Workshop on Challenges for Digital Proximity Detection in Pandemics: Privacy, Accuracy, and Impact

Jan. 26 - 28, 2021

https://www.nist.gov/news-events/events/2021/01/challenges-digital-proximity-detection-pandemics-privacy-accuracy-and

Tuesday, January 26, 2021

All times are Eastern Standard Time (EST)

10:00 am **Welcome and Opening Remarks**

10:10 am **Who should you be talking to? 3 lessons in interdisciplinary problem-solving**

Joanna Masel, Professor, Department of Ecology & Evolutionary Biology, University of Arizona

A critical look at exposure notification through the lens of its end-goal – fighting the pandemic – reveals a variety of pitfalls in interdisciplinary problem-solving. For example, assuming that problems in disciplines other than your own are already solved can lead to overly narrow design specifications, such as classification with respect to 6 foot 15 minute thresholds rather than estimation of infection risk. Strategies for extracting information from other disciplines, and indeed for discovering the existence of relevant disciplines in the first place, will be discussed.

10:55 am **A Brief Tutorial on Private Automated Exposure Notification for COVID-19**

Marc Zissman, Associate Head, Cyber Security and Information Sciences Division, Lincoln Laboratory, Massachusetts Institute of Technology

Beginning early in the pandemic, international teams of cryptographers, electrical engineers, physicians, computer scientists, public health professionals, privacy experts and other specialists proposed approaches to automate the process of detecting potential exposure to COVID-19-infected individuals using Bluetooth signaling on smartphones that could supplement conventional, manual contact tracing (MCT). The value proposition had four components: automated exposure notification could lead to faster alerting and action vs MCT alone, could reach persons who are not personally known to an index case, could continue to function even when MCT reaches resource limits or breaks down, and could provide alerts while protecting privacy. Influenced to some extent by the work of these international teams, Apple|Google developed an automated exposure notification system based in part on the protocols and prototypes developed and demonstrated by these international teams. A|G deployed that system quickly and widely, and the system is now in use in over 30 nations and US states, has been enabled via user opt-in on tens of millions of smartphones, and has provided hundreds of thousands of exposure notifications to close contacts. To varying extents, all four elements of the value proposition have been proven – the system works. In this talk, the overall approach to private, automated exposure notification is explained, with emphasis on the operation and performance of all three layers: Bluetooth-based proximity measurement, the private cryptographic protocol, and the public health /

individual user interfaces. Preliminary estimates of both performance and effectiveness from deployments around the world are discussed.

11:25 am **Transition**

11:28 am **Real-world effectiveness of digital contact tracing**

Luca Ferretti, Senior Researcher in Statistical Genetics and Pathogen Dynamics at the Big Data Institute, University of Oxford

After many countries deployed apps for proximity detection and exposure notifications, there is still a lack of understanding of their potential and actual impact. In this talk we review the theoretical expectations about the potential impact of app-based contact tracing, and we discuss the main known and unknown factors that affect its effectiveness. Then, we discuss the role of these factors and the actual impact of such apps in some European countries.

11:50 pm **Break**

12:20 pm **Transition/introduction of speakers**

12:25 pm **The SwissCovid GAEN app after six months: It's not just about technology.**

Viktor von Wyl, Assistant Professor, Epidemiology, Biostatistics and Prevention Institute, University of Zurich

The SwissCovid app was released in Switzerland as one of the first GAEN apps on June 25, 2020. This presentation will briefly recap the challenges for measuring effectiveness in a highly decentralized health system, the state of evidence for effectiveness, as well as lessons learned. Ultimately, the success of GAEN apps not only depends on technological aspects but also on appropriate health system embedding and engagement by different actors.

12:47 pm **Public acceptance of emerging technologies**

Alta Charo, Knowles Professor Emerita of Law & Bioethics, University of Wisconsin Madison

This presentation will describe some experiences in the past with public reaction to new technologies, and identify measures that can be taken to increase enthusiasm, decrease concern, and substantively address risks.

1:09 pm **Public health perspective of digital contact tracing in COVID-19 using Bluetooth-enabled technology**

Meghna Patel, Deputy Secretary for Health Resources and Services, Pennsylvania Department of Health

The spread of COVID-19 in the communities is so overwhelming across the globe that the ability to track, trace, isolate and test the individuals suspected to have the virus is impossible without the influx of additional staff and use of technology assisted applications. Traditional contact tracing is unable to account for contact with individuals

unknown to the person who tested positive (e.g., an individual who tested positive cannot name others he/she rode the bus with). Bluetooth-enabled technology is a promising solution to assist with exposure notification where traditional contact tracing cannot. It is important that guiding principles of data privacy remains at the core when implementing a technology- assisted exposure notification. These applications will be effective if priority for testing is established or mass testing is available or both as well as massive campaign focusing on trust. As the future of public health becomes more led by technology to help stop the spread of infectious diseases, there are several limitations to implementing and sustaining digital contact tracing technology solutions.

1:31 pm **Break**

1:40 pm **Transition/introduction of speakers**

1:45 pm **Privacy considerations, an overview**

Naomi Lefkovitz, Senior Privacy Policy Advisor, Information Technology Lab, NIST

Management of privacy risks, whether real or perceived, is a key factor in successful adoption of large-scale pandemic technology solutions. This presentation provides an overview of some of the privacy considerations for proximity detection technologies, including considerations for assessing tradeoffs with effectiveness, usability, security, and different implementation environments.

2:07 pm **Privacy preserving protocols for encounter metrics**

Rene Peralta, Computer Scientist, Cryptographic Technology Group, NIST

We propose measuring aggregate levels of encounters in a population, a concept we call “encounter metrics”. Our proposal is to design encounter metrics in such a way that it can be deployed while preserving the privacy of individuals. To this end, our proposal is to label encounters with a random number (an encounter ID) that cannot be linked to anything that is broadcast at the time of the encounter. This mitigates significant privacy concerns inherent to methods that broadcast and track user pseudonyms instead of encounter IDs.

Encounter metrics can be used to analyze the interactions within populations as we attempt to safely restart our societies during the pandemic of 2020. The aggregate encounter metric statistics will facilitate analysis of population interactions in buildings, comparisons across buildings or campuses, and data-driven adjustments in reopening processes. These measurements will also be valuable in designing our future working environments to be more resilient to spread of infectious diseases.

2:19 pm **Privacy by Design as Infrastructural Power**

Seda Gürses, Associate Professor, Department of Multi-Actor Systems at TU Delft

During this talk, I will give an overview of the series of events that led to and followed from the development of the Decentralized Privacy Preserving Proximity Tracing (DP3T) protocol that underlies the Google Apple Exposure Notification (GAEN) API. Underlying engineering efforts in privacy by design is the assumption that data control and data

minimization will enable the protection of individuals and therewith mitigate the growth of power asymmetries. The GAEN story, however, suggests that data minimization, a guiding design principle for engineers and privacy advocates, may not always come to tame power. On the contrary, the infrastructural advantage that companies like Google and Apple possess allows them to leverage privacy enhancing protocols to expand their reach. This has serious repercussions both for privacy by design as well as the democratic governance of technologies for public use, matters pertinent to reflect on given the increasing number of applications for population management using digital technologies.

2:41 pm **Transition/introduction of speakers**

2:45 pm **Flipping the Perspective on Contact Tracing**

Po-Shen Loh, Founder of NOVID, Professor of Mathematical Sciences at Carnegie Mellon University, and National Coach of USA International Math Olympiad team

We introduce a fundamentally different paradigm for contact tracing, enabled by the proliferation of smartphones: for each positive case, do not only ask direct contacts to quarantine; instead, tell everyone how many relationships away the disease just struck (so, "2" is a close physical contact of a close physical contact). This new approach, which has uniquely been deployed in the publicly downloadable app NOVID, brings a new tool to bear on pandemic control, powered by network theory. Like a weather satellite providing early warning of incoming hurricanes, it empowers individuals to see transmission approaching from far away, and becomes the first proximity detection app whose installation reduces the user's own chance of infection.

This flipped perspective incites natural self-interested instincts of self-preservation, reducing reliance on altruism, and the resulting caution reduces pandemic spread in the social vicinity of each infection. Consequently, our new system solves the behavior coordination problem which has hampered many other app-based interventions to date. Indeed, from the game-theoretic perspective of Nash Equilibria, standard apps unfortunately only reach equilibrium when nobody installs, whereas our approach is also at equilibrium when everybody installs. In addition to this, our approach has 3 order-of-magnitude power gains over the status quo.

3:07 pm **Machine learning based digital proximity detection: lessons learned from the NIST TC4TL Challenge and beyond**

Omid Sadjadi, Computer Scientist, Information Technology Lab, NIST

The NIST pilot Too-Close for Too-Long (TC4TL) Challenge, which was conducted in the summer of 2020 in response to the COVID-19 pandemic, was a machine learning challenge to explore promising new ideas in, and evaluate the efficacy of, digital proximity detection based on Bluetooth Low Energy (BLE) and other smartphone sensor data. This talk will provide an overview of the TC4TL challenge, including descriptions of the task, datasets, performance measure, participation statistics, as well as results and system performance analyses. Some potential avenues for future work will also be presented and discussed.

3:30 pm **Adjourn**

Wednesday, January 27, 2021 — All times are Eastern Standard Time (EST)

10:00 am **Panel discussion on the *effectiveness of digital proximity detection at limiting the spread of infectious diseases*.**

This panel will discuss questions such as *How should we define 'effective'? How do we know models showing proximity detection effectiveness are right? How does the implementation and effectiveness change for different sizes and types of communities?*

Krister Shalm (moderator), Applied Physics Division, NIST and Physics Department, University of Colorado, Boulder

Marc Zissman, Associate Head, Cyber Security and Information Sciences Division, Lincoln Laboratory, Massachusetts Institute of Technology

Po-Shen Loh, Founder of NOVID, Professor of Mathematical Sciences at Carnegie Mellon University, and National Coach of USA International Math Olympiad team

Mike Judd, Lead, COVID-19 Exposure Notification Initiative, US Centers for Disease Control and Prevention

Viktor von Wyl, Professor, Epidemiology, Biostatistics and Prevention Institute, University of Zurich

Louise Ivers, Professor of Medicine, Harvard Medical School; Interim Chief of Infectious Diseases and Executive Director of Center for Global Health – Massachusetts General Hospital

11:30 am **Instructions for breakout sessions**

11:40 am **Break**

Breakout session topics are tentative and may change based on Jan. 26 presentations and attendee feedback (via survey). Finalized workshop topics and links to sessions will be e-mailed to participants before 10 am ET on Jan. 27.

At 12:40 there will be a 10-min break. Participants join a different breakout session for the final 40 minutes if they want to participate in another discussion.

12:00 pm	**1a *Applications of proximity detection***	**1b *Privacy 1***	**1c *Technologies for Proximity Detection***	**1d *Role of government***
	What are the different ways proximity detection can be used to limit the spread of pandemics (digital contact tracing, encounter metrics, etc.)?	*How are privacy risks generated by proximity detection technologies understood and managed?*	*How accurately can different technologies identify a contagious interaction?*	*What role should local, state, and federal government play in digital contact tracing?*

	Which are most promising?			
	Facilitator: Leah Kauffman	**Facilitator:** Jessica Staymates	**Facilitator:** Ashley Boggs	**Facilitator:** Brandi Tolliver

1:30 pm **Break**

At 2:40 there will be a 10-min break. Participants join a different breakout session for the final 40 minutes if they want to participate in another discussion.

2:00 pm	**2a *Implementation***	**2b *Privacy 2***	**2c *Technology verification***	**2d *Commercialization***
	What adoption rate is needed to be effective in different communities? What are the barriers to adoption and use, and how should they be addressed?	*What are the greatest challenges to achieving strong privacy properties while delivering effective proximity detection? How can privacy gains or losses be understood with different implementations?*	*What is needed to verify the performance of proximity detection technologies?*	*What are the barriers to commercialization?*
	Facilitator: Jeanita Pritchett	**Facilitator:** Jessica Staymates	**Facilitator:** Callie Higgins	**Facilitator:** Jeremy Lawson

Thursday, January 28, 2021 — All times are Eastern Standard Time (EST)

10 am **Reports from working groups (10 minutes each)**

Moderator: Heather Evans, Program Coordination Office, National Institute of Standards and Technology

11:30 am **Contributed Talks**

Moderator: Michelle Stephens, Applied Physics Division, National Institute of Standards and Technology

11:30 am ***Privacy-Protecting COVID-19 Exposure Notification Via Cluster Events Without Proximity Detection***, Paul Syverson, U.S. Naval Research Laboratory

11:42 am ***Augmenting GAEN with opt-in case linking***, James Petrie, WeHealth

11:54 am ***Adoption metrics for Proximity Technologies***, Scott David, Director of Information Risk Research Initiative (IRRI), University of Washington Applied Physics Laboratory

12:06 pm ***Modeling the impact of automatic exposure notification for vulnerable communities*** Krister Shalm, Applied Physics Division, NIST and Physics Department, University of Colorado Boulder

12:18 pm ***Understanding and Rewiring Epidemic Networks: A Data-driven Approach Towards Enabling Quarantine in-Motion***, Radu Marculescu, Department of Electrical & Computer Engineering, The University of Texas at Austin

12:30 pm **Break**

1:00 pm **Contributed Talks/Discussion**

Moderator: Michelle Stephens, Applied Physics Division, National Institute of Standards and Technology

1:00 pm ***Interoperable Privacy Preserving Digital Contact Tracing***, Yang Yaling, Virginia Tech

1:12 pm ***Function Secret Sharing for PSI-CA: With Applications to Private Contact Tracing***, Steve Lu, Stealth Software Technologies, Inc.

1:24 pm ***Modelling multipath interference for BLE proximity detection and exposure scoring***, Ramsey Faragher, CEO Focal Point Positioning, Fellow in Computer Science, Queen's College, University of Cambridge

1:36 pm ***COSMOS Testbed – Proximity Detection and Social Distancing Estimation in COVID-19 Pandemic***, Zoran Kostic, Electrical Engineering Dept., Columbia University

1:48 pm ***A Simplistic Machine Learning Approach to Contact Tracing*****,** Niamh Belton, ML-Labs, University College Dublin

2:00 pm ***The Feasibility of Co-location Detection through a Deep Learning Fusion of Mobile Sensors***, Sheshank Shankar, Data Science Researcher, PathCheck Foundation

2:12 pm ***Entropy Based Discretization's and Weight Optimization for Configuring the GAEN system***, Nicholas Maynard, The MITRE Corporation

2:24 pm ***Efficacy of Current Approaches and An Alternative Paradigm for Digital Contact Tracing*****,** Brian Thompson, MITRE Corporation

2:36 pm **Break**

2:45 pm **Discussion and Summary**

Moderator: Heather Evans, Program Coordination Office, National Institute of Standards and Technology

3:30 pm **Adjourn**