Resource Mapping on Hybrid Testbeds
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Problem Statement:
Given a cyber-range with a finite amount of resources, design mechanisms to enable accurate large-scale experiments with attacks and defenses.

Why perform large-scale network experiments?
- Study network attacks (DoS, Worms)
- Verify defense mechanisms
- New routing protocols

> Emulation testbeds provide high fidelity but have limited capacity.

Mapping Large Experiments:
- Testbeds can scale via intelligent resource mapping mechanisms.
- Scenario partitioning across platforms/virtual machines is currently user-specified.

> We need to automate the mapping procedure to support large-scale experiments on testbeds.

Popular Virtualization Techniques on Testbeds:

<table>
<thead>
<tr>
<th>Method</th>
<th>Scalability</th>
<th>Fidelity</th>
<th>Existing solutions</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full virtualization</td>
<td>Small</td>
<td>High</td>
<td>Virtualbox, Vmware, KVM</td>
<td>High overhead (especially without hardware support).</td>
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<tr>
<td>Paravirtualization</td>
<td>Small</td>
<td>High</td>
<td>Xen</td>
<td>Can only install modified Guest OS.</td>
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<tr>
<td>OS-level virtualization</td>
<td>Medium+</td>
<td>Medium</td>
<td>LXC (Linux), OpenVz (Linux), Jail (FreeBSD)</td>
<td>Native performance, but cannot install Guest OS.</td>
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<tr>
<td>Real-time simulator</td>
<td>Large</td>
<td>Low</td>
<td>ns-3, PRIME</td>
<td>Low fidelity. Hard to interact with real systems (e.g., real routers).</td>
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</tbody>
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