CDC Global Digital Health Strategy

Appendices

May 2022

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INTRODUCTION

This set of appendices provides additional context for the CDC Global Digital Health Strategy (GDHS) document and the corresponding Executive Summary. Information on the stakeholders who contributed to and were consulted on the strategy is included, as well as additional information on key concepts. For instance, further information on the connection to enterprise architecture and the DMI logic model is provided.

Following this is a list of illustrative activities that fall within CDC's capabilities and are required to achieve the goals and objectives of this strategy. The list does not touch on the role of other donors and members of the global health community. Lastly, information on critical success factors for the implementation of a shared digital platform is provided.

LIST OF CDC DIVISIONS AND EXTERNAL ORGANIZATIONS CONSULTED

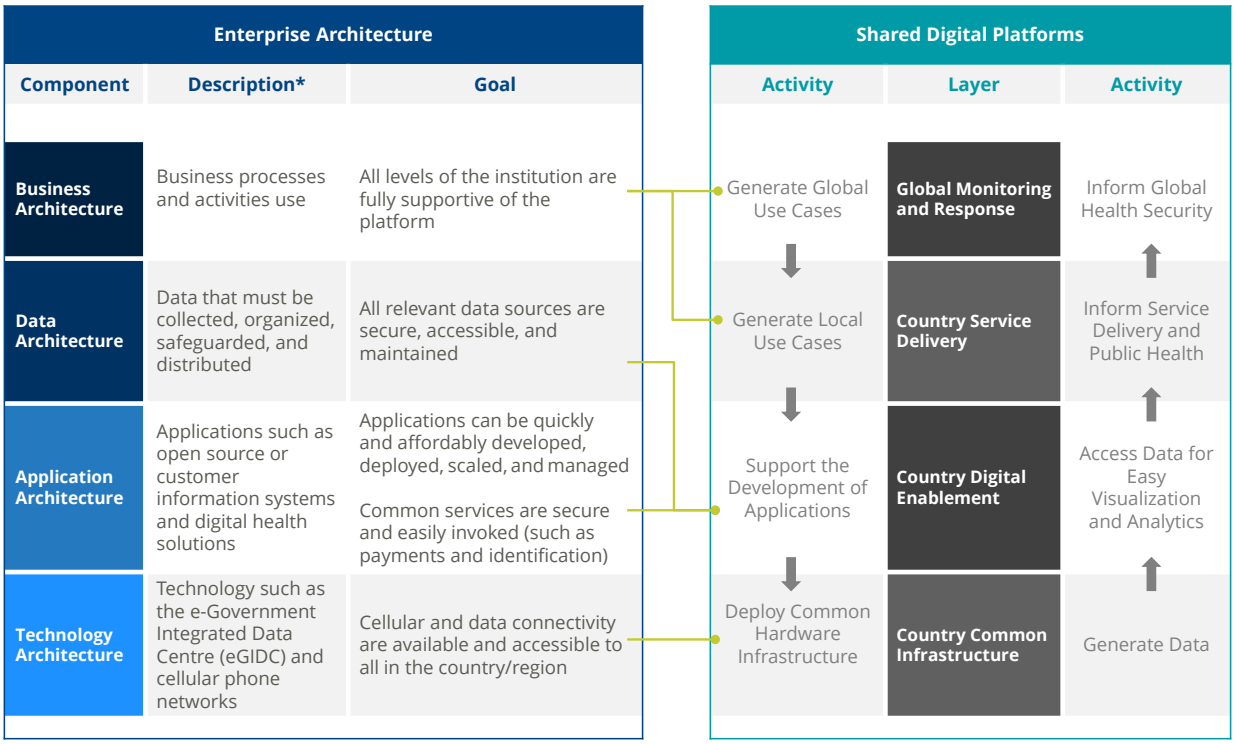
The following list of CDC centers, offices, and external global health partners were consulted as part of the development of this strategy:

CDC AFFILIATION	EXTERNAL ORGANIZATION
▶ Center for Global Health (CGH) ▶ Center for Preparedness and Response (CPR) ▶ Center for Surveillance, Epidemiology, and Laboratory Services (CSELS) ▶ Deputy Director for Public Health Science and Surveillance (DDPHSS) ▶ Office of General Counsel ▶ National Center for Health Statistics (NCHS) ▶ National Center for Immunization and Respiratory Diseases (NCIRD) ▶ National Center for Emerging and Zoonotic Infectious Diseases (NCEZID) ▶ Office of the Chief Information Officer (OCIO) ▶ Office of the Chief Operating Officer (OCOO) ▶ Regional Offices ○ South America (SAM) Regional Office ○ Central America Regional Office	▶ Bill and Melinda Gates Foundation ▶ Gavi, the Vaccine Alliance ▶ The Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) ▶ President's Emergency Plan for AIDS Relief (PEPFAR), United States Agency for International Development (USAID) ▶ World Bank ▶ World Health Organization (WHO)

THE CONNECTION TO ENTERPRISE ARCHITECTURE

Enterprise architecture (EA), as depicted in Figure 1, consists of four components that interface with each other. The middle two layers – data and applications (including shared common services) – create an enabling environment to allow for applications to be quickly and affordably developed, deployed, and managed with scaled capability. Through common services, these applications can also securely exchange timely data. The bottom layer, technology architecture, extends the system's capabilities to reach the largest-possible cohort, while the top layer ensures all levels of the institution are supportive of digital interventions over time.

Figure 1: Enterprise Architecture and a Shared Digital Platform



*The component descriptions were adapted from the *Digital Implementation Investment Guide*[i]

Figure 1 makes the conceptual link between the four EA components and the four layers of a shared digital platform. Business processes, workflows, and use cases are mapped to the first two layers of the holistic approach (global monitoring and response, and country service delivery). The data and application architecture components are connected to country digital enablement, and technology architecture maps to country common infrastructure.

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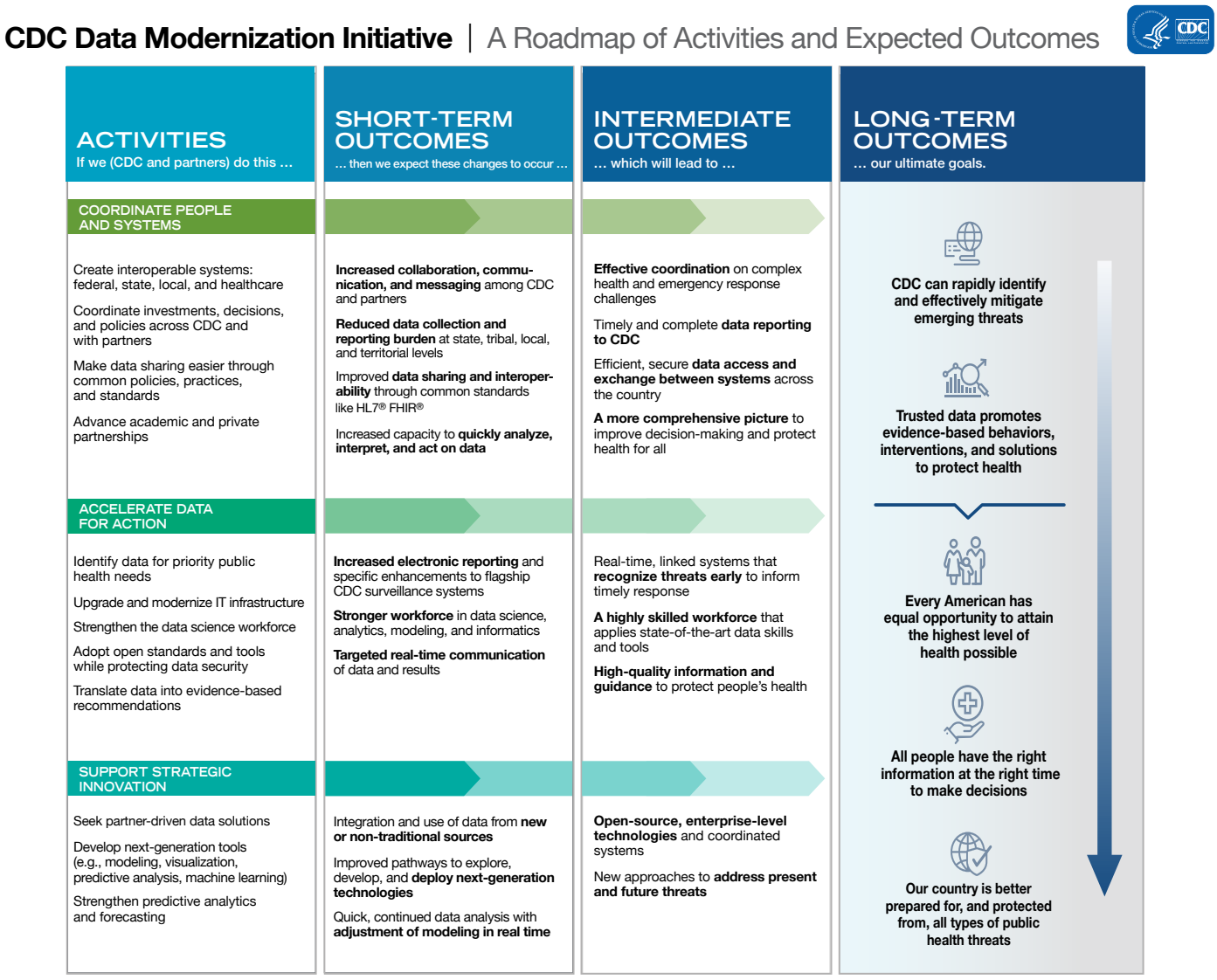
[i] *World Health Organization (WHO) (2020) Digital Implementation Investment Guide (DIIG): Integrating Digital Interventions into Health Programmes. Geneva, Switzerland: World Health Organization. Available at: https://www.who.int/publications-detail-redirect/who-digital-implementation-investment-guide (Accessed: 13 October 2020).*

THE DATA MODERNIZATION LOGIC MODEL

Figure 2 describes the various activities and anticipated outcomes of the Data Modernization Initiative (DMI) in a logic model.[ii] All activities and their corresponding outcomes articulated in this logic model can be applied for use in the global context, effectively expanding the long-term outcomes globally, supporting countries to be better prepared and protected from health threats and achieving equal opportunity to attain the highest level of health possible to individuals all over the world. The overlap between the DMI and the GDHS speaks to the opportunities for utilizing and sharing learnings, assets, artifacts, and investments where possible to realize digital enablement both domestically and globally.

Figure 2: The DMI | A Roadmap of Activities and Expected Outcomes



[ii] *U.S. Centers for Disease Control and Prevention (no date) The CDC Data Modernization Initiative: A Roadmap of Activities and Expected Outcomes. Atlanta, GA: Centers for Disease Control and Prevention, p. 1. Available at: https://www.cdc.gov/surveillance/pdfs/318212-A_DMI_LogicModel_July23b-508.pdf (Accessed: 17 June 2021).*

ILLUSTRATIVE CDC-SPECIFIC ACTIVITIES

Regardless of the context, the CDC strategies and vision articulated in this document involve a set of recommended activities that are repeatable across geographies and implementations. A list of these illustrative activities is articulated in the tables below. These activities fall within CDC's capabilities and do not touch on the role of other donors and members of the global health community that would be required to achieve the goals and objectives. The phases of the activities will be dependent on program specific timelines and schedules.

GOAL 1: GLOBAL AND REGIONAL MONITORING AND RESPONSE – Protect global health security by enabling timely access, protection, and use of high-quality, shared country data with global health community and practitioners in sectors such as environment and animal health.

DIGITALLY ENABLED SERVICES: Objective 1.1 – Shared data and analyses from country-driven systems are being used at the global level in support of global health goals.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
1.1.1 Work with global, regional, and domestic partners to identify common existing and potential new global digital health use cases.[iii] Catalog the data relevant to	a) Identify use cases central to CDC functions b) Identify repeating or recurring use cases c) Identify potential new use cases	a) Analyze metadata, workflows, and architecture for each use case b) Normalize findings into common core data and systems architecture,

[iii] *The strategies reference use cases that should be identified and detailed. An example of a global use case could be the collation of COVID19 data points from multiple countries. An example local use case could be the collection of HIV viral load information for adherence monitoring at country level. The repositories would reference the required data points and workflows.*

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
each use case and normalize the findings into a common core data and systems architecture.		using international standards for interoperability
1.1.2 Contribute to the development of a CDC global repository consisting of use cases, core metadata, systems architectures, and standardized requirements for disease surveillance and epidemiology.	a) Design structure and functionality of the use case repository b) Deploy publicly accessible CDC global repository	a) Add outputs of Activity 1.1.1 to the repository
1.1.3 Implement a CDC global data warehouse securely storing data described by the global use case repository. The warehouse should expose open data interfaces and public datasets where possible (and supported by data-sharing agreements) and utilize standard data structures and flexible architecture. It will store aggregate data as well as identified and de-identified individual data depending on the use case and security considerations.	a) Design the warehouse with learning taken from the CDC open data initiative and other complimentary initiatives (e.g., WHO xMart) b) Begin adding data sets to the warehouse	a) Incentivize partners to utilize and add data sets to the data warehouse
1.1.4 Develop population linkage strategies and techniques to enable analytical modelling and statistical analysis across disparate data sets. Unlock new epidemiological insights for global health security.	a) Identify data and interoperability standards relevant to global health projects, aligned with DMI initiatives b) Identify CDC data sets that could be linked to provide new insights	a) Develop, share, and use techniques and algorithms to link data across data sets
1.1.5 Identify data generated or consumed by CDC that would be useful to other partners but are not yet currently available. Identify how those data could be	a) Assess current data systems and identify data relevant to routine service delivery	a) Make current data publicly available where possible

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
more readily shared, ensuring privacy, security, and confidentiality.	b) Generate country-driven use cases that would collect that same data	b) Add use cases to use case repository

OPERATIONS AND SKILLED WORKFORCE: Objective 1.2 – Decision-making is data-driven and based upon the best available science and technology.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
1.2.1 Develop new and contribute to existing materials and provide training for health informatics and data science capacity building (internally and globally). Ensure training and capacity building resources are institutionalized in country (e.g., ministries of health, agriculture, environment, national public health institutes, academic centers) and readily available to public health workforce.	a) Identify user prerequisites in using digital tools for specified use cases b) Develop training materials to fulfill user prerequisites	a) Deploy training materials to fulfill user prerequisites
1.2.2 Elevate health informatics as a core skill necessary for relevant CDC staff.	a) Socialize the need for health informatics across CDC human resource functions	a) Modify human resource processes to include expectations about core health informatics expertise

1.2.3 Establish cross-disease, -sector, and -domain (lab, analytics, informatics, surveillance) public health teams to help ensure that digital policies, standards, guidelines, systems (existing or new), data requirements, and data analytics meet the needs of the public health systems and emergency response activities.	a) Define opportunities and needs for cross-domain public health teams at a global level b) Define the mandate and structure of teams	a) Activate cross-domain public health teams
1.2.4 Engage staff and resources with existing critical disease surveillance systems to advance integration and interoperability across platforms and sectors.	a) Identify appropriate staff and resources for engagement compared to identified needs b) Develop engagement plan and supporting processes	a) Refine and institutionalize engagement

GOVERNANCE AND LEADERSHIP: Objective 1.3 – Countries have established data governance policies and mechanisms to make relevant data available to all partners.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
1.3.1 Support active coordination of digital health efforts and investments and advocate for adoption of shared goals and objectives.	a) Identify projects that could facilitate partnerships that support the use of shared enterprise-wide common digital components, data sets, and platforms	a) Generate memoranda of understanding (MOU) with partners to execute projects

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
1.3.2 Participate in communities of practice in order to socialize the advantages of and share best practices or lessons learned from sharing country data for global utilization.	a) Engage with other partners in documenting the need for and advantages of better access to country data in support of global health security	a) Promote MOUs as an example of best practices for partner behavior
1.3.3 Develop a cost analysis showing the long-term cost benefits of investing in country-owned systems.	a) Engage with other partners in documenting the need for and advantages of better access to country data in support of global health security	a) Use documented findings to encourage data sharing with country partners
1.3.4 Support the development of policy, guidelines, and practice by using data-driven technical expertise.	a) Generate cost benefit analysis showing cost savings to CDC of using country-generated data (especially over long time periods)	a) Use cost benefit analysis to secure operational budget for activities defined by strategies
1.3.5 Drive the development and implementation of policy and standards, including those for privacy and security of data for cross-border data sharing.	a) Identify policies, practices, and standards for global health b) Create global health recommendations document c) Identify extensions to existing cyber-security, interoperability and privacy standards required in order to support global health use cases	a) Use recommendations document to drive standards and policy development with other global health partners b) Identify tools required for implementing relevant standards c) Work with partners to deploy relevant standards in country digital health strategies and project implementations

GOAL 2: COUNTRY HEALTH PROGRAMS – Implement data-driven public health and healthcare workflows, decision making, supervision, and programs that improve delivery of services, health outcomes, science, and research.

DIGITALLY ENABLED SERVICES: Objective 2.1 – Common digital components are being deployed in support of service delivery and public health programs.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
2.1.1 Document local use cases driven by CDC core activities and identify the data associated with each. Identify common use cases within and across the pillars, and with other partners.	a) Identify opportunities for digital enablement of current and future services b) Define these opportunities in the form of use cases	a) Add local use cases and workflows to the global repository
2.1.2 Identify data relevant to CDC's mission and cross reference the data with what are currently available in any given country to produce a gap analysis.	a) Document data inputs, outputs, and flows for each use case identified b) Identify existing data and their availability in support of new use cases	a) Create data dictionary for identified local data sets b) Map dictionary concepts to standard vocabularies to support semantic interoperability c) Add data sets to global data warehouse, making them publicly available where possible
2.1.3 Collaboratively identify common digital components and tools that can be applied to identified use cases.	a) Assess and identify common digital components that can address identified use cases	b) Prioritize and implement components and tools
2.1.4 Ensure appropriate data privacy and security technology and services are incorporated across all digital health platforms, with attention to unique	a) Develop monitoring protocols required to ensure data are managed in accordance with security policies	a) Integrate monitoring protocols into relevant projects

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
country-specific privacy laws and data governance policies where necessary.		b) Incentivize the use of these protocols by other partners
2.1.5 Use machine learning and data science techniques (such as data triangulation, descriptive, diagnostic, predictive and prescriptive analytics, and forecasting) to understand and answer key programmatic questions.	a) Share global learnings and expertise with country teams to catalyze use of new technologies and skill sets b) Add new use cases to use case repository	a) Update use case repository with data science techniques available to fulfill use cases
2.1.6 Use data for resource allocation (e.g., workforce deployment, supply allocation, or investments) across new or established systems.	a) Define requirements for data-driven dashboards, business intelligence, and analytics depicting current and historical supply and demand of health services	a) Develop functional proof of concept dashboards to demonstrate advantages of data-driven resource allocation
2.1.7 Share data across programs where possible and where enabled by common digital tools.	a) Identify opportunities to unify programmatic-level services into a common delivery platform b) Document change management procedures required in order to combine services	a) Develop cost benefit analysis (CBA) of merging programs onto shared platforms b) Use CBA to secure funding for relevant activities

OPERATIONS AND SKILLED WORKFORCE: Objective 2.2 – The workforce is trained and able to keep up with current demand to use digital tools and data to improve service delivery and other health activities.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
2.2.1 Identify existing assets related to workforce development and produce a skills and coverage gap analysis.	a) Identify and document incentives required to help workforce convert to use of digital platforms b) Develop supporting change management guidelines (that spell out operational activities and roles on how to manage and control transition)	a) Add incentives to an evolving change management guideline document b) Apply change management guidelines to project planning methodology
2.2.2 Catalyze in-country and regional public-private partnerships that support workforce development (pre-service and in-service).	a) Identify areas in need of workforce development b) Add identified areas to change management guidelines	a) Provide budget, training, and technical assistance in support of workforce development in needed areas
2.2.3 Provide mentoring and technical assistance to countries and programs where needed, in support of their use of data for decision-making.	a) Identify required curriculum for informatics training program	a) Develop training materials b) Provide mentoring and other forms of technical assistance to users to improve data-driven decision-making

GOVERNANCE AND LEADERSHIP: Objective 2.3 – Country governments are supporting technology and policy regarding use of digital technology.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
2.3.1 Work with ministries to enable better health outcomes for overall population health by leveraging digital technology. Promote the value of data collection, analytics, and visualization and determine gaps that need to be filled.	a) Generate documents (defining digital requirements) that will help governments understand how to specify their digital health requirements related to data collection, analytics, and visualization b) Generate documents (EA, CBA, and total cost of ownership [TCO]) that will help governments understand the possibilities of return on investment (ROI) of digital health enablement	a) Help governments understand how to specify their digital health requirements b) Help governments understand the possibilities and ROI of digital health enablement
2.3.2 Work with countries to address broader enterprise data management and digital platform maturity issues in order to advance sustainable solutions.	a) Develop a maturity model depicting the progressive steps required to transition from local pilots to national, multi-sectoral platforms b) Include in the model potential governance structures for each level of maturity and steps for continuous improvement	a) Assess countries against this maturity model and help them to advance to along the continuum

GOAL 3: COUNTRY DIGITAL ENABLEMENT – Improve ability to collect, secure, and analyze quality data in service of strengthening health programs to improve effectiveness, including cost and access to services, via digital enablement.

DIGITALLY ENABLED SERVICES: Objective 3.1– Countries are developing or using existing digital global goods in support of service delivery and public health programs.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
3.1.1 Use global and local use cases to inform system design and requirements.	a) Identify all use cases and data to be supported by country systems – at both global and country levels	a) Add use cases to use case repository
3.1.2 Support identification and implementation of global goods and interoperability standards to improve service delivery use cases.	a) Identify use cases that would benefit from usage of digital global goods b) Compare use cases to existing and applicable global goods	a) Assist with implementation of digital global goods
3.1.3 Help partners implement cloud-based shared services, including workflow engines and identity management systems.	a) Define key components of cloud-based shared services for health service delivery	a) Incentivize implementation of these components in country-owned systems
3.1.4 Help drive development of cloud-based data privacy and security standards.	a) Promote cloud-based cyber-security models and standards b) Promote cloud-based data privacy standards c) Ensure cloud-based standards are incorporated into country digital health strategies	a) Deploy cloud-based cyber-security, health messaging, and coding models and standards in reference deployments b) Deploy cloud-based data and privacy standards in reference deployments c) Develop and improve cloud-based capabilities

OPERATIONS AND SKILLED WORKFORCE: Objective 3.2 – Countries are capacitated and able to implement, use, and maintain digital components.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
3.2.1 Provide mentoring and technical assistance where required to help countries make decisions about system requirements and standards.	a) Provide technical assistance to countries developing digital health plans in order to ensure inclusion of relevant standards	a) Provide technical assistance to countries in monitoring system conformance to standards
3.2.2 Identify workforce requirements for deploying digital assets and integration of existing systems.	a) Identify user prerequisites in using digital tools for specified use cases b) Develop training materials to fulfill user prerequisites and identify hiring needs	a) Deploy training materials to fulfill user prerequisites
3.2.3 Build capacity in interoperability standards, open data architecture, and mechanisms for health information exchange.	a) Identify skills needed for increased use of interoperability standards, open data and health information exchange based on use cases	a) Support skills development at country level
3.2.4 Support competency in, and knowledge and usage of, national data privacy and security standards to allow for identification and remediation of cyber security risk.	a) Identify existing country normative security and privacy policies and standards b) Develop gap analysis between global and local policies c) Identify gaps in workforce competency	a) Support countries to adopt standards where there is a gap or no existing normative standards b) Engage and support implementing partners with helping countries assess, remediate, and document their cyber security risk c) Support development of workforce competencies in data governance and security standards

GOVERNANCE AND LEADERSHIP: Objective 3.3 – Country strategy and implementation plans have support across partners and sectors, and country government digital core services are cross-sector.

STRATEGIES	PHASE 1 AND PHASE 2 ACTIVITIES
3.3.1 Lead or participate with other partners in aligning specific country projects to a shared implementation roadmap.	a) Coordinate with other partners to align project plans and resources in support of collaborative development and sustainability of country digital health systems
3.3.2 Work with other partners to ensure software platforms are aligned in support of identified common use cases.	a) Help countries incorporate support of common global use case requirements in their digital health strategies
3.3.3 Engage with other partners in promoting reference implementations of CDC programs supporting country health programs or activities.	a) Support the documentation of best practices and the publication of reference implementations
3.3.4 Support the development of materials quantifying return on investment (ROI) of an enterprise approach.	a) Develop an ROI and TCO for countries depicting the advantages of an enterprise approach

GOAL 4: COMMON INFRASTRUCTURE – PROVIDE SECURE ICT INFRASTRUCTURE, ACCESSIBLE AS APPROPRIATE TO ALL USERS AND SERVICE PROVIDERS.

DIGITALLY ENABLED SERVICES: Objective 4.1 – A critical mass of the workforce across sectors has access to cellular or internet network connectivity and functional devices.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
4.1.1 Support the provisioning of reliable electrical power to currently under-served areas to enable use of digital tools.	a) Identify challenges to provision of power and document potential solutions b) Work with countries and other partners to identify and prioritize underserved (no electricity) geographies	a) Work with countries and other partners to identify options for providing power to these areas
4.1.2 Facilitate partnerships to ensure hardware infrastructure and/or cloud services conform to national ICT regulatory requirements.	a) Identify and promote hosting service and architectural standards b) Identify and promote best practices around business continuity, disaster recovery, and high availability	a) Work with countries to promote the incorporation of these standards into country digital health strategies where relevant
4.1.3 Support cloud-based deployment of services and software, ensuring business continuity and supporting necessary change management.	a) Develop guidelines to assist countries in migrating to cloud-based services	a) Support migration of current services to the cloud

OPERATIONS AND SKILLED WORKFORCE: Objective 4.2 – A critical mass of the workforce across sectors has access to cellular or internet network connectivity and functional devices.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
4.2.1 Partner with multilateral donors and development organizations that fund infrastructure where CDC cannot.	a) Create partnerships to help fund data hosting services for countries where CDC has active programs	a) Explore possibilities and ROI of aggregating country systems into regional ICT platforms
4.2.2 Partner with the private sector and other partners (e.g., mobile network operators) to develop and deploy business models to increase network accessibility.	a) Document ROI of extending digital connectivity to underserved populations b) Document risks, mitigations, and costs of extending network coverage in country	a) Work with the private sector to estimate costs of extending services and potential incentives
4.2.3 Support training of service delivery personnel in the deployment, use, and maintenance of digital tools, including implementation of protocols necessary to ensure data privacy and security. Support effective and efficient personnel management.	a) Create index of training programs that will support deployment of common digital tools	a) Work with partners to deploy these training programs in countries

GOVERNANCE AND LEADERSHIP: Objective 4.3 – Scope of hardware platforms and connectivity is cross-sector.

STRATEGIES	PHASE 1 ACTIVITIES	PHASE 2 ACTIVITIES
4.3.1 Support the incorporation of digital health within government digital services.	a) Promote standardization of country digital health strategies around common elements, while still leaving room for country localizations	a) Provide technical assistance to countries to support development of digital health strategies
4.3.2 Support in-country partnerships across sectors and ministerial divisions.	a) Document ROI of cross-sector ICT platform for service delivery b) Define risks, mitigations, and governance required for cross-sector ICT	a) Identify potential implementation partners and cost of implementations at various levels of scale
4.3.3 Work with other partners to ensure hardware and network resources are available to provide sufficient infrastructure to support secure service delivery at scale.	a) Define model showing economies of scale of hosting architecture b) Define guidelines to ensure business continuity with security, connectivity, and server infrastructure	a) Identify TCO for hosting at each level of scale b) Identify funding partners for hosting services
4.3.4 Implement policies that enable the secure movement and sharing of data across cross-sectoral information systems, such as geospatial, environment, agriculture, security, animal health, and refugee data.	a) Implement data governance agreements with countries around technical data use and access	a) Work with countries to standardize technical data use agreements in line with global partners such as the WHO
4.3.5 Support the generation of policies that inform the adoption of cloud-based services and data sharing.	a) Document ROI for countries to adopt cloud-based hosting of digital services	a) Advocate for the adoption of cloud-based services and data sharing policies at all levels of government

CRITICAL SUCCESS FACTORS FOR EACH LAYER OF A SHARED DIGITAL PLATFORM

A shared digital platform leads to seamless transitions across the different layers and optimizes access to healthcare services and public health activities. Each layer of a shared digital platform consists of a number of critical success factors, spanning across digital (e.g., interoperability, standards, and analytical tools) and non-digital (e.g., leadership and governance, policy development, and capacity building) elements. Figure 3 describes the critical success factors for each layer.

Figure 3: Critical Success Factors for Each Layer