

Open Source Software Platform for Electronic Monitoring

Sea State Inc, Saltwater Inc, Chordata LLC

Eric Torgerson

eric@chrdata.com

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Open Source?

- Open source software is ubiquitous.
- Open source software is compatible with private enterprise. IBM, Intel and Google are key contributors to libraries of source code used in this project. Microsoft provided some of the development tools free of charge because this project is open source.
- Use of existing open source libraries significantly reduces development costs
- Many types of open source licenses:
 - Public Domain - no license
 - MIT - liability protection and attribution
 - GPL - source from derivative works must also be made available

Open Source?

- Open source software encourages collaboration. Here are a couple of examples:
 - R statistical software – There is no proprietary aspect that acts as a barrier to the sharing of R-based solutions. Anyone can download R and run an analysis developed by someone else. We see sharing of configurations and other “recipes” for successful EM programs as a key potential benefit of this project.
 - Open CV – This is the most widely used computer vision library, initially developed by Intel. Universities teach computer vision using Open CV. Broad familiarity with this library means that it is not difficult to find programmers capable of extending the computer vision components in this project.
- Open source is NMFS Policy: <http://www.nmfs.noaa.gov/op/pds/documents/30/30-133.pdf>

Platform? A Collection of Easily Interfaced Software Components

- **Data acquisition** -> video analytics and other preprocessing of data -> **review** -> archival
- Designed with simple interfaces between components
- Simple interface points also allow for easy integration with proprietary components
 - Machine learning models
 - Archival solutions such as Amazon Glacier or Google Cloud Platform
- Well suited to integration into a production data environment – designed by database people, for database people

Key Technologies

- IP Camera Control using Open Network Video Interface Forum (ONVIF): <http://www.onvif.org/>
- Configuration and message passing using Google Protocol Buffers (Protobuf): <https://developers.google.com/protocol-buffers/>

Flexible to a Wide Variety of EM Programs

- All components are configuration driven, so EM programs using already supported sensors, cameras and computer hardware will require no additional software development effort
- Triggering of recording as well as changes to video parameters such as resolution, frame rate and image quality are based on rules involving sensor data, spatial lookups and/or computer vision

```
recording_profile {
  identifier: "BASELINE"
  camera_recording_profile {
    camera_module_identifier: "BACK_DECK"
    video_profile_identifier: "LOW_RES_2_FPS"
    mode: RECORD
  }
  camera_recording_profile {
    camera_module_identifier: "DISCARD_CHUTE"
    mode: STANDBY
  }
}

recording_profile {
  identifier: "HAULING"
  camera_recording_profile {
    camera_module_identifier: "BACK_DECK"
    video_profile_identifier: "HIGH_RES_10_FPS"
    mode: RECORD
  }

  camera_recording_profile {
    camera_module_identifier: "DISCARD_CHUTE"
    video_profile_identifier: "HIGH_RES_30_FPS"
    mode: RECORD
  }
}
```

GREEN indicates a reference to another configuration block (not all are shown on these slides)

BLUE indicates a built-in property or mode

```
trigger {
  identifier: "TRANSIT"
  condition: "GPS.IN_AREA.PORTS_KODIAK == false"
  failure_mode: TRUE_ON_FAILURE
  precedence: 2
  post_trigger_active_seconds: 60
  satellite_transmission_profile_identifier: "HOURLY"
  logging_profile_identifier: "BASELINE"
  recording_profile_identifier: "BASELINE"
}
```

```
trigger {
  identifier: "HAULING"
  condition: "AD.BACK_DECK_HYDRAULIC_PRESSURE > 150"
  failure_mode: TRUE_ON_FAILURE
  precedence: 1
  post_trigger_active_seconds: 7200 #two hours
  satellite_transmission_profile_identifier: "HOURLY"
  logging_profile_identifier: "BASELINE"
  recording_profile_identifier: "HAULING"
}
```

GREEN indicates a reference to another configuration block (not all are shown on these slides)
BLUE indicates a built-in property or mode

Shipboard Integration of Video Analytics

- Computer vision based recording triggers such as deck activity level or hatch position
- Logging and/or satellite transmission of virtual sensor values such as deck activity level, camera function
- Real time UI feedback for skippers – detection of an out of focus or failing camera...



Recording with profile HIGH_RES_HIGH_FRAMERATE (fishing) since Sat Aug 19 00:20:17 2017



Focus: OK Exposure: OK



Recording with profile LOW_RES_LOW_FRAMERATE (rtsp://192.168.3.13:8554/CH002.sdp) since Sat Aug 19 00:52:15 2017



Focus: **WARNING** Exposure: **OK**



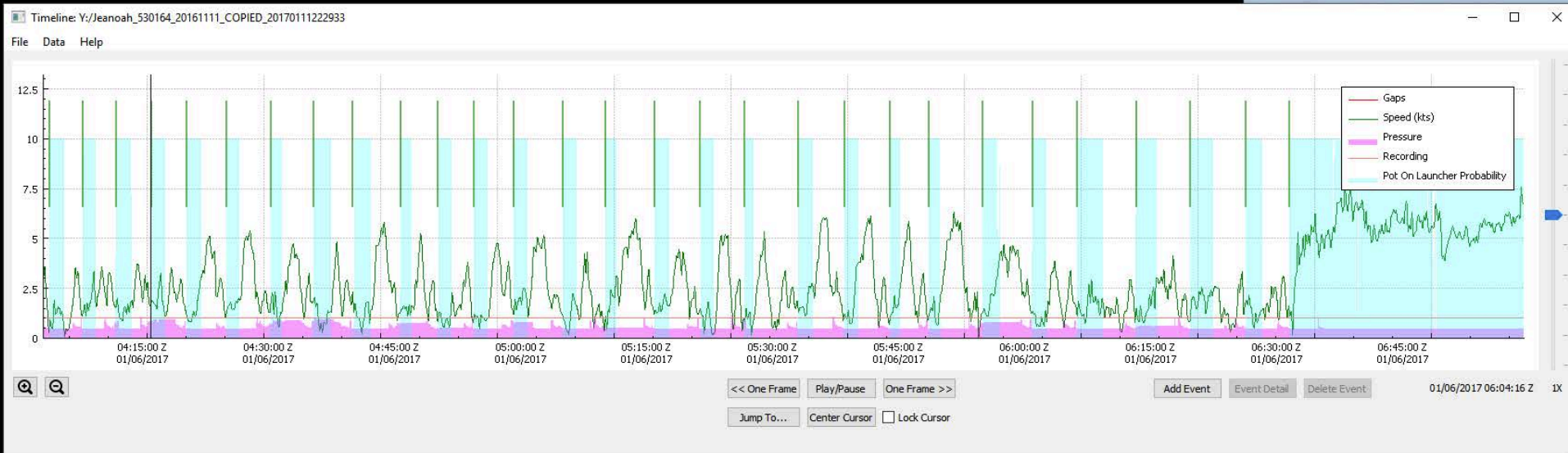
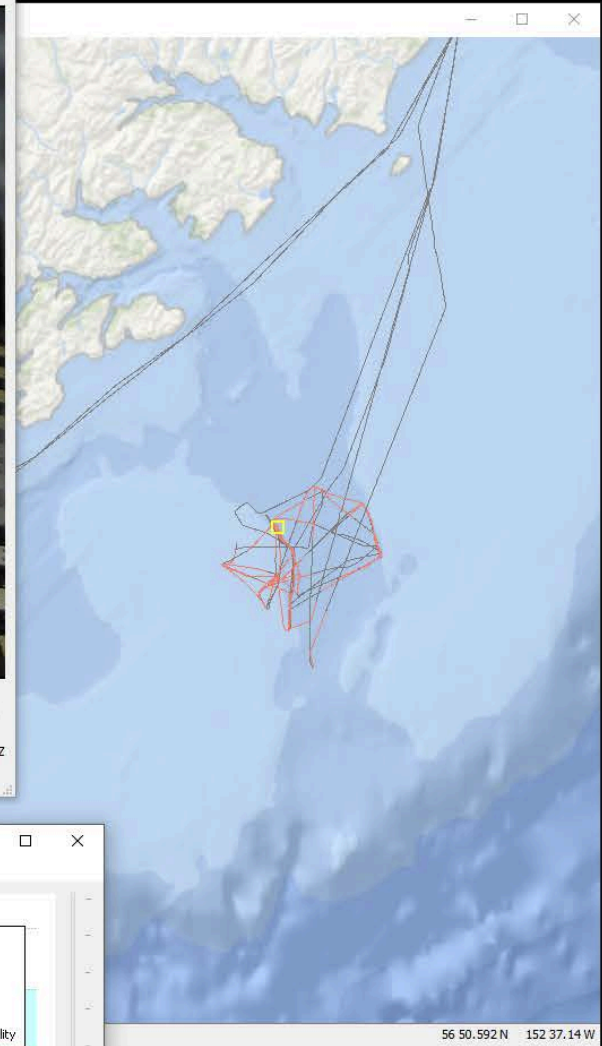
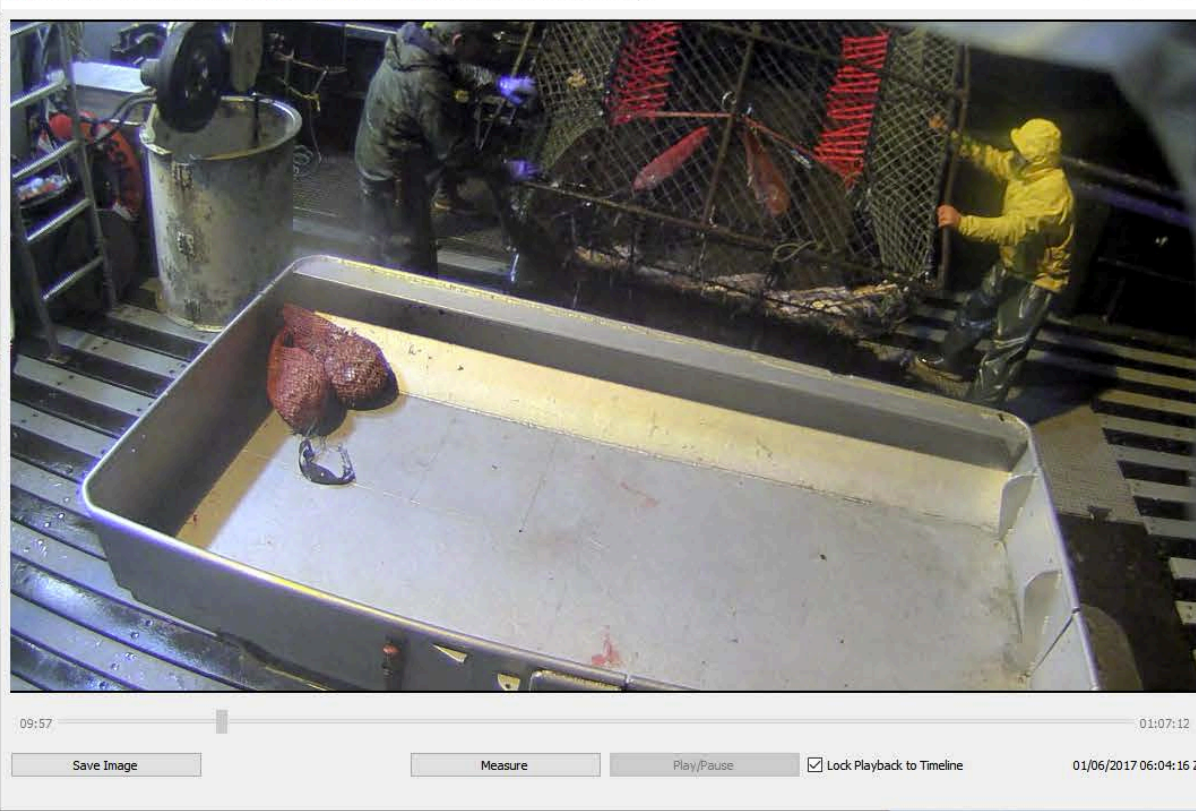
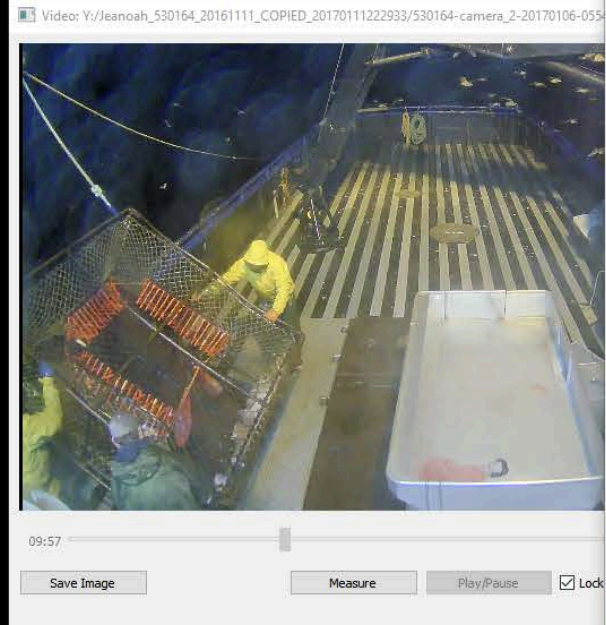
Recording with profile LOW_RES_LOW_FRAMERATE (rtsp://192.168.3.13:8554/CH002.sdp) since Sat Aug 19 00:52:15 2017



Focus: **ERROR** Exposure: **OK**

Shoreside Integration of Video Analytics

- Level of deck or sorting table activity
- Fish identification
- Gear identification - is there a pot on the launcher launcher?
- Automated creation of review data...



Secure

- No sensor or video data ever has to be written to disk in unencrypted form
- Software encryption is optional, allowing for use of hardware or OS level encryption if desired

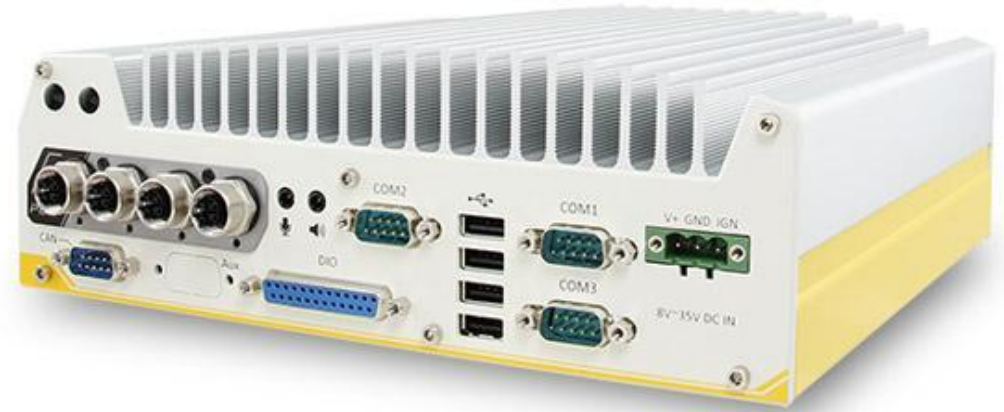
VMS Capabilities Using Iridium Satellite Network

- Provides near real time vessel position, sensor data and EM system health for a few dollars per day
- Works everywhere (on earth)
- Capture data on any interval and report it on any interval, with sophisticated queue and retry behavior
- Secure storage of all satellite messages along with EM sensor and video data

Hardware and Operating System Flexibility

- Well suited to low power, low cost platforms, can operate as a datalogger without cameras or a user interface
- Easy to achieve power budgets of 20-30W including 2 cameras
- Hardware cost of \$500-1500 before cameras
- Easily scales to 8+ camera systems
- Shipboard component supports Linux and Windows
- Review component supports Windows only currently
- C++ is fairly portable, so many other OS and hardware architectures are possible

Custom or Commodity Hardware?



Scheduled Field Trials

- Bering Sea Pollock Trawl (Sea State Inc)
- Gulf of Alaska Pot Cod (Saltwater Inc)
- Gulf of Maine Herring Pair Trawl (Saltwater Inc)
- Hawaii Tuna/Swordfish Longline (Saltwater Inc)

Requirements and Design Documents

- Data Acquisition: *<https://s3-us-west-2.amazonaws.com/chrdta/NFWF-EM/SeaStateSaltwaterChordataEmDataAcquisition.pdf>*
- Review: *<https://s3-us-west-2.amazonaws.com/chrdta/NFWF-EM/SeaStateSaltwaterChordataEmReview.pdf>*

Thanks!

- To all those who supported the project at inception, provided feedback on the design and helped with testing and field trials.

