Getting Started with Amazon Redshift

Maor Kleider, Sr. Product Manager, Amazon Redshift
Agenda

• Introduction
• Benefits
• Use cases
• Getting started
• Q&A
What is Big Data?

When your data sets become so large and diverse that you have to start *innovating* around how to collect, store, process, analyze and share them.
It’s never been easier to generate vast amounts of data

Individual AWS customers generate over a PB/day
Amazon S3 lets you collect and store all this data

Individual AWS customers generating over PB/day

Collect & Store

Store exabytes of data in S3
But how do you analyze it?

Individual AWS customers generating over PB/day

Generate

Collect & Store

Analyze

Collaborate & Act

Store exabytes of data in S3

Highly Constrained
The Dark Data Problem
Most generated data is unavailable for analysis

Sources:
Gartner: User Survey Analysis: Key Trends Shaping the Future of Data Center Infrastructure Through 2011
Amazon Redshift

Fast, simple, petabyte-scale data warehousing for $1,000/TB/Year

150+ features
Relational data warehouse
Massively parallel; petabyte scale
Fully managed
HDD and SSD platforms
$1,000/TB/year; starts at $0.25/hour
Selected Amazon Redshift customers
Use Case: Traditional Data Warehousing

- **Business Reporting**
- **Advanced pipelines and queries**
- **Secure and Compliant**
- **Bulk Loads and Updates**

**Easy Migration** – Point & Click using AWS Database Migration Service

**Secure & Compliant** – End-to-End Encryption. SOC 1/2/3, PCI-DSS, HIPAA and FedRAMP compliant

**Large Ecosystem** – Variety of cloud and on-premises BI and ETL tools

- **docomo**
  - Japanese Mobile Phone Provider

- **SCHOLASTIC**
  - World’s Largest Children’s Book Publisher

- **Nasdaq**
  - Powering 100 marketplaces in 50 countries
Use Case: Log Analysis

Log & Machine IOT Data

Clickstream Events Data

Time-Series Data

Cheap – Analyze large volumes of data cost-effectively

Fast – Massively Parallel Processing (MPP) and columnar architecture for fast queries and parallel loads

Near real-time – Micro-batch loading and Amazon Kinesis Firehose for near-real time analytics

Pinterest
Interactive data analysis and recommendation engine

Lyft
Ride analytics for pricing and product development

Yelp
Ad prediction and on-demand analytics
Use Case: Business Applications

**Multi-Tenant BI Applications**

**Back-end services**

**Analytics as a Service**

**Fully Managed** – Provisioning, backups, upgrades, security, compression all come built-in so you can focus on your business applications

**Ease of Chargeback** – Pay as you go, add clusters as needed. A few big common clusters, several data marts

**Service Oriented Architecture** – Integrated with other AWS services. Easy to plug into your pipeline
Amazon Redshift architecture

**Leader node**
- Simple SQL endpoint
- Stores metadata
- Optimizes query plan
- Coordinates query execution

**Compute nodes**
- Local columnar storage
- Parallel/distributed execution of all queries, loads, backups, restores, resizes

**Start at just $0.25/hour, grow to 2 PB (compressed)**
- DC1: SSD; scale from 160 GB to 326 TB
- DS2: HDD; scale from 2 TB to 2 PB
Benefit #1: Amazon Redshift is fast

Dramatically less I/O

Column storage
Data compression
Zone maps
Direct-attached storage
Large data block sizes

analyze compression listing;

<table>
<thead>
<tr>
<th>Table</th>
<th>Column</th>
<th>Encoding</th>
</tr>
</thead>
<tbody>
<tr>
<td>listing</td>
<td>listid</td>
<td>delta</td>
</tr>
<tr>
<td>listing</td>
<td>sellerid</td>
<td>delta32k</td>
</tr>
<tr>
<td>listing</td>
<td>eventid</td>
<td>delta32k</td>
</tr>
<tr>
<td>listing</td>
<td>dateid</td>
<td>bytedict</td>
</tr>
<tr>
<td>listing</td>
<td>numtickets</td>
<td>bytedict</td>
</tr>
<tr>
<td>listing</td>
<td>priceperticket</td>
<td>delta32k</td>
</tr>
<tr>
<td>listing</td>
<td>totalprice</td>
<td>mostly32</td>
</tr>
<tr>
<td>listing</td>
<td>listtime</td>
<td>raw</td>
</tr>
</tbody>
</table>

10 13 14 26 ...
324 ...
375 ...
623 ...
637 ...
959 ...
Benefit #1: Amazon Redshift is fast

Parallel and distributed

Query
Load
Export
Backup
Restore
Resize
Benefit #1: Amazon Redshift is fast

Hardware optimized for I/O intensive workloads, 4 GB/sec/node

Enhanced networking, over 1 million packets/sec/node

Choice of storage type, instance size

Regular cadence of auto-patched improvements
Benefit #1: Amazon Redshift is fast

**REDFIN.**

“Did I mention that it’s **ridiculously fast**? We’re using it to provide our analysts with an alternative to Hadoop”

**boingo**

“On our previous big data warehouse system, it took around 45 minutes to run a query against a year of data, but that number went down to **just 25 seconds** using Amazon Redshift”

**Periscope**

“After investigating Redshift, Snowflake, and BigQuery, we found that Redshift offers **top-of-the-line performance at best-in-market price points**”

**Pinterest**

“...[Redshift] performance has blown away everyone here. We generally see **50-100X speedup over Hive**”

**44 CHANNEL FOUR TELEVISION**

“We regularly process multibillion row datasets and we do that in a matter of hours. We are heading to up to 10 times more data volumes in the next couple of years, easily”

**optimum.**

“We saw a **2X performance improvement** on a wide variety of workloads. The more complex the queries, the higher the performance improvement”
And has gotten faster...

5X Query throughput improvement over the past year
- Memory allocation (launched)
- Improved commit and I/O logic (launched)
- Queue hopping (launched)
- Query monitoring rules (launched)

10X Vacuuming performance improvement
- Ensures data is sorted for efficient and fast I/O
- Reclaims space from deleted rows
- Enhanced vacuum performance leads to better system throughput
The life of a query

Client

- BI tools
- Analytics tools
- SQL clients

Amazon Redshift Cluster

1. Leader node
2. Queue 1
3. Queue 2
4. Compute node

Client tools communicate with the Amazon Redshift Cluster, which consists of a Leader node and Compute nodes. Queries are processed through queues, with each compute node handling specific tasks.
Query monitoring rules

- Allows automatic handling of runaway (poorly written) queries

- Metrics with operators and values (e.g. query_cpu_time > 1000) create a **predicate**

- Multiple predicates can be **AND-ed** together to create a **rule**

- Multiple rules can be defined for a queue in WLM. These rules are **OR-ed** together

\[
\text{If } \{ \text{rule} \} \text{ then [action]} \\
\{ \text{rule : metric operator value} \} \text{ eg: rows_scanned > 100000} \\
\quad \text{Metric : cpu_time, query_blocks_read, rows scanned, query execution time, cpu & io skew per slice, join_row_count, etc.} \\
\quad \text{Operator : }, <, >, == \\
\quad \text{Value : integer} \\
\text{[action] : hop, log, abort}
\]
Query monitoring rules

Monitor and control cluster resources consumed by a query

Get notified, abort and reprioritize long-running / bad queries

Pre-defined templates for common use cases
Query monitoring rules

Common use cases:

- **Protect interactive queues**
  
  \[
  \text{INTERACTIVE} = \{ \text{"query}_{\text{execution}}_{\text{time}} > 15\ \text{sec} \} \text{ or } \\
  \text{"query}_{\text{cpu}}_{\text{time}} > 1500\ \text{uSec} \} \text{ or } \\
  \text{"query}_{\text{blocks}}_{\text{read}} > 18000\ \text{blocks} \} \ [\text{HOP}]
  \]

- **Monitor ad-hoc queues for heavy queries**
  
  \[
  \text{AD-HOC} = \{ \text{"query}_{\text{execution}}_{\text{time}} > 120\} \text{ or } \\
  \text{"query}_{\text{cpu}}_{\text{time}} > 3000\} \text{ or } \\
  \text{"query}_{\text{blocks}}_{\text{read}} > 180000\} \text{ or } \\
  \text{"memory}_{\text{to disk}} > 400000000000\} \ [\text{LOG}]
  \]

- **Limit the number of rows returned to a client**
  
  \[
  \text{MAXLINES} = \{ \text{"RETURN}_{\text{ROWS}} > 50000\} \ [\text{ABORT}]
  \]
## Benefit #2: Amazon Redshift is inexpensive

<table>
<thead>
<tr>
<th>DS2 (HDD)</th>
<th>Price per hour for DS2.XL single node</th>
<th>Effective annual price per TB compressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-demand</td>
<td>$0.850</td>
<td>$3,725</td>
</tr>
<tr>
<td>1 year reservation</td>
<td>$0.500</td>
<td>$2,190</td>
</tr>
<tr>
<td>3 year reservation</td>
<td>$0.228</td>
<td>$999</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DC1 (SSD)</th>
<th>Price per hour for DC1.L single node</th>
<th>Effective annual price per TB compressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-demand</td>
<td>$0.250</td>
<td>$13,690</td>
</tr>
<tr>
<td>1 year reservation</td>
<td>$0.161</td>
<td>$8,795</td>
</tr>
<tr>
<td>3 year reservation</td>
<td>$0.100</td>
<td>$5,500</td>
</tr>
</tbody>
</table>

Pricing is simple

- Number of nodes x price/hour
- No charge for leader node
- No upfront costs
- Pay as you go
Benefit #3: Amazon Redshift is fully managed

Continuous/incremental backups

Multiple copies within cluster

Continuous and incremental backups to Amazon S3

Continuous and incremental backups across regions

Streaming restore
Benefit #3: Amazon Redshift is fully managed

Fault tolerance

Disk failures

Node failures

Network failures

Availability Zone/region level disasters
Node fault tolerance

Data-path monitoring agents

Node level monitoring can detect SW/HW issues and take action
Node fault tolerance

Data-path monitoring agents

Failure is detected at one of the compute nodes
Node fault tolerance

Data-path monitoring agents

Redshift parks the connections

Next, the node is replaced
Node fault tolerance

Data-path monitoring agents

Queries are re-submitted
Node fault tolerance

- Data-path monitoring agents
- Cluster-level monitoring agents

Additional monitoring layer for the leader node and network
Benefit #4: Security is built-in

- Load encrypted from S3
- SSL to secure data in transit
  - ECDHE perfect forward secrecy
- Amazon VPC for network isolation
- Encryption to secure data at rest
  - All blocks on disks and in S3 encrypted
  - Block key, cluster key, master key (AES-256)
  - On-premises HSM & AWS CloudHSM support
- Audit logging and AWS CloudTrail integration
- SOC 1/2/3, PCI-DSS, FedRAMP, BAA
Benefit #5: Amazon Redshift is powerful

- Approximate functions
- User defined functions
- Machine learning
- Data science
Benefit #6: Amazon Redshift has a large ecosystem

Data integration:
- Attunity
- CloudBeam
- Bryte Systems
- FlyData
- Informatica
- Matillion
- Pentaho
- Segment
- SnapLogic
- Talend
- QuBole
- Xplenty

Business intelligence:
- Action
- Alteryx
- JReport
- Logi Analytics
- Birst
- ClearStory
- Looker
- MicroStrategy
- Dundas
- Chart.io
- Mode
- Panorama
- Yellowfin
- Redrock BI
- Tableau
- Tibco
- Panorama
- Yellowfin

Systems integrators:
- 2ndWatch
- Accenture
- Beeva
- Brightlight
- Capgemini
- Cloud Pack
- Cognizant
- Full
- IOlap
- Isobar
- Magnus Data
- NorthBay Solutions
- Slalom Consulting
Benefit #7: Service oriented architecture

- RDS/Aurora
- EC2/SSH
- DynamoDB
- Amazon Redshift
- EMR
- Amazon ML
- Data Pipeline
- S3
- Amazon Kinesis
- CloudSearch
- Amazon Mobile Analytics
Amazon Redshift Spectrum
Amazon Redshift Spectrum
Run SQL queries directly against data in S3 using thousands of nodes

- Fast @ exabyte scale
- Elastic & highly available
- On-demand, pay-per-query
- High concurrency: Multiple clusters access same data
- No ETL: Query data in-place using open file formats
- Full Amazon Redshift SQL support
Life of a query

Query

\[
\text{SELECT COUNT(*) FROM S3.EXT_TABLE GROUP BY...}
\]
Amazon Redshift Spectrum – Current support

**File formats**
- Parquet
- CSV
- Sequence
- RCFile
- ORC (coming soon)
- RegExSerDe (coming soon)

**Compression**
- Gzip
- Snappy
- Lzo (coming soon)
- Bz2

**Encryption**
- SSE with AES256
- SSE KMS with default key

**Column types**
- Numeric: bigint, int, smallint, float, double and decimal
- Char/varchar/string
- Timestamp
- Boolean
- DATE type can be used only as a partitioning key

**Table type**
- Non-partitioned table
  (s3://mybucket/orders/..)
- Partitioned table
  (s3://mybucket/orders/date=YYYY-MM-DD/..)
The Emerging Analytics Architecture

Storage
- Amazon S3: Exabyte-scale Object Storage
- AWS Glue Data Catalog: Hive-compatible Metastore

Serverless Compute
- Amazon Kinesis Firehose: Real-Time Data Streaming
- AWS Glue: ETL & Data Catalog
- Amazon Redshift Spectrum: Fast Exabyte scale
- AWS Lambda: Trigger-based Code Execution

Data Processing
- Amazon EMR: Managed Hadoop Applications
- Amazon Redshift: Petabyte-scale Data Warehousing
- Amazon Athena: Interactive Query
Over 20 customers helped preview Amazon Redshift Spectrum
Use cases
NTT Docomo: Japan’s largest mobile service provider

68 million customers
Tens of TBs per day of data across a mobile network
6 PB of total data (uncompressed)
Data science for marketing operations, logistics, and so on

Greenplum on-premises

Scaling challenges
Performance issues
Need same level of security
Need for a hybrid environment
NTT Docomo: Japan’s largest mobile service provider

125 node DS2.8XL cluster
4,500 vCPUs, 30 TB RAM
2 PB compressed

10x faster analytic queries
50% reduction in time for new BI application deployment
Significantly less operations overhead
Nasdaq: powering 100 marketplaces in 50 countries

Orders, quotes, trade executions, market "tick" data from 7 exchanges
7 billion rows/day
Analyze market share, client activity, surveillance, billing, and so on

Microsoft SQL Server on-premises

Expensive legacy DW ($1.16 M/yr.)
Limited capacity (1 yr. of data online)

Needed lower TCO
Must satisfy multiple security and regulatory requirements
Similar performance
Nasdaq: powering 100 marketplaces in 50 countries

- 23 node DS2.8XL cluster
- 828 vCPUs, 5 TB RAM
- 368 TB compressed
- 2.7 T rows, 900 B derived
- 8 tables with 100 B rows
- 7 man-month migration
- ¼ the cost, 2x storage, room to grow
- Faster performance, very secure
Amazon.com clickstream analytics

Web log analysis for Amazon.com
- PBs workload, 2TB/day@67% YoY
- Largest table: 400 TB

Understand customer behavior

Previous solution
- Legacy DW (Oracle)—query across 1 week/hr
- Hadoop—query across 1 month/hr
Results with Amazon Redshift

• Query 15 months **in 14 min**
• Load 5B rows in **10 min**
• 21B w/ 10B rows: 3 **days to 2 hrs** (Hive → Redshift)
• Load pipeline: 90 **hrs to 8 hrs** (Oracle → Redshift)

• 100 node DS2.8XL clusters
• Easy resizing
• Managed backups and restore
• Failure tolerance and recovery

• 20% time of one DBA
• Increased productivity
Resources

Detail Pages

- http://aws.amazon.com/redshift
- https://aws.amazon.com/marketplace/redshift/
- https://aws.amazon.com/redshift/developer-resources/
- Amazon Redshift Utilities - GitHub

Best Practices

Thank you!