Cross Layers Semantic Experimentation for Future Internet

Alex Dias[1], **Caio César Ferreira**[2], **Eduardo Souza Santos**[2],
Fabíola Souza Fernandes Pereira[3], **Flávio de Oliveira Silva**[4],
Isabelle Cecília de Andrade[2], **João Henrique de Souza Pereira**[4],
Lásaro Jonas Camargos[2], **Luiz Cláudio Theodoro**[2],
Maurício Amaral Gonçalves[2], **Rafael Pasquini**[2],
Pedro Frosi Rosa[2], **Sergio Takeo Kofuji**[4]

[1]Federal Institute of Triângulo Mineiro – Uberlândia – MG – Brazil

[2]Federal University of Uberlândia – Uberlândia – MG – Brazil

[3]Algar Telecom – Uberlândia – MG – Brazil

[4]University of São Paulo (USP) – São Paulo – SP – Brazil

alexdias@iftm.edu.br, eduardo@doutorado.ufu.br,

{flavio, kofuji}@pad.lsi.usp.br, joaohs@usp.br,

lclaudio@feelt.ufu.br, {lasaro, pasquini, frosi}@facom.ufu.br

{caiocf, isabelle, mauricio, fabiolas}@algartelecom.com.br,

Abstract. *There are important perspectives for the future Internet research area with the collaborative efforts between different working groups. In this scenario this work expands the possibilities of the network to understand and support the entity needs. This paper presents the results of the Net-Ontology experimentation that brings semantics to the intermediate layers and contributes with the different approaches for the Future Internet networks. The results, compared with the traditional TCP/IP protocols, show the reduction over 25 percent of the packets to support the delivery guarantee need. These results increase the expectations for future works using different experimental network testbeds.*

Introduction

The scientific community has attempted the emergence of numerous research proposals related to the Future Internet. Among them, there are the use of new approaches, such as software-defined networking (SDN) [Greene 2009], and the use of testbed environments to perform experiments in a more realistic scenario, like [FIBRE , OFELIA , OpenLab] and others.

In this context, the MEHAR Group (http://www.mehar.facom.ufu.br/) researchers team proposes the use of semantics cross layers, formalized with ontology, to minimize the dependency on the use of strict protocols and to approximate the lower and upper layers of the Internet Architecture.

Another research to the support of the Internet applications needs is the FINLAN (Fast Integration of Network Layers), which can contribute in a simple and optimized way [Malva et al. 2009, Pereira et al. 2009, Pereira et al. 2010]. The proposal of the

FINLAN project is: when the upper layer has some specific need, the intermediate layer, called Net-Ontology, verifies the requirements and assumes the responsibility to support the request. After that, the primitives are sent to the next layer, DL-Ontology, which will process and forward them to the lower layers.

The FINLAN approach was used to support communication applications where users can select the options as delivery guarantee, for example. In a test environment, FINLAN demonstrated how to exchange information among entities connected by a workspace with an horizontal address to have a direct communication between the application and DL-Ontology, through the Net-ontology.

This paper shows how the Net-Ontology can be used to support the entities needs to optimize the network communication and it is organized as the following: section 1 shows the Net-ontology modules to support the entities requirements; section 2 presents the experimental results; section 3 shows the conclusions and proposals for future work.

1. Net-ontology and Entities Requirements

The ability to adapt in different contexts and meet different communication needs, is a topic under discussion in several future Internet proposals. The Net-Ontology contributes to provide this feature to the Title Model Ontology as presented in [Pereira et al. 2011], through a semantic analysis based on dynamic ontologies, that map the entity needs into services provided by the network.

The Net-Ontology, as presented in [Santos et al. 2011], is responsible for interpreting the requests of the superior layer, inform them to the network and provide necessary information to the primitives sent via DL-Ontology. For this reason, the network structure must be able to understand these needs and deal with them, through the Net-Ontology features, which are divided into two modules: *requirement analysis* and *requirement manager*, as illustrated in the Figure 1.

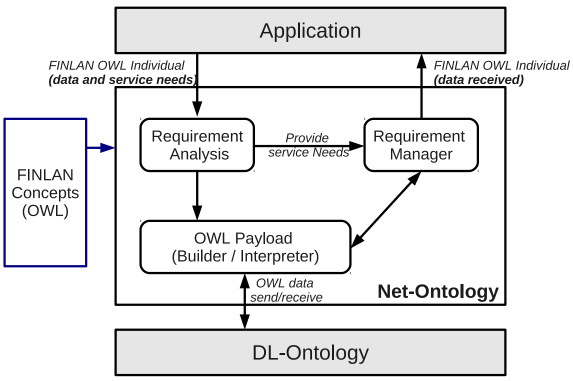


Figure 1. Net-Ontology modules.

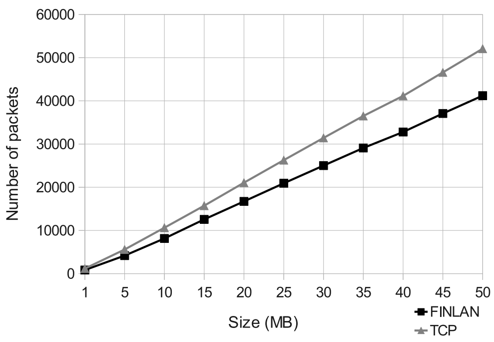
The *requirement analysis module* (RAM) is responsible for handling requirement requests and registering them into DTSA (Domain Title Service Agent) through Leśniewski logic as proposed in [Leśniewski 1930]. The RAM is able to recognize what resources and services are necessary to satisfy a given requirement, combining them in axioms.

The *requirement manager module* (RMM) has the mission of transforming the rules provided by RAM into FINLAN ontology fragments, and deploying algorithms correlated with the requirement in the network stack. In this approach, the Net-Ontology adapt to meet the application needs, through a semantic analysis of the requirements requests. By the ontology use, it provides dynamics to ensure high cohesion and to allow the implementation of new services without the obligation to change static protocol stacks.

2. Experimental Results

The Net-Ontology layer has been implemented in the FINLAN structure improving the proposal of [Santos et al. 2011]. In this implementation was developed a java library that uses raw sockets in the communication interfaces with the operating systems, via JNI (Java Native Interface).

In order to validate the Net-Ontology implementation, was created the delivery guarantee requirement, based on the algorithm proposed in [Pereira et al. 2010]. Through this, it was possible to perform experiments comparing FINLAN with the TCP/IP protocols. For the tests were used file transfer operations with delivery guarantee between two hosts, resulting in the network traffic optimization showed in Figure 2 [Silva et al. 2012].



(a)

Size	FINLAN	TCP	Reduction (%)
1 MB	847	1168	37,9%
5 MB	4174	5594	34,0%
10 MB	8140	10631	30,6%
15 MB	12566	15733	25,2%
20 MB	16722	21060	25,9%
25 MB	20920	25277	25,6%
30 MB	25017	31423	25,6%
35 MB	29089	36495	25,5%
40 MB	32786	41143	25,5%
45 MB	37070	46585	25,7%
50 MB	41207	52067	26,4%

(b)

Figure 2. FINLAN and TCP traffic comparison.

In these experiments, the optimization average for different files size was over 25 percent of the total number of packets in the communication.

As the actual working in progress, we are experimenting the Net-Ontology implementation at OFELIA testbed [OFELIA], as proposed in [Silva 2011]. This experimentation intends to use OpenFlow to validate the horizontal address by title and to test the orchestration capability of DTS (Domain Title Service). In parallel, there are efforts toward the implementation of the security and QoS requirements in Net-Ontology. These are important steps to extend the FINLAN contribution with other Future Internet working groups as [Galis et al. 2009] and to experiment it in other testbeds, like [FIBRE].

3. Conclusions

There are extensive researches in the future Internet area and it is important that the collaboration between different working groups converge in a complementary way.

This work presents the Net-Ontology experimentation to support the delivery guarantee need. The results show an optimization over 25 percent of the total packets quantity, compared with the traditional TCP/IP protocols.

It is expected that the optimization can be either superior by the use of the Net-Ontology in a world wide network with the multicast aggregation by the workspace. This experimentation is intended to be done in future works by the use of testbeds as OFELIA and FIBRE. We also intend to test the DTS orchestrating capability, mainly when it is dealing with different applications and needs.

In future works also is expected to demonstrate the Net-Ontology semantic interoperability with openflow and routeflow, and the comparative results of this approach with other future Internet proposals.

References

FIBRE. FIBRE Project. Jan. 2012.

Galis, A., Denazis, S., Bassi, A., et al. (2009). Management Architecture and Systems for Future Internet. *Towards the Future Internet - A European Research Perspective*, page 112.

Greene, K. (2009). TR10: Software-Defined Networking. *MIT - Technology Review*.

Leśniewski, S. (1930). Comptes rendus des séances de la Société des Sciences et des Lettres de Varsovie. *Class III*, pages 111–132.

Malva, G. R., Dias, E. C., Oliveira, B. C., et al. (2009). Implementação do Protocolo FINLAN. *8th International Information and Telecommunication Technologies Symposium*.

OFELIA. OFELIA Project. Jan. 2012.

OpenLab. OpenLab Project. Jan. 2012.

Pereira, F. S. F., Santos, E. S., Pereira, J. H. S., et al. (2009). Proposal for Hybrid Communication in Local Networks. *8th International Information and Telecommunication Technologies Symposium*.

Pereira, F. S. F., Santos, E. S., Pereira, J. H. S., et al. (2010). FINLAN Packet Delivery Proposal in a Next Generation Internet. *IEEE International Conference on Networking and Services*, page 32.

Pereira, J. H. S., Silva, F. O., Filho, E. L., et al. (2011). The Title Model Ontology for Future Internet Networks. In *The Future Internet*, Lecture Notes in Computer Science, pages 103–114. Springer Berlin / Heidelberg.

Santos, E., Pereira, F., Pereira, J. H. S., et al. (2011). Meeting Services and Networks in the Future Internet. In *The Future Internet*, volume 6656 of *Lecture Notes in Computer Science*, pages 339–350. Springer Berlin / Heidelberg.

Silva, F. O. (2011). Experimenting Domain Title Service to Meet Mobility and Multicast Aggregation by Using OpenFlow. *MyFIRE Workshop*.

Silva, F. O., Dias, A., Ferreira, C. C., et al. (2012). Semantically Enriched Services to Understand the Need of Entities. In *The Future Internet*, Lecture Notes in Computer Science. Springer Berlin / Heidelberg. Submitted.