

Next Generation Network Architecture Challenge: the "...ities"

Jim Kurose

Department of Computer Science
University of Massachusetts
Amherst MA

<http://www.cs.umass.edu/~kurose>

Challenge: on beyond the data plane

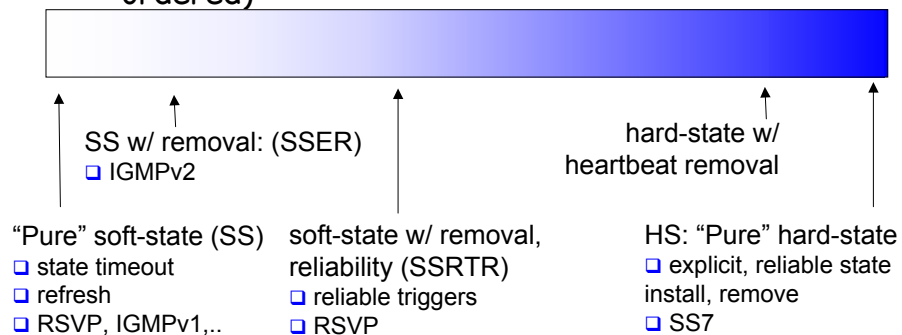
- Q: data plane performance really *the* major roadblock?
 - ❖ "robustness" ❖ adaptability
 - ❖ "complexity of control" ❖ reconfigurability
 - ❖ maintainability ❖ security
 - ❖ evolvability ❖ manageability
- the "...ities"
- Fundamental advances here are hard!
 - ❖ "efficiency" not always the most important measure
 - ❖ little/no past work on the "...ities"
 - ❖ metrics and models still to be defined

Example: soft state control

- ❑ conventional wisdom: "soft-state is robust, less complex than hard-state signaling"
 - ❖ really?
 - ❖ how to define "robustness"?
 - ❖ how to define "complexity"?
- ❑ posing/answering such a question is:
 - ❖ *hard*: no well-accepted models, paradigms
 - ❖ *easy*: little/no past research
 - ❖ *important*: a fundamental question
 - ❖ *religious*: beliefs, rather than formal analysis

Soft-state versus hard-state

spectrum of signaling choices (not totally ordered)



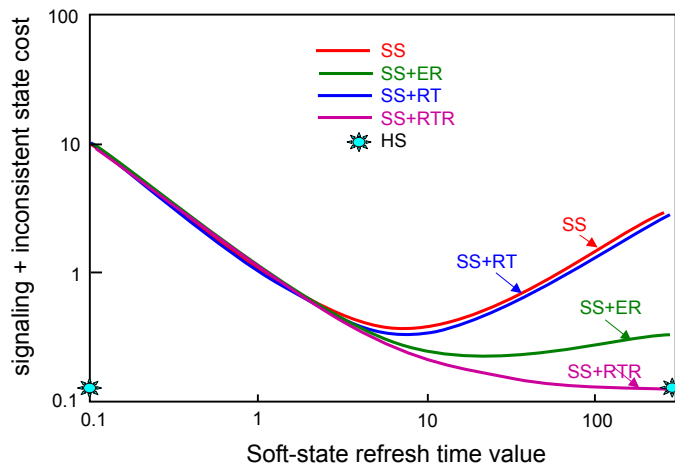
Soft-state versus hard-state: a performance comparison

unified Markov model for approaches

- ❖ state installer, state holder: (in)consistency
- ❖ message loss
- ❖ signaling overhead cost
- ❖ cost of inconsistent state: e.g., receipt of unwanted multicast data

J. Ping, G. Zihui, J. Kurose, D. Towsley
"A comparison of hard-state and soft-state signaling protocols,"
ACM Sigcomm 2003 (to appear)

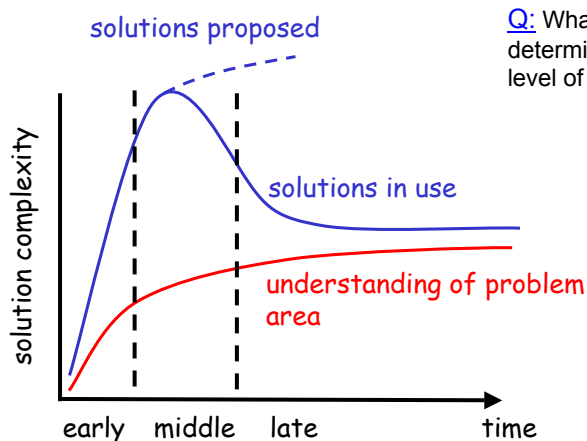
Soft-state versus hard-state: a performance comparison



Soft-state versus hard-state

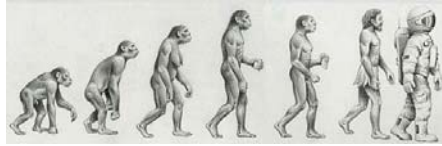
- so far: performance only, no “..ities”
- theory for design of soft-state systems
 - ❖ self-stabilizing algorithms
- implementation, operational complexity
 - ❖ resilience to bugs, misconfiguration, attacks?
 - ❖ operational overhead/management required?
 - ❖ measures of such complexity?
 - ❖ quantifying performance/complexity tradeoff

The right level of complexity



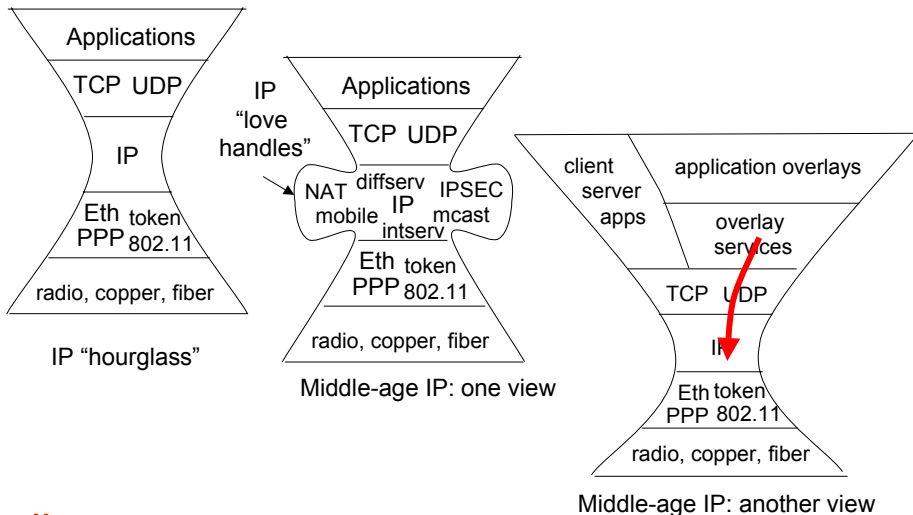
[adapted from Hluchyj 2001]

Evolvability



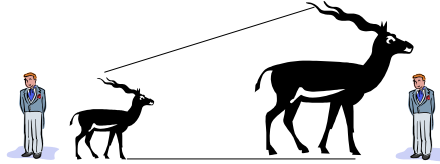
- difficulty: extending existing infrastructure
 - ❖ investment in legacy systems
 - ❖ economic incentives?
 - ❖ works well enough: "if it ain't broke, don't fix it"
- ossification as a result of success?
- approaches towards evolution:
 - ❖ active (extensible) networks: programmability in net "core"
 - ❖ overlays: programmability at the "edge"

Middle age: narrowing mind, widening waist?



On being the right size

“For every type of animal there is a most convenient size, and a large change in size inevitably carries with it a change of form” [J. Haldane, 1928]



On being the right complexity?

For every type of networked system, there is a most convenient complexity of control, and a large change in size or function inevitably carries with it a change of form of control... [Adapted from L. Zhang]