Listing 1: Packet header file changes

```
1  static const packet_t PT_PHR = 73;
2  static packet_t PT_NTYPE = 74; // This MUST be the LAST one
```

Listing 2: Make packet has high priority

```
1  type == PT_PHR ||
2  type == PT_MDART)
```

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PHR directory contains three files, i.e. *phr.cc*, *phr.h* and *phr_packet.h*. In order to integrate and compile *PHR* protocol in *NS2*, the following steps should fulfilled.

- It should install a fresh copy of *NS2.35*.

- Download and copy *PHR* directory into */ns-allinone-2.35/ns-2.35/*.

- Add *case PT_PHR* to */ns-allinone-2.35/ns-2.35/queue/priqueue.cc* from line 94.

- *PHR* packet header need to be defined, */ns-allinone-2.35/ns-2.35/common/packet.h* file should modified accordingly by adding *#define HDR_PHR(p) (hdr_phr::access(p))* after line 62.

- Modifying same file, PT_NTYPE should change to 74, and for *PHR* protocol PT_PHR = 73. If you have already installed another routing protocol. Just make sure PT_NTYPE is last, and protocol number is ordered sequentially. Code in **??** shows the changes to *packet.h*.

- Add the *type == PT_PHR* as shown in **??** at line 280 of the same *packet.h*. Then add *name_[PT_PHR]="PHR"* in line 420.

- In order to provide a trace functionality into the simulation, it should enable *NS2* to trace all the events in the simulation, to do that, */ns-allinone-2.35/ns-2.35/trace/cmu-trace.h & cmu-trace.cc* files need to be modified.

- First, define drop reasons by adding lines in **??** into *cmu-trace.h* at line85.

- Define trace function in *cmu-trace.h* at line 165 as shown in **??**.

Listing 4: Define trace function

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

1

Listing 3: Define drop reasons

```
1  #define DROP_PHR_PH_CLOSER        "CLOSER"//PH is closer to D
2  #define DROP_PHR_DKNOW            "DKNOW"// know flag set and don't
       know about D.
```

- The implementation of the trace function should be added in *cmu-trace.cc* at line 1182 as shown in **??**.

Listing 5: Main body of PHR trace function.

```
1  #include <phr/phr_packet.h> //PHR protocol
2  // main body of the trace function.\
3  void
4  CMUTrace::format_phr(Packet * p, int offset)
5    {struct hdr_phr *phr = HDR_PHR(p);
6     struct hdr_phr_bc *bc = HDR_PHR_BC(p);
7     switch (phr->pkt_type) {
8     case PHR_BC:
9       if (pt_->tagged())
10        {sprintf(pt_->buffer() + offset,
11          "-PHR:t %x -PHR:h %d -PHR:b %d -PHR:s %d "
12          "-PHR:ts %f "
13          "-PHR:c PHR ",
14          bc->bc_type,
15          bc->bc_hop_count,
16          bc->bc_bcast_id,
17          bc->bc_src,
18          bc->bc_timestamp);
19      } else if (newtrace_)
20        {sprintf(pt_->buffer() + offset,
21          "-P phr -Pt 0x%x -Ph %d -Pb %d -Ps %d -Pts %f -Pc PHR ",
22          bc->bc_type,
23          bc->bc_hop_count,
24          bc->bc_bcast_id,
25          bc->bc_src,
26          bc->bc_timestamp);
27      } else {sprintf(pt_->buffer() + offset,
28          "[0x%x %d %d [%d] [%f]] (PHR)",
29          bc->bc_type,
30          bc->bc_hop_count,
31          bc->bc_bcast_id,
32          bc->bc_src,
33          bc->bc_timestamp);
34      }
35        break;
36     default:
37  #ifdef WIN32
```

Listing 6: Set PHR agent

```
1   PHR {
2     set ragent [$self create-phr-agent $node]
3   }
4   \item At line $870$ code in \~\ref{tcl} should be added.
5   \begin{lstlisting}[caption= Create PHR agent \label{tcl}, float]
6   Simulator instproc create-phr-agent {node}
7       {set ragent [new Agent/PHR [$node node-addr]]
8      $self at 0.0 "$ragent start"
9      $node set ragent_ $ragent
10     return $ragent
11  }
```

Listing 7: Set ports of PHR agent

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

```
38          fprintf(stderr,
39              "CMUTrace::format_phr: invalid PHR packet typen");
40      #else
41          fprintf(stderr,
42              "%s: invalid PHR packet typen", __FUNCTION__);
43      #endif
44          abort();
45        }
46    }
```

- After changing C++ files, TCL files also need to be changed to create *PHR* routing agent to be used in TCL file. This is done by modifying */ns-allinone-2.35/ns-2.35/tcl/lib/ns-packet.tcl*.

- Add *PHR* at line 172

- Set routing agent by modifying */ns-allinone-2.35/ns-2.35/tcl/lib/ns-lib.tcl* at line 639 as shown in **??**.

- Set port numbers of *PHR* agent (sport is the source port, dport is destination port) by adding code in **??** to */ns-allinone-2.35/ns-2.35/tcl/lib/ns-agent.tcl* at line 201.

Listing 8: Set ports of PHR agent

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

- Modify */ns-allinone-2.35/ns-2.35/tcl/lib/ns-mobilenode.tcl* by adding code in **??** at line 204.

- Modify */ns-allinone-2.35/ns-2.35/Makefile* by adding *phrphr.o* after *pumapuma.o* line to the list of object files for *NS2*.

Now, *NS2* should be ready to be recompiled. To do so, run make command in */ns-allinone-2.35/ns-2.35/*. When the compilation is done, *NS2* ready to be tested with *PHR*.