

Babel

ROUTING PROTOCOL FOR OMNET++

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Theory
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BABEL

Intro

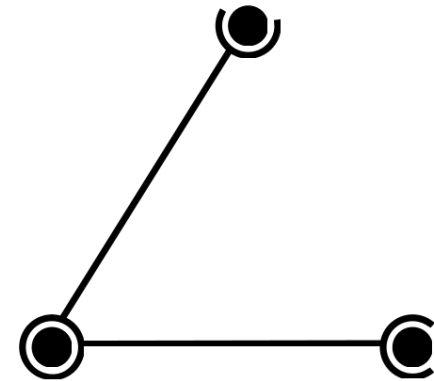
Theory

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EIGRP



Babel



BABEL

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

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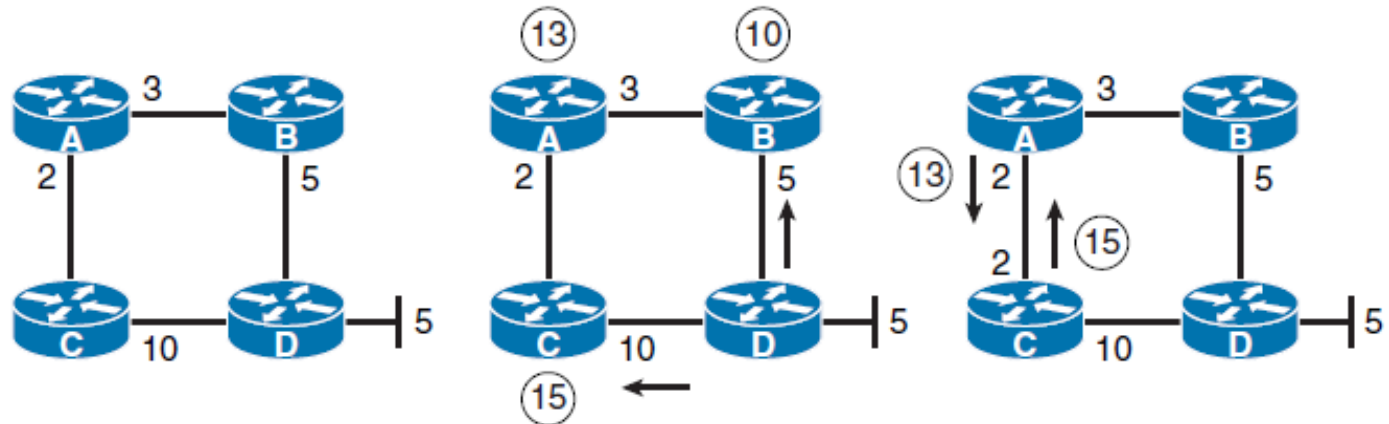
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BEST ROUTE SELECTION

◆ 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 $FD_A(N)$

$$D_B(N) = (s_B, m_B), FD_A(N) = (s_A, m_A):$$

$$D_B(N) < FD_A(N) \leftrightarrow (s_B = s_A \wedge m_B < m_A) \vee s_B > s_A$$

◆ Metric

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

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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 reachability 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

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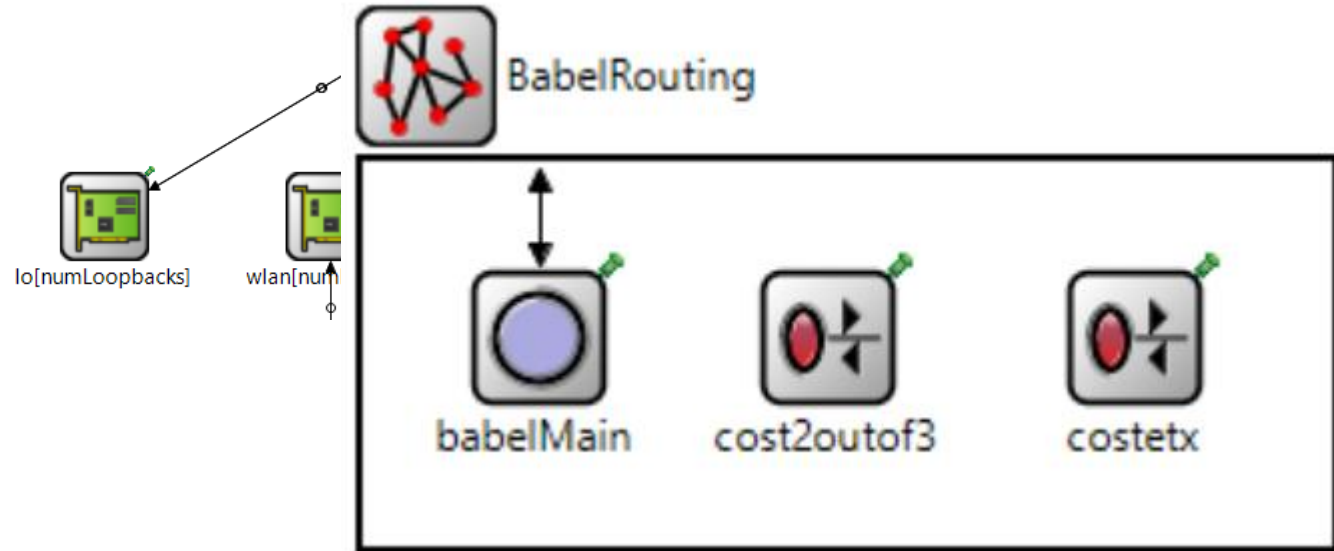
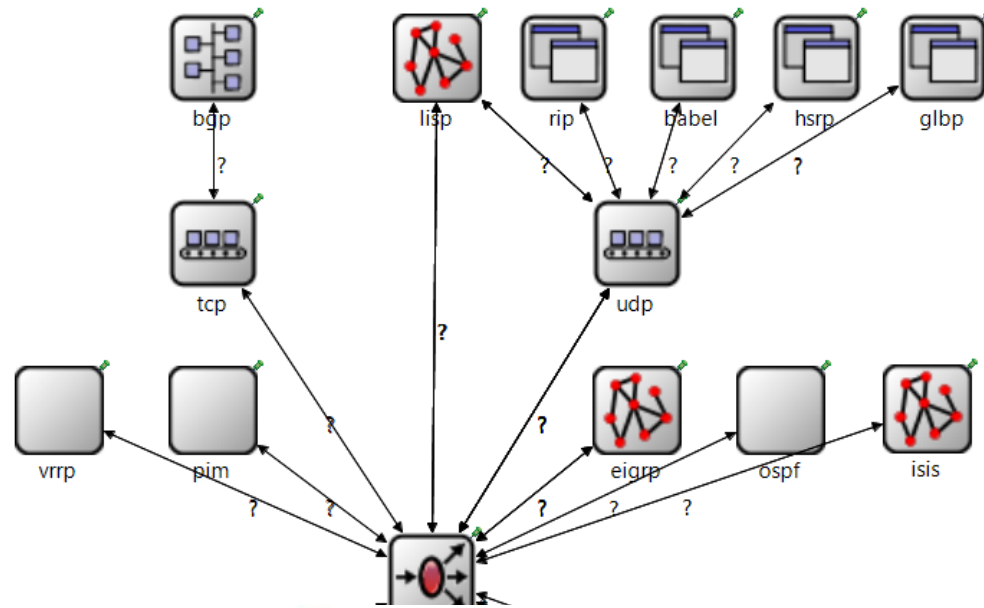
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IMPLEMENTATION

- status
- energyStorage
- energyGenerator
- mobility
- routingTable
- interfaceTable
- order[numPcapRecorders]

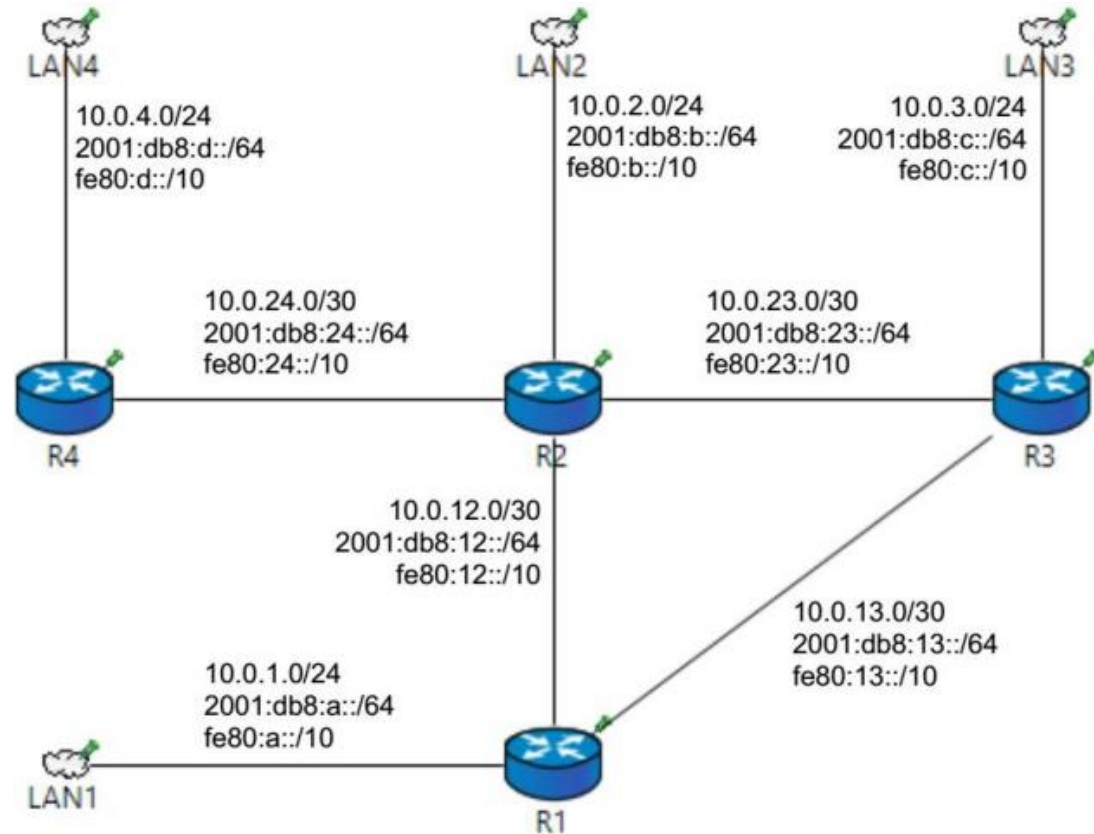


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SCENARIO

- ◆ Comparing real and simulated network



- Establishing neighborship
- Routing table convergence
- Link failure and subsequent routing information propagation

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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

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B) ROUTING TABLE CONVERGENCE

```
bt.getRoutes() (std::vector<BabelRoute *>)  
  bt.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

```
└─ btt.getRoutes() (BabelRoute *>)
  └─ elements[15] (inet::BabelRoute *)
    └─ [7] = > 2001:db8:a::/64 NH:fe80:12::1 metric:96 orig:1111:1111:1111:1111 from:fe80:12::1 RD:(52620, 0), in RT

└─ btt.getRoutes() (BabelRoute *>)
  └─ elements[14] (inet::BabelRoute *)
    └─ [6] = 2001:db8:a::/64 NH:fe80:12::1 metric:65535 orig:1111:1111:1111:1111 from:fe80:12::1 RD:(52620, 65535)

└─ btt.getRoutes() (BabelRoute *>)
  └─ elements[14] (inet::BabelRoute *)
    └─ [12] = > 2001:db8:a::/64 NH:fe80:23::3 metric:192 orig:1111:1111:1111:1111 from:fe80:23::3 RD:(52621, 96), in RT
```

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 😊

10:45 - 11:30

Invited Speaker: Vladimír Veselý

Introducing OMNeT++-based Research Frameworks: ANSAINET

INET is well-known OMNeT++ framework allowing simulation and modeling of traditional TCP/IP-based networks. ANSAINET extends the functionality of original INET framework with various technologies focused on wired networks. ANSAINET contributed to INET with multicast routing, PIM protocol, RIP and others in the past. During the last year, we have successfully migrated our framework to INET 3.3 (compatible with OMNeT++ 5.0). Moreover, we developed a lot of new simulation modules (e.g., EIGRP, Babel, IS-IS, TRILL, LISP, CDP, LLDP, HSRP, VRRP, GLBP) and we would like to tell the community about them. For more information, take a look at the project's [Github repository](#).

Invited speaker: Vladimír Veselý

- ◆ Thank you for your attention! Questions?