Scientific Paper / Artículo Científico

UNIVERSIDAD POLITÉCNICA SALESIANA ECUADOR
INGENIUS
Revista de Ciencia y Tecnología
https://doi.org/10.17163/ings.n21.2019.08
pISSN: 1390-650X / eISSN: 1390-860X

Migration to NGN in the Granma province

Migración hacia NGN en la provincia Granma

Randy Verdecia Peña[1]

Abstract

Due to the need of introducing and integrating the province network into a Next Generation Network (NGN), as a solution to the deficiencies of its infrastructure, in this paper a NGN for Granma province is proposed, based on its current conditions and considering the existence of the IP/ MPLS national backbone as vehicle. First, the NGN model structure features, facilities and signaling protocols are analyzed. Then, a detailed analysis of the equipment proposed by the manufacturer Huawei is performed, evaluating the availability and potentials of this technology. At last, elements that contribute to the migration of the current telecommunications network in Granma Province to a NGN are discussed.

Palabras clave: Granma Province, Solution, Next Generation Network (NGN), IP/MPLS, Multiservice Access Node (MSAN), NGN migration.

Resumen

Debido a la necesidad de introducción e integración de la red de la provincia Granma, hacia una red NGN, como solución a las deficiencias en la infraestructura de la misma, en el presente trabajo se brinda una propuesta de Red de Nueva Generación para la provincia Granma partiendo de las condiciones actuales de esta y considerando la existencia del dorsal nacional IP/MPLS como transporte. Primeramente, se analiza la estructura del modelo NGN, así como sus características, facilidades y protocolos de señalización. Posteriormente se realiza un profundo análisis del equipamiento propuesto por el fabricante Huawei, evaluando la disponibilidad y las potencialidades de esta tecnología. Finalmente, se exponen elementos que contribuyen a la migración de la red de telecomunicaciones actual de Granma hacia una red NGN.

Keywords: Provincia Granma, solución, red de nueva generación (NGN), IP/MPLS, nodo de acceso multiservicio (MSAN), migración hacia NGN.

[1,*]Department of Electrical Engineering, Center of Telecommunication Studies (CETUC), Pontificia Universidad Católica de Río de Janeiro. Río de Janeiro - Brazil. Corresponding author ✉: randy.verdecia@cetuc.puc-rio.br. http://orcid.org/0000-0003-4798-2681.

Received: 17-12-2018, accepted after review: 05-11-2018

Suggested citation: Verdecia Peña, R. (2019). «Migration to NGN in the Granma province». Ingenius. N.°21, (january-june). pp. 78-87. doi: https://doi.org/10.17163/ings.n21.2019.08.

1. Introduction

Nowadays, the telecommunications sector has been in significant and intense evolution, mainly due to the variable and increasingly demanding requirements of the users [1]. This evolution implies that telecomm operators should continuously improve their networks in order to fulfill the needs of users who expect more and better services [2, 3].

On the side of the demand, the growth has been propelled by the involvement of telecommunication and information technology in all facets of human life, in all sectors of economic and social activities [4–6], public administration [7], public service supply and management of public infrastructure [8], education [9, 10], health [11] and cultural expression, management of the environment and emergencies, either natural or man-made. From the supply side, the growth has been encouraged by the fast technologic evolution that continuously improves the efficiency of existing products, systems and services, and lays the foundations for a constant flow of innovations in each of these sectors [12].

In recent years there has been a continuous increase on the volume of information traffic in telecommunication networks, mainly due to the proliferation of new applications that combine voice, data and video. The data traffic (demand of the market) increases, both in the residential and corporate segments, mainly as a result of the combination of traditional data services, Internet traffic and e-commerce. This increase in the demand of bandwidth, together with the request for good performance of the associated services, requires a reassessment of existent public networks and a project to fulfill the demands. In terms of evolution, the Next Generation Network (NGN) is a step towards the replacement of the Public Switched Telephone Network (PSTN) by an IP (Internet Protocol) network, which is packet-based. In this regard, the NGN integrates the TDM (Time Division Multiple) voice network and the packet network based on IP/ATM (Internet Protocol/ Asynchronous Transfer Mode) [3, 13].

In Cuba, the Cuban Telecommunication Company (ETECSA) has been in charge of the development of the telephony infrastructure and data networks. For some years now, ETECSA started an intensive investment plan aimed at the implementation of modern solutions that lead to the integration of telephony and data services in a unique system, thus improving the throughput to users [14].

One of the main defects of the telecommunication network in the Granma Province is the coexistence of two networks, namely, telephony and data. This complicates the resources management and hinders, in many cases, the implementation of new services based on the IP technology. Based on this discussion, the objective of this research is to propose a solution for migrating the telecommunication network of the Granma Province to a NGN.

2. Materials and methods

The telecommunication network of the Granma Province is mainly constituted by four loops; 93% of the municipalities use optic fiber as transmission media, which employs SDH (Synchronous Digital Hierarchy) as transportation technology. This network has 63 commutation elements, which are implemented on 80 Huawei transmission devices such as: OSN 3500, OSN 2500, Metro 2050, Metro 1000, Metro 100, Metro 500. For commutation of voice the network has a provincial tandem Huawei C&C08, located in Bayamo.

On the other hand, the data network is constituted by devices DSLAM (Digital Subscriber Line Access Multiplexer) IP distributed all over the province, which are connected to the national network through a redundant link implemented on a NE-40 router, one with the Santiago de Cuba Province and the other with Holguín. All this network is based on the existence of the IP/MPLS (Multiprotocol Label Switching) national backbone as transportation network.

The NGN is a packet network capable of supplying broadband communication services, to users from different providers. Its main advantage is that all services, voice and data, operate on a single network. Its architecture is based on four fundamental layers that, together with the signaling protocols, achieve a correct functioning. Some of these protocols are the H.248, H.323, SIP [15].

A migration to NGN was proposed some years ago, in which it was recommended to use a Huawei NE40 border router, to aggregate all the network at this point. That router does not have the capability to carry out such task, since it should handle all the traffic of the province. Such work does not specify the locations at the province where the technology (MSAN IP) might be installed in order to yield the migration to this network, neither makes reference to necessary quantity of POTS, ADSL2+ y SHDSL lines. As a consequence, the transmission velocity which should be used in the different data links of the Granma Province is not calculated.

Different service providers have proposed a solution for this type of network, but Huawei offers a complete solution according to the possibilities of the country's economy. To this effect, this manufacturer has available various devices such as UMG8900, Softswitch3000, UA5000, that make this network flexible, as described in [16–18].

3. Results and discussion

Based on the current situation of the telecommunication network of the Granma Province, as well as the existence of the backbone IP/MPLS, of the Softswitch and the possibilities offered by Huawei, the migration to NGN of the Granma Province was proposed. In this proposal, a CX300 is the element that will do all the voice and data commutation. In addition, this device will be in charge of the communication with the national network. A gateway UMG8900 with 32 E1 flows is located in the digital exchange C&C08, and this element will be used to communicate the IP world with the TDM. Other elements used are the MSAN IP, which are deployed all over the province.

The actual solution is maintained for data subscribers since the DSLAM IP will stay for connectivity, and will be inserted in the IP world through the border router like the MSAN IP. In order to extend the services of the NGN to all the URA connected to the C&C08, all the equipment must support NGN functionalities. There are in the province devices RSM, RSP, ESM, OLT and the Alcatel exchange, that do not support NGN functionalities; as a consequence, the segments of the network that involve such equipment will not benefit from all the advantages of the solution. Therefore, it is necessary that the consolidation stage of the NGN includes their successive replacement.

A call from the current PSTN of Granma Province telephone exchange with the NGN world (external to this province) will be made through the UMG (used as media gateway); the traffic will be directed by the border router located at Bayamo, which will travel through the IP/MPLS backbone to his destination. On the contrary, a territorial call from the new NGN segment to the PSTN and vice versa will be established through the UMG, whose routing is guaranteed in the border router located at the province, without leaving to the backbone IP/MPLS. The complete control of establishing the call and metering, among other network supervising actions, will be carried out by the two softswitches.

The Figure 1 illustrates the proposed migration to NGN for Granma Province. The service provider will be Huawei, since it offers a more complete solution, at a reasonable cost consistent with the current economic situation of Cuba. It is proposed that the digital exchange TDM C&C08 and the UMG 8900 are located in the same site; the latter will be used as the gateway of the TDM C&C08, allowing the communication between the TDM and IP users. In addition, two 24-port S5328 lanswitches connected in stack will be installed in the same premises, with the purpose of adding all the services supplied by the MSAN IP which will be also located in the same site. It is suggested to foresee future expansions of the MSAN IP and the gradual migration of the subscribers connected to the C&C08 towards NGN.

In the site of the CMT it is proposed to locate the Huawei CX 300, which will carry out all provincial network commutations, and will have aggregation functionalities for both networks, voice and data. It will connect via two G/E links to the lanswitches S5328 and through F/E to the provincial SDH network using the OSN 3500 device located at the CMT, and with national SDH network through two G/E links using the OSN 7500. The CX 300 has a backplane velocity of 48 Gbps, and uses the routing protocols OSPF, IS-IS and BGPv4. In the proposed migration, the MSAN TDM, the URA and other equipment that is currently used to provide services to the municipalities in the province will be maintained. A total of 8 MSAN IP will be installed, including one in the site of the digital exchange to provide service to 24000 new subscribers in all the province, even though in this solution only 9408 services will be installed, between fixed telephony and data.

Future actions should be directed toward the consolidation of the NGN networks, thus the current MSAN with TDM functionality should be gradually migrated to the IP world, eliminating the function carried out nowadays by the C&C08 by connecting them directly to the CX 300 router; similarly, all new sites added to the network should already include IP functionalities. Only 8 sites will be installed in this proposal, due to three main reasons: technological change, low telephone density and network expansion. Table 1 shows the equipment to be used and their location.

Erlang's theory is applicable to the basic telephone service, independently of the support, medium or technology used to supply such service; its validity is determined by the behavior of the users. It is applied to the service, not to the technology. There are two theories: losses (Erlang B) and queuing (Erlang C). Therefore, it is applicable to dimensioning the resources that will support the NGN; in this case, the transmission velocity VoIP required to carry traffic on this type of network. In traditional TDM networks, when calculating the quantity of required circuits to carry a particular traffic with one percent losses, the transmission velocity is being indirectly calculated because each circuit is a PCM channel with a transmission velocity of 64 Kbps.

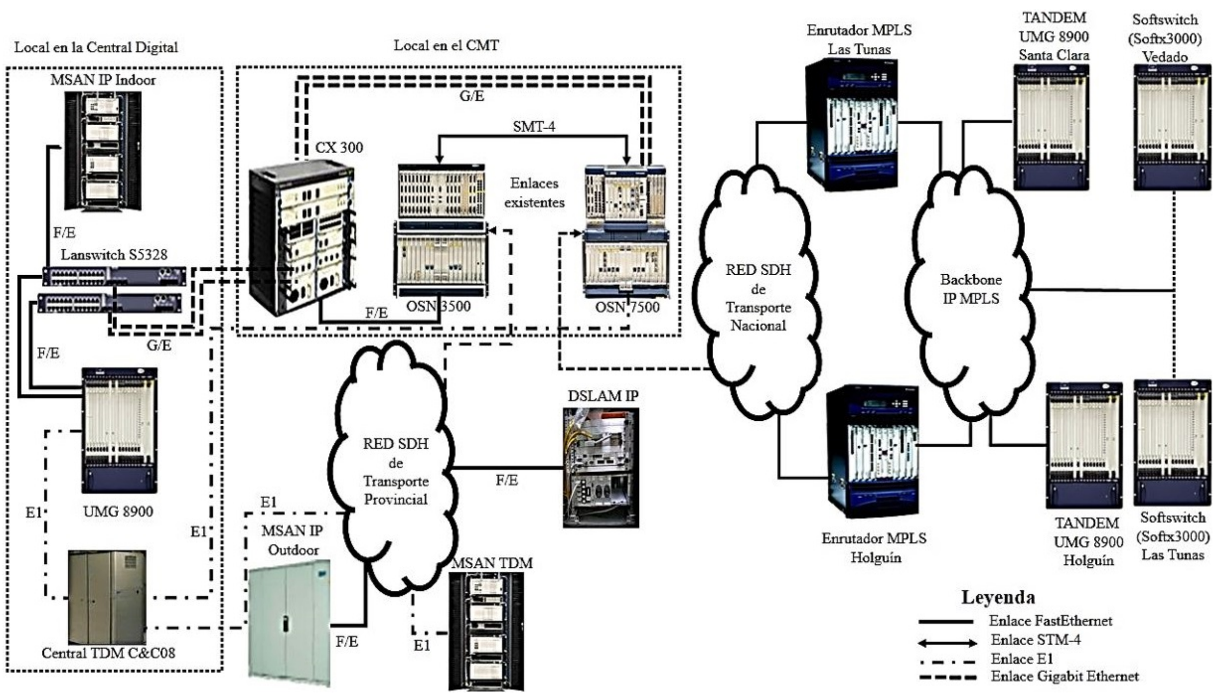

Figure 1. Proposed migration to NGN for Granma Province, Huawei provider.

Table 1. Location of the MSAN IP

Equipment	Location	Transmission device
MSAN IP (Inside)	Bayamo	Metro 1000
MSAN IP (Inside)	Cauto Cristo	Metro 1000
MSAN IP (Inside)	Río Cauto	Metro 1000
MSAN IP (Inside)	Niquero	Metro 1000
MSAN IP (Inside)	Manzanillo	OSN 3500
MSAN IP (Outside)	Vázquez	OSN 500
MSAN IP (Outside)	Camilo 1	OSN 500
MSAN IP (Outside)	Camilo 2	OSN 500

Table 2. Number of lines and necessary transmission velocities

Locations	N.° lines	Voice (Mbps)	Data (Mbps)	Voice + Data (Mbps)
Bayamo	896	12	26	38
Cauto Cristo	864	12	22	34
Río Cauto	1216	15	34	49
Niquero	960	13	26	39
Manzanillo	896	12	26	38
Vázquez	960	13	26	39
Camilo I	960	13	26	39
Camilo II	960	13	26	39

For calculating the velocity of transmission of the voice, it is necessary to take into account that each protocol or layer encapsulates an IP packet by adding some headings to be able to process and route it. As a consequence, the packet to be transmitted has a bit size much greater than the Payload (usable load of the voice). Each CODEC has a predetermined transmission velocity of voice packets; the required velocity should be higher due to the increase in the size of the packet. In order to transmit the voice from a MSAN IP through the IP network, the following protocols should be used: Layer 2 link, IEEE 802.3, IP, UDP (User Datagram Protocol) and RTP (Real-time Transport Protocol) [19].

Table 2 shows the transmission velocities calculated in [20], as well as the necessary number of lines in each of the 8 locations.

3.1. Migration of sites Camilo I and II

The Camilo Cienfuegos neighborhood is one of the greatest areas of the provincial town (Bayamo). It is a location with a high density of households and a low density of telephones (only 8.58% of demand of twisted pairs). Currently, the network is saturated with low capacity cables, as compared with the number of existent households and the demand for telephony services. The problem of the network in this zone is due to the saturation of the networks in the province: fixed, mobile, radio. In addition, there are no more ports available in the URAs at Bayamo, which results in the following facts:

- 66.67% of the households demands, at least, one telephone pair.
- 41.67% of the buildings are two-story or more.

- The remaining 33.33% demands one telephone pair for two households.
- The density of the telephone service is 2.04 for every 100 inhabitants.

Figure 2 shows the network structure for Camilo Cienfuegos. For migrating this zone, it is proposed to use two Outdoor MSAN IP (Camilo Cienfuegos I y Camilo Cienfuegos II). Those MSAN IP will employ the provincial SDH network to carry the IP packets. It is also proposed to install two OSN 500 that will be utilized as transmission elements for the new network structure of the site; they will have an EFS card for Ethernet services, foreseeing future connections for data transmission associated to the external distribution area. In addition, the MSAN IP will use two control cards for narrowband services (PVM), and two for broadband services (IPMD).

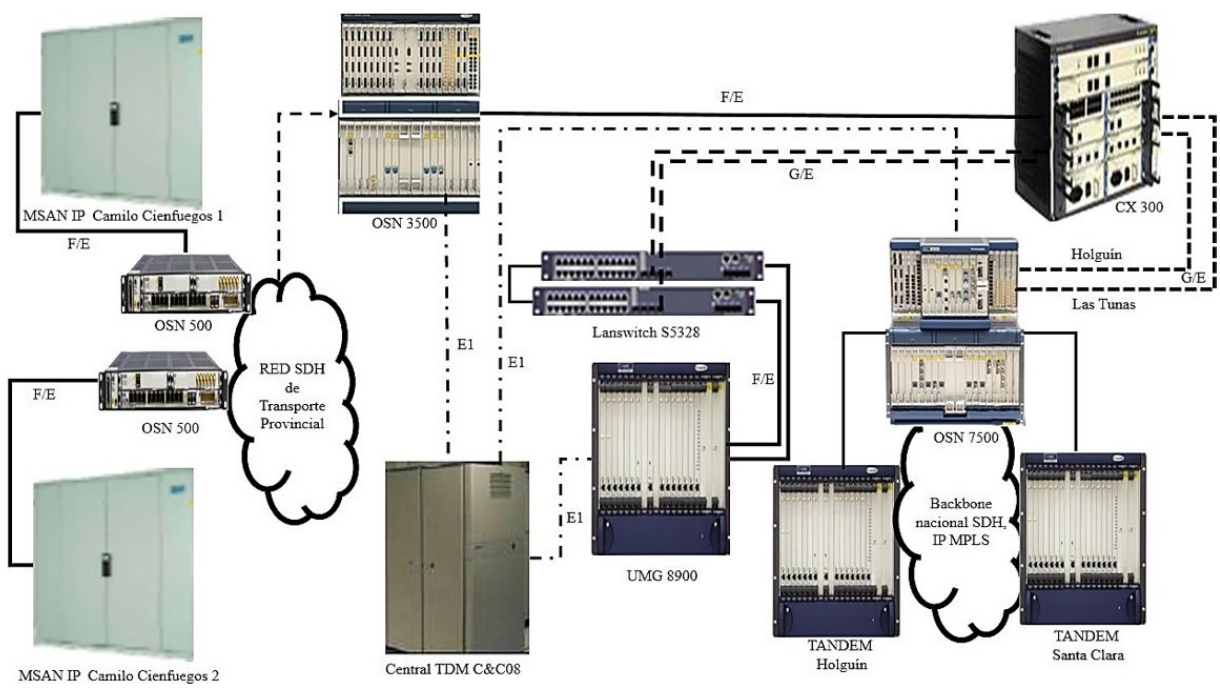

Figure 2. Proposed network for sites Camilo Cienfuegos I and II.

3.2. Migration of site Bayamo

The Bayamo site has an exchange TDM C&C08 with 51520 lines, 9040 of which are installed in the telephone center itself distributed in three RSP cabinets, with 8942 currently in operation. Besides being considered an obsolete technology, they already reached maximum capacity.

As can be seen in Figure 3, the MSAN of Bayamo will be directly connected to the s5328 lans witches, and these to the CX300, which is the device in charge of carrying out the commutation to the final destination.

The MSAN of Bayamo will have two control cards for narrowband services (PVM), and two for broadband services (IPMD). The four cards will be wired to the S5328 lanswitches, which will concentrate the traffic of the URA IP. Softswitches in El Vedado and Las Tunas will control de MSAN IP by means of the protocol H.248.

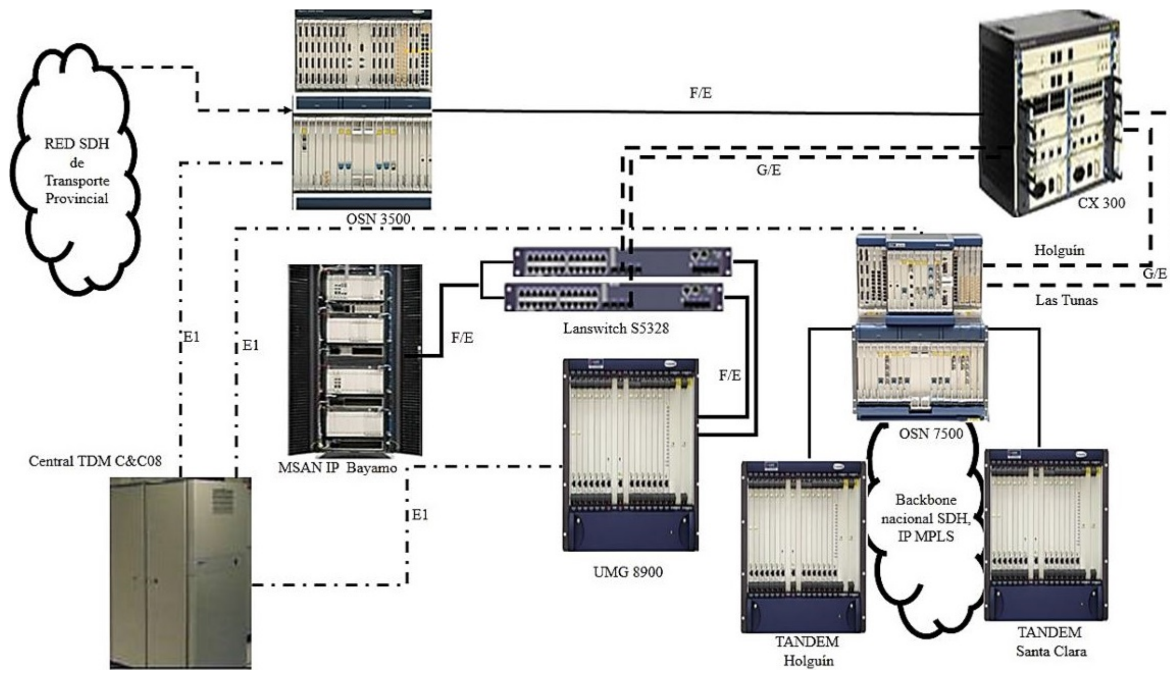

Figure 3. Proposed network for site Bayamo.

3.3. Migration of site Río Cauto

The Río Cauto municipality currently has a URA DLC of the exchange TDM C&C08, with a total of 800 lines, 788 of which are in operation; this technology is considered obsolete.

To solve the problem in this municipality, it is necessary to completely replace the DLC technology in the site. This will be achieved through the installation of a Huawei Indoor MSAN IP type F02A HABA with rear wiring, which will be controlled by softswitches in El Vedado and Las Tunas. The MSAN IP will have a S3328 lanswitch to receive the wiring from the FE interfaces of the PVM and IPMD control cards. The transmission equipment that will be used is the Metro 1000 currently installed in the municipality, as shown in Figure 4.

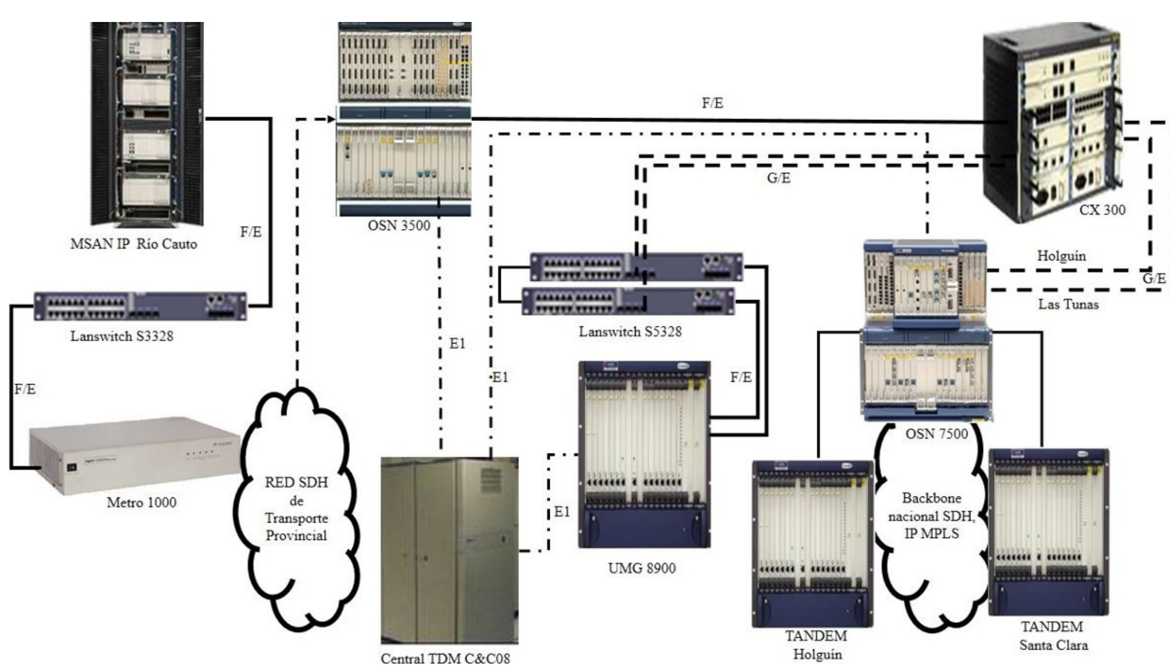

Figure 4. Proposed network for site Río Cauto.

3.4. Migration of site Cauto Cristo

Cauto Cristo has an exchange CDPC A4300 of small capacity, linked to the central TDM C&C08. It has 704 lines installed, of which 666 are in operation in this equipment which is considered obsolete technology. Therefore, a Huawei MSAN IP will be installed to make a technological change in the CDPC.

Figure 5 shows the structure of the network of Cauto Cristo, where the MSAN with rear wiring will have a S3328 lanswitch to receive the wires from the FE interfaces from the ports of the broadband (IPMD) and narrowband (PVM) control cards. The MSAN IP will have 864 POTS, 160 ADSL2+ and 16 SHDSL lines.

The POTS lines in the cards H60D00VASL01 will be for 64 subscribers, while the ADSL2+ lines in the cards H60DCSRB6101 (which in this case operate as a combo because it also houses POTS subscribers) will be for 32 subscribers. The lines SHDSL (H60-SHLB) have 16 service ports. A Metro 1000 is proposed as the transmission element for the site, which will be used to travel on the SDH network of the province.

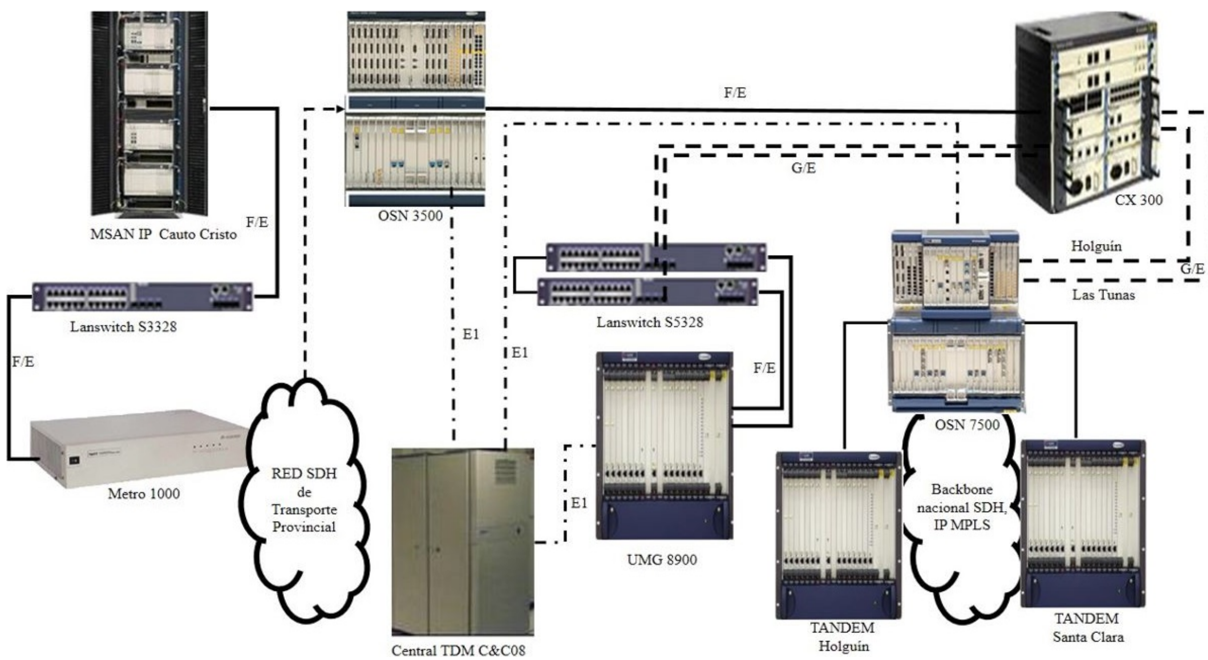

Figure 5. Proposed network for site Cauto Cristo.

3.5. Migration of site Manzanillo

The Manzanillo municipality has a URA in the exchange TDM C&C08 that has 5776 lines, 5447 of which are in operation, and distributed in four cabinets of an ESM, which is considered obsolete technology. In order to increase the number of lines in the city, it is proposed to install a Huawei MSAN IP type F02A HABA with rear wiring, inserted in the solution of the province NGN. This device will be controlled by softswitches in El Vedado and Las Tunas, by means of the protocol H.248.

For this increment, it has been devised the acquisition of a MSAN IP UA5000 that will have a S3328 lanswitch to receive the wiring from the FE interfaces from the ports of the broadband (IPMD) and narrowband (PVM) control cards, with 896 POTS, 192 ADSL2+ and 16 SHDSL lines.

The POTS lines in the cards H60D00VASL01 will be for 64 subscribers, while the ADSL2+ lines in the cards H60DCSRB6101 (which in this work are called combo because they also may house POTS subscribers) will be for 32 subscribers. The lines SHDSL (H60-SHLB) will have 16 service ports. The OSN 3500 in service will be used for the transmission, thus carrying the traffic on the provincial SDH network, as shown in Figure 6.

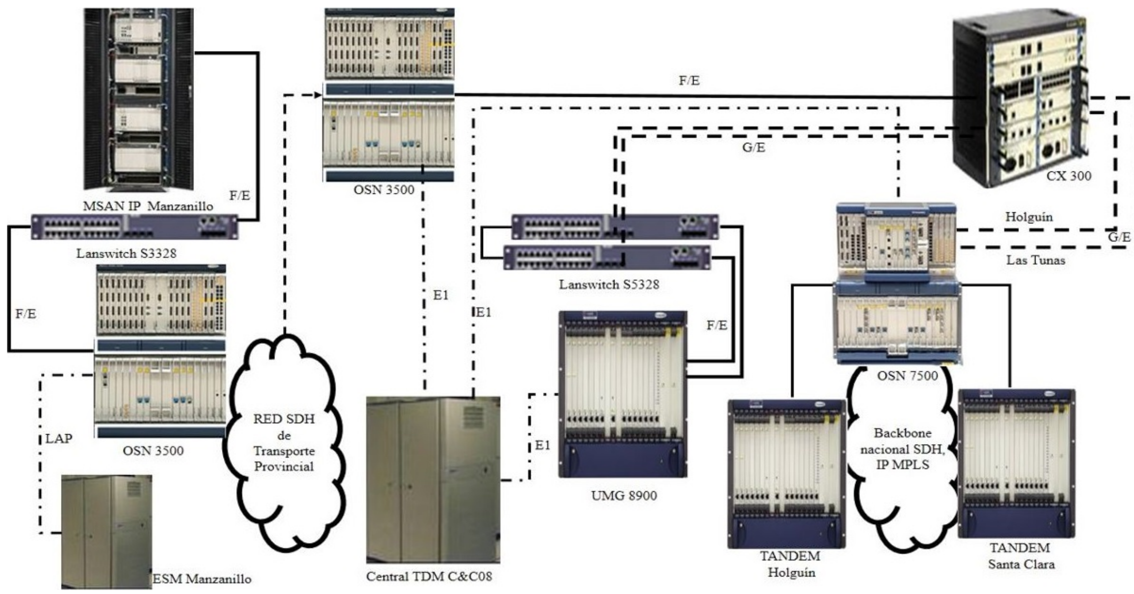

Figure 6. Proposed network for site Manzanillo.

3.6. Migration of site Vazquez

The neighborhood Vázquez is one of the largest of the Manzanillo municipality. It is a zone of high density of households, and low density of telephones. To overcome the situation previously described, a MSAN IP of type F01D1000 with 960 POTS, 192 ADSL2+ (combos) and 16 SHDSL (pure data) lines, equipped to offer VoIP services. The MSAN will use narrowband (PVM) and broadband (IPMD) control cards.

Figure 7 shows the structure of the network of site Vázquez. The MSAN IP will use the provincial SDH network for carrying the IP packets, and an OSN 500 is proposed as the transmission element for this zone; it will have an EFS card for the Ethernet services, foreseeing the future connections for data transmission associated to the external distribution area. The telephone and data traffic may be from the IP world to the TDM, and between worlds IP, municipal, provincial and national. The communication of this network segment with the provincial and national subscribers will travel through the provincial SDH network, in the same way as in the Camilo Cienfuegos site, using an OSN 500 as transmission element.

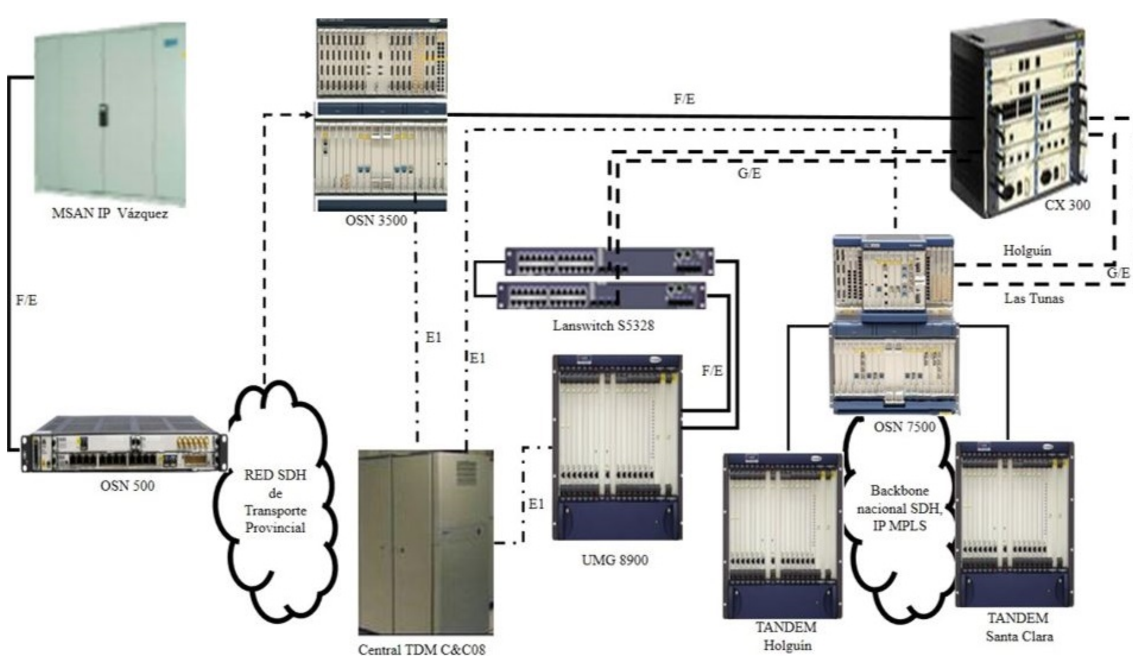

Figure 7. Proposed network for site Vázquez.

3.7. Migration of Niquero site

The MSAN will have a S3328 lanswitch to receive the wiring from the FE interfaces from the ports of the broadband (IPMD) and narrowband (PVM) control cards, with 896 POTS, 192 ADSL2+ and 16 SHDSL lines. This equipment will comprise 960 POTS, 192 ADSL2+ and 16 SHDSL lines. It will be inserted in the provincial transport network by means of a Metro 1000 that is operating in the site, as shown Figure 8.

Currently, the Niquero coastal municipality has a URA RSM in the exchange TDM C&C08 that comprises 1216 lines, 1153 of which are in operation. Since this is an obsolete equipment, its internal hardware cannot be expanded.

In order to expand the number of lines in this part of the Granma province, a Huawei MSAN IP F02A HABA with rear wiring will be included in the Huawei NGN solution for the province.

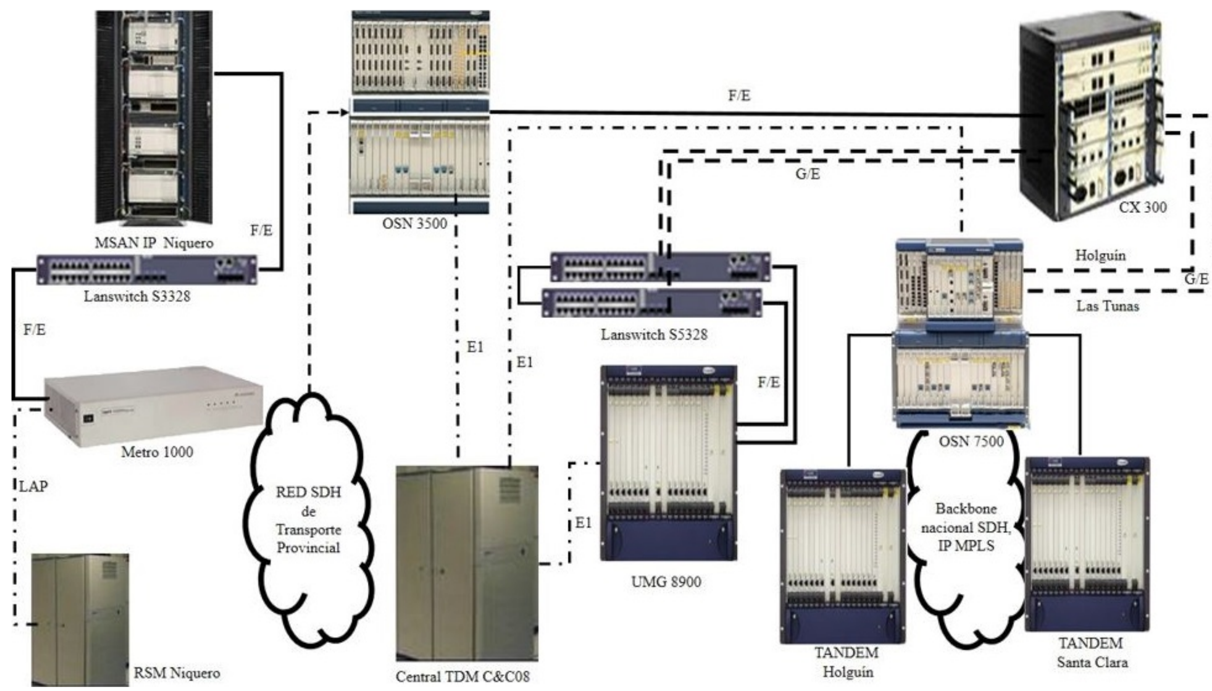

Figure 8. Proposed network for site Niquero.

4. Conclusions

The migration proposal toward NGN of the Granma Province telephony and data network, reuses the current telecommunication infrastructure to the maximum extent possible, thus allowing significant savings in the budget allocated to the project.

The proposed solution does not lead to the total migration of the Granma Province to NGN, because the capital to cover all sites is not completely available; nevertheless, it lays the foundations for the rapid expansion of this technology to the places which are not reached in this phase.

The fact that more than 90% of the municipalities are connected to the national optic fiber, facilitates the future installation of the necessary NGN equipment in the sites that were not taken into account in this phase of the project.

References

[1] E. Öztürk, E. Basar, and H. A. Çirpan, "Generalized frequency division multiplexing with flexible index modulation," *IEEE Access*, vol. 5, pp. 24 727–24 746, 2017. [Online]. Available: https://doi.org/10.1109/ACCESS.2017.2768401

[2] UIT, *Informe sobre el desarrollo mundial de las telecomunicaciones 2002*. Union internacional de Telecomunicaciones, 2002. [Online]. Available: https://goo.gl/HLLi74

[3] CET, *Las telecomunicaciones y la movilidad en la sociedad de la información*. Entro de estudios de telecomunicaciones de América Latina, 2004. [Online]. Available: https://goo.gl/oGBt4P

[4] S. Jiménez and J. Lira, *Desarrollo de las Telecomunicaciones: Una Fuente para el Progreso*. Libertad y desarrollo, 2015. [Online]. Available: https://goo.gl/5HWYgT

[5] M. Rodríguez, "Crecimiento y expansión de los servicios de telecomunicaciones en argentina durante la posconvertibilidad ¿concentración económica con descentralización productiva?" *Galega de Economía*, vol. 25, no. 1, pp. 121–136, 2016. [Online]. Available: https://goo.gl/o6QmmQ

[6] A. L. Mellado Ochoa, "La infraestructura de telecomunicaciones y el desarrollo económico de los países," Master's thesis, Universidad del Pacífico, Perú, 2016. [Online]. Available: https://goo.gl/82nRgN

[7] ENS, *El sector de las telecomunicaciones: Entramado de relaciones laborales con lox gigantes colombianos*. ENS. Escuela Nacional Sindical, 2015. [Online]. Available: https://goo.gl/dDpqmo

[8] M. de Telecomunicaciones, *Plan Nacional de Telecomunicaciones y Tecnologías de la Información del Ecuador 2016-2021*. Ministerio de Telecomunicaciones y de la Sociedad de la Información, Ecuador, 2016. [Online]. Available: https://goo.gl/kJwWaa

[9] R. Verdecia Peña and M. Paneque Mojena, "Aula especializada para el fortalecimiento de la preparación integral de los trabajadores de la Empresa de Telecomunicaciones de Cuba," *Didasclia: Didáctica y Educación,*, vol. 8, no. 1, pp. 131–142, 2017. [Online]. Available: https://goo.gl/pDoKg7

[10] R. M. Hernandez, "Impacto de las tic en la educación: Retos y perspectivas," *Propósitos y Representaciones*, vol. 5, no. 1, pp. 325–347, 2017. [Online]. Available: http://dx.doi.org/10.20511/pyr2017.v5n1.149

[11] L. Y. Avella Martinez and P. P. Parra Ruiz, *Tecnologías de la Información y la Comunicación (TICS) en el sector salud*. Especialización en Administración en Salud Pública y Servicios de Salud, Universidad Nacional de Colombia., 2013. [Online]. Available: https://goo.gl/8e8eTQ

[12] G. E. Cano Pita, "Las tic en las empresas: evolución de la tecnología y cambio estructural en las organizaciones," *Dominio de las Ciencias*, vol. 4, no. 1, pp. 499–510, 2018. [Online]. Available: https://goo.gl/JFPNRs

[13] S. K. Mohapatra, "Integrated planning for next generation networks," in *2009 IFIP/IEEE International Symposium on Integrated Network Management-Workshops*, June 2009, pp. 205–210. [Online]. Available: https://doi.org/10.1109/INMW.2009.5195961

[14] O. A. Gusmán Obregón, Y. A. Marín Muro, and C. Rodríguez López, *Red de Próxima Generación. Una alternativa para la implementación de nuevos servicios en la red de telecomunicaciones de Cuba.* Facultad de Ingeniería Eléctrica. Universidad Central Marta Abreu de las Villas, Cuba., 2007. [Online]. Available: https://goo.gl/aXtjBV

[15] A. B. Johnston, *SIP: Understanding the Session Initiation Protocol*. Artech House, 2009. [Online]. Available: https://goo.gl/jCCYgk

[16] ETECSA, *U-SYS NGN*. Empresa de telecomunicaciones de CUBA S. A., 2006.

[17] HUAWEI, "U-sys softx3000 softswitch system," Huawei Technologies Proprietary, Tech. Rep., 2004. [Online]. Available: https://goo.gl/xSp4Wy

[18] Huawei, "System description of umg5900," Huawei Technologies, Tech. Rep., 2004. [Online]. Available: https://goo.gl/HXAXGU

[19] O. Gonzalez Soto, *Concepto y arquitectura de las Redes NGN*. International Telecommunications Union (ITU), 2006. [Online]. Available: https://goo.gl/RZ4sD7

[20] R. Verdecia Peña, *Propuesta para la migración hacia NGN en la provincia de Granma*. Tesis presentada en opción al título de Ingeniero en Telecomunicaciones y Electrónica, Universidad de Oriente Sede ISPJAM, Santiago de Cuba, Cuba, 2014.