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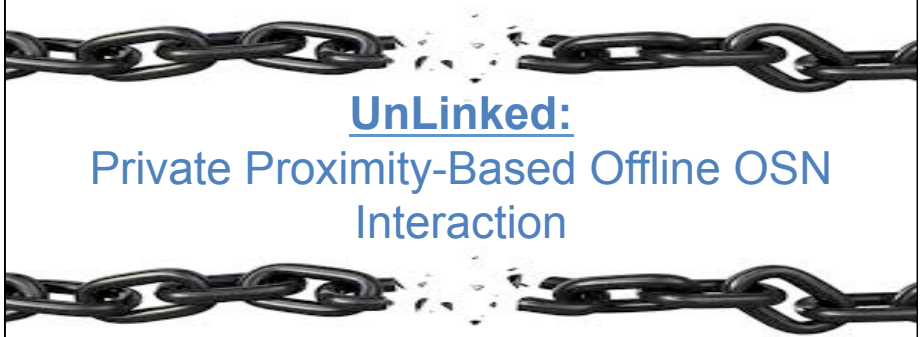

UnLinked:
Private Proximity-Based Offline OSN Interaction

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Joint work with R. Petrlic (Univ. of Saarland) and S. Faber (UCI)

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Current Research

- Privacy in Social Networks
  - Stylometric Linkability and Attribution
  - Off-Line Networking via Cryptographic Techniques
- Genomic Privacy
- Security of Embedded/IoT Devices
- Private Database Querying
- Usable Security
- Biometrics
- S&P in Future Internet Architectures

For more info: **sprout.ics.uci.edu**

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Outline (privacy-preserving)

- Topic 1
- Topic 2
- Topic 3
- …
- …
- …
- Summary

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Today's OSNs

- Facebook, RenRen, Tumblr, VK, LinkedIn, etc.
- Global heaven for voyeurs and exhibitionists
- Percolated into many aspects of life
- Enormous worldwide popularity
- Membership leads to many other services
- Reached the limit of penetration
- **What's next?**
- OSN for pets? Inanimate objects?
- Ventriloquistic operation

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My $0.02:

- Off-line OSN support
- OSN for the dead

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OSN PRIVACY?

- Lots of righteous noise about lack of privacy
- Is it reasonable to expect it?
- Expecting total (even strong) privacy is silly…
- How about at least some?
- What/who to blame for lack of privacy?
  - Ignorant user? Centralization?
- Distributed (p2p) OSNs have been proposed
  - e.g., DIASPORA, SAFEBOOK
  - unlikely to succeed

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Why Offline OSN Interactions

Want limited OSN functionality in case of:

- Poor connectivity: low bandwidth, intermittent, lossy (lousy?) links.
- Expensive connectivity: e.g., abroad, on trains, planes and cruise-ships.
- No connectivity: e.g.: in air, under water, under ground, EMI-shielded environments, remote locations, disasters.
- OSN service outage
- Personal preference not to connect to OSN, i.e., want to use OSN in off-line mode

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Offline Interactions (1)

Scenario 1:

1. Alice and Bob meet (physically)
2. They talk
3. Discover some common factors
4. Both decide to later connect (good for OSN)

   Or
5. Nothing further happens because:
   - Neither is interested
   - One is interested, the other isn't

NOTE: OSN learns nothing if (5)

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Offline Interactions (2)

Scenario 2:

1. OSN USER X and OSN USER Y meet
2. They discover common factors
3. If mutually sufficient, they reveal themselves as Alice and Bob
4. They talk
5. Both decide to later connect (good for OSN)
   Or
6. Nothing further happens because:
   – Neither is interested
   – One is interested, the other isn't

NOTE: OSN should ideally learn nothing if (6)

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Claim

Private off-line OSN interactions are good:

- For OSN users

and

- For OSN itself

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Generic Scenario

- Alice and Bob are near e/o
- Unaware of e/o identities
- Discover e/o presence as OSN* users
- Privately compare their profile features, determine common factors or # thereof
- If insufficient, drop it
- Otherwise: reveal identities, chat, record

…

- Optionally connect on OSN

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Whose job is it?

- OSN itself

OR

- Separate service

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Who are you?

- On the Internet, no one knows you're a hog (or a dog)
- Off-line OSN user can be anyone, could claim arbitrary friends/connections
- Need authenticity & integrity of OSN profiles
  - Motivates new service

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UnLinked Design Goals

1. Support for Off-line Interaction
2. Anonymity wrt Peers (debatable)
3. Profile Privacy wrt Peers
4. Interaction Privacy wrt OSN provider
5. OSN Connection Spillover
6. OSN Profile Authenticity and Owner Authentication
7. OSN-Independent Operation
8. OSN-Agnostic Design
9. Voluntary Participation

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UnLinked – bird's eye view

LinkedIn: a somewhat "professional" OSN

Android smartphone platform

Components:

- UnLinked App (ULA):
  - ATW-PSI and ATW-PSI-CA
  - Android framework
  - Bluetooth communication
- UnLinked Server (ULS): CA, reg-n, OSN i/f

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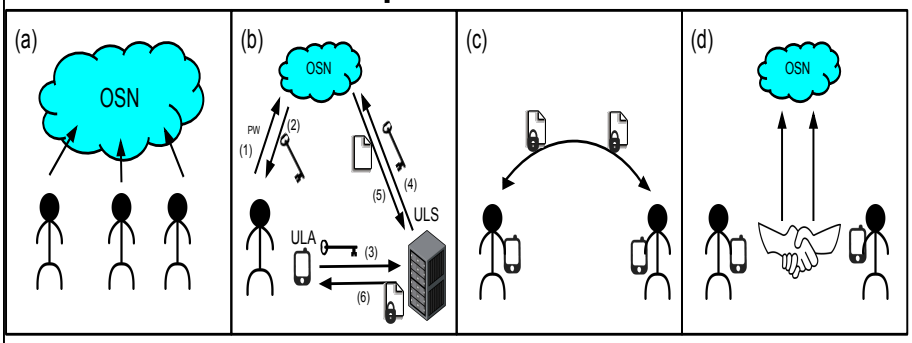
Operation



In online phase (b):

- Alice installs ULA (UnLinked App)
- Alice logs into OSN
- ULA contacts ULS, provides OAuth
- ULS pulls profile, extracts features, signs/certifies, returns

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More Details

- OSN independence
  - OAuth token
  - Profile API
- Communication medium independence
  - Broadcast channel
- Off-line, proximity-based
- Underlying PSI/PSI-CA protocol independence
  - We use OPRF-DH-based PSI, can also use GC or HE
  - Need to convert to two-way and introduce authorization

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Protocol Properties

- Correctness
- Peer Input Privacy
- Pseudonymity
- Authenticity
- Input Binding (for 2-way)
- Output Integrity (beyond auth+corr)
- Early Termination Resistance

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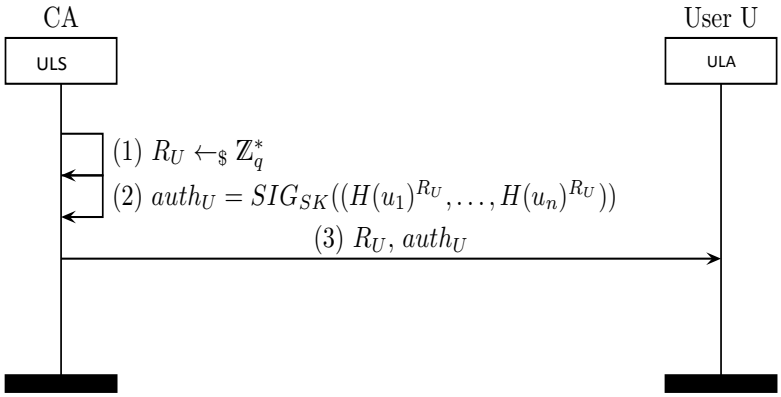
On-Line ULA-ULS protocol

Part b in Operation



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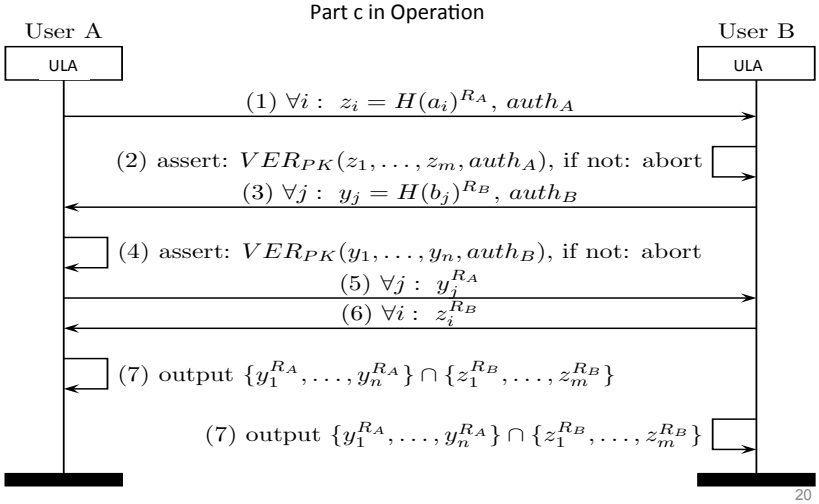
Off-Line ULA-ULA protocol

Part c in Operation



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ATW-PSI

- Mirrored, two-way protocol that privately computes set intersection
- Each party has ULS-authorized input
- HbC model but extensible to malicious
- Assume ULA does not collude with ULS
- Internal adversaries (external trivial)
- Security based on OMG-DH in ROM

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ATW-PSI-CA

- Mirrored, two-way protocol that privately computes **cardinality** of set intersection
- Each party has ULS-authorized input
- HbC model but extensible to malicious
- Assume ULA does not collude with ULS
- Internal adversaries (external trivial)
- Security based on OMG-DH in ROM

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ULA Notification Policy

- Automatically notify user when criteria met (set by user)
  - Execute a more revealing protocol
  - Alert user to presence of peer
  - Request ID exchange
  - Send message(s) to peer
  - Receive/display messages and ID exchange requests
- Criteria – function on any protocol output
  - Presence of specific element in ATW-PSI
  - Threshold wrt size of ATW-PSI-CA
- Benefits
  - Spam/DoS prevention
  - Usability
  - Efficiency

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Policy contd.

Current Coarse-Grained Policies

- Open
  - Any other ULA user
- Low
  - At least one friend in common, and one school or employer.
  - At least three friends in common.
  - Common current employer or current academic institution.
- Medium
  - At least three connections in common, and at least one employer or academic institution, other than current one.
  - At least five connections and one institution in common.
  - More than seven connections in common

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Policy Management

- Policy is a complicated beast
- Alice and Bob can have many combinations of policies/thresholds
- Some policy combinations are incompatible

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Performance Evaluation

Input Size	Setup Time (s)	Signature Size (kb)	Offline Time (ms)	Offline Band. (kb)
10	0.0739	3.41	143	9.2
100	0.837	25.2	508	75
1000	8.57	243	8790	2941
10000	86.4	2420	14530	7337

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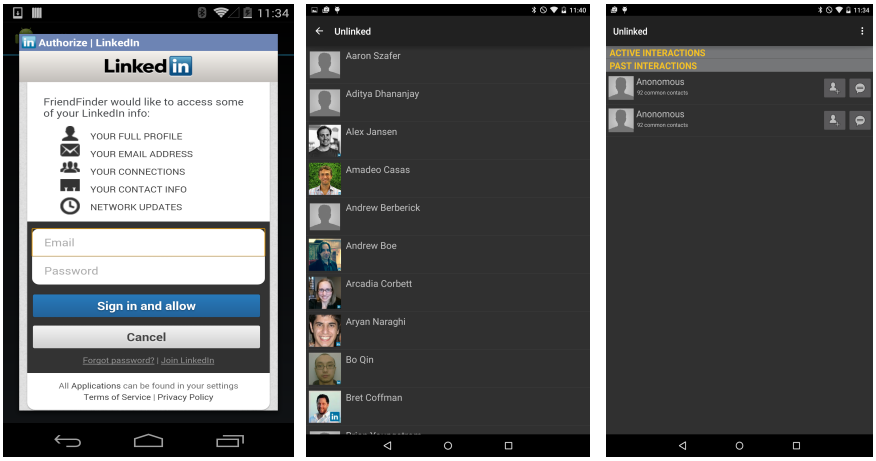
Screenshots 1



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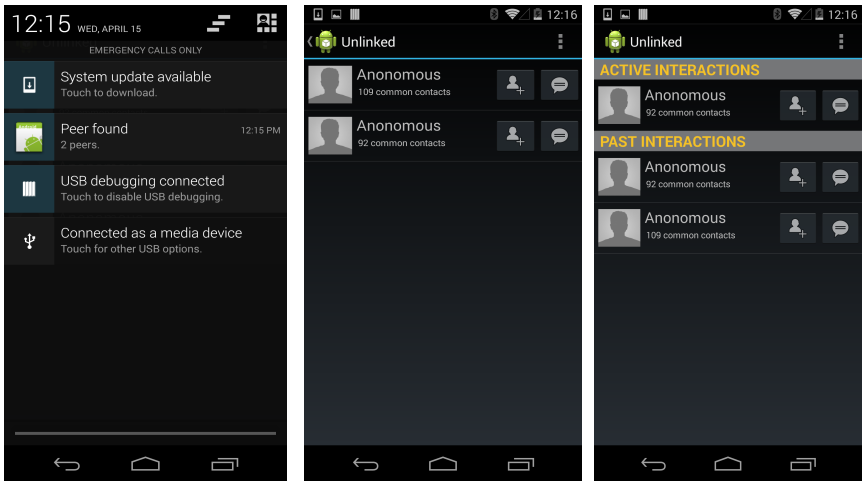
Screenshots 2



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Extensions

- Existing Friend Early Detection
  - Introduce oneself into set input to ATW-PSI
- Authenticated Channels
  - Start conversations with DH key exchange.
- Unlinkability
  - Download many authorizations
  - Need to modify network addresses
    - e.g., Bluetooth or WiFi MAC
- Detecting misbehavior via auditing
- WiFi Direct + IP
- Other OSNs, e.g., facebook
- Secret handshakes to obscure OSN affiliation

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Related Work

- M. Nagy, et al. “Do I know you? efficient and privacy-preserving common friend-finder protocols and applications”, ACSAC 2013.
- E. De Cristofaro, et al. “Private Discovery of Common Social Contacts”, ACNS 2011.

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Summary

- UnLinked: off-line private OSN interactions
- Reasonably strong privacy possible
- Is it desired? Need user studies & trials
- Bootstrapping problem
  - Ideally should run as independent service
  - But, being part of OSN would make it easier
- Lots of things left to do…

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QUESTIONS?

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