Polio eradication: How technologies are helping us travel the last mile

John Vertefeuille, PhD

Chief, Polio Eradication Branch
CDC

World Health Organization · Rotary · CDC · unicef · Bill & Melinda Gates foundation · Gavi The Vaccine Alliance

What is Polio?

Only one serotype of Wild Poliovirus (WPV1) is still in circulation globally

Polio is a crippling and potentially deadly infectious disease caused by the poliovirus. Spreads person-to-person and causes paralysis in 1 out of 200 of infections

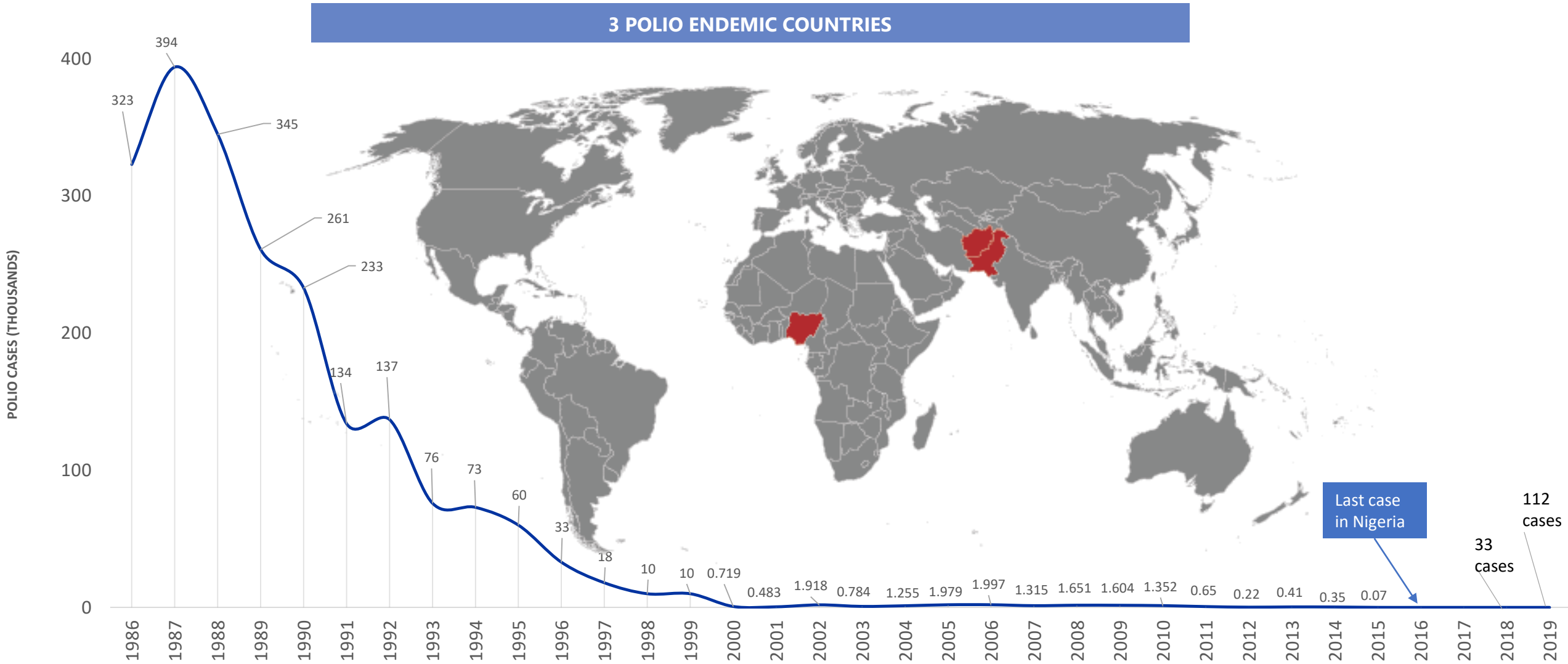
Two vaccines provide protection against the virus

Improved sanitation and polio vaccination have resulted in eradication of Type 2 (September 2015) and Type 3 (October 2019)

In 1988, GPEI started upon the bold mission to eradicate polio

POLIO GLOBAL ERADICATION INITIATIVE

Wild Poliovirus is currently circulating in two countries: Pakistan & Afghanistan

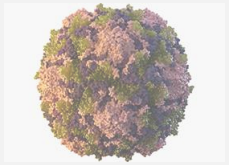


Reaching the last child and traveling the last mile requires new innovations

The Eradication Program Faces Challenges

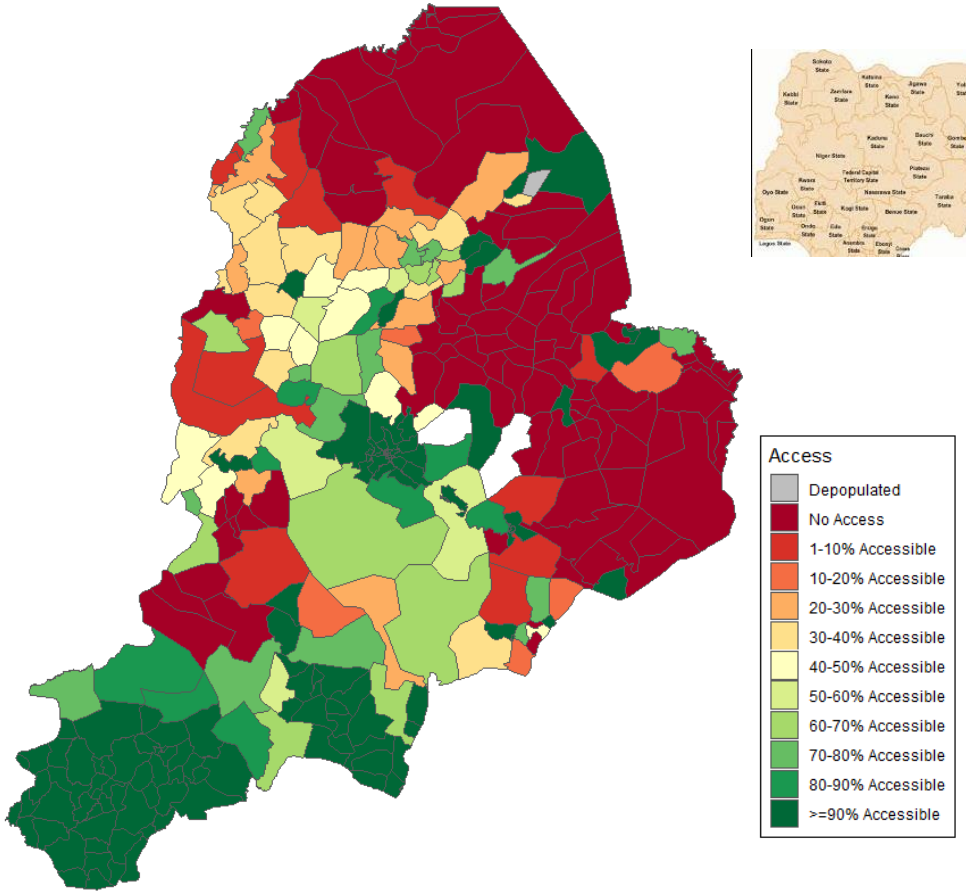
Insecurity: limits the reach of vaccination campaigns and threatens the safety of polio volunteers

Poor health infrastructure: Limits vaccine coverage through routine immunization allowing continued transmission



Changing epidemiology: new outbreaks of cVDPV2 stretch the resources of the program

Ward Level Access in Borno, 2016



Challenge: Insecurity in North East Nigeria allowed transmission of Polio to continue undetected for years

Inhabited through 2016 rainy season

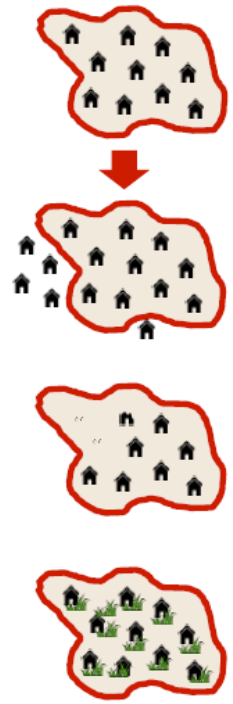
Abandoned between 2016 and 2017 rainy seasons

	2016												2017											
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg Precip (mm)	0	0	0.3	13	30.5	73.8	147.1	193.2	83	11.1	0	0.1	0	0	0.3	13	30.5	73.8	147.1	193.2	83	11.1	0	0.1

Solution: satellite imagery with machine learning reviews thousands of settlements annually

Program now using machine learning to estimate percentage of structures intact

CDC data integrated into VTS
Assessments modify VTS settlement level population estimates:



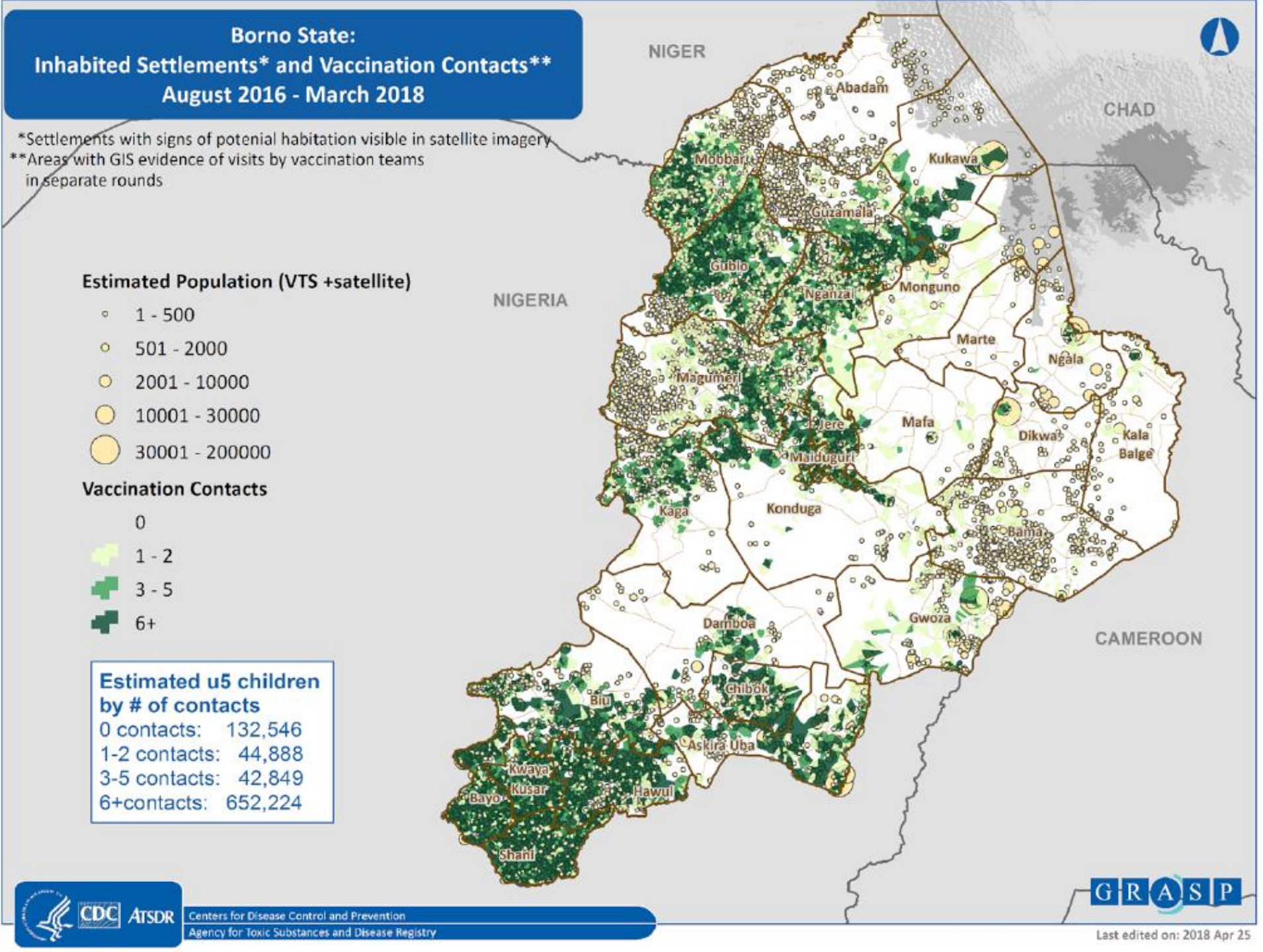
Example settlement
VTS baseline population = 100

Intact percent = 150%
Inhabitancy = fully inhabited
Adjusted pop = 150

Intact percent = 75%
Inhabitancy = partially aban.
Adjusted pop = 75

Intact percent = 100%
Inhabitancy = abandoned
Adjusted pop = 0

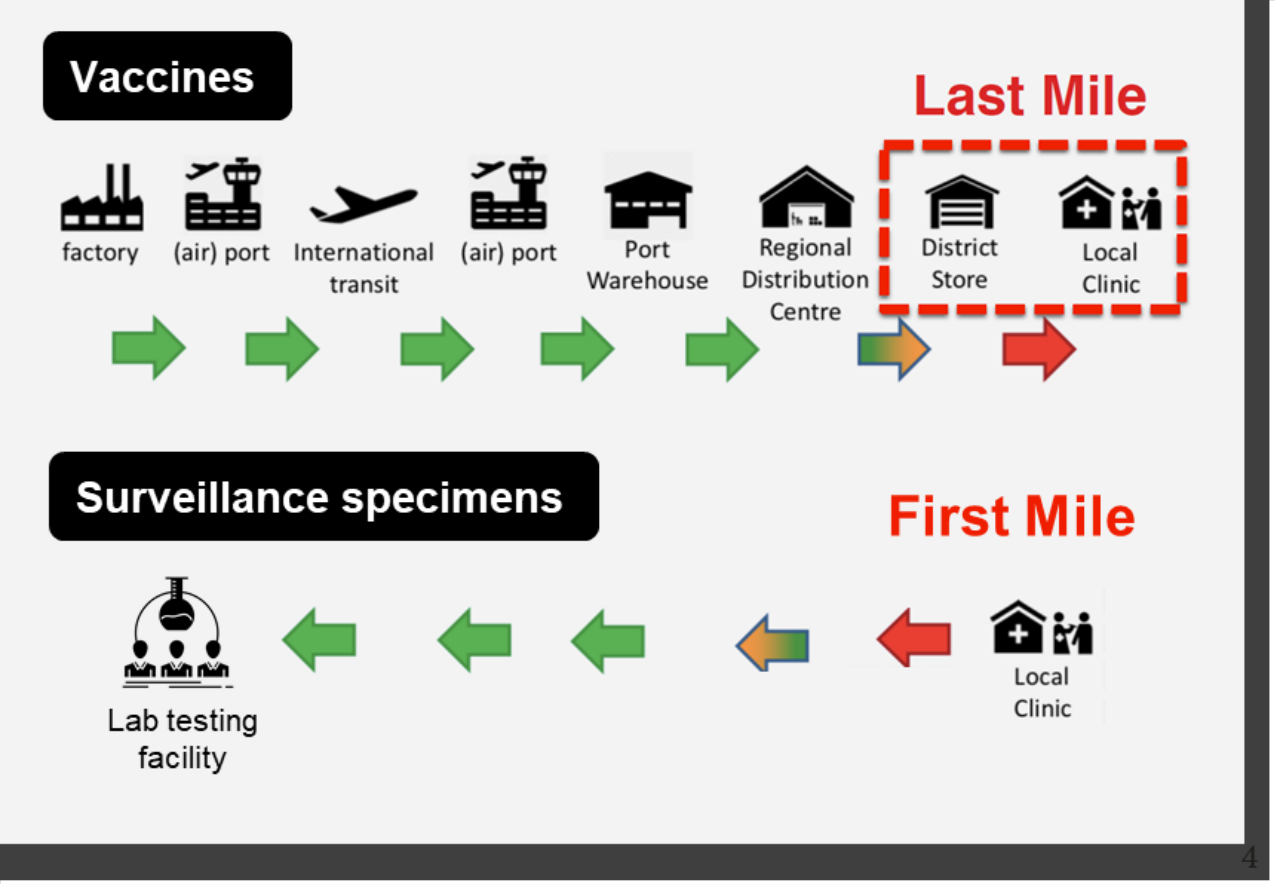
Satellite images used to adjust the size of the population



Using GPS, we now track which settlements are visited by vaccination campaigns and estimate the size of the population missed

Challenge: Poor infrastructure creates barriers for even basic tasks

Credit: Matternet



Solution: Drones can help overcome challenges with landscape and maintaining cold chain to help deliver vaccines and return surveillance specimens

Currently the technology is being piloted in Papua New Guinea and Cameroon

Phase I (PNG)

Building foundations for learning, capacity building

Introduce stakeholders to technology

Test how quickly drone team could be deployed and flight permission secured

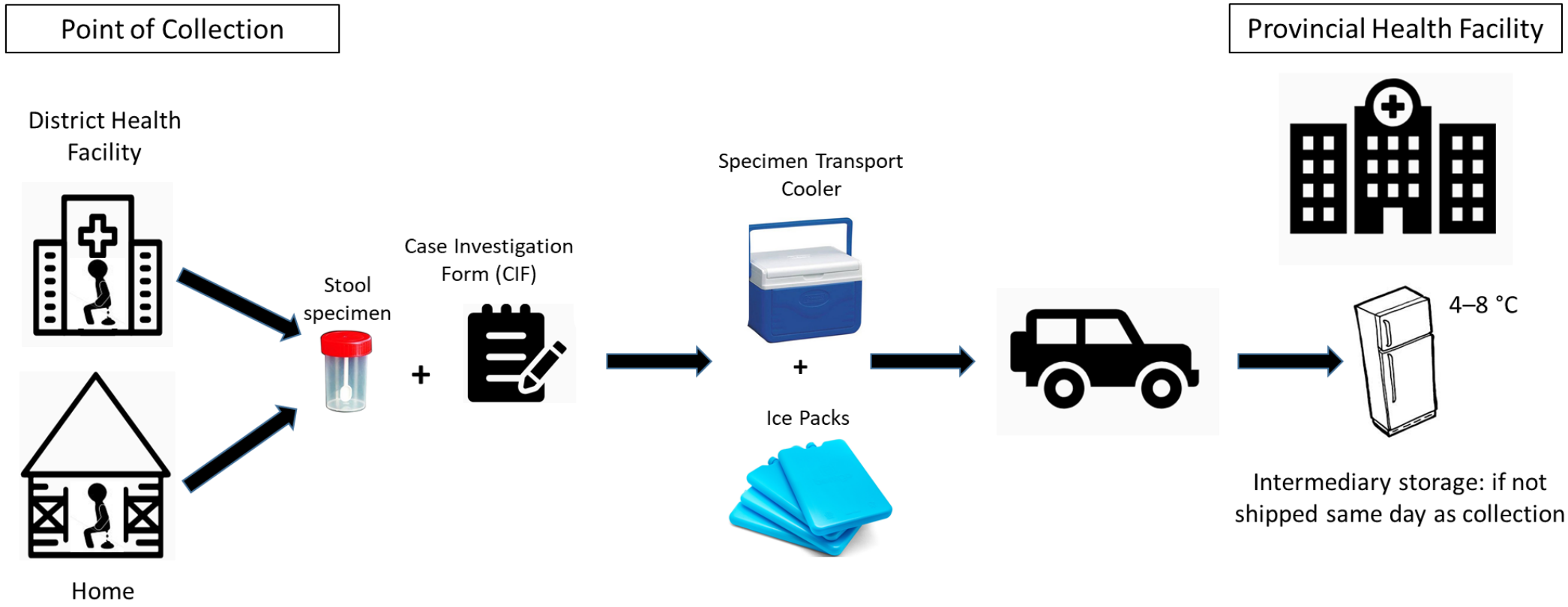
Phase II (Cameroon)

Implement flight routes

Collect a lot of data to evaluate value and inform future project planning

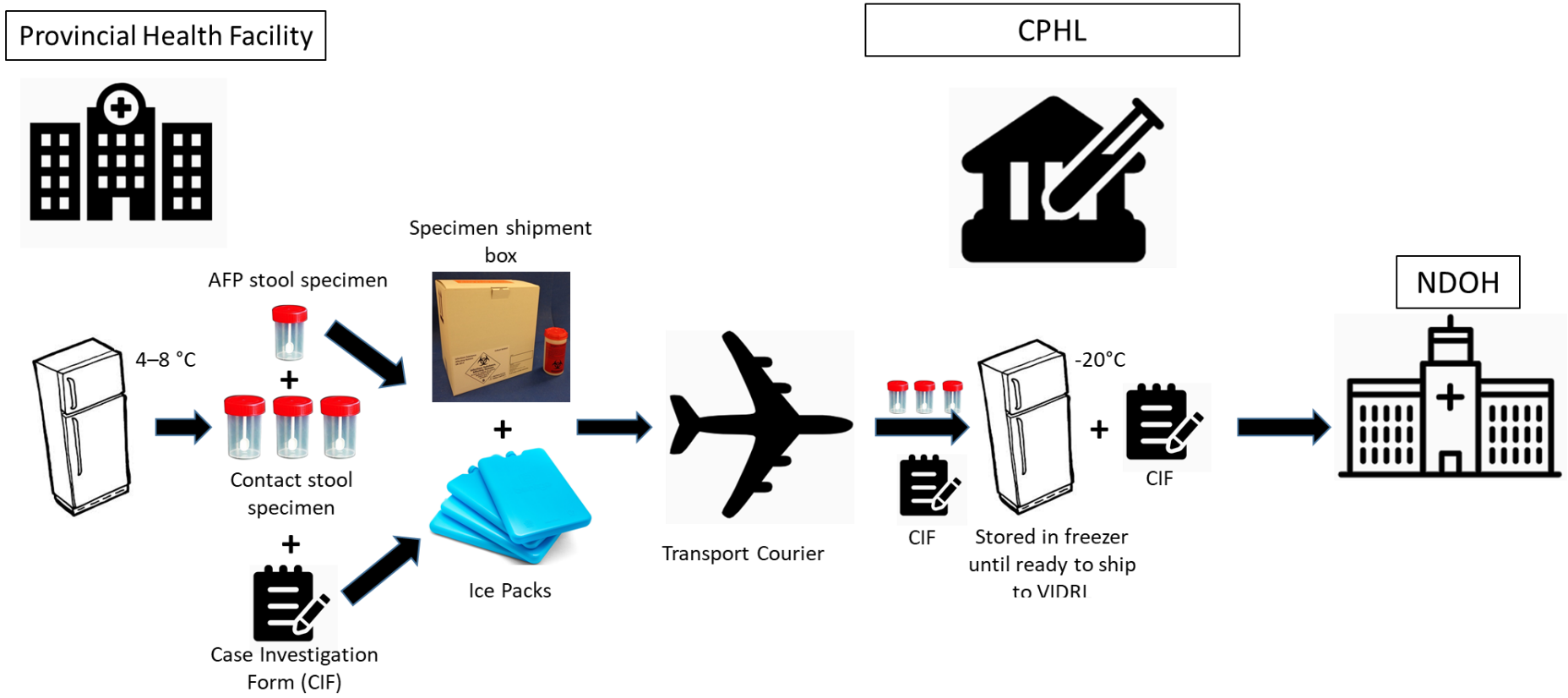
Plan for sustainability and scale up

Challenge: Poor understanding of weak links in the complex cold chain for specimen shipment and vaccines



From point of collection to province-level health facility

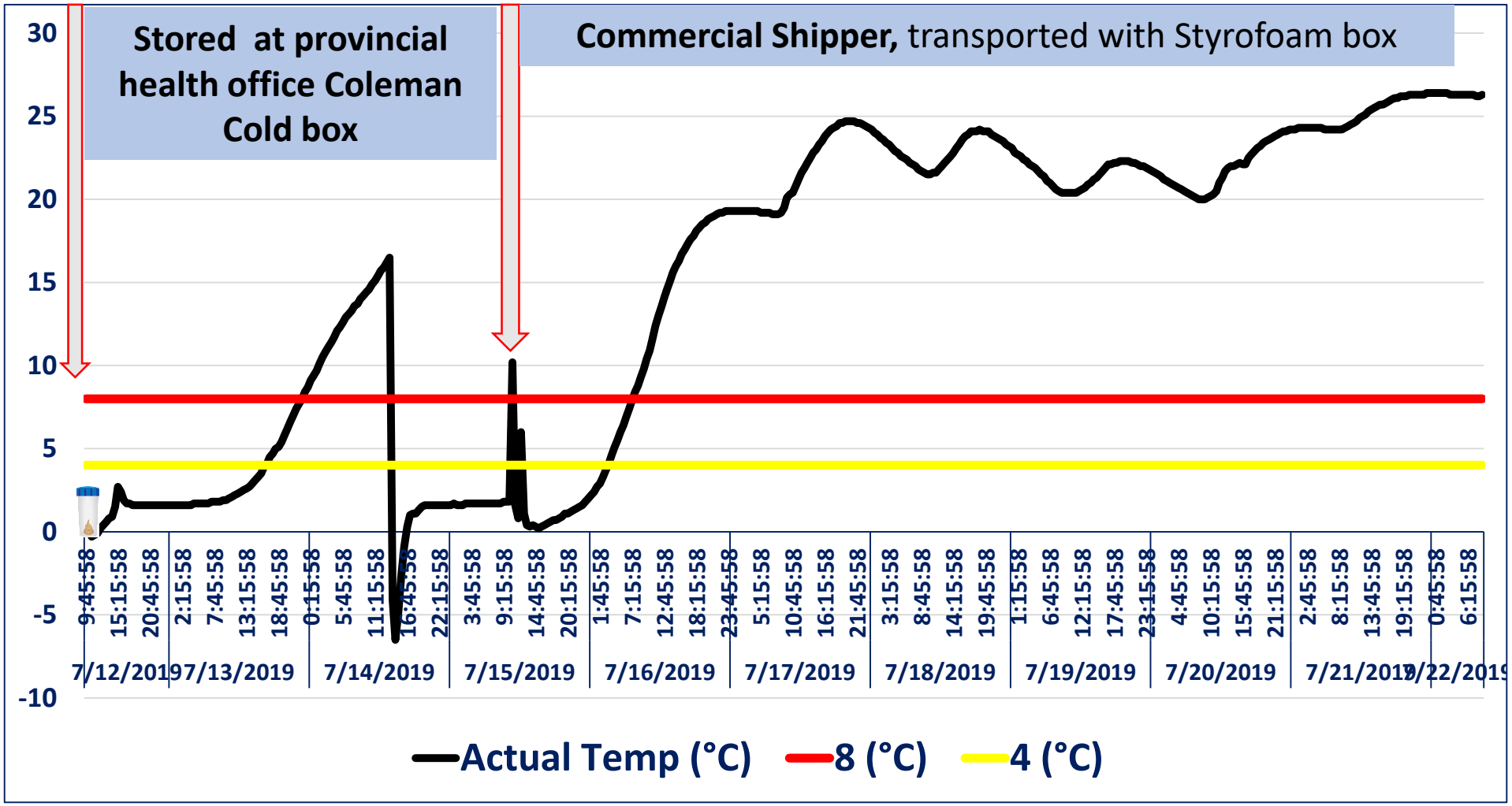
Challenge: Poor understanding of weak links in the complex cold chain for specimen shipment and vaccines



From provincial facilities to the National reference laboratory (CPHL)

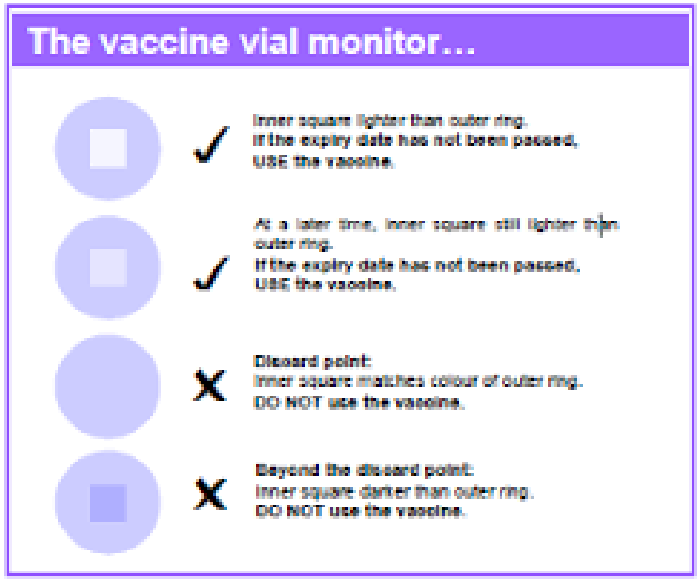
Solution: Study using LogTags in Papua New Guinea identified commercial shippers as the weakest link in the cold chain

Finding used to inform conversations with commercial shippers to improve cold chain



Solution: Vaccine Vial Monitors (VVM) provide an easy way to monitor if vaccines have been outside cold chain too long

The sticker on the vials changes color when exposed to heat letting vaccinators know if they vaccine has lost its potency and should be discarded



Challenge: As we move to eradication, we need more environmental surveillance to detect virus without reliance solely on surveillance of paralytic cases

program uses the “Two Phase” method for separation of ES samples

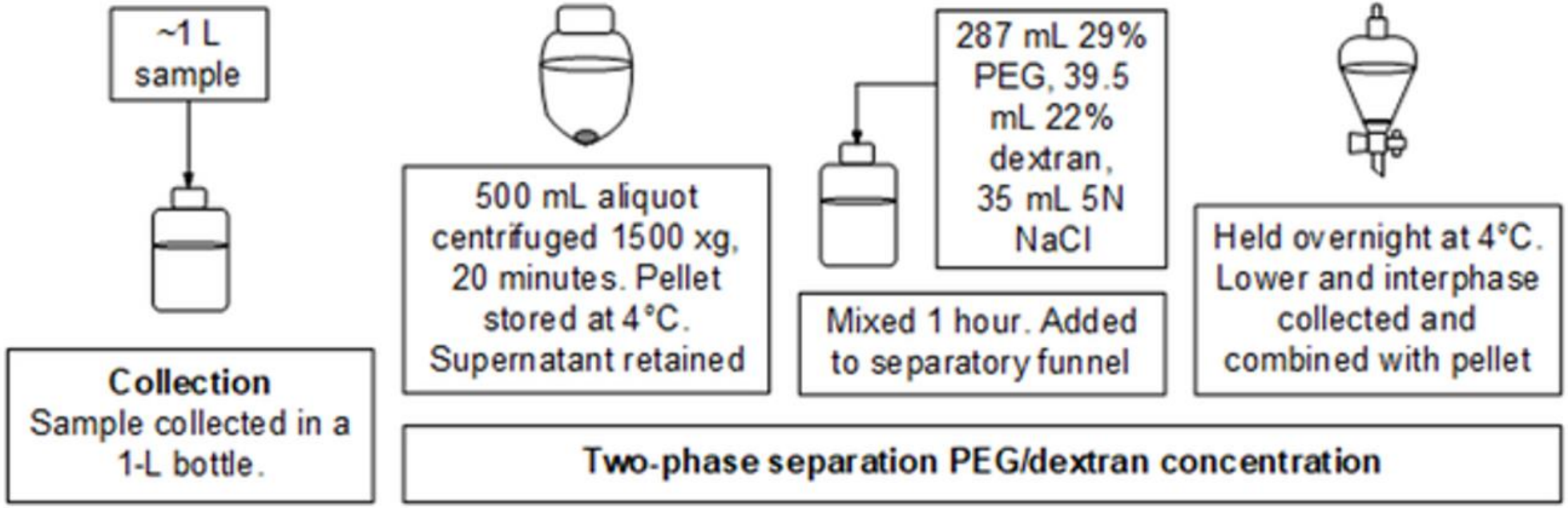


Figure adapted from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0200551

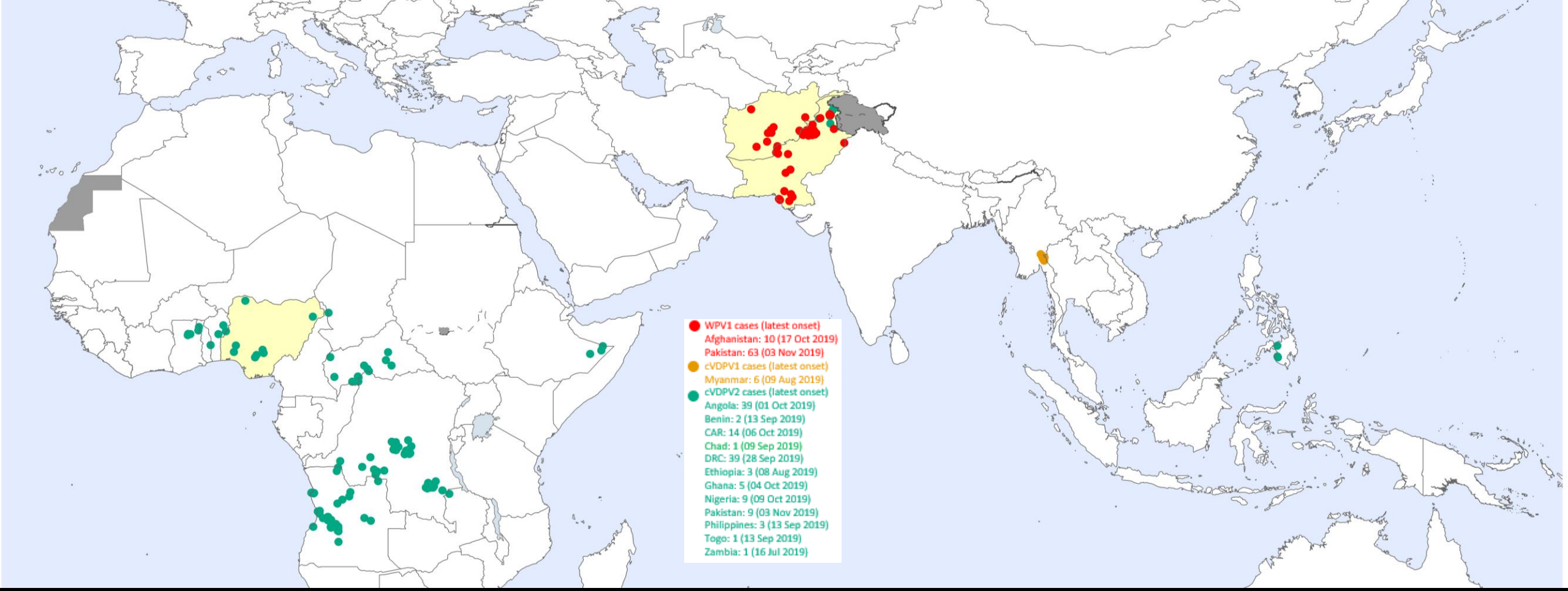
Solution: Development of cheaper, more sensitive CaFÉ method

CaFÉ method is more sensitive than traditional Two Phase testing (n=119)

CaFÉ	Two Phase NPEV*	
	Positive	Negative
Positive	63	23
Negative	2	13

CaFÉ	Two Phase Polio	
	Positive	Negative
Positive	3	14
Negative	1	101

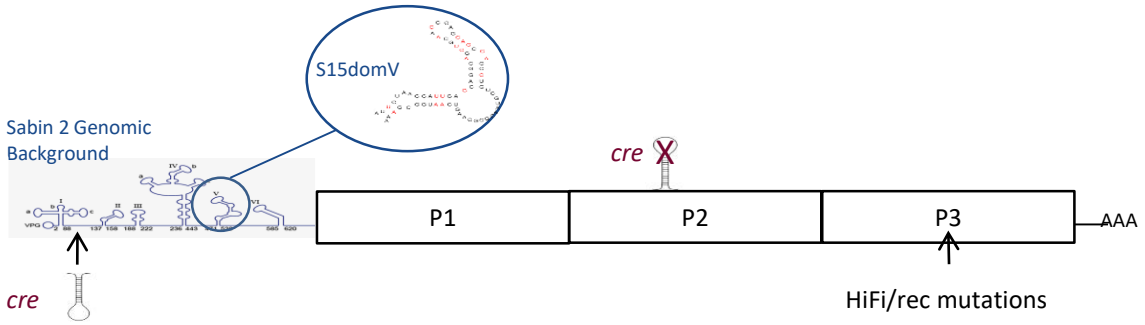
The CaFÉ method detected 23 additional non-polio enteric virus and 14 additional polio viruses than the traditional Two-Phase method



Challenge: Oral Polio Vaccine (OPV) can, in very rare instances, revert back to its neurovirulent form and cause outbreaks of cVDPV in under- immunized populations

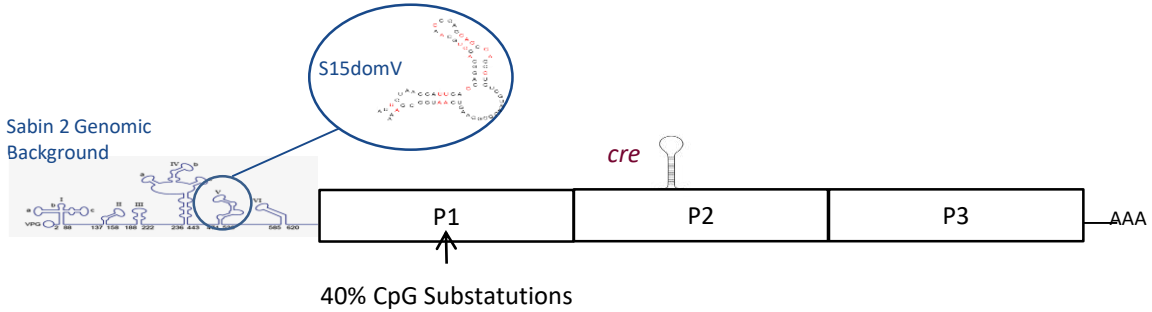
Globally we are responding to outbreaks in 16 countries due to cVDPV2

Solution: Development of novel OPV (nOPV) which is genetically stable and less prone to revision to neurovirulence



nOPV2 – **1b**

1. 5’ UTR modification
2. Cre relocation
3. HiFi mutations
4. Rec mutations



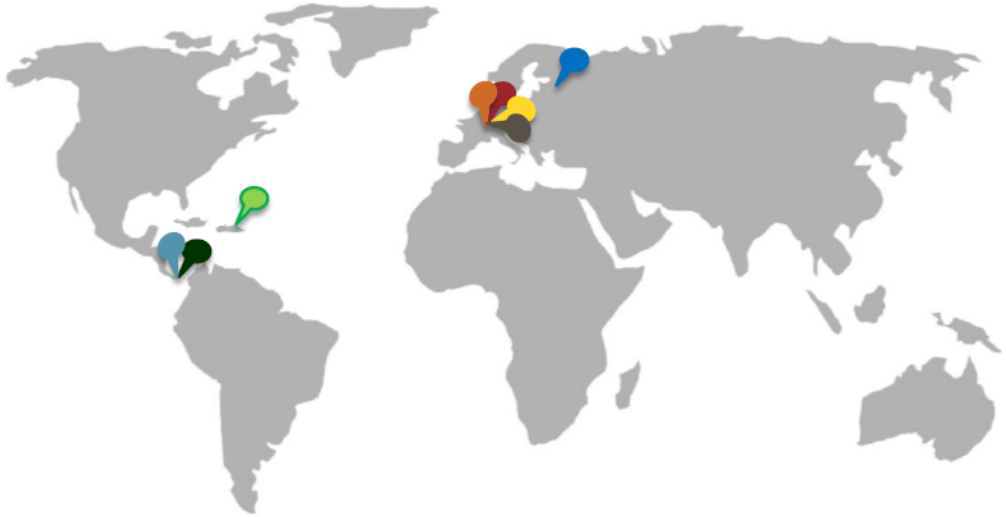
nOPV2 – **2a**

1. 5’ UTR modificaton
2. CpG substatutions
3. Cre NOT moved

Two vaccine candidates use the original Sabin vaccine strain as a backbone

Attenuated virus is mutated to be more genetically stable

Study	FSFV	LSLV
M1 * *Belgium, adults*	Jan 25 2016	May 31 2016
M2 * *Panama, kids/infants*	Oct 23 2015	Apr 27 2016
M3 *Lithuania, kids*	Jan 7 2016	Apr 30 2016
T1 *Belgium, adults*	Dec 7 2015	May 3 2016
T2 *Dominican Rep, kids/infants*	Nov 30 2015	Mar 2 2016
M4a * *Belgium, adults, contained*	May 16 2017	Oct 27 2017
M4 * *Belgium, adults*	Oct 15 2018	May 08 2019
M5 * *Panama, kids/infants*	Dec 7 2018	*Sep 28 2019*

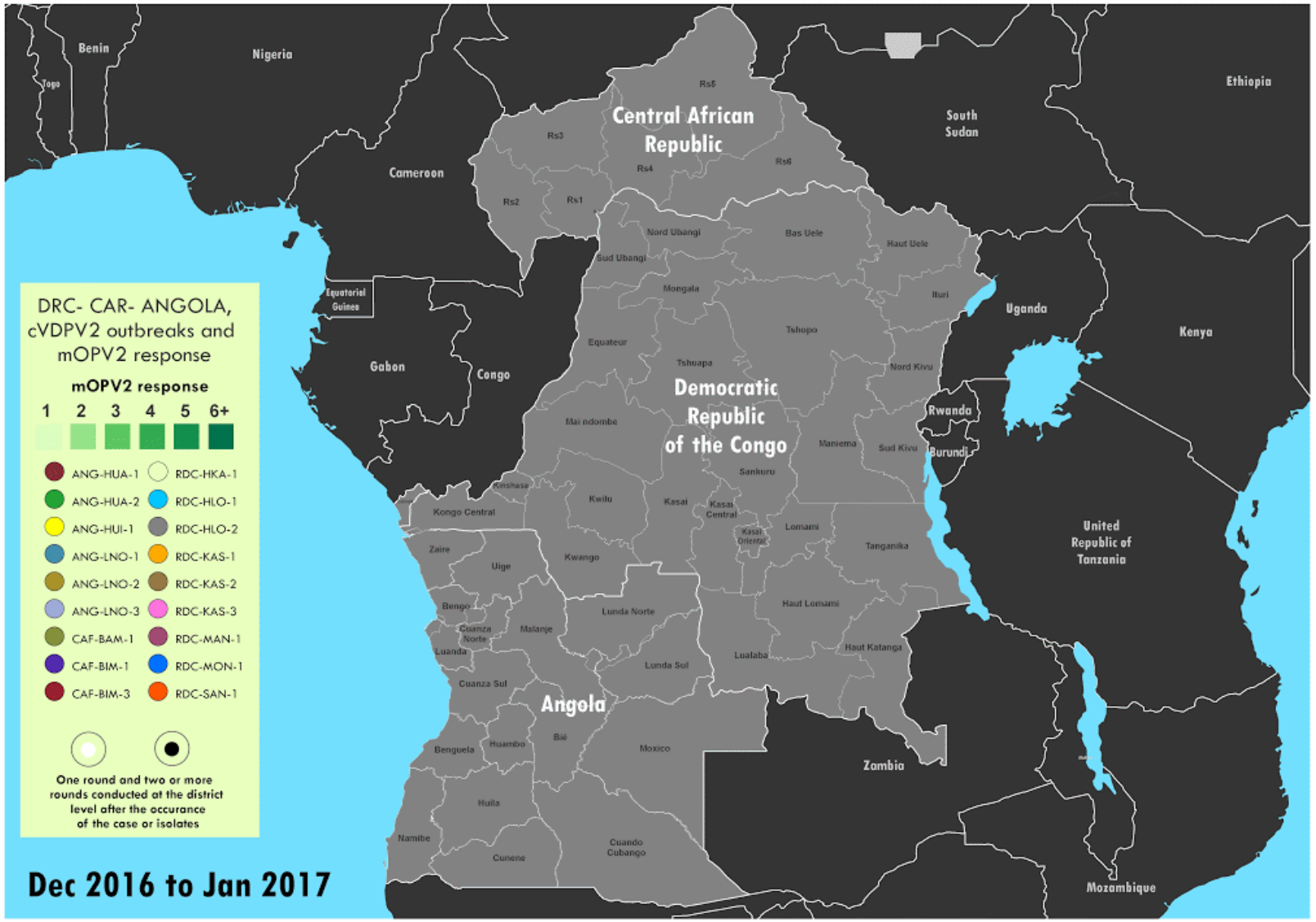


* Clinical trials prioritized for clinical development, with focus on EUL submission

nOPV2 now in clinical trials around the world and Emergency Use Licensure for outbreaks targeted for mid 2020

But, in the last mile challenges remain

Call to Action: Can we better anticipate cVDPV2 outbreaks?



Can machine learning help us predict the next emergence of cVDPV2?

Can big data solutions help us process data faster for improved decision making and more efficient responses?

Thank you