Health Data from the (Consumer) Edge

Open mHealth over NDN

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NDN focus within “mobile health”

**Consumer-facing mHealth applications** can have significant impact but do not rely on integration with EHRs / HIPAA-compliant systems for initial success.

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**Gartner, 2014**
Open mHealth: Approach

• Leveraging the public’s everyday mobile devices (cell phones, tablets, etc.) to extend evidence-based interventions beyond the reach of traditional care and thereby improve disease management and prevention.

• e.g.: pre- and post-natal care of mothers; diabetes; everyday activity in stroke patients and others with chronic disease; and community exposure to environmental pollutants.

• Collaborators: Open mHealth project led by Deborah Estrin (Cornell) and Ida Sim (UC San Francisco).
Open mHealth Fundamental Idea: Data rather than System Interoperability

- Interoperable, Internet-inspired data exchange as the backbone of the application ecosystem
- Thin waist of open data interchange standards that will enable an ecosystem of sensing, storage, analysis, and user interface components to support medical discovery and evidence-based care
- Market-supported, patient-centered landscape of innovative health applications
- Patient-controlled, privacy-aware data exchange across device, component, and application boundaries

D. Estrin (Cornell), I. Sim (UCSF)
For this application in particular, NDN provides much more relevant functionality at the network layer than IP.

Thus, solutions in the architecture have direct impact on the scalability, security, and ease of development; we need not build up additional layers on IP to get near the app challenges.

- Namespace / schema design (bottom-up)
- Repository / storage design
- Service composability
- Authentication / identity assurance
- Data provenance
- Access auditing
- Mobile publishing
- Legal requirements for success

Open mHealth arch. looks a lot like NDN
NDN – Suitability / Benefits

- **Open mHealth** already focuses on named data as the “thin waist” of interoperability.

- **Data-centric security** a good match, and could be a major improvement over a current pain point – OAuth, in terms of ease of development and overall security.

- **Distributed storage** is straightforward to implement. Could drive a new **data-diffusion focused model** for this application.

- **Reduction in overhead** for request-response architecture should be useful given that many apps are always running on a variety of types of devices.

- Intrinsic **disruption tolerance and multi-path support** are a good fit for mobile devices if challenges of mobile publishing can be addressed.
2014 Open mHealth Driver Application

NDNEx - Physical Activity Data Ecosystem

- Supporting physical activity is both a critical part of building healthy communities and a key retail market.
- For NDN-NP in 2014, explore a non-proprietary ecosystem for consumer physical activity data.
- Start with end-user mobile+web application that captures and reports walking, jogging, and running activity.
- Calculate and report activity metrics based on GPS and accelerometer data – both automatically and self-identified rounds of exercise.
- Capable of location-based content “push” during the exercise, which can be used for health, entertainment, local, and team-related content.
- Envisioned as an open-data ecosystem.
Data flow for a single user who gets 1) fitness / activity metrics, 2) walking or running path visualizations, and 3) location-based content during exercise – all through the same ecosystem, but from different providers.
**Conceptual Block Diagram: Data Flow**

**Ohmage platform**

- [http://ohmage.org/](http://ohmage.org/)
Personal Data Repository


Conceptual Block Diagram: Data Flow

Location Anonymization

- Avoid providing specific location information to services that do not need it. Range of techniques from the simple, which may be used here, to the more sophisticated.


  [http://lbsstorage.googlecode.com/svn/trunk/Location-based%20Services/3.1%20Anonymity%20based%20defense/5B21%5DLocation%20anonymity%20in%20continuous%20location-based%20services.pdf](http://lbsstorage.googlecode.com/svn/trunk/Location-based%20Services/3.1%20Anonymity%20based%20defense/5B21%5DLocation%20anonymity%20in%20continuous%20location-based%20services.pdf)

Conceptual Block Diagram: Data Flow

Activity Classification

- Generate classified / tagged location data, or simply activity streams based on GPS and accelerometer data.

- Some classification currently built-in to the Ohmage Mobility utiliy on the mobile device: http://ohmage.org/static/ohmagehome/docs/Mobility%20tech%20report%20%28dec%202013%29.pdf


Conceptual Block Diagram: Data Flow

**Geofencing**

- Prevent service activation / data access outside of a location boundary.
- Implemented as (transparent) post-processor on raw location data.
Conceptual Block Diagram: Data Flow

Fitness Visualizer

- Start with Ohmage front end (see previous slides).
- Web-based front end using NDN-JS to access derived data without location information.
- Examples: http://quantifiedself.com/fitbit/
MOBILE TRACE CAPTURE
Ohmage on Android

PERSONAL DATA REPOSITORY
DSU

LOCATION ANONYMIZATION
DPU

ACTIVITY CLASSIFICATION
DPU

FITNESS VISUALIZER
(NO LOC. DATA)
DVU

GEOFENCING FILTER
DPU

PATH VISUALIZER
(LOC. DATA)
DVU

LOCATION-BASED CONTENT EMMITTER
DVU

Path Visualizer

- Web-based front end using NDN-JS with access to geofenced location information, providing (for example) running trail visualization.

- Perhaps use many GPX format visualizers. E.g., [http://flowingdata.com/2014/02/05/where-people-run/](http://flowingdata.com/2014/02/05/where-people-run/)
Conceptual Block Diagram: Data Flow

- Location-based Content Emitter
  - Web-based front end using NDN-JS with access to geofenced location information, providing location-specific content back to the mobile user.
Collaboration: Join us

The NDN-NP Campuses

Euihyun Jung, Anyang University
Dan Pei, Tsinghua University
Christian Tschudin, University of Basel

* Looking for a postdoc!

Topics
- Naming and application design
- Trust and security
- Storage in the network
Possible Collaborative Approach??

MOBILE TRACE CAPTURE
Ohmage on Android

PERSONAL DATA REPOSITORY
DSU

LOCATION ANONYMIZATION
DPU

ACTIVITY CLASSIFICATION
DPU

FITNESS VISUALIZER
(NO LOC. DATA)
DVU

PATH VISUALIZER
(LOC. DATA)
DVU

LOCATION-BASED CONTENT EMITTER
DVU

JUNG/ANYANG

PEI/TSINGHUA
CLUE/UCLA

NFN/BASEL

REMAP/UCLA

CROSS-CUTTING
DATA NAMESPACE DESIGN – INITIATED BY UCLA
TRUST / SECURITY DESIGN – U. MICHIGAN AND UCLA
Intersection with “Values in Design”

New NeTS-Small 2014-2017, PI: Katie Shilton, University of Maryland

*From Intentional to Enacted Values in a Future Internet Architecture*

• How will the NDN application choices reaffirm or reshape values in the NDN architecture?
• How do values embedded in architecture become enacted in application design and use?
• What social issues are bound up in NDN technical problems?
• How can values-in-design perspectives help solve these technical problems?
• What interventions and strategies encourage values conversations within the technical work of infrastructure design?

Focus on four technical challenges: **naming**, **trust management**, congestion management, and **evaluation** metrics.
mHealth Reality Check

• Are your systems interoperable?

• Are you using open standards?

• How will you evaluate?