100 Snowflake Cost Optimization Techniques

ALL ABOUT

COST AND PERFORMANCE OPTIMIZATION

IN SNOWFLAKE

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Best Ways to Benefit from this Course

* Free Trial Snowflake Account
* VSCode Project Setup + GitHub
* 10 Sections w/ Introductions
* Eventual Hands-On + End-Review (slides)
* Quizzes to Test Your Knowledge
* Captions + Playback Speed
* Q&A + Money Back Guarantee
* Review

Introduction to Virtual Warehouses

Tip #1: Larger Virtual Warehouses May Actually Cost You Less

Tip #2: Auto-Suspend Any Warehouse After One Minute

Tip #3: Any Resumed Warehouse Will Cost You at Least One Minute

Tip #4: Never Auto-Suspend Any Warehouse After Less Than One Minute

Tip #5: X-Small Warehouses Could Be Powerful Enough

Tip #6: Resized Warehouses are for More Complex Queries

Tip #7: Multi-Cluster Warehouses are for Multiple Users and Concurrency

Tip #8: Multi-Cluster Warehouses Should Always Have Min Clusters 1

Tip #9: Use Economy Scaling Policy To Save Money

Tip #10: When to Use Snowpark-Optimized Warehouses

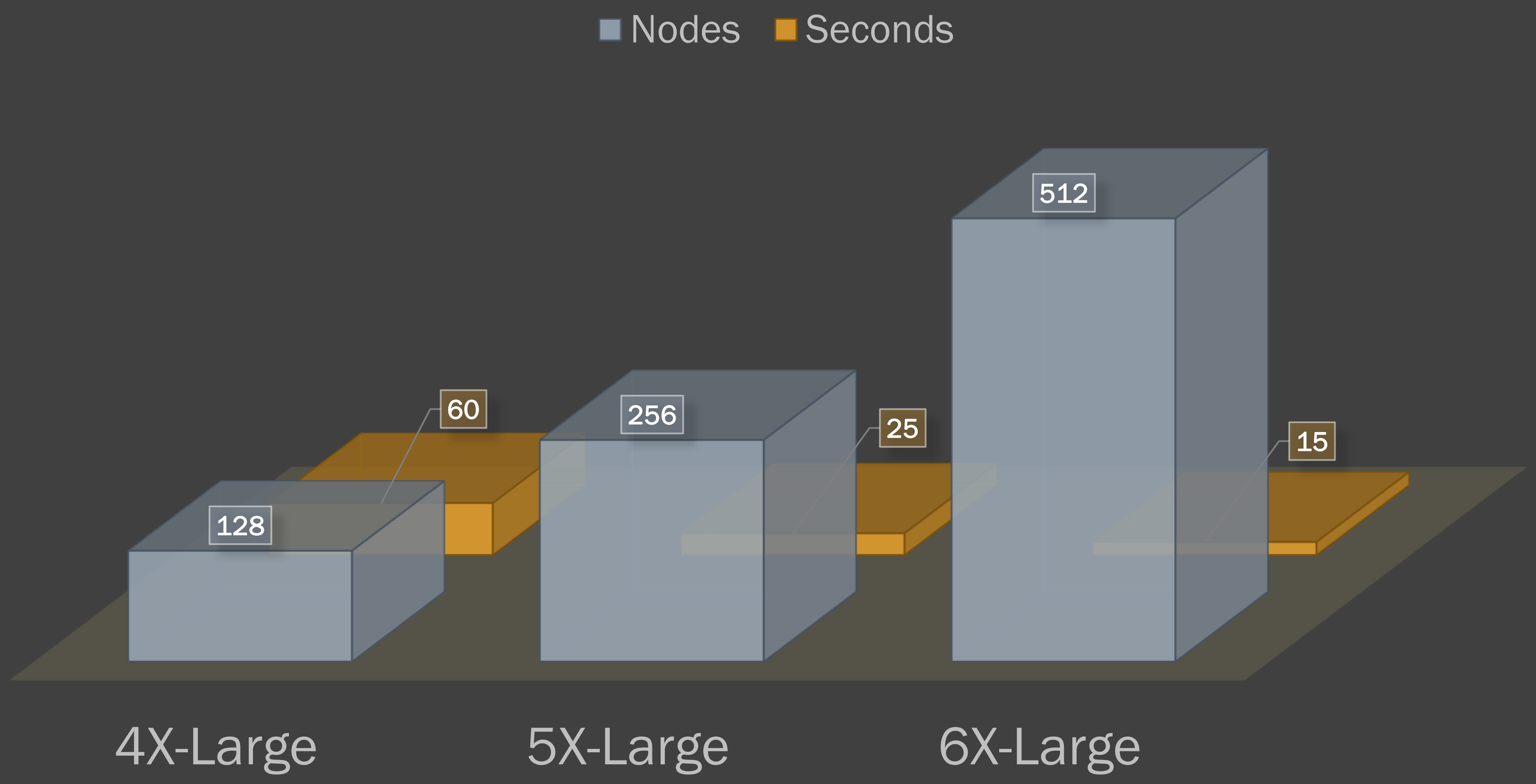
Larger Warehouses

May Actually

Cost You Less

Tip #1

WAREHOUSE SIZE
VS QUERY EXECUTION TIME



Cost

4X-Large: 128 Nodes x 60 secs = 128 x 5c = **$6.40**

5X-Large: 256 Nodes x 30 secs = 256 x 2.5c = **$6.40**

6X-Large: 512 Nodes x 15 secs = 512 x 1.25c = **$6.40**

at $3/credit = $3/hour/node = 5c/minute/node

Checkpoints

* virtual warehouses bring 80-90% of all Snowflake costs!
* *cost effective* = ~same cost, but using more resources
* double in size WH + query twice faster → ~same cost!
* bigger warehouses can actually save you money!
* at some point, bigger warehouses will no longer execute so fast
* small warehouses could take forever in very complex queries

Auto-Suspend

Any Warehouse

After One Minute

Tip #2

Cost

query execution time: 4 min/hour = 96 min/day x 5c = **$4.80**

1 min auto-suspend: 4 min/hour = 96 min/day x 5c = **$4.80**

5 min auto-suspend: 20 min/hour = 480 min/day x 5c = **$24**

for one query taking one min every 15 min

w/ X-Small warehouse → $3/credit = 5c/min (running!)

Checkpoints

* idle warehouses cost money (the same!)
* reducing auto-suspend to the min will save you big!
* creating a warehouse will auto-resume it
* can set INITIALLY_SUSPENDED to True only by code
* avoid auto-suspend by executing more queries together

Resumed Warehouses Will Cost You at Least One Minute

Tip #3

Cost

suspend after 10 secs: 192 nodes x 1 min x 5c = $9.60

suspend-resume in 10 secs: 192 nodes x 2 min x 5c = $19.20

for 3 clusters w/ 3X-Large WH each = 3 x 64 nodes = 192 nodes

Checkpoints

* you are charged at least one minute for any WH resume

* min auto-suspend (recommended) is one minute

* default auto-suspend is 5 minutes → change it to 1 min

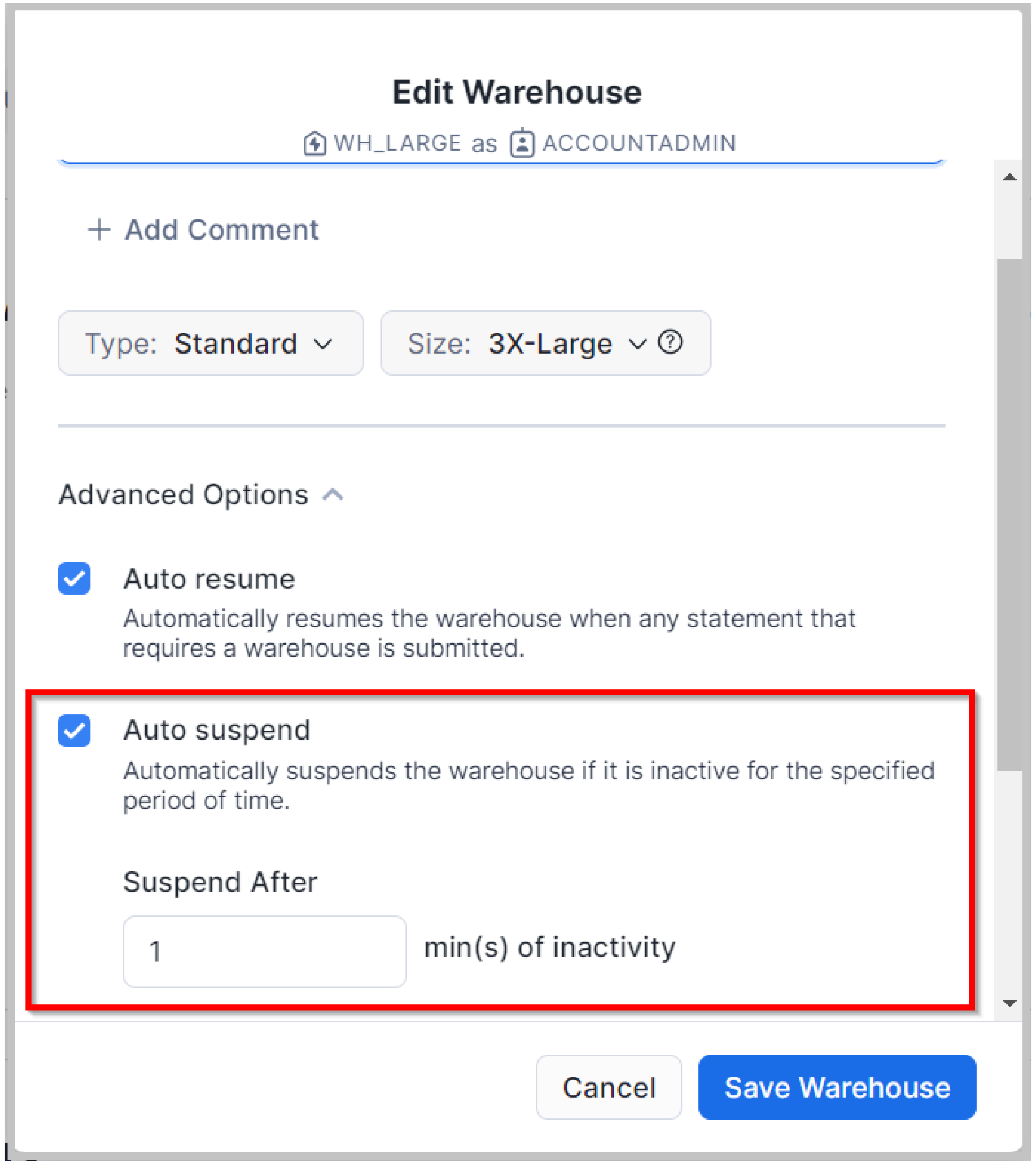
* a background task checks every minute for auto-suspend

* the one-minute period restarts when warehouse resumed

* suspend+resume within a minute may charge you twice

Never Auto-Suspend Any Warehouse After Less Than a Minute

Tip #4


Edit Warehouse
WH_LARGE as ACCOUNTADMIN
+ Add Comment
Type: Standard
Size: 3X-Large
Advanced Options
Auto resume
Automatically resumes the warehouse when any statement that requires a warehouse is submitted.
Auto suspend
Automatically suspends the warehouse if it is inactive for the specified period of time.
Suspend After
1
min(s) of inactivity
Cancel
Save Warehouse

Checkpoints

* in Snowsight → min auto-suspend is one minute (recommended)
* in SQL → min auto-suspend is 0 seconds (60 recommended)
* auto-suspend zero means you always keep it alive
* a background task checks every minute for auto-suspend
* the one-minute period restarts when warehouse resumed
* suspend+resume within a minute may charge you twice

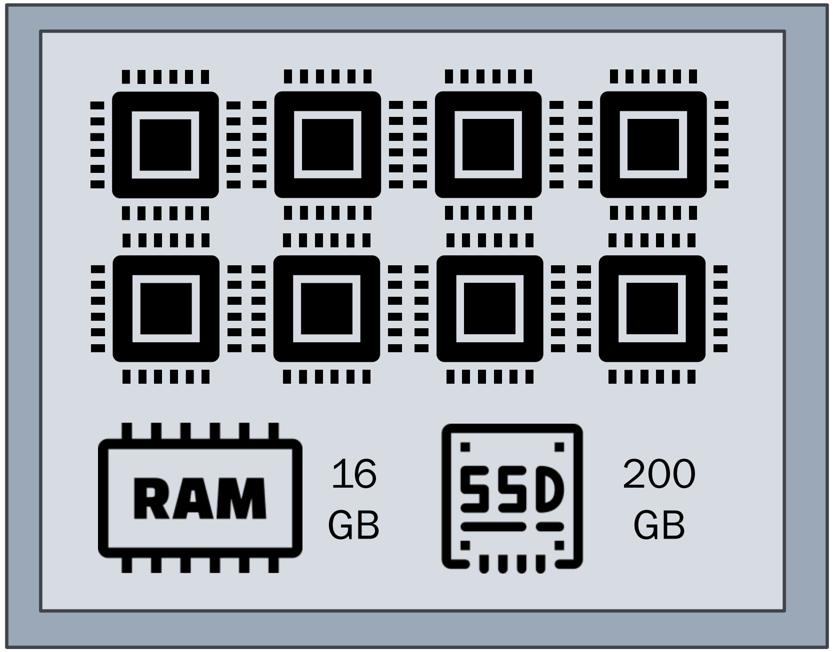
X-Small Warehouses

Could Be

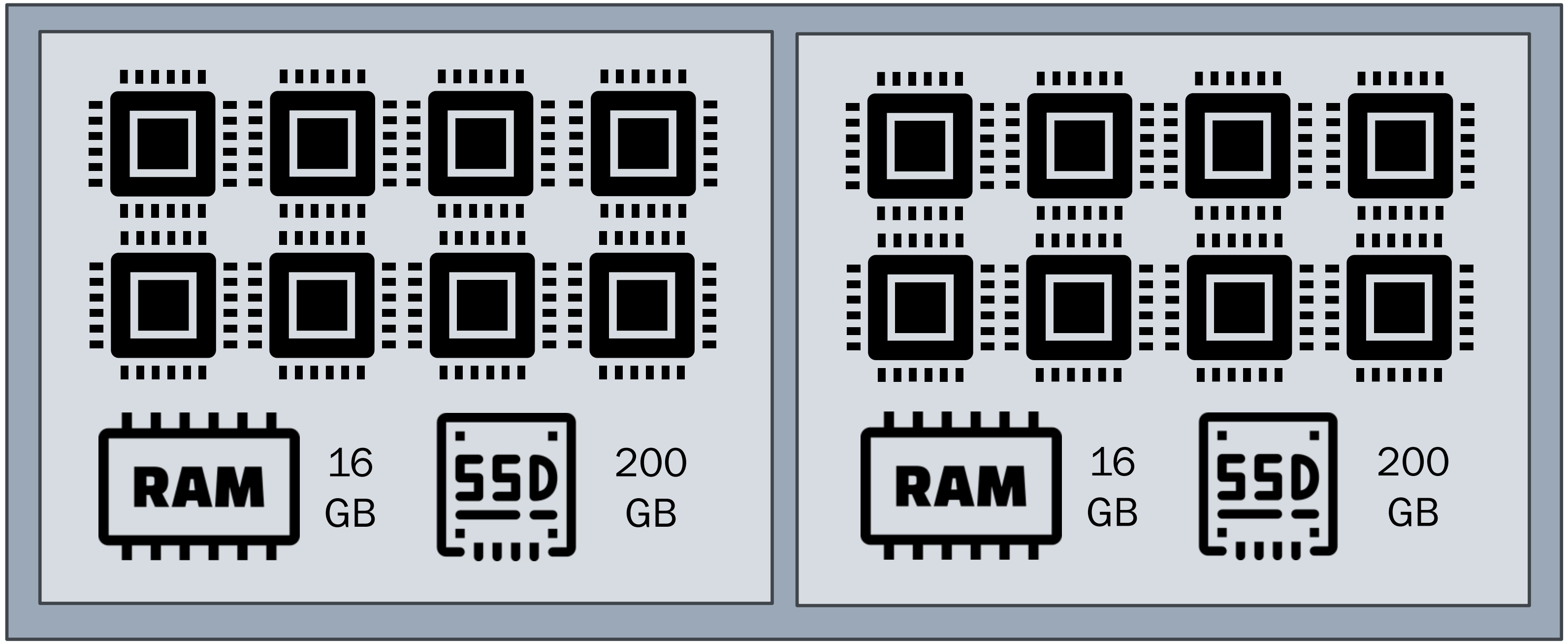
Poweful Enough

Tip #5

X-Small Warehouse (1 node)



Small Warehouse (2 nodes)



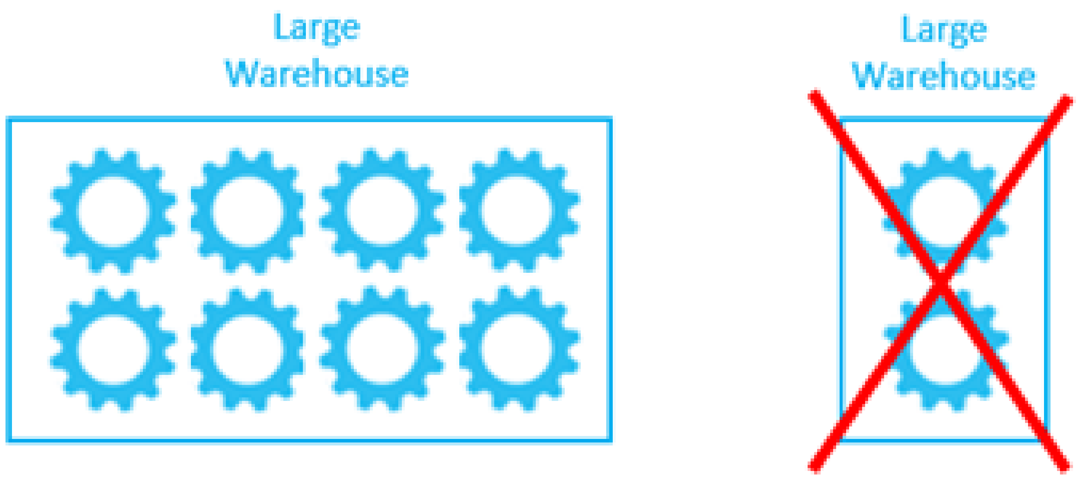
Checkpoints

* a "node" is way more than a one-CPU VM
* a single "node" is rather a powerful server w/ 8-vCPUs
* do not overspend, as X-Small could be enough
* assumed 16 GB RAM + 200 GB SSD
* for AWS: c5d.2xlarge EC2 instance (except for 5XL and 6XL)
* but only Snowflake knows what's in a node (CPU, RAM, SSD)

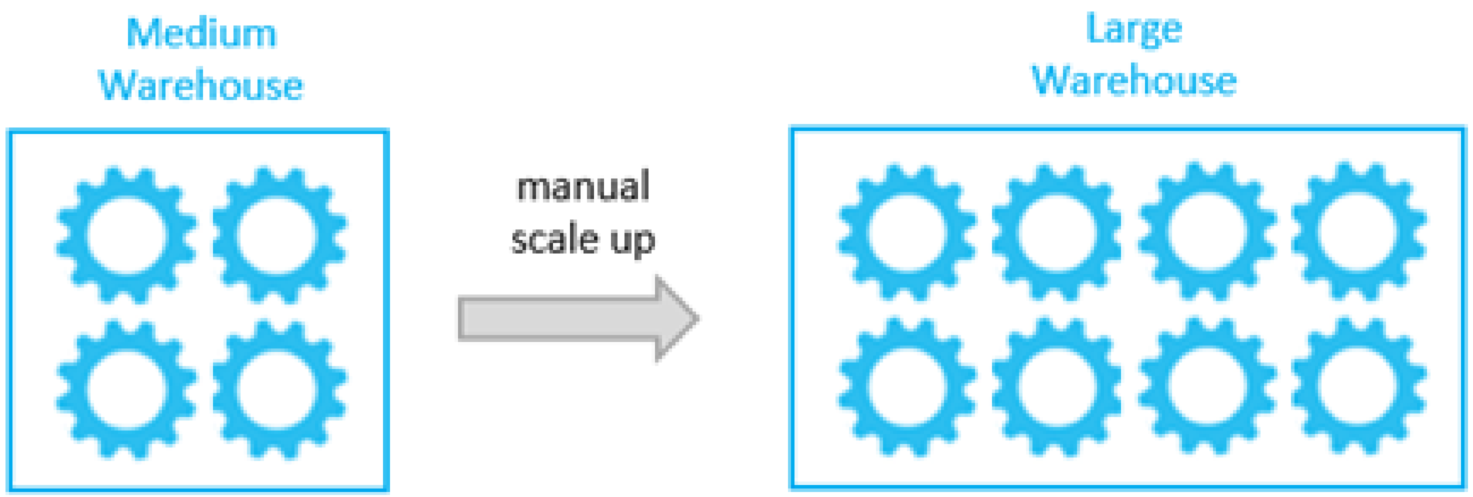
Resized Warehouses are for More Complex Queries

Tip #6

Fix Warehouse Size



Manual Scale



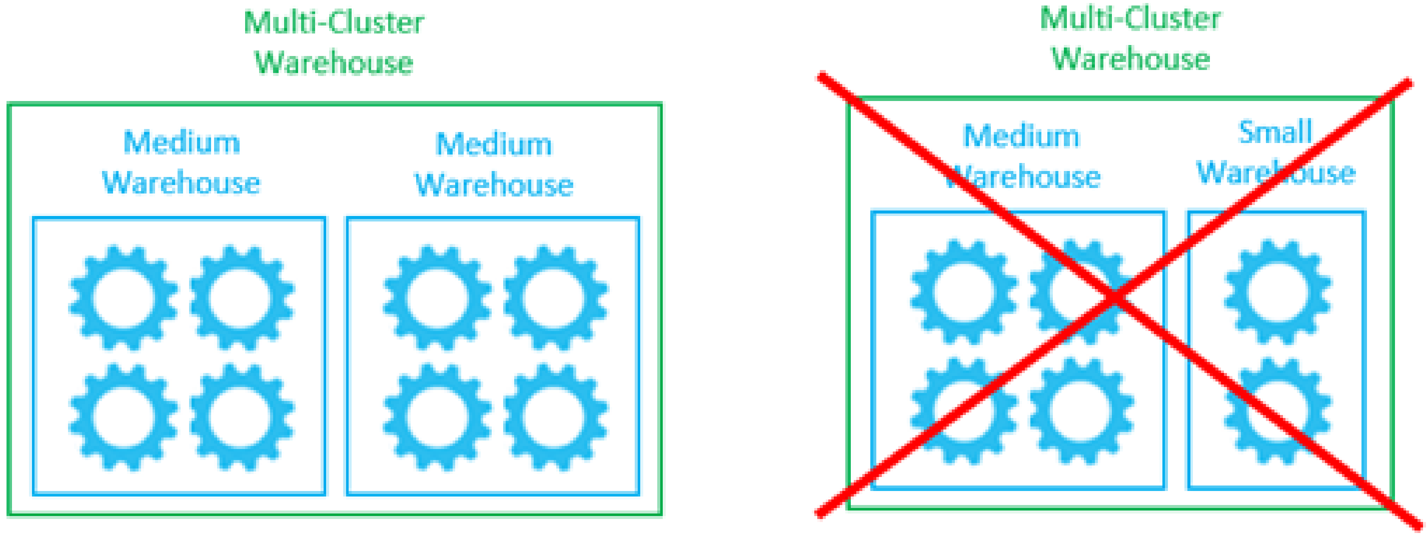
Checkpoints

* bigger sizes could help more complex queries execute faster
* bigger warehouse size could cost you less (as seen before)
* no concurrency improvement by resizing
* resizing a warehouse is always a manual process
* one query can be executed by only one warehouse
* cannot have different sizes in a multi-cluster warehouse

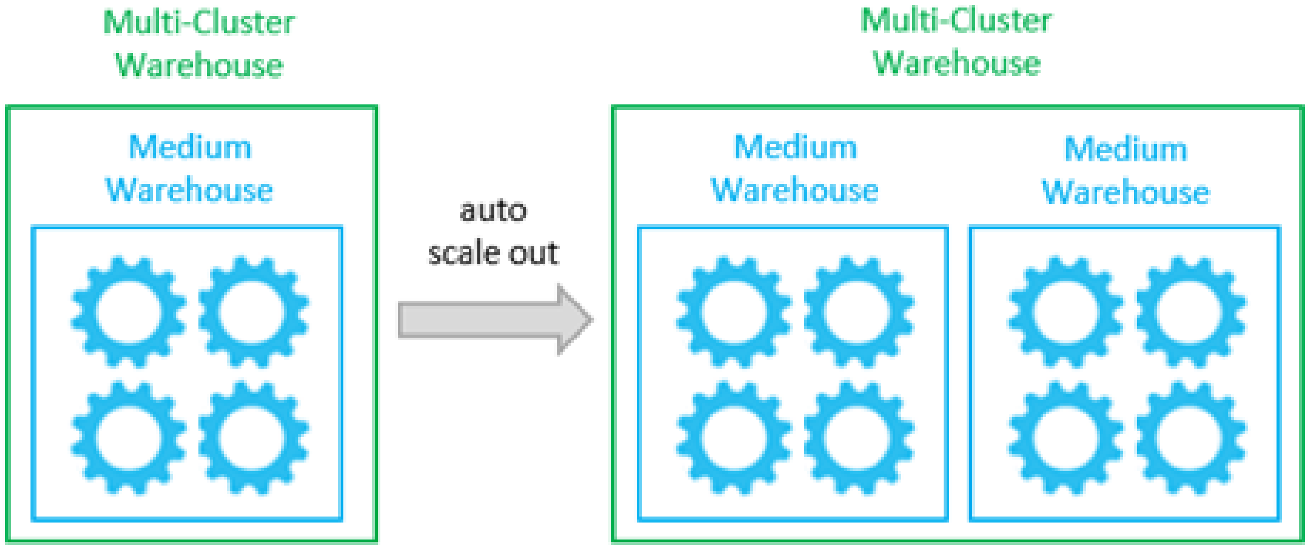
Multi-Cluster Warehouses are for Multiple Users and Concurrency

Tip #7

Fix Cluster Size



Auto Scale


Multi-Cluster Warehouse
Medium Warehouse
auto scale out
Multi-Cluster Warehouse
Medium Warehouse
Medium Warehouse

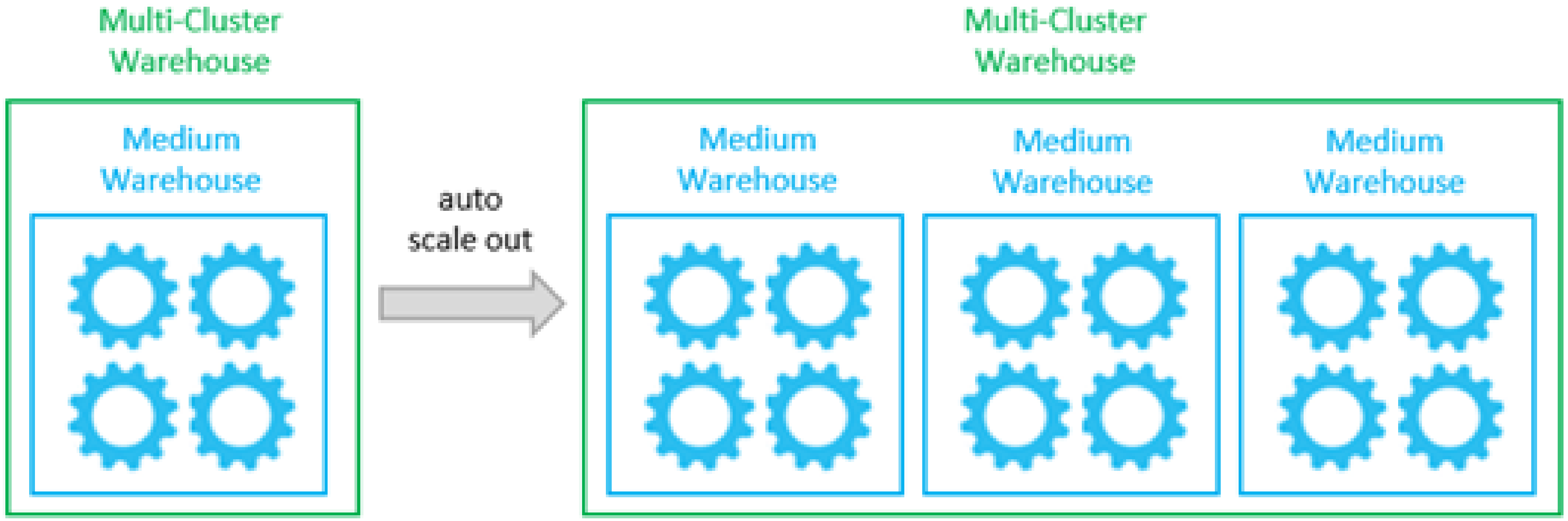
Checkpoints

* multi-cluster warehouses improve concurrent access
* multi-cluster warehouses do not help with complex queries
* multi-clustering = main reason you should have Enterprise Edition
* cannot have different sizes in a multi-cluster warehouse
* could be avoided by assigning diff users/queries to diff warehouses
* support auto-scaling (between 1..10 clusters)
* one query can be executed by only one warehouse

Multi-Cluster Warehouses Should Always Have Min Clusters 1

Tip #8

Auto Scale


Multi-Cluster
Warehouse
Medium
Warehouse
auto
scale out
Multi-Cluster
Warehouse
Medium
Warehouse
Medium
Warehouse
Medium
Warehouse

Checkpoints

* do not over-provision w/ min cluster count > 1

* unnecessary costs

* you may have one user running queries w/ very low latency (no queuing)

* min cluster count = max cluster count → no auto-scale

Use Economy Scaling Policy To Save Money

Tip #9

Multi-Cluster Warehouses

* *scale modes*

- **maximized** → min=max clusters
- **auto-scale** → between min < max clusters

* *scaling policies*

- **standard** (def) → for end-user live queries (performance is top priority)
- **economy** → for lower priority batch jobs (to optimize cost)

Standard Scaling Policy

* *auto-resume*: after 20 secs when new queued req + prior WH at its capacity

* *auto-suspend*: after 2-3 checks every min, if queries on least loaded WH can be distributed elsewhere

* avoid query queuing without saving credits

* for end-user live queries, when performance is a priority

Economy Scaling Policy

* *auto-resume*: when crt queue load could keep new WH busy for min 6 mins

* *auto-suspend*: after 5-6 checks every min, if queries on least loaded WH can be distributed elsewhere

* save credits, query queuing may happen

* for lower priority batch jobs, to maximize throughput + optimize cost

Checkpoints

* standard scaling policy (def) = will avoid queuing, but save no credits

* economy scaling policy = will save credits, but have query queuing

* auto-scale in (WH shutdown) could take 5-6 or 2-3 minutes!

* avoid scale mode *maximized* → prefer *auto-scale* between min..max

* avoid MAX_CLUSTER_COUNT 10 → keep 5 ok

* MAX_CONCURRENCY_LEVEL (def 8) = queries in parallel on a WH

When to Use Snowpark-Optimized Warehouses

Tip #10

Costs

Type of Virtual Warehouse	X-Small	Small	Medium	Large	X-Large	2X-Large	3X-Large	4X-Large	5X-Large	6X-Large
Standard	1	2	4	8	16	32	64	128	256	512
Snowpark-optimized	n/a	n/a	6	12	24	48	96	192	384	768

Checkpoints

* they have 16x more memory than Standard WHs + cost 33% more

* they are more for Data Science and ML experiments

* for one stored proc deployed by Snowpark in a single-node WH

* well-suited for model training in ML (not model serving!)

* no GPUs → see rather Snowpark Container Services w/ NVIDIA

Introduction to Compute Workloads

Tip #11: Use Resource Monitors

Tip #12: Use Account-Level Budgets

Tip #13: Prevent Never-Ending Queries

Tip #14: Manually Kill Running Queries

Tip #15: Reduce Warehouse Sizes

Tip #16: Consolidate All Warehouses

Tip #17: Use Parallel Jobs for Batch Transformations

Tip #18: Avoid Checking Too Much on Metadata

Tip #19: Charts for Warehouse Monitoring

Tip #20: Revisit the Main Traps with Warehouses

Use

Resource Monitors

Tip #11

CREATE RESOURCE MONITOR

* *levels*: account / warehouse ← SET RESOURCE_MONITOR = ...

* with *credit_quota* ← auto-reset monthly by default

* *triggers* (on N percent do) notify / suspend / suspend_immediate

* *frequency* = <u>monthly</u> / weekly / daily / yearly / never

* *start_timestamp* (= immediately) *... end_timestamp*

* *notify_users* = ("CRISTISCU", ...) ← all ACCOUNTADMIN by def

Checkpoints

* specify one monitor for the whole account

* specify one monitor for each virtual warehouse (1-N)

* enable notifications for each account admin

* watch all warehouses with no res mon assigned

* suspend immediate if long running queries expected

* schedule, for batch queries w/ periodic runs

Use

Account-Level

Budgets

Tip #12

Checkpoints

* *account budget*
  - PuPr, only for paying accounts, must enable/activate first
  - max monthly spending limit → auto-send emails when exceeding
  - SNOWFLAKE.LOCAL.ACCOUNT_ROOT_BUDGET class
* *custom budgets*
  - on group of resources, in db.schema, max 100
  - dbs, schemas, tables, mat views, WHs, pipes, tasks, serverless
  - SNOWFLAKE.CORE.BUDGET class

Prevent Never-Ending Queries

Tip #13

Checkpoints

* a running query is canceled by the system after 2 days
* STATEMENT_TIMEOUT_IN_SECONDS = sess/WH/acct
  - def 2 days (172,800 secs), 0 to 604800 (7 days)
  - max overall time = queue + locked + exec + compile + ...
  - also for queries w/o WH (DDL/DML: CLONE, CREATE...)
* STATEMENT_QUEUED_TIMEOUT_IN_SECONDS = def 0

Manually Kill Running Queries

Tip #14

Checkpoints

* *Cancel* button in Snowsight, *X* button in Query History
* SYSTEM$CANCEL_QUERY with last_query_id()
* CTRL+C from SnowSQL
* only own queries (not necessarily ACCOUNTADMIN)
* NOT with: close browser, abort session, suspend WH
* could also manually stop WH when query ends, to save money!

Reduce

Warehouse Sizes

Tip #15

Checkpoints

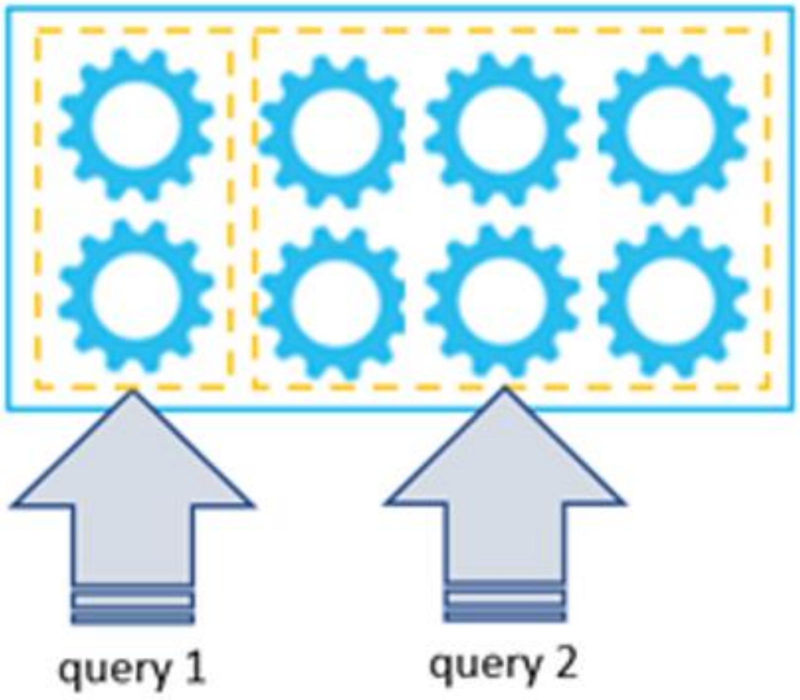
* start with the smallest 1-node X-Small warehouse
* start with MIN_CLUSTER_COUNT 1 in multi-cluster WH
* as a user, connect with an X-Small default WH
* upsize only when need for larger WH is proven
* use Snowpark-optimized only for mem-intensive workloads
* drop expensive warehouses, not frequently used
* cancel queries taking too long w/ current warehouse

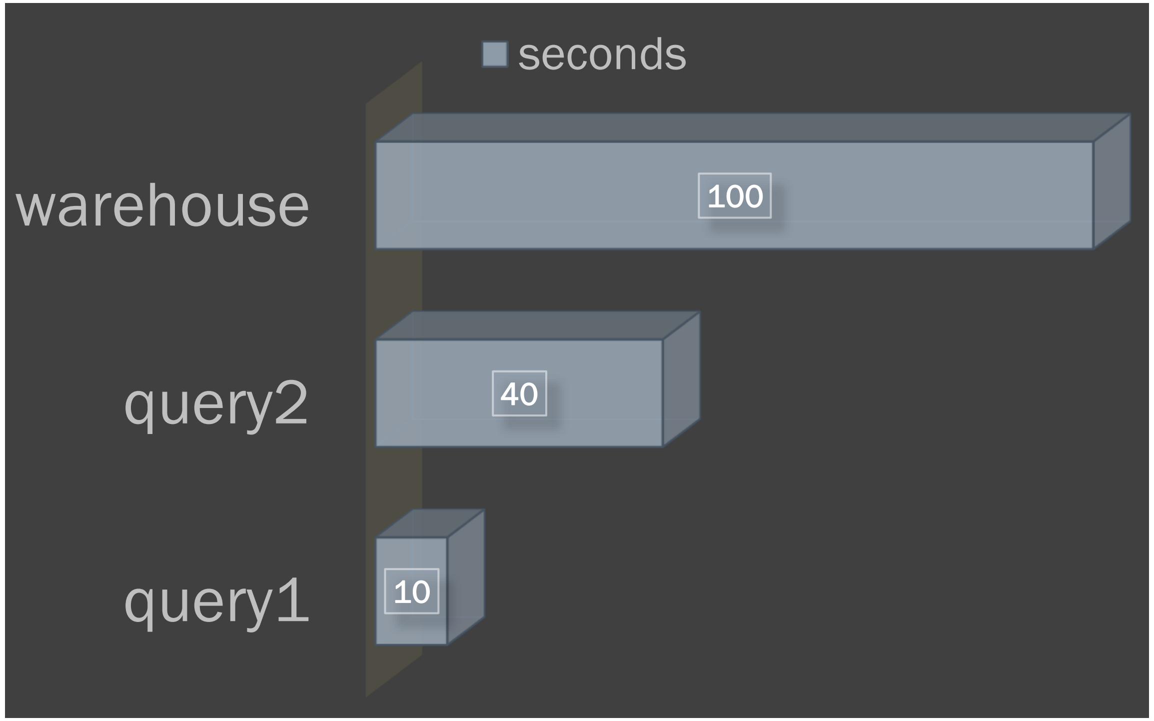
Consolidate

All Warehouses

Tip #16

Query Execution





Warehouse Load/Utilization

* *query1 load*: 10/100/2 = 5% (could run 20 such queries in 100 secs)

* *query2 load*: 40/100/2 = 20% (could run 5 such queries in 100 secs)

* *warehouse load/utilization*: 0.05 + 0.2 = 25%

query1 (10 secs) + query2 (40 secs)

warehouse max_concurrency_level = 2

warehouse up: 40 secs (queries) + 60 secs (auto-suspend) = 100 secs

System Views

* WAREHOUSE_METERING_HISTORY
    - *start_time .. end_time + warehouse_name*
    - ***credits_used***
* QUERY_HISTORY
    - *start_time .. end_time + warehouse_name*
    - ***execution_time*** + *query_load_percent*

Checkpoints

* consolidation = reduce # of *underutilized* warehouses (cost money!)

* *overutilized* warehouses (w/ queuing) have no cost impact

* *query latency* (queuing) vs *warehouse utilization* ← compromise!

* *query load* vs *warehouse load* (+ MAX_CONCURRENCY_LEVEL)

* redirect queries from some WHs to other WHs ← see utilization heatmap

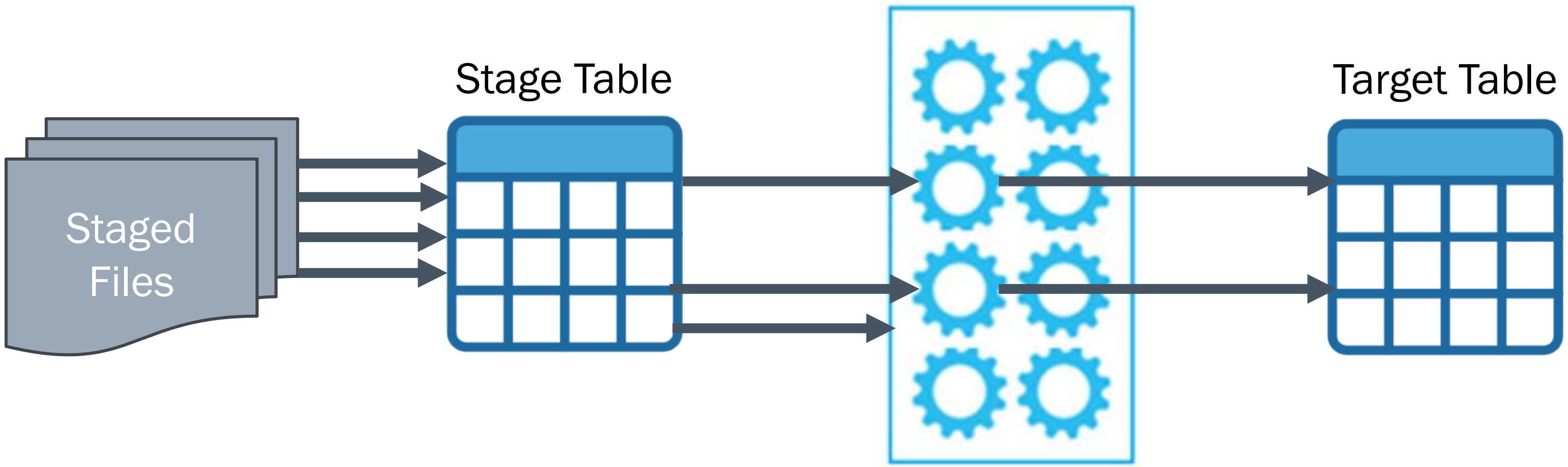
* group similar workloads in the same WH

* *workload type* (*util. target*): ETL (95%), interactive (80%), dashboards (60%)

Use Parallel Jobs for Batch Transformations

Tip #17

Data Transformation Pipeline



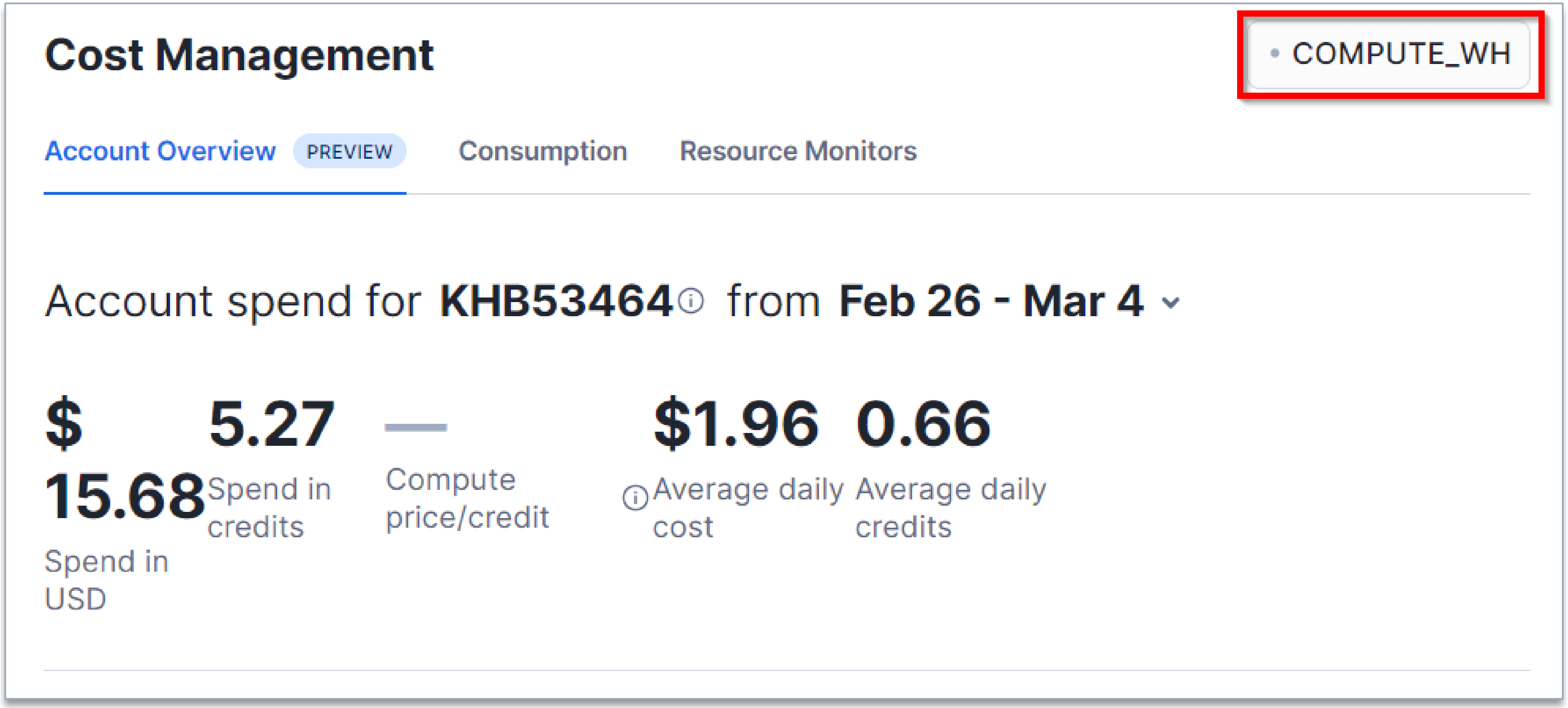
Checkpoints

* ~parallel ingestion into table from staged files
* split intensive MERGE statements w/ filters
* send multiple SQL jobs in parallel on diff connections
* max concurrency on 1-node X-Small WH is 10
* increase WH size for better distribution
* multi-cluster WH could also make sense for >> opers

Avoid Checking Too Much on Metadata

Tip #18

Snowsight


Cost Management
COMPUTE_WH
Account Overview
PREVIEW
Consumption
Resource Monitors
Account spend for KHB53464 from Feb 26 - Mar 4
$ 15.68
Spend in USD
5.27
Spend in credits
—
Compute price/credit
$1.96
Average daily cost
0.66
Average daily credits

Checkpoints

* *Snowsight*
  - Snowflake's admin console will incur a cost!
  - check Snowsight screens w/ a WH
  - auto-refresh Query History every N seconds

* *querying metadata*
  - querying Information Schema does not require a WH
  - querying Account Usage schema requires a WH
  - many Account Usage queries are rather slow (ex: *grants_to_roles*)
  - many Account Usage views could return a lot of data (ex: *query_history*)
  - many columns return JSON data, that needs flattening (ex: *access_history*)

Charts for Warehouse Monitoring

Tip #19

Checkpoints

* overall compute: warehouses / cloud services / serverless
* WAREHOUSE_METERING_HISTORY view
* top warehouses by cost → credits used
* utilization heatmaps → warehouse loads
* queries → running/provisioning/blocked/queued
* total spending per user / query type ...
* timeline charts

Revisit the Main Traps with Warehouses

Tip #20

Checkpoints

* no predef. resource monitors + not through UI → no proactive approach to overspending
* AUTO_SUSPEND by def 600 (10 minutes) in code + 5 min in UI
* billed per second, but at least 1 min + AUTO_SUSPEND 1 min at least (can be set lower!)
* manual 2+ resume+suspend pairs in the first minute → billed for 2+ minutes!
* INITIALLY_SUSPENDED by def FALSE and no UI access → bill 1 min no matter what
* MIN_CLUSTER_COUNT could be set to >1 → should be always 1
* STATEMENT_TIMEOUT_IN_SECONDS 2 days by def + hidden Cancel btn in Query History
* STATEMENT_QUEUED_TIMEOUT_IN_SECONDS 0 by def (no timeout)

Introduction to Snowflake Accounts

Tip #21: What to Choose for a Free Trial Account

Tip #22: When to Use a Free Trial Account

Tip #23: Understand Price Tables for Warehouse Compute Services

Tip #24: Understand Price Tables for Cloud and Serverless Services

Tip #25: Understand Price Tables for Storage and Data Transfer

Tip #26: Use the Account Overview Interface in Snowsight

Tip #27: Use Organization Accounts

Tip #28: Limit Warehouse Changes with Access Control

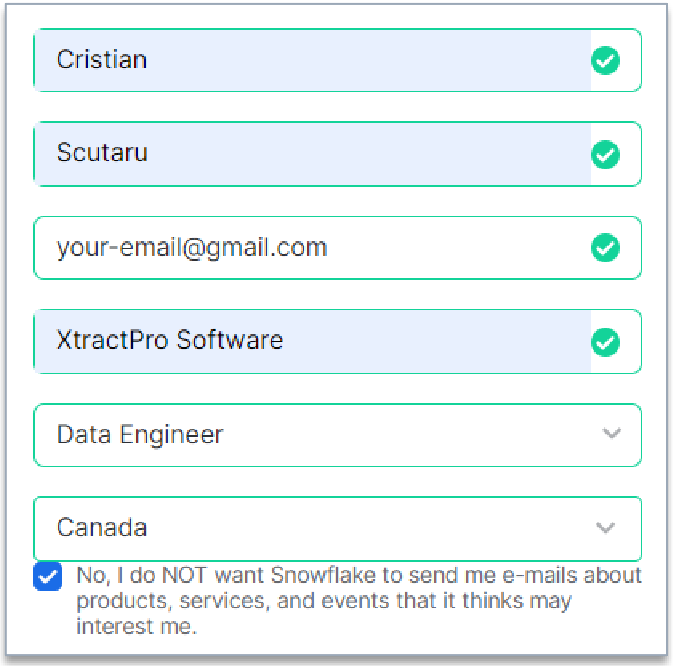
Tip #29: Adjust Default Values of Account-Level Parameters

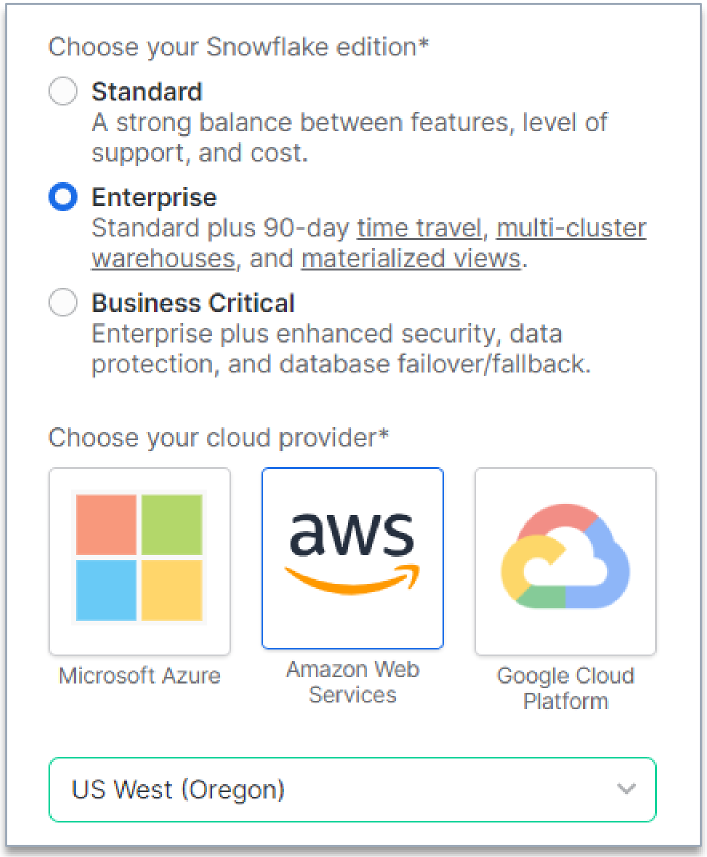
Tip #30: Careful with Reader Accounts

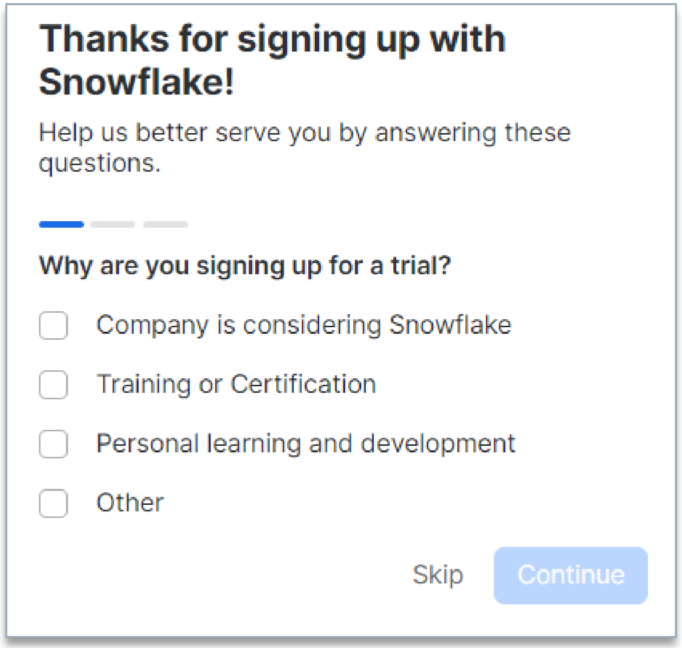
What to Choose for a Free Trial Account

Tip #21

signup.snowflake.com







Checkpoints

* no credit card required / no obligations whatsoever
* email address could be reused after a while
* no need for a corporate email address
* default Enterprise edition could be the most appealing
* AWS is frequently used first as provider for new PuPr features
* region closest to where you are / where your data is
* can skip the last survey questions

When to Use

a Free Trial Account

Tip #22

Limitations

* running out of email addresses
* some new features (Budgets) not on free trial accounts
* native apps sharing requires accounts within org
* no Snowflake customer service
* you'll need to upload/reinstall all after one month
* you lose all access after one month

Checkpoints

* trial of native apps from Snowflake Marketplace
* experiments on large public datasets
* prototyping + trying new Snowflake features
* introducing a new potential client to Snowflake
* prepare for + write a new Udemy course

Understand Price Tables for Virtual Warehouse Compute Services

Tip #23

VW Compute Pricing

* Standard Edition = $2/credit/node = $2/h for X-Small WH

* Enterprise Edition = $3/credit/node = $3/h for X-Small WH

* Business Critical Edition = $4/credit/node = $4/h for X-Small WH

in AWS/US region, for active 1-Node WH

Small (2-Nodes) is 2x more expensive, Medium (4-Nodes) 4x etc.

Snowflake Pricing

* Compute = w/ credits, for active **VW/SPCS**, per second, minimum 1 min

* Cloud Services = 4.4 credits/h, not billed if < 10% of daily VW credits

* Serverless Features = on managed compute (+cloud services), per second

* Data Sharing = pay for all Reader Accounts, not for other Snowflake accounts

* Storage = avg TB/mo (snapshots of data), compressed, diff for hybrid tables!

* Data Transfer = Ingress/Egress, separate for external functions

Checkpoints

* *all compute*

- VW Compute
- Cloud Services
- Serverless Features

* *for the same supported queries*

- Enterprise is 1.5x more expensive than Standard
- Business Critical is 2x more expensive than Standard

Understand Price Tables for Cloud and Serverless Services

Tip #24

Cloud Services

* distributed back-end systems
* SHOW commands
* query compilation
* result caches
* INFORMATION_SCHEMA queries

Serverless Features

* Query Acceleration Service (QAS) - Nx boost of a WH
* Search Optimization Service (SOS) - (also in secondary db)
* Automatic Clustering - for clustered tables (w/ clustered key), initial + recluster
* Materialized Views - for maintenance (also in secondary db), auto-refresh data
* Snowpipe & Snowpipe Streaming - w/ fixed credits/files or h
* Serverless Tasks - 1.5x Managed Tasks (w/ WH)
* Hybrid Tables - for maintenance+requests, indexes, R/W data
* Replication - only in Business Critical for objects other than dbs

Checkpoints

* *cloud services*

- charged only when > 10% x daily VW consumption (rare!)
- could pile up for very frequently used metadata queries (~10k times)

* *serverless features*

- Snowflake-managed vs user-managed resources
- charged w/ credits, ~WH, depending on the service
- billed per second, not when idle (like for the user-managed resources)
- Snowflake-managed compute + cloud service credits

Understand Price Tables for Storage and Data Transfer

Tip #25

Checkpoints

* *storage*

- small fraction, in average TB/mo, for compressed data
- On-Demand / Capacity
- Hybrid Tables storage billed separately → GB/mo

* *data transfer*

- very small fraction, in TB transferred, ~the cloud provider
- for data out only (data in free)
- free when within same region/continent/provider
- from COPY, replication, external functions

Use the Account Overview Interface in Snowsight

Tip #26

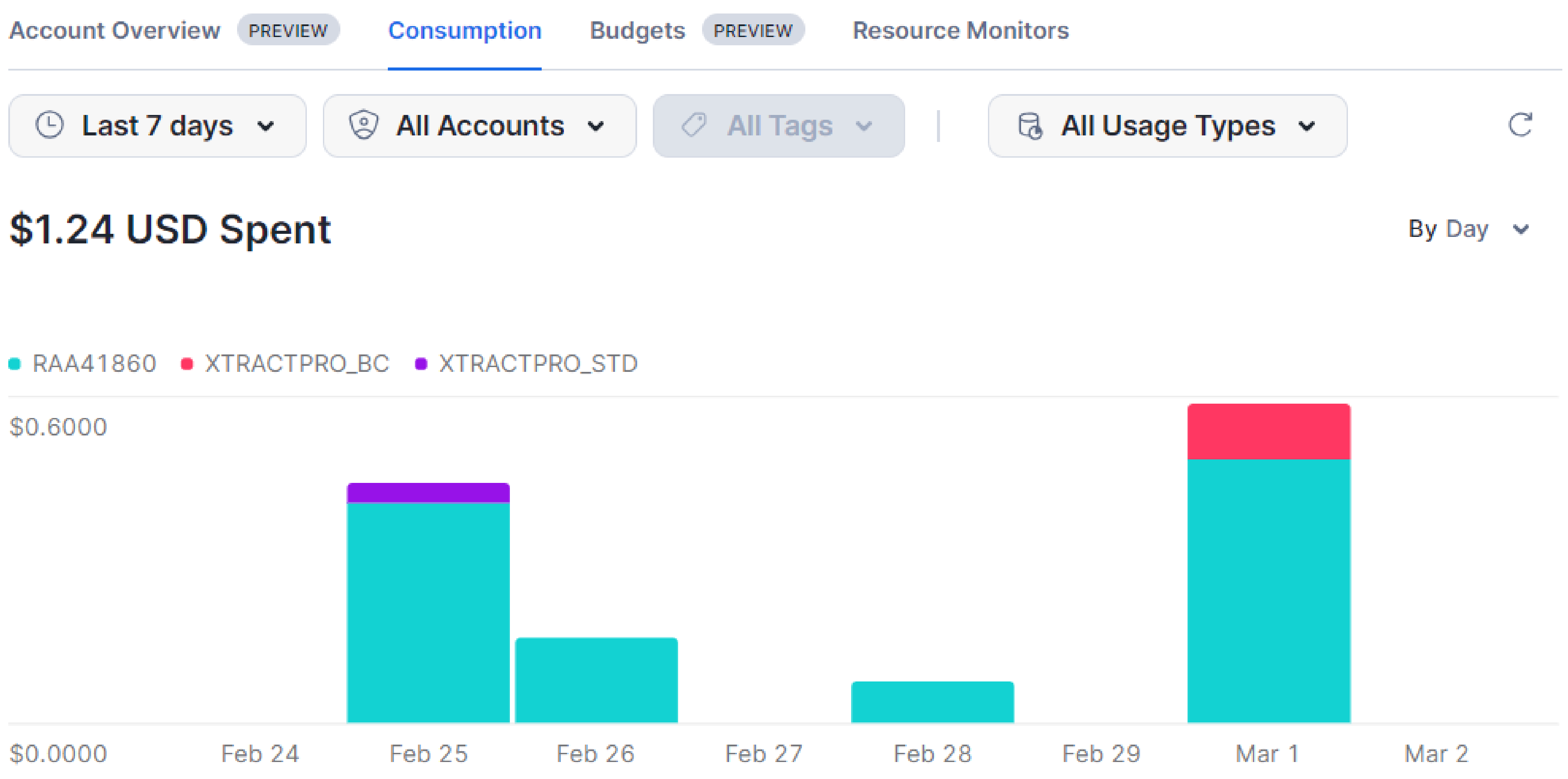
Cost Management interface

Account Overview PREVIEW | Consumption | Budgets PREVIEW | Resource Monitors

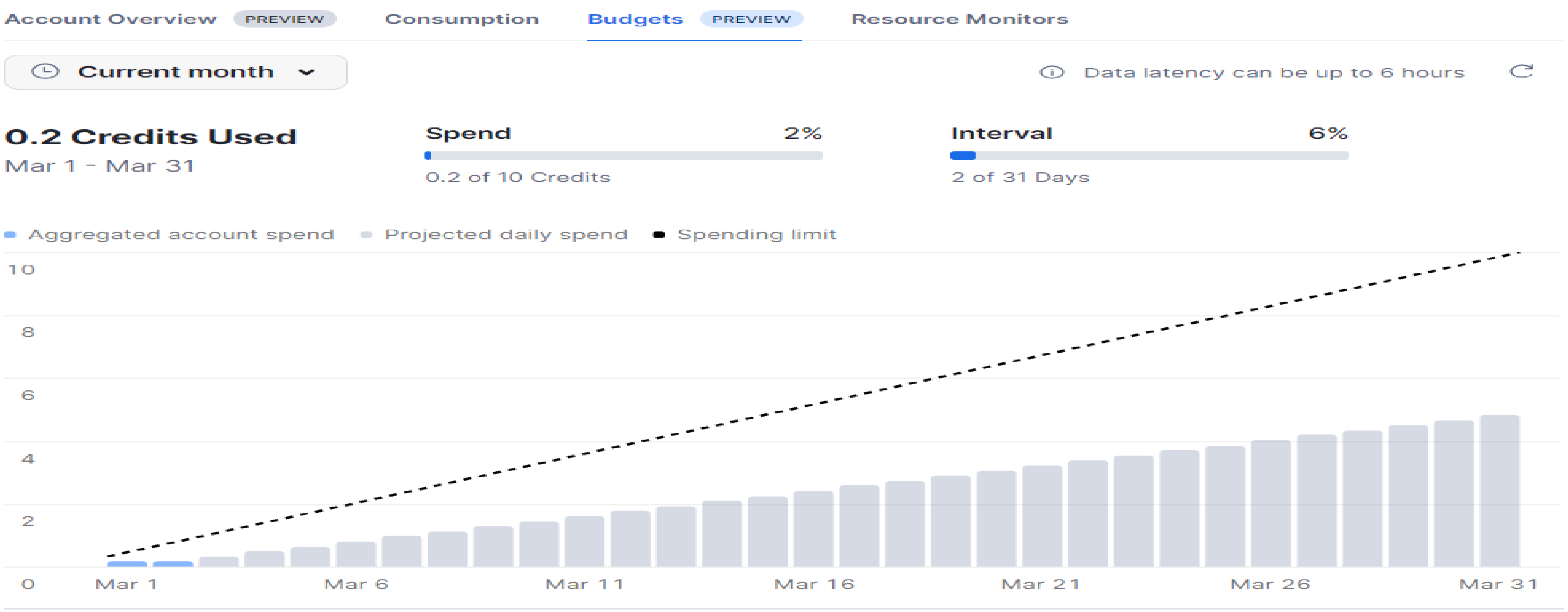
Account spend for **RAA41860** from **Feb 24 - Mar 2**

$1.11	**0.32**	**$3**	**$0.14**	**0.04**
Spend in USD	Spend in credits	Compute price/credit	Average daily cost	Average daily credits

Consumption



Budgets



Account Overview
PREVIEW
Consumption
Budgets
PREVIEW
Resource Monitors
Current month
Data latency can be up to 6 hours
0.2 Credits Used
Mar 1 - Mar 31
Spend
2%
0.2 of 10 Credits
Interval
6%
2 of 31 Days
Aggregated account spend
Projected daily spend
Spending limit
10
8
6
4
2
0
Mar 1
Mar 6
Mar 11
Mar 16
Mar 21
Mar 26
Mar 31

Checkpoints

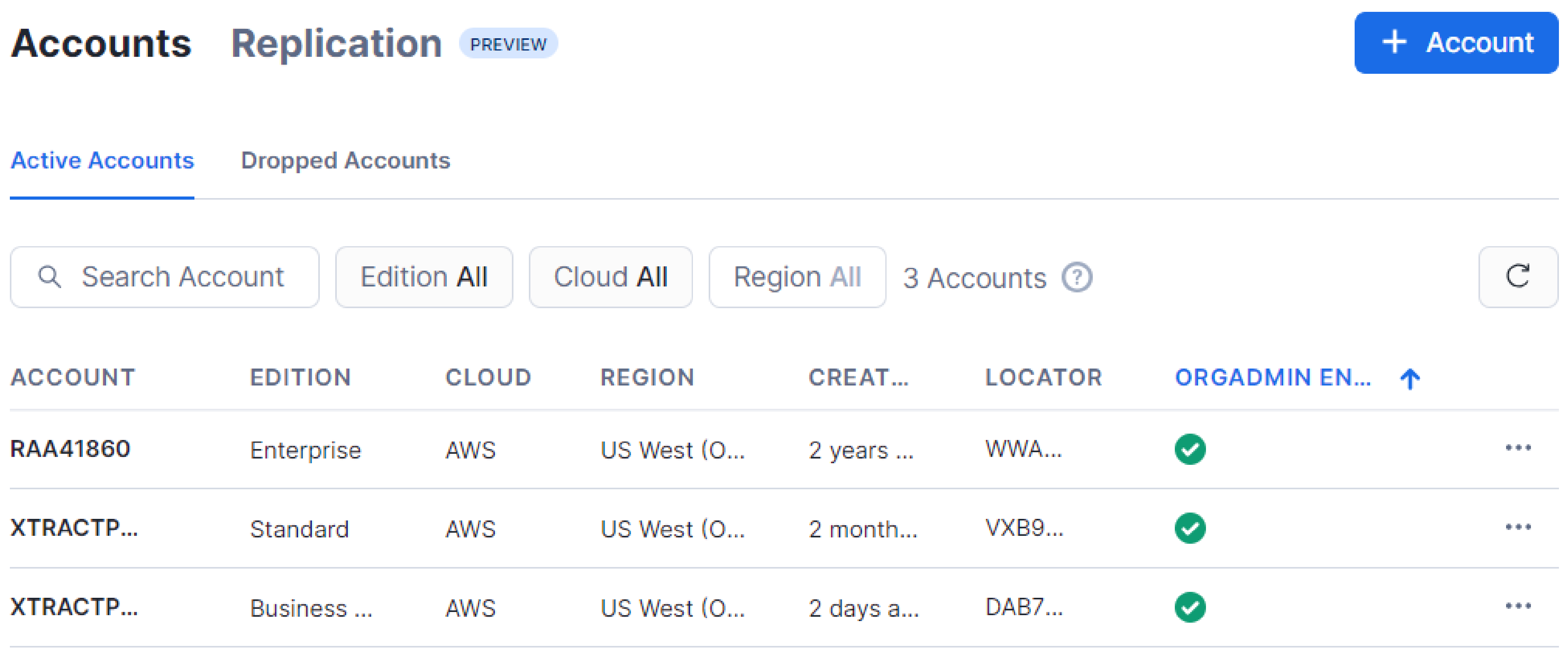
* **Cost Management** - Admin interface, w/ date range
  - Account Overview - PuPr
  - Consumption - per date range/acct, C/S/DT
  - Budgets - PuPr, only paid accounts
  - Resource Monitors -

* Account Overview Insights
  - ***Account budget for current month*** - w/ budget(s)
  - ***Top warehouses by cost*** - w/ SQL
  - ***Top databases by storage*** - w/ SQL
  - ***Most expensive queries*** - total/avg exec time + #

Use Organization Accounts

Tip #27

Accounts interface



Accounts interface

* Create New Account
  - *edition*: Standard/Enterprise/Business Critical
  - *cloud/region*: AWS/Azure/GCP
* accounts: active/dropped ← 3..90 days grace period
  - manage URLs: locator/org-acct
  - enable/disable ORGADMIN

Checkpoints

* create new related paid Snowflake accounts
* create Standard account for basic query experiments
* private share data & native apps within org accounts
* test new PuPr features available only in paid accounts
* requires higher level of security than free trial accounts
* SHOW ORGANIZATION ACCOUNTS ← w/ ORGADMIN

Limit Warehouse Changes with Access Control

Tip #28

Checkpoints

* USAGE ← execute/abort queries (w/ eventual auto-resume)

* OPERATE ← execute/abort queries + view crt/past queries + suspend/resume

* MODIFY ← alter properties (including size) + assign to resource monitors

* MONITOR ← view current/past queries + usage statistics

* APPLYBUDGET ← add/remove from a budget

* OWNERSHIP ← full control (for a single role)

* ALL ← all privileges but OWNERSHIP

Adjust Default Values of Account-Level Parameters

Tip #29

Checkpoints

* *time travel* ← cannot be disabled for an account!

- MIN_DATA_RETENTION_TIME_IN_DAYS - (def 0), can force TT, does not alter current settings
- DATA_RETENTION_TIME_IN_DAYS - (def 1) 0..90 Ent / 0..1 Std, set def for database/schema/permanent tables, but cannot force disable w/ 0

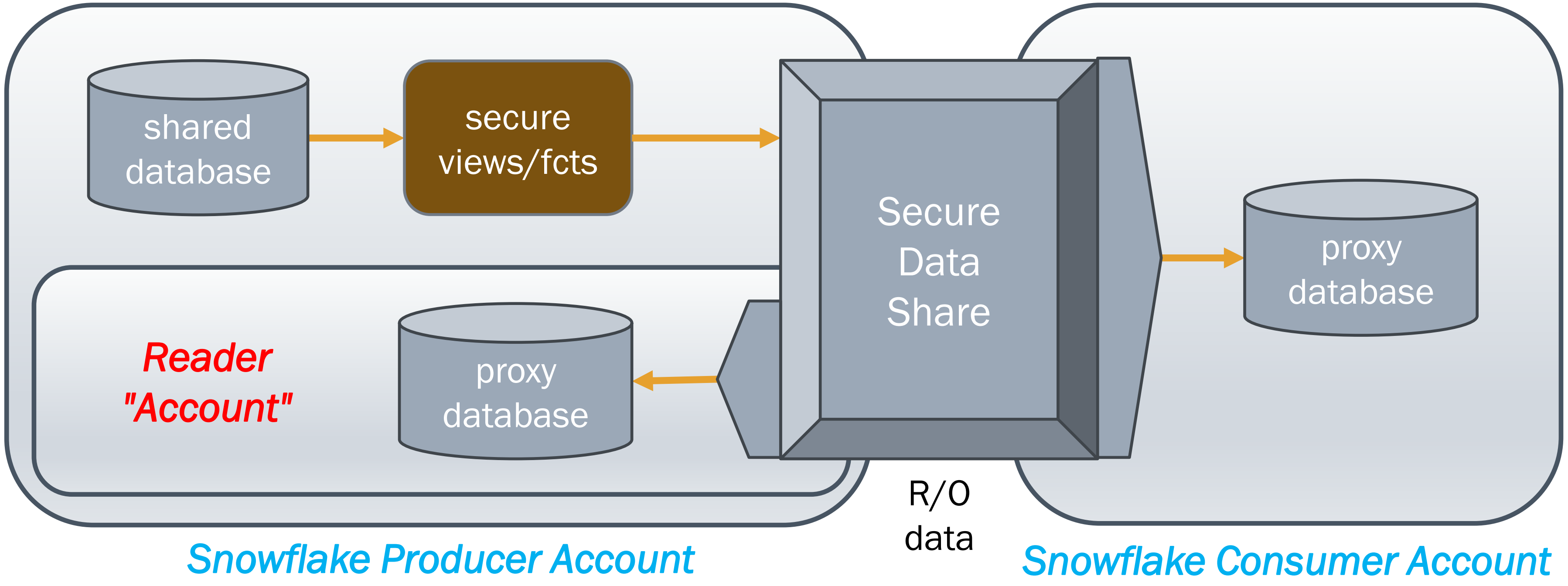
* *replication*

- INITIAL_REPLICATION_SIZE_LIMIT_IN_TB – (def 10) max estimated size limit for initial replication of a primary db to a sec db, to prevent accounts w/ sec dbs from accidentally incurring large replication charges

Careful with Reader Accounts

Tip #30

Data Share w/ Reader Account



Checkpoints

* Reader accounts are not separate Snowflake accounts
* Reader accounts consume YOUR credits!
* monitor closely all your Reader accounts
* set resource monitors w/ budget alerts
* "local" admins could create/manage WHs there!

Introduction to Snowflake Editions

Tip #31: When to Choose Enterprise over Standard Edition

Tip #32: How to Avoid Multi-Cluster Warehouses

Tip #33: When to Use Incremental Materializations

Tip #34: How to Emulate Materialized Views

Tip #35: The Case for Extended Time Travel

Tip #36: Use Standard Edition Account for Analytics

Tip #37: Use Separate Standard Edition Account for Common Queries

Tip #38: How to Reduce Costs to Zero for an Inactive Paid Account

Tip #39: When to Choose the Business Critical Edition

Tip #40: When to Choose the Virtual Private Snowflake (VPS) Edition

When to Choose Enterprise over Standard Edition

Tip #31

Esential New Features

* **Multi-Cluster Virtual Warehouses** → w/ auto-scaling out for concurrency
* Query Acceleration Service → boost WH size Nx, for eligible queries
* Search Optimization Service → for point lookup queries
* Materialized Views → w/ auto-maintenance of results
* Extended Time Travel → max 90 days (from 1) for permanent tables

Other New Features

* Data Masking Policies → column-level security in tables/views
* Row Access Policies → row-level security for query rows
* Object Tagging → to track sensitive data + resource usage
* Classification → to auto-tag potentially sensitive data
* User Access Auditing → in ACCESS_HISTORY view
* Periodic Rekeying of Encrypted Data → increased protection
* Early Access to Weekly New Releases → 12-hour

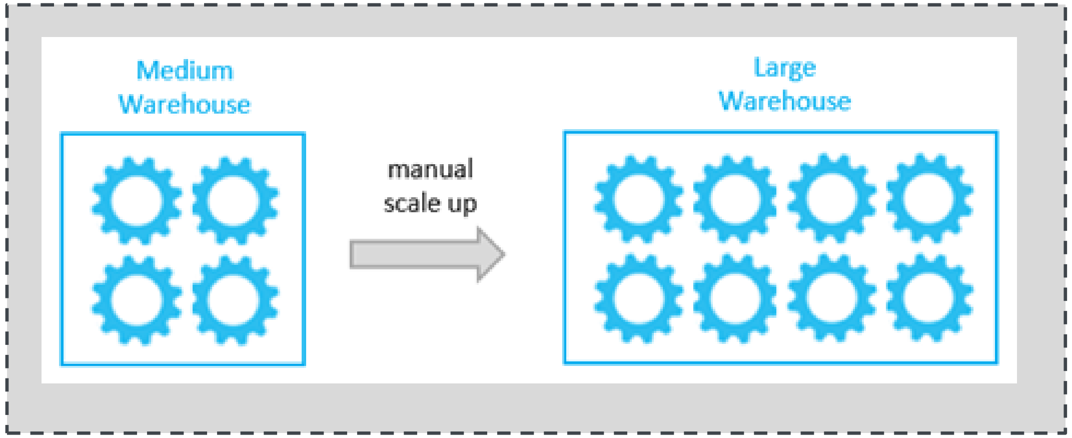
Checkpoints

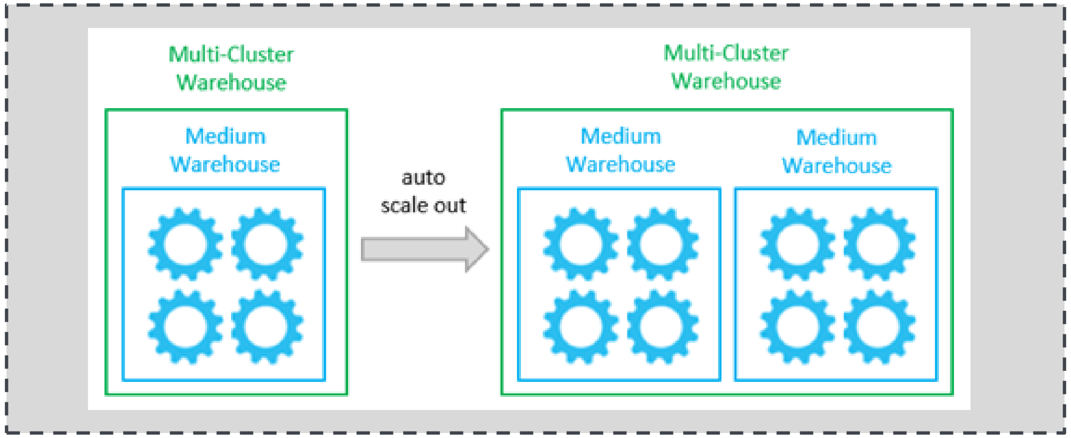
* SMB → large enterprise/org
* 1.5x credit cost
* higher number of users → multi-cluster WHs (concurrency)
* QAS + SOS + MVs → improved query performance
* 90 days TT → better data protection
* column/row policies, obj tagging, classif → better data gov
* rekey, user audit → better security

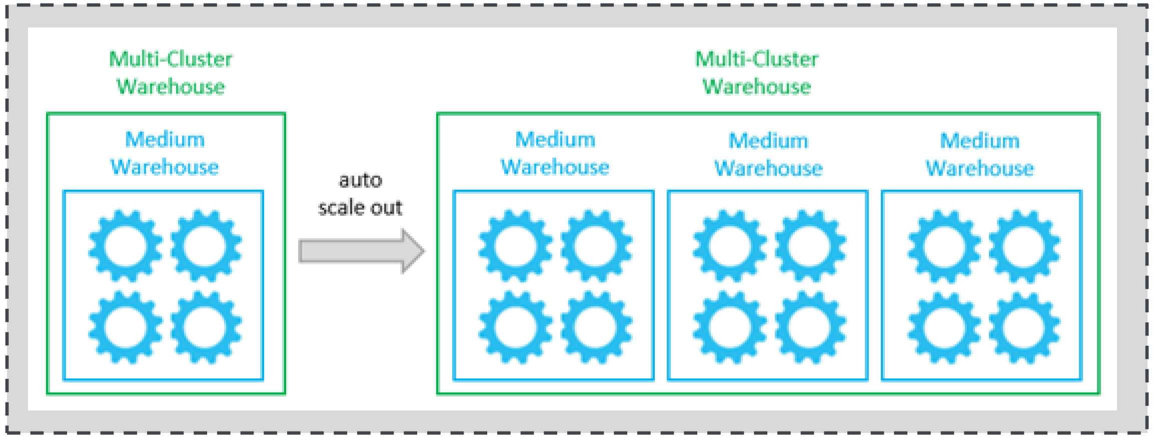
How to Avoid Multi-Cluster Warehouses

Tip #32

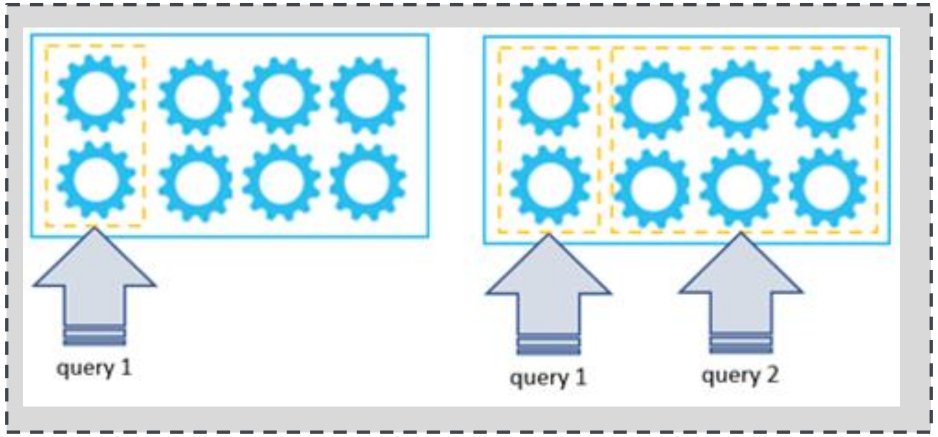
Scalability

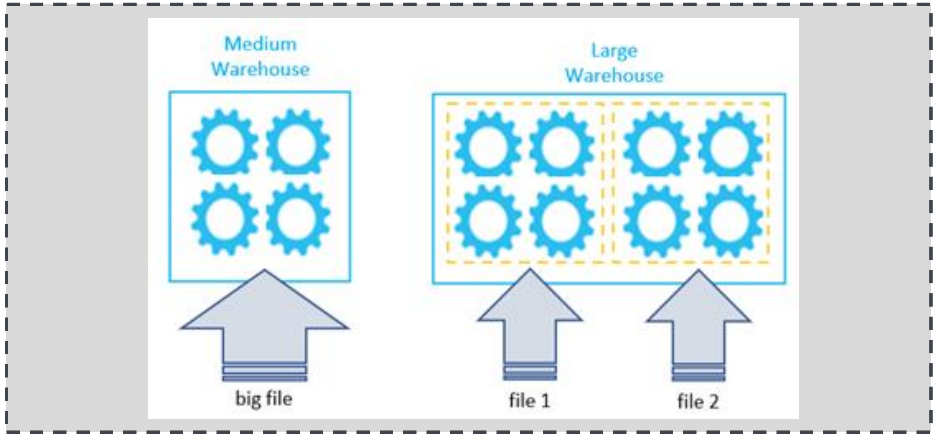


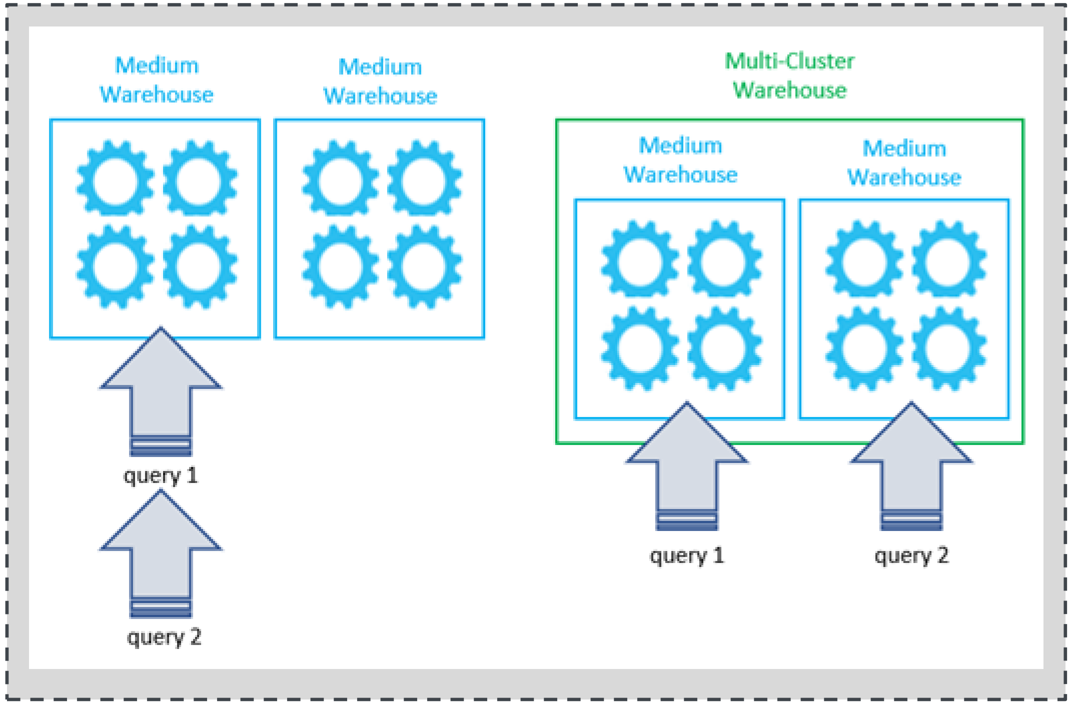




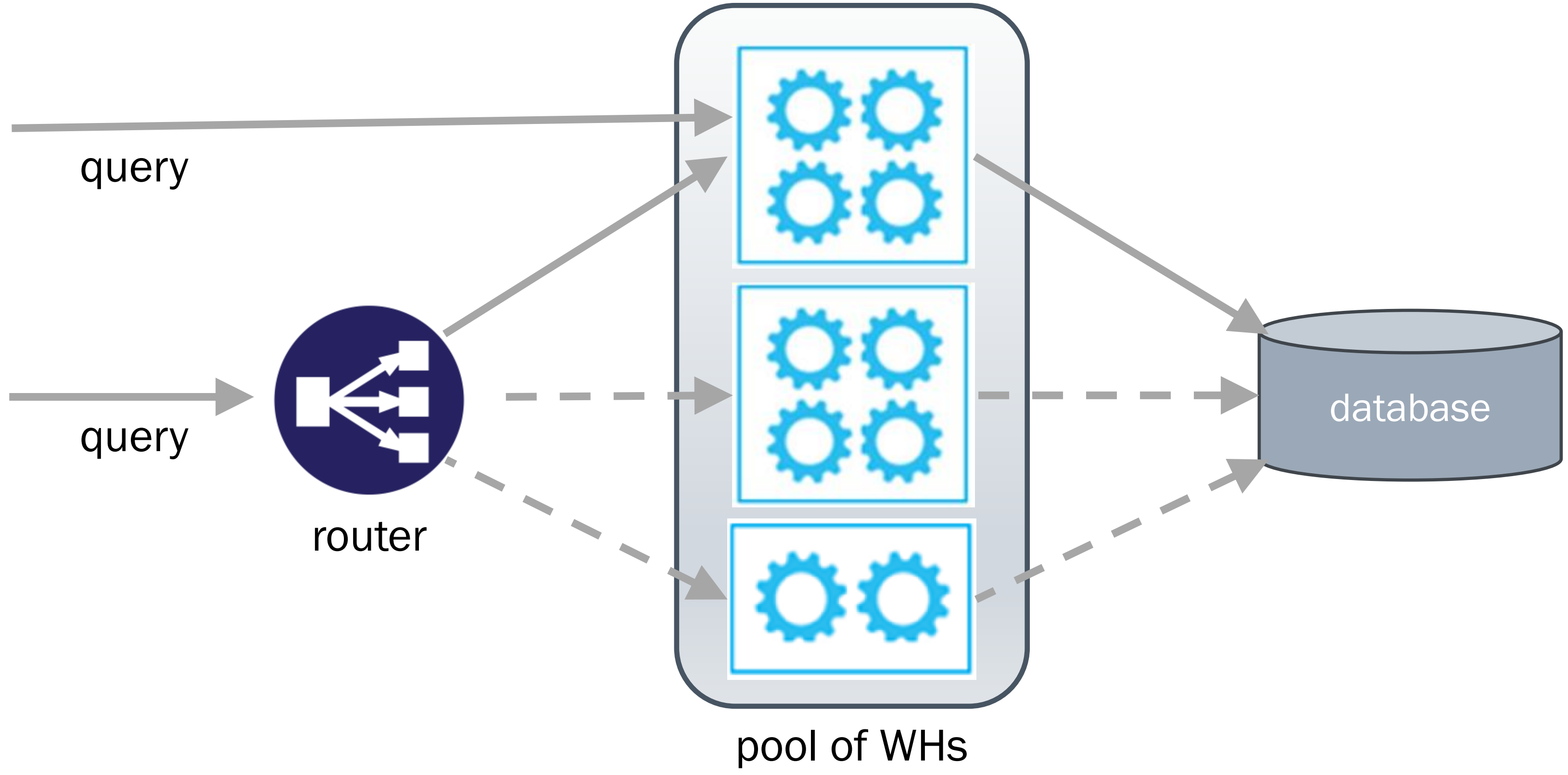
Concurrency







Custom Auto-Router



Checkpoints

* multi-cluster WHs (Enterprise+ only) improve concurrent access (avoid queuing)

* *custom auto-router* =~ load balancer, on standard WHs

* auto-scale out/in to standard overflow WHs (manual scale up/down normally)

* could reroute if M+ queries on current WH (use MAX_CONCURRENCY_LEVEL)

* auto-route work on load spikes (to existing/dynamic WHs w/ same/different sizes)

* reroute to pool of WHs (10+!) after STATEMENT_QUEUED_TIMEOUT_IN_SECONDS expires

* could use default auto-suspend times (multi-cluster could use longer time!)

When to Use Incremental Materializations

Tip #33

Materialized Views

* Enterprise+, storage + compute costs (10 credits/h) → when refreshed
* act more like tables, as they store R/O data → result never outdated
* base table data changes → back incremental update
* based on one single table (self-joins not allowed)
* can be secured (not optimized) + can have a (different) cluster key
* has limited SQL syntax, no UDFs

Checkpoints

* when query result doesn't change often (base table not freq updated)
* when results are asked often (less complex query executed here)
* when original query consumes lots of resources
* to improve performance on an external query
* when lots of aggregations returned
* when few rows constantly returned only from a very large table
* need a different cluster key than the base table

How to Emulate Materialized Views

Tip #34

Checkpoints

* use a table instead, instantly/periodically updated

* use a task to periodically update the table

* task + CHANGE_TRACKING enabled on the source table

* task + STREAM ← legacy mechanism for CDC

* use a Snowflake *dynamic table* instead ← new!

The Case for Extended Time Travel

Tip #35

Time Travel Use Cases

** looking back in time*

- SELECT … FROM … AT (TIMESTAMP => timestamp) …
- SELECT … FROM … AT (OFFSET => rel_time_diff) …
- SELECT … FROM … AT (STREAM => 'name') …
- SELECT … FROM … AT/BEFORE (STATEMENT => query_id) …

** in zero-copy cloning*

- CREATE DATABASE/SCHEMA/TABLE target CLONE source AT/BEFORE (…)

** restoring dropped objects*

- DROP DATABASE/SCHEMA/TABLE name
- SHOW DATABASES/SCHEMAS/TABLES HISTORY […] ← dropped
- UNDROP DATABASE/SCHEMA/TABLE name ← restore dropped object

Checkpoints

* *time travel*
    - max 90 days for permanent tables in Enterprise Edition
    - max 1 day for permanent tables in Standard Edition
    - max 1 day for transient/temporary tables (in any edition)

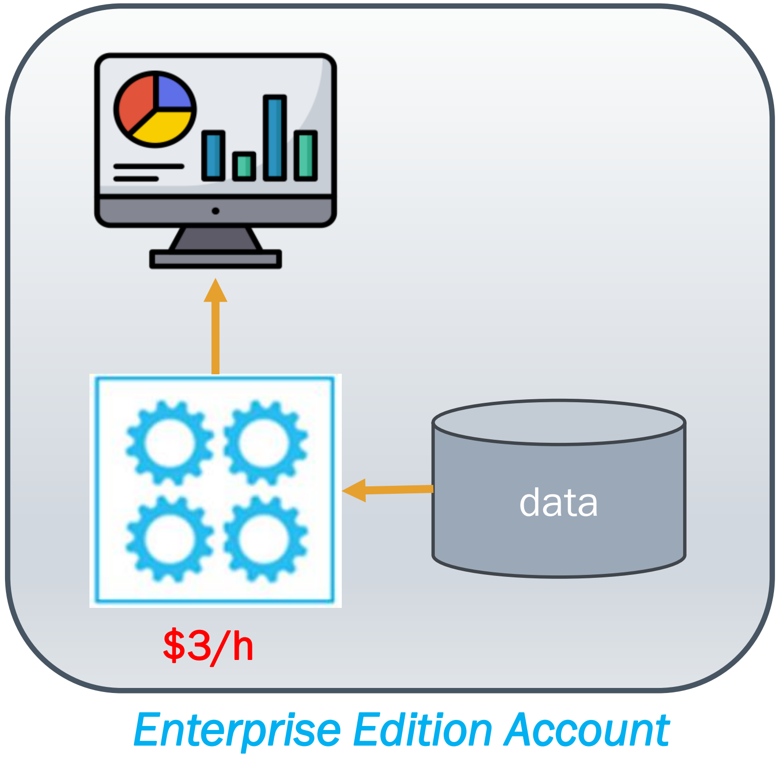
* for DATABASE → SCHEMA → TABLE

* DATA_RETENTION_TIME_IN_DAYS → in CREATE … / ALTER … SET …
    - set to 0 to disable → but cannot permanently disable in account!

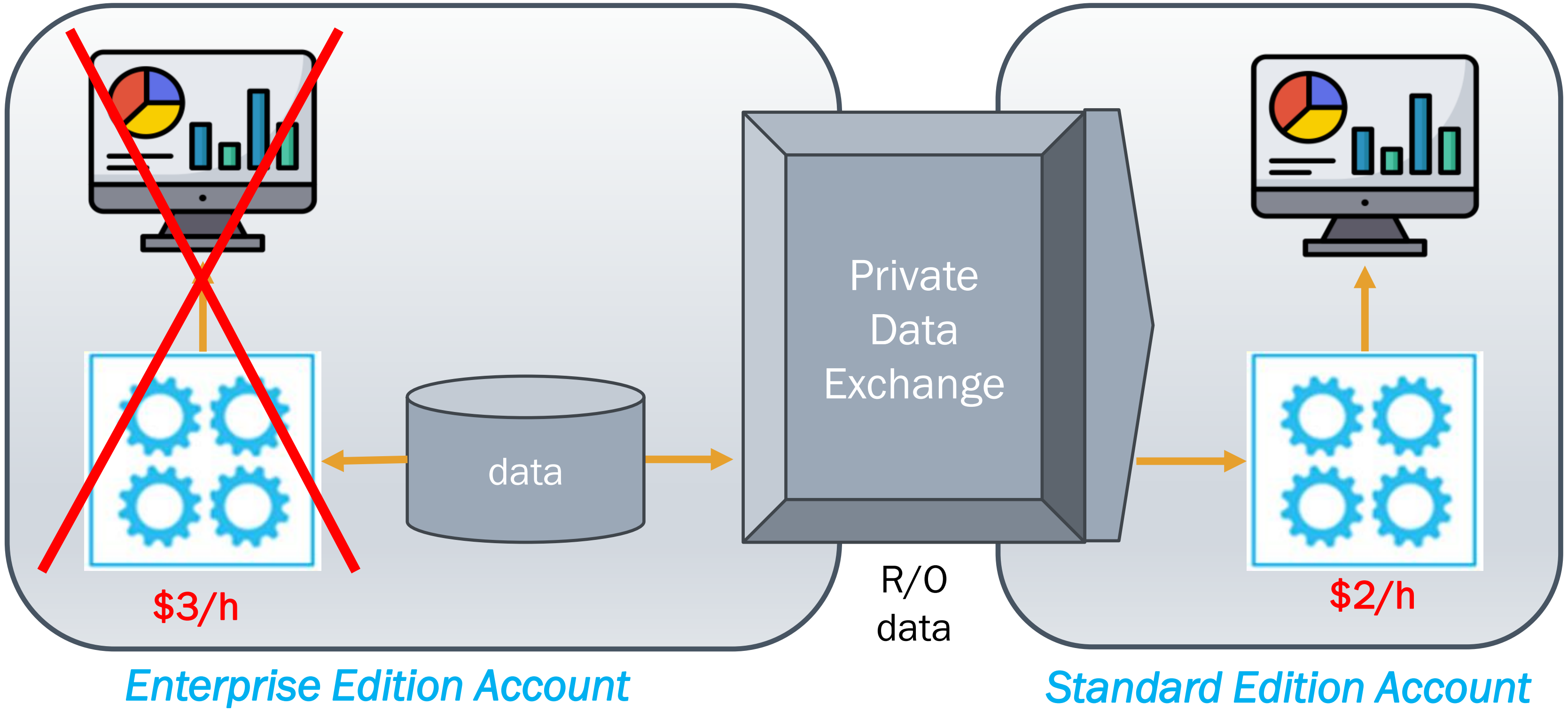
Use Standard Edition Account for Analytics

Tip #36

Analytics in Enterprise Edition



Analytics in Standard Edition



Checkpoints

* w/ private data share Enterprise → Standard accounts
* analytics in Standard Edition consume just $2/h credits
* save 30% on compute costs!
* *limitations*: multi-cluster WHs, mat views, QA, SO, clustering
* multi-cluster warehouses could be avoided
* keep data w/ mat views + clustering in Enterprise

Use Separate Standard Edition Account for Common Queries

Tip #37

Checkpoints

* any Organization must also have one Standard account
* for higher edition account → create also one Standard
* if no special features needed → run query on Standard
* *credit cost*: $2 Standard, $3 Enterprise, $4 Business
* no need for a multi-cluster warehouse if you're alone

How to Reduce Costs to Zero for an Inactive Paid Account

Tip #38

Checkpoints

* do not share it with other people
* keep one single 1-Node X-Small WH w/ auto-suspend 1 minute
* associate your user connection w/ this WH
* do not run long queries (Cancel them if they already take too long)
* do not have active/scheduled tasks running (better drop them all)
* do not leave any serverless features running

Checkpoints (2)

* drop any potential dangerous object after experiments, even if inactive (WHs, tasks)

* don’t check too much on metadata (in screen or by SQL)

* remove any app installed from the Marketplace after testing

* create explicit transitory tables w/ no time travel

* change default days for time travel to 0 at the account level

* do not store/copy/keep/transfer large data

When to Choose the Business Critical Edition

Tip #39

Enhanced Data Protection

* Failover/failback Snowflake accounts → w/ redir conns
* Tri-Secret Secure w/ CMKs
* AWS PrivateLink support
* Ext Funcs through AWS API Gateway Private Endpoints

Support for Regulations

* PHI Data Support (for HIPAA and HITRUST CSF)
  - for orgs w/ extremely sensitive data, as in healthcare
  - required signed business agreement w/ Snowflake
* PCI DSS Compliance (payment card industry)
* Support for public sector (FedRAMP and ITAR)
* Support for IRAP - Protected (P) data (in Asia Pacific)

Checkpoints

* former ESD (Enterprise for Sensitive Data)
* Enterprise+, 2x compute credit cost over Standard
* enhanced security and data protection
* failover/failback between Snowflake accounts
* for business continuity/disaster recovery
* support for regulations (PHI/HIPAA, PCI, US Federal)
* combine w/ Standard/Enterprise for reg queries → 50% cost savings!

When to Choose the Virtual Private Snowflake (VPS) Edition

Tip #40

New Features

* completely separate Snowflake environment

* isolated from all other Snowflake accounts

* dedicated virtual servers (w/ in-memory encryption key)

* pool of compute resources (used in VWs)

* dedicated metadata store

* secure data share (w/ Marketplace/Data Exchange) disabled by def

* call support to enable data sharing with non-VPS customers

Credit Cost

* Standard: $2.00 - $3.10
* Enterprise: $3.00 - $4.65
* Business Critical: $4.00 - $6.20
* VPS: $6.00 - $9.30

Checkpoints

* Business Critical+, 2x credit cost of Enterprise ($6+ in AWS/US)

* completely isolated/separated account/env → highest level of security

* dedicated servers, metadata, pool of VW resources

* secure data share disabled by def, but can enable

* 24-hour early access to weekly new releases

* for orgs w/ strictest reqs: financial inst., large ent. w/ highly sensitive data

Introduction to Query Monitoring

Tip #41: Monitor Longest Running Queries

Tip #42: Interpret Query History

Tip #43: More Charts for Query Monitoring

Tip #44: Use Query Tags

Tip #45: Reduce Frequency of Simple Queries

Tip #46: Reduce Frequency of Metadata Queries

Tip #47: Reduce Frequency of SHOW Commands

Tip #48: Clone Less Frequently

Tip #49: Change Query Schedules

Tip #50: Parallel over Sequential Transfer and Processing

Monitor

Longest Running

Queries

Tip #41

Checkpoints

* from **snowflake.account_usage.QUERY_HISTORY** view
* top N w/ longest individual *execution_time*
* top N w/ longest AVG exec time, by *type/WH size/user/...*
* top N query types w/ most consumed *credits*
* top N w/ longest *total* execution time overall
* top N most *frequently executed* queries

Interpret

Query History

Tip #42

Checkpoints

* Monitoring - Query History ← in Snowsights (14 days)
* ACCOUNT_USAGE.QUERY_HISTORY view (1 year)
  - *total_elapsed_time* = compilation + execution + queued…
    - queued_provisioning/repair/overload_time
    - transaction_blocked_time
  - *transferred bytes* = …
* INFORMATION_SCHEMA.QUERY_HISTORY[_BY…] functions (7 days)
  - filter by session/user/warehouse
  - less info

More Charts for Query Monitoring

Tip #43

Checkpoints

* histogram of queries duration - in seconds + log scale

* zoom into top-3 longest queries in detail

* time-histograms of aggregate queries duration - in seconds

* day-hour histogram

* longest and most frequent queries - with log scales

Use

Query Tags

Tip #44

Checkpoints

* QUERY_TAG = session-level param, 2k chars max, can use JSON
  - ALTER SESSION SET QUERY_TAG = '...' ← w/ SQL
  - session_parameters={'QUERY_TAG': '...'}) ← w/ Python Connector
  - session.query_tag = '...' ← w/ Snowpark
* filter QUERY_TAG column in QUERY_HISTORY
* alternative: end query w/ '-- comment'
* not a session variable (no SET QUERY_TAG = ...)
* no object tagging (no CREATE TAG ...)

Reduce Frequency of Simple Queries

Tip #45

Checkpoints

* ~10K calls/day → significant cloud service usage
* for SELECT 1 / seq1.NEXTVAL / CURRENT_SESSION()
* session ID does not change while a connection is open
* could save CURRENT_SESSION() value after first call
* JDBC SnowflakeConnection.*getSessionId*() uses cache!
* could use a dashboard chart, to monitor

Reduce Frequency of Metadata Queries

Tip #46

Checkpoints

* ~10K calls/day → significant cloud service usage

* query INFORMATION_SCHEMA → uses cloud services

* query ACCOUNT_USAGE → uses a virtual warehouse

* ACCOUNT_USAGE has more data → 1y, for account

* could use a dashboard chart, to monitor

Reduce Frequency of SHOW Commands

Tip #47

SHOW for RBAC

SHOW ROLES → builtin+custom roles

SHOW GRANTS TO ROLE … → assigned roles+privs

SHOW USERS → users

SHOW GRANTS TO USER … → assigned roles

SHOW for ERDs

SHOW TABLES → tables

SHOW COLUMNS → table columns

SHOW PRIMARY KEYS → PRIMARY KEY constraints

SHOW UNIQUE KEYS → UNIQUE constraints

SHOW IMPORTED KEYS → FOREIGN KEY constraints

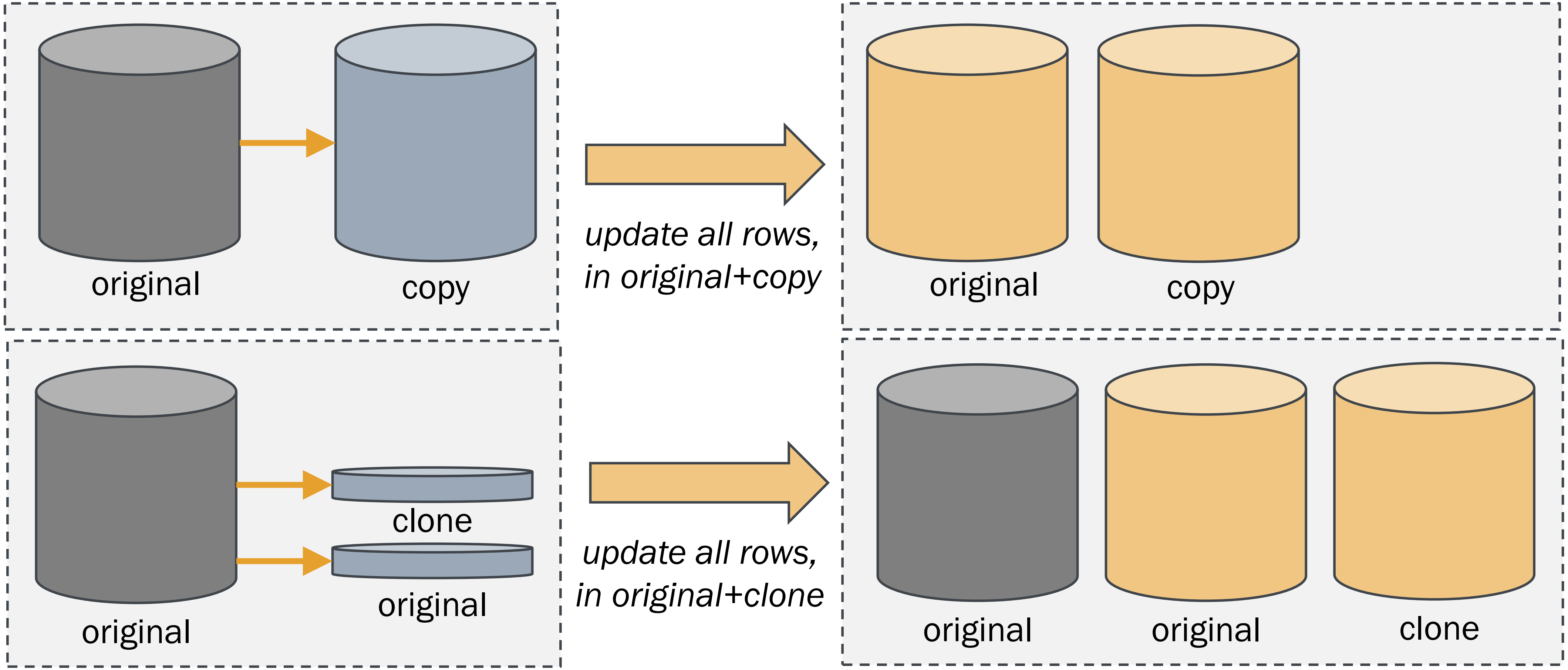
Checkpoints

* SHOW cmds → consume only cloud service resources
* avoid SHOW cmds at a high frequency
* check third-party tools, on top of Snowflake
* check partner tools
* could use a dashboard chart, to monitor

Clone Less Frequently

Tip #48

Changing Most Rows in Common



Checkpoints

* extensive DDL (cloning) → significant cloud serv usage
* DDL opers (like cloning) use only cloud compute serv

* do not frequently create/drop large schemas/tables
* do not frequently clone databases for backup
* avoid cloning if you intend to change most rows in common
* updating most rows in common will increase total storage space

Change Query Schedules

Tip #49

Cost

* *task*
  - scheduled every 2 mins, runs for max 2 secs each time
  - (24h x 60 mins / 2 mins) x 2 secs = 1440 secs = 24min/day
  - 24min/day for a related WH → 0.5 credits/day = $1.5/day
* *warehouse*
  - X-Small, 1 credit/h ($3/credit), auto-suspended after 1 min inactivity
  - resumed by the task every 2 mins = 30mins/h = 12h/day
  - 24h x 30 mins = 720min = 12h → $36/day

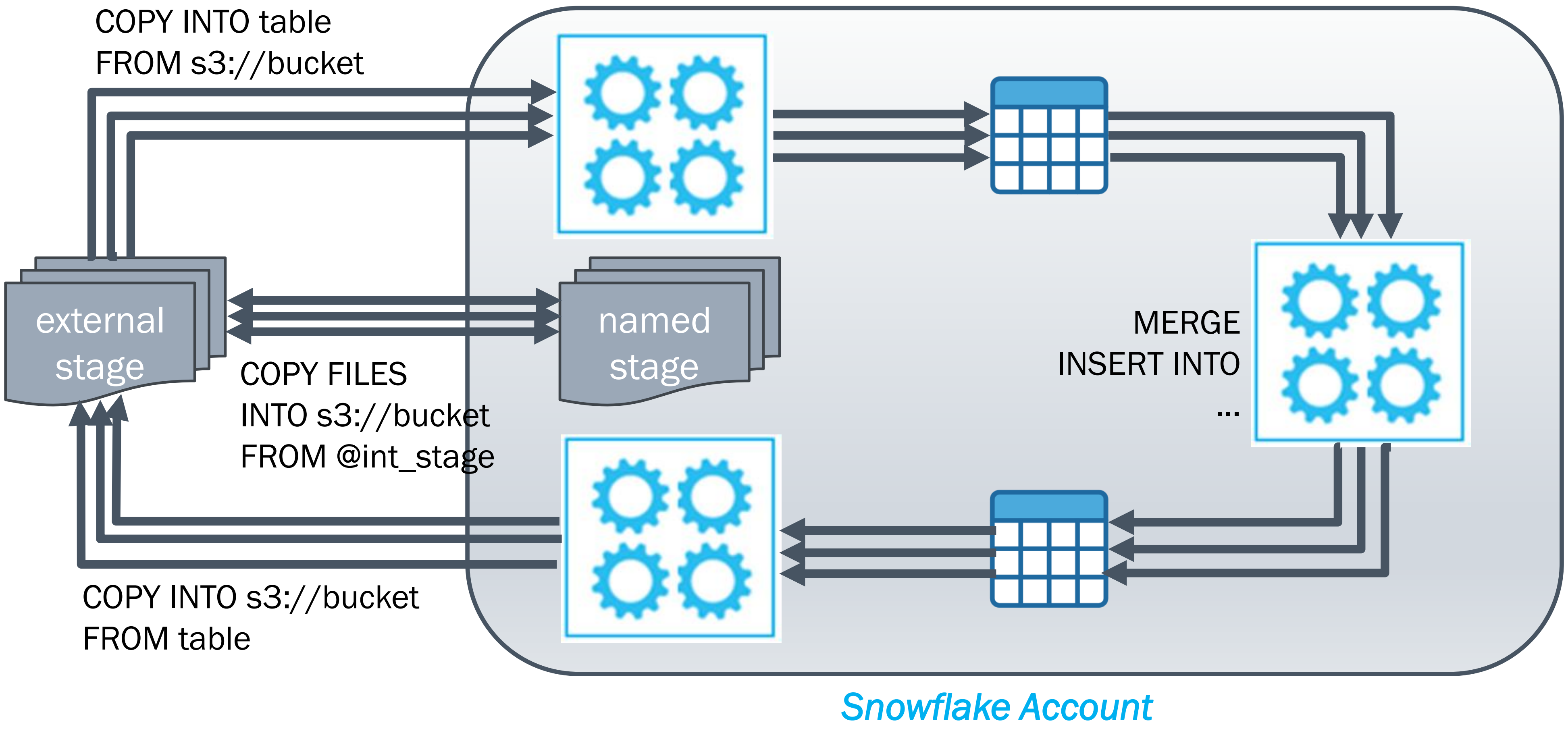
Checkpoints

* frequently scheduled tasks not ok w/ managed WHs
* you may pay more for the WH idle, suspending (1 min)
* *solution*: try using a WH already up, w/ other queries
* adjust eventually the schedule, to find such a WH up
* avoid up-down pattern → exec more queries together
* consider a serverless task (no WH, but 1.x the price)

Parallel over Sequential Transfer and Processing

Tip #50

Parallel Processing



Checkpoints

* use parallel query processing → max_concurrency_level at WH
* COPY INTO table from multiple split input files
* COPY INTO @stage w/ multiple split output files
* COPY FILES w/ multiple files, from stage to stage
* MERGE over individual INSERT/UPDATE/DELETE
* INSERT INTO multiple tables w/ parallel processing
* batch transformations w/ multiple SQL connections

Introduction to Query Optimization

Tip #51: Use the Query Profile

Tip #52: Use the Explain Statement

Tip #53: Use Data Caching

Tip #54: Queries on Data Lakes

Tip #55: Use Vectorized Python UDFs

Tip #56: Use Batch Commands to Prevent Transaction Locks

Tip #57: Reduce Query Complexity and Compilation Time

Tip #58: Check for Cross Joins and Exploding Joins

Tip #59: Process Only New or Updated Data

Tip #60: Remote Spillage Optimization

Use the Query Profile

Tip #51

Checkpoints

* generates graph of the actual execution plan
* can use for running queries as well
* based on the generated query ID
* carefull w/ queries executed from cache
* great for TableScan and Join steps ← most costly
* evaluate partitions scanned/total + bytes scanned
* check number of rows returned by a Join → exploding joins?

Use the Explain Statement

Tip #52

Checkpoints

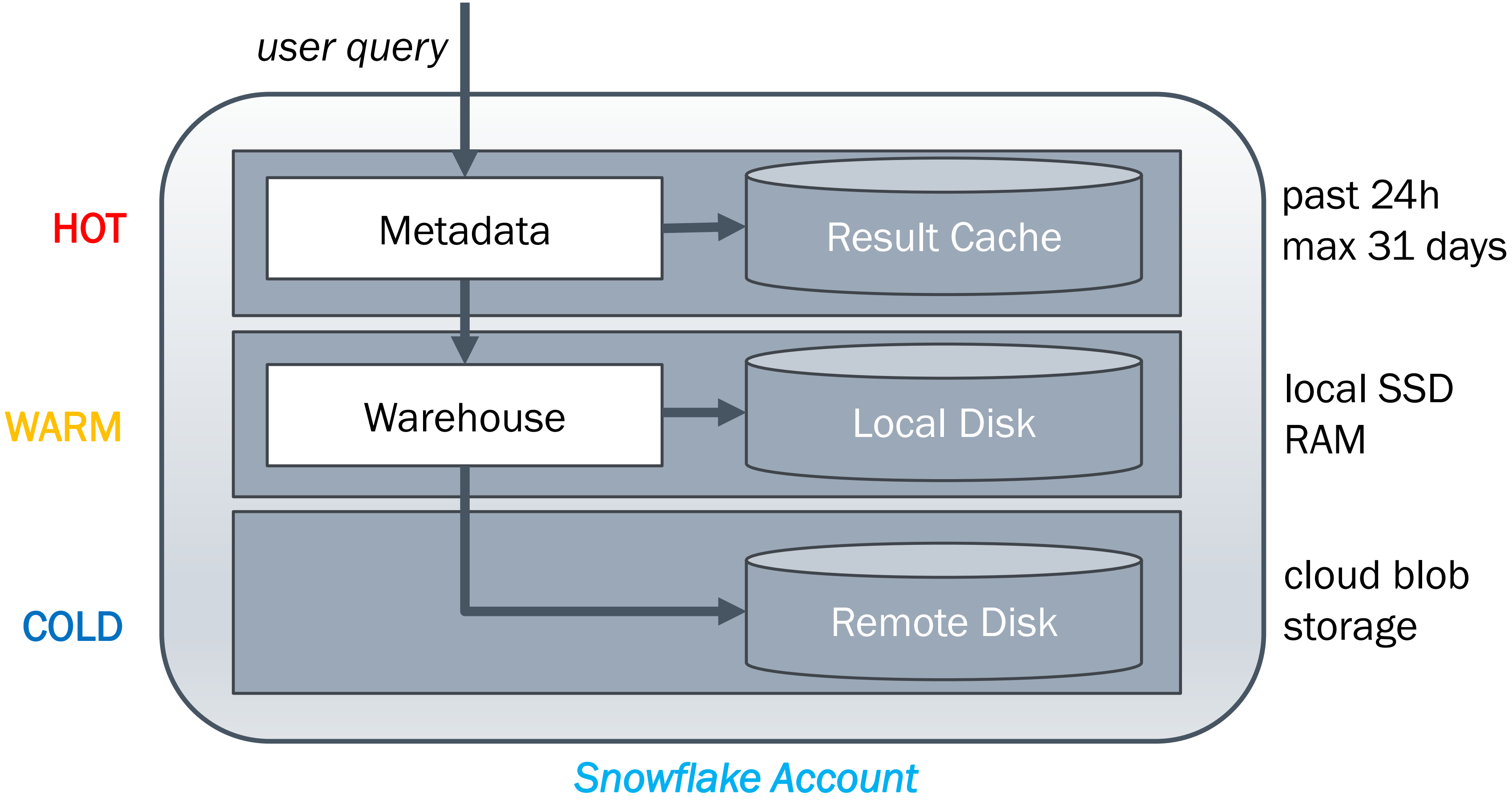
* get the logical execution plan without running the query
* estimates micro-partitions to scan and total bytes
* USING TEXT/JSON → hierarchy of logical steps
* TableScan steps could use lots of data
* consider columns used for Automatic Clustering
* see when mat views could be scanned in the back
* could use as query syntax check

Use

Data Caching

Tip #53

Query Result Caching



Checkpoints

HOT

- result cache on
- cache hit → SELECT * FROM TABLE(RESULT_SCAN(LAST_QUERY_ID()))

WARM

- result cache off or no cache hit
- warehouse up and result still in the warehouse (in RAM or local disks)
- get query result from warehouse cache (BYTES_SCANNED > 0)

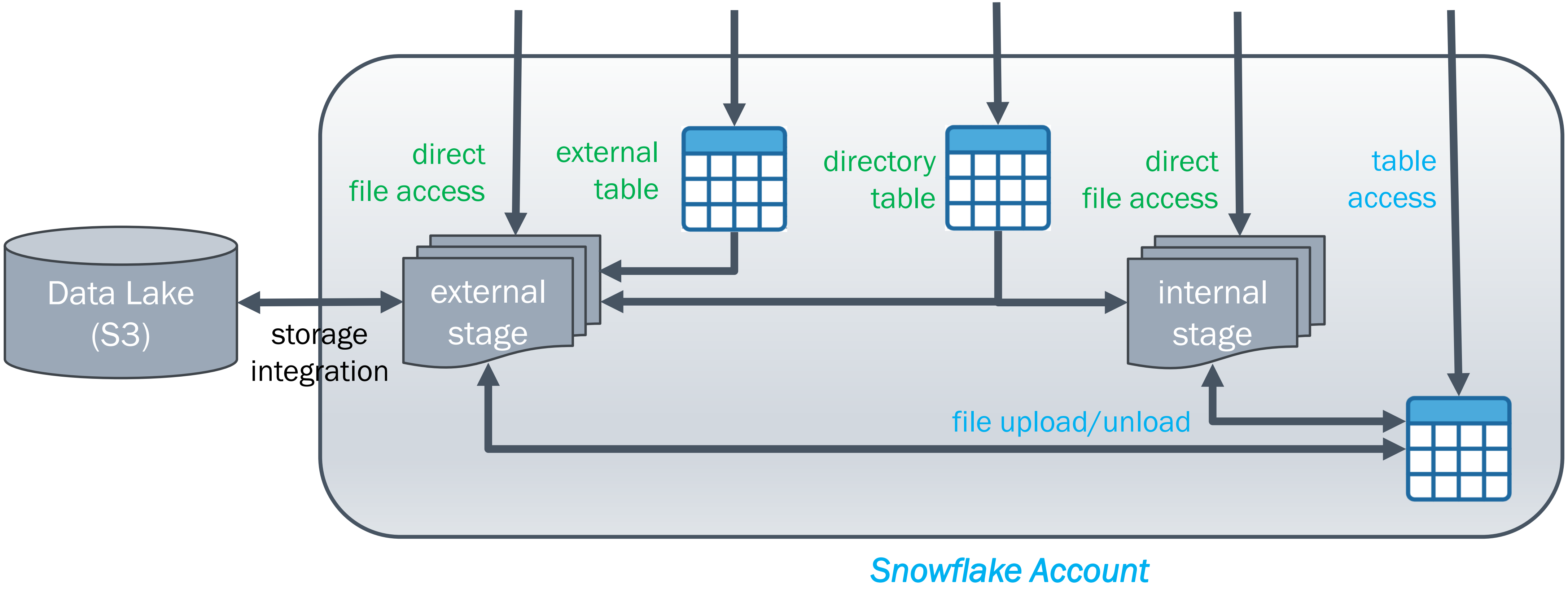
COLD

- no warehouse cache (warehouse suspended, not up)
- result cache off (ALTER SESSION SET USE_CACHED_RESULT = false) or no cache hit
- must run query (could also be a new query)

Queries on Data Lakes

Tip #54

Data Warehouse vs Data Lake



Checkpoints

* could be better to leave files in stage and query from there

* *data warehouse*

- *file upload/unload* → between stage files and tables (partitions!)
- *table access* → typical SQL on stored Snowflake data

* *data lake*

- *direct file access* → on internal/external stage files ($1, $2...)
  - JSON in VARIANT is more optimized!
  - Parquet vs CSV: 50x+ times faster!
- *external tables* → on external stage (w/ column defs!)
- *directory tables* → for unstructured data (refs only in the database!)

Use Vectorized Python UDFs

Tip #55

Checkpoints

* row-by-row processing → batches of rows (better performance!)

* non-vectorized UDF = scalars → UDF → scalar return

* vectorized UDF = scalars → pandas DataFrames → UDF → pandas arrays/Series → scalar returns

@vectorized(input=pandas.DataFrame)

optional max_batch_size

Use Batch Commands to Prevent Transaction Locks

Tip #56

Checkpoints

* UPDATE/MERGE → transaction lock on a table
  - other cmds cannot exec on table until lock released
  - queries consume cloud serv credits waiting for lock
* *solution*: use a batch cmd instead of single updates
  - use multi-row batch INSERT in temporary stage table
  - use task to periodically UPDATE/MERGE into target table

Reduce Query Complexity and Compilation Time

Tip #57

Cost

* *object dependencies query*
  - compilation: 19 secs
  - execution: 5.6 secs
  - rows returned: 0
* *data lineage query*
  - compilation: 1.2 secs
  - execution: 4.2 secs
  - rows returned:1.4K

Checkpoints

* *complex queries*

- can consume significant cloud services compute resources
- will have high compilation times
- see *compilation_time* vs *execution_time* in QUERY_HISTORY

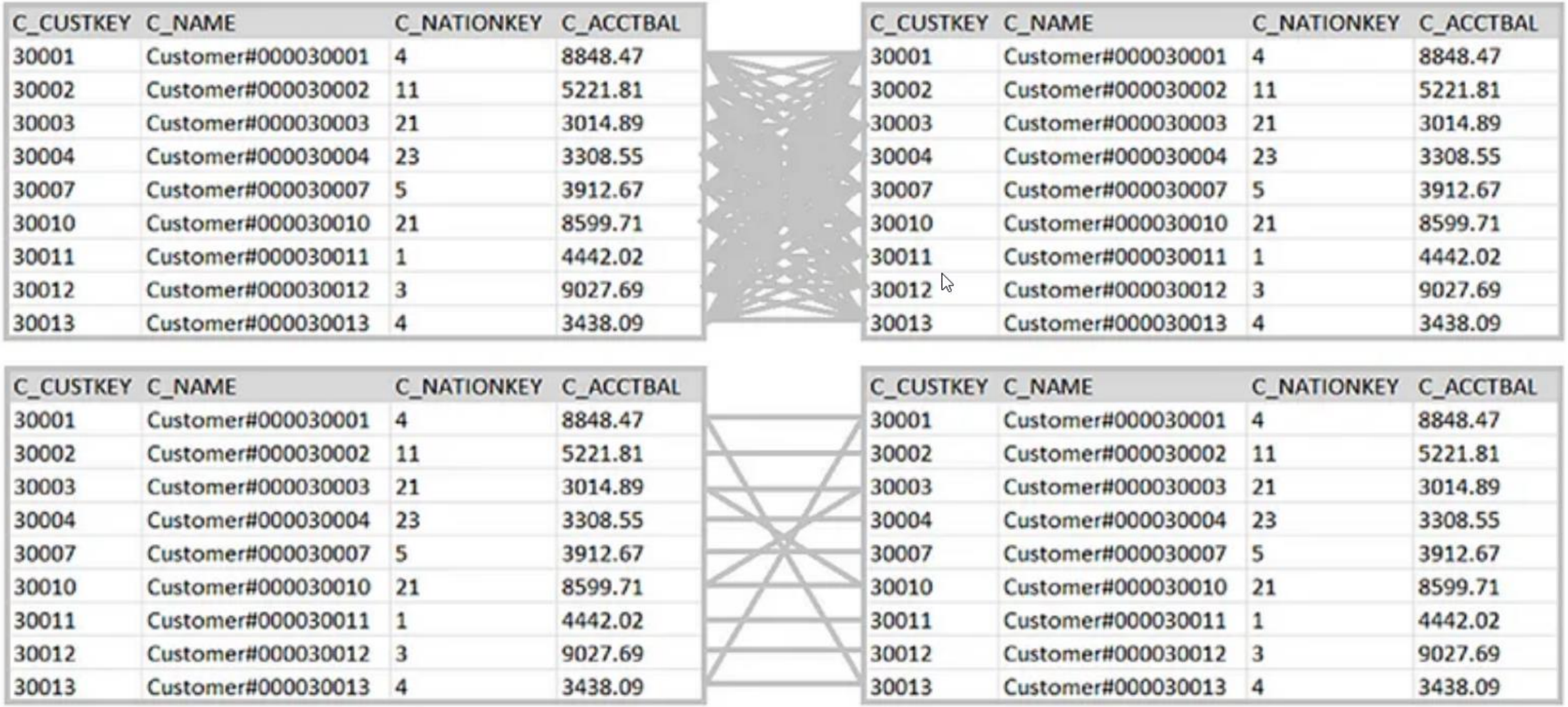
* *examples*

- queries with lots of joins
- queries with cartesian products
- queries with IN operator and large lists
- very large queries

Check for Cross Joins and Exploding Joins

Tip #58

Cross Joins vs Exploding Joins



C_CUSTKEY	C_NAME	C_NATIONKEY	C_ACCTBAL
30001	Customer#000030001	4	8848.47
30002	Customer#000030002	11	5221.81
30003	Customer#000030003	21	3014.89
30004	Customer#000030004	23	3308.55
30007	Customer#000030007	5	3912.67
30010	Customer#000030010	21	8599.71
30011	Customer#000030011	1	4442.02
30012	Customer#000030012	3	9027.69
30013	Customer#000030013	4	3438.09

C_CUSTKEY	C_NAME	C_NATIONKEY	C_ACCTBAL
30001	Customer#000030001	4	8848.47
30002	Customer#000030002	11	5221.81
30003	Customer#000030003	21	3014.89
30004	Customer#000030004	23	3308.55
30007	Customer#000030007	5	3912.67
30010	Customer#000030010	21	8599.71
30011	Customer#000030011	1	4442.02
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30007	Customer#000030007	5	3912.67
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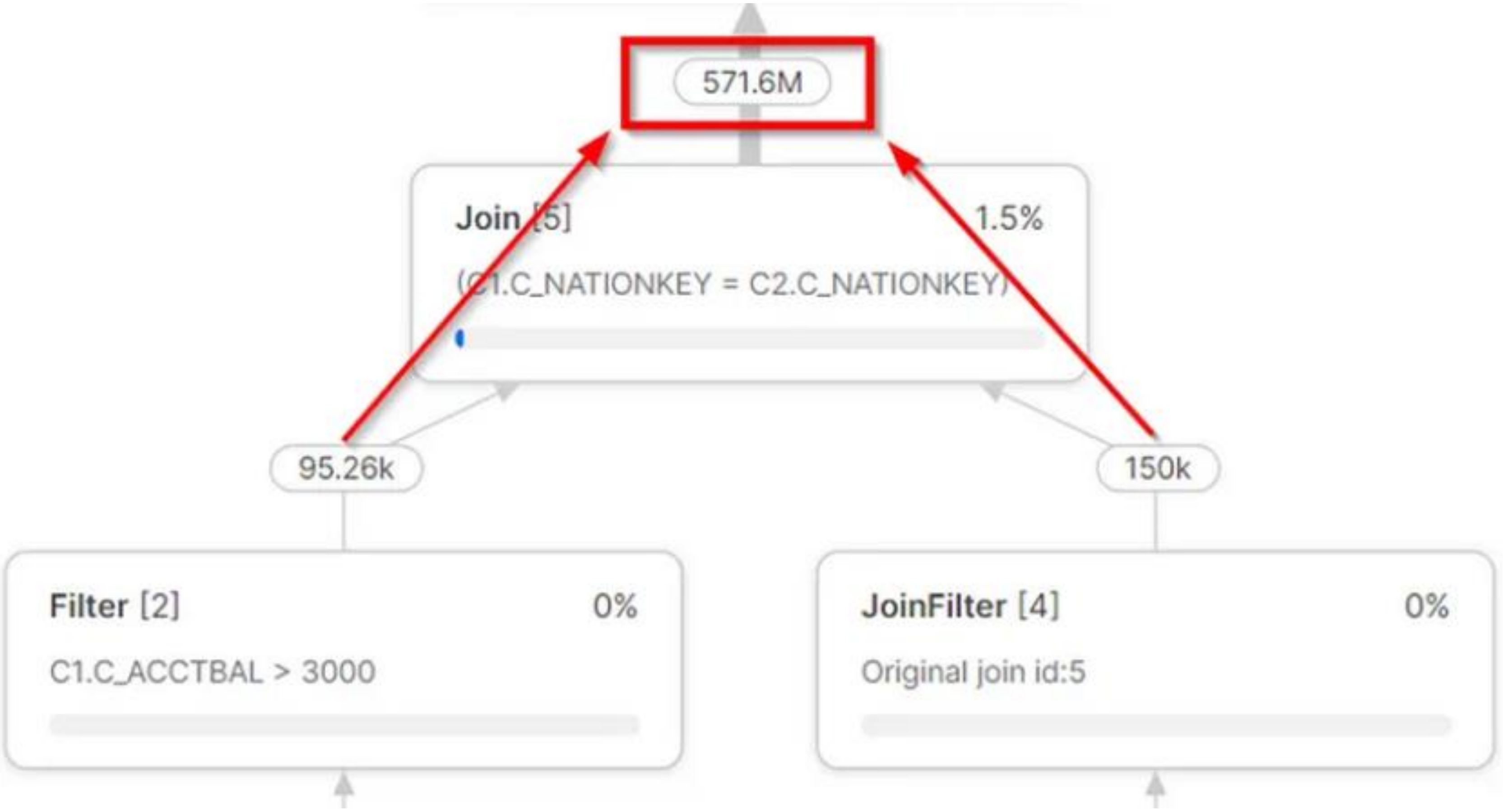
30004	Customer#000030004	23	3308.55
30007	Customer#000030007	5	3912.67
30010	Customer#000030010	21	8599.71
30011	Customer#000030011	1	4442.02
30012	Customer#000030012	3	9027.69
30013	Customer#000030013	4	3438.09

Exploding Joins in Query Profile



Joins

* *one-to-one joins*: 95.26K rows

* *cross joins*: 95.26K * 150K = **9B+ rows** (cancelled)

* ***exploding joins***: < 95.26K * 150K = **571.6M rows**

customer → 150K rows

customer w/ c_acctbal > 3000 → 95.26K rows

Checkpoints

* exploding joins = inner join w/ huge number of matches
* ~cross joins/cartesian product → large number of rets
* returns close to N x M rows (N, M = rows of tables)
* more related to many-to-many relationships
* detect by looking at the Query Profile

Process Only New or Updated Data

Tip #59

Checkpoints

* only the changed data gets processed → reduce compute costs

* avoid transferring the whole batch of data, daily → when most data did not change

* CDC (Change Data Capture) → "play" transaction log for new changes only

* *incremental processing*: do not rerun entire batches of data for minor updates

* restart interrupted pipelines from point of interruption → no redundancies

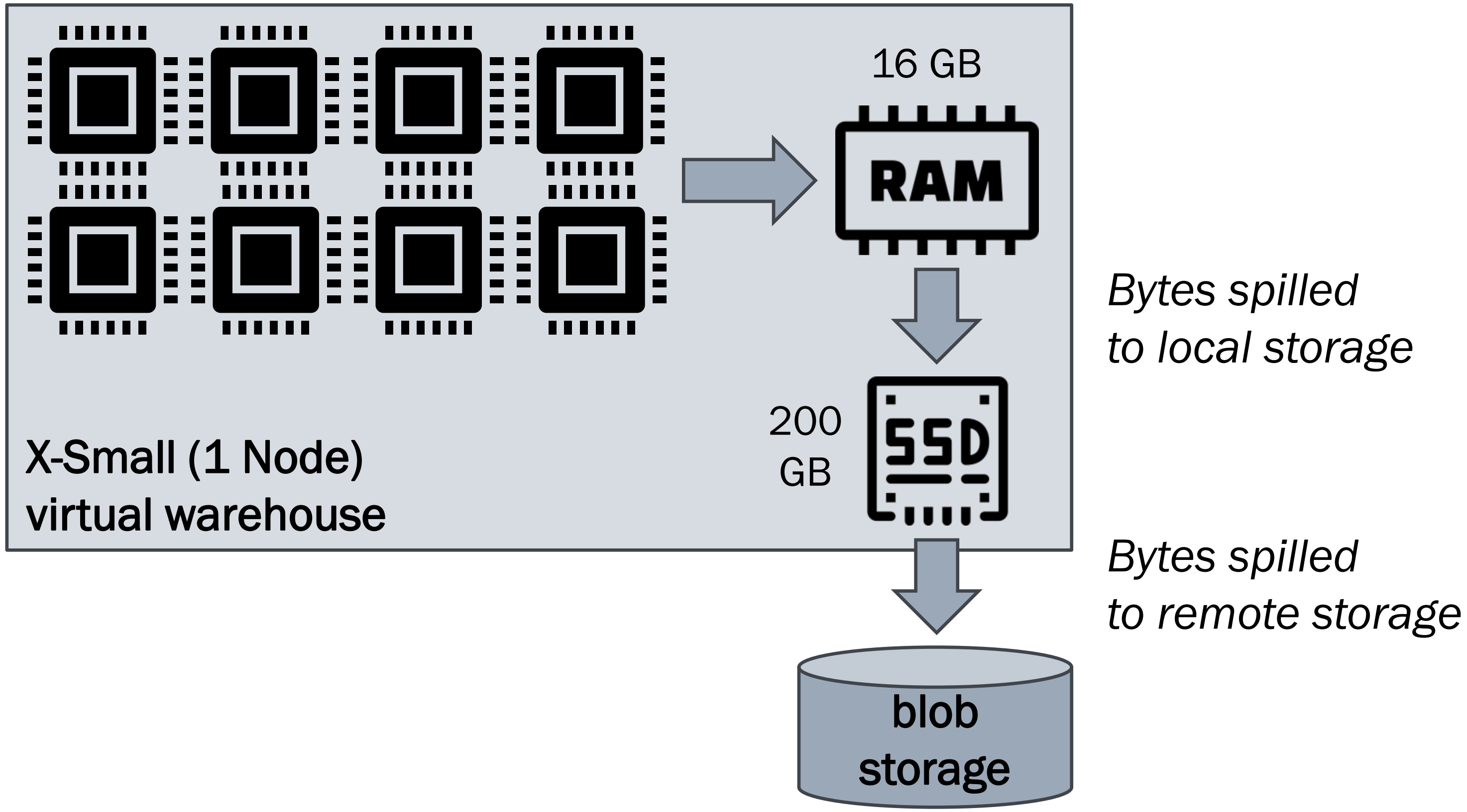
* on failed data uploading → keep successful loaded data, continue w/ failed

* on failed batch data transformations → partition and replay for failed ranges only

Remote Spillage Optimization

Tip #60

Spilling to Local/Remote Storage



Cost

* Large (8 Nodes): 2 mins, 60 GB spilled to local

* Snowpark-optimized Large (16x memory): 1:30m, ~3 GB spilled to local

on 48.6 GB table

Checkpoints

* Bytes spilled to local storage = RAM → SSD (all in WH!)
* Bytes spilled to remote storage = SSD → blob storage (slowest!)
* on SSD = intermediate results for ORDER BY, GROUP BY, PIVOT…
* RAM (fastest + most expensive) >> SSD (disk) >> blob storage (network)
* *solution*
  - use a bigger WH (= 2x RAM+SSD!) - Snowpark-optimized (16x RAM) or QAS as alternative
  - use less data
* check *bytes_spilled_to_local/remote_storage* in QUERY_HISTORY

Introduction to Serverless Features

Tip #61: Monitor the Cost of Automated Jobs

Tip #62: Estimate Cost of Scheduled Tasks

Tip #63: When to Use Serverless Tasks

Tip #64: Replace Snowpipe with Snowpipe Streaming

Tip #65: Estimate Cost of Automatic Clustering on Tables

Tip #66: Estimate Cost of the Query Acceleration Service (QAS)

Tip #67: Estimate Cost of the Search Optimization Service (SOS)

Tip #68: Reduce Materialized Views Maintenance Cost

Tip #69: Reduce Database Replication Cost

Tip #70: Estimate Cost of Hybrid Tables

Monitor the Cost of Automated Jobs

Tip #61

Cost

Table 5: Serverless Feature Credit Table

Feature	Snowflake Credits per Compute-Hour	
	Snowflake-managed compute	Cloud Services
Clustered tables	2	1
Copy Files[10]	2	N/A
Hybrid Tables requests[10]	1	1 In addition: 1 Credit per 30GB read 1 Credit per 7.5GB write
Logging	1.25	1
Materialized views maintenance	10	5
Materialized views maintenance in secondary databases	2	1
Query acceleration	1	1
Replication	2	1
Search optimization service	10	5
Search optimization service in secondary databases	2	1
Serverless tasks	1.2	1
Snowpipe	1.25	N/A but charged 0.06 Snowflake Credits/1000 Files
Snowpipe Streaming	1	N/A but charged at an hourly rate of 0.01 Snowflake Credits per client instance

METERING_HISTORY View

* *start_time* .. *end_time* = hourly credit usage, for 1y

* *service_type* + *name*

* *credits_used_compute* = WH + serverless

* *credits_used_cloud_services* = ~1 credit/h (10 for MVs/SO)

* *credits_used* = *credits_used_compute* + *credits_used_cloud_services*

* *bytes* + *rows* + *files* – for auto-clustering / pipe / snowpipe_streaming

Service Types

* WAREHOUSE_METERING[_READER] – any edition, w/ WH name [+for Reader accounts]

* SERVERLESS_TASK – not user-managed, ~1.5x more expensive (1.2x now)

* AUTO_CLUSTERING – any edition, auto-background maintenance of clustered table/MV (+initial clustering+reclustering), ~2 credits/h

* MATERIALIZED_VIEW – 10 credits/h [2 in sec dbs] + 5 for cloud → storage+compute (per second). when base table changes → MVs updated by serverless back service

* QUERY_ACCELERATION – scale factor to limit cost → N nodes x boost

* SEARCH_OPTIMIZATION – 10 credits/h [2 in sec dbs] + 5 for cloud → storage+compute maintenance (higher cost when large table data changes + deletes + auto-clustering)

Service Types (cont.)

* PIPE + SNOWPIPE_STREAMING — Snowpipe ~1.25 credits/h + 0.06 credits/1000 files. Streaming w/ 2 table+service entries, 1 credit/h + 0.01 credits/h/client.

* HYBRID_TABLE_REQUESTS — 1 credit/h per req + 1 cloud credit per 30GB R/7.5GB W

* COPY_FILES — for COPY INTO between stages, 2 credits/h (no cloud)

* REPLICATION — for dbs/shares (any edition) / failover across accounts (BC) – 2 credits/h

* SNOWPARK_CONTAINERS — SPCS, all editions → costs for storage (image repository+logs+mounting volumes) + compute pool (1+ VM nodes) + data transfer (outbound + cross-AZ)

* AI_SERVICES — compute cost for Cortex LLM functions → per number of tokens (~4 chars) processed by the calls

Checkpoints

* automated jobs → ~70% of all compute cost

* credits per compute-hour

* credits used = Snowflake-managed compute + cloud services

* *cloud services*: for AuthN / infra/metadata management / query parsing+optimization / access control…

* METERING_HISTORY view

Estimate Cost of Scheduled Tasks

Tip #62

Cost

* *managed task*: 1 sec (exec time) x 60 x 24 = <30 min → <**$1.50**/day (estimated)

* *warehouse*: 1 min (up every time) x 60 x 24 = 24 h → $3 x 24h = **$72**/day

user-managed task w/ 1 sec total exec time + executed every minute

X-Small dedicated WH w/ 1 min auto-suspend, at $3/h/node credit (in AWS/US)

Checkpoints

* *user-managed* (w/ WH) vs *serverless* tasks (no WH)
  - USER_TASK_MANAGED_INITIAL_WAREHOUSE_SIZE → def MEDIUM!
* WHEN sql_condition → just cloud service credits!
  - task not triggered at all if WHEN not satisfied
* SCHEDULE → not for child tasks, w/ manual EXECUTE TASK if none
* USER_TASK_TIMEOUT_MS → def 1h (max 1 day)
  - STATEMENT_TIMEOUT_IN_SECONDS → sometimes w/ higher priority, in WH
* information_schema.**TASK_HISTORY**()
* check orphan tasks running but not being used

When to Use Serverless Tasks

Tip #63

Cost

* *serverless task*: 1 sec (exec time) x 60 x 24 = <30 min → <**$1.80**/day

* *managed task*: 1 sec (exec time) x 60 x 24 = <30 min → <**$1.50**/day (estimated)

* *warehouse*: 1 min (up every time) x 60 x 24 = 24 h → $3 x 24h = **$72**/day

serverless task w/ 1 sec total exec time + executed every minute → $3.6/h/node

user-managed task w/ 1 sec total exec time + executed every minute

X-Small dedicated WH w/ 1 min auto-suspend, at $3/h/node credit (in AWS/US)

Checkpoints

* favor serverless tasks for *frequently executed* + *short-running* operations

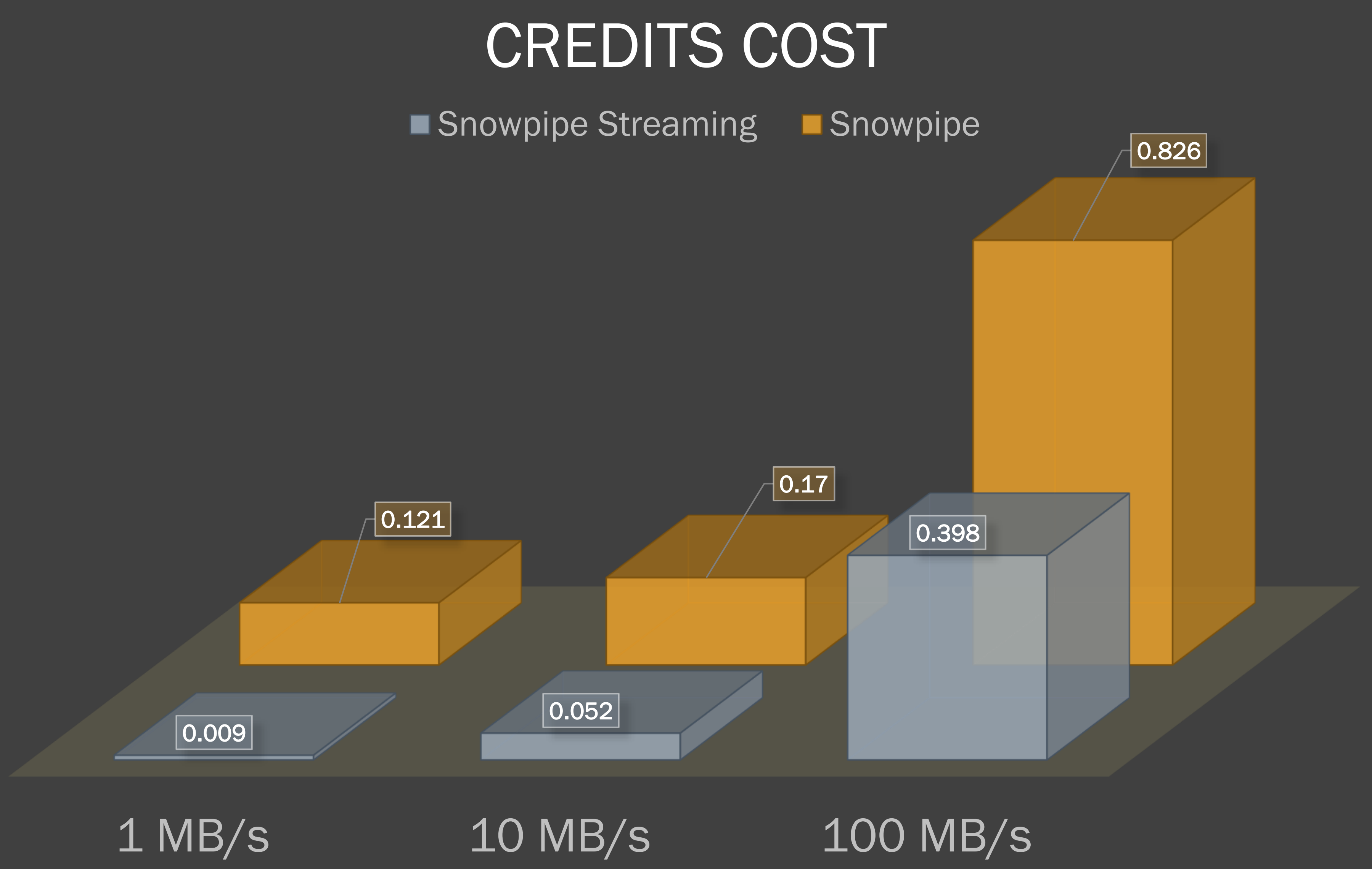
* try grouping more user-managed tasks on the same WH → WH consolidation

* *user-managed* (w/ WH) vs *serverless* tasks (no WH, 1.2x more expensive)
  - USER_TASK_MANAGED_INITIAL_WAREHOUSE_SIZE → def MEDIUM!

* information_schema table functions
  - SERVERLESS_TASK_HISTORY() → for serverless tasks
  - TASK_HISTORY() → for user-managed tasks
  - WAREHOUSE_METERING_HISTORY() → for warehouses

Replace Snowpipe with Snowpipe Streaming

Tip #64


CREDITS COST
Snowpipe Streaming
Snowpipe
0.826
0.121
0.17
0.398
0.009
0.052
1 MB/s
10 MB/s
100 MB/s

Checkpoints

* Snowpipe + Snowpipe REST API
  - old legacy service + API for streaming in small batches
* Snowpipe Streaming API
  - more cost-effective data ingestion + save on storage costs
  - high-throughput + low-latency streaming + low cost
  - automated service (no VW)
  - uses managed-compute resources + fixed credit charge per file

Estimate Cost of Automatic Clustering on Tables

Tip #65

Checkpoints

* *Automatic Clustering* = serverless, in any edition
* no clustering keys → no Automatic Clustering costs
* Clustered Tables serverless price = 2 credits/hour
* AUTOMATIC_CLUSTERING_HISTORY view/function
* AUTOMATIC_CLUSTERING Snowflake WH
* avoid table fragmentation → check load+query patterns

Estimate Cost of the Query Acceleration Service (QAS)

Tip #66

Cost

w/o QAS: 8min x 5c/min = **40c**

w/ QAS: 40sec x 5c/min x 14 nodes =< **47c**

*X-Small WH (1 node) = **$3**/h = 5c/min*

*QAS 14x scale factor =~ **$3**/h/node = 5c/min/node*

Programming QAS

* ENABLE_QUERY_ACCELERATION - in WH, to enable
* QUERY_ACCELERATION_MAX_SCALE_FACTOR - ctrls boost
* SYSTEM$ESTIMATE_QUERY_ACCELERATION - w/ qID
* QUERY_ACCELERATION_ELIGIBLE - system view
* QUERY_HISTORY - system view, w/ data
* QUERY_ACCELERATION_HISTORY - in info schema, for cost

Checkpoints

* Query Acceleration Service (QAS) = serverless, on WH
* can accelerate parts of a WH query workload
* parts of query processing → shared compute resources
* billed per second, no minimum
* no cost if enabled + no eligible queries
* in some cases could cost less than scalling up the WH

Estimate Cost of the Search Optimization Service (SOS)

Tip #67

Search Optimization Service

* for some lookup/analytical queries/views

* for queries w/ filters/joins, running for seconds+

* not on the primary cluster key

* at least one column must have 100K+ distinct values

* for numbers, date, string, variant, geography, binary etc (not float, geometry)

* filtering predicates: EQUALITY, SUBSTRING, GEO → keep a search access path

* for IN, reg exp, substrings, JSON searches, geospatial queries, and/or

* not for external/dynamic tables, MVs, casts…

Checkpoints

* Enterprise+, 10 credits/h + 5 credits/h cloud (2+1 in sec. dbs)
* avoid in high churn tables
* avoid when data changes a lot in the table
* enable only on specific columns, w/ the right predicate
* disable once you no longer have benefiting queries
* check actual query improvements
* pair the service with smaller warehouses to lower the cost

Reduce Materialized Views Maintenance Cost

Tip #68

Checkpoints

* MV cost = 10 credits/h + 5 credits/h cloud (2+1 in sec. dbs)

* there are no tools to estimate costs of maintaining MVs (serverless)

* *what may trigger MV maintenance*
  - any change of micro-partitions in the base table
  - any changes w/ DML statements on the base table
  - reclustering of the base table

* cost proportional to: number of MVs + clustered MVs

* suspend/resume MVs → only defers costs, not reducing them

* *best practice*: start by creating only a few MVs + monitor the costs over time

Reduce Database Replication Cost

Tip #69

Replication in Snowflake

* Database Replication = ~db backup, for all editions
    ◦ w/ replication groups, across multiple accounts
* Share Replication = for all editions
* Account Replication = Business Critical only, same org
    ◦ w/ failover/failback ← w/ failover groups
* Cross-Cloud Auto-Fulfillment = shared listing → other regions

Checkpoints

* *db replication compute costs* = 2 credits/h managed + 1 credit/h cloud

* standard costs in both source+target accounts!

* initial+refresh replication → lower refresh frequency

* avoid transfer between regions → data transfer costs

* avoid very large databases, or w/ lots of data changes

* refresh granular objects → use a replication group

* DATABASE_REPLICATION_USAGE_HISTORY view → CREDITS_USED

Estimate Cost

of Hybrid Tables

Tip #70

Hybrid Tables

* Snowflake Unistore = OLTP (transactional) + OLAP (analytical)

* fast writes as well → stores data also by row

* required primary keys

* optional foreign keys → referential integrity enforced

* allows indexes

* row locking

Checkpoints

* Standard+, PuPr in some AWS paid accounts (currently)
* *consumption modes*
  - **compute** = for WHs, same credits as for standard tables
  - **storage** = fix monthly rate per GB, more expensive
  - **requests** = for serverless resources on the row storage clusters
* *cost per request*
  - 1 credit/h managed + 1 credit/h cloud
  - 1 credit per 30 GB read + 1 credit per 7.5 GB write

Introduction to Data Storage

Tip #71: Use On-Demand When You Don't Know Your Spending Pattern

Tip #72: Copy and Keep Less Data

Tip #73: Lower Data Retention with No Time Travel

Tip #74: Estimate Storage Cost of the Fail-Safe

Tip #75: Use Transient or Temporary Tables

Tip #76: Use Zero-Copy Cloning

Tip #77: Clone Less Data

Tip #78: Ensure Tables Are Clustered Correctly

Tip #79: Drop Unused Tables and Other Objects

Tip #80: Remove Old Files from Stage Areas

Use On-Demand Storage When You Don’t Know Your Spending Pattern

Tip #71

Data Storage Costs

OPTIMIZED STORAGE

Snowflake charges a monthly fee for data stored in the platform. Calculated using the average amount of storage used per month, after compression, for data ingested into Snowflake.

Download Snowflake Pricing Guide

On-Demand Storage

Pay for usage month-to-month.

$23 / per TB / per month ($USD)

AWS, US West (Oregon)

Capacity Storage

Discounted storage paid upfront.

$23 / per TB / per month ($USD)

AWS, US West (Oregon)

Capacity Storage Pricing

Table 3(a): Standard Storage Pricing

Cloud Provider	Region	On Demand Storage Pricing (TB/mo)	Capacity Storage Pricing by ACV Range (TB/mo)						
			Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6	Tier 7
			USD $0 - $1,199,999	USD $1,200,000 - $2,999,999	USD $3,000,000 - $4,999,999	USD $5,000,000 - $9,999,999	USD $10,000,000 - $19,999,999	USD $20,000,000 - $39,999,999	USD $40,000,000+
AWS	US East (Northern Virginia)	$23.00	$23.00	$21.47	$19.94	$18.40	$16.86	$15.34	$13.80
AWS	US West (Oregon)	$23.00	$23.00	$21.47	$19.94	$18.40	$16.86	$15.34	$13.80

Checkpoints

* On-Demand (PAYG) vs Capacity (prepaid) Storage Pricing
  ◦ US $23/TB/mo → lowest for AWS/Azure US ($20 for GCP Central US)
  ◦ storage billing → average stored per day
* Capacity Storage → less only for $2M+ accounts
  ◦ storage price → per TB/mo (from highest for On-Demand)
  ◦ long-term contract for small discounts → could overspend
  ◦ auto-switched to On-Demand if underspent
  ◦ use eventually once you know your spending patterns

Copy and Keep Less Data

Tip #72

Cost

* table data storage: 2B rows (65GB)

* Time Travel: 1 day (def)

* Fail-safe: 7 days (fixed)

* one clone: 2B rows (shared)

copied from tpcds_sf100tcl.store_sales (288B rows, 10TB) in 11 mins

TABLE_STORAGE_METRICS

* in INFORMATION_SCHEMA → w/ 1-2h latency

* Active bytes = live data that can be queried

* Bytes in Time Travel = deleted, but still kept for the retention period

* Bytes in Fail-safe = deleted, past the Time Travel, but still kept for 7 days

* Bytes retained for clones = deleted, but still kept as clone refs

Retention Policies

* do not use Snowflake as an archiving system
  - backup/store raw data cheap in Amazon S3 Glacier
* ex: retention policy: 5 → 3 years
  - less bytes scanned in queries
  - 36% storage cost saving

Checkpoints

* copy less, clone more → for dev/test/prod envs
* use transient/temporary tables for no Fail-safe
* disable Time Travel
* cloned tables will transparently keep shared table data
* create huge table + delete right away → still expensive!
* limit period of retention policy

Lower Data Retention with No Time Travel

Tip #73

Checkpoints

* *permanent table*
  - 0..1 days (def 1) Time Travel for Standard Edition
  - 0..90 days (def 1) Time Travel for Enterprise Edition
* *temporary/transient table*
  - 0..1 days (def 1) Time Travel

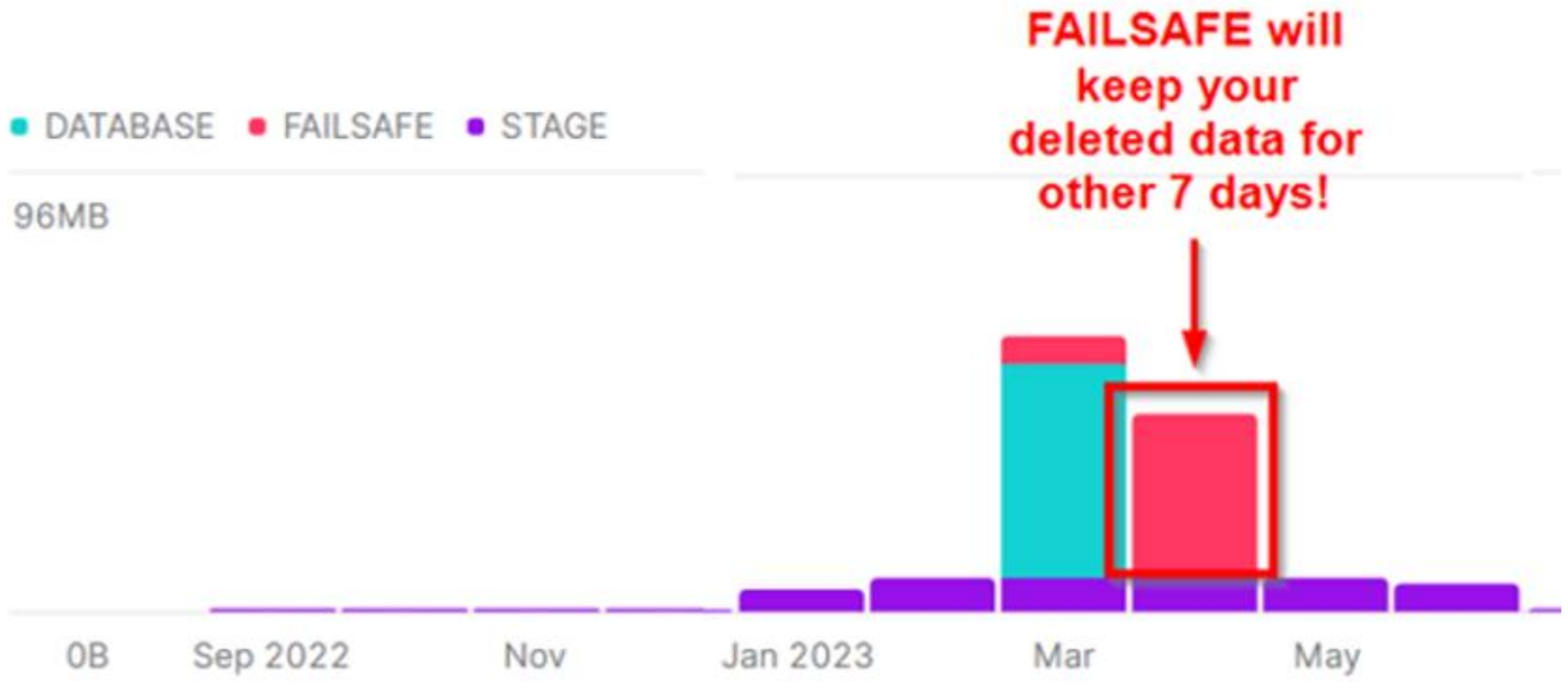
Time Travel may remain there after you drop a table

set DATA_RETENTION_TIME_IN_DAYS = 0 to disable

Estimate Storage Cost of the Fail-Safe

Tip #74

Fail-Safe for Large Dropped Table



Cost

* 1TB table dropped after 1 day → $23 / 30 days ~= 77c

* Fail safe for dropped table → $23 x 7/30 days = $5.37

cost On-Demand storage: US **$23**/TB/mo

Checkpoints

* permanent table : 7 days Fail-safe

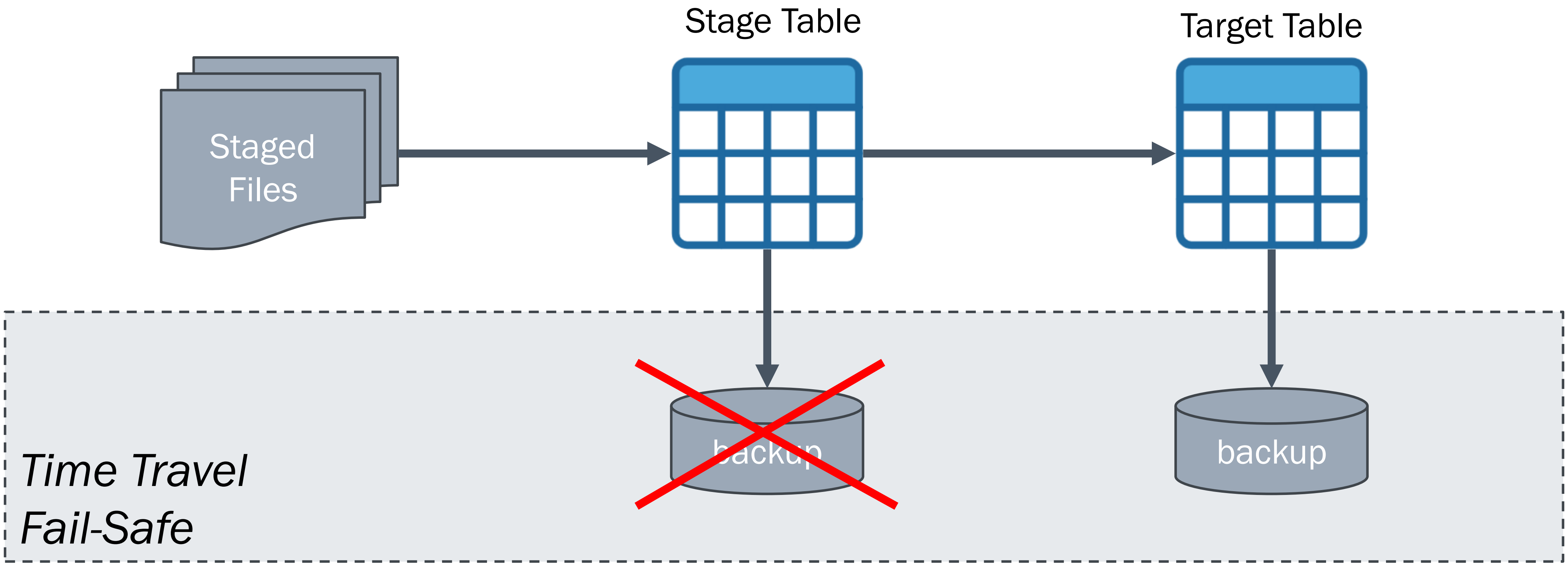
* temporary/transient table: no Fail safe

* drop a large table → *all* its data moves into Fail safe!

Use Transient or Temporary Tables

Tip #75

ELT Data Pipeline



Checkpoints

* temporary table = auto-deleted at the end of session

* transient table = shared, req explicit drop

* max time travel 1 day (def 1) → save on storage

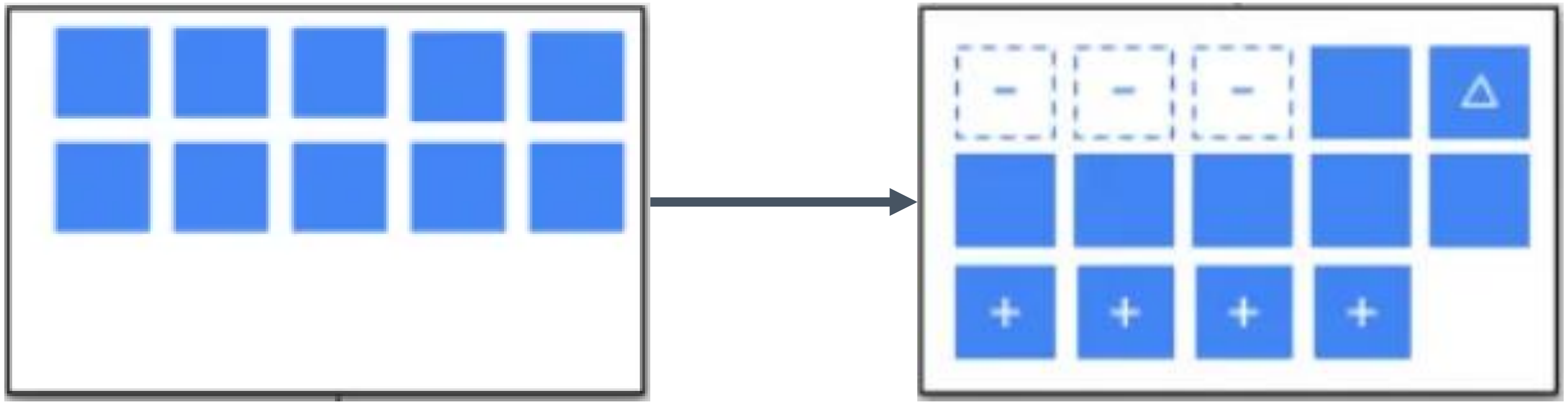
* no fail safe (else 7 days) → save on storage

* for transitory data (no need for backup)

Use Zero-Copy Cloning

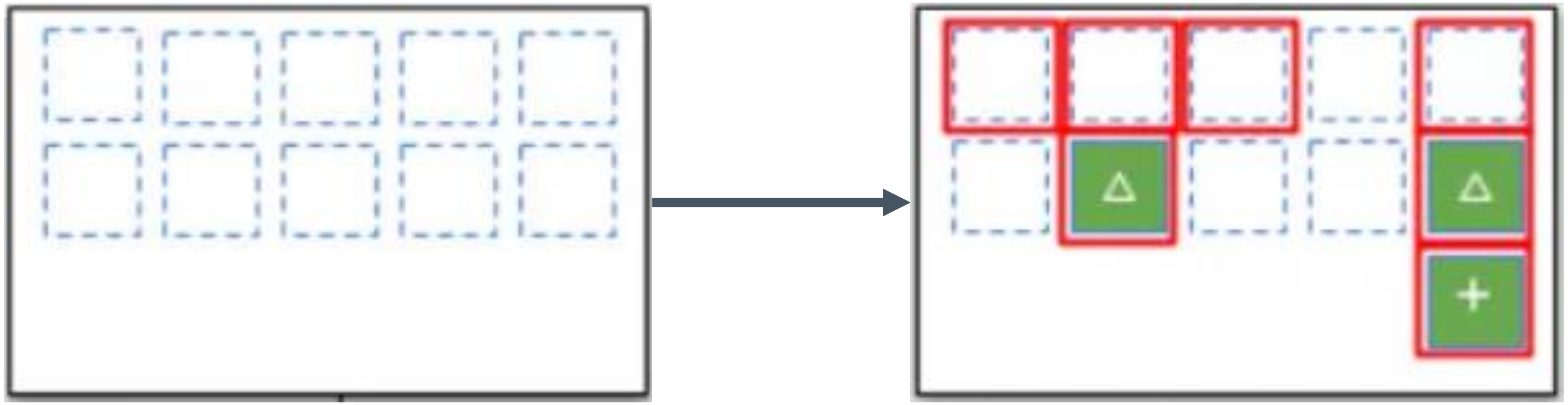
Tip #76

Table Copy



Storage Cost for Copied Table = Original Data + New Data - Deleted Data

Table Clone



Storage Cost for Cloned Table = Changed Data + New Data

Checkpoints

* copied table cost = orig data + INSERTs - DELETEs
* cloned table cost = UPDATEs + INSERTs

* clones will save on storage (keep data references)
* clones will save on compute (to duplicate data)
* clones will avoid redundancies → less error prone

Clone

Less Data

Tip #77

Checkpoints

* extensive DDL (cloning) → significant cloud serv usage
* DDL opers (like cloning) use only cloud compute serv

* clone more granular objects
* clone only individual tables rather than entire schemas

Ensure Tables Are Clustered Correctly

Tip #78

CLUSTERING_INFORMATION

* *cluster_by_keys*, *total_partition_count* - just info

* *total_constant_partition_count* - higher is better (reclustered)

* *average_overlaps* - lower is better (<1), higher not well-clustered

* average_depth - lower is better (CLUSTERING_DEPTH)

* *partition_depth_histogram*
  - 0, 1, 2, 3, ..., 16, 32, 64, 128, ...
  - most w/ depth 1 or on top is best
  - worst if most at the bottom

* *clustering_errors* - max 10 recent reclustering errors [...]

Checkpoints

* load data → natural auto-clustering

* evaluate for natural auto-clustering (no key → no cost!)

* evaluate for a clustering key (auto-clustering cost!)

* identify + evaluate for candidate columns

* load data according to current/new clustering key

* use queries that benefit from current table clustering

Drop Unused Tables and Other Objects

Tip #79

Storage Usage History

* DATABASE_STORAGE_USAGE_HISTORY
  - *average_database_bytes*
  - *average_failsafe_bytes*
  - *average_hybrid_table_storage_bytes*
* STAGE_STORAGE_USAGE_HISTORY
  - *average_stage_bytes*

Table Storage Metrics

* *active_bytes*

* *time_travel_bytes*

* *failsafe_bytes*

* *retained_for_clone_bytes*

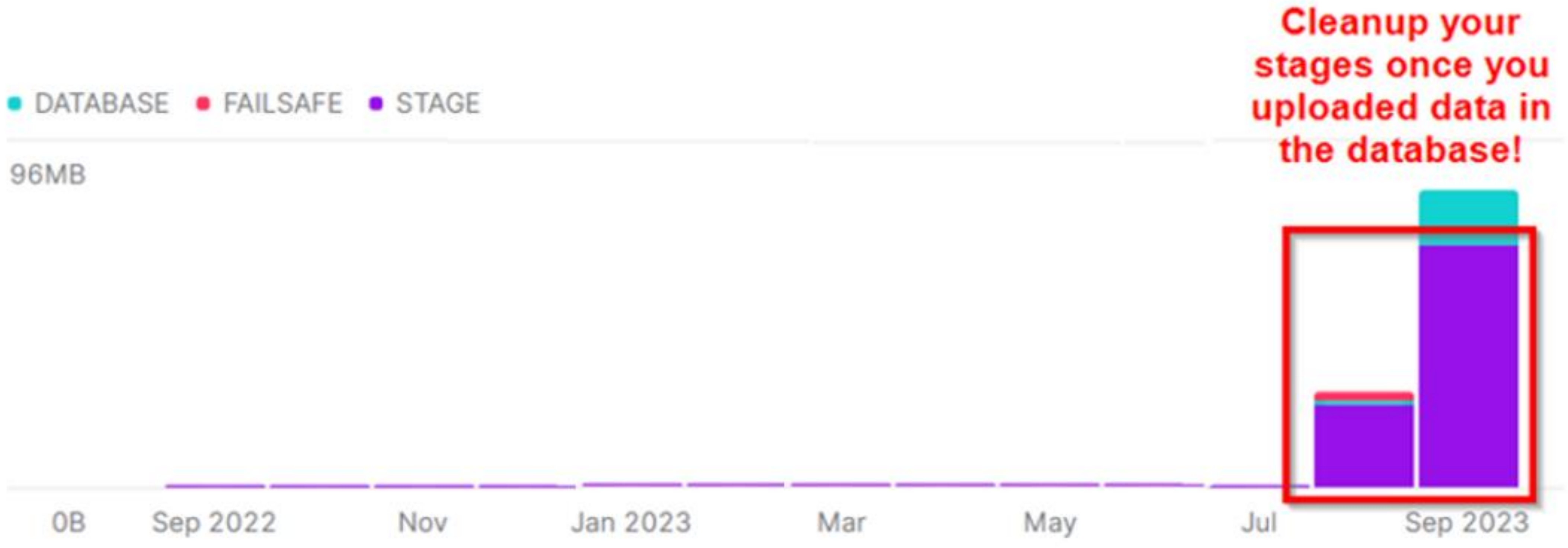
Checkpoints

* *storage*
  * db active + time travel + fail-safe + retained for clones + hybrid tables + stages
* drop any unused objects → recreate them from scripts!
* *unused tables* = not modified/changed/accessed lately
* TABLES view
  * *last_altered* → by DDL/DML operation
* ACCOUNT_HISTORY view
  * *base_objects_accessed* → JSON array, must flatten!
  * *query_start_time* → last accessed time

Remove Old Files from Stage Areas

Tip #80

Storage Wasted by Old Stage Files



Checkpoints

* delete files no longer required from stages
* external+internal stages (named/table/user)
* ACCOUNT_USAGE.STORAGE_USAGE.stage_bytes

SHOW STAGES IN ACCOUNT → all stage names

LIST @mystage → all files

REMOVE @mystage / @%mytable / @~

Introduction to Data Transfer

Tip #81: Data In is Free, Data Out is Expensive

Tip #82: Choose the Same Provider and Region Where Your Data Is

Tip #83: External Access Integrations vs External Functions

Tip #84: Use Data Compression

Tip #85: Use Batch Transfer with Path Partitioning

Tip #86: Use Bulk Loads instead of Single-Row Inserts

Tip #87: Use Parallel Data Uploading

Tip #88: Design Cost-Effective Data Pipelines

Tip #89: Use External Tables in a Data Lake

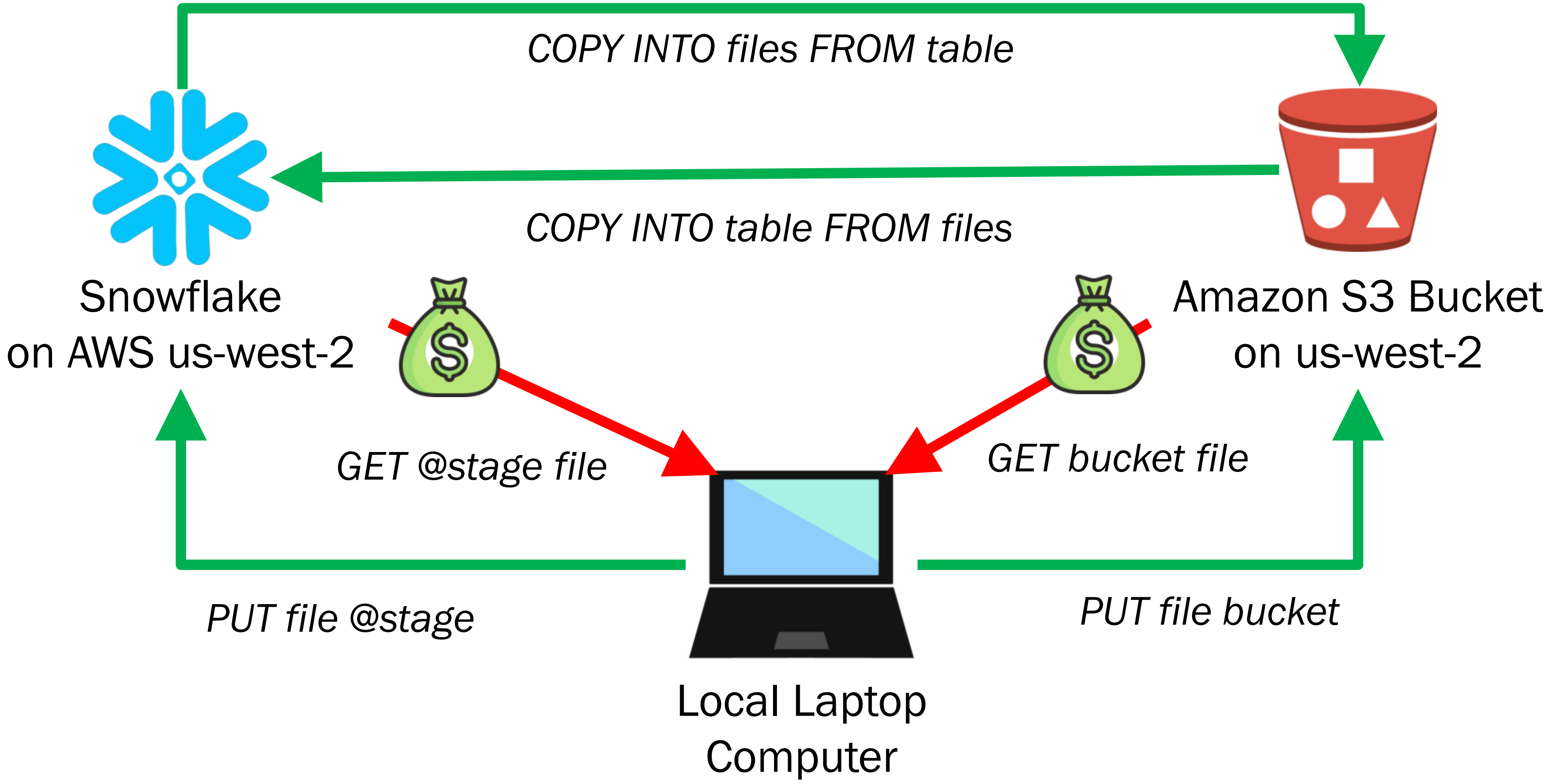
Tip #90: Query Parquet Files instead of CSV

Data In is Free,

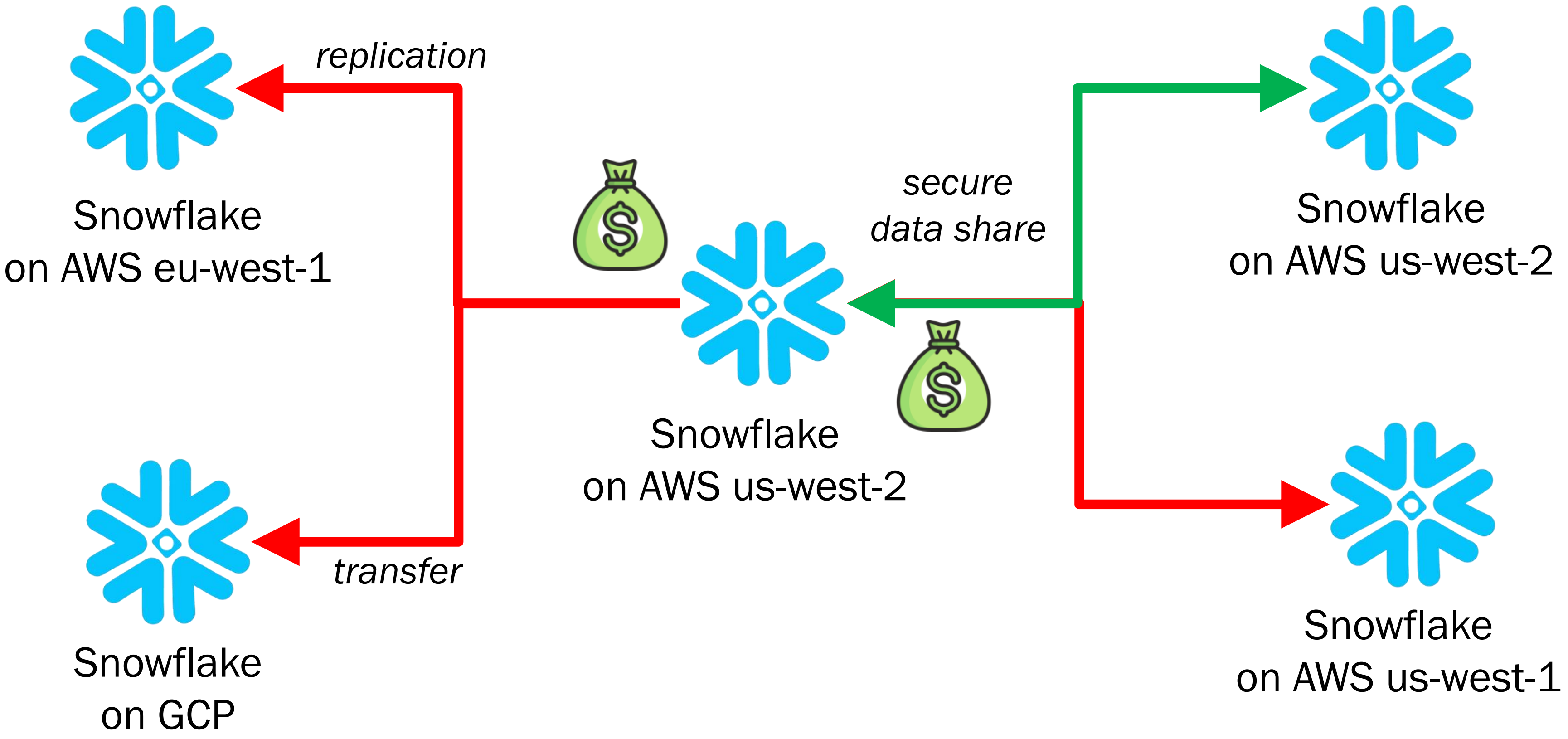
Data Out is Expensive

Tip #81

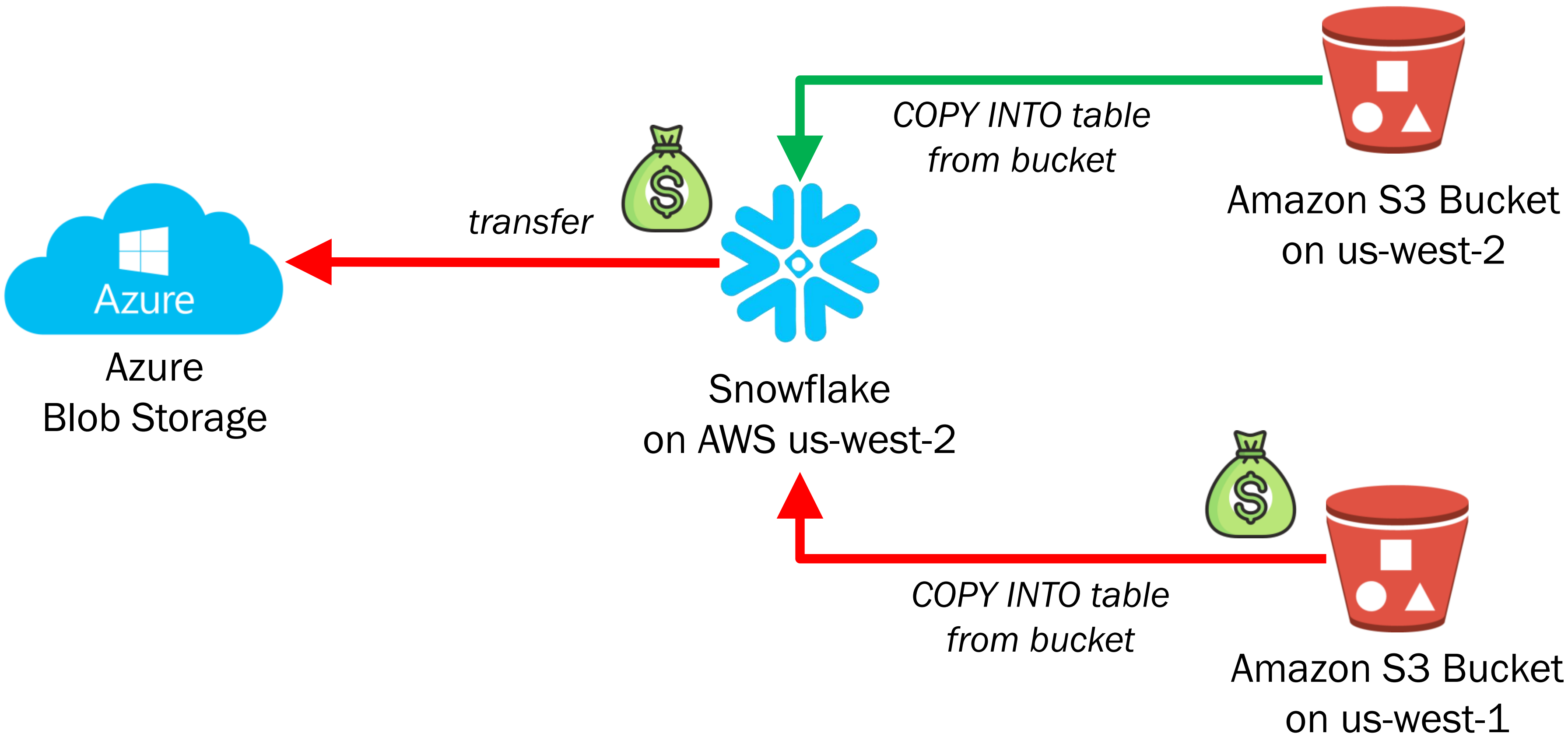
Local Data Transfer Costs



Snowflake-to-Snowflake Costs



Internet Data Transfer Costs



DATA_TRANSFER_HISTORY

	TFX	TRANSFER_TYPE	BYTES_TRANSFERRED
1	aws (us-west-2) → (aws) us-west-2	EXTERNAL_FUNCTION	2808091
2	aws (us-west-2) → (aws) us-east-2	EXTERNAL_FUNCTION	27797
3	aws (us-west-2) → (internet) internet	EXTERNAL_ACCESS	98058
4	aws (us-west-2) → (aws) us-west-2	COPY	101584

Checkpoints

* Snowflake (us-west-1) → S3 bucket (us-west-2) - $ to Snowflake

* Snowflake (us-west-1) ← S3 bucket (us-west-2) - $ to AWS

* Snowflake → local - $ to Snowflake

* AWS → local - $ to AWS

Choose the Same Provider and Region Where Your Data Is

Tip #82

Data Transfer Pricing

* AWS: diff region $20+ / diff prov $90+

* Azure: same cont $20+ / diff cont $50+ / diff prov $87.50+

* GCP: same cont $10+ / diff cont $80+ / diff prov $120+

pricing is per TB of data transferred

within the same region+provider is FREE

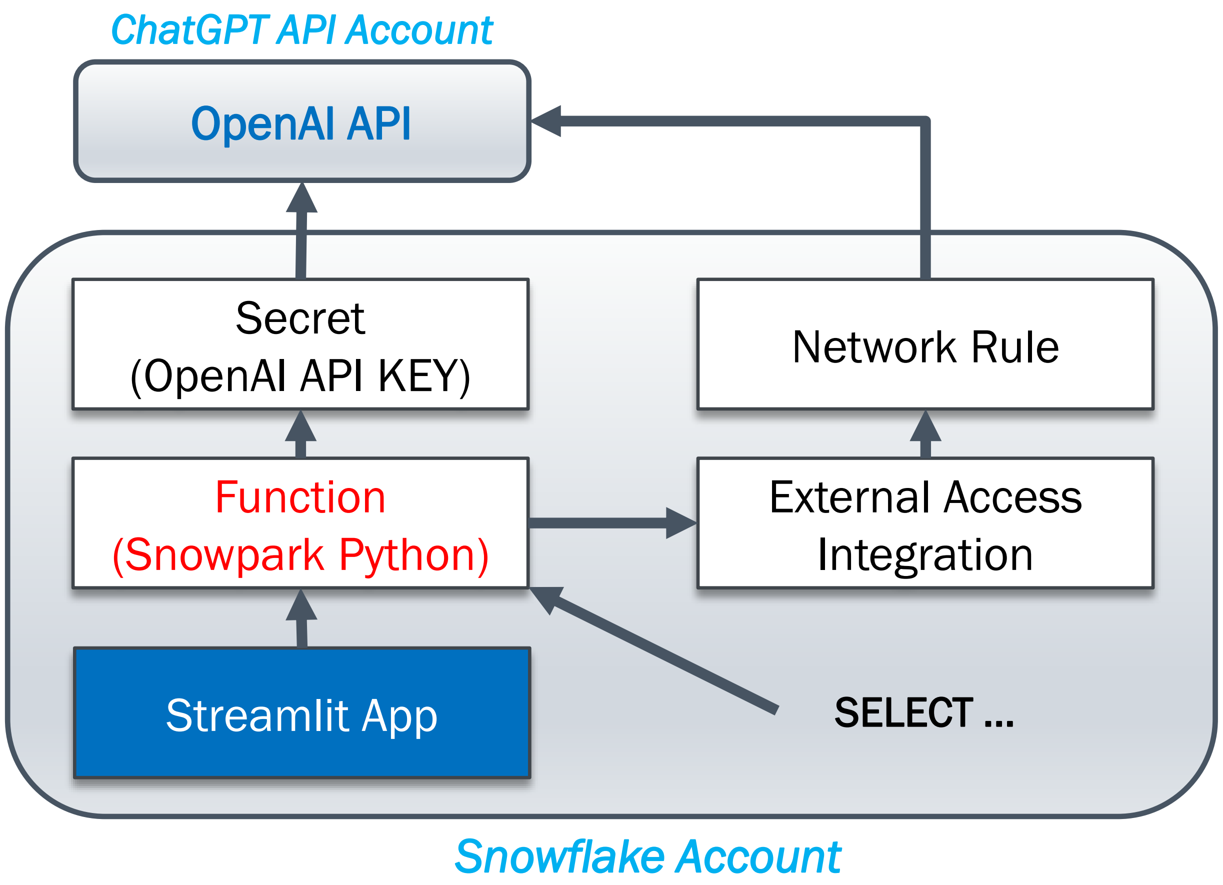
Checkpoints

* no cost to tfx data in (upload)
* no cost to tfx data out within the same region+provider
* moderate cost to tfx to another region, same provider
* moderate cost to tfx within the same continent+provider
* higher cost to tfx to another continent, same provider
* highest cost to tfx to another provider

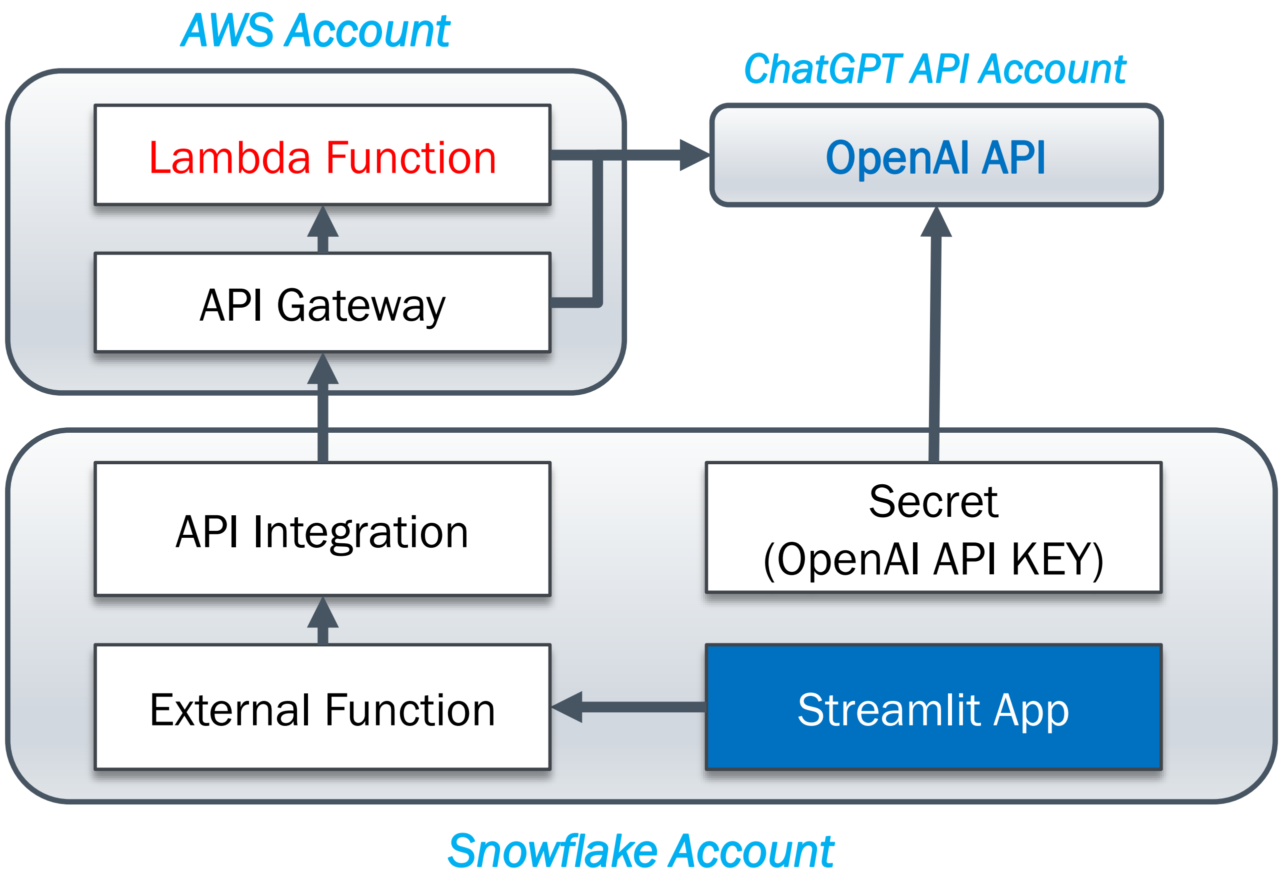
External Access Integrations vs External Functions

Tip #83

External Access Integration



External Function



Checkpoints

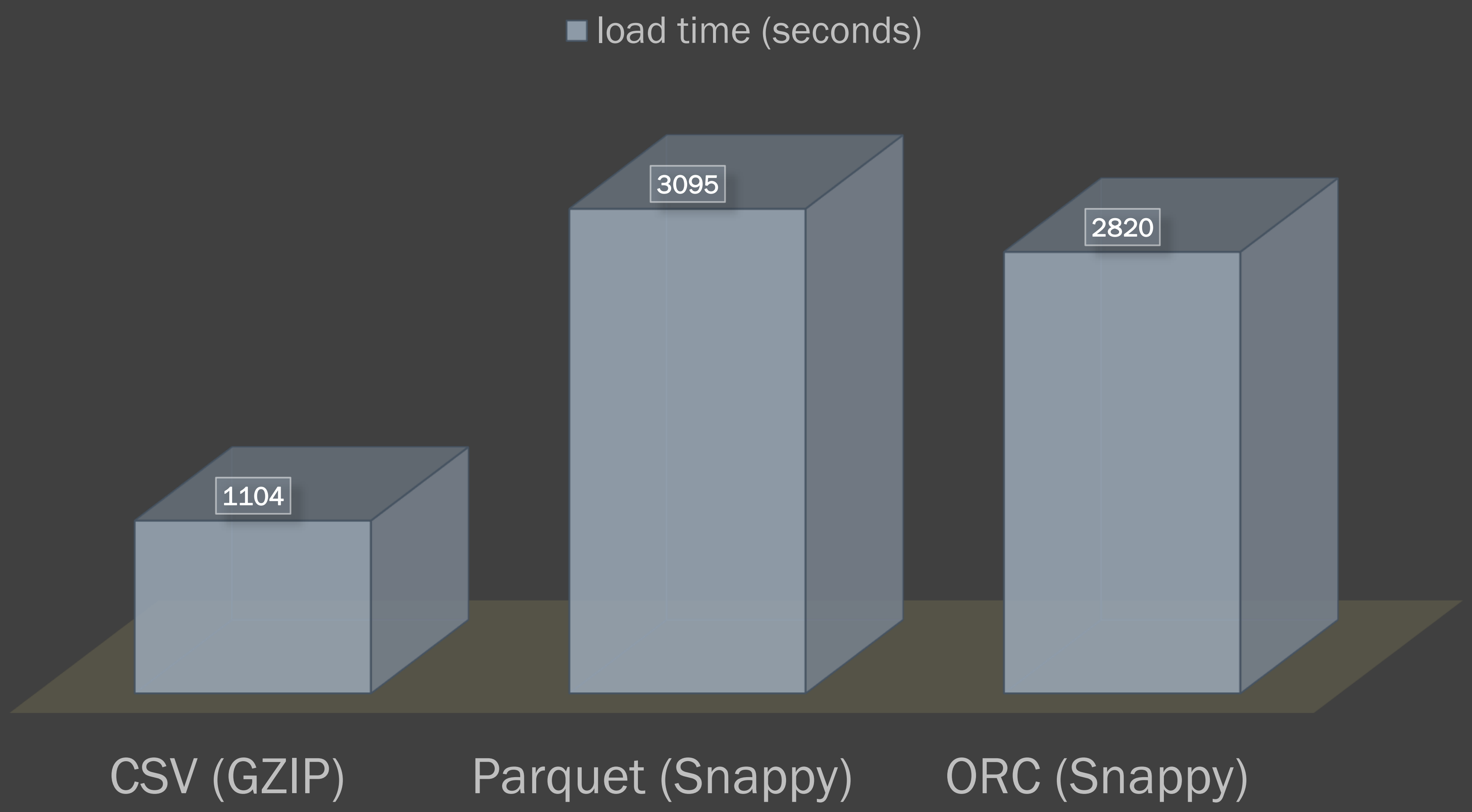
* *External Access Integration*
  - business logic mostly within Snowflake, in the WH
  - use when you do not transfer a lot of data w/ the remote API
  - easier to implement and deploy
* *External Function*
  - business logic mostly remote, in another cloud service
  - use when you may transfer a lot of data w/ the remote API
  - more complex to implement and deploy

Use

Data Compression

Tip #84

LOADING STRUCTURED DATA



Checkpoints

* Snowflake storage
    * min 3:1 compression ratio → billed only compressed storage!
    * 4.7 TB uncompressed (28.8B rows) → stored as 1.3 TB
* loading compressed data
    * less data transfer cost + less time (cheaper COPY INTO)
    * from CSV (GZIP) >> faster than Parquet/ORC (Snappy)
    * keep data files 100-250 MB in size compressed
    * COMPRESSION = GZIP/BZ2/BROTLI/ZSTD/DEFLATE/RAW_DEFLATE

Use Batch Transfer with Path Partitioning

Tip #85

Checkpoints

* partition staged data files w/ logical granular paths
* COPY INTO must list S3 folder files → improve performance!
* ex: s3://bucket/app2/loc1/2016/07/01/14/
* copy any fraction of data w/ a single command
* could copy data by hour/day/month etc
* create subfolders of 10-15 mins increments per hour

Use Bulk Loads instead of Single-Row Inserts

Tip #86

Checkpoints

* COPY INTO (batch/bulk) vs INSERT (single row)

* OLTP vs OLAP

* batch/bulk copy consumes less cloud res + faster

* batch/bulk loads can be done in parallel

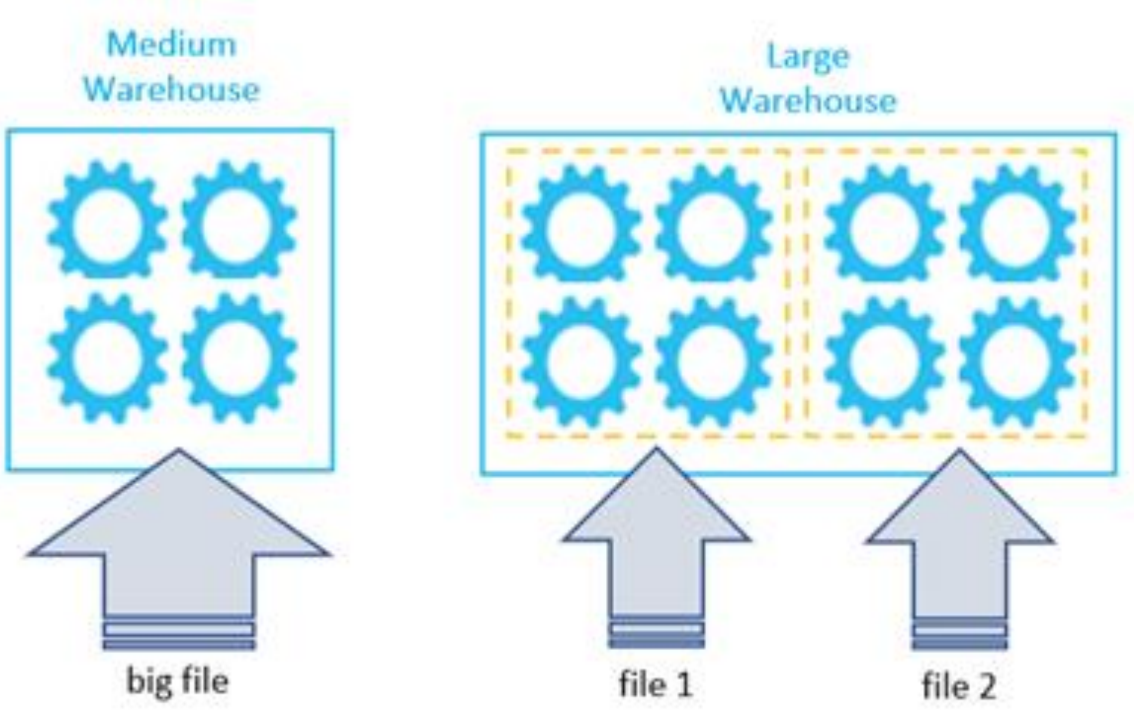
* not for hybrid tables (Snowflake Unistore)

Use Parallel

Data Uploading

Tip #87

Parallel Data Uploading



Checkpoints

* small WH + one file → ok in most cases

* big WH + one file → may take longer if large file

* big WH + single file → could waste idle nodes

* big WH + parallel loading → faster for ~100 files

```
COPY INTO mytable FROM @stage/folder/ FILES=('file1.csv', ...)
```

Design Cost-Effective Data Pipelines

Tip #88

Checkpoints

* check that data-loading processes don’t run more often than consuming data pipelines

* reduce sync frequency of your data ingestion tool + evaluate how often to update data

* upload data to S3 + use as external stage for data loading to Snowflake

* check related costs when running all type of workloads in Snowflake

* it could be more cost-effective to transform S3 data w/ AWS Glue, then load it in Snowflake

* incremental processing: do not rerun entire batches of data for minor updates

* restart interrupted pipelines from the point of interruption, w/ no redundant computation

Use

External Tables

in a Data Lake

Tip #89

Checkpoints

* to query in-place data lake files, from ext stages, R/O
* slower than Snowflake tables → use mat view
* metadata$filename + metadata$file_row_number
* value → single VARIANT column, use for column defs (or INFER_SCHEMA)
* partitioning always recommended → PARTITION BY col1, ...
* manual/auto-refresh metadata → w/ event notifs, may incur cost
* PIPE_USAGE_HISTORY → estimate charge

Query Parquet Files instead of CSV

Tip #90

Parquet vs CSV

* 80%+ less data stored
* 30%+ faster queries
* 99% less data scanned
* 99%+ cost savings

Dataset	Size on Amazon S3	Query Run Time	Data Scanned	Cost
Data stored as CSV files	1 TB	236 seconds	1.15 TB	$5.75
Data stored in Apache Parquet Format	130 GB	6.78 seconds	2.51 GB	$0.01
Savings	87% less when using Parquet	34x faster	99% less data scanned	99.7% savings

Checkpoints

* transform CSV to Parquet when left in the data lake
* less storage because of binary format + compression
* less data scanned because of less storage + columnar
* faster queries because of the columnar format
* huge compute + storage cost savings

Introduction to Snowflake Apps

Tip #91: Estimate Cost Impact of Data Sharing in Snowflake

Tip #92: Estimate Cost Impact of Client and Server (Snowpark) Apps

Tip #93: Estimate Cost Impact of Streamlit in Snowflake and Native Apps

Tip #94: Estimate Cost Impact of Data Science Applications

Tip #95: Check All Connected Applications

Tip #96: Third-Party Apps Saving Money Will Spend Money

Tip #97: Free Marketplace Native Apps Will Cost Money

Tip #98: Keep App Versions Updated

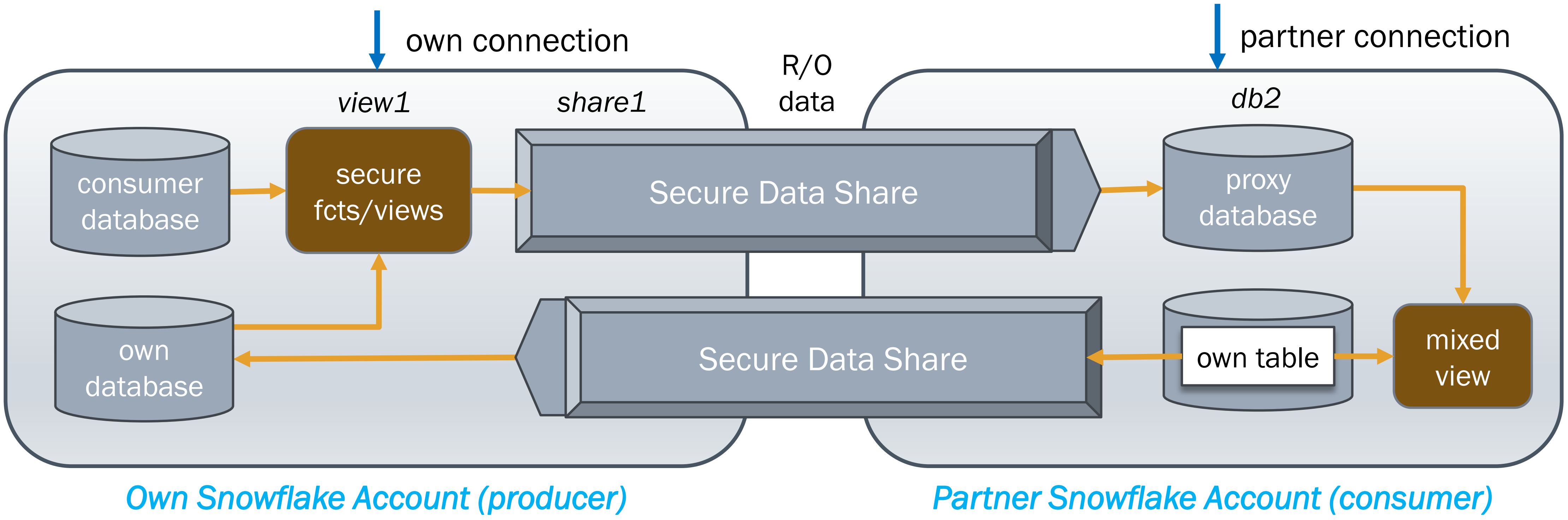
Tip #99: Cache Data in Third-Party Tools

Tip #100: Auto-Abort Running Queries from Disconnected Apps

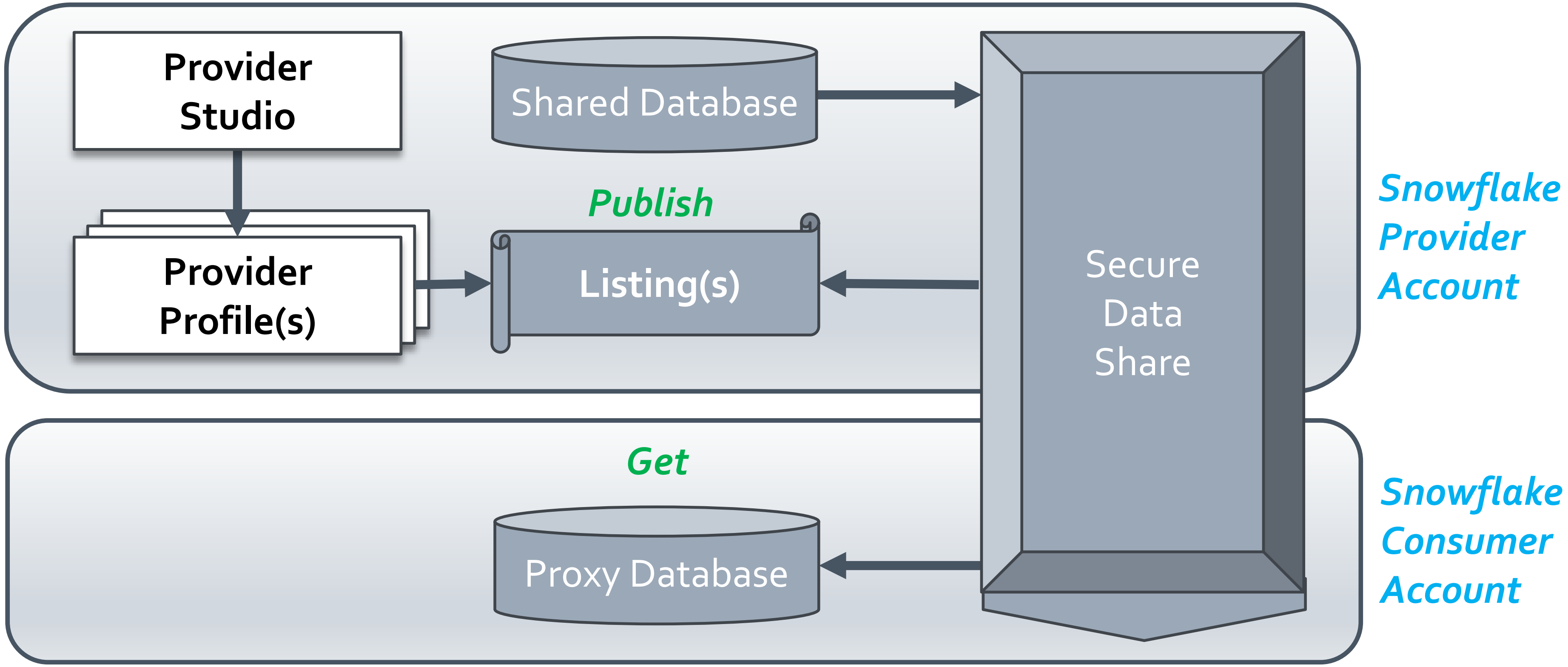
Estimate Cost Impact of Data Sharing in Snowflake

Tip #91

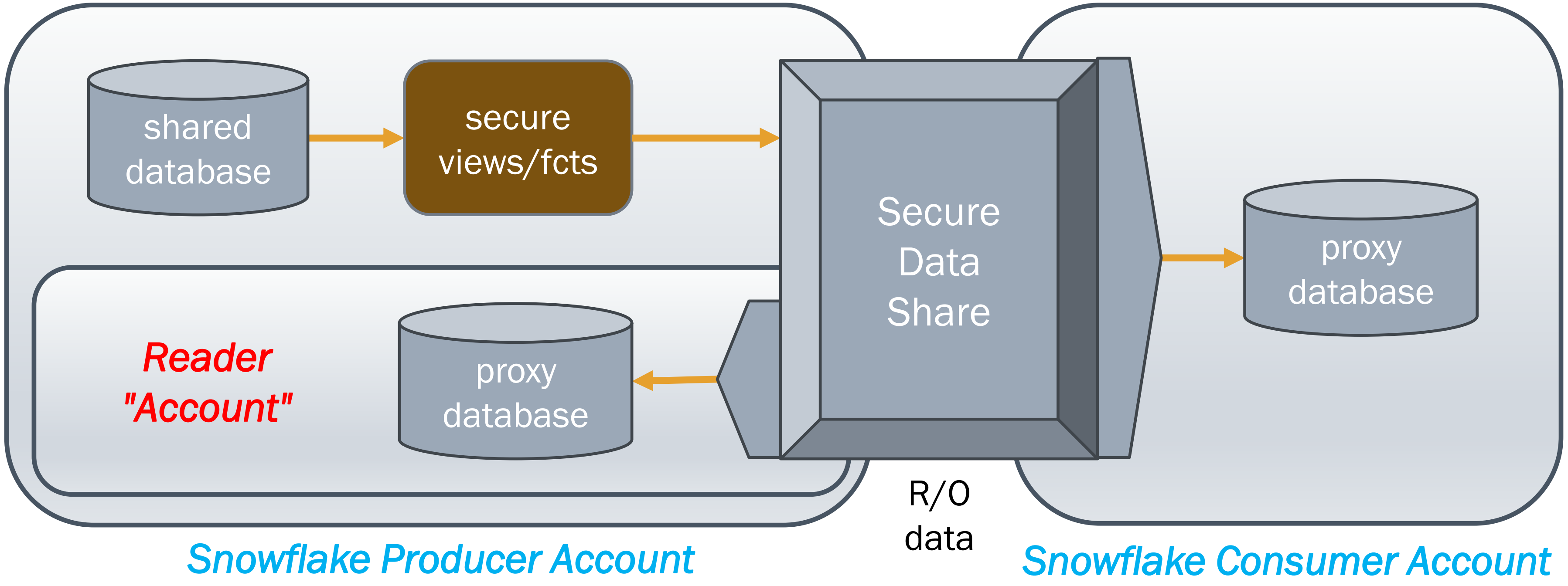
Inbound/Outbound Data Shares



Private Data Exchange



Data Share w/ Reader Account



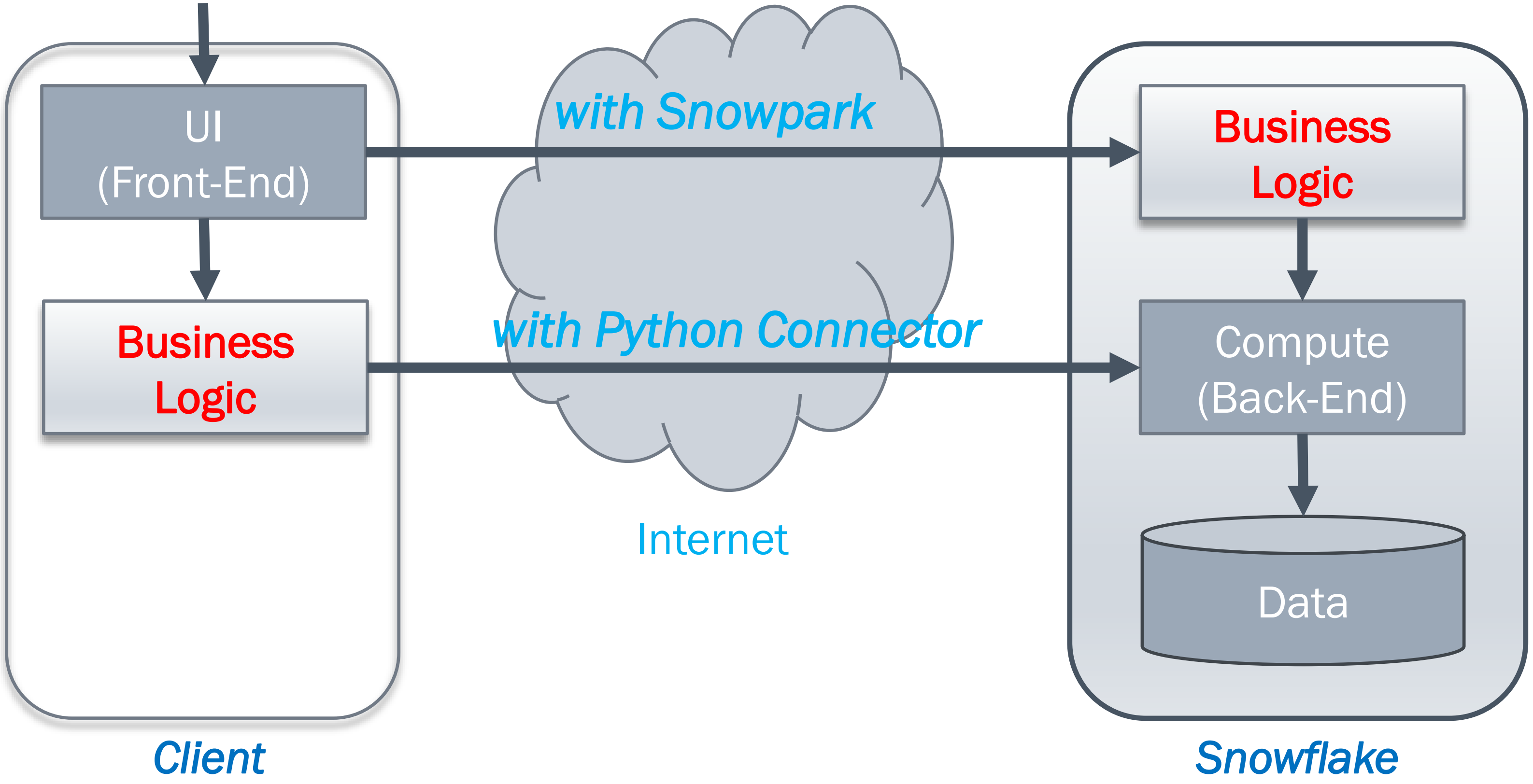
Checkpoints

* data shares
  - if provider → consume some other account compute credits
  - if provider for Reader account → consume OWN credits!
  - if consumer → consume OWN credits
* Marketplace (public) / Data Exchange (private)
  - consumer of shared datasets → consume OWN compute credits
  - ex: SNOWFLAKE_SAMPLE_DATA datasets → some are huge!

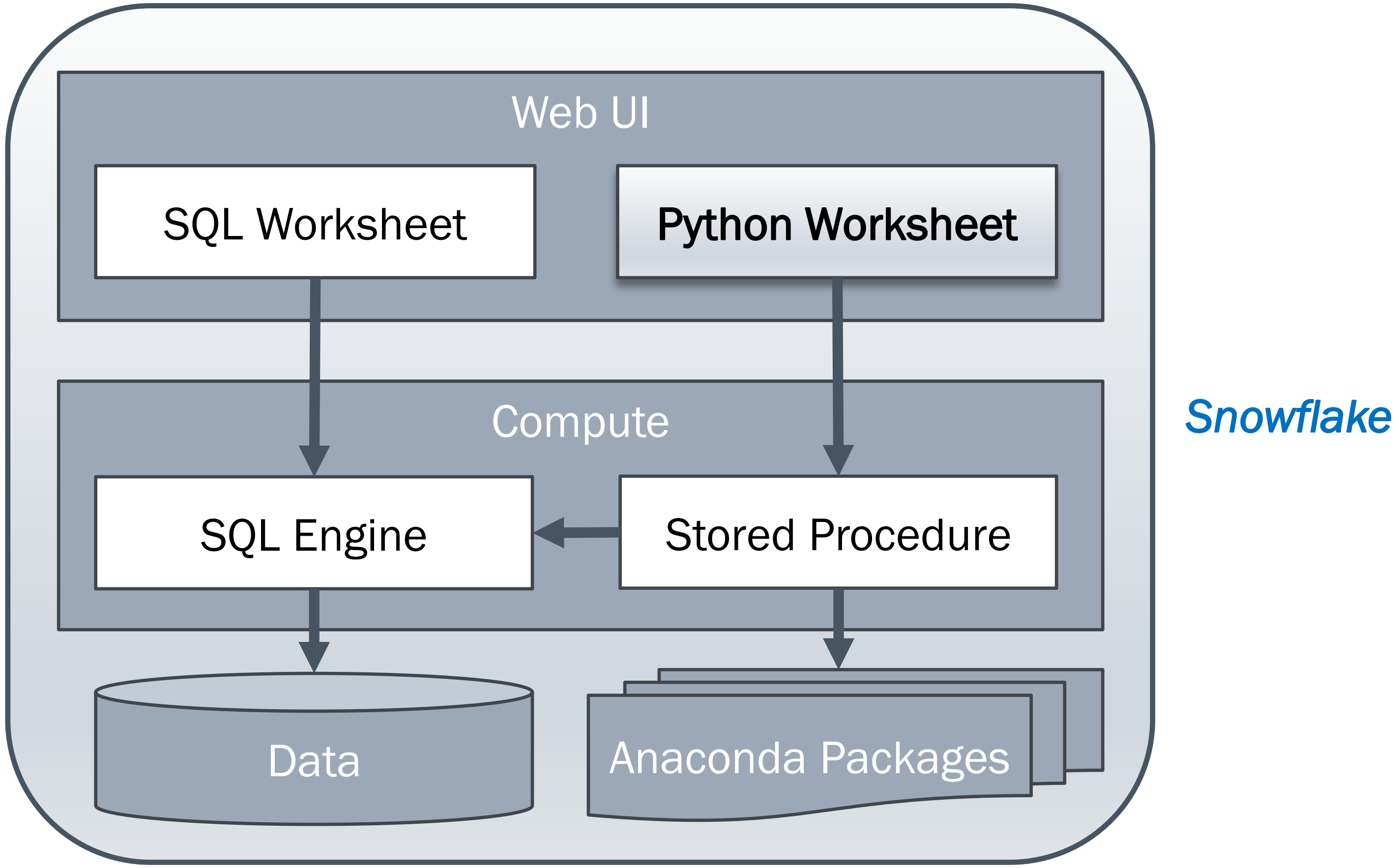
Estimate Cost Impact of Client and Server (Snowpark) Applications

Tip #92

Snowpark vs Python Connector



Python Worksheet



Client and Server Applications

* client apps (w/ client drivers)
  - consume YOUR compute + storage credits
  - plus lots of data transfer, eventually
* server apps (w/ Snowpark, SiS, Container Services)
  - consume **A LOT OF** YOUR compute + storage credits
  - but less data transfer (as they are closer to data)

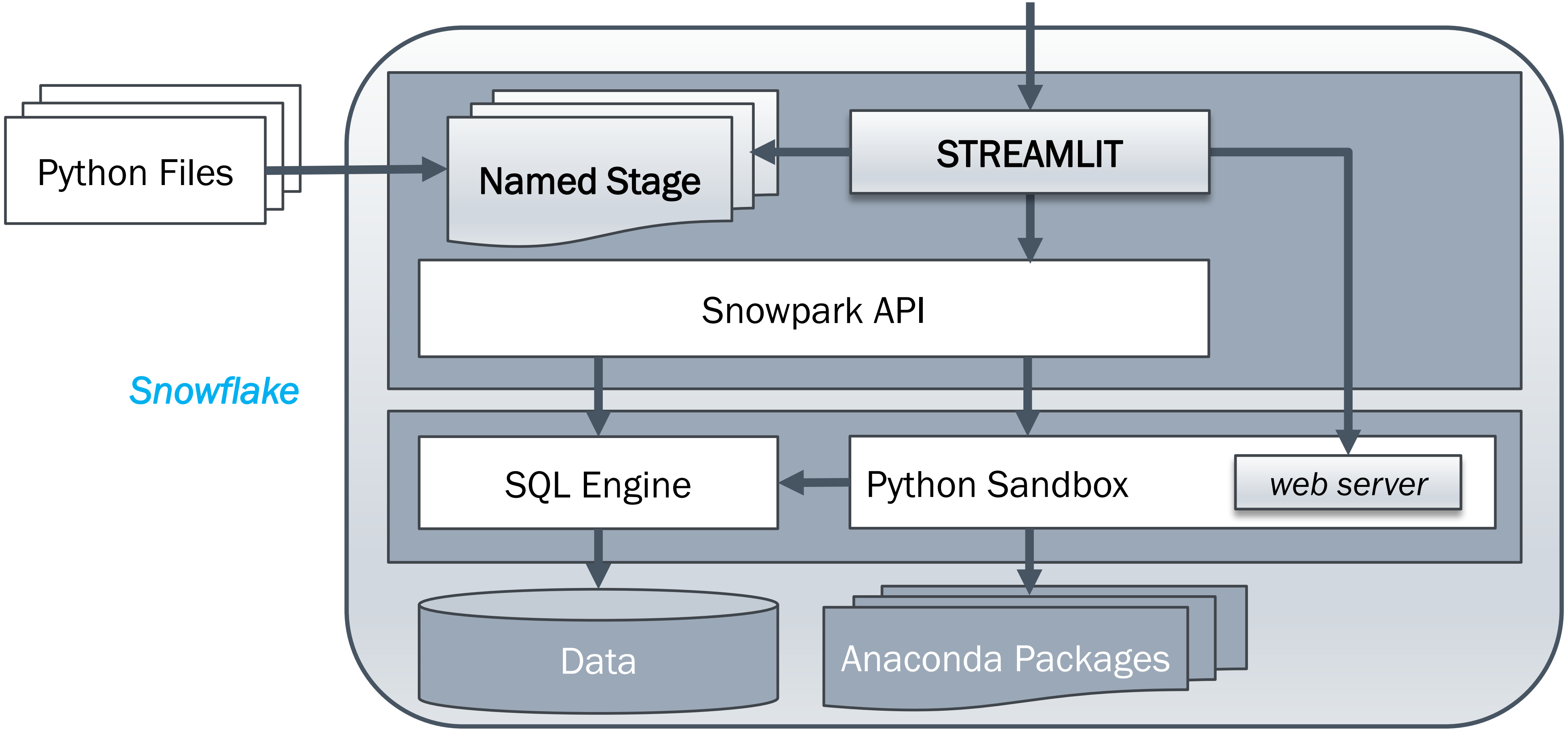
Checkpoints

* Snowpark apps = mostly server-side apps
* unlike client apps, business logic is deployed in WHs
* Snowflake WHs = db servers (SQL) → app servers (Python)
* better rich alternative to Snowflake Scripting
* stored proc wrappers around Python code → in WHs
* efficient if executing code closer to data is justified

Estimate Cost Impact of Streamlit in Snowflake and Native Applications

Tip #93

Streamlit in Snowflake (SiS)



Snowflake Native Apps

* if provider → consume some other account credits

* if consumer → consume OWN compute credits

* *warning*: any FREE native app will cost you money!

* ex: SNOWFLAKE app, w/ ACCOUNT_USAGE schema

* it is your metadata, but expensive to browse!

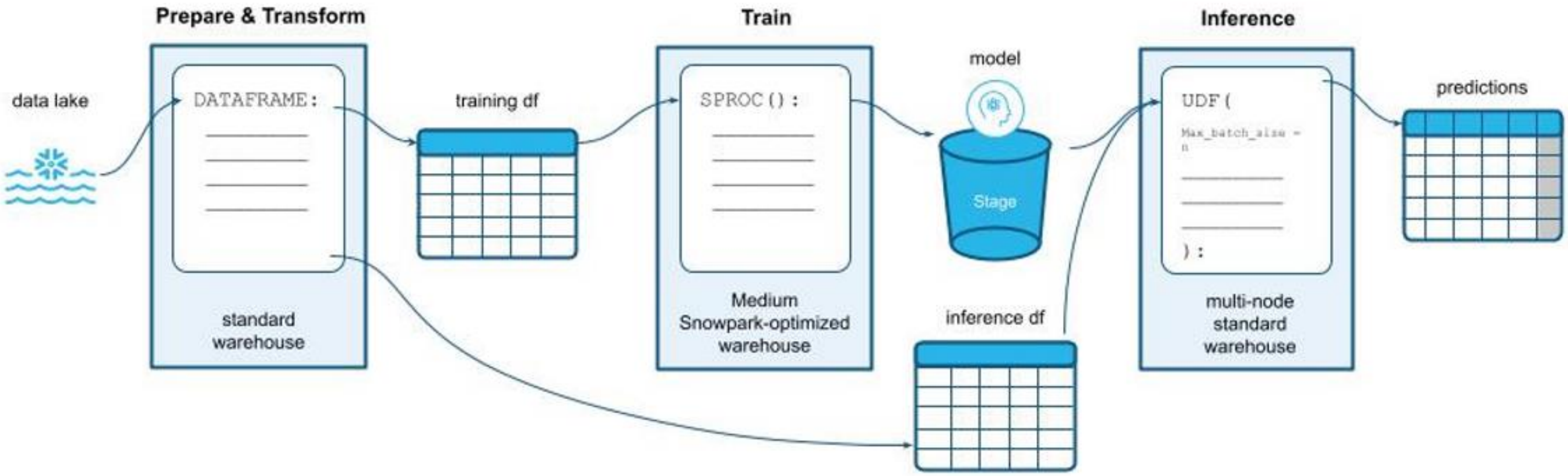
Checkpoints

* Streamlit in Snowflake (SiS) = wrapper around Python code
* STREAMLIT object, deployed+executed as stored proc in WH
* it keeps WH up as long as app used → expensive!
* app goes to sleep when WH auto-suspended
* most Streamlit web apps can be easily deployed as SiS
* alternatives: native apps, Container Services

Estimate Cost Impact of Data Science Applications

Tip #94

Model Training & Serving



https://www.snowflake.com/blog/snowpark-python-feature-engineering-machine-learning/

Checkpoints

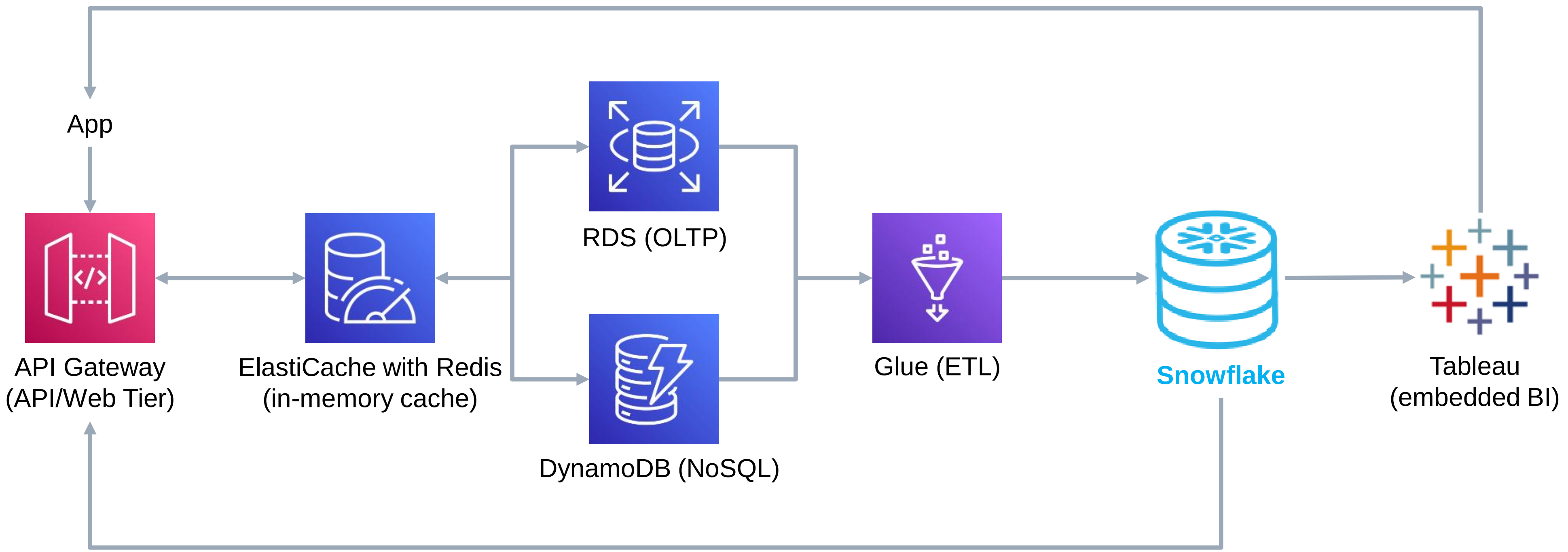
* Snowflake made Data Science/ML a top priority
* model training may require *optimized WHs* (expensive)
* no GPUs → not for NN (but see Container Services w/ NVIDIA)
* model serving w/ *multi-node standard WHs* (also expensive)
* is Snowflake ready for Data Science? → still experimental
* Snowflake Notebooks, Snowflake Cortex etc coming up

Check All

Connected Applications

Tip #95

Embedded Analytics



Checkpoints

* keep an architecture diagram w/ all your integrations
* understand how they all consume data, use caches…
* check all in-house developed applications
* check analytic apps: Tableau, Power BI, Looker…
* check ETL tools: Fivetran, dbt…

Third-Party Apps

Saving Money

Will Spend Money

Tip #96

Checkpoints

* they all install in your account → consume YOUR credits!
* principle: "*spend even more money to save money*"
* claim: "*we save you more than you spend on us*"
* they all rely on best practices and tips from this course
* this proves that Snowflake is not at all a zero-admin DW

Free Marketplace Native Apps Will Cost Money

Tip #97

Checkpoints

* no free Marketplace native app is truly free
* they all install in your account → use YOUR compute credits
* plenty of them are actually unreliable → use w/ much care!
* are better suited for expensive prod account, not test accounts
* will start an expensive STREAMLIT object
* may query metadata w/ intensive queries
* may transparently schedule expensive tasks!

Keep

App Versions

Updated

Tip #98

Checkpoints

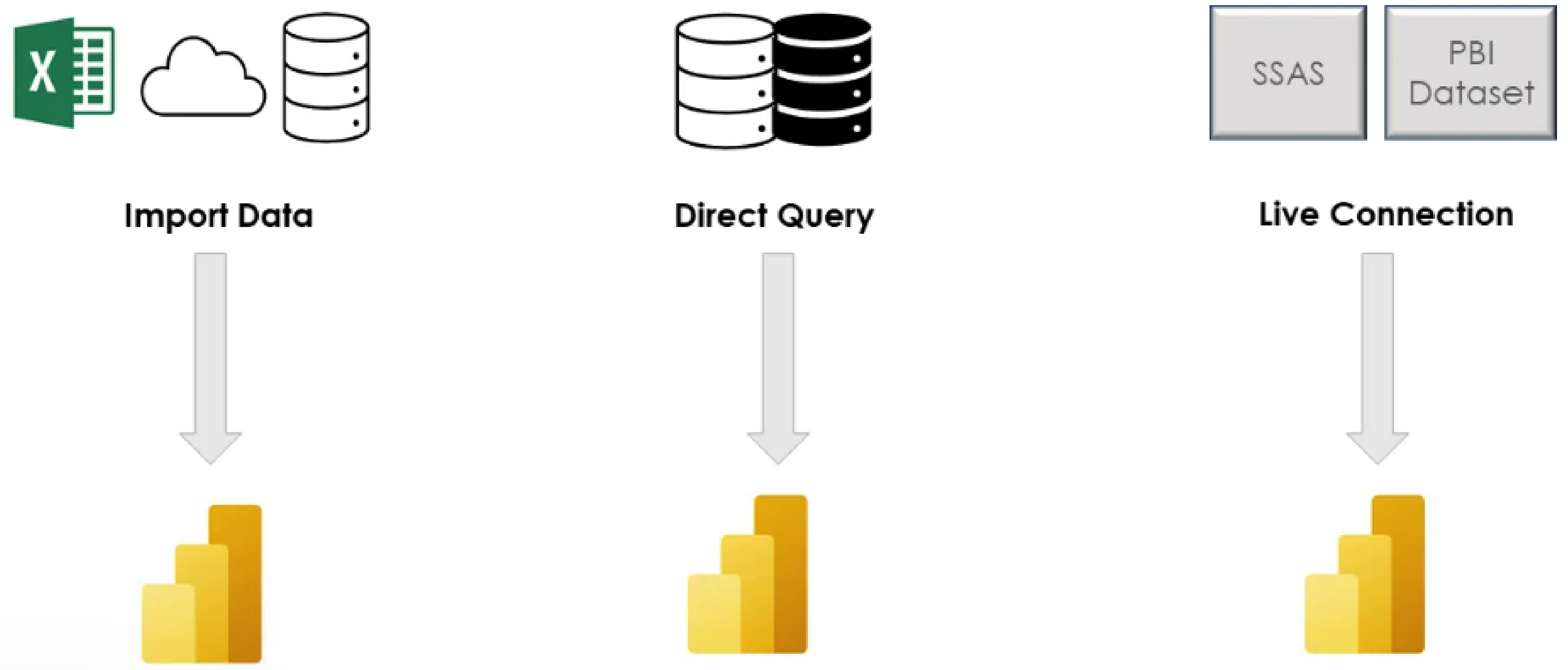
* hard to use latest performance and security updates
* WHs usually have installed older versions → check!
* check and use the latest deployed framework versions
* check and use latest deployed packages & libs
* update your Snowflake client drivers & libraries

Cache Data

in Third-Party Tools

Tip #99

Power BI Connection Types



Checkpoints

* mostly for analytic tools (Tableau, Power BI, Looker)
* avoid querying Snowflake data at every visit
* should combine access to live+cached data
* use data extracts w/ aggregations for dataviz
* avoid refreshing dashboards too frequently
* use query tags to identify intensive operations

Auto-Abort

Running Queries

from Disconnected Apps

Tip #100

Checkpoints

* conn closed on sync queries → all aborted right away
* conn closed/lost (net outage) on async queries
  - all may continue, for max 2 days!
  - STATEMENT_TIMEOUT_IN_SECONDS (account/session/WH level)
  - ABORT_DETACHED_QUERY (session level) → abort after 5 mins max

100 Snowflake Cost Optimization Techniques

100 Snowflake Cost Optimization Techniques