

What Are the **Fundamental Principles** in Mobile Routing Design?

— from an Internet person's view

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The questions from INFOCOM Mobility Panel chair:

- What are the *fundamental principles* underlying mobility designs and deployment in a ① *heterogeneous*, ② *easily manageable*, ③ *secure and robust* ④ *global* mobile network?
- How do we conceive this network today, if we were to design it from scratch?

What do I know about mobility?

- I have never attended a MOBICOM
- This talk is "look over the fence"
 - What we've learned from the Internet which is
 - heterogeneous,
 - not easily manageable or secure
 - pretty robust against physical failures
 - a global system
 - What applies?
 - What doesn't?

Some principles/lessons from the global Internet

(not meant to be a complete list)

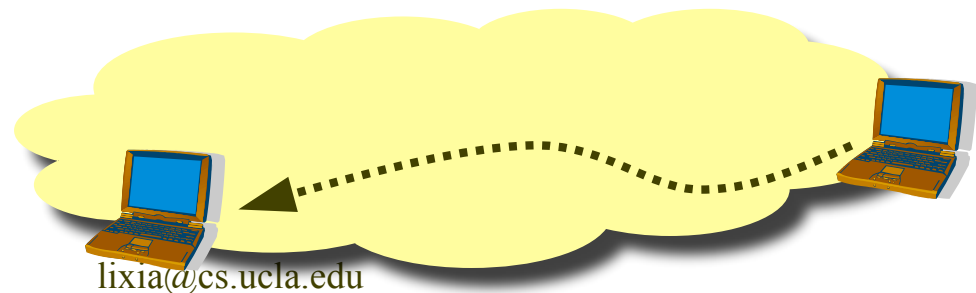
- Reachability is number one
- Delegation of responsibility
 - Distributed, not centralized
 - Keep local changes local
- Must be prepared for things to go wrong
- Keep it simple
- Performance seems to take care of itself
- big regret: management and security not designed in

Two mobility challenges

- Mobility of individual hosts
- Mobility of all the nodes in a network (Ad hoc networks)

Supporting host mobility

- Goal: delivering packets to the right IP *interface* in the *global* Internet
- IP address: defines attachment point
- Mobility=moving from one place to another \Rightarrow change of IP addresses
- The *fundamental* design question: *who/where* to keep the state (=new address) of a moving host?



Some clarification

- IP address \neq upper layer identifier
 - whether TCP did right or wrong thing (by using IP address as part of conn. ID) is an orthogonal question
- Looking into future: most likely to see multiple different identifier spaces
 - for different applications, serving different purposes
 - *Simplest* architectural choice: bind upper layer identifier to home agent IP address
 - "*Simplest*" is unlikely to give "*optimal*" performance

Mobile IP design

- Who: individual mobile hosts to choose
- Where:
 - Within IP layer
 - Outside network routing infrastructure
- How: let the moving host report back to its chosen home agent

Is mobile IP design a patch-on?

- It *was* added on later
- If we were to start from scratch, would it have been done differently?

Many alternative designs possible

- The network could take over the responsibility of keeping tracking mobile hosts
 - Keeping the mobility state inside the routing infrastructure
- The address change could be directly reported to a name lookup service
 - Keeping state outside (above) IP layer
- And a number of others

Q: how do we judge which way is *better*?

Let's measure by the principles

- Reachability is number one
- Delegation of responsibility
- Must be prepared for things to go wrong
- Keep it simple
- Performance is important, but below any of the above
- ➔ Keeping mobile state at home agent
 - Keep the matter in your own hand
 - X's failure will not affect Y
 - Perhaps easier to add crypto (I'm handwaving here:-)
 - Not the most efficient
 - Not giving highest possible performance

Mobile IP: a patch on?

Host location

Fixed

moving

topology

Topology change

- link/node failures
- semi-static structure
- dynamic routing to destination

- Host move \Rightarrow address change
- keep state outside the network

- A number of remaining issues to be sorted out
- But (I believe) it got the basic principle right

Ad hoc networking: a different beast? (or not?)

topology
Fixed

Topology *does* change

- link/node failures
- semi-static structure
- routing: Baran's hot-potato flooding \Rightarrow separate routing protocols

changing

Structure-free \Rightarrow host routing
Resource constrained \Rightarrow On-demand routing
To handle high dynamics \Rightarrow flooding
To scale better \Rightarrow Cluster/landmark routing
Can we do better? Probably yes !

Robin Kravets: 5 challenges

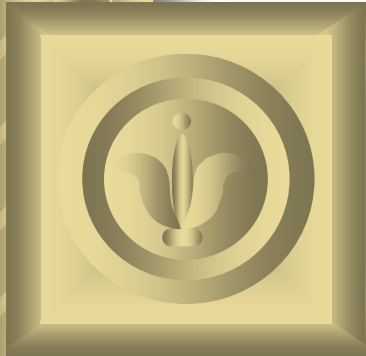
- Connectivity discovery
- Resource discovery
- Naming
- End-to-end service
- Resource management

I would add, perhaps putting in front of the above five:

- manageability, and
- security !!!

What to take away

- Keep the *global* picture in mind
- *Reachability* is the first and foremost goal
- Performance tends to take care of itself
 - But management and security **not**
- Avoid ABC (Attack By Complexity)
- **Learn from the past**
 - A rich set of lessons
 - A rich set of working solutions



Thank you!

Questions?

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