

Advances in smart cards

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Abstract

Since the turn of the century, smart card technology has pushed its borders both on the high end to integrate new functionalities (e.g., networking) and on the low end to adapt to new constrained environments (e.g., radio-frequency identification). This has required changes in the hardware, software and cryptography underpinning smart cards. This special issue covers some of these developments in depth.

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1. Introduction

Smart card technology has evolved a long way since the idea of using plastic cards to carry micro-electronic chips was patented back in 1968 by Dethloff and Grötrupp. In July 2001, a special issue of *Computer Networks* was devoted to smart cards [1], with the purpose of surveying the key issues and solutions that had turned smart cards into full fledged computers (with or without a plastic card around the microchip). Since the turn of the century, another qualitative jump has occurred and smart cards have become *smart devices*, in the sense

that they have conquered new application fields related to pervasive computing. On the high end, network smart cards have appeared which integrate networking capabilities; on the low end, smart cards have transformed into radio-frequency identification (RFID) tags.

This special issue of *Computer Networks* contains one invited article and seven contributed articles selected by anonymous review from the submissions received. Altogether, these papers cover key issues and research underpinning the aforementioned expansion of smart cards. The topics of the papers are cryptographic primitives, network smart cards, RFID protocols and other smart-card based protocols. Our intention as guest editors was not to give comprehensive coverage of the field, but to gather articles that provide readers with in-depth understanding of what the state of the art is, and what the future real-life impact of smart devices is likely to be.

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2. Cryptographic algorithms

The invited article “A survey of recent developments in cryptography for smart cards”, by Preneel, presents an update on recent advances in cryptographic algorithms relevant for smart cards. In particular, it reviews hash functions, block ciphers, stream ciphers and authenticated encryption. Later in the paper, secure padding for the RSA algorithm is discussed in some detail. Finally, an update on Elliptic Curve Cryptography is given.

3. Network smart cards

The communications standards of current smart cards are inadequate to ensure their successful integration in the Internet world. Turning smart cards into network devices is therefore a challenge and a line of progress for high-end smart cards. This special issue features two papers on this subject.

The article “Network smart card review and analysis”, by Lu, reviews the progress made by research on network smart cards. It then analyzes and compares various networking options for these devices. Furthermore, an outline is provided for the technical challenges that remain to be solved before smart cards can effectively couple with Internet computing.

In “Advances in network smart card authentication”, by Torres et al., the authentication implications of using smart cards as network devices are examined. Traditionally, the role of smart cards in the authentication process has been one of simple hardware tokens connected to a larger, networked device (e.g., PC, teller machine, etc.). Directly plugging the smart card into the network changes the authentication scenario and results in new requirements and threats.

3.1. RFID protocols

Low-end smart cards have a brilliant future as RFID tags. The main challenge here is to offer reasonable security and privacy with lightweight protocols which can be cost-effectively implemented in tags and readers. There are two papers in the issue dealing with RFID protocols.

“HB-MP: A further step in the HB-family of lightweight authentication protocols”, by Munilla and Peinado, presents a new authentication protocol called HB-MP which is intended to repair the HB and HB⁺ protocols earlier broken by cryptanalysts. Protocols in the HB-family are especially suit-

able for RFID systems in which every tag has to be authenticated by the reader.

In addition to authentication of tags by readers, tag privacy is a desirable property of RFID systems if these must be accepted by the citizenship. “A distributed architecture for scalable private RFID tag identification”, by Solanas et al., presents a cell-based architecture and a communication protocol whereby readers co-operate to conduct tag identification in a private and scalable way. In this way, a large population of operating tags does not result in unacceptable computing time for private identification of a particular tag by a particular reader.

4. Other smart-card based protocols

The remaining three papers in this special issue describe cryptographic protocols for applications that exploit the tamper-resistance of smart cards.

“Security enhancement of an IC-card-based remote login mechanism”, by Cheng et al., describes a repaired version of an earlier remote password authentication scheme using smart cards. The new protocol withstands forgery attacks and provides mutual authentication between a remote server and login users. A time-stamping mechanism is used to prevent replay attacks in which an intruder tries to gain access to a remote server by using a previously intercepted login request.

“Smart card-based agents for fair non-repudiation”, by Marín et al., presents a new fair non-repudiation protocol. This kind of protocol is of paramount importance for electronic transactions. A good non-repudiation protocol should work even if the computational power of the parties is substantially different and the communication channel is unreliable. Additionally, it should minimize the involvement of trusted third parties (TTPs). In the new protocol proposed in this paper, the TTP role is played by notary agents executing inside a smart card. Furthermore, the protocol can run on unreliable channels, disconnected from the certification authority, which makes it very attractive for ad hoc networks.

The last paper in this issue, “Secure many-to-one symbol transmission for implementation on smart cards”, by Sebé et al., exploits the tamper-resistance of smart cards to provide secure many-to-one transmission from a set of emitting leaves to a receiving root node, where security means confidentiality and authenticity in the leaf-to-root traffic. The method described offers secure and scalable many-to-one communication in a computationally simpler, more

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