CARIS

IEHG XIII
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Introduction

- 35+ years developing commercial GIS solutions
  - Specialised focus on GIS for the maritime community
  - Includes enterprise GIS for marine spatial data
- Use international standards and participate in industry working groups:
  - IHO, ISO/TC211, OGC and others
  - Ensures interoperability and maximum use of data
- Installations in over 85 countries
  - Includes government agencies, private companies and academic institutions
  - Used by 92% of the world's hydrographic authorities

- ISO 9001:2008 certified Quality Management System
  - Includes all CARIS processes
    - Software development, business/sales, customer service and more
- 170 employees world wide
  - Canada, Netherlands, USA, Australia and the UK
  - Industry leading team of professionals with industry experience and academic backing
- Global network of Alliance Partners/Representatives
  - 20+ Alliances

Key Areas of Focus

- **Processing**
  - Hydrographic data processing and visualisation
- **Analysis**
  - Elevation data (i.e. bathymetry and terrestrial) and metadata
  - Engineering analysis (e.g. ports and waterways)
  - Maritime limits and boundaries
- **Production**
  - Nautical paper charts and electronic products (e.g. S-57)
  - Products under IHO S-100 (e.g. S-101 ENC)
- **Discovery**
  - OGC standards based web mapping for interoperability
  - Technology in support of Marine Spatial Data Infrastructure (MSDI)
- CARIS is the only organisation able to offer the marine community a complete and streamlined GIS solution from Ping-to-Chart

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Towards Data Centricity

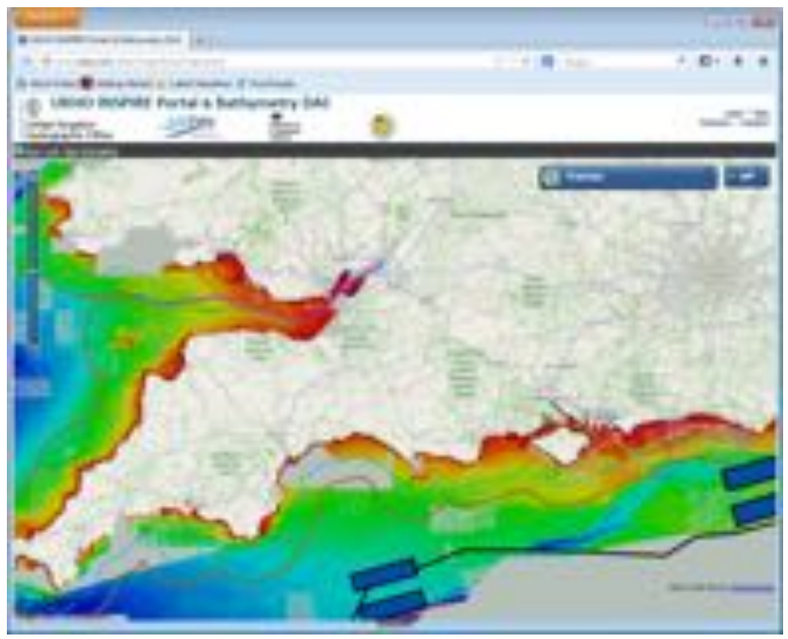
Many geospatial organisations are thinking about data centric workflows and management

- To realise efficiencies
  - Quicker turn around of bigger survey datasets
  - More automation in processing and product compilation
  - Better utilisation of human resources
  - Greater use of hydrographic data
- To cater for a broader customer base
  - New and ad hoc products and services
- To be an effective data provider

The basic challenge of interoperability has been solved, standards based technology and data abound

In order to get maximum value from hydrographic data, hydrography needs to embrace interoperability further

- At the last IHO HSSC meeting in Chile CARIS was asked by the OGC to bring this topic to the IHO's attention



OGC and ISO standards are supporting rapid discovery, access, fusion and application of location based info

- CARIS software continues to further utilize these standards in all its applications
  - Web Map
  - Web Feature
  - Web Coverage
  - Web Processing
  - Catalogue
  - Geographic Markup Language
  - Sensor Web Enablement

- Which allows a greater range of data to be supported

GML Application Activities

Profiles

- GML Point Profile
- GML Simple Features Profile
- GML GeoShape for use in IETF
- GML in JPEG2000
- GeoRSS: GML Serialization

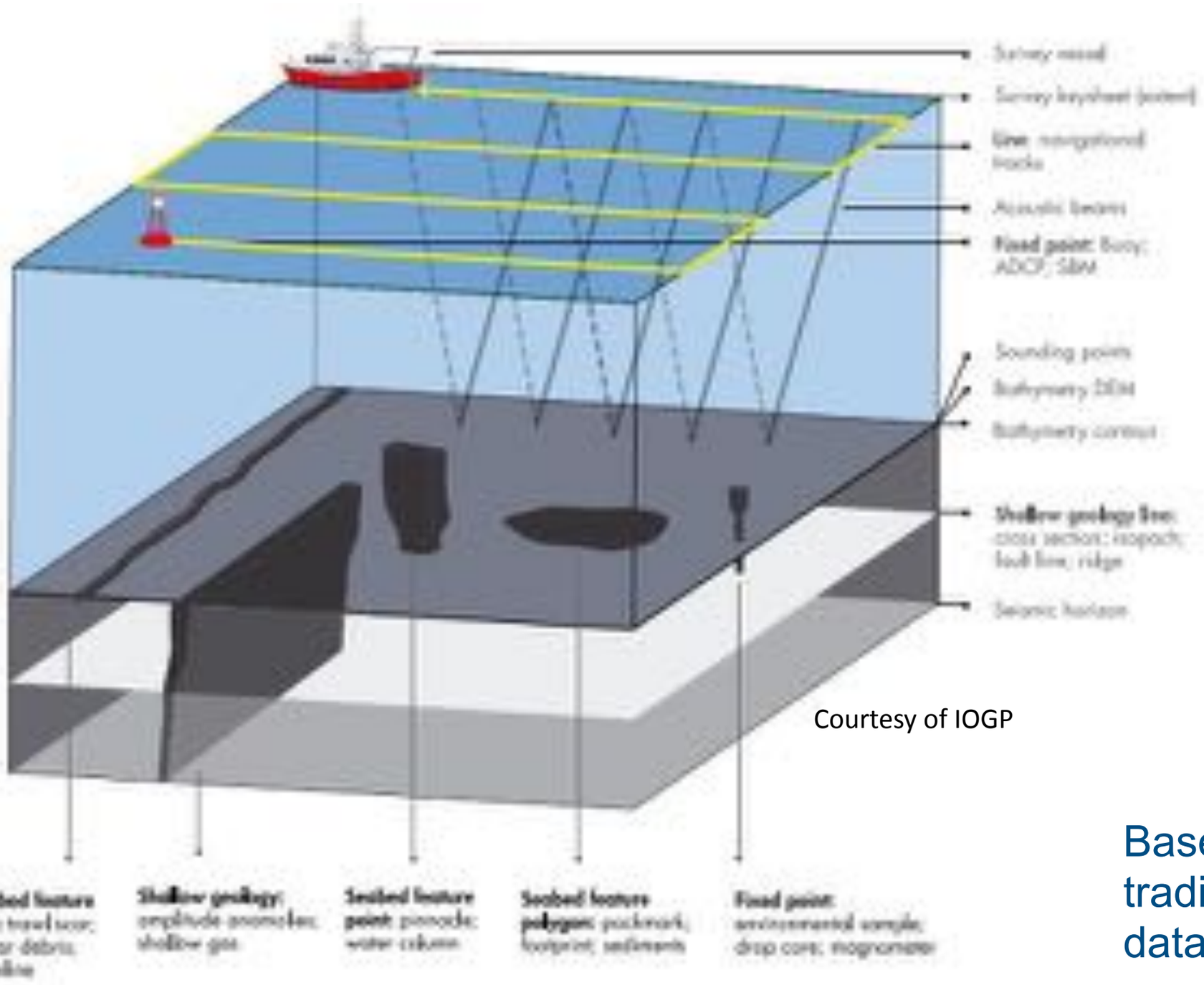
Groups building GML Application Schemas

- US NSDI
- GEOINT
- INSPIRE
- IHO
- IOGP

Application Schemas

- CityGML
- WaterML
- GeoSciML
- Climate Science ML (CSML)
- CleanSeaNet
- NcML/GML (NetCDF and GML)
- TDWG Biodiversity GML
- MarineXML
- Ground Water Modeling Language
- S-100
- SeabedML (SSDM)

Seabed Survey Data Model has been developed by the Oil and Gas industry to standardise survey deliverables



Courtesy of IOGP

Based on a traditional GIS data model

SeabedML is the non proprietary exchange format for SSDM

- It is a GML application schema
  - GML is a ISO std
  - GML is a OGC std
  - XML is W3C std

- SeabedML allows any GIS to work with SSDM

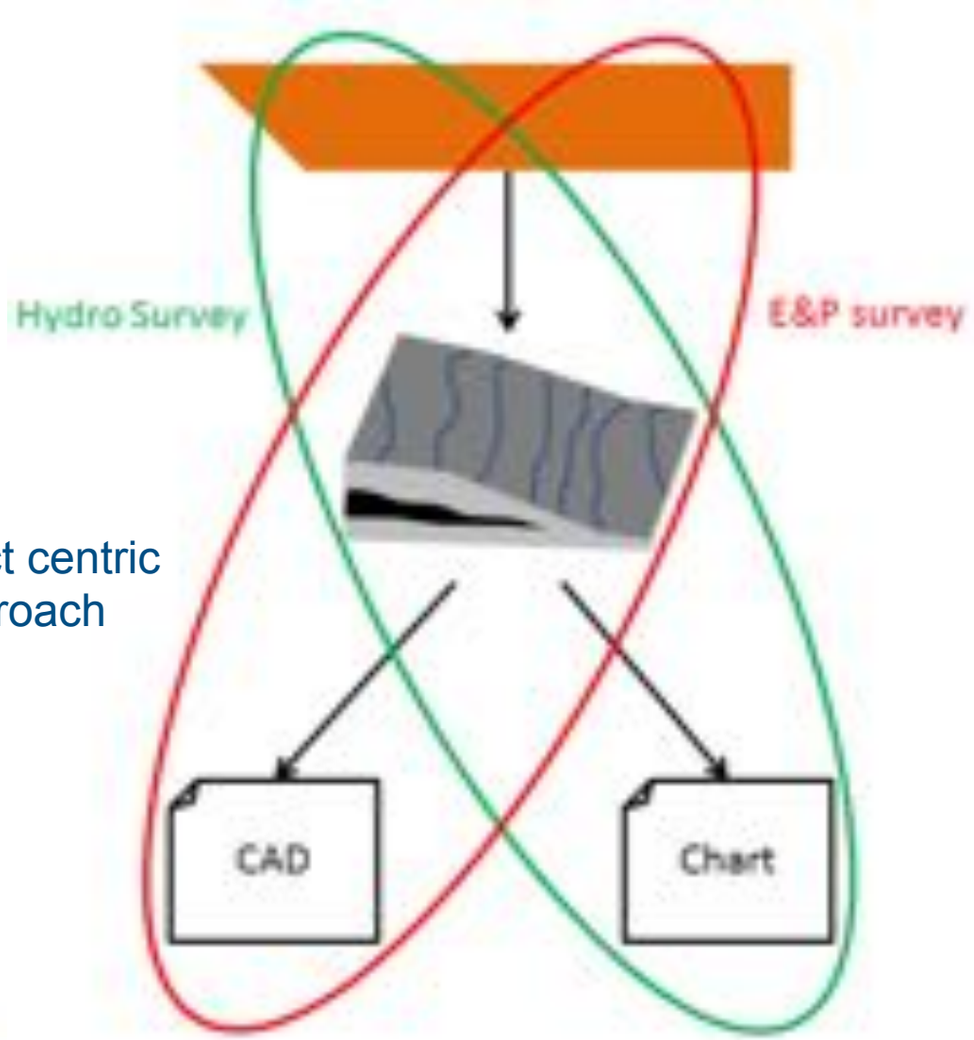
- CARIS helped develop SeabedML with SHELL Malaysia

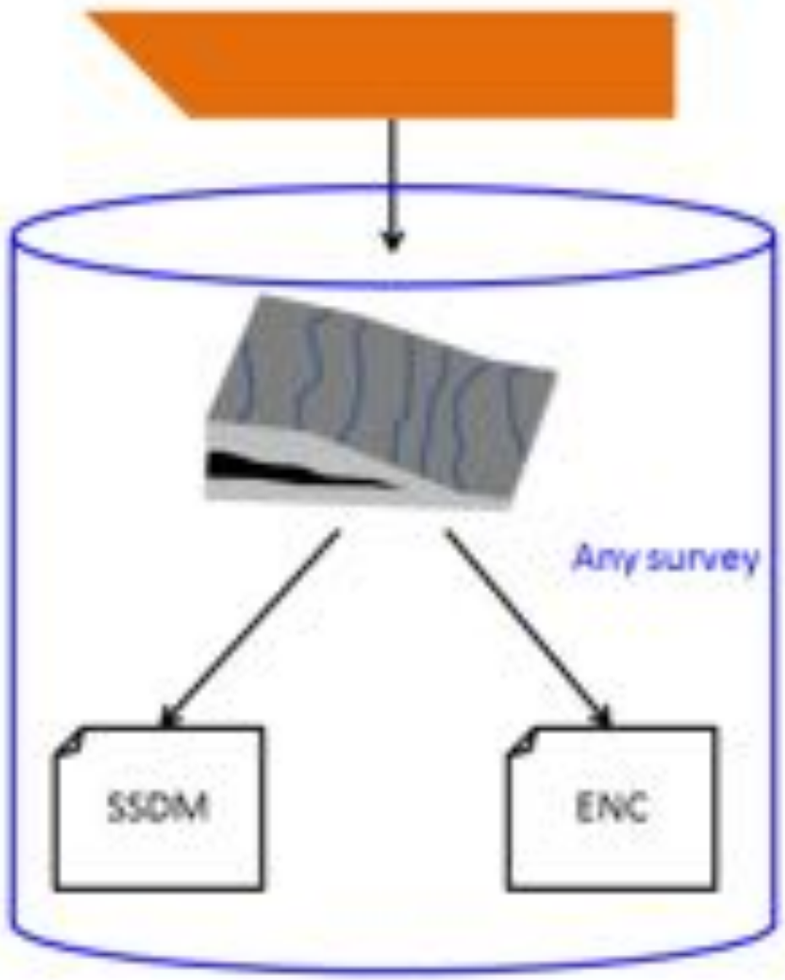
SeabedML will allow Hydrographic agencies and Oil and Gas companies to exchange data more easily

Different processes, data standards and deliverables depending on the purpose of the hydrographic survey

- IMCA/IOGP guidelines for Oil and Gas
- IHO guidelines for SOLAS

product centric approach

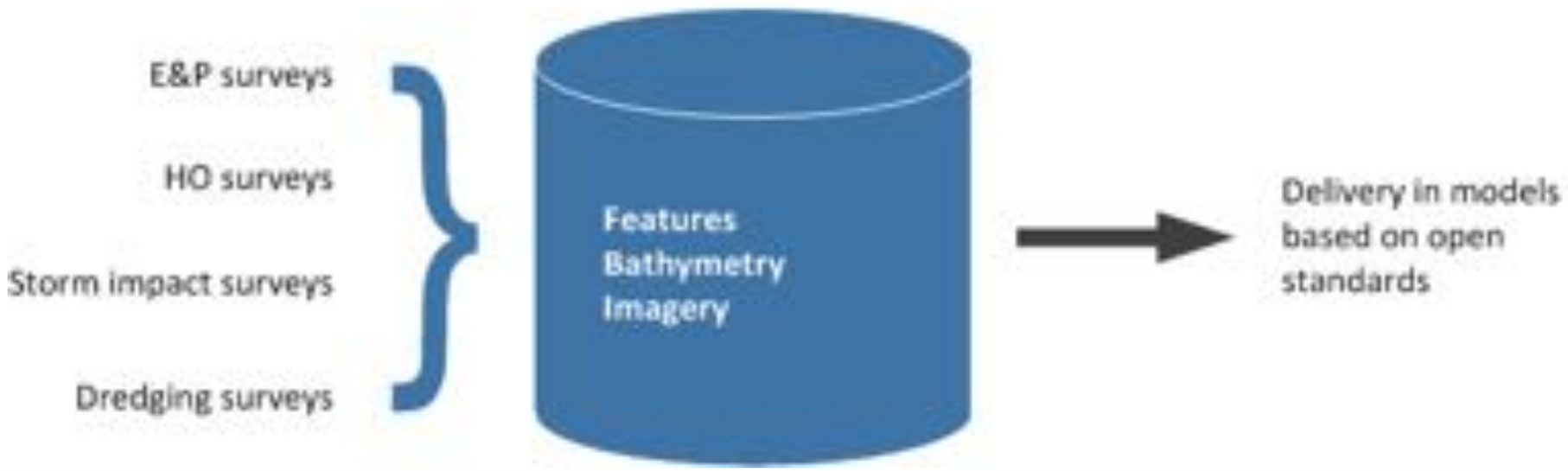




data centric approach

Hydrographic Offices and Oil and Gas companies can benefit from modern data management and GIS practices

- Increased focus on data not paper
- High res source and derived features
- Support for multiple data models
  - S-100, SSDM, AIXM5, VPF
- Standard metadata profiles



Interoperability and data harmonisation is key to putting hydrographic data to work and realising greater value from it

e.g. Common Operating Picture for Oil Spill Response

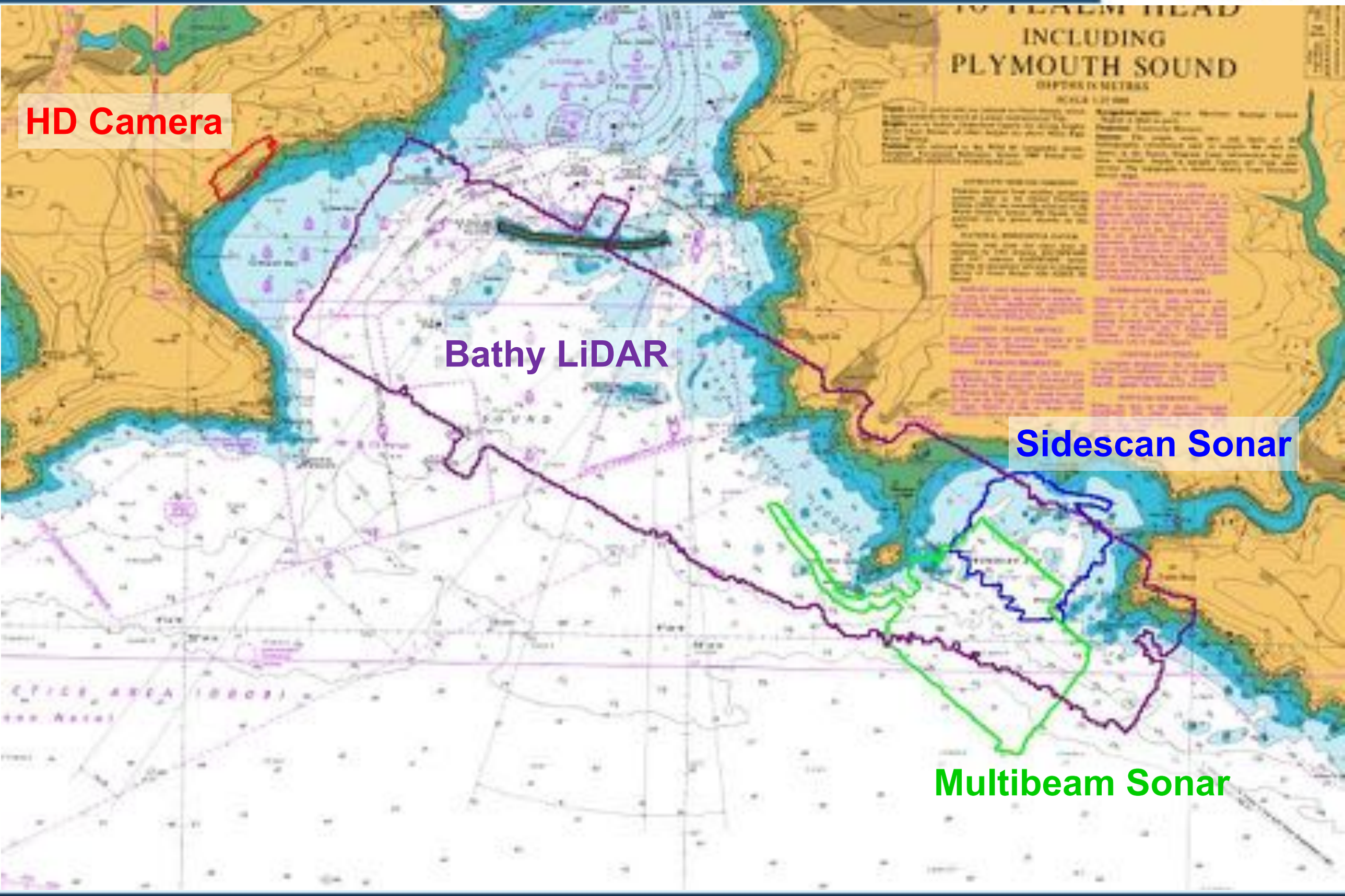
(Figure Source: Shell)

The surveyors toolbox is constantly expanding and the sensors used are generating bigger and bigger datasets

- OPTICAL
  - Laser scanner
  - LiDAR
  - Camera
  - Underwater laser technology
- ACOUSTIC
  - Multibeam sonar
  - Sidescan sonar
  - Synthetic aperture sonar
  - Imaging sonar
  - Sub-bottom profiler
- LOCATION
  - GNSS
  - Motion


Underwater Laser Scanner
2G Robotics

Data Fusion


HD Camera
Bathy LiDAR
Sidescan Sonar
Multibeam Sonar
INCLUDING
PLYMOUTH SOUND

Elevation data from camera on a Topcon Sirius Pro

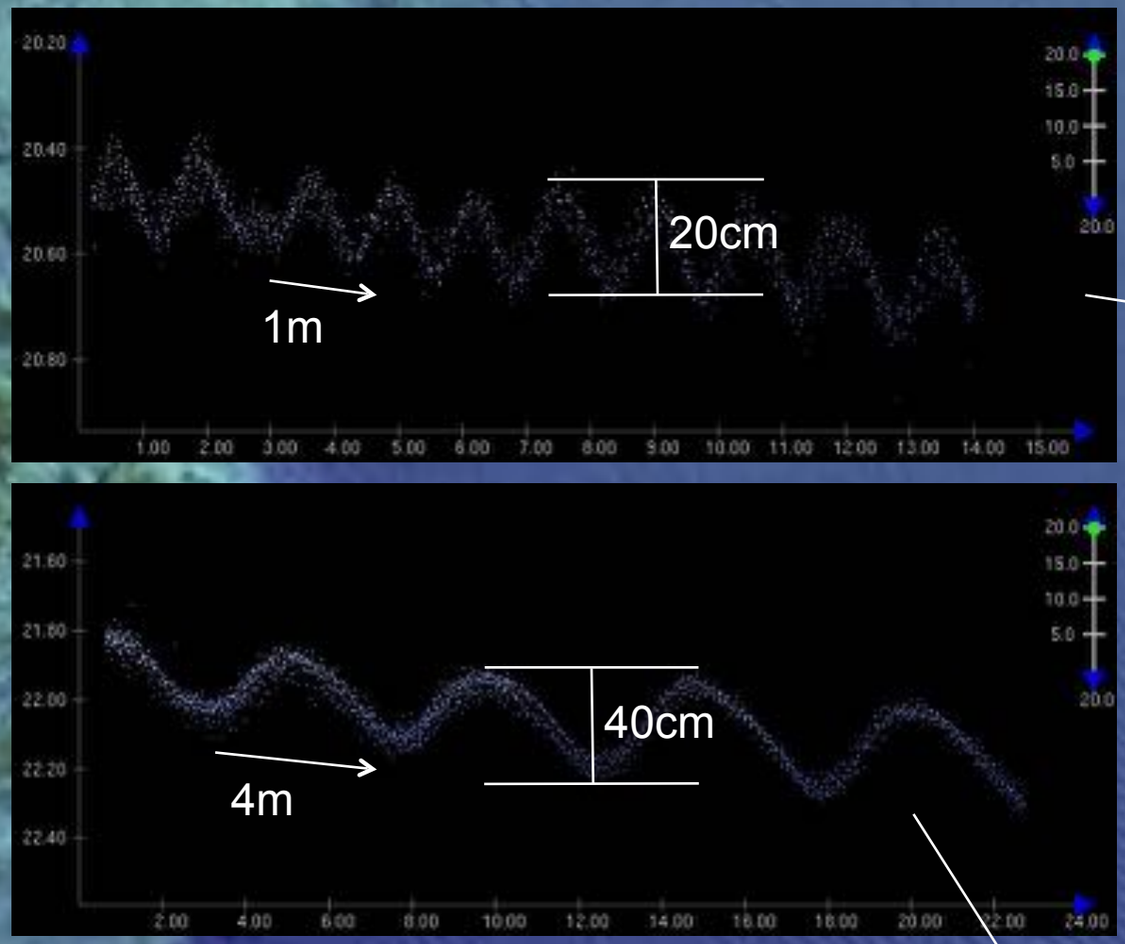
CSAR Point Cloud = 82 million points
Area = 300m x 700m

Bathy LiDAR – Fugro LADS Mk II

Data from Shallow Survey 2005

CSAR Grid = 3m Resolution
Topographic and bathymetric data

Multibeam Sonar – Kongsberg EM2040



CSAR Grid = 20cm Resolution

Data from Shallow Survey 2015

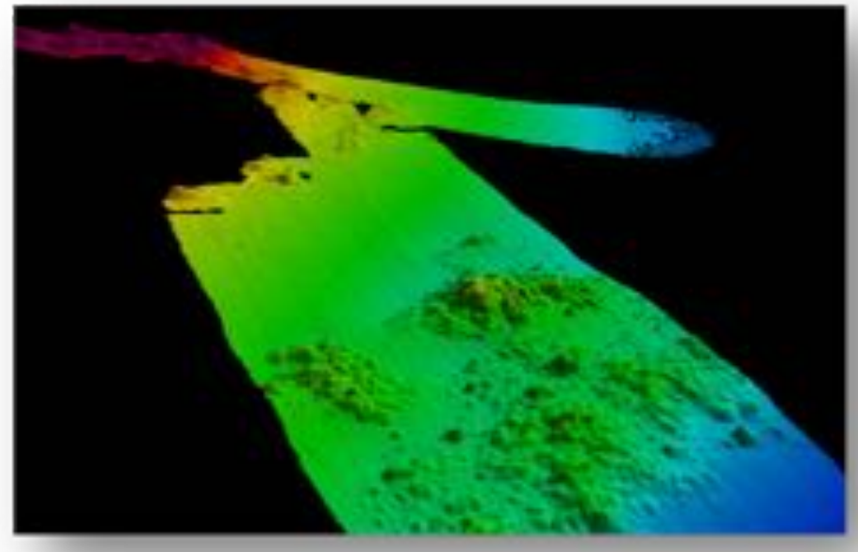
Autonomous Survey Platforms

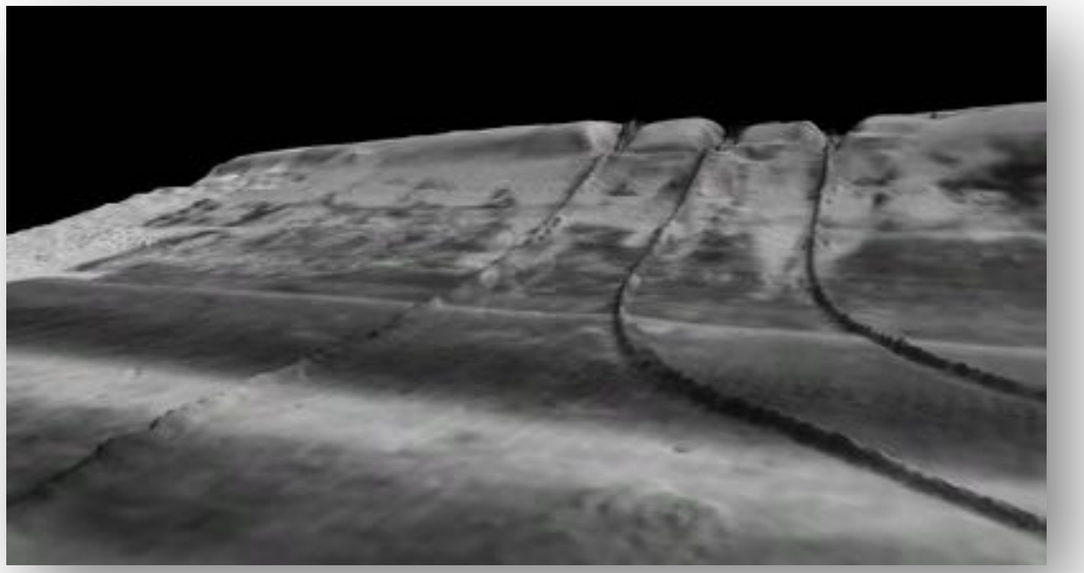
- AUV
- USV
- UAV

- Will become widely adopted survey platforms
- They serve as a force multiplier for survey operations

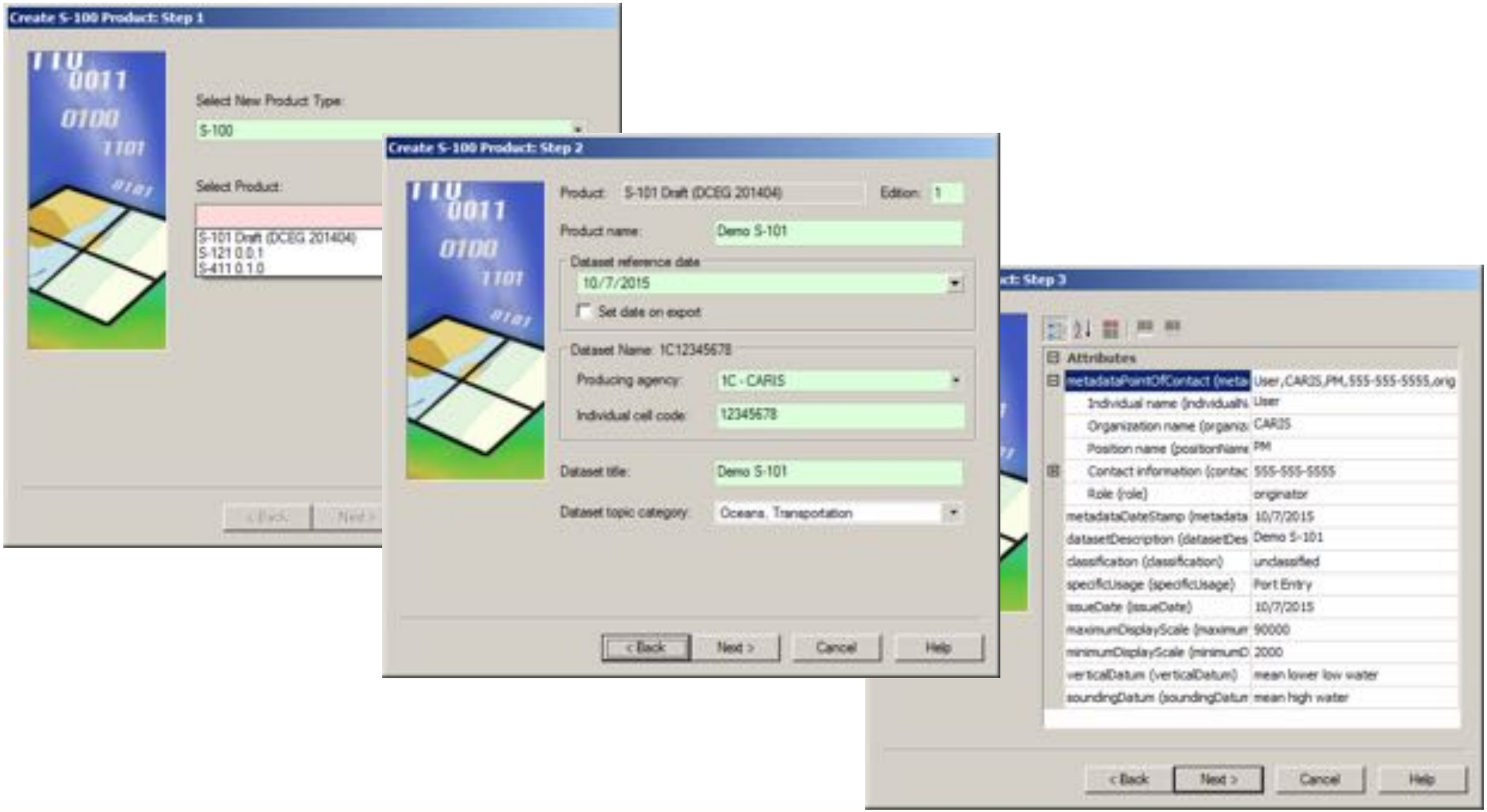
The BIG Data Processing Challenge

- Autonomous Survey Operations have increased over the past 5 years
- Benefits are lower operating costs, rapid deployment/recovery, ability to work closer to the intended target
- Data stored internally and processed post mission
- As power sources improve operating times extend = more data!
- Creating a data processing bottleneck
- Driving the need for automation and near real-time processing
- CARIS Onboard to Data Store





S-57 Composer 3.0 & S-100



S-100 Attributes

Multiplicity

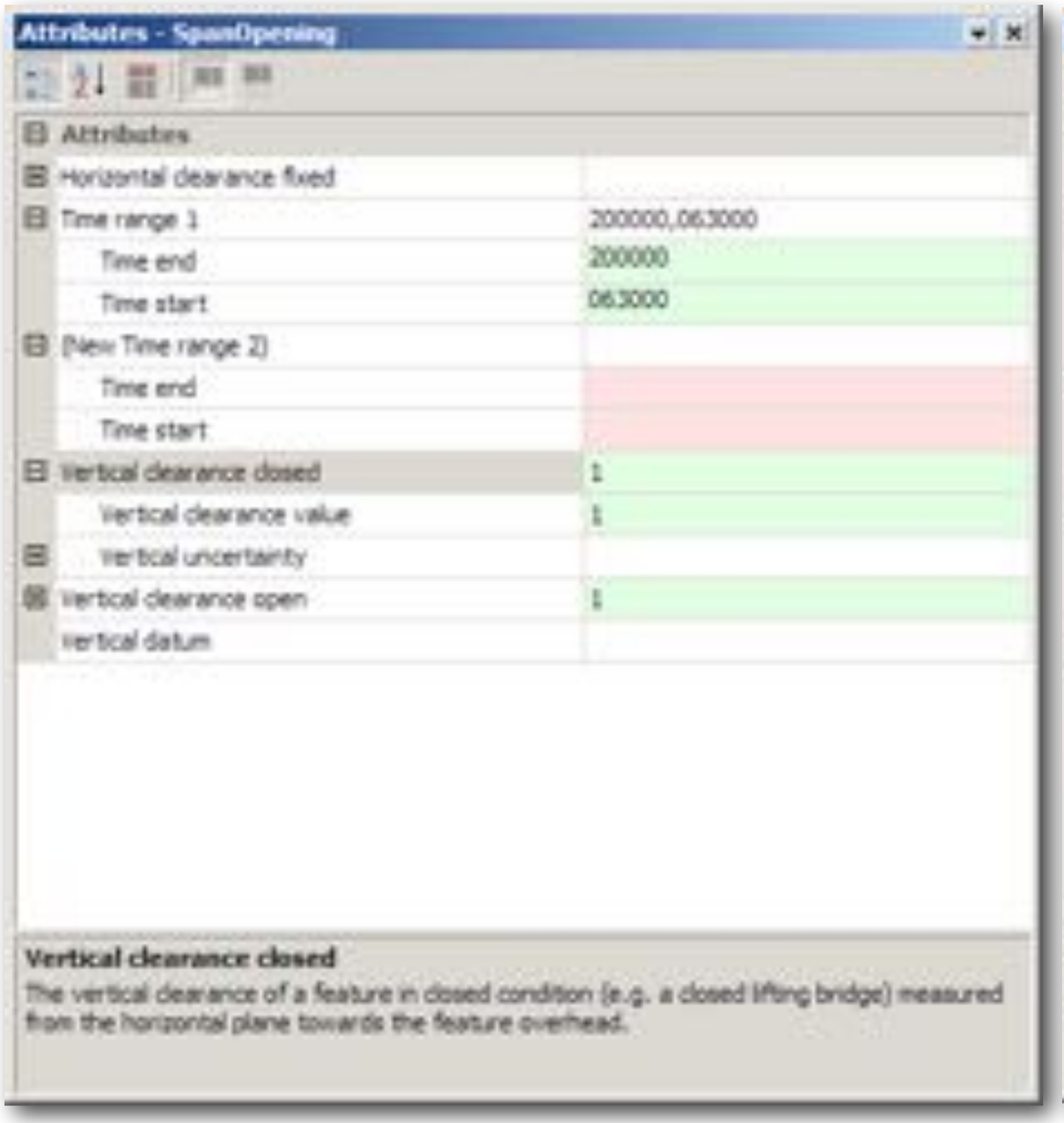
Colour	(COLOUR)	1 : white 2 : black 3 : red 4 : green 5 : blue 6 : yellow 7 : grey 8 : brown 9 : amber 10 : violet 11 : orange 12 : magenta 13 : pink	EN	1,* (ordered)

S-100 Attributes

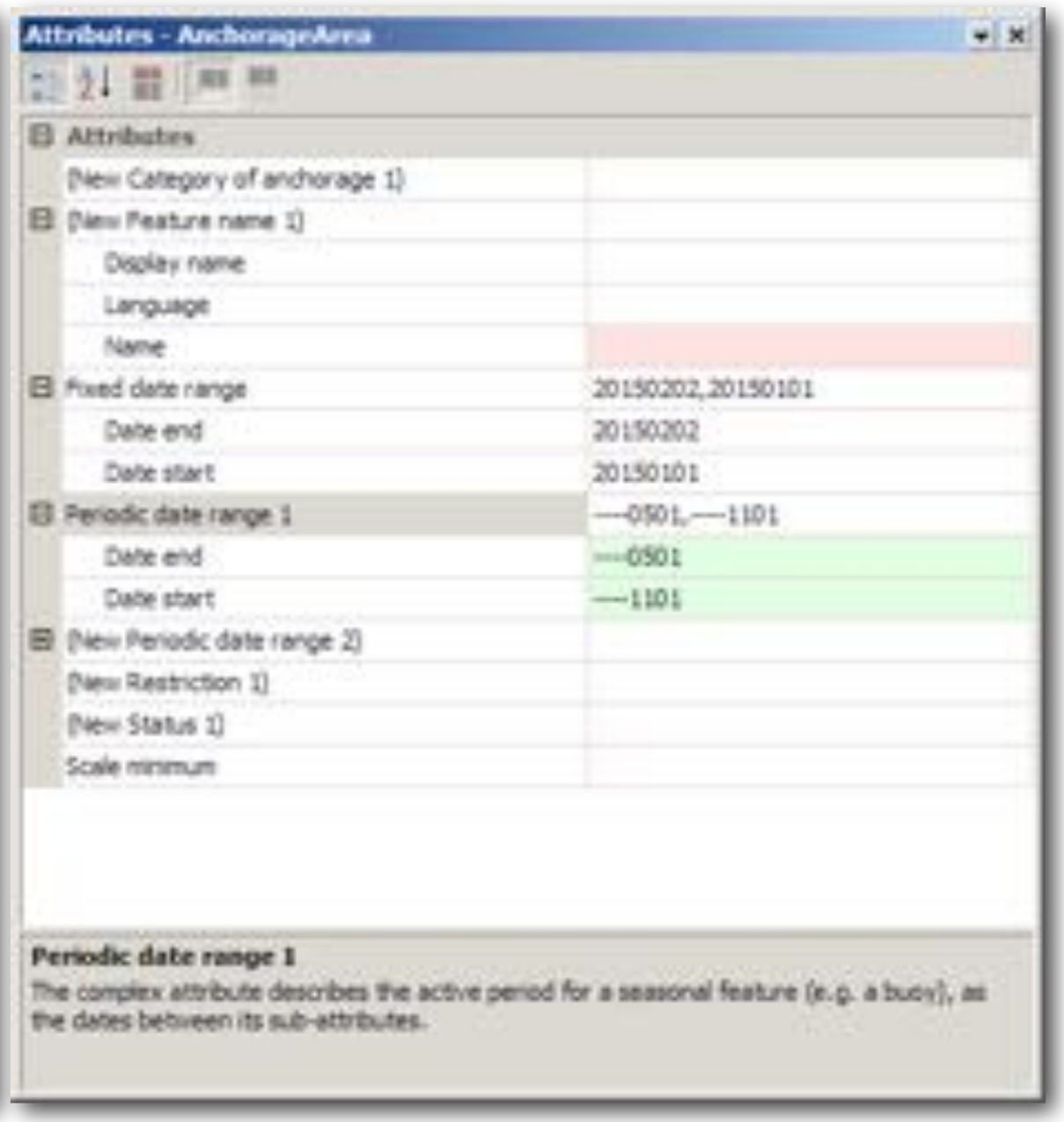
Complex Attributes

Topmark	*(TOPMAR)*		C	0,1
Colour	(COLOUR)	1 : white 2 : black 3 : red 4 : green 5 : blue 6 : yellow 7 : grey 8 : brown 9 : amber 10 : violet 11 : orange 12 : magenta 13 : pink	(S) EN	0,1
Topmark/daymark shape	(TOPSHP)	1 : cone, point up 2 : cone, point down 3 : sphere 4 : 2 spheres 5 : cylinder (can) 6 : board 7 : x-shape (St. Andrew's cross) 8 : upright cross (St George's cross) 9 : cube, point up 10 : 2 cones, point to point	(S) EN	1,1

Time & Date Ranges (Complex)

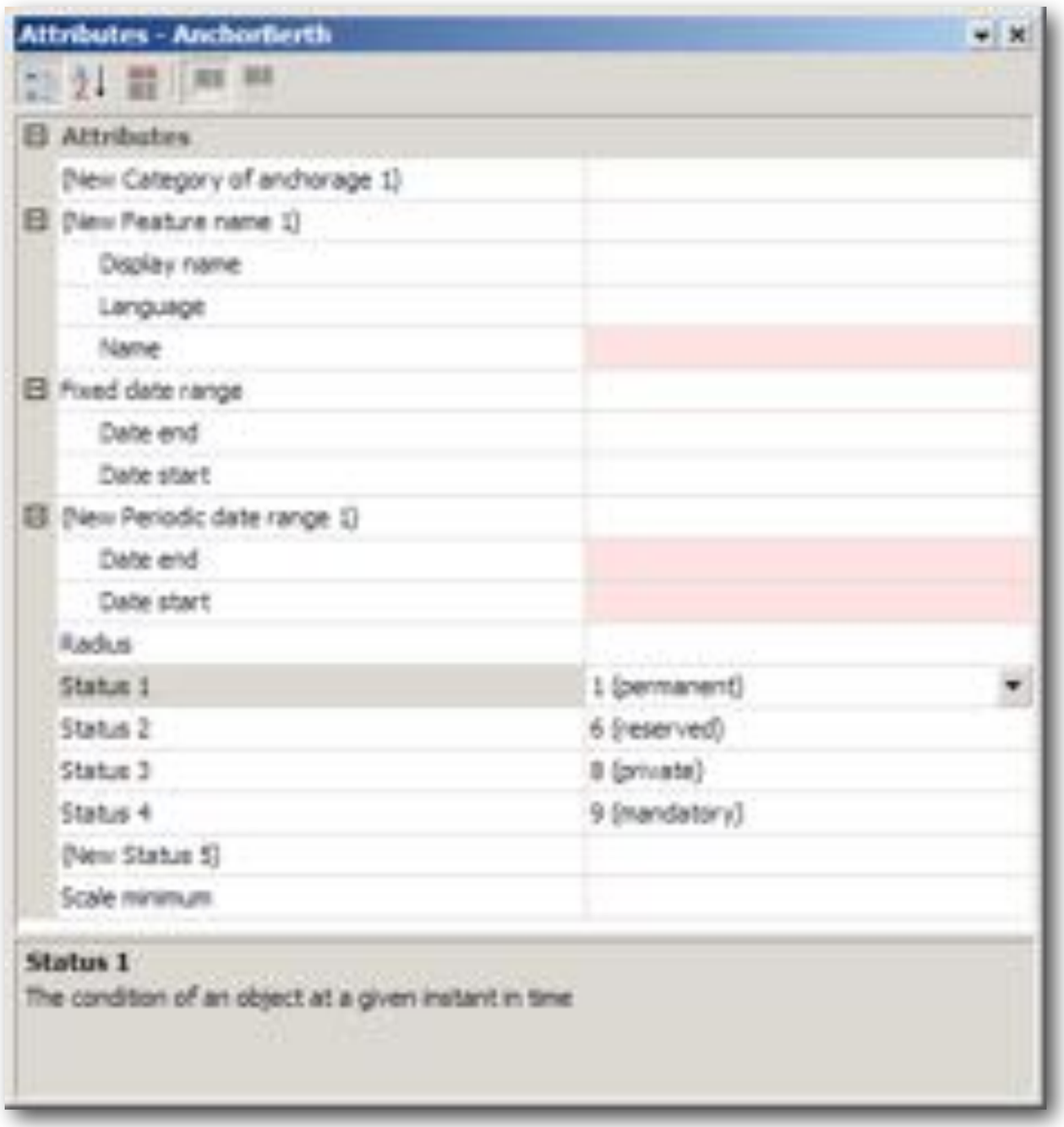


Time

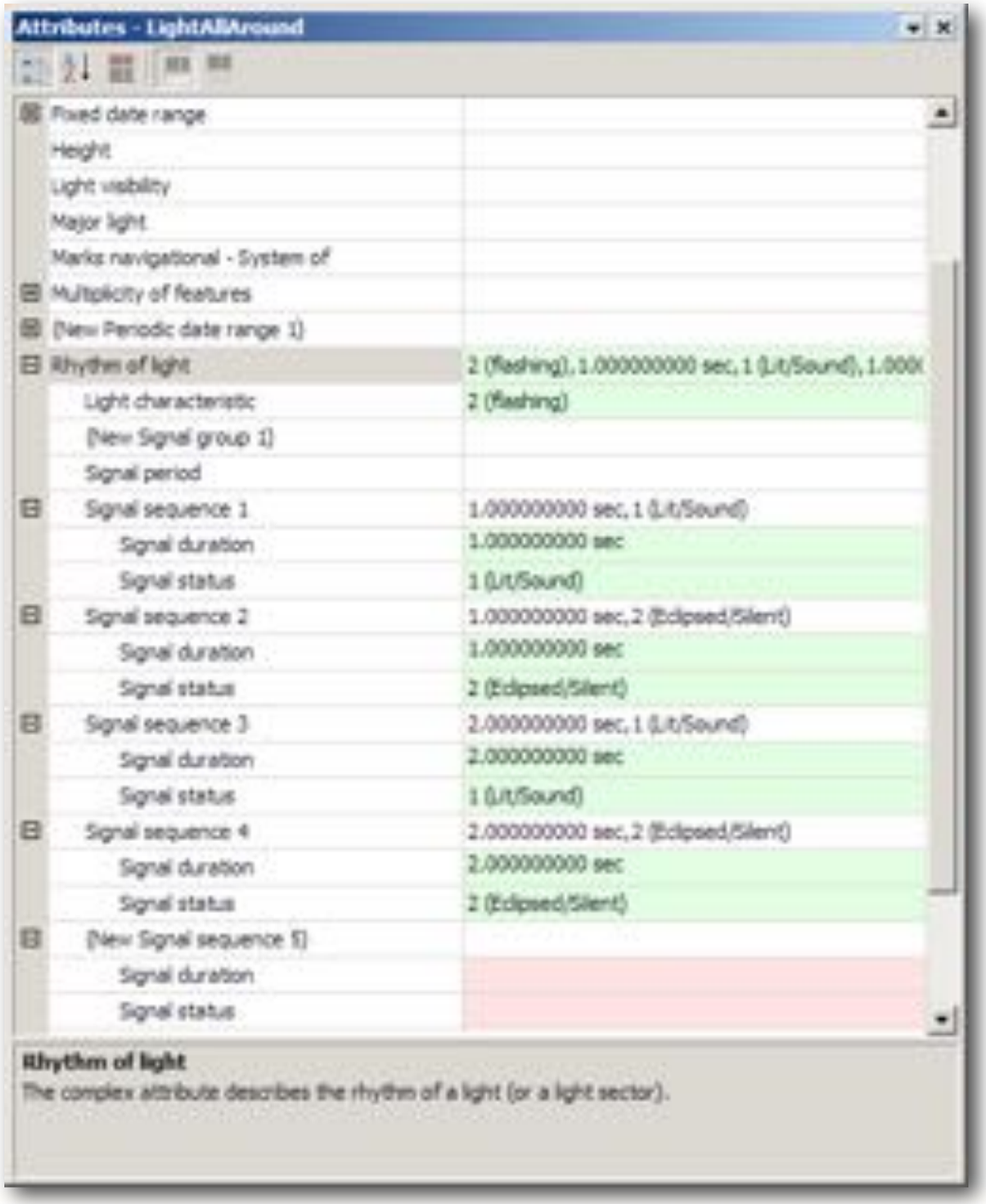


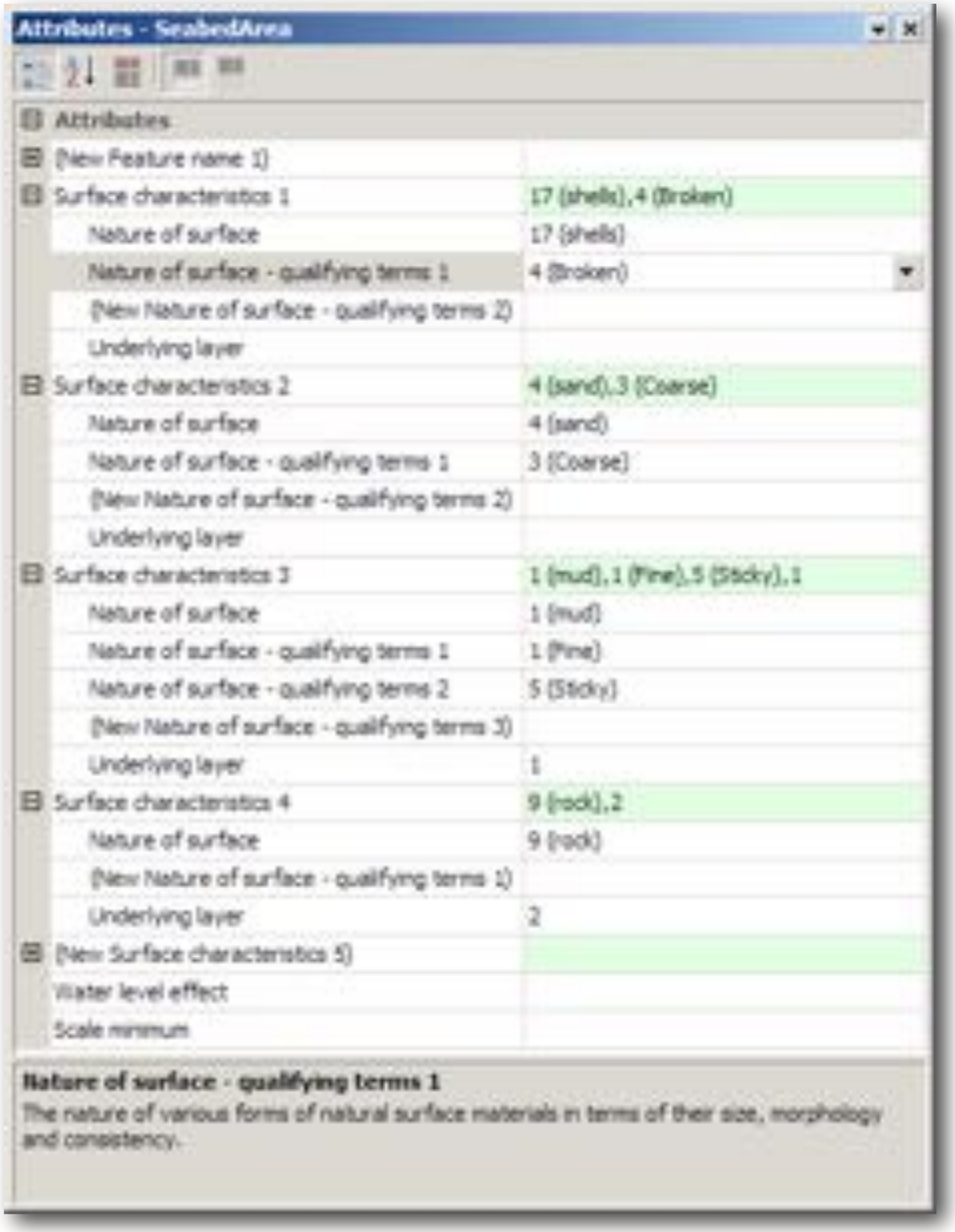
Fixed & Periodic Dates

Multiplicity

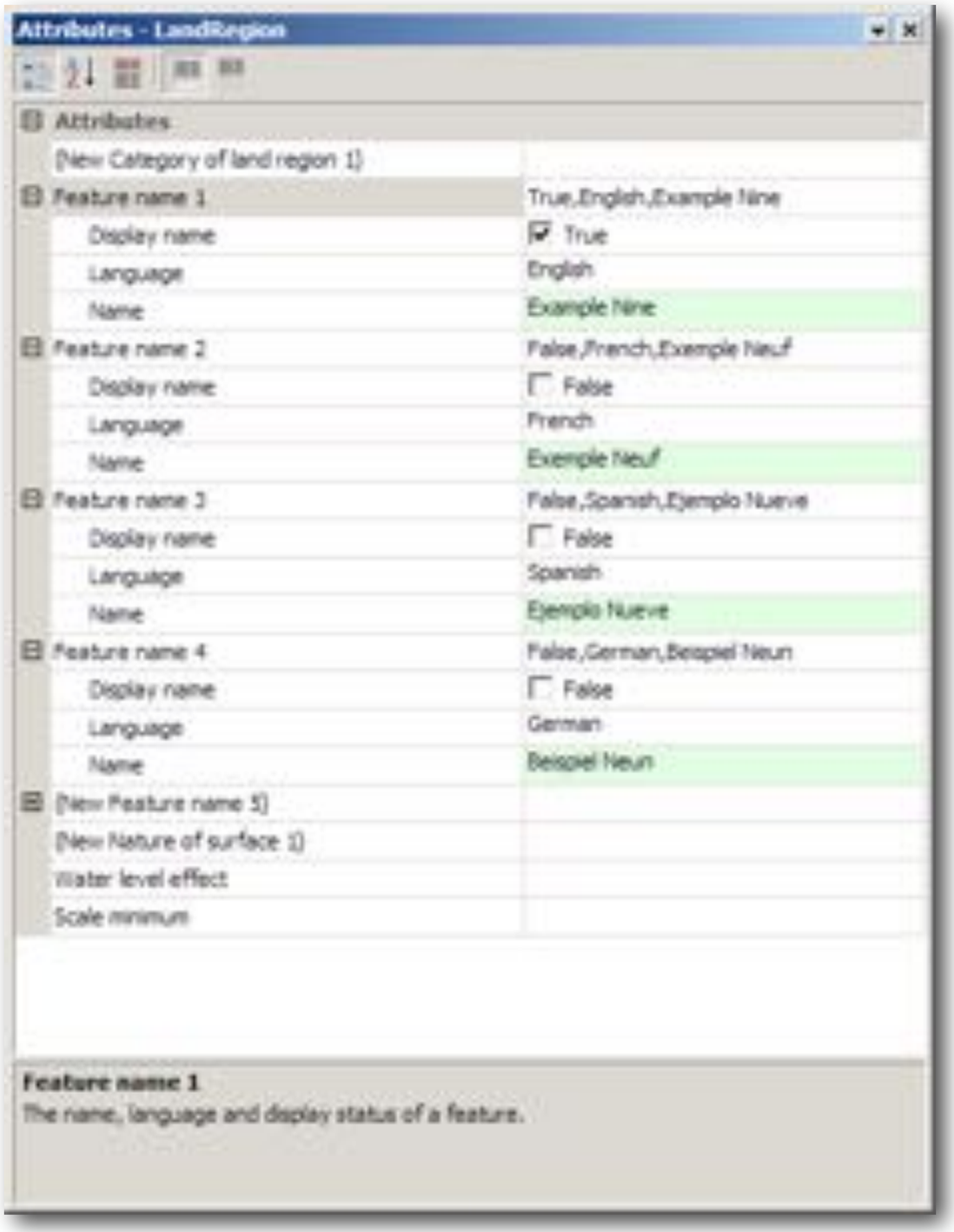


Complex with Multiplicity

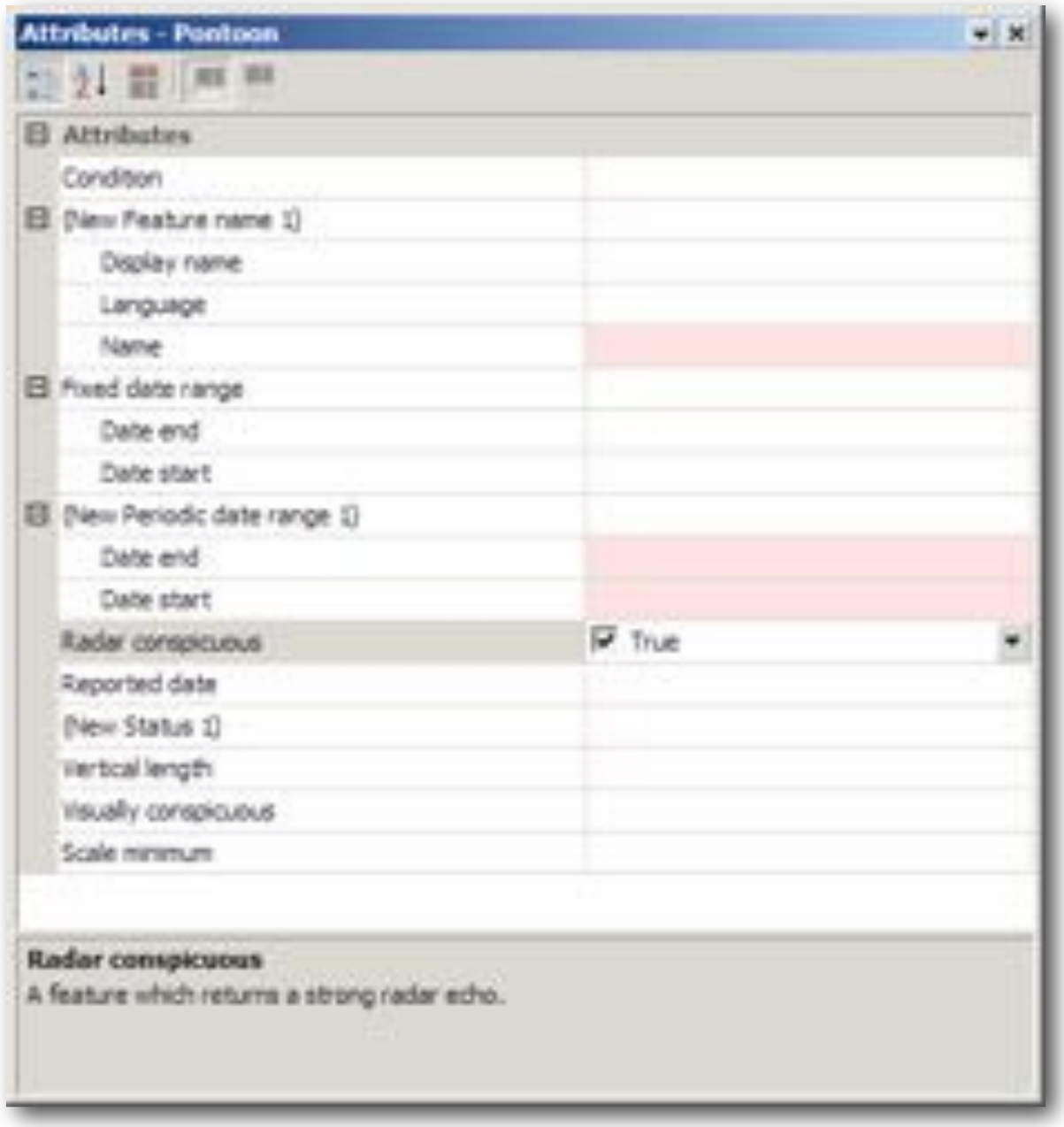




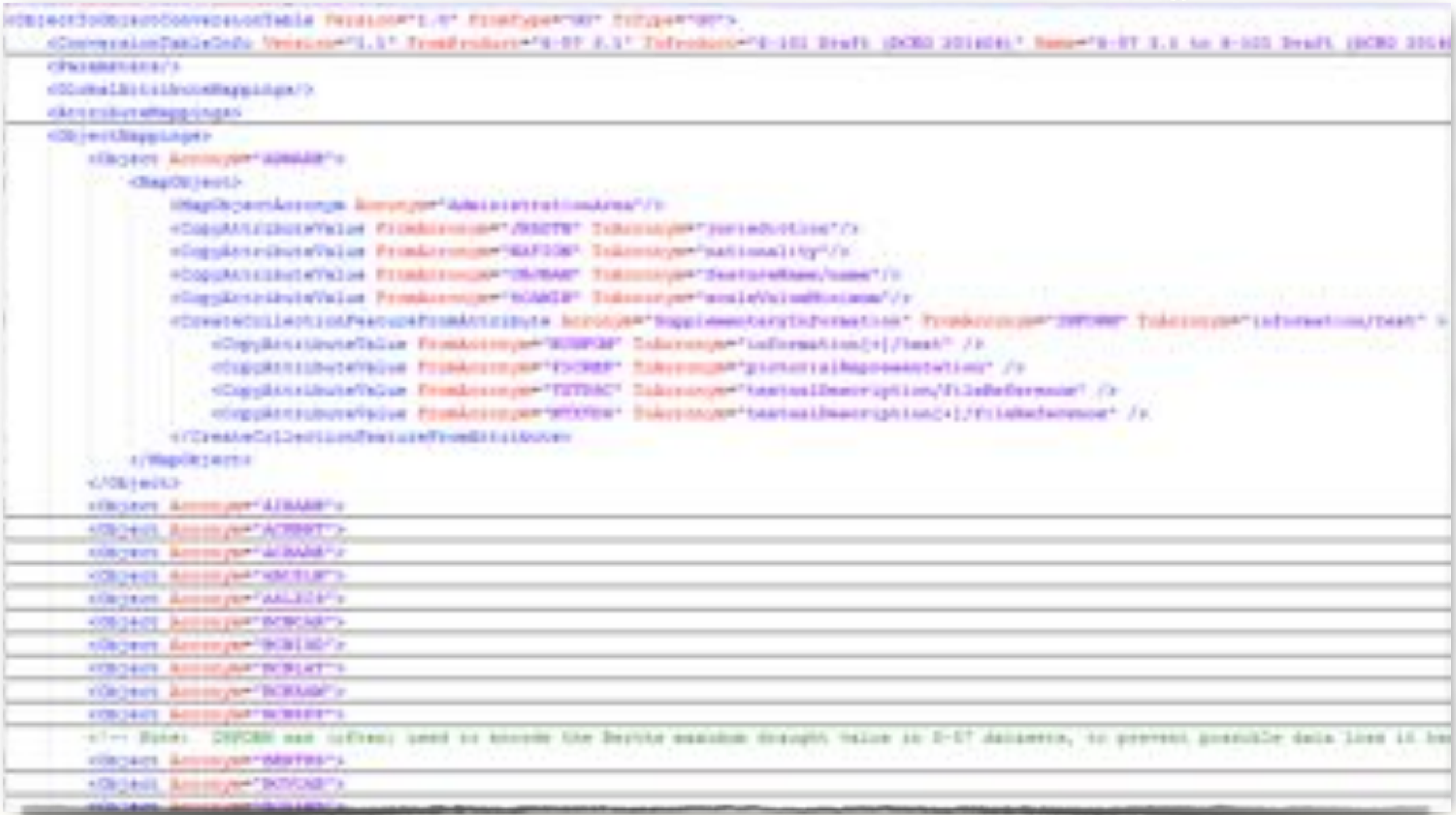
Displayed Feature Names



Boolean


Attributes - Pontoon
Attributes
Condition
[New Feature name 1]
Display name
Language
Name
Fixed date range
Date end
Date start
[New Periodic date range 1]
Date end
Date start
Radar conspicuous
True
Reported date
[New Status 1]
Vertical length
Visually conspicuous
Scale minimum
Radar conspicuous
A feature which returns a strong radar echo.

S-57 to S-101 Mapping



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An Introduction to Near Real Time Data Processing

Introduction

- The volume of Autonomous Survey Operations have increased over the past 5 years
  - Not only AUVs, but ASVs

- Potential benefits
  - lower capital & operating costs
  - rapid deployment/recovery
  - work closer to the intended target

- Traditionally, the platform would be sent on a pre-defined mission and gather hydrographic data, to be stored internally until recovery when it would be processed

- As power sources improve operating times, little has been done to address the data bottleneck

Autonomous Platform Market

Mission Duration

Short - term

Persistent

Sub Surface

Surface

Manned / Autonomous

- Autonomous platforms often lack the ‘human control’ in the feedback loop
- Data deliverables may be slower
  - Data typically has to be processed after download at end of mission (small real-time communications bandwidth)
  - Data could be incorrectly acquired due to lack of surveyor interaction with platform (no feedback loop)

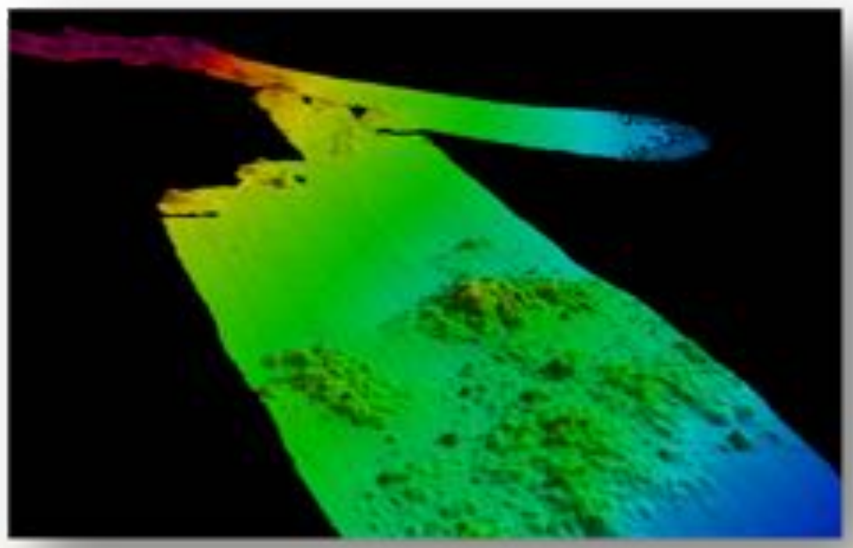
- By processing hydrographic data ‘On Board’, we can mitigate the data bottleneck

  – A processed dataset can be made available over limited bandwidth to the surveyor

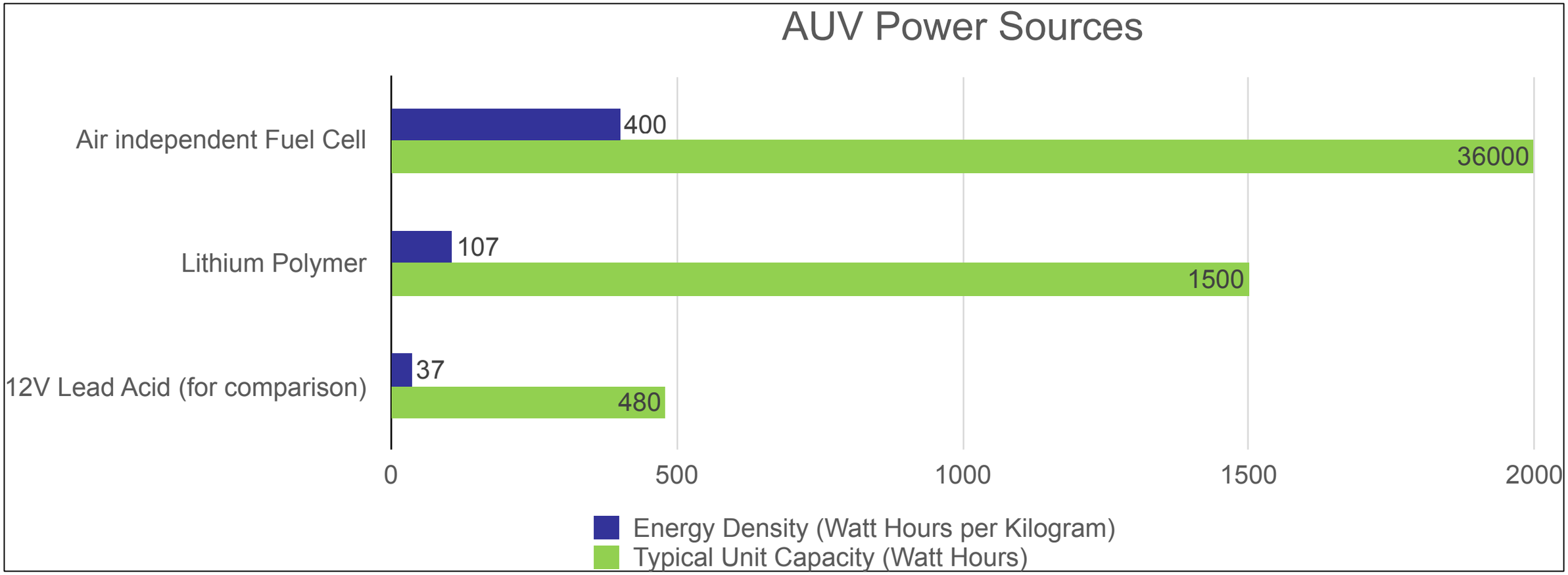
  – Decisions can then be made as to how to proceed with the survey in the most time efficient manner

  – If no bandwidth is available, an almost final dataset can be quickly reviewed before redeployment of the vessel

  - For survey launches and manned vessels, a near-completed survey dataset is immediately available at the end of the survey



AUV Power Source Improvement



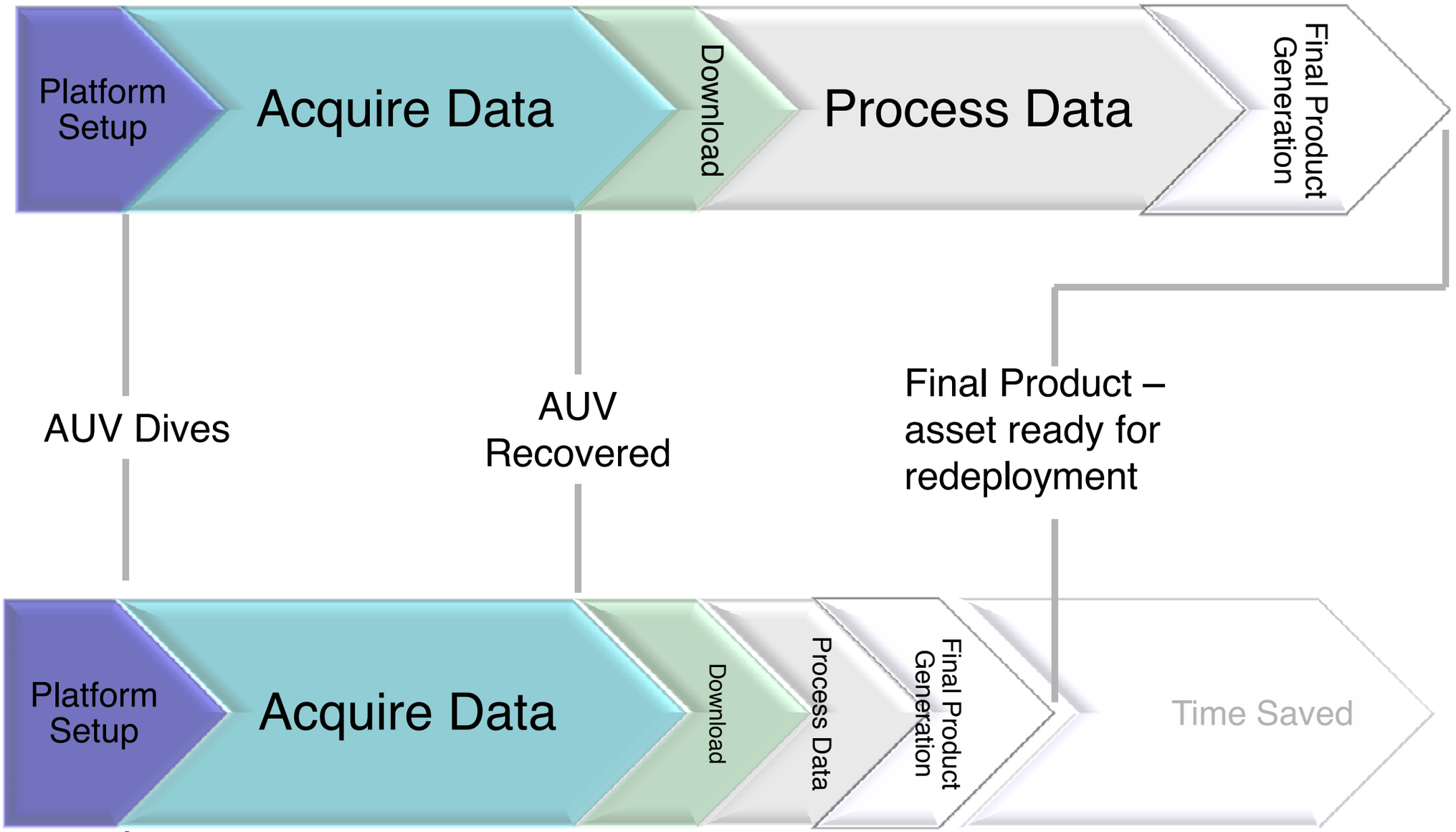
	Threshold	Objective
Nominal Power Density (Watts/liter)	0.4	0.6
Energy Section Length	304.8 cm (120")	304.8 cm (120")
Energy System Volume (liter) (see Figure 1)	3454[1] liters	3454[1] liters
Energy System Mass (kg)	3540[2,3]	3540 kg[2,3]
Energy System Buoyancy (kg)	0[3]	0[3]
Energy (kWh)	817[4]	1800[4]
Duration (hrs)	46 Days (1104 Hrs)	70 Days (1680 Hrs)

Note 1. Flooded volume with ambient seawater per the 42" X 42" X 120" stator hull geometry (reference Figure 1).
Note 2. Includes the fuel + oxidizer + tankage + BOP + Power converter + pressure vessel (if required) + ballast/syntactic foam (if required) + seawater with a tolerance of +/- 50kg.
Note 3. Ambient seawater Specific Gravity of 1.025.
Note 4. Includes an additional 10% of reserve energy beyond that required for power profiles in Figures 2 & 3.

Table 1: Threshold and Objective Metrics

Source: *1. Current State of Technology of Fuel Cell Power Systems for Autonomous Underwater Vehicles, Alejandro Mendez, Teresa J Leo and Miguel A. Herreros, Energies 2014*
2. Large Displacement Unmanned Underwater Vehicle Innovative Naval Prototype (LDUUV INP) Energy Section Technology

Traditional Workflow



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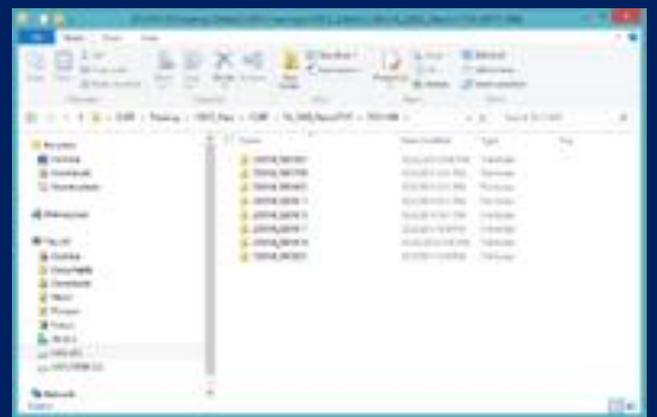
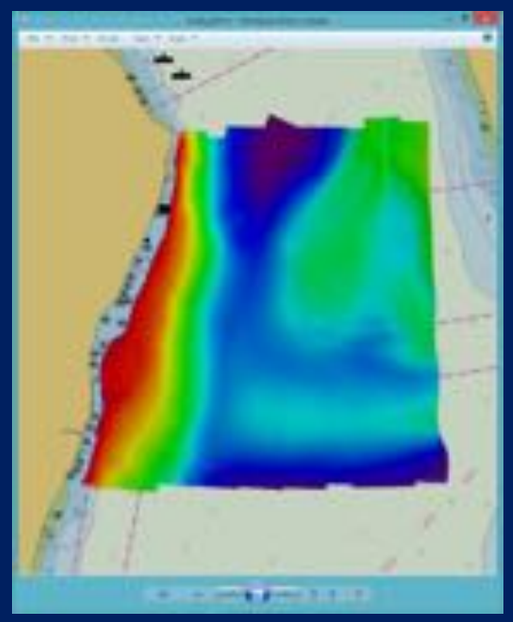
Examples of near real time products

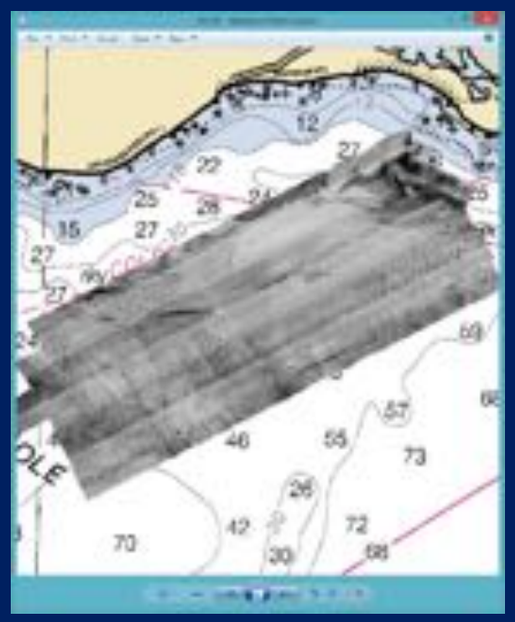
High Bandwidth



CARIS line files



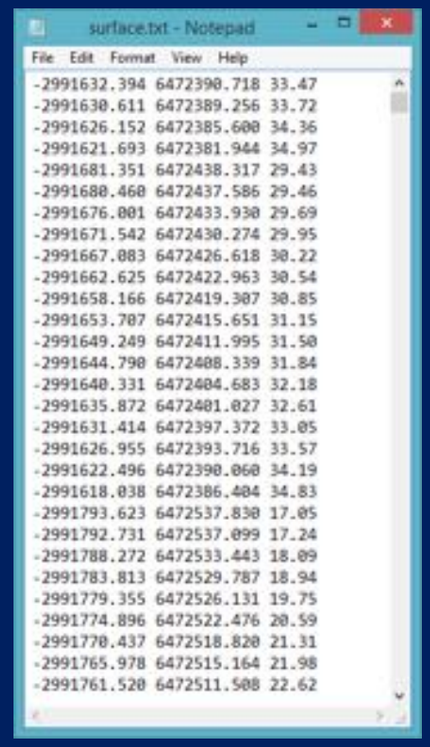
GeoTiff



Sidescan Mosaic

Low Bandwidth

Bathymetry surface QC report



ASCII depths

Sounding Surface

- Various deployment options:
  - Desktop computer
  - Rack mount computer
  - Laptop
  - Computer payload of autonomous vehicle

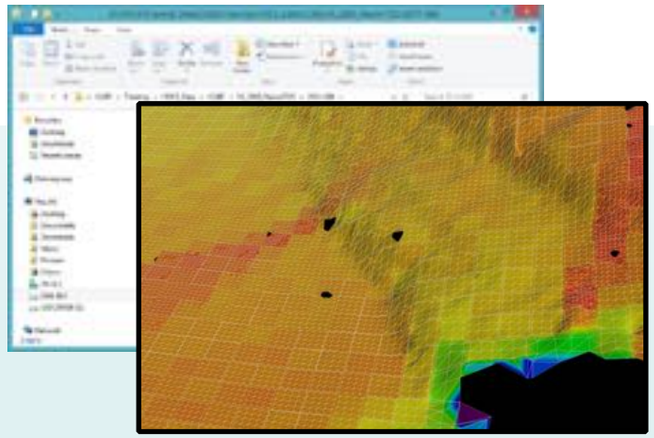
- Operating systems:
  - Windows 7
  - Linux

- Hardware versions:
  - Rack mount for vessel operations
  - Water tight canister for subsea vehicles

- OEM agreements
  - Can be arranged with sensor or vehicle manufacturers

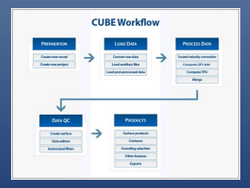
Use Cases – Autonomous Underwater Vehicle

Product(s)



Deployment

QA/QC
Product(s)



Data
Files

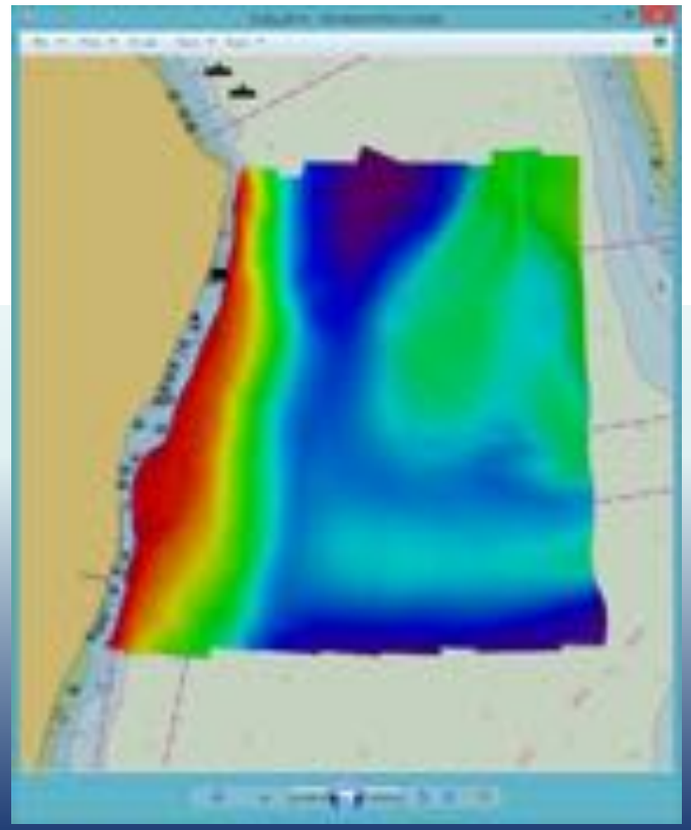
Store

Process

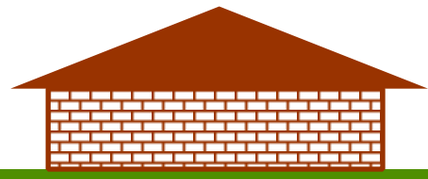
Use Cases – Autonomous Surface Vessel

(Satellite Communications)

Bathymetric Surface



ASV gathering multibeam data, processing using CARIS Onboard



Shore Data Centre

Use Cases – Manned Vessel

Sonar Hardware

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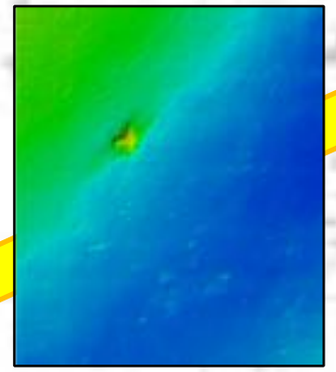
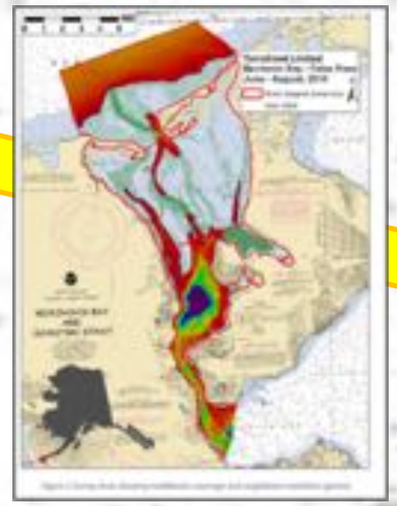
CARIS Project

Command & Control

Surveyor in Charge on Mother Ship, monitoring survey launches remotely and directing operations





Crowdsourcing

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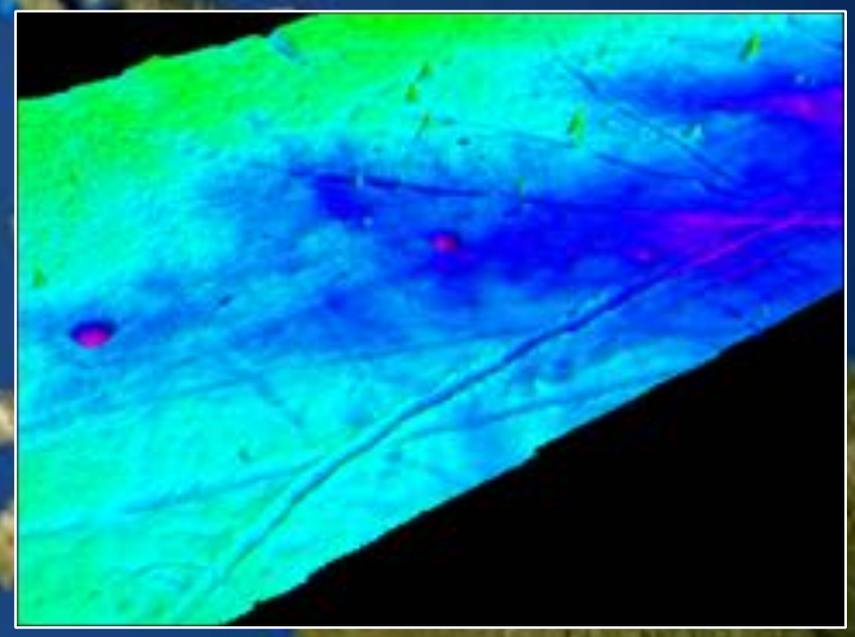
Lean manned vessel equipped with survey sensors



Bathymetry Surface

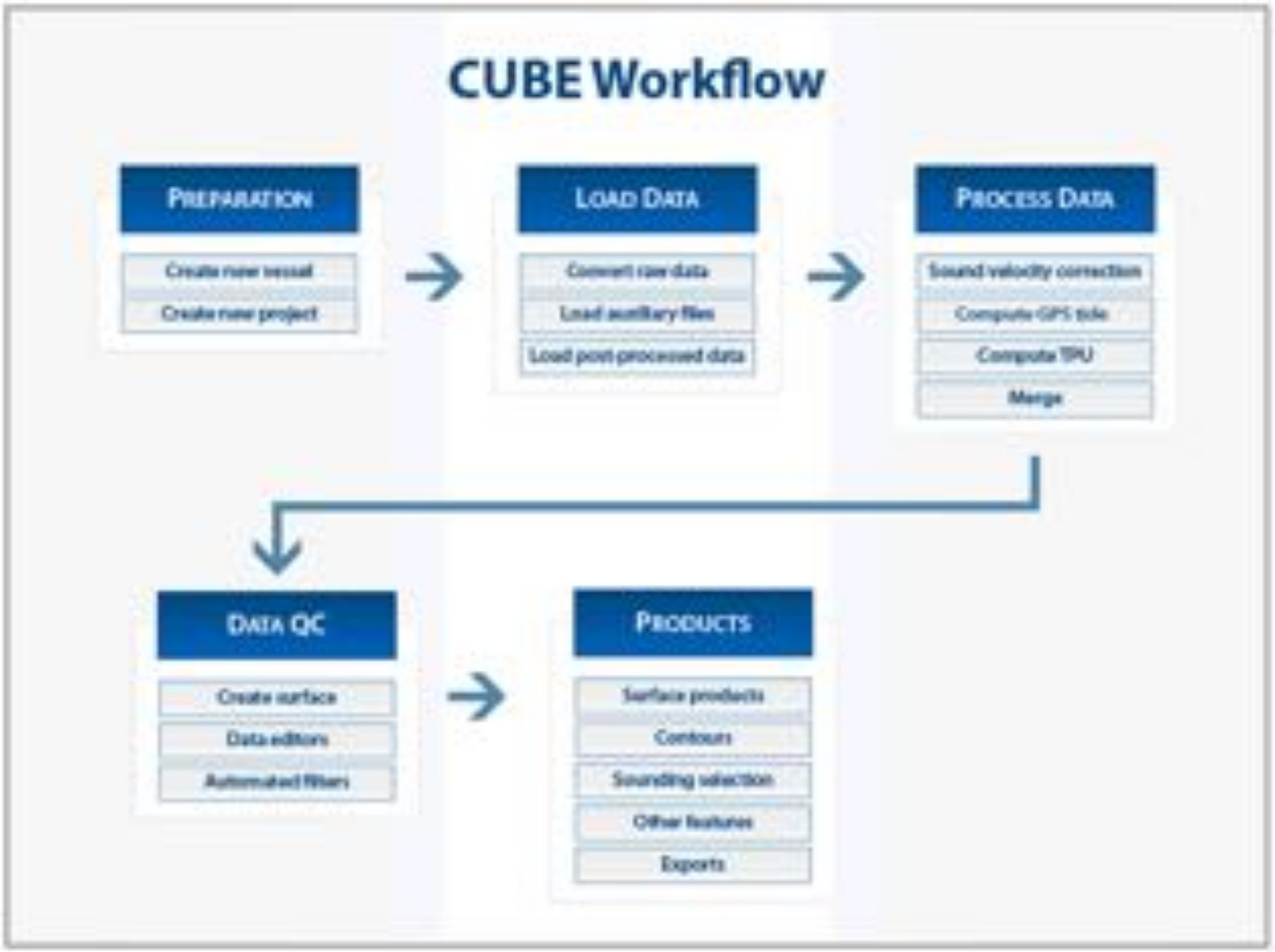
Hydrographic Office

- Follows a similar path to the traditional workflow
  - Key processing steps automated.

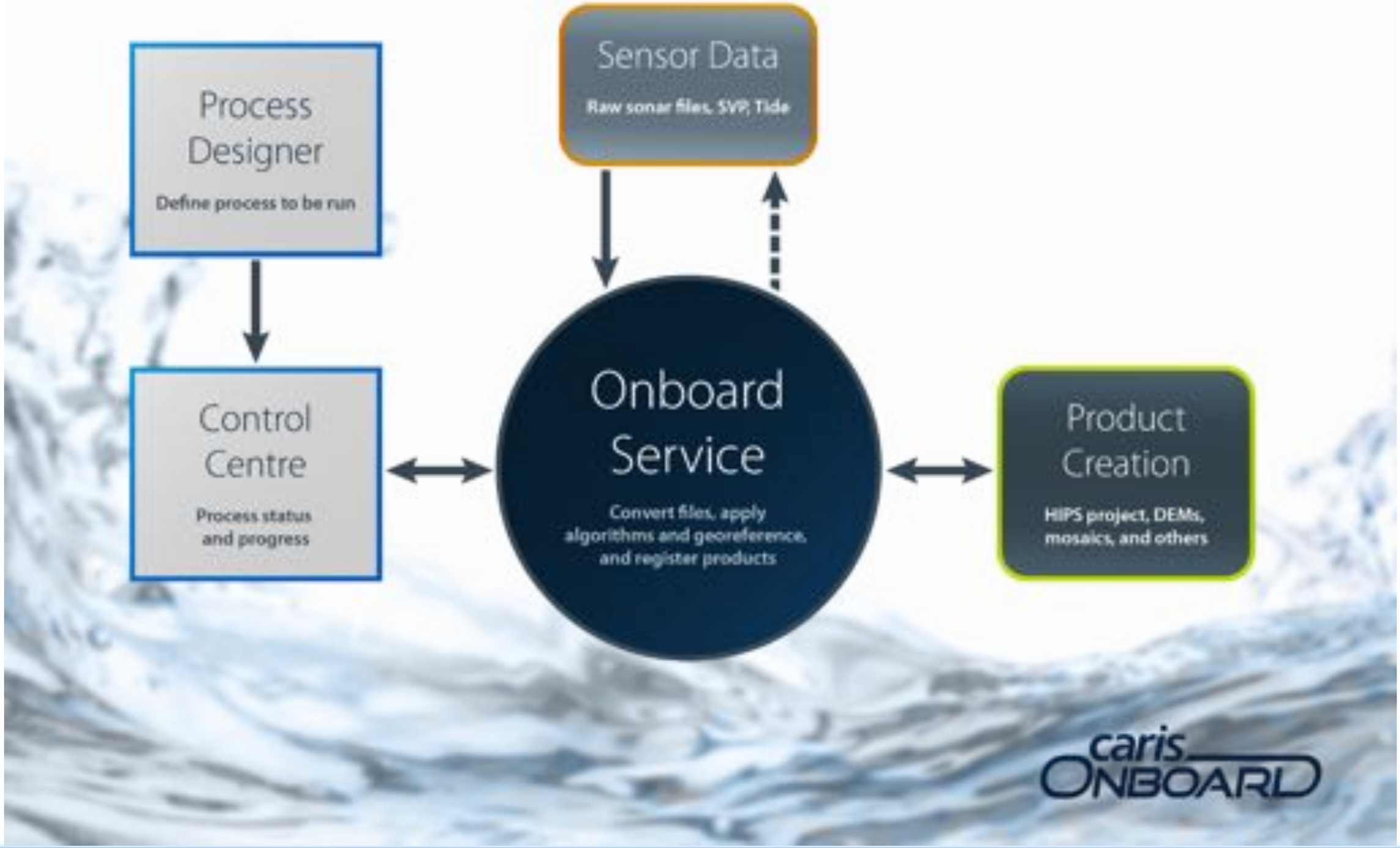
- Defined before platform deployment
- Surveyor configurable to meet the needs of the survey

- Saves time
- Aids in repeatability of processing
- Ensuring consistency and compliance

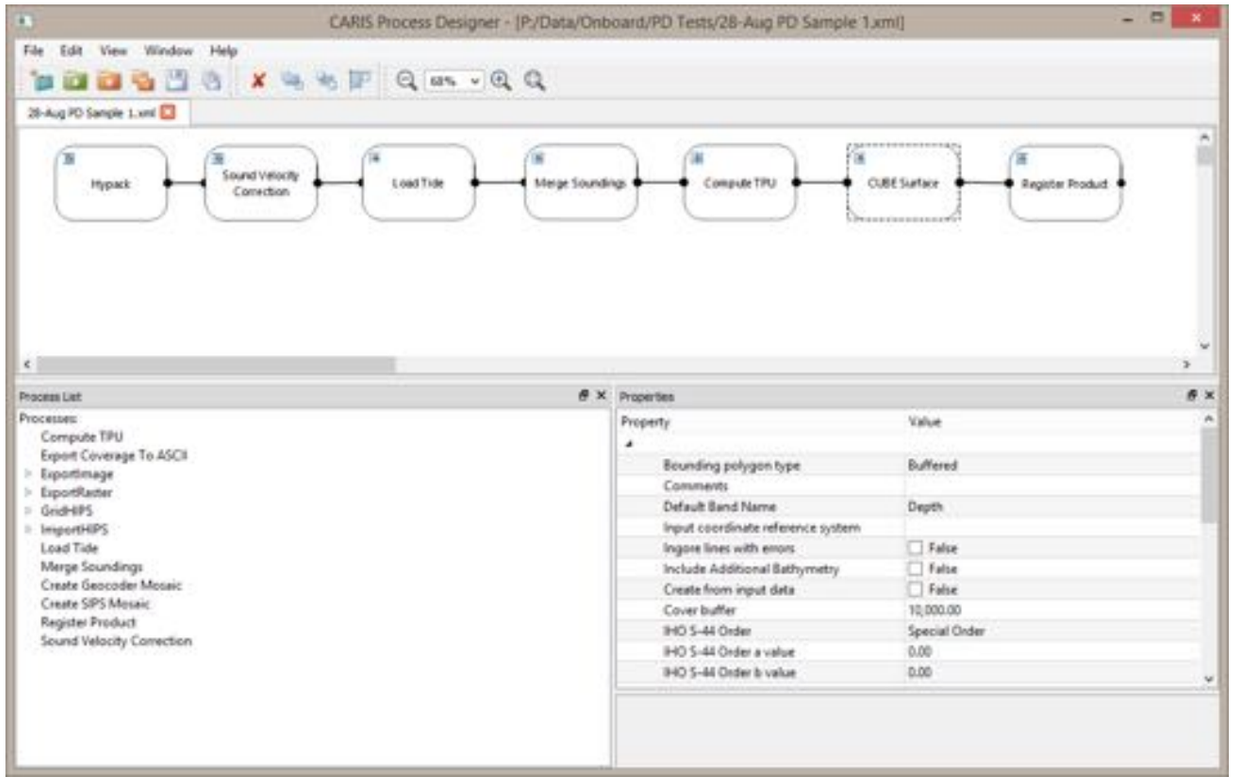
Typical Process Workflow

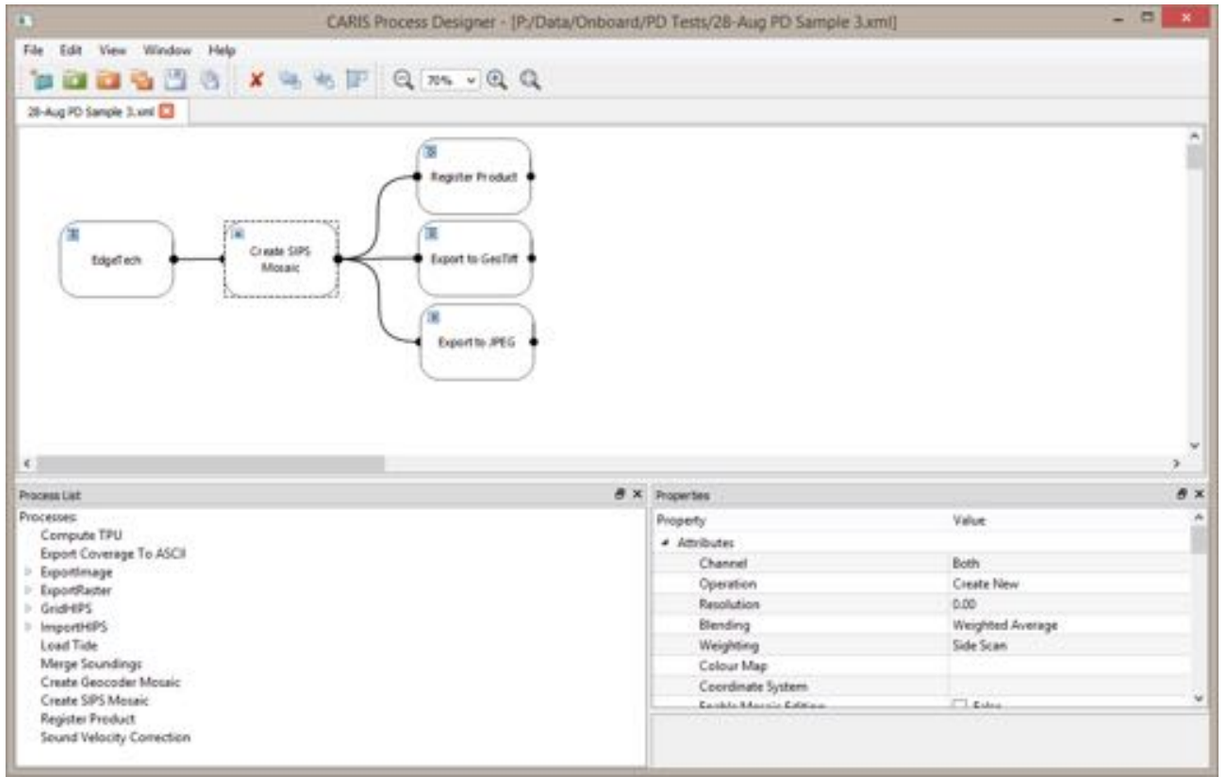


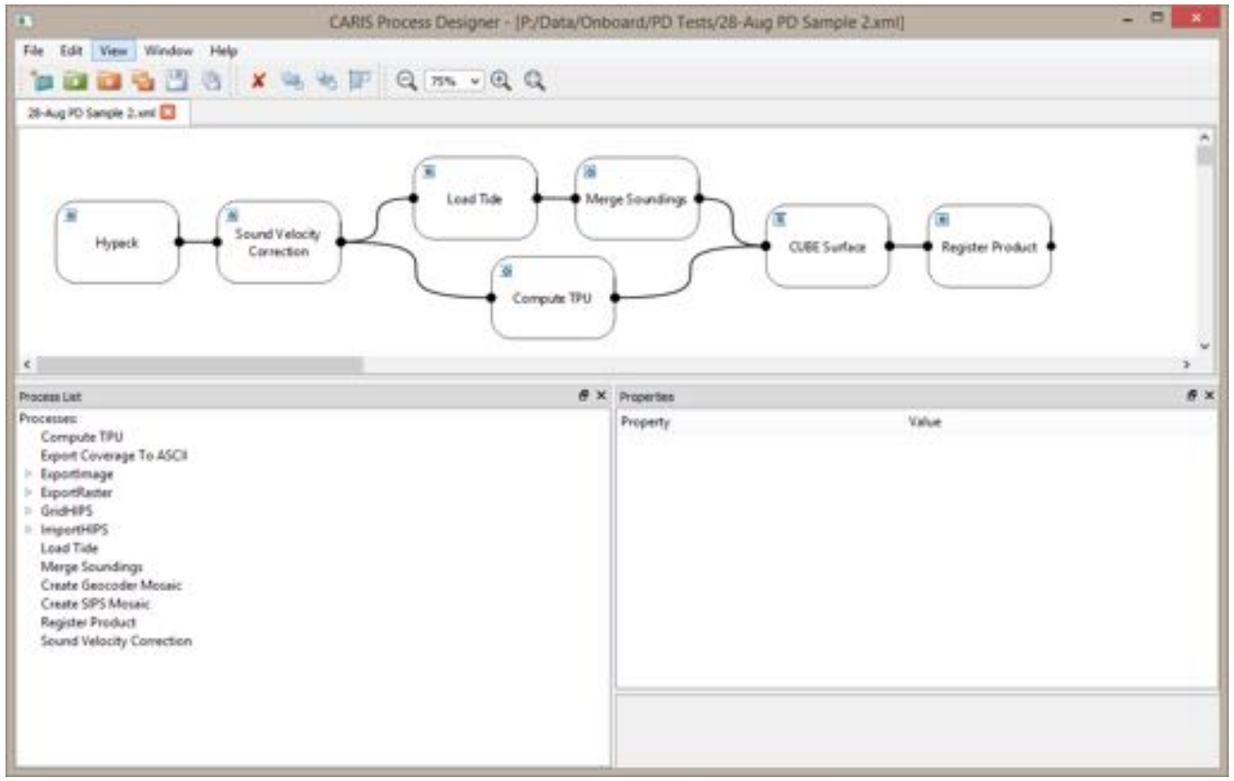
CARIS Onboard Workflow

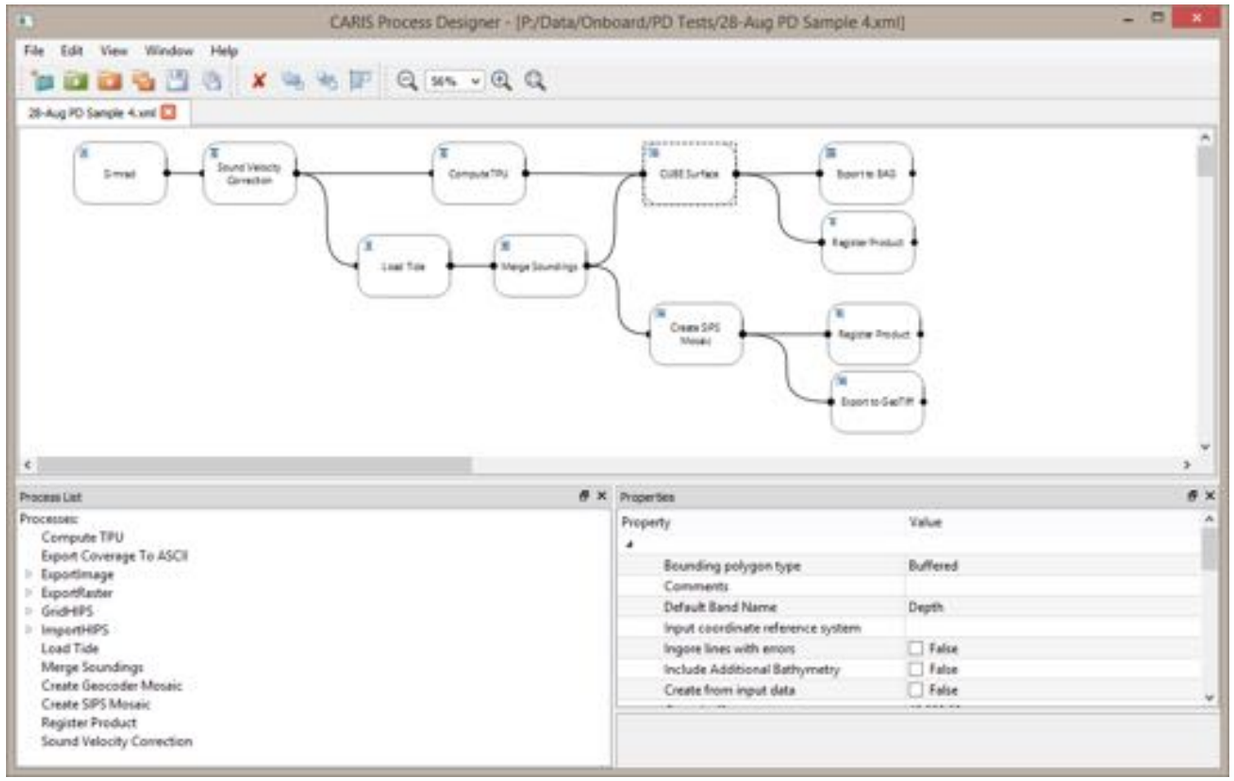


CARIS Process Designer

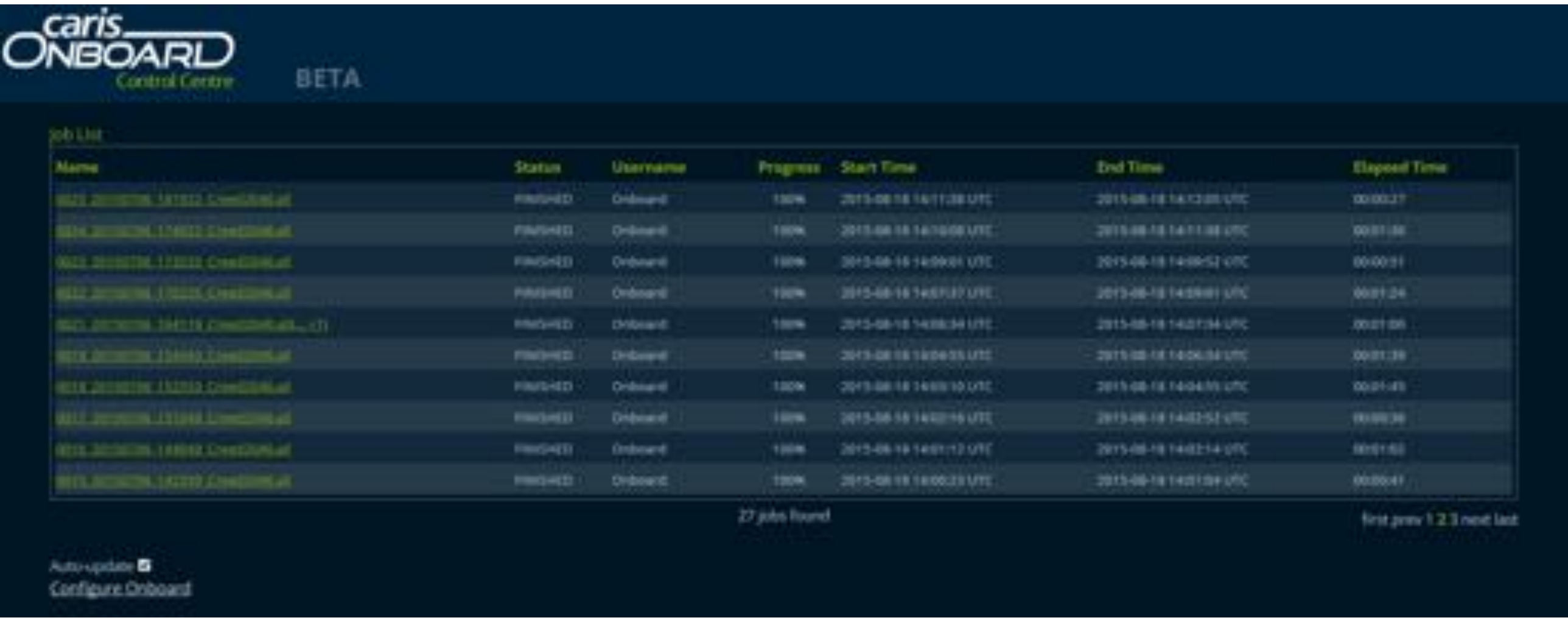








- Control Centre
  - Manage, configure and monitor Onboard Services
  - Web interface to be accessed on a vessel or remotely from office location, via internet connection

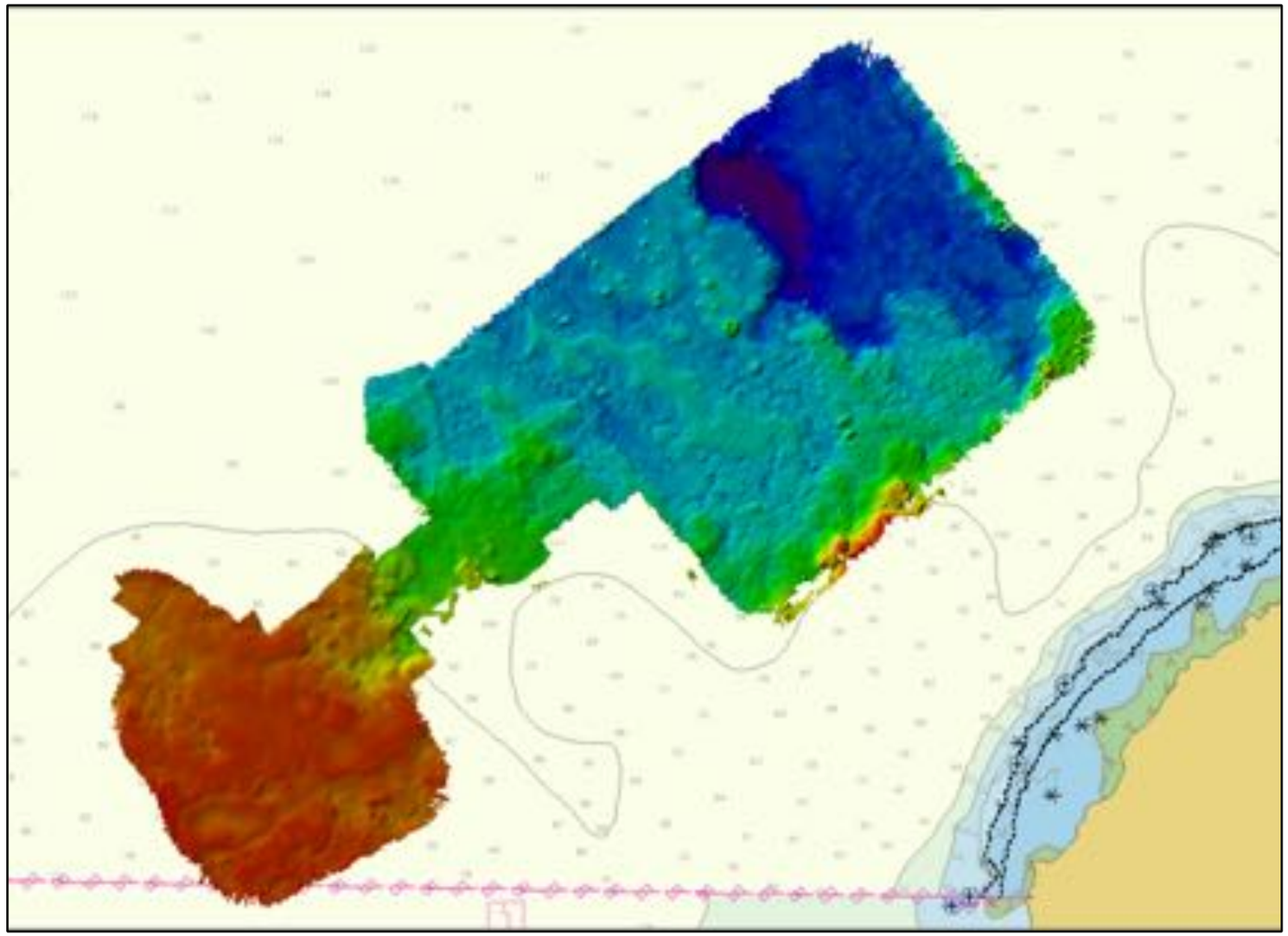


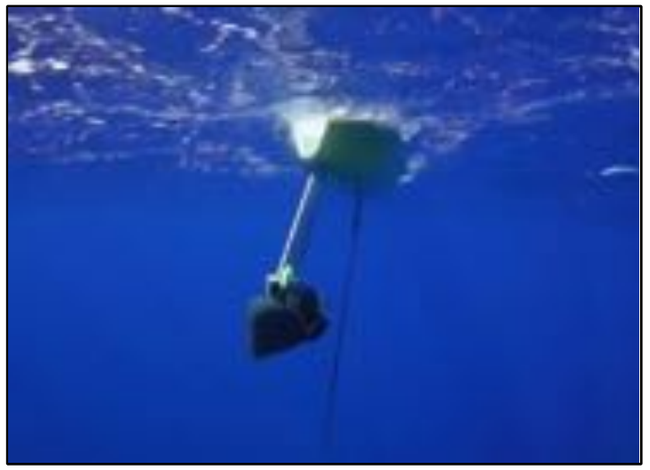
Proof of Concept – 3 tier approach

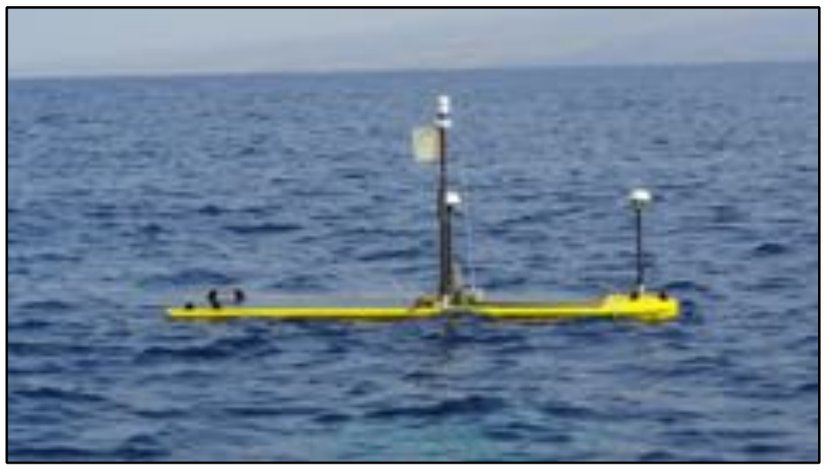
- In order to prove the concept, 3 platforms were identified:
  - Autonomous Surface Platforms
  - Autonomous Underwater Vehicles
  - Manned Survey Launches
- This allowed a scaled approach to proving the software with both the platform and sensors

Proof of Concept – Liquid Robotics & Teledyne

LIQUID ROBOTICS







Wave Glider SV3

Proof of Concept - Z Boat at US Hydro 2015

caris

U.S. HYDRO 2015

March 16-19 · Gaylord Hotel · National Harbor, Maryland U.S.A.

Proof of Concept – NOAA Bay Hydro II & Terrasond

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

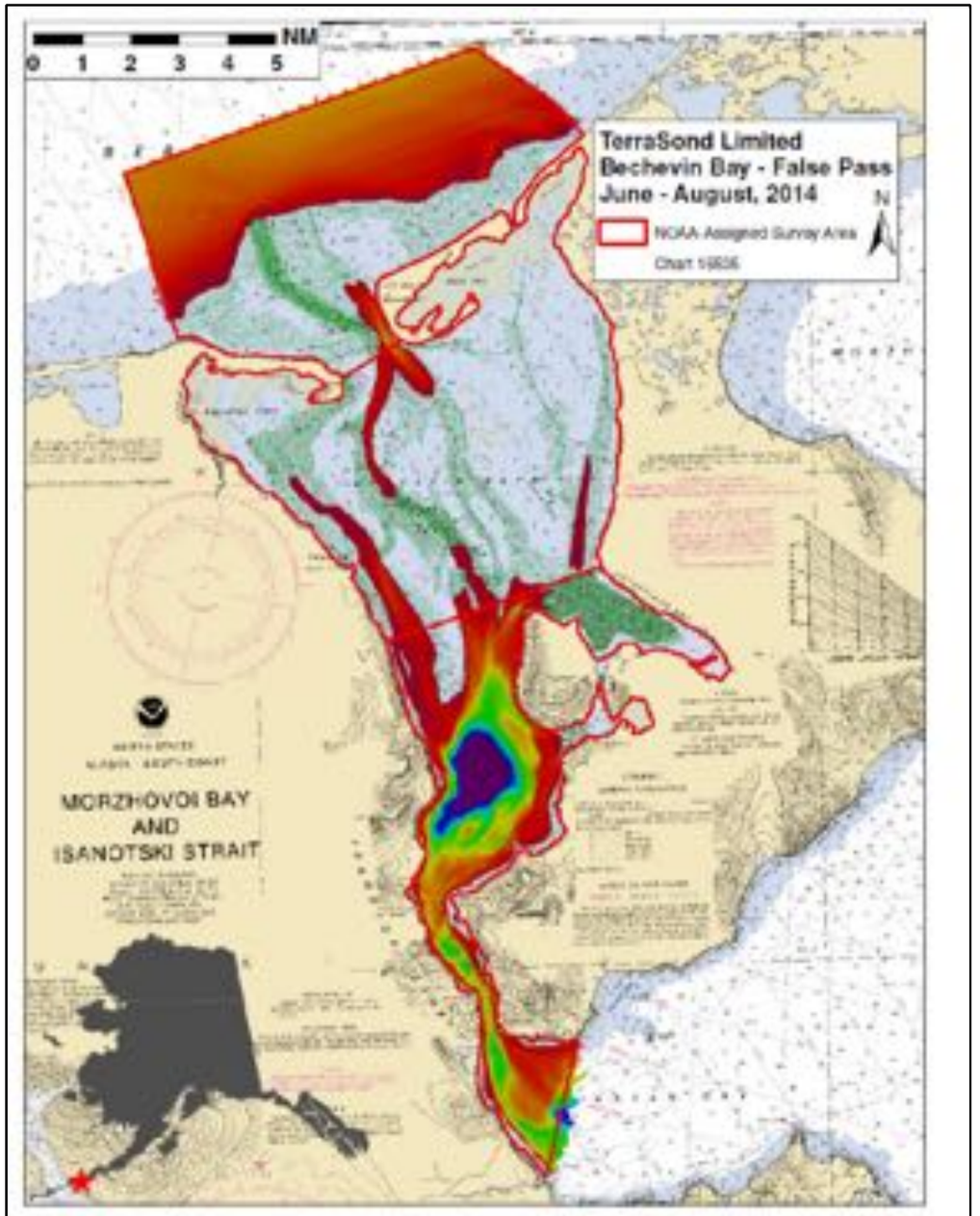


Figure 2 Survey Area showing multibeam coverage and singlebeam tracklines (green)

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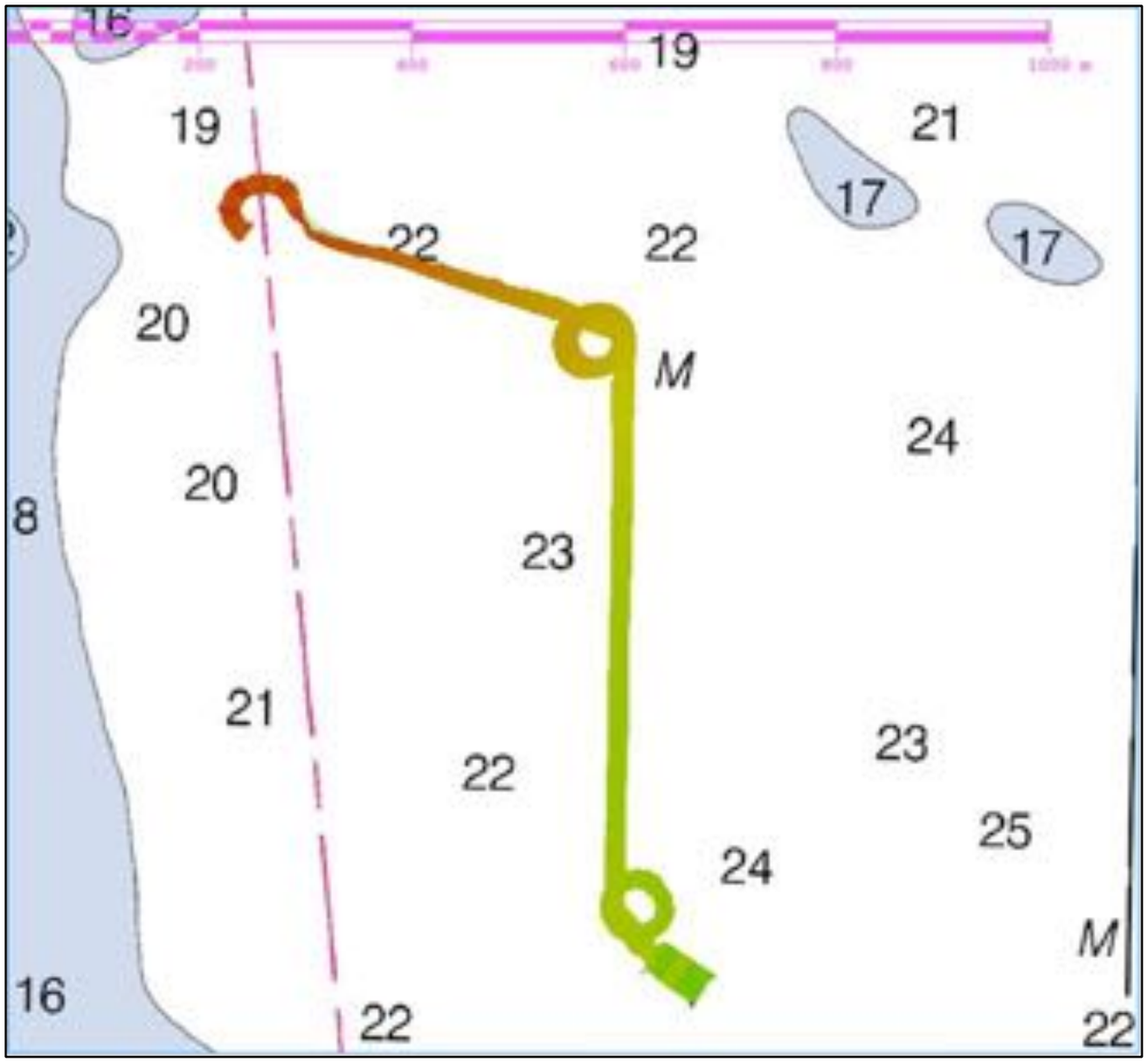
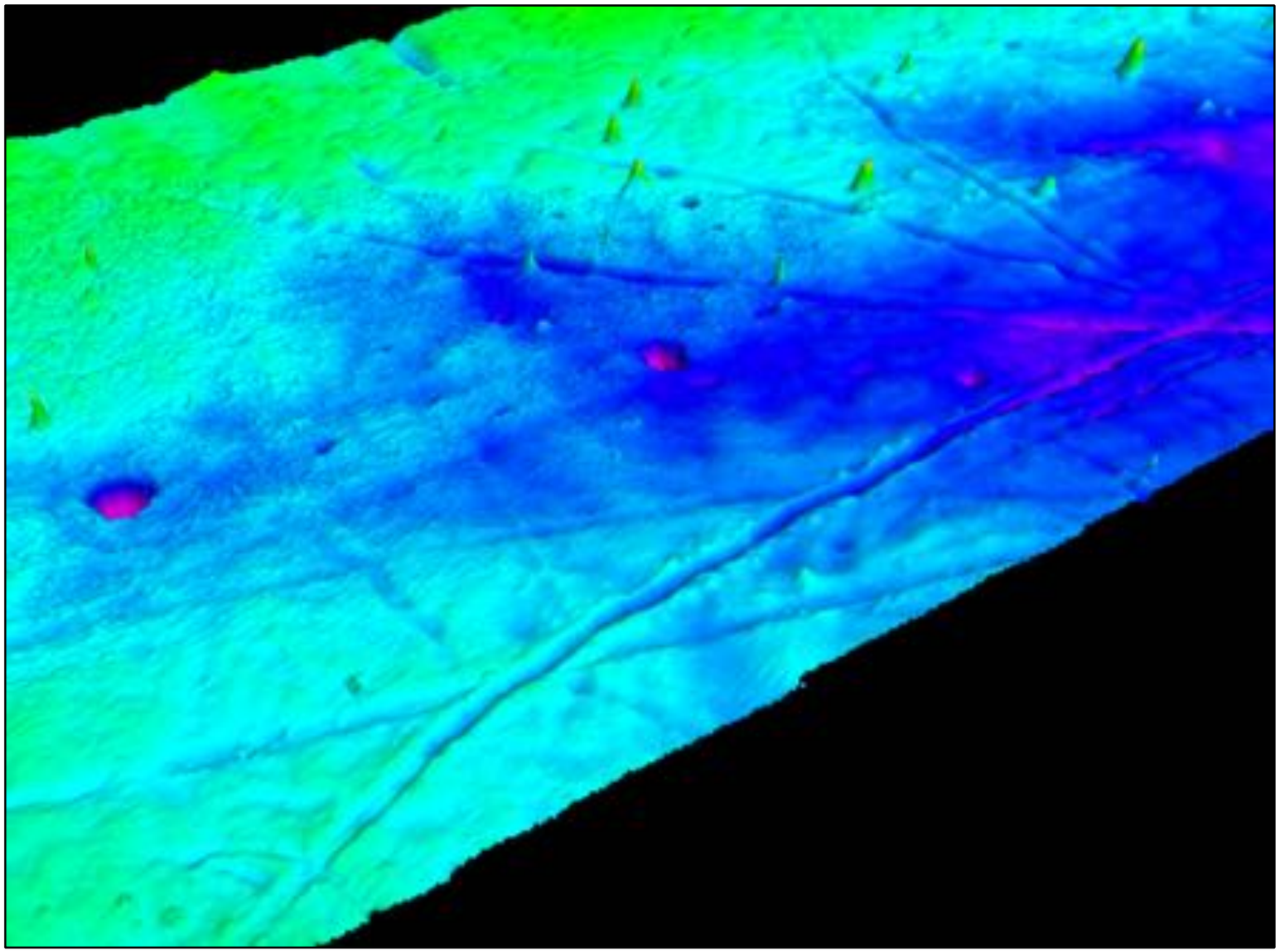
Proof of Concept – Hydroid Remus



- Successful trial on Remus vehicle conducting trials in Boston, MA

Proof of Concept – Kraken SAS

AquaPix®



Conclusions

- Onboard data processing reduces overall ping to product time
- Allows for remote transfer of meaningful data from your survey platform, preventing costly errors in data acquisition and allowing effective management of remote assets
- Allows survey personnel to focus on higher level hydrographic tasking
- As part of the CARIS Ping-to-Chart™ solution, the data gathered can be processed in an optimal workflow to final product

CARIS WORLD TOUR 2016

- CARIS experts will be coming to a city near you

- Three day practical Ping-to-Chart workshop
  - Latest advances in CARIS software.
  - Real-time processing with CARIS Onboard,
  - S-100 and other data models and our new modular architecture.
  - Tour T-shirt!

- Locations and dates to be announced later this year.

- Last stop:
  CARIS user conference, Ottawa, Canada, Spring 2017.

- If your organisation would like to host a workshop, or if you want to tell us why your city is a great location for us to visit please contact info@caris.com with your suggestion.

Questions?