

OPAQUE: Protecting Path Privacy in Directions Search

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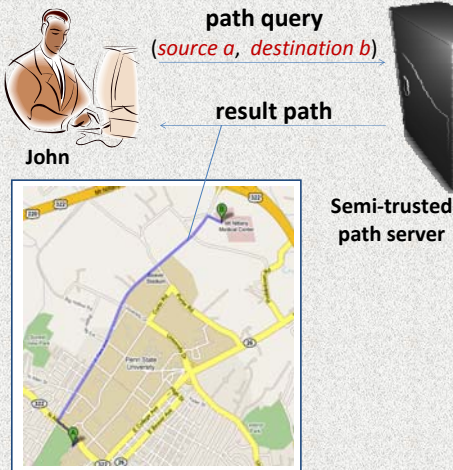
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Path Privacy Problem



Threats

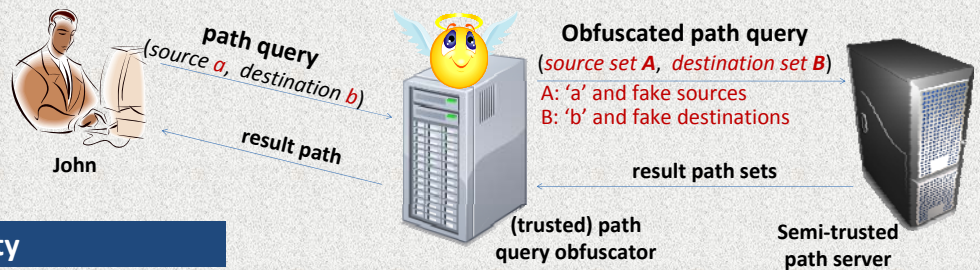
Inference attack

a : user's home/office, user identity
 b : clinic specialized for a certain disease
 info: "John" is going to clinic, possibly has a disease

Possible Trajectory Prediction

info: "John" would travel in the resulted path

Protection by Path Query Obfuscation



Privacy Protection verse Service Utility

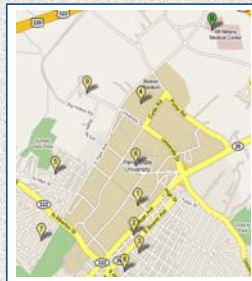
Breach probability:
 $\frac{1}{|A| \times |B|}$

Stronger protection (smaller breach probability) if larger $|A|$ and $|B|$ are used.

Path search performance:

$$O(\sum_{a \in A} \max_{b \in B} \|a, b\|^2)$$

Faster search if small $|A|$ and closely located destinations are specified.



User specifies a protection requirement (the min. breach probability)
 Path Query Obfuscator determines the sizes of A and B

Shared Obfuscated Path Query



Obfuscated path query shared by John and Paul

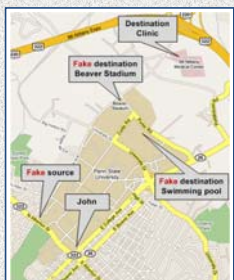
Breach probability:

$$\frac{1}{3 \times 4} = \frac{1}{12}$$

Number of path searches: 3

Shared Obfuscated Path Query saves path search overhead, while retaining small breach probability.

Independent Obfuscated Path Query



John's obfuscated path query

Breach probability:

$$\frac{1}{2 \times 3} = \frac{1}{6}$$

Number of path searches (Dijkstra's search): 2



Paul's obfuscated path query

Breach probability:

$$\frac{1}{2 \times 2} = \frac{1}{4}$$

Number of path searches: 2

References

- E. W. Dijkstra, "A Note on Two Problems in Connexion with Graphs" In Numerische Mathematik, 1959
- M. F. Mokbel, C.-Y. Chow and W. G. Aref "The New Casper: Query Processing for Location Services Without Compromising Privacy", in VLDB, 2006
- M. Gruteser and D. Grunwald, "Anonymous Usage of Location-Based Services Through Spatial and Temporal Cloaking" in MobiSys 2003

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