Mobile Phone Apps Become Medical Devices – The Tale of the NHS Covid-19 App
NHS COVID-19 App

Key non-functional needs:
- Speed, Reach & Precision
- Anonymous & Private
- CE Mark from MHRC
- WCAG AA Compliant
- Support 12 Languages
- Continuous Evolution
- Google/Apple ENAPI

- **Trace**
  Get alerted if you've been near other app users who have tested positive for coronavirus.

- **Alert**
  Lets you know the level of coronavirus risk in your postcode district.

- **Check-in**
  Get alerted if you have visited a venue where you may have come into contact with coronavirus.

- **Symptoms**
  Check if you have coronavirus symptoms and see if you need to order a free test.

- **Test**
  Helps you book a test and get your result quickly.

- **Isolate**
  Keep track of your self-isolation countdown and access relevant advice.
Reflection for context-awareness

Traditional distributed systems were based on the premise of *transparency*: distributed components should be unaware of network connectivity, location, operating system etc. This was widely implemented in distributed computing middleware.

In her PhD thesis, Lica Capra was first to argue that context-awareness is important in mobile computing and that these transparencies need to be given up from time to time. She built a first reflective middleware that would enable applications to adapt to context (which could be defined in terms of signal strength, location, reachability of other services etc).

The Apple/Google Exposure Notification API is an example of such reflective middleware.

FluPhone
Using Bluetooth signal strength for contact tracing

See E. Yoneki, and J. Crowcroft (2011): "EpiMap: Towards Quantifying Contact Networks and Modelling the Spread of Infections Developing Countries ". International Conference on Wireless Technologies for Humanitarian Relief (ACWR), December,
Digital contact tracing

(1) Record contacts based on proximity measurement from Bluetooth signal strength

Risky contact: less than 2m for more than 15 minutes
Symptom Checks and Tests

The reason why the app is a Class-1 Medical Device
Digital contact tracing (continued)

(2) Processing a positive test result

- Asia
- Ian (F56B1E13)
- India (F56B1E13)
- Bianca (F56B1E13, A56BDE12)
- Henry (A56BDE12)
- Ed
Digital contact tracing

(3) Six daily exposure checks against files with risky contacts
Digital contact tracing

(4) Show exposure notification and switch to self-isolation mode

India

Indian

F56B1E13

Ian

India

F56B1E13

Bianca

F56B1E13

A56BDE12

Henry

A56BDE12

Ed
Venue Check in

Successful check-in

Zuhlke Engineering Ltd
19 Mar 2021 at 17:02

Thank you for scanning. You have now checked in!

By checking in, you will be able to get a notification if people with coronavirus visit this venue at a similar time as you.

More info about venue check-in

Back to home

Delete all my data
Digital contact tracing revisited

(3) Six daily exposure checks against risky venues
Timeline

Mid-May 2020
- Technical Spike
  - Technical ENAPI POC
  - Field Testing

Late-June
- Design
  - Decision made to pivot to ENAPI
  - Rapid UI prototypes
  - Architecture design

July
- Pilot in Newham & IoW
  - Rapid incremental delivery of mobile app and APIs
  - Virology Integration
  - AWS platform build and security testing
  - Field Testing

13th August
- National Launch
  - Production scale and hardening of AWS
  - Multi-language support
  - CE Mark
  - WCAG AA Compliance
  - DPIA Published

24th September
- Ongoing Improvements
  - ENAPI v2.0
  - Localised Tier Messaging
  - UK Interoperability
  - Responding to Kent variant
  - Isolation Payments
  - Data Analytics
  - Lateral Flow Tests
  - Check-in improvements
  - Test to release
  - Variants of concern

Today
Programme Organisation

Self contained COVID App organisation
Continuous Discovery Process

Discovery process
- Service Design
- UI/UX Design & Prototypes
- User Research
- System Architecture
- Policy feedback
- Medical feedback
- Accessibility review
Continuous Delivery Process

Roadmap

1 week
Story Refinement
1 week
Build & Test
1 week
Assurance

Story Refinement
Build & Test
Assurance

Weekly release
Weekly release
Weekly release

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25 October 2021 | Wolfgang Emmerich

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Ongoing Governance & Compliance

Continuous embedded governance

- **Government Digital Services**
  - Usability testing and user needs research
  - Fully Open Sourced

- **ICO approval and ongoing DPIA**

- **NCSC embedded in team**

- **WCAG AA Compliance**
  - Accessible by design with embedded disability user research
  - Published accessibility statement
Architectural Principles

Keep It Simple

Go all in on AWS Cloud-native features

Use limited number of well-understood patterns
- All Inbound is via WAF + CloudFront
- All outbound content is signed
- CDN for high volume
- API Gateway
  -> Lambda for submissions
- S3 or Timer Event
  -> Lambda for processing
AWS serverless architecture enabled us to scale

Ability to scale to millions of users while keeping costs low

- ~28 million installed apps
- 700 million user requests per day and serving up 12TB of data
- Automatic scaling to handle peaks seamlessly
- S3 and CloudFront enable the distribution of exposure keys at scale
- Highest load API is for analytics, steady state of between 20k-40k requests per minute with peaks of 300k requests per minute
Downloads

Number of app downloads (England and Wales)

Source: faq.covid19.nhs.uk. Downloaded 18/3/2021
Venue check-ins

Number of check-ins (England)

Source: faq.covid19.nhs.uk. Downloaded 18/3/2021
Test results entered

Source: faq.covid19.nhs.uk. Downloaded 18/3/2021
Contact tracing alerts delivered

Source: faq.covid19.nhs.uk. Downloaded 18/3/2021
Infections and deaths averted

Source:
Conclusions

- Digital contact tracing through a mobile phone app works and is saving lives
- It provided an effective instrument to respond to challenges of the pandemic
- It cannot replace manual contact tracing and is synergistic with it as it reaches exposures that manual contact tracers cannot reach
- Digital contact tracing will become more important again as the government releases lockdown restrictions
Thank you
Questions?