



# ETSI White Paper No. 1

# Security for ICT - the Work of ETSI

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He is Chairman of the NISSG, a group that was set up to co-ordinate security standards amongst the three European Security Standards Organisations and other bodies outside Europe. He is also on the Permanent Stakeholders group of ENISA, the European Network and Information Security Agency.

He is also Chairman of ETSI OCG Security, which is responsible for security within ETSI, has been Chairman on the GSM Association Security Group (representing operators in over 200 countries) for many years, and has been involved in GSM and 3GPP security standards.

# Security for ICT - the Work of ETSI

**December 2009**

This White Paper offers an overview of ETSI's work on security in Information and Communications Technologies (ICT).

Each section introduces a specific technology and outlines ETSI's involvement in the standardisation of security in that area. Some of our major achievements are then highlighted and ongoing activities are described. At the end of the paper, all ETSI's specifications and standards for security are listed. Listed documents referenced in the text are indicated by a number in [ ].

Each ETSI document number in the list of publications at the end of this paper links to the ETSI deliverable available **online**, from where the **latest published version** at the time of your search can be downloaded, as well as any previous versions.

This third edition of the ETSI Security White Paper updates all areas as necessary. New publications have been added, while a large number of previously referenced publications have undergone revision and now have updated versions. New areas of work which have, or will have, security aspects have been included: Quantum Key Distribution, Aeronautics, Reconfigurable Radio Systems, IPv6 and new developments in 3GPP. Some details on various Plugtests™ events related to security matters have been added.

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* MESA and 3GPP are Partnership Projects of which ETSI is a co-founder

** SMG and M-COMM are closed Technical Committees, having successfully completed their work

*** QKD is an ETSI Industry Specification Group (ISG)

## FOREWORD

The increasingly rapid evolution and growth in the complexity of new systems and networks, coupled with the sophistication of changing threats and the presence of intrinsic vulnerabilities, present demanding challenges for maintaining the security of Information and Communications Technology (ICT) systems and networks. To minimise exposure to risks, security must be built in from the beginning when designing new architectures, not added on later as an optional feature.

As a response to such challenges, Information Security standards are essential to ensure interoperability among systems and networks, compliance with legislation and adequate levels of security. These standards provide the means for protecting the user, creating a more secure and profitable environment for the industrial sector, from SMEs to large global companies, and providing benefits for a diverse range of interest groups that include government organisations, research bodies and universities.

ETSI is an independent, non-profit organisation, with over 20 years of experience of successfully pursuing its mission to produce globally-applicable ICT standards. It has always maintained a strong focus on security matters.

ETSI is committed to the establishment and continuous improvement of effective and interoperable telecommunications systems for the benefit of the global community. Addressing security issues in Next Generation Networks, protecting citizens in emergency scenarios, and combatting global climate change by lowering power consumption are examples which highlight some of ETSI's commitments. ETSI continues to intensify its focus on matters related to security innovation by participating actively in EU security research and innovation initiatives which aim to provide Europe, and the rest of the world, with the tools necessary to create a secure environment for the global citizen.

Standardisation activities carried out within various ETSI Technical Committees, Working Groups, Industry Specification Groups and Partnership Projects cover a broad spectrum of security issues, of which this White Paper provides an overview.

*Carmine Rizzo, ETSI Security Standardisation Projects, ETSI Secretariat*

*Charles Brookson, Chairman, ETSI OCG Security*

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*Carmine Rizzo*

## INTRODUCTION - THE ORGANISATION OF WORK IN ETSI

ETSI's work is organised into Technical Committees (TCs) and ETSI Partnership Projects. Supported by Working Groups (WG), each is responsible for producing and maintaining standards in its own technical area. The scope of some TCs is closely related to security aspects; others, including the Partnership Projects, have a much broader scope, but necessarily deal with security issues in the process of producing a complete set of standards for a technology.

The main areas of work related to security cover Mobile/Wireless Communications, Emergency Telecommunications, Information Technology Infrastructure, Smart Cards, Fixed Communications and Security Algorithms. Some TCs work specifically within one of these areas, whereas the work of other TCs can overlap several areas.

This complex and dynamic scenario creates a need for a group to co-ordinate security matters across the ETSI work areas. For this reason ETSI has created an Operational Co-ordination Group on Security (OCG SEC). Its primary role is to provide a light-weight horizontal co-ordination structure for security issues that will ensure that this work is considered appropriately in each ETSI TC and that any duplicate or conflicting work is detected and managed accordingly.

This White Paper outlines ETSI's work in each of the security-related fields. A complete list of the relevant publications for each field is included at the end of this document, followed by the reference numbers of the documents added since the second edition of the ETSI Security White Paper published in October 2008.

**Key to ETSI Technical Committees (TC) / Partnership Projects**

| | |
|---|---|
| **3GPP (partnership project)** | Third Generation Partnership Project |
| **MESA (partnership project)** | Mobility for Emergency and Safety Applications |
| **AERO** | Aeronautics |
| **ATTM** | Access, Terminals, Transmission and Multiplexing |
| **BROADCAST** | Joint TC on broadcasting matters |
| **DECT** | Digital Enhanced Cordless Telecommunications |
| **EMTEL** | Special Committee on Emergency Telecommunications |
| **ERM** | Electromagnetic Compatibility and Radio Spectrum Matters |
| **ESI** | Electronic Signatures and Infrastructures |
| **ITS** | Intelligent Transport Systems |
| **LI** | Lawful Interception |
| **M-COMM (closed TC)** | Mobile Commerce |
| **MSG** | Mobile Standards Group |
| **MTS** | Methods for Testing and Specification |
| **QKD (ISG)** | Quantum Key Distribution (Industry Specification Group) |
| **RRS** | Reconfigurable Radio Systems |
| **RT** | Railways Telecommunications |
| **SAGE** | Security Algorithms Group of Experts |
| **SCP** | Smart Card Platform |
| **SES** | Satellite Earth Stations and Systems |
| **SMG (closed TC)** | Special Mobile Group |
| **TETRA** | Terrestrial Trunked Radio |
| **TISPAN** | Telecommunications and Internet converged Services and Protocols for Advanced Networking |

## ETSI Security Workshops

Each year, in January, ETSI organises a Security Workshop in its premises, attracting a large number of experts from all over the world. These events are highly appreciated for the quality and relevance of the presentations, many of them focusing on standardisation issues. They also provide valuable co-operation opportunities, and help set the direction for future standardisation work, in line with the requirements of ETSI Members. In recent years the discussions have focused increasingly on the broad issue of security innovation, and the role that security standards can and should play in such context.

Speakers are selected from a call for contributions, which is announced at

*http://www.etsi.org/SECURITYWORKSHOP*.

Each of the four ETSI Security Workshops so far has featured many expert speakers, representing organisations that included ETSI, CEN, CENELEC, European Commission, ENISA, ITU-T, ISO, NIST as well as the private sector, governments, universities and research bodies, including the European Commission's Joint Research Centre.

Information about all ETSI Security Workshops, together with the workshop report and presentations for download, is available from the above link. The 5th ETSI Security Workshop (Security Innovation) is scheduled for 20-22 January 2010 in the ETSI premises in Sophia Antipolis, France.

## MOBILE AND WIRELESS TELECOMMUNICATIONS

Mobile and wireless technologies are enormously flexible. Beyond the well-known and widespread commercial use (e.g. cellular telephones, wireless networks and cordless home telephones), applications include public safety and military communications.

The wireless infrastructure that terminals use to access the network makes these technologies vulnerable to attack. Over the years, ETSI has developed a unique expertise in securing these forms of communication, providing encryption techniques and fraud prevention mechanisms.

ETSI's standardisation work includes various mobile and wireless technologies.

## GSM™ - background and achievements

Shortly after its creation in 1988, ETSI took over the task of specifying GSM from the European Conference of Posts and Telecommunications Administrations (CEPT). In 2001, GSM standardisation was transferred to the Third Generation Partnership Project (3GPP™), which ETSI helped to found to develop globally applicable specifications in the mobile telecommunications area. A new Technical Specification Group (TSG GERAN) was created within 3GPP to handle the GSM-specific radio aspects. Responsibility for standards specifically for regulatory use remains with ETSI's Mobile Standards Group (TC MSG).

Standardisation of GSM has continued relentlessly, bringing enhancements to the basic GSM technology, as well as its evolution to more advanced technologies such as the General Packet Radio Service (GPRS) and Enhanced Data Rates for GSM Evolution (EDGE). Although GSM can offer a basic data service, these newer technologies have introduced users to practical mobile data and multimedia services, dramatically extending the reach of the Information Society to all peoples of the world and helping to resolve the “Digital Divide”.

Security has been a major driver for the success of GSM. Specifications have been developed to prevent terminal equipment theft, allow encryption and authentication, control payment for copyright material downloading and respond to many other security threats. The general description of the security functions can be found in [57].

Standardisation work related to specific security aspects of GSM is currently being carried out within ETSI's Railways Telecommunication committee (TC RT) and within the joint ETSI ERM/MSG group.

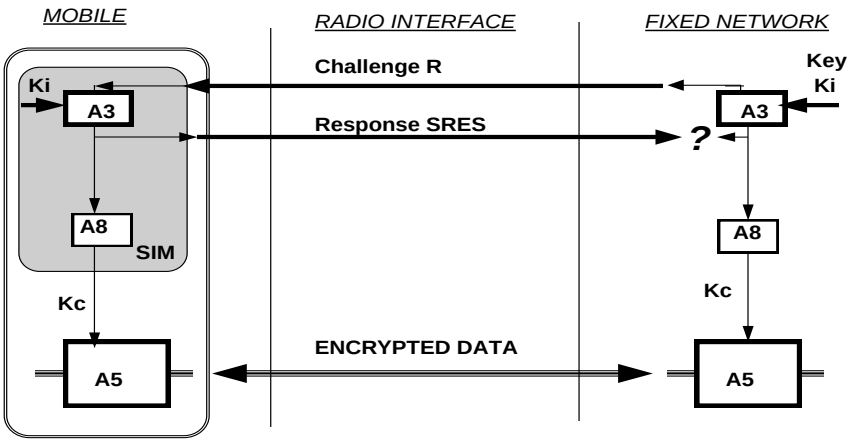
The major characteristics of security in GSM are described below.

**Anonymity** - Anonymity entails preventing the tracking of the location of the user and preventing the identification of calls made to or from the user by eavesdropping on the radio path. Anonymity in GSM and UMTS is provided by using temporary identifiers when the feature is activated by the operator. When a user first switches on his mobile device, the real identity is used and a temporary identifier is then issued. From then on, the temporary identifier is used, until such time as the network requests the real identity again. Only by tracking the user is it possible to determine the temporary identity being used (see [25], [65], [73] and [74]).

**Authentication and Signalling Protection** - Authentication is used to identify the user (i.e. the holder of a Subscriber Identity Module (SIM) card) to the network operator and is based on encryption.

ETSI has developed three security algorithms for GSM: A3, A5 and A8. The A3 and A8 algorithms are specific to the operator and are saved on the SIM card and in the authentication centre. A5 is saved in the mobile equipment and allows for data encryption and decryption over the radio air interface.

Authentication is performed by a challenge and response mechanism. A random challenge is issued to the mobile, the mobile encrypts the challenge using the authentication algorithm A3 and the key assigned to the mobile, and sends a response back. The operator can check that, given the key of the mobile, the response to the challenge is correct. Eavesdropping on the radio channel reveals no useful information, as the next time a new random challenge will be used. More specifically, the procedure is as follows: a random number (R) is generated by the network and sent to the mobile. The mobile uses the random number as the input to the encryption and, using a secret key (Ki) unique to the mobile, transforms this into a response (SRES) which is sent back to the network. The network can check that the mobile really has the secret key by performing the same process and comparing the responses with what it receives from the mobile. The response is then passed through an algorithm, A8, by both the mobile and the network to derive the key (Kc) used for encrypting the signalling and messages to provide privacy (A5 series algorithms). The process can be represented graphically as follows (see also [60] to [63]):




**IMEI** - Mobile terminals are by their nature attractive objects, at great risk of theft, often described by the acronym CRAVED (Concealable, Removable, Available, Valuable, Enjoyable and Disposable). ETSI has created a set of standards (see [64] and [65]) which define a system to prevent handset theft, based on a handset identity number called the International Mobile Equipment Identity (IMEI). This is a unique number attributed during handset manufacturing, registered by the Mobile Network Operator (MNO) and implemented into the mobile terminal. Using the IMEI, mobile equipment declared as stolen can be blacklisted by the MNOs.

IMEI blacklisting is currently in operation, though not yet on a world-wide basis; stolen phones often leave their original country for less developed countries where people cannot afford the price of a new handset. To use the handset in the same country it has been stolen in, the IMEI value can also be changed to an authorised one. To reduce handset theft, some countries have passed laws that make IMEI alteration illegal. In parallel, handset manufacturers are working on increasing the IMEI's security.

The IMEI offers other benefits too: for example, certain handsets can be tracked by the network for evaluation or other purposes. The IMEI is also useful for identifying makers of hoax emergency calls.

**FIGS -** Fraud Information Gathering System (FIGS) is a method of monitoring a subscriber's activities to limit the accumulation of large unpaid bills run up whilst roaming (see [1], [5], [14], [16] and [54]). FIGS allows the network that roaming subscribers are entering to collect information about their activities. The network then sends this information back to the home network of the subscriber, which can then clear certain types of calls and prevent fraudulent use of the system (see [6] and [10]).

**Priority** - GSM specifications include a public safety service called Priority (see [67], [68]). This allows users of the appropriate category (typically the emergency services, government agents and the military) to obtain high priority access to network services in crisis conditions, when there is a danger of overloading a potentially impaired network.

## GSM™ - current work

The current standardisation work carried out within ETSI related to the GSM technology includes several specific application areas, notably GSM onboard aircraft, GSM for automatic emergency calls from vehicles and GSM for railway telecommunications.

**GSM onboard aircraft (GSMOBA) -** GSM onboard aircraft has been developed and standardised by the joint ETSI group ERM/MSG GSMOBA, established in 2006. The European Harmonised Standard for GSMOBA (EN 302 480) was published in April 2008 [77]. GSMOBA addresses major security concerns, the main ones being related to causing interference to ground networks. To make effective use of the spectrum in terrestrial networks, these need to be protected from interference originating from installations and GSM terminals on aircraft flying above.

The GSMOBA group has devised means to prevent such communications between terrestrial networks and handheld terminals on aircraft, thus making communication from aircraft-located terminals possible only via aircraft-located base stations. This is achieved raising the RF noise floor within the cabin to such a level that neither interference nor communication with ground networks is possible. In future, the GSMOBA concept may be expanded to UMTS/LTE (Long Term Evolution) technologies. ETSI White Paper No. 4 provides more information.

**GSM eCall -** The term “eCall” refers to automatic emergency calls from vehicles and other eCall-equipped devices in case of a crash or other catastrophic event. This work has been ongoing in ETSI TC MSG since 2004, and relies on analysis and definition of requirements from 3GPP. eCall is expected to be GSM-based in its first deployment, although successive extensions to UMTS and LTE are foreseen.

**GSM Direct Mode Operations (DMO) -** DMO (Direct Mode Operation) features of GSM are being developed in ETSI TC RT for use in a variant of GSM for railway operators, known as GSM-R. The DMO features constitute an extension of GSM, allowing terminals with DMO functionality to communicate directly with each other without having to rely on a background telecom network infrastructure. In areas without GSM (or GSM-R) coverage, e.g. unpopulated areas, tunnels or during major breakdown of the underlying GSM infrastructure, track maintenance personnel and the like would still be able to communicate in simple terminal-to-terminal direct mode.

The addition of such functionality to GSM terminals is not trivial, due especially to spectrum regulation and spectrum management issues, as the GSM spectrum is licensed, and its utilisation needs to be controlled by GSM (and GSM-R) operators. Properly controlled and authorised DMO demands a series of security considerations essential to the safe operation of railways in case of network breakdown. The DMO working group within TC RT is addressing these requirements.

## UMTS™

Development of specifications for the 3rd Generation Universal Mobile Telecommunication Systems (UMTS) is the task of a partnership project known as 3GPP, of which ETSI is a founding partner. 3GPP brings ETSI together with five other regional standardisation organisations in Asia and the USA, plus organisations representing market interests and several hundred individual companies. 3GPP is also responsible for the maintenance and evolution of the specifications for GSM, and for transitional technologies such as GPRS and EDGE.

The UMTS security specifications developed in 3GPP build on the mechanisms used in the GSM specifications. In addition, they offer numerous enhancements that include the following:

**Authentication** - To further enhance the security already present in GSM, 3GPP has adopted an innovative authentication and key agreement protocol for UMTS. The protocol retains the framework of the GSM authentication mechanism and provides additional features such as mutual authentication, agreement on an integrity key between the user and the serving network, and freshness assurance of agreed cipher key and integrity key. As in the GSM authentication mechanism, the serving network authenticates the user by using authentication data (called authentication vectors) transferred from the user's home network. In each authentication vector, a protected sequence number is included, verified by the terminal's smart card (USIM) to achieve authentication of the network by the user. There are also mechanisms for freshness assurance of agreed cipher and integrity keys (see [28], [29], [30], [31], [34], [38], and [41]).

**Public Safety -** 3GPP has invested significant effort in ensuring that emergency calls in UMTS are always connected and has introduced various public safety functionalities.

Location services are also an important feature (see [69] to [72]). Several techniques have been specified to improve the accuracy of the positioning, from the simple retrieval of the radio cell where the mobile is located to the more advanced, assisted GPS positioning. In the specification work, several ancillary aspects related to location services have been addressed such as privacy protection for the users and when there is a need for public authorities to trace mobile phones.

3GPP has also been working to enhance the capabilities of cell broadcast services to introduce the MBMS (Multicast Broadcast Multimedia Service) (see [33]). This enables MNOs to transmit multimedia content to a selected area of the mobile network, a feature of particular value when the need arises to issue public warnings.

## Ongoing activities

3GPP activities related to security are now focused on the IP Multimedia Subsystem (IMS), which is an Internet Protocol (IP) based core network dedicated to the control and integration of multimedia services. Extensions to IMS security specifications to encompass the requirements of Next Generation Networks, enabling Fixed-Mobile Convergence, are currently being applied.

Among other important issues, extensions for GAA/GBA (Generic Authentication and Bootstrapping Architectures) are being addressed, as is the feature of Selective Disabling of User Equipment (UE) Capabilities. The latter can be very useful when a downloaded and activated application repeatedly makes a connection request requiring the allocation of both radio resources and network signalling processing, potentially resulting in a substantial threat.

## EPC / LTE™

LTE™ is a major advance in the evolution of 3GPP radio interfaces to deliver global mobile broadband, derived from a plan first conceived in 2004. It has significantly increased data throughput with a downlink target 3-4 times greater than HSDPA (High Speed Downlink Packet Access) Release 6, and an uplink target 2-3 times greater than HSUPA (High Speed Uplink Packet Access) Release 6. The complementary core network upgrade, Evolved Packet Core (EPC), will focus on an enhancement of Packet Switched technology to cope with rapid growth in IP traffic, (i.e. higher data rates, lower latency and packet optimised systems), through fully IP networks with simplified network architecture and distributed control.

LTE form the basis of 3GPP Release 8, functionally frozen in December 2008. The security architecture is being defined by the 3GPP Services and System Aspects Working Group on Security, SA3.

Authentication and key agreement are based on UMTS AKA (Authentication and Key Agreement) which is re-used for Evolved Packet Systems (EPS). Subscriber Identity Module (SIM, as used in GSM) access to LTE is explicitly excluded and only Release 99 or later Universal Subscriber Identity Modules (USIMs) are allowed.

As far as signalling protection is concerned, core network signalling (Non-Access Stratum (NAS)), integrity and confidentiality protection terminates in the Mobility Management Entity (MME). Integrity and confidentiality protection for the radio network signalling (Radio Resource Control, RRC) and for the MME is maintained over the radio path, i.e. between the User Equipment (such as a mobile terminal) and the eNodeB (the base station in the LTE technology), as is the encryption for the User plane protection. Network domain security is used to protect the internal interfaces.

Two new sets of security algorithms were developed for LTE: one set is based on AES (Advanced Encryption Standard) and the other on SNOW 3G. The principle being adopted is that the two should be as different from each other as possible, to prevent similar attacks being able to compromise them both. The ETSI Security Algorithms Group of Experts (SAGE) is responsible for specifying the algorithms. The key length is of 128 bits, with the possibility to introduce 256-bit keys in the future if necessary. A third set of algorithms may be produced for Release 10.

LTE will enable efficient interworking with legacy and non-3GPP networks. In this scenario, trust models become more complex and a deeper key hierarchy than that used in UMTS will be needed for LTE. A (one-way) Key Derivation Function (KDF) is used for LTE. The extended key hierarchy will also enable faster intra-LTE handovers.

Interworking with non-3GPP networks will be based on EAP-AKA and its revised version EAP-AKA', where the EAP (Extensible Authentication Protocol) server is the 3GPP AAA server residing in the EPC, which is a framework for an evolution or migration of the 3GPP system to a higher-data-rate, lower-latency, packet-optimised system that supports, multiple Radio Access Technologies (RATs). AKA' is a small revision of the AKA method which comprises a new key derivation function that binds the keys derived within the method to the name of the access network, and employs SHA-256 instead of SHA-1 (SHA stands for Secure Hash Algorithm) In circumstances where the non-3GPP network is un-trusted, an IPSec tunnel will be used.

## HNB/H(e)NB - Femtocell

Access to 3G and evolved 3G Evolved Packet System (EPS) services may be provided via UMTS Terrestrial Radio Access Network (UTRAN) or Evolved UTRAN (E-UTRAN) cellular base stations used for domestic or commercial purposes. The EPS comprises the Evolved Packet Core together with the evolved radio access network. E-UTRAN is an evolution of the 3G UMTS radio access network towards a high-data-rate, low-latency and packet-optimised radio access network.

This type of access may be provided by the Public Land Mobile Network (PLMN) by means of NodeBs referred to as Home Node B (HNB) and Home (e) Node B (H(e)NB). The H(e)NB provides services to a Closed Subscriber Group (CSG). CSG membership, including temporary membership, is managed by both the CSG manager and the network operator.

3GPP is currently standardising Home Node B and Home eNode B technologies. From the security point of view there are a number of differences compared to a traditional UMTS or LTE architecture, as the Node B is an element that is traditionally owned and controlled by the operator, whereas the Home (e) Node B resides in the customer's premises.

The threats that can occur from this change are collected in the 3GPP document TR 33.820, where the countermeasures are proposed. 3GPP has also standardised the security architecture which specifies how the H(e)NBs can ensure an adequate level of security, and comply with regulatory requirements (see [79] to [81]).

## Common IMS

First defined by 3GPP as a core network feature dedicated to the handling of the signalling and user traffic flows related to multimedia applications, the IP Multimedia Subsystem (IMS) has since been recognised as having enormous potential for use in many different networks (mobile, fixed, cable TV etc.), particularly given the trend towards the convergence of such networks. An agreement for 3GPP to be the sole owner of the IMS specifications has led to the conception of the Common IMS. This has resulted in a set of specifications defining the Core IMS and additional features, including Security, to satisfy the requirements coming from a variety of standardisation bodies.

In this perspective the security requirements coming from ETSI TC TISPAN, CableLabs and 3GPP2 were inserted into the Common IMS specifications. More specifically, several new normative annexes were added to Release 8 (see [27]):

- NASS (Network Access SubSystem) - IMS Bundled Authentication (NBA), which was a contribution by ETSI TC TISPAN;
- SIP Digest - based authentication, also a contribution by ETSI TC TISPAN;
- Access security with TLS (Transport Layer Security), which was a contribution by CableLabs;
- 3GPP2 Access, a contribution by 3GPP2.

A further annex illustrates the co-existence of authentication schemes. This annex explains how the following authentication mechanisms should be handled in a Common IMS: Full IMS AKA, Early IMS, re-named GIBA (GPRS-IMS Bundled Authentication), NBA, and SIP Digest.

## TETRA

ETSI Technical Committee TETRA is responsible for producing specifications for TErrestrial Trunked RAdio (TETRA), a mobile radio communications infrastructure targeted primarily at public safety groups (such as the police and fire departments). Nevertheless TETRA has been - and continues to be - deployed in other traditional private/professional mobile radio (PMR) markets, such as transportation, utilities, industrial and public access mobile radio (PAMR), as well as in the military sector for peacekeeping and other activities, where fast and accurate field communications to and from a central office or dispatcher, as well as between the unit's members, are often critical.

In recent years, emergency response teams from several European nations have had difficulties communicating with each other, due in part to the lack of standardisation in their mobile radio equipment. The TETRA standards evolved to answer this and other communication challenges, including those anticipated by the European Commission in its efforts to unify communications across the different member states. The mission-critical effectiveness and operational efficiency of TETRA as a wireless communications technology was demonstrated during the Madrid railway bombings and the Olympic Games in Athens in 2004.

Based on digital, trunked radio technology, TETRA is considered to be the next-generation architecture and standard for current analogue PMR and PAMR markets. TETRA actually uses features taken from several different technological areas: mobile radio, digital cellular telephone, paging and wireless data.

Fraud prevention and confidentiality are critical to the success of radio mobile systems such as TETRA because the air interface is open to being overheard or attacked if not protected. The security-related functions of the standard comprise the following features (see also [82], [83] and [84]):

**Mutual authentication** - With mutual authentication over the air interface, a mobile station can check if a network can be trusted before entering, and the TETRA system can control the access of a mobile station. This mechanism offers guarantees against an attacker penetrating the network, thus preventing fraud, Denial of Service (DoS) situations, spoofing and other forms of attack, while at the same time ensuring correct billing and access as well as a secure data distribution channel. The mutual authentication security mechanism is available for both TETRA modes: Voice and Data mode and the Packet Data Optimised mode. In Direct Mode Operation (DMO) an explicit authentication mechanism is not available; in this case the use of Static Cipher Keys can provide implicit mutual authentication.

**Encryption -** As the air interface is vulnerable to eavesdropping, encryption is crucial. Air interface security is intended to secure the connection between mobile stations and the network. This interface is essential to provide certain security functions in a mobile network. In addition, end-to-end security can be provided to offer a higher level of security. The use of several encryption algorithms, both standard and proprietary, is supported.

TETRA end-to-end security service is achieved by protecting information transmitted from one mobile station to another, not only over the air interface but also within the network. The technical solution can be customised to address particular requirements. As TETRA is implemented by diverse user groups for many purposes, this feature is essential.

**Anonymity -** Anonymity is achieved using temporary identities to identify the network nodes and encrypting these identities over the air interface. In addition, each time an identity is transmitted, it is encrypted in a different way, making it difficult to eavesdrop and identify active terminals.

## Ongoing activities

The security requirements for the second release of TETRA are currently being produced. In addition, TC TETRA is preparing the Lawful Interception specifications for this technology.

## DECT™

DECT (Digital Enhanced Cordless Telecommunications) is a flexible digital radio access standard for cordless communications in residential, corporate and public environments. The DECT standard makes use of several advanced digital radio techniques to achieve efficient use of the radio spectrum; it delivers high speech quality and security with low risk of radio interference and low power technology.

DECT standardisation started in CEPT, and was transferred into ETSI at its creation in 1988. Work today is the responsibility of ETSI's DECT Technical Committee.

The major threats to cordless technologies are:

- impersonation of a subscriber identity
- illegal use of a handset
- illegal use of a base station
- impersonation of a base station
- illegal acquisition of user-related signalling information.

To combat these threats, the specifications include features which provide for:

- authentication of terminals
- data confidentiality
- user authentication.

As a contribution to DECT security, ETSI has developed the DECT Standard Authentication Algorithm (DSAA) and the DECT Standard Cipher (DSC). ETSI is currently developing a second set of these algorithms (DSAA2 and DSC2) which strengthen the security features (see Algorithms section).

The combination of Time Division Multiple Access/Time Division Duplex (TDMA/TDD) digital radio technology and dynamic channel selection with additional encryption techniques, authentication and identification procedures makes DECT radio transmissions extremely secure against unauthorised radio eavesdropping by third parties.

For an overview of the security features in DECT see [89].

### Ongoing activities

TC DECT is currently working on “DECT New Gen”, an upgrade of the DECT technology which will add more features to the base standard such as Wideband Speech, Broadband Data and Audio Streaming. The new security features in DECT New Gen will include:

- longer key length
- mandatory encryption or encryption activation
- new optional security algorithms DSAA2 and encryption DSC2 (see section Algorithms)
- dynamic keying during call
- More secure authentication, and in both directions.

## Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) is a method of storing and remotely retrieving data. An RFID tag is an electronic device that holds data. An RFID transceiver is a device that can read this data by querying an RFID tag via a radio path. Typically the tags are attached to an item and contain a serial number or other data associated with that item.

RFID can be used as a technology to achieve authentication and access. As the technology can be used in company access badges and passports, for toll payments and other systems, it is potentially vulnerable to fraudulent or terrorist attack.

Security in RFID technology must prevent illicit tracking and cloning of tags. In addition, RFID tags carry a relatively low amount of computational resources within the tag itself, which makes the use of standard cryptographic techniques unfeasible. Lighter encryption algorithms need to be created for the RFID tags.

In 2002, ETSI's Electromagnetic Compatibility and Radio Spectrum Matters Technical Committee (TC ERM) established a Task Group (ERM TG34) to produce deliverables for future RFID technologies and products. Two European Standards were published ([95] and [96]) and are updated regularly as necessary. A Technical Report providing guidelines for the installation and commissioning of RFID equipment at UHF was also published [97].

## Ongoing activities

Efforts are being made to obtain an extension of the UHF frequency band used by RFID technology. The enhanced band will serve a broader range of applications than just RFID, posing additional security issues which will need to be addressed within any future related standards. Work related to RFID security and privacy “by design” is currently being carried out by ETSI TISPAN WG7, with the cooperation and feedback of ETSI ERM TG34 (see section on Next Generation Networks).

## Reconfigurable Radio Systems (RRS)

The creation of ETSI's Reconfigurable Radio Systems Technical Committee (TC RRS) was approved by the ETSI Board in September 2009. The TC is responsible for standardisation activities in Software Defined Radio (SDR) and Cognitive Radio (CR). TC RRS has a Working Group (WG4) which focuses on the application of SDR and CR concepts to public safety.

TC RRS has produced a Technical Report which identifies and defines user requirements for RRS in the Public Safety and Defence domains [98].

## Ongoing activities

TC RRS is working on a Technical Report to define the system design and architecture of RRS in the Public Safety domain. Further security aspects will be taken into account as the SDR and CR standardisation progresses.

## Satellite

ETSI's Technical Committee on Satellite Earth Stations and Systems (TC SES) produces standards for satellite communication services and applications (including mobile and broadcasting), for earth stations and earth station equipment, especially the radio frequency interfaces and network- and user interfaces, and for protocols implemented in earth stations and satellite systems.

It is important that satellite networks are able to offer IP network services that remain comparable to and competitive with terrestrial services. These objectives require the development of satellite standards to keep pace with the rapid evolution of the terrestrial IP network standards.

TC SES has published two Technical Specifications and a Technical Report on network security ([99], [100] and [101]) in the area of broadband satellite multimedia services.

In addition, the committee's working group on geo-mobile radio interfaces, which is responsible for standards on radio interfaces for geostationary earth orbit satellite access to the core network of GSM, has undertaken work on the security of the interface and the services delivered through it ([102] to [104]). Similarly, another working group within TC SES has produced a Technical Specification for security aspects of the satellite component of UMTS [105]. The work of these two working groups was merged recently, and progress continues currently in the TC SES working group on Mobile Satellite Systems.

## Intelligent Transport Systems

Intelligent Transport Systems (ITS) concern the provision of services to improve the safety, reliability, efficiency, quality - and enjoyment - of transport. ETSI's Technical Committee on Intelligent Transport Systems (TC ITS) is responsible for the production and maintenance of standards to support the development and implementation of ITS communications and services across the network, for transport networks, vehicles and transport users.

TC ITS Working Group 5 deals with security aspects in ITS. This group is developing standards focusing on securing vehicular communications, such as to prevent eavesdropping and malware. They will cover vehicle-to-vehicle and vehicle-to infrastructure communication, and will provide credential and identity management, privacy and anonymity, integrity protection, authentication and authorisation.

## LAWFUL INTERCEPTION

Lawful Interception (LI) is the legally authorised process by which a network operator or service provider gives law enforcement officials access to the communications (telephone calls, e-mail messages etc) of private individuals or organisations. Lawful Interception is becoming crucial to preserve national security, to combat terrorism and in the investigation of serious criminal activities.

The standardisation of Lawful Interception is vital to provide an economically and technically feasible solution that complies with national and international conventions and legislation. ETSI has played a leading role in LI standardisation since 1991; today the work is concentrated in Technical Committee Lawful Interception (TC LI), which has the active participation of the major telecom manufacturers, network operators and regulatory authorities of Europe and from around the world.

ETSI's LI work covers the whole spectrum of interception aspects, from a logical overview of the entire architecture and the generic intercepted data flow, to the service-specific details for e-mail and Internet, and the requirements of law enforcement agencies. In the recent years TC LI has intensified its efforts with regards to standardisation of retained data.

### Achievements

A major achievement of ETSI's work in this area has been the publication of the specifications for the handover procedure: TS 101 671 [111] and ES 201 671 [106]. These specifications illustrate the flow that the intercepted data should follow in telecommunication networks and services. In this context, they specify the network or service protocols necessary to provide lawful interception, as well as the physical or logical point at which the interception has to take place (the handover interface) both for packet data and circuit-switched communications.

Other ETSI Technical Committees have also produced other important specifications on Lawful Interception. TC LI therefore works in close collaboration with those committees, notably TC TISPAN, the committee in charge of creating the specifications for Next Generation Networks (NGN) in ETSI, as well as TC TETRA, 3GPP and TC ATTM ([126] to [132]).

The LI handover specifications are already widely used in a number of countries, being first adopted in 2003. Other countries are in the process of implementation or have expressed an interest in adopting them.

ETSI TC LI has standardised the general requirements of network operators, service providers and access providers [107] who are obliged to make available results of interception to the law enforcement agencies. Complementing these requirements, a Technical Specification [112] relating to handover interfaces for the interception provides guidance for law enforcement agencies on the co-operation required by network operators/service providers with the lawful interception of telecommunications.

The specifications are subject to regular review and updating within ETSI to accommodate emerging needs, and are being used as the basis for specifying the procedures for LI. The increasing trend in the use of packet-switched technologies has necessitated the production of standards for the delivery of IP-based interception. As a result, since LI has to be possible on several specific services that make use of the IP framework, a multi-part ETSI TS on the ‘Handover Interface and Service-Specific Details (SSD) for IP delivery' has been published. This currently contains seven parts:

- part 1: Handover specification for IP delivery [117]
- part 2: SSD for e-mail services [118]

- part 3: SSD for Internet access services [119]
- part 4: SSD for Layer 2 services [120]; this specification is particularly important because, in many situations, information on higher layers is either not accessible or not stored
- part 5: SSD for IP Multimedia Services [121]
- part 6: SSD for PSTN/ISDN services [122]
- part 7: SSD for Mobile Packet Services [123]

Several versions have been published of an ETSI Technical Report (TR) on Abstract Syntax Notation version 1 (ASN.1) Object Identifiers in Lawful Interception Specifications, which focuses on the ASN.1 tree structure of the security domain [116].

Two other TRs, published in 2006, cover Lawful Interception of public Wireless LAN Internet Access [109] and the Lawful Interception domain architecture for IP networks [110].

TC LI has produced a TR ([124]), which was published at the end of 2008, defining a security framework for securing Lawful Interception and Retained Data environment (see below) of the Communication Service Provider *(*CSP) and the Handover of the information.

ETSI organised two Plugtests™ events for TC LI in order to test the interoperability of equipment from different vendors against a number of TC LI specifications. During the first LI Plugtests™ event in 2006, the following TSs were tested: [117], [118], [119]. During the second LI Plugtests™ event in 2007, the following TSs were tested: [111], [117], [118], [121], [122]. The outcome of both events highlighted issues which were looked after by the TC LI through a number of updates to the relevant publications.

## Data Retention

Data Retention is another vital subject for TC LI. The ability for Law Enforcement Agencies to request, and for operators and service providers to deliver, retained data are requirements of European Directive 2006/24/EC on the retention of data. TC LI has produced a TS [108] which deals with the requirements from Law Enforcement Agencies for the handling of Retained Data (RD). This document gives guidance for the delivery and associated issues of retained data of telecommunications and subscribers. It provides a set of requirements relating to handover interfaces for the retained traffic data and subscriber data by law enforcement and state security agencies and other authorised requesting authorities.

TC LI's work on Retained Data has been intense, and is now widely recognised worldwide. At the end of 2008 a Technical Specification was published ( [125]) which standardises the Handover Interface (HI) for the request and delivery of retained subscriber and traffic data from a Network Operator, an Access Provider or a Service Provider (NWO/AP/SvP) to the Requesting Authority.

**Liaisons and Co-operations -** As noted earlier, effective co-operation between organisations and committees working on Lawful Interception is imperative. TC LI works closely with other committees outside and within ETSI, including:

- The International Organization for Standardisation (ISO) TC 204 on building an open dialogue on LI matters
- ETSI's TISPAN committee on LI in IPTV
- ETSI's Operational Co-ordination Group on Electronic Communications Networks and Services Directives (OCG ECN&S) on an assessment of the

consequences of the European Union ECN&S regulatory viewpoint on the standardisation of Next Generation Networks (NGN)
- TC TISPAN on the security of Retained Data.

TC LI also collaborates closely with the LI group in the Third Generation Partnership Project (3GPP™) (SA3-LI) on LI for the Universal Mobile Telecommunications System (UMTS) and the Global System for Mobile Communication (GSM). By monitoring each other's activities, the groups ensure that their respective LI specifications are aligned.

TC LI continues to maintain the suite of Lawful Interception and Data Retention publications by updating them regularly. In 2009 work started on a new TS providing a standardised mechanism for the dynamic triggering and revocation of the interception of communications content. This involves important security aspects, as the dynamic triggering functions need to be carried out with adequate levels of security to protect them from misuse or eavesdropping of the related commands. It is also essential that the triggering interface does not impact the underlying security of the network or services being intercepted. The publication of this TS is expected in 2010.

## ELECTRONIC SIGNATURES

An electronic signature is data in electronic form that is attached to or logically associated with other electronic subject data and serves as a means of authentication.

A digital signature is one form of electronic signature that uses a cryptographic transformation of the data to allow the recipient of the data to prove the origin and integrity of the data, and to protect against forgery of the data by the recipient.

Standards to support the use of electronic signatures and public key certificates are a key driver in enabling the successful evolution of electronic commerce. ETSI's Electronic Signatures and Infrastructures Technical Committee (TC ESI) is responsible for standardisation in the areas of electronic signatures and Public Key Infrastructure (PKI) to support electronic commerce in open environments.

ETSI's involvement in this area began in September 1996, with the provision of specifications related to electronic signatures with the contribution of CEN. Activities in this area intensified with the release of the European Directive 1999/93/EC on a Community framework for electronic signatures. This addresses the issue of establishing a harmonised infrastructure for electronic signatures and the deployment of new vendor-specific infrastructures.

### Achievements

ETSI's publication of deliverables in support of the European Directive began in 2000 with a standard on Electronic Signature formats, specifically on CMS (Cryptographic Message Syntax) Advanced Electronic Signatures (CAdES) formats [142]. An analogous twin specification was published defining XML Advanced Electronic Signature (XAdES) formats [150].

These documents were followed by two TSs on CAdES and XAdES profiles ([143] and [151]). In 2008 a revision of the ETSI TS which defines CAdES formats [142] was published to align it with the corresponding Internet Engineering Task Force Request for Comments (IETF RFC) 5126. In 2009, a revision of [150] was produced as a result of comments raised during Plugtests™ (interoperability) events organised by ETSI.

ETSI has organised five XAdES Plugtests™ events since 2003. The first two in 2003 and 2004 were face-to-face events which took place in Sophia Antipolis, France, at the ETSI premises. The last three Plugtests™ have been organised and carried out as remote events in 2008 and 2009. These gave several organisations the opportunity to participate without travelling. The last Plugtests™ event was a combined CAdES and XAdES interoperability event. All the outcomes of the events were used as inputs to update the related deliverables as necessary.

In 2009 TC ESI published a set of profiles for PDF Advanced Electronic Signatures (PAdES) as a multipart TS. It consists of 5 parts: Part 1 is a framework document for PAdES [170]. Part 2 describes how to use ISO 32000-1 for advanced and qualified electronics signatures satisfying the above-mentioned European Directive [171]. Parts 3 to 5 are profiles for advanced electronic signatures in PDF, equivalent to the profiles for CAdES and XAdES, and they support long-term validation features [172 to 174].

The following topics have been addressed by TC ESI, with a dual purpose: to provide electronic signature users with secure, and therefore reliable, tools, and to provide them with interoperable specifications to foster the uptake of, and trust in, electronic signatures:

- organisational and security requirements for Certificate Service Providers (CSPs) issuing qualified [146] and non-qualified [148] certificates (these documents are now in widespread use both within and beyond the bounds of the European Community); since 2008 the document [140] has been continually updated to include the policy requirements for issuing Extended Validation Certificates (EVCs) and for ensuring alignment of the Certification Authorities (CA) with the EVC guidelines issued by the CAB Forum (EVCs include standardised procedures for verifying and expressing the identity of the certificate holder); see also [147], a Technical Report which provides guidance on [146]:
- organisational and security requirements for Certificate Service Providers issuing attribute certificates [139] and for Time Stamping Authorities issuing Time Stamp Tokens [156];
- profiles for Qualified Certificates meeting the requirements laid down in the European Directive [152], to streamline Qualified Certificate based transactions, and for Time Stamp Tokens [157].

A number of Technical Reports (TRs) were also created to explain ‘Signature Policy' to users ([134], [147], [155] and [158]).

The profile for Qualified Certificates was subsequently supported by another TS [144] on profiling certificates issued to natural persons. This specification helps identify the requirements related to qualified certificates for natural persons, issued in compliance with ISO/IEC 9594-8:2001 and with the IETF specification RFC 3280.

Interoperation among the European Union member states is necessary to allow a user based in one state, relying on its rules, to ascertain whether certificates issued in another state are issued in compliance with that state's rules. This matter is addressed by a TS [138], which defines a standard for Trust-service Status Lists (TSLs). A TSL provides a harmonised way for trust services (services which enhance trust and confidence in electronic transactions) and their providers to publish information about the services and providers which they oversee. This TS was updated in 2009 to include Uniform Resouce Identifiers (URIs) and extensions to be used for the EU Member States' national Trusted Lists of supervised/accredited Certification Service Providers

In the final months of 2009 ETSI organised remote Plugtests™ events in order to verify the interoperability of tools supporting the various forms of TSLs as specified in [138]. This work was funded by the European Commission and had two phases: the first aimed at verifying that the TSLs published by each EU member state complies with [138]; the second sought to test that each EU member state can validate electronic signatures by using each others' TSLs. The outcome of these Plugtests™ events will be evaluated in 2010.

Since 2002, TC ESI has been working to achieve harmonisation of the ETSI specifications at the global level, aligning with the work of the IETF, the Asia-Pacific Economic Community (APEC), the International Organisation for Standardisation (ISO), CEN etc. Reports have been produced on these various activities ([136], [137]) and regular co-operation continues.

TC ESI published a set of algorithm papers for Advanced Electronic Signatures [153], [154] in 2006/07. These were preceded by a preparatory document, a Special Report on Algorithms and Parameters for Secure Electronic Signatures [141]. Together, these

documents contain a set of security mechanisms and their parameters that can be used for advanced electronic signatures: specifically, they deal respectively with hash functions and asymmetric algorithms, and with secure channel protocols and algorithms for signature creation devices.

In close collaboration with the US Federal Administration (US FPKI), TC ESI published a TR in 2006 on cross-recognition between EU Qualified Certificates and US Federal Bridge medium level certificates [161].

TC ESI has worked on Digital Accounting, which is fundamental for boosting the advent of paperless accounting documentation (such as eInvoicing). This will increase business efficiency and reduce the potential for fraud. An ETSI TR was published in 2007 on best practices for handling signatures and signed data relevant for accounting [163], and an ETSI TS on policies of Trust Service Providers (TSPs) signing and/or storing data for accounting [164].

In recent years TC ESI has finalised its work on the creation of a Registered E-Mail (REM) framework for registered email services. In 2007 a TR was published [162] which provides a report on requirements survey for REMs. The REM framework specifications consists of 5 parts (TSs). In 2008 the first three parts were published [165 to 167] which provide a framework for origin authentication, proof of delivery and long term availability. The work specifies the format of the signatures to be applied on registered emails, In 2009, the work was completed with the definition of conformance and interoperability profiles in parts 4 and 5 [168 and 169]. . The applications of this project are potentially enormous, bringing together areas of Information Technology, telecommunications and postal business.

## Ongoing activities

TC ESI also continues its focus on Digital Accounting, especially on two critical aspects: the requirements and best practices for Trusted Service Providers (TSPs), and electronic signature profiles.

The ETSI Technical Specification (TS) which defines XML Advanced Electronic Signature (XAdES) formats [150] is currently being further revised to ensure compliance with the European Directive and to incorporate additional information about cases of common use.

Building on the TSs on CAdES and XAdES formats, work has started on a new TS, which will define unique conditions for signature certificate validation to achieve interoperability and long-term signature certificate verification. This final document will describe a common algorithm for certification path building and validation which can be extended or replaced with an algorithm based on local requirements, e.g. specific EU country legislations.

New work has also been launched to update the procedures for electronic signature verification and to update the security requirements for signature creation applications.

The work on PAdES has entered a new phase with the collaboration with ISO in order to introduce the features defined in the multipart TS [170] to [174], e.g. Long Term Validation (LTV) extension, into the next version of ISO 32000. The work also encompasses enhancements in order to achieve conformance of reader support for advanced electronic signatures including visible signatures and interfaces to signature support functions.

TC ESI has started work on certificate information expression with aiming at making the certificate human readable and machine readable.

The work on Registered E-Mail is planned to continue in order to ensure interoperability of REM messages between Simple Mail Transfer Protocol (SMTP)-based and Simple Object Access Protocol (SOAP)-based implementations.

New work is also planned on best practices for secure long-term document storage.

A PAdES remote Plugtests™ interoperability event in under consideration for 2010.

## ALGORITHMS

ETSI's Security Algorithms Group of Experts (SAGE) provides our standards makers with cryptographic algorithms and protocols specific to fraud prevention, unauthorised access to public and private telecommunications networks and user data privacy.

## Achievements

Accomplishments include algorithms for 3GPP [203], DECT, GSM and TETRA ([184] to [188], [198] and [199]), audiovisual services ([175], [176]), GPRS and Universal Personal Telecommunications (UPT) [181]. SAGE also collaborates with other ETSI committees to produce encryption algorithms.

All of the standardised security algorithms for UMTS were developed by SAGE (for an overview of the overall algorithm mechanisms in UMTS, see [40]:

- The initial set of algorithms for the UMTS radio interface (UTRA) - UEA1 and UIA1 - was developed by SAGE in collaboration with the 3GPP Organisational Partners. UEA1 is the standard encryption algorithm, and UIA1 is the standard integrity algorithm; both are based on the Kasumi block cipher, also designed by SAGE (as a variation of Mitsubishi's MISTY1 algorithm). The specifications for the algorithms (which are only for the development and operation of 3G mobile communications and services) can be found in TS 135 201 ([45], see also [46] to [48]).
- SAGE also developed a second set of algorithms, UEA2 for encryption and UIA2 for integrity, again in collaboration with 3GPP. These algorithms are based on the SNOW 3G stream cipher, which was in turn developed by SAGE as a variant of the public domain cipher SNOW 2.0 ([204] to [208]). A strong motivation for the design is that the algorithms should be fundamentally different in nature from UEA1 and UIA1, so that any new advances in the science of cryptanalysis are unlikely to impact both sets of algorithms.
- SAGE was also responsible for the specification of the Milenage algorithm set, an example algorithm set for the UMTS authentication and key generation functions f1, f1*, f2, f3, f4, f5 and f5* ([49] to [53]).

SAGE has also specified standardised cryptographic algorithms for the Long Term Evolution (LTE™) mobile radio access architecture. Two sets of algorithms have been defined for the radio interface:

- The encryption algorithm 128-EEA1 (EPS Encryption Algorithm 1), and the integrity algorithm 128-EIA1 (EPS Integrity Algorithm 1), are identical to the UMTS algorithms UEA2 and UIA2, with a defined mapping of LTE parameters onto UMTS parameters.
- The encryption algorithm 128-EEA2, and the integrity algorithm 128-EIA2, are both modes of operation of the Advanced Encryption Standard (AES), with SAGE specifying the precise details and generating test vectors.

SAGE has designed a new set of cryptographic algorithms for DECT: an authentication and key derivation algorithm DSAA2, and an encryption algorithm DSC2. These support longer encryption keys than the original DECT algorithms. Both algorithms are defined as modes of operation of the Advanced Encryption Standard. They are scheduled to be incorporated into the DECT standard during 2010.

Other recent achievements include the design of encryption algorithms for GSM, EDGE and GPRS (A5/3 for GSM and EDGE and GEA3 for GPRS) which provide users of GSM mobile phones with a higher level of protection against eavesdropping than previously available. Again, the algorithms were developed in collaboration with the 3GPP organisational partners ([59] to [63], [193], [194] and [201]), and are closely based on the UMTS algorithm UEA1.

Some of the earlier work of SAGE is not publicly available, although most algorithms produced in recent years have been made public. Their implementation is generally subject to a license which restricts their utilisation to the equipment or service for which they have been designed. ETSI acts as a Custodian for the algorithms and is responsible for the distribution and licensing of the confidential information and documents.

## Ongoing activities

SAGE is assessing a proposed third radio interface algorithm set for LTE, submitted as a candidate for standardisation by a 3GPP member company. This is the ZUC algorithm, a stream cipher which forms the basis of the proposed encryption and integrity algorithms, named after Zu Chongzhi, a Chinese mathematician and astronomer of the 5$^{th}$ century.

## QUANTUM KEY DISTRIBUTION

The creation of ETSI's Industry Specification Group (ISG) Quantum Key Distribution (QKD) was approved by the ETSI Board in September 2008 in order to bring together the important stakeholders from science, industry, and commence to address standardisation issues in quantum cryptography, and quantum technology in general.

ETSI Industry Specification Groups (ISGs) operate alongside the existing structure of Technical Committees and Working Groups and supplement ETSI's conventional standards development process. ISGs provide a mechanism for the speedy preparation of technical requirements or specifications for well-defined, specific issues, typically in response to a need expressed by a subset of the ETSI membership.

During recent years quantum cryptography has been a subject of increasing activity and rapid progress, and it is now extending into a competitive industry with commercial products. QKD can be seen as atomic cryptographic primitive and as such it covers only one part of the cryptographic functionality, which is necessary to build a secure communication system. Analysing the cryptographic implications of QKD is a very complex task. It requires a combination of knowledge belonging to separate academic and industry communities, ranging from classical cryptography to fundamental quantum mechanics and network security.

Quantum cryptography has great potential to become the key technology for securing confidentiality and privacy of communication in the future ICT world and thus to become the driver for the success of a series of services in the field of e-government, e-commerce, e-health, transmission of biometric data, intelligent transport systems and many others. Its power stems from the fact that quantum communication allows for a new primitive, which permits two parties to establish a secret key from a short pre-shared secret and a public exchange, i.e. something which was never possible with classical, non-quantum means.

ETSI's QKD Industry Specification Group develops ETSI Group Specifications (GSs) that describe quantum cryptography for ICT networks. Quantum Key Distribution is the essential credential in order to use quantum cryptography on a broad basis. It is the main task of the ISG QKD to specify a system for Quantum Key Distribution and its environment.

### Ongoing activities

Below is the list of the topics of the eight GS which the ISG QKD is currently working on. The first publications are expected in 2010.

- Assurance requirements for the security certification of quantum cryptographic equipment
- Security and functional user requirements
- Properties of components and internal interfaces
- Application interface of a QKD systems
- Study and systematisation of existing security proofs
- Integration of QKD devices within standard optical networks
- Ontology, vocabulary and terms of reference
- Security specifications for QKD systems.

## SMART CARDS

A smart card generally takes the form of a credit card-sized token containing a micro-processor enabling it to process and store information, to support single or multiple applications operated both off-line and on-line. A smart card may be a contact card, where physical contact between the card and the card reader is necessary for operation, or a contactless card, where the card and the card reader establish a short-range wireless communication (in which case the contactless card reader acts as a power source for the contactless card). A smart card may be built as both a contact and contactless card..

Smart cards are an important enabler in applications where a user's credentials (e.g. a private key in a PKI scheme or a biometric template) are used for authentication and secure communication. A card may perform security-related processing and being certified both from the platform and the application standpoints.The card may require a user's Personal Identification Number (PIN) or biometric sample in order to perform any tasks, thus minimising the risk of security breaches associated with sending authentication credentials over computer networks. Smart cards are used in a wide range of applications in the banking, ID and telecom worlds, among others. Access control, payments, network authentication, electronic purses, storage of confidential information, loyalty and ticketing are examples of common smart card applications.

As any other device, a smart card may be vulnerable to physical attacks.However such attacks are very unlikely to be successful without the use of very advanced and expensive technology, as a range of strong security features and countermeasures are usually implemented to prevent unauthorised access to smart cards and tempering with the contained data. .

Standards for smart cards can roughly be split in three families:

- Definition of the physical features, such as form factor, physical constraints (e.g. temperature, humidity, bending) and electrical interfaces
- Definition of the logical features, from a platform or application-specific standpoint; these standards address logical protocols and applications
- Definition of a runtime environment and Application Programming Interfaces (APIs) for the smart card to be able to host interoperable applications.

The main task of ETSI Technical Committee Smart Card Platform (TC SCP) is to maintain and expand the specifications of a smart card platform, the Universal Integrated Circuit Card (UICC) for mobile communication systems upon which other committees and organisations can base their system-specific applications. The current set of specifications delivered and maintained by TC SCP allows user access to global roaming by means of their smart card, irrespective of the radio access technology used. TC SCP also has an important part to play in the growth of mobile commerce, by developing the standards for Integrated Circuit (IC) cards to secure financial transactions over mobile communications systems. Additionally, the current integration of contactless card technology in mobile communication terminals requires card issuers and third parties to use a secure platform for their business critical applications. The UICC is evolving to meet this need, addressing the needs for hosting confidential applications, higher storage capacity and use of IT standard protocols.The specifications of TC SCP are generic; they provide a true and state-of-the-art multi-application platform not just for mobile communication systems but for all applications using smart cards.

## Achievements

ETSI standardised the Subscriber Identity Module (SIM) card for GSM, which is one of the most widely deployed smart cards ever. The concepts developed in the GSM specifications have also been imported into the 3GPP specifications to create the USIM (Universal SIM) card used in UMTS. The UICC platform can also used in TETRA and 3GPP2 systems.

An important recent milestone in the evolution of the Smart Card Platform was the completion in 2008 of Release 7 of all specifications. Since then Release 8 was also completed and Release 9 is currently being developed.

Major achievements include:

- Addition of a new, high-speed, physical interface for use in contact-based operation. This new interface, based on the Inter-Chip USB, enables higher speed communication alongside the use of a more common software communication stack. This specification was approved as TS 102 600 [212]
- Addition of a dedicated interface for the UICC to be used as a secure element in contactless communications such as Near Field Communication (NFC). This feature is specified in a pair of specifications:
    - for the physical interface and lower communication layer, the Single Wire Protocol was created, TS 102 613 [213]
    - for the logical interface, high-level communication and administration layer, the Host Controller Interface was created, TS 102 622 [214]
- Definition of IP connectivity for the UICC, TS 102 483 [215]
- Specification of a Secure Channel between the UICC and an endpoint, either platform to platform or application to application oriented, TS 102 484 [216]
- Delivery of an Application Programming Interface for the Smart Card Web Server (SCWS, defined by the Open Mobile Alliance, OMA), TS 102 588 [217]
- Technical realisation of the UICC Security Service Module (USSM), which could add significant value to Digital Rights Management (DRM), secure e-mail, payments, banking and application download (to both the card and the terminal device)
- Confidential applications: a toolbox and set of features to enable hosting of third party applications on the UICC without compromising the platform or the confidentiality of any applications running on the UICC.

TS 102 221 [218] is a comprehensive presentation of all the mandatory security features a UICC smart card must have. The UICC security architecture is designed so as to be able to provide, if necessary, a multi-verification environment, i.e. an environment in which the card can have more than one first level application and may support separate user verification requirements for each application.

## Ongoing activities

Currently the committee is focusing on delivering specifications regarding:

- M2M-oriented UICC: a UICC capable of being operated in M2M (machine to machine) communications, taking into account some of the very specific constraints of industrial environments
- Card Application Toolkit features transposed onto the IP-based layer that can be supported by the High-Speed interface.

## NEXT GENERATION NETWORKS

Communication services can now be delivered over multiple technology platforms and received via a broad range of terminals - using fixed and mobile, terrestrial and satellite systems. It is widely expected that the telecommunication services of the future will be delivered seamlessly over the most appropriate access network, with users roaming between domains and networks unaware of the underlying mechanisms that enable them to do so. This opens the door to a new range of security risks.

The new converged and access-independent network model - dubbed Next Generation Networks (NGN) - is based on the extensive use of IP, and is designed to accommodate the diversity of applications inherent in emerging broadband technologies. ETSI is already heavily committed to, and is well advanced in, developing the necessary standards to bridge disparate networks and domains and enable them to interoperate. Our work on NGN is being managed by Technical Committee TISPAN (Telecommunications and Internet converged Services and Protocols for Advanced Networking) and security is one of its core concerns.

TC TISPAN collaborates closely with 3GPP, with the aim of reusing 3GPP security mechanisms on the IP Multimedia Subsystem (IMS). In particular, TC TISPAN is standardising, within its Working Group (WG) 7, the security for the fixed network part of NGN and identifying gaps and requirements to extend or modify 3GPP security specifications for its purpose. The committee is also looking into the possibility of standardising new NGN-specific security components where necessary, and is responsible for formally approving technical deliverables covering generic security aspects.

### Achievements

When designing new architectures, security must be built in from the beginning - not patched on later. TC TISPAN established the security requirements for the subsystems of Next Generation Networks [233] in its first version (NGN Release 1) of the general network and service specifications for the convergence between the traditional public switched telephone networks (PSTNs) and the new IP-based networks.

In addition, TC TISPAN has produced a set of Security Design Guides ([227], [228] and [229]) which should be followed in the design of any new component of the network. This work references the guidelines on the use of the Common Criteria for the evaluation of IT security (ISO/IEC 15408). The Common Criteria are a set of drivers to be used as the basis for the evaluation of security properties of IT products and systems, establishing the framework for an IT security evaluation that is meaningful to a wide audience. The Common Criteria primarily address the protection of information from unauthorised disclosure, modification or loss.

The publications deal with the issue of the application of the Common Criteria framework in the ETSI standardisation process and the development of protocols and architecture standards [229]. They describe the way to map the Common Criteria framework drivers onto the process of defining a new standard, from the *a priori* definition of the purpose, the environment and the acceptable level of risk, to the actual definition of the subsystems, modules and protocols that constitute the standard.

One of the Design Guides [227] provides guidelines for the preparation of Protection Profiles. A Protection Profile defines an implementation-independent set of security requirements for a category of communication equipment or system which is subject to evaluation under the Common Criteria. The Protection Profile relevant to an ICT product could be used without modification to specify the security requirements of a specific product or service. This ETSI Standard describes the steps necessary to create such a

Protection Profile.

TC TISPAN has also provided additional guidance on the preparation of Security Targets (STs) based upon ETSI communication standards. The concept of Common Criteria evaluation involves the preparation of an ST that specifies the security requirements for an identified IT product and describes the functional and assurance security measures offered by that component to meet the stated requirements.

A TR [230] provides an analysis of the security provisions made in IPv6 and outlines how they may be used to support the implementation of Public Key Infrastructure (PKI) solutions and the further deployment of IPv6 and IP security (IPsec).

TISPAN has addressed the challenge of security in Next Generation Networks with an analysis of risks and threats [235] and by defining an extensible NGN security architecture [236] (revision published in 2009).

TISPAN has also published an ETSI Guide on the application of security countermeasures to service capabilities [239], an analysis of security mechanisms for customer networks connected to TISPAN NGN Release 2 [240], a feasibility study on Media Security in TISPAN NGN [241], a NAT traversal feasibility study report [242], a feasibility study on the prevention of unsolicited communication in NGN [243], a report on the security of identity in NGN [244], and a report on the application of ISO 15408-2 requirements to ETSI standards (method and application with examples) [245].

For the purposes of Lawful Interception and data retention, TC TISPAN has identified appropriate interfaces, reference points and entities in the NGN architecture (see TS [234]) and has published a TR [247] providing guidance on compliance to the data retention directive (see section on Lawful Interception / Data Retention).

A TR was published in 2009 providing guidance on the use of the ETSI eTVRA (electronic Threat Vulnerability and Risk Analysis) web application ([246]), which acts as a tool for entering analysis results obtained through the ETSI TVRA method defined in [237].

## Ongoing activities

TC TISPAN is working on emergency communication from citizen to authority within the NGN architecture, a feasibility study on IPTV security architecture, the development of a schematic overview of the NGN security architecture, a TS on how to counteract the occurrence of Unsolicited Communications (UC) in NGN, and a TS on the provision of countermeasures to assure that users of the NGN are protected from abuse of identity. The TC continues to update previously published deliverables as necessary.

During 2009, TISPAN WG has been working on RFID security and privacy “by design” for the NGN, in response to the European Commission's RFID Mandate (Mandate M/436, published December 2008). In the envisaged context that RFID will be the “gateway” technology for the future “Internet of Things” (IoT), this mandate stresses the related crucial security and privacy aspects, and encourages the European Standards Organisations to perform the relevant standardisation work. The work in ETSI on this Mandate is being carried out in cooperation with CEN and CENELEC.

# EMERGENCY AND SAFETY TELECOMMUNICATIONS

Emergency Telecommunications and Public Safety are areas requiring considerable standardisation activity. Existing infrastructures and services have been shown to be inadequate when faced with widespread disruption due to natural disasters and other emergency situations. ETSI is heavily committed in this area and is co-operating with other organisations around the globe.

## EMTEL

Special Committee on Emergency Telecommunications (EMTEL) is the focal point in ETSI for the co-ordination and collection of European requirements for emergency service communications. The committee's scope includes issues related to user needs, network architectures, network resilience, contingency planning, priority communications, priority access technologies and network management, national security and Public Protection and Disaster Relief (PPDR).

EMTEL works with ETSI TC TISPAN, TC ERM, Project MESA, 3GPP and entities such as ITU-T, National Emergency Number Association (NENA), European Computer Manufacturers Association (ECMA) International, and European projects. One example of this collaboration has been on the definition of protocols for the location identification of emergency calls in TISPAN.

### Achievements

Among EMTEL's earliest achievements was the publication of two ETSI Technical Reports (TRs): on emergency call handling [248] and on the European regulations covering communication during emergency situations [249]. In collaboration with TC TETRA, EMTEL has been heavily involved with work on communications between authorities and organisations, leading to the publication of a Technical Specification (TS) on related matters [250], and a TS on communications from authorities/organisations to individuals, groups or the general public during emergencies [251].

Public protection and emergency preparedness is a key topic for EMTEL, and the committee has examined communications networks and the requirements for telecommunication and data transmission to enable the efficient functioning of the emergency services in response to disasters. These studies have resulted in the publication of a series of related TRs ([252], [253], [254] and [255]).

### Ongoing activities

EMTEL is currently working on a study on unauthenticated and unregistered access to emergency services, which today is mandated by some countries while other countries do not allow the use of emergency services when the user cannot be identified. The committee is also working on call forwarding and referral of emergency calls and on the test and verification procedure for emergency calls.

EMTEL is currently revising [251] (see above) to add parameterisation of the requirements and any additional requirements, including those originating from the European Public Warning System (PWS). A revision of [248] (see above) is also being carried out to take into account the use of Short Message Service (SMS) in the transmission of emergency communications from the public to the authorities.

EMTEL has also started work on a new TR describing the Mobile Device Functionality (MDF) for a PWS.

## MESA

Project MESA (Mobility for Emergency and Safety Applications) is a transatlantic partnership project, established in 2000 by ETSI and the North American Telecommunications Industry Association (TIA). The Project's membership has since expanded, and now also includes members in Canada, India, Korea, Australia and Japan. Its aim is to define a digital mobile broadband system which will revolutionise the efficiency of first responders and rescue squads during an emergency or a disaster. In such scenarios, the data rates needed for advanced services, together with the demand for mobility, reach far beyond the scope of current established wireless standards.

MESA-capable communications systems will directly improve the effectiveness of law enforcement, disaster response, fire fighting, peacekeeping and emergency medical services. Typical applications include the sending of vital information about operators, the transmission of building maps and plans, video monitoring, robotic control, suspect identification and the sensing of hazardous material. To provide a speedier solution than the development of brand new technologies, Project MESA has adopted a ‘System of Systems' approach, which involves linking together a variety of existing and foreseen technologies and systems. The key factor is interoperability.

Project MESA's Service Specification Group has published the system technical requirements ([256] to [258]), whilst the MESA Technical Specification Group has published a system overview [259], a system and network architecture document [260] and the system's functional requirements definition [261].

### Ongoing activities

Project MESA's Technical Specification Group is currently working on an assessment of the suitability of COTS (Commercial Off-The-Shelf) solutions for Public Safety broadband communications.

## AERONAUTICS

The creation of the ETSI TC AERO was approved by the ETSI Board in June 2009. TC AERO has the primary responsibility to develop European standards under EC Mandates on aeronautical communications and related interoperability matters. More specifically, it deals with interoperability aspects of the European Air Traffic Management Network (EATMN) under the Single European Sky (SES) regulation.

The standardisation of safety aspects is one of the goals of TC AERO, in cooperation with organisations such as the European Aviation Safety Agency (EASA) and the European Organisation for the Safety of Air Navigation (EUROCONTROL).

## BROADCASTING

Broadcasting technologies distribute audio and video signals to a large group of recipients, delivering radio, television and data services. The delivery of some services (such as pay-per-view or subscription-based channels) requires a payment. In these instances, the contents of the broadcasting must be protected with an encryption technique.

ETSI is performing security work in this area in its Joint Technical Committee (JTC) Broadcast, which brings the Institute together with the European Broadcasting Union (EBU) and the European Committee for Electrotechnical Standardisation (CENELEC). JTC Broadcast co-ordinates the drafting of standards for broadcasting and related fields. It is particularly active in response to the European Commission Mandate M/331 on Interactive Digital Television, which aims to improve interoperability and support the roll-out of digital interactive television.

Two areas in which JTC Broadcast is involved address specific security features: TV-Anytime and the Digital Video Broadcasting (DVB) Project. TV-Anytime is a set of specifications for the controlled delivery of multimedia content to a user's personal device (Personal Video Recorder). It seeks to exploit the evolution in the convenient, high capacity storage of digital information to provide consumers with a highly personalised TV experience. Users will have access to content from a wide variety of sources, tailored to their needs and personal preferences. ETSI standards for TV-Anytime have been developed in JTC Broadcast, based on proposals from the TV-Anytime Forum, which has now closed after publishing the TV-Anytime specifications. The documents are regularly updated by JTC Broadcast.

The DVB Project is an industry-led consortium of over 250 broadcasters, manufacturers, network operators, software developers, regulatory bodies and others, in over 35 countries, committed to designing global specifications for the delivery of digital television and data services. ETSI standards for DVB systems are developed in JTC Broadcast, based on proposals from the DVB Project.

### Achievements

A major achievement of the DVB Project has been the release of the DVB Common Scrambling Algorithm. Approved by the Steering Board of the DVB Project, the Common Scrambling Algorithm is composed of the Common Descrambling System and the Scrambling Technology. The specification for each is distributed separately under arrangements with ETSI, which acts as Custodian for the companies which developed the Common Scrambling Algorithm. A new version, known as CSA3, has recently been approved and is now available from ETSI. The various agreements, together with the licensing conditions, are available on the ETSI website at:

http://www.etsi.org/WebSite/OurServices/Algorithms/DVBCSA3Algorithm.aspx

The TV-Anytime specifications were developed in two phases. Phase 1 has been published by ETSI in 2003 as the multi-part TS 102 822. Part 7 of this standard [267] specifies how the TLS (Transport Layer Security) Protocol is used in TV-Anytime to protect the delivery of data: the primary goal of the protocol is to provide privacy and data integrity between two communicating applications. TLS also provides choices of cipher suites where data encryption may be disabled. It can thus be used to ensure the data integrity of metadata conveyed between service provider (server) and user (client).

At the request of the TV-Anytime Forum, JTC Broadcast has worked on the second phase, incorporating an enhanced feature set. These Phase 2 specifications have now also been published by ETSI within the same TS 102822 series.

A European Standard has been published on the Interaction channel for satellite distribution systems [268], and an ETSI TR has been published related to production scrambling algorithms and IP or higher layer security mechanisms [269].

The DVB Project has prepared the specifications that will form a multipart collection of TR and TS deliverables (13 parts, TR/TS 102 825-x) on CPCM (Content Protection and Copy Management). The first ten parts have already been published [271 to 280].

## Ongoing activities

Current work includes security issues regarding satellite distribution systems, with the intention of protecting the user identity in terms of location, signalling and data traffic to prevent unauthorised use of the network.

The DVB Project is preparing the last three parts of the multipart TR/TS 102 825-x for publication in 2010. These last parts deal with CPCM content management scenarios, implementation guidelines and a compliance framework.

## IPv6

IPv6 is regarded as the main protocol for the next generation internet. It provides vastly increased address space, takes into account the necessary security features and allows “plug-and-play” connection to the network. Due to the complexity of implementing the IPv6 technology, effective testing of IPv6 products is one of the key factors to ensure successful deployment, interoperability, reliability and security of the IPv6 infrastructure.

ETSI's Technical Committee for Methods for Testing and Specification (TC MTS) is responsible for the evaluation of available methods and techniques for the advanced and/or formal specification of standards with respect to efficiency and quality with particular focus on testability. It is also responsible, for the provision of methodologies for the generation, processing and verification of test suites.

TC MTS has produced the following ETSI TSs dealing with IPv6 security aspects:

- A catalogue of all of the security-related IPv6 requirements extracted from Internet Engineering Task Force (IETF) specifications [281]
- A Test Suite Structure and Test Purposes (TSS&TP) ([282]) for conformance tests of the security IPv6 protocol based on the requirements defined in [281]
- A specification for interoperability tests for IPv6 security [283]
- An Abstract Test Suite (ATS) [284] for the mobility functions of IPv6, based on [281] and [282]; this document provides a basis for conformance tests for IPv6 equipment to achieve a high probability of interoperability between IPv6 equipment from different manufacturers.

In the years 2004-2006 TC MTS has carried out an IPv6 Testing project co-funded by ETSI, the EC and EFTA (European Free Trade Association), taking into account the needs of bodies such as 3GPP and ETSI TC TISPAN. This project provided a publicly available test development framework for four key areas of IPv6: core protocols, security, mobility and migration from IPv4 to IPv6.

The security part of this work resulted in a conformance test suite containing 90 tests, covering IETF RFC 4306, i.e. Internet Key Exchange version 2 (IKEv2) later updated as RFC 5282, RFC 4302 i.e. Authentication Header (AH) and RFC 4303, i.e. Encapsulating Security Payload (ESP). The tests were based on authentication and hash algorithms such as HMAC-SHA1 (Hash-based Message Authentication Code – Secure Hash Algorithm 1) and HMAC-MD5 (Hash-based Message Authentication Code – Message Digest 5), and encryption algorithms such as DES (Data Encryption Standard), 3DES (Triple Data Encryption Standard) and AES (Advanced Encryption Standard).

## IPCablecom™

IPCablecom is a technology which provides high quality, secure communications using IP over the cable television network. ETSI has set standards defining the protocols and functional requirements for this technology in its Technical Committee for Access and Terminals (TC AT), which was merged with the TC Transmission and Multiplexing (TM) in January 2007, to become Technical Committee for Access, Terminals, Transmission and Multiplexing (TC ATTM).

Security is a key issue for IPCablecom, since it is a shared network providing valuable content. As well as the standards on Lawful Interception ([131], [132]), TC AT has produced a security specification for the technology [285], covering security for the entire IPCablecom architecture, identifying security risks and specifying mechanisms to secure the architecture.

## MOBILE COMMERCE

ETSI undertook work on electronic payment for Mobile Commerce in its M-COMM committee, which closed in June 2003, having successfully completed its work.

### Achievements

ETSI produced specifications for the development of mobile signatures, which protect the end-user and the application provider from fraudulent behaviour from each other, and from third party hackers. Because a mobile signature is a universal method for using a mobile device to confirm the intention of a citizen to proceed with a transaction, the mobile signature service becomes a crucial security element within the architecture of the application provider itself.

ETSI's deliverables specify the requirements which must be fulfilled by a telecommunications system to support a payment system in a mobile commerce environment ([286] to [290]). They provide a wide and common understanding of the security considerations for mobile signatures and identify the level of security a mobile signature service provider should provide.

## OTHER SECURITY ISSUES

Over the years, ETSI has produced numerous standards, specifications and reports covering generic security aspects including:

- a comprehensive glossary for security terminology ([291] and [298])
- a guide for the selection and application of basic security mechanisms ( [301] and [305])
- a guide for ETSI Technical Committees on the inclusion of security features in their Technical Specifications and Reports ([295] and [296])
- a guide to specifying requirements for cryptographic algorithms ([292], [293], [302], [303] and [304])
- a report providing guidance to the availability and use of methods for the development of ETSI security standards ([308]).

In addition, to maintain coherence and co-ordination within ETSI, the Institute has produced documents offering an overall assessment of work done in the field of security ([299] and [307]).

## CONCLUSIONS

This latest edition of the ETSI Security White Paper illustrates how, since its inception, ETSI has steadily advanced the standardisation of security across the whole spectrum of ICT, from algorithms to smart cards, from mobile and mobile telecommunication infrastructures to electronic signatures, from Lawful Interception to broadcasting. As a result, ETSI has developed exceptional expertise along with a unique vision of security in ICT as a whole.

As ICT becomes ever more essential for business, public administration, public safety and commercial needs, a vast number of new technologies are being developed and becoming mature for standardisation. Security is not an additional feature that can be patched on after the adoption of a technology: it must be taken into account from the beginning of the standardisation process. Indeed, in many cases it can be a winning driver that enables the overall success of the technology.

The threat to the security of our ICT systems grows daily. Experience has revealed many breaches of security that have had a significant impact on ICT systems, whether the causes were deliberate or accidental. Ways must be found to protect customers. There has also been a noticeable increase in legislation world-wide, driven by growing security concerns in recent years. These continue to drive our activities.

Solutions will certainly include a reliable and secure network infrastructure. But they will also depend on trust on the part of users - both citizens and businesses - that privacy, confidentiality, secure identification and other issues are rightly addressed. Security standardisation, sometimes in support of legislative actions, therefore has an important role to play in the future development of ICT.

Technology is constantly evolving. Criminals are becoming ever more inventive. The personal safety of the individual citizen is far too frequently at risk from terrorism and natural disasters. Security standardisation must evolve too to keep pace with the developing risks and threats. Throughout its lifetime, ETSI has already proved it can adapt to changing situations; it will continue to do so, moving into new technical areas as they emerge and tackling new issues.

## PUBLICATIONS

The following publications are ETSI documents, available for download free from the ETSI website[1] (pda.etsi.org/pda). Each ETSI document number in the list below links to the ETSI deliverable available **on line**, where the **latest published version** at the time of your search can be downloaded, as well as any previous versions.

### GSM and UMTS


[1] ETSI TR 101 105 (SMG 10): "Digital cellular telecommunications system (Phase 2+); Fraud Information Gathering System (FIGS); Service requirements - Stage 0 (GSM 01.31)".

[2] ETSI TR 101 514 (SMG 10): "Digital cellular telecommunications system (Phase 2+); Lawful interception requirements for GSM (GSM 01.33)".

[3] ETSI TS 101 106 (SMG 10): "Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); GPRS ciphering algorithm requirements (GSM 01.61)".

[4] ETSI TS 100 920 (SMG 01): "Digital cellular telecommunications system (Phase 2+); Security aspects (3GPP TS 02.09)".

[5] ETSI TS 101 107 (SMG 10): "Digital cellular telecommunications system (Phase 2+) (GSM); Fraud Information Gathering System (FIGS); Service description - Stage 1 (GSM 02.31)".

[6] ETSI TS 101 749 (SMG 10): "Digital cellular telecommunications system (Phase 2+); Immediate Service Termination (IST) Service description - Stage 1 (GSM 02.32)".

[7] ETSI TS 101 507 (SMG 10): "Digital cellular telecommunications system (Phase 2+); Lawful interception - Stage 1 (GSM 02.33)".

[8] ETSI TS 100 929 (SMG 03): "Digital cellular telecommunications system (Phase 2+); Security-related network functions (3GPP TS 03.20)".

[9] ETSI TS 101 509 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+) (GSM); Lawful interception; Stage 2 (3GPP TS 03.33)".

[10] ETSI TS 101 967 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Immediate Service Termination (IST) (3GPP TS 03.35)".

[11] ETSI ETR 363 (SMG 10): "Digital cellular telecommunications system; Lawful interception requirements for GSM (GSM 10.20)".

[12] ETSI TS 121 133 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); 3G security; Security threats and requirements (3GPP TS 21.133)".

[13] ETSI TS 122 022 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Personalisation of Mobile Equipment (ME); Mobile functionality specification (3GPP TS 22.022)".

[14] ETSI TS 122 031 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Fraud Information Gathering System (FIGS); Service description; Stage 1 (3GPP TS 22.031)".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[1] Some deliverables that are relevant to security algorithms, or that are for internal use, are only available on a restricted basis. This is made explicit for each of these deliverables with the statement “NOT AVAILABLE FOR DOWNLOAD”.

[15] ETSI TS 122 032 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Immediate Service Termination (IST); Service description; Stage 1 (3GPP TS 22.032)".
[16] ETSI TS 123 031 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Fraud Information Gathering System (FIGS); Service description; Stage 2 (3GPP TS 23.031)".
[17] ETSI TS 123 035 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Immediate Service Termination (IST); Stage 2 (3GPP TS 23.035)".
[18] ETSI TS 133 102 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; 3G security; Security architecture (3GPP TS 33.102)".
[19] ETSI TS 133 103 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); 3G Security; Integration Guidelines (3GPP TS 33.103)".
[20] ETSI TS 133 105 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; Cryptographic algorithm requirements (3GPP TS 33.105)".
[21] ETSI TS 133 106 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); Lawful interception requirements (3GPP TS 33.106)".
[22] ETSI TS 133 107 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; 3G security; Lawful interception architecture and functions (3GPP TS 33.107)".
[23] ETSI TS 133 108 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; 3G security; Handover interface for Lawful Interception (LI) (3GPP TS 33.108)".
[24] ETSI TS 133 120 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); 3G Security; Security Principles and Objectives (3GPP TS 33.120)".
[25] ETSI TS 133 141 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; Presence service; Security (3GPP TS 33.141)".
[26] ETSI TS 133 200 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); 3G Security; Network Domain Security (NDS); Mobile Application Part (MAP) application layer security (3GPP TS 33.200)".
[27] ETSI TS 133 203 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; 3G security; Access security for IP-based services (3GPP TS 33.203)".
[28] ETSI TS 133 210 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; 3G security; Network Domain Security (NDS); IP network layer security (3GPP TS 33.210)".
[29] ETSI TS 133 220 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Generic Authentication Architecture (GAA); Generic bootstrapping architecture (3GPP TS 33.220)".
[30] ETSI TS 133 221 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Generic Authentication Architecture (GAA); Support for subscriber certificates (3GPP TS 33.221)".
[31] ETSI TS 133 222 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Generic Authentication Architecture (GAA); Access to network application functions using Hypertext Transfer Protocol over Transport Layer Security (HTTPS) (3GPP TS 33.222)".

[32] ETSI TS 133 234 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; 3G security; Wireless Local Area Network (WLAN) interworking security (3GPP TS 33.234)".
[33] ETSI TS 133 246 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; 3G Security; Security of Multimedia Broadcast/Multicast Service (MBMS) (3GPP TS 33.246)".
[34] ETSI TS 133 310 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; Network Domain Security (NDS); Authentication Framework (AF) (3GPP TS 33.310)".
[35] ETSI TS 142 009 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Security aspects (3GPP TS 42.009)".
[36] ETSI TS 133 204 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; 3G Security; Network Domain Security (NDS); Transaction Capabilities Application Part (TCAP) user security (3GPP TS 33.204)".
[37] ETSI TR 133 980 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Liberty Alliance and 3GPP security interworking; Interworking of Liberty Alliance Identity Federation Framework (ID-FF), Identity Web Services Framework (ID-WSF) and Generic Authentication Architecture (GAA) (3GPP TR 33.980)".
[38] ETSI TR 133 901 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); 3G Security - Criteria for cyptographic Algorithm design process (3G TR 33.901)".
[39] ETSI TR 133 902 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); Formal Analysis of the 3G Authentication Protocol (3GPP TR 33.902)".
[40] ETSI TR 133 908 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); Security Algorithms Group of Experts (SAGE); General report on the design, specification and evaluation of 3GPP standard confidentiality and integrity algorithms (3GPP TR 33.908)".
[41] ETSI TR 133 909 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); 3G Security; Report on the design and evaluation of the MILENAGE algorithm set; Deliverable 5: An example algorithm for the 3GPP authentication and key generation functions (3GPP TR 33.909)".
[42] ETSI TR 133 919 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; 3G Security; Generic Authentication Architecture (GAA); System description (3GPP TR 33.919)".
[43] ETSI TR 133 918 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Generic Authentication Architecture (GAA); Early implementation of Hypertext Transfer Protocol over Transport Layer Security (HTTPS) connection between a Universal Integrated Circuit Card (UICC) and a Network Application Function (NAF) (3GPP TR 33.918)".
[44] ETSI TR 133 978 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; Security aspects of early IP Multimedia Subsystem (IMS) (3GPP TR 33.978)".
[45] ETSI TS 135 201 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; Specification of the 3GPP confidentiality and integrity algorithms; Document 1: f8 and f9 specification (3GPP TS 35.201)".
[46] ETSI TS 135 202 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; Specification of the 3GPP confidentiality and integrity algorithms; Document 2: Kasumi specification (3GPP TS 35.202)".

[47] ETSI TS 135 203 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; Specification of the 3GPP confidentiality and integrity algorithms; Document 3: Implementors' test data (3GPP TS 35.203)".
[48] ETSI TS 135 204 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; Specification of the 3GPP confidentiality and integrity algorithms; Document 4: Design conformance test data (3GPP TS 35.204)".
[49] ETSI TS 135 205 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; 3G Security; Specification of the MILENAGE algorithm set: An example algorithm set for the 3GPP authentication and key generation functions f1, f1*, f2, f3, f4, f5 and f5*; Document 1: General (3GPP TS 35.205)".
[50] ETSI TS 135 206 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; 3G Security; Specification of the MILENAGE algorithm set: An example algorithm set for the 3GPP authentication and key generation functions f1, f1*, f2, f3, f4, f5 and f5*; Document 2: Algorithm specification (3GPP TS 35.206)".
[51] ETSI TS 135 207 (3GPP SA 3): 3GPP SA 3 Universal Mobile Telecommunications System (UMTS); 3G Security; Specification of the MILENAGE algorithm set: An example algorithm Set for the 3GPP Authentication and Key Generation functions f1, f1*, f2, f3, f4, f5 and f5*; Document 3: Implementors"Universal Mobile Telecommunications System (UMTS); LTE; 3G Security; Specification of the MILENAGE algorithm set: An example algorithm set for the 3GPP authentication and key generation functions f1, f1*, f2, f3, f4, f5 and f5*; Document 3: Implementors" test data (3GPP TS 35.207)".
[52] ETSI TS 135 208 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; 3G Security; Specification of the MILENAGE algorithm set: An example algorithm set for the 3GPP authentication and key generation functions f1, f1*, f2, f3, f4, f5 and f5*; Document 4: Design conformance test data (3GPP TS 35.208)".
[53] ETSI TR 135 909 (3GPP SA 3): "Universal Mobile Telecommunications System (UMTS); LTE; 3G Security; Specification of the MILENAGE algorithm set: an example algorithm set for the 3GPP authentication and key generation functions f1, f1*, f2, f3, f4, f5 and f5*; Document 5: Summary and results of design and evaluation (3GPP TR 35.909)".
[54] ETSI TR 141 031 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Fraud Information Gathering System (FIGS); Service requirements; Stage 0 (3GPP TR 41.031)".
[55] ETSI TR 141 033 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Lawful Interception requirements for GSM (3GPP TR 41.033)".
[56] ETSI TS 142 033 (3GPP SA 3): "Digital cellular telecommunications system (Phase 2+); Lawful Interception; Stage 1 (3GPP TS 42.033)".
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## GLOSSARY

| | |
|---|---|
| **3DES** | Triple Data Encryption Standard |
| **3GPP™** | Third Generation Partnership Project |
| **3GPP2** | Third Generation Partnership Project 2 |
| **AAA** | Authentication, Authorisation and Accounting |
| **AES** | Advanced Encryption Standard |
| **AH** | Authentication Header |
| **AKA** | Authentication and Key Agreement |
| **API** | Application Programming Interface |
| **ATS** | Abstract Test Suite |
| **CA** | Certification Authority |
| **CA** | Conditional Access *(broadcast systems)* |
| **CAB** | Certification Authority/Browser |
| **CAdES** | CMS Advanced Electronic Signatures |
| **CMS** | Cryptographic Message Syntax |
| **CEN** | European Committee for Standardisation |
| **CENELEC** | European Committee for Electrotechnical Standardisation |
| **CEPT** | European Conference of Posts and Telecommunications Administrations |
| **CPCM** | Content Protection and Copy Management |
| **CR** | Cognitive Radio |
| **CSA3** | Common Scrabling Algorithm version 3 |
| **CSG** | Closed Subscriber Group |
| **CSP** | Communication Service Provider (*in Lawful Interception*) |
| **DECT™** | Digital Enhanced Cordless Telecommunications |
| **DES** | Data Encryption Standard |
| **DMO** | Direct Mode Operation |
| **DRM** | Digital Rights Management |
| **DSAA** | DECT Standard Authentication Algorithm |
| **DSC** | DECT Standard Cipher |
| **DVB** | Digital Video Broadcasting |
| **EAP** | Extensible Authentication Protocol |
| **EASA** | European Aviation Safety Agency |
| **EC** | European Commission |
| **ECMA** | European Computer Manufacturers Association |
| **EDGE** | Enhanced Data Rates for GSM Evolution |
| **EEA1** | Evolved Packet System Encryption Algorithm 1 |
| **EFTA** | European Free Trade Association |
| **EIA1** | Evolved Packet System Integrity Algorithm 1 |
| **EMTEL** | Emergency Telecommunications (ETSI Special Committee) |
| **ENISA** | European Network and Information Security Agency |
| **EP** | ETSI Project |
| **EPC** | Evolved Packet Core |
| **EPS** | Evolved Packet System |
| **ESP** | Encapsulating Security Payload |
| **eTVRA** | electronic Threat Vulnerability and Risk Analysis |
| **EU** | European Union |
| **EVC** | Extended Validation Certificate |
| **E-UTRAN** | Evolved UMTS Terrestrial Radio Access Network |
| **FIGS** | Fraud Information Gathering System |

| | |
|---|---|
| **GAA/GBA** | Generic Authentication Architecture / Generic Bootstrapping Architecture |
| **GIBA** | GPRS IMS Bundled Authentication |
| **GPRS** | General Packet Radio Service |
| **GPS** | Global Positioning System |
| **GS** | ETSI Group Specification |
| **GSM™** | Global System for Mobile Communication™ |
| **GSMOBA** | GSM Onboard Aircraft |
| **HMAC** | Hash-based Message Authentication Code |
| **HNB** | Home Node B |
| **H(e)NB** | Home (e) Node B |
| **HSDPA** | High Speed Downlink Packet Access |
| **HSUPA** | High Speed Uplink Packet Access |
| **ICT** | Information and Communication Technologies |
| **ID** | Identification |
| **IEC** | International Electrotechnical Commission |
| **IETF** | Internet Engineering Task Force |
| **IKEv2** | Internet Key Exchange version 2 |
| **IMEI** | International Mobile Equipment Identity |
| **IMS** | IP Multimedia Subsystem |
| **IoT** | Internet of Things |
| **IP** | Internet Protocol |
| **IPSec** | IP Security |
| **IPTV** | Internet Protocol Television |
| **IPv6** | Internet Protocol version 6 |
| **ISG** | Industry Specification Group of ETSI |
| **ISO** | International Organisation for Standardisation |
| **IT** | Information Technology |
| **ITS** | Intelligent Transport System |
| **JTC** | Joint Technical Committee |
| **KDF** | Key Derivation Function |
| **LI** | Lawful Interception |
| **LTE™** | Long Term Evolution |
| **MBMS** | Multicast Broadcast Multimedia Service |
| **MD** | Message Digest |
| **MDF** | Mobile Device Functionality |
| **MNO** | Mobile Network Operator |
| **MME** | Mobility Management Entity |
| **M2M** | Machine to Machine |
| **NAS** | Non-Access Stratum |
| **NASS** | Network Access SubSystem |
| **NAT** | Network Address Translation |
| **NENA** | National Emergency Number Association |
| **NFC** | Near Field Communication |
| **NGN** | Next Generation Networks |
| **NIST** | National Institute of Standards and Technology (USA) |
| **PAdES** | PDF Advanced Electronic Signatures |
| **PAMR** | Public Access Mobile Radio |
| **PIN** | Personal Identification Number |
| **PKI** | Public Key Infrastructure |
| **PLMN** | Public Land Mobile Network |
| **PMR** | Private Mobile Radio |
| **PWS** | Public Warning System |

| | |
|---|---|
| **QKD** | Quantum Key Distribution |
| **REM** | Registered Electronic Mail |
| **RFC** | Request for Comment |
| **RFID** | Radio Frequency Identification |
| **RRC** | Radio Resource Control |
| **RRS** | Reconfigurable Radio System |
| **SAE** | System Architecture Evolution |
| **SDR** | Software Defined Radio |
| **SES** | Satellite Earth Stations & systems (ETSI Technical Committee) |
| **SES** | Single European Sky *(in Aeronautical)* |
| **SHA** | Secure Hash Algorithm |
| **SIM** | Subscriber Identity Module |
| **SIP** | Session Initiation Protocol |
| **SMTP** | Simple Mail Transfer Protocol |
| **SMS** | Short Message Service |
| **SOAP** | Simple Object Access Protocol |
| **ST** | Security Target |
| **TC** | Technical Committee of ETSI |
| **TDMA/TDD** | Time Division Multiple Access/Time Division Duplex |
| **TETRA** | TErrestrial Trunked RAdio |
| **TISPAN** | Telecommunications and Internet converged Services and Protocols for Advanced Networking (ETSI Technical Committee) |
| **TLS** | Transport Layer Security |
| **TR** | ETSI Technical Report |
| **TS** | ETSI Technical Specification |
| **TSL** | Trust-service Status List |
| **TSS&TP** | Test Suite Structure and Test Purposes |
| **TVRA** | Threat Vulnerability and Risk Analysis |
| **UE** | User Equipment |
| **UEA** | UMTS Encryption Algorithm |
| **UIA** | UMTS Integrity Algorithm |
| **UHF** | Ultra High Frequency |
| **UICC** | Universal Integrated Circuit Card |
| **UMTS** | Universal Mobile Telecommunications System |
| **USB** | Universal Serial Bus |
| **USIM** | Universal Subscriber Identity Module |
| **UTRAN** | UMTS Terrestrial Radio Access Network |
| **WG** | Working Group of an ETSI TC |
| **WLAN** | Wireless Local Area Network |
| **XAdES** | XML Advanced Electronic Signature |
| **XML** | eXtended Mark up Language |
| **ZUC** | Zu Chongzhi |