



# Autonomous Network

Project of governance, infrastructure and operation of an autonomous network  
and community internet provider at  
Association of Organic Farmers of Boa Vista do Acará (APOBV)

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# 1 Context

## 1.1 Background and context description

Boa Vista do Acará is a small rural community near the state capital city of Belém, about forty minutes riding a boat from a small local harbor called Porto da Palha. There is also a road access from the village to Belém, which takes approximately 1h30m.

Boa Vista has an estimate of two hundred families that uses the land and the gathering of forest resources as the main source of their income. The small village around the harbor is part of the public administration territory, and serves as a local center to provide school, basic health care and a police station base, with an effective of about ten policemen, equipped with one heavy duty car and provides those basic services to neighboring villages.

There is a high voltage power line to provide electric power to the capital city that was built in the late 1980s. The popular way to refer to this line is *linhão*, and its surroundings are portions of land managed by the state energy company CELPA. The energy flows from the hydroelectric power plant of Tucuruí in the neighbor state of Maranhão, and extends for hundreds of kilometers through the middle of the amazon forest.

This way of conceiving the infrastructure, based in large projects is a legacy of the development model adopted countrywide, and really draws the attention of whoever witness the huge proportions of those wonders of human achievements.

Our host is APOBV (Association of Organic Farmers of Boa Vista do Acará), an association founded in 2003 by about thirty families, mainly farmers developing projects of mixed agriculture and extraction of forest goods, based on sustainable management of those resources.

This agricultural project is an ongoing effort of strengthening the collective instances of governance and creating a self-managed autonomous infrastructure, initially proposed by a company that buy them some key local products, and profit of its way of managing. They have some long term agreements on this private sector partnership, that is a great deal on matters of associative culture, and makes the local association an excellent carrier of the project we propose in this document, developed during the International Development Design Summit IDDS Amazon 2016. [refer to inter-sector partnership HBS paper, 2005]

Boa Vista is one of the communities that integrates the lower Acará region, and they are organically tied to the Acará municipality, despite the geographical proximity with the capital city Belém, which is their reference for marketing and dealing of goods and services.

The association has plans of expanding the activities to create other business arrangements, such as a cooperative to deal with different farming products of the families in the surrounding area, and looking for ways to generate more income and to further develop the community.

In our preliminary talks with community members, we identified an opportunity to address the question of Internet services. Nowadays, the available service is provided by a company with their infrastructure established in Belém, and providing 2nd and 3rd generation of data exchange technology, and their services are billed in terms of traffic amount.

There is not enough coverage area to provide a good quality of service in

terms of speed and there is virtually no chance of getting an affordable contract based on bandwidth to institutional use inside the community.

Our project started with a cooperation agreement established between the Laboratory for Embedded Systems of the Federal University of Pará (LASSE) which provided a point-to-point link, connecting the university campus to a sixty meters tower near the harbor. With support of equipments and personnel from the Instituto Tecnológico de Aeronáutica (ITA) to bootstrap the network, having access to Internet as an attractive to the network expansion.

Our proposition is to establish a local network, managed by the association and allowing them to operate as an autonomous Internet provider. This means that they would act as a proxy, with autonomy to deal with other providers, managing the contracts between the association and community members, with freedom to establish their own rules and expand their network and to find local solutions to address technical and administrative solutions.

The main goal is to develop a governance model to create the conditions to have a consistent income coming from the community, in terms of financial resources, labour or goods exchange.

Some technical problems in terms of wired and wireless connectivity arose during the analysis, because of the sometimes extreme conditions imposed by the landscape, such as constant thunderstorms, and unstable trees falling often, as part of forest self regeneration process.

## 1.2 Project Goal

The main goals of this project are the following:

- To provide good quality Internet service for the community in terms of adequate contracts and respecting local practices.
- To introduce innovative models of project design to explore creative ways of problem solving approaches.
- Capacity building on the first generation of management team.
- To create management structures of network governance based in local practices and principles for problem solving.
- To generate income for the association, increasing the general interest on local matters on the youngsters of the locality.
- To increase the access to educational and knowledge sources for the community.

## 2 Design process

### 2.1 Project frame

For two weeks, our team worked closely with two members of the community (Gaúcho and Eliane) that were interested in being part of the first generation of the project carriers and managers.

For the first week, the team focused on gathering information from the existing communication resources and technologies. During this phase, it became evident that there was great need and desire from the Boa Vista community to

have access to a more effective Internet service, not only in terms of price of acquisition, but mainly in terms of quality.

The main desire of use that was expressed from the majority of the interviewed community members was as educational and research tool for the younger generations. In fact, social interaction and communication were the mostly observed use of the resources.

In addition, there is an relevant concern that came up during this research phase, and it is the potentially negative impact that readily available Internet service can have in the cultural dynamics of the community and the fear that it could motivate a culture of individuality and segregation.

Having all these aspects in mind, the project was defined in order to meet the needs of the community regarding Internet service and also as a way to strengthen the dynamics that already take place, such as the culture of sharing and taking care of each other and of the environment they live in. Their current housing arrangements are geographically observable in local family clusters that grow around the community with the concession of land to build their houses, as soon as the families are growing by marriages and new born children arriving.

The community has a stable and low birth-rate in the associated families, the number of children per house rarely exceeds two children. One of the main concerns is generating and maintaining interest from the new generations to remain in the community and to keep dynamics and their traditional ways of managing the resources. No further observations were made outside the association, but it seems to be a general tendency on the entire Boa Vista community.

For the governance structure design that will be in charge of managing the Internet network, we propose a distribution system that is organized in small units of several houses that are geographically close to each other. We call these units clusters. The local term to designate those family groupings is *alamedas*. Each of those clusters will organize autonomously, defining its own local manager (person in charge of handling the relation with the provider, APOBV) and its own set of local rules regarding the ultimate instance of provision of the service.

In its initial phase of the project, developed during the two weeks of the summit, we developed three aspects that together make the prototype:

1. The tower In order to receive the Internet signal, we propose a tower that is built with local materials that are readily available in the community and that they could replicate as needed.
2. The cluster Consists of the first group of houses that will receive service from the association.
3. Modeling of the network management plan, regarding technical and management concerns, and the creation of a business road-map on how to deliver to the collective instances of decision, the discretionary over the contracts that will be placed by association.

## 2.2 Value Proposition

In the model of autonomy that we propose, the association is the main Internet provider for the community. This places it in a situation that could potentially lead to an unbalanced state of authority. Therefore, we propose a decentralized authority of management of the use scenarios to avoid interference by the APOBV in terms of moral impositions on the lifestyle and moral questions regarding the use of the resources. Nonetheless, granting the association some

authority on the management to control for abuses that can violate the terms imposed by the link provider, which is UFPA in this case.

By modeling the distribution system considering autonomous clusters, the authority is not concentrated in a single group, but distributed to a lower organizational level composed of several clusters that keep each other accountable.

### 2.3 Summary of design process

The governance model prototype

For the governance model, we established as a goal a preliminary discussion of the following aspects, which are left to further elaboration and development by the members themselves:

0. Create structure and organogram for distribution network
1. Define and map the local clusters based on interest of receiving the service
2. Identify an entitle local cluster managers to deal with charges and responsibilities
3. Determine the best approach to physical network distribution, best practices, equipment and structure planning.
4. Define among the associations collective decision instances the best way of charging for the service, different use case scenarios and charging methods.
5. Build the necessary infrastructure, making use of local materials and manpower when possible.
6. Operate and manage the network.
7. Manage contract adhesion and keep track of the providers requisites. Consider legal aspects of the contract.
8. Form and give capacity to a local team with necessary knowledge about the network management.
9. Define resources limits and contract rules (Volume or bandwidth model of charge) depending on the use case
10. Establish penalties in case of discordance with the contract terms by the service consumers.

In terms of physical structure concerns, we elaborated a prototype to address the question of elevating the antenna equipment as high as 20m to be possible to establish point-to-point connections inside the community, which is in the middle of a forest area. Those low cost antenna could be a good solution to dramatically decrease the initial cost of infrastructure.

To this subject, we decided to build a prototype with an abundant and underestimated material in the region, that is bamboo.

From the initial drawings and initial planning phase, it took us 6 days, between scale models until the final prototype in proper 20m scale.

It involved effort in creating the structures and gathering peoples engagement, but in terms of the design itself, it is easy enough to replicate only by observation once enough human power is gathered.

### 2.4 Analysis and experimentation

During our investigation period, we developed a GPS map of the community, locating different points where a cluster would need to be established in order to get a quality signal to the surrounding houses. The map is showed in the picture section below.

It was determined that several antennas are needed in order to achieve the network distribution goals for the entire community. Therefore, it was left to the association discretion in discussions with the individual clusters, to decide what the process would be to develop this part of the network. The two options

are that each cluster builds its own antenna or that the association builds the antenna for them and charges for that service accordingly.

The experimentation process was done mainly regarding the bamboo tower. There were several small scale prototypes that were developed during the initial phase (see picture section), but once the real scale prototype was started, it was decided to go along until the end and test it out by putting the real antenna for weight purposes. The reason for this was the difficulty to deal with the heavy material and iterate several times.

## **3 Technology and final prototype**

### **3.1 Criteria**

Considering that our prototype consists of several parts, the success criteria of our prototype is defined as follow:

1. Successfully build the Internet connection to the first cluster, which for matters of proximity, we defined as the cluster that includes Beбето and Jose Maria's houses.
2. Build a bamboo tower that effectively holds the antenna to a height that achieves quality connection from the emitter antenna.

### **3.2 How it works**

After several modifications, the final prototype for the bamboo tower was determined to have a system of pulleys on top which serves to pull up and bring down the antenna for maintenance purposes. There are also three rope strings coming from the joint point of the tower and attached to wooden stakes on the ground, creating tension in the three directions and helping to maintain the vertical position of the main pole.

### **3.3 Performance**

It was not possible, due to the short time-frame to test in field conditions the proposed tower solution. However, some interesting insights and challenges were observed during the process of dealing with some materials, such as the need of resilient structures to keep the hardware antennas and physical structure steady and safe around the territory.

The governance model was put in the first round of discussion between the involved community members, and the first generations of young managers.

### **3.4 Bill of materials**

The following is the list of materials that were used to build the prototype for this project: 1. 240m or soft rope 2. Bamboo sticks from the forest (approximately 15 of them, with lengths ranging between 8 to 12m) 3. One 2.4GHz Household router (for the first cluster) 4. 100m Cat5 network cables

## 4 Lessons Learned

### 4.1 How does the project fits in the context

In terms of explaining by practice the material challenges of managing infrastructure, and the management costs of establishing a network with a full business plan, governance guidelines and a two years time-frame window, we intended to concentrate in key aspects of management and infrastructure planning. Even with no functional tower, the directors of the association are aware of the challenges and opportunities of an Internet provider, managed by themselves, with further possibilities of enhancements and expansion, the capacity building challenges on creating a team to manage the contracts, and provide a good quality service, with proper maintenance and the value of this network for strengthening the community bonds, and keeping under their own set of rules the way this news technologies are absorbed by community members. We recommended a strict attachment of the collective instances to discuss the strategic decisions concerning contract boundaries, attributions and responsibilities distribution, as well the resources management, personnel and other delicate questions concerning the parts involved in the business operations that this enterprise demands. User feedback In the process of building the tower prototype, we received some interesting inputs from community members concerning the use of bamboo to structural construction, something that was not explored in the region. If well managed, the bamboo could be a good alternative material for a lot of uses, as furniture, practical application on harvesting pupunha fruits, which is a spiky tree very tricky to climb, and other ideas that came up during the bamboo working sessions.

Two young members of the community which took part in the project design process were committed to dedicate time and attention to this project and they are aware of the need to acquire specific knowledge, either technical and in terms of management.

The association by their representatives, the president, financial manager and a small group of most active members of the board demonstrated interest on keep this project going on.

In a alignment meeting between the Federal University, the managers of the network assured at least two years of providing this service, and also offered an experimental service of 2nd generations mobile phone technology, which is already installed near the community, with a 10W cell antenna, that provides voice over IP experience, free of charge inside the boundaries of community, the CelCom project from the laboratory of embedded systems (LASSE/UFPA).

The general response of the potential users of the service are receptive, and as soon as they get the idea of being able to set their own local rules, and negotiating with the near neighborhood about the access rules and increase of the quality, even pay a fee that are subject to the practical governance instances, on which they can have some sort of influence, were positive in all cases. Troubleshoots The two years term of the free leasing agreement of the Internet connectivity via UFPA to the RNP network will imply in some deadlines to have the operation of the network with enough structure until the end of the agreement.

All the initial infrastructure costs are still a subject to evaluation of practical use and application, regarding the weather conditions, terrain, interest on

adoption of the service, capacity to keep the steadiness of the signal and the discussion of the rules of the service, plans, methods of charging, surplus and strategies for network expansion.

Some local solution to decrease the costs of towers and methods to deliver cabling access to each cluster will be some aspect to further development and enhancement.

All the institutional support for the first stage of development of the initial infrastructure should be discussed with the association members, and some milestones should be set to keep track of the network expansion through the next years.

Any kind of previous communication with commercial operators should be encouraged, and ways of dialog with foundations and institutions with interest in support this kind of initiative must be actively encouraged.

An educational program is something to be addressed to form local people to provide some specialized support to the provider, as system admins, business managers, hardware and physical installations and also we need to anticipate some career progression program based in specialization, for in the future, generate knowledge and know-how on community provider services.

## **4.2 User feedback**

Several feedback was gathered during the brief time that we had after the tower was built. One common commentary was the fact that building tall and complex structures with bamboo was actually possible. It was noted that bamboo was perceived as a bad quality material for building purposes, and this was reflected in the almost null use of it around the community. After we built the prototype tower in front of the association, the community members were perplexed by its stiffness and height. This sets a precedent for them, such that in the future they can start thinking of bamboo in creative ways to build structures in their houses and alamedas. In fact, some of them made the comment that they could see themselves building such tower in their house.

Another important piece of feedback was the fact that the systems of pulleys was not robust enough to easily pull the antenna up, because the rope was very thin for the weight. This made the process of pulling the antenna slow and tedious since danger of cutting the rope was perceived during the handling of it.

## **5 Pictures**



Figure 1: Stakeholder Map

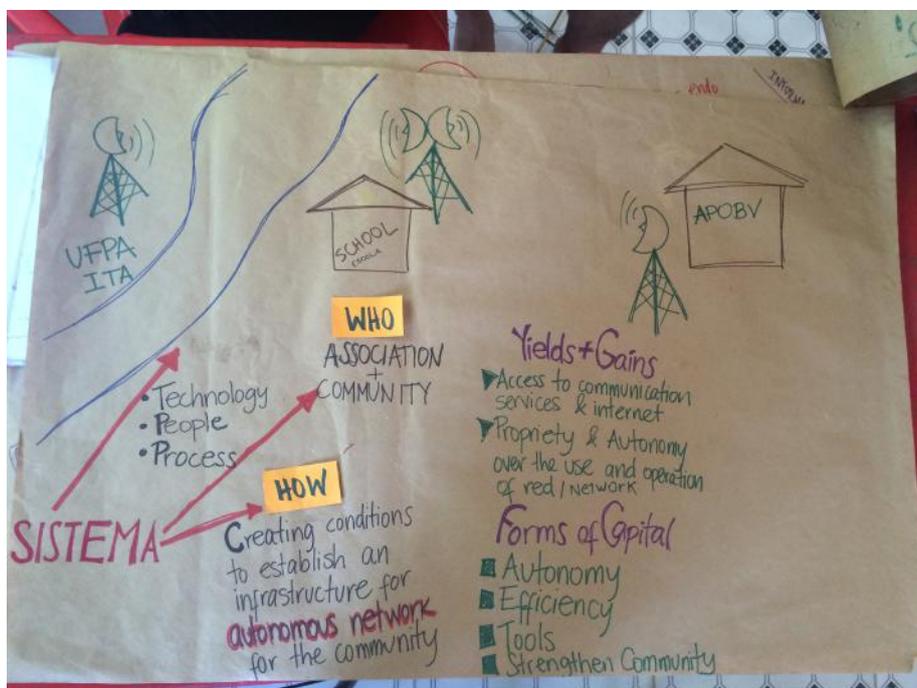


Figure 2: How the System work

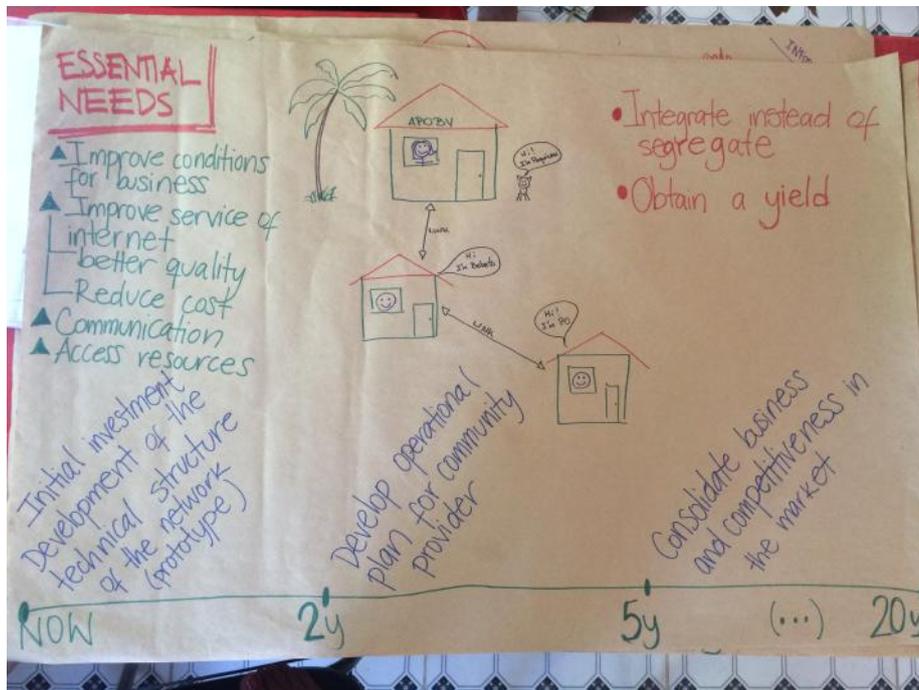


Figure 3: Essential needs

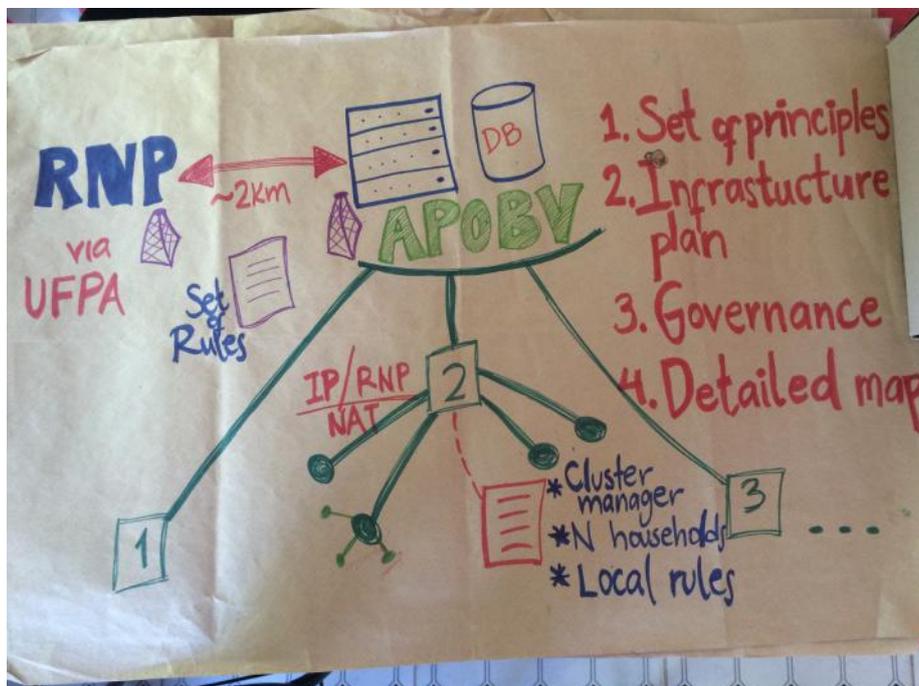


Figure 4: Schema of agreement between APOBV and clusters





Figure 6: Bill of materials 1



Figure 7: Bill of materials 2



Figure 8: Bill of materials 3



Figure 9: Bill of materials 4



Figure 10: Bamboo used to make the prototypes



Figure 11: Amanda, Eliane and Pedro looking at the prototype



Figure 12: The final prototype



Figure 13: Meeting at UFPA