Perspectives on Digital Contact Tracing

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Outline

- (Disambiguation Page)
- Manual Contact Tracing
- Digital Contact Tracing
- Ranging Accuracy – TC4TL (Too Close For Too Long)
- Privacy
- Integration with PH
- Adoption
- Effectiveness
- Law
- Policy
- Conclusions

(Disambiguation Page)

- PACT (aka "PACT-East") *
  "Private Automated Contact Tracing"
  http://pact.mit.edu/

- PACT (aka "PACT-West")
  "Privacy Sensitive Protocols and Mechanisms for Mobile Contact Tracing"
  https://arxiv.org/abs/2004.03544

Manual Contact Tracing (MCT)

- When a person ("index case") tests positive, finding all or most of the people he may have exposed ("contacts") is called *contact tracing.*
- Manual CT is based on interviews with the index case, and phone calls to contacts.
- CT allows contacts to be quarantined, symptom-checked, and tested.
- CT is a powerful method for "flattening the curve", as it removes infectious people from circulation.
- Classic method, used widely for many pandemics.
- Limitations: *speed, compliance, and recall ability.*

Digital Contact Tracing

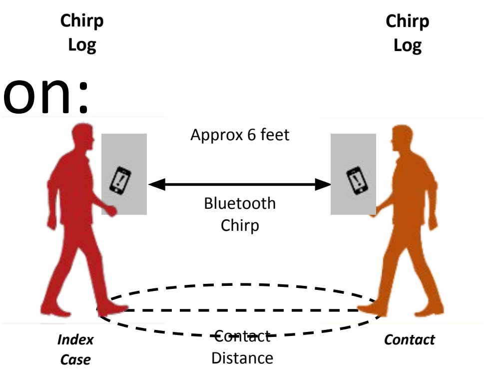
- PACT protocol inspired by Apple "Find My" (taught by Yael Kalai and me in Spring 2020 security course)
- Uses Bluetooth by Apple devices to sense proximity.
- Phone broadcasts values; these change frequently for privacy protection.
- Public DB allows owner to find "where lost phone was last seen" while protecting privacy.
- PACT protocol is similar: phone broadcast changing "chirps".
- If owner tests positive, can upload to DB the seeds for generating chirps.
- Others can check parties in a *decentralized* manner if they have heard chirps of infected.
- Similar protocols developed concurrently: DP3T, TCN, …
- Dozens of countries now rolling out such apps…

PACT (East) team

- PACT organized early March
- Leadership:
  - MIT campus: me, Danny Weitzner
  - MIT Lincoln Lab: Marc Zissman, Israel Soibelman
  - MGH: Louise Ivers (Medical / Public-Health advisor)
- Many organizations represented: MIT, MIT Lincoln Lab, MGH, Weizmann, BU, Brown, IBM, CMU, MITRE, Northeastern, Qualcomm, Sandia, …
- > 100 people (particularly strong on "layer 1" = BT ranging)
- Strong relationships with other teams, Apple|Google, other vendors, jurisdictions, public health, …
- PACT role: technology evaluator and advisor, not app developer; more interest in "helping good things happen" than "taking credit"

TC4TL Accuracy (Distance & Time)

- CDC says "too close for too long" should be < 6 feet for > 15 minutes.
- BT is for local *communications* (<30m) -- can it be used for *ranging?*
- Received signal strength (RSSI) depends on:
  - Transmitter power
  - Phone orientation (carriage)
  - In-pocket / out-of-pocket
  - Indoors / Outdoors (multipath)
  - Intervening bags of water (bodies!) – but not intervening walls!



- This may be the *biggest challenge* for BT-based contact tracing.

TC4TL (Cont.)

- Getting sufficient samples can also be dicey (battery drain!)
- MIT LL has put incredible effort into BT phenomenology
  - Paper by Gary Hatke et al. on arXiv gives details https://arxiv.org/abs/2006.15711 (June 30, 2020)
- Data Collection Coalition – collects BT ranging data
- NIST challenge applying ML to TC4TL: https://www.nist.gov/itl/iad/mig/nist-tc4tl-challenge
- PACT also exploring fixed beacons, wearables, ultrasound, UWB

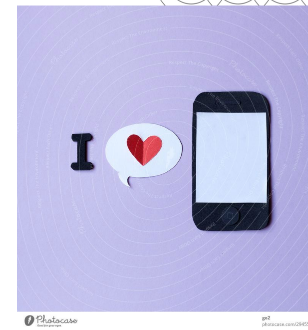
Privacy

- No data leaves phone without user consent.
- No usage of GPS location.
- Phone broadcasts changing pseudorandom “chirps”, so no tracking.
- Phone records “chirps it has heard”
- Infected users (who test positive) may post seeds for their chirps.
- Phone matches (locally!) against posted DB of “infected chirp seeds”
  - No need for central DB to store sensitive personal information
- Match causes user to be alerted (stay-at-home, watch symptoms, test!)
- Extensions exist for dealing with replay & relay attacks.

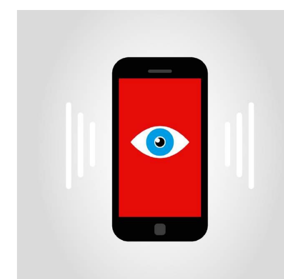
Integration with Public Health

- Goal is to *improve* and *extend* manual contact tracing, not to *replace* it.
- Contacts need information about what to do, where to obtain support services, etc.
- Digital contact tracing should feed into MCT software.
- Digital contact tracing can make MCT *faster* and *more complete.*

Adoption can be a challenge



- For DCT to be effective, *both* parties need to be running DCT service.
- So 50% adoption rate may mean only 25% of contacts get logged.
- Apple and Google have announced **AEN** (Automatic Exposure Notification) an API in iPhones **and** Androids, providing **interoperability**. (*A huge, and very welcome, development! Thanks, A|G!!*)
- People may resist adoption because:
  - Fear of "big brother" (privacy concerns; police; ICE; housing)
  - Confusing UI (e.g. request on Android for "location services" permission)

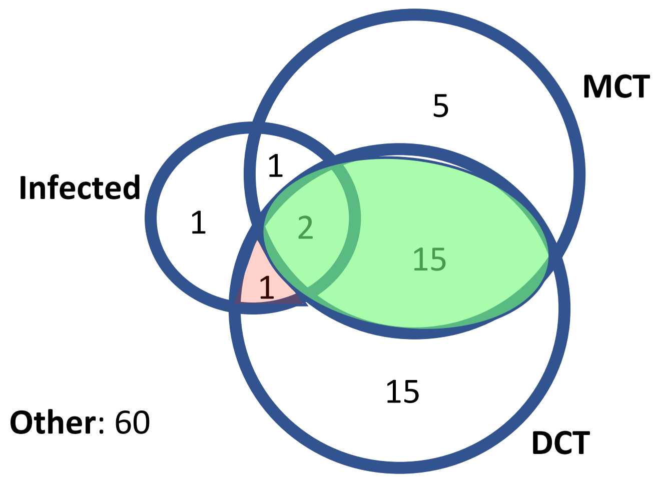


- Rollouts in EU (Switzerland, Germany, Denmark) have >10% so far.

Effectiveness

- Can digital contact tracing really help?
  Can it save lives?
- Ferretti et al. (*Science, May 8 2020)* show via model:
  "Immediate notification through a contact-tracing mobile phone app could, however, be sufficient to stop the epidemic if used by a sufficiently high proportion of the population."
- Singapore: digital contact tracing does reveal new contacts, beyond those found by manual contact tracing.
- DCT may allow for *faster* alerts of duplicate contacts.
- But: *mask-wearing* may decrease number of *strangers* you infect, and thus decrease utility of DCT…

Venn Diagram



- Numbers are made-up (100 total).
- **New** contact (1 in pink) discovered by DCT.
- **Duplicate** contacts (17 in green) can get faster notification.

Law

- Most interesting legal questions (?):
  - *Can law enforcement access or use contact-tracing information in any way?*
  - *Do we need to update laws concerning protection and sharing of medical data, for handling DCT data?*

Policy

- Can/should app use be made ***mandatory***? (e.g. for jurisdictions, services, businesses, schools??)
- Tension between Public Health and Privacy: more information revealed to system may improve public health results, at a cost to privacy:
  - GPS data
  - "who infected me?"
- Who decides policy: government or high-tech?
- How/whether to turn off DCT when this pandemic is over?

Conclusions

- We have come a long ways since COVID-19 appeared, including:
  - Decentralized privacy-preserving protocols
  - Much better understanding of BT phenomenology
  - Apple-Google collaboration on AEN API
- Yet there remain significant challenges:
  - Improving ranging accuracy
  - Dealing with fragmented nature of US health care
  - Achieving sufficient adoption rates