Unterstützung der Privatsphäre in mobiler IP-basierter Kommunikation

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Outline

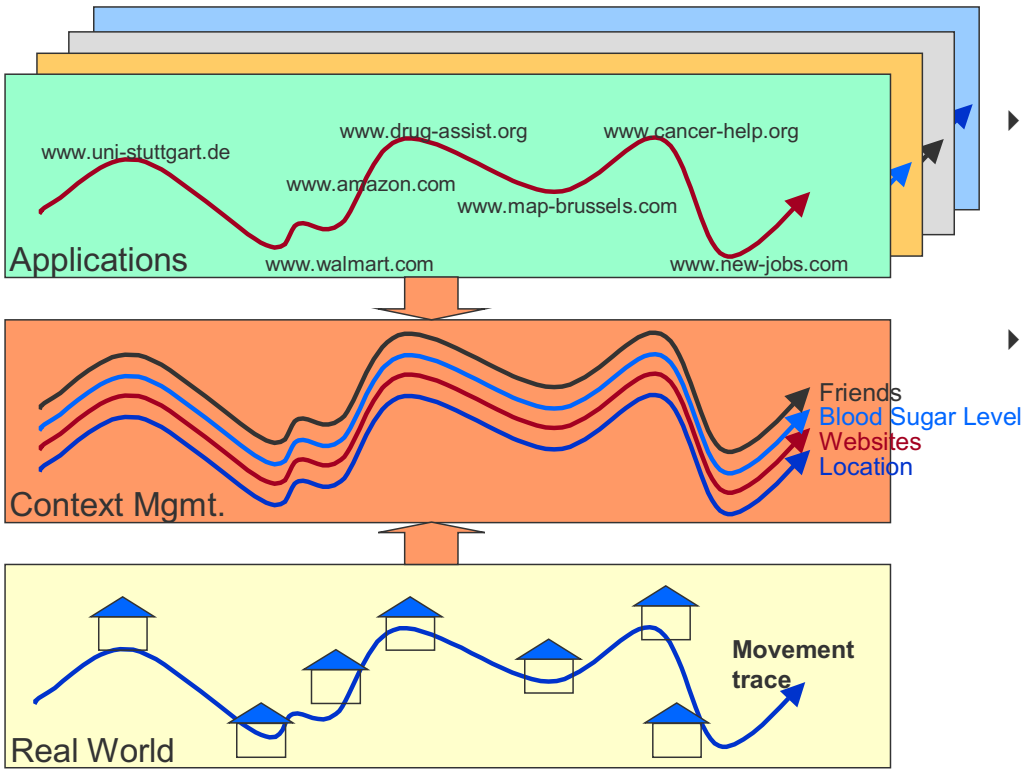
Motivation

Threat Analysis

A New Approach

Conclusions and Future Work

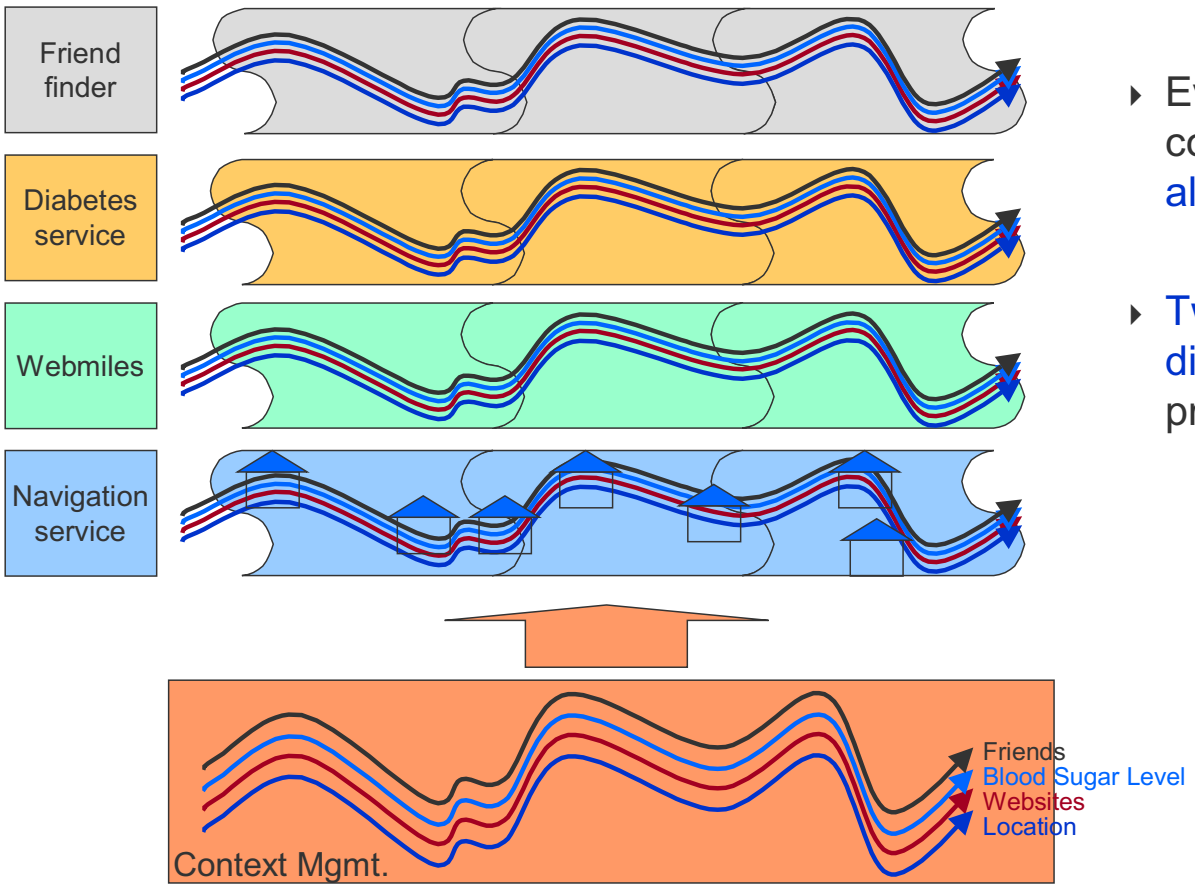
Collection of Context Data



- Ubiquitous use of platform → many different applications
- Detailed traces of context data combined by context management
  - Real World (e.g., location)
  - Applications

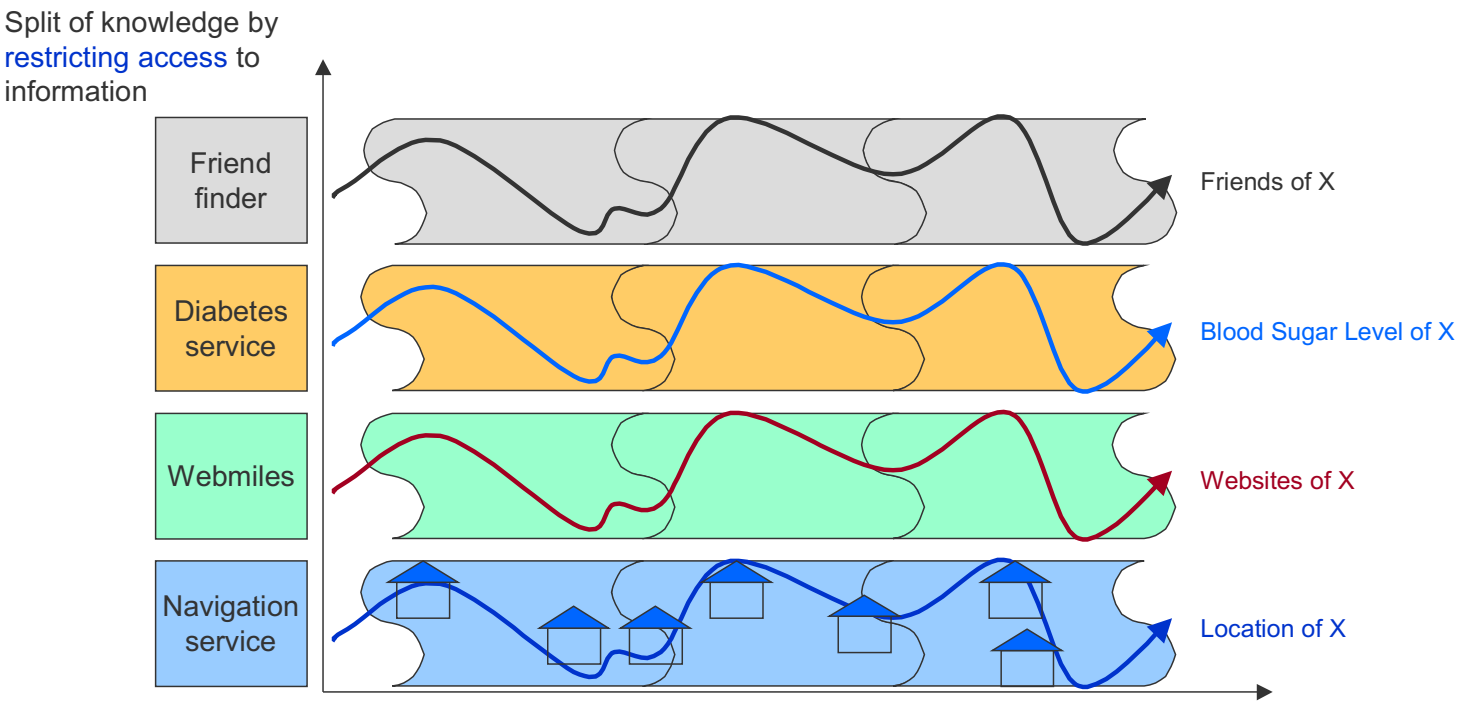
→ Privacy Risk!

Context-Use Without Protection

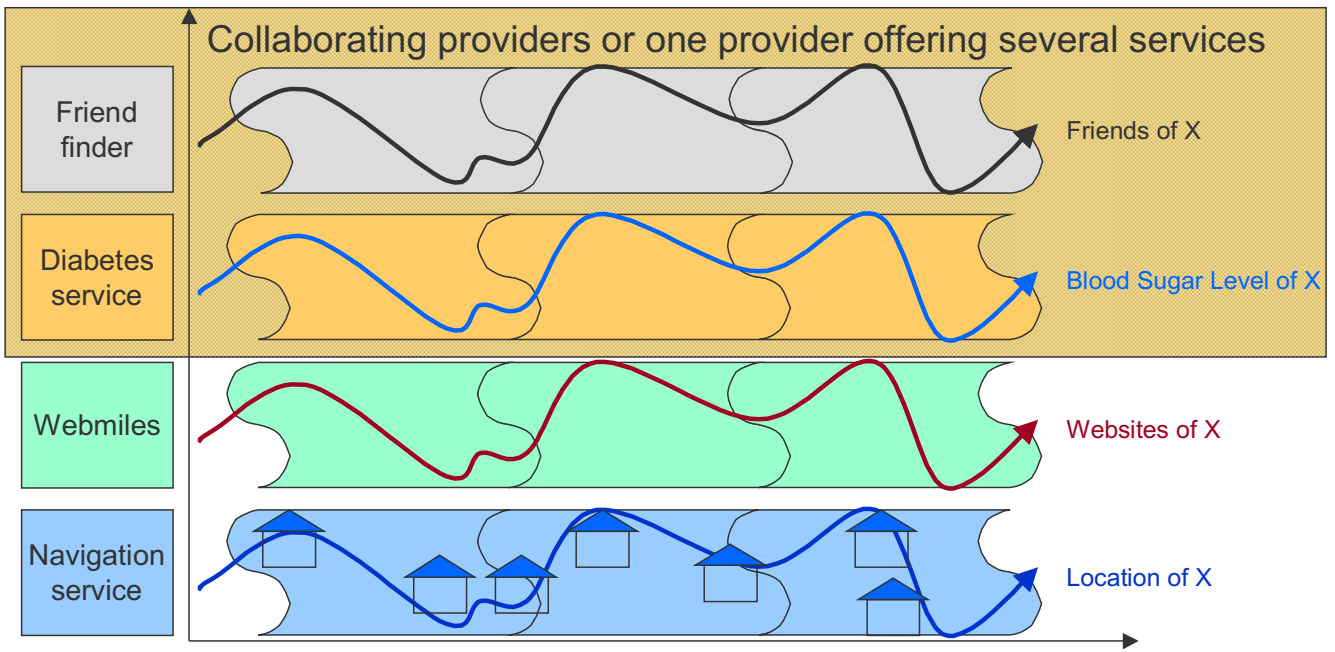


- Everybody could access all context
- Two dimensional problem
  - Rich trace
  - Long trace

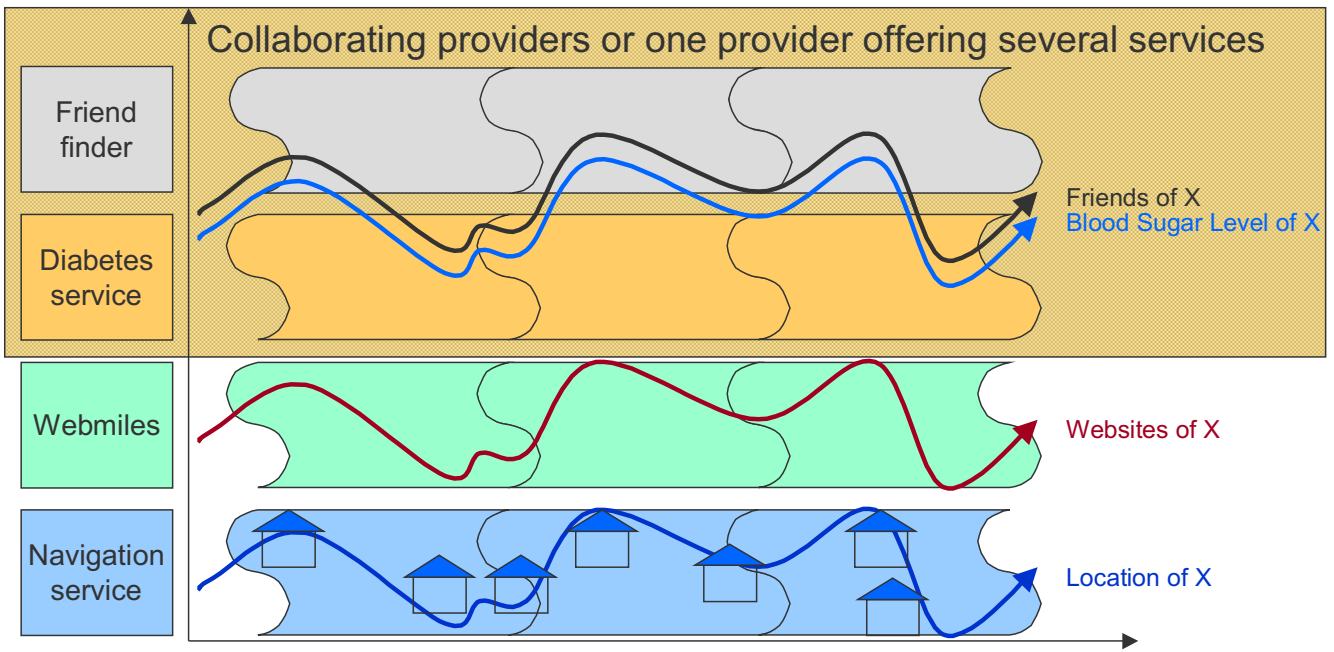
Privacy Protection Approach (1)



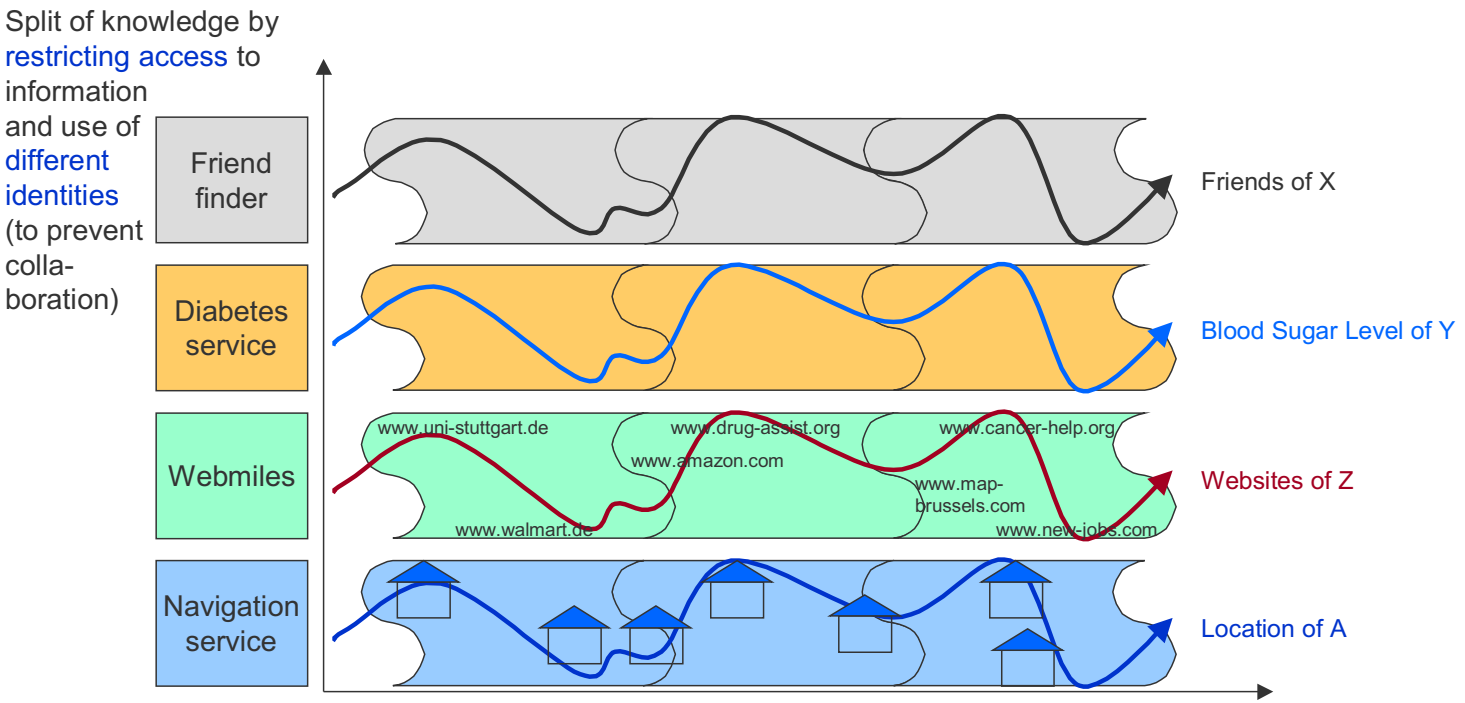
Privacy Protection Approach (2)



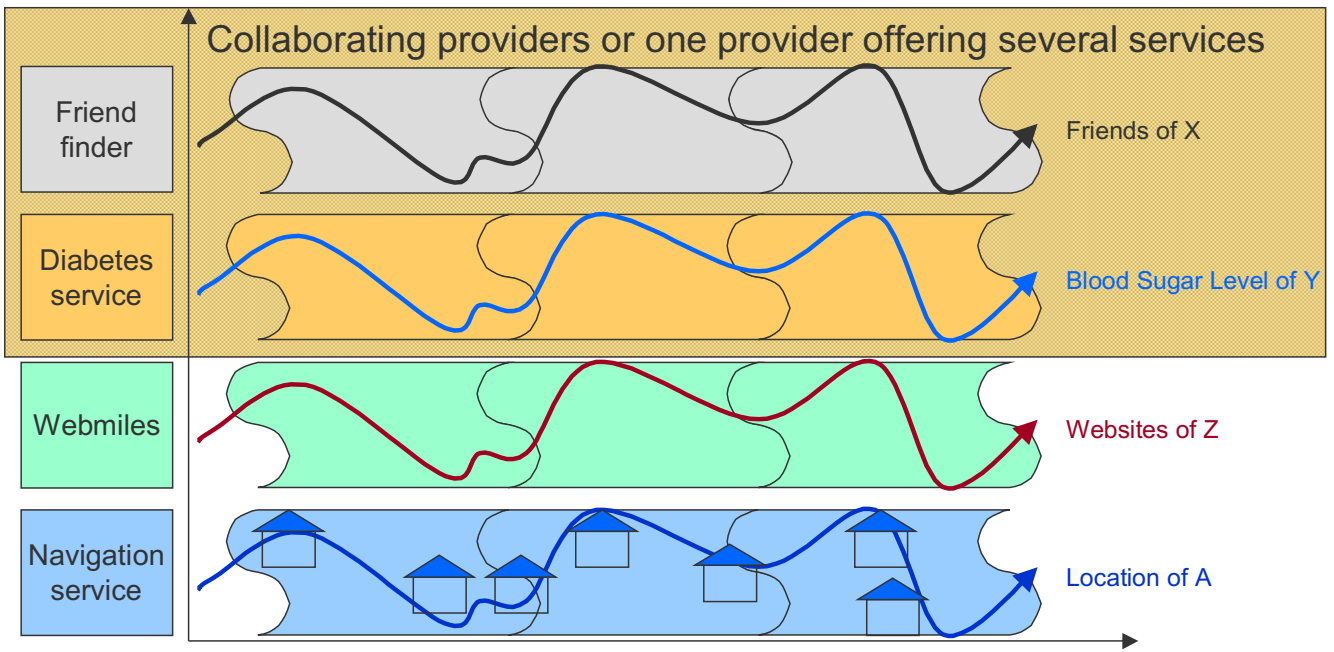
Privacy Protection Approach (3)



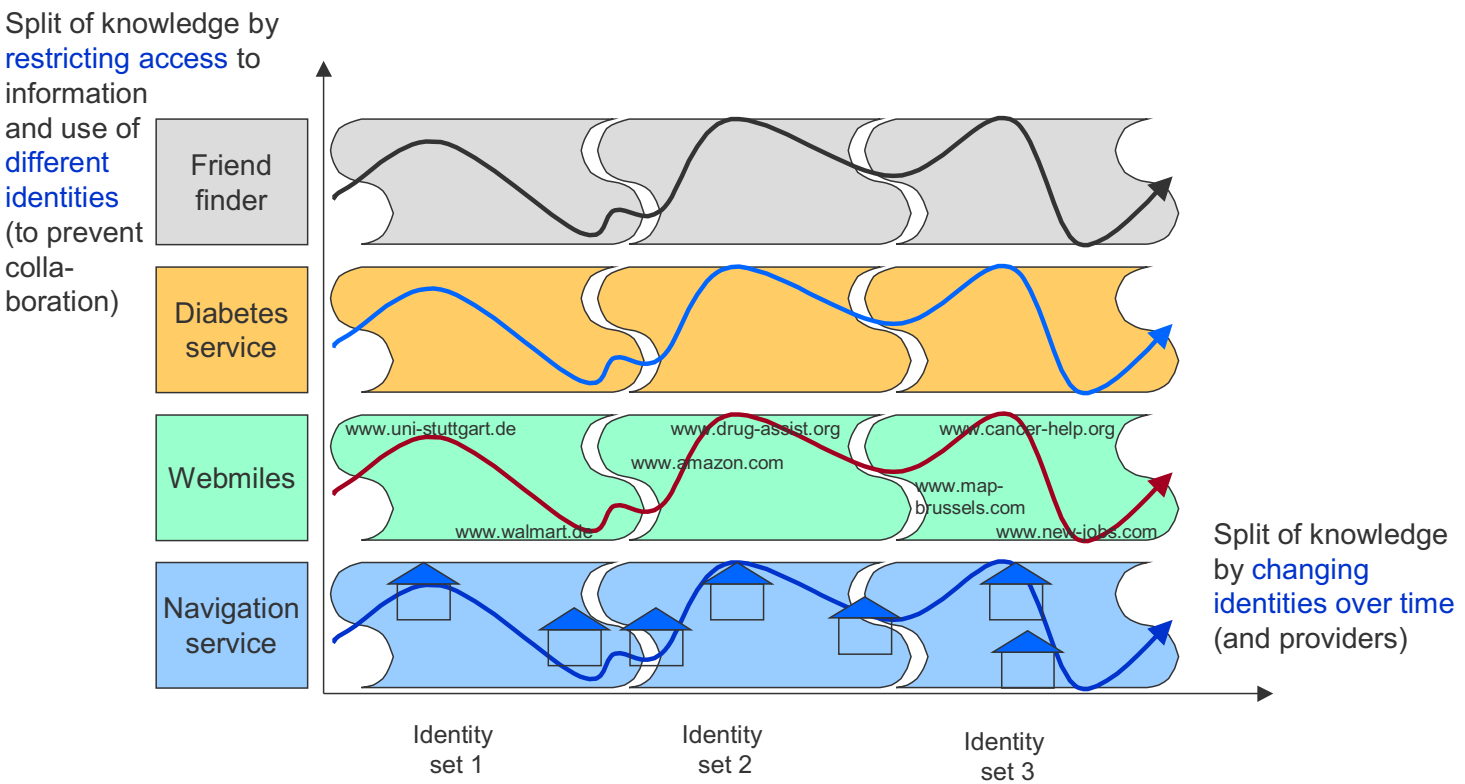
Privacy Protection Approach (4)



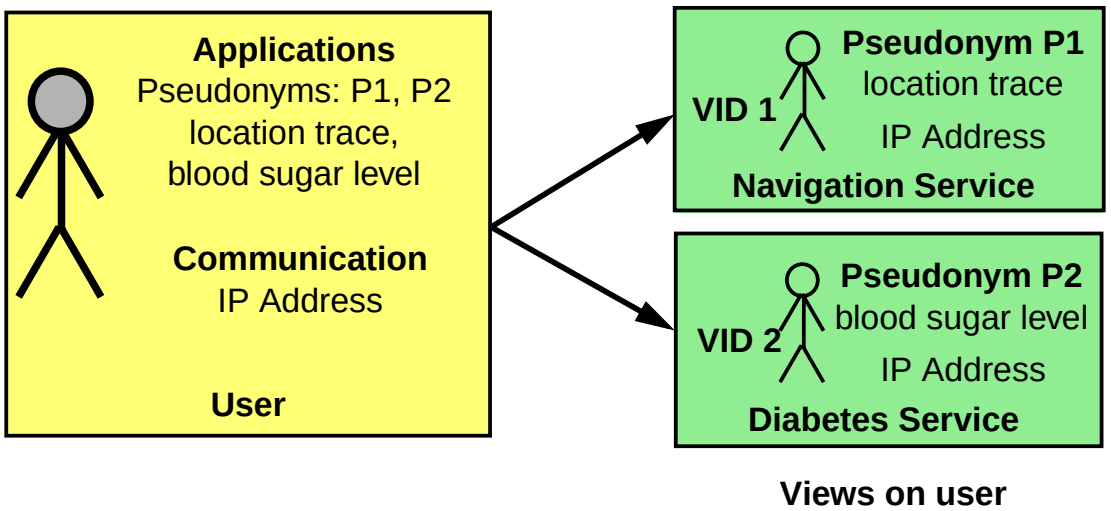
Privacy Protection Approach (5)



Privacy Protection Approach (6)



Example and Focusing



- **Privacy approach**
  - use of multiple (virtual) identities, VIDs
  - tune amount of disclosed data in context of each identity separately

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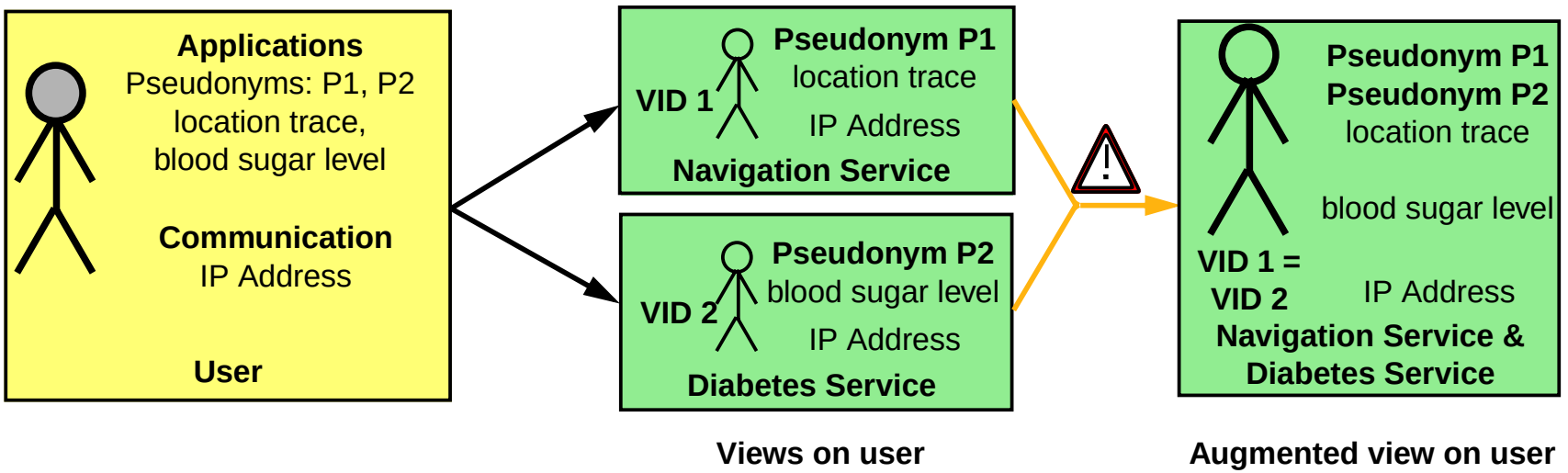

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- **Pitfall: Augmentation of a VID**

  Two possibilities: Linking of several VIDs

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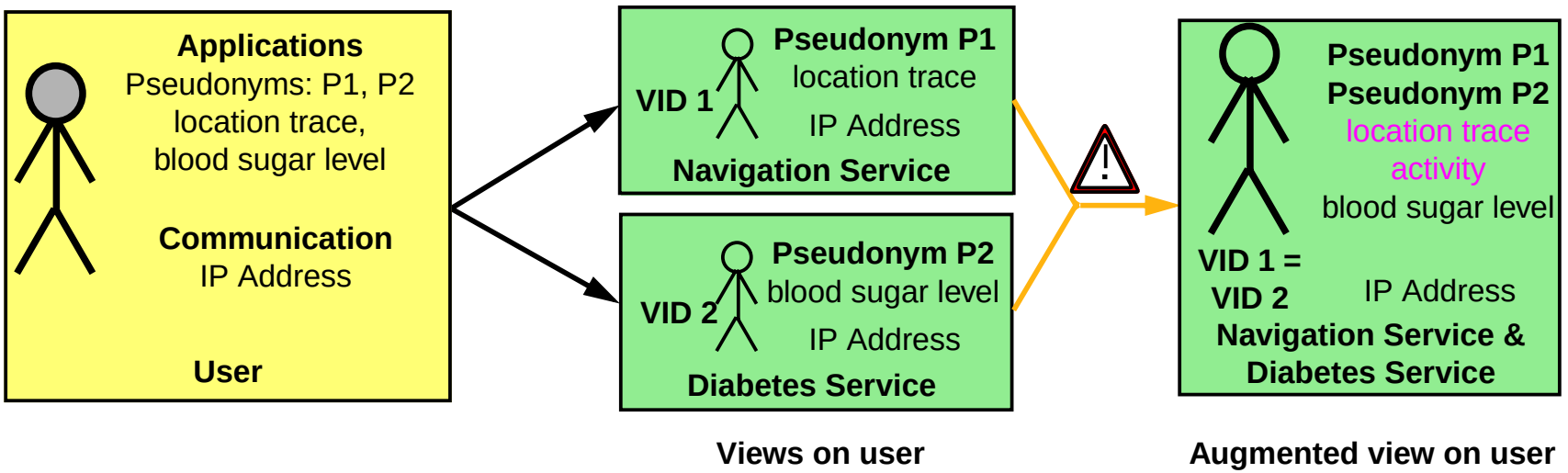

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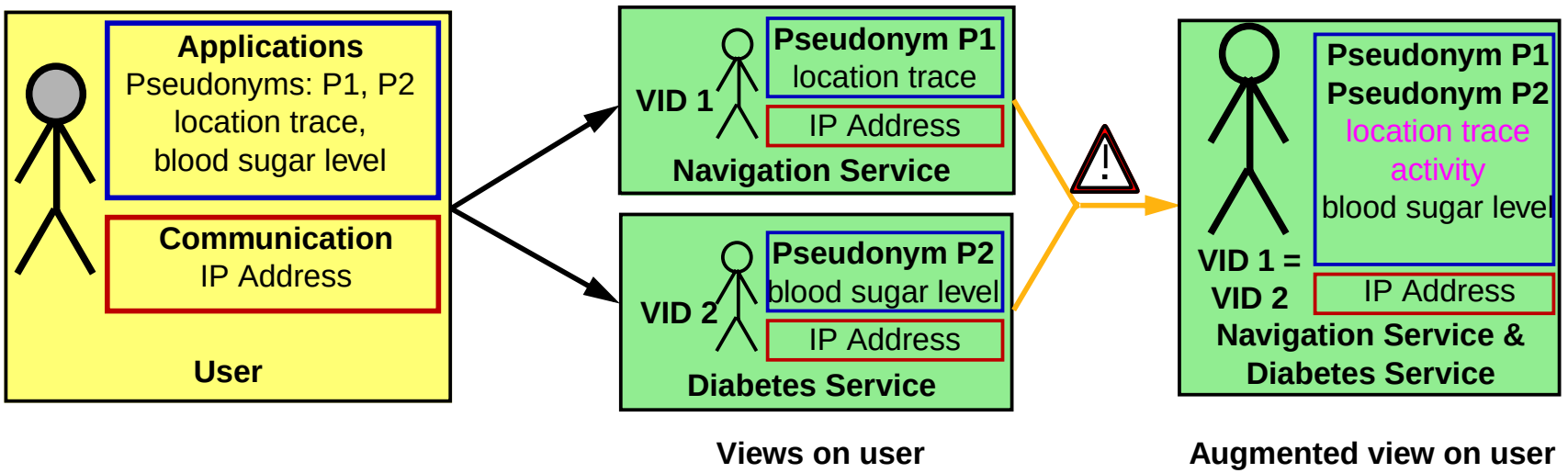

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  Two possibilities: Linking of several VIDs and inference of data
  - application data
  - data of communication system
- **Focus on IP based communication system**

Problem Statement

Protection Goals

- **Unlinkability of VIDs**

  trace cannot be enriched by information of several VIDs

- **Limitation of trace**

  short trace alleviate inference danger

➥ **Violation of both: More knowledge at the attacker than user wants --> against right on informational self-determination**

Potential Attackers

- **Communication partners**

  other (private) users or service providers

- **Providers of the communication systems**
  - can be forced to disclose information (legal interception)
  - can be hacked
  - may be not trustworthy (according to "Internet Model" everybody can be provider, i.e., provide a Home Agent)

Threat Analysis

- **Packet based communication: Two basic pieces of information**
  - identifier: indicates which device is addressed
    - may be chosen arbitrarily (thus without containing any sensitive information)
    - known to communication system and communication partner
  - locator: indicates where packet must be delivered to
    - inherently contains location in terms of network topology which can be mapped to (sensitive) geographical location in IP
    - must be known to communication system
    - does not have to be known to communication partners
- **Comparison: Classical IP**

  both pieces of information collapse into the IP address
- **Comparison: Mobile IP**
  - home address is a kind of identifier
  - care-of address is a kind of locator
  - (but: home address is locator to user's home and care-of address is known to communication partners in case of route optimization)

Abstraction of the linking problem

- **(Many) VID contexts of the user are inherently merged**
  - behind all VIDs is only one user
  - ➥ everything that leads to the (real) user is dangerous wrt. link of VIDs (and often regarding privacy in general)
- **Real-world attributes, reflected in the system**
  - location, location changes (movement), network connection, ...
  - global use patterns
    - sleeping times, working times, ...
  - ➥ attributes, which are identical for all VIDs of same user
  - ➥ danger rises with decrease of number of users having the attribute
- **Contrast**
  - communication sessions not dangerous wrt. to link
  - ➥ can be different for each VID
  - ➥ rather similar for VIDs of different users (e.g., when using same service)

Concretion of linking problem to communication

- **Real-world user behaviour reflected in locator, reflecting**
  - location, movement, network connection
  - (vertical handover models, ...)
- **Remarks**
  - there exist more unique attributes (e.g., one identifier/locator/interface per user)
  - could be solved by technical systems – the real-world things can't

Inference

Question: Where is sensitive information contained?

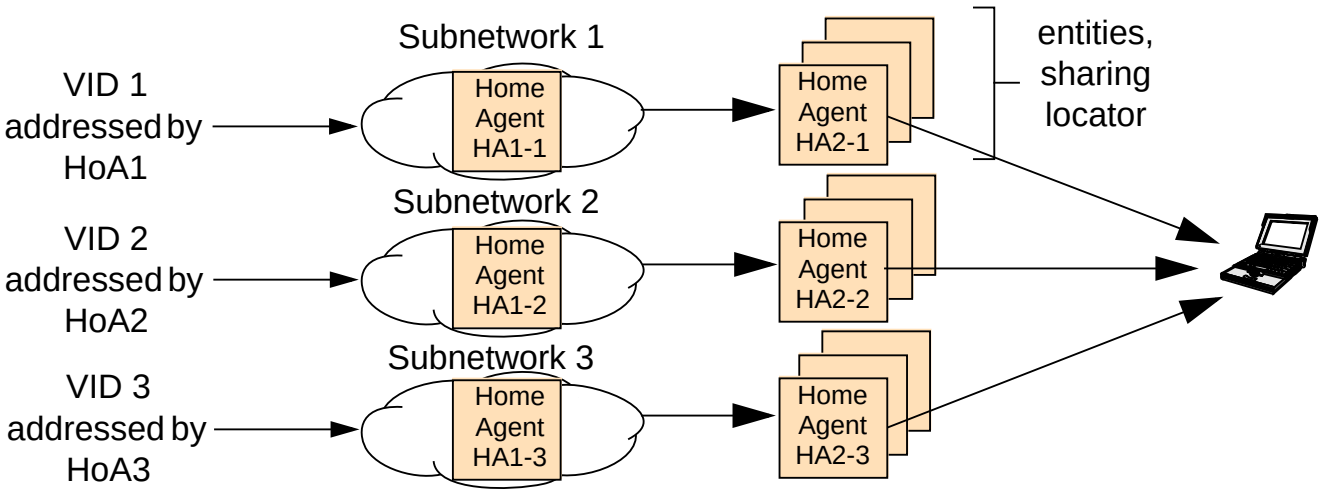
1. In identifier: Home of user (usually)
2. In locator: Location, network connection
3. In locator changes: Movement behaviour

Threat Analysis — Summary

	Threats in fixed scenario	Additional threats in mobile scenario
Linking of VIDs	**LinkF:** Identical data in context of VIDs *Example:* Identical identifier, identical locator	**LinkM(1):** Identical behavior of VIDs observed by identical patterns of data or events *Example:* Change from identical old locator to identical new locator
		LinkM(2): Identical behavior of VIDs observed by similar patterns of data or events *Example:* Simultaneous locator changes with unknown locators
Inference of personal information	**InfFI:** Inference from the identifier *Example:* home of VID	No additional inference from the identifier
	InfFL: Inference from a single locator *Example:* Location of the user at communication time	**InfML(1):** Inference from several locators *Example:* Location trace of a user over a period of time
		InfML(2): Inference from user behavior by locator changes *Example:* Inference of activity by rate of locator changes

A New Approach

System Approach



- **Different networks supposed to be operated by different parties**
- **Separate contexts for VIDs throughout packet's path**
- **Two agents in a row: no entity knows both, identifier and locator**
- **Locator invisibly stored when not needed**
- **Home Agents HA2-x are changed frequently**
- **Identifiers not from home netw. but from different, arbitrary networks**

  Each of those networks operates a "Home Agent"
- **User can configure trade-off between performance and privacy**

Conclusions and Future Work

- **Future context-aware systems need suitable privacy protection**

  approach of multiple VIDs very promising

  - support by communication system necessary
  - new threat implied: Linking of VIDs

- **Threat analysis regarding communication system**

  - mobility adds significantly to threat

  ➥ solution must be especially designed for multiple identities and mobility

- **Existing proposals not well prepared**
- **New approach**

  - solves or at least alleviates all identified problems
  - user in control of trade-off: costs vs. privacy

- **Future work**

  - realization of proof-of-concept
  - quantification of protection vs. costs

    ➥ evaluation of sensible configurations