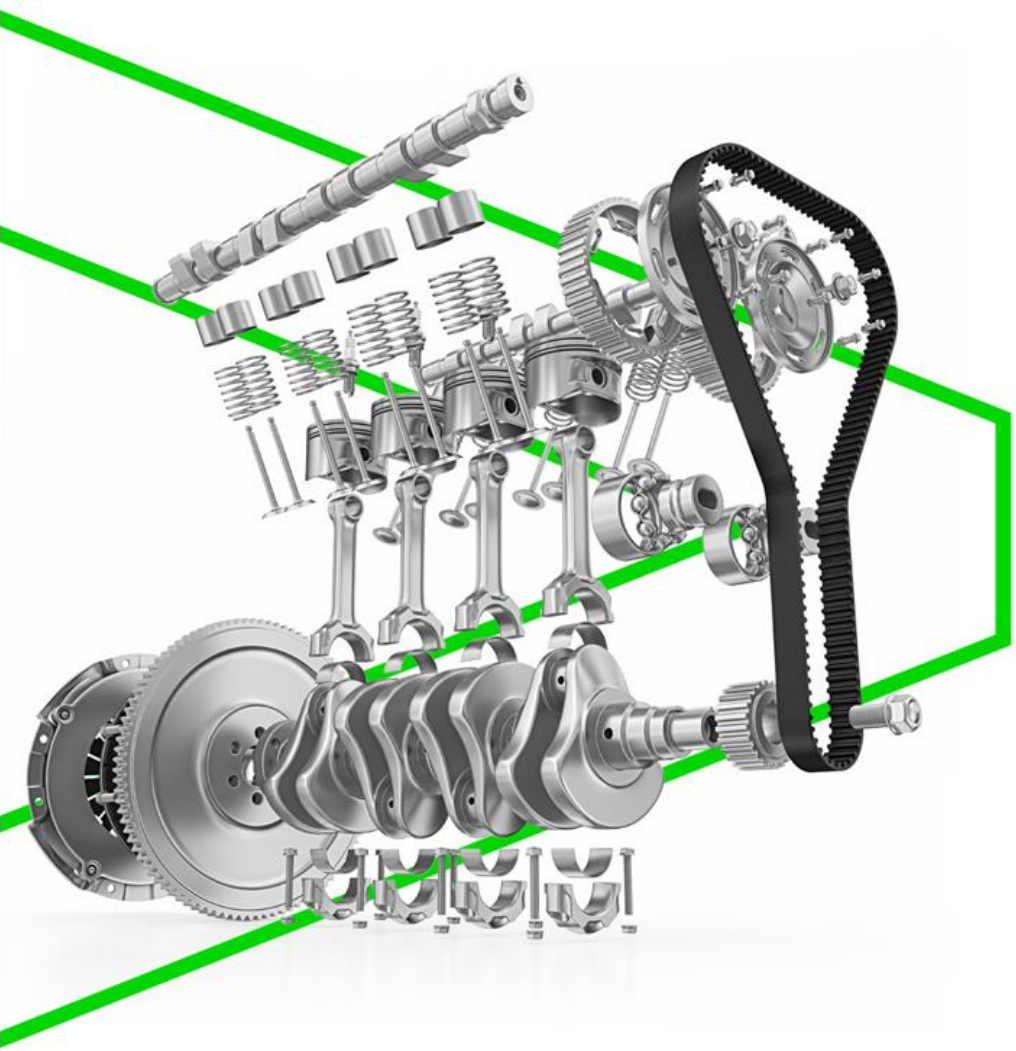

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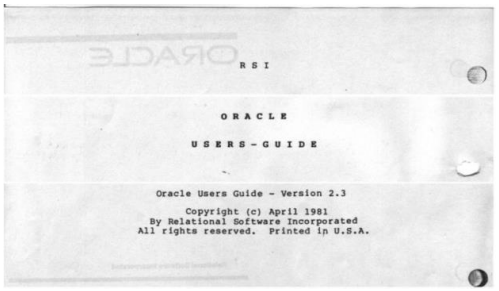
Accenture Enkitec Group

Comparing Oracle Database Performance in the Cloud

April 2nd, 2020

- 10.000+ hours of 24x7 on-call DBA
- First Oracle Certified Master in Europe: 2002
- Oracle ACE Director
- Master Technology Architect
- Master Data Architect
- Database Blog at: juliandontcheff.wordpress.com

THE ORACLE AUTONOMOUS DATA WAREHOUSE CLOUD:



COMBINING CLOUD AND MACHINE LEARNING INTO THE WORLD'S FIRST SELF-DRIVING, AUTONOMOUS DATABASE

CAN THE WORLD'S FIRST AUTONOMOUS DATABASE UNLEASH THE INTELLIGENT ENTERPRISE?

ACCENTURE TESTED THE AUTONOMOUS DATA WAREHOUSE CLOUD ON A REAL APPLICATION, RUNNING REAL-WORLD WORKLOADS

- Tests performed at multiple Accenture locations and innovation centers
- Conducted by a team of Accenture's Oracle data specialists
- Data replicated on both the Oracle Database Cloud Service and the Autonomous Data Warehouse Cloud

EXTREMELY FAST

TESTING SHOWED SIGNIFICANT SPEED IMPROVEMENT

- Inserting 500 million rows of data took less than three minutes, on average
- 1.6x performance improvement compared to published findings
- 14x performance acceleration

FEATURE COMPARISON

DATABASE PROVISIONING

MANUAL INSTALL*

4 HOURS

DBCS

1 HOUR

ADWC

SECONDS

SCALE UP / DOWN HARDWARE

PHYSICAL HARDWARE

Not possible as the hardware is not elastic

DBCS

30 MINUTES

Database is down while scaling is happening

ADWC

SECONDS

Database remains active while scaling is happening

*assume hardware is already procured

TESTING APPROACH

Utilizing an existing cloud based analytics application called PRETT [Platform Resource Enablement Tracking Tool] running on OACS [Oracle Analytics Cloud Service]. Data will be replicated in DBCS and ADWC to provide a real life application usage experience

The data will then be extrapolated and expand based on that existing application to simulate ADWC functionality.

SPRINT 1
BASELINE

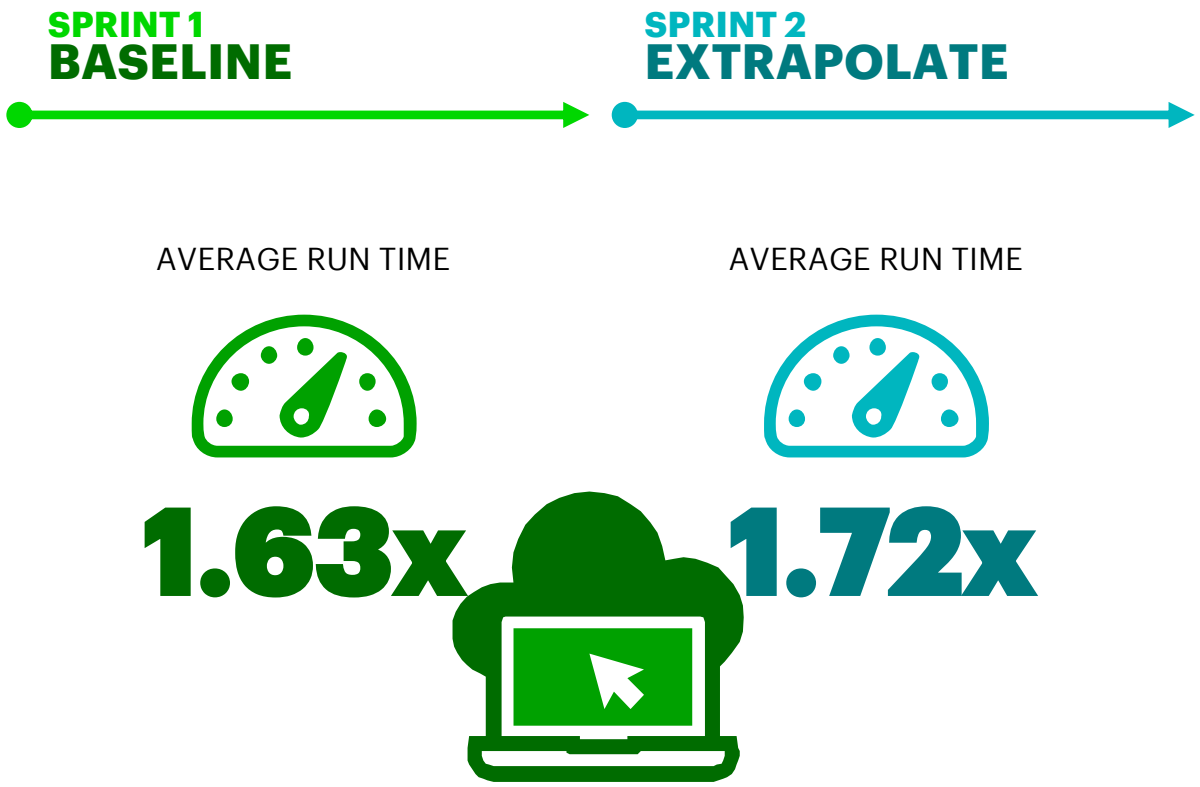
- Compare like to like data volume in OACS[DBCS] to OACS[ADWC]
- 3 Month Data volume
- Run and compare performance in OACS[ADWC] and compare with baseline OACS[DBCS] information

SPRINT 2
EXTRAPOLATE

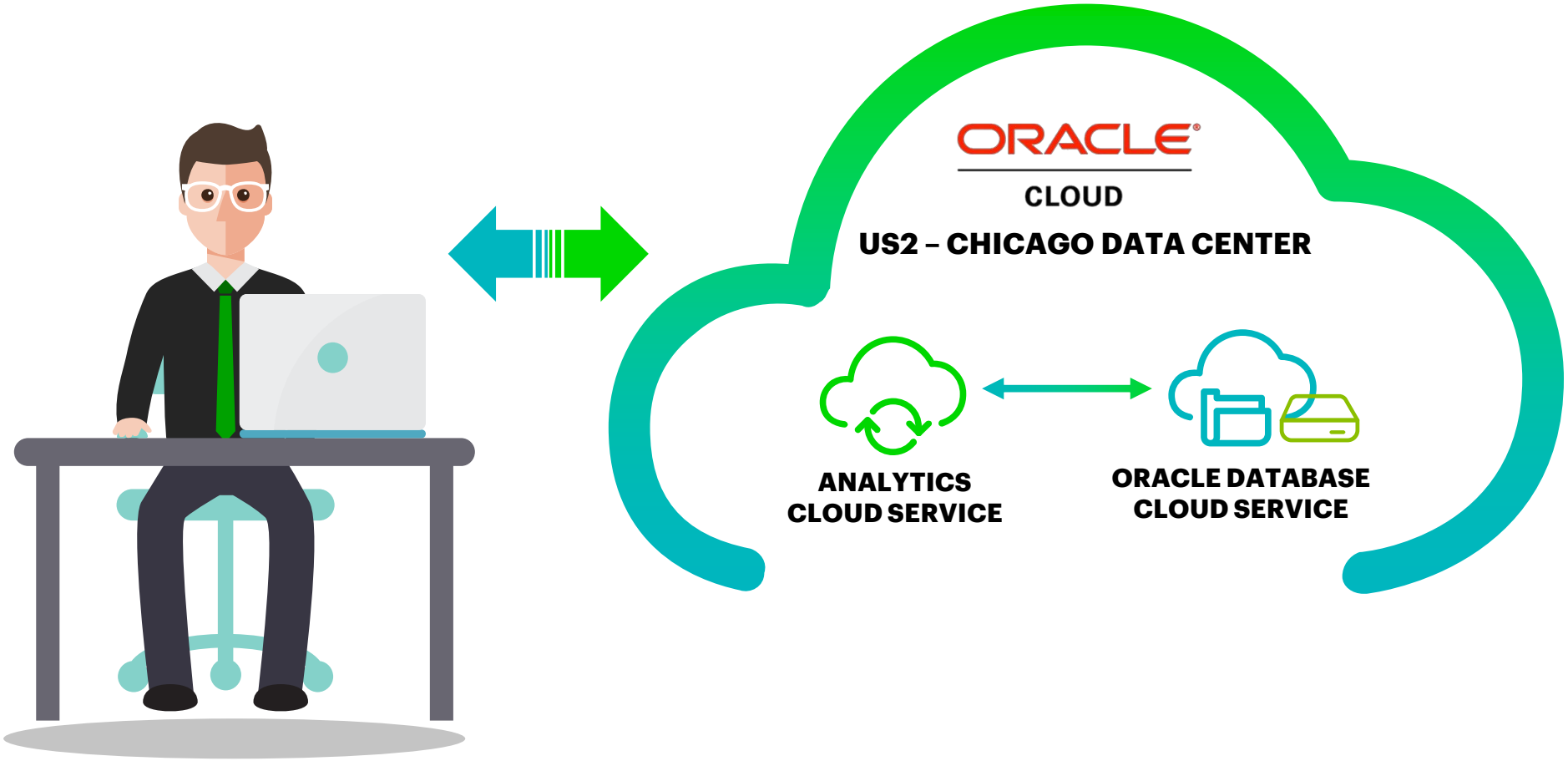
- Create 9 years of data on ADWC based on the 3 month live data to then compare performance on high volume data.

TESTING RESULTS

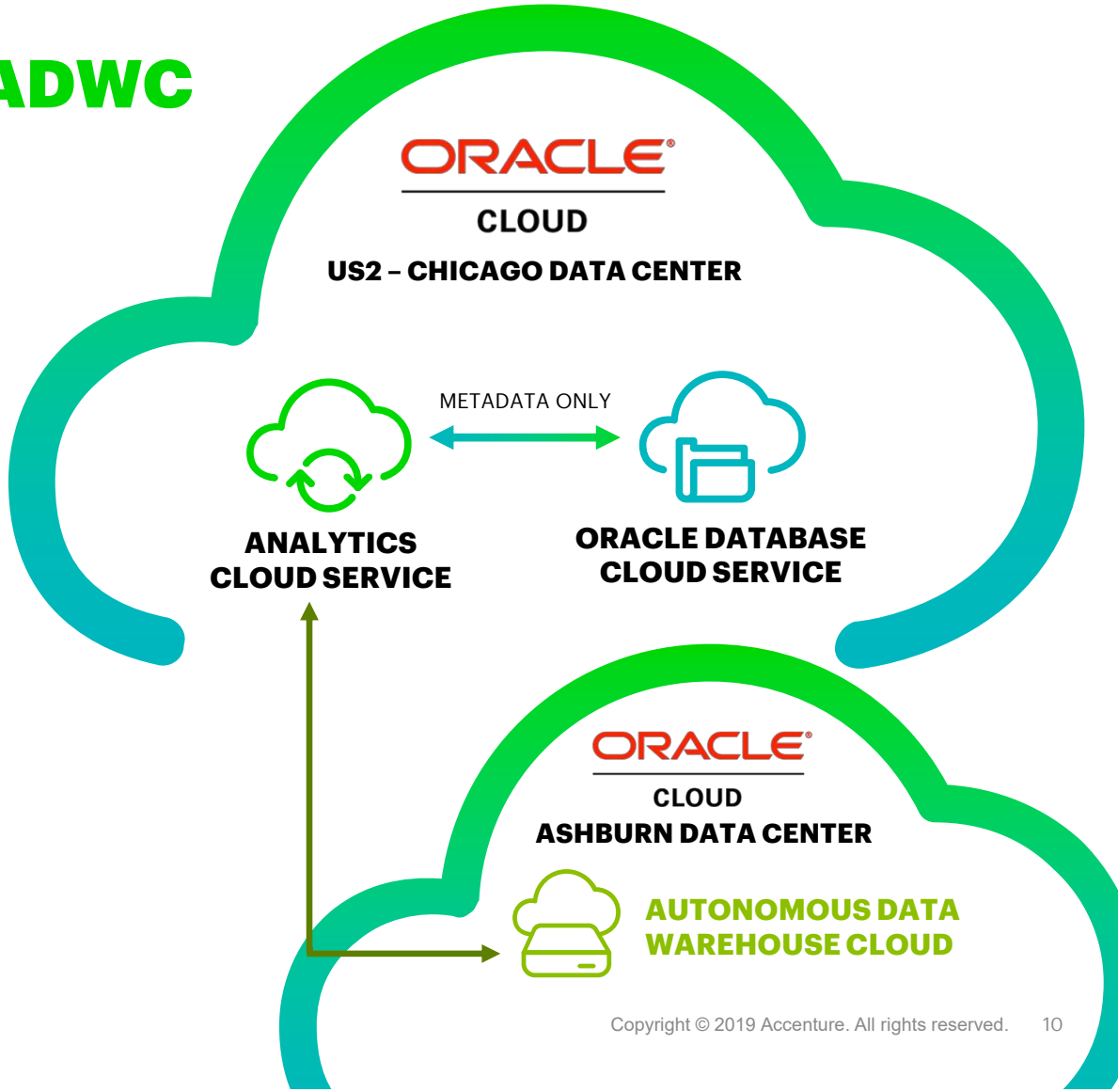
ADWC IS CONSISTENTLY PERFORMING FASTER



ORIGINAL ARCHITECTURE



ARCHITECTURE USING ADWC



Four Areas of Self-Securing of Autonomous Databases

Self-securing starts with the security of the Oracle Cloud infrastructure and database service. Security patches are automatically applied every quarter or as needed, narrowing the window of vulnerability. **Patching** includes the full stack: firmware, operating system [OS], clusterware, and database. There are no steps required from the customer side.

Oracle encrypt customer data everywhere: in motion, at rest, and in backups. The encryption keys are managed automatically, without requiring any customer intervention. And **encryption** cannot be turned off.

Administrator activity on Oracle Autonomous Data Warehouse Cloud is logged centrally and monitored for any abnormal activities. Oracle have enabled database **auditing** using predefined policies so that customers can view logs for any abnormal access: UNIFIED_AUDIT_TRAIL

Built upon Oracle Database Vault, unique to Oracle Cloud, operations personnel have privilege to do all administrative tasks without any ability to ever **see any customer data**

Four Areas of Self-Automation of Autonomous Databases

Automatic provisioning: pluggable databases
Automatic scaling: PDB resource manager

Automatic tuning: SQL Plan Management, Adaptive Plans, SQL Tuning Advisor – Automatic SQL Tuning, Storage Indexes, Automatic Storage Management, Automatic detection and correction of regressions due to plan changes, Automatically tune memory, process, sessions

Automatic Fault Tolerant Failover: RAC and Data Guard
Automatically kill run-away transactions and SQL
Automatically kill inactive session

Automatic Backup and Recovery: RMAN, Flashback

Seven Areas of Self-Repairing of Autonomous Databases

Outage	Key Feature	Potential Downtime
Server Outage (HA)	**RAC**	Near-Zero
Regional Outage, Disaster Recovery	**ADG**	Seconds
Data Corruption	**ADG**	Zero
Patches (Updates)	**RAC**	Near-Zero
Database Upgrade	**ADG**	Seconds
Table/Index Changes	**Redef**	Zero
User Error	**Flashback**	Time Since Error

“This is the most important thing we have done in a long, long time. The automation does everything. We can guarantee an availability time of 99.995%, less than 30 minutes a year of planned or unplanned downtime.”

Larry Ellison
Oracle Executive Chairman and CTO

ORACLE

19c: why automating index creation in the database?

- For a very long time, both DBAs and Developers, have been struggling (really struggling) with what indexes should be created, what type of indexes they should be created as and what indexes should be dropped from the database
- By far, the most interesting new feature of Oracle Database 19c is Automatic Index creation (AI Creation)
- In the long run, this is to be one of the most important features in the Oracle database

19c: Machine Learning and Artificial Intelligence in the DB

- Oracle first create invisible-invalid indexes using dbms_stats.report_col_usage
- Then they test-parse SQL in the SQL tuning set to see if it will use the indexes - because at this stage Oracle have candidate indexes but Oracle won't yet know if they stand a chance of actually being useful - if the SQL does use the indexes, then Oracle make them invisible-valid
- Then they test execute the queries in SPA (allowing the SQL to see the invisible-valid indexes) and they check to see if they run better with these proposed indexes - if they do, then we can make the valid indexes visible
- In theory we can get a new batch of visible indexes every 15 minutes

Four Areas of differences between ADW and ATP

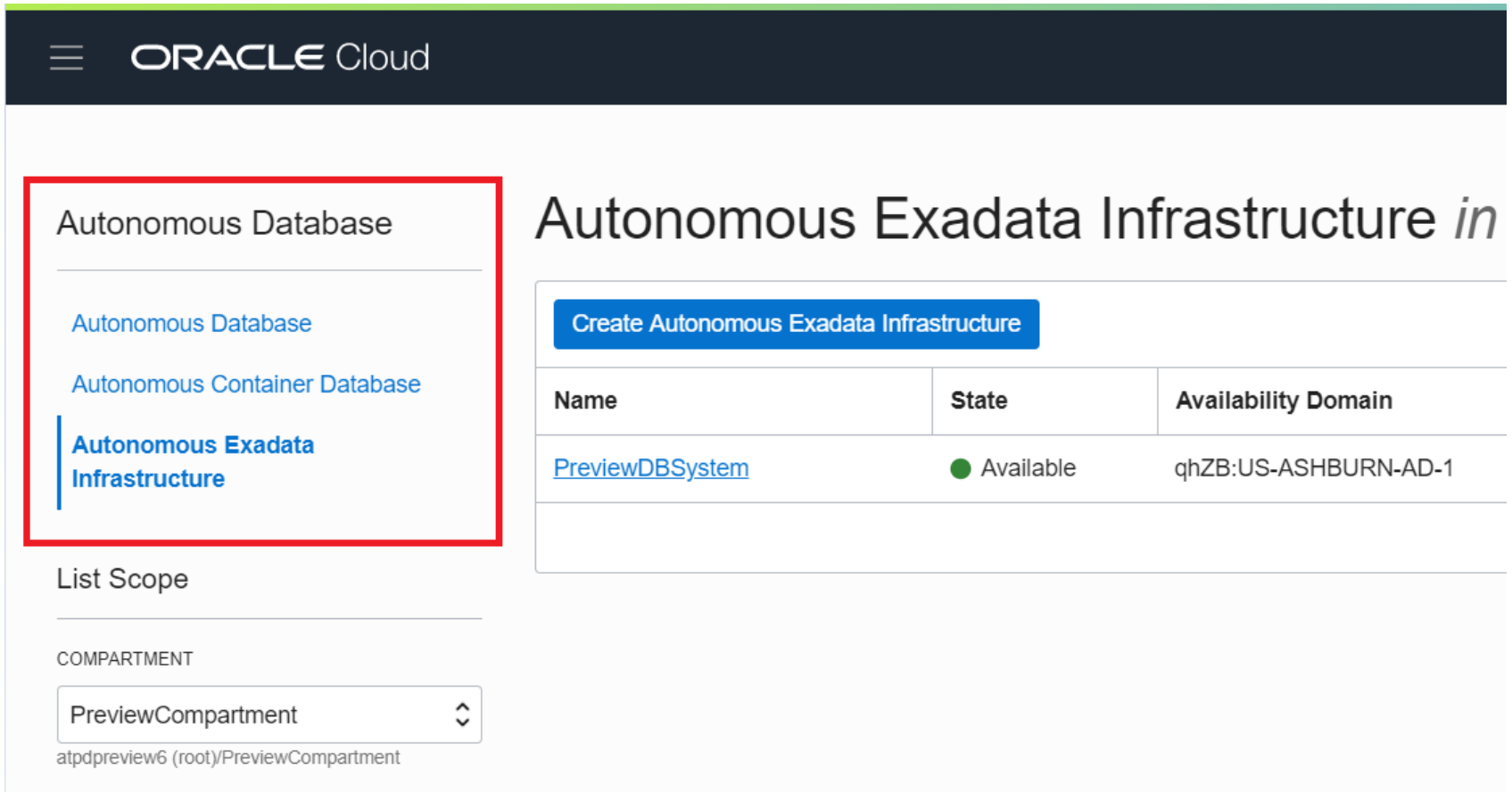
In ADW: the majority of the memory is allocated to the PGA – joins, aggregations in memory
In ATP: the majority of the memory is allocated to the SGA – minimize I/O

In ADW: data is stored in a columnar format as that's the best format for analytics processing
- ADW uses DBIM option features like in-memory columnar flash cache under the covers
In ATP: data is stored in a row format

In ADW: statistics are automatically maintained as part of bulk load and DBMS_CLOUD activities
In ATP: statistics are automatically gathered when the volume of data changes significantly enough to make a difference to the statistics

In ADW: only one service (LOW) automatically runs SQL statements serially, all is parallel
In ATP: the PARALLEL service does no longer exist (as of 12.11.2018)

ATP-D generally available since June 18th, 2019



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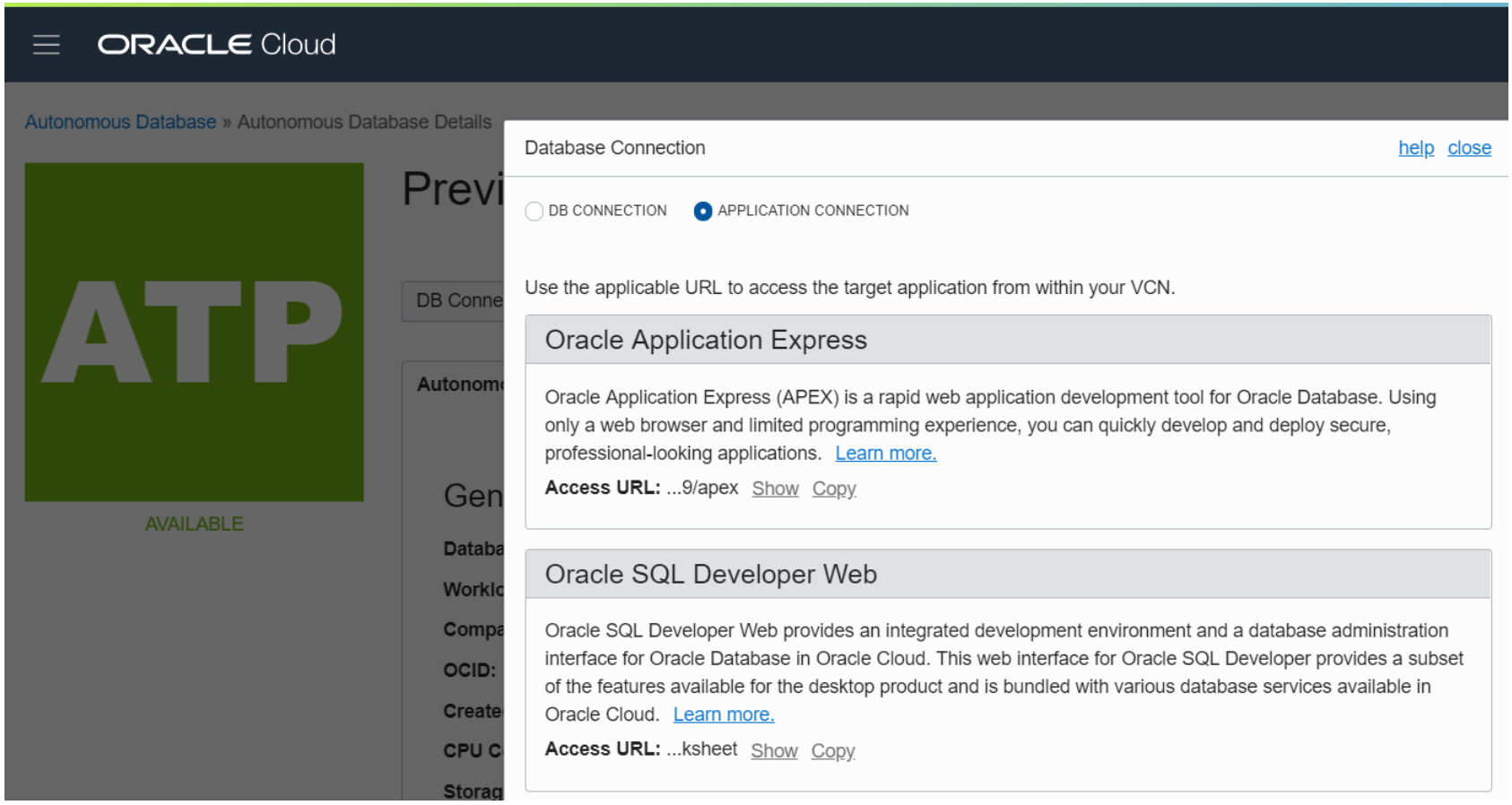


Four Areas of how ATP-D is different

- Private IPs are not yet supported for serverless ADB deployments but they are on the short-term roadmap
- Private IPs are supported with ATP-Dedicated

- ADB (serverless) does have auto-scaling - you can select auto scaling during provisioning or later using the Scale Up/Down button on the Oracle Cloud Infrastructure console
- ATP-D does not have auto-scaling support

- Loading data from object stores via DBMS_CLOUD is the recommended method for loading large data sets
- DBMS_CLOUD to load data is not applicable for ATP-D because DBMS_CLOUD is not available on ATP-D

- In ADB-D, the database version is 19c which is required for Auto-Indexing which is on by default
- Support for 19c and 20c / Auto-Indexing on ATP-S is on the roadmap

New Performance Tests: Oracle ADW and Major Cloud DW

Other Cloud DWs are a solid offering that performed well in the tests, especially in the smaller cloud- and data-size scenarios

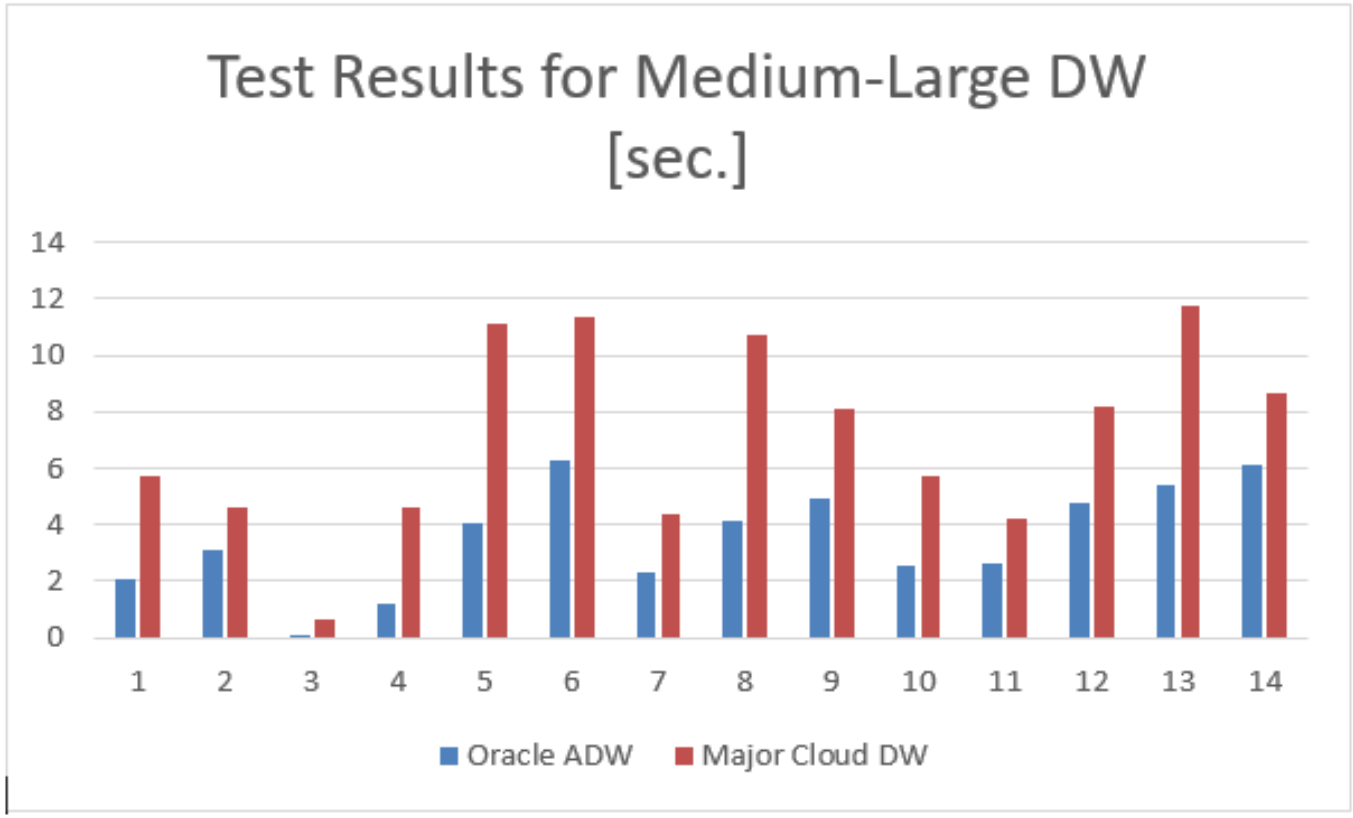
With its data-caching and parallel-execution capabilities, they showed performance above and beyond that which would be expected from a traditional database engine

Nevertheless, Oracle ADW essentially matched or exceeded that performance in the small and medium scenarios, and it clearly exceeded it in the large scenario

At the same time, when it comes to heavy workloads ADW delivers higher performance at much lowers costs

With its winning performance/cost ratio—and the operational advantages offered by its extensive autonomous capabilities—Oracle ADW should be considered by companies that want to run their enterprise data warehouse in the cloud

Accenture New Performance Tests



TCO Savings for Autonomous Data Warehouse

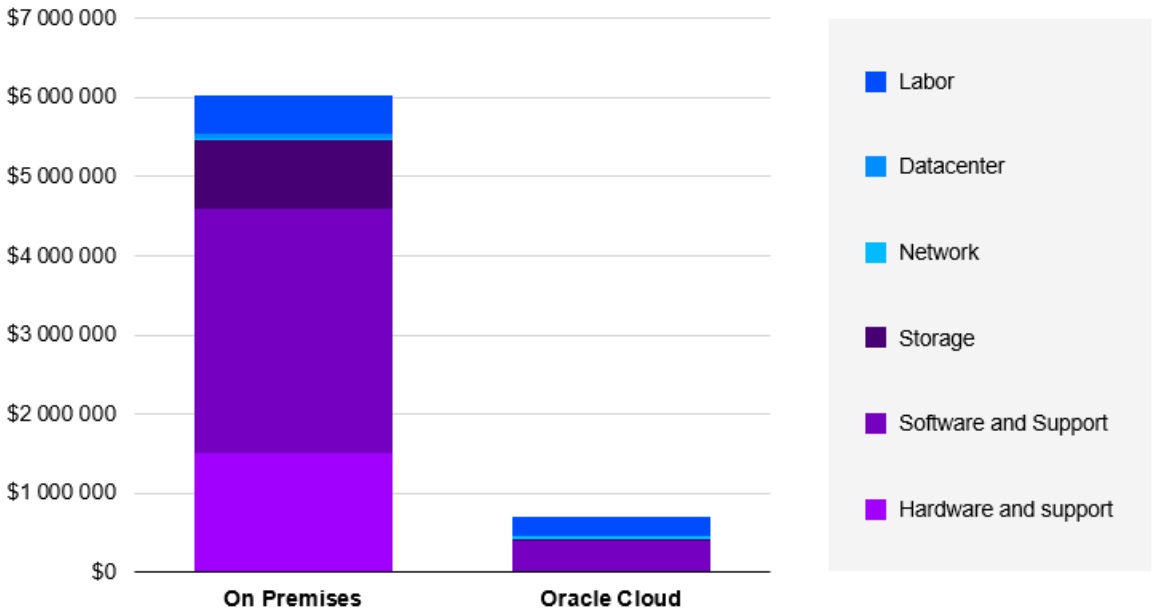
A client TCO analysis

	Year 1		Year 2 through 5	
Description	Associated Cost on Premises (130 Cores)	Associated Autonomous DW Cost (92 Cores)	Associated Cost on Premises (130 Cores)	Associated Autonomous DW Cost (92 Cores)
5 x Exadata 1/4 racks (130 cores) (25% Discount)	$1,262,250	Included	$0	Included
Hardware and OS Support	$252,450	Included	$252,450	Included
Oracle EE, RAC, Partitioning, Diagnostics (@ 60% discount) (65 licenses)	$2,522,000	$394,260	$0	$394,260
Annual Support for DB and options	$554,840	included	$554,840	Included
Exadata Storage (480TB) (60% Discount)	$720,000	$0	$0	$0
Exadata Storage Support	$158,400	$0	$158,400	$0
ADW Storage (8TB)	$0	$21,310	$0	$21,310
Labor – FTE @ $165,000 ea.	$495,000	$247,500	$495,000	$247,500
Datacenter	$54,000	Included	$54,000	Included
Network Costs	$15,600	$31,200	$15,600	$31,200
Oracle Fast Connect		$11,385		$11,385
Total Cost	**$6,034,540**	**$705,655**	**$1,530,290**	**$705,655**
	88% TCO Year 1		**54% TCO Years 2–5**	

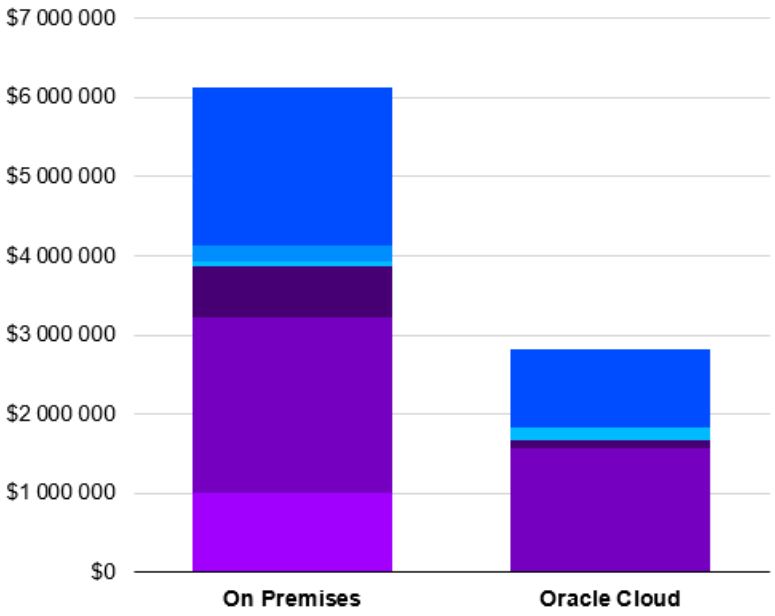
TCO savings for Autonomous Data Warehouse – a graphical view

A client TCO analysis

Year 1 cost comparison of On Premises vs. Oracle Cloud



Years 2 through 5 cost comparison of On Premises vs. Oracle Cloud



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SPEED: FEEL THE NEED

	LEADING CLOUD PROVIDER	ORACLE CLOUD INFRASTRUCTURE	AUTONOMOUS DATA WAREHOUSE	
vCPU	**16**	**16 (8 OCPU)**	**16 (8 OCPU)**	**4 (2 OCPU)**
Memory	128 GB	120 GB		
Disk Type	SSD	NVME SSD	Exadata	Exadata
Disk Size	1 TB	6.4 TB	1 TB	1 TB
Queries per Hour	**65**	**1,264**	**11,975**	**2,453**

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MONEY: MAKE IT WORK

	LEADING CLOUD PROVIDER	ORACLE CLOUD INFRASTRUCTURE	AUTONOMOUS DATA WAREHOUSE	
			LARGER	SMALLER
Queries per Hour	65	1,264	11,975	2,453
Term Commitment	3 Years	None	3 Years	None
Annual IaaS Cost	$5,352	$8,928		
Annual Oracle DB Support	$110,000*	$55,000*	**$101,580**	**$46,812**
Annual Infrastructure + Oracle DB Cost	**$115,352**	**$63,928**		

* Database licensing only includes Oracle Database Enterprise Edition and Advanced Security

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VALUE: MORE FOR LESS

	LEADING CLOUD PROVIDER	ORACLE CLOUD INFRASTRUCTURE	AUTONOMOUS DATA WAREHOUSE LARGER	AUTONOMOUS DATA WAREHOUSE SMALLER
Annual Total Cost	$352	$63	$101,580	$46,812
Queries / Hour		1,2	11,975	2,4
Cost / Hour	$	$7.	$11	$5
Cost / Query	**$0.2026**	**$0.0058**	**$0.0010**	**$0.0022**
Patching for Security	**Days / Weeks / Months**	**Days / Weeks / Months**	**Real-Time**	

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ORACLE RUNS BEST ON ORACLE CLOUD

READ THE STUDY AT:
accenture.com/adb

READ THE TECH VISION:
accenture.com/tvo