
Data Patterns
for Successful Applications

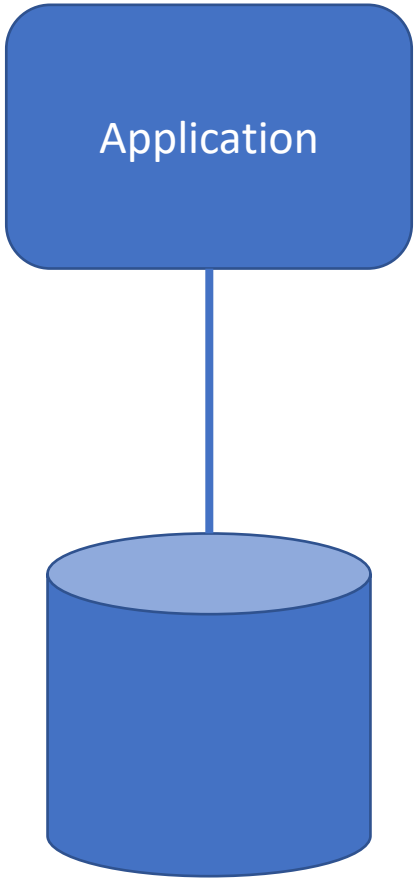
Sean Whitesell

So, what we going to do?

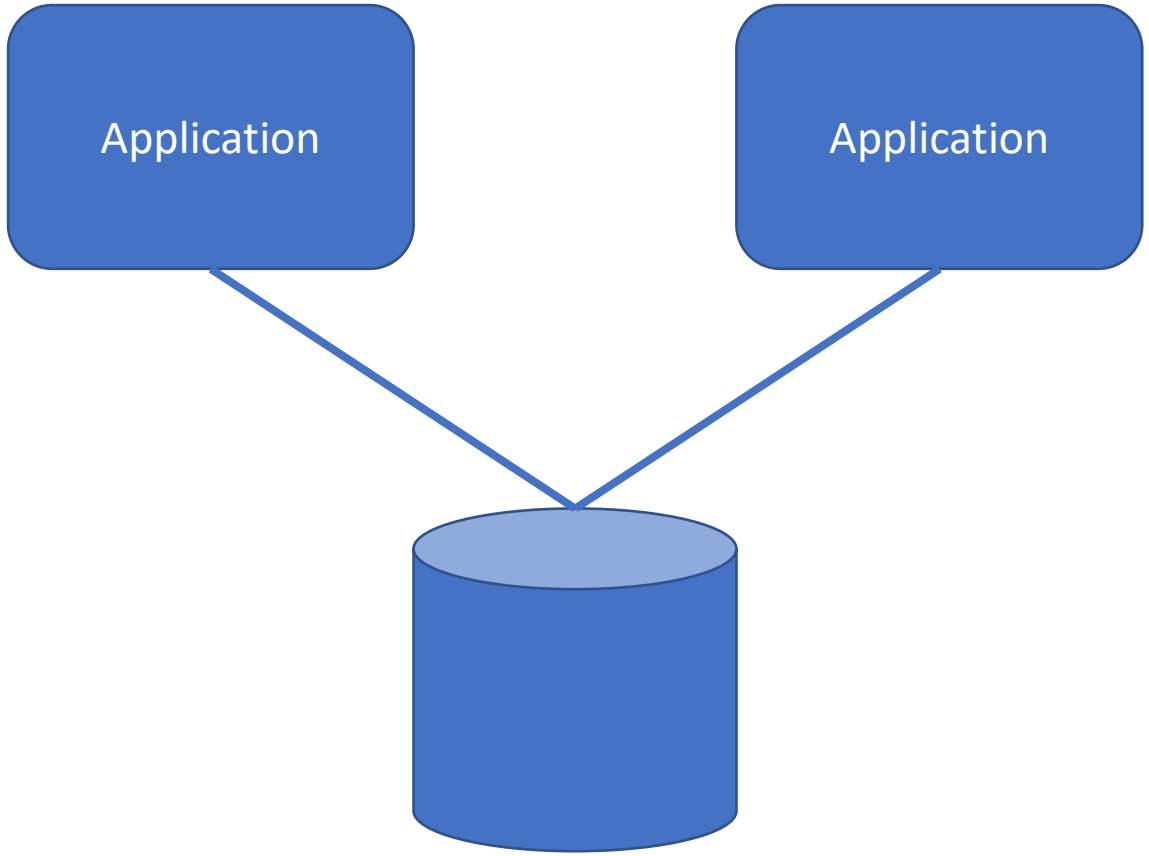
Agenda:

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

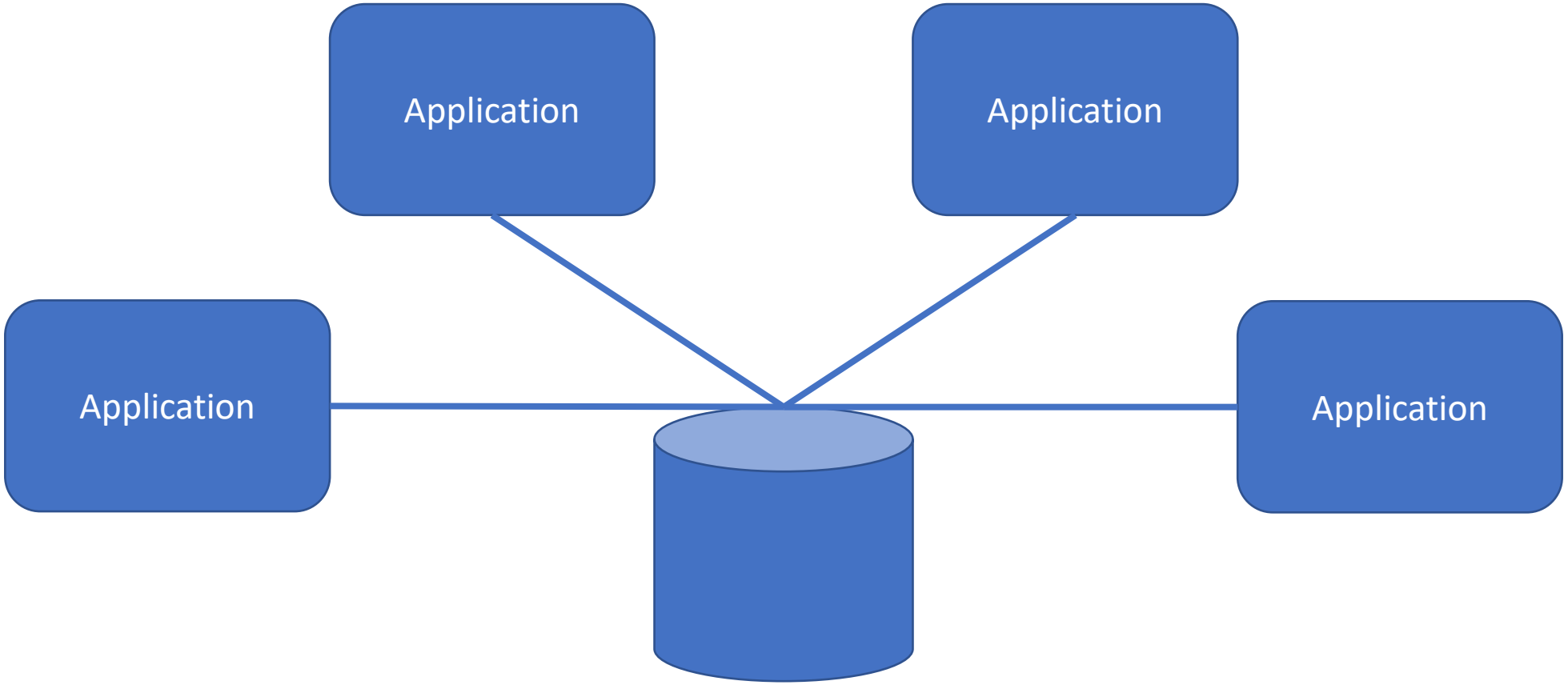
Common Architecture



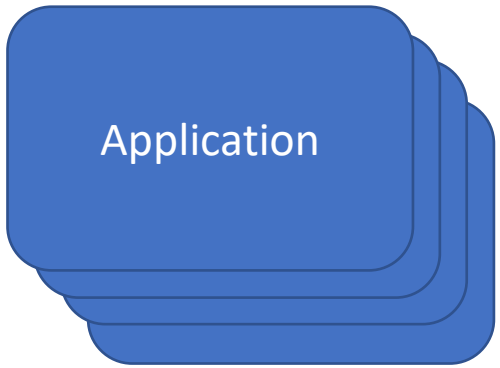
Common Architecture

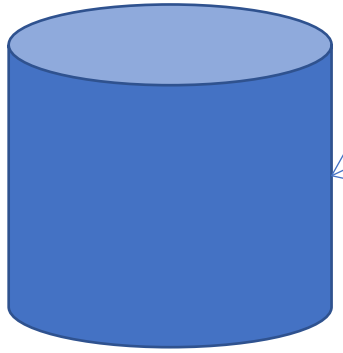


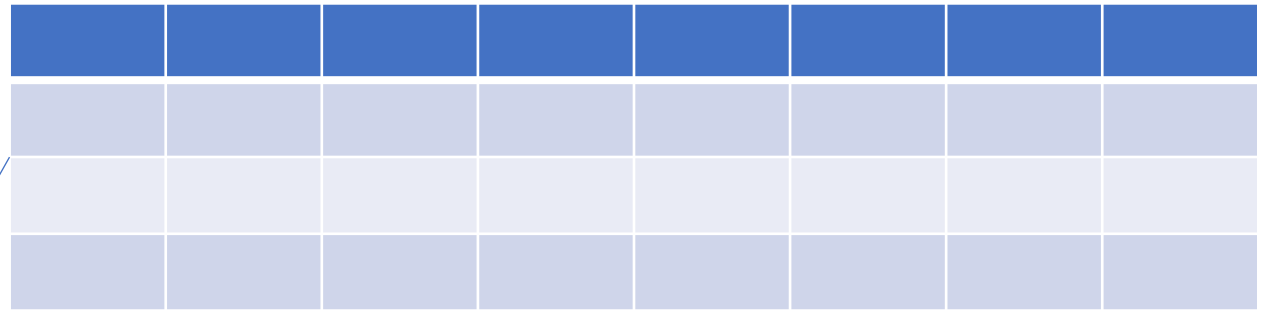
Common Architecture

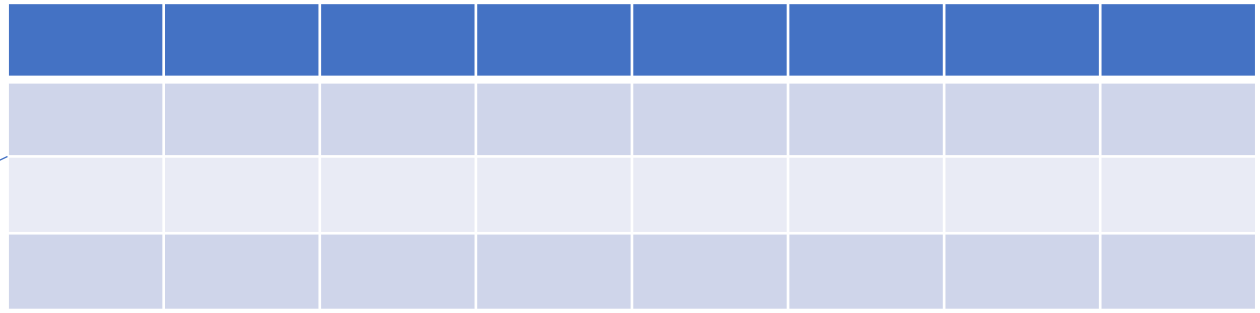


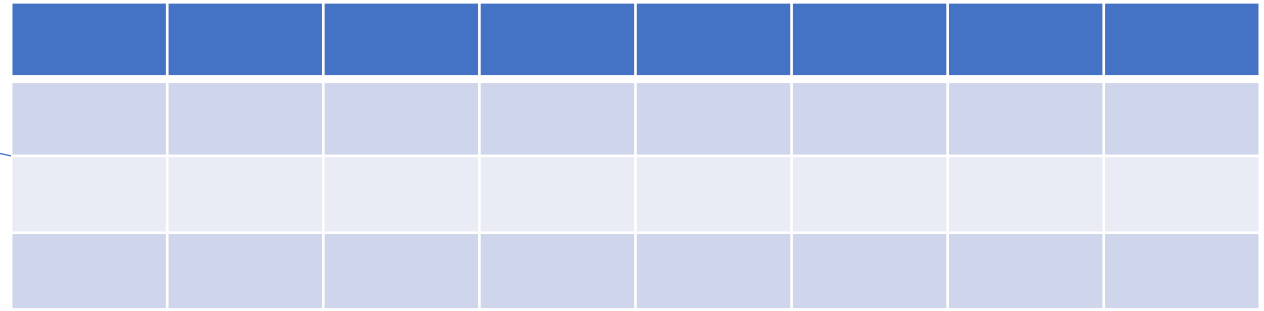
Common Architecture











Common Architecture

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

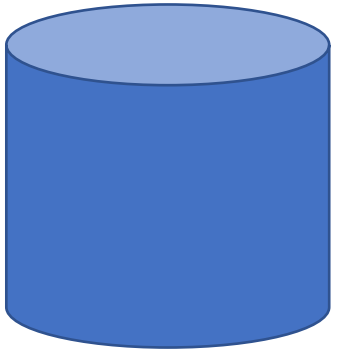
Common Architecture

Application

```
public class InsuranceClaim
{
    public void CreateInsuranceClaim( ClaimInfo information )

    public ClaimInfo GetInsuranceClaimInfoById( int id )
}

public class ClaimInfo
{
}
```



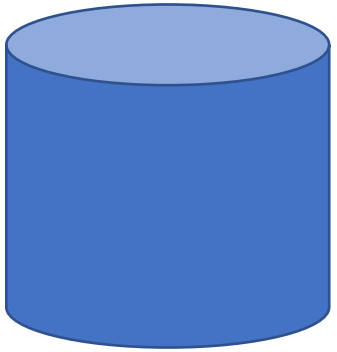
Common Architecture

Application

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

    public ClaimInfo GetInsuranceClaimInfoById( int id )
}

public class ClaimInfo
{
}
```



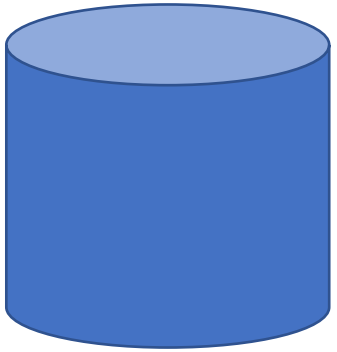
Common Architecture

Application

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

    public ClaimInfo GetInsuranceClaimInfoById( int id )
}

public class ClaimInfo
{
}
```

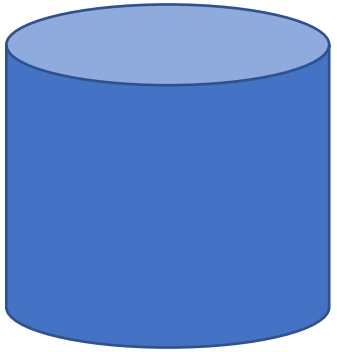


Common Architecture

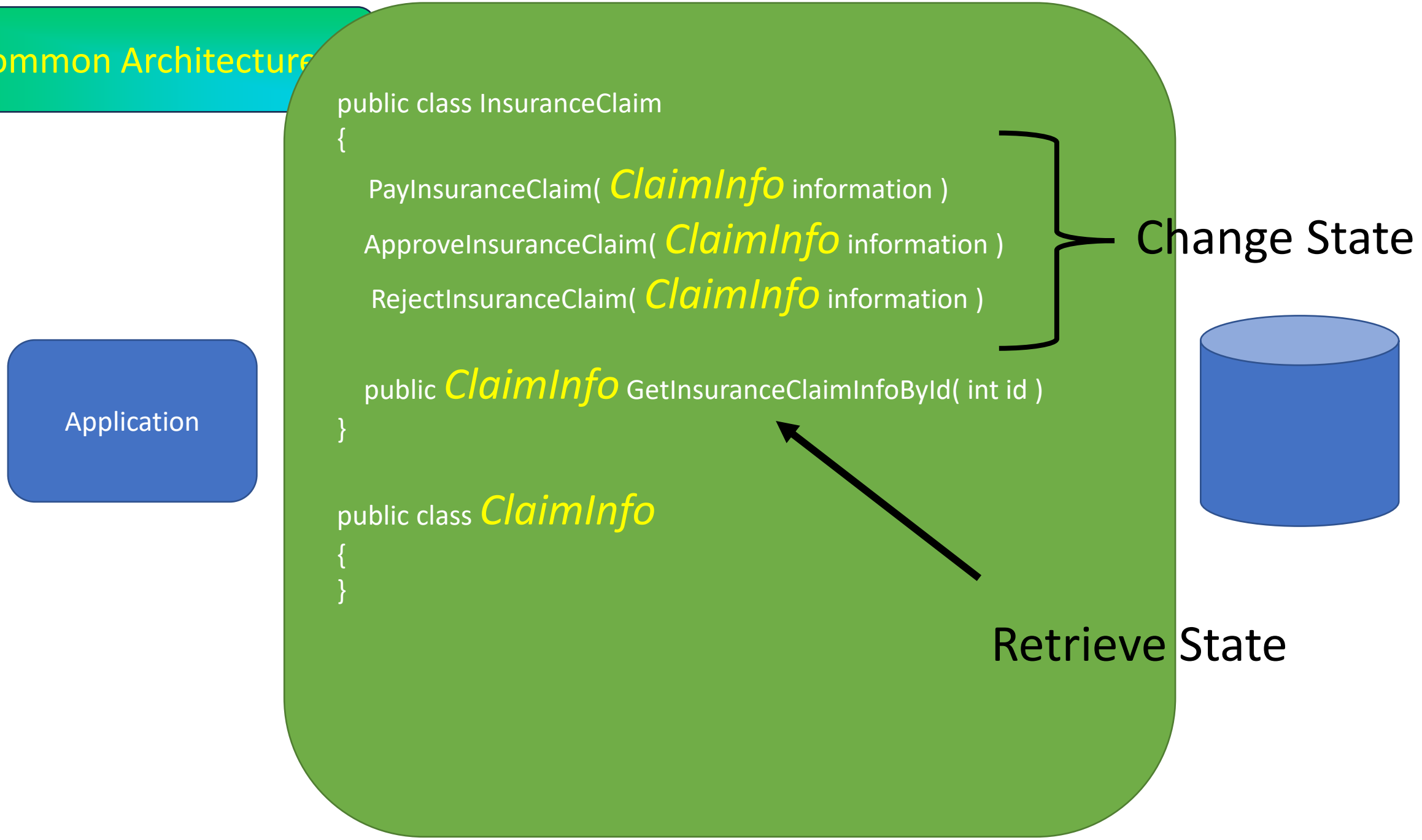
Application

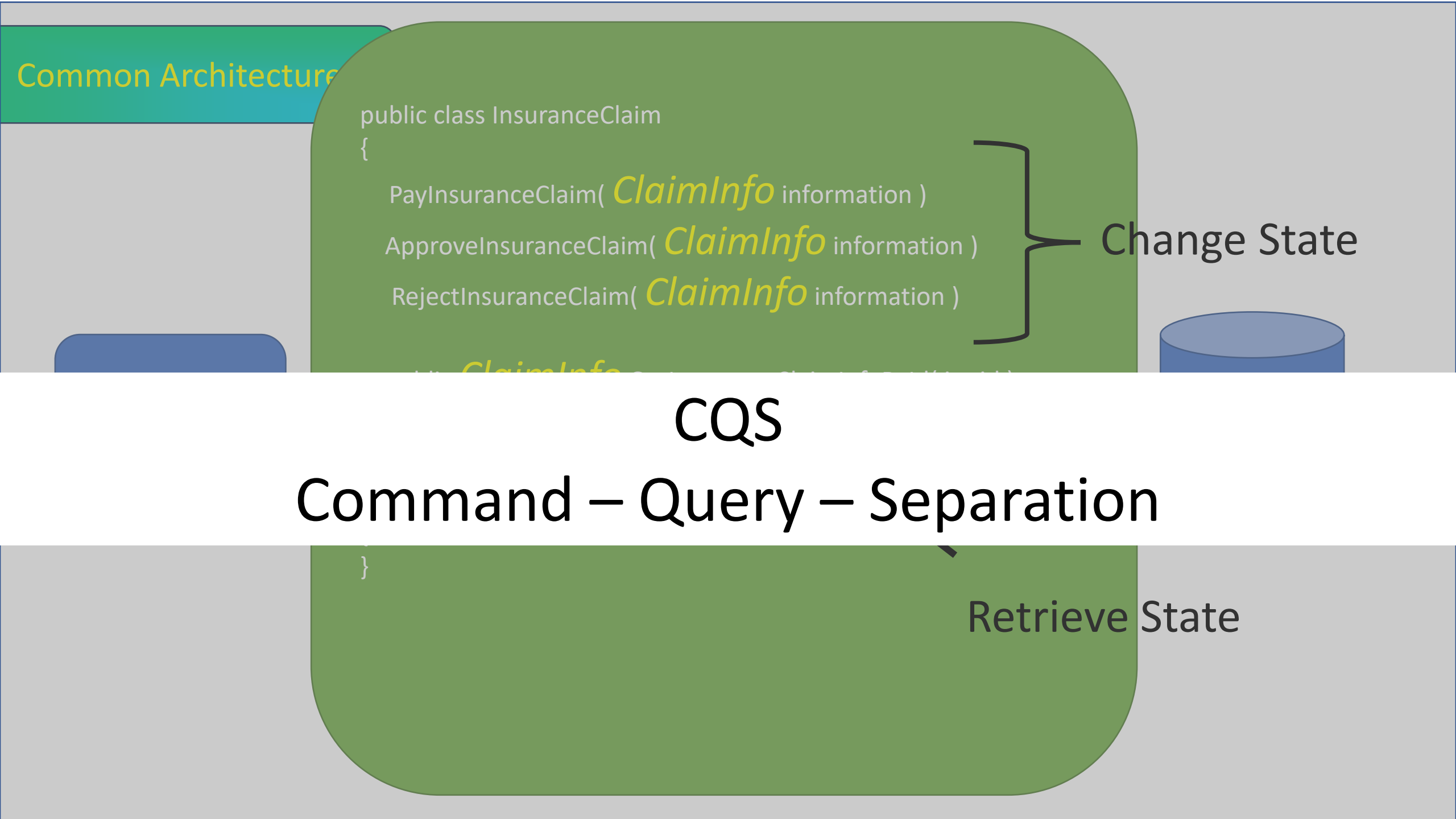
ClaimInfo

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



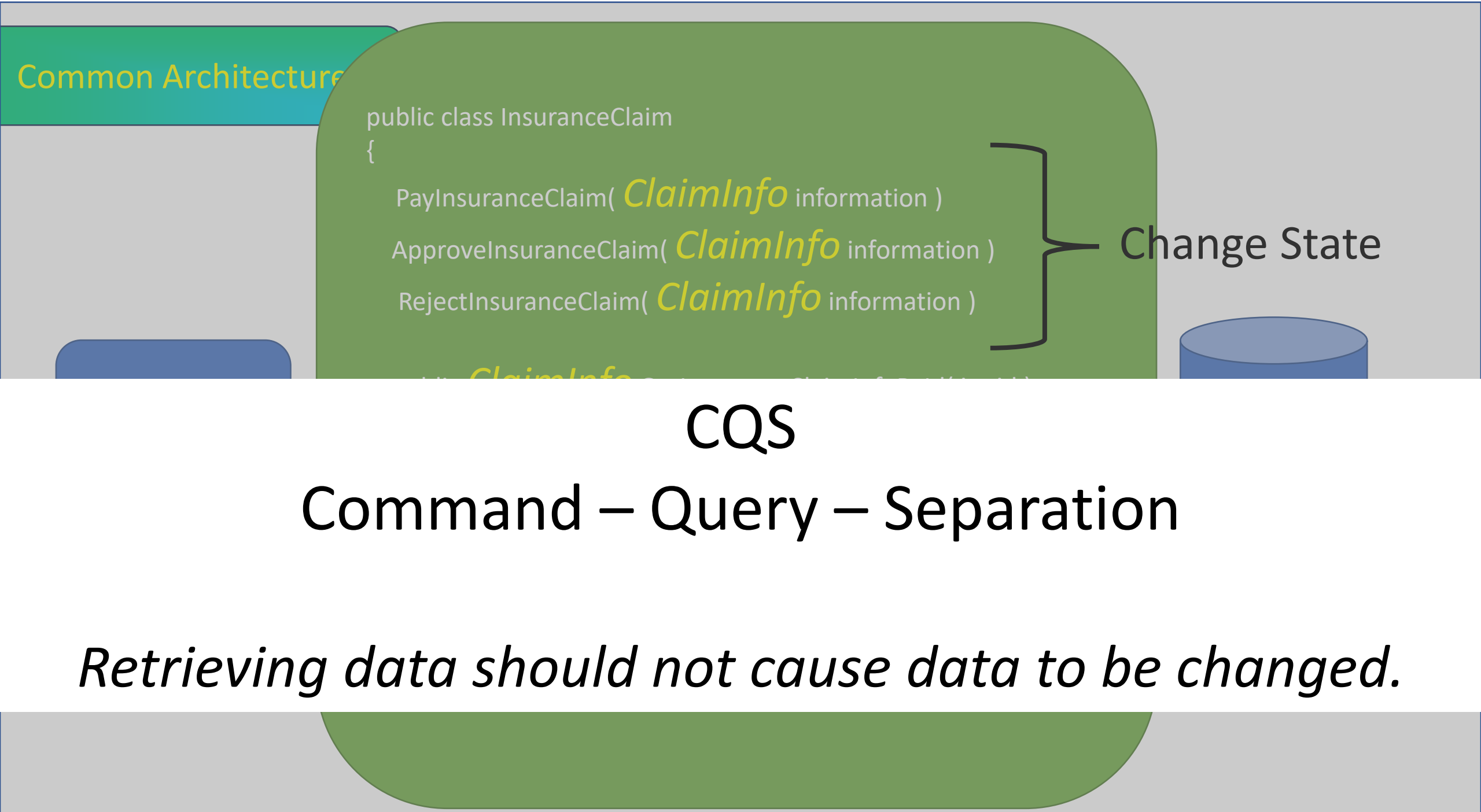
Common Architecture





CQS

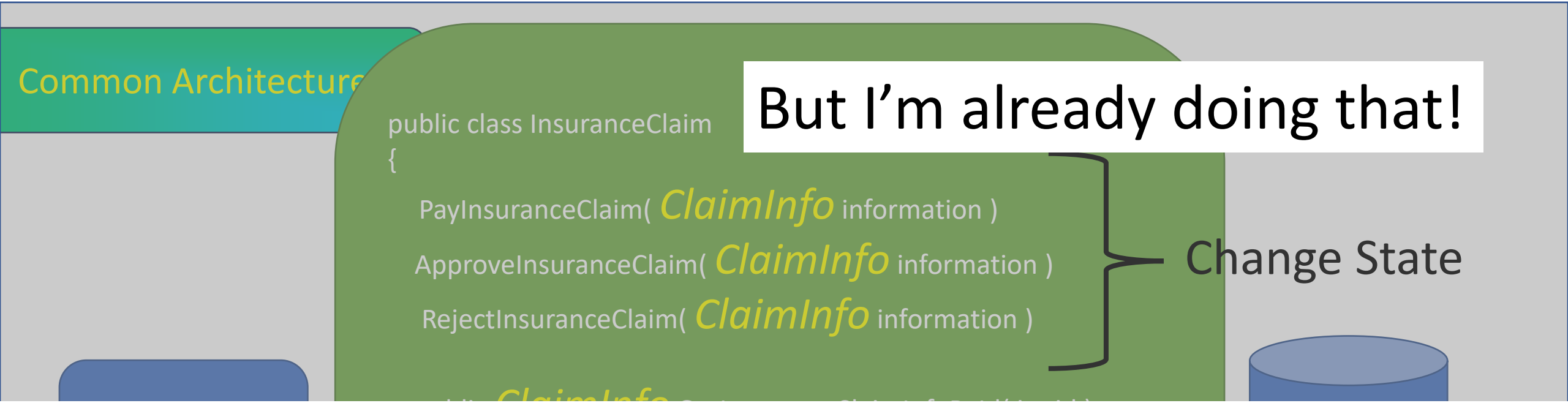
Command – Query – Separation



CQS

Command – Query – Separation

Retrieving data should not cause data to be changed.

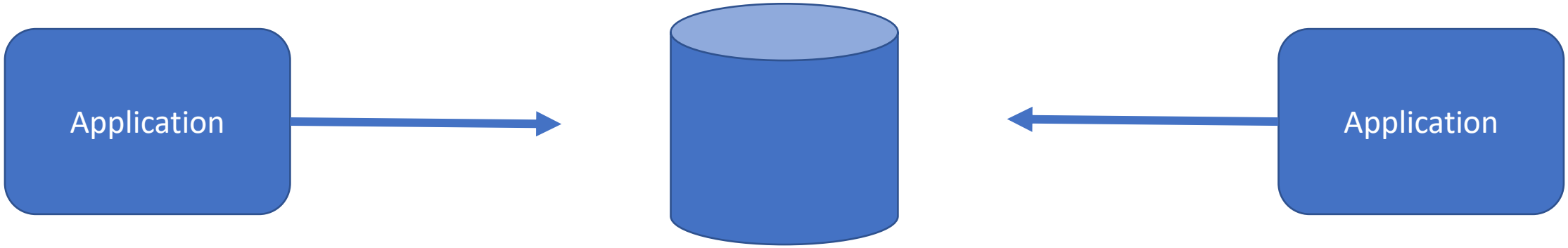


CQS

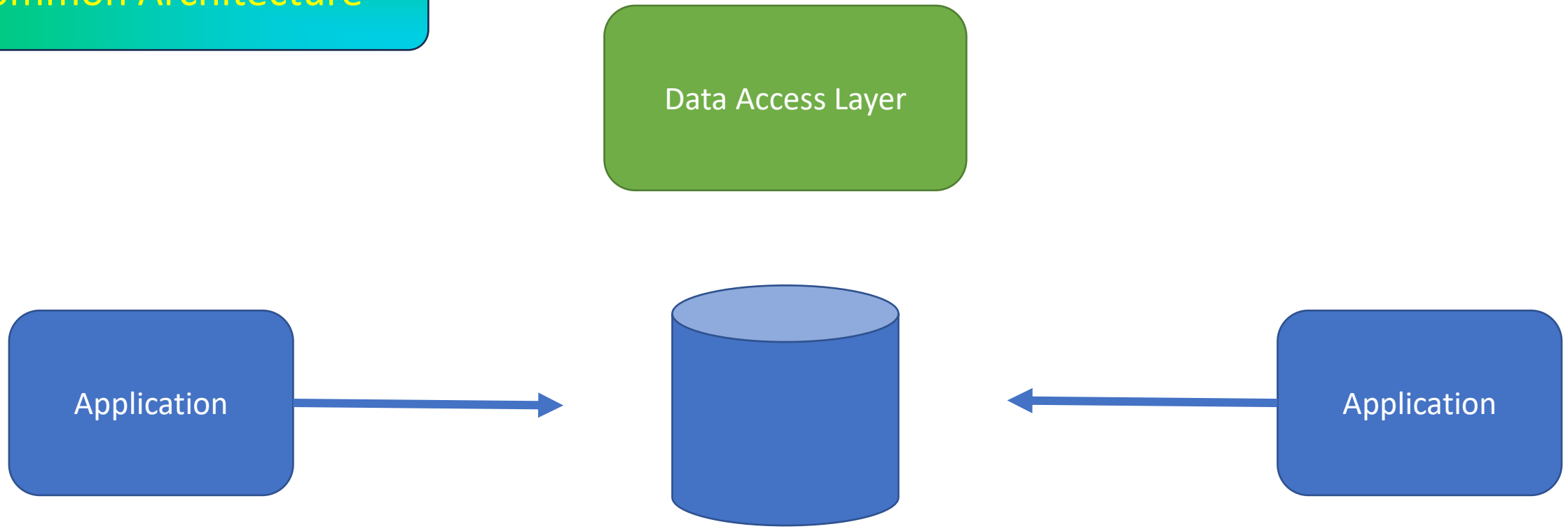
Command – Query – Separation

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

Application

Application

1. Code change contention

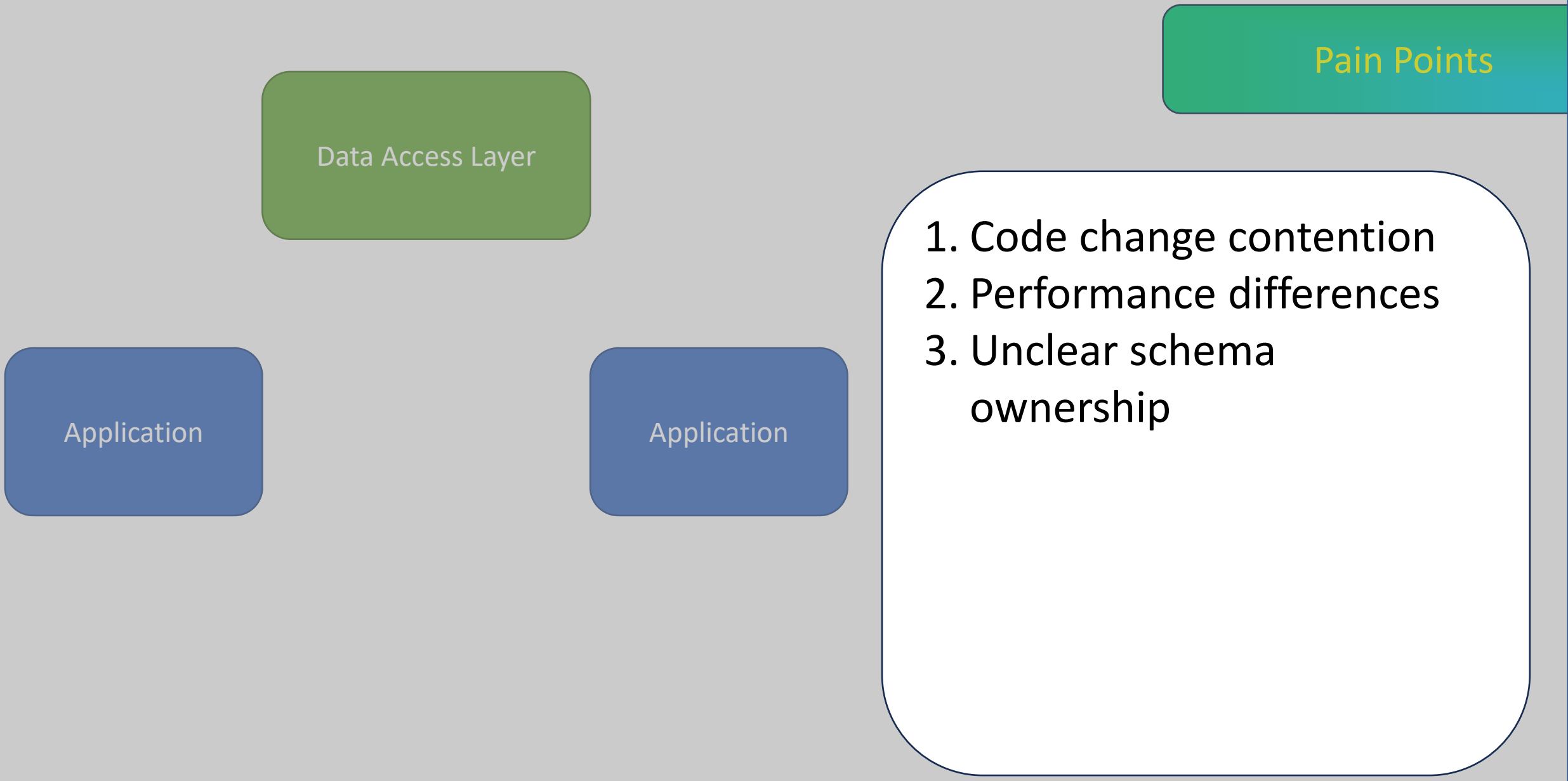
Data Access Layer

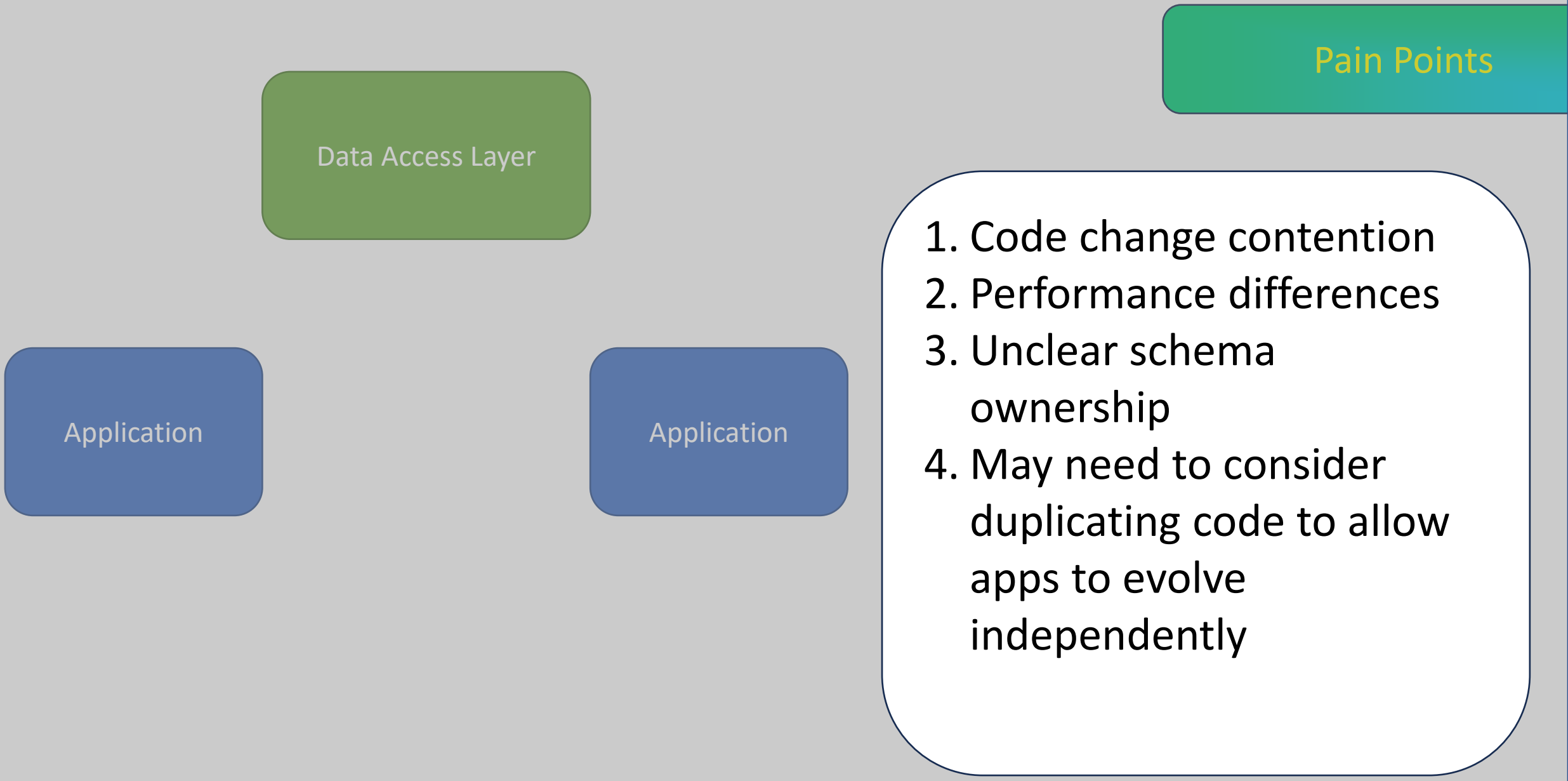
Application

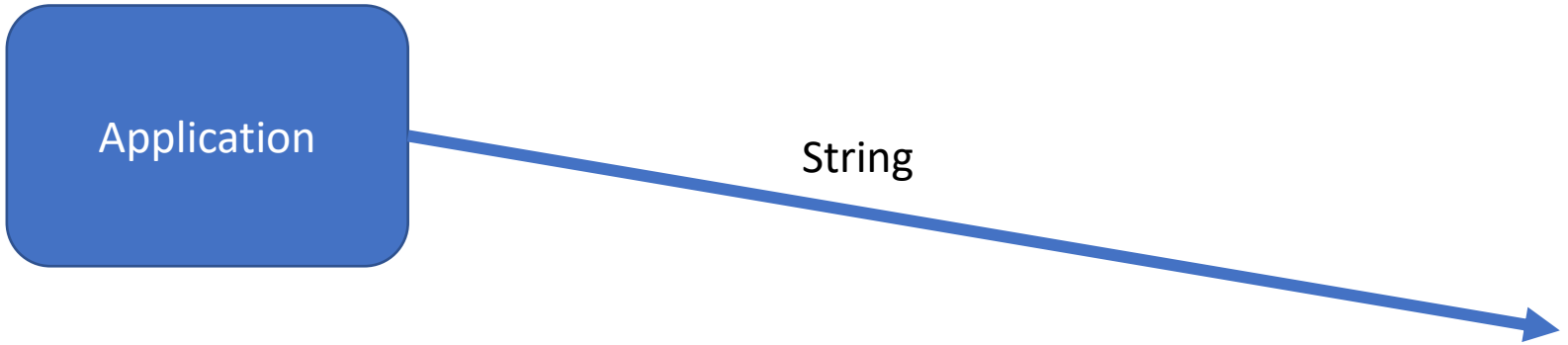
Application

Pain Points

1. Code change contention
2. Performance differences


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


Pain Points
Data Access Layer
Application
Application
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

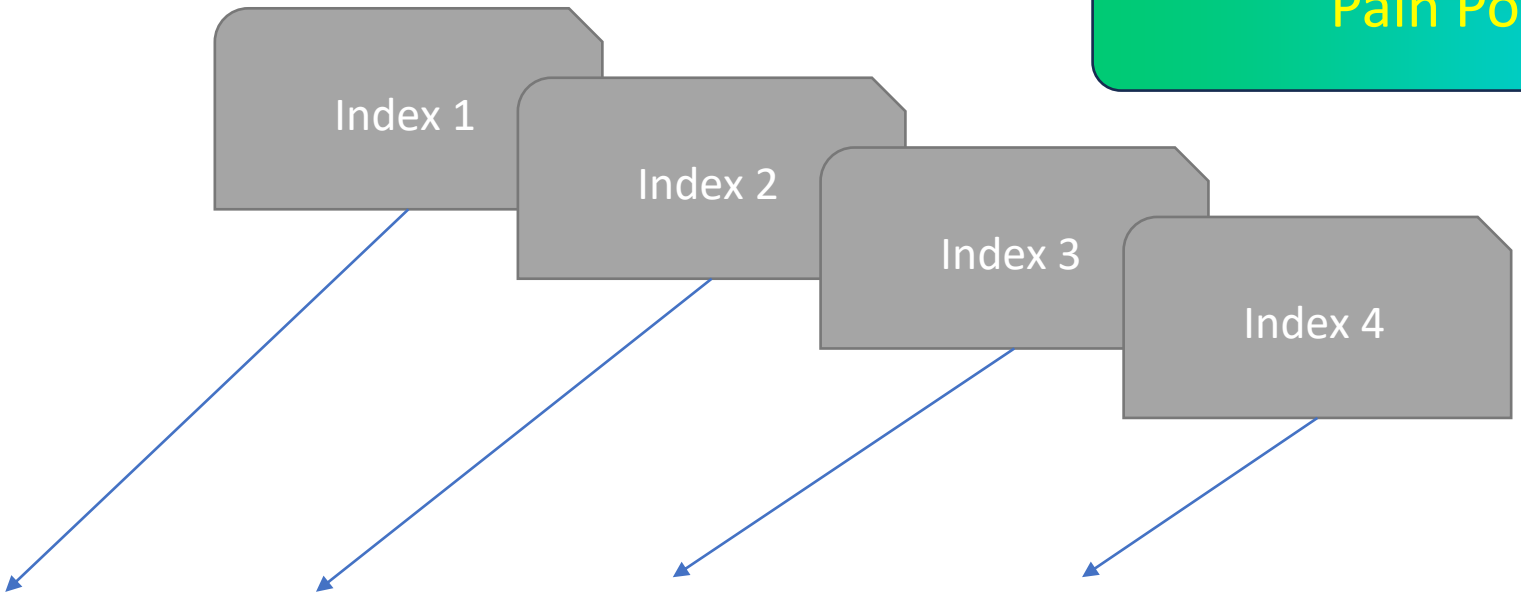
							ProcessingCode

Integer

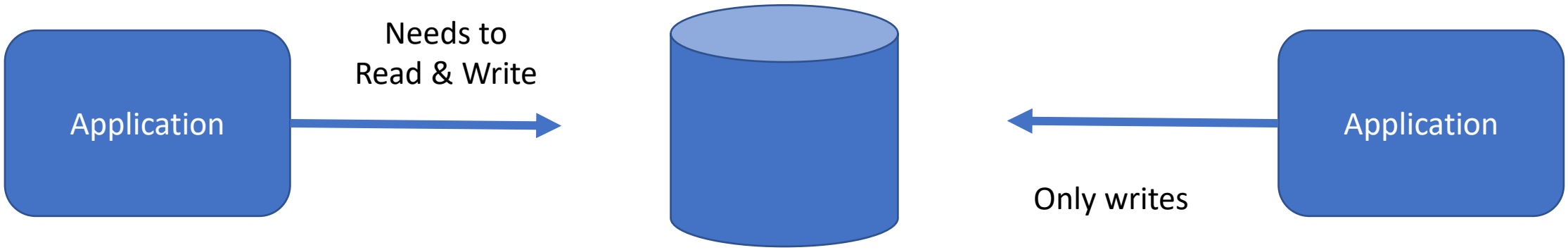
Application

Application

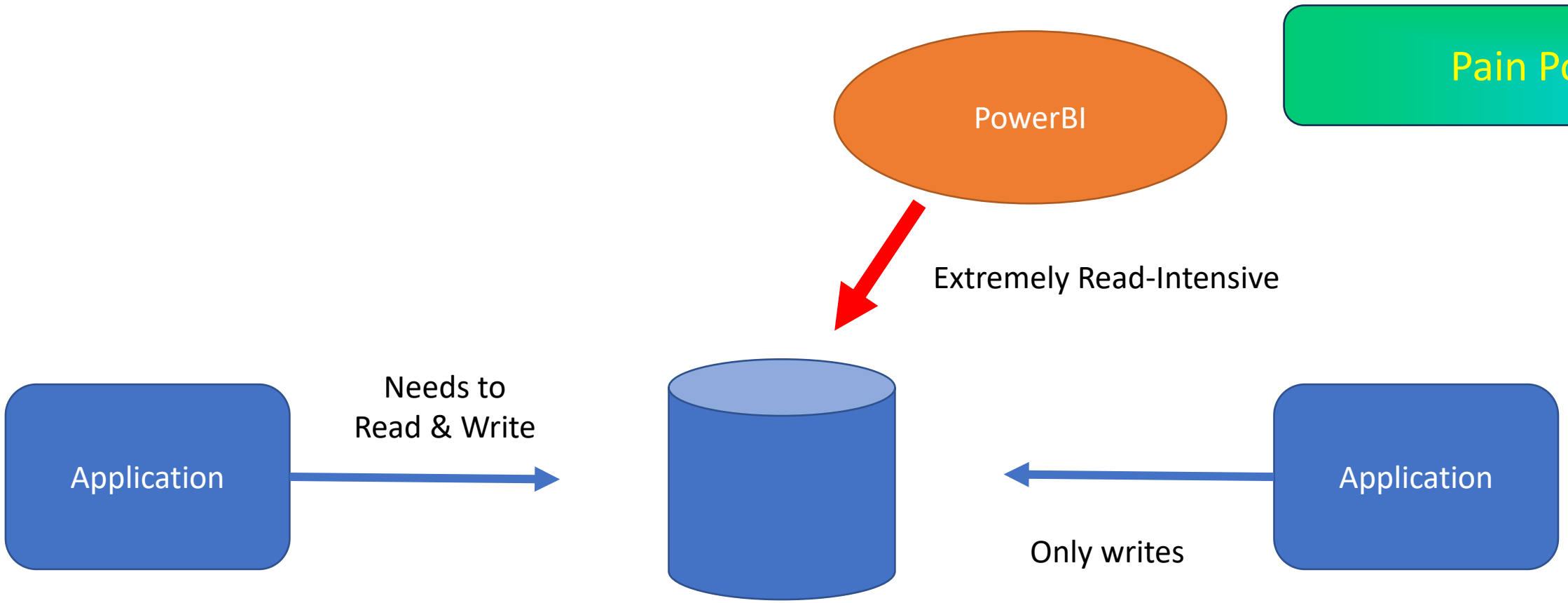
Pain Points



Pain Points



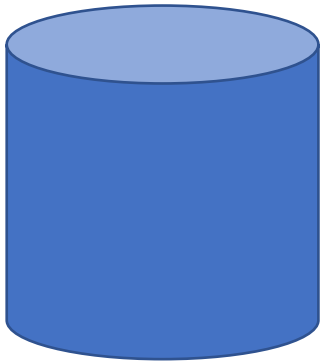
Pain Points


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

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

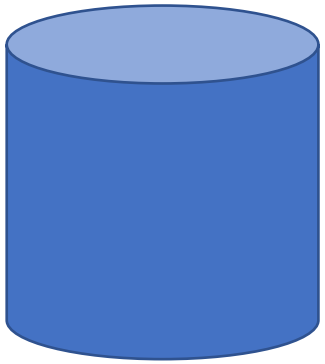
A database is a data store. But a data store is not necessarily a database.

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 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.

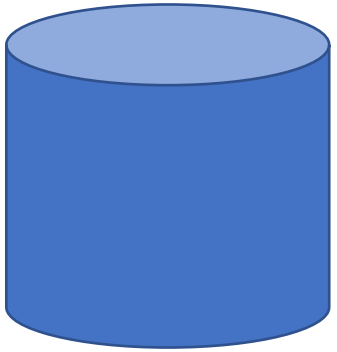
A data store could be a database but could also be a File, Excel File, Azure File Share, Azure Table Storage, Azure Blob Account, AWS S3 Bucket, …….

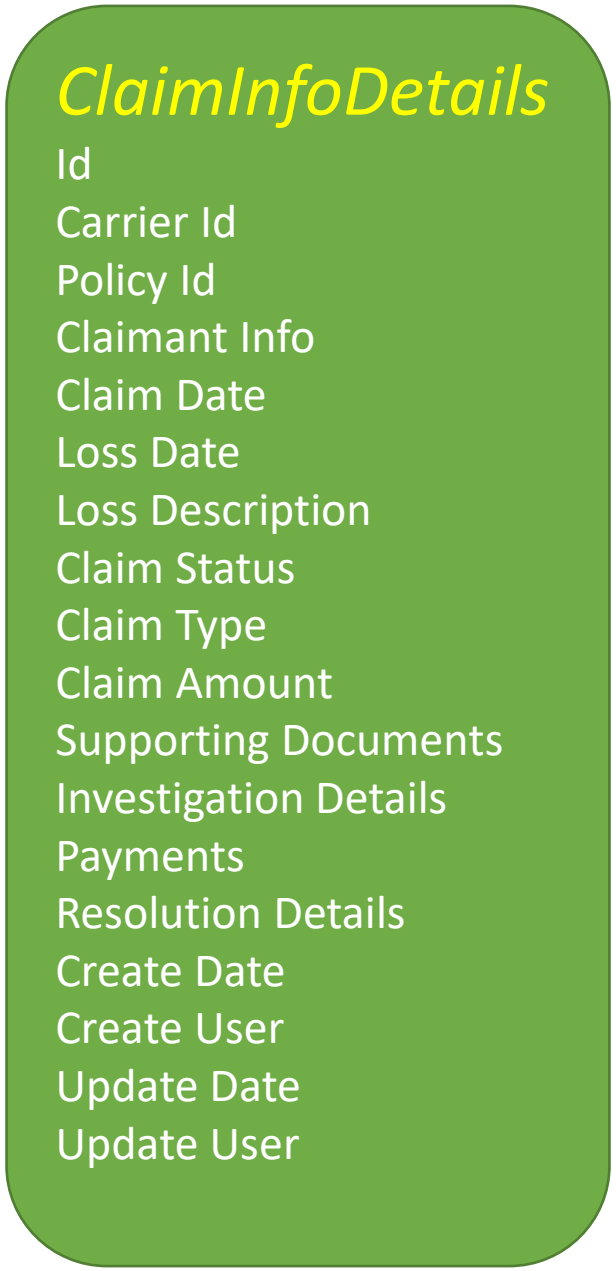
Common Architecture

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

NewClaimInfo

Id
Carrier Id
Policy Id
Claimant Info
Claim Date
Loss Date
Loss Description
Claim Status
Create Date
Create User

AddClaimInfoDocs

Id
Policy Id
Supporting Documents
Create Date
Create User

AmendClaimInvestigationDetail

Claim Id
Investigation Id
Investigation Detail

Payment Detail
Payment Amount
Create Date
Create User

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

ClaimSupportDocs

Id
Carrier Id
Policy Id
Supporting Documents

ClaimStatusHistory

Id
Policy Id
Claim Status

ClaimAppliedPmts

Policy Id
Payment Details
Payment Amount

ClaimResolutionDetails

Id

ClaimInvestigationDetails

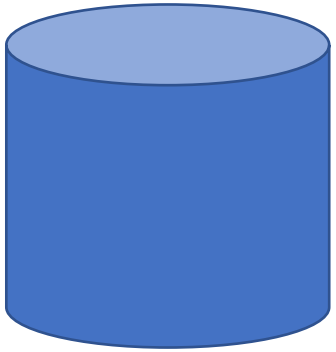
Id
Policy Id
Investigation Details

Read Models

Write Models

Changes data

Application



Does ***not*** change data

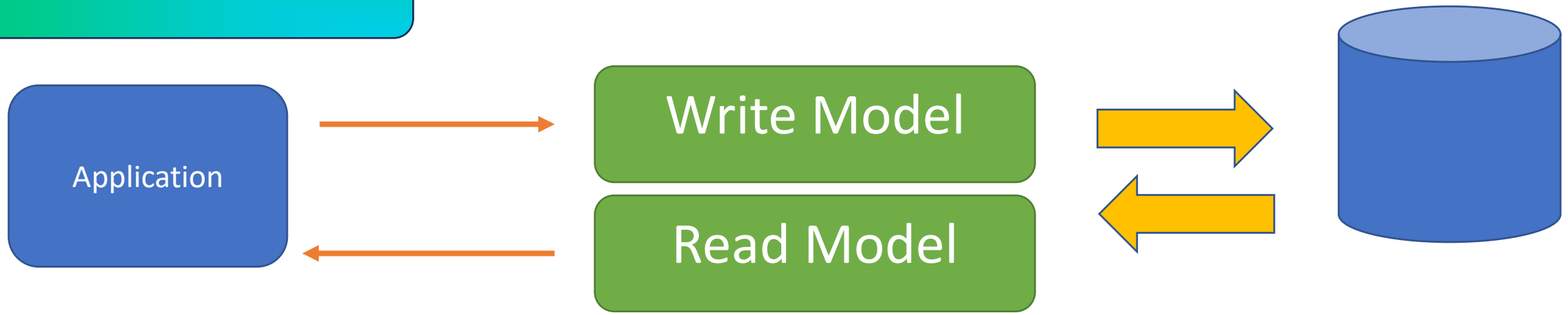
Read Models

CQRS

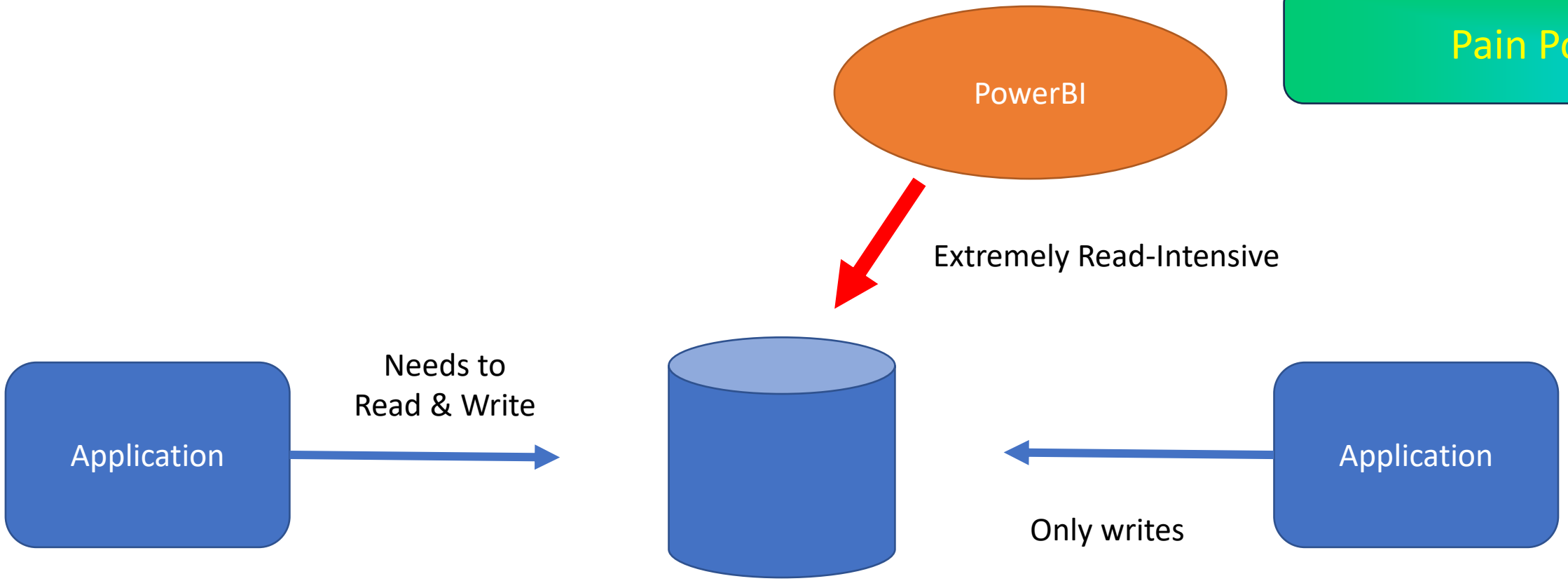
Command – Query – Responsibility - Segregation

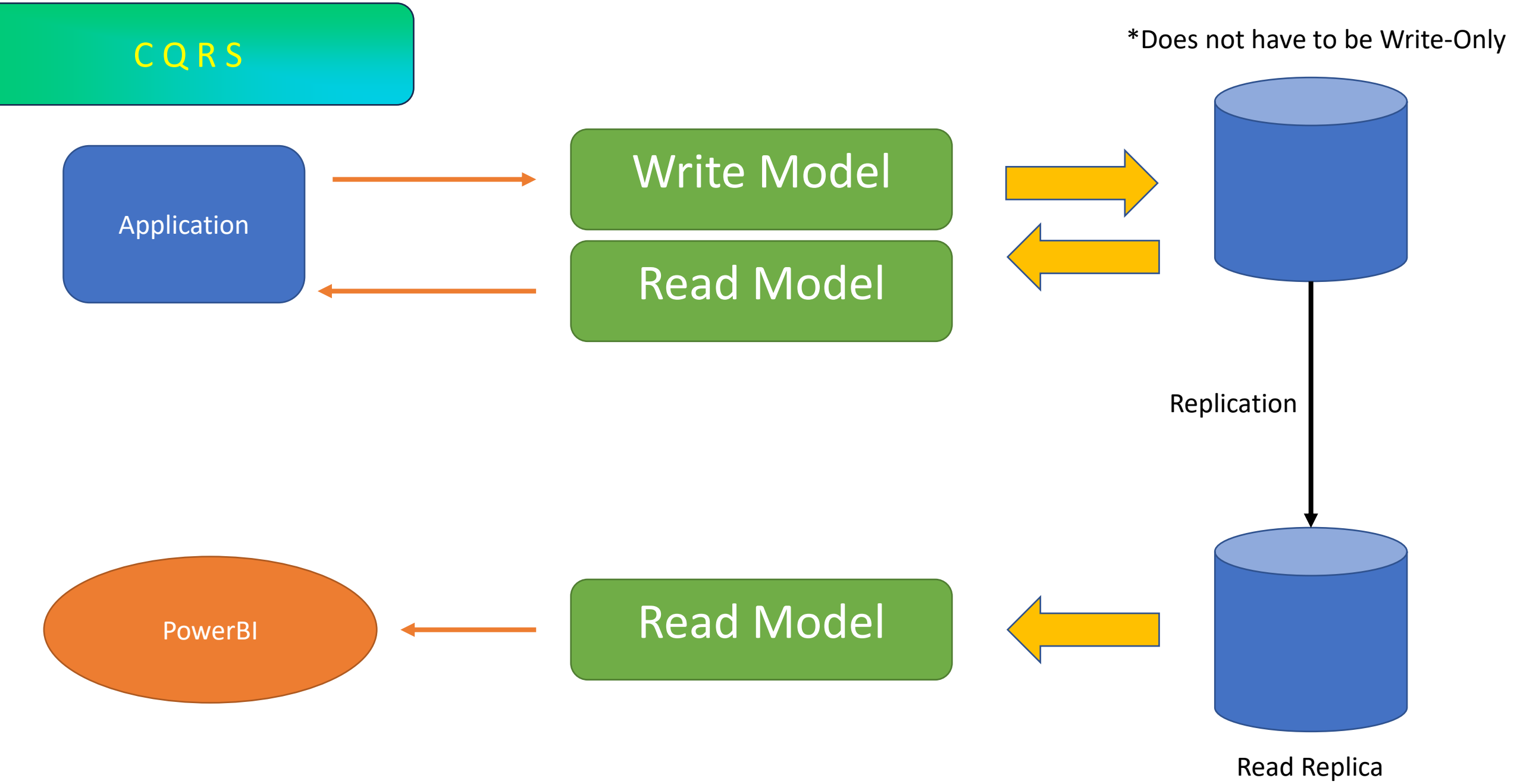
C Q R S

*Does not have to be Write-Only

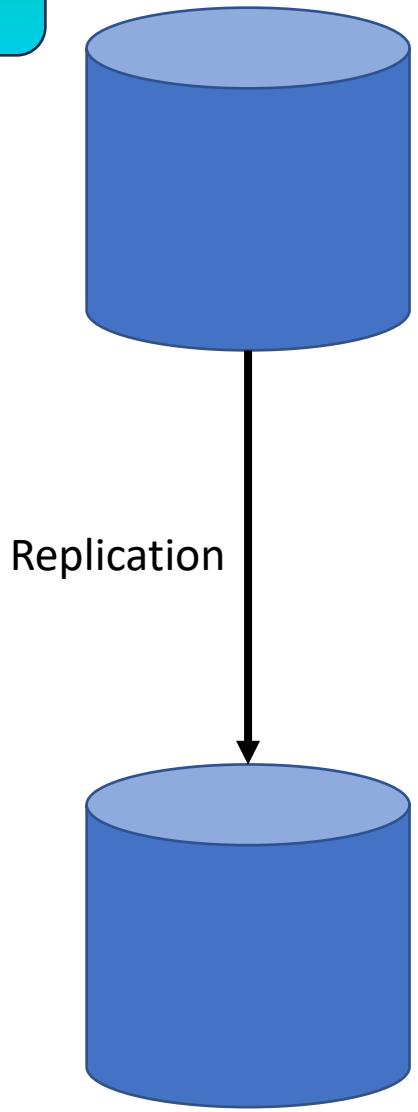


Pain Points

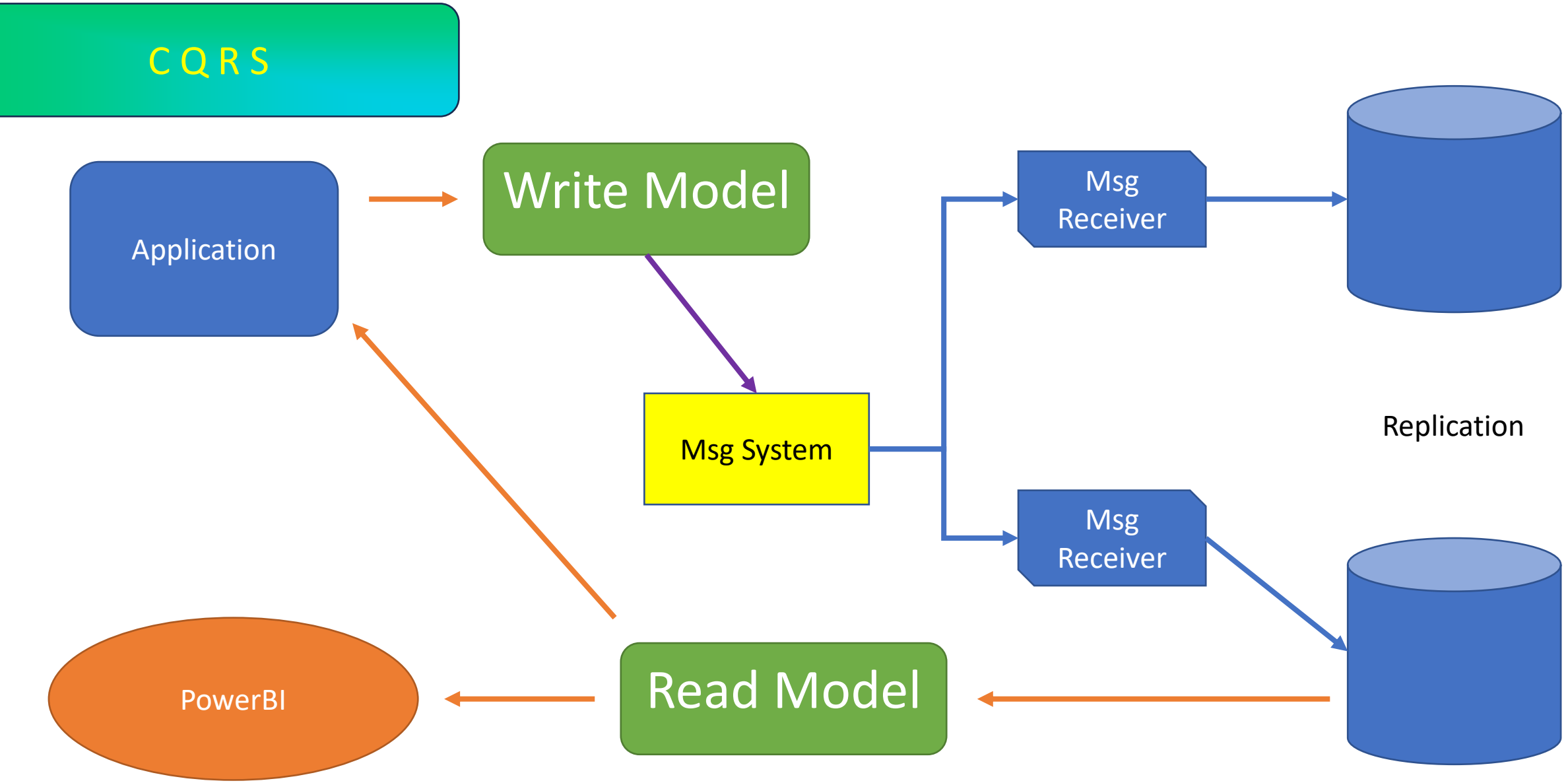

PowerBI
Extremely Read-Intensive
Application
Needs to
Read & Write
Application
Only writes

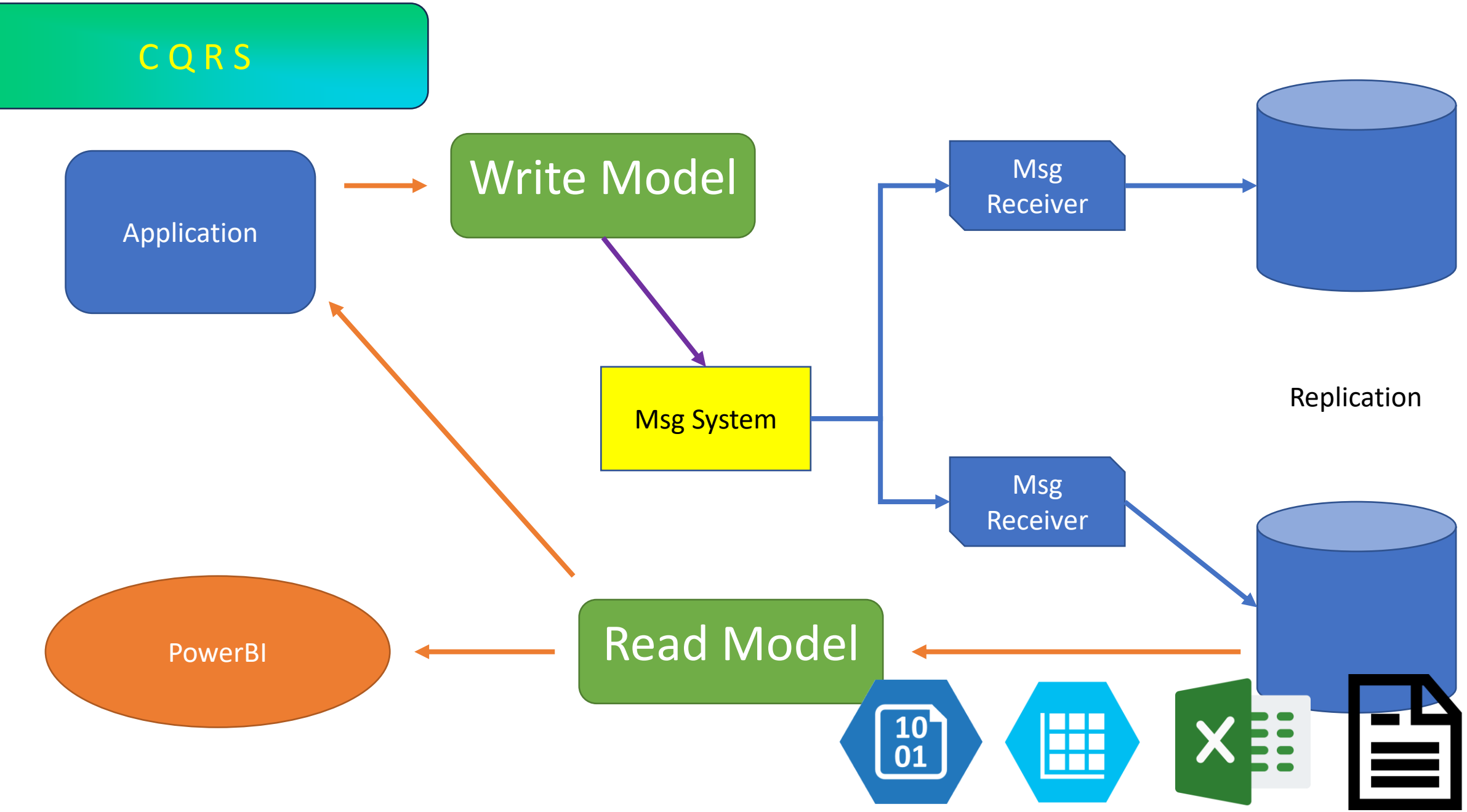

C Q R S
*Does not have to be Write-Only
Application
Write Model
Read Model
Replication
PowerBI
Read Model
Read Replica

Replication

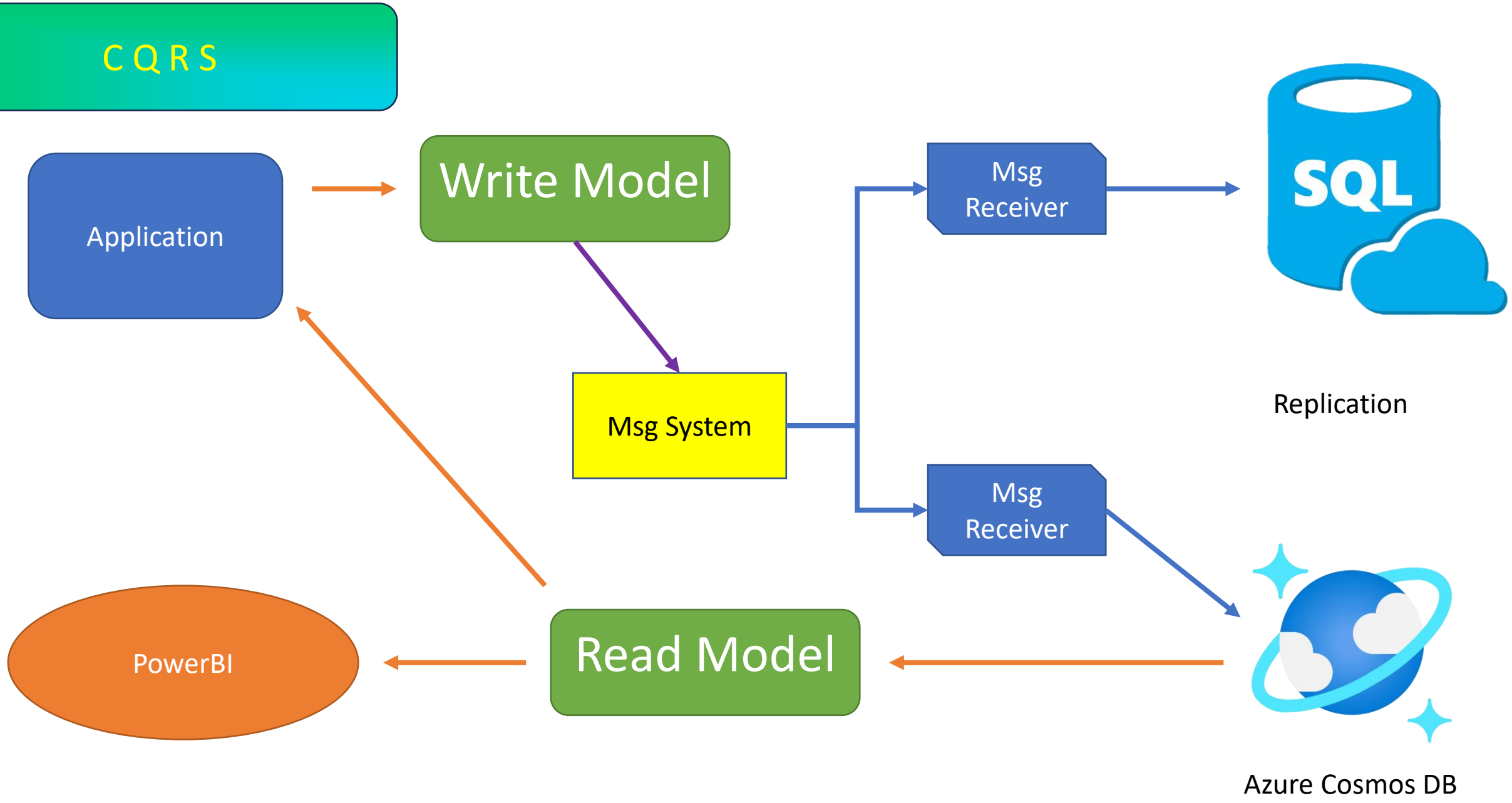


MySQL Replication
Postgres – Streaming Replication
SQL Server – Transactional Replication
MongoDB – Replication Sets
Amazon Aurora

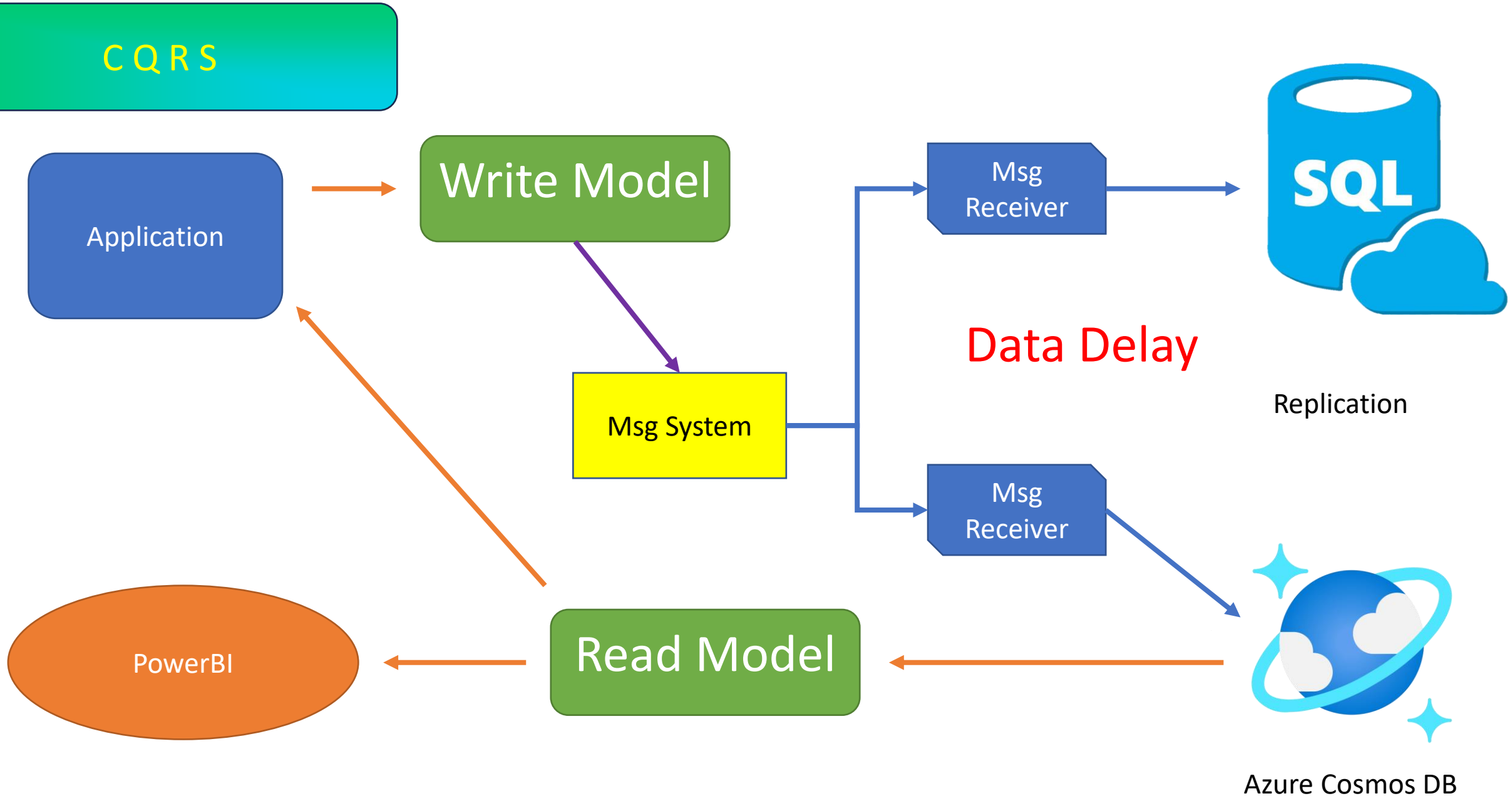

C Q R S
Application
Write Model
Msg System
Msg Receiver
Msg Receiver
Replication
PowerBI
Read Model


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

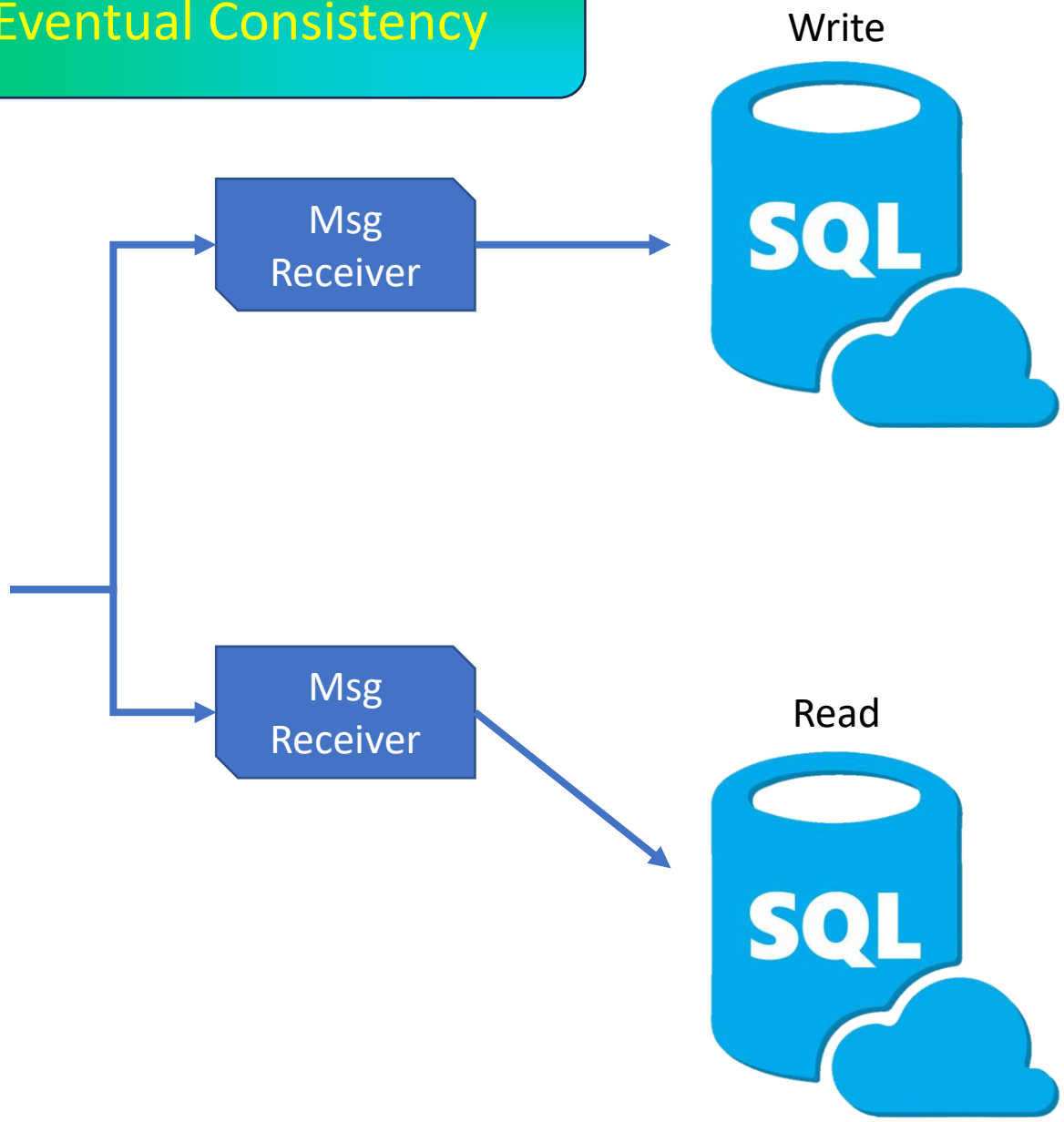
C Q R S


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

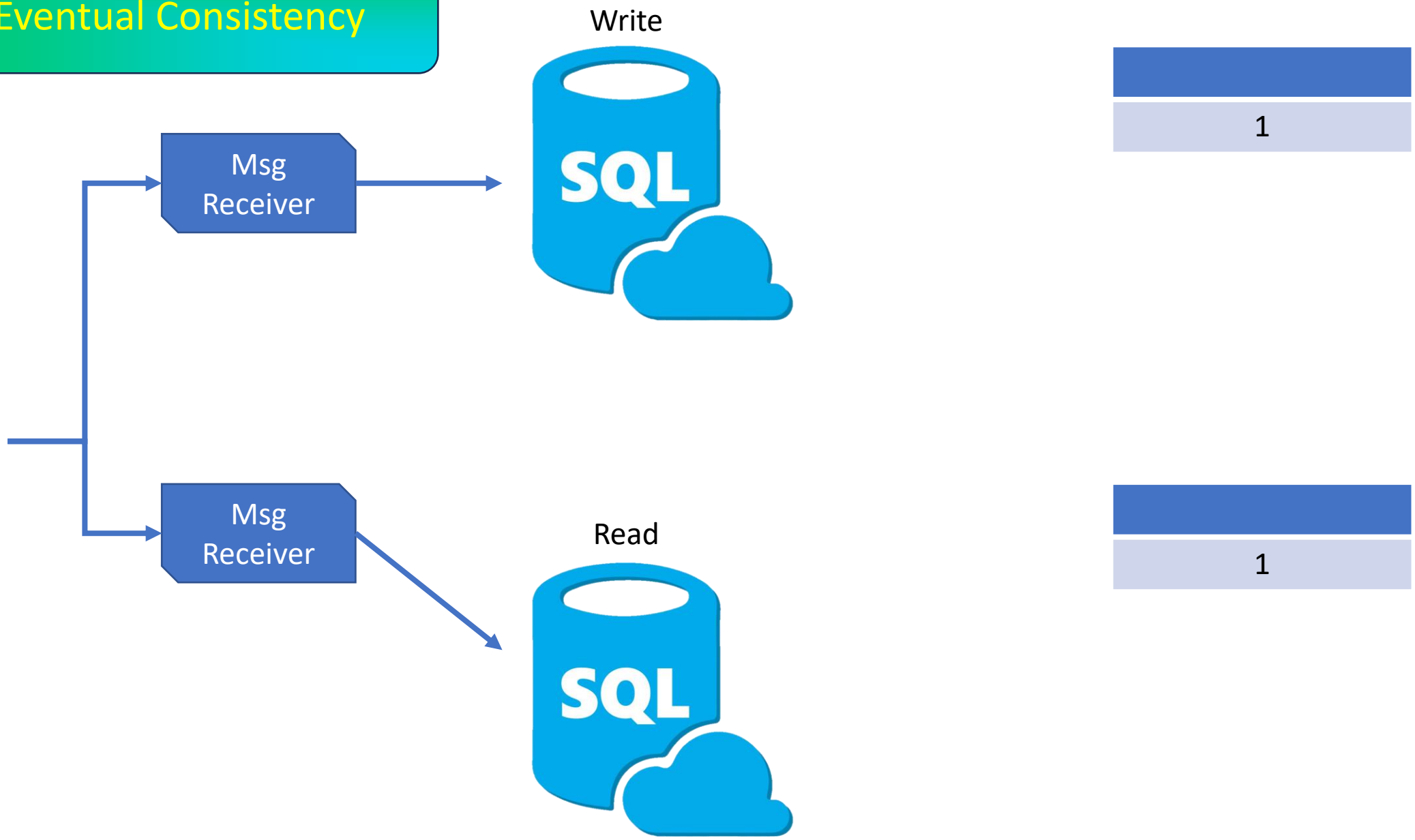
C Q R S


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

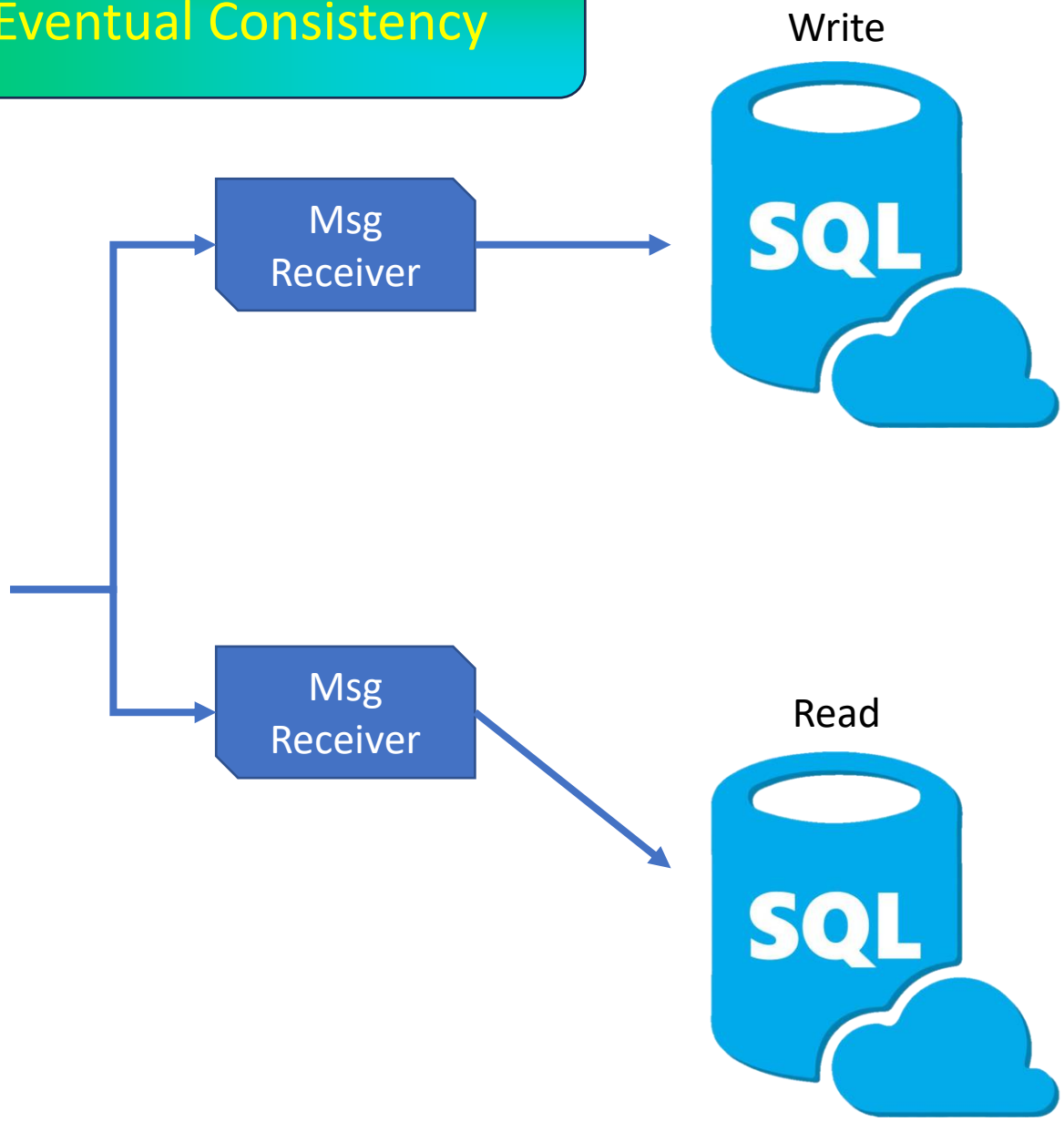
Eventual Consistency



Eventual Consistency



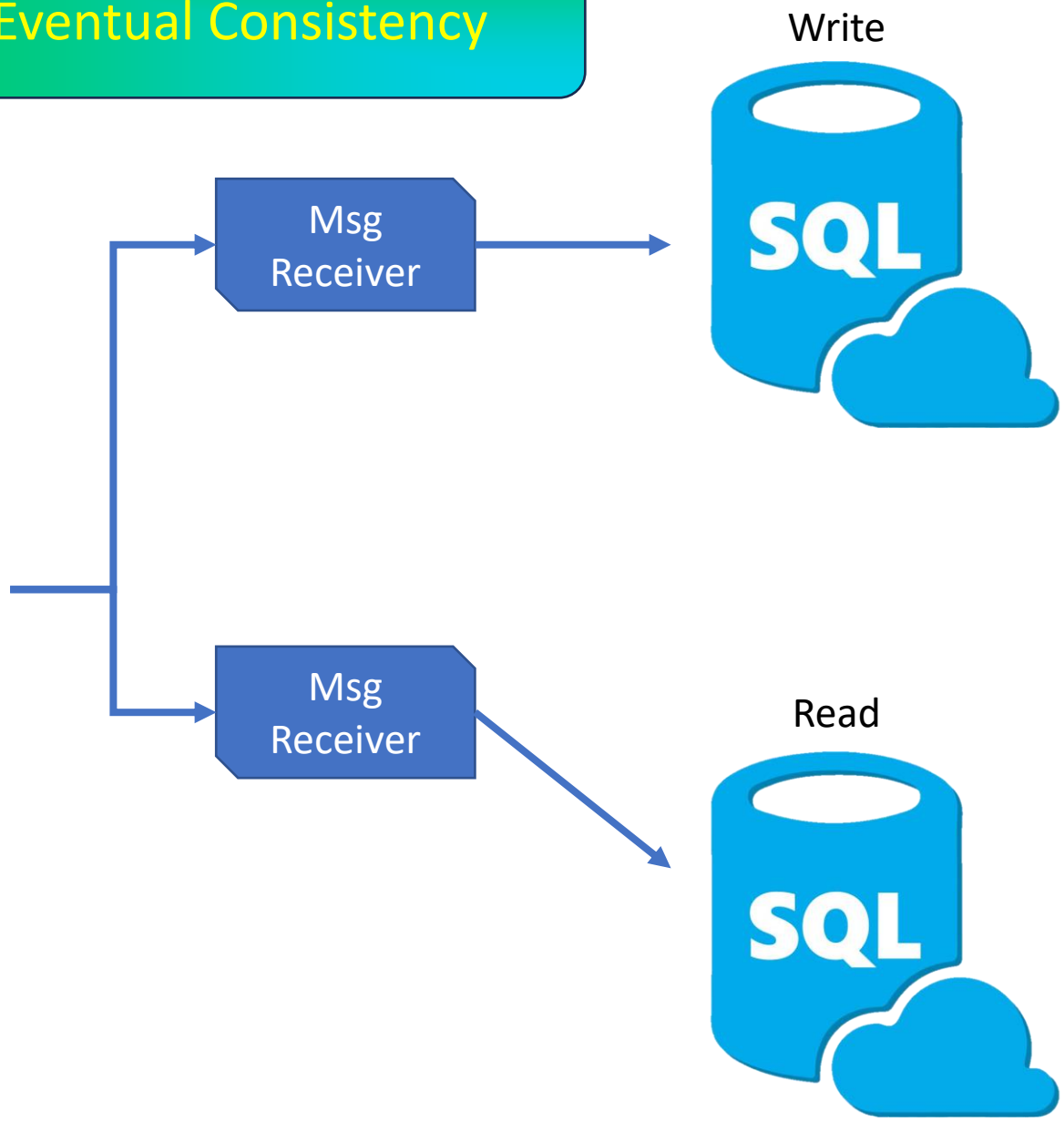
Eventual Consistency



1
2

1
2

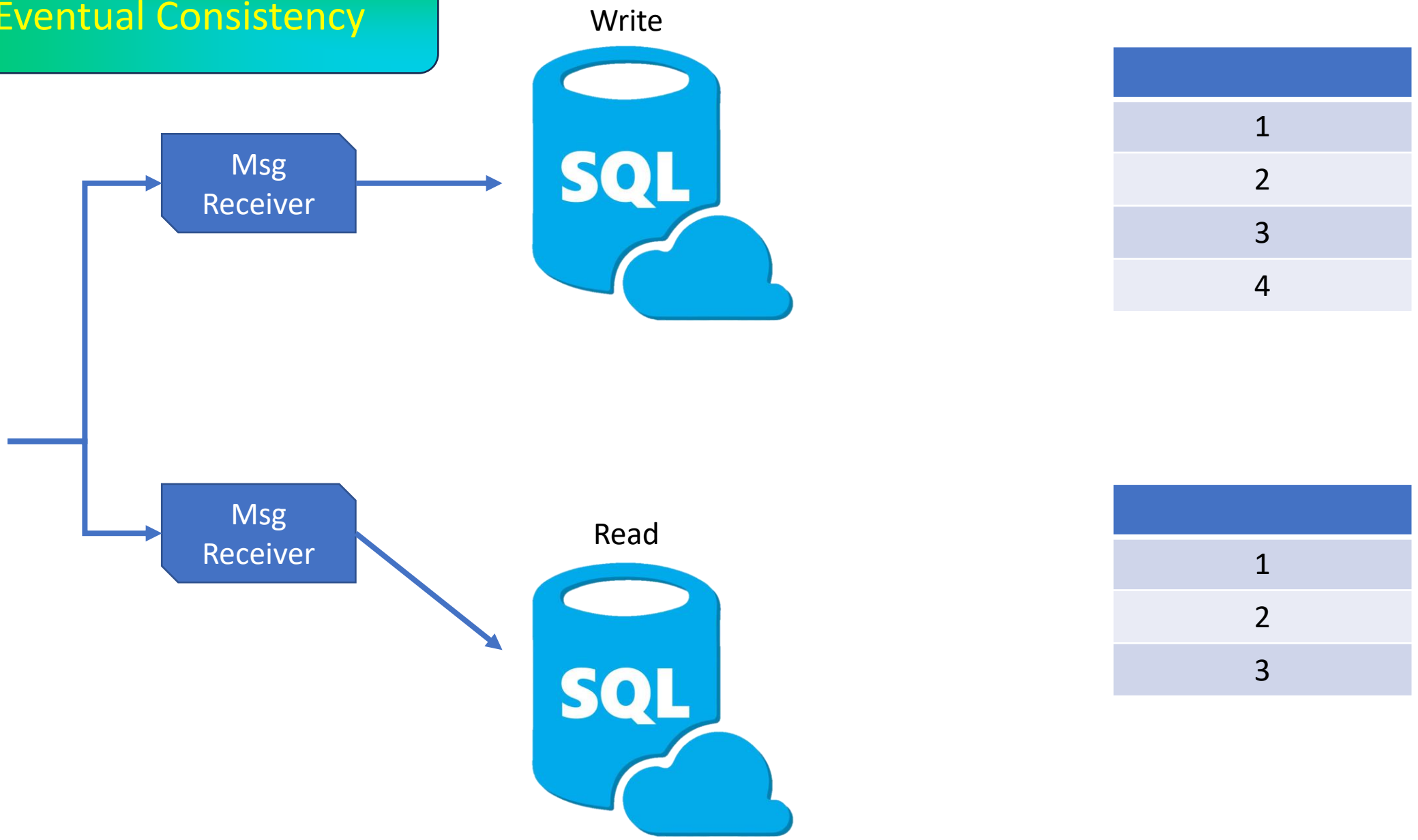
Eventual Consistency



1
2
3

1
2

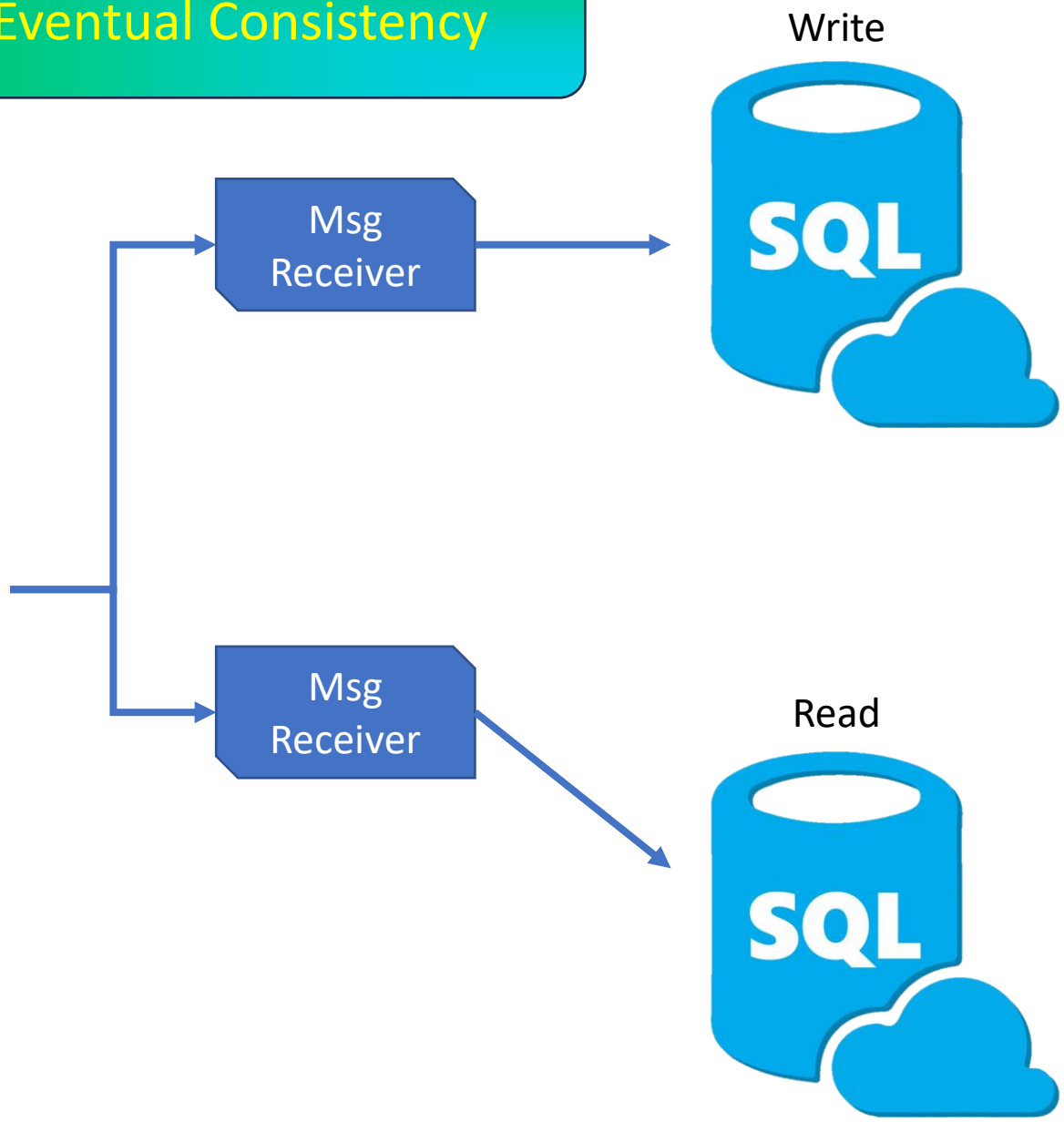
Eventual Consistency



1
2
3
4

1
2
3

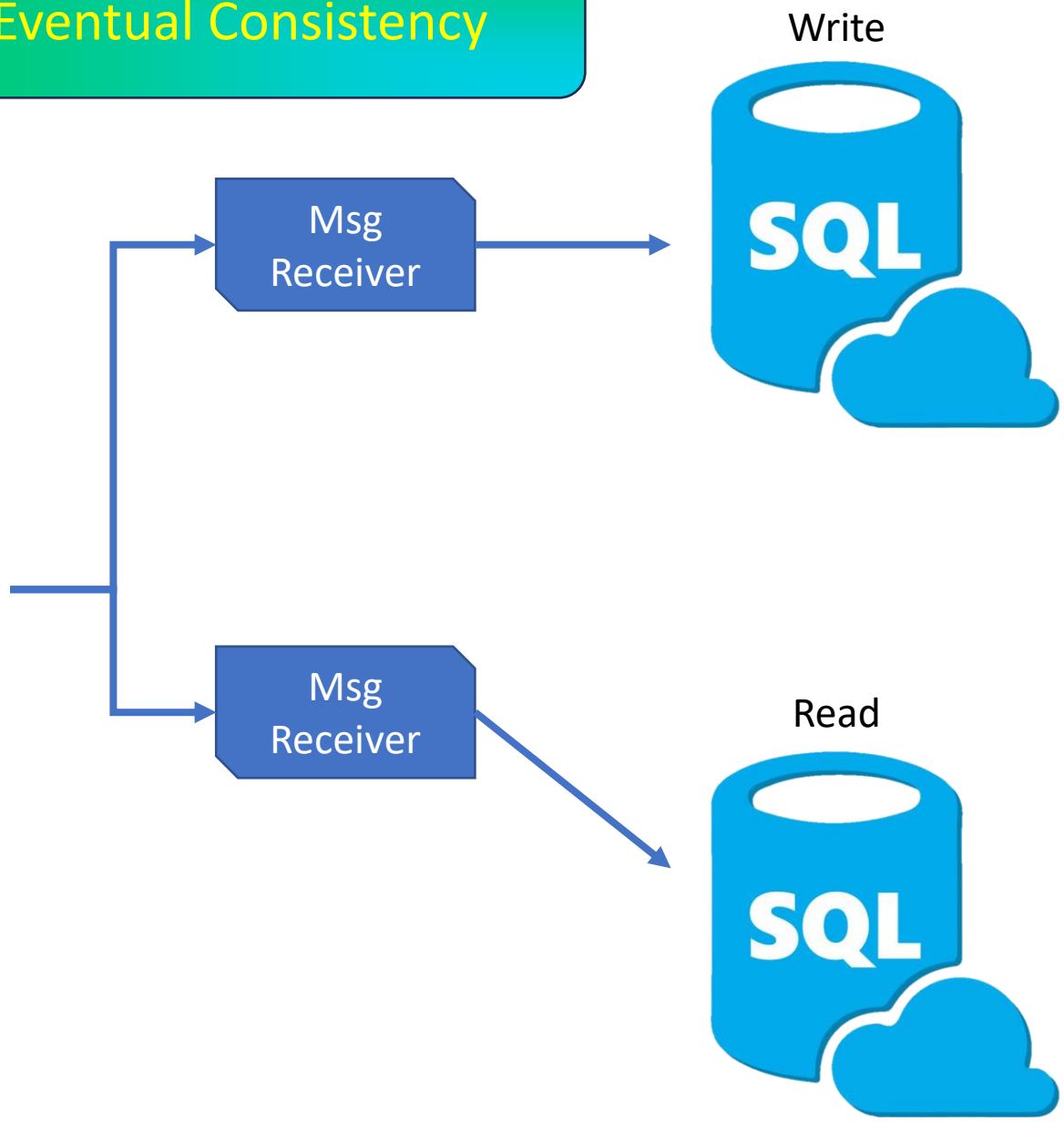
Eventual Consistency



1
2
3
4
5

1
2
3
4

Eventual Consistency



1
2
3
4
5

1
2
3
4
5

Eventual Consistency

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

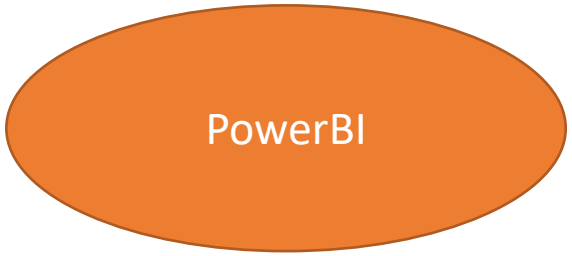
1
2
3
4
5

View

Read

View

1
2
3
4
5



View

Read

View

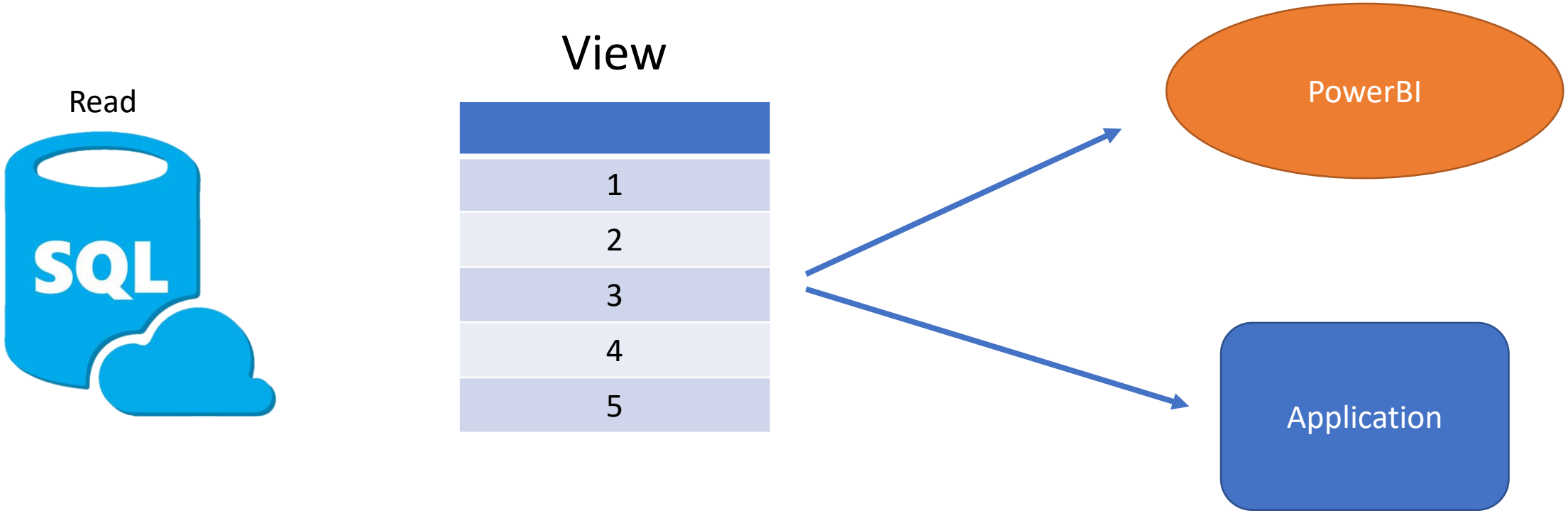
1
2
3
4
5

PowerBI

Application

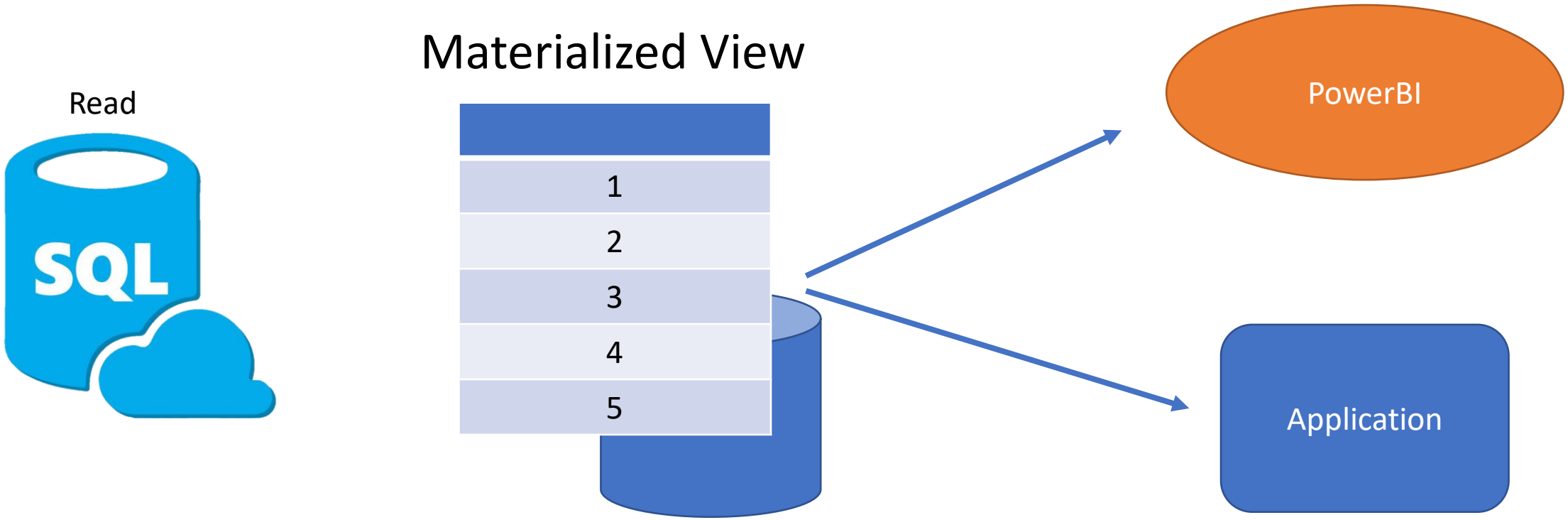
View

A *view* executes the query for each request.



Materialized View

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



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”:”AddItem”,
      "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”:”AddItem”,
      "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”:”RemoveItem”,
      "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”:”AddItem”,
      "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 Source?

Event Sourcing

When to consider using Event Source?

*not exhaustive list

Event Sourcing

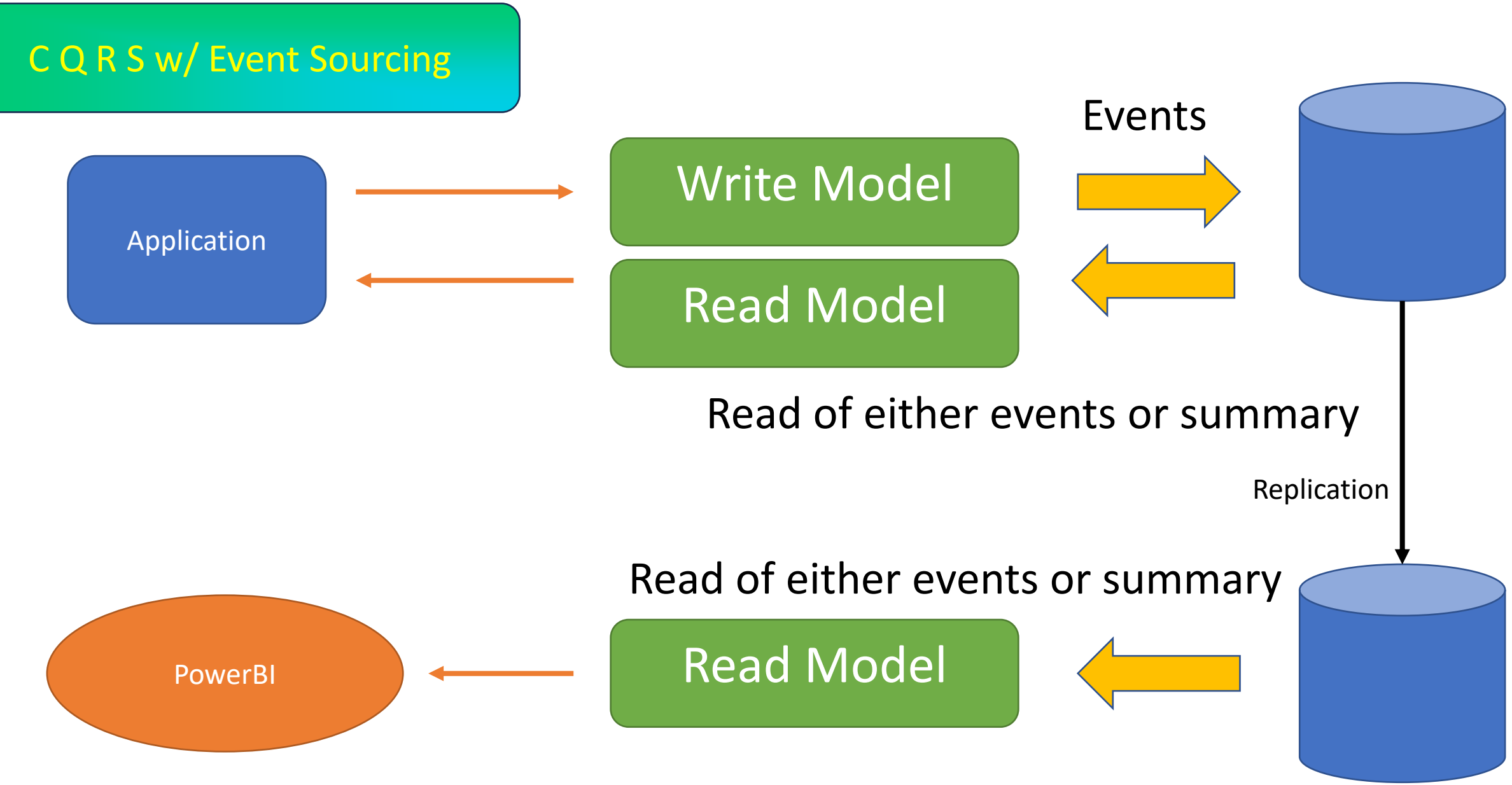
Key point about Event Sourcing.

Event Sourcing

Key point about Event Sourcing.

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

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 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**

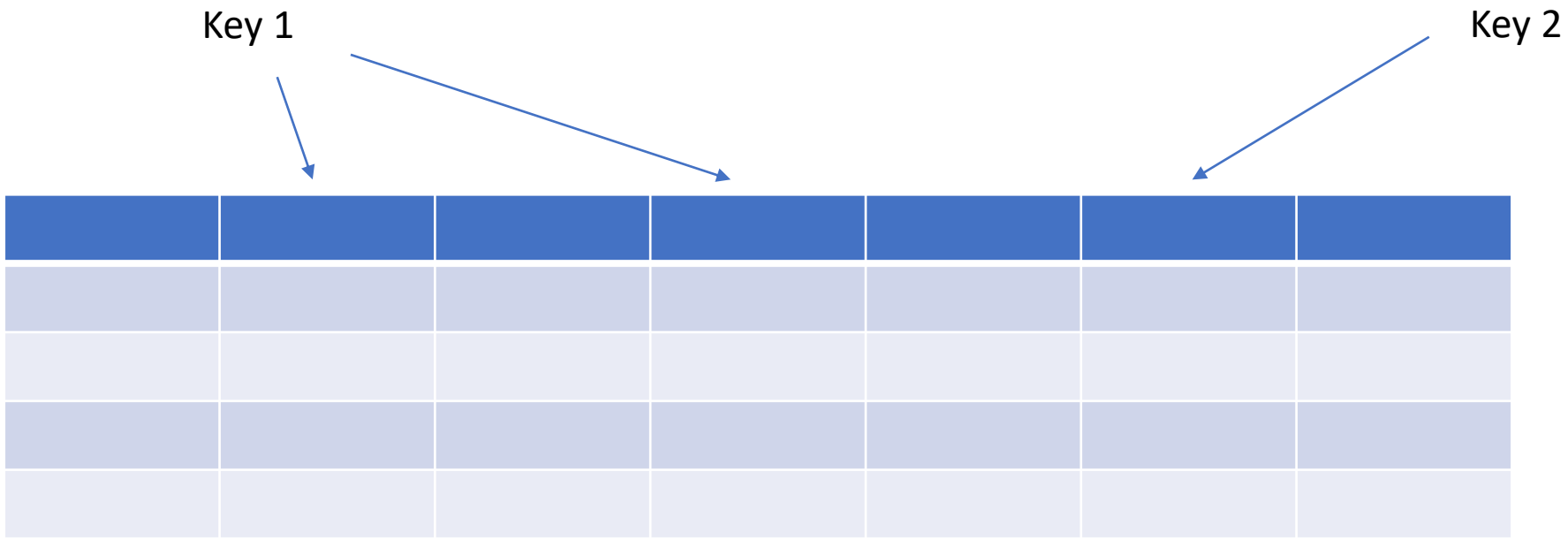
Some databases, like SQL Server, offer **Row-Level Security**.

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?

github: seanw122/presentations

Sean Whitesell

President of Tulsa .NET User Group &&
Microsoft MVP &&
Sr. Cloud Architect @ ArchitectNow
Twitter: @codewithseanw

meetup.com/TulsaDevelopers-net