STAMP: Enabling Privacy-Preserving Location Proofs for Mobile Users

Abstract:

Location-based services are quickly becoming immensely popular. In addition to services based on users' current location, many potential services rely on users' location history, or their spatial-temporal provenance. Malicious users may lie about their spatial-temporal provenance without a carefully designed security system for users to prove their past locations. In this paper, we present the Spatial-Temporal provenance Assurance with Mutual Proofs (STAMP) scheme. STAMP is designed for ad-hoc mobile users generating location proofs for each other in a distributed setting. However, it can easily accommodate trusted mobile users and wireless access points. STAMP ensures the integrity and non-transferability of the location proofs and protects users' privacy. A semi-trusted Certification Authority is used to distribute cryptographic keys as well as guard users against collusion by a light-weight entropy-based trust evaluation approach. Our prototype implementation on the Android platform shows that STAMP is low-cost in terms of computational and storage resources. Extensive simulation experiments show that our entropy-based trust model is able to achieve high collusion detection accuracy.

Introduction:

AS LOCATION-ENABLED mobile devices proliferate, location- based services are rapidly becoming immensely popular. Most of the current location-based services for mobile devices are based on users' current location. Users discover their locations and share them with a server. In turn, the server performs computation based on the location information and returns data/services to the users. In addition to users' current locations, there is an increased trend and incentive to prove/validate mobile users' past geographical locations. This opens a wide variety of new location-proof based mobile applications. Saroiu *et al.* described several such potential applications in. Let us consider three examples: (1) A store wants to offer discounts to frequent customers. Customers must be able to show evidence of their repeated visits in the past to the store A company which promotes green commuting and wellness mayreward their employees who walk or bike to work. The company may encourage daily walking goals of some fixed number of miles. Employees need to prove their past commuting paths to the company along with time history. This helps the company in reducing the healthcare insurance rates and move towards sustainable lifestyle. On the battlefield, when a scout group is sent out to execute a mission, the commanding center may want every soldier to keep a copy of their location traces for investigation purpose after the mission. The above applications require users to be able to obtain proofs from the locations they visit. Users may then choose to present one or more of their proofs to a third-party verifier to claim their presence at a location at a particular time. In this paper, we define the past locations of a mobile user at a sequence of time points as the *spatial-temporal provenance* (STP) of the user, and a digital proof of user's presence at a location at a particular time as an *STP proof*. Many works [1]–[3] in literation have referred to such a proof as *location proof.* In this paper, we consider the

two terms interchangeable. We prefer "STP proof" because it indicates that such a proof is intended for past location visits with both spatial and temporal
Information. Other terminologies have been also used for similar concepts, such as location claim, provenance proof, and location.