Inter-American Development Bank

International Case Studies of Smart Cities

Rio de Janeiro, Brazil

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Institutions for Development Sector

Fiscal and Municipal Management Division

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of Smart Cities

RIO DE JANEIRO

Brasil

BID – KRIHS Joint Research

IDB

THE REPUBLIC OF KOREA

KRIHS
Korea Research Institute for Human Settlements

GDPC
Global Development Partnership Center

Abstract

This case study is one of ten international case studies developed by the Inter-American Development Bank (IDB), in association with the Korean Research Institute for Human Settlements (KRIHS), for the cities of Anyang, Medellín, Namyangju, Orlando, Pangyo, Rio de Janeiro, Santander, Singapore, Songdo, and Tel Aviv. At the IDB, the Competitiveness and Innovation Division (CTI), the Fiscal and Municipal Management Division (FMM), and the Emerging and Sustainable Cities Initiative (ESCI) coordinated the study. This project was part of technical cooperation ME-T1254, financed by the Knowledge Partnership Korean Fund for Technology and Innovation of the Republic of Korea. At KRIHS, the National Infrastructure Research Division coordinated the project and the Global Development Partnership Center (GDPC) provided the funding.

The case study includes the experience of the city of Rio de Janeiro in smart city initiatives, focusing mainly on Rio Operations Center Project-COR. The methodology was based on field research, site visits, publications, and interviews held with representatives of local government of the City of Rio de Janeiro. The report addresses the city backdrop, the main urban challenges, the history of digital initiatives, and their evolution over time. For the Rio Operations Center, the general model of participation, organizational aspects, the keys functions, the monitored events, the mechanisms for access, dissemination of information, and the decision-making process are described, as well as the typologies of existing systems and their integration with COR. The study concludes that it is a successful model with a high degree of maturity, and that sharing the experience of Rio de Janeiro with other cities is very important. However, the model needs to continue evolving and rely on strong institutional support so that Rio de Janeiro's population can increasingly enjoy the benefits of technological innovations applied to the city's daily challenges.

JEL Codes: L32, L86, L96, O21

Keywords: smart cities, COR-Rio, Rio Operations Center, 1746, technological innovation, information and communication technologies, mobility, transportation, transit, public safety, video surveillance, integrated emergency system, environment, community warning system, service attention to citizens, social networks, learned lessons, Rio de Janeiro, Latin America and the Caribbean, integrated operation and control centers, resilience.

Author: Clara Schreiner

Pedro Junqueira

Chief Operating and Resilience Officer

With respect to the Rio Operations Center (COR) and the possibilities that it provides, I will use some analogies and some personal opinions about life in the community.

I learned from my father that "Your rights end where another's begin". By the hands and love of my mother, I learned that living is about balancing the pressures of the challenges that we have over time, to care for things with due attention. I agree with my parents that the basis of coexistence is respect and consideration for others.

In the city operation, we have much to gain if we take these simple principles into account. Working to preserve the normality of Rio (and as far as possible of its neighboring cities) is what we do at COR every day. COR handles the routine emergencies of any center city in a complex metropolitan region and supports the planning of various actions and major events. Saving lives and minimizing inconvenience is our mantra.

Untying a dead knot is an operation that is usually undertaken with caution and intelligence, not merely by applying pressure and pulling to the side that you want. The most complicated situations of day-to-day life of a big city can be seen as a dead knot that we need to untie. This involves inter-agency work on different priorities and resources that need to be added in a coordinated manner to isolate and resolve the issue. And there is always the obligation to find alternatives to any disruptions and discontinuities that may be affecting the population.

The decision to build and provide full functionality to an agency operating 24 hours a day, 7 days a week with many different levels of public services and administrative regimes, in addition to the permanent presence of the press, must inevitably rest with the

mayor, with the support of the governor and possibly the President of Brazil. And that is what Mayor Eduardo Paes did.

Collaborative work in teams is turned into guidelines for how the operational machine will attend to the needs of its territories and establish partnerships; we are talking about public policy, and not decisions made by some departments or individuals. It is the institutionalization of a close relationship with the citizens, so that we can help ourselves in the name of the society for which we are responsible.

This is a smart city, which, in addition to all the technology, manages its resources focusing on the citizen as its real reason for being.

The modernity of this planning, monitoring, and urban operation tool is not restricted to existing technologies and the embedded virtual intelligence. These aspects are like trampolines, or potential accelerators, that challenge paradigms. But any kind of automation, big data, screens and technological developments will be available to anyone. The most modern and robust toolbox, however good it may be, does not alone produce results during the work if there are no purposes, staff, understanding, and a lot of collaboration.

Still speaking analogously, as withwork that follows a project's progress with metrics and numerical methods of determining compliance with certain rules, the integrated city operation, once it has reached a certain momentum and maturity, must be able to monitor its own indexes. For us, professionals of #cidadeolimpica a few months before the opening of the Rio 2016 Games, who have been working on this operations center for five years, it is a privilege to have the opportunity to document this milestone, and to seek indexes that help us to clarify the real impacts and direct this work of which we are so proud, as a group of employees that exceeds the ability of any of us individually, any motivation other than real desire to work to improve quality of life.

Summary

Rio de Janeiro, Brasil

Executive Summary

What Makes Rio One of the Smartest Cities in the World

A Smart City Plan presents managers with the challenge of turning traditional metropolitan cities into smarter, more interactive, and sustainable environments. Modernizing and expanding the infrastructure of cities, increasingly bringing the government closer to the citizen, are among the major challenges of the century.

In Rio de Janeiro, this plan includes the implementation of various initiatives and projects that demonstrate how technology has a positive impact on the life of the city. The long-term program has partnerships with the private and public sectors and universities.

There are digital initiatives that serve, for example, the Educating City Program, such as *Naves do Conhecimento* (Knowledge Spaceships). The use of technologies for the management of the city is also part of the Present Local Government Program with community alarms and alerts, the Citizen Service Center 1746, and the thematic collaboration platform Rio Agora, where citizens can propose, discuss, and contribute to the improvement of public policies.

One of the main innovative management initiatives of the local government is the Rio Operations Center, known as COR. The project is considered new in Brazil. The local government continuously monitors the city from this center so that the agencies can act more quickly in different situations, such as unforeseen events in traffic or environmental disasters.

The Operations Center, which is frequently called by the city in its daily operations, is also essential to the production of major events in the city, as Rio de Janeiro is the first city in Latin America to feature an integrated urban management system capable of real-time analysis.

Since 2010, this agency has been changing the quality of life for local citizens. It receives frequent visits of watchers of Brazil and the world; more than 60 foreign delegations have visited there to learn about the details of the project, such as:

- **Monitoring the city 24 hours a day, 7 days a week** – this involves more than 1,000 video surveillance cameras, in addi-

tion to a team of 500 professionals who take turns in three shifts to take care of the city every day.

- **City Map at the Decisions Center** – this is a geographic platform that allows viewing of assets, legacy systems, and occurrences in the city, in an integrated manner, with real-time analysis tools.
- **Real-time Asset Tracking** – administrative buildings, schools, hospitals, cars, bus fleets, radios, and agents in the service of the municipality, are tracked in real time.
- **Surveillance and Predictability of Weather Conditions** – weather radar, rain gauges installed at strategic points in the city, using mathematical models, and specialized professionals on duty 24 hours a day.
- **Alarm trigger in the communities and regular training of residents** – involving simulations and adoption of security protocols in the communities in landslide risk areas.
- **IBGE demographic data integrated into the operation** – figures on the population and families living in different regions.
- **Direct contact with the population** – Citizen Service Center 1746, heavy use of social media and apps such as Waze, Moovit, Alerta Rio, and others.
- **Journalists at COR** – the presence of reporters from major media agencies, who closely follow the operation of the city, ensure credibility, transparency of public administration and, in case of a situation, increase the scope of the alerts and recommendations of the local government.

These and other initiatives of Rio de Janeiro's local government will be discussed in more detail throughout this document.

1. Introduction

1.1 The City of Rio de Janeiro

In its 450th year since its founding, Rio de Janeiro is celebrating the title of the Smartest and Most Connected City of Brazil. This award in the ranking Connected Smart Cities,[1] prepared by the Consulting Firm Urban Systems Brasil[2] from a study of 70 public indexes indicating the Brazilian cities with the highest development potential, is added to the international recognition granted by Smart Community Forum (ICF),[3] also in 2015 (O Globo, 2015). In this case, the entity assesses 300 municipalities and elected Rio de Janeiro one of the seven smartest cities in the world, which shows how Rio plans its future and prepares to leave a legacy (2015 Local Government Portal).

The municipality, which is Brazil's second and fourth Latin American metropolitan region, was also elected in November 2014 the Smartest City of the Year in the Smart City Expo World Congress,[4] a renowned meeting on Smart Cities in Barcelona, Spain. Driven by major events, Rio de Janeiro reinvents itself and uses new technologies for urban planning, improving the population's quality of life and management of the city, which has an area of 1,197,493 square kilometers, where about 6.5 million inhabitants live.

The "Wonderful City," world renowned for its welcoming and friendly people and the parties of Carnival and New Year's Eve, has been consolidated in Brazil as the capital of grand events. This calendar of events creates opportunities, provides improvements, and creates unprecedented economic strength, from the economic growth of sectors such as tourism, information technology, communications and research, and development and creative industry.

The city, which has the second largest municipal GDP of Brazil, estimated at about US$108 billion in 2012, had its growth also reflected on the Mu-

[1] Study conducted in 2015 by the Consulting firm Urban Systems on "The 50 smartest cities of Brazil."
[2] Urban Systems Brasil is a business intelligence firm specializing in behavioral research and analysis of statistical data of markets and cities.
[3] Smart Community Forum (ICF) – International Forum of cities that studies the social and economic development in the 21st century community.

[4] Smart City Expo World Congress, congresso e feira inter- nacional que apresenta soluções para cidades.

nicipal Human Development Index (MHDI). In ten years, between 2000 and 2010, the city advanced in the ranking and became one of the top 50, with MHDI of 0.799 out of more than 5,000 Brazilian municipalities.

The city's economy is based primarily on services — 86 percent. The rest is mostly from industry, with intense participation of multinational companies Petrobras and Vale, the oil and mining sectors, respectively, and only a small portion—less than 1 percent—based on agriculture.

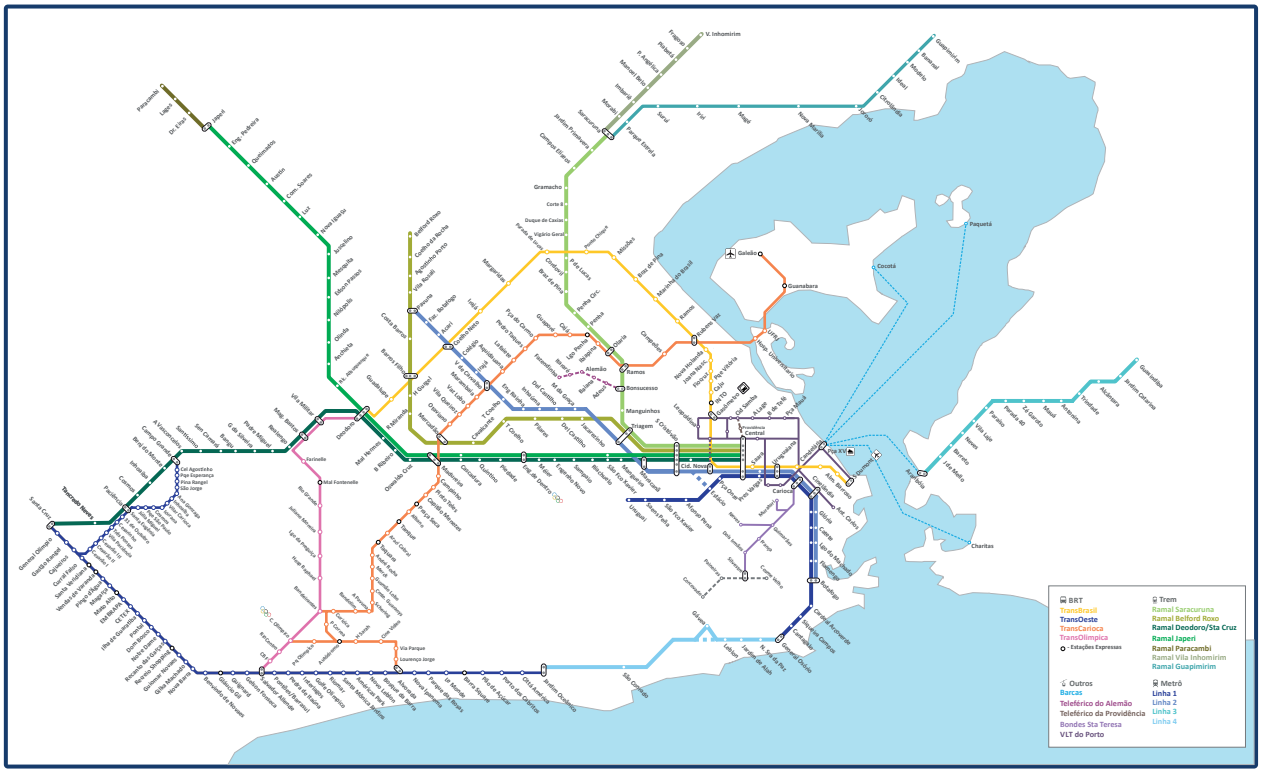
The City of Major Events

Public urban development projects and investments in technology, such as the platform integrating government agencies and improving the population's living conditions, undoubtedly enable Rio de Janeiro to host major international events.

Over the past decade, the city has hosted major events, such as the 2007 Pan American Games, the Rio + 20 International Conference, in 2012, the Confederations Cup, the XXVIII World Youth Day 2013, and the World Cup 2014.

In 2016, the Olympic Games will be held for the first time in Latin America. And the expectation for Rio is huge, especially because it follows the significant changes in the quality of life of the "Wonderful City."

Since 2009, when it was chosen to host the Olympic Games, Rio has experienced one of the greatest urban transformations in its history: more than 200 structural works and initiatives simultaneously executed in the areas of infrastructure, mobility, accessibility, the environment, social integration, and connectivity, all of which are building a new Rio de Janeiro.



Mapa de Mobilidade 2016

Panorama of Urban Mobility in 2016

A major transformation has occurred in urban mobility. Interventions include implementation of a modern integrated high-capacity transportation system, expansion of avenues, and the construction of bridges and roads.

In the case of public transportation, the integrated public transportation design extends the urban mobility map. This includes the installation of more Rapid Bus Transit (BRT), Bus Rapid System (BRS) corridors, implementation of Light Rail Vehicle (LRV), and expansion of the subway in partnership with the state government, which doubles the underground network built over 30 years ago and completes the high-performance ring of transport in the city for 2016. Subway Line 4 connects the West Zone to all the existing subway system (South Zone, the Center and Northern Zone) and the local government's BRT system.

The Mobility Plan of the City was one of the commitments assumed by the city for the Rio 2016 Olympic Games. With the implementation of this plan, there will be a significant increase in the number of passengers. The projection is that the users of public transportation in Rio will increase from 18 percent in 2010 to 63 percent in 2016 when all the projects are completed and in operation.

Urban mobility, as will be shown below, is one of the main operational areas of COR in the city's ongoing monitoring to improve its functioning.

1.2. Smart City Rio

Over the last few years, Rio de Janeiro has been heavily using the information and communication technology to bring the government closer to the citizens. It has adopted solutions that are helping the city to become more equal, more inclusive, and to provide better quality of life.

The basis for the development of the Smart City Plan for Rio de Janeiro was the expansion of the local government's telecommunications network, which has intensified the presence of the government throughout the city, and a Digital Inclusion Program, an important indicator that tracks the population's access to new technologies, particularly in disadvantaged communities and segments.

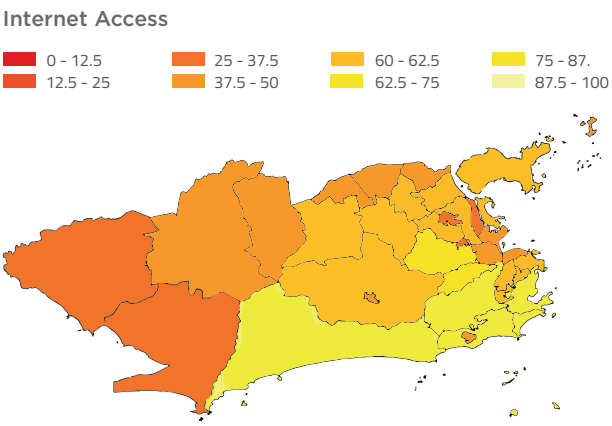
Connected Citizens

In most countries, digital inclusion is defined by the ratio between the total population and the percentage of people with access to mobile phones, computers, and the Internet at home. In 2012, according to a survey conducted by the Getulio Vargas Foundation (FGV), more than half the population was included in the digital world. (2012 FGV study).

However, it is impossible to work on digital inclusion separately from social inclusion. Smart cities need their populations to be stimulated and involved in the process of improving the quality of life. Therefore, since 2011, the local government has tried different ways to relate to citizens on site or through online forums. Rio de Janeiro promotes technology and interacts with its population because it believes that strengthening this relationship also contributes to the development.

According to the survey conducted by FGV, 71.5 percent of people surveyed in Rio de Janeiro have access to mobile phones, computers, and the Internet at home. Among the state capitals, the city ranks seventh. The data indicate that 30 percent of Internet users access social networks, 26 percent share photos, videos or texts, 25 percent have access to email, and 23 percent download applications.

Municipality of Rio de Janeiro



On the map above, we note that the upper class area of the city—neighborhoods in the Southern Zone, such as Leblon and Ipanema, and the growing Barra da Tijuca, an upper-middle-class area of the West Zone—have a more connected population (among the examples in yellow). However, as digital inclusion is one of the priority themes of Rio de Janeiro, the city invests in information and communication technology, offering training programs to minimize the impact of the arrival of these new technologies to the neediest communities and neighborhoods of the Northern Zone, for example.

Another key feature of this plan is to increase interaction with the population, from the projects that meet the demands and interests.[5] In this way, the city is making citizens feel that they are an important part of the development of the city.

Half of the Brazilian population is connected. In Rio:

- 71.5 percent have access to mobile phones
- 30 percent of Internet users access social networks
- 25 percent use e-mail

Innovation and Technology applied to the City

The Smart City Plan consists of initiatives and projects that integrate the strategic planning of the local government and further strengthen the citizens' relationship with the city and the government. (2013—2016 PCRJ Plan)

The Citizen Service Center 1746, COR, the Knowledge Spaceships, and online access to services offered by Digital Carioca web portal are some of the initiatives and projects that can be highlighted for their scope and importance.

1.3. Challenges for the City

Rapid and Uncontrolled Growth of Large Cities

The history of Rio de Janeiro's development is not much different than that of any other large city. Coupled with rapid urban growth, the implementation of inadequate policies, and periods lacking support from the government favored the illegal occupation of the population in several areas of the city and overloaded its infrastructure system.

The challenge for the manager is to plan for the future, based on meeting the basic demands of the population and to respond, in parallel with and with the same care, to emergency care in the city.

To meet these challenges, the local government of Rio de Janeiro has a strategic plan for the period 2012-2016—with 56 goals and 58 initiatives—which includes responses to the issues of urban mobility, housing, urbanization, sanitation, and others.

Cities with the Most Effective and Rapid Responses

The responses of cities to urban challenges need to be more efficient. Especially when one takes into account the dynamics of climate change with events becoming more frequent and intense — and the risks inherent to natural disasters. According to the report "Global Estimates: People Displaced by Disasters," of the Internal Displacement Monitoring Centre (IDMC) of the Norwegian Refugee Council, since 2008, disasters leave at least one person homeless every second.

The report also points out that the lack of infrastructure and appropriate public policies are largely responsible for lives devastated by natural disasters.

Different Approaches Produce Different Results

Due to heavy rain at night and the difficulty of locating and mobilizing municipal authorities so that a tragedy was prevented, the mayor of Rio decided that the city needed to adopt new management tools that could produce more rapid and efficient responses to the population.

The Lessons of April 2010

In Rio de Janeiro, episodes of heavy rain usually meant a fear scenario for the poorest people and chaos in the lives of locals. On the night of April 5, 2010, an extreme situation took place: there was heavy rain in the city and surrounding municipalities, resulting in dead, wounded, and homeless people throughout the state.

Rio came to a halt. There was flooding in dozens of streets. Rivers and canals overflowed. There were fallen trees and landslides in several districts. The storm caused huge traffic jams, paralyzed part of the train circulation, and affected air traffic.

There being no light at various points of the city with roads flooded, drivers became immobilized, and dozens of cars and buses stood still—many of them stalled—in the streets and viaducts until the next morning.

According to meteorological data released at the time, in 24 hours, between the 5th and the 6th days, it rained 280 mm, twice the historical average expected for the entire month of April. In addition to such chaos, the large volume of accumulated water for five hours of storm was slow to drain, hindering the restoration of city's services.

The Creation of Rio Operations Center: Origin and Evolution

The main lesson that the municipality of Rio de Janeiro learned from the rains of April 2010 was the need for full monitoring of the city at the exact moment that the situations require. During such a tragedy, various agencies were impacted by reduced mobility, according to the city's operating conditions, and ended up being unable to develop and share assessments in different regions. The result was the lack of immediate care to the population. Given this scenario, Mayor Eduardo Paes has identified the need for watchful eyes throughout the city to monitor, prioritize, and ensure a more rapid response to the population.

The local government, to monitor the city 24 hours a day, seven days a week, decided to create COR. The plan was to provide information about situations and propose quick solutions.

A physical and technological, connected, and interactive space was designed, with the video surveillance system of the city as one of its main functions for monitoring weather conditions, incident management, risk and situation, as well as the planning of major events.

COR was opened on December 31, 2010, just eight months after the April tragedy. With the primary mission of minimizing inconvenience and saving lives, COR began its activities with a modern weather radar system that can identify in real time and with greater accuracy the approach of rain and storms.

After the structure was completed and as its first management challenge, COR began operations at the end of the year, monitoring the Copacabana Beach New Year's Eve party and the New Year's Eve party in other parts of Rio.

COR'S Scope of Work – 2010 Source

Key Functions

- City video surveillance
- Monitoring of weather conditions

Infrastructure

- 10 agencies – 24 hours a day/7 days a week
- Video wall with 80 46-inch screens
- 92 video surveillance cameras
- 32 rainfall stations and 1 weather radar
- Geoportal system (15 thematic layers)

COR's scope of work – 2015 Current

Key Functions

- City video surveillance
- Monitoring of weather conditions
- Management of situation, risks, and incidents
- Strategic planning of major events
- Resilient Rio

Infrastructure

- More than 30 agencies, 500 professionals working 24 hours a day/7 days a week
- Video wall with 100 47-inch full HD LED screens
- Over 1,000 video surveillance cameras
- Over 15,000 sensors monitored
- Geoportal system with more than 250 thematic layers
- Adoption of new system, apps, and social networks

2. Smart Services

Among the smart services offered by the city are the monitoring and operation of COR, which enhances integration between agencies and utilities, supporting the local government's decision-making process. The application of technology in initiatives, aimed at improving public services and citizens' quality of life, is remarkable and indispensable.

Many advances have been made in strategic areas. There are projects in progress and scheduled for completion in 2016; others are being designed and discussed together with the population. These projects involve issues that are important to the city, such as:

Transport and Mobility

A series of structural interventions in the transport and mobility area is in progress in Rio de Janeiro. They include, for example, the construction of exclusive BRT and BRS corridors and the integration of various means of transportation with the launch of the Unified Ticket of Rio de Janeiro.

In view of such interventions, the technology projects that are in progress include modernization of the infrastructure of the traffic equipment network such as traffic lights, variable message signs, cameras, and other sensors, in addition to the real-time monitoring of the bus fleet.

This whole network is integrated into COR, which also receives information from urban mobility operations centers such as BRT, MetrôRio utilities, and Supervia Urban Trains.

Other initiatives are also being deployed, such as "Digital Traffic," which monitors and reports in real time the path of the main routes and alternative routes in the city.

Citizen Safety

Public spaces are monitored, and technology is used to maximize resources and reposition teams in events in the city. The Municipal Guard has radios, smartphones, and GPS in cars, plus an occurrence system, elements integrated into COR, through the GeoPortal.

COR also shares this information with the Integrated Command and Control Center (CICC).

Responses to Emergencies

COR has a strong and successful partnership with the CICC, bound to the Department of Public Security of the State of Rio de Janeiro. This partnership allows a job aligned with the emergency services of the Military Police (190), SAMU (ambulances—192), fire emergency number (193), and state civil defense. These agencies operate from the CICC.

The CICC and COR are composed of fiber channel and have a cooperation agreement for sharing data and information.

The municipal civil defense also has several prevention initiatives with actions for disaster reduction in the city. The focus of this agency is on community protection, especially for residents in areas of high geological risk. The community alert and alarm system is a positive and successful example of the Community Protection Program, based on three pillars: neighborhood empowerment, community alert and alarm system, and performance in schools.

Environment

In recent years, the government of Rio de Janeiro has implemented a series of actions that contributed to the restoration and preservation of the environment. To improve air quality, the MonitorArRio Program, in charge of monitoring the city's air quality, has been expanded. The program currently has eight fixed stations that analyze particles and gases. There is also a mobile unit, which verifies each part of the city over a period of three months.

Data on air quality from all regions are on the website of the Municipal Department of the Environment and in daily newsletters published by COR. Based on the data, emergency situations can be identified and the population warned.

Energy Efficiency

The local government has been working on initiatives on energy efficiency, with the challenge of identifying impact solutions for the city of Rio. The Program for Modernization of the Street Lighting Network, for example, includes geo-referenced mapping of the street lighting network of the city, cataloging points of light and equipment. The program also provides for the development of a Master Plan for Street Lighting and the replacement of technology with LED and solar energy.

Communication with Citizens

Rio de Janeiro uses various channels to communicate with citizens, the main one being Center 1746. The service operates 24 hours a day, seven days a week, and includes more than a thousand municipal services. The citizen contacts and logs a request, complaint, or request for information. The request is forwarded to the relevant agencies, and the caller receives a SMS message or email with the protocol number, which can be used in the prosecution of the request. The message is also sent when the problem is solved.

The center has enabled the unification of services—over a hundred numbers of different phones—into a single service and established deadlines for the requested services. By bringing together the previously dispersed phone services of the local government, Center 1746 reduced the works of the municipal depart-

ments and agencies, which now can focus on the solution of the demands received by a structured and transparent system.

The service capacity is 600,000 calls a month. Center 1746 can also be accessed directly through the web portal of the local government.

Two other initiatives of the local government have also gained prominence in communication with citizens: Digital Carioca Web Portal5 and RiosemprePresente Web Portal.6

Carioca Web Portal aggregates all digital services offered by the local government in a personalized way. RiosemprePresente is a permanent dialogue channel for questions, suggestions, or criticism, where citizens can follow the map of the achievements with the information of the works that are transforming the city.

Citizen Participation

The city has been experiencing new forms of participation of society in municipal management. For this, it seeks to incorporate in its strategic plan projects and ideas that can reflect the national vision for the future of Rio, from different forums and tools and various technologies.

The local government has used LAB.RIO to encourage citizen participation with the government. This is a laboratory that encourages engagement, collective, and collaborative construction of the city, through digital and on-site experiments, to test, create, and discover new forms and formulas, achieving results expected by society. The following projects and experiments are part of LAB.RIO: Rio Ágora Challenge, Immersion, Sustainable Urban Mobility Plan (PMUS), Chega Junto (Come Together), Youth City Council, and Mapeando (Mapping).

Rio Agora Challenge[7]

LAB.RIO's main project is a social network that allows citizens to propose and debate public policy with municipal departments and agencies. It works in thematic cycles on the web page. Started in September 2014, the first issue was the legacy of the Olympic Games. The theme of the second issue, in January 2015, was mobility, which included the participation of the mayor through a video conference tool.

[5] Carioca Web Portal: http://carioca.rio.rj.gov.br/
[6] RioSemprePresente Web Portal: http://www.riosemprepresente.com.br/

[7] Desafio Ágora: https://desafioagorario.crowdicity.com/

3. Monitoring and Control

3.1. Execution and Control of the Strategic Plan

The Strategic Plan of the local government is the main government instrument to ensure focus on and transparency to the municipal administration. The Plan sets action priorities for the various departments and agencies of the local government, with specific goals and objectives for the short, medium, and long term[8].

The materialization of the plan includes the implementation of various initiatives and strategic projects that are strictly monitored by two units within the Office of the President's Chief of Staff: Results Monitoring and the Project Office. In addition, the mayor participates in various agendas for the close monitoring of the results achieved.

3.2. Some Initiatives and Results

RIO CONNECTED

Connectivity and High Availability

What it is: The City's telecommunication network extension for 480 km of fiber optic cables, technology park renovation, and creation of a new data center.

What it allows: By the end of 2016, the interconnection of 2437 points of the government's structure through high-speed connection, with greater integration, efficiency of the processes and services offered, reduction of operational risks, and creation of collaborative environments.

Result: From 2013 to 2015, 1944 points were interconnected with high-speed connection, allowing the integration of 15 administrative buildings, including Rio Operations Center. Eleven hundred thirty-seven schools and four major hospitals in the municipal health network are connected as well.

[8] City Council' publication – Local Government of Rio de Janeiro - 2012

KNOWLEDGE SHIPS

Digital Inclusion

What it is: Community spaces in low-income areas that function as digital inclusion poles.

What it allows: Creates "cyber citizens", offering technological knowledge, encouraging citizenship and awareness of their rights as citizens.

Result: Since 2012, eight Knowledge Spaceships have been opened, accumulating more than 1.8 million visits. There are about 150 000 people registered and more than 15,000 students have been certified in courses and program workshops.

RIO ÀGORA

Interactivity and Communication

What it is: A social network directed at citizens who live in Rio, to discuss and propose public policies with the city. The dynamics of Agora Challenge runs through thematic challenges proposed to society.

What it allows: Involvement, participation, transparency, clarity and supervision. Encourages citizen participation in municipal management as a key instrument for change and improvements to the whole city.

Result: After a year from the launch, the project discussed with society two major challenges: the legacy of the Olympic and Paralympic Games of 2016 and the Sustainable Urban Mobility Plan of the city. Seven hundred sixty-four ideas were presented with the participation of 1,688 people; 8,562 votes were counted.

RIO IDEAS AND RIO APPS

Interactivity and Communication

What it is: Initiatives for the development of innovative projects in the form of contests, Rio Ideas seeks answers to citizens' proposals, and Rio Apps is a challenge for programmers' groups.

What it allows: Solutions and answers. Popular involvement and citizen participation to help transform Rio into an increasingly connected and smart city.

Result: In three years, the city formed a collection of more than 4,000 ideas for different areas and resulted in the creation of two applications—winners of previous editions of the contest—which are widely used by Rio's population: Easy Taxi and Procon Carioca.

RIO CALL CENTER

Interactivity and Communication

What it is: Main communication channel between the local government and the citizen, it operates 24 hours, seven days a week and includes more than 1,000 municipal services.

What it allows: Order any public service, such as garbage collection and exchange of street lights, citizens can search a single channel, 1746, by phone, on the website or in the application for smartphones and tablets.

Result: Since its inception in 2011, the center has received more than 14 million calls. Overall citizen satisfaction with services provided through 1746 is about 70 percent.

DIGITAL CARIOCA

Interactivity and Communication

What it is: A personalized portal that integrates online services of the local government of Rio de Janeiro.

What it allows: From a personalized account on the web portal, citizens have access to information about different municipal services in a customized manner, such as: cultural agenda, newsletter and presence of children at school, meals, menu and school calendar, vehicle fines (municipal infractions), history and status of requests made through 1746, registration and tax status of the property, duplicate copy of the urban real estate tax instrument, license permit for places of business and events, among other services.

Result: Greater dialogue between the government and the citizens; integration and simplification of the main municipal services.

RIO OPERATIONS CENTER

Monitoring the City

What it is: Institutional and technological environment for monitoring, operation and management, which includes more than 30 municipal and state agencies and utilities.

What it allows: Integration of various sensors, cameras, and systems that allow monitoring and operation of the city 24 hours a day, in the areas of traffic, public transportation, urban sanitation, urban order, civil defense, and major events, ensuring the city the permanent sense of urgency needed.

Results: In five years, COR presents results on three important fronts: (i) communication with the population, (ii) operation in multi-agency model (iii) planning of major events.

Communication with the Population

The agency is increasingly known as a focal point of information on any event affecting the operational routine of the city. This is reinforced in times of crisis, when the audience grows exponentially, reaching over 500,000 users consuming information and receiving guidance on a daily basis.

In five years, COR managed a direct audience of more than 300,000 Internet users via Twitter and Facebook and 100,000 users who access the site monthly. This channel is highly interactive and has dedicated staff who publish information and respond to interactions with the population.

In 2013, in recognition of the importance of this communication project, Twitter released a feature for issuing alerts that only some public institutions from Japan, the United States, South Korea, and the United Kingdom have: Twitter Alert. In 2013, in its first year of operation in the Operations Center, more than 7,000 users received alerts via text message.

Multi-Agency Operation

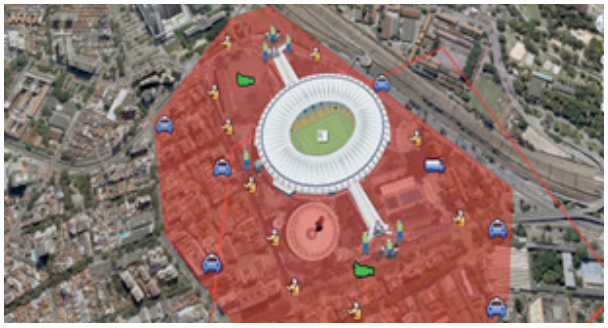
One of the most successful results in COR is the maturity in the operation along with municipal, state and federal agencies, in addition to utilities, such as Metro Rio and Supervia. The following are also part of this model: Municipal Department of Tourism/Riotur, Companhia de Engenharia de Tráfego/CET-Rio, Municipal Department of Transport, Companhia de Limpeza Urbana/ Comlurb, Municipal Public Order Department, Municipal Department of Conservation/ Seconserva, Municipal Guard, and Civil Defense. At the state level, the military police, the fire department, and the civil police provide support.

The increasingly synchronized coordination of the various actors, collaboration among agencies, and the performance of drills provide COR with a relevant reduction in response time in meeting the needs of the city. Demands whose service time could reach five hours began to be answered in 45 minutes.

Planning of Major Events

Rio has the most complete schedule of events in Brazil and, therefore, has expanded its experiences and improved its processes.

Since 2012, COR has an online knowledge base, covering special planning of traffic, transportation and special events, which also helps to reduce negative impacts on the city's routine.



Stored information serves as a reference and background for the planning of new events in the multi-agency model.

The following experiences form the basis of knowledge of COR: World Youth Day, the Confederations Cup, Copacabana New Eve's Parties, and Carnival—with 420 scheduled blocks, the World Military Games, Rock in Rio, and works of urban transformation in the Port Region. In 2015, the COR's knowledge base had already covered 169 events held in the city.

RESILIENT RIO

Resilience

What it is: A pioneering strategy that outlines the main guidelines for the city in different everyday situations.

What it allows: Addressing and managing impacts and adapt the city to chronic shocks and stresses caused by urban challenges and climate change.

Result: At the end of 2013, the city was selected for the Rockefeller Foundation's network of "100 Resilient Cities." Within the program, Rio received technical support to deploy resilience in the municipality and to be able to exchange experiences with other cities such as Medellín (Colombia), Melbourne (Australia) and New Orleans (United States).

COMMUNITY ALERT AND WARNING SYSTEM

Resilience

What it is: A system that receives information from the city's sensors—such as weather radar and rain gauges—and monitors weather conditions, sending warnings about of risk situations to residents and community workers. Messages are triggered by free SMS and siren ringtones in high-risk areas.

It operates in 103 communities, which have 165 sirens, 83 automatic rain gauges, and 194 points of support. The sites are indicated by mapping

developed by the Geotechnical Institute (GeoRio) as communities located in landslide risk areas.

What it allows: Saving lives, acting preventively, informing and supporting the agencies of competent jurisdiction; ensuring that communities at risk will be alerted, so that residents, guided by community workers, adopt security protocols in case of emergency.

Result: Seven thousand community workers trained by the Civil Defense to act in emergency situations, and implementation of training in 119 public schools for 7,891 students.

DATA.RIO

Open Data

What it is: Open data web portal of the local government, with practical resources to search for information in raw and organized data catalog (Open Data).

What it allows: Provides citizens and researchers with documents, data, and information on the municipality. There are 989 sets of data, divided into the following categories: Center 1746, Public Administration, Social Development, Education, Entertainment, Sports, Taxes and Duties, Environment, Income and Expense, Health, Transport and Mobility, Tourism, and Urban Planning.

Result: Increase in the number of applications developed using city information and development of partnerships with universities.

PENSA IDEAS ROOM

Big Data

What it is: A group of professionals from different fields working in the analysis, compilation, translation, and use of data from different sources to propose solutions and preventive measures to the city's problems. The group's work was inspired by the Geek Squad in New York (United States) and is bound to the Office of the President's Chief of Staff of Local Government.

What it allows: The group works daily with concepts of big data and is dedicated to thinking about the routine of the city, seeking solutions on various issues. 'Pensa' has free access to 400 terabytes of raw data from the local government.

Result: Studies aimed at supporting decisions made by the local government's managers on the following topics: bike paths, traffic jams, illegal parking, overlapping of bus lines, bus super-

vision, school consumption—water and electricity—and, more recently, a mobility study for the Rio 2016 Olympic Games. This study was developed in partnership with the Massachusetts Institute of Technology (MIT).

PORTO MARAVILHA

Role Model Neighborhood

What it is: Urban revitalization project of the Port Zone, an area of five million square meters. This is the biggest PPP in Brazil, with R$8 billion in investments.

What it allows: Deployment of a smarter, more human role model neighborhood, with residential and commercial areas, public transportation network, and telecommunications infrastructure. The neighborhood will offer a smart service platform that will enable citizens and visitors to connect with each other, the city, and the government.

Result: Creation of a new economic hub in the city with all modern infrastructure and high capacity connection based on public-private partnership (PPP) model. All management is measured by levels of agreed services.

4 . Operations Center: The Watchful Eyes of the City

COR was created with the mission of promoting effective and efficient management of services provided to the population, through an integrated control model of the main services of the municipality. This enables interoperability of agencies involved, to provide monitoring and control of actions and productivity. The goal is to enable continuous improvement of services.

One of the most modern information and technology structures in Latin America, Rio Operations Center is located next to the

headquarters of the City Hall, Cidade Nova, and City Center. The building has an area of 1800 square meters spread over four floors.

COR integrates, in the same environment, more than 30 local and state agencies and utilities. The watchwords are collaboration and cooperation. Nearly 500 professionals take turns in shifts, 24 hours a day, seven days a week, devoting full and close attention to everything that happens in Rio.

Thus, it works in an integrated manner, seeking to anticipate solutions to minimize the impact of incidents and save lives by alerting the sectors responsible for the risks and urgent measures to be taken in cases of adverse situations and emergencies.

Rio Operations Center has the latest technology. In addition to the captured images, data from various sensors, such as rainfall stations and municipal systems are interconnected and made available for viewing and analysis on a screen of 65 square meters (videowall), capable of playing any array of information essential to the decision-making process.

4.1. Monitored Events and Main Services

Events monitored and operated by COR are related to five topics: natural disasters, urban mobility, urban planning, public safety, and major events.

The main services provided by the Operations Center are:

- Weather alerts
- Coordination of disaster responses
- Information and guidance on mobility: digital traffic, digital clock, interdiction of roads, track reversal, planned and emergency works, as well as actions of agents on site
- Monitoring of essential public services to the operation of the city: transport, electricity, water, gas, roads
- Monitoring of public spaces
- Monitoring of public order
- Support and guidance during events in the city
- Coordination and operation of major events

4.2. The Meteorological Prevention Activity

Full-time Meteorologists

The monitoring and management of weather conditions in the city's risk areas are priority issues of the municipality. There is a team of experts allocated in COR.

To monitor weather conditions, COR has a rainfall and landslide alert system in hillsides called Alerta Rio System.
The system belongs to the Geotechnical Institute of the City of Rio de Janeiro (Geo-Rio), which integrates the Municipal Department of Public Works and is responsible for the hillsides of the city.

Understanding the Importance of Rio Alerta System to the City

The Rio Alerta system is a weather monitoring service that collects data from automatic rain gauge stations spread throughout the city and monitors and records the rainfall every 15 minutes, stating the accumulated amount of water per hour.

Rio Alerta System has a team of meteorologists, engineers, and geologists working 24 hours a day, seven days a week at COR.

All data collected by the system are shared at the COR control room. Thereafter, the information is processed in an integrated and smart manner, ensuring that municipal authorities act as soon as possible to respond quickly to emergencies. This content allows, for example, evaluations required for sending alerts to the population living in communities located in high-risk areas.

Alerts are triggered to mobile phones of people

and community leaders previously registered by SMS. Such information is also released by the press office of COR to people through their social networks and the news media.

The system also issues newsletters to the population in the event of forecasts of heavy rains that may cause flooding of roads and/or landslides.

Essential Technology

Since December 2010, Rio Alerta also has its own weather radar, installed in Sumaré. This feature is fully operated by the local government, which makes it possible to carry out specific studies during rainfall events that can possibly hit Rio de Janeiro.

The weather radar shows the conditions of rainfall each time. Together with other meteorological parameters, such as wind and humidity, such information allows the meteorologist of the integrated agency to make a short-term forecast (nowcasting) on the most likely path of the rain in the coming hours.

4.3. Special Spaces

The building that houses COR was conceived and designed to serve as the headquarters of City Hall, in crises and special moments. In addition to the operations room, there are areas such as the office for the mayor's orders, situation management environment, meteorology room, auditorium and conference room where journalists of the city's media agencies make calls and inserts throughout the day, publishing news about the daily life of Rio.

The Operations Room has 70 working positions and a video wall consisting of 100 full HD LED monitors. This large screen exposes the city's monitoring tools: maps, aerial photos, graphics, and images displayed in real time.

The operators of service agencies and utilities can access the cameras distributed in all neighborhoods of the city from the operating room. COR never stops. The work is continuous there.

The Situation Room is the environment for assessments and decisions. This immersion room was created for special meetings, often with authorities who comprise the situation cabinet, offering the latest technology and telepresence system for decision making in emergencies.

The solution enables virtual meetings with advanced audio and video features and is connected to the official residence of the mayor and the building of the Municipal Civil Defense.

Disseminating Information with Credibility and Transparency

In COR, the press has a reserved space to write articles on a daily basis. The agency's press office team has direct contact and transparent relationship with journalists, who receive information almost firsthand, since all data are initially disclosed in the Press Room.

Not only does the presence of journalists at COR increase the credibility and transparency of public administration, but also, in the event of situations, also ensures that diagnostics, alerts and recommendations from the Local Government are given to the people quickly. It is in such an environment that the authorities usually give press conferences, supported by the database of the Operations Center.

It is a two-way street: in building relationships of trust and finding solutions to the city, journalists headquartered in the Press Room also contribute to the prompt response and transmit to the Operations Center information they receive from their listeners, readers, and followers about accidents or incidents.

Among the many representatives of the media—radio and TV stations, newspapers and Internet portals—CBN, Paradiso, Band News, Tupi and Globo radio stations are present, as well as broadcasters of TV Globo, Band, SBT, Record and Globonews, and also the portal G1 and Globo.com. Note that TV Globo teams make daily and live entries in the main news programs of the broadcaster and inform viewers about everything that happens in the city, from the press office's guidelines.

4.4. Strategic Partnerships for the City

After the implementation of the Operations Center, the Local Government of Rio de Janeiro enhanced its ability to mobilize its own resources and partners' resources.

The joint work also depends on the dedication and concentration of efforts of representatives of municipal agencies such as CET-Rio, which is the traffic management agency in the city, and the Municipal Guard, as well as of partners such as companies and utilities, with a permanent presence at the Operations Room of COR.

In the city of Rio de Janeiro, the model of multi-agency cooperation and integration is prioritized. Find below the list of the main agencies and utilities integrated into COR:

Municipal Agencies

- Alerta Rio - Radar and Rain Gauges
- CVL Pensa – Technology
- CET-RIO - Traffic
- COMLURB - Urban Cleaning
- Conservation – Maintenance
- Civil Defense - Disasters
- GEORIO – Hillsides
- Municipal Guard - Urban order
- IPLANRIO – Technology
- RIO ÁGUAS – Gauges and Drainage Network
- RIOLUZ – Street Lighting
- SMTR - Transports
- SMH – Housing
- SMAC – Environment
- SMS - Health
- SMDS – Social Development
- SMDS / CRV – Regulation of Places in Shelters

State, Federal Agencies and Utilities

- CEDAE – Water and Sewage
- CEG – Gas
- LAMSA - Highway
- LIGHT – Electricity
- METRÔ - Transport
- SUPERVIA - Transport
- CICC (PMERJ, PCERJ, Bombeiro, SAMU, Civil Defense, PRF)

Partnership with the Public Security of Rio de Janeiro State Government

One of the most significant external partnerships of COR is with the CICC, the Secretary of State for Public Security, which integrates the actions of state and federal institutions. CICC resembles COR in concept, with respect to the constant monitoring and integration of actions, but acts within the state powers.

Representatives of seven agencies operate on the premises of CICC: Military, Civil and Federal Highway Police Forces, Fire Department, SAMU, State Civil Defense, and COR (Municipal Civil Defense, Municipal Guard, and CET-Rio).

To operate the city during major events, COR develops action plans along with these agencies, in addition to its communication strategies to lead drivers and care or service teams through the best routes.

The CICC building has four floors with 10618 square meters of built area. A 17 x 4.5 screen generates images in 98 modules of 55 inches. The building also has a situation room, an auditorium, accommodation for team members, living room and bedroom reserved for the authorities, offices for intelligence personnel from each public agency, plus a helipad.

4.5. Ability to Innovate Creativity and Innovation

Even a technological and connected center such as COR improves its capacity for learning and innovation to promote the initiatives of member agencies. One of the principles of COR is continuous development. Therefore, those involved are continuously provided with training and simulation exercises that depict real situations, to stimulate creativity and improve their processes.

Because of this dynamic, many ideas are presented, tested, and incorporated into COR to solve the city's problems, ranging from the expansion of the sensor infrastructure in the city to the creation of interactive environments among agencies and with the citizens.
Since 2013, COR uses WhatsApp and Telegram applications as communication tools among agencies, as well as in communication with the mayor and secretaries. In the communication with citizens, the Operations Center has an important partnership with Waze, entered into in 2013, when the application has integrated its database to COR's system, which allowed users' messages to be tracked in real time on the map of the agency's panel in a georeferenced environment.

Thus, reports on accidents, dangers on the road, and traffic jams, for example, appear as pop-ups, and operators are able to analyze the frequency of that user who appears anonymous and his/her credibility on the network.

Georeferencing, in turn, enables the immediate location of the various situations so that public administrators may act.

It is the execution of the basic concept of smart city, using the contribution of citizens, even if unintentionally, as a form of management. The city benefits, with prompt response and quick problem solving.

4.6. International Recognition

In October 2014, the local government presented the use of Waze application in support of urban management as a case at a conference held in New York in the United States. In Brazil, Rio is the only city that uses the tool, with about 50,000 reports per day and approximately 1.5 million per month. Initiatives in Tel Aviv, Israel, and Houston and New York, USA were mentioned in this international meeting.
Strategic partnerships developed by COR have allowed the rapid incorporation of innovative and successful experiences in everyday life of the city. COR also uses tools such as Facebook, Twitter, Twitter Alert, Instagram, the website and the hot site. The use of social networks by COR undoubtedly brings citizens closer to it and encourages this direct contact.

The interest that the work of COR arouses among other national and international authorities move management events. There are about 200 visitors a month, including officials, academics and ordinary citizens. The Operations Center, together with the other digital initiatives of Local Government, turns Rio de Janeiro into an example for the use of technology to manage cities.

Knowledge sharing - another feature that makes a Smart City - and the innovative urban management made the mayor Eduardo Paes chair, at the end of 2013, C40 group for climate leadership of cities.

Mayor Paes is the first mayor in a developing country to lead the global megacities network, which promotes sustainable urban development through strategies to address climate change and increase the resilience of cities.

In addition to the election as the Smart City of the Year at the 2013 Smart City Expo World Congress, a trade show for smart cities in Spain, in November 2014, Rio de Janeiro was appointed as one of 21 Smarter Communities of the World for the second consecutive year by the Smart Community Forum (ICF).

4.7. Organizational Structure

The Chief Operating and Resilience Officer reports to the Mayor upon decree that assigns him or her the responsibility of running the operation to deal with situations that arise.

COR, established on December 23, 2010, is the official entity responsible for disclosing the city's operating stage and acting on situational risk management in the city.

COR's organizational chart enhances the integrated working model rather than the idea of hierarchy and power. Its model discourages internal barriers and enhances the value of unity of purpose and joint efforts among the branches, which are divided into Operations, Technology, Infrastructure, and Resilience.

Operations: this is the reason for the creation of the agency, the main function of COR. From here, the remaining work areas are tested and make the most significant difference to the city. It seeks solutions to the inevitable problems, works to prevent increasing disorders, and supports the day-to-day routine.

Technology: the group responsible for innovative actions, such as integration with Waze, Twitter, rain gauges and other sensors, as well as with the citizens, the greastest urban asset. With the research and development work, together with the knowledge generated by big data, this

task has very high value added.

Infrastructure: in practice, these works are possible because of the equipment to support all activities of COR, with very clear technical responsibilities and commitment. This team is responsible for the management and maintenance of building. Hundreds of professionals work simultaneously, with redundancy of some services, 24 hours a day, all year round, with a number of different specialties technologies, which makes the process more complex.

Resilience: this formal area of expertise was incorporated into COR's scope of action. Resilience Management works on the development and execution of projects that help consolidate the vision of a city that learns from experience and prepares itself, building the foundation for greater strength and adaptability to shocks. The team works to create better conditions to resume the city's regular activities when it is severely impacted.

The areas that guide the resilience work are climate change, resilient behavior, social and economic resilience, and resilient management.

4.8. The Operation inside COR

What to do in case of an accident?

When the monitoring system detects an emergency or incident with potential impact to the city, COR operational teams meet requirements and procedures in their routine. During the service, COR assesses the impact and urgency of a solution, classifying the incident according to the level of criticality.

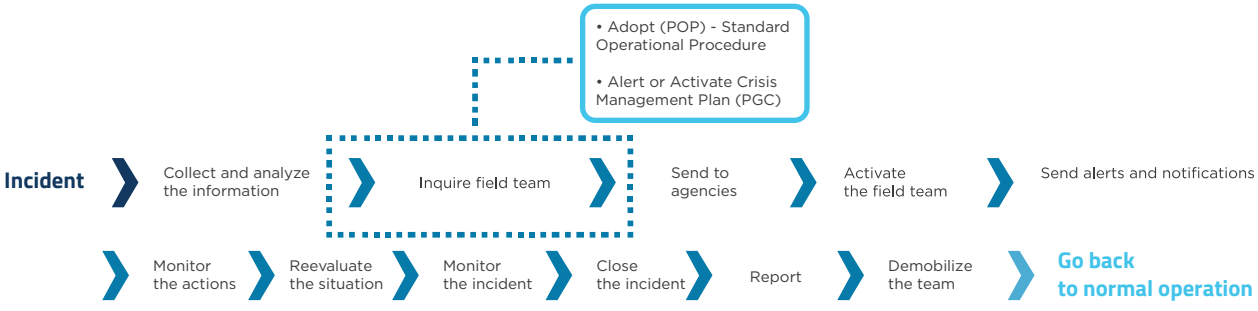
For this, the following factors are taken into account: location of the incident, time, and affected population, number of fatalities, injuries, expected resolution time, potential aggravation, and operational impact.

According to the final classification of the incident, the Chief Executive Officer of COR can notify the situation management team, which will adopt special protocols during the services up to completion.

Classification of Incidents and Operational Stages of the City

COR uses color coding to indicate the operational stage of the city, which can be changed depending on the classification of incidents of any kind, such as rain, accidents, and movement of vehicles for long holidays.

The operational stages are represented by three colors: Normal (green) Warning (yellow) and Situation (red).



Normal stage: when there are no events that may cause major changes in the daily lives of those going around the city. These include minor accidents, stalled vehicles, falling trees with no or little impact on traffic flow, or water accumulation on the road without risk to drivers and without interference with traffic.

Warning stage: when there are one or more incidents that are impacting at least one area of the city, which can cause significant disruption to traffic and hinder the movement of people. Examples: heavy rainfall, big shows with impacts on a region, and incidents that give rise to significant restrictions on movement in the city.

Crisis stage: severe occurrence or a large unexpected event that causes disorders in various parts of the city, such as a long thunderstorm causing consecutive high rainfall indexes, creating the risk of mudslides. During this stage, COR's web portal automatically directs visitors to the hot site, giving all of the necessary information and guidance to the public.

At the mayor's prerogative, there are also Emergency and Calamity stages, but these depend on decrees to be effective.

4.9. Information Flow

In the Palm of the Hand

The task of conducting the joint work of several agencies and utilities has required COR to review and adopt new procedures to improve the information flow.

Data entry and smart use of information are fundamental to the success of the work of agencies and utilities.

GeoPortal information is also shared with field staff, who are working on the streets and can receive alerts, alarms, and information on incidents on their smartphones, via email, Telegram, and WhatsApp.

Currently, the information flow in this structure includes the following steps: data entry, response actions, dissemination of information, and operational intelligence.

How it Works

The "data input" stage includes data from sensors, cameras, legacy systems, and mobile applications. The data are processed, analyzed, and forwarded to the responsible agencies, which make decisions and notify their field staff.

- Responsible: operators
- Bottom line: analysis

The **response actions** stage concerns support and multi-agency coordination, management and analysis of situations, smart use of the video surveillance system, adoption of standard operating procedure and collaboration with field teams via Telegram and WhatsApp.

- Responsible: coordinators of the agencies
- Bottom line: collaboration with field staff

The **dissemination of information** stage concerns the dissemination of information to citizens. It is supported by the press office team, which coordinates the communication strategies and the use of various communication channels. At this stage, the content of interest is also communicated to the press.

- Responsible: Press office
- Bottom line: Communication

The **operational intelligence** stage includes analysis and data correlation, process improvement, creation of new services, and transformation of the knowledge acquired in intelligence accessible to agencies. This is where the history is stored. The experience, exchange of information and the exchange of data, in turn, provide studies and projections. Thereafter, it is possible to plan new actions and create solutions in search of preventing and reducing the impact of adverse conditions on the city.

- Responsible: Pensa group
- Bottom line: the search for solutions and strategic planning

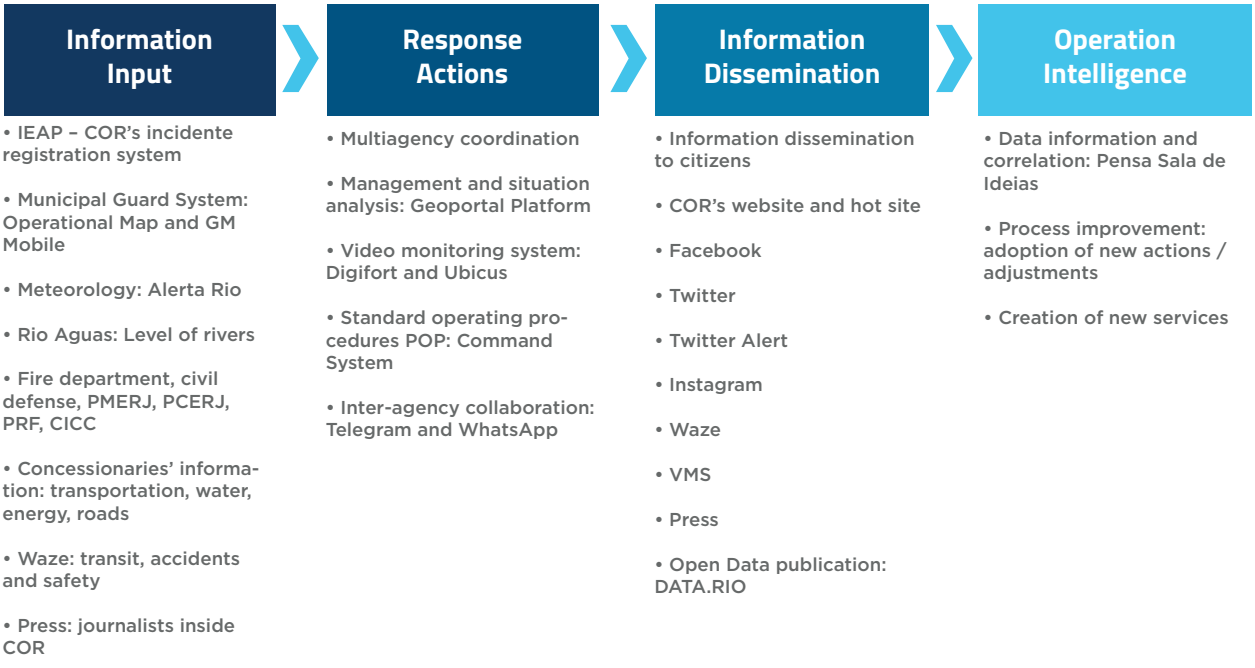
4.10. The Role of Social Networks

Social Networks: Main Channel of Communication with the Population

Social media are widely used to communicate with the population. These tools help COR to understand the urgency and the impact of incidents on the city and guide the public about various situations at any time of day.

It is the responsibility of the agency's press office to strengthen such links and disseminate information through social media and the press, 24 hours a day. The tools used by COR are:

Waze: The partnership developed with Waze allows citizens to share data in real time with the Operations Center, complementing the images



captured by the city's cameras and incidents reported by municipal guards and traffic agents. There are about 50,000 reports per day.

Twitter: The microblogging network is the most widely used tool in everyday life of the press office of Rio Operations Center. All incidents recorded by CET-Rio and other agencies communicated to COR are communicated through the @operacoesrio profile. There are more than 221,000 followers in this network.

The platform also informs, when necessary and appropriate, the detour options and alternative routes to be used. During accidents or incidents, @operacoesrio also reports traffic conditions on site and the impact on the surroundings, offering citizen guidance on which way to go or when to resume circulation.

COR also interacts with the population on Twitter. Followers of @operacoesrio can send messages, which are answered as soon as possible, as the city's operating conditions permit.

Twitter Alert: Depending on the credibility and usefulness of the information disclosed by COR, in December 2013, the microblogging network made available to @operacoesrio Twitter Alert a feature that allows a particular post to be automatically sent as a SMS to mobile phones of more than 7,000 registered followers.

Facebook: Used since 2011, Facebook publishes information and an interdiction newsletter daily major accidents and impacts on the city: road closings, detours and the actions taken by the agencies involved. COR also alerts people to planned construction, special traffic schemes, and weather conditions of the city. Facebook is also a communication and interaction channel with the public, with service 24 hours a day. More than 157,789 Internet users like COR on this network.

Instagram: The social network of photos has been in use since 2012. This is a more informal communication channel, whose purpose is to publish beautiful images captured by the local government's cameras. It also posts photos taken by followers who participate in campaigns developed by the press office. Here, more than 4,000 people follow the messages of COR.

Social networks	Beginning	Followers	Publications	Average per day	2015 audience target
Twitter	2011	221,204	274,385	163	404,359
Facebook	2011	105,228	34,000	20	150,000
Instagram	2012	4,493	864	1.4	6,000
Twitter Alert	2013	7,149	31	on demand	8,000

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COR Website: Redesigned in July 2012, the portal provides real-time pictures from some of the local government's cameras, weather radar information and traffic panels with traffic conditions on major city streets. Information and interdiction newsletters are accessible to the entire population as well as information on major accidents and their effects on the city (road closings, detours, and actions taken by the agencies involved), planned works, special traffic schemes, bathing water standards of the municipality's beaches, and weather conditions inthe city.

COR Hot Site: An important tool for the city designed to be used whenever the municipality faces a situation, as described in the previous chapter. The platform automatically replaces the institutional site, with the most important information about the city's operation during situations. The hot site has a simple, practical, and easy viewing format for mobile devices such as smartphones or tablets.

For COR, participating in networks is another way to ensure that messages from the Operations Center be disseminated and reach the greatest number of people. Being able to count on the population's contribution only reinforces the concept of a smart city, as it encourages the involvement of residents and visitors to the city.

Every situation reported by citizens to COR undergoes a check to work on solving the problem.

4.11. Technology in the Work Performance of COR

In its simplest form, the bill creates a new technology platform that connects, integrates, and correlates data from multiple agencies, allowing full and immediate analysis of information.

The platform developed by COR, called GeoPortal, has ensured to the local government a more efficient management of the city, anticipating everyday situations caused by the dynamism of urban life and thereby reducing risk.

Smart Map

GeoPortal is a smart map: Rio Operations Center monitors and adds to this map transportation, traffic, weather, and rainfall information, location of schools, hospitals, social media applications, and other information that could affect the citizens' routine.

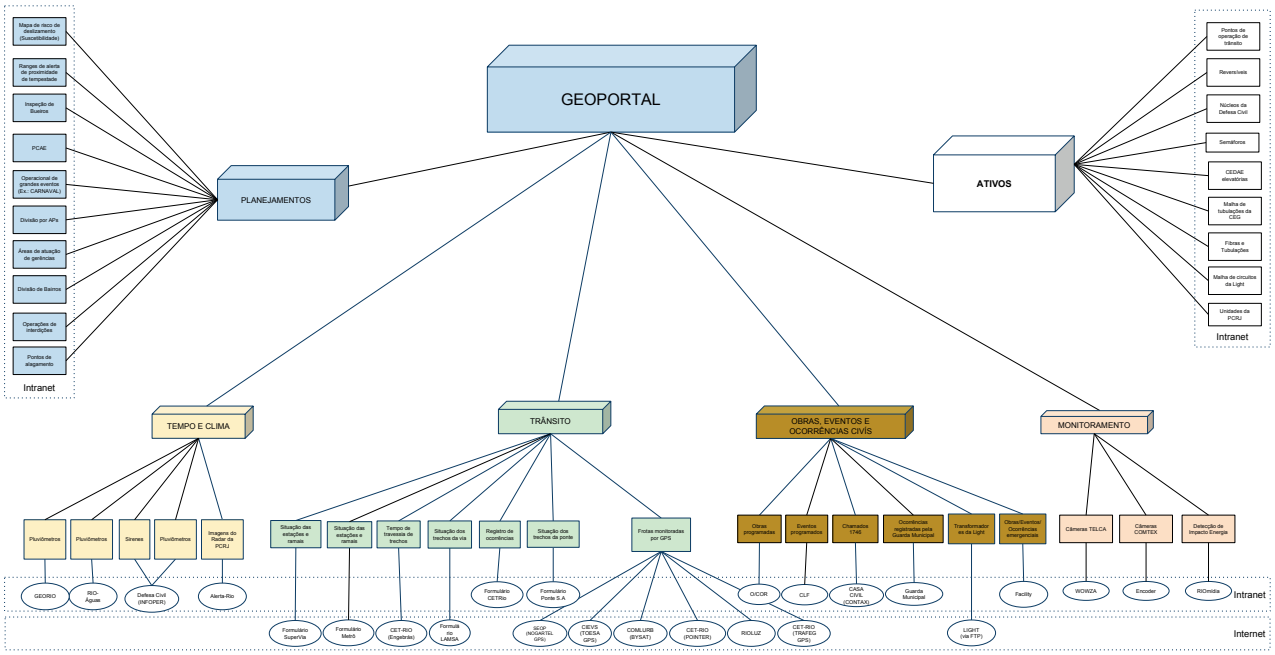
The platform also includes integrations with legacy systems, cameras, sensors, and other operations centers.

The main goal of the platform is to provide routine support to joint operations of the agencies, integrating and optimizing the strategic, tactical, and operational support efforts in meeting the demands of the city.

The platform uses a Cesium tool for creating and sharing geospatial data with agencies and other partners, allowing the center to have an integrated view of events and ongoing operations and thus detect potential problems.

Integration and Interoperability

The COR Integration Platform is a core service-oriented technology platform based on open standards and rules that allow the interconnection of multiple data sources and provides services for consumption by other applications.



4.12. Information Systems

System Architecture

The structure designed by COR simplifies the processing and handling of data from different sources and in increased volume, which are required for construction of the situational view.

Data from various sources are received through various protocols (FTP, SOAP, and REST) in different formats (XML, JSON, KML, GeoJSON) and are monitored for integrity and availability.

Such data, when combined with and presented in a single interface, enables a wider and complete assessment of the situation by the agencies.

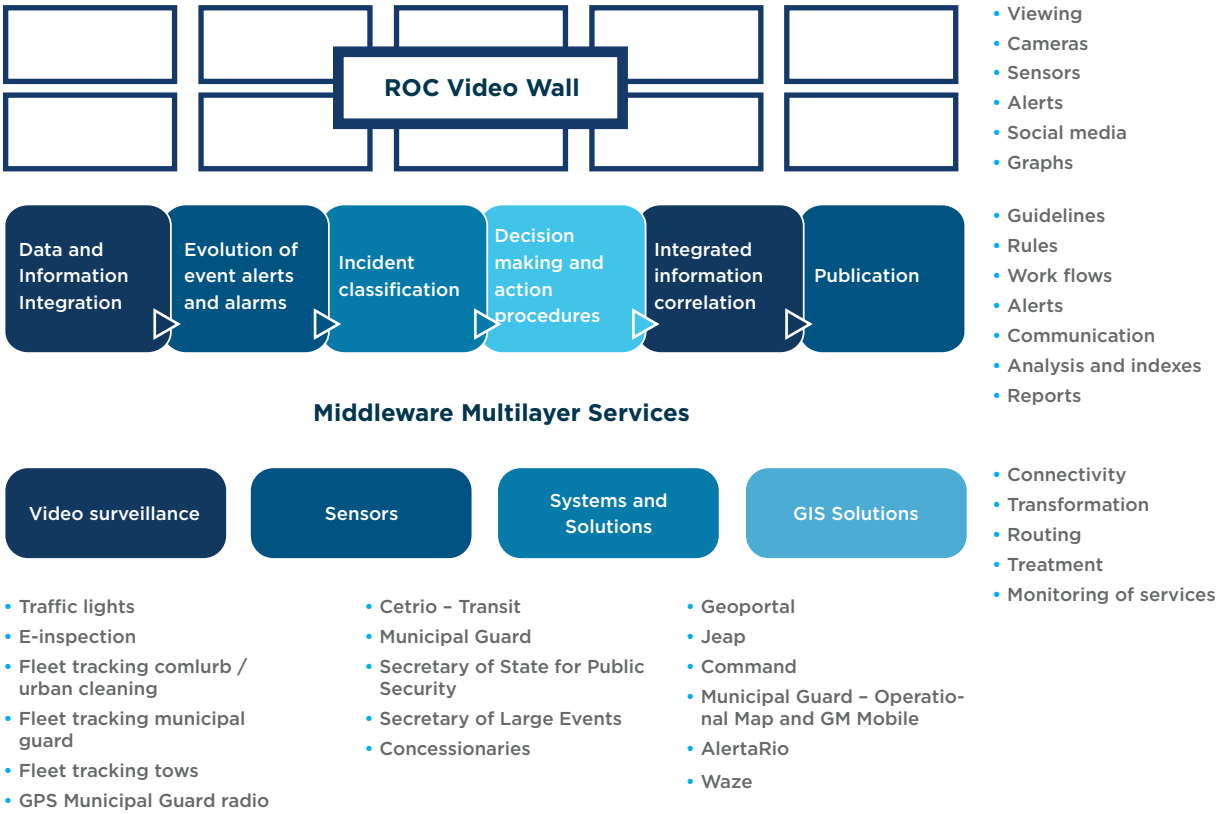
The purpose of adopting a service-oriented architecture is to achieve greater integration among the various systems and data from governments and partners.

> The system architecture allows the management of the local government's assets and shared assets in real time, increasing the analytical power of the Operations Center. In addition, it enables more flexible handling of events, alerts, and notifications.

However, some difficulties related to the complexities found in legacy systems environments still need to be overcome. The consolidation and development of the model adopted by COR are included in the Strategic Plan of the local government (2013-2016 PCRJ).

Geoportal Platform

GeoPortal has a configurable interface that allows authenticated users to observe the information matrix in the most useful, convenient,



Google Earth 250 layers, including the following topics:

- Education
- Health
- Public order
- Municipal Guard
- Risk areas
- Rio Águas
- Comlurb
- Traffic
- Transportation
- Street Lighting
- Works
- Event planning
- Cameras
- Sensors
- Traffic lights
- Utilities

and actionable manner.

All of the local government's assets are geo-referenced, such as sensors, cameras, variable message signs (VMS), traffic lights, cars, radios, smartphones, and administrative units such as schools, kindergartens, hospitals, family clinics, and others.

250 Thematic Layers Available for Consultation

The platform allows geo-referenced correlation between information clearly and situationally. It also allows the monitoring and management of all types of assets, simultaneously and in real time.

Operators and managers can monitor and manage information through a single view: they can view live video, alarms, incidents, or any other information in real time.

The execution of controls of legacy system sensors from the platform control panel allows for greater integration and prevents the operator from having to use multiple systems in more than one working control panel.

Understanding the Benefits for Operators and Managers

One of the platform's main features is to give operators a view and an awareness of the situation and the available resources. For managers, it allows them to be aware of the situation, promoting quick decision-making and more efficient management.

See the main features of GeoPortal:

Features

Traffic jam monitoring	Interactive chart that lists and locates the main traffic jams in the city
Video surveillance support	Tools set (Alerts, integrated PTZ Control and Mosaic of Cameras) that enhances the video surveillance
Traffic spot	Heat map spot that facilitates identification of areas with major complaints about traffic in the city
Digital traffic	Set of tools used to check weather, incidents, cameras, and the fleet on registered routes
Waze gallery	Allows simultaneous viewing of all photos attached to the incidents recorded by Waze community
Datamining	Enables analysis of only the data in the selected geographic area
Impact detection	List of assets resulting from special intersection between two data layers
Timeline	Shows a schematic diagram of the events in progress and finished events, with a feature to advance and delay the time window.
Planning	List of layers in which operations plans are stored, allowing these layers to superimpose data received in real time.
Dashboard	General bar and pie chart that fits the data integrated into geoportal for quick reference.

Traffic jam monitoring

Video surveillance support

Traffic spot

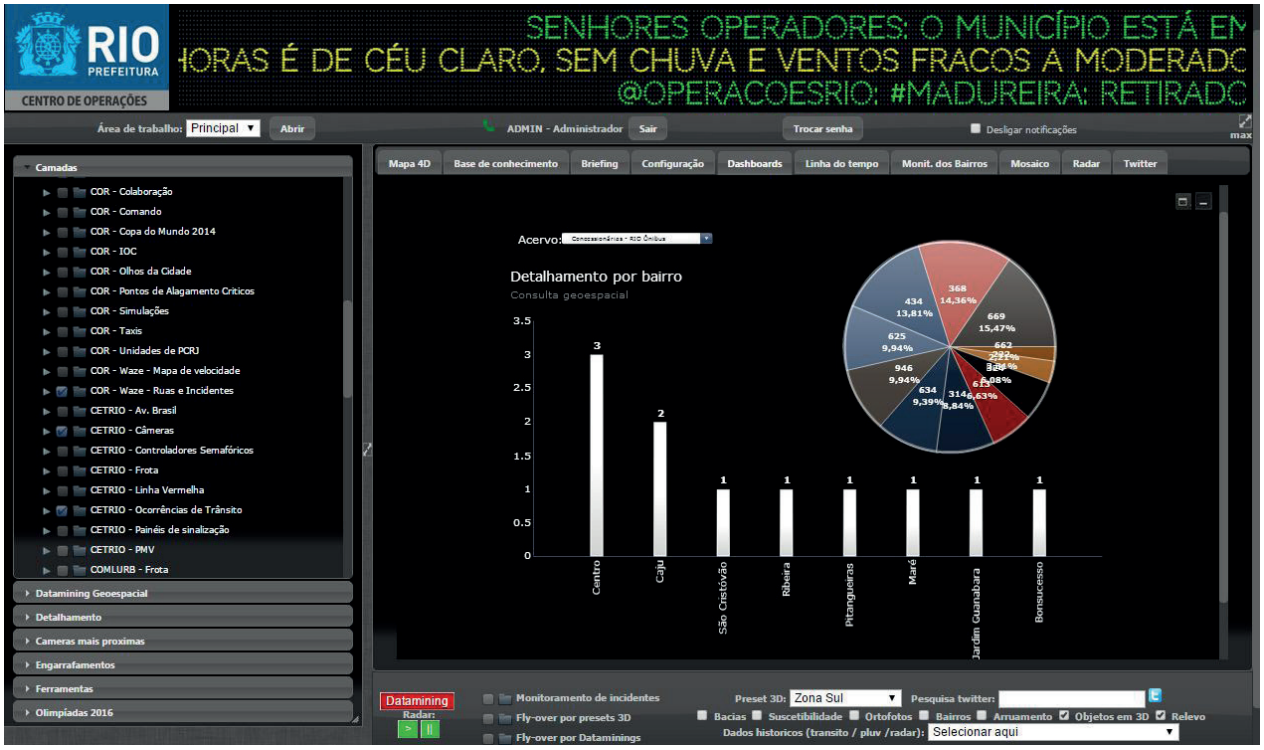
Digital traffic

Waze gallery

Data mining

Impact detection

Timeline



Dashboard

Planning

Systems Integrated to GeoPortal

One of the main challenges for the Rio Operations Center is the continuous collection, treatment, and collaboration of information in real time.

1) Direct communication between systems	Systems, cameras, GPS, alerts, and other sensors
2) Data Input	JEAP
3) Operation	COMANDO

This fundamental task is accomplished through three systems developed by a technology team in the operations center and integrated to the Geoportal platform. They are the following:

1 – Service Bus: Direct Communication Between Systems

This includes the collection, treatment, and integration of information from various sources and different formats in real time, for example: information from legacy systems, cameras, GPS, sensors, and alerts.

Some integrations already undertaken by GeoPortal by direct communication between systems are: electric power transformers of the city, Waze alerts, real-time location of buses, rain volume meters (gauges), and the position of utility vehicles from different agencies of the local government via GPS.

2 – Data Input by the Operator and/or Agency: JEAP System

The system allows the registration of events and integration with other event systems. JEAP consists of a series of modules that allow different agencies and partners to provide essential information about what is happening in the city.

Some Modules of JEAP System

- Events and Notifications from Utilities

The utilities have an interface that allows them to notify COR of any problems that occur on mapped stations and stretches. It is possible to indicate the problem by changing the status and describe in detail what is happening.

- Traffic Events of CET RIO

Companhia de Engenharia de Tráfego of Rio de Janeiro (CET-Rio) keeps a large number of agents on public roads. Any irregularity in the city's traffic is communicated to the operations center through JEAP.

- Events Calendar

Throughout the year, Rio de Janeiro has events of different complexities. COR works with key information to organize the city properly along with other government agencies. The goal is that the event will cause the least possible impact on Rio's routine. For this purpose, they jointly answer the following questions:

Where will the event take place? When? What is the estimated audience? How long will it last? What resources are needed?

JEAP enables municipal agencies responsible for issuing permits for the production of events to include all necessary information during the evaluation and approval process of the event.

3 – Operations: COMMAND System

The system allows work with the multi-agency model, from the creation of standard procedures to the production of statistics for each service. Registered procedures in COMMAND are designed and reviewed by the agencies involved, to guide the actions for each circumstance.

Among its main features are the following:

- Registration of operating procedures
- Assignment of tasks to agents
- Sharing of information with other agencies and field teams
- Production of statistics to guide resilience policies

COMMAND has the following flow:

Standard operating procedures (SOP) record	Record of events	Monitoring of events	Production of statistics

Integrated work
The task of orchestrating this joint work requires a well-designed baseline, operating procedures, trained agents, and knowledge and control of events occurring throughout the city.

4.13. Infrastructure of Network and Server

The IT assets needed to meet the demands of the operations center are in the data center of IPLANRIO, which provides equipment and services and stores information important to the operation of the city.

The infrastructure available to serve COR includes 29 servers, Internet access, and connectivity of COR to other local, state and federal agencies, utilities, radio and TV stations, and social media, among others.

The Operations Center Infrastructure Technology

COR's building is equipped with 250 workstations, 200 IP phones in wired LAN, three CISCO telepresence equipment, four internal video wall sectors, the largest with 104 46-inch screens and the other with four, six, and eight screens, video conferencing and sound systems, WLAN wireless network, printer pooling, and other IT devices.

The information technology team has 30 professionals who take turns in shifts for 24-hour service. This team consists of local government employees and service providers.

Mission-critical Environment

IplanRio is responsible for data communication and servers infrastructure for the Rio Operations Center. Because the services provided are considered mission-critical, they cannot fail.

WAN Network Topology of COR

The drawing below shows the physical layout of the data network, with IT assets and interconnections with local, state, and federal agencies, water, electricity utilities, and public transportation, among others.

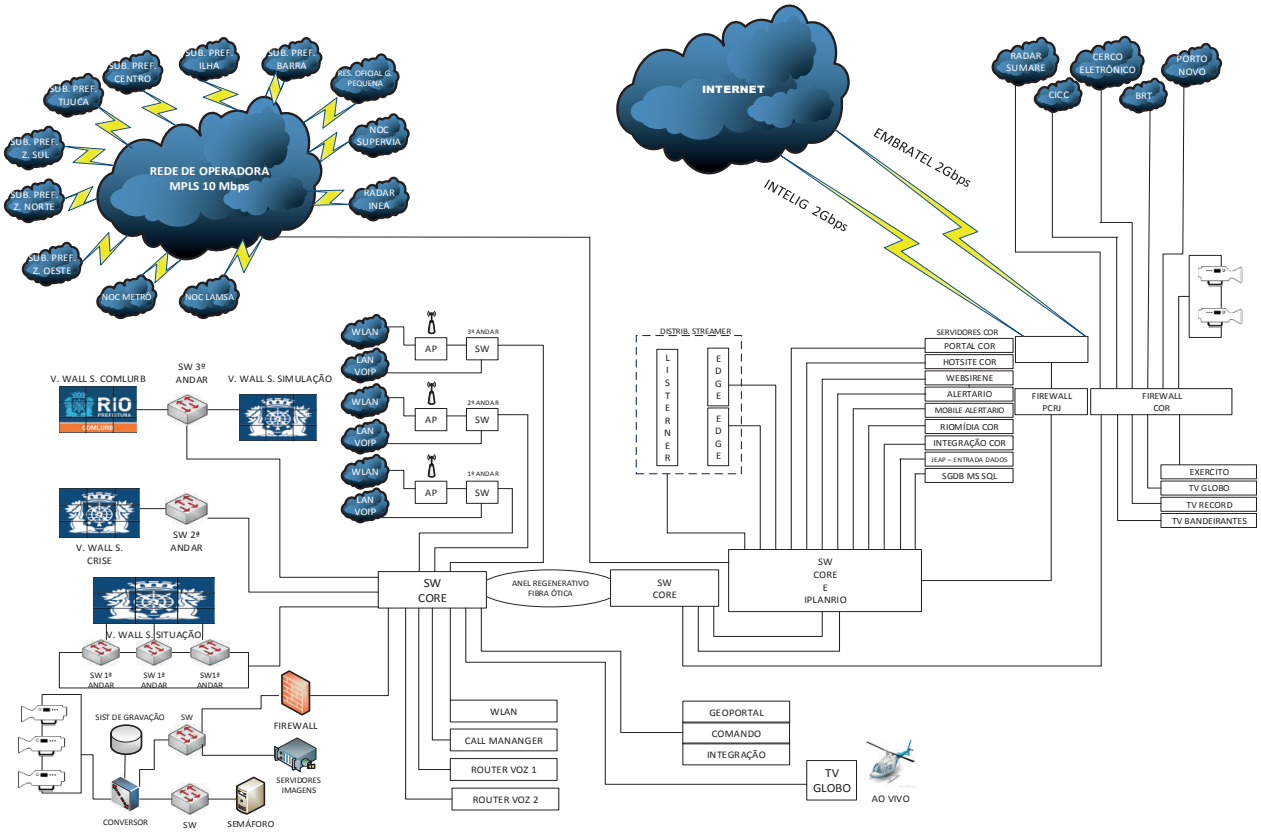
The bottom-left drawing illustrates that there are two main networks of external cameras connected via fiber optics, reaching COR and connected to management systems of images, in this case UBICUS system of INEO. Also on the left, there are the four integrated video wall systems through the internal network (LAN) and

LAN infrastructure for connectivity of internal workstations and IP telephony, both wired and wireless networks (Wi-Fi) to staff and visitors.

The bottom right shows the connectivity of COR to the data center through a fiber regenerative ring.

The top right demonstrates the second network of cameras, connected wirelessly, to DIGIFORT image management servers installed in the data center of IplanRio. Also on the right side of the drawing, there are networks and external websites of agencies and companies that send and receive information from COR, for situation management activities and events in the city.

On the top right of the drawing, there are also the three major WAN connectivity networks, such as commercial network of telecommunications operators, Internet and network wired by the local government, obtained through the agreements of IplanRio with COMEP Network, and TELEBRAS, among others.



Local Government Technology Infrastructure

The administration of information technology resources of the local government is the responsibility of IplanRio — a municipal computer company of Rio de Janeiro — which is bound to the Municipal Department of Administration — SMA .

The company hosts 285 websites, manages 32,000 e-mail accounts, and the Web Portal PCRJ is accessed 48,000 times a day.

Corporate Data Network

The network consists of commercial links from operators and a metropolitan optical backbone of approximately 480 Km that currently connects 51 administrative units of the local government.

Infrastructure of the Data Center of IplanRio

The data center is equipped with a backup site that protects against all types of natural, artificial, and intentional aggression, such as fire, sabotage, explosion, gas, firearms. The backup site of IPLANRIO is certified by international agencies.

The available infrastructure resources are: 358 TB of storage, 300 virtual servers, 204 physical servers, and 280 network links connected to the backbone of the local government.

Service Desk and Partnerships

The service has a call registration system, IPLANFACIL, which allows control and monitoring of technical support requests, management of the demands, and service time. There are 80 employees in the service desk with four decentralized service bases: North Zone, South Zone, West Zone and Center. The number of cases is approximately 5,000 records per month.

In the period 2009-2012, more than 80 new systems and applications were delivered in partnership with ten local government agencies: Municipal Department of the President's Chief of Staff—CVL, Office of the Attorney General of the Municipality—PGM, Municipal Department of Administration—SM, Municipal Department of Social Development—SMDS, Municipal Department of Transport—SMTR, Municipal Department of Education—SME, Municipal Department of Sports and Leisure—SMEL, Municipal Department of Public Order—SEOP, Municipal Department of Health—SMS, Municipal Department of Conservation—SECONSERVA .

The performance of IplanRio in the local government also includes the strategic planning, information architecture, design, implementation and operation of ICT solutions, storage of information of PCRJ (trustee), technical user support, and corporate contracting of technology solutions.

5. Field Systems

Rio de Janeiro has been preparing to quickly address the urban issues that affect the quality of life of its residents and those traveling through the city.

Accordingly, COR was designed to be the focal point of the local government's management capacity as it dominates the new technologies to coordinate the city in a unified way. It receives information from different systems and provides the data to enable the agencies to interpret them and thus act efficiently, quickly and safely.

Currently, COR receives data from more than 15,000 sensors in the city to support instructional, guidance, control, and monitoring activities.

The following table shows some of the assets being monitored:

5.1. Subsystems and Features

The city's monitoring services are performed based on the data received from the field subsystems, which are shared with the control room of COR.

Some subsystems are detailed in Annex A of this document and are classified as follows:

Video Surveillance System

- Urban monitoring
- Traffic monitoring
- Automatic detection of incidents

Traffic Signal Control System

Variable Message System

- Mobile PMV
- Fixed PMV

Weather Control System

- Weather radar
- Rainfall stations
- Fluviometric stations
- Stations with audible alerts (sirens)

Urban monitoring

- **652** cameras of City Hall of Rio de Janeiro, with 52 automatic incident detection cameras
- **350** cameras of the Public Security Department
- **100** cameras of Utilities
- **72** cameras of Porto Novo – PPP
- **50** cameras of private companies

Urban mobility

- **2,570** intersections/signalized pedestrian crossings
- **637** equipment with OCR system for reading and automatic recognition of license plates
- **25** fixed variable message signs
- **18** mobile message signs
- **70** digital clocks with time shifts in the city's main roads

Citizen safety

- **2,100 Municipal Guard smartphones**
- **770 portable radios, 269 mobile radios, and 75 fixed radios**

Natural disasters

- **1** weather radar with operating range of 250 km
- **164** rainfall stations that generate data automatically every 15 minutes, with 83 installed in high-risk communities
- **26** gauged stations
- **164** audible alert stations with sirens, with 103 installed in high-risk communities. All mapped communities have trained representatives.
- **200** points of support to high-risk communities

Fleet monitoring

- **300** Municipal Guard cars
- **45** trailers
- **500** car Comlurb
- **8,000** municipal buses

6. Lessons Learned

High Performance Management

Focus, discipline, and pragmatism is the management model adopted by Rio de Janeiro in conducting the government strategic plan that has as one of its main goals the construction and realization of the future view of the city.

The initial proposal aimed mainly at initiatives such as: formation of a leadership team, financial restructuring, creation of a solutions office, approach with the private sector, transparency of actions, and a long-term plan with clear goals, specific and validated annually with each government area.

Work teams have been designated to monitor and support the delivery of strategic projects and to detail the work plans and agreements of results based on merit and monitoring of important indexes, which evaluate and award servers based on results.

Mayor Eduardo Paes is always present, demanding the results agreed with the government areas, which helps to spread among departments and other managers a culture of continued attention to the goals and initiatives to be met. Undoubtedly, this experience deserves to be shared with other cities, especially in a country where the government still has many challenges to overcome.[9]

How to Put an Operations Center into Action

The creation of COR was only possible because of the strong support and understanding of the executive branch that a technological, integrated, and shared environment would contribute to the development of the city and improve the population's quality of life. The operations center, therefore, must be located in the organizational structure of the local government with the mayor's office, with the authority to support planning and governance.

It is essential to create an information survey team, able to equalize the relationship between the actors involved and ensure that everyone understands the project. Moreover, a project team and processes with multidisciplinary vision are

[9] City Council Publication – Local Government of the City of Rio de Janeiro, 2012.

necessary to understand the business area of each agency involved in the operational environment and its processes, ensuring the construction of an integrated view of operations.

The situation team, in turn, must be trained and qualified for the possible situations alerts. For the city's demands to always be met in the shortest possible time, planning and revisions are frequent in the operations center.

The operations center is a mission-critical tool. Therefore, it is important that a plan of business continuity be developed from its inception, so that in case of failures of any nature, in the building's infrastructure or in the information technology field, for example, there is no interruption of activities.

Respect for Partner Institutions

During five years of existence and more than 30 partner agencies, the importance of preserving the data of each institution became apparent, keeping the systemic legacy of integrated agencies. An operations center has—and should have—a single decision-making command under the responsibility of the executive branch. The manager needs to have political skills, operational capacity, leadership spirit, and engagement in the development of people and the environment.

Note that the exchange of information is situational. Therefore, no new database is created, but each agency should be familiar with the work of other partners and how they act in the field. For operational alignment, periodic training and daily briefings are recommended, to share information within the operations center.

Strategic Partnership to Inform the Population

To quickly inform citizens, COR has maintained, since its inception, a close, transparent, and professional relationship with the media. From the journalists' work, which is conducted daily in a pressroom inside COR, the population receives quick, relevant guidelines, with a high degree of accuracy, allowing for more effective action of the city's operations center.

Exclusive Focus on Operation

An operations center should be free of any bureaucratic interference by the public administration. It must be exclusively dedicated to the operation of the city.

On the operational side, and to fulfill all the necessary processes, a User's Manual for COR should be created that lists the internal rules and goals for the use of the center, a list of agencies with their components, the manner of operation and support rooms, and a designation of the coordinator and that person's duties.

This material should also include the teams and governance, situational awareness, command and control features, intelligence support, environment, and collaboration among agencies, scenarios and basic items such as the description of event types, criticality, available technologies, situation management plans, decision making and information processing.

The disclosure of information by the media team requires specialized evaluation. Therefore, a communication plan must be developed to address all forms of communication of the center internally or externally.

Social Participation

The participation of the population in the generation of information is critical to the success of an operations center. Such involvement should

be encouraged with the use of applications and social networks. However, professionals with experience in data analysis must accompany the large volume of information so that one can interpret the moment and transform the data into relevant information for the operation.

Operational Integration and Actionable Intelligence

For the project to succeed in managing the city, the operations center must be, above all, an integrative agency. It also needs to ensure that the number of agencies increases gradually, so that the institution can be admitted and processes integrated.

Throughout its existence, COR has increased the number of partner agencies, integrated with other operations centers, and developed plans together based upon the multi-agency model.

7. Conclusions

The Eyes of Rio: Future Challengesand Plans

Maturity. Now in its fourth year of operation, one of the most modern Latin American operations centers began in 2014 to consolidate several monitoring practices and a growing movement of modernization with which it intends to pursue and expand collaboration among agencies and other operations center, always for the benefit of society.

Its implementation has changed the urban management of Rio de Janeiro. The operation in the multi-agency mode integrates people, systems, agencies, and departments. Today, therefore, it is possible to seek joint solutions with more professionalism and discuss service efficiency, reducing response times. In addition, Rio de Janeiro is able to anticipate situations and minimize inconvenience.

COR is the backbone of this developing smart city. Having more and more information in real time, technology is a major partner in managing the routine of Rio.

COR presented as a differential a team of meteorologists dedicated full time to monitor the weather conditions of the municipality as well as the communication plans for the dissemination of procedures, messages, and alerts to the population.

- Reduction of operating costs
- Prioritizing preventive actions
- Reduction of energy Interventions
- Adoption of integrated service protocols according to the multi-agency model
- Adoption of international operating procedures
- Expansion of analytical capacity in planning and operations
- Improvement in handling failures in operations
- Improvement in post-failure procedures in operations
- Improvement and expansion of integration among agencies, agents, and society
- Use of simulators for more realistic training
- Adoption of new technologies: virtual reality
- Improvement of data and information on corporate governance

However, there are new challenges to be overcome, such as greater sharing of the use of available assets, cyber security, handling of failures, and increased use of virtual reality as a tool for the simulation, operation, and analysis of impacts in the real world.

The table below highlights important issues for the evolution of the model of an operations center. Some of these are already being addressed in different guidelines conducted by COR.

Throughout this integrated work, it is possible to see the local government's investments in technology and innovation to provide higher quality of life to its population.

Currently, there are references, process records, adopted measures, prevention, and a lot of work in taking care of the routine of Rio and preparing the city to host big events with responsibility and credibility.

The 2016 Olympic Games in Rio is perhaps one of the greatest challenges for the city in the near future.

To provide better conditions for the population of Rio, the city is also encouraging digital inclusion initiatives, intrinsic to the social inclusion process, in which the population has participated increasingly and realized the improvements made in the city.

Prevent, monitor, mobilize, communicate, and learn. The local government of Rio de Janeiro continuously improves its planning, prioritizing integrated solutions to a city in motion. And there is more.

ANNEX A Subsystems and Features

1. Video Surveillance System

The main goal of COR's video surveillance system is to observe traffic in the city and promote public order and public safety. Signals from the cameras are directed and concentrated on repeating sites. From such points, they travel through a dedicated link to the COR monitoring center. The whole system is connected in a closed and protected network, guaranteeing the secure exchange of data.

For the operation of the cameras, COR uses two systems: DIGIFORT and UBICUS, which allow the display of images in real time in fixed, sequential, or programmed forms by displaying them simultaneously, according to operational need.

For the sharing of images by various technological resources of COR, such as the web portal, social media, and GeoPortal, images are initially processed by WOWZA tool for adaptation of format and streaming distribution.

Urban Monitoring Cameras

This system is comprised of equipment that is designed for monitoring and recording to generate high-resolution images.

These images converge over a TCP/IP network of the capture point to the monitoring center, ensuring the viewing and recording of the images generated by dome cameras. These are installed at predetermined points based on the need for visualization and control. The system is digital, with a wireless network structure in 4.9 GHz.

Each image capture point is made up of a post, a lightning rod system, a dome camera, a radio transmitter with integrated antenna, and a switchboard.

The camera captures the images. Switchboards provide power to the dome camera and operate as a UPS to power the system, in the event of primary energy source outage. The camera's signal is transmitted via radio in TCP protocol and 4.9 GHz frequency to the repeating site.

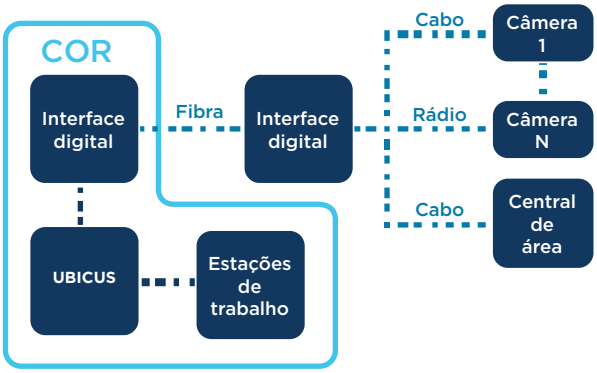
Once received from the remote capture points through the digital broadcasting network, the images are properly stored for 30 days in the video server software.

With a 4CIF resolution at 30 FPS, they are displayed simultaneously on high-resolution monitors at workstations.

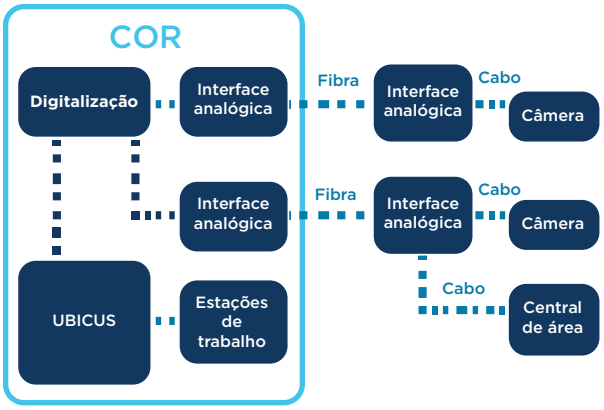
Traffic Monitoring Cameras

The traffic monitoring cameras communicate via fiber optics to COR. In this system, single-mode fibers are used, using analog and digital optical interfaces. There are also cameras that use wireless technology; however, these cameras are concentrated at a point where there is fiber from CET-Rio, so that images can be transmitted to COR.

CCTV system using digital interface



CCTV system using analog interface

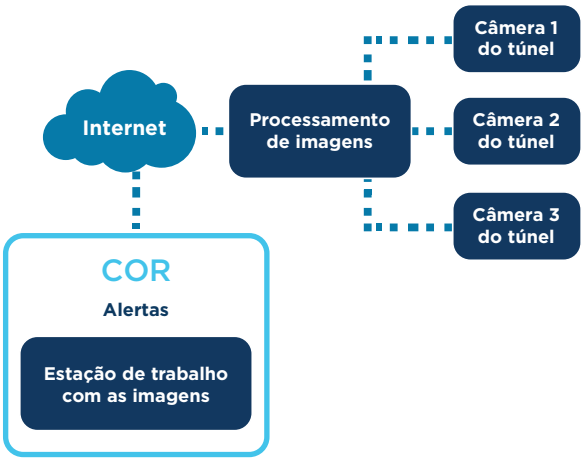


Automatic Incident Detection Cameras

The Automatic Incident Detection (DAI) system was installed in André Rebouças tunnel, an important link between the northern and southern areas of Rio. DAI cameras allow greater flexibility in dealing with events inside the tunnel, reducing traffic jams in the region.

Rebouças tunnel registers an average of 900 incidents per month. Complications in this tunnel, with lanes that head in both directions, affect the flow of traffic and people.

Automatic incident detection system



Note: to ensure the traffic flow, the devices are installed in the two tunnel tubes, every hundred meters, so there are no blind spots on the road.

Whenever there is an event, COR receives alerts and images are captured. The operational part of the system is performed by the local team, headquartered at Rebouças tunnel.

The system allows automatic detection of:

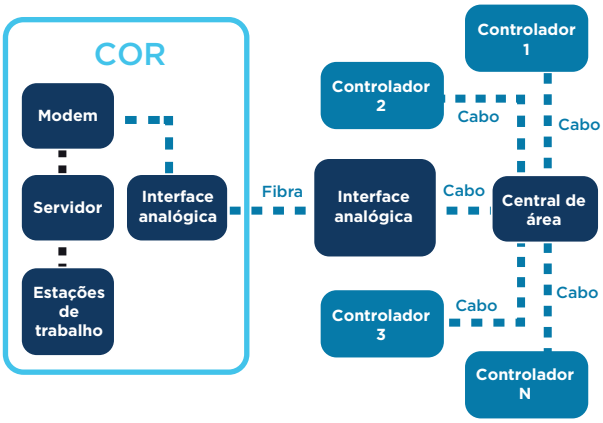
- accidents on the roads
- cars on the shoulder
- traffic jams
- pedestrians or animals on the road
- fire
- load loss
- stalled vehicles or vehicles moving in the opposite direction

2. Traffic Light Control System

In Rio de Janeiro, traffic signals, or lights, are remotely controlled centrally by two traffic control systems. In both, the controllers communicate by cable and wireless.

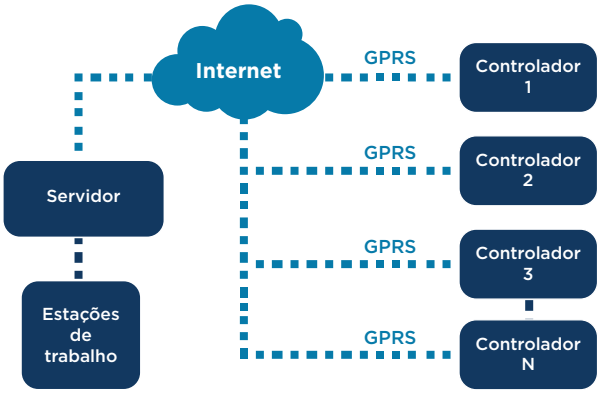
In wired cable communication, physical area centers are used, which are in charge of concentrating traffic signal controllers in a particular region.

Traffic light control system – cabled controllers



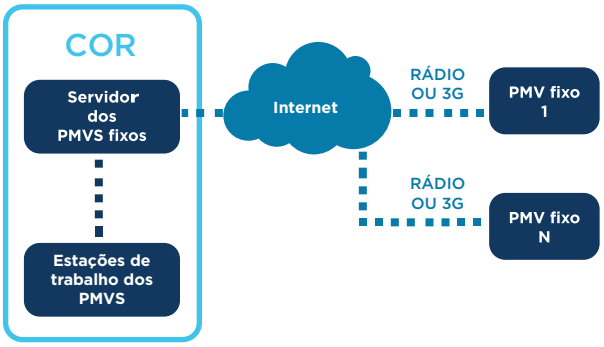
For wireless communication, the traffic signal controllers use GPRS technology. Communication takes place directly point to point so there is no physical area center on the street.

Traffic light control system – wireless controllers



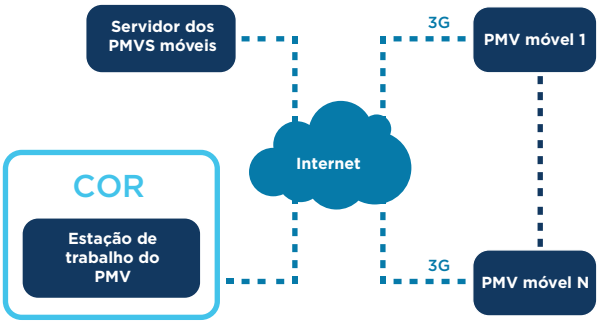
3. Control System of Variable Message Signs

Control System of Fixed Variable Message Signs (VMS)



There are fixed VMS that remotely communicate by radio or 3G in two different systems. All fixed PMVs use amber LEDs and have two different resolutions 120x24 and 30x16.

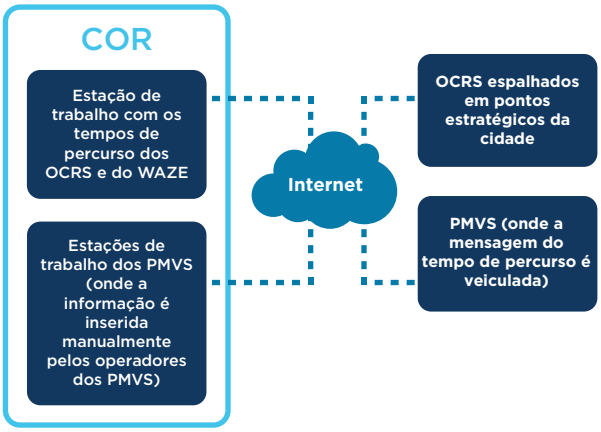
Control System of Mobile Variable Message Signs (VMS)



There are mobile baby PMVs, which communicate remotely by 3G. Such PMVs are very compact and used in places where fixed PMVs might not work. Generally, mobile PMVs are used at scheduled events or in emergency operations. They use amber LEDs, with MD display and 16x24 resolutions.

Travel Time System

Travel times are reported in the fixed variable message signs through the information coming from the readers of optical character of CET-Rio and Waze applications.



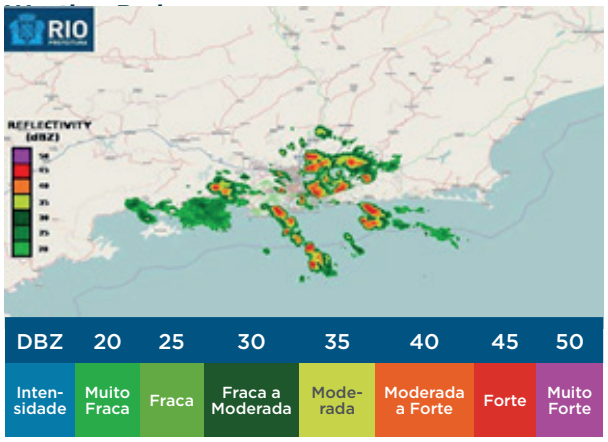
Currently, most of the information on travel times is obtained from the partnership with the Waze application. The travel times are available online for operators of PMVs using an Internet browser. The operators, in turn, inform such

times by manually entering messages in PMVs.

Travel times are also used and made available by GeoPortal for consumption of other services, such as the digital clocks, which, since October 2014, have displayed in 26 points of the city the travel time of the main routes and alternative routes all day.

4. Weather Control System

The Meteorological Control System has radar and a network of 164 rainfall stations spread across all regions of the municipality. These sensors are the responsibility of Geo-Rio Foundation/Rio Alerta, which has a team of engineers, geologists, technicians, and meteorologists allocated in COR. The system monitors weather conditions and maintains the network equipment at all times.



Weather radar images are critical for detecting storms. The local government operates the radar of the municipality. The radar has a 250km range and doppler technology that gets through the clouds by measuring the speed and direction of the phenomena.

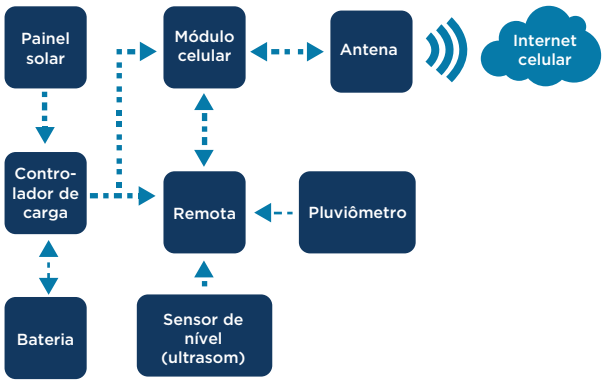
The radar is located in Morro do Sumaré. It provides access to information that originates between the altitudes of 700m and 1800m. Images are updated every two minutes and allow observation of the location, displacement, and intensity of precipitation.

The reflectivity (caption) captured by radar can be related to the intensity of rainfall. The higher the value in dbz, the stronger the rainfall as shown in the table below:

Rainfall Stations

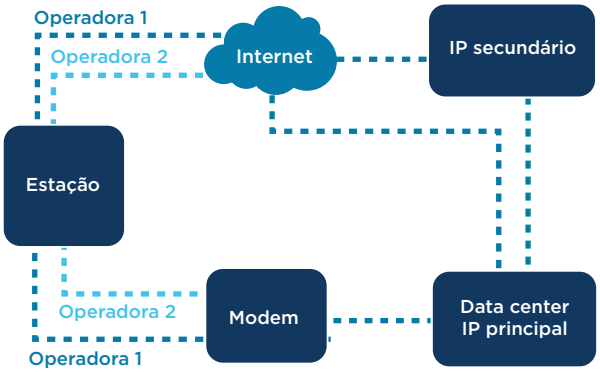
The stations allow 24-hour monitoring and real-time reading. There are 164 rainfall stations, 83 of which are installed in risk areas.

The rainfall stations send data in real time every 15 minutes to the service center and COR. Two of the weather stations—Sao Cristóvão and Guaratiba—are complete and send data on wind, air temperature, humidity, atmospheric pressure, and rainfall.
The following figure shows the general scheme of the rainfall stations.



Fluviometric Stations: Monitoring Rivers and Lakes

These stations allow 24-hour monitoring of Rio's rivers and lakes through the sensor reading. The analyses are possible on site and remotely, in 5 minute intervals. There are 26 sustainable and pinpoint accuracy stations. The fluviometric stations also have rain gauges.



The data are recorded by the sensor, which is submerged in rivers and lakes, and the weighing-scale in the rain gauge station, located above the box where all the station system is.

The modem is in charge of the online transmission of data.

The following figure shows the general layout of the monitoring station:
The monitoring network of Rio-Águas Foundation has two types of stations: the first measures precipitation and level (PN) and the other measures quality and level (QN). This station is used in lakes and in the Rainha River. As per the figures below:

Precipitação e nível (PN)

Qualidade e nível (QN)

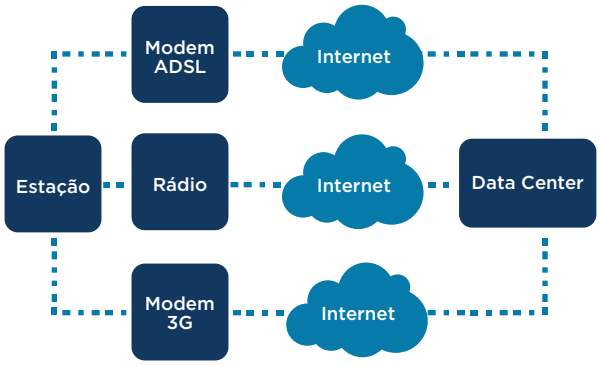
Sound Alerts Stations

The stations allow 24-hour monitoring of rainfall and remote reading in real time. They consist of sound amplifiers and soundboard monitors (sirens) with drivers and rain gauges.

The stations are connected to the reception server installed in the data center of the local government and COR every minute, and send by their identifier operating status information and their current connection IP.

For rain gauge stations, an accumulated rainfall reading is sent every minute concerning the latest quarter of an hour, for example: at 10:07 a.m. the accumulated rainfall reading of 10:00 a.m. is sent. Fifteen attempts are made to send the accumulated rainfall reading, one per minute.

The following figure shows the general scheme of Sound Alerts stations:



ANNEX B
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www.riotransparente.rio.rj.gov.br/

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Social Networks of Rio Operations Center

Facebook
www.pt-br.facebook.com/operacoesrio

Instagram www.instagram.com/operacoesrio/

Twitter
www.twitter.com/operacoesrio

Twitter Alert
www.twitter.com/operacoesrio/alerts
Institutional Video in Portuguese
www.youtube.com/watch?v=KhOcQLaDSz0

Institutional Video in English
www.youtube.com/watch?v=nFwbXNopnTI

Video Waze
www.youtube.com/watch?v=0eLvjdv9Sv8

Cardeman Google Lecture
www.youtube.com/watch?v=Du3GhKEbNL8

Globo Ciência (TV Globo)
www.youtube.com/watch?v=5HHeolZY4Wg

Cities and Solutions Program (GloboNews)
www.youtube.com/watch?v=GiMaZXZI6Fs

Video Google Maps
www.youtube.com/watch?v=DxcQd1GCdn0

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2. Collaborators: Case Study Rio Smart City

Alexandre Cardeman (Technology Director COR); Antonio Carlos Ramos (CVL Advisor); Bruno Lima (COR Systems Analyst); Carlos Roberto Osorio (State Secretary of Transport of Rio de Janeiro); Catia Poyares (CET RIO Coordinator); David Bizzo (COR Systems Analyst); Dario Marques (COR Systems Coordinator); Franklin Dias Coelho (Municipal Secretary for Science and Technology); Gabriela de Oliveira (COR Assistant); Igor Krauss (COR Visual Communication Advisor); Julio Urdangarin (IplanRio Operations Director); Leonardo Maciel (Chief Operating Officer of the Municipal Olympic Company);Luciana Nery (Resiliency Director); Marcio Almeida (COR Operations Deputy Chief); Márcio Barroso (COR Systems Analyst); Marcio Motta (Commander of the Municipal Civil Defense); Marcos Gentil (COR Chief Administrative Officer); Mauricio Maximino (COR Assistant); Pablo Cerdeira (Coordinator of Pensa CVL Group); Paulo Canarim (COR Chief Communications Officer); Paulo Cesar Figueredo (Rio Águas); Paulo Cezar (Rio Luz); Pedro Junqueira (COR Head of Resiliency and Operations); Pedro Martins (COR Operation Planning Coordinator); Pedro Perácio (Head of Digital Services of the Local Government—Office of the Mayor); Ricardo Neiva Dorsi (Geologist—GeoRio); Savio Franco (Former COR Coordinator); Thompson Pacheco (COR Technology Coordinator); Wilson França (Social Communication Coordinator – Department of Science and Technology).

ANNEX C
Service Maturity Level

Service range		Smart city functions and means				
Service domain	Service system	Data collection and monitoring	Control	Information production and data processing	Information reporting for citizens	Exchange of information between services
		Signal controller, image detector, BIS, closed circuit television		Smart city operations center	VMS, VDS, BIS, internet, mobile devices, call center, e-government, Open-API, broadcasting and media	Information Platform (ownership, control and monitoring system)
Transport and urban mobility	Adaptive traffic light system	3	3	3	3	3
	Advanced driving systems	3	3	3	3	3
	Public transport information system	2	2	2	2	2
	Incident management system	3	3	3	3	3
	Automatic oversight system	3	3	2	2	2
Citizen security	Integration with the CICC / SESEG State Government	3	3	3	2	2
Emergencies and civil protection	Disaster management system	4	4	4	4	4
Environment	Aqueduct management system	2	2	2	1	1
	Waste management system	2	2	2	2	2
	Environmental control (noise, air quality, weather)	3	3	3	3	3
Energy efficiency	Energy management system	2	2	2	1	1
Interaction with citizens and means for communication	Communication systems with citizens	4	4	4	4	4

Note: The numbers refer to the different levels of performance according to the following references: 4: Advanced; 3: Moderated; 2: Basic, 1: to be introduced in the future and 0: Absent.

ANNEX D
Interviews and Testimonies

1. Thematic Interviews

RESILIENT RIO
Monitoring, Mobilization, Communication and Learning

Pedro Junqueira – Chief Resilience and Operations Officer of the Rio Operations Center - COR

RIO SMART CITY
Interaction with the Population

Franklin Dias Coelho – Municipal Secretary of Science and Technology - SECT

ACTIONS TO REDUCE DISASTERS IN THE CITY
Prevention

Marcio Motta – Municipal Subsecretary of Civil Defense

LOCAL GOVERNMENT DIGITAL INITIATIVES
Innovation and Technology

Pedro Peracio - Chief Digital Officer of Rio City Hall

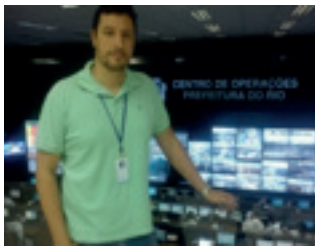
STRATEGIC PARTNERSHIPS
Cooperation among Agencies

Alexandre Cardeman – Chief Technology Officer of the Rio Operations Center - COR

Access the interviews through this QR code
http://www.iadb.org/en/20271.html

2. Testimonies of the Managing Team of COR

Márcio Almeida - Operations Deputy Chief COR



”We have worked continuously for the people’s well-being, prepared ourselves for the worst, but always hoped for the best. We operate mainly for the preservation of human life and to minimize the adverse effects of the daily disruptions that typically occur in large cities. But all this has only been possible because of the strong partnership we have developed with the agencies and public and private companies. This partnership relationship is fundamental for the work of our teams to be successful. “

Paulo Canarim - Head of Communication of COR

“Communication is one of the target activities of COR, being an essential tool for the operation of the city. As there is no situation management—regardless of its complexity—without strong and permanent transfer of information to the population, our job is to be the authoritative source for better decision making by citizens and visitors. For this, we supply the communication channels of Rio Operations Center 24 hours a day, 7 days a week. A team of nine journalists generates content and interact in real time in four social networks, in addition to updating the corporate website. We also operate in direct interface with the media, with some representatives in an exclusive space within COR, which amplifies our message and increases the reach of public service information and service provision. The Press Office also receives information from press events reported by listeners, viewers or readers, who are additional sources of information to operate the Control Room. This change reinforces the ongoing partnership between the government and the population, a major feature of so-called smart cities.”

Luciana Nery - Resilience Director COR

“Resilient Rio brings together measures for dealing with chronic shocks and stresses and plans actions to improve the city’s responsiveness to impacts and disruptions. In January 2015, the book “Resilient Rio: Assessment and Focus Areas” was launched, with an introduction by Eduardo Paes and a preface written by Al Gore, which identifies key challenges of resilience of Rio de Janeiro and sets priorities for action. Four areas were established: climate change, resilient management, resilient behavior, and social and economic resilience. Currently, Resilient Rio develops potential assessment project of water and energy saving in 1,450 schools and kindergartens, in partnership with the World Bank, Accenture, Pensa and SME; promotes the installation of solar panels and other eco-efficiency measures in Rio Operations Center; and develops personal resilience indexes in partnership with WRI/Brazil, among many other ongoing projects related to health and heat islands, as well a citizen awareness. “

Dario Marques - Systems Coordinator of COR

"In 2010 the City of Rio de Janeiro already had dozens of expert systems, however compartmentalized in each Department, in every Utility. Rio Operations Center went further to integrate them by making these important data visible for joint operations, creating a smart situational view and in real time. "

Marcos Gentil - Managing Director COR

"The Board of Directors and Infrastructure is responsible for keeping all of the physical installation and integrity of Rio Operations Center (electrical equipment such as Motor generator and UPS, air-cooled equipment and the whole structure that enables the operational and logical part). We have a management contract with 140 people, totaling more than 35 professions from all areas of activity that are necessary for the perfect functioning of the municipal equipment. An important aspect that broadens the responsibilities in the mission to keep the building running in full is at the heart of our work 24 hours a day, 7 days a week; a building that never shuts so that Rio does not stop. "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