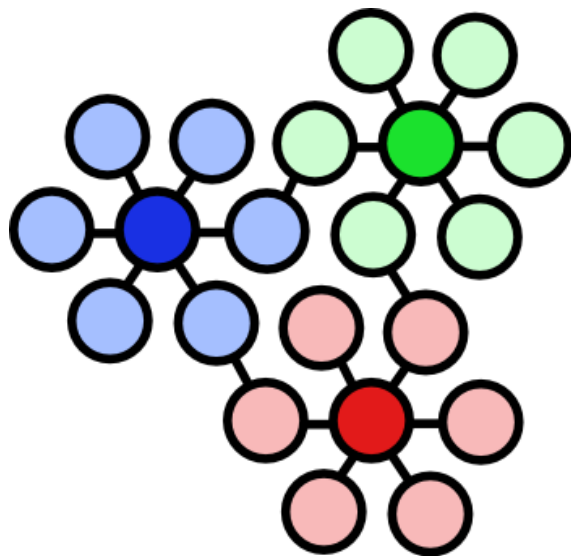


Toward Replayable Research in Networking and Systems



emulab

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“Replayable” Research

- the goal of the networking and systems communities should be *replayable* research
- repeatable
 - *network testbeds*
 - *data repositories*
 - *experiment-management systems*
- *replayable*
 - *fully encapsulated and easily re-executable*



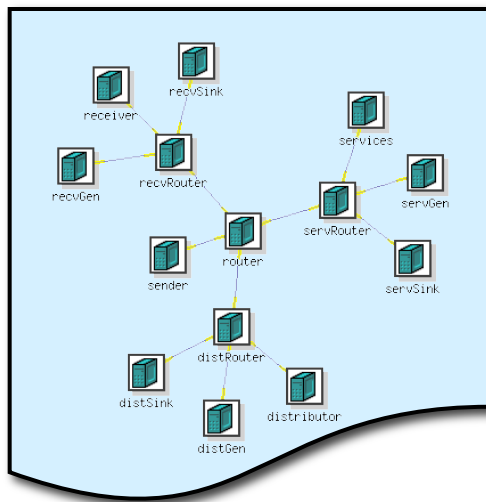
Emulab

- machines
 - *500+ PCs, and more*
 - *time- & space-shared*
 - *loads OS and software*
- network
 - *config. topology & quality*
- services
 - *file storage, email, ...*
 - *available to researchers and educators worldwide*





Emulab Experiments



*topology +
SW (by reference) +
events*

Emulab.Net - Begin Experiment
https://www.emulab.net/beginexp.html.php3

emulab total network testbed

131 Free PCs
pc0001 18 pc0001 \$1
pc3000 48 pc2000 6
pc3000a 10 pc0000 0
1 PCs reloading

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Documentation
Papers and Talks (May 1)
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Experimentation
My Emulab
Begin an Experiment
Create a Template
Create a Parallel Slice
Experiment List

Collaboration
My Wiki
My mailing Lists
My Bug Databases
My DVD Repositories
My Chat Buddies

Begin Experiment

Select Project: Please Select

Group: Default Group (Must be default or correspond to selected project)

Name:

Description: (A concise sentence)

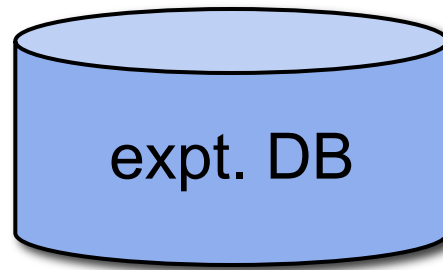
Your NS file: Browse...
or
On Server:

Swapping:
 Idle-Swap: Swap out this experiment after 2 hours idle.
If not, why not?

Max. Duration: Swap out after 16 hours, even if not idle.
 State Saving: Save disk state on swapout

Linktest Option: Level 3 - Plus Loss (What is this?)

Submit





Resources Alone: Not Enough

- testbeds give you lots of resources...
- ...but offer little help in *using* those resources

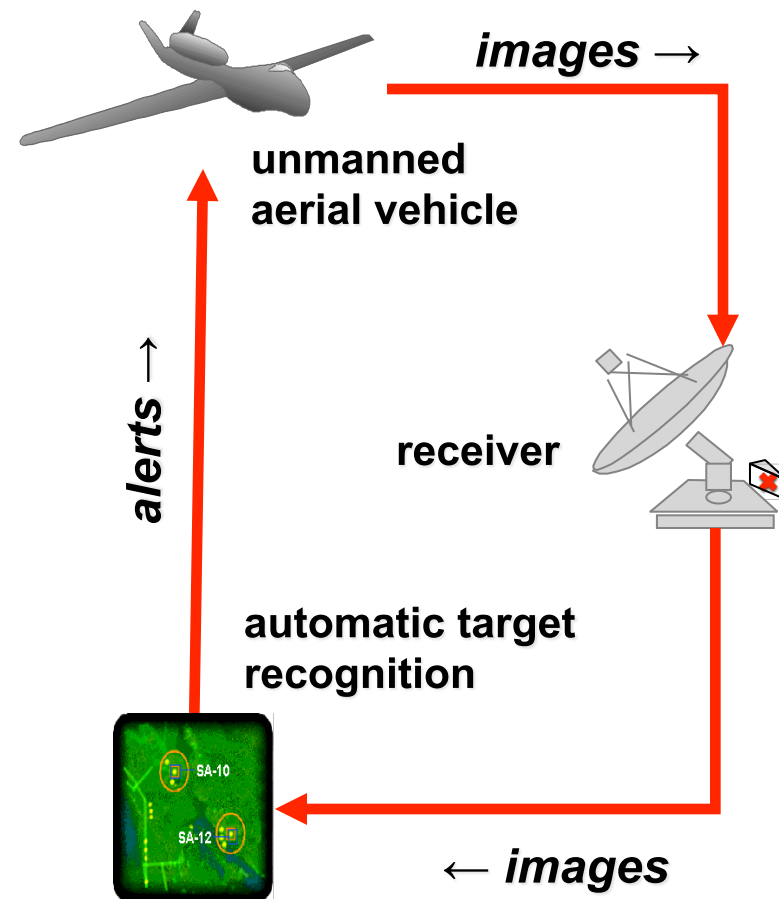
- *package / distribute / configure / instrument / init / execute / monitor / stop / collect / analyze / archive / revise / repeat*





Example

- a distributed, real-time application
- evaluate improvements to real-time middleware
 - *vs. CPU load*
 - *vs. network load*
- **4 research groups**
- **x 19 experiments**
- **x 56 metrics**
- **how to manage this?**





Needs

- my experiment needs...

- *encapsulation*
- *automation*
- *instrumentation*
- *preservation*

package / distribute /
configure / instrument /
init / execute / monitor /
stop / collect / analyze /
archive / revise / repeat

- benefits

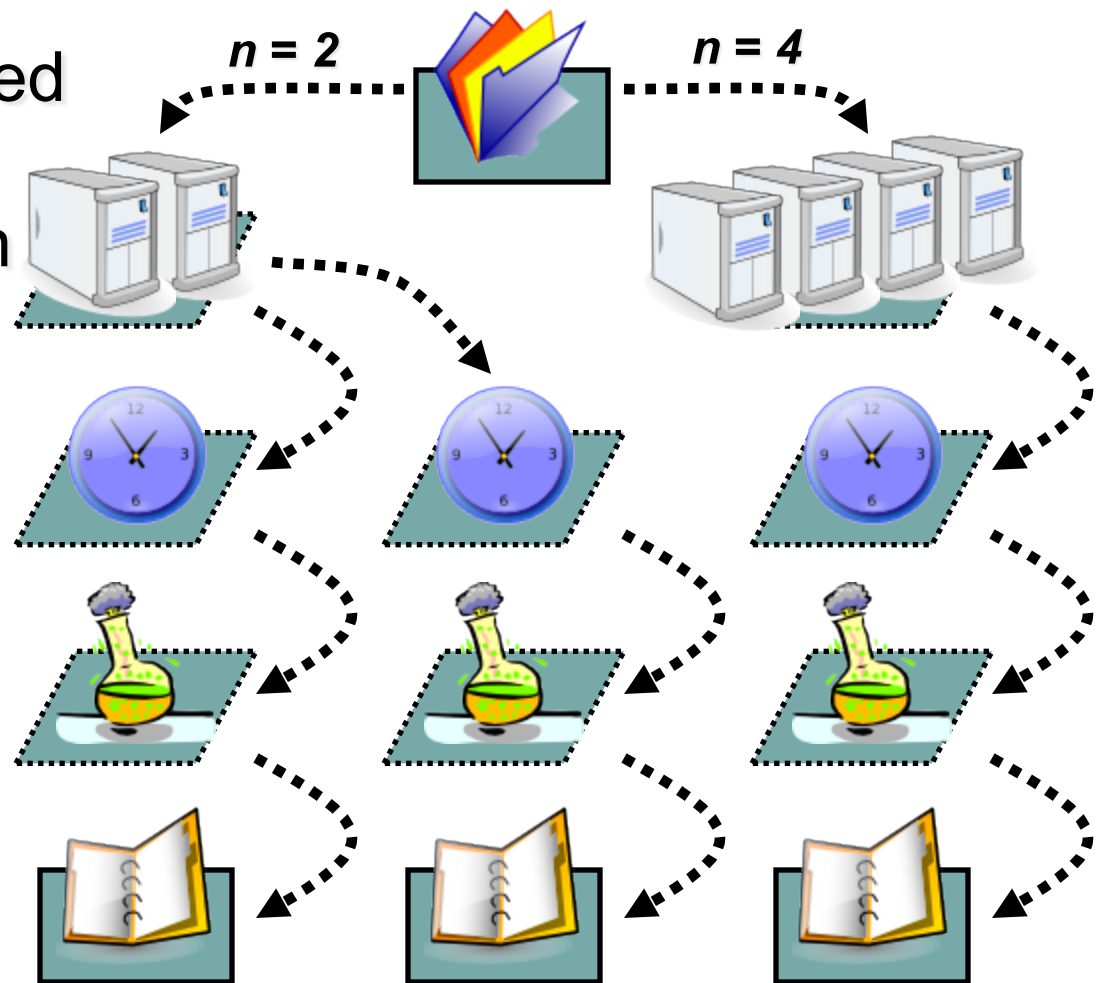
- *verify previous results*
- *establish base for new research*
- *my own, or someone else's*



Emulab “Workbench”

- an Emulab-integrated environment for replayable research

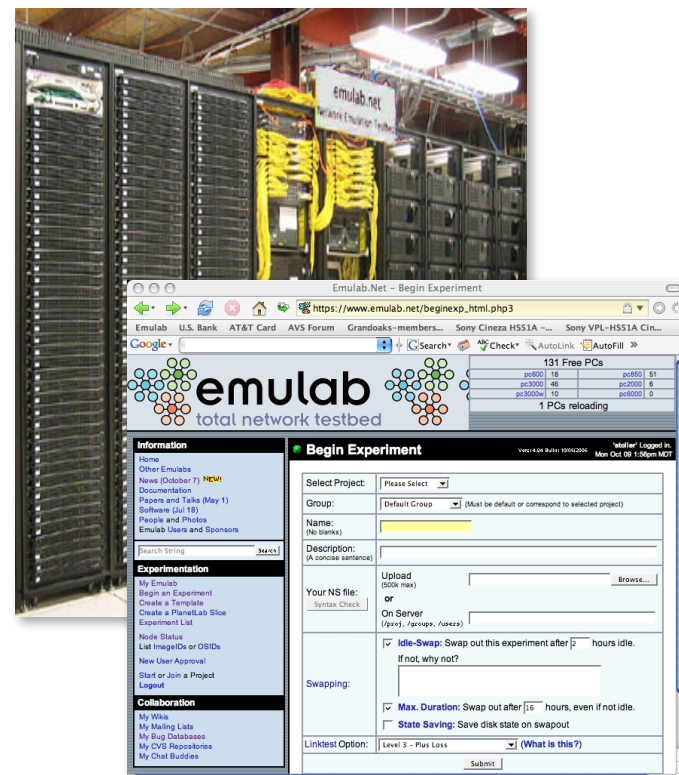
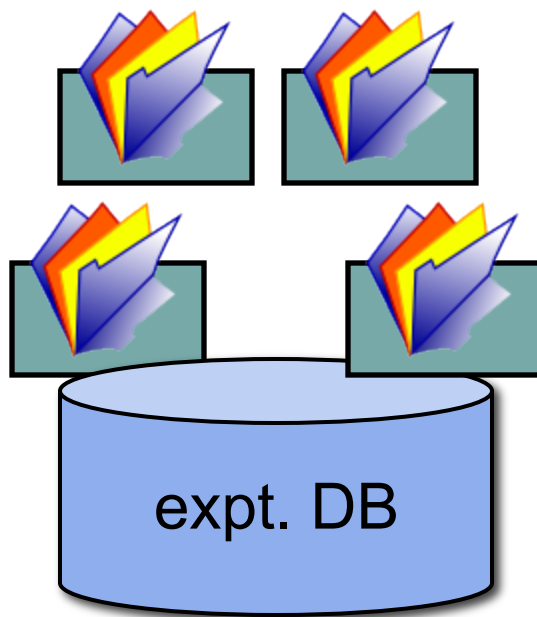
- *expt. management*
- *expt. execution*
- *encapsulation*
- *automation*
- *output data capture*
- *exploration*
- *provenance*
- *metadata*





Are We Replayable Yet?

encapsulated expts + testbed = replay?





Challenges to Replayability

- packaging is still too hard
 - *interactive use*
 - *capturing semantics & metadata*
- *partly address “not worthwhile” perception*



Challenges to Replayability

- external events & nondeterminism
 - *cost of capture*
 - *need to replay even when experiment is modified*



Challenges to Replayability

- long-term access to physical resources
 - *physical devices needed by systems research*
 - *physical resources wear out [and/or lose funding]*
 - *virtualized resources*
 - possible? useful?



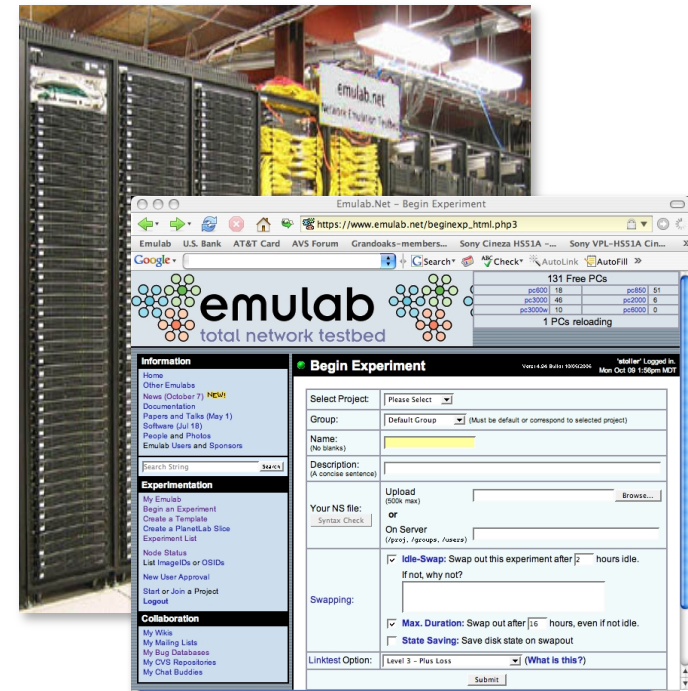
Challenges to Replayability

- better definition of “replayable”
 - *replayable with respect to chosen properties only*
 - *let experimenters be explicit about this*
- *potential benefits*
 - better design and instrumentation of expts
 - expts designed with replay in mind
 - separating *what matters* from accidental detail

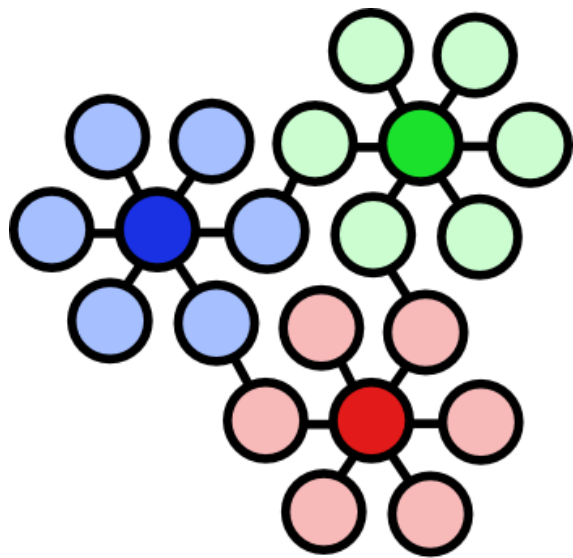


Summary

- the goal of networking and systems researchers should be *replayability*
 - *not just repeatable*
 - *also easily re-executable*
- challenges
 - *easier packaging*
 - *designing experiments for replay & reuse*



<http://www.emulab.net/>



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**Thank you!
Questions?**