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NS2: How to add new routing protocol

🕓January 20, 2010 ✎Article

Writing routing protocol is fairly easy in NS2, but for beginners it seems very difficult. Therefore, if you are new to NS2 and want to write your own routing protocol, I would strongly recommend to revise AODV source code. Because, I believe AODV source code is straightforward and fairly easy to understand due to the simplicity of the AODV protocol.

Before you begin reading this post, I assume that you have already installed NS2 on Linux. I have used version 2.34, which is current release. If you have not installed yet, DOWNLOAD HERE (http://sourceforge.net/project/showfiles.php?group_id=149743&package_id=169689&release_id=58864) and INSTALL. Okey, simple requirements to write your own routing protocol

- **NS2 installed**
- **You should know how to program in C/C++.**
- **Optionally, shell scripting and perl.**

Let's start with creating directory of routing protocol. Goto the *"$NS_ROOT/ ns-2.34/"*. Create directory named as **wfrp**, we call it **W**SN **F**looding-based **R**outing **P**rotocol in which sink nodes periodically send a beacon message and other nodes construct route towards the sink nodes. Then nodes report to sink node every certain period using UDP protocol. Direct Diffusion may be an example of such protocol, but what we are writing is simpler and has more functionalities.

```
1  mkdir wfrp
```

In the directory we create three files : wrfp.cc (/sfiles/wfrp/wrfp.cc), wrfp.h (/sfiles/wfrp/wrfp.h), wrfp_packet.h (/sfiles/wfrp/wfrp_packet.h). Download and put these files in **wfrp** directory. I will not explain the code here, and if you don't understand just leave comment I will try to answer.

Now, we are going to modify following files. Therefore it is better you backup these files before you start adding new protocol, so that you can easily go back.

- $NS_ROOT/Makefile
- $NS_ROOT/queue/priqueue.cc
- $NS_ROOT/common/packet.h
- $NS_ROOT/trace/cmu-trace.h
- $NS_ROOT/trace/cmu-trace.cc
- $NS_ROOT/tcl/lib/ns-packet.tcl
- $NS_ROOT/tcl/lib/ns-lib.tcl
- $NS_ROOT/tcl/lib/ns-agent.tcl
- $NS_ROOT/tcl/lib/ns-mobilenode.tcl

Let's start with ~/ns-allinone-2.34/ns-2.34/**Makefile** just add following lien at 269

```
1  wfrp/wfrp.o
```

Add following lines to ~/ns-allinone-2.34/ns-2.34/queue/**priqueue.cc** from line 93.

```
1  // WFRP patch
2  case PT_WFRP:
```

To define new routing protocol packet type we have to modify ~/ns-allinone-2.34/ns-2.34/common/**packet.h** file. We change PT_NTYPE to 63, and for our protocol PT_WFRP = 62. If you have already installed another routing protocol. Just make sure PT_NTYPE is last, and protocol number is ordered sequentially. From line 85 changes would be :

```
1  // WFRP packet
2  static const packet_t PT_WFRP = 62;
3
4  // insert new packet types here
5  static packet_t PT_NTYPE = 63; // This MUST be the LAST one
```

We make following code change at line 254 of ~/ns-allinone-2.34/ns-2.34/common/packet.h. The code is used that the packet is routing protocol packet and has high priority.

```
1  type == PT_AODV ||
2  type == PT_WFRP)
```

And at line 390 of the same file

```
1  // WFRP patch
2  name_[PT_WFRP] = "WFRP";
```

Now we will make NS2 trace our simulation and write it to *something*.tr, in order to do that we have to modify cmu-trace.h and cmu-trace.cc.

To add trace function we add following line to ~/ns-allinone-2.34/ns-2.34/trace/**cmu-trace.h** at line 163:

```
1  void      format_wfrp(Packet *p, int offset);
```

~/ns-allinone-2.34/ns-2.34/trace/**cmu-trace.cc** must be added following code at line 1071

```
1   // WFRP patch
2   void
3   CMUTrace::format_wfrp(Packet *p, int offset)
4   {
5       struct hdr_wfrp *wh = HDR_WFRP(p);
6       struct hdr_wfrp_beacon *wb = HDR_WFRP_BEACON(p);
7       struct hdr_wfrp_error  *we = HDR_WFRP_ERROR(p);
8   
9       switch(wh->pkt_type) {
10          case WFRP_BEACON:
11  
12              if (pt_->tagged()) {
13                  sprintf(pt_->buffer() + offset,
14                          "-wfrp:t %x -wfrp:h %d -wfrp:b %d -wfrp:s %d "
15                          "-wfrp:px %d -wfrp:py %d -wfrp:ts %f "
16                          "-wfrp:c BEACON ",
17                          wb->pkt_type,
18                          wb->beacon_hops,
19                          wb->beacon_id,
20                          wb->beacon_src,
21                          wb->beacon_posx,
22                          wb->beacon_posy,
23                          wb->timestamp);
24              } else if (newtrace_) {
25  
26                  sprintf(pt_->buffer() + offset,
27                          "-P wfrp -Pt 0x%x -Ph %d -Pb %d -Ps %d -Ppx %d -Ppy %d -Pts %f -Pc BEACON ",
28                          wb->pkt_type,
29                          wb->beacon_hops,
30                          wb->beacon_id,
31                          wb->beacon_src,
32                          wb->beacon_posx,
33                          wb->beacon_posy,
34                          wb->timestamp);
35  
36              } else {
37  
38                  sprintf(pt_->buffer() + offset,
39                          "[0x%x %d %d [%d %d] [%d %f]] (BEACON)",
40                          wb->pkt_type,
41                          wb->beacon_hops,
42                          wb->beacon_id,
43                          wb->beacon_src,
44                          wb->beacon_posx,
45                          wb->beacon_posy,
46                          wb->timestamp);
47              }
48              break;
49  
50          case WFRP_ERROR:
51              // TODO: need to add code
52              break;
53  
54          default:
55  #ifdef WIN32
56              fprintf(stderr,
57                      "CMUTrace::format_wfrp: invalid WFRP packet typen");
58  #else
59              fprintf(stderr,
60                      "%s: invalid WFRP packet typen", __FUNCTION__);
61  #endif
62              abort();
63      }
64  }
```

Now we will modify tcl files to create routing agent. First we define protocol name to use in tcl file. It would done by modifying ~/ns-allinone-2.34/ns-2.34/tcl/lib/**ns-packet.tcl** @ line 172

```
1   # WFRP patch
2   WFRP
```

Now we set routing agent by modifying ~/ns-allinone-2.34/ns-2.34/tcl/lib/**ns-lib.tcl** @ line 633

```
1   WFRP {
2      set ragent [$self create-wfrp-agent $node]
3   }
```

From line 860 of the same file following code should be added.

```
1   Simulator instproc create-wfrp-agent { node } {
2      #  Create WFRP routing agent
3      set ragent [new Agent/WFRP [$node node-addr]]
4      $self at 0.0 "$ragent start"
5      $node set ragent_ $ragent
6      return $ragent
7   }
```

Now we will set port numbers of routing agent. sport is source port, dport is destination port. Modify ~/ns-allinone-2.34/ns-2.34/tcl/lib/**ns-agent.tcl** line 202

```
1   Agent/WFRP instproc init args {
2      $self next $args
3   }
4
5   Agent/WFRP set sport_   0
6   Agent/WFRP set dport_   0
```

Frankly speaking I have no idea why I have to add following things. But I believe it should be done according to some tutorial : ~/ns-allinone-2.34/ns-2.34/tcl/lib/**ns-mobilenode.tcl** line 201

```
1   # Special processing for WFRP
2   set wfrponly [string first "WFRP" [$agent info class]]
3   if {$wfrponly != -1 } {
4      $agent if-queue [$self set ifq_(0)]   ;# ifq between LL and MAC
5   }
```

We are done. got to ~/ns-allinone-2.34/ns-2.34/ directory and do

```
1   make clean
2   make
```

When the compile is finished, you can test using wfrp_802_15_4.tcl (/sfiles/wfrp/wfrp_802_15_4.tcl)file as :

```
1   ns wfrp_802_15_4.tcl
```

In this test the NODE 0 is *sink node,* starts sending beacon 1 second after simulation i started, and NODE 10 is reporting node. It starts sending report over CBR/UDP at 5.0 seconds (after simulation is started). Report interval is 2 seconds.

To remove debugging WFRP, uncomment #define DEBUG (line 36 of wfrp.cc & re-make it).

Categories: Network Simulator (NS2) (http://elmurod.net/en/index.php/archives/category/network-simulator-ns2)

Tags: Adding Routing Protocol (http://elmurod.net/en/index.php/archives/tag/adding-routing-protocol), Flooding (http://elmurod.net/en/index.php/archives/tag/flooding), New Protocol (http://elmurod.net/en/index.php/archives/tag/new-protocol), NS2 (http://elmurod.net/en/index.php/archives/tag/ns2), routing (http://elmurod.net/en/index.php/archives/tag/routing), Routing Protocol (http://elmurod.net/en/index.php/archives/tag/routing-protocol)

36 comments

- zhangyong January 30, 2010 at 1:24 pm (http://elmurod.net/en/index.php/archives/157#comment-56) - First, appreciate your share , and i hope you can understand what i want to mean due to my poor english . i am new to ns, and i just do as you told above but it goes wrong when i input "make" ,dispaly as follows

  error:'HDR_WFRP' was not declared in this scope
  error:'HDR_WFRP_BEACON' was not declared in this scope
  error:'HDR_WFRP_ERROR' was not declared in this scope

error:invalid use of incomplete type 'struct hdr_wfrp'

error:forward declaration of 'struct hdr_wfrp'

……

- smartnode (http://elmurod.net) January 30, 2010 at 4:16 pm (http://elmurod.net/en/index.php/archives/157#comment-57) -
My bad, you have to include the packet header in trace/cmu-trace.cc in line 58.

  #include < wfrp/wfrp_packet.h > (without spaces)

  And of course you have to download wfrp_packet.h into ns-2.33/wfrp/ directory.

- mangal (http://elmurod.net/wps/?p=157) January 31, 2010 at 4:02 pm
(http://elmurod.net/en/index.php/archives/157#comment-58) -
it shows error:

- mangal (http://elmurod.net/wps/?p=157) January 31, 2010 at 4:05 pm
(http://elmurod.net/en/index.php/archives/157#comment-59) -
#include (without spaces)

  it not work

  wt? i do next

- mangal (http://elmurod.net/wps/?p=157) January 31, 2010 at 5:14 pm
(http://elmurod.net/en/index.php/archives/157#comment-60) -
warning show unused variable 'we'

- smartnode (http://elmurod.net) February 1, 2010 at 8:57 am (http://elmurod.net/en/index.php/archives/157#comment-61) -
C'mon guys, that's such simple C/C++ problem. You just have to include wfrp_packet.h file in trace/cmu-trqace.cc. If you can't do that, DO NOT SIMULATE, you need to study basic programming.

- foziyetti February 7, 2010 at 5:45 am (http://elmurod.net/en/index.php/archives/157#comment-62) -
hi,
i an see in the TCL file that u've posted that you are invoking the wfrp agent u created using [set ragent_].
What can i do to invoke 2 different agents that i created in a single simulation, we have only one adhocrouting agent or one ragent. i think i have to create 2 agents but not routig agents. But how?
Look, thats a very plausib;le scenario, suppose u have sensor-agent and anchor-agent.

- smartnode (http://elmurod.net) February 8, 2010 at 12:09 am (http://elmurod.net/en/index.php/archives/157#comment-63) -
Foziyetti, your question is a bit confusing. Even if you have sensor-agent and anchor-agent these agents are performing different functions but in single routing solution. Therefore, I believe you don't have to create two agent but assign two different functions by assign which one is sensor and which one is anchor. For example in WFRP protocol, I have assigned sink special function, i.e. broadcasting a beacon message periodically.

  Here is the code that processes the function-assigning.

  ```
  if(strncasecmp(argv[1], "sink", 4) == 0) {
  bcnTimer.handle((Event*) 0);
  return TCL_OK;
  }
  ```

  In tcl file you will assign the sink node…. with special instruction which is available in example tcl file, check it.

- SangeethaGanesan February 8, 2010 at 7:37 pm (http://elmurod.net/en/index.php/archives/157#comment-64) -
If we run the TCL file it results in error….what should we do….

  The error is

  num_nodes is set 100

  ```
  (_o14 cmd line 1)
  invoked from within
  "_o14 cmd addr"
  invoked from within
  "catch "$self cmd $args" ret"
  invoked from within
  "if [catch "$self cmd $args" ret] {
  set cls [$self info class]
  global errorInfo
  set savedInfo $errorInfo
  ```

error "error when calling class $cls: $args" $…"
(procedure "_o14" line 2)
(SplitObject unknown line 2)
invoked from within
"_o14 addr"
("eval" body line 1)
invoked from within
"eval $node addr $args"
("default" arm line 2)
invoked from within
"switch -exact $routingAgent_ {
DSDV {
set ragent [$self create-dsdv-agent $node]
}
DSR {
$self at 0.0 "$node start-dsr"
}
AODV {
set ragent [$self cre…"
(procedure "_o3" line 14)
(Simulator create-wireless-node line 14)
invoked from within
"_o3 create-wireless-node"
("eval" body line 1)
invoked from within
"eval $self create-wireless-node $args"
(procedure "_o3" line 23)
(Simulator node line 23)
invoked from within
"$ns node"
("for" body line 2)
invoked from within
"for {set i 0} {$i < $val(nn) } { incr i } {
set mnode_($i) [$ns node]
}"
(file "wfrp_802_15_4.tcl" line 74)

- SangeethaGanesan February 9, 2010 at 2:47 pm (http://elmurod.net/en/index.php/archives/157#comment-65) -
Please tell the answer for the previous post

- Jayavignesh February 9, 2010 at 7:52 pm (http://elmurod.net/en/index.php/archives/157#comment-66) -
Hi,

Thanks for posting this as it will be useful to entire community of newbies working in ns2.

I have certain queries regarding the implementation of protocol.

1.is it possible to track the mac-level acknowledgement of data in my routing code?? Suppose i send a data packet to the next hop node and i don't receive any ack for data, i switch to a different next hop neighbor??

2.There is no queuing code illustrated. Could you please guide on how to handle the queuing process if a node has no routing table, the data has to be queued till it receives a control packet..

Thanks & Regards,
Jayavignesh

- smartnode (http://elmurod.net) February 9, 2010 at 8:19 pm (http://elmurod.net/en/index.php/archives/157#comment-67) -
SangeethaGanesan, I am not sure what the error is. But I guess, you have not processed some commands provided in your TCL file. Commands are check and returned TCL_OK, when everything is okey. Otherwise, it will give error. Check this part.

Did you modify the code? I believe there must not arise such errors if you have done as instructed.

Jayavignesh,

(1) Yes you can use mac-level acknowledgements. To do that you have to register callback function.
As you need to consider only failure cases, you can set set callback function when you are sending packet:
ch->xmit_failure_ = your_callback_function;

```
ch->xmit_failure_data_ = (void*) this;
```

If packet transmission fails the callback function is called with the originally transmitted data (to void* this)

Note, obviously, there is no acknowledgement for broadcast packets.

(2) For queuing packet refer to aodv_queue.cc. Or you can simply create linked list using structure "Packet" and when route is available send one-by-one.

- Ahsan February 13, 2010 at 4:13 am (http://elmurod.net/en/index.php/archives/157#comment-68) - @ smart node::

  I am getting the exact same output as SangeethaGanesan, can you suggest me what to do ? I have followed exactly what you told in the tutorial. Thanks.

- Jayavignesh February 14, 2010 at 9:17 pm (http://elmurod.net/en/index.php/archives/157#comment-69) - Thanks for reply.

  1. I like to know the fields present in the common(Channel) header(ch).? What is the significance of this header in ns2?

  2. I need mac-level ack for tracking both success and failure of sending data to next-hop.
  If there is no ack from that next hop, lookup that next hop in sender's table and change the
  rt->rt_state = ROUTE_STALE;

  If there is ack from next_hop,lookup that next hop in sender's table and and update the timer value associated with that entry rt->rt_expire = CURRENT_TIME + DEFAULT_ROUTE_EXPIRE.

  Pls help me out with sample code and the functioning with call_back function. I want to make your code event-driven rather that periodic beaconing..

  2.TTL field in IP header indicates the no of hops that a packet can survive and is set to default NETWORK_DIAMETER macro value. Is there any timer value to indicate the lifetime of a data packet in ns2?? Say a packet will be dropped if it exceeds 250ms?

  3.My understanding on the headers in ns2 is shown below. Pls correct me if i am wrong.

  Format of Control Packet
  ————————————————————–
  Channel Header + IP Header + My packet Header

  Format of Data Packet
  ————————————————————–
  Channel header + IP Header + Segment UDP data

  Thanks for help!!
  Jayavignesh

- smartnode (http://elmurod.net) February 16, 2010 at 3:08 am (http://elmurod.net/en/index.php/archives/157#comment-70) - Ahsan, I don't know why the thing you have told happens. I believe there is no error in my code.

  Jayavignesh,

  1. Common (channel) header is actually something like MAC header, but it is hooked with NS2.

  2. If packet does not fail it has been successfully delivered. Therefore initially just set rt->rt_expire = CURRENT_TIME + DEFAULT_ROUTE_EXPIRE. Then if route fails. Your callback function will be called.

  I have no sample code now.. Just follow instruction

  ```
  ch->xmit_failure_ = your_callback_function (just use static function);
  ch->xmit_failure_data_ = (void*) this;
  ```

  2x. Right, TTL in IP header is # of hops. If you want to use timer, you can do it as follows:

  in recv_beacon(Packet *p) add this code at appropriate place.

  ```
  if ( (bcn->timestamp + 0.25) >= CURRENT_TIME ) // 0.25s = 250ms
  return ;
  ```
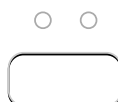
  3. I guess your understanding is right.

- Jayavignesh February 16, 2010 at 12:57 pm (http://elmurod.net/en/index.php/archives/157#comment-71) - Fine Thanks!!

- SangeethaGanesan February 17, 2010 at 3:51 pm (http://elmurod.net/en/index.php/archives/157#comment-72) -
  Can U please help with the Shortest Path Routing Protocol with the energy constraints……………

- sanjoy February 19, 2010 at 2:48 pm (http://elmurod.net/en/index.php/archives/157#comment-73) -
  sir i did as per your instruction but when i try to make
  it gives the followings
  Makefile:327: *** commands commence before first target. Stop.
  [root@localhost ns-2.33]# make clear
  Makefile:327: *** commands commence before first target. Stop.

- Ashwin Perti (http://www.abes.ac.in) February 21, 2010 at 12:54 pm (http://elmurod.net/en/index.php/archives/157#comment-74) -
  sir i also did as per your instruction but when i try to make
  $ make clean
  Makefile:327: *** commands commence before first target. Stop.
  [root@localhost ns-2.34]# make clear
  Makefile:327: *** commands commence before first target. Stop.

- SangeethaGanesan February 23, 2010 at 3:26 pm (http://elmurod.net/en/index.php/archives/157#comment-75) -
  Please say me how to set energy constraints in any of the routing protocols to maximize network lifetime…

- smartnode (http://elmurod.net) February 25, 2010 at 11:47 am (http://elmurod.net/en/index.php/archives/157#comment-76) -
  Sangeeth, what you are asking is designing whole routing protocol. I can't explain it in two-three words. Just try to obtain current energy of node and make the node participate in routing (by accepting beacon message), or just drop the beacon. I am not sure this is promising routing protocol, but it does work.

  Sanjay, Ashwin, what is line 327 of Makefile ?

- Matthew Orlinski February 25, 2010 at 8:19 pm (http://elmurod.net/en/index.php/archives/157#comment-77) -
  Great guide man, its a great starting point and I've already used what i learnt to create a new concept protocol. I'll be linking to this when i blog about it xx

  Could you mail me with who the analyse files belong to? They don't appear to have a licence file attached and we may want to alter and redistribute them later on.

- SangeethaGanesan March 2, 2010 at 8:29 pm (http://elmurod.net/en/index.php/archives/157#comment-78) -
  Thanks…….Explain How to set Data Rate for each node……

- KIran March 9, 2010 at 12:21 am (http://elmurod.net/en/index.php/archives/157#comment-79) -
  I m new to NS ….n my question is …can we install NS-2.x on window?

- smartnode (http://elmurod.net) March 20, 2010 at 1:00 am (http://elmurod.net/en/index.php/archives/157#comment-80) -
  KIran u can install ns2 in cygwin on windows. But, i would recommend to use linux.

- Lotfi March 24, 2010 at 10:58 pm (http://elmurod.net/en/index.php/archives/157#comment-81) -
  Hi sir,
  can you apload the snip code to add in the cmu-trace? thanks for your help!!!

- Jayavignesh March 26, 2010 at 10:30 pm (http://elmurod.net/en/index.php/archives/157#comment-82) -
  Hi,

  I would like to know the functioning of timer handler functions like resched and handle?? What is use of these?

  Also, in my routing code, when i attach any traffic to my node like [cbr(0) start] in my tcl, automatically i should invoke a beaconing procedure function, where that particular node for which the cbr traffic is attached should send the beacon packet.

  Any sample flow to explain this would be of great help!!

  Thanks,
  Jayavignesh

- Le Truong April 2, 2010 at 3:16 am (http://elmurod.net/en/index.php/archives/157#comment-83) -
  Hi Mr.Abduvoyitovich Talipov,

  I follow your tutorial, and deploy successfully.
  However I have a question about debugging. How can I debug when I program with a new protocol?
  You know sometimes we need to debug step by step/ line by line …. like VC++, …

  Thanks in advance.
  Le Truong

- smartnode (http://elmurod.net) April 1, 2010 at 6:15 pm (http://elmurod.net/en/index.php/archives/157#comment-84) - Use gdb

- Arthi April 3, 2010 at 8:28 pm (http://elmurod.net/en/index.php/archives/157#comment-85) -
  sir,
  I followed the steps which u hav told in creating wfrp protocol…. Its saying ns command not found…. Before i could create wfrp protocol ns command was working… Pl tell me what i must do to make ns command work…

- smartnode (http://elmurod.net) April 9, 2010 at 12:30 am (http://elmurod.net/en/index.php/archives/157#comment-86) -
  If anybody has error when they run TCL script send me email which provides SSH access to you NS2 server and the code. I will try to fix. I am not sure why it is happening. Because I did not find any error in my code. Also, many people already succeed to run my code without such errors.

- Le Truong April 12, 2010 at 12:39 am (http://elmurod.net/en/index.php/archives/157#comment-87) -
  Hi smartnode
  Could you make an tutorial about how to add a new application in NS2?
  I am going to implement an P2P application with MANET routing protocol.

  Thanks you in advance

- smartnode (http://elmurod.net) April 12, 2010 at 2:22 am (http://elmurod.net/en/index.php/archives/157#comment-88) -
  Truong, i am not sure when i am going todo that. Why don't do that and give us a link. I need that but have no time .

- NIKI03 April 16, 2010 at 2:31 am (http://elmurod.net/en/index.php/archives/157#comment-89) -
  I have successfully installed the protocol and it is running. But i am unable to figure out wat is WFRP protocol ?
  I also tried to find on google but unable to get a any information. Please guide me sir. I am an eager learner. If you can provide me some links or pdf it will really be great

- smartnode (http://elmurod.net) April 19, 2010 at 6:14 pm (http://elmurod.net/en/index.php/archives/157#comment-90) -
  There is no published article for this protocol, because it is too simple to be an article. Its kind of Direct Diffusion. You MUST read explanation carefully before asking such questions.

- Le Truong April 19, 2010 at 7:56 pm (http://elmurod.net/en/index.php/archives/157#comment-91) -
  As I know, trace file only include the information about packets. If you want to print the value of your variable, then you can use #if DEBUG … like smartnode used. Another way is to print the value to the file. Like this http://elmurod.net/wps/?p=13 (http://elmurod.net/wps/?p=13)

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