

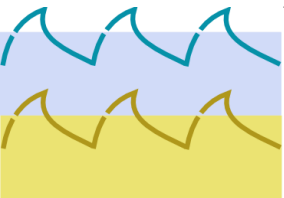
Simulation vs Emulation

UNWis - Padova (Italy)

29th of January – 2nd of February 2024

**Filippo Campagnaro, Roberto Francescon,
Angela Soldà, Antonio Montanari, Michele Zorzi**

filippo.campagnaro@unipd.it



Simulation vs emulation

event based scheduler - machine time vs
simulation time

Event-based simulators

- Event-based simulators operate by taking events, one at a time.
- Any change in input stimulus is identified as an event:
 - a packet generation is an event,
 - a sleep operation is an event,
 - the scheduling of a retransmission is an event, etc
- Speed of execution depends on the number of events, and the simulation time is not correlated to the machine time.
 - E.g., 10 days of network deployment can be simulated in a few seconds
 - If heavy events (e.g., execution of ray tracing), it can be the other way around

Simulation time vs machine time

- Speed of execution depends on the number of events, not on the simulation time!!
- Question: who takes less?
 - simulation of 10000 s where only one node generates 1 packet every 1000 s
 - simulation of 10 s where 100 nodes generates a packet every 10 ms?

Real-time schedulers

- Real-time schedulers for event-based simulators are event-schedulers that try to be synchronized with the machine time
- In this case the simulation time (almost) matches the machine time
 - Note: this works if the simulation time (in case of the normal event-based scheduler) \ll machine time
- Disadvantages: the simulation speed
- Advantages: allow hardware in the loop simulations, emulations and sea trials.
 - Interface with hardware often performed with a spinner to switch between the scheduler and the real world.

Simulation vs emulation vs sea trial

- In a network simulation we model the real world into a virtual environment and simulate the protocol in that virtual environment.
- In an emulation we mimic all hardware and software features of a real network, including the modems.
- In a sea experiment we test the system in the sea with real modems.
- In this winter school we do all the three

DESERT Underwater

ns2 – ns2 miracle - DESERT

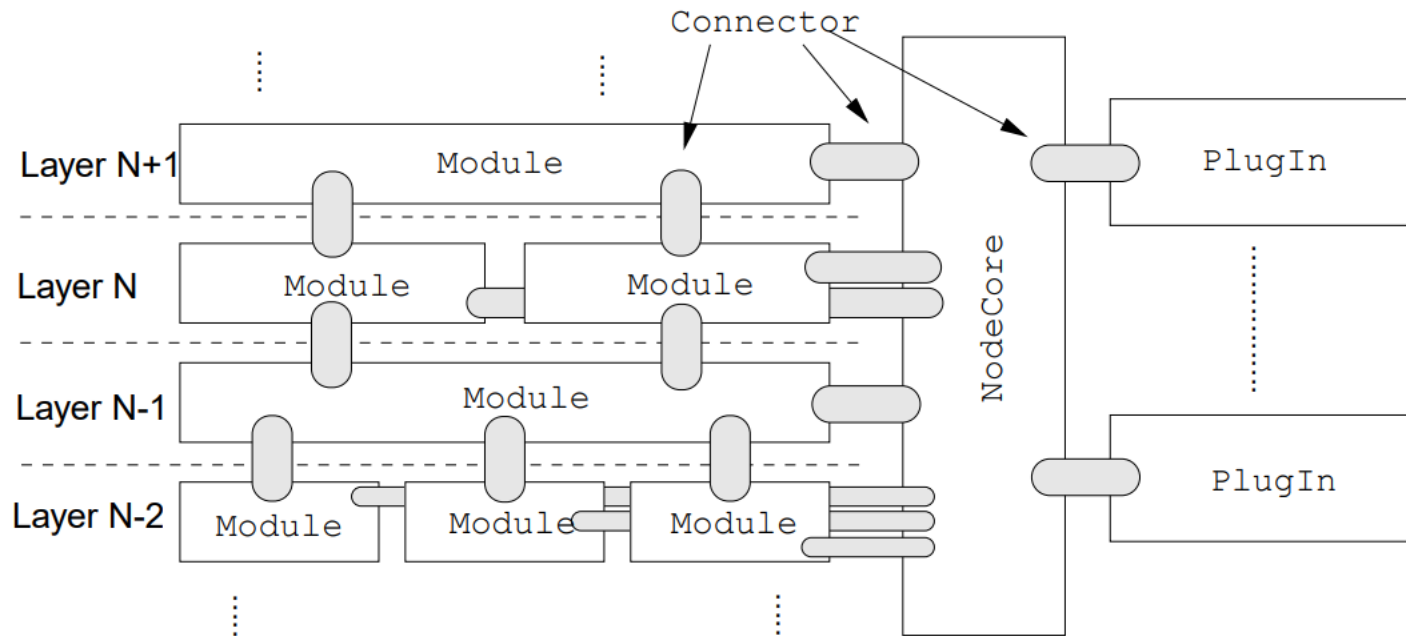
ns2 - the network simulator 2

- Event based-simulator written in C++ and OTcl
 - C++ to develop protocols and models
 - OTcl scripts to configure the simulation
- Provides also a real-time scheduler
- Has various random-generators
 - Uniform, Pareto, Exponential, etc
 - next-substream method instead of seed makes sequence statistically independent

```
global def_rng
set def_rng [new RNG]
$def_rng default
for {set k 0} {$k < $opt(rep_num)} {incr k} {
    $def_rng next-substream
}
```

ns2-miracle

- Modular Framework for Multi-Technology and Cross-Layer Support in Network Simulator 2
- Developed by University of Padova
- Includes a simple physical layer and propagation model for acoustic communications based on Urlick-Thorp formula



DESERT Underwater

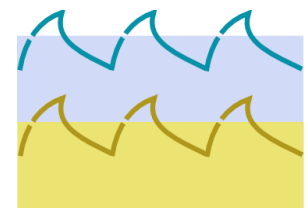
- Opensource framework publicly available to simulate, emulate and realize testbeds of underwater networks
<http://desert-underwater.dei.unipd.it/>
- Supports simulation of acoustic, optical and multimodal networks
- Includes many routing and MAC protocols
- Uses different models to simulate the channel
- Allows sea trials with the removal of simulated physical layers and addition of real modems
- Can be cross-compiled for embedded

DESERT Underwater - more

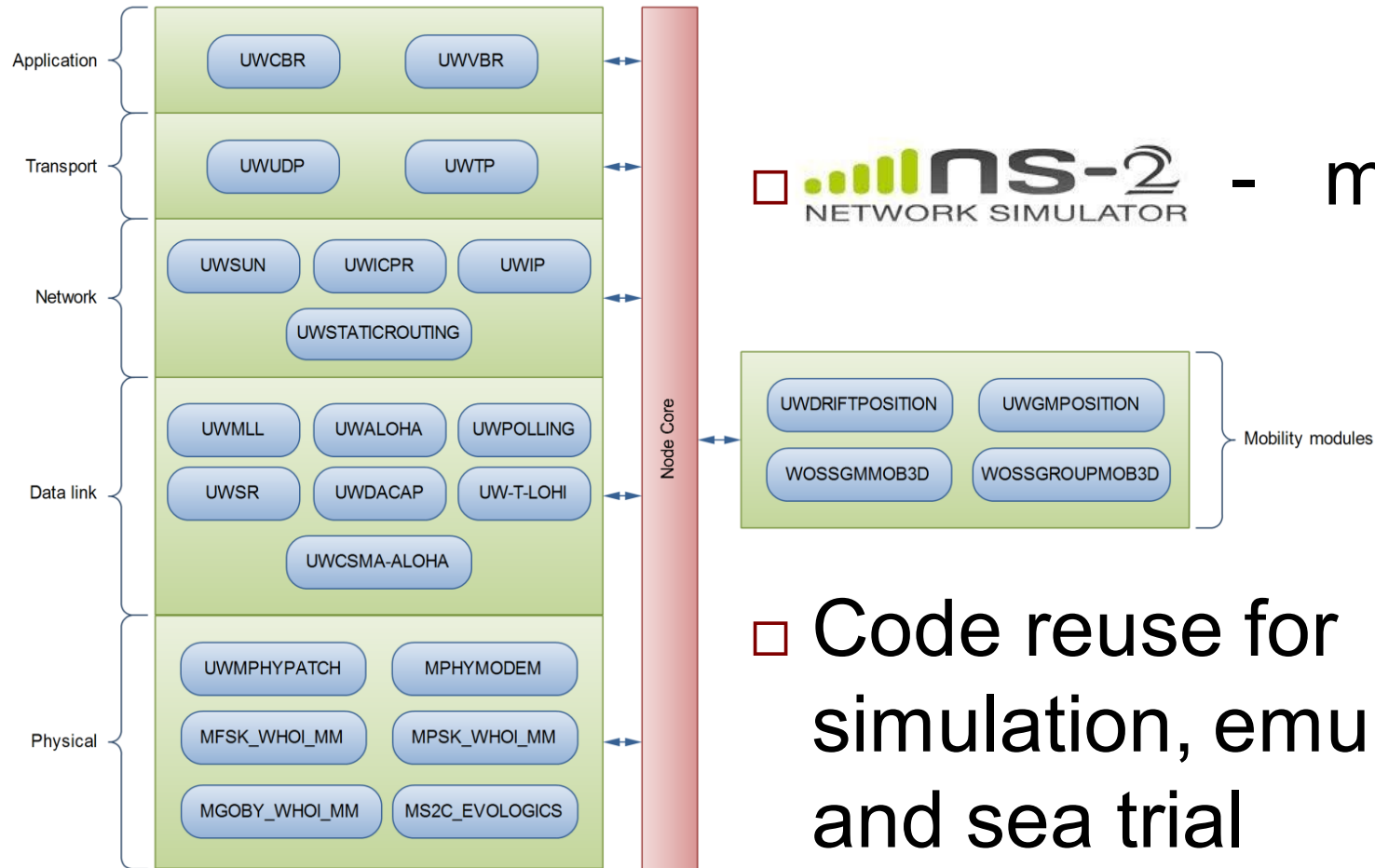
DESERT..

- is an extension of ns2-miracle
- can directly use all modules of ns2-miracle
- all DESERT modules have a prefix uw to distinguish them from ns2 and ns2-miracle
 - E.g., uwcbr vs cbr, uwaloha vs aloha
- This looks like a duplication, but it is not
 - All layers have been reimplemented as uw network do not use IP and all protocols need to be customized due to the characteristics of the uw channel

DESERT Underwater v3



“DEsign, Simulate, Emulate and Realize Test-beds for Underwater network protocols”



 - miracle

- Code reuse for simulation, emulation and sea trial

Simulation results - benchmark

- When you do simulations of your new protocols, it is always important to compare it with other protocols before stating that is good
- DESERT counts a wide set of MAC and routing protocols for uw networks
- Some of them can be used as benchmark:
 - uwflooding vs your brand-new routing protocol
 - uwcsma-aloha vs your brand-new contention-based MAC
 - uwtdma vs your brand-new contention-free MAC