Means for Peer-to-Peer Research

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Requirements

- Peer-to-peer algorithms and systems …
  - involve massive number of nodes.
    - To 1,000,000s or more.
  - required to work in real environment.
    - i.e. on Internet, ad-hoc wireless network, …

- Researchers and developers want/have to confirm/prove scalability and practicality of their idea or software. They have …
  - a paper to be accepted
  - software to launch

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Experiments

- Some experiments required to confirm/prove scalability and practicality.
  - even only to convince a reader, especially a reviewer ☺
- Various means to make experiments have its own strengths and weaknesses.
  - Means: simulation, …
  - Properties: scalability, …
- Software design should reflect what we confirm/prove because it determines (restrict) means.

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Means

- (With a piece of paper and a pen)
- Simulation
  - of an algorithm
- Emulation
  - of a distributed environment / network
- On a PC cluster / LAN
  - e.g. StarBED, …
- On a wide-area testbed
  - e.g. PlanetLab, XXX Grid, …
- Normal use
  - by the developer, friends or customers.

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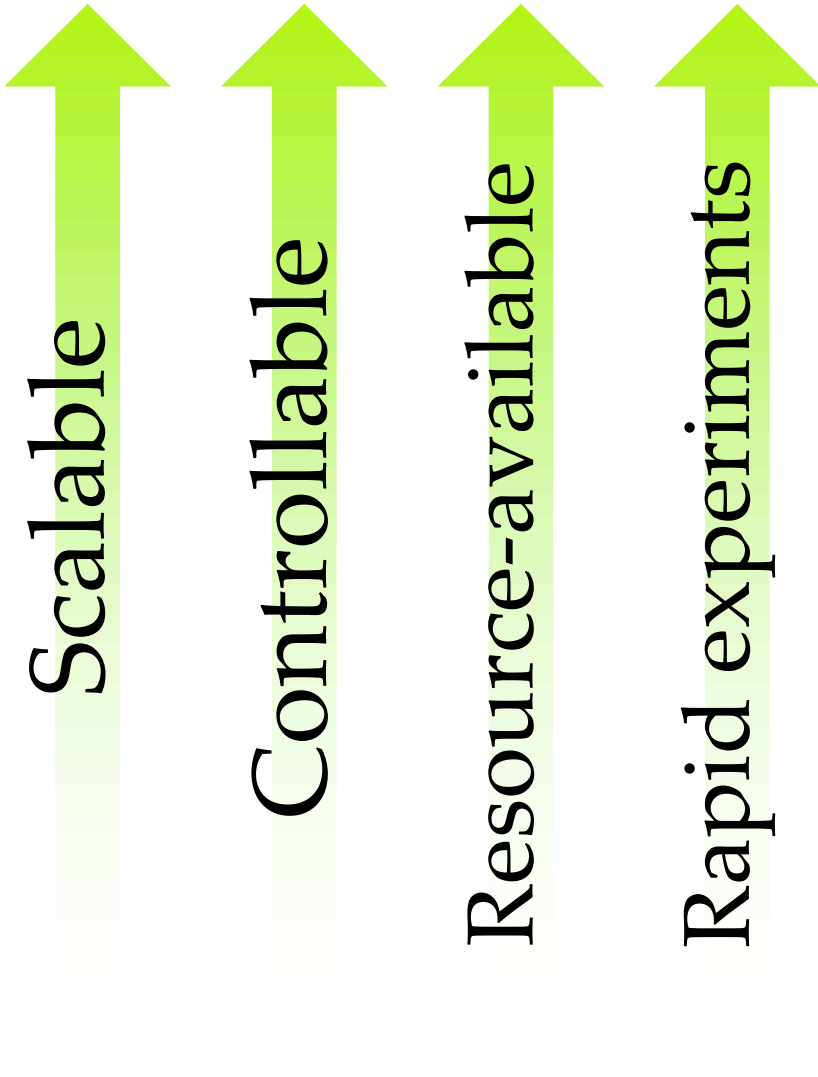
Properties of each means

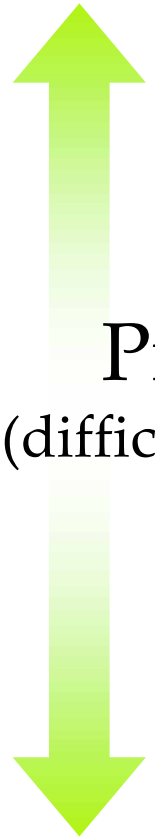
- Simulation
- Emulation
- PC cluster / LAN
- Wide-area testbed
- Normal use



Properties of each means

- Simulation
- Emulation
- PC cluster / LAN
- Wide-area testbed
- Normal use

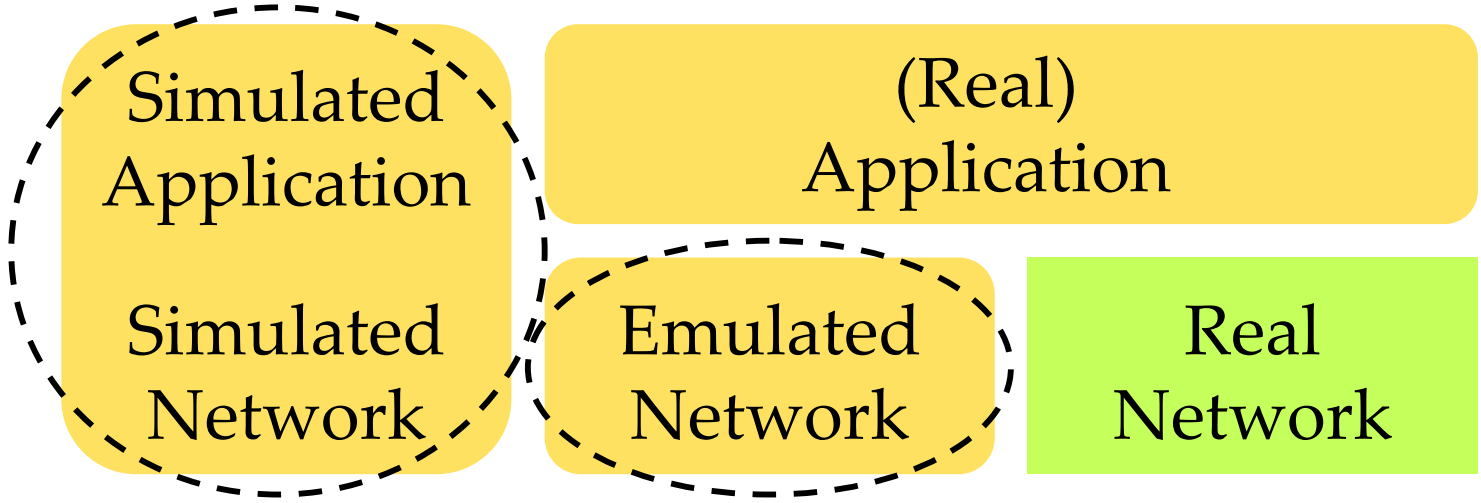
Personal Means



Professional
(difficult for an amateur)
Means

Simulation vs. Emulation

- Simulation of an application / algorithm
  - A simulated appl / algo generally does not run on a real network.
- Emulation of a distributed environment
  - An emulated network hosts real applications.



Simulation vs. Emulation

- Strength of each means:

Simulation	Emulation
•Scalability: more nodes / PCs –with less resources. •Performance •Rapid / accurate experiments	•Reality –A real app instances run. •Natural programming

- A simulated appl / algo is more lightweight than real software.
  - A real appl is tied to (heavy) OS resources such as processes and threads.
- It is not necessary for a simulated clock to be bound with a real clock.
  - Faster experiments and accurate simulation for a longer time.
- But it is difficult for simulation to be compatible with natural programming.
  - e.g. A sim. does not allow `new Thread()` and `new Socket()` in Java.
  - A sim. requires its own dedicated manners to write code for it.

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Scalability: Examples

- Simulation - 1,000,000 nodes
  - p2psim (MIT): 3,000 nodes on a single PC
    - "we simulate Chord with 3000 nodes in a very reasonable amount of time."
  - OverSim (U. Karlsruhe): 10,000 nodes in a Chord network on a single PC
  - PIAX: 300,000 nodes on a single PC
    - implements Skip Graph to support location-based (2-D range) search.
    - Runs on a real network

- Emulation - 10,000 nodes
  - ModelNet (Duke U.): 1,000 DHT nodes on 40 PCs (in a Bamboo paper)
    - An Internet emulator imposing network topology, wide-area delay and bandwidth restrictions.
  - Overlay Weaver (AIST, Kazuyuki Shudo): 4,000 nodes on a single PC
    - supports DHT and ALM as services, and Chord, Kademlia, Koorde, Pastry and Tapestry as overlay algorithms.
    - # of nodes limited by # of threads Linux kernel supports.
  - peeremu (NEC): 1120 nodes = 80 nodes x 14 PCs
    - supports packet delay / loss.

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Scalability: an open problem

- Generally,
  - 100 nodes run fine but 1000 nodes …
  - 1000 nodes run fine but …

- In the first place, what you see with X nodes?
  - Is a 1,000,000 nodes experiment better than 1,000 nodes one? What is the difference?
  - Is larger better?

  - Countermeasures:
    - Clarify relationships between a scale and its characteristics.
    - Set the number based on a real numbers.
      - E.g. 40 millions households in Japan.
    - Do not mention ☺

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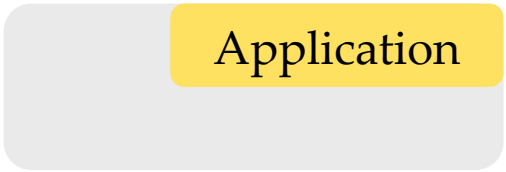
Research tools

(Usual) Application



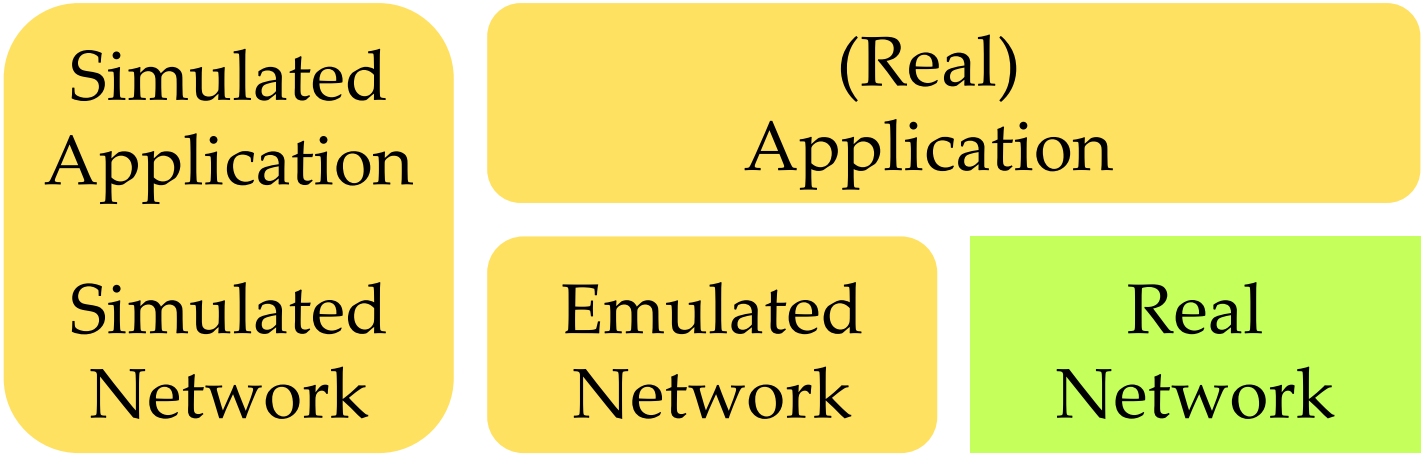
Simulator

p2psim, PeerSim, OverSim, …

Emulator

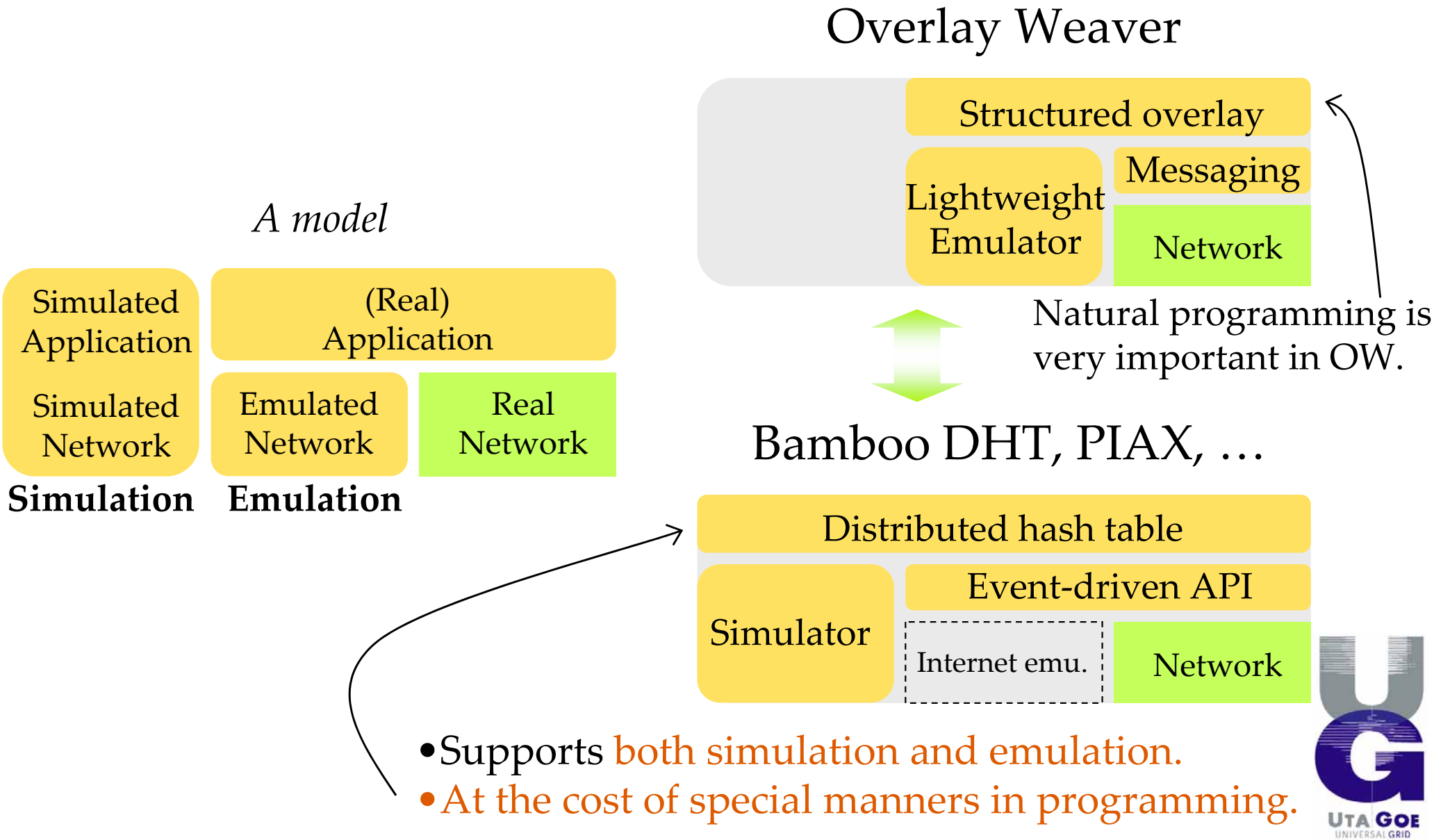
ModelNet, peeremu, …

A model of peer-to-peer research tools



Simulation **Emulation**

Research tools



Research tools

Simulation | Both | Normal use (and emulation)

Which one is your software?

- Each one has its advantages and disadvantages.
- Fixed at an early stage of software design and to be considered carefully.

A model