

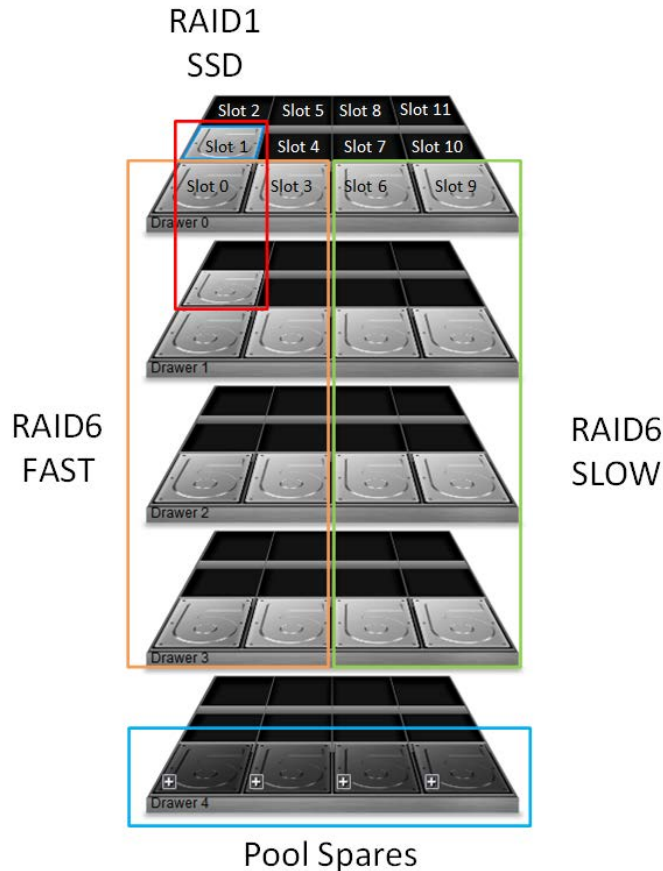
Redundant Aspen Data Centers

Intra Data Center Redundancy

The redundant Aspen Data Center addresses two aspects of modern seismic data acquisition systems in order to obtain well in excess of “2-nines” (99%) data availability:

- Continuous computational resources
- Complete state of health (SOH) information of remote stations and communication links

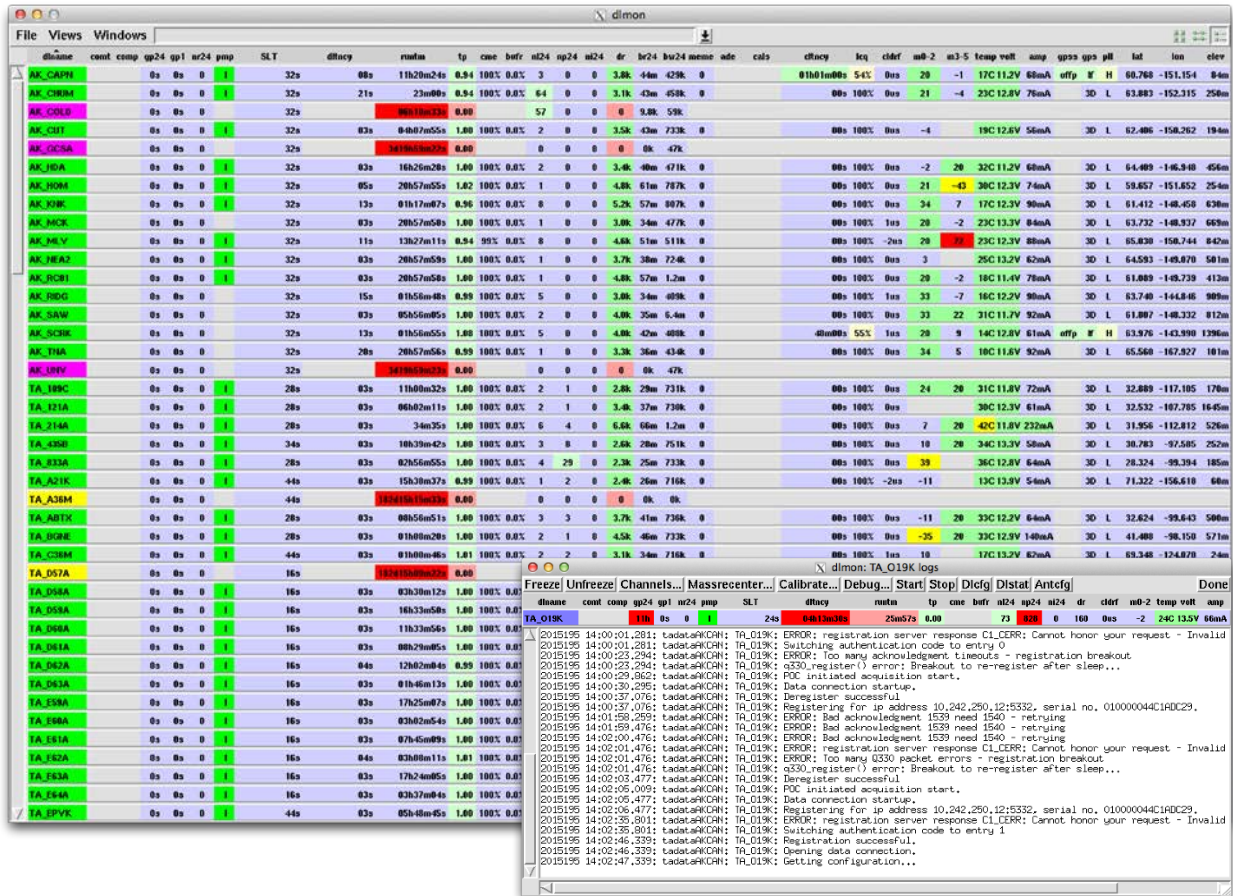
Continuous computational resources are secured with two or more enterprise-class servers that share redundant-connected external disk space. The two virtual machines for data acquisition and processing can move between the servers in case of any necessary maintenance operation (manual failover) or failure within a server (automatic failover). The shared disk space is located on a RAID that is directly attached via two dual-controllers to each server providing failsafe connection. Moreover, employing a combination of very fast solid-state drives (SSD), fast hard disk drives, and slow large disks optimizes data access, availability of large deep storage, and cost per archived byte.



Disk space optimization

The servers communicate through two network switches providing continuous intra-server and LAN connection.

Complete SOH information is often overlooked as an essential feature for successful network operation. Without detailed SOH information of the remote stations and their communication links the seismic network operator is limited in the evaluation of the current state of the network and consequently narrows the knowledge for immediate corrective action or escalated maintenance tasks. In addition, better SOH knowledge results in more effective preventive maintenance with reduced frequency of scheduled visits. The Antelope data acquisition and processing software has multi-threaded acquisition modules that reap all available SOH information from compatible dataloggers. It calculates communication parameters like communication efficiency, data latency, data throughput etc. All information is provided in a graphic user interface designed to display SOH information in an easily to read layout. Furthermore, the monitoring program allows for remote command-&-control of the dataloggers.



The screenshot displays the 'dimon' software interface. The main window shows a table with columns for station name, communication status, and various performance metrics. A log window is open in the foreground, showing detailed error messages and system events for station TA_019K.

Station	cont	comp	gp24	gp1	nr24	mp	SLT	dlncy	rtmfn	tp	one	brfr	nr24	np24	nr24	dr	br24	br24	memc	ade	calc	efncy	lq	clbrf	ns0-2	ns1-5	temp	volt	amp	gprs	gpr	plf	lat	lon	cler
AK_CAVN	0s	0s	0	0	0	0	32s	0s	11k20m24i	0.94	100%	0.0%	3	0	0	3.8k	44m	429k	0			01k01m00s	54%	0s	20	-1	17C 11.2V	60mA	off	W	H	68.768	-151.154	84m	
AK_CORL	0s	0s	0	0	0	0	32s	21s	23m00s	0.94	100%	0.0%	64	0	0	3.1k	43m	458k	0			00s 100%	0s	21	-4	23C 12.8V	76mA	3D	L	63.883	-152.315	256m			

```

2015195 14:00:01.281: tadata@KCN: TA_019K: ERROR: registration server response CL_CERR: Cannot honor your request - Invalid
2015195 14:00:01.281: tadata@KCN: TA_019K: ERROR: Switching authentication code to entry 0
2015195 14:00:02.294: tadata@KCN: TA_019K: ERROR: Too many acknowledgment timeouts - registration breakout
2015195 14:00:02.294: tadata@KCN: TA_019K: q330_register() error: Breakout to re-register after sleep...
2015195 14:00:02.962: tadata@KCN: TA_019K: POC initiated acquisition start.
2015195 14:00:03.295: tadata@KCN: TA_019K: Data connection startup.
2015195 14:00:03.076: tadata@KCN: TA_019K: Deregister successful
2015195 14:00:03.076: tadata@KCN: TA_019K: Registering for ip address 10.242.250.12:5332, serial no. 010000044C140C29.
2015195 14:01:59.259: tadata@KCN: TA_019K: ERROR: Bad acknowledgment 1539 need 1540 - retrying
2015195 14:01:59.476: tadata@KCN: TA_019K: ERROR: Bad acknowledgment 1539 need 1540 - retrying
2015195 14:02:00.476: tadata@KCN: TA_019K: ERROR: Bad acknowledgment 1539 need 1540 - retrying
2015195 14:02:01.476: tadata@KCN: TA_019K: ERROR: registration server response CL_CERR: Cannot honor your request - Invalid
2015195 14:02:01.476: tadata@KCN: TA_019K: ERROR: Too many q330 packet errors - registration breakout
2015195 14:02:01.476: tadata@KCN: TA_019K: q330_register() error: Breakout to re-register after sleep...
2015195 14:02:03.477: tadata@KCN: TA_019K: Deregister successful
2015195 14:02:05.009: tadata@KCN: TA_019K: POC initiated acquisition start.
2015195 14:02:05.477: tadata@KCN: TA_019K: Data connection startup.
2015195 14:02:05.477: tadata@KCN: TA_019K: Registering for ip address 10.242.250.12:5332, serial no. 010000044C140C29.
2015195 14:02:25.801: tadata@KCN: TA_019K: ERROR: registration server response CL_CERR: Cannot honor your request - Invalid
2015195 14:02:25.801: tadata@KCN: TA_019K: ERROR: Switching authentication code to entry 1
2015195 14:02:46.339: tadata@KCN: TA_019K: Registration successful.
2015195 14:02:46.339: tadata@KCN: TA_019K: Opening data connection.
2015195 14:02:47.339: tadata@KCN: TA_019K: Getting configuration...
  
```

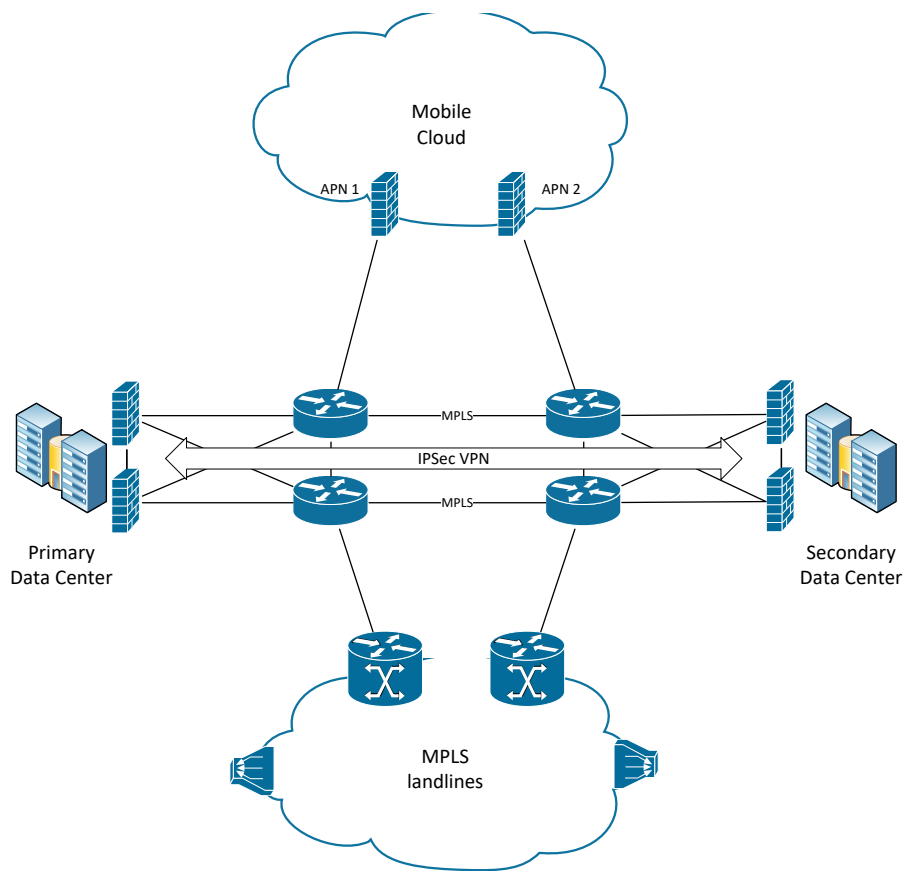
SOH monitoring

Antelope's data acquisition program allows acquiring data and SOH packets once and distributing it to more than one data center/user. This effectively reduces bandwidth and data throughput and maintains redundancy that can be used within the data center or with a backup data center.

Inter Data Center Redundancy

To provide truly continuous access to computing resources, a backup center is required in order to overcome catastrophic events within the data center, like fire and flooding, or damages to the building after a large earthquake or unexpected service interruptions, for example of communication links due to nearby construction work.

Kinematics' Open Systems & Services Division (OSS) developed and deployed application failover procedures that switches seismic network monitoring and alarm tasks to a backup data center if the main data center loses its operational functionality. This includes data acquisition, processing and event review, as well as keeping an authoritative earthquake database. The latter is important to maintain the timeliness and reliability of earthquake information.



Data center redundancy

New display technologies allow operators and users to access the backup data center via a web browser with full capabilities of their job tasks. This reduces the need to have a fully staffed remote location.

The failover procedure itself provides copious amounts of time-tagged log messages and notifications to the operators during the failover procedure. This enables forensic analysis of an incident in terms of error description (i.e. what was the root cause?) and process (i.e. what could be done better) leading the way for future improvements.