Cooperative Research and Development Project between FUB/CDT and TERRACAP

Technical and Economic Feasibility Study for
Digital Capital Technology Park
[Parque Tecnológico Capital Digital – PTCD]

Product 5.1 – Evaluation of Business Infrastructure	
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1. Introduction

The Companhia Imobiliária de Brasilia (Terracap), created under the law nº. 5.861, in December 12 1972, is corporation that belongs to the Federal District Government. Governed by the law that created it, by means of the institution's social statute and by the legislation applicable to the societies by actions, Terracap aims at executing, by means of payment, all real state activities interest to the Federal District, including the use, acquisition, management, disposition, merger, encumbrance and disposal of assets.

According to law nº 4.586 of July 13, 2011, Terracap started to also play the role of the Federal District's Development Agency, by means of proposal, operationalization and implementation of economic and social development programs and projects interest to the Federal District, being even able to promote agreements between the public and private sectors, constitute Special Purpose Entities (SPE) and promote joint urban operations to implementation and development of enterprises considered as strategically by the Federal District Government. In this context, Terracap is an important vector of public politics that are defined in the programs that are being implemented by the current Federal District Government, especially when it refers to the Digital Capital Science Park - PTCD.

Having in mind a cooperation among FUB and the Union's Assets Department – SPU, the Ministry of Planning, Budget and Management, which has been on since January 2009, with the coordination of the Decision-Making Technologies Laboratory – LATITUDE, UnB's Department of Electric Engineering, by means of three structuration projects of processes, methodologies and SPU's management tools, Terracap verified that the approach used in handling the Union's assets could be extended and applied to the District's assets, especially concerning the PTCD project management.

Besides that, the topics concerning the strategies of the PTCD implementation were approached in UnB's early studies, demanded by the GDF (Project FAPDF-FUB, 2008), giving conditions to subject PTCD management be handled with previous knowledge of the matter. Such experience justifies the participation of the LATITUTDE laboratory staff in this new situation. Considering that PTCD is a park destined for information and communication technologies, in its feasibility study, the following

questions must be answered: types and size of ICT that can integrate the park, types of services and products of major potential, productive capacity, necessities and existence of professional competencies (electric engineers, network engineers, computational engineers, production engineers, automation and control engineers, computer scientists, information engineers and technologists), academic unities able to research, innovate and transfer technologies to the park, etc.

Thus, and considering CDT/UnB's extensive experience in elaborating the studies on technical and economic feasibility (EVTEC), Terracap and the LATITUDE Laboratory, counting with the support of CDT/UnB, started talking about the possibility of putting the cooperative research and development project in practice; and, in the context of improving the district assets management and promoting strategic enterprises for the Federal District, looking forward to put the EVTEC in practice in reference to the PTCD.

As a result, it was established a contract between Terracap and FUB, having as object a technology and information services project that aims at supporting the implementation of the PTCD, acting in the elaboration of products that make part of the correspondent Technical and Economic Feasibility Study.

Among the deliverable products of this project, the “Product 5.1 – Evaluation of Business Infrastructre” is the object of this technical report.

This product aims to indicate the technical and economical feasibility of the business to be developed, specifically in what refers to evaluate from the parameter already defined in governmental decisions to the area of the Park, the probable business infrastructure available in the area defined as Lot 1 area in the PTCD.

2. Evaluation of the PTCD Business Infrastructure

This report aims to evaluate the probable business infrastructure available in the area defined as Lot 1 of the PTCD based on the Complementary Law 741, in October 10, 2007, in the Attachment I of the Decree 19,071 of March 6, 1998, and on the NGB 002/07 defined for the area of the Capital Digital Technology Park.

Because of the absence of a basic plan of official urbanization, the estimates come from the maximum parameters of occupation defined in the legislation cited above and the

hypothesis in which the area architecture standard will be in the historically practiced at Brasilia's Plano Piloto.

2.1. The NGB and Its Impacts

The main restrictions to construction in the area were defined by the NGB 002/07 and are, at least partially, derived from previous legislation.

According to the NGB 002/07, the occupation rate is defined as the ration between the horizontal projection of the built-up area and the Lot area multiplied by one hundred. By the norm, the maximum occupation rate cannot be greater than 30% of the Lot 1.

In relation to the occupancy rate, defined as the ratio between the total built-up area and the lot area multiplied by one hundred, is allowed a built-up total square meter equivalent to one time the area of Lot 1.

Because of legal determination, it is necessary to meet the following requirements:

- Offer of a parking space for each 45 square meter built. The outdoor parking spaces on ground level should be paved with permeable material. While the underground parking spaces do not go in the occupancy rate calculation, the spaces on level are considered 50% for calculating the minimum permeability of the land, defined as 57% of Lot 1 total area;
- The total ways can't cross 10% of the Lot's total area;
- The non-built area should necessarily be object of landscape project that prioritizes the native species and avoid the excessive use of one same plant species.

The restrictions foreseen in the NGB and other legal norms have significant impact on the project's financial potential. The limits for constructing significantly reduce the resource sources that come from real estate receivables and considerably increase the price of the square meter built-up, seen that the land price is distributed in a reduced installment of occupied area.

The reduction in the financial potential of real state receivables creates obstacles to adequate payment of the investments in urbanization and adequacy of Lot 1, also necessary due to the existence of an old dumpster in the area mentioned.

2.2. Physical Characteristics

The total area of the PTCD is 1,230,000 m2, from which 958,898 m2 makes Lot 1, which in turn its built-up space corresponds to 30% of the Lot area, or 287,669,4 m2.

The total built area cannot be greater than 958,898 m2, or one time the total area of Lot 1. The buildings located in the higher part and the middle part of Lot 1 can have up to 15 meters, while those located in the lower part of the ground area cannot have more than 7.5 meters. Water tanks and lifts machine houses do not take part in the maximum height calculation.

For the built-up area it is necessary a building of 21,309 vacancies total, which will demand a 291,189,78 m2 total area. As a proposal, the project assumed that:

- 2% of the Lot 1 goes to vacancies in level. Considering 12 m2 for each vacancy, 19,177,98 m2 would be occupied, which would allowing the construction at a cost of R$ 17,805,160.80, being the corresponding circulation area contained in the ways in equivalent area of 1,598 vacancies;
- For all the other spaces a 236,532 m² would be necessary, with 15% extra for vehicle circulation, built in the underground of the building or the paved streets, since the construction in other areas would impact the permeability calculation. The costs for such construction was estimated in R$ 252,541,195.40, for an offer of 19,711 spaces.

The 002/07 NGB limits in 10% the area used for paths. Based on the averages used in the Superquadras and commercial areas of Brasilia's Plano Piloto, it is estimated allocating 6.98% of Lot 1 to paths of vehicle circulation, or around 66,906 m². The standard employed was the two-way street, with two traffic lanes of 3,5 meters wide for each lane. For this standard, in total it could be built around 18.48 kilometers of roads costing R$ 33,264,000.

Still based on the average urban project of the Plano Piloto, 2% (28,767 m²) of the Lot 1 were allocated to paving, with which the width defined as 1.2 meters results in 23.97 kilometers of sidewalks built up by a cost of R$ 2,397,000.

To the masonry work of squares and access areas, 1% of the total Lot 1 or 9,588.98 m² was allocated.

The area meant for grass and gardens is 546,571,86 m2 with a cost for

landscaping of R$ 27,326,593.

The total pavement should be enough to connect all building of the complex. For that reason, it was employed as a basis to calculate the connections of power energy, hydraulics, sanitary sewage and broadband optical infrastructure.

From the limits of the NGB and with a hypothesis that the blocs will have a horizontal projection of 4,000 m2, a total of 72 blocs are estimated.

2.3. Users

From the total of vacant spots offered, it was calculated the maximum capacity of simultaneous users on Lot 1 in the Capital Digital Technology Park, estimated in 63,927 people, that is, considering 2 people taking public transportation for each person taking a car.

2.4. Water

With a hypothesis of average consumption of 65 liters of water per user, and having counted the volume needed to maintaining and cleaning the built-up areas, the daily necessity of water is estimated in 4,155.2³, having in mind that the sewage system should be proportional to the water system.

To connect all inhabitable buildings in the water system, we estimate the following:

- The necessity of a network with 26.4 kilometers for treated drinking water;
- The sewage system should have 36 kilometers and,
- The stormwater system, 48 kilometers.

In terms of structure composition, such systems will have the following basic components:

- The drinking water distribution systems projected is composed by 40% of piping system of 50 millimeters and 60% of piping system of 85 millimeters;
- The sewage system consists of 50% of pipes of 150 millimeters and 50% of 200 mm pipes.
- The drinking water system is composed by 30% of piping system of 400 millimeters and 70% of piping system of 700 millimeters;

The total cost estimated for building the water, sewage and stormwater infrastructure was R$ 28,231,686.

The manager of the area has the option of (provided that he complies with the legal requirements of the responsible bodies) employing alternative sources such as:

- Using a well to gross water consumption. It is worth noting that, being the provided drinking water treated exclusively by CAESB, the non-treated water distribution system should be necessarily physically separated from the drinking water distribution system.
- Building a unit of water reuse. In this case the drinking water distribution system should be double;
- Possibility of negotiation, in the role of great consumer, on the price of water m^3 with the supplier company, in a way that the price the end consumer is charged should follow CAESB's pricing chart.

None of the alternative hypothesis foreseen in the above items will be target of pricing in this study.

2.5. Electric Power

The electric power structure is one of the most important elements of the Technology Park. Guaranteeing the continuity of the service and stability of the system is fundamental so that the PTCD be competitive in the international scenario.

The manager has the option of using CEB's substation built in the area of the Park (but outside Lot 1 area limits) or building one private substation connected directly in the basic network.

The present project adopts as more interesting alternative the construction of a private substation in the park area. This will allow the manager ease to access the electric power open market, thus with a higher control of quality standards of the offered energy.

In order to show the viability of this alternative, we compared the cases of having a private substation or using that provided by CEB. As one can verify in Table 5.1, high-voltage energy charges are over five times cheaper than low-voltage energy charges. Therefore it is interesting to the PTCD manager the construction of a substation.

Table 5.1 – CEB charging data.

Type of client	Charged value
Residential over 500 kWh (ICMS 25%)	0.4967369
Commercial/Industrial low voltage (greater than 1 MWh)	0.2250876
Commercial/Industrial 69kV (over 100kWh)	0.0428417

The costs to building a substation with a 32 MVA transformer is R$ 15,000,000 and each extra transformer costs R$ 3,000,000 R$ 3.000.000,00.

To estimate the return on investment in building the substation, we can assume a power factor of 0.7 and average apparent power of 32 MVA, thus the total average power is 22.5 MW. Assuming the PTCD runs 8 hours a day and 21 business days per month, it implies a minimum average consumption with a 3780 MWh transformer, which is the same as 3,780,000 kWh. Table 5.2 presents the PTCD monthly expenses with electric power according to the alternative of service hiring.

Table 5.2 – Monthly electric power expenses estimate.

Type of client	PTCD monthly expenses with electric power (R$)
Residential over 500 kWh (ICMS 25%)	1,877,665.50
Low voltage commercial (CEB substation)	851,000
High voltage commercial (CEB substation)	162,000

Comparing the high voltage and low voltage commercial fee, the Managing Company (EG) would save R$ 689,000 per month. From that economy, the substation with a 32 MVA transformer would be paid within 22 months approximately. Therefore, after 22 months, the EG would pay the substation and make a profit R$ 689,000.

In a more complete scenario, it is necessary to build a substation with a total capacity to hold 128 MVA of electric power, being 64 MVA the demand estimated for a

park and 64 MVA of redundancy. R$ 24,000,000 is estimated cost to build the substation.

Especial attention should be addressed to the meter standard placed in the economic sub-unities (companies), which will work within the Lot 1 area. The economic exploration of energy trade in the Lot 1 area will only be possible if the power meters follow the standards required by the sector regulation.

Also the manager should guarantee to supply at least 25% of the total power demand of Lot 1 by self-generating electricity. Despite the ideal in this case be the use of gas supplied plants (because of the restrictions in providing this raw material), a diesel-electric generator set was employed. In total, the self-generation should be at least 16 MVA which, complied with the requirements of the responsible regulator bodies, can be negotiated in the open market of electric power (in case there is an surplus between self generation and Lot 1 consumption).

In that hypothesis, an important issue is the necessity of the manager to have the technical and legal skills specific of the sector.

The generator set and its facilities have been estimated at R$ 6,335,200 (Table 5.3). The masonry structure that shelters the generator will not shelter human life for long periods of time and, thus, by the norms of the Lot 1 construction, it does not make part of the math for the occupation rates; it only goes in the math for the permeability rates.

Table 5.3 – Generator set

Description	Quantity	Unit Price (R$)	Total Price (R$)
Generator group 16 MVA	1	6.000.000,00	6.000.000,00
UPS	30	7.840,00	235.200,00
Place adequacy for the generator group	1	100.000,00	100.000,00
Total			**6.335.200,00**

The electric connection network projected for the blocs that make part of Lot 1 is underground and consists of 26.4 kilometers of triple cables, with redundancy of a second network with the same extension cables.

The lighting for Lot 1 is formed by 1200 lampposts, being 616 of them made of

concrete in order to illuminate the street lanes for vehicles, 1,200 lampposts to spread light on the sidewalks and 250 lampposts to illuminate squares and other areas. In sum, 2,066 lampposts are needed at an average unit cost estimated at R$ 3,500 and a total cost to implement the system at R$ 7,231,000. All electricity used in public streetlight should be originated from alternative source of energy. This project adopted the use of solar powered lampposts.

2.6. Productive Area

The productive area of the PTCD's Lot 1 has buildings for producing goods and services allowed by the Lei Complementar nº 741, October 10, 2007.

According to what was determined in the NGB 002/07, the total built-up area cannot be larger than one time the area of Lot 1, that is 958,898 $m^{2.}$

Based on the Basic Unitary Cost (CUB) for rooms and high-standard business stores in the DF, October 2011, R$ 1,271.73, last value available during the elaboration of this report, we calculate an approximate cost at R$ 1,219,459,354 to execute the work.

Since not all costs involved in the construction are included in the CUB, R$ 750 is added to each square meter, which implies an extra R$ 719,173,500 to conclude masonry works on productive buildings.

Thus, the masonry stage total cost is R$ 1,938,632,854.

In order to equip the area adequately, we estimate the necessity to invest R$ 2,000 per square meter and a possible cost in adequating the structure for specific equipment at R$ 500 per each built square meter. These costs are preliminary estimates of the PTCD technology needs, once there is no possibility to detail the specific activities that will be developed there.

Therefore, the total cost to technologically adequate the buildings to the development of the productive activities expected for the Lot 1 is at R$ 2,397,245,000.

To comply with the legislation, it is necessary to build underground some spaces in the building, according to what was previously specified in this document. The estimated cost for the square meter of these spaces was R$ 928.51, which results in a total investment of R$ 252,541,195.40, to an offer of 19,711 underground spaces.

We estimate, then, that the total investment needed to build and make the Lot 1

productive area available is approximately R$ 4,588,419,049.

This investment can be done by the bidding winner partner to make part of the Special Purpose Entity (SPE) or by means of the agreement made between the SPE and the occasionally interested businesses in exploring the area.

2.7. Security and Building Maintenance

Every security service and building maintenance in the area of Lot 1 should be monopoly of the Special Purpose Entity (SPE), being formed by TERRACAP and the bidding winner.

The SPE can (in case it finds interesting or profitable) give up this economic right for the benefit of other companies.

The way of exploring the right is open choice of the SPE, if by means of direct offer or by outsourcing services. However, the minimum offer of security services should contemplate:

i) Integrated System for Security Information Processing (SIPIS):
   a. surveillance camera system;
   b. Communication system for security agents; and
   c. Telephone center for users.

ii) Internal security of buildings and parking lots;

iii) Common areas security;

iv) Ostensive surveillance; and

v) In case of serious incidents, contact and forwarding to Police of the Federal District.

To make item (i), the Integrated System for Security Information Processing (SIPIS), we estimate the need of an investment at R$ 13,680,642.49.

The security agents involved in items (ii), (iii) and (iv) should preferably hold non-lethal gun. In case of lethal gun necessity, such equipment should be used by the minimum amount of employees as possible. In all events where those responsible for the SIPIS judge necessary to send the armed team to the spotted problem, the Federal District Military Police (Polícia Militar) should be contacted simultaneously with the private security team.

The basic security team for the PTCD's Lot 1, based on the assumption of the service monopoly and the maximum capacity of the PTCD in use, should consist of:

i) 1,076 sentinel; and

ii) 1,599 firemen.

To calculate the amount of firemen and sentinels, we adopted as hypothesis 50% of the maximum amount of people at the PTCD as fixed population, or 31,964 people. The number of security people was estimated following the principles bellow:

- 2 posts for each building – 576 sentinels;
- 1 post for each underground parking lot – 288 sentinels;
- 15 spare armed posts - 60 sentinels; and,
- 38 posts for the patrol in the ground area of the park – 152 sentinels;
- Total: 1,076 sentinels.

The building maintenance services and general services fulfill the requirements for the people needed to maintenance of Lot 1 common area and other areas inside the buildings. Based on the hypothesis of 72 blocs, 546,571.86 m2 of gardens and 105,261.98 m2 of pathways, squares and sidewalks, there will be necessary at least:

i) 432 concierges;

ii) 959 cleaners;

iii) 72 janitors;

iv) 144 gardeners; and,

v) 27 garbage collectors;

The maintenance, security and general service staff will be able to count with the support of all equipment and supply needed to provide services, to which there is a need of at least:

i) 20 automobiles;

ii) 20 motorcycles; and

iii) 5 trucks;

Already considering the profit of the operator and social charges, the monthly cost estimated to each one of these services is:

i) Sentinels and firemen on a 12 on, 24 off schedule: R$ 11,459,500.

   a. Sentinels: R$ 4,264,000.

   b. Firemen; R$ 7,195,500.

ii) Building maintenance and general services: R$ 3,011,600.

a. Concierges: R$ 1,296,000.
b. Janitors: R$ 1,154,400.
c. Janitor: R$ 288,000.
d. Gardener: R$ 230,000.
e. Garbage collector: R$ 43,200.

The revenues of the parking lots and the revenues of the service fees that are provided in the PTCD should finance such costs. In case the basic common service fee is apportioned, assuming as hypothesis the 45 m2 for an average office space, with 15% built-up area being addressed to circulation and walls, there would be around 18,100 offices built, which would implicate an impact of R$ 799.51 in the basic common service fee on each office.

Based on the average price of high-standard business condominium fees in the Federal District (DF) and, in the fees practiced by other Brazilian Technology Parks for an equivalent office, it is estimated a building maintenance fee of R$ 1,6500 per month. Excluded the costs with security people and general services, the rest of the costs with maintenance of the PTCD should be R$ 850.49 (1,650 – 799.51), or around R$ 15,393,869 monthly.

To explore these services, the SPE should fulfill the legal requirements suited to each kind of specific activity.

2.8. Customs Clearance Unit

To improve customs clearance of the park companies' imported products, as well as exporting products from PTCD, an advanced unit for customs clearance will be created.

This unity should have at least 9,805,76 m2, being 9,000 m2 addressed to storage and processing and 805,76 m2 for the offices area.

R$ 7,475,666.45 is estimated cost to build and equip the unit.

2.9. Disbursement of the SPE Partnership and Division

The bidding winner company will have as an obligation to implement the basic

infrastructure of the PTCD's Lot 1, just as to build 266,033 m2 of building for rental, being 10,000 m2 to headquarter the PTCD central services and the common use laboratories to develop technology and technology innovation processes.

The disbursement of the partnership is estimated as follows:

i) Basic works: R$ 404,849,420.25.

a. Lanes and sidewalks: R$ 35,661,000.
b. Landscaping: R$ 27,326,593,000.
c. Leveled parking spaces: R$ 17,805,160.80.
d. Land adequation: R$ 148,319,357.51.
e. Water, sewage and stormwater installations: R$ 28,231,686.
f. Redundant transformer central: R$ 24,000,000.
g. Common areas lighting: R$ 7,231,000.
h. Security and maintenance vehicles: R$ 1,350,000.
i. Security system: R$ 13,680,642.49.
j. Broadband infrastructure, set of power generator and grid power and additional expenses with technologies: R$ 93,768,314.
k. Custom Clearance Unit; R$ 7,475,666.45.

ii) Areas for rental: R$ 809,861,463.40.

a. Laboratories for common use: R$ 54,502,400.
b. Offices for rental (masonry): R$ 755,359,063.40.

iii) Total investment: R$ 1,214,710,883.65.

The partner has the option of building immediately and on its own area for rental greater than the minimum 266,033 m^2 required. In this case, although the investment occurs necessarily by means of the SPE, the extra cash flows will belong exclusively to the partner. The exceeding investment will not count as part of the formation of the Social Capital of the SPE, and it will not affect the distribution of the property defined during the bidding process.

The full payment of TERRACAP Capital will be the land, which the value for this business was estimated at R$ 1,080,000,000. So, the total value of the SPE Social Capital will be R$ 2,294,710,883.

The division of the propriety will be proportional to the each associate fully paying

the capital. Therefore, 47.07% of the SPE stocks will be property of TERRACAP, being the rest of it (52.93%) from the bidding winner.

The distribution of the society's profits can be done in different proportion of the assets division and will be proposed by the bidding competitors.

2.10. Land and Buildings value

According to report in the bidding process, the land value was estimated at R$ 1,080,000,000 with a usable area for economically exploitable buildings at of 287,669.40 m^2. Thus the price of the usable area square meter for constructions is at R$ 3,754.31. Included the R$ 404,849,420.25 invested in common areas, this value goes up to R$ 5,161.65 by square meter, which with 18.5% gain on investments goes up to R$ 6,116.56.

The cost of the square meter of non-specific equipment construction (only masonry and vacancies) was estimated in R$ 2,950.24. With the equipment, the square meter of the construction goes up to R$ 5,450.24.

A typical building, with horizontal projection of 4,000 m^2 and total area of 13,318.03 m^2, will have a cost of R$ 20,646,600 with the land and, without specific equipment, a cost of R$ 39,291,384.83 with masonry, which results in a total cost of R$ 59,937,984.83 or R$ 4,500.52 per square meter.

In case it is equipped, the total cost to build a typical building, adding the land value, will raise to R$ 93,233,059.83 or R$ 7,000.51 per square meter.

Being 15% of the built-up area addressed to walls and common circulation area, a typical building without equipment would have a cost of R$ 5,294.72 commercially exploitable square meter, while the equipped building would cost R$ 8,235.89. In this case, we consider only 11,320.33 m^2 as economically exploitable area in each building.

In case the adopted office space standard is 45 m^2, an office in a non-equipped building would cost R$ 238.262.85 and, with an equipped building, R$ 370,615.05.

With a profit rate of 18.5% over the invested value on the construction, the market value of the exploitable square meter on a non-equipped standard building would be R$ 6,274.26 and, on an equipped building, R$ 9,759.53.

The market value estimated for the non-equipped standard building is at R$ 71,026,693.71, while the equipped building is estimated at R$ 110,481,100.20.

As a basic hypothesis, we assume that the SPE will build around 19 non-equipped building and 1 building, with about 10,000 m^2, equipped, which will work as the service central and common use laboratories.

Therefore, the market value of the SPE real estate asset is estimated at:

i) Real estate built for rental: R$ 1,459,988,281.

ii) Land available for leasing: R$ 1,272,244,480; and,

iii) Total real estate asset on market value: R$ 2,738,232,761.

2.11. Technological Infrastructure

In this item we describe the expected technical solution to the PTCD technological infrastructure, as well as its viability in terms of the PTCD, considering the nature of the PTCD as a park that its vocation is to explore the information and communication technologies products and services.

In this context, the general network architecture will be initially presented and then the several network services will be described. The equipment necessary to provide the adequate infrastructure and their minimum requirements will also be specified.

Figure 5.1 below illustrates the solution proposed for the communication network architecture of the PTCD.

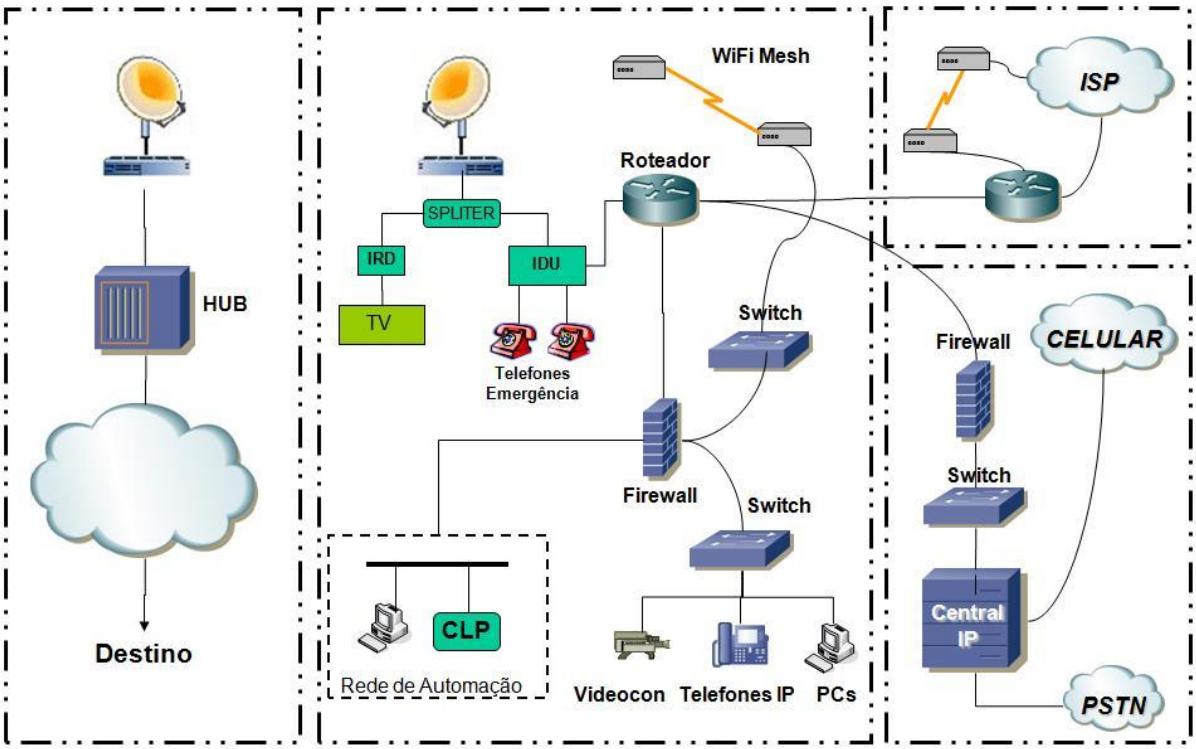

Figure 5.1 The communication network architecture of the PTCD

The proposed solution aims to: (i) install redundant high capacity links by means of optical fiber; (ii) redundant high capacity radio link for first contingency; and (iii) satellite link to operate in second contingency.

The edge routers are responsible, among other factor, for the connection with external circuits of internet servers. Core routers will be installed and configured to make part of the park's internal network. Switches and firewalls will also be installed and configured together with routers and servers aiming to logical and physical network operation, as well as their protection against attacks from external and internal networks of the park, including possibly an automation network. The solution should cover the following communication services:

- Data communication network;
- Ultra broadband connection;
- Wireless broadband connection;
- Corporate telecommunication;
- Videoconferencing;

- CFTV;
- Websites and content hostage;
- Email;
- Network support and management;

To enable these services, a lot of equipment should be acquired according to the technical specifications here presented. The following items take into consideration these necessities as well as the proposed solution operation.

2.11.1. Types of External Links

There will be two types of network connection in the PTCD with external networks as Figure 5.2 illustrates:

- The primary connection should be establish by means of optical fiber redundant links;
- The contingency connection should be established by means of radio link and satellite.

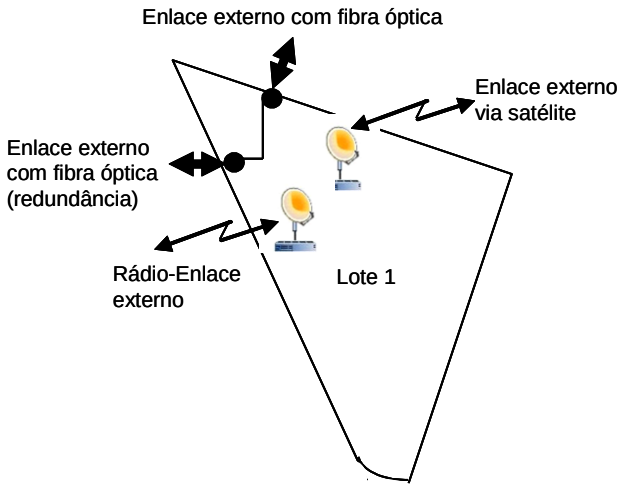

Figure 5.2 – External links with telecommunication service providers

2.11.2. Features of the primary external links

The primary connection links with external networks should be established by means of optical fiber and should obey the following requirements:

- 40 Gbps total minimum transmission rate;
- 99.9% minimum availability;
- 40 ms maximum latency;
- Operating with load and redundancy balancing;
- Different physical connection locations in the PTCD to provide better redundancy;
- The links physical connections should be compactible with the edge routers ports.

2.11.3. Features of the contingency external links

In case of failure in the primary external connection via optical fibers, it shall be used the contingency via radio or satellite. The system via radio shall obey the following minimum requirements:

- 500 mbps total minimum transmission rate;
- 99.9% minimum availability;
- 10-6 maximum error rate;
- Adaptive modulation scheme;
- Source redundancy;
- Operating with direct line of sight
- Operating frequency rate licensed by ANATEL.

The contingency link via satellite shall obey the following requirements:

- 2 mbps total minimum transmission rate;
- 1.2 m diameter antenna;
- The modem should have at least 2 extensions for emergency;
- The links physical connections should be compactible with the edge routers ports.
- 98% minimum availability;

- 10-7 minimum error rate;
- 250ms maximum latency;
- Synchronization according to recommendation ITU-T G.823;
- The satellite radiant system may be used to provide simultaneously satellite TV service by means of a splitter. It is recommended to use only one satellite band that can operate the data link and receive open TV signals;
- The satellite link address should be a internet access server

2.11.4. Internal network of optical fiber

a) Optical cable sizing

For the PTCD to be prepared to the traffic growth generated by its corporate entities, it is recommended to use 144 optical fiber cables, even if it represents idleness in a first stage. This recommendation is based on the fact that installing these cables represent a long-term investment. Thus, we estimate that it should be able to absorb the yearly duplication of traffic volume. This growth represents a multiplication on the traffic volume by one thousand in ten years and by one million in twenty years, which is the compactible term with the optical cables life span, which is over 20 years.

b) Local Optical Backbone Architecture

The features of the communication traffic in the PTCD suggest the implementation of local backbone architecture similar to the modern access network architecture of carriers. This architectural adherence with access networks comes from some basic requirements such as:

- The traffic nature tends to be less and less asymmetric: New applications demand architecture solutions that provide high access traffic upstream;
- The PTCD should be able to give support to voice, data and video integrated services for corporate users, by means of a cheap, simple and scalable solution. The architecture should be optimized for internet protocol data traffic, the current dominant communication protocol;
- To alleviate the traffic paths of the band, the optical fiber and the optical knots should be in the first mile - phrase often used as reference to the

access networks.

The combination of mature technologies, decrease of components cost and positive experiences acquired in the optical backbones made the construction of access optical network an economically feasible business. Although most part of the current access networks still do not use optical fiber as means of transmission, the tendency is the predominance of this technology in the next years because they area capable of giving support to services with big necessities of broadband, transmitting them to significant distances when compared to physical dimensions in their own networks. The case of the PTCD is peculiar for not being a carrier. To the PTCD, the access network is a local backbone that will interconnect the offices and corporate units to the routers that will have external links by which it will connect to the broadband servers outside the Park.

For the PTCD optical backbone, we suggest the implementation of a passive optical network, PON. The standardized PONs are currently networks which use the time division multiplexing, TDM and two different wave lengths in the bidirectional transmission of traffic on the same fiber, in which the only active elements are in a central point (that is, the optical line termination) and on the user installations (that is the optical network units, ONUs). The PONs are typically available with the star topology, in which the optical distribution network (ODN) is composed by the fibers and the passive splitter used as remote terminal (RT) to distribute the OLT signal to the ONUs in the downstream. In the opposite direction of the transmission, different ONUs signals area multiplexed in time to share the upstream. The PON standard adopted in Brazil is the G-PON, described in the ITU-T G.984 recommendation. Figure 5.3 is an illustration of the architecture of a G-PON network.

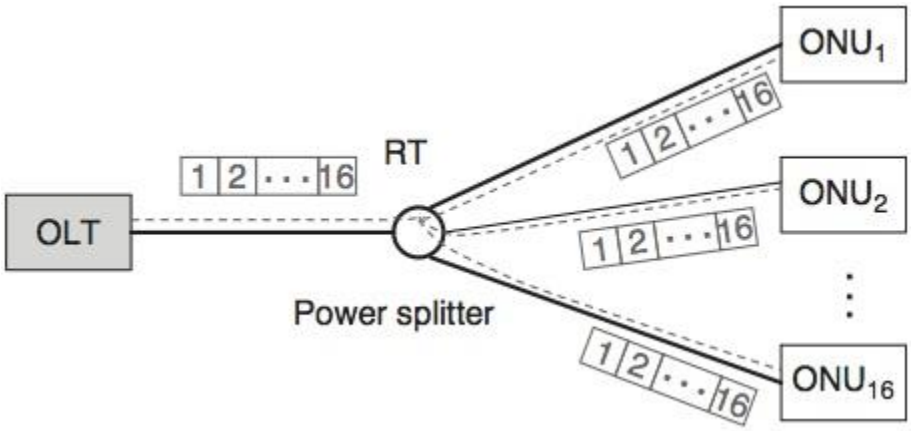

Figure 5.3 – G-PON network architecture

The G-PON technology is currently characterized for a 2.5 Gbps downstream traffic and a 1.25 Gbps upstream, shared among the users of the same PON. G-PON solutions with greater transmission rates (e.g. 10 Gbps) are in stage of standardization and should be available in the market in the next 5 years.

It is worth observing that the capacity projected for the optical fibers (cables with 144 fibers) enables implementing – besides the shared services by the PON network – private connections point-by-point between users and the communication service central at the PTCD.

The basic premises of the G-PON network project of the PTCD are:

- G-PON network (ITU-T G.984) point-to-multipoint, star topology;
- External optical network to assist 4 optical access in each one of the 72 blocs of the PTCD, meaning 4 PON network typology (Figure 5.3) in parallel to assist all blocs, summing 288 optical accesses;
- The sizing should allow an evolution of the transmission rates to at least 10 Gbps in upstream direction;
- Optical Line Terminals (OLT) + Optical Network Units for 288 initial clients;
- Total capacity for OLT: 128 clients;
- SC-SPC connectivity;
- G.652B optical fiber monomode;
- Up to two levels of optical division;
- 1x8 PLC optical splitters Fusion type installed in each splice closure;

- Average radius in the initial coverage of the distribution/access network; 2km;
- NAP box with 8 subscribers;
- Downstream cable; 2 fibers per client;
- Average/client size for each drop cable: 100m;
- Material and accessories for the FTTH internal network.

The access network per optical fiber should be composed of optical access, high-density polyethylene tubes (HDPE), optical cables, junction boxes, splice closures and optical distribution boxes.

2.11.5. Wifi network

The PTCD manager should make available in the external circulation places, broadband access to wife Internet, as well as inside the buildings commonly used and in the underground parking lots. The coverage should be guaranteed at least 95% of the Park area, except for the areas exclusively addresses for vegetation, and in 90% of the internal areas mentioned above. The wireless access cannot depend on softwares or owner applications and should be possible to any certified equipment by WiFi Alliance.

The server should guarantee a 10 Mbps minimum symmetric TCP throughput by user in the areas covered. This greater transmission rate can be offered as a premium service, but a throughput of 1Mbps should be freely guaranteed within all covered area. The transmission rates refer to the fixed or nomadic users. The premium service access can be charged by the park manager or by means of roaming agreement with other external access servers.

From the first access, the roaming in all points of access of the PTCD should be guaranteed. A session level connectivity should be maintained for users moving up to a 50km/h speed.

The access will be done through the Wi-Fi technology by means of access points spread through all park area operating as infrastructure. The access points should have support to the IEEE 802.11a/b/g/n technology, with MIMO 2x2. Each access point should make possible the access of at least 30 users simultaneously.

The authentication should be done through a RADIUS server and should also have support to the IEEE 802.11i (WPA) and to the TKIP and AES encrypting. Users using the free service can be admitted without authentication. The authentication servers should have redundancy.

The premium access to the Wi-Fi network cannot have any content blocking, providing the user the possibility of using it for any application and service within legal boundaries. For the free access services might be blocked when they demand extremely high rate, such as downloading, streaming and video sharing.

The access points should allow multiple SSID, which can be used for example for distinguished service offer such as premium subscriptions, or even for the VLANS establishment for corporate clients, with different use profiles, like authentication schemes, encryption and service quality.

In order to reduce the costs of implementation and wireless maintenance, the access points can be connected to the data network by means of mesh technology, since the requirements above area achieved.

The external equipment should support operation in any problems project for the region and within the range of temperature 0° and 50°C. The wireless network should have power electricity backup that guarantees running for 1h in case of power outage.

The implemented Wi-Fi solution should also allow the localization of equipment.

The wireless access network should have 99.9% reliability. The wireless transportation network should have 99.9% reliability.

The network should have technical support 24/7 for connectivity issues and failures or degradation of service. Sales assistance, hiring, canceling and service charging for premium users should be available during business hours. The assistance should be available by telephone and by electronic means (email, chat).

2.11.6. Equipment for wire and wireless core network data

The installation of Routers, Switches and Firewalls for interconnecting the internal network of the PTCD should be in accordance to the topology presented by Figure 5.1.

The core routers and edge routers should be the industrial type and support service quality treatment and distinguished services, in a way so to make easy the assistance to

videoconferencing and VPN canalization traffic. QoS and DiffServ will be implemented. Minimum configuration of the routers is the following:

- 4 GibabitEthernet, 10/100/1000 Mbps interfaces;
- 1 V.35 serial interface that supports at least 512 Kbps, transparent mode and support to TCP/IP protocol;
- Hot-swappable redundant source (1:1) with Fan Tray, operation tension compatible with the one made available by the provider, with hot-swappable modules too;
- Software able to provide processing of calling different telephones inside the vessel;
- Treatment of the VPN tunnel IPSec base with hardware processing;
- Support to distinct router tables for voice and data, separating the traffic of these services (VRF light– Virtual Routing/Forward Table);
- Manager Support: SNMP, WebView, Telnet, SSH, serial port RS232;
- Support to router based on OSPF protocol;
- Operation temperature; +5 to +40 Centigrades;
- Support to multicast: RFC 2236, RFC 2362, RFC 2934;
- Support to QoS and multiservices like voice and video in real time.

The core network switches should be implemented with the minimum features below:

- 48 GibabitEthernet, 10/100/1000 Mbps interfaces with remote feeding capacity based on the 802.3af standard.
- Hot-swappable redundant source (1:1) with Fan Tray, operation tension compatible with the one made available by the provider, with hot-swappable modules too;
- Should support the following standards: IEEE 802.3, 10BaseT, 10 Base FL, IEEE 802.3u, 100 Base-TX, 100 Base-FX, IEEE 802.3z, 1000 BaseT, IEEE 802.1q, IEEE 802.1d, IEEE 802.1p, IEEE 802.1x.

- Should support at least the following physical means: RJ45, R121 (copper), SC, MT-RJ (optical fiber).
- MIB support at least the following: RFC 1190, RFC 1213, RFC 1354, RFC 1493, RFC1573, RFC 1595, RFC 2515, RFC 1757.
- Manager Support: SNMP, WebView, Telnet, SSH, serial port RS232;
- Operation temperature; +5 to +40 Centigrades;
- Support to multicast: RFC 2236, RFC 2362, RFC 2934;
- Support to QoS and multiservices like voice and video in real time.

The use of a Firewall between a possible automation system and the data network is linked to the Security Standard of Industrial Information. The main benefits of using firewall on the platforms are enumerated as following:

- Local access control can be installed, substituting the access lists on the routers;
- The antivirus control function can be implemented on the firewalls when necessary, considering that part of the automation stations will not have antivirus software;
- The firewall will also have the worm blocking function, avoiding a attacked started by other people's equipment spreads out on the PTCD network;
- The firewall can provide VLANs split in three user classes, namely: PTCD user, non-PTCD user (in the case of third party people using the PTCD network) and third party (external users of external network); the originated traffic will be filtered and the it will be triggered the VPN tunnel finishing on the VPN concentrator located at the PTCD in a segregated way through specific VLANs. According to what was explained previously, because the third party access is expected in these environments and being possible the risk of a token being under malicious intention, we consider these accesses also as insecure connections.

Firewall can be used to protect the internal network from attacks coming from external networks. Therefore, the firewall should have the following minimum features:

- 2 i7 3.4 GHz processors;
- 8GB memory;
- 2 GibabitEthernet, 10/100/1000Mbps Mbps ports;
- 2 mirroring discs (500Gb minimum);
- 1 DVD-RW unit;
- 19” wiring rack.
- Source redundancy;

2.11.7. Videoconferencing

The videoconferencing system should allow the establishment of conference meetings in two or more environments adequately equipped and provide voice and video interactive communication, transmitting simultaneously graphic images and/or photographs and data. These meetings can involve the PTCD professionals and/or others outside.

In this evaluation, we consider the need of implementing 10 videoconferencing rooms that can be available in the form of services for the PTCD users.

Each videoconferencing room should be built within the PTCD facilities and its management and maintenance will be duties of the Park manager. The implementation of the videoconferencing room should be done employing terminal equipment compatible with most videoconferencing international networks and the H-320 and H-323 protocols, having facilities of remote management with SNMP protocol. The videoconferencing codec will be connected to the network data (TCP/IP) of the PTCD. The band for videoconferencing will be 4Mbps at least (maximum 20% of overhead) and the service class will be sensitive.

A MCU should be installed specifically to manage the events in rooms for that sort of activity, having in mind the interface of this system should be via IP. It should be expected an access point to the system in the room to be used. The codec should have an IP interface and the configuration of QoS and the codec and the MCU should be done.

Videoconferencing demands the use of adequate rooms with operational characteristics that have the criteria of: localization, acoustics, illumination, environment, layout and infrastructure. Figure 5.4 illustrates the adequate room proposed to provide

videoconferencing service.

The noise level inside a videoconferencing environment should be significantly affected because of the near external sources that give it causes such as:

- Lifts, air-conditioning compressors and other devices;
- Hallways for big circulation of people;
- Generator systems, compressors and pumping (rotating machinery in general);
- Restaurants and cafeterias;
- Sports areas;
- Expedition areas/ material reception;
- Repair shops;
- Radio-operation stations;
- Pathways for motor vehicles;
- Classrooms.

Therefore, the presence of such elements on choosing the place of videoconferencing room should be minimized, since in this choice there is a great possibility of reducing problems of acoustic treatment of the chosen place, since this is the item of greater expense of money after the investment on equipment.

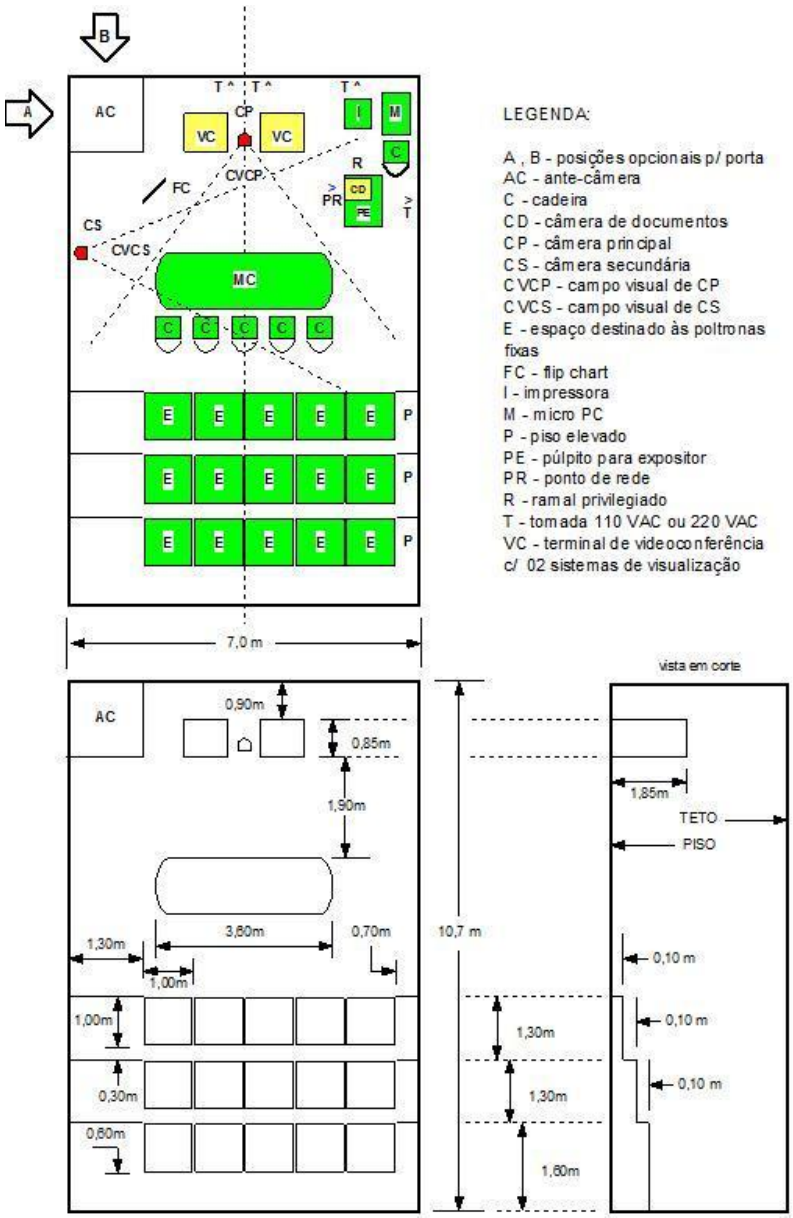

Figure 5.4 – Videoconferencing room

The audio quality is one of the more relevant features in videoconferencing. There should not be internal or external noise sources that might affect the audio in the videoconferencing room. However, if not possible to avoid such interference sources, the solution recommended is to submit the room to an acoustic treatment in way that its level of maximum internal noise acceptable do not exceed 50 dB-SPL (50 dBA).

There are two aspects of acoustic treatment that should be considered:

- Acoustic isolation through isolating techniques and materials, which have two objectives:

- Reduce the influence of external sources of noise in the room internal ambient;
- Assure the secrecy of information, making difficult the external hearing of strategic issues talked in the room;

- Reverberation: All surfaces, including the walls, ceilings and floors in a room, reflect the sound, causing echoes or reverberation, according to their dimensions.

Thus, in the PTCD videoconferencing room there should be reduction to acceptable levels of sound reflections, which should use neutralization techniques and absorbing acoustic materials (carpets, corks, curtains, latticework, etc) in treating the floors, walls, windows and glass doors and ceilings. The acoustic treatment of window (when they exist) should be done with heavy or pleated curtains. Window blind will not be used. The treatment will be carried out in way that its level of maximum acceptable internal noise does not exceed 50 dB-SPL (50 dBA).

The video quality generated in the videoconferencing room will be directly associated to ambient light. Thus, some recommendations are essential to guarantee an acceptable standard of video in the videoconferencing service of the PTCD:

- Windows: recommend to avoid always as possible to chose windowed ambient. Being inevitable this option, the use of curtains become indispensable to neutralized external light sources. Window blind does not offer efficient light blocking, therefore its use is not recommended.
- Type of light: it is recommended that the rooms be illuminated through homogenic light sources, preferably fluorescent lamps. It is not convenient the use of light sources such as incandescent lamps, or external daylight (window) mixed with fluorescent illumination.
- Light diffusion in the room: It is recommended that the rooms are uniformly illuminated, that is, do not present shadowing areas in any place of the room, except for the adjacent areas to the front and back wall, that should receive distinguished treatment of illumination. The luminaires should be distributed throughout the ceiling according to ABNT norms of illumination.
- Ambient light intensity: it is recommended that the ambient light intensity of videoconferencing be situated within the range of 600 to 800 Lux, that is, a

little above ABNT standards for office illumination.

For an adequate visualization of people we recommend that:

- The camera should receive light in quantity, quality and adequate angle;
- The light that illuminates participant's face should focus from top to bottom forming an angles between 45º and 60º (Figure 5.5); 5.5);

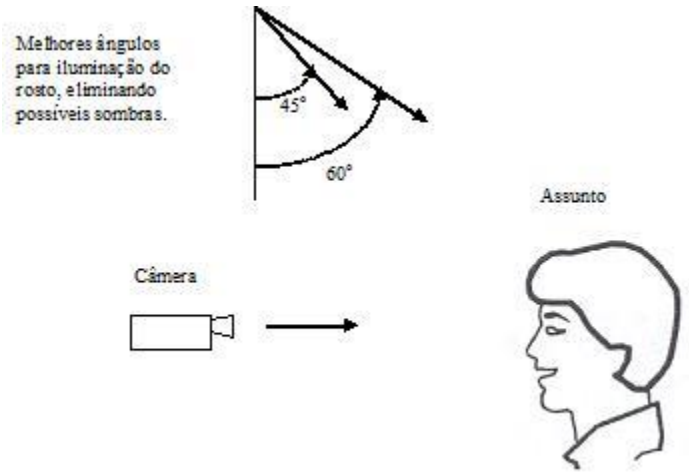

Figure 5.5 – Illumination Model

- The light should project in a horizontal plane on the participants faces according to the illustration on Figure 5.6, which lessens the formation of shadowing on the ocular orbits, below the nose and the chin;

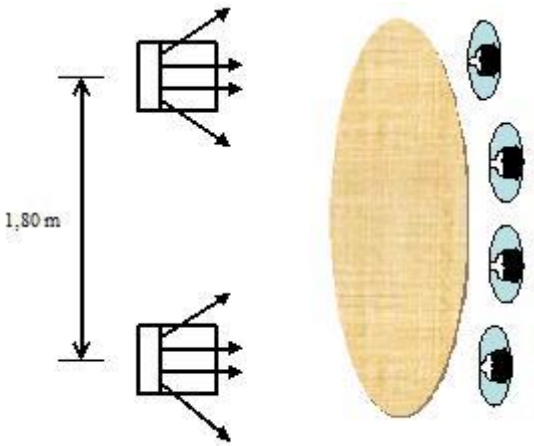

Figure 5.6 – Light plan

- The maximum light quantity reaches the face of each participant, measured according to that advised in Figure 5.7. It should have a value between 600

and 800 Lux.

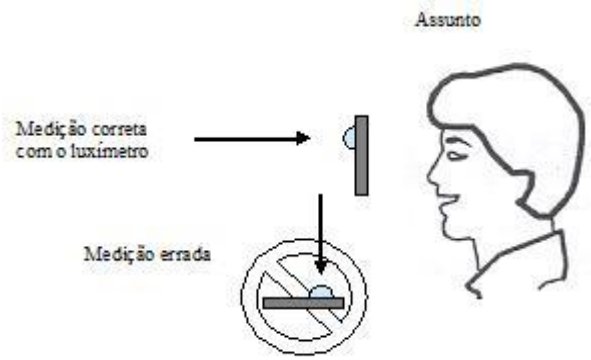

Figure 5.7 – Light quantity

The adequate light quality for the video cameras used in videoconferencing environments should be assured with the use of fluorescent lamps of 3000 K (color temperature in Kelvin degrees), with a CRI (color renderization index) of 82+.

The wall where it locates the visualization system (screen or monitor) – area 2, Figure 5.8 – should receive a minimum of illumination to preserve the contrast and image sharpness visualized.

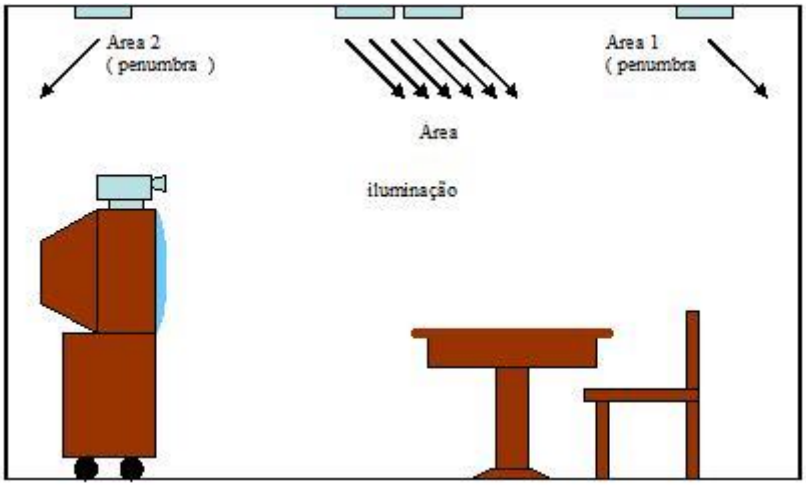

Figure 5.8 – Minimum illumination

The wall behind the participants (area 1 in Figure 5.8) and a small adjacent extension in the side walls (about 1.5 m) should receive light in such quantity that does not generate any of the effects below:

- Excessive brightness on the face of the participants, cause by the opening of the camera shutter that tries to compensate the scarce light receive from the poorly illuminated wall of area 1 according to Figure 5.9;

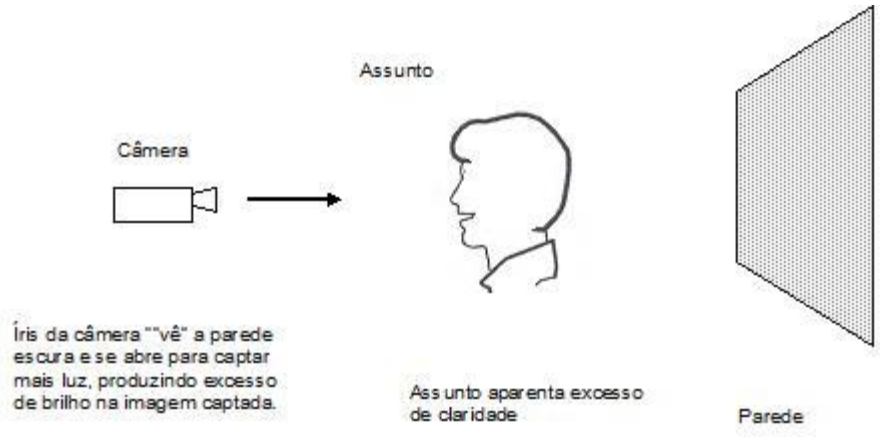

Figure 5.9 - Brightness

- Dimly lit participant faces, by the closure of the camera shutter what tries to block the excess of light received from the poorly lit wall in area 1 (Figure 5.10) 5.10).

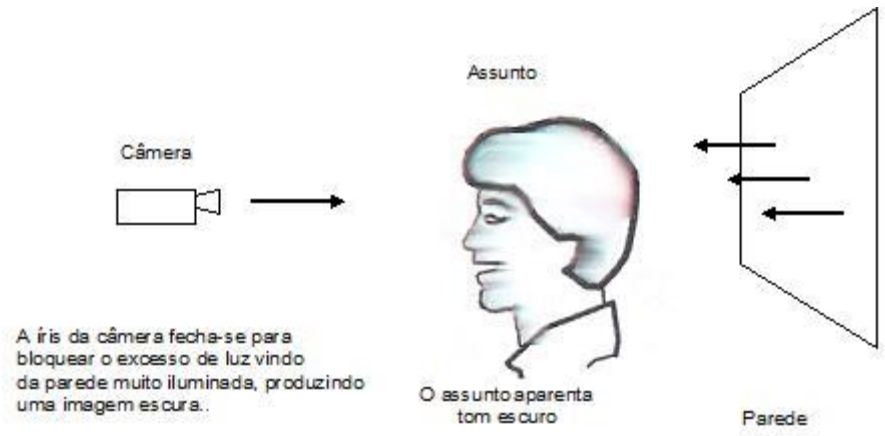

Figure 5.10 – Dim illumination

The light control in areas 1 and 2, Figure 5.8, should be done by means of reduction devices specific for each area. These devices allow balancing light intensity levels adequate to each area so to minimize the deleterious effects in capturing image.

The devices that solve the incidence demand according to angles between 45º and

60º area two basic types:

- Asymmetric lighting fixture, with its respective side views and horizontal plane (Figure 5.11) 5.11);

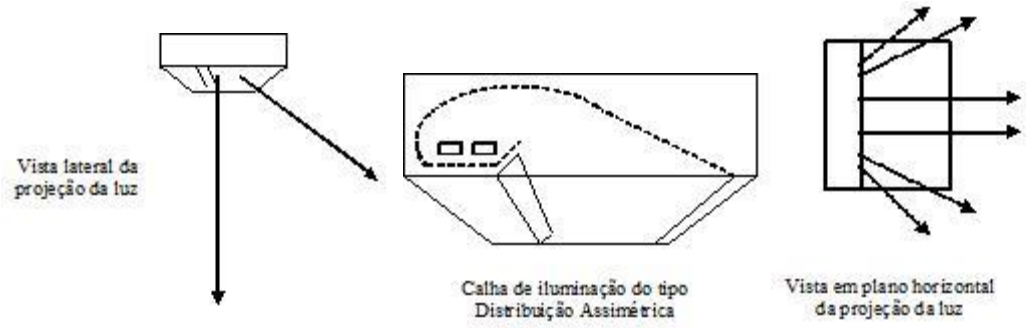

Figure 5.11 – Lighting fixture.

- Rotating light fixture (Figure 5.12) 5.12).

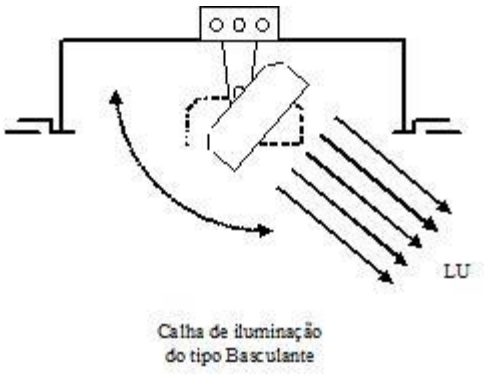

Figure 5.12 – rotating light fixture

The furniture to be purchased is strictly necessary to operating the videoconferencing room. Being so, it is recommended to acquire:

- 1 flat matte light colored top table, glassless, in a half circular sector with 3.60m x 1.30 m dimensions;
- 5 adjustable height swivel chairs, with seat, lean back and matte light color padded arms

- 15 fixed chairs, grouped in blocs of five, with seat, lean back and matte light color padded arms (same colors as the swivel chairs), with foldable writing board on the right airchair. Project 15% of these seats with left-handed tablet armchairs.
- 1 computer desk;
- 1 adjustable height swivel chairs, with seat, lean back and matte light color padded arms for the computer desk;
- 1 flip chart.
- One office podium measuring approximately 1.15m x 0.80m x 0.60m.

We recommend that the videoconferencing room be provided with electric power sockets, three pins, located according to the room layout, in 110VAC or 220 VAC (whichever is available) to feed the following charges:

- 1 charging point finished in a 4 socket adapter for the videoconferencing terminal (CODEC);
- 1 charging point finished in a 4 socket adapter for the computer;
- 1 charging point finished in a 4 socket adapter for the podium;
- Data network access;
- The room should make available 2 points for local network data to be used as:
    - Point of connection of the videoconferencing terminal to the IP network infrastructure with Qi's treatment for access to the Videoconferencing Corporate Service;
    - Point of connection of a computer or laptop to data network.
- Also there will be wireless coverage for laptop access.

2.11.8. Closed-circuit television- CFTV

The Closed-circuit television (CFTV) is an audio and video transmission system that distributes signals from cameras located in specific and strategic points up to one or more pre-determined management points. In the PTCD, the CDTV should be integrating part of the security and asset surveillance technology - extremely important area and very

relevant in managing the Park.

The minimum requirements recommended for the CFTV system are the following:

- Cameras with TCP/IP protocol batteries and support to the Wi-Fi Mesh network and/or to the wire data network;
- Pan/tilt/zoom cameras;
- Night vision capacity;
- Large range microphone;
- Audio and video recorders;
- Audio and video capture board compactible with the IP network;
- HD and DVD recording capacity;
- External protection boxes;
- PTZ speed dome;
- Motion detector sensors;
- Audio amplifiers;
- Video distributors;
- Illuminated infrared; and
- Monitors for management.

The detailed planning of the CFTV solution, including the localization of cameras, adequate room for management, and the intervention politics, should follow the strategic recommendation of the asset security sector of the PTCD. Therefore, this document will only project a budget to implement the system of CFTV in the PTCD that is in accordance with the local physical dimensions.

2.11.9. Telecom

The telephone service of the PTCD Lot 1 will have as main goal to provide the voice service to corporate users of the Park. The access should be done by means of the IP network of the PTCD and should obey the plans defined by the Manager Company. Technically it will be possible to make phone calls to other telephones inside the PCTD, as well as to digital and analogic terminals of fixed or mobile telephone external networks. Still, it should be possible to make audio conference and videoconferences among internal extensions and/or external terminals.

In order to implement the telephone services, the following equipment should be taken into consideration:

- 1 IP telephone central
  - The manufacturer should offer a solution with redundant telephone central with package commutation;
  - Q.SIG signaling;
  - Over 20 tie-lines from local PSTN;
  - SIP protocol;
  - Support to over 4 T.39 fax on IP, being able to be assisted with external gateway;
  - Configuration redundancy and power supply system;
  - Gatekeeper function executing function like: IP terminal register, connection admission control (CAC), terminal/connection state (status), calling notification etc;
  - Permit blocking of national and international calling, cell phones and unwanted numbers, and DDC (in DDR entrance calls by the Public network);
  - Permit conversion up to 5 digits (analysis up to the fifth figure – C). and regeneration of up to 3 digits, based on the number plan WXYZ-MCDU;
  - Control of echo cancelling activation, support to VAD (Voice Activity Detection) and CNG (Confort Noise Generation);
  - Make GigabitEthernet and RS-232 interfaces available;
  - Make the use of wireless terminal available;
  - Support CODEC's; G.711 and 729a;
  - Automatic ticketing system;
- IP device fixed terminals;
  - They are telephones that contain a chipset that run all codification/decodification functions and packing/ unpacking of voice, and can have Ethernet interface for intercall to a local network interface;

- 1 switch with the following features:
  - 48 GibabitEthernet, 10/100/1000 Mbps interfaces with remote feeding capacity based on the 802.3af standard.
  - Hot-swappable redundant source (1:1) with Fan Tray, operation tension compatible with the one made available by the provider, with hot-swappable modules too;
  - Should support the following standards: IEEE 802.3, 10BaseT, 10 Base FL, IEEE 802.3u, 100 Base-TX, 100 Base-FX, IEEE 802.3z, 1000 BaseT, IEEE 802.1q, IEEE 802.1d, IEEE 802.1p, IEEE 802.1x.
  - Should support at least the following physical means: RJ45, R121 (copper), SC, MT-RJ (optical fiber).
  - MIB support at least the following: RFC 1190, RFC 1213, RFC 1354, RFC 1493, RFC1573, RFC 1595, RFC 2515, RFC 1757.
  - Manager Support: SNMP, WebView, Telnet, SSH, serial port RS232;
  - Operation temperature; +5 to +40 Centigrades;
  - Support to multicast: RFC 2236, RFC 2362, RFC 2934;
  - Support to QoS and multiservices like voice and video in real time.
  - The voice VLAN should be configured to accept IP terminals according to an 802.1x authentication. In case the IP telephones do support 802.1x, the voice VLAN can also have support to authentication by MAC address.
- 1 firewall that will be installed to protect the IP telephone equipment, allowing only the entrance of voice VLAN, with the following minimum features:
  - 2 i7 3.4 GHz processors;
  - 8GB memory;
  - 2 GibabitEthernet, 10/100/1000Mbps Mbps ports;
  - 2 mirroring discs (500Gb minimum);
  - 1 DVD-RW unit;
  - 19” wiring rack.
  - Source redundancy;

2.11.10. Network and system management center – CGRS/Datacenter

The technology infrastructure will have a network and system management center (CGRS), with capacity of:

- Installing and configuring the network and the systems so to provide access, transport, processing and information storage services;
- Monitoring the network and services so to:
  - Detect, isolate and repair failures as well as reestablish services;
  - Configure and adjust service development;
  - Treat security incidents;
  - Do the accounting of service usage.

In particular, in this activity, principles, processes and methods should be applied to constitute the politics of information treatment in the PTCD and be linked to a service level agreement. Among the basic requirements for such politics:

- There should have classification of the network traffic, as well as prioritizing the traffic by the network, should follow the recommendations that QoS to be defined by the IT team of the PTCD;
- Should be implemented the QoS configuration on the routers and switches to guarantee priority on the voice, videoconferencing services and others of critical nature that can come along. The mechanism of traffic classification should be the IEEE 802.1p/802.1q, that is the highlight of the information bits of 802.1p priority in the 802.1Q label of the Ethernet board, according to the IEEE specifications. The service class recommended for the voice traffic is the SENSITIVE class, DSCP 46 (Differentiated Services Code Point);
- There should be done the segmentation of the Voice and Data traffic using separated VLANs, blocking the access of PCs to voice VLANs, stopping the passage of traffic marked as voice (via 802.1q) through the PC port of the IP

telephone and blocking attempts of sniffing from the this PC port. The IP telephones should support the 802.1q standard so that this segmentation can be configured from the telephone;

- The politics of information security should define the minimum security procedures as follows:

  - Establishing as standard pre-requirement – obligatory for remote connection of computational resources to the automation network of the PTCD – that use operational systems with all corrections and security updated properly installed;
  - Implementation of setup password in all computers, workstations and laptops that will be remotely connected to the network;
  - Use of screensaver with password in all computers, workstations and laptops that will be remotely connected to the network;
  - Not to give computer users, the workstations and laptops that will be connected remotely to the privilege network of the machine administrator. This task should be exclusive of the IT support staff;
  - On the unsafe areas it should be made available exclusive ambient (room or dedicated office) to install the communication equipment and automation terminal equipment aiming at guaranteeing the access restrictions to these rooms.
  - There should be configure a network point enabling connection of automation terminal equipment and supervision and control stations, linking and locking the Ethernet pot to a specific MAC address and designating a fixed IP address for terminal through ACLs (access control lists).

For specification effect of the PTCD, we adopted the basic definition that the Network and Systems Management Center – CGRS is the place where the network and systems are operated and administered. Thus it is a physical spatial structure for equipment and people, as well as the locus where objective work processes are developed.

The plans and elements to be considered in a project of a center with such

functionalities are determined in figure 5.13.

Figure 5.13: CGRS components

In the next text, first we present the normative reference for the physical structure and for the CGRS processes and, following we describe the CGRS components and its correlation with the processes that are carried out using such components.

2.11.10.1 Normative Reference

From the point of view of the spatial physical structure, the reference to define the CGRS is the TIA-942 norm ((ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers, 2005) that determines how the functional parts of the CGRS Data Center are put side by side.

In this organization, illustrate by figure 5.14, the space for infrastructure of IT has a size relation of 1:1 with area addressed to operational activities, because of the tendency of compacting components. It is worth noting that the CGRS area in general is found in the access sector of the computational and communication resources, following the

tendency that the CGRS works as the situation control room, in particular presenting a network and managed system dashboard, which often is presented with great visibility through large screens and video walls.

From the work processes point of view, the ISO 7498-4 (ISO/IEC 7498-4: Information processing systems -- Open Systems Interconnection -- Basic Reference Model -- Part 4: Management framework, 1989) norm defines with all technical accuracy, the functional areas of open system management. Even if the corresponding network management ISO protocol has become obsolete because of definitions related to the Simple Network Management Protocol – SNMP, these functional areas have been as a CGRS reference and are defined as following:

- The configuration management identifies, controls, collects data and provides data from and to open systems, with the purpose of preparing to start, turn on, provide continuous operation and finish open system services. Such daily operational activities should be articulated with strategy activities and tactics related to managing network and system modifications;
- The failure management encompasses the detection of failures, isolation and correction of abnormal operations of open system ambients. Such daily operational activities should be articulated with strategy activities and tactics related to managing network and system issues;
- Performance management enables behavior and effectiveness evaluation of resources and services of open system ambient. Such daily operational activities should be articulated with strategy activities and tactics related to managing network and system growth;
- Security management has the objective of supporting the application of security policies by means of security services and mechanisms in the open systems. Such daily operational activities should be articulated with strategy activities and tactics related to managing network and system risks;
- The accounting management enables defining the charges related to the use of open system resources and the identification of these resources costs. Such daily operational activities should be articulated with strategy activities and tactics related to managing network and system costs;

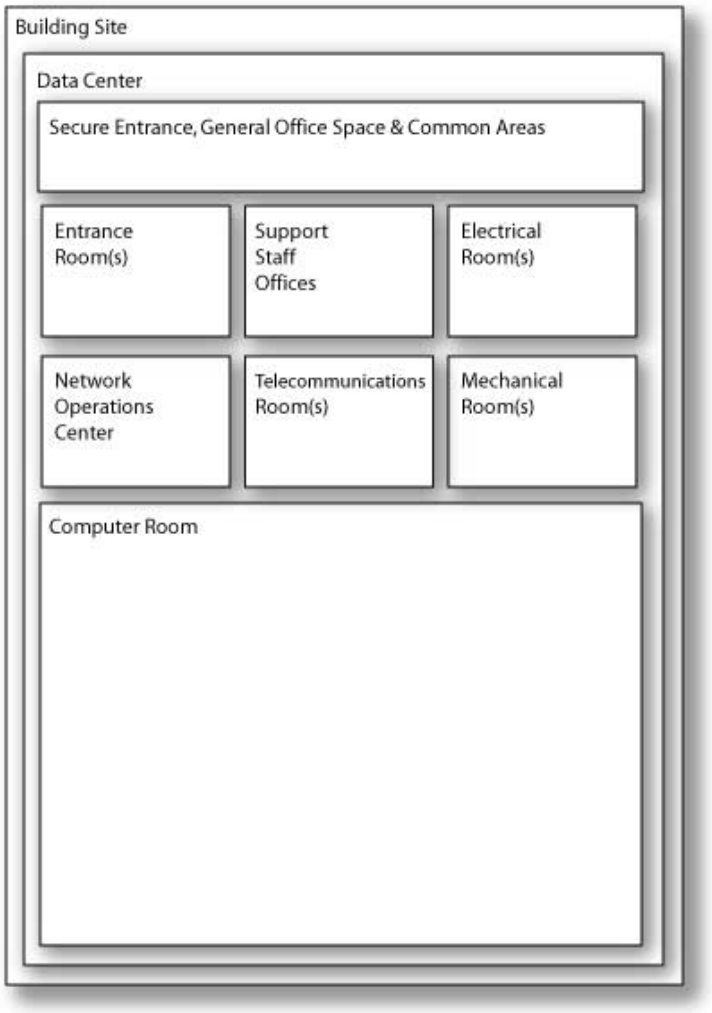

Figure 5.14: Space relationships at the Information Center (TIA-942 Norm).

It is worth noting that these definitions from 1989 are fully incorporated - sometimes without the technical detail of the correlated series of the ISO norms - in all modern frameworks of best IT service practices.

2.11.10.2 CGRS Objectives and Processes

The Network and Systems Operation Center should manage configuration and change, failure and performance monitoring, issues treating and growth management, observing the security requirements, situation reports, service quality guarantee,

scheduling and activities and documentation escalation, using sophisticated management softwares, monitoring and analysis tools.

The main typical objective of a CGRS is:

- Monitoring operations of all long distance links, local segments and network equipment;
- Assuring the operation continue and enabling network, servers, storage, electrical resources, ambient and services control;
- Providing unstoppable support and quality for the users;
- Solving every problem related to the network or systems;
- Opening and following-up trouble tickets and documenting the solution for any troubles;
- Operating 24/7 under technical supervision as well as network engineering and system engineering supervision.

For such, the CGRS should provide a structured environment that effectively coordinates the operational activities with all participants and service providers related to the network and system functions. The CGRS engineers and technicians in charge for the support should (in 24/7 period) monitor and manage central servers, storage equipment and network equipment, using automated software's or packages of network and system management-specific softwares. These softwares should assist daily processes that include:

- Monitoring and managing all servers, critical and non-critical network equipment, application servers and services such as production, desktops, electrically fed systems and other resources using the protocols needed, like the SNMP (Simple Network Management Protocol);
- Diagnosing network failures and performance problems, from a central location and analyzing problems by observing tendencies during time;
- Keeping the assets inventory and managing maintenance activities and changes by means of automated softwares;

- Customizing and fine tuning of the configurations to reach an optimized effective cost;
- Supervising the call answering process to assure the proper prioritization and scale the technical problems to provide fast solution for the user troubles and in a short-time period.
- Providing activity and progress reports to monitor and analyze the servers, applications and services performance;
- Documenting the monitoring processes, call answering procedures and trouble escalation logics.

2.11.10.3 CGRS communication equipment rooms

At least two communication equipment rooms should be built to store the main equipment and the redundant ones. It is recommended that these rooms be located in way to reduce the probability of the external links being interrupted simultaneously by human activities and/or natural phenomena. The exact locations of the rooms, just like their structural suitability should be a task for the PTCD manager company, which should follow the EIA/TIA-560 norm.

2.11.10.4 CGRS hardware components

To fulfill the requirements above, the CGRS should have a computer and storage base, as well as its own stations and servers to monitor and track activities in the network and systems and consequently apply such managing stations to define the actions to be taken in case of receiving failure notifications and performance and security warnings.

Thus, the CGRS should have:

- Computer cluster with minimum configuration of 128 nodes;
- Storage base with 128 terabytes minimum configuration;
- Monitoring server consoles;
- Workstations to manage network and systems;

- Administration and support team's equipment.

This equipment should serve the use of system for providing services to the PTCD users (services access control, email, www, etc.) as well as the management softwares describe next.

2.11.10.5 CGRS Software Components

Because of the processes and objectives required in the CGRS, the set of management softwares should reach the following main objectives:

- Constant monitoring and managing real-time network, including equipment, communication and service channels;
- Constant monitoring and managing in real time of equipment and server systems and high-capacity storage;
- Constant monitoring and managing in real time of applications and data banks;
- Automated managing of client equipment (desktop), support center operation and help (help desk).

Details of operations to reach such objective and capacity of the support softwares will be discussed on the next sub-section.

2.11.10.6 Network Monitoring

The specific object of network monitoring and management is to:

- Monitor all segments and communication channels like LAN, MAN and WAN;
- Monitor and manage equipment and network, installation and configuration resources;
- Detect, diagnose and solve all performance troubles on the network.

Routinely, the reach of these objectives imposes challenges to network monitoring. The network administrators need to optimize the service quality, balancing throughput, compromised transmission rate and avalanche transmission rate, in relation to the probability of traffic, response time, and error and losses rates. For that to be done effectively a software suit pack is necessary to provide:

- Skill to manage and monitor all devices of the network infrastructure, such as routers, local commuters, servers, firewalls, etc, of only one management console;
- Monitoring in real time of operational and administrative status of the devices (and their subcomponents) managed, with collection of parameters such as port usage rate, error rate per port, CPU occupation, memory and buffers;
- Monitoring all types of communication channels, in terms of link usage, activity time of links, figures and traffic standards in layers 2 to 7, identifying and classifying by intensity of traffic of channels, sources and destinations;
- Optimizing allocation of bandwidth so to reduce costs, in particular those related to long distance services;
- Guarantee of network high availability with the capacity of organizing the traffic flux by alternative paths and fast error solution;
- Tendency analyses to plan capacity and define futures requirements;
- Managing change and network configuration.

This software pack should be able to discover the network equipment, build an inventory base, present a network map and allow that administrators have control over configuration of equipment from a central console and also from a web-based console. The discovery of resources managed should cover the central area of network and its local segments, but also the long distance network and the local networks at remote places, always with a data bank of management information at the CGRS and fulfilling all network devices managed.

2.11.10.7 Server and Storage Monitoring

The management software should be able to - from a central point – to find out, present on the screen and monitor all machines and server softwares, just as the storage equipment, presenting a service level panel with several information monitored on system resources such as:

- Using CPU, with details of the processes and their specific attributes;
- Using and occupying memory;
- Using disks and input and output statistics;
- Communication channels status;
- Server inventory with details about components such as processor, memory, control boards, CD-ROM devices, etc.

In what refers to storage monitoring, the software pack should be able to discover the storage devices in the installation, offering the unified inventory and the means of visualization of such devices. The software should provide too management components of failures and performance for several means of physical storage to operate in a central console but also via web interface.

2.11.10.8 Help Desk

To support all users, covering the national coverage of the network, it is necessary to establish help and support desk for users with the productivity resources of a Help Desk.

To do so, a desk with web interface is required so to offer a software pack integrated for request treatment and tracking (trouble ticketing and tracking). That interconnects to the corporate email system and call center system with voice communication and application to client service automation to assist clients.

2.11.10.9 Asset and Inventory Management Software

This software pack is addressed to asset tracking associate to contract and purchase management. Thus, it should have components to automatically survey hardware and software and collect inventory information. It also should scan the logical areas of the network and discover the stations and their configuration features, including physical aspects, operational system attributes, installed applications, etc. The software should be able to do scheduled audits to track modifications on the assets.

2.11.10.10 Log Management

A web interface solution to manage logs is required to collect, file and elaborate reports about the events occurred in the workstations, as well as routers, commuters and firewalls with the following features:

- Centralized management of event logs: the software should collect events of devices, applications, systems, security components, directory service, DNS server, files servers and workstations everywhere on the network. All events should be stored automatically in a central data base and from there obligatory reports should be generated;
- Conformity reports: the software should include the capacity of producing reports of pre-defined conformity that help to comply with the requirements of normative or legal conformity. These reports should include details like user logon/logoff, attempts of failed login, and other events essential for an institution to comply with public policies and norms;
- Real-time alerts: the software should be able to generate alerts to notify system administrators when specific events are generated. Happenings that indicate uncommon activity such as system damage, application failures, etc. should lead to warnings by email to administrators, everytime the alerts are activated. The alerts are based on threshold violations that should be defined for servers individually or in groups;
- Security analysis; The software should be able to generate instantaneous reports when non-authorized operations occur, even with information about login failure attempts in critical devices, applications and servers, which can

help identifying vulnerable machines and malicious users that can be on the network.

- Automatic archiving of events: the software should be able to archive records collected from each server and then transfer the archived events to a data base and generate specific reports with these events.

2.11.10.11 Monitoring and Managing Application and Data Bank

Generally, the corporate application softwares and data bank management softwares offer monitoring modules and management of applications, data bank, web pages and other services. This involves the automatic diagnosis and the trouble notification and help to control performance and availability of the data bank and application servers and support services.

For the CGRS to be effective in this dominium, it is required a set of monitoring that fulfill such requirements. This module should provide a broad management of failures and proactive alert mechanism via notifications, verifying imminent problems, triggering adequate actions and gathering performance data that make the planning, analysis and report elaboration all possible. Thus it should assist administrators to keep the applications available and working flawless, besides of quickly solving any flaws.

Beside, the software pack should provide a broad range set of analytical reports to explore the tendencies and standards of data use by the users and applications, so to point out which applications use most part of the data bank resources and indicate the applications that are being used. This should, later on, allow the use of resource management functions to adjust the data bank in terms of quotas and priorities, assuring that the critical applications obtain what they need, while other applications continue to operate with acceptable levels of answering time.

2.11.11. Technology Infrastructure Costs

Table 5.4 – Costs estimate of a G-PON optical network with 4 OLTs and 288 ONUs.

Item	Service/ Material	Description	Quantity	Unit Price (R$)	Total Price (R$)
01	Underground optical cable (meters)	Cable measure (meter cost = R$/meter). Cable that works on 1310nm or 1550 nm window, with fibers coated in acrylate, positioned in tubes and protected by an internal coat against rodents and an external coat made of polyethylene with flame retardancy, with a CFOA-SM-DDR-GXXX-R designation (where XXX indicates the quantity of cables vias), 0.36 dB/km and 0.22 dB/Km maximum attenuation e maximum chromatic dispersion of 3.5 PS/nm.Km and 18 PS/nm.Km. Respectively to the windows indicated above with 144 monomode vias;	40,000 meters	30,00	1.200.000,00
02	Duct and sub-duct meter, 144 vias	Also as item 10 with 144 monomode vias;	40,000 meters	44,00	1.760.000,00
03	Installation of FIST standard splice closures	Installation with FIST closure with fusion kits for the corresponding FIST closure. The estimated value should be by installed and provided FIST closure. (Cost per installed equipment = R$/equipment installed), with 144 (twelve) positions (fibers);	72	8.000,00	576.000,00
04	Conduit boxes installation	Installation, with provision of all material, R1 conduit boxes: iron cover painted with anticorrosive, with safety lock and reinforced hinges that ensure lasting or equivalent box (properly authorized) with the civil material included. (Cost per box installed = R$ installed box.	72	280,00	20.160,00
05	DIOs Infrastructure	Installation with provision of Internal Optical Distributors - DIO, approved by ANATEL to install the indicated buildings. The DIOS provided should be composed of trays to accommodate the optical fibers, optical adapters for SC_APC connectors, pigtail optical extensions (for monomode fiber) with 12 SCAPC connectors to each DIO and tray to accommodate the splices of the resistant optical cable and protected against corrosion. The optical adapters support and the optical splice and fiber excess storage areas are inside the products, improving protection and safety to the system (cost per installed equipment = R$/installed equipment.	72	770,00	55.440,00

06	Optical Terminator	Installation with provision of optical terminator box that enables the splice of the external optical cable with pig-tail connector for internal use. The same should be on a steel or aluminum plate for fiber accommodation.	72	800,00	57.600,00
07	Fiber fusion	Fiber fusion (cost of fusion point = R$/ fusion point	144x4X2	40,00	46.080,00
08	Infrastructure - Racks	Installation with provision of Rack vertical mobile frame to fix on wall, 19'' and 10 U's height, with dimensions (W=56 cm, H=50 cm and D=68 cm), which will cover inside a DIO, SC/APC optical connectors, pig-tails and an active network equipment (which will not be responsibility of provision of the hired). The Rack should be made in steel, with tempered glass frontal door and removable side access (cost per unit = R$/ unit installed	72	620,00	44.640,00
09	Digging and closing trench per meter – Rough terrain	Digging and closing trench per meter, with 50 cm wide and 80 cm deep to launch ducts and sub ducts in rough terrain (sand, land, grass). (Cost per meter of built-up trench – R$/meter	20.000	9,40	188.000,00
10	Optical line terminal OLT + Switch GbE	Optical equipment located at the Park central office, responsible for distributing the downstream traffic for users connected to the same PON network and receiving the upstream traffic of the same users; includes optical transmission plate, controller plate, GbE plates, licences, chassis and system management.	04	600.000,00	2.400.000,00
11	Optical network unit - ONU	Optical equipment situated on the premise of the park corporate user	4x72	1.000,00	288.000,00
12	Power splitter	Passive device situated on the remote terminal (or remote knot) responsible for dividing and distributing the OLT optical signal to the ONUs and	8	800,00	6.400,00
TOTAL					**6.830.320,00**

Table 5.5 – Wireless network

Item	Service/ Material	Description	Quantity	Unit Price	Total Price (R$)
01	External Access Point		50	5000,00	250.000,00
02	Internal Access Point		20	1000,00	20.000,00
03	Servers for managing network and authentication		2	10000	20.000,00
04	Software for managing network		1	30000	30.000,00

	and				
07	Laptops for monitoring and tests		2	3000	6.000,00
08	Installation and tests		1	20.000,00	20.000,00
TOTAL					**R$ 346,000.**

Table 5.6 – Data Network

Description	Quantity	Unit Price (R$)	Total Price (R$)
Router	8	64.736,28	517.890,24
48 port switch 10/1000/1000 PoE	14	36.857,82	516.009,48
24 port switch 10/1000/1000 PoE	8	16.412,31	131.299,04
Firewall	2	21.456,78	42.913,56
19''Rack	2	5.040,13	10.080,26
Servers	4	10.349,32	41.397,28
Installation and tests	1	50.000,00	50.000,00
TOTAL			**1.309.589,30**

Table 5.7 – Telephone system

Description	Quantity	Unit Price (R$)	Total Price (R$)
Redundant IP telephone central	1	139.431,27	139.431,27
Simple IP terminals	200	415,34	83.068,00
IP terminals with additional functions	50	896,40	44.820,00
2 cable Gateway for RJ-45 with 4-port fax	8	1589,45	12.715,60
Ticketing	1	54.007,92	54.007,92
Installation and tests	1	30.000,00	30.000,00
TOTAL			**364.042,79**

Table 5.8 - Videoconferencing

Description	Quantity	Unit Price (R$)	Total Price (R$)
Codec (main + spare)	20	52.336,00	1.046.720,00
Projector	20	12.000,00	240.000,00
Motorized widescreen	20	9.000,00	180.000,00
Room adaptation	10	350.000,00	3.500.000,00
Installation and tests	10	14.000,00	140.000,00
TOTAL			**5.106.720,00**

Table 5.9 – Close-Circuit TV

Description	Quantity	Unit Price (R$)	Total Price (R$)
CFTV System; IP cameras, servers, management room, recorders, sensors, amplifiers	1	1.850.000,00	1.850.000,00
TOTAL			**1.850.000,00**

Table 5.10 – Contingency Links

Description	Quantity	Unit Price (R$)	Total Price (R$)
Communication system via contingency satellite	1	350.000,00	350.000,00
Communication system via contingency radio	1	450.000,00	450.000,00
TOTAL			**800.000,00**

Table 5.11 – Network and System Management Center

Description	Quantity	Unit Price (R$)	Total Price (R$)
Computational and storage infrastructure, with packs of server softwares and network and system management	1	30.000.000,00	30.000.000,00
TOTAL			**30.000.000,00**

2.12. Environmental Issues

The environmental aspects should be taken into account to build the PTCD since, besides representing the increased financial impact, there is the conditioning that only in treating the correlated problems is that is going to be possible to have an environmental license from the Environmental Institute and Water Resources of the Federal District – Brasilia Ambiental (IBRAM).

Before starting the works on the PTCD, there are two important factors that should be considered as following:

- Part of Lot 1 of the park was used in the past as dumping area and before the construction of the PTCD on this area a solution is needed for the dump. Otherwise, there is a risk of not getting an environmental license, which would implicate in not building the PTCD.
- The southern part of the PTCD is next to the Paranoa basin and because of that, it should be taken care of before starting to build it.

In addition to both features mentioned above, others aspects about the building stages of the PTCD should also be taken into account so that the IBRAM can generate the environmental license.

2.12.1. Location of the Dump at Lot 1

To survey with better precision the location of the dump, we used table 5.11 obtained in the Reference Term Suggestion done by the Union of Information Industries of the Federal District (Sinfor), to hire technical services to remove wastes from the Capital Digital Technology Park. Sinfor survey used 16 points and they measured the soil composition.

As Table 5.11 is in UTMs, typical of GPS, the UTM was converted to geographical coordinates, i.e. latitude and longitude in degrees as shown by Table 5.12.

Table 5.11 – Coordinates of Survey Points of Wastes in the PTCD

Point	Coordinates (UTM millesimal scale)

1xTM Easting (x)	188364.4484
1xTM Northing (x)	8260876.6075
2xTM Easting (x)	188552.0651
2xTM Northing (x)	8260807.3257
3xTM Easting (x)	188739.6819
3xTM Northing (x)	8260738.0439
4xTM Easting (x)	188048.3824
4xTM Northing (x)	8260886.7218
5xTM Easting (x)	188517.4242
5xTM Northing (x)	8260713.5174
6xTM Easting (x)	188309.2228
6xTM Northing (x)	8260725.5231
7xTM Easting (x)	188072.9090
7xTM Northing (x)	8260664.4642
8xTM Easting (x)	188448.1425
8xTM Northing (x)	8260525.9006
9xTM Easting (x)	188635.7592
9xTM Northing (x)	8260456.6189
10xTM Easting (x)	188319.6932
10xTM Northing (x)	8260466.7332
11xTM Easting (x)	188003.6272
11xTM Northing (x)	8260476.8475
12xTM Easting (x)	188191.2439
12xTM Northing (x)	8260407.5657
13xTM Easting (x)	188378.8607
13xTM Northing (x)	8260338.2839
14xTM Easting (x)	187968.9863
14xTM Northing (x)	8260383.0391
15xTM Easting (x)	188215.7705
15xTM Northing (x)	8260185.3081

16xTM Easting (x)	188497.1956
16xTM Northing (x)	8260081.3854

Obs.: **xTM Zone: 23 L.** The information of the Zone was not included in the Reference Term Suggestion.

Table 5.12 – Transformation of the UTM coordinates to geographical coordinates

Point	Coordinates (Millesimal scale)
1 – Latitude (South)	15° 42' 40.01"
1 – Longitude (West)	47° 54' 26.99"
2 – Latitude (South)	15° 42' 42.35"
2 – Longitude (West)	47° 54' 20.72"
3 – Latitude (South)	15° 42' 44.69"
3 – Longitude (West)	47° 54' 14.46"
4 – Latitude (South)	15° 42' 39.54"
4 – Longitude (West)	47° 54' 37.59"
5 – Latitude (South)	15° 42' 45.38"
5 – Longitude (West)	47° 54' 21.93"
6 – Latitude (South)	15° 42' 44.9"
6 – Longitude (West)	47° 54' 28.91"
7 – Latitude (South)	15° 42' 46.78"
7 – Longitude (West)	47° 54' 36.87"
8 – Latitude (South)	15° 42' 51.45"
8 – Longitude (West)	47° 54' 24.34"
9 – Latitude (South)	15° 42' 53.79"
9 – Longitude (West)	47° 54' 18.08"
10 – Latitude (South)	15° 42' 53.32"
10 – Longitude (West)	47° 54' 28.68"
11 – Latitude (South)	15° 42' 52.85"
11 – Longitude (West)	47° 54' 39.28"
12 – Latitude (South)	15° 42' 55.18"
12 – Longitude (West)	47° 54' 33.02"

13 – Latitude (South)	15° 42' 57.52"
13 – Longitude (West)	47° 54' 26.75"
14 – Latitude (South)	15° 42' 55.88"
14 – Longitude (West)	47° 54' 40.49"
15 – Latitude (South)	15° 43' 2.42"
15 – Longitude (West)	47° 54' 32.3"
16 – Latitude (South)	15° 43' 5.92"
16 – Longitude (West)	47° 54' 22.9"

Obs.: Program to convert UTM in geographical coordinates: http://leware.net/geo/utmgoogle.htm

The soil composition observed in such points is presented on Table 5.14.

Table 5.14 – Survey of soil composition of the points selected with backhoe loader.

Point	Soil composition at the point
1	Only natural soil
2	Natural soil 1 meter distance On the interval: pieces of wood and concrete
3	Natural soil 1.2 meter distance On the interval: plastic, bricks and wood pieces
4	Only natural soil
5	Natural soil 2.5 meter distance Interval 0 to 1 meter: plastic bags and plastic bottles mixed with sand Interval from 1 to 2.5 meters: wood pieces, glass, tire, paper and concrete mixed with portions of organic matter.
6	Natural soil 2.5 meter distance Interval 0 to 1 meter: plastic bags and plastic bottles mixed with sand Interval from 1 to 2.5 meters: wood pieces, glass, tire, paper and concrete mixed with portions of organic matter.
7	Only natural soil
8	Natural soil 1.4 meter distance On the interval: wood pieces, plastic bottles, cans and rubber (tire)
9	Natural soil 1.4 meter distance

	On the interval: wood, plastic bottles, cans, concrete and bricks mixed with non-natural sand and organic matter.
10	Natural soil 2.8 meter distance Interval 0 to 1.4 meters: wood, plastic, cardboard and cans mixed with organic matter. Interval 1.4 to 2.8 meters: concrete, brick, wood and plastic
11	Only natural soil
12	Natural soil 1.8 meter distance On the interval: plastic, cans, wood and concrete chuncks
13	Natural soil 1.5 meter distance On the interval: wood, concrete and bricks mixed with organic matter.
14	Only natural soil
15	Natural soil 2.3 meter distance Interval 0 to 1.4 meters: organic matter, plastic, wood and paper. Interval 1.4 to 2.3 meters: concrete, plastic bottles and brick chunks
16	natural soil 1.6 meter distance On the interval: wood, brick, plastic, paper and a little bit of organic matter.

From Table 5.12 it is possible to find in a map all survey points used, as shown in Figure 5.13. When combining information of Figure 5.13 with the localization of others lots, we can elaborate a fragmented map, as seen in Figure 5.14.

Figure 5.14 shows a dashed line indicating separation of Lot 1 from the other lots. The purple dotted line defines the area close to the dump concentration. The solid lines indicate the localizations of lots 2, 3, 4, 5 and 6. Lot 1 was divided in two subareas defined as stage 1 and stage 2.

The area of stage 1 is the close one to lots 2, 3, 4, 5 and 6 and thus it's an area where the construction of the PTCD can be done immediately. Besides, due to closeness to the other lots, the access to water, sewage and electricity are easier. By means of negotiations with the IBRAM, it is possible to get an environmental license only for non-dump areas of Lot 1. However, this is a negotiation that should be taken care by the PTCD manager.

The area of stage 2, though there is no dump there, it is close to the Paranoa basin. Therefore, before start building on stage 2, the draining and landfilling of the area is

needed. There is no survey about the costs of this work.

There are different strategies to start building on the dump areas, namely:

- Using tractors to remove the garbage and thus reduce its area. This approach is only possible in areas where the landfill depth is inferior to 2 meters. On Table 5.14, we can see that points that obey such restriction.
- Building directly over the dump. This approach significantly reduces the cost of the dump treatment, because the dump will not need to be removed from the PTCD area and be deposited in a new far area. To build over the dump is crucial observing the absence of organic matter in the area. For example, on Table 5.14, on the following points the organic matter can be observed: 5, 6, 9, 10 and 16.
- For the areas in which the garbage is found in great depth and also with organic matter, the only solution would be removing the garbage.
- Recycling the dump can also be a solution.

Figure 5.13 – Survey points

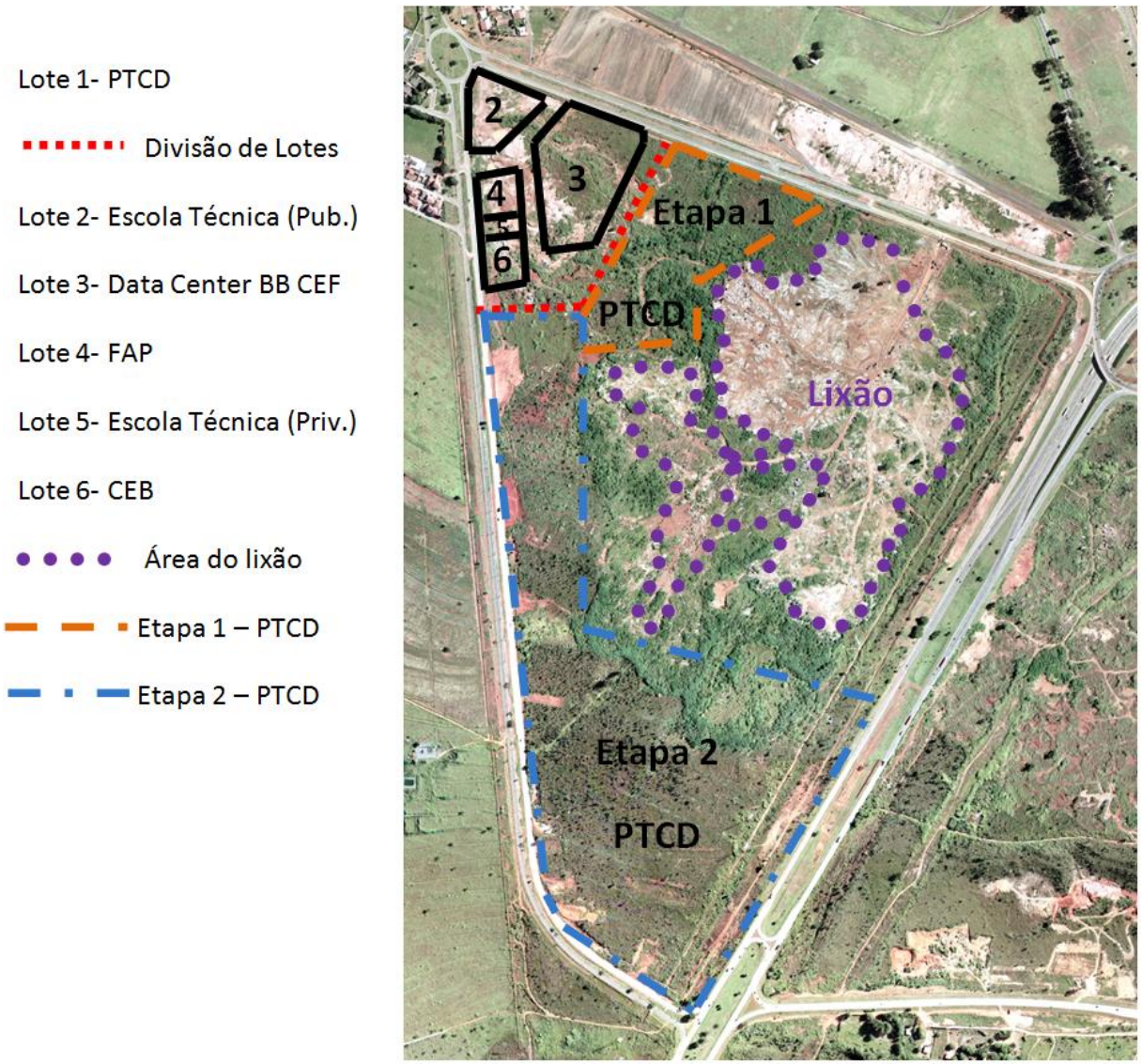

Figure 5.14 – Scenario to install the PTCD based on SINFOR's survey

In a survey with more points done by NOVACAP, the dump area differs from Figure 5.14 as we can see on Figure 5.15. 5.15.

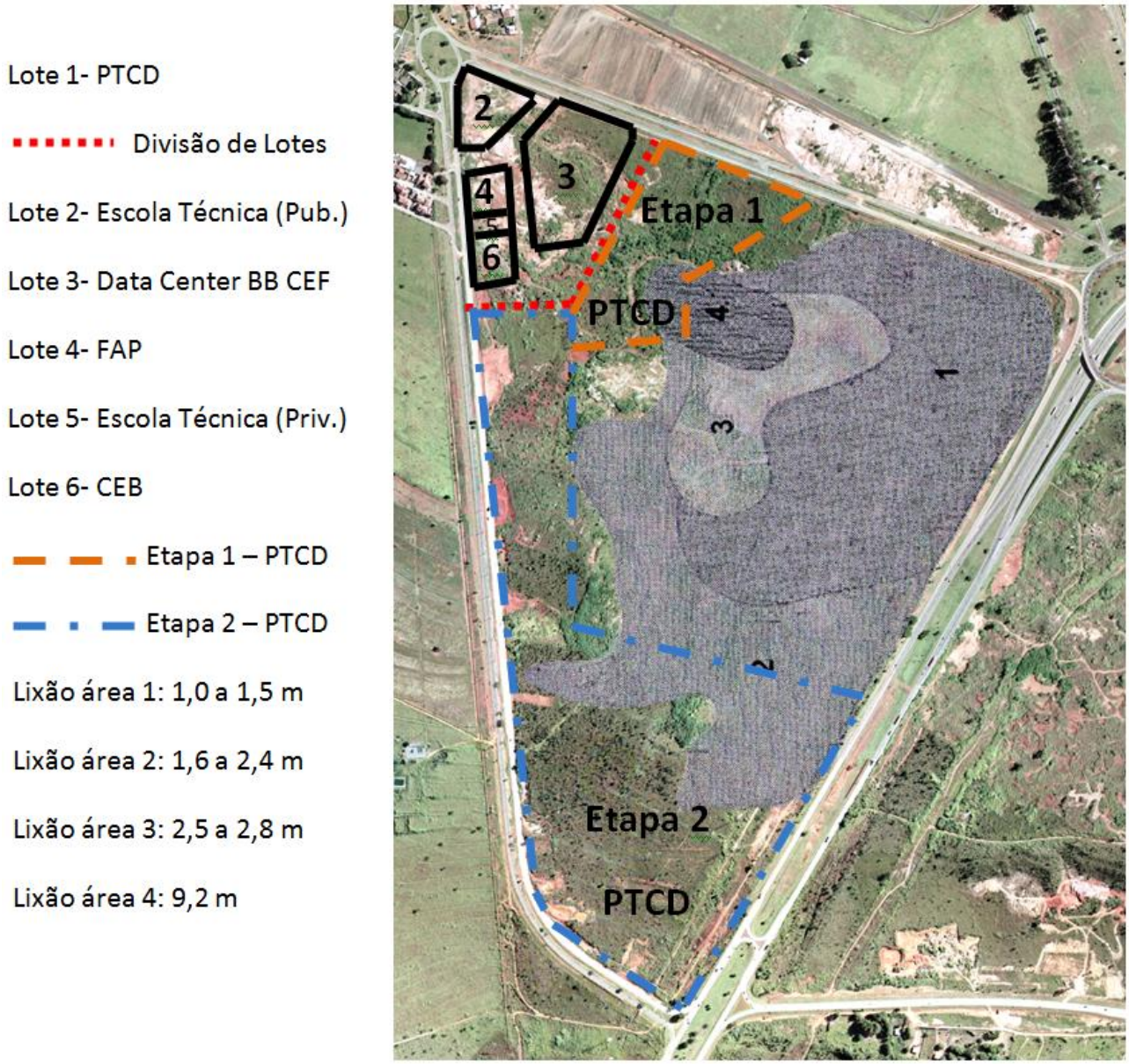

Figure 5. 15 – Possible scenario to install the PTCD considering the survey of the dump made by NOVACAP

2.12.2. Cost estimate to remove garbage

According to NOVACAP, the total cost to remove the garbage was estimated according to Table 5.15. We notice that the cost estimate to remove the garbage has been done by areas. The map showing the localization of these areas can be obtained with TERRACAP.

Table 5.15 – Cost estimate to remove garbage from areas 1, 2, 3 and 4.

Task	Area 1 (in R$)	Area 2 (in R$)	Area 3 (in R$)	Area 4 (in R$)
1	690.462,74	560.385,19	195.710,89	94.971,82
2	8.874.512,51	11.524.202,98	5.332.798,07	11.474.228,65
3	28.010.379,99	36.373.524,84	16.831.764,11	28.356.415,72
TOTAL	37.575.355,24	48.458.113,01	22.360.273,07	39.925.616,19

Having in mind that NOVACAP's surveying is more critical to planning, it will be assumed as truth. Thus, in this context, to start building stage 1 the garbage in area 4 must be removed, which means a paying right at once R$ 39,925,616.19.

For stage 2, that is, within a period of 5 years, the garbage in area 2 needs to be removed and the costs for that are at R$ 48,458,113.01. Areas 1 and 3 could have their garbage removed throughout 15 years long.

Thus, the total cost to remove the dump of all the PTCD area was estimated at R$ 148,319,357.51.

It is still worth noting that, according to the official letter on the 1194/2011 dated from 7/19/2011 from the Public Prosecutor's Office to TERRACAP, there are still the following pending things in terms of documentation:

- There is no document proving the withdraw of waste and the destination of the garbage and the waste to be removed.
- Surveying able to attest the building viability of the area and the techniques to take care of decomposing materials.

According to what is proposed in this EVTEC, the environmental license should be requested in stages. First for the stages with no dump involved and then for the stages where the dump makes part. As we can observe on the cited document, all pending issues area related to the dump.

2.12.3. Environmental problems during the construction of the PTCD

The following environmental problems can be taken into account during the construction of the PTCD: erosion, particle emission, land contamination and noise level.

This section used as basis the RIME for licensing of the Florestal Investimentos Florestais S/A enterprise on Três Lagos region in the State of Mato Grosso do Sul.

a) Erosion

The process of preparation of the land to implement the PTCD will make the land more susceptible to erosion. However, some measures can be taken to mitigate the effects of erosion.

The works of excavation and earth leveling should be followed by temporary surface drainage works, and implementation of deviation and control of surface drainage, implementation of hydraulic damping device and retaining sediments, using preventive plastic lining on the dug material or the other areas of the exposed land.

- Constant monitoring the areas where the foundations are being built to guarantee the continuing efficiency of sediment retaining.
- Constructive procedures should adopt measures to protect the areas with exposed land and sediment retaining.
- We recommend that the works should be preferably done during the dry season. Restricting soil removal to the areas of project implementation.

b) Particles emission

We estimate an increase of emissions of particle material (fugitive dust emissions) in initial stage of implementation, highlighting earth leveling activities, machinery movement and truck traffic, cleaning the base to implement the works.

The occurrence of high levels of particle material can reduce visibility on the area, compromising the traffic of vehicles and increasing the risk of accidents and risk of human health. However, some measures can be taken to mitigate the effects of particles:

- During the works, the access lands, lanes, work sites and other surfaces capable of generating fugitive dust emissions should be humidified with periodical aspersions. Trucks that transport dirt, rocks and all powder material shall have their load covered, protecting the release of particles and dust.
- The use of individual protection equipment shall be used, like masks to the

staff exposed to this impact.

- Preventive maintenance of machines and equipment and operator training.
- Adopting an internal program to inspect properly the maintenance of the freight in relation to black smock emissions according to the Decree number 85, from October 17, 1996, set by the Brazilian Institute of Natural Environment and Renewable Resources – IBAMA.
- Inspecting the freight that takes the highway to verify discharge fumes.
- These inspection campaigns should be carried out by the competent organisms (Road Police and Environment Organs).

c) Soil Contamination

In the stage of enterprise implementation, the contamination of chemical products in general can occur in the work site and maintenance squares, load transports and the traffic of vehicles, machines and equipment.

In general contamination by hydrocarbon derived of petroleum (fuel, solvent and lubricant) that comes from the following activities: supplying; equipment maintenance; structure and tool cleaning; leaking equipment; spillage or overflow during operations of loading and unloading of products; pipe dripping; storage tanks, vehicles and equipment; indirect launching by surface run-off, sub-surface or by the drainage network of the enterprise.

Solid wastes will be generated during the implementation stage, which corresponds predominantly the wastes of the works, IIB class and organic organic wastes from cafeterias (food wastes, napkins and likewise) and the toilets (toilet paper basically), IIA class.

- With the objective of avoiding the contamination coming from repair shops, wash places and maintenance points, building decanting systems like water and oil separator container.
- We recommend that all stationary equipment be installed with containing systems such as metallic trays, definite and/or temporary dikes or sealed basins so to avoid possible leaking.
- The teams involved daily in the use or handling the chemical products should be advised about the handling or discarding wastes and the project should

aim at areas that storage chemical products, as well as the contention structures for possible leaking.

- The wastes from the implementation stage should go to a specific area with isolation of the access area for people and animals. The management (collection, storage and disposal) should agree with its generation properties:
  - Organic
  - civil construction (works wastes)
  - Health Services;
- The final destination should be provided by companies with qualification and licensed by the responsible environment institution.

d) Noise level

An alteration on the noise level is expected due to the land moving (excavator, forklift trucks, motor graders, trucks, etc.), foundations (pile driving and pneumatic picks), civil works (concrete mixers and concrete vibrators), cutting and exploring construction materials (crushers and drill rigs). To mitigate the effects on altering the noise level:

- Planning of the works should be developed preferably during the night;
- Installation of work sites and auxiliary installations far from passive receptor, permanent and corrective protective mechanical maintenance of equipment, crushing and others in a way that they do not generate noise level beyond the one foreseen in each equipment;
- Using the Collective Protection Equipment (EPC) and Individual Protection Equipment (EPI) by the staff of the works.

2.13. Conclusion

The proposed infrastructure in this analysis has the objective of guaranteeing competitiveness of Lot 1 of the Capital Digital Technology Park (PTCD).

Because of the large volume of investments necessary to the urban suitability of Lot 1, ensuring the monopoly of security services, building maintenance and electric power for the Special Purpose Entity (SPE) that will manage Lot 1.

As profitability goal for the enterprise, we worked with a cost-of-capital rate of 18.5% yearly. Such objective of profitability is comparable to services and sources of resources foreseen in this product.

Once all implementation stages are complete, the Lot 1 of PTCD will have all competitive conditions to attract investors and technology companies interested in enlarging or starting their productive plants in Brazil.