NS-2 Tutorial-4

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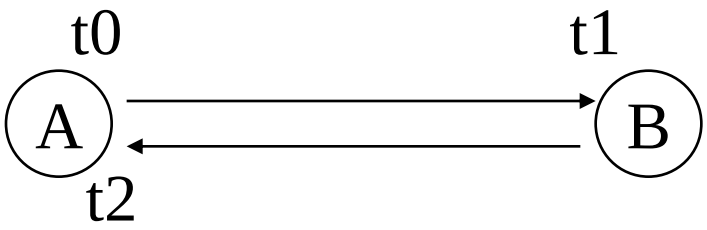
Creating A New Protocol

- NS-2 tutorial: Section VII
  - http://www.isi.edu/nsnam/ns/tutorial/index.html
- Actually, you should go through the whole tutorial
- We start from a simple protocol: ping



Ping computes (t2-t0)

What we should implement

- The structure of Ping Packet
  - Send_time: the time this PING transmit
  - RET: how many times this PING delivered
- The Ping protocol
  - send (called from script)
  - recv (triggered by NS-2)
- The parameters
  - Packet size
  - Header offset

Ping.h

Header of Ping Packets

```
struct hdr_ping {
  char ret;
  double send_time;

  // Header access methods
  static int offset_; // required by PacketHeaderManager
  inline static int& offset() { return offset_; }
  inline static hdr_ping* access(const Packet* p) {
        return (hdr_ping*) p->access(offset_);
  }
};
```

char?

Ping.h

- Ping Agent
  - C++ definition

```
class PingAgent : public Agent {
 public:
  PingAgent();
  int command(int argc, const char*const* argv);
  void recv(Packet*, Handler*);
 protected:
  int off_ping_;
};
```

TCL command from ns-2

Ping.cc

[Class]Ping Packet Header

```
int hdr_ping::offset_;
static class PingHeaderClass : public PacketHeaderClass {
public:
        PingHeaderClass() : PacketHeaderClass("PacketHeader/Ping",
                                              sizeof(hdr_ping)) {
                bind_offset(&hdr_ping::offset_);
        }
} class_pinghdr;
```

[Class]Ping Agent

```
static class PingClass : public TclClass {
public:
        PingClass() : TclClass("Agent/Ping") {}
        TclObject* create(int, const char*const*) {
                return (new PingAgent());
        }
} class_ping;
```

Binding the C++ and OTcl objects/variables

- Ping.cc

```
PingAgent::PingAgent() : Agent(PT_PING), seq(0), oneway(0)
{
        bind("packetSize_", &size_);
}
```

- tcl/lib/ns-default.tcl(or your tcl script)

```
Agent/Ping set packetSize_ 64
```

Command Methods: sending packet

In Tcl:

$ns at 0.2 "$p0 send"

$ns at 0.4 "$p1 send"

$ns at 0.6 "$p0 send"

$ns at 0.6 "$p1 send"

- Reference:
  NS-2 manual
  Section 3.4.4

```
int PingAgent::command(int argc, const char*const* argv)
{
  if (argc == 2) {
    if (strcmp(argv[1], "send") == 0) {
      // Create a new packet
      Packet* pkt = allocpkt();
      // Access the Ping header for the new packet:
      hdr_ping* hdr = (hdr_ping*)pkt->access(off_ping_);
      // Set the 'ret' field to 0, so the receiving node knows
      // that it has to generate an echo packet
      hdr->ret = 0;
      // Store the current time in the 'send_time' field
      hdr->send_time = Scheduler::instance().clock();
      // Send the packet
      send(pkt, 0);
      // return TCL_OK, so the calling function knows that the
      // command has been processed
      return (TCL_OK);
    }
  }
  // If the command hasn't been processed by PingAgent()::command,
  // call the command() function for the base class
  return (Agent::command(argc, argv));
}
```

Receiving Packets (ping.cc)

```
void PingAgent::recv(Packet* pkt, Handler*)
{
  hdr_ip* hdrip = hdr_ip::access(pkt);   // Get IP header
  hdr_ping* hdr = hdr_ping::access(pkt); // Get Ping header

  if (hdr->ret == 0) {
    // Send an 'echo'.
    double stime = hdr->send_time; // First save the send_time
    Packet::free(pkt); // Discard the packet

    Packet* pktret = allocpkt(); // Create a new packet
    hdr_ping* hdrret = (hdr_ping*)pktret->access(off_set_); // Get Ping header
    hdrret->ret = 1;              // Set the 'ret' field to 1
    hdrret->send_time = stime;    // Set the send_time field to the correct value

    send(pktret, 0);  // Send the packet
  } else {
    char out[100];
    sprintf(out, "%s recv %d %3.1f", name(),
            hdrip->src_.addr_ >> Address::instance().NodeShift_[1],
            (Scheduler::instance().clock()-hdr->send_time) * 1000); // Format TCL command
    Tcl& tcl = Tcl::instance();
    tcl.eval(out);

    Packet::free(pkt); // Discar
  }
}
```

- **recv in C++** (you should look at the Tcl codes in the next page)
- It will execute the TCL command like:
- node_(0) recv node_(1) 5.00

tcl: Agent/Ping class

- The tutorial put the simulation script and tcl function in the same file
  - Usually, they are different files
  - You can put the TCL functions into tcl/lib/ns-lib.tcl
- instproc
  - Function in Tcl

* **recv in Tcl** (you should look at the C++ codes in the previous page)

```
Agent/Ping instproc recv {from rtt} {
        $self instvar node_
        puts "node [$node_ id] received ping answer from \
              $from with round-trip-time $rtt ms."
}
```

In C++ codes:

void **recv**(Packet*, Handler*){

sprintf(out ,"%s recv %d %3.1f"...)

};

OTcl Linkage

- Invoking Tcl object
  - Tcl& tcl = Tcl::instance();
  - tcl.evalc(char *)
  - tcl.eval(const char *)
  - tcl.evalf("%d %f…",int,double,…)
- Passing results
  - tcl.result(const char *)
  - tcl.resultf("%d %f…",int,double,…)
- Error handling
  - tcl.error()

tcl: simulation

- Simulation Script

```
set p0 [new Agent/Ping]
$ns attach-agent $n0 $p0
set p1 [new Agent/Ping]
$ns attach-agent $n2 $p1
$ns connect $p0 $p1
$ns at 0.2 "$p0 send"
$ns at 0.4 "$p1 send"
```

Other Modifications

- Makefile
  - You should learn how to use ***make*** for Unix/Linux programming
- common/packet.h
  - Add new packet type
- tcl/lib/ns-packet.tcl
  - Packet header option
- tcl/lib/ns-default.tcl
  - Default Tcl values

/common/packet.h

```
static const packet_t PT_TFRC = 42;
static const packet_t PT_TFRC_ACK = 43;
static const packet_t PT_PING = 44;
```

New packet type

(TYPE_NAME=id)

For a new packet type, you should set an unused id

```
class p_info {
public:
        p_info() {
                name_[PT_TCP]= "tcp";
                name_[PT_UDP]= "udp";
                ............
                name_[PT_TFRC]= "tcpFriend";
                name_[PT_TFRC_ACK]= "tcpFriendCtl";

                name_[PT_PING]="Ping";

                name_[PT_NTYPE]= "undefined";
        }
        .....
 }
```

tcl/lib/ns-packet.tcl

To save some memory, you can disable unneeded packet headers (Not necessary)

```
#       { TFRC off_tfrm_ }
#       { Ping off_ping_ }
#       { rtProtoLS off_LS_ }
#       { MPLS off_mpls_ }
```

tcl/lib/ns-default.tcl

- Define all the Tcl default values

```
Agent/Ping set packetSize_ 64
```

In ping.cc

```
PingAgent::PingAgent() : Agent(PT_PING), seq(0), oneway(0)
{
        bind("packetSize_", &size_);
}
```

Makefile

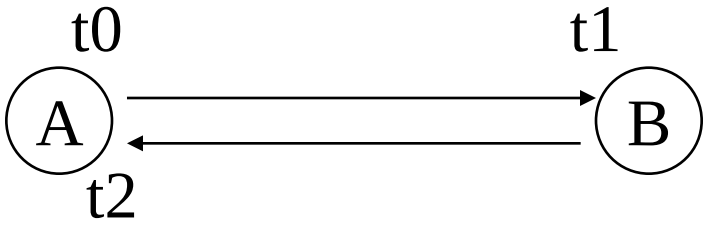
- Add your module (ping.o) into OBJ_CC
- You can also edit Makefile.in
  - Then enter "configure" to build new Makefile

Source Codes

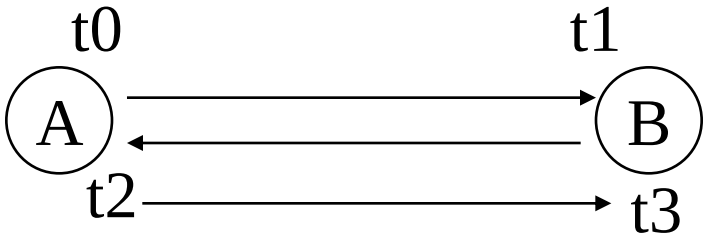
- Ping in NS-2
  - ns-allinone-2.*\ns-2.*\apps\ping.*
  - A complete version ping
- Ping in Tutorial
  - A simplified ping version for teaching purpose
- You could learn from both

Homework #3

- Deadline: 2 weeks from now
  - 5/1 13:00
- Create a new protocol called "pong"
  - Create pong.cc, pong.h
  - Make other necessary modifications on other files
- You could consider "pong" as a 3-way ping protocol
- "pong" packets should be recorded in trace file



Ping computes (t2-t0)



Pong computes (t3-t0)

- Create a "pong" traffic generator
  - You could reference the cbr/tcp traffic generator (cbrgen.tcl in HW2)
  - Pong transmitter and pong receiver are randomly selected from *n* nodes
    - Note: transmitter and receiver should be different
  - Time intervals between pong event follow exponential distribution
- Use AODV for routing with 10 randomly located nodes in 400m x 600m rectangular area
  - Nodes move based on random-waypoint model with zero pause time
  - Simulate moving speed of maximum 1m/s, 5m/s and 10m/s
    - Use 1, 5, 10 as the maximum speed parameter in setdest tool
  - The expected time interval between pong events is 0.5 second
  - Compute the success ratio of pong messages
    - Delivered Pong/ Total trial
  - Compute the average and the standard deviation of "pong" delay time
  - Compute the overhead due to AODV routing
  - Total simulation time = 21 seconds. Pong starts from 1 second.
- Use DSDV for routing. Compare the network performance.
  - You should run simulation for several times (with randomly generated scenarios)
  - You could plot the DSDV and AODV results on the same set of figures for comparison

Clarification on Overhead

- Overhead
  - overhead due to AODV routing
  - overhead due to DSDV routing
  - Routing overhead only counts routing related control packets (e.g. AODV RREQ, DSDV route update)
    - Do not count headers of data packets
    - Do not count ARP packets

Submission

- Email to tomkywang+introwmn@gmail.com
  - Title: [HW#3] b94xxxxxxxx
  - Submit: b94xxxxx_hw3.zip
    - Source codes (all files that you created and modified) and simulation scripts
    - readme.txt
      - Describe the new files and how you modify the relevant files
      - Instruction on how to run your codes
    - b94xxxxx_hw3.doc (pdf or txt)
      - Describe your simulation results
      - What have your observed? Why?

Some Hints

- Recompile ns-2
  - Go to ns-2.xx directory
  - ./configure (If you edit Makefile, skip this)
    - Will use Makefile.in to configure Makefile
    - If you want to add new files into ns-2, please modify Makefile.in and then ./configure
    - You might directly change Makefilie
      - But there is some drawbacks..
  - make clean
  - make depend
  - make
- How do you know that compiling ns-2 is successful?
  - Check the bin/ns.exe(cygwin) or bin/ns to see if it's new (file creation time)

Some Hints

- You should rename the tutorial version of Ping into "Pong" first
  - Add the "Pong" into your ns-2, and check if it works
  - If so, you can start to implement Pong

- Do as early as you can
  - Or you WILL NOT make it