FRANCIS SAA-DITTOH

FROM RADIO TO AI

African Community-driven Development of Sustainable Information Systems

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African Sustainable Human-Centered Digital Development of Systems

FRANCIS SAA-DITTOH

1. PhD Candidate

   Vrije Universiteit Amsterdam

2. ICT4D Researcher

   Ghana, Burkina-Faso, Malaysia, The Netherlands

3. Lecturer; ict4d, hci, programming...

   University for Development Studies, Tamale, Ghana

THE INTERNET IS FLAWED!!

Yeah, I said it!!

The Methodologies for building ICTs in most regions of the world are also flawed

THE FATHERS AGREE

The Internet *is* flawed

Inclusion

"I wish that people like you were around when we were making decisions concerning how the Internet should be"

Vint Cerf

(2023)

Colonized & Centralized

"From Utopia to Dystopia"

Sir. Tim Berners Lee

(2018)

Hardware

"We need to start looking at wireless technologies; radio, satellites, to help the unconnected"

Robert Metcalfe

(2023)

THE DIGITAL DIVIDE

The flaws are more evident (and dangerous) in resource-constrained environments because we have to deal with even more barriers

Infrastructure Gaps

Lack of reliable internet connectivity, especially in rural and underserved areas

Literacy Barriers

Low literacy rates; most unconnected communities do not read nor write resourced languages like English or French

Relevance of Content

Existing digital content is not tailored to the needs and interests of unconnected communities

Addressing these issues of the digital divide is not trivial, but multi-faceted and contextual

ICTs?

UN SDG (9c)

only states that we need to "*significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020*"

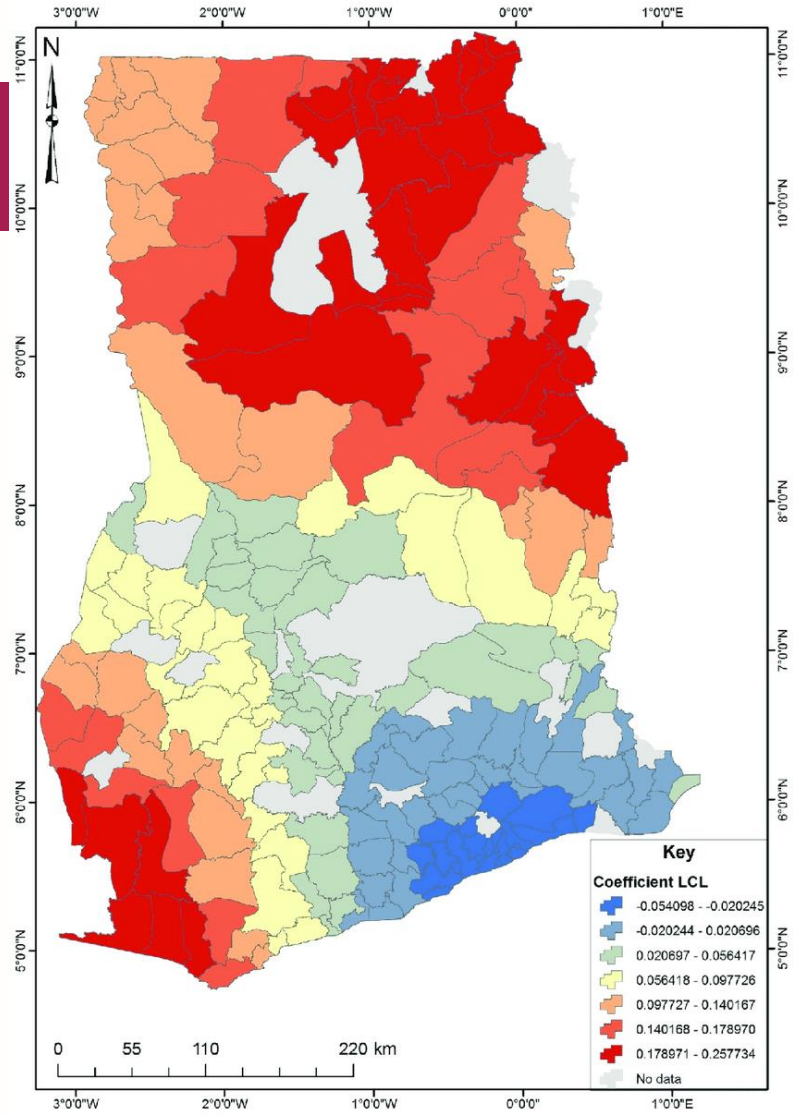
This is insufficient and totally failed

The question we needed to answer is; **How?**

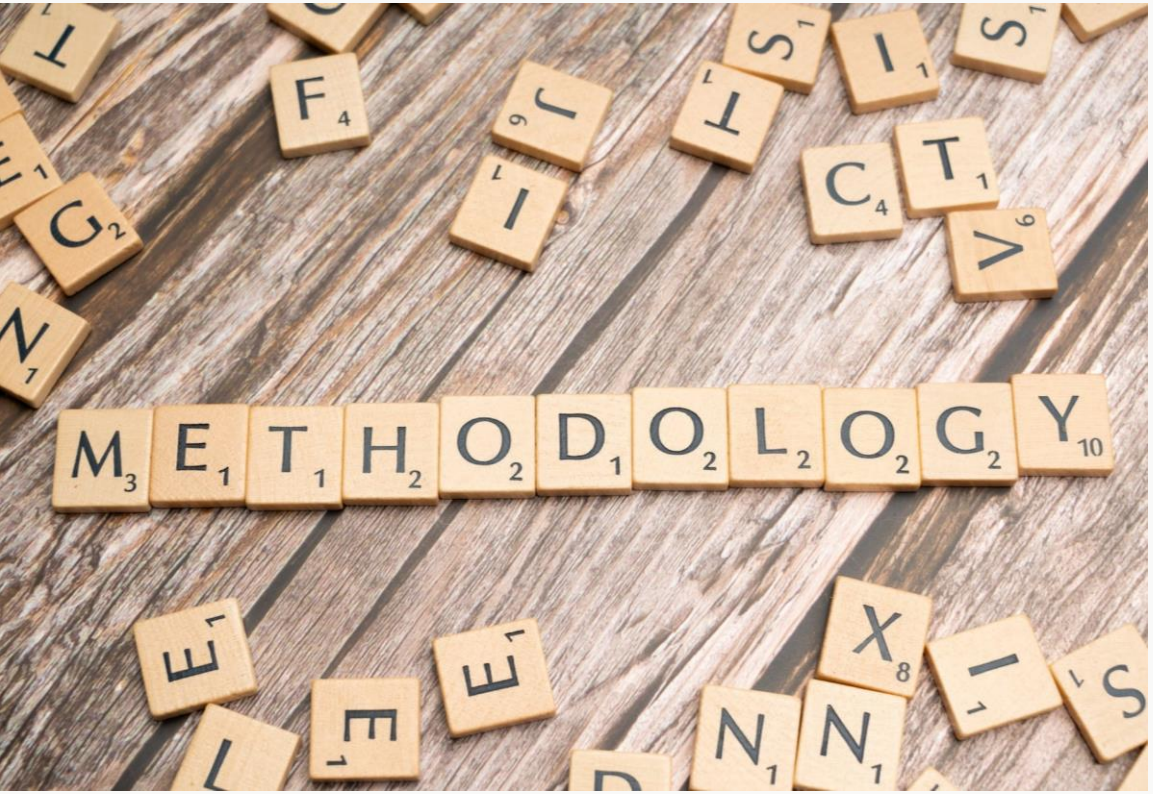
how exactly will this be achieved?

Internal Digital Divide

- Ghana Literacy Rate??
  - 80.4%
- Northern Region Literacy Rate
  - >30%



How?



Systems Engineering

Agile

Prototyping

HCI

Human-centered approach

Ethics

Social Science

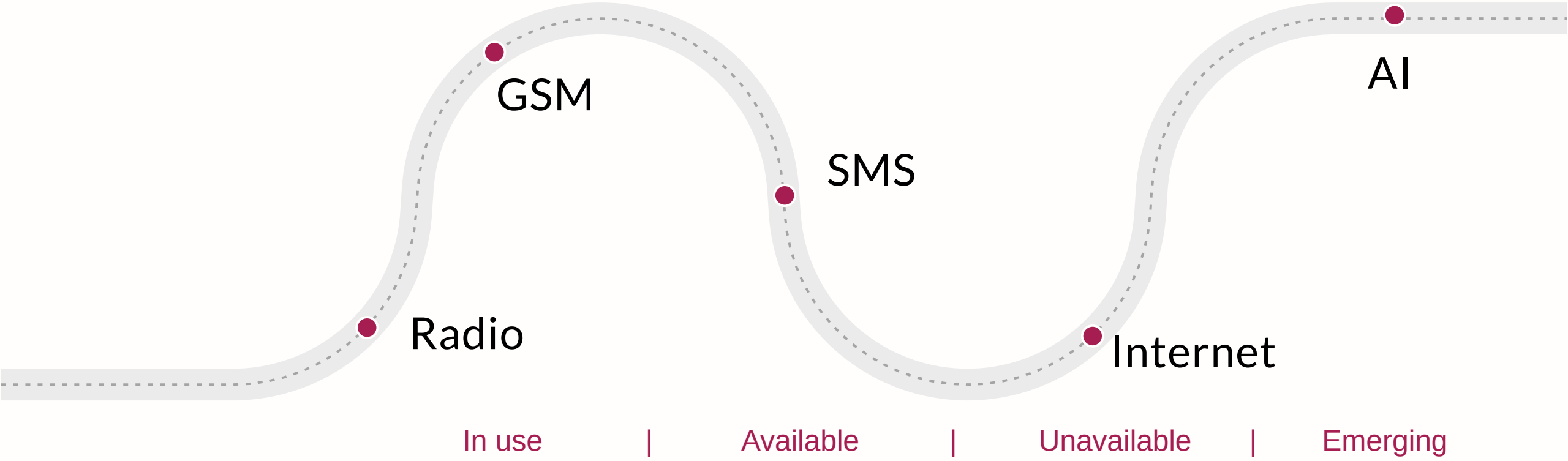
Living Labs

Participatory Action Research

Food security

Community-based Research

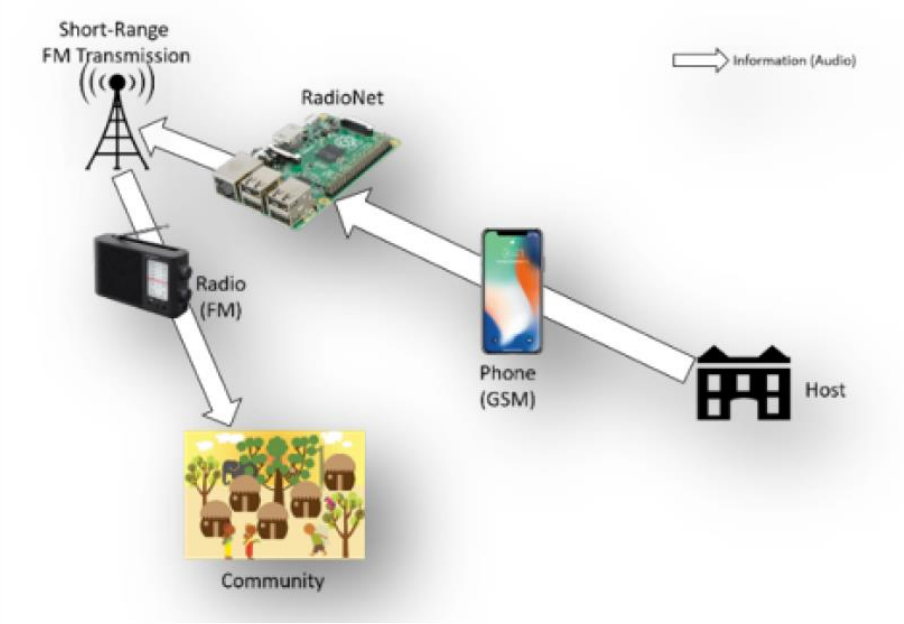
Technologies



In use | Available | Unavailable | Emerging

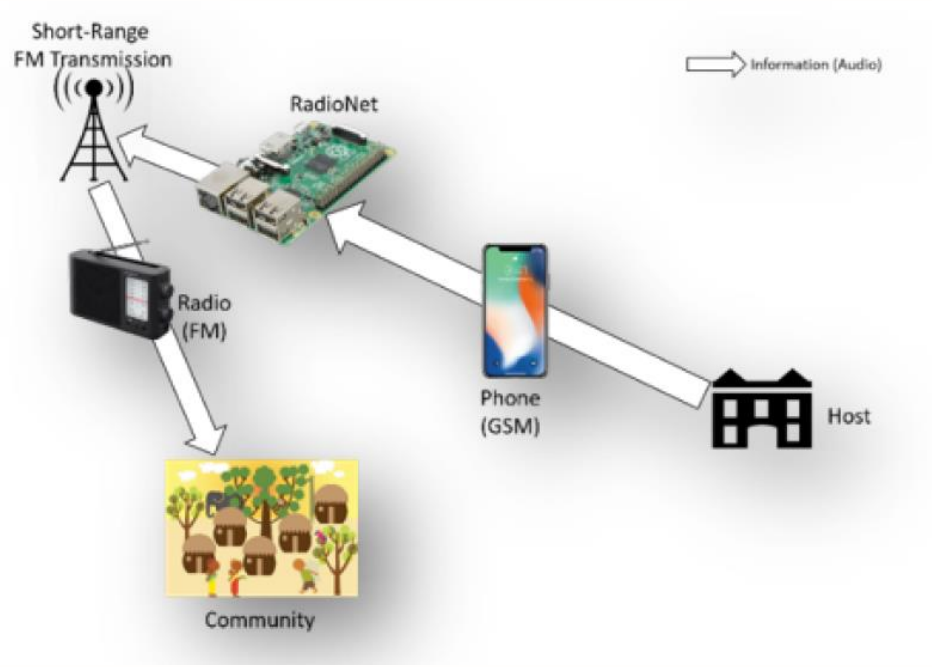
Use-Case - Tibaŋsim (Radio/GSM/SMS)

- Built on local initiatives
- Adapted to local conditions
- Built with available technologies
- Decentralized
  - Data
  - Hardware



Tibaŋsim

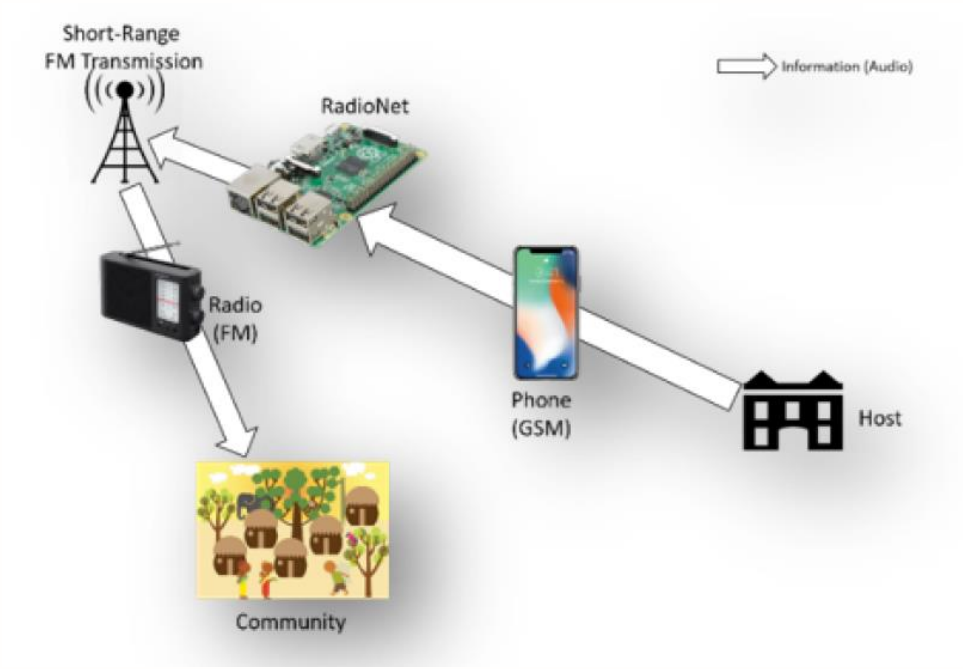
- The Tibaŋsim (RadioNet) System allows the host to make a normal call over a phoneline and using an Interactive Voice Response (IVR) interface, record messages which are stored on the device.
- The device will then automatically begin broadcasting all stored audio fragments over a pre-selected FM frequency over a short-range
- Users in the community simply tune in to the said frequency to listen to these repeated transmissions.



Tibaŋsim (GSM)

Technical Overview

- Voice Input
  - Kasadaka
- Broadcast System
- Monitoring System



Tibaŋsim (Radio)

Technical Overview

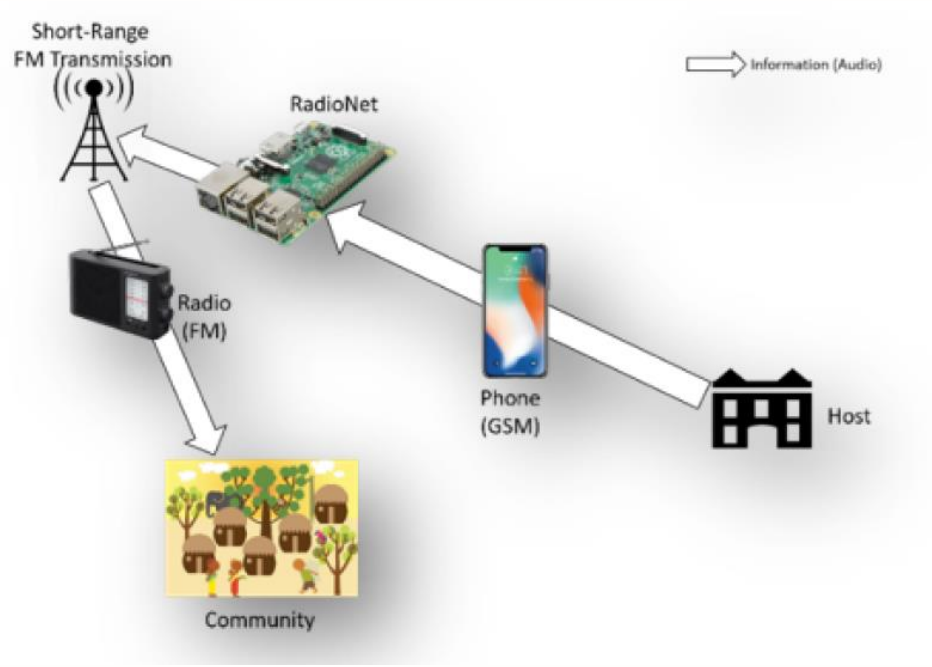
- Broadcast System: Pi-FM-RDS

- Pi-FM-RDS generates an FM modulation, with RDS (Radio Data System) data generated in real time

- It can include monophonic or stereophonic audio.

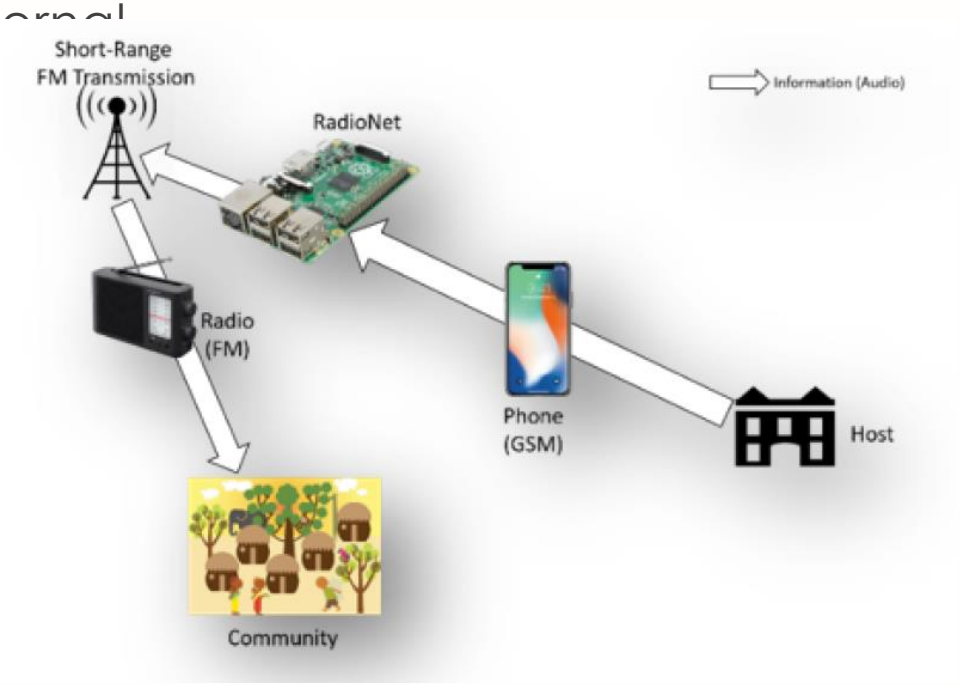
- The transmitter uses the Raspberry Pi's PWM generator to produce VHF signals.

- Pi-FM-RDS generates its audio from an audio stream or file.



Tibaŋsim (SMS)

- Monitoring System: BashOverSMS
  - Uses the existing GSM connection to send int measurements to a pre-defined number.
  - The information, which includes device temp CPU & IO utilization, number of running proce uptime and the names of the available recordings from the Kasadaka file system, is s at 30 minute intervals.
  - Also receives commands sent from a pre-de number and executes them on the system.
  - **Just don't SMS rm –rf**



Tibaŋsim


#Chapterthon2019 Winners
2
Internet Society
South Africa Chapter
1
Internet Society
US New York Chapter
3
Internet Society
Ghana Chapter

TIBaLLi - AI

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TAHMO

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH • GHANA • CSIR

- Making AI Work for Internet Inclusiveness in the Global South
- Can advanced AI methods (ML, NLP) be reconstructed so as to make the Internet more inclusive for communities in low-resource environments in the Global South --- such that local weather data combined with Internet-based global climate information become sharable beyond the Internet's current boundaries and in people's own language?

TIBaLLi - AI

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- Participatory Action Research (PAR)
- Language – Dagbani; a Gur language spoken in Northern Ghana. Its native speakers are estimated around 3,160,000

TIBaLLi - AI

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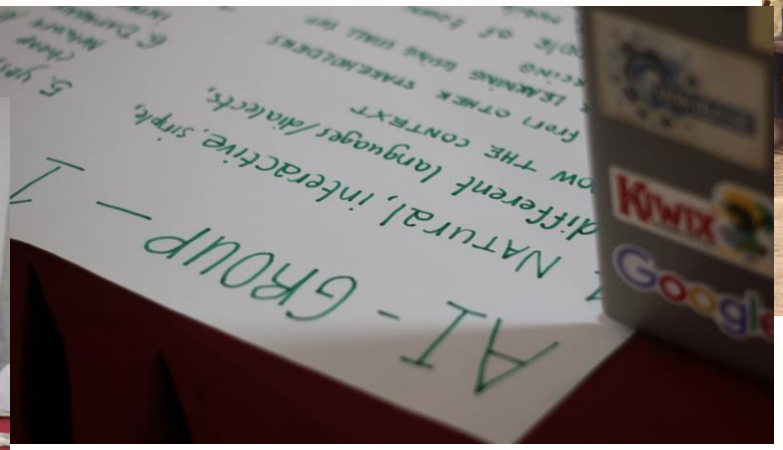
- Participatory Action Research (PAR)
  - Stakeholder Workshops
  - Focus-Group Discussions



TIBaLLi - AI

Internet Society Foundation

- Build Data Collection Tools Suitable for the Region ✓
- Crowd-source for a language dataset ✓
- Implementing new AI Model(s) through ML based on the dataset
- Building NLP systems for the local language using the AI Model(s)
- Integrate the system into a real-world low-resource digital information system (Tibaŋsim, Mr. Meteo)
- User and Technical Evaluations.

Antria Panayiotou

Wilhelm Kutah

TIBaLLi - AI

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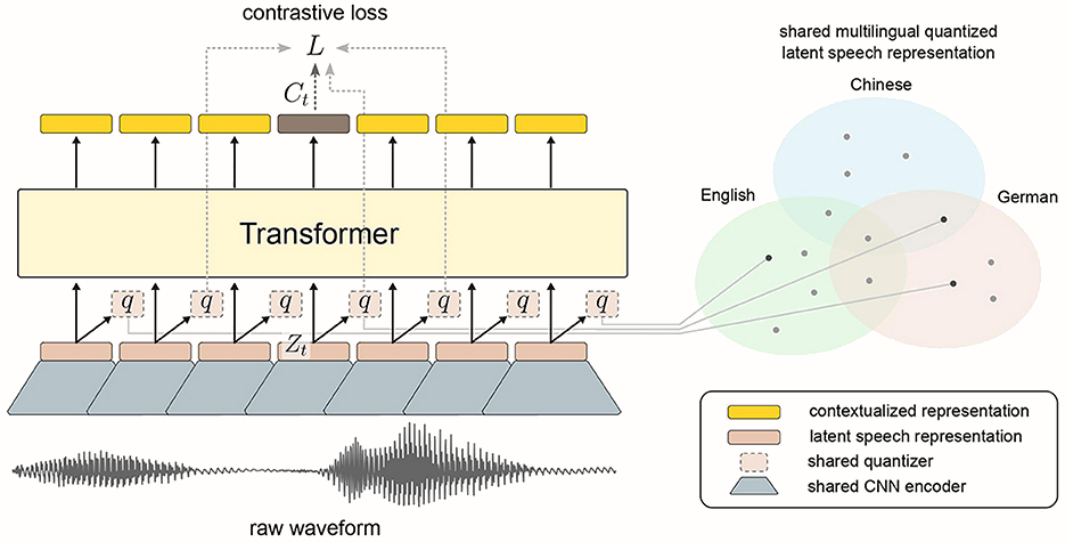
André Baart

Gossa Lô

Bram Kruger

TIBaLLi - AI

- The base model chosen was Wav2Vec. This model has been pre-trained on a diverse corpus encompassing over 1,100 languages.
- 4,000 utterances of specific Dagbani words were collected. This dataset comprised recordings of native speakers pronouncing words such as "yes," "no," and numerals from zero to ten
- Audio Preprocessing: normalized, trimmed
- Data Augmentation
- Fine-Tuning
- Evaluation and Testing



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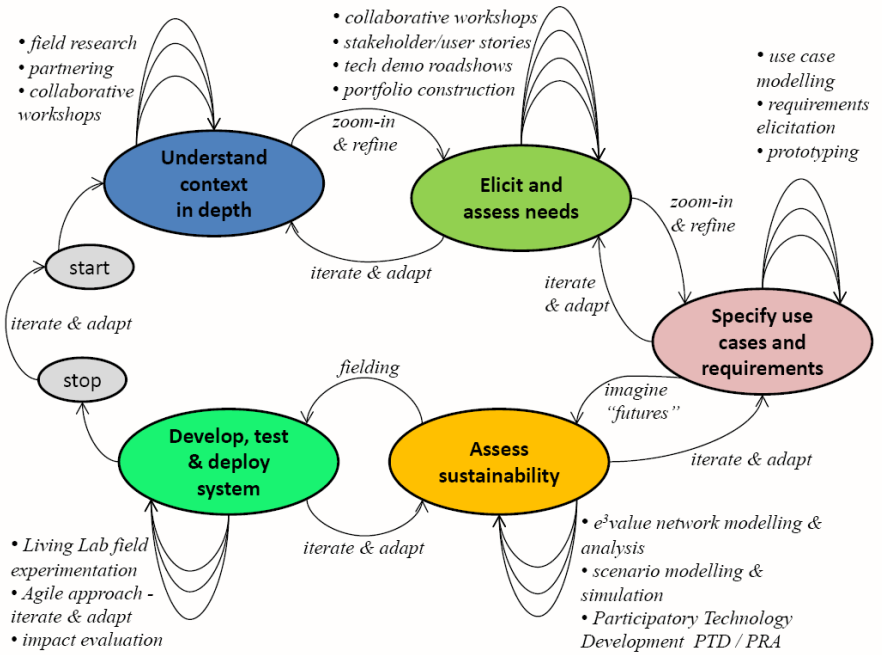

TIBaLLi - Additional Research

- ASR using existing LLMs phonemes
  - For rapid development of ICT tools that have ASR for small languages, we are looking for ways of by-passing the tedious, time-consuming and resource intensive steps
  - ASR Model that uses phonetics in Large Languages to recognize any word based on the fact that languages share the similar sets of phonemes or at least as close as possible
- Optimizing ASR Models to run locally on Android or Raspbian
- SMS 4 Good – Data Transfer using SMS
- Android-Based Voice Server
- Low-Earth Orbit Satellite Internet for Resource-Constrained Environments

THE PLUG-IN PRINCIPLE FOR ICT4D

1. ICTs should not replace indigenous communication methods, but should only better them
2. The ICT intervention should be narrower as compared to the existing system. Any intervention that is not narrower stands the risk of being too disruptive
3. ICT4D researchers and developers must thoroughly understand the existing situation
4. ICT4D researchers and programmers need to be known, and accepted by stakeholders and community members as far possible. Local communities are largely people-centered
5. ICT interventions must produce an amalgamation of a system that is mostly indigenous but merged with our developed ICTs; this requires that we understand and appreciate the existing system
6. ICT systems should be developed with the intention that they will be replicated and/or reused in other places or within other systems.

Thank You from Africa