DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

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WOSS – Quick how-to and exercises

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WOSS – Download the databases

WOSS databases

- https://woss.dei.unipd.it/woss/files/WOSS-dbs-v1.6.0.tar.gz

GEBCO

- https://www.bodc.ac.uk/data/open_download/gebco/gebco_2023/zip/

WOSS – extract databases

- Extract the archives in the default folder, i.e., usr/share/woss

  sudo mkdir /usr/share/woss

  sudo chown <your_user> /usr/share/woss

- Add read/write privilege to gebco: either right click, properties and privileges, or open a terminal and write

  chmod +rw GEBCO_2023.nc

- Place the GEBCO_2023.nc inside dbs/bathymetry
- Move the dbs folder inside /usr/share/woss
- You can also use a different folder, but you need to specify it in the examples path

WOSS – database list of files

- bathymetry
  - GEBCO_2023.nc hamburg_port.csv
- seafloor_sediment
  - DEC41_coordinates.nc DEC41_marsden_one_degree.nc DEC41_marsden_square.nc …
- ssp
  - WOA2001 WOA2005 WOA2009 WOA2013 WOA2018
- transducers
  - Btech ITC ITT Neptune RESON

WOSS – tcl examples

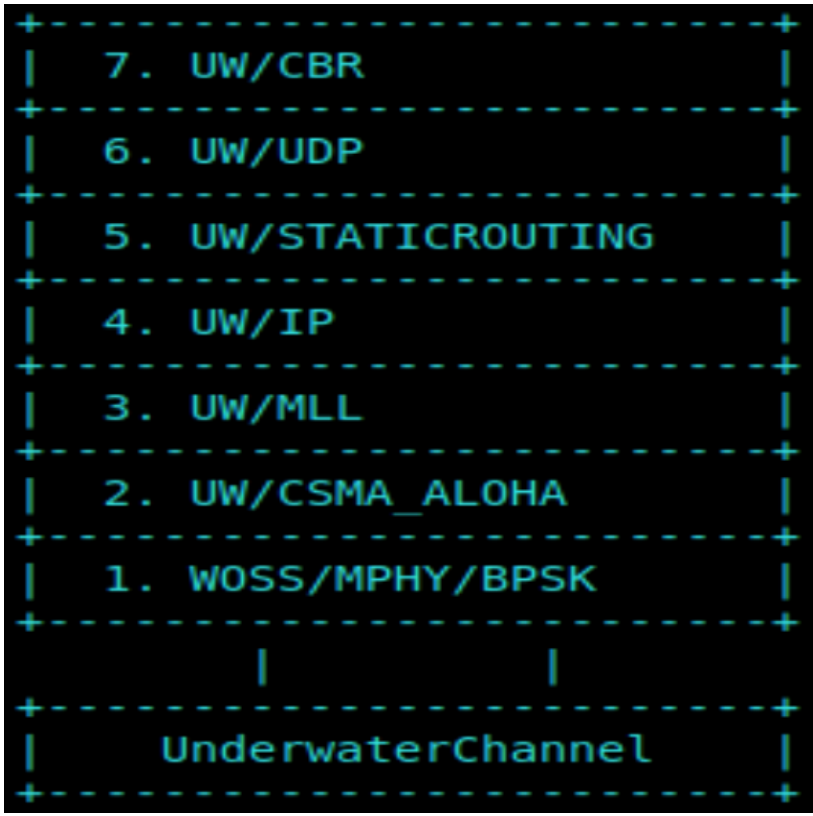
- Navigate in the desert with woss example folder
  - cd DESERT_Framework/DESERT/samples/desert_with_woss_samples

Today we analyze three examples:

- **test_desert_woss_no_dbs.tcl**
  - NO databases are required
- **test_desert_woss_dbs.tcl**
  - Databases are required
- **test_woss_waypoints_time_evo.tcl**
  - Databases are required, time varying simulation

test_desert_woss_no_dbs.tcl

- Does not need any database
- Scenario: 4 nodes, one sink
- Nodes dept = 50 m
- Sink dept = 10 m
- cbr period: 100 s
- packet size = 125 bytes
- freq. 25 kHz, bw 5 kHz
- bitrate 4.8 kbps
- tx power 150 dB
- distance = 1 km



…_no_dbs.tcl - ssp

- SSP taken from a txt file ssp-test.txt in the same folder

```
SSP

42.59
10.125

0.0  0    1508.41186
0.0  10   1508.41186
0.0  20   1508.41186
…
```

- First line: SSP (fixed)
- (white line)
- latitude
- longitude
- (white line)
- Bearing depth sound speed
- Bearing always 0.0
- You can create your ssp here

…_no_dbs.tcl – sediment, altimetry

- Custom sediment

$db_manager setCustomSediment <name> <compressional_velocity> <shear_velocity> <desnity> <compr_wave_attenuation> <shear_wave_attenuation>

$db_manager setCustomSediment “Test Sedim” 1560 200 1.5 0.9 0.8 1.0

This is an average sediment

- Custom altimetry

set cust_altimetry [new “WOSS/Definitions/Altimetry/Flat”]

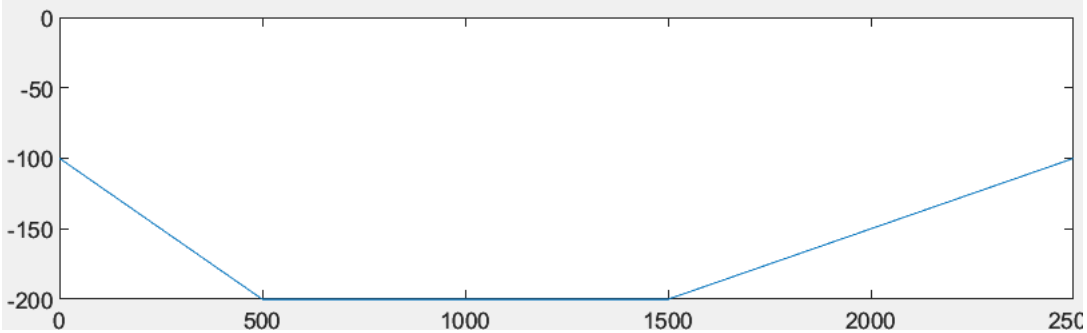
Other altimetries are available, such as the Bretschneider time evolving bathimetry → nice, but causes very long simulations

…_no_dbs.tcl – batimetry

- Custom bathymetry

$db_manager setCustomBathymetry <initial_lat> <initial_long> <bearing> <n_values> range1 depth1 range2 depth2 …

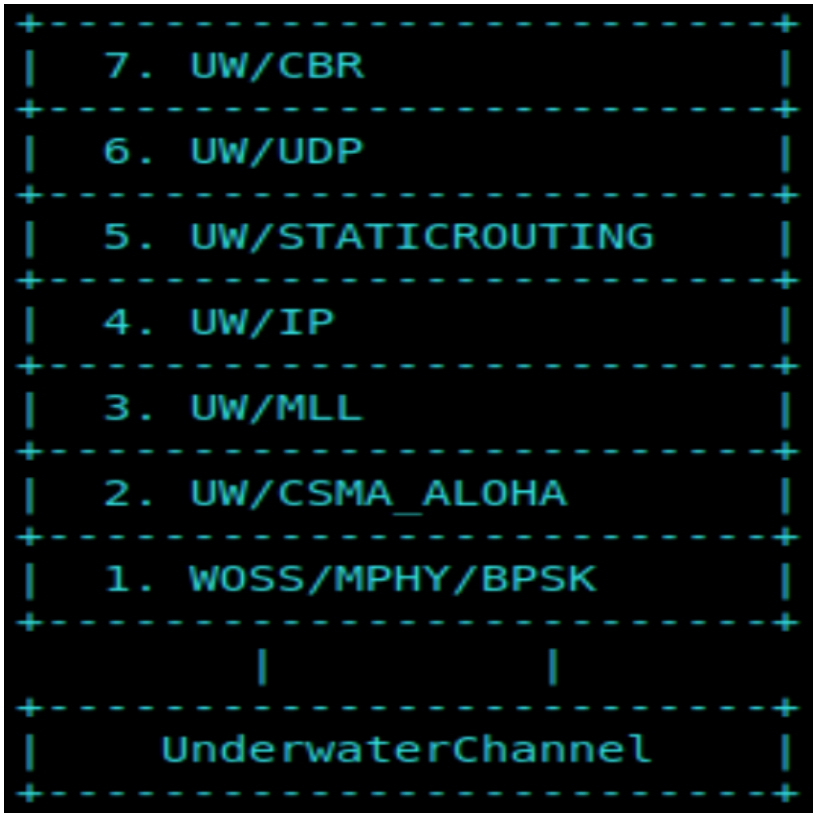
$db_manager setCustomBathymetry $lat $long -500 4 0 100 500 200 1500 200 2500 100



If bearing < -180 or > 180, this Bathimetry is applied in all directions starting from initial lat and initial long (solid rotation)

test_desert_woss_dbs.tcl

- Uses the database
- Scenario: 4 nodes, one sink
- Nodes dept = 50 m
- Sink dept = 10 m
- cbr period: 100 s
- packet size = 125 bytes
- freq. 25 kHz, bw 5 kHz
- bitrate 4.8 kbps
- tx power 150 dB
- distance = 200 m



…_dbs.tcl – the databases

- Database path is set to the default directory

  set opt(db_path) “/usr/local/share/woss/dbs”

- can be changed if needed,
- can be passed through command line together with random sequence
  - you need to set to 1 opt(bash_parameters)

…_dbs.tcl – ssp

- Check existence of ssp path with

  set exist_ssp [file exist <path>]

- We have one db of ssp per each month of year 2001 2005 2009 2013 and 2018. Each db covers all the world
- db_ssp of type WOA2013/MonthlyAverage,
- db_ssp setDbPathName “${opt(db_path)}/WOA2018/WOA2018_SSP_June.nc”

…_dbs.tcl – bathymetry (gebco)

- Existence of path checked with

  set exist_gebco [file exist <path>]

- Bathymetry of type GEBCO
- $db_bathy setDbPathName "${opt(db_path)}/bathymetry/GEBCO_2023.nc"

- It provides an updated grid with a global terrain model of ocean and land providing elevation data in meters, with 15 arc-second interval grid
  - Provided by Nippon Fundation GEBCO

…_dbs.tcl – altimetry

- Custom altimetry: same as no dbs

set cust_altimetry [new “WOSS/Definitions/Altimetry/Flat”]

Other altimetries are available, such as the Bretschneider time evolving bathimetry → nice, but causes very long simulations

…_dbs.tcl – sediment

- Sediment type: DECK41

```
set db_sedim [new "WOSS/Creator/Database/NetCDF/Sediment/DECK41"]

$db_sedim setDeck41DbTypeV2

$db_sedim setUpDeck41CoordinatesDb
"${opt(db_path)}/seafloor_sediment/DECK41_V2_coordinates.nc"

$db_sedim setUpDeck41MarsdenDb
"${opt(db_path)}/seafloor_sediment/DECK41_V2_marsden_square.nc"

$db_sedim setUpDeck41MarsdenOneDb
"${opt(db_path)}/seafloor_sediment/DECK41_V2_marsden_one_degree.nc"
```

WOSS/Module/MPhy/BPSK – AGC

- In the case the automati gain control is enabled

WOSS/Module/MPhy/BPSK set SPLOptimization_ 1

- Tx power adaptation up to a maximum

WOSS/Module/MPhy/BPSK set MaxTxSPL_dB_ 190

- In order to get a target PER (if achievable)

WOSS/Module/MPhy/BPSK set PER_target_ 0.01

- PER target is computed estimating the channel from the received packets from a node, assuming channel symmetry.
- If bad channel and PER target not achievable, the maximum power is used

test_woss_waypoints_time_evo.tcl

Scenario:

- 4 nodes placed in a square with edge = 1 km
- one AUV that loops (datamuling) from node to node, speed = 4 knots

```
$position_auv addWayPoint $curr_lat $curr_lon $curr_depth $opt(speed) 0.0
$position_auv addLoopPoint $curr_lat $curr_lon [expr -1.0 * $opt(auv_depth)]
$opt(speed) 0.0 0 4; # loop point means that the next waypoint will be the first
```

- Pktsize = 512 bytes, period = 400 s
- Custom bathymetry created in tcl with the function createBathymetryMap

…_time_evo.tcl - Altimetry

- Altimetry time evolution

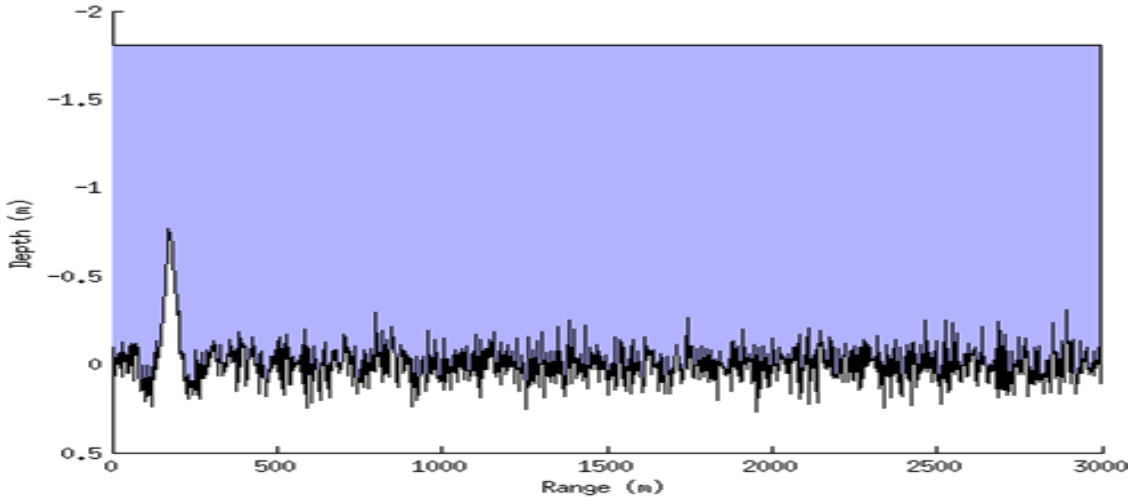
set altimetry_creator [new "WOSS/Definitions/Altimetry/Bretschneider"]

WOSS/Definitions/Altimetry/Bretschneider set evolution_time_quantum 100;# [s]

WOSS/Definitions/Altimetry/Bretschneider set characteristic_height 1.0;#[m]

WOSS/Definitions/Altimetry/Bretschneider set average_period 1.0; #[s]

set cust_altimetry [new "WOSS/Definitions/Altimetry/Bretschneider"]



.._time_evo.tcl - ssp

- Time evolving channel is simulated
- SSP time evolution

We set different SSP for different Time values, to account for time evolution

set time_evo_ssp_1 [new "WOSS/Definitions/Time"]

set time_evo_ssp_2 [new "WOSS/Definitions/Time"]

set time_evo_ssp_3 [new "WOSS/Definitions/Time"]

#first ssp, time key is 1st january 2014, 10:11:01

$time_evo_ssp_1 setTime 1 1 2014 10 11 1

#first ssp, time key is 1st january 2014, 10:40:01

$time_evo_ssp_2 setTime 1 1 2014 10 40 1

#first ssp, time key is 1st january 2014, 11:01:01

$time_evo_ssp_3 setTime 1 1 2014 11 0 1

.._time_evo.tcl – ssp - 2

- SSP varies 3 times (3 different databases)

#we insert in the custom SSP database, each SSP value with its related Time key

```
$db_manager setCustomSSP      $time_evo_ssp_1 "./dbs/ssp-test.txt"
$db_manager setCustomSSP      $time_evo_ssp_2 "./dbs/ssp-test_2.txt"
$db_manager setCustomSSP      $time_evo_ssp_3 "./dbs/ssp-test_3.txt"
```

.._time_evo.tcl - transducer

- A realistic transducer beam pattern is used

```
set transducer_handler [new "WOSS/Definitions/TransducerHandler"]

#### we import a transducer, and we link it to "ITC-3001" tag
$transducer_handler importAscii "ITC-3001“
"$opt(db_path)/transducers/ITC/ITC-ITC-3001-17.5kHz.txt"
# $transducer_handler importAscii "NEPTUNE-T186"
"$opt(db_path)/transducers/Neptune/Neptune-T186-17kHz.txt"
```

For all woss samples

Bellhop can be run once to speed up next simulation (10x speedup

- test_desert_woss_no_dbs.tcl saves the woss results in a .dat file placed in the folder test_desert_woss_no_dbs
  - Contains binary data with the results of the Bellhop ray tracer processed by WOSS
- **Ex1**: run **the test_desert_woss_no_dbs.tcl** simulation two times, checking how long the two simulations last
  - ns test_desert_woss_no_dbs.tcl
- **IMPORTANT**: **if conditions are changed (node position, ssp, transducer, etc) the file need to be deleted as new Bellhop will not be performed**

…_no_dbs.tcl – Ex2

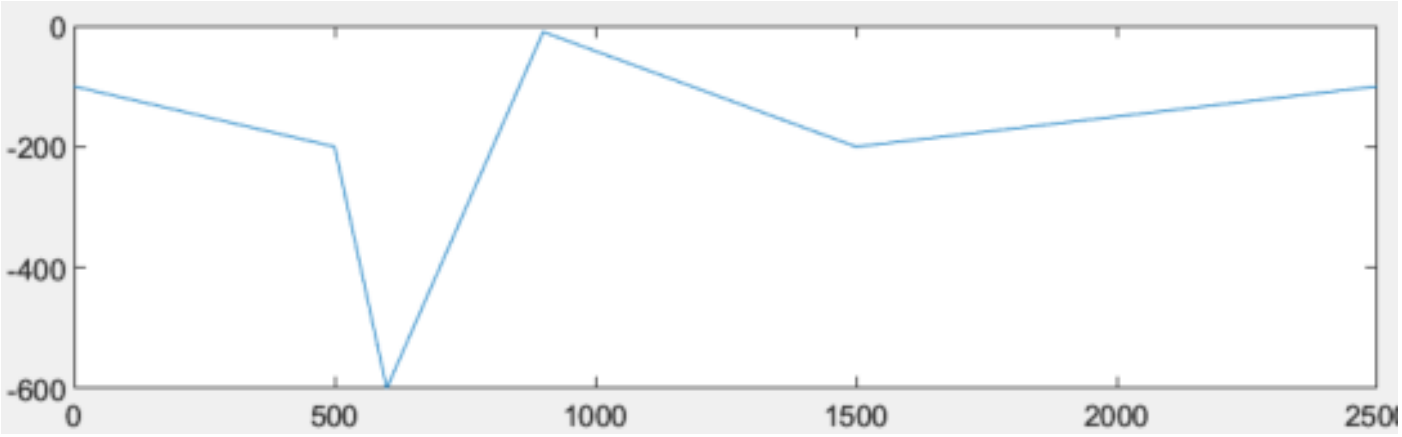
- Change node depth, setting them as bottom nodes 0.5 m above the seafloor and sink at depth 1 m

set curr_depth [expr [$db_manager getBathymetry $curr_lat $curr_lon] -0.5]

set sink_depth 1

- Change Bathymetry creating a deep-water area (>600m) and a very shallow water area (<=10m) like in the picture

$db_manager setCustomBathymetry $lat $long -500 <num> <distance1> <depth1> … <dist_num> <depth_num>



- Check the PER

- Try different tx_power, from 160 to 200 dB, changing WOSS/Module/MPhy/BPSK set MaxTxSPL_dB_ 190

- Plot tx_power vs PER

test_desert_woss_dbs.tcl – Ex3

- Run the simulation
- Remove the results in test_desert_woss_dbs/
  - Or you can remove line 361 to avoid saving them `$woss_controller setTimeArrResultsDbCreator $db_res_arr`
- Place the nodes 0.5 above the seafloor and the sink 1 m below the sea surface
- Test different ssp. i.e., January and July
- Change node distance from 200 m to 1 km

  `set opt(dist_nodes) 1000`
- Try different tx_power, from 150 to 180 db, and plot power vs range with January ssp and July ssp

test_woss_waypoints_time_evo.tcl – Ex4

- Run the simulation and save KPIs in a file.. It will take a while
- Remove the results in test_aloha_no_dbs_waypoints_with_evo_res_att
- Open the tcl file and read the parts related to:
  - Altimetry
  - SSP
  - Bathymetry
  - AUV path
- Change the AUV path from clockwise to counterclockwise

$position_auv **addWayPoint** <lat> <lon> <depth> <speed> <time_in_waypoint>

$position_auv **addLoopPoint** <lat> <lon> <depth> <speed> <time_in_waypoint>

- <loop_id> <num_loop>
- Run the simulation and compare with previous results

test_woss_waypoints_time_evo.tcl – Ex5

- Remove the results in test_aloha_no_dbs_waypoints_with_evo_res_att
- Use a different transducer (NEPTUNE-T186 instead of ITC-3001)
- $transducer_handler importAscii "NEPTUNE-T186
- Run the simulation and compare with previous result

- Ex 6: feel free to change time-varying parameters (the simulation can be very long)