STRATEGIC RESEARCH AGENDA IN FUTURE INTERNET

RECIIF CINTEL

- RECIIF -

Red de Colaboración para la I+D+i en Internet del Futuro en Colombia

Colombian Technology Platform in Future Internet

STRATEGIC RESEARCH AGENDA

Version1.0
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List of Acronyms

ETP	European Technology Platform[1]
FI	Future Internet
IPR	Intellectual Property Rights
LATP	Latin American Technology Platform
M2M	Machine to Machine
MSME	Micro, Small and Medium Enterprises
SC	Steering Council
SENA	National Training Service
SME	Small and Medium Enterprises
SRA	Strategic Research Agenda
SW	Software
RECIIF	Collaborative Network for R&D&I in Future Internet in Colombia *Red de Colaboración para la Investigación en Internet en Futuro en Colombia*
R&D&I	Research, Development and Innovation
TP	Technology Platform
WG	Working Group

[1]**Technology Platform:** A private-publicpartnership of the Industry and the Academia aimed at fostering R&D&I activities, projects and programs in a more rapid and effective way.

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1 Introduction

RECIIF is the collaborative network for R&D&I in Future Internet in Colombia. It is Colombian Community for R&D&I in Future Internet, a community that gathers representatives from the Industry (Large companies and SMEs) and the Academia in order to foster and promote a consistent approach to R&D&I activities in Future Internet in Colombia.

"RECIIF will be for the year 2012 the national meeting place par excellence of the Colombian Industry and Academia, a national reference point for the Government and the international reference point for the promotion and creation of R&D&I projects and activities on Future Internet that contribute to the development of ICT sector and society in the country, allowing Colombian R&D&I efforts to contribute to the goal that all Colombians access the virtual world anytime, anywhere and through any device"

RECIIF focuses in three areas of the Future Internet field, namely:

- Mobile and wireless communications
- Networked & Electronic Media (Digital Contents)
- SW & Services

This document presents the Strategic Research Agenda for Colombia, a proposal of the R&D&I priorities from RECIIF for the areas of mobile and wireless communications, networked & electronic media and Software and associated services.

It is important to highlight that this document is developed under the project FIRST, a support action funded by the European Commission, aimed at implementing cooperation on Future Internet and ICT components between Europe and Latin America.

Chapter 2 describes the methodology used for the generation of the Strategic Research Agenda. Chapter 3 presents a compilation of current trends in ICT worldwide. Chapter 4 presents a first analysis of the strengths, weaknesses, opportunities and threats of Colombian R&D&I, particularly, in the three topics studied by RECIIF and finally, Chapter 5 presents a proposal on the R&D&I priorities in Future Internet for Colombia, which also represents a proposal on potential areas for future cooperation projects between Colombia, Latin America and the European Union in this field.

RECIIF thanks European Technology Platforms NEM, NESSI and Net!Worksand the FIA initiativefor the valuable documentation for the analysis of the R&D priorities in Future Internet. Additionally, RECIIF thanks projects FORESTA, SALA3D and PRO IDEAL-Plus for the interesting discussion opportunities that were of great input for the creation of this Strategic Research Agenda.

2 Methodology for developing the SRA

On January 26th 2011, CINTEL invited the President, Vice-president and Coordinators of the Working Groups of RECIIF to a meeting for preparing the activities of RECIIF during 2011. At this meeting, the Coordination Group evinced the need of developing a work plan of RECIIF's Working Groups for 2011.

The coordinators of RECIIF's NEM group, Alejandro Pérez (CEO of Crearmedia, Industry) and Maria Gaby Boshell (Research Professor and Coordinator of the network USTA-Net, Universidad Santo Tomás, Academia) decided to undertake the proposal of a methodology to be followed by the Working Groups in order to achieve RECIIF's goals. Two discussions about the methodology were held with the coordinators of RECIIF's NEM group and the President and Vice-president of RECIIF.

The methodology and activities performed for the development of the SRA are described below:

The starting point of the methodology is RECIIF's Vision as a community:

> *"RECIIF will be for the year 2012 the national meeting place par excellence of the Colombian Industry and Academia, a national reference point for the Government and the international reference point for the promotion and creation of R&D&I projects on Future Internet that contribute to the development of ICT sector and society in the country, allowing Colombian R&D&I efforts to contribute to the goal that all Colombians access the virtual world anytime, anywhere and through any device"*

Therefore, from its vision, RECIIF holds the following guidelines:

1. Being a meeting place for the Colombian Industry and Academia in the topics addressed by RECIIF,
2. Being a reference point for the promotion and creation of R&D&I projects in Future Internet and,
3. To impact the ICT sector and the Colombian society from this development.

Then, as each group would focus in its respective field and according to the guidelines of RECIIF, it is in the work to achieve goals 1 and 2 where **the possibilities, capacities, difficulties and topics** of being both, a meeting space and to promote R&D&I activities, must be determined in order to achieve result 3.

Therefore, as a first step in the methodology, RECIIF proposed a **SWOT analysis** considering Colombian current situation and institutions, which would help towards the identification of short- and medium-term activities (current date - 3 years). In addition, a search about current trends in ICT was performed. Parallel to this activity a **Delphi**

approach wasfollowed. RECIIF asked a panel of experts about their opinion about the importance, opportunity in time and impact of the priorities identified by the community in Colombia's context. Finally, RECIIF members considered the available information from ETPs for its discussion and analysis, as well as the results of the projects FORESTA, SALA3D and PRO-IDEAL Plus and information from other initiatives funded by the European Commission, the Future Internet Assembly, among others.

2.1 SWOT Analysis

The SWOT analysis is aimed at identifying the strengths, weaknesses, opportunities and threats of Colombian R&D&I for each of the topics addressed by RECIIF in the short- and medium-term. The analysis was performed within three categories: Government, Academia and Industry; three sectors: Mobile and Wireless Communications, Networked & Electronic Media and SW & Services; and the current research topics from the Academia. The following topics were considered: research areas, international publications, topics addressed by the Government, knowledge from RECIIF members about the market, among others.

2.2 Delphi method

CINTEL developed on September 2010 a survey to identify research priorities in the three topics addressed by RECIIF: Mobile and wireless communications, digital content (networked & electronic media), Software and Services. This survey considered R&D&I topics addressed in the Strategic Research Agendas of ETPs (NESSI, NEM and Net!Works, former E-Mobility), the calls and challenges within the Seventh Framework Programme and topics addressed by projects such as Pro-ideal Plus and Sala+. The survey was validated by a group of professionals of CINTEL as well as the coordinators of RECIIF's thematic groups. The survey was answered so far by 14 entities (Large companies, SME and universities) within the members of the Steering Council of RECIIF and the ICT sector (Industry and Academia), namely:

- UNE
- Telefónica – Telecom
- ETB
- Multimedia Services
- Crearmedia
- Ethos
- Avantel
- VIANet ws.
- Universidad de los Andes
- Universidad del Quindío
- Universidad San Buenaventura
- Universidad Santo Tomás – Sede Bogotá
- Universidad Santo Tomás – Sede Bucaramanga
- Universidad Tecnológica de Bolívar

However, in order to identify Colombian R&D&I in Future Internet in a more appropriate manner, to "guarantee" that the outcome of the survey is reliable and taking into account that it is very difficult that the right person at every institution fills out the survey; instead of sending the survey to several Colombian institution, which could risk the reliability of the data, RECIIF considered appropriate to send the survey to a selected group of experts of the ICT industry. To identify the experts, the following requirements were considered.

- At least 10 years of experience (in the Industry **AND** the Academia) in the ICT field, in particular in the topics of Mobile and Wireless Communications, Networked & Electronic Media and SW& Services.
- Experience in Research and ICT Trend Analysis.

The following experts were invited to complete the survey and express objectively their opinion:

- Jorge Castro, Planning Chief, NEC Colombia.
- Gary Cooper, project manager, CINTEL
- Luis Linares, solutions architect, Microsoft
- Eduardo Rojas,Researcher, Universidad del Cauca
- Jaime Rubio, ICT Consultant

The survey sent to the group of experts is available online. See Annex 1 – Survey of priorities.

2.3 Documents for analysis and discussion

For the development of the SRA, RECIIF members had available quality information on ICT trends, the strategic research agendas of the ETPs, reports from the Future Internet Assembly, reports from projects FORESTA, PROIDEAL-PLUS, SALA3D and the European Commission. Below there is a list of documents shared within the RECIIF community:

- **Future Internet**
  - European Commission, *"Future Internet Enterprise Systems (FInES) Position Paper on Orientations for FP8: A European Innovation Partnership for Catalysing the Competitiveness of European Enterprises"*, 2011
  - European Commission DG INFSO, *"Towards a Future Internet: Interrelation between Technological, Social and Economic Trends"*, 2010
  - European Commission, *"Future Internet 2020: Visions of an Industry Expert Group"*, May 2009
  - ETP, *The Cross-ETP Vision Document. Future Internet*, 2009

- **Mobile and Wireless Communications**
  - E-Mobility, *"Strategic Applications Research Agenda (SARA), Staying ahead"* 2010
  - E-Mobility, *"Position Paper on Grand Societal Challenges"*, 15 September 2010
  - Net!Works, *"Position Paper on Transport".* December 2010.
  - Net!Works, "Position Paper on Health", December 2010
  - Net!Works, *"Position Paper on Environment",* December 2010
  - CINTEL, "*Overview of Telecommunications in Colombia (Panorama de las Telecomunicaciones en Colombia)"*, 2009. www.interactic.co

- **Networked & Electronic Media**
  - CINTEL. *"QualitativeStudyon Digital Content (Estudio Cualitativo Contenidos Digitales)"*, 2010. www.interactic.co
  - CINTEL, Sector AnalysisRoundtable: "*Sectoraldynamics, weaknesses and challenges of generatingcontentonvariousplatforms (Dinámica sectorial, debilidades y retos de la generación de Contenidos sobre diferentes plataformas)"*, 2010. www.interactic.co
  - Cosette Castro, *Content Industry in Latin America*, 2008
  - Ministry of National Education,"*Proposal for a Centre for Content"*, Colombia, 2009
  - Ministry of National Education, "National System for Educational Innovation", Colombia, 2010
  - NEM, "Vision 2020: Networked and Electronic Media", September 2009
  - NEM, *"Strategic Research Agenda"*, September 2009
  - Secretaría de Estado de Telecomunicaciones y para la sociedad de la Información, Gobierno de España, "White bookon Digital Contents in Spain", 2008

- **SW & Services**
  - NESSI, "Research Priorities for the next Framework Programme for
  - Research and Technological Development FP8", 2011
  - NESSI, "Smart services for the digital society: The NESSI Vision Statement", 2010
  - NESSI, "SRA Vol 1: Framing the future of the Service Oriented Economy", 2006
  - NESSI, "SRA Vol 2: Strategy to Build NESSI", 2007
  - NESSI, "SRA Vol 3: Research Priorities for FP7", 2011
  - NESSI, "Contributing to the Digital Agenda", 2010

- **Others**
  - Ministry of Information and Communications Technologies, *"Plan Vive Digital"*. February 2011

- CINTEL, *"BIT – Business and Information Technologies – Colombia 2008. ICT Adoption in Colombia: a development opportunity",* 2008. www.interactic.co
- CINTEL, "*WIP - World Internet Project WIP - Colombia 2008, Internet, changing the way of doing things*", 2008.
- Deutsche Telekom, T-Systems: *"Megatrends and Core Beliefs: How ICT enables competitiveness in tomorrow's world.",* 2011
- Argentinean Ministry of Science, Technology and Productive Innovation, *"White book on ICT prospective: Project 2020 (Libro Blanco De La Prospectiva TIC, Proyecto 2020)"*, 2009
- OECD, *"Perspectives of Information Technologies",*2010.

It is important to note that ETP's SRA evolve continuously, allowing for a periodic review on the relevance of R&D priorities.

2.4 Meetings

RECIIF held two meetings to discuss trends, to present the priorities of European technology platforms, review the status of the Colombian Strategic Research Agenda and to discuss about the priorities to be included in this document. These two meetings were held on May 6 and May 13, 2010

In addition to these meetings, the project FIRST and RECIIF held on May 25th and 26th the third national workshop of the project FIRST in Colombia, where in addition to the signature of RECIIF's vision by the Steering Council, RECIIF reviewed the status of the SRA andthe project FIRST presented ICT trends and gave an open space to the ICT industry to identify priorities for discussion of the ICT sector.

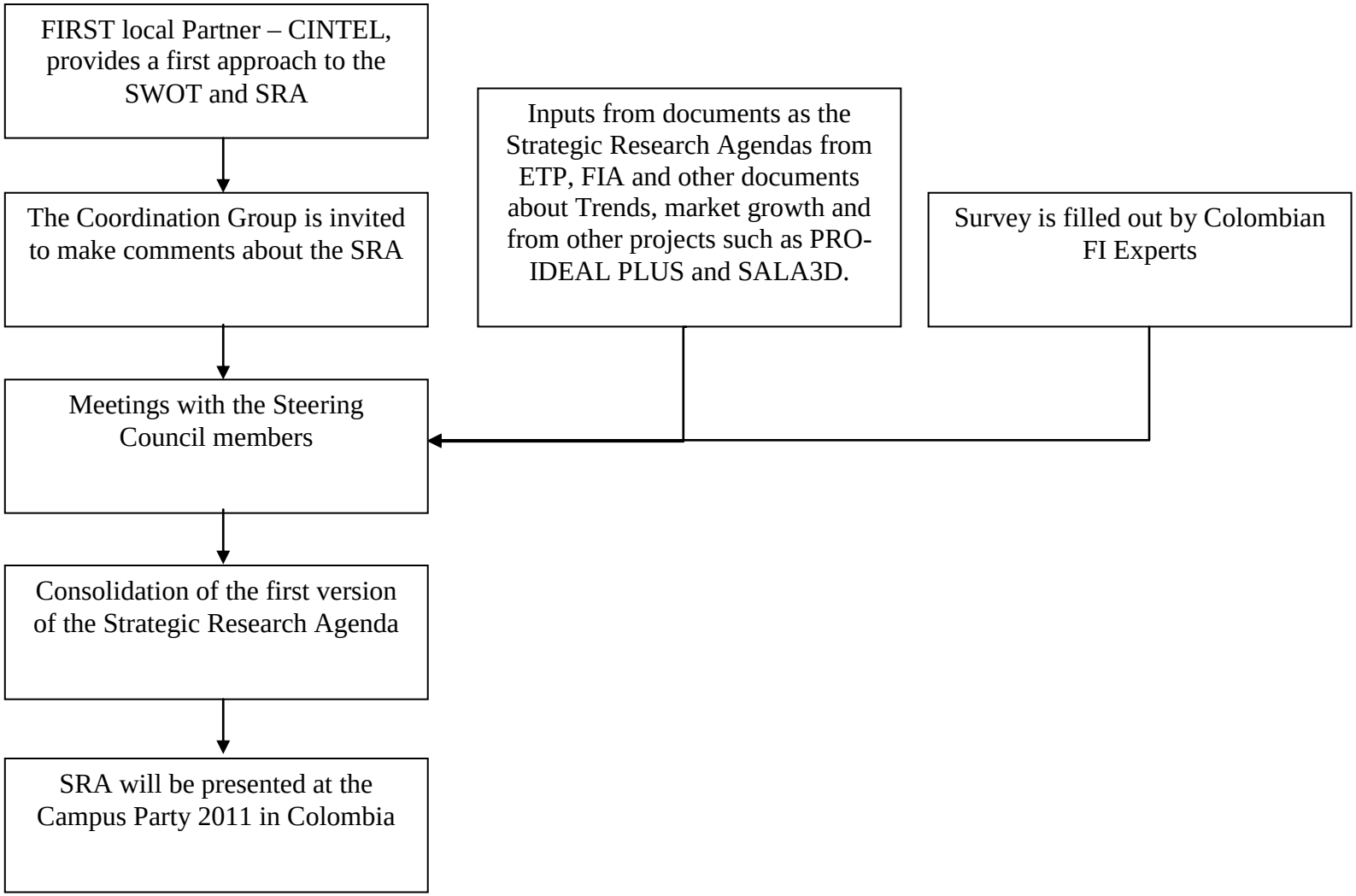
Similarly, CINTEL was invited to participate in the workshop: "ICT research and technological development in Colombia and cooperation with the European Union", organized by the project PROIDEAL-PLUS on June 2, 2011. The event allowed the discussion of R&D priority areas of ICT for Colombia, talent management and training for R&D and infrastructure for R&D.

During the elaboration of the SRA, RECIIF members were invited to express their views and make comments on the SRA.

2.5 Consolidation of the first version of the SRA

The elaboration of the AEI took into account all the above parameters. However, it is important to note that this document represents the first version of the SRA, which may be modified at the request of the members of the RECIIF'sSteering Council before approval at the first General Assembly to be held in the second half of 2011. The following figure summarizes the methodology for the development of the SRA:

Figure 1 Methodology for developing the first version of RECIIF's SRA



2.6 Validity and updating of the SRA

The SRA is an evolving document. The first version of the document will be presented to various stakeholders in the ICT sector and young innovators at the Campus Party 2011. The ICT sector will be invited to express their comments to strengthen the work of the project FIRST and the community RECIIF. The official launch of the SRA will be held during the first General Assembly of the Community RECIIF in the second half of 2011 and will valid until a new version or update is officially released by the community.

Subsequent updates of the SRAwill be made annually and presented to the ICT sector during the General Assemblies of RECIIF or as defined by RECIIF members.

2.7 Dissemination of the SRA to international equivalent communities

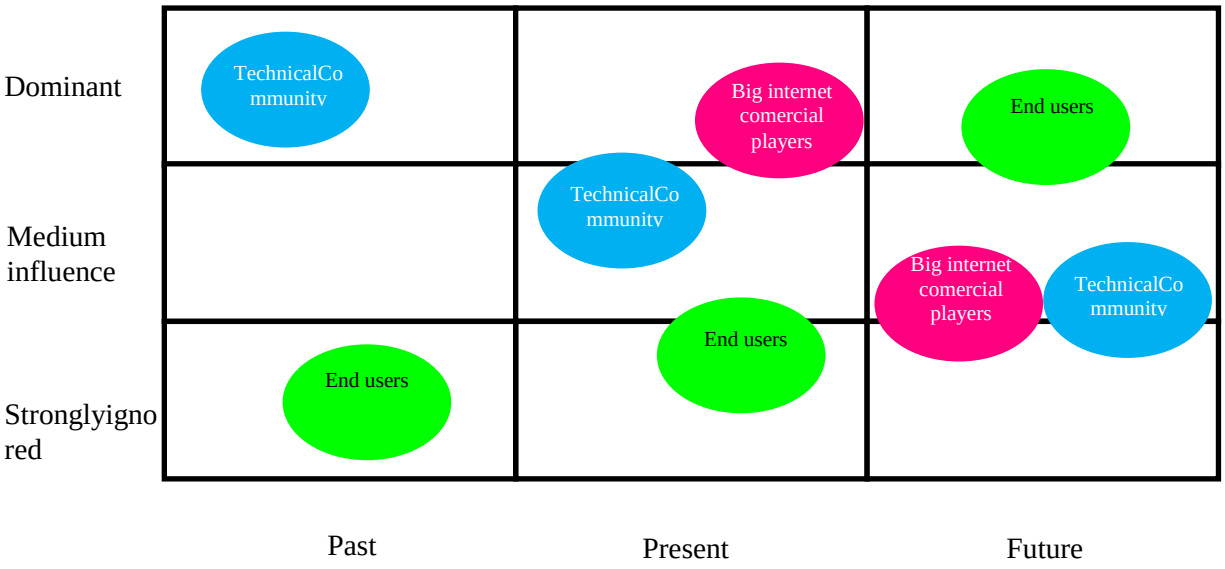
RECIIF, within its principles, works towards the internationalization of Colombian Research, Technological development and Innovation. The network is aimed at establishing stronger bounds for cooperation with equivalent Latin American, European and international communities. For this reason, RECIIF will provide its SRA to communities as BRAFIP (Brazil), MACHI (Chile), MTP (Mexico) and PLATA (Argentina), consolidated under the projectFIRST; the European communities NEM, NESSI and Net!Works and initiatives as FIRE (Future Internet Research and Experimentation), FIA (Future Internet Assembly) and other international initiatives with the aim of identifying common areas for potential cooperation, to establish a constant dialogue to strengthen R&D collaboration with Colombia and to constantly validate the priorities identified in the SRA according to national and international technological advances.

3 Future Internet

Internet has connected about 1,966,514,816 users worldwide[2] until 2010, users who share knowledge, create opportunities and build an Information Society. Internet has changed, is changing and will continue changing the way we do things, how we interact with the world, the way we do business, build communities, access to information, purchase and sell products and services, educate, entertain...The end-user becomes increasingly a more important player in the network and will influence what Internet should be in a greater extent than the technical community and commercial Internet players.

Internet has today some limitations: there are security flaws, not all people have access to it, and not all systems are interoperable...Limitations that have emerged due to the fact that Internet"was never designed to be used as is done today"[3] and that the world demands constant change due to continuous innovation in the ICT sector. Convergence, globalization and competition have become the pillars that drive the current information society.

Figure 2 - Who will influence the evolution of Internet



Source: SCF Associates Ltd. Adapted by CINTEL

In December 2010, the project SMART, a support action funded by the Seventh Framework Programme of the European Commission presented to the Directory of Information Society and Media of that Institution the results of a study performed by the

[2] Internet World Stats: Usage and population statistics:http://www.internetworldstats.com/stats.htm
[3]European Commission, "Future Internet 2020: Visions of an Industry Expert Group", May 2009

Oxford Internet Institute to investigate the interrelation between technological, social and economic trends towards a Future Internet, to explore the needs of the user and to highlight the principles that should govern the development of the Internet of the future. According to the study (Oxford Internet Institute, 2010), the Internet of the future should be:

1. **Accessible**by all and**available** at all times.

2. **Diverse** and **inclusive** to considerthe cultural, educational and technical differences of the people as well as their interests, preferences and needs.

3. **Scalable** and **sustainable.**

4. **Open** and **shareable.**

5. **Green** and **affordable.**

6. **Reliable** and **resilient.**

7. **Safe** and **secure.**

8. **Trustworthy** and **private.**

9. **Appealing** and **usable.**

10. **Customizable** and **adaptable.**

Each of these principles is in line with specific characteristics that will differentiate the Future Internet and that will define the requirements of the network based on the needs of the user, the context, the interaction between the user and the network, the infrastructure and the contents. The design of the Future Internet will be for everybody according to their needs. The content should be highly comprehensive and intuitive. The user interfaceshould be easy-to-use, adaptable, appealing and flexible to respond to the user requirements. Networks should provide an immediate response and support large amounts of information flow. Network will be ubiquitous, mobile, low-cost and available at any time. There should also be greater storage capacity. Internet should support open platforms, be compatible with earlier versions, must be resistant to attacks and be protected from abuse. It should protect the privacy of users.

These and many other factors will be the requirements of the Future Internet, and R&D&I is the mechanism to meet these requirements through technological progress.

3.1 Trends

At the beginning of the year, different international organizations place their bets on technologies that will lead the market in the coming years. The following is a compilation of global trends in ICT for the next years proposed by leading entities in the ICT sector:

TeleManagement Forum

The TeleManagement Forum, one of the world's leading organizations to improve business efficiency for service providers for information technology and communications, introduced in 2011 ten (10) main predictions for the year (TM Forum Insights Research, 2011):

1. Crisis to secure margin from fixed and mobile services will be intensified. Providers should focus on improving the user experience to retain customers. Growth strategies are intended to enable large-scale and innovative services for other industries.

2. The usage of cloud services will increase in small and medium enterprises. Large companies will start to invest in private cloud. But not all cases will be successful. Cloud service brokers will come to play an important role.

3. Security concerns will increase due to cyber terrorism, the growing rise of smartphones and the migration of personal information.

4. Machine-machine communications (M2M) will continue to grow. The use and application of smart devices will increase in different areas such as energy, security of home and business. The deployment of IPv6 will be a reality and technologies such as Wi-Fi, ZigBee and DASH7 will be major players. M2M communications will increase the deployment of Wi-Fi and femtocells.

5. Smart utilities will increase. The combination of demand, increased energy costs and funds are driving this sector, where most of the growth comes from smart meters and dynamic pricing experiments. Smart grids will play an important role.

6. Mobile advertising will become a central point. Text, social media integration, search, rich-media, location, video and applications will contribute to this phenomenon.

7. Concern about the crisis of broadband will increase. The demand for video, Internet TV, smartphones grows faster than the deployment of fibre. Wi-Fi and femtocells will support, but fixed broadband will remain thechoice for connectivity of applications that consume high bandwidth. Technologies such as HSPA will continue to be important.

8. Mobile banking will expand in developing markets and virtual currency will accelerate its adoption. Interest in the capacity of near field communications will increase.

9. Social media poses new opportunities and threats. Integration of social networking with VoIP platforms presents a major competition in the way people communicate. Social media will emerge as a tool for telecommunication service providers to monitor the customer experience and market.

10. Data analysis, operation and management will be transformed into critical skills that will improve the user experience, particularly when the information is available in real time or close to it.

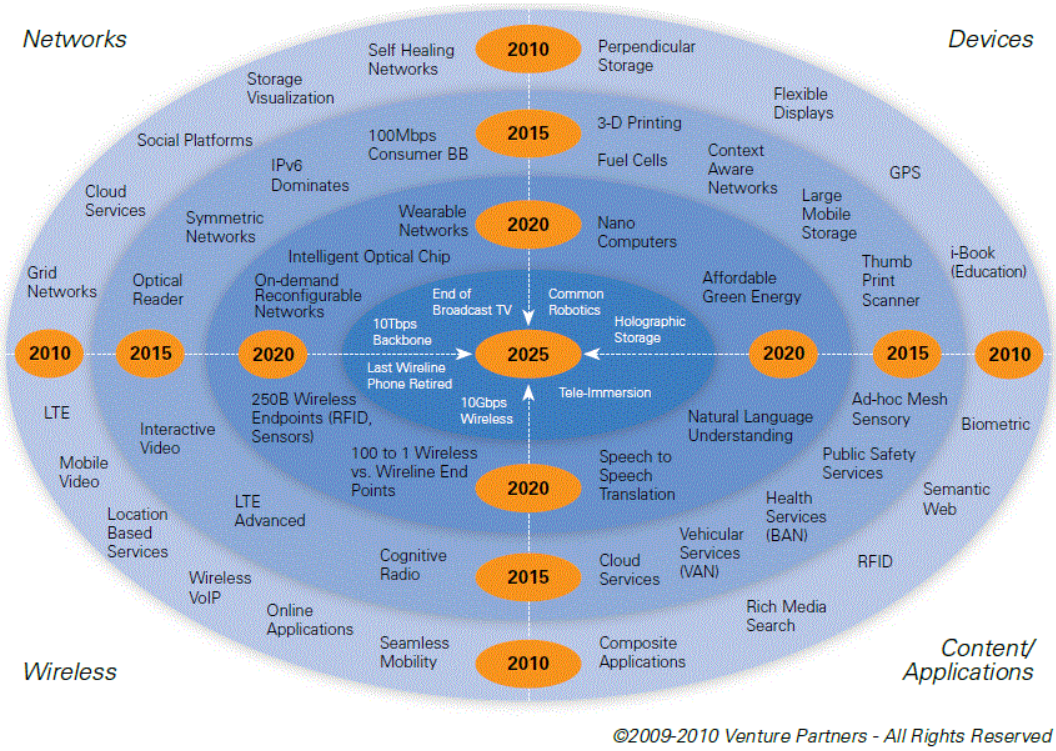
2020 Venture Partners Group

2020 Venture Partners Group, a consulting firm in the area of ICT, (2020 Venture Partners, 2011) presented ten trends for the next fifteen years:

1. IP networks must be ready for sextuple play, including (fixed, mobile, broadband, IPTV, sensory-based services (applications in medicine) and financial services).
2. Security requirements must move from reactive – defensive – 3P model (proactive, predictiveand preventative) onto the offensive.
3. All future IP services will be designed for three screens – mobile, TV, and PC.
4. Wireless Internet access will be big – driving better modes of mobility with Wi-Fi and 4G/5G achieving explosive growth.
5. Sensor networks will proliferate.
6. Video requirements now drive IP network design.
7. Broadband wireless will be common – locality is now important for presence and advertising – not routing.
8. Cloud network capacity and cloud computing will replace static resource provisioning.
9. Privacy becomes consumers' biggest concern.
10. Next gen speech recognition and natural language understanding will redefine the human machine interface.

The group also presented the trends in networks, devices, content and applications for the coming years. Figure 3 illustrates the trends suggested by the group for 2010-2025.

Figure1 - Trends 2010 - 2025



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Source: 2020 Venture Partners. (2011). The top 10 trends for the next 15 years – and why they matter urgently. Perspectives, 2011.

GartnerS.A

Gartner, a firm specializing in IT consulting and research (Gartner, 2011) identified seven issues that IT vendors must consider for the next three years.

1. **Context aware computing**. By 2016, one third of the mobile consumermarketing strategy will be based on the context. Issues like user experience and augmented reality to create context-enriched specific services will be important.

2. **New Realities of IT**: CIOs must seek approval to appoint an innovative group capable of adding value to product development groups. Additionally, they should assume leadership in the development of new rules for risk management and governance, while seeking to optimize costs and resources.

3. **Strategies based on patterns:** IT and business leaders should focus on four elements that enable the development of strategies based on patterns: pattern seeking, operational tempo, performance-driven culture, and transparency.

4. **Business gets social:** During 2011, companies must determine what role they will take to exploit social networks and create new revenue streams.

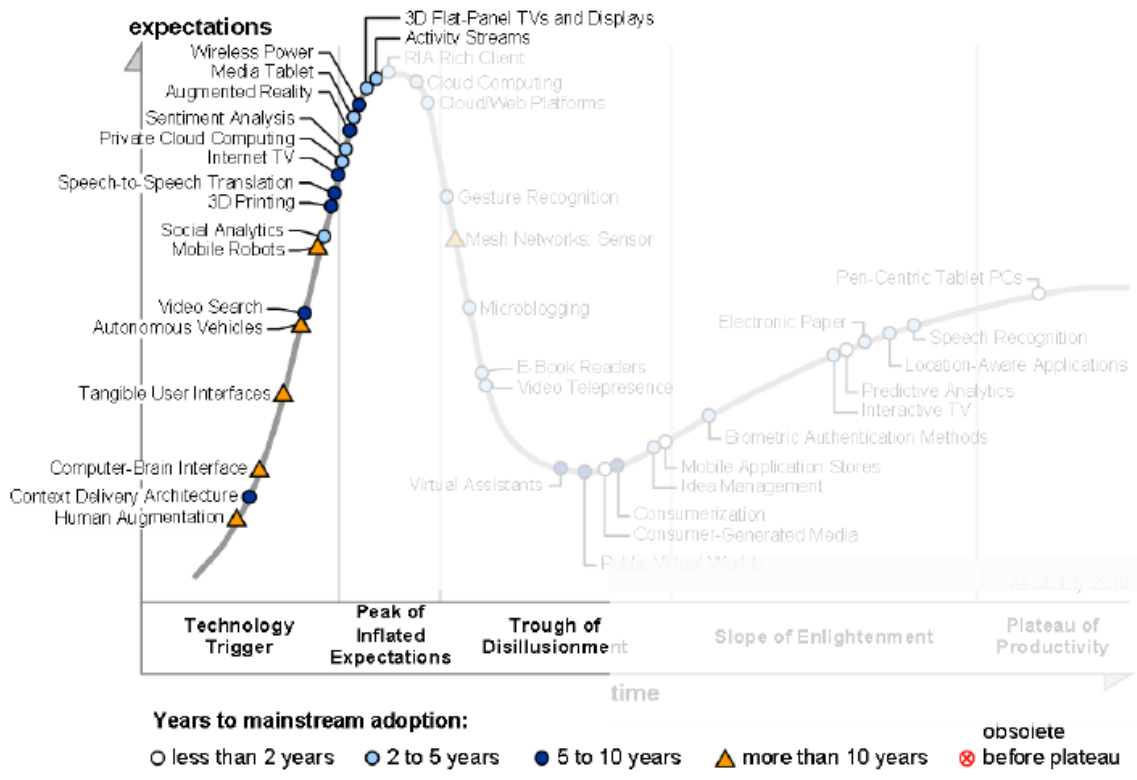
5. **Cloud computing:** Cloud market (comprising public and private services) was $ 58.6 billion at the end of 2009 and could reach $ 148.8 billion for the year 2014 (CAGR of 20.5%).

6. **IT and OT Aligning:** Companies can develop an integrated view of IT standards and operational technology (OT) to establish integrated governance. This way, an automated, integrated, intelligent, transformed real-time enterprise can be designed.

7. **Sustainability:** The Environmental Protection Agency of the United States defines sustainability as "policies and strategies that meet society's present needs without compromising the ability of future generations to meet their own needs." Companies must ensure that the CIO has an interest in developing sustainable strategies.

Similarly, Gartner presented in addition candidates for emerging technologies that would generate future revenues (see Figure 4):

Figure2 - Future $1 Billion Candidates from the Hype Cycle for Emerging Technologies, 2010



Source: Gartner (January 2011)

Source: Gartner (January 2011)

Project SMART

According to the study performed by the Oxford Internet Institute Oxford (Oxford Internet Institute, 2010), the human interface emerges as a key research area for development of the Future Internet. Research should focus on the Internet as a social machine with a multi-disciplinary approach, where the main areas to explore include:

1. **The sociology and psychology of the Internet user:** social interactions; psychology of perception in Internet interactions, optimized interface structures for different social environments (workplace, home, driving, etc.); identity, security and privacy; Cultural, age, gender and class difference in online requirements.

2. **Re-engineering the Internet using social and psychological factors:** control and intelligence on intelligent network structures for reliability and security in private life; relations between data, information, knowledge, semantics and wisdom for interfaces; cultural symbols in the interfaces; media for new user interfaces and novel e-commerce environments.

3. **Combining novel Internet design with socio-economic drivers:**new Internet technology and semantic web;wearable and invisible computing; reliable global applications, labeling (including RFID) and logistics, semantic directories, functional requirements for the Internet of things;massive data intensive compute structures using grids and virtualization and Chaos and complexity models for large networked systems' operations/performance.

4. **Future applications to test and drive development**: real-time environmental monitoring and control; education, healthcare, e-democracy;future social networking structures with high user protection; large trading, retail and financial platforms and payments systems.

5. **Technology to support new modes of Internet use:**Efficient storage, retrieval, transmission of very large digital multimedia objects and streams with semantic methods; Broadband radio systems for access networks; Infrastructure-less mesh radio networks for broadband diversity and resilience and Cloud computing functional and technical requirements.

Finally, the Institute highlighted the impact of high costs of Internet technologies in the future and the role played by the developing countries: "Developing nations will be the largest users and their concerns will become the basis for its engineering. These include a) low cost, b) low-energy, c) ease of access by billions d) thinly-spread infrastructure, e) lower educational resources and f) energy and environmental management using smart grids and metering, etc." (Oxford Internet Institute, 2010)

ProjectPRO-IDEAL PLUS

The project PRO- IDEAL PLUS, asupport action funded by the Seventh Framework Programme of the European Union, aimed at facilitating the active participation of universities, research centres and Latin American companies in ICT R&Dprojects,developed a survey for the ICT sector in Latin America in order to identify priorities in ICT. The top ten priorities of the survey results are presented below:

1. Technology-enhanced learning
2. Future Networks
3. Intelligent Information Management
4. ICT for efficient water resources management
5. Computing Systems
6. ICT for access to cultural resources
7. ICT Systems for Energy Efficiency
8. ICT solutions for governance and policy modelling
9. Smart Energy Grids
10. Patient Guidance Services (PGS), safety and healthcare record

4 Current Status

In February 2011 the Ministry of Information and Communications Technologies (ICT) of Colombia published the document "Plan Vive Digital", Colombian Government policy intended to ensure a technological jump in Colombia over the next four years through the mass usage of Internet and the development of the digital ecosystem in the country. In the document (Ministerio de Tecnologías de la Información y las Comunicaciones, 2011), the Ministry of ICT presented a study of the current situation ofICT in Colombia and Colombia's position in the international context.

In accordance with the study presented by the Ministry, the penetration of PCs and Internet is relatively high in small, medium and large enterprises, while extremely low in the microenterprises. 96% of the 1.6 million existing businesses in Colombia are micro enterprises, of which only 7% have Internet service. There are four major barriers that hinder the mass usage of Internet in Colombia:

1. Citizens and micro enterprises do not see the usefulness of the Internet
2. Low purchasing power of citizens
3. High costs of infrastructure deployment
4. Limited Government resourcesavailable for investingin infrastructure

The lack of usefulness perceived by citizens and entrepreneurs is due to lack of local content with relevant information to their lives or businessesin their ownlanguage. Thus, a major focus of the Plan *Vive Digital* will be the generation of applications and content.

On the other hand, Colombia has a success case: like other countries,cellular penetration is 94%, which has led to greater Internet penetration by the availability of mobile Internet. In addition, according to the document, Colombia has improved its position at a higher rate than the world's average in the globalNetworked Readiness Index (NRI), which "examines how prepared countries are to use ICT effectively on three dimensions: the general business, regulatory and infrastructure environment for ICT"[4].

[4] World Economic Forum, Global Information Technology, http://www.weforum.org/issues/global-information-technology

4.1 SWOT Analysis

This section presents a general preliminary SWOT analysis for discussion of the state ofR&D&Iin ICT in Colombia. This SWOT analysis considers mainly information from Colciencias, National Administrative Department of Science, Technology and Innovation; the Ministry of ICT, as well as inputs from the projects FORESTA, FIRST, SALA3Dand the national Plan *Vive Digital*:

Strengths	Weaknesses
1. Colombia has a comparative advantage in costs, infrastructure and business environment in the region[5]. **Academia** 1. Academia is connected through RENATA, a network that connects the scientific community of 138 institutions. **Government** 1. There is a general regulatory framework for the ICT sector. 2. Colombian Government promotes and strengthens research through incentives and allocates resources for research. 3. Colombian Government promotes the use of ICT as an essential cross-sector tool. 4. COLCIENCIAS was consolidated as the National Administrative Department of Science, Technology and Innovation 5. Colombia stands out for itse-GovernmentStrategy in the region.	**Academia** 1. Publications of the research groups do not correspond with their lines of action in some cases. 2. There are administrative barriers that hinder working together with other entities. 3. There is a low amount of research experience with the Industry. 4. There is a lack of coordination with the needs of the Industry. **Industry** 1. Low investment in R&D&I. 2. Low number of staff in the R&D department, if it exists. 3. Low activity from the private sector because the Government is the driving force of the industry. 4. Low recruitment of trained personnel for R&D in industry. 5. Lack of tools to facilitate the negotiation of R&D&I results with other organizations. **Government** 1. Lack of coordination of actors. 2. There is no interaction between national policy and SMEs. 3. Composition of SMEs is unknown, generating scattered efforts and lack of focus on investments. 4. There is no solid research infrastructure

[5]EIU connectivity ranking 2004; McKinsey IT; EIU; Working Group analysis.Takenfrom: "Desarrollando el Sector de TI Como uno de Clase Mundial", McKinsey, 2008

	5. Lack of funds for R&D. 6. There is not a roadmap for research.
Opportunities	**Threats**
Government 1. Three (3) R&D centres will be created in the sector, promoting research and technology transfer to industry. 2. Government will fund projects using ICT infrastructure in academia and industry and also development and productivity centres, including 5 centres of productive transformation. 3. Colombian Government has identified the country's world-class sectors. 4. Easy access to the Latin American market. 5. New resources to invest in R&D&I. 6. Promotion of innovative teaching and use of ICTs for the formation of work skills. 7. Consolidation of ICT as a technological platform for educational processes. 8. Centre for Research, Development and Innovation on e-Government. 9. The Ministry of Education will lead various training and infrastructure programs for innovation in the ICT sector. 10. Colciencias will support innovative projects and training of professionals: Generation Bicentennial Scholarship Program, funding for ICT projects and a platform for science, technology and innovation.	1. Globalization. 2. Policies do not respond with the same speed to changes in innovation, infrastructure development and technology transfer. 3. Lack of continuity in policies.

4.1.1 Mobile and Wireless Communications

Strengths	Weaknesses
1. Colombia has a comparative advantage in costs, infrastructure and business environment[6].	**1.** Low average of researchers at the Industry.

[6]EIU connectivity ranking 2004; McKinsey IT; EIU; Working Group analysis.Takenfrom: "Desarrollando el Sector de TI Como uno de Clase Mundial", McKinsey, 2008

2. R&D&I in communications have the backing of around 70 academic research groups at national level. 3. The national average for researchers in communications is 7.4 researchers per entity in the Academia.	
Opportunities	**Threats**
1. Government fosters the development of mobile applications. 2. Government will create mechanisms of financial leverage and support for those who want to develop mobile applications in the country. 3. According to the Plan *Vive Digital*, through mobile networks additional services to basic telephony, SMS and data transmission, can be provided, which in turn could be used by a variety of applications.Mobile financial services and weather information services can be provided.	1. Globalization 2. Policies do not respond with the same speed to changes in innovation, infrastructure development and technology transfer. 3. Lack of continuity in policies

4.1.2 Digital Content

Strengths	**Weaknesses**
1. Colombia has a comparative advantage in costs, infrastructure and business environment in the region[7]. 2. R&D&I in digital contents have the backing of around 90 academic research groups at national level. 3. The national average for researchers in digital content is 7.74 researchers per entity in the Academia.	1. Colombia is shifting from the telecommunications sector to the ICT sector. There is not yet in Colombia detailed information about ICT indicators and particularly in the digital content industry. 2. Colombia lacks a widespread defined concept for digital content industry, despite the recent efforts of the Government.
Opportunities	**Threats**
1. Government will promote the development of Digital TV and mobile applications and digital content.	1. Globalization 2. Policies do not respond with the same speed to changes in innovation,

[7]EIU connectivity ranking 2004; McKinsey IT; EIU; Working Group analysis.Takenfrom: "Desarrollando el Sector de TI Como uno de Clase Mundial", McKinsey, 2008

2. Government will promote the digital content industry, emphasizing more strongly in animation and video gaming. 3. Government will create hubs of digital content thus stimulating the market for them. 4. The National Training Service -SENA will promote human talent through training in virtual environments, bilingualism, digital animation and international certification of professionals. 5. Government will promote the generation of the National Policy on Responsible Use of ICT, which aims to prevent production and consumption practices of online content, online interaction among people, display and use of personal information through networked electronic communications that violate the development and security of minors, confidentiality of personal information from citizens and copyright.	infrastructure development and technology transfer. 3. Lack of continuity in policies

4.1.3 Software and Services

Strengths	Weaknesses
1. Colombia has a comparative advantage in costs, infrastructure and business environment. In costs, in particular, it has an advantage relative to Brazil, Chile and Mexico.[8] 2. R&D&I in Software have the backing of around 117 academic research groups at national level. 3. The national average for researchers in Software is 7.19 researchers per entity in the Academia.	1. Local IT industry is not specialized. 2. Profit margins of local IT industry are low. 3. The number of professional and technical graduates in the IT sector has not increased. 4. Strong orientation towards the domestic market.

[8]EIU; Mercer HR Consulting; AT Kearney analysis.Takenfrom: "Desarrollando el Sector de TI Como uno de Clase Mundial", McKinsey, 2008

Opportunities	Threats
1. Government will improve the telecommunications infrastructure and services for the IT industry towards the interior and exterior. 2. Government will promote the development of applications for MSMEs. 3. Government will develop the necessary human resources, together with the Ministry of Education and SENA. 4. Government will create an appropriate regulatory framework with appropriate legal protection for innovation and laws to protect information and privacy.	1. Globalization 2. Policies do not respond with the same speed to changes in innovation, infrastructure development and technology transfer. 3. Lack of continuity in policies.

5 R&D&I Priorities on Future Internet in Colombia

Research, technological development and innovation are bases for the growth and development of a country. The efforts of the Colombian Industry and Academia must be aligned and oriented to meet short, medium and long-term needs of Colombians. For this reason, it is important to identify R&D&I priorities to foster the development and modernization and to improve productivity in the country, which will also allow that Colombia becomes worldwide a major player for R&D&I.

RECIIF's vision promotes the development of smart cities, that is, cities that are self-sufficient and self-sustaining, where information and communication technologies support the work of the citizen, the Governement, the Industry and the Academia and improve the quality of life of all. These cities require an ICT infrastructure that enables ubiquity, access to high-speed Internet, both wired and wireless, deployment of sensors and actuators as well as a range of citizen-oriented services and applications.

This is where the development of the Future Internet and R&D&I in ICT becomes a tool to support the development of smart cities and ofColombians, and additionally provide solutions to the challenges faced by the current cities (in mobility, efficient supply of services, new services and applications, culture, environment, creation of communities). RECIIF has identified a set of R&D&I priorities in mobile and wireless communications, digital content and SW and services necessary to build, in the future, those smart cities, and to respond to the current and future Internet limitations.

5.1 R&D&I priorities in Mobile and Wireless Communications

Mobile and wireless communications are a tool to achieve that all Colombians have access to the information highway. These communications have proved to be tools for economic development, job creation and improving quality of life in different scenarios. RECIIF believes that R&D&I in mobile and wireless communications should act from different perspectives to ensure the proper development of these communications. Thus, it is important to undertake R&D&I in infrastructure, solutions, applications and businesses.

5.1.1 Infrastructure

Telecommunications infrastructure is essential for the development of ICT in Colombia. Given the geographical and economic conditions of the country's telecommunications infrastructure must use multiple technologies, such as optical fibre, satellite links, and wireless communications, among others.

Mobile and wireless communications will be the main support for the deployment of content and services for entertainment, health, transport, security, etc.., in particular in regions where access by other means is difficult. In addition, applications such as mobile Internet, multimedia communications over mobile and wireless networks, virtual and augmented reality, tele-presence, among others, require strong infrastructure capacities, always considering in the design issues as**interoperability**, **cost reduction** and **energy efficiency**.

Mobile and Wireless Broadband

Multimedia applications are increasingly demanding greater bandwidth. To achieve high data rates for future services it will be necessary to developnew technologies that support the efficient delivery of these services, which poses challenges in mobile and wireless technologies.

R&D&I activities could focus on mobile and wireless broadband networks and communications systems as well as fourth generation systems (4G, LTE-Advanced) and subsequent developments (5G), with special attention to the evolution of these systems that support greater speed and capacity. Also, are of interest new developments in radio transmission, design of systems for mobile broadband communications and new methods of signal processing.

Finally, it is also considered R&D&I in high-capacity end-to-end technologies enabling the ubiquitous broadband access; convergence and interoperability of heterogeneous dynamic mobile technologies (interoperability of 2G, 3G, 4G and later); development of robust and secure networks with optimized interconnection to core, metro and edge networks, both

wired and wireless, in a domain of several telecommunication network and services providers.

Spectrum management

According to the Government Plan *Vive Digital*, "there is scarcity of spectrum to meet the current demand, especially in cities." This opens an opportunity to find new ways to manage this resource and to improve their availability for mobile communications and wireless.

This requires developing tools (methods, information systems, databases) for analysing, storing and displaying information on the allocation, licensing and spectrum usage. It also requires new innovative methods to measure the spectrum,its use and to evaluate the results in order to make efficient and transparent use of it.

Research can then be aimed at enabling technologies for flexible use of spectrum for mobile broadband, including approaches such as cognitive networks, and devices for sensing the environment and allocating the spectrum in an opportunistic way, taking into account the regulatory constraints and new technologies that arise. It is also important to create the tools for monitoring and controlling this resource and to support new pricing and licensing models.

Additionally, it is important to facilitate the harmonious use of the spectrum, ensuring no interference, and to obtain a proper balance between capacity and coverage through technical studies and analysis of interference, to optimize economies of scale to ensure a timely availability of equipment and to respond quickly to market needs.

The released frequencies may be used for data transmission and the provision of new services for new users and to respond to the growing use of mobile spectrum, which would support the distribution of high-quality content for new challenges as mobile TV, among others, where data traffic for Internet access, broadband multimedia content and social networking converge.

Mobile and wirelessad hoc networks

R&D in this field will support the expansion of Internet to physical objects, the Internet of things. In this sense, research in this field will be aimed at managing information on real objects through the use of sensor networks and wireless devices in different scenarios. This will require secure communication protocols that adapt to the characteristics of objects.

Research may then focus on wireless object networks, wireless sensor networks, and short-range technologies, which enable the development of home networking, among others.

Fixed Mobile Convergence

In this field, it is important to investigate new protocols and architectures for access and core network that allow the convergence of fixed and mobile communications with a strong integration of different networks using wireless technologies to serve as support for unified seamless communications and deployment of services, which allows simple, efficient and transparent communications. Fixed-mobile convergence should support the convergence of platforms in order to reduce costs.

Research on the integration of radio technologies with fibre optic networks for the consolidation of mobile and wireless networks inintegrated communication systems that provide high-speed wireless access at home, on the street or atwork as well as technologies as Radio over fibre can be considered within this area.

Satellite communications

Given the coverage and monitoring capabilities in wide geographical areas and their potential support to systems such as systems for e-health, satellite communications can facilitate the flow and exchange of medical knowledge in emergency situations where the available information must be accurate and timely, especially in regions where infrastructure is scarce.

Satellite communications research could focus on developing secure, integrated and flexible satellite communications through the development of high-capacity architectures and technologies that enable end-to-end connectivity with lower transmission costs than the current systems. For this, it is necessary to develop capabilities for integrating satellite communications with terrestrial networks to support the Future Internet, fixed and mobile, through joint dynamic reconfiguration ofsatellite-earth protocols.

In addition, it is encouraged to undertake R&D&I in innovative technologies and robust but flexible network architectures that enable deployment of multiple services and a secure and reliable communication, where there is need for high network availability, high efficiency in information processing and interoperability with other systems.

Security

Security of mobile communications is still a matter of vital importance, since without an adequate protection for networks, equipment and information, the confidence of users of these systems could decrease and thus the use of mobile communications. Security threats over the Internet will become increasingly relevant for mobile and wireless communications, given the increasing integration between mobile systems offering data services and Internet services. This research area includes also topic such as reliability, availability and privacy.

Solutions in this field should beend-to-end and across the layers of the OSI model: from infrastructure to applications, so that there is a transparent and secure communication regardless of the different network elements, services, actors and processes involved. It is important to generate new security mechanisms and models of reliability that can be implemented in technical designs and architectures, defining relationships between the actors and responsibilities for security and privacy.

In addition to traditional security mechanisms, it is important to undertake R&D&I activities in defence mechanisms to detect and counter intrusion attempts and modifications, as well as to improve security services against new threats. R&D efforts on modelling the processes necessary for detection and response to certain attacks and malfunctions should be considered. The design of protection for the operation of systems and services should also include resistance to attacks and fault tolerance. Additionally research in offensive security mechanisms could be included.

The role of security, trust, reliability and privacy is essential in all parts of the network architecture in the future. These features must include the design of infrastructure for the delivery of services. The levels of security, trust, reliability and privacy should adapt to the needs in terms of authentication, authorization, confidentiality, integrity and information.

Solutions developed in this field must be context-aware, transparent, scalable, seamless and designed for change;they should evolve and adapt against new and unpredictable threats in order to provide a flexible and efficient environment for users to enjoy their applications, safely and privately, while ensuring the reliability of services offered. However, the new solutions must be easy to understand, use, monitor and control, so that users wishing to use them may do it easily, no matter how robust the solution is. The current security solutions often suffer from poor usability.

5.1.2 Solutions and applications

Mobile applications

According to the study: "Perception, uses and habits of Colombians facing Information and Communication Technologies"[9] conducted by Ipsos-Napoleon Franco and published by the Ministry of Information and Communication Technologies in December 2010, one of the main reasons of Colombians for not having Internet service at home or at the workplace is the perception that the service is not necessary or useful to them. Taking advantage of the high penetration of mobile telephony in Colombia, the GovernmentPlan *Vive Digital*is intended to stimulate the development of mobile applications for national and international market. The plan highlights that, even with the basic functionality of most mobile phones in Colombia, relatively sophisticated services can be supplied.

[9]Ipsos-Napoleón Franco. Percepción, usos y hábitos frente a las Tecnologías dela Información y la Comunicación. Diciembre de 2011.
http://www.vivedigital.gov.co/foros/comentarios/encuesta_percepcion_TIC.pdf

It is important to highlight that social networks are one of the main applications that encourage the use of mobile broadband and as this application there are other applications and services that will strongly encourage the use of Internet in the short, medium and long term.

In this research area, it is important to carry out R&D&I activities in novel and innovative applications for mobile financial services (m-banking), business services (m-commerce, mobile advertising, social networks), entertainment (video, social network, information and dissemination), mobility (intelligent transportation systems), education (m-learning) and health (m-health).

Mobile Health

This field deserves special attention within the applications and solutions that could be offered through mobile and wireless communications. Within this research area, it is important to highlightR&D&I activities in the design of patient monitoring systems and intelligent systems for remote health in order to help patients undergoing treatment at home, to allow the interconnection of the health system while improving healthcare in rural areas and with low population, to deliver remote monitoring and care, to increase the efficiency of diagnostic and treatment, to reduce treatment and management costs and to provide citizens with better quality of life.

It is also important to develop R&D&I activities to facilitate the Internet usage and approach to ICT for people with physical disabilities (e-disability).

Machine-to-machine communications

Machine-to-machine communications (M2M) represent technological solutions and implementations enabling machinesto communicate with each other without any human intervention. The infrastructure of these solutions is supported by sensor networks and actuators to measure and exchange information through the network. M2M solutions are characterized by a high degree of autonomy and a most efficient use of network infrastructure. Currently, M2M communications represent one of the most attractive emerging markets, with applications in logistics, smart metering, and health, among many others, to facilitate the daily lives of citizens. In this field, it is important to undertake R&D&I activities in information and context management models: new models for traffic, data and billing; as well as in the scalability of solutions and interoperability.

5.1.3 Business

Business models

One of the additional challenges in mobile and wireless communications is the creation of innovative business models to meet the specific needs of the millions of users and sectors

that can make use of ICT. In this field, it is important to create value through new services and applications, generating models that support ubiquitous mobility over a single network, which requires global collaboration among key players in the telecommunications sector, in particular, operators of the current mobile networks. R&D&I in this area includes the definition of new business models based on global or regional roaming policies as well as new billing and business models to supply services to different businesses.

5.2 R&D&I priorities in Digital Contents

Internet is evolving to an Internet of people, content and knowledge, where people connect to social networks, share photos, videos, opinions (blogs, micro blogs,...) Colombia is building a content industry with high potential for development, therefore, Internet should provide the necessary tools to facilitate information management, user profiles, user- and context-aware advertising, among others. Internet will provide amore real, vivid and interesting experience to the user; it should be accessible by anyone and should become a support for other economic sectors. Digital content is the basis of a knowledge-based society, it is where knowledge is stored, extracted and used by everyone.

Research will focus on the generation of innovative digital content that enable high-quality interaction in a virtual world allowing an augmented reality experience;on creating new and better search engines, which even allows the identification of objects within images; and the use of adaptive systems and intelligent inference processes to produce coherent recommendations to users, new service developments, among others.

5.2.1 Creation of content and applications

R&D&I can focus on creating new and appealing forms of content and applications, context-aware applications, collaborative media creation, among others. The creation of useful and appealing content poses a need for new and innovative services and infrastructure that support them. However, in the process of content creation is important to consider the value added by content to businesses and users, and understanding how value is created and how it can be protected.

New forms of content

Consumers, who used to be at the end of the content creation, have positioned themselves in recent years as content generators, and now they have become an important part of the value chain of the content industry. R&D&I in this field may focus on how to conduct and promote the adoption of new content and how to adapt technologies for broader purposes. Similarly, R&D&I should take into account the content personalization and adaptation to the user profile and context, in order to generate useful content to the user, however, discussions about privacy should be consider first. Work could focus on making the home user recognize him/herself as a major player in content production.

Similarly, it is important to develop **tools for content creation**that also allow easy manipulation of contents. Additionally, content creation requires the development of automated processes and procedures for the generation of tools that allow flexibility and adaptability to the environment.

Context-aware applications

One of the remaining challenges in this research area is the ability to improve the performance of applications based on the information that characterizes the interaction between the user, the application and the environment. Context-aware applications should provide a richer and easier interaction; therefore, it is important to develop solutions to conceptual models and methods to help the design of context-aware applications and tools to develop these applications. As a result, context-aware applications require interoperable mechanisms. These applications are of great interest in the field of advertising, marketing and communications.

Network-aware applications

These applications are sensitive to network conditions and thus can be adapted to the infrastructure in order to achieve acceptable and predictable performance. These applications allow a better quality of content and latency depending on the capacities of the network. In order to serve more users with different network capacities, applications have to be able to adapt to changes in the networks. This requirement is even more critical for mobile multimedia applications, where the demand for bandwidth is much higher.

Collaborative media creation

Just as trendsfoster convergence of networks, applications, devices, etc., companies face blurry boundaries between fields of action of the organizations, which leads to changing their business models. For this reason, it is increasingly important the need to collaborate to create new experiences and new content, where companies in the digital content industry have the opportunity to work together to extend the reach of their products. This responds to the increasing demand by consumers to interact with the content in different ways according to their own requirements, which represents a change in the way contentwas previously delivered. Similarly, consumers will increasingly contribute to the creative process by developing new content. It is therefore important to study how social networks and media-sharing can have a positive impact on the content industry.

5.2.2 Content presentation

Representation of content

R&D in digital content is composed, besides data, of the components used to represent this data, their interactions and mechanisms to adapt the content through various networks and devices. Under the concept of representation of content are included formats (video, audio, text, data and metadata) that represent the content. In line with this, a new content format should be adaptable to different screens, must be open, should be easy to manage and should integrate, if possible, as much of the semantics of content. The format must allow dynamic adaptation and scalability across different platforms and tools for production and publication of content. R&D&I in this field should aim to design solutions that meet these

format features. Within this area, there is a need for developing new tools for classifying metadata formats.

Additionally, activities should be performed towards a more efficient content handling and compression. The manipulation of multimedia content should be as simple as possible. In addition, definition of standards aimed at achieving interoperability and collaboration of actors in the content industry should be encouraged.

User-environment interaction

Interaction between the user and his/her environment remains an important research topic. In this field it is important to undertake R&D&I aimed at meeting user requirements and enhancing the quality of experience; thus, it is important to develop new methods for measuring quality of experience that can replace the current service quality metrics. It is also encouraged to develop user interfaces that imitate human communication skills (voice, writing, actions, gestures, and expressions) for communication and exchange information and control between users and the media. By giving users the tools to interact with the media in a natural and transparent way, it is sought to overcome the complexities of interacting with systems. This approach should be more fun and appealing to use, encouraging users to take new devices and services and linking the real and virtual worlds.

Context and types of application will determine the modes of interaction to be used. Different users will express their preferences of usage. Terminal equipment can recognize different communication styles in order to offer users more efficient interactions, allowing better adaptation to the context and individual differences (mode preferences, knowledge, among others.)This approach, known in some contexts as multi-modal services, will be more efficient than current interfaces for user-environment interaction and will present a more powerful experience for users. It is encouraged to research on the integration of the different ways in which the user can access content. However, analysis of the result of the benefits of multi-modal services in different environments and studies on how peopleuse multimodal systems are also important.

R&D&I may focus on the interpretation of the information of the environment, the levels of semiotics and semantics, to understand and interpret user inputs and to provide information in the best way. It is also important to mature several technologies such as voice recognition, handwriting recognition, gestures, voice synthesis and haptic technologies that improve user interaction with the environment.

Finally, it is encouraged to perform activities that enhance the collective user experience, where the creation of communities, the analysis of their collective experiences and collective interaction in virtual worlds are relevant.

Virtual, augmented and mixed reality

Special attention to the interaction between the user and the environment focuses on advances in virtual, augmented and mixed reality systems. R&D could focus on improving the simulation of the context in which users can communicate, interact and cooperate to create the illusion of presence in a virtual or remote world as an immersive and integrated experience. Tele-presence services must provide a virtual environment that allows humans control other devices in remote scenarios through remotely operated actuators.

R&D&I should be encouragedin the generation of business applications, distance learning, remote working in risk areas, virtual healthcare and applications for entertainment, including interactive applications like games, in order to provide benefits that cover more people.

Multimodal interaction with remote environments is a challenge in regard to the growing needs for effective remote collaboration. For an efficient remote interactivity, it is important the handling ofmultimodal stimuli and network latency, since the systems require a quick response.

On the other hand, it is important to undertake R&D in augmented and mixed reality. Future research should address architectures and interfaces for smart devices, in particular in the specification of the interfaces between functional entities, so that new functionalities can be automatically learned and integrated with future applications.

5.2.3 Content management

Content search

Content on the Internet will continue to grow. The development of methods for efficient content search and access content delivered in real time will become increasingly important. For this reason, it is necessary to carry out R&D&I activities in architectures and technologies to optimize the search for web content, in the web 3.0 and later., where Web 3.0 refers a new model for Internet-based services, "through the use of Semantic Web, natural language search, data mining, machine learning and artificial intelligence technologies, among others, to facilitate understanding of the information and provide a more intuitive and productive user experience."[10]

Search technologies must evolve to make the best use of available metadata and provide the user with useful information, even when the query is unexpected and possibly poorly formulated. Personalized search techniques should be better fit between user expectations and the search results. In this context, it is important to undertake research activities in multimedia content analysis to generate new tools to enrich the metadata.

[10]ITALTEL, “Context-aware Community Service” Paves the Way Towards Web 3.0.

Content recognition will use the meaning of the content. It is important to advance in the conceptualization and implementation of ontological models to facilitate communication and exchange of information between different systems and entities. "Semantic techniques have recently begun to be applied in multi-agent systems to provide software agents with reasoning capabilities allowing them to exhibit intelligent behaviour"[11].

Quality of contents

The quality of digital content and user experience is of great importance for the proper management of content and their consumption. In order to provide all consumers with a high multimedia service quality, a specific relationship between media content, format, required quality and specifications of the network should be identified and considered for the development of an advanced framework quality assessment of the content. This is especially important when the content is adapted to different formats for viewing on different screens.

Service quality control should be driven by subjective assessment of end users. In practice, this can be achieved by introducing metrics and indicators as well as different evaluation schemes to assess the quality of the content.

Capture of contents

Capture of content and information through different media requires advances in sensors and actuators. It is important to continue to capture content through other means in order to extend the set of parameters (temperature, position, motion, force, etc.) that can be digitally detected and manipulated by consumers. Activities should be encouraged for the automatic capture of metadata and the development of devices that enhance the service experience through the coordination and integration of multiple transducers.

Content adaptation

Content adaptation refers to the ability to tailor the content to the user's current circumstances, which depends on the capabilities of terminal equipment, communication networks, and the physical capacities or disabilities of users. This adaptation should be transparent to users, so it is necessary to know all the technical parameters that influence the display of the content. Additionally, adaptation covers customizing content to user needs.

R&D&I in this field are oriented towards identifying different forms of content adaptation, format transcoding, fusion of different media channels of communication and content management, capable of supporting changes in the context of the user in different scenarios.

[11] NEM Strategic Research agenda

Content integrity

Content integrity can be understood as the property that characterizes contents where information is accessed or modified only by those authorized to do so. This includes measures to ensure the integrity of content ranges from control of the physical environment of networked terminals to the development of rigorous authentication practices.

In line with this, it is important to have tools and distribution channels that provide content developers an affordable, reliable, secure and usable access to create content. It is also important to undertake activities that improve safety, privacy and trust in the management of content.

5.2.4 Support technologies

In addition to the support provided by advances in mobile and wireless communications and in the design of optimized services for the delivery and distribution of content, there are R&D&I priorities on support technologies that will allow content distribution.

Networks and platforms for content delivery and distribution

R&D&I should focus on an intelligent delivery of information and content, so that users can access interactive services of all kinds, regardless of the underlying network infrastructure. Therefore, content delivery should be supported mainly by an intelligent network, a multi-vendor multi-service network that will provide connectivity to service providers with other network providers to offer greater flexibility in supporting new services and to optimize the use of network resources.

It is therefore necessary to undertake R&D&I in the design of open, standardised and scalable architectures, to allow interaction and transparent delivery over networks where multiple operators are involved. Additionally, it is encouraged to performR&D&Iin delivery mechanisms and roaming to provide mobile users with the requested content and services. Similarly, it is important to innovate in mechanisms for collecting and processing information from heterogeneous networks and terminals and in designing new solutions capable of selecting optimal networks taking into account the requirements of the application and user, as well as the provision of an extensive multi-access test network to ensure the interoperability of different network technologies and applications.

In addition, it is encouraged the design of architectures and scalable converged networks and the design of platformsand technologies for the delivery and distribution of content through an open environment that allows customization and high capacity of user participation.

It is also important to promote the use of optical networks and their potential usage for delivering content as well as develop technologies for automatic content adaptation.

Additionally, it is encouraged the optimization of the capacity of existing infrastructure and to provide low-latency for real-time applications for ensuring the quality of service. Research in this area covers fixed and mobile environments, and metropolitan access segment, and a variety of user contexts, inside or outside the home and office.

Finally, it is suggested to perform R&D&I for the development of platforms for audio-visual content based on population studies and monitoring tools, systems and components for compression and web display of content as well as activities to improve the quality of service and experience in IP networks for distribution of multimedia content.

Content-aware networks

In this area, it is suggested to perform R&D&I in the architectural design of the network in their physical connections, interfaces, protocols, and operational aspects in order to maintain a single, flexible and generic network infrastructure that supports the diversity of traffic and the requirements of different services. This type of multi-service content –aware adaptive networks must be scalable to cope with increased traffic at a much lower cost to the user. Particular focus is suggested in order to generate networks with the capacity to organize dynamically to meet the needs of the media, to alert the user of the available services and to provide new services to existing ones. Additionally, R&D&I should consider efficient technical monitoring and support in cooperative architectures.

Advanced interfaces and devices

It is also important to undertake R&D&I to ensure the integration and creation of different devices and specialized peripherals (mobile phones, PDAs, game consoles,...) to new schemes of contents.

5.3 R&D&I priorities in Software and Services

With the introduction of service-oriented architecture (SOA) and Web services, the Software and services sector is taking a big leap forward. Here are a set of R&D&I priorities in the field of SW and associated services.

5.3.1 Software

Software engineering

Software engineering is one of the main lines of investigation of software research groups in Colombia. Additionally, Colombian software companies excel in the market for offering tailored solutions. Advances in this field contribute to improving the usability of services through the development of multifunction and intuitive user interfaces.

Software engineering has to reach new and improved approaches to support new and different services, to improve productivity in software development and increase its performance. R&D&I activities aimed at improving software quality, the generation of frameworks and SW development methodologies, SW testing tools, and innovative service-oriented architecture (SOA next-generation, etc.) are of interest. Similarly it is important the composition and orchestration of software as well as the engineering driven by models and languages and tools to support modelling and new developments.

It is necessary to carry out R&D&I on design patterns, techniques and tools for building efficient software systems and services, and modelling software engineering processes and tools to support maintenance, development and portability of legacy code.

5.3.2 Services

Service Engineering

Although the term "Service Engineering" is not used in Colombia, this term gathers concepts such service design andmodelling and the tools needed for the deployment of services, where, beyond the focus on the software, an integration of the service in the environment is sought. It is not only about running the service but also to consider problems of security, reliability, quality of service and quality of experience, among others, that is, a multi-disciplinary approach that will contribute significantly to shaping the business models and processes of more advanced services. This includes the application of user profiles and user contexts to enable personalization of services and the dynamic composition of a large number of services that depend on context.

It is encouraged to perform R&D&I activities in engineering platforms for the creation and deployment of services, new flexible and open methods and techniques for the design of

services, able to cope with the large business and cycles of technology, in order to understand and optimize the use of long-term services and their benefits.

Additionally, R&D&I can focus on engineering services based in the community, where new concepts and Internet-based tools aredeveloped to support collaborative development ofdistributed services taking into account the principles of open innovation, meaning open innovation as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology."[12]This also requires the development of standardized components, platforms and tools that facilitate the development of open services and frameworks and environments for the provision of community-based services.

Finally, it is encouraged to accomplish R&D&I activities oriented tocomplex and adaptive service engineering, where negotiating Service Level Agreements and service contracts are important. Also it is recommended to undertake activities in the formulation of a coherent life cycle of adaptable service compositions that evolvewith a continuous quality assurance after implementation.

5.3.3 Service support and infrastructure

The development of infrastructure for the deployment of services is of interest to RECIIF. Under this scheme, in addition to models like grid computing and virtualization, cloud computing and the design of novel Internet architectures generate particular attention.

Cloud Computing

Cloud Computing, as a trend and as a model for supporting services, still has challenges for its deployment and progress in Colombia. In particular, R&D&I could focus to solve the challenges on the management of service level agreements in different scenarios, by adopting an integrated end-to-end approach through different layers, including services, network infrastructure, devices and sensors, taking into account not only the quality aspects of service, but also features such as security, privacy and interoperability.

In addition, R&D&I should include interoperability and management of different scenarios and use cases; new standardized approaches for cloud resource management; and integration of energy infrastructure and the use of green technologies. It is also important to identify common components to different cloud topologies in public, private and hybrid scenarios and their application and functionality as standard functional blocks.

Finally, migration of SMEs to the cloud, the economy and economic benefits of the cloud, cloud interoperability, challenges in standardization of architectures and application

[12]Henry Chesbrough, Open Innovation: Researching a New Paradigm (2006)

development are of interest to the ICT sector. Also security concerns of cloud services and licensing schemes of cloud infrastructure of new players.

Novel Internet architectures

R&D&I could include the design of architectures that are resilient, reliable and energy-efficient to support open access and the increasing diversity of user requirements. Networks should support a large number of devices and manage large irregular flows of information. It also must provide high end-to-end connectivity.

5.3.4 Intelligent Information management

Under intelligent information management R&D&I could focus on generating reactive algorithms, infrastructure and methodologies to extend the techniques for handling large volumes of data in real time, to support integrated intelligent systems for decision-making and dynamically recognition of situations. This includes the recognition of complex events and models difficult to detect, aggregation and mediation of opinions or predictions, ensuring the integrity and accuracy of the information.

5.3.5 Interoperability

R&D&I in interoperability can be approached from different levels. A level of knowledge should be seen as the compatibility of skills, competencies and knowledge assets of a company with other external organizations. A semantic and ontological level is based on creating a common understanding by all actors involved in service provisioning. At a system-level, ICT capacities should be considered to enable an organization to operate, make decisions and exchange of information within and outside its borders. Services should be easily integrated and must be able to interact and exchange information through open platforms and standardized interfaces. Services must be accessible on any device.

To ensure a high level of interoperability, compatibility test suites and compliance with open standards should be available. Open standards provide benefits to economic and social development and collaborative innovation. Flexibility, interoperability and even freedom, represent an important step in leading to adoption and mass commercialization of technology.For this reason, it is important to undertake R&D&I in the development of open standards, which may contribute to global interoperability, not only in infrastructure but also in semantic information, business processes and applications based on services.

Finally, aspects as the interfaces between different systems at the level of connectivity, standardised protocols, interoperability to support the dynamic composition of services, business processes interfaces, rules for cooperation between companies and the integration of sensors and new devices should be considered.

5.3.6 Security

Security should be integral to the design of systems, applications, software, hardware and infrastructure. In this field, R&D&I include activities to respond to specific security challenges imposed by the Internet: digital identity management and privacy issues. Services must provide security, privacy and trust.

R&D&I should improve the usability of security, create user-friendly solutions and standardisedand understandable security interfaces. It is also encouraged to undertake research onanalysing the user behaviour and developing tools and methods to increase safety awareness: developing of security management policies based on services and the visualization and analysis of monitoring information. Additionally, new approaches and mechanisms to ensure balance and confidentiality, integrity and availability of information and knowledge should be considered.

Finally, R&D&I should include risk management and mitigation of vulnerabilities in the life cycle of the service, new forms of security control of the whole system and analysis at all levels from network to services, by implementing innovative methodologies, such as proactive protection, detection, automatic analysis and mitigation, which also requires research on obtaining and analysing information from multiple sources and designing security mechanisms and controls for content, knowledge, infrastructure and objects.

5.4 Cross-sector impact of R&D&I on Future Internet

According to the Government Plan *Vive Digital*, as opposed to jobs in traditional sectors like agriculture and manufacturing, ICT jobs are aligned with the new service economies.Each new job in the ICT industry also generates jobs in other sectors of the economy.[13]Hence the importance that R&D&I in Future Internet will be applied and aligned with the needs from other industries such as: agriculture, environment and housing, culture, defence, education, finance and public credit, interior and justice, mines and energy, health and social protection, foreign affairs, transport, in order to achieve a conscious usage of information and communication technologies and a materialization of the results of research and to support to all the sectors of the economy.

[13] Ministry of ICT. Document Vivo del Plan Vive Digital. February 2011

6 Conclusions

Research, technological development and innovation R&D&I are three pillars that enable ICT industry to continue its steady growth and expansion and contribute to building and strengthening an information society. In particular, R&D&I in mobile and wireless communications, digital content and SW & services contribute to shaping the vision of smart cities through solutions that allow access to ICT and their conscious use and adoption by citizens in response to current and future Internet limitations.

Colombia has R&D&I potential in the areas of mobile and wireless communications, digital content and Software and services. However, R&D&I should follow a consistent association approach, where Colombian Academia and Industry, who have long led isolated R&D&Iefforts, participate, discuss, and collaborate to intelligently undertake joint activities to achieve more concrete results.

The strategic research agenda presented in this documentaimed to align the R&D&I priorities of Academia and the Industry in order to avoid multiplicity of efforts and to allow that results from research (basic or applied), technology developments and innovation become applications in the medium- and long-term. RECIIF considers important to undertakea multi-disciplinary research approach complemented by a focus on innovation and market to generatesolutions to the challenges faced by Colombian and global society in the short, medium and long-term.

National and international cooperation is one of the engines that drive generation of new knowledge and open spaces for new opportunities and business. For this reason, Colombia must be present in the international R&D&I arena at all times. Since its creation RECIIF promotes the identification of common areas of cooperation to undertake collaborative R&D projects withits international counterparts, so that Colombian R&D&I potentialbecomes progressively renowned for its quality, active participation and knowledge.

On the other hand, RECIIF recognizes the potential forR&D&Iof each of the regions of Colombia and promotes the strengthening of their capacities to promote the development of each region. Regions must exploit their strengths so that R&D&I is not centralized in capital cities, but to allow that each region contributes with the knowledge of its context in the construction of the current and future society.

Finally, RECIIF invites the ICT sector to undertake consistent R&D&I activities, to complement efforts and work for the development of ICT and the community.

7 Table of R&D&I priorities

7.1 R&D&I priorities in Mobile and Wireless Communications

R&D&I TOPICS	IMPORTANCE	IMPACT	OPPORTUNITY IN TIME		
			SHORT-TERM	MEDIUM-TERM	LONG-TERM
Infraestructure					
Mobile and Wireless Broadband	**High**	**High**			
Spectrum management	**High**	**High**			
Mobile and wireless ad hoc networks	**Medium**	**Medium**			
Fixed Mobile Convergence	**High**	**Medium**			
Satellite communications	**Medium**	**High**			
Security	**High**	**High**			
Solutions and applications					
Mobile applications	**High**	**High**			
Mobile Health	**High**	**High**			
Machine-to-machine communications	**High**	**Medium**			
Business					
Business models	**High**	**High**			

7.2 R&D&I priorities in Digital Contents

R&D&I TOPICS	IMPORTANCE	IMPACT	OPPORTUNITY IN TIME		
			SHORT-TERM	MEDIUM-TERM	LONG-TERM
Creation of content and applications					
New forms of content	**High**	**High**		■	■
Context-aware applications	**High**	**High**	■	■	■
Network-aware applications	**Medium**	**Medium**	■	■	■
Collaborative media creation	**Medium**	**Medium**		■	■
Content presentation					
Representation of content	**High**	**High**	■	■	■
User-environment interaction	**High**	**Medium**		■	■
Virtual, augmented and mixed reality	**Medium**	**Medium**		■	■
Content management					
Content search	**High**	**High**	■	■	■
Quality of contents	**High**	**High**		■	■
Capture of contents	**Medium**	**Medium**		■	■
Content adaptation	**Medium**	**High**	■	■	■
Content integrity	**Medium**	**Medium**	■	■	■
Support technologies					
Networks and platforms for content delivery and distribution	**High**	**High**		■	■
Content-aware networks	**High**	**High**	■	■	■
Advanced interfaces and devices	**Medium**	**Medium**			■

7.3 R&D&I priorities in Software and Services

R&D&I TOPICS	IMPORTANCE	IMPACT	OPPORTUNITY IN TIME		
			SHORT-TERM	MEDIUM-TERM	LONG-TERM
Software engineering	**High**	**High**			
Service Engineering	**High**	**High**			
Intelligent Information management	**Medium**	**Medium**			
Interoperability	**High**	**High**			
Security	**High**	**High**			
Soporte de servicio e infraestructura					
Cloud Comuputing	**High**	**High**			
Novel Internet architectures	**Medium**	**Medium**			

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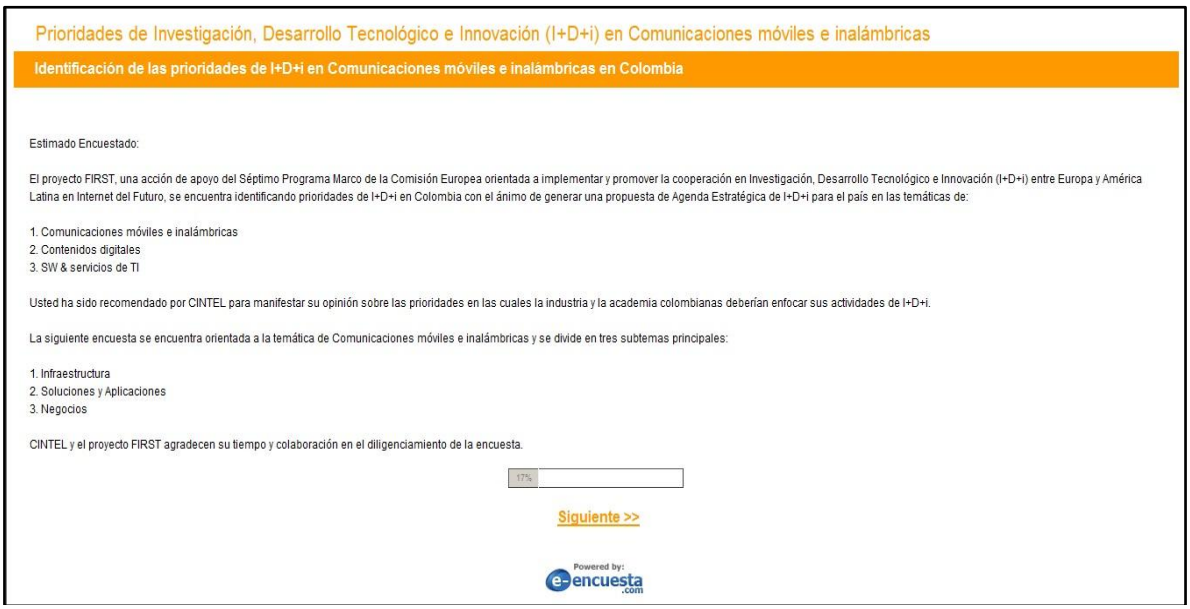
Annex 1 – Survey on R&D&I priorities

Mobile and Wireless Communications



Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Comunicaciones móviles e inalámbricas

Identificación de las prioridades de I+D+i en Comunicaciones móviles e inalámbricas en Colombia

Estimado Encuestado:

El proyecto FIRST, una acción de apoyo del Séptimo Programa Marco de la Comisión Europea orientada a implementar y promover la cooperación en Investigación, Desarrollo Tecnológico e Innovación (I+D+i) entre Europa y América Latina en Internet del Futuro, se encuentra identificando prioridades de I+D+i en Colombia con el ánimo de generar una propuesta de Agenda Estratégica de I+D+i para el país en las temáticas de:

1. Comunicaciones móviles e inalámbricas
2. Contenidos digitales
3. SW & servicios de TI

Usted ha sido recomendado por CINTEL para manifestar su opinión sobre las prioridades en las cuales la industria y la academia colombianas deberían enfocar sus actividades de I+D+i.

La siguiente encuesta se encuentra orientada a la temática de Comunicaciones móviles e inalámbricas y se divide en tres subtemas principales:

1. Infraestructura
2. Soluciones y Aplicaciones
3. Negocios

CINTEL y el proyecto FIRST agradecen su tiempo y colaboración en el diligenciamiento de la encuesta.

17%

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Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Comunicaciones móviles e inalámbricas

Identificación de las prioridades de I+D+i en Comunicaciones móviles e inalámbricas en Colombia

Datos personales (*)

Nombre:

Apellido:

E-mail:

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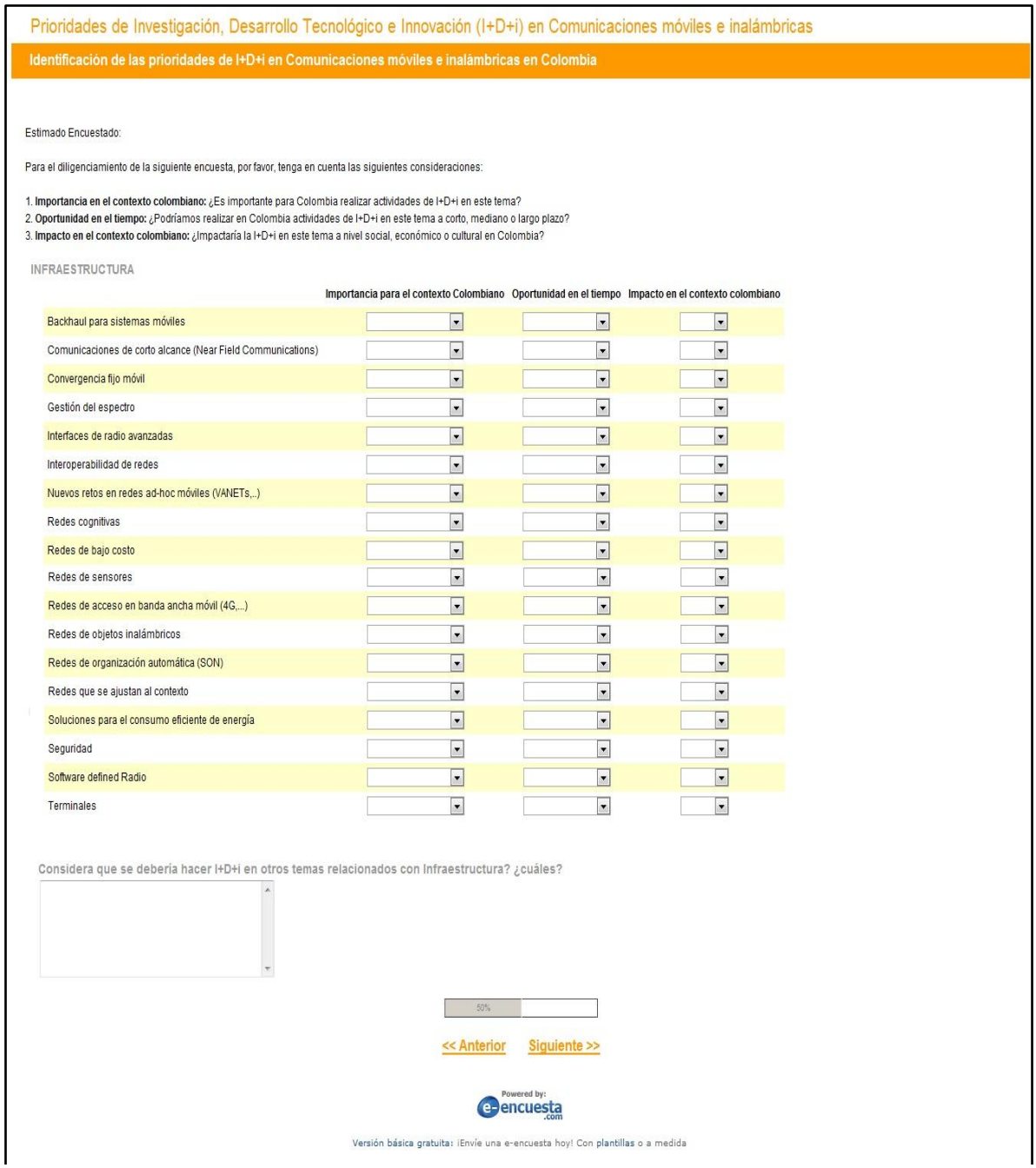

Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Comunicaciones móviles e inalámbricas

Identificación de las prioridades de I+D+i en Comunicaciones móviles e inalámbricas en Colombia

Estimado Encuestado:

Para el diligenciamiento de la siguiente encuesta, por favor, tenga en cuenta las siguientes consideraciones:

1. **Importancia en el contexto colombiano:** ¿Es importante para Colombia realizar actividades de I+D+i en este tema?
2. **Oportunidad en el tiempo:** ¿Podríamos realizar en Colombia actividades de I+D+i en este tema a corto, mediano o largo plazo?
3. **Impacto en el contexto colombiano:** ¿Impactaría la I+D+i en este tema a nivel social, económico o cultural en Colombia?

INFRAESTRUCTURA

	Importancia para el contexto Colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Backhaul para sistemas móviles			
Comunicaciones de corto alcance (Near Field Communications)			
Convergencia fijo móvil			
Gestión del espectro			
Interfaces de radio avanzadas			
Interoperabilidad de redes			
Nuevos retos en redes ad-hoc móviles (VANETs,..)			
Redes cognitivas			
Redes de bajo costo			
Redes de sensores			
Redes de acceso en banda ancha móvil (4G,...)			
Redes de objetos inalámbricos			
Redes de organización automática (SON)			
Redes que se ajustan al contexto			
Soluciones para el consumo eficiente de energía			
Seguridad			
Software defined Radio			
Terminales			

Considera que se debería hacer I+D+i en otros temas relacionados con Infraestructura? ¿cuáles?

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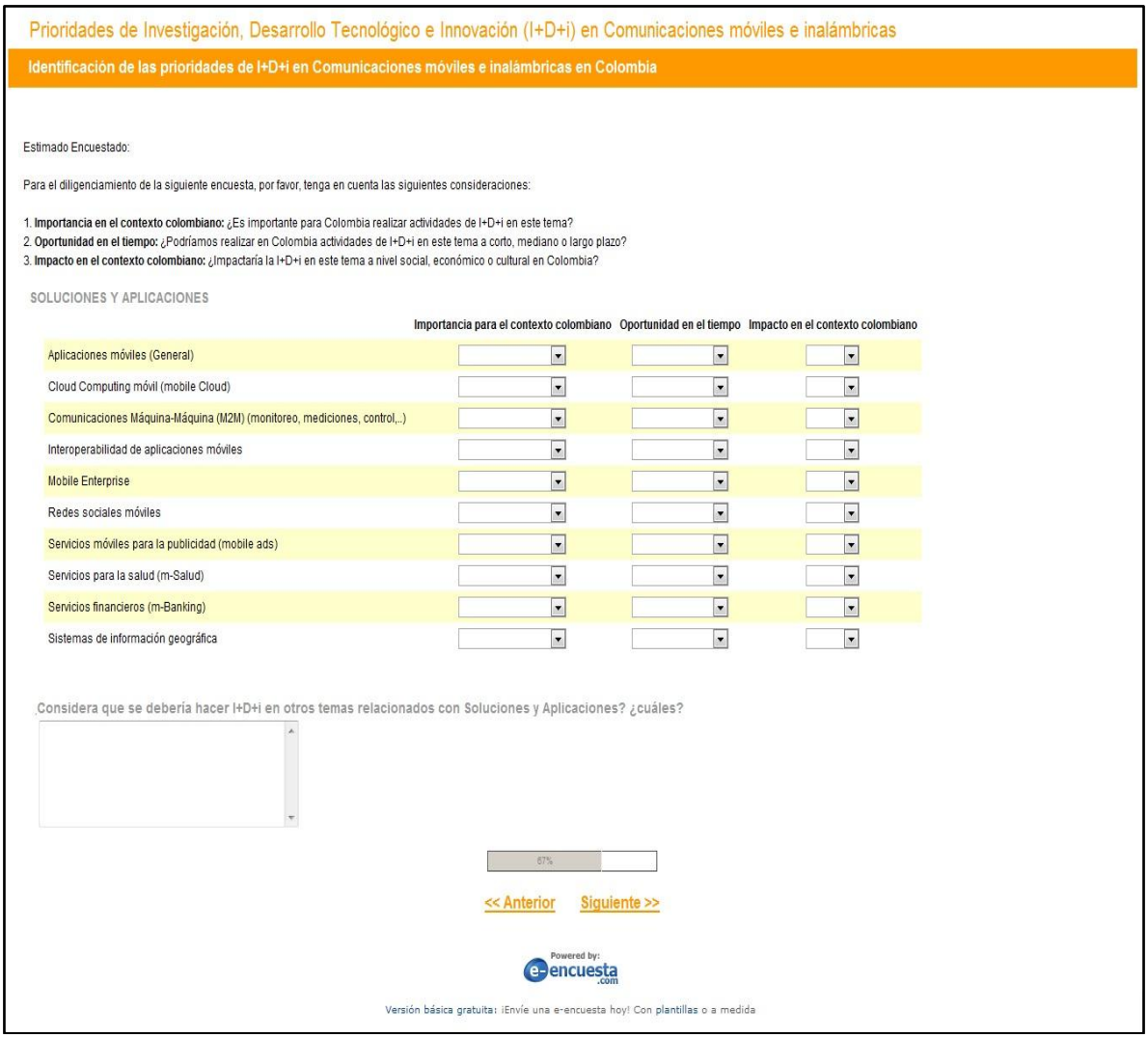

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Identificación de las prioridades de I+D+i en Comunicaciones móviles e inalámbricas en Colombia

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3. **Impacto en el contexto colombiano:** ¿Impactaría la I+D+i en este tema a nivel social, económico o cultural en Colombia?

SOLUCIONES Y APLICACIONES

	Importancia para el contexto colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Aplicaciones móviles (General)			
Cloud Computing móvil (mobile Cloud)			
Comunicaciones Máquina-Máquina (M2M) (monitoreo, mediciones, control,..)			
Interoperabilidad de aplicaciones móviles			
Mobile Enterprise			
Redes sociales móviles			
Servicios móviles para la publicidad (mobile ads)			
Servicios para la salud (m-Salud)			
Servicios financieros (m-Banking)			
Sistemas de información geográfica			

Considera que se debería hacer I+D+i en otros temas relacionados con Soluciones y Aplicaciones? ¿cuáles?

67%

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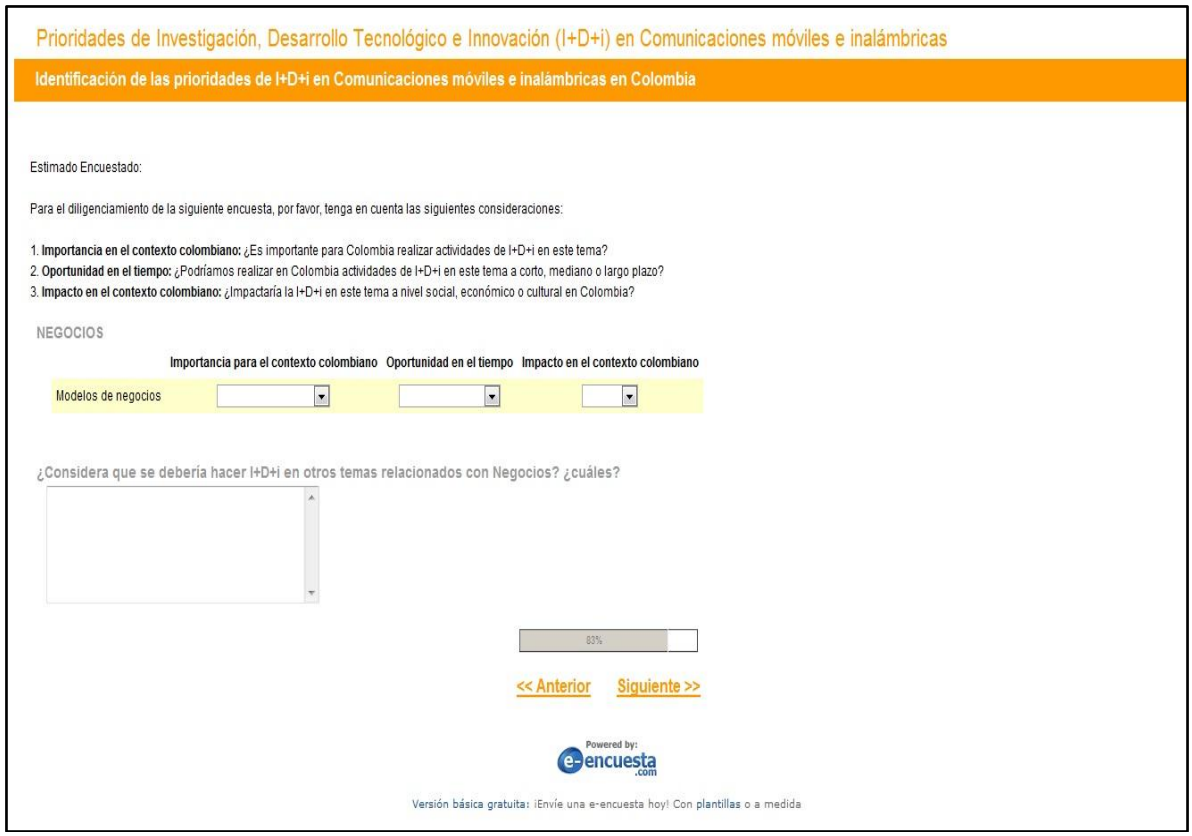
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Para el diligenciamiento de la siguiente encuesta, por favor, tenga en cuenta las siguientes consideraciones:
1. Importancia en el contexto colombiano: ¿Es importante para Colombia realizar actividades de I+D+i en este tema?
2. Oportunidad en el tiempo: ¿Podríamos realizar en Colombia actividades de I+D+i en este tema a corto, mediano o largo plazo?
3. Impacto en el contexto colombiano: ¿Impactaría la I+D+i en este tema a nivel social, económico o cultural en Colombia?
NEGOCIOS
Importancia para el contexto colombiano
Oportunidad en el tiempo
Impacto en el contexto colombiano
Modelos de negocios
¿Considera que se debería hacer I+D+i en otros temas relacionados con Negocios? ¿cuáles?
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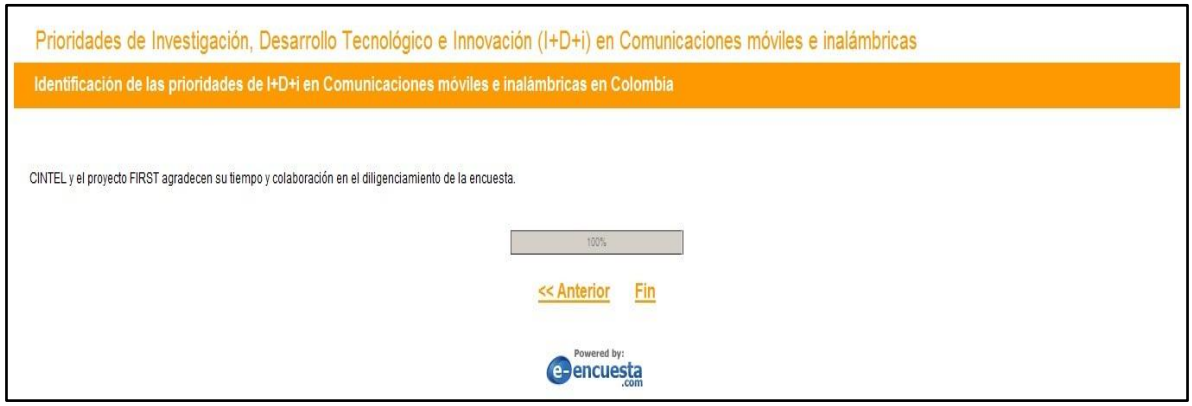
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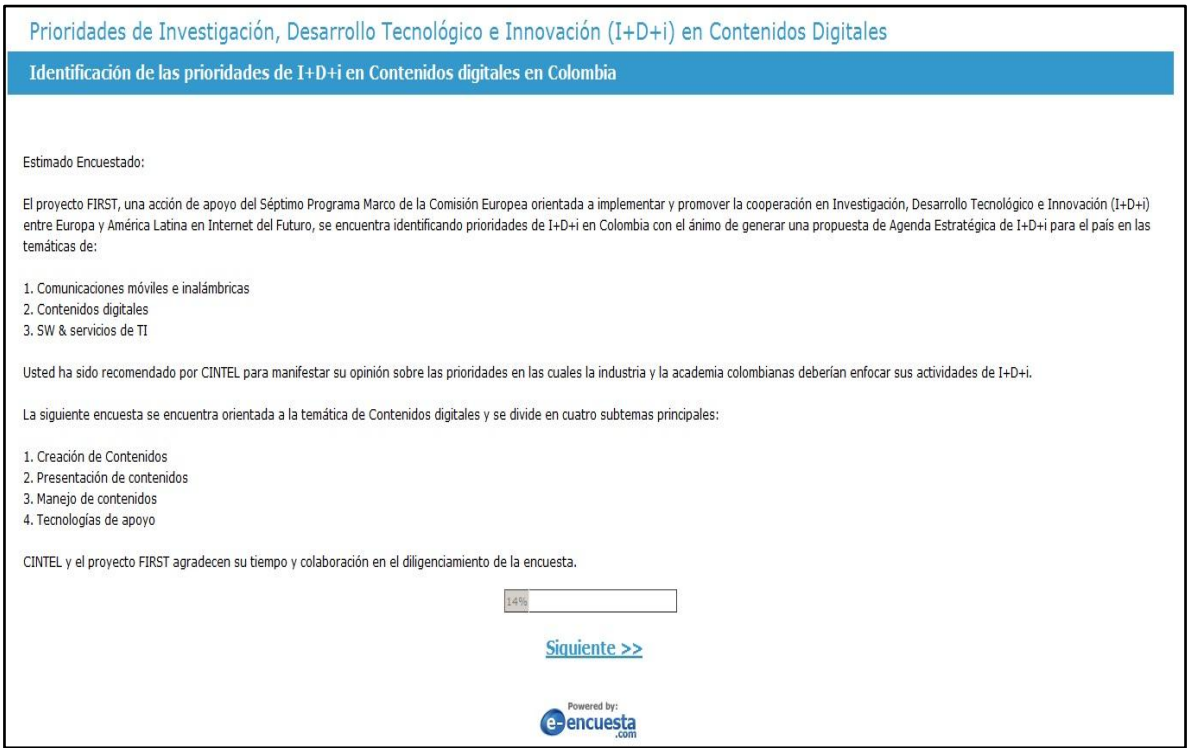
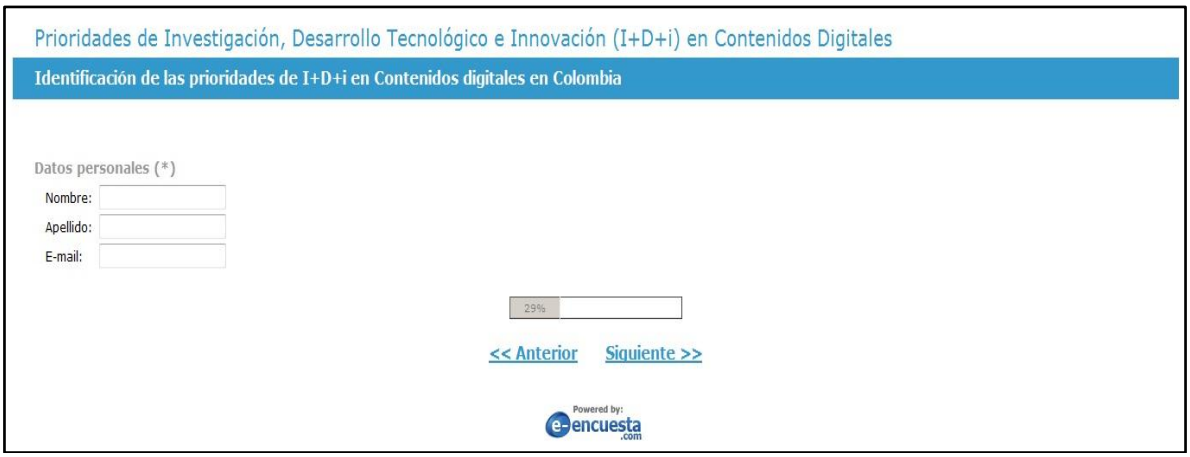
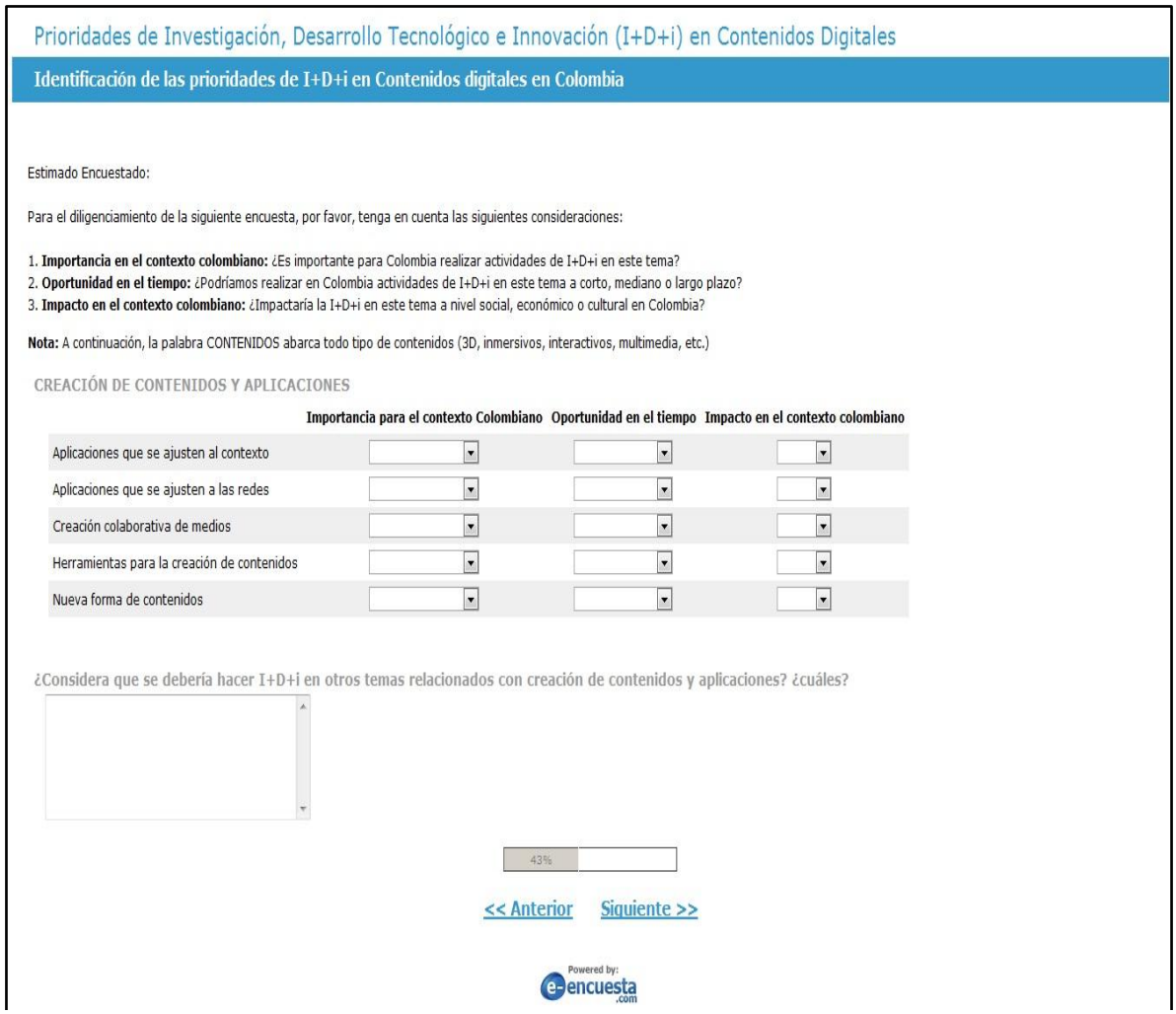
Digital content







Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Contenidos Digitales

Identificación de las prioridades de I+D+i en Contenidos digitales en Colombia

Estimado Encuestado:

Para el diligenciamiento de la siguiente encuesta, por favor, tenga en cuenta las siguientes consideraciones:

1. **Importancia en el contexto colombiano:** ¿Es importante para Colombia realizar actividades de I+D+i en este tema?
2. **Oportunidad en el tiempo:** ¿Podríamos realizar en Colombia actividades de I+D+i en este tema a corto, mediano o largo plazo?
3. **Impacto en el contexto colombiano:** ¿Impactaría la I+D+i en este tema a nivel social, económico o cultural en Colombia?

Nota: A continuación, la palabra CONTENIDOS abarca todo tipo de contenidos (3D, inmersivos, interactivos, multimedia, etc.)

CREACIÓN DE CONTENIDOS Y APLICACIONES

	Importancia para el contexto Colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Aplicaciones que se ajusten al contexto			
Aplicaciones que se ajusten a las redes			
Creación colaborativa de medios			
Herramientas para la creación de contenidos			
Nueva forma de contenidos			

¿Considera que se debería hacer I+D+i en otros temas relacionados con creación de contenidos y aplicaciones? ¿cuáles?

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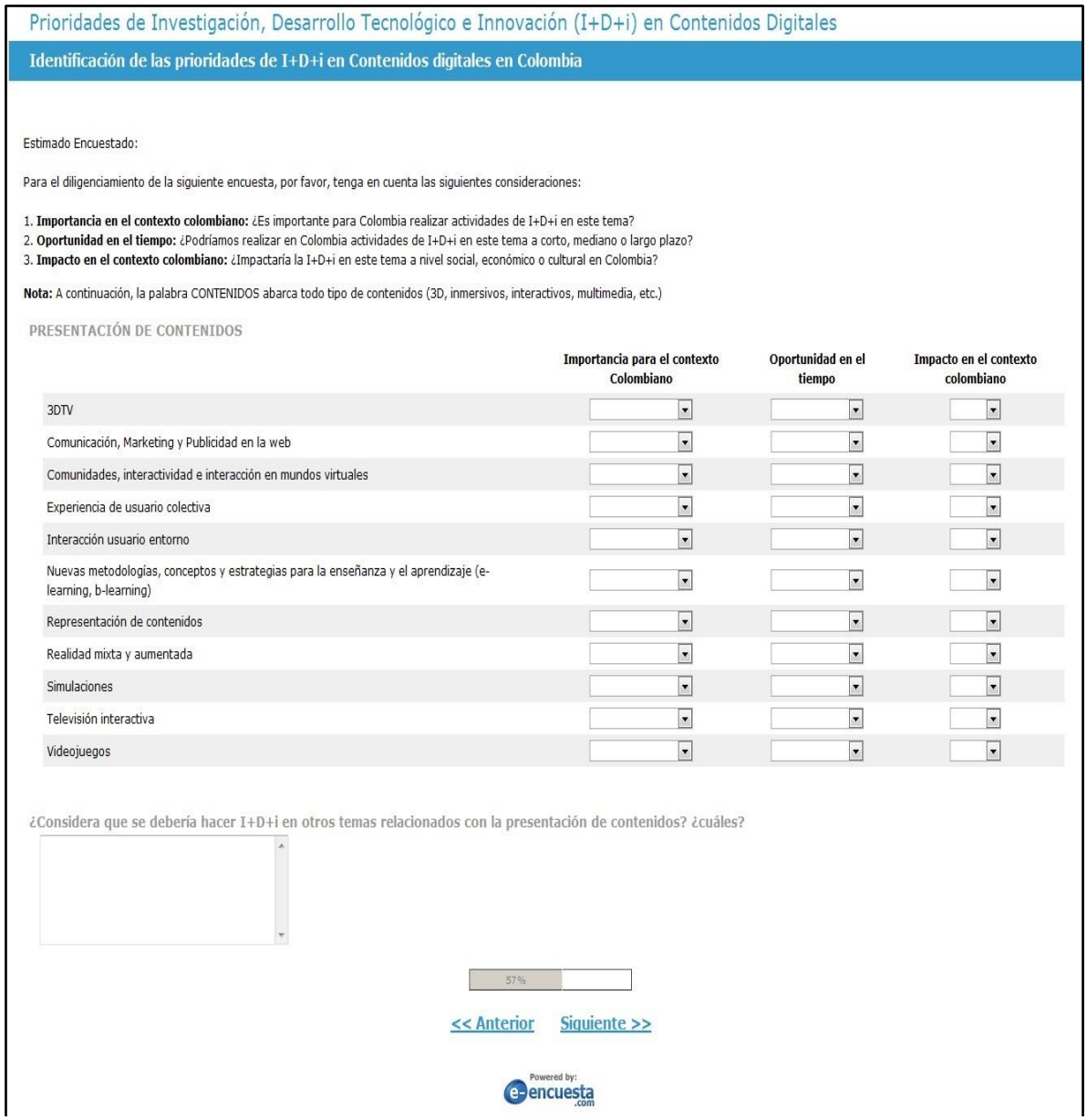

Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Contenidos Digitales

Identificación de las prioridades de I+D+i en Contenidos digitales en Colombia

Estimado Encuestado:

Para el diligenciamiento de la siguiente encuesta, por favor, tenga en cuenta las siguientes consideraciones:

1. **Importancia en el contexto colombiano:** ¿Es importante para Colombia realizar actividades de I+D+i en este tema?
2. **Oportunidad en el tiempo:** ¿Podríamos realizar en Colombia actividades de I+D+i en este tema a corto, mediano o largo plazo?
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Nota: A continuación, la palabra CONTENIDOS abarca todo tipo de contenidos (3D, inmersivos, interactivos, multimedia, etc.)

PRESENTACIÓN DE CONTENIDOS

	Importancia para el contexto Colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
3DTV			
Comunicación, Marketing y Publicidad en la web			
Comunidades, interactividad e interacción en mundos virtuales			
Experiencia de usuario colectiva			
Interacción usuario entorno			
Nuevas metodologías, conceptos y estrategias para la enseñanza y el aprendizaje (e-learning, b-learning)			
Representación de contenidos			
Realidad mixta y aumentada			
Simulaciones			
Televisión interactiva			
Videojuegos			

¿Considera que se debería hacer I+D+i en otros temas relacionados con la presentación de contenidos? ¿cuáles?

57%

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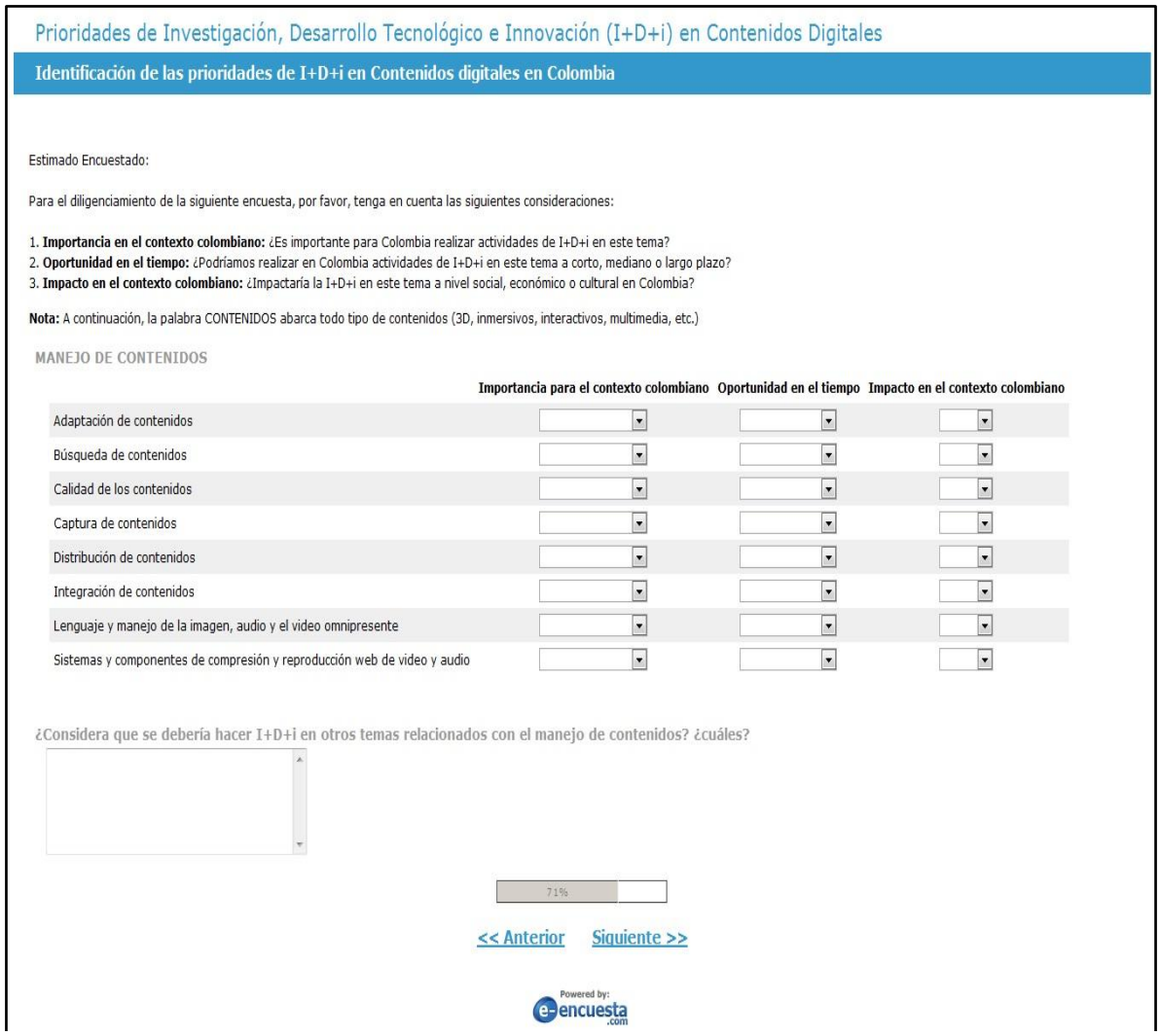

Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Contenidos Digitales

Identificación de las prioridades de I+D+i en Contenidos digitales en Colombia

Estimado Encuestado:

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Nota: A continuación, la palabra CONTENIDOS abarca todo tipo de contenidos (3D, inmersivos, interactivos, multimedia, etc.)

MANEJO DE CONTENIDOS

	Importancia para el contexto colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Adaptación de contenidos			
Búsqueda de contenidos			
Calidad de los contenidos			
Captura de contenidos			
Distribución de contenidos			
Integración de contenidos			
Lenguaje y manejo de la imagen, audio y el video omnipresente			
Sistemas y componentes de compresión y reproducción web de video y audio			

¿Considera que se debería hacer I+D+i en otros temas relacionados con el manejo de contenidos? ¿cuáles?

71%

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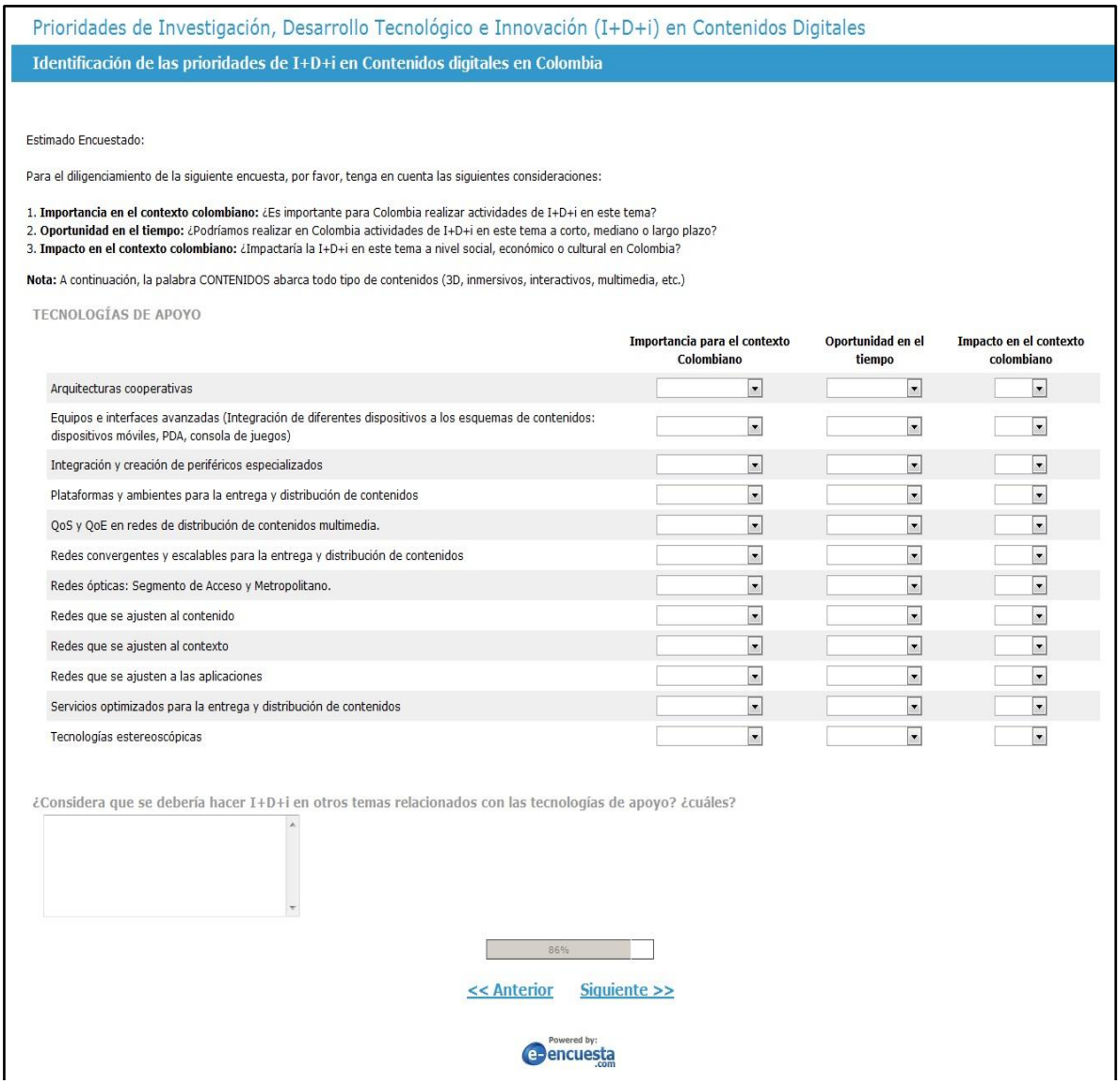

Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Contenidos Digitales

Identificación de las prioridades de I+D+i en Contenidos digitales en Colombia

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TECNOLOGÍAS DE APOYO

	Importancia para el contexto Colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Arquitecturas cooperativas			
Equipos e interfaces avanzadas (Integración de diferentes dispositivos a los esquemas de contenidos: dispositivos móviles, PDA, consola de juegos)			
Integración y creación de periféricos especializados			
Plataformas y ambientes para la entrega y distribución de contenidos			
QoS y QoE en redes de distribución de contenidos multimedia.			
Redes convergentes y escalables para la entrega y distribución de contenidos			
Redes ópticas: Segmento de Acceso y Metropolitano.			
Redes que se ajusten al contenido			
Redes que se ajusten al contexto			
Redes que se ajusten a las aplicaciones			
Servicios optimizados para la entrega y distribución de contenidos			
Tecnologías estereoscópicas			

¿Considera que se debería hacer I+D+i en otros temas relacionados con las tecnologías de apoyo? ¿cuáles?

86%

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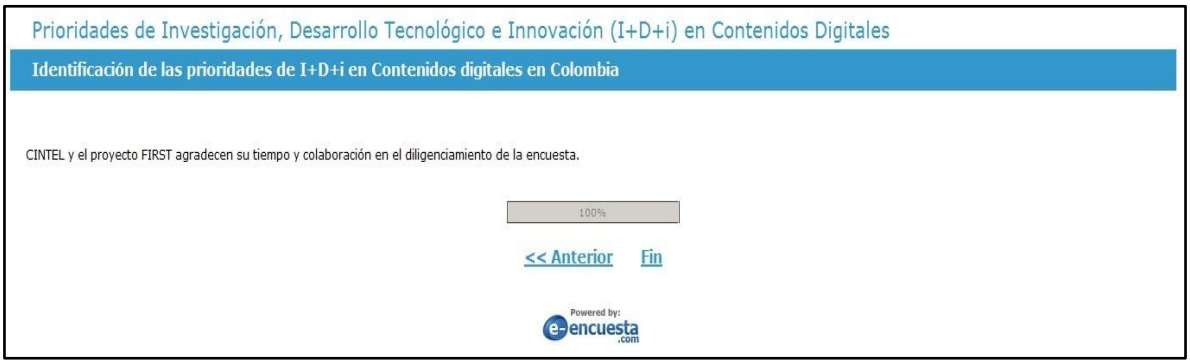

Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Contenidos Digitales

Identificación de las prioridades de I+D+i en Contenidos digitales en Colombia

CINTEL y el proyecto FIRST agradecen su tiempo y colaboración en el diligenciamiento de la encuesta.

100%

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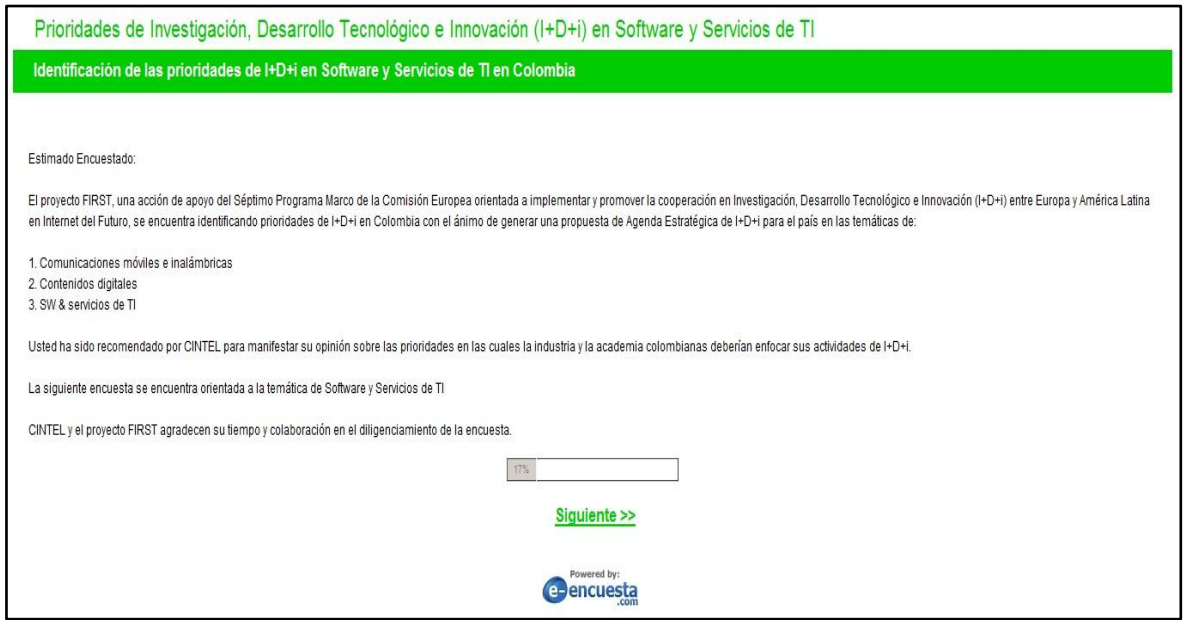
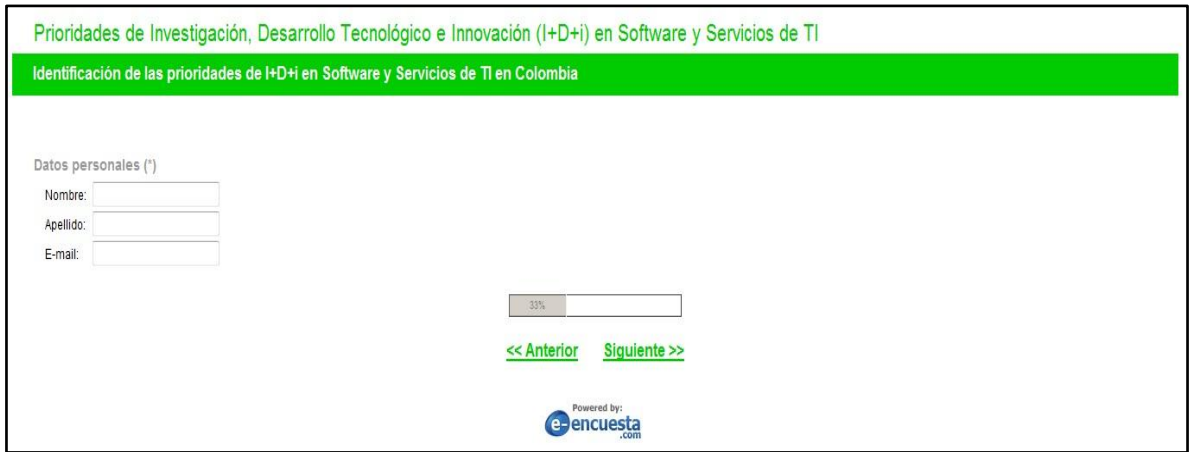
Software and Services





Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Software y Servicios de TI

Identificación de las prioridades de I+D+i en Software y Servicios de TI en Colombia

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NEGOCIOS

	Importancia para el contexto Colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Arquitectura empresarial			
BPM (Business Process Management)			
Inteligencia de negocios			

SOFTWARE

	Importancia para el contexto Colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Aplicaciones para dispositivos móviles			
Aplicaciones orientadas a servicios			
Aseguramiento de la calidad del SW			
Arquitecturas de software			
Composición, orquestación y coreografía de software			
Cloud services			
Estándares abiertos para Software			
Frameworks de desarrollo de SW			
HCI (Human-Computer Interaction), Accesibilidad, usabilidad			
Ingeniería manejada por modelos			
Lenguajes de modelado			
Lenguajes de programación			
Metodologías de desarrollo de software			
Modelos de programación			
Protocolos			
Pruebas de software			
SaaS (Software como un servicio)			
Sistemas expertos e Inteligencia artificial			
SOA (Service Oriented Architecture)			
Web Services			

50%

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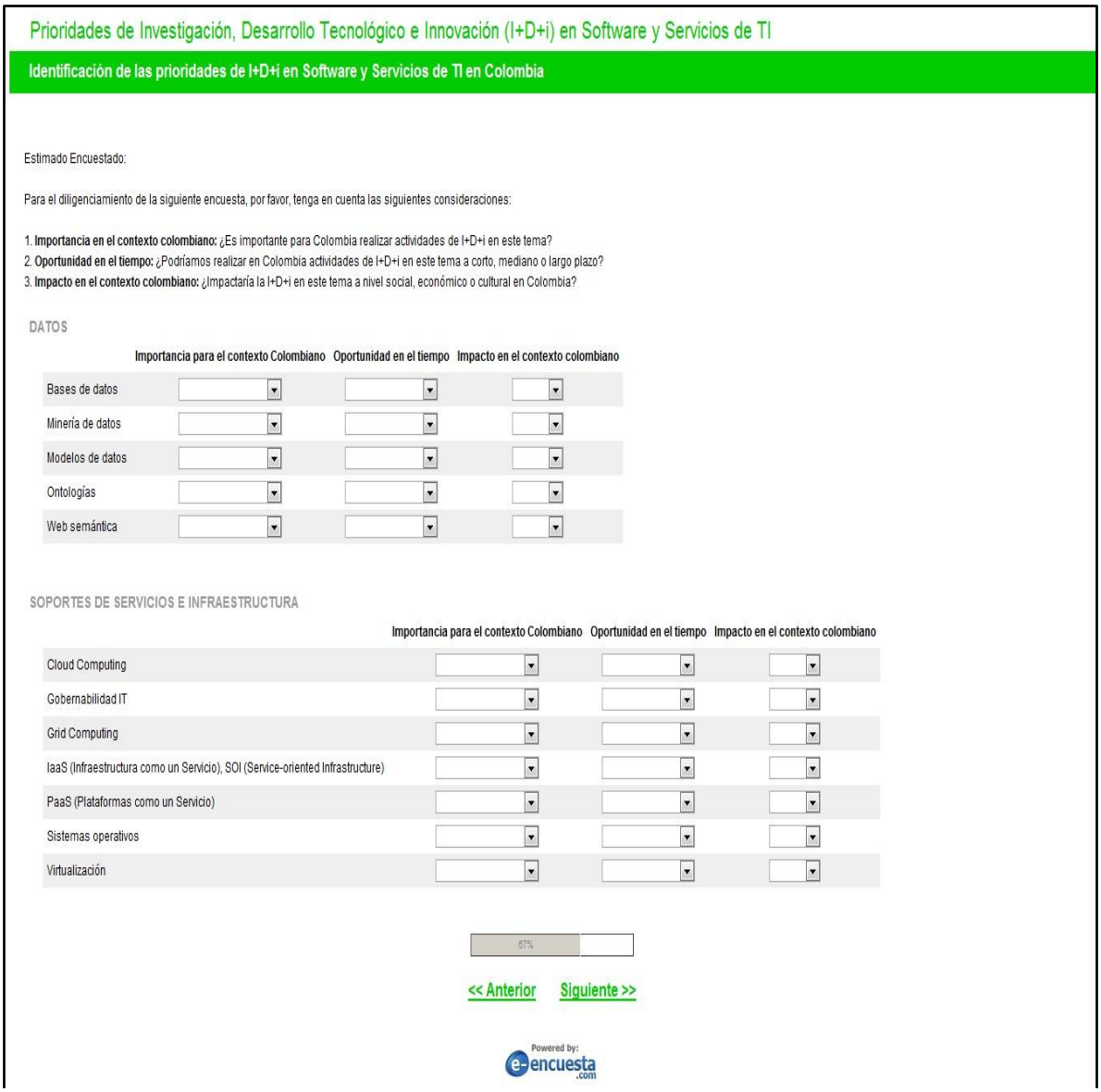

Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Software y Servicios de TI

Identificación de las prioridades de I+D+i en Software y Servicios de TI en Colombia

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DATOS

	Importancia para el contexto Colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Bases de datos			
Minería de datos			
Modelos de datos			
Ontologías			
Web semántica			

SOPORTES DE SERVICIOS E INFRAESTRUCTURA

	Importancia para el contexto Colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Cloud Computing			
Gobernabilidad IT			
Grid Computing			
IaaS (Infraestructura como un Servicio), SOI (Service-oriented Infrastructure)			
PaaS (Plataformas como un Servicio)			
Sistemas operativos			
Virtualización			

67%

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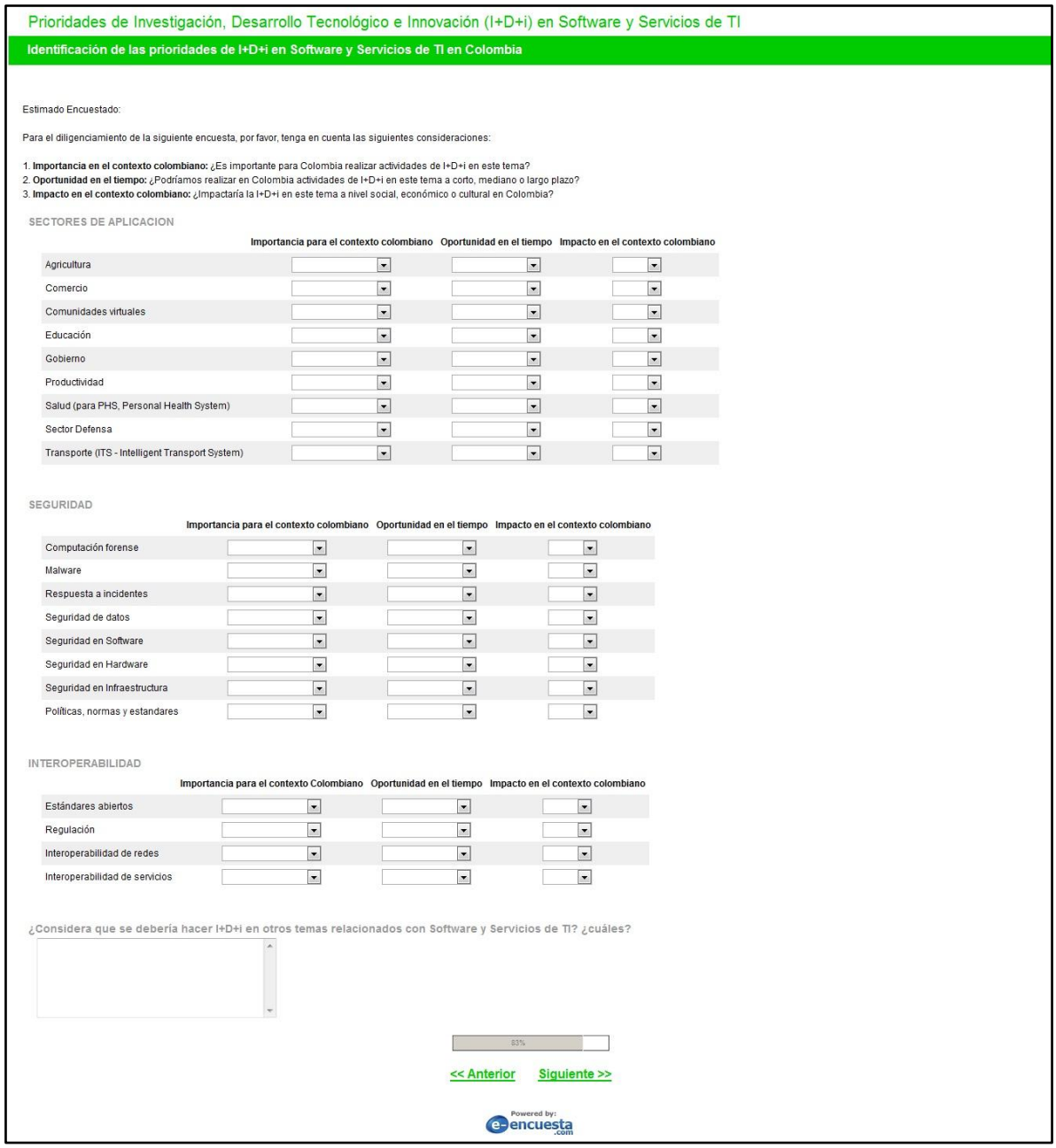

Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Software y Servicios de TI

Identificación de las prioridades de I+D+i en Software y Servicios de TI en Colombia

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SECTORES DE APLICACION

	Importancia para el contexto colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Agricultura			
Comercio			
Comunidades virtuales			
Educación			
Gobierno			
Productividad			
Salud (para PHS, Personal Health System)			
Sector Defensa			
Transporte (ITS - Intelligent Transport System)			

SEGURIDAD

	Importancia para el contexto colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Computación forense			
Malware			
Respuesta a incidentes			
Seguridad de datos			
Seguridad en Software			
Seguridad en Hardware			
Seguridad en Infraestructura			
Políticas, normas y estandares			

INTEROPERABILIDAD

	Importancia para el contexto Colombiano	Oportunidad en el tiempo	Impacto en el contexto colombiano
Estándares abiertos			
Regulación			
Interoperabilidad de redes			
Interoperabilidad de servicios			

¿Considera que se debería hacer I+D+i en otros temas relacionados con Software y Servicios de TI? ¿cuáles?

83%

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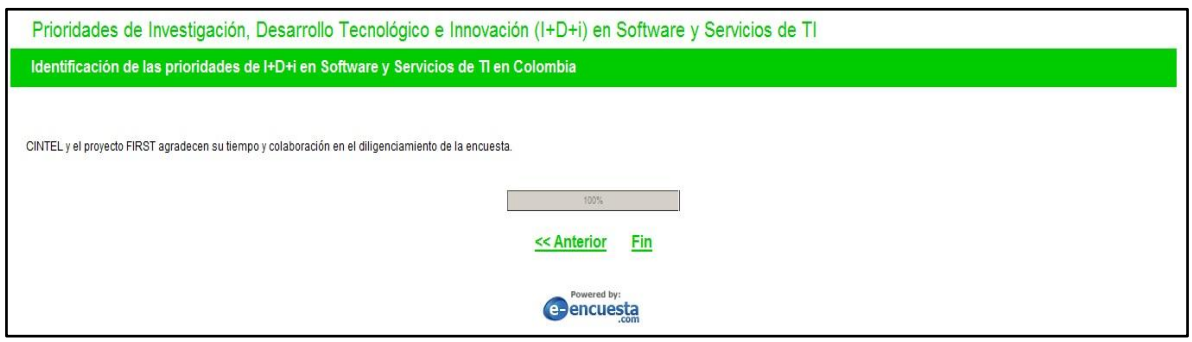

Prioridades de Investigación, Desarrollo Tecnológico e Innovación (I+D+i) en Software y Servicios de TI

Identificación de las prioridades de I+D+i en Software y Servicios de TI en Colombia

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100%

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Annex 2 – Contributors

The FIRST project and RECIIF thank all contributors for their valuable inputs and comments for the elaboration of this Strategic Research Agenda at different stages of the process (alphabetical order):

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- Harold Castro, AssociateProfessor, UNIVERSIDAD DE LOS ANDES
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- Jaime Cruz, UNE
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- Jorge Castro, Planning Chief, NEC Colombia
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