

EVALUATION OF THE USE OF THE NATIONAL ACADEMIC NETWORK OF ADVANCED TECHNOLOGY (RENATA) IN COLOMBIA

EVALUACIÓN DEL USO DE LA RED ACADÉMICA NACIONAL DE TECNOLOGÍA AVANZADA (RENATA) EN COLOMBIA

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ABSTRACT

This paper models the operation of Internet 2, the advanced national academic network (RENATA) in Colombia, by as-sessing the fundamental services that it supports and its respective performance. The academic and scientific importance of the article lies on discussing the problem of NLAN networks not being harnessed as scientific tools that may have a domino effect by driving the use of said tools in different education and research centers of the highest level. It is concluded that the connectivity model

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in the associated networks, i.e., the university networks of every important city within RENATA do not effectively use the advantages of bandwidth capacity, hereby proven with 0.039 Gbps.

RESUMEN

Este artículo modela el funcionamiento de Internet 2, la red académica nacional avanzada (RENATA) en Colombia, mediante la evaluación de los servicios fundamentales que apoya y su respectivo desempeño. La importancia académica y científica del artículo radica en discutir el problema de que las redes NLAN no se aprovechen como herramientas científicas que pueden tener un efecto dominó al impulsar el uso de dichas herramientas en diferentes centros de educación e investigación del más alto nivel. Se concluye que el modelo de conectividad en las redes asociadas, es decir, las redes universitarias de todas las ciudades importantes dentro de RENATA, no aprovechan

de manera efectiva las ventajas de la capacidad de ancho de banda, probada con 0.039 Gbps.

KEYWORDS: RENATA

National Academic Network Bandwidth

PALABRAS CLAVE: RENATA

Ancho de banda de la red académica nacional

1. INTRODUCTION

The National Academic Network of Advanced Technology (RENATA) in its essence of origin, is a partnership effort between academic institutions with research priority in Colombia, which must be previously grouped into regional networks aimed at seeking an interconnection between them and the world, managing to promote and cooperate in scientific and knowledge of production value to humanity.

However, at the time of writing and by unanimous majority in the last assembly directive [1] regional network of Rumbo (Bogota Metropolitan University Network), all members⁴: They decided to disconnect the network indefinitely RENATA adducing escaza use little added value for universities and a new viable economic model.

Substantial financial resources have been invested in high-speed academic networks.

⁴ Rumbo members: "National Library of Colombia, Corporacion Cooperativa Clinic University of Colombia, Juan City Hospital Corporation - Unified National mederi, CUN Corporation on Higher Education, University Corporation Minuto de Dios University Corporation UNITEC, Universidad Autonoma de Colombia Foundation, Foundation University of the Andean area University Foundation the Liberators, Institution University Politecnico Colombiano Gran, Pontificia Universidad Javeriana, Universidad Antonio Nariño, Catholic University of Colombia, Cooperative University of Colombia, University College of Cundinamarca, University of Applied and Environmental Sciences UDCA, University of Cundinamarca, University of La Sabana University of La Salle, Universidad de los Andes, Universidad de los Llanos, San Buenaventura University, Universidad del Rosario, University Francisco José de Caldas, EAN University, University Escuel a Colombian Engineering Julio Garavito, Universidad Jorge Tadeo Lozano University Colombia, Free University, Military University Nueva Granada, National Open and Distance University, National University of Colombia, Pilot University of Colombia, University of St. Tomás de Aquino, Universidad Sergio Arboleda) "

Furthermore, services such as teleconferences, videoconferences, telepresence and augmented reality have been implemented both on a national and international scale within networks that belong to the internet. However, the productivity and efficiency in terms of results have yet to assure the sustainability of these types of networks on a long-term basis. A simulation in RENATA is proposed to assess its sustainability in medium and long term.

The scope of research addresses the problems of appropriation and actual use of the academic network in Colombia as causes aversion by most players in the national science technology and innovation (SNCTI) for this network.

The academic and scientific contribution of this article lies in discussing the problem of not harnessing NLAN networks on a national scale as scientific tools that can have a domino effect, by promoting the massive use of the tools available in different education and research centers of the highest level.

The problem is if we take as large as the native origin of Renata which is closely linked to the scientific and academic production in the country; In this context, the question that arises is why there is no appropriation and use of the academic network in Colombia and if this means a delay scientific production level compared to other countries in Latin America.

The above questions form the focus of debate and analysis of this research paper; as a hypothesis, it appears that the services offered, and the value chain Renata offers is poor and little added value for member institutions and that a profound change is needed in terms of organization and services Renata, otherwise, we would verge of extinction.

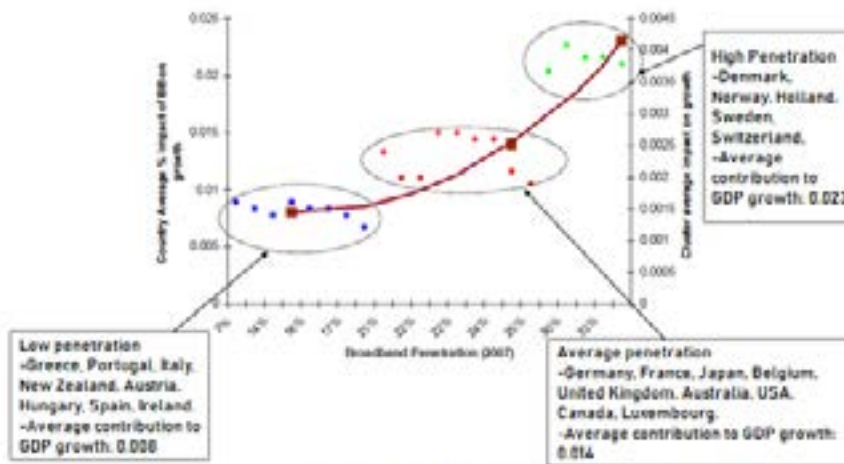
2. Impact of internet penetration and broadband

Globally there is a consensus about the positive impact of information and communication technologies - ICT in the processes of economic and social development of a society. Economic and social effects generated are defined in:

- Growth in GDP of a nation
- Employment generation
- Increase in average household income
- Creating consumer surplus

Impact on GDP: In 22 OECD member countries, a study showed that an increase in broadband penetration of 1% leads to an increase in the growth rate of GDP of 0.025%. [2]. Illustration No 1 shows an upward trend GDP growth according to the level of penetration of bandwidth connections for OECD member countries.

In emerging countries, [3] a production function specified concluded that an increase of 1% in broadband penetration contributes 0.0158% to GDP.



Source: Adapted from Kouroumis (2009)

Figure. 1. Impact penetration bandwidth vs GDP. [2].

All analyzes the impact of broadband on GDP growth conclude demonstrate the positive effect of it. However, the impact varies between 0025 and 0138 for each 1% incremental penetration:

Country/region	Study	Data	Impact
United States	Crandall et al (2007)	48 US states for the period 2003-05	It does not generate significant results from the statistical point of view
	Thompson et al (2008)	46 US states for the period 2001-2005	A 10% increase in broadband penetration is associated with a 3.6% increase in the efficiency rate
OECD	Czemich et al. (2009)	25 OECD countries between 1996 and 2007	The adoption of broadband increases the GDP per capita between 1.9 and 2.5%
	Koutroumpis (2009)	25 OECD countries between 1996 and 2007	An increase in broadband penetration of 1% generates 0.025% increase in GDP growth
Germany	Katz et al. (2010a)	2000-2006 for 424 counties of Germany	An increase in broadband penetration of 1% generates 0.0255% increase in GDP growth
Developed countries	Qiang et al. (2009)	1980-2002 for developed countries in a sample of 120 countries	1% of broadband penetration generates an increase of 0.121% in GDP growth
Countries of medium and low development	Qiang et al. (2009)	1980-2002 for remaining countries (medium and low development) in a sample of 120 countries	1% of broadband penetration generates an additional 0.138% in economic growth
Latin America	Katz (2010c)	2001-2006 for 19 countries of Latin America and the Caribbean	An increase in broadband penetration of 1% generates 0.0150% increase in GDP growth
Middle East and North Africa	Katz (2011)	2000-2010 for Arab States of the Middle East and North Africa	An increase in broadband penetration of 1% generates 0.010% increase in GDP growth

Figure. 2. Impact of broadband on GDP growth. [4].

2.1. Impact on job creation:

The impact of increased penetration of broadband versus job creation, are broken into two types of effects: jobs arising from the deployment of infrastructure and the resulting employment network effects and spill into other areas of the economy [4].

There are six studies that estimate the impact of the construction of broadband networks in employment: [5], [6], [7], [8], [9] Y [10]. These estimate the number of jobs created as a result of capital investment required for the deployment of broadband networks and conclude that there is a positive effect where increased penetration of 1% in broadband contributes to employment growth 0.002% to 0.3%.

Country	Authors	Objective	Results
	Crandall et al. (2003)	Estimate the employment impact of broadband deployment that increases the adoption of 60% to 95% of households requiring an investment of \$ 6.3 billion	* Generation of 140000 new jobs per year * Total jobs: 1.2 million (including 545,000 per construction and 645,000 indirect)
	Katz et al.	Estimate the impact on employment of the	* Total 128,000 jobs
USA	(2009a)	\$ 6.3 billion investment contemplated in the US government's stimulus program	(including 37,000 direct, 31,000 indirect and 60000 induced)
	Atkinson et al. (2009)	Estimate the impact on a \$10 billion investment in broadband deployment	* Total jobs: 1,80000 (including 64,000 direct and 116,000 indirect and induced)
Switzerland	Katz et al. (2008)	Estimate the impact of deployment of a national fiber optic network requiring an investment of CHF 13 billion	* Total jobs: 114,000 (including 83,000 direct and 31,000 indirect)
Germany	Katz et al. (2010a)	Estimate the impact of the \$ 4.7 billion investment required to implement the National Broadband Plan	* Total jobs: 542,000 (including 281,000 direct, 126,000 indirect and 135,000 induced)
United Kingdom	Liebenau et al. (2009)	Estimate the impact of the \$ 7.5 billion investment implicit in the "Digital Britain" plan	* Total jobs: 211000 (including 74500 direct and 134500 indirect and induced)

Figure. 3. Creation employment for broadband penetration. [4].

2.2. Impact on the increase in average household income:

A study in the city of Costa Rica, [eleven] Concluded that an increase of 1 percentage point in the regional broadband penetration results in an increase of 2.96% in the average household income.

Katz (2010d) A study the state of Kentucky in the United States [12], It was determined that, on average, an increase in broadband penetration of 1% results in an increase of 0.097% in the average household income in the following year.

2.3. Impact on creating consumer surplus:

This concept is defined as the benefit of users to be able to acquire a service for a lower price than they would be willing to pay.

In an analysis conducted between the period 1999 to 2006 in the United States [13], It was determined that the surplus generated by broadband represents 7.5 million US dollars, equivalent to 27% of the total surplus of the country.

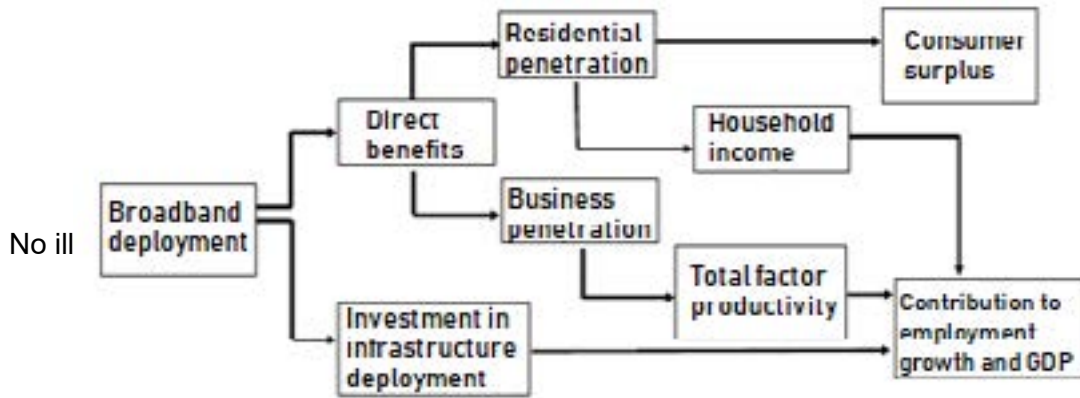


Figure. 4. Impact penetration bandwidth.[4].

3. RENATA network topology

Renata is made up of three government agencies: Ministry of ICT, Ministry of Education and Colciencias and eight regional academic networks: PATH, RIESCAR, UNIREL, RUANA, RADAR, RUMBO, RUAV and RUP. In the illustration No 5-national coverage in Colombian territory Renata shown:

1 6 7



Figure. 5. Renata national coverage.[14].

In order to simulate the RENATA network, it is needed to understand and keep in mind that, according to Katz, the implementation and development of these types of networks affects the following economic variables:

- Growth in the PIB of a country
- Job creation
- Increase of average income of households
- Creation of consumer surplus

The RENATA structure was considered for simulation. Backbone topology Renata is made up of 27 nodes distributed nationwide. As seen in Figure No 6, Core nodes are concentrated in Bogotá, Bucaramanga, Barranquilla, Medellín and Cali and from them the Capillarization is achieved towards the other major cities of Colombia.

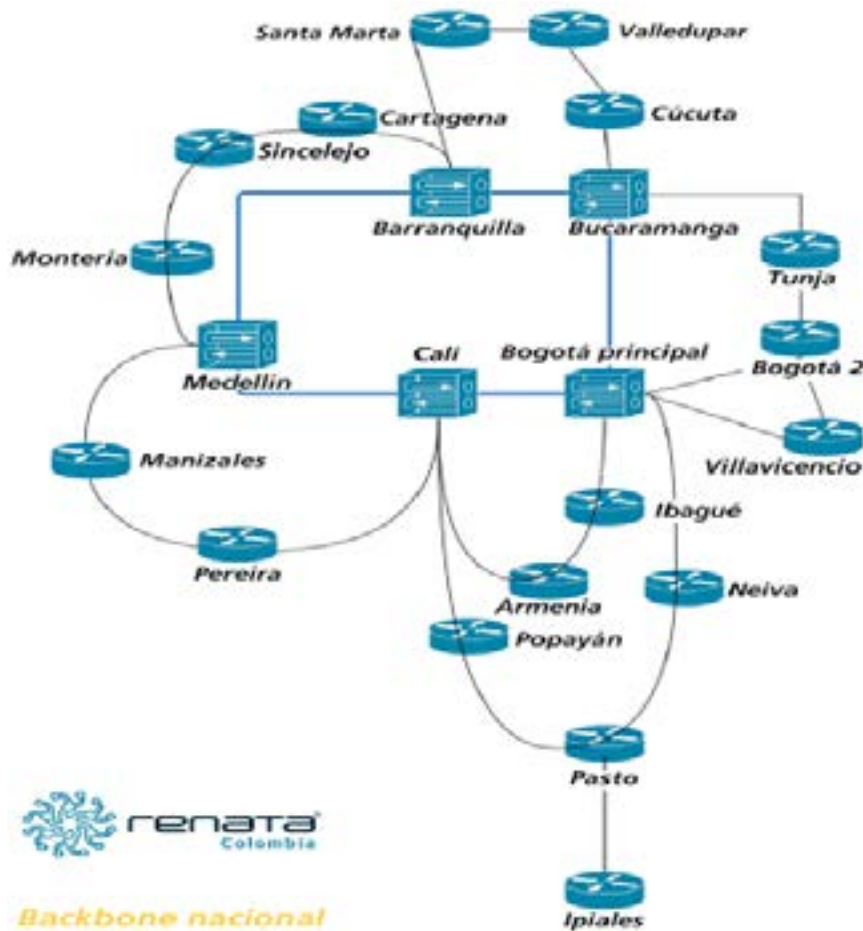


Figure 6. Renata national backbone. [14].

In order to evaluate the network topology Renata, a simulation of logic layer 3 currently deployed through software GNS3 v1.5.2 was performed. Images of real operating systems for real-life results, specifically, were used for the 7200 cisco routers deployed image was the “7200-adventerprisek9-mz.150-1.M.bin” (see illustration No 8). A final level of client

virtualization tool VMWare® 12 Pro Workstation version 12.5.0 build-4352439 in order to virtualize end hosts with Windows XP and content providers with Windows Server 2008 Datacenter Enterprise was used. In the No 9 Renata illustration topology simulated under free software GNS3 shown with a test LAN to LAN connectivity between the “Universidad del Rosario” and “Universidad de Antioquia”.



Figure. 7. Renata topology last kilometer. [14].

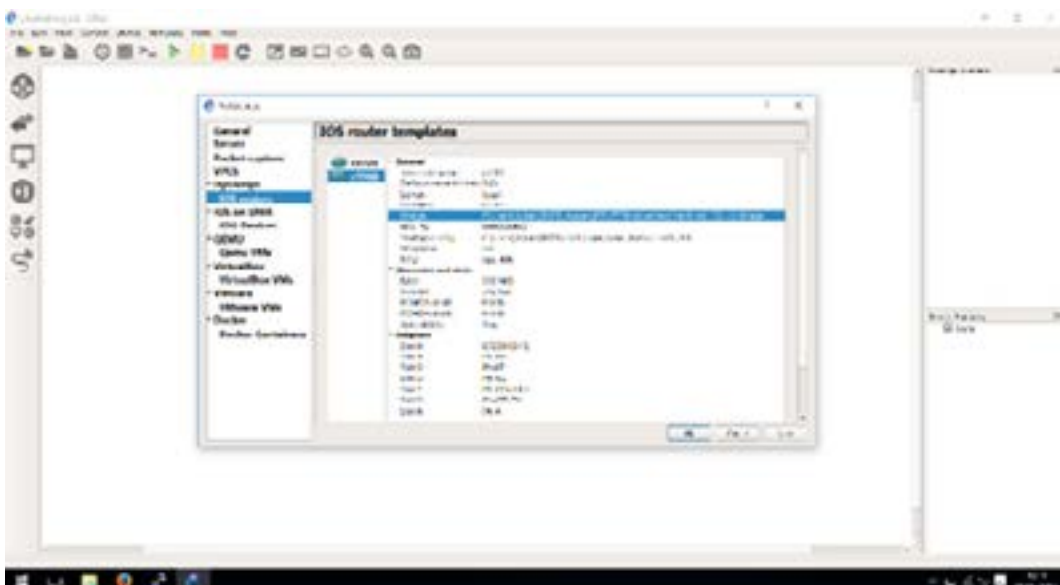


Figure. 8. Operating system used. Cisco IOS 7200.[16].

As a result of the simulation, it is concluded that the network of Renata is a typical network of a carrier commercial telecommunications, with dynamic routing type MP-BGP (Multi-Protocol – Border Gateway Protocol) which runs on MPLS (Multiprotocol Label Switching) technology; IGP level of Core, OSPF is used with a single area (area backbone 0). Further, as design

solution for implementing the full mesh IBGP, router reflector scheme is used.

To provide connectivity to customers of regional networks (Rumbo, Ruana, Riescar, etc.) scheme VRF (virtual route forwarding) is used for each along with a model extranet among all members of Renata, ie everyone can achieve public ip including segments.

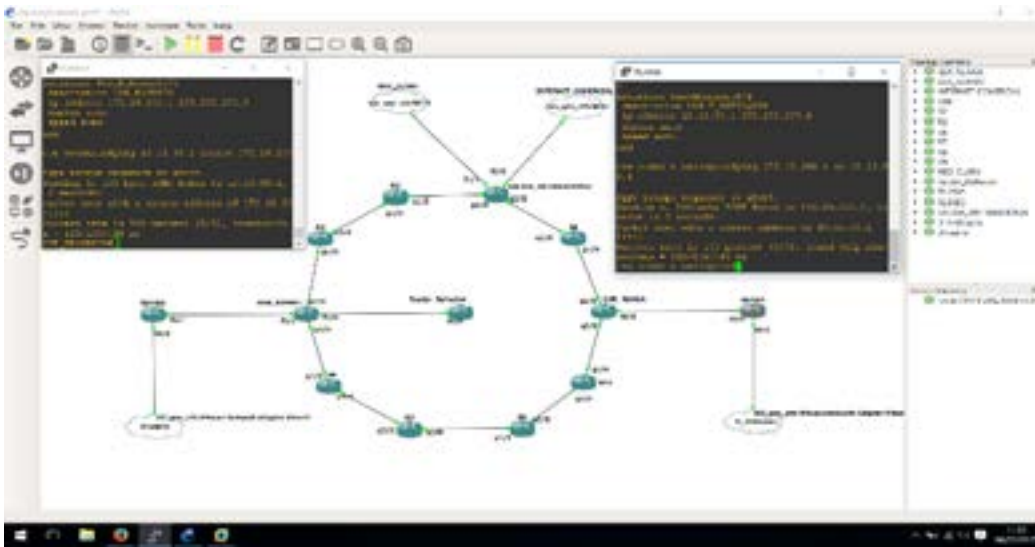


Figure. 9. Renata simulated topology. LAN to LAN connectivity [16].

Communications scheme Renata is summarized as follows:

- I. The final client requests a connection to a content or service external through a dynamic routing system (usually BGP), the request reaches router vendor.
- II. Through virtualization network through VRFs (virtual route forwarding), the IP packet continuous transit to the final destination; at this point, the internal IBGP routing telecommunications carrier responds with the address of the destination router (even within the cloud Renata), in this case "GSR_Ruana". Note, (Figure 10), the router responds, and everything known is the reflector router, that serves to form a full-mesh iBGP between all network nodes

Renata and therefore knows every end-customer segment.

- III. The reflector router responds to where you need to get the IP packet to reach its destination, however, per se, the IBGP does not know how to reach that destination (in the case of simulating the GSR_Ruana) so it rests on the IGP overall to achieve, in this case named as the OSPF 84. Note that this mismatch between the IBGP and IGP is necessary that within the customer BGP command "no sync", otherwise, be routing table of routers never would raise customer networks.

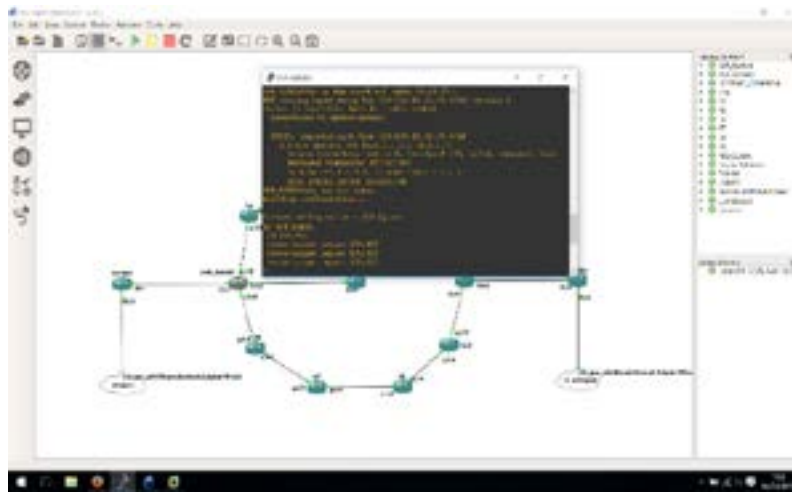


Figure. 10. Reflection topology router.[16].



Figure. 11. MP-BGP RENATA [16].

In the simulation traffic is routed via R2, R3 passing successively, international departure, R9 and GSR_Ruana.

IV. Finally, on target router, the request asks again to IBGP looking for their final destination, the router sends it directly to the end customer.

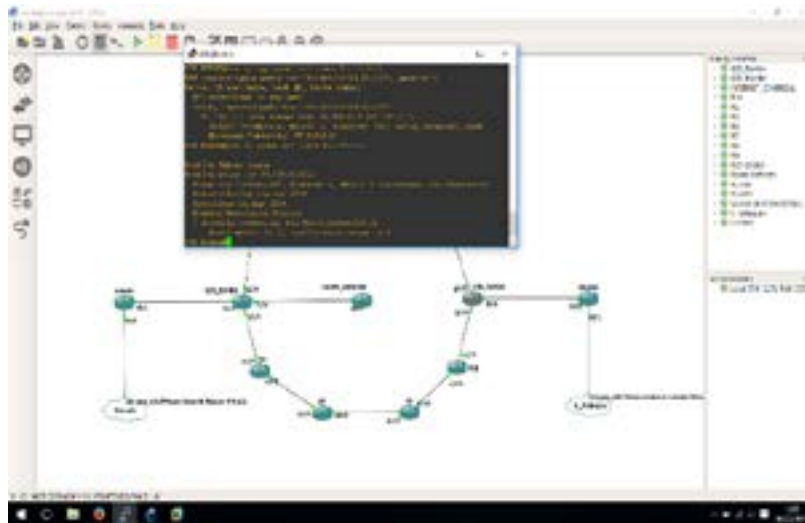


Figure. 12. Final Destination IP packet.

In conclusion, the logical network architecture Renata in essence, is identical to a commercial mpls network with dynamic model protocols IGP (Interior Gateway Protocol) and EGP (Exterior Gateway Protocol) as BGP. Physically, runs on a DWDM layer providing connectivity level 1 throughout the Colombian territory. In its creation, the value proposition of Renata was defined as an architecture unique network-level resources and physical infrastructure for their end customers, obtaining higher speeds than against business side, however, over the years and according to the evolution of the internet, this gap is completely closed, and such capabilities are comparable and easily surmountable by commercial services with competitive costs. This comparison can be seen in section 8, which describes the main differences in the use of bandwidth between RENATA and other academic networks worldwide.

4. NETWORK UTILIZATION RENATA – COLOMBIA

Speaking of Renata and taking into account the topology analysis in the previous section, we think of a high-speed network, with clear connection to the network who connects us

with the world and the National Research and Education Network (NREN). One might think that the consumption and use of network channels is huge with tera bytes or hexa bytes of information coursing through their infrastructure between local institutions and foreign research.

On the other hand, the prestige of being connected to a scientific high-speed network delves even the bodies of national academic accreditation and CAN (National Accreditation Council), who in their certification programs, consulting if the institution or university is connected to a high-speed academic network, if it is SNCTI, they add points for the accreditation process in the academic program.

As an example, in this research, the University of the Andes to evaluate your use of Renata choose. No illustration 13 shows the traffic carried by the University of the Andes through academic high-speed network in October 2016, the 95th percentile results in a utilization of 44 Mbps and 1 Mbps output input.

In order to determine globally the total consumption of bandwidth on the connection interface Rumbo (all affiliated universities in Bogotá) illustration No 14 is presented, it appears that for the month of October 2016; the

peak input traffic is 116.35 Mbps and 110 Mbps output, however, the 95th percentile results in 50 Mbps and 34 Mbps input output, ie the total use of Renata, including all universities associated Flights, 95% of the time, this maximum 50 Mbps and 34 Mbps input / output respectively for October 2016.

With the aim to evaluate a wider range of use of Renata academic network, a comparative study of average consumption of bandwidth of 30 universities plus the interconnection of communication throughout 2016 was conducted; illustration No 15 summarizes the consolidated performance (traffic input and output add understanding that both are part of the concept of network utilization) where it is observed that most universities used an average bandwidth during 2016 from 0 to 5 Mbps and only 3 had a slightly higher average (Universidad Minuto de Dios, Universidad de los Andes and Universidad Javeriana) ranges between 5.65 to 22 Mbps. The full interconnection was at its lowest average 30.79 mbps and at its highest value average 50.14 mbps. The peak of use over 2016 was 316.46 mbps and happened on April 27, 2016.

The results conclude that the consumption and use of network Renata is scarce. In spot investigation conducted at the University of Rosario, Renata is solely used to access Web pages that are known through the network, ie for a subject at a technical level publication and knowledge of prefixes IP internet level, which, itself, the services that the network provides.

The results show that the academic network infrastructure in Colombia is sub used by the connected institutions. This phenomenon occurs due to the lack of content and value to their end customers and even more so because there is no ownership and proper synergy between the academic network and their end customers in order to use all the potential that can be happen through this network, for example, pursue research and collaborations nationally and internationally, performing telemedicine services and second medical opinion, transfer big data, high performance computing, science cloud, telepresence, infrastructure as a service, IP telephony , etc.

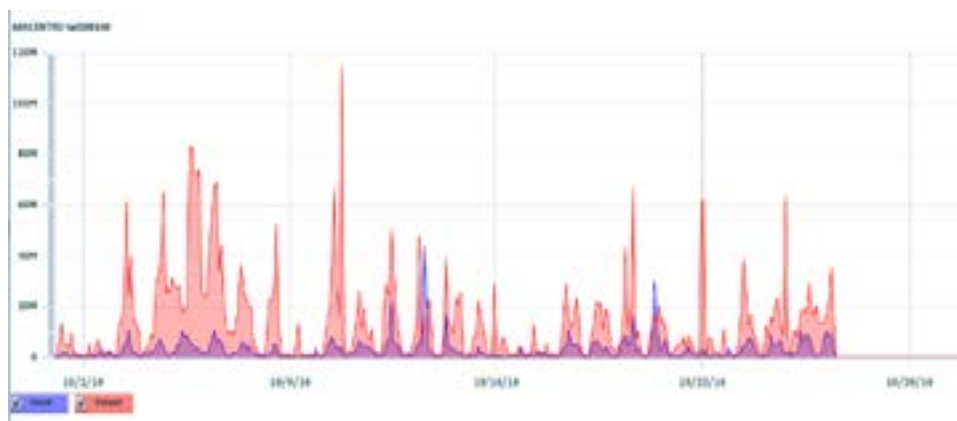


Figure. 13. Renata traffic Universidad de los Andes October 2016.[17].



Figure. 14. Renata use of the network – interconnection. October 2016 against Rumbo. [17].

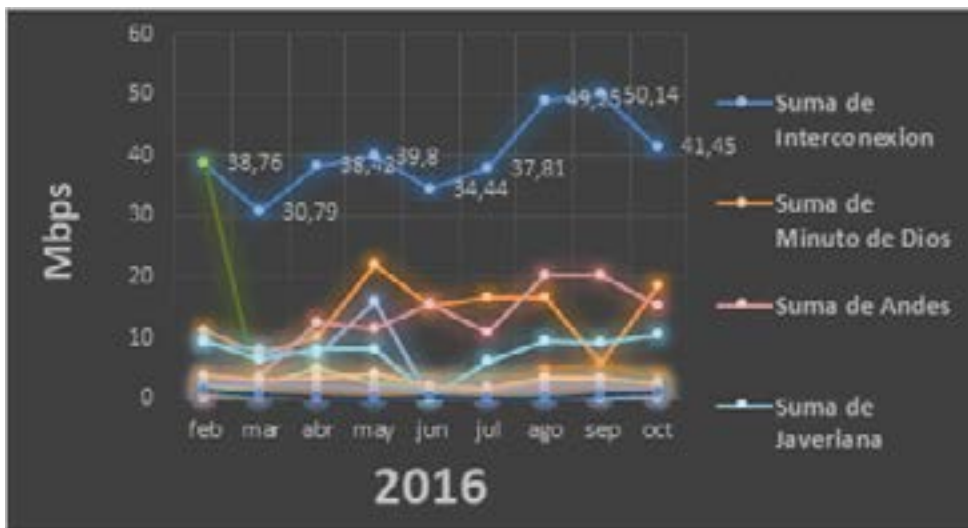


Figure. 15. Bandwidth consumption Renata 2016 consolidated.

5. Network use RNP – REDE NACIONAL Education and Research. Academic Network – BRAZIL

As a benchmark the appropriation and use of the academic network in Brazil was investigated. Illustration No 16 lists the RNP service catalog.

Catálogo de Serviços	2008	2009	2010	2011	2012	2013	2014	2015	2016
Comunicação e Colaboração									
Conferência Web	✓	✓	✓	✓	✓	✓	✓	✓	✓
fone@RNP	✓	✓	✓	✓	✓	✓	✓	✓	✓
Telepresença				✓	✓	✓	✓	✓	SM
Videoconferência	✓	✓	✓	✓	✓	✓	✓	✓	SM
Disponibilização de Conteúdos Digitais									
FileSender@RNP							✓	✓	✓
Transmissão de Sinal de TV	✓	✓	✓	✓	✓	✓	✓	✓	✓
Transmissão de Vídeo ao Vivo	✓	✓	✓	✓	✓	✓	✓	✓	✓
Videoaula@RNP				✓	✓	✓	✓	✓	SM
Video sob Demanda	✓	✓	✓	✓	✓	✓	✓	✓	SM
Gestão de Identidade									
CAFe			✓	✓	✓	✓	✓	✓	✓
eduroam					✓	✓	✓	✓	✓
ICPEdu			✓	✓	✓	✓	✓	✓	✓

Figure. 16. Service Catalog Brazilian academic network. [18].

The use of the catalog offered by the Brazilian academic network has grown consistently in recent years [18], Services are the fastest growing web conferencing service which grew 26% over 2015 and IP telephony, which had an increase of 64% compared to 2015.

Currently, there are 255 scientific research institutions in Brazil with its canals last mile

saturated waiting to be increased according to individual financial capabilities indicating a fairly high use of this academic network [18].

The average bandwidth interconnection RNP 2016 use was about 7 Gbps [18], Demonstrating an appropriation and proper use of the scientific community in Brazil for academic research network.



Figure. 17. Number of web conferencing RNP. [18].



Figure. 18. Number of minutes via fone @ RNP. [18].



Figure. 19. Number of monthly hours of use for videoconferencing in RNP. [18].

6. CUDI – University Corporation for Internet Development. Academic Network MEXICO

The academic network of Mexico CUDI is formed by a high-speed backbone (Figure 20) with 10 Gbps links between their main hubs: Toluca, Monterrey, Juarez and Tijuana. Interestingly, a direct connection to Internet2 (academic network in the United States) plus the RED CLARA (Internet 2 in Latin America) and GEANT (Internet 2 in Europe). The use of the academic network in Mexico presents a similar behavior to that of Brazil, although less therefore use is high and constant. No illustration 21 shows that the average traffic in the interconnection network CUDI against INTERNET 2 is close to 1 Gbps.

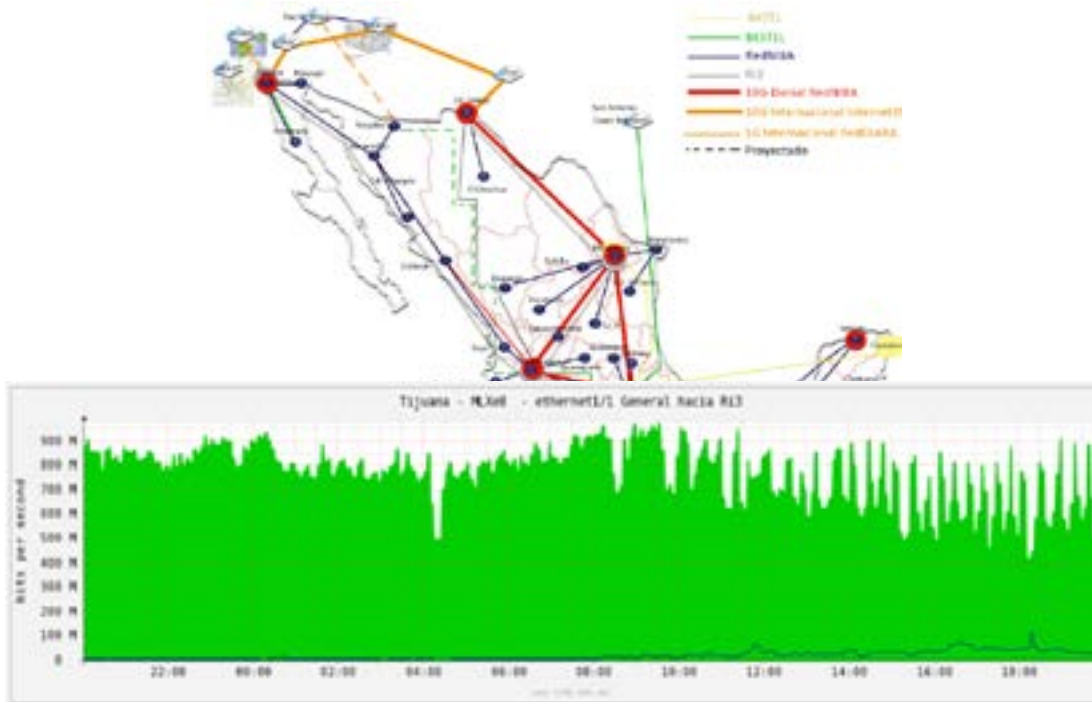


Figure. 21. Using CUDI bandwidth. Academic Network Mexico. [20].

7. RED IRIS – SPANISH ACADEMIC NETWORK

RedIRIS is the academic research network in Spain, offering advanced services to the scientific community and university authorities. It currently has 516 connected institutions.

No illustration 22 shows the network topology RedIris, is a fully meshed and dark fiber connection to the Canary Islands network. A level of external connection, has 4 international links, three of them with a capacity of 20 Gbps each with Level3, Cogent and Espanix providers and a 2 Gbps with Catnix provider.



Figure. 22. RedIris network topology [21].

Figure No 23 consolidates the monthly incoming traffic to the institutions connected RedIris from 2016. Illustration No 24 consolidates the monthly outgoing traffic RedIris from the connected institutions.

The use of Spanish academic network is very high, the scales of the illustrations shown in Peta bytes of information versus the timeline on a monthly scale. As for the incoming traffic from the institutions, in May 2016, they recorded 5.06

Peta bytes of information transmitted, on average throughout the year is in the range of 4 to 4.5 Peta bytes of information except the month of August 2016 where the summer season and holiday in Spain is presented. Referring to outbound traffic to the institutions, the use is further enhanced with a record of 9,331 Peta bytes of information sent in May 2016 and an average of 6 to 8 Peta bytes of information throughout the year.

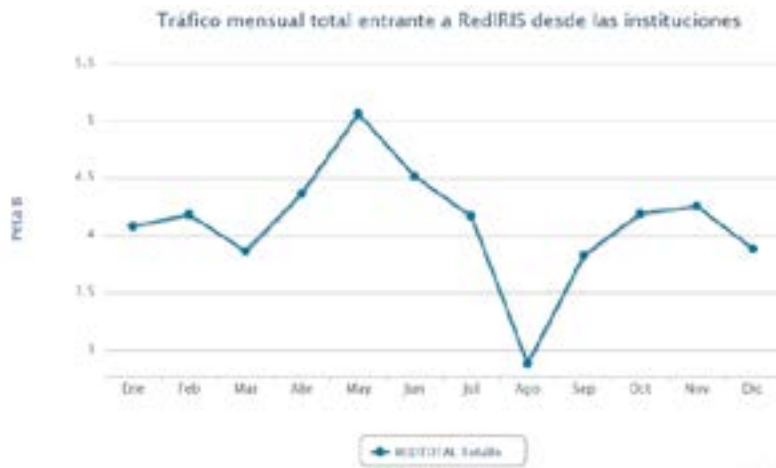


Figure. 23. RedIris 2016 consolidated incoming traffic. [21].



Figure. 24. Outgoing traffic RedIris 2016 consolidated. [21].

8. INTERNET 2 – NETWORK ACADEMIC USA

Academic and scientific network in the United States of America is on another level of use and ownership. Its backbone is summarized in redundant interconnections in a full mesh with a capacity of 100 Gb / s, including counting at various points of presence, 2 or 3 such

connections. 25 No detailed illustration network infrastructure Internet2.

As for its use and appropriation, illustration No 26 network shows consumption by 2016; the yellow refers to consumption type “Commodity Peering” and the green traffic type “Research & Education”. Use levels are in the range of 300 to 500 Gb / s.



Figure. 25. Backbone Internet 2 – United States. [22].

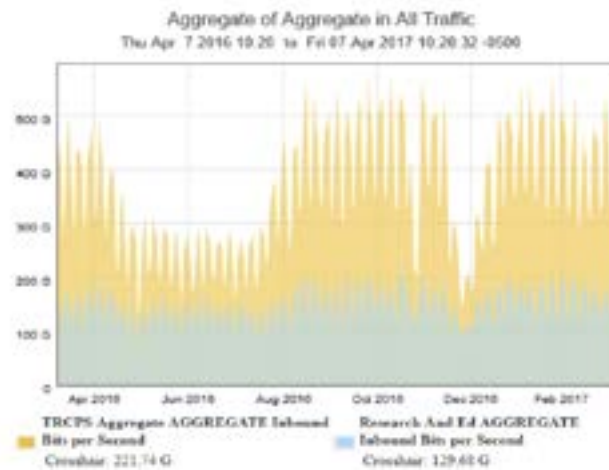


Figure. 26. Use Internet 2 – 2016 – United States. [23].

Illustration No. 27 shows the consolidated utilization of bandwidth investigative academic networks in Colombia, Brazil, Mexico, Spain and the United States for 2016 with timeline month, ie on average every month 2016, used these transmission speeds through academic high-speed networks. It is concluded that the use of academic networks in Brazil, Mexico and Spain are vastly superior to the use and appropriation of research academic network of Colombia which reached a monthly average utilization of 0.0390 Gb / s per month in 2016. The network academic and research US is simply another level of infrastructure and use.

Taking as a baseline the average utilization of the academic network of Colombia, which in

2016 was 0.0390625 Gb / s, is that there are some differences clearly marked on the use of academic networks worldwide.

Academic network	Using % above RENATA
RENATA	0.0390625 Gb / s (Baseline)
CUDI	2560%
RNP	17920%
RedIris	52531%
Internet 2	1024000%

Figure. 27. Using wide band 2016 academic networks.

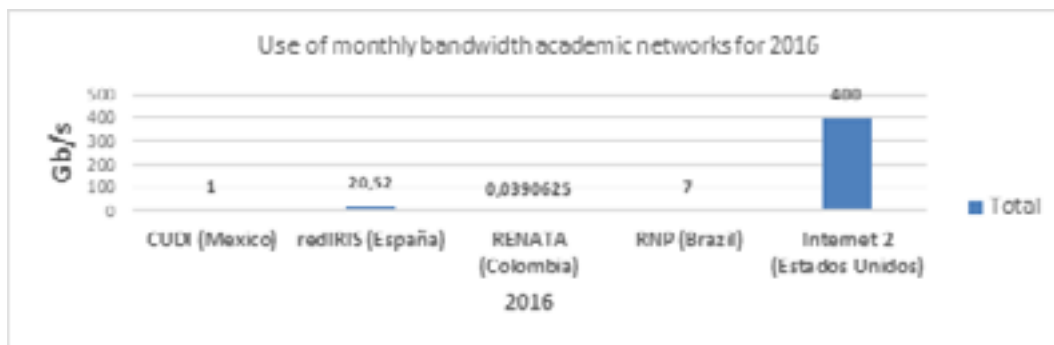


Figure. 28. Using wide band 2016 academic networks.

9. SERVICES OFFERED BY RENATA AND CONTENT

The services provided Renata are summarized in:

9.1. Connectivity services:

In the present investigation it was found that 2016 Renata entered into a change of provider for your entire network infrastructure, step of having as infrastructure provider Claro⁵ and he signed a new contract with Telefónica – Movistar⁶. The fact that the network infrastructure

⁵ Claro is a registered trademark of Grupo Carso.

⁶ Telefonica Movistar is a registered trademark under Telefónica SA

Renata is a telecommunications provider implies that network-level topology and communication, will be similar to the network architecture of the commercial internet, is possibly resources between the commercial network sharing and Renata network to its outputs and international connections, for example, VLANs, lambdas, sub interfaces or even within the same national network. Under the new model with Telefonica, the value proposition states that the network Renata is completely unique, low physical topology DWDM (Dense Wavelength Division Multiplexing) technology, the new network Renata is shown as a high-capacity network and performance, however, as evidenced in

chapter IV, the current use of this network is not warranted in any way a migration project to another supplier but a thorough plan of joint ownership between universities in Colombia and Renata.

No 29 in the illustration different connectivity services proposed by Renata shown, high speed academic network is 80 Mbps and the highest is

950 Mbps; for Internet shopping, the minimum bandwidth offered is 20 Mbps and greater than 350 Mbps. This range of possibilities is low interest for universities because the capabilities offered as a commercial internet are very low as to consider Renata as a single integrated provider for connectivity solutions.

Types of affiliation		Benefits included in the affiliation												
		Network capacity in MBPS		Monitoring	IPv6	Colfire	WAN	Eduroam	Colab.*	RENATA live	Voice	VC	Diffusion	Appropriation ESRC
		Academic	Public											
Prémium	950	50	X	X	X	X	X	X	X	X	X	X	X	
	900	100	X	X	X	X	X	X	X	X	X	X	X	
Standar	850	150	X	X	X	X	X	X	X	X	X	X	X	
	800	200	X	X	X	X	X	X	X	X	X	X	X	
	750	250	X	X	X	X	X	X	X	X	X	X	X	
	700	300	X	X	X	X	X	X	X	X	X	X	X	
	650	350	X	X	X	X	X	X	X	X	X	X	X	
	450	50	X	X	X	X	X	X	X	X	X	X	X	
Basic	100	0			X	X	X	X	X	X	X	X	X	
	80	20	X	X	X	X	X	X	X	X	X	X	X	

Figure. 29. Connectivity services. [18].

9.2. **Collaboration Services:**

Renata makes available on its website a platform called “Collaboratory” where they meet the collaboration services offered to universities and research institutions, then specifically disclosed:

ShippingService for sending large files. To test performance of this service is discharged from facilities University Rosario file “ubuntu-16.04.1-desktop-amd64.iso” 1.40 GB which is discharged in 190 seconds (3 minutes approximately) with speeds between 5 to 7 MB / s:



Figure. 30. Test internet download commercial Universidad del Rosario.

Later the same file is sent through the service of sending Renata, loading the file took 52 minutes 27 seconds. Illustration No 31 in the loaded file is displayed in the platform Renata:



Figure. 31. File storage platform Renata.

Email the recipient gets a link with the authorization details:



Figure. 32. Authorization to download the file sent.

We proceed to download the same file, this time from the high-speed network Red Clara – Renata:

1 8 2



Figure. 33. Download time from network Renata

Downloading the same file through the network of Renata took 1 hour 10 minutes. Tests were performed similarly with the service “Google Drive”, the file was uploaded to the cloud of Google in just 1 minute 54 seconds and was discharged in 1 minute 53 seconds with transfer rates between 12 and 15 MB / s. In conclusion,

service Shipping Renata has low performance compared to direct powers as Google Drive, Drop Box, One drive, among others; This is surprising because the network infrastructure that supports Renata. Then a table summarizing tests shown:

Table 1. Unlike downloading. Level 3 vs Renata vs Google.

File	Commercial Internet level 3	RENATA Network	Via Google Drive
File download "ubuntu-16.04.1-desktop-amd64" 1.40 GB	3,16 minutes	70 minutes	1,53 minutes

9.3. Academic Content

ServicesRenata offers services called: Communities, training, reference, Snaac (national system of open access Colombia).

As for the service of “communities”, this is an academic and scientific social network that consolidates all research groups registered to Renata, a total of 440 groups for the subject area of “engineering and technology” aims to share knowledge and discussions. At the time of this writing, it is investigated and service only shows the logo of the group or hotbed of research, there are no links to reach every official website and are mostly private; 140 with no current discussion groups and less than 3 members (people registered) were reviewed; the “communities” service is a failed attempt at a social network to academic and scientific level; compared with social networks other area as LinkedIn (professional network in the world with approximately 400 million users), Facebook with 1590 million users (nearly 25% of the world’s population), this research finds that there is no single and successful social network of the type “academic-scientific” in the world. The reasons for a social network to be successful are complex, so Facebook is a case of successful global network, however, the timeline many others and large successful companies like Apple, Microsoft, succumbed and died cases like hi5, MySpace, Badoo, ping, to name the most representative.

Perhaps the brake in the scientific community that there is a boom on an academic social network is the still preserved suspicion by copyright and failure to publish research results quickly and online until no legal effect of ownership take intellectual, patents, reviews and copyright, however, is a point that should try to resolve so that science can move forward “without handbrake” and achieve start a scientific boom worldwide perhaps supported by a network of social collaboration single, global scientific.

Services academic training offered by Renata called “training”, “reference” and “SNAAC” are value-added services, first because consolidate scientific information open to the entire research community, secondly, because they are free and thirdly because it provides visibility of the scientific production in Latin America. Examples of open policies of knowledge and innovation throughout history, have proven to be stronger and survive against counterparts closed, examples such as the BlackBerry company and its closed operating system with instant messaging software closed by the “pin “the Windows Mobile, Windows operating systems, operating system have suffered, in some cases, up to their extinction against open systems as” WhatsApp “, Android, Linux, MySQL databases, among others.

Academic content services offered by Renata themselves are of value to universities and research institutes in Colombia, however, an outreach strategy and ownership much stronger by Renata to end users is urgently needed.

10. VALUE PROPOSITION FOR ACADEMIC NETWORK IN COLOMBIA

Obviously academic research network in Colombia requires a fundamental change with the aim of promoting their ownership and use and thus leverage scientific productions of the country.

Then an organization and services that we consider of value to universities and research institutes in Colombia through its academic network is proposed, the idea is to generate discussion and debate with the aim of encouraging its transformation into a network of high value on research and scientific level.

10.1. Organization

1. Colombia academic network should be composed of all government ministries (like the Brazilian academic network) who can leverage applied research in different areas of interest, in addition to regional networks.
2. Colombia academic network should have staff in each institution aiming to promote projects within the university through the academic network.
3. Colombia academic network should manage projects on their own, take them to the implementation phase and make the corresponding outreach to universities to leverage their use and appropriation.

10.2. Services

1. Colombia academic network should provide scientific storage service in order to have high volume repositories of information available to all regional networks in Colombia, must implement a SAN type scheme, the order of Peta bytes of capacity.
2. Academic network Colombia must provide service HPC (high performance computing) processing capabilities of the order of 20 Tera bytes in RAM, co-processing of the order of 600 Tera flops (1 flops Tera is 1000 million operations per second) and 8000 CPU cores.
3. Colombia academic network should provide such services SAAS (software as a service) and IaaS (Infrastructure as a service) model under elastic capabilities growth and resource depletion according to customer needs.
4. The academic network of Colombia must provide the Science cloud service, this is a cloud with purely investigative object to publish the results of investigations virtually online, without waiting for purposes of copyright or patents that expand the benefit to take the society.

5. Colombia academic network together with universities, must develop a physical area of telepresence; This goes beyond a webcast service as it should manage to be as immersive and so real that it seems to be working in person with other universities in Colombia.

11. PRACTICAL AND ACADEMIC IMPLICATIONS

The academic importance of this work involves using powerful simulation tools such as gns-3 in the assessment and efficiency of high-speed academic networks in scientific research since implementation and operation in real time is very expensive in networks such as RENATA.

It allows to know firsthand the speeds, operativity, function and behavior in real time of these academic-oriented networks. On another note, the article presents an assessment and future outlook in the use and potential of high-speed academic networks in Colombia.

12. CONCLUSIONS

The National Academic Network of Advanced Technology (Renata) does not differ technically a commercial network of a telecommunications carrier in the country. Further, due to unnecessary change of provider network infrastructure (formerly Of course, now Telefonica), the economic model for SNCTI became more expensive, even offering less capacity to the current model, this led to the regional network of Bogotá (RUMBO), one of the most important in the country for its prestigious universities like the National University of Colombia in Bogotá, the University of the Andes, etc., Renata decided disconnected indefinitely citing little added value for universities.

The research carried out through RENATA focuses on the detection of the lacking use of international channels, i.e. the use for each region that comprises RENATA of the access networks (bandwidth). This reveals the need of universities to apply, develop and collaborate in a democratization process for the effective use of Internet 2 tools. Particularly through the simulation of the connectivity of associated networks, it was determined that they do not efficiently harness the advantages related with bandwidth which is evidenced with a use of 0.039 Gbps.

Future studies and recommendations could greatly benefit from the massification of Internet 2 technologies such as tele-immersion, augmented reality and the use of automated learning for streaming forecasts to be applied in medical and financial fields.

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