LSTS Software Toolchain

Oceans 2015

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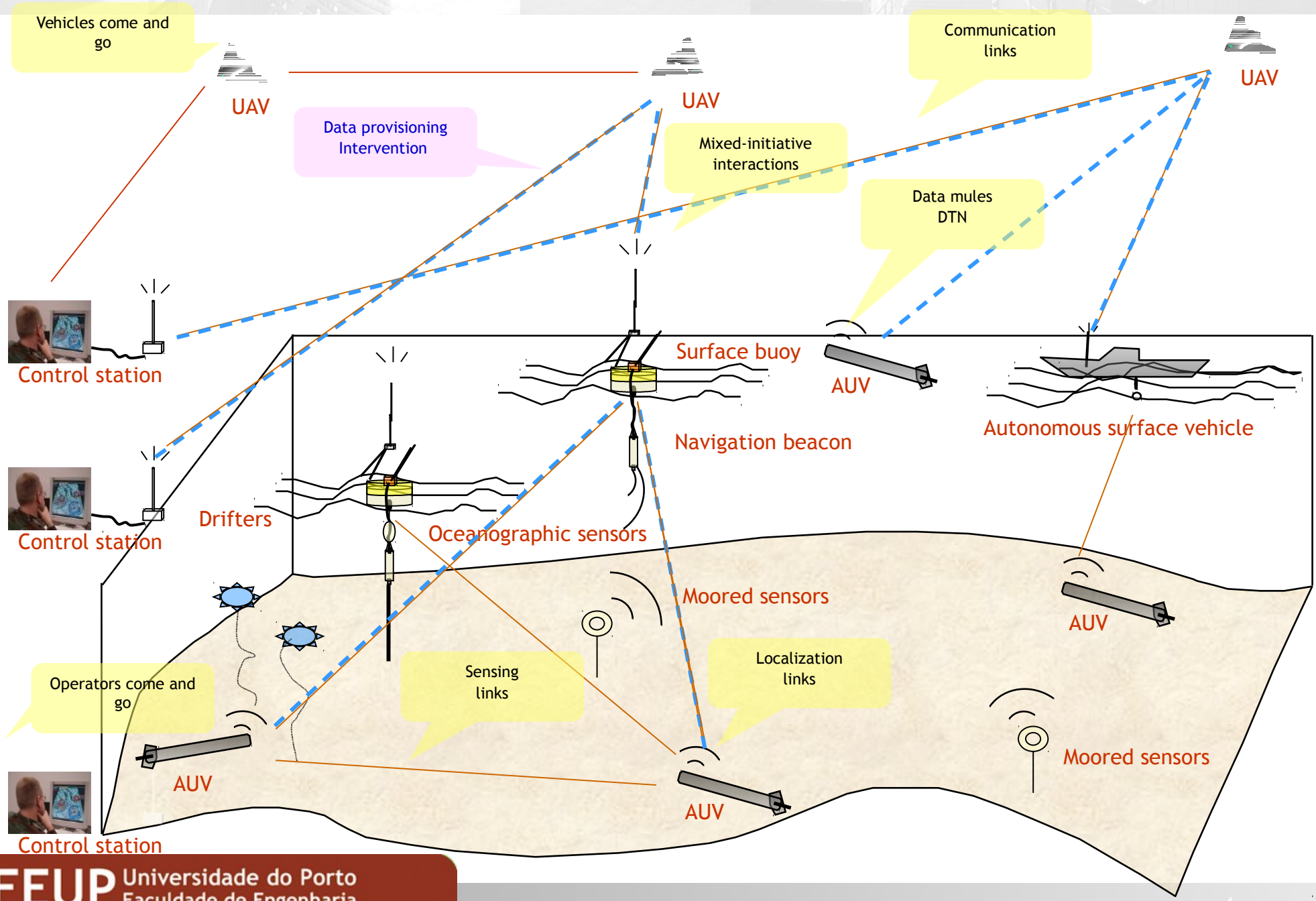
Underwater Systems and Technology Laboratory (LSTS)

Tutorial Overview

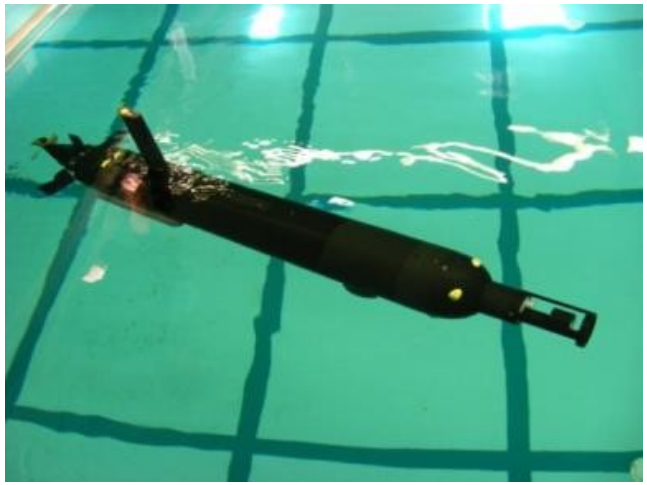
- **Background**
- **Toolchain Overview**
  - GLUED / IMC / DUNE / Neptus
- **Using the toolchain**
  - Compiling
  - Running
- **Extending**
  - DUNE, Neptus

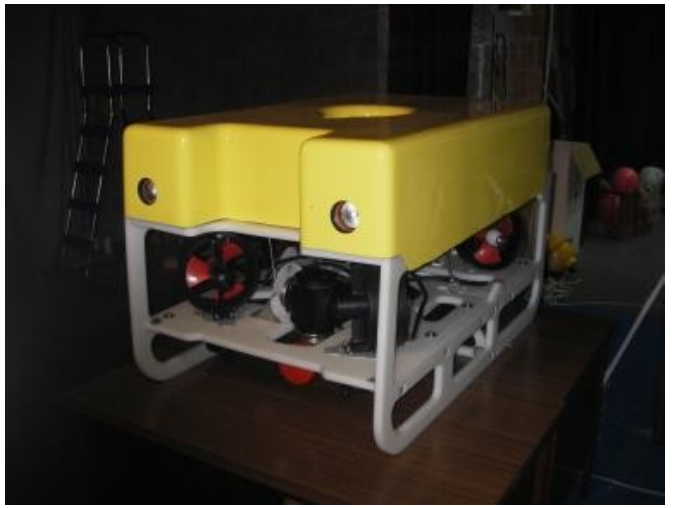
Background

Networked Vehicle Systems

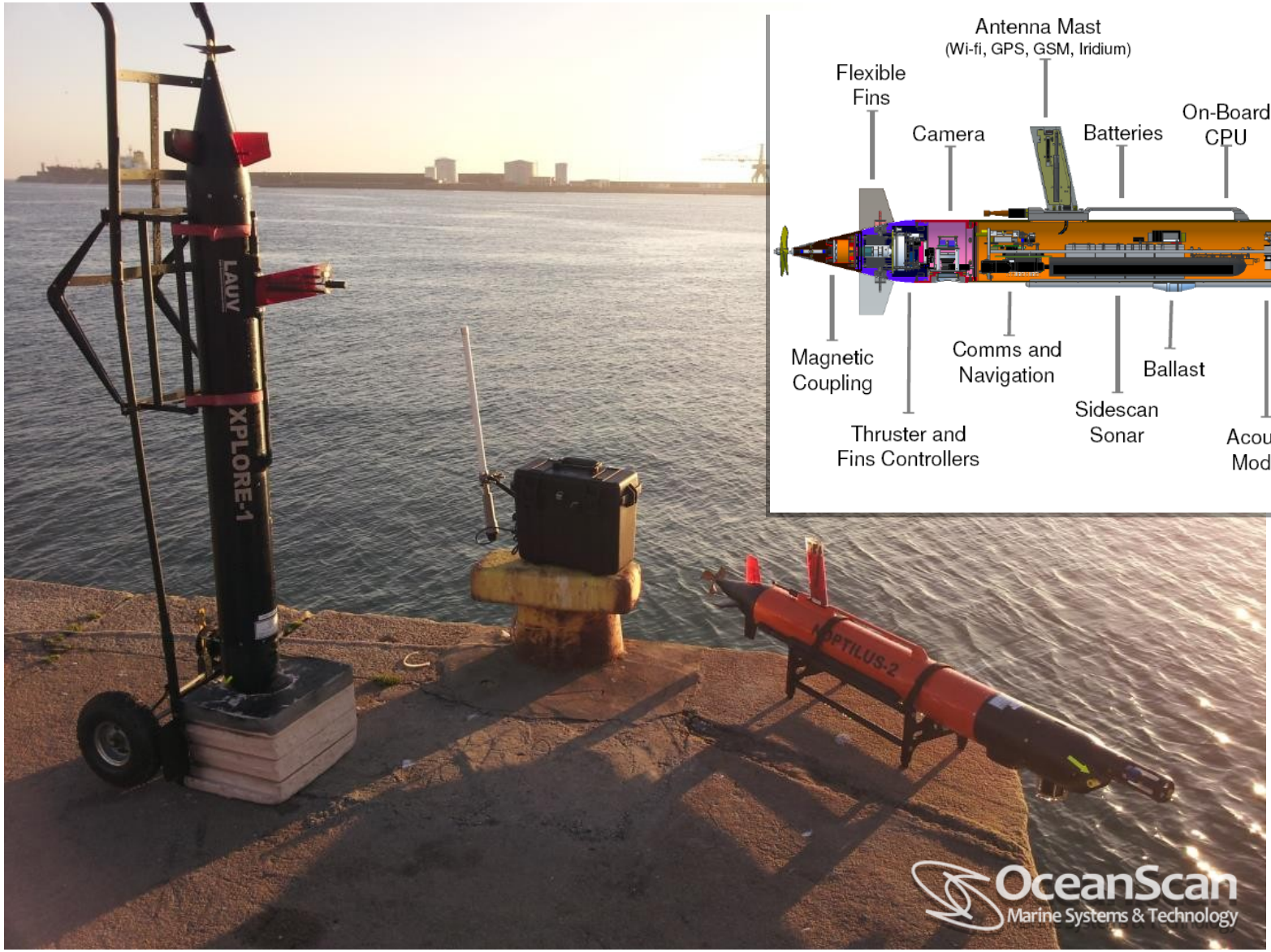


Ocean Vehicles @ Porto University





The Light AUV (LAUV)



The Light AUV (LAUV)

Endurance of up to 24 hours

Moving at ~1 m/s

1 man operation

Portable

Easy deployment and recovery

Intuitive software tools

Customizable sensor payloads

Sidescan / Multibeam Sonars

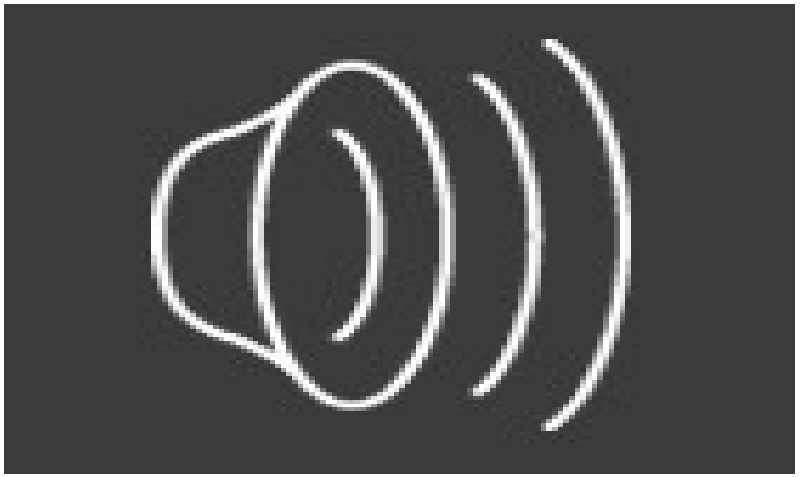
Video camera

CTD, pH, Fluorometer, ...

Other payloads

Comms: WiFi, GSM, Acoustic Modem, Iridium

Navigation: GPS, Compass, IMU, DVL, LBL, ...



CPUs

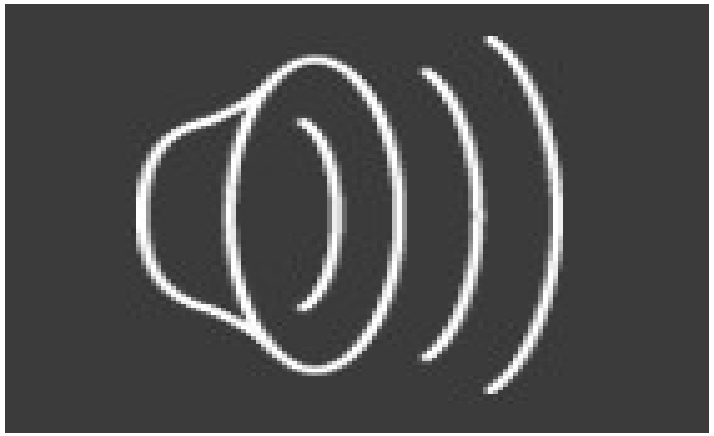
Geode X86 (Main CPU)

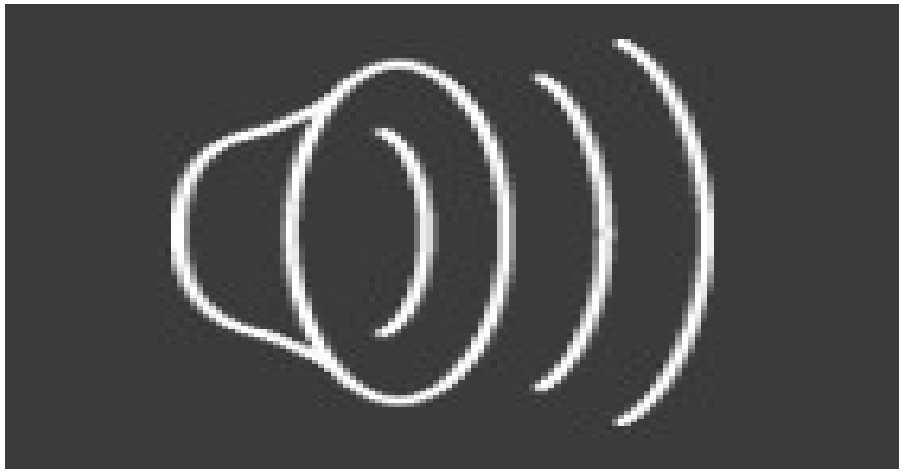
Beagle Bone Black (Auxiliary)

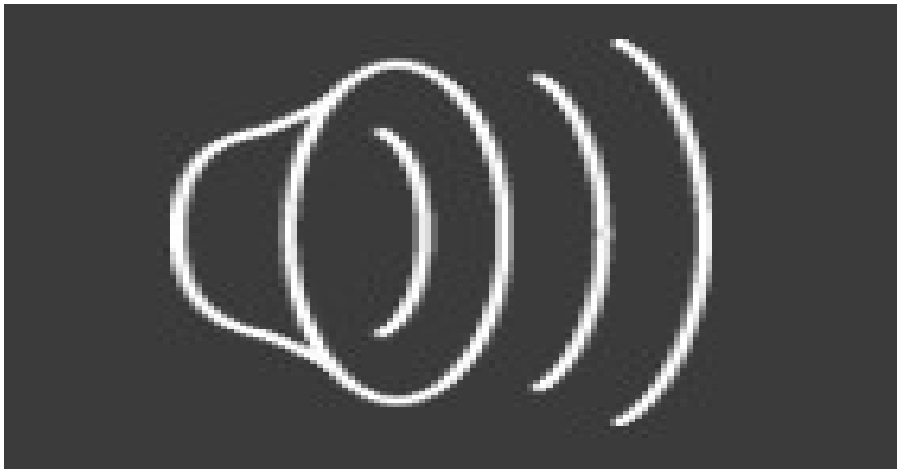
Aerial Vehicles @ Porto University

Platforms - X8 UAV

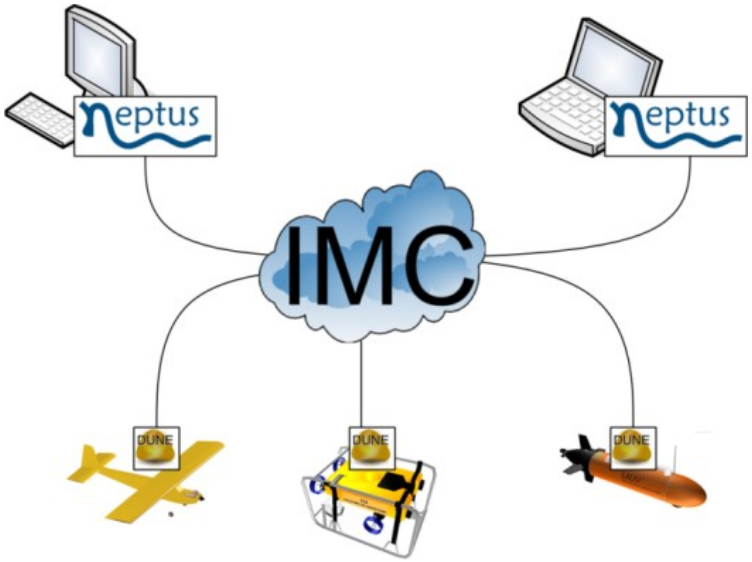
- Ardupilot + DUNE
- Planner runs on the ground
- Telemetry + video feed up to 10 Kms
  - Using auto-oriented directional antenna
- Easy deployment and recovery





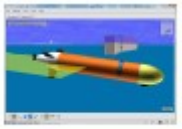


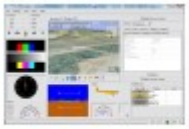
LSTS Toolchain for NVS

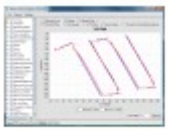


C4I – Command and Control Framework

Neptus







http://vhale.fe.up.pt

Inter Module Communications

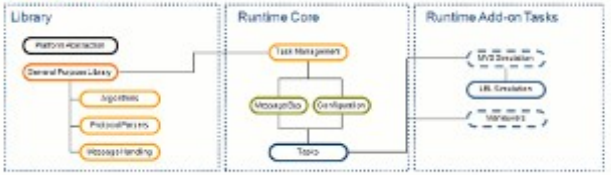
IMC

Message Protocol

http://vhale.fe.up.pt

DUNE: Uniform Navigational Environment On-board software

DUNE



http://vhale.fe.up.pt

https://www.github.com/LSTS

LSTS Timeline

- 1997 – LSTS was created
- 1997 – First AUV was purchased (WHOI REMUS AUV)
- 2004 – Neptus was created
- 2005 – First ROV built from scratch
- 2006 – DUNE and IMC were created
- 2006 – First AUV built from scratch (LAUV)
- 2007 – Projects and MoU with the PO Ministry of Defence
- ...
- 2015 – 20 LAUVs, 1 ROV, 1 ASV, 20 UAVs, 10 LAUVs sold, toolchain used by external entities (NTNU, KTH, LabUST, EvoLogics GmbH, ...)

What is It ?

- Complete software solution for autonomous vehicles
- Operating system (Linux distribution)
- API for interaction between software modules
- On-board software for sensor interaction, Control, Guidance, Navigation
- GUI Command & Control Unit
- Mission Review and Analysis (Log Analysis)

Why start from scratch ?

- The REMUS on-board software was starting to show its age (based on QNX4 and Pre ISO C++ 98)
- The code-base was developed and maintained poorly
- Freely available software had a few shortcomings:
  - Highly experimental
  - Cumbersome or impossible to use in embedded systems
  - Command & Control software was primitive
  - We disagreed with the architecture/design choices

Further motivation

To avoid things like this:

// Created by John Doe (1996)

// Updated by John Smith (1999)

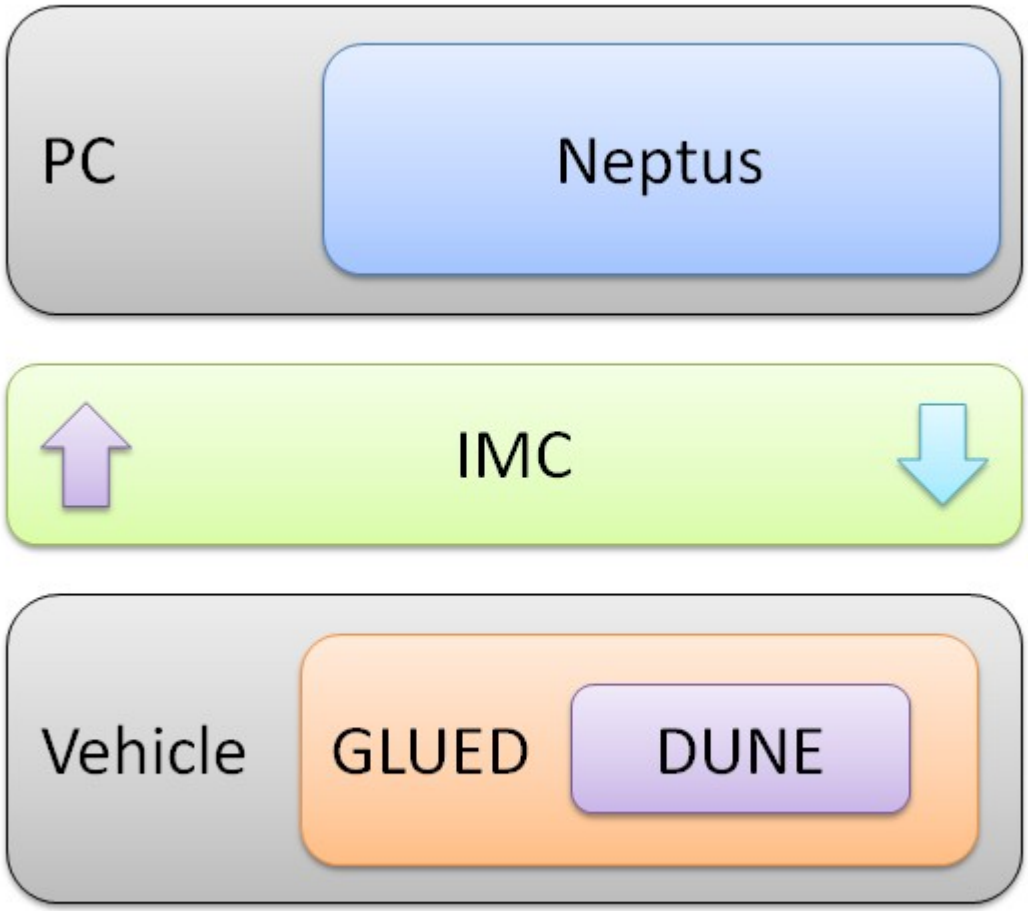
// Updated by Tommy Toe (2001)

// Vandalized by Joe Bloggs (2005)

From *common/abstraction/shared/whoi_mboard.h*

(Fictitious names)

Toolchain Overview



GLUED

GNU/Linux Uniform Environment Distribution

https://github.com/LSTS/glued

Overview

- Minimal GNU/Linux distribution focused on embedded systems
- Small footprint
  - around 10 MiB
- Fast boot time
  - 2 to 5 seconds depending on target machine and peripherals
- Target machine binaries are cross compiled (i.e., built for a platform other than the one on which the compiler is running)
- Creates a reproducible root filesystem for a given target
- Supports several x86, ARM, and MIPS targets

Motivation

- Time to build large software projects in embedded systems is almost unbearable
  - several hours vs a few minutes in modern PCs
- Embedded systems usually require bootloader and kernel customization
- The longer the system takes to boot the longer it is uncontrollable
- Upgrading the operating system should be an unattended process with a predictable outcome
- The root filesystem and target binaries should be easily replicated and traceable

Supported Hardware

- ARM
  - BeagleBone White & Black (TI AM3359 @ 1 GHz)
  - ISEE IGEPv2 (TI DM3730 @ 1 GHz)
- x86
  - IEI PM-LX 800 (AMD Geode LX @ 500 MHz)
  - IEI PM-LX2 800 (AMD Geode LX @ 500 MHz)
  - Kontron pITX (Intel Atom Z510 @ 1.6 GHz)
- MIPS
  - Ubiquiti RouterStation (Atheros AR7161 MIPS 24K @ 680 MHz)

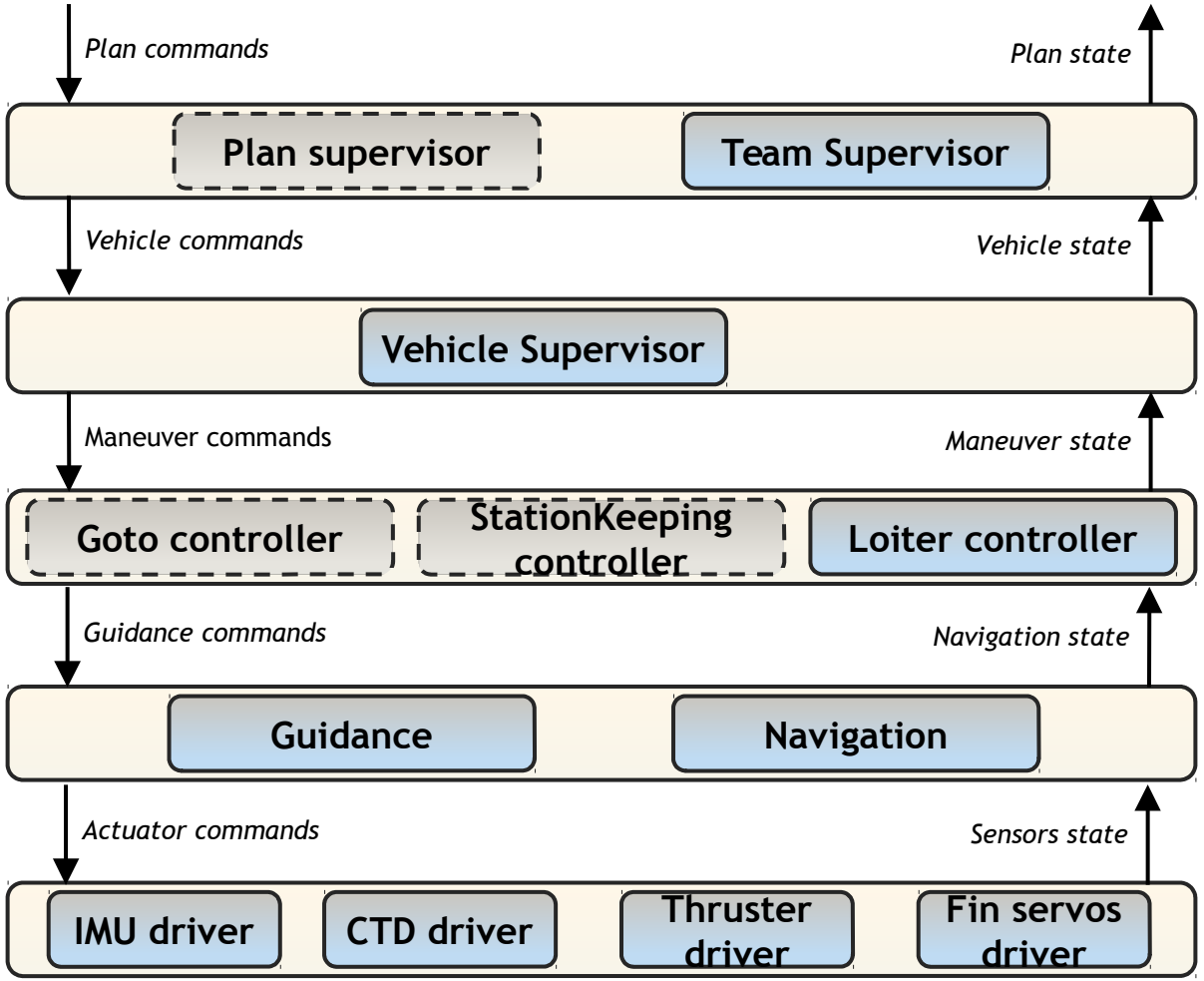
IMC: Inter-Module Communication API

Overview

- Message Oriented Protocol
- One XML document defines all messages
- Generators for documentation, C++ and Java code
- Serialization/deserialization to/from:
  - JSON
  - XML
  - **Binary**
- Serialized messages are used for logging and communication
- Binary serialization format can be translated to human-readable format (LLF)

Interaction Layers

- Plan control
- Vehicle control
- Maneuvering
- Guidance
- Navigation
- Sensing
- Actuation
- Networking
- Storage



Addressing

- Addresses are partitioned in classes (AUV, UAV, ROV, CCU, etc)
- Each system has a unique address (i.e., unique number)
- Subsystems/submodules of a system are called ***entities***
- Each entity has a unique local number used to further qualify a message (e.g., disambiguate messages of the same type but different sources, temperature from a CTD vs CPU temperature)

Anatomy of a message

- Synchronization Number
  - Marks the beginning of a message
  - Identifies protocol version
  - Allows for endianess detection
- Message Identification Number
  - Uniquely identifies a message type
- Message size
- Timestamp

Anatomy of a message

- Source Address
- Source Entity
- Destination Address
- Destination Entity
- ***Message Specific*** *Fields*
- CRC16

Example

```
<message id="263" name="Temperature" abbrev="Temperature">

  <description>
    Temperature measurement.
  </description>

  <field name="Value" abbrev="value" type="fp32_t" unit="°C">
    <description>
      Temperature value.
    </description>
  </field>

</message>
```

https://www.github.com/LSTS/imc

DUNE: Uniform Navigational Environment

Overview

- Designed for embedded systems
- Written in C++
- Used in AUVs, UAVs, ROVs, ASVs, data-loggers and communication gateways
- Related logical operations are isolated from each other in tasks, usually running in a separate thread of execution
- Communication between tasks and communication with external software is performed exclusively by using the set of messages described in the IMC API

Overview

- Communication
  - TCP, UDP, Acoustic modem, Iridium, GSM
- Logging
- Interaction with sensors, actuators, and power devices
- Controllers for attitude, speed, manual operation, etc
- Guidance algorithms
- Maneuvers (way-point following, area coverage, follow reference, loiter, station keeping, etc)

Supported Platforms

- Architectures
  - x86, ARM, PowerPC, SPARC, MIPS, AVR32
- Operating Systems
  - Linux v2.6+/Android, QNX v6.x, Oracle Solaris, Mac OS X, eCos, RTEMS, OpenBSD, FreeBSD, NetBSD, Microsoft Windows
- Hardware Interfaces
  - Serial Port, I²C, I/O port, CAN

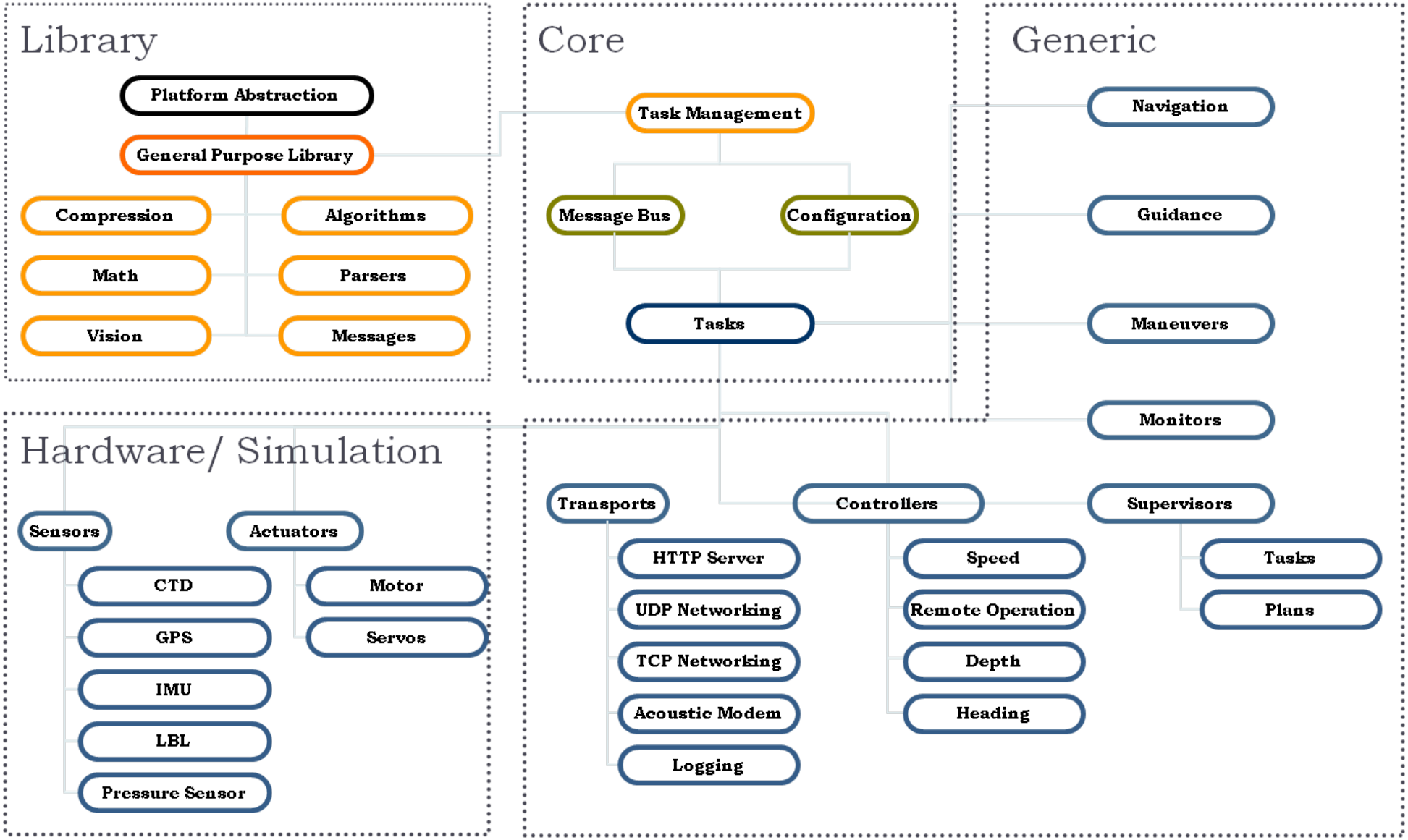
Required Software

- **Mandatory**
  - Git
  - CMake
  - C/C++ Compiler
  - Python Interpreter
- **Optional**
  - Eclipse
  - Microsoft Visual Studio

Required Software

- **Ubuntu/Debian**
  - sudo apt-get install cmake git g++ make python
- **Microsoft Windows**
  - http://www.cmake.org/download/
  - http://git-scm.com/downloads/
  - http://sf.net/projects/mingw/files/Installer/mingw-get-inst/
  - http://www.microsoft.com/express
- **Apple Mac OS X**
  - http://www.cmake.org/download/
  - https://developer.apple.com/xcode/

Example System



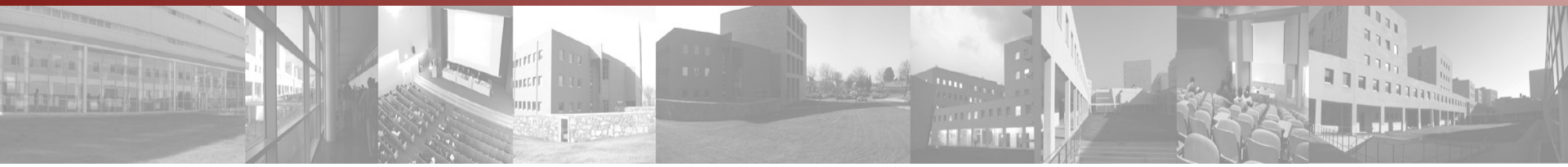
Resources

- **Source Code**
  - https://github.com/LSTS/dune
- **Documentation**
  - http://lsts.pt/docs
  - https://github.com/LSTS/dune/wiki
- **Mailing List**
  - https://groups.google.com/forum/#!forum/lsts-toolchain
  - lsts-toolchain@googlegroups.com
- **Nightly Builds**
  - http://www.lsts.pt/cdash/index.php?project=DUNE

Nightly Builds

Nightly

Site	Build Name	Update	Configure		Build		Test			Build Time
		Files	Error	Warn	Error	Warn	Not Run	Fail	Pass	
macosx-8-x86-64	x86-32bit-darwin-apple-clang	0	0	0	0_{-50}	0	0_{-13}	0	13^{+13}	Nov 13, 2014 - 07:55 GMT
dragonflybsd-3-x86-32	x86-32bit-dragonfly-bsd-gcc4x	0	0	0	0	0	0	0	13	Nov 13, 2014 - 10:31 GMT
freebsd-10-x86-64	x86-32bit-freebsd-libcxx-clang	0	0	0	0_{-50}	0_{-50}	0_{-2}	0	13^{+2}	Nov 13, 2014 - 13:33 GMT
he162	x86-32bit-linux-glibc-clang	0	0	0	0_{-50}	0	0_{-13}	0	13^{+13}	Nov 13, 2014 - 14:29 GMT
ubuntu-12-x86-64	x86-32bit-linux-glibc-clang	0	0	0	0_{-50}	0	0_{-13}	0	13^{+13}	Nov 13, 2014 - 03:09 GMT
ubuntu-12-x86-32	x86-32bit-linux-glibc-clang	0	0	0	0_{-50}	0	0_{-13}	0	13^{+13}	Nov 13, 2014 - 04:02 GMT
ubuntu-13-x86-64	x86-32bit-linux-glibc-clang	0	0	0	0_{-50}	0	0_{-13}	0	13^{+13}	Nov 13, 2014 - 13:07 GMT
he162	x86-32bit-linux-glibc-gcc4x	0	0	0	0	0	0	0	13	Nov 13, 2014 - 14:02 GMT
centos-6-x86-64	x86-32bit-linux-glibc-gcc4x	0	0	0	0	1	0	0	13	Nov 13, 2014 - 01:28 GMT
ubuntu-12-x86-64	x86-32bit-linux-glibc-gcc4x	0	0	0	0	0	0	0	13	Nov 13, 2014 - 02:25 GMT
ubuntu-12-x86-32	x86-32bit-linux-glibc-gcc4x	0	0	0	0	0	0	0	13	Nov 13, 2014 - 03:41 GMT
debian-6-x86-64	x86-32bit-linux-glibc-gcc4x	0	0	0	0	1	0	0	13	Nov 13, 2014 - 08:36 GMT



Neptus – Command and Control Infrastructure

What's Neptus?

- Neptus allows planning, control and revision of missions performed by unmanned vehicles
- Neptus supports multiple heterogeneous vehicles
  - AUVs, UAVs, ROVs, ASVs, ...
  - Controlled individually or as a team
- Neptus supports multiple operators
  - Operators join in and access / control the network of vehicles
- Neptus can be extended through plug-ins
  - Map layers, Data visualizations, Console widgets, Maneuvers, Communication protocols, ...

Neptus mission concept

- In Neptus, a mission is specified as
  - A set of map features
  - A set of programmed plans
  - A set of vehicle configurations

- The mission is usually...
  - Created prior to execution (planning)
  - Changed during execution (monitoring / revision / re-planning)

Part 1: Using Neptus

Neptus Requirements

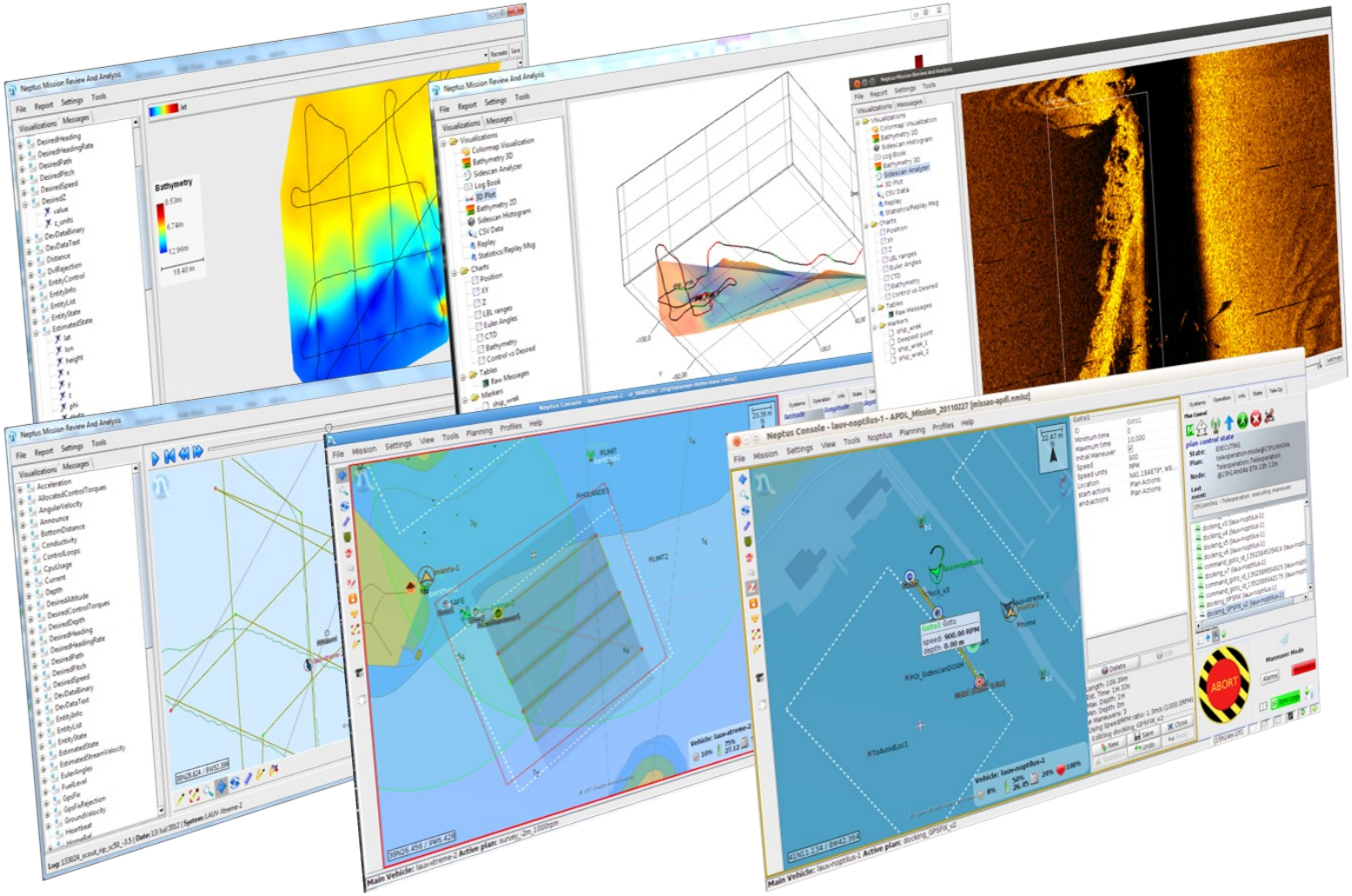
- Neptus requires prior installation of Oracle's Java Runtime Environment version 8
- For 3D widgets an OpenGL-compatible graphics adapter is recommended
  - For some 3D data visualizations, VTKJava library is required
- At least 1 GB of RAM (4 GB recommended)
- Compatible with Windows and Linux (known to work under OSX but rarely tested)

Installing and Running Neptus

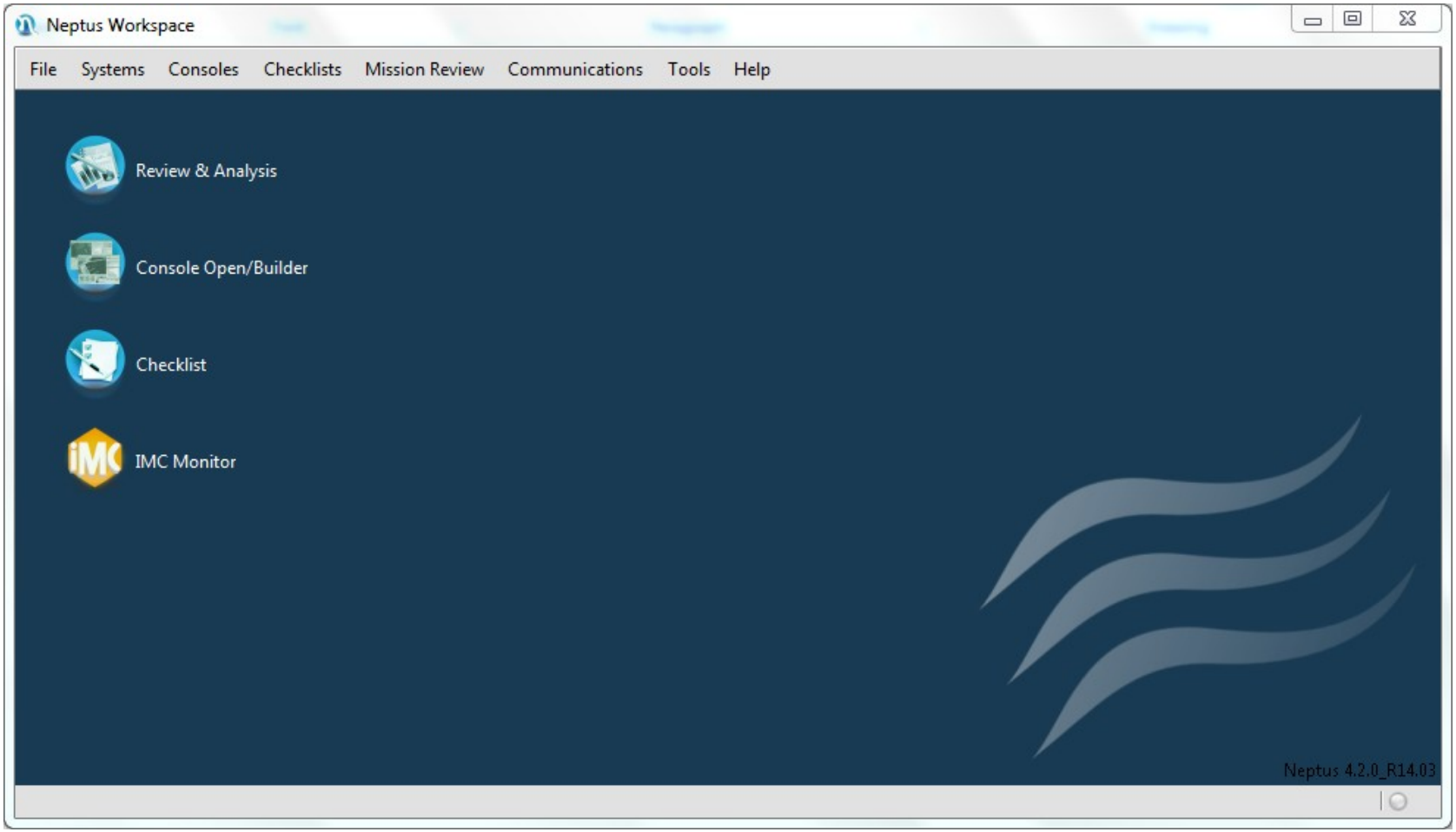
- To install Neptus, just download the latest version to a directory of choice
  - Logs will be put under this directory so make sure you leave extra disk space for them
- Downloading Neptus
  - Use your favorite Git client to clone Neptus from https://github.com/LSTS/neptus

    git glone https://github.com/LSTS/neptus.git
- Running Neptus
  - In Windows: run neptus.bat
  - In Linux: execute ./neptus.sh

Interfaces Adjusted/Adjustable to Several Needs



The Neptus Workspace



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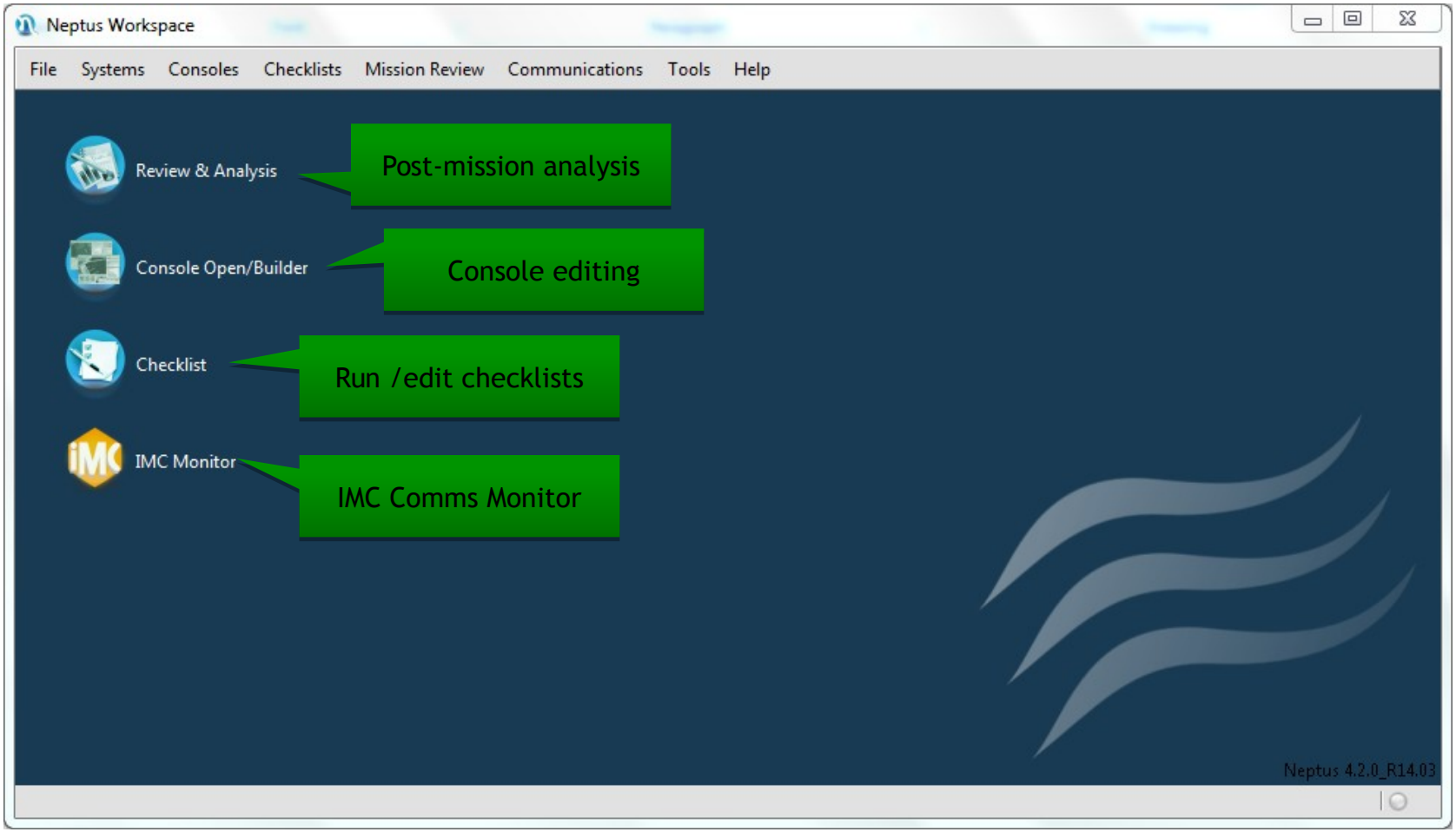
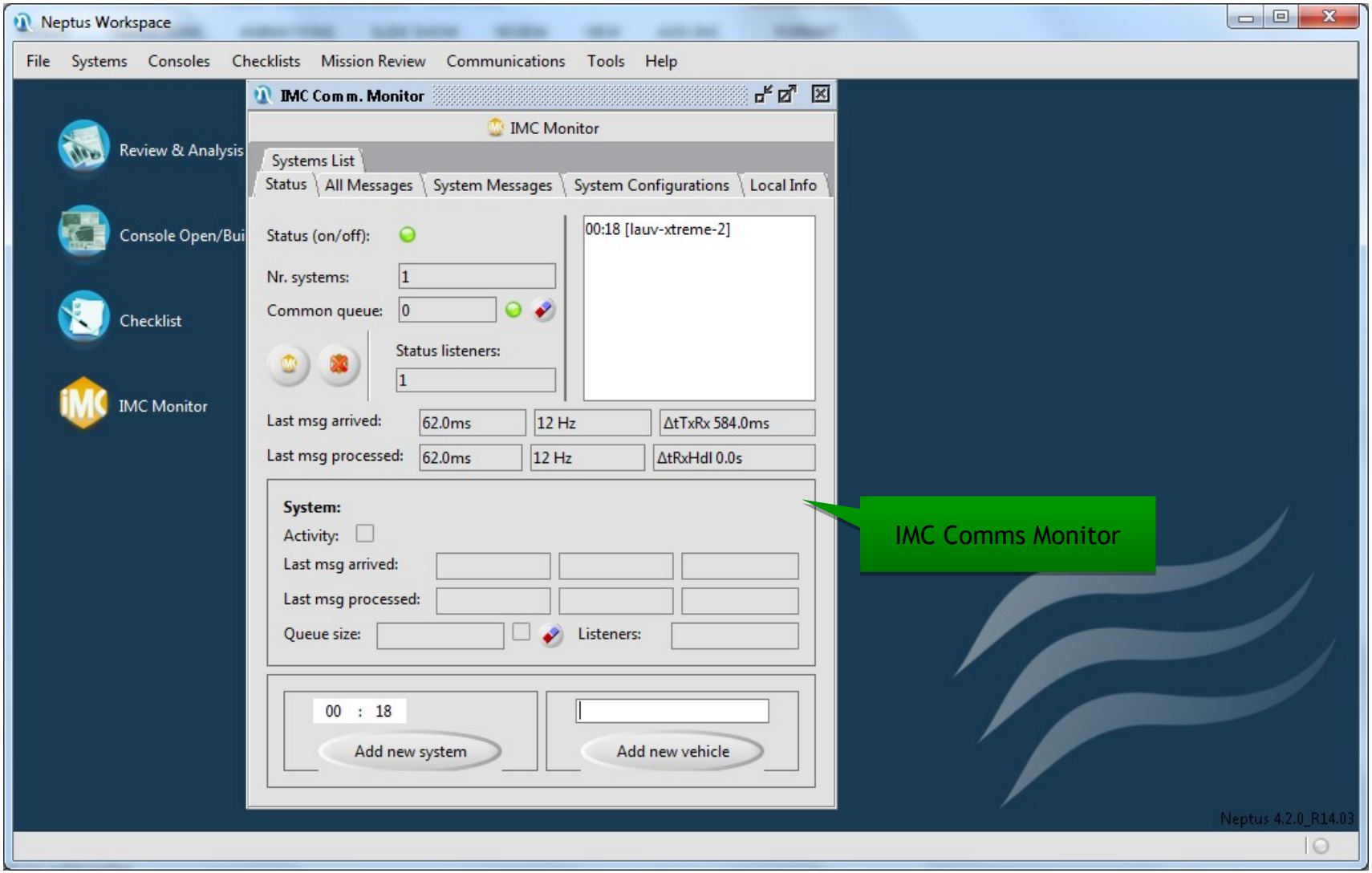


The Neptus Workspace

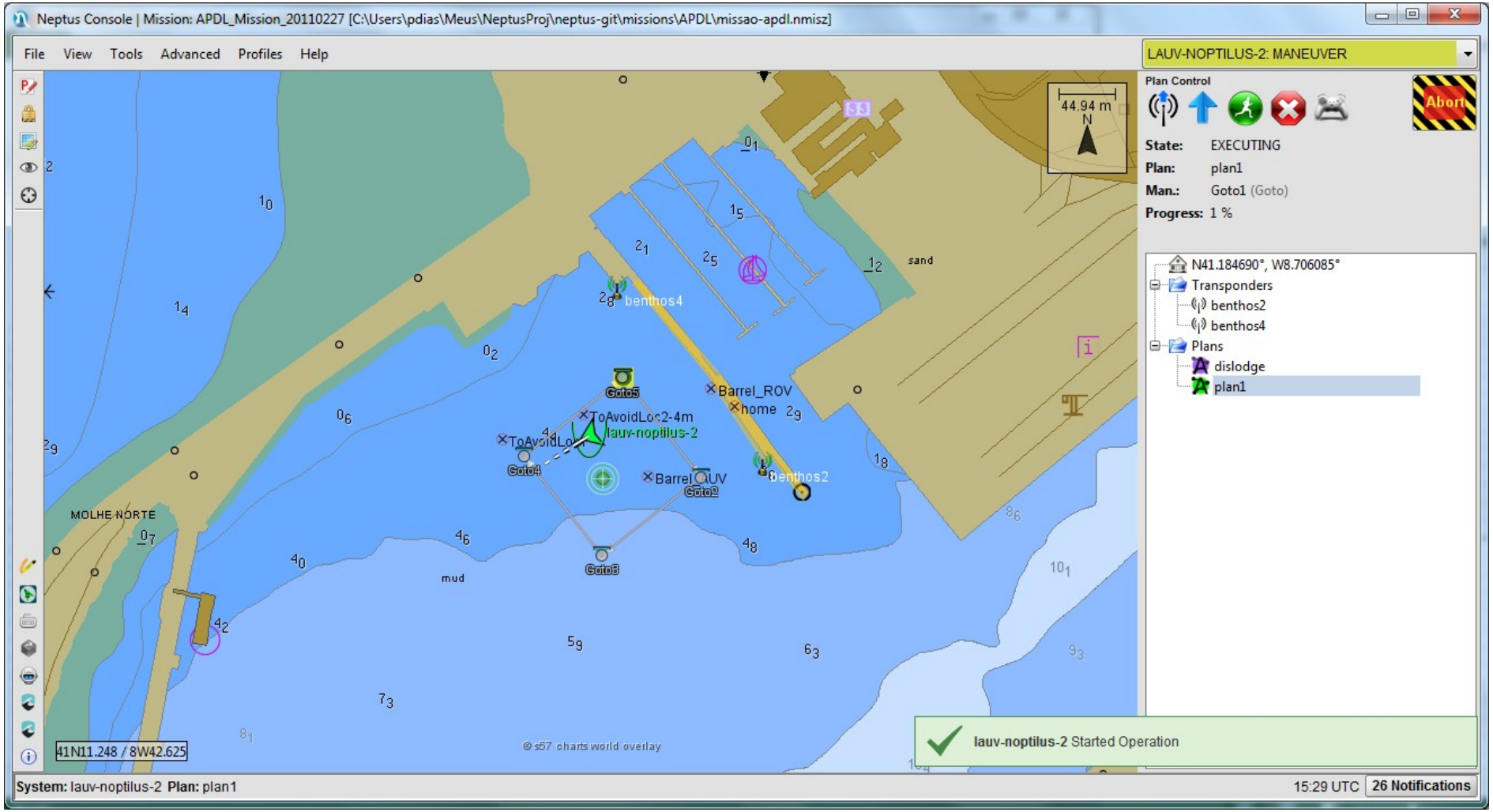


Neptus Consoles

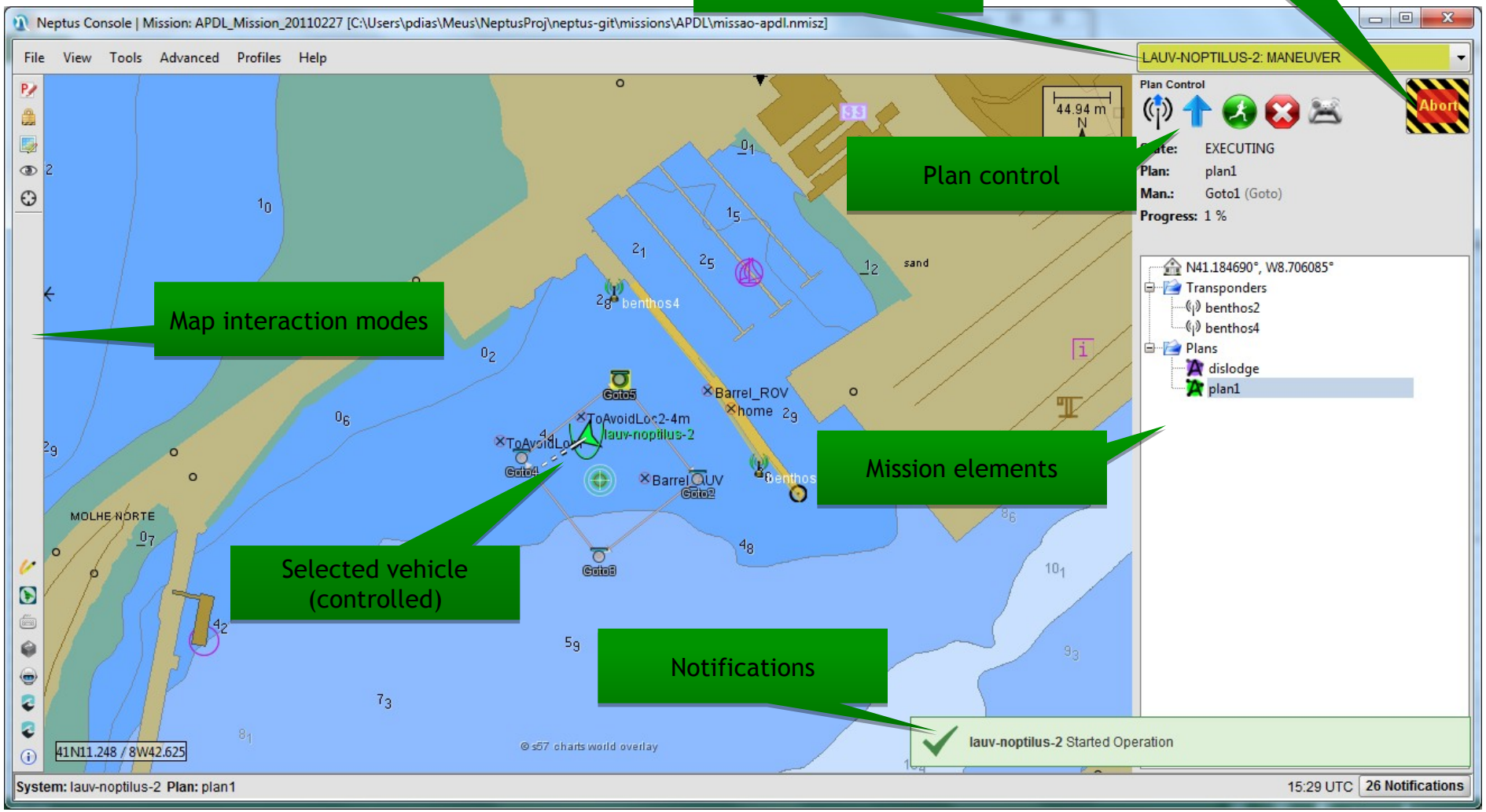
- Neptus allow end-users to create Operational Consoles
  - Based on existing widgets
  - Adapted to specific missions/vehicles

- Mission console definitions are stored as XML
  - .ncon file extension
  - A sort of consoles are already bundled

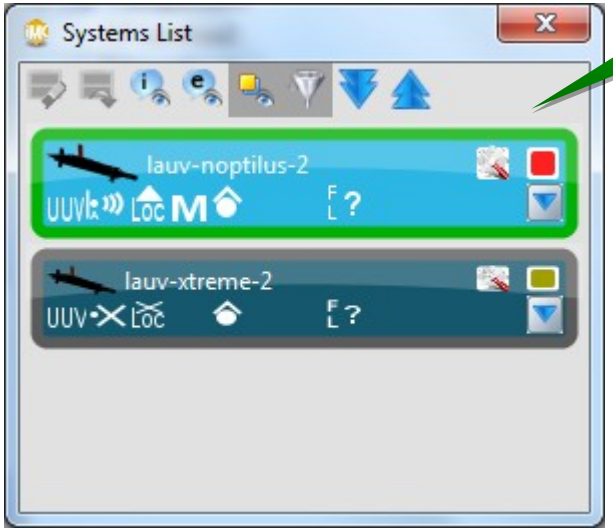
Neptus Consoles



Neptus Consoles

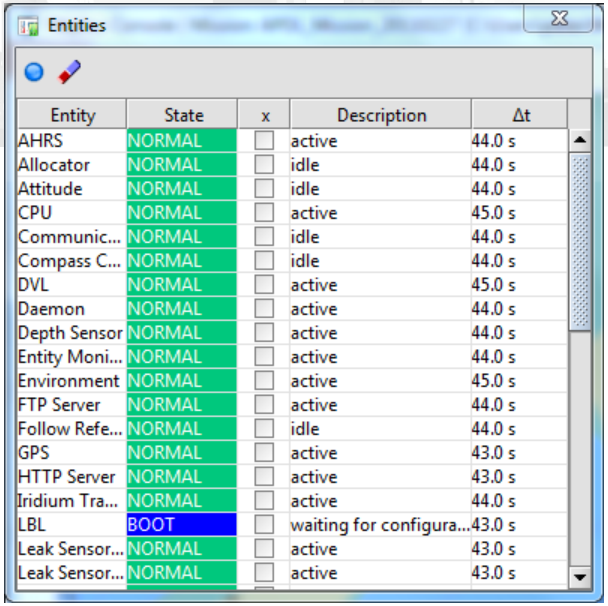


Neptus Consoles

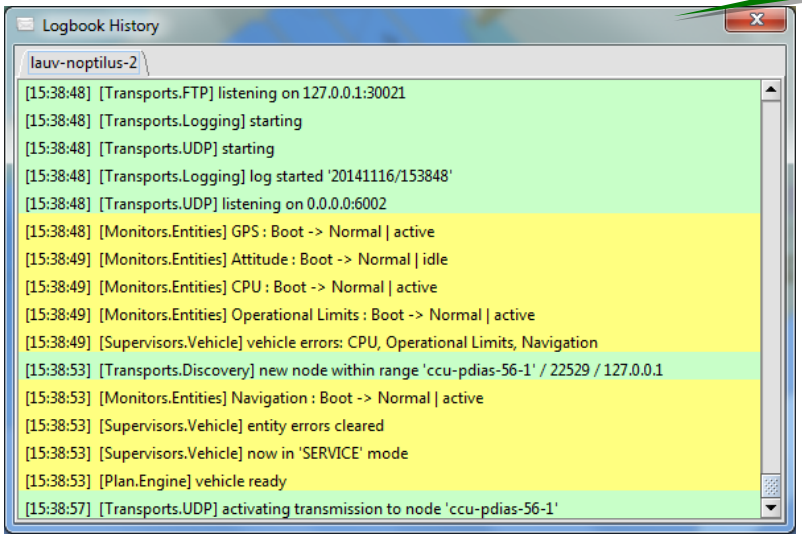


Systems listing and selection

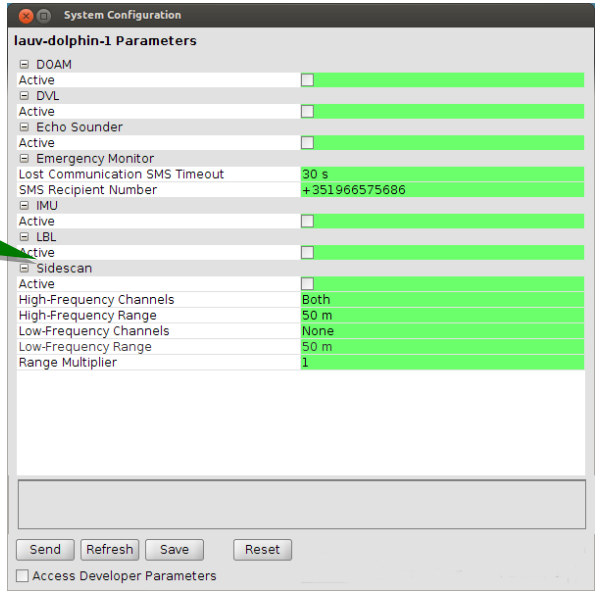
Vehicle subsystems state



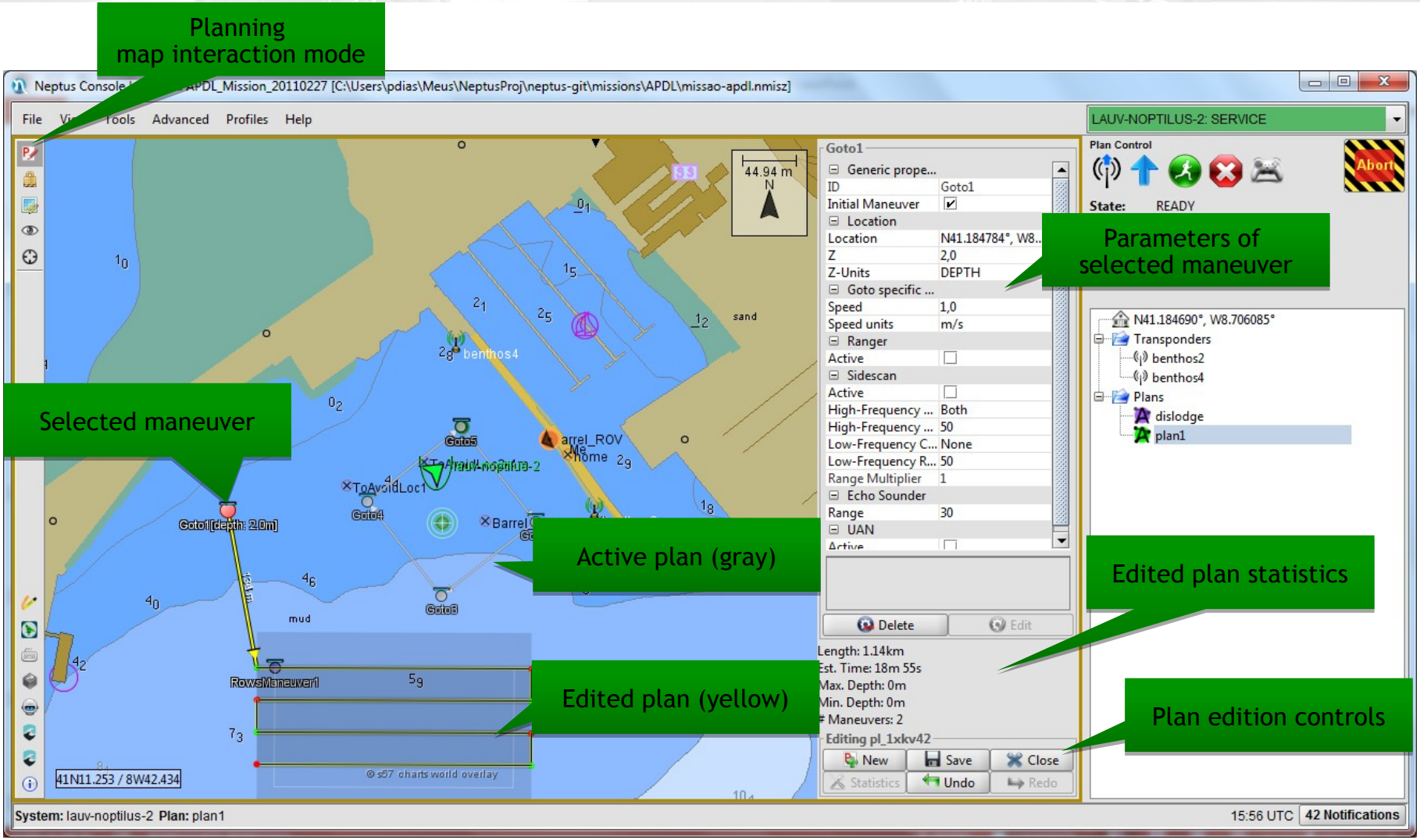
Vehicle Log Book



Vehicles Configurations



Neptus Consoles



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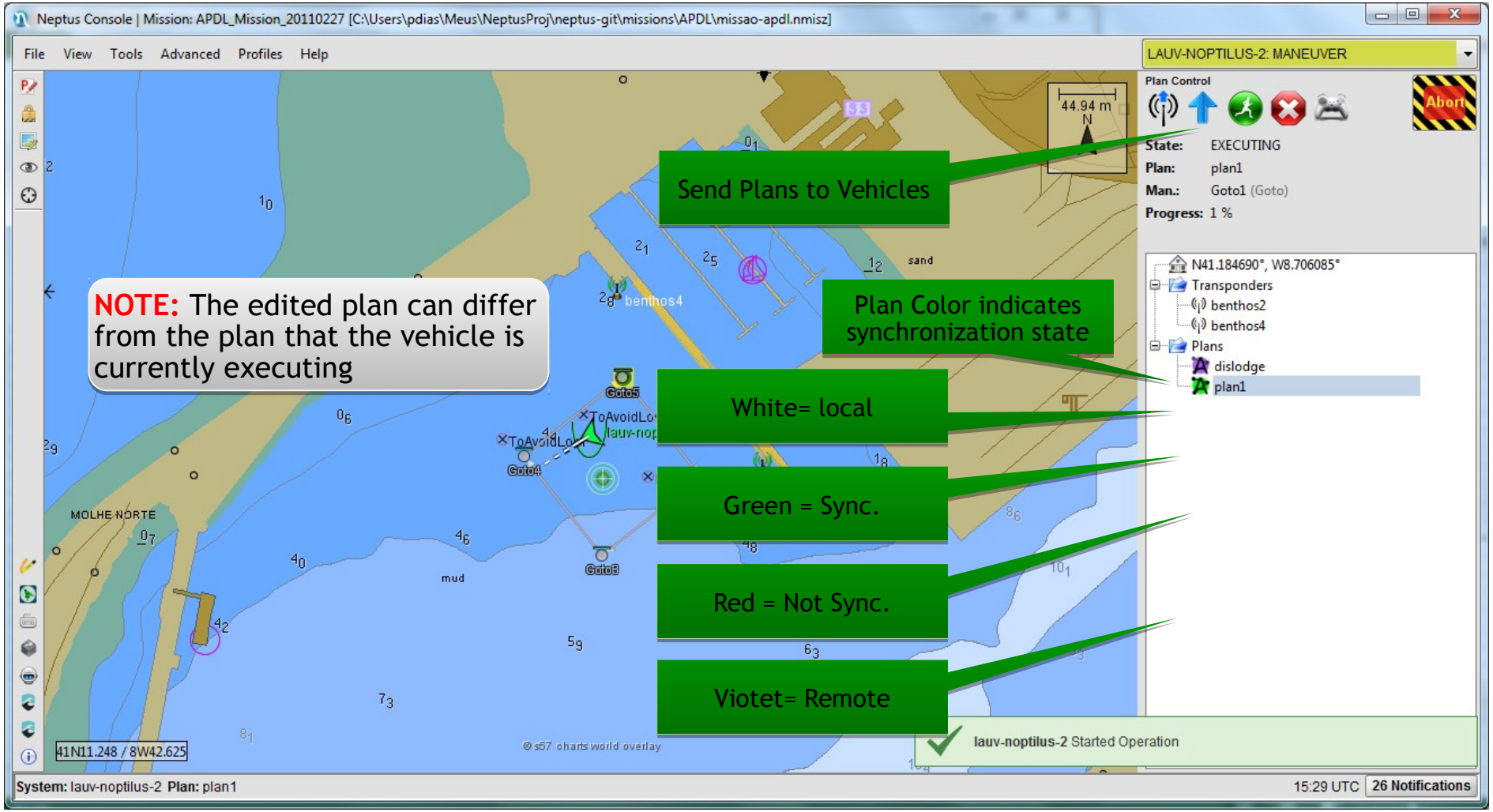
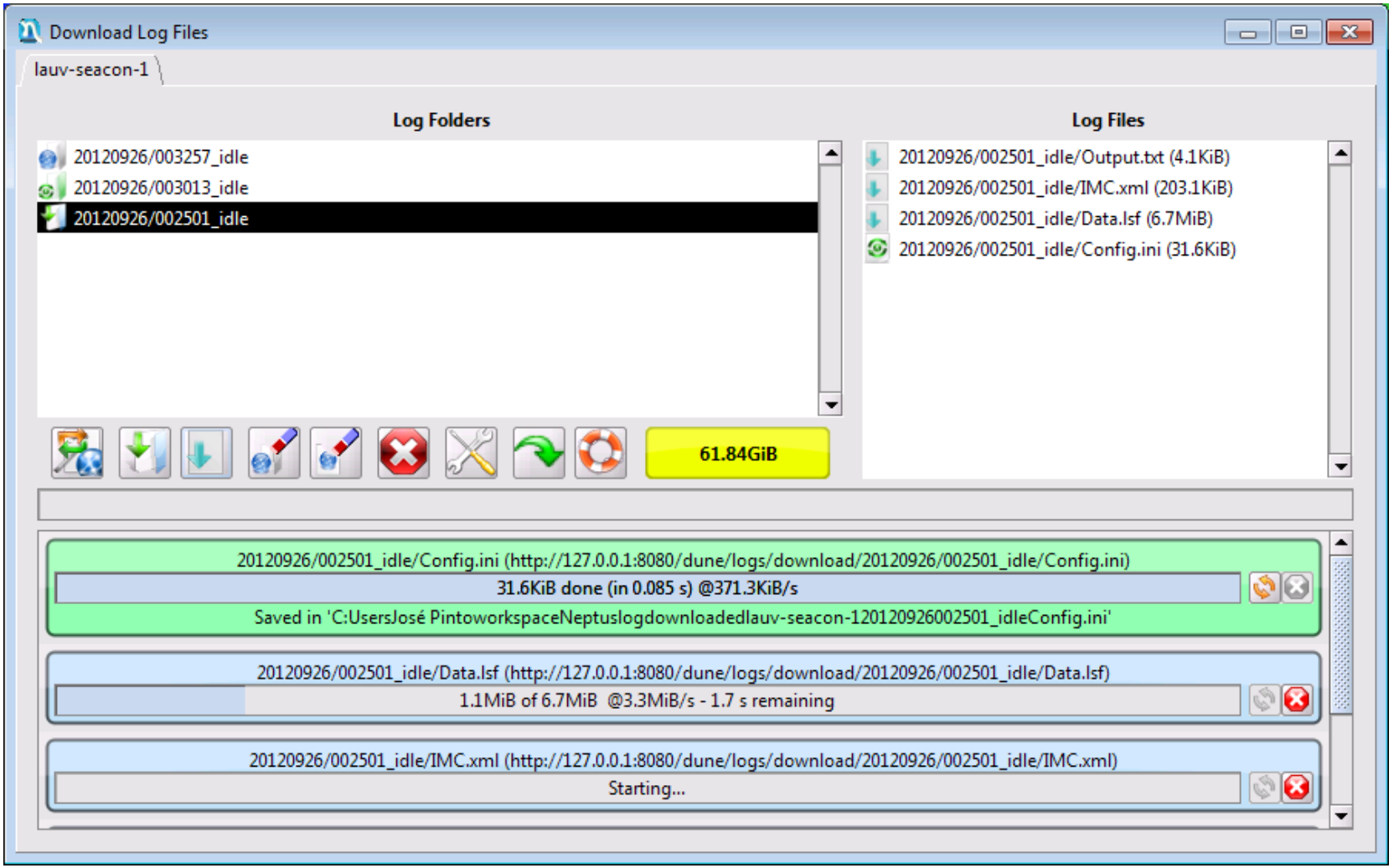


Neptus Consoles - Log Download Dialog



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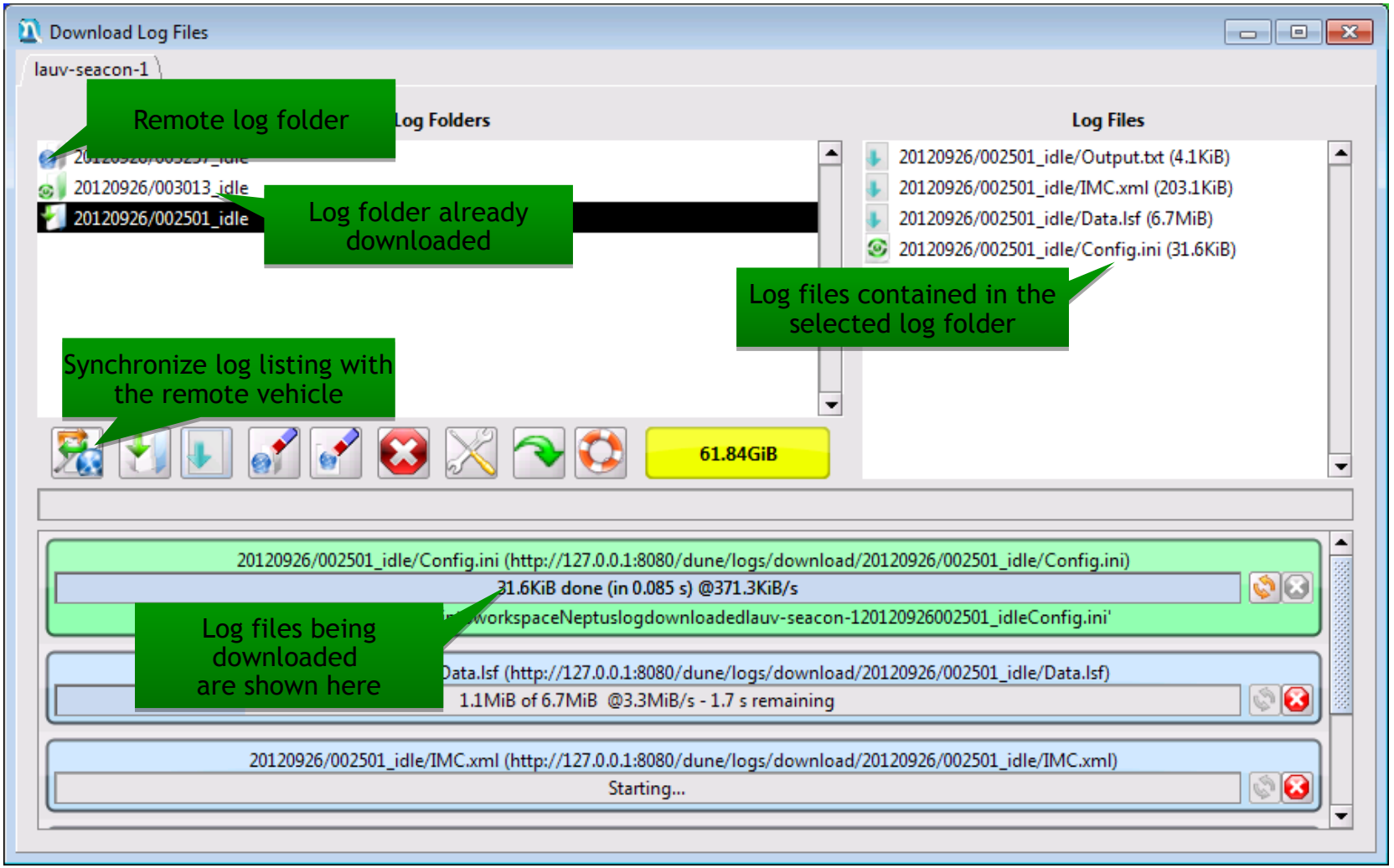
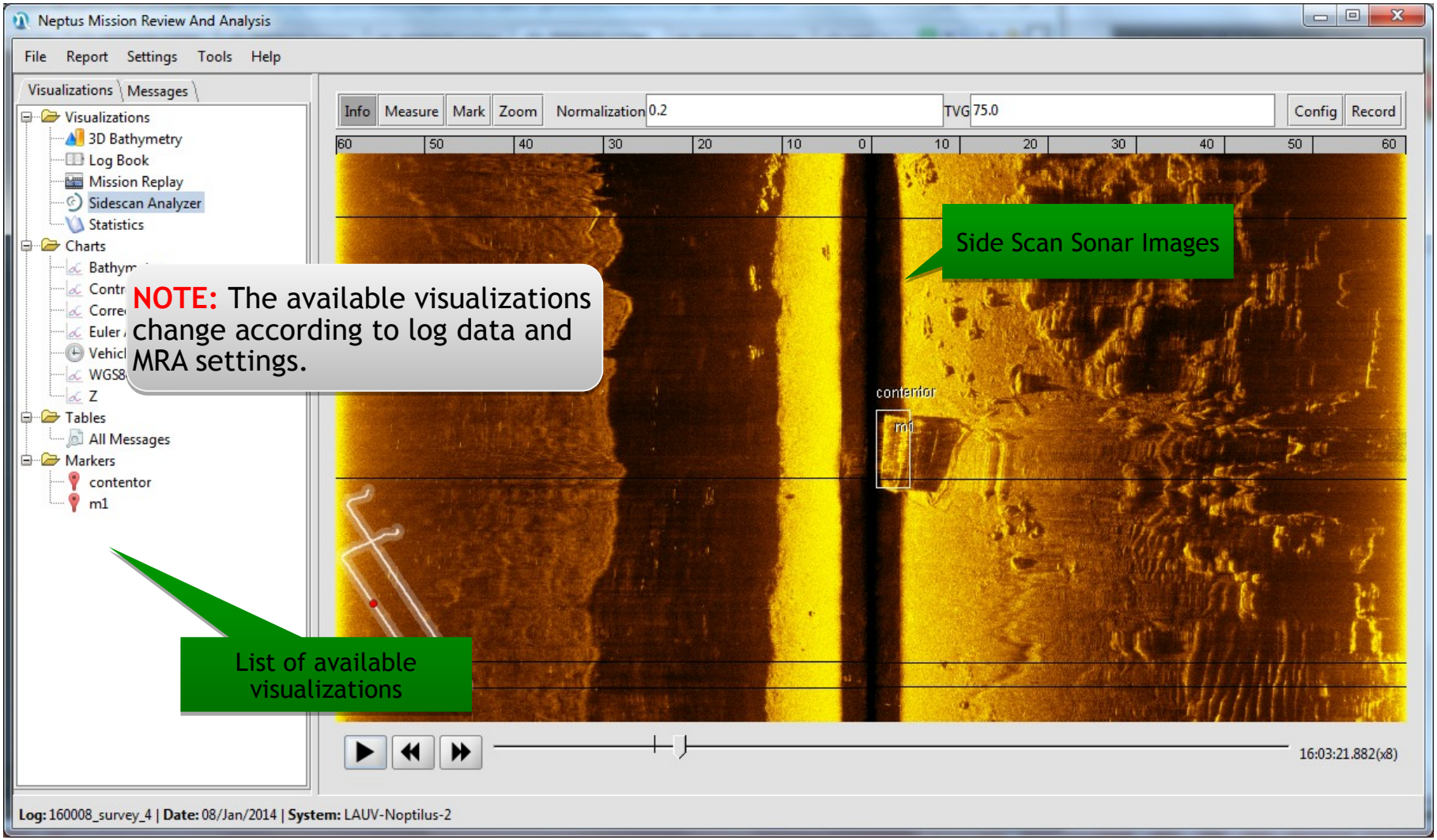


Neptus Mission Review and Analysis

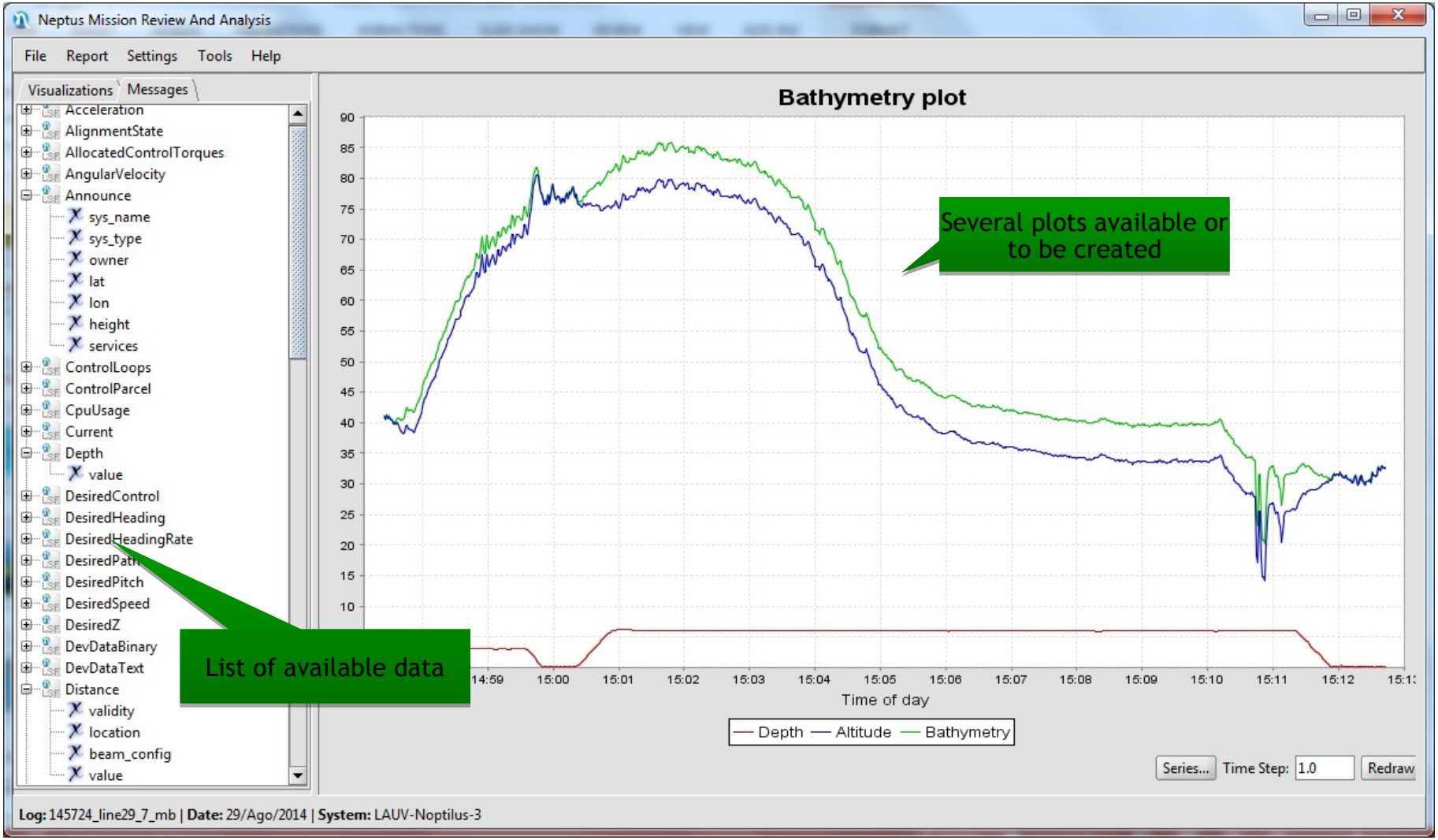
- Can be acessed
  - Directly by right-clicking a downloaded log
  - From the Neptus workspace

- Compatible with LSF log folders
  - Data.lsf (binary concatenation of IMC data)
  - IMC.xml (definition of the protocol used in the LSF)
  - config.ini (used vehicle configuration)

Neptus Mission Review and Analysis



Neptus Mission Review and Analysis



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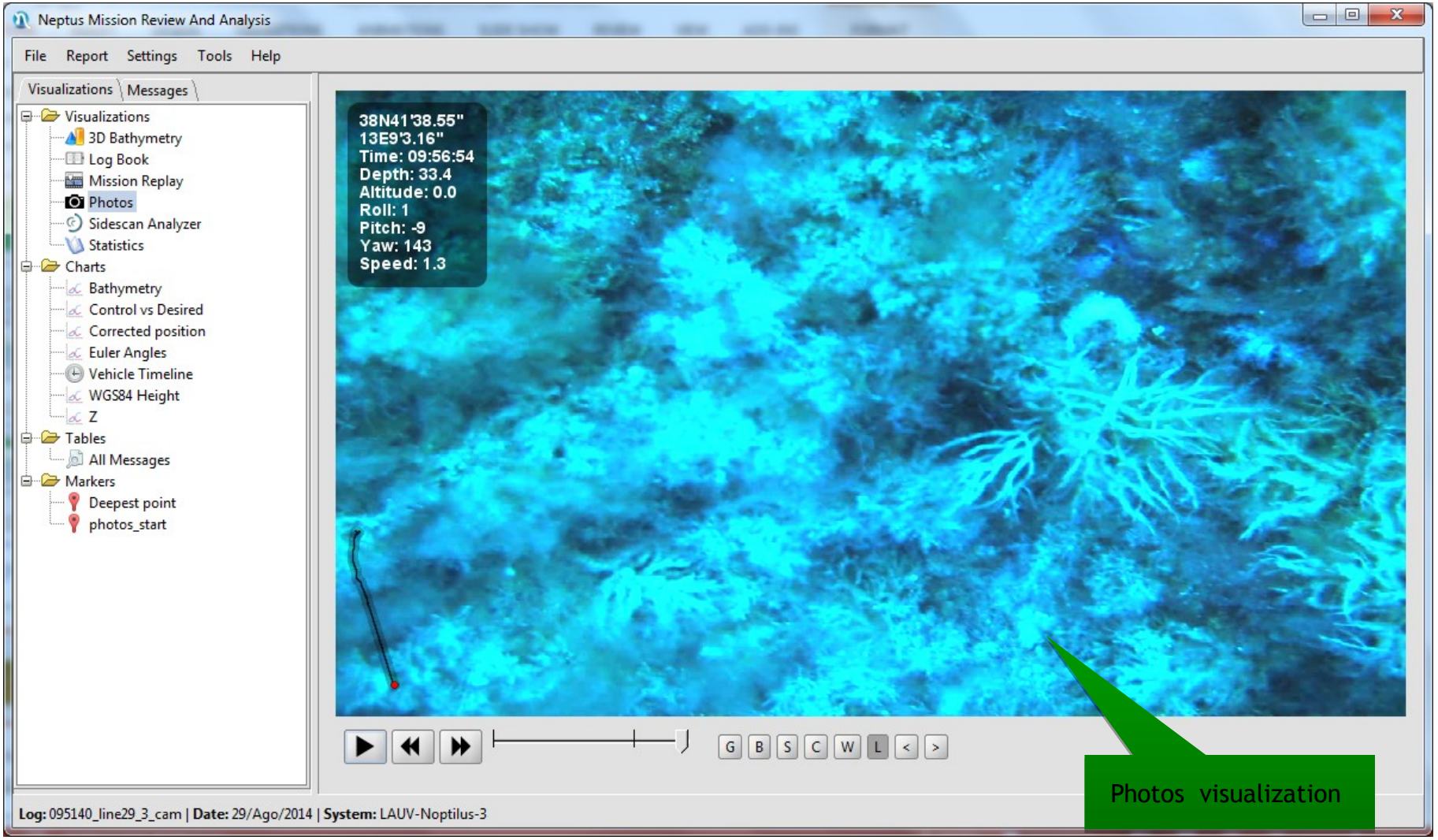

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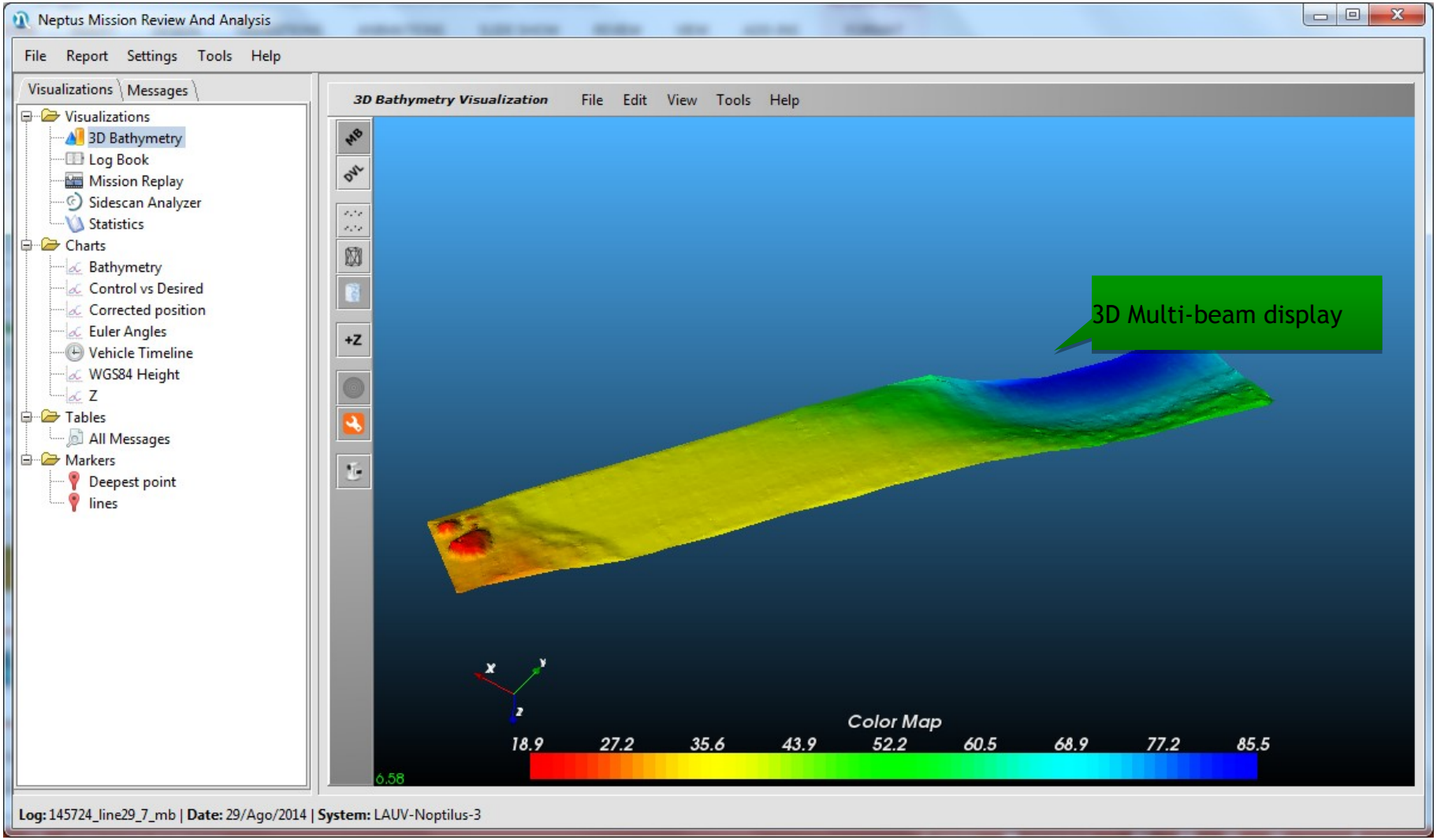

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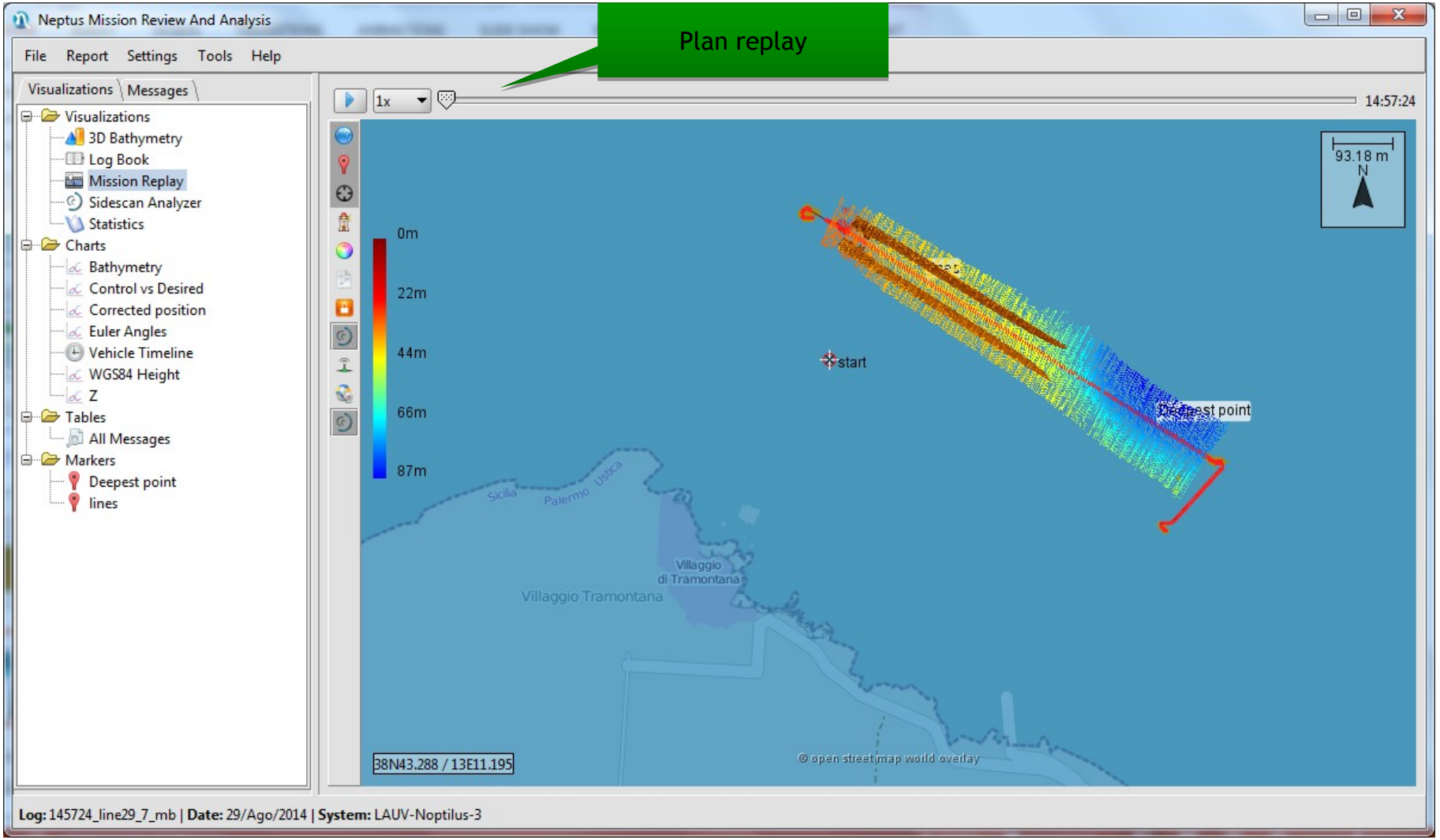

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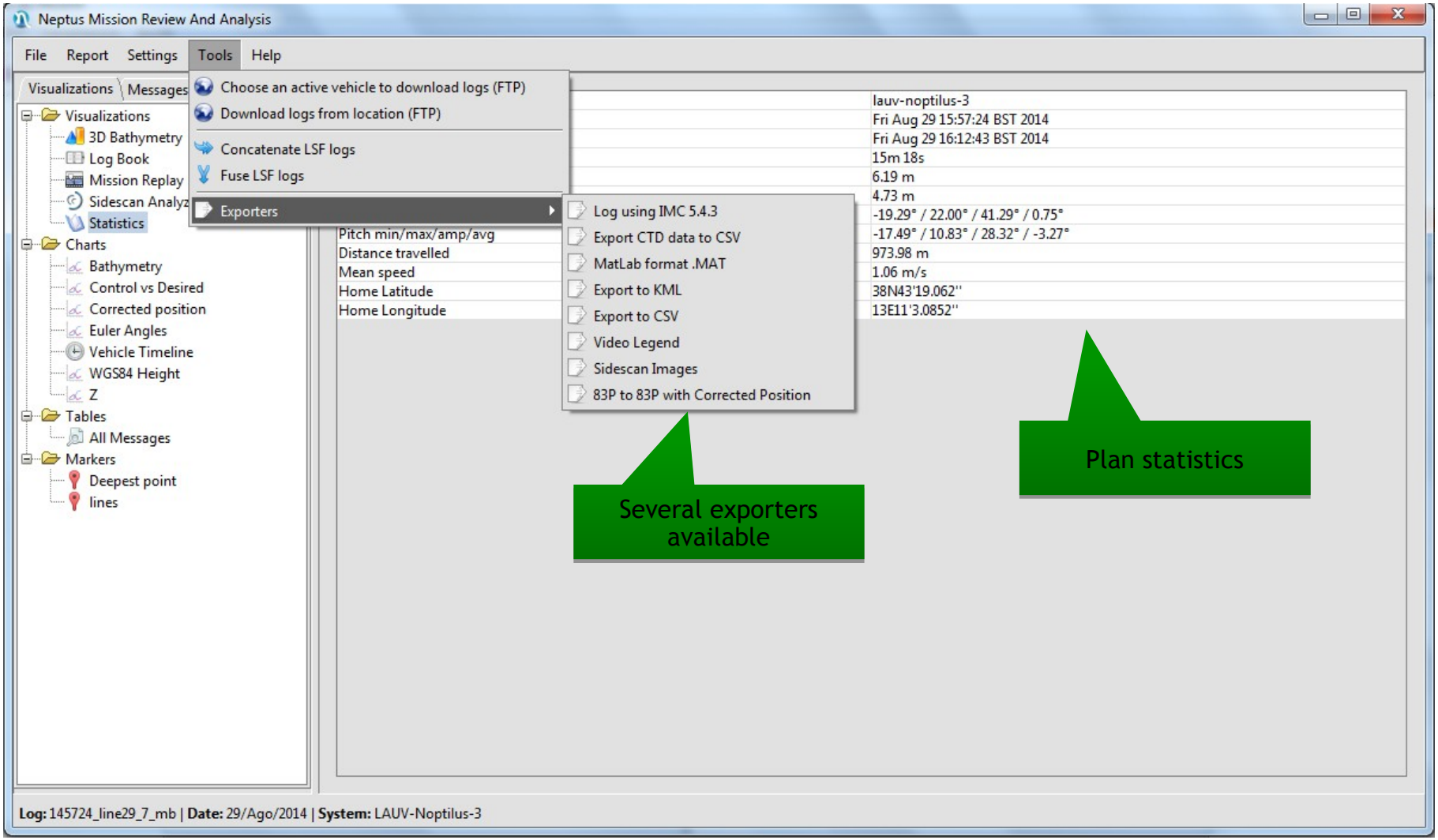
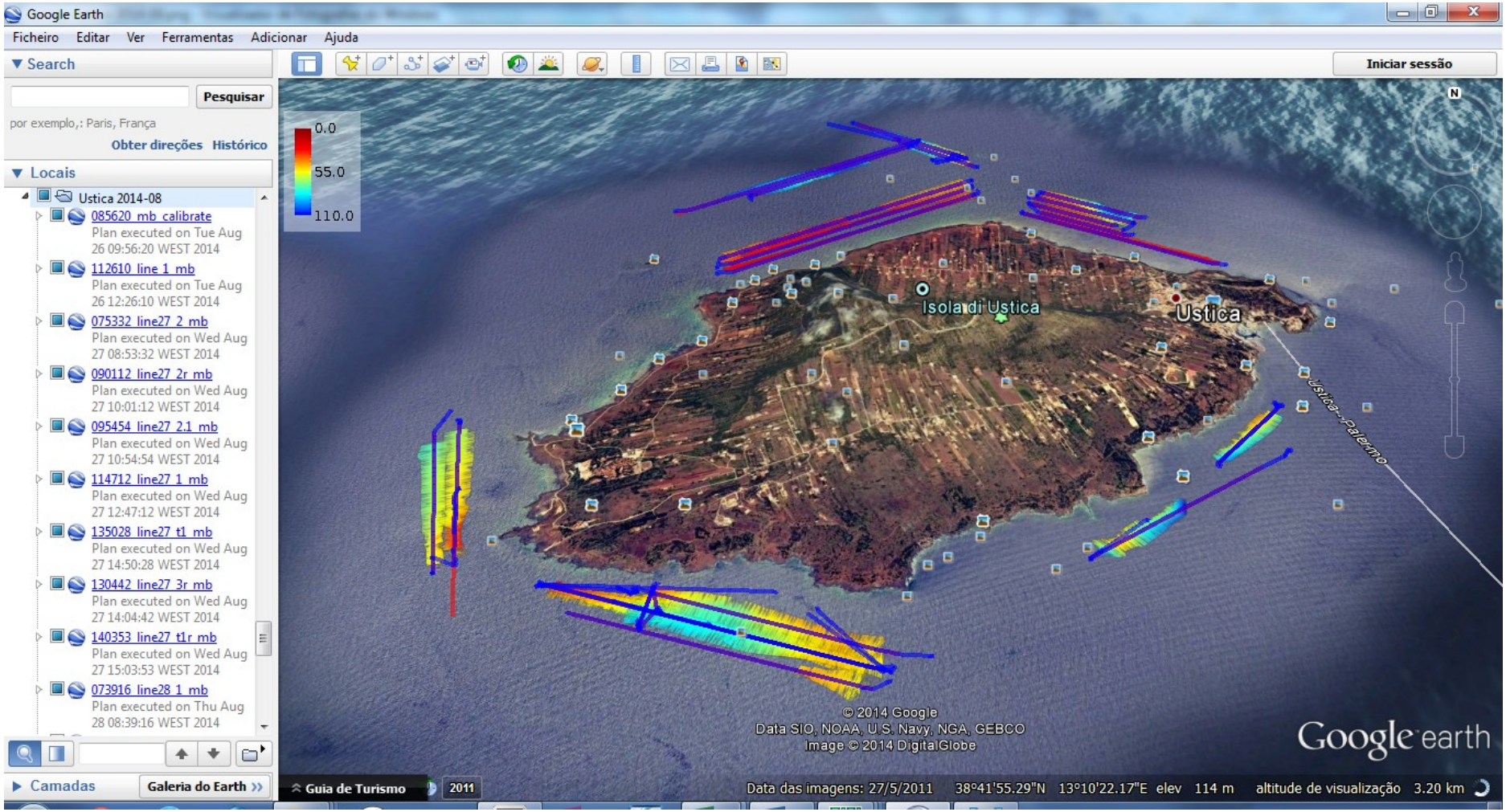


Neptus KML Export



Extending DUNE

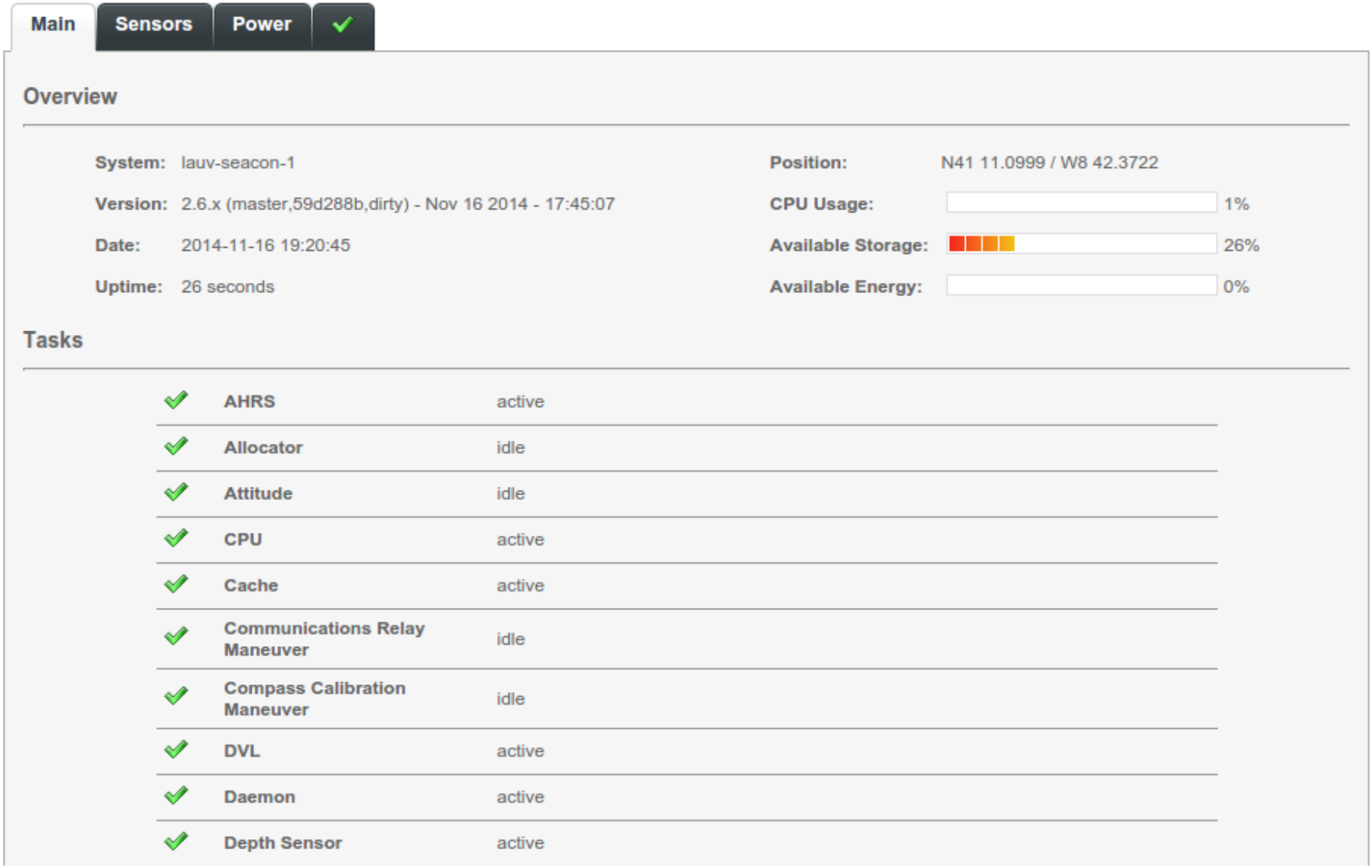
Compilation and Execution

- mkdir $HOME/tutorial && cd $HOME/tutorial
- git clone https://github.com/LSTS/dune.git dune
- mkdir build && cd build
- cmake ../dune -G "Eclipse CDT4 - Unix Makefiles"
- make
- ./dune -c lauv-seacon-1 -p Simulation

  - Optional: have a look in **dune/src/etc/lauv-seacon-1.ini**

Web Interface

- http://127.0.0.1:8080



Anatomy of a Task

- Runs concurrently with other tasks
- Communicates with other tasks using IMC messages
- Does one job (and does it right)
- Can be event-driven or periodic

Basic Functions

- **Task**(const std::string& name, Tasks::Context& ctx)
  - Task constructor
  - Never fails, doesn't throw exceptions
  - Declares configuration parameters
  - Allocates resources that do not depend on configuration parameters
- void **onUpdateParameters**(void)
  - Called when configuration parameters change
- void **onEntityReservation**(void)
  - Called when the task can reserve entities

Example Task: Consumer

- http://goo.gl/1n2Cpk
- Task consumes temperature messages and prints them to the output (console)
- Scaffold created using the command:
  - python ../dune/programs/scripts/dune-create-task.py ../dune 'Ricardo Martins' 'Workshop/Consumer'
  - make rebuild_cache
- Source code resides in ***src/Workshop/Consumer***
- Task entry point is ***src/Workshop/Consumer/Task.cpp***
- Build: make

Example Task: Consumer

```
 1  // DUNE headers.
 2  #include <DUNE/DUNE.hpp>
 3
 4  namespace Workshop
 5  {
 6    //! Simple task that consumes temperature messages and prints them to
 7    //! the terminal.
 8    namespace Consumer
 9    {
10      using DUNE_NAMESPACES;
11
12      //! Entry point.
13      struct Task: public Tasks::Task
14      {
```

Example Task: Consumer

```
15        //! Task constructor.
16        Task(const std::string& name, Tasks::Context& ctx):
17          Tasks::Task(name, ctx)
18        {
19          bind<IMC::Temperature>(this);
20        }
21
22        //! Process temperature messages.
23        void
24        consume(const IMC::Temperature* msg)
25        {
26          inf("temperature is %f", msg->value);
27        }
```

Example Task: Consumer

```
28
29          //! Main loop.
30          void
31          onMain(void)
32          {
33            while (!stopping())
34            {
35              waitForMessages(1.0);
36            }
37          }
38        };
39      }
40    }
41
42    DUNE_TASK
43
```

Basic Functions

- void **onEntityResolution**(void)
  - Called when the task can resolve entities
- void **onResourceAcquisition**(void)
  - Called when the task can acquire resources (open serial ports, sockets, etc)
- void **onResourceInitialization**(void)
  - Called when the task can initialize previously acquired resources
- void **onResourceRelease**(void)
  - Releases all acquired resources
- void **onMain**(void) / void **task**(void)
  - Main task loop

Example Task: Producer

- http://goo.gl/FUezwX
- Task produces random temperature values and dispatches them to the message bus
- Scaffold created using the command:
  - python ../dune/programs/scripts/dune-create-task.py ../dune 'Ricardo Martins' 'Workshop/Producer'
  - make rebuild_cache
- Source code resides in ***src/Workshop/Producer***
- Task entry point is ***src/Workshop/Producer/Task.cpp***
- Build: make

Example Task: Producer

```
1  // DUNE headers.
2  #include <DUNE/DUNE.hpp>
3
4  namespace Workshop
5  {
6    //! Simple task that produces random temperature measurements.
7    namespace Producer
8    {
9      using DUNE_NAMESPACES;
```

Example Task: Producer

```
10
11      //! Task arguments.
12      struct Arguments
13      {
14        //! PRNG type.
15        std::string prng_type;
16        //! PRNG seed.
17        int prng_seed;
18        //! Mean temperature value.
19        float mean_value;
20        //! Standard deviation of temperature measurements.
21        double std_dev;
22      };
23
```

Example Task: Producer

```
24      //! Entry point.
25      struct Task: public Tasks::Periodic
26      {
27        //! PRNG handle.
28        Random::Generator* m_prng;
29        //! Task arguments.
30        Arguments m_args;
```

Example Task: Producer

```
32      //! Task constructor.
33      Task(const std::string& name, Tasks::Context& ctx):
34        Tasks::Periodic(name, ctx),
35        m_prng(NULL)
36      {
37        param("Standard Deviation", m_args.std_dev)
38        .units(Units::Meter)
39        .defaultValue("0.1");
40
41        param("PRNG Type", m_args.prng_type)
42        .defaultValue(Random::Factory::c_default);
43
44        param("PRNG Seed", m_args.prng_seed)
45        .defaultValue("-1");
46
47        param("Mean Value", m_args.mean_value)
48        .defaultValue("25.0")
49        .units(Units::DegreeCelsius)
50        .description("Mean temperature value");
51      }
```

Example Task: Producer

```
53      //! Acquire resources.
54      void
55      onResourceAcquisition(void)
56      {
57        m_prng = Random::Factory::create(m_args.prng_type,
58                                         m_args.prng_seed);
59      }
60
61      //! Release resources.
62      void
63      onResourceRelease(void)
64      {
65        Memory::clear(m_prng);
66      }
```

Example Task: Producer

```
68          //! Periodic work.
69          void
70          task(void)
71          {
72            IMC::Temperature temperature;
73            temperature.value = m_args.mean_value
74                              + m_prng->gaussian()
75                              * m_args.std_dev;
76            dispatch(temperature);
77          }
78        };
79      }
80    }
81
82    DUNE_TASK
83
```

Configuration File

- http://goo.gl/n4nli4
- Configuration file etc/development/workshop.ini:

```
[Require ../common/transports.ini]

[Workshop.Producer]
Enabled      = Always
Entity Label = Producer

[Workshop.Consumer]
Enabled      = Always
Entity Label = Consumer

[Transports.Logging]
Enabled      = Always
Entity Label = Logger
Transports   = Temperature
```

Runtime Output

Command: ./dune -c development/workshop

```
[2014/11/16 19:51:26] - MSG [Daemon] >> system name: 'unknown' (65535)
[2014/11/16 19:51:26] - MSG [Daemon] >> registered tasks: 160
[2014/11/16 19:51:26] - MSG [Daemon] >> base folder: '/home/rasm/tutorial/build'
[2014/11/16 19:51:26] - MSG [Daemon] >> configuration folder: '/home/rasm/tutorial/dune/etc'
[2014/11/16 19:51:26] - MSG [Daemon] >> web server folder: '/home/rasm/tutorial/dune/www'
[2014/11/16 19:51:26] - MSG [Daemon] >> log folder: '/home/rasm/tutorial/build/log/unknown'
[2014/11/16 19:51:26] - MSG [Daemon] >> library folder: '/home/rasm/tutorial/build'
[2014/11/16 19:51:26] - MSG [Daemon] >> firmware folder: '/home/rasm/tutorial/dune/firmware'
[2014/11/16 19:51:26] - MSG [Transports.Cache] >> starting
[2014/11/16 19:51:26] - MSG [Transports.FTP] >> starting
[2014/11/16 19:51:26] - MSG [Transports.Fragments] >> starting
[2014/11/16 19:51:26] - MSG [Transports.HTTP] >> starting
[2014/11/16 19:51:26] - MSG [Transports.LogBook] >> starting
[2014/11/16 19:51:26] - MSG [Transports.Logging] >> starting
[2014/11/16 19:51:26] - MSG [Workshop.Consumer] >> starting
[2014/11/16 19:51:26] - MSG [Workshop.Producer] >> starting
```

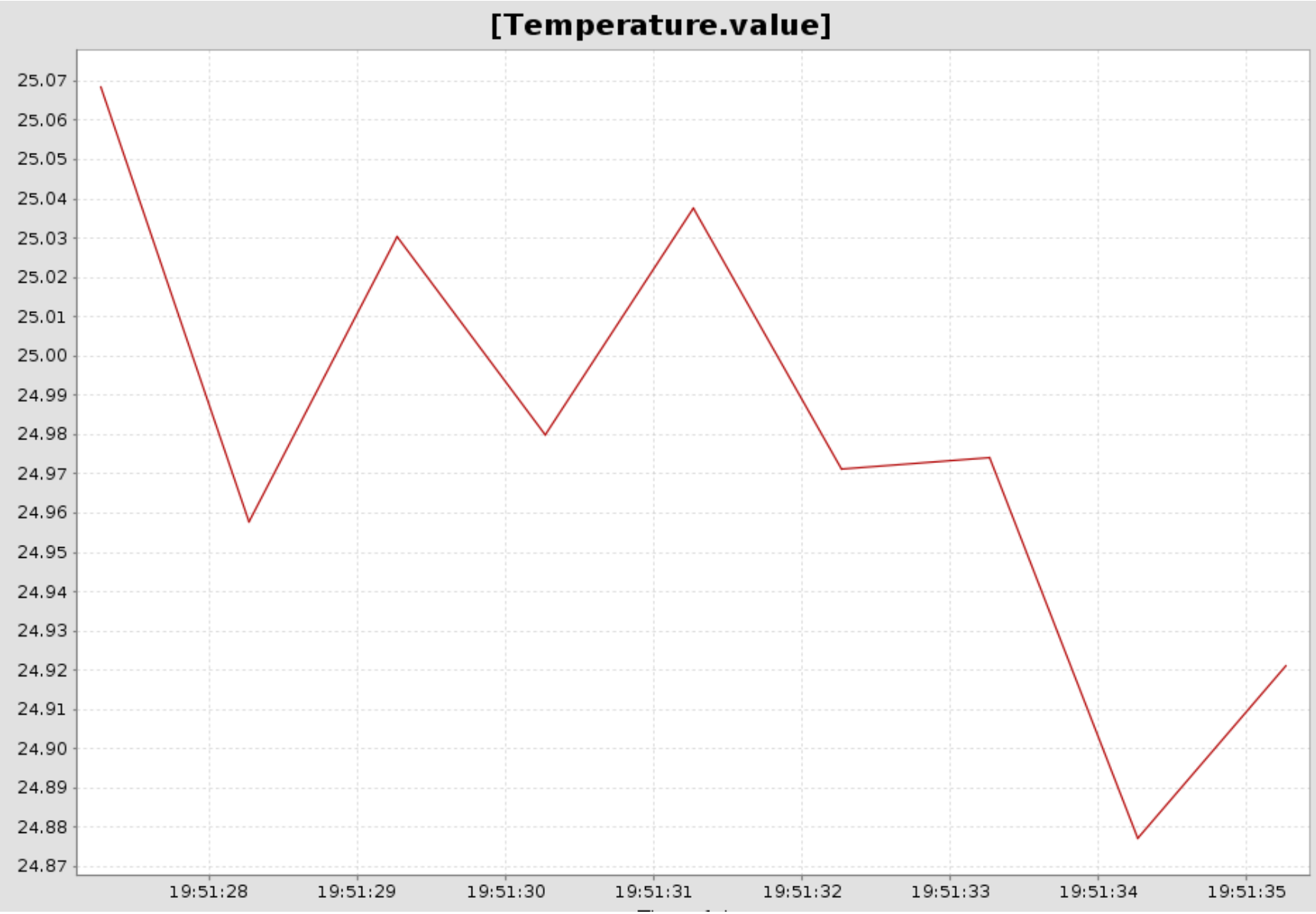
Runtime Output

```
[2014/11/16 19:51:26] - MSG [Transports.HTTP] >> listening on 0.0.0.0:8080
[2014/11/16 19:51:26] - MSG [Transports.Logging] >> log started '20141116/195126'
[2014/11/16 19:51:26] - MSG [Transports.FTP] >> listening on 127.0.0.1:30021
[2014/11/16 19:51:26] - MSG [Transports.FTP] >> listening on 192.168.1.178:30021
[2014/11/16 19:51:26] - MSG [Transports.FTP] >> listening on 10.0.254.1:30021
[2014/11/16 19:51:27] - MSG [Workshop.Consumer] >> temperature is 25.068323
[2014/11/16 19:51:28] - MSG [Workshop.Consumer] >> temperature is 24.957678
[2014/11/16 19:51:29] - MSG [Workshop.Consumer] >> temperature is 25.030371
[2014/11/16 19:51:30] - MSG [Workshop.Consumer] >> temperature is 24.979784
[2014/11/16 19:51:31] - MSG [Workshop.Consumer] >> temperature is 25.037634
[2014/11/16 19:51:32] - MSG [Workshop.Consumer] >> temperature is 24.971085
[2014/11/16 19:51:33] - MSG [Workshop.Consumer] >> temperature is 24.974072
[2014/11/16 19:51:34] - MSG [Workshop.Consumer] >> temperature is 24.877298
```

Log Files

- **DUNE stores log files in the IMC serialization format:**
  - Binary format
  - 1 file for all messages and message types (Data.lsf)
  - Messages are stored roughly in the same order as they were created
  - Supports Gzip and Bzip2 compression (Data.lsf.gz, Data.lsf.bz2)

Log File (Neptus MRA)



Extending Neptus

Requirements for Extending Neptus

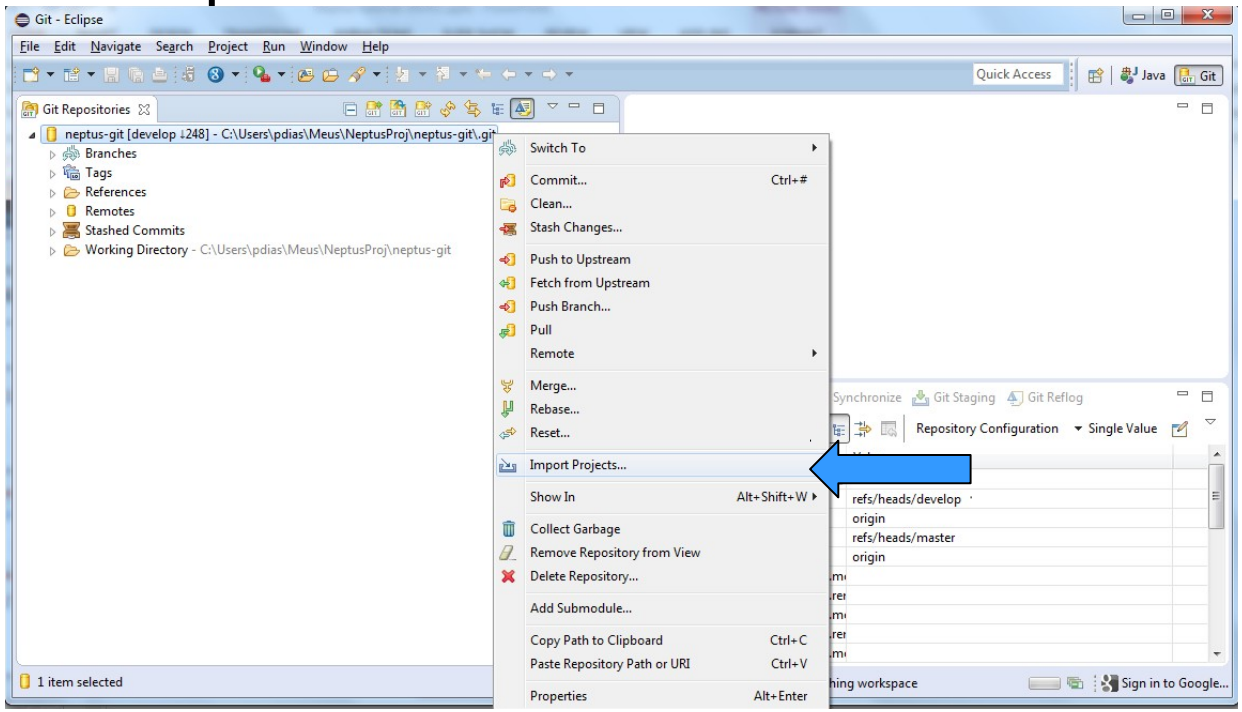
- Installation of Oracle's Java JDK version 8
- Git (Source Control Management)
- Ant (Build System)
- Eclipse Luna for Java Developers

Setup Your Development Tool

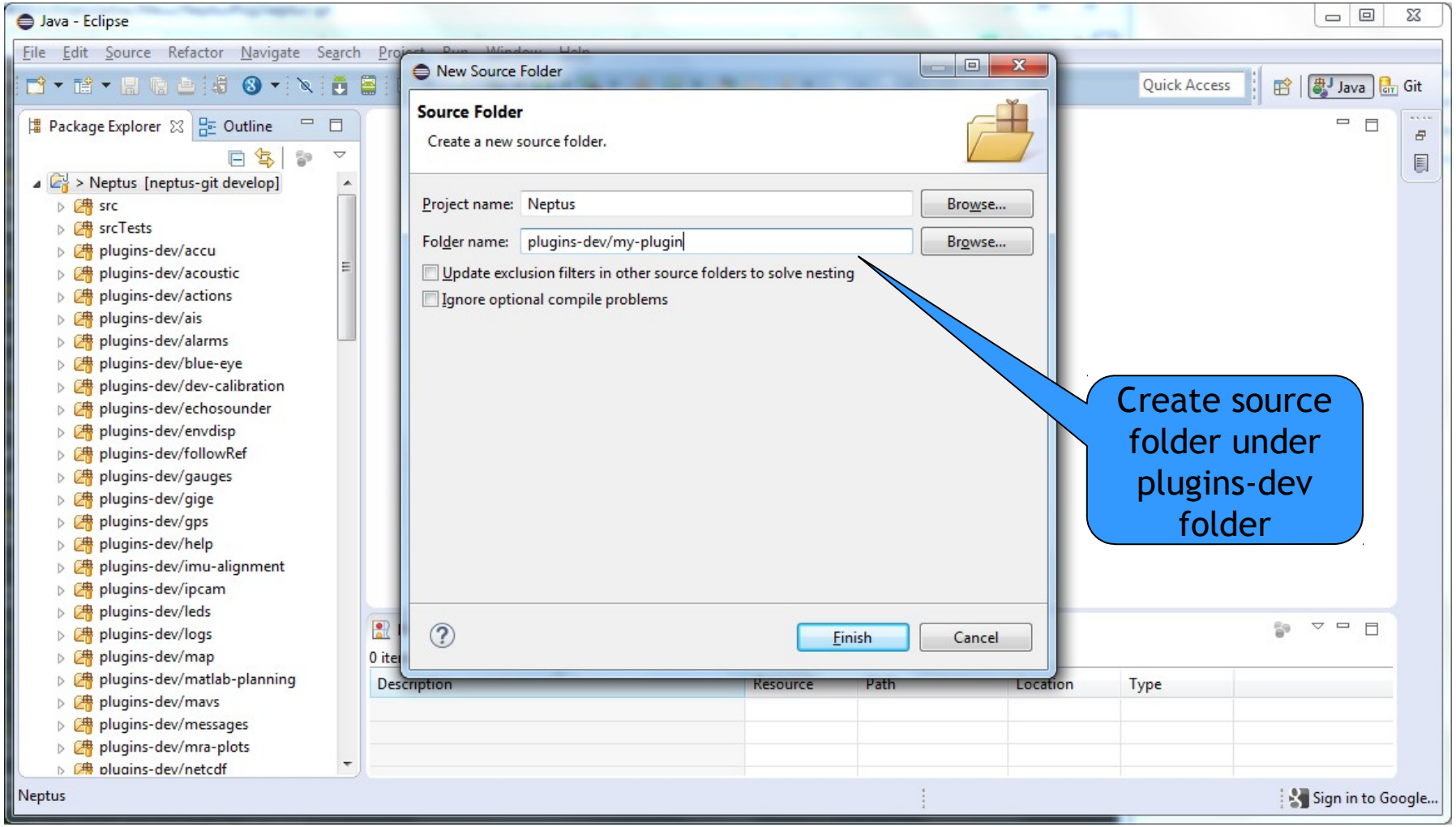
- Clone Neptus
  - Use your favorite Git client to clone Neptus:

    git clone https://github.com/LSTS/neptus.git

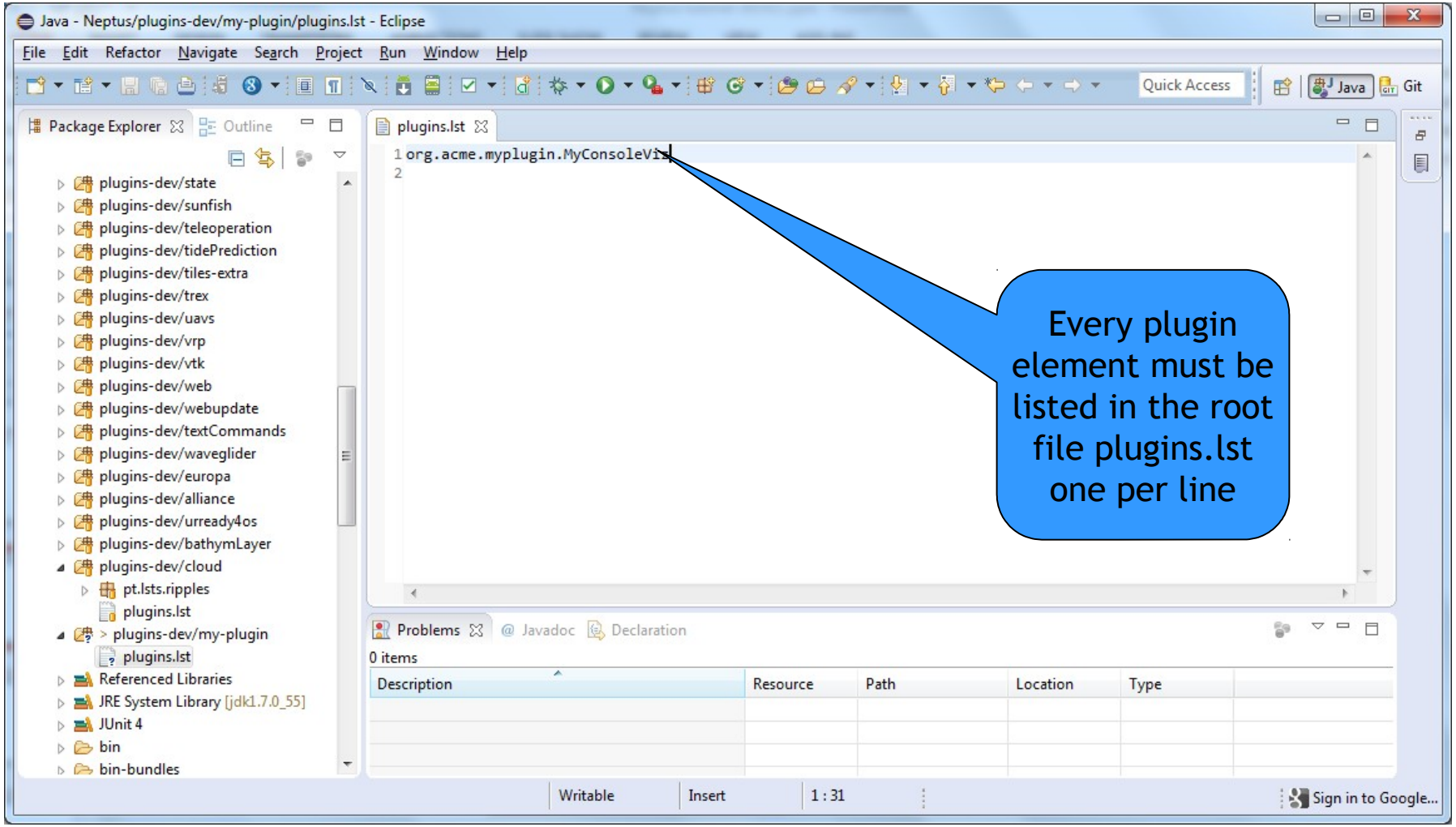
- Configure Eclipse



Creating a plug-in



Plug-in properties



Plug-in example - Console Widget

```
package org.acme.myplugin;
import pt.lsts.neptus.console.ConsoleLayout;
…
/**
 * @author You
 *
 */
@PluginDescription(name = "My Console Viz")
@Popup(pos = POSITION.RIGHT, width = 200, height = 200, accelerator = 'Y')
@SuppressWarnings("serial")
public class MyConsoleViz extends ConsolePanel {

    /**
     * @param console
     */
    public MyConsoleViz(ConsoleLayout console) {
        super(console);
    }

    @Override
    public void initSubPanel() {
    }

    @Override
    public void cleanSubPanel() {
    }
}
```

Every plugin is anotated with PluginDescription

Optionally the panel may be a popup dialog instead of living in the main window

Base console widget extends ConsolePanel

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Base console widget extends ConsolePanel

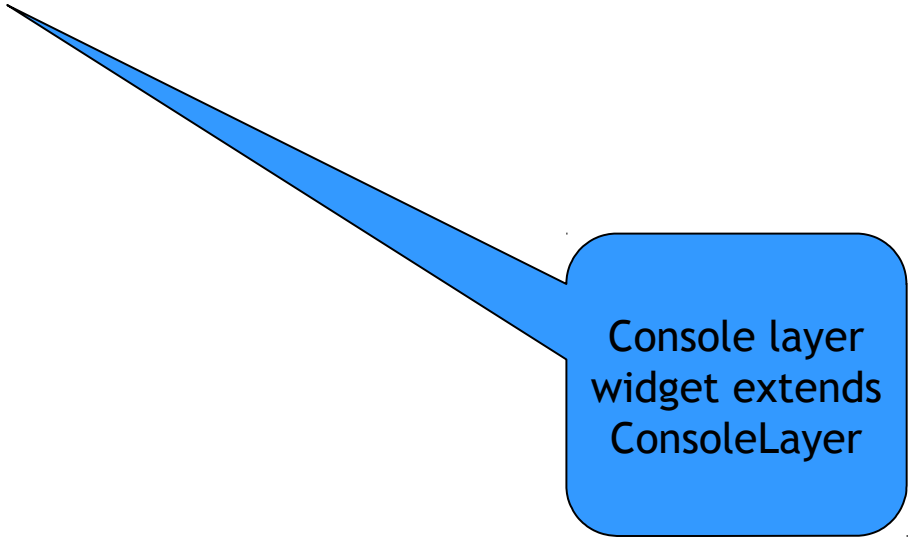
Plugin example - Map Layer

```
package org.acme.myplugin;
import pt.lsts.neptus.console.ConsoleLayer;
…
/**
 * @author You
 *
 */
@PluginDescription(name = "My Console Layer")
@LayerPriority(priority = 66)
public class MyConsoleLayer extends ConsoleLayer {
    public MyConsoleLayer() {
    }

    @Override
    public void initLayer() {
    }

    @Override
    public void cleanLayer() {
    }

    @Override
    public boolean userControlsOpacity() {
        return false;
```



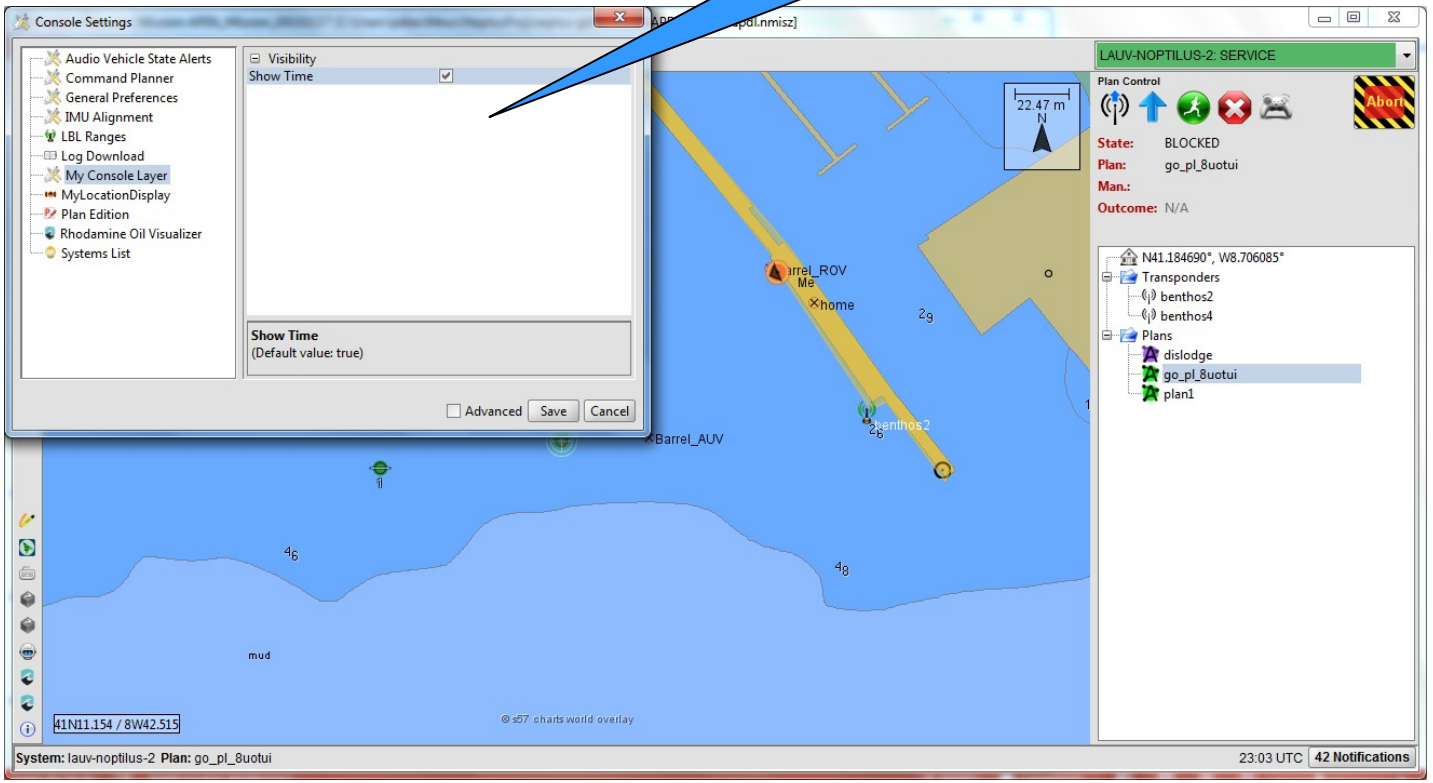
Plug-in example - Map Layer

```
…
public class MyConsoleLayer extends ConsoleLayer {

    @NeptusProperty(name = "Show Time", userLevel = LEVEL.REGULAR,
            category="Visibility", editable = true)
    public boolean showTime = true;

    public MyConsoleLayer() {
    }
…
```

Adding properties for the operator to change



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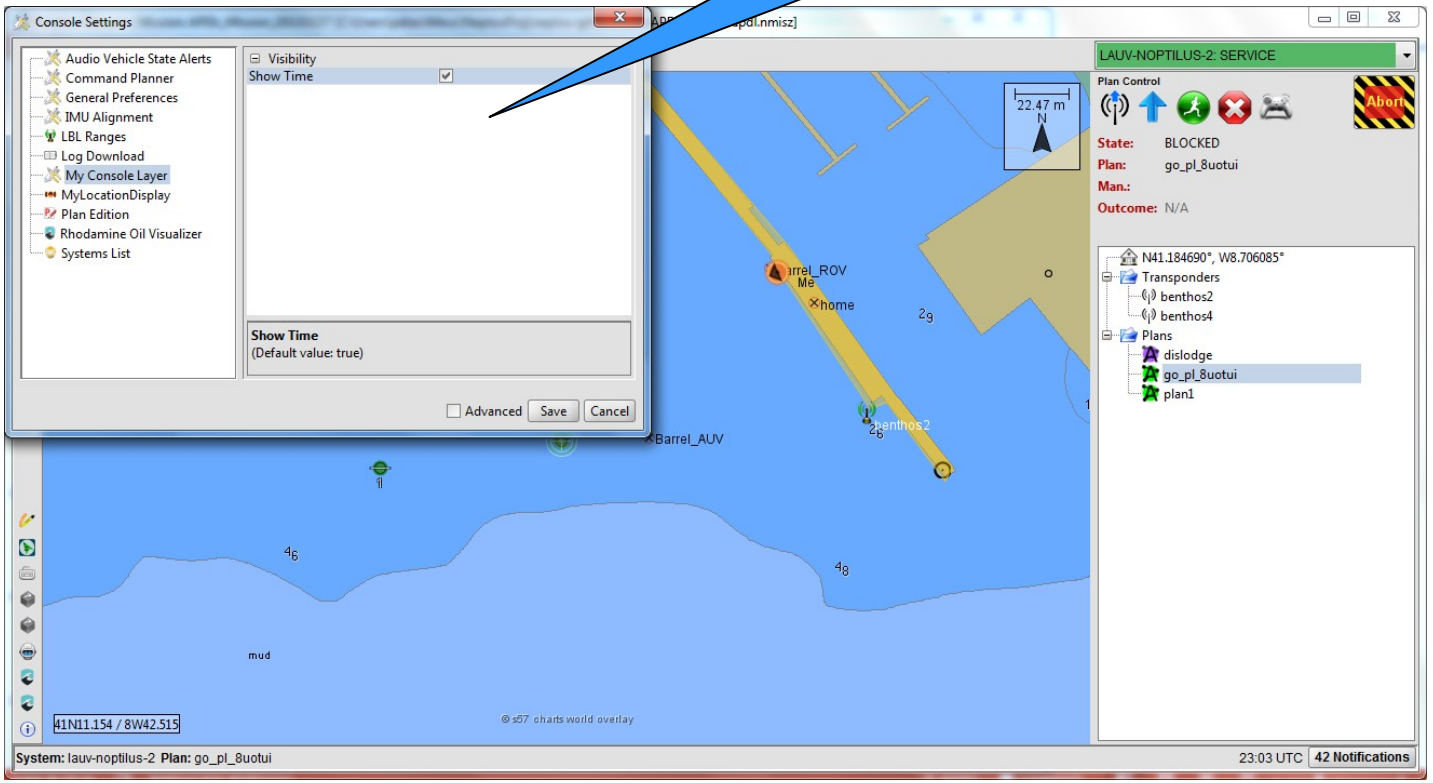

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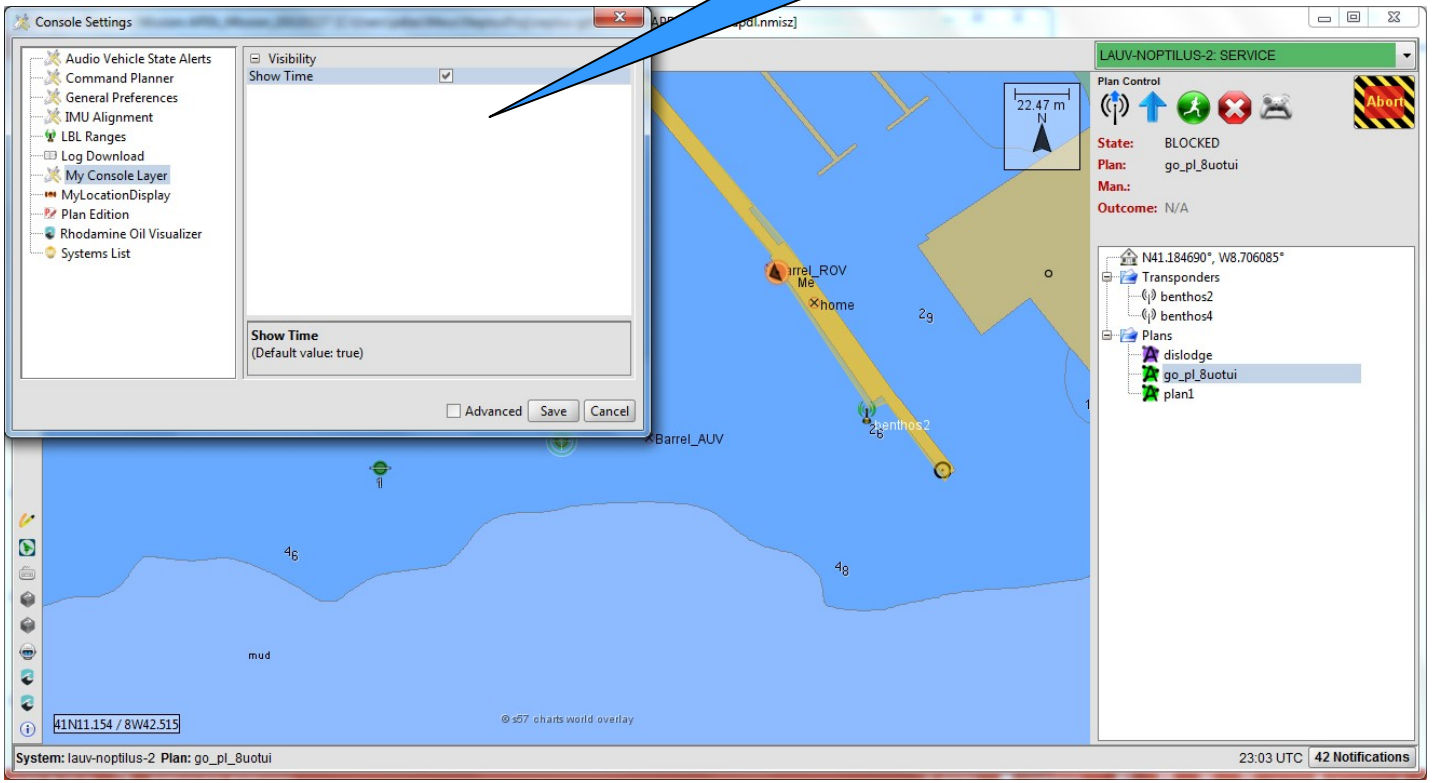

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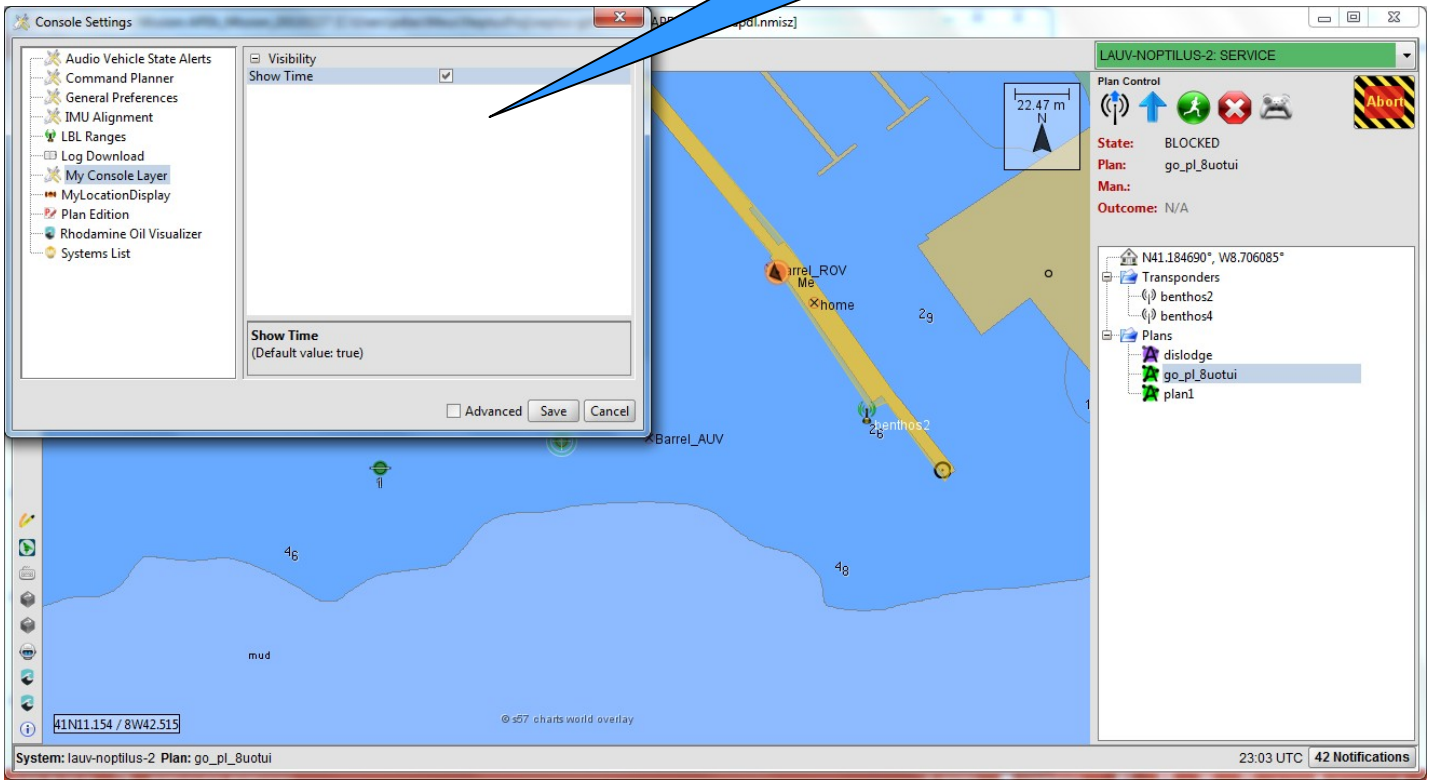

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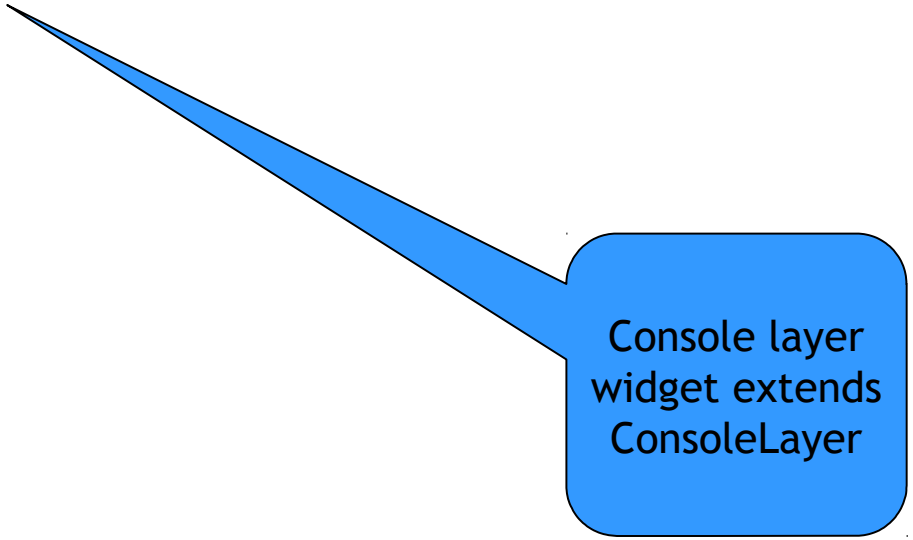

Packaging the plug-in

- By using Ant you can compile all
  - ant
- It will create a jar in plugins folder name my-plugin.jar
- To add to console to test
  - Run pt.lsts.neptus.loader.NeptusMain
  - Open lauv.ncon console
  - Click menu View>Plugin Manager add your plugins elements and save console