

## **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 5.3 – Technical Feasibility Study	
Clearance by University of Brasilia:	Date: ____/____/2012.
Acceptance by Terracap:	Date: ____/____/2012.

**Prepared by:**  
**University of Brasilia – UnB**  
**Technology Development Support Center – CDT**  
**Laboratory for Decision Making Technologies – LATITUDE/UnB**

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**Tadeu Filippelli**  
Vice Governor

**Antonio Carlos Lins**  
President of Terracap

**José Humberto Matias de Paula**  
Director of New Ventures Office – Dipre/Terracap

## TECHNICAL TEAM

**Christiane Freitas Nóbrega de Lucena**  
**João Alberto Legey de Siqueira**  
**Patrícia Mussi Sarkis**  
**Renato Castelo de Carvalho**  
**Rossini Dias de Souza**

## UNIVERSITY OF BRASILIA

**José Geraldo de Sousa Júnior**  
Rector

**Luiz Afonso Bermudez**  
Director of the Technology Development  
Support Center – CDT

**Rafael Timóteo de Sousa Júnior**  
Coordinator of the Laboratory for Decision  
Making Technologies – LATITUDE

## TECHNICAL TEAM

**Alexandre de Souza**  
**André Noll Barreto**  
**Andréia Campos Santana**  
**Ararigleno Almeida Fernandes**  
**Daniel Correia de Brito**  
**Daniel France Valadão**  
**Divanilson Rodrigo Campelo**  
**Edna Dias Canedo**  
**Egmar Rocha**  
**Fábio Lúcio Lopes Mendonça**  
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**Marcelo Pontual**  
**Márcio Mariano Lisboa**  
**Oswaldo Joaquim de Souza**  
**Rafael Timóteo de Sousa Júnior**  
**Renato Alves Borges**  
**Robson de Oliveira Albuquerque**  
**Saulo Daniel Monteiro Anacleto**  
**Ugo Silva Dias**  
**Valério Aymoré Martins**  
**William Ferreira Giozza**

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## 1. INTRODUCTION

Companhia Imobiliária de Brasília (Terracap), established through Law No. 5861, of December 12th, 1972, is a state-owned enterprise under the Government of the Federal District (GDF). It is governed by the law under which it was established, its articles of incorporation and the applicable law of corporations, Terracap's purpose is to operate in the real estate business for the best interest of the Federal District in exchange of compensation, and this business comprises use, acquisition, management, provision, development, encumbrance or disposal of properties.

Pursuant to Law No. 4586, of July 13th, 2011, Terracap also took on the role of Development Agency for the Federal District by designing, deploying and implementing economic and social development programs and projects for the Federal District, and it may also foster public-private partnerships, incorporation of special purpose companies and engage in urban joint ventures for the deployment and development of projects considered to be strategic by the Government of the Federal District. In view of this backdrop, Terracap plays a key role in the public policies included in programs that are being implemented by the Federal District Government, in particular with regard to the Parque Tecnológico Capital Digital [Digital Capital Technology Park] – PTCD.

Considering the existing collaboration between the University of Brasilia Foundation (FUB) and the Ministry of Planning, Budget and Management's Federal Property Department – SPU established in January 2009, with coordination of the Decision Making Technology Laboratory – LATITUDE, University of Brasilia's Department of Electrical Engineering, through three projects for the development of SPU's processes, methodologies and management tools, Terracap realized that the approach to dealing with Federal property can be extended and applied to Federal District's properties, in particular to the management of the PTCD project.

In view of the above, and considering CDT/UnB's extensive experience in the preparation of technical and economic feasibility studies (TEFS), Terracap and the LATITUDE Laboratory, with support from CDT/UnB, started discussing the possibility of conducting a cooperative research and development project in order to carry out a TEFS

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for the PTCD with a view to improving the Federal District's property management and fostering strategic ventures for the Federal District.

As a result, an agreement has been established between Terracap and FUB for the development a technology and information services project to support implementation of the Digital Capital Technology Park – PTCD, with preparation of the products that will make up the respective Technical and Economic Feasibility Study. Project deliverables includes “Product 5.3 – Technical Feasibility Study,” which is covered in this technical report.

This product has been designed as an indication of the technical feasibility conditions of the project to be developed by identifying various technologies to be used and the costs associated with infrastructure as described in the sections below. Specifically, this document has the following primary objectives:

- Provide an economically viable technical solution to be implemented for the PTCD;
- Describe the technologies to be used as part of the technical solution;
- Identify technological innovation items that can be deployed at the PTCD;
- Estimate the costs involved in the implementation of the technical solution;
- Estimate the costs involved in the technological upgrades.

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## 2. DESCRIPTION OF PRODUCTS AND SERVICES

As described in Product 5.1, the Managing Company (GE) will be responsible for developing the following products and services commercially: water and sewage, electricity, security and building maintenance, lease of offices and laboratories, network and system (datacenter, storage, etc.) management services, and voice and data communication.

All of these services must meet the standards set by their relevant regulatory bodies, e.g., the National Water Agency (ANA) will cover water and sewer, electricity will be covered by the National Electric Energy Agency (ANEEL), and the National Telecommunications Agency (ANATEL) will be in charge of voice and data communication. Therefore, the specifications of PTCD's products and services contained in this product are in accordance with those standards.

### 2.1. Profile of the Proposed Technological Solution

This section describes the proposed technology solution to be implemented at the PTCD, considering the park's profile, which is intended to provide information and communications technology products and services. The proposed solution is designed to address the following communications services:

- Data communications network;
- Ultra-broadband Internet;
- Broadband wireless Internet;
- Corporate telephony;
- Videoconferencing;
- CCTV (Closed Circuit Television);
- Website and content hosting;
- E-mail;
- Network management and support.

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The estimated costs for the proposed solution are provided at the end of this document, and are provided and described in the consolidated cash flow of Product 5.4.

Figure 1 shows the overall architecture of PTCD's communications network that will support implementation, operation and maintenance of the services to be provided.

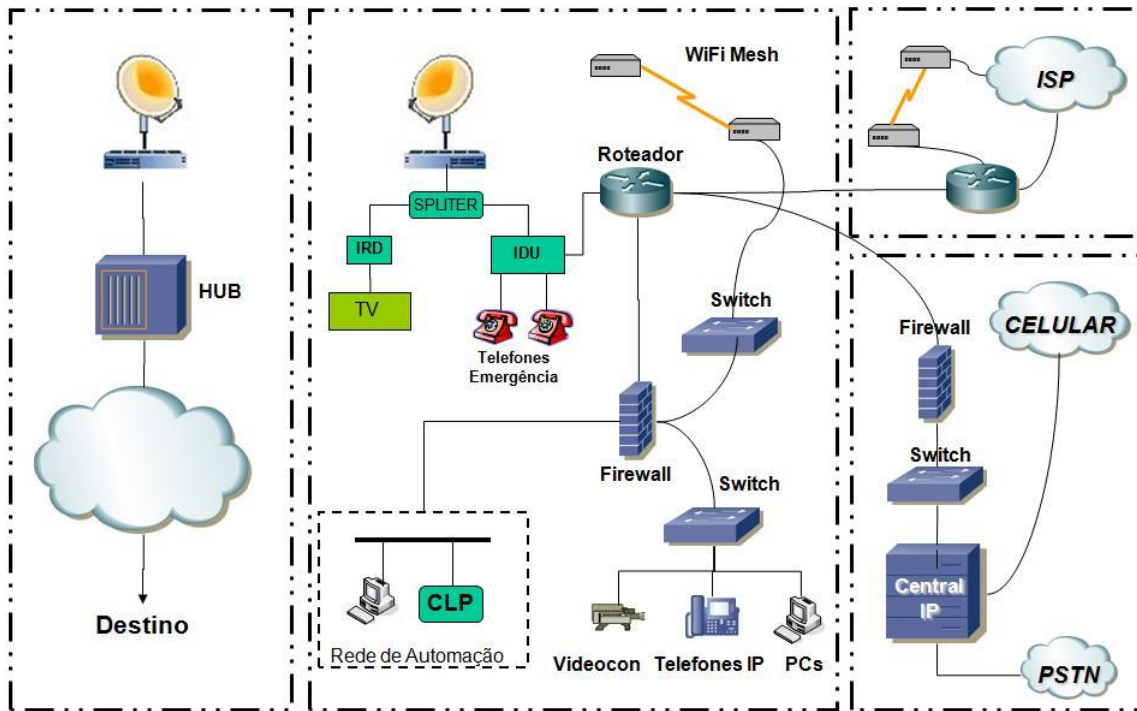


Figure 1 – Flowchart of PTCD's communications system

Original	Tradução
Destino	Target
Telefones Emergência	Emergency Phone Lines
Rede de Automação	Automation Network
Roteador	Router
Celular	Cellular

The system will consist of advanced communications technologies that are able to support both low-traffic users with low security requirements and large corporations with significant installed capacity and high confidentiality requirements. To achieve the predefined objectives, the communications network to be implemented is expected to rely on an infrastructure based on a fiber optic network, wireless network, satellite network, and other data, voice and imaging items. There will be primary high capacity links and secondary links for backup purposes. These links are described below. The total costs are provided under Section 3 of this document, and are also covered in the economic and financial feasibility study for the PTCD – Product 5.4.

### External Links

PTCD’s network will be connected to external networks in two ways as illustrated in Figures 1 and 2:

- The primary connection is expected to be set up via redundant fiber optic links to be installed in various sites of PTCD and in various routers;
- The backup connections are to be set up through a radio link and satellite.

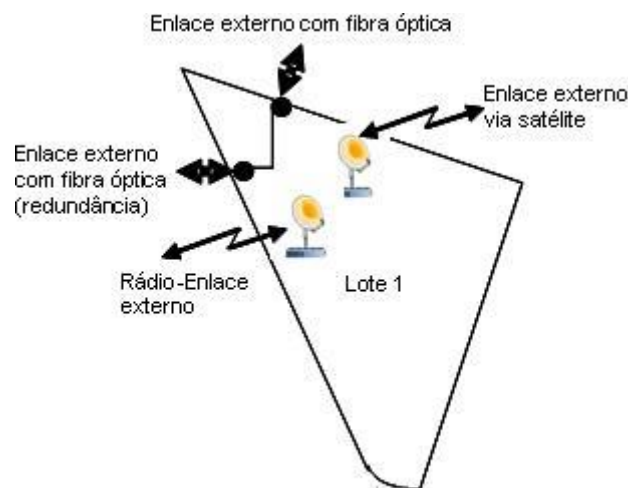


Figure 2 - External links to providers of telecommunications services

Original	Tradução
Enlace externo com fibra óptica	External optic fiber link

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Enlace externo com fibra óptica (redundância)	External optic fiber link (backup)
Rádio-Enlace externo	External radio link
Enlace externo via satélite	External satellite link
Lote 1	Lot 1

## Profile of the Primary External Links

The primary connection links to external networks are to be based on optical fiber and shall conform to the following requirements:

- Minimum transfer rate of 40 Gbps;
- Minimum availability of 99.9%;
- Maximum Latency of 40 ms;
- Operating with load balancing and redundancy;
- Distinct connection facilities at the PTCO in order to provide enhanced redundancy;
- Physical connections of links must support ports of edge routers.

## Profile of the Backup External Links

In case of failure in the primary external connection via optical fiber, the first backup option should be a radio based connection, and second should be a satellite link. The radio system must meet the following minimum requirements:

- Minimum transfer rate of 500 Gbps;
- Availability of 99.99%;
- Maximum error rate of  $10^{-6}$ ;
- Adaptive modulation scheme;
- Source redundancy;
- Operating with a direct line of sight;

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- Operating in a frequency band that is licensed by ANATEL.

The satellite backup link must comply with the following requirements:

- Minimum transfer rate of 2 Gbps;
- 1.2-meter-diameter antenna;
- The modem must have at least 2 extensions for emergencies;
- Physical connections of links must support ports of edge routers;
- Minimum availability of 98%;
- Minimum error rate of 10<sup>-7</sup>;
- Maximum Latency of 250 ms;
- Synchronization that is compliant with Recommendation G.823 by the ITU-T (International Telecommunication Union – Telecommunications Standardization).

The radiant satellite system can be used to simultaneously provide satellite TV services using a splitter. It is recommendable to use a single satellite band that can support the data link and receive broadcast TV signals. The satellite link is meant to be an Internet provider.

## Profile of the Data Network

The core routers will be installed and configured as part of the PTCD's internal network. Switches and firewalls will also be installed and configured in conjunction with routers and servers to support the network's physical and logical operation, as well as its protection against attacks from external networks and PTCD's internal network nodes, including a potential automation network. Edge routers will primarily support the PTCD's network connection with external circuits of Internet providers. The technical requirements for individual network devices can be found in the description of the PTCD (Product 5.1) and the impact of costs on the Economic and Financial Feasibility Study of the PTCD can be found in Product 5.4.

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The data network will provide optical fiber-based and wireless WiFi Mesh bandwidth access. Optical access will be provided through passive optical networks (PONs) according to the G-PON (Gigabit-capable PON) standard, ITU-T G.984. In G-PON networks, the downstream traffic rate is 2.5 Gbps, and the upstream rate is 1.25 Gbps, which is shared among the users in a PON network. For the PTCD, there will be 4 optical access nodes in each of the 72 blocks; i.e., 4 PON network topologies (as illustrated in Product 5.1) operating simultaneously to support all blocks, in a total of 288 optical access nodes. The optical fiber-based network will be comprised of optical access equipment, high density polyethylene (HDPE) pipes, optical cables, connection boxes, splice boxes, and optical racks (DGOs).

For access via the wireless network, PTCD's manager should provide broadband access to WiFi Internet in outdoor environments, as well as in the communal buildings and in underground car parks. Coverage is required in at least 95% of the PTCD area, except those areas designated solely for vegetation, and in 90% of the indoor areas specified above. Access to the wireless network may not rely on proprietary programs or applications, and should be available for any equipment certified by WiFi Alliance. The service provider must ensure a minimum symmetric TCP rate (throughput) of 10 Mbps per user in the coverage areas. This higher transfer rate may be offered as a premium service, but a rate of 1 Mbps should be guaranteed free of charge to users throughout the coverage area. Transfer rates refer to stationary or mobile users. Access to the premium service may be billed by the Park manager or through roaming agreements with other third-party access providers. From the initial access, roaming must be ensured at all access points in the PTCD. A session-level connection must be maintained for mobile users to a speed of up to 50 km/h.

Premium access to the wireless network may not have any blocked content, and users may use it for any lawful application or service. For free access, services that require extremely high rates may be blocked, e.g., downloading, streaming and video sharing.

Assuming the price of a corporate GPON network access at 500 reais, and considering a scenario with 288 access nodes (4 optical nodes to each of the 72 blocks of

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the PTCD), as described in Product 5.1, the monthly gross revenue would be R\$144,000.00 (288 \* 500).

Therefore, since the cost of the optical network described under Product 5.1 is R\$6,830,320.00, it would take **48 months** for the return to cover the investment (6,830,320.00/144,000.00).

## Profile of the Voice and Imaging Network

The voice network should be equipped with IP telephony technology with a SIP protocol. A redundant IP phone system should be set up to provide communication between the internal extensions of the PTCD, as well as with external fixed and mobile telephony networks. In addition to voice calls, the telephone network may provide video calling services through IP terminals equipped with cameras. Because IP technology will be used, a firewall should be set up to provide the appropriate level of security to inter and extra network operations. The technical requirements for the equipment involved can be found in Product 5.1 and the impact of costs on the economic and financial feasibility of the PTCD can be found in Product 5.4.

The PTCD's communications network will also be equipped with imaging technologies for video conferencing services and CCTV. The videoconferencing system should support conference meetings in two or more properly equipped environments and provide interactive voice and video communications, with simultaneous transmission of graphic and/or photographic imaging and data. Such meetings may involve PTCD's workers and/or third parties in outdoor areas. In this assessment, the need to deploy 10 video conferencing rooms that can be made available as services to users of the PTCD is considered. Each videoconference room must be built within the premises of the PTCD, and their management and maintenance will be the responsibility of the PTCD's manager. Deployment of videoconferencing rooms must rely on the use of terminal equipment compatible with the majority of international videoconferencing networks and with protocols H-320 and H-323, and must provide remote management capabilities with the SNMP protocol. The videoconferencing codec will be connected to the PTCD's data network (TCP/IP). The videoconferencing band will be at least 4 Mbps (with a maximum of

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20% overhead) and classes of service will vary. A specific Multipoint Control Unit (MCU) for managing events in rooms designated for this purpose should be set up, and this system must have an IP-based interface. A point of access to the system should be provided at the designated room. The codec should have an IP interface and QoS between the codec being used and the MCU should be configured. The requirement to use appropriate rooms with operating capabilities that support aspects related to location, acoustics, lighting, ambience, layout, and infrastructure should be emphasized, and this is reflected in the Technical and Economic Feasibility Study document for the PTCD.

The CCTV system is expected to distribute audio and video signals through cameras located in strategic and specific locations to one or more designated management points. At the PTCD, the CCTV should be an integral part of the security and surveillance technology, which is an aspect of paramount importance and relevance in the management of the PTCD. The recommended features for the CCTV system are as follows: TCP/IP-protocol based cameras and support to the WiFi Mesh network and/or the wired data network; cameras with pan/tilt/zoom capabilities; night vision capabilities; broadband microphone; audio and video recorders; audio and video capture cards that are supported by the IP network; HD and DVD recording capabilities; external protection cases; motion detection sensors; audio amplifiers; video distributors; infrared illumination; and monitors for the management team. Detailed planning of the CCTV solution, including the location of cameras, an adequate control room and intervention policies should follow the strategic recommendations of the PTCD's asset security division.

## **Profile of the System and Network Management Center – CGRS**

As per Product 5.1, the System and Network Management Center (CGRS) is governed by standard TIA-942 (ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers, 2005) which outlines the functional elements of the CGRS's datacenter area.

Product 5.1 provides the following definitions for the CGRS: Objectives; processes; equipment rooms; hardware and software components; network, server and storage

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monitoring; help desk; asset and inventory management software; logs; application and database management.

A **Business Intelligence (BI)** is expected to be set up in the CGRS to provide automated access to all information related to the PTCD, as well as the crossing of data and merger of data, voice and imaging. Furthermore, this BI system should provide for a predictive analysis of the PTCD's activities so as to allow for the preemptive allocation of resources to those processes that come close to their operating limit. A cost analysis can be found in Table 4 of Product 5.4, and the specific costs can be found in section 3 of this document.

### **Profile of the Customs Clearance Service**

As stated in Product 5.1, a customs clearance office is expected to be established. This office is intended to speed up the process of importing and exporting products. In addition, it will serve as a major incentive for companies to choose the PTCD. Please note that the products will be kept at the PTCD itself during the customs clearance process, which will minimize potential damage due to improper transportation or storage.

Although the facilities for the entire office is to be built by the EG, the premises will be leased to the government, and other services are expected to be contracted.

### **Profile of the Electric Power System**

As described in Product 5.1, the electric power system of the PTCD may use high or low voltage. In case the system uses low voltage, it will be necessary to use the structure provided by the Federal District's Electricity Corporation (CEB), and, as a result, the rate is five times greater than the rate for high voltage.

Thus, Product 5.1 includes construction of a proprietary substation for the PTCD. Also regarding this reduced rate, the investment in this proprietary substation for the PTCD would be paid in less than two years.

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The electrical wiring outside the masonry facilities are also the responsibility of the PTCD. Therefore, the estimated cost as shown in the Product 5.1 is R\$7,231,000.00. This figure includes deployment of lamp posts and passage of electrical wiring through the outdoor masonry facilities.

In addition to the substation, it is also necessary to acquire a motor-generator set in case of failure of the main supply system for the PTCD.

The total costs of the electric power system are described in Table 1 of Subsection 3.2 for this Product, and the impact of these costs on the economic and financial feasibility study for the PTCD can be found in Product 5.4.

## Profile of the Debris Recycling Service

In view of the large amount of construction debris in the PTCD area, recycling the associated waste may represent a significant reduction in the cost of its construction. Moreover, recycling helps prevent this waste from degrading nature elsewhere.

According to paper “*A reciclagem na construção civil: como economia de custos*” (Recycling in construction as cost savings) by P. A. de Paiva and M. S. Ribeiro, FEA-RP/USP, the startup cost of a recycling plant is R\$226,000.00 and the monthly maintenance cost is R\$20,681.97. This plant produces 100 bricks from one tin of cement and 7 tins of debris, where each tin can hold 18 liters. These 100 green bricks cost R\$13.73, while the market price of 100 bricks is R\$30.00. **Therefore, it is estimated that the masonry materials can provide savings of at least 50%.**

Recycling of the debris is an alternative solution that should be considered by the EG.

## 2.2. Profile of Innovation

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In addition to meeting the goals under Subsection 2.2, the EG should also include innovative elements in the services.

The PTCD should serve as an environment for the establishment of innovative businesses, and, for this reason, its infrastructure and services provided should also be based on the latest technologies in order to foster the flow of ideas for innovation in the various services. Use of advanced technologies by the EG will create an enabling environment for the participation of innovative companies in the venture. These technologies may also be implemented as a partnership between the EG and the tenant companies.

In order to meet quality requirements, the services described under Section 2.1 must already use the latest technologies available. Moreover, the PTCD can also serve as a showcase for different technologies in the final stage of development, which reflect the state of the art in various branches of knowledge and technology. This section discusses the innovation technologies proposed for the PTCD.

The innovation feature in the PTCD's optical network will be the use of power- and energy-efficient equipment. As energy efficiency has had an increasingly important role in the architectural design of telecommunications networks, the PTCD's optical network will have power management functions that will reduce the power consumed by optical network units (ONUs) according to the level of traffic in user interfaces. Over the past few years, power management devices in ONUs have been proposed by the academic community, industry and standardization bodies such as the ITU-T. Some manufacturers have now indicated their use of this function on their equipment. Power saving mechanisms for ONUs can reduce energy consumption by more than 60% in PON networks.

The power supply may also rely on many innovative elements in line with the global trend towards renewable energy and enhanced energy efficiency. To this end, a part of the lighting system should be made up of solar panels, and alternative energy sources should also be tapped into, such as wind turbines embedded into buildings and the use of

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methane gas from organic waste. Energy efficiency may be improved by putting together an architectural design that emphasizes natural lighting and cooling, as well as the use of low-consumption LED lamps. More efficient use of energy may also be encouraged through a smart pricing system, with differentiated energy prices according to time of day, for example. Also, the concept of smart grids may be deployed at the PTCD.

When it comes to water consumption, here, too, there is plenty of room for optimization and cost reductions. It is now quite common to reuse rain water and even water from sinks and showers, which may be reused for flushing, washing or soil irrigation. Consumption can also be significantly reduced by using low-flow, automatic shutoff taps and flushing systems. Electronic leakage detectors may also be employed in order to minimize water wastage.

Using techniques to reduce carbon emissions and save water provides gains in terms of operating costs, and can also be used as a marketing tool. To this end, it is desirable that the Leadership in Energy and Environmental Design (LEED) certification by the Green Building Council is obtained for the entire PDCT. This certification could help attract innovative companies in view of the great importance of environmental issues to the public, especially considering the short distance between the PTCD and Brasilia National Park.

Other suggestions for innovation include:

- Pricing and maintenance of the power grid according to smart grid concepts;
- Use of biometric systems and automated recognition capabilities for access control;
- Technologies in near field communications for parking access and micro-payments in the PTCD's premises.

A wireless communications network based on opportunistic use of spectrum based on cognitive radio is suggested. Additionally, equipment based on array microphones in videoconferencing rooms is suggested. Use of array microphones makes it possible to

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identify the location of speakers in a room and thus automatically track video and audio based on voice signals. Furthermore, it is important to set up arrays of loudspeakers to ensure that sound quality is consistent throughout the room.

## 2.3. Technologies Used

To implement the proposed technical solution, the following technologies should be used: ultra-broadband optical networking, wireless WiFi mesh networking, data networking, network management.

The WiFi technology will be used to provide access to the wireless network through access points deployed throughout the park area, operating in infrastructure mode. Access points should support IEEE – Institute of Electrical and Electronics Engineers’s 802.11a/b/g/n technologies, with MIMO (multiple-input and multiple-output) 2x2. Each access point must support access to at least 30 users at any given time. Authentication will be done through a RADIUS (Remote Authentication Dial In User Service) server, and IEEE 802.11i (WPA - Wi-Fi Protected Access), TKIP (Temporal Key Integrity Protocol) encryption and AES (Advanced Encryption Standard) should also be supported. Users using the free service may log on with no authentication. The authentication servers must have back-up servers.

The fiber optic technology will be used to enable ultra-broadband traffic at the PTCD. A PON will be deployed for the optical backbone of the PTCD. The standardized PONs currently available are networks that use Time Division Multiplexing (TDM) and two distinct wavelengths for bidirectional transmission of traffic on a fiber, in which the only active elements are centrally located (i.e., optical line termination, OLT) and at the premises of users (i.e., the optical network units, ONUs). PONs are typically arranged in a star topology, where the optical distribution network (ODN) is made up of fibers and the passive optical splitter used as a remote terminal (RT) to distribute the signal from the OLT to the ONUs in the downstream wavelength. In the opposite direction of transmission, signals from different ONUs are time multiplexed to share the upstream wavelength. The

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PON standard adopted in Brazil is the G-PON, which is described in ITU-T Recommendation G.984.

The G-PON technology currently involves a downstream traffic rate of 2.5 Gbps, and an upstream rate of 1.25 Gbps, which is shared among the users in a PON network. G-PON solutions with higher transmission rates (e.g. 10 Gbps) are in the process of being standardized and should be commercially available within the next 5 years.

The optical fiber capacity to be installed (cables with 144 fibers) will make it possible to deploy, in addition to the shared services through the PON network, private end-to-end connections between users and the PTCD's communications service center.

Now, the technology for the establishment of the communications network, as well as the network management processes, is the consolidated, standardized Internet TCP/IP architecture, with professionals available and recognized quality at all levels.

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### 3. PLANNED FIXED INVESTMENT

The planned fixed investments are described in the subsections below, and are also covered in the Economic and Financial Feasibility Study for the PTCD – Product 5.4.

#### 3.1. Additional Civil Construction Works and Facilities

Investments in civil works include the construction of videoconferencing rooms in accordance with item 2.11.7 of Product 1, laboratories and workrooms as also described in item 2.6 of Product 1. In addition, the core paving infrastructure also described in Product 1 should be included.

As described in Product 5.1 and taking into consideration the number of people expected to be at the PTCD, **the estimated costs for masonry works is R\$1,938,632,854.00**. Hence, these costs cover the construction of classrooms, laboratories, auditoriums, and any other civil constructions.

The total estimated cost for the construction of the **water, sewage and rainwater infrastructure** is **R\$28,231,686.00**, as per Product 5.1.

#### 3.2. Machinery and Equipment

This section describes the primary equipment for the operation of the PTCD. It is important to point out that wireless equipment should be upgraded once every 5 years.

The costs involved in the PTCD's masonry, electrical system and technology infrastructure are described in Product 5.1. Table 1 provides a breakdown of these costs. Thus, according to Table 1, **the total cost of masonry, technology and electrical infrastructure is R\$2,051,037,412.09**. The optical network, the wireless network and the network data should be upgraded once every **5 years**, which requires an investment of

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**R\$8,485,909.30.** The remaining technology capabilities should be upgraded once every **10 years** for a total of **R\$39,120,762.79.**

Table 2 shows innovation-related costs for the PTCD. It is estimated that an investment of R\$2,000,000.00 in solar panels is required for the generation of 200 kW. Once all of these capabilities are in place, the PTCD will be the largest solar power generator in Brazil's Mid-West region.

Table 1. Costs for the PTCD's infrastructure: construction works, machinery and equipment

Type of technology infrastructure	Cost
Masonry works	1,938,632,854.00
Water, sewage and rainwater infrastructure	28,231,686.00
128-MVA substation for the PTCD with transformers	24,000,000.00
Motor-generator set for the electrical grid	6,335,200.00
External electrical wiring outside buildings: lamp posts and cabling	7,231,000.00
Total cost of the G-PON optical network with 4 OLTs and 288 ONUs	6,830,320.00
Wireless network	346,000.00
Data network	1,309,589.30
Telephony	364,042.79
Videoconferencing	5,106,720.00
Closed Circuit Television	1,850,000.00
Backup links	800,000.00
System and Network Management Center	30,000,000.00

Based on Table 5.1 for Product 5.1, the low-voltage rate per kWh charged by CEB is R\$0.2250876, CEB's high-voltage rate is R\$0.0428417. Therefore, for the production of 200 kWh the cost would be R\$45.02 (low voltage) and R\$8.57 (high voltage).

As a result, the low-voltage system of solar panels would be paid over a period of 62 years, while the high-voltage system would be paid over a period of 324 years. Although the solar panel system seems economically impractical due to the long-term return on the

investment, its use can attract companies that invest in environmental preservation and encourage research in this area.

It is estimated that achieving the LEED certification would mean an increase of 8% to 15% in the total cost of construction of the PTCD. The costs of smart grids are around 20% of total costs of the electrical grid.

According to Table 2, the total cost of innovation is estimated at R\$28,276,530.80. As required by Brazilian law, the entire PTCD and all its functions must provide accessibility for the disabled.

Table 2. Costs of technological innovation

Type of technology innovation	Cost
Electrical system for solar panels	2,000,000.00
MIMO Communications	500,000.00
Systems for opportunistic use of the electromagnetic spectrum	5,000,000.00
LEED Certification	14,576,530.80
Smart grid system	5,000,000.00
Automated biometric identification for access	500,000.00
Microphone array systems at videoconferencing rooms	200,000.00
Loudspeaker array systems at videoconferencing rooms	500,000.00
Total	R\$ 28,276,530.80

## 4. OTHER POTENTIAL SERVICES FOR THE PTCD'S MANAGER

Please note that the economic feasibility study for the PTCD is based on the return from the provision of shared infrastructure and services.

However, it is reasonable to predict that the managing company of the Park may also have return from other activities that are under its direct administration or in association or subcontracting with third parties. These include:

- Convivial services: food, fitness, banking, retail, convention center, hospitality;
- Incentive to technology innovation: participation in joint ventures, development of an investment fund for the PTCD, allocation of risk capital, etc.;
- Encouragement of cooperative interactions between the institutions operating at the PTCD: participation in research and development activities, patenting and copyright management, incubation, establishment of startups, etc.

Estimating costs and returns related to such items is more susceptible to uncertainties at the present moment, but the managing company of the PTCD may set up a specific unit to look into such possibilities, regardless of the technical feasibility assessment since such services are of an administrative and business nature.

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## 5. CONCLUSION

The PTCD is a major real estate development with environmental, urbanism and architectural restrictions. Its construction will primarily involve architectural techniques and civil and electrical engineering techniques. The communications, processing and storage services will use computing, network engineering and telecommunications techniques. The technical feasibility assessment for the PTCD described in this product assumes that these technologies are relatively commonplace and that the solutions adopted are well established.

As shown, there is no need for extremely complex buildings or the use of new materials that would be difficult to find the Brazilian market. The information and communication technology services are supported by the TCP/IP architecture, which has been developed and established on the Internet, and computing services with various suppliers with a proven track record.

Because it requires only relatively commonplace technologies, as well as design, development, construction, installation, certification services, etc. for which suppliers and skilled professionals are available locally, and because the costs are consistent with local and national industry practice, it is therefore concluded that, from a technical point of view, the PTCD is feasible. On the other hand, the technical solution put forward herein is in agreement with the economic and financial feasibility study for the PTCD (Product 5.4), which demonstrates the feasibility of technology investments.

It is worth noting that, besides the minimum technology infrastructure, this document identifies innovation characteristics that will raise the profile of the PTCD both in Brazil and abroad. Given the rapid evolution of wireless, optical and data technologies, this infrastructure should be renewed once every 5 years. The rest of the technology infrastructure, including innovation aspects, should be renewed once every 10 years.

Brasília, March 30, 2012.

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