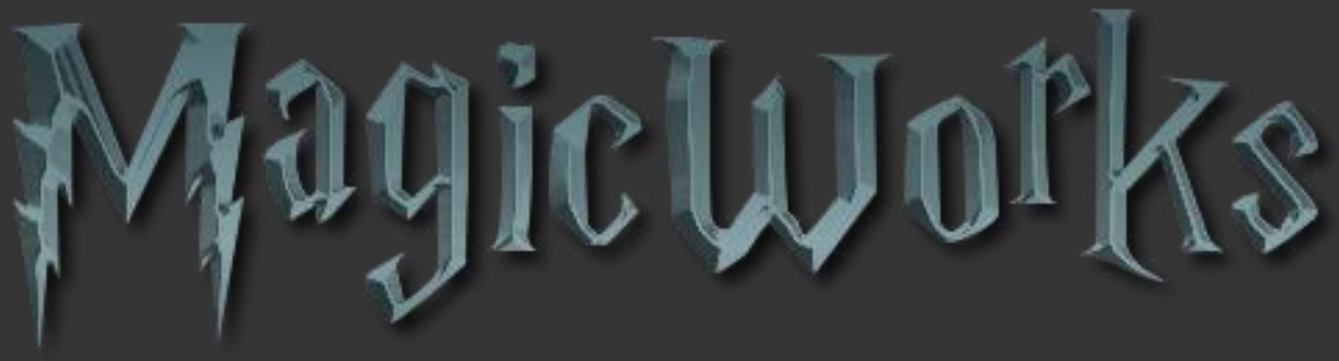
# Where to Start?




MagicWorks™ have settled on Azure SQLDW, but what's next?

- Review our Options
- Design our Data Model
- Load a sample Data Set

# Agenda

Distributed tables

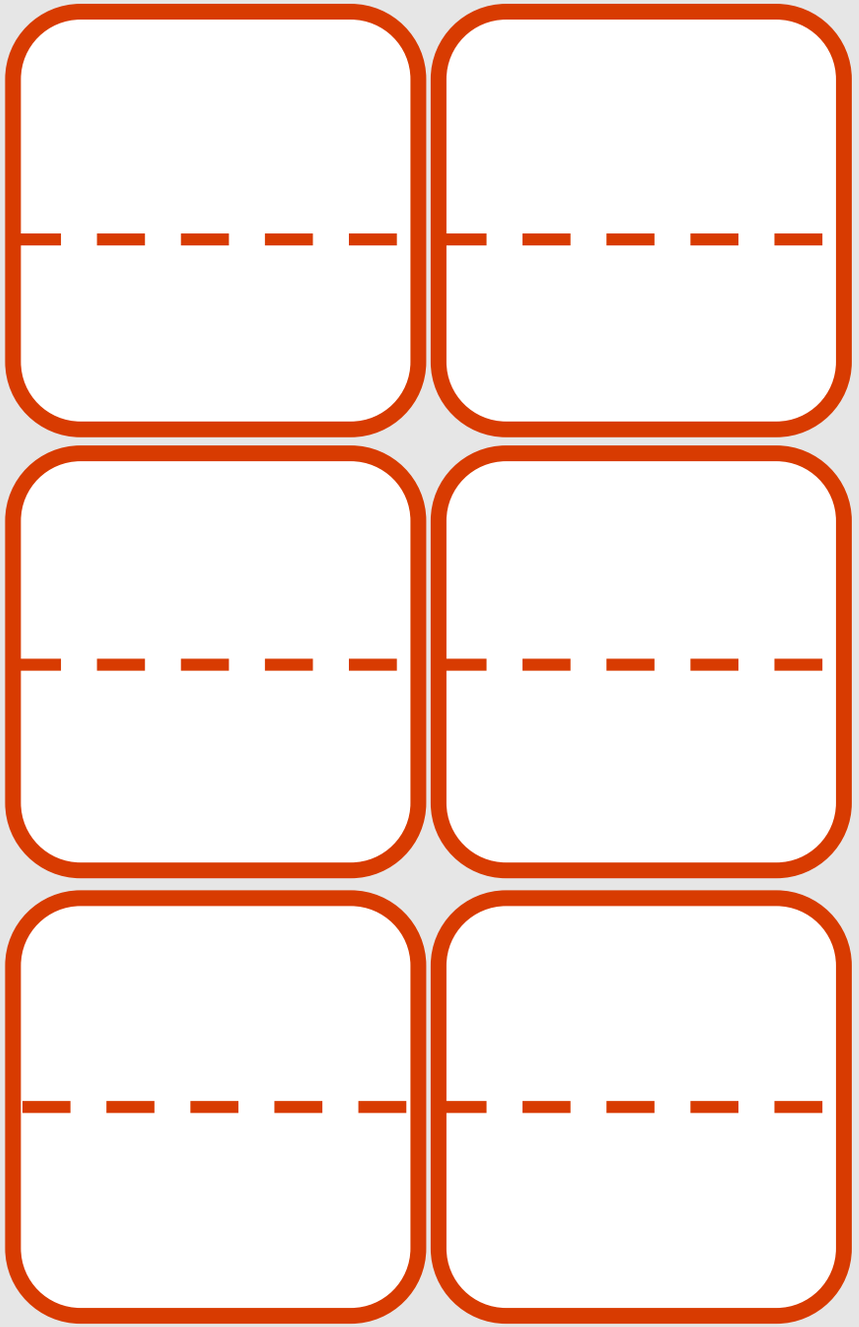
Replicated tables

Maximizing Load performance

# Distributed tables

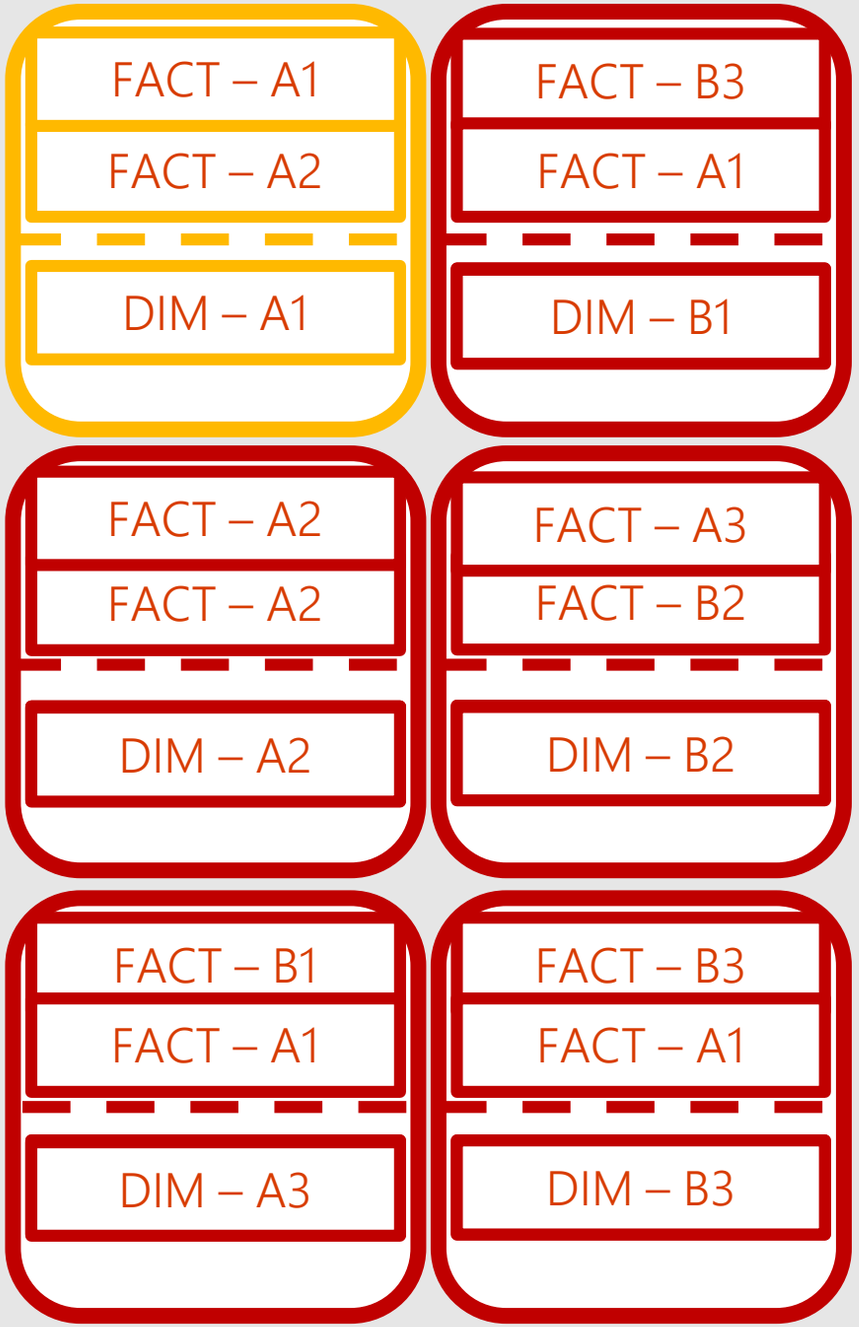
| | |
|---|---|
| FACT – A1 | FACT – A1 |
| FACT – A1 | FACT – B3 |
| FACT – A2 | FACT – A3 |
| FACT – B2 | FACT – A2 |
| FACT – A2 | FACT – B1 |
| FACT – A1 | FACT – B3 |

| | |
|---|---|
| DIM – A1 | DIM – B1 |
| DIM – A2 | DIM – B2 |
| DIM – A3 | DIM – B3 |

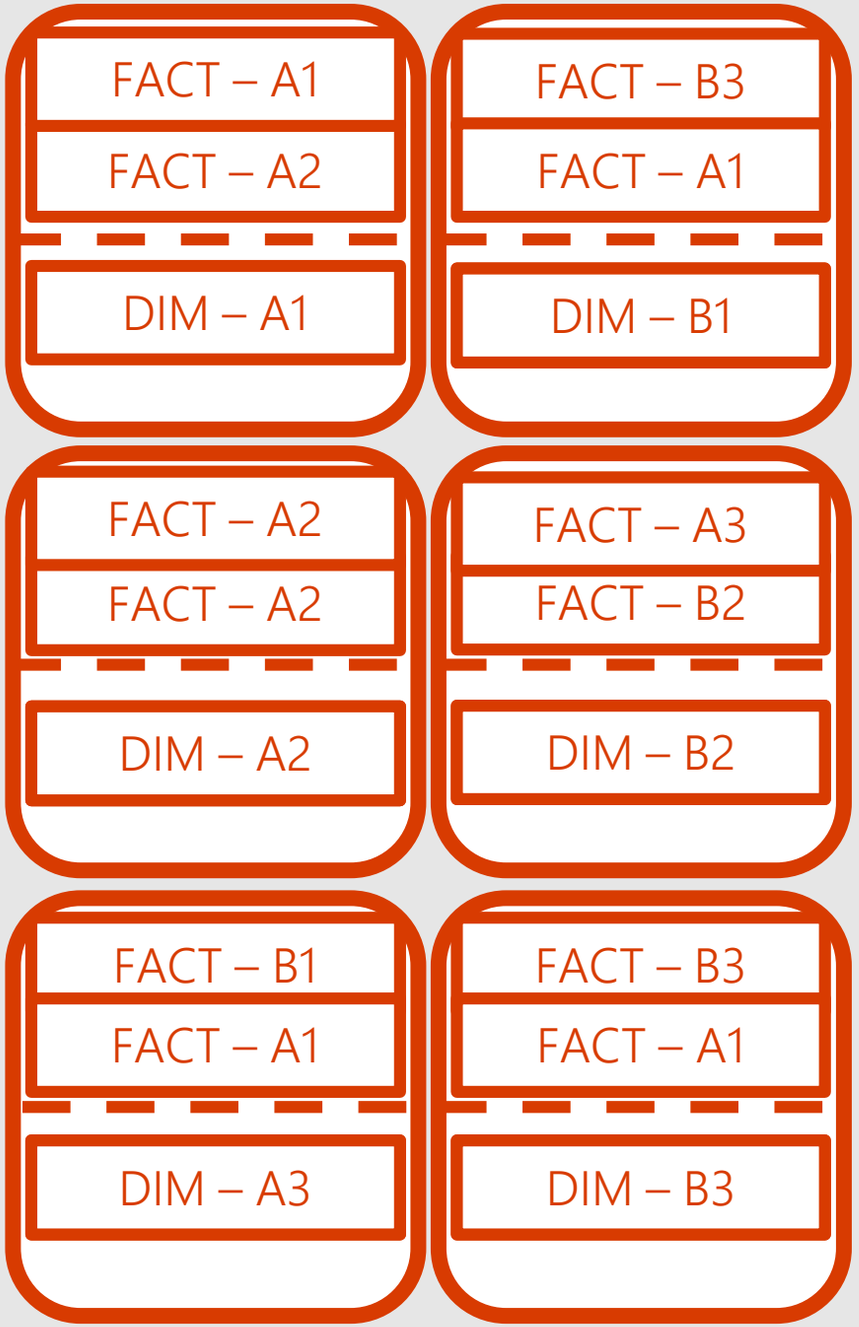


# Distribution: Round Robin

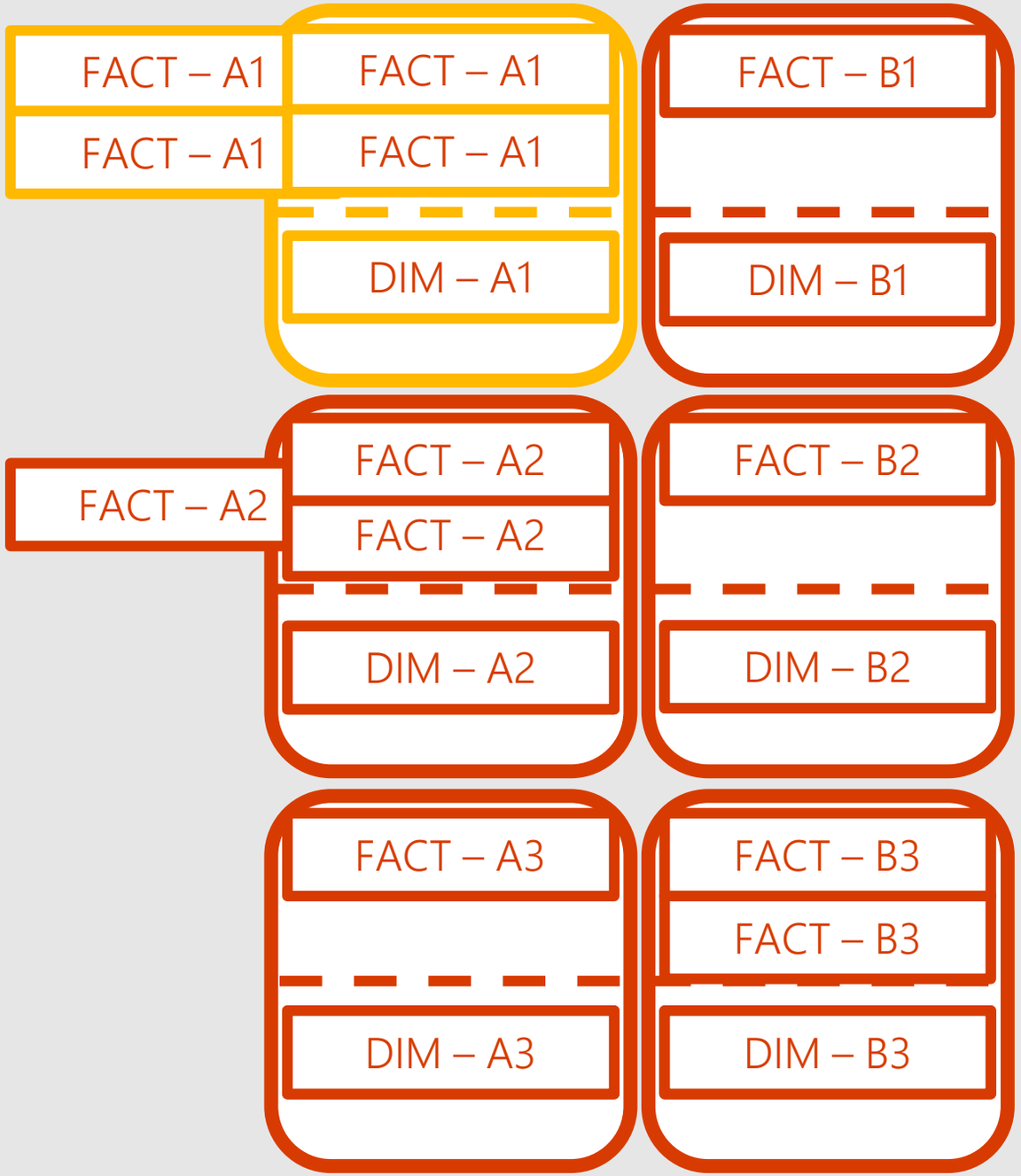
# Query Execution

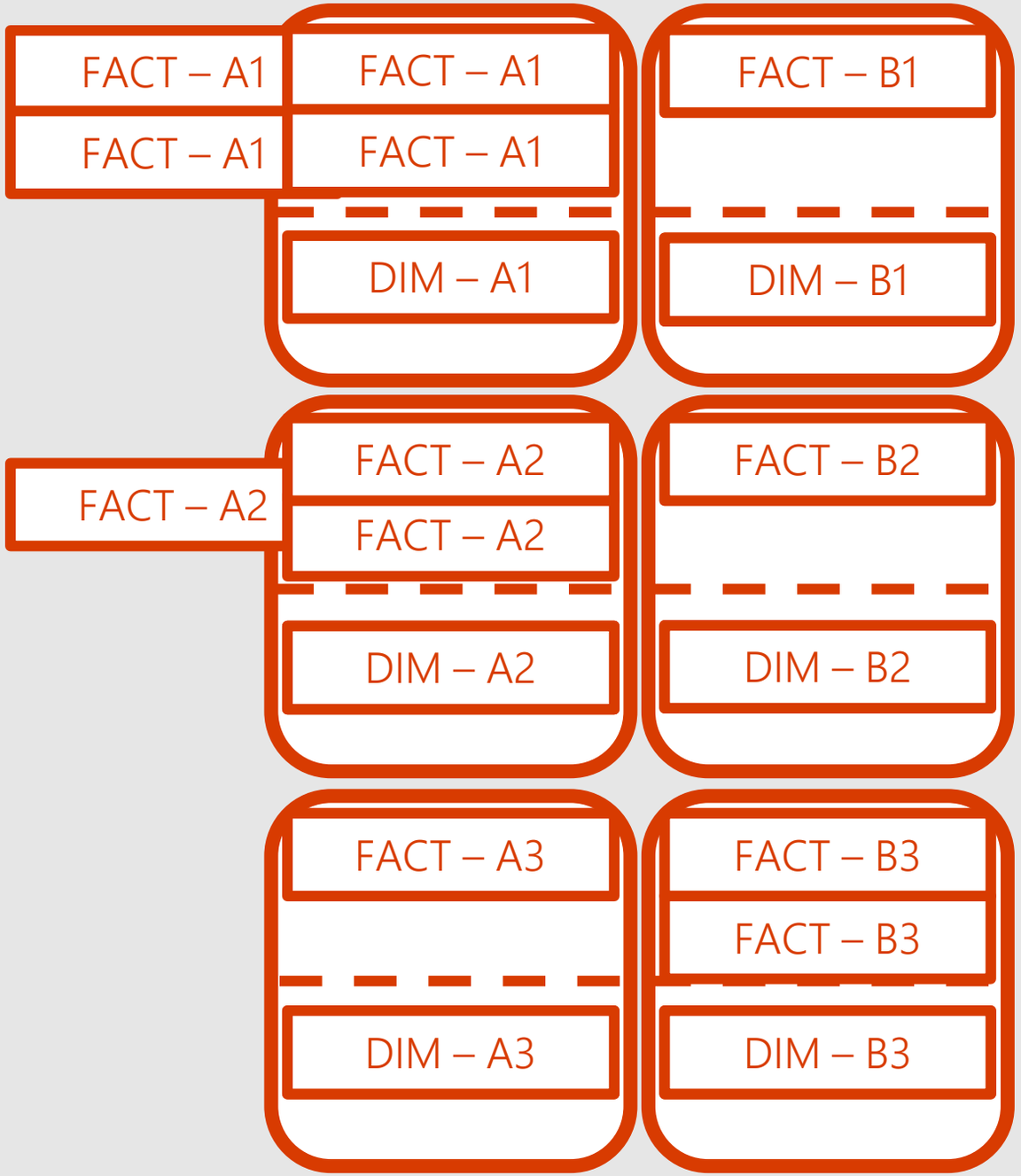


# Distribution: HASH Column



# Query Execution






```
SELECT DIM.NAME, COUNT(*)
FROM FACT
INNER JOIN DIM ON FACT.KEY = DIM.KEY
GROUP BY DIM.NAME
```

# Creating tables

```
CREATE TABLE [dbo].[DimStore]
(
    [StoreKey]          int             NOT NULL
,   [GeographyKey]      int             NOT NULL
,   [StoreName]         nvarchar(100)   NOT NULL
,   [StoreType]         nvarchar(15)        NULL
,   [StoreDescription]  nvarchar(300)   NOT NULL
,   [Status]            nvarchar(20)    NOT NULL
,   [OpenDate]          datetime        NOT NULL
,   [CloseDate]         datetime            NULL
,   [ETLLoadID]         int                 NULL
,   [LoadDate]          datetime            NULL
,   [UpdateDate]        datetime            NULL
)
WITH
(   CLUSTERED INDEX([StoreKey])
,   DISTRIBUTION = ROUND_ROBIN
)
;
```

Row

```
CREATE TABLE [dbo].[FactOnlineSales]
(
    [OnlineSalesKey]        int             NOT NULL
,   [DateKey]               datetime        NOT NULL
,   [StoreKey]              int             NOT NULL
,   [ProductKey]            int             NOT NULL
,   [PromotionKey]          int             NOT NULL
,   [CurrencyKey]           int             NOT NULL
,   [CustomerKey]           int             NOT NULL
,   [SalesOrderNumber]      nvarchar(20)    NOT NULL
,   [SalesOrderLineNumber]  int                 NULL
,   [SalesQuantity]         int             NOT NULL
,   [SalesAmount]           money           NOT NULL
)
WITH
(   CLUSTERED COLUMNSTORE INDEX
,   DISTRIBUTION = HASH([ProductKey])
)
;
```

Column

Distribution

# Distributed table design goals

Minimize data skew

Minimize data movement

# Data Skew

# Finding Skew

## DBCC PDW_SHOWSPACEUSED

- Very quick
- Not a programmatic interface

## DMV gives more detail and control

- sys.dm_pdw_nodes_db_partition_stats
- Examples in documentation

Documentation: Table Size Queries

# Using the vTableSizes view

```
SELECT      [distribution_id]
,           SUM([row_count]) AS [total_distribution_row_count]
FROM        [dbo].[vTableSizes]
WHERE       [schema_name]    = 'Fact'
AND         [table_name]     = 'Flights'
GROUP BY    [distribution_id]
ORDER BY    [total_distribution_row_count]
;
```

# Demo: checking for skew

# Lab 002 – Monitoring Skew

*10 Mins*

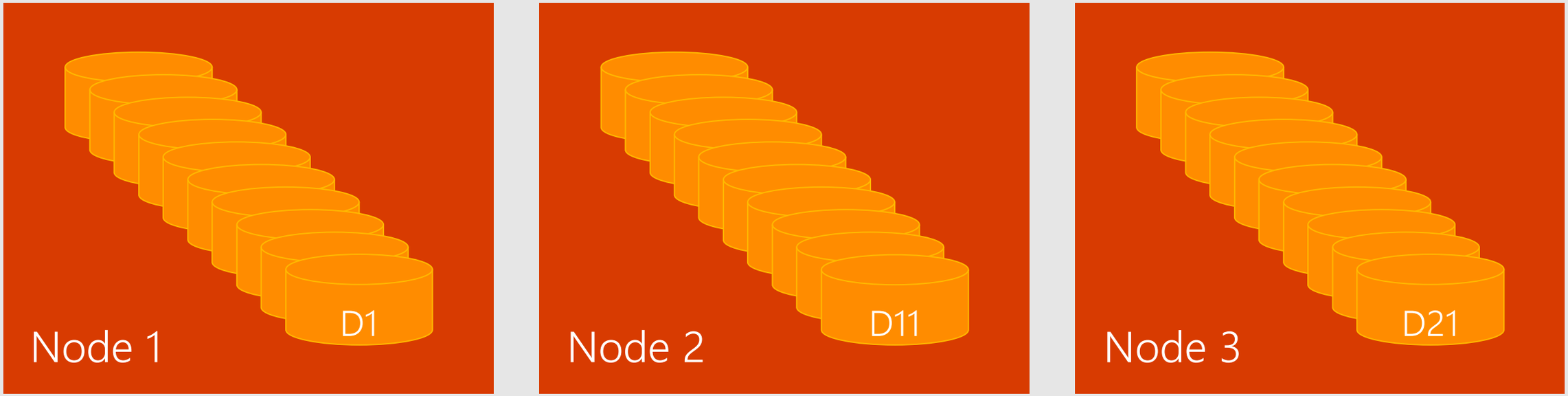
# Replicated Tables

# What is a replicated table

One complete copy of the data on each node

Improves read performance

Impacts write performance



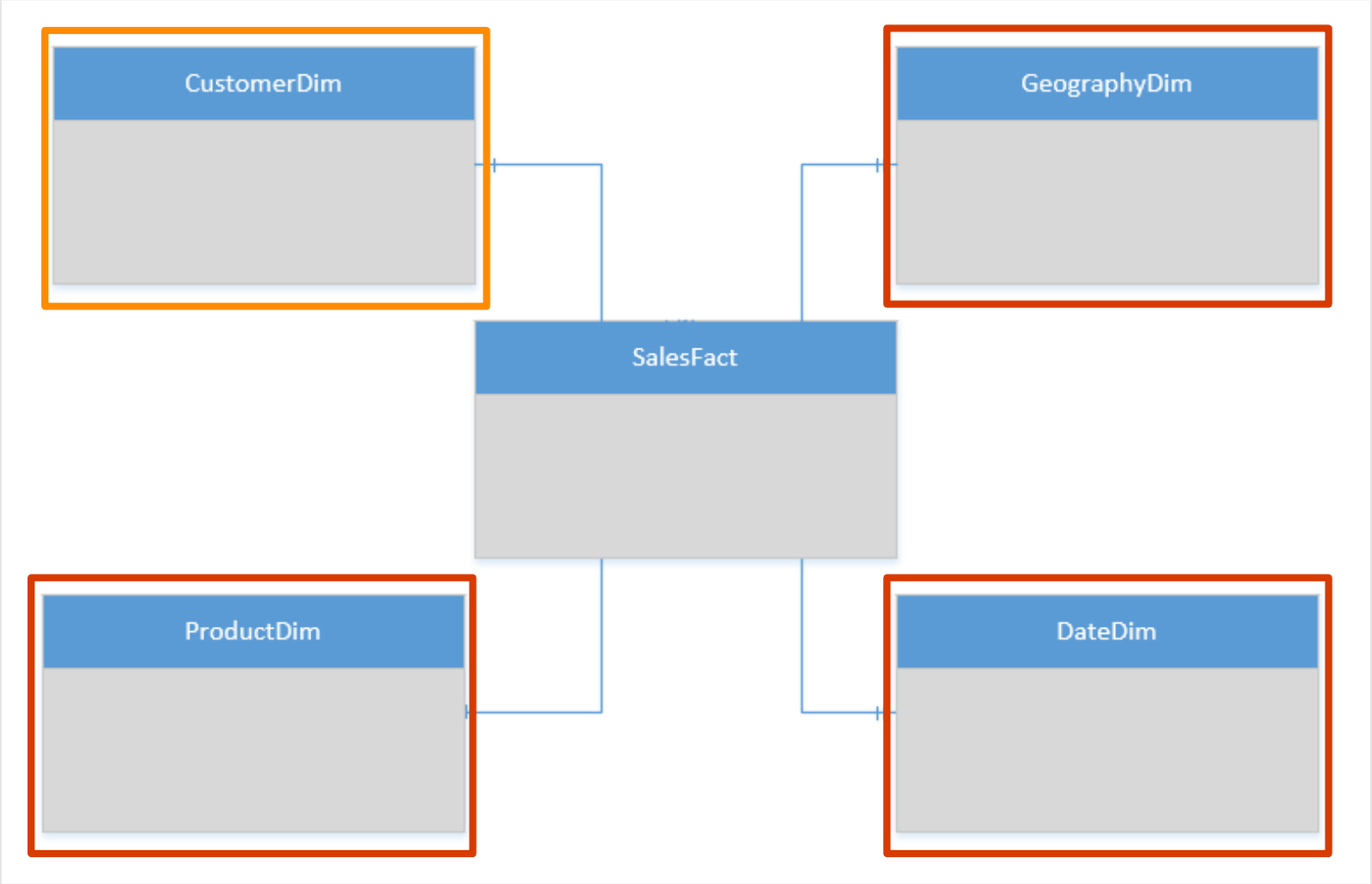
# Replicated Table Scenarios

Dimensions

Master data

Reference data

Lookup tables in ELT



# T-SQL: Create a Replicated table

```
CREATE TABLE dbo.DimCustomer
(    CustomerKey           int             NOT NULL
,    GeographyKey          int             NULL
,    CustomerAlternateKey  nvarchar(15)    NOT NULL
,    Title                 nvarchar(8)     NULL
,    FirstName             nvarchar(50)    NULL
,    LastName              nvarchar(50)    NULL
,    BirthDate             date            NULL
,    Gender                nvarchar(1)     NULL
,    EmailAddress          nvarchar(50)    NULL
,    YearlyIncome          money           NULL
,    DateFirstPurchase     date            NULL
)
WITH
(    CLUSTERED COLUMNSTORE INDEX
,    DISTRIBUTION = REPLICATE
)
;
```

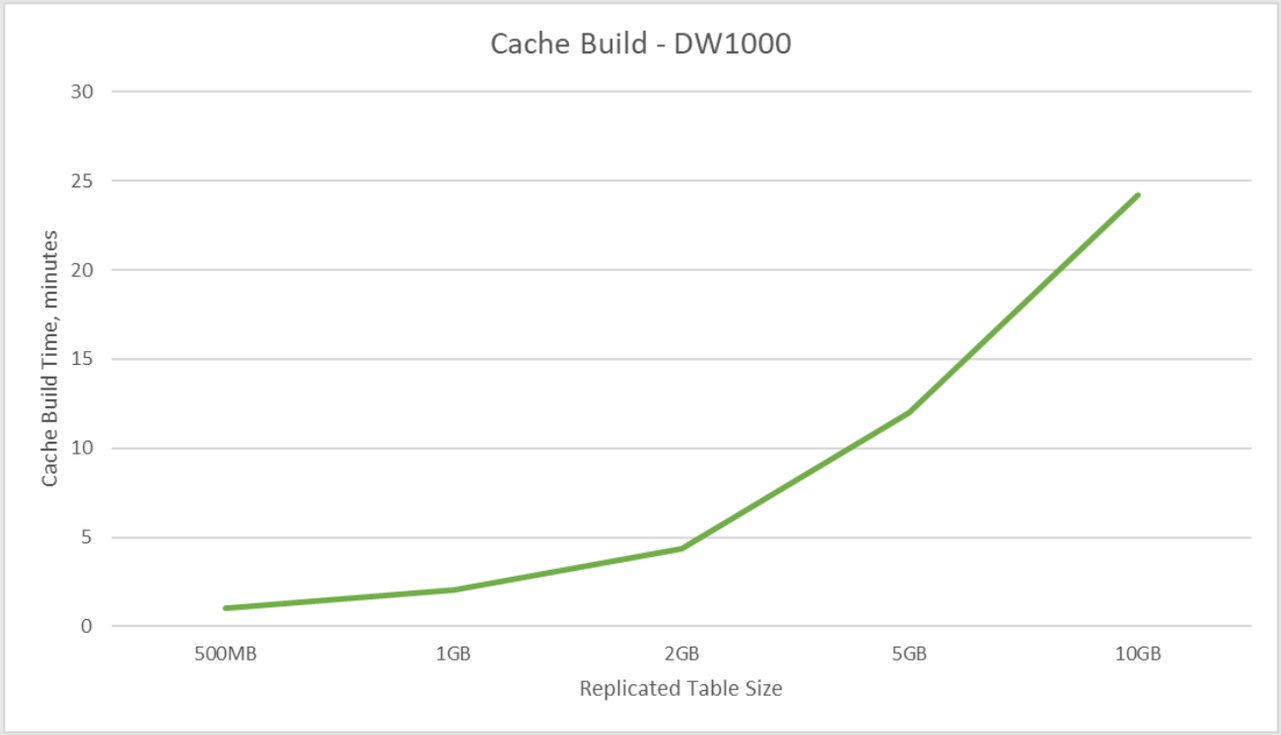
# Table Size

Guideline is 2GB

- Compressed on disk size (typically observe 5x compression)
- Regardless of the number of rows

Guideline grounded in physics of tenable cache refresh time

Carefully consider additional indexes as this adds to build time



# Replicated Table Candidates

Tables involved in frequent joins that do not have a suitable HASH distribution column.

Use sys.dm_pdw_request_steps

- BroadcastMoveOperation: replicated table at runtime…

Results | Messages

| | step_index | operation_type |
|---|---|---|
| 1 | 0 | RandomIDOperation |
| 2 | 1 | OnOperation |
| 3 | 2 | BroadcastMoveOperation |
| 4 | 3 | RandomIDOperation |
| 5 | 4 | OnOperation |
| 6 | 5 | BroadcastMoveOperation |
| 7 | 6 | OnOperation |
| 8 | 7 | PartitionMoveOperation |
| 9 | 8 | OnOperation |
| 10 | 9 | OnOperation |
| 11 | 10 | ReturnOperation |
| 12 | 11 | OnOperation |

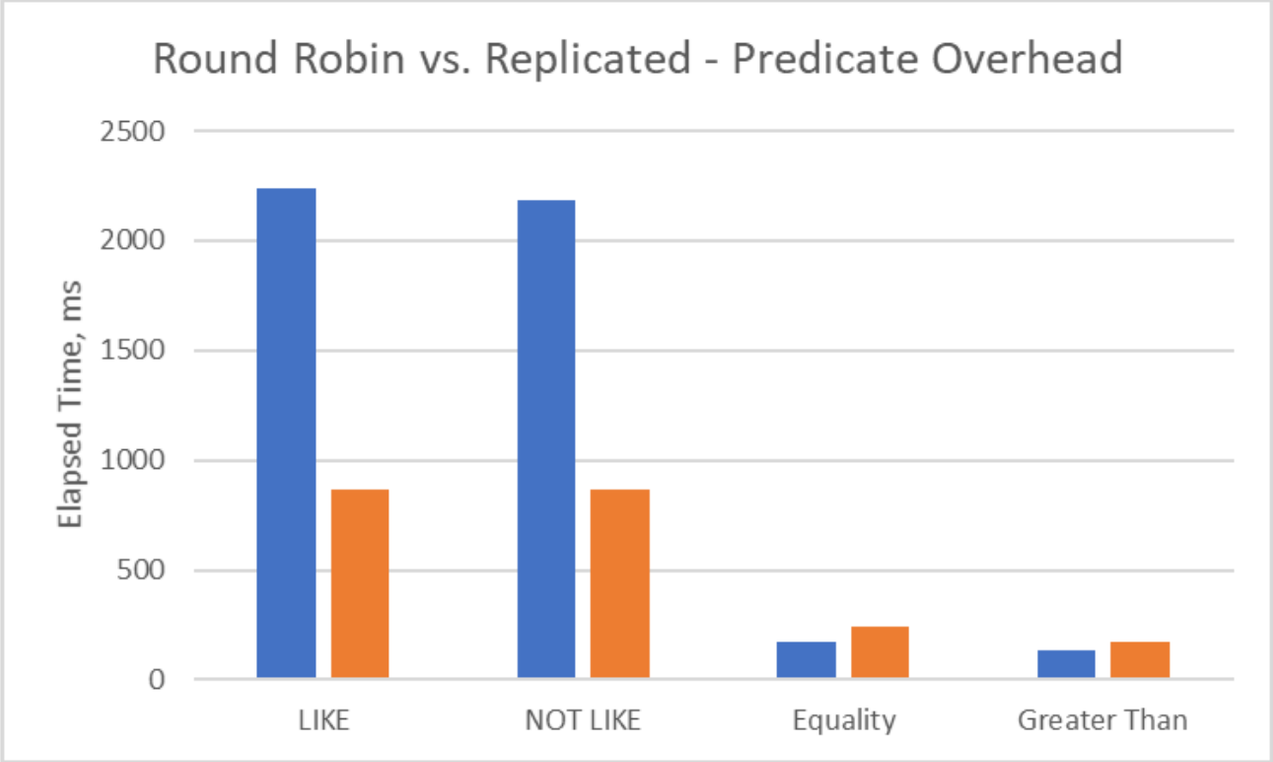
# Query Cost Considerations

Data movement cost must outweigh predicate and join overhead.

Resource-intensive queries perform best when the work is distributed across all of the Compute nodes.

Query cost (select from replicated table):

- Replicated table:[Query CPU Cost] x [1 Compute Node]
- Round Robin: [Query CPU Cost] / [# Compute Nodes]



# Replicated Table DMV

```
SELECT  t.[name]                                    AS Table_Name
,       c.[state]                                   AS Cache_State
,       p.[distribution_policy_desc]                AS Dist_Type
FROM    sys.[tables]                                AS t
JOIN    sys.[pdw_replicated_table_cache_state]      AS c
ON      c.[object_id] = t.[object_id]
JOIN    sys.pdw_table_distribution_properties       AS p
ON      p.[object_id] = t.[object_id]
;
```

# Demo: Redistributing Data

# Lab 003: Redistributing Data

*15 Mins*

# Table re-cap

# Table structure options

## Hash Distributed
(to optimize)

Data divided across nodes based on hashing algorithm

Same value will always hash to same distribution

Single column only

Check for Data Skew, NULLS, -1

## Round Robin Distributed
(default)

Data spread evenly across nodes & distributions

Easy place to start, don't need to know anything about the data

Simplicity at a cost

Will incur more data movement at query time

## Replicated
(For small tables)

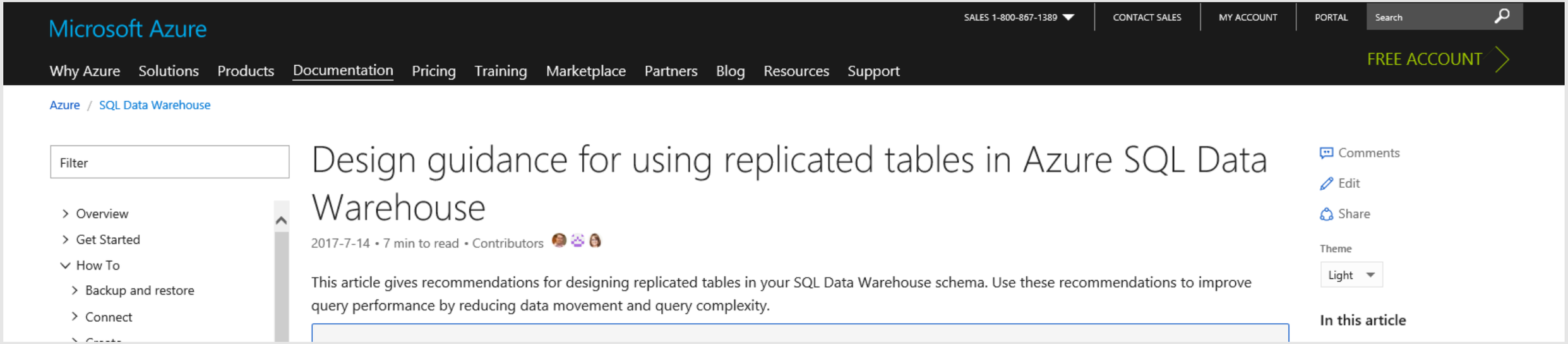
Data repeated on every node

Simplifies many query plans and reduces data movement

Best with joining hash table

Consumes more space
Queries using just replicated tables executed on one node only

# Design Guidance Doc




Reference:

[Design guidance for using replicated tables]

# Modelling Magic

Dim Date

Dim Geography

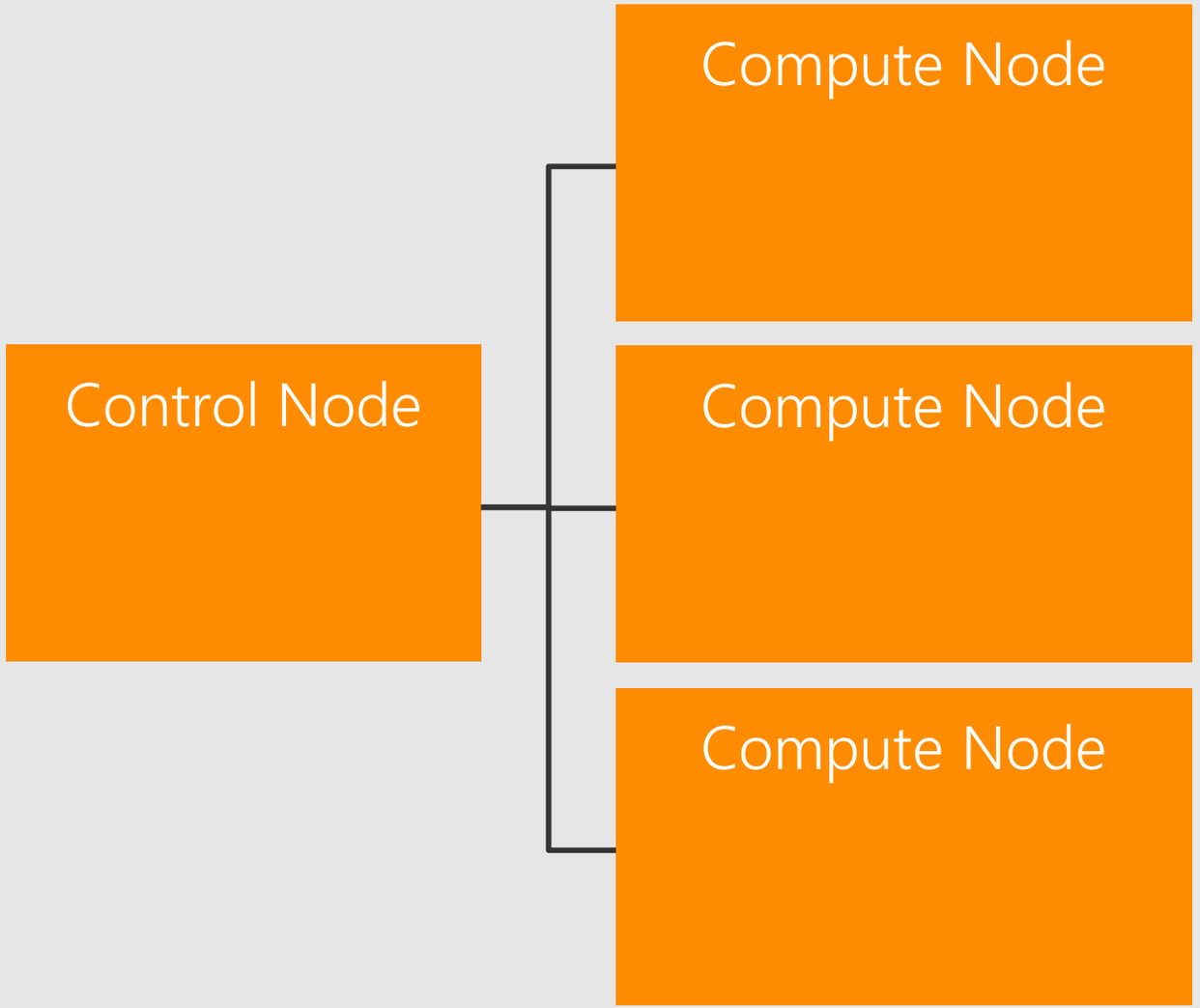
Fact Orders

Dim Customers

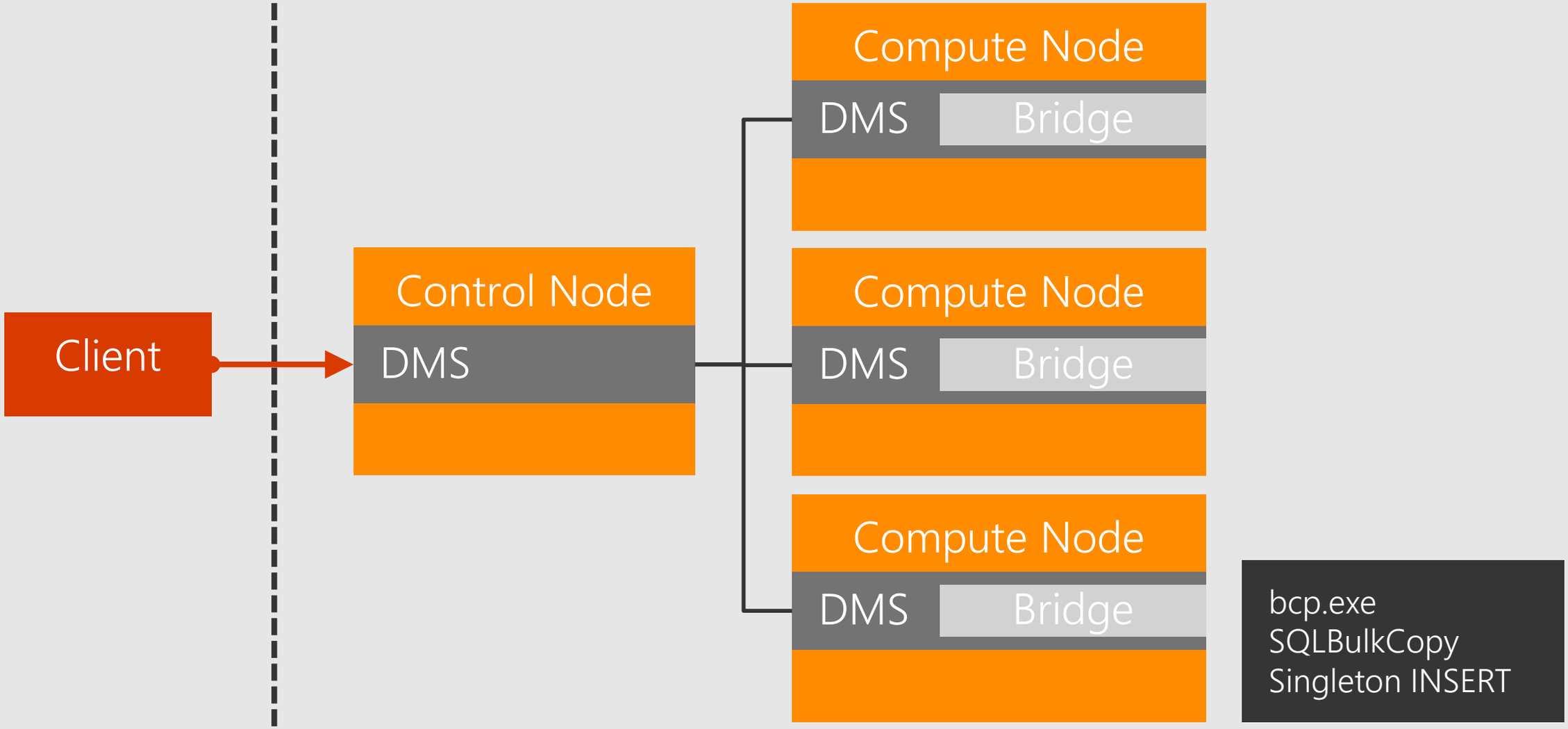
Dim Product

# Loading choices

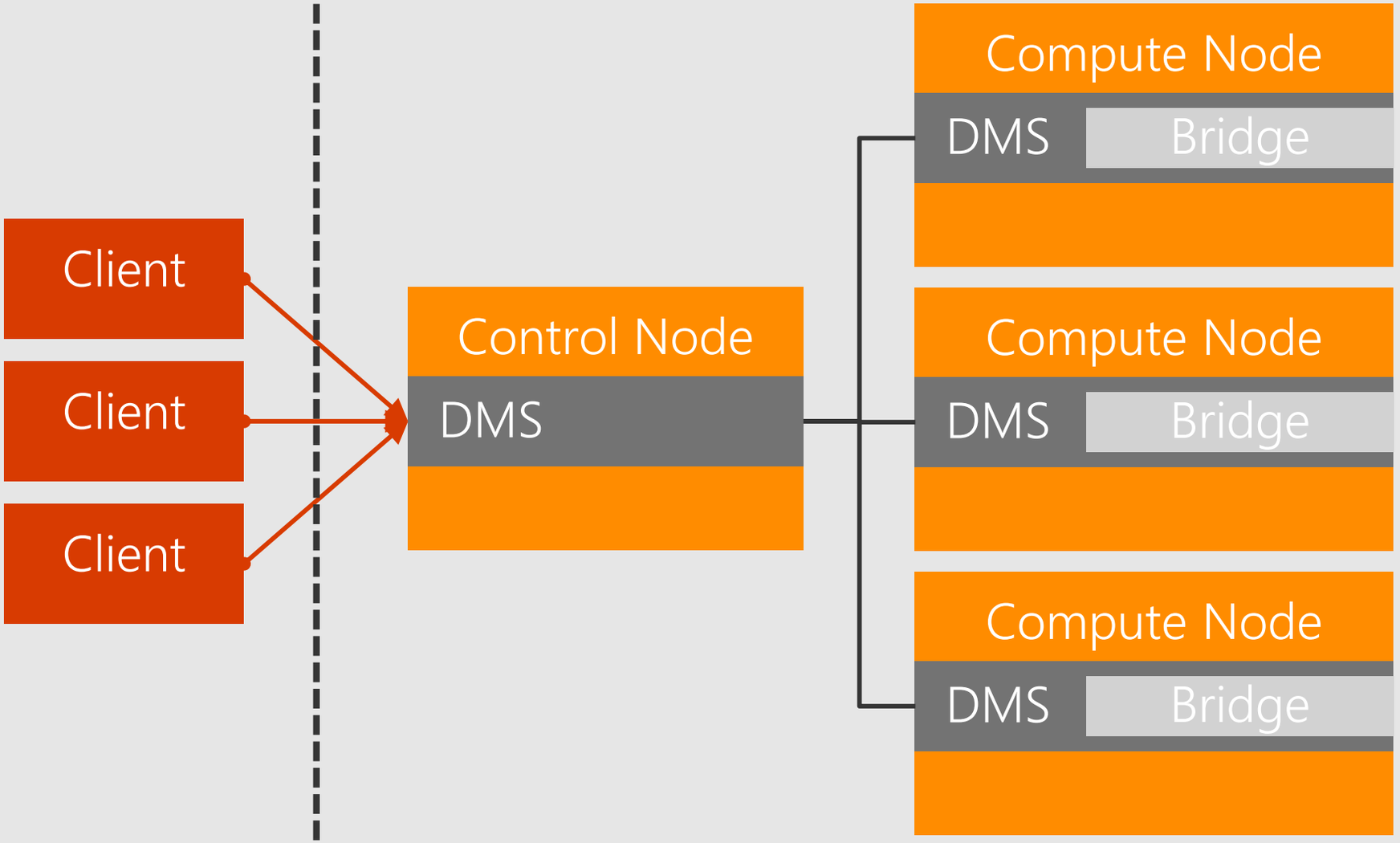
# Scaling



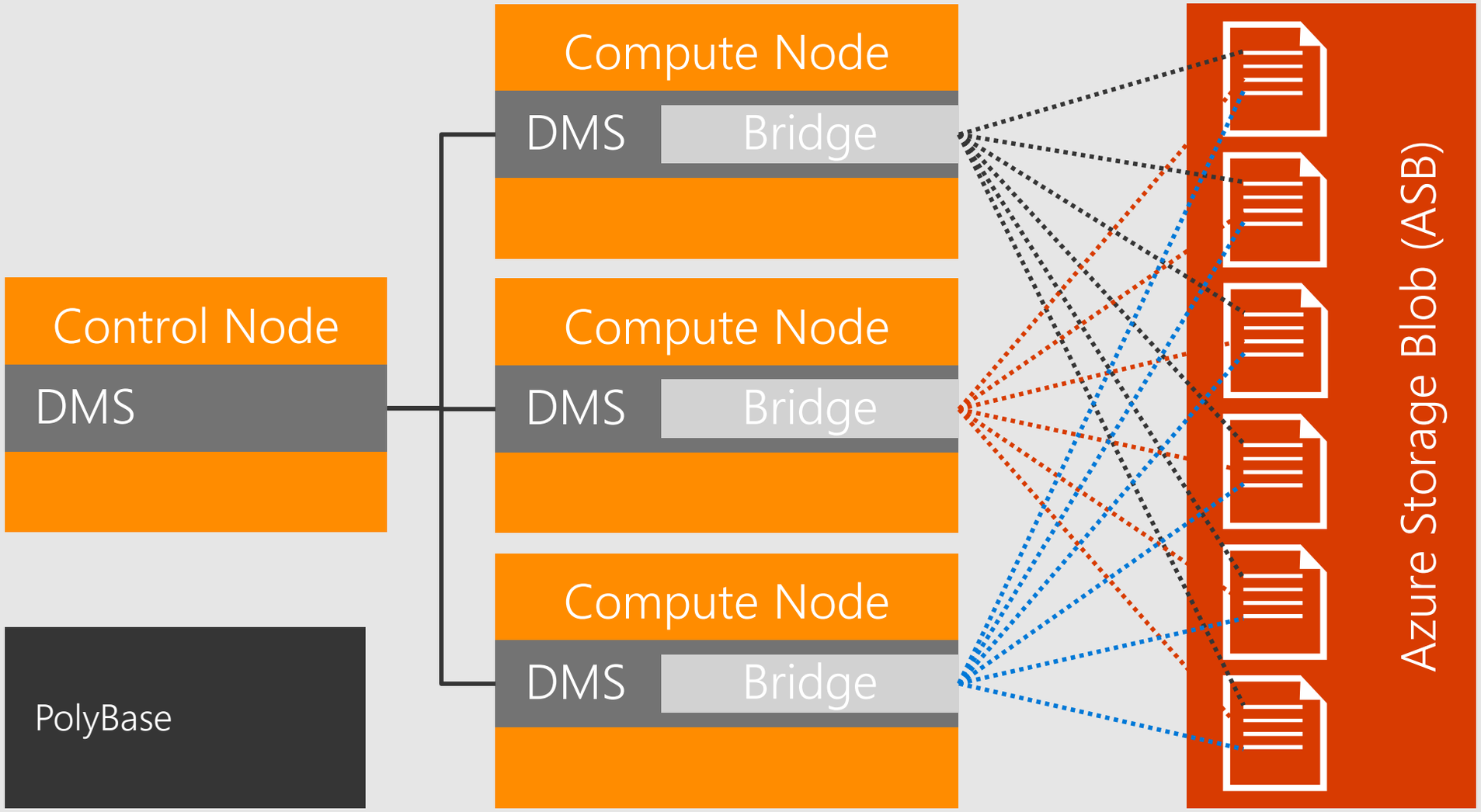
# Single gated client



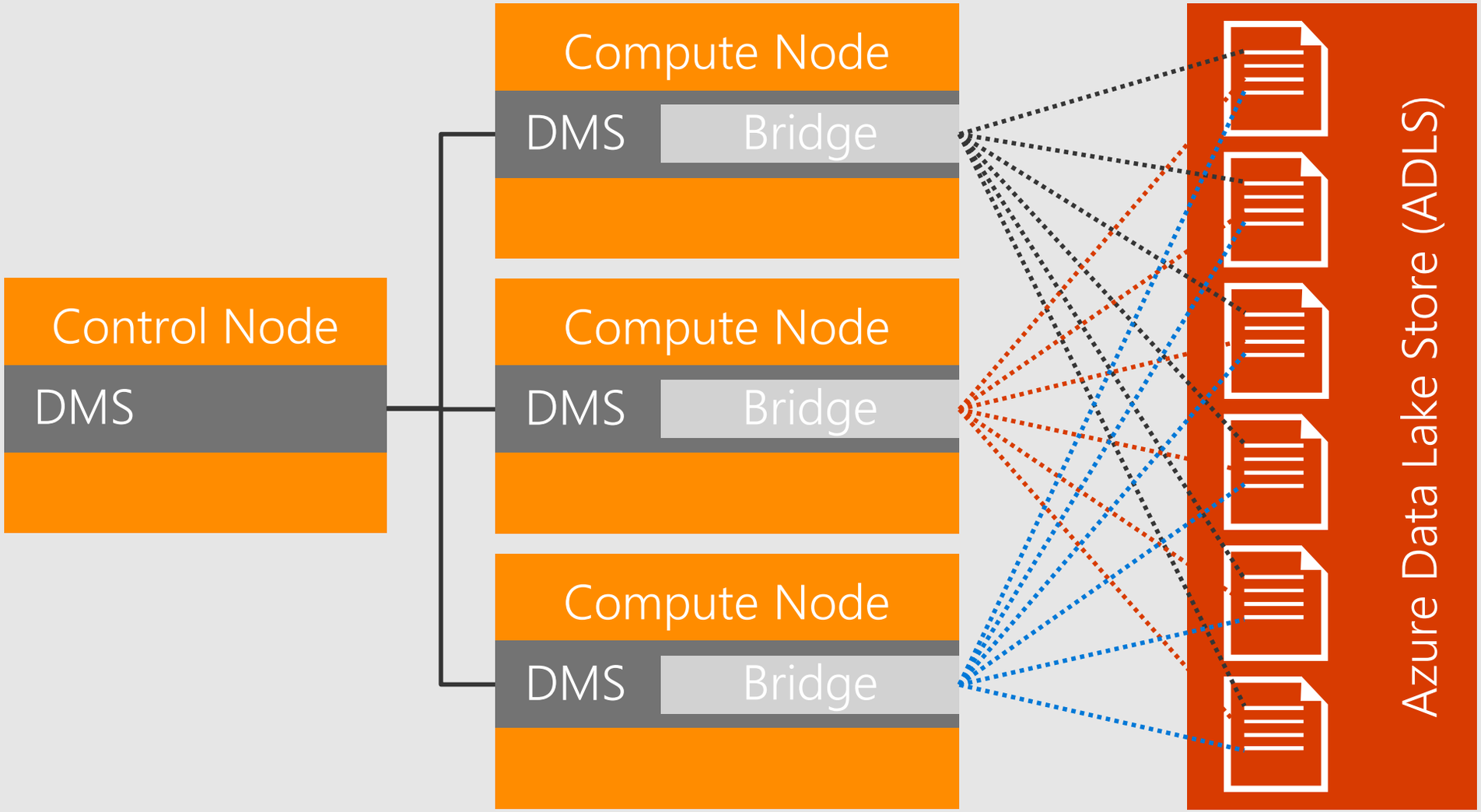
# Single gated client parallelized



# Parallel load via Azure Storage Blob



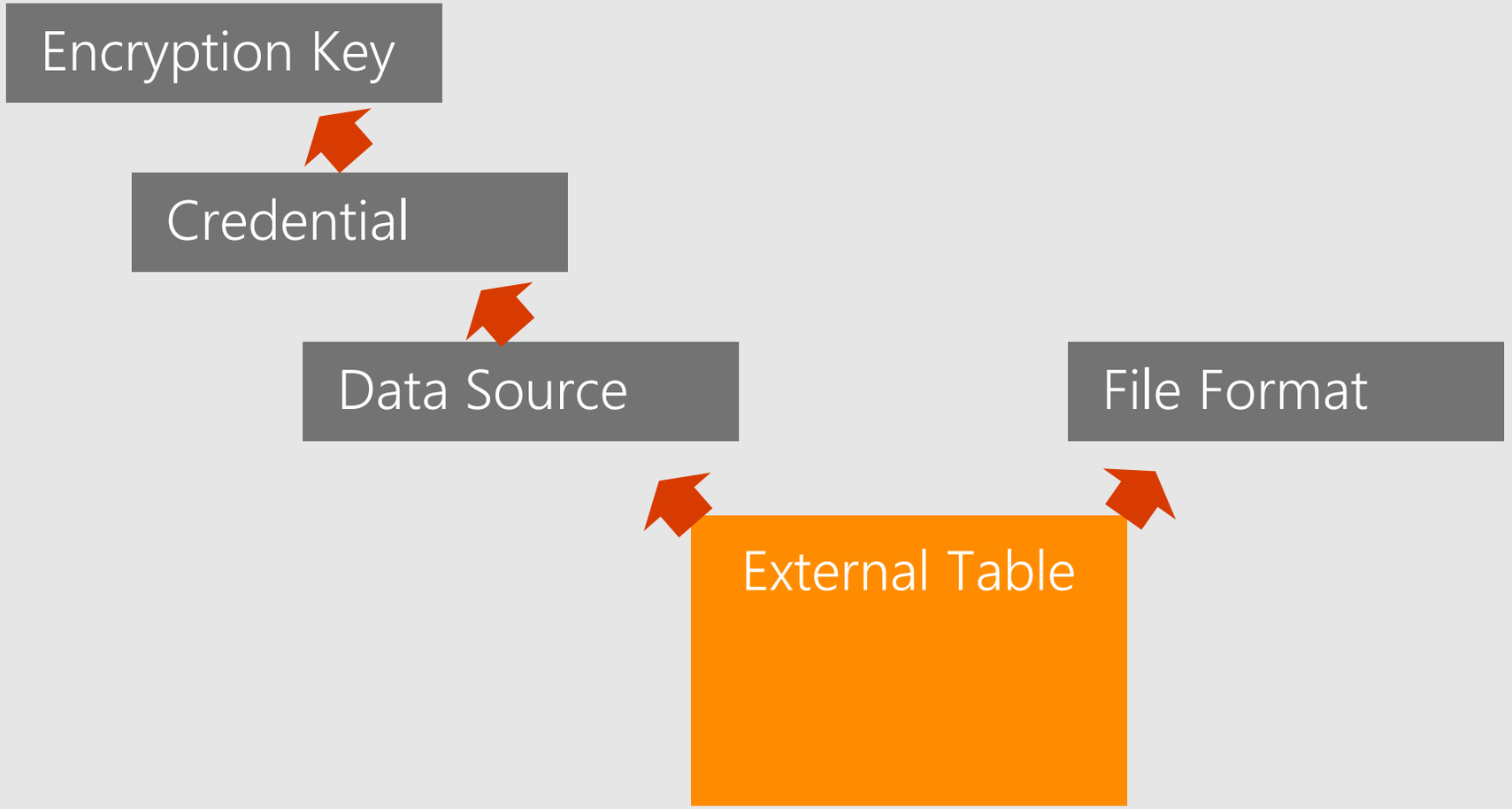
# Parallel load via Azure Data Lake Store



# Mechanism for loading

| | PolyBase | BCP | SqlBulkCopy | SSIS |
|---|---|---|---|---|
| Rate | Fastest Slowest | | | |
| Rate increase as DWU increases | Yes | No | No | No |
| Rate increases as you add concurrent load | No | Yes | Yes | Yes |

# External Table Object Structure



# Create external tables

```
CREATE EXTERNAL DATA SOURCE WASBStor
WITH (TYPE = Hadoop,
      LOCATION = 'wasbs://<container>@<account_name>.blob.core.windows.net',
          Credential = <Database scoped credential>)
;
CREATE EXTERNAL FILE FORMAT TextFile
WITH ( FORMAT_TYPE = DELIMITEDTEXT,
          DATA_COMPRESSION = 'org.apache.hadoop.io.compress.GzipCodec',
          FORMAT_OPTIONS (FIELD_TERMINATOR ='|', USE_TYPE_DEFAULT = TRUE)
     )
;

CREATE EXTERNAL TABLE [dbo].[Customer_import] (
    [SensorKey] int NOT NULL,
    [CustomerKey] int NOT NULL,
    [Speed] float NOT NULL
)
WITH (LOCATION='/Dimensions/customer',
      DATA_SOURCE = WASBStor,
      FILE_FORMAT = TextFile
)
;
```

Once per WASB container

Once per file format

File path

# Load statements

## CREATE TABLE AS SELECT

```
CREATE TABLE [dbo].[Customer]
WITH
(         Distribution = ROUND_ROBIN
,         Clustered Index (customerid)
)
AS
SELECT * FROM [dbo].[Customer_import]
```

Creates new table with specified distribution method and index.

Takes column definitions and nullability from External table

## INSERT … SELECT

```
INSERT INTO [dbo].[Customer]
SELECT * FROM [dbo].[Customer_import]
```

Inserts the data into existing relational table

# Demo:
# Simple table load

# Lab 003 – Data Loading through Polybase

*15 Mins*

# Load scenarios

| Loading Type | Source | Concerns | Advice |
| --- | --- | --- | --- |
| Batch load | WASB/ADLS | Latency of data | Do it! |
| Micro batch load | WASB/ADLS | Columnstore Index compression<br>Impact on machine resources | Make sure that loads are big enough |
| Streaming load<br>Trickle load | Azure Stream Analytics, BCP | Tight coupling limits elasticity<br>Stream load performance | Split streams to parallelize<br>Orchestrate pause and resume with source systems |

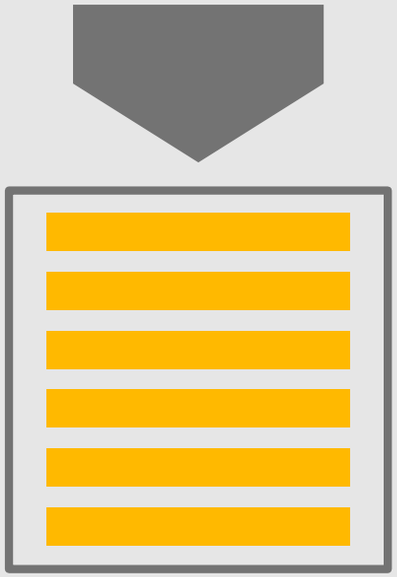
# Summary

# Row store or Column store?

Physical ordering of data

Frequent updates

Small dimension tables

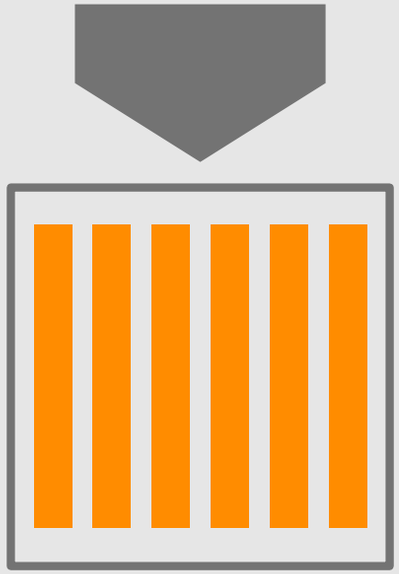


Row store

Default Recommendation

Append oriented loads

Fact tables & large dimensions



Column store

# Wrap Up

Use column store for large fact tables

Use row store for specific problems

Know your biggest join queries

Use those to figure out your hash distribution keys

Use partitioning for data lifecycle management

# Distribution Guidance

## For large fact tables, best option is to Hash Distribute

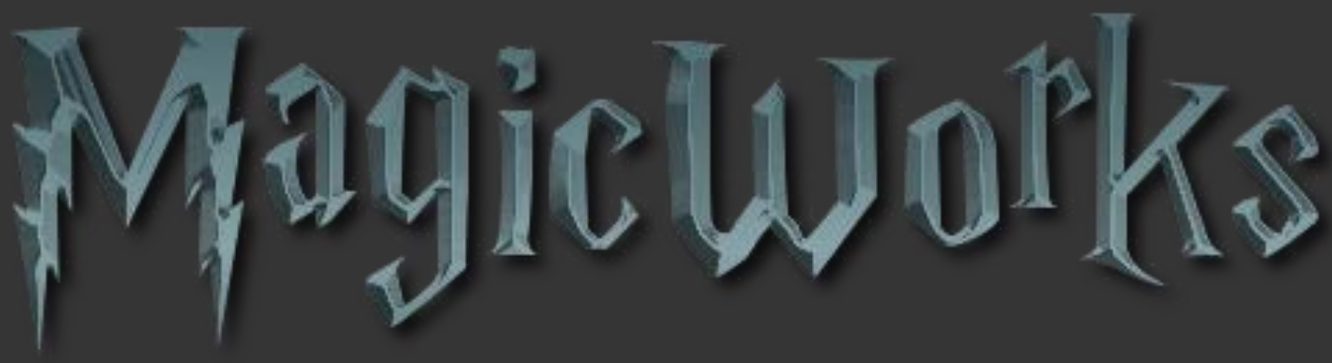
- Clustered Columnstore
- Distribute on column that is joined to other fact tables or large dimensions
- Primary or surrogate key maybe a good choice for distribution

## However, be mindful of …

- Hash column should have highly distinct values (Minimum 600 distinct values)
- Avoid distributing on a date column
- Avoid distributing on column with high frequency of NULLs and default values (e.g. -1)
- Distribution column is NOT updatable
- For compatible joins use the same data types for two distributed tables

## If there are no distribution columns that make sense, then use Round Robin as last resort

# Let's Get Loading




Blob Location: wasb://<container>@<account>.blob.core.windows.net

Git Repo Location: http://gitrepo/LoadingScripts