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# Current Interests

Time-Sensitive  
Networking  
Architectures

In-Vehicular  
Networking

Named-Data  
Networking

Service-Centric  
Load-Balancing  
Techniques

5th Generation  
Mobile Networks

Network  
Slicing

Discrete-event  
simulation

- Can we guarantee and support low-latency requirements beyond Layer 2 in Time-Sensitive systems?
- Can Information-Centric Networking aid transition from legacy technologies to Ethernet with TSN in automotive and industrial automation scenarios?

## SCALE: Service-Centric Adaptive Load Balancing in Edge Time-Varying Networks

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**Motivation** 1

Low Earth Orbit (LEO) constellations promise low latency communication with global coverage. Variable LEO network topology is challenging for provision of internet services with strict QoS requirements.

- Service Placement and Discovery
- Service Execution

**SCALE** – A service-centric, ROSA-based load-balancing mechanism for time-varying networks, aiming to enhance user experience.

- Service Edges at the borders of the LEO network
- In-path service name resolution (tagged with a load balancing mechanism)
- Consider both service instance load and network path conditions

**Enhanced ROSA Service Address Router (SAR)** 4

Figure 2 Enhanced ROSA SAR packet handling

ROSA does not support load balancing decisions according to SI load and network path conditions by default. Extend decisions with forwarding choice utility. Utility information saved in extended FIB and NHIB tables.

**What is ROSA?** 2

ROSA – Routing on Service Addresses [1]

- Next service-centric networking framework
- Services instead of communication hosts determine the addressing semantics

Figure 1 General ROSA message exchange

**Forwarding Choice Utility** 5

$$U = \alpha \cdot U_p + (100 - \alpha) \cdot U_L$$

Defined as a combination of:

- SI load –  $U_p$  = Cost of reaching the SI
- Client response via  $\alpha$  attached to Service Requests

Utility components saved in the FIB and NHIB tables. Updates using the Service Responder and Service Announcement tables.

**FIB and NHIB Tables** 6

Table 1 Example FIB table with two entries comprising service names with general next hops and their associated utility

Service Name	Next Hop	Cost	Push Utility	Max Load Utility
SI1	SI1	20	1	30
SI2	SI2	25	2	30

Table 2 Example NHIB table with two entries comprising entry IDs with IP addresses of associated next hops

Target IPv4 Address	Next Hop ID	Is SAR
192.168.1.1	20	Yes
192.168.1.2	25	Yes

**Service Edge Design** 7

Figure 3 Simplified diagram of a Service Edge

**Initial Validation** 9

Figure 5 Requests served by each SI in the 2nd experiment

Figure 6 Requests served by each SI in the 1st experiment

- Centralized forwarding and balancing decisions
- Agile reactions to system changes
- Even request distribution among SIs
- Consideration of client needs
- Control for service provider and network operator

**System Requirements** 3

- Need to efficiently distribute the load across globally distributed Service Instances (SIs)
- Need to support a time-varying network

Therefore, the load-balancing mechanism must:

- Adapt to rapid load and availability changes
- Resolve semantic service names (e.g., domain names) to IP addresses in-band
- Minimize service exchanged messages
- Handle inconsistent load-balancing information
- Minimize routing hops
- Give service providers some control over policy and load-balancing decisions
- Allow client to influence load-balancing decisions

**Initial Deployment** 8

- Service Edge implemented in Go
- Client- and Service-side gateways enabling use of generic TCP applications

Figure 4 Network showcasing the first system deployment

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Control Research and Technology, Airbus

[1] D. Toscani, L. M. Corradi, J. Frenkner, and P. Mendes. Architecture for Routing on Service Addresses. Internet Draft draft-toscani-rgwg-rosa-arch-01, July 2020.