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

- ***Antelope 5.12***

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CTO/COO, Boulder Real Time Technologies, Inc.

January, 2023

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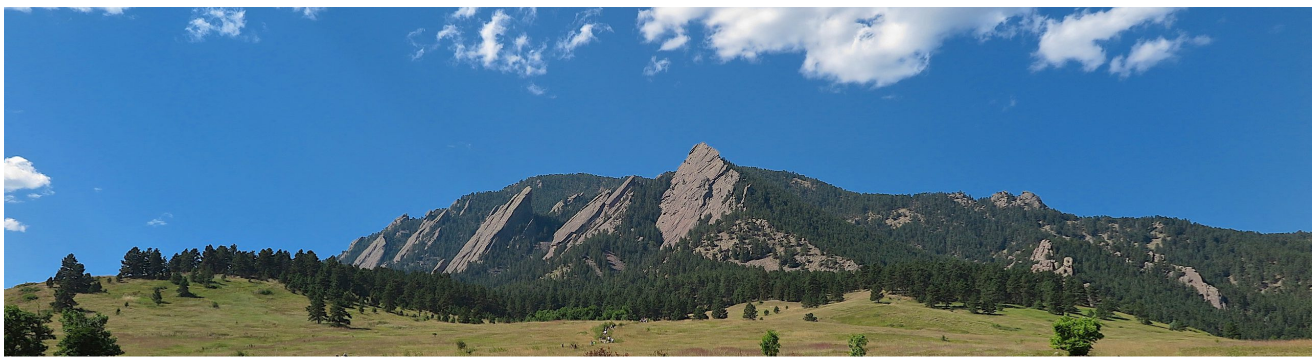
- Founded 1996
- Based in Boulder, Colorado, USA
- Makers of the ***Antelope*** *Environmental Monitoring System*



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Thanks to Kinemetrics

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

KINEMETRICS

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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*

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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

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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

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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

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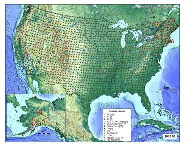
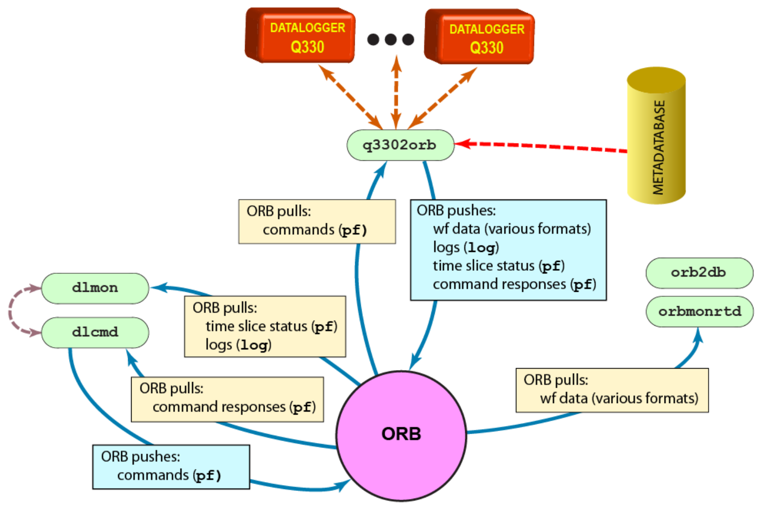
Data Acquisition: q3302orb

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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Data Acquisition: q8

orb2orb

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

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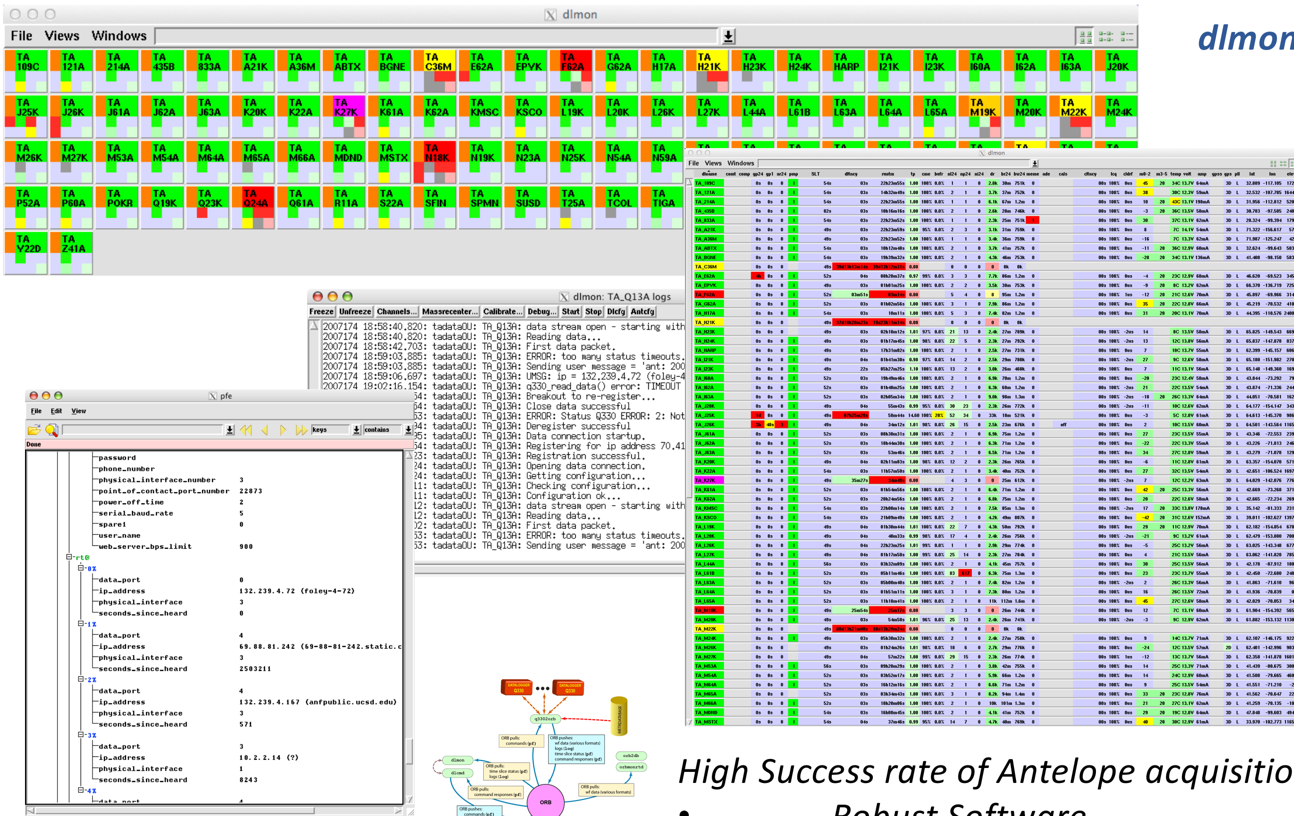
Dataflow SOH Monitoring



dlmon

High Success rate of Antelope acquisition:

- *Robust Software*
- *Sophisticated SOH Monitoring*

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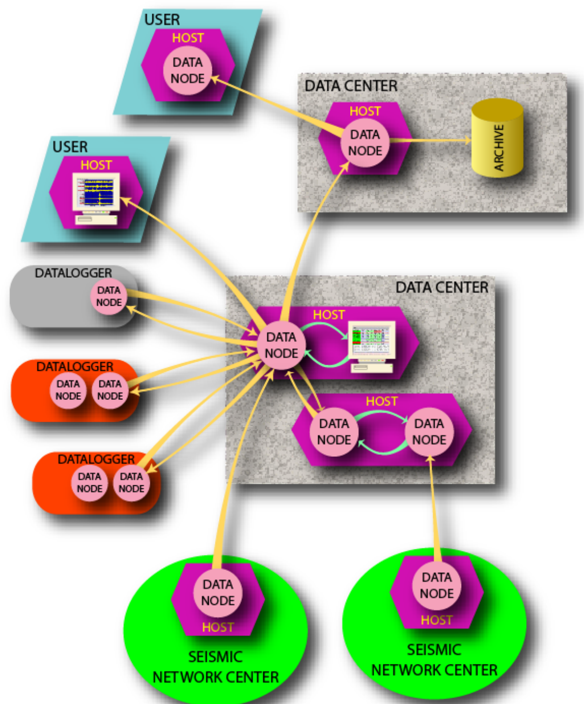
Data Transport Backbone

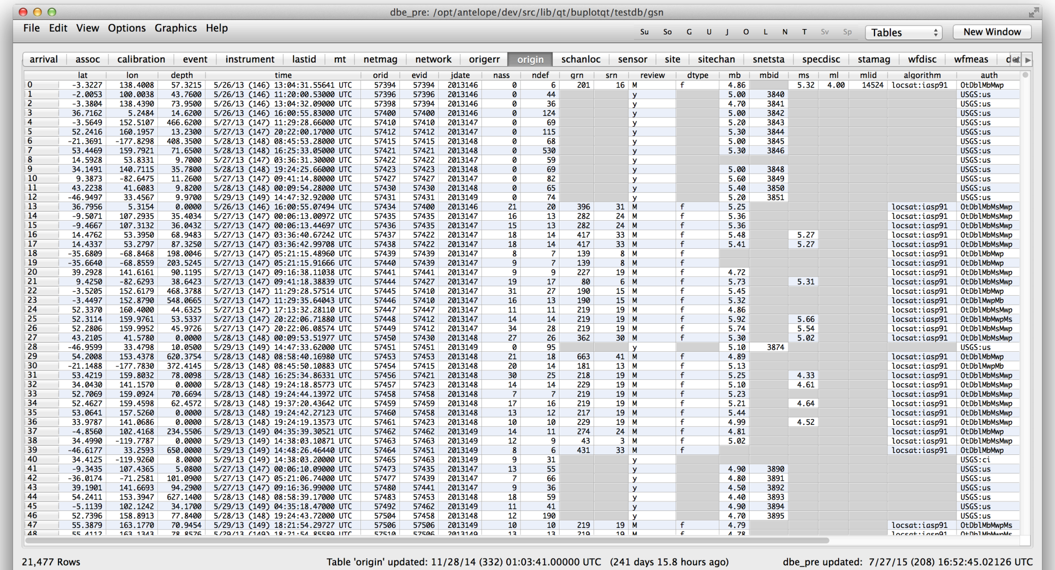
orbserver

- *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



Embedded Relational Database

Datascope



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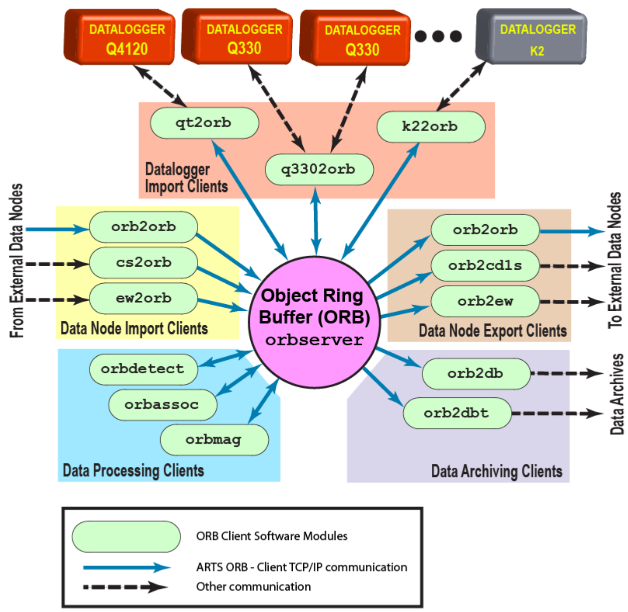
Real-time System

- 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



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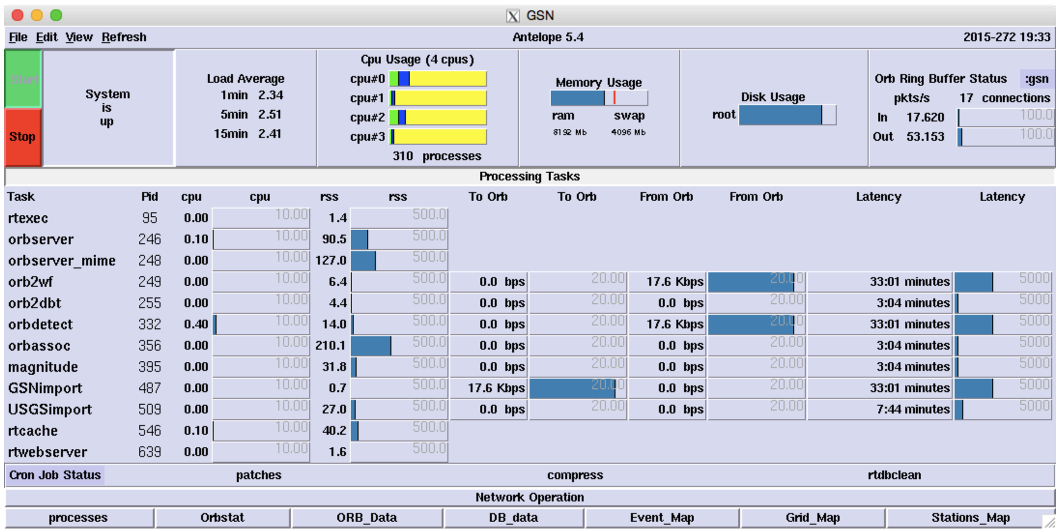
Real-time Executive

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.

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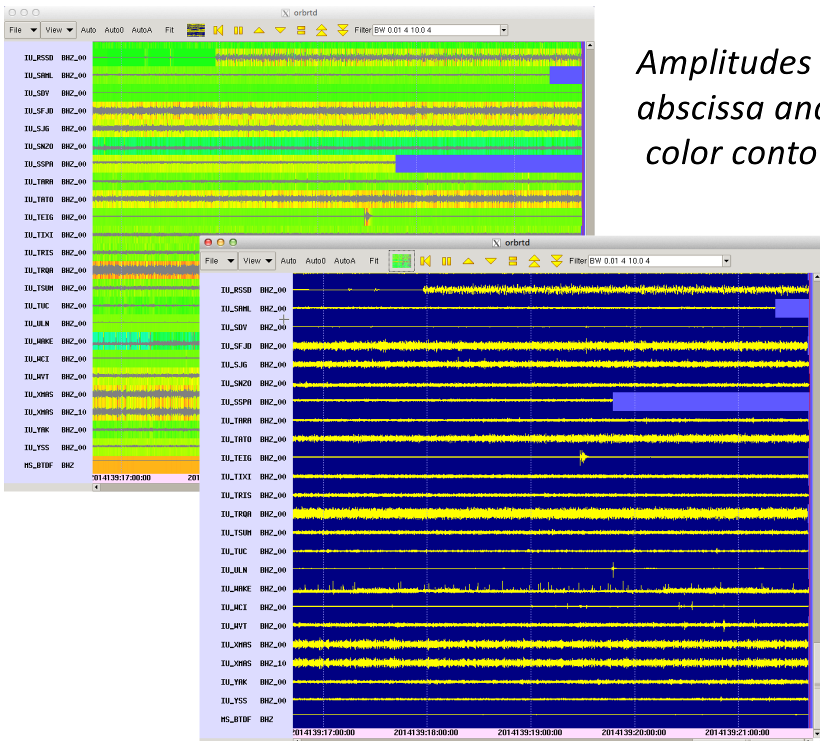
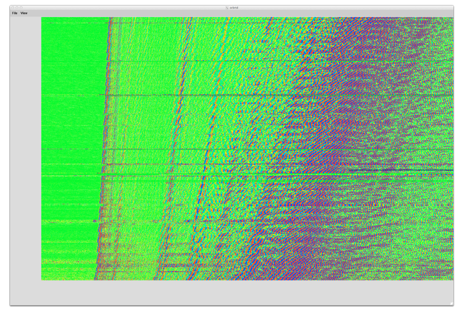
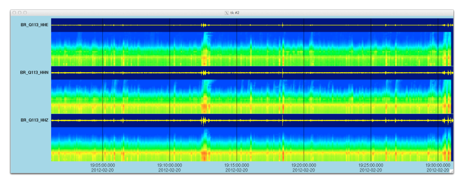
Streaming Time-series Display

orbrtd



Amplitudes on abscissa and/or color contours





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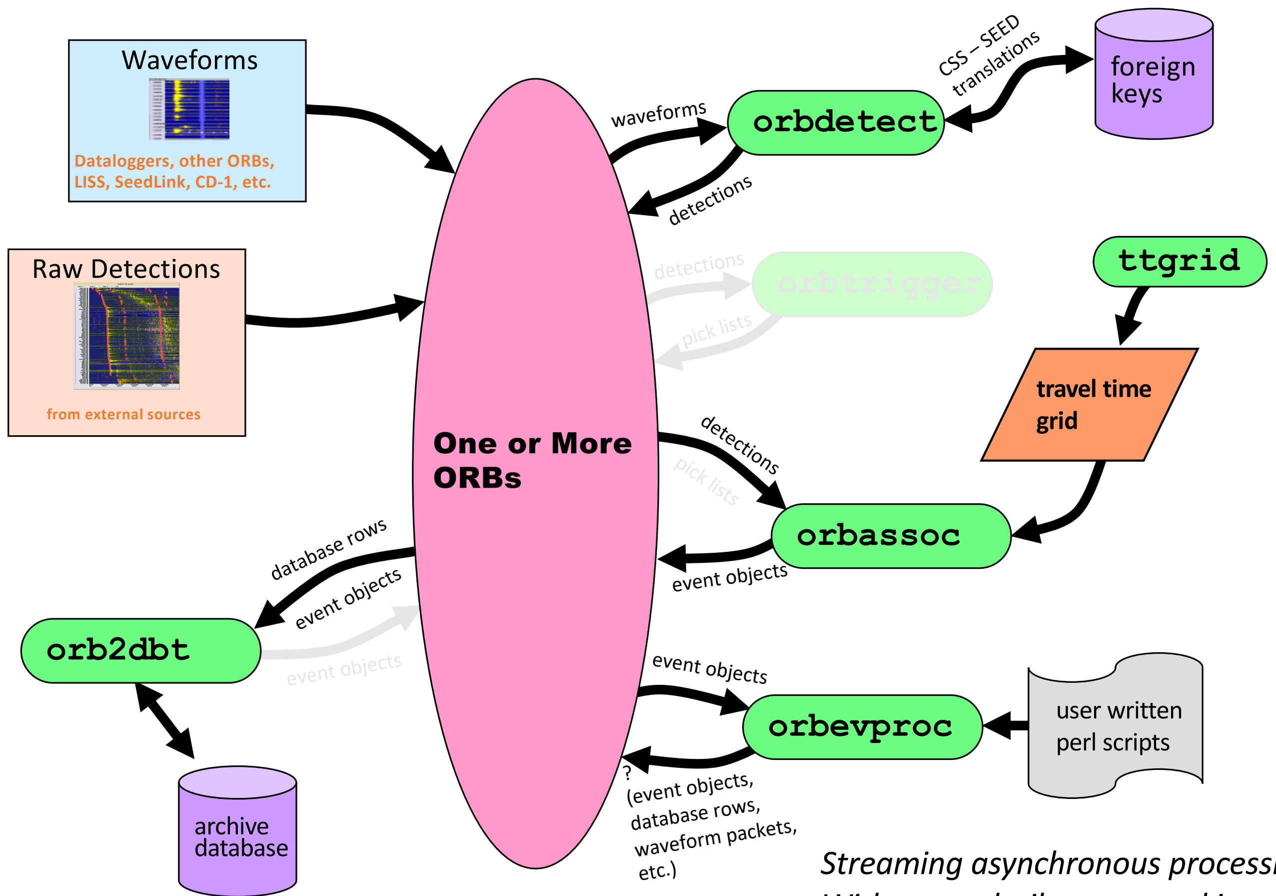
Antelope Automated Event Processing



Streaming asynchronous processing
With non-volatile state tracking

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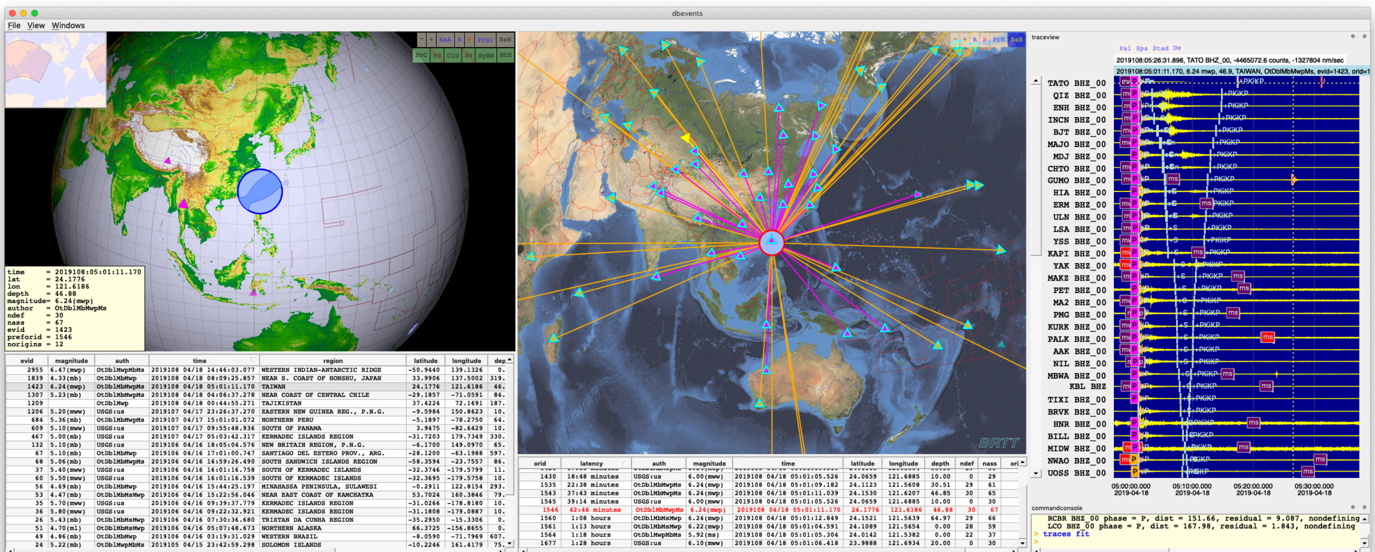
Event Display

dbevents



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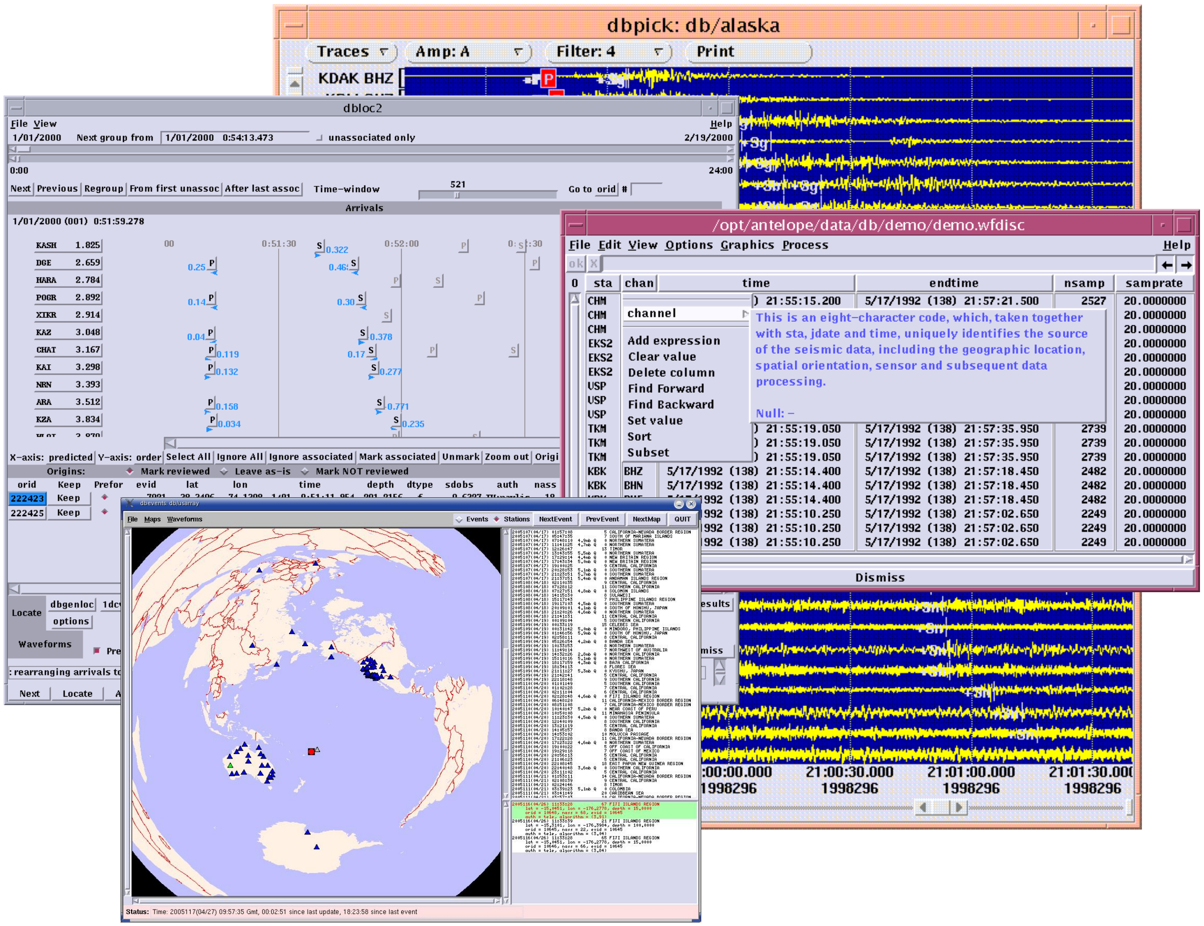
Analyst Event Location and Review

dbloc2



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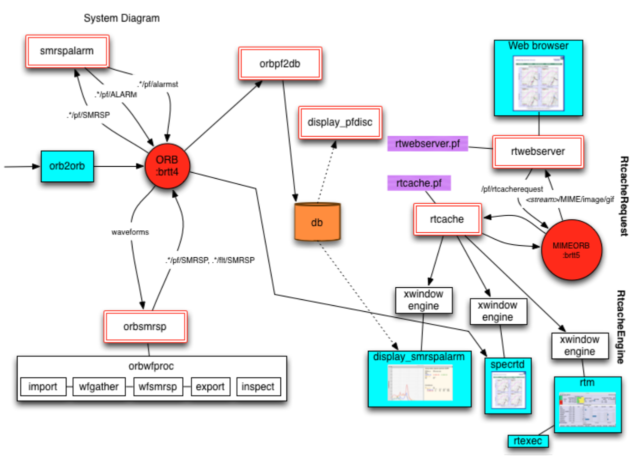
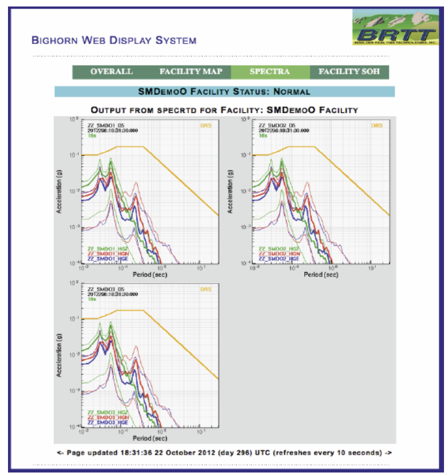
Structural Health Monitoring: Bighorn

Please See Frank Vernon's upcoming talk on Bighorn and SHM!





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Antelope 5.12

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

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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)

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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*)
- *TclTk 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_obspy***(1) command

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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 – scability 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, Kinemetrics
- 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)*

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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

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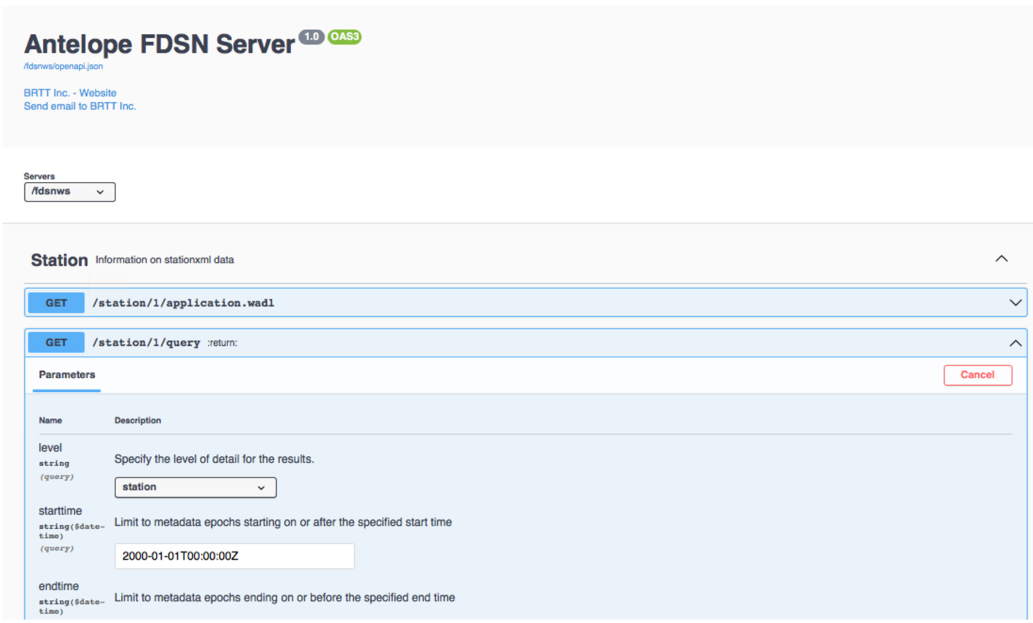
FDSN Web Service basic user interface

- 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



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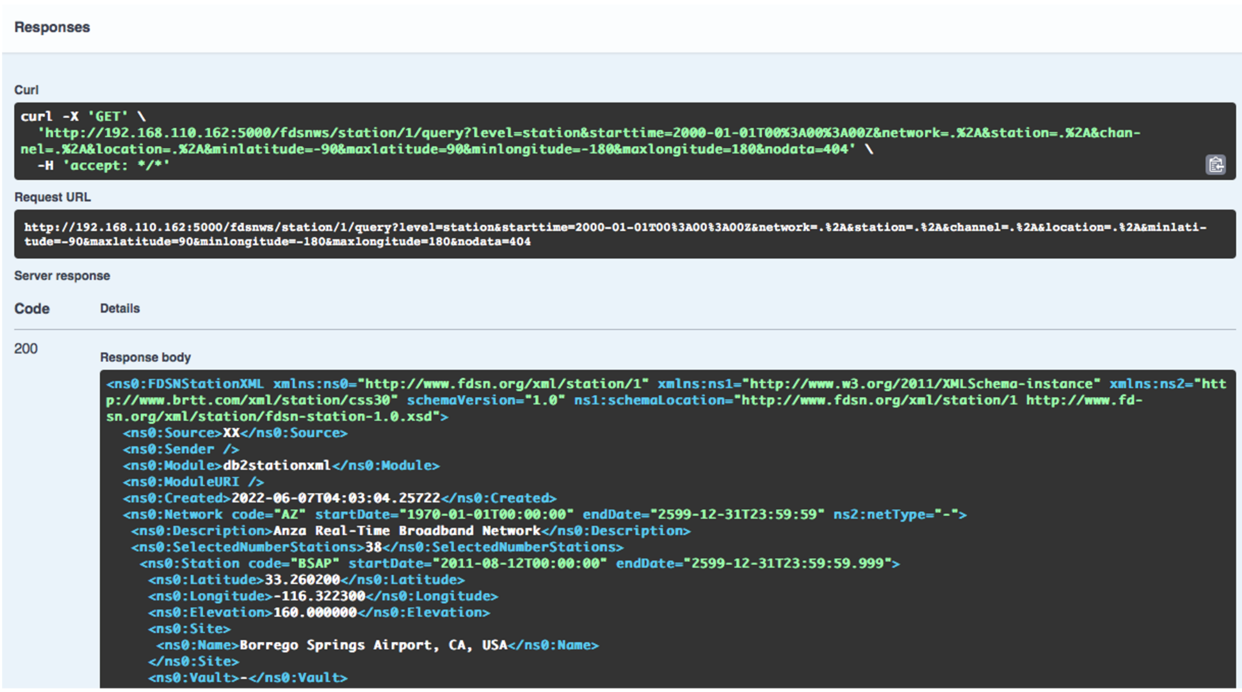
FDSN Web Service Request/Response



Machine-friendly request, API or command-line

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

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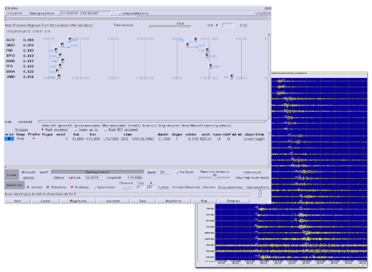
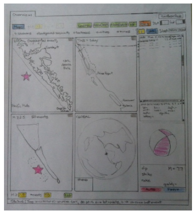
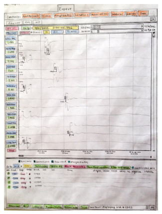
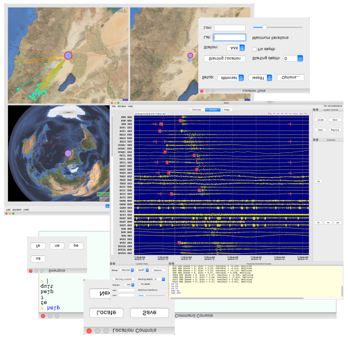
dbloc History

- 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)

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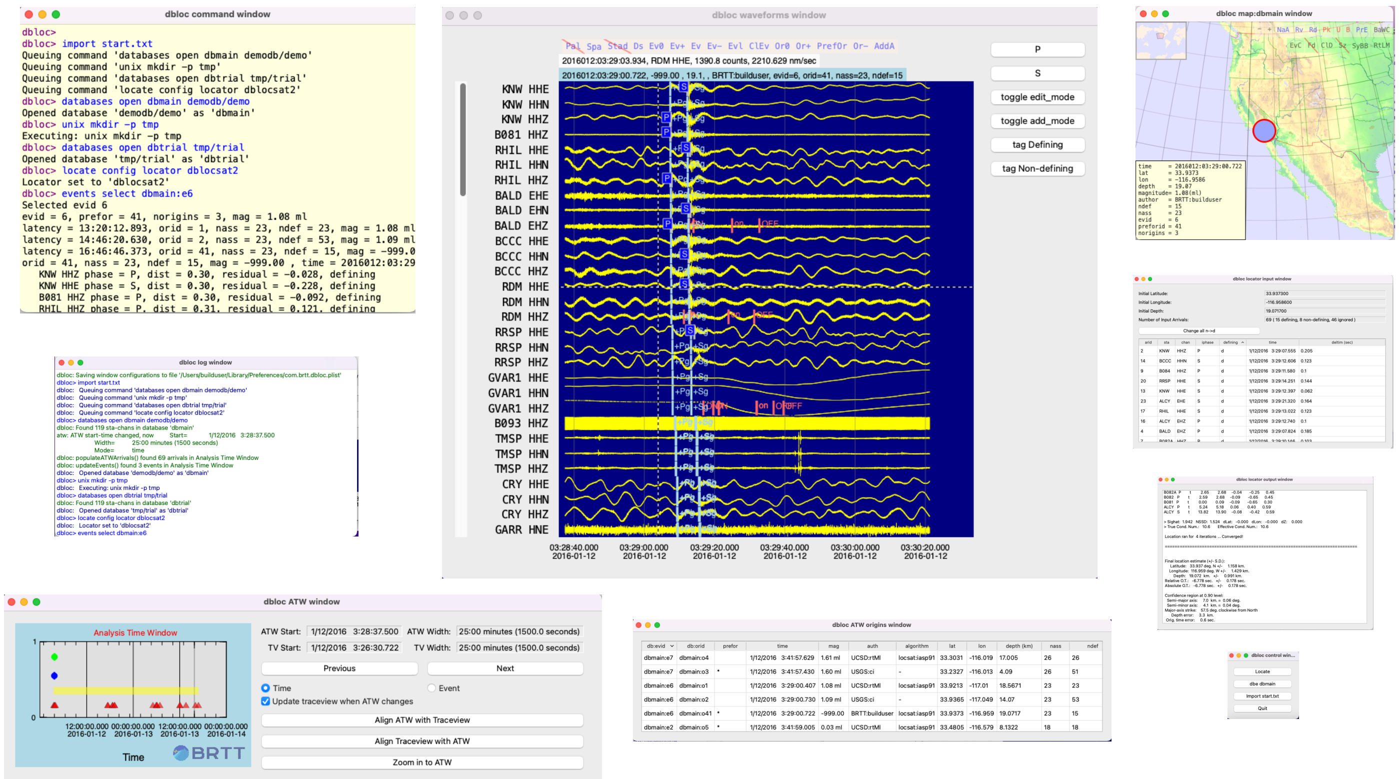
dbloc – default layout



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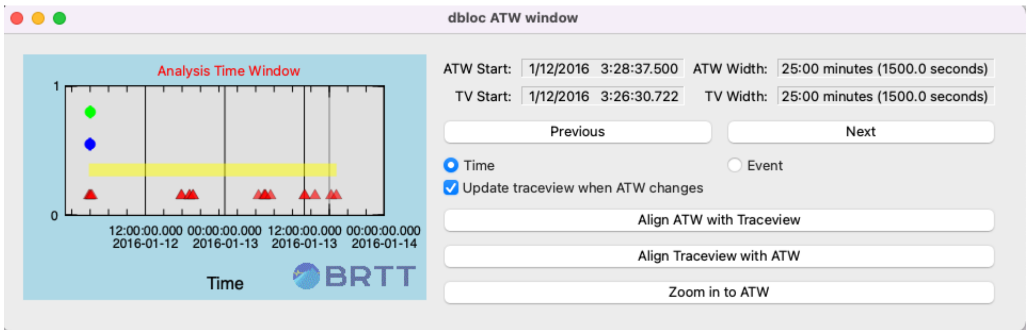
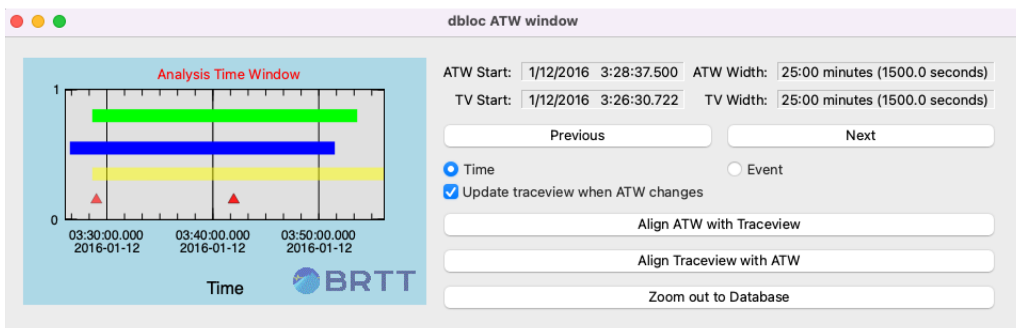
dbloc – Analysis Time Window





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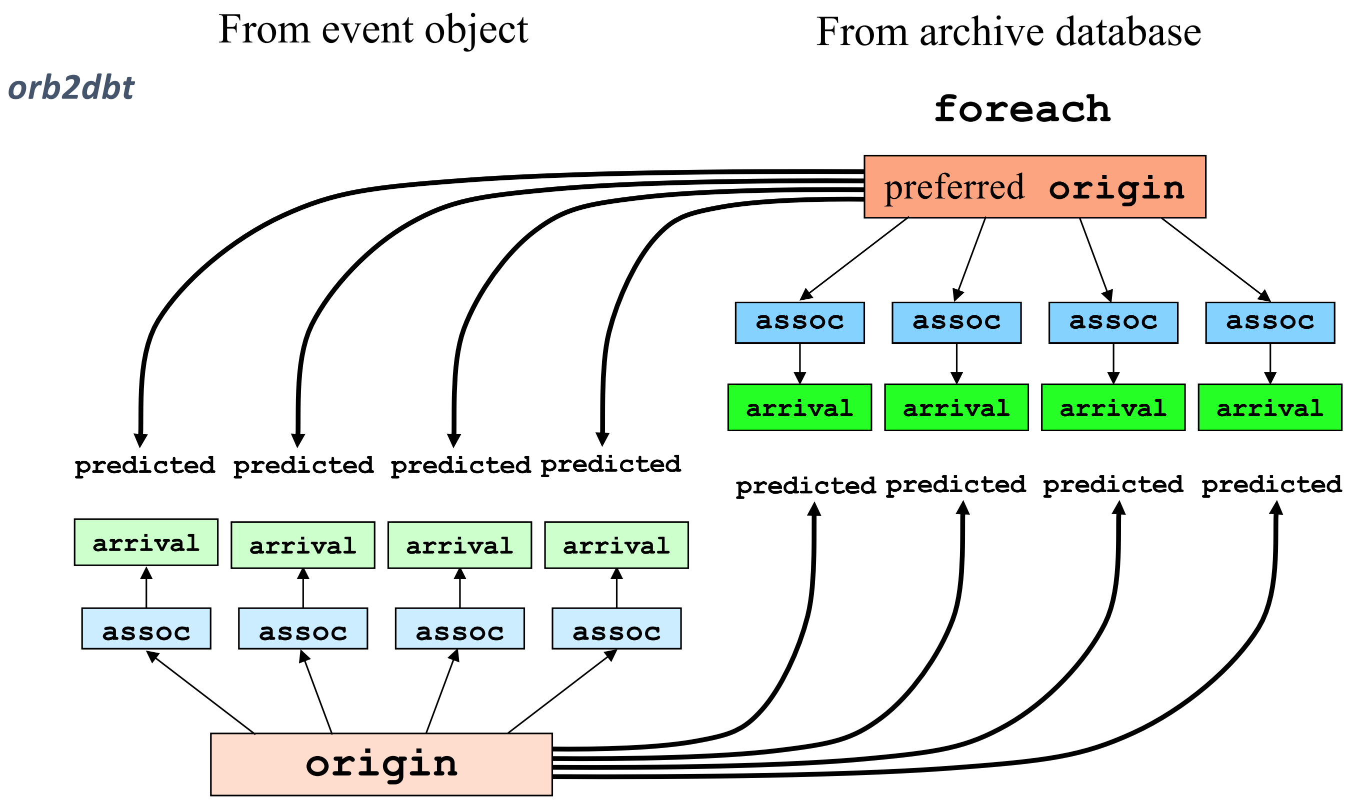
“Smart” event association



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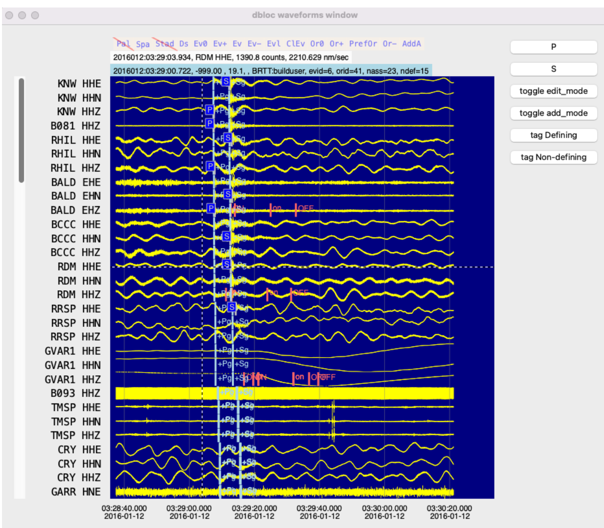
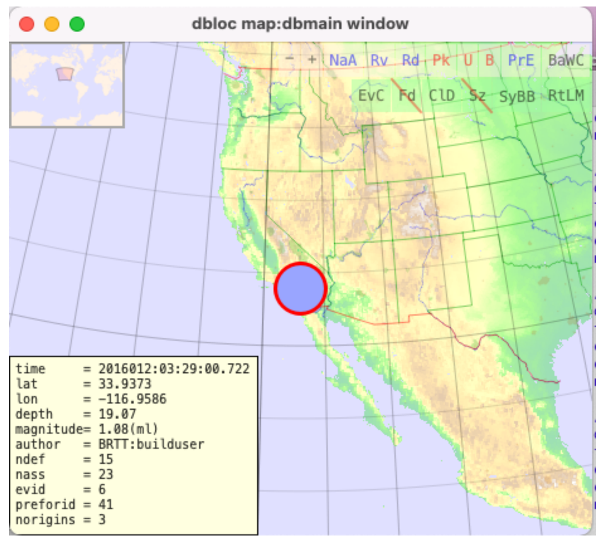
dbloc – Embedded Waveform Analysis and Mapping





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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.

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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

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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

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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

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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 Kinematrics, Inc.:
    - ***sales@kmi.com***
- Technical questions about Antelope:
  - Contact BRTT:
    - ***support@brtt.com***

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Thank You

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