Dynamic Names and Private Address Maps: Complete Self-Configuration for MANETs

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Quick overview of this presentation

- **Main motivation:** MANET is not Internet
  - Is IP routing and addressing the right way to go?

- **Where addresses are not addresses in MANETs.**
  - Why "routing by name" is a valid alternative.

- **Private Address Maps:**
  - A 100% NAT proposal.

- **Dynamic Shortest Discriminating Names:**
  - The human to network interface.
MANET (address) Autoconfiguration

- Very active field of research for the last 5 years
  - However, no clear "winner solution" yet.
  - IETF AUTOCONF Working Group has not yet produced a single wg document!

- Focus is on addresses, addresses, and addresses …
  - Because of IP routing, each address must be unique - challenging in MANETs (no infrastructure, node mobility, network merging and partitioning, etc).
  - Core common issues of all autoconf solutions are
    - address validation ("is this address already used?") – initialization phase
    - collision detection ("is someone using my address?") – continuous phase

Objective of this work: to radically solve address autoconfiguration by "removing" addresses from the MANET networking model!
The MANET world today: "Shoch's world"

✓ Name resolution à la AODV
✗ Name autoconfiguration

✗ Address autoconfiguration

✓ MANET routing (with addresses)

- NAME: What we seek
  - Mapping (e.g. directory function)

- ADDRESS: Where it is
  - Mapping (forwarding)

- PATH: How to get there

✓✓ ✓✓
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✓✓ ✓✓
On addresses and paths in MANETs

- In Shoch's model, an address indicates where a resource is located.
  - In the Internet, an address has a topological meaning: it indicates a point of attachment.
  - That is, L3 mobility implies an address change: an address is not portable.

- But in a MANET, an address indicates how to get to a node.
  - An address has no topological meaning: routing is typically flat (i.e. a route identifies a unique node).
  - L3 mobility is handled via routing: addresses do not change.
  - Addressing is totally topology independent.
  - Does this sound like Shoch's definition of an address? Our answer: No.

Is there an alternative to the name-address-path networking model?
Revisiting MANETs: removing addresses

The "Routing by name" [Hauzeur86] networking model.

✓ Name resolution à la AODV
✗ Name autoconfiguration

✓ MANET routing (with names)

Mapping: Routing, Forwarding

✓✓ ✓✓

NAME  What we seek

PATH  How to get there

No more issues with addresses: We "just" need to solve name autoconfiguration and use a clever way to label paths.
Challenges to achieve routing by name

 Name autoconfiguration.
   In MANETs, names (FQDNs) should not be assigned statically.
   Dynamic names? hey this is non-sense ... ;-) 
   Actually a user is interested by what is identified by the name, not by the name itself as long as it "does the job" (i.e. identify the target resource).

 However, today's networking world works in an IP-by-default mode.
   We cannot get rid of IP addresses without introducing backwards compatibility problems (e.g. existing applications expect DNS+IP).

 Actually the main issue faced by address autoconfiguration is address uniqueness: for IP routing to work, each address must be (globally) unique.
   BUT we already know how to solve this with NAT.
Our proposal: an overview

- Address (no) autoconfiguration.
  - Private Address Maps.
  - Based on an extreme use of NAT.
  - Mainly to guarantee backwards compatibility with the IP world.

- Name autoconfiguration.
  - Dynamic Shortest Discriminating Names.
  - User specifies a set of ordered keywords used to dynamically create a unique name (inside the MANET).
Private Address Maps

Inspired by NAT:

Node A sees:
A = 192.168.23.65
B = 2.1.67.92

Node B sees:
B = 10.1.34.22
A = 1.2.32.89

Private Address Maps = extension of this scenario to all the MANET nodes (100% NAT)
Private Address Maps: let me choose your address

gethostbyname() → "Application is happy" ;-) → IP stack

DNS request → LUNAR Underlay

RREQ (AODV-style) with name

Faked DNS reply: LUNAR chooses an address for peer

RREP

Forwarding cannot be done with IP address (addresses have no global meaning).

Routing creates a label-switched forwarding path à la MPLS (i.e. with local labels).
Private Address Maps: lookup + path setup

A?B, label = 3, reply = ethA
A?B, label = 7, reply = ethD

a) Route request sent by A looking for B

label = 7, reply = ethD
label = 5, reply = ethB

b) Route reply sent by B towards A

Src = 172.16.2.23
Dest = 172.16.2.75

Src = 10.1.1.132
Dest = 10.1.1.2

dest = ethD, label = 7, IPpkt
dest = ethB, label = 5, IPpkt
Private Address Maps

✓ No need to maintain unique addresses.
✗ Only suitable for flat networks with host routes.

Physical topology

A's map

B's map

C's map

10.1.1.132
B
10.1.1.38
E
C
10.1.1.2

10.1.1.132
B
10.1.1.2
C
10.1.1.38

172.16.2.23
B
172.16.2.75
A

No need to maintain unique addresses.

Only suitable for flat networks with host routes.
Dynamic Shortest Discriminating Names (DSDNs)

- Each user specifies a set of ordered keywords
  - e.g. {John, Doe, UniBasel, CSDept, Switzerland}
  - and {Paul, Doe, UniBasel, BioDept}

- LUNAR dynamically creates FQDN with minimum number of keywords (first 2 are always used).
  - e.g. john-doe.net.lunar
  - and paul-doe.net.lunar

- If a name conflict is detected, names are extended
  - e.g. {John, Doe, UniBasel, CSDept, Switzerland}
  - and {John, Doe, UniBasel, BioDept}
  - → john-doe-csdept.net.lunar
  - john-doe-biodept.net.lunar
DSDNs: identifying nodes

- Names can change!
  - How does LUNAR maintain paths?

To identify nodes in the long term, each LUNAR node has a Host Identity Tag or HIT (see [HIP]).
  - Unique 128-bit string.
  - Once known, the HIT is always used to identify a LUNAR node.
  - That is, name changes do not break connections.

- Hence for each of its active peers, a LUNAR node maintains:
  - a static HIT for long term identification.
  - a dynamic name for human to network interface (i.e. yellow pages).
  - an address, to make IP stack + applications happy.
So where are we now? What's coming next?

- Complete self-configuring MANET:
  - User specifies a set of keywords without having to care about uniqueness.
  - Unique name is generated by LUNAR.
  - Any address can be used: no need to be unique.
  - Implemented as a Linux kernel module (with home-made NAT).

- Note that:
  - Private address maps can be used with any naming/routing scheme that can perform a lookup and create virtual circuits (MPLS-style).
  - I.e., DSDN + Reactive-MPLS-style routing is just one way of generating names and performing routing by name.

- Potential extensions:
  - NAT ALGs for applications using names in payload (e.g. HTML).
Questions?

Want to learn more?
… I invite you to read our CoNEXT and Wons06 papers.

Want to try?
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