



VOIce-based Community-cEntric mobile Services for social development

Grant Agreement Number 269954

Deliverable No D7.4
Technology Implementation Plan

June 2013

PROJECT DELIVERABLE REPORT

Project	
Grant Agreement number	2699542
Project acronym:	VOICES
Project title:	<i>VOIce-based Community-cEntric mobile Services for social development</i>
Funding Scheme:	<i>Collaborative Project</i>
Date of latest version of Annex I against which the assessment will be made:	30 June 2013
Document	
Deliverable number:	D7.4
Deliverable title	Technology Implementation Plan
Contractual Date of Delivery:	June 30, 2013
Actual Date of Delivery:	July 5, 2013
Editor (s):	Anna Bon
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Work package no.:	WP7
Work package title:	Dissemination, exploitation & community building
Work package leader:	VUA
Work package participants:	Web Foundation, FT, TNO, W3C, CSIR
Distribution:	PU
Version/Revision:	1.2

Draft/Final:	1.2		
Total number of pages (including cover):	40		
Keywords:	Voice-based implementation	technologies,	technology

CHANGE LOG

Reason for change	Issue	Revision	Date
Creation of document; chapters 1, 2 and 3	0.1	Anna Bon	29-5-2013
Input from partners: VUA, WF, SE, NWU, CRS4, FT, TNO, PT, CSIR, CRS4	0.2	partners	13-6-2013
Final version	1.0	Anna Bon	14-6-2013
W3C contribution; ESMT contribution	1.01	partners	25-6-2013
Short final editing, FMX contribution	1.1	Anna Bon Wendelien Tuyp	30-6-2013
Final version	1.2	Anna Bon	5-7-2013

DISCLAIMER

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VOICES is a project funded in part by the European Union.

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SUMMARY

This document contains the technology implementation plans for the VOICES project. It describes how the results of VOICES will be advanced and implemented in research programs, businesses, partnerships, and communities of practice.

This document forms a trilogy, with the Dissemination and Use Plan (D7.2), and the Report on Local Social Networking and Community Building Activities (D7.3). These three documents describe the dissemination and uptake of the VOICES results and products.

In chapter 2 we summarize the objectives and results of the VOICES project. In chapter 3 we map the VOICES results against the EU-ICT Work Programme. In chapter 4 we present our vision on the future of voice technologies for social-economic development. In chapter 5 the technology implementation plans for each of the partners in the VOICES consortium are given. In chapter 6 the conclusions are given.

The partners in the VOICES consortium operate in different sectors. Therefore implementation of VOICES results will take place for each partner using a different approach. The technology implementation plans will cover following areas:

- Research and Technology Development
- Adoption of innovations in the African context through local community building
- Education and training
- Business development and new initiatives

In this document each partner of VOICES presents its technology implementation plan, to further the VOICES results after the end of the project.

1. INTRODUCTION

There is a widespread agreement that ICT services have the potential to play a major role in furthering social and rural development in developing economies such as Africa. The VOICES project has addressed two important challenges that still hamper successful adoption of ICT services in developing regions. (i) The leveraging of content that is locally relevant to actors and entrepreneurs who are of key importance to on-the-ground social and rural development. (ii) The removal of a range of access barriers, notably limitations related to access channels, literacy, and languages that hamper information/knowledge sharing and associated community building especially in rural areas.

The VOICES project delivered an integrated bundle of results that were in line with its objectives. With its results the VOICES project has made contributions to the domains of information access by underprivileged communities, local content creation and management, speech technologies, and of sustainability of ICT for Development initiatives.

2. VOICES OBJECTIVES AND RESULTS

a. VOICES Concept and Objectives

ICT services, especially mobile ones, have the potential to play a major role in furthering social and rural development in developing economies such as Africa. Market penetration and rural community adoption of basic mobile telephony and services have been extremely rapid in recent years. This is opening up lots of new opportunities, but, in order to realize the full potential of mobile ICT services, important challenges must be overcome. The VOICES objectives have been defined to address two important challenges (i) The leveraging of content that is locally relevant to actors and entrepreneurs who are of key importance to on-the-ground social and rural development. (ii) The removal of a range of access barriers, notably limitations related to access channels, literacy, and languages that hamper information/knowledge sharing and associated community building especially in rural areas.

b. Results of the VOICES project

With its results the VOICES project has made contributions to the domains of information access by underprivileged communities, local content creation and management, speech technologies, and of sustainability of ICT for Development initiatives. The VOICES project delivered an integrated bundle of results in line with the VOICES objectives.

VOICES results:

Open and Wider Access: improved voice-based access to content and mobile ICT services through a toolbox for the development of voice services that is made available to **local communities** and entrepreneurs as Open Source.

Integration of Local Community Radios and ICT: Among its features and functionalities, the toolbox enables the bridge with **local community radios**, by offering a Web archiving option and off-line individual voice access, thereby making broadcast audio content widely available to people.

Better Support of Languages: VOICES has delivered tool support and a methodology for under-researched and under-resourced languages that facilitates the **local creation of content** in African languages.

Long-term Sustainability: To ensure the **local adoption** and exploitation of the VOICES tools and methods **beyond the project**, VOICES has created a sustainable architecture and designed business models for its results in co-creation with local partners and communities.

Faster Uptake: VOICES has organized a number of important **community-building activities**. This included, amongst other initiatives, the delivery and roll-out of a mobile training lab that offers education for local partners and entrepreneurs in developing mobile ICT and Web services, and community of practices, that want to further deploy voice technologies in their own environment.

VOICES has proved the fitness of its results and its adaptability to the **African context** by local pilots and associated **community building**: this was focused on health services in Senegal, and on agricultural and regreening knowledge sharing in the Sahel countries.

The results of the VOICES project are summarized in the following diagram:

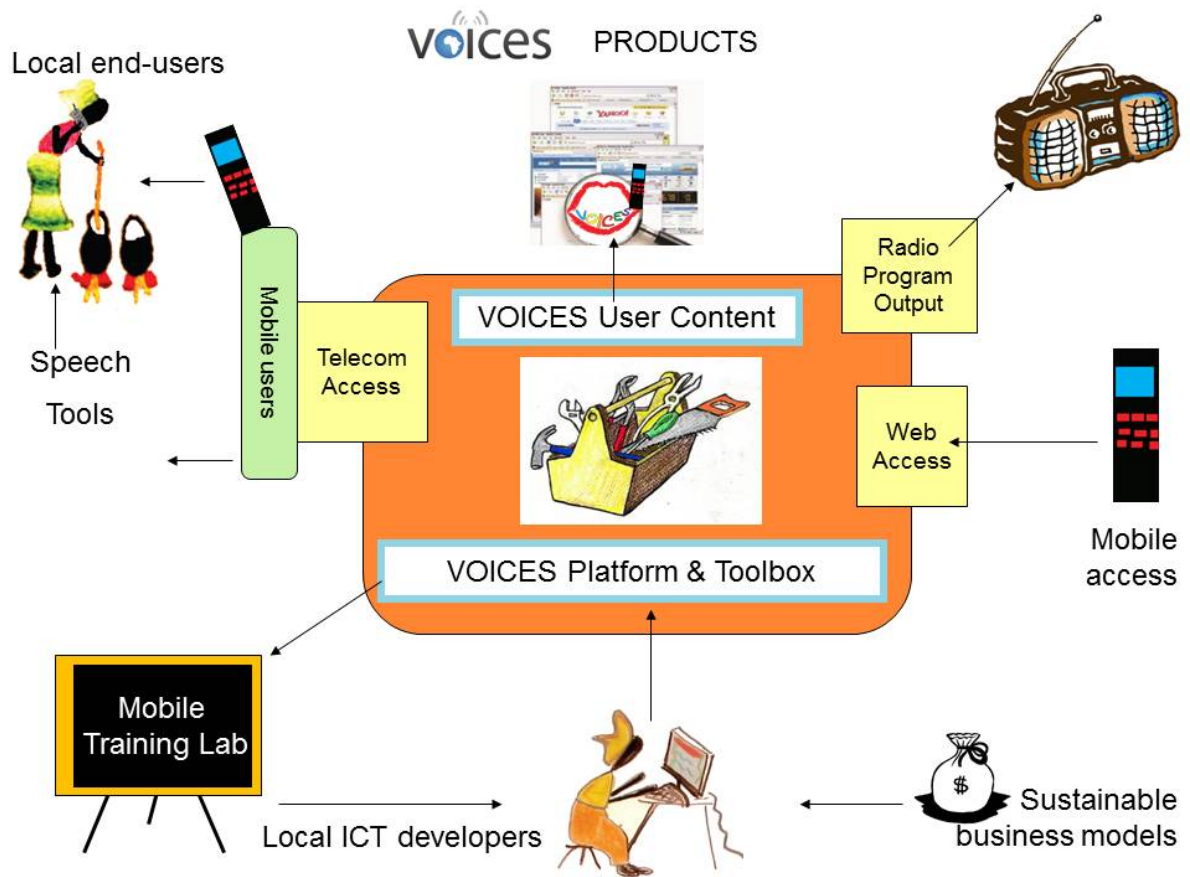


Figure 1: Diagram summarizing the products and results of VOICES

3. VOICES IMPLEMENTATION AND UPTAKE OF EUROPEAN ICT RESEARCH RESULTS

a. The VOICES results mapped against the EU-ICT Work Programme

The VOICES technology implementation plan responds to the EU-ICT FP7 Work Programme 2009/2010 Objective ICT-2009.9.1: International cooperation, in particular b) *Support to the uptake of European ICT research results in developing economies*. How the VOICES project did this, can be shown by comparing the list of EU Work Programme elements (*in italic below*) and how they map onto the VOICES results:

"Facilitate the widest diffusion and local exploitation of European ICT research results, through the piloting and testing of solutions adapted to local infrastructures, service needs, users, culture, and business and social structures." •

VOICES has facilitated diffusion and exploitation of European ICT research results and helped to unleash the potential of mobile ICT services for developing economies and resolving existing content and access barriers for such services, through its voice service development toolbox. The VOICES pilots in Mali and Senegal have demonstrated how mobile ICT services are adaptable to the local context both by providing mechanisms for local adaptation (integrating rural community radio into Web content management, and by providing novel speech technology suited for African languages)

VOICES has demonstrated the adequacy of its solutions through its local pilots in Mali and Senegal, with a wide range of African partners. Finally, VOICES is built on the results of a series of previous EU-FP projects, and has reused the achievements of these projects and has adapted them in the local context.

"Provisioning of public services as well as business-related applications" "or solutions supporting sustainable development" •

VOICES has provided, especially through the voice services tool box and mobile training lab, a new means for local development of entrepreneurship in mobile ICT services. The two pilots, and the setup of the mobile training lab have demonstrated the social impact of voice-based services and the opportunities for local entrepreneurs to create new businesses in mobile ICT that are accessible to all segments of the population. For the domains of health and agriculture, the two pilots have demonstrated this specifically for their high potential social impact. Moreover, the two pilots have shown in different domains (health and agriculture), different economic conditions and different countries, the portability, applicability, and business opportunities of the VOICES results.

"Activities will analyse and test the application of relevant technology as well as business models with a particular focus on socio-economic impacts and aspects such as affordability, deployment and local exploitation opportunities" •

VOICES has analysed the potential of voice technologies and services for people who are out of the scope of ICT due to lack of broadband infrastructure, low reading skills, or literacy in under-resourced languages. The VOICES platform can host different services in different local languages. The identification of business opportunities and possible business models from the two field pilots, and the involvement of local entrepreneurs has given insight in local ecosystems, and aspects such as affordability, deployment and local exploitation of the VOICES results, and the conditions necessary for successful deployment of voice-based services in the near future.

VOICES has applied a user-centric approach based on co-design: the results were extensively validated in the field, in a 2-cycles iterative process that has permitted maximal appropriation by the local stakeholders in Mali and Senegal.

"Facilitate transformation of research results into local innovation, through the networking of relevant technology developers with local academia, incubators, SMEs, representatives from civil society as well as local authorities, notably for the provision of public services" •

VOICES has facilitated local innovation and networking through its local pilots, one focused on health services in Senegal, and the other focused on agricultural and greening knowledge sharing in the Sahel region (esp. Mali, Burkina Faso, Ghana). These pilots were not just simply of a technical nature but explicitly involved local social networking and community building activities and events. The VOICES consortium has engaged local technology developers in Mali and Senegal, local academia in different African countries, local NGOs in Mali, Burkina Faso and Ghana, and a foundation driving a network of rural health centres, to help create the conditions for local adoptions of the technology and platform developed in the project. The mobile training lab has engaged local entrepreneurs to acquire appropriate expertise and awareness on relevant mobile ICT technologies and sustainable business models, opening the door for local innovation.

"Promote transfer of know-how, best practices and technology through the establishment of self-sustainable partnerships and collaborative initiatives" •

VOICES has transferred know-how and technology both by its pilots and by developing a sustainable architecture and business model co-developed with African partners inside and outside the VOICES consortium. The involvement in the VOICES consortium of two foundations focusing on development issues, and universities with strong cooperation networks and on-going field actions, has promoted and made the results of the VOICES project widely known within the networks of the different partners.

"Activities should contribute, if applicable, to the implementation of established European research and innovation roadmaps." •

VOICES is a direct follow-up, with the same core partners, of FP7 Digital World Forum (DWF) project which developed EU roadmaps on ICT for Development. VOICES has specifically addressed key challenges of the Mobile Web for Social Development roadmap, one of the roadmaps developed by DWF, in particular:

4. EXPLOITATION PLAN

The VOICES project has shown a suite of project results from the different Work Packages that is leading towards successful exploitation after the end of the project period, notably:

- The voice mobile services toolbox (from WP2). To maximize the exploitation of the VOICES toolbox beyond the project, it has been made available to practitioners and entrepreneurs as Open Source, and actions by the VOICES project are taken to build and support the corresponding Open Source community.
- The mobile training lab and its training materials (from WP6). Project tasks explicitly focused on exploitation of the VOICES mobile training lab, in particularly through piloting it in cooperation with a business incubator in Dakar, Senegal. Furthermore, the training materials themselves played a direct role in strengthening the exploitability of the project as a whole, as they are developed with a strong eye on building local competencies and enabling local entrepreneurs to actively take up the various project outcomes in a way that suits them.
- The speech technology and methodology (from WP3). Apart from African language packs as an exploitable result, the speech technology work in VOICES has led to a new methodology tailored to suit under-resourced languages.

A second important element of the active exploitation strategy of the VOICES consortium lies in the two local pilots, on m-health in Senegal and on rural greening agro-knowledge sharing in Sahel countries (WP4 and WP5, respectively). From the exploitation point of view, the Africa pilots of the project have contributed to exploitation of the project results in significant ways:

- The Africa pilots have demonstrated in the field and on-the-ground that the results of the VOICES project are successfully adapted and adaptable to the local context and conditions, and can be further developed, modified and adopted in a locally sustainable way.
- The pilot activities are furthermore geared to creating new partnerships and local community building and to strengthening of the existing ties with local parties and entrepreneurs, such that a hands-on local business interest in the VOICES mobile services and tools is now already emerging.

Thirdly, in order to maximize impact and ensure exploitation beyond the project, the VOICES work plan contained a specific overarching Work Package (namely WP1) that addressed the key issues involved in successful exploitation. It did so in particular by carrying out the following tasks:

- Development of a general sustainable technical architecture to fit local conditions and practices.
- Carried out impact assessments and adoption methodology studies, and from there guidelines were produced how to increase local adoption.
- Analysis of local business potential related to the VOICES results, and design of sustainable business models for the produced VOICES mobile services, content, and tools.

Finally, we point out that the composition of the consortium itself was such that it could be able to maximize the exploitation potential of the project, in particular through:

- A significant participation and role of African partners from several countries (esp. South Africa, Mali, Senegal).
- From the industry point of view, through a significant participation and role of two major mobile services and telecoms providers, both having in addition a strong presence and footprint in many African countries (including Senegal, Mali, and other French-speaking countries, as well as Angola and Mozambique).

Exploitation activities within the project have been carried out by each of the Consortium members. The activities have been defined in the Dissemination and Use Plan and the Technology Implementation Plan, as part of the Dissemination and Exploitation Work Package of VOICES (WP7). These plans covered the full range of needs from the local SMEs – local ICT service providers as well as end-users in the health sector and the agriculture sector. The plans covered the knowledge, skills and prototype products and services that were necessary for exploitation and marketing of these services after the end of the VOICES project.

5. TECHNOLOGY IMPLEMENTATION FOR EACH VOICES PARTNER

1. Web Foundation

a. Partner role

The World Wide Web Foundation (Web Foundation) is Swiss public charity (foundation) focusing on the use of ICT for Social Development. It has been announced in September 2008, and formally incorporated in 2009. Founded by Sir Tim Berners-Lee, the inventor of the Web and director of the World Wide Web Consortium (W3C), the Web Foundation has been established by a task force of W3C, and its technical staff is coming from the W3C. The Web Foundation has three programs focusing on three specific challenges:

- *Web in Society Program:* Creation of locally-relevant content on the Web is impeded for many people by the lack of knowledge and technology. Life-critical information and services are in limited supply, especially for those who need help the most. A first step towards filling the content gap, the Web Foundation works directly in the field to provide grass roots organizations, governments, NGOs and entrepreneurs with the knowledge, training and tools to share locally-relevant information more effectively.
- *Web Standard Program:* More than one billion people who read poorly, read only languages not well-supported on the Web, or have disabilities are blocked from creating and exploring Web content because of inadequate Web technology and practice. To ensure that Web technologies fill identified gaps, and that technologies work together, the Foundation works with the World Wide Web Consortium, which develops free and open technical specifications and guidelines. Particularly important is accelerating standard work that removes barriers to Web use for those people now blocked because of literacy, language and ability.
- *Web Research Program:* The Web is not just technology, but “humanity connected by technology”. Even experts do not fully comprehend the complexity and potential of this evolving system of people, information and links. This is a risk to the creative, yet responsible, evolution of the Web. To address the knowledge gap, the Web Foundation collaborates with the Web Science Trust and its development of a new field of study: Web Science. Web Science seeks to educate the next generation of scientists who will improve our understanding of the Web’s complex nature, and explore new technologies that could ultimately make the Web even more powerful for all people on the planet. The Foundation is also developing a Web Index, designed to measure growth and usage of the Web, and guide future investment in the Web.

Web Foundation coordinated the whole project, and was in charge of the Mobile training lab WP (WP6). Web Foundation also took part of the implementation of the pilot in the Sahel region (WP5). Web Foundation has also contributed to the VOICES sustainable architecture and business modeling.

b. Technology implementation plan for Web Foundation

The Web Foundation plans to reuse many of the results of VOICES in its activities and programs. In particular:

- The Emerginov Platform and toolbox
- The speech tools
- Some of the service specific elements
- The business models and related methodologies
- The training materials

Emerginov Platform

The Emerginov platform offers a completely integrated deployment platform for mobile services. It supports multiple technologies (voice services, SMS, mobile Web) and can be connected to a wide range of infrastructure for basic low-cost equipment that would fit a small NGO till a mobile operator infrastructure that could support thousands of services and customers. Emerginov is the only platform of this kind that can be used for multiple purposes:

- Training of future entrepreneurs and mobile technologies specialists
- Deployment of services in the field
- Setup of demonstration pilots

The Web Foundation is planning to use the Emerginov for all these activities. The Web Foundation is running a set of mobile entrepreneurs' lab in Ghana and Kenya. We are planning to reuse the platform for training and piloting in these labs.

The Web Foundation is also continuing its research activities related to mobile services for development. In that regard, we are planning to use the Emerginov platform for all the filed deployment that we are planning to implement in the future. Given that Emerginov is a generic platform that could be used in different domains; we will be able to sue it in our different sectors including education, citizen engagements and media.

Finally, as part of our mission on dissemination and awareness raising within the community, we are demonstrating our services all over the world at different conferences and events. We are also planning to use the Emerginov platform for that purpose.

Speech tools

The speech tools developed as part of VOICES are essential for the development and deployment of dynamic voice-based services in local languages. While the specific language packs developed as part of VOICES are not directly applicable in other applications, the generic tools and methodologies developed are critical for the development of other speech elements for under-resourced languages. Given our engagement all over the World in e.g. Kenya, India or Rwanda, we are planning to reuse these tools to support more local languages such as Swahili, Hindi or Keniarwanda.

Service-specific elements

Some of the services that have been developed in Mali and Senegal are innovative and applicable to wide variety of context. In particular, the Tabale service and the Foroba Blon (WP5) service offer functionalities that are generic and can be very useful in different context.

Concerning Tabale, the service allows the provision of voice-based messages to people who are illiterate. This can be applicable in many contexts. For instance, most alert systems today are SMS-based making them useless for illiterate people. We are planning to reuse and extend Tabale for such applications. In the same way, voice-based Question & Answer services could benefit from this type of functionalities. We are currently running a few services of this kind, e.g. in India, where people have to manually check if the answer to one of their questions is available on the system. We are planning to plug Tabale in such systems.

Concerning Foroba Blon, the functionalities are essential to engage with citizens and allow them to have their voice heard. Thanks to VOICES and the development of this platform, it is now quick and easy to deploy a service that will collect people feedback and opinions. We have already reused this platform three times in three different settings. Through a joint-project with Al Jazeera, we have successfully deployed the Foroba Blon service in Ghana and Kenya to cover the recent presidential elections (December 2012 in Ghana, and March 2013 in Kenya). We also deployed a nation-wide service in Mali in January 2013 to gather news from war zones in the northern part of the country. Those deployments are illustrating the huge opportunities that Foroba Blon is offering, and the Web Foundation is planning to continue its exploitation in different domains.

Business models and related technologies

All the services that the Web Foundation is deploying in the field have the aim to be sustainable and scalable. The portfolio of business models and methodologies developed in VOICES are major resources to be used in the different services we are driving and we are already using some of results of VOICES in our other projects.

Training Material

The training material developed as part of VOICES as well as the experimentations with online and face-to-face training are essential for all the initiatives of this kind that are existing in Africa and other regions of the World. There is growing movement in the developing regions to setup similar mobile laboratories. More than 15 countries have no innovation hubs or incubators or training labs. The vast majority of these initiatives do not integrate training sessions. The Web Foundation, being a prominent actor in this space as we were pioneer in the domain and we are currently running two labs in Kenya and Rwanda, we are planning to raise awareness of this material and share it with all organizations that are willing to engage in training.

2. France Telecom

a. Partner role

France Telecom is the number three mobile operator and number one provider of broadband internet services in Europe, and a world leader in telecommunications services for enterprises. Orange is the Group's flagship brand for internet, television and mobile services in the majority of the countries where the Group operates, with some 200 million customers. Innovation is a fundamental aspect of the telecommunications sector and a strategic lever for the France Telecom Group. By participating in European programmes that focus on the Information Technology society, France Telecom Group is contributing to the success of the work that has already been carried out on major future themes.

France Telecom had two primary roles in the VOICES project, within the Technical Voice Platform & Toolbox:

- WP2 aims to define the technical architecture of the platform functionally specified in WP1 and WP4, to develop and integrate all of the components, and to deliver the platform for direct implementation by the field pilots of WP4 and WP5.
- To deliver a comprehensive description of the platform and of its technical ecosystem, which enables easy replication of the concept, by social entrepreneurs in similar contexts.

b. Technology implementation plan for France Telecom

One of the important achievements in VOICES has been the development of a technical toolbox to support mobile services, and in particular voice-based services. This toolbox, called "Emerginov", was originally developed by Orange Labs prior to VOICES, and has been extended to support effectively voice-based services and to integrate the different extensions. It has been deployed in Mali and Senegal for the pilot services of VOICES WP4 and WP5, and has been tested for its ability to work in these local contexts.



Figure 3: Diagram showing the basics of the Emerginov platform

Emerginov has been released in the open-source domain, and it was redesigned so that it can be used both in the context of a mobile operator, and in a context of a service provider.

The platform consists of two modules:

- A gateway that is connected to the mobile infrastructure
- A core platform hosting all the services

In terms of Emerginov core platform components, the toolbox is a smart integration of lots of open source components. Several developments were required to ensure the consistency of all these components, allowing the smart integration of developments realized by VOICES partners. Additional developments were required for the publication of the open source solution.

The complete Emerginov platform has been released as an open source solution that can be downloaded on <http://emerginov.ow2.org>. Installation, administration and user guides are available online, including tutorials to connect gateways, configure VoIP clients, use specific low-cost hardware, etc.



Figure 4: Diagram showing the number of phone calls to and from the Emerginov voice-platform between May 2012 and May 2013.

In terms of projects, more than 20 projects have been created by almost 15 developers of the VOICES project. The summary of the overall development activities can be described in the table below:

Project	Number of lines	Number of PHP lines	Nb of files	Number of commits	Nb of developers
Vocs	1568770	100735	5541	1209	3
Voices_asr	2018	533	128	198	5
Voices_snfts	8415	52	24	60	3
V_radio_auth	8873	7766	1125	149	1
Voices_meetup	134635	12092	816	679	2
surveillance epidemiolog	351846	95755	947	2553	4
info du mois	877	855	73	360	2
Forobablon	30721	16571	734	695	3
glue emerginov	43909	30509	319	401	4
total	2150064	264868	9707	6304	27

Table 1: Projects hosted on the Emerginov platform including VOICES project pilots

To ensure local uptake of the VOICES results, Orange has participated in the offering of trainings to local ICT developers in Senegal in Dakar in May 2012. The goal consisted in was to explain how the toolbox was working, how to create projects and asking for Telecom resources. Support was provided to local developers using Emerginov:

- applicative support: support of the VOICES developers for all the pilots and the tooling developments. We validated account and project creations, attributed routable numbers and validated ad-hoc APIs such as Text-To-Speech.
- system administration support: support Sonatel administration team of the platform in Dakar (help them to restore platform after crashes) and support and supervision of the French platform on which the gateway in Mali was connected. Hundreds of alarms were managed monthly.

The code source of all the projects is freely accessible and can be downloaded as anonymous/anonymous here:

- <http://svn.emerginov.org> for all the application related to pilot in Mali and tooling
- <http://svn.emerginov.orange.sn> for m-health use case

It includes the media file produced during the different pilots (under the /media folder).

Thanks to VOICES, Emerginov offers a completely integrated deployment platform for mobile services. It supports multiple technologies (voice services, SMS, mobile Web) and can be connected to a wide range of infrastructure for basic low-cost equipment that would fit a small NGO up to a mobile operator infrastructure supporting thousands of services and customers. Emerginov is an essential element for mobile service deployment and fills an important gap, since no other platforms with this functionality exist in the open-source domain. All the documents are available on the site of the Emerginov community, which has evolved from a pure Orange Labs to a full open source project.

The business approach of Orange regarding Emerginov can be summarized according to three axis:

- detect innovation where it happens as soon as possible in order to find the best innovative partners;
- test concept directly on the field with the agility of a web company;
- detect high potential for possible recruitment.

The goal of the platform is not to make direct business, but through the delivery of Open Source platform and toolbox, to enable spread of innovation through communities of developers and communities of practice. The inbound traffic (SMS & VOICE) of the applications may generate some revenues but is also not an objective.

Depending on the Orange affiliate policy, routable numbers could even be declared as toll free number. For VOICES in Mali and Senegal, the call rate corresponded to local call rate.

The platform has been published under a free license software for several reasons.

First of all opening the code was coherent with the overall project as the solution consists in the smart integration of open source components. An open source governance has been initiated within Orange. Orange, as operator, is used to integrate open source components in solutions or devices. There is also a wish to contribute to community and get rightful regarding open source communities.

Secondly the publication answers to the demand of sustainability beyond the life of the VOICES project. The choice of open source simplifies intellectual property management - nothing is hidden and anyone can install its own instance of Emerginov to re-use/adapt the pilots that have been successfully tested on it over the past two years.

Finally it was important to be able to share the tools with the local developers. We thus could not impose proprietary solutions (even Orange solutions) within a toolbox that any student was supposed to be able to install locally on his/her laptop.

3. The Netherlands Organisation for Applied Scientific Research TNO

a. Partner role

The Netherlands Organisation for Applied Scientific Research (TNO) is a non-profit research organisation. Established in 1932, TNO's public mission has been established by law to support industry and society in general in transforming knowledge into products and processes of economic and societal value. In 2013 TNO employs about 3400 professionals. Its ICT related research, clustered under the theme "Information Society", forms a unique center of innovation in the Netherlands that brings together technical ICT and Telecom disciplines with social or economic fields (e.g. psychology, privacy, customer behavior, new business models). It helps companies, government bodies and (semi-)public organisations to realize successful innovations in ICT. Since 2006, TNO is involved in a variety of ICT-related project in developing countries under its ICT for Development (ICT4D) proposition. TNO ICT4D is active in projects in Sub Saharan Africa, South America and developing Asia. TNO was in the lead in WP1, and contributed to WP4, 5 and 6.

b. Technology implementation plan for TNO

Research activities

TNO has produced an ongoing series of scientific articles, practical publications, presentations and workshops from the research performed in the VOICES project. The focus in these efforts was on successful business models for BoP innovations, mostly focusing on ICT. TNO has been able to use these publications, presentations and workshops to greatly increase its international visibility in the field of ICT4D. As a concrete example of new business, TNO was hired by Engineers for Change (USA based subsidiary of IEEE) after delivering a workshop at the IEEE 2012 GHTC conference based on knowledge built up during the VOICES project. Presentations at for instance the EIRMA conference (2013) have also opened up new and interesting networks to TNO ICT4D.

Business development

In the future, TNO is committed to a focus on successful business models for BoP innovations, both for ICT and in other domains. The strong theoretical foundations, as well as the many case-study examples built up in the VOICES project, are core elements to TNO's offering in this field. TNO has and will continue to use this knowledge in all its ICT4D portfolios, and also in projects in other sectors, such as Energy or Health.

The most concrete examples of where and how TNO plans to use or is using the knowledge of the VOICES project are:

TNO has joined a consortium to bid for the EANOVI-ICT Europe Africa Collaboration Call in the area of ICT4D. TNO focuses on strategic alliance management, where parts of the Business Model framework developed in VOICES will be used.

TNO is discussing adding the Business Model Framework developed in the VOICES project as part of the Inclusive Innovation Hub (IIH) infrastructure to be set up by DGIS (Netherlands Ministry of Foreign Affairs) and BoP Innovation Center.

TNO is discussing adding parts of the Business Model Framework developed in the VOICES project as part of a new tool by Agentschap NL (Agency NL) aimed at strengthening Netherlands entrepreneurs who plan to startup businesses in developing countries.

TNO is discussing involvement in setting up local innovation hubs in Uganda and Bangladesh (Ministry of Foreign Affairs) where the knowledge from WP6 will be valuable background information.

TNO is discussing using the online learning tool (business model course for starting entrepreneurs) as a capacity building tool in Vietnam, in a project spearheaded by the World Bank and Global Research Alliance.

TNO is investigating an opportunity in India to use speech technology in combination with innovative packaging to decrease waste and corruption in the logistics of the regional school feeding programs

TNO is exploring a cooperation with Erasmus University, Leiden University and Delft University on 'frugal innovation', where TNO's BoP business modelling knowledge is considered a crucial asset in the negotiations.

TNO is exploring work on business models for community radio as part of a multimedia content strategy for an international NGO.

TNO is in contact with MIT (USA) to discuss business models for ICT for disease surveillance

TNO has made a connection with CSIR Meraka during this project, and efforts to start up joint projects are ongoing. The most concrete example of the effectuation of this relationship is the submission of a joint proposal to the South African Green Fund on 'Smart Grids for the Rural Poor' where TNO will focus on business modelling.

TNO is actively using the methods as well as the background knowledge in the development of its own products and services in Africa. Some examples include a biogas generator coming to the market in Tanzania in 2013, the rearing of crickets for human consumption in Kenia and Malawi, and the use of tablets for school teachers in war-torn Southern Sudan.

Education and training

TNO has employed 2 MSc students during the Voices projects, Veerle Michelbrink who graduated on her study on Impact Assessment and Renske Aarnoudse, who graduated on Adoption Methodology. Renske has found employment in the development sector at IDH in Utrecht.

4. VU University Amsterdam

a. Partner role

VU University Amsterdam (VUA) was established in 1880. VUA consists of twelve faculties, eleven research institutes and has currently 20,000 students. Research at VUA covers a wide range of fields that often cut across disciplinary boundaries.

The Network Institute is one of VUA's interdisciplinary research institutes. The Network Institute's mission is to come to a better scientific understanding of the emerging networked world in all its technological, economic and social aspects, and help advance its proper development. The Network Institute involves different academic disciplines, including information systems, communication science, computer science, business and management research, knowledge management, marketing and strategy, economics, artificial intelligence, mathematics, and organization science. Foci of its research programs are: (i) the networked organization; (ii) the connected world – handling complexity; (iii) Web and e-Science. Network Institute staff has been involved in a large number of EU projects (FP1-FP7) over the past years, and is up to present taking leading roles in many EU projects.

The Network Institute actively promotes one Free and Open Web: it participates in the international Web Science Trust through research and education, it has been key to Web Standards (in particular the semantic Web standard OWL), and supports the World Wide Web Foundation's "Web In Society" endeavour by the initiative called W4RA - Web alliance for Regreening in Africa, which is an important input to the VOICES project.

VUA's Centre for International Cooperation (CIS-VUA) is VUA's window to the developing world. VUA has fifty years of experience implementing international projects, and closely collaborating with partners and institutions in developing countries, especially in Sub-Saharan Africa. Recently, the achievements of the African Re-greening Initiatives, initiated and led by CIS-VU, are receiving vast international media attention.

In the VOICES project VUA has lead the m-agro knowledge sharing pilot (WP5) in several Sahel countries, especially Mali. The objective of the pilot was to design and deploy a rural community voice-based service system and voice toolbox involving local communities in innovation creation. VUA has also contributed to the VOICES sustainable architecture and business modelling.

b. Technology implementation plan for VUA

Research activities

VUA has produced a number of scientific papers (11 up to present) directly related to results of the VOICES project in the period 2011-2013. VUA will continue to do research on topics related to VOICES in 2013 and 2014 and beyond. One full PhD research has been dedicated to the VOICES work (in a scholarship funded by Nuffic). The PhD thesis is due end of 2013. The topic of the thesis is: Voice-based access in rural Africa.

Eight master's students at VUA have done research and completed their master theses, in topics directly connected to the VOICES research activities.

The results of the VOICES project will lead to more PhD research and more publications are expected in 2013 and 2014.



Figure 5: A student at VUA presenting his master thesis, directly related to the research done in the VOICES m-agro pilot

Education

A course on ICT4D for Master students in Computer Science, Information Science and Artificial Intelligence of VU University Amsterdam started in January 2013, and will be continued in the next academic year (2013-2014). This new course was a direct consequence of the VOICES project for VUA at the Network Institute.

Positioned at the heart of the VUA's vision of social relevance as one of the guiding principles, the core aim of the course is to raise the awareness that we as Computer Scientists can make a significant difference by sharing our expertise according to well established principles of international development. We present initiatives in which VUA is involved in: a project to use voice technology for local data exchange in small markets in Mali.

Intended results of the ICT4D course at VUA are to make the next generation of Computer Scientists aware of the importance of ICTs for the developing world and to equip the students with some initial project management, technological and programming skills specific to an ICT deployment in a developing country.

The VOICES results were also presented at the course on "Sustainable Land Management" for Master students in environmental studies and social sciences.

Partnerships and communities of practice

VUA is currently working, in collaboration with Orange Labs, to ensure the sustainability of the Emerginov Voice platform, after the end of the VOICES project. Emerginov is developed in WP2 by Orange Labs, and has recently been released as Open Source software.

VUA wants to ensure sustainability of the voice platform by:

- Setting up a global community of developers of voice technologies, as to set up a common-based peer production system;
- Set up long-term arrangements with Orange Mali, to ensure that phone lines will be available after the end of the VOICES project;
- Research on possible alternative (robust, inexpensive) voice platforms that can be hosted locally in African environments;
- Testing inexpensive alternative setups that may be deployed locally by partners outside the VOICES project;

As a consequence of VOICES, VUA is currently setting up partnerships with groups that want to become collaborators and help maintain and further the results of the VOICES project in the African context, after the end of the project. This group includes e.g. SMEs, NGOs, local governments and governmental agencies, experts in development, ICT service providers, local African academic partners, communities of (web, ICT) developers.

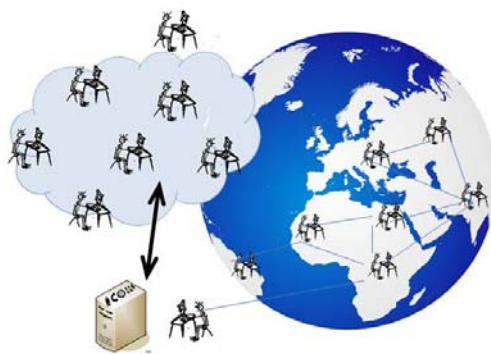


Figure X" This picture visualizes the global "community of voice & web developers" that VUA is aiming to establish, that is to support the results of VOICES over a longer period of time, to ensure sustainability.

The new ICT4D course (started in 2013) is one of the activities that supports this vision.

Follow up projects

MPOWER – A new proposal for further deployment of VOICES results

VUA has developed a proposal, in collaboration with SE, NWU and WF, and two other African partners for continuation and further deployment of VOICES activities and results towards Burkina Faso and Northern Ghana.

Other consortium partners are: Réseau Marp (a local NGO in Burkina Faso), University of Development Studies, Ghana, SB Consultancy. Associate partners are 10 radio stations in Burkina Faso and Mali. A local ICT SME in Burkina Faso (Yam Pukri).

This proposal has been submitted to EuropaID on 7 February 2013 regarding a call from ACP-EU Science and Technology II.

Name of the proposed project is MPOWER: *Mobile Participatory knOWledge sharing for Regreening*.

The expected project period is 1st September 2013 – 1st September 2016 . The proposal has still to be approved by the EU.

Participation of VOICES partners are VUA, NWU, Sahel Eco, WF. The project will be implemented in Mali, Burkina Faso, and Ghana.

Target groups of this proposal are rural communities in the Sahel countries, SMEs, NGOs, local governments and governmental agencies, experts in development, ICT service providers, local African academic partners, communities of (web, ICT) developers.

Intended results of the MPOWER project:

- Further development of voice technologies and toolbox adapted to the local contexts;
- Deliver tool support and methodology for speech technologies as to facilitates the local creation of content in African languages;
- Build new language packs for under-resourced languages for northern Ghana and Burkina Faso;
- Facilitate local uptake of results of the VOICES project;
- Transfer of knowledge to local partners in voice technologies, entrepreneurship, end-user support;
- Build local capacity of African academic partners in methodologies related to VOICES;
- Ensure overall long term sustainability of VOICES results after the end of the VOICES project.

5. CRS4 Italy

a. Partner role

The Centre for Advanced Studies, Research and Development in Sardinia (CRS4, www.crs4.it) is an interdisciplinary applied research centre based in Pula, Italy. The centre develops and applies innovative solutions across a broad range of important areas by leveraging its key strengths in several scientific and technological disciplines. CRS4 areas of interest include Advanced Computing and Communications, Energy and Environment, Bioinformatics, Renewable Energies and Information and Communications Technology. These areas encompass large-scale computational problems that require application of advanced simulation techniques supported by High Performance Computing and the timely integration of newly emerging Information and Communications Technology. The focus is on problems stemming from natural, social and industrial environments. The aim is the development and analysis of appropriate mathematical models, their numerical solution by advanced algorithms and innovative software tools for programming and visualization, as well as the validation and assessment of results based on benchmark problems.

In the field of ICT, CRS4 is doing research and development in mobile learning, wireless broadband communications, software and computing technologies, distributed applications, digital media technologies, digital asset management, video content delivery, semantic web and knowledge management.

CRS4 does extensive work on information management and digital media applications. Among other things, CRS4 developed an open source digital asset management framework (NotreDAM, www.notre-dam.org) and an open source platform for producing TV channels from user-generated content (CreaTivù, www.creativu.com). CRS4 also carries out research in the field of M-learning, specifically in knowledge construction and processing through open platform, instructional design and knowledge representation. The problem of hypermedia architecture is currently studied as a key aspect of knowledge accessibility. CRS4 is currently involved in the transfer of M-learning technologies for regional industries and institutes.

b. Deployment of VOICES results

The development of the VOCS crowd-sourcing tool has been another activity carried out by CRS4 within the scope of VOICES. Targeted to collecting vocal samples for tuning TTS and ASR algorithms for African languages, VOCS played an important role in the deployment of VOICE services.

Based on the Emerginov platform, which is freely available under an Open Source license, VOCS is oriented toward reuse across a wide spectrum of applications.

In the specific research fields of CRS4, the tool could be useful for collecting speech samples for testing and tuning an application aimed to identifying people through the analysis of their voice (VoiceID, <https://code.google.com/p/voiceid/>). Other areas of application could be envisaged, based on the same model (crowd-sourcing) and technologies.

6. CSIR – Council for Scientific and Industrial Research

a. Partner role

The CSIR is one of the leading scientific and technology research, development and implementation organizations in Africa. The CSIR has been constituted by an Act of parliament of the Republic of South Africa in 1945 as a science council. The CSIR undertakes a multi-disciplinary research approach and technological innovation to improve the quality of people's lives.

The CSIR Meraka Institute is a unit focusing on ICT. Various aims of the CSIR Meraka Institute are the research & development new technology that enables ICT access, inclusion and use, the research & development and transfer of innovative ICT products and the contribution of skills and outcome that change the profile of the ICT landscape.

The integrative systems, platforms and technologies competence area focuses on the research, design and development of next generation ICT systems, platforms, frameworks and components. The aim is to provide novel building blocks and integrative mechanisms to enable and empower multidisciplinary ICT solutions for developing market environments.

The Human Language Technology (HLT) competence area develops speech technologies, such as speech recognition, speech synthesis and spoken dialog systems, with the aim of facilitating better interaction between humans and computers through natural languages (such as English, isiZulu or Setswana). This can benefit a wide range of people – from illiterate farmers in remote villages who want to obtain relevant medical information over mobile phones – to scientists in state-of-the-art laboratories who want to focus on problem-solving with computers.

b. Deployment of VOICES results

The CSIR's participation in the VOICES project enabled us to contribute towards developing speech technologies that are easy to use, affordable, in local languages and that meet the needs of the users at the pilot sites. The CSIR also contributed towards developing a tool to measure the user experience relating to mobile voice services.

The intention was that the work done and experience gained would be shared and would allow for opportunities for future research on relevant dimensions of the project. This ensures that deliverables and results of the VOICES project will not fade away but will allow for new opportunities of research collaboration and the creation of new knowledge, which would benefit Africa.

Two outcomes from the VOICES project have already been identified and are in the process of being realised.

Research activities

The first relates to the on-going supervision of students in the field of Human Computer Interaction, specifically user experience of mobile speech technologies. A Masters student is currently developing a tool to measure the user experience for mobile speech technologies based on two use cases, viz. the agriculture pilot in Mali and a local agriculture use case. The research will lead to papers published at conferences and in journals as well as the completion of a Master's dissertation.

Business development

Secondly, a collaborative opportunity has been identified with France Telecom Orange (a current partner to the CSIR in the VOICES project) and Afrivet Training Services (a partner to the CSIR in the Lwazi project) to replicate voice services in a call for proposals by the Southern African Innovation Support (SAIS) initiative. The proposal is entitled the Development of 2 mobile agri-platforms for livestock owners in Botswana and the aim is to roll these services out to Namibia and Zambia after piloting and commercialisation in Botswana.

If successful, France Telecom Orange will be the network provider, host and main implementation agency of the services. The services will include IVR (Interactive Voice Response), a related web-interface and an outbound voice service. The voice and web technologies will be designed and developed by the CSIR. The content and relations with local agricultural middle-men will be provided by Afrivet Training Services. The services will be customised to the recipient countries' native languages, e.g. Setswana in Botswana.

Mobile voice technology and services that access technical and market information in the agricultural sector are well-documented. Our aim is to take the lessons learnt from other m-agri projects (i.e. disease surveillance and marketing of agricultural products) to ensure that future projects are successful, and particularly, scalable and sustainable.

7. École supérieure multinationale des télécommunications

a. Partner role

The birth of this University, in 1981, is the outcome of a successful regional cooperation between seven countries: Benin, Burkina Faso, Mali, Mauritania, Niger, Senegal, and Togo.

ESMT is located in Dakar, and its mission is to train engineers in the field of ICT (Information and Communication Technologies). Those who graduate from the institution are mainly hired by telecommunication Operators, Regulators, authorities in charge of development policies in the sector of ICT, and Civil Society.

Being aware of the role of ICT in development of their countries, governments have integrated it in their programs of development, democracy consolidation, and poverty reduction. However ICT is not yet playing a full role in those countries, because of problems relating to its availability, accessibility, and affordability. The lack of trained human resources, equipped with the skills required for the design of ICT applications and their management is also a major problem for developing countries in general and sub-Saharan Africa in particular. As partner in the VOICES project, ESMT, in collaboration with the Work Package Leaders of WP2 and WP4, had the opportunity to contribute to various aspects of the accomplishment of tasks and plans of the pilot in Senegal.

Aiming at diminishing the impact of infectious diseases on the population, notably in the rural zones, ESMT accomplished the following tasks :

- Design, development and realization of applications for WP 4 (Epidemiologic monitoring, information of the month, Quiz, technical assistance, development of the web site: projects.emerginov.org/surveillance_epi/interWeb/), according to specifications, modalities, and delivery dates, defined in the project work plan.
- Design and development of applications in 4 iterations for different tasks identified for each scenario.
- Maintenance of applications up to the end of the project.

These applications, constituting of a system to collect epidemiological information and provide biomedical training for lab technicians, will facilitate the circulation of data amongst different entities within the National Network of Laboratories.

- ESMT has contributed to the training of mobile entrepreneurs in Senegal on mobile technologies. This non-profit organization introduced local entrepreneurs and interested developers in the opportunities of the Web and mobile technologies. This is aimed at creation of useful applications for local communities.

“Mobile entrepreneurs in Senegal” is an initiative of the Web Foundation, TNO, PT Inovação, CRS4 and ESMT within the VOICES project, (mvoices.eu), in collaboration with W3C and Orange labs.

b. Technology implementation plan for ESMT

Education and business development

- Student trainings to develop micro-services on the voice- platform;
- Continue the partnership with Orange Labs and other partners in VOICES towards other projects;
- Extend the experiences of Senegal to other countries (especially multinational schools) with support from the partners ;
- Develop new expertise and training in development of mobile application that bring added value to the local environment;
- Valorization and dissemination of this experience in seminars and conferences;
- Re-utilization and enrichment of our support to training facilities.

8. Sahel Eco (SE) Mali

a. Partner role

Sahel Eco is a Malian non-governmental organization (NGO) founded in 2004 by the transformation of the Mali Country Programme of SOS Sahel International UK into an independent national structure. The mission of Sahel Eco is to work with men and women in Mali and in other countries in West Africa, and improve and secure their livelihoods through better management of the environment. Strategic objectives for the current planning period are 1) improved environmental governance through support for the co-management of water, forest and pastoral resources by local communities, municipalities and state services and 2) more diverse and secure rural livelihoods through the development of small and medium agro-pastoral and forest enterprises and investments in appropriate infrastructure.

Sahel Eco has offices in Bamako, Mopti, Bankass and Tominian (Mali). Technical and financial partners in 2010 include VU Amsterdam (Sahel Regreening Initiative – Mali) Tree Aid, IIED, CARE Mali and the FAO. Sahel Eco is focal point in Mali for the Sahel Regreening Initiatives and moderates the francophone social networking site www.reverdirlesahel.ning.com.

Sahel Eco acted as a host/organizer of the m-agro knowledge sharing WP5 pilot and provided input to the development of the voice-based services for agriculture being the contact between local stakeholders as a bridge to the local social network and the project partners, and by providing extensive domain knowledge.

b. Technology Implementation for Sahel Eco

Sahel Eco will remain the bridge between the local stakeholders in the African rural development context, and the ICT entrepreneurs and web developers, who want to deploy the results of VOICES in a production environment. Sahel Eco and its stakeholders and beneficiaries, the farmers and rural communities are already planning to deploy and scale up the results of VOICES.

Adoption of innovations and business development

- Radio Marché is presently deployed in the Tominian region. There is much interest by rural communities to deploy an instance of Radio Marché in other production environments, to improve trade facilities for rural communities in other regions of Mali. Sahel Eco wants to scale up Radio Marché and is working with web Foundation, VUA and NWU to deploy Radio Marché in different local languages (e.g. Dogon) and for different tree-products.
- Tabale is a very useful tool for communication for Sahel Eco. Sahel Eco will train local users how to use this service.
- Foroba Blon is requested by several radio stations, who learnt about this radio-based blogging system on several dissemination events. Sahel Eco already helped to scale up the use of Foroba Blon by other radios in Mali, or other countries. Foroba Blon is already in use in Ghana. Radios in Burkina Faso are interested in adopting it.

9. GEIE ERCIM W3C

a. Partner role

GEIE ERCIM is the European host of the World Wide Web Consortium (W3C). W3C is an international consortium where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C's mission is: To lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web.

Tim Berners-Lee and others created W3C as an industry consortium dedicated to building consensus around Web technologies.

W3C has a proven track record of success, and has contributed to what may be some of the most important developments in the IT and Internet industry in the last ten years, including the development of XML and, of course, the development of the Web itself.

W3C had two roles in the project, one in the management part, one in the technical part. As part of the management activities, W3C was the financial manager of the project.

b. Technology implementation plan

W3C through its network of offices, notably in Africa, will also serve as a local relay to disseminate the results of the project locally, and ensure a greater involvement of local partners.

10. Fondation Mérieux

a. Partner Role

Fondation Mérieux (FMX) is an independent family foundation set up by Dr Charles Mérieux, in 1967 with official charitable status awarded in 1976. Fondation Mérieux' mission is to strengthen local capacities in developing countries to reduce the impact of infectious diseases on those most vulnerable. FMX is established across the world at the heart of infectious outbreaks. In each of its fields of activity, it brings together and mobilizes the world's top doctors, pharmacists, researchers, and specialists in infectious diseases, vaccinology, and epidemiology. It runs projects that contribute to developing and strengthening the capacity of local governments in public health matters. It is setting up its own aid projects in developing countries and has local and international public and private partners, or it is integrating itself into already existing programs and providing them with its financial, material and human support. It has four areas of action: 1. Health infrastructures strengthening, 2. Training and knowledge sharing, 3. Applied research and 4. Patients' support.

Through the RESAOLAB project (<http://resaolab.globe-network.org/fr>), Fondation Mérieux aims to strength the National Network of Laboratories in Senegal, Burkina Faso and Mali and finally the quality of analysis. One of the goals is to improve the communication between different level of laboratories and the national level, especially concerning the epidemiological data.

In the VOICES project, Fondation Mérieux has involved the ministry of health in Senegal in the pilot study and worked with France Telecom to define the use-cases and to test the pilot in different sites. Fondation worked with France Telecom and National Network to identify different possibilities of sustainable economic model to extend the pilot and to

b. Technology implementation plan

Fondation Mérieux has the desire to continue to support this m-health project beyond its pilot phase, which enabled to demonstrate the benefits of mobile phones using the application developed by VOICES. Promoting its expansion and sustainability in Senegal and creating a linkage with the Laboratory Information Management System **Lab-Book** (developed as part of RESAOLAB, which also includes a tool for epidemiological surveillance for laboratories via the Internet) are paths of collaboration between the Fondation Mérieux, Orange and the ministries of health in RESAOLAB partner countries.

A new project called RESAOLAB+ is starting. The aim of the project is to reinforce the laboratory system in seven West-African countries (Burkina, Mali, Senegal, Guiney, Togo, Benin, and Niger). On short term, Fondation Mérieux, who organized the pilot in Senegal, wishes to extend the epidemiological surveillance application to the six others countries.

11. Portugal Telecom Inovação

a. Partner role

Portugal Telecom Inovação, SA develops innovative and competitive services and solutions for the telecommunications market. Our success has been built and sustained on the competences we can call on in applied research, technology integration, services and solutions development, telecommunications engineering and training services. Major products include systems and solutions for intelligent networks, Access Networks, Multimedia and IP Solutions, Mobile Networks, Services and Platforms, Network Management, Business Intelligence, IT Systems and Software Engineering, as well as Telecommunications Business Processes, Support and Training.

With operations spread over three continents and its headquarters in Aveiro, PT Inovação also has branches in Oporto and Lisbon. In Latin America, the company has a subsidiary in São Paulo and, more recently, has set up a software development centre in Salvador, both in Brazil. Since last year, the operation in Africa has been centred on a subsidiary company in Luanda, Angola.

PT Inovação promotes R&D cooperation and has privileged partnerships with major universities and centres of innovation, at both the national and international level.

In Voices project, PTIN was responsible for the Moodle-based platform development and for the creation of multimedia contents over HTML 5 technology. Furthermore, it had contributed to the establishment of a sustainable architecture and to the analysis and evaluation of the voice platform and speech technologies tools.

b. Technology implementation plan for PTIN

PTIN intends to exploit the outcomes of VOICES projects in three main axes:

- E-learning Platform - One of the main objectives was to create a self-sustainable auto-expandable mobile training lab in Senegal. PTIN has developed a Moodle-based platform targeting the VOICES requirements for e-learning. This platform will be reutilized as a distance learning tool and also as a useful model to check the developments required for PTIN e-learning portfolio. Furthermore, the work done in VOICES triggered innovative approaches of research to enable an efficient knowledge acquisition through the usage of new methodologies over enhanced learning platforms (context-aware for learning, learning objects and massive open on-line courses).
- Contents – PTIN intends to use the knowledge gathered in HTML 5, a mark-up language for structuring and presenting content for the Web, in the building of a new generation of multimedia contents. Furthermore, the contents created within the VOICES project will be internally distributed in order to increase global PTIN competences.
- Consulting - PTIN intends to promote and exploit project results within PT Group or externally to its customers. The information collected related with voice tools and speech technologies during the project will definitely be used by PTIN in all consultancy work related with the global ecosystem involved in voice-based services for developing countries.

12. North-West University, South Africa

a. Partner role

The North-West University (NWU) is a South African university with campuses in Mafikeng, Potchefstroom and the Vaal Triangle. The NWU came into being on 1 January 2004 through the merger of two universities with very different histories, personalities and cultures: the Potchefstroom University for Christian Higher Education and the University of the North-West.

The Multilingual Speech Technologies Group (MuST) operates on the Vaal Triangle campus of NWU, and is active in research and development of speech technologies for the developing world, with a particular focus on the languages of Southern Africa. MuST has been involved in a number of projects aimed at providing information access in the developing world using speech technology; these include medical applications in Botswana, agricultural applications in India and support for social services in South Africa.

In VOICES, NWU had primary responsibility for the development and evaluation of speech technology. Thus, simple text-to-speech systems were developed for Bambara, Bomu and West-African French, and a speaker- and vocabulary-independent speech-recognition system was created in Bambara; these technologies were integrated and tested in the m-agro knowledge sharing pilot in Mali.

b. Technology implementation plan for NWU

Research activities

NWU intends to utilize the tools and resources that were developed in VOICES in three overlapping ways:

- Most prominently, we will continue to develop technologies and applications that can assist citizens of the developing world with information access, using speech technology. We are involved in a number of initiatives to further improve the performance of these technologies, e.g. by incorporating tonal information, and are in ongoing discussions with parties such as the South African government as well as companies and NGOs in Southern Africa aimed at creating applications of this nature.
- The developments that resulted from VOICES will also be utilized in our attempts to create commercial applications of speech technology for under-resourced languages. We are currently investigating a number of such ventures using the eleven official languages of South Africa; these include a directory-assistance application and systems for voice analytics in call centers; currently, there are no applications in those categories in any under-resourced language.
- Although the VOICES project demonstrated the potential of speech technology, it is clear that much research remains to be done in order to make these technologies more capable and easier to develop. The tools and resources developed during

VOICES will thus be used as important inputs in our research strategy to continue development in those directions.

Besides these initiatives, technologies developed during VOICES will also play an important role in our educational initiatives. We intend to graduate approximately 2 Ph.D. students and two MSc students per year for the foreseeable future, and all of those students will benefit from the VOICES outputs. In addition, undergraduate students at our university will be offered short courses and workshops in speech technologies, for which the VOICES technologies will be useful tools.

6. CONCLUSION

The VOICES project delivered an integrated bundle of results in line with its objectives. In this document the VOICES partners presented their technology and implementation plans for the results of the VOICES project. These results will be implemented in different domains, depending on each partner's core competency. The technology implementation plans of the VOICES partners are focused on :

- Research and Technology Development
- Adoption of innovations in the African context through local community building
- Education and training
- Business development

From the technology implementation plans in the previous chapters we may conclude that the results of the VOICES project have made an important contribution to the domains of information access by underprivileged communities, local content creation and management, speech technologies, and of sustainability of ICT for Development initiatives. The results of VOICES will be advanced in different sectors of society, by different partners of the consortium, each partner according to its own competencies, target groups, vision and mission, shaping the future of voice technologies for social-economic development.