Application-Driven Network Management using ProtoRINA

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What is RINA? [1][2]

- RINA: Recursive InterNetwork Architecture
- A clean-slate network architecture that overcomes inherent weaknesses of the current Internet, e.g., security, mobility support
- Based on the fundamental principle that networking is Inter-Process Communication (IPC) and only IPC
- Distributed Application Facility (DAF): a set of application processes cooperating to perform a certain function, such as communication service, management service, etc.
- Distributed IPC Facility (DIF): a collection of distributed IPC processes with shared states. They provide communication service to application processes over a certain scope (i.e., range of operation)
- DIF is a special DAF whose job is to provide communication services among participating application processes

ProtoRINA: A RINA Prototype [3]

- ProtoRINA is Boston University’s user-space prototype of RINA
- Experimental tool for developing (non-IP based) user and management applications, and teaching tool for networking and distributed systems classes
- A RINA node is a host (or machine) where application processes and IPC processes reside, and each RINA node has a DIF allocator which manages the use of various existing DIFs

Traditional Network Management

- Tied to the Internet architecture, and inevitably inherits various problems, such as:
  1. static management and one-size-fits-all structure
  2. ad-hoc mechanisms with no common management framework

Software-Defined Networking (SDN) aims to provide better and more flexible management, but still suffers from aforementioned problems due to it being tied to the TCP/IP architecture [4]

Some work (such as FlowVisor and AdvIsor) has been done to support network virtualization based on application requirements, but their virtual network is limited to routing and not for transport purpose, and they do not support dynamic formation of virtual networks

Application-Driven Network Management

- Definition: given the physical topology of the network, virtual networks can be built on the fly to satisfy application-specific demands and achieve better network performance
- With the development of new networking service models (such as Private Cloud as as Service or Software as a Service), as well as the demand for different SLAs (Service-Level Agreements), we believe application-driven network management is necessary and will become the norm
- In RINA, the DIF is such a virtual network, i.e., a secure transport container providing inter-process communication. A DIF can be dynamically formed, where each DIF has its own scope, and they all use the same RINA mechanisms but can have different policies

RINA’s Management Architecture

- A common management framework: the DAF-based architecture
- Application processes providing management functionalities form different management DAFs, and the same DAF-based management structure repeats over different scopes
- For a single DIF, the Management Application Entity of each IPC process forms the management DAF, and this DAF manages a single DIF
- For a network made up of multiple DIFs, the DIF allocator of each RINA node forms the management DAF, and this DAF manages the whole network
- The DIF allocator is able to form new DIFs dynamically to meet various application requirements

Network Management for Video Multicast

- Fig 3: The whole network is made up of four enterprise networks (networks A, B, C, D). RTP video server provides a live video streaming service, and multiple clients, e.g., clients 1 and 2, want to access this service
- Fig 4: Video streaming can be done through unicast connections supported by two level-1 DIFs (DIFs 4 and 5), which consume unnecessary bandwidth over DIF 1

Two Multicast Solutions

- Fig 5: Video multicast through multicast service provided by level-1 DIF 4
- Fig 6: Video multicast through an RTP video multicast server which can placed closer to clients

Experiments over GENI

- Fig 7: VMs from four InstaGENI aggregates connected through stitched VLANs
- Fig 8: Comparison of bandwidth usage over DIF 1: unicast vs. multicast
- Fig 9: Video seen by clients when RTP video multicast server (cf. Fig 6) is placed at two different aggregates

References