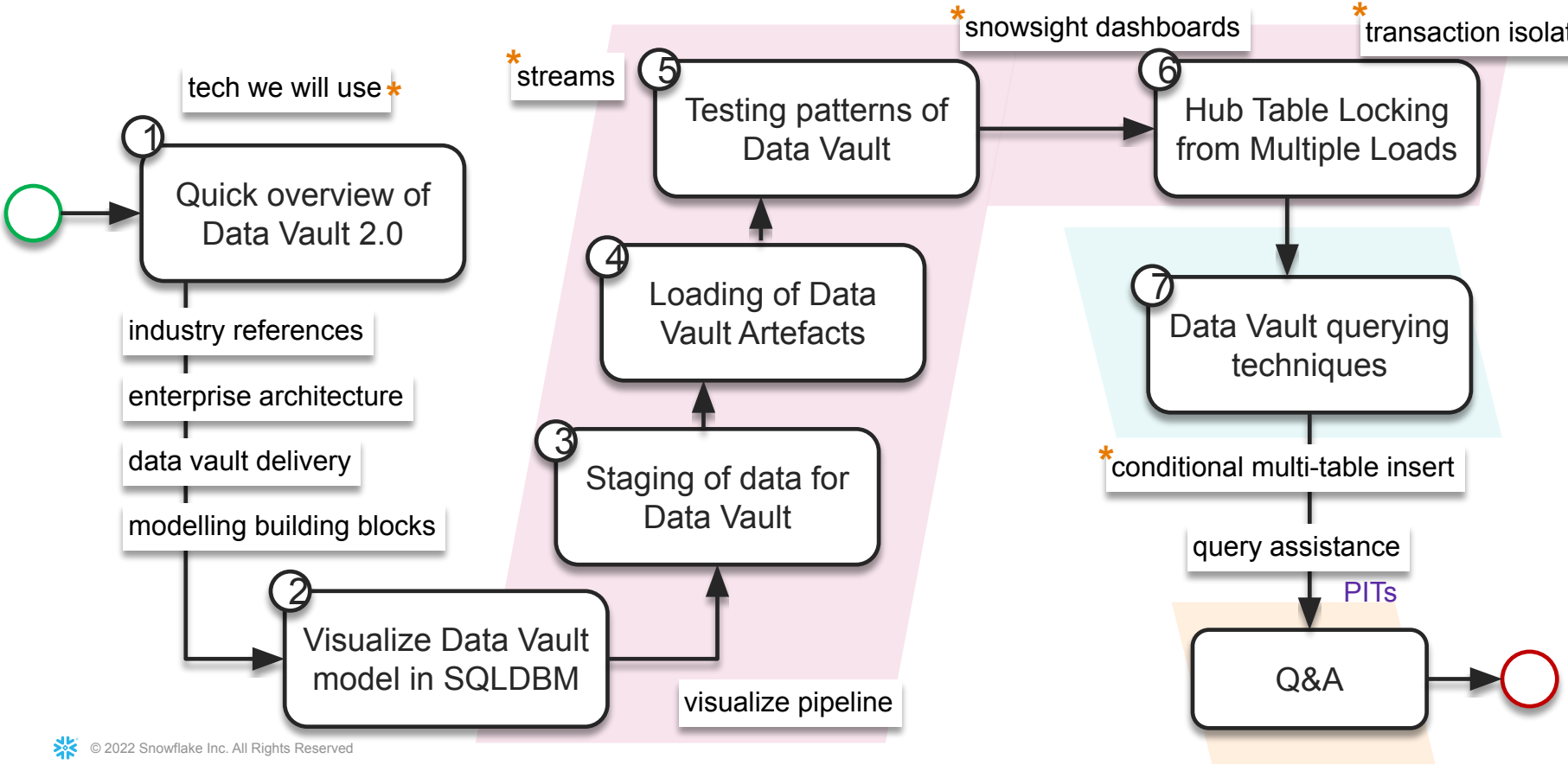
PRAGMATIC GUIDE TO BUILDING A DATA VAULT ON SNOWFLAKE

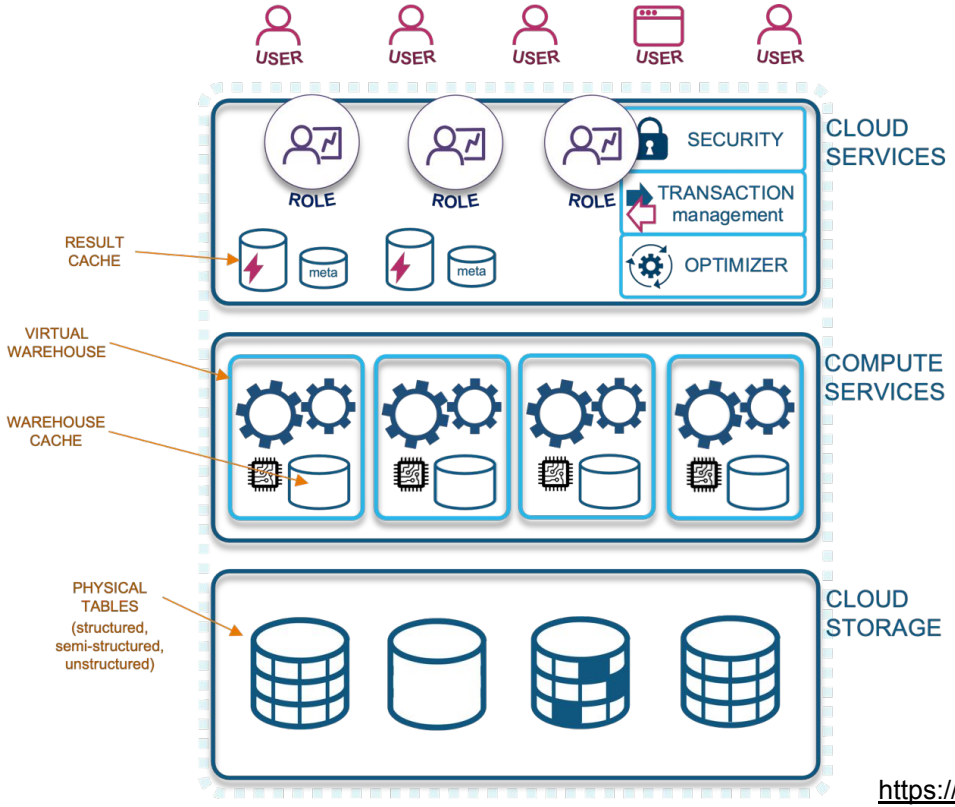
Overview, References & What Works

… explanation and a follow along demo

ZERO TO (Data Vault on) SNOWFLAKE



SNOWFLAKE CACHE



Services Layer

- **Metadata Cache**

- Object Definitions, Statistics

- **Results Cache – same ROLE can access**
  - Exact Results from Exact Queries
  - Lasts for 24 Hours, 7-day max
  - Underlying data cannot have changed
  - Context functions case expiries

Compute Layer – autoscale, autosuspend

- Virtual Machines
- SSD cache
- Suspended flushes Cache
- Can have partial cache

Storage Services – centralized (“Remote”)

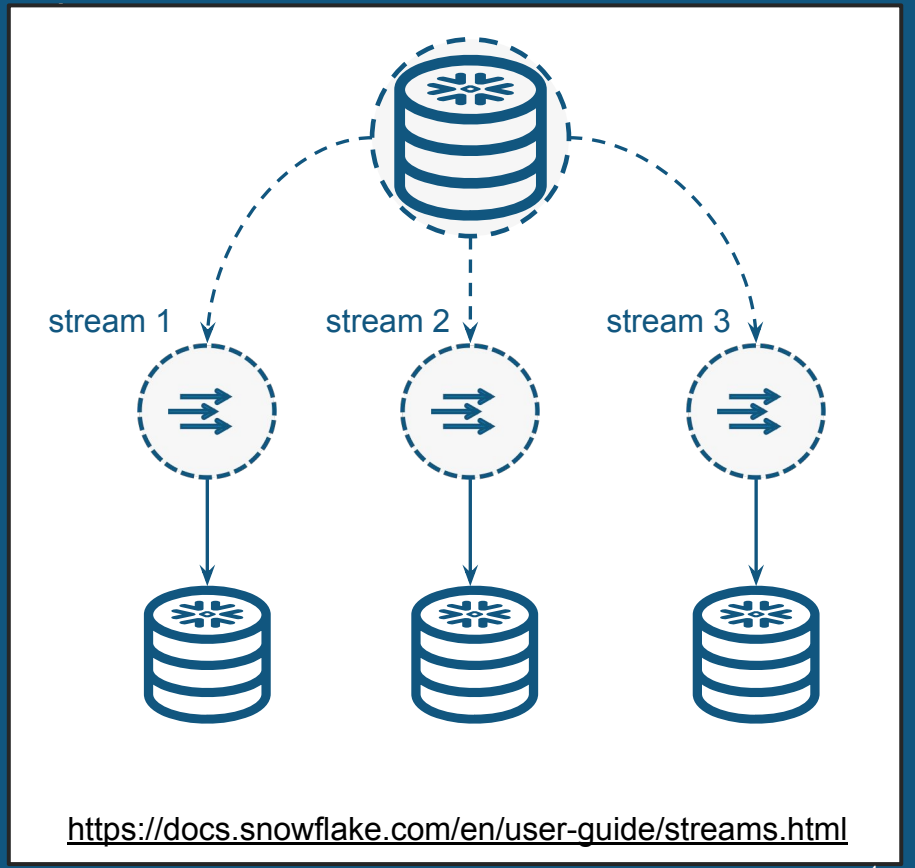
- Database, schema, tables, views, etc.
- S3 / Blob / Cloud Storage

https://docs.snowflake.com/en/sql-reference/functions/result_scan.html
https://community.snowflake.com/s/article/Caching-in-Snowflake-Data-Warehouse

STREAMS (CDC)

- Change Data Capture (CDC) for Snowflake tables
- Provides a mechanism for detecting and recording data ***CHANGES*** to tables over time – this is the ***OFFSET.***
- Provides a timestamp, operation and column values
- Useful for efficient, **INCREMENTAL** data processing within ELT
- Stream Types: Standard or **APPEND ONLY**
- **NO LIMIT** on Streams per object
- DML ***consumes*** streams, **progresses** OFFSET

create or replace stream reconcile_hub_account
on table hub_account append_only = true



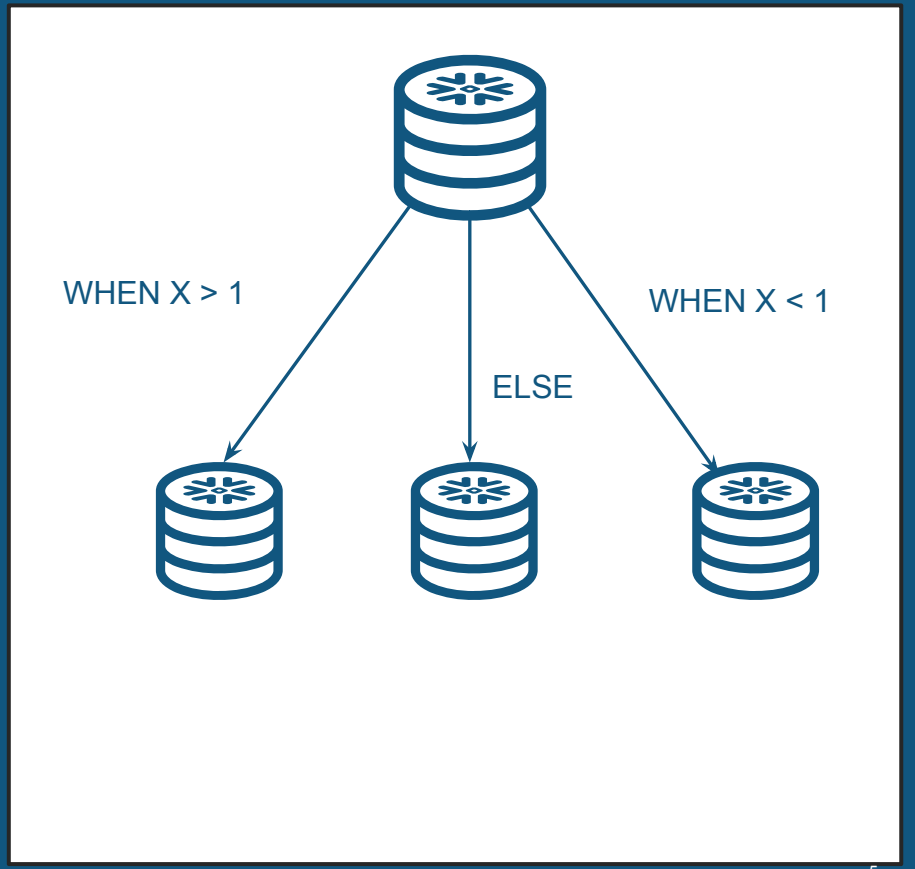
https://docs.snowflake.com/en/user-guide/streams.html

MULTI-TABLE INSERT

- Single source query, can include joins
- **UNCONDITIONAL** – insert to all identified targets
- CONDITIONAL ***WHEN*** clause can be
- FIRST - *executes for first TRUE condition*
- ALL – executes for all TRUE conditions
- OVERWRITE – reloads target

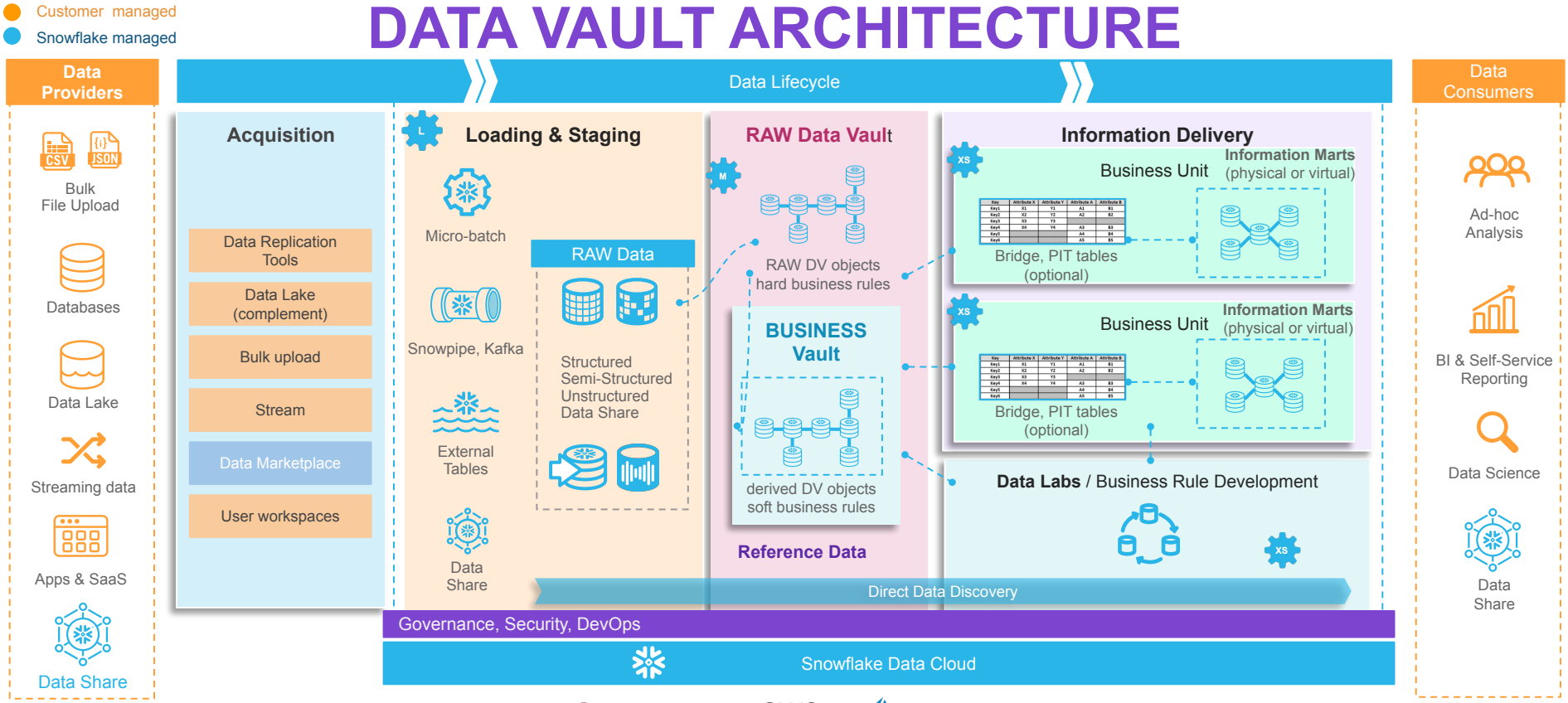
https://docs.snowflake.com/en/sql-reference/sql/insert-multi-table.html

insert all when (aof_week_lastday=1) …



DATA VAULT 2.1
AUDIT, AGILE, AUTOMATED

MULTI-TIER (+CHARGEBACK)
DATA VAULT ARCHITECTURE



Google Cloud aws Azure

*"A system of Business Intelligence containing the necessary components needed to accomplish **enterprise vision** in **Data Warehousing and Information Delivery**"*

Dan Linstedt, Data Vault inventor

*"A data warehouse is a subject-oriented, integrated (**by business key**), **time-variant** and **non-volatile** collection of data in support of management's decision-making process, and/or in support of **auditability** as a system-of-record.'*

Bill Inmon, father of the data warehouse at World Wide Data Vault Consortium (wwdvc) 2019

*"Data Vault **reaches a tipping point** – Data Vault modelling techniques are going to reach a tipping point in 2020 where a plurality of projects that involve building or refactoring the "hub" layer of a 3-tier data warehouse architecture will employ this modelling technique".*

Eckerson Group

ENTERPRISE ARCHITECTURE

Business process as defined as a behaviour element that groups behaviour based on an ordering of activities

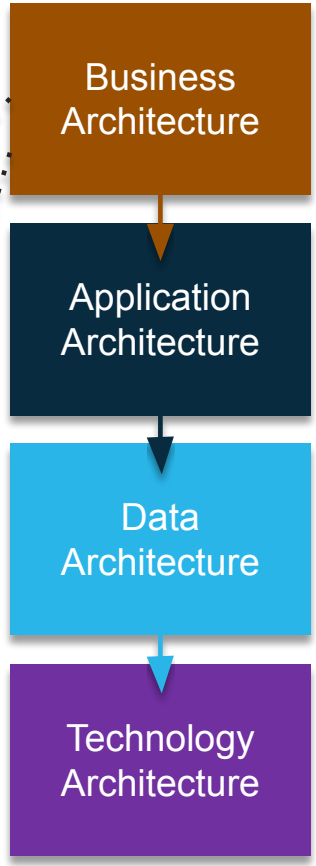
A ***business object*** is a passive element that has relevance from a business perspective

- ArchiMate 2.1

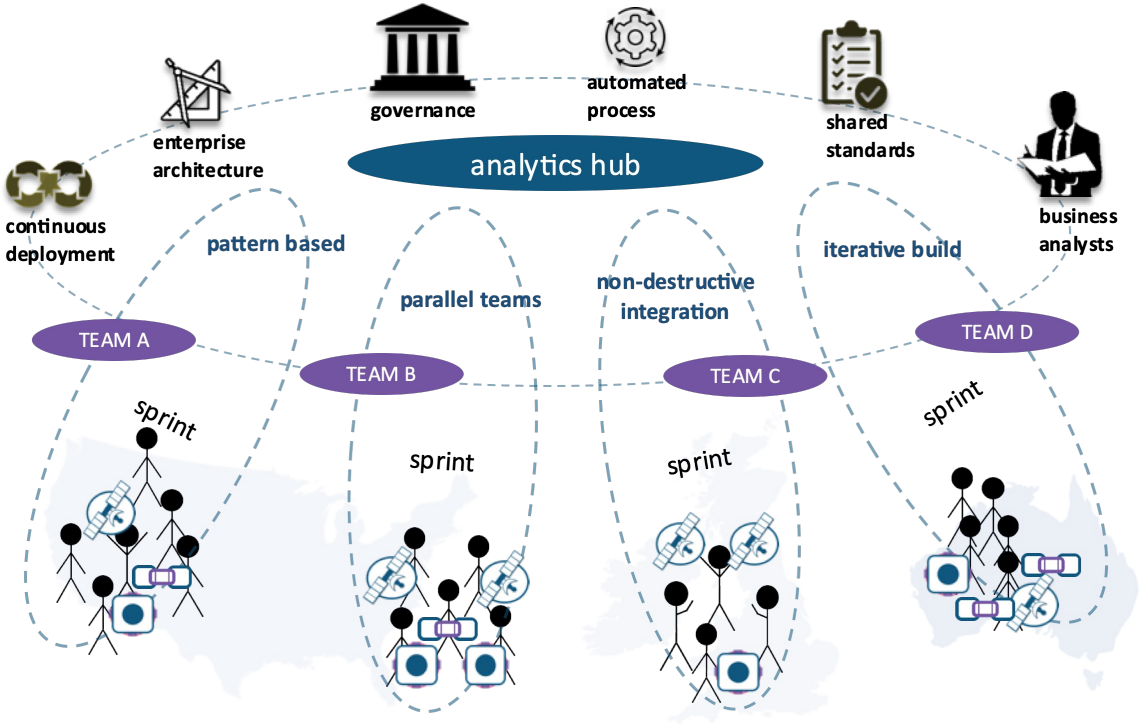
A ***Business Capability*** defines *what* the business does…
Capabilities are based on ***Business Objects***

Business Objects are tangible things commonly recognized by the business, ex. agreement, customer, account, insurance policy, claim, asset, agent, plan, message, research and human resource

- The Business Architecture Body of Knowledge (BIZBOK)

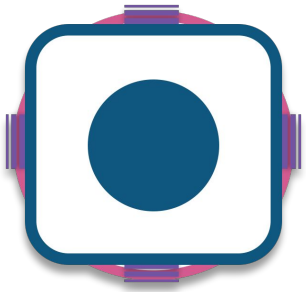


DATA VAULT DELIVERY



- **Shared** approach & standards
- **Central governance**
- Independent **agile teams**
- Data model that relates to **business architecture**
- Common Hubs but **autonomous** business cases
- **Scalable**, flexible, rapid analytics

DATA VAULT MODELLING BUILDING BLOCKS



hubs

contains a unique list of **business objects** that represents a domain or concept within the enterprise, everything else connected to the hub gives us more context

immutable business key

links

represents the relationship between two or more **business objects**, representing a part of one or many business processes or even value streams

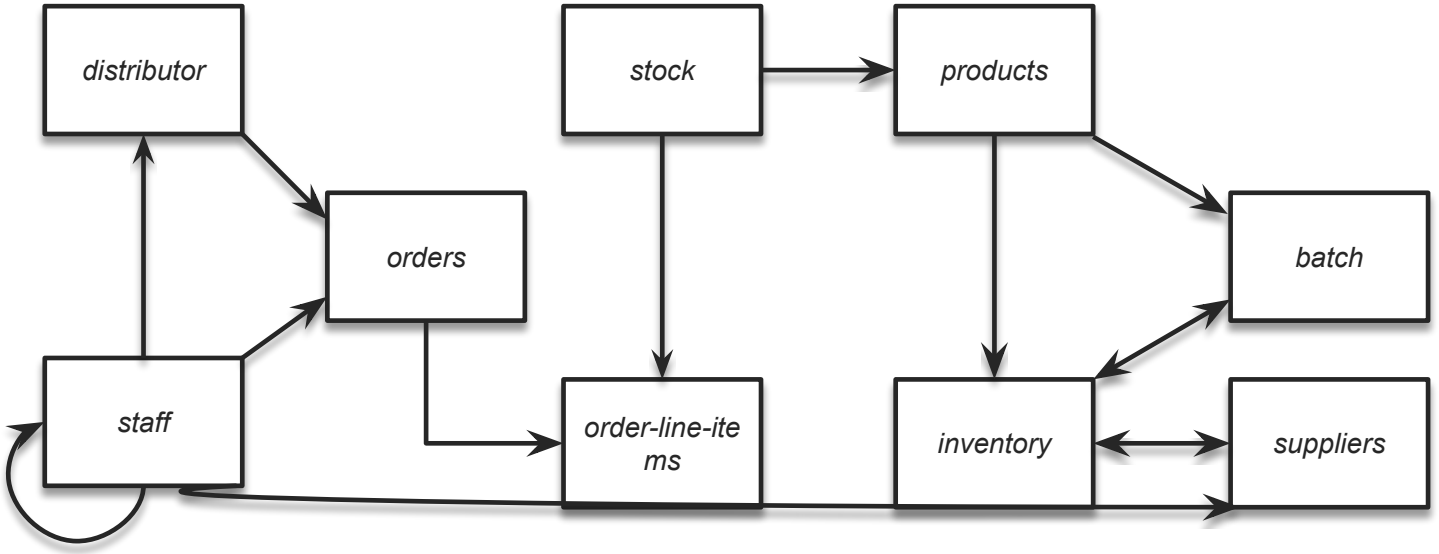
unit of work

satellites

descriptive change-tracking content either describing the **business object** (hub-satellite) or the unit of work (link-satellite)

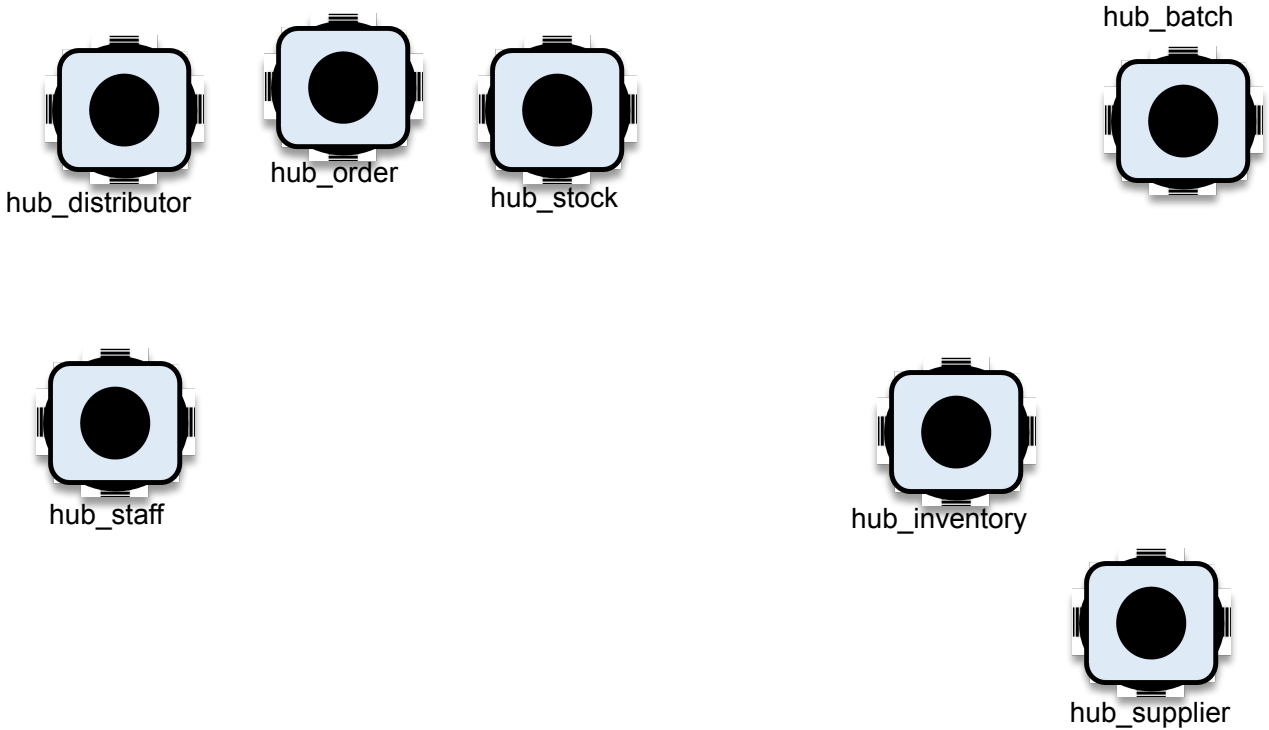
descriptive content

BUSINESS CAPABILITY EXAMPLE

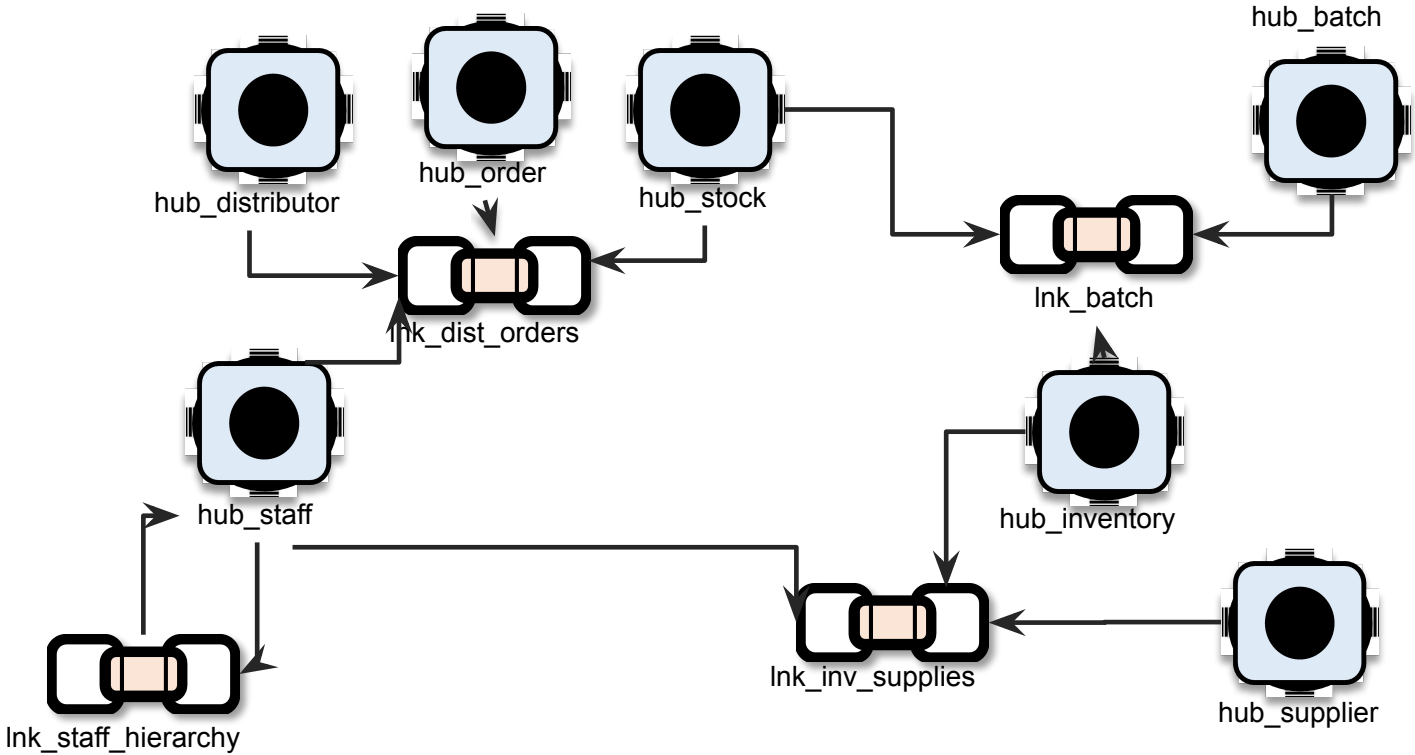


From: https://medium.com/snowflake/learning-data-vault-is-like-learning-how-to-make-beer-fff2f7f4d3b

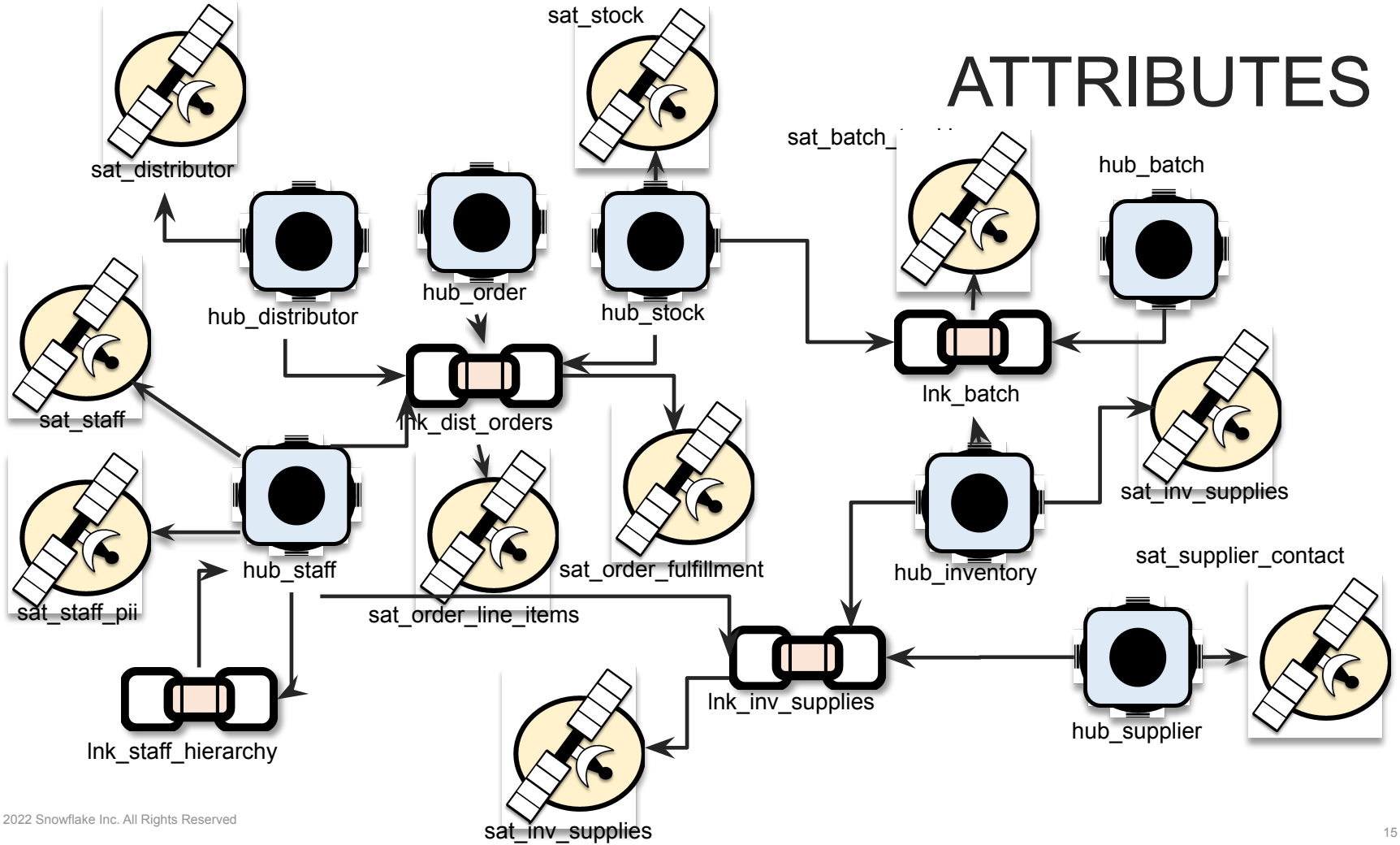
MODELLED BUSINESS OBJECTS



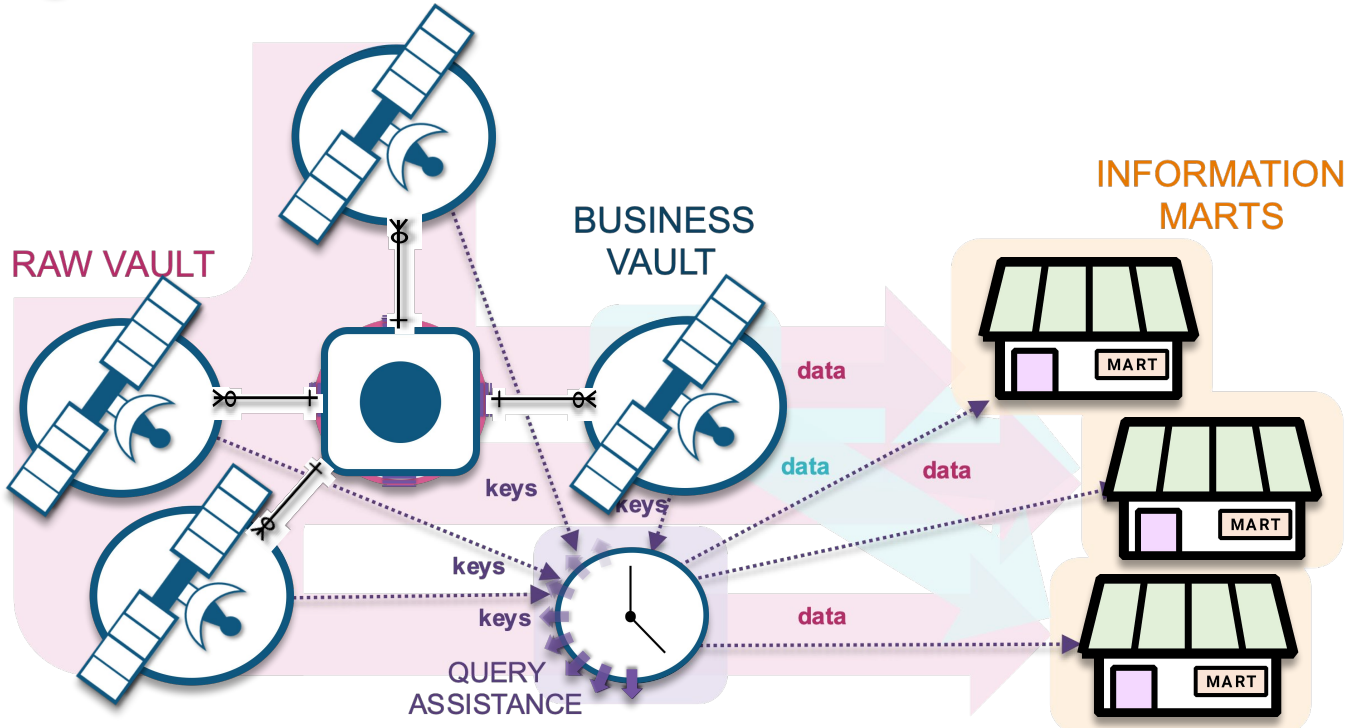
UNIT OF WORK / BUSINESS PROCESS



ATTRIBUTES



② DATA VAULT 2.0 MODEL

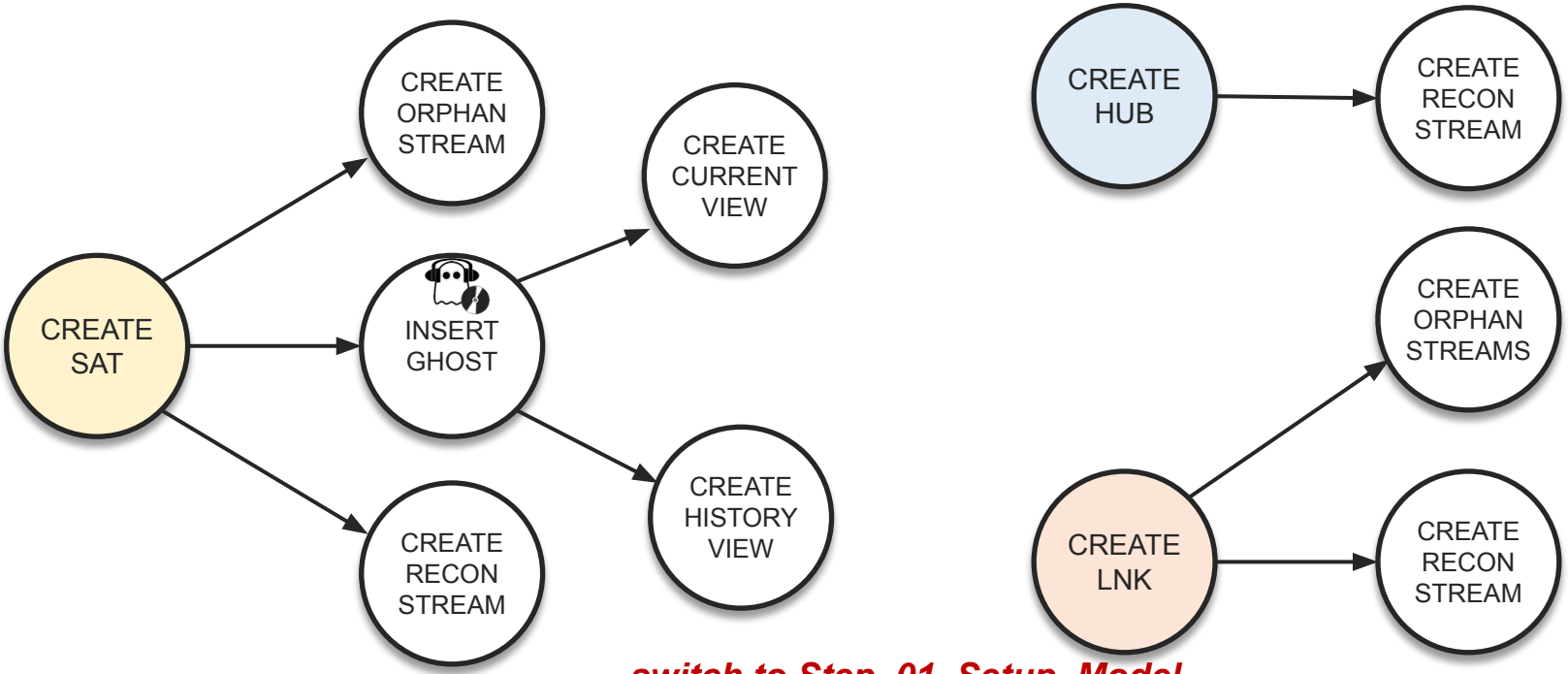


-switch to SQLDBM

- Raw Vault modelled as *hubs*, *links* & *satellites*
- Business Vault ***sparsely*** modelled
- Query Assistance provided by *PITs* & *Bridges*
- Information Marts delivered as *VIEWS*

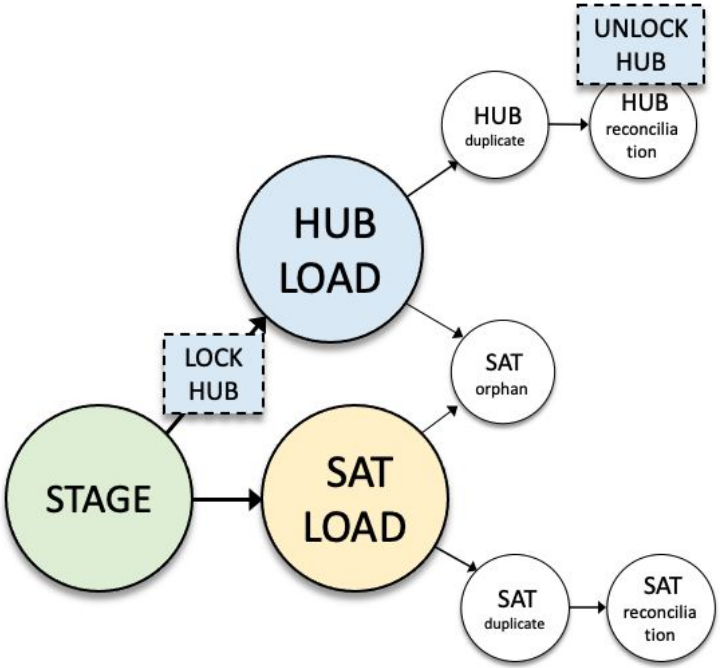
INITIALISE DATA VAULT

run once (still a template)



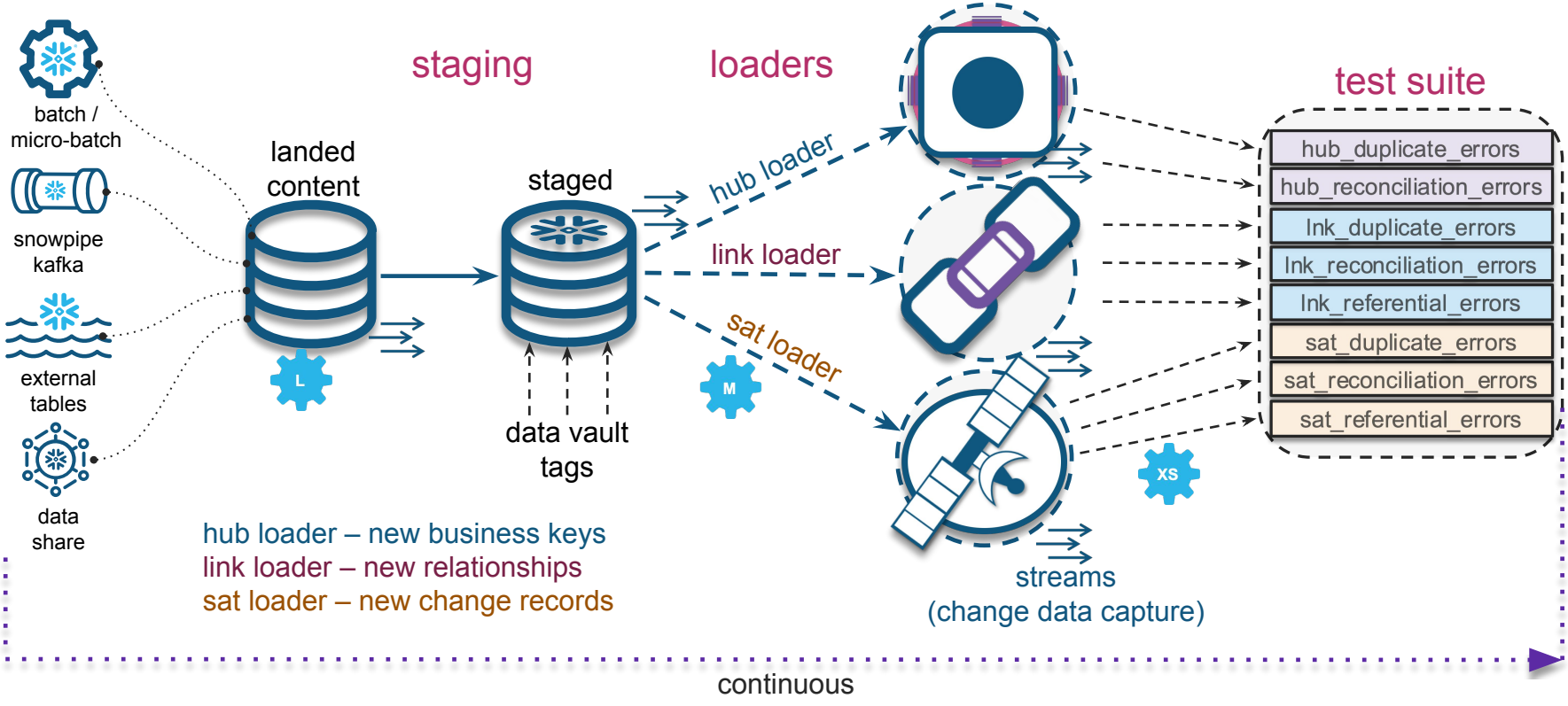
-switch to Step_01_Setup_Model

SAMPLE ORCHESTRATION



1. Landed content is STAGED with Data Vault tagging
2. The following will happen in parallel:
   a) Lock is attained for Target HUB Table
   b) HUB is loaded
   c) HUB Tests
      - HUB duplicate check
      - HUB reconciliation check
   d) Unlock HUB
2. SAT is loaded
   b) SAT Tests
      - If HUB LOADED, SAT-orphan
      - SAT duplicate check

TEMPLATED INGESTION PIPELINES



-switch to Step_02_populate_for_one_day

STAGED DATA VAULT TAGS

③

Tag	Description	Data Type	Hub	Link	Sat
Business Key (not a tag)	***Immutable*** key representing the ***business object***	text	✔		
Surrogate Hash Key	***Durable*** key optimized for join efficiency	binary/text	✔	✔	✔
Load Date	Timestamp of data ***loaded*** to vault	timestamp	✔	✔	✔
Record Source	***Lineage*** describing ***business process*** source	text	✔	✔	✔
Applied Date	When the business events applies, extract date	timestamp	✔	✔	✔
Business Key Collision Code	Used to ensure business keys are ***uniquely*** represented in a hub	text	✔		
Surrogate Sequence Key	***Incremental*** key, for optimizing joins	numeric			✔

there are more you can add to increase lineage, ex. jira-id, job-id etc

hashing at least MD5, SHA1 is better

-switch to Step_02_populate_for_one_day

TEST HARNESS

DATA VAULT TEST FRAMEWORK

⑤

template based

hub_duplicate_errors

hub_reconciliation_errors

lnk_duplicate_errors

lnk_reconciliation_errors

lnk_referential_errors

sat_duplicate_errors

sat_reconciliation_errors

sat_referential_errors

Cat	Test	Hub	Link	Sat
1	Have we loaded duplicates into the target table?	✔	✔	✔
2	Does the target reconcile with the source?	✔	✔	✔
3	Have I maintained referential integrity?		✔	✔

TEST: CHECKING FOR DUPLICATES

hub business keys, link relationships, satellite current details

COLUMN	DESCRIPTION	EXAMPLE
TABLENAME	Hub / Link / Satellite name	HUB_ACCOUNT
SOURCE_TABLENAME	Lineage	CARD_MASTERFILE
LOADDATE	Same as the load date used in staging	${LOADDATE}
RUNDATE	When test was executed	current_time()
HUB / LINK KEY ERROR COUNT	**Hubs** – duplicate hash key, duplicate business key collision code + business key **Links** – duplicate link-hash key, duplicate of all hub-hash keys **Satellites** – duplicate parent hash-key + current load date	err > 0

highlighted portion is the same for each test table

reactive approach

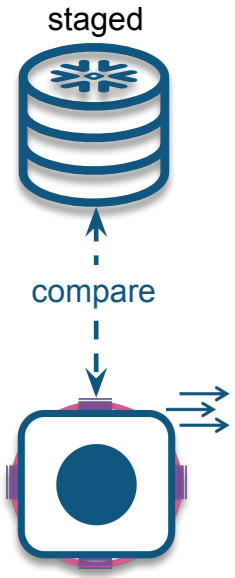
-switch to Step_02_populate_for_one_day

TEST: RECONCILIATION

staged source to data vault artefact

COLUMN	DESCRIPTION	NOTES
NEW KEYS / DATA	**Hubs** – new hash keys, business keys **Links** – new hash keys, relationships **Satellites** – new hash key + load date	Uses STREAMS
STAGED KEYS / DATA	**Hubs** – staged hash keys, business keys **Links** – staged hash keys, relationships **Satellites** – staged hash key + load dates	Uses METADATA CACHE
*DISTINCT KEYS / DATA	**Hubs** – distinct staged hash keys, business keys **Links** – distinct staged hash keys, relationships **Satellites** – distinct staged hash key + load dates	Must query all MICRO-PARTITIONS
TOTAL KEYS / DATA	**Hubs** – hub record total count after load **Links** – link record count after load **Satellites** – satellite record count after load	Uses METADATA CACHE
RECON ERROR COUNT	**Hubs** – missing hash keys, business keys **Links** – missing hub & link hash keys **Satellites** – missing hash key + load dates	err > 0

*optional test



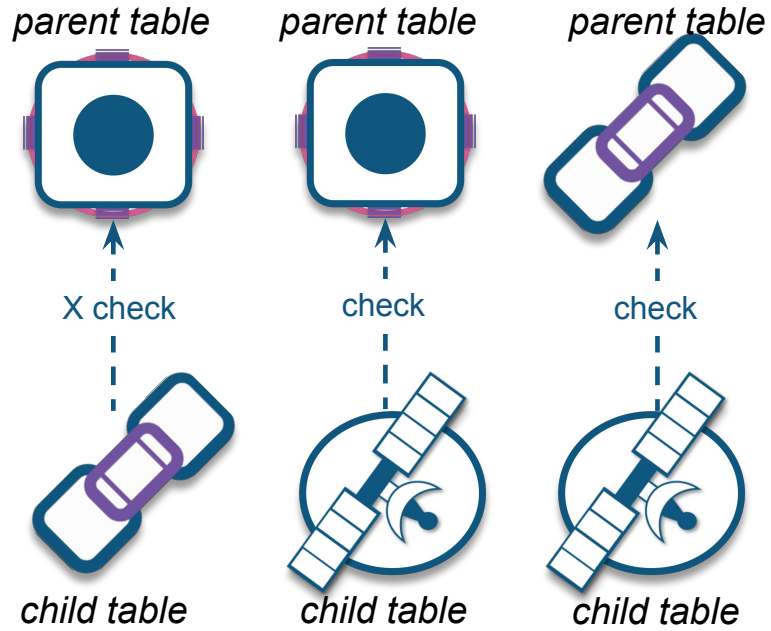
-switch to Step_02_populate_for_one_day

TEST: REFERENTIAL INTEGRITY

satellites to parent hub or link, link to parent hub(s)

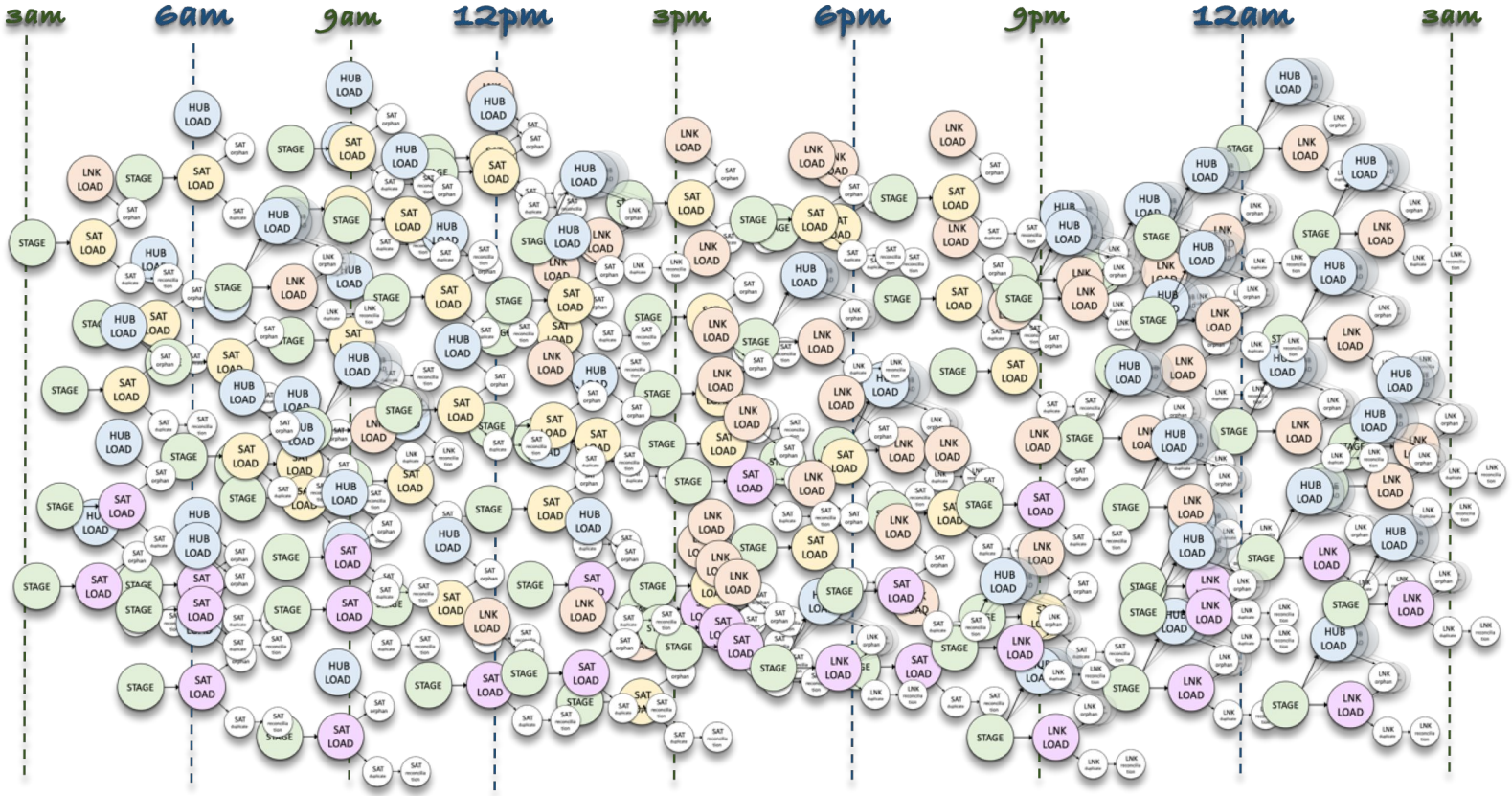
COLUMN	DESCRIPTION
MISSING PARENT KEY ERROR COUNT	**Links** – Link hub hash keys not found in adjacent hub table(s) **HUB-Satellites** - Satellite hub hash key not found in Parent Hub table **LINK-Satellites** – Satellite link hash key not found in Parent Link table

AKA Orphan-checks



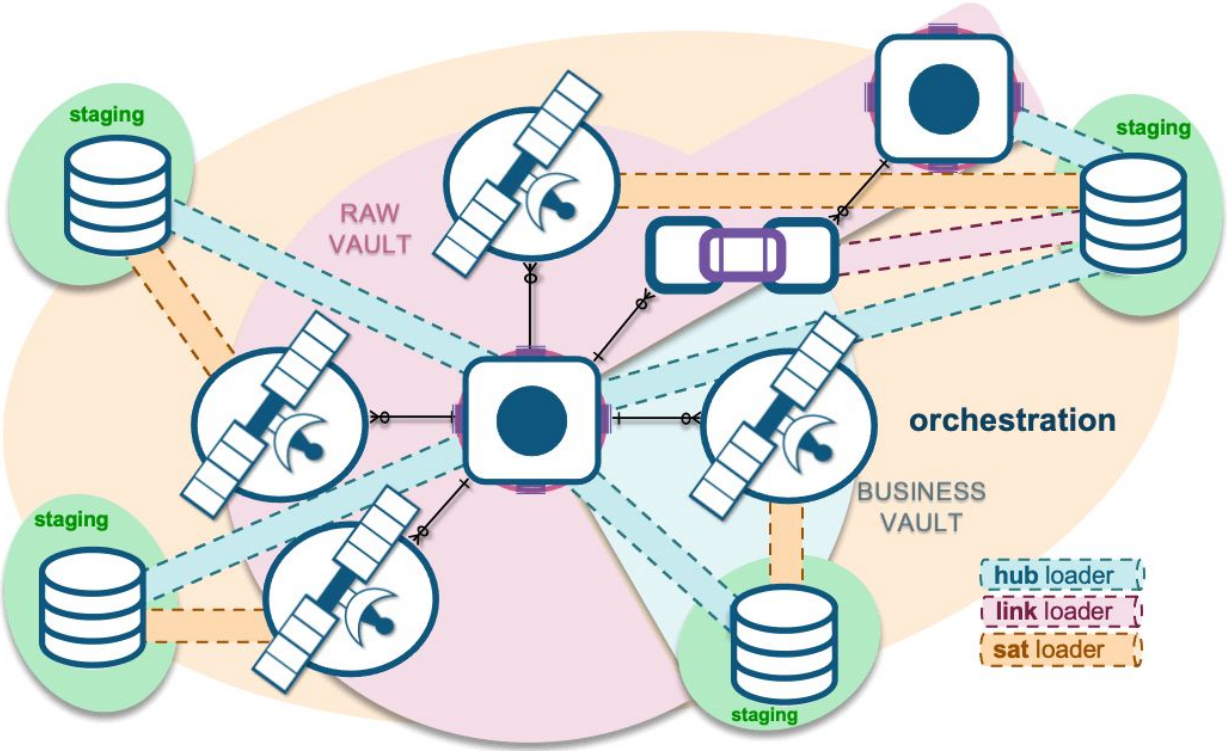
-switch to Step_02_populate_for_one_day

LOAD ANYTIME, ALL DAY



HUB LOCKING

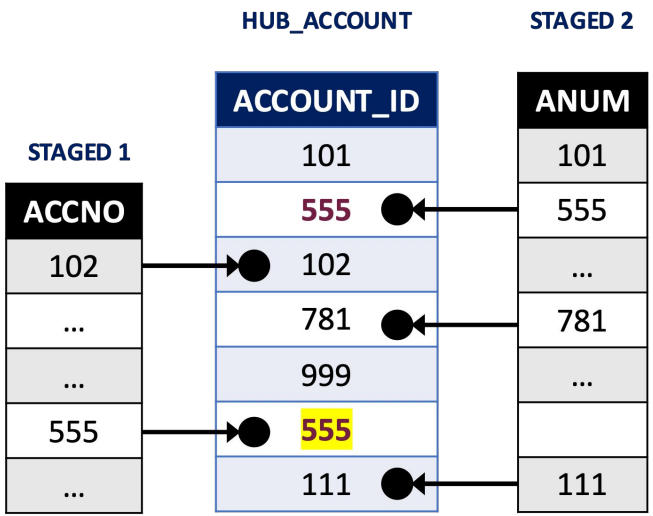
⑥ DATA VAULT PARALLEL LOADING



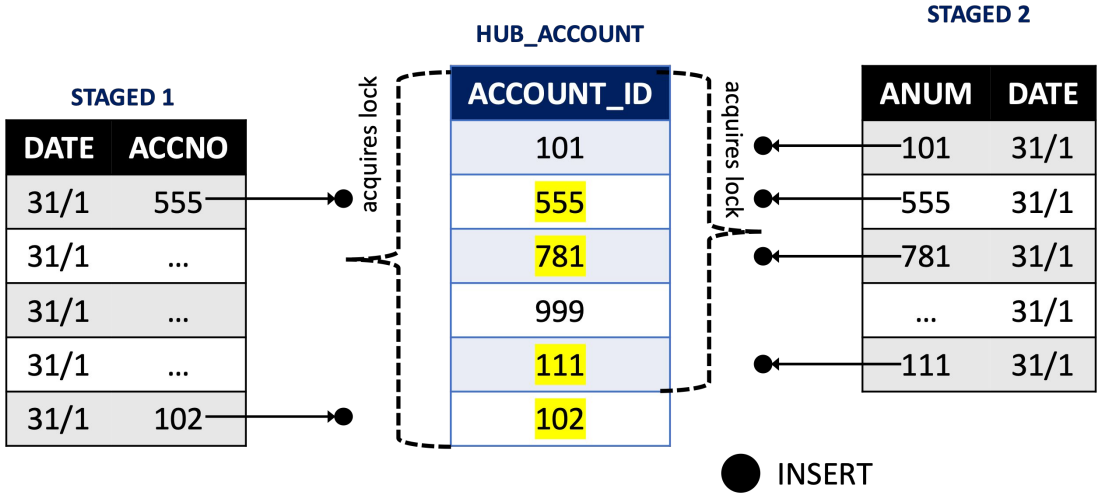
-switch to Parallel Scripts

TRANSACTION ISOLATION

INSERT



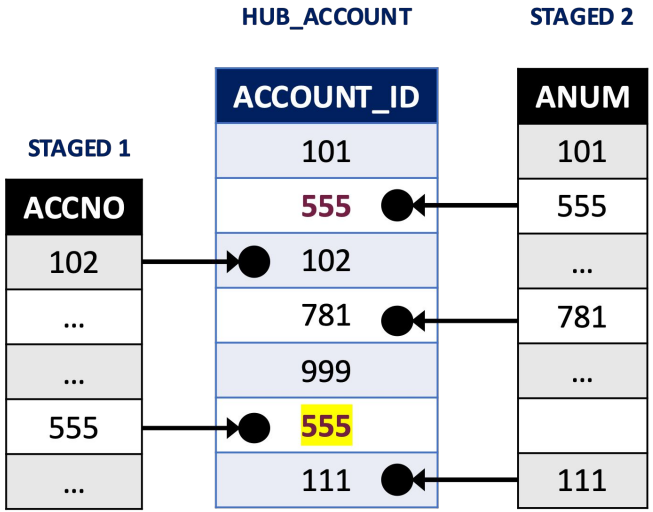
MERGE



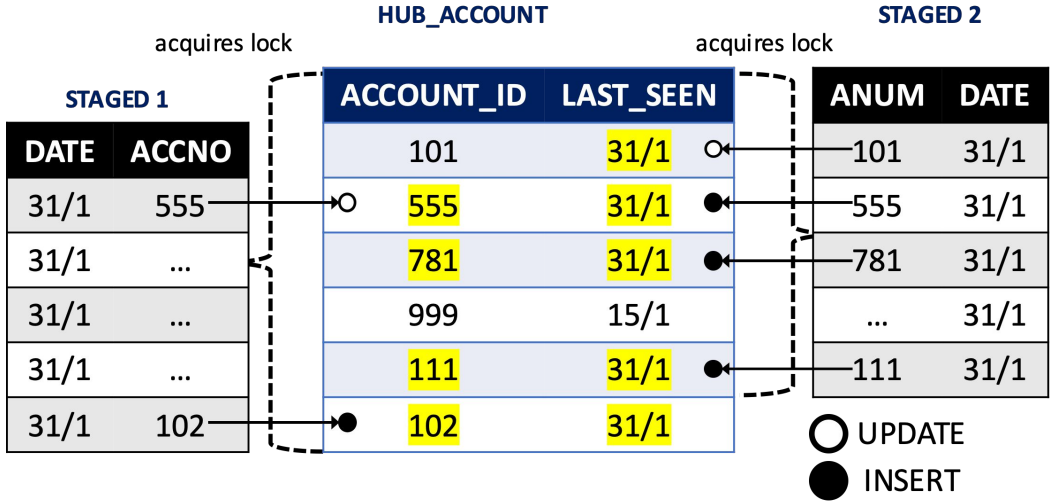
MERGE acquires locks

TRANSACTION ISOLATION

INSERT



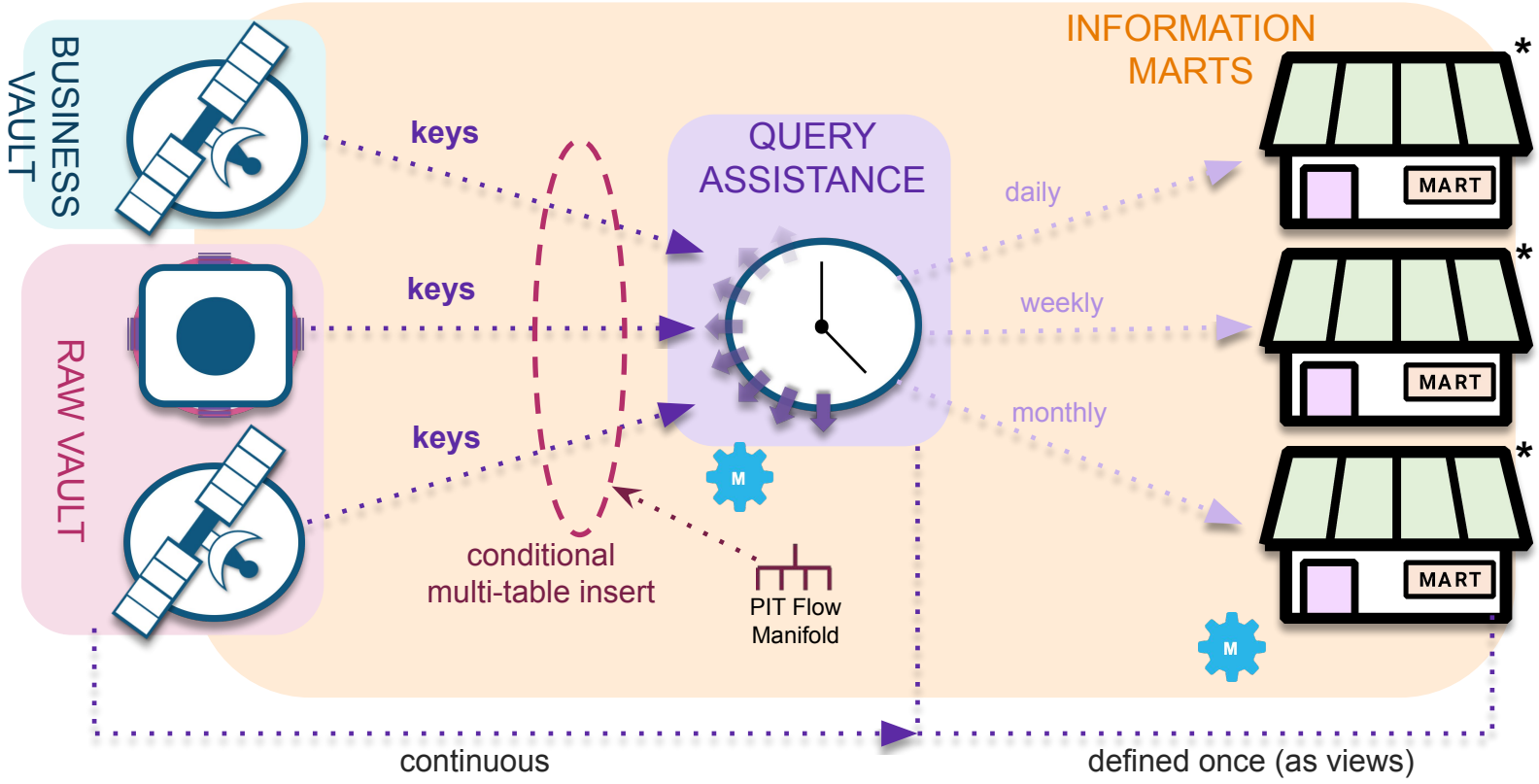
MERGE *(optional update)*



applicable to HUBs and LINKs, SATELLITEs remain INSERT-ONLY

QUERYING DATA VAULT
Point in Time tables

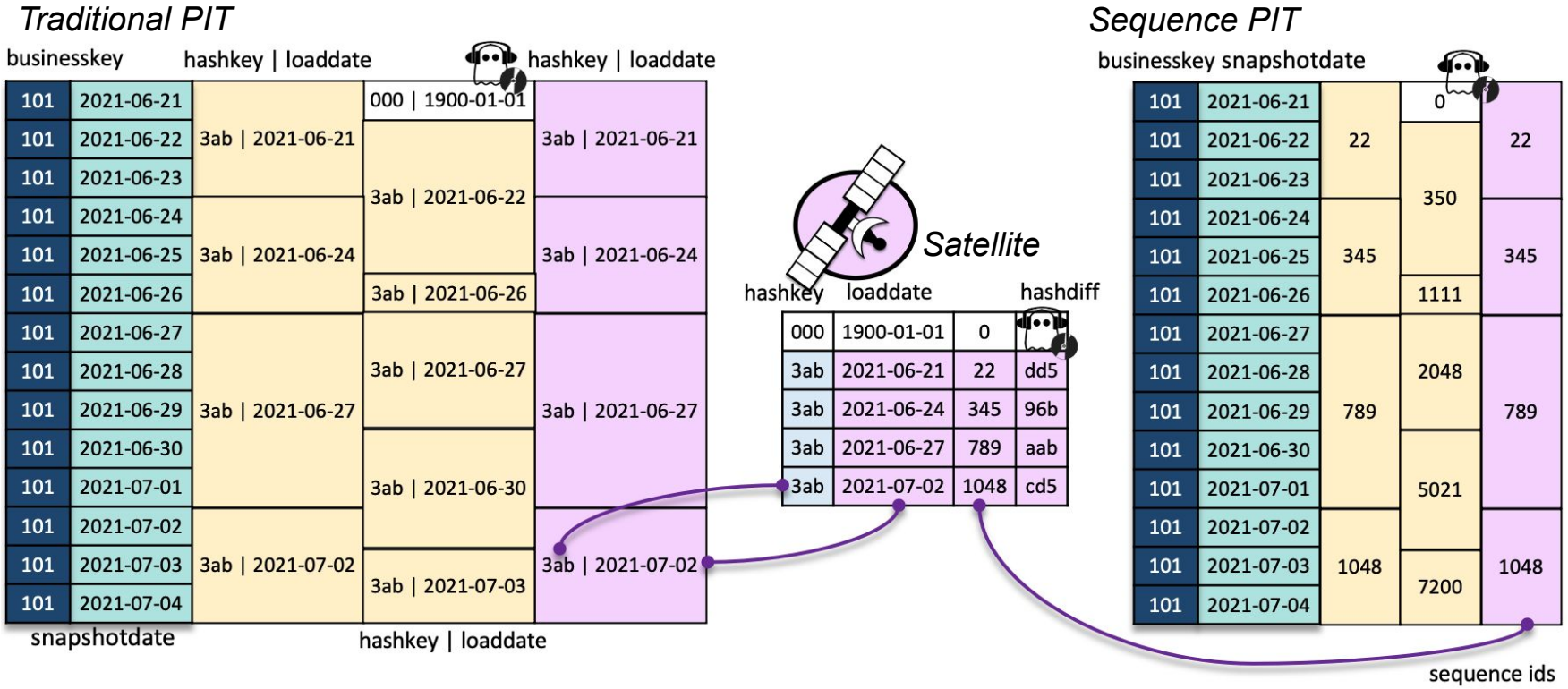
TEMPLATED CONSUMPTION PIPELINES



first query will cache the result; Information Mart is **in memory as result_scan*

-switch to Step_04_Querying_Information_Marts

PIT & Sequence Number PIT



Enable EQUI-JOIN, like dimensions around a fact!

TABLE CLUSTERING

Tablename	Record count	Column count	Size
hub_account	150,000	9	4MB
sat_card_masterfile	17,253,768	613	3GB
sat_card_balancecategories	17,259,059	419	2GB
sat_card_transaction_header	17,257,668	12	875.3MB
sat_bv_account_card_summary	150,001	10	4.4MB

Column(s)	Average overlaps	Average depth
dv_hashkey_hub_account	1452.0	1453.0
dv_hashkey_hub_account, dv_loaddate	1452.0	1453.0
dv_loaddate	0	1.0
dv_sid	6.9897	7.9897

Tablename	Record count	Column count	Size
pit_cardaccount_daily	27,297,309	11	2.7GB
pit_cardaccount_weekly	3,900,000	11	400MB
pit_cardaccount_monthly	900,000	11	92.3MB
pit_cardaccount_current	150,000	11	15.4MB
snopit_cardaccount_daily	27,297,309	7	929MB
snopit_cardaccount_weekly	3,900,000	7	132.3MB
snopit_cardaccount_monthly	900,000	7	30.5MB
snopit_cardaccount_current	150,000	7	5.1MB

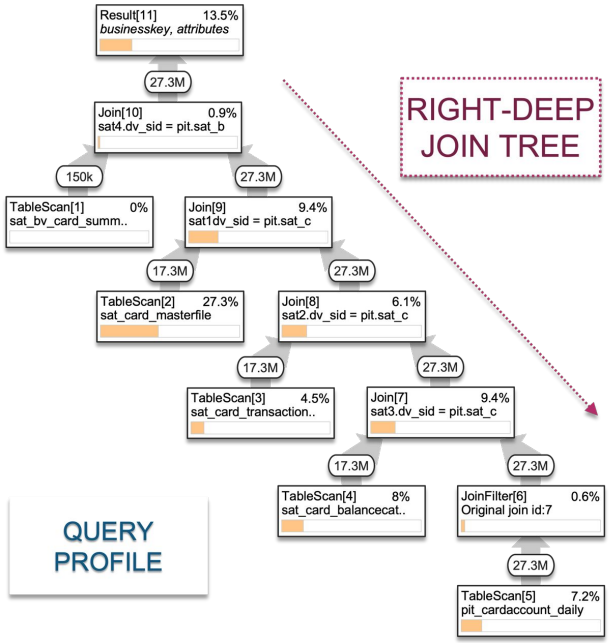
```
create table sat_card_masterfile
(dv_tenantid varchar(20) not null
 , dv_hashkey_hub_account binary(20) not null
 , dv_loaddate datetime not null
 , dv_applieddate datetime not null
 , dv_recsource varchar(100) not null
 , dv_hashdiff binary(20) not null
 , dv_sid int autoincrement(0, 1)
 , card_type varchar(1)
 , card_balance decimal
 , card_status varchar(1)
 , credit_limit decimal
, …
```

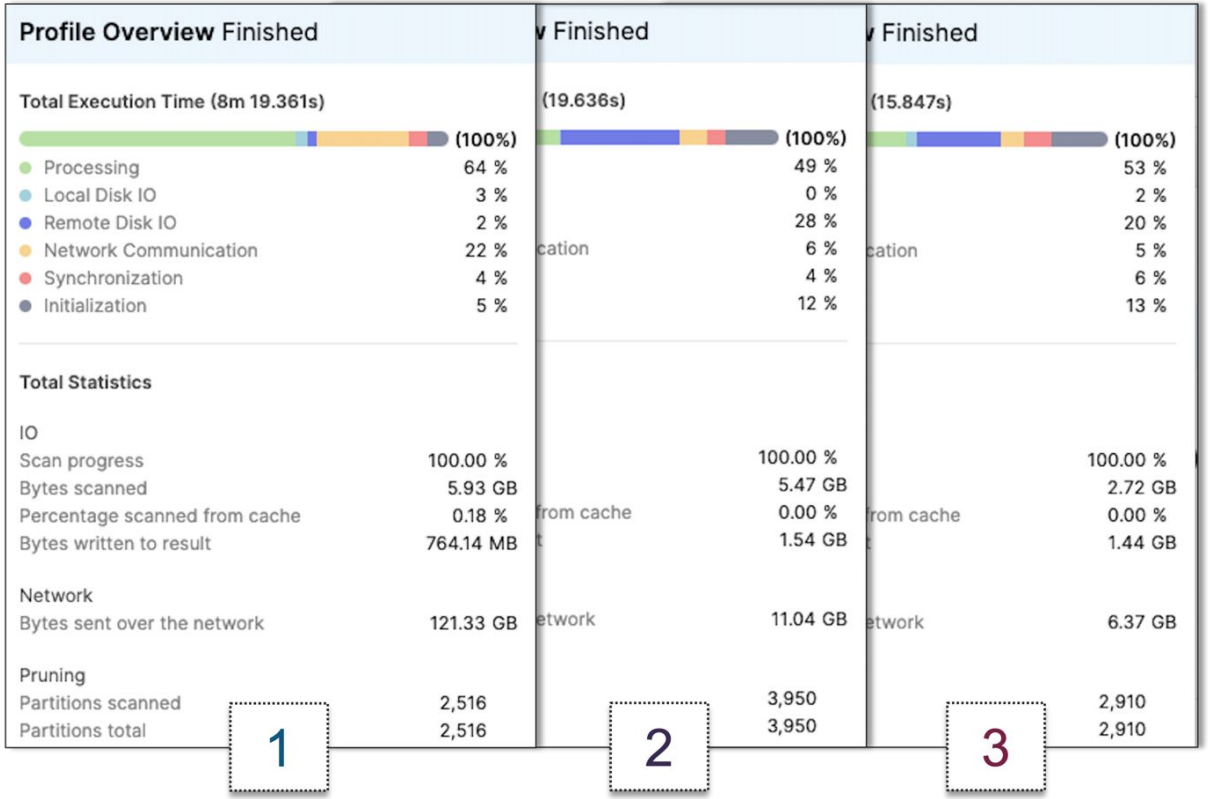
-switch to Step_04_Querying_Information_Marts

https://docs.snowflake.com/en/sql-reference/functions/system_clustering_information.html

STAR JOIN QUERY

Query Planner – for PIT
(acts like a factless fact)

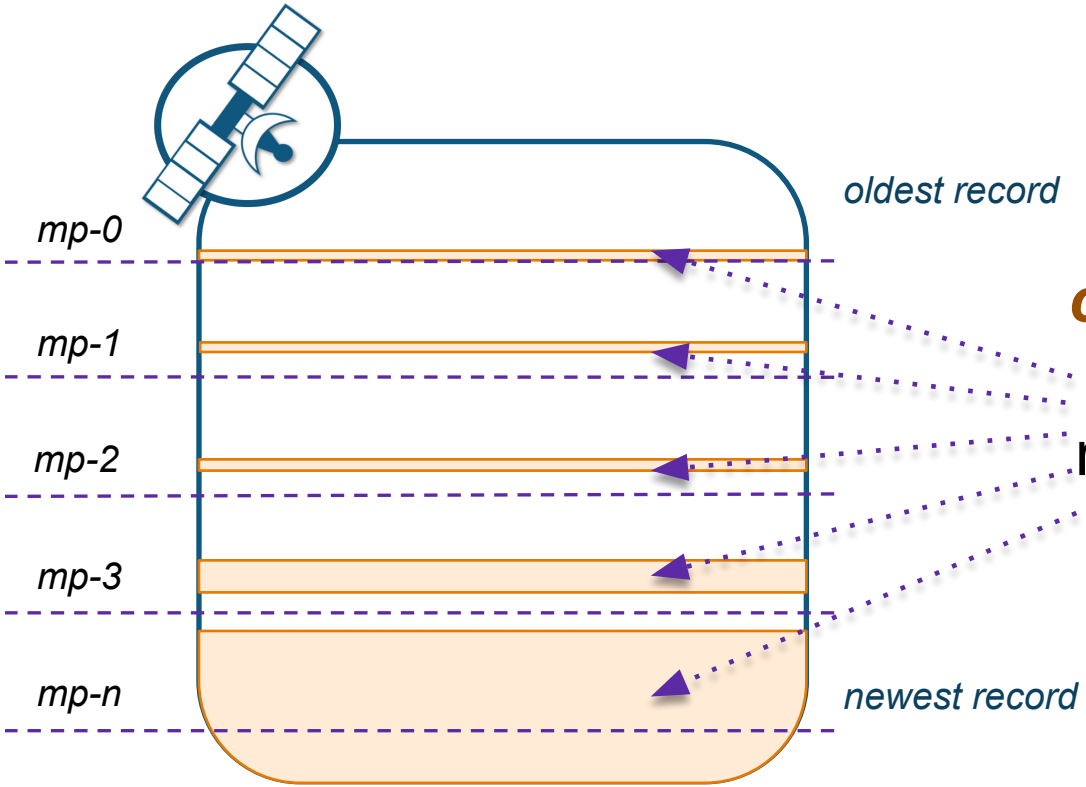




1) No PIT, 2) PIT, 3) Sequence-PIT

More on clustering depth: bit.ly/2SzCAH3

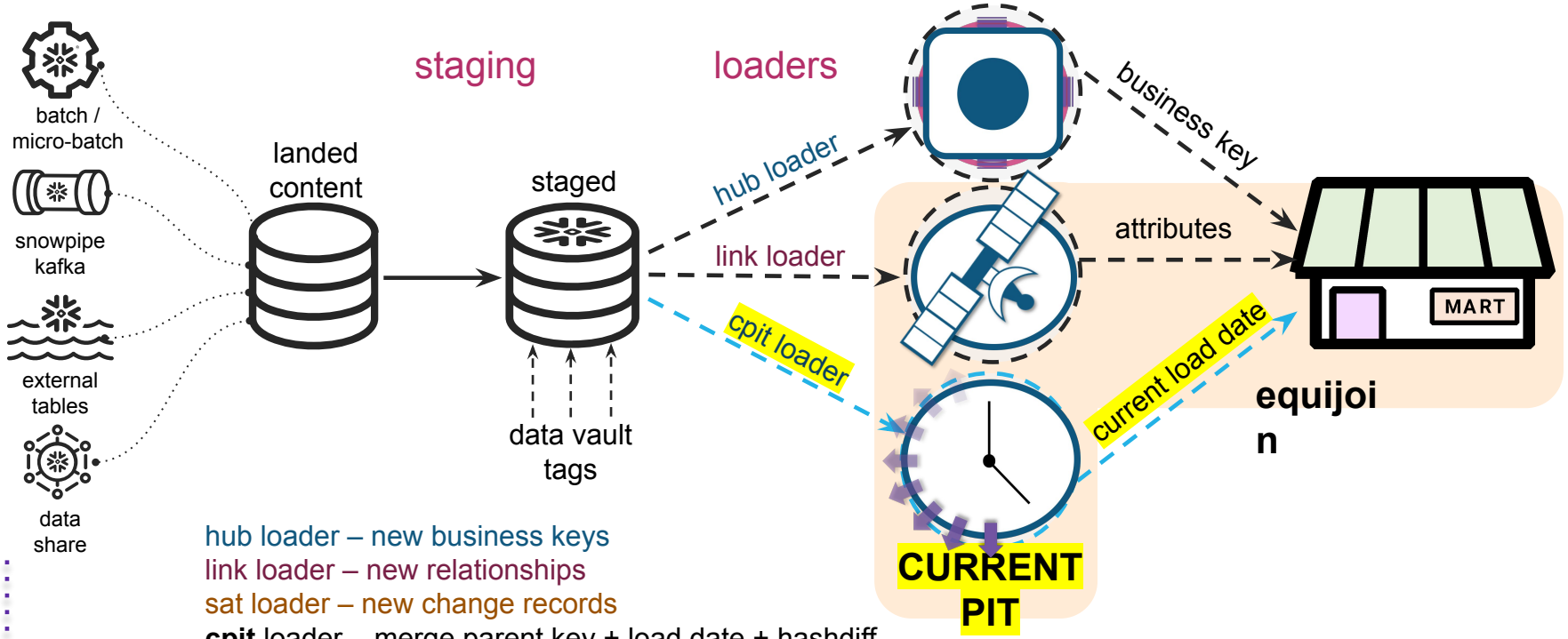
QUERYING BIG SATELLITES



***current* record** (high-date) for *different* parent keys may be *scattered* across a satellite table in *different* micro-partitions

-switch to Step_05_Current_record_from_a_BIG_satellite

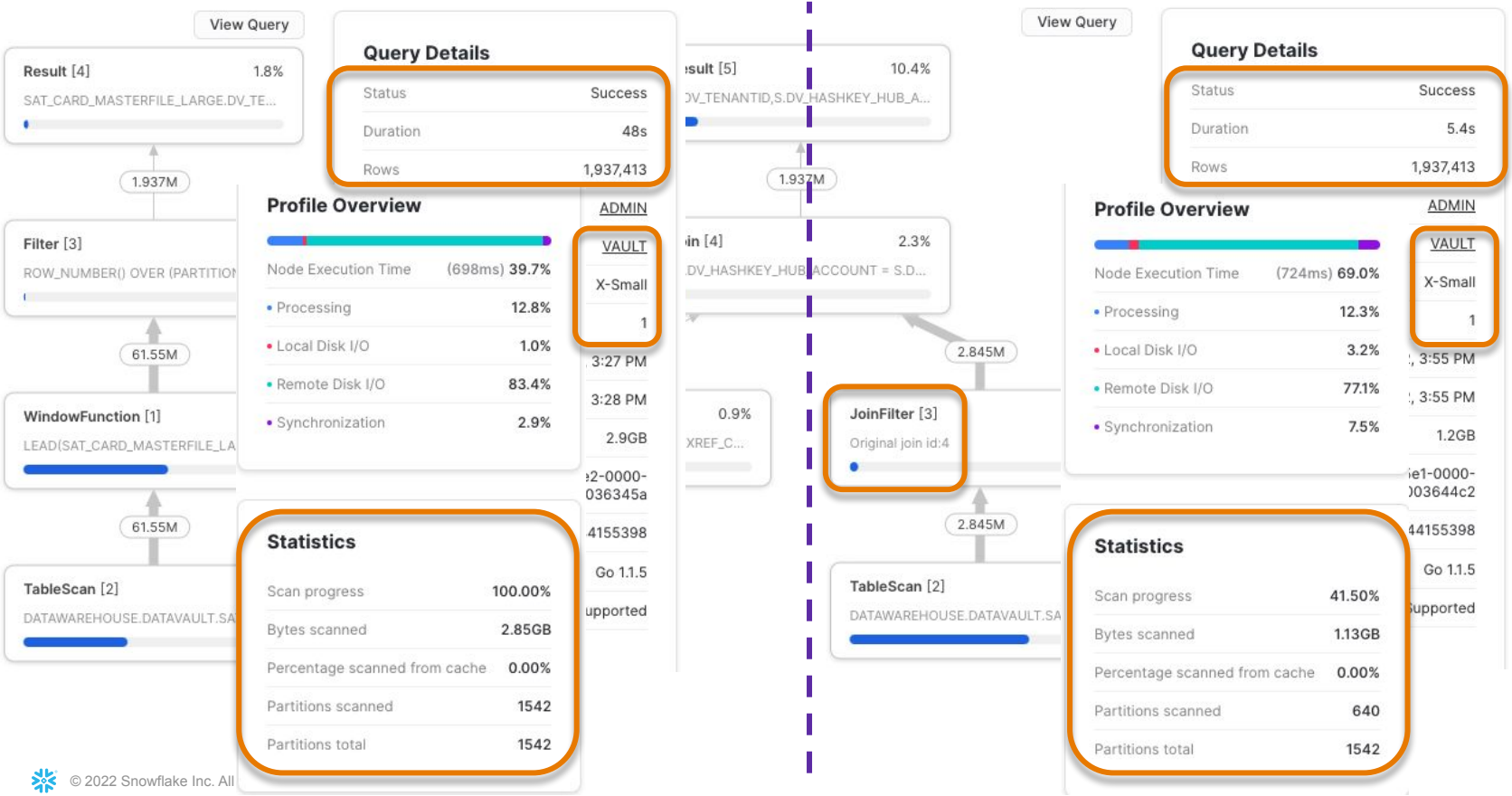
PARALLEL LOADING A PIT



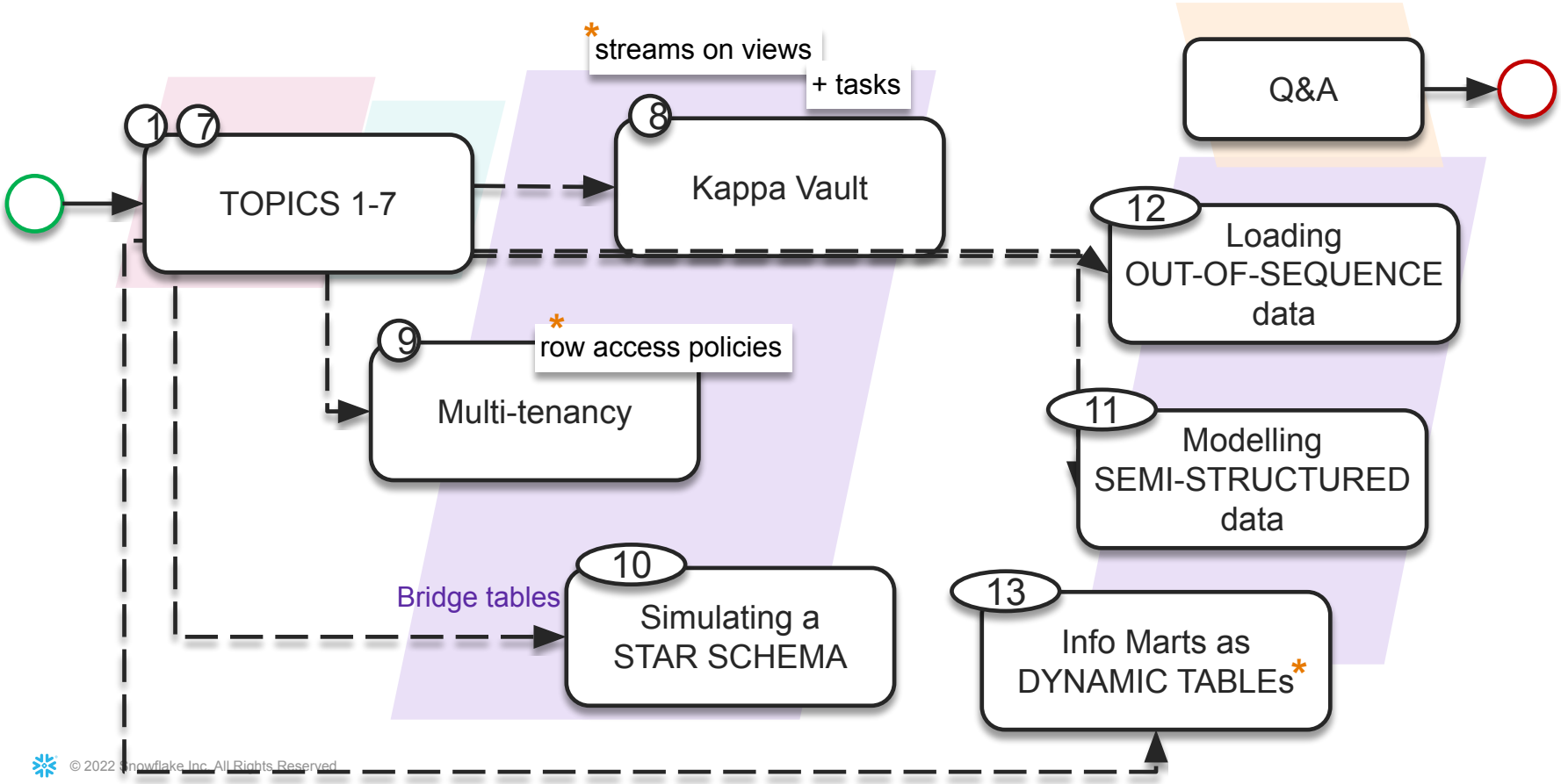
hub loader – new business keys
link loader – new relationships
sat loader – new change records
cpit loader – merge parent key + load date + hashdiff

https://bit.ly/3rqX8Pu

DYNAMIC PRUNING



ADVANCED TOPICS & PATTERNS

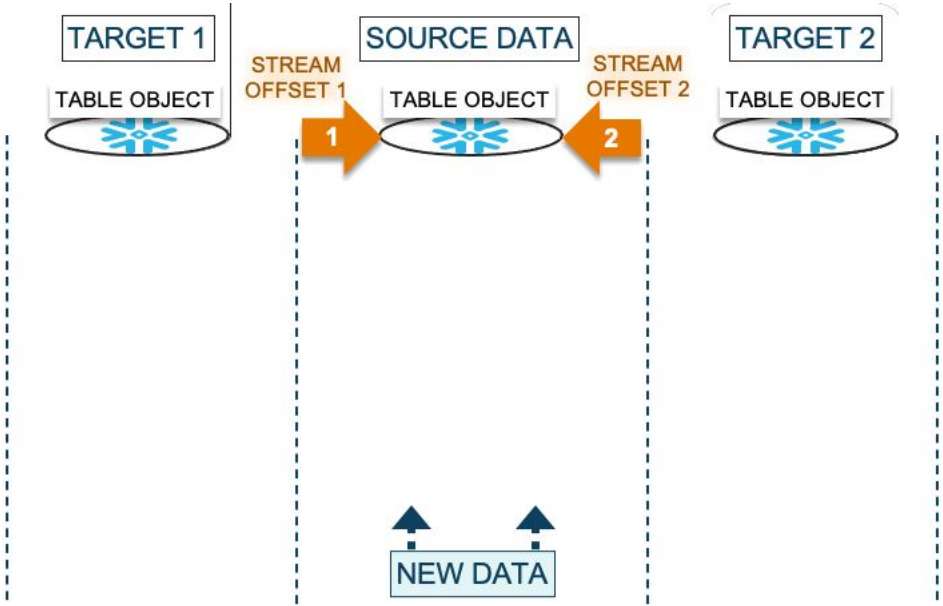


KAPPA VAULT

STREAMS & TASKS

How Streams Work

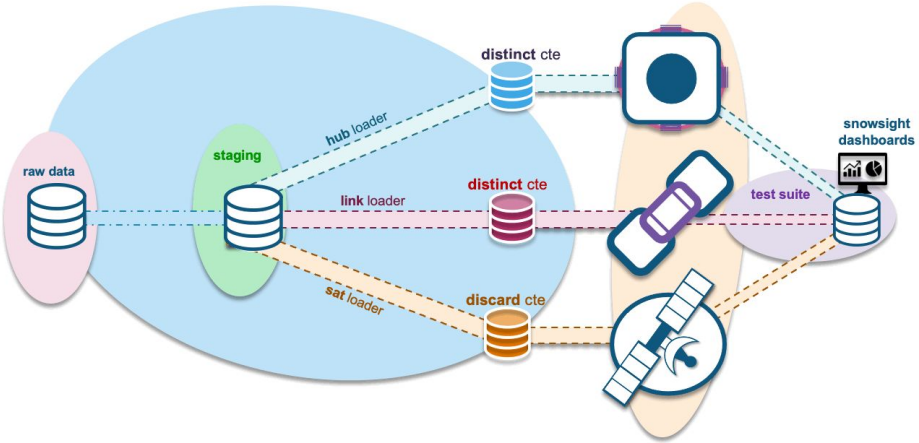
- Tracks **Change Data Capture** (CDC)
- You can have as many streams on an object as you like
- Streams on Tables, Shares, External Tables, Views
- Load & Test on the *same* data requires **Repeatable READ Isolation**



(reusing streams) https://docs.snowflake.com/en/user-guide/streams-intro#repeatable-read-isolation

STREAMS ON VIEWS

Tasks firing Streams



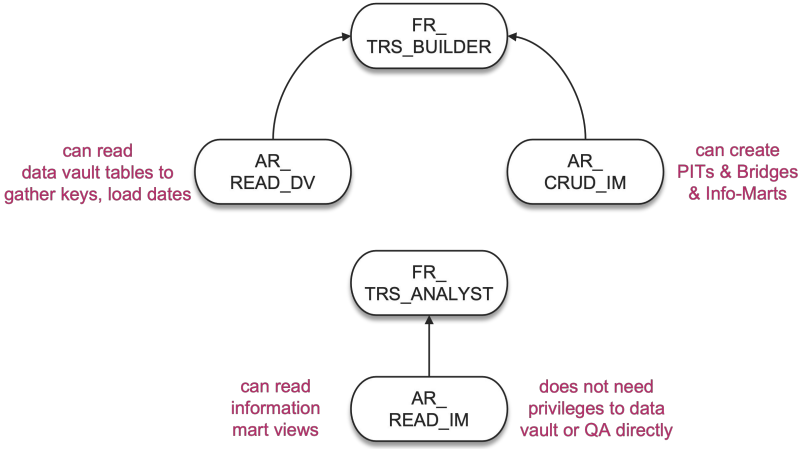
a pattern to delta with *true change* in the staged content

- 1 view with DV metadata columns
- 1:M streams on the view for each data pipeline
- 1x Stream: 1x Task for each table that needs loading and each test executed
- CTE discards non-true change in staging before standard load pattern
- Repeatable-read isolation if you include a test harness

-switch to Step_06_Set_and_Forget

MULTI-TENANCY

RBAC & ENTITLEMENTS



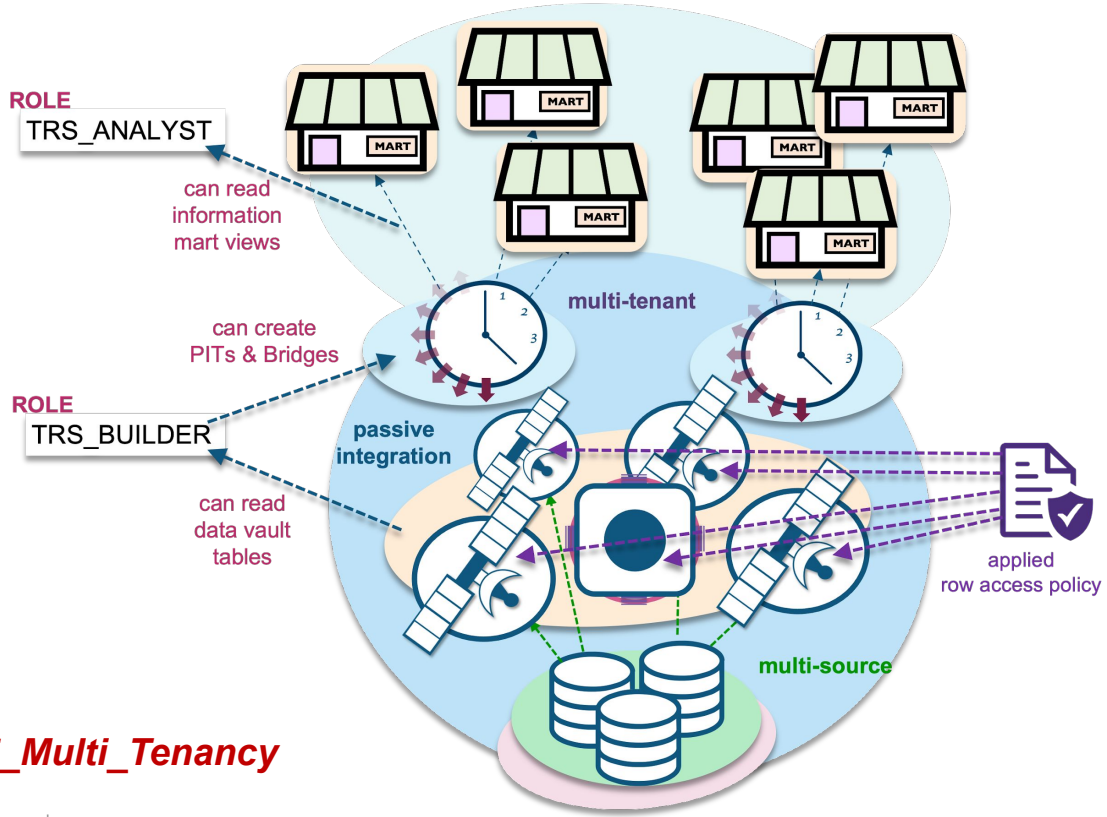
Tenant	Tenant Code	Role	Description
Enterprise	Default	ENGINEER	Custodians of the Vault
Treasury	TRS	TRS_BUILDER	This role can use data vault but only see data the role is entitled to. This role will build Query Assistance tables, i.e., PITs & Bridges
Treasury	TRS	TRS_ANALYST	Has no access to Data Vault directly, but using views defined using PITs & Bridges

Combine DV multi-tenancy + RBAC + Row Access Policies (RAP)

- Every DV table has a tenant code
- Build look entitlements lookup
- Deploy RAP
- Use RAP + Role to Build PITs
- VIEW role does not need explicit access to DV
- Consider INVOKER_ROLE and Memoizable function

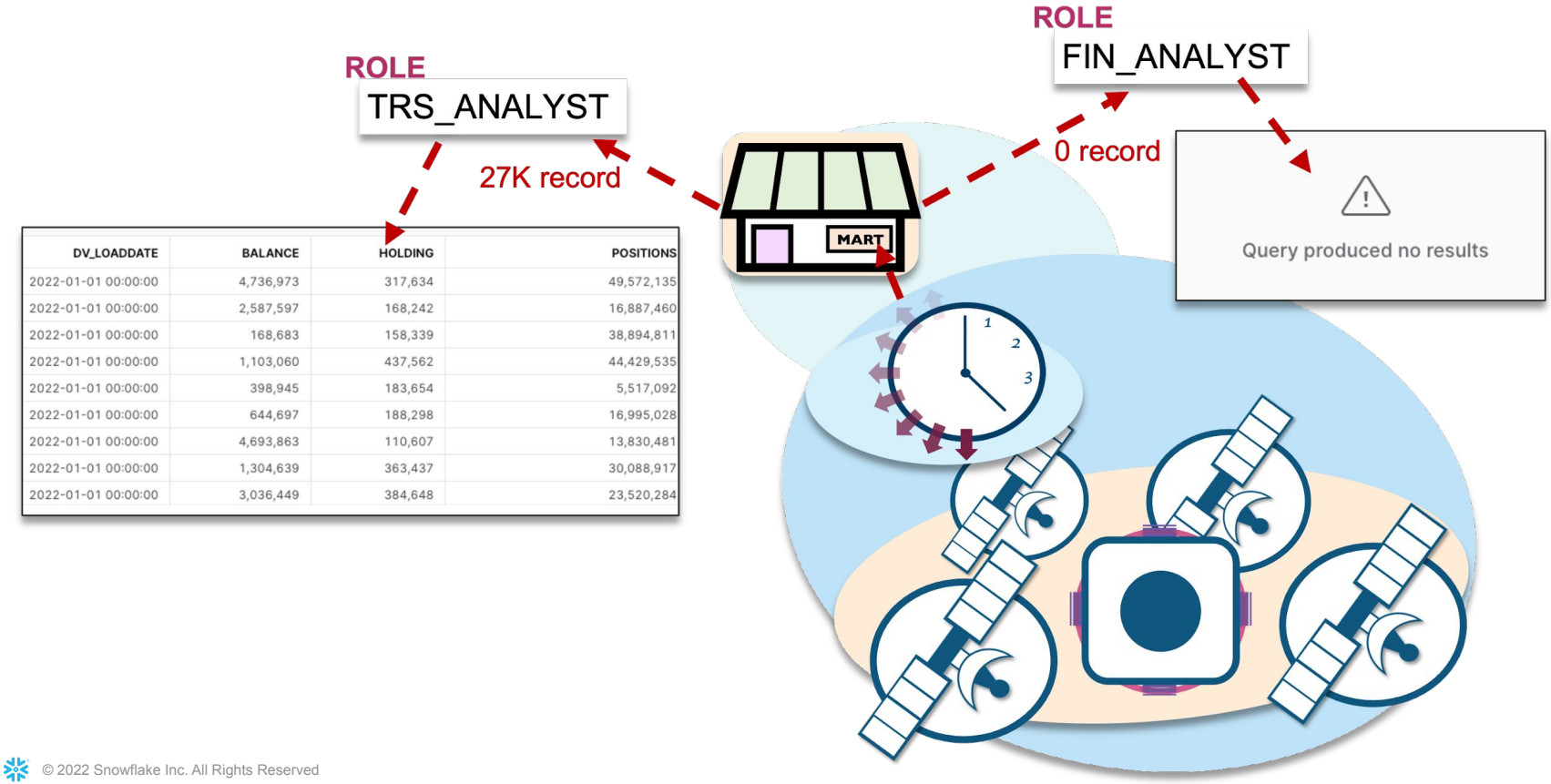
ROLE + RAP + DV MULTI-TENANCY

9



-switch to Step_07_Multi_Tenancy

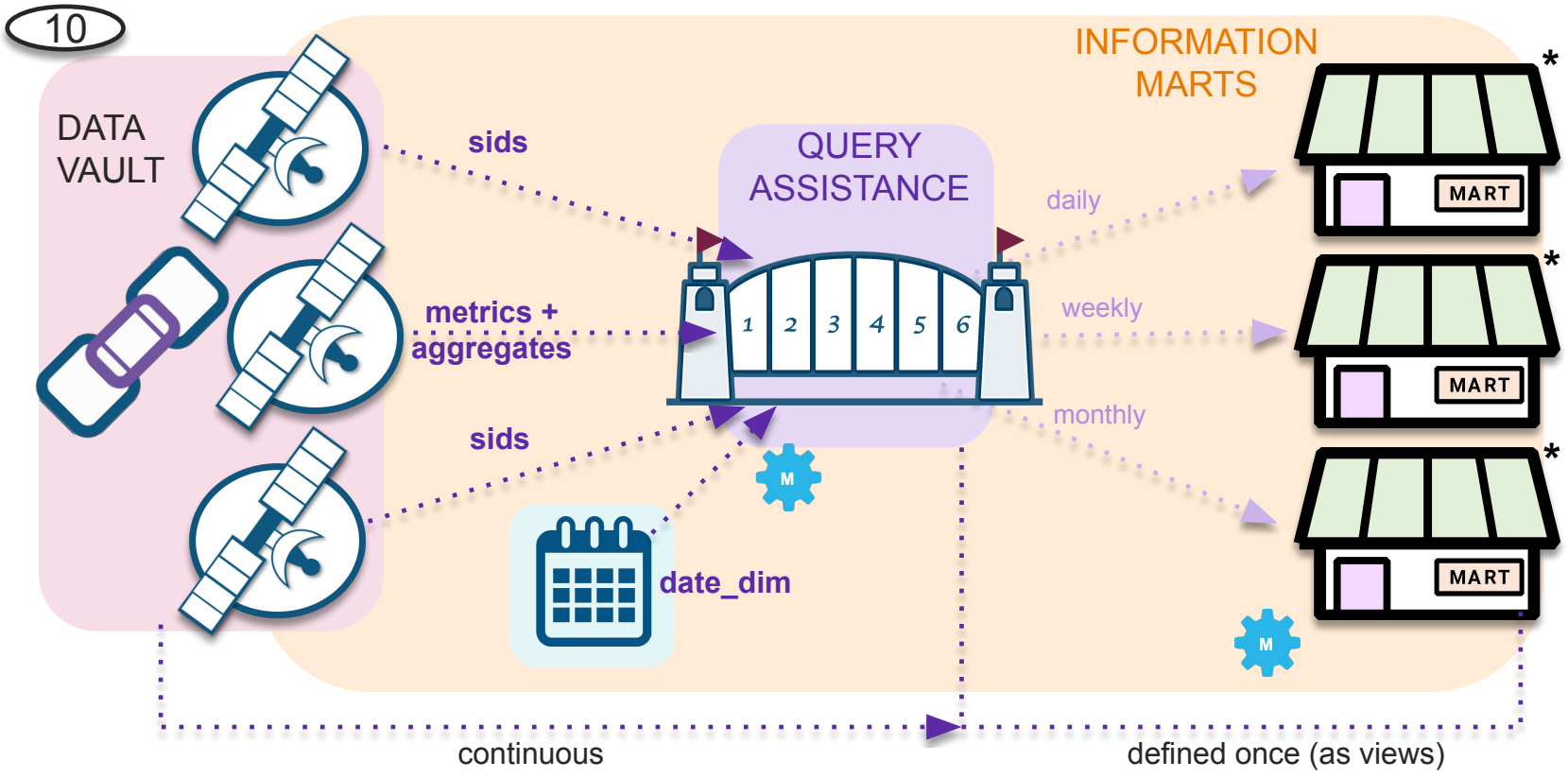
ROLE with and without TRS ACCESS



DV_LOADDATE	BALANCE	HOLDING	POSITIONS
2022-01-01 00:00:00	4,736,973	317,634	49,572,135
2022-01-01 00:00:00	2,587,597	168,242	16,887,460
2022-01-01 00:00:00	168,683	158,339	38,894,811
2022-01-01 00:00:00	1,103,060	437,562	44,429,535
2022-01-01 00:00:00	398,945	183,654	5,517,092
2022-01-01 00:00:00	644,697	188,298	16,995,028
2022-01-01 00:00:00	4,693,863	110,607	13,830,481
2022-01-01 00:00:00	1,304,639	363,437	30,088,917
2022-01-01 00:00:00	3,036,449	384,648	23,520,284

SIMULATING A STAR SCHEMA

PRE-AGGREGATE FACTS



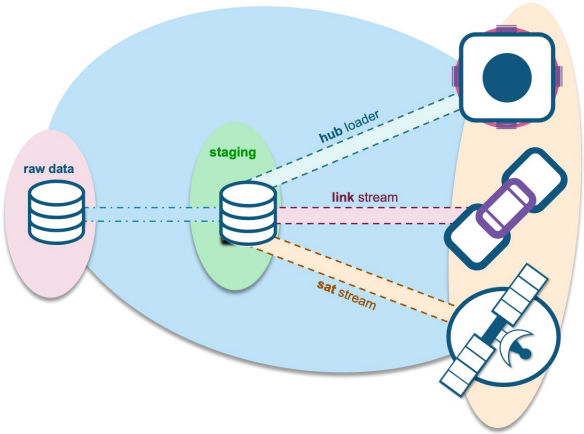
satellites act as dims, bridge tables act as facts with metrics & aggregations

-switch to Step_08_Bridge_and_Metrics

Modelling SEMI-STRUCTURE DATA

GUIDELINES / BEST PRACTICES

11

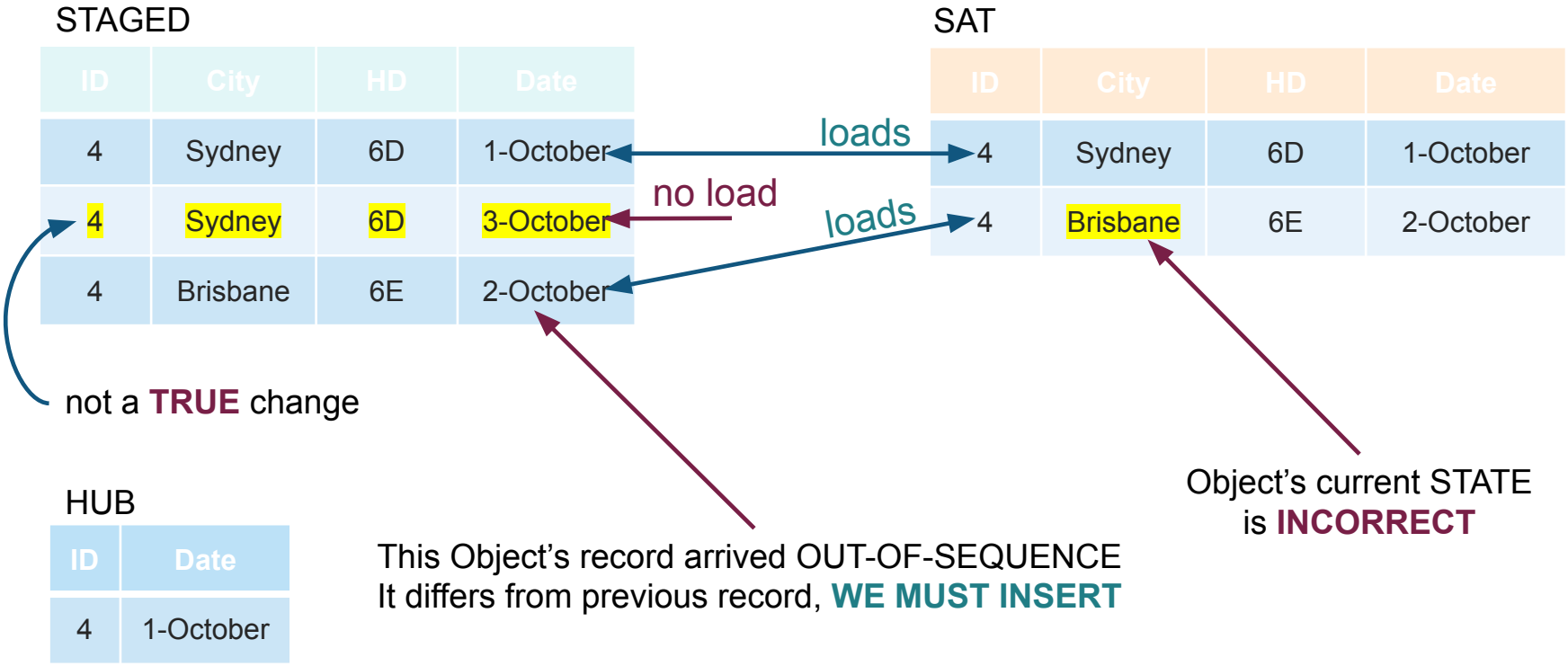


1. Load semi-structure+structured together
2. Persist only key-pairs that you need
3. Consider natural key DV
4. Load DV first or after
5. Streaming use non-historized load
6. Extract bkeys & event timestamps
7. Consider sensitive key-pairs
8. Must schedule test harness

-switch to Step_09_SemiStructure_Query_and_Design

TIME CRIME
(loading OUT-OF-SEQUENCE data)

The Problem: Data Arrives Out of Sequence



The Solution: COPY correction w/ XTS

STAGED

ID	City	HD	Date
4	Sydney	6D	1-October
4	Sydney	6D	3-October
4	Brisbane	6E	2-October

SAT

ID	City	HD	Date
4	Sydney	6D	1-October
4	Brisbane	6E	2-October
4	Sydney	6D	3-October

enforces a **COPY** as previous record

STATE is now **CORRECT**

XTS

ID	HD	Date
4	6D	1-October
4	6D	3-October
4	6E	2-October

HUB

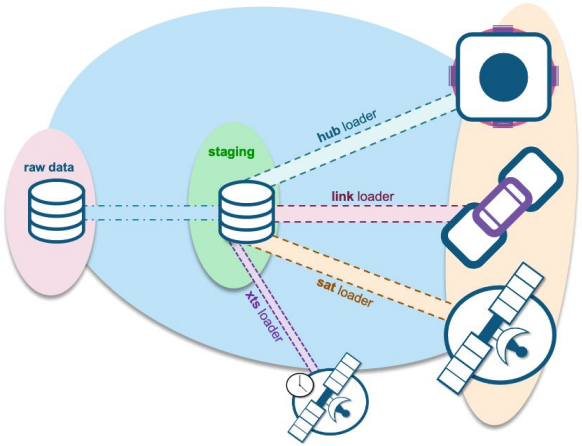
ID	Date
4	1-October

NEW RECORD DIFFERS from **PREVIOUS** record and **NEXT** record

-switch to Step_11_Solving_Time_Crime_Part_1

GUIDELINES / BEST PRACTICES

12



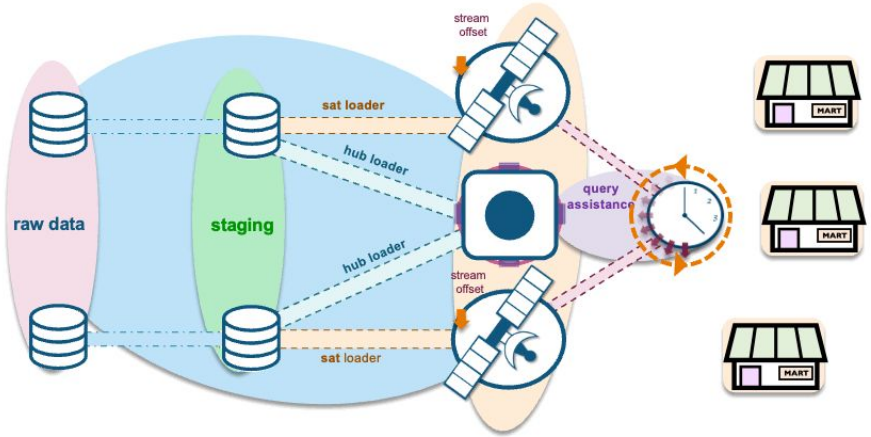
1. One XTS per Hub or Link or one XTS per Satellite
2. Each XTS has the record_target column denoting which hashdiff it is recording
3. XTS can be populated before or after (dirty load) the current record being loaded, don't let XTS get too dirty

-switch to Step_11_Solving_Time_Crime_Part_1

Info Marts as DYNAMIC TABLES

GUIDELINES / BEST PRACTICES

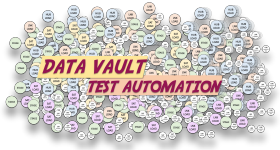
13



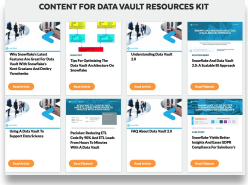
1. Should NOT be used to replace Hub, Link and Satellite Tables
2. Can be used as Materialized Views but beware of *LAG..*
3. Should be considered based on NON-HISTORISED Links and Satellites for *STREAMING* use cases
4. Can VIEWS be used instead?
5. Beware that Dynamic Tables are NOT FREE

-switch to Step_10_Using_Dynamic_Tables_for_BV

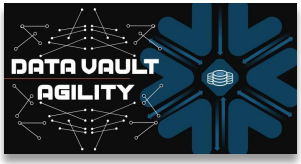
DATA VAULT LITERATURE



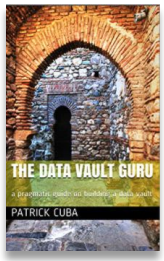
Data Vault Blogs



Snowflake Data Vault Resource Kit
(lots of Snowflake DV content)



Data Vault on Snowflake Techniques
(transactions & pruning)



The Data Vault Guru
(sample code and modelling examples)

Recommended coaching and training, and

join a community of data vault modelers

https://forum.ukdatavaultusergroup.co.uk/

Data Vault Accelerator: https://bit.ly/3yGTzas
(take a copy as PDF)

BUILD OR BUY - PLAYERS

WhereScape®	Internal Demo: https://bit.ly/3s2Qejp Webpage: https://www.wherescape.com/	Head office in NZ Thick Client
VAULTSPEED	Internal Demo: https://bit.ly/3FqYheM Webpage: https://vaultspeed.com/	Head office in Belgium Thin Client
AutomateDV formerly known as dbtvault	Internal Demo: https://bit.ly/3xCstzL Webpage: https://dbtvault.readthedocs.io/en/latest/	Head office in UK Thin Client, dbt package
erwin by Quest	Internal Demo: https://bit.ly/3iyRW95 Webpage: https://bit.ly/3qKlEfD	Head office in US Thick Client, no orchestration
DataJoinery.	Internal Demo: https://bit.ly/2VIMibb Webpage: https://datajoinery.io	Head office in South Africa Thin Client
Datavault BUILDER	Internal Demo: https://bit.ly/3LWSCSj Webpage: https://datavault-builder.com/	Head office in Germany Thin Client
Varigence	Internal Demo: https://bit.ly/3DoJ93m Webpage: https://www.varigence.com/	Head office in Australia Thin Client
coalesce®	Internal Demo: https://bit.ly/3n0oa1B Webpage: https://coalesce.io/	Head office in US Thin Client

Q&A

THANK YOU

Any organization that designs a system will inevitably produce a design whose structure is a copy of the organization's communication structure.

-Melvin E. Conway