Teleradiology network in Amazonas rainforest

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1. Summary

The Amazon Forest is known as one of the planet's greatest forest reserves [1]. Dense vegetation; high index of humidity, rainfall and lightning; basically flat ground; and complex transport's logistics dependent on winding rivers and their floods and drainage [2]; All of these translates in a challenge for a project’s implementation.

With healthcare that’s not different: it didn’t have minimal infrastructure, personnel and supplies. In addition, the local population density - 2 habitants/km² [1] – makes the cost-benefit ratio prohibitive to the Brazilian government. Telemedicine could help, however there was so many problems: an unstable telecommunication environment, difficult to operate, administrate and maintenance; high costs due to scarce space presence; and poor structural availability in hospitals.

This work aims to present the challenge of implanting a specialized and innovative technological solution in the traffic of radiological data in hostile environments, making feasible the operation of more than 100,000 radiological examinations.

2. Literature Review

2.1. Teleradiology and Big Data

Teleradiology is the Telemedicine area that most consume storage equipment. Radiological digital image require a large volume of data to be stored and therefore transported [3].

The solutions established by the DICOM standard presupposes the existence of communication channels capable of transmitting in a timely manner the attendance and execution of the medical report.

However, reality in remote environments around the world does not reflect and do not meet the demand imposed by these solutions. They are basically constituted to operate in physical environments and under optimal technical conditions. There is thus a need to seek a context capable of operating in information technology host environments and that may add quality to the service provided.

2.2. Transmission of high volume medical data in host environments

The Dicom data is transmitted to the similar to the standard, in terms of the use of data compression tools in real time, however use a patent protocol specialized in external networks, providing a so better efficiency [4]. Some features are above:

1. Data's Availability: Transmission of entire DICOM images from radiology equipment to the datasets.
2. Equipments: Development of specialized network gateways.
3. No transmissions interruption: Connection intermediated by a data center; Separation between sending’s device and the common medium; Retransmission from the interrupted place; CRC evaluation.
5. Security problems: The system controls the information's input / output data, using 2048-bit RSA cryptograph keys.
6. General unforeseen failures: Management of communication between the entities involved; The data is sent as soon as connection is established; Generation of reports for automatic control of failures.
7. Lossless images: Resolution following the established standard.
8. General efficiency: Up to 96%, regardless of media stability.

2.3. The necessity of teledicine in Amazonas

It is undeniable the usefulness of the X-ray examination in general for medical science, for the detection of diseases and traumas; in urgent care or in outpatient practice. However, due to the almost inexistence of minimal infrastructure for its use - of accomplishment and report - little was used in the Amazon region.

The breast cancer is a priority too. In Brazil, mortality rates remain high, given that the disease is still diagnosed in advanced stages due to non-routine check-up [5].

3. Methodology

3.1. Initial conditions

Several difficulties were faced in the project:

1. The telecommunication environment provided was characterized by satellite links of Ku-band (128-256Kbps), 64 units dividing a common block; 2. The logistics of sending general supplies to State Hospitals is done using expensive and complex modes;

3. The examinations needed to be sent to a Radiological Reports Center in Manaus, the State’s capital.

3.2. Laboratory evaluations and technological development

1. Network equipment was developed on a small computer (processors with low electrical consumption, and with restricted memory capacity), without internal mobile assets, and managed totally remotely (Figure 2); 2. This management is done through automated VPN with NOC (Figure 2); (1) The available environment allows operation 24 hours/day; (2) Performs automatic and programmed maintenance, making general repairs; (3) The tools provide reports, containing system communication speeds, general availability, list of patients transferred, delivery times of exams, general tests, etc. 3. Average implementation of Dicom Gateways: less than 5 minutes; 4. Simples installation of the equipment. Needs only to insert the equipment in the pre-defined radiology environment; 5. For health professionals and other operational teams, the system were transparent, including in the performance of the exams.

4. High availability and communication load balancing: 2 channels are simultaneously responsible for downloading the exams from the interior at Manaus Report Center;

7. A system providing quality of service: maximum use of the available communication block.

4. Results and discussions

Basically, the result found can be summarized in the time for transmission and the results of the tests - Table 1 and the number of radiological examinations performed in the interior of the Amazon Forest when compared to the previous history - Table 2.

5. Conclusions

After the actual start of the operations and comparing the preliminary results to the originally projected needs, it was concluded that the results achieved by the technological model implemented by the State Health Department associated with the use of the specialized transmission services promoted significant economies of approximately 60% of original budget, and in efficiency terms: fluidity of the transportation of general data, better management of the team production capacity in all services, use of the environments acquired by the State for the provision of the service, the full use of the communication medium, etc.

6. Bibliographic reference