

What's New in Antelope 5.12: Challenges and Future Directions

- *Antelope 5.12*

Dr. Kent Lindquist

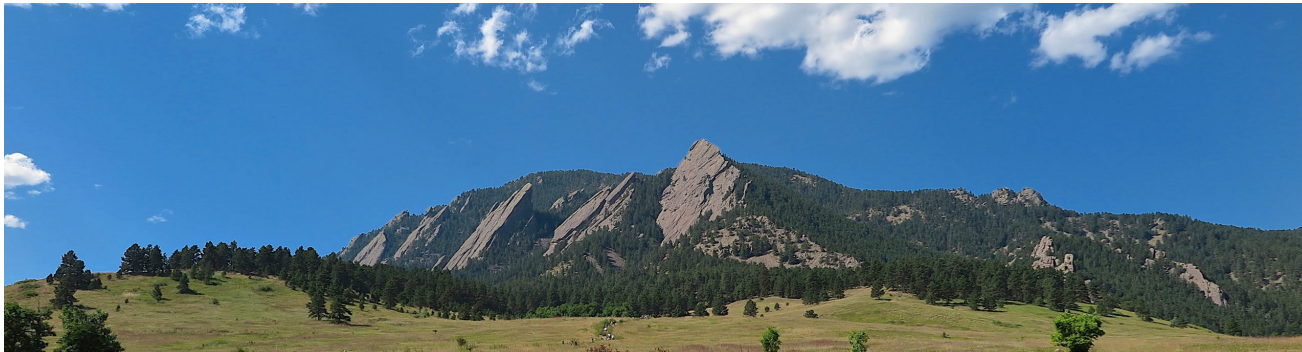
CTO/COO, Boulder Real Time Technologies, Inc.

January, 2023



Boulder Real Time Technologies, Inc.

- Founded 1996
- Based in Boulder, Colorado, USA
- Makers of the ***Antelope Environmental Monitoring System***

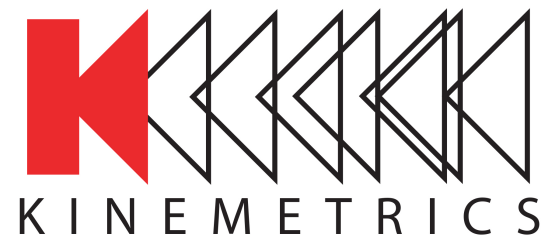


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Thanks to Kinometrics

Thanks to our long-time strategic partners, Kinometrics, Inc.



Return of the Antelope Users' Group Meetings!

- 18 and 19 Jan. 2023, 9:00 am – 12:00 pm US Pacific Standard Time
- Working on more VAUG time-slots amenable to other time zones
- *Working on possible in-person meeting, Europe, Spring 2023*



Outline

- What is Antelope
 - Enterprise-grade Software for Operations
 - Review of some main features
- Antelope 5.12
 - Platform Support
 - Interpreters
 - FDSN Web Services
 - dbloc: Earthquake location analyst-review
- Enterprise Software Creation
 - Compilation Challenges
 - Open-source Challenges
 - macOS Challenges
 - Linux Challenges
- Coming Year
 - Virtualized Builds
 - Docker Containerization
 - Ubuntu release



Antelope: Enterprise-grade Software for Earth Monitoring Operations

- “Enterprise” = Created to serve a clearly-defined mission
 - All further decisions made in subservience to that mission
 - Hardware, operating system, mission software, configuration etc.
 - Usually licensed, offers upgrades and support, “someone to call”
 - Supports virtualization and cloud computing
- “Operations” = 24/7 functioning with specific, quantitative requirements
 - Up-time, Output speed, Data completeness, Processing completeness, Downtime service windows, Possible hot-swap failover, etc.
- Turn-key operation on standard system

What is Antelope

- *Software platform* for earthquake, geophysical, and structural health monitoring
 - Data Acquisition
 - State-of-health monitoring
 - Centralized Command and Control
 - Automated and manual processing
 - Research
- Scalable and Extensible
 - Used at most of the largest seismic networks and data centers, down to the smallest research and monitoring networks
- Dual mission:
 - The monitoring mission
 - The network operations mission



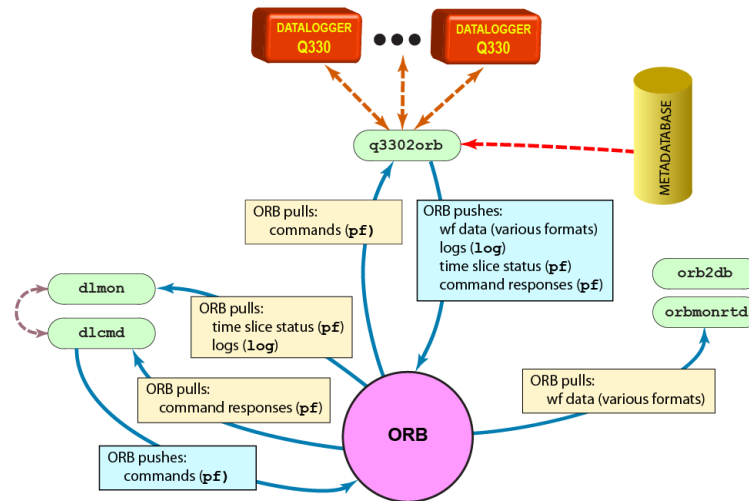
Data Acquisition: q3302orb

q3302orb

Over 2 years at USArray:



- 1166 dataloggers
- 10,292 physical data channels at multiple sample rates
- ~40,000 channels of SOH waveform data
- 8760 instance-days of software running
- 16 Terasamples of end user data collected (not including SOH)



- **0 downtime, 0 lost data** due to acquisition software failures
- 1 FTE to manage data center O&M
- **99.5% data completeness**



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orb2orb

Data Acquisition: q8

Please See Dennis Pumphrey's upcoming talk on the Q8!



Dataflow SOH Monitoring

The screenshot displays the dlmon software interface. At the top, there is a grid of traffic analysis windows, each labeled with a traffic analysis (TA) ID and a port number (e.g., TA 119C, TA 121A, TA 214A, etc.). Below this grid, there are several windows showing detailed logs and network configurations. One window shows a log for 'dlmon: TA_Q13A logs' with entries such as 'data stream open - starting with', 'Reading data...', and 'ERROR: too many status timeouts'. Another window shows a network configuration for a device with fields like 'password', 'phone_number', 'physical_interface', 'ip_address', and 'seconds_since_heard'. A third window shows a network diagram with nodes and connections, including a central node labeled 'ORF' and various other nodes like 'ORF-1', 'ORF-2', etc.

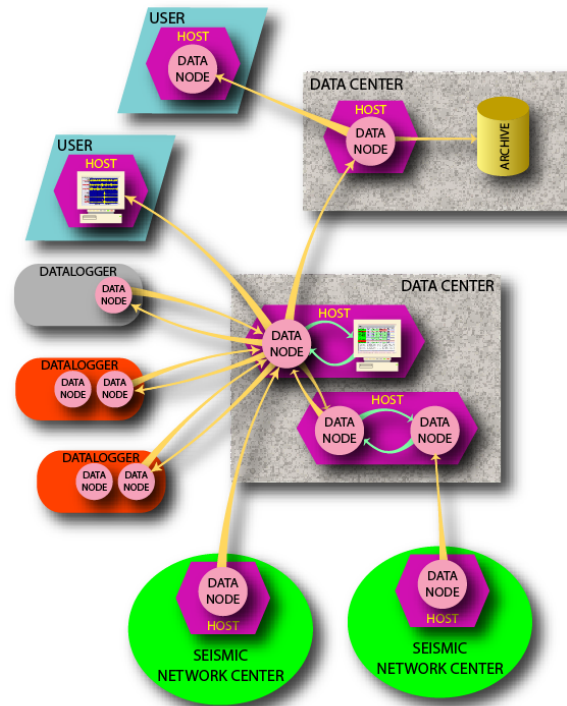
High Success rate of Antelope acquisition:
 • Robust Software
 • Sophisticated SOH Monitoring



Data Transport Backbone

orbserver

- *orbserver* / *orb* protocol
- Network transparent
- Data-neutral
- Data-driven
- Extremely reliable
- Short-haul Inter-process communication
- Long-haul, low latency data transport
- Extension to standard networking stack:
 - IP = packet transport
 - TCP = reliable transport of bytes
 - Orb = reliable transport of monitoring-data packets



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Embedded Relational Database

Datascope

arrival	assoc	calibration	event	instrument	lastid	mt	netmag	network	origerr	origin	schanloc	sensor	site	sitechan	snetsta	speedisc	stamag	wfdisc	wfmeas	diew				
0	-3.3227	138.4008	57.3215	5/26/13 (C46)	13:04:31.55641 UTC		57394	57394	2013146	mass	ndef	grm	snr	review	dtype	mb	mbid	res	ml	mid	algorithm	auth		
1	-2.0053	100.0038	43.7000	5/26/13 (C46)	11:20:00.53000 UTC		57396	57396	2013146	0	44	y		f		5.00	3840			5.32	4.00	14524	locset::lasp91	DDB:IMbMap
2	-1.3884	138.4300	73.9500	5/26/13 (C46)	13:04:52.00000 UTC		57398	57398	2013146	0	36	y		f		5.00	3841						USGS:us	
3	36.7162	5.2484	14.6200	5/26/13 (C46)	16:00:55.83000 UTC		57400	57400	2013146	0	124	y		f		5.00	3842						USGS:us	
4	-3.3669	152.5187	466.6300	5/27/13 (C47)	11:29:28.60000 UTC		57410	57410	2013147	0	69	y		f		5.20	3843						USGS:us	
5	52.2416	160.1957	13.2300	5/27/13 (C47)	20:22:00.17000 UTC		57412	57412	2013147	0	115	y		f		5.30	3844						USGS:us	
6	-21.3601	-177.8298	400.3500	5/28/13 (C48)	08:45:53.24000 UTC		57415	57415	2013148	0	68	y		f		5.00	3845						USGS:us	
7	53.4469	159.7921	71.6500	5/28/13 (C48)	16:25:33.00000 UTC		57421	57421	2013148	0	50	y		f		5.30	3846						USGS:us	
8	14.5928	53.8331	9.7000	5/27/13 (C47)	03:36:31.30000 UTC		57422	57422	2013147	0	59	y		f		5.00	3848						USGS:us	
9	34.1491	240.7155	35.7000	5/28/13 (C48)	19:24:25.60000 UTC		57423	57423	2013148	0	69	y		f		5.00	3848						USGS:us	
10	9.3873	-82.6475	11.2600	5/27/13 (C47)	09:41:14.80000 UTC		57427	57427	2013147	0	82	y		f		5.60	3849						USGS:us	
11	43.2258	41.0883	9.8200	5/28/13 (C48)	00:09:34.20000 UTC		57430	57430	2013148	0	65	y		f		5.40	3850						USGS:us	
12	-46.9497	33.4567	9.9700	5/29/13 (C49)	14:47:35.30000 UTC		57431	57431	2013149	0	74	y		f		5.20	3951						USGS:us	
13	36.7956	5.3154	0.0000	5/28/13 (C48)	16:00:55.87494 UTC		57434	57400	2013146	21	20	396	31	M	f	5.25						locset::lasp91	DDB:IMbMap	
14	-9.5021	107.2935	35.4034	5/27/13 (C47)	00:06:13.00002 UTC		57435	57435	2013147	16	13	282	24	M	f	5.36						locset::lasp91	DDB:IMbMap	
15	-9.4667	107.3132	36.0432	5/28/13 (C48)	00:06:13.44697 UTC		57436	57435	2013147	15	13	282	24	M	f	5.36						locset::lasp91	DDB:IMbMap	
16	14.4762	53.3950	66.9463	5/27/13 (C47)	03:36:40.67242 UTC		57437	57422	2013147	18	14	417	33	M	f	5.48				5.27			locset::lasp91	DDB:IMbMap
17	14.4337	53.2797	87.3250	5/27/13 (C47)	03:36:42.99708 UTC		57438	57422	2013147	18	14	417	33	M	f	5.41				5.27			locset::lasp91	DDB:IMbMap
18	-35.6809	-68.8468	198.0046	5/27/13 (C47)	05:21:15.40960 UTC		57439	57439	2013147	8	7	139	8	M	f	5.00						locset::lasp91	DDB:IMbMap	
19	-35.6640	-68.8509	203.5245	5/27/13 (C47)	05:21:15.50566 UTC		57440	57430	2013147	9	7	139	8	M	f	5.00						locset::lasp91	DDB:IMbMap	
20	39.2928	141.6161	90.1195	5/27/13 (C47)	09:16:38.11038 UTC		57441	57441	2013147	9	9	227	19	M	f	4.72						locset::lasp91	DDB:IMbMap	
21	9.4250	-82.6093	38.6423	5/27/13 (C47)	09:41:28.38039 UTC		57444	57427	2013147	19	17	80	6	M	f	5.73				5.31			locset::lasp91	DDB:IMbMap
22	-3.5205	152.6179	468.3788	5/27/13 (C47)	11:29:28.57514 UTC		57445	57410	2013147	31	27	190	15	M	f	5.45						locset::lasp91	DDB:IMbMap	
23	-3.4407	152.8790	548.0065	5/27/13 (C47)	11:29:30.64063 UTC		57446	57430	2013147	16	13	190	15	M	f	5.32						locset::lasp91	DDB:IMbMap	
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25	52.3114	159.9761	53.5337	5/27/13 (C47)	20:22:06.71800 UTC		57448	57412	2013147	14	14	219	19	M	f	5.02				5.66			locset::lasp91	DDB:IMbMap
26	52.2906	159.9952	45.9706	5/27/13 (C47)	20:22:06.00574 UTC		57449	57412	2013147	34	28	219	19	M	f	5.74				5.54			locset::lasp91	DDB:IMbMap
27	43.2185	41.5700	0.0000	5/28/13 (C48)	00:09:53.51977 UTC		57450	57430	2013148	27	26	362	30	M	f	5.30				5.02			locset::lasp91	DDB:IMbMap
28	-46.3099	33.4798	18.0000	5/29/13 (C49)	14:47:33.62000 UTC		57451	57451	2013149	0	95	y		f		5.10						USGS:us		
29	54.2088	153.4378	620.3754	5/28/13 (C48)	08:58:40.16980 UTC		57453	57453	2013148	21	18	663	41	M	f	4.89						locset::lasp91	DDB:IMbMap	
30	-21.1488	-177.7830	372.4345	5/28/13 (C48)	08:45:50.10883 UTC		57454	57415	2013148	20	14	181	13	M	f	5.13						locset::lasp91	DDB:IMbMap	
31	53.4210	158.8032	78.0000	5/28/13 (C48)	16:25:34.80313 UTC		57456	57421	2013148	30	25	218	19	M	f	5.25				4.33			locset::lasp91	DDB:IMbMap
32	34.0430	141.1570	0.0000	5/28/13 (C48)	19:24:18.85773 UTC		57457	57423	2013148	14	14	229	19	M	f	5.10				4.61			locset::lasp91	DDB:IMbMap
33	52.7809	159.0024	70.6054	5/28/13 (C48)	19:24:14.12972 UTC		57458	57458	2013148	7	7	219	19	M	f	5.23						locset::lasp91	DDB:IMbMap	
34	52.4627	159.4598	62.4572	5/28/13 (C48)	19:37:20.43642 UTC		57459	57459	2013148	17	16	219	19	M	f	5.21				4.64			locset::lasp91	DDB:IMbMap
35	53.0641	157.5260	0.0000	5/28/13 (C48)	19:24:42.27123 UTC		57460	57458	2013148	13	12	217	19	M	f	5.44						locset::lasp91	DDB:IMbMap	
36	33.9767	143.0086	0.0000	5/28/13 (C48)	19:24:19.13273 UTC		57461	57423	2013148	10	10	229	19	M	f	4.50				4.52			locset::lasp91	DDB:IMbMap
37	-4.8500	102.4168	234.5506	5/29/13 (C49)	04:35:39.30521 UTC		57462	57462	2013149	14	11	274	24	M	f	4.81						locset::lasp91	DDB:IMbMap	
38	34.4950	-119.7787	0.0000	5/29/13 (C49)	14:38:10.10873 UTC		57463	57463	2013149	12	9	43	3	M	f	5.02						locset::lasp91	DDB:IMbMap	
39	-46.6177	33.2593	650.0000	5/29/13 (C49)	14:48:26.46440 UTC		57464	57451	2013149	8	6	431	33	M	f	5.00						locset::lasp91	DDB:IMbMap	
40	34.4123	-119.9460	0.0000	5/29/13 (C49)	14:38:43.20000 UTC		57465	57463	2013149	9	31	y		f		4.90	3890					USGS:ct		
41	-9.2453	107.4365	0.0000	5/27/13 (C47)	00:06:10.00000 UTC		57473	57435	2013147	13	55	y		f		5.00	3891					USGS:us		
42	36.0174	-71.2581	101.0000	5/27/13 (C47)	05:21:06.74000 UTC		57477	57439	2013147	7	66	y		f		4.80	3892					USGS:us		
43	39.1901	141.6093	94.2500	5/27/13 (C47)	09:16:36.90000 UTC		57480	57441	2013147	9	36	y		f		4.50	3892					USGS:us		
44	54.2411	153.3947	627.1400	5/28/13 (C48)	08:58:39.17000 UTC		57483	57453	2013148	18	59	y		f		4.40	3893					USGS:us		
45	-5.1139	102.1242	34.1700	5/29/13 (C49)	04:35:18.47000 UTC		57492	57462	2013149	21	41	y		f		4.90	3894					USGS:us		
46	52.7396	158.8913	77.8400	5/28/13 (C48)	19:24:43.72000 UTC		57504	57458	2013148	12	100	y		f		4.70	3895					USGS:us		
47	55.3879	163.1770	70.9454	5/29/13 (C49)	18:21:54.29727 UTC		57506	57506	2013149	10	18	219	19	M	f	4.79						locset::lasp91	DDB:IMbMap	
48	65.4117	163.3343	24.8076	5/29/13 (C49)	18:21:54.80000 UTC		57508	57506	2013149	11	11	219	19	M	f	4.74						locset::lasp91	DDB:IMbMap	

21,477 Rows

Table 'origin' updated: 11/28/14 (332) 01:03:41.00000 UTC (241 days 15.8 hours ago)

dbe_pre updated: 7/27/15 (208) 16:52:45.02126 UTC



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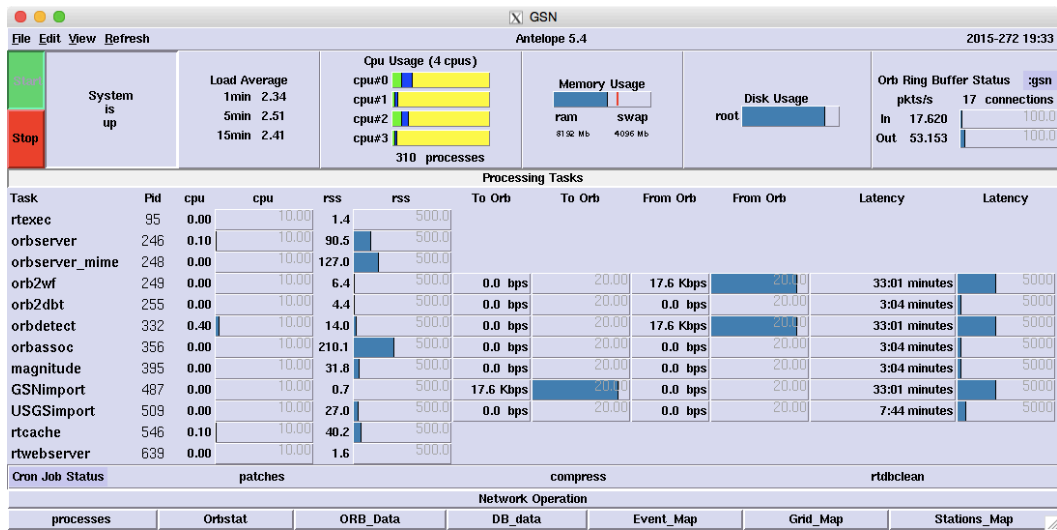
Real-time System

- Unix building-block design
 - Hundreds of small, well-designed programs, each with a clear job
 - Shared-object libraries of generic and specialized tools
- Framework to customize solutions
- Scalable
- Network-transparent
 - Allows local deployments
 - Allows distributed processing
- Demonstration system based on GSN
 - Learning and Testing
 - Augment small networks with global processing for context
 - Basis for rapid configuration of larger operations



Real-time Executive

rtexec
rtm

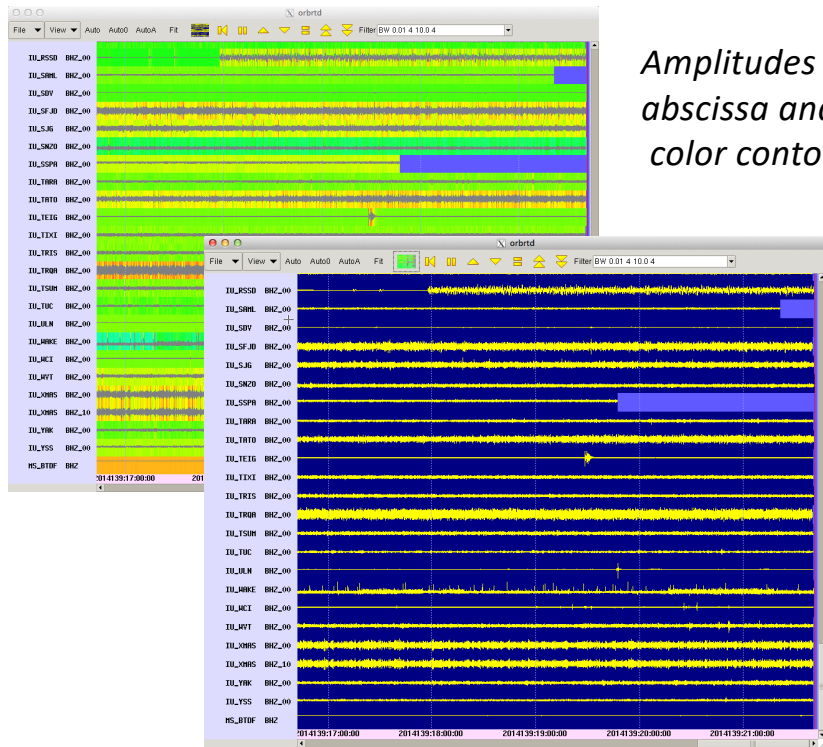


- System Command-and-control
- Run-time monitoring
- System State-Of-Health
- Comprehensive logging
- Alerting on hardware infrastructure, RT system, and process-status
- Headless, enterprise server operation with optional graphical front-end
- Turnkey reboot capability
- Cooperates with advanced deployments – high availability, redundant failover networking etc.

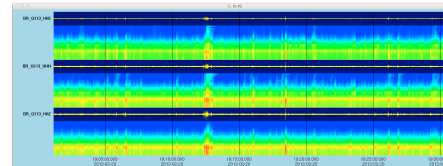
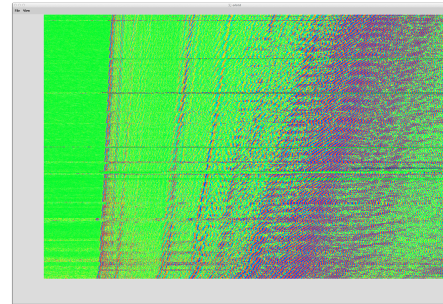


Streaming Time-series Display

orbrtd



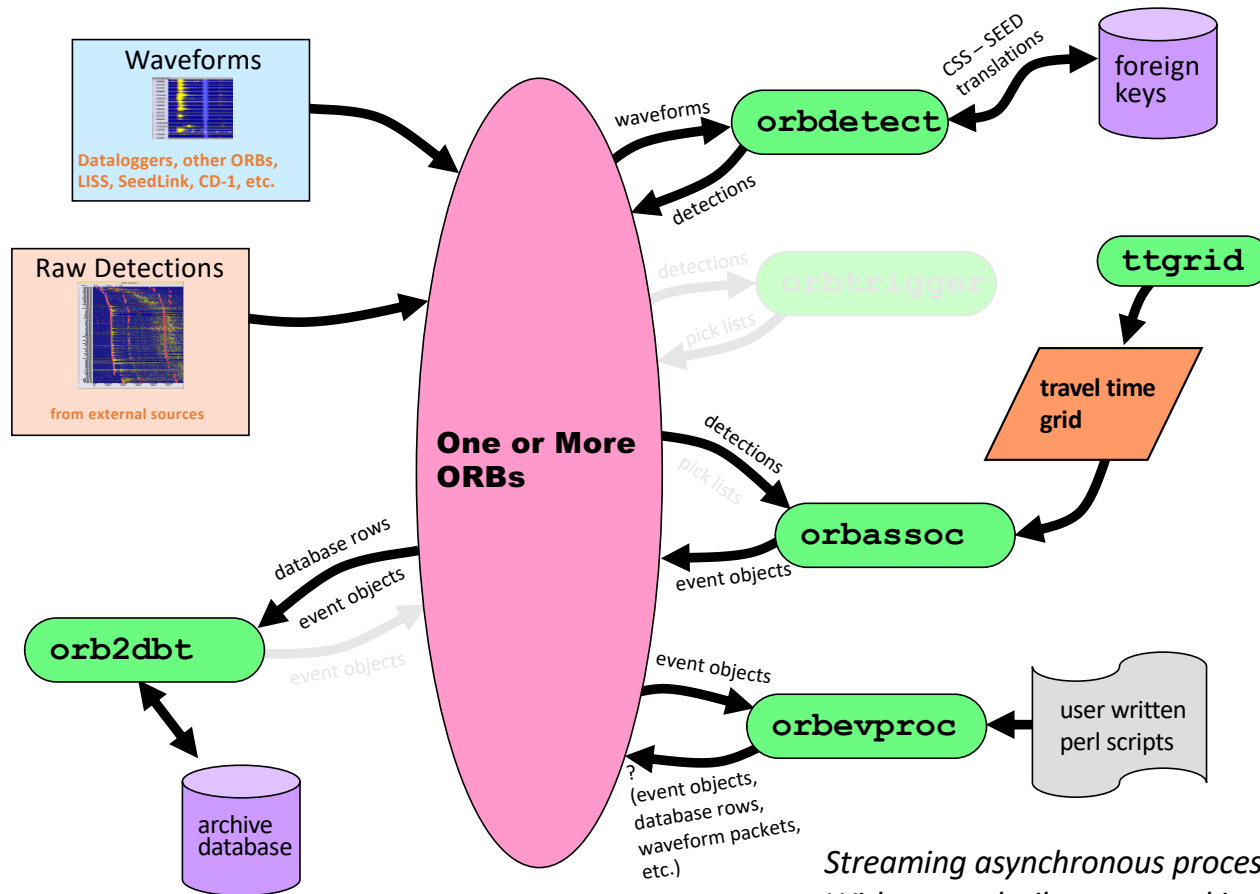
*Amplitudes on
abscissa and/or
color contours*



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Antelope Automated Event Processing



*Streaming asynchronous processing
With non-volatile state tracking*

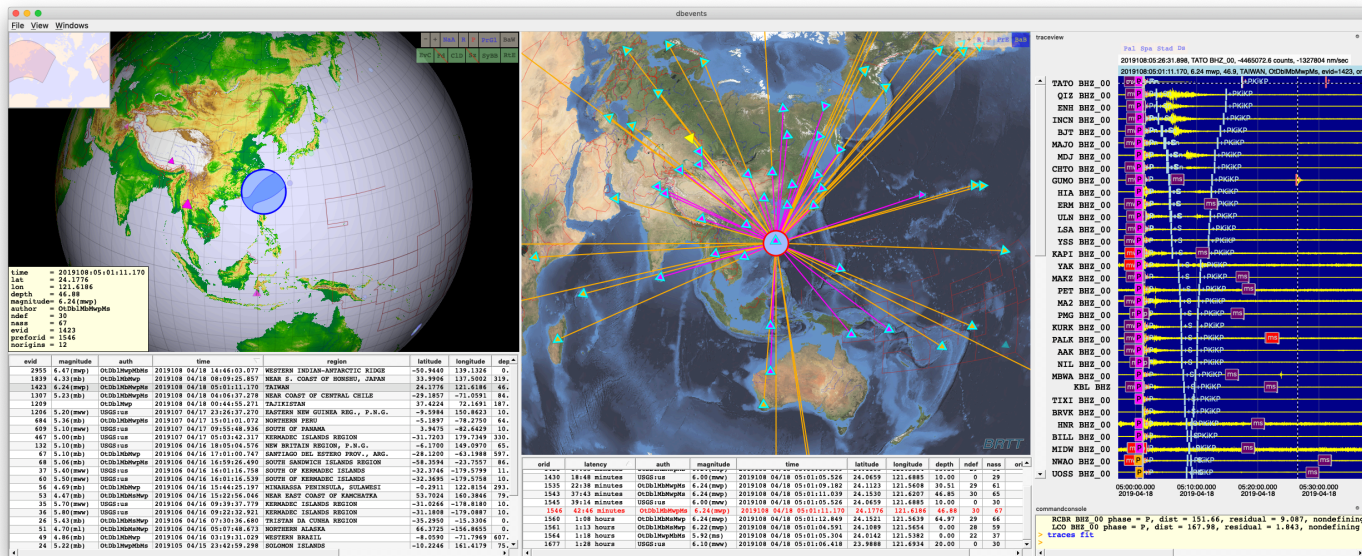


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Event Display

dbevents

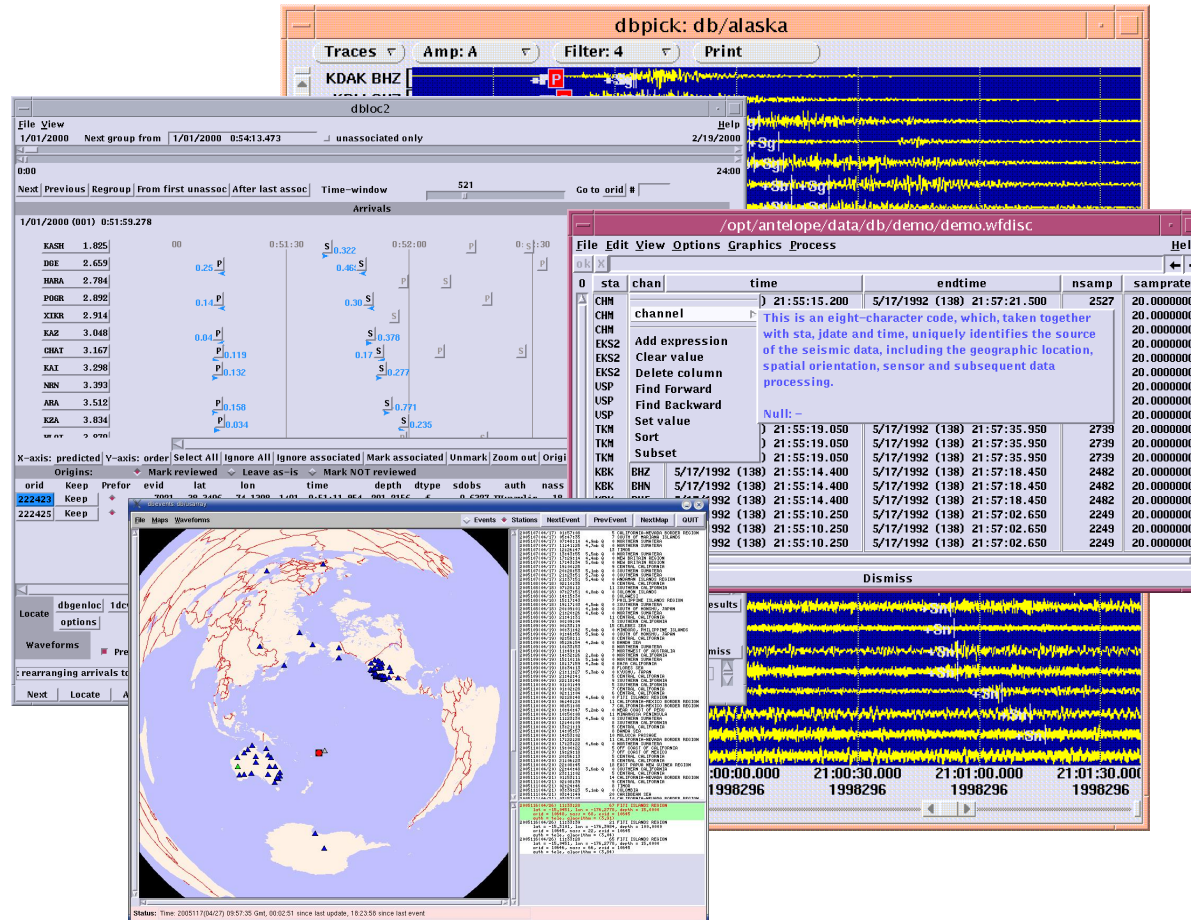


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Analyst Event Location and Review

dbloc2



Antelope 5.12

- Platform Support
- Interpreters
- FDSN Web Services
- dbloc – Analyst-review Earthquake Location

Antelope 5.12 Platform Support







- Linux

- CentOS / RHEL 7 (compiled on CentOS 7.9)
- RHEL 8 (compiled on RHEL 8.5)
- (CentOS Stream) (Not promised, but working so far)

- macOS

- Intel-architecture Monterey (compiled on Intel macOS 12.2.1)
- M1-architecture Monterey (compiled on M1 macOS 12.2.1)

Antelope 5.12 Interpreters

-  • Qt 5.15.8, Qt 6.2.4 *(Latest at release. Two versions, older for CentOS 7)*
-  • Perl 5.34.0 *(Aiming to change each release, collision avoidance)*
-  • Tcl/Tk 8.4.19 and 8.6.0 *(Same as previous Antelope versions. Dead language.)*
-  • MATLAB R2021b, R2022a *(No MATLAB for M1 macOS yet; will support when released)*
-  • Python 3.10.2 *(Aiming to change each release, collision avoidance)*
 - Many modules updated
 -  • ObsPy support preserved through ***install_obspsy(1)*** command

Antelope 5.12 FDSN Web Services

- Federation of Digital Seismograph Networks (FDSN) Web Service specification defines RESTful web service interfaces for accessing common FDSN data types - Station, Event, DataSelect
- (REST=Representational State Transfer, architectural definition for the WorldWideWeb – scalability etc.)
- Antelope 5.12 ships with the FDSN web services implementation, allowing data centers to serve their station/event/waveform data via well defined REST APIs
- Robustness improvements by author Rohan Ambli to reflect operations experience at UCSD, AEC, Kinematics
- Support for *dbcentral(1)*-based Database clusters (for waveforms distributed amongst multiple input databases)
- Support for all FDSN specification v1.1 required parameters
`man webservice_fdsn`
- Out-of-the-box User Interface supporting API queries
- Service enables users to write API scripts for querying data Eg: Via Obspy
- Customizable via an Antelope-native parameter file
- Can be configured to run as part of *rtdemo_gsn(1)*



Web Service – Meaning

- Disambiguating terms:
 - *Web Site*
 - *Human-to-machine* interface
 - Designed to be used *interactively*
 - *Web Service*
 - *Machine-to-machine* interface
 - Designed to be used *programmatically*
 - *Web Server*
 - The second ‘machine’ side of both interactions above
 - Computer program that runs on a machine at a well-known internet location

FDSN Web Service basic user interface

- Simple Web User Interface to make API (“Application Programmer Interface”) requests to Station metadata, Event parametric data, and Waveform data (“Dataselect”)
- Not designed for human interaction, but there is an interface nonetheless

Antelope FDSN Server 1.0 OAS3
fdsws/openapi.json
BRTT Inc. - Website
Send email to BRTT Inc.

Servers
/fdsws

Station Information on stationxml data

GET /station/1/application.wadl

GET /station/1/query :return:

Parameters Cancel

Name	Description
level string (query)	Specify the level of detail for the results.
starttime string(datetime) (query)	Limit to metadata epochs starting on or after the specified start time
endtime string(datetime) (query)	Limit to metadata epochs ending on or before the specified end time

FDSN Web Service Request/Response

Responses

Curl

```
curl -X 'GET' \
'http://192.168.110.162:5000/fdsnws/station/1/query?level=station&starttime=2000-01-01T00:3A00%3A00Z&network=.%2A&station=.%2A&channel=.%2A&location=.%2A&minlatitude=-90&maxlatitude=90&minlongitude=-180&maxlongitude=180&nodata=404' \
-H 'accept: */*'
```

Request URL

```
http://192.168.110.162:5000/fdsnws/station/1/query?level=station&starttime=2000-01-01T00:3A00%3A00Z&network=.%2A&station=.%2A&channel=.%2A&location=.%2A&minlatitude=-90&maxlatitude=90&minlongitude=-180&maxlongitude=180&nodata=404
```

Server response

Code Details

200

Response body

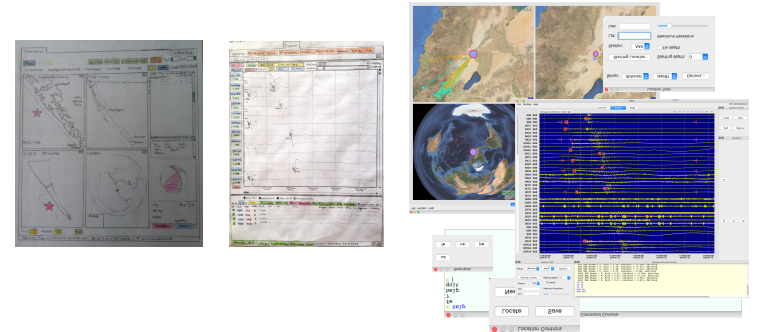
```
<ns0:FDSNStationXML xmlns:ns0="http://www.fdsn.org/xml/station/1" xmlns:ns1="http://www.w3.org/2011/XMLSchema-instance" xmlns:ns2="http://www.brrtt.com/xml/station/css30" schemaVersion="1.0" ns1:schemaLocation="http://www.fdsn.org/xml/station/1 http://www.fdsn.org/xml/station/fdsn-station-1.0.xsd">
  <ns0:Source>XX</ns0:Source>
  <ns0:Sender />
  <ns0:Module>db2stationxml</ns0:Module>
  <ns0:ModuleURI />
  <ns0:Created>2022-06-07T04:03:04.25722</ns0:Created>
  <ns0:Network code="AZ" startDate="1970-01-01T00:00:00" endDate="2599-12-31T23:59:59" ns2:netType="--">
    <ns0:Description>Anza Real-Time Broadband Network</ns0:Description>
    <ns0:SelectedNumberStations>38</ns0:SelectedNumberStations>
    <ns0:Station code="BSAP" startDate="2011-08-12T00:00:00" endDate="2599-12-31T23:59:59.999">
      <ns0:Latitude>33.260200</ns0:Latitude>
      <ns0:Longitude>-116.322300</ns0:Longitude>
      <ns0:Elevation>160.000000</ns0:Elevation>
      <ns0:Site>
        <ns0:Name>Borrogo Springs Airport, CA, USA</ns0:Name>
      </ns0:Site>
    </ns0:Station>
  </ns0:Network>
</ns0:FDSNStationXML>
```

Machine-friendly response, e.g. StationXML shown above

Machine-friendly request, API or command-line

dbloc History

- dbloc2
 - First released version, dbloc2, created by Dan Quinlan and Luda Ratnikova in the 1990's for Joint Seismic Program Center
 - Focused on small networks, e.g. Kyrghyz Seismic Network
 - Vastly expanded in ensuing years, scaled to serve networks as large as Alaska Earthquake Center and USArray
 - Written in TCL/Tk
 - Communicated with 'dbpick' application for waveform analysis
- Dbloc Gen 1 Prototype
 - First prototype rewrite written 2018, described in Victoria, BC AUG meeting
 - Overhauled based on experience and feedback
- Dbloc Gen 2 Prototype
 - Gen 2 Prototype released with Antelope 5.12
 - Still under construction



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dbloc Gen 2 Prototype

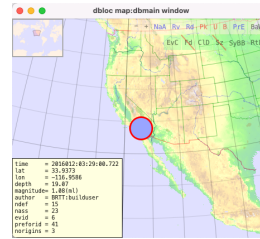
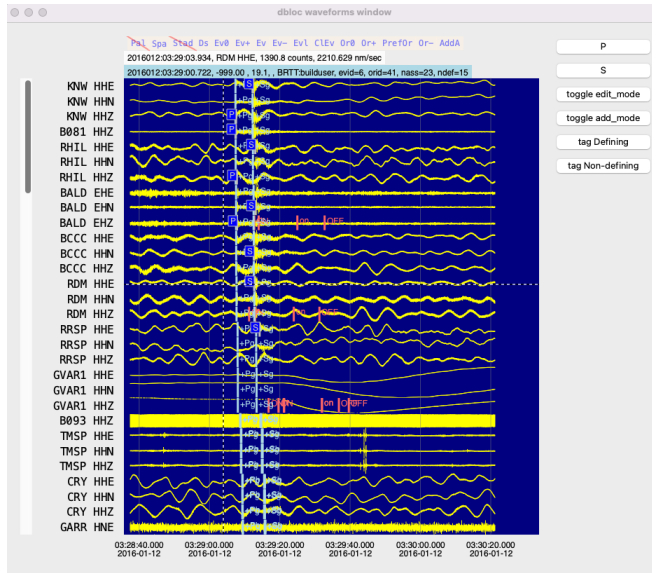
- Complete rewrite from last version
- New dbloc command language
- Interfaces with *traceview(1)* – waveform analysis built into main program
- High-resolution mapping built into main program
- Modular windows that remember their locations
- No trial database– all edits done in main database
- Analysis Time Window made explicit
 - Disambiguate “What event am I working on” vs “What time window”
- Smart Association of new hypocenters into main database
- Preservation and simplification of critical features – e.g. reassigning evids and prefors
- Join our beta-test group if you wish, run
antelope_update_custom dbloc
For the latest version (*support@brtt.com* for questions)



dbloc – default layout

```

dbloc command window
dbloc> import start.txt
Queuing command 'databases open dbmain demodb/demo'
Queuing command 'unix mkdir -p tmp'
Queuing command 'databases open dbtrial tmp/trial'
Queuing command 'locate config locator dblocsat2'
dbloc> databases open dbmain demodb/demo
Opened database 'demodb/demo' as 'dbmain'
dbloc> unix mkdir -p tmp
Executing: unix mkdir -p tmp
dbloc> databases open dbtrial tmp/trial
Opened database 'tmp/trial' as 'dbtrial'
dbloc> locate config locator dblocsat2
Locator set to 'dblocsat2'
dbloc> events select dbmain:6
Selected evid 6
evid = 6, prefor = 41, norigin = 3, mag = 1.08 ml
latency = 13:28:12.893, orid = 1, nass = 23, ndef = 23, mag = 1.08 ml
latency = 14:46:20.630, orid = 2, nass = 23, ndef = 53, mag = 1.09 ml
latency = 16:46:46.373, orid = 41, nass = 23, ndef = 15, mag = -999.0
orid = 41, nass = 23, ndef = 15, mag = -999.00 , time = 2016012:03:29
KNW HHZ phase = P, dist = 0.30, residual = -0.028, defining
KNW HHE phase = S, dist = 0.30, residual = -0.226, defining
B801 HHZ phase = P, dist = 0.30, residual = -0.802, defining
RHIL HHZ phase = P, dist = 0.31, residual = 0.121, defining
    
```



dbloc location input window

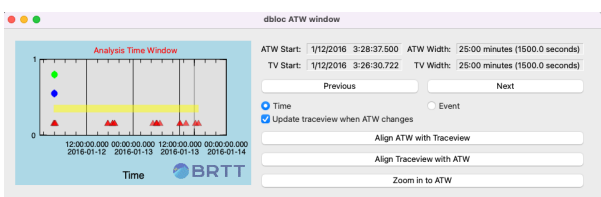
Initial Location: UCSD/MI
 Initial Origin: -116.956000
 Initial Depth: 16.870000
 Number of Input Events: 40 (10 defining, 6 non-defining, 40 ignored)

id	lat	lon	depth	defining	mag	event time
1	KNW	HHZ	P	F	1.080000	2016012:03:28:12.893
2	B001	HHZ	S	F	1.080000	2016012:03:28:12.893
3	B004	HHZ	P	F	1.080000	2016012:03:28:12.893
4	B007	HHZ	P	F	1.080000	2016012:03:28:12.893
5	B008	HHZ	P	F	1.080000	2016012:03:28:12.893
6	B009	HHZ	P	F	1.080000	2016012:03:28:12.893
7	B010	HHZ	P	F	1.080000	2016012:03:28:12.893
8	B011	HHZ	P	F	1.080000	2016012:03:28:12.893
9	B012	HHZ	P	F	1.080000	2016012:03:28:12.893
10	B013	HHZ	P	F	1.080000	2016012:03:28:12.893
11	B014	HHZ	P	F	1.080000	2016012:03:28:12.893
12	B015	HHZ	P	F	1.080000	2016012:03:28:12.893
13	B016	HHZ	P	F	1.080000	2016012:03:28:12.893
14	B017	HHZ	P	F	1.080000	2016012:03:28:12.893
15	B018	HHZ	P	F	1.080000	2016012:03:28:12.893
16	B019	HHZ	P	F	1.080000	2016012:03:28:12.893
17	B020	HHZ	P	F	1.080000	2016012:03:28:12.893
18	B021	HHZ	P	F	1.080000	2016012:03:28:12.893
19	B022	HHZ	P	F	1.080000	2016012:03:28:12.893
20	B023	HHZ	P	F	1.080000	2016012:03:28:12.893
21	B024	HHZ	P	F	1.080000	2016012:03:28:12.893
22	B025	HHZ	P	F	1.080000	2016012:03:28:12.893
23	B026	HHZ	P	F	1.080000	2016012:03:28:12.893
24	B027	HHZ	P	F	1.080000	2016012:03:28:12.893
25	B028	HHZ	P	F	1.080000	2016012:03:28:12.893
26	B029	HHZ	P	F	1.080000	2016012:03:28:12.893
27	B030	HHZ	P	F	1.080000	2016012:03:28:12.893
28	B031	HHZ	P	F	1.080000	2016012:03:28:12.893
29	B032	HHZ	P	F	1.080000	2016012:03:28:12.893
30	B033	HHZ	P	F	1.080000	2016012:03:28:12.893
31	B034	HHZ	P	F	1.080000	2016012:03:28:12.893
32	B035	HHZ	P	F	1.080000	2016012:03:28:12.893
33	B036	HHZ	P	F	1.080000	2016012:03:28:12.893
34	B037	HHZ	P	F	1.080000	2016012:03:28:12.893
35	B038	HHZ	P	F	1.080000	2016012:03:28:12.893
36	B039	HHZ	P	F	1.080000	2016012:03:28:12.893
37	B040	HHZ	P	F	1.080000	2016012:03:28:12.893
38	B041	HHZ	P	F	1.080000	2016012:03:28:12.893
39	B042	HHZ	P	F	1.080000	2016012:03:28:12.893
40	B043	HHZ	P	F	1.080000	2016012:03:28:12.893

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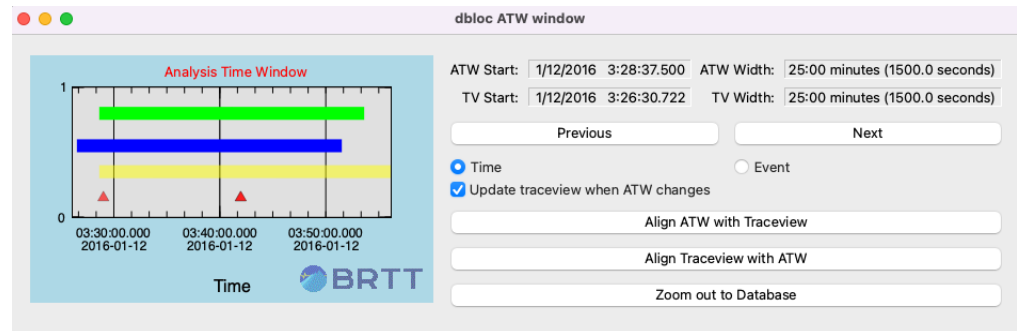
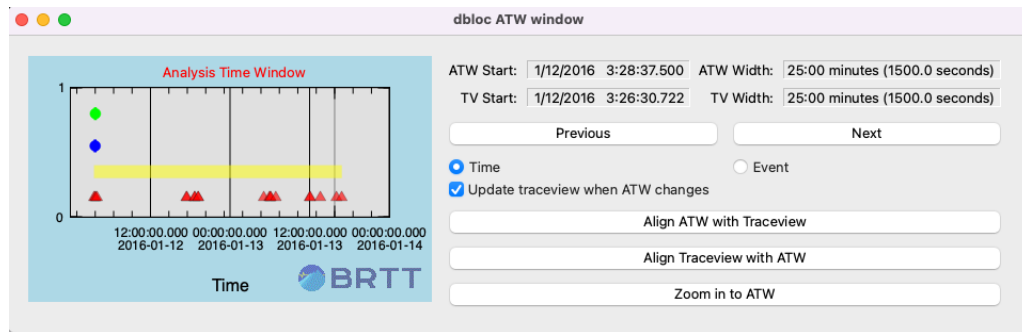
id	lat	lon	depth	defining	mag	event time
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23	B026	HHZ	P	F	1.080000	2016012:03:28:12.893
24	B027	HHZ	P	F	1.080000	2016012:03:28:12.893
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dbloc ATW origins window

dbloc	db-orig	prefor	time	mag	auth	algorithm	lat	lon	depth (m)	nass	ndef
dbmain=7	dbmain=04		1/12/2016 3:41:57.629	1.61 ml	UCSD/MI	locat:amp91	33.3031	-116.019	17.005	26	26
dbmain=7	dbmain=03	*	1/12/2016 3:41:57.430	1.60 ml	USGS/CI	-	33.2327	-116.013	4.09	26	51
dbmain=6	dbmain=01		1/12/2016 3:29:06.807	1.08 ml	UCSD/MI	locat:amp91	33.3019	-116.019	16.801	23	23
dbmain=6	dbmain=02		1/12/2016 3:29:00.730	1.08 ml	USGS/CI	-	33.3065	-117.048	14.07	23	63
dbmain=6	dbmain=041	*	1/12/2016 3:29:00.722	999.00	BRTTbukuser	locat:amp91	33.9373	-116.959	19.077	23	15
dbmain=2	dbmain=05	*	1/12/2016 3:41:59.005	0.03 ml	UCSD/MI	locat:amp91	33.4805	-116.579	8.132	18	18

dbloc – Analysis Time Window



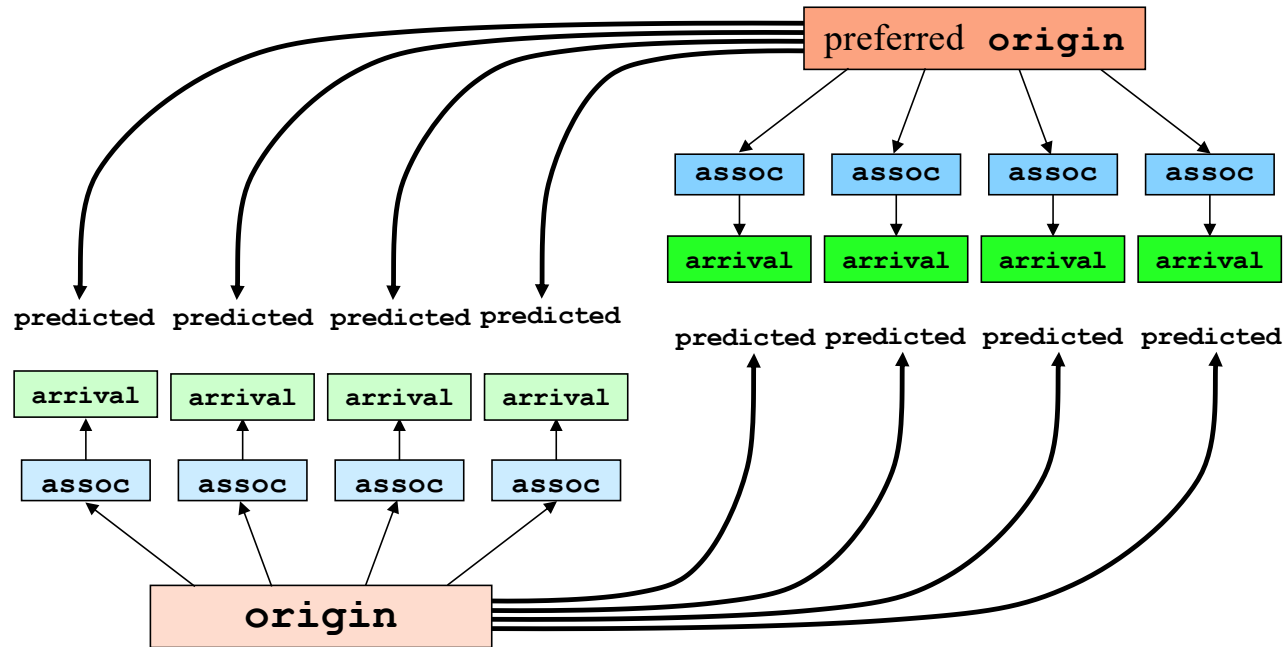
“Smart” event association

From event object

From archive database

orb2dbt

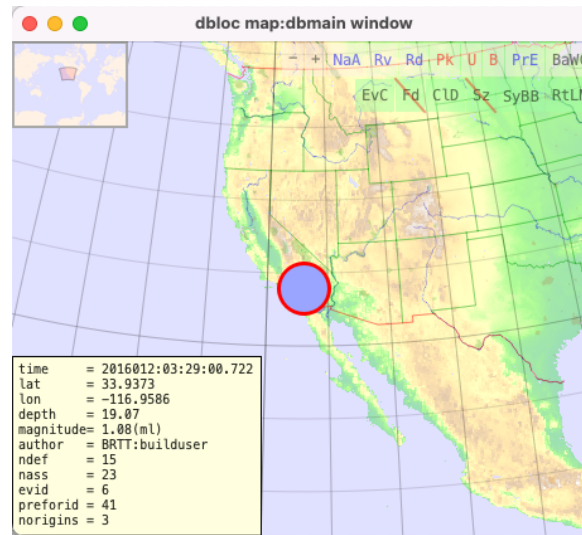
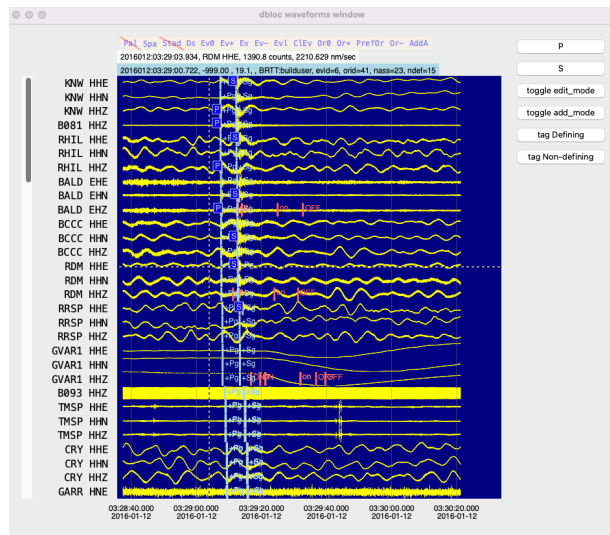
foreach



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dbloc – Embedded Waveform Analysis and Mapping



Enterprise software creation

- Forces
 - Hardware technology advances to meet growing user compute needs
 - Large corporate entities move according to macro economics, not small scientific software companies. We're the passenger, not the driver.
 - Advances in hardware and user market needs drive Operating System advances
 - Computer science advances drive language change, compiler change, component-package changes
 - Hardware purchased for network operations ages, breaks, and gets decommissioned, requiring updates – to hardware, thus OS, thus software
 - Continual improvement of application software drives updates, on newer OS's; can't run on older OS's. Limited ability to support older versions due to hardware aging and irreplaceability of old machines.
 - "Software Rusts" –*Danny Harvey*
 - Software at its best: codified explanation of how to do monitoring task, in every detail, to both the humans and the machines. This understanding advances in sophistication. [N.B. 'Spaghetti code' loses the 'explain to humans' part]
 - Research-purposed software – has to adapt to varied ecosystems, impacting robustness and adding admin work.
 - Enterprise software aiming for *mission support*. Install it and it runs out-of-the-box. Tremendous amount of work to create this effect with sophisticated applications.



Compilation Challenges

- Aiming for consistent behavior across platforms, maintainability
- Pull over past number of years towards identically matched toolchains on all OS platforms, *clang* compiler
- Lines of Code
 - Antelope – millions
 - Out of a single cross-platform source-code tree
 - Source-code as codified explanation of how to do real-time earthquake monitoring, reflecting 25+ years of operations hardening
 - Qt – Millions
 - Python – interpreter plus 121 packages
 - Perl – interpreter plus 122 modules
 - TCL/Tk – two stacks of interpreters plus variety of extension modules
 - MATLAB – commercial
- Cross-links: All to Antelope; All to C/C++; TCL/Tk to Perl, Python; plus C to MATLAB, Python to ObsPy
- Need to adapt to moving operating systems

Open-source Challenges

- Open source –
 - Antelope using many millions of lines of open-source
 - Antelope releases significant code open-source as part of maintained platform
 - Fixable – with enough time and expertise
 - Operational cost for maintaining, linking into continuously running platform
 - Many ‘solutions’ available to reduce complexity aren’t sufficient for Antelope (Brew, Macports, rpms, etc.)
 - Lesson learned long ago: need to build interpreters in to platform to guarantee intended behavior

macOS Challenges

- macOS internalized clang and segwayed to disjoint numbering system
- /usr/include encapsulated in Xcode SDK
- System libraries incorporated into shared dynamic linker cache
 - Needs Apple's toolchain to link
 - Increased effort to harmonize macOS and Linux compilations
- Libcrypto
 - Critical e.g. for making secure web downloads
 - Only linkable with Xcode tools
 - Other versions detected and rerouted to macOS
- Gatekeeper
 - Full code signing requires deep dive into Xcode toolchain
 - Increased effort to coordinate with Apple security infrastructure
- M1 Native compile
 - Rosetta2 can work for old Antelope versions
 - Needs everything native – interpreters included



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Linux Challenges

- CentOS Stream
 - Changed from tracking just-behind RedHat to just-after
 - Between RHEL and Fedora
 - (RedHat <- CentOS Stream <- Fedora)
 - Moving target and no longer a stable clone of RHEL
- CentOS 7 & RHEL 8
 - These plus macOS forced Qt5 / Qt6 split
- First Antelope *virtual machine build* for CentOS 7

Coming Development Year

- Ubuntu Linux version (Ubuntu 22)
- Docker container support
- Continued *dbloc* development
- Jupyter Notebook support in Python
- Requests? Suggestions?



Antelope is the product it is today because of our users, your needs and feedback.

We look forward to continuing to support you.

Bring us your ideas!



Obtaining Antelope

- Evaluation copies, subscriptions or upgrades to Antelope 5.12:
 - Contact Kinematics, Inc.:
 - sales@kmi.com
- Technical questions about Antelope:
 - Contact BRTT:
 - support@brtt.com



Thank You

support@brtt.com

