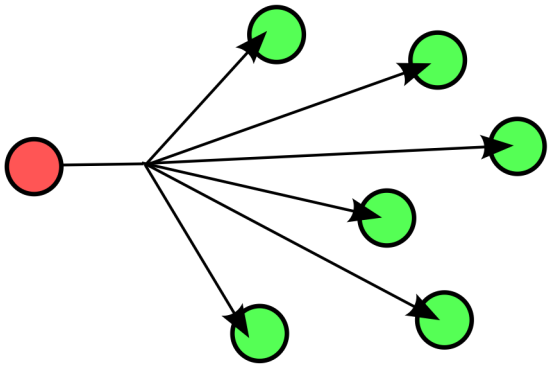
Broadcast Communication Tutorial

What is Broadcast?

- Broadcast is used to describe a type of communication in which a piece of information is sent from one node to all the other nodes in a network
- One-to-one communication, called unicast, is typical for wired networks, but broadcast is more common in the case of wireless networks



Rime Network Stack

- Rime is a light-weight layered communication stack for sensor networks that provides a set of communication primitives ranging from best-effort anonymous local area broadcast to reliable network flooding
  - The purpose of Rime is to simplify implementation of sensor network protocols and facilitate code reuse
  - For details, refer to: http://contiki.sourceforge.net/docs/2.6/a01798.html
- Contiki includes the Rime stack, in addition to the IPv4 and IPv6 stacks, as an alternative for low-power wireless networks, which don't require all the functionality (and complexity) of the traditional stacks

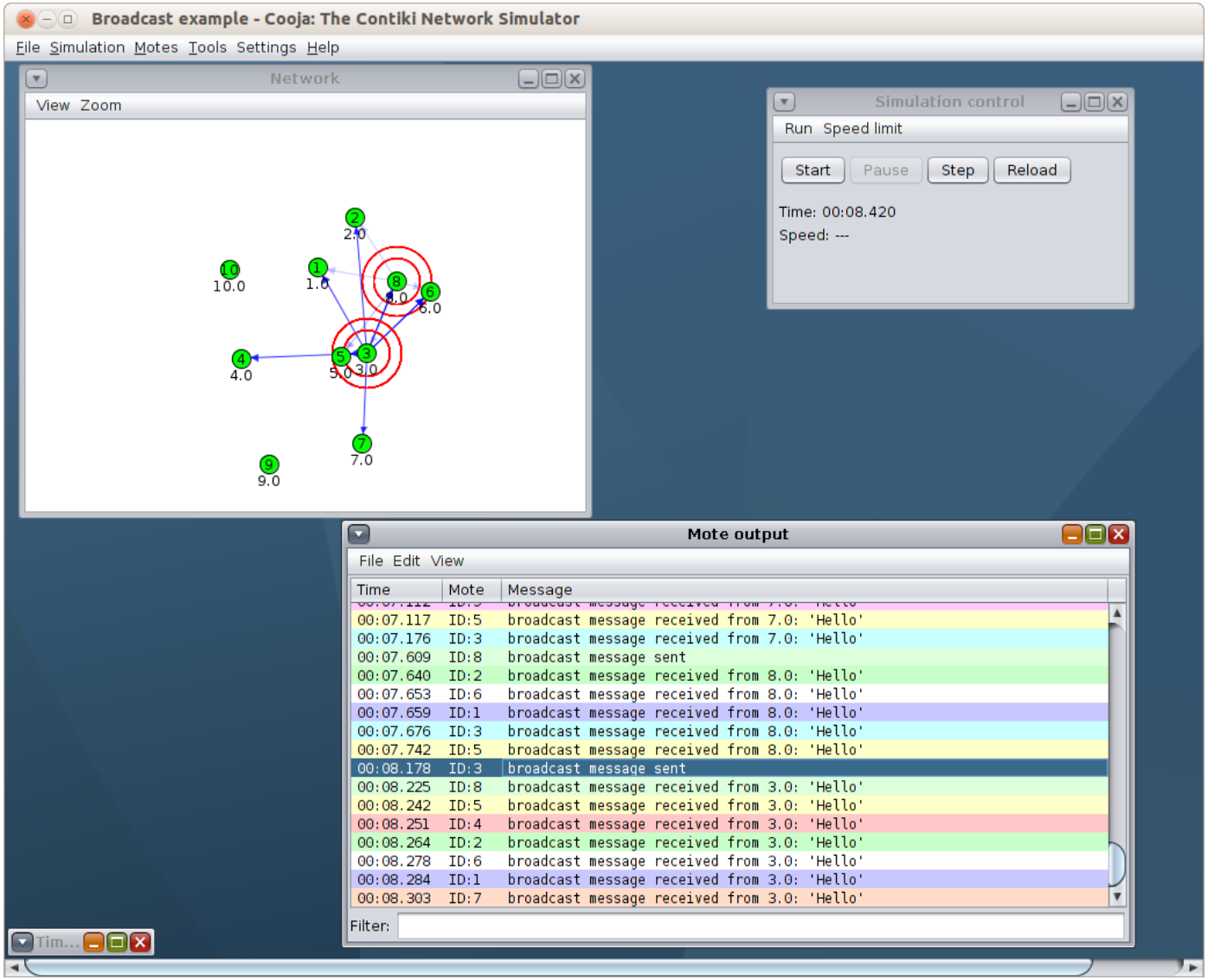
Rime Implementation in Contiki

- The source files for the Rime stack are available in “contiki/core/net/rime”
- Use examples for Rime can be found in the directory “contiki/examples/rime”
  - broadcast
  - unicast
  - collect
  - mesh
  - multihop

Broadcast Simulation Example

- The simplest way to open the simulation is to select "Broadcast Simulation" in the IoTrain-Sim interface
- Alternatively, you can open it manually as follows
  - Open Cooja
  - Click File > Open simulation > Browse...
  - Go to the folder "iotrain-sim/database/fundamental_training/networking/broadcast/simulation"
  - Select the file "broadcast.csc"
- The simulation control window will appear showing 10 motes in the Network panel (see next page)
  - Click the "Start" button to begin the simulation
  - Communication will be visualized in the Network panel, and traffic details will be shown in the Mote output panel

Broadcast Simulation in Cooja



Source Code Commentary

- Each node sends a string via a broadcast packet
  - Source code: iotrain-sim/database/fundamental_training/networking/broadcast/simulation/broadcast-ex.c *

```
#include “contiki.h” ❶
#include “net/rime/rime.h” ❷
#include “random.h”
#include “dev/button-sensor.h”
#include “dev/leds.h”
#include <stdio.h> ❸
/*---------------------------------------------------------------------------*/
PROCESS(example_broadcast_process, “Broadcast example”); ❹
AUTOSTART_PROCESSES(&example_broadcast_process); ❺
/*---------------------------------------------------------------------------*/
static void
broadcast_recv(struct broadcast_conn *c, const linkaddr_t *from) ❻
{
  printf(“broadcast message received from %d.%d: ‘%s’\n”, from->u8[0], from->u8[1], (char *)
packetbuf_dataptr());
}
static const struct broadcast_callbacks broadcast_call = {broadcast_recv};
static struct broadcast_conn broadcast;
```

** The file name is not “broadcast.c” to avoid a conflict with the Rime broadcast implementation*

Source Code Commentary (cont.)

```
/*---------------------------------------------------------------------------*/
PROCESS_THREAD(example_broadcast_process, ev, data)
{
  static struct etimer et;
  PROCESS_EXITHANDLER(broadcast_close(&broadcast);)
  PROCESS_BEGIN();
  broadcast_open(&broadcast, 129, &broadcast_call);
  while(1) {
    /* Delay 4-8 seconds */
    etimer_set(&et, CLOCK_SECOND * 4 + random_rand() % (CLOCK_SECOND * 4));
    PROCESS_WAIT_EVENT_UNTIL(etimer_expired(&et));
    packetbuf_copyfrom(”Hello", 6);
    broadcast_send(&broadcast);
    printf("broadcast message sent\n");
  }
  PROCESS_END();
}
/*---------------------------------------------------------------------------*/
```

❽

❼

Source Code Commentary (cont.)

1. Header file needed by Contiki applications
2. Header file needed for the Rime stack
3. Header file needed for the printf() function
4. Name for the application process
5. Automatically start the application process
6. Callback function that is invoked when a broadcast packet is received; the function prints information about the packet sender and received data
   - The first argument is of type broadcast_conn *, and contains information about the connection and receive and send functions
   - The second argument is of type linkaddr_t *, and contains information about the sender
   - For details, refer to “contiki/core/net/rime/broadcast.c” and “core/net/rime/broadcast.h”

Source Code Commentary (cont.)

❼ Operations for broadcast communication

- Open a best-effort broadcasting connection on a given UDP port, with the callback function given as argument to be called when a packet is received on this connection
  broadcast_open(struct broadcast_conn *, uint16_t, const struct broadcast_callbacks *)
- Send a broadcast packet on an already open connection (data must be prepared in advance via a call to the packetbuf_copyfrom() function)
  broadcast_send(struct broadcast_conn *)
- Close an open best-effort broadcast connection
  broadcast_close(struct broadcast_conn *)

❽ Use a timer to introduce a random delay of 4 to 8 seconds between the broadcast packets

Exercise 1

- Modify the source code to alter the content of the packet that is broadcasted in the provided example
- Hints
  - Locate the function packetbuf_copyform() in the source code file “broadcast-ex.c”, and replace the string “Hello” with another word (e.g., “Goodbye”)
  - You must change the string length argument to a value equal to the length of the new word + 1, in order to account for the null character at the end of the string **Example**: For “Goodbye” (a string of length 7), the function argument should be 8

For a possible solution, see the file “iotrain-sim/database/fundamental_training/networking/broadcast/simulation/solution_broadcast1.c”

Exercise 2

- Try other source code samples located in the Rime directory “contiki/examples/rime” to understand their behavior
- Topics of interest include
  - Unicast communication: example-unicast.c
  - Multi-hop forwarding: example-multihop.c
  - Mesh networking: example-mesh.c