SORMAS® - Surveillance Outbreak Response Management and Analysis System

HZI HELMHOLTZ Centre for Infection Research

History of SORMAS

2015

- Development of prototype (based on HANA platform), short field pilot
- Primarily for Ebola plus 3 reference diseases
- Funding from Federal Ministry for Research and Education (BMBF) via German Centre for Infection Research (DZIF), Hasso-Plattner-Institute and SAP (in-kind)

2016

- Full transition to open source
- Expansion to 7 diseases, inclusion of laboratories
- Funding from Federal Ministry for Economic Cooperation and Development (BMZ) via Gesellschaft für internationale Zusammenarbeit (GIZ)

2017

- Initiation of pilot and ad hoc activation in Monkeypox outbreak
- Expansion to 10 diseases, further functional and technical expansion
- Funding from DZIF, BMBF, GIZ

2018

- Massive roll-out in Nigeria, response to simultaneous outbreaks
- Expansion to 12 diseases, French version, further technical improvements
- Funding from GIZ, Helmholtz Association (HGF), BMBF

2019

- Further roll out in Nigeria, pilot in Ghana
- Addition of clinical management module and completion of global goods model
- Funding from BMZ&EU via GIZ, HGF, BMBF, Bill & Melinda Gates Foundation, Nigerian Basic Health Care Provision Fund (BHCPF), CDC

Mission and Objectives of SORMAS

Surveillance **O**utbreak **R**esponse **M**anagement and **A**nalysis **S**ystem

- Mission
  - Improve prevention and control of communicable diseases particularly in resource-poor settings.
  - Designed by those involved in public health surveillance and disease control.
  - Free of charge, highest data protection, good scientific practice and open access policy
- Full integration of
  - Response business process managements
  - Surveillance and analysis
- Multi-directional and case based throughout
- Wireless and independent from continuous electricity or internet
- Open source and free of charge

Objectives: Digital, Mobile Outbreak Detection & Response

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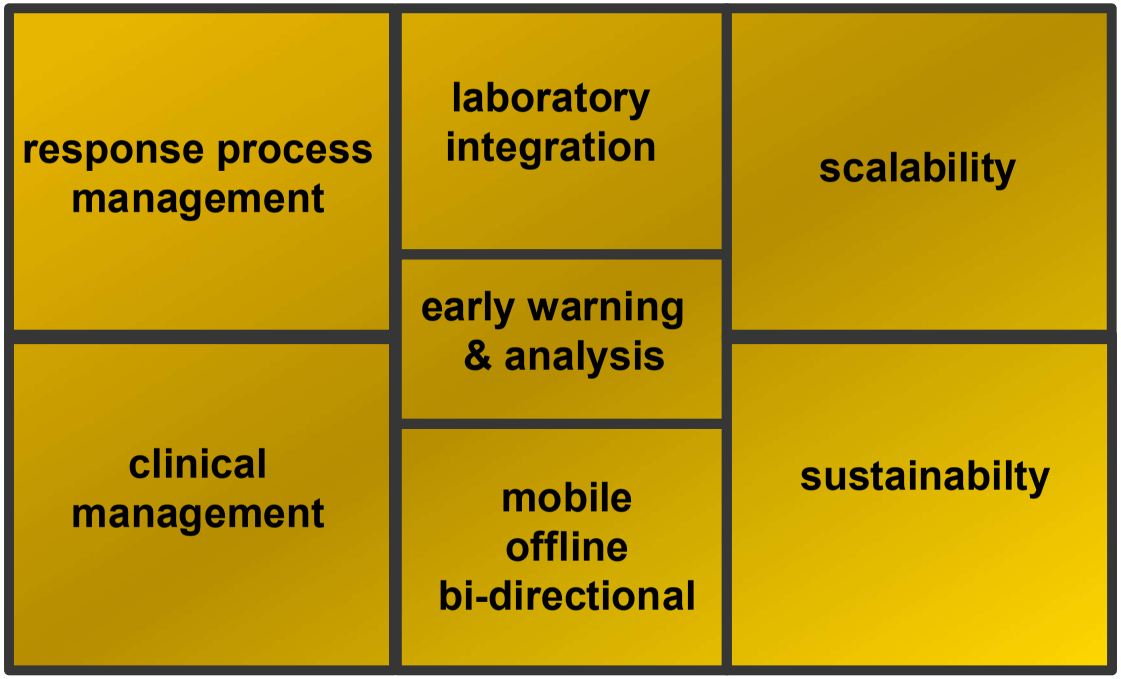
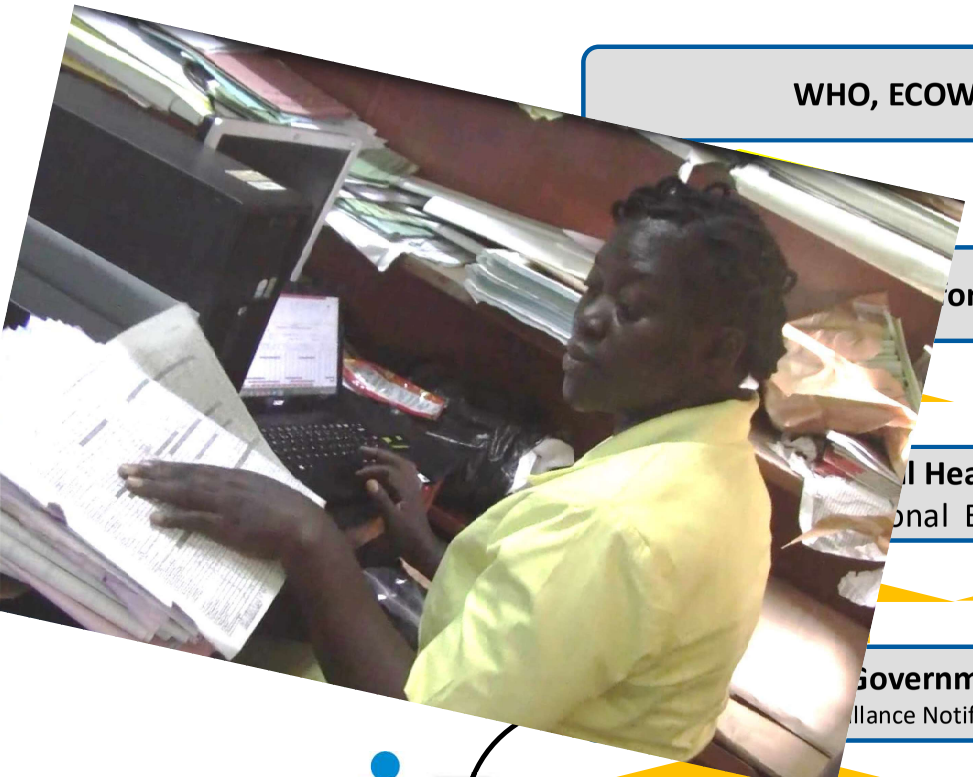
Surveillance
Outbreak
Response
Management
Analysis
System



Integrated Disease Surveillance and Response System
Conventional Information Flow



WHO, ECOWAS, R-CDC

or Disease Control

l Health Department
onal Epidemiologist

case based weekly

Government Area Health Dpt.
llance Notification Officer (DSNO)

aggregated weekly (by Monday)

case based Immediately

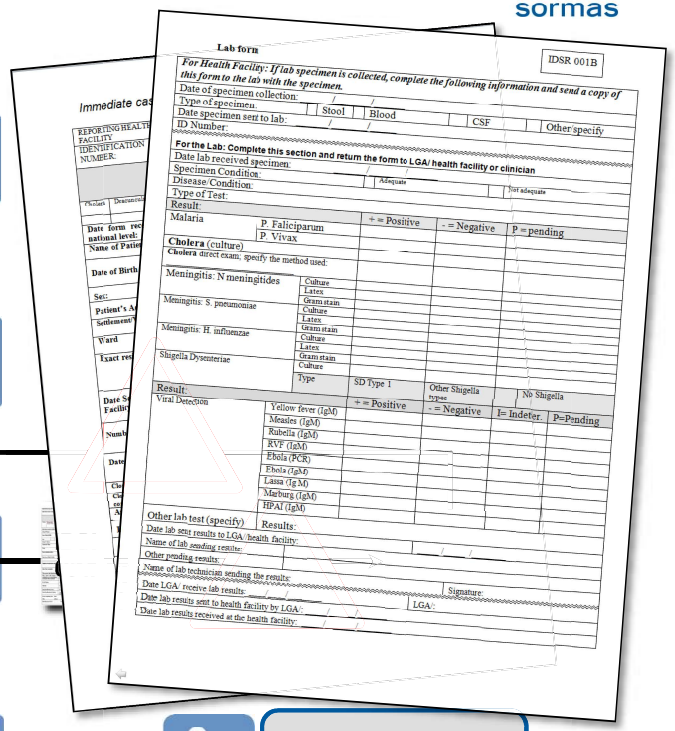
Local Health Care Facilities

Field investigator

Laboratory

IDSR 001B

IDSR 001A



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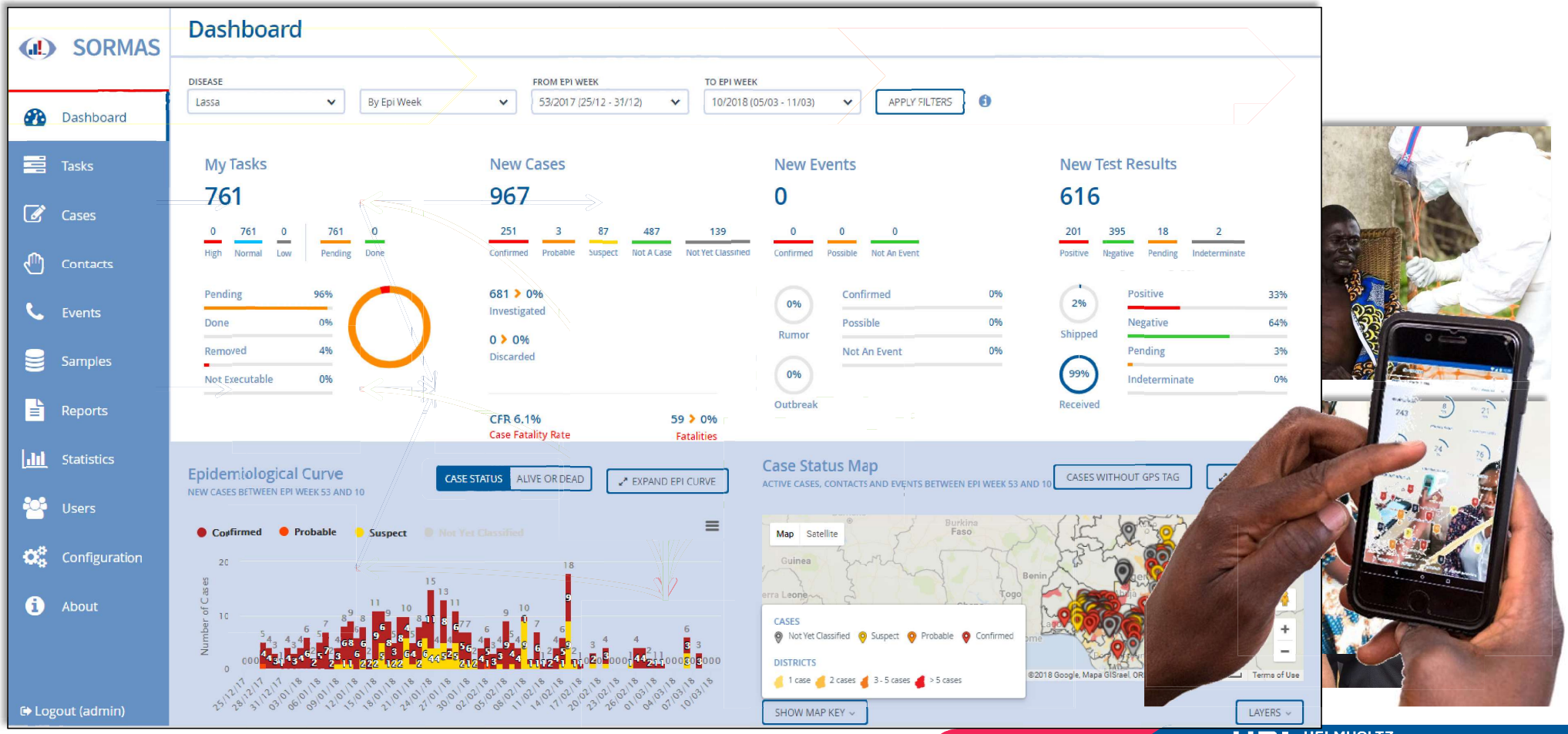
Response Management in SORMAS (e.g. Ebola)



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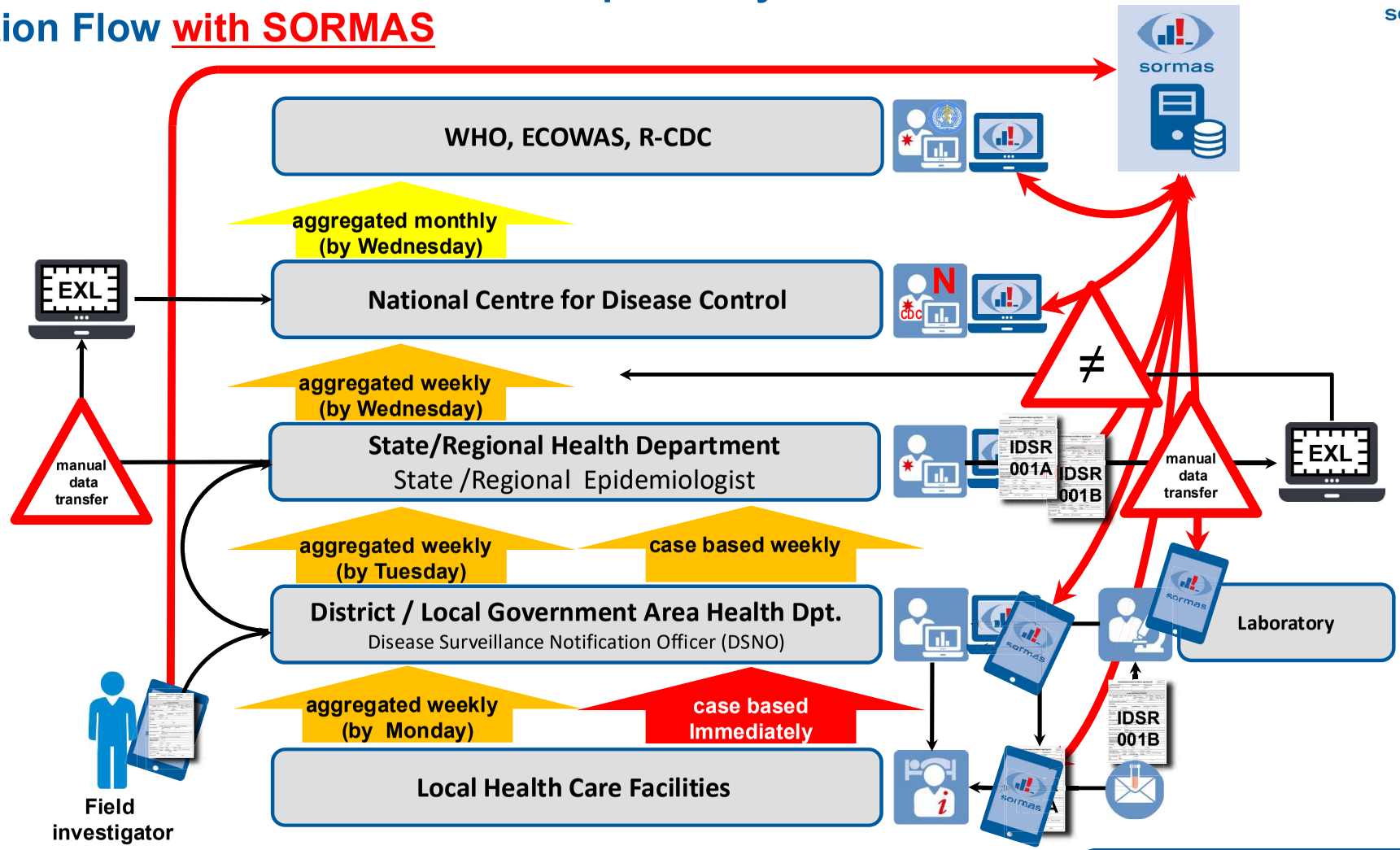
Integrated Disease Surveillance and Response System
Information Flow with SORMAS



Personas / Users of SORMAS

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Detect
notification, screening

Investigate
validation, analysis

Control
treatment, containment

Community Informant
refers suspect cases in community to hospital informant

Hospital Informant
Notifies suspect cases

Point of Entry Officer
Notifies suspect cases at airports, ports and border crossing

Rumour Officer
State DSNO
Receives calls on events from general population

Surveillance Officer
LGA-DSNO
Investigates case, identifies contact persons

Surveillance Supervisor
State epidemiologist
Coordinates surveillance officers

Laboratory Officer
Documents and reports laboratory results

National CDC
Incident Command Centre
Assesses risk, coordinates national response

Supranational Centre
Regional CDC, WAHO, WHO
International coordination

Case Officer
Executes case based control measures (eg. isolation)

Case Supervisor
MD, head of isolation facility
Coordinates case based control measures

Contact Officer
Assistant LGA-DSNO
Conducts follow-up of contact persons

Contact Supervisor
State epidemiologist
Coordinates follow- up of contact persons

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Persona Profile: Laboratory Officer

Tasks

- Receives collected specimens from suspected cases from Surveillance supervisor
- Coordinates the laboratory sampling procedure and collection of results in hers/his respective laboratory
- Documents tests done, test results and gives feedback to Surveillance supervisor
- Coordinates specimen referrals for higher level laboratories when needed

Needs

- to get informed about incoming samples from surveillance supervisor
- to acknowledge the received samples
- to enter the information on the samples
- to have line list of tested specimens with results

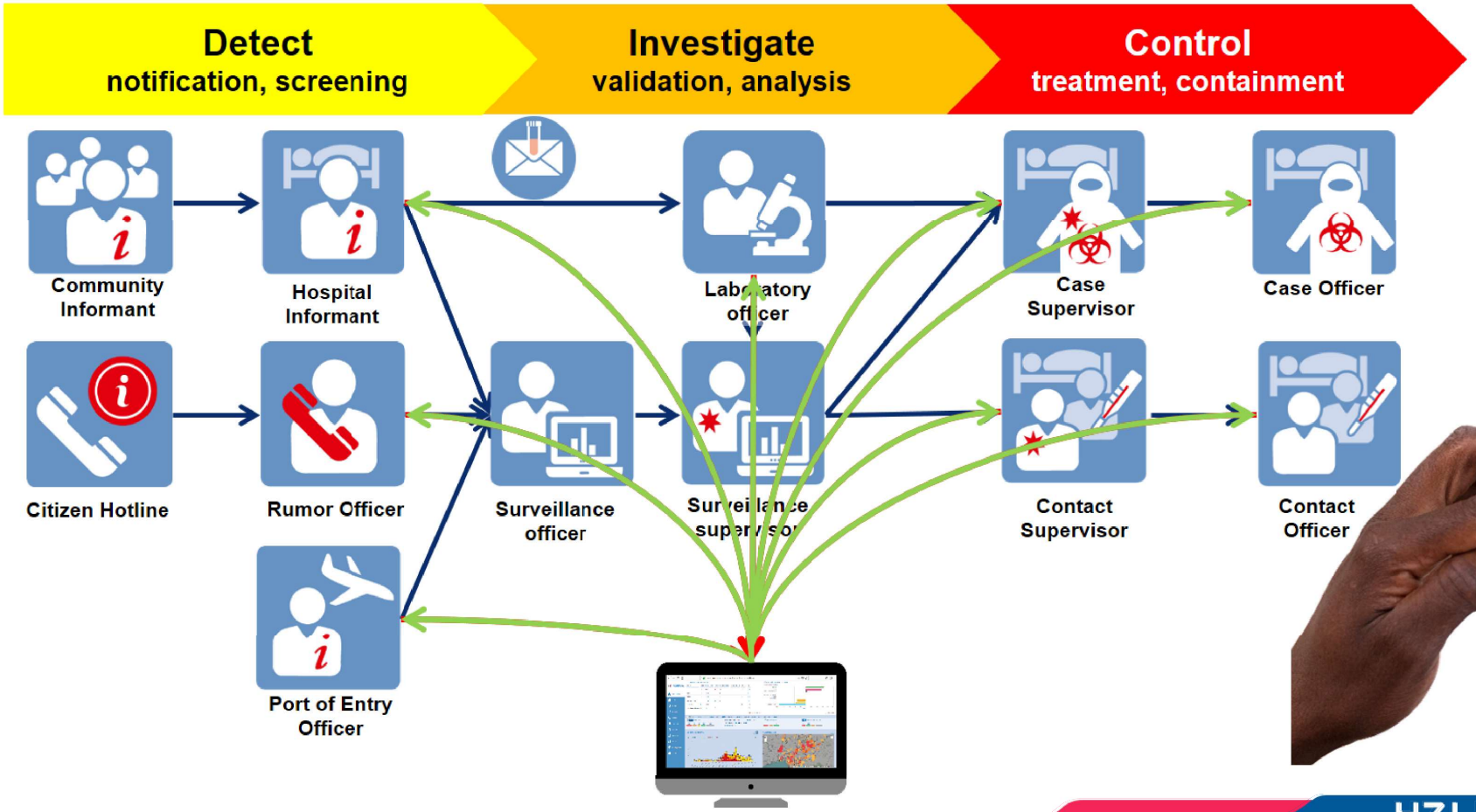
Interaction/Dependencies with/other personas

- Surveillance supervisor

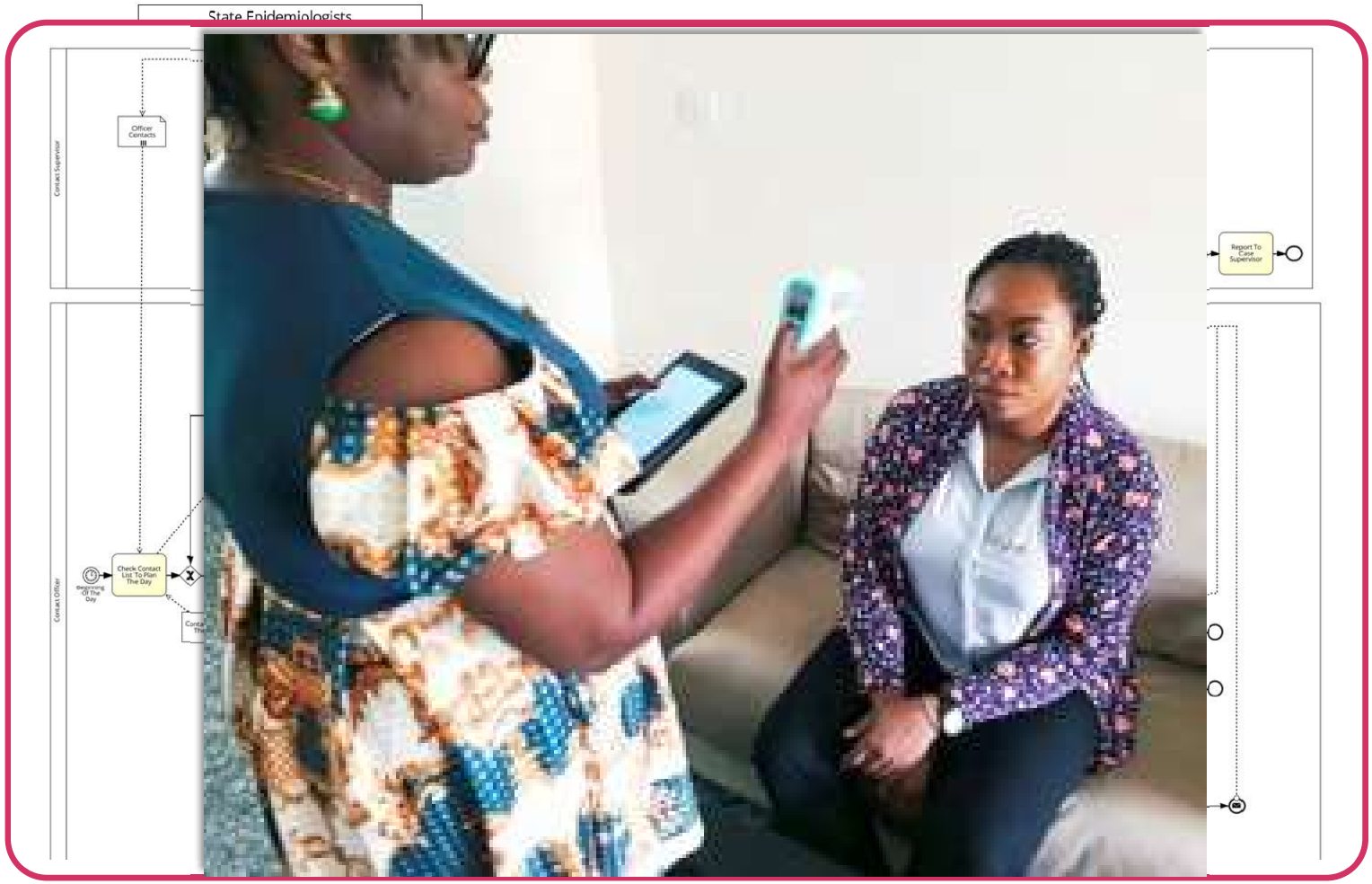
Artefacts (Input/Output)

- Laboratory investigation form

Response Management in SORMAS (e.g. Ebola)



Process model Ebola virus - contact follow-up



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Process Models for Di

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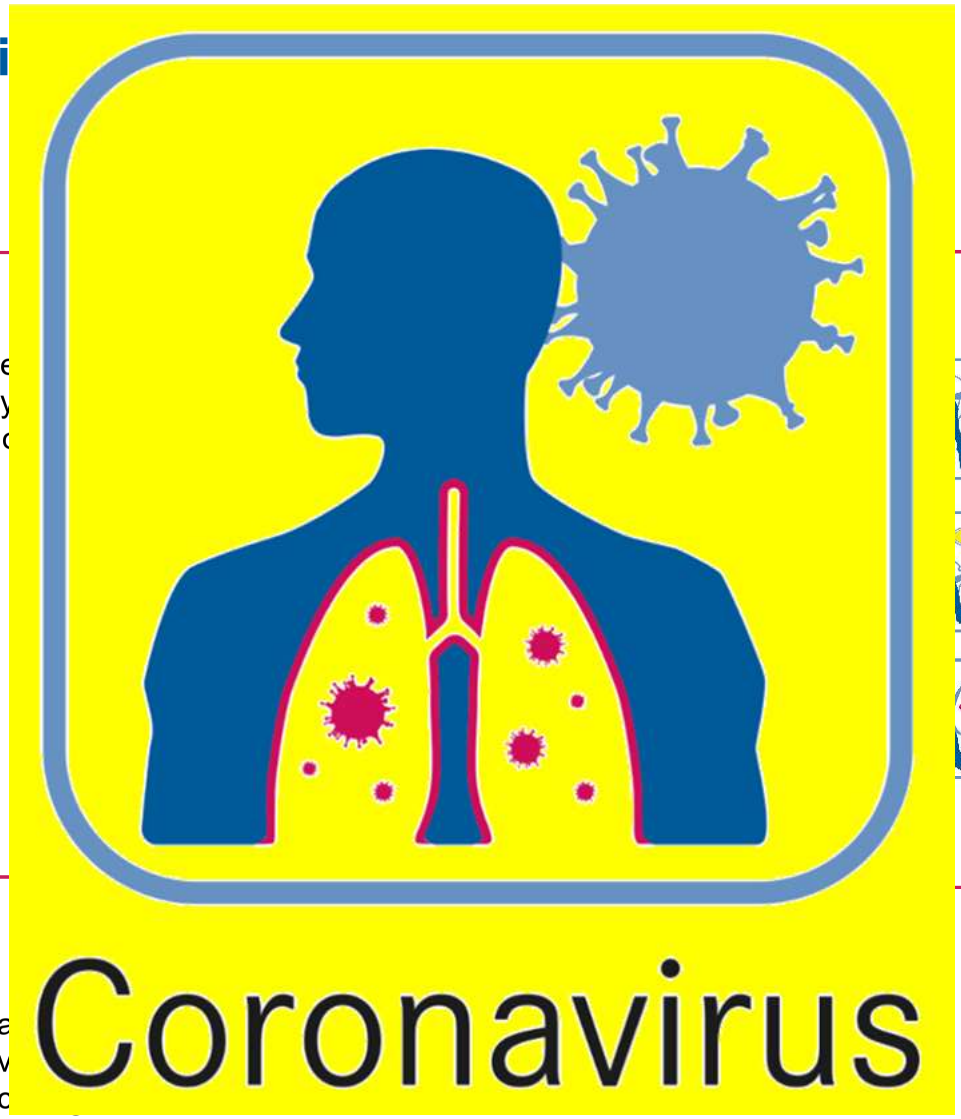


VECTOR CONTROL

- vector traps
- treatment of breeding sites
- residential spraying

Emerging Disease X

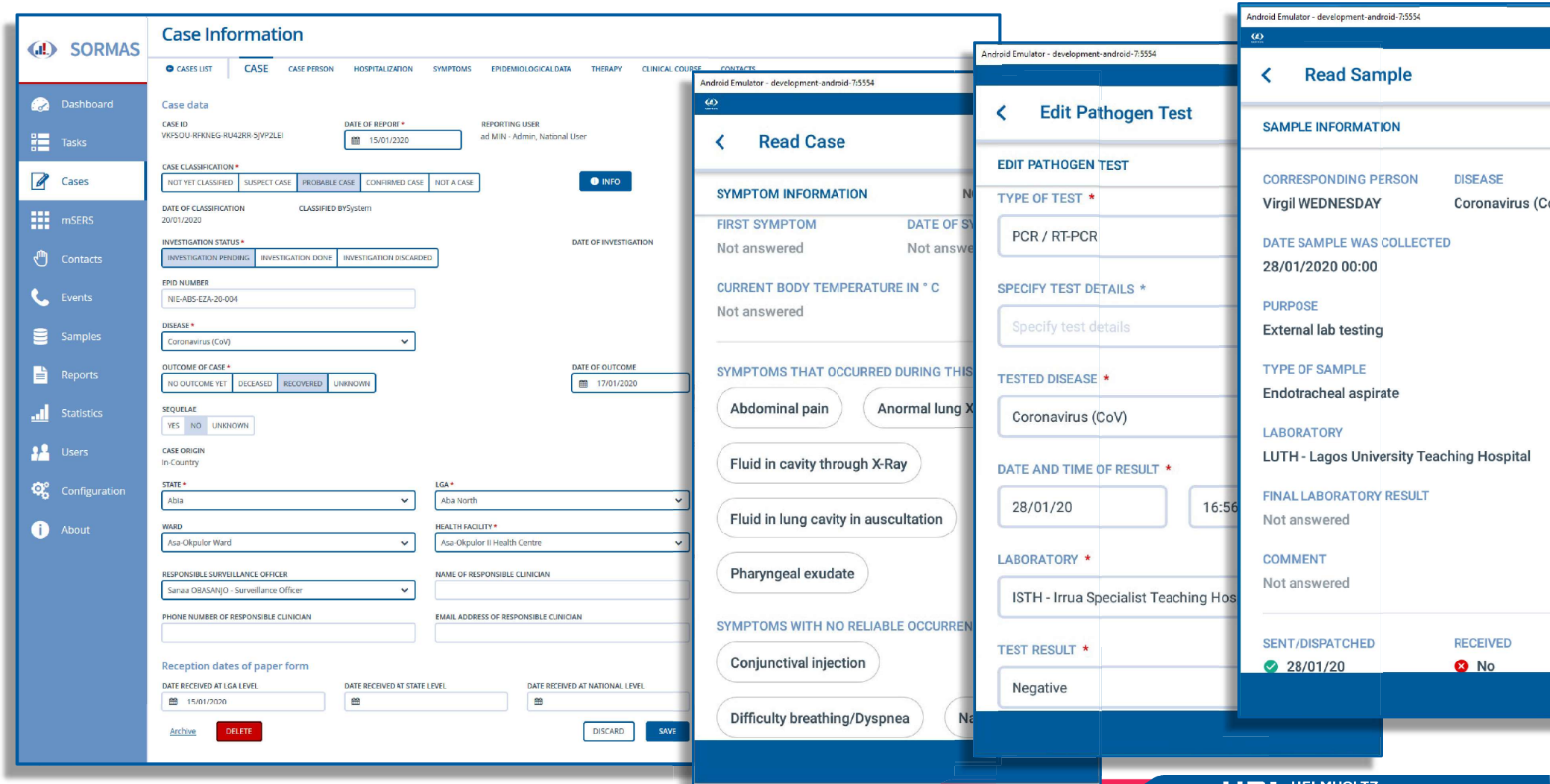
Lassa

Rabies

ENVIRONMENTAL SANITATION

- environmental samples
- alternative supply
- access control or recall

SORMAS Coronavirus Module (mobile offline and web online)



Process Models for Disease Specific Control Measures

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CLINICAL MANAGEMENT

VECTOR CONTROL

Plague

ENVIRONMENTAL SANITATION

Process Models for Disease Specific Control Measures

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CLINICAL MANAGEMENT

SORMAS Deployment in 3 Simultaneous Outbreaks

November 2017 - July 2018
Monkeypox Outbreak

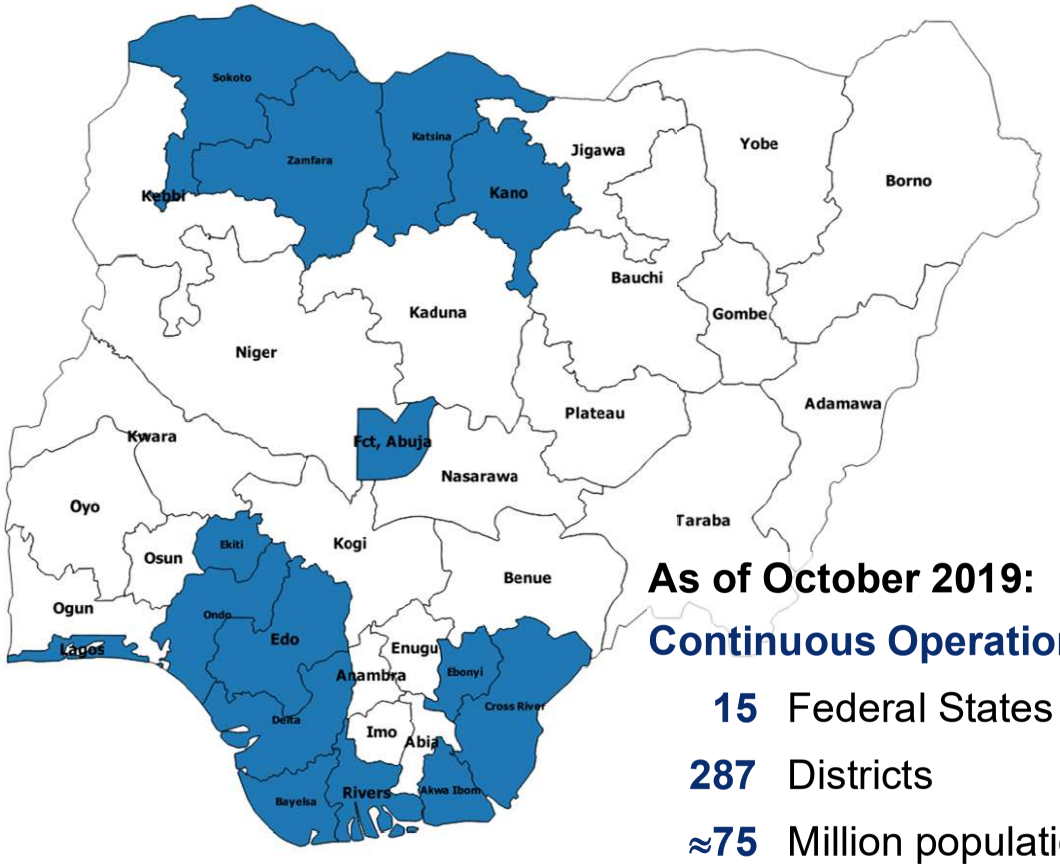
- 8 Federal states
- 33 Districts

January - March 2018
Bacterial Meningitis Outbreak

- 8 Federal states
- 33 Districts

February - April 2018
Lassa Fever Outbreak

- 3 Federal states
- 49 Districts



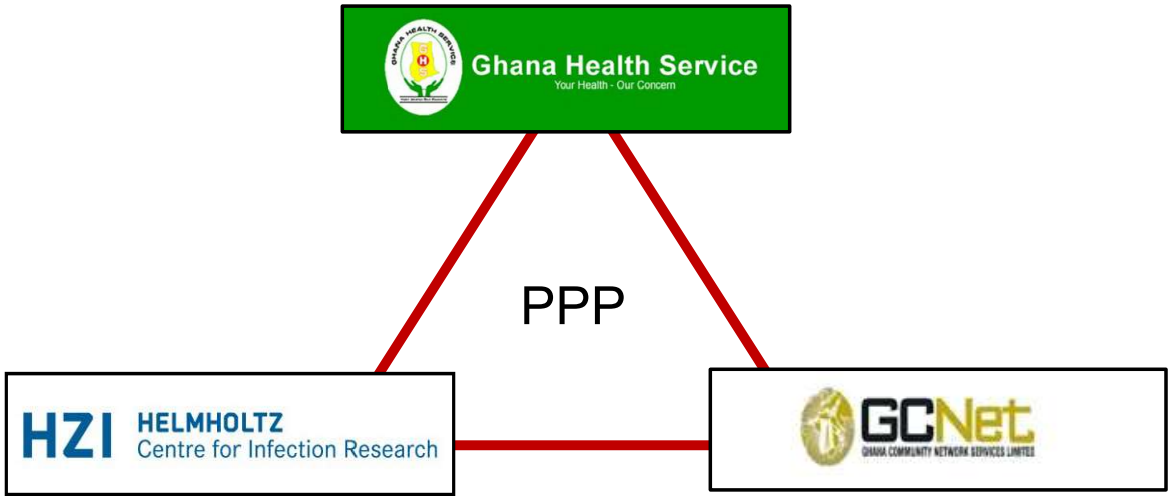
As of October 2019:

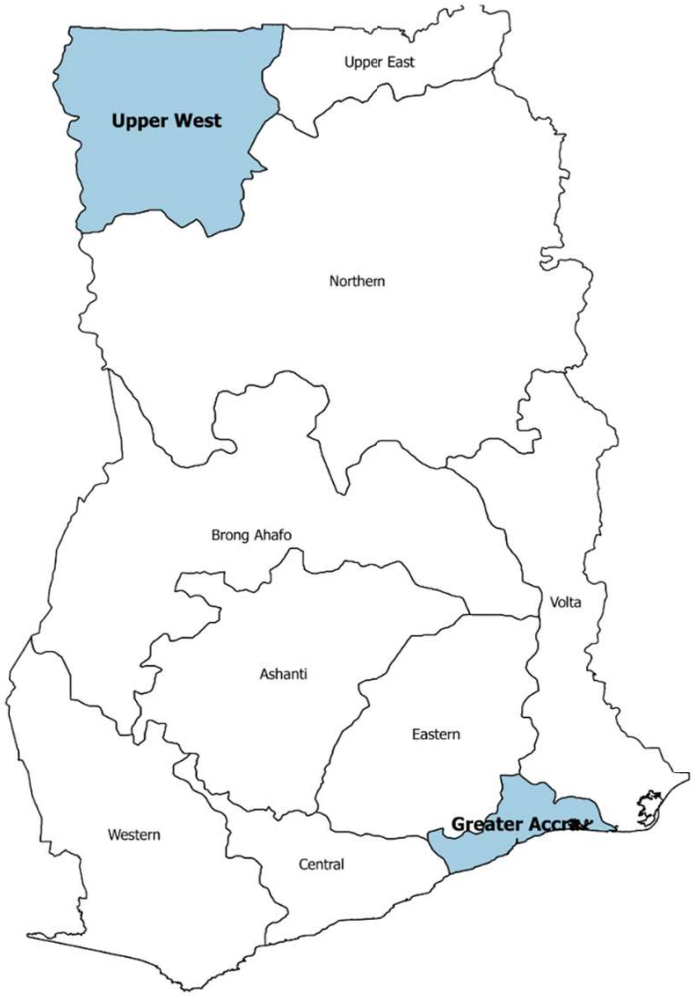
Continuous Operation in

- **15** Federal States
- **287** Districts
- **≈75** Million population covered

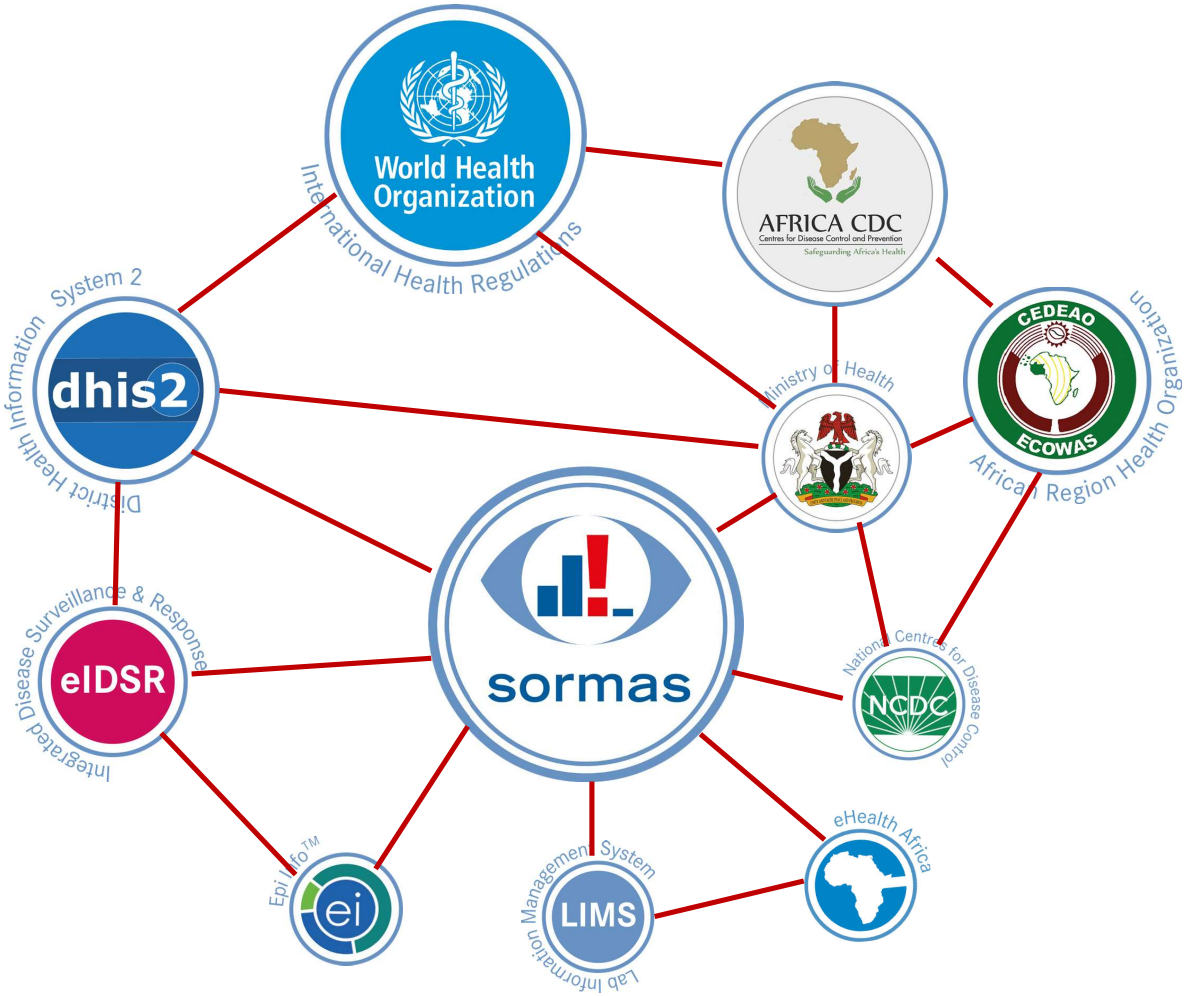
SORMAS Implementation in Ghana

- **Start November 2019**
- **40 Districts in 2 Regions**
- **Private Public Partnership**





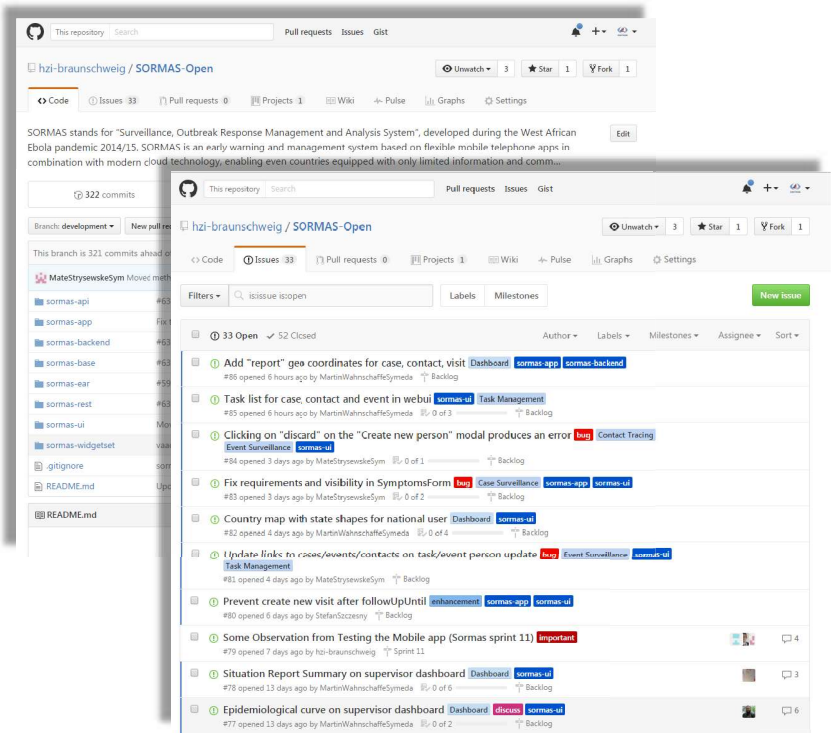
Technical and Organizational Interoperability of SORMAS



Technology Stack of SORMAS

- **UNIX System UBUNTU** LTS 16 Server 16GB RAM, HDD efficient, 500GB
- **Data Backup** (separate system storage from the scripts using CRON JOB scripts
- **Vaadin** Web Client (vaadin.org)
- **JAVA** EE Server Payara
- **POSTGRES SQL** Database (pgadmin)
- **CRONJOB Service** Backup
- **Android OS 5.0** and above
- **Open Street Map**

➢ **Codes and Roadmap on GitHub**



Systematic Review on mHealth Tools for Surveillance and Outbreak Response for Viral Hemorrhagic Fevers

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Sources

- Google Scholar, MEDLINE, CAB Abstracts, Popline, Web of Science

Search strategy

- 01.01.2014 - 31.12.2015
- any language
- "Outbreak" OR "Epidemic") AND ("mobile phone" OR "smartphone" OR "smart phone" OR "mobile phone" OR "tablet" OR "mHealth") AND ("Ebola" OR "EVD" OR "VHF" OR "Ebola Virus Disease" OR "viral hemorrhagic fever"

Result

- 1,220 publications manually screened
- 77 (6%) publications identified as relevant and original
- 58 mHealth tools for surveillance of hemorrhagic fevers
- 3 tools (ComCare, Ebola SenseFollowup, SORMAS)
  - surveillance
  - contact tracing
  - case management
  - laboratory data
- only SORMAS covers
  - >12 epidemic prone diseases
  - ad-hoc process models
  - task management

Tom-Aba et al, JMIR Public Health and Surveillance, 2018

Overview of functionalities of eSurveillance tools in Nigeria

INDICATORS	SORMAS	DHIS2	EWARS	EWORS	AVADAR	eIDSR	ARGUS	eSurveillance	mSERS	GO.DATA
Number of states	**15**	**37**	**1**	**1**	**2**	?	?	?	**37**	?
Primarily short term use	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES
Continous use	YES	YES	?	YES	?	YES	?	YES	?	?
Long term use	YES	YES	NO	YES	?	YES	?	YES	?	NO
Aggregate reporting	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Case based reporting	YES	NO	NO	NO	NO	NO	?	?	NO	YES
Number of case based diseases	**12**	**0**	?	?	?	?	?	?	8	?
Response process management	YES	NO	YES	YES	NO	NO	NO	NO	NO	YES
Bi-directional information	YES	NO	?	?	?	?	?	?	NO	YES
Mobile app (YES/NO)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Offline included	YES	YES	?	?	?	?	?	?	?	?
Web app (YES/NO)	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES
Case management (EMR)	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO
Contact tracing	YES	NO	?	NO	NO	NO	NO	NO	NO	YES
Health facility use	YES	YES	?	YES	NO	?	?	?	?	?
Laboratory use	YES	NO	?	?	?	?	?	?	?	?
Event based surveillance	YES	NO	YES	YES	NO	?	?	?	?	?
Point of entry	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO
Task management	YES	NO	?	NO	?	?	?	?	?	?
Multi-lingual platform	YES	YES	YES	NO	?	?	?	NO	NO	YES

Case-Based versus Aggregate Notification

Aggregate Reporting

Advantage

+ Little training need
+ Short data entry

Disadvantage

- Delay
- No updates & corrections
- Lack of detail
- No risk assessment
- No quality control
- No individual response
- No migration to case based

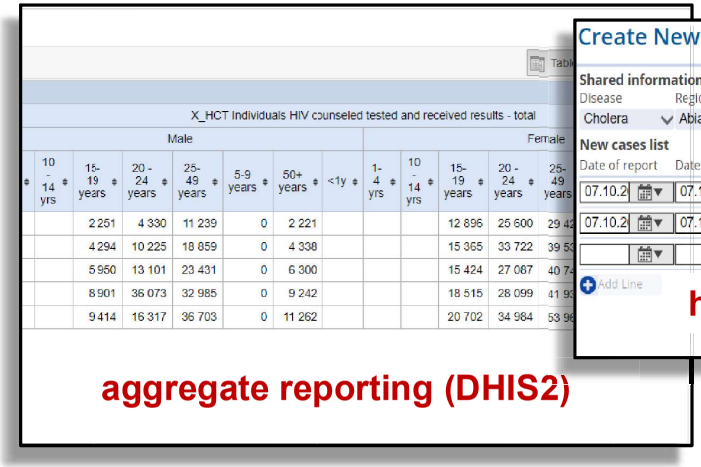
Case Based Reporting

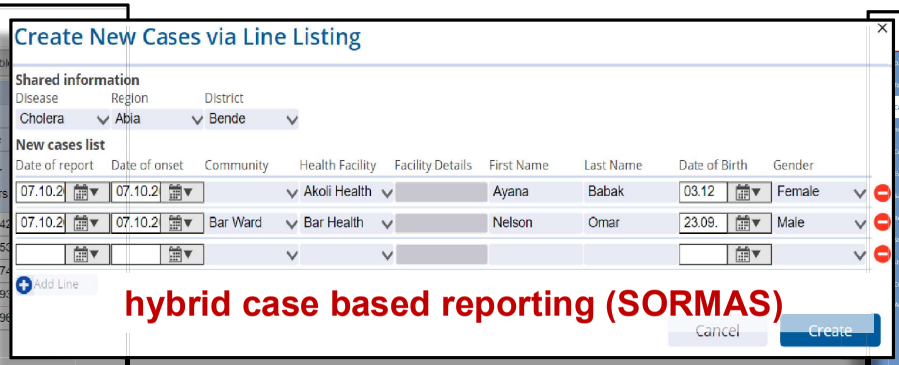
Advantage

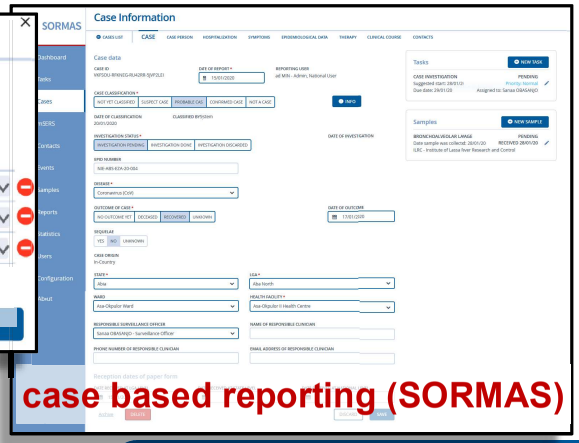
+ No Delay
+ Enables updates & corrections
+ Detailed
+ Facilitates risk assessment
+ Allows quality control
+ Allows response management
+ Can migrate to aggregation

Disadvantage

– More training need
– ~~Longer data entry~~







SORMAS vs DHIS2 Tracker 2.29

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Indicator	SORMAS	DHIS2
Surveillance Notification	Yes	No
Outbreak response	Yes	No
Case Management (Patient)	Yes	No
Contact tracing	Yes	Yes
Follow up visits & Automatic Scheduling	Yes	No
Visualization & Analysis	Yes	Yes
Lab Sample Management	Yes	Yes
Automatic Task management	Yes	No
Integrated User Work flow	Yes	No
Disease process model	Yes	No
Case Based Surveillance	Yes	No
Automated Message Reminder	Yes	Yes
Automated Aggregation	Yes	Yes
Automatic Case Classification	Yes	No
Interactive Epidemiological Maps (cases, contacts, events)	Yes	No
Event Surveillance (rumor management, persons involved)	Yes	No

Complementarity between openHIE, DHIS2 and SORMAS

Open Health Information Exchange

Objective:
development and support health information architecture

Scope:
all health related events

Primary customer:
owners and developers of health information systems

District Health information System

Objective:
collection, warehousing, visualization & analysis of health information

Scope:
all health related events

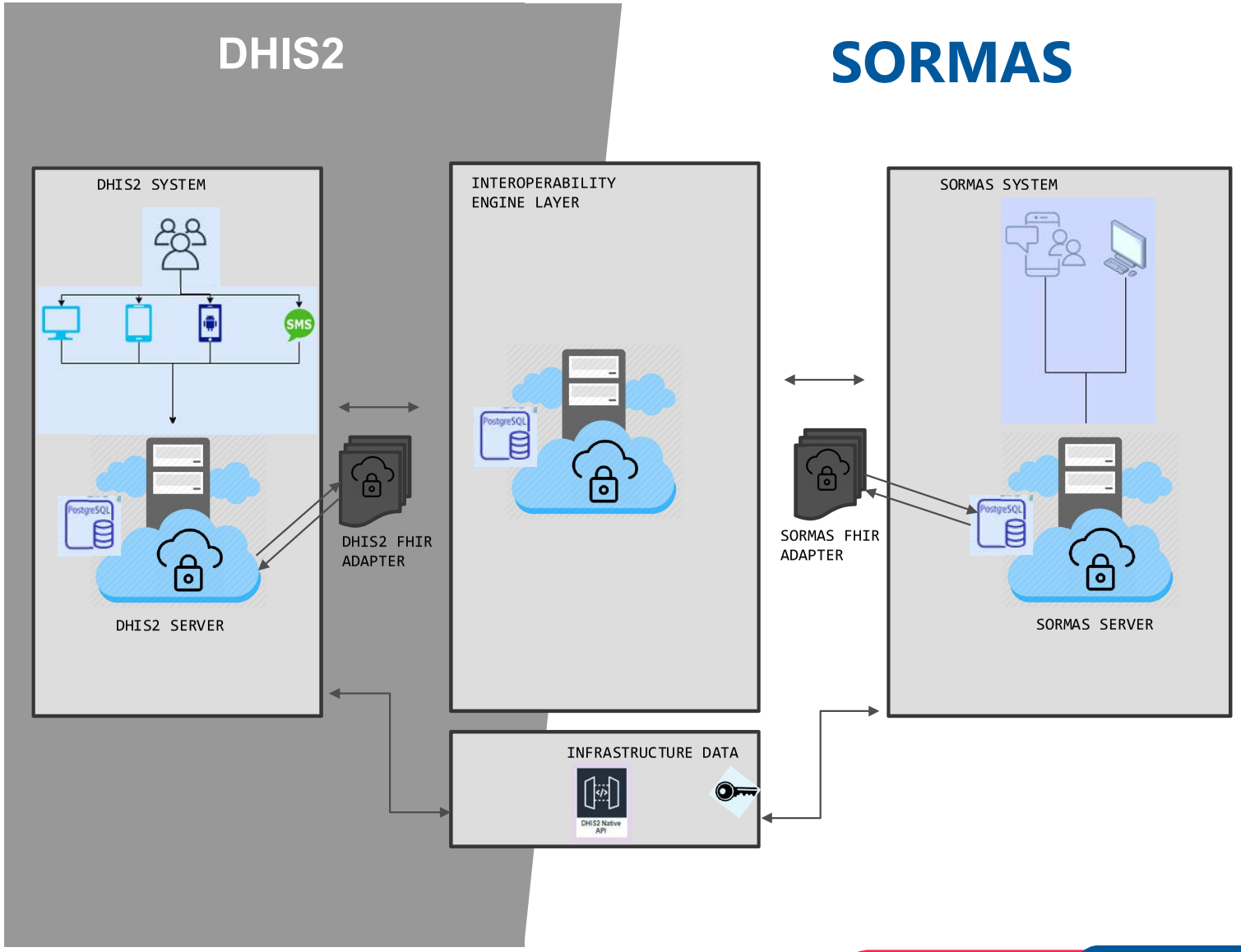
Primary customer:
policy makers

Surveillance Outbreak Response Management and Analysis System

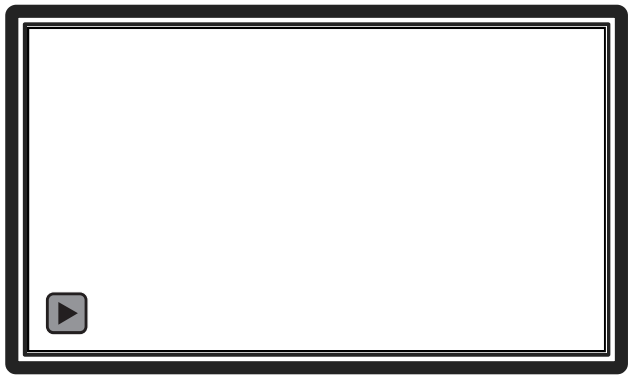
Objective:
outbreak detection, process management of control measures, analysis

Scope:
infectious diseases

Primary customer:
public health service


DHIS2
SORMAS
DHIS2 SYSTEM
SMS
PostgreSQL
DHIS2 SERVER
DHIS2 FHIR
ADAPTER
INTEROPERABILITY
ENGINE LAYER
PostgreSQL
SORMAS FHIR
ADAPTER
SORMAS SYSTEM
PostgreSQL
SORMAS SERVER
INFRASTRUCTURE DATA
DHIS2 Native
API

Training Materials for SORMAS



Instructional Cartoon Videos

- Surveillance Supervisor
- Contact Officer
- Contact Supervisor
- Hospital Informants
- Surveillance Officer

https://www.youtube.com/watch?v=0vTKZZr8-vg – Surveillance Supervisor

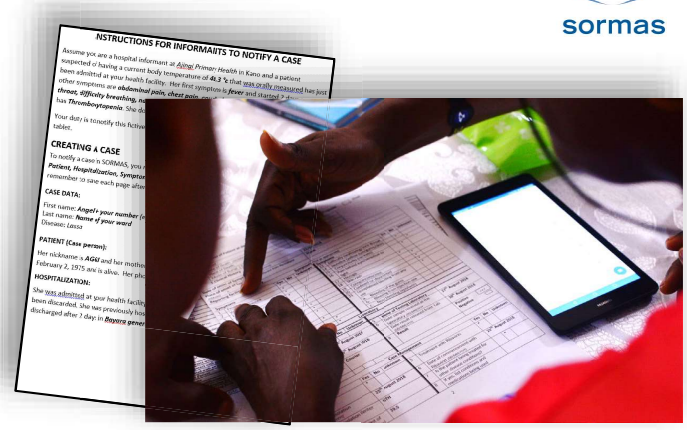
https://www.youtube.com/watch?v=YCA_0K46dqE&t=43s – Contact Officer

https://www.youtube.com/watch?v=J7JUdTieEPQ&t=11s - Contact Supervisor

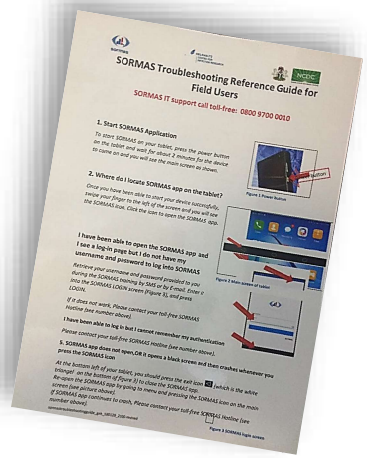
https://www.youtube.com/watch?v=it2ve1ARRbU – Hospital Informants

https://www.youtube.com/watch?v=nVJ1k-84d-0&t=65s – Surveillance Officer

Didactic Lectures



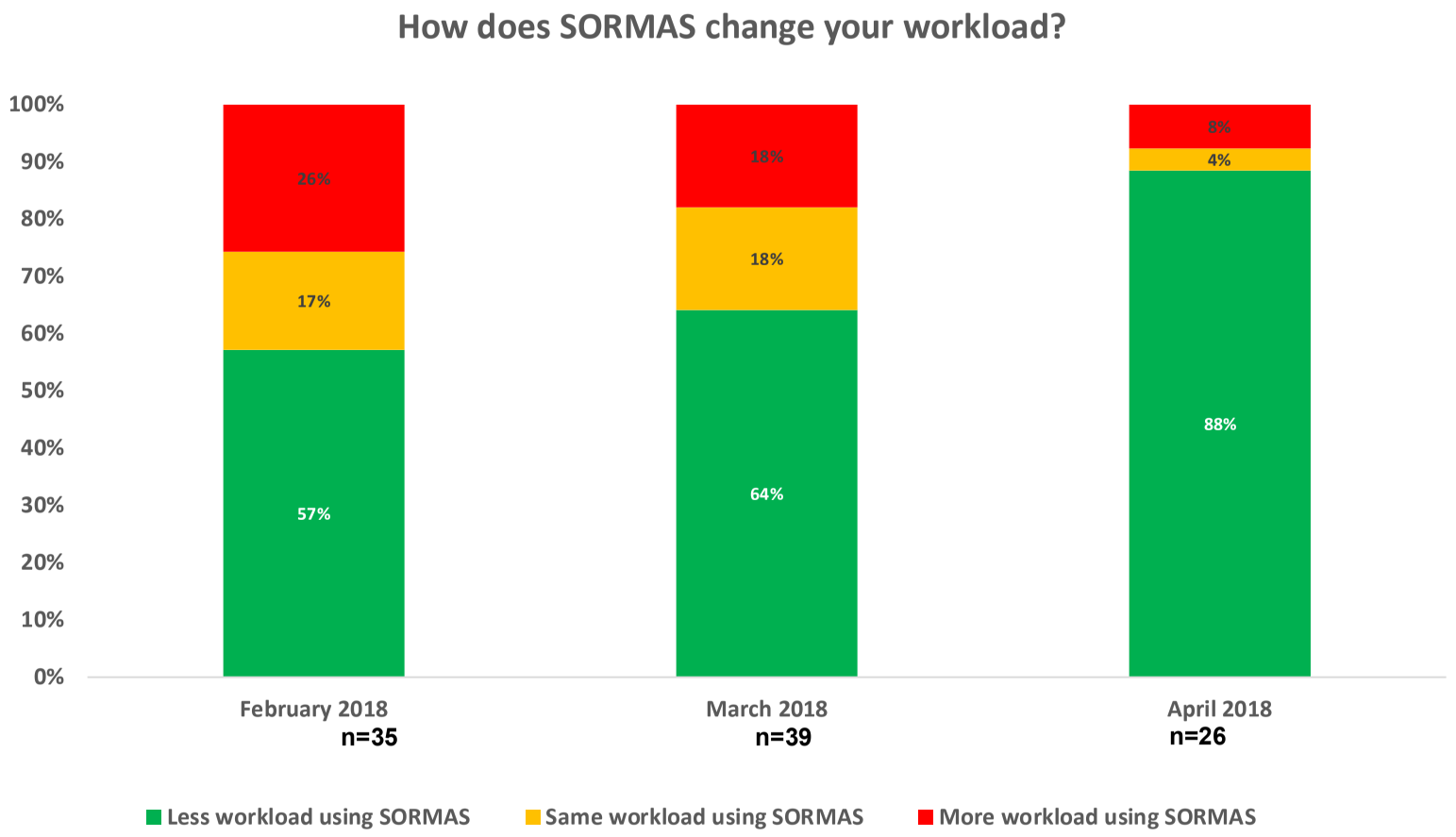
Interactive Training Scenarios



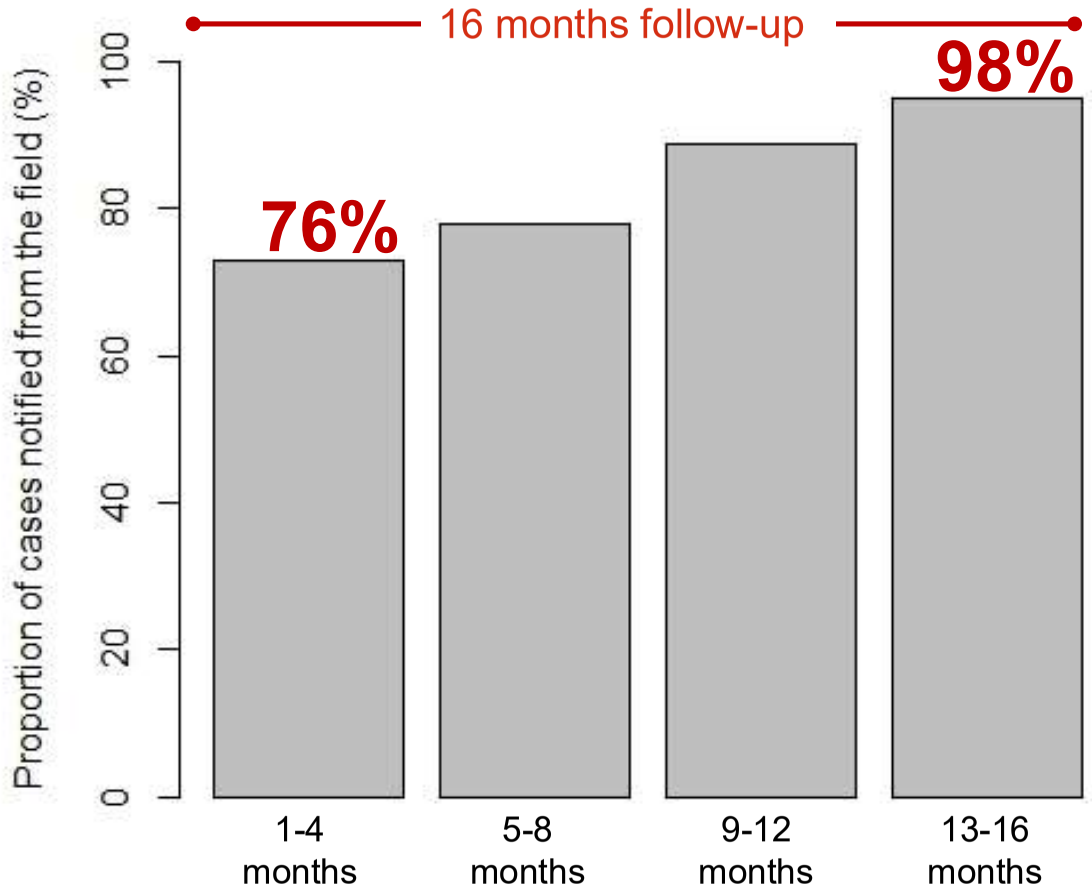
Trouble Shooting Guide

User Manual

Repetitive User Survey among SORMAS Users, Nigeria 2018

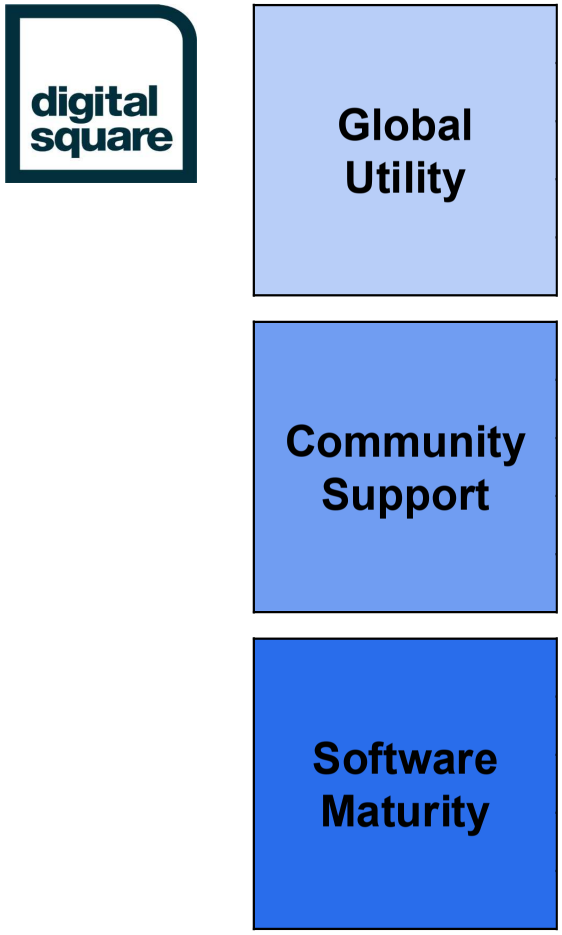


Increasing Performance upon Deployment



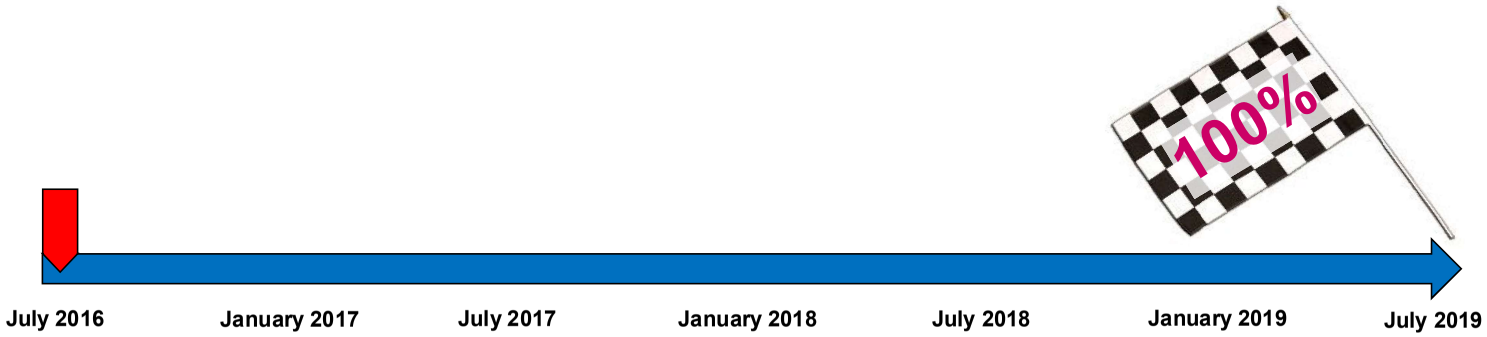
Four-month-intervals after implementation of SORMAS
N= 15491 reports of 5 diseases in 10 states in Nigeria

Global Good Maturity Model for Digital Health Software



https://wiki.digitalsquare.io/index.php/What_are_Global_Goods

Progress of Global Good Maturity Score of SORMAS:
full score as of July 2019



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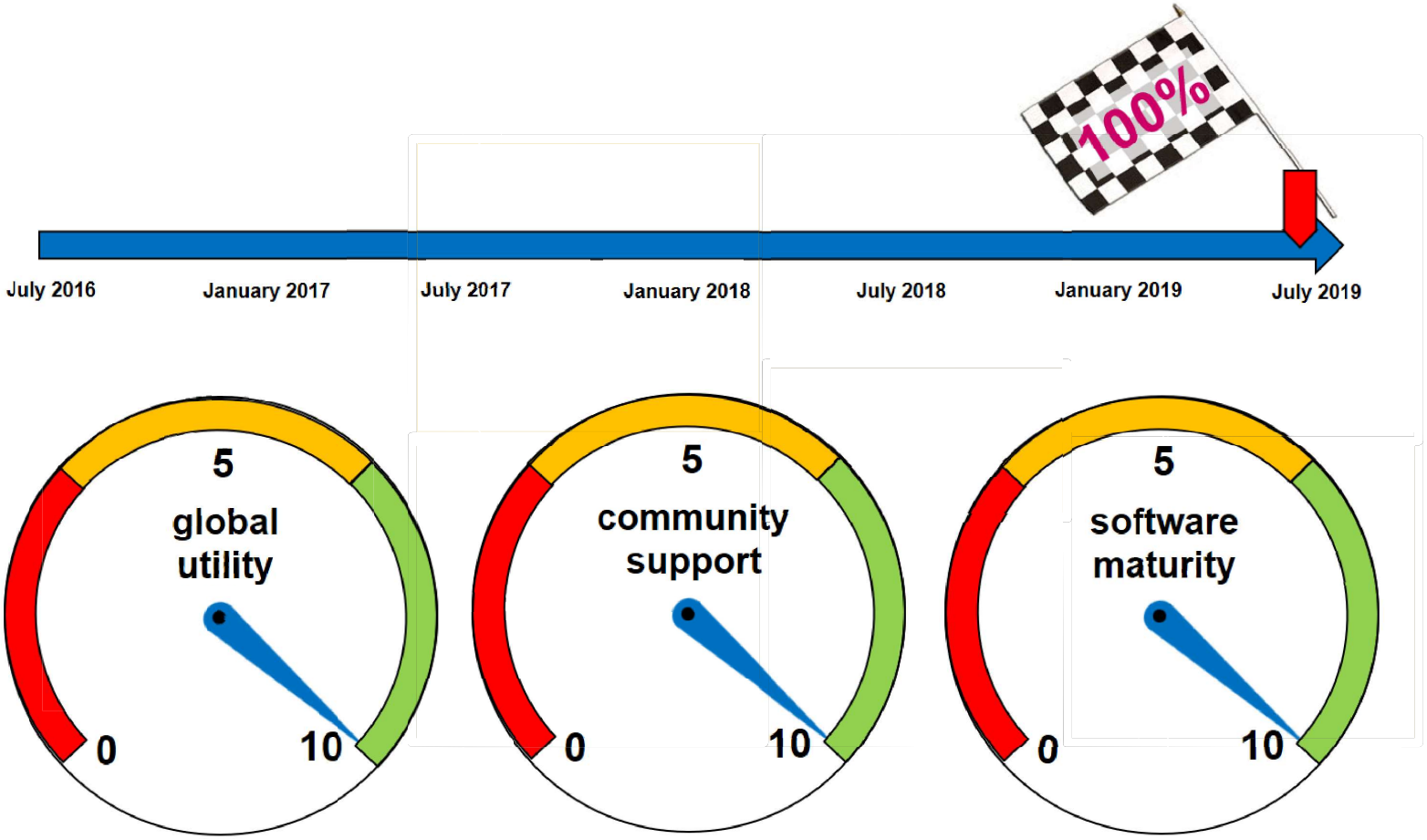
Progress of Global Good Maturity Score of SORMAS:
full score as of July 2019



https://wiki.digitalsquare.io/index.php/What_are_Global_Goods

Acknowledgements to all Partners, Sponsors, Advisors and Contractors

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Partners

African Field Epidemiology Network (AFENET)
Centers for Disease Control and Prevention (CDC)
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
Digital Square
Ghana Community Network Services Limited (GCNET)
Ghana Health Service (GHS)
Helmholtz Center for Infection Research (HZI) [lead]
Nigerian Centre for Disease Control (NCDC)
University College London (UCL)
University of Maryland Baltimore, Nigeria (UMB)

Sponsors

Basic Healthcare Provision Fund Nigeria (BHCF)
Bill and Melinda Gates Foundation (BMG)
Centers for Disease Control and Prevention (CDC)
Centre for Infection Research (DZIF)
European Union (EU)
German Federal Ministry for Economic Cooperation and Development (BMZ)
German Federal Ministry for Education and Research (BMBF)
Helmholtz Center for Infection Research (HZI)
Helmholtz Association (HGF)
WHO-Country Office Nigeria
World Bank

Advisors

Africa Centers for Disease Control (Africa CDC)
Centers for Disease Control and Prevention
DHIS2 Design Lab, University of Oslo
Hasso Plattner Institute (HPI)
Kreditanstalt für Wiederaufbau (KfW)
Robert Koch Institute (RKI)
University Braunschweig (TU)
West African Health Organization (WAHO)
World Health Organization (WHO-HQ)

Contractors

Symeda
Scigraphix
Crowdcode
Mirabilia
Elektro- & Datentechnik

Strategy on Future Concepts and Methods in SORMAS

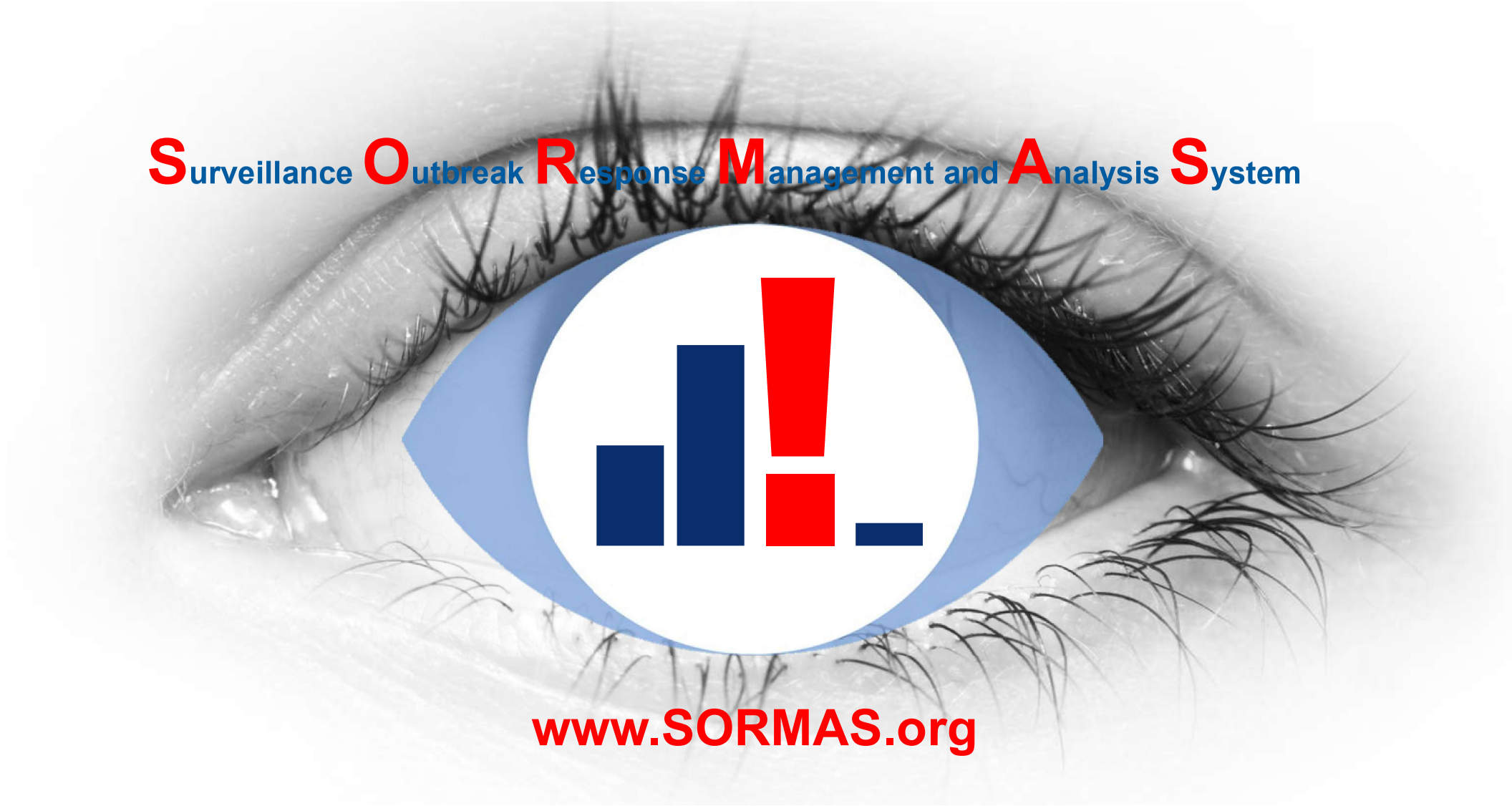
- Tuberculosis
  + 32 additional diseases
- Regional Center for Surveillance and Disease Control (RCSDC) of WAHO/CEDEAO
- Vaccination campaign & vigilance
- Antimicrobial resistance monitoring
- Molecular surveillance
- Predictive analytics & epidemic intelligence

Challenges and Measures to Overcome them

⚠ Variable competency in disease control at local level	✓ Interactive algorithms serve training and supervision ✓ Training portfolio covers more than just SORMAS
⚠ Low contribution from industry (data bundles, hardware)	✓ Negotiations between GAVI and telecom industry ✓ Private Public Partnership (example Ghana)
⚠ Inappropriate private use of data plans by users (whatsapp, youtube)	✓ Complete block of non-related apps ✓ Considering in-built messenger service
⚠ Weak and irregular internet connectivity via mobile phone net	✓ Development of novel “LBDS”-technology (Low Bandwidth Database Synchronization)
⚠ Duplicate parallel initiatives in eSurveillance	✓ Full transparency of road map in SORMAS ✓ Expansion of diseases in SORMAS ✓ Back-up option for aggregate entry ✓ Concept for integration of tools ✓ Adherence to common standards ✓ Intensive exchange between groups

Peer Reviewed Scientific Publications on or from SORMAS

1. Tom-Aba D et al: Digital Health Global Goods Maturity Assessment of the Surveillance Outbreak Response Management & Analysis System (SORMAS) JMIR public health and surveillance. 2020 in print
2. Silenou BC et al.. Use of Mobile Digital Surveillance Outbreak Response Management & Analysis System (SORMAS) for Human Monkeypox Outbreak, Nigeria, 2017–2019. Emerg Infect Dis. 2020;26(2):345-349.
3. Yinka-Ogunleye A et al. Outbreak of human monkeypox in Nigeria in 2017-18: a clinical and epidemiological report. Lancet Infect Dis. 2019;19(8):872-9
4. Tom-Aba T et al. User Evaluation Indicates High Quality of the Surveillance Outbreak Response Management and Analysis System (SORMAS) After Field Deployment in Nigeria in 2015 and 2018. Studies in health technology and informatics. 2018;253:233-7.
5. Tom-Aba et al. Assessing the Concepts and Designs of 58 Mobile Apps for the Management of the 2014-2015 West Africa Ebola Outbreak: Systematic Review. JMIR public health and surveillance. 2018;4(4):e68
6. Perscheid C,et al.. Ebola Outbreak Containment: Real-Time Task and Resource Coordination With SORMAS. Frontiers in ICT. 2018;5.
7. Adeoye O, et al. Implementing Surveillance and Outbreak Response Management and Analysis System (SORMAS) for Public Health in West Africa- Lessons Learnt and Future Direction. IJTDH. 2017;22(2):1-17.
8. Moyer Det al. Taking Digital Innovation into the Field of Infectious Diseases: The Case of SORMAS®. In Shaping the Digital Enterprise 2017 (pp. 219-236). Springer, Cham.
9. Fähnrich C et al. Surveillance and Outbreak Response Management System (SORMAS) to support the control of the Ebola virus disease outbreak in West Africa. Euro Surveill. 2015;20(12).


Surveillance Outbreak Response Management and Analysis System
www.SORMAS.org

Risks and challenges resulting from multiple parallel digital tools

- Duplication of separate data collection increases data discrepancies
- Duplication of workload for local officers
- Risk for incompleteness in all systems
- Unecessary expenses for
  - Training
  - Hardware
  - Data plans
  - Data transfer
  - Quality control
  - Software maintenance, security measures, support

Envisoned diseases for immediate case based notification in Nigeria and digital implementation

sormas

Aggregate weekly (11)
Envisioned

MAL - Malaria
TYF - Typhoid fever
AVH - Acute viral hepatitis
NNT - Non-neonatal tetanus
HIV - HIV/AIDS
SCH - Schistosomiasis
STH - Soil transmitted helminths
TRY - Trypanosomiasis
DWD - Diarrhea w. dehydration (<5)
DWB - Diarrhoea with Blood (Shigella)
SNB - Snake bite

Aggregate Monthly (9)
Envisioned

AEF - Adverse event follow. immunisation (AEFI)
DIM - Diabetes mellitus
EPL - Epilepsy
HYP - Hypertension
SCD - Sickle cell disease
INJ - Injuries (road traffic accidents)
MNU - Malnutrition (<5 Y)
SPN - Severe pneumonia (<5 Y)
STI - Sexually transmitted infections

Aggregate digital weekly (11)
To be added into SORMAS

MAL - Malaria
TYF - Typhoid fever
AVH - Acute viral hepatitis
NNT - Non-neonatal tetanus
HIV - HIV/AIDS
SCH - Schistosomiasis
STH - Soil transmitted helminths
TRY - Trypanosomiasis
DWD - Diarrhea w. dehydration (<5)
DWB - Diarrhoea with Blood (Shigella)
SNB - Snake bite

Aggregate Monthly (9)
already covered in DHIS2

AEF - Adverse event follow. immunisation (AEFI)
DIM - Diabetes mellitus
EPL - Epilepsy
HYP - Hypertension
SCD - Sickle cell disease
INJ - Injuries (road traffic accidents)
MNU - Malnutrition (<5 Y)
SPN - Severe pneumonia (<5 Y)
STI - Sexually transmitted infections

Envisoned diseases for immediate case based notification in Nigeria and digital implementation

Case based IDSR (24)
Envisioned

CSM - Cerebrospinal Meningitis
CLR - Cholera
MEA - Measles
YWF - Yellow Fever
LAF - Lassa fever
DEF - Dengue
INS - Influenza new subtype
GUW - Guinea Worm
AFP - Acute flaccid paralysis
MPX - Monkeypox
RAB - Dog bites (Rabies)
RUV - Rubella
TUB - Tuberculosis
LEP - Leprosy
LYF - Lymphatic filariasis
BUU - Buruli ulcer
PER - Pertussis
NTE - Neonatal tetanus
ONC - Onchocerciasis
DOP - Diphteria
TRA - Trachoma
YAW - Yaws and endemic syphilis
MAD - Maternal deaths
PED - Perinatal deaths

Aggregate digital (8)
already in MSERS 2019

CSM - Cerebrospinal Meningitis
CLR - Cholera
MEA - Measles
YWF - Yellow Fever
LAF - Lassa fever (VHF)

INS - Influenza new subtype
GUW - Guinea Worm
AFP - Acute flaccid paralysis

Case based A (13)
already digital in SORMAS 2019

CSM - Cerebrospinal Meningitis
CLR - Cholera
MEA - Measles
YWF - Yellow Fever
LAF - Lassa fever
DEF - Dengue
INS - Influenza new subtype

MPX - Monkeypox
RAB - Dog bites (Rabies)
RUV - Rubella (congen. synd.)

EVD - Ebola
ANT - Anthrax
PLA - Plague

Case based B (13)
to be added into SORMAS 2020

RUV - Rubella
TUB - Tuberculosis
LEP - Leprosy
LYF - Lymphatic filariasis
BUU - Buruli ulcer
PER - Pertussis
NTE - Neonatal tetanus
ONC - Onchocerciasis
DOP - Diphteria
TRA - Trachoma
YAW - Yaws and endemic syphilis
MAD - Maternal deaths
PED - Perinatal deaths

Transition & Integration Phases for Digitalization of Case Based Surveillance in Nigeria

Status Quo (duplication):

- Total of envisioned case based — 24 diseases
- overlap and redundancy between MSERS and SORMAS — 6-8 diseases
- Case based missing in any of the digital systems — 12 diseases

Phase 1(alignment and integration):

- SORMAS adds case based GW & AFP — 12 +2 diseases
- SORMAS includes mSERS-app for aggregate notification — 20 diseases
- MSERS adds all aggregate diseases — 22 diseases
- Wherever SORMAS runs
  - aggregate diseases are entered in SORMAS via mSERS app
  - only one mobile device needed per LGA

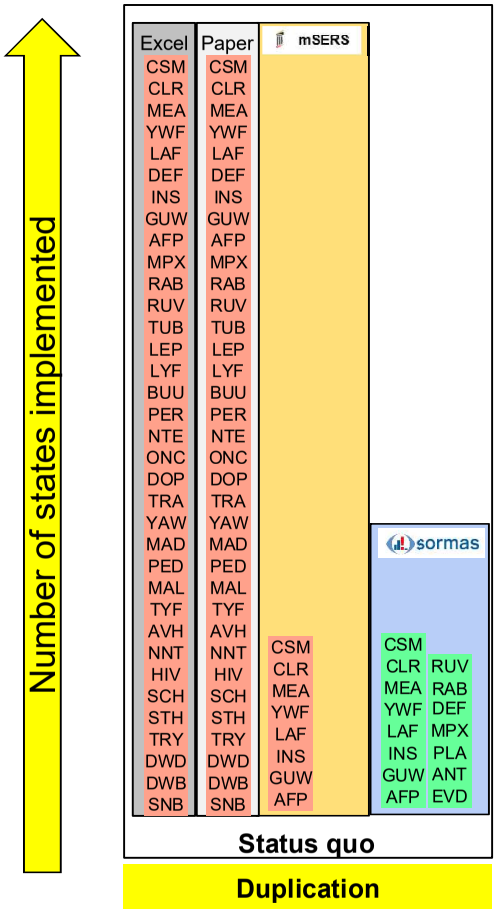
Phase 2 (transition):

- SORMAS adds all remaining case based diseases — 24+3 diseases
- SORMAS covers all remaining diseases as aggregate — 11 diseases
- MSERS covers all diseases as aggregate — 34 diseases
- Wherever SORMAS runs
  - only one mobile device needed per LGA
  - integrated mSERS app via SORMAS for remaining aggregate diseases
  - Excel optional

Phase 3 (full integration):

- SORMAS covers all case based diseased — 24+2 diseases
- integrated mSERS app via SORMAS for all aggregate diseases — 11 diseases
- Paper based optional as back up

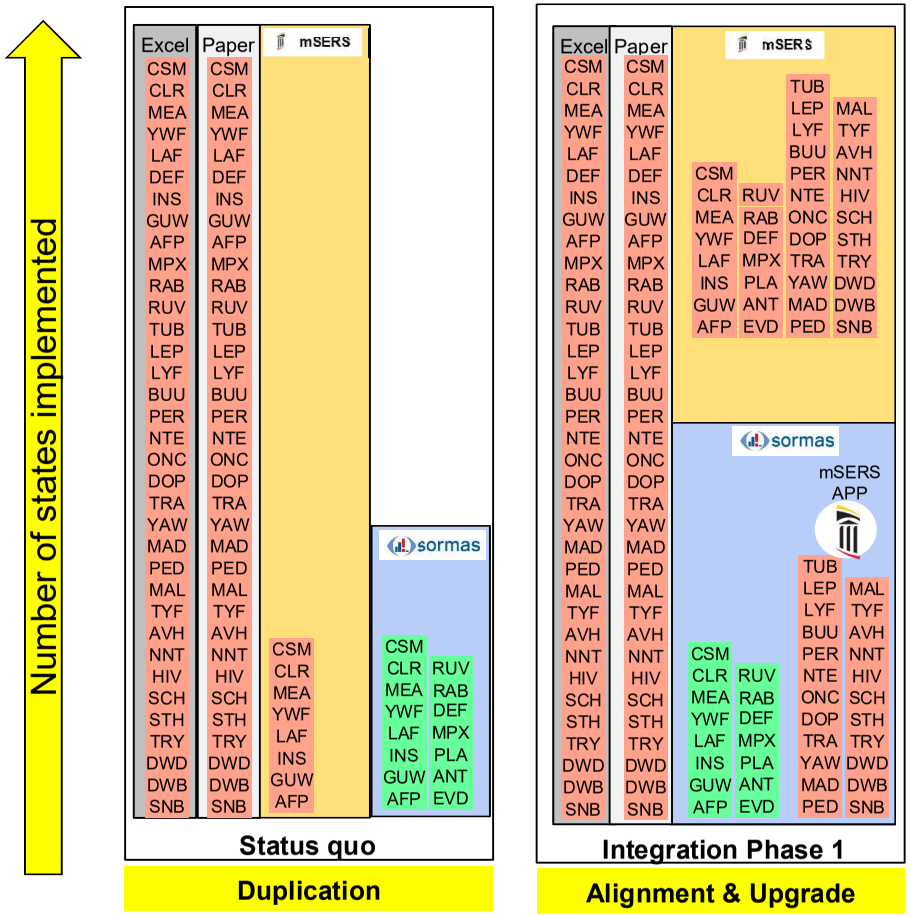
Transition & Integration Phases for Digitalization of Case Based Surveillance in Nigeria



= case based

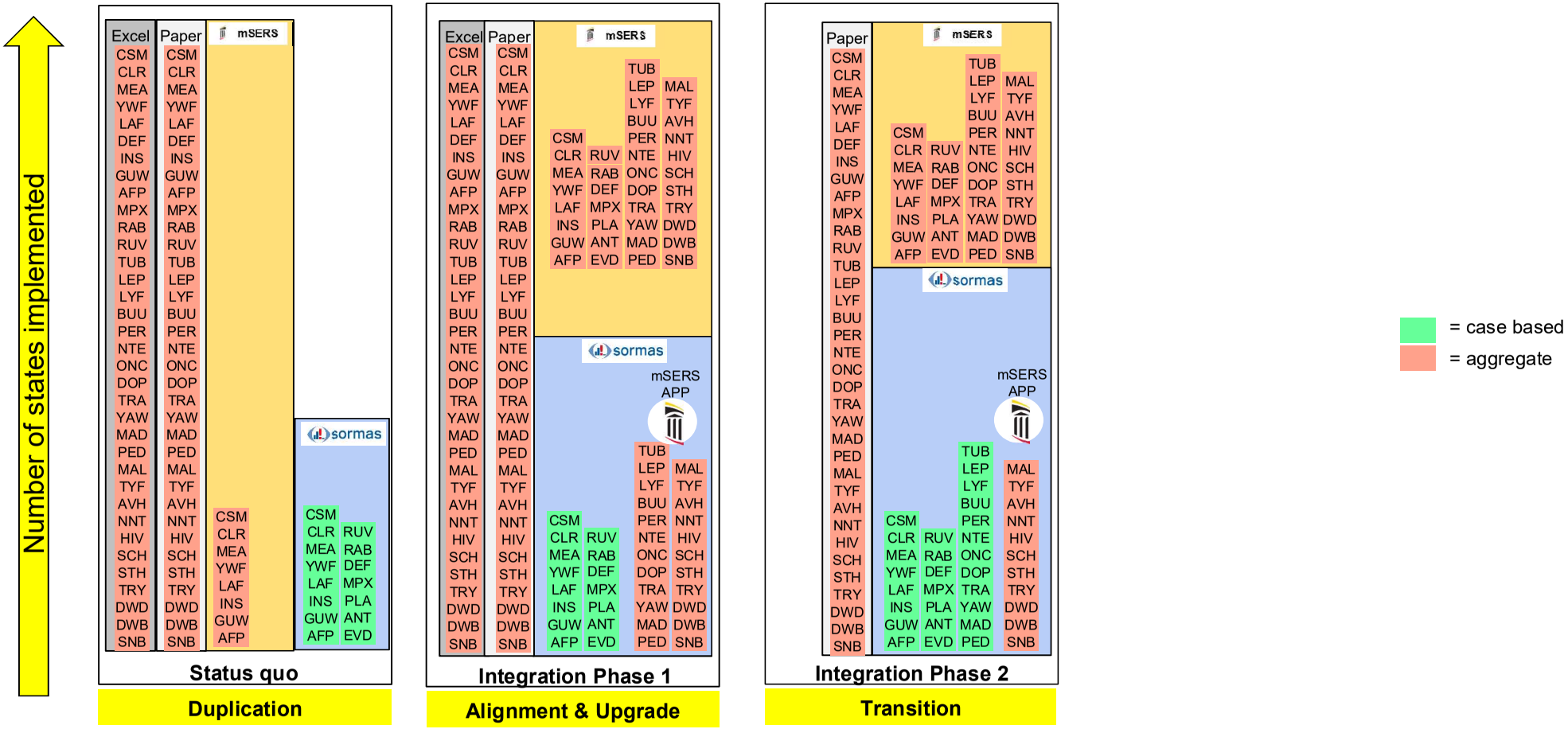
= aggregate

Transition & Integration Phases for Digitalization of Case Based Surveillance in Nigeria

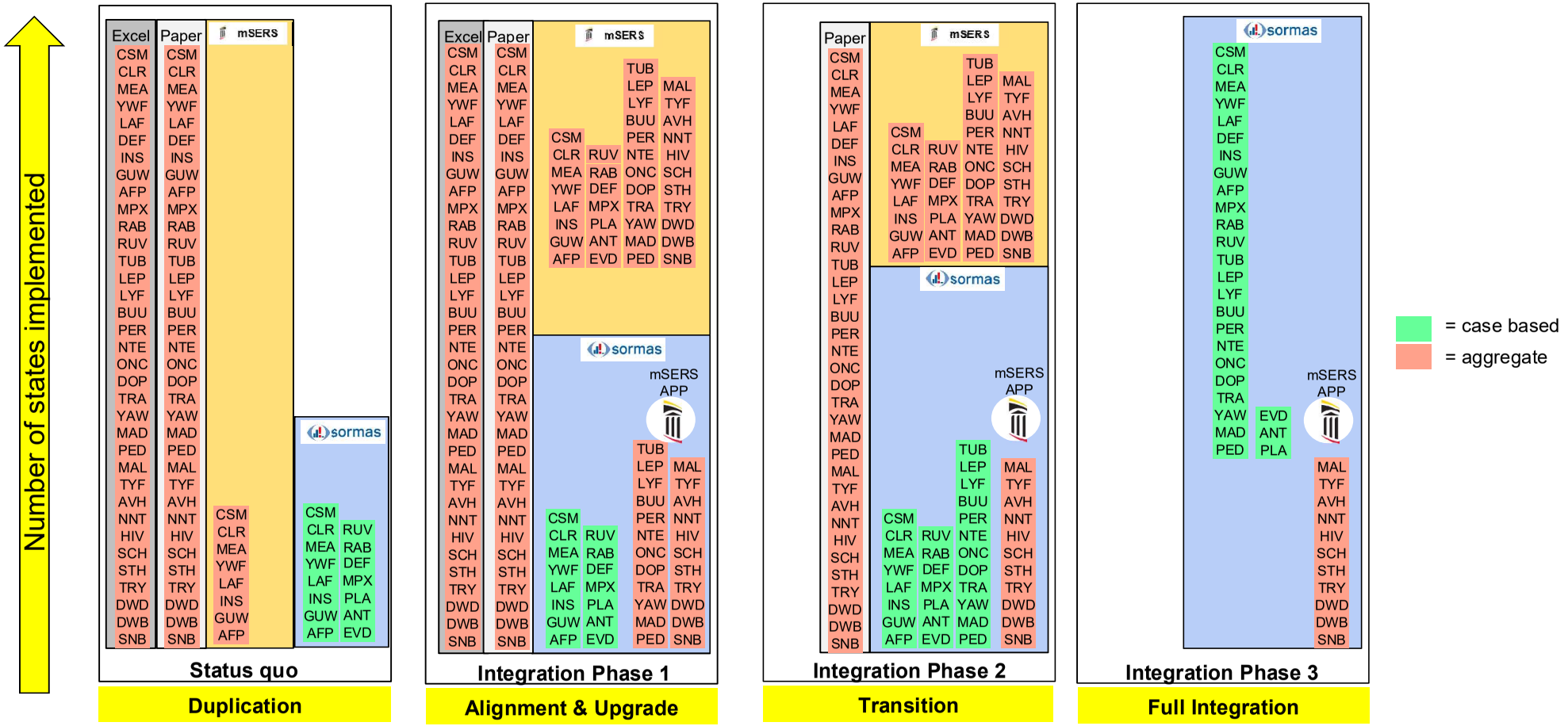


= case based
= aggregate

Transition & Integration Phases for Digitalization of Case Based Surveillance in Nigeria



Transition & Integration Phases for Digitalization of Case Based Surveillance in Nigeria



Advantages of phased integration approach

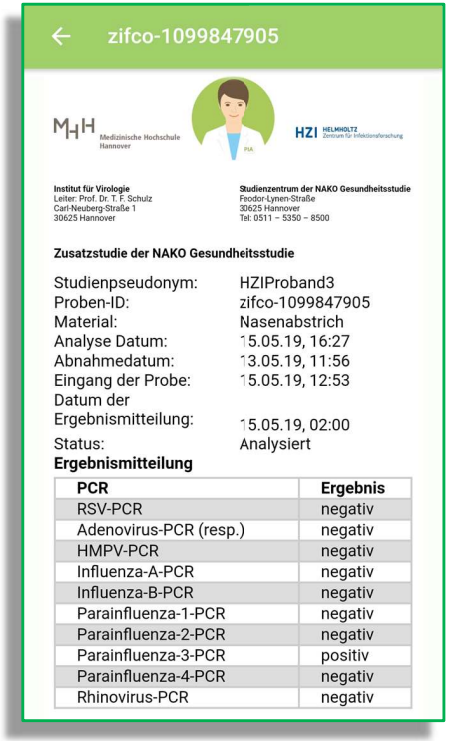
- Digital aggregate reporting already improves timeliness, while case based digitalization is being developed
- Benefiting from added value of mSERS in
  - Competency in aggregate digital reporting
  - Country wide coverage
- Benefiting from added value of SORMAS in
  - Case based reporting
  - Bi-directional information exchange
  - Response management process
  - Established data feed into DHIS2
- Redundancy reduced in phases allows back-up option
- Resources reduced for
  - Hardware (Phase 1-3)
  - Data plans (Phase 1-3)
  - Manual data transfer into Excel (Phase 2-3)
  - Software maintenance, security measures, support (Phase 3)

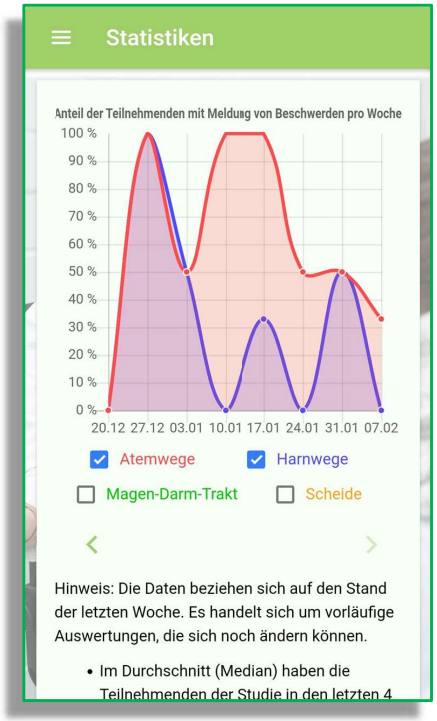
➢ Use case for alignment and integration of other digital tools

Mobile eResearch System
PIA – App: Prospective Assessment of Incident Health Events

sormas

- Comprehensive data protection scheme & IT-security
- iOS, Android, Web-application
- Complex roles and specific access
- Integration of bio-samples e.g. in case of infection
- Real-time & personalized surveillance
- New topics easily implemented
- Gamification features
- Feedback for participants





Mobile eResearch System
PIA – App: Prospective Assessment of Incident Health Events

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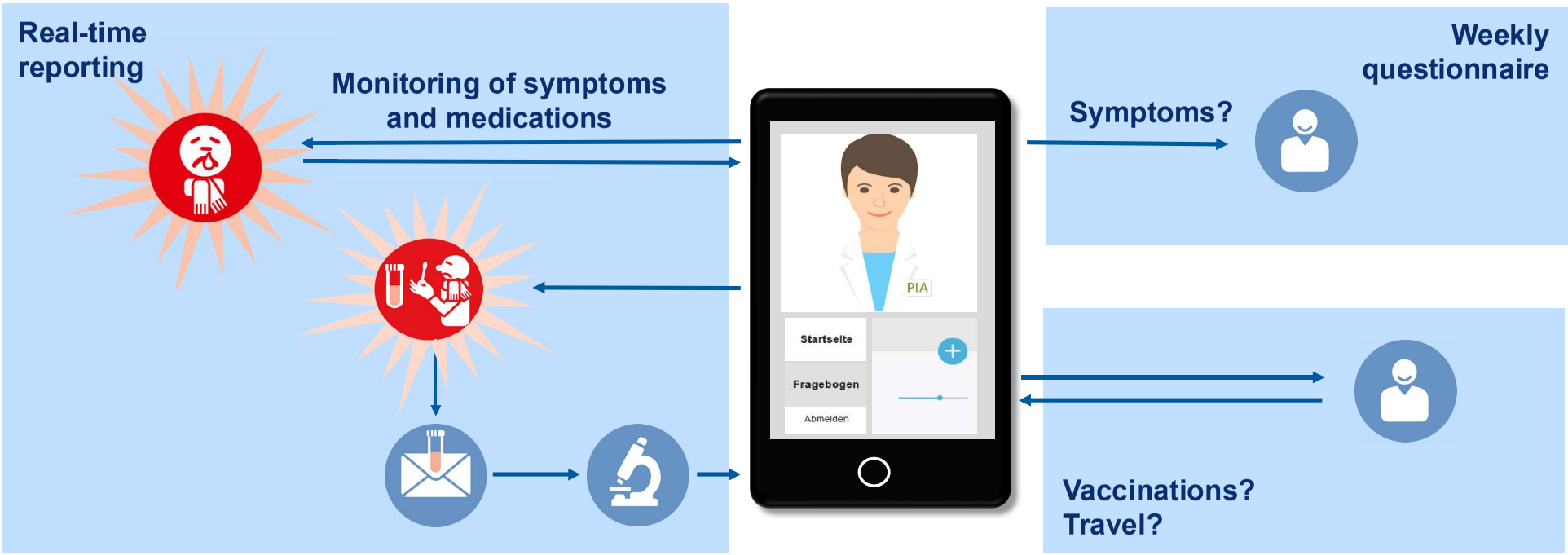

Diabetes | Lung | Allergy | Heart | Mental Health | Cancer