USER EXPERIENCES ON NETWORK TESTBEDS

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Testbeds: Opportunities and Challenges

- Many network testbeds: Cloudlab, Chameleon, Deterlab, COSMOS
  - Some include general compute nodes
  - Some are specialized: SCADA, IoT, smart drones, etc.
- Opportunities:
  - Provide realistic platforms for research evaluation
  - Engage students, improve knowledge retention in classes
  - Provide useful skills for job search
- Challenges:
  - New environment, new principles, steep learning curve
  - Requires user initiative and individual learning
  - Limited budget for testbed staff may impact user support
Research Questions

• Do users encounter obstacles when using testbeds?
  – Which ones? How serious?
  – Do all users have similar experiences?
    • Age, gender
    • Type of use (research vs class)
    • Prior experience and skills
    • Testbed

• How to prioritize interventions?
  – Many possible interventions, which ones are the best?
  – Many obstacles, which ones must be solved first?
Research Methodology

• Two user studies:
  – Disseminated broadly, but limited num. of volunteers
  – Reviewed and approved by our IRB

• Designed and ran the interview study
  – Users’ experiences when using tbeds in classes
  – Open-ended, minimally guided
  – 13 participants, repeated answers
  – 2 testbeds: Deterlab and EDUrange

• Used these findings to design and run the online study
  – Users’ experiences when using tbeds in classes or research
  – Guided (multiple choice) with a few open-ended questions
  – 69 participants, repeated answers
  – Multilple testbeds
Limitations

• Volunteer bias
  – Participants who had a good experience will volunteer
  – Focused on current users, not on potential or absent users

• Small and non-diverse user population
  – From a small number of testbeds
  – Most are male (76%), and used one testbed (66%)
  – Most rated SSH and Linux experience as 3+ on 1-5 scale (80-85%)
  – Good mix of class and research users (72%/58%)
  – Good mix of novice vs experienced users (62%/38%)

<table>
<thead>
<tr>
<th>Testbed</th>
<th>Interview</th>
<th>Online</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterlab</td>
<td>12 (92%)</td>
<td>53 (76%)</td>
</tr>
<tr>
<td>EDURange</td>
<td>2 (15%)</td>
<td>0</td>
</tr>
<tr>
<td>Emulab/Cloudlab</td>
<td>0</td>
<td>18 (26%)</td>
</tr>
<tr>
<td>Chameleon</td>
<td>0</td>
<td>8 (11%)</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>18 (26%)</td>
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</tbody>
</table>
Difficult: Design, Diagnostics and Monitoring

• Asked to rate difficulty of *early* and *recent* experiences
• Other activities are either easy or improve quickly
Few Other Factors of Influence

• A few differences between class and research users  
  – Experiment setup and running are harder for research users due to higher difficulty of tasks

• SSH and Linux experiences help  
  – Only for early experiences with understanding and running SSH, SSH forwarding, and transferring files between nodes

• No difference between testbeds  
  – Similar early and recent experiences

• No difference wrt length of experience  
  – Improvement happens quickly on easy tasks and does not happen on difficult tasks
Users Appreciate Testbeds

- Testbed staff is helpful and responsive (90-95%)
- Overall positive experience with testbeds
- Overall testbeds are very helpful for learning
Obstacles and Interventions

• **Orientational** – learning new environment
  – Early struggle, but quickly overcome
  – Users appreciate learning new skills and feel empowered
  – Better documentation/UI can help

• **Implementational** – tbed architecture and focus
  – No support for experiment setup and running
  – Poor support for mental and physical context switch
  – Clean slate design is a burden
  – Better targeted support for design, setup and running
    (new backend and frontend functionalities)

• **Domain-specific** – testbed and research domain specif.
  – Provide basic tools for monitoring and diagnostics
  – Empower groups to develop and share domain-spec. tools
Conclusions

• Testbeds help users’ learning but present some obstacles
  – Most obstacles are overcome quickly by users
  – Some obstacles remain around deeper functionalities
• We need higher investment into testbed tools and environments to tackle deeper problems
  – Akin to scientific experimentation domain
• Users appreciate testbeds and testbed staff
• Next study – adoption:
  – What influences the choice of researchers and teachers to use or not use testbeds
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