Toward Replayable Research in Networking and Systems

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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

expt. DB
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
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

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

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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”
  - \textit{replayable with respect to chosen properties only}
  - \textit{let experimenters be explicit about this}

- \textit{potential benefits}
  - better design and instrumentation of expts
  - expts designed with replay in mind
  - separating \textit{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/

Thank you! Questions?

emulab