

Issues, Challenges and Opportunities of Setting up Experimental Peer-to-Peer Facilities



A Personal Story



André König, Aleksandra Kovacevic, Ralf Steinmetz:
Issues, Challenges and Opportunities of Setting up Experimental Peer-to-Peer Facilities - A Personal
Story. In: Udo Bub, Anastasios Gavras, Thomas Magedanz, Phuoc Tran-Gia: Panlab Workshop on
Setup and Operation of Open Testbed Infrastructures in the Context of NGN and Future Internet -
Status Quo and Quo Vadis in conjunction with 16. ITG/GI Fachtagung Kommunikation in Verteilten

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The Story's Moral



This is about first insights into a starting project. Please do not expect a how-to for setting up a perfect peer-to-peer testbed.

Outline



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Characters of the story

- Peer-to-peer systems
- G-Lab

Issue: Size

- Challenge: Limited number of nodes in G-Lab

Issue: Heterogeneity

- Challenge: Homogeneous structure of G-Lab

Opportunity: Planned G-Lab Work

- QoS, QoE, Security, and Monitoring in peer-to-peer systems
- Validate theoretical work and simulation results

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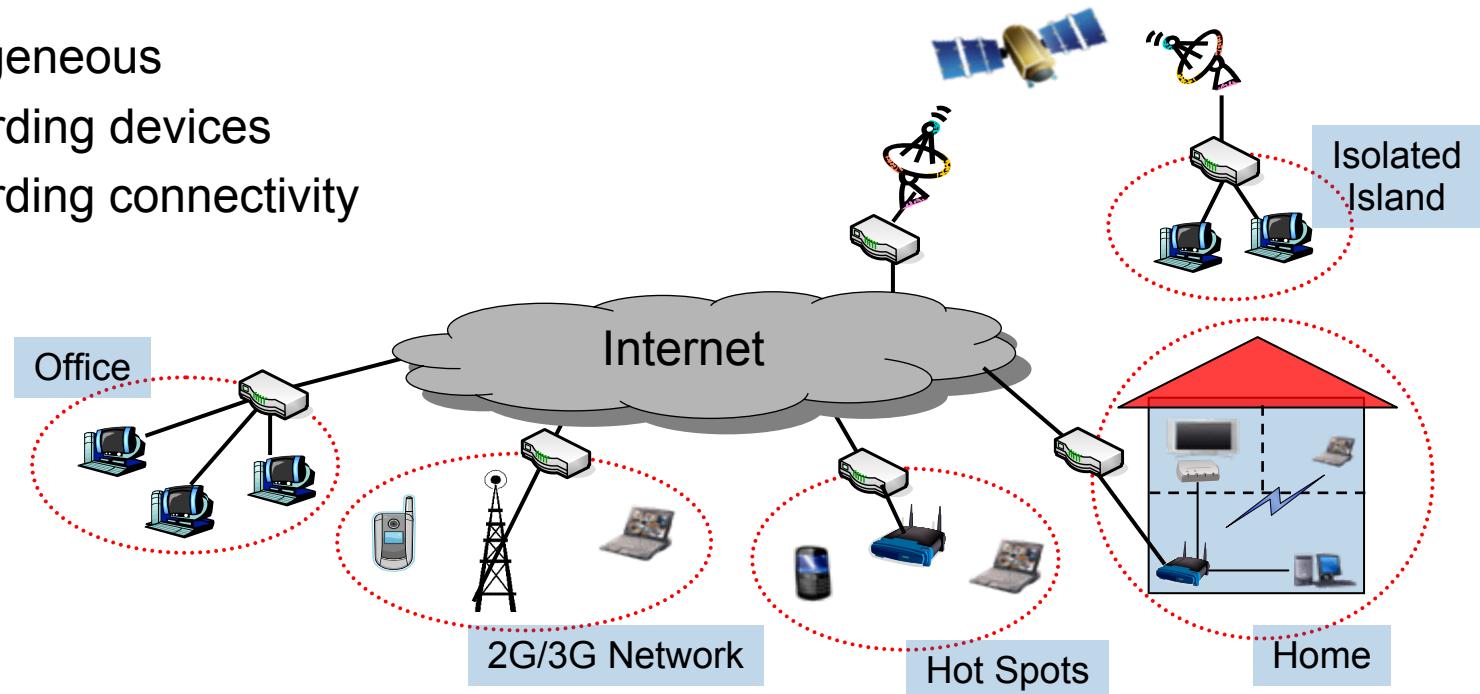
Peer-to-Peer Systems



For the scope of this talk peer-to-peer systems are

- Big
 - E.g. Skype: $\sim 10^7$ online users worldwide
 - E.g. Zattoo: $\sim 10^6$ registered users in Europe

- Heterogeneous
 - Regarding devices
 - Regarding connectivity



BMBF Project G-Lab

- Experimental facility for the future Internet
- Phase 1: ~175 nodes at 6 sites
 - All Sun Fire X4150 / X4250
 - All gigabit DFN Uplink
 - All starting with PlanetLab software

Issues w.r.t. peer-to-peer

- Size: ~ 10^2 nodes
- Homogeneous infrastructure
 - Regarding devices
 - Regarding connectivity



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Issue: Size



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Challenge:

- G-Lab: $\sim 10^2$ nodes
- Real-world peer-to-peer systems: $\sim 10^{6+x}$ nodes

→ How to close this million-nodes-gap?

Possible Solutions:

- Within the testbed:
 - Virtualization
- Supported by the testbed:
 - Mathematical models & simulation tools
 - Validated on a small scale
- Supported by other testbeds:
 - Federation of testbeds

Source: Wikimedia Commons



Issue: Size

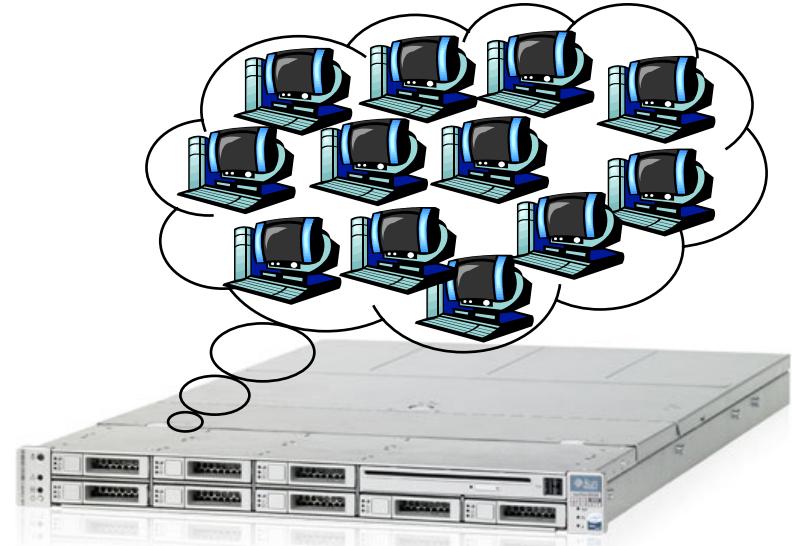
Approach: Virtualization

Each Sun Fire node has

- 8 × 2.5 GHz cores
- 8 GB RAM
- 450 GB disk
- Gigabit uplink

Should bring us from 10^2 to 10^4 nodes

- Rough estimate based on resource requirements of FreePastry



Source: sun.com

But: Virtualization (in this context) causes loss of realism

- E.g. what about connectivity?
 - Need for virtual networks
 - Need for simulated components
 - Need for abstractions
 - Need for ...

Issue: Size

Approach: Federation of Testbeds

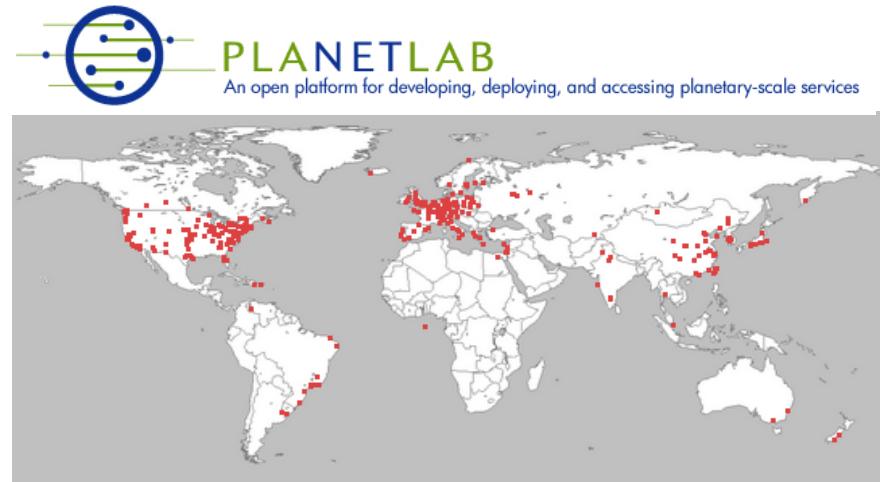


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PlanetLab currently consists of

- ~1000 nodes
- At ~500 sites

**Federation of PlanetLab and G-Lab
would bring us to 10^3 nodes**



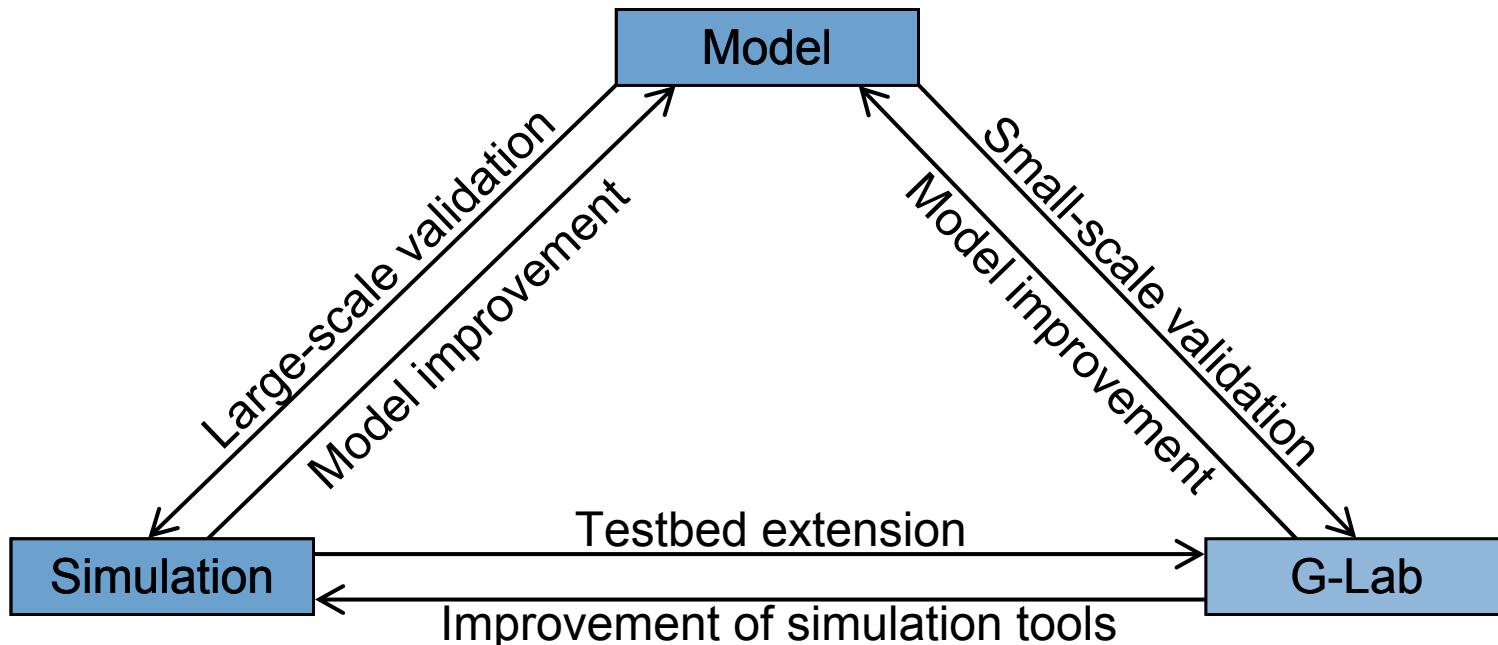
Source: planet-lab.org

But: Federation causes loss of control

- Behavior of PlanetLab is anything but predictable
 - Curse and blessing ...
- What about reproducibility?

Testbed can support improvement of

- Models (on a small scale) and
- Simulation tools
 - For large-scale model validation



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Issue: Heterogeneity

Challenge:

- G-Lab:
 - All Sun Fire X4150 / X4250 nodes
 - All gigabit connected by DFN
- Real-world peer-to-peer systems:
 - Desktops, notebooks, cell phones, PDAs, ...
 - Heterogeneous access networks



→ How to bring heterogeneity into a homogeneous testbed?

Possible Solutions:

- Virtualization of devices and connectivity
- Federation of Testbeds

Issue: Heterogeneity

Approach: Virtualization

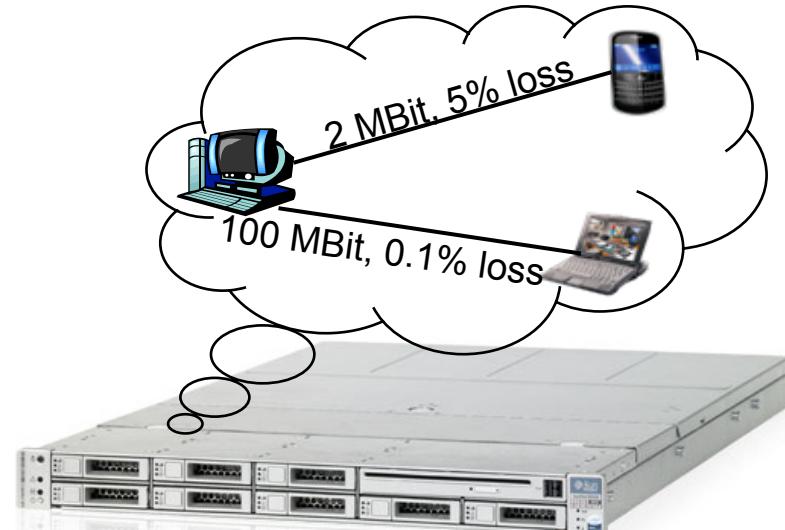


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Each Sun Fire node can run

- Virtual devices and
- Virtual networks
 - E.g. based on Emulab software

Should bring us to desired degree of heterogeneity



Source: sun.com

But: Virtualization causes loss of realism

- Results are just as good as models of virtualized components

But: Virtualization appears to be an appealing approach

- Flexible, fast and cheap
- May be main character of the continuation of this story

Issue: Heterogeneity

Approach: Federation of Testbeds



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Again: G-Lab & PlanetLab

- Inherent heterogeneity of devices and connectivity in PlanetLab

And also: G-Lab & Federica

- Heterogeneity of connectivity
- Network infrastructure beyond DFN

Source: fp7-federica.eu



But: Federation causes loss of control

- What about reproducibility?

But: Federation appears to be an appealing approach

- Increases degree of realism, leads to more general results
- May be main character of the continuation of this story

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Opportunity (Planned Work): Underlay Aware Overlays

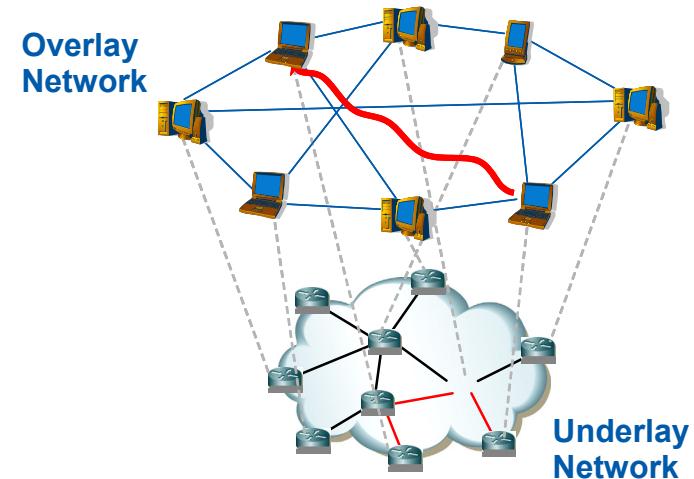


P2P systems cause up to 70% of traffic

- Expected to increase with new applications
 - Video streaming (Live and on-demand)
 - Content distribution

P2P overlays are constructed randomly

- Underlay un-aware
 - Using Murphy's Law: Delay is maximized
 - Inefficient



P2P lack complete information on where resources are located

- Domain borders are crossed many times before reaching the destination

Vision:

- Providing QoS / QoE in service delivery for high-demanding P2P applications by considering underlay topology and state

Opportunity (Planned Work): Security in Decentralized Systems



Focus in G-Lab: Cooperative decisions in peer-to-peer systems

- Challenge: No predefined decision policies
- Thus: User interaction may be required
- But: How to optimize number of users involved?
 - As 'QoE' metric for cooperative decisions



By now: Models for overhead / performance trade-off

$$p_{succ} \geq \left(\frac{p_{reply}(n_{gossip} - n_{threshold} + 1)}{(1 - p_{reply})(n_{threshold} - 1)} \right)^{n_{threshold}-1} \cdot \left(\frac{(1 - p_{reply})(n_{threshold} - 1)}{n_{gossip} - n_{threshold} + 1} + (1 - p_{reply}) \right)^{n_{gossip}}$$

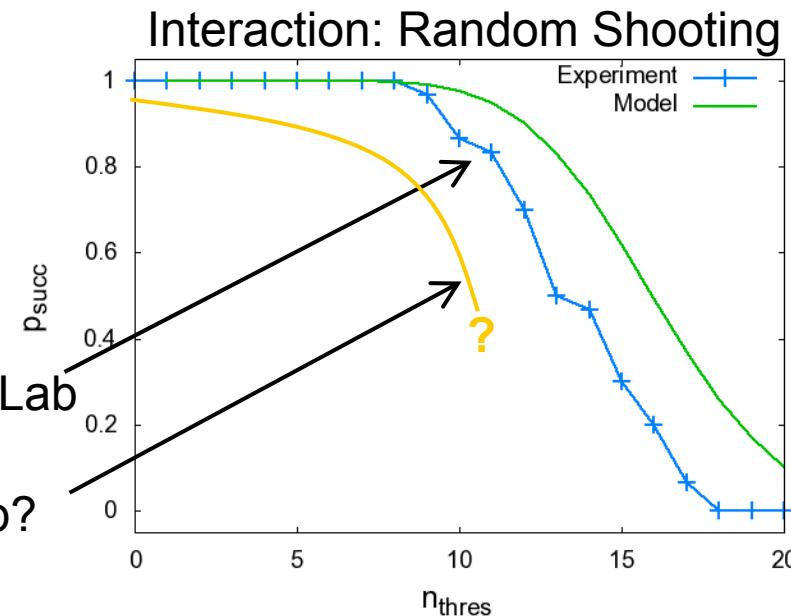
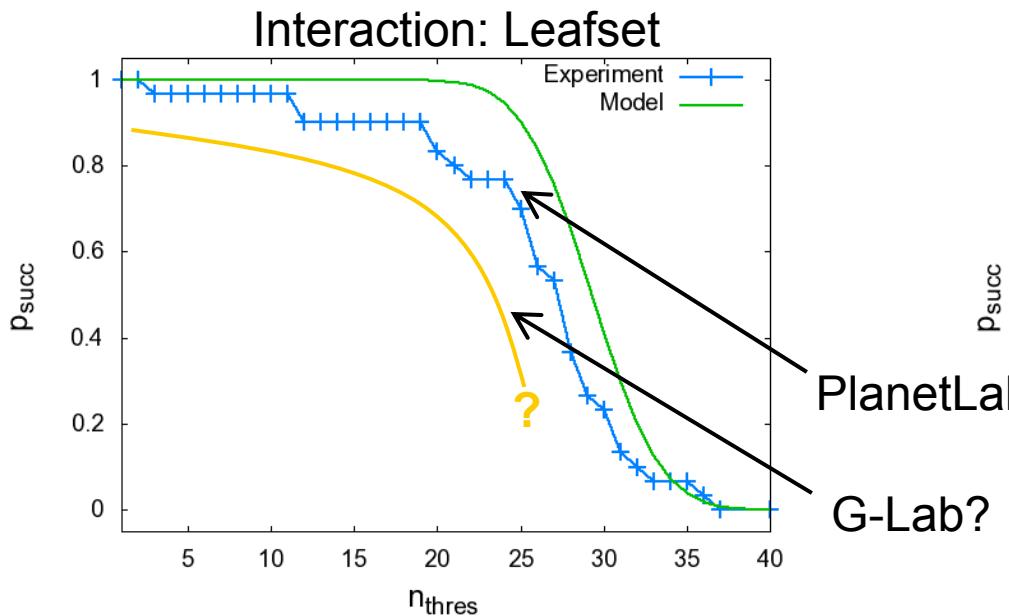
Goal: Implementation in real system & evaluation in testbed

Opportunity (Planned Work): Security in Decentralized Systems (cont'd)



By now: Models and experimental results from PlanetLab

- E.g. comparison of different interaction schemes



How will G-Lab results look like?

- Opportunity to compare results from different testbeds

Thanks for your attention!



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