Project 5

Ad-hoc networking

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Slide heritage: Previous TAs → Robert Escriva

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Administrative Information

- Projects 2 and 3 have been graded. Use CMS for regrade requests.
- Project 5 will be released this evening. Due date: November 20 at 11:59PM. **There will be no extension for this project**.
- No supplementary lecture for project 5.
- Next week: Project 6 lecture.

> *There are three kinds of death in this world. There's heart death, there's brain death, and there's being off the network.*
>
> Guy Almes

1. Overview
2. Project Scope
3. Implementation Details
4. Testing your project
5. Concluding Thoughts

What is an “ad-hoc networking layer”?

What is an “ad-hoc networking layer”?

Ad-hoc networking enables wireless communication without the need for infrastructure.

What is it useful for?

- Removes infrastructure costs.
- Allows quick deployment.
- Potentially more reliable (no single point of failure).

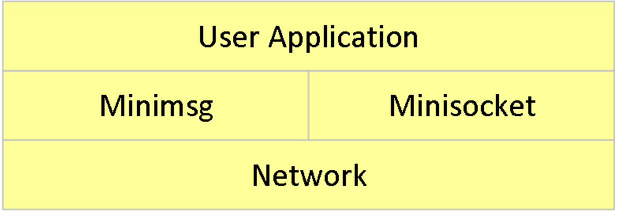
Based on Dynamic Source Routing.*

* `http://www.cs.cornell.edu/People/egs/615/johnson-dsr.pdf`

What do you mean by routing?

- Packets that arrive at your machine may not be meant for you.
- Packets not meant for you should be routed to their destination.
- Insert a routing layer between the network and transport layer.
- Both minimsg and minisocket implementations should work on top of miniroute.

Our networking stack until now...

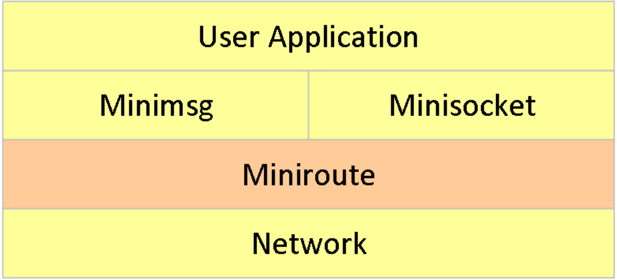


User Application

Minimsg | Minisocket

Network

Our networking stack after P5



User Application

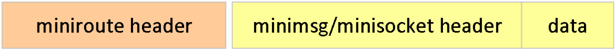
Minimsg

Minisocket

Miniroute

Network

What does this mean for the network headers?



miniroute header

minimsg/minisocket header

data

Route discovery

- DSR is a reactive protocol.
- If a host does not know how to route a packet, it must discover the route.
    - It does so by sending a **route discovery packet**.
- A route discovery packet is broadcast to all hosts within proximity of a wireless signal.
- Hosts will re-broadcast discovery packets if they are not the destination.
    - The host will add itself to the constructed route.
- The destination will send a unicast **route reply packet** along the reverse route.

Route replies

- Upon receiving a reply, the route will be updated into the cache.
- If the received route contains A → B → C where A is the source, C is the destination, C will flip the route to C → B → A to send a reply to host A.
- Route cache entries expire in 3 seconds to prevent stale cache entries.
- Route discovery must be performed again upon route expiration.
  - Is there a better way to do this?

More on DSR

- How does the protocol terminate?
  - By tracking a time-to-live (`ttl`) value.
  - `ttl` decrements by 1 each time a message is forwarded.
- Set the initial `ttl` to `MAX_ROUTE_LENGTH`.
- What happens when `ttl` = 0?
- How do we prevent loops while broadcasting?

What do you need to implement?

- Convert calls in higher network layers to `network_send_pkt` to `miniroute_send_pkt`.
  - But your `miniroute_send_pkt` function may still need to depend on `network_send_pkt` for unicasts.
- Update the network handler.
  - Interpret the miniroute header.
  - Handle routing control packets.
  - Deliver packet as usual if the destination has been reached.[†]

[†] Strip off miniroute header before delivering packet up the network stack.

Routing Cache

- The cache must be able to hold `SIZE_OF_ROUTE_CACHE` entries.
- Routes are invalidated after a 3 second timeout.
  - Alarms may be used, but it can be done without.
- Access should be somewhat efficient, as you may increase `SIZE_OF_ROUTE_CACHE` to be large.
  - Aim for $O(1)$ access speed on operations.
  - Use a hash table with linear probing.
  - We have provided a hash function for network addresses.

`miniroute_send_pkt` semantics

- Allow only one routing discover request per destination on the network at any one time.
  - Block threads if `miniroute_send_pkt()` was called and route isn't in the cache.
  - Discoveries for multiple destinations can be done concurrently, but...
  - Multiple threads should not trigger multiple routing discovery requests for the same destination.
  - Unblock all threads waiting on a route when that reply arrives.

Miniroute packets

- Use the header format provided in `miniroute.h`:
    - Pack fields into the structure.
    - Append `minimsg` or `minisocket` messages (if necessary).
    - Maximum overall network packet size is still 8192, so you may have to make adjustments in your P3/P4 code.

Additional implementation requirements

- Write an Instant Messenger application that runs on miniroute.
  - Read input from the user (look at `read.[ch]`).
  - Add `miniterm_initialize` to your system initialize functions.
  - `miniterm_read` will let you read from the keyboard.
- Try running `network6.c` over miniroute.
  - Test interoperability with your friends.

Trying out your implementation

- Open `network.h`.
- Set `BCAST_ENABLED` to 1.
- Set `BCAST_ADDRESS`:
  - 192.168.1.255 for ad-hoc network (see instructions for setting up an ad-hoc network).
  - x.y.z.255 for CSUGLAB.
- For debugging/testing in the CSUGLAB:
  - Set `BCAST_TOPOLOGY_FILE`.
  - Provide a topology file (see project description).
    - Test without wireless.
  - Use only in CSUGLAB.

If you are really interested in this stuff...

- Hybrid proactive/reactive routing protocols
- See Professor Sirer's SHARP[‡]

[‡] http://www.cs.cornell.edu/courses/cs414/2004SP/papers/sharp.pdf

Concluding thoughts

- Have some fun with this project.
- It's much less work than P4.
- Computers in the CSUGLAB may get snapped up by other students near the deadline, so start early.
- Come see the TAs in office hours[§].

[§] some of the TAs get lonely