Hassle-free Dynamic Policy Enforcement in Trino

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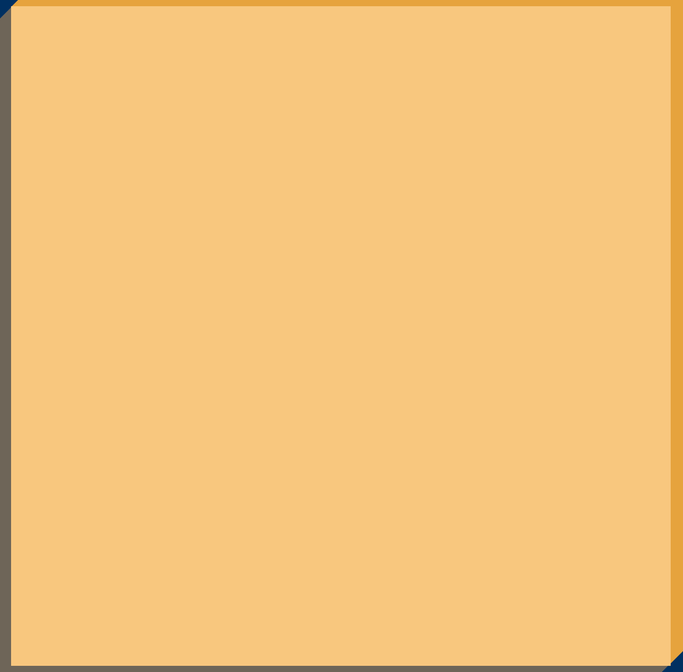
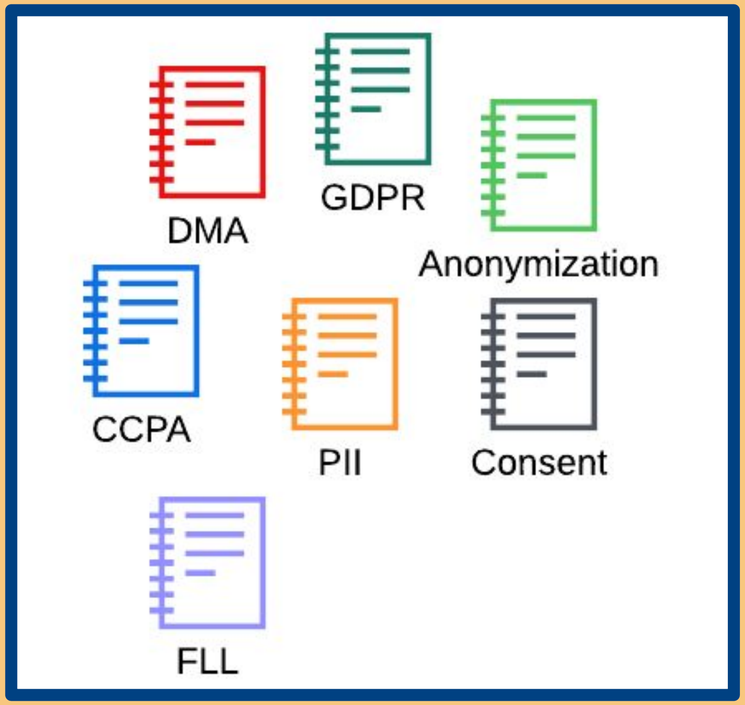
Policy Enforcement



Motivation



Too Many Policies!

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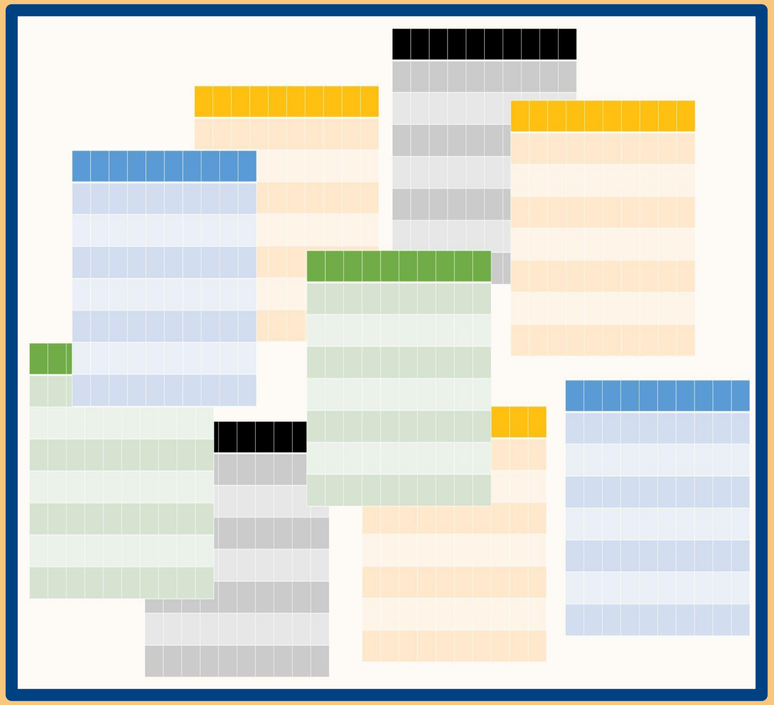

Too Much Data!

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Overwhelmed Data Engineers!

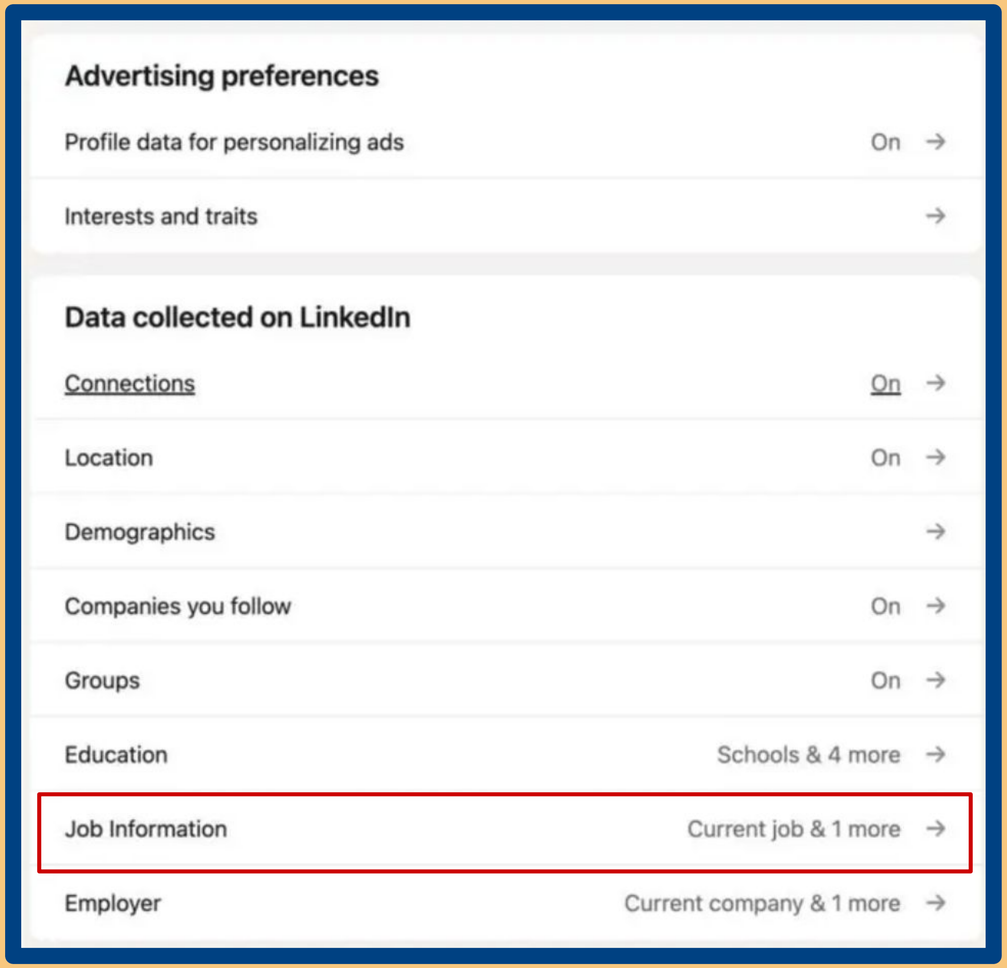
Policy Enforcement @ LinkedIn

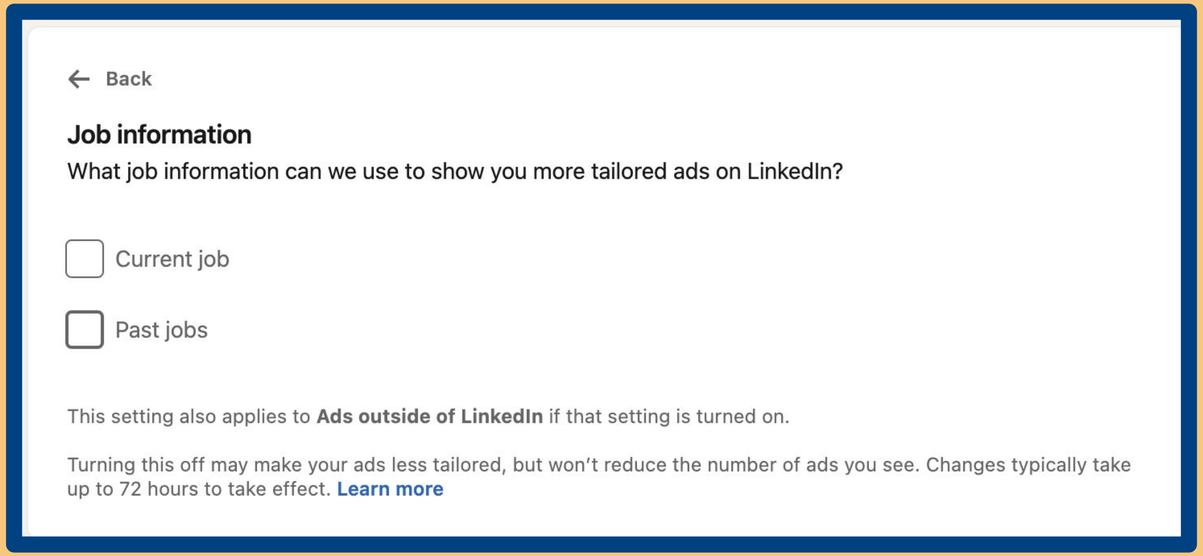
Member Preferences

Data Collection & Labeling

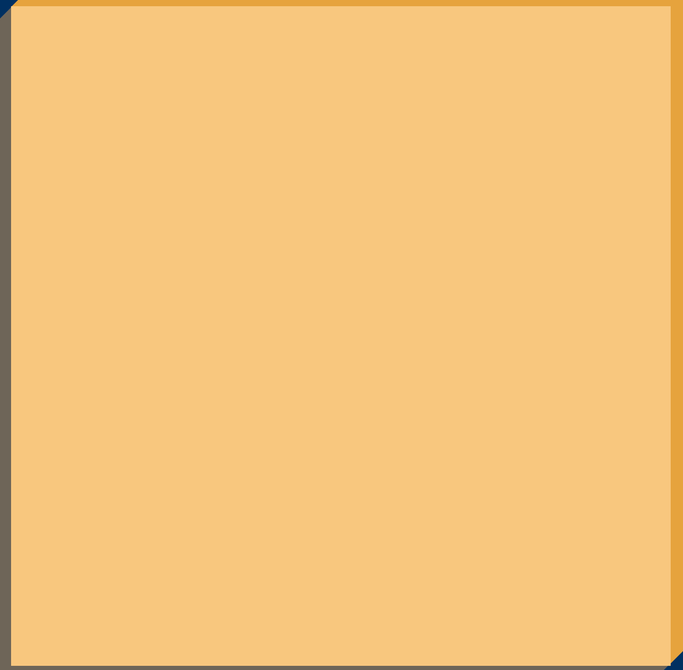
Purpose Limitation

Member Preferences : Example



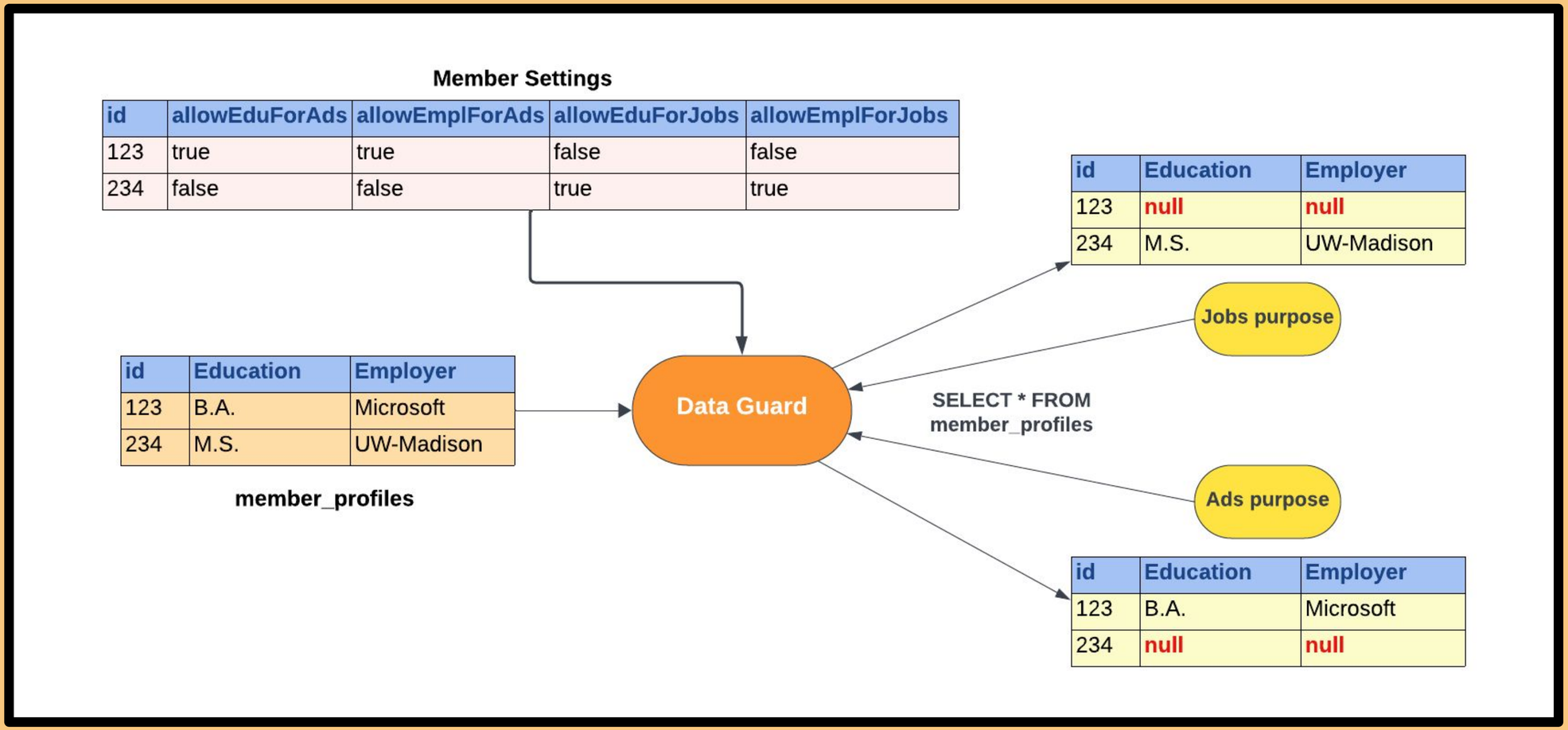


Data Guard:
How does it work?



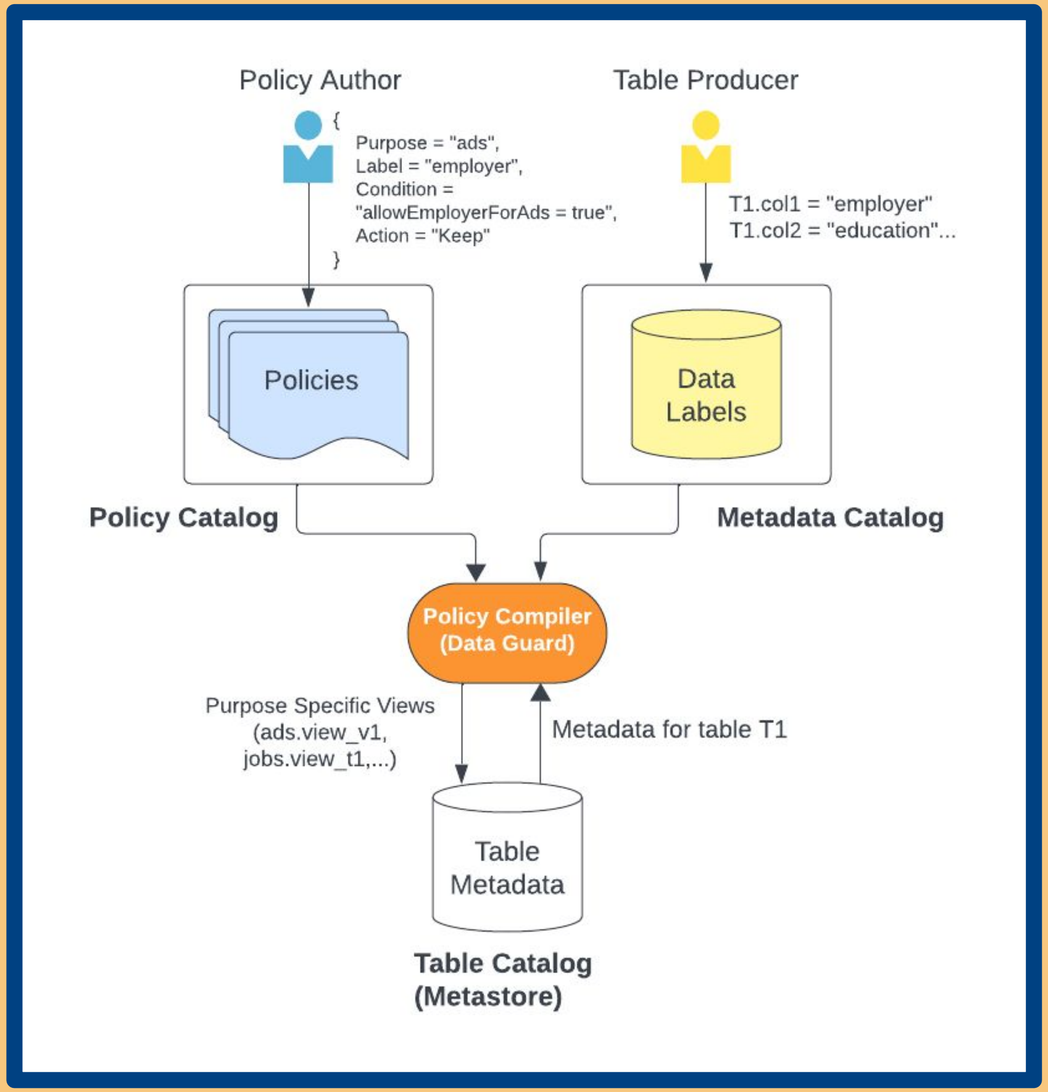
Policy Enforcement @ LinkedIn: Data Guard

- Data access through query engines (Trino, Spark) needs to be masked based on
  - Purpose of access
  - Data labels
  - Auxiliary data like member “preferences”



Data Guard : Data Masking Views

- *Views* are the interface for policy enforcement
- Data Guard programmatically creates purpose-specific data-masking views on tables
- Views are accessible through query engines like Trino and Spark
- Data Guard compiles the View SQL on a table using the metadata catalog for “data labels” and policy catalog for “policies”
- Views are refreshed periodically with changes in policies and data labels



Data Masking Views : Example

member_profiles table

id	col1	col2
123	B.A.	Microsoft
234	M.S.	UW-Madison

Labels for member_profiles

column_name	label
id	*dataSubjectId*
col1	*education*
col2	*employer*

member_settings

id	allowEduForAds
123	true
234	false

Data labeled as "education" should not be used for "Ads" purpose if the user has not consented to it

Data Guard View SQL for "Ads" Purpose

Schema preserving

Consent check

```
SELECT
    T1.id id,
    T1.col1 col1,
    CASE
      WHEN T2.allowEduForAds = true THEN T1.col2
      ELSE NULL
    END col2
FROM
     member_profiles T1 JOIN member_settings T2
ON T1.id = T2.id
```

Views : Masking Granularity

col1	col2		col3	col4
	field21	field22		
abc	123	foo	field31 / field32 s1 / 113	null
def	243	bar	null	null
ghj	123	bar	field31 / field32 s1 / 345 s3 / 212	key / value k1 → field41 / field42: v1 / true; v2 / false k2 → null

	Scenario	Field path representation
	primitive	$.col1
	conditional row filter	$[?(@.col1 = 'def')]
	conditional field removal	$[?(@.col2 = 'ghj')].col2
	array conditional removal	$.col3[:][?(@.field31 = 's1')]
	map conditional removal	$.col4[:].value[?(@.field41 = 'v2')][:].field42

Using Views

Expressive - Express multiple policies with projections, filters, joins, UDFs.

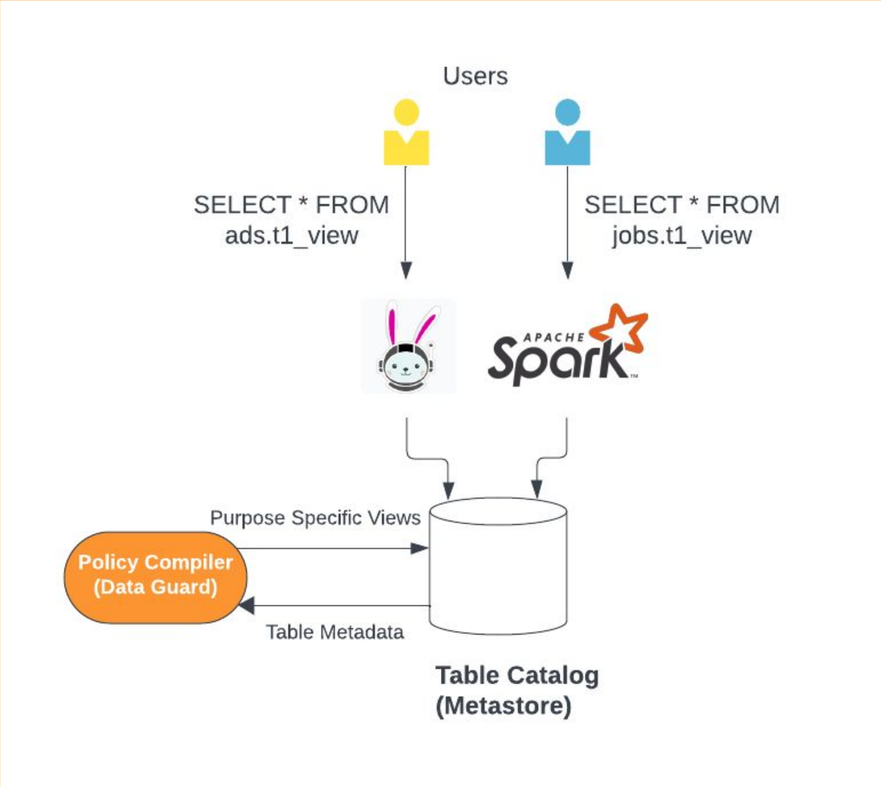
Portable - Executable on multiple engines

Modular - Can be drop-in replacement to underlying data

Agile - Roll-out new views, version, rollback to previous views

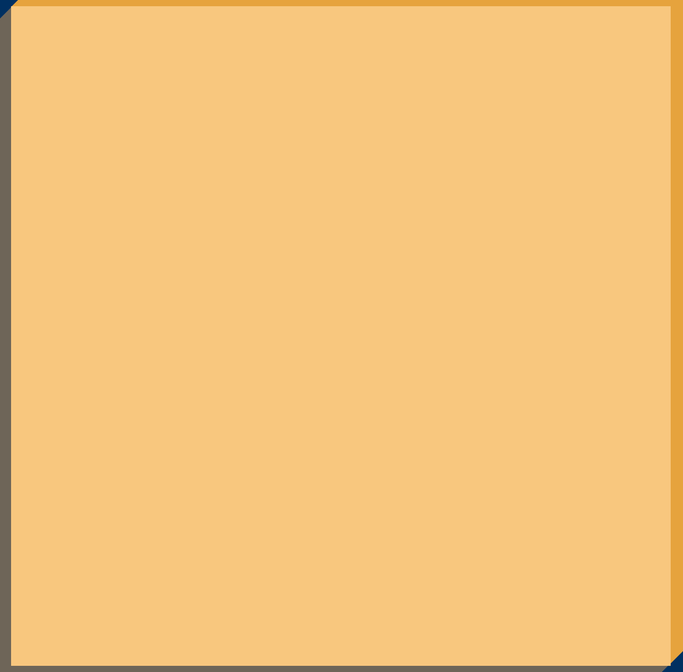
Data Guard : View Usage

- Users can access purpose-specific views through Trino and Spark



- Next : How to roll this out to make workloads compliant?

Data Guard:
How is it rolled out?



How to roll out views?

Large Scale Migration?

- Force apps/users to apply the policy by explicitly adopting Data Guard views

Expensive & Slow

```
Select
    T1.a,
    T2.b,
    MAX(T3.c)  AS  max_c
FROM
    T1
INNER  JOIN
    T2  ON  T1.a  =  T2.c
LEFT  OUTER  JOIN
    T3  ON  T2.b  =  T3.a
GROUP  BY
    T1.a,  T2.b
ORDER  BY
    T1.a  DESC,  T2.b  ASC;
```

→

```
Select
    T1_DMView1.a,
    T2_DMView1.b,
    MAX(T3_DMView1.c)  AS  max_c
FROM
    T1_DMView1
INNER  JOIN
    T2_DMView1  ON  T1_DMView1.a  =  T2_DMView1.c
LEFT  OUTER  JOIN
    T3_DMView1  ON  T2_DMView1.b  =  T3_DMView1.a
GROUP  BY
    T1_DMView1.a,  T2_DMView1.b
ORDER  BY
    T1_DMView1.a  DESC,  T2_DMView1.b  ASC;
```

Expose implementation details

```
Select
    *
FROM
    member_profiles;
```

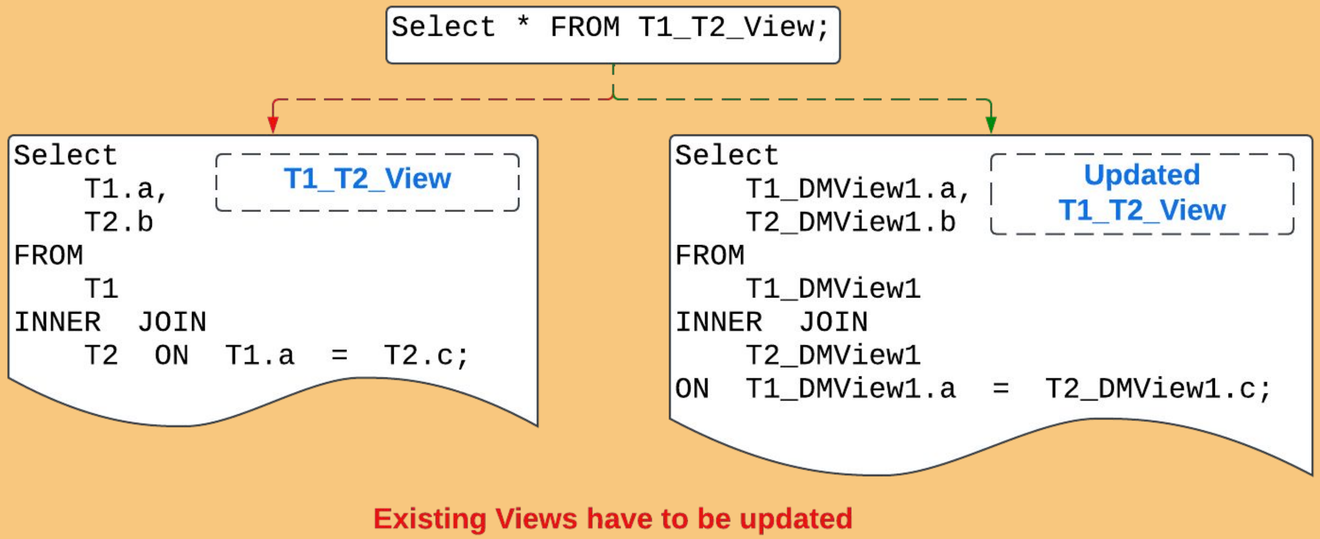
→

```
Select
    *
FROM
    ads.member_profiles_redact_pi;
```

How to roll out views?

Large Scale Migration?

- Force apps/users to apply the policy by explicitly adopting Data Guard views

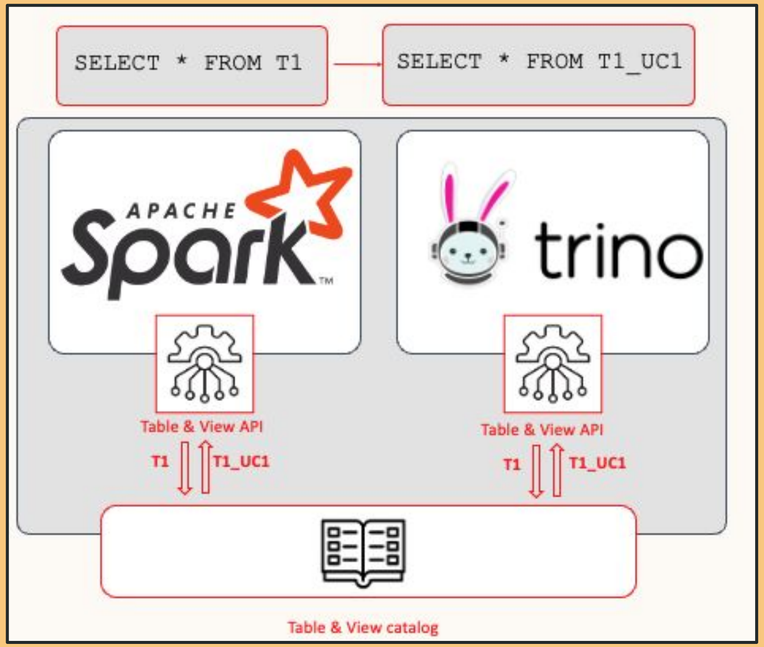


Recreate/Update Existing Views

Error prone

Solution → ViewShift

Dynamically route tables to views at runtime!



Transparently replaces table access with views

Familiar dataset names
Does Not expose policy details

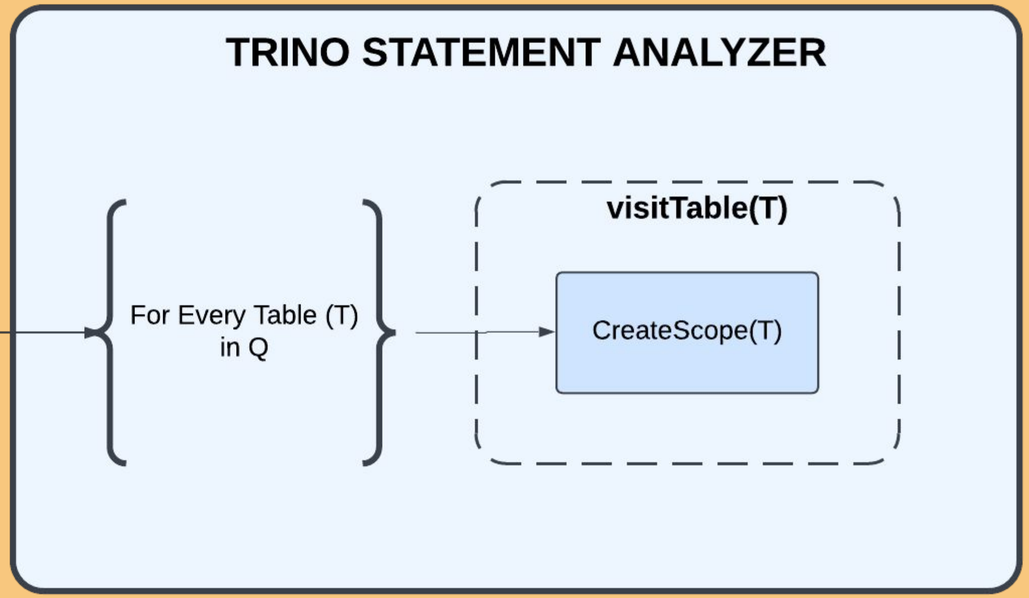
Works for future regulation

Cross engine compatibility

Trino without ViewShift

Query (Q)

```
1  Select
2      T1.a,
3      T2.b,
4      MAX(T3.c)  AS  max_c
5  FROM
6      T1
7  INNER  JOIN
8      T2  ON  T1.a  =  T2.c
9  LEFT  OUTER  JOIN
10     T3  ON  T2.b  =  T3.a
11 GROUP  BY
12     T1.a,  T2.b
13 ORDER  BY
14     T1.a  DESC,  T2.b  ASC;
```



Trino with ViewShift

Query (Q)

```
Select
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FROM
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INNER  JOIN
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LEFT  OUTER  JOIN
    T3  ON  T2.b  =  T3.a
GROUP  BY
    T1.a,  T2.b
ORDER  BY
    T1.a  DESC,  T2.b  ASC;
```
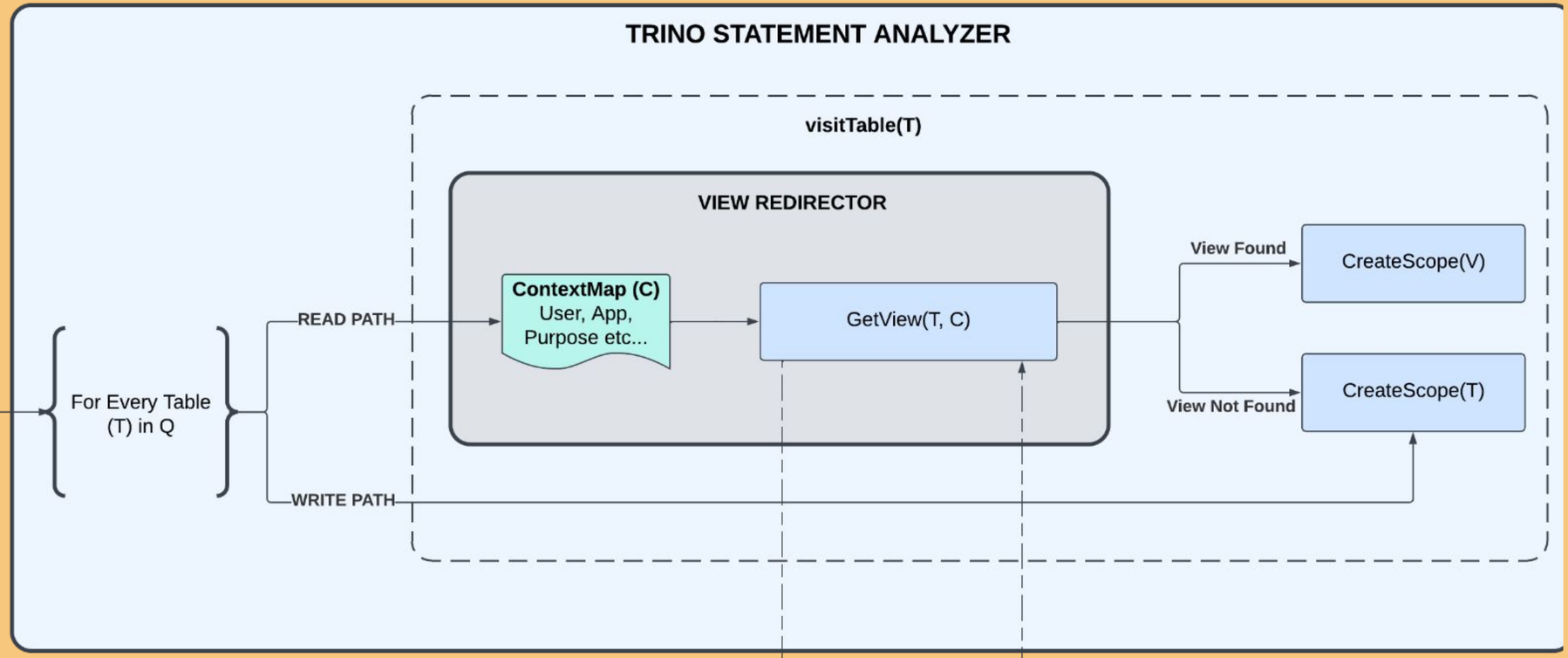
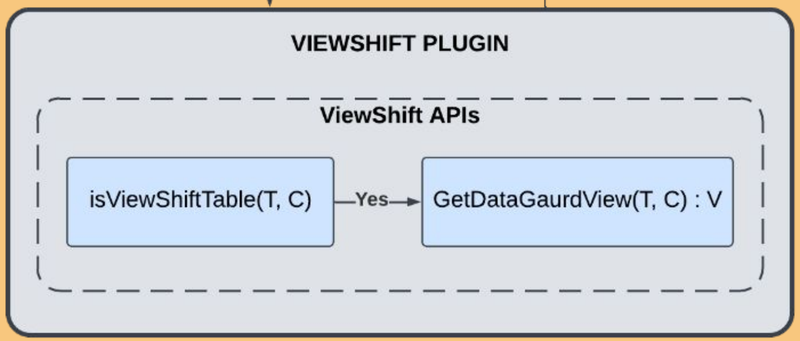
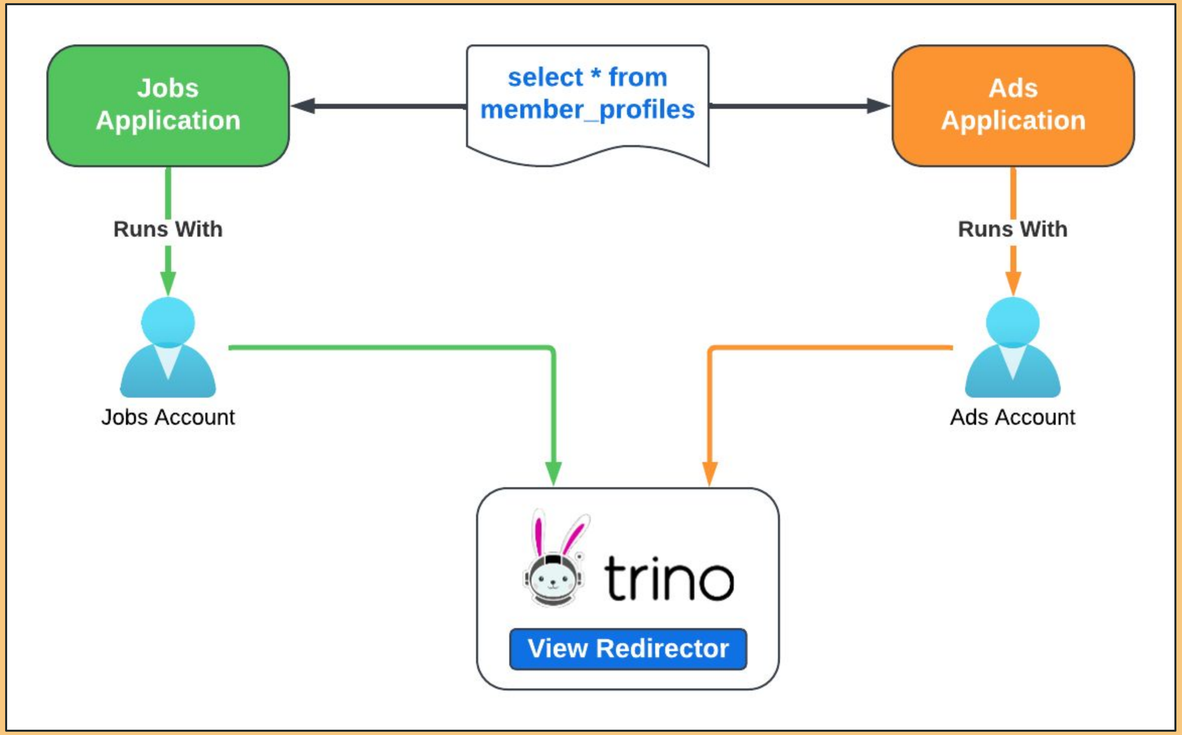
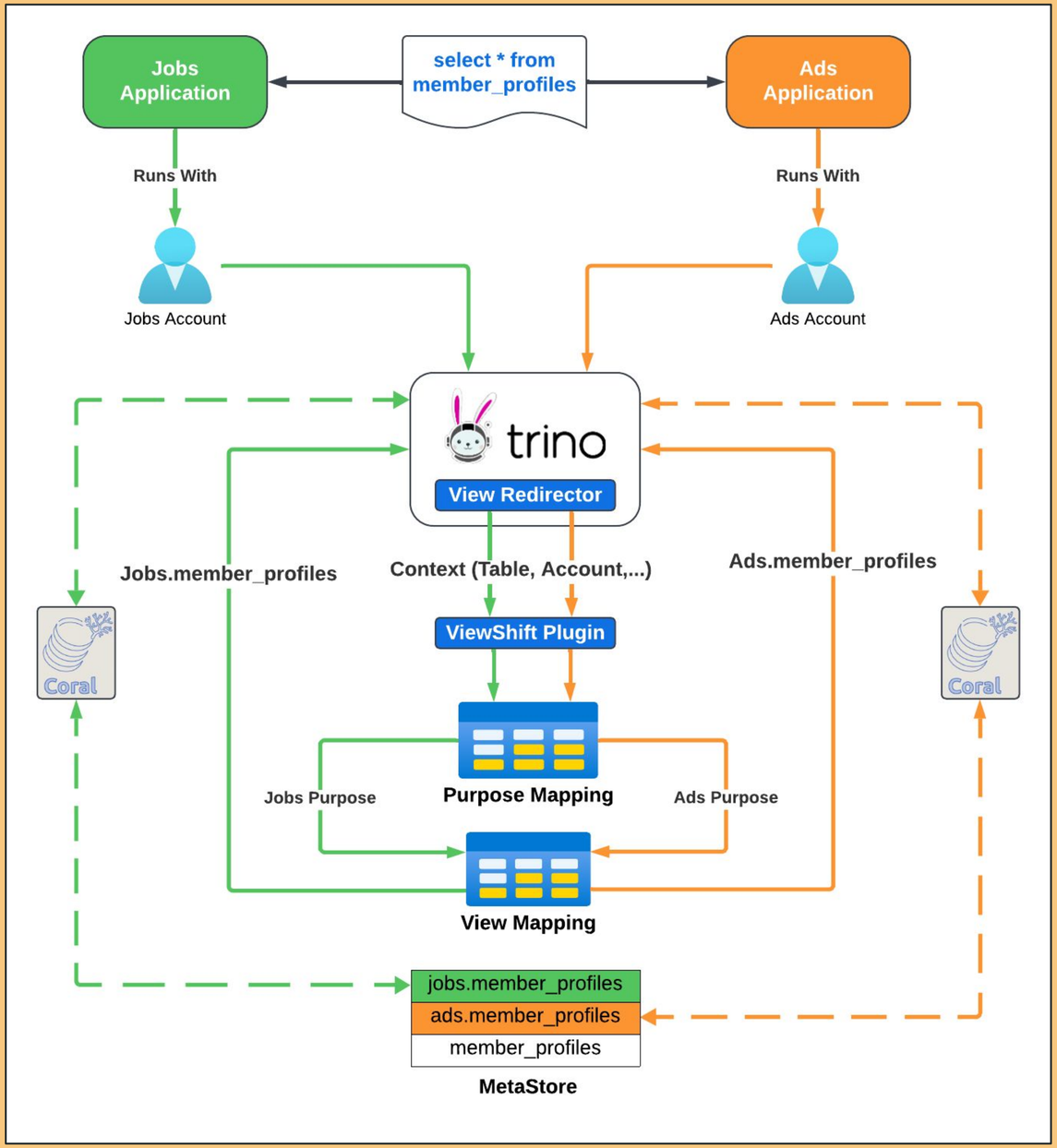





Example : Trino Query With ViewShift



Example : Trino Query With ViewShift



Other Approaches

- *Row Filter/Column Masking*
- *View + Table Redirection*

Future Work

- ***Open Source***
  - *Goal : More Generic and OSS friendly*
  - *Approach : Extend Table Redirection With ViewShift APIs*

Thank you