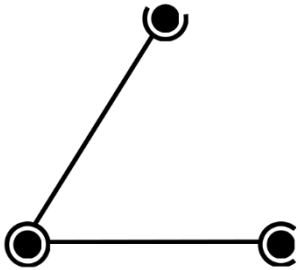

# Babel
# Routing Protocol for OMNeT++

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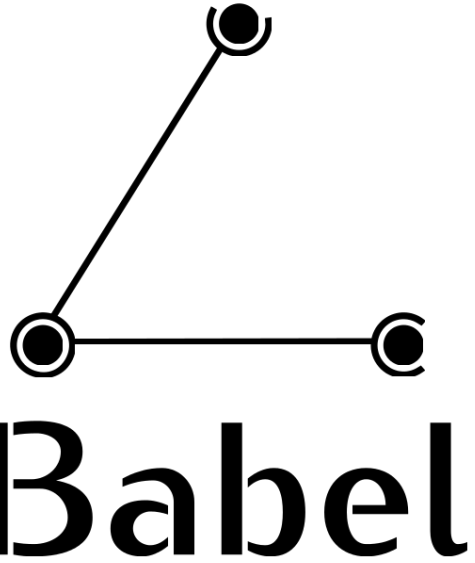
3rd OMNeT++ Summit
15th-16th September 2016, Brno, Czech Republic

# BABEL



EIGRP

# BABEL

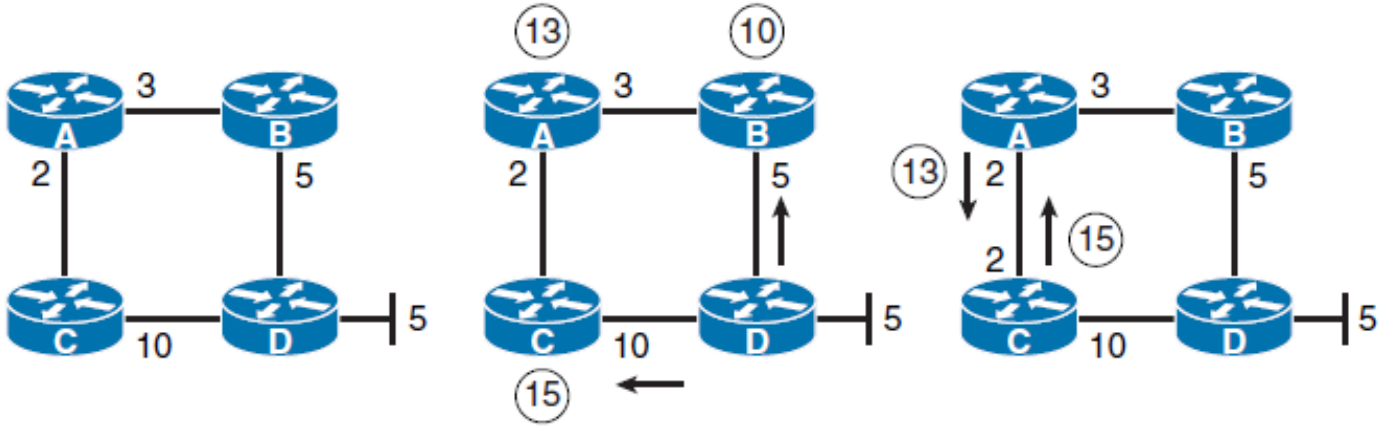
- $\stackrel{\text{def}}{=}$ is a routing protocol
  - multi-address family support (IPv4, IPv6)
  - hybrid distance-vector
  - open-source alternative to EIGRP
  - policy-based metric calculation
  - codified in RFC 6126

- Implementations
  - *babeld*
  - *Pybabel*
  - *Sbabeld*

- Unavailable in any other major simulator NS-2/3, OPNET, etc.
  - We need Babel in order to compare it with our EIGRP
  - We want to use it in frame if PRISTINE project

# Best Route Selection

## Feasibility condition




- The best known metric $m_A$ (lower means better) together with a sequence number $s_A$ (higher means more current) to a destination network $N$ from a router $A$ denotes its feasible distance $FD_A(N)$

$$D_B(\boldsymbol{N}) = (s_B, m_B), FD_A(\boldsymbol{N}) = (s_A, m_A):$$
$$D_B(\boldsymbol{N}) < FD_A(\boldsymbol{N}) \leftrightarrow (s_B = s_A \wedge m_B < m_A) \vee s_B > s_A$$

## Metric

- is a sum of link costs: $m_A = m_B + c$
- Programmable link cost calculation
  - k-out-of-j
  - ETX

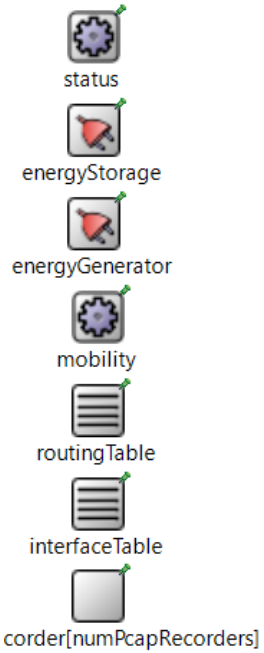
# Messages

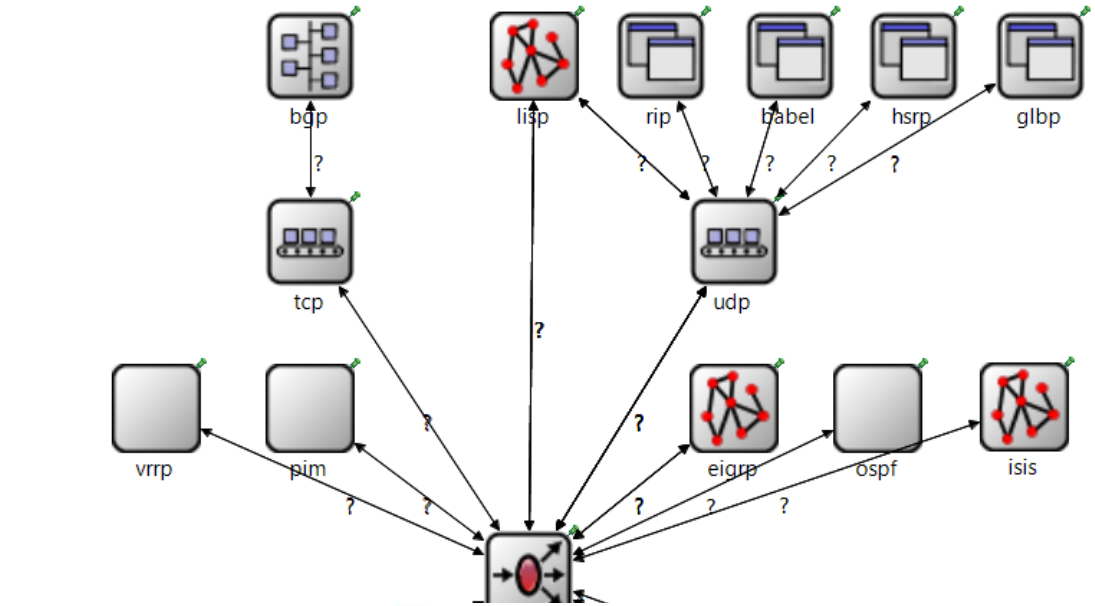
- Communication
  - Multicast addresses 224.0.0.111 and ff02::1:6
  - UDP on port 6696

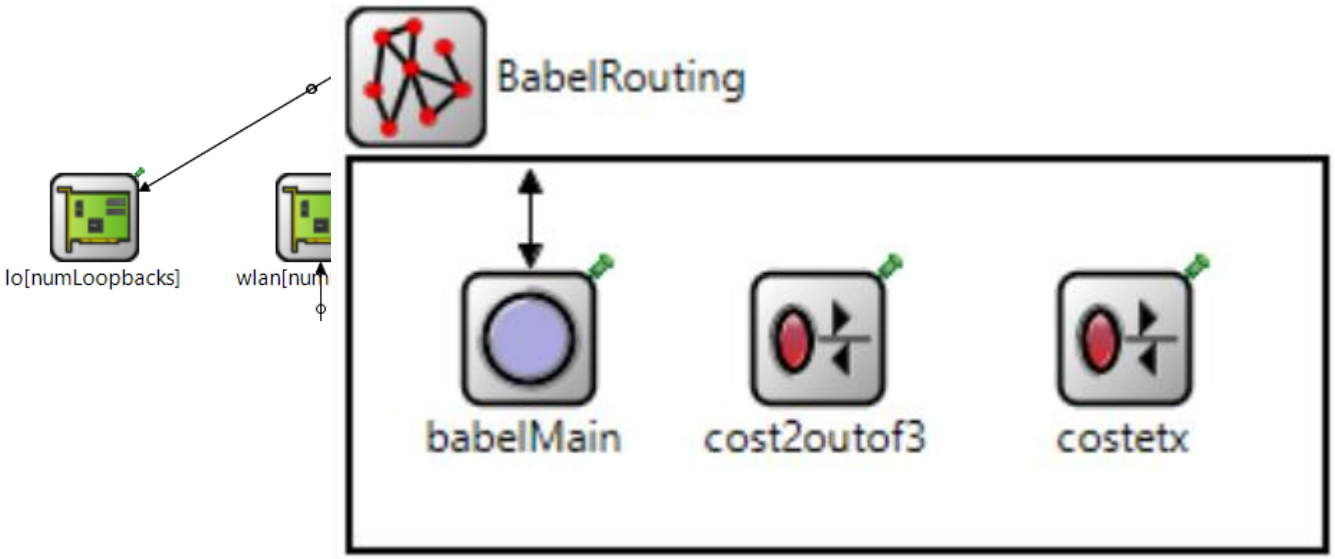
- Babel messages employs TLV protocol extensions
  - *Hello* – neighbor discovery
  - *AckReq* and *Ack* – solicited ack request and confirmation response
  - *IHU* – I Hear You confirms mutual reachbility of neighbors
  - *Router-id* – unique router identifier
  - *NextHop* – nexthop IP address
  - *Update* – advertises or withdraws routes
  - *RouteReq* – request for specific route
  - *SeqNoReq* – request for route with specific sequence number
  - *Pad1*, *PadN* – padding

# IMPLEMENTATION



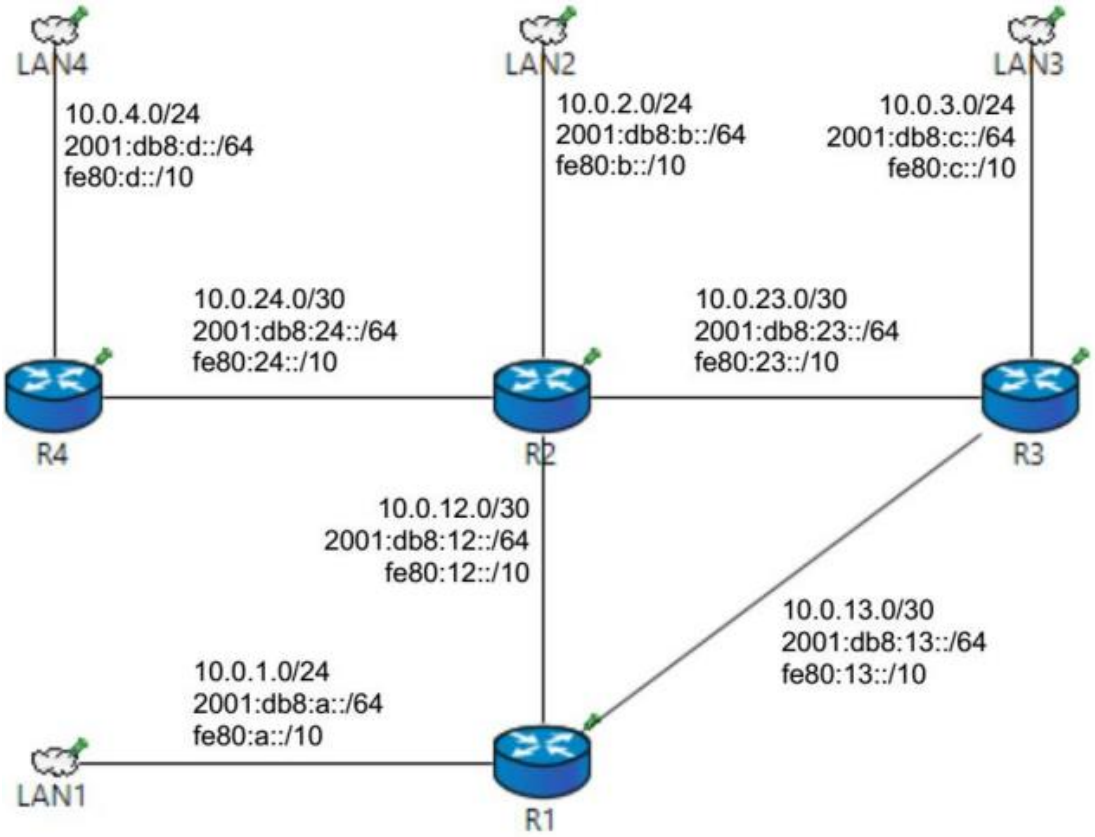


# SCENARIO

- Comparing real and simulated network




a) Establishing neighborship
b) Routing table convergence
c) Link failure and subsequent routing information propagation

# A) Establishing Neighborship



| Ord. | TLVs | S → R | Simul.[s] | Real [s] |
|---|---|---|---|---|
| #1 | Hello, RouteReq | R1→R2 | 0.092 | 0.006 |
| #2 | Hello, IHU, Update | R2→R1 | 0.292 | 0.007 |
| #3 | Hello, IHU | R1→R2 | 0.492 | 0.040 |
| #4 | Hello, IHU | R2→R1 | 0.692 | 0.134 |
| #5 | RouteReq | R2→R1 | 0.692 | 0.903 |
| #6 | Hello, IHU, Update | R1→R2 | 0.892 | 1.084 |
| #7 | RouteReq | R1→R2 | 0.892 | 1.085 |
| #8 | Update, IHU | R2→R1 | 1.902 | 1.744 |
| #9 | Hello, IHU | R2→R1 | 5.632 | 5.111 |

# B) Routing Table Convergence



```
btt.getRoutes() (std::vector<BabelRoute *>)
  btt.getRoutes()[13] (BabelRoute *)
    [0] = > 2001:db8:a::/64 local metric:0 orig:1111:1111:1111:1111
    [1] = > 2001:db8:12::/64 local metric:0 orig:1111:1111:1111:1111
    [2] = > 2001:db8:13::/64 local metric:0 orig:1111:1111:1111:1111
    [3] = > 2001:db8:c::/64 NH:fe80:13::3 metric:96 orig:3333:3333:3333:3333 from:fe80:13::3 RD:(31921, 0), in RT
    [4] = > 2001:db8:23::/64 NH:fe80:13::3 metric:96 orig:3333:3333:3333:3333 from:fe80:13::3 RD:(31921, 0), in RT
    [5] =   2001:db8:13::/64 NH:fe80:13::3 metric:96 orig:3333:3333:3333:3333 from:fe80:13::3 RD:(31921, 0)
    [6] = > 2001:db8:b::/64 NH:fe80:12::2 metric:96 orig:2222:2222:2222:2222 from:fe80:12::2 RD:(27469, 0), in RT
    [7] =   2001:db8:12::/64 NH:fe80:12::2 metric:96 orig:2222:2222:2222:2222 from:fe80:12::2 RD:(27469, 0)
    [8] =   2001:db8:23::/64 NH:fe80:12::2 metric:96 orig:2222:2222:2222:2222 from:fe80:12::2 RD:(27469, 0)
    [9] = > 2001:db8:24::/64 NH:fe80:12::2 metric:96 orig:2222:2222:2222:2222 from:fe80:12::2 RD:(27469, 0), in RT
    [10] =  2001:db8:12::/64 NH:fe80:13::3 metric:192 orig:2222:2222:2222:2222 from:fe80:13::3 RD:(27469, 96)
    [11] =  2001:db8:13::/64 NH:fe80:12::2 metric:192 orig:3333:3333:3333:3333 from:fe80:12::2 RD:(31921, 96)
    [12] = > 2001:db8:d::/64 NH:fe80:12::2 metric:192 orig:4444:4444:4444:4444 from:fe80:12::2 RD:(53887, 96), in RT
```

| Flag Prefix | Met | RD | Router-Id | Next-Hop |
|---|---|---|---|---|
| > 2001:db8:a::/64 | 0 | | | |
| > 2001:db8:12::/64 | 0 | | | |
| > 2001:db8:13::/64 | 0 | | | |
| > 2001:db8:b::/64 | 96 | 0 | 2222:2222:2222:2222 | fe80:12::2 |
| > 2001:db8:c::/64 | 96 | 0 | 3333:3333:3333:3333 | fe80:13::3 |
| > 2001:db8:d::/64 | 192 | 96 | 4444:4444:4444:4444 | fe80:12::2 |
| 2001:db8:12::/64 | 96 | 0 | 2222:2222:2222:2222 | fe80:12::2 |
| 2001:db8:13::/64 | 192 | 96 | 3333:3333:3333:3333 | fe80:12::2 |
| 2001:db8:12::/64 | 192 | 96 | 2222:2222:2222:2222 | fe80:13::3 |
| 2001:db8:13::/64 | 96 | 0 | 3333:3333:3333:3333 | fe80:13::3 |
| > 2001:db8:23::/64 | 96 | 0 | 2222:2222:2222:2222 | fe80:12::2 |
| 2001:db8:23::/64 | 96 | 0 | 3333:3333:3333:3333 | fe80:13::3 |
| > 2001:db8:24::/64 | 96 | 0 | 2222:2222:2222:2222 | fe80:12::2 |

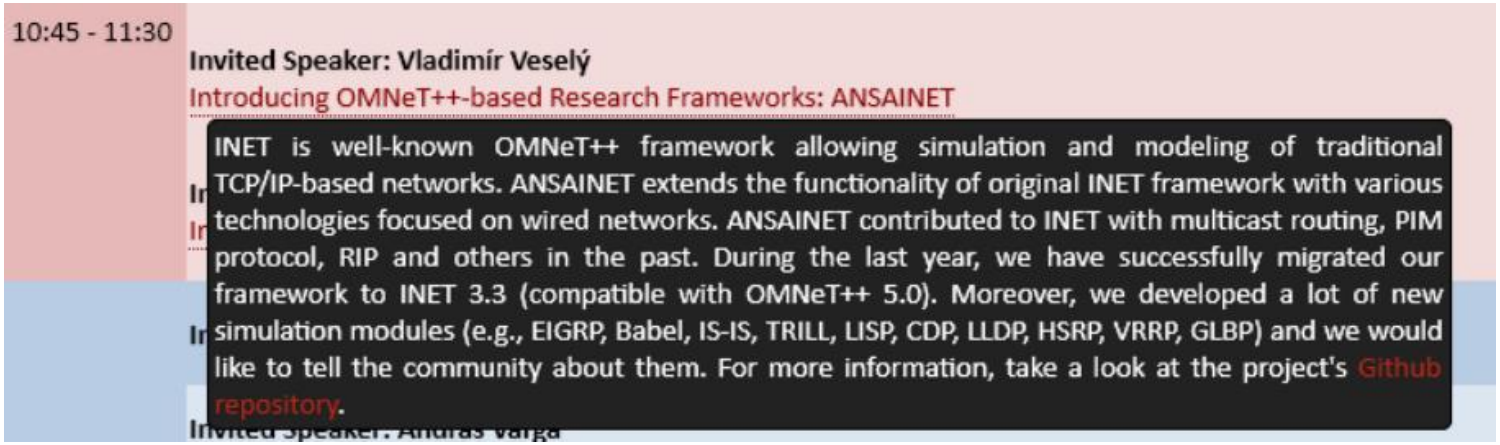
# C) LINK-FAILURE


| Ord. | TLVs | S → R | Simul.[s] | Real [s] |
|---|---|---|---|---|
| #1 | SeqNoReq | R2→R3 | 0.187 | 0.208 |
| #2 | SeqNoReq | R3→R1 | 0.347 | 1.079 |
| #3 | Update | R1→R3 | 0.595 | 1.152 |
| #4 | Update | R3→R2 | 0.673 | 1.275 |

# The End

- ANSAINET extends INET with new simulation modules
  - IS-IS, TRILL
  - EIGRP, OSPFv3
  - LISP
  - CDP, LLDP
  - HSRP, VRRP, GLBP


- Please do not go anywhere ☺




- *Thank you for your attention! Questions?*