Multicast Simulation and Modeling in OMNeT++

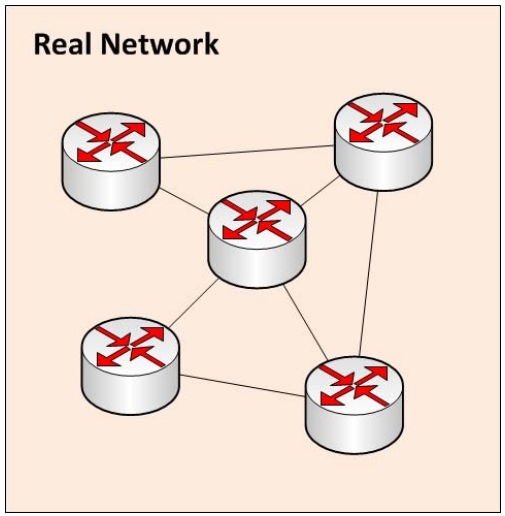
Agenda

1) Introduction & Motivation
2) Multicast in OMNeT++
3) Use-case example and its validation
4) Final Notes

Our Research

- **Formal verification and analysis of computer networks**
  - Reachability analysis
  - Static analysis
  - Simulation and modeling
- **Two goals**
  - Long-term: Variety of tools helping network administrator
  - Short-term: Framework for multicast simulation
- Selected resources
  - ANTLR
  - OMNeT++ with INET framework
  - ANSA extension – our dedicated software

Basic Idea



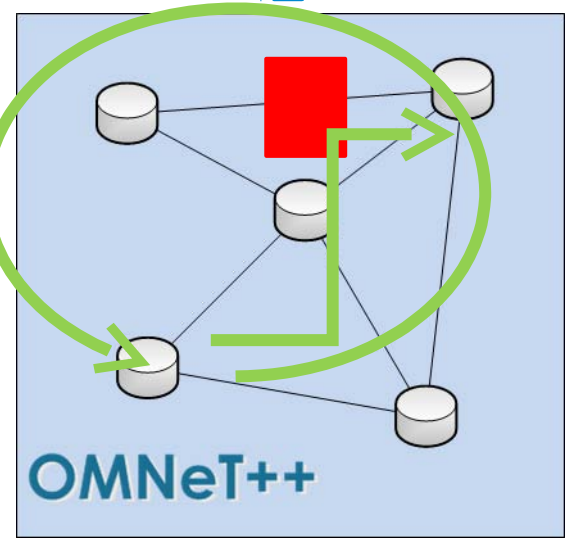
Running configuration

SNMP

```
<?xml version="1.0"?>
<Routers>
  <Router id="192.168.3.1"> <!-- R1 -->
    <Interfaces>
     <Interface name="ppp0">
        <IPAddress>192.168.3.1</IPAddress>
        <Mask>255.255.255.0</Mask>
      </Interface>
      <Interface name="eth0">
        <IPAddress>172.16.100.1</IPAddress>
        <Mask>255.255.255.0</Mask>
      </Interface>
    </Interfaces>
    <Routing>
      <Static>
        <Route>
          <NetworkAddress>172.16.200.0</NetworkAddress>
          <NetworkMask>255.255.255.0</NetworkMask>
          <ExitInterface>ppp0</ExitInterface>
        </Route>
      </Static>
```

Create model

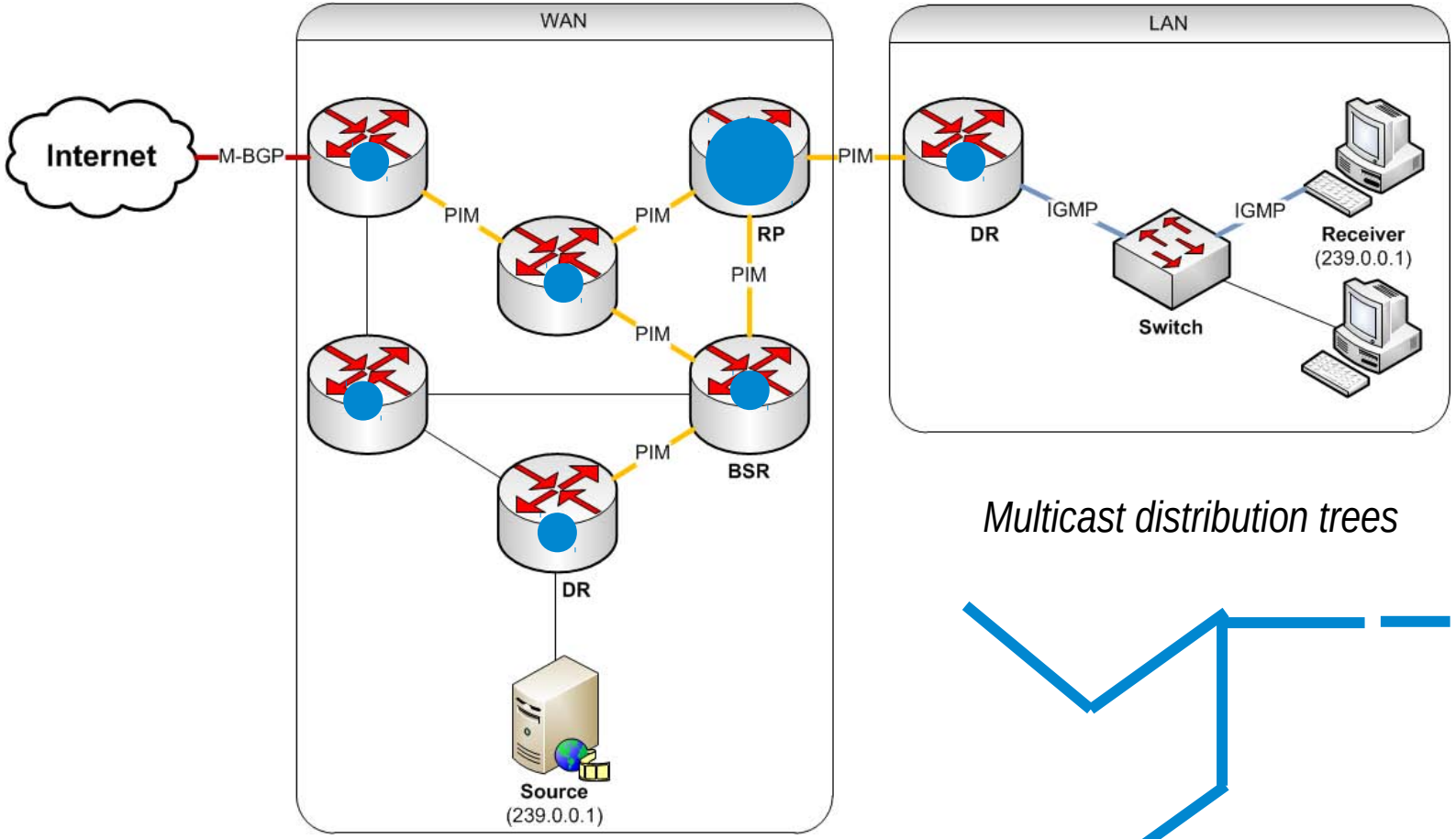
Suggest configuration or design changes



Paper Outlines…

- Multicast
  - Goal driven by our university needs
- ANSATranslator
  - ANTLR grammar translator
  - from running config to XML
- ANSARouter
  - Enhanced compound model with multicast support
- ANSASwitch

General Multicast Architecture



Multicast distribution trees

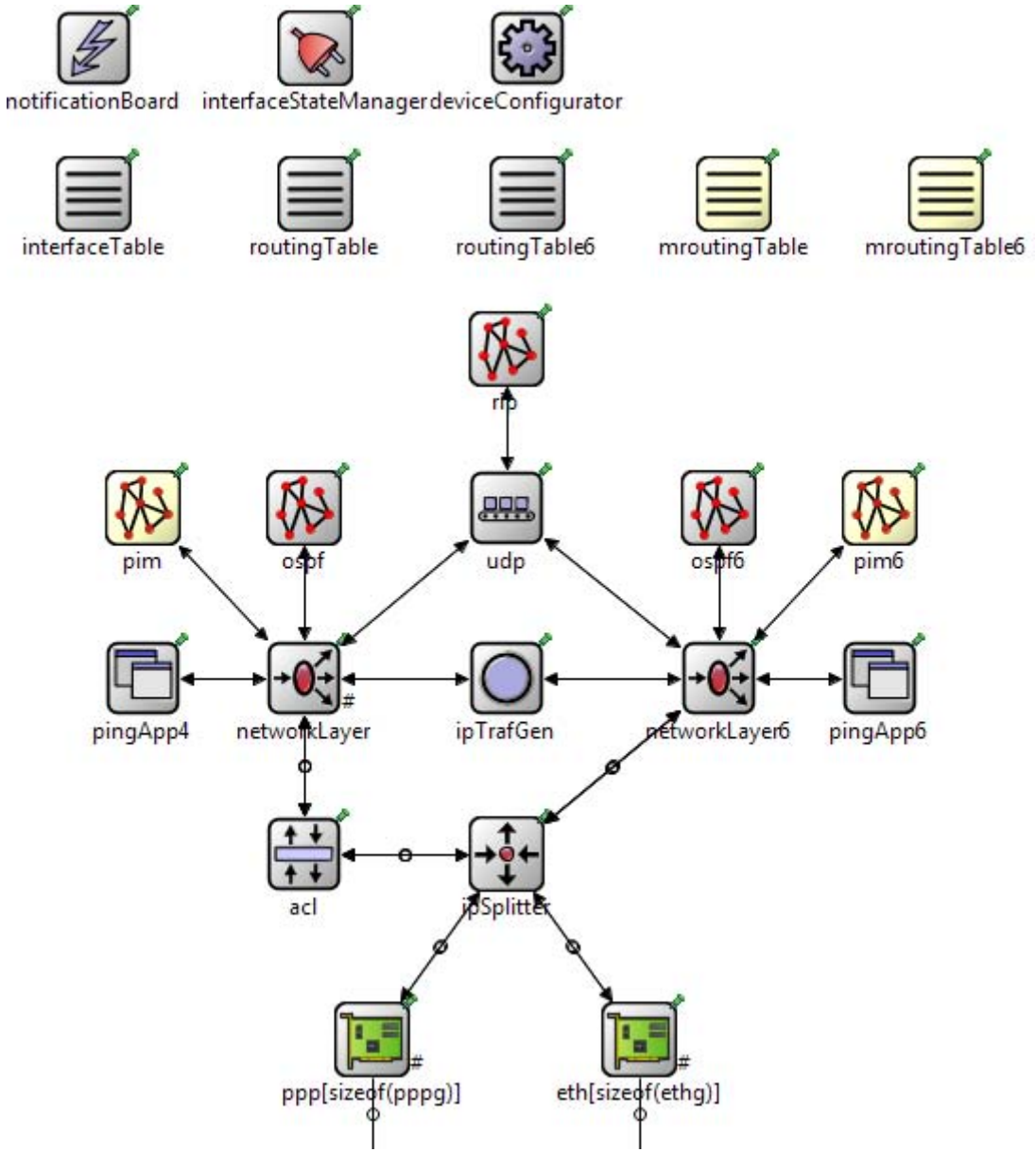
Proposed Modules

- **Routing (IPv4 and IPv6)**
  - RIP
  - OSPFv2
  - OSPFv3
  - IGMP, MLD
  - PIM
- **Switching**
  - VLANs
  - RSTP
  - MSTP
  - TRILL
- **Quality of Service**
  - Queues (PQ, WFQ, CB
  - Dropping algorithms (RED, WRED)



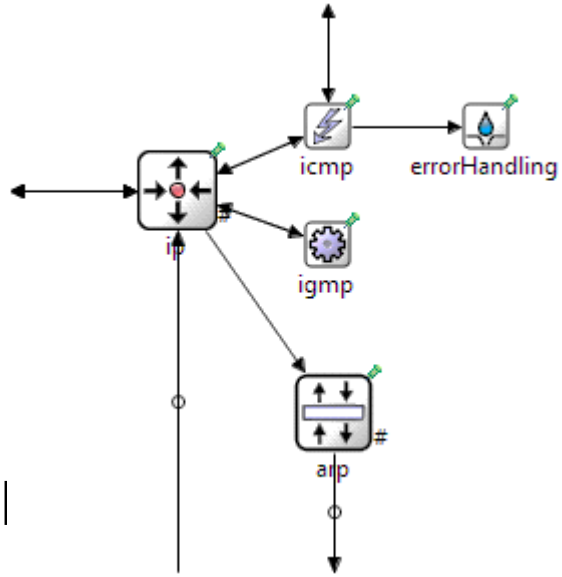


OSPFRouter and ANSARouter

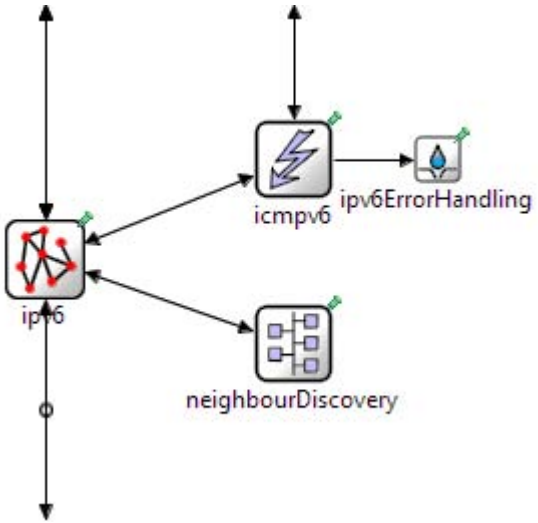


Multicast in Network Layers

- NetworkLayer – IGMP Module



- NetworkLayer6 – ICI

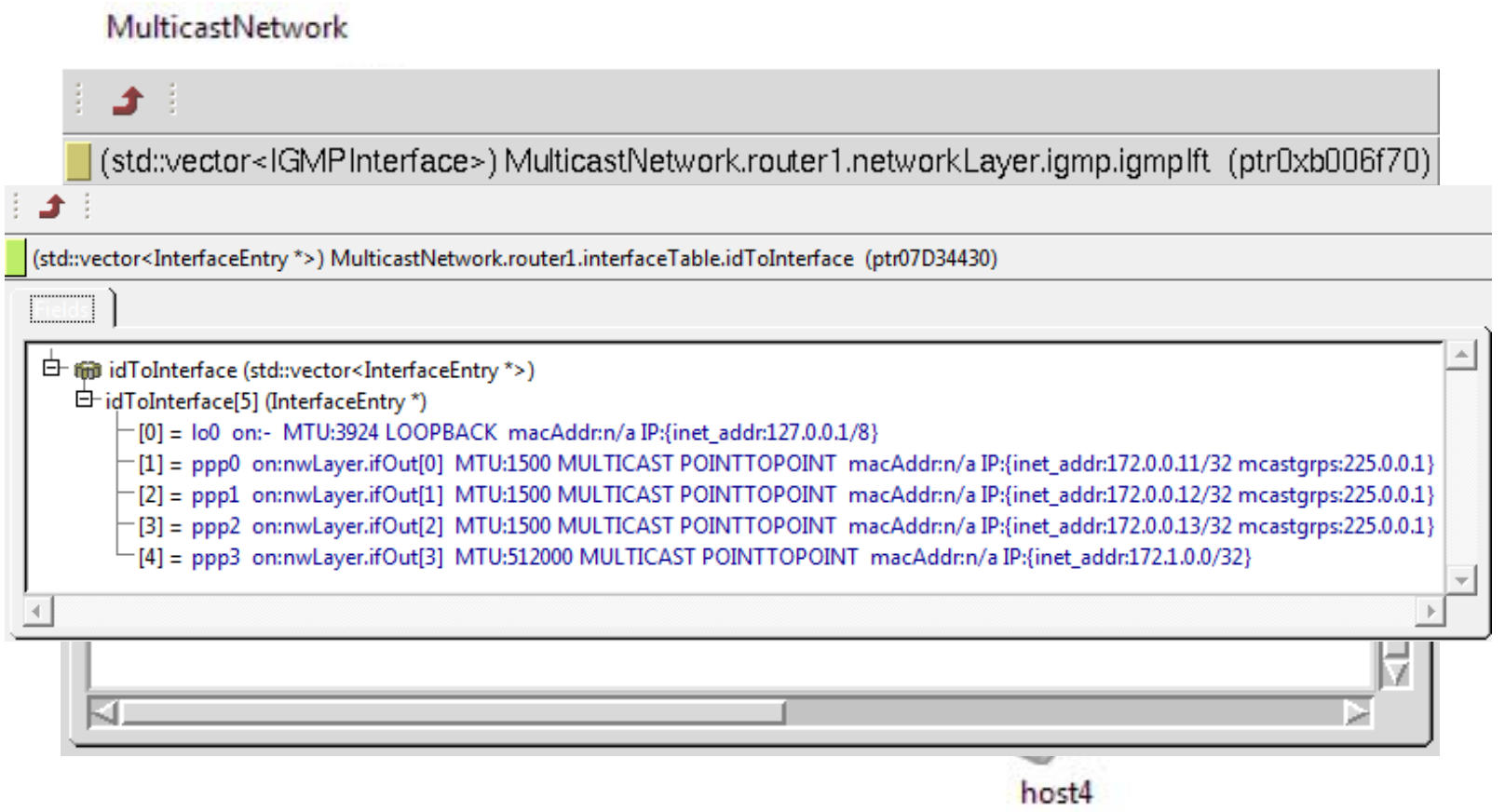


IGMPv2

- Comparable with RFC 2236
  - Election of IGMP Querier
  - Generating and processing of messages
  - Finite state machine
- Simplified message structure

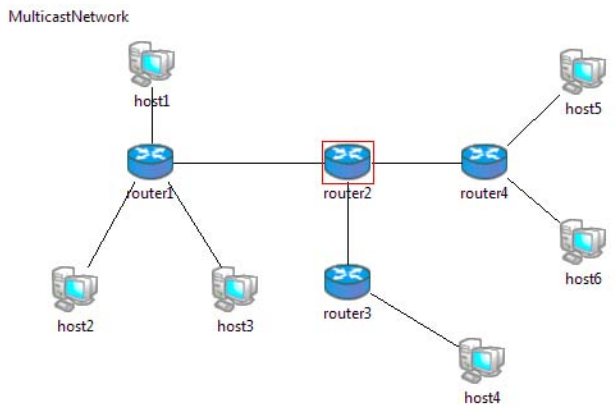
```
enum IGMPType
{

    IGMP_MEMBERSHIP_QUERY = 0x11;
    IGMP_MEMBERSHIP_REPORT_V1 = 0x12;
    IGMP_MEMBERSHIP_REPORT_V2 = 0x16;
    IGMP_LEAVE_GROUP = 0x17;
};

//
// IGMP message class
//
packet IGMPMessage
{
    short type enum(IGMPType);
    short maxRespTime;          //  1/10 s (e.g. for 10 s = 100)
    IPAddress groupAddress;
};
```

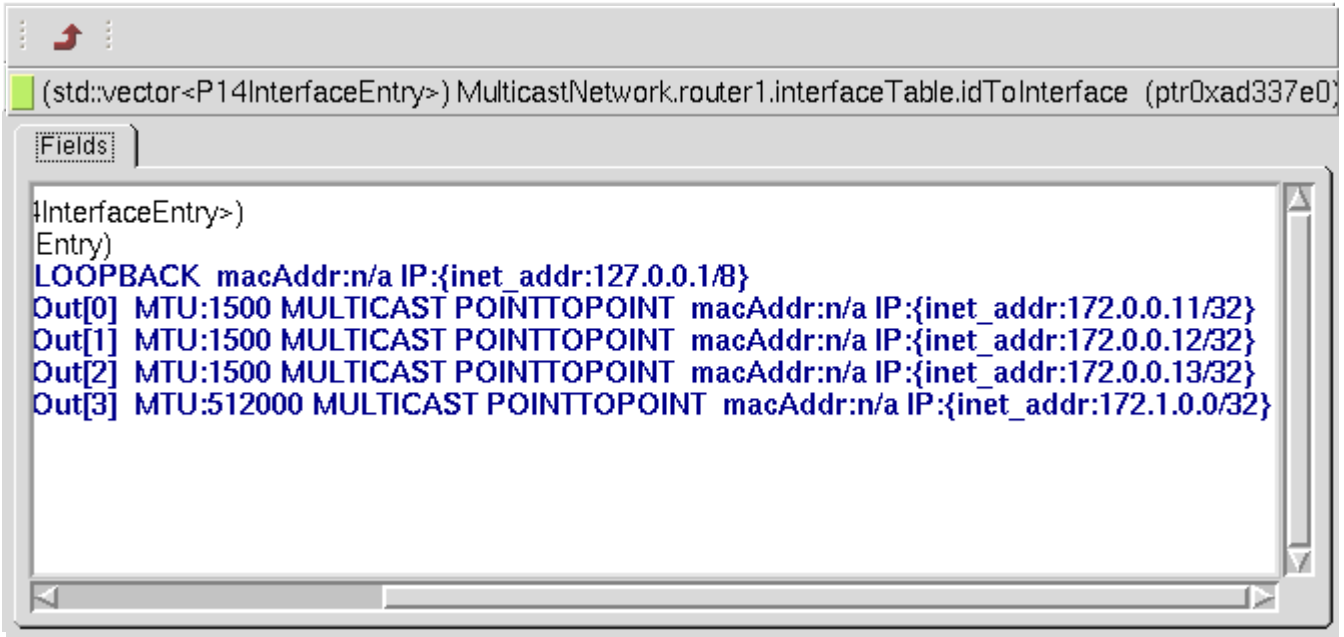
Use-Case



Different Scenarios Behavior

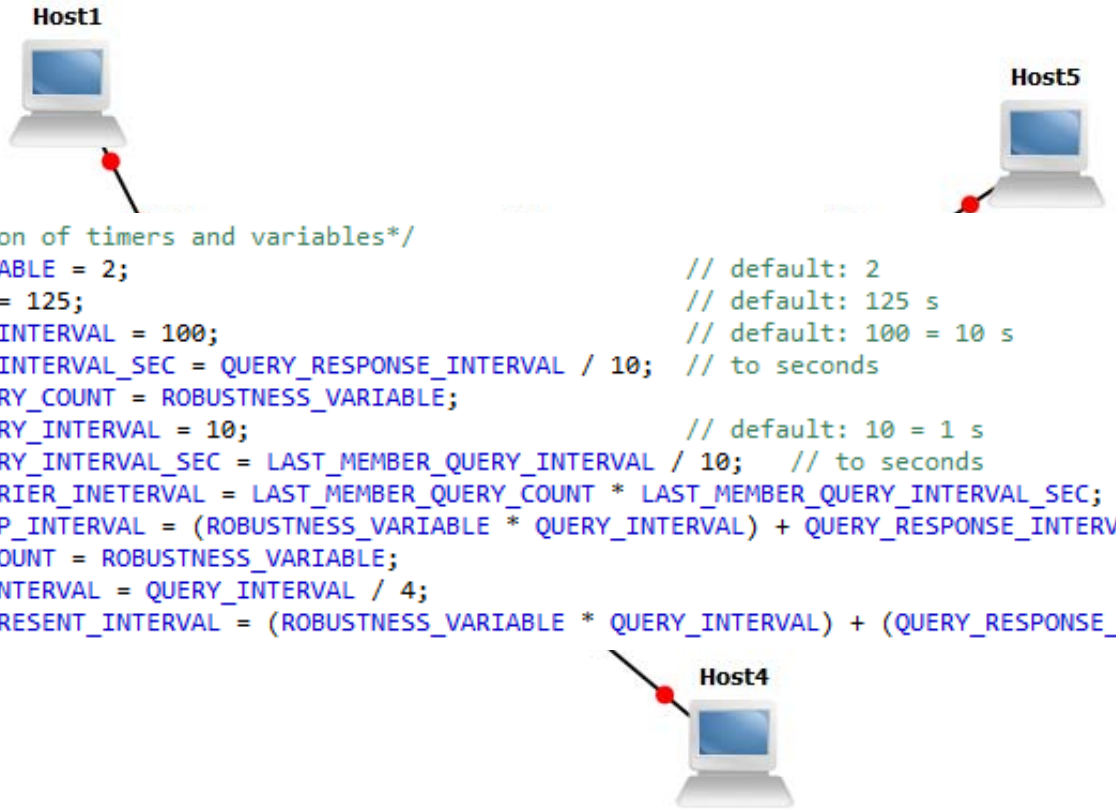
- **Signing on to the multicast group**
  - Membership General Query, Membership Report
- **Leaving the multicast group**
  - Leave Group, Membership Specific Query
- **Timing out group membership**
  - Membership Query…after 350 s





Validation

- Cisco 2621 with IOS12.24 and Ubuntu 10.10 hosts
- Same order of message exchange but different times




```
/* initialization of timers and variables*/
ROBUSTNESS_VARIABLE = 2;                                    // default: 2
QUERY_INTERVAL = 125;                                       // default: 125 s
QUERY_RESPONSE_INTERVAL = 100;                              // default: 100 = 10 s
QUERY_RESPONSE_INTERVAL_SEC = QUERY_RESPONSE_INTERVAL / 10;  // to seconds
LAST_MEMBER_QUERY_COUNT = ROBUSTNESS_VARIABLE;
LAST_MEMBER_QUERY_INTERVAL = 10;                            // default: 10 = 1 s
LAST_MEMBER_QUERY_INTERVAL_SEC = LAST_MEMBER_QUERY_INTERVAL / 10;   // to seconds
LAST_MEMBER_QUERIER_INETERVAL = LAST_MEMBER_QUERY_COUNT * LAST_MEMBER_QUERY_INTERVAL_SEC;
GROUP_MEMBERSHIP_INTERVAL = (ROBUSTNESS_VARIABLE * QUERY_INTERVAL) + QUERY_RESPONSE_INTERVAL_SEC;
STARTUP_QUERY_COUNT = ROBUSTNESS_VARIABLE;
STARTUP_QUERY_INTERVAL = QUERY_INTERVAL / 4;
OTHER_QUERIER_PRESENT_INTERVAL = (ROBUSTNESS_VARIABLE * QUERY_INTERVAL) + (QUERY_RESPONSE_INTERVAL_SEC / 2);
```

- IGMPv

Conclusion

- First step towards multicast support!

- Future work
  - Implementation of IGMPv3
  - Create models for MLD in IPv6
  - Dynamic multicast routing with PIM-DM

- Problems
  - Migration process
  - Lack of backward compatibility in INET1.99.3

The End

- *Thank you very much for your attention!*
- *Do you have any questions?*