KINEMETRICS
Advancement through Innovation

Since 1969

Seismic Networks in the Could

New Possibilities to Increase Availability & Collaboration

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AGENDA

01 **Introduction**
About us, Markets we Serve, Aspen Platform

02 **Case Study 1 - Increased Availability**
Archive Strategy, Virtual Private Cloud, Hybrid Data Center

03 **Case Study 2 – Simplified Collaboration**
Shared Computing and Disk Resources

04 **Summary**
Data and structural engineers

ADVANCEMENT THROUGH INNOVATION

SEISMOLOGY

Earthquakes, volcanoes, and explosions monitoring, remote data telemetry, acquisition and processing, and automated mechanisms for alerts dissemination.

EARTHQUAKE ENGINEERING

Structural and building code compliant monitoring, seismic hazard and risk assessment and a broad range of related engineering services.

INDUSTRY

Monitoring of a wide range of industry applications including: dams, geothermal, LNG, and nuclear plants, as well as oil and gas and vibration impact.

BUSINESS CONTINUITY

Earthquake business continuity technology platform and performance-based engineering services for buildings and smart cities.

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50+ years of experience in monitoring earthquakes and their impact on the built environment

This presentation aims at providing …

… an overview of **two** possible cloud implementation for two use-cases

… a general description of major **components** and their **costs**

… a path for a **gradual** approach to moving into the cloud

… ideas and stimulating discussions for a regional **cloud-based** data center

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Why the Cloud

Pay-per-Use

Minimal upfront infrastructure investments

Flexibility

Tools to administer, automate, scale without limits

Different Location

Easy to distribute regionally

Hybrid

Create a bridge with cloud and on-premises

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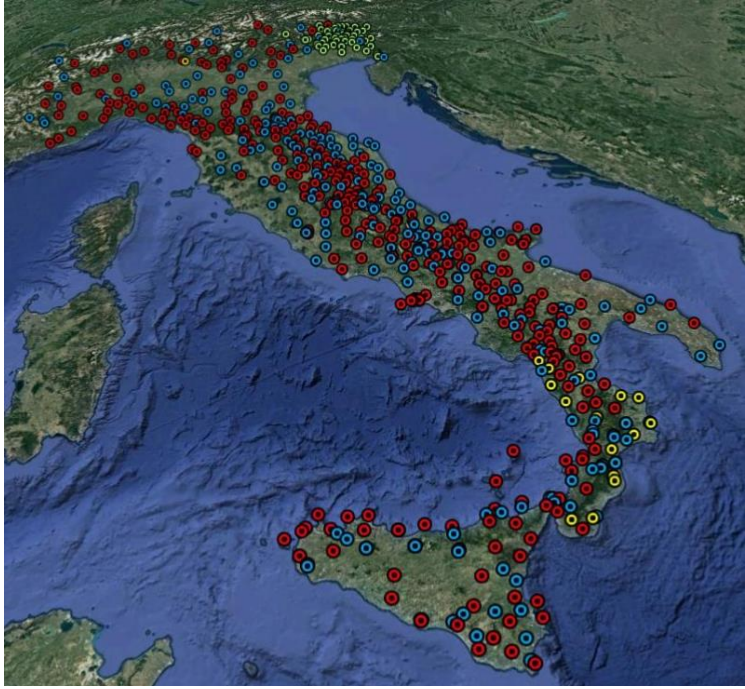
Case Study 1



Italian Strong-Motion Network (Rete Accelerometrica Nazionale)

- Mission Critical network of the Civil Protection Department
- Aspen System operated and maintained by Kinemetrics & Geovis since 2012 with 8 FTE
- Total number of stations: 650
- Kinemetrics stations: 395 Etna2 and Obsidian (99.8% stations availability in 2022)
- Real-time data return: 99.1% in 2022
- Monthly data rate: ~0.5TB

Issues to be addressed with a cloud implementation

- Local maintenance of a growing data archive is unsustainable (currently >30TB)
- Disaster recovery with undefined *Return Time Objective* (RTO)
- Well-known risks and points of failures in the current architecture
- Local access to data and information
- Growth of service portfolio

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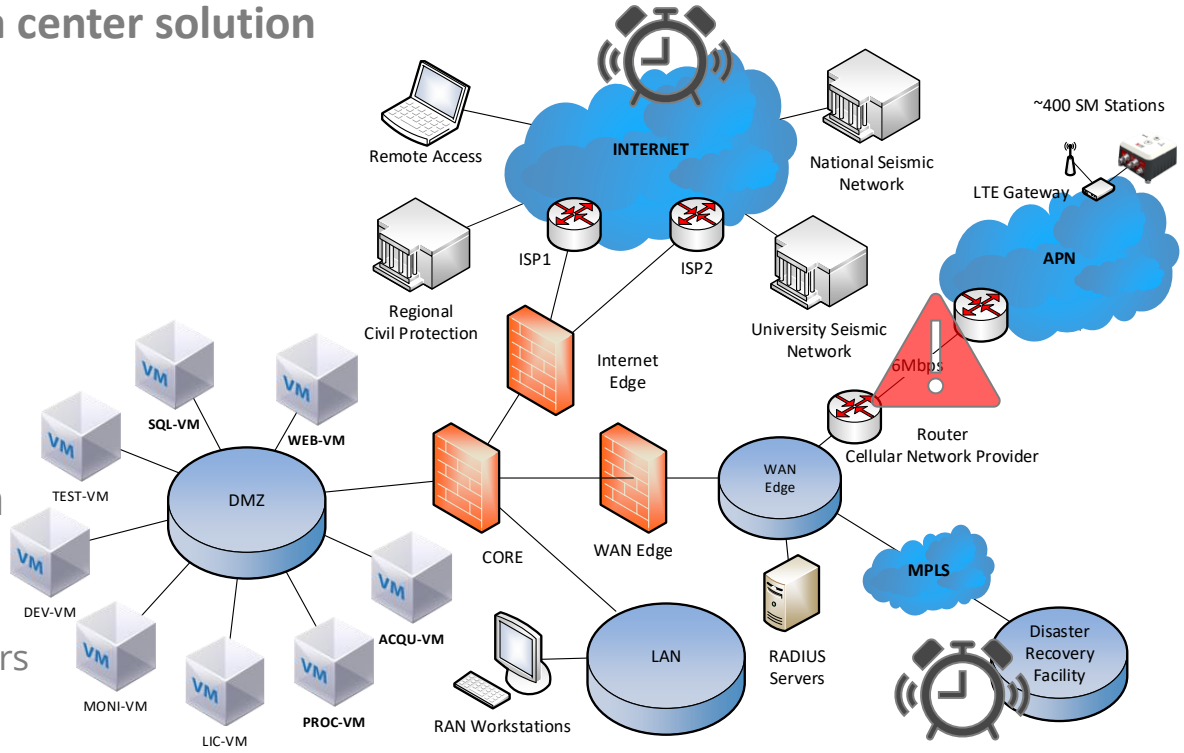
Current Situation

Well-structured, single data center solution

But

- Unresolved backup issues
  - Long *Recovery Time Objective* (RTO)
  - Unsupported *Point in Time Recovery* (PiTR)
  - Archive growth
- Single access path for data network
- How to handle
  - Growth of external data users
  - Data sharing with other seismic networks



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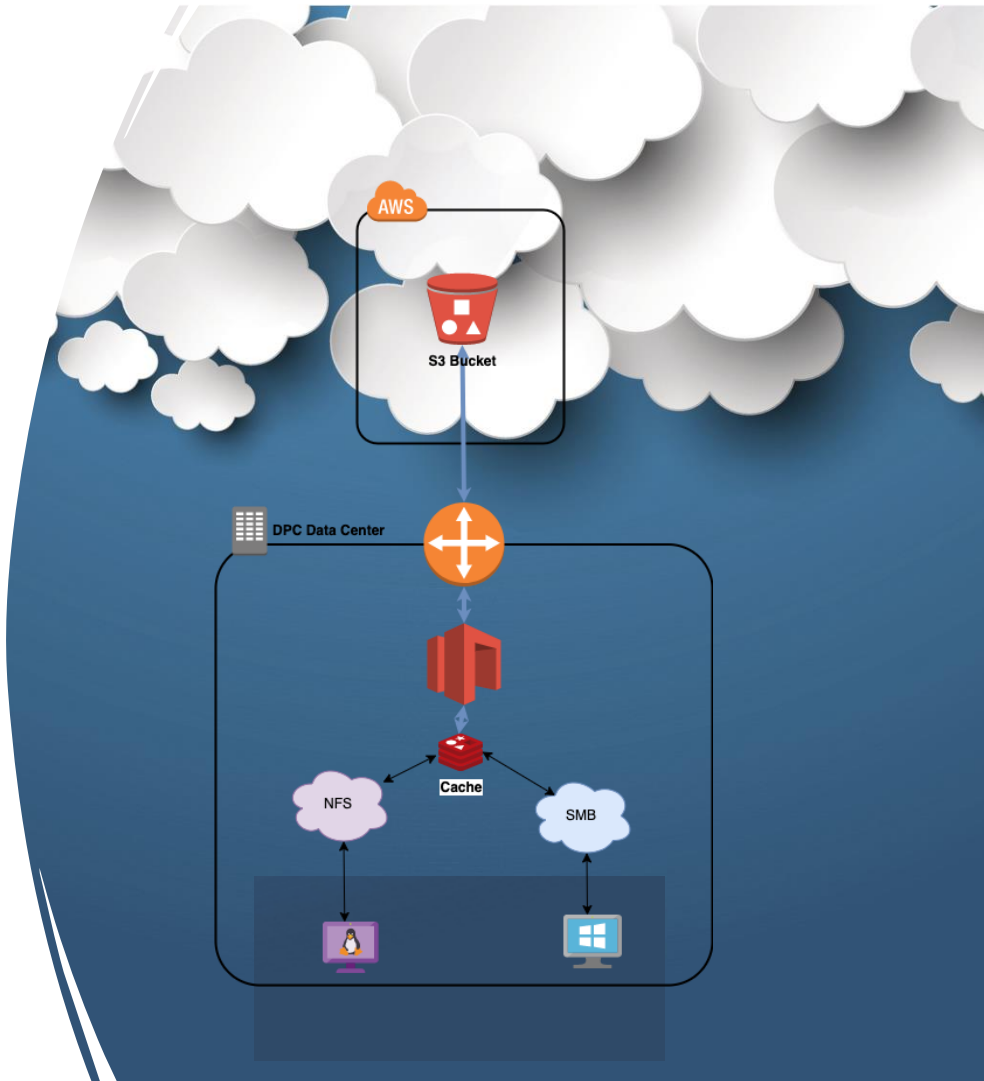
1. The archive

Low-Hanging Fruit

- Easy step to create a presence in the cloud
- Minimal investment
- Cost savings
- The first step towards a (hybrid) storage infrastructure
- Not limited to the archive



Amazon AWS S3

- **Scalable** without limitation
- Flexible storage with different **storage classes** & **lifecycle policy**
- Archive storage at **low costs**
- Easy access from on-premises
- Flexible data migration with easy remote access.
- Configurable **replication** (in different regions)

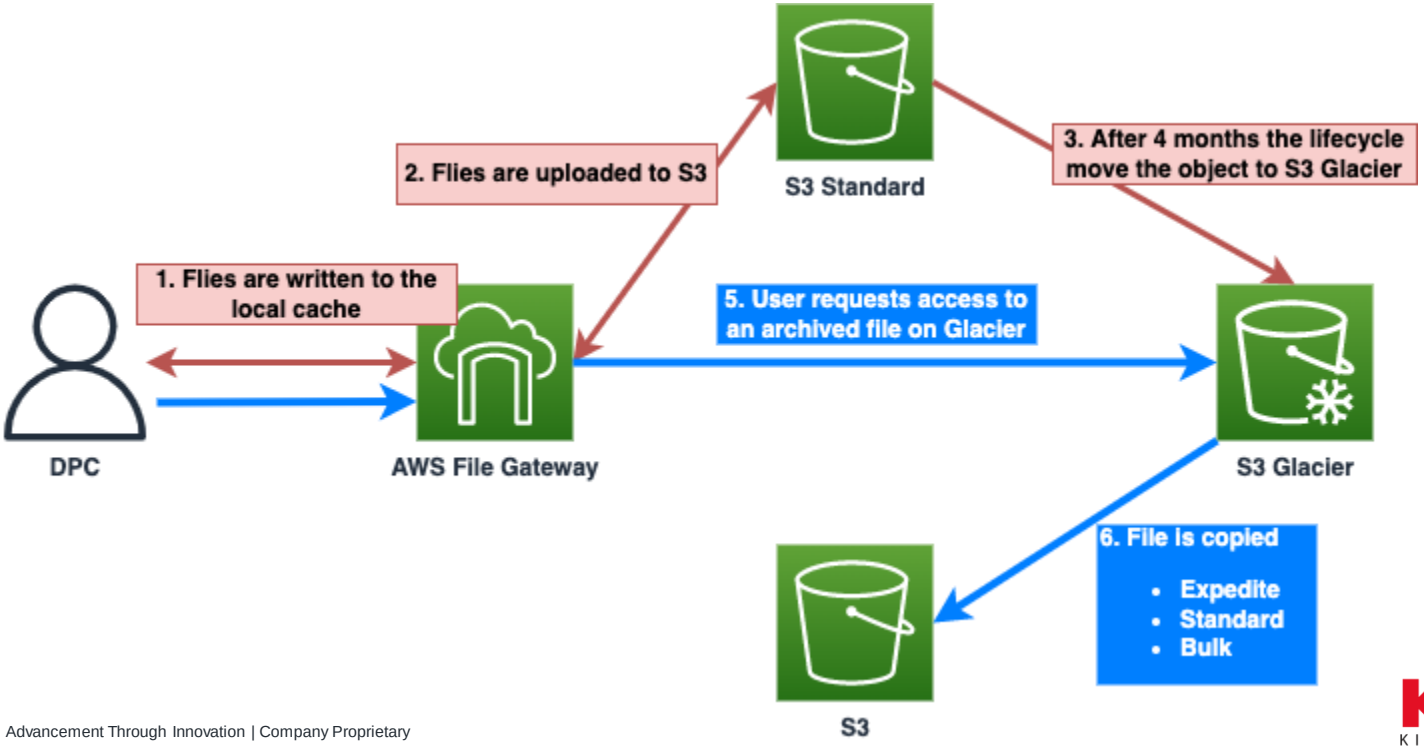
S3 Classes

- **S3 Standard** - for frequently accessed data
- **S3 Intelligent-Tiering** - for automatic tiering/cost savings
- **S3 IA** - for less frequently accessed data
- **S3 One Zone-IA** - for less frequently accessed data
- **S3 Glacier Instant Retrieval** - for archive data with immediate access
- **S3 Glacier Flexible Retrieval** - for rarely accessed long-term data
- **S3 Glacier Deep Archive** - for long-term archive with retrieval in hours.

Recovery Time Objective (RTO) minutes to hours

Decreasing Costs

Archive – Data Lifecycle



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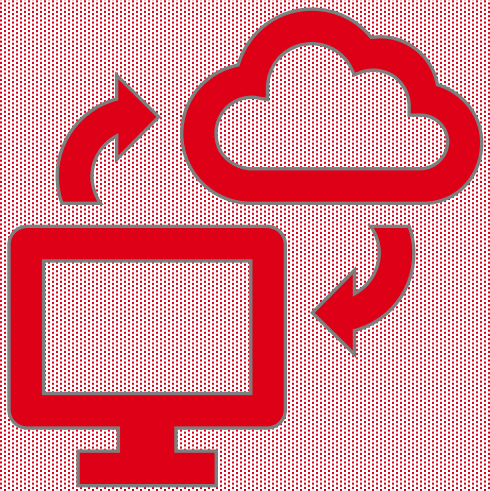


2. External Network

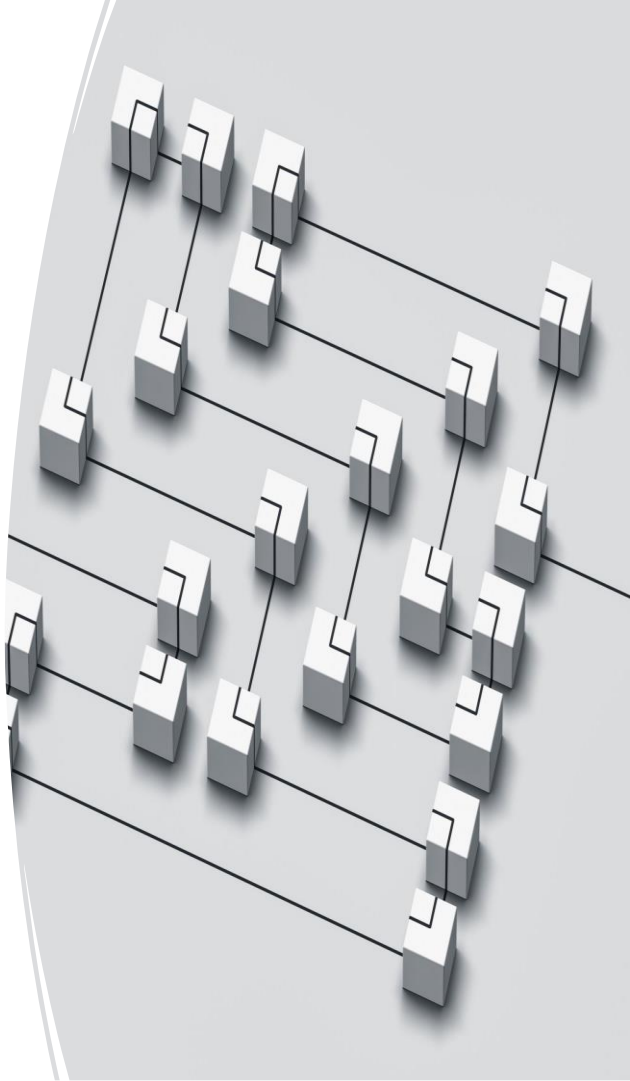
External Network

Independent/Alternative Data Services

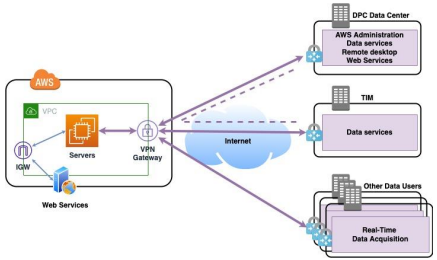
Independent and reliable data acquisition and dissemination services are critical to comply with the network's mission.

Consolidate Exchange Services

Consolidate the data communication requirements by designing one scalable hub for all current and *future* identified stakeholders.



External Network Requirements



Provide network operator and partner institutions with a secure channel to access the (real-time) data services.

Separate web and applications from data services.

VPN is an essential requirement to administer the AWS services in a safe environment.

There is the need for resilient communication between partners as for operator and the network communication provider.

User requirements, as well as configuration details, need to be assessed and tested.

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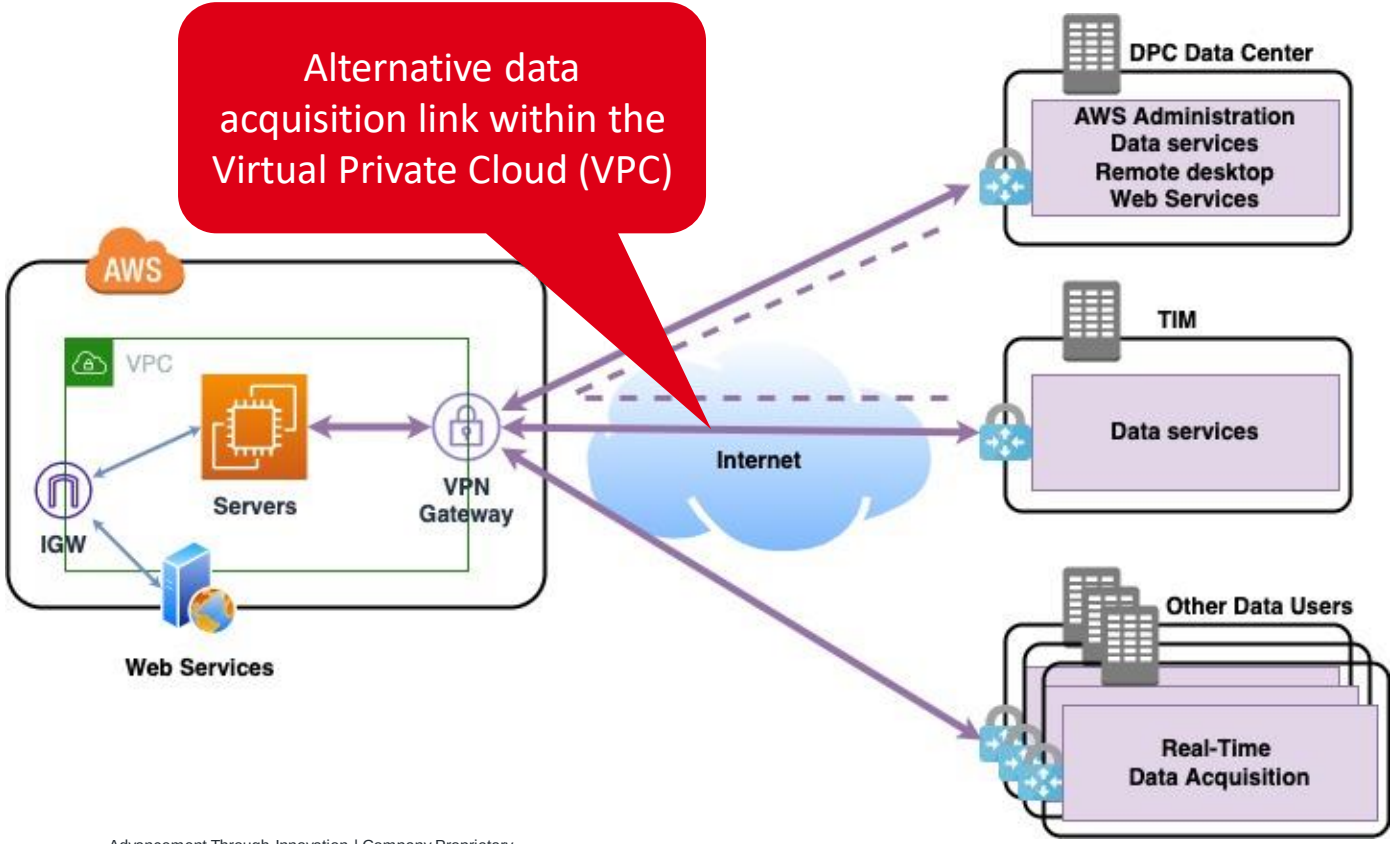
Design Overview



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AWS VPN Components

AWS Site-to-Site VPN

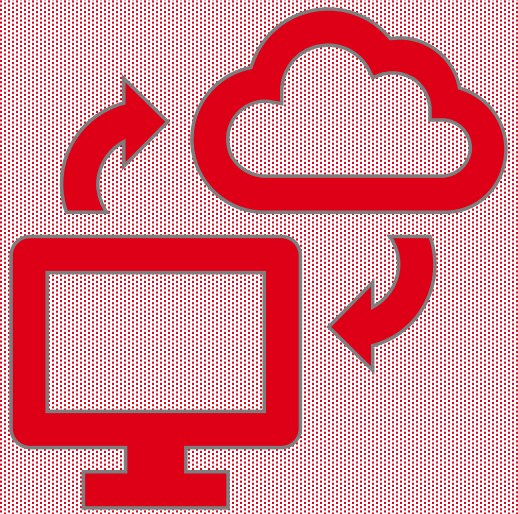
Access to the remote network can be enabled from the Virtual Private Cloud (VPC) by creating a Site-to-Site VPN connection and configuring routing to pass traffic through the connection.

Virtual Private Gateway

is the VPN concentrator on the Amazon side of the Site-to-Site VPN connection. It needs to be linked to the VPC needed to take part to the Site-to-Site VPN connection.

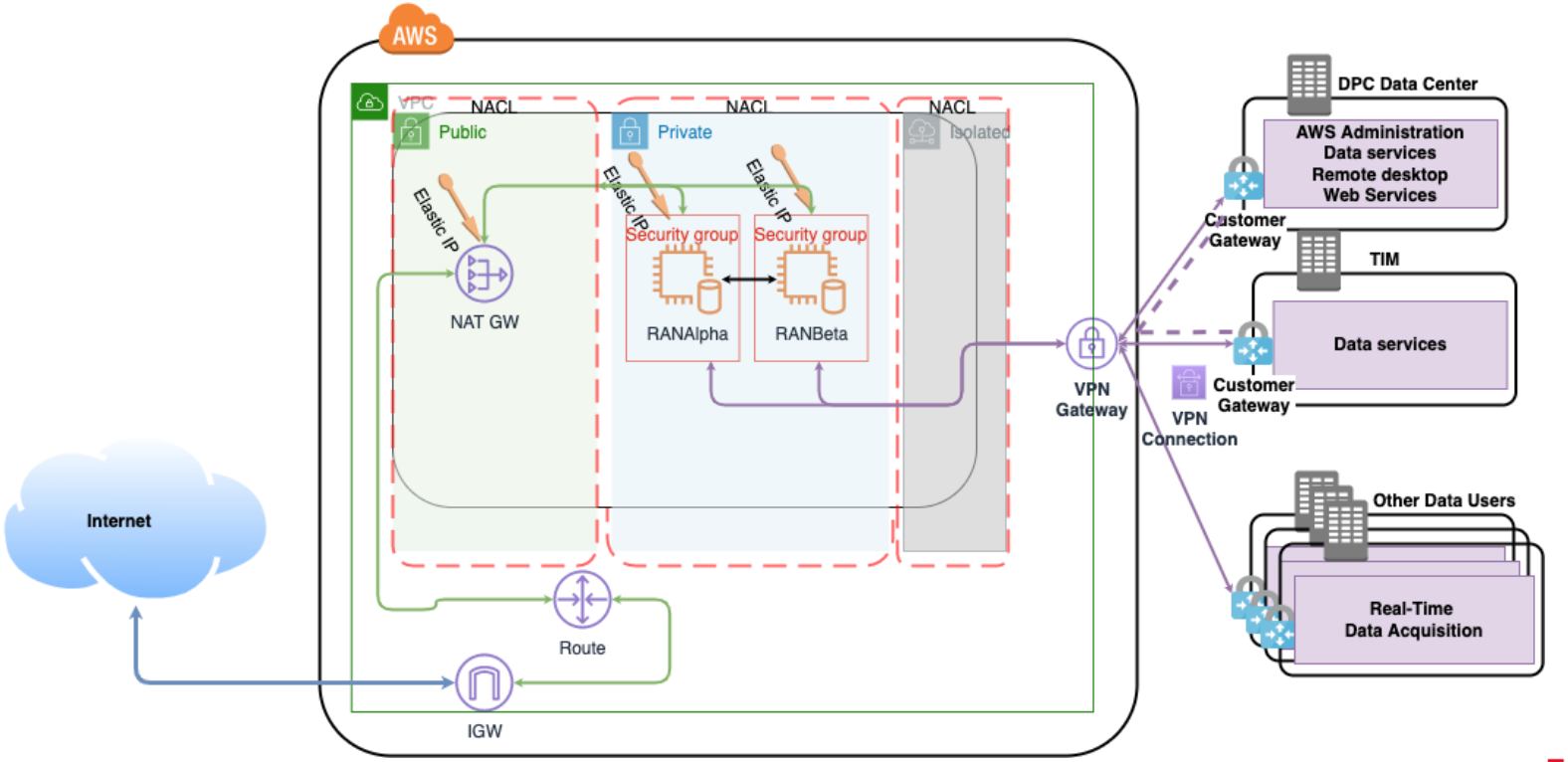
VPN Customer Gateway

is a physical or software appliance that customer owns or manages in its on-premises network.



3. AWS Internal Network

Overview



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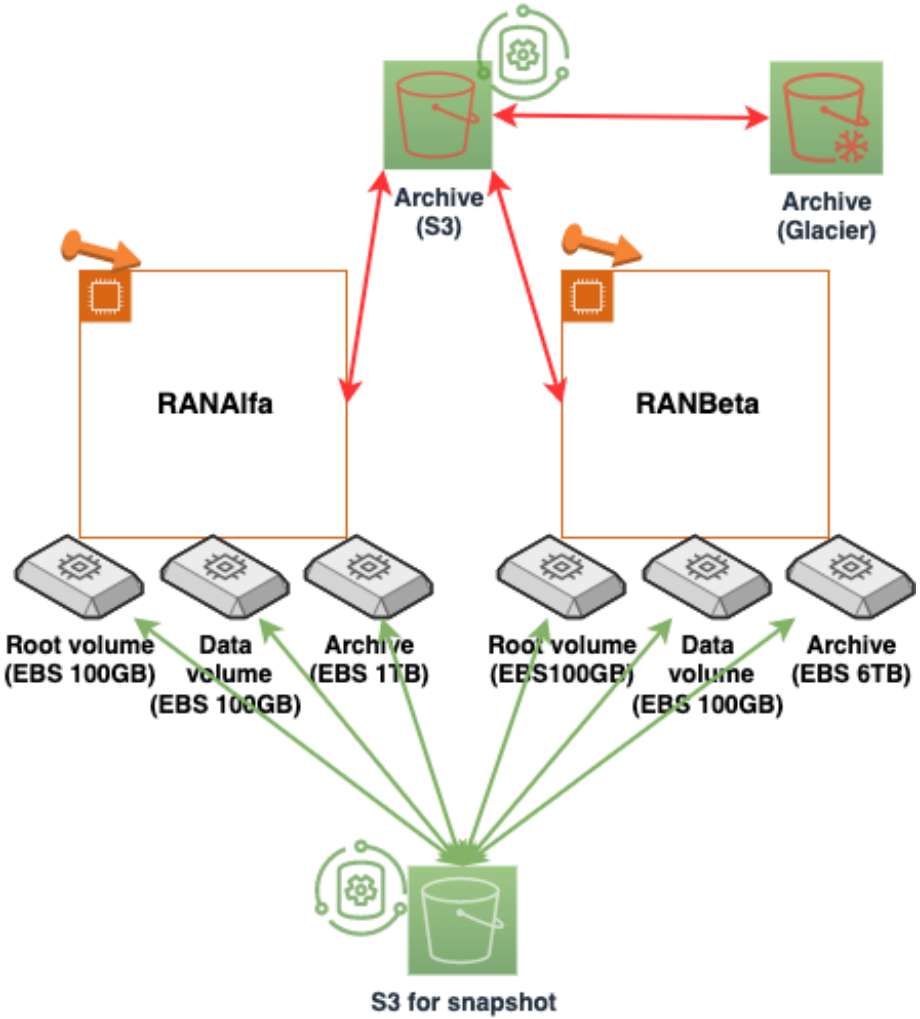
4. Computing and Storage

Storage Schema



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Server's Config

Server – "m6i.4large"	
RAM	64GB
vCPU	16
Storage	EBS Only
Network	Up to 12.5 Gigabit
Standard Reserve for 3y (monthly)	USD 250
Total for 2 Servers	**USD 500**

Elastic Block Storage (EBS)	
EBS Type	General purpose SSD GP2
Size	2x 100GB
Max Throughput / Volume	250MiB/s
Price/Volume/month	USD 10
Total for 4 Volumes	**USD 40**

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Point in Time Recovery (PiTR)

Elastic Block Storage Backup

Snapshot as backup (monthly fees)		
Total snapshots	30 incremental	
Initial snapshot	100GB x 0.0525 USD	USD 5
Monthly cost for each incremental snapshot	40GB x 0.0525 USD x 30 days	USD 30
Total Costs Volume/month		USD 35
Total for 4 Volumes/month		**USD 140**

Point in Time Recovery (PiTR)

Local Waveform Storage

Point in Time Recovery (PiTR)

EBS ST1 (Throughput optimized HDD)	
EBS Storage costs (1TB Volume) (0.0525 USD / GB / month)	USD 55
EBS Snapshot (1TB volume)	USD 85
Subtotal (1TB)	**USD 140**
EBS Storage costs (6TB Volume) (0.0525 USD / GB / month)	USD 320
EBS Snapshot (6TB volume)	USD 400
Subtotal (6TB)	**USD 720**
Total (1TB + 6TB)	**USD 860**

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5. Summary of Costs

Total Cost

Summary Cost	
Backup Storage (30TB)	USD 225
Virtual Private Cloud	USD 365
(2) Servers with SSD & daily snapshots	USD 680
EBS Storage with HHD & daily snapshots	USD 860
Total Operational Cost (monthly)	**USD 2,130**

Current Costs

- Server and other hardware costs
- Data center costs, such as power and cooling
- Storage costs
- Licensing costs
- The cost of backing up and implementing disaster recovery methods
- The costs of securing services
- Staffing costs to support and maintenance services
- Costs to grow/switch

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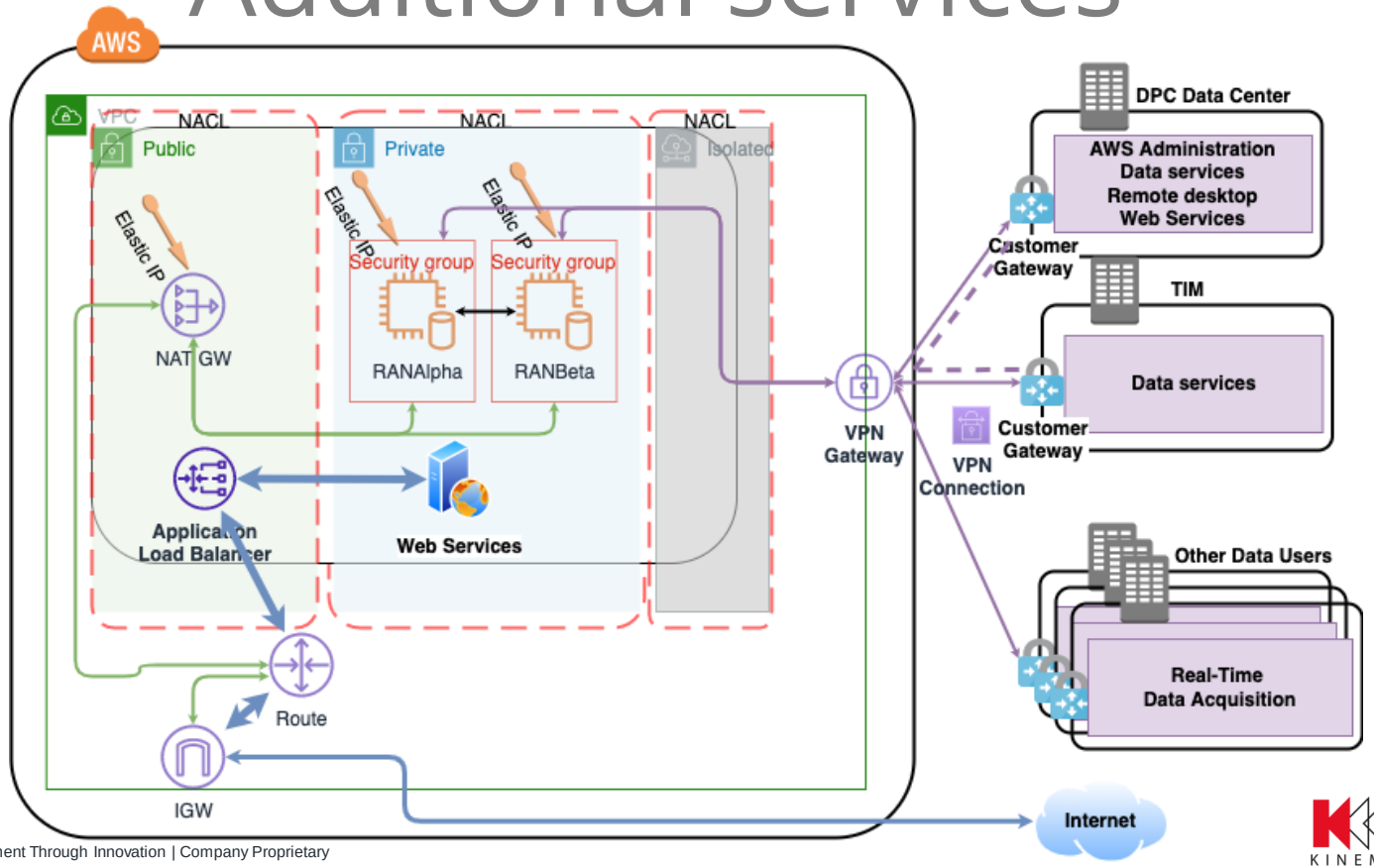
6. Ideas for Enhancements

Additional services



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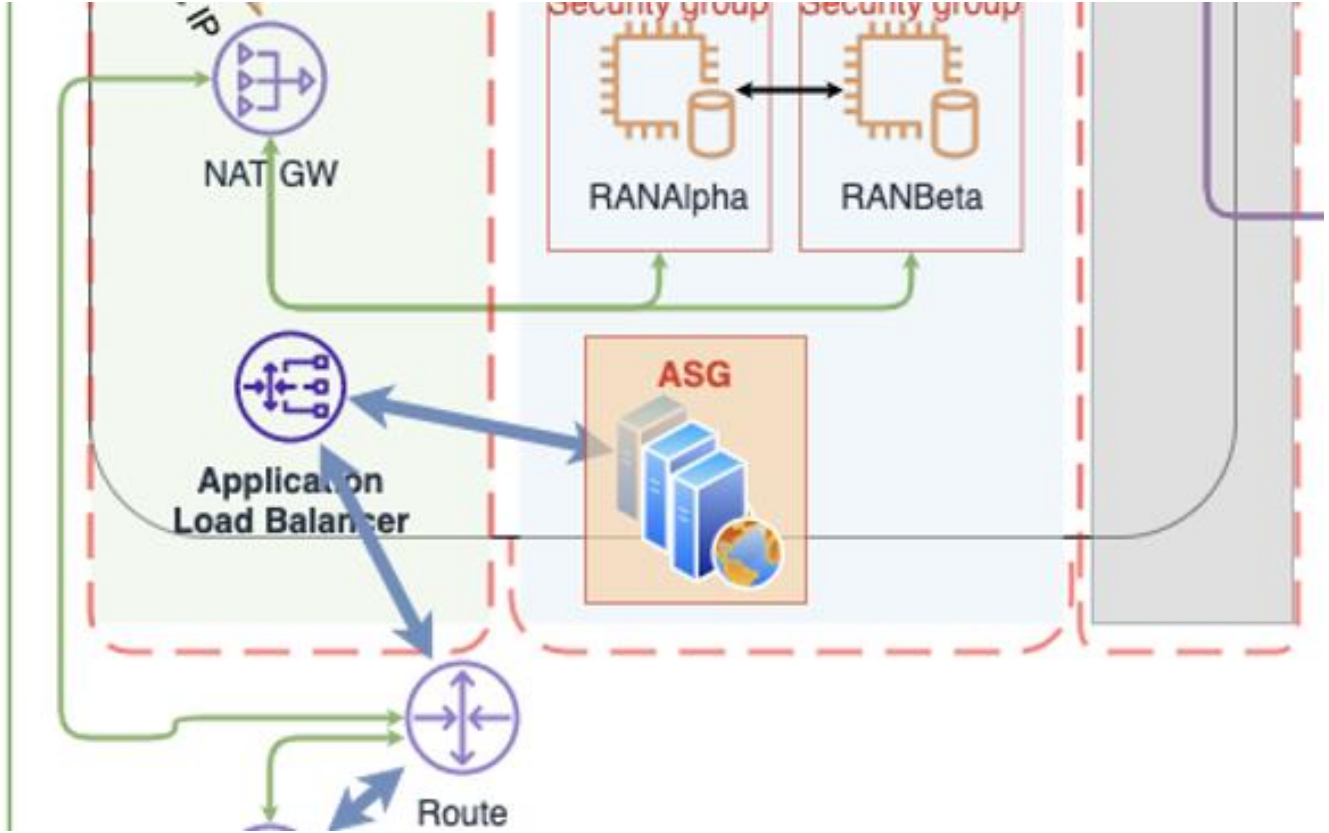
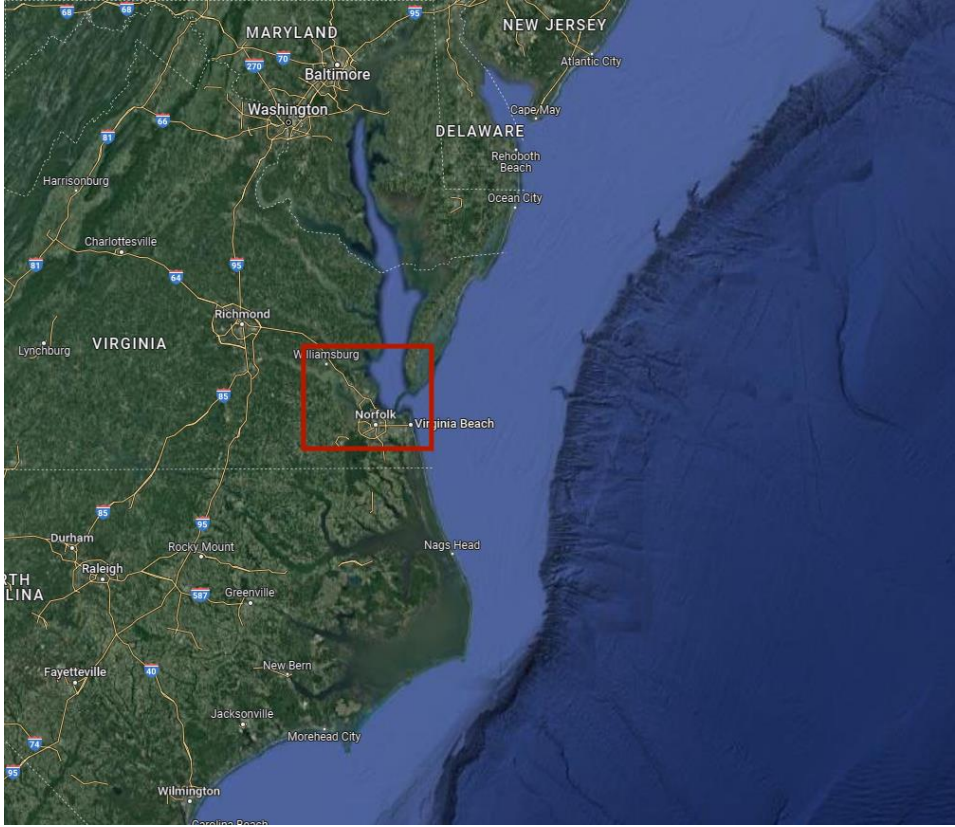
Additional services



Case Study 2

Small Research Network (Hampton Roads Seismic Network)



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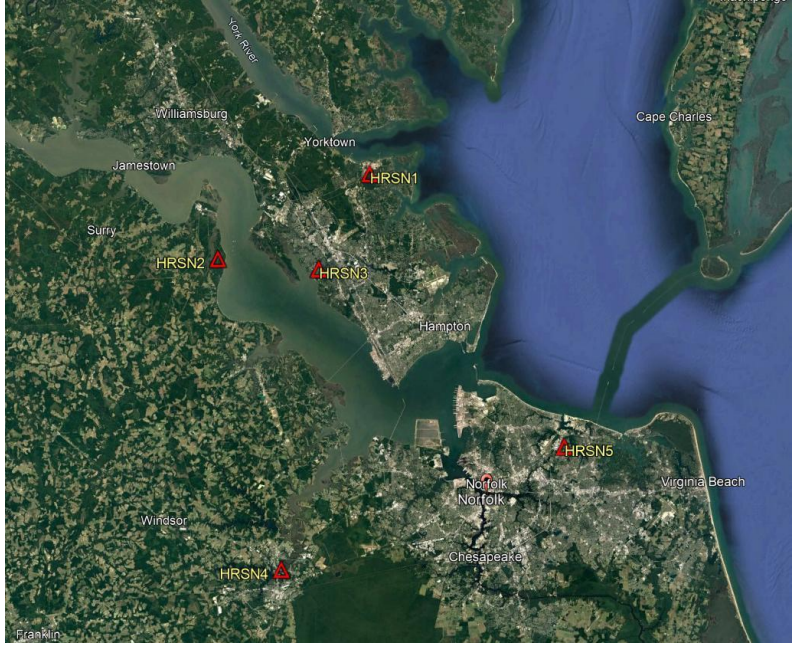
Case Study 2

Small Research Network (Hampton Roads Seismic Network)

- Monitoring water injection in the Potomac Aquifer for the HRSD by Virginia Tech (US largest sequestration project; target ~450,000m^3/day)
- Aspen System in the cloud operated and maintained by Kinemetrics since 2022 with 0.2 FTE
- Total number of stations: 5
- Consisting of: MBB-2 sensor, Q330S+ datalogger, miniARTiSt power & communication system
- Real-time data return: 98.9% in 2022
- Monthly data rate: ~7GB



Issues to be addressed with a cloud implementation

- Collaboration platform for operator (Kinemetrics) and data user (Virginia Tech)
  - Real-Time data acquisition and processing environment
  - Data accessibility and download
  - SOH information

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Server's Config

Server – "m4.xlarge"	
RAM	16GB
vCPU	4 (2.4GHz)
Storage	EBS Only
Network	Up to 750 Megabit
Elastic Block Storage (EBS)	
EBS Type	General purpose SSD GP2
Size	32GB & 100GB
Max Throughput /Volume	128MiB/s
Price	
Total (monthly)	**USD 162**

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Conclusions & Observations

The cloud provides cost-saving solutions for seismic networks with different **complexities**

The cloud provides cost-saving solutions for seismic networks with different **commitments**

The cloud provides an alternative solution to improve **availability** (HA)

… by extending the **Aspen Platform** into the cloud

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