Communication network systems within white spot areas

Prof. Cheikh Ahmadou Bamba GUEYE
Université Cheikh Anta Diop (UCAD)
http://per-edmi.ucad.sn/~gueye

ITU-D Study Group Question 3/1 Workshop, April 25th 2024

Roadmap

- Introduction
- What technology to connect the unconnected areas in Senegal for economic growth?
- COWShED: COmmunication within White Spots for brEeDers
- Beyon COWShED

Introduction

- Almost 75% of this unconnected population is located in least developed countries and is concentrated in rural, low-income, and low-literacy areas

- Presence of **white spot area** which means **geographic location not covered** by mobile network **operators**

- **White spot areas ⇔ natural disaster situation**

- A huge amount of Senegalese territories are within white spot areas due to cost to business and poor return on investment

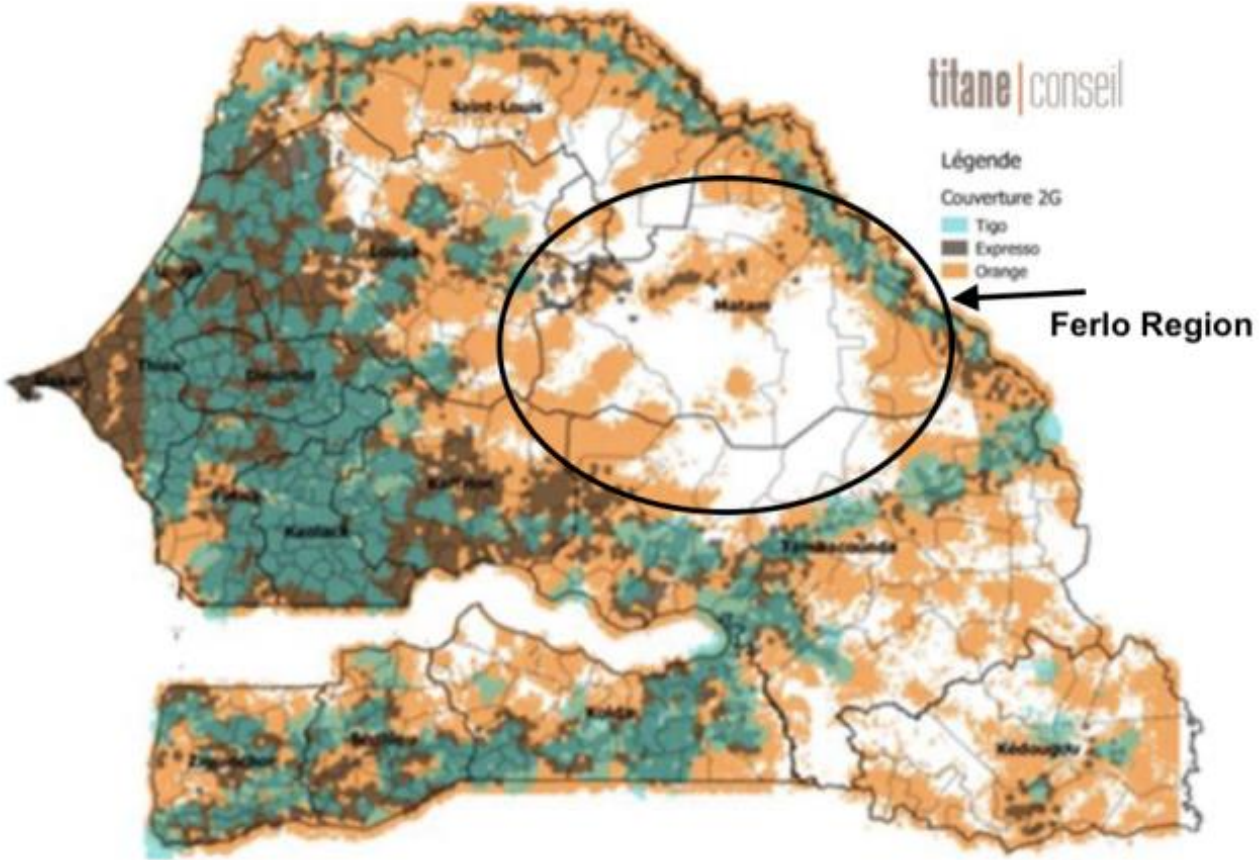
Outcomes

- A **mesh-based proof-of-concept network** was built for **communication** between herders based on RF transmission within **ISM bands** for **areas without cellular coverage**

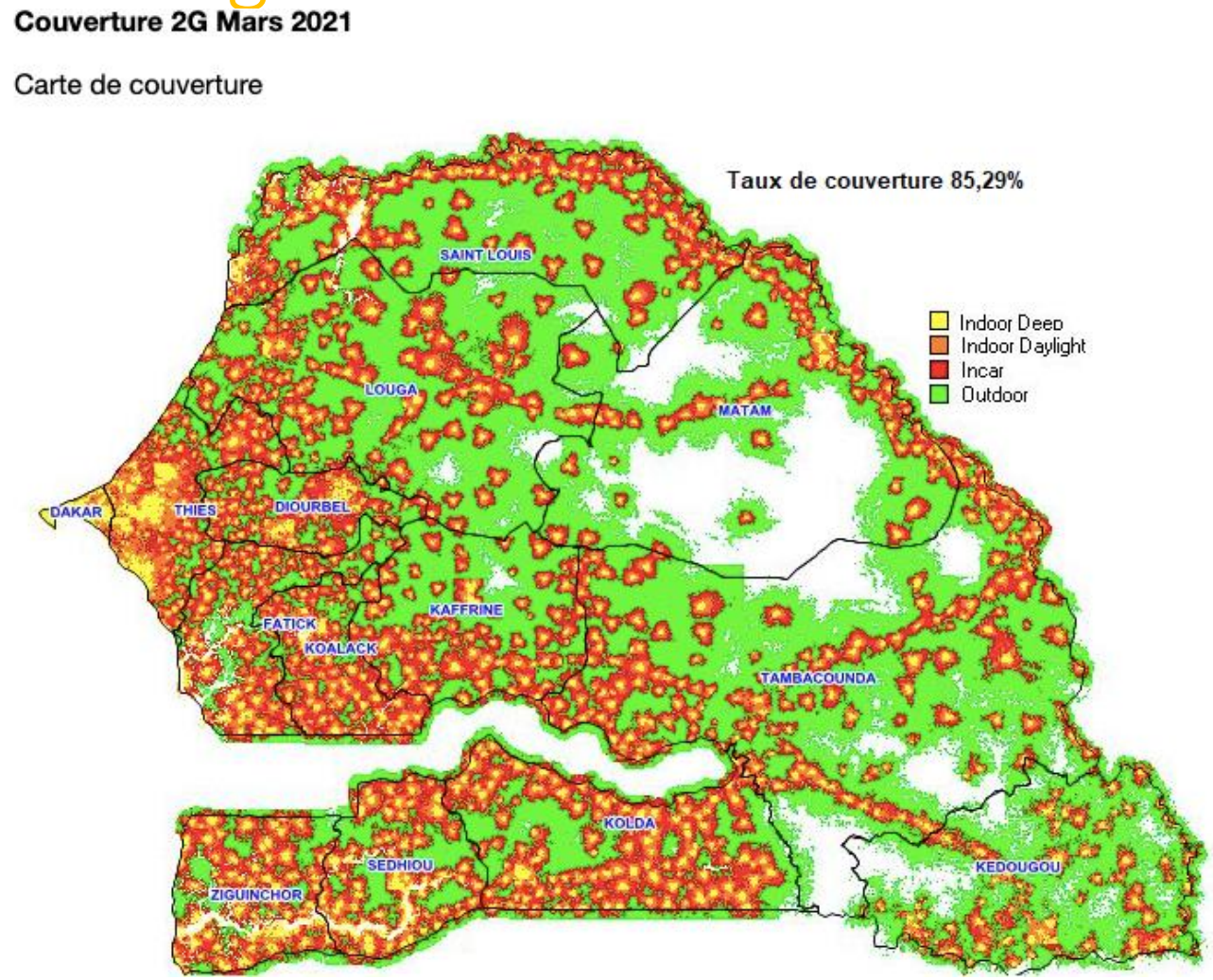
- A radio network and computing infrastructure for herders, farmers, and other stakeholders, covering previously unconnected regions

- A new data-driven strategy for sustainable land, pastoral mobility and artisanal fishing management

Mobile networks operators coverage issues

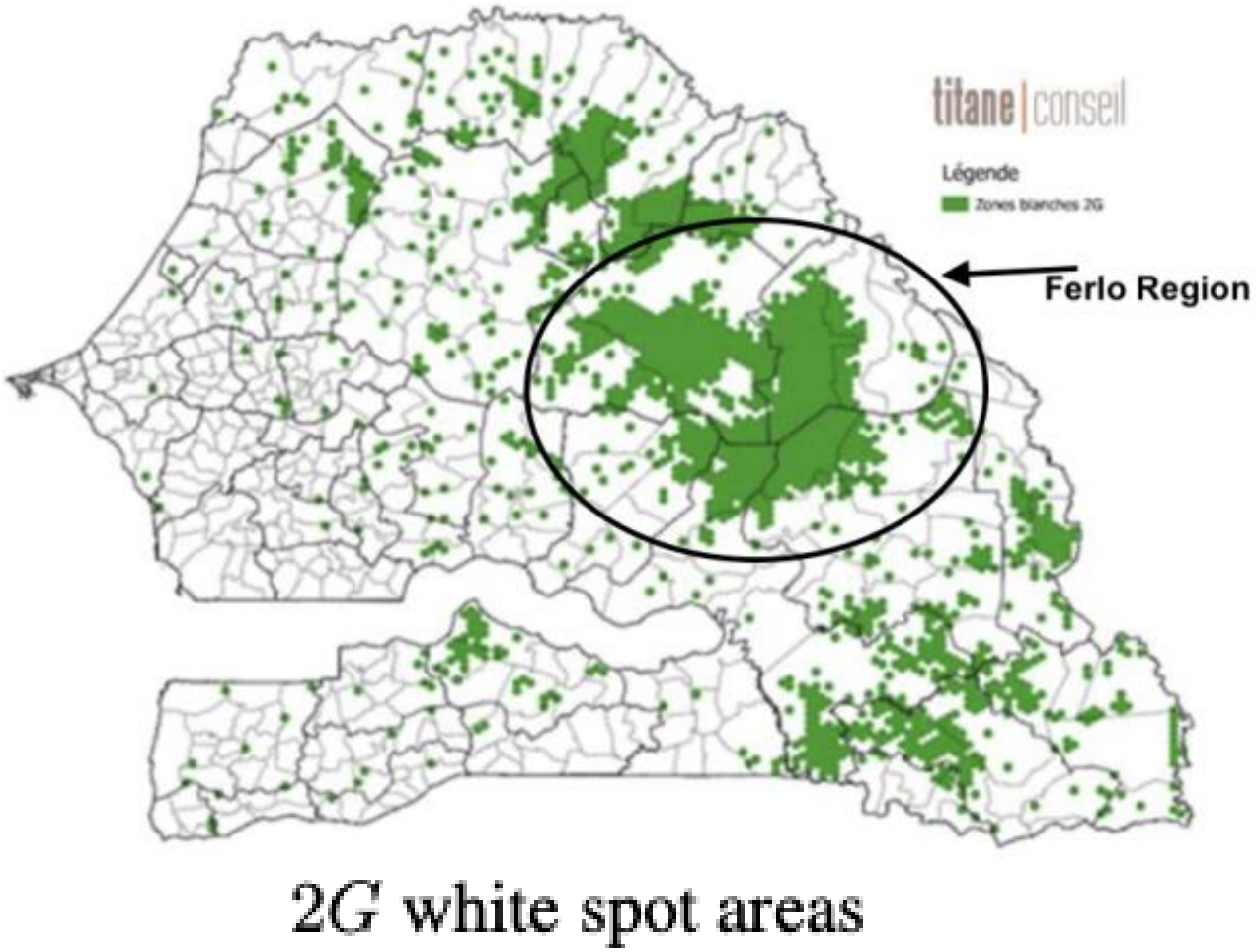


2G mobile coverage of 3 cellular networks operators in 2017



2G mobile Orange cellular network in 2021

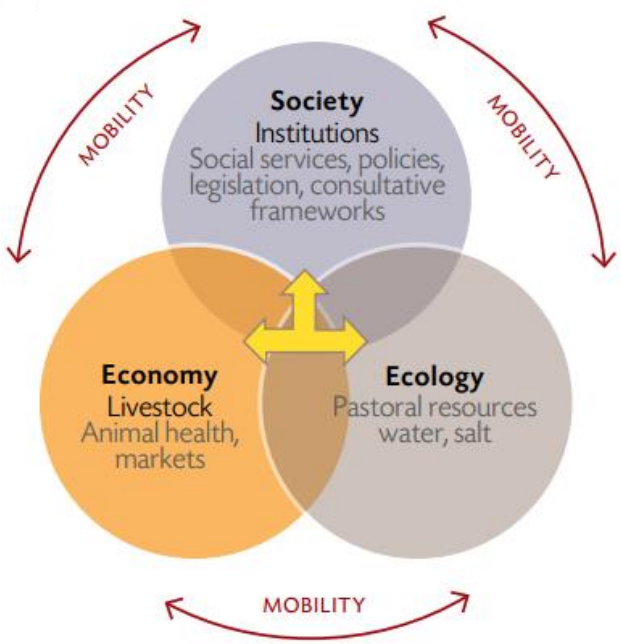
Pastoralism in Senegal



2G white spot areas

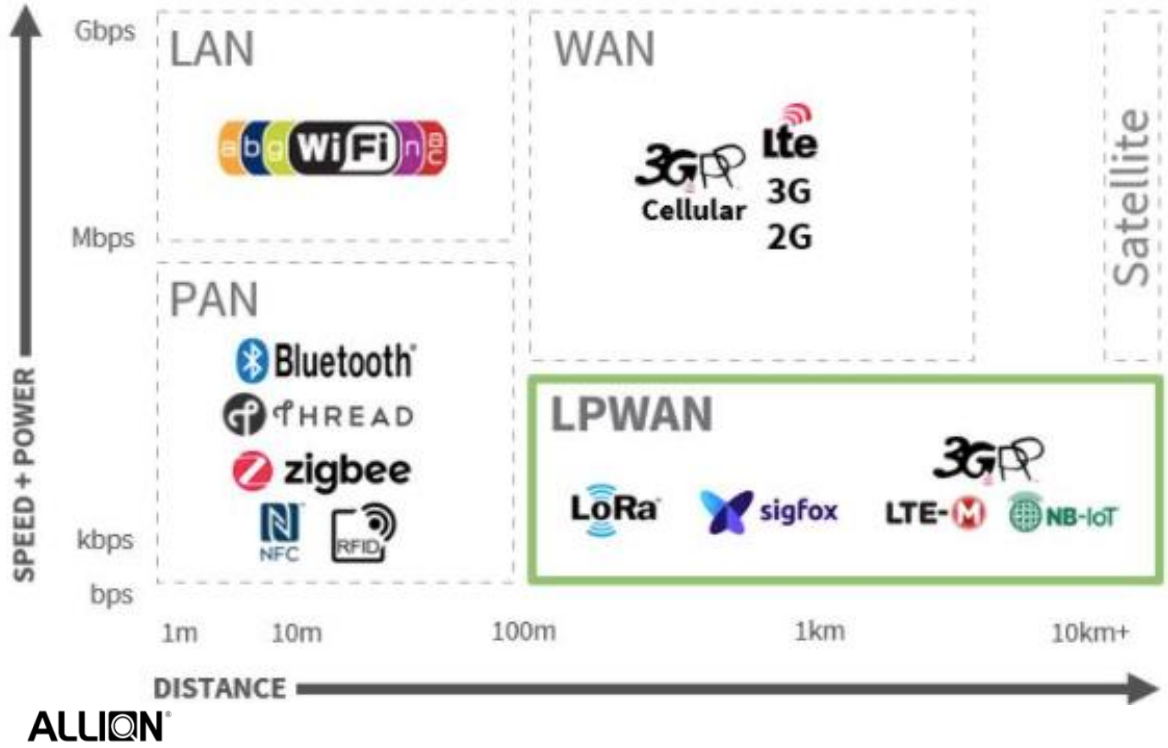
- Pastoralism exists in the Sahel (Senegal, Mauritania, Mali, Niger, Chad)
- An important socioeconomic role in Senegal, and in particular in the **Ferlo** region
- It provides many goods and services for the rural population

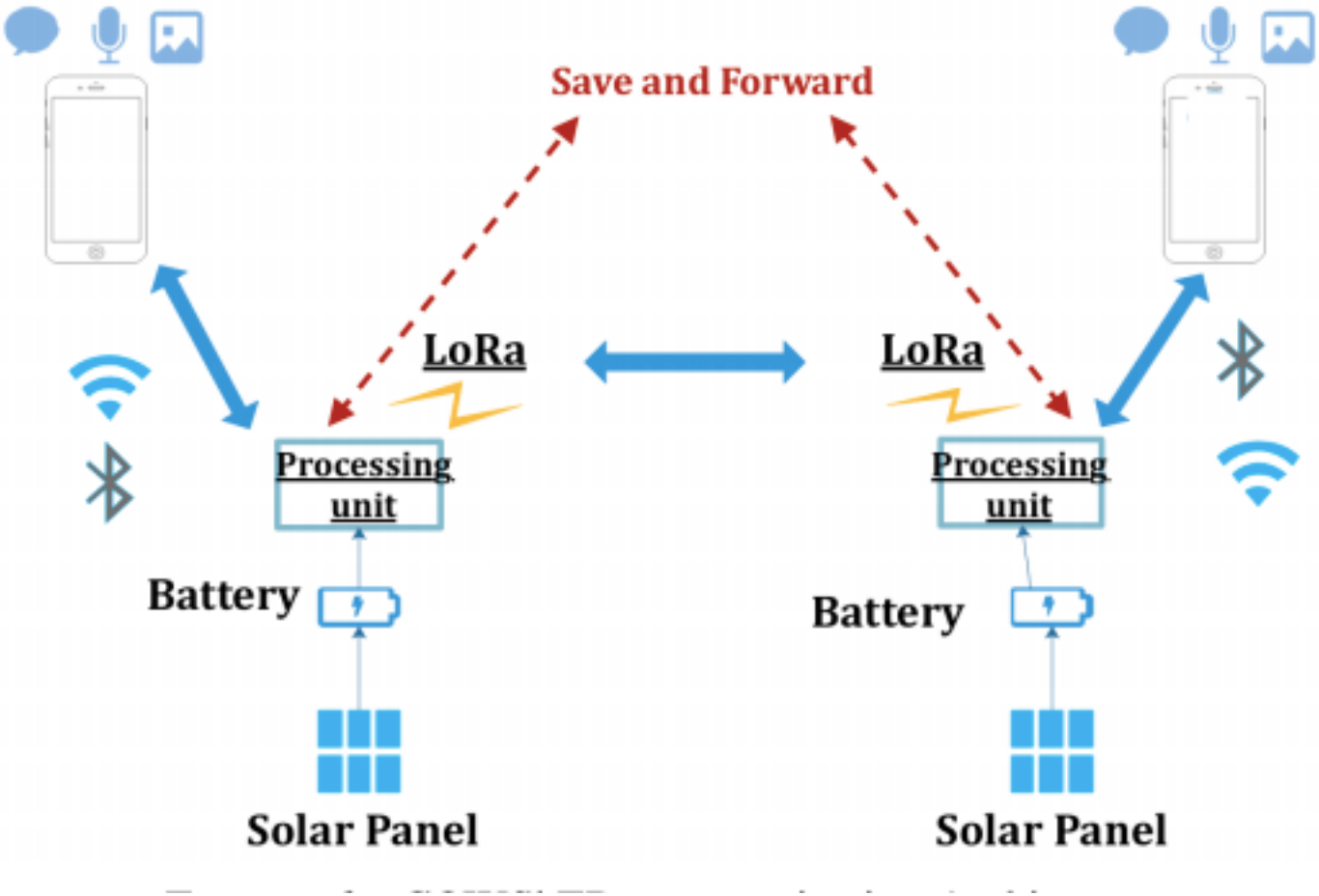
COWShED
COmmunication within White Spots for brEeDers



- A geolocalization communication system based on **long range radio frequency** transmission within white spots
- Deploying terrestrial **LoRa solutions** for uses in pastoral mobility and artisanal fishing
- The proposed autonomous mobile mesh network is developed by breeders to lead livestock's, in a safe manner, where grass and water points are available
- Encourage activities that can generate financial returns for rural population by preserving the environment

LoRa-based COWShED communication architecture

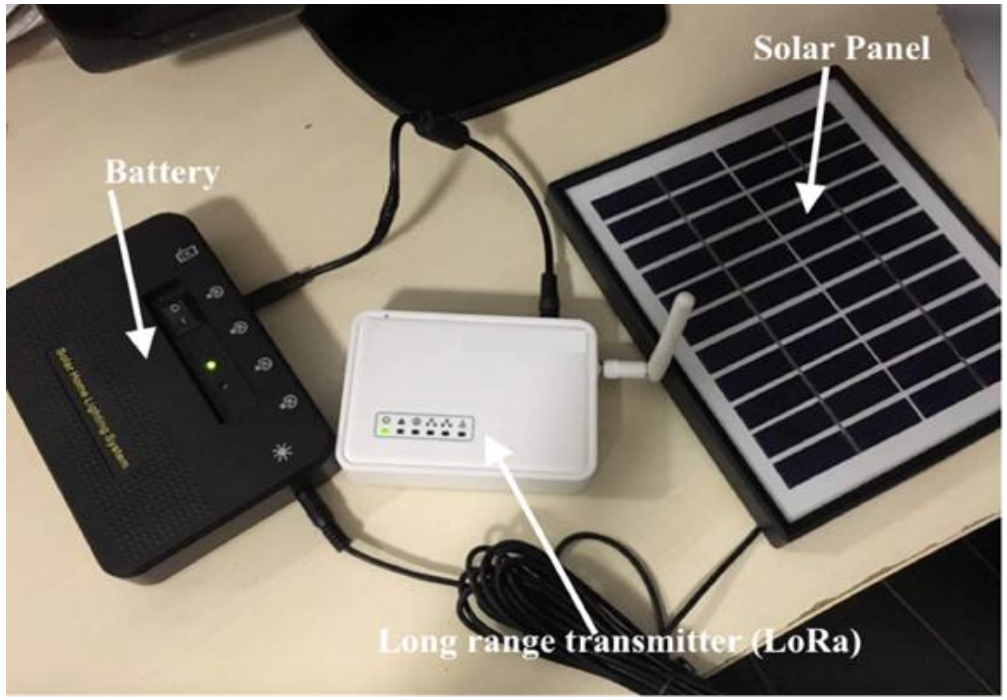




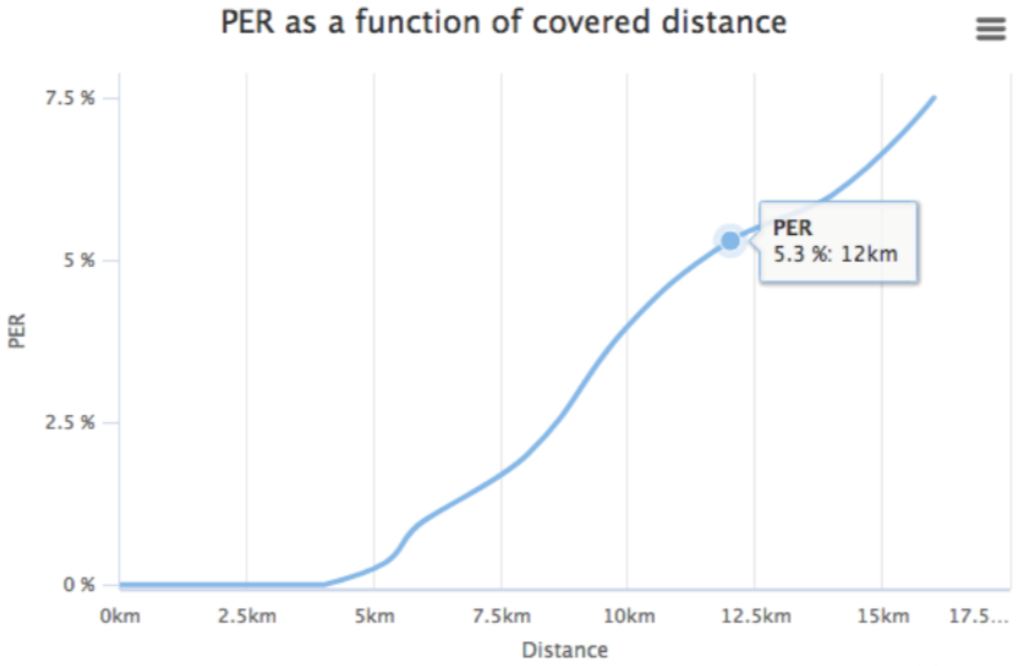
Namarel village (Ferlo region)

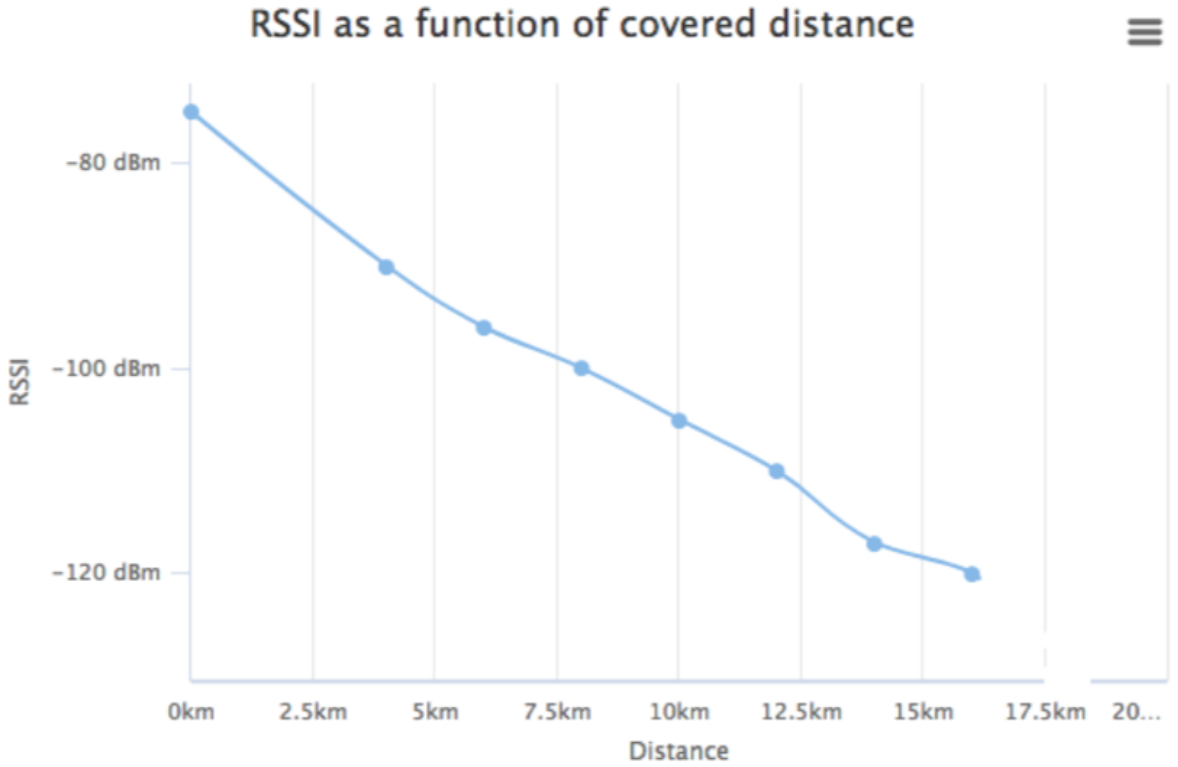
Deployment at Namarel village (April 2018)

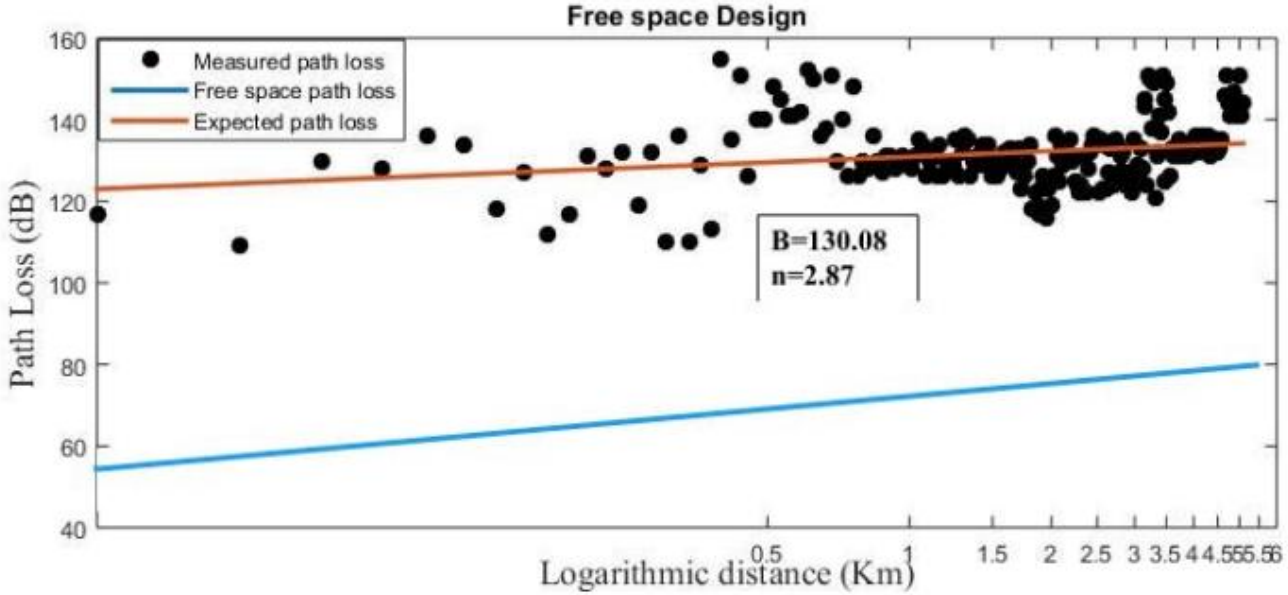
- We investigated LoRa scalability and conduct measurement within Namarel



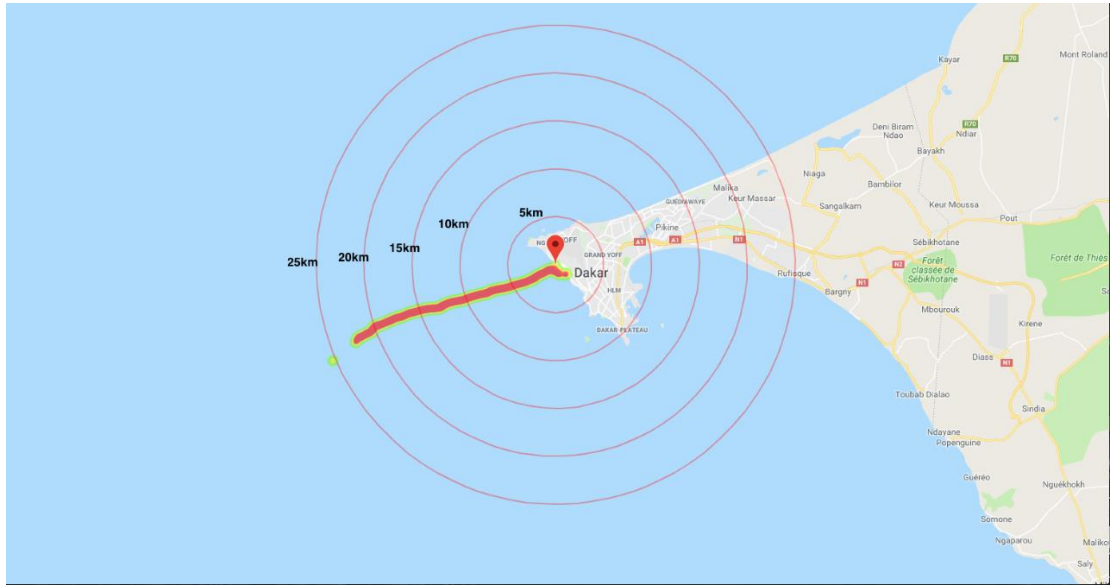
Performance evaluation







Path Loss for a rural base station.



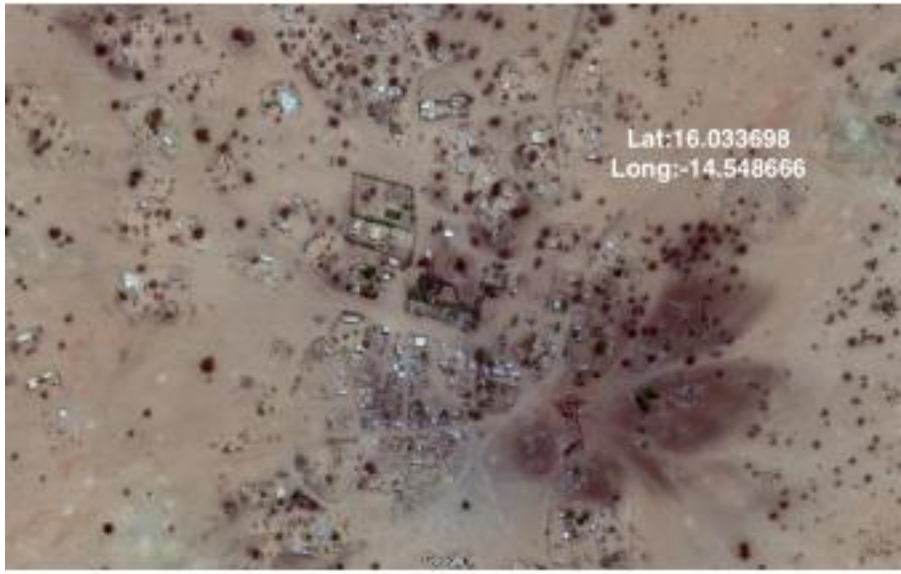
Technology adoption

Help **livestock herders** to make better travel decisions

Artisanal fishing: Send mayday in case of distress

Technology adoption and gender inclusion (milk collection)

Dairy processing plant at Namarel



Village in Ferlo at 12km from Namarel

Village in Ferlo at 7km from Namarel

FerloNet

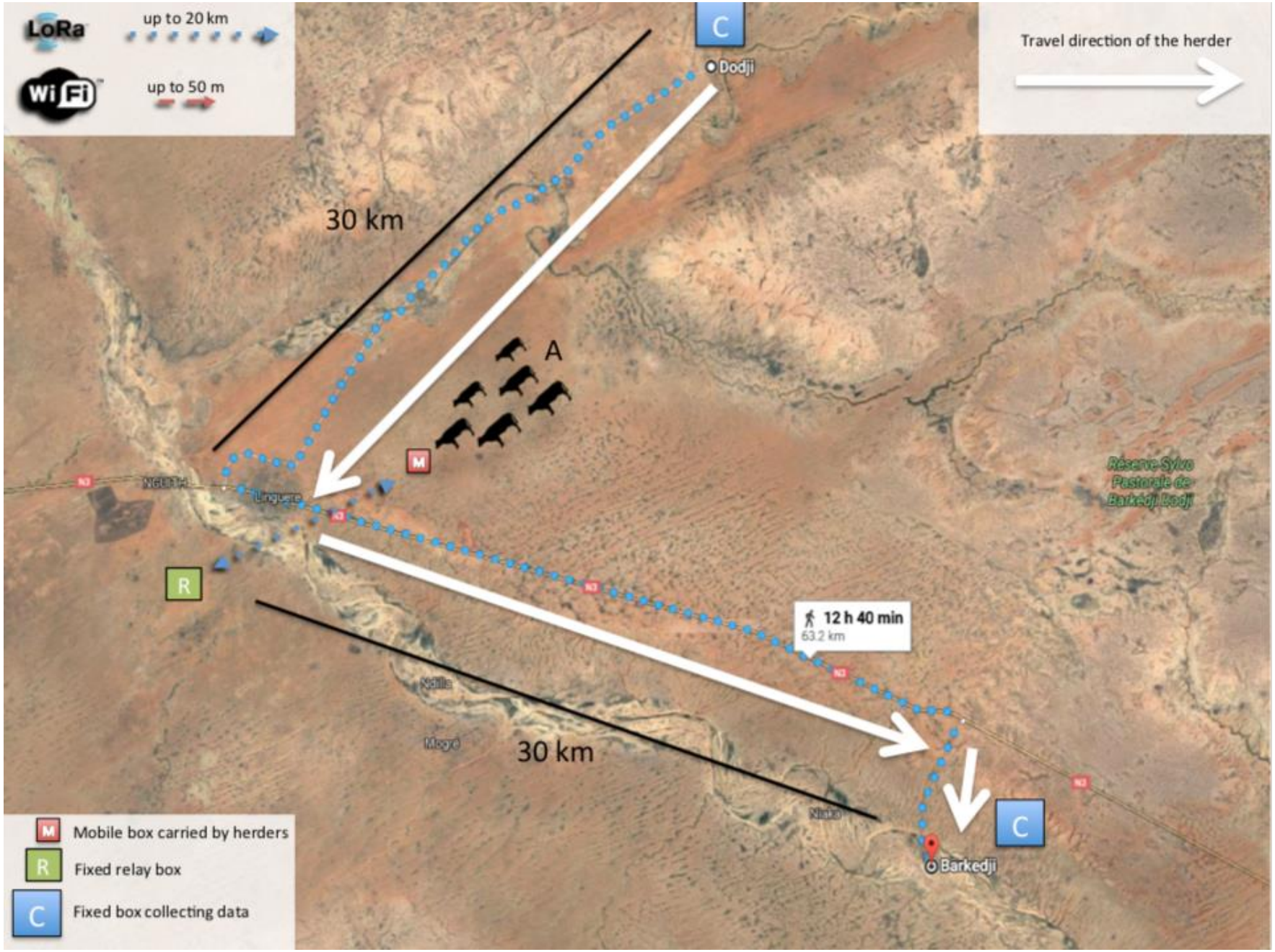
- Proposes a holistic approach that addresses opportunistic delay-tolerant networks, Internet of Things, and device-to-device communication for an efficient information delivery

- Considers **opportunistic networks** which include mobile nodes and enables communication even when **no permanent route** between source and destination node **is available**

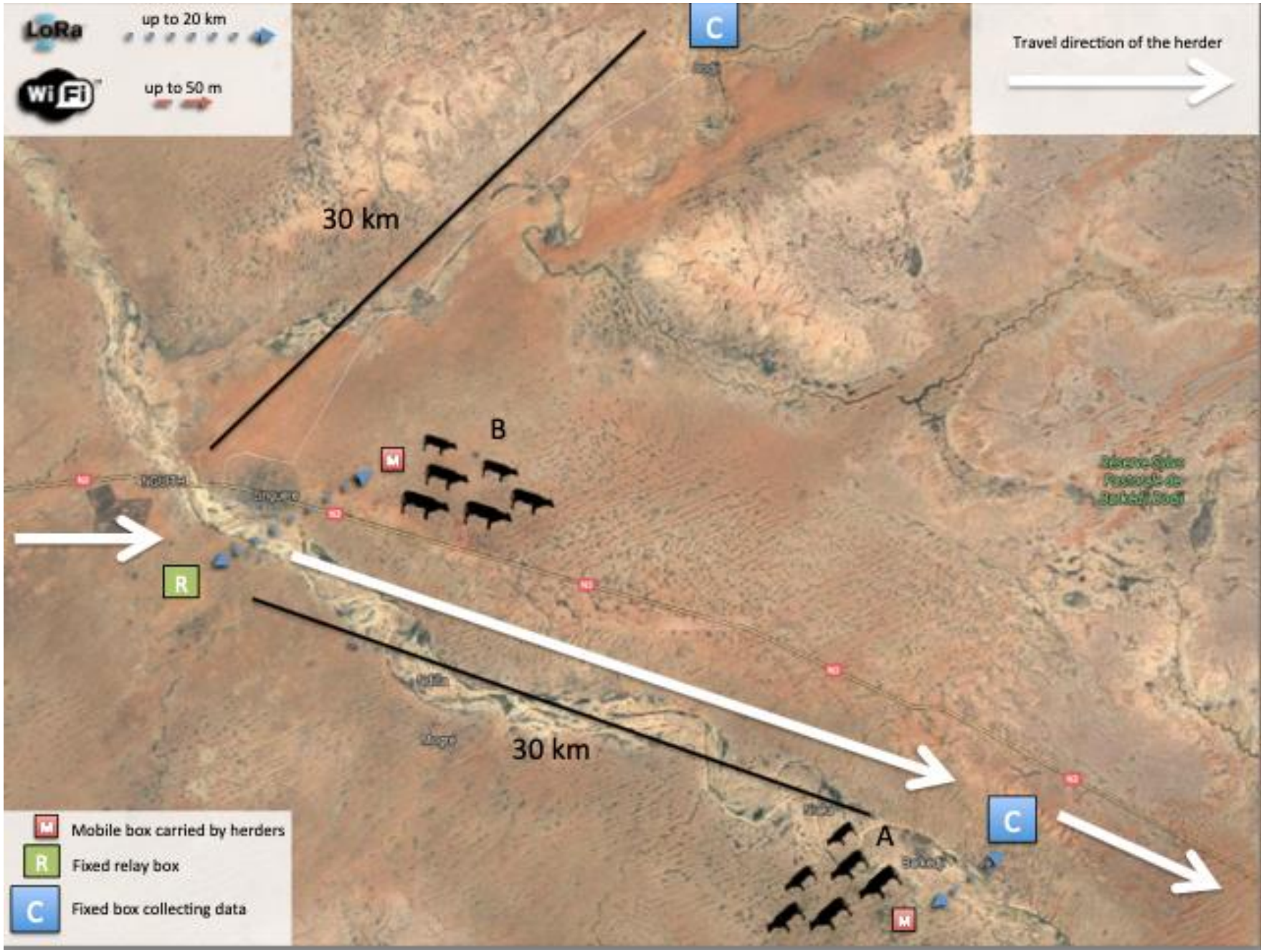
- Fosters **store and forward communication** between fixed and mobile box

Pastoral mobility management

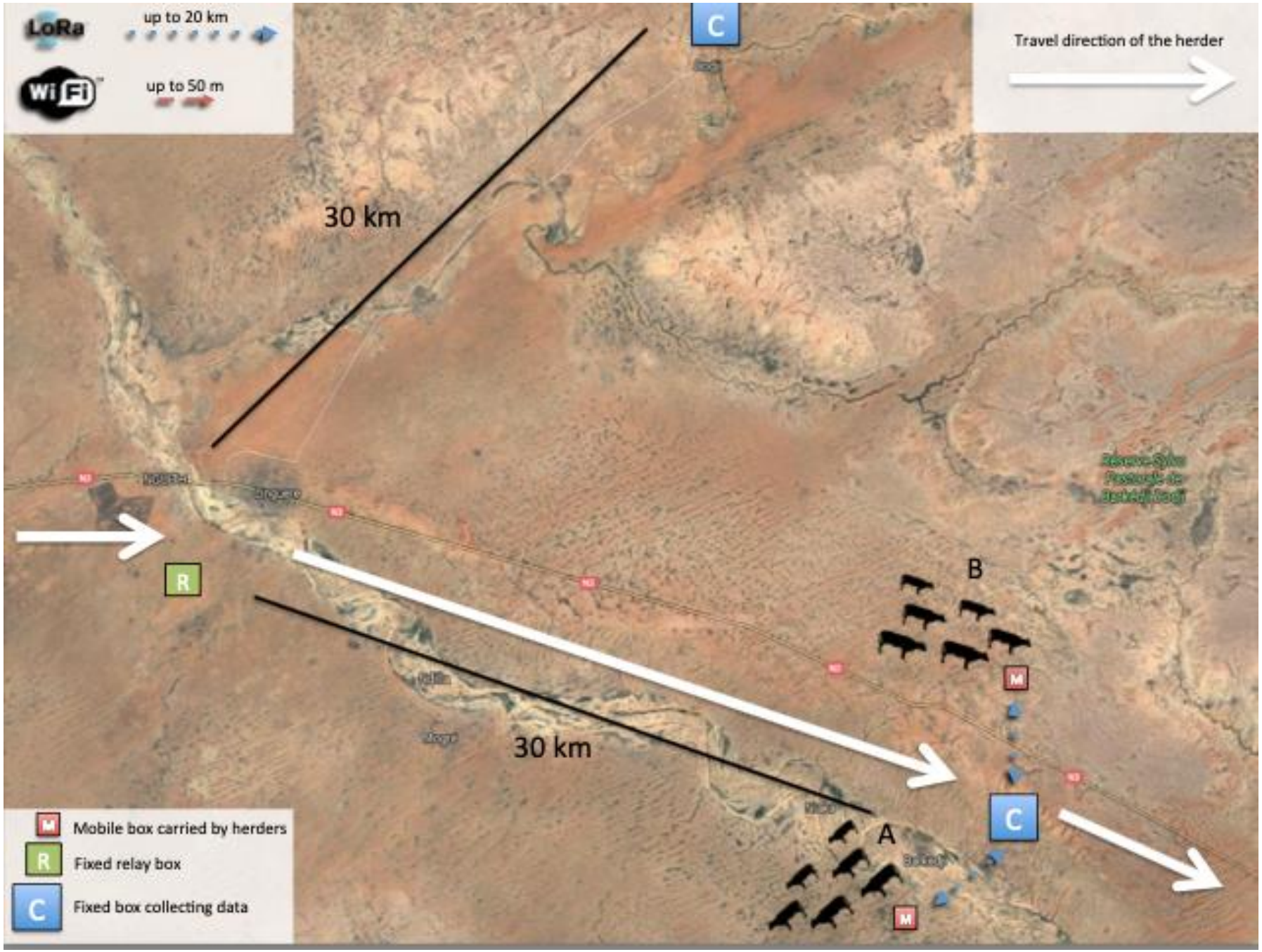
- Herder can use a smartphone to connect to her mobile box to access data to decide where to relocate the herd next
- Mobile boxes can exchange these information with other boxes while travelling on transhumance corridors



Pastoral mobility management (2)



Pastoral mobility management (3)



Conclusion and on-going work

- Management and resilience of digital technology achieves a real impact: social, economic, management of zoonotic diseases, more reliable information and then save it in secure manner
- Develop a full on messaging platform that relies on LoRa and **delay tolerant network**
- Working with Lacuna Space to connect **COWShED to LoRa-satellite**
- Deploying a radio network and computing infrastructure for fishermen, students/teachers, and other stakeholders, covering previously unconnected regions through the use of **TV white space technology**

Jërë-Jëf

References

- M. R. Seye, M. Diallo, B. Gueye and C. Cambier, "COWShED: Communication Within White Spots for Breeders," 2019 22nd Conference on Innovation in Clouds, Internet and Networks and Workshops (ICIN), Paris, France, 2019, pp. 236-238, doi: 10.1109/ICIN.2019.8685838
- M. R. Seye, B. Ngom, B. Gueye and M. Diallo, "A Study of LoRa Coverage: Range Evaluation and Channel Attenuation Model," 2018 1st International Conference on Smart Cities and Communities (SCCIC), Ouagadougou, Burkina Faso, 2018, pp. 1-4, doi: 10.1109/SCCIC.2018.8584548
- D. Wohwe Sambo, A. Forster, B. O. Yenke, I. Sarr, B. Gueye and P. Dayang, "Wireless Underground Sensor Networks Path Loss Model for Precision Agriculture (WUSN-PLM)," in IEEE Sensors Journal, vol. 20, no. 10, pp. 5298-5313, 15 May15, 2020, doi: 10.1109/JSEN.2020.296835
- Diouf, F.A.Y., Seye, M.R., Diallo, M., Gueye, B. (2024). SAFeComNet: Safer Artisanal Fishing intEgrating a COMmunity NETwork. ICICT 2023. Lecture Notes in Networks and Systems, vol 696. Springer, Singapore. https://doi.org/10.1007/978-981-99-3236-8_22