Recursive InterNetwork Architecture
An Assessment of the IRATI Implementation

Jeroen van Leur  Jeroen Klomp

University of Amsterdam
System and Network Engineering

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Research goals

Research question

What is the current state of the IRATI RINA implementation?

- Find out which Recursive InterNetwork Architecture (RINA) implementations exist
- Find out their differences
- Find out how an experimental network needs to be set up
- Find out how resilient the routing in a small network is
Problems with TCP/IP

- Mobility not straightforward
- Multihoming does not scale
- Multicast does not scale
- Quality of Service does not scale
- Many security issues
What causes these problems?

- TCP/IP has an incomplete addressing scheme
  - Applications are not named
  - IP addresses name the interface, not the node
  - Point of attachment (link-layer) addresses are in concept the same as IP addresses
- No integrated security
What is wrong with the layers?

- Layers not properly defined and inflexible

Figure: TCP/IP model?¹

¹(Veselý, Marek, Hykel, & Ryšavý, 2015)
"The Internet is an unfinished demo" — John Day (2008)

Figure: RINA’s recursive layered approach\(^2\)

\(^2\)(Veselý et al., 2015)
Figure: RINA layers and components

3Based on (Grasa et al., 2011)
Communication in RINA

Figure: RINA directory, routes and paths

4 based on (Grasa et al., 2011)
RINA protocols

- Only two protocols
  - Error and Flow Control Protocol
    - Provides both unreliable (DTP)\textsuperscript{5} and reliable (DTCP)\textsuperscript{6} flows
    - No need for handshakes
    - Flows distinguished by Connection-ID
  - Common Distributed Application Protocol
    - Object-based communication
    - Only six primitive operations: Create/Delete, Read/Write, Start/Stop

\textsuperscript{5}Data Transfer Protocol
\textsuperscript{6}Data Transfer Control Protocol
Implementations

Figure: PSOC overviewed RINA implementations

7 Adapted from (Grasa, 2015)
IRATI

- **Multiple shim Distributed IPC Facilities (DIFs)**
  - UDP/IP
  - Ethernet via 802.1Q
  - Hypervisor to guest
  - Dummy shim for debugging

- **Routing**
  - Intermediate System-to-Intermediate System (IS-IS)
  - IP Fast Reroute (IPFRR)
  - Optional multipath routing with equal-cost multipath routing (ECMP) plugin
Design

Figure: Physical network design

Figure: Logical network design
Basic tests

- IRATI stack
  - Initialisation
  - Enrolling to DIF
- Connectivity test
  - Behaviour of flow
  - Monitoring the connectivity
- Performance test
Results

- Susceptible to configuration errors
- Debugging options: high I/O and impact CPU
- Tooling results:
  - Echo tool shows response round-trip time (RTT) less than 1 ms.
  - Wireshark showed src/dst address correctly after patching
  - Performance tests results from 400 Mbit/sec to 15 Gbit/sec

Figure: Wrong address

Figure: Correct address
Physical design
Logical design
Routing tests

- Configuration
  - Enrolling to the DIFs
  - Changes in the tools
- Resilience tests
  - Disconnecting links
  - Connectivity test
- Multipath plugin
- Performance test
Results

- Manual configuration of all systems
- Routing information in resource information base (RIB)
  - Next Hops
  - Underlying DIF
  - All neighbours
- Network updates are propagated

Next hops

Name: /resalloc/nhopt/key=16-0; Class: NextHopTableEntry; Instance: 47
Value: Destination address: 16; QoS-id: 0; Cost: 1; Next hop addresses: 17 /

Name: /resalloc/nhopt/key=17-0; Class: NextHopTableEntry; Instance: 48
Value: Destination address: 17; QoS-id: 0; Cost: 1; Next hop addresses: 17 /

Name: /resalloc/nhopt/key=18-0; Class: NextHopTableEntry; Instance: 49
Value: Destination address: 18; QoS-id: 0; Cost: 1; Next hop addresses: 18 /
Routing Resiliency

- System 1 - System 2 disconnected
- No re-routing possible for existing and new flows
- Multipath plugin
  - Multiple paths in Wireshark
  - Next hops change in RIB
  - Lacks link failure resiliency

### Multipath next hops

**Name:** /resalloc/nhopt/key=16-0; **Class:** NextHopTableEntry; **Instance:** 47
**Value:** Destination address: 16; QoS-id: 0; Cost: 1; Next hop addresses: 17/

**Name:** /resalloc/nhopt/key=17-0; **Class:** NextHopTableEntry; **Instance:** 48
**Value:** Destination address: 17; QoS-id: 0; Cost: 1; Next hop addresses: 18/

**Name:** /resalloc/nhopt/key=18-0; **Class:** NextHopTableEntry; **Instance:** 49
**Value:** Destination address: 18; QoS-id: 0; Cost: 1; **Next hop addresses:** 17/ 18
Conclusion

- IRATI is still in an experimental phase
- Routing was not resilient
- Using IRATI requires Unix background and programming skills to debug issues
- Ongoing progress:
  - Future projects will enhance IRATI
  - New ProtoRINA release this year
  - Active improvement of the RINA reference model
Any questions?
References
