Congestion Control in Recursive Network Architectures

David Hayes, Peyman Teymoori, and Michael Welzl
University of Oslo
[davihay, peymant, michawe]@ifi.uio.no
IETF95 Buenos Aires — ICCRG
Pristine: Who we are and what we’re doing

ict-pristine.eu

RINA
Recursive Inter-Network Architecture

Iso
Pouzin Society

Tools
RINA simulator
RINA sdk
Omnet++

C++

Scheduling and QoS
Research
Security
Routing
Congestion Control

Standards

ISO
Pouzin Society

David UiO University of Oslo
The Internet and Recursive Architectures

### Internet

<table>
<thead>
<tr>
<th>Layer</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>TCP/UDP</td>
</tr>
<tr>
<td></td>
<td>Generic Layer</td>
</tr>
<tr>
<td>IP</td>
<td></td>
</tr>
<tr>
<td>Link</td>
<td>LLC, MAC</td>
</tr>
<tr>
<td>Physical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QoS, MPLS, etc</td>
</tr>
<tr>
<td></td>
<td>Proxies, middle boxes, etc</td>
</tr>
</tbody>
</table>

### Recursive Architecture

<table>
<thead>
<tr>
<th>Layer</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Recursive Inter-Network Architecture (RINA) <a href="http://www.pouzinsociety.org/">http://www.pouzinsociety.org/</a></td>
</tr>
<tr>
<td></td>
<td>Recursive Network Architecture (RNA) <a href="http://www.isi.edu/rna/">http://www.isi.edu/rna/</a></td>
</tr>
<tr>
<td>Generic Layer</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>Generic Layer</td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td></td>
</tr>
</tbody>
</table>

Examples include:
- Recursive Inter-Network Architecture (RINA)
  http://www.pouzinsociety.org/
- Recursive Network Architecture (RNA)
  http://www.isi.edu/rna/
In IEEE International Conference on Communications (ICC), Next Generation Networking and Internet Symposium, May 2016.

To appear
## Congestion Control

### Types of “solvable” Network Congestion
- Network adaption – traffic rerouted along less congested paths
- Network restriction – admission control and policing
- End system adaption – traffic sources adjust send rates

### Recursive CC work in RINA
- Stability of chained and stacked congestion controllers
- Congestion signals and how they influence performance
- Stable scalable new types of congestion control
Recursive Congestion Signals

- ISP 1
- Access
- ISP 2
- Access
- GW
- Public Internet Layer
- Inter ISP Layer
- ISP 1 Layer
- ISP 2 Layer
- Server

Feedback options in RINA:
- Implicit:
  - Push back and push up
- Explicit:
  - Packet marking and reflection
  - Control packet notifications

Potentially provides:
- Faster responses
- Smaller buffer requirements

Cautions — Current research
- CC interactions
- Stability
Recursive Congestion Signals

- ISP 1
- Access
- ISP 2
- Access
- GW
- Public Internet Layer
- Inter ISP Layer
- ISP 1 Layer
- ISP 2 Layer
- Server
- Host

Feedback options in RINA:
- Implicit:
  - Push back and push up
- Explicit:
  - Packet marking and reflection
  - Control packet notifications

Potentially provides:
- Faster responses
- Smaller buffer requirements

Cautions — Current research CC interactions, Stability
Recursive Congestion Signals

Feedback options in RINA

- Implicit:
  - Push back and push up

- Explicit:
  - Packet marking and reflection
  - Control packet notifications
Recursive Congestion Signals

Feedback options in RINA
- Implicit:
  - Push back and push up
- Explicit:
  - Packet marking and reflection
  - Control packet notifications

Potentially provides
- Faster responses
- Smaller buffer requirements

Cautions — Current research
- CC interactions
- Stability
Stable CC inspired by Logistic Growth in Nature

\[ P(t) = \frac{KP_0e^{rt}}{K+P_0(e^{rt}-1)} \]

P.-F. Verhulst. *Notice sur la loi que la population poursuit dans son accroissement.*

*Correspondance mathématique et physique, 10:113–121, 1838.*

URL [http://books.google.com/?id=8GsEAAAYAAJ](http://books.google.com/?id=8GsEAAAYAAJ)
Logistic Growth Based Congestion Control

Competition for resources
incrementally for senders:

$$x_i(t + 1) = x_i(t) r_i \left( C - x_i(t) - \frac{N - 1}{N} \sum_{j=1}^{N} x_j \right) + x_i(t)$$

Recursive layered congestion control – ongoing
- predator–prey food chain based CC
- has calculable convergence and stability properties
Conclusions and Future work

- Stability and CC interactions also relate to the current Internet
- New CC can work in the Internet as well
- Upcoming publication:
- OCARINA (Optimizations to Compel Adoption of RINA) (see https://titan.uio.no/node/1403)

Acknowledgements

The authors are funded by the European Community under its Seventh Framework Programme through the PRISTINE project (CNECT-ICT-619305). The views expressed are solely those of the authors.
For more information about PRISTINE see http://ict-pristine.eu/
Extra slides