Algebraic Formal Modelling of EIGRP Using ACP

Formal description modelling on EIGRP routing protocol

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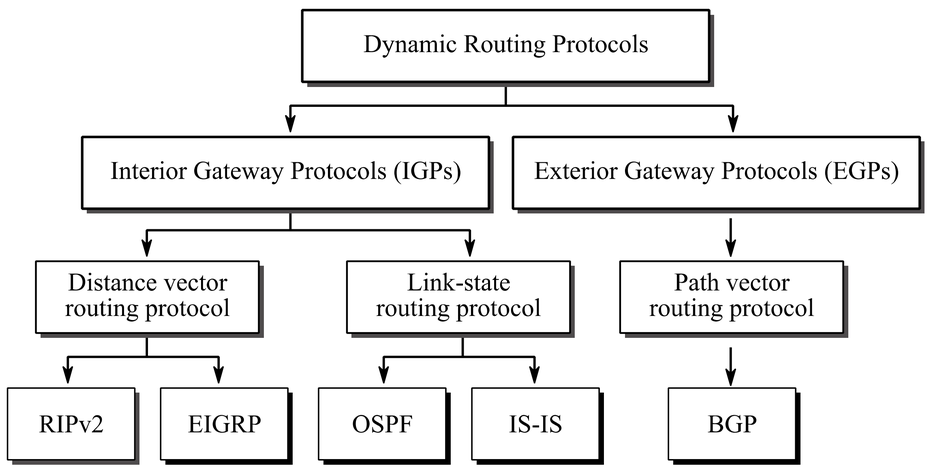
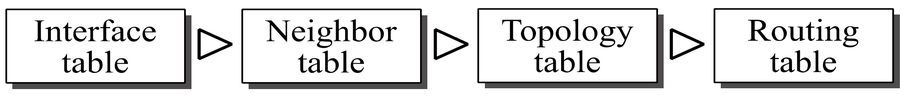
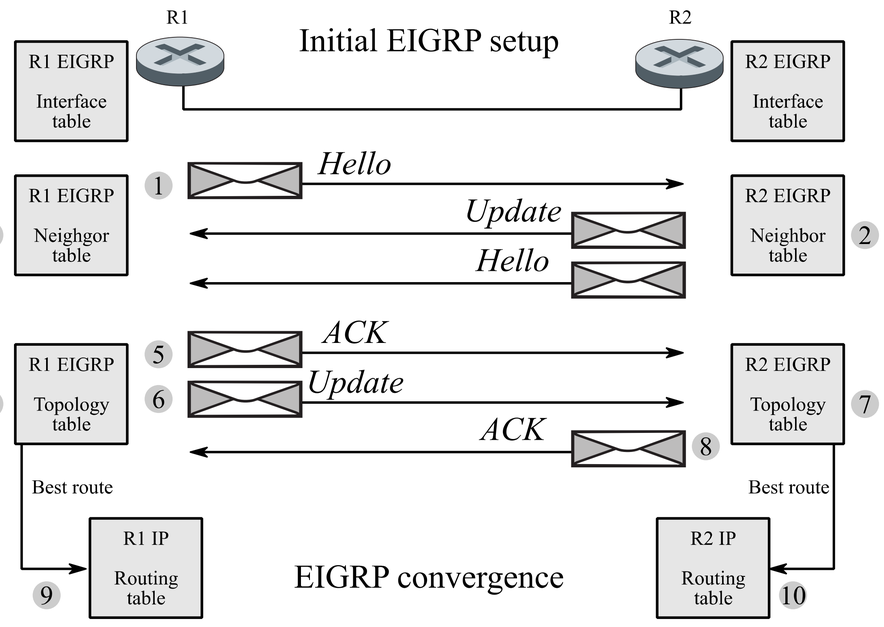
Dynamic Routing Protocols



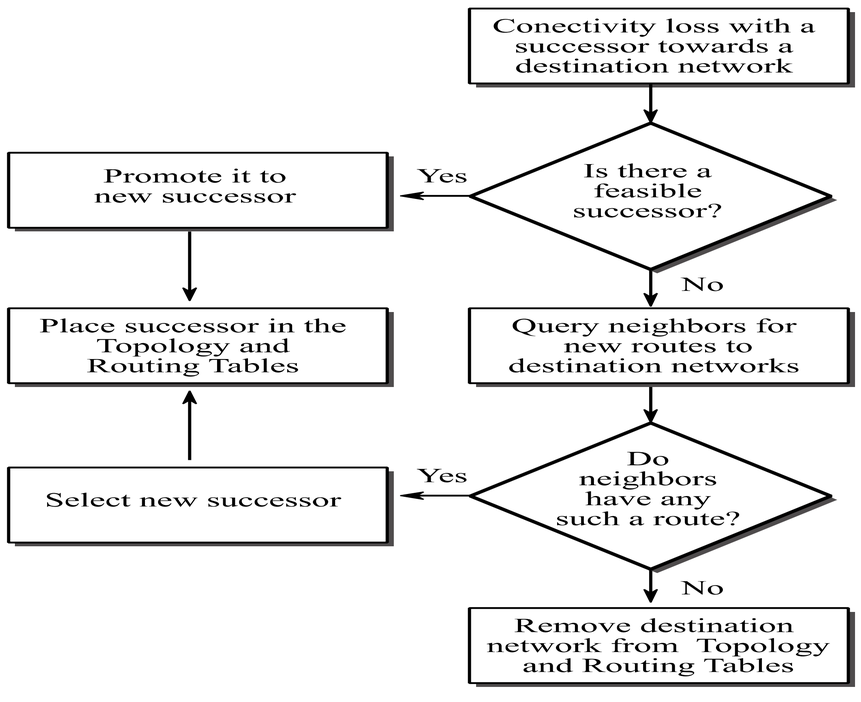
Flow chart for EIGRP tables



Flow chart for EIGRP convergence



Flow chart for EIGRP reconvergence



EIGRP timers

$t_{helloMAX\_i,j} = 5 \quad t_{holdMAX\_i,j} = 15 \quad t_{queryMAX\_i,j} = 90 \quad t_{siaMAX\_i,j} = 90$

EIGRP model draft

- Initial exchange of Hello packets and Update packets, both one way and another
- Exchange of Hello packets on a regular basis, both one way and the other
- Exchange of Update packets on an occasional manner, just when there are topology changes, both one way or the other way around
- If a destination prefix is not available, check for a feasible successor, or otherwise, start off the query-reply process to search for a new successor and, in case it is not possible, then delete that destination
- In case the hold timer from a neighbour becomes zero, then kill the neighbour adjacency with it and search for new routes to all the destinations being reached through it

Model for non-timing EIGRP

$$R(i) = \sum_{j=1}^{m}\left(\begin{array}{l} s_{i,j}(h)\cdot r_{i,j}(h)\cdot s_{i,j}(u)\cdot r_{i,j}(ACK)\cdot \\ \cdot r_{i,j}(u)\cdot s_{i,j}(ACK)\cdot \sum_{d=1}^{n_j}\left((d \to D_i)\cdot P_d\right)\end{array}\right) +$$

$$+\sum_{j=1}^{m}\left(\begin{array}{l} r_{j,i}(h)\cdot s_{j,i}(h)\cdot r_{j,i}(u)\cdot s_{j,i}(ACK)\cdot \\ \cdot \sum_{d=1}^{n_j}\left((d \to D_i)\cdot P_d\right)\cdot s_{j,i}(u)\cdot r_{j,i}(ACK)\end{array}\right) +$$

$$+\sum_{j=1}^{m}\left(s_{i,j}(h)\right)+\sum_{j=1}^{m}\left(r_{j,i}(h)\right)+\sum_{j=1}^{m}\left(s_{i,j}(u)\cdot r_{i,j}(ACK)\right)+$$

$$+\sum_{j=1}^{m}\left(\begin{array}{l} r_{j,i}(u)\cdot s_{j,i}(ACK)\cdot \\ \cdot\left(\left(\sum_{d=1}^{n-\{j\}}\left((d \to D_i)\cdot P_d\right)\right)\cdot\left(\sum_{k=1}^{n-\{j\}}\left(\begin{array}{l} s_{i,k}(u)\cdot \\ \cdot r_{i,k}(ACK)\end{array}\right)\right)\right) \\ \lhd u_d \notin D_i \rhd 1\end{array}\right) +$$

$$+\sum_{k=1}^{m-\{j\}}\left(P_{d_k} \lhd FC_{i,j}(d_k) \rhd A_d \cdot LABEL\right)+$$

$$+\sum_{k=1}^{m-\{j\}}\left(\sum_{d=1}^{n_j}\left(P_{d_k} \lhd FC_{i,j}(d_k) \rhd A_d \cdot LABEL\right)\right)\cdot(d_j \leftarrow D_i)$$

LABEL :

$$\sum_{k=1}^{m-\{j\}}\left(\sum_{d=1}^{\tilde{n}_j}\left(\cdot\left(\begin{array}{l} s_{i,k}(q_d)\cdot r_{i,k}(ACK)\cdot \\ \left(\begin{array}{l} r_{i,k}(r_d)\cdot s_{i,k}(ACK)\cdot P_d + \\ \cdot\left(\begin{array}{l} s_{i,k}(q_{SIA})\cdot r_{i,k}(ACK)\cdot \\ \cdot r_{i,k}(r_{SIA})\cdot s_{i,k}(ACK)\cdot \\ \cdot\left(\begin{array}{l} r_{i,k}(r_d)\cdot s_{i,k}(ACK)\cdot P_d \\ \lhd r_d \in D_k \rhd (d \leftarrow D_i)\end{array}\right)\end{array}\right)\end{array}\right)\end{array}\right)\right)\right) +$$

$$+\sum_{k=1}^{m-\{j\}}\left(\sum_{d=1}^{\tilde{n}_j}\left(\cdot\left(\begin{array}{l} r_{k,i}(q_d)\cdot s_{k,i}(ACK)\cdot \\ \left(\begin{array}{l} s_{k,i}(r_d)\cdot r_{k,i}(ACK)+ \\ \left(\begin{array}{l} s_{k,u}(q_d)\cdot r_{k,u}(ACK)\cdot \\ \cdot\left(\sum_{u=1}^{m-\{j\}}\left(\begin{array}{l} \cdot\left(\begin{array}{l} r_{k,u}(r_d)\cdot s_{k,u}(ACK)\cdot P_d \\ \cdot s_{k,i}(r_d)\cdot r_{k,i}(ACK)\end{array}\right)+ \\ +\left(\begin{array}{l} r_{k,i}(q_{SIA})\cdot s_{k,i}(ACK)\cdot \\ \cdot PATCH\end{array}\right)\end{array}\right)\right)\end{array}\right)\end{array}\right)\end{array}\right)\right)\right)$$

PATCH :

$$\left(\begin{array}{l} s_{k,i}(r_{SIA})\cdot r_{k,i}(ACK)\cdot \\ \cdot\sum_{u=1}^{m-\{j\}}\left(\begin{array}{l} s_{k,u}(q_{SIA})\cdot r_{k,u}(ACK)\cdot \\ \cdot\left(\begin{array}{l} r_{k,u}(r_{SIA})\cdot s_{k,u}(ACK)\cdot \\ \cdot s_{k,i}(r_{SIA})\cdot r_{k,i}(ACK)\cdot \\ \cdot\left(\begin{array}{l} r_{k,u}(r_d)\cdot s_{k,u}(ACK)\cdot P_d \\ \lhd r_d \in D_u \rhd (d \leftarrow D_i)\end{array}\right)\end{array}\right)\end{array}\right)\end{array}\right)$$

Model for timing EIGRP

$$\sum_{j=1}^{m}\left(\left(1 \lhd t_{hello\_i,j} = -1 \rhd 0\right)\cdot\left(\begin{array}{l}(t_{hello\_i,j} = T_{hello})\cdot \\ \cdot(t_{hold\_j,i} = T_{hold})\cdot(\ldots)\end{array}\right)\right)+$$

$$+\sum_{j=1}^{m}\left(\left(1 \lhd t_{hold\_j,i} = -1 \rhd 0\right)\cdot\left(\begin{array}{l}(t_{hold\_j,i} = T_{hold})\cdot \\ \cdot(t_{hello\_i,j} = T_{hello})\cdot(\ldots)\end{array}\right)\right)+$$

$$+\sum_{j=1}^{m}\left(\left(1 \lhd t_{hello\_i,j} = 0 \rhd 0\right)\cdot\left((t_{hello\_i,j} = T_{hello})\cdot(\ldots)\right)\right)+$$

$$+\sum_{j=1}^{m}\left(\begin{array}{l}\left(1 \lhd t_{hold\_j,i} > 0 \rhd 0\right)\cdot \\ \cdot\left(\begin{array}{l}\left((t_{hold\_j,i} = T_{hold})\cdot(\ldots)\right)+(t_{query\_i,j} = T_{query})+ \\ +(\ldots)+(\ldots)+\left(t_{hold\_j,i} = t_{hold\_j,i} - 1\right)\cdot \\ \cdot\left(\left(t_{hello\_i,j} = t_{hello\_i,j} - 1\right) \lhd t_{hello\_i,j} > 0 \rhd 1\right)\end{array}\right)\end{array}\right)+$$

$$+\sum_{j=1}^{m}\left(\begin{array}{l}\left(1 \lhd t_{query\_i,j} >= 0 \rhd 0\right)\cdot \\ \cdot\left(\begin{array}{l}(\ldots)\cdot\left(\begin{array}{l}(t_{query\_i,j} = -1)+\left(t_{SIA\_i,j} = T_{SIA}\right) \\ +\left(t_{query\_j,i} = t_{query\_j,i} - 1\right)\end{array}\right)\end{array}\right)\end{array}\right)+$$

$$+\sum_{j=1}^{m}\left(\begin{array}{l}\left(1 \lhd t_{SIA\_i,j} >= 0 \rhd 0\right)\cdot \\ \cdot\left((\ldots)\cdot\left(\left(t_{SIA\_i,j} = -1\right)+\left(t_{SIA\_j,i} = t_{SIA\_j,i} - 1\right)\right)\right)\end{array}\right)+$$

$$+\sum_{j=1}^{m}\left(\left(1 \lhd t_{hold\_i,j} = 0 \rhd 0\right)\cdot\left(t_{hold\_j,i} = t_{hello\_j,i} = -1\right)\cdot(\ldots)\right)$$

Conclusions

- Two formal description models for EIGRP routing protocol, no-timed and timed, have been presented using ACP syntax and semantics.
- Both mathematical models meet the requirements set in the EIGRP specifications