

# Building Blocks for Privacy-Preserving Decentralized Online Social Networks

iSocial Summer School



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### **Online Privacy Problematic**

- Current services (FB, GMail, GCal, Flickr, Pinterest) are "free" – users pay with their data, advertisementbased business model ("If you're not paying, you're the product")
- Centralized data collection, privacy leaks
  - accidental
  - deliberate
- Information flow to third parties (companies, governments, the web-browsing public, hackers)
- Tracking
- Data Mining





### **Online Social Networks Worse**

They have desirable functions

But:

- Personal, compound data collection
- Revealing increasing amounts, increasingly personal
- Not only what users upload, also data about them

Not only about users themselves but others as well





Why so much data mining?

- Improve service
- Attention economy



Why Is This a Problem?

- Once leaked, the data cannot be revoked
- Potential audience exceeds expectations, copying easy
- Not known who has what information
- Pieces of information that are harmless, taken together can be identifying or damaging





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### Project Goal

- Privacy-preserving social networks
- Keeping functionality
- Giving control over the data back to the users







- Provider independence by decentralization
- Data protection by prevention (access control, cryptographic means)
- Bonus: locality, off-line functioning, authentication by direct exchange of data between devices

- At KTH: Oleksandr Bodriagov, Sonja Buchegger, Benjamin Greschbach, Guillermo Rodriguez Cano.
- Collaborators: Anwitaman Datta NTU Singapore, Krzysztof Rzadca U Warsaw. Alumni: KTH, EPFL, T-Labs



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### Longer-Term Goal

- Social networks are an important example
- ... but what we really want is building blocks for
  - privacy-preserving
  - provider-less / decentralized
  - future communications and applications





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### **Research Question Categories**

- How can we decentralize functionality?
- How can we preserve user privacy?
- Context: Decentralized system, heterogeneous resources and demand, requirements on availability, scalability, robustness, functionality, efficiency.



# Research Questions: Distributed Systems

#### Design:

- P2P topology, social graph
- Storage, availability
- Asynchronous comm.
- Add/remove/update
- Search
- Scalability
- Incentives
- Direct exchange, DTN
- Self-contained system

#### **Challenges:**

Geo-temporal diversity
Heterogeneous resources
Heterogeneous demand
Churn
Delay tolerance



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# Research Questions: Security/Privacy

#### **Design:**

- Encryption, credentials
- Key management
- Content/key revocation
- Authentication
- Usage control
- Transparency, usability
- Direct exchange for security
- Data chunking
- Anonymity, traceability

#### **Challenges:**

Distributed system challenges
Online social network properties
Privacy of

Access

- Location
- •Data existence, size
- Relation





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### Distributed Storage, Availability

So far:

- concept [BD09]
- architecture [BSVD09]
- game-theoretic and complexity analysis [RDB10]
- ongoing: storage API





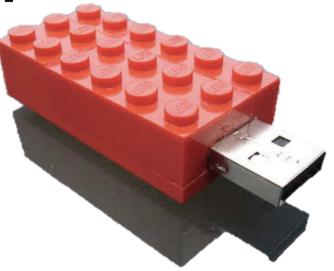
### **Distributed Access Control**

#### So far:

- simple digital-envelope based [YA08]
- broadcast encryption based [BB11a,b]
- policy based (XACML, SAML) [RN11]
- predicate encryption [BKB14]

Ongoing:

Combinations of encryption





### Privacy of Access, Relations, Existence

So far:
meta data [GKB12, GB12]
access policy hiding encryption [BKB14]
privacy-preserving user search [GBB13]

Ongoing:data structures





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### Distributed Authentication

#### So far:

threshold-crypto based key recovery [VABD09]

• passwords in peer-to-peer [KBGRB12]





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### Wider Perspective Goal

- Privacy components as enabler for future communications:
  - More devices, more connections
  - Security concern: Higher complexity, more vulnerability
  - Quantity concern: More data collected (sensors, logging)
  - Quality concern: Improved data joining, mining, and crunching
  - Sensitivity concern: Increasingly personal (health, energy monitoring)
- Need privacy to make new applications possible: remote healthcare, independent living, nomadic work, smart home/ office/city/grid, etc.



# Summary: Toward Decentralized Privacy-Preserving Communications

- Privacy question has increasing relevance for society
- Will need privacy solutions for highly connected dataintensive applications
- Fundamental shift from provider-dependent to decentralized systems opens a wide range of research questions



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