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jUDPWrapper: A Lightweight Approach to Access the OMNeT++/INET UDP Functionality from Java

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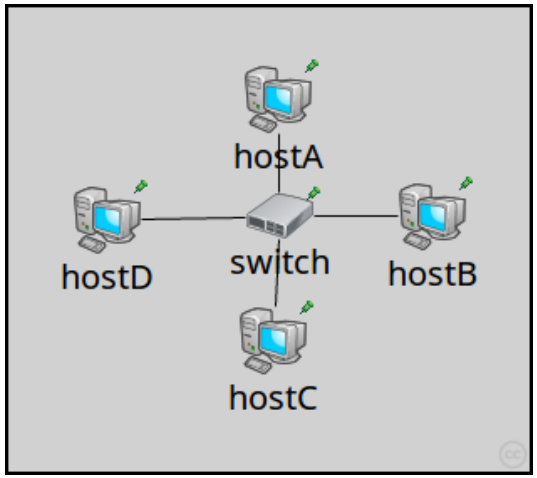
Motivation

- Evaluation of networks during design: simulation, testbed, math analysis
- Our idea of an enhanced evaluation methodology:
  1. Java simulation models using OMNeT++
  2. Derive a Java prototype implementation
- Java Extensions for OMNeT++ (JEO) exist
- Next logical step: provide a socket-based API for Java simulation models
- Abstraction layer between app. layer models und INETs UDP module
  ➔ Ease simulating as well as the derivation of prototype implementation



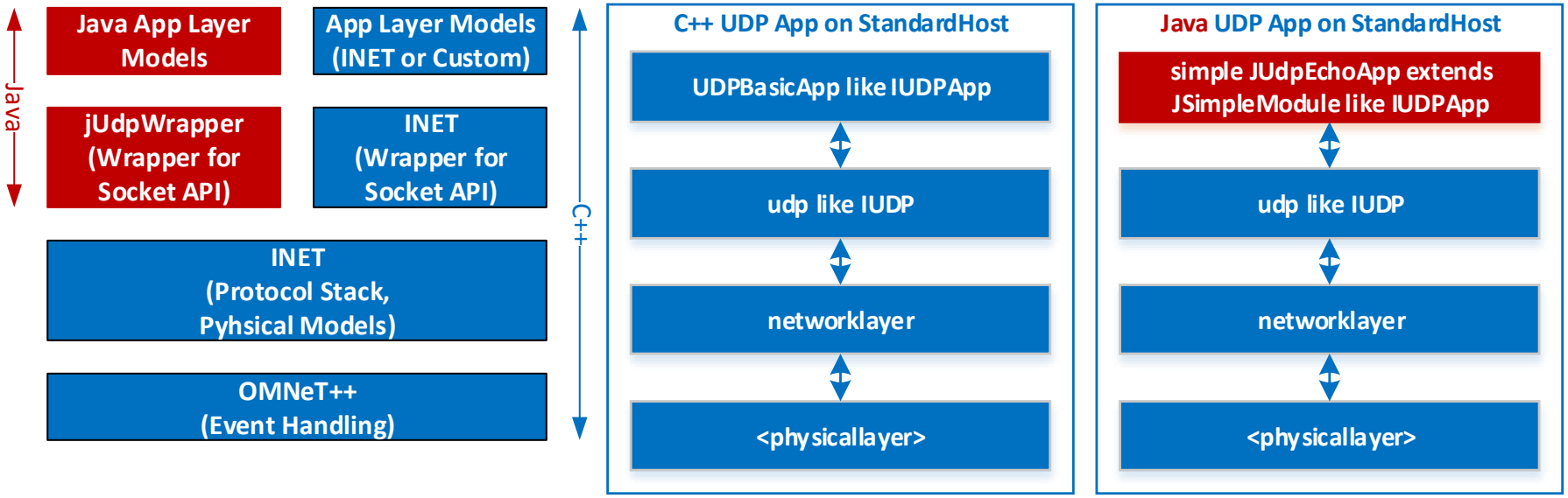
Related Work

- **Wanted: Framework to simulate Java application layer models**

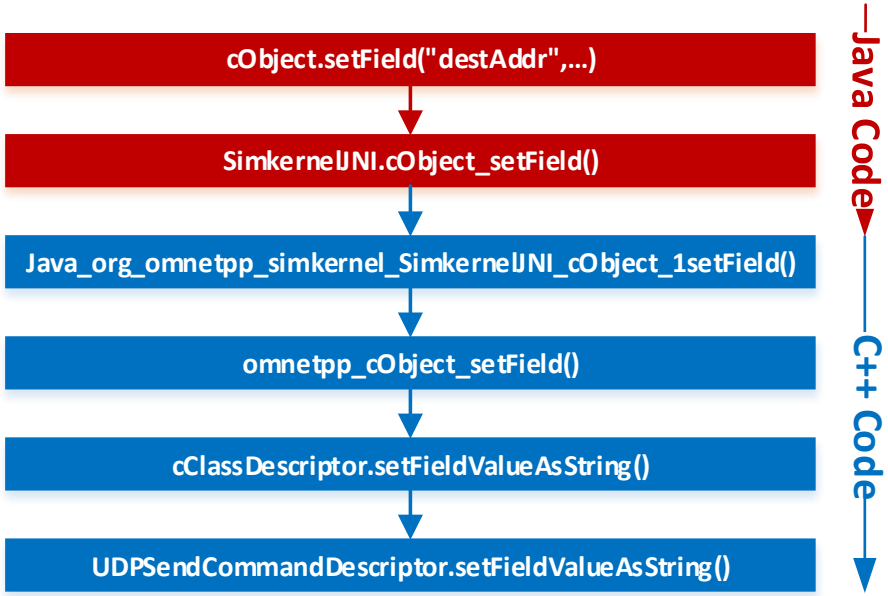
Name	Java Simulation Models	Access to Simulation Time	Still Under Maintenance
NS-3 + LXC* + JVM (*Linux Containers)	✓ (only app. layer)	✓ (only with modified Linux kernel, limited precision)	✓
NS-3 + DCE* (*Direct Code Execution)	✘ (C++ only)	✓	✓
FNSS* (*Fast Network Simulation Setup)	✓ (needs a Java simulator/ emulator)	✘ (there is no Java simulator)	✓
JNS/ JNetworkSim/ Jprowler/ Java Simulator	✓	✓	✘

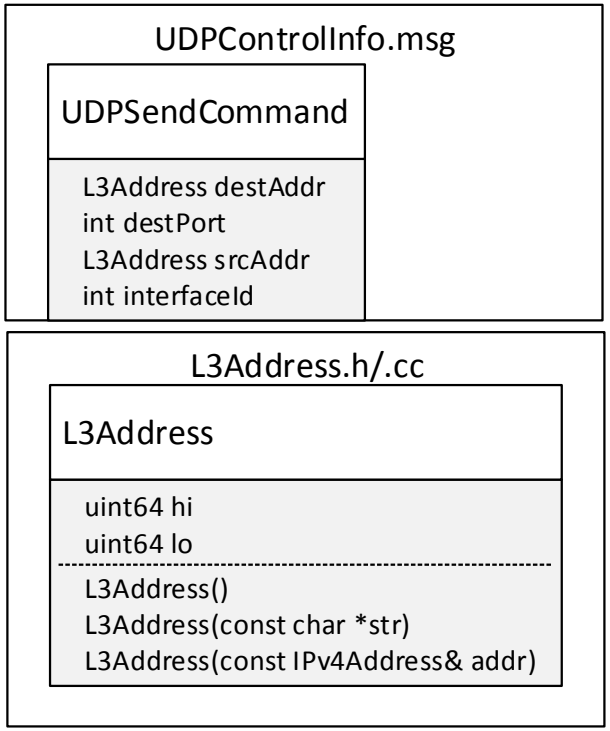
jUDPWrapper – Basic Concept

- **Design targets:**
  - **Fit optimally into the OMNeT++/INET ecosystem**
  - **No modifications of the OMNeT++/INET code**
  - **Lightweight ➔ keep track with new OMNeT++/INET versions easily**
- ***DatagramSocket* and *InetAddress*:**
  Same API as *java.net.DatagramSocket* and *java.net.InetAddress*



jUDPWrapper – Accessing Message Fields of a Custom Data Type from Java: e.g., L3Address





- String as type for domain conversion
- *getField()*: can access any field of a message
- *setField()*: only works for standard types (e.g., *int*, *double*, *bool*)
  ➔ how to access a field of a custom type?
- Our approach: utilize a special syntax in the **.msg* file
  ➔ link the *setFied()* method to the corresponding string constructor

jUDPWrapper – Accessing Message Fields of a Custom Data Type from Java: e.g., L3Address 2

```
//Original *.msg file
class UDPSendCommand extends
UDPControlInfo {
L3Address destAddr;

int destPort = -1;
//...
}
```

```
//Modified *.msg file
class UDPSendCommand extends
UDPControlInfo {
L3Address destAddr @editable
@fromstring(inet::L3Address($));
int destPort = -1;
//...
}
```

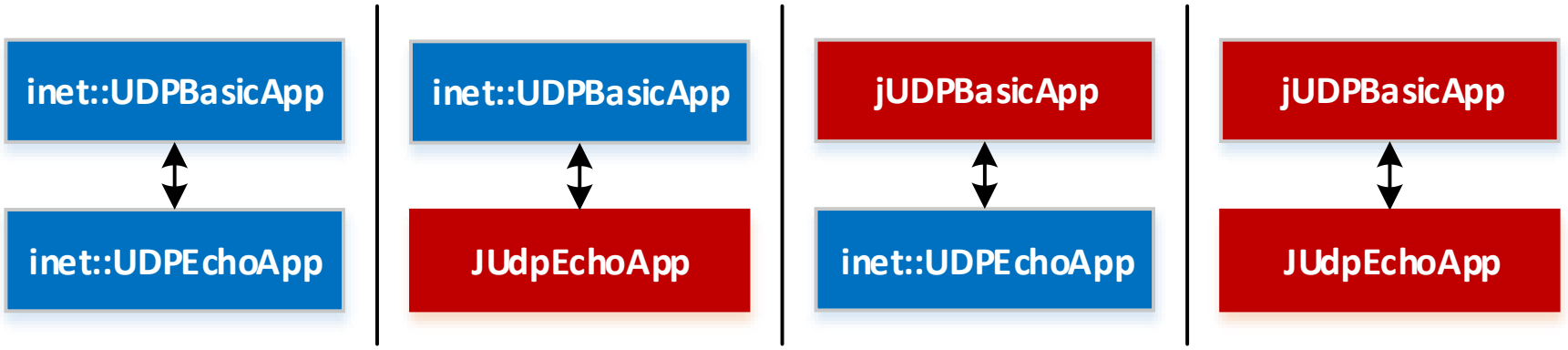
```
//Original *.cc file
bool UDPSendCommandDescriptor::
setFieldValueAsString(/*...*/) const{
//...
switch (field) {


case 1: pp->setDestPort(string2long(
          value)); return true;
//...
}}
```

```
//Modified *.cc file
bool UDPSendCommandDescriptor::
setFieldValueAsString(/*...*/) const {
//...
switch (field) {
case 0: pp->setDestAddr(inet::L3Address(
          value)); return true;
case 1: pp->setDestPort(string2long(
          value)); return true;
//...
}}
```

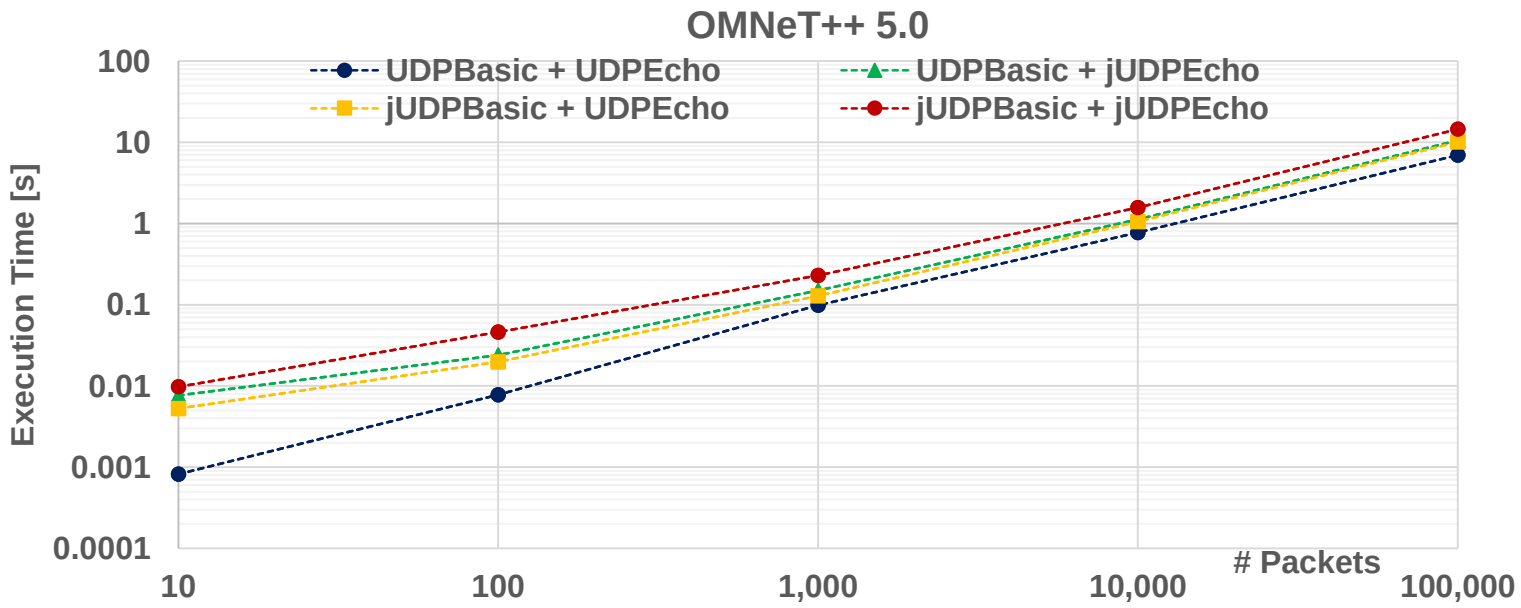
jUDPWrapper – UDP Example Networks

- Four example networks used for evaluation
- Show interoperability and performance of Java and C++ application layer simulation models
- Every network: 2 *StandardHosts* connected Ethernet switch (not shown for the sake of simplicity)
- jUDPBasicApp and jUDPEchoApp equivalent to their INET counterparts
  ➔ Evaluation of performance is feasible



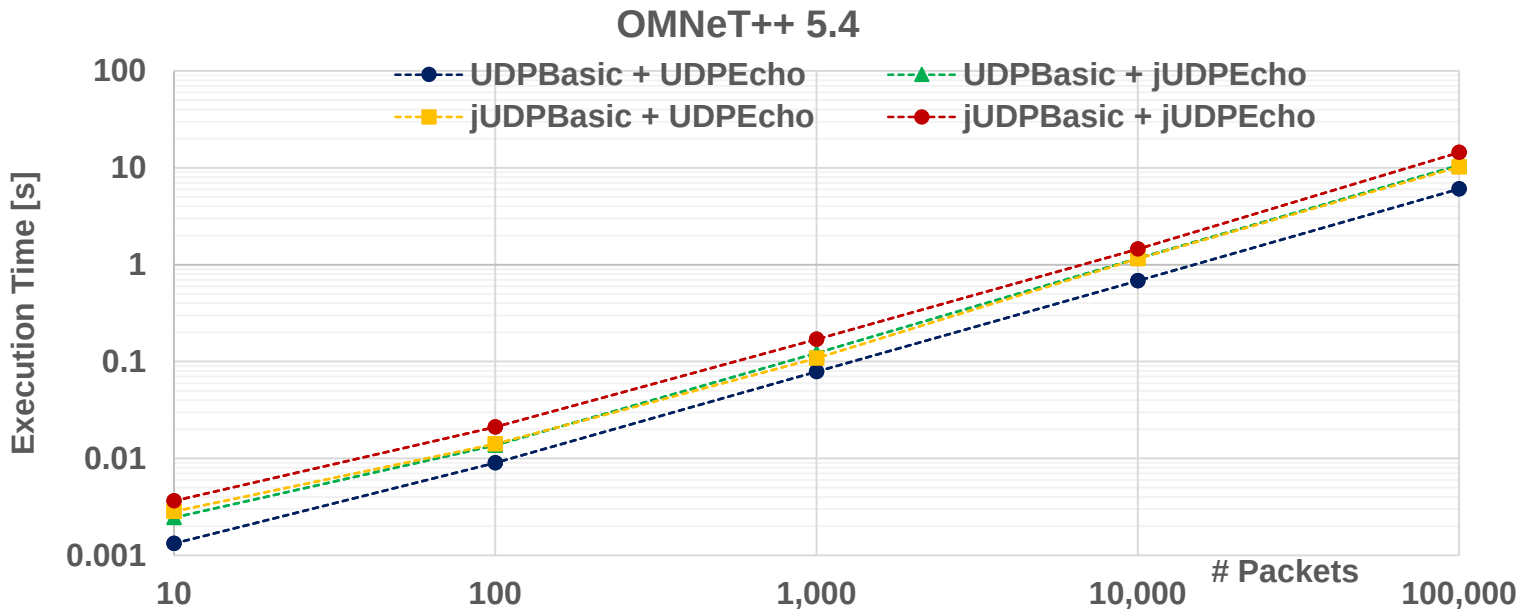
jUDPWrapper – Performance Evaluation 1

- Execution time grows linearly with the # packets➔ expected behaviour
- OMNeT++ 5.0:
  - 10 packets: C++ (0.0008s) approx. one order of magnitude faster than Java (0.0097s)
  - 100,000 packets: C++ (6.89s) approx. twice as fast as Java (14.5s)



jUDPWrapper – Performance Evaluation 2

- **OMNeT++ 5.4:**
  - **10 packets: C++ (0.0013s) approx. 3 times faster than Java (0.0036s)**
  - **100,000 packets: C++ (6.04s) approx. twice as fast as Java (14.39s)**
- **Remarkable: intermediate performance of mixed language setups**
  ➔ Use existing C++ modules from INET to work with your Java modules



Conclusion and Outlook

- jUDPWrapper: simple + socket-based interface to INET's UDP functionality
- Generic approach to access message fields that have a custom data type
  ➔ Serves as example of how to access INET modules from Java
- Different example applications for custom Java simulation models
- Evaluation: OMNeT++ 5.0/INET 3.4.0 and OMNeT++ 5.4/INET 3.6.4.
  ➔ Provide the Java Extensions for OMNeT++ 5.4
- Performance: C++ approx. twice as fast as Java simulation models
  - Valid for long simulation runs and release mode
  - Speedup reduced in debug mode or if a mixed language setup is used
- Entire system is publicly available [1]
  ➔ Everyone can retry the performance measurements
- Interesting for future work: Wrapper for INET's TCP functionality

[1] https://bwsyncandshare.kit.edu/dl/fi8R6skmuBPh6UfXHWzcgBxt/.zip

Thank you for your attention.

Questions?