Privacy-Aware Contact Tracing
SafePaths Towards Resilient Societies

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Digital contact tracing

1. Use smartphone GPS + Bluetooth based proximity

2. Notify if you have crossed paths
   Provide location + context

3. Provide public health and businesses coordination tools
Safe Paths platform
Privacy Preserving Algorithms and Software Principles

Today:
• Expedite tracing conversation
• Improve quality and accuracy of data
• Aggregates data for reporting

Today:
• Exposure notification
• Access to resources
• Ongoing Tracking
• Interface with public health infection data

Coming Soon:
• Personalized guidance
• Symptom tracking
• Quarantine Verification
• Immunity Passport
• Corporate verifications

Proximity Technology APIs
• Telecom
• GPS
• BlueTooth (Apple/Ggl/PACT/Pepp-pt)
• Wifi
• Others

SafePlaces Dashboard
For Public Health and Businesses

Today
• Expedite tracing conversation
• Improve quality and accuracy of data
• Aggregates data for reporting

Coming Soon:
• Predict HotSpots, Spread Prediction
• Coordinate at-home population
• Integrated Dashboards
• Certification
Safe Paths Pillars

Technology
- Safe Paths Mobile App
- Safe Places WebTool
- Open Source Code
- Algorithms/ SDK/API
- Interoperable BackBone

Think Tank
- Interoperability Standards
- Privacy Guidelines
- Convening Stakeholders
- Landscape Analysis
- Publications

Implementations
- Public Health Engagements
- Training and Monitoring
- Venture Capital and Startups
- Corporate Relations
COVID Safe Paths Alliance

**MIT Safe Paths**
- Ramesh Raskar, Kevin Esvelt, Fadel Adib
- Mentors: Amandeep Gill (I-DAIR), Bernardo Mariano Jr (WHO), Brian McClelland, Don Rucker (HHS), and Subbu Subramanian, Suraj Kapa (Mayo Clinic)
- Research Mentors: Yoshua Bengio (MILA), Richard Janda (McGill), John Halamka (Mayo Clinic)

**Path Check, Inc**
- Greg Nadeau
- CovidWatch, OpenMined, CovidActNow
Safe Paths for different stakeholders while preserving privacy

Workers
- Get notified if exposed to COVID+ patient
- Contain spread by self screen, quarantine
- Connect to telemedicine service, if testing is required
- Stay up-to date with hotspot updates
- Get sick leaves approved
- Keep union members safe, without giving up personal freedom with respect to employers

Public Health
- Monitor COVID + individuals
- Identify selective lockdown of hotspots
- Issue alerts to individuals/localities
- Verify health official credentials

Insurance
- Connect individuals to telemedicine service, based on insurance coverage
- Monitor individual health
- Get notified if exposed to COVID+ patient
- Contain spread by self screen, quarantine
- Connect to telemedicine service, if testing is required
- Stay up-to date with hotspot updates
- Get sick leaves approved
- Keep union members safe, without giving up personal freedom with respect to employers

Tech enabled individuals using COVID Safe Paths
- Scan at entrance to attend classes
- Track student attendance
- Monitor COVID+ students in dorms
- Clear employees for work
- Manage social distancing at work
- Monitor employee health
- Selectively shutdown, if
- Improve team effectiveness
- Compute risk scores
- identified as hot spot

Labs
- Leverage demography/geography information for research
- Verify lab result
- Verify that validity of the lab

Governments
- Manage selective lockdown of hotspots
- Restart economy

Schools
- Scan at entrance to attend classes
- Track student attendance
- Monitor COVID+ students in dorms

Businesses
- Clear employees for work
- Manage social distancing at work
- Monitor employee health
- Selectively shutdown, if
- Improve team effectiveness
- Compute risk scores
- identified as hot spot

The public
- Get notified if exposed to COVID+ patient
- Contain spread by self screen, quarantine
- Connect to telemedicine service, if testing is required
- Stay up-to date with hotspot updates
- Get sick leaves approved
- Keep union members safe, without giving up personal freedom with respect to employers
**Individual’s Experience Flow** for Privacy-protected Safe Paths powered solutions

1. **Download Safe Paths**
   - App tracks location via GPS & Bluetooth
2. **Exposure screen**
   - Personal, private tracking and notification via Safe Paths app
   - Possible contact or start of symptoms
3. **Triage**
   - Monitor and triage
   - Call health authority
4. **Symptom Check**
   - Symptom check
   - Need to test
   - Need to isolate
5. **Capture insurance details**
   - Need to test
   - Connect to telemedicine service to perform test
6. **Positive**
   - “Low Risk Passport”
7. **Negative**
   - Resume daily activities
8. **Public health authority monitoring**
9. **Quarantine verified via Safe Paths**
10. **Testing site and scheduling**
11. **“Low Risk Passport”**
12. **Sick leave authorization**

**Recover | Restart**
Business asks employees to download app

Employees can use the app to screen at home

Business wants to know the relative risk of an employee

Business screens for symptoms at point of entry

Symptomatic

Go to infirmary/home to isolate/get tested

Result is sent to app

Employer verifies test result

Business runs analytics to manage overall risk

Non-Symptomatic

Infected individual enters workspace

Infected individual enters workspace

Track interactions

Proximity warnings

Staggering

Scheduling

Communication

Congregations

Manage risk

Download Safe Paths

Exposure screen

Monitor Employee Activity

1. Business asks employees to download app

2. Business screens for symptoms at point of entry

3. Symptomatic

4. Go to infirmary/home to isolate/get tested

5. Result is sent to app

6. Employer verifies test result

7. Business runs analytics to manage overall risk

8. Non-Symptomatic

9. Employee enters office

10. Track interactions

11. Proximity warnings

12. Standard protocol involving quarantine and workspace cleanup

Business' Experience Flow for Privacy-protected Safe Paths powered solutions
Solution Providers
Does your company have innovative ideas or solutions to help return to work and build new opportunities?

Solution Seekers
Does your business need solutions to help you re-open and operate safely?

Solution Funders
Are you a venture capitalist, governmental or corporate investment group looking to invest to help get businesses open again?

Pose your challenge
Pilots, Contribute expertise

Submit 1-page summary + 1-6 slide deck (Deadline: Every Tuesday, 5 PM ET)

Invest in solutions that address most prominent challenges
Build on Google-Apple Proximity API

- Phones exchange keys by whispering over Bluetooth
- Infected phone uploads keys to server
- Health phone downloads ‘infected keys’ and find a match with heard keys
BlueTooth Only

Benefits

• Best proximity indicator (feet to meters)
• Good Privacy if key-server and access by Apps is tightly controlled
• Good A/G implementation will be available (but emitted Bluetooth signal can be snooped)

Challenges

• Dependent on A/G benevolence, or MIT PACT becoming the standard
• Adoption vs Effectiveness: BT requires large adoption (12% adoption = 1.44% encounters)
• Fomites: Infection spread from surfaces can be missed
• Inclusivity: Users without smartphone (or opt-in) get no information
• False positives: person from neighboring office, False negatives: phones left behind → risky behavior

Hacks

• Emitted Bluetooth signal can be snooped by other third party apps
• Keys cannot be in public domain, Key server maintained by large tech companies instead of Govt or other parties. Can lead to stifled innovation.
GPS only

Benefits

• Great privacy if GPS logs remain on the healthy person phone and users only download the public health data to compute encounters (SafePaths approach). No upload from health users.
• Easily available on most phones, easy to implement without battery issues
• Adoption: scales linearly (12% adoption = 12% of infected sites on SafePlaces)
• Inclusivity: Users who do not have smartphone can learn encounters published on TV/ SMS

Challenges

• Reduced proximity accuracy (meters), can lead to false positives and negatives
• Infected person: releasing their information without PII requires trained public health workers
• Future encryption algorithm: Requires two servers, difficult for a single server for GPS proximity

Benefits of location and context

• User: Easy to explain context for trust in the system, and check verbally
• Public health needs: Easy to interview, heat maps, spread analysis
Hazards without location context in Contact Tracing

Contact Tracing is about location and context
If we only provide ‘you were exposed’ without context
• User: Low trust in the system
  • Dealing with false positives and negatives
  • Where? When? (Wearing mask? Shook hands?)
  • Lack of agency and confusion can lead to irrational behavior
• Public health: Needs to interview, heat maps, spread analysis
• Societal challenges: Without context minorities blamed, overzealous enforcement, civil unrest

Public Health Requires more than Contact Tracing
• Public health needs: Quarantine verification, Health verification, Immunity passport
Bluetooth (proximity) + GPS (location context)

New Encryption Method from SafePaths

• BT for proximity detection with G/A
• GPS for location context but not proximity
  • Option 1: Use GPS APIs in parallel to store location log or geofencing
    • As a backup if Bluetooth is unreliable/ Opt-out/ Surface exposure
    • Geofence (e.g. home) to remove all BT/GPS logs,
  • Option 2:
    • No location logging, Self GPS revealed to health person only if exposed
    • GPS of infected person never revealed to health authorities or central server
    • GPS is encrypted on BT payload
• Benefits of Context eliminates false positives, and interview captures false negatives

New SafePaths Paper: BLE + GPS Encryption
Raskar, Abhishek Singh, Sam Zimmerman
Factor to Consider: Public Health IT Decisions

- Privacy-first
- Open Source, avoid vendor lock
- Interoperable Backbone
- Multiple Language Support
- Support non-smartphone users/ Equity
- Ecosystem for Public Health
- Dashboard for hotspots/spread
- Modularity/ Ease of Use/ Integration

SafePaths Papers:
- Landscape Analysis of Covid19 Apps
- ‘Apps Gone Rogue’: Unintended consequences
Contact Tracing and Reopening Business with Covid SafePaths

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COVID SafePaths App

**v1**
- Log Personal Trails in Diary
- Compare with Public Infection Cases Data

**v2**
- Compare with redacted trails of Infection Cases from Public Health Dept

**v3**
- Reducing burden on health officials using Self-Report, Authenticate, Computational methods
SafePaths Mobile App

Download on the App Store

Get it on Google Play

GitHub
1. Patient 28 day trail with health officials
2. The health official redacts PII
3. Anon/Aggr/Encrypted Trails

Faster and more accurate than a traditional patient interview
Choreographed by Govt & Businesses
Private Tools for Coordination among Communities

- Public Health
- Restart Economy
- Resilient Society