



NIEHS Cyberinfrastructure Leadership Committee

# Informatics and Information Technology Strategic Roadmap Fiscal Years 2019–2021

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## LETTER FROM THE CYBERINFRASTRUCTURE LEADERSHIP COMMITTEE

The National Institute of Environmental Health Sciences (NIEHS) is world-renowned for research leadership and its unique mission to discover how the environment affects people in order to promote healthier lives. To advance this mission and remain at the forefront of environmental health and biomedical science innovation, NIEHS priorities are continuously updated. As a result, NIEHS Informatics and Information Technology (I&IT) must also constantly adapt and improve. In guiding these efforts, the Cyberinfrastructure Leadership Committee (CLC) is honored to present this I&IT Strategic Roadmap.

The roadmap will help to ensure that the institute has the essential technology, tools, and expertise to advance science, accelerate the translation of data to knowledge to action, and enhance scientific stewardship. Success will integrate excellence in enterprise and scientific computational systems, data science, and website communications in support of the critical priorities of the entire NIEHS community.

Development of the roadmap was guided by a grassroots effort that combined input from both technology users and providers. It aligns the goals and priorities of the NIEHS community with technology and its governing and regulatory principles. The institute has made significant strides to enable research, grant making, and administrative processes that are fully integrated and reliant upon technology tools, but there is much more to accomplish. Real success in implementing the roadmap depends on continued close collaboration between the CLC and the NIEHS community. Working together, the institute will maximize scientific progress through optimal I&IT capabilities.

All aspects of I&IT will be informed by the roadmap. Enterprise IT efforts will assure IT, as well as data security and privacy, and promote new best practices for technology support, infrastructure, business process improvement, applications development, and governance.



**David Fargo**  
Acting Director of  
Environmental Science  
Cyberinfrastructure, and  
Scientific Information Officer



**Bernard Brown**  
Chief Information Officer,  
Office of Information  
Technology



**Charles Schmitt**  
Director,  
Office of Data Science



**Beth Lauderdale**  
Manager,  
Project Management Office



**Christine Flowers**  
Director,  
Office of Communications  
and Public Liaison

Scientific IT efforts will advance the diverse and specific needs in the laboratories and clinic and expand opportunities and infrastructure for scientific discovery through data- and model-driven scientific computing. Data science, as an expanding critical element of all scientific processes, will enhance data utility and provide opportunity for more holistic data understanding, emphasizing standards and policies that make data and metadata findable, accessible, interoperable, reusable, and computable (FAIR+). Website-based systems will promote communications and education and are the critical public interface to NIEHS science. The roadmap supports integration of these efforts and highlights dependencies and opportunities for expanded coordination.

The Federal Information Technology Acquisition Reform Act (FITARA), passed by Congress in December 2014, is a historic law that represents the first major overhaul of federal information technology in almost 20 years. FITARA mandates process efficiencies that impact the entire technology ecosystem. Guided by these goals and principles, NIEHS will continue to reduce and limit the growth of on-premise resources, and instead will employ applicable outsource technology tools. Expanded implementation of cloud technologies will help manage I&IT costs, while increasing user-directed capabilities. The institute will further invest in science-enhancing resources, such as graphics processing units that power machine learning and emerging methods, including linked data technologies for increasing data usability and integration.

The roadmap is intended to represent management themes and priorities. Its purpose is to characterize the overall I&IT landscape and guide the management of that landscape, to achieve a more robust and agile system that effectively supports institute research plans.

Finally, the committee reiterates that continuous collaboration and engagement with the entire NIEHS community is critical to success.

With sincere appreciation,

The NIEHS Cyberinfrastructure Leadership Committee

# I&T MISSION AND VISION



## MISSION STATEMENT

**NIEHS Mission:** *The mission of NIEHS is to discover how the environment affects people in order to promote healthier lives.*

**I&T Mission:** The NIEHS I&T mission is to provide innovative and reliable cyberinfrastructure that advances environmental health science and promotes healthier lives.

The CLC manages NIEHS systems that empower the use of information and computing technologies, providing oversight and governance. The committee ensures that the institute has a reliable and secure I&T foundation, integrating systems, and expertise essential for the scientific and administrative mission. In doing so, the CLC strives to meet the challenge of delivering I&T services that meet federal regulations and mandates, while proactively supporting dynamic I&T goals and maintaining a clear focus on user satisfaction.

### **Cyberinfrastructure enables I&T.**

Cyberinfrastructure at NIEHS includes technology systems, instruments, data and knowledge management, analytics, policy, and expertise, coordinated to advance environmental health and biomedical science, and provide interoperability with the broader life sciences community.

I&T plays a critical role in enabling scientific discovery, in facilitating scientific collaborations and team-based science, and in communicating findings to the broader community. Advances in scientific computing and data science are providing business technology and communications systems used in the day-to-day operations of the institute, and altering how discoveries are made and communicated. The committee recognizes that the mission extends beyond traditional IT boundaries, and that achieving this mission includes providing leadership in advancing the capabilities and usage of computing and data technologies, as well as providing leadership in cyberinfrastructure governance.

This roadmap defines governance, goals, priorities, and strategies to support NIEHS in its mission to uncover the complex dependencies between health and the environment, and to use those discoveries to promote healthier lives. It also frames the implementation priorities and plans that the CLC uses to achieve its mission.

## VISION STATEMENT

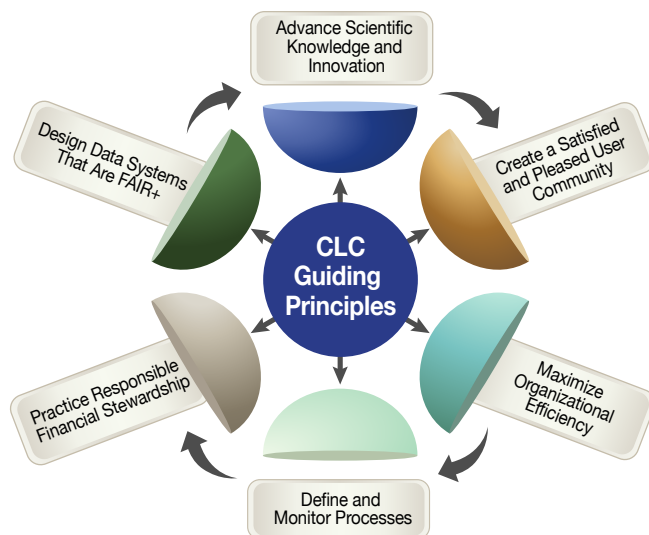
**NIEHS Vision:** *The vision of NIEHS is to provide global leadership for innovative research that improves public health by preventing disease and disability.*

**I&T Vision:** The NIEHS I&T vision is to empower and catalyze the translation of data to knowledge to action and improve public health through the application of transformative cyberinfrastructures.

## GUIDING PRINCIPLES AND CHALLENGES

Understanding current and anticipated I&IT challenges has been an integral component of the roadmap development process. The CLC and a diverse group of participants from across the institute have collaborated to identify I&IT challenges critical to ensuring the success of the collective mission. The process has helped to emphasize core guiding principles that will address these challenges, including:

- Advance Scientific Knowledge and Innovation.
- Create a Satisfied and Pleased User Community.
- Maximize Organizational Efficiency.
- Define and Monitor Processes.
- Practice Responsible Financial Stewardship.
- Design Data Systems That Are FAIR+ (Findable, Accessible, Interoperable, Reusable, and Computable).



### Advance Scientific Knowledge and Innovation

Innovative, high-quality, cost-effective, and secure I&IT operations are essential elements of the institute's mission. I&IT personnel will consistently demonstrate technical expertise, exhibit professionalism, and facilitate communication to maintain an effective working relationship with the NIEHS community. This will foster an environment for I&IT operations that advances scientific knowledge and innovation through the following principles:

- Consistently define I&IT roles and responsibilities, capabilities, and services.
- Understand and anticipate the I&IT needs of the scientific and administrative community.
- Adapt to individual needs to provide the best available service and technology solutions.
- Provide accurate expectations of resources, services, and the duration of tasks.
- Value scientific and administrative stakeholder engagement and perspectives.
- Educate the NIEHS community on the application of I&IT solutions.
- Support broad training to maximize the use and efficacy of I&IT solutions.

### Create a Satisfied and Pleased User Community

Providing efficient, effective, and agile customer service is an integral part of I&IT operations and must not be viewed as optional. Meeting the needs of the community goes beyond technical expertise, and includes important, but basic, characteristics:

- Be prepared.
- Be pleasant.
- Value people's time.
- Never promise more than you can deliver, and always deliver.

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## **Maximize Organizational Efficiency**

A significant measure of the success of I&IT is its contribution to the institute's productivity. I&IT must be focused on maximizing organizational efficiency to support the mission.

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## **Define and Monitor Processes**

Defining processes involves creating an operating manual that documents each step in an I&IT process (process mapping) and states who is accountable and responsible for a function. It enables a universal understanding of the roles involved in delivering a product or service, what each of these roles does, and what changes because of actions taken by each role. Consistent and systematic monitoring of I&IT processes will help identify where I&IT operations can improve or be streamlined and will enhance I&IT and business effectiveness.

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## **Practice Responsible Financial Stewardship**

Financial stewardship includes the mindful planning, management, conservancy, and care of financial choices and resources, beginning at the individual level. It ensures that the performance and efficacy of past projects inform future I&IT investments, helps manage risks, optimizes resources, and fosters the exploration of the potential benefits of new investments.

Responsible financial stewardship begins with an effective and inclusive I&IT budget planning process that promotes accountability and establishes purchasing metrics and guidelines. A commitment to effective data-driven budget planning will enhance prioritization processes and assist in maintaining a roadmap for future investments. Additionally, I&IT systems will promote responsible financial stewardship by maintaining lifecycle-based understanding of current technology.

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## **Design Data Systems That Are FAIR+ (Findable, Accessible, Interoperable, Reusable, and Computable)**

Robust data and metadata management are essential for knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse by the research and public health community. I&IT will emphasize solutions that produce and support FAIR+ data. FAIR+ principles further emphasize enhancing the ability of computer systems to automatically find and use data in support of greater automation and efficiencies, in addition to supporting its reuse by individuals.

FAIR+ principles will guide data generators, publishers, curators, and stewards in evaluating whether data management processes are rendering their digital research products effectively. Through these guiding principles, I&IT will provide best practice solutions in data and metadata management to the NIEHS community.

# I&T STRATEGIC ROADMAP DEVELOPMENT

The development of the roadmap included the examination of 11 I&T Landscape categories: Facilities and Physical Plant; Network; Data Center (Servers, Storage, Cloud); Clinical I&T; Laboratory I&T; Data and Knowledge Management; Website Communications; Non-Commodity Software; Commodity Business Computing; Continuity of Operations (COOP) and Disaster Recovery; and Security and Privacy.

Subject matter experts and stakeholders in each Landscape category were tasked with delineating boundaries and defining goals and strategic capabilities. Capability statements included what the priority capabilities were, why they matter, how to measure progress or success, and current status. CLC and the I&T community will lead the implementation of these priorities.



Crosscutting I&T themes spanning all 11 Landscape categories were identified and aligned with the NIEHS strategic plan themes. They include:

## **1. Agility**

Promoting flexibility, adaptability, and interoperability across data, applications, systems, and personnel.

## **2. Analytics**

Employing data-driven processes and technology to inform resource prioritization and optimize scientific, administrative, and funding decisions.

## **3. Communications and Transparency**

Communicating the value, impact, and urgency of systems, processes, and policy in relationship to the NIEHS mission.

## **4. Foster Collaboration**

Enhancing systems and policies that support data and personnel accessibility and interconnection for diverse internal and external stakeholders.

## **5. Governance**

Implementing policies and procedures that inform and structure decision-making to enhance innovation and support compliance.

## **6. Optimize Resources**

Increasing value of systems, platforms, applications, and processes by promoting efficiency and cost savings.

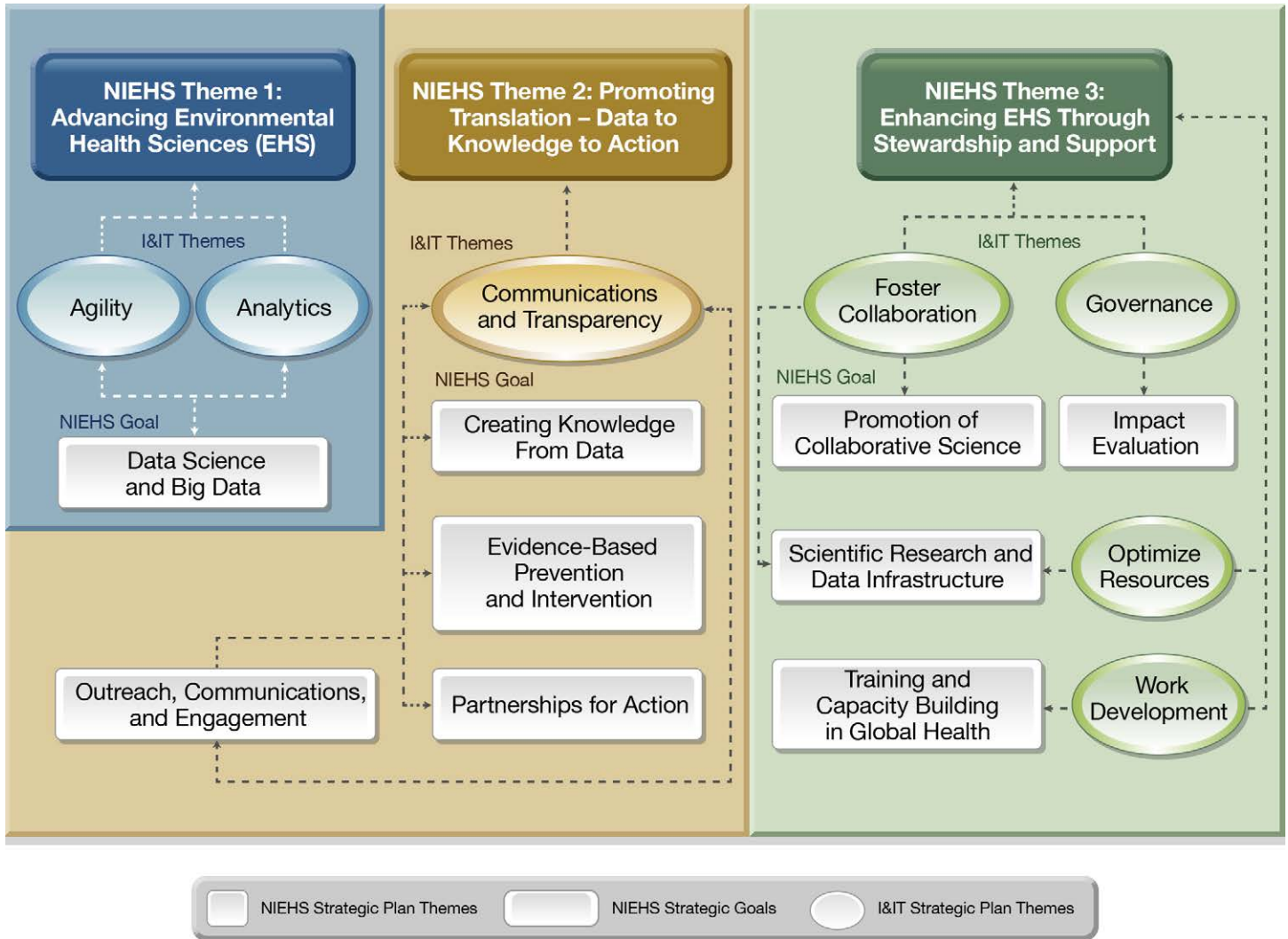
## **7. Workforce Development**

Improving personnel efficacy, innovation, and coordination by developing new and enhanced skills to guide effective and impactful decisions.

Across the capabilities and crosscutting themes, CLC, with input from the NIEHS community, will develop an integrated and prioritized implementation plan that includes translation into specific I&T projects. Project implementation will include identification and assignment of responsibility and accountability, and support prioritization of unmet staffing and funding requests, if applicable.



## NIEHS I&T Strategic Themes Support NIEHS Themes and Goals



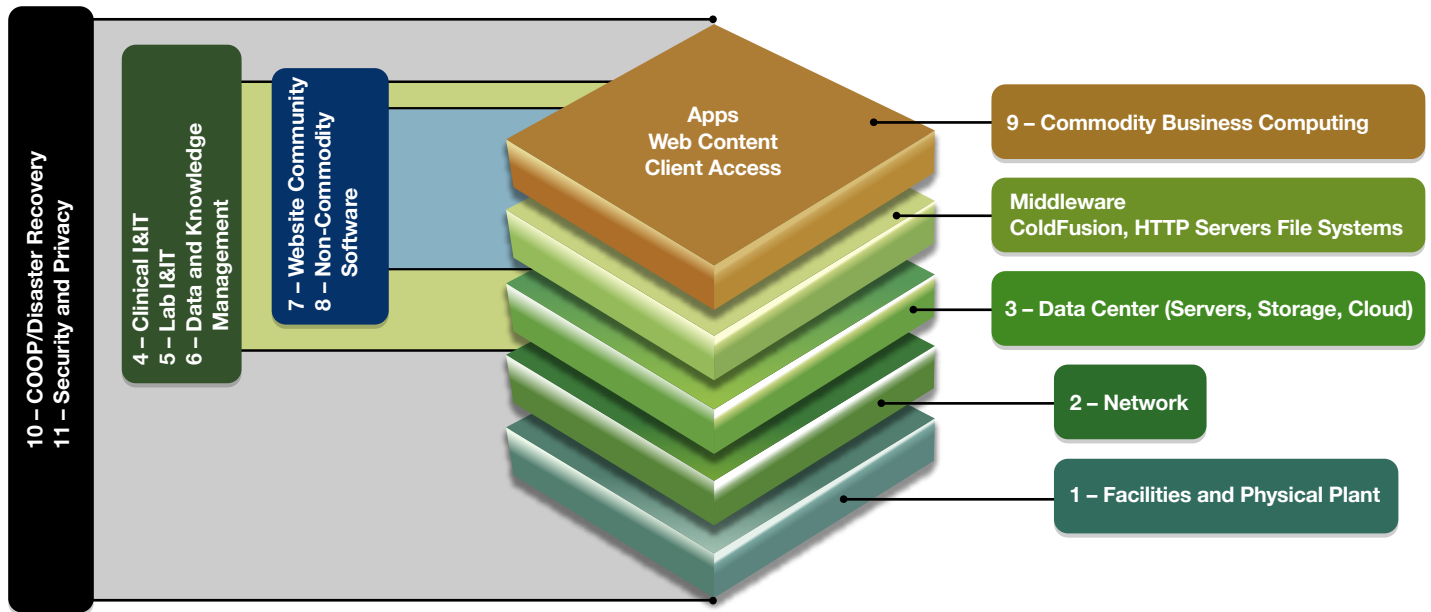
The I&T Roadmap aligns strategic themes and priorities to achieve a more robust and agile technological environment that effectively supports the NIEHS mission.

### 2019 – 2023 NIEHS Mission

The mission of the National Institute of Environmental Health Sciences is to discover how the environment affects people in order to promote healthier lives.

# I&T LANDSCAPE CATEGORIES

## I&T Landscapes Relationships and Dependencies



## Landscape Categories Overview

Landscape categories provide a framework for organizing the I&T environment. Individual Landscape category descriptions include a rationale with definitions and scope, key goals, and strategic capability priorities that will be translated into action.

Each strategic capability priority includes a description of what, why, how to measure, and current status.

## The Eleven NIEHS I&T Landscape Categories

### 1. Facilities and Physical Plant

NIEHS facilities and physical plant I&T will be a secure, highly reliable, flexible, and planned resource that meets scientific and administrative requirements.

### 2. Network

The NIEHS network will be a secure, highly reliable, highly scalable resource that supports diverse scientific and administrative operations. The Network will provide a consistent robust quality of service, while also providing ample throughput and speed and security for specialty scientific applications and systems.

### 3. Data Center (Servers, Storage, Cloud)

NIEHS data center infrastructure will support, foster, and enhance NIEHS scientific and administrative needs, while meeting federal requirements and mandates. Data center capability includes the primary data center, and associated communications closets and local redundant services locations.

#### **4. Clinical I&IT**

NIEHS clinical I&IT infrastructure and policy will support intramural clinical research needs, by integrating and coordinating resources with the National Institutes of Health (NIH) and other academic and federal institutions.

#### **5. Laboratory I&IT**

NIEHS laboratory I&IT infrastructure and policy will support, foster, and enhance science conducted by investigator-led and core scientific groups.

#### **6. Data and Knowledge Management**

NIEHS data and knowledge management (DKM) infrastructure and policies will support research and administrative goals, by ensuring data meets FAIR+ principles and by providing access to the business and scientific knowledge sources, tools, and expertise that enable scientific discovery and inform operational and programmatic decision-making processes.

#### **7. Website Communications**

NIEHS website communications will promote the use of established and emerging internet-based technologies to facilitate scientific collaboration and expand public health awareness. By using technology, the institute will communicate effectively with diverse audiences and disseminate research findings. Through these methods, research will aid in disease prevention, contribute to scientific discovery, and inform public opinion. NIEHS will also use these methods to improve internal effectiveness through improved communications. Metrics and analytics will be used to measure and improve website communications.

#### **8. Non-Commodity Software**

NIEHS non-commodity software will be a planned, maintainable, and cost-effective resource for meeting scientific, grant making, and administrative requirements.

#### **9. Commodity Business Computing**

The NIEHS commodity business computing strategy, policy, and implementation will support, foster, and enhance the scientific and administrative needs of its diverse intramural and extramural scientists and administrators.

#### **10. Continuity of Operations and Disaster Recovery**

Continuity of operations (COOP) and disaster recovery I&IT will provide NIEHS with the continuation of essential functions. The institute will identify the needed I&IT support architecture for essential functions and ensure that they can be continued throughout, or resumed rapidly after, a disruption of normal activities. I&IT continuity planning incorporates overall COOP and disaster recovery activities that ensure appropriate I&IT architecture is in place prior to an event.

#### **11. Security and Privacy**

The NIEHS I&IT security and privacy program will implement policy and develop infrastructure to protect data and technology systems while supporting collaborative science. It will be aligned with federal, U.S. Department of Health and Human Services (HHS), and NIH mandates, National Institute of Standards and Technology (NIST) standards, and industry best practices. The program will maintain security and privacy operations, support Information System Security Officer (ISSO) and Privacy Coordinator responsibilities, and enhance security and privacy risk management, internal auditing, and training.

# 1. FACILITIES AND PHYSICAL PLANT

## Rationale

Facilities, physical plant, and space for I&IT operations are critical for the maintenance of NIEHS I&IT systems and the availability and preservation of data. Electrical power, cooling and other climate controls, and associated components provide the foundation for system reliability and performance. Strategic and operational planning, provisioning, auditing and monitoring of facilities, physical plant, and space allocations are essential to ensure effective operations. Facilities dependencies and impacts will be coordinated with I&IT systems modernization, change, and risk management in alignment with NIEHS strategic plan goals.

## Goals

### Facilities Operational Security

- I&IT facilities systems will control and manage security and I&IT personnel access.
- I&IT facilities systems will be audited, monitored, and managed to ensure reliability, and provide data and metrics that support reporting compliance.

### Facilities Strategic Alignment

- I&IT facilities and physical plant modifications will be planned and communicated to all stakeholders, to create an engineered and sustainable I&IT ecosystem that is aligned with the institute's strategic plan goals.

### Facilities Transformation

- I&IT facilities and physical plant design and management will be agile and flexible, to accommodate changes in scientific and administrative I&IT requirements.

## Strategic Capability Priorities

### Data-Driven Data Center Environmental Management

FAC-01 NIEHS will implement and maintain a data-driven data center environmental management system, including electrical, air and temperature, fire protection, and physical access. Data center environmental management is essential for security, efficiency, and external audit compliance; and will be evaluated by enhanced utility and efficiency for systems managers and users. Supporting data and systems are currently incomplete.

### Software-Enhanced Facilities Management

FAC-02 NIEHS will have software-enhanced I&IT facilities systems management that promotes automation, supports reliability and flexibility, formalizes processes, and defines best practices and standard operating procedures (SOPs). Facilities systems management will enhance definitions of processes and best practices, improve collaboration, and help maintain standards; and will be evaluated by redundancy in workflows and systems, including electrical infrastructure. Status is heterogeneous with some systems operating effectively and with gaps in others.

## **I&IT Facilities Risk Tolerance and Management Planning**

FAC-03 NIEHS will implement risk tolerance and management-based planning that incorporates realized loads and maximizes uptime. Risk planning will foster improved risk management, minimize planned outages, improve reliability, and enable dynamic software managed infrastructure, including power. Risks will be categorized by probability and potential impact. Status of risk tolerance and management planning will be determined by measuring actual loads and uptimes.

## **I&IT Facilities Integrated Systems Automation**

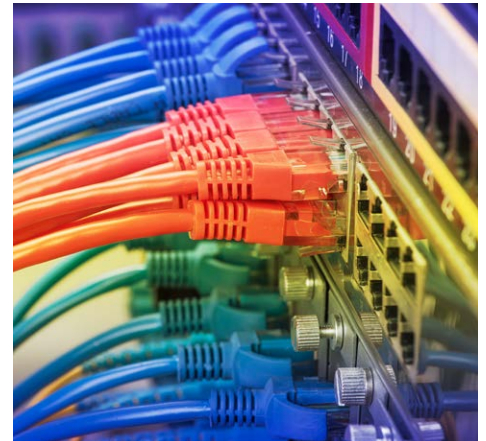
FAC-04 NIEHS will implement integrated systems-level automation that promotes and utilizes redundancy, and emphasizes alerting, reporting, and auditing. Integrated systems will improve communications and provide understanding of system-wide electronic footprints. Analyses of all current processes will determine appropriate automation and redundancy. Improved reporting and auditing metrics with reduced effort will be tracked.

## **Office of Research Facilities Engineering Standards and Material Requirements**

FAC-05 NIEHS will increase alignment of I&IT facilities and space-impacting practices to Office of Research Facilities (ORF) engineering standards and material requirements (ESMR) and other general NIH facilities guidelines. All I&IT facilities and spaces will be compliant with NIH ORF standards for compliance, safety, efficiency, and cost savings. Audits of I&IT facilities and spaces will support understanding of alignment, and continuous improvement will be measured. Current ORF manual alignment is heterogeneous.

## **Telecommunications and Structured Cabling Infrastructure Management**

FAC-06 NIEHS will enhance jurisdictional understanding and control of federally owned and leased telephone, computer and data, building automation control, and closed-circuit television cabling systems, if applicable. Four discrete, on-premises wiring infrastructures – distributed antenna system (DAS), NIH wireless network, I&IT network, and ORF facilities I&IT – and on-premises, vendor-owned equipment, are managed differently with different binding agreements. Improved communications, understanding, and integration of telecommunications and structured cabling jurisdictional controls will promote robustness, agility, and cost management. Enhanced integration of control will be determined by required level of effort for each network, as well as the overall system.



## **I&IT Facilities Lifecycle Modernization**

FAC-07 NIEHS will expand strategic planning for systems lifecycle and modernization, including planning for end-of-life capital replacement of I&IT facilities equipment. Facilities lifecycle planning will make systems modernization more proactive, enhance I&IT facilities integration, and help secure capital funding. Lifecycle planning will be evaluated through consistent capital management monitoring and decreased past end-of-life equipment risk. Current lifecycle planning is ineffective, with overreliance on unmet needs. The status is Red.

## I&IT Facilities Monitoring and Accountability

FAC-08 NIEHS will enhance security monitoring and integrity assurance, by expanding use of badge readers to promote individual accountability and support auditing and logging. Expanded use of in and out badge readers, logging, centralized management of in and out logs, and automation of logs will promote enhanced individual accountability and improve performance. Increased measurement of the number of personnel and visitors per day, as well as audits of manual logs, will be reported and improved accountability monitored. Badge reader use is currently heterogeneous with robust use in the data center and no availability in communications closets.

## Communications Closet Modernization

FAC-09 NIEHS communication closets will be modernized to accommodate I&IT facilities–approved spaces, including spaces needed for networks, systems hardware, and Voice over Internet Protocol (VoIP). The institute has a growing need for endpoint computing and power over ethernet that demands modernization of closets. Modernization will be measured by enhanced utility and compliance, as well as minimal impact on productivity during the upgrade process. Communications closets are currently critically undersized and out of date.

## DCOI/DCIM Reporting Alignment

FAC-10 NIEHS will enhance alignment to Data Center Optimization Initiative (DCOI)/Data Center Infrastructure Management (DCIM) reporting and compliance, including overall utilization metrics that are cognizant of data center consolidation risk. DCOI/DCIM alignment is critical for improved efficiency and to meet compliance mandates. Alignment will be measured using central metrics, including server utilization, achievement of 1.5 measurement of power usage effectiveness (PUE), power and performance monitors of I&IT systems, and reporting and auditing centralization as mandated by NIH and HHS. Current DCOI/DCIM metrics are heterogeneous with inefficient or insufficient reporting in critical areas.

## I&IT Space Planning

FAC-11 NIEHS will enhance I&IT space planning to support proactive flexibility, including dynamic support for staffing changes. Continuous periodic planning and assessment will improve short- and long-term space allocation, including support for staff changes that impact available space. Space planning will be evaluated by impacts to operations and maintenance staff, software developers, the number and location of CSPs, and the desire for certain staff to be co-located. I&IT space planning is improved but needs more rigorous and integrated governance.

## FACILITIES AND PHYSICAL PLANT THEME MAP:

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
Facilities and Physical Plant	FAC-03 FAC-06 FAC-07 FAC-09	FAC-03 FAC-06 FAC-07 FAC-09	FAC-08		FAC-05 FAC-10	FAC-02 FAC-11	

See Appendix A

## 2. NETWORK

### Rationale

The NIEHS network is made up of many subnetworks. NIEHS operates and controls most, but not all, network components on its campus. The network consists of interconnected devices that provide network access, system distribution, and data center core routing and connectivity for I&IT operations. NIEHS has six locally managed networks and one shared network. On the primary system, the institute hosts five networks, including:

1. **NIEHSnet** (the primary network): NIEHSnet is the general support system (GSS) and commodity network that provides day-to-day network access to the internet and all points in between for NIEHS personnel.
2. **FACnet** (the ORF facilities services network): FACnet is composed of virtual networks that support the Metasys (environmental controls) and Pegasys (physical security) systems. There are several ORF application services on FACnet.
3. **iVLAN or IVL** (a special segment that interconnects laboratory instruments): The instrument VLAN (iVLAN or IVL) is a virtual network that interconnects scientific devices with more I&IT security freedom than the primary network under NIH policy.
4. **SciNet** (a special segment that interconnects some devices to NIH): SciNet is a 10G fiber network used for high-speed data transfers to scientific storage (DDN) and Biowulf.
5. **Access Control VLAN** (a special segment that provides a security layer for new devices on the network): Sometimes called the dungeon, this network functions as an access control step. It functions as a limited access network used to isolate unauthorized users.

NIEHS networks also include two overlay networks referred to as DAS and Wireless. These networks include additional cables, switches, and routers.

- **DAS:** The interior cellphone signal distribution network allows for individual offices to receive cellphone signals from the primary providers. In 2018, DAS only carried Verizon signals. This limit has critical security and emergency response implications. NIEHS has more than 400 antennas on campus for DAS.
- **Wireless:** This additional network provides Wi-Fi or wireless computing network. This service is centralized with NIH, but distributed into NIEHS communications rooms. NIEHS sees the wireless network as NIEHS-Wireless and NIH-Guest-Network on devices. The institute modernized the network in 2018 to be compliant with the NIH network modernization project.

Additionally, NIEHS has five network enclaves. Network enclaves are virtual network zones that are logically separated for I&IT security. These networks are often referred to in discussions, but are not always fully delineated in technical layout. Institute enclaves include:

1. **Test:** An environment where application and system developers can create new applications and systems without potentially adversely affecting the commodity network.
2. **Development:** An environment where new systems and applications can be tested in a mock production environment.

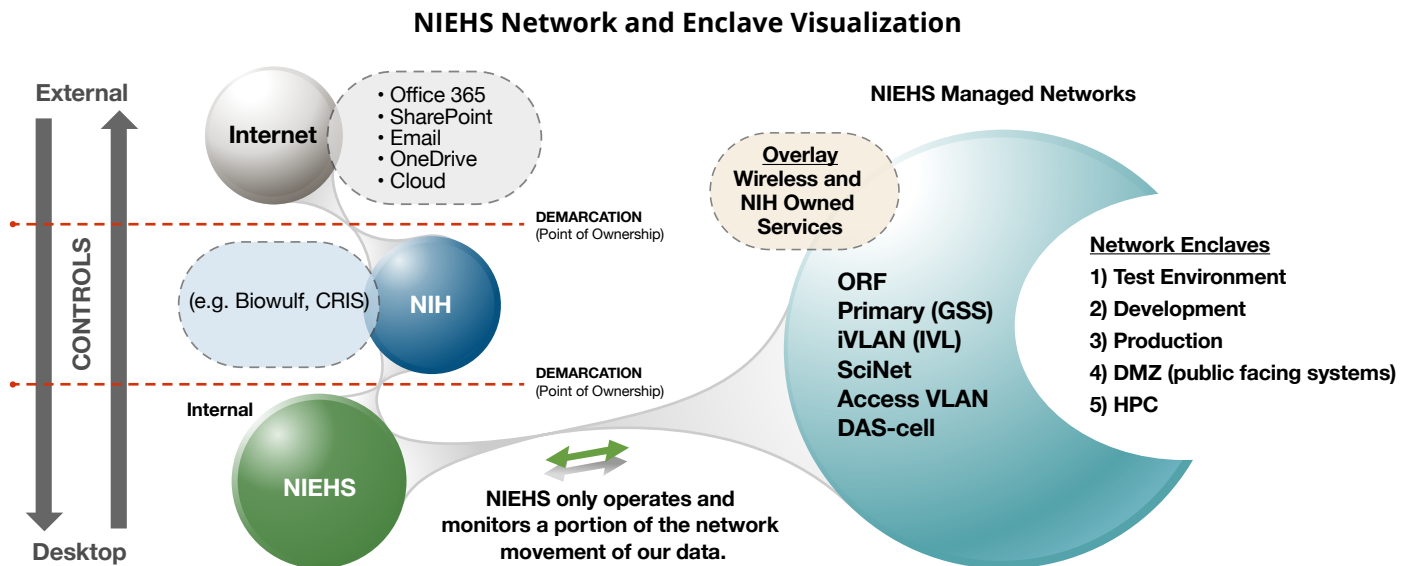
### 3. **Production:** NIEHS GSS and commodity network.

- 1) **Demilitarized Zone (DMZ):** An environment that is isolated, using security devices, from the commodity network and the internet. DMZ is the NIEHS safety buffer for public-facing systems and devices.
- 2) **High-Performance Computing (HPC):** NIEHS has isolated a section of the network directed at speed enhancement. The institute operates large and complex servers and storage HPC services.

There are additional descriptive protocols associated with network discussions and services. For example, the new Unified Communications system and its VoIP telephone services are carried by the network. Many network communication protocols are supported by the network. For example, the NIH Active Directory is a form of network communications that makes I&IT devices work. The network refers to many layers and components.

## NIEHS Network and Enclave Visualization

The network diagram provides a visual depiction of the complexity of NIEHS virtual networks and enclaves. It shows the ownership of networks, virtual network separation, and network classification. The demarcation marks the point where a network interfaces with the network owned by another entity.



## Goals

- Establish a highly flexible, robust, fast, and redundant network that enables the use of new technologies for the NIEHS scientific and administrative community, while employing user access-defined security to prevent breaches, meet HHS mandates, and reduce operational risk.
- Further mature operational enclaves that isolate systems, applications, and databases between NIEHS environments. Enclave definition will increase overall network efficiency and resiliency.
- Implement and respond to continuous monitoring to ensure availability, develop centralized metrics, support planning, and confirm compliance.
- Establish an effective process of network equipment lifecycle, while increasing network capability and reducing overall operational cost.



## Strategic Capability Priorities

### Network Access Control Deployment

NET-01 NIEHS operates a network access control (NAC) infrastructure that provides security and management controls. This technology is part of an NIH centralization project. NIEHS currently operates end-of-life hardware, so planning for this replacement technology is a priority. The strategy and implementation may require the NIH-required solution with a hybrid local solution. NIEHS purchased CISCO ISE technology in 2018, but also depends on an NIH project to deploy further Forescout technology. Collaborative teams are exploring institute options in the coming months. Success will involve compliant NIH technology working harmoniously with an NIEHS system that reports data to an asset management and security system. Components of this hybrid solution still need to be worked out with NIH.

### Network Monitoring Dashboard

NET-02 NIEHS will improve communications with the user community on the status of network operations. The current network dashboard is technical. The desired dashboard will allow all users to receive less technical, but more informative, information about the network as it is impacted. The desired outcome for this objective is an automated and web-enabled dashboard that fits diverse user needs. The project is yet to be prioritized.

### Improve Network Monitoring and Reporting

NET-03 NIEHS network performance monitoring is not yet mature. The continued improvement and maturity of the network monitoring capabilities is important to I&IT reliability and integrity. The current data center and server monitoring product, SolarWinds, will be used to monitor the network. The institute will improve and customize this monitoring tool to better support all users. Success measures will involve the creation of custom reports using the tool that monitors specific networks and protocols for performance and consistency, such as VoIP traffic reports, video traffic reports, and facilities network-specific reports. The work is yet to be prioritized.

### Optimizing Network Protocols

NET-04 The NIEHS network runs many services and protocols that provide communications for an array of applications. Certain protocols require more bandwidth and control over peak times of communications. Network systems have a quality control implementation called quality of service (QoS) that will be used if there are known gaps in current operations. The tracking, measurement, and reporting of these metrics is needed to determine if the institute requires QoS as a technical capability. NIEHS will add this tracking and reporting to its contracted reports. QoS recommendations will be made for the next one to three years. The project is yet to be prioritized.

### Adding Services to the Cellphone Network

NET-05 NIEHS operates and maintains a DAS for cellphone carriers. The DAS improves cellphone reception inside buildings where signals are not normally received. These connections are owned by the providers and the services must be formally arranged. Currently, Verizon is the only operational provider within Building 101. NIH carries all popular providers across the campus DAS, and NIEHS should do the same. The institute will increase its provider network by two carriers over the next two years. Provider expansion is limited by mandated legal agreement review.

## Improve Specialized Network Services

NET-06 NIEHS operates secure low-speed DSL network lines supporting several functions. Over time, the number of unrelated uses splitting this internet service has reduced performance. Currently, there are several specialized services using a single DSL line splitting performance for all users. There are several reasons to upgrade the DSL service to a faster connection. Services include on-campus contractors who need high-speed network services, but do not have badges for I&IT systems access; infrastructure services that have cloud-based maintenance monitoring, which are best hosted on a separate network (e.g. Distributed Antenna System); and external monitoring of NIEHS networks. NIEHS will improve network service speed and performance for these purposes by using technology that is faster than DSL for these alternative internet routes. With growth in end-point computing, NIEHS expects expanded needs in this area.

## Wireless Network Expansion

NET-07 NIEHS facilities teams require new wireless services in several campus buildings that do not have wireless service. The project is ORF-funded, and NIEHS is ready to provide new wireless access points when completed. The wireless network will then be added to the NIH wireless network. When the NIEHS facilities team has robust wireless services, the project will be completed. The acquisition is currently moving forward.



## IPv6 Planning With NIH

NET-08 The federal government is required to deploy native Internet Protocol version 6 (IPv6) network protocols to public-facing I&IT services. The new technology requires an internal network strategy and plan for transition. NIEHS will produce a documented plan that details the strategy and considers timing and options for this project. NIH has not required additional action, even though the prescribed timeline has passed.

## Develop Out-of-Band Network for I&IT Management

NET-09 NIEHS needs an out-of-band (OOB) network to improve the ability to operate and maintain the network. An OOB network will provide a separate connection to certain devices for direct management that does not depend on the operating systems of the primary network. OOB systems use a dedicated network that is up all the time. As an initial strategy, NIEHS will use retired lifecycle equipment to minimize OOB cost and complexity. An OOB network governing strategy will be generated. OOB planning has been initiated, but not prioritized.

### NETWORK THEME MAP:

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
<b>NETWORK</b>	NET-07 NET-08 NET-09	NET-01 NET-03 NET-04	NET-02	NET-05		NET-06	

See Appendix A

## 3. DATA CENTER (SERVERS, STORAGE, CLOUD)

### Rationale

The NIEHS data center serves a diverse group of intramural and extramural scientists and administrators. The center directly enables science and supports administrative functions that are critical to the NIEHS mission. Data center infrastructure includes an extensive and diverse set of components, as well as the underlying architecture that enables these technologies. The center is essential to generate, manage, and organize institute data. Standard operations, as well as risk and change management of the data center, are influenced by and impact NIEHS science.

### Goals

#### Provide Efficient and Reliable Data Center Operations for Customers

- Meet or surpass federal mandates and metrics for data center operations.
- Provide efficient lifecycle planning that minimizes risk and promotes innovation for data center infrastructure.

#### Manage Lifecycle of the Data Center Hardware

- Effectively manage server technologies, including planned hardware lifecycle.
- Select optimal technologies that support diverse NIEHS requirements.
- Provide secure and reliable centralized storage and proactively plan for storage growth.

#### Provide Core Technologies and Capabilities

- Provide the technologies to connect to and utilize cloud-based services securely, when advantageous.
- Provide the needed infrastructure and platforms to support diverse I&IT services.

#### Provide Security Across the Data Center Architecture

- Emphasize appropriate physical and information systems security principles, such as least privilege and segregation of duties within operational constructs to minimize risk.
- Provide robust systems and data backup services.
- Emphasize redundancy to optimize availability.



## Strategic Capability Priorities

### Maintain an Authorization to Operate From NIH for the NIEHS General Support System

DC-01 NIEHS will fulfill NIST 800-53 series requirements for certification and accreditations with NIH. The NIH Chief Information Security Officer (CISO) monitors compliance to federal IT policy and authorization. NIST guidance is required under federal mandates. The NIH CISO signed approval in 2018 for NIEHS GSS Authorization to Operate (ATO).

### Measure Power Efficiency in the Data Center

DC-02 NIEHS will actively provide automated PUE compliance measurements. The PUE measurement is a key component of the federal data center consolidation initiative. The existing compliance metric is 1.5 for existing data centers. NIEHS reports an average of 1.8, down from 2.3.

### Use and Maintain a Redundant Infrastructure Hub for Service Availability

DC-03 NIEHS will design a redundant architecture to ensure that viable options exist to maintain service availability. NIEHS will ensure multiple paths for communications when possible, such as with NIH connections. The institute will also improve the risk profile of this hub with enhanced environmental controls for HVAC and UPS systems; monitor the service performance for these connections and increase usage of redundant architecture; and continue to build to this objective with the F module facilities.

### Establish Physical Server Performance Monitoring in the Data Center

DC-04 NIEHS will prioritize automation for the measurement of server usage. Software tools will measure and report on physical server processor utilization. The federal data center consolidation initiative requirements mandate this metric. The metric for data centers like the institute one is greater than 65 percent average by formula during primary working hours. There are several related projects underway to evaluate and improve monitoring.

### Implement Hardware Lifecycle

DC-05 NIEHS will manage data center hardware to ensure it remains viable in terms of equipment age and mean time to failure. Hardware lifecycle minimizes risk and supports the most modern technology. The institute will monitor vendor mandated end-of-service and end-of-support dates. Two years of lifecycle replacements have helped with hardware modernization.

### Enable Cloud Technology Usage With Network Speed

DC-06 To support cloud-hosted technologies, NIEHS will provide fast connections to NIH and the internet. Connection speed enhances user experience and increases likelihood of operational success. NIEHS will monitor the two 10G connections to NIH, along with the associated connectivity for those connections. A proof of concept is completed and available at <https://traffic.niehs.nih.gov/NetworkDashboard.html>. The status is Green.



### **Use Cloud Platforms When Practical**

DC-07 NIEHS will explore Platform as a Service (PaaS) as a viable option when evaluating I&IT solutions. The cloud-first objective is a federal priority. Project teams will include evaluation of cloud PaaS solutions early in their evaluation plans. Two cloud pilots have been completed.

### **Leverage NIH Services When Beneficial**

DC-08 NIEHS will include NIH services in the analysis of optimal I&IT solutions. The diverse institute scientific and administrative community requires the best technology choices, and NIH offers many services now. When appropriate, NIEHS will make greater use of NIH services, such as the Biowulf cluster and cloud offerings, and will monitor user satisfaction when NIH services are used. NIEHS currently uses Biowulf and some cloud systems, but will expand usage.

### **Select the Optimal Technology Solutions**

DC-09 NIEHS will include robust analysis of technology options as part of project management baselines. The institute will evaluate available technologies to ensure the most advantageous choices. Providing this robust analysis aligns with FITARA requirements. Recent initiatives for moving desktop products and email to the cloud have been completed, and other technologies will follow.



### **Provide I&IT Operations Capability That Supports All Mission Domains**

DC-10 NIEHS will provide robust and efficient operations and maintenance support for servers and storage to meet mission requirements. The data center will host servers and storage that meet the needs of the scientific and administrative operations. The institute will maintain 99 percent availability for these I&IT services. NIEHS currently uses NetApp and DDN storage and backup technologies that provide group shares, scientific storage, and primary data locations for all users, along with more than 300 servers that support diverse needs.

### **Ensure Storage Has Appropriate Backups**

DC-11 NIEHS will ensure a quality data backup posture, including adequate disaster recovery for primary storage. Backups are required in case of outages and emergencies that impact data availability, integrity, and operations. Primary operations for data storage will report monthly on backup quality. Backup systems exist, but improvement is needed.

### **Maximize Virtual Server Technology for Efficiencies**

DC-12 NIEHS will utilize modern technology to maximize virtualization, which supports many advantages in server and data center management. It saves hardware and power, as well as enhances portability. The institute currently uses VMWare, which offers robust performance reporting. The institute will conduct a review of this service and document needed actions. The metric from the federal mandates for virtualization is a ratio greater than 4.0 to physical servers. The current ratio in the data center is 3.0.



**Upgrade Server Technology in the Data Center**

DC-13 NIEHS will prioritize continuous improvement in data center server technology. The institute will support and enhance diverse scientific needs with better graphics processor units and more powerful server processing; and invest in blade technologies to meet server technology objectives. Providing these improvements will improve power and space efficiency. These technology improvements will directly enhance the scientific user experience for data center services. NIEHS has significant hardware procurements moving forward.



**Manage the Security Principle of Least Privilege to Minimize Risk**

DC-14 NIEHS will design facilities and logical access with the concept of least privilege. To ensure I&IT integrity, these controls will be continuously improved. A proposed project to improve communications closets in scientific areas will support this objective. Accountable access will be monitored in the centralized logging tools and reports generated for the ISSO. The institute has active initiatives to improve.

**DATA CENTER THEME MAP:**

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
DATA CENTER	DC-10	DC-02 DC-04 DC-11 DC-12			DC-01	DC-03 DC-05 DC-06 DC-07 DC-08 DC-09 DC-13 DC-14	

See Appendix A

## 4. CLINICAL I&IT

### Rationale

Clinical and translational research is an integral part of environmental health science, whereby scientific insights are gained by evaluating human subjects, and findings are converted into human health gains. NIEHS has entered a new era of clinical research that is aided by the advent of big data, electronic health and clinical research records, increased capacity for monitoring, real-life biological and exposure assessments, and precision and personalized medicine approaches. I&IT systems are integral to all these processes. However, several I&IT-specific challenges have also been introduced along with these research capabilities, including privacy; encryption; safety; integration and cross-communication between disparate databases; big data storage and analysis capacities; accessibility across institutes and among NIH intramural and extramural institutions; and electronic interactions among investigators and with study subjects (electronic consenting, real-time data entry, web-based questionnaires and data forms, telemedicine, etc.). The goal for clinical research data also includes governing principles that foster FAIR+ and machine and algorithm readable models.

### Goals

#### **Integrate Clinical Databases and Repositories Among Clinical Research Branch (CRB), NIEHS, and Other NIH Institutes and Centers, and Between CRB and Extramural Institutions**

- Large clinical databases and specimen repositories in the NIH Clinical Center (CC), NIEHS Clinical Research Unit (CRU), and other collaborating facilities exist, but their searchability and interoperative use are hampered by the inability to integrate data and samples in a user-friendly and efficient way.
- Clinical I&IT will enable integration of high-priority databases and repositories, and assist in the planning of prospective database and repository logistics and storage, to enable better access, interoperability, and integration.

#### **Provide Secure Interfaces Among Clinical Investigators and Study Subjects, and Enhance Study Recruitment**

- CRB investigators are located primarily in the CRU in Research Triangle Park, North Carolina, and in the CC in Bethesda, Maryland. However, they collaborate with many other researchers around the world, to assess and enroll subjects into studies from many different locations. These diverse locations make secure, real-time, high-resolution, audiovisual communications among clinical researchers, and among clinical staff and subjects, a critical need that is difficult to achieve with the current infrastructure.
- The public is increasingly familiar with electronic formats of communication and interface on multiple devices. These are often the preferred method of interaction, and aid subject recruitment and retention.
- Electronic remote interfaces among clinical researchers, and among investigators and study subjects, is a cost-effective, resource-sparing, and versatile addition to paper-based, on-site interactions.



- Subject recruiting for clinical studies is mostly a passive and inefficient process. Social media and other novel approaches have the potential to allow for more active, directed, and effective ways to connect subjects with appropriate studies.
- Clinical I&IT will address communications, data, technology, and privacy and security challenges that need to be overcome to enable seamless, real-time audiovisual interactions among clinical researchers, as well as between researchers and subjects in multiple locations, to allow the efficient recruiting, assessment, and enrollment of subjects remotely.
- The NIEHS Freedom of Information Act (FOIA) and Privacy Office will work closely with I&IT providers to ensure that existing measures for collecting, maintaining, and sharing personally identifiable information (PII) for all human research study participants are sufficient and in accordance with NIH and NIEHS requirements, including, but not limited to, Privacy Impact Assessments, Office of Management and Budget [OMB] clearance, and records management requirements.

### **Enable Big Data Storage, Analysis, and Backup**

- Hypothesis-generating and testing clinical research projects increasingly rely on the analysis of large data sets from electronic, multiomics (e.g., genome, metabolome, microbiome, exposome, etc.) or phenotypic sources (e.g., electronic health records, U.S. Environmental Protection Agency [EPA] pollution monitors, laboratory assessments, imaging data, wearable personal health monitors, etc.).
- NIEHS will develop the capability to store, organize, analyze, and back up large clinical data sets, including environmental and genomic information on Environmental Polymorphism Registry (EPR) participants, as well as other principal investigator-generated projects.

### **Support I&IT Alignment and Infrastructure Lifecycle Support, as Well as Security, Access, and Reusability of Data**

- Clinical data and metadata infrastructure and policy will ensure I&IT alignment and infrastructure lifecycle support, data accessibility, security, integrity, and provenance, as well as support and foster FAIR+ data principles.

## **Strategic Capability Priorities**

### **Develop Coordinated Architecture and Development Plans for Addressing Strategic Capability Priorities and Resource the Implementation of the Clinical I&IT Plan**

CLIN-01 Strategic Clinical I&IT goals and priorities represent significant development and deployment efforts. If these are done separately, the institute risks inefficiencies and misaligned architectures. NIEHS will develop an overarching architecture for both systems and software development, and to resource the development and ongoing operations of the plan. Success will be defined by establishment of an architecture that has full support from I&IT areas, and by implementation of the planned systems in user-friendly and reliable ways.

### **Develop, Plan, and Implement an Approach for Managing EPR and Other CRB Genomic Data**

CLIN-02 The planned sequencing of the EPR and other CRB cohorts will provide a significant and important research data set. To make use of the genomic data, plans for managing the data, including curation, archiving, moving, storage, and processing, will be generated and implemented. Success will be defined by the ability to search for and identify genetic associations with high-priority phenotypes.



### **Integrate CRB, NIEHS, and Trans-NIH Clinical and Genomics Data Sets and Repositories**

CLIN-03 Many databases (e.g., CTDB, Clinical Conductor, GDC, CRIS, BTRIS, PAX, REDCap, BSI, EPR, dbGaP, EAG, SSS systems, etc.), other sources of clinical information (CRU and CC clinic notes, discharge summaries, etc.), and clinical specimen repositories are used by the CRB, but there is no current capability to search these systematically, create interactive databases from this information, or integrate databases across these platforms. Also, this limitation does not allow researchers to know what NIH resources are currently available for possible clinical studies, thus limiting the capability to assess data across platforms, and results in redundancy of efforts. Multiple datasets also contain, at least in part, the same information, which necessitates multiple redundant entries or access points. This multiplies the cost and potential for significant errors in PII and other data entry and analyses. Success will be defined by the number of high-priority use cases, including operational (e.g., reducing data entry) and scientific, that are addressed in a user-friendly and functional way, after integrating and linking databases and repositories.

### **Integrate CRB and Extramural Clinical, Environmental, and Genomics Data Sets and Repositories**

CLIN-04 The ability to search, access, and utilize electronic health records, environmental, geospatial, other medical and research data; and sample repositories in existing online databases and collaborating institutions, will exponentially increase the research capacity of the CRB, and is becoming the state of the art for clinical research. Novel methods can also translate historic written clinical notes and summaries into useable databases. Currently, there is no such ability for these functions in CRB. Success will be defined by the number of high-priority use cases, including operational (e.g., reducing data entry) and scientific, that are addressed in a user-friendly and functional way, after integrating and linking databases and repositories.

### **Establish Reliable Secure Interfaces With Research Investigators**

CLIN-05 The CRB will have highly reliable, real-time, high-resolution, secure audiovisual interfaces with other collaborating clinicians, researchers, and staff across the U.S. and ideally around the world. This includes the capacity to share clinical and research information from medical institutions on subjects, including databases, slide sets, clinical and radiographic images, and videos. Some capability now exists, but it is often unreliable and of limited capability. Success will be defined by the number of goals that are achieved with multiple collaborators in a user-friendly and fully reliable system.

### **Establish Reliable Secure Interfaces With CRB Research Subjects**

CLIN-06 The CRB will have the ability to maintain and use systems that interface with research subjects remotely, securely, and confidentially. This includes modalities, such as uploading and downloading of subject-supplied medical records and high-resolution images; electronic consenting; patient access to, and completion of, electronic questionnaires and secure data entry sites; and ability to use smart device apps for monitoring and data entry over time. Success will be defined by the number of effective user-friendly interfaces with subjects' data (e.g., medical record access, electronic consenting, secure access, and ability to complete questionnaires and study websites, etc.).



### Establish Telemedicine Capabilities

CLIN-07 The ability for health care personnel to reliably interact with remote subjects in real time and at high resolution by audiovisual means is crucial to the evolution of CRB to the worldwide scope of the institute’s planned research. This is also increasingly the accepted state-of-the-art mode in research and medicine, and is expected to substantially expand research capacity, while curtailing costs (e.g., travel, space, etc.). Some capabilities for limited interactions between the CRU and the CC have been recently established, but these are not as reliable, user friendly, or expansive as desired. Success will be defined by the ability to develop user-friendly, reliable, seamless, secure, encrypted, confidential interactions with subjects at home and in multiple collaborating medical facilities.

### Develop Stable CRB Support Systems Alignment and Infrastructure Lifecycle

CLIN-08 Alignment of the network, data center, and other systems to diverse and domain-specific clinical I&IT needs, including legacy systems, emphasizing usability, agility, and flexibility, is required. Clinical research hardware and software pose specialized security and reliability needs. For example, the Omnicell medical cabinet cannot afford to fail, because it would block access to medications and must be secure to protect sensitive patient data. CRB local area networks and computers have access to sensitive PII and must have additional security. New high-priority clinical care and research devices will be incorporated into these networks and provided with appropriate I&IT support. Success will be defined by user satisfaction of support systems alignment and the percentage of lifecycle-compatible I&IT equipment in the CRB.

### Enhance Recruitment of Subjects for Clinical Studies

CLIN-09 A major roadblock to the successful and timely completion of clinical studies is identifying and enrolling adequate numbers of appropriate subjects. Subject recruiting for clinical studies is currently a passive and generally inefficient process. Social media and other novel approaches, such as ResearchMatch, will allow for more directed and effective ways to connect subjects with appropriate studies. Success will be defined by increased numbers of subjects enrolled per protocol and more rapid completion of clinical studies.

### Enhance Systems That Promote Software Developers Building Data Sharing and Interoperability Services Into Clinical Projects

CLIN-10 NIEHS sponsors the development of diverse independent software applications and databases that host and generate data and metadata to fit variable clinical needs. The institute further supports modifications and enhancements to existing applications and databases. To promote data sharing and interoperability, NIEHS will work across the entire development lifecycle to define and build services that enable effective data search and access. NIEHS clinical software and database development efforts will include requirements for data interoperability and portability, and integration services. Projects will provide metadata visibility across scientific and clinical fields, to allow monitoring of data sharing opportunities. Success will be measured by the number of development efforts that include systems for effective clinical data and metadata sharing and integration.

### CLINICAL/CRU I&IT THEME MAP:

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
Clinical/CRU I&IT	CLIN-10	CLIN-02		CLIN-03 CLIN-04 CLIN-05 CLIN-06 CLIN-07	CLIN-01 CLIN-08	CLIN-09	

See Appendix A

## 5. LABORATORY I&T

### Rationale

Laboratory I&T is an integral component of science, and its infrastructure and policy impacts experimental, in silico, and clinical practice. I&T systems compose, manage, and coordinate laboratory instrumentation, as well as laboratory processes. I&T is also essential to generate, manage, and organize raw and derived data, as well as metadata that is critical for experimental reproducibility, research collaboration, and scientific innovation. Goals for laboratory data and metadata include robust backup and integrity, and governing principles that foster FAIR+ models. I&T systems

frequently have extended lifecycles, which demand legacy systems support. This delayed end of life impacts risk and change management policy and implementation, and demands robust asset management systems.



### Goals

#### Support Diverse Lab I&T Needs

- Scientific needs, demands, and innovation will drive laboratory I&T policy and implementation.
- Laboratory I&T systems and policy will support diverse NIEHS scientific needs, including heterogeneous infrastructure and data systems that support scientific innovation, productivity, and cross-platform integration.
- Laboratory I&T will support the scientific computing, instrumentation, and data needs of researchers separate from standard desktop support models.

#### Fit With I&T Ecosystem

- I&T, infrastructure, and other support providers will communicate and collaborate with scientific stakeholders across laboratory I&T project planning and systems implementation.
- Laboratory I&T systems will respond to, and integrate, scientific needs, including planning across I&T security, the network, local and remote hardware, and software layers, to minimize system and maintenance costs and ensure that I&T staff can deliver timely support. Agile support will be based on scientific needs.
- Laboratory I&T hardware, software, and integrated change and risk management will inform lifecycle planning, including end of life. Design and policy will accommodate legacy infrastructure.

#### Optimize Laboratory Data Practices

- Laboratory I&T data infrastructure and policy will ensure data accessibility, security, integrity, and provenance, and support and foster FAIR+ data principles.

## Strategic Capability Priorities

### Laboratory I&IT Support Systems Alignment

LAB-01 NIEHS will improve alignment of the network, data center, and other systems to diverse and domain-specific laboratory I&IT needs, including legacy systems, emphasizing usability, agility, and flexibility. I&IT instruments and systems depend on a well-designed and highly functional ecosystem. Scientific user satisfaction of support systems alignment will be evaluated. Status of current alignment is significantly heterogeneous, ranging from excellent to only partially existent.

### Laboratory I&IT Facilities Alignment

LAB-02 NIEHS will enhance laboratory I&IT alignment and integration with laboratory facilities and space planning, renovation, and design. I&IT and laboratory space planning will be integrated under 360-degree understanding models. Strategic alignment of I&IT systems across lab space planning will ensure improved flexibility and effectiveness. I&IT and space alignment will be measured by scientific user acceptance and satisfaction, as well as cost-benefit optimization. Currently, NIEHS has little centralized understanding of the alignment of laboratory I&IT and laboratory space.

### Laboratory Equipment Lifecycle

LAB-03 NIEHS will enhance support and responsiveness, proactive risk, and change management for laboratory instruments. Scientific instruments are increasingly computer-dependent and are at risk from changes to industry and technology practices, as well as government compliance mandates (operating system obsolescence, network security requirements, FITARA compliance). Ensuring continuity of scientific equipment functions is essential to laboratory operations and NIEHS strategic plan goals. Essential steps include strategic capacity planning and central determination, and management of costs, liabilities, and risks, as currently scientists and scientific management have little concept of the financial liability associated with obsolescence of systems running scientific instruments. Assessment will include an estimate of the institutional and individual laboratory cost of replacing or updating computer systems. NIEHS is insufficiently aware of these issues and is just beginning to work with lab staff to estimate scope. Significant effort remains.

### Laboratory I&IT Asset Management

LAB-04 NIEHS will develop, deploy, and manage laboratory hardware and software asset management systems and associated infrastructure. Laboratory asset management systems will be aligned with enterprise asset management systems and include understanding of physical and logical relatedness and dependencies. Asset management is essential for I&IT support staff allocation, lifecycle planning, I&IT security management, and centralized auditing and reporting compliance. Asset management systems will be evaluated by improved I&IT support and scientific user efficiency and efficacy. Centralized laboratory asset management is currently operating under different systems that are not integrated and do not report consistent information. NIEHS has no current authoritative asset understanding.

### **Laboratory I&IT Support Optimization**

LAB-05 Laboratory I&IT support staff will be optimized, including distributed domain expertise and incentivized retention. Proactive engagement, including I&IT wellness understanding will enhance support. I&IT needs must be understood and managed under different models than enterprise commodity I&IT. Domain expert I&IT support staff are critical for effective laboratory operations. Diverse experimental systems, instruments, and data needs are optimally supported under a collaborative expert support model. Staff support optimization will be assessed by scientific user satisfaction, in addition to standard quantitative metrics. A designated laboratory I&IT support staff system has been implemented. I&IT support delivery quality is heterogeneous, depending heavily on provider experience and training.

### **Laboratory I&IT Data Backup**

LAB-06 Laboratory data backup and storage infrastructure will be aligned with laboratory I&IT practices and I&IT security and compliance mandates. Data backup practices will be enhanced, including systems modernization and scientific user training. Data backup will be auditable, and includes enhanced reporting of backup status, scientific user training, and backup wellness checks. Data backup strategies will be multifaceted, including system disaster mitigation and user error prevention. I&IT support staff will routinely inspect instrumentation for backup status. Laboratory data integrity is essential and integral to the scientific process. Backup systems and process status will be evaluated, by diminishing realized data loss and recovery efforts. Backup systems are currently technically robust but rely on user compliance with best practices. User training and wellness evaluations must be enhanced.

### **Laboratory I&IT Technology 360-Degree Training**

LAB-07 NIEHS will implement 360-degree training for laboratory I&IT support staff and the scientific community. Expanded opportunities will be provided for relevant scientific domain-specific training for I&IT support staff, and technology training for scientists. Diverse cross-training will enhance I&IT support and improve scientific best practices. Training efficacy will be evaluated by quantitative surveys and trainee satisfaction. Training will be prioritized by cost-benefit analyses. Current cross-training opportunities are heterogeneous, but limited. Communication of existing training opportunities will be expanded.



### **Laboratory I&IT Analytics Training**

LAB-08 NIEHS will enhance and expand laboratory data analytic methods training, as well as improve coordination with other groups providing training, including NIH. NIEHS-wide development methods and best practice training, including a recommended common framework(s), is critical (software engineering). Enhanced lab data analytic training is needed to provide researchers with specialized knowledge and skills to make the most of scientific data, and to foster effective and appropriate I&IT support of research. End user satisfaction will be measured by post-training surveys, program evaluation by divisional representatives, acceptance of best practices, standardization, and institution-wide coordination of development approaches. Training is currently heterogeneous and primarily ad hoc.

## Improve Commercial Scientific Software Program

LAB-09 NIEHS will continue improvement of the commercial scientific software program, by modernizing titles and expanding scientist access to the software suite. Open source alternatives will be emphasized as appropriate. Training opportunities, improved communications, and fostering communities of practice will be enhanced. The increasing complexity of biomedical and environmental health science research data requires that scientists in all divisions have access to a wide range of scientific software tools, including commercial software to conduct critical research, as well as manage and interpret data. Total cost of ownership, specific use, and scientific user satisfaction will be evaluated.

## Laboratory I&T Data Practices

LAB-10 NIEHS will standardize laboratory I&T metadata terms to ensure that appropriate experimental data sets can be readily interpreted, shared, and integrated (FAIR+) where applicable, particularly in core labs. A metadata catalog(s) that will serve as a central reference source for these terms will be implemented. Infrastructure supporting enhanced data sharing and interpretation will improve institute science by expanding data utility. Implementation will be initially evaluated on selected systems and then expanded based on user adoption and continuous feedback. Although some labs and cores are using standard metadata fields, NIEHS has inconsistencies in adoption of standard metadata terms within and across labs. Active collaborative support and intervention will be critical for success. .

## LIMS Implementation

LAB-11 NIEHS will expand and integrate Laboratory Information Management Systems (LIMS) for core Labs with an application programming interface(s) (API). Scientists, including core staff, will optimize time and effort spent on understanding, tracking, and reporting data. Enhanced data analytics, process optimization, and business logic will improve core efficiency, improve core resource allocation, ensure metadata retention, and enhance core accountability, transparency, and governance. Commercial LIMS supports diverse functions with differential utility and the institute is just getting started in LIMS implementation. NIEHS is lacking broader infrastructure, including granular sample tracking, barcoding, and label printing. LIMS implementation success will be evaluated by adoption and user satisfaction. For several cores, NIEHS has a reasonable understanding of differential requirements and how available tools can be applied before venturing into custom development.

## Electronic Laboratory Notebook Implementation

LAB-12 NIEHS will implement user-friendly electronic laboratory notebooks (ELNs) that are integrated with other hardware and data resources. ELN adoption by individual researchers will improve data management and search, enable direct incorporation of instrument-generated data, improve metadata accuracy, and maximize data and metadata retention. Scientific user acceptance and satisfaction will drive ELN adoption, inform practices, and help determine status. NIEHS has not yet begun implementing ELNs, including market research and needs analysis that will align ELN implementation with institute needs.

## LABORATORY I&T THEME MAP:

I&T Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
Laboratory I&T	LAB-02 LAB-03		LAB-09	LAB-10 LAB-12	LAB-06	LAB-01 LAB-04 LAB-11	LAB-05 LAB-07 LAB-08

See Appendix A

## 6. DATA AND KNOWLEDGE MANAGEMENT (DKM)

### Rationale

Data and knowledge management (DKM) systems collect, manage, and provide controlled access to data and knowledge resources. These systems may also provide critical analytical and visualization capabilities to support research and decision processes. Data within the DKM may be at any stage of its lifecycle.

The ability to effectively curate, combine, and use scientific and operational data and knowledge resources (e.g., research data sets, databases, knowledge bases, content management systems [CMS]) is integral to the goals of each NIEHS division. The goals vary across the institute, including enabling data-driven scientific discovery, informing health policies and funding decisions, and informing business operations. The ability to use data- and knowledge-driven approaches is increasingly providing competitive advantage for researchers and is necessary for informed and defensible decision-making. Further, data- and knowledge-driven approaches are integral to fulfilling the NIH mandate for scientific rigor and transparency in the biomedical sciences.

The ability to use interoperable terminologies and semantics between systems is a critical requirement to bring together and make effective use of disparate data and knowledge resources. Unfortunately, DKM systems, whether they are commercial off-the-shelf tools or in-house developed tools, can be costly to acquire, develop, and customize, as well as maintain. The rapid pace in data and knowledge generation, and evolution of DKM solutions, is a stressor for planning, budgets, and staff resources. Investments in DKM infrastructure, expertise, and policies will balance costs, meet central needs, support innovation, and enable users in the scientific and business stakeholder communities.

The scope of DKM includes:

- Content comprising structured or unstructured data, and information owned or managed by NIEHS (directly or via contract) or other data that is publicly available.
- Technologies that directly relate to the creation, management, maintenance, and use of NIEHS data and knowledge assets. This includes commercial, externally procured, and internally developed databases and knowledge bases.
- Products that are acquired or created for collecting and using data to inform scientific discovery, or decision support for environmental health policies.
- Tools or systems used in, or necessary for, production, enterprise management, operational-level activities (e.g., CMS, search engine, storage management system, and others).

Although DKM overlaps with all other landscape areas, including laboratory, clinical, security and privacy, commodity business computing, non-commodity software, and website communications, the focus of I&IT is to ensure NIEHS has a unified approach to meeting DKM needs. The overlap is often use-case specific, but a general rule is that systems producing or consuming data or knowledge for other independent systems are part of the DKM infrastructure.



## Goals

### **Ensure NIEHS-Generated Research Data Meets NIH and NIEHS Policies and FAIR+ Principles for Data Quality, Management, Lifecycle, Security, Access, Discovery, and Sharing**

- NIEHS research data, whether generated by intramural or extramural, should be prioritized to comply with FAIR+ principles.
- However, FAIR+ principles do not specifically call for data to be made computable — that is, available in a form that fosters semi-automated and automated search, access, and usage by computer programs. This ability is increasingly critical given the rise in data volume and automated and semi-automated data processes, mining, and analysis tools. Therefore, NIEHS will help lead in making research data computable (i.e., FAIR+).
- The implementation of FAIR+ principles, and how they overlap with research data management practices (e.g., capture of data provenance) and federal records retention requirements has not been worked out. The institute will work with NIH in defining and implementing relevant policies and best practices, especially regarding data of priority to NIEHS.

### **Adopt an Interoperable Set of Metadata, Terminologies, Vocabularies, and Data Exchange Protocols That Facilitate Data Integration Across Identified Data and Knowledge Management Systems**

- Integration of data and summarized knowledge is increasingly valuable for research. However, the cost is high, as integration requires ongoing maintenance. In addition, the number of data sets and DKMs to map between can scale proportionally, if standards that facilitate integration are not planned for and adopted.
- NIEHS will limit integration costs using several strategies. First, prioritizing the adoption of data standards for highly valuable data sets and DKMs. Second, educating and training data producers on data curation practices and providing resources to aid data producers in adopting standards. Third, championing and advancing new and existing methods for linking datasets.
- Efforts exist to advance standards and practices to improve integration, both within NIH and externally (e.g., Research Data Alliance, Global Alliance for Genomics and Health). Partnerships and collaborations with these efforts will aid in promoting environmental health data integration standards and practices.

### **Provide Data and Knowledge Management Systems and Services That Enable and Promote a Growing Collection of Tools and Capabilities for Data- and Knowledge-Driven Research and Decision Support**

- The continued growth in data and knowledge sources, coupled with the growth in realistic biomedical and population-level computer models, are improving the way research discoveries and policy decisions are made.
- However, accessing data, knowledge, and models for data exploration, hypothesis testing, advanced analytics, and machine learning purposes is often a challenging and tedious task. These efforts are often duplicated needlessly across separate efforts and lead to increased percentage of time lost due to data cleaning and wrangling.



- NIEHS I&T will accelerate the development and adoption of data- and knowledge-driven methods among all staff, by coordinating and supporting the development and usage of core data and knowledge systems (e.g., databases, metadata catalogs, software libraries), services (e.g., application programming interfaces [APIs]), data sets (e.g., for training artificial intelligence algorithms), and software libraries.
- I&T will further ensure DKM capabilities meet policies around lifecycle, data standards, security, cost efficiencies, and federal regulations, while supporting best practices that foster innovation and best-of-breed solutions.

### Align NIEHS Data and Knowledge Management Systems With Select External Efforts

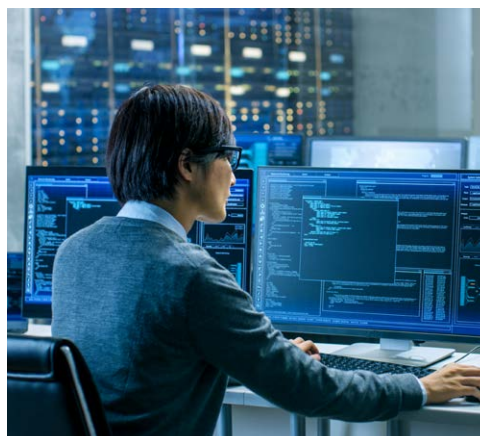
- There are multiple efforts to manage, aggregate, and provide DKM systems and tools for accessing and analyzing biomedical and population-level health data, both within and external to NIH (e.g., National Cancer Institute [NCI] Commons, NIH Data Commons, All of Us cohort). Many of these efforts are making use of public clouds as supporting infrastructure. In aligning with and making use of these efforts, NIEHS will advance use of data standards that promote interoperability and reduce duplication of costly DKM capabilities.



- Multiple challenges exist in aligning with external systems, including technical challenges in interfacing with external systems (e.g., moving data securely between sites, authenticating with external DKM systems) and challenges in adopting evolving standards used by external partners, in addition to the challenge of funding and staffing such efforts (especially where cloud technologies are in use).
- NIEHS I&T will facilitate alignment by engaging with external efforts to prioritize external systems to work with, advocate around NIEHS needs, and build tools and services to minimize technical challenges in using external systems.

### Cultivate a Data Science–Oriented Workforce

- Data- and knowledge-driven approaches (e.g., deep learning for training classifiers, use of vocabularies for enrichment) represent a foundational method of conducting research (in addition to empirical, theoretical, and computational approaches). Increasing training of staff and researchers in data science methods will increase the use and effectiveness of such approaches and reduce the burden on centralized I&T for developing DKM-related tools and services.
- NIEHS I&T will facilitate training of data science researchers and staff, both intramural and extramural, by helping identify gaps in training, providing training sessions, promoting a community of data science, and providing infrastructure (e.g., servers, installed software, training data sets) for development of skills.



## Strategic Capability Priorities

### Convene a Standing Data Governance Committee to Establish Data Management Policies

DKM-01 NIEHS will create a Data Governance Committee to work with NIEHS researchers, staff, and I&IT groups to establish policies and compliance criteria for management of internal and contract-generated data with the goal of meeting FAIR+ principles and federal requirements for management of records. Policies include, but are not limited to, data retention; archiving of research data, including use of tiered and cloud storage; metadata standards for describing research data; and standards for representing, publishing, supporting, discovering, and indexing data. Policies must be tiered to account for differing levels of data prioritization. The Committee will interface with related NIH standards and NIEHS extramural data governance policies. Success will be determined by creation of policies that allow I&IT groups to make purchasing and development decisions, and compliance of NIEHS-generated data governed by data management policies.

### Implement Processes for Strategic Oversight of Data and Knowledge Management Activities and Investments

DKM-02 NIEHS will put into practice processes to inform best approaches for addressing DKM needs (e.g., developing internally, contracting, partnering with other ICs), to prioritize I&IT investments and projects, to increase coordination between I&IT groups and users on implementations and change management, and to evaluate ongoing activities and lifecycle decisions. The process will include developing inventories of internal needs, capabilities, and projects (including lifecycle); developing inventories of external DKM resources (especially at NIH); formation of internal committees to plan and review activities from scientific and technological perspectives, and support strategic planning; use of knowledge and project management tools (e.g., Confluence, Jira) for process management; and creation of an external review panel to provide expertise in data- and knowledge-intensive methods. Success will be understood by direct evidence of business processes guiding DKM and data science investments.

### Advance Adoption of Metadata and Vocabularies for Describing Data Sets and for Use in Data Analysis Efforts

DKM-03 NIEHS will use vocabularies to link knowledge systems to aid in analysis approaches (e.g., enrichment analysis). Advancing use will entail several efforts including tagging of prioritized NIEHS research data sets using manual SOPs and automated mechanisms (e.g., that link to LIMS and ELNs); creation of a reference catalog of commonly used metadata and linked vocabularies that can facilitate automation, inform SOPs, and allow for controlled crowdsourcing of updates; incorporation of metadata and vocabularies into search capabilities; increasing staff expertise in developing semantic and linked data-aware analysis and search tools; education and training on methods to integrate metadata and linked vocabularies into data analysis; aligning NIEHS internal and extramural efforts with environmental health vocabularies and other external communities; and formation of an internal working group to advance adoption of metadata and vocabularies. Success will be evaluated with metrics on metadata tagging on research data sets (accounting for governance policies), and use of metadata and linked vocabularies in tools for searching, analysis, and visualization.

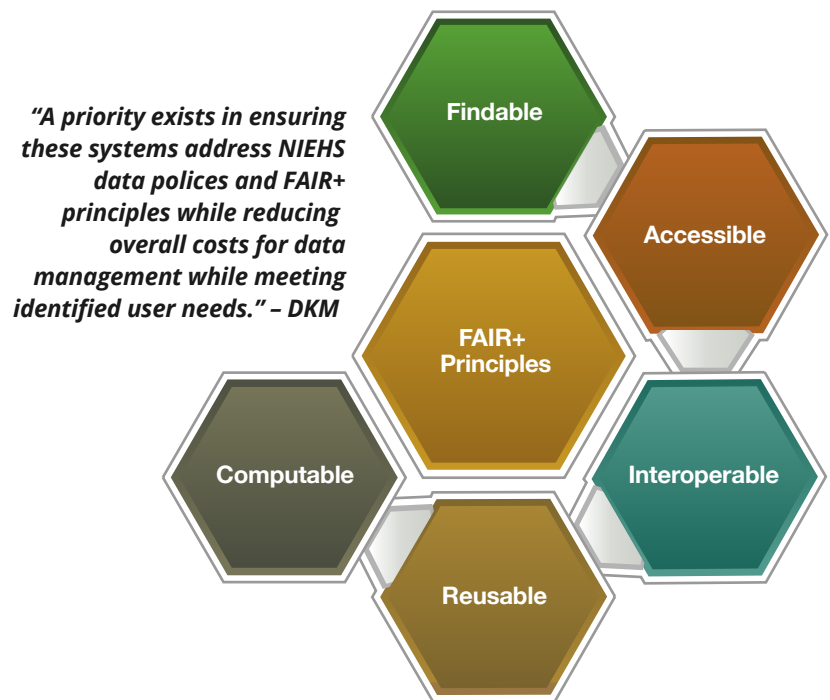
## Conduct Pilots to Inform Solutions for External Environmental Health Research Data

DKM-04 Whether an NIEHS grantee, external collaborator, or part of a public or private partnership arrangement, researchers are not always able to maintain or properly curate data resources, especially after funding periods end. A critical need exists to provide a solution for long-term management of such NIEHS-funded data, with a goal of ensuring the data meets FAIR+ principles. Multiple questions exist on how to sustain funding and control access, what level of access should be provided, and what services will be provided with the data. The evolving focus of data science at NIH, including the NIH Data Commons currently under development, and the proposed storage of publication-linked data at PubMed, may generate solutions. One or more pilots will aid in assessing these solutions, as well as provide detailed information on needs and constraints. Pilots will address providing standards and expectations for long-term data management, as well as testing the use of specific data repositories. Success will be determined by completion of pilots that inform and lead to decisions for long-term solutions.

## Advance FAIR+ Practices for Intramural Research Data

DKM-05 A portion of the NIEHS-generated research data (internally or by contract) is managed by internal systems (e.g., CEBS, EpiShare, REDCap, NIEHS Data Commons) or external systems (e.g., dbGaP, GEO). These systems are at various levels of meeting FAIR+ principles, and limited commonality exists across these systems (e.g., for search, access, archiving, transport, data standards, data provisioning processes). A priority exists in ensuring these systems address NIEHS data policies and FAIR+ principles, while reducing overall costs for data management while meeting identified user needs.

A second priority is classifying internal research data as to the level of management needed (e.g., none, archive only, FAIR, FAIR+) and ensuring the data is managed according to its classification. Decisions around inclusion of legacy data will be made based on the nature of the data. Success will be understood by the percentage of research data managed according to NIEHS policies, lack of redundant common data management functionality, percentage of user identified needs met, and user satisfaction.



**Provide an NIEHS Information Commons for Querying and Computing Across FAIR+ Designated Data Sets and Knowledge Bases**

DKM-06 NIEHS will develop and provide APIs to access and query DKM systems, which provide multiple benefits in enabling data- and knowledge-driven research methods. APIs provide access to statistical distributions that may be difficult to obtain due to data security and sharing concerns, facilitate development of new tools and methods by providing easy-to-obtain results for common queries that allow for auditing of data usage patterns, and inform data management practices. Coordinating the terminologies and vocabularies adopted by APIs such that common standards are adopted can further allow for integration of data between systems without direct mapping of the data systems, allowing for separation of implementations. Existing efforts at NIH and elsewhere (e.g., NIH Data Commons, EPA CompTox, Global Alliance for Genomics and Health) are making strides toward global information commons. Thus, providing APIs will increase NIEHS data utility and use. Success will be understood by the percentage of DKM systems with APIs, and usage of APIs by intramural and extramural researchers, tool developers, and partner resources.

**Provide Centralized Resources to Support Researchers in Using and Advancing Data- and Knowledge-Driven Methods**

DKM-07 As research staff and programs adopt greater use of data- and knowledge-driven research, there is a need to increase support for these activities. Support will fall into several areas, including developing and deploying data-centric tools, including visualizations and websites; developing, deploying, loading, and querying databases and knowledge bases, including traditional (e.g., RDBMS) and specialized data systems (e.g., Graph databases); working with novel data and computational science technologies (e.g., GPU-based computing, machine learning libraries, and semantic and linked data methods); managing and accessing research data; prototyping data science tools and transitioning tools to production use; and creating a tool and project repository to provide a centralized platform of available resources. Success will be understood as a pipeline of research projects involving NIEHS support staff and researchers; success in matrixing of support staff from I&IT groups (including Bioinformatics); development and retention of staff resources; development of software and data resources reused across projects; and successful use of temporary staffing (e.g., postbacs, summer students) to provide tailored expertise.

**Establish Processes to Foster a Data-Oriented Workforce**

DKM-08 Increasing the adoption of data- and knowledge-centric tools and methods broadly across NIEHS will be achieved through a number of targeted activities, including identifying and promoting resources for training and education; identifying and promoting tools and methods; conducting regular webinars and workshops to showcase methods, tools, and resources, and foster exchange of ideas; holding internal user meetings and journal clubs to foster communities of practice; and identifying NIEHS experts in topic areas willing to provide internal advice and consulting. Success will be evaluated as training and education efforts meet user needs; establishment of well-attended, active community and engagement efforts; and increased adoption of data- and knowledge-centric tools across NIEHS.

**DATA AND KNOWLEDGE MANAGEMENT THEME MAP:**

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
Data and Knowledge Management	DKM-07	DKM-03 DKM-05 DKM-06	DKM-02		DKM-01	DKM-04	DKM-08

See Appendix A

## 7. WEBSITE COMMUNICATIONS

### Rationale

The act of communicating — that is, the sharing of information, knowledge, data, stories, ideas, images, and tools — has transitioned into a technology-dependent, multidirectional endeavor. Websites make up the internet, and together they have become the essential and foundational component of all modern-day communications. NIEHS websites inform the institute community and present NIEHS to the world, and serve as home for known and emerging electronic communication mediums used by the public and research partners alike. Communications at NIEHS begin with websites and multimedia content that is leveraged to broader audiences through other technologies, such as social media platforms, mobile devices, online data sharing, and the internet of things. The demand for web-based information continues to grow as research itself becomes more reliant on technology-assisted analysis and virtual collaboration. Good web interfaces will enable the institute's commitment to FAIR+. Visitors and users of NIEHS websites include current and potential researchers, educators and students, governments and policymakers, health care professionals and patients, regulators, and millions of people interested in environment and health.

### Goals

- NIEHS will maintain the reputation as the leader of the environmental health field and go-to source for environmental health information.
- NIEHS audiences will be able to use internet-enabled devices to access data and resources presented in well-organized, user-friendly formats.
- NIEHS will establish a culture of information sharing, foster and strengthen multidirectional knowledge and data sharing, and make NIEHS data FAIR+.
- NIEHS will use technologies to further recruitment, partnerships, and collaborations.
- NIEHS will effectively use communications technologies to inform and educate staff (contractors, employees, fellows, guests, and volunteers).
- NIEHS audiences will receive information through multiple venues when, where, and how they want to receive it, and thus be more likely to think and act upon it. By delivering information directly to individuals, the institute can carefully manage content, accuracy, and timing.
- NIEHS will have the tools and technologies to measure the effectiveness of these technologies.
- NIEHS will follow good practices and industry standards of efficient spending and product lifecycle management.
- NIEHS will implement technologies and policies mandated by HHS, NIH, General Services Administration, and other federal agencies.



## Strategic Capability Priorities

### Support NIEHS Knowledge and e-Science Initiatives

WEB-01 NIEHS will support knowledge and e-science initiatives, to increase the consumption of data. Success will be measured by evaluation, which will be project-dependent. For example, NIEHS may collect and analyze metrics (e.g., through web analytics, number of logins, number of downloads, etc.) on use of the electronic products created. Success will be understood based on return on overall investment.

### Establish a Web Content Lifecycle

WEB-02 Users do not rely on or trust sites that are not updated, and building trust helps make audiences receptive to messages. Search engines downgrade sites not updated regularly (displaying those sites lower in results). Internal efficiencies are also hurt by old or incorrect intranet information. Additionally, there is a small cost for every webpage that must be maintained, even if it is not edited often. While some content is evergreen, most is not. Success will be determined by semiannual measurement of web documents from all contract and federal sources, updated according to an overall content lifecycle (creation, storage, categorizing, metadata tagging, delivery or sharing, repurposing, review and reporting, archiving and destruction), which will be established.

### Update Web Infrastructure

WEB-03 To ensure availability of systems and reduce the risk of instability from using out-of-date components necessary for website communications, NIEHS will update I&IT infrastructure, including, but not limited to, software and hardware. Success will be determined by the establishment of a lifecycle process and an inventory, and by measuring the percentage of website communications components that are compliant with that lifecycle.

### Continued Improvements of User Interfaces for All Audiences, Including Navigation and Search

WEB-04 To increase credibility and ease of use, and further spread institute information, NIEHS will make continued improvements of user interfaces for all audiences, including navigation and search. The institute will measure success by defining, gathering, and analyzing metrics regularly, using the July 2018 federal digital analytics program Google Analytics as a baseline. NIEHS will track IC to IC status over time via the federal Digital Analytics Program, to weed out general marketplace variability. Qualitative metrics, such as user satisfaction surveys and usability tests, will also be collected.

### Lower Barriers for and Enhance Internal Communications and Communication Efficiency

WEB-05 To reduce duplication of efforts, promote collaboration, and save staff time by communicating effectively, NIEHS will lower barriers for and enhance internal communications and communication efficiency. The institute will measure success by establishment and evaluation of metrics around communication efficiency; monitor, collect, and analyze metrics regularly (time to receive a notification, time to understand a notification, time to find information); and react to metrics to increase communication efficiency. Qualitative metrics, such as user satisfaction surveys and usability tests, will also be collected.

### Build and Facilitate Access to NIEHS, NTP, and EHP Presences on Social Media Sites

WEB-06 To increase consumption of information, the institute will build and facilitate access to NIEHS/National Toxicology Program (NTP), and Environmental Health Perspectives (EHP) presences on social media sites. Messaging will be increased on diverse and domain-specific channels, following federal, HHS, and NIH policies for use of social media. Success will be measured by evaluating metrics available from social media staff.

### Create and Use More Multimedia

WEB-07 To increase engagement and offer information in multiple modalities, NIEHS will create and use more multimedia. Success will be measured by the amount of multimedia created quarterly, which should show an increase over time. Additionally, NIEHS will measure increased access to multimedia, via metrics available from web analytics internally and externally.

### Inform and Educate Internal I&IT and Website Communications Communities About Best Practices, Industry Changes, New Technologies, and Policies

WEB-08 To increase credibility and ease of use, and further spread institute messages, NIEHS will inform and educate internal I&IT and website communications communities about best practices, industry changes, new technologies, and policies. Best practices will also be adopted, from other NIH institutes and centers (ICs) and local universities, to include both informing audiences and expanding capabilities. Success will be measured by evaluation of changes to technologies and approaches due to internal information sharing. NIEHS will develop the appropriate knowledge base(s) for target audiences.

### Increase Virtual Meeting and Virtual Collaboration Capabilities and Use

WEB-09 To reduce travel costs, increase transparency, and increase community involvement, NIEHS will increase virtual meeting and collaboration capabilities and use. The website communications capability statement includes increased use of webcasts and website content collaboration. Additionally, website communications are responsible for effectively communicating about in-scope virtual meeting and collaboration tools available to NIEHS audiences. Success will be measured by evaluation of the monthly webcast counts, which should increase over time. Utilization of any new technology will be monitored.

### Upgrade NIEHS Websites From Percussion to Drupal CMS

WEB-10 Drupal migration will allow NIEHS to remain synchronized with NIH and HHS efforts, while also reducing the cost to NIEHS of using a CMS. Most of this migration will be completed within two years. Success will be measured by evaluating the percentage of NIEHS (including NTP) pages migrated from Percussion to Drupal, with no measured degradation in performance, as measured by baseline and periodic robust stress and speed testing of the website(s).

### WEBSITE AND COMMUNICATIONS THEME MAP:

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
Website Communications			WEB-01 WEB-02 WEB-04 WEB-05 WEB-06 WEB-07			WEB-03 WEB-10	WEB-08 WEB-09

See Appendix A

## 8. NON-COMMODITY SOFTWARE

### Rationale

Non-commodity software includes custom-built applications and substantially reconfigured commercial software. Examples include BRT (budget), CareerTrac, committees on promotion system, statistical and analytical software, grant application development and support, health and safety management, inventory management system, and many others. The current non-commodity software inventory reflects decades of adoption of I&IT software technology across the institute as the scientific mission has evolved and grown. However, divisions and offices have developed custom software solutions for their respective needs with varying line-of-sight connections to an integrated institute-wide strategy. As a result, NIEHS has opportunities to streamline, gain efficiencies, and make effective use of today's rapidly evolving technology landscape. The institute must develop the ability to plan for its future application environment. To address this, NIEHS must implement a lifecycle strategy with guidelines and best practices that will drive an optimized non-commodity software environment.

### Goals

#### Support Diverse Mission Functions and Domains

The institute provides non-commodity software to support broad functional capabilities across a diverse set of scientific, grant-making, and enterprise-wide mission areas. The types of supported functional capabilities include streamlining and automating business processes to maximize efficiency and transparency; monitoring and predicting costs and expenditures; tracking non-monetary resources, people, and materials; monitoring and informing staff about needed actions; managing and monitoring distribution of workload across staff to balance work and operate efficiently; controlling and sharing information with internal and external communities; characterizing and communicating outputs and impacts; scientific analysis and visualization, and many others. These capabilities are essential across all domains of the NIEHS mission.

#### Ensure Software Lifecycle Planning

NIEHS will conduct strategic planning for non-commodity software needs, addressing key challenges and gaps. The institute will implement lifecycle planning for all non-commodity software systems, including plans to stay current with related version releases. Existing and future non-commodity software will be secure, user friendly, innovative, state of the art, nimble, and meet customer needs. Staff will develop methods and approaches that enable the institute to adapt to changing conditions and anticipate changes (e.g., those related to security, new technologies, etc.). The non-commodity software environment will comply with federal, HHS, NIH, and NIEHS policies.

#### Implement Software Best Practices

NIEHS will use robust approaches to gather and prioritize business requirements, develop budget estimates, secure contracts, develop solutions focused on user experience, ensure compatibility with existing architecture, test solution delivery, fix bugs and defects, and deliver completed software. Staff will develop the skills and capacity to manage non-commodity software development activities according to project management standards and best practices.



The institute will identify opportunities to streamline and consolidate non-commodity software development based on cost-benefits analysis and foster collaborations for crosscutting needs. Non-commodity systems will be interoperable where it makes sense. Staff will develop methods and practices to coordinate non-commodity software development with hardware, middleware, and storage I&IT groups. Staff will implement standard metrics for measuring and assessing non-commodity software use, both internally and externally.

## Strategic Capability Priorities

### Non-Commodity Software Inventory

NCSW-01 NIEHS will maintain a well-characterized inventory of non-commodity software systems and their interdependencies. The inventory will provide the data needed to develop strategy-enabling analysis of needs, facilitating prediction of future needs, identifying areas of overlap, enabling better acquisition planning, and facilitating communication around change control. System success will be determined when it is editable by a key set of system owners and representatives, is regularly updated (once per year with business owners), has a specific champion or owner named for each tool, a comprehensive list of custom applications and the programs needed to support them, and once the required set of fields is established and 90 percent are complete.



NCSW-02 NIEHS will develop application profiles that map to the business owner, as well as the functional capabilities and mission domains. Adding functional capabilities and mission domain fields to the inventory will allow the institute to create a comprehensive management structure for the entire inventory, and know that nothing has been lost and everything can be included in an appropriate roadmap for budgeting. Success will be determined when each application is assigned to a domain area for tracking and budgeting. Budgets and contracts will include all applications assigned to a domain (i.e., no orphans).

NCSW-03 NIEHS will review the non-commodity software inventory regularly to assess compliance with approved architecture and update or retire applications that do not conform. Review will ensure that systems are secure and conform to the architecture. In turn, this will assure that the institute maximizes the capacity of the infrastructure while monitoring costs. Success will be understood by domain area leader satisfaction and when outdated and nonconforming applications are retired.

NCSW-04 NIEHS will decide what, if any, non-commodity software inventory information is made available on the Junction. Non-commodity software inventory information review will assure that content is accurate and that access to protected information is controlled. Success will be understood with inventory and content updates and removal of inappropriate information from the Junction.

## **Application Development Guidelines**

- NCSW-05 NIEHS will establish and maintain application guidelines that provide appropriate constraints for what programming languages, platforms, application servers, and versions are used for non-commodity software development. Guidelines will prevent any disallowed uses, while maintaining as much flexibility as possible. Lack of guidance creates vulnerabilities, inconsistencies, and unevenly administered policies. Guidance will help avoid unexpected costs and downtimes (e.g., Cold Fusion 7 upgrades). Success will be understood with a central repository that is easily accessible, distributed to contractors, and updated as needed. NIEHS will develop use cases of significant contracts or activities that use the guidelines. Guidelines are nonexistent at the institute level, although they are frequently set at the contract or project level.
- NCSW-06 NIEHS will provide training and education for researchers and developers on best practices for developing open-source software. Training will enhance consistency and security. Success will be understood by training on open-source software each year, positive training participant surveys, and elimination of inappropriate software cases.

## **Non-Commodity Software Staffing and Organization**

- NCSW-07 NIEHS will establish an ongoing group to support non-commodity software goals and priorities. The institute will develop the ability to plan for its future application environment. To address this, a group needs to be established (or an existing group assigned) to lead institute partners in implementing lifecycle strategy, guidelines, and best practices that will drive an optimized non-commodity software environment. Success will be understood as a group exists and is effective.
- NCSW-08 NIEHS will ensure that non-commodity software development projects include appropriate levels of federal project management. Project management assures accountability and project completion. The institute Project Management Office (PMO) will manage this as it gets up and running. Success will be understood by improved management and user satisfaction.
- NCSW-09 NIEHS will continue to develop a solution delivery organization and process to assist application owners with end-to-end understanding and solutions for their requirements. Right-size project management will be used to maximize successful projects and customer satisfaction. Success will be understood as projects are completed on time, on schedule, and within budget, and customers get what they need.

## **Non-Commodity Software Future-State Planning**

- NCSW-10 NIEHS will develop a three-year plan for needed enterprise architecture changes in coordination with the Information Technology Architectural Review Group (ITARG). Planning will help create standard parameters to prioritize non-commodity software development and coordinate enterprise architecture to adapt to changing needs. Success will be understood as a plan is developed and standard parameters to prioritize non-commodity software development exist.
- NCSW-11 NIEHS will create a three-year non-commodity software requirement roadmap for each domain. Roadmaps will include broad requirements and expected costs for development, operations, and retirement and will inform budget and help set realistic expectations. Details will be critical for setting priorities within and across domains. Success will be understood as each domain area has a leader who submits priorities and provides a high-level plan for each domain, and as all software items are represented in domain roadmaps.

NCSW-12 NIEHS will facilitate discussions of application transition and adoption as part of planning processes. This planning will help address why systems are developed but not adopted. Success will be understood as the PMO facilitates these kinds of discussions at the outset of projects.

NCSW-13 NIEHS will establish procedures and opportunities to elaborate needs and system requirements so they are serving needs of the users and stakeholders. Too many tools are developed that do not meet user needs and are perceived to be a waste of resources. Sometimes, these are duplicative of other efforts. Success will be understood as the PMO and solution delivery organization are facilitating these kinds of discussions at the outset of projects.

**Facilitating Day-to-Day Non-Commodity Software Interactions**

NCSW-14 NIEHS will communicate non-commodity software policies, procedures, events, and deadlines clearly to the entire community. Lack of transparency slows productivity and fosters inconsistency. Success will be understood as updates on application development guidelines, patching schedules, availability of new servers, and contact information are updated regularly in plain language. Opportunities for multidirectional communication are evident. Both pull-and-push communication methods are used.

NCSW-15 NIEHS will improve onboarding and startup for non-commodity software contractors (e.g., create new onboarding SOPs and default images). Non-commodity software staff, and especially new contractors, experience delays in getting new computers, servers, and authorizations, and this incurs hidden costs. Success will be understood as new default images are created for contractor machines that include the most common development tools to support non-commodity software activity and as SOPs for onboarding contractors are improved.

NCSW-16 NIEHS will develop hardware standards and default images for widely used development stacks, and a process to identify standards for optimal performance. Standards will set appropriate expectations for hardware performance and inform strategic planning for hardware purchases and capacity. Success will be understood as regular discussions about software dependencies on hardware occur, hardware standards and software images are available and installed, and standards for optimal performance are circulated.

NCSW-17 NIEHS will analyze policies and procedures for gaps and inconsistencies and create a process for approval of non-commodity software. Procedures are needed to ensure a coordinated, flexible, and interactive environment that operates smoothly and efficiently. Success will be understood as no (or minimal) surprises for business teams and I&IT providers.

**NON-COMMODITY SOFTWARE THEME MAP:**

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
Non-Commodity Software	NCSW-05 NCSW-16	NCSW-11	NCSW-01 NCSW-02 NCSW-04 NCSW-14		NCSW-07 NCSW-17	NCSW-03 NCSW-09 NCSW-10 NCSW-12 NCSW-13	NCSW-06 NCSW-08 NCSW-15

See Appendix A

## 9. COMMODITY BUSINESS COMPUTING

### Rationale

Commodity business computing supports and maintains general enterprise systems, including providing staff expertise, software, and hardware. Commodity business computing includes packaged software that is deployed for workplace productivity, business functions, and communications (Microsoft Office, Adobe Acrobat, Citrix Receiver, WebEx), as well as packaged software deployed in the NIEHS data center or as service in a cloud environment (ColdFusion, Oracle, Master Calendar, Drupal). Packaged software is generally developed for a large and diverse audience with economical price points, and it cannot be as individualized as non-commodity or custom-programmed software because it is purchased off the shelf. In general, all software that NIEHS centrally distributes and patches is considered packaged or off-the-shelf software. Commodity business computing further includes desktop hardware and peripherals, including desktop and laptop computers, monitors, keyboards, PIV card readers, printers, mobile devices, digital signage, web conferencing equipment, VoIP phones, and others.

### Goals

#### Support Diverse Mission Functions and Domains

The institute will provide effective commodity business computing that supports operations, automation, and communications across diverse scientific, grant-making, and enterprise-wide mission areas.

#### NIEHS I&IT Will:

- Provide desktop productivity resources that enable the workforce to accomplish tasks and increase efficiency.
- Provide and maintain client computing to enable the institute to utilize network, server, and cloud-based resources.
- Provide for secure computer-based communications and collaboration.
- Streamline and automate business processes to maximize efficiency and transparency.
- Track monetary and nonmonetary resources, people, and materials.
- Enable business analytics.
- Provide and maintain application development platforms and frameworks.
- Provide financially and technologically sustainable and environmentally friendly refresh and replacement.
- Monitor and respond to trend analyses.
- Support the institute community with quality and timely service.

## Ensure Lifecycle Planning

- Conduct strategic planning for commodity business computing needs, addressing key challenges and gaps.
- Implement lifecycle planning for all commodity business computing equipment, software, and systems, including plans to stay current with related version releases or to retire legacy computing resources.
- Assure that existing and future commodity business computing will be secure, user-friendly, innovative, state of the art, nimble, and meet institute needs.
- Utilize cloud services when beneficial to take advantage of economies of scale and efficiencies.
- Manage licensing to take advantage of economically beneficial volume licensing and to mitigate risk of lapses in licenses.
- Enhance staff development methods and approaches that enable the institute to adapt to changing conditions and anticipate changes (e.g., those related to security, new technologies, etc.).
- Comply with applicable federal, HHS, NIH, and NIEHS policies and laws.

## Implement Best Practices

- Use robust approaches to gather and prioritize business requirements, develop budget estimates, secure contracts and licenses, deploy solutions focused on user experience, ensure compatibility with existing architecture, and ensure timely patching and maintenance.
- Develop the skills and capacity to manage commodity business computing acquisition and maintenance activities, according to project management standards and best practices.
- Provide high-quality customer service and track customer satisfaction to facilitate continuous improvement, through I&IT staff and contracts.
- Identify opportunities to streamline and consolidate commodity business computing, based on cost-benefits analysis, and foster collaboration for crosscutting needs.
- Ensure commodity business computing systems are interoperable, if applicable.
- Develop methods and practices to coordinate commodity business computing with the non-commodity software, data center, and related groups.
- Implement standard metrics for measuring and assessing commodity business computing use.



## Strategic Capability Priorities

### Maintain an Accurate, Up-to-Date Inventory of Commodity Business Computing

CBC-01 NIEHS will maintain a well-characterized inventory of commodity business computing software, hardware, systems, and devices. An accurate inventory is required for lifecycle management, to facilitate bulk purchasing and on-time license renewals, ensure appropriate and timely maintenance, define support requirements, ensure security and architecture compliance, support strategic business and technology planning, support out-year budgeting, and drive economies of scale. Success will be determined as inventories are in place, licenses do not lapse, hardware does not pass its end of service, demonstrated compliance with security and architecture, effective budgeting, and customer satisfaction.



CBC-02 NIEHS will develop inventory profiles that map to the business owner and program, as well as the functional capabilities and mission domains. Adding this level of detail will allow the institute to create a comprehensive management structure for the entire inventory, and know nothing has been lost and everything can be included in an appropriate roadmap for budgeting. Success will be determined by the percentage of mapping of inventory items to profiles.

CBC-03 NIEHS will review the commodity business computing inventory regularly to assess compliance with the approved architecture, and update or retire inventory items that do not conform. Review will ensure that assets conform to the architecture. The institute will keep the I&T ecosystem healthy and right-sized by retiring or removing what is no longer used or presents an unacceptable security risk. Success will be determined by the rate of compliance.

### Streamline Commodity Business Computing Purchasing

CBC-04 NIEHS will establish and maintain purchasing guidelines that provide appropriate constraints, policies, processes, technical specifications, and contract vehicles for acquiring software, hardware, systems, and devices that are used for commodity business computing. Improved purchasing systems will promote cost savings, make purchasing more efficient, ensure proper acquisition management, prevent disallowed uses, and maintain as much flexibility as possible. Current lack of guidance creates inefficiencies, lost staff time, and unevenly administered policies. Success will be determined by readily available guidelines, as a communications plan is developed and implemented, and user satisfaction.



## **Maximize Commodity Business Computing Education and Training**

- CBC-05 NIEHS will educate the community on the availability and capabilities of the current commodity systems inventory. Enhanced education will maximize the use of the inventory, increase staff productivity, and increase return on investment. Success will be determined by development and implementation of a communications plan and measurement of utilization.
- CBC-06 NIEHS will ensure regular training of users and business owners on the use of commodity software, hardware, systems, and devices. Training will maximize the use of the inventory, increase staff productivity, and increase return on investment. Success will be determined by regular needs assessment and related training.
- CBC-07 NIEHS will encourage the use of currently supported technology. Use of supported technologies will reduce costs and risks associated with bringing on new technologies. Success will be determined by development and implementation of a communications plan, the speed and effectiveness of development projects, and measured utilization.

## **Optimize Cloud-Based Commodity Systems Use**

- CBC-08 NIEHS will increase cloud usage when purchasing commodity functionality. Cloud use enables a business model that can be more efficient because the Government pays for only what it uses. Cloud-based services typically cost less than the total cost of ownership of data center–hosted services. Reducing the data center footprint complies with federal data center consolidation goals. Success will be determined by use of cloud services with relevant data, comparing the total cost of ownership trajectory after moving to the cloud, and customer satisfaction.
- CBC-09 NIEHS will coordinate the use of PaaS and Software as a Service (SaaS) with other I&IT efforts, ITARG, and PMO. Increased coordination will ensure that the institute is purchasing cloud services that comply with federal policy for I&IT security and controls, planning cloud migrations effectively, and coordinating cloud strategy across NIEHS for economies of scale. Success will be determined by the percentage of compliance with policy that are managed as projects and conform to schedule and budgets, and with demonstrated economies of scale and cost savings (compare projected costs without PaaS/SaaS to actual costs with these services).

## **Provide Necessary Commodity Business Computing Staffing and Organization**

- CBC-10 NIEHS will establish or verify organizational capacity to support commodity business computing goals and priorities. Organizational gaps currently put these capabilities at risk, while organizational support and leadership will ensure success. Success will be determined by demonstration that staff positions support these capabilities.
- CBC-11 NIEHS will ensure that commodity systems lifecycle management includes appropriate levels of federal project management. Project management practices are essential for lifecycle management. Project managers will be assigned sufficient resources and have authority to manage lifecycle successfully. Success will be determined by identification of project managers, understanding resource requirements, and as the backlog of noncompliant machines is reduced.

**Commodity Business Computing Future-State Planning**

CBC-12 NIEHS will develop and maintain a three-year plan for prioritized enterprise architecture changes in coordination with the ITARG and create standard parameters to prioritize commodity business computing. The institute will facilitate discussions of application transition and adoption as part of planning processes. NIEHS will develop a roadmap to rationalize its investment over the next three years in commodity business computing. Success will be determined as enterprise architecture changes are prioritized, planned, and well executed.



CBC-13 NIEHS will establish procedures and opportunities to elaborate commodity business computing needs and requirements so they are serving the needs of users and stakeholders. Users will drive the requirements by articulating functional needs, so the institute invests in what is actually needed for mission success. I&IT providers cannot drive these requirements. Success will be determined by evaluating requirement definition processes and as commodity and non-commodity software procurements are coordinated to prevent gaps in service and access.

**Enhance Commodity Business Computing Customer Service**

CBC-14 NIEHS will provide improved systems for I&IT staff to provide feedback on commodity business computing services. The institute will better understand how services are perceived and how users are experiencing services, to make continual process improvements. Success will be determined by enhanced effectiveness and user satisfaction, and the implementation of additional features in ServiceNow.

CBC-15 NIEHS will analyze feedback, use it to improve service delivery, and report results back to the user community. The institute will better understand how commodity business computing services are perceived and how users are experiencing these services to make continual process improvements. Success will be determined as improvements are made and reports are provided to the community.

**COMMODITY BUSINESS COMPUTING THEME MAP:**

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
Commodity Business Computing	CBC-08	CBC-15	CBC-01 CBC-02 CBC-13 CBC-14		CBC-03	CBC-04 CBC-09 CBC-12	CBC-05 CBC-06 CBC-07 CBC-10 CBC-11

See Appendix A



## 10. CONTINUITY OF OPERATIONS (COOP) AND DISASTER RECOVERY

### Rationale

Continuity of operations (COOP) and disaster recovery planning are part of federal requirements for I&IT contingency planning. These efforts identify how critical operations will continue under a broad range of circumstances.

Contingency planning is an important business practice that addresses I&IT recovery and survival during and after emergency situations. The federal government's guiding document for I&IT contingency planning is the NIST 800-34 series document. The federally required guidance from NIST defines eight component plans to address contingency planning.

A continuity of operations plan establishes policy and guidance, ensuring critical functions continue, and personnel and resources are relocated to an alternate facility for up to 30 days in case of emergencies. Industry definitions are available at <https://csrc.nist.gov/Glossary> to help define scope in these areas.



### Goals

- Comply with NIST requirements that define a contingency planning policy, responsible contacts, and update contingency plan for the NIEHS GSS.
- Assist the institute in deciding on critical functions over a 30-day period and help sustain those I&IT components. Decide the level of business impact analysis (BIA) required to support these plans and the essential business functions that I&IT must support.
- Understand the current I&IT approach to contingency planning and detail the I&IT systems under this scope and its supporting plans.
- Define which I&IT tools must persist during each phase of an event (e.g., email, internet access, voice communications).
- Utilize the existing NIEHS COOP plan.

## Strategic Capability Priorities

### Conduct the Business Impact Assessment

COOP-01 NIEHS will utilize the existing COOP program to help identify essential business functions and the I&IT support needed to continue those functions. As part of this effort, the institute will coordinate a formal BIA with the NIEHS community. Providing this information and planning meets the required controls for I&IT certification. The successful completion of the BIA will be the milestone.

### Document a Snapshot of the Current Capability

COOP-02 NIEHS will create an information system backup document that provides a current understanding for backup capabilities. GSS documents will be updated, and critical stakeholders informed of the services. The existing NIEHS data center disaster recovery and contingency plans that are part of the NIH documentation that support the ATO will be supplemented with this new information. The documentation provides compliance to the NIST standards and controls.

### Perform a Gap Analysis on the Current Capability Versus the BIA Results

COOP-03 NIEHS will evaluate the current disaster recovery capability and identify issues and gaps. The institute will also identify the items that are currently working well for disaster recovery. The document will fulfill required controls for accreditation and inform stakeholders about the services.

### Perform Analysis on Offsite Location Needs

COOP-04 Evaluate and decide if NIEHS requires a formal recovery location for the data center and which systems are short-term recoverable. The institute will also decide if the institute needs an alternate storage site based on defined essential functions and invest in this process, and will consider cloud opportunities for alternative storage sites along with Center for Information Technology computing as options in contingency planning actions. Recovery location controls are part of the required NIST accreditation controls. The process and decision will include updates to the Disaster Recovery plan to ensure success.

### Include the Existing Campus COOP Information Technology Team

COOP-05 The current campus Information Technology Team (ITT) is responsible for managing and coordinating all I&IT matters related to NIEHS COOP operations. These I&IT efforts will supplement the existing emergency response efforts, as well as all recovery and reconstitution activities. The ITT develops pre-incident strategies necessary for COOP operations; routinely maintains and tests I&IT systems and equipment; and provides consultation, support, and resources throughout COOP activations. Success depends on robust communications. During emergency situations, effective communication is critical in affecting positive outcomes. Reliable and redundant connectivity to provide access to all vital NIEHS files, records, and databases is necessary for NIEHS to continue essential functions. The institute has an existing COOP team to include in this I&IT initiative.

### COOP AND DISASTER I&IT RECOVERY THEME MAP:

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
COOP & DISASTER RECOVERY	COOP-05	COOP-02 COOP-04			COOP-01	COOP-03	

See Appendix A

# 11. SECURITY AND PRIVACY

## Rationale

Security and Privacy intersect all aspects of NIEHS I&IT systems and data. NIEHS I&IT systems and data are diverse and rapidly changing, and demand fit-to-need security and privacy practices. NIEHS has a customized local approach to I&IT security and privacy directed at improving user experience while maintaining compliance. A significant component of NIEHS security and privacy design includes trusted internal accessibility and controlled external accessibility. This design is aligned with collaborative scientific needs, including data sharing and remote systems access. Increased systems migration to externally hosted (cloud) infrastructure demands new I&IT security and privacy policy and practices. Security and privacy compliance frequently imposes change mandates, including forced end of life of applications, platforms, and operating systems.

## Goals

The NIEHS I&IT security and privacy program supports the NIEHS mission by collaborating with scientists and administrators in the design of the I&IT security and privacy ecosystem. These collaborations optimize systems design and policy implementation and provide balanced security and privacy risk management. Goals of the program include:

- Minimize I&IT security and privacy risks by reducing impact and time to resolution.
- Provide the NIEHS ISSO and privacy coordinator with the necessary reporting and policy parameters and data.
- Provide internal auditing functions that monitor directly managed systems for policy and procedural compliance, including risk-based accreditations.
- Ensure I&IT security and privacy training and consulting are key components of the NIEHS culture.

## Strategic Capability Priorities

### Security and Privacy Strategy Alignment

SEC-01 The I&IT security and privacy program will provide controls that support the NIEHS mission and enable science. Enabling collaborative science in alignment with overall NIH, NIEHS, and I&IT strategic plans will be obtained through careful planning beginning early in projects. The success of this capability will be understood by user satisfaction with a fit-to-design collaborative approach. Enhanced communication with the security and privacy program is needed.

### Operate a Secure I&IT Infrastructure

SEC-02 NIEHS will operate and maintain core security and privacy infrastructure tools, including firewalls, intrusion prevention systems, vulnerability scanners, and event auditing and logging systems. Many of these tools and techniques are both centralized at NIH and implemented locally. NIEHS will continue to reduce the impact and time to resolution for I&IT security and privacy incidents. Security and privacy tools are operational, and incidents are tracked.

## Protect Sensitive Data

SEC-03 Sensitive NIEHS data will be protected. Systems that collect, maintain, or share data with sensitive PII or Protected Medical Information will meet all I&IT security and privacy requirements. The security and privacy program will comply with NIH privacy requirements and appropriate NIST controls. NIEHS has devoted resources to protect sensitive data.

## Early Security and Privacy Design

SEC-04 The I&IT security and privacy program will review and advise on all system designs hosted internally where the confidentiality, integrity, or availability of NIEHS data is at potential risk. Security and privacy requirements will be vetted in the early phases of projects. Acquisition plans involving I&IT components and externally hosted systems will include appropriate security and privacy sections. The ISSO is involved in development of contract clauses and application consulting.



## Internal Security Verification

SEC-05 Security and privacy policy and implementation will oversee, advise, and audit compliance with HHS, NIH, OMB, and other mandates. The level of compliance is managed by results on the NIH Dashboard for IT security. Improving the NIEHS Dashboard score for the compliance section is a measure of success. The current level of staffing does not support sufficient verification and correction.

## Security Incident Handling

SEC-06 Security and privacy staff will investigate and respond to all reported, discovered, or suspected threats to NIEHS infrastructure or data. Incidents are tracked monthly by NIH. Success is defined by keeping the outstanding (greater than 15 days) incident level low, responding to each in a timely manner, and resolving the incident efficiently. The staff keeps the NIEHS I&IT security incident count very low.

## Security and Privacy in Acquisitions

SEC-07 The security and privacy program will collaborate with the Office of Acquisitions to provide presolicitation guidance and regulation clarity for all acquisitions involving I&IT. Within a compliance framework, balance between scientific need and security and privacy will be maintained. Staff will evaluate and determine baseline requirements to be incorporated into all contracts and acquisitions containing I&IT components. Contracts will be audited for appropriate clauses. NIEHS is not aware if all contracts go through this process.

## Risk Management Lifecycle

SEC-08 The security and privacy program will be integrated with risk management systems, including lifecycle planning. Hardware and software systems require end-of-life planning to ensure vulnerabilities can be managed and patches are available. The I&IT security program will monitor out-of-date hardware and software. Risk management lifecycle success will be ensured using automated reports that find no out-of-support software or hardware to ensure security in I&IT architecture. Limited resources impact completion.

**NIEHS Authorization to Operate**

SEC-09 The security and privacy program will provide the needed information to secure a full IT ATO for the network and IT. NIEHS will produce and maintain adequate documentation necessary to sustain the ATO. The NIH tracked GSS is current and ATO-approved for 2019.

**Information Support for Administrative Matters**

SEC-10 The security and privacy program will collect, process, and preserve data as required for ethical, civil, personnel, and criminal proceedings involving NIEHS staff. This will include assistance in locating and gathering records from respective systems in response to FOIA requests, in coordination with the NIEHS FOIA and Privacy Office. The success of this activity is management satisfaction for the required activities. Workload is very high.

**Privacy Impact Assessment Support**

SEC-11 The security and privacy program will collaborate with the NIEHS FOIA and Privacy Office to ensure existing measures for collecting, maintaining, and sharing PII for all human research study participants are sufficient and in accordance with NIH and NIEHS requirements (Privacy Impact Assessments, OMB clearance, and Records Management requirements). The program is tracked by NIH. Data calls and NIH-required submissions will be met. Workload is very high.

**I&IT SECURITY AND PRIVACY THEME MAP:**

I&IT Landscape	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
I&IT Security and Privacy					SEC-01 SEC-02 SEC-03 SEC-05 SEC-07 SEC-09 SEC-10 SEC-11	SEC-04 SEC-06 SEC-08	

See Appendix A

## Glossary

<b>API</b>	Application Program Interface	<b>GSS</b>	General Support System
<b>ATO</b>	Authorization to Operate	<b>HHS</b>	Health and Human Services
<b>BIA</b>	Business Impact Analysis	<b>HPC</b>	High-Performance Computing
<b>CC</b>	Clinical Center	<b>I&amp;IT</b>	Informatics and Information Technology
<b>CIO</b>	Chief Information Officer	<b>IPS</b>	Intrusion Prevention System
<b>CISO</b>	Chief Information Security Officer	<b>IPv6</b>	Internet Protocol version 6
<b>CLC</b>	Cyberinfrastructure Leadership Committee	<b>ISSO</b>	Information Systems Security Officer
<b>CMS</b>	Content Management System	<b>ITARG</b>	Information Technology Architecture Review Group
<b>COOP</b>	Continuity of Operations Planning	<b>ITT</b>	Information Technology Team
<b>CRB</b>	Clinical Research Branch	<b>LIMS</b>	Laboratory Information Management Systems
<b>CRU</b>	Clinical Research Unit	<b>NAC</b>	Network Access Control
<b>DAS</b>	Distributed Antenna System	<b>NIST</b>	National Institute of Standards and Technology
<b>DCIM</b>	Data Center Infrastructure Management	<b>NTP</b>	National Toxicology Program
<b>DCOI</b>	Data Center Optimization Initiative	<b>OMB</b>	Office of Management and Budget
<b>DKM</b>	Data and Knowledge Management	<b>OOB</b>	out-of-band network
<b>DMZ</b>	Demilitarized Zone	<b>ORF</b>	Office of Research Facilities
<b>Drupal</b>	Web Content Management	<b>PaaS</b>	Platform as a Service
<b>DSL</b>	Digital Subscriber Line	<b>PII</b>	Personally Identifiable Information
<b>EHP</b>	Environmental Health Perspectives	<b>PMO</b>	Project Management Office
<b>EHS</b>	Environmental Health Sciences	<b>PUE</b>	Power Use Effectiveness
<b>ELN</b>	Electronic Lab Notebooks	<b>QoS</b>	Quality of Service
<b>EPA</b>	Environmental Protection Agency	<b>SaaS</b>	Software as a Service
<b>FAIR+</b>	Findable, Accessible, Interoperable, Reusable, and Computable	<b>SOP</b>	Standard Operating Procedure
<b>FITARA</b>	Federal Information Acquisition Reform Act	<b>VoIP</b>	Voice over Internet Protocol
<b>FOIA</b>	Freedom of Information Act		

# APPENDIX A: I&IT PRIORITIES SUPPORT NIEHS STRATEGIC THEMES

I&IT Landscape	Theme 1: Advancing Environmental Health Sciences (EHS)			Theme 2: Promoting Translation - Data to Knowledge to Action			Theme 3: Enhancing EHS Through Stewardship and Support							
	Promoting flexibility, adaptability, and interoperability across data, applications, systems, and personnel.	Employing data-driven processes and technology to inform resource prioritization and optimize scientific, administrative, and funding decisions.	Communicating the value, impact, and urgency of systems, processes, and policy in relationship to the NIEHS Mission.	Enhancing systems and policies that support data and personnel accessibility and interconnection for diverse internal and external stakeholders.	Implementing policies and procedures that inform and structure decision making to enhance innovation and support compliance.	Increasing value of systems, platforms, applications, and processes by promoting efficiency and cost savings.	Improving personnel efficacy, innovation, and coordination by developing new and enhanced skills to guide effective and impactful decisions.	Agility	Analytics	Communications & Transparency	Foster Collaboration	Governance	Optimize Resources	Workforce Development
Clinical I&IT	CLIN-10	CLIN-02		CLIN-03 CLIN-04 CLIN-05 CLIN-06 CLIN-07	CLIN-01 CLIN-08	CLIN-09								
Commodity Business Computing	CBC-08	CBC-15	CBC-01 CBC-02 CBC-13 CBC-14		CBC-03	CBC-04 CBC-09 CBC-12								CBC-05 CBC-06 CBC-07 CBC-10 CBC-11
COOP & Disaster Recovery	COOP-05	COOP-02 COOP-04			COOP-01	COOP-03								
Data & Knowledge Management	DKM-07	DKM-03 DKM-05 DKM-06	DKM-02		DKM-01	DKM-04								DKM-08
Data Center	DC-10	DC-02 DC-04 DC-11 DC-12			DC-01	DC-03 DC-05 DC-06 DC-07 DC-08 DC-09 DC-13 DC-14								
Facilities & Physical Plant	FAC-03 FAC-06 FAC-07 FAC-09	FAC-01 FAC-04	FAC-08		FAC-05 FAC-10	FAC-02 FAC-11								
Laboratory I&IT	LAB-02 LAB-03		LAB-09	LAB-10 LAB-12	LAB-06	LAB-01 LAB-04 LAB-11								LAB-05 LAB-07 LAB-08
Network	NET-07 NET-08 NET-09	NET-01 NET-03 NET-04	NET-02	NET-05		NET-06								
Non-Commodity Software	NCSW-05 NCSW-16	NCSW-11	NCSW-01 NCSW-02 NCSW-04 NCSW-14		NCSW-07 NCSW-17	NCSW-03 NCSW-09 NCSW-10 NCSW-12 NCSW-13								NCSW-06 NCSW-08 NCSW-15
I&IT Security and Privacy					SEC-01 SEC-02 SEC-03 SEC-05 SEC-07 SEC-09 SEC-10 SEC-11	SEC-04 SEC-06 SEC-08								
Website Communications			WEB-01 WEB-02 WEB-04 WEB-05 WEB-06 WEB-07			WEB-03 WEB-10								WEB-08 WEB-09

## APPENDIX B: I&IT STRATEGIC ROADMAP PARTICIPANTS

Ahlmark, Kathy	Grovenstein, John	Reter, Roy
Arnette, Robin	Harris, Toni	Rider, Lisa
Barnes, Martha	Heacock, Michelle	Ruben, Liz
Baucom, Jason	Holmgren, Stephanie	Schiffenbauer, Adam
Beard, Sharon	Hooth, Michelle	Schmitt, Charles
Bell, Marcus	Jacobson, Mary	Schurman, Shepherd
Bird, Gary	Jeter, Shawn	Scott, Wendell
Blair, Bill	Jordan, Matt	Shatz, Maria
Bowden, Beth	Kennedy, Helena	Shilling, Jeff
Brown, Bernard	Kleinstreuer, Nicole	Simpson, Troy
Bushel, Pierre	Kulkarni, Resham	Smith, Spencer
Conway, Mike	Lauderdale, Beth	Stabile, Regina
Day, Frank	Lenox, Kelly	Stone, Chris
Deaton, Troy	LeVine, Rob	Thigpen-Tart, Kim
Del Corral, Debi	Luecke, Hans	Thomas, Ian
Devito, Mike	Mastin, Pat	Thompson, Cheryl
Drew, Christie	Mathis, J'Ingrid	Tucker, Jeff
Duncan, Chris	McKenzie, Stanford	Wade, Paul
Duran, Bryan	Miller, Fred	Williams, Frank
Fargo, David	Mueller, Geoff	Williams, Mitch
Field, Jack	Mullaney, Janis	Worth, Leroy
Flowers, Christine	Nicholson, James	Woychik, Rick
Fostel, Jennifer	O'Fallon, Liam	
Garantziotis, Stavros	Poccia, Joseph	
Gordenin, Dmitry	Powell, Nancy	





NIEHS Cyberinfrastructure Leadership Committee

**Informatics and Information Technology  
Strategic Roadmap  
Fiscal Years 2019–2021**

National Institute of Health • U.S. Department of Health and Human Services