EXECUTIVE SUMMARY

As communities relax stay-at-home orders and ramp up testing, the public health system is seeing increases in COVID-19 cases. Until vaccines are broadly available, the primary ways of preventing transmission of COVID-19 include interventions such as case investigation, contact tracing, social distancing, and isolation and quarantine. Case investigation and contact tracing are well-established public health functions that have been implemented for many diseases like Ebola, sexually transmitted infections (STIs), and tuberculosis. However, the scale and speed needed for COVID-19 is unprecedented.

An extensive and swift expansion of the case investigation and contact tracing workforce—paired with continuous evaluation to ensure effectiveness—is needed to adequately respond to rising caseloads and rapid investigation cycles. To complement this time-tested, workforce-based solution, technology companies have been engaging with various public health experts to develop new tools that could aid in COVID-19 response efforts. Public health officials may choose to incorporate solutions that can augment and support case investigation and contact tracing while also protecting privacy.

There are a wide range of technology options that can be used to support discrete steps involved in case investigation and contact tracing, including those that provide capabilities for exposure notification, digital surveys, telemedicine, symptom tracking, testing and care coordination options, and “customer” relationship management. However, no single technology solution covers all functions required for case investigation and contact tracing. Taking full advantage of technology options may require layering and linking multiple technologies across the case investigation and contact tracing workflows.

Many of these technologies have not been used extensively for contact tracing and need to be tested to show that they are fit for the purpose. Integrating these tools into the public health infrastructure will require careful thinking about operational issues, privacy and consent, and stakeholder engagement. Given the governance structure of the United States public health system, each state and locality may decide independently on the technology they use to operationalize their case investigation and contact tracing programs.

This guide aims to help health officials think through critical functionalities needed for case investigations and contact tracing, technological options, and issues of implementation in adopting these technologies. It also addresses the latest topic of focus: the Apple|Google exposure notification application programming interface. The background and key considerations included are intended to inform decision-making for technology-enabled enhancement of case investigation and contact tracing capacity.
I. HEALTH AGENCY INFLUENCERS ON CASE INVESTIGATION AND CONTACT TRACING

Governmental public health in the United States consists of 59 state and territorial health departments, nearly 3,000 local health departments, tribal health departments, and the federal agencies that support them, including the U.S. Department of Health and Human Services (HHS), Centers for Disease Control and Prevention (CDC), Assistant Secretary for Preparedness and Response (ASPR), Health Resources and Services Administration (HRSA), U.S. Department of Agriculture (USDA), Environmental Protection Agency (EPA), Centers for Medicare and Medicaid Services (CMS), Office of the National Coordinator for Health Information Technology (ONC), Food and Drug Administration (FDA), and many others. Together through a collection of complex activities, agreements, and funding sources, these local, state, territorial, and federal agencies hold primary responsibility for planning, coordinating, and executing the public health emergency response. State public health governance structures vary across the nation, with over half of states reporting decentralized governance, meaning local government employees hold primary authority over local health units. Close to 30 percent of states report a centralized structure in which state employees primarily lead local health units, with the remainder of states reporting shared and mixed governance structures.\(^1\)\(^2\) The range of governance structures can influence or dictate how public health decisions are made and services delivered—the impact of which is evident during the domestic response to COVID-19.

Across the nation, jurisdictions are implementing a variety of public health containment and mitigation measures, including population-based social distancing strategies, case investigation, and contact tracing. When determining how to assess tools and technologies to support case investigation and contact tracing, jurisdictions involve a range of different leaders or experts, including chief information officers, chief technology officers, chief data officers, informatics experts, epidemiologists or others, which also influences decision-making, planning, and execution of the response.

While there can be agreement on large-scale national policy such as social distancing, contact tracing, and other public health approaches to respond to COVID-19, local implementation can vary significantly. These variations in decision-making factors allow for interventions that are focused and responsive to the epidemiology and needs of the community, yet they can also pose challenges—especially when assessing or implementing novel and evolving tools such as exposure notification mobile applications for an infectious disease that recognizes no borders.

II. TECHNOLOGY FOR CASE INVESTIGATION AND CONTACT TRACING

Case investigation and contact tracing are core public health functions that involve working with individuals diagnosed with an infectious disease to identify and provide support to contacts that may have been exposed to infection. Specifics of contact tracing procedures and job tasks will vary across jurisdictions, but there are common workflows and steps involved (Appendix 1). In addition to the core case investigation and contact tracing workflows, other functions include both the coordination of care during isolation and quarantine, and that of teams executing this work (i.e., to ensure efficient triage, assignment, and hand-offs between job tasks). Technology options may automate or accelerate tasks throughout these workflows.

*Figure 1* provides a condensed conceptual diagram of the workflows for case investigation and contact tracing. The diagram highlights a subset of the case investigation and contact tracing steps described above and will serve as a framework against which relevant technology options can be mapped.
Traditional case investigation and contact tracing can take weeks to carry out. COVID-19 modeling studies, however, have shown that faster contact tracing is needed to curb the spread of infection. Transmission models suggest that contact tracing must be highly effective (i.e., more than 70% of contacts traced)\(^5\) and leverage technology to facilitate instant contact notification in order to contain the epidemic.

The scale at which this work must be carried out is also unprecedented. ASTHO and the Johns Hopkins Bloomberg School of Public Health have estimated that approximately 100,000 contact tracers need to be added to the workforce to adequately conduct large-scale COVID-19 contact tracing.\(^5\) This estimate does not include the workforce requirements for case investigation and other job functionalities. Furthermore, all workforce estimates are dynamic and evolve with patterns of transmission, testing capacity, and other local factors. Meaningful incorporation of technology to accelerate or automate elements of case investigation and contact tracing workflows can serve as a force multiplier for this expanded workforce.

The Case Investigation and Contact Tracing Technology Requirements and Issues

The COVID-19 pandemic and the resulting public health response have accelerated the development of new technologies and digital solutions, and in many cases highlighted multiple needs. In the context of case investigation and contact tracing technologies, these needs—organized into people, process, partnerships, and technology domains—include, but are not limited to:

1. **People:** A skilled workforce trained to assess, develop, and manage technology and digital solutions; vendors with public health expertise.

2. **Process:** Standard evaluation criteria for measuring how well solutions meet the intended outcome; guidance on technology procurements and contracts; trusted data-sharing frameworks within and across state lines; and state and federal resources to support implementation and sustainability.

3. **Partnerships:** Ensuring partnerships with healthcare providers and community-based organizations are in place to connect cases and contacts to needed social or healthcare services.
III. TECHNOLOGIES INTENDED TO ENHANCE CASE INVESTIGATION AND CONTACT TRACING

Data technologies, advanced analytics, and mobile devices can potentially be leveraged as force multipliers for speed and scale in case investigation and contact tracing. As seen in South Korea, Singapore, and China, technology tools can be deployed to facilitate contact tracing with varying outcomes. Several other countries are exploring the use of a range of technologies with a strong focus on proximity sensing and exposure notification capabilities.¹

There is a range of technology that can be used to support the steps involved in case investigation and contact tracing. Table 1 outlines how various technology options can support specific case investigation and contact tracing steps. Descriptions of the technology options are included below.

Notably, no single technology option spans across the full range of steps involved in case investigation, contact tracing, care coordination, or team coordination. Rather, taking full advantage of technology options may require layering multiple technologies across the full range of work functions.

Table 1. A range of technology is useful for specific tasks that enable the overarching case investigation (blue), contact tracing (green), care coordination (purple), and team coordination (orange) capabilities. Checkmarks in the table indicate the technology enables at least part of the function.

<table>
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<th>TYPES OF TECHNOLOGY</th>
<th>Case Investigation</th>
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¹A group at MIT has begun tracking where exposure notification technologies are being deployed. For more information: O’Neill PH, Ryan-Mosley T, and Johnson B. “A flood of coronavirus apps are tracking us. Now it’s time to keep track of them.” MIT Technology Review. May 7, 2020. Accessible at: https://www.technologyreview.com/2020/05/07/1000961/launching-mitts-covid-tracing-tracker/. Covid Tracing Tracker read-only database accessible at: https://docs.google.com/spreadsheets/d/1ATaA5OS8kzZMx_zREoOvHnN8q-Aaq11-CjVRS5CW.
EXPOSURE NOTIFICATION
Exposure notification, sometimes referred to as digital contact tracing or proximity sensing, refers to technology products that support the otherwise manual tasks involved in contact elicitation (traditionally collected during a case interview) and contact notification. If users opt in, deidentified information such as broadcasted Bluetooth pings or location details are shared between mobile devices and/or centralized systems. A contact is then logged when close physical proximity occurs. If someone is diagnosed with COVID-19, these logged contacts can be used to communicate with those in the log that a potential exposure has occurred.

The advantage of exposure notification technology is that it allows contacts to be notified in situations where cases may not know their contacts (e.g., large gatherings or public spaces). This technology has garnered significant public interest given its ability to rapidly warn contacts of their exposure. It is not known how effective this technology will be for COVID-19, as it has not yet been applied for this purpose. Apple and Google jointly released a specification that would enable public health authorities to develop and release exposure notification apps (Appendix 2).

DIGITAL SURVEYS
Case investigators use established questionnaires to conduct interviews and elicit information about close contacts of confirmed or probable cases. The questionnaires are designed to collect information about the case and potential contacts that would likely be at highest risk of exposure. In traditional case investigation models, these questionnaires are used in-person, over the phone, or via videoconference.

For COVID-19, several efforts have focused on digitizing contact elicitation questionnaires so that individuals can opt-in and volunteer information about potential exposures. The benefit of this technology is the ability to make the case interview process faster and scalable. This approach does not require advanced location-based tracking, though it could incorporate data from such systems as they become available. For example, a project called NextTrace is developing digital survey technology to support COVID-19 case investigation and contact tracing.⁶

SYMPTOM TRACKING
Symptom tracking capabilities can be provided by a range of technologies such as apps, websites, and potentially wearable devices.⁷ Integrating these data into contact tracing data systems has been worked out for some systems, such as MITRE’s Sara Alert (Appendix 3).⁸

WEARABLES
Wearables are sensors that are worn by an individual to collect, analyze, or transmit data about the wearer (e.g., heart rate, blood pressure) or their activities (e.g., steps taken, sleep quality). Fitness trackers, smart watches, smart clothes, and real-time patient monitors are all examples of wearable technologies that could be applied to case management or contact tracing.

TELEMEDICINE
Telemedicine allows for the remote provision of healthcare services. Telecommunication capabilities are used to enable connection between healthcare providers and patients for consultation, monitoring, diagnoses, admissions, and clinical interactions. Telemedicine may support diagnosis notification, in addition to medical consultations that may take place during the follow-up and monitoring steps of the case investigation and contact tracing workflows, or as part of a care coordination workflow.

CUSTOMER RELATIONSHIP AND CASE MANAGEMENT SOFTWARE
With respect to case investigation and contact tracing, there are at least two main types of software platforms that enable teams to work together more efficiently and manage data on cases and contacts. These can be broadly described as modified case management software or customer relationship management (CRM) software. Case management tools can support the care coordination workflow by coordinating clinical and support staff to provide treatment to
patients. CRM software can coordinate and track efforts by contact tracer teams and support medical service teams as well. The main objective of these systems is to enable contact tracing teams to manage data collected from cases and contacts and provide quality follow-up services. Within the United States, several systems (e.g., Salesforce, CommCare, Conduent, MTX) are being adapted, piloted, and used by jurisdictions to coordinate different teams.

**Comparison of Exposure Notification Technologies**

Apps designed to automate exposure notification have proliferated. A comparison of some of the dimensions of these approaches is shown in Table 2 below. The table displays types of proximity sensing technologies used in exposure notification by their features and protocols to enable quick decision-making based on what each tool offers.

**Emerging Uses and Practices**

States are considering, developing, and piloting a variety of technology approaches and partnerships to support case investigation and contact tracing (Appendix 4). Most states are contracting with members of the private sector to outsource data storage, data management, and workforce functions. Examples of private sector partner technologies include Sara Alert, Salesforce, Amazon Connect, MTX, Twilio, and Dimagi. Some states are in conversations with Apple and Google about an affiliated API to build mobile exposure notification apps for their residents, and guidance is emerging to support health agencies interested in using this framework. Other states have explored partnerships with non-profits and universities to develop mobile contact tracing apps. While some of these apps utilize location tracking, others use a combination of crowdsourcing and statistical modeling to act upon presumed hotspots.

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Table 2. **Comparison of proximity-based exposure notification apps.**

| TYPES OF PROXIMITY SENSING TECHNOLOGIES USED IN EXPOSURE NOTIFICATION |
|-----------------------------|------------------------|------------------------|
|                            | Bluetooth | Location Services | External Sensors |
| Government-associated privacy | High     | Medium             | Low                |
| Private sector-associated privacy | High     | Low                 | High               |
| Background capable with no new OS features | Requires special application programming interface (API) and app rules | Yes | Yes |
| Can geolocate | No | Yes | Yes |
| False positive problems | Very High | Medium | Medium-low |
| Requires security services coordination | No | No | Yes |
| Requires a network effect of users | Very High | High (herd-immunity level) | No |

Key example(s) Singapore’s TraceTogether; Google/Apple Exposure Notification API and apps MIT SafePaths

**Israel’s HaMagen**

"Struck down by Supreme Court, now uses GPS"
**Table 2 Definitions**

**Bluetooth:** Phones send out pings via Bluetooth Low Energy that are received by other phones and recorded.

**Location Services:** Phones record location using the GPS sensor and WiFi triangulation.

**External Sensors, Multi-Sensor Fusion:** A combination of methods, but mostly from external sensors in use by government security services.

**Government-Associated Privacy:** Government-associated privacy means keeping personally identifiable information (PII) private from federal or local government authorities. Crowdsourced or local proximity sensing technologies such as Ultrasonic and Bluetooth do not inherently require a central authority to collect location data. We mark Ultrasonic as less private because of its reliance on the microphone and in the inability to guarantee that only ultrasonic waveforms are collected.

**Private Sector-Associated Privacy:** Private sector-associated privacy means keeping PII private from private application developers. Geolocation information is widely collected by private sector entities. The private sector can be compelled to share this information with the public sector depending on local laws, therefore the privacy from the government is not high even if there is a promise not to share.

**Background Capable with no New OS Features:** Can the user’s phone be on standby (screen turned off) with proximity sensing still in effect? We believe this capability is essential for wide use of this technology.

**Can Geolocate:** Does the proximity sensing technology give you a longitude and latitude?

**Requires Security Services Coordination:** If the tracking relies on technology only available to intelligence agencies or internal security services.

**Requires a Network Effect of Users:** Decentralized technologies require a wide level of population usage. For example, if an infected person was not using the Bluetooth technology in the days before infection, there will be no way to know who she was in contact with. Likewise, even if she used the app, any contacts not using the app will not know if they were exposed. Location services do not have the latter weakness.

Based on our best expert opinion given descriptions of these technologies, we have assessed options for privacy qualitatively. These assessments must be quantitatively tested to determine their accuracy as technologies are developed and deployed.

**IV. CRITICAL CONSIDERATIONS FOR PUBLIC HEALTH LEADERS**

As noted above, some of the challenges posed by COVID-19 reveal the opportunities and roles digital and technology options can play in case investigation and contact tracing. Beyond these opportunities and functionalities, the decision of whether to adopt and use these digital and technology options includes considerations related to privacy and consent, stakeholder and community engagement, and operational issues. While not an exhaustive list, the considerations below aim to complement emerging guidance to assess and evaluate digital case investigation and contact tracing tools.11,12

**Privacy and Consent Considerations**

The workflows for case investigation and contact tracing set out above involve the collection, storage, access, and sometimes disclosure of personal information. Public health agencies should review and assess the impact that federal
privacy laws and relevant state privacy laws may have on any of the digital and technology options used for case investigation and contact tracing (e.g., the Health Insurance Portability and Accountability Act (HIPAA) and state laws such as the California Online Privacy Protection Act, the California Consumer Privacy Act, the Minnesota Government Data Practices Act, and the Kansas COVID-19 Contact Tracing Privacy Act). Public health agencies should consult with their legal counsel if they have any questions about the applicability of federal or state law.

It is important that the design of technology options addresses privacy considerations while also deriving public health benefits from the data. These considerations should address the points of data collection, storage, access, and disclosure and also reduce the likelihood of a privacy breach. Breaches of privacy can result from the unauthorized disclosure of the data and linkage attacks. An example of unauthorized disclosure is when personally identifiable information (PII) is unwittingly sent to a cloud service during data use and analysis. Linkage attacks occur when de-identified data is linked to additional data sources to allow re-identification.

*The privacy and consent considerations outlined below are relevant across the spectrum of technology types articulated in Table 1.*

**POINT OF COLLECTION**

- Clearly and explicitly define and communicate the purpose for collecting the data.

- Limit the collected data to what is necessary and relevant for the purpose.

- Depending on the case investigation or contact tracing functionality being implemented, consider whether data computation will be done on the device collecting the data or sent and returned to the device after computation.

- Ensure that collected data are accurate and of sufficient quality for the intended use.

- Encrypt the data when it is collected, transmitted and stored. When possible, use password protected files on the device collecting the data. Avoid transmitting unencrypted data that could be copied by an email provider and remain on a computer server.

**POST-COLLECTION STORAGE AND ACCESS**

- Ensure that only a minimum number of necessary people or systems have access to the data through user access controls and/or password protections and limit the sharing of passwords.

- Continue data encryption if the data is transferred from the device that collected it and stored on another computer system.

- Develop and maintain policies for what is and is not an acceptable use of collected data.

- If feasible, use technical solutions to block unacceptable use of data and make sure staff with data access are trained on the acceptable use policy. Develop and use practices to prevent the data’s unauthorized disclosure through human error and create access and usage logs for the data.
DATA DISCLOSURE

- Only the minimum amount of information collected for case investigation and contact tracing that is necessary and consistent with acceptable use policies should be disclosed. Aggregation and differential privacy (see more below) can provide safeguards against linkage attacks. If feasible, only allow access for research through a control system rather than sharing a copy of the data.

- To the extent possible, erect barriers to prevent unacceptable use. This might include displaying data as static images rather than interactive web applications, disallowing download, or having researchers sign data use agreements.

- To the greatest extent possible, use activity logs on any website with an application serving sensitive data. Logging any activity at the point of storage and processing may also capture unauthorized access by a cloud service’s API.

OTHER CONSIDERATIONS

- Unless allowed by state or federal law (e.g., situations to which the public health exception to HIPAA’s Privacy Rule are applicable), consent for the collection and use of personal information should be voluntary, as well as freely and expressly given. Consent should be obtained with clear, specific, and comprehensible language.

- Location data is particularly prone to linkage attacks and can alone be enough to identify a person (e.g., a nightly series of location data collected from a house can identify the person living there). When location data is displayed in a web application, aggregating over geographical areas and adding differentially private noise may limit the risk of linkage attacks.

- Differential privacy is a mathematical definition of privacy that can limit linkage attacks. The mathematical definition adds noise to data or data computations that reduces the likelihood of information leaking and extends to downstream computations. While differential privacy does not guarantee that information will not leak, it quantifies the tradeoff between privacy of individual records and precise computations so the data owner can adjust to their level of risk tolerance.

Community and Stakeholder Considerations

Certain populations are at higher risk for severe outcomes from COVID-19 and may lack access to the technology or technology infrastructure (e.g., internet service, a mobile device or other computer, cell phone coverage, etc.) leveraged for contact tracing. These populations may include individuals experiencing homelessness, the elderly, low-income individuals and families, etc. The use of additional public health measures, such as in-person contact tracing and efforts to raise community awareness and acceptance of contact tracing, should be considered for these populations. Additionally, with evidence showing the disparate impact of COVID-19 on minority communities, it is important to ensure that any technology solution is culturally and linguistically competent and trusted within these communities. Doing so can prevent creating new—or exacerbating existing—health disparities.

The use of technology options in case investigation and contact tracing may raise concerns about privacy and discrimination. Engaging with privacy, security, accessibility, and civil rights experts, in addition to community leaders, as technologies are being vetted and operationalized will support efforts to gain community buy-in and acceptance. In some instances, individuals may feel that they have been wronged through their engagement with case investigation or contact tracing technologies. Clear policies for those seeking redress should be determined prior to rolling out any technology options. Community-based organizations and healthcare providers should also be consulted, as their staff may support the care coordination activities that flow from case investigation and contact tracing.
Operational Considerations

Operational considerations related to the use of digital and technology options for case investigation and contact tracing include the needed expansion of the contact tracing workforce, issues around cross-jurisdictional collaboration and sharing of data, and other legal considerations beyond data privacy and security.

**CONTACT TRACING WORKFORCE**

Implementation of technology options must support existing efforts to expand the contact tracing workforce. Appropriate training and ongoing support should be provided to case investigators, contact tracers, and other job functions involved in using technology systems. Workforce planning should account for increased needs for IT support staff and data managers, as well as infrastructure support for local health departments and communities. These positions are critical in supporting uptake of any new technologies, management of digital infrastructure, and new developments or modifications to existing data systems.

**CROSS-JURISDICTIONAL COLLABORATION AND DATA SHARING**

While decisions around technologies implemented to support case investigation and contact tracing are made at the state level, the implications may be felt across borders. For example, fragmented approaches to the adoption of exposure notification technologies could reduce the likelihood of gaining the number of users required to make these technologies effective. Adoption of differing technologies may also challenge real-time data collection, analysis, and sharing capabilities for cases and contacts who may travel between jurisdictions.

Health officials should consider the following issues which may nurture or impede cross-jurisdictional data sharing:

- Current technological infrastructure and staff available to support data sharing.
- Cultural and community concerns regarding trust and ownership of data.
- Promising practices from organizations that have interjurisdictional data exchange or sharing agreements in place.
- Defining a standard minimum data set for information recorded by case investigation and contact tracing technologies.
- Ensuring transparency and privacy of case and contact data throughout the data exchange process, with clear information about data ownership and use.
- Laws, policies, or processes for effective cross-jurisdictional collaboration for case investigation and contact tracing.
PURCHASING MODELS

Decision-makers responsible for procuring, building, or repurposing technology to support case investigation and contact tracing may consider an array of purchase models, including:

- Paid subscription with required licenses for each user.
- Paid subscription without required licenses.
- License-free for a temporary period of time (post-COVID-19).
- Current purchased product or contractual agreement being repurposed for COVID-19 case investigation and contact tracing.
- Purchased new product with fee for service including consultation and technical support from the development team.
- Open-source or freely available tools with technical support from an implementation partner.

OTHER LEGAL CONSIDERATIONS

The use of digital and technology options for case investigation and contact tracing will require an awareness of federal and state laws and regulations related to other sectors beyond public health and healthcare and in addition to areas of privacy. The digital and technology options should be consistent with the laws and regulations governing telecommunications, consumer protection, online privacy of children, and electronic surveillance. Employment and labor law may also come into play if an employer is directed to require the use of the technology or an employee is required by an employer to use it.

Contracts for digital and technology projects often require different considerations than contracts for other products and services. For example, when negotiating these types of contracts, consider using a Statement of Objectives instead of a Statement of Work to avoid costly and timely change orders. Also, for specialized projects it may be better to use a variety of purchased or built systems rather than relying on commercial off-the shelf software that can cost extra to customize and update. Needed changes are likely to occur as more information is learned about COVID-19 and successful countermeasures to it. For custom software, governments should consider obtaining all legal rights, source code, build and test scripts, etc., so that if necessary, any future changes can be made by the government agency itself or by a different vendor. Otherwise, the agency could be locked into services from the initial vendor for all future changes, risking inordinate costs. Additional resources, such as checklists and questions for state agencies to ask when executing contracts with digital and technology vendors are available.14
**BENEFITS OF OPEN SOURCE OPTIONS**

Health agencies implementing case investigation and contact tracing programs have jurisdiction-specific requirements to support integration to internal systems, privacy adherence, launch and feature release timing, external data sharing, and the skills of technical teams. Open source software is software where anyone can inspect, modify, and enhance its source code (the form of software suitable for modification). Open source software has proven itself to be one of the most effective ways to deliver individual application deployment needs without the penalty of building and supporting bespoke solutions.

Development of open source software technologies are handled through mass collaboration. As a result, engineering choices are transparent and open for review. Subsequently, internal and external integration paths are adaptable and known. Privacy implementations can be verified by both community developers and security domain experts. And finally, technical staff can use shared training resources to gain understanding of a common contact tracing architecture. **While anyone can modify such software, organizations such as public health agencies can select which version they deploy, making open source solutions a cost-effective way of implementing software.**

**V. CONCLUSION**

The unprecedented experience of the COVID-19 pandemic is prompting technology companies and public health officials to explore and consider novel options to support proven, workforce-driven case investigation and contact tracing activities. While technology options should not supplant the people-centered efforts of case investigators and contact tracers, digital tools do hold the promise of accelerating and automating portions of these traditionally manual workflows.

Though a wide array of technology options are being developed and piloted across jurisdictions, models of technology-enabled contact tracing are nascent, and decision-makers must consider issues related to privacy and consent, stakeholder and community engagement, and operational issues. Because no single technology option addresses the full arc of functionalities required for rapid and scaled up case investigation and contact tracing, layering multiple technologies may be required to take full advantage of digital options to support this work.

To improve effectiveness and outcomes, standards for evaluating data technologies should be established and evolved based on lessons learned. Case investigation and contact tracing technologies should be assessed to ensure they accomplish their intended function and protect data appropriately. The CDC has developed preliminary criteria for evaluating digital contact tracing tools, and ongoing engagement from the public and private sector is required to develop and refine evaluation standards.

Though the demands on health agencies during the COVID-19 pandemic are extraordinary, they are continuously innovating and building or strengthening non-traditional relationships, including with partners in the technology sector. As states explore technology options that are culturally acceptable, privacy protecting, and fit for function, planning for sustainability is also key. Further, the technology innovations being explored— if deployed responsibly and effectively— could help save lives during the COVID-19 pandemic and beyond.

While this guide aims to provide an overview of the factors and considerations policy leaders should take into account for decision-making, planning and implementation purposes, the authors do wish to note that additional efforts to guide decision-making for leaders, as well as address significant challenges such as system interoperability between existing and new technologies, is still needed. As some jurisdictions pilot various approaches, lessons learned and emerging practices should be closely examined and shared broadly.
RESOURCES FOR PUBLIC HEALTH LEADERS

Think Tank, Academic, and Foundation Reports and Resources

- ASTHO COVID-19 Technology and Digital Solutions Master Data Sheet
- CDC Digital Contact Tracing Tools for COVID-19
- Contact Tracing Mobile Apps for COVID-19: Privacy Considerations and Related Trade-offs
- Health Affairs: Protecting Privacy in Digital Contact Tracing For COVID-19: Avoiding A Regulatory Patchwork
- Linux Foundation Public Health Landscape
- Public Health Informatics Institute (PHII) Digital Tools in Support of Contact Tracing for COVID-19
- Resolve to Save Lives: COVID-19 Contact Tracing Playbook
- U.S. Digital Response
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ASTHO is the national nonprofit organization representing the public health agencies of the United States, the U.S. territories and freely associated states, and the District of Columbia, as well as the more than 100,000 public health professionals these agencies employ. ASTHO members, the chief health officials of these jurisdictions, are dedicated to formulating and influencing sound public health policy and to ensuring excellence in public health practice.

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Appendix 1: Case Investigation and Contact Tracing Workflows

Case investigation and contact tracing involve working with individuals that have been diagnosed with an infectious disease to identify and support contacts that may have been exposed to infection. Contact tracing procedures and job tasks will vary across jurisdictions, but there are common workflows and steps involved, as described by CDC. Tasks most impacted by the evolution of technology solutions during the COVID-19 pandemic are highlighted and align with the representative functions described in Figure 1 (found on page 4).

CASE INVESTIGATION

CONTACT TRACING

COLOR KEY
Representative function as described in Figure 1
- Case investigation
- Contact tracing
- Care coordination
- Team coordination

*Adapted from CDC’s Case Investigation and Contact Tracing workflows.
In addition to the core case investigation and contact tracing workflows, vital functions include the coordination of care during isolation and quarantine, and the coordination of team members involved in this work.

**CARE COORDINATION (HIGHLIGHTED IN PURPLE)**
Information collected in the case or contact interviews may inform care coordination activities. These activities may include linking individuals to medical care and social supports (e.g., housing, food delivery, childcare, etc.) that will help them adhere to isolation and quarantine recommendations. The division of job tasks across case investigation, contact tracing, and care coordination will vary across jurisdictions. Depending on local or state process variations, care coordination may overlap with monitoring and follow-up steps included in the case investigation and contact tracing workflows.

**TEAM COORDINATION (HIGHLIGHTED IN ORANGE)**
Roles and responsibilities involved in supporting COVID-19 case investigation and contact tracing are complex, and may require discrete job functions for case investigators, contact tracers, care resource managers, high-risk medical monitors, team leads, and surveillance and triage support—to name a few. Coordination of these teams requires efficient triage, assignment, and hand-offs between job tasks. This work also involves the management of a high volume of data collected throughout each of these workflows. In the diagram above, steps involving hand-offs, triage, and referral of cases or contacts amongst team members are highlighted as team coordination steps.
5. How will the system protect user privacy and security?

Google and Apple put user privacy at the forefront of this exposure notification technology’s design and have established strict guidelines to ensure that privacy is safeguarded:

- Each user will have to make an explicit choice to turn on the technology. It can also be turned off by the user at any time.

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Footnote:

HIGHLIGHT: SARA ALERT ENGAGEMENT OF ASTHO MEMBERS

- ASTHO and its respective members were approached by MITRE to inform and pilot their Sara Alert open-source tool. The tool allows remote monitoring of persons exposed to or infected with COVID-19.

- After weeks of refining their initial proof of concept and engaging in user testing, two health agencies were prepared to pilot test and implement the tool.

- Each health agency had various reasons for being an early adopter, including building up data and informatics infrastructure, data modernization efforts, or because the current technologies being used did not adequately manage the volume of cases for the jurisdiction, requiring more time or manual labor than was feasible.

- Currently, 11 jurisdictions have adopted the Sara Alert tool for their case management efforts and MITRE is actively engaging in discussions to build a smart Fast Healthcare Interoperability Resources API that allows other information systems to easily connect with the tool, including Apple and Google’s exposure notification system, REDCap, and other contact tracing applications.

MITRE. “Sara Alert.” Available at: https://saraalert.org/.


**Appendix 4: Current COVID-19 Technology and Digital Solutions**

ASTHO collected data on state and territorial health agency adoption of COVID-19 technology and digital solutions used for surveillance, case investigation, symptom monitoring, case data management, and data analysis/visualization. This evergreen resource continues to be updated bi-monthly, with the last update occurring on June 24, 2020. This data includes details about the vendors and functionality of each option as operationalized by health agencies.

A live and more detailed version of this table is available in the data sheet [here]. Data was sourced in raw, unstructured form from discussions with health agencies as they began their implementations. Greyed out boxes in the table represent gaps in information, including several cases where the information is still changing and not available. ASTHO continues to collect, refine, update, and validate this data with health agency leaders and staff working on COVID-19.

**COVID-19 Technology and Digital Solutions Details**

<table>
<thead>
<tr>
<th>Name</th>
<th>Data Customization (Y/N)</th>
<th>Characteristics</th>
<th>Developer</th>
<th>Resources/Cost Model</th>
</tr>
</thead>
</table>
| Care19 (North Dakota) | Yes                      | **Case volume support:** Low  
**Contact notification:** Contact management limitations  
**Data tracking:** Confirmed cases only  
**Load testing:** Required | ProudCrowd and customized by North Dakota Department of Health | Cost and resource considerations for adoption and implementation                        |
| Care19 (South Dakota) |                          | **Availability:** Rapid deployment, in use for COVID-19  
**Case/PUI identification:** Import data, real-time synchronization capable  
**Clinical Decision Support:** Yes  
**Contact Elicitation/Identification:** Manually record data on case contacts  
**Contact Notification:** Manual and automated contact notification  
**Contact Follow-up:** Follow-up with known contacts for longitudinal data  
**Platform support:** Accessible via mobile or web browser, offline data entry  
**Other:** TA support from vendor, vendor has public health experience, supports case management | Dimagi                                            |                                                                                     |
<p>| CommCare        |                          |                                                                                                                                 |                                               |                                                                                     |</p>
<table>
<thead>
<tr>
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</table>
| COVID-19 Epidemiological Surveillance System | Yes                      | **Platform:** App-based  
**Other:** Standalone technology or monitoring service                                                  | Puerto Rico Public Health Trust | License Required for ArcGIS               |
| emocheck                                 | No                       | **Platform:** App-based  
**Other:** Standalone technology or monitoring service                                                  | emocheck Mobile Health, Inc. - John’s Hopkins | Paid-subscription service                 |
| Epi Info™                                 | Yes                      | **Availabilty:** Open source  
**Data tracking:** Confirmed cases only  
**Data entry:** Manual  
**Platform:** App-based  
**Load testing:** Required in large jurisdictions  
**Privacy concerns:** Yes  
**Tool communication/Outreach:** Tracks locations visited not individual contacts | CDC                             | Open Source                             |
| EpiTrax                                   | Yes                      | **Case/PUI Identification:** Requires data migration from legacy system  
**Platform:** Accessible via mobile or web-browser  
**Other:** Upgrades available to expand access rights, TA support and maintenance | Utah Department of Health       | Annual subscription                     |
| Custom SMS Healthy Together Beta App and TestUtah | Yes                      | **Contact notification:** Manual and automated contact notification of other app users  
**Load testing:** Required for use in large jurisdictions  
**Platform:** App-based  
**Other:** Locate testing centers, view test results, education | Utah Department of Health (Developer - Twenty Holdings, Inc.). | Open source - Utah residents only         |
| Maven COVID-19                            | Yes                      | **Availability:** Rapid deployment, in use for COVID-19  
**Case/PUI Identification:** Import data, real-time synchronization capable  
**Contact Elicitation/Identification:** Manually record data on case contacts, self-report contacts  
**Contact Notification:** Manual and automated contact notification  
**Contact Follow-up:** Follow-up with known contacts for longitudinal data, automated reminders to contacts, automated predictions based on self-reported data  
**Interoperability:** Yes- with existing and external systems  
**Platform support:** Accessible via mobile or web browser  
**Other:** TA support from vendor, vendor has public health experience | Conduent, Inc.                  | License required                        |
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</tr>
</thead>
</table>
| Custom Microsoft Solution (Microsoft Dynamics)                        | Yes                      | **Availability**: Rapid deployment, in use for COVID-19  
**Case/PUI Identification**: Import data, real-time data synchronization  
**Contact Elicitation/Identification**: Manually record data on case contacts, self-report contacts  
**Contact notification**: Manual and automated contact notification  
**Contact Follow-up**: Follow-up with known contacts for longitudinal data, automated reminders to contacts, automated prediction based on self-reported data  
**Platform support**: Accessible via mobile or web browser, offline data entry  
**Other**: TA support from vendor, vendor has public health experience | Microsoft    | License required                             |
| ContaCT (Connecticut)                                                |                          |                                                                                                                                                  |              |                                             |
| Apple|Google Contact Tracing                                                |                          |                                                                                                                                                  | Apple, Google, and State/ Territorial Health Agencies own the data and the actual application |              |                                             |
| REDCap                                                              | Yes                      | **Availability**: Rapid deployment, in use for COVID-19, insufficient automation which does not meets needs  
**Case/PUI Identification**: Import data, real-time data synchronization  
**Case Volume Support**: Does not keep up with the volume of cases  
**Contact Elicitation/Identification**: Manually record data on case contacts, self-reported contacts  
**Contact Notification**: Manual and automated contact notification  
**Contact Follow-up**: Follow-up with known contacts for longitudinal data, automated reminders to contacts, automated prediction based on self-reported data  
**Level of Back-end Maintenance**: High  
**Platform Support**: Accessible via mobile or web browser, offline data entry  
**Surveillance system integration**: Difficult  
**Staff capacity/requirements**: Manual burden and custom applications are defined by the user  
**Other**: Vendor has public health experience | Vanderbilt    | Free to non-profit, academic, and governmental institutions                        |
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</table>
| Customer Salesforce Solution| Yes                      | **Availability**: Rapid deployment, in use for COVID-19, costs for non-school entities (schools receive MTX version for free)  
**Case/PUI Identification**: Import data, real-time data synchronization  
**Contact Elicitation/Identification**: Manually record data on case contacts, self-reported contacts  
**Contact Notification**: Manual and automated contact notification  
**Contact Follow-up**: Follow-up with known contacts for longitudinal data, automated monitoring and reminders to contacts (SMS), automated prediction based on self-reported data, includes scripts based on call outcomes  
**Platform Support**: Accessible via mobile or web browser, offline data entry, multiple languages  
**Other**: TA support from vendor, vendor has public health experience, used for symptom monitoring, integration with tools like Amazon Connect, cases pushed in from surveillance system into Salesforce | Salesforce System Integrators, which include Accenture, Deloitte, MTX | License required         |
| Sara Alert                  | Yes                      | **Availability**: Rapid deployment, in use for COVID-19  
**Case/PUI Identification**: Import data  
**Contact Elicitation/Identification**: Manually record data on case contacts  
**Contact Notification**: Manual and automated contact notification  
**Contact Follow-up**: Follow-up with known contacts for longitudinal data, automated reminders to contacts, automated prediction based on self-reported data  
**Platform Support**: Accessible via mobile or web browser  
**Staff capacity/requirements**: Requires dedicated staff time for deployment/launch and to maintain monitoring workflow  
**General**: TA support from vendor, vendor has public health experience, messaging available in multiple languages, supports vulnerable populations | MITRE                              | Open Source                      |
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</thead>
</table>
| Text Illness Monitoring (TIM)| No                       | **Availability:** Open source, license free  
**Contact Elicitation/Identification:** Manually record data on case contacts  
**Case Volume Support:** Low  
**Contact Notification:** Manual and automated contact notification  
**Contact Follow-up:** Management limitations  
**Other:** Produces reports listing all text responses | CDC’s National Center for Immunization and Respiratory Diseases |                                                              |

*Availability, Contact notification, Data Tracking, Data Entry Case Volume Support, Load Testing, Privacy Concerns Case/PUI Identification Clinical Decision Support, Contact Elicitation/Identification Contact Follow-up, Platform Support, Tool Communication/Outreach, Interoperability, Level of Back-end Maintenance, Surveillance System Integration, Staff capacity/requirements, General, Other (relevant information that does not fit in the above the categories)
REFERENCES


