Novel-t
Innovative solutions

Supporting Polio eradication through the use of geographic information systems

Based on experience from the Polio program in Nigeria

Annual Disease Modeling Symposium

Stephane VOUILLAMOZ

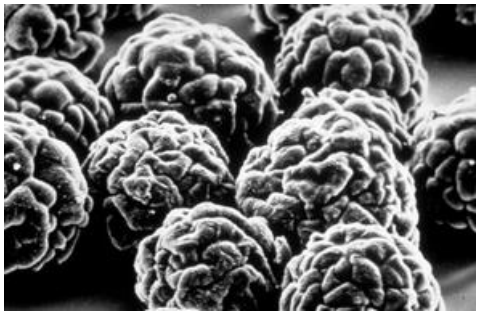
April 17, 2018

Seattle

Under Dr. **Vincent SEAMAN**'s leadership

Poliomyelitis

- Highly infectious disease caused by a virus
- Spreads through person-to-person contact usually via the fecal-oral route
- Can cause irreversible paralysis
- Mainly affects children under five years old



Source: www.polioeradication.org

Novel-t
Innovative solutions

Poliomyelitis eradication

- Poliovirus detection
  - Acute Flaccid Paralysis (AFP) Surveillance
  - Environmental surveillance

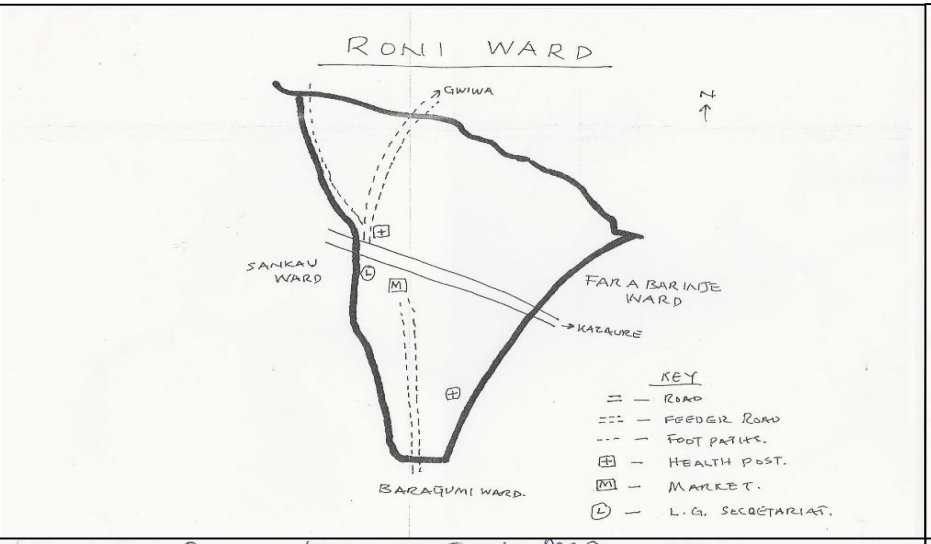
-> identify where and how poliovirus is circulating

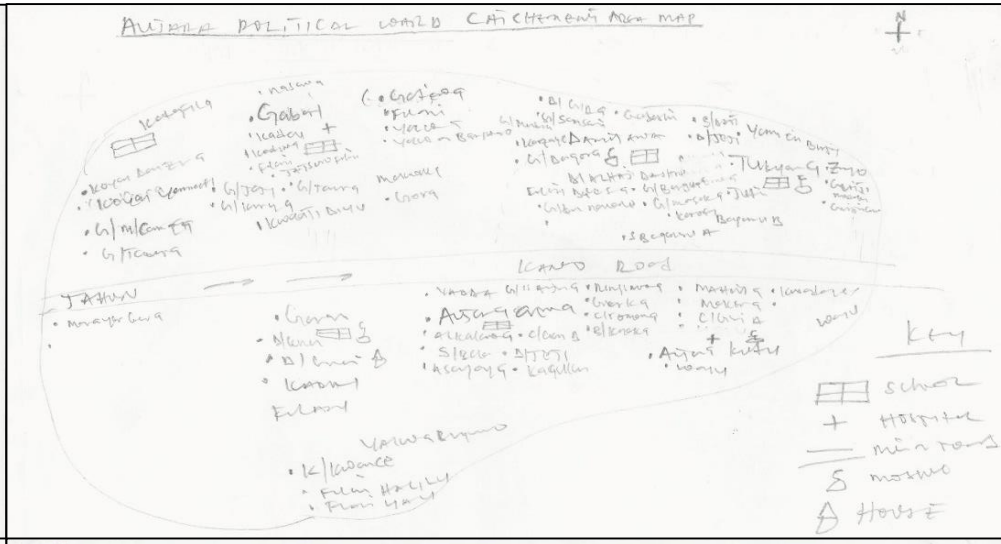
- Poliovirus interruption
  - Routine Immunization (RI)
  - Supplementary Immunization Activity (SIA)
  - Rapid outbreak response

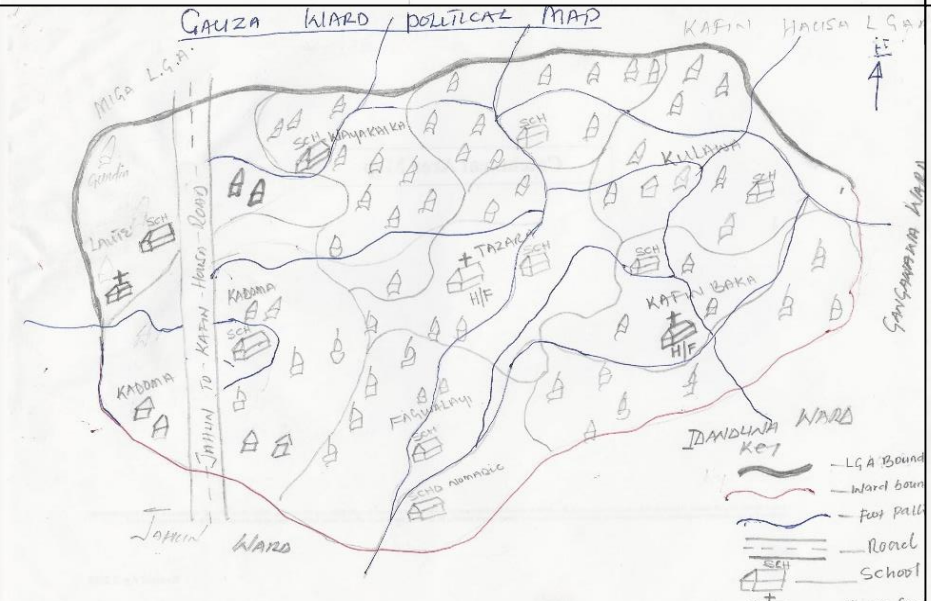
-> increase population immunity and stop the transmission cycle

Novel-t
Innovative solutions

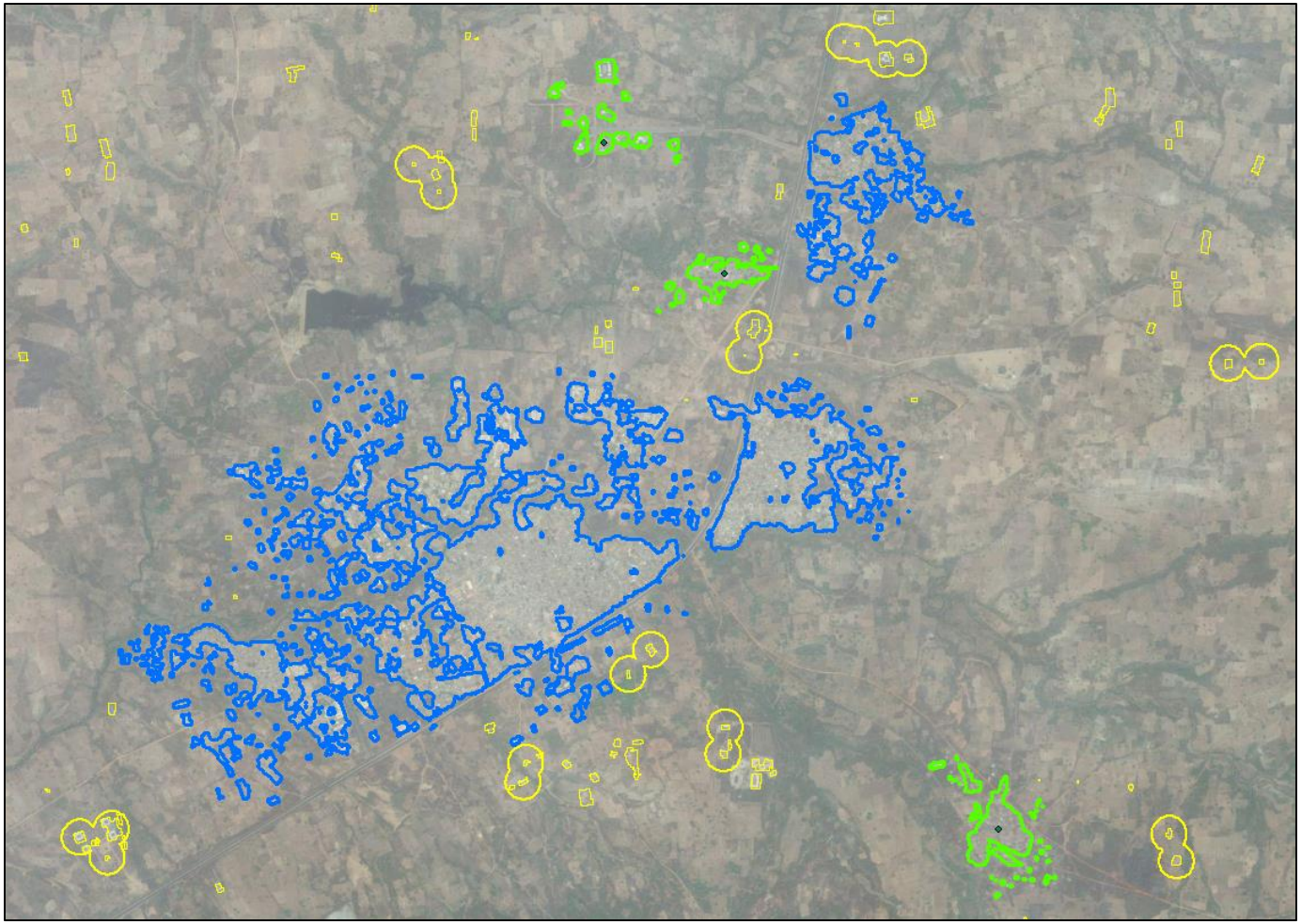
SIA and microplanning





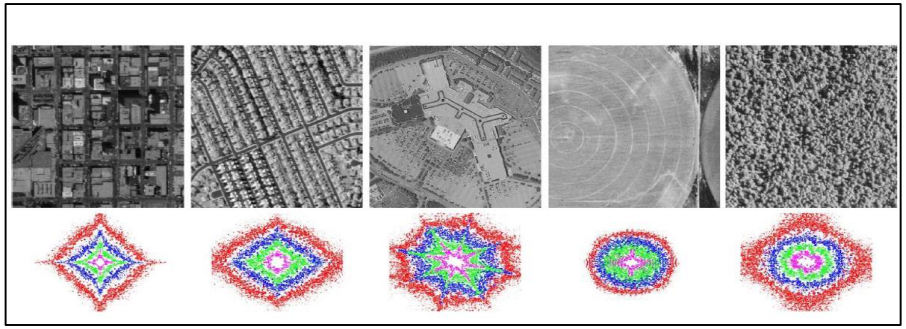


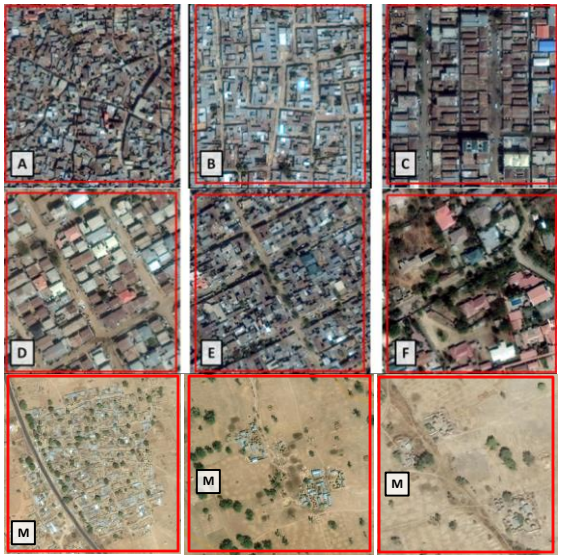
Building the basemap

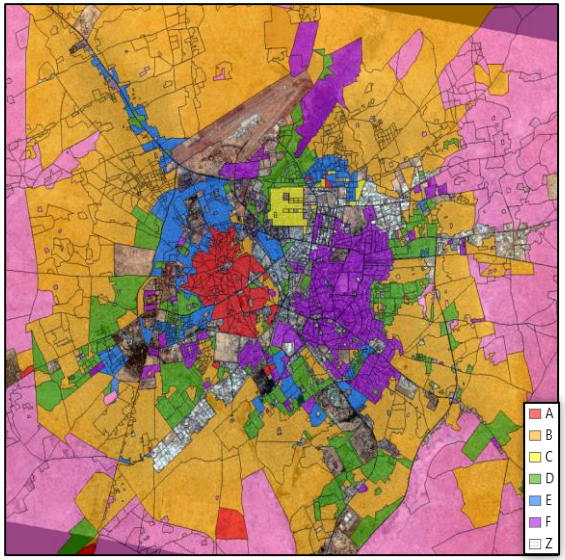


High resolution satellite imagery, machine learning and settlements extraction

Building the basemap







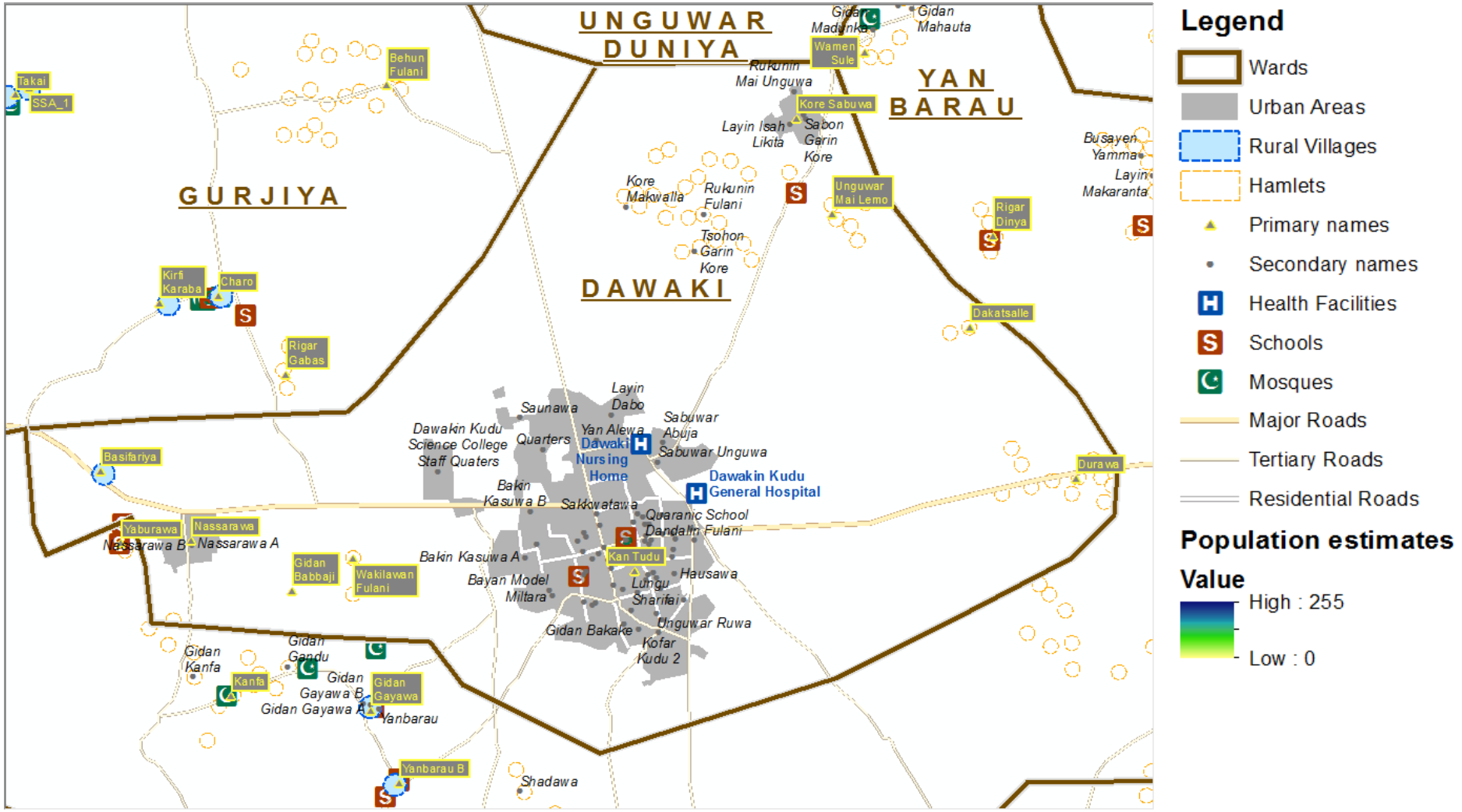
Spectral signatures and neighborhood types

Building the basemap

- Field data collection using GPS-enabled mobile devices to collect
  - Settlement names
  - Settlement's Admin-3 attribution (to generate vaccination boundaries using voronoi polygons)
  - Points Of Interests (health facilities, markets, schools, etc.)
  - Microcensus data for each neighborhood type to generate a 90-meter GIS-based population model

Novel-T
Innovative solutions

The resulting basemap



Legend

- Wards
- Urban Areas
- Rural Villages
- Hamlets
- Primary names
- Secondary names
- Health Facilities
- Schools
- Mosques
- Major Roads
- Tertiary Roads
- Residential Roads

Population estimates

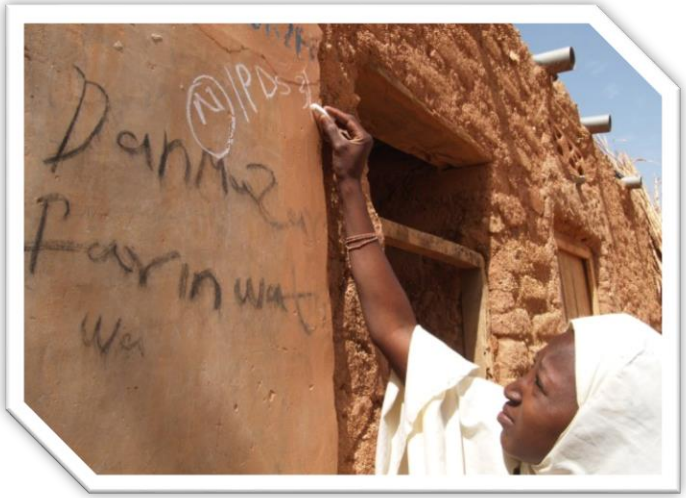
Value

High : 255

Low : 0

Novel-T Innovative solutions

Leveraging the basemap



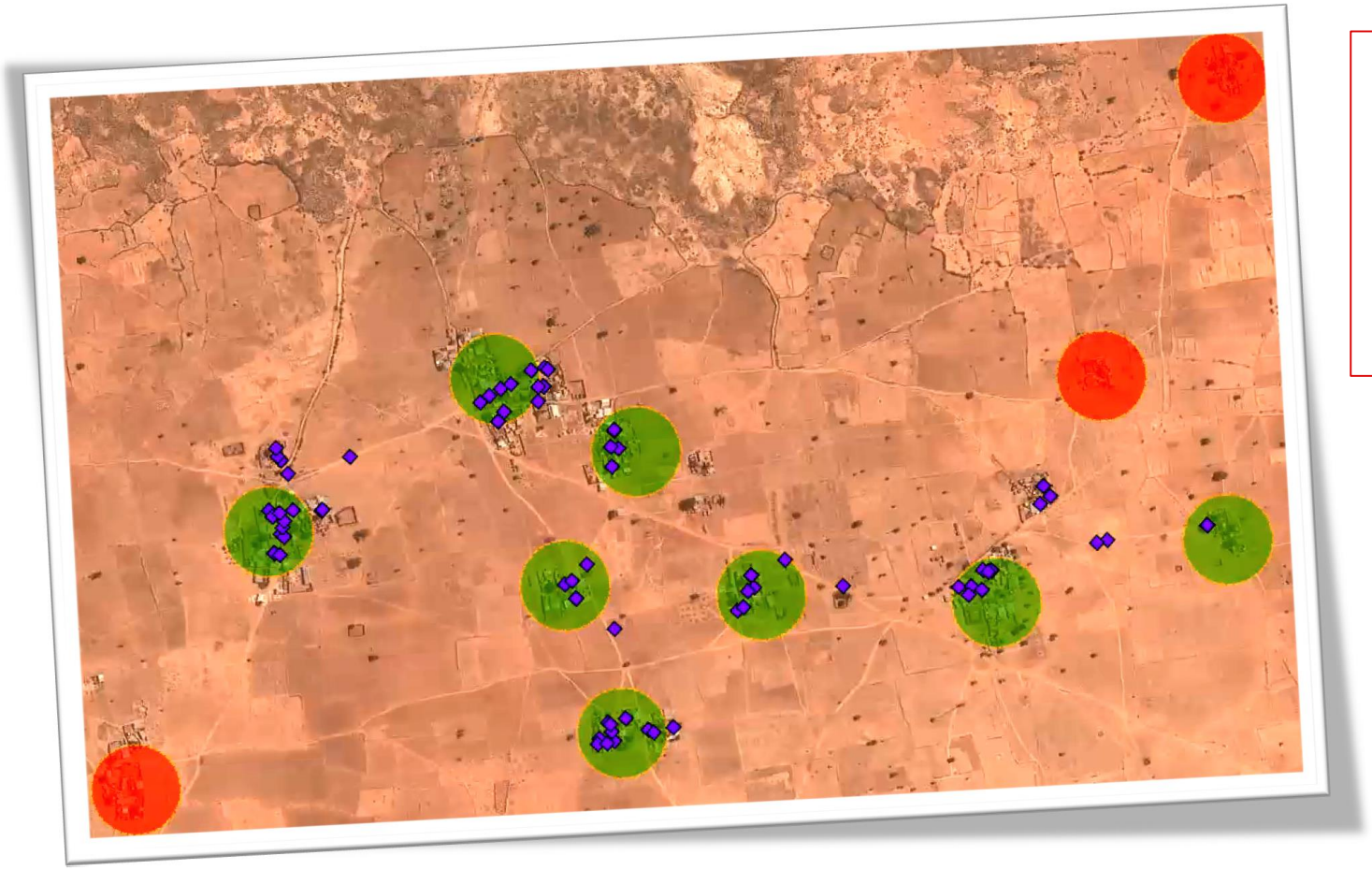
Ensure every settlement is visited

So that every child is vaccinated

Novel-T
Innovative solutions

The Vaccination Tracking System (VTS)

An information system which monitors vaccination teams going house to house during SIAs



Novel-T
Innovative solutions

Assessing the quality of SIAs

- Compute "geographic coverage" at settlement, Ward, LGA and State levels and combining multiple interventions

- Identify in near real-time missed or partially covered settlements

- Identify chronically missed or partially covered settlements

- Estimate target population of non-visited settlements

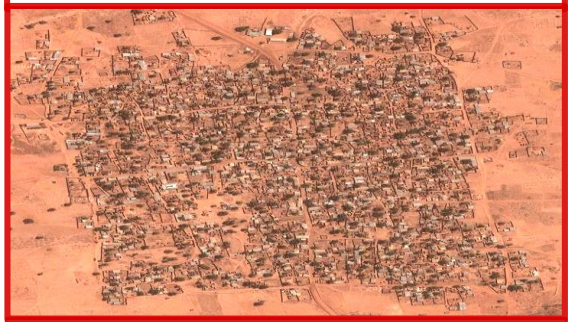
Novel-T
Innovative solutions

Calculation of geographic coverage

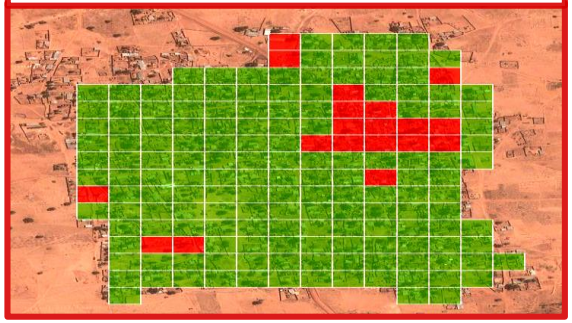
Built up areas
(11’000+)

Large settlements

Cities with more than 100 residences



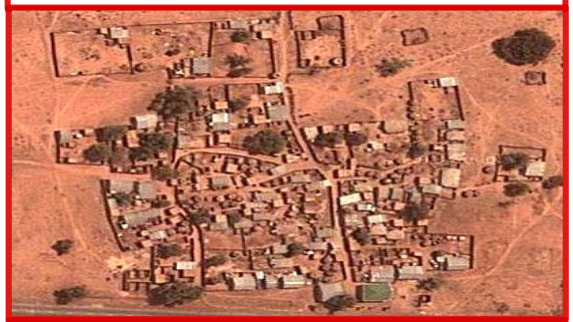
BUA polygons divided into 50 meter grid squares



Small Settlement Areas
(24’000+)

Rural villages

with 20-100 residences

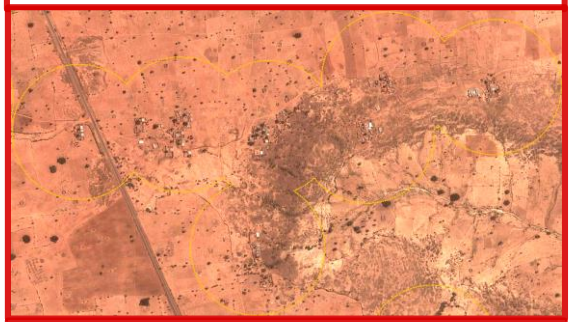


75 meter Buffer around SS Point Feature

Hamlet Areas
(60’000+)

Clusters of hamlets within 200m from one another

Each hamlet containing less than 20 residences

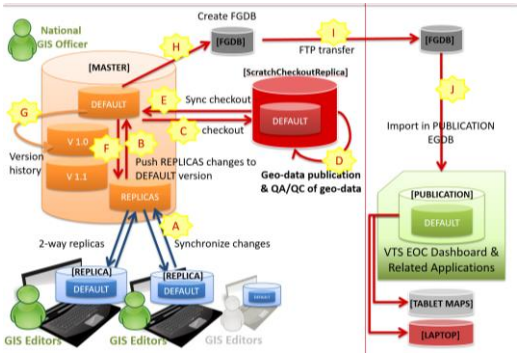


50 meter buffer around each hamlet

Novel-T
Innovative solutions

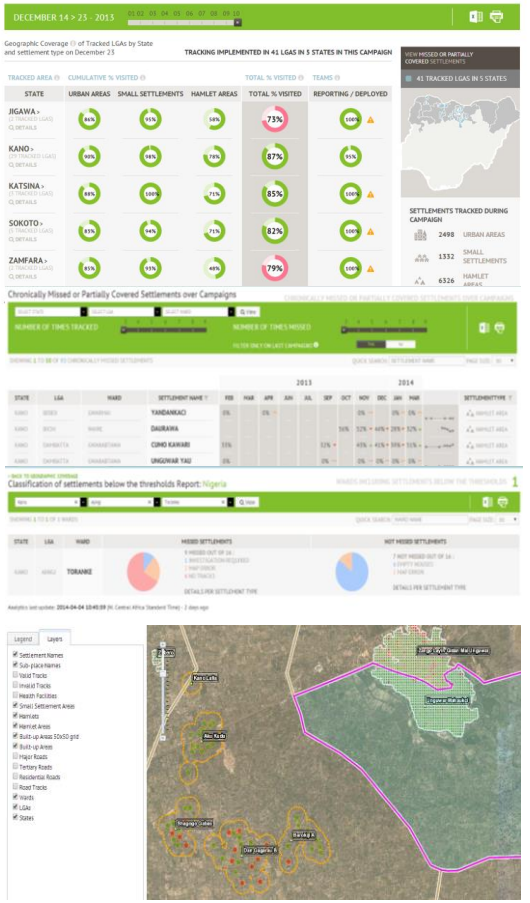
Solution components

Geodatabase



Local Laptops

National EOC Dashboard



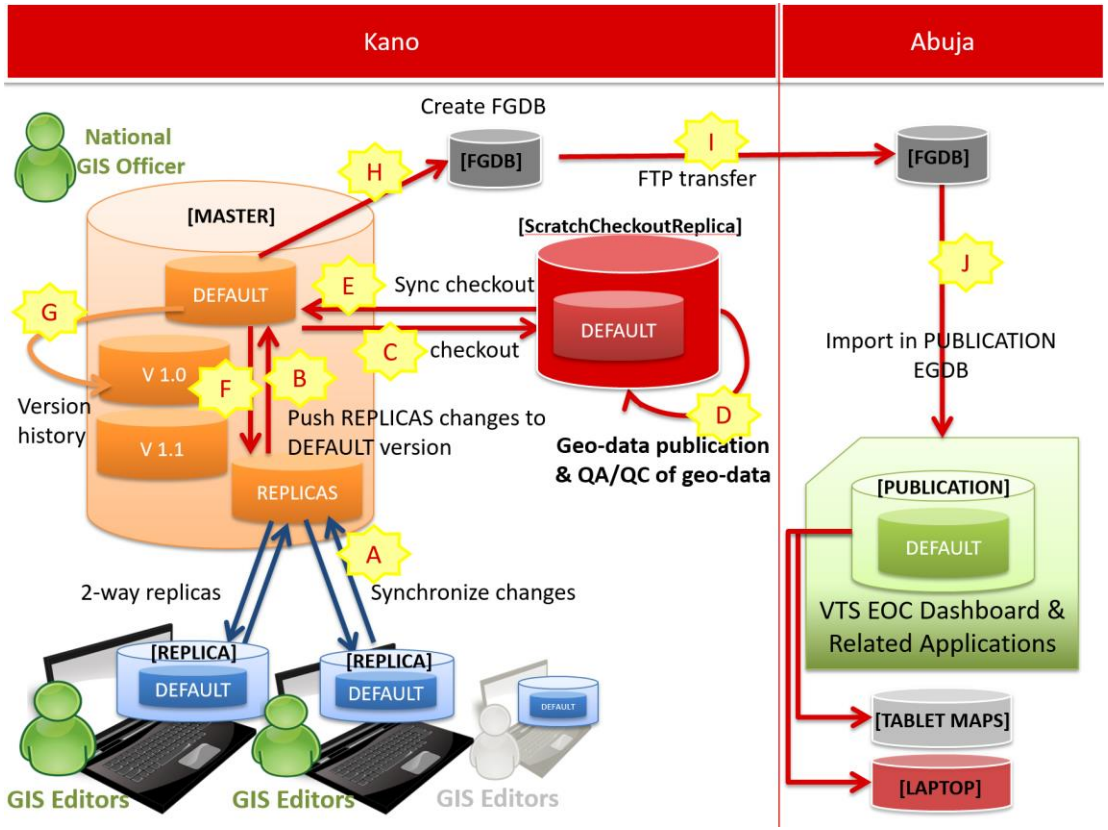
GPS-enabled phones

Tablets / Hamlet Buster

Novel-T
Innovative solutions

Geodatabase

- Repository of inhabited settlements and other geo-data
- Architected to support multiple concurrent editors regularly enhancing the geo-data



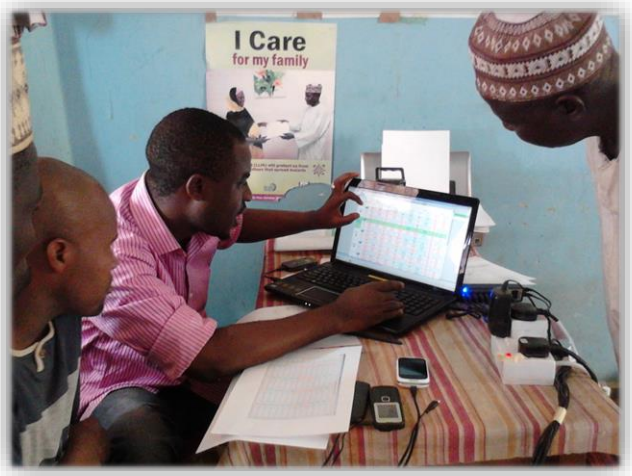
GPS-enabled Phones

- GPS-enabled android phones
- Rely on GPS network only
- Operate completely offline
- Capture GPS position every 2 mins
- Distributed to 12’000+ vaccination teams
- No interaction required - vaccination teams simply need to carry it

Novel-T
Innovative solutions

Local Laptops

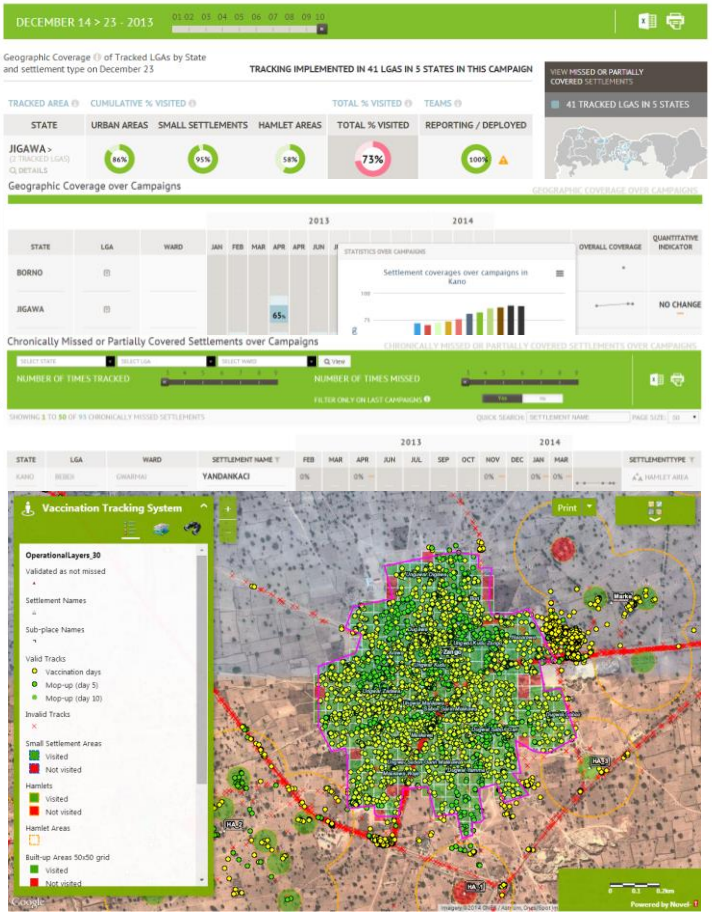
- Extract GPS positions from the phones via USB
- Operate completely offline
- Centralize all GPS position per day / LGA / campaign



- Compute daily analytics, display dashboard and maps including offline satellite imagery
- Inform the decisions and planning for the next days
- Transfer GPS positions to EOC via MiFi / WiFi

Emergency Operation Center (EOC)

- Web-based dashboard
- Consolidated view at the National EOC
- Fully automated data reception and processing
- updated near real-time (< 30 mins to compute daily analytics)
- Cross-campaign analyses



Novel-T
Innovative solutions

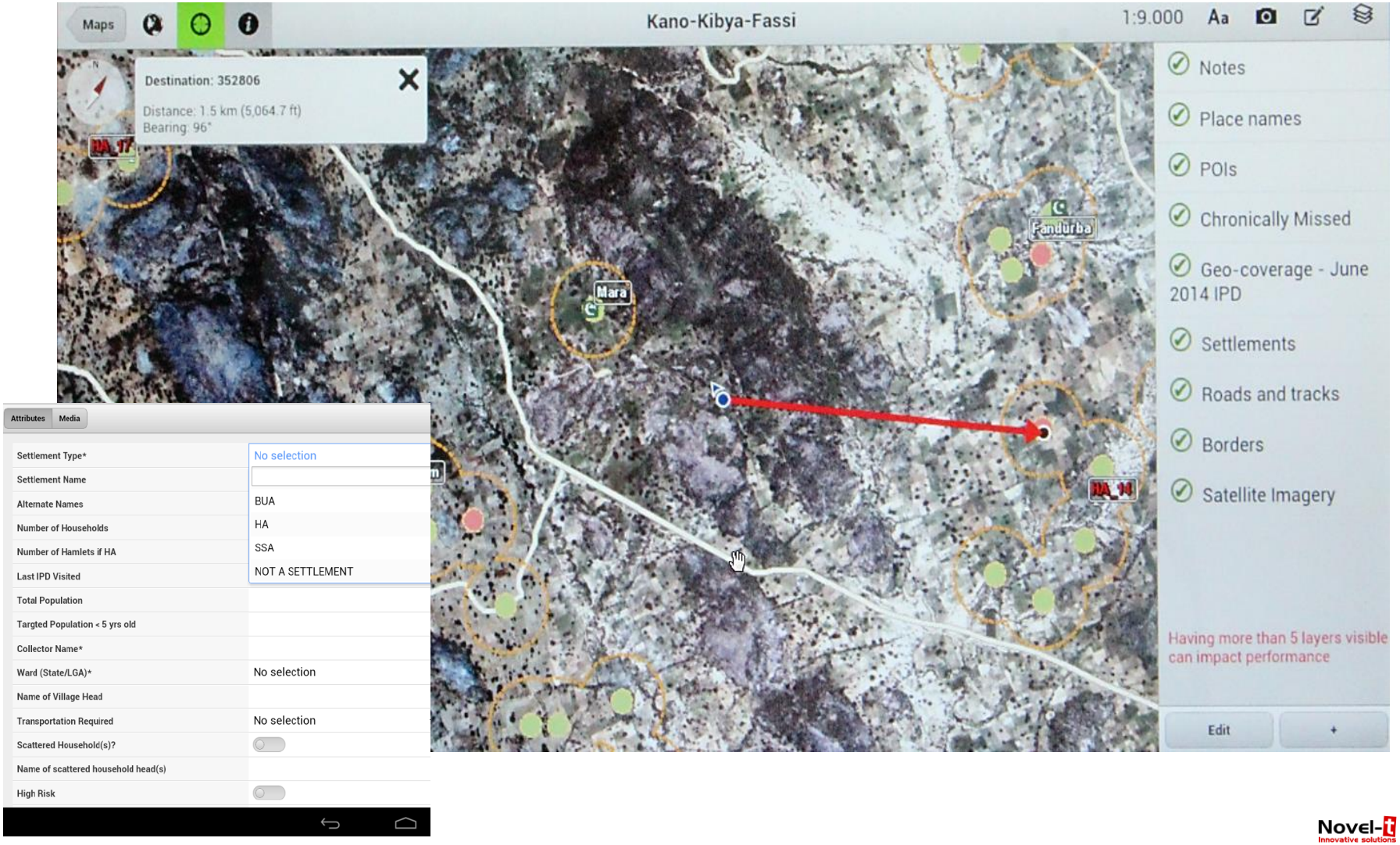
Tablets (aka Hamlet Buster)

- Ruggedized and field-ready
- Rely on GPS network only
- Operate completely offline

- Contains settlement locations and offline satellite imagery
- Help locate and reach chronically missed settlements during microplanning or in-between round activities
- Can collect geo-referenced data such as place names and other information

Novel-T
Innovative solutions

Tablets (aka Hamlet Buster)



Tablets (aka Hamlet Buster)

Zero-dose child #1…..

Zero-dose child #2…..

Novel-t
Innovative solutions

Campaign Workflow

given to Ward Focal Person (WFP) at LGA HQ each morning

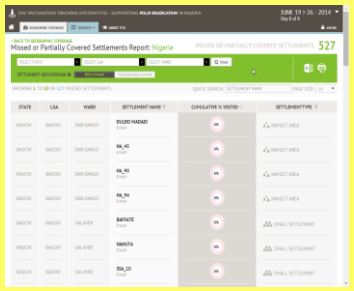
5a-6:30a

WFP returns to Ward take-off point and gives phones to vaccinators

7a-8a

Vaccinators return phones to WFP at the end of their day

GPS-enabled phones collect time-stamped GPS coordinates every 2 minutes



Missed Settlement Report generated at end of days 4 & 5

11a-5p

WFP returns to LGA-HQ where GPS tracks are downloaded to Laptop and geo-coverage computed

2p-8p

Feedback for daily coverage provided to WFPs and LGA team at daily meeting

Tracks uploaded to EOC/Dashboard via MiFi

Novel-T Innovative solutions

Data flow

Field level

RES tracks

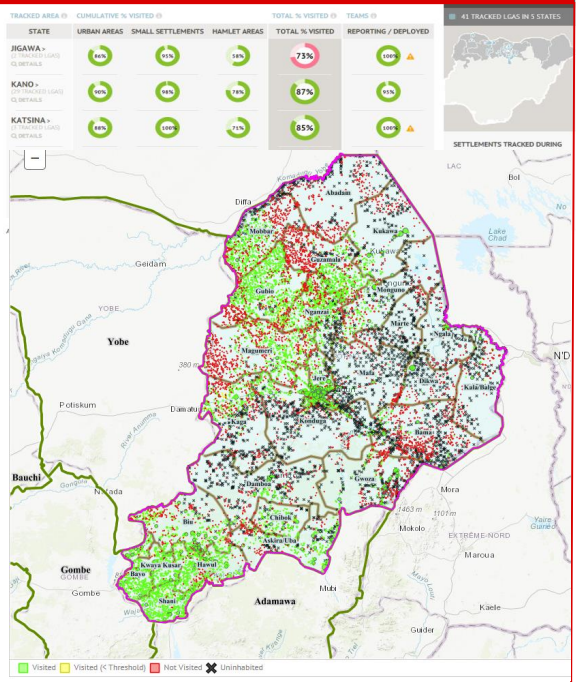
Data/WiFi

H2H tracks/data

MiFi/WiFi

National level

National EOC

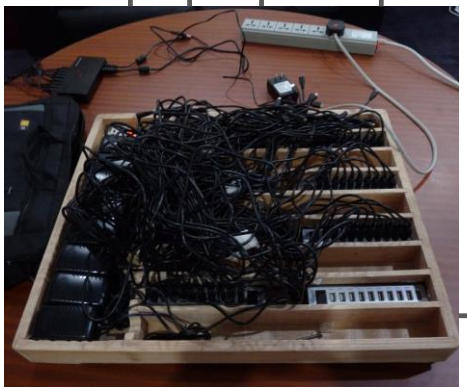


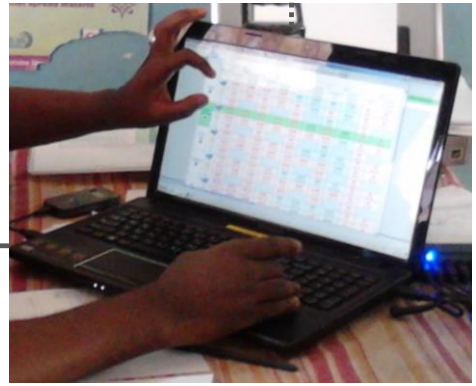
Analytics automatically updated every half hour

Web server

Internet

LGA level

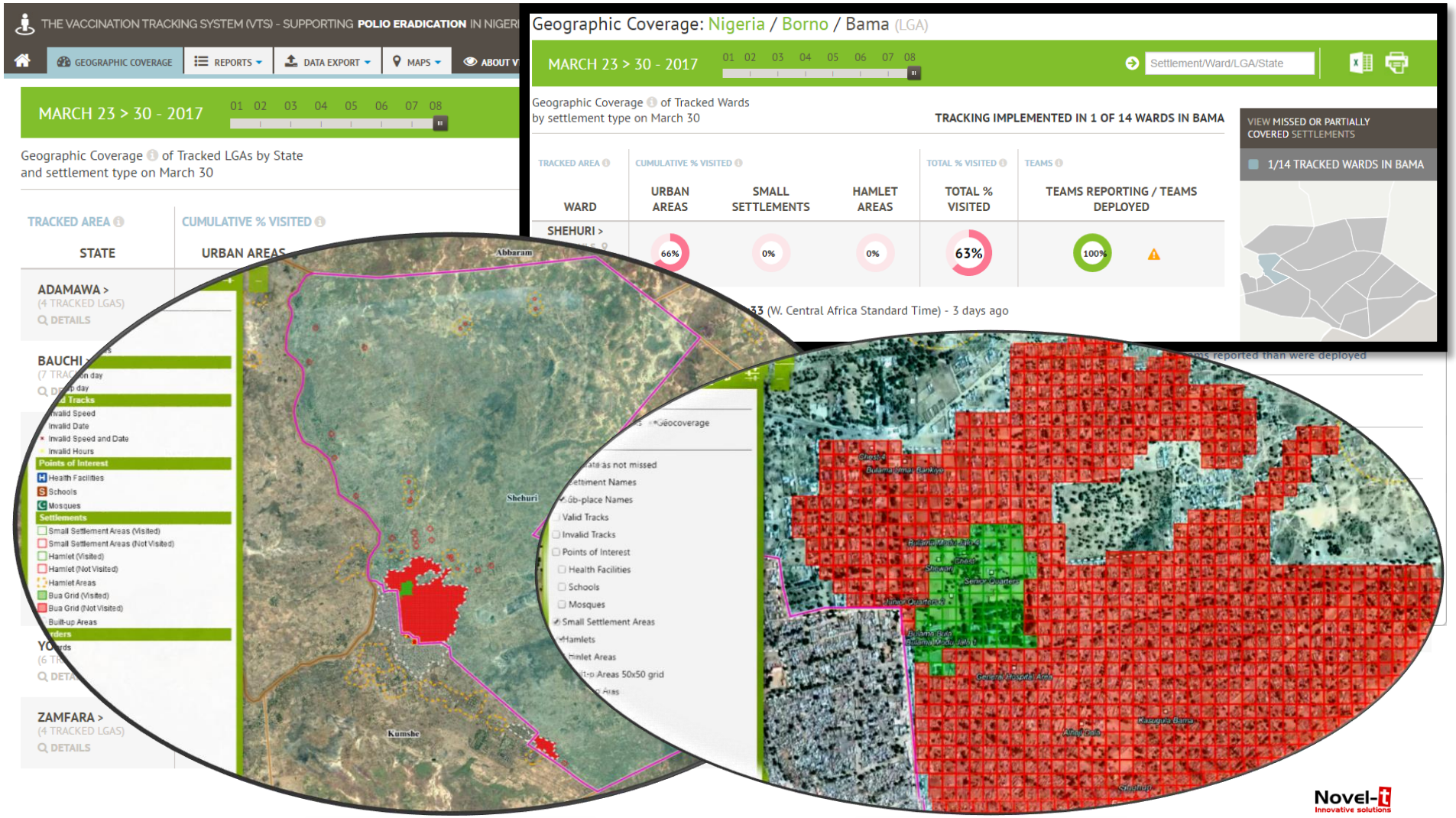




Novel-T Innovative solutions

Analytics

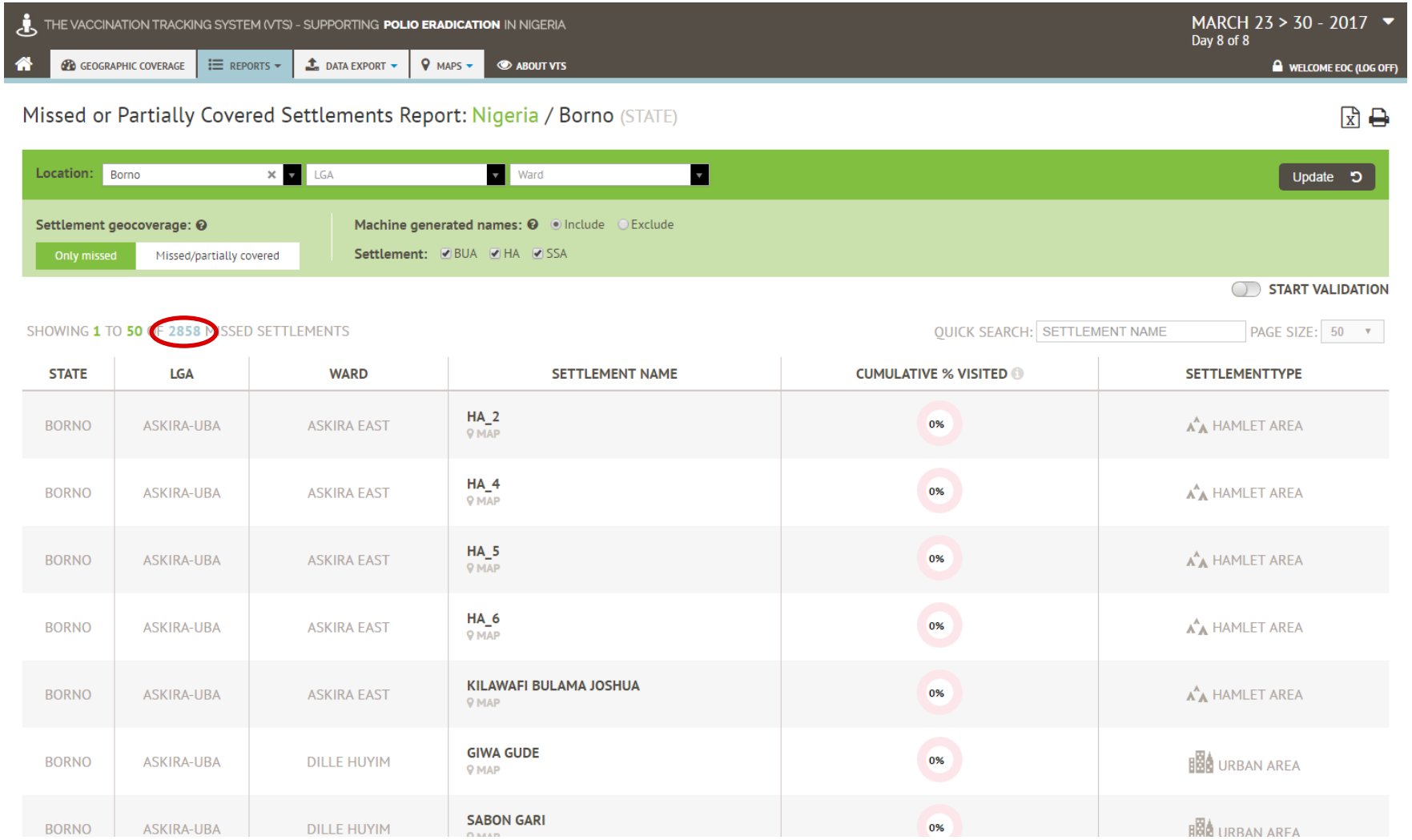
Geographic coverage at National, State, LGA, Ward and settlement levels



Novel-T
Innovative solutions

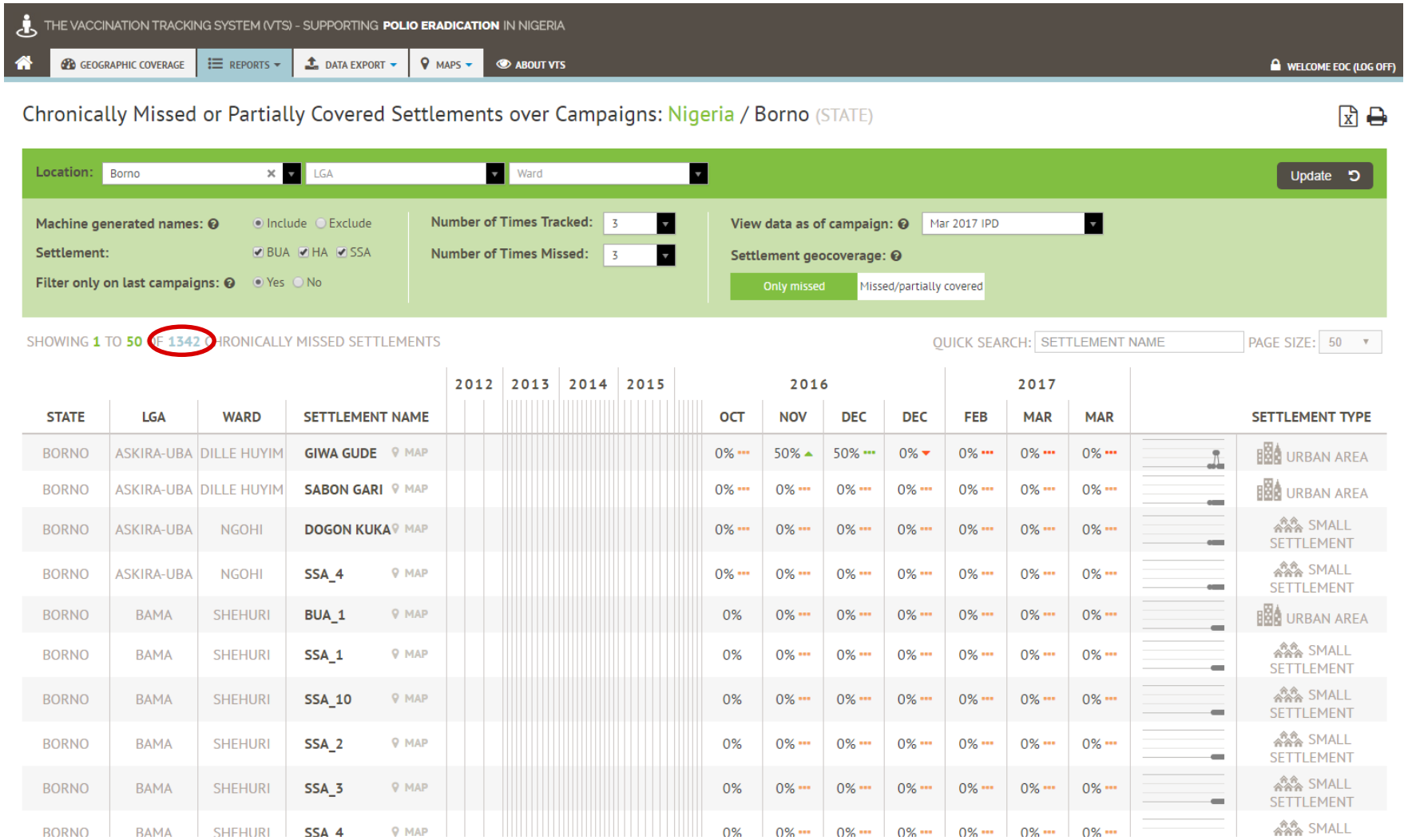
Analytics

Missed Settlement List (MSL)



Analytics

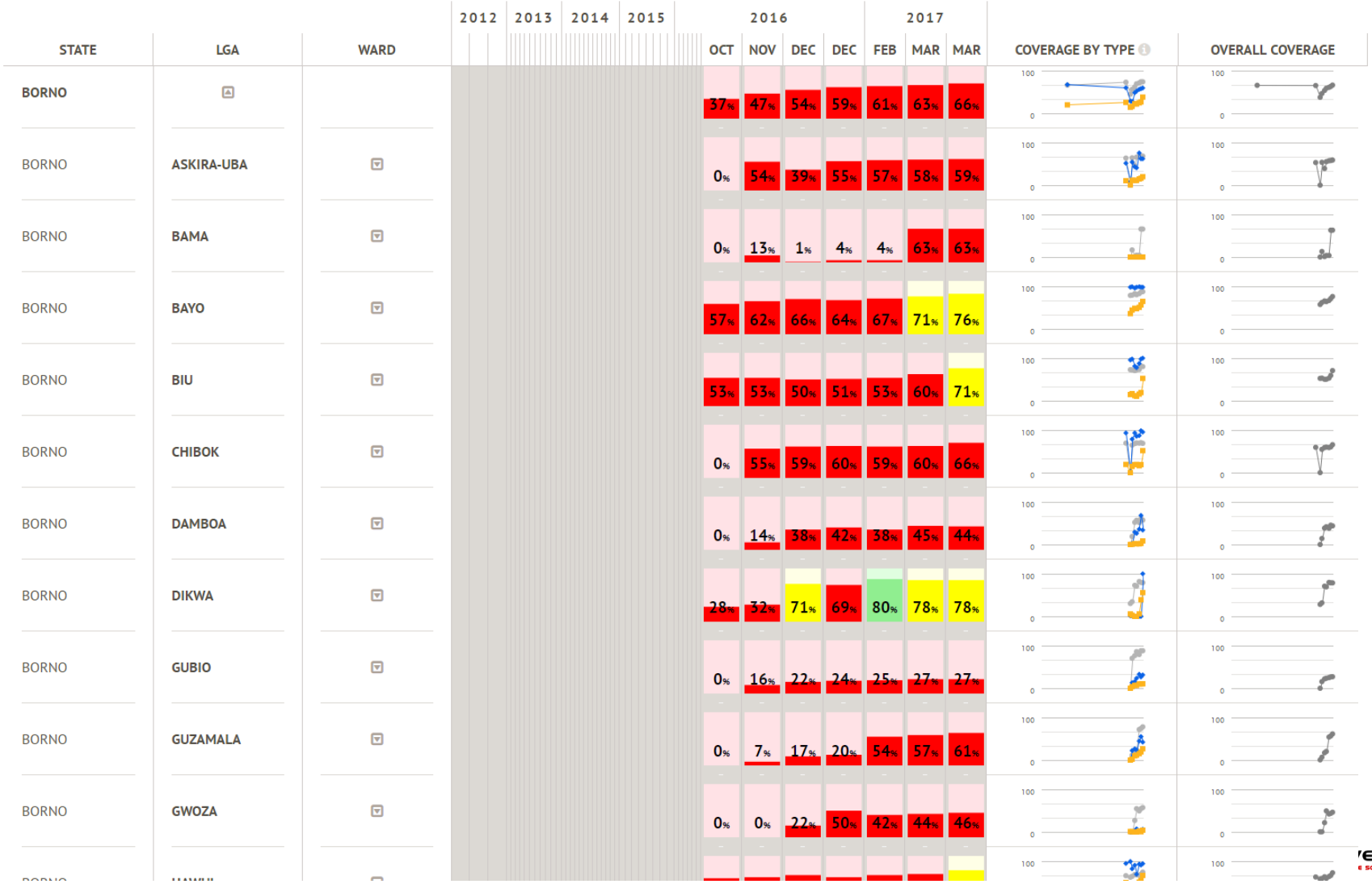
Chronically Missed Settlement List (CMSL)



Novel-T Innovative solutions

Analytics

Geographic coverage time trend at State, LGA and Ward levels



Analytics

Vaccination Reach

THE VACCINATION TRACKING SYSTEM (VTS) - SUPPORTING **POLIO ERADICATION** IN NIGERIA

BORNO OUTBREAK RESPONSE - ACCESSIBILITY MAP

WELCOME EOC (LOG OFF)

Back to VTS

Borno Outbreak Response

Location: Borno | Select 1 or more LGA | Select 1 or more Ward | Update

Period: August 1, 2016 To April 8, 2017 | Last 30 Days | Current Month | Last Month

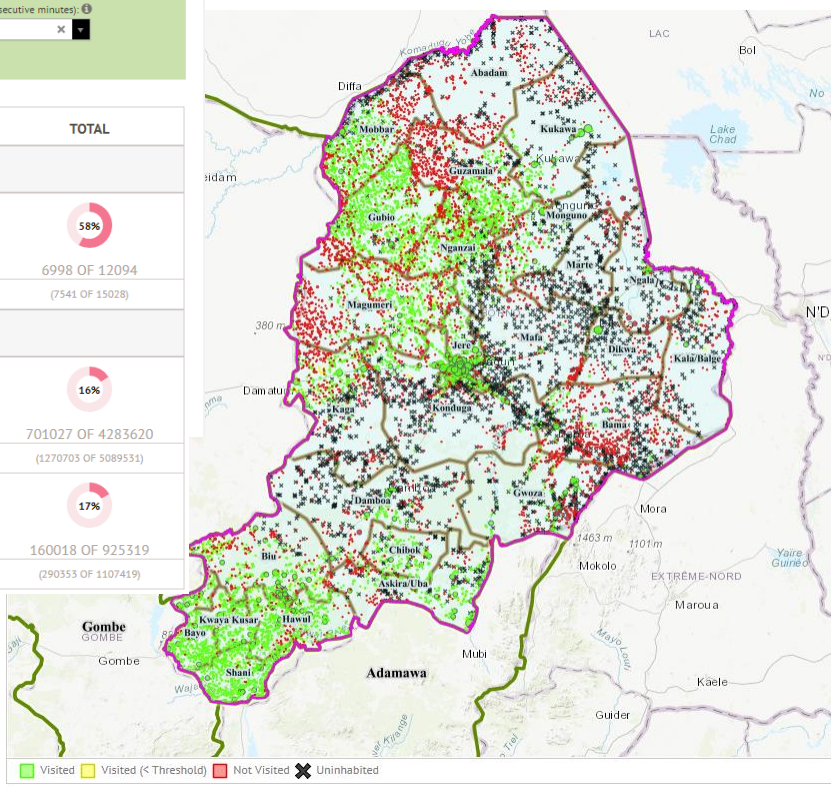
Activities: H2H Campaign, RES Campaign ... | Include MSL

Show Tracks | Show All Settlements | Highlight selection

Settlements: All

Visited Threshold (consecutive minutes): 10 minutes

	URBAN AREAS	SMALL SETTLEMENTS	HAMLET AREAS	SINGLE HAMLET AREAS	TOTAL
Visited Settlements					
Inhabited Settlements Visited	90%	65%	59%	49%	58%
	355 OF 395	1324 OF 2036	3323 OF 5590	1996 OF 4073	6998 OF 12094
(Including Uninhabited Settlements)	(400 OF 540)	(1544 OF 3132)	(3426 OF 6295)	(2171 OF 5061)	(7541 OF 15028)
Non-Visited Settlements Estimated Population					
Estimated Total Population of Non-Visited Settlements	3%	33%	30%	43%	16%
	81254 OF 2406817	106634 OF 323091	355177 OF 1184323	157962 OF 369389	701027 OF 4283620
(Total Unadjusted Population)	(375403 OF 2865530)	(245718 OF 498245)	(429619 OF 1270964)	(219963 OF 454791)	(1270703 OF 5089531)
Estimated Under 5 Population of Non-Visited Settlements	4%	34%	31%	43%	17%
	18265 OF 506400	24475 OF 71911	80962 OF 262913	36316 OF 84096	160018 OF 925319
(Under 5 Unadjusted Population)	(86019 OF 609609)	(56099 OF 111758)	(97905 OF 282605)	(50332 OF 103447)	(290353 OF 1107419)

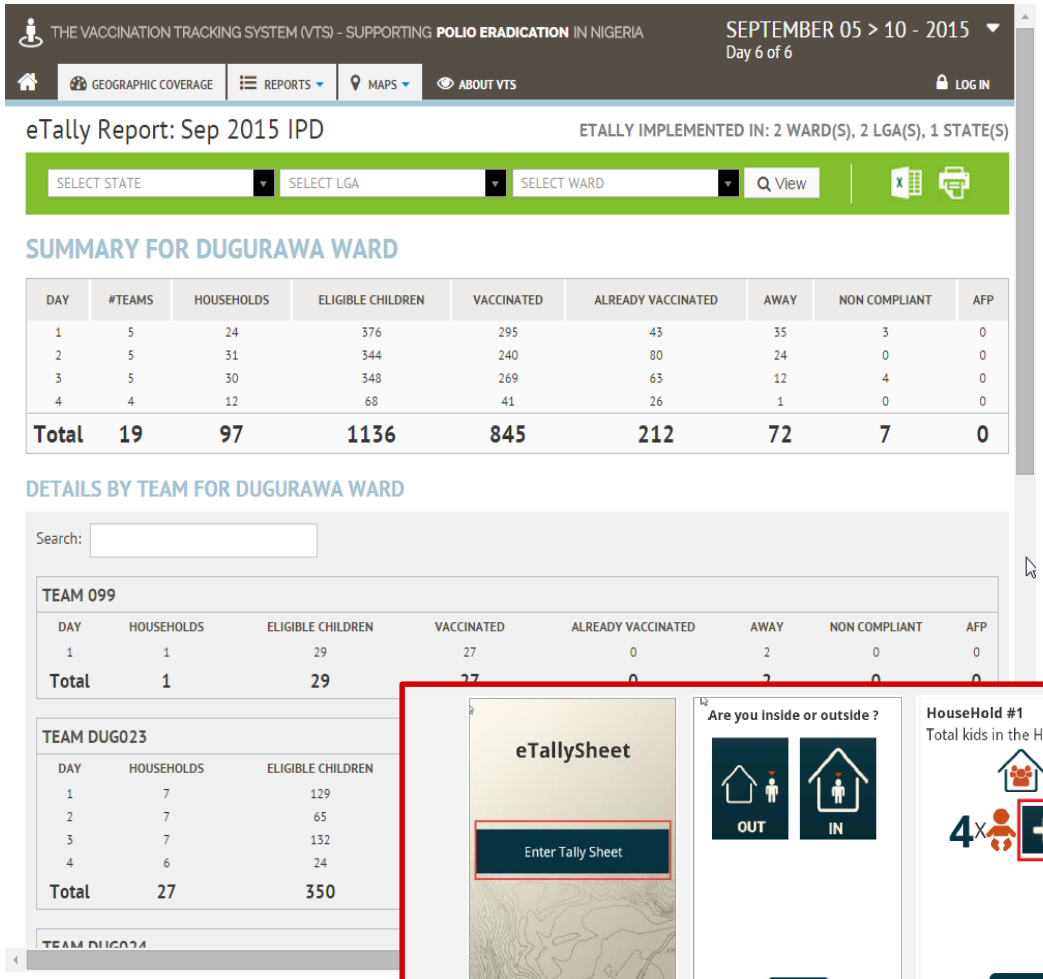


Integrates H2H tracks as well as other special interventions (e.g. RES, RIC, hit and run, ODK lat-lon, etc.) to have a comprehensive view of vaccination reach.

Novel-T Innovative solutions

Analytics - eTally

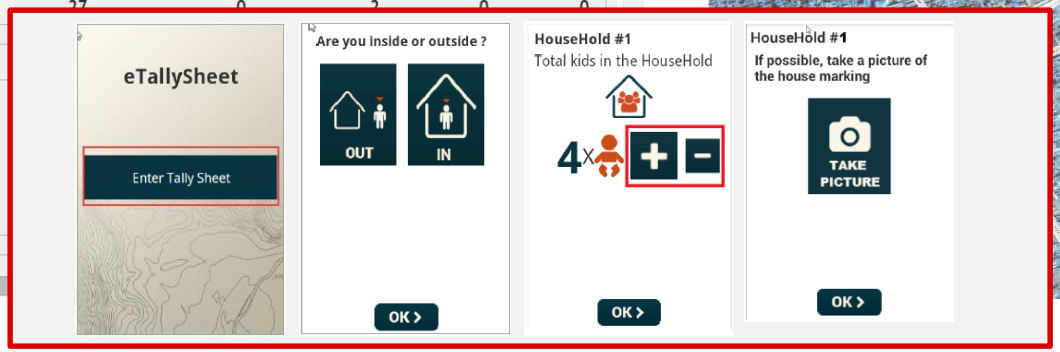
Tally sheet at State, LGA, Ward and team levels and map depicting location of vaccination activities, revisits and non-compliances

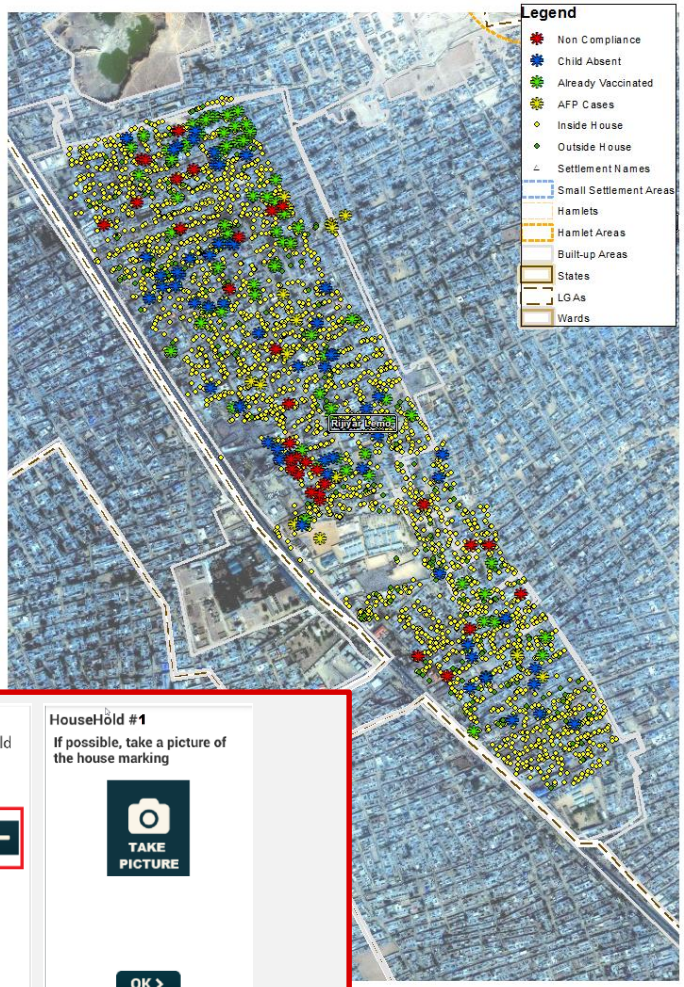


DAY	#TEAMS	HOUSEHOLDS	ELIGIBLE CHILDREN	VACCINATED	ALREADY VACCINATED	AWAY	NON COMPLIANT	AFP
1	5	24	376	295	43	35	3	0
2	5	31	344	240	80	24	0	0
3	5	30	348	269	63	12	4	0
4	4	12	68	41	26	1	0	0
Total	**19**	**97**	**1136**	**845**	**212**	**72**	**7**	**0**

DAY	HOUSEHOLDS	ELIGIBLE CHILDREN	VACCINATED	ALREADY VACCINATED	AWAY	NON COMPLIANT	AFP
1	1	29	27	0	2	0	0
Total	**1**	**29**					

DAY	HOUSEHOLDS	ELIGIBLE CHILDREN
1	7	129
2	7	65
3	7	132
4	6	24
Total	**27**	**350**



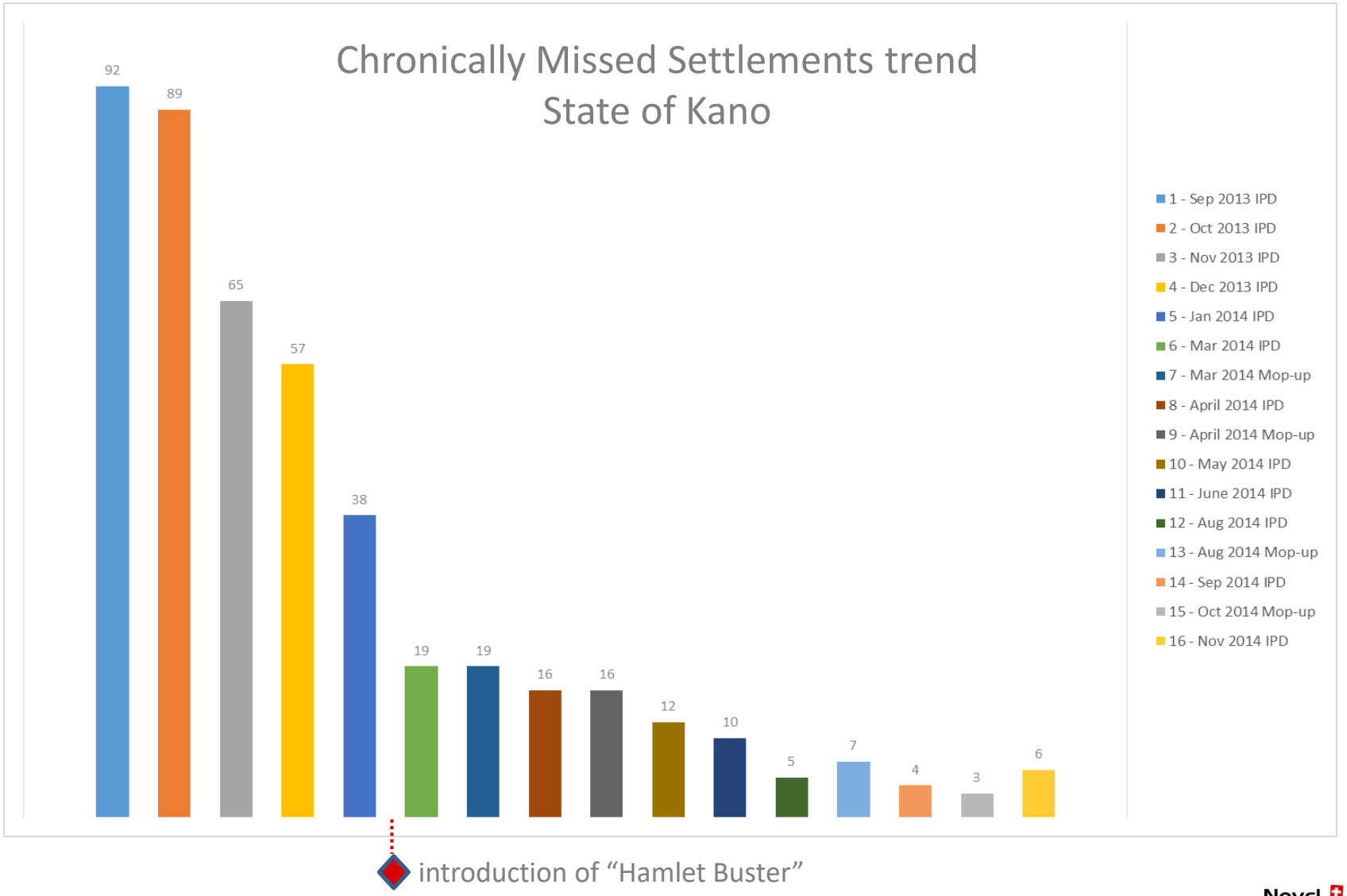


The VTS – at scale

- **58** campaigns monitored since Jan 2013
- Up to **80** LGAs monitored per campaign
- Up to **12’000+** teams in the field visiting **20’000+** settlements per campaign
- Generating **4’000’000+** GPS positions in a single day
- Processed in **< 30 mins**
- **19’000’000+** GPS positions collected in a single campaign
- **450’000’000+** GPS tracks in the VTS
- **hundreds** of zero dose child vaccinated thanks to the “Hamlet Buster”

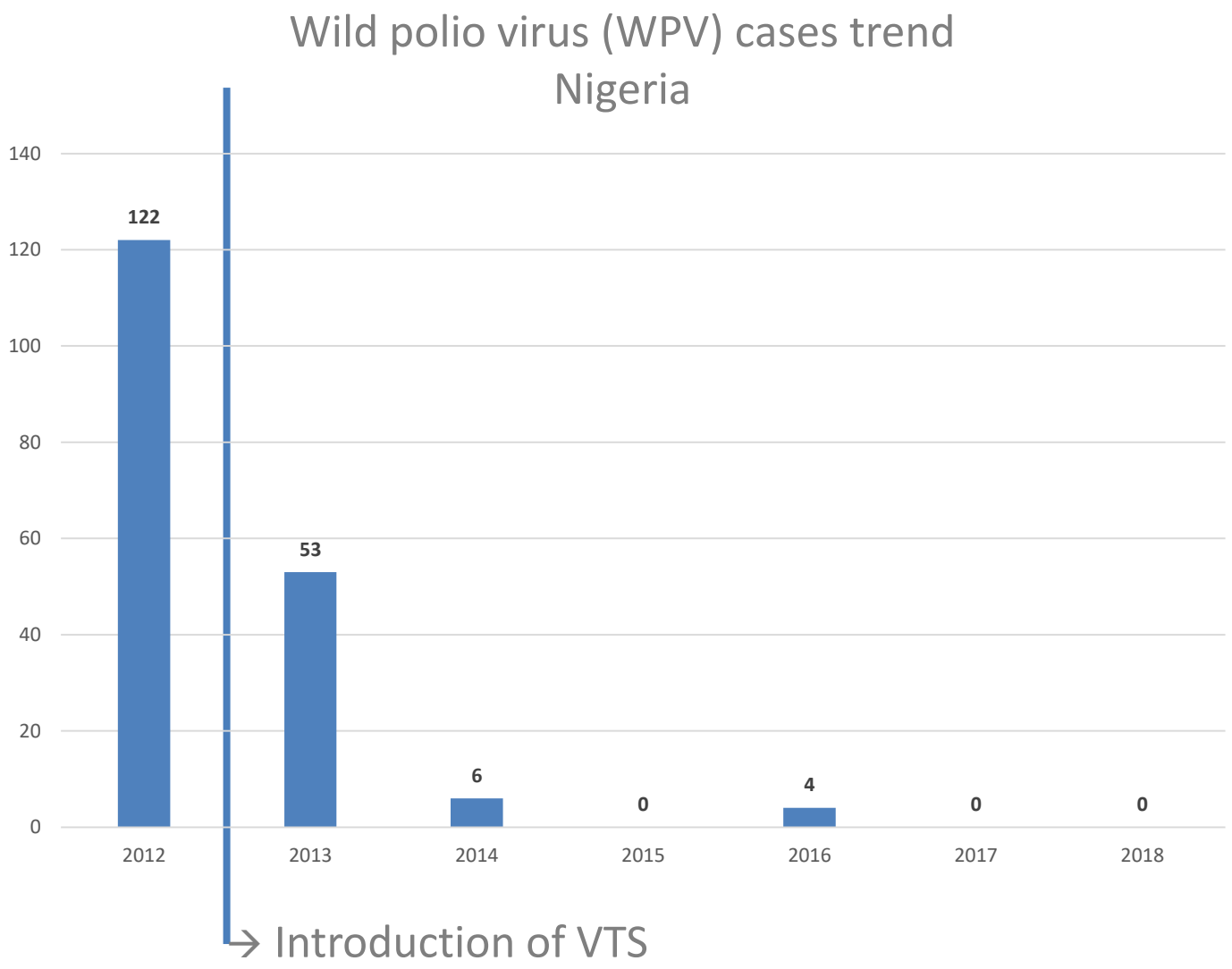
Novel-T
Innovative solutions

The VTS – Impact



Novel-T
Innovative solutions

The VTS – Impact



World Health Organization

BILL & MELINDA GATES foundation

CDC

OAK RIDGE National Laboratory

world pop

NPHCDA
National Primary Health Care Development Agency

SPHCDA

eHealth AFRICA

Novel-t
Innovative solutions