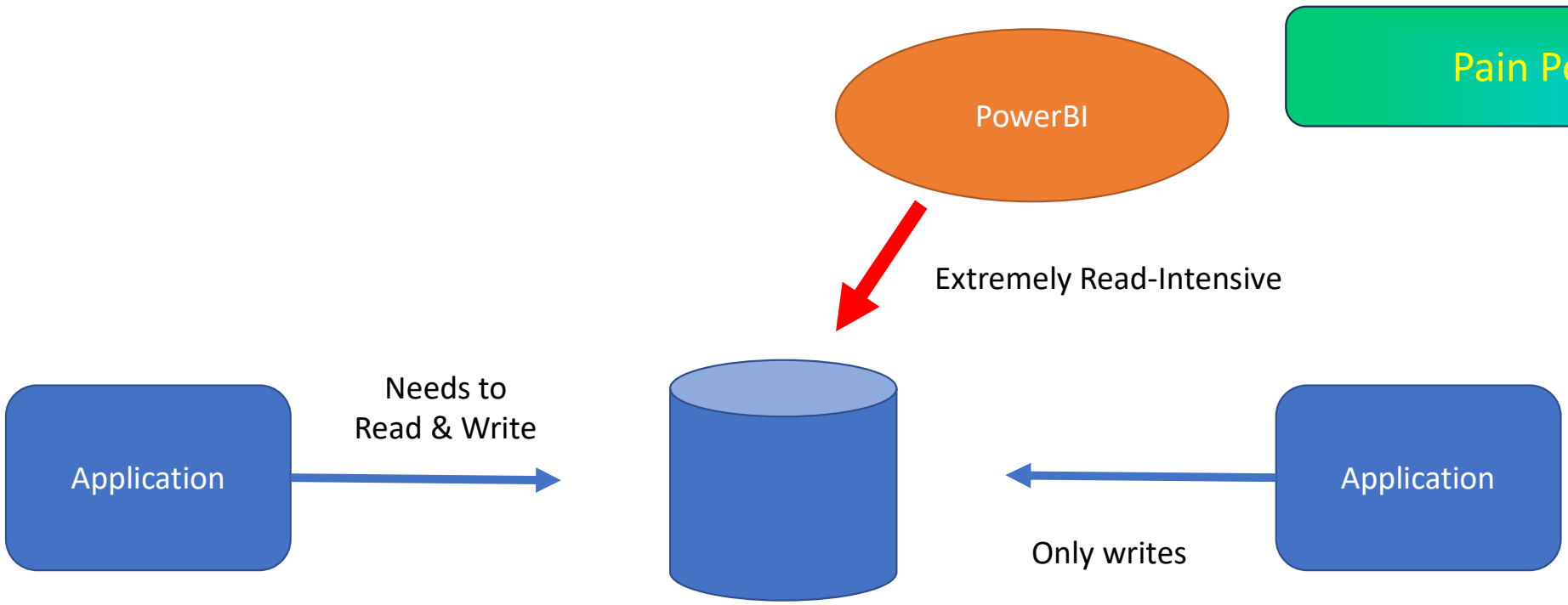
Investigation Details
Payments
Resolution Details
Create Date
Create User
Update Date
Update User
ClaimSupportDocs
Id
Carrier Id
Policy Id
Supporting Documents
ClaimAppliedPmts
Policy Id
Payment Details
Payment Amount
ClaimStatusHistory
Id
Policy Id
Claim Status
ClaimResolutionDetails
Id
ClaimInvestigationDetails
Id
Policy Id
Investigation Details
Read Models

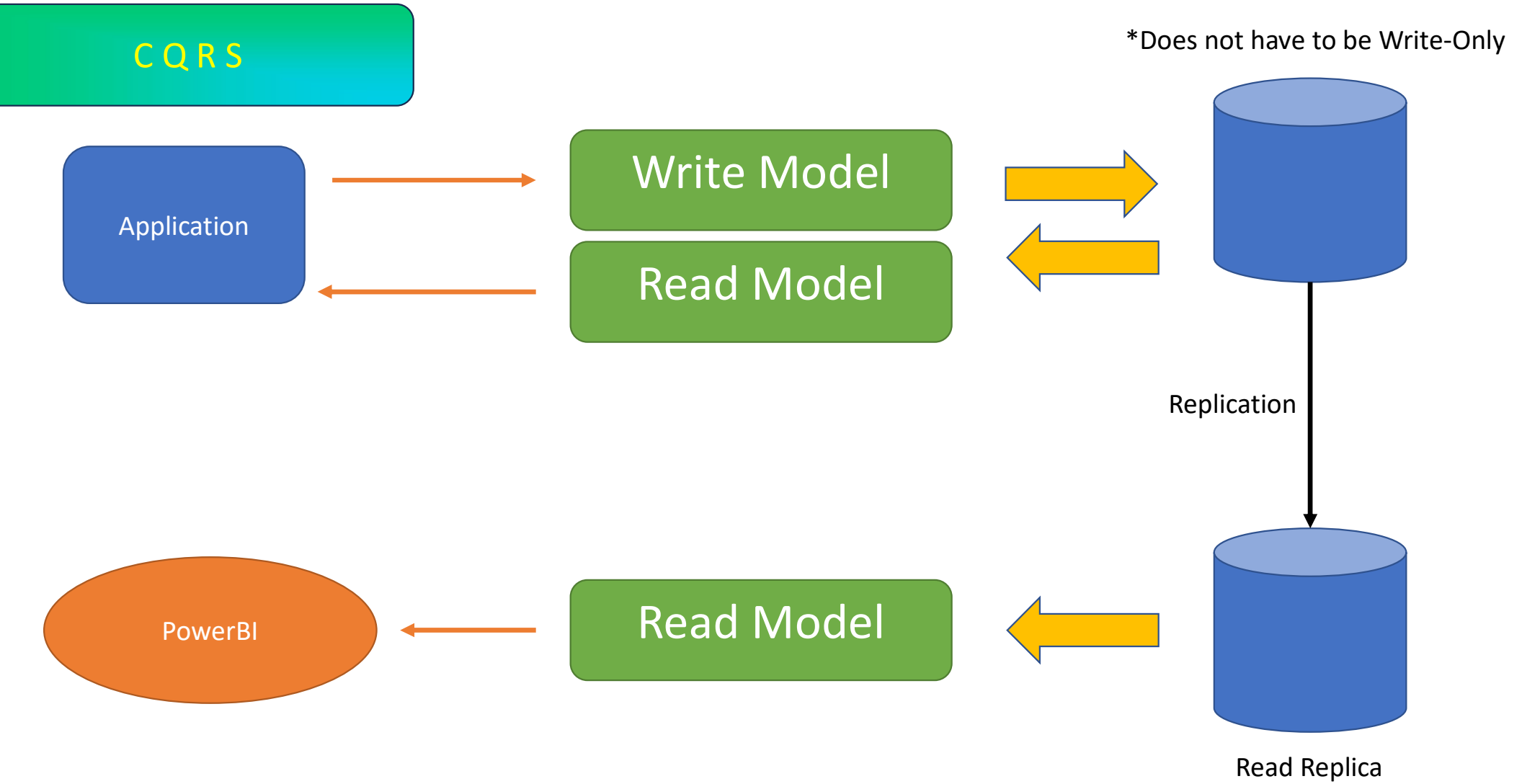

Write Models
Changes data
Application
Does *not* change data
Read Models

CQRS

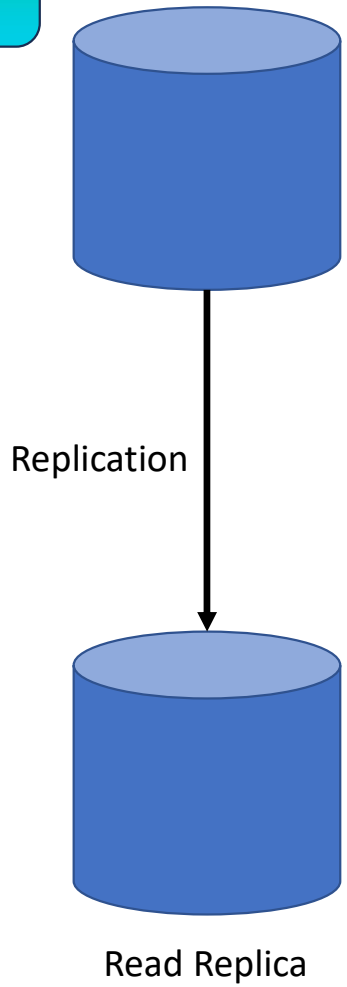
Command – Query – Responsibility - Segregation


C Q R S
Application
Write Model
Read Model

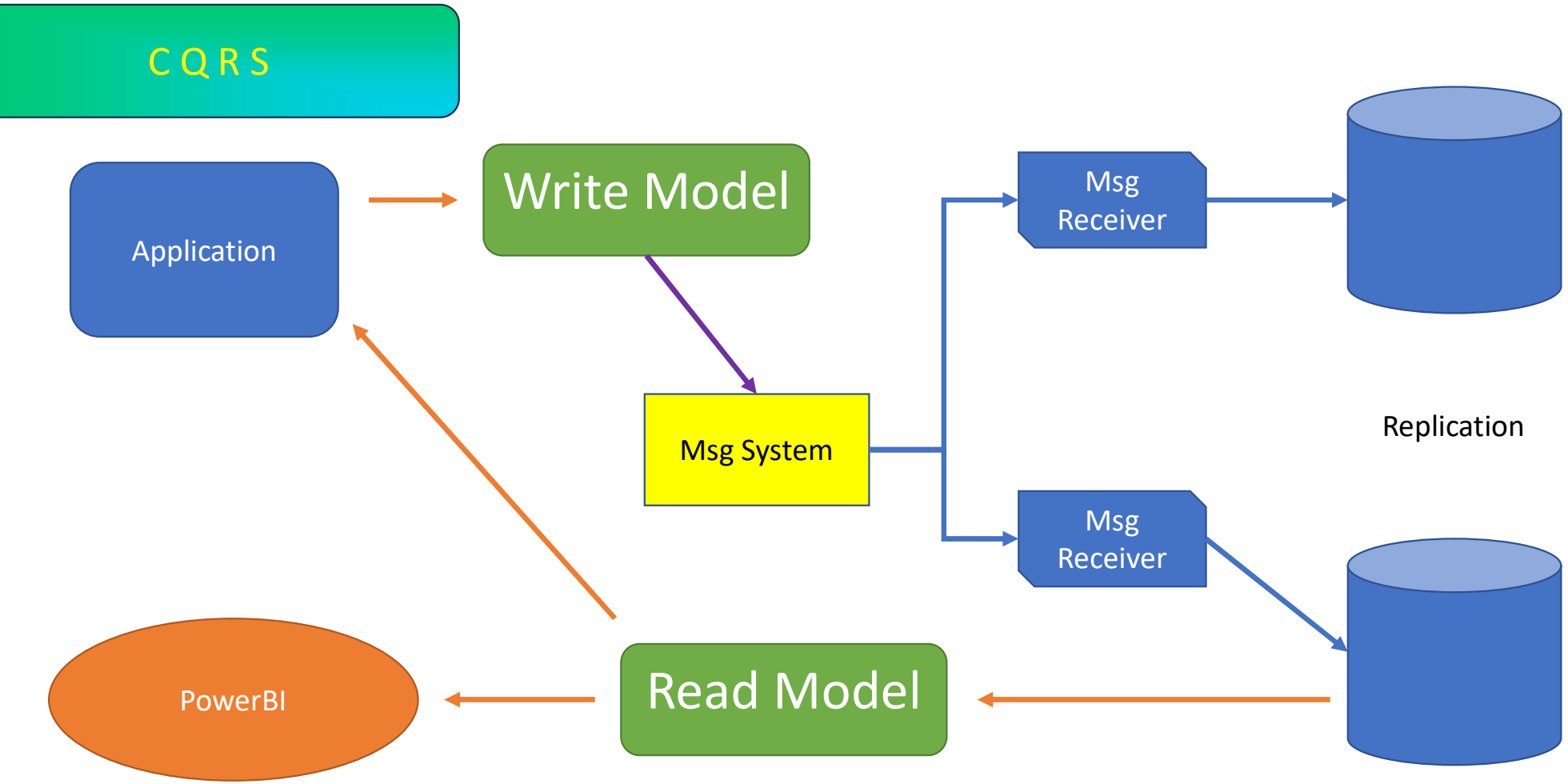

Pain Points
PowerBI
Extremely Read-Intensive
Application
Needs to
Read & Write
Application
Only writes

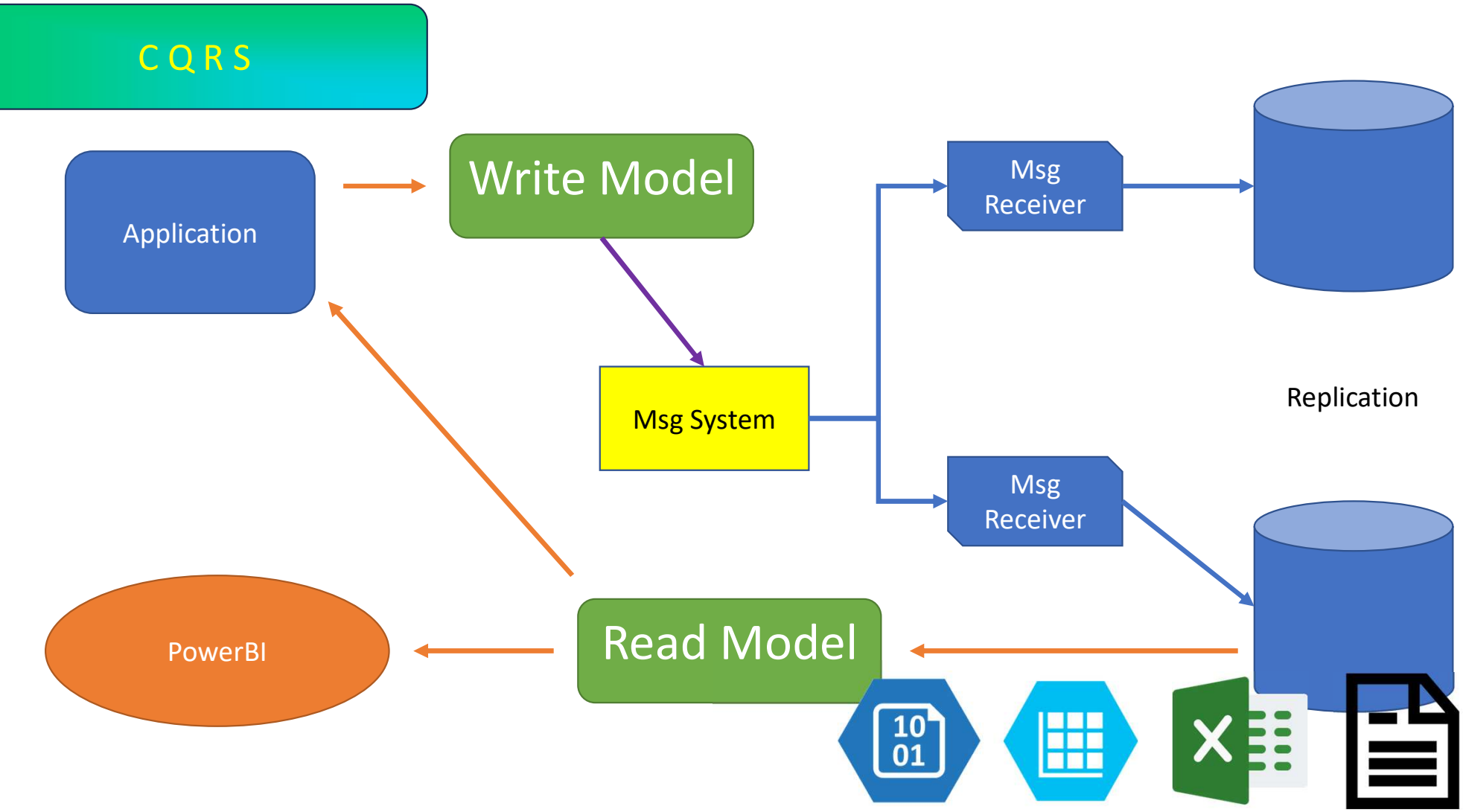

C Q R S
*Does not have to be Write-Only
Application
Write Model
Read Model
Replication
PowerBI
Read Model
Read Replica

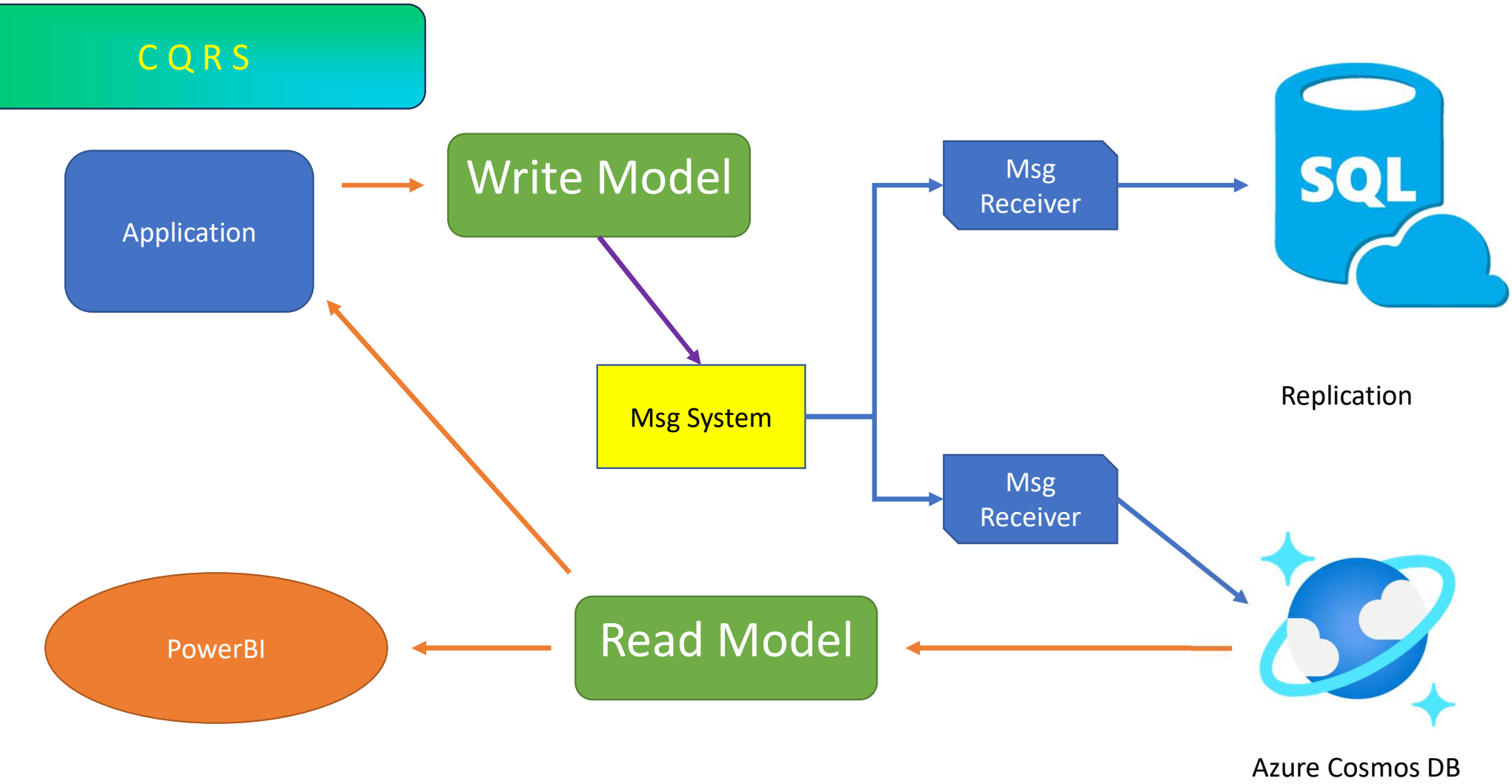
Replication

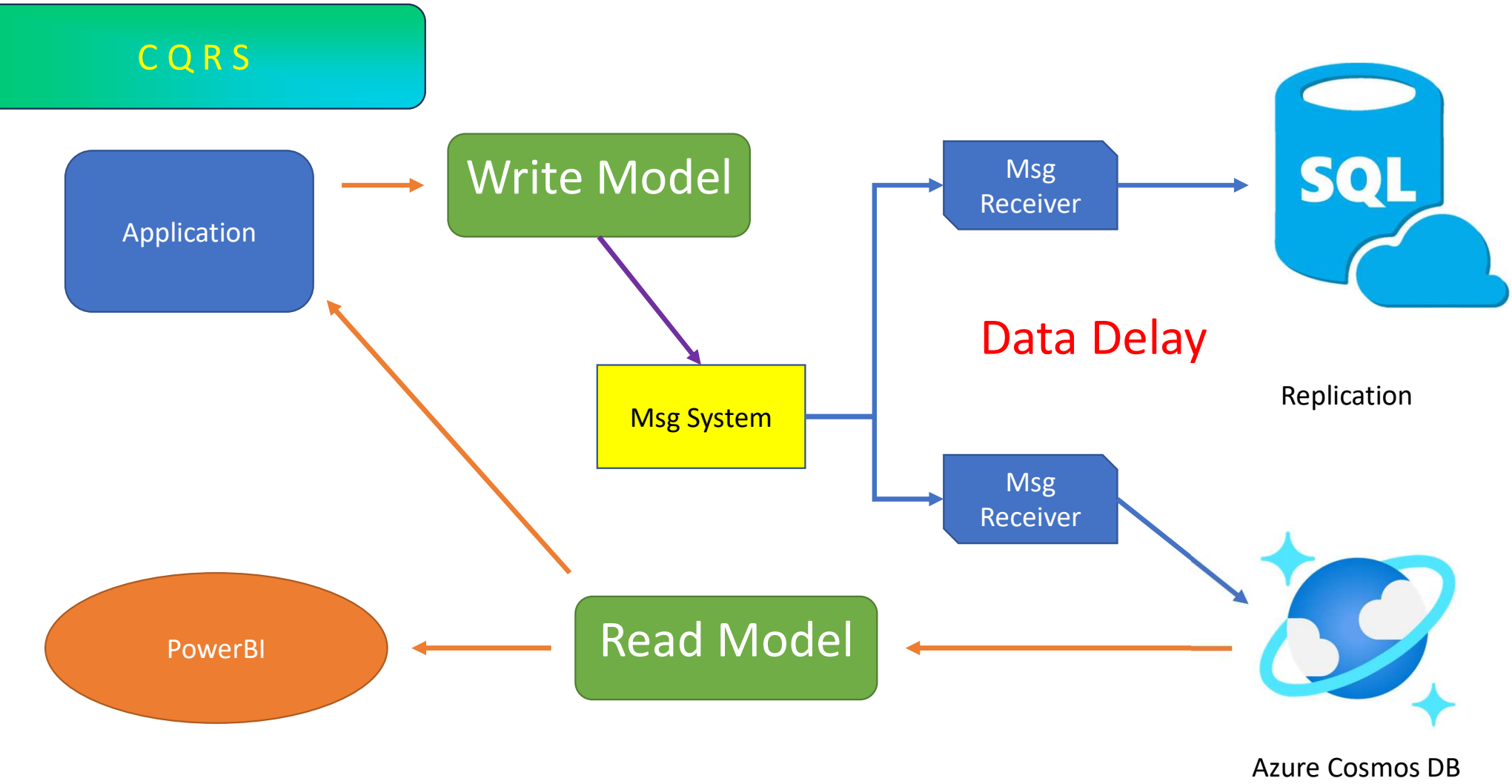


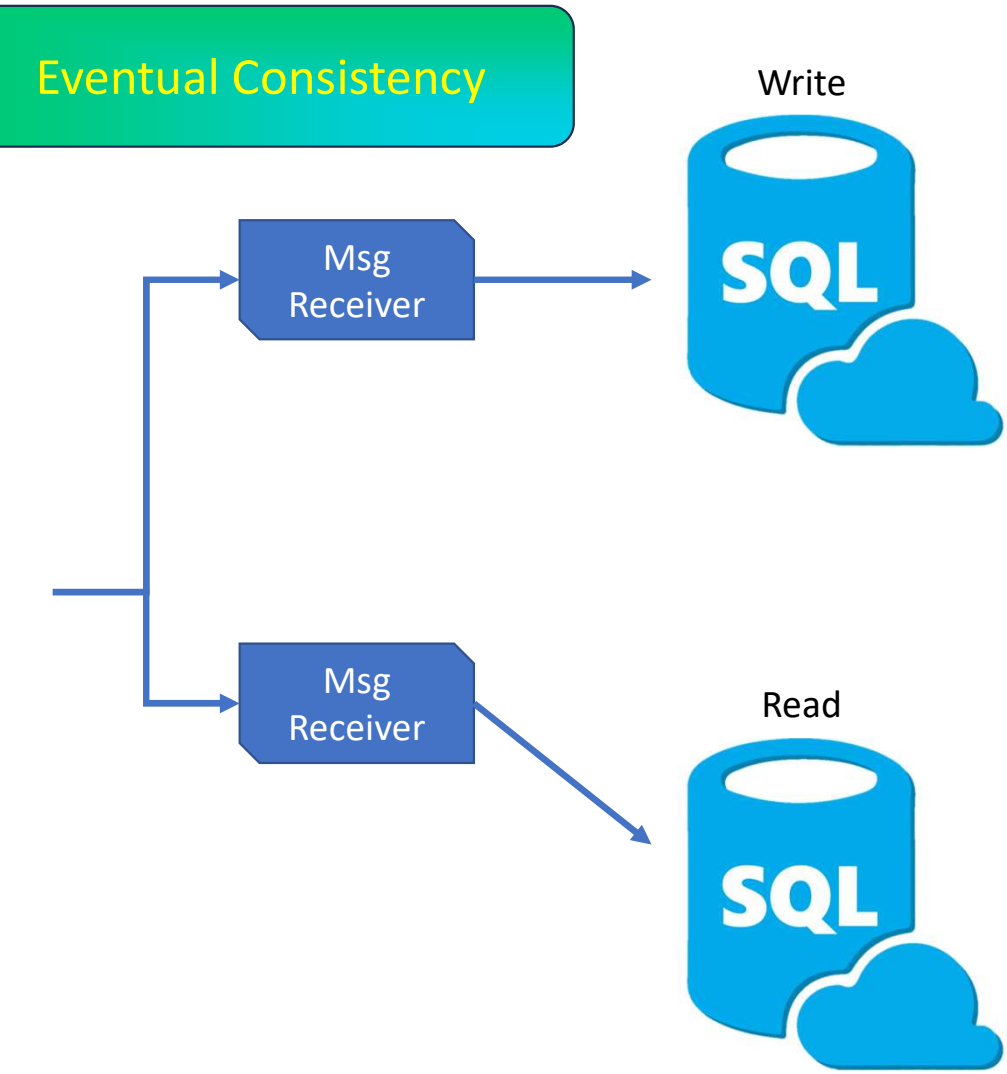
MySQL Replication
Postgres – Streaming Replication
SQL Server – Transactional Replication
MongoDB – Replication Sets
Amazon Aurora

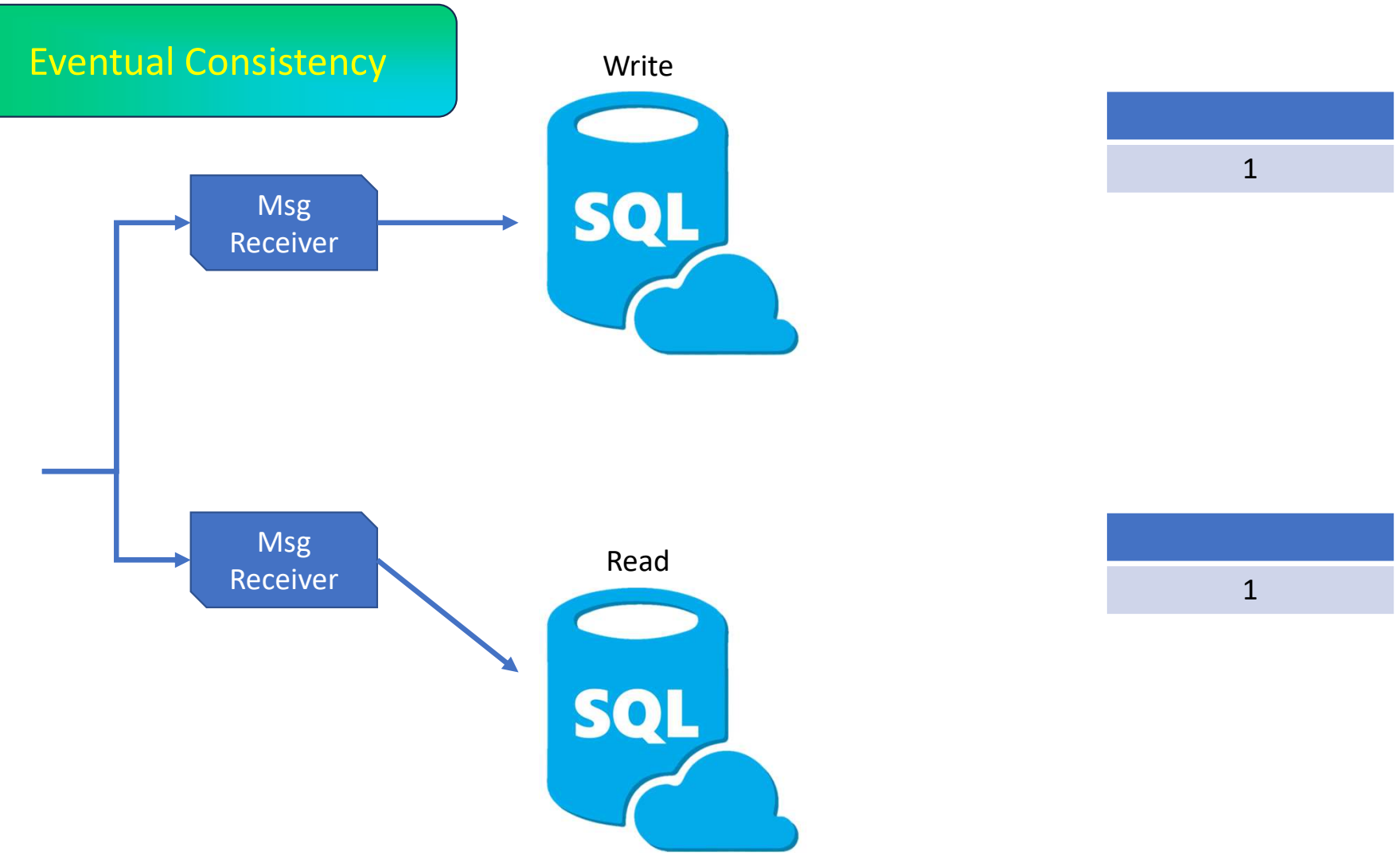

C Q R S
Application
Write Model
Msg System
Msg Receiver
Msg Receiver
Replication
PowerBI
Read Model


C Q R S
Application
Write Model
Msg System
Msg Receiver
Msg Receiver
Replication
PowerBI
Read Model
10
01

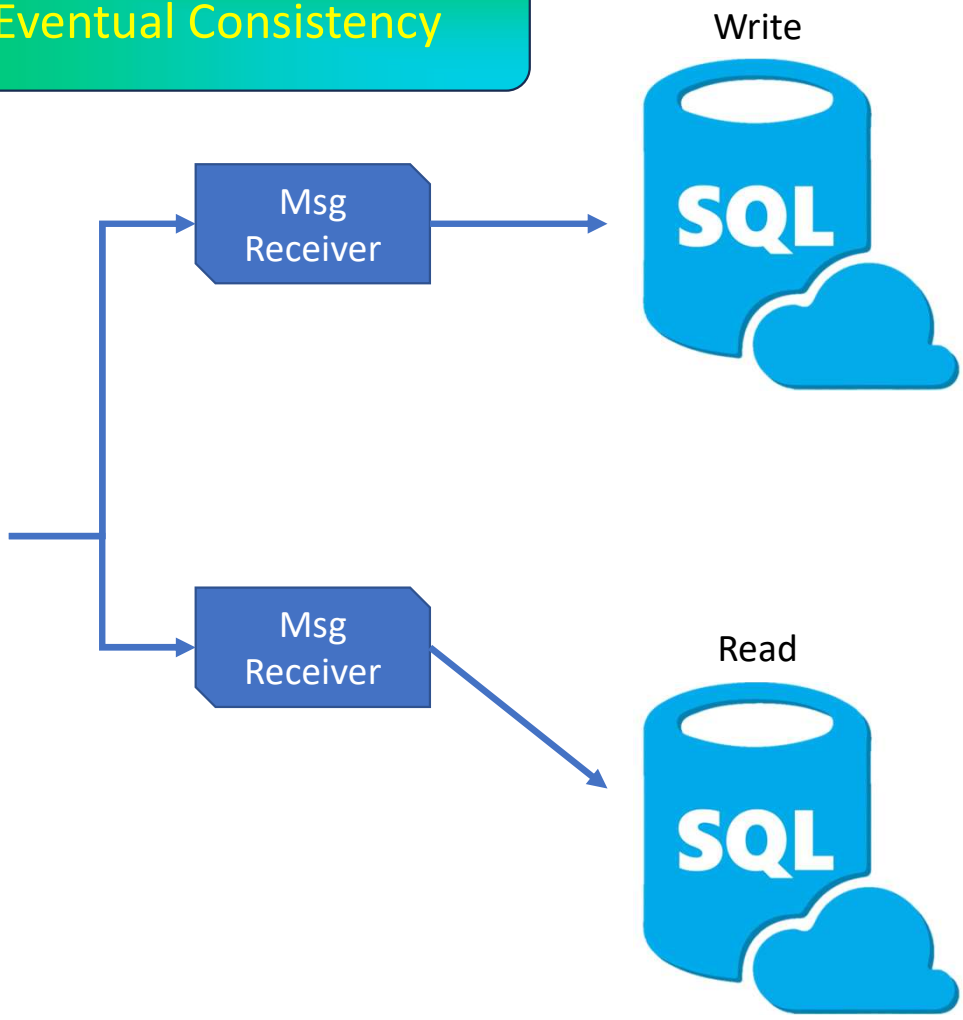

CQRS
Application
Write Model
Msg System
Msg Receiver
Msg Receiver
SQL
Replication
PowerBI
Read Model
Azure Cosmos DB


C Q R S
Application
Write Model
Msg System
Msg Receiver
Msg Receiver
SQL
Data Delay
Replication
PowerBI
Read Model
Azure Cosmos DB


Eventual Consistency
Write
Msg Receiver
SQL
Msg Receiver
Read
SQL


Eventual Consistency
Write
Msg Receiver
SQL
1
Msg Receiver
Read
SQL
1

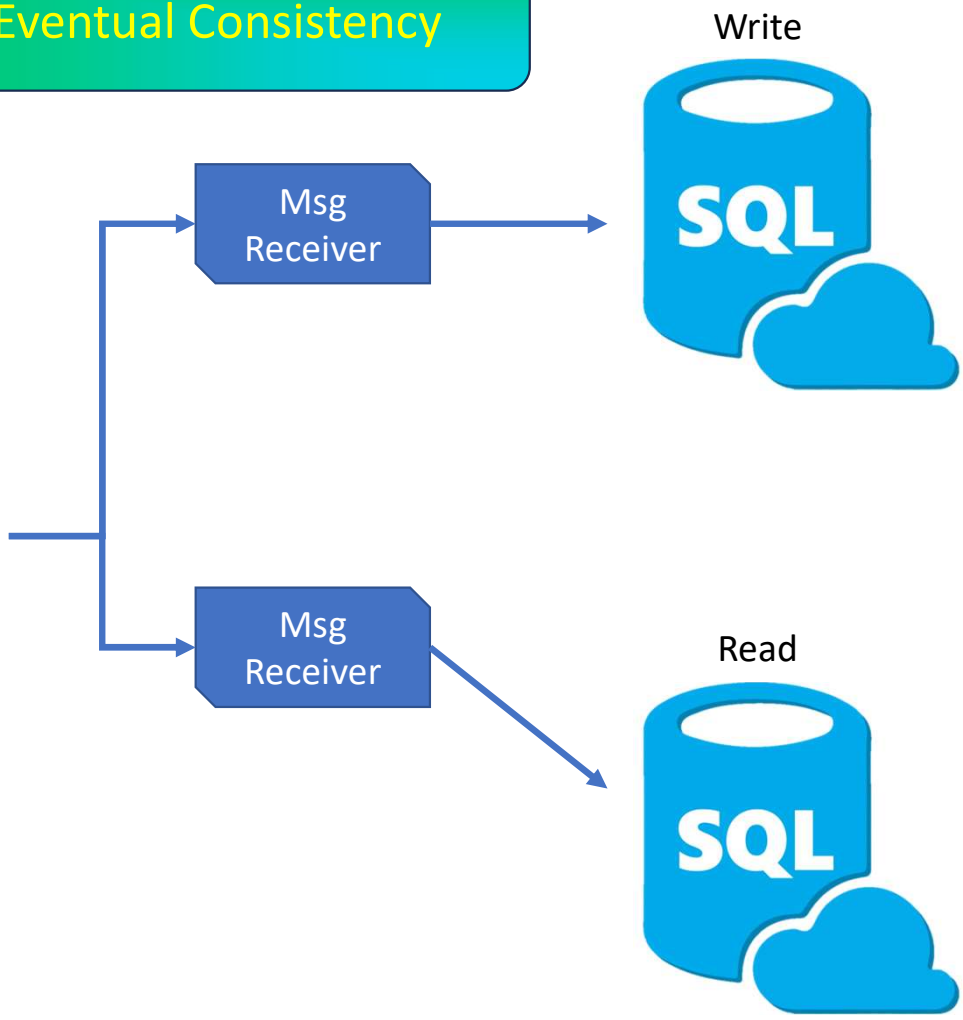
Eventual Consistency



1
2

1
2

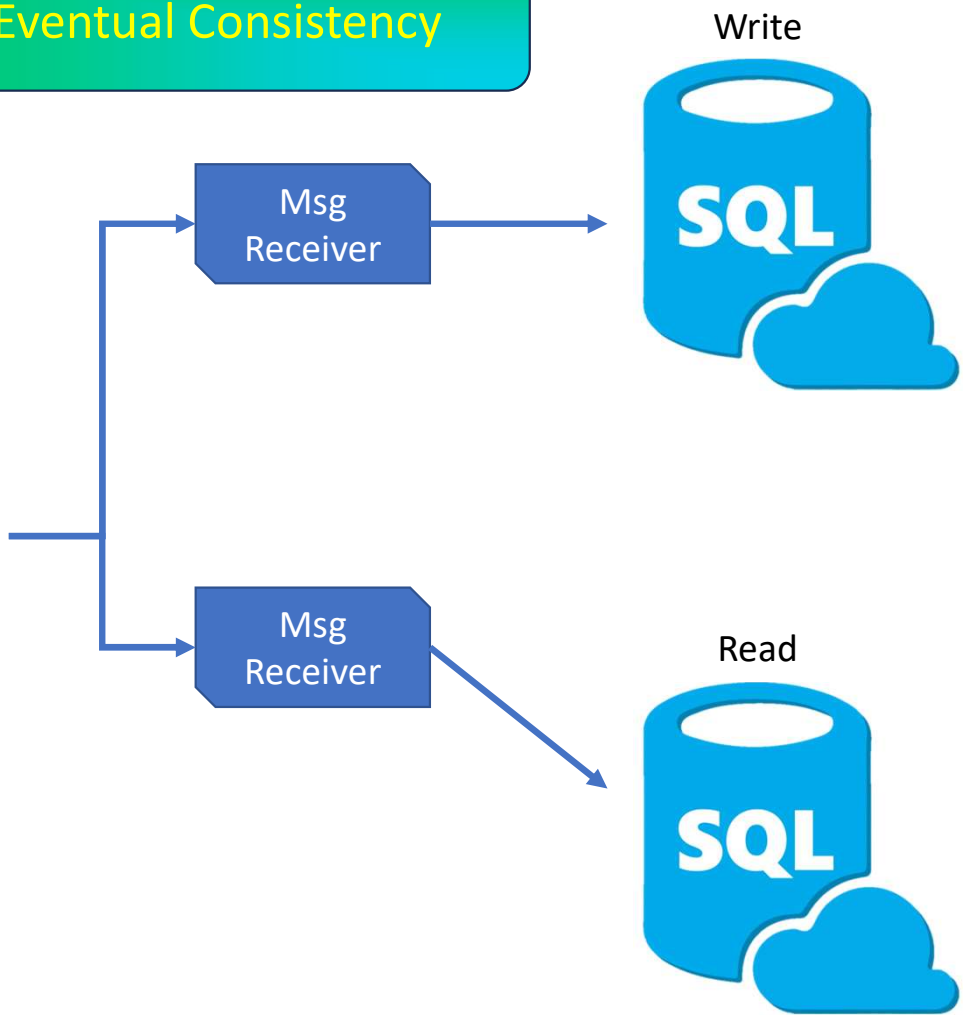
Eventual Consistency



1
2
3

1
2

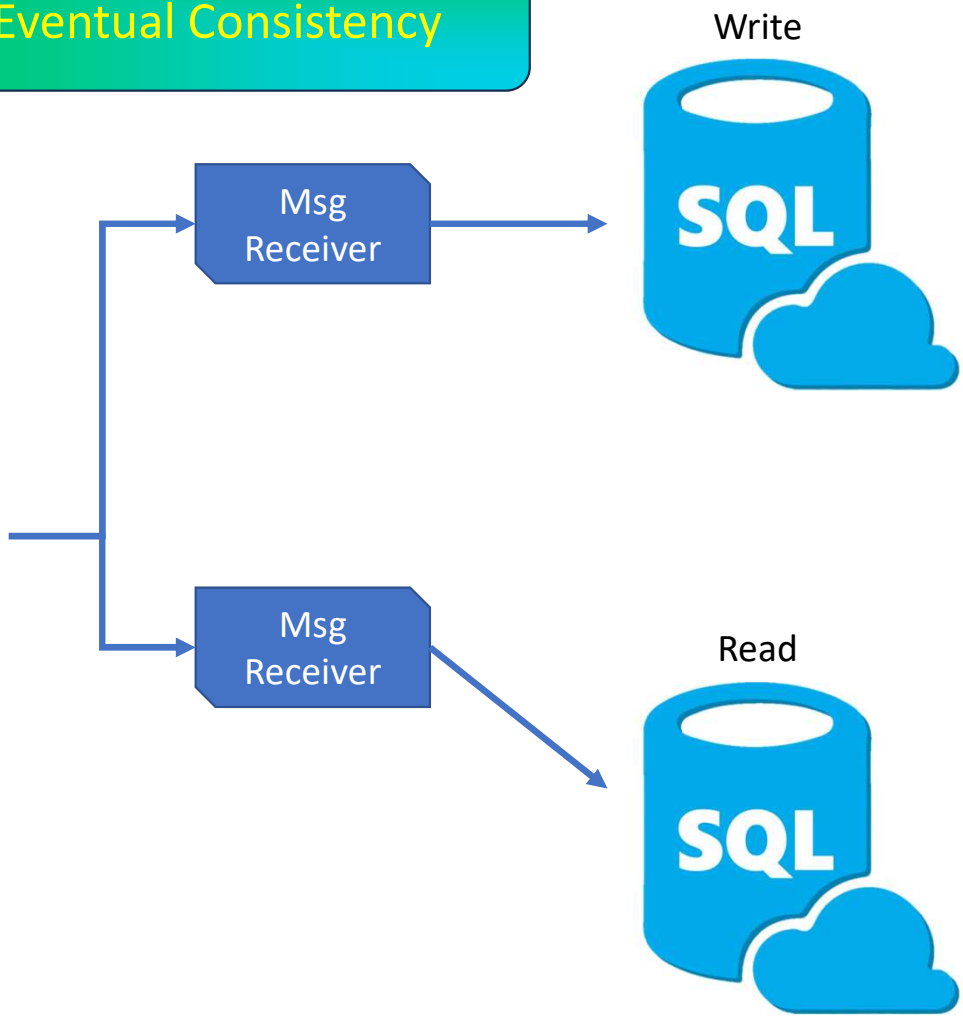
Eventual Consistency



1
2
3
4

1
2
3

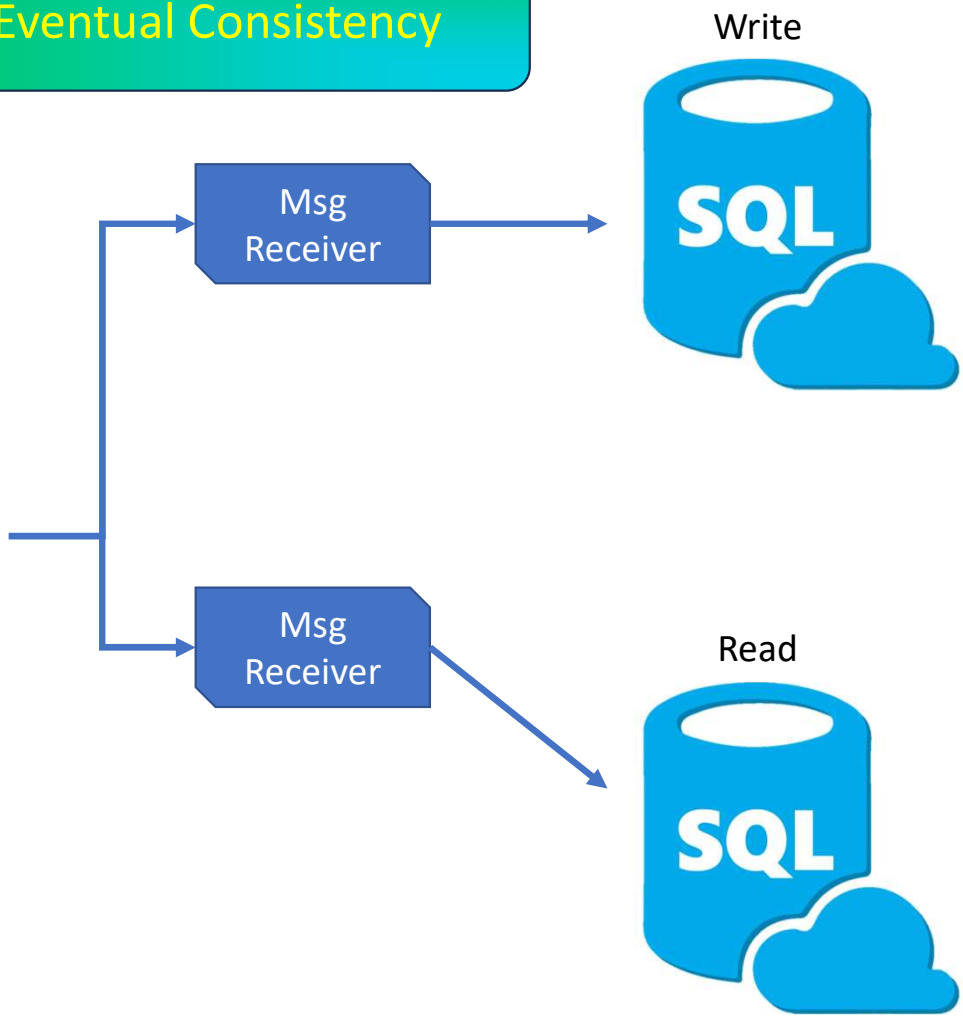
Eventual Consistency



1
2
3
4
5

1
2
3
4

Eventual Consistency



1
2
3
4
5

1
2
3
4
5

Select * From blah

Read

1
2
4
3
5

1
2
3
4
5

View

Select * From blah

Read

1
2
4
3
5

View

1
2
3
4
5

View

Read

View

1
2
3
4
5

PowerBI

View

Read

View

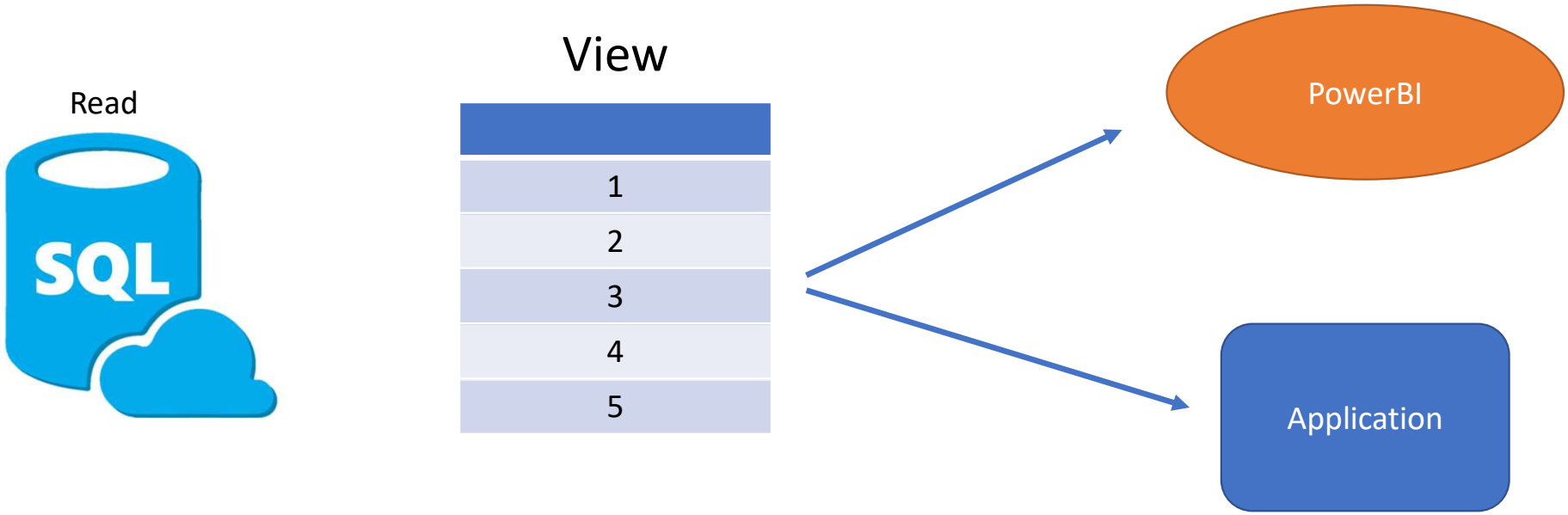
1
2
3
4
5

PowerBI

Application

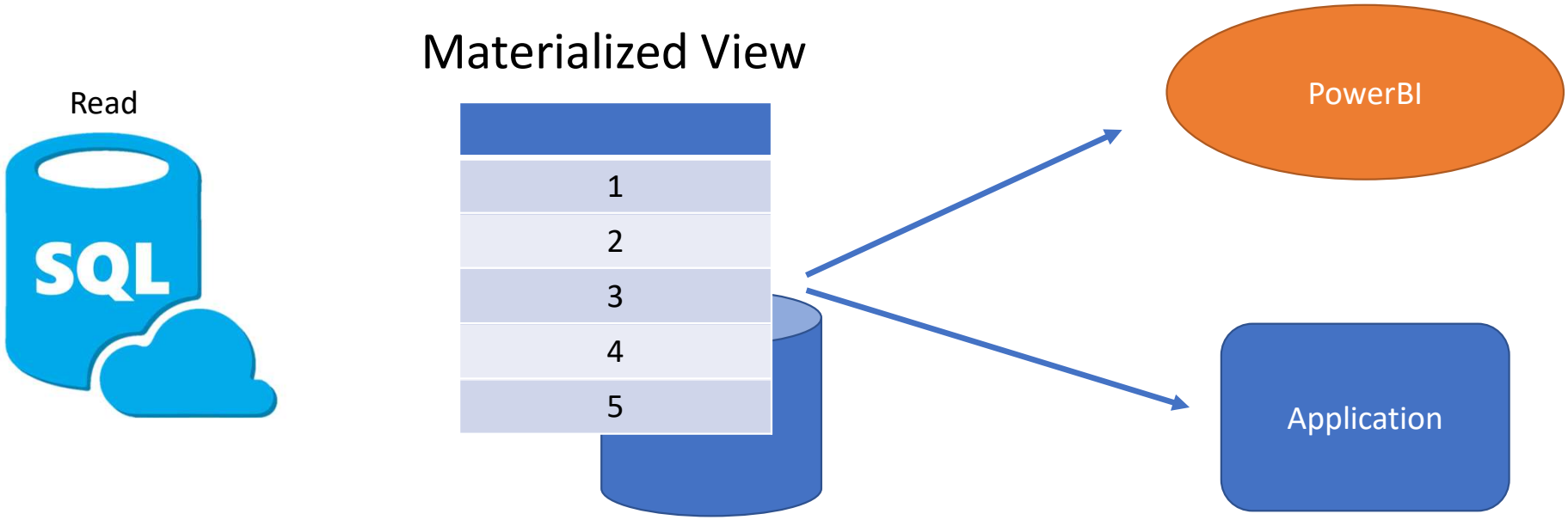
View

A *view* executes the query for every request.



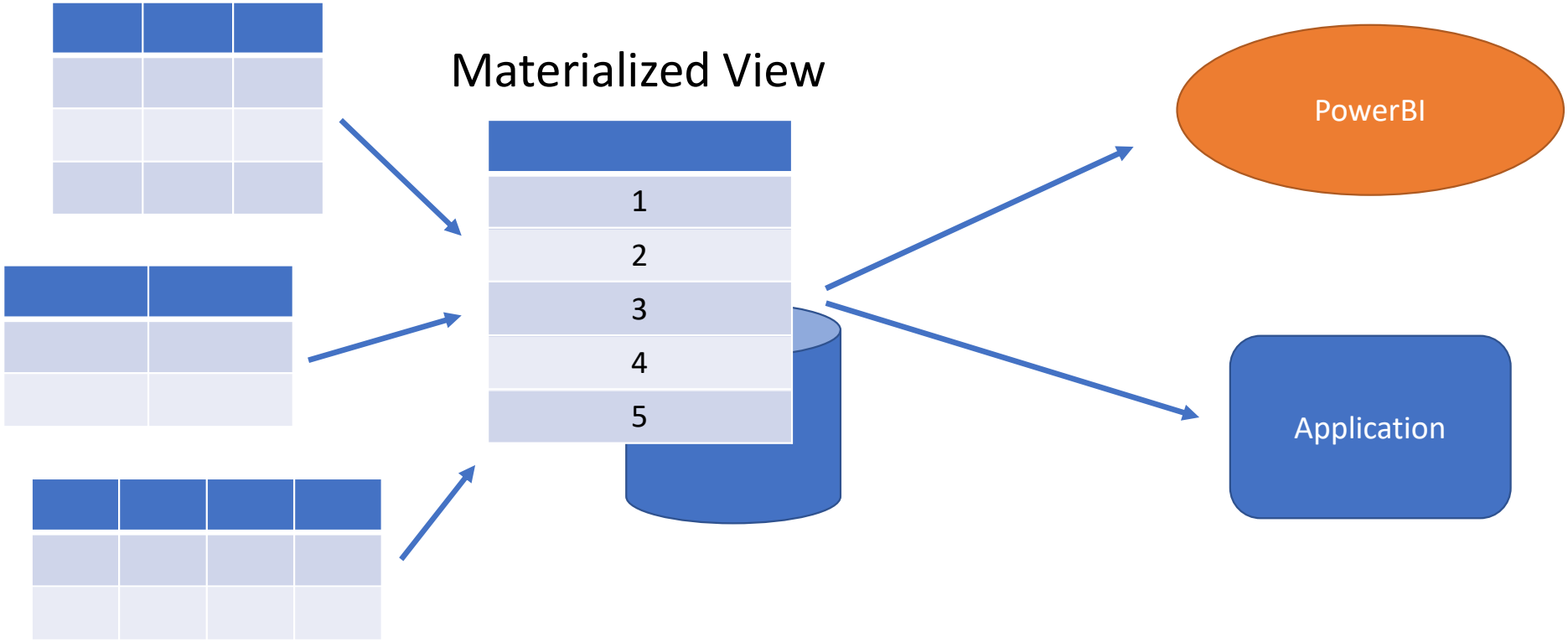
Materialized View

A *materialized view* is a form of a cache.



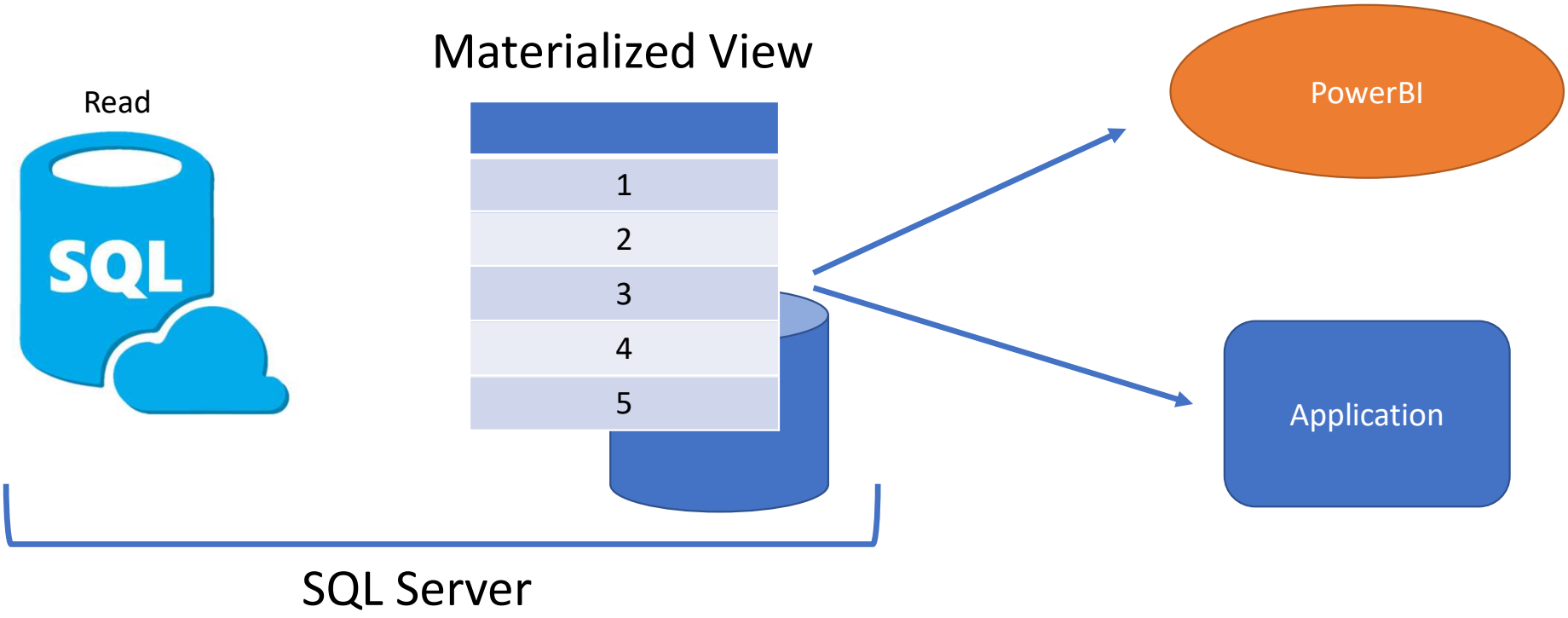
Materialized View

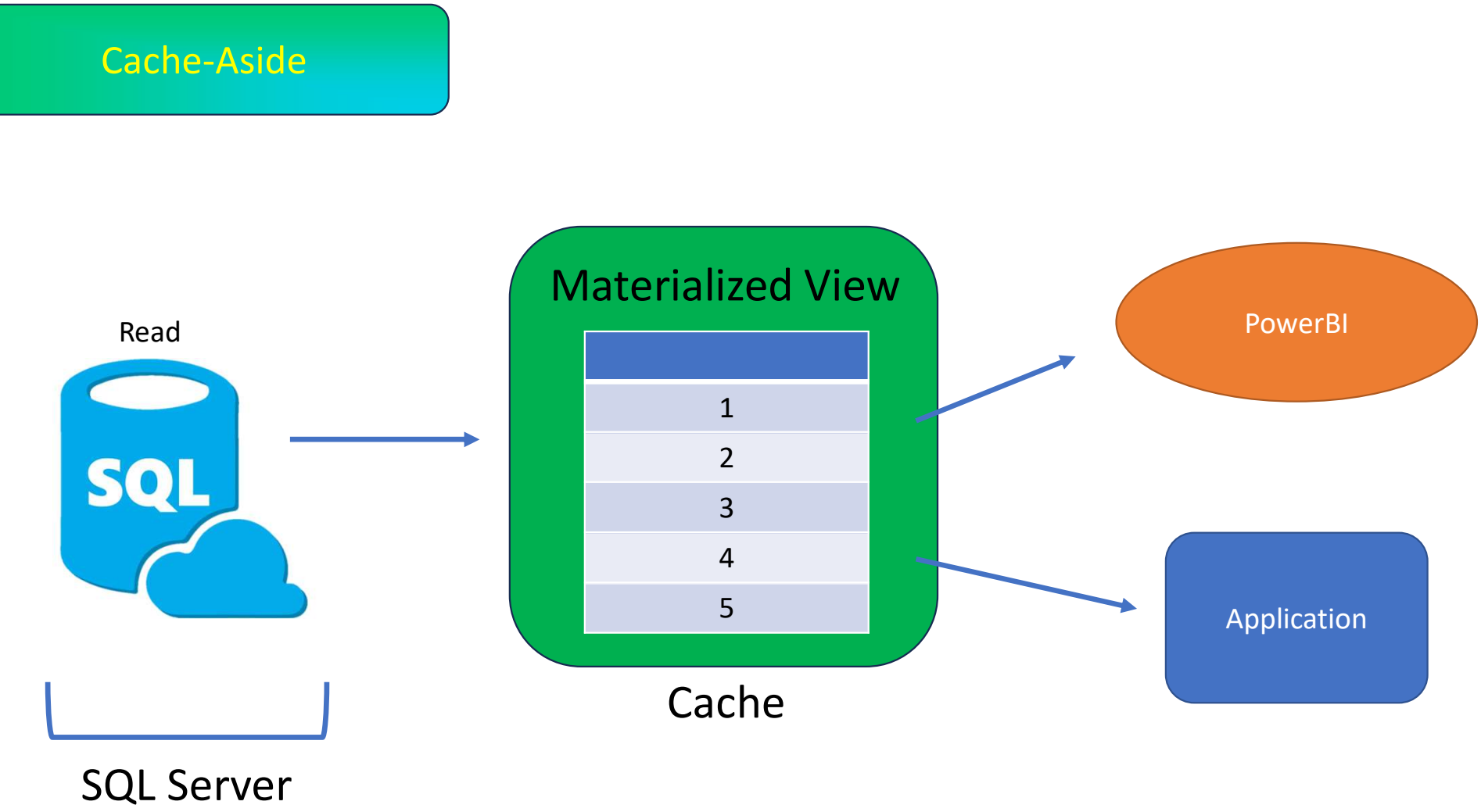
A *materialized view* is a form of a cache.



Materialized View

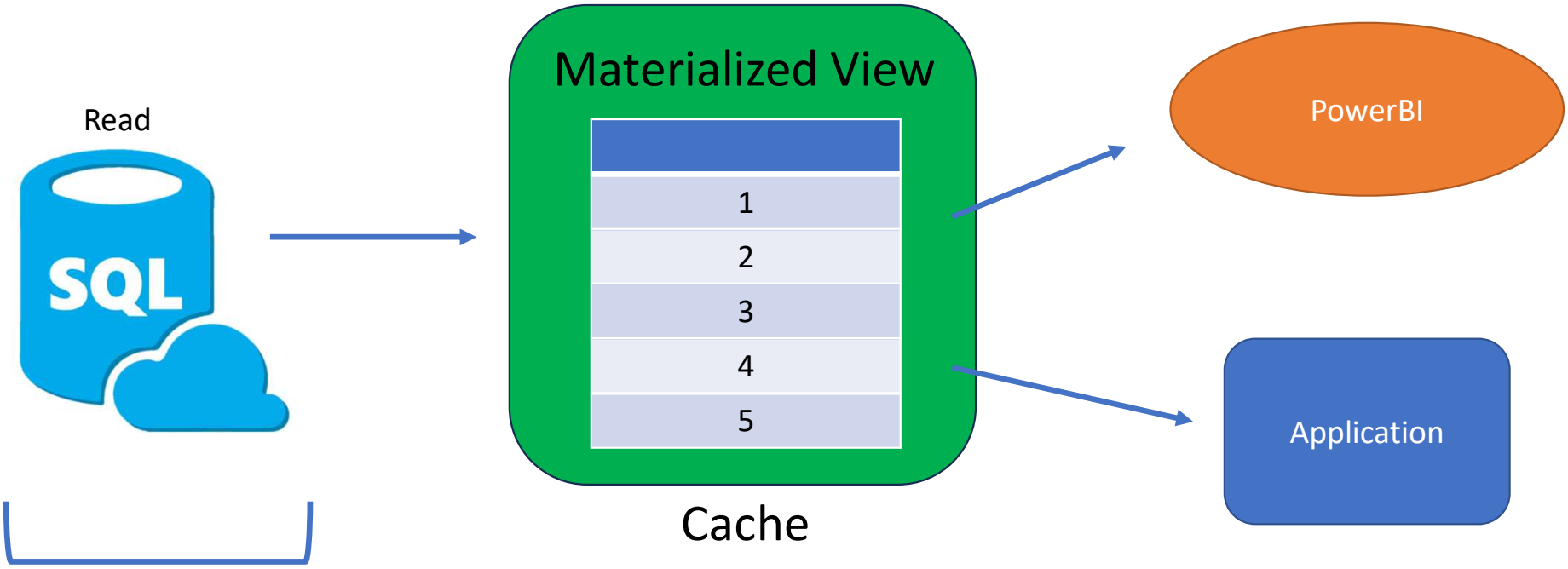
A *materialized view* is a form of a cache.




Cache-Aside
Read
SQL
SQL Server
Materialized View
1
2
3
4
5
Cache
PowerBI
Application

Cache-Aside

Example cache systems:
Redis or Azure Redis



Indexes

Primary Key	FirstName	LastName	DOB
1	Suzy	Q	4-3-1975
2	Bob	Eubanks	2-3-1943
3	Bob	Hope	12-19-1938
4	Lucille	Ball	10-24-1939
5	Estelle	Geddy	9-5-1947

Index on Primary Key

Primary Key	Data
1	FirstName:Suzy;LastName:Q;DOB:4-3-1975
2	FirstName:Bob;LastName:Eubanks;DOB:2-3-1943
3	FirstName:Bob;LastName:Hope;DOB:12-19-1938
4	FirstName:Lucille;LastName:Ball;DOB:10-24-1939
5	FirstName:Estelle;LastName:Geddy;DOB:9-5-1947

Indexes

Primary Key	FirstName	LastName	DOB
1	Suzy	Q	4-3-1975
2	Bob	Eubanks	2-3-1943
3	Bob	Hope	12-19-1938
4	Lucille	Ball	10-24-1939
5	Estelle	Geddy	9-5-1947

Index on Primary Key

Index on other fields

Primary Key	Data
1	FirstName:Suzy;LastName:Q;DOB:4-3-1975
2	FirstName:Bob;LastName:Eubanks;DOB:2-3-1943
3	FirstName:Bob;LastName:Hope;DOB:12-19-1938
4	FirstName:Lucille;LastName:Ball;DOB:10-24-1939
5	FirstName:Estelle;LastName:Geddy;DOB:9-5-1947

Indexes

Primary Key	FirstName	LastName	DOB
1	Suzy	Q	4-3-1975
2	Bob	Eubanks	2-3-1943
5	Estelle	Geddy	9-5-1947

Index on Primary Key

Index on other fields

This is great! - for relational data

Primary Key	Data
1	FirstName:Suzy;LastName:Q;DOB:4-3-1975
2	FirstName:Bob;LastName:Eubanks;DOB:2-3-1943
3	FirstName:Bob;LastName:Hope;DOB:12-19-1938
4	FirstName:Lucille;LastName:Ball;DOB:10-24-1939
5	FirstName:Estelle;LastName:Geddy;DOB:9-5-1947

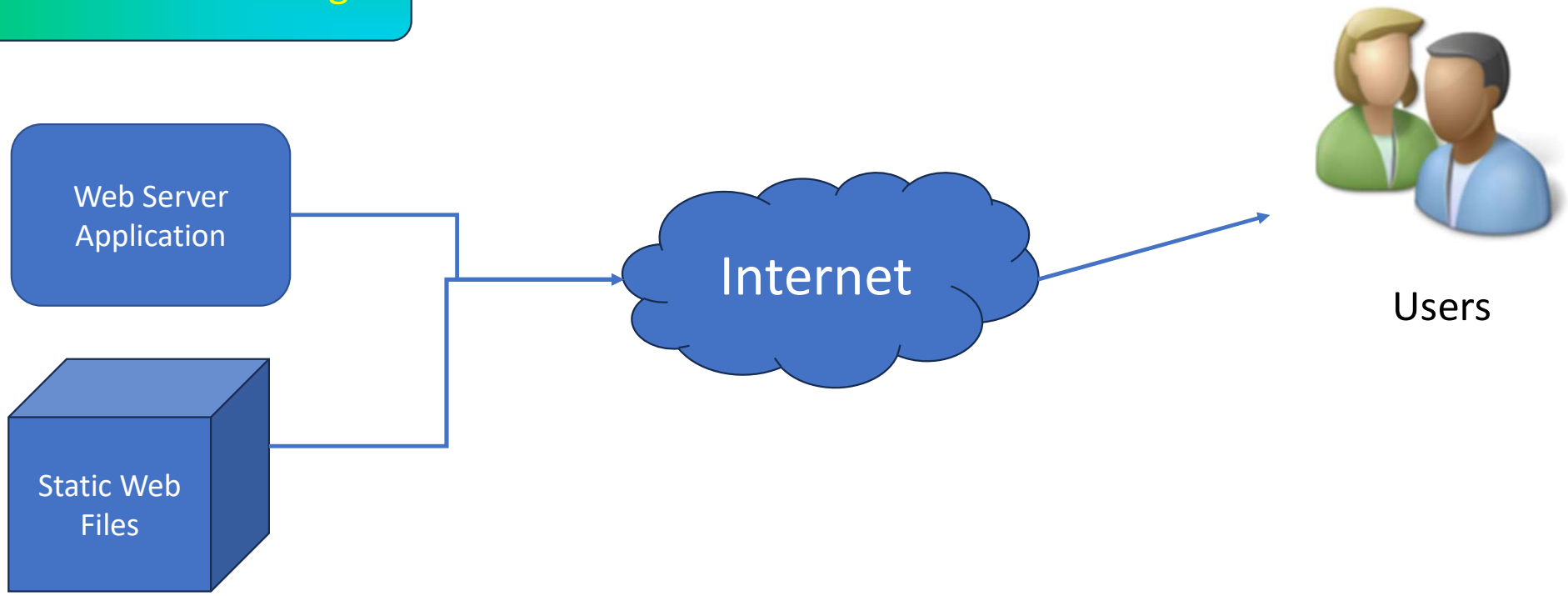
Index Table

Primary Key	Data
1	FirstName:Suzy;LastName:Q;DOB:4-3-1975
2	FirstName:Bob;LastName:Eubanks;DOB:2-3-1943
3	FirstName:Bob;LastName:Hope;DOB:12-19-1938
4	FirstName:Lucille;LastName:Ball;DOB:10-24-1939
5	FirstName:Estelle;LastName:Geddy;DOB:9-5-1947

LastName Key	Ref ID
Q	1
Eubanks	2
Hope	3
Ball	4
Geddy	5
Richardson	15
Jones	23
Williamson	34
Williamson	35

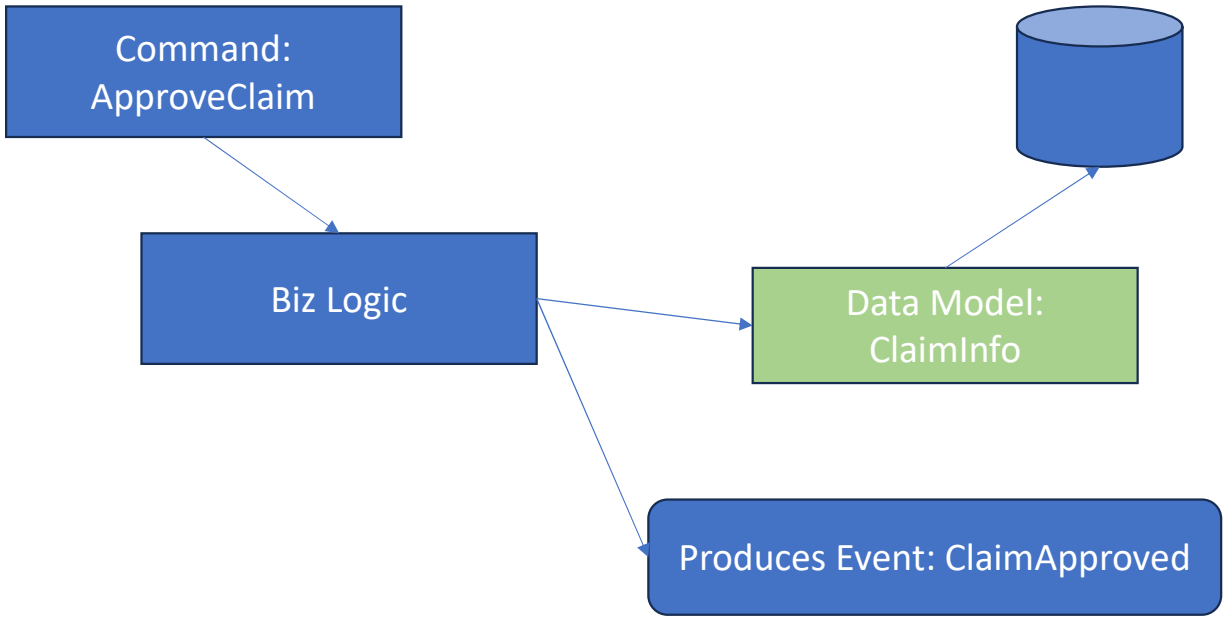
FirstName Key	Ref ID
Suzy	1
Bob	2
Bob	3
Lucille	4
Estelle	5
Mary	15

Static Content Hosting



Images, css, js, txt, PDF, doc, zip, …

Azure Storage Account, Azure CDN, Azure Front Door


Command:
ApproveClaim
Biz Logic
Data Model:
ClaimInfo
Produces Event: ClaimApproved

Event Sourcing

Event Sourcing

	A	B	C	D	E	F	G	H
1	**Checkbook Register**							© 2008 Vertex42 LLC
2	http://www.vertex42.com/ExcelTemplates/excel-checkbook.html							See instructions in the Help worksheet
3								
4	Date	Num	Payee/Transaction Description	Category	R	Withdrawal, Payment (-)	Deposit, Credit (+)	Balance
5	1/01/08		[Balance As of 01/01/2008]					546.00
6	1/01/08	DEP	Direct Deposit from Employer	Wages & Tips			1,000.00	1,546.00
7	1/10/08	EFT	Car Payment	Auto		115.20		1,430.80
8	1/15/08	2032	Joe's Food Mart	Groceries		87.34		1,343.46
9	1/18/08	TXFR	Transfer to Savings Account			100.00		1,243.46
10								
11								
12								
13								
14								
15								
16								
17								
18								

Event Sourcing

1/1/2023	5,000

Event Sourcing

1/1/2023	5,000
1/5/2023	100
1/5/2023	-50

Event Sourcing

1/1/2023	5,000
1/5/2023	100
1/5/2023	-50
1/15/2023	3,000

Event Sourcing

1/1/2023	5,000
1/5/2023	100
1/5/2023	-50
1/15/2023	3,000
1/16/2023	-2,400

Event Sourcing

1/1/2023	5,000
1/5/2023	100
1/5/2023	-50
1/15/2023	3,000
1/16/2023	-2,400
1/20/2023	-4,300

Event Sourcing

1/1/2023	5,000
1/5/2023	100
1/5/2023	-50
1/15/2023	3,000
1/16/2023	-2,400
1/20/2023	-4,300

Ending Balance?

Event Sourcing

1/1/2023	5,000
1/5/2023	100
1/5/2023	-50
1/15/2023	3,000
1/16/2023	-2,400
1/20/2023	-4,300

~~Ending Balance?~~ 1,350

Balance as of … ?

Getting a balance is relative to when you query the data.

Event Sourcing

```
{
   "Shopping Cart":{
      "Id":"SC-C123-202305301907-001",
      "CustomerId":"C123",
      "CustomerName":"Sean Whitesell",
      “Action”:”ItemAdded”,
      "Item":{
            "ItemId":"CoffeeXYZ-12345",
            "Description":"100 ct K-cup coffee",
            "Price":"24.99"
         }
   }
}
```

*Immutable Record

Event Sourcing

```
{
   "Shopping Cart":{
      "Id":"SC-C123-202305301907-001",
      "CustomerId":"C123",
      "CustomerName":"Sean Whitesell",
      “Action”:”ItemAdded”,
      "Item":{
            "ItemId":“CoffeeXYZ-StirStraw123",
            "Description":"100 ct coffee stirring straws",
            "Price":“5.49"
         }
   }
}
```

Event Sourcing

```
{
   "Shopping Cart":{
      "Id":"SC-C123-202305301907-001",
      "CustomerId":"C123",
      "CustomerName":"Sean Whitesell",
      "Items":[{
            "ItemId":"CoffeeXYZ-12345",
            "Description":"100 ct K-cup coffee",
            "Price":"24.99"
         },
         {
            "ItemId":“CoffeeXYZ-StirStraw123",
            "Description":"100 ct coffee stirring straws",
            "Price":“5.49"
         } ]
   }
}
```

View Cart

1. Add item Coffee
2. Add item Stir Straws

Event Sourcing


```
{
   "Shopping Cart":{
      "Id":"SC-C123-202305301907-001",
      "CustomerId":"C123",
      "CustomerName":"Sean Whitesell",
      “Action”:”ItemRemoved”,
      "Item":{
            "ItemId":“CoffeeXYZ-StirStraw123",
            "Description":"100 ct coffee stirring straws",
            "Price":“5.49"
         }
   }
}
```

Event Sourcing


```
{
   "Shopping Cart":{
      "Id":"SC-C123-202305301907-001",
      "CustomerId":"C123",
      "CustomerName":"Sean Whitesell",
      "Items":[{
            "ItemId":"CoffeeXYZ-12345",
            "Description":"100 ct K-cup coffee",
            "Price":"24.99"
         }]
   }
}
```


View Cart

1. Add item Coffee
2. Add item Stir Straws
3. Remove item Stir Straws

Event Sourcing

```
{
   "Shopping Cart":{
      "Id":"SC-C123-202305301907-001",
      "CustomerId":"C123",
      "CustomerName":"Sean Whitesell",
      “Action”:”ItemAdded”,
      "Item":{
            "ItemId":“CoffeeABC-StirStraw123",
            "Description":“200 ct coffee stirring straws",
            "Price":“6.49"
         }
   }
}
```

Event Sourcing

```
{
   "Shopping Cart":{
      "Id":"SC-C123-202305301907-001",
      "CustomerId":"C123",
      "CustomerName":"Sean Whitesell",
      "Items":[{
            "ItemId":"CoffeeXYZ-12345",
            "Description":"100 ct K-cup coffee",
            "Price":"24.99"
         },
         {
            "ItemId":“CoffeeABC-StirStraw123",
            "Description":“200 ct coffee stirring straws",
            "Price":“6.49"
         }]
   }
}
```

View Cart

1. Add item Coffee
2. Add item Stir Straws
3. Remove item Stir Straws
4. Add item Stir Straws

Event Sourcing

Forecasted and Actual Temperature Data

Time	Forecasted	Actual
6:00:00	76	77
7:00:00	76	75
8:00:00	65	62
9:00:00	60	56

Event Sourcing

Analytics!

Forecasted and Actual Temperature Data

Time	Forecasted	Actual	Variation
6:00:00	76	77	1
7:00:00	76	75	-1
8:00:00	65	62	-3
9:00:00	60	56	-4

Event Sourcing

When to consider using Event Sourcing?

Event Sourcing

When to consider using Event Sourcing?

*not exhaustive list

Event Sourcing

Key point about Event Sourcing.

Event Sourcing

Key point about Event Sourcing.

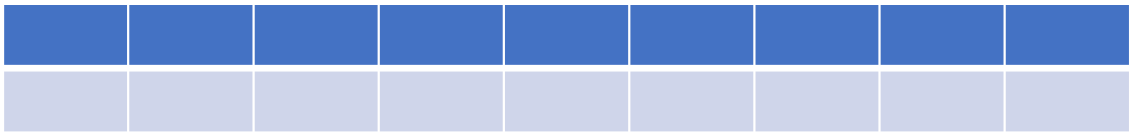
Use when you need to replay the change events as the “source of truth.”

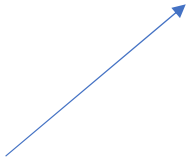
Event Sourcing

Scenario

Event Sourcing

Scenario

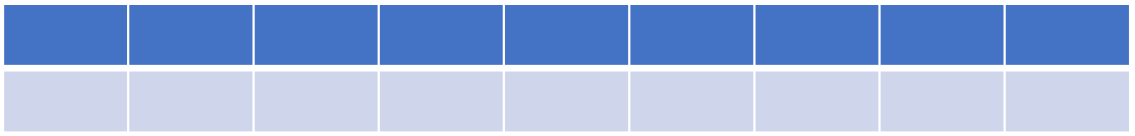




Current State

Event Sourcing

Scenario

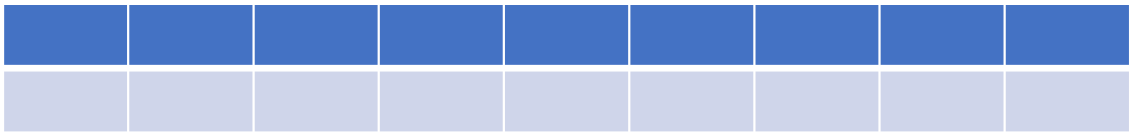


Current State

Change Log

Event Sourcing

Which one is the source of truth?



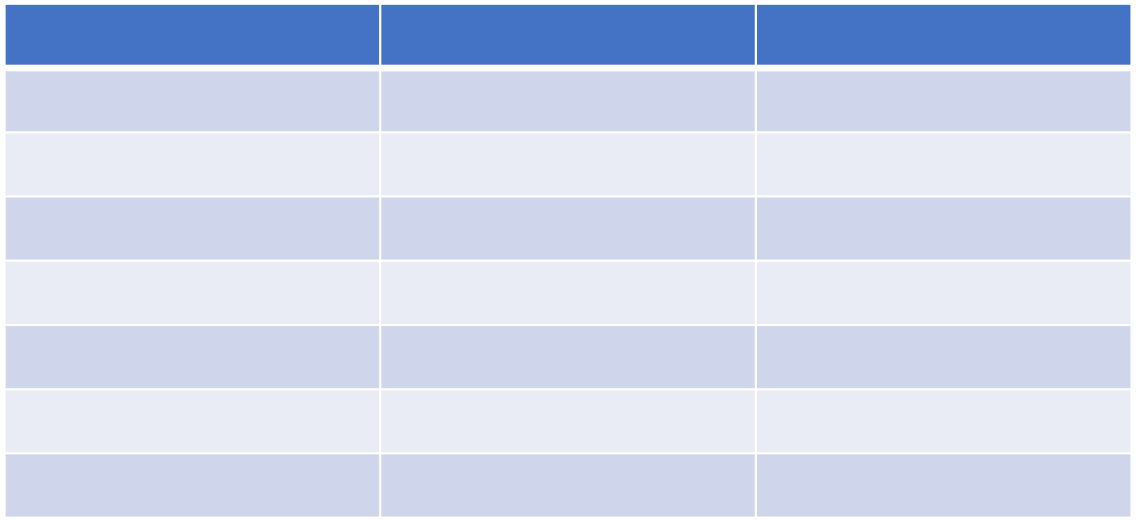
Current State

Change Log

Event Sourcing

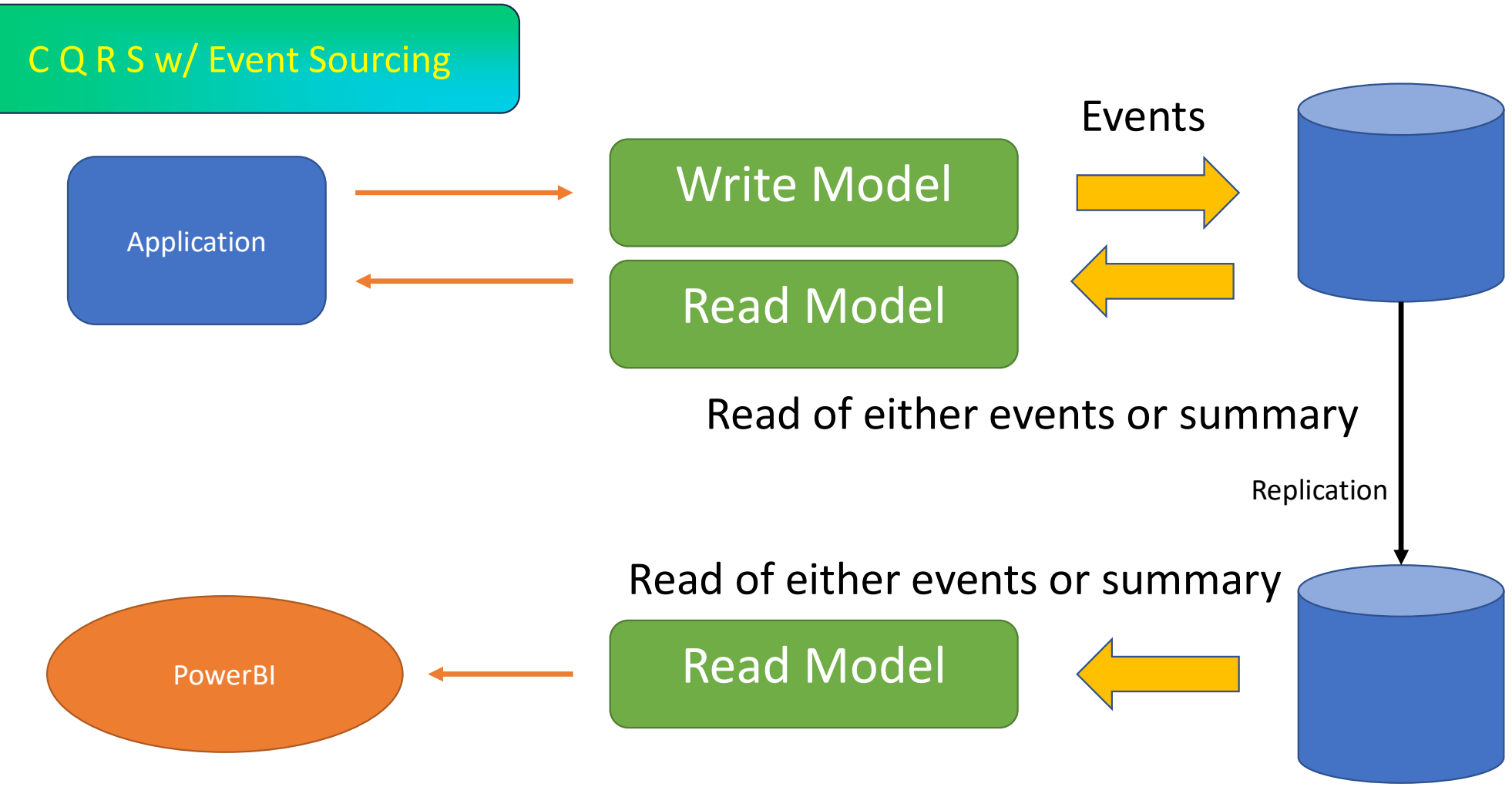
Event Sourcing is having a change log *AS* the source of truth.

Change Log



Events of data changes

CQRS + Event Sourcing


C Q R S w/ Event Sourcing
Application
Write Model
Read Model
Events
Read of either events or summary
Replication
Read of either events or summary
PowerBI
Read Model

Data Security

Data Residency
Deletion
Ownership
Access
Encryption

Data Security

1. **At Rest vs In Transit**

Data that is stored on disk either spinning hard drive or solid-state is considered "*at rest*".

Data in the network to or from a data store or between applications like microservices is considered "*in transit*".

SSL connections is one way of encrypting data in transit between a source and destination.

Data Security

1. At Rest vs In Transit
2. **Key Management**

Data encrypted at rest uses an encryption key.

Most cloud providers do not allow you access to this key. Instead, they offer you a “customer managed key”. This CMK is a “*key encrypting key*.” It is used to encrypt the key that is used for encrypting the data at rest.

Data Security

1. At Rest vs In Transit
2. Key Management
3. **Access and Authorization**

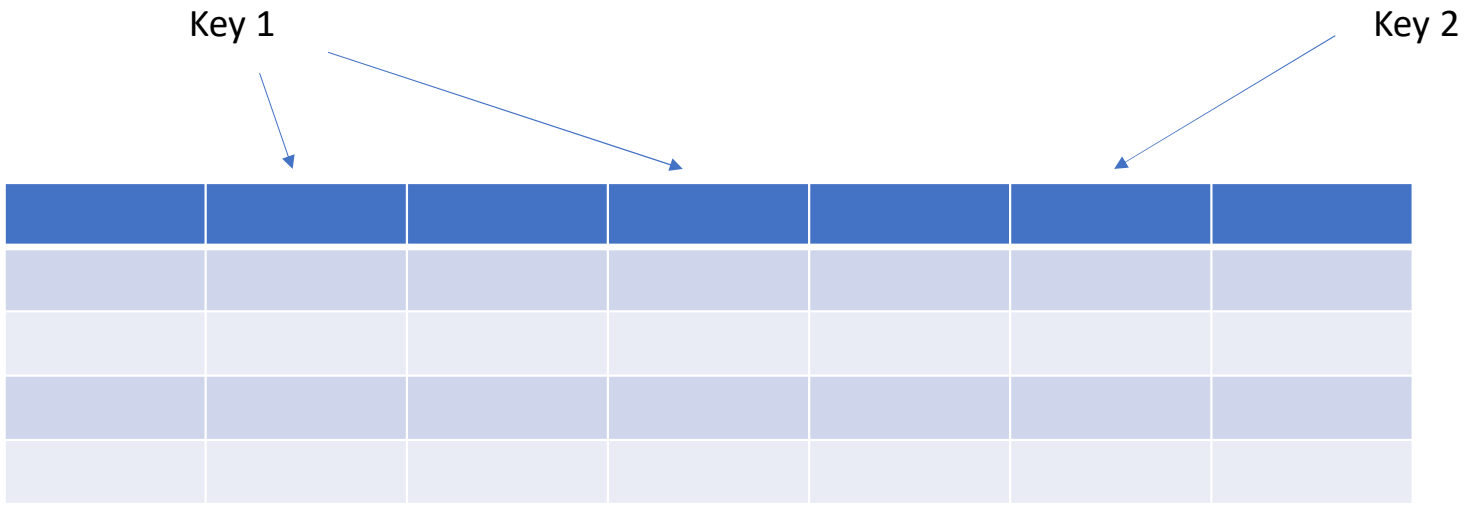
Some databases, like SQL Server, offer **Row-Level Security**.

This Row-Level Security allows for control of who has access to see any data at a row-by-row level.

Data Security

1. At Rest vs In Transit
2. Key Management
3. Access and Authorization
4. **Columnar Encryption**

Some databases, like SQL Server, offer **Transparent Data Encryption**. This uses a predefined key you set up for how the data in specified columns are encrypted.



Data Security

1. At Rest vs In Transit
2. Key Management
3. Access and Authorization
4. Columnar Encryption
5. **Compliance**

Data residency laws are becoming more prominent.

GDPR - General Data Protection Regulation
CCPA - California Consumer Privacy Act
PII – Personally Identifiable Information

Questions?

Recap how the patterns HELP address the pain points that were listed.

Um, what did we cover?

- Common architectures that can grow to have a variety of pain points.
- Discussed areas of possible data contention issues on shared code and data schemas.
- Saw that additional applications like PowerBI can require reading so much data it can impact ability to write data.
- Data store vs database.
- Patterns like CQS, CQRS, Event Sourcing, and Materialized Views
- Finally, data security

CQRS - https://learn.microsoft.com/en-us/azure/architecture/patterns/cqrs
Event Sourcing - https://learn.microsoft.com/en-us/azure/architecture/patterns/event-sourcing
Materialized View - https://learn.microsoft.com/en-us/azure/architecture/patterns/materialized-view

github: seanw122/presentations

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