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RUTRONIK
ELECTRONICS WORLDWIDE

Security Aspects

V 1.1

White Paper on How to Make State of the Art Electronic Designs

Content

Our Product Portfolio

- Semiconductors
- Passive Components
- Electromechanical Components
- Displays & Monitors
- Boards & Systems
- Storage Technologies
- Wireless Technologies

Our Innovation Centers

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Committed to Excellence

Consult – Know-how. Built-in.

The Technical Competence from RUTRONIK

Worldwide and individual consulting on the spot: by competent sales staff, application engineers and product specialists.

Components – Variety. Built-in.

The Product Portfolio from RUTRONIK

Wide product range of semiconductors, passive and electro-mechanical components, displays & monitors, boards & systems, storage and wireless technologies for optimum coverage of your needs.

Logistics – Reliability. Built-in.

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Innovative and flexible solutions: from supply chain management to individual logistics systems.

Quality – Security. Built-in.

Quality Management without Compromise

The integrated management system (IMS) encompasses quality control, environmental protection and occupational health and safety.

One Leak in Security Could be One Leak Too Much

Adding security to a device costs extra money, time, power consumption and makes everything worse. The only reason for adding security to a device is the need to improve marketing – security components help to sell more products. To participate in the evolution of Industry 4.0, the Internet of Things and cloud technologies to make devices, portfolios and your ecosystem smarter, you have to start thinking about Security in another way:

If your products are connected, they are the perfect target to destroy your company's reputation. If your products do not fulfill the requirements of the European General Data Protection Regulation (GDPR), the impending fine could make your company going bankrupt.

The battle between companies will start in the second half of 2018 and we expect a wave of legal actions. Last but not least: if a third party gets control over your products, a damage of life and goods could be the result.

As the leading high tech distributor we decided not to build a single security division. We think it´s not the right way to have a security specialist on board who is managing the security semiconductors and helping our customers from all over the world if they have need for adding a security solution.

We believe that security will be mandatory for the complete design, in all layers, regarding data transmission, data processing and data storage. It affects hardware, software and virtual services. Having in mind that one leak, one little mistake, one delay of making an update could destroy human life, causing a commercial collision and destroy your business from one moment to the next. We take security very seriously and added this way of thinking to all our product managers in all product divisions.

When it comes to security, there is no one-size-fits-all solution. Thorough risk analyses have to be carried out to identify the specific threats to individual systems. In most cases, secure identities are exposed to a high level of threat as they are used to protect know-how and intellectual property, safeguard the integrity of systems and protect stored data and data distributed over networks.

If you thought SECURITY is only useful for marketing reasons, then we hope that this security brochure will change your point of view. It should make you aware about some more aspects and motivate you to make contact with us to talk about your individual needs and tailored solutions.

Enjoy reading and discover new aspects of security!

General Data Protection Regulation

If you want to sell your electronic products within the European Union, you should be aware of this new law about the protection of personal data. This law is already valid and will be mandatory to follow from May 2018 onwards. It is important to know that some courts of justice have already issued judgments regarding the definition of personal data.

For example all data which enters or leaves the motor control box of a car and the levels of all operating fluids are defined as personal data – even though they are indirectly personal and do not clearly belong to a specific person. In addition the meaning of "state of the art" was defined by the German Federal Office for Information Security (BSI) as the best available technology or products to satisfy the requirements of the law. We recommend reading the complete GDPR, but here are some quotes as extracts:

Article 25 –- Data Protection by Design and by Default

1. Taking into account the state of the art, the cost of implementation and the nature, scope, context and purposes of processing as well as the risks of varying likelihood and severity for rights and freedoms of natural persons posed by the processing, the controller shall, both at the time of the determination of the means for processing and at the time of the processing itself, implement appropriate technical and organisational measures, such as pseudonymisation, which are designed to implement data-protection principles, such as data minimisation, in an effective manner and to integrate the necessary safeguards into the processing in order to meet the requirements of this regulation and protect the rights of data subjects.

2. The controller shall implement appropriate technical and organisational measures for ensuring that, by default, only personal data which are necessary for each specific purpose of the processing are processed. That obligation applies to the amount of personal data collected, the extent of their processing, the period of their storage and their accessibility. In particular, such measures shall ensure that by default personal data are not made accessible without the individual's intervention to an indefinite number of natural persons.

Article 32 – Security of Processing

1. Taking into account the state of the art, the costs of implementation and the nature, scope, context and purposes of processing as well as the risk of varying likelihood and severity for the rights and freedoms of natural persons, the controller and the processor shall implement appropriate technical and organisational measures to ensure a level of security appropriate to the risk, including inter alia as appropriate:

a) the pseudonymisation and encryption of personal data;

b) the ability to ensure the ongoing confidentiality, integrity, availability and resilience of processing systems and services;

c) the ability to restore the availability and access to personal data in a timely manner in the event of a physical or technical incident;

d) a process for regularly testing, assessing and evaluating the effectiveness of technical and organisational measures for ensuring the security of the processing.

2. In assessing the appropriate level of security account shall be taken in particular of the risks that are presented by processing, in particular from accidental or unlawful destruction, loss, alteration, unauthorised disclosure of, or access to personal data transmitted, stored or otherwise processed.

3. Adherence to an approved code of conduct as referred to in Article 40 or an approved certification mechanism as referred to in Article 42 may be used as an element by which to demonstrate compliance with the requirements set out in paragraph 1 of this Article

.... Article 32 – Security of Processing

4. The controller and processor shall take steps to ensure that any natural person acting under the authority of the controller or the processor who has access to personal data does not process them except on instructions from the controller, unless he or she is required to do so by Union or Member State law.

Article 83 – General Conditions for Imposing Administrative fines

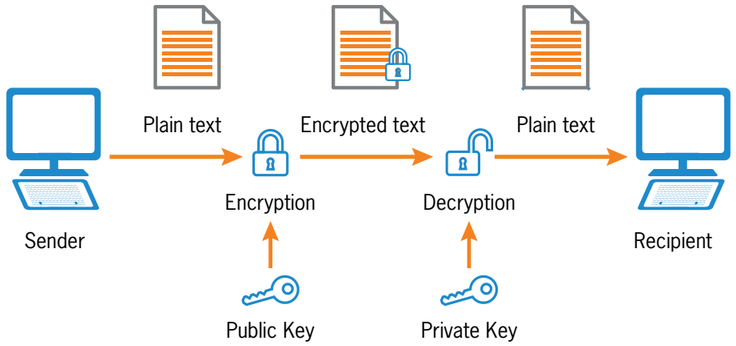
4. Infringments of the following provisions shall, in acccordance with paragraph 2, be subject to administrative fines up to 10 000 000 EUR, or in the case of an undertaking, up to 2 % of the total worldwide annual turnover of the preceding financial year, whichever is higher:

a) the obligations of the controller and the processor pursuant to Articles … 25, …32, …;

How to Protect Your Business

The effects of this law for your electronic product design are hard to predict. We recommend using the most secure components to avoid getting accused by your competitors later on. Some aspects about how to choose the right technologies to be on the safe side (as best as possible by today) can be found on the next pages.

Cryptography in a Nutshell



There are three security concerns where cryptography is used: Authentication, Integrity and Confidentiality.
To choose the right technology for cryptography, you should be aware about some general understanding and differences:

The Kerckhoffs' Principle

In cryptography, Kerckhoffs' principle (also called Kerckhoffs' desideratum, Kerckhoffs' assumption, axiom, or law) has already been stated by Dutch cryptographer Auguste Kerckhoffs in the year 1883 and is still valid:

Picture 1: Auguste Kerckhoffs

A cryptosystem should be secure even if everything about the system, except the key, is public knowledge

- It is much more difficult to keep an algorithm secret than a key
- It is more difficult to replace one compromised algorithm with another than a compromised key
- Secret algorithms can be reconstructed by reverse engineering from software or hardware implementations
- It is easier to hide a backdoor in "secret" encryption methods
- Bugs in public algorithms are more easily discovered when as many people as possible deal with them

This principle is used in all relevant cryptographic methods – independent if they are symmetric, asymmetric or hybrid.

Most Popular Cryptographic Algorithms

Symmetric Cryptographic Algorithms

- Encryption and decryption with one single key (Secret-Key-Cryptography)
  - Key must be present during encryption and decryption
  - Key must be exchanged in advance (side channel)
  - Keys must be stored safe
- 128 bit keys are considered as safe, 256 bit is considered as future proof
- Fast encryption method
- Examples of algorithms: AES, Rijndael, Blowfish, RC4/5/5a/6, 3DES, DES, A5, CAST, IDEA
- Examples of applications: WPA2 (IEEE802.11i), IPsec-VPN, OpenSSL

Asymmetric Cryptographic Algorithms

- Encryption and decryption with different keys (Public-Key-Cryptography)
  - Generation of a pair of keys (private key and public key)
  - Private key does not need to be exchanged
  - Encrypt data with public key, decrypt data with private key
  - Sign data with private key, check signature with public key
- Based on one-way function
  - Trapdoor function (easy to compute in one direction, yet difficult to compute in the opposite direction as long as no "Trapdoor" information is known
  - Potential attack by reversing the one-way function (not by trying to find out the key)
  - Only 2048 Bit Keys (RSA) or 256 Bit keys (ECC) considered to be sufficient
  - Slow encryption method (RSA is approximately 1000 times slower than symmetric encryption like AES)

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- Examples of algorithms: RSA, ECC (eliptic curve cryptography), Diffie-Hellman, ElGamal
- A successful man-in-the-middle attack at key-exchange could make the system useless

Hybrid Cryptographic Algorithms

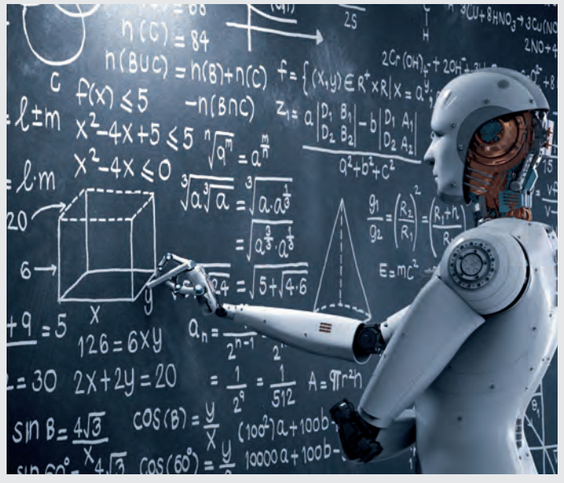
- A hybrid algorithm uses asymmetric session key creation algorithms, but a symmetric algorithm to encrypt the data. At the end it´s a compromise using the biggest advantage of both methods
- Examples of algorithms: SSL, TLS
- Examples of applications: very often used to protect internet sessions. The SSL/TLS is used on top of TCP/IP, but below the application layer for websites, E-Mail or file transfer. Very often the application protocol is renamed when it´s based on a cryptographic protected session – for example HTTPS is the encrypted version of HTTP

SSL (Secure Sockets Layer) and TLS (Transport Layer Security) are both hybrid encryption protocols for a safe and secure data transfer via the internet. SSL was the former protocol. After SSL 3.0, TLS 1.0 followed as successor. (TLS 1.0 is sometimes also known as SSL 3.1.) Currently the latest standard is TLS 1.3.

SSL and TLS have basically two tasks. The first is to guarantee the reliability of the connected server through a certificate. The second is an encrypted data exchange between client and server.

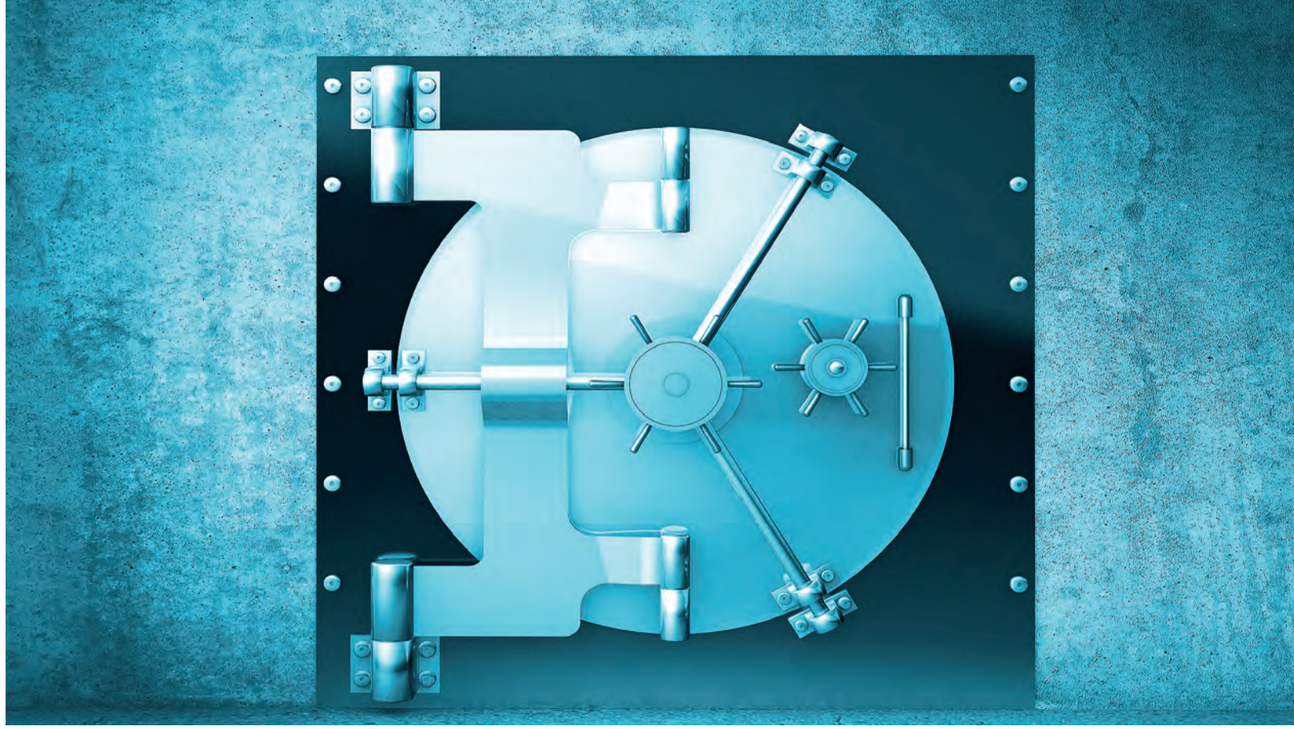
Hash Cryptographic Algorithms

- The algorithm uses the net data to calculate a fixed size of another data packet, called hash value (128 bit to 512 bit are usual)
- The hash value is always unique. The algorithm will not create the same hash value when another data source is used
- It´s not possible to calculate the net data when only having the hash file
- Examples of algorithms: SHA, CRC, MD4, MD5, MD2, Tiger, RIPEMD
- Examples of applications: testing the integrity of files, making passwords more secure, creation of digital signatures and it'a also part of asymmetric algorithms



Encryption Technologies

The Key to Security



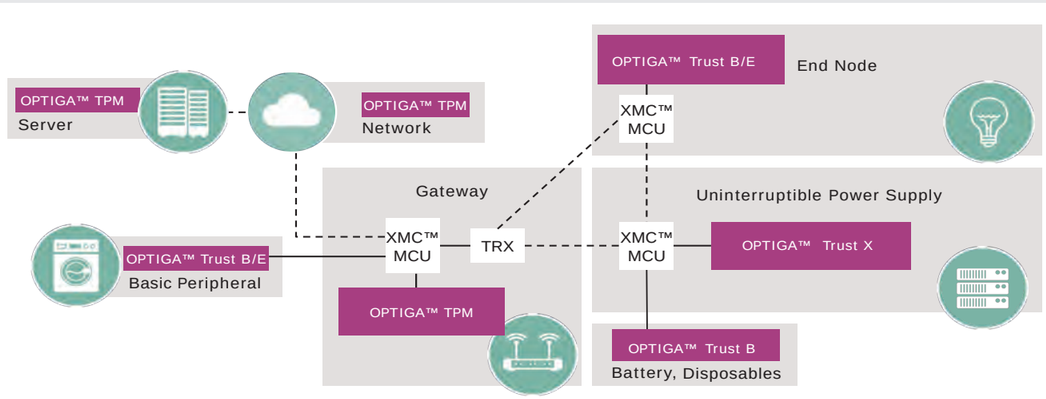
Threats resulting from new technologies regularly make the headlines – whether thefts of vehicles with Keyless Go, illicit surveillance scandals, data theft, disclosure of passwords on the Internet, or phishing attacks. However, the greatest damage is in most cases not suffered by the users: Once negative publicity has stuck to a product, or a manufacturer, it becomes a serious threat to the business. Encryption technologies offer comparatively cost-effective protection. When handling personal data, encryption is required by data protection laws in any case.

Security is Always a System

The issue of security is often neglected in relation to embedded systems especially. The result: Industrial spies can use hacked devices to penetrate the entire corporate network, gain access to the company's intellectual property (IP) and business secrets, and manipulate data. Users of smart home devices might unintentionally disclose information to potential thieves through their security cameras, or even open doors and windows for them by way of automated control systems. Automobiles are also subject to virtually infinite vulnerabilities thanks to autonomous driving and over-the-air firmware updates. When such cases become known, customers' trust in the device – or even the entire business – is lost. In view of this, encryption should be top of the priority list for all manufacturers of connected products.

In order to understand encryption, it is helpful to consider what its aims are. These are focused on three key areas: authenticity, confidentiality, integrity. When a user wirelessly connects multiple products in his home, for example, it is important that only authorized products can join the network, and that both the data in the network and the complete system are protected.

That is to say, protection must be in place against unauthorized access to the network (authenticity), data tapping (confidentiality) and manipulation (integrity). State-of-the-art cryptography covers all three aspects. It is available in two fundamentally different modes: symmetric and asymmetric encryption.



Different encryption ICs create a secure smart home in every respect. (Source: Infineon)

Symmetric Encryption

In symmetric encryption, the same key is used for both encryption and decryption. The best-known and most frequently used encryption method is AES (Advanced Encryption Standard). AES works with either 128, 192 or 256 bit keys. Even 128 bit AES keys are classed as secure according to the current state of the art.

It is noteworthy that the principle of modern cryptography formulated by Auguste Kerckhoffs in 1883 still holds true: The security of an encryption method is founded on the secrecy of the key and not on the secrecy of the algorithm. This is particularly important in relation to a symmetric encryption method such as AES, as the same key is used on both ends (encryption and decryption). If the key is known, or is disclosed, the entire encryption process is nullified.

Consequently, the greatest challenge of AES lies in the management of the keys. In this, above all it must be ensured that the keys are generated using a genuine random generator; that they are deposited in a secure element; and that they cannot be intercepted the first time they are transferred.

Asymmetric Encryption

Asymmetric encryption always uses two different keys: a private key and a public key. They are always generated as a pair. The private key remains permanently with the originator of the keys, while the public key goes to the receiving party. The recipient can use the public key to encrypt messages which can only be decrypted with the linked private key. The private key can also generate a signature by which the recipient can uniquely identify the sender using the linked public key.

Asymmetric encryption is based on oneway mathematical functions. They must be as simple as possible to calculate, but very complex to reverse. Continually increasing computing power is also steadily improving the ability of computers to calculate complex reversing functions. To ensure adequate security, the keys therefore must have a certain length. Keys with 2048 bits, such as RSA 2048, are currently classed as secure. Because encryption and decryption speeds decrease as keys get longer, asymmetric methods are only practical for handling small amounts of data.

Elliptic Curves for More Speed

An alternative to this conventional asymmetric encryption is Elliptic Curve Cryptography (ECC). It is based on the same approach, but utilizes points on elliptic curves. That makes computing operations much more complex, so ensuring that even 256 bit keys offer a secure level according to the current state of the art. And ECC 256 does not take much more time than comparably secure symmetric methods.

Encryption Technologies

The Key to Security

Hybrid Encryption Eliminates Disadvantages

If symmetric encryption of user data is chosen, but the security it offers is not adequate, it can be improved by means of hybrid encryption. In this, the symmetric key is sent again in encrypted form by means of an asymmetric public key. This means only the authorized recipient is able to decrypt the symmetric key with the matching private key.

At the same time, the sender of the symmetric key can use his private key to generate a signature which enables the recipient to uniquely identify him using the matching public key. Once these keys have been exchanged and decrypted, the foundation has been laid for symmetrically encrypted communications.

This combination method eliminates the disadvantages of the two separate methods – namely the insecure key transfer of symmetric encryption and the slower speed of asymmetric encryption.

Hardware or Software?

Each encryption method can be implemented by software or hardware. Software-based encryption entails the major disadvantage that the program is not an autonomous self-contained unit, but is always dependent on its environment, such as the operating system. It is susceptible to errors and attacks as a result. And there is another negative: As the microcontroller or processor of an embedded system additionally has to handle the complex encryption and decryption, loss of performance is inevitable.

The opposite case is represented by encryption using specially developed ICs. Their sole function is encryption, so there is no performance loss. Many encryption ICs are additionally protected against physical attacks. The security of those components – and also of the keys – is thus independent of the security of the overall system.

Encryption ICs in different designs meet the requirements of a range of applications: Simple authentication chips, such as from the Infineon Optiga Trust series, use asymmetric encryption (ECC 163), and are good choice for the authentication of original accessories in consumer electronics for example. The Optiga Trust E series with ECC 256 and SHA 256 assures authentication of medical equipment, in smart homes, in industry, or in cloud computing authentication for license management for example.

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The Optiga Trust P series with ECC 521 and RSA 2048 features a Java-based operating system, in which dedicated applets can be programmed. The STSAFE (ECC 384, SHA 384, AES 256) products from STMicroelectronics also offer the highest protection, based – among other features – on secure authentication, encrypted communications, secure depositing of keys, and protection when running firmware updates.

Standardized Trusted Platform Modules (TPMs) combine highly complex encryption and secure depositing of large numbers of keys and signatures with protection against physical readout of the data stored in them. They are offered by Infineon for example.

Encrypted Smart Home

A simple practical example illustrates the use of encryption ICs: In a smart home, simple authentication chips such as the Optiga Trust SLS ensure that only authorized devices – such as shutter controls or surveillance cameras installed by the user – are able to log in to the central smart home gateway.

An STSAFE Secure microcontroller encrypts the communications between the cameras and the central gateway. A TPM in the central gateway assures key storage, firmware updates, and the transfer of all data to the Cloud. As a result, the homeowner can be certain that authenticity, confidentiality and integrity are assured.

Security ICs

Secure identities are established using secret keys and cryptographic processes. They are fundamental for the entire chain of security measures required to protect your application.

Have you ever thought about if your secret keys are stored/hidden safe enough? Attackers could easily gain access to valuable software code, key material or sensitive data. If you are using so far just a common MCU or module with no special hardware crypto functions, anybody could hire a company like Circuit Engineering Company Limited or Mikatech Innovative Limited to get your software knowledge or the data stored inside. Already the name of their homepages “ic-cracker.com” or “break-ic.com” gives a hint in what kind of business they are working

What if Your Secure System was Designed from Insecure Components?

In the end, the overall security of your system is determined by the weakest link. Even if you implement a protocol which is probably secured, your system could be broken if the key can be easily extracted from the hardware by simple physical attacks.

Therefore, if you do not already use a Security MCU, we recommend to integrate a hardware Crypto IC into your design. The purpose of a hardware security IC is to act as the keystone of a security subsystem, eliminating the need to protect the rest of the system with hardware or software security measures.

A crypto and authentication IC keeps your secret keys hidden against attacks. They are tamper-resistant and hardened against physical attacks through different measures like an active shielding, randomized layout and mechanisms which force to stop operation if they detect abnormal conditions. They can furthermore be used as brand protection and enable secured boot and secured DFU (Device Firmware Update).

An opponent with unlimited ressources in terms of time, equipment and knowledge can even break any chip protection. The question is how practical it would be. If it takes too much time and financial ressources well beyond the expected gain, then your defense has won. IC attackers would most probably switch to other products rather than spending time and money on breaking your IC.

So if you want to be on the safe side, think about integrating a security hardware IC, so you have a comprehensively secured system/product. And last but not least, integrating a security IC means also that you do not have any performance losses as your microcontroller has not to do the complex de- and encrypt tasks.

The following security solutions are built to provide secured information transfer for a wide range of application areas, using security solutions like authentication and data management services, secured key transfer, host verification, secured boot and many more.

Type	Security Level	Functionality	NVM (Data)	Cryptography	Type of Host System	Inter-face	Package
OPTIGA™ Trust B SLE95250	Basic	Authentication	512 Byte	ECC131	MCU without OS / proprietary OS / RTOS	SWI	PG-TSNP-6-9
OPTIGA™ Trust X	CC EAL 6+	Connected device security	10 kByte	ECC384	MCU without OS / proprietary OS / RTOS, Embedded Linux	I²C	-
OPTIGA™ Trust P SLJ 52ACA	CC EAL 5+	Programmable	150 kByte	ECC251 RSA2K	MCU without OS / proprietary OS / RTOS, Embedded Linux	UART	VQFN-32
OPTIGA™ Trust E SLS 32AJA	CC EAL 6+	cost effective security for high value goods	3 kByte	ECC 256	MCU without OS / proprietary OS / RTOS	I²C	USON-10-2
OPTIGA™ TPM SLB 9645	-	Security Cryptocontrollerfor Trusted Platform Modules	6 Kbyte	ECC256 RSA2K	Embedded Linux, Windows / Linux	I²C	TSSOP-28, VQFN-32
OPTIGA™ TPM SLB 9660	CC EAL4+ moderate	Security Cryptocontrollerfor Trusted Platform Modules	6 Kbyte	ECC256 RSA2K	Embedded Linux / Windows	LPC	TSSOP-28, VQFN-32
OPTIGA™ TPM SLB 9665	CC EAL4+ moderate	Security Cryptocontrollerfor Trusted Platform Modules	7206 Byte	ECC256 RSA2K	Embedded Linux / Windows	LPC	TSSOP-28, VQFN-32
OPTIGA™ TPM SLB 9670	CC EAL4+ moderate	Security Cryptocontrollerfor Trusted Platform Modules	6 kBbyte	ECC256 RSA2K	Embedded Linux / Windows / MCU without OS / proprietary OS	SPI	VQFN-32
STSAFE-A1SX	CC EAL5+	Authentication, data integrity, confidentiality	6 kByte	AES-128	Sigfox devices	I²C	SO8N 8, UFDFPN 8
STSAFE-A100	CC EAL5+	Authentication	6 kByte	ECC256/384, ECHD, ECDSA256/384, AES-128/256	MCU without OS / proprietary OS	I²C	SO8N 8, UFDFPN 8
STSAFE-J100	CC EAL5+	Authentication, secure data storage, cryptographic services	80 kByte	TRNG, DRNG, DES/3DES, ECC, AES	Java Card operating system / VGP 2.1.1	I²C	VFQFPN32

Security ICs from Infineon and STMicroelectronics

STSAFE-A is the optimized secure element for device protection in Internet of Things environments

- State-of-the-art security relying on CC EAL5+ hardware
- Security functions
  - Authentication
  - Encryption
  - Secure channel
  - Firmware upgrade
- USB Type-C standard compliant
- Full turnkey solution with secure OS and personalization services
- Optimized for small platforms
- Easy integration by using libraries

Security ICs

STMicroelectronics STSAFE Embedded Security Solutions

Running on a Common Criteria EAL5+ platform, STSAFE-A is a highly secure authentication solution whose security is certified by independent parties. Its command set is tailored to address strong authentication, establish a secure channel in the scope of a TLS session, verify signatures, and offer secure storage as well as decrement counters for usage monitoring. It is particularly well suited for applications heavily exposed to fraud and counterfeiting attacks, such as printers, game controllers, phone accessories, and Internet of Things networks and devices. By offering a complete solution ranging from an internally-developed secure operating system embedded in the security microcontroller, example code for integrating solutions in the applicative environment, and personalization services for storing confidential customer data in the secure microcontroller, ST offers seamless integration of security measures for customers who might not be experts in secure systems.

Infineon OPTIGA™ Embedded Security Solutions

Infineon OPTIGA™ embedded security solutions are scalable, easy-to-integrate security for your embedded project. The OPTIGA™ Trust family includes turnkey products for smaller platforms as well as programmable solutions, while OPTIGA™ TPM (Trusted Platform Module) products are ideal for embedded PC, mobile and computing applications. All OPTIGA™ TPM products comply with the Trusted Computing Group (TCG) standards.

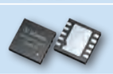
The OPTIGA™ Trust product family offers a full range of security chips to address individual needs in the field of embedded authentication and brand protection and further security applications. Whether you are looking for a turnkey security chip enabling fast and easy integration or a feature-rich programmable solution, OPTIGA™ Trust has the perfect match for your business model.

OPTIGA™ TPM (Trusted Platform Module) offers a broad portfolio of standardized security controllers to protect the integrity and authenticity of embedded devices and systems. With a secured key store and support for a variety of encryption algorithms, OPTIGA™ TPM security chips provide robust protection for critical data and processes through their rich functionality.

OPTIGA™ TPM security controllers are ideal for platforms running both Windows and Linux (and its derivatives). Based on Trusted Computing Group (TCG) standards, they support the TPM 1.2 or the latest innovative TPM 2.0 standard.

Rutronik can offer Infineon OPTIGA™ solutions as a chip to make your own embedded system build on your own PCB, as well as offering ready to use embedded boards and standard mainboards with already having Infineon OPTIGA™ technology on board.

OPTIGA™ Embedded Security Family

Family	OPTIGA™ Trust B	OPTIGA™ Trust E	OPTIGA™ Trust X 1)	OPTIGA™ Trust P	OPTIGA™ TPM
Type	SLE 95250	SLS 32AIA	SLS 32AIA020x	SLJ 52ACA	SLB 96xx
Image					
Security Level	Basic	CC EAL 6+ *	CC EAL 6+ *	CC EAL 5+	CC EAL 4+
Functionality	Authentication	Authentication	Connected device security	Programmable	TCG standard
NVM (Data)	448 Byte	3 kByte	10 kByte	150 kByte **	6 kByte
Cryptography – Private key stored in secure HW	ECC163	ECC256	ECC384	ECC521 , RSA2K	ECC256, RSA2K
Type of Host System	MCU without OS / proprietary OS / RTOS				
			Embedded Linux		
					Windows / Linux
Interface	SWI	I²C	I²C	UART	I²C, SPI, LPC
System Integration	X	X	X	X	Platform vendor

* Based on certified HW ** Code & Data x Done by IFX X Customer Implementation, support by IFX 1) Launch Q1/2018

The right security for IoT

Protect your embedded project with the OPTIGA™ product family

Security is more than data protection – in many cases, security measures also enable new business models and services such as remote feature management. However, performance and security requirements vary considerably from one embedded project to another.

To reflect this diversity, our proven OPTIGA™ product family allows you to match security functionality to your specific application needs. Designed for ease of integration, this proven, scalable family ranges from authentication solutions (OPTIGA™ Trust family) to advanced implementations based on our Trusted Platform Modules (OPTIGA™ TPM).

Check out our OPTIGA™ product family and make your embedded solution a secured success:
www.infineon.com/iot-security

Wireless Data Transport

Wireless communication is used nowadays in many different applications, accepted by users, and trusted as a secure way of communication. Security risks like cable breaks, cable oxidation, loose connection, cable fire, theft of copper cable, vandalism or reconnection and monitoring a communication are more unlikely than at wired solutions. Nevertheless there are still some security aspects of different wireless technologies which should be known.

Jamming Detection

Jamming devices could be found in dark market places and they could be made by you easily. A jamming device is transmitting random codes with as much power as possible on the same frequency spectrum of the wireless connection which should be disturbed. The use of a jamming device is forbidden in most cases. It could be used to avoid closing a car on the supermarket parking lot or to disturb the alarm system of a house. For security reasons you should make sure that the transmission of the data was successful. Therefore you should implement an acknowledgement feature in your communication process. Further there are wireless products available in the market, which have already an implemented jamming detection feature. All cellular and GNSS modules (GPRS, UMTS, LTE, etc.) from the manufacturer Telit have this feature. In the case of detecting a jamming signal which prevents the connection to the mobile network operator base station, the modules are able to react locally with emergency measures.

Unidirectional vs. Bidirectional

Unidirectional and bidirectional describe the way two electronic devices communicate. Unidirectional means that there is only one receiver on one side and a transmitter on the other. A typical example is a car key. The car key is able to send the orders Open/Close etc. so the car receives the information, but there is no communication from the car towards the key to tell e.g. that the command has been received. Another example is the radio broadcast: on one side you have the speaker as a transmitter and on the other the audience with their receivers. Bidirectional communication contains a receiver and transmitter on both sides – a so called transceiver. This configuration allows a duplex communication. There are three security reasons to use a bidirectional transceiver: after sending your data you can receive an acknowledgement data packet to make sure that your data has been received successfully. This ensures that your communication partner has been in range and no disturbances occurred. The second reason to use a transceiver is the possibility to exchange security keys in order to make sure that you are sending the data to the right subscriber. You can avoid man-in-the-middle attacks and you can establish an encrypted connection to avoid that anybody else can listen. The third reason is the already mentioned possibility to make jamming detection by using the receiver before transmitting data. Independent of the security aspects there are further advantages of using a transceiver, like adjusting the transmit power level to save energy and an automatic resend of data packets in case of reception problems.

General Security Strategy Regarding Frequencies and Protocols

Mobile network operators have bought own frequency ranges to offer GSM, LTE and other services to you. For all other kind of common used wireless technologies you will use licensed free and public available frequencies – so called ISM-bands (Industrial, Scientific, Medical Bands). Bluetooth, Wi-Fi, ZigBee, ANT, SigFox, LoRa, Thread, RFID, NFC and all the other known technologies are working within these frequency areas. The three most popular ISM-bands in Europe for standard applications are 433 MHz, 868 MHz and 2.4 GHz. You should be aware that the allowed transmission power, the available bandwidth and the allowed duty cycle are different and it has an impact to the security of your communication as well.

...

For example: the 868 MHz band has a bandwidth of 600 kHz, while the 2.4 GHz band has space for ca. 85 MHz. That means you can in general establish more data channels in parallel at 2.4 GHz, just for the case that some frequency areas are already used by others. The 868 MHz band has a more strict regulated duty cycle than the 433 MHz band. That means you have restrictions on the durations of sending data. On the one hand this could be a problem if your duty cycle capacity is already being used but you need to send another important data packet. If you think it would be better to use 433 MHz because of the missing restriction, then think about what could happen if you send this important further data packet when another application is already using this frequency channel all the time – for example a 433 MHz headphone system, which streams audio on this channel permanently.
If you will use a popular wireless standard, many of these aspects have already been solved. 2.4 GHz technologies based on IEEE802.15.4 specification (like ZigBee, Thread and some others) are using 16 channels with 5 MHz modulation per channel. That makes them robust against small signal disturbances. Wi-Fi is using 20 MHz per channel, which is even more robust. Classic Bluetooth is using the same frequencies splitted into 79 channels with 1 MHz each. To make sure that the connection will be robust as well, it changes the used channel 1600 times per second. With this strategy Bluetooth makes sure not to stay on a busy channel. Bluetooth Low Energy doesn´t change the channel without having detected a disturbance, but it uses 2 MHz per channel as a compromise.

In case you want to connect your device to a smartphone, you have to take a supported protocol like Bluetooth, Wi-Fi, ANT or NFC. But if your devices only have to communicate with each other, you have also the opportunity to create your own proprietary protocol. From security aspects this has some advantages: you would have full control inside your own network. There is no device from another company which could interrupt or cause delays. That´s the reason why most of the wireless smoke detector systems in public buildings are using a secret proprietary protocol from the vendor. Another advantage is that it is not very attractive for a hacker to invest a lot of time to hack your device. Most hackers more likely tend to look for bigger ecosystems to cause damage, because the commercial outcome of a successful Zero-Day-Exploit Attack (ZETA) would be much higher. This advantage could turn into a disadvantage as well: if you make a mistake, you have to solve it and pay the bill alone. If you choose a standardized protocol, there will be a big community who takes care about making updates, patches and fixes if a security problem becomes public.

Conclusion: If you use a standardized wireless technology, like Bluetooth for example, you cannot choose the features by yourself and you have to trust the community. But if you want to create your own proprietary wireless technology, you should be aware about each of the seven layers of the ISO-OSI-model in communication system. Our recommendation is to check the regulations at the ETSI website to be aware about the advantages and disadvantages of the different ISM-Bands. After this, you should look for established and proofed software from experienced specialists. In addition to the well-known wireless technologies, Rutronik can also help to get an overview of the features from protocols like RFDP8, ShockBurst, WDP, Gazell, SNAP® or the smartphone supported ANT™ and ANT BLAZE™.

Wireless Data Transport

RFID and NFC

RFID transponders are available in different frequency ranges: Low frequency (LF, 125 kHz), high frequency (HF, 13.56 MHz) and ultra-high frequency (UHF, 868 MHz). UHF tags are often readable over distances of more than one meter and it is possible to detect hundreds of them at once. That is why this technology is often used for car windshields or logistic applications. The reading range of HF transponders is usually only a few centimeters.

That makes this technology perfect for security applications like payment or to identify individuals. NFC uses specialized protocols, but is based on HF RFID as well.
A RFID transponder is a memory that gets the energy for reading and writing from the electromagnetic field. The memory contains two main areas: one area contains a unique identification number (UID). This 64 bit code is only available once in the world. It was defined and programmed by the creation of the silicon and it cannot be changed or erased. The UID code is often used for products to identify if a device is an original device or not. You can also link the set of a database to a specific UID code, like the personal number of an employee or the name of a team member.

The second area inside the memory can be programmed by the user. It can be used to save non static information, like the data of the last inspection, who conducted the inspection, and other useful information. In some RFID transponders this memory area can be split into sub-areas. Each of these sub-areas can be individually protected by different codes to protect it against unwanted reading and/or writing.

A further variant of RFID transponders are the dual interface memories. Dual interface means the wireless interface (to connect the antenna directly) and a second interface to connect a microcontroller. The interface to connect a microcontroller can be I²C or SPI, depending on the product. Also the memory size, the memory technology (EEPROM or FeRAM) and the supported protocols (ISO15693, ISO14443A/B, ISO18092, etc) could be chosen differently.

Sector	Area	Sector security status
0	1 Kbit EEPROM sector	5 bits
1	1 Kbit EEPROM sector	5 bits
2	1 Kbit EEPROM sector	5 bits
3	1 Kbit EEPROM sector	5 bits
	I²C password	System
	RF password 1	System
	RF password 2	System
	RF password 3	System
	8-bit DSFID	System
	8-bit AFI	System
	64-bit UID	System
	8-bit configuration	System
	16-bit I²C Write Lock_bit	System
	20-bit SSS	System

Memory Sector Organisation of a M24LR04E-R (STMicroelectronics)

A dual interface RFID transponder allows programming the memory without having powered the microcontroller. After powering the microcontroller, it can read inside the memory what has happened while it was sleeping.

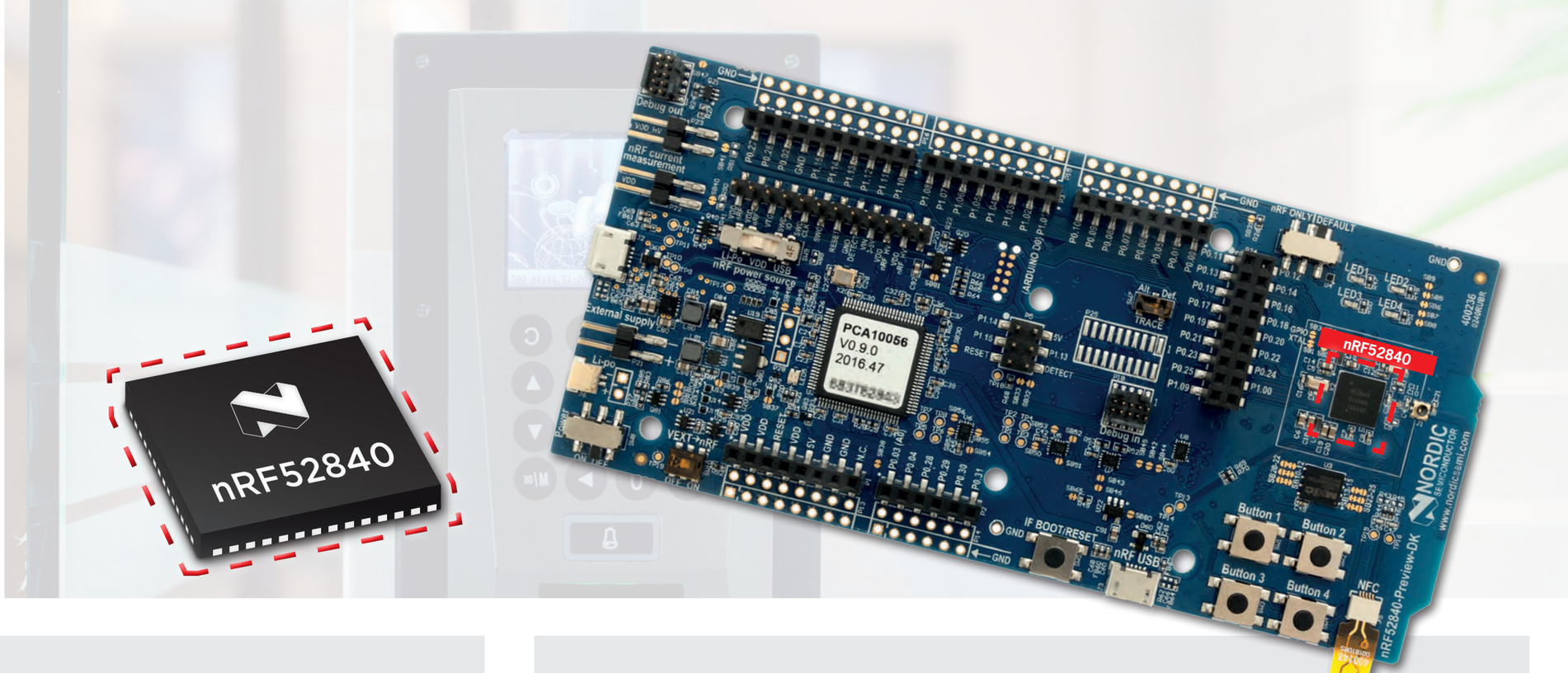
For example, the STMicroelectronics M24LR04E-R provides a special protection mechanism based on passwords. In RF mode, each memory sector of the M24LR04E-R can be individually protected by one out of three available passwords, and each sector can also have read/write access conditions set.

Each memory sector of the M24LR04E-R is assigned with an sector security status byte including a sector lock bit, two password control bits and two read/write protection bits.

Rutronik offers RFID/NFC solutions from STMicroelectronics, Fujitsu, Panasonic, Murata, Toshiba and Melexis. As an example, ST provides an exhaustive offer of NFC products and solutions including ST21NFC state-of-the-art Controller and ST54 System in Package, integrating the widely deployed ST33 Secure Element, to address secure mobile transaction applications. It´s already pre-certified for most of payment and transit schemes including EMVCo, PBOC, Visa, MC, Amex, Discover, and MIFARE® allowing customers to easily and quickly ensure security in mobile transactions. Therefore a complete development ecosystem is available including reference designs, expansion boards, pre-certification services and integration into the most popular TSMs to help reduce the time to market as well as development costs.

Key Components Setup of a Full NFC System

Wireless Data Transport



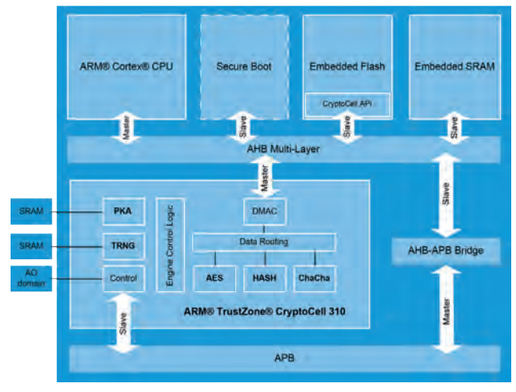
Wireless SoCs and Wireless SoMs

It has become very popular during the last years to use System-on-Chips or System-on-Modules with an integrated wireless transceiver.

The reason is, that the supplier of these components has full control about the microcontroller, the peripherals, the memory, the wireless transmitter and wireless receiver blocks and in case of a module also regarding the antenna performance. As a result the supplier can offer wireless protocols tailored for his own chip. The customer doesn´t need to take care to adapt the software to hardware, because it was already developed for this setup.

Rutronik can offer Wireless-SoCs from Nordic Semiconductor, Renesas, Infineon, Toshiba and ST. Equivalent modules, including antenna, crystals, pre-certifications etc., are available from Telit, InsightSiP, Dynastream, Fujitsu, Redpine Signals and RF Digital. There are solutions available with 8 bit, 16 bit and 32 bit MCU, different memory sizes, USB, ADC, NFC, Sub-GHz, 2.4 GHz and a lot of other features you can choose of.

Taking an example: For the SoC named nRF52840 and its 3rd party module variants, there are free wireless stacks available, like Thread (IPv6 based home automation), Gazell (open source star network), ANT (lowest power mesh network), Bluetooth Mesh, Bluetooth 5 (including high speed and long range modes) and customers have the possibility to create their own wireless protocol as well. The nRF52840 implements the ARM® CryptoCell-310 cryptographic co-processor on-chip for building trustworthy applications with robust industry grade levels of security.

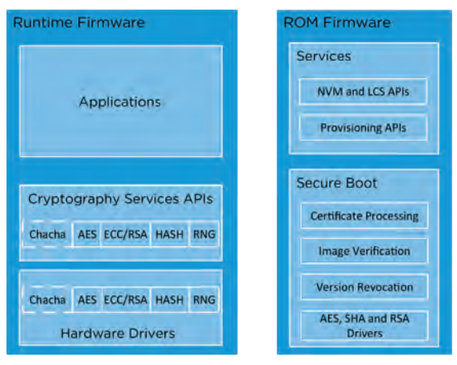


Schematic Blockdiagram / Source: Nordic Semiconductor

Security is a paramount consideration for the design of connectable IoT devices today and in the future. Security must be a design consideration from the ground up in any truly secure application.

ARM CryptoCell-310 is an integrated security core that consists of both HW and SW components. It provides a comprehensive security infrastructure that enables system wide protection that includes use cases inside and outside the device.

It has a cryptographic hardware engine, providing CPU host offloading, operation acceleration and power consumption reduction.



Middleware Architecture and Features / Source: Nordic Semiconductor

There are cryptography and security middleware services available. Platform Security building blocks library and Device Life-Cycle-State management is available, as well as a Key Management infrastructure and a function called Secure Boot to avoid loading dangerous codes at startup.

So the CryptoCell-310 inside the Nordic Semiconductor nRF52840 is a multi-layered product, consisting of a hardware security infrastructure, and a middleware layer on top of it.

Algorithm Family	Identification Code
Stream Cipher	Cha Cha
MAC	Poly 1305
Key agreement	SRP
AES	FIPS197
	NIST SP 800-38A
	NIST SP 800-38B
	NIST SP 800-38C
	ISO/IEC 9797-1
Hash	FIPS180-3
	RFC2104
RSA	PKCS#1
Diffie-Hellman	ANS X9,42
	PKCS#3

Algorithm Family	Identification Code
ECC	ANS X9,63
	IEEE 1363
	ANS X9,62
	Ed25519
	Curve25519
	FIPS-1864
	NIST SP 800-56A rev.2
TRNG	NIST 800-90B3
	AIS-31 (Class „P2 High“)
PRNG	AIS-20 (Class „K4 high“)
General	FIPS 140-2

Wireless Data Transport

Wi-Fi

Data transmission with Wi-Fi is carried out with radio waves at high frequencies and is commonly used in many different applications where a high data rate is needed, or the internet access by using an existing Wi-Fi infrastructure or to offer an own webserver service. Most established is Wi-Fi within the 2.4Ghz band, but also 5 GHz is already accepted at least in the consumer world. New specifications also offer Wi-Fi within 60 GHz and Sub-GHz bands as well. The amount of personal data sent over the air makes it attractive for cyber criminals to buck up this information or manipulate it. Luckily there are security protocols which make it more difficult for unauthorized persons to get access to this data.
The currently used security protocol within Wi-Fi is WPA2 which is presumed to be very robust and safe, but still attackable by the Brute-Force-Method. WPA2 makes the connection between Wi-Fi access point and Wi-Fi device secure, so that nobody is able to fish a readable data stream out of the air. WPA2 is not a solution for E2E (end-to-end) security, so you need to have SSL/TLS or other security layers on top of it to protect your net data also on its way through the internet after the access point.

There are two versions of WPA2: WPA2 Enterprise Security and WPA2 Personal. Both use a strong encryption method called AES-CCMP to encrypt data transmitted over the air. The main difference between these security modes is in the authentication stage: While WPA2 Personal uses pre-shared keys (PSK), WPA2 Enterprise uses IEEE 802.1X. The WPA2 protocol is only securing from device to the access point, not form device to end device. To avoid this problem there is the option of using a VPN-tunnel, which provides a secure point-to-point connection across the internet on the lower communication layer (independent of the applications on higher layers in use).

WPA2 Enterprise Security

WPA2 Enterprise uses IEEE 802.1X authentication and is currently the most robust authentication for WLAN. It is specifically designed for the use in large organizations with many Access Points, for example hospitals or universities. It requires a RADIUS authentication server and needs a username and password. It also supports multiple accounts for each user. For both encryption and decryption the same key is used within the AES block cipher, which has a length of 128 bit. There are four stages included for one round in AES encryption, that's why it's often also called four-way handshake.

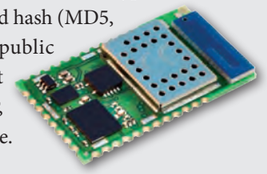
WPA2 Personal / WPA2 PSK

WPA2 Personal uses pre-shared keys (PSK) and is designed for small networks like for example home use. A PSK is a secret alpha-numerical string associated to the Access Point (AP). The communication between the Station and the Access Point is encrypted by AES cipher with a 256 bit symmetric key. It only uses one single password/key which is generated at every session and is the most used Wi-Fi security standard. Like in WPA2 Enterprise Security, the protocol used to derive the key is called four-way handshake. The alternative cryptographic method WEP is not secure and should not be used any more. The predecessor WPA is considered as secure, but shouldn´t be used because WPA2 is qualified as even more secure.

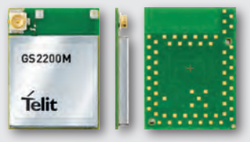
Examples of Secure Wi-Fi Solutions

Some Wi-Fi examples of our portfolio with embedded security:

ST Microelectronics SPWF04
The SPWF04S from ST is a standalone 2.4 GHz 802.11 b/g/n Wi-Fi transceiver module. It includes the common encryption algorithms AES (128 bit & 256 bit) and hash (MD5, SHA-1 & SHA-256), as well as the public key algorithm RSA. Furthermore it supports the security protocols WEP, WPA2 Personal and WPA2 Enterprise.



Telit GS2011, GS2101, GS2200
The GainSpan Wi-Fi modules from Telit are based on the GainSpan SoC GS2000. It contains the security protocols WPA2 Personal and WPA2 Enterprise and uses TKIP and AES encryption. Upper layer encryption includes TLS, SSL, HTTPs, PKI and digital certificates.



Redpine Signals Wi-Fi Modules and Combined Technology Modules
Connect-io-nTM Family modules are ready to use Wi-Fi modules, optionally having Bluetooth and ZigBee integrated as well. WEP, WPA and WPA2 are onboard, as well as HTTPS, SSL 3.0, TLS 1.2 and the possibility to make wireless firmware updates. WiSeConnect™ Family are supporting Enterprise Security (EAP-TLS, EAP-FAST, EAP-TTLS, EAP-PEAP) on top of the features of Connect-io-n™.

The n-Link™ family offers WPA2 and Enterprise Security featured on the external host system. Software stacks are available for Linux, Android, WinCE7, WEC2013, Windows 7, Windows 10 and Windows 10 IoT.

Further stand-alone solutions with WPA2 Personal are offered by Panasonic and Silex. Advantech, Silex and Intel are offering solutions with standard interfaces to run also Enterprise Security on the host system.

SSID and WPS

Most people would recommend hiding the SSID (Service Set Identifier - the name of the WLAN network) to prevent connection attempts from others. But this method is useless: when connecting to your own WLAN network / SSID, your device sends out signals containing the SSID name not crypted, so everybody in the network range can sniff it anyway. A disadvantage would be the higher power consumption for all Wi-Fi nodes scanning for available Wi-Fi networks. We recommend to do it in the opposite way:
use the administrators e-mail address as name for your network.
Then everybody could contact you if there is a topic on frequency management (channel adaption) or if somebody wants to ask to get the network key or adding his device to the whitelist of MAC addresses.
The feature Wi-Fi Protected Setup (WPS) was made to connect devices more easily to an access point. The WPS will exchange the WPA2 key by only using a four digit pin code, for example. This makes it much more easy to hack a WPS enabled router.

The connection will be jammed until it breaks. At the try of a reconnect there will be a fake access point offering the same SSID and WPS service. The records of the WPS procedure will be used to attack the original access point, similar to a man-in-the-middle attack. The leak was possible because the pin code was linked to the MAC address of the routers. At new routers this bug was solved. Anyway, using WPS is always more comfortable by losing some levels of security.

In general, we recommend to use the MAC filter of your access point to allow only listed devices to join your network. Use long WPA2 keys and they shouldn´t contain words of a dictionary. Check available firmware updates frequently. Disable WPS and don´t hide your SSID. Use the channels 1.6 and 11 only. These are non-overlapping. All other channels would not allow to establish three Wi-Fi networks in parallel without having double used frequency blocks. This would make at least two networks slower, because more resent packages will be necessary.

Wireless Data Transport

Bluetooth EDR vs. Bluetooth LE vs. Bluetooth 5

Bluetooth (IEEE 802.15.1) is the most used wireless standard in the 2.4 GHz ISM band. It is good for the exchange of data over short distances. Within this technology you can mainly differentiate between Bluetooth Classic (EDR) and Bluetooth Low Energy (BLE). Bluetooth 5, which was published lately, is an enhancement of Bluetooth Low Energy mainly adding modes for longer range or higher speed.

Bluetooth Classic (EDR – Enhanced Data Rate)

Bluetooth EDR is using between 21 and 79 channels depending on how much Wi-Fi networks (interferences) are detected. Each channel has a bandwidth of 1 MHz and the channels are changed 1600 times per second – always and permanently. It has Adaptive Frequency Hopping (AFH), Forward Error Correction (FEC) and a 128 bit AES-encryption.

Adaptive Frequency Hopping (AFH) is a technology that comes into action, when Bluetooth and Wi-Fi (both using the unlicensed 2.4 GHz ISM band) are competing in the same frequency band and therefore interfering each other. AFH detects these interferences and then excludes these blocked channels. At least 21 channels (21 MHz) will be used and still could influence a Wi-Fi network.

The Forward Error Correction (FEC) is a method which enables a receiver to detect and also correct errors in transmitted data. Bluetooth is still considered as secure because of the AES-128 coding.

Bluetooth Low Energy (BLE)

Bluetooth Low Energy is transmitting single data telegrams and has quick connecting times. It's extremely energy saving and therefore perfectly for applications which for example only need to send a signal every few minutes. Like Bluetooth Classic, it is using Adaptive Frequency Hopping (AFH) and Forward Error Correction (FEC). Each channel has a bandwidth of 2 MHz, by having 37 channels for data exchange and 3 channels for advertising. The advertising channels are placed before Wi-Fi channel 1 starts, between channel 1 and 6, and the thirst BLE advertising channel is placed after Wi-Fi channel 11. A further difference between BLE and classic Bluetooth is that BLE is not changing the channels permanently. Only if disturbances are detected, the channel will be changed.

Bluetooth Low Energy
Supports the Following Security Concepts:

- Pairing: Devices create one or more shared secret keys
- Bonding: The act of storing the keys created during pairing for use in subsequent connections; this forms a trusted device pair
- Device authentication: Verification that the paired devices have trusted keys
- Encryption: Scrambling of plaintext message data into cipher text data
- Message integrity: Protects against tampering with data

Since Bluetooth Low Energy Version 4.2 there is also an increased security support implemented: the numeric comparison method and the Elliptic Curve Diffie-Hellman (EDHC) algorithm. Also the fact that private keys are not shared over the air makes this version and successors secure against passive eavesdropping, as it's difficult to encrypt the transmitted data without.

Bluetooth 5

Bluetooth 5 is an upgrading of Bluetooth Low Energy: It could have four times the range, two times speed and eight times data transmission, but still using low energy. That makes Bluetooth 5 an attractive alternative for many Wi-Fi IoT applications, but also easier for hackers to get the transmitted data from a bigger distance in a shorter time. Till now, Bluetooth 5 only offers device authentication, but no user authentication.
The most popular products to use Bluetooth technology are SoC or SoM components because of the complexity of the wireless stack and the fast ongoing evolution and available improvements tailored to dedicated host system. Please have a look to chapter “Wireless SoCs and SoMs” in this book.

Bluetooth Mesh Networking

In order to keep up with rival standards like Thread or ZigBee, Bluetooth SIG decided to launch a communication standard that allows a many-to-many (m:m) connection as well as connections between devices of different suppliers. Until July 2017, there was only a star network and point-to-point Bluetooth Low Energy connection possible.

Bluetooth mesh networking supports connections up to 32,000 nodes. With that, this network is much bigger than all other mesh networks and allows bigger distances. As many benefits and improvements m:m connection has, as many security risk this brings.

One main focus while developing Bluetooth mesh networking was therefore the question how to keep this technique secure. Important to know is, that all possible security features are subject to the decision of the product designer, he can decide which of them will be integrated.

The Most Important Security Features are:

- Authentication and encryption of all Bluetooth mesh messages
- Network, application and device security are addressed independently
- Subnets of the mesh network are distinct and secure form the others
- Key refresh procedures allow the change of the security key during lifetime of the network
- Message obfuscation hinders message and node tracking within the network
- Bluetooth mesh security protects the network against replay attacks
- Secure removal of nodes from the network, so that trashcan attacks are prevented
- Secure adding of devices to the network to become nodes

Nordic Semiconductor provides a Software Development Kit (SDK) for any Bluetooth Mesh development – the nRF5 SDK. It is compatible to the nRF51 and nRF52 System on Chips and is perfect for the use in consumer, smart home and industrial applications.

Additionally to the Bluetooth mesh security features of the Bluetooth SIG, Bluetooth mesh devices of Nordic support a secure side-by-side and blocking device firmware updates. Next to that, a serial interface allows control of the mesh network.

DESIGN TRUSTWORTHY IoT APPLICATIONS WITH ROBUST LEVELS OF SECURITY

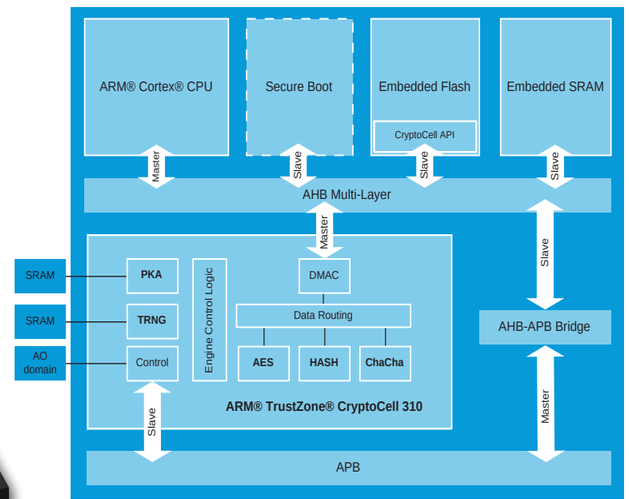
Designed to address the inherent security challenges that are faced in IoT, the nRF52840 advanced multi-protocol SoC (supporting Bluetooth 5, ANT, 802.15.4, and 2.4GH proprietary) incorporates the ARM® CryptoCell-310 cryptographic accelerator offering best-in-class security for Cortex-M based SoCs.

ARM CryptoCell-310 is an integrated security core that consists of SW and HW accelerator for symmetric and asymmetric cryptography including NIST recommended standards for key exchange, hash generation and data encryption. It includes a FIPS compliant True Random Number Generator (TRNG) and implementations for Cha Cha, ECC (with multiple curves), AES, RSA, SHA and others.

The nRF52840 SoC also supports read/write/erase protection for memory that can be reserved for cryptographic keys. On-chip memory protection module is to protect stored bootloader code memory from flash write/erase.

Secure boot - Using a combination of HW supported cryptographic functions and memory protection, secure boot to establish a root of trust is able to be implemented.

Secure OTA DFU – Using a combination of on-chip security accelerators, memory protection features and bootloader SW implementations, Over-The-Air Device Firmware Update (OTA DFU) is supported for secure, authenticated deployment of firmware images.



ARM CryptoCell-310 high level block diagram

Wireless Data Transport

Thread vs. ZigBee vs. other 2.4 GHz Mesh Solutions

Further technologies are available to build up wireless mesh networks. Some protocols are based on top of the IEEE802.15.4 specification (PHY and MAC layer specification). The advantage is the possibility to change the transceiver from one supplier to another, so you are more independent than using a single source. The disadvantage is the specification itself. The DSSS modulation, having 5 MHz per channel and only 16 channels available is very often not the perfect choice for an application because it needs more energy and frequency resources than other modulation schemes. Also IEEE802.15.4 solutions are often based on SoCs instead of separated transceiver and microcontroller. In case of using a SoC the advantage of being independent from a single source is not given.

Thread

Thread is based on IEEE 802.15.4. At the network and transport layers Thread uses a combination of IPv6, 6LowPAN (IPv6 over Low power Wireless Personal Area Networks), UDP (user Datagram Protocol) and DTLS (Datagram Transport Layer Security).

The application layer can be defined individually. As it is using IPv6, Thread can be used to integrate home automation devices directly to the IoT, without the need of making any protocol and address conversion. IPv6 has a strong encryption and authentication mechanism integrated – the IPsec. Part of this security protocol is:

- Interoperability
- Cryptographic protection of the transmitted data
- Access control
- Integrity of data
- Authentication of transmitter (user authentication)
- Encryption
- Authentication of keys
- Administration of keys (key management)

For the Nordic Semiconductor nRF52840 there is a free Thread stack available, which could be used in parallel to Bluetooth 5, ANT and others at the same time. The Thread Group has some strong market drivers in its board, so we would not wonder if it will be the de facto standard for home applications soon.

ZigBee

Also ZigBee is based on IEEE 802.15.4. The network, transport and application layers are defined by the ZigBee Alliance. ZigBee is already widely adopted and includes a mature application layer called the ZigBee Cluster Library. ZigBee uses the counter mode (CTR) encryption, which has a 128 bit AES length and the cipher block chaining (CBC) with a 128 bit AES for the generation of the message integrity code (MIC). Within ZigBee a Trust Center (TC) device is determining and approving who wants to join the network. The Trust Center either instructs the router to authenticate the joined device or force it to leave. There are three types of ZigBee security keys to protect the data: link, network and master/application keys. All of them are symmetric.

Be Aware:
In 2016 scientists from the Weizmann Institute of Science in Israel and from the Canadian Dalhousie University found a security hole within the wireless ZigBee standard, extracted a security key and put manipulated firmware (“worm”) on to the Philips hue bulb. Through that, they were able to control the lightbulbs. This is a serious problem regarding security, as this “worm” can “infect” all other wireless devices in the same network.

The Telit ZE61 (100 mW, long range) modules enable the certified Telit ZigBee PRO protocol stack. They are suited for home automation and control applications as well as building automation.

ANT, ANT BLAZE and ANT+

ANT is a wireless sensor network protocol with ultra-low-power consumption and communication over short distances. As it is very compact, it requires few memory capacities and therefore reduces system costs. The ANT protocol was developed to connect coin cell battery powered sensors (small data packets). ANT supports different network topologies like peer-to-peer, star, tree and mesh. ANT has a network key integrated, which ensures that only devices with the same valid network key can communicate with each other. ANT will be placed on top of the PHY and MAC layer of the ICs from Nordic Semicondtcor, using GSFK modulation (1 MHz per channel, channel will be changed only if disturbances are detected). On top of ANT you can choose if you want to make your own application layer or you can choose one of the defined ANT+ stacks. ANT+ application stacks are available for a lot of standard sensors and services. Using ANT+ makes you part of the ecosystem and being compatible to other companies giving security and allows to make your communication very efficiency in regards to energy consumption.

Important to know: ANT is supported by most of the Android based smartphones. There is also a small USB stick available to integrate computers to the network. Further there is a combined stack of ANT and Bluetooth LE available, which enables further connectivity possibilities.

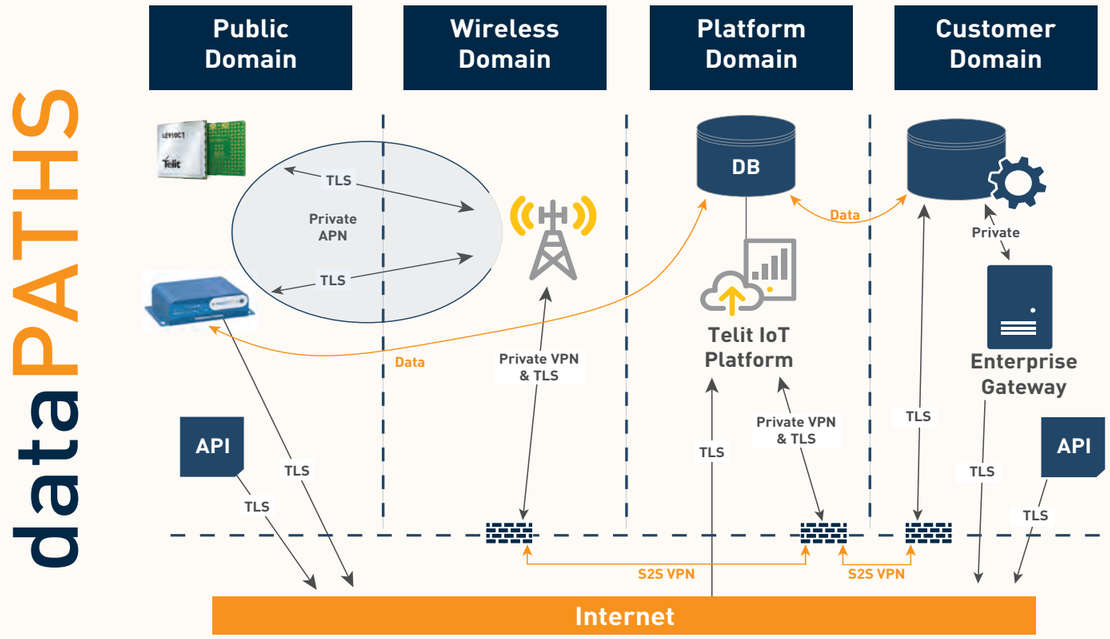
Most of the SoCs by Nordic Semiconductor supports ANT. Regarding SoMs we recommend to use a module from Dynastream. This supplier is the only one who has full control about the protocol and standardized profiles. The D52 ANT SOC Module Series supports dual protocol ANT and Bluetooth Low Energy.

There are two categories: The general purpose category provides the most cost effective module solution for ANT and ANT+ applications. And the premium category adds the capability to run licensed IoT technologies such as ANT BLAZE. This series offer advanced burst data transfer mode with up to 60 kbps and optional the 128 bit AES encryption mode.

Gazell and ShockBurst

Gazell is a free low-power open source protocol for the 2.4 GHz ISM band developed by Nordic Semiconductor, which is implemented on top of the Enhanced ShockBurst (ESB) protocol. It is robust against interferences as it has channel hopping functionality. It supports the star network topology between a single host and up to eight devices. Data transfer within Gazell or ShockBurst is carried out bidirectional. To prevent data loss, Gazell and ShockBurst includes packet buffering, packet acknowledgement and automatic packet retransmission of lost packets.

Wireless Data Transport



Security at Cellular Wireless Technologies

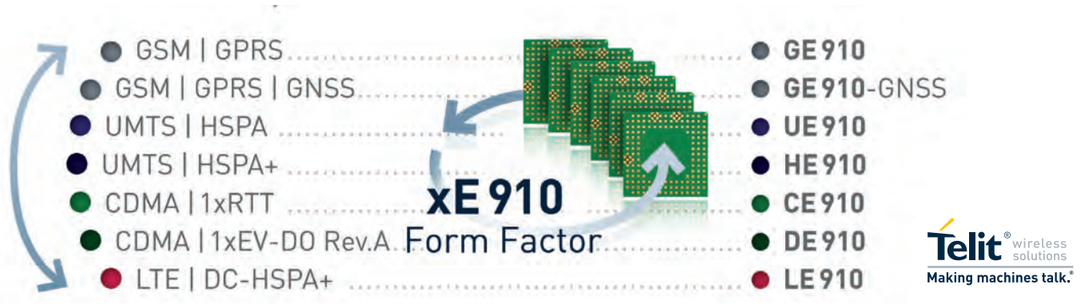
Within a mobile cell, there are many members who transfer their data for and back to a base station and therefore for and back to the internet, different safety aspects have to be considered. First of all a secure protocol needs to be in place for encryption and authentication aspects, so the transferred data can't be read out by anyone else and the sender and receiver can be trusted. Secondly the SIM Card needs to have an up-to-date encryption standard so the end nodes can't be attacked by an unauthorized third party.

Telit's one stop one shop philosophy brings a great choice, from different Cellular Hardware solutions, like the xE910 and xE866 family which can be combined with the right SIM Card solution and IoT Portal from Telit, especially created for industrial applications.

xE910 Family from Telit

The xE910 family from Telit addresses global applications requiring one-region-at-a-time coverage and is ideal for fixed-wireless applications such as utility metering, home and commercial security and situations with limited in-region mobility such as POS and logistics terminals.

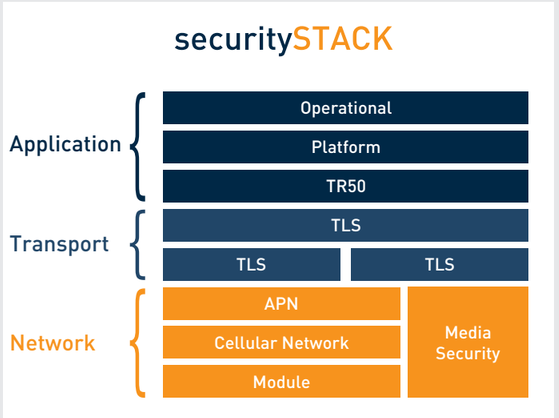
The xE910 family allows applications to be upgraded easily, through a variety of options, such as migrating from 2G to 3G or 4G or upgrading from 2 bands to 3, 4 or more. The family fully preserves the core design of the application or device from launch to phase-out with modules packaged in a common 28.2x28.2 mm LGA footprint. SSL 3.0 and TLS 1.0 - 1.2 protocols are integrated in the xE910 family software package and can be easily set via AT commands.



Change easily between technologies thankss to same form, same size and same AT commands

What Could Happen if You Choose the Wrong Module?

The biggest German motorists' club, ADAC, was able to hack the BMW ConnectedCar system in the beginning of 2015. They were able to remotely unlock 2.2 million vehicles of BMW, Mini and Rolls-Royce by using the internal GSM module. The communication was using the same symmetric key for all cars, based on DES with a 56 bit key. To sign the messages, three methods were implemented: DES CBC-MAC, HMAC-SHA1 and HMAC-SHA256. The algorithm used is indicated in the header of the message. To sign and encrypt data, 16 pairs of two 64 bit keys each are used. Which key pair is being used is also noted in the header of the message. It was not clear why BMW was using DES encryption as this algorithm has been considered broken for some time. Its block length is shorter compared to several other crypto algorithms, leading to shorter messages. The surprising thing about what had happened was that the cellular connection between the vehicle and the BMW servers could be logged without problems in an emulated network. The car had sent a simple HTTP Get request; there was no encryption with SSL or TLS in transit. We want to mention that the used module inside the car box was not a module from Telit. At that time Telit has already offered SSL/TLS as a standard. The disclosure of the vulnerabilities was coordinated by ADAC with BMW to give the company enough time to secure their services. A configuration change to enable encryption in transit for ConnectedDrive data has now been triggered via cellular connection. According to BMW, the certificate of the server is now being checked as a consequence of this. However, car owners cannot be sure if their car has received this change. To find out, owners can contact a BMW hotline at 0 89 / 1 25 01 60 10. Owners can also trigger the change manually by selecting Update Services in the car's main menu.



M2M SIM Cards with Higher Level Security

Each SIM Card has basically the same function: to identify and register the owner in a cellular network. The SIM Card buffers the secure keys in order to acknowledge the owners identity and to encrypt and decrypt all the data/communication. Unfortunately not all SIM Cards use a secure encryption system and the software is not implemented well enough, so they can be easily hacked. We recommend: Keep your fingers away from SIM Cards which have only DES (Data Encryption Standard) as encryption standard. It is not considered safe enough.

We recommend, check for SIM Cards, like the one from Telit with high security levels.

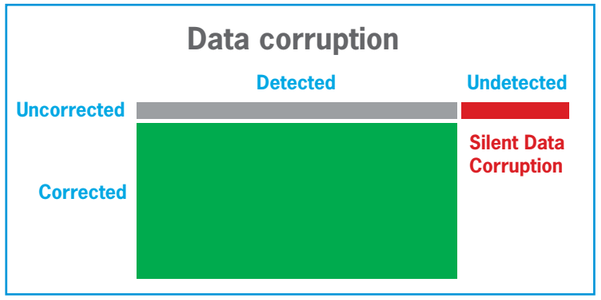
Telit's SIM cards offer 2G, 3G & 4G LTE custom plans for data, SMS & voice on tier-one networks. The terms of use are simple – one agreement with predictable pricing and no hidden fees or roaming charges. Furthermore Telit offers a 24/7 support with dedicated IoT experts and an account team. The SIM cards offer a multi-layer security & VPN connections. A 4-8 digit PIN protection preserves the system from use of unwanted third. The VPN solution uses IPSEC, an encryption protocol in order to transfer data packets with the highest security level by using tunnels. Furthermore the SIM cards are manufactured in heavily audited production sites. The IoT NOC (Network Operation Center) from Telit works 24/7/365 and monitors all the operations. It works reactive as well as proactive and alerts to customers on misbehavior devices. Telit works with different MNOs (Mobile Network Operators) all around the globe, like Vodafone, Telefonica, at&t, Verizon, Sprint, Tele2 and Rogers. This enables roaming across different regions & networks around the world so the connection will not be lost.

Silent Data Corruption – The Neglected Hazard

Generally we can distinguish between two types of errors: the ones that are detected and those that are not. Although all types of errors are unwanted, at least detected errors are a known variable. Unlike detected errors, undetected errors give no notification, no warning and leave no logging information, which makes it extremely difficult to implement error-correction routines.

Silent errors can result in unreported data corruption, which has the capability of destroying data or rendering the data completely useless. These errors pose a serious threat now and in the future when considering the projected amount of data that will be generated from IoT, Industry 4.0 and many more industries. A study conducted some years ago by CERN revealed that undiscovered errors can occur every 10^{16} bits on average. More recent studies have produced similar average values.

Larger capacities are not a solution to the problem, as modern hard disks simply multiply the $1/10^{16}$ error count several times over.



Silent data corruption can be costly and occur more frequently than expected

Silent data corruption events may occur more frequently than perceived and can seriously impact a business on multiple levels. Approximately 11 drives per 1000 can experience silent data corruption in a year and up to 10% of catastrophic storage system failures have been linked to silent data corruption. This unwanted scenario can lead to multiple negative consequences, such as operations being carried out incorrectly or data being lost completely. A business affected by a silent data error scenario can experience significant downtime and in the worst case loss of business. It is estimated that retrieving the data and servicing the data center due to downtime has an average cost of $8,850 per minute. A prime example of costs and business risk associated with silent data corruption is Amazon's 36 hour S3 cloud server downtime in 2008, which left many businesses with partially or fully broken websites, apps and devices. This and many other examples highlight the vast potential damage that silent data corruption can have on your business.

The Causes of Silent Data Corruption

Cosmic Rays

For SSDs cosmic rays are the main source of worry for silent errors. Protons and heavy ions originate from the sun and stars and interact with the atmosphere to create neutrons. The neutrons multiply quickly in a cascading reaction and once reaching the earth, they pass through a person with approximately 10 neutrons/second. In rare circumstances, these high-energy particles can strike integrated circuits, such as a SSD, causing bits to flip in the silicon of the flash cell.

Neutron and Alpha Particles

Generally, neutrons do not carry electrical charges. However, if a neutron gets close enough to a Silicon nucleus, there is a chance that the Silicon nucleus turns into an excited state. An excited Silicon nucleus tends to disintegrate while generating a shower of particles. The shower can be made of more alpha particles or heavier particles which is a carbon nucleus. If these extra free electrons and particles, which were generated from alpha particles interaction with electrons in the silicon substrate, are created close enough to a source or a drain junction, these electrons can essentially get sucked into the output of the transistor, creating a current pulse. These pulses are lower than neutron particles, but last longer – 60 to 100 picoseconds. Alpha particles occur less frequently than neutron particles, but, because they generate electric hole-pairs every time, they cause errors at about the same rate as cosmic rays. Susceptibility to these particles varies on the SSD component.

As the larger nucleus travel through the substrate, they create a large amount of charge. The charge creates a current pulse in the transistor, which results in a bit flip.

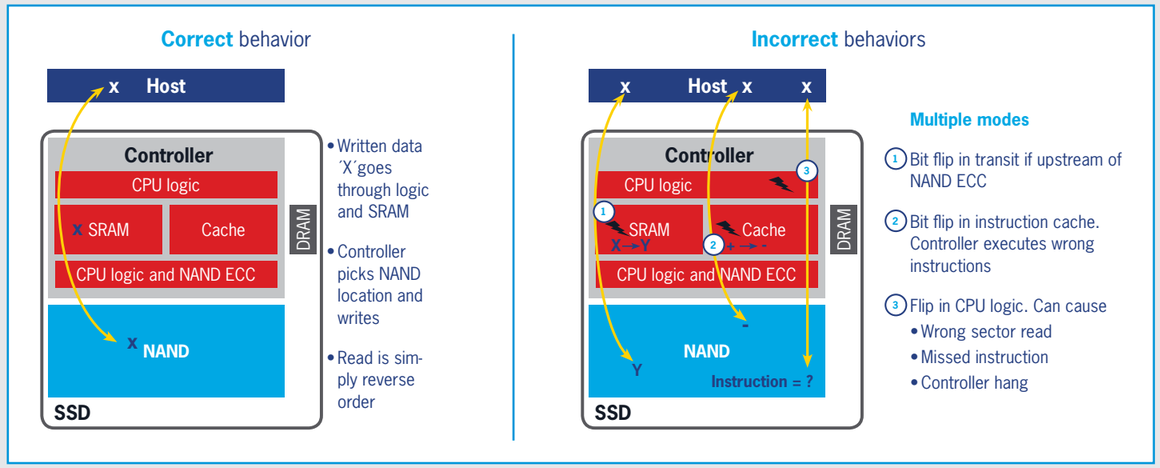
SSD Susceptibilities to Particle Incursions

Essentially, scaling down of geometries increases the susceptibility to particle current pulse. In a Solid State Drive (SSD) the controller and DRAM are the most vulnerable components to a bit flip.

Bit flips in these components can apparently make firmware code execute incorrectly, causing silent errors and other problems. On the other hand, flash memory in SSDs is fairly insensitive to these kinds of errors. The NAND is loaded with ECC protection, and enterprise drives (among others!) have end-to-end data protection.

Ideally, the data written by the host goes through the CPU logic and SRAM, which are located in the controller, and the controller picks an available and suitable position on the NAND to write the data. This way the data goes through the transfer buffer and makes it into the NAND completely intact. If the user wants to read the data then the order is simply reversed. However, in case of incorrect behaviour in an SSD we know three bit flip scenarios:

1. The bit flip can occur in transit if upstream of NAND ECC
2. The bit flip can happen in the controllers cache, which results in the controller performing the wrong instruction
3. The bit flip might occur in the CPU logic, which can cause wrong sector reads, missed instructions and / or controller hang.



Data Storage

Intel's Security Solutions – Designing for Data Integrity

Server customers have extremely rigorous specifications for silent errors. Usually they allow as few as silent error per 1025 bits, or one per billion drives. Simply put, server customers have close to zero tolerance for silent errors. Consequently, Intel wants to eliminate bit flips completely and reduce them to a bare minimum in order to fulfil the customer's rigorous requirements. This is achieved by implementing quality control and testing procedures that go beyond the basics. To combat faulty execution, Intel designed firmware that validates its own behaviour. If the self-testing mechanism detects suspicious activities, then the drive performs any actions necessary to preserve the integrity of the data. These actions could entail reporting an uncorrectable error to the host or cancelling a non-critical operation. If a critical operation cannot be verified and data corruption is possible, the drive locks down, which prevents the possibility to compromise the data's integrity.

Quality and control procedures that help to detect and prevent bit flips:

- ECC or parity on RAMs
- End-to-End CRC data protection
- Interleave to reduce vulnerability to multi-bit errors
- Protect all critical storage arrays within controller
- The firmware will activate a brick drive if it is not certain whether a silent data corruption occurred

Validating Silent Data Corruption Requirements

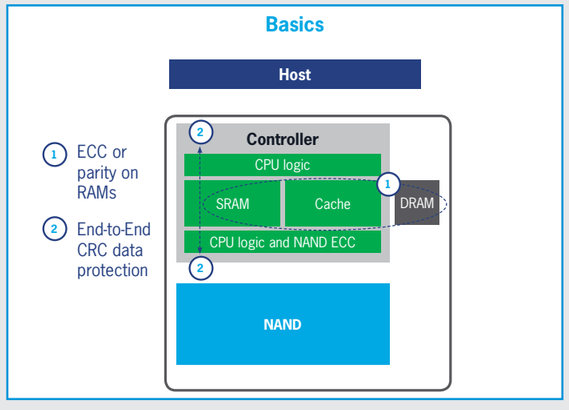
Apart from rigorous hardware selection and software implementation processes Intel also goes above and beyond in their testing capabilities. Intel owns a neutron particle testing facility – the Los Almost Neutron Science Center. Intel's science center allows them to perform neutron and alpha particle tests beyond the standardized guideline by the industry. While traditional tests have a RDT limit of 10^{-18} Intel uses measurements as low and accurate as smaller than or equal to 10^{-22}. This way Intel exposes their SSDs to high intensity particle beams detecting to 0.000001 % per year. At measured conditions, less than 1 drive per 1,000,000 per year will experience silent data corruption.

The Intel Advantage – Security and Integrity for Your Data

Besides offering integrity and reliability against unknown and known errors, Intel also includes features in their SSD products that keep your data safe and secure –the hardware encrypted 256 bits Advanced Encryption Standard (AES). AES is a cypher with different key and block sizes that helps to keep data safe from unwanted access. The block size is set to 128 bits while the key has up to three lengths: 128, 192 and 256 bits. Out of the three key lengths 256 bits offers the highest level of security, due to the large number of bits being used in the key. Hardware encryption offers an additional layer of security, because all the data is encrypted prior to being stored in the SSDs flash memory. Once the data has been encrypted and written into the flash memory, the data becomes almost impossible to decrypt without the original encryption key. The AES 256 bit encryption feature is considered to be so secure that it has even been approved by the National Security Agency (NSA) for securing top secret information.

Intel – A Trusted Partner for Unparalleled Reliability & Integrity

Intel's design and testing allows them to deliver a wide selection of SSDs with unparalleled reliability, which minimizes silent data corruption to occur in your data center, enterprise and industry application.



Intel's SSD Products with AES 256-Bit Hardware Encryption

Consumer SSDs	Professional SSDs	Data Center SSDs	Embedded SSDs
545s 540s 535s 530s 600p	Pro 5450s Pro 6000p Pro 5400s Pro 2500 Pro 1500	S4600 S4500 P4501 P4600 P4500 S3520 P3100 P3520 S3100 D3700 D3600 S3610 P3608 S3510 S3710 S3610 S3500 S3700 S3320	E 5100s E 7000s E 6000p E 5400s

RAID – Redundant Array of Independent Disks

RAID systems are one option to prevent data loss. A RAID system consists of multiple physical mass storage devices, ordinarily hard disks or solid state disks, which are then organized into a single logical drive. A RAID system requires at least two storage media to be operated as a unified storage medium in order to increase reliability. There are different RAID levels, with RAID 1 having a specified reliability rate of 0.0001%. In a RAID 1 system, two disks are written with identical data, containing all of a system's data. If one of the two disks fails, the second disk can continue to supply all of the data. A RAID system is especially indispensable in real-time systems where security and safety are critical.

ECC – Error Correction Code

Another way to prevent memory corruption is to employ error correction methods such as ECC (error correction code). RAM and memory modules in particular feature models that offer additional ECC RAM. Especially in applications where the memory needs to process a large number of write and read operations, errors can arise when writing, causing the wrong data to be stored and possibly crashes to occur. Such RAM should be an essential feature of any server or storage system. With ECC, an additional redundant byte is generated for each 8-byte word before writing. This byte is used to detect errors when data is written and transferred, and to correct them where possible.

Data Storage

Data Storage – What Needs to be Borne in Mind when Selecting Storage Media?

Storage of personal data should be subject to adequate security measures. Companies are required to adopt suitable technical and administrative measures to protect such data, and also to document such measures.

The measures include protection against unauthorized access to the data, as well as ensuring availability and a sufficient degree of robustness for the systems involved. In other words, the data should be protected against inadvertent impairment or loss of the body of information. In this connection, attention needs to be paid not only to storing the information, but also to removing it, i.e. to its permanent deletion. Scenarios in which this aspect may gain in relevance include requirement to do so by an authorized party, replacement of storage media and theft. Following evaluation of the security level needed to address the risks involved, a suitable technical solution must be found that meets current engineering standards.

Hardware-based Data Protection

Hardware-based data protection differs from software-based data protection in that it provides a much higher degree of security. Computer centers are very willing to implement software-based security measures, amongst other things for reasons of scalability and cost reduction. However, in such cases the assumption is made that an attacker cannot access the hardware under any circumstances. In embedded scenarios, the hardware is generally very close to the customer and very prone to attack. Hardware-based security measures are of crucial significance here.

Authentication

The implementation and administration of roles and access rights are determined by strong authentication. Whereas hardware can be configured so that access is determined through authentication by means of a retry counter, no software is capable of withstanding so-called 'brute-force' attacks. There are many common examples of a dual strategy, also referred to as two-factor authentication, including the procedure to switch on a mobile telephone or obtain cash from an automatic teller machine. In the latter case, a transaction is only authorized when a user can supply a data carrier that cannot be copied and the matching PIN. Whenever confidence and securing valuables is concerned, data protection involves hardware.

Encryption

In addition to authentication, data encryption within a data carrier is also advantageous. Where software encryption is involved, the key is necessarily present on the processing machine. This represents a risk, because these days any environment can be virtualized using open source software, and this means that it is, in principle, possible to examine encryption software while it is executing. In other words, as soon as an application can be separated from the target platform, purely software-based data protection concepts prove to have weaknesses. Such risks do not exist where hardware-based encryption is used – or only to a very limited extent.

Much sensitive data is stored externally – in other words, physically removed from a company's own IT infrastructure. If such information also involves personal data, the same requirements in respect of protection apply. In all these circumstances, an adequate degree of security must be provided for. This means, it makes no difference whether the data is to be found on laptops, smartphones, in third-party offices or on a central server. A case in point is to be seen in the encryption of data on mobile devices. If such a device is stolen or gets lost, the data should not be accessible to anyone else, and preferably remotely deletable. Any encryption implemented to this end should only be decryptable by the company itself.

Comprehensive security measures such as encryption are very beneficial. If it is possible to prove that all lost, stolen or in any other way endangered personal data has been made inaccessible to all unauthorized persons, it is not necessary to inform the authorities of the data protection issue, nor the affected persons. This means that the security requirements can be fulfilled more easily and the risk of financial loss and an image problem can be minimized.

Apacer
Access the best

Apacer's Security Solutions

Apacer's CoreSecurity is a proprietary data protection technology developed to elevate the data security level through customized firmware and prevent data leakage for higher reliability of storage devices.
CoreSecurity is a proprietary data protection technology built into Apacer SSD products. It is crucial for mission-critical applications, where data erase, drive sanitization, and reliability of data storage are essentially required. CoreSecurity provides the following three types of technologies designed with exclusive software commands to meet clients' requirements of a high level of data protection.

CoreDestroyer Technology

The CoreDestroyer Technology terminates all the data in the drive, even the firmware and the management table. The drive would be unable to perform its functions. To bring the SSD back to life, firmware reloading is necessary.

CoreEraser Technology

Apacer's Core Eraser Technology provides highly comprehensive drive sanitization measures, developed to securely and thoroughly erase data in operating blocks. The CoreEraser comes in three classes of block sanitizations and can be implemented through vendor software command or hardware architect.

Class 1: Quick Erase eliminates FAT (File Allocation Table) and the MBR (Master Boot Record) in LBA that manages partition tables and boot sector during system start-up process. With both of the MBR and FAT erased, the drive would appear as uninitialized on operating system.

Class 2: Full Erase Function has a more comprehensive Quick Erase, where all contents of the user blocks, free blocks, MBR and FAT table are erased after the procedure is completed. Drive will be reinitialized upon the completion of the erase action. The device will behave as a raw disk as cells in the drive would display "FF" (or "00").

Class 3: MIL Erase includes a list of globally certified drive purge methods that meet the military and industrial standards, such as NSA 9-12. The process would sanitize the MBR, FAT tables as well as user & free blocks by erasing the blocks, overwriting with random data, then verify. These certified erase features are widely approved in military applications, while providing confidence in secure data erase.

CoreProtector

The widespread adoption of SSDs over HDDs in mission critical applications may attract potential data theft. In order to reinforce data security, Apacer introduces the CoreProtector technology that integrates multiple layers of protection for your valuable data.

Class 1 Data Protect: Apacer SSDs come with a unique 512 byte Security Key when they leave the factory. The key is activated whenever the host boots up. The host BIOS can retrieve the 512 byte key data and the host user can use it as password identification for accessing certain application programs or booting up process. Failure to match the key will result in aborted operations.

Class 2 Write Protect: Apacer implements the Virtual Write scheme that allows write commands to go through the flash controller and data temporarily stored. The OS can then function normally but since the whole process is virtual, no data has actually been written into the flash. When the host system is reset or rebooted, all the temporarily stored data will be lost and nowhere to be found in the system. Since the Virtual Write scheme runs at device level, it requires no software of driver installation and is independent from the host OS.

Class 3 Device Protect: Developed as a more comprehensive security solution, Device protect can be considered as Write protect scheme integrated with read protection that prevents unauthorized accesses to read files in the device. When enabled, the Device Protect scheme would allow read commands to go through flash controller, but no actual data in the device can be read during the whole process. Without the proper way to disable the protection, unauthorized read attempts would receive only invalid data, indicated as "FFh" or "OOh".

Class 4 Boot Protect: Boot Protect Technology is the ultimate security class of Apacer CoreProtector series that restricts the unauthorized from accessing the computer system. Users can set access code during the system booting process so that no one else would be able to access their operating system and SSDs without the correct access code. Boot Protect technology is also ideally applicable for SSDs with multiple OS-run storage zones that are independent from one another. For instance, if a SSD is divided into two storage zones with OS installed in each, the host can decide which zone to access by entering the corresponding access code.

Data Storage

Swissbit's Security Solutions

swissbit®

Convenience for developers: The products offer tangible hardware security using a plug and play approach. The flash memory can be used by any host to store and retrieve data on the cards at high speed. At the same time, various security functions on the card can be activated to protect any data. IT legislation is very strict regarding requirements for maintaining current technological standards when it comes to the storage of personal or system-critical data. With the aid of secure Swissbit products, it is very easy to enhance security in existing products or provide even greater flexibility in new products.

Valuable data such as sensitive files, e-mails, photos, OS images, firmware updates, log files and audit trails can be protected by encryption, authentication and specific access protection, and subsequent manipulation can be prevented. Data streams for M2M communication (IoT), medicine and video surveillance can be protected against third-party access as confidential data on the storage medium with the aid of a secure, high speed memory card.

Swissbit's DP (data protection) security product series is based on a security extension for the Swissbit durabit™ firmware. The Swissbit Security Interface enables solution providers to build applications for various platforms. An SDK is available to develop applications on Windows and Linux PC platforms.

Smart card technology is one of the most reliable technologies for protecting data, e.g. through secure device login, data encryption, speech encryption, cloud authentication and many other techniques. The large number of application areas brings about benefits for solution providers such as achieving autonomy with respect to third parties, extremely high security levels and flexibility.

Typical Areas of Application

Industrial equipment is suffering new threats that require counter measures. Domains like copy protection, license management, counterfeit protection, system integrity and data protection now need responses, that can be easily solved by using Swissbit security products while data retention and endurance still meet the highest requirements of industrial customers.

Body-worn Cameras and Dashcams

Mobile police units and vehicles are increasingly being equipped with cameras. Strong encryption of the data and strong authentication protect the registered data against loss and unauthorized access.

More and more organizations that have to do with road traffic, such as security firms, public transport operators, taxi companies etc., register data that could contain personal information and therefore needs to be protected against falling into the wrong hands. This requires that the data can only be evaluated by the data protection officer, and that this is verifiable. Such data can be protected adequately and risks minimized by separating the registration and reproduction processes into different roles.

Application Areas	Type	SE Standard Edition	VE Voice Edition	FE FIPS Edition	PE Premium Edition	DP Data Protection
Mobile / PC	PS-100u micro SD	8 GB – 16 GB	8 GB – 16 GB	8 GB – 16 GB	–	8 GB – 32 GB
Medical Automotive	PS-45 SD	8 GB – 16 GB	8 GB – 16 GB	8 GB – 16 GB	8 GB – 16 GB	8 GB – 64 GB
	PS-45u micro SD	8 GB – 16 GB	8 GB – 16 GB	8 GB – 16 GB	8 GB – 16 GB	8 GB – 32 GB
Industrial	PS-450 SD	4 GB – 32 GB	4 GB – 32 GB	4 GB – 32 GB	4 GB – 32 GB	4 GB – 32 GB
	PS-450u microSD	0.5 GB – 2 GB	0.5 GB – 2 GB	0.5 GB – 2 GB	0.5 GB – 2 GB	0.5 GB – 2 GB

Reliable Boot-up

Secure booting up of devices is required under circumstances in which there is a need to ensure that the device in question always boots up in a particular way or as configured through a given policy. This is normally done by means of a CD ROM or comparable methods.

However, for embedded and IoT devices, this option is precluded simply on size grounds. As an alternative, SD and microSD memory cards with enhanced functionality can be used. It is also possible to provide these cards with unique identifiers and define privileges that determine whether and under which conditions the data can be read at all.

Of course, the card content can be managed by the card administrator. For critical infrastructures such as in power stations or energy distribution networks, legislators have laid down strict definitions for the run-time environment and its traceability. More stringent measures are required in all cases where human life could be directly or indirectly threatened. Here, too, hardware-based system protection is essential.

Protection of Personal / Patient Data

Patient data and other personal data must be given the highest level of protection. It must be clear at all times who is authorized to access which data in which role. This clearly includes the adoption of measures against uncontrolled data loss, but also intra-organizational and customer processes such as maintenance, servicing, usage and configuration.

Data protection legislation varies from country to country. However, the traceability of data processing and the implementation of current technological standards represent a common denominator.

These requirements can be fulfilled readily through the use of hardware-based security measures.

In Germany, the legal requirements are laid down in the Bundesdatenschutzgesetz (Federal Data Protection Act, BDSG).

Copy Protection and License Management

Developing high-quality, sophisticated software is expensive. According to the VDMA (German Mechanical Engineering Industry Association), the German economy suffers huge losses in turnover every year.

The protection of intellectual property includes the need to protect embedded and IoT devices. In particular, the trend towards unification of hardware platforms has the effect of making protection of software the only means of differentiation between competitors, so that it now has the highest priority. Protection against copying is considerably enhanced through making access to storage media content on strong authentication. Content is only readable within the context of a defined usage scenario, and attacks are much less likely to succeed.

The unique identification of each storage device can be enhanced to such an extent through certificates or encryption that even when software is misappropriated, it will not function without a secure memory card. The aim, therefore, is to provide for enough additional security through viable means without unreasonably increasing product and processing costs during the life-cycle stages.

Data Storage

Transcend's Hardware-based AES Solution

For applications that handle especially sensitive data or require special levels of confidentiality, Transcend offers hardware-based AES encryption on several SSD models for various 2.5", M.2, and mSATA models.

Transcend Information's SSDs equipped with hardware-based AES encryption offer considerably more professional data protection and performance compared to alternative programs that utilize software-based or firmware-based encryption.

With hardware-based encryption, all data is encrypted before being stored in NAND flash memory (See Figure 1). After the encrypted data has been written into the flash memory, it becomes virtually impossible to decrypt the data without the original encryption key. Performance is also improved compared to software-based solutions, since hardware-based encryption does not require system resources to perform the encryption/decryption process.

Transcend Information offers a variety of SSDs equipped with hardware-based AES encryption, thereby enabling reliable handling of sensitive data and enhanced data security.

From securing personal data, such as credit card information or medical records, to protecting sensitive corporate information, Transcend Information's SSDs with hardware-based encryption mechanisms provide an excellent solution that guarantees data protection.

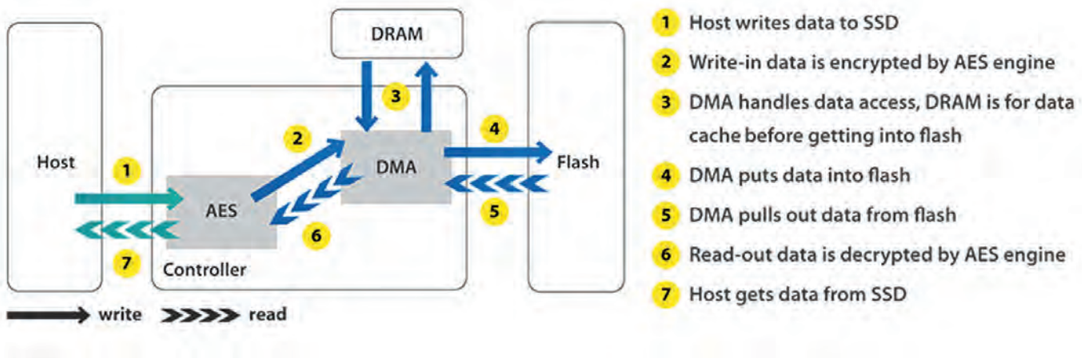


Figure 1

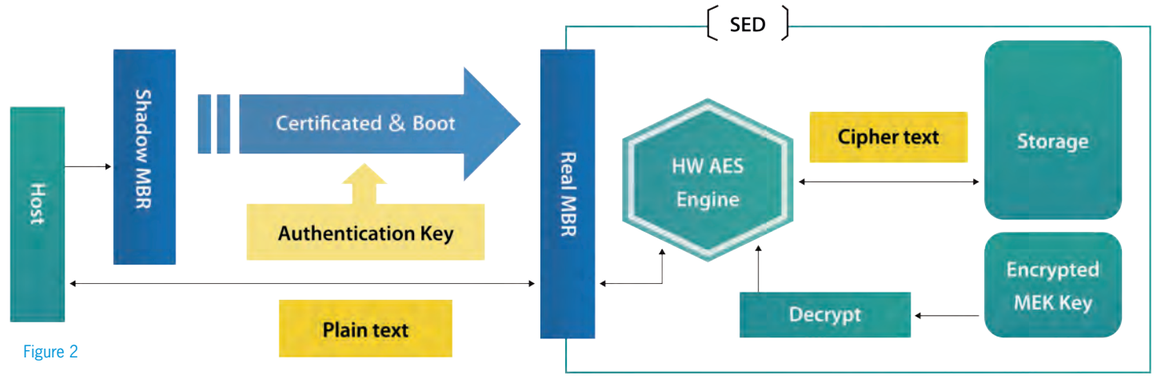


Figure 2

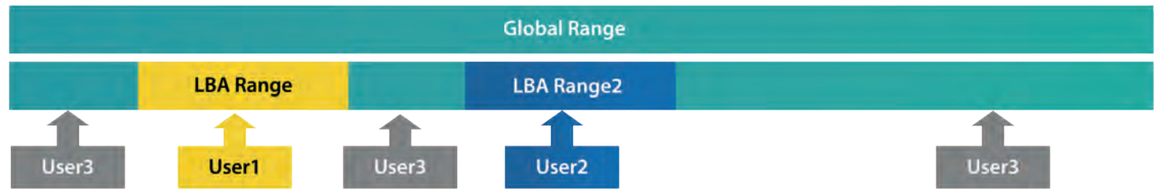


Figure 3

TCG OPAL Specifications

The Trusted Computing Group (TCG) is an organization whose members work together to formulate industry standards with the intention that these should enjoy cross-industry validity.
TCG's Storage Work Group created the Opal Security Subsystem Class (SSC) as a class of security management protocols for storage devices. It applies mainly to products used in PCs and notebooks. The class defines specifications concerning file management on storage devices, and defines multi-stage access levels for data management and protection. Devices conforming to Opal SSC specifications may be referred to as TCG Opal devices, a mark of trustworthiness.

TCG Opal Features

Opal is a comprehensive set of guidelines. The target audience includes manufacturers of storage devices, software vendors, system integrators, and academia. These specifications cover the manufacture of storage devices, system setup, management, administration, and use. They require password protection and hierarchical storage management in order to guarantee data security and protection.

Advantages of Opal

1. In a hierarchically managed system, access privileges can be assigned to certain persons by means of passwords. This minimizes the chance of data being stolen, tampered with, or lost.

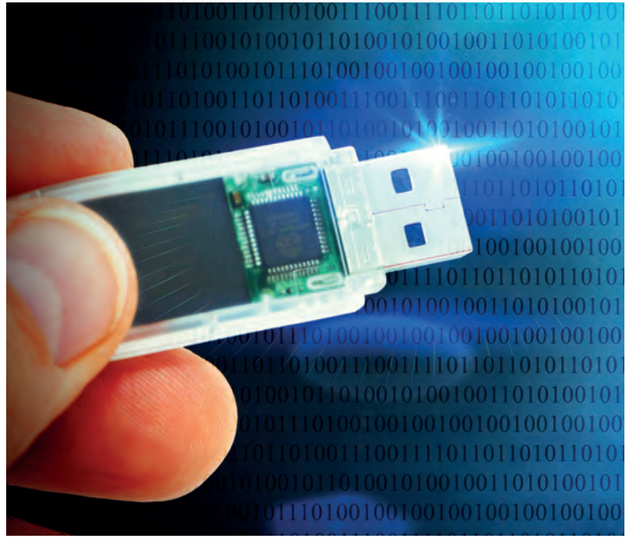
2. All security functions take place within the device itself. They do not need to pass through the host operating system. They do not exploit system resources, making for faster and more secure execution. In addition, compatibility problems can no longer arise.

Storage devices comply with Opal SSC specifications when they display the following characteristics:

1. Self-encryption: Data encryption is performed directly on the device (hardware encryption) and not via the host (software encryption) outside the device. The encryption key is also stored directly on the device, commonly in the form of an AES key.
2. Supports boot authentication: When the user starts the device, a superordinate MBR (Master Boot Record) carries out pre-boot authentication; if the user is cleared, the normal boot process begins and connections to devices are made. See Figure 2.
3. Sector-specific access privileges: The device manager may create separately addressable sector ranges using logical block addressing (LBA) and assign different privileges for each range. Only users with the correct key for a particular LBA range may perform certain actions. Where locations on the medium are password-protected, only users with the correct key will be granted authorized access. See Figure 3.

With increasing volumes of data, information security is becoming one of the most important issues for both business and private users. The TCG designed Opal to address both software and hardware aspects of security, and take account of the need for hierarchical management approaches. From the manufacturer to the user, Opal is a standard that serves the needs of everyone.

Transcend's AES SSDs are compliant with the TCG Opal 2.0 standards, and can be customized to meet specific customer needs as required.



Data Storage

Transcend's Hardware-based AES Solution

Hardware Purge

In addition to data encryption, Transcend Information offers a variety of SATA III SSD models that can be equipped with a hardware purge function, ensuring quick and irrevocable erasure of data.

Hardware purge refers to the effective, hardware-based erasure of all data blocks in flash memory, which returns the SSD to its original state at the time of manufacture.

Whereas software-based methods utilize the ATA 'erase' command to delete data, a hardware purge constitutes a different kind of access via an external switch that is connected with the controller's General Purpose Input/Output (GPIO) interfaces. Here, the voltage levels of all the installed flash memory units are switched from High to Low at the same time.

The erase function is activated and all data present on the SSD is simultaneously deleted through short-circuiting the hardware purge pins (see Figure 1). Erased data is absolutely non-recoverable, meaning that this procedure reliably and irrevocably destroys confidential information.

The hardware purge pin is connected to the designated pin of the controller's GPIO (see Figure 2). Customized firmware settings are required to support the hardware purge pin.

With Transcend's hardware purge feature, sensitive data can be securely, permanently and effectively deleted.

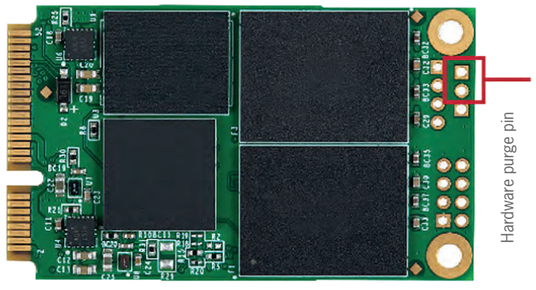


Figure 1

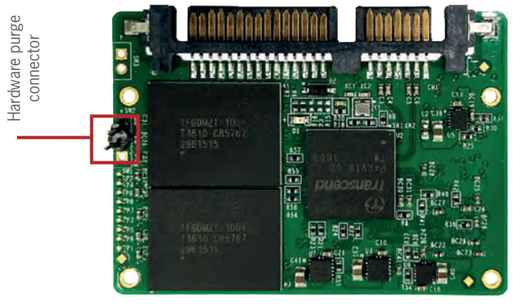


Figure 2

Seagate's Security Solution

Locking Down Firmware

Firmware is a very attractive target for cybercriminals, because it cannot be scanned by anti-virus programs.

Therefore the 'Secure Download and Diagnostics' feature is now standard on every Seagate hard disk. It prevents unauthorized access to the firmware of a drive, as well as preventing manipulation of executable firmware code and sensitive system-level data.

Therefore customers can be sure that the devices are free of malware, and provide evidence of this to authorities.

Simple Data Deletion Prior to Disposal

Companies and institutions are responsible for the entire life cycle of the personal data in their possession, from its initial acquisition until its deletion. So what actually happens when a storage medium reaches the end of its service life?

Overwriting data on such a medium is expensive and can block valuable resources for days at a time. Demagnetization of media is complicated and risky. Physically shredding media is expensive, environmentally questionable and also involves a lot of effort. Long-term storage of media at another location is expensive and also risky.

The intelligent solution is called Seagate Instant Secure Erase. It is part of the SeaTools suite and is an aid to IT specialists involved in data deletion and media sanitization. It provides for secure, fast and problem-free disposal of storage media.

Encryption

Encryption keeps data protected even in cases where a hard disk is lost, gets stolen or misplaced. Also, your customers can minimize the risks for the affected persons, and this plays a major role when it comes to weighing up whether the authorities have to be informed or not. Seagate's self-encrypting storage media can delete the key required for decryption, so that all the data on a disk are rendered illegible in less than one second. Subsequently, the disk can be returned, reused or disposed of without any risk. Also, self-encrypting hard disks lock down automatically as soon as they are removed from a system, or when the disk or the system is switched off. This represents an additional degree of protection for the stored data.

Data Processing

Central Processing Unit Security

Intel Authorised Distributor

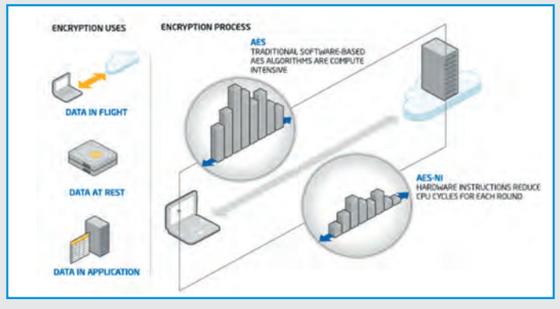
These days it is not a matter of "if" but when private data begins to roam outside of your secure perimeter. In 2016 there were over 1.3 billion registered data breaches and with the new European data protection regulation to be introduced in 2018, it becomes even more essential to protect users identity, to prevent and detect malware, to protect your data and have resiliency and recovery features. Intel has numerous hardware- and software-based solutions that address security issues and help reduce data compromise and data loss, providing protection at the point of creation and throughout the data lifecycle.

Intel® AES New Instructions (Intel® AES NI)

- Encryption instruction set for improvement and acceleration of AES data encryption in hardware with Intel® Xeon® an Core™ processor families
- Implemented intensive sub-steps of AES algorithm in hardware
- Strengthens and accelerates execution of AES applications
- Accelerate encryption and decryption
- Improve key generation and matrix manipulation
- Minimizes application performance concerns inherent in traditional cryptographic processing
- Provides enhanced security by addressing side channel attacks on AES associated with traditional software methods of table look-ups

Best Way to Secure Business-critical Data Within the Following Fields:

- Network traffic
- Personal data
- Corporate IT infrastucture



Intel® Secure Key

- Intel® 64 Architecture instruction RDRAND and its underlying Digital Random Number Generator (DRNG) hardware implementation
- RDSEED instruction is part of the Intel® Secure Key
- Digital Random Number Generator is a key enabler for Information Security Applications
- Cryptographic protocols rely on RNGs for generating keys and fresh session values to prevent replay attacks
- Can be used to fix this weakness, thus significantly increasing cryptographic robustness
- RDRAND has been engineered to meet existing security standards and can be used in general for information security standards

Other Uses of Digital Random Number Generation Include

- Communication
- Gaming
- Secure disk wiping or document shredding
- Protecting online services against RNG attacks

Intel® Execute Disable Bit

- Security feature that can help to reduce system exposure to viruses
- Allows the processor to classify areas in memory where application code can or cannot execute
- When code wants to insert in the buffer, the processor disables code execution, preventing damage and worm propagation
- Usage needs a PC or server with a processor with Execute Disable Bit capability and a supporting operating system

Intel® Trusted Execution Technology (Intel® TXT)

- Hardware-based Technology for enhancing Server Platform Security
- High virtualized increased data center or high workloads will be shared across physical infrastructure
- More trusted infrastructure is the key to maintain the assurance and controlling
- Visibility of the security and workloads within the data center
- New control capabilities

Intel® Memory Protection Extensions (Intel® MPX)

- Set of extensions to the x86 instruction set architecture
- With compiler, runtime library and operating system support
- Brings increased security to software by checking pointer references whose normal compile-time intentions are maliciously exploited at runtime due to buffer overflows
- Two-level address translation is used for storing bounds in memory
- Top layer consists of a Bounds Directory (BD) created on the application startup
- Each BD entry is either empty or contains a pointer to a dynamically created Bounds Table (BT), which in turn contains a set of pointer bounds along with the linear addresses of the pointers
- Bounds load (BNDLDX) and store (BNDSTX) instructions transparently perform the address translation and access bounds in the proper BT entry

Architecture Includes Two Configuration Registers

- BNDCFGx
  - BNDCFGU in user space
  - BNDCFGS in Kernel
- BNDSTATUS status register
  - Provides a memory address
  - Provides an error code

Data Processing

Central Processing Unit Security

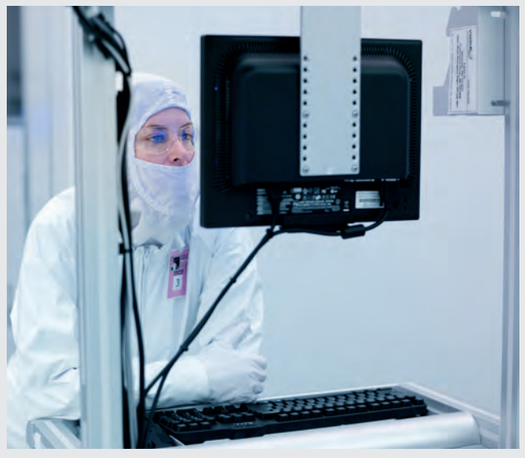
intel® Authorised Distributor

Intel® Software Guard Extensions (Intel® SGX)

- Intel technology for application developers who are seeking to protect selected code and data from disclosure or modification
- Protection possible through the use of enclaves, which are protected areas of execution in memory
- Application code can be put into an enclave by special instructions
- Software is available to developers via the Intel® SGX Software Development Kit (SDK)
- Collection of APIs, libraries, documentation, sample source code, and tools that allows software developers to create and debug Intel SGX enabled applications in C and C++

Application Code Executing Within an Intel SGX Enclave

- Introduced with 7th generation of Intel Core and Xeon E3 v5 processors for data center servers
- Usage of the full processor power possible
- Possibility of cold boot
- Uses hardware-based mechanisms to respond to remote attestation challenges that validate its integrity
- Synchronization with parent application
- Can be used with standard development tools
- Supports initial data center use



Intel® Transactional Syncronization Extensions – New Instructions (TSX-NI)

- Programmer-specified code regions are executed transactional
- Memory operations will appear and be occurred when viewed from other logical processors, after successful execution
- A processor makes architectural updates performed within the region visible to other logical processors only on a successful commit, a process referred to as an atomic commit
- Serialization through lock-protected critical section if required
- Synchronization of hidden applications with exposing

Intel® ECC Memory Support

- Detect and correct the internal data corruption
- ECC memory maintains a memory system immune to single-bit errors
- Data that is read from each word is always the same as the data that had been written to it, even if one or more bits actually stored have been flipped to the wrong state
- Most non-ECC memory cannot detect errors although some non-ECC memory with parity support allows detection but not correction
- Supported by integrated memory controller at Intel® Xeon® processors and some application specific Intel® Atom processors

Intel® vPro™ Technology

- Allows PCs to be fixed and maintained remotely
- Service providers can use vPro to solve problems after entering a key sequence
- Ability to access a computer even if it has been turned off within a wired or secure wireless network
- Laptops outside the internal network can be accessed with the newest versions of software
- Possibility for remotely operating system security patches and BIOS updates

Intel® Boot Guard

- Provides reliable information about the state of the system
- Hardware implemented
- Processor is called Trusted Platform Module (TPM)
- First verification of signatures happens by code on the CPU
- Possibility to emulate a “properly” booted system
- A key which is written in the CPU makes it possible to lock down the boot block
- In "Measured Boot" mode, Boot Guard creates a hash over the bootblock and sends it off to the TPM
- Value is stored in TPM registers, which aren't writable by code running on CPU
- Supposed to prevent replay attacks with possibility to fake a certain Boot Guard state if an attacker manages to disable Boot Guard altogether

Intel® Identity-Protection-Technology

- Will be managed with hardware based certificates and PIN for a safe Protected-Transaction-Display (PTD)
- With multifactor-authentification (MFA)
- Framework for the basis of identification and access management, which could be integrated in the IT-infrastructure
- Flexibility in access management for different users and applications
- MFA Engine based on the firmware guarantees the given access
- The authentication occurs between user, system and network
- „Walk-Away Lock“: Bluetooth device connected to the PC for ability to block and unblock the system
- „Domain/OS-Login“: required key for the system login saved in the hardware, which secures the user, system and network for malware attacks
- „VPN-Login“: similar to “Domain/OS-Login” secures the hardware based VPN-authentication and system from malware due to file all relevant keys in the hardware

Data Processing

Central Processing Unit Security

Authorised Distributor

Intel® Atom® Embedded

Type	Intel Atom® x5-E8000 Processor	Intel Atom® x5-E3930 Processor	Intel Atom® x5-E3940 Processor	Intel Atom® x7-E3950 Processor
Code Name	Braswell	Apollo Lake	Apollo Lake	Apollo Lake
Essentials				
Vertical Segment	Embedded	Embedded	Embedded	Embedded
Processor Number	E8000	E3930	E3940	E3950
Lithography	14 nm	14 nm	14 nm	14 nm
Performance				
# of Cores	4	2	4	4
# of Threads	4	2	4	4
Base Frequency	1.04 GHz	1.30 GHz	1.60 GHz	1.60 GHz
TDP	5 W	6.5 W	9.5 W	12 W
Memory Specifications				
Memory Types	DDR3L	DDR3L; LPDDR4	DDR3L; LPDDR4	DDR3L; LPDDR4
ECC Memory Supported	No	Yes	Yes	Yes
Graphics Specifications				
Processor Graphics	Intel® HD Graphics	Intel® HD Graphics 500	Intel® HD Graphics 500	Intel® HD Graphics 505
Package Specifications				
Sockets Supported	FCBGA1170			
Package Size	25 mm x 27 mm	24 mm x 31 mm	24 mm x 31 mm	24 mm x 31 mm
Operating Temperature Range		-40°C to 85°C	-40°C to 85°C	-40°C to 85°C
Advanced Technologies				
Intel® Virtualization Technology (VT-x)	Yes	Yes	Yes	Yes
Intel® Virtualization Technology (VT-d)	No	Yes	Yes	Yes
Intel® VT-x with EPT	Yes	Yes	Yes	Yes
Intel® 64	Yes	Yes	Yes	Yes
Instruction Set	64 bit	64 bit	64 bit	64 bit
Security & Reliability				
Intel® AES New Instructions	Yes	Yes	Yes	Yes
Secure Key	Yes	Yes	Yes	Yes
Secure Boot	No	Yes	Yes	Yes
Execute Disable Bit	Yes	Yes	Yes	Yes
Intel® Identity Protection Technology	Yes	Yes	Yes	Yes

Intel® Pentium® Embedded

Type	Intel® Pentium® Processor N3710	Intel® Pentium® Processor N4200
Code Name	Braswell	Apollo Lake
Essentials		
Vertical Segment	Embedded	Embedded
Processor Number	N3710	N4200
Lithography	14 nm	14 nm
Performance		
# of Cores	4	4
# of Threads	4	4
Processor Base Frequency	1.60 GHz	1.10 GHz
TDP	6 W	6 W
Memory Specifications		
Memory Types	DDR3	DDR3L, LPDDR4
ECC Memory Supported ‡	No	No
Graphics Specifications		
Processor Graphics	Intel® HD Graphics 405	Intel® HD Graphics 505
Package Specifications		
Sockets Supported	FCBGA1170	FCBGA1296
Package Size	25 mm x 27 mm	24 mm x 31 mm
Advanced Technologies		
Intel® Virtualization Technology (VT-x)	Yes	Yes
Intel® Virtualization Technology (VT-d)	No	Yes
Intel® VT-x with EPT	Yes	Yes
Intel® 64	Yes	Yes
Instruction Set	64 bit	64 bit
Intel® Identity Protection Technology	Yes	Yes
Security & Reliability		
Intel® AES New Instructions	Yes	Yes
Secure Boot	Yes	Yes
Secure Key	Yes	Yes
Execute Disable Bit	Yes	Yes

Intel® Celeron® Embedded

Type	Intel® Celeron® Processor 3965U	Intel® Celeron® Processor N3350	Intel® Celeron® Processor N3160	Intel® Celeron® Processor N3060	Intel® Celeron® Processor N3010	Intel® Celeron® Processor G3900E	Intel® Celeron® Processor G3902E	Intel® Celeron® Processor G3930E	Intel® Celeron® Processor G3930TE
Code Name	Kaby Lake	Apollo Lake	Braswell	Braswell	Braswell	Skylake	Skylake	Kaby Lake	Kaby Lake
Essentials									
Vertical Segment	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded
Processor Number	3965U	N3350	N3160	N3060	N3010	G3900E	G3902E	G3930E	G3930TE
Lithography	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm		
Performance									
# of Cores	2	2	4	2	2	2	2	2	2
# of Threads	2	2	4	2	2	2	2	2	2
Processor Base Frequency	2.20 GHz	1.10 GHz	1.60 GHz	1.60 GHz	1.04 GHz	2.40 GHz	1.60 GHz	2.90 GHz	2.70 GHz
TDP	15 W	6 W	6 W	6 W	4 W	35 W	25 W	54 W	35 W
Memory Specifications									
Memory Types	DDR4, LPDDR3, DDR3L	DDR3L, LPDDR3, LPDDR4	DDR3L	DDR3L	DDR3L	DDR4, DDR3L	DDR4, DDR3L	DDR4, DDR3L	DDR4, DDR3L
ECC Memory Supported	No	No	No	No	No	Yes	Yes	Yes	Yes
Graphics Specifications									
Processor Graphics	Intel® HD Graphics 610	Intel® HD Graphics 500	Intel® HD Graphics 400	Intel® HD Graphics 400	Intel® HD Graphics 400	Intel® HD Graphics 510	Intel® HD Graphics 510	Intel® HD Graphics 610	Intel® HD Graphics 610
Package Specifications									
Sockets Supported	FCBGA1356	FCBGA1296	FCBGA1170	FCBGA1170	FCBGA1170	FCBGA1440	FCBGA1440	FCLGA1151	FCLGA1151
Package Size	42 mm X 24 mm	24 mm x 31 mm	25 mm x 27 mm	25 mm x 27 mm	25 mm x 27 mm	42 mm x 28 mm	42 mm x 28 mm	37.5 mm x 37.5 mm	37.5 mm x 37.5 mm
Advanced Technologies									
Intel® Virtualization Technology (VT-x)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Virtualization Technology (VT-d)	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Intel® VT-x with EPT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® 64	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instruction Set	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit
Security & Reliability									
Intel® AES New Instructions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Secure Key	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Secure Boot	No	Yes	Yes	Yes	Yes	No	No	No	No
Intel® Software Guard Extensions (Intel® SGX)	Yes	No	No	No	No	Yes	Yes	Yes	Yes
Intel® Memory Protection Extensions (Intel® MPX)	Yes	No	No	No	No	No	No	Yes	Yes
Intel® Trusted Execution Technology	No	No	No	No	No	No	No	No	No
Execute Disable Bit	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OS Guard	Yes	No	No	No	No	No	No	Yes	Yes
Intel® Identity Protection Technology	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Intel® Device Protection Technology with Boot Guard	No	No	No	No	No	Yes	Yes	Yes	Yes

Data Processing

Central Processing Unit Security

Authorised Distributor

Intel® Core™ Embedded

Type	Intel® Core™ i3-7100U Processor	Intel® Core™ i3-7100E Processor	Intel® Core™ i3-7101TE Processor	Intel® Core™ i3-7101E Processor	Intel® Core™ i3-7102E Processor	Intel® Core™ i5-7300U Processor	Intel® Core™ i5-7440EQ Processor	Intel® Core™ i5-7442EQ Processor	Intel® Core™ i5-7500T Processor	Intel® Core™ i5-7500 Processor	Intel® Core™ i7-7600U Processor	Intel® Core™ i7-7700T Processor	Intel® Core™ i7-7700 Processor	Intel® Core™ i7-7820EQ Processor
Code Name	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake
Essentials														
Vertical Segment	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded
Processor Number	i3-7100U	i3-7100E	i3-7101TE	i3-7101E	i3-7102E	i5-7300U	i5-7440EQ	i5-7442EQ	i5-7500T	i5-7500	i7-7600U	i7-7700T	i7-7700	i7-7820EQ
Lithography	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm
Performance														
# of Cores	2	2	2	2	2	2	4	4	4	4	2	4	4	4
# of Threads	4	4	4	4	4	4	4	4	4	4	4	8	8	8
Processor Base Frequency	2.40 GHz	2.90 GHz	3.40 GHz	3.90 GHz	2.10 GHz	2.60 GHz	2.90 GHz	2.10 GHz	2.70 GHz	3.40 GHz	2.80 GHz	2.90 GHz	3.60 GHz	3.00 GHz
TDP	15 W	35 W	35 W	54 W	25 W	15 W	45 W	25 W	35 W	65 W	15 W	35 W	65 W	45 W
Memory Specifications														
Memory Types	DDR4, LPDDR3, DDR3L	DDR4	DDR3L, DDR4	DDR3L, DDR4	DDR4	DDR4, LPDDR3, DDR3L	DDR4	DDR4	DDR4, DDR3L	DDR4, DDR3L	DDR4, LPDDR3	DDR4, DDR3L	DDR4, DDR3L	DDR4
ECC Memory Supported	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
Graphics Specifications														
Processor Graphics	Intel® HD Graphics 620	Intel® HD Graphics 630	Intel® HD Graphics 630	Intel® HD Graphics 630	Intel® HD Graphics 630	Intel® HD Graphics 620	Intel® HD Graphics 630	Intel® HD Graphics 630	Intel® HD Graphics 630	Intel® HD Graphics 630	Intel® HD Graphics 620	Intel® HD Graphics 630	Intel® HD Graphics 630	Intel® HD Graphics 630
Package Specifications														
Sockets Supported	FCBGA1356	FCBGA1440	FCLGA1151	FCLGA1151	FCBGA1440	FCBGA1356	FCBGA1440	FCBGA1440	FCLGA1151	FCLGA1151	FCBGA1356	FCLGA1151	FCLGA1151	FCBGA1440
Package Size	42 mm X 24 mm	42 mm x 28 mm	37.5 mm x 37.5 mm	37.5 mm x 37.5 mm	42 mm x 28 mm	42 mm X 24 mm	42 mm x 28 mm	42 mm x 28 mm	37.5 mm x 37.5 mm	37.5 mm x 37.5 mm	42 mm X 24 mm	37.5 mm x 37.5 mm	37.5 mm x 37.5 mm	42 mm x 28 mm
Advanced Technologies														
Intel® vPro™ Technology	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Virtualization Technology (VT-x)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Virtualization Technology (VT-d)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® VT-x with EPT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® TSX-NI	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® 64	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instruction Set	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit
Security & Reliability														
Intel® AES New Instructions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Secure Key	Yes	No	No	No	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No
Secure Boot	No	Yes	No	No	Yes	No	Yes	Yes	No	No	No	No	No	Yes
Intel® Software Guard Extensions (Intel® SGX)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Memory Protection Extensions (Intel® MPX)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Trusted Execution Technology	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Execute Disable Bit	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OS Guard	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Stable Image Platform Program (SIPP)	No	No	No	No	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No
Intel® Identity Protection Technology	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Device Protection Technology with Boot Guard	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes

Data Processing

Central Processing Unit Security

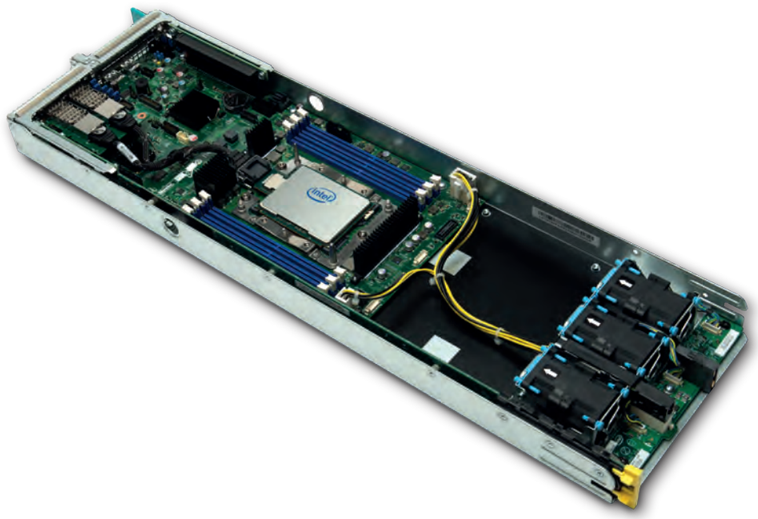
Intel Authorised Distributor

Intel® Xeon® E3 Embedded

Type	Intel® Xeon® Processor E3-1505M v6	Intel® Xeon® Processor E3-1505L v6	Intel® Xeon® Processor E3-1501L v6	Intel® Xeon® Processor E3-1501M v6	Intel® Xeon® Processor E3-1275 v6
Code Name	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake	Kaby Lake
Essentials					
Vertical Segment	Embedded	Embedded	Embedded	Embedded	Embedded
Processor Number	E3-1505MV6	E3-1505LV6	E3-1501LV6	E3-1501MV6	E3-1275V6
Lithography	14 nm	14 nm	14 nm	14 nm	14 nm
Performance					
# of Cores	4	4	4	4	4
# of Threads	8	8	4	4	8
Processor Base Frequency	3.00 GHz	2.20 GHz	2.10 GHz	2.90 GHz	3.80 GHz
TDP	45 W	25 W	25 W	45 W	73 W
Memory Specifications					
Memory Types	DDR4, LPDDR3, DDR3L	DDR4	DDR4	DDR4	DDR4, DDR3L
ECC Memory Supported	Yes	Yes	Yes	Yes	Yes
Graphics Specifications					
Processor Graphics	Intel® HD Graphics P630	Intel® HD Graphics P630	Intel® HD Graphics P630	Intel® HD Graphics P630	Intel® HD Graphics P630
Package Specifications					
Sockets Supported	FCBGA1440	FCBGA1440			FCLGA1151
Package Size	42 mm x 28 mm	42 mm x 28 mm	42 mm x 28 mm	42 mm x 28 mm	37.5 mm x 37.5 mm
Advanced Technologies					
Intel® vPro™ Technology	Yes	Yes	Yes	Yes	Yes
Intel® Hyper-Threading Technology	Yes	Yes	No	No	Yes
Intel® Virtualization Technology (VT-x)	Yes	Yes	Yes	Yes	Yes
Intel® Virtualization Technology (VT-d)	Yes	Yes	Yes	Yes	Yes
Intel® VT-x with EPT	Yes	Yes	Yes	Yes	Yes
Intel® TSX-NI	Yes	Yes	Yes	Yes	Yes
Intel® 64	Yes	Yes	Yes	Yes	Yes
Instruction Set	64 bit	64 bit	64 bit	64 bit	64 bit
Security & Reliability					
Intel® AES New Instructions	Yes	Yes	Yes	Yes	Yes
Secure Key	Yes	Yes	Yes	Yes	Yes
Intel® Software Guard Extensions (Intel® SGX)	Yes	Yes	Yes	Yes	Yes
Intel® Memory Protection Extensions (Intel® MPX)	Yes	Yes	Yes	Yes	Yes
Intel® Trusted Execution Technology	Yes	Yes	Yes	Yes	Yes
Execute Disable Bit	Yes	Yes	Yes	Yes	Yes
OS Guard	Yes	Yes	Yes	Yes	Yes
Intel® Identity Protection Technology	Yes	Yes	No	Yes	No
Intel® Stable Image Platform Program (SIPP)	Yes	No	No	No	No
Intel® Device Protection Technology with Boot Guard	No	No	No	No	Yes

Intel® Xeon® D Embedded

Type	Intel® Xeon® Processor D-1529	Intel® Xeon® Processor D-1539	Intel® Xeon® Processor D-1557	Intel® Xeon® Processor D-1559	Intel® Xeon® Processor D-1567	Intel® Xeon® Processor D-1577
Code Name	Broadwell	Broadwell	Broadwell	Broadwell	Broadwell	Broadwell
Essentials						
Vertical Segment	Embedded	Embedded	Embedded	Embedded	Embedded	Embedded
Processor Number	D-1529	D-1539	D-1557	D-1559	D-1567	D-1577
Lithography	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm
Performance						
# of Cores	4	8	12	12	12	16
# of Threads	8	16	24	24	24	32
Processor Base Frequency	1.30 GHz	1.60 GHz	1.50 GHz	1.50 GHz	2.10 GHz	1.30 GHz
TDP	20 W	35 W	45 W	45 W	65 W	45 W
Memory Specifications						
Memory Types	DDR4, DDR3	DDR4, DDR3	DDR4, DDR3	DDR4, DDR3	DDR4, DDR3	DDR4, DDR3
ECC Memory Supported	Yes	Yes	Yes	Yes	Yes	Yes
Graphics Specifications						
Processor Graphics	None	None	None	None	None	None
Package Specifications						
Sockets Supported	FCBGA1667	FCBGA1667	FCBGA1667	FCBGA1667	FCBGA1667	FCBGA1667
Package Size	37.5 mm x 37.5 mm	37.5 mm x 37.5 mm	37.5 mm x 37.5 mm	37.5 mm x 37.5 mm	37.5 mm x 37.5 mm	37.5 mm x 37.5 mm
Advanced Technologies						
Intel® Virtualization Technology (VT-x)	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Virtualization Technology (VT-d)	Yes	Yes	Yes	Yes	Yes	Yes
Intel® VT-x with EPT	Yes	Yes	Yes	Yes	Yes	Yes
Intel® TSX-NI	Yes	Yes	Yes	Yes	Yes	Yes
Intel® 64	Yes	Yes	Yes	Yes	Yes	Yes
Instruction Set	64 bit	64 bit	64 bit	64 bit	64 bit	64 bit
Security & Reliability						
Intel® AES New Instructions	Yes	Yes	Yes	Yes	Yes	Yes
Secure Key	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Trusted Execution Technology	Yes	Yes	Yes	Yes	Yes	Yes
Execute Disable Bit	Yes	Yes	Yes	Yes	Yes	Yes
OS Guard	Yes	Yes	Yes	Yes	Yes	Yes



Intel® Xeon® Scalable Processors

Type	Intel® Xeon® Platinum 8160T Processor	Intel® Xeon® Gold 6138T Processor	Intel® Xeon® Gold 6138 Processor	Intel® Xeon® Gold 6130T Processor	Intel® Xeon® Gold 6130 Processor	Intel® Xeon® Gold 6126T Processor	Intel® Xeon® Gold 6126 Processor	Intel® Xeon® Gold 5120T Processor	Intel® Xeon® Gold 5119T Processor	Intel® Xeon® Gold 5118 Processor	Intel® Xeon® Silver 4116T Processor	Intel® Xeon® Silver 4116 Processor	Intel® Xeon® Silver 4114T Processor	Intel® Xeon® Silver 4110 Processor	Intel® Xeon® Silver 4109T Processor	Intel® Xeon® Bronze 3106 Processor
Code Name	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake	Skylake
Essentials																
Vertical Segment	Server	Server	Server	Server	Server	Server	Server	Server	Server	Server	Server	Server	Server	Server	Server	Server
Processor Number	8160T	6138T	6138	6130T	6130	6126T	6126	5120T	5119T	5118	4116T	4116	4114T	4110	4109T	3106
Lithography	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm	14 nm
Performance																
# of Cores	24	20	20	16	16	12	12	14	14	12	12	12	10	8	8	8
# of Threads	48	40	40	32	32	24	24	28	28	24	24	24	20	16	16	8
Processor Base Frequency	2.10 GHz	2.00 GHz	2.00 GHz	2.10 GHz	2.10 GHz	2.60 GHz	2.60 GHz	2.20 GHz	1.90 GHz	2.30 GHz	2.10 GHz	2.10 GHz	2.20 GHz	2.10 GHz	2.00 GHz	1.70 GHz
TDP	150 W	125 W	125 W	125 W	125 W	125 W	125 W	105 W	85 W	105 W	85 W	85 W	85 W	85 W	70 W	85 W
Memory Specifications																
Memory Types	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4	DDR4
ECC Memory Supported	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Package Specifications																
Sockets Supported	FCLGA3647	FCLGA3647	FCLGA3647	FCLGA3647	FCLGA3647	FCLGA3647	FCLGA3647	FCLGA3647		FCLGA3647		FCLGA3647		FCLGA3647	FCLGA3647	FCLGA3647
Package Size	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm	76.0 mm x 56.5 mm
Advanced Technologies																
Intel® vPro™ Technology	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Virtualization Technology (VT-x)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® TSX-NI	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® 64	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Security & Reliability																
Intel® AES New Instructions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Trusted Execution Technology	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intel® Run Sure Technology	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes						
Mode-based Execute Control (MBE)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Execute Disable Bit									Yes		Yes		Yes			

Data Processing

Security on ARM Based Embedded Boards

Secure Boot as a Service

Secure Boot

F&S makes it easy to get a higher security level for your application. The key is Secure Boot. Secure Boot ensures that only genuine or authentic software is allowed to run on your board. Furthermore, it supports encrypted boot including image cloning protection and, depending on the use case, image confidentiality. In short, using Secure Boot on your platform prevents hackers from altering the boot process.

F&S provides two different offers for the Secure Boot:

- **Secure Boot as a Service**
  Signing and Encrypting of the images will be managed by F&S
- **Secure Boot as a Package**
  Signing and Encrypting of the images will be managed by customer

Secure Boot is the concept of protecting the system from manipulation and the software from decrypting. Both procedures can be used for the boot loader as well as for the device tree and kernel.

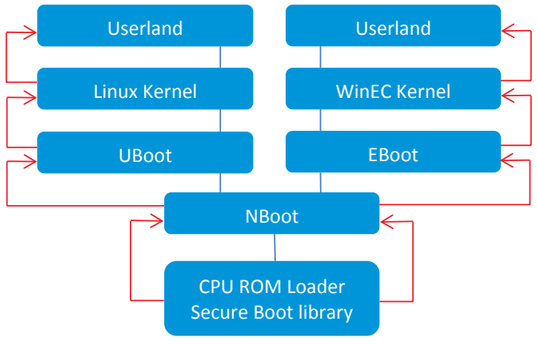
The software developed by F&S makes the software of NXP simplify the process of signing and encryption.

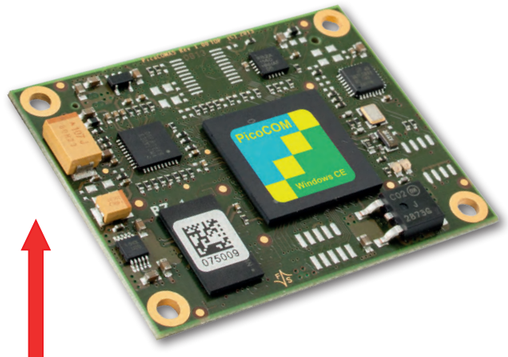
Protection of Intellectual Property

- Boot code cannot be read out

Protection against Manipulation

- Only certified software is accepted



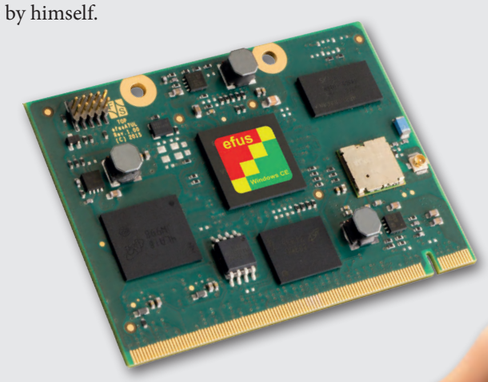


No Break of Security

Windows Embedded Partner

Secure Boot as a Service

This additional functionality is available with Linux only. F&S needs nboot, uboot, device tree and kernel image from the customer and of course the order for the one-off costs. Customers get 2 pieces of samples for test and confirmation. If the confirmation sheet (signed from the customer) is available, customer can order boards for mass production.
Boards with Secure Boot enabled from F&S, only run with certified images. Any other images which are not signed or corrupted can't be downloaded or saved on the board. If the customer wants to update the software, he must send the Software back to F&S. F&S will create a certified image and send it back to the customer. Then the customer can update the software by himself.

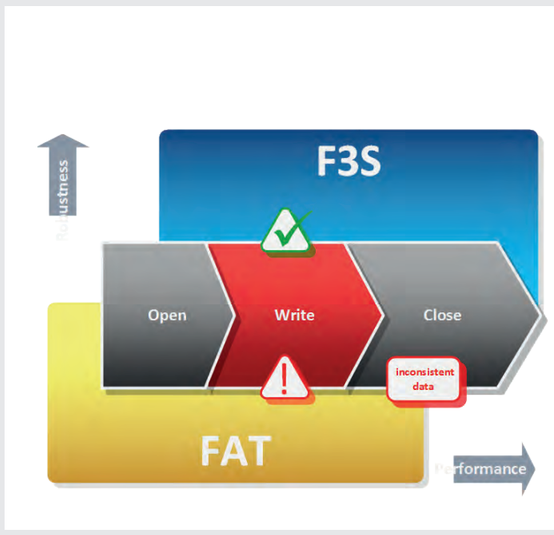


F3S – Failsafe Flash Filesystem

The Failsafe Flash Filesystem is a filesystem that is especially designed to be robust against (abrupt) electrical power outages. Data modifications of a file will be written in several, definable transactions, where each change only will be committed completely. Unfinished operations will be revoked. It's designed for NAND-Flash-Memories particularly. In contrary to other file systems it is able to guarantee a reliability in transaction on file-level. The user has the option to define the point of validation of modified data, in easiest case by closing the file-handle. In this way important data can be stored permanently and safely.

Features

- Modifying file contents can be accepted only in completed operations (state-transition)
- During modification transitions can also be accomplished by using explicit calls within the application (FlushFileBuffers)



Data Processing

Security Features on Standard x86 Based Boards

WATCH DOG

PC systems can use the "WATCHDOG" function. The term "WATCHDOG" is usually used for a component of a system that monitors the function of other components. If a possible fault is detected, it is either signaled according to the system agreement or a corresponding step instruction is initiated which corrects the current problem. The signal or jumper commands directly serve as a trigger for other co-operating system components to solve the problem. The integrated controllers are completely independent of CPU and software. For this reason, the WATCHDOG can act as a reliable monitor to monitor the regular WATCHDOG RESET event that must be performed by operating system tasks or by the SystemGuard utility. If the retrigger events do not arrive in time, a malfunction of hardware or software must be accepted, then the system is restarted.

There are several WATCHDOG functions possible:

- **Hardware-WATCHDOG**
  The Hardware-WATCHDOG is integrated into the Microcontroller or placed on the PCB as an independent unit.

- **Time-Out WATCHDOG**
  The controller must report to WATCHDOG before a specified time has elapsed. If the time has elapsed, a reset of the controller is triggered. If the WATCHDOG is integrated in the controller, a so-called trap can also be triggered. The task of the software module assigned to the trap is to provide a suitable response to save the WATCHDOG problem and to put the system in a safe state. This is followed by a partial or complete restart.

- **Time-Slot-WATCHDOG**
  At this WATCHDOG the microcontroller has to communicate with the WATCHDOG between a defined time slot. The reaction at none communication is the same as by Time-Out-WATCHDOG.

- **Intelligent-WATCHDOG**
  In the intelligent WATCHDOG, the controller must answer a question posed by a WATCHDOG module. The process is also referred to as a challenge-response concept for the reason. In the event of an error, the controller is reset and the WATCHDOG moves the controller to a safe state.

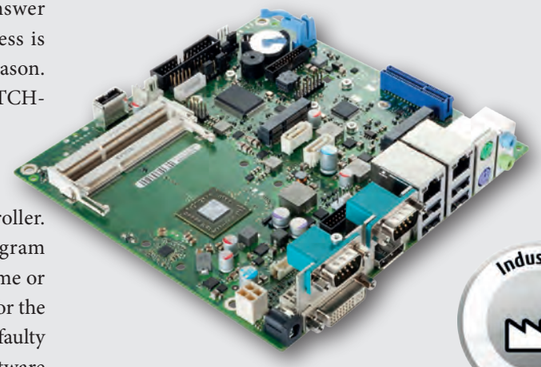
- **Software-WATCHDOG**
  The WATCHDOG software is a test software in the controller. The software module checks whether all important program modules are executed correctly within a specified time frame or whether a module requires an unacceptable length of time for the processing. This does not necessarily have to be caused by a faulty processing, but can also be caused by a deadlock. The software WATCHDOG can be monitored by a hardware watchdog

Benefits

- Additional reliability
- The watchdog itself is independent of the operating system and any application software
- Additional BIOS POST watchdog and/or BIOS BOOT watchdog
- Easy set-up of watchdog functionality possible via BIOS setup and SystemGuard utility
- Integration into customer applications through programming interface

Supported Mainboards

Mainboard	BIOS POST WATCHDOG	BIOS Boot WATCHDOG	OS WATCHDOG
D3313-S		X	X
D343x-S	X	X	X
D344x-S	X	X	X
D3417-B	X	X	X
D3402-B	X	X	X
D3598-B	X	X	X



Industrial Series

Fujitsu implements the following three various WATCHDOGs

- BIOS POST WATCHDOG
- BIOS (OS) Boot WATCHDOG
- Operating System Runtime WATCHDOG

Please note, that the implementation of the various WATCHDOG features depends on the mainboard model. All three WATCHDOGS are physical identical, but they are handled by different application levels.

The mainboards provide full BIOS POST-, Operating System Boot-, and Operating System-Runtime watchdog supervision.

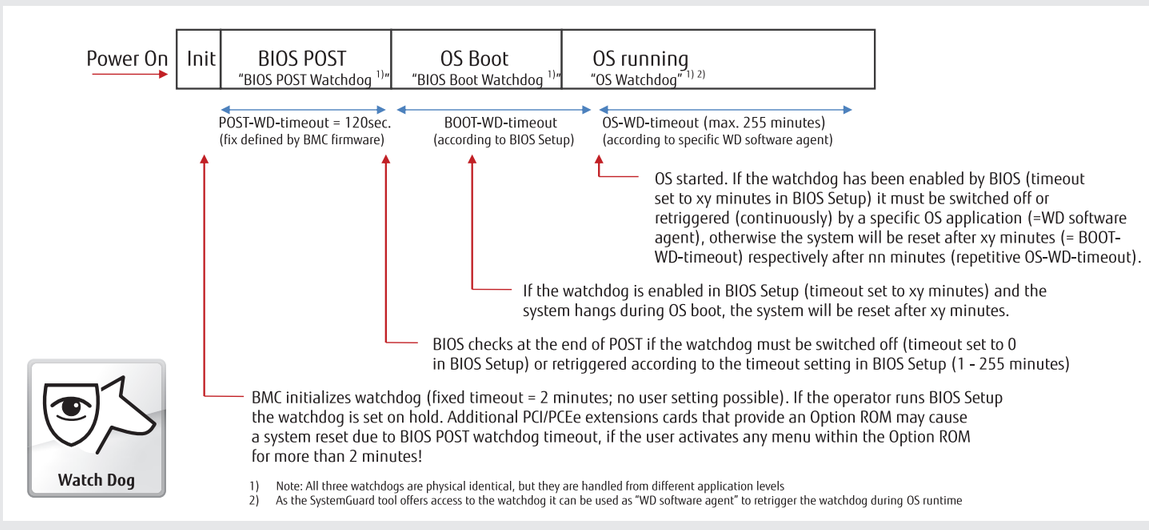
How to handle the different WATCHDOG levels?

- BIOS POST WATCHDOG
  - No user interaction possible
  - POST WATCHDOG is always enabled

- BIOS Boot WATCHDOG
  - Set WATCHDOG in BIOS Setup
    0 = WD disabled
    1–255 = WD enabled (timeout = 1–255 minutes)

- OS WATCHDOG
  - Use “WATCHDOG software agent” to stop or retrigger the WATCHDOG during OS runtime

The following diagram shows the sequence after powering on the system



1) Note: All three watchdogs are physical identical, but they are handled from different application levels
2) As the SystemGuard tool offers access to the watchdog it can be used as “WD software agent” to retrigger the watchdog during OS runtime

Data Processing

Security Features on Standard x86 Based Boards

Erase Disk

Erase Disk is a Fujitsu Technology Solutions feature embedded in the system firmware to erase all data reliably from a hard disk. The main purpose of this feature is to delete all data from the hard disk before it will be changed or the complete system will be sold. It can be also used whenever a hard disk should be deleted, for example before a new operating system will be installed.

The great benefits against other software are

No additional cost, because it is included in the system	**A part of the BIOS can't get lost during the lifetime of the board**

Description

This application itself is called EraseDisk and it is a part of the UEFI Firmware at the end of the PowerOnSelfTest (POST).

To erase all data from the hard disk you have to do the following steps

1. The application can only be selected and deleted if you have set an Admin password
2. Start the BIOS and set the switch from EraseDisk to enable. After reboot you have to enter your admin password for security purpose
3. A dialog will be displayed which allows you to select a specific, several or all hard disk – depending on the number of attached hard disks in the system
4. Select a hard disk which shall be deleted

EraseDisk offers you four different options how to delete your hard disk from “fast” to “very secure”

- Zero Pattern (1 pass) overwrite the flash with “0” in 1 pass
- German BSI / VSITR (7 pass) 6 pass overwrite with changing numbers, last pass with “010101”
- DoD 5220.22-M ECE (7 pass) 7 pass overwrite with random numbers, (DoD=Department of Defense)
- Guttmann (35 pass) 35 pass overwrite with certain values after a certain pattern, not more up today

5. Select hard disk deletion algorithm

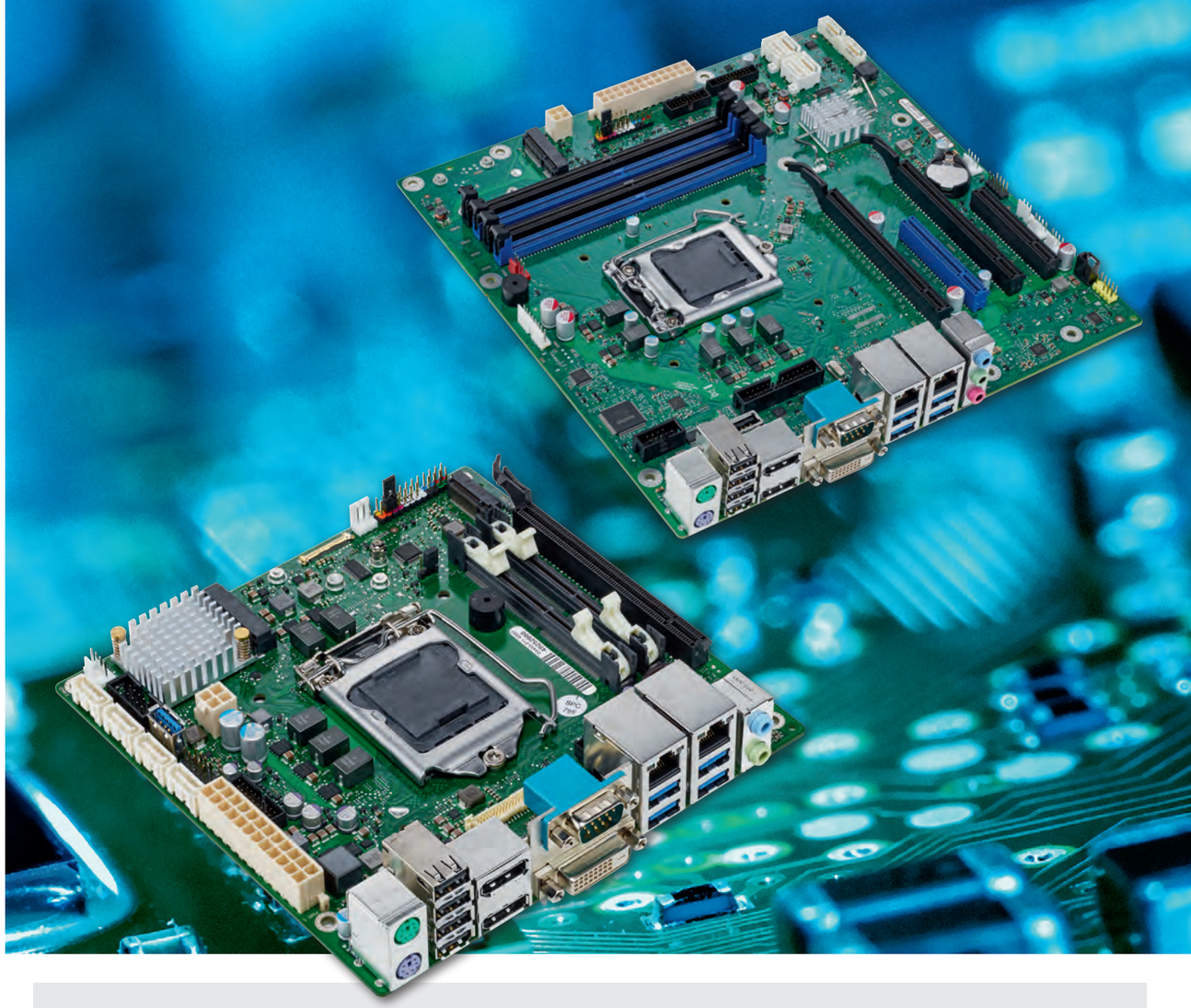
After the hard disk deletion process, the user can select as follows which tasks he will be executed by the system.

- Reset password
- Load Setup Defaults
- Shutdown System

6. Select desired tasks

The deletion process will start now. The complete disk erase can be recorded as an audit proof protocol and copied to an external USB drive.

Depending on the selected algorithm the duration ranges from 10 sec. until 10 min. per GByte.



Full Disk Encryption

Full disk encryption (FDE) is a security tool whereby every bit of data is encrypted on the hard disk drive. Encryption involves converting information into unreadable code, which cannot be deciphered easily by unauthorized users. Thus full disk encryption prevents unauthorized access to the stored data.

FUJITSU OEM Mainboards are able to support this feature which is mainly a HDD feature.

Trusted Platform Module

Trusted Platform Module (TPM) is a security feature available on selected Fujitsu OEM Mainboards. The TPM itself is a computer chip (microcontroller) which securely stores information, such as passwords, certificates or encryption keys, used to authenticate your PC or laptop. A TPM can also store information regarding your PC or laptop, enabling you to determine whether your device is trustworthy and has not been breached.

All Fujitsu Skylake-based mainboards provide TPM V2.0 as recommended for MS Windows 10.

Type	Win7 (x32/x64) Legacy	Win7 (x32) UEFI	Win7 (x64) UEFI	Win8.x (x32/x64) Legacy	Win8.x (x32/x64) UEFI	Win10 (x32/x64) Legacy	Win10 (x32/x64) UEFI
TPM 2.0 Support	No	No	Yes[1]	No	Yes	No	Yes

1) MS Hotfix required: Update to add support for TPM 2.0 in Windows 7 and Windows Server 2008: https://support.microsoft.com/en-us/kb/2920188

Data Processing

Secure Software Solution from Advantech, Acronis, McAfee

ADVANTECH
Enabling an Intelligent Planet

Advantech attach great importance to deliver the highest level of threat visibility & protection for their customers – we are not alone

Embedded security solutions from Advantech and those partners, world leading companies like McAfee, Acronics and SUSI help manufacturers to ensure their products and devices are protected from cyberthreats and attacks. Embedded systems and device security solutions span a range of technologies, including application whitelisting, antivirus and anti-malware protection, device management, and encryption. Solutions can be tailored to meet the specific design requirements for a manufacturer's embedded device and its architectures.

One additional important advantage of our Embedded Systems products:

- Panel PC's
- Box PC's
- Tablet PC's
- Touch Panel PC's
- Fanless Box PC's

This is the all-around secure package about security of our hardware which was mentioned before.
The software for our "Bulletproof" secure shield from outside is reloaded with Acronis, McAfee and SUSI 4.0, highest provided security software on planet.

WISE-PaaS/Security – Embedded System

Advantech create WISE-PaaS Software solution for customers with various IoT software services and solution packages.

This integrates:

- Backup Recovery
- Application Control
- Endpoint Security 10
- Integrity Control

into their 'Cloud' based WISE-PaaS.

Acronis and McAfee embedded solutions provide superior and intelligent security functions, for protecting IoT devices and data from

- Zero-day attacks
- Monitoring/tracking system changes
- Guarding entire systems

Acronis True Image 2017 – The No.1 Personal Backup Software

Acronis True Image 2017 is an integrated software suite that ensures the security of all of the information on your PC. It can back up your documents, photos, e-mail, and selected partitions, and even the entire disk drive, including operating system, applications, settings, and all of your data.

- Back up everything in just two clicks
- Get the fastest backup and recovery available
- Protect mobile, social and remote data

Easy Image Backup
Protect everything easily: operating system, programs, settings, files, and boot information.

Simple Two-click Backup
Back up to external drives, network shares, and cloud with just two clicks.

Dual-Protection™
Back up locally to your external drives, network shares, and store copies in the Acronis Cloud.

Mobile Backup
Back up all your phones and tablets to your Windows PC and/or to Acronis Cloud. Manage all devices from touch friendly online dashboard. Migrate your data from Android to iOS and back. Better than native backup!

Remote Backup
Back up remote computers easily and safely.

Social Backup
Protect Facebook photos and posts with automatic, incremental social backup.

More than just Backup – Use powerful features and tools above and beyond backup

- Clone disks and create exact replicas of your system disk to faster or larger storage devices
- Migrate your system to a new computer with Acronis Universal Restore
- Archive files from your computer to cloud storage or an external drive to free up disk space
- Find selected files within backups and archives with powerful search
- Synchronise files between multiple computers and access the most important data any time
- Safely try new software and drivers and roll back to a previous configuration with Try & Decide
- Securely delete temporary files, purge recycle bin, and free disk space with system cleanup

New Features

- Ransomware protection
- Proving file authenticity with Blockchain technology
- Mobile backup encryption
- Browsing content of local mobile backups
- Separate activation of Acronis Cloud
- Encryption of a Facebook backup

Cloud Features
Get the following benefits when your purchase includes Acronis Cloud Storage:

- Back up files, folders, and full disk images to the Acronis Cloud
- Archive files to the cloud
- Search backup files in the cloud
- Back up mobile devices to the cloud
- Synchronise files to the cloud and between computers
- Gain additional protection with the 3-2-1 rule: Have 3 copies of your data; on 2 different types of storage; 1 being in the cloud
- Implement additional ransomware protection by having a copy in a location not reachable by a virus on your local computer

The Original Full Image Backup

- 14 years & more than 5.5 million users worldwide!
- Backup up everything with one solution.

Acronis is faster than all competitors with backup technology to local drives. Cloud archives, backups, and synchronisation take advantage of your entire broadband capability.

- Full image backup
- Multi-platform backup to PC and cloud
- Modern disk drive and NAS device support
- Full computer recovery to dissimilar hardware
- Remote backup plans
- Cloud and local archive
- File synchronisation

... and much more!

Data Processing

Secure Software Solution

McAfee Deliver the Solution

McAfee

McAfee is one of the world's leading independent cybersecurity companies. Inspired by the power of working together, McAfee creates business and consumer solutions that make the world a safer place. By building solutions that work with other companies' products, McAfee helps businesses orchestrate cyber environments that are truly integrated, where protection, detection, and correction of threats happen simultaneously and collaboratively. By protecting consumers across all their devices, McAfee secures their digital lifestyle. By working with other security players, McAfee is leading the effort to unite against cybercriminals for the benefit of all.

McAfee Whitelisting Technology

McAfee Embedded Security Solution is ideal for protecting systems that are fixed-function in terms of CPU or memory resources. Embedded security solutions from McAfee help manufacturers ensure their products and devices are protected from cyberthreats and attacks.

Features

- Low overhead because dynamic whitelisting eliminates manual effort
- Low impact on system performance
- Low CPU and memory requirements
- Low ownership costs result from no-need-to-manage as long as devices are operating well

Key Features 1: Application Control

- Protects against zero-day-attacks
- Only authorized software is allowed to run
- Prevents all unauthorized applications from being executed
- Makes sure the machine does what it should do
- Automatically accepts new software added through authorized process

Key Feature 2: Change Control

- Sets access rights for who or which application can access protected data
- Prevents outages resulting from unplanned changes

Key Feature 3: ePolicy Orchestrator

- Fast time to remote deployment/configuration
- Reporting
- Central management
- Compliance requirements
- Monitors data of managed clients

McAfee Solidifier Command Line

Advantech Complete Bundle Solution for Security of Embedded Sytems – SUSI

SUSI – A Bridge to Simplify & Enhance H/W & Application Implementation Efficiency.
When developers try to write an application that involves hardware entry, they have to study the specifications to write the drivers. This is a time-consuming job and requires lots of expertise. Advantech has done all the hard work for customers with creation of a suite of Software APIs (Application Programming Interfaces), which is called Secured & Unified Smart Interface (SUSI). SUSI provides not only the underlying drivers required but also a rich set of user-friendly, intelligent and integrated interfaces, which speeds up development, enhances security and offers add-on value for Advantech platforms.

Secured & Unified Smart Interface (SUSI) – Faster Time to Market

Remote Monitoring

You can fully monitor remote devices, like CPU temperatures, fan speeds and hard disks.

Remote On/Off

The Remote On/Off tools let you power on, or power off all or individual devices within a group. It also allows the user to setup scheduled timings with alerts and warnings.

System Protection

The System Protection can let you ensure all remote devices are protected from caber threats and attacks. It is powered by McAfee Embedded Security solutions to enable the best security in the world.

Remote KVM

You can directly control remote desktops through the Remote KVM tool to carefully manage all aspects of their resources.

System Recovery

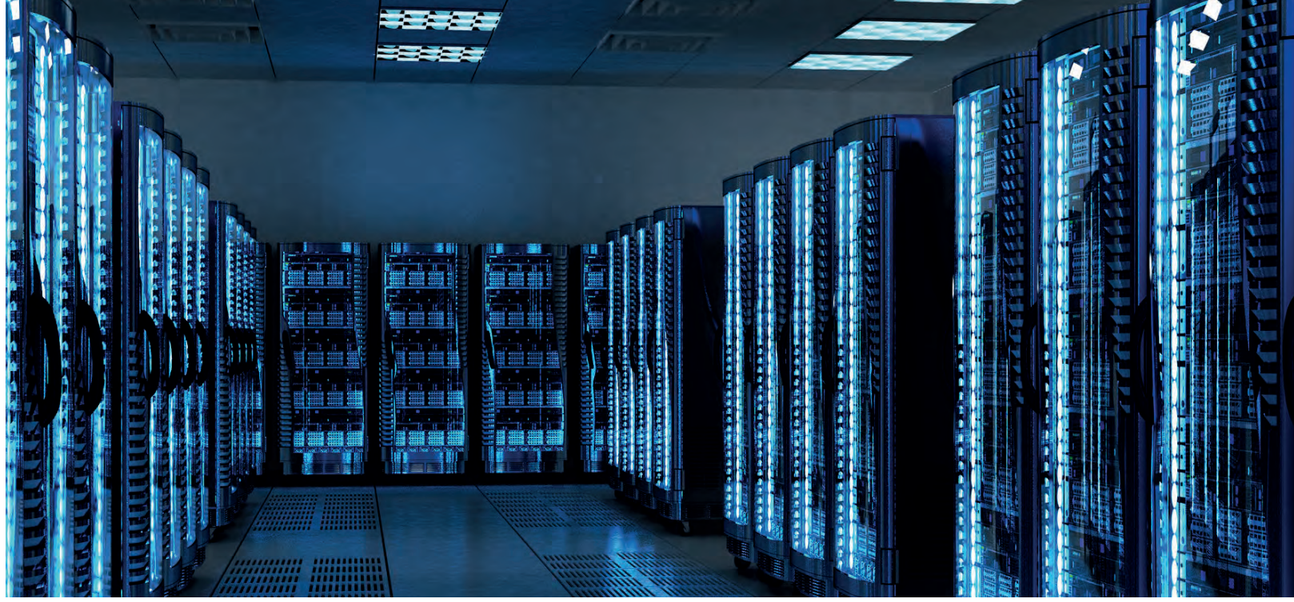
The System Recovery can let you protect data and devices with backup and disaster recovery. It is powered by Acronis True Image to enable the fast and reliable backup & restore

Benefits

- SUSI's unified API helps developers write applications to control the hardware without knowing the hardware specs of the chipsets and driver architecture.
- Reduced Project Effort
  When customers have their own devices connected to the onboard bus, they can either: study the data sheet and write the driver & API from scratch, or they can use SUSI to start the integration with a 50% head start. Developers can reference the sample program on the CD to see and learn more about the software development environment.
- Enhances Hardware Platform Reliability
  SUSI provides a trusted custom ready solution which combines chipset and library function support, controlling application development through SUSI enhances reliability and brings peace of mind.
- Flexible Upgrade Possibilities
  SUSI supports an easy upgrade solution for customers. Customers just need to install the new version SUSI that supports the new functions.
- Backward compatibility
  Support SUSI 3.0, iManager 2.0 and EAPI 1.0 interface. Customers don't need to change any APIs in their applications.

Data Processing

Secure Power Supply



FSP

The GDPR is pushing a manufacturer to build robust systems. The basis for a system is always the power supply. Having a robust power supply can be addressed by a redundant strategy against failure of a power supply or a battery buffered power supply against failure of the power input itself. A robust power supply will help to avoid data corruption.

Redundant Power Supplies

Redundant Power Supplies for seamless switching between two or three independent Power Supplies in case of defect on one Power Supply is very important to safe data in networking servers and cloud systems.

Features

- Alert-LED identifies the defect Power Supply
- Monitoring the power supplies via software tools and PMBus functionality
- Typically less than 18ms Hold-Up-Time
- Hot swappable for replacement and maintenance
- Highest efficiency and reliability due to selected components

Type	Series
1U	FSP250-60RGBHA, FSP300-60RGBHA, FSP600-RHHS
	YH5151-1EAR, YH5301-1EAR, YH5451-1GAR, YH8651-1EAR
2U	FSP550-50ERS, FSP600-50ERS, FSP700-50ERS, FSP800-50ERS
	YH5301-1CAR, YH6621-1BBR, YH5681-1HAR, YH5821-1CAR
3U	YH7761-2AGR, YH5132-2AA03R
PS2	FSP400-70RGHBB1, FSP500-70RGHBB1, FSP600-70RGHBB1, FSP700-70RGHBB1,
Mini	FSP350-80EVMR, FSP500-80EVMR, FSP350-50MRA(S), FSP500-50MRA(S) YH8511-1AAR, YH8611-1AAR, YH5651-1TA02R, YH5751-1EA04R
DC/DC	YH8511-1AAR, YH8611-1AAR, YH5651-1TA02R, YH5751-1EA04R

Uninterruptible Power Supplies

Uninterruptible Power Supplies are mandatory for systems where failures are not acceptable. They provide uninterrupted power in case of power failure and ensure the voltage quality. There are different types of UPSs.

Features

- Off-Line UPSs
  Starts to feed the system typically 2-10 ms after power failure
- On-Line UPSs
  draw power through the power conditioning and charging components continuously
- Line-Interactive UPSs
  are a mixture between Off- and On-Line, they start after power failure but the main power is always conditioned by the inverter and the battery charger is connected continuously
- AVR UPSs provide an automatic voltage regulation for constant voltage and power line conditioning combined with a battery
- Highest efficiency and reliability due to selected components

Feature	Technical Data
Off-Line	Champ RM 1k/2k/3k/6k/10k
	Mplus 30 – 300 kVA
	Proline (3P-3P) 10 – 30 kVA
On-Line	NANO 400/600/800
Line-Interactive	FP600/800/1000/1500/2000
	CP750/1000/1500/2000
	EP450/650/850/1000/1500/2000
AVR	SCUDO600/1000/1200
Phase	Single w/ground or 3 phase
Capacity	1KVA / 900 W
Input	110 – 280 Vac / 46~70 Hz
Output	200-240 Vac / 47~63 Hz
Efficiency	83 % – 93 %
Battery	12/9 Ah
Indicators	Load level, Battery level, Line mode, Battery mode, Bypass mode, Fault indicators
Alarms	Battery mode, Low Battery, Overload, Fault
Dimensions	D x W x H (mm)
Management	Windows 2000 to Windows 10, Mac, Linux and Power Mgmt. from SNMP and Web browser

Data Processing
Microcontroller

The Defenses of the Standard Microcontroller

In the midst of the rise of IoT, Industry 4.0 and robotics, microcontrollers are increasingly becoming a protective shield from tampering and cyber-attacks. Various microcontroller families are already equipped with an arsenal of security features. Once the European General Data Protection Regulation (GDPR) enters into legal force in May 2018, businesses must have implemented the data security standards specified therein. The law regulates the pseudonymization and encryption of personal data much more stringently, with new resilience and accountability provisions compared to the previous legal basis in Germany.

The GDPR affects not only manufacturers but also operating enterprises such as OEMs and network operators. As a central control and regulatory component, microcontrollers have a key role to play in networked systems. Manufacturers are already working with development processes that are certified in accordance with corresponding security standards. With a secured production chain, semiconductor manufacturers also offer their customers secure end-to-end solutions. STMicroelectronics was recently the first microelectronics component manufacturer to receive the “France Cybersecurity Label” for microcontroller solutions that combine maximum security and flexibility for a variety of target markets.

Security Takes on Different Meanings for Each Application

In security terms, the target applications can be broken down into different microcontroller categories:

- Authentication solutions and TPMs (Trusted Platform Modules), e.g. for trademark protection and IoT networks
- Banking and ID solutions for traditional smartcard enterprises in the fields of payment, personal identification, transportation and paid TV content
- Mobile security solutions for SIM-based solutions in mobile products and machine-to-machine (M2M) applications
- Automotive solutions for near-field communication (NFC, eSE) and safe driving

Integrated Data Security Features

Within the IoT and in Industry 4.0 and robotics, standard microcontrollers for industrial and consumer applications are usually used (general purpose microcontrollers). Models with integrated security features are already available in this field. Our Linecard possesses a variety of features that offer protection as regards

- Identity theft (anti-tampering mechanisms, integrity checks, traceability)
- Throttling of data services
- Data and code interception and tampering (memory protection, rights management, debug levels, anti-tampering mechanisms, integrity checks, secure firmware updates)
- Physical or mechanical attacks (anti-tampering mechanism on module)

These features are mainly integrated into the chip and ensure robust authentication, integrity of the platform and consistent data security, thereby ensuring the privacy of the end user and providing comprehensive protection of data, IP and trademarks – thereby also satisfying the highest standards when it comes to data security in standard products. Typical target applications include printers, computers, gateways, IoT end nodes and sensors.

Hardware-Based Functions

Integrity & Safety

The cyclic redundancy check determines a check value that enables errors in data transmission or storage to be detected. This means that it is not only possible to check the integrity of the data but also verify the signature of the software while it is running.

The secured power supply monitoring system (POR [Power on RESET] / PDR [Power down RESET] / BOR [Brown out RESET] / PVD [Programmable Voltage Detector] flag status) enables the reason for a reset to be identified and ensures that it has been conducted on the basis of legitimate access. It is supplemented by the “read while writing” function for efficient tampering detection and logging.

The Clock Security System (CSS) is based on the clock and the system upon restoration, as well as internal and external clocks functioning independently of one another. The Watchdog and Window Watchdog also monitor the time windows independently of one another.

The integrity and trustworthiness of the memory contents are ensured using Error Correction Code (ECC) and parity checking. It also offers expanded protection from attacks aimed at sneaking in errors. A temperature sensor continuously monitors the ambient temperature of the IC to prevent it from deliberately being heated above its specified range, permanently damaging it.

Encryption Methods

Encryption methods protect a source text from unauthorized access by encrypting the original plaintext using a code. Breaking the code enables the hacker to decode the encrypted text. More sophisticated cryptographic methods use symmetric or asymmetric encryption. With symmetric encryption, there is only one key with encryption and decryption, meaning that the sender and receiver use the same key.

With asymmetric methods, each of the communication partners uses their own key, which is used to generate a key pair. This consists of a public key, which is used to encrypt the data, and a private key, which decrypt it.

For example: Symmetric method – Certain STM32 series have a genuine random number generator, used to generate 32 bit keys for encryption, integrated entirely into the chip.

Security in General Purpose Microcontrollers

Hardware-Based Functions

...Encryption Methods
The encryption is based on the symmetric Advanced Encryption Standard (AES), whereas STM32F2, F4, F7, L4 series employing a key length of 128 bits (AES-128) and 256 bit (AES-256) with a variety of methods (ECB, CBC, CTR,GCM, GMAC, CMAC), while STM32L0 / L1 employing a key length of 128 bits (AES-128). Such symmetric encryption standard is also available within dedictated MCU/MPU-families of few other suppliers (e.g. Renesas RX, Renesas Synergy and Toshiba TZ1000) (see cross list).

Additionally, Renesas RX-family and Synergy S5 & S7 series offer asymmetric encryption engine in hardware, an outstanding feature.

The advantage of the symmetric method is that, because there is only one key, key management is simpler than with asymmetric methods. Encryption and decryption is also significantly faster.

Some microcontroller parts also have fully integrated hash functions, where data is hashed and scattered, and the function maps a larger amount of input to a smaller amount of target data.

There is also the keyed-hash message authentication code (HMAC). The structure of this message authentication code (MAC) is based on a cryptographic hash function. HMACs are specified in RFC (Request for Comments) 2104 and in the NIST (National Institute of Standards and Technology) standard FIPS 198.

Anti-Tamper Mechanism
The anti-tamper mechanism is used to defend against deliberately or unintentionally launched physical attacks against the hardware system outside of the microcontroller. The backup domain, which references various wake-up sources, ensures that protection is maintained even in low-power mode. The real-time clock (RTC) timestamps each tamper event.

Some microcontroller series also have RTC register protection, which blocks unauthorized write operations and operates independently of the system reset, but does not include protection when writing a sequence of keypresses.

If tampering is detected, the backup register ensures that the written content is automatically deleted. The communication channels can also be selectively blocked with a GPIO communication block. This prevents selected general purpose inputs/outputs (GPIO), and the block can be removed upon next reset.

Debug Block
The debug block prevents unauthorized access to the microcontroller via a debug interface. The security level can be selected for each application or requirement, although it cannot be downgraded again after that point.

Access Rights Management
Access rights confer upon users or user groups the authority to perform certain actions. To this end, the integrated memory protection unit (MPU) divides the memory into regions with different access rights and rules.

During data transfer, the firewall isolates the code or data component of the flash memory or SRAM from the remainder of the code executed outside of the protected area. The firewall is more restrictive than the memory protection unit (MPU) and is only integrated into the STM32L0, L4 and Renesas Synergy S5 & S7.

Memory Protection
Read protection is used to manage how memory is accessed. Memory dumps and backups of user IPs for instance are not permitted. Write protection enables each sector to be protected from unwanted write operations. Proprietary code protection allows each memory region to be configured as “execute only”, meaning that only code may be executed here – it is not possible to write to this region.

IPs and confidential data can be securely deleted using the mass erase or secure erase functions. This function resets the memory entirely to its factory state.

Traceability of Data
Many microcontroller series have a specific, unique 96 bit ID to ensure that an end product is traceable. This can also be used for the diversification of security keys.

Many series also have functions enabling a secure firmware update.

Software-Based Encryption Methods

The security functions implemented in hardware can also be supplemented with software-based solutions. Cryptographic library packages are available for different microcontroller families with a range of cryptographic algorithms. They are provided as standard in binary object format, and can also be provided in source code form under the terms of an NDA-based license. A hardware expansion is also available to provide certain groups of integrated circuits with functional support.

In addition to the random number generator integrated into the chip, a software package provides protection from replay attacks, which use prior requests for a renewed attack.

A hash algorithm verifies digital signatures and authentication codes of messages in order to ensure that the data is trustworthy and to protect its integrity. There are also software packages available with symmetric and asymmetric encryption methods.

For sophisticated IoT solutions, there is also the option of utilizing another on-board module – the STSAFE-A100 from STMicroelectronics or the OPTIGA family from Infineon are supplied as a ready-to-run solution with a secure operating system. This latest generation of secure microcontrollers enhances authentication and data management service security for local and remote host PCs, smart home, smart city and industrial applications, electronic entertainment devices and all kinds of other end devices, utilities and accessories.

Data Processing

Microcontroller

Security Features Built in General Purpose MCUs – Industrial & Consumer Purpose

The cross list for security features refers to MCU families whereas each subline within MCU family contains at least ONE part number with listed security features.
The portfolio listed is usually silicon based / hardware integrated. Exception: the SW based methodes of encryption and the Crypto (SW) feature

Supplier		STMicroelectronics										Infineon		Renesas						Toshiba		EPSON	
Family		Proprietary	CortexM0+	CortexM0	CortexM3	CortexM3	CortexM3	CortexM4	CortexM4	CortexM4	CortexM7	CortexM0	CortexM4	Proprietary		Cortex A	Cortex M0+	Cortex M4	Cortex M	Cortex M4	Cortex M4	Propriatary	CortexM0+
Series		STM8L STM8S	STM32L0	STM32F0	STM32L1	STM32F1	STM32F2	STM32F3	STM32L4	STM32F4	STM32F7	XMC1x	XMC4x	RL78	RX	RZ	Synergy S1	Synergy S3	Synergy S5 & S7	TZ1xxx	TXZ	S1C17	S1C31
Integrity & Safety	CRC Calculation Unit		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	–	–
	Power Supply Integrity Monitoring	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
	Read While Write	X	X		X	(X)			X	(X)	(X)						X	X	X		X	–	–
	Clock Security System (CSS)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
	Error Correction Code (ECC)	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			–	–
	Parity Check			X				X	(X)			X	X	X	X	X	X	X	X		X	X	X
	Temperature Sensor	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X			X	X
	Watchdogs	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Random Number Generator		X				X		X	X	X	X			X		X	X	X	X		X	X
Crypto HW	Hashing Functions & HMAC						X			(X)	X				x		X	X	X	X			
	Symmetric Cryptography	(X)	X		X		X		X	X	X				X		X	X	X	X			
	Asymmetric Cryptography														X				X				
	Asymmetric Key Generations Accerlator														X			X	X			–	–
Crypto Software Package	Random Number Generator		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			–	–
	Hashing Functions & HMAC		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			–	–
	Symmetric Cryptography		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			–	–
	Asymmetric Cryptography		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			–	–
Tamper Protection	Anti Tamper	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X			–	–
	Backup Domain		X	X	X	X	X	X	X	X	X	X	X		X		X	X	X		X	–	–
	RTC (Alarm Timestamp)	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X	–	–
	RTC Register Protection	X	X		X		X	X	X	X	X	X	X		X		X	X	X		X	X	X
	Backup Registers	X	X	X	X	X	X	X	X	X	X		X		X		X	X	X			–	–
	GPIO Configuration Locking		X	X	X	X	X	X	X	X	X	X	X	X	X				X			X	X
Debug Lock Level	JTAG or SWD	X	X	X	X	(X)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Permission Management	Memory Protection Unit (MPU)		X		X	(X)	X	X	X	X	X		X		X		X	X	X	X	X	–	–
	Firewall		X						X								x	x	x			–	–
Memory Protection	Read Protection (RDP)	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
	Write Protection (WRP)	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
	Proprietary Code Protection		X		(X)				X	(X)		X	X	X	X		X	X	X	X	X	X	X
	Mass Erase		X		X				X	(X)	X	X	X						X	X	X	X	X
Traceability	Device 96 Bit-Unique ID	X	X	X	X	X	X	X	X	X	X	X	X	X*	X	X	X	X	X			–	–
Secure Update	Software FSU		X				X			X	X	X	X		x							X	X

(X) STM32: SECURITY feature not available at each sub-Line of mentioned MCU family

X* Renesas RL78: Device Electronic 64 bit Unique ID only

– Epson: Even NOT available currently, could be included in new products tbd.

Data Processing
Microcontroller

Security Features in General Purpose MCUs of STM32 Family

Integrity & Safety 1/2

Features	Benefit	STM32 Family
CRC calculation unit	Used to verify data transmission or storage integrity	L0,L1,L4
	Computes a signature of the software during runtime	
Power Supply Integrity Monitoring	Ultra safe supply monitoring (POR/PDR/BOR/PVD)	F0,F1,F2,F3,F4,F7, L0,L1,L4
	Flag status to determine what causes reset (SW, watchdog, power up, low power, option bytes, ...)	
Read While Write	For efficient tamper detection logging	F1,F4,L0,L1,L4
Clock Security System (CSS)	Independent clock sources and Clock recovery systems	F0,F1,F2,F3,F4,F7,L0,L1,L4
Error Correction Code (ECC)	Robust memory integrity	F1,F2,F3,F4,F7,L0,L1,L4
	Hardened protection against fault injection attacks thanks to error detection	
Parity check	Memory content integrity check	F0,F3,L4
	Hardened protection against fault injection attacks	
Temperature Sensor	Check if device is operating in expected temperature range. Hardened protection against temperature attacks. (AN3964)	F0,F1,F2,F3,F4,F7, L0,L1,L4
Watchdogs	Independent watchdog and window watchdog for software timing control	L0,L1,L4
	Key registers to control watchdogs	

Crypto – Hardware

Features	Benefit	STM32 Family
Random Number Generator (RNG)	True RNG is done entirely by the hardware. It delivers 32 bit random numbers	F2,F4,L0,L4,F7
Hashing Functions & HMAC	MD5, SHA-1, SHA-2	F2,F4,F7
Symmetric Cryptography	AES-128 Bits (ECB, CBC,CTR)	F2,F4,F7, L0,L1
	AES-128/265 Bits (ECB, CBC, CTR, GCM, GMAC, CMAC) (only L4)	

Crypto – Software

Features	Benefit	STM32 Family
Random Number Generator (RNG)	On chip entropy generation. Ensure strong keys, protect against replay attacks. (UM0586)	Based on DRBG-AES-128; F0,F1,F2,F3,F4,F7,L0,L1,L4
Hashing Functions & HMAC	Hash algorithm provides a way to guarantee the integrity of information, verify digital signatures and message authentication codes. MD5, SHA-1, SHA-224, SHA-256. (UM0586)	F0,F1,F2,F3,F4,F7,L0,L1,L4
Symmetric Cryptography	STM32 cryptographic library package: (UM0586) ▪ DES/TDES: ECB,CBC ▪ AES: ECB, CBC, CTR, CCM, CBC-MAC, GCM, CMAC, KEYWRAP	F0,F1,F2,F3,F4,F7,L0,L1,L4
Asymmetric Cryptography	RSA signature function with PKCS#1v1.5	F0,F1,F2,F3,F4,F7,L0,L1,L4
	ECC (Elliptic Curve Cryptography): Key generation, Scalar multiplication, ECDSA. (UM0586)	

Tamper Protection 1/2

Features	Benefit	STM32 Family
Anti Tamper	Protect against a wide range of physical attacks on HW system outside the MCU	F0,F1,F2,F3,F4,F7, L0,L1,L4
	(AN3371)	
Backup Domain	Maintains tamper protection active even in Low Power modes	F0,F1,F2,F3,F4,F7, L0,L1,L4
	Multiple wake up sources.	
	(AN3371)	
RTC (Alarm Timestamp)	Timestamp on tamper event	F0,F2,F3,F4,F7, L0,L1,L4
	(AN3371)	
RTC Register Protection	Write protection. Unprotecting by writing a key sequence Independent from system reset	F2,F3,F4,F7, L0,L1,L4
Backup Registers	For confidential data storage (Keys ...)	Backup register and SRAM
	Tamper automatically deletes registers content	See product datasheets
	(AN3371)	
GPIO Configuration Locking	Lockofselected GPIO. Impossible to unlock until next reset	F0,F1,F2,F3,F4,F7, L0,L1,L4
	Capability to lock communication channels after tamper detection	

Debug Lock level 0,1,2

Features	Benefit	STM32 Family
JTAG or SWD	Prevent unauthorized access to the device through debug interfaces	F0,F1*,F2,F3,F4,F7,L0,L1,L4
	Highest security level is irreversible	
	(AN4246)	

Privileges Permission Management

Features	Benefit	STM32 Family
Memory Protection Unit (MPU)	The processor MPU is a component for memory protection. It divides the memory map into a number of regions with privilege permissions and access rules	F1*,F2,F3,F4,F7,L0,L1,L4
Firewall	Even more restrictive than MPU. Made to protect a specific part of code or data Flash Memory, and/or to protect data into the SRAM from the rest of the code executed outside the protected area	L0, L4
	(AN4632)	

Memory Protection

Features	Benefit	STM32 Family
Read Protection (RDP)	Global memory access control management. Prevents memory dumps, safeguarding user's IPs (AN4246)	F0,F2,F3,F4,F7, L0,L1,L4+SRAM
Write Protection (WRP)	Each sectors can be protected against unwanted write operations	F0,F1,F2,F3,F4,F7, L0,L1,L4+SRAM
	(AN4246), AN4701(F4), AN4758(L4)*	
Proprietary Code Protection (PCROP)	Each Sector can be configured in "execute only". AN4246(L1), AN4701(F4), AN4758(L4)*	F4,L0,L1*,L4
Mass Erase	Safely remove IPs and confidential data. Forcefactory reset	F7,L0,L1,L4

*Security feature not available at each sub-Line of mentioned MCU family

Traceability

Features	Benefit	STM32 Family
Device Electronic 96 Bit Unique ID	Enables product traceability	F0,F1,F2,F3,F4,F7, L0,L1,L4
	Can be used for security key diversification	

Secure Firmware Update

Features	Benefit	STM32 Family
Software FSU	Secure firmware upgrade capability	F2,F4, L0,L4,F7
	(AN4023 & AN4024)	

Security of Automotive MCUs – EVITA and SHE Security Features

EVITA and SHE are major security initiatives in the automotive world which define security standards. In order to harden ECUs against security attacks, the security mechanisms should prevent successful manipulation of SW, data, keys and keying material – so they must be rooted in hardware. The Secure Hardware Extension (SHE) specification known as an Automotive initiative of the HIS working before 2010 has meanwhile been accepted as an open and free standard. The SHE specification defines a portfolio of functions and a programmer's model (API) enabling a secure zone to coexist within any electronic control unit installed in the vehicle. The most significant features inside a secure zone are storage and management of security keys, plus encapsulating authentication, encryption and decryption algorithms that application code can access through the API. These features help maximize flexibility and minimize costs.

EVITA – E-Safety Vehicle Intrusion Protected Applications

The project EVITA, which is coordinated by the Fraunhofer SIT has the aim of the provision of a cost-effective hardware security architecture fulfilling the requirements of present on-board security issues. The following general categories are considered to be protected:

- Vehicle-to-X (V2X) communication
- On-board communication between actors, sensors and electronic control unit (ECU)
- Integration of mobile devices
- Diagnosis processes
- Vehicle safety applications
- Drivers privacy

Therefore, security methods have to be implemented in hardware like hashing routines, authentication protocols and encryption algorithm. Furthermore, the ECUs have to be protected against tamper, unauthorized cloning and thievery. EVITA is an open specification to offer the benefits to the whole automotive industry. In the given EVITA specification TPM and SHE are already covered. [1][3]

The Hardware Security Modules (HSM)

The Hardware security module (HSM) components are splitted into mandatory / optional components. Depending on the use cases, different security requirements must be considered. For cost-effective HW-solutions, three different EVITA HSM variants are specified with different security level.

Full EVITA HSM

Provides the maximum level of functionality, security and performance of HSM variants. Focus on protecting in-vehicle domain against security vulnerabilities of V2X communications. Therefore electronic signatures must be created / verified. A very efficient asymmetric cryptographic engine is needed in order to meet the specified security performance. Suited for a maximum of security life time.

Medium EVITA HSM

Focus on securing on-board communication with the ability to perform several non-time-critical asymmetric cryptographic operations in SW, e.g. in order to establish shared secrets. All internal communication protection is based on symmetric cryptographic algorithms. Compared to the full version it comes without the integrated asymmetric cryptographic building block and allows only a reduced CPU performance (e.g. 25 MHz vs. 100 MHz).

...The Hardware Security Modules (HSM)

Light EVITA HSM

Focus is a secure interaction of secured ECUs with sensors / actuators. The only requirement – it contains a symmetric cryptographic engine and a corresponding hardware interface, which enables to fulfill strict cost and efficiency requirements for sensors / actuators applications (e.g. regarding message size, timings, protocol limitations or processor consumption). Shared secrets are handled in a different way i.e. by means of pre-configuration during manufacturing, by self-initialization, which is based on physically unclonable functions, or based on running a key establishment protocol in software at the attached application processor. [2]

Automotive SECURITY Level Classification

Type	SHE	EVITA Light	EVITA Medium	EVITA Full
Internal Clock w/ incl. external UTC synchron.		X	X	X
Internal NVM (Non Volatile Memory)	X	X (optional)	X	X
Counter (16 x 64 bit)			X	X
Tamper Protection (HW)	X	X	X	X
Parallel Access- Multiple sessions		X	X	X
CPU internal				
...CPU programmable			X	X
...CPU PRESET	X (option)			
Boot Integrity Protection:				
Authentication & Secure	Secure only	X (optional)	X	X
Random Number Generator				
.... based on PRNG w/ TRNG seed	X	PRNG w/ external seed	X	X
Crypto algorithm, incl. key generation (HW)				
AES /MAC	X	X	X	X
Options: ECDSA, ECDH, WHIRLPOOL / HMAC			X	X
Crypto acceleration (HW)				
AES	X	X	X	X
ECC, WHIRLPOOL				X

Components for different EVITA HSM`s, suggested in publications

Security requirements and related functional requirements considered for EVITA

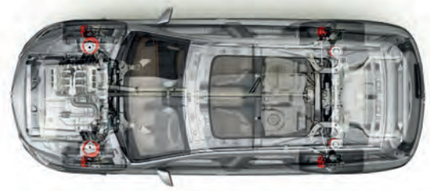
- Integrity / authenticity of e-safety related data: in terms of origin, content, and time. Forgery of such information, tampering, or replay of this information should be at least detectable
- Integrity / authenticity of ECU / firmware installation / configuration: Any replacement / addition of an ECU, also with related firmware or configuration to the vehicle must be authentic in terms of origin, content, and time
- Secure execution environment: Limited consequences requested on separate / more trusted zones of the platform, in case of a successful ECU attack
- Vehicular access control: Control requested in regard to the access of vehicular data and functions
- Trusted on-board platform: Integrity / authenticity of operated software has to be ensured
- Secure in-vehicle data storage: in regard to ensure access control and integrity, freshness and confidentiality of data stored within a vehicle
- Confidentiality of certain on-board or external communication: in regard to confidentiality of existing software / firmware, updates and security credentials which must be ensured
- Privacy data: for personal data stored within a vehicle, contained in messages sent from vehicle to the outside
- Interference of security functionality: availability of bus systems, CPUs, RAM and wireless communication technologies must be ensured [2]

Source:

[1] EVITA E-Safety Vehicle Intrusion Protected Applications. URL: https://www.evita-project.org/EVITA_factsheet.pdf. visited: 24.08.17
[2] F2010-E-035 SECURE AUTOMOTIVE ON-BOARD ELECTRONICS NETWORK ARCHITECTURE URL: https://www.evita-project.org/Publications/AEHR10.pdf. visited: 24.08.17
[3] Securing Vehicular On-Board IT Systems: The EVITA Project. URL: https://www.evita-project.org/Publications/HRSW09.pdf. visited: 24.08.17

Data Processing

Microcontroller



EVITA and SHE Security Features – Automotive

The Automotive HSM

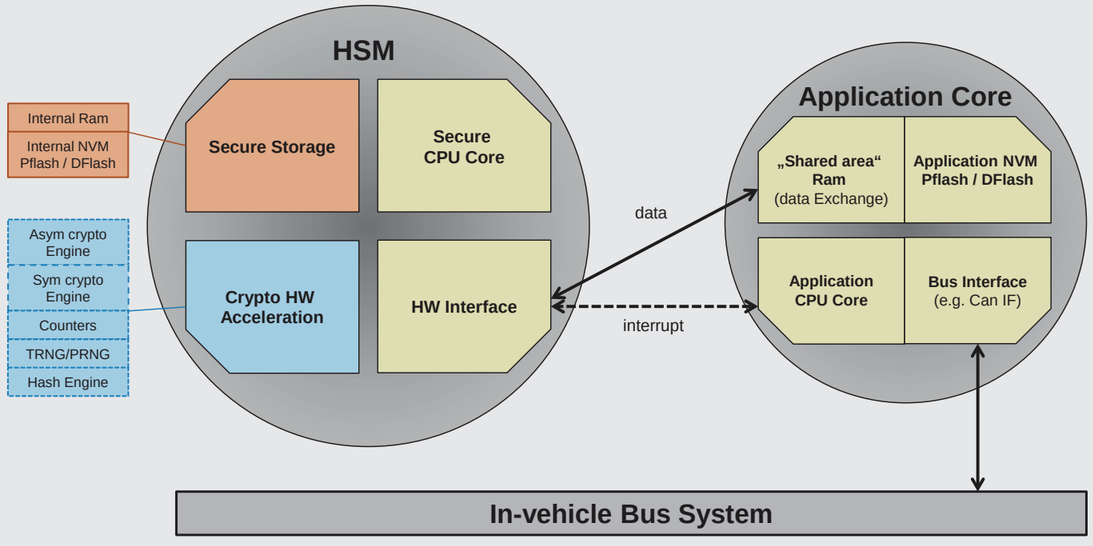
The HSM Block consists of HW embedded mandatory functional blocks:

Secure Storage
HW embedded Internal RAM and
Internal NVM PFlash/DFlash

Crypto HW Acceleration
basically with HW embedded Symmetric Crypto Engine.
Further blocks are available as option:
- Symmetric Crypto Engine
- Asymmetric crypto engine (optional)
- TRNG/PRNG (optional)
- Hash Engine (optional)
- Counters (optional)

Secure CPU Core
CPU architecture and specific HW embedded features dedicated for highest possible security. It incorporates a Tamper – resistant processor and several security features based on dedicated hard-ware implementation. It is optimized for Security applications, known primarily from tamper-resistant smart cards, also suited for usage of advanced payment systems, electronic passwords and others. It is now migrating into an area of transporting, vehicle etc.

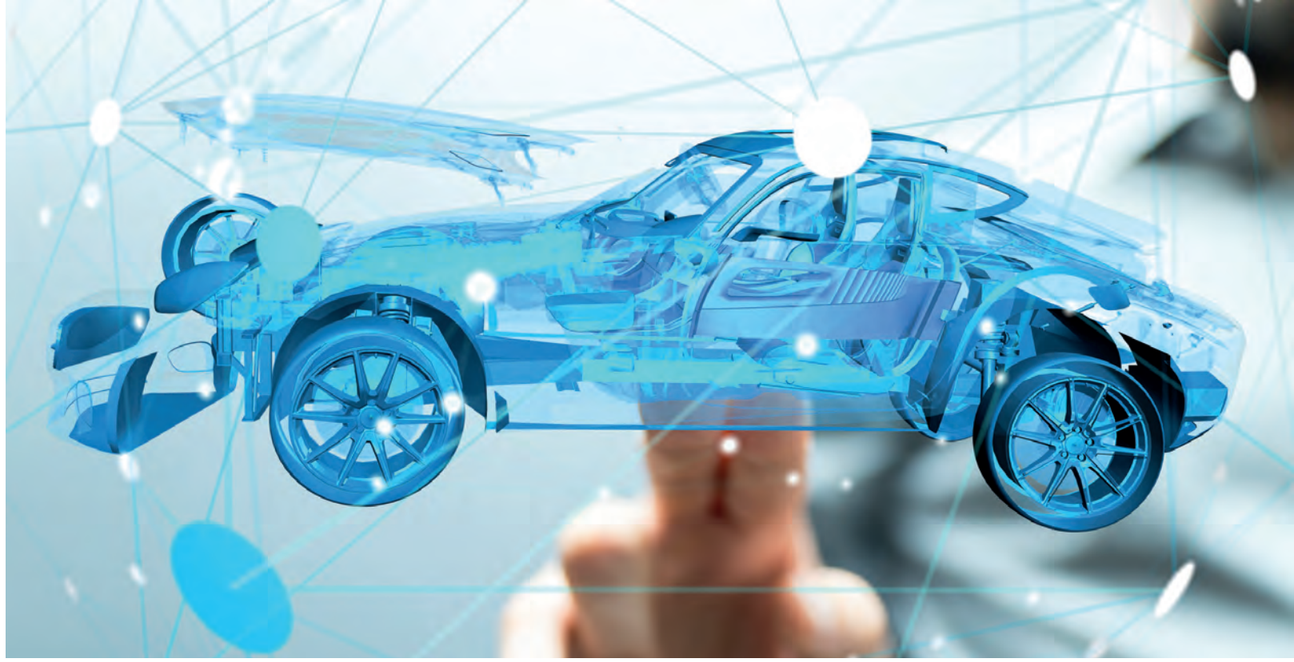
HW-Interface
enables data exchange and interrupt request exchange with application core.



Application Core

The Application Core consists of a Application CPU and Bus Interface, e.g. a CAN Interface, as well as Shared area RAM for data exchange and/or an Application NVM (PFlash/DFlash).
Interrupts are exchanged between HSM block (HW interface) and the Application Core (Application CPU Core).
Data are exchanged between HSM block (HW interface) and the Application Core (“Shared area RAM”).

Source: https://www.evita-project.org/Publications/AEHR10.pdf



Overview Security Features

Aurix 1./2. Generation – TC2xx / TC3xx Series

Series	TC2xx	TC3xx
EVITA	medium	full
HSM	X	X
HSM Block	X	X
Cryptographic Coprocessor (HSM)	X	X
Secure System Configuration	X	X
Secure Boot	X (SHE +SW)	X (SW 3rd party)
Flash Memory Protection	X	X
External Access Protection	X	X
Device Life Cycle	X*	X*
ROM keys	on request	on request
Test Life Cycle	on request	on request
Sealing	on request	on request
CAN / FlexRay Clock Jitter Disable	on request	on request
Reset Password	on request	on request
eFuse	on request	on request

X Feature available

X* Depends on configuration

on request NDA requested

EVITA Medium – Aurix TC2xx Series

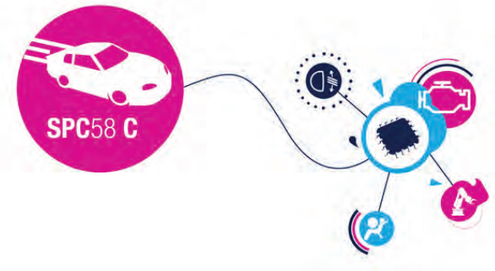
Type	SAx-TC21x	SAx-TC22x	SAx-TC23x	SAx-TC26x	SAx-TC27x	SAx-TC29x
Series	1x Series	2x Series	3x Series	6x Series	7x Series	9x Series
Safety: SIL Level	ASIL-D	ASIL-D	ASIL-D	ASIL-D	ASIL-D	ASIL-D
Security: HSM			X (optional)		X (optional)	X

EVITA Full – AURIX TC3xx Series

Type	SAx-TC32x	SAx-TC33x	SAx-TC33x	SAx-TC35x	SAx-TC36x	SAx-TC37x	SAx-TC38x	SAx-TC39x
Series	2x Series (1 MB)	3x Series (2 MB)	3x Series +eXtens (2 MB)	5x Series (4 MB)	6x Series (4 MB)	7x Series (6 MB)	8x Series (10 MB)	9x Series + eXtens (16 MB)
Safety: SIL Level	ASIL-D	ASIL-D	ASIL-D	ASIL-D	ASIL-D	ASIL-D	ASIL-D	ASIL-D
Security: HSM+ECC256	X	X	X	X	X	X	X	X

Data Processing

Microcontroller



Security Features at a Glance – STMicroelectronics SPC5x Family

Security Concept – SPC5x Series

Production Line	SPC56	SPC57			SPC58		
Nick Name	**Bolero**	**Lavaredo**	**K2**	**Velvety/Sphaero**	**Chorus 1M**	**Chorus 2M /4M/6M**	**Eiger/Bernina**
Evita Level	Light					Medium	Medium
HSM Block						X	X
Cryptographic Coprocessor	CSE					C3	C3
ROM Keys	Needed	Not needed	Not needed	Not needed	Not needed	Needed	Needed
Device Life Cycle		X	X	X	X	X	X
Test Life Cycle		X	X	X	X	X	X
Boot	BAM	BAF	BAF	BAF/Cust.	BAF	BAF	BAF
HSM exclusive + alternative Interface						X	X
Censorship[1]	X	X	X	X	X	X	X
Pass Module		X	X	X	X	X	X
TDM Module			X		X	X	X
Sealing		X	X	X	X	X	X
CAN/Flexibility clock jitter/ disable			X			X	X
Retest Password		X	X	X	X	X	X
eFuse						X	X
Secure System Configuration	X	X	X	X	X	X	X
Production Disable		X	X	X	X	X	X
Security vs. Testability		X	X	X	X	X	X

Notes

Censorship External access protection and read protection of Flash region

ROM key During the production test, ST generates two 128-bits random numbers and stores them into two fixed locations of the “UTest”. When the device is shipped to the customers, these locations are not-readable by any system master. In case they are read, the bus transfer returns an all-0 result. More details on request.

BAM Boot assist Module – for initialization of boot code

BAF Boot assist Flash – for initialization of boot code

Pass Module Used for READ / WRITE protection of FLASH memory in case of „OEM Production“. Activation in case of „OEM life cyle“ has be started. Five passwords need to be defined by the user before. More details on request.

TDM Module Tamper Detection Module: Diary / signature to track the ERASE operation. The user is forced to create diary / signature before erasing specific Flash blocks.

Security Features for Automotive & Industrial Purpose

STM8Ax Series

SECURITY Features integrated in MCUs		STM8AF	STM8AL
Integrity & Safety	CRC calculation unit		
	PowerSupply integrity monitoring	X	X
	Read While Write	X	X
	Clock Security System (CSS)	X	X
	Error Correction Code (ECC)	X	X
	Parity check		
	Temperature Sensor	X	X
	Watchdogs	X	X
Crypto HW	Random Number Generator (RNG)		
	Hashing Functions & HMAC		
	Symmetric Cryptography		
Cryptro SW	Random Number Generator (RNG)		
	Hashing Functions & HMAC		
	Symmetric Cryptography		
	Asymmetric Cryptography		
Tamper Protection	Anti Tamper	X	X
	Backup Domain		
	RTC (alarm timestamp)	X	X
	RTC Register protection	X	X
	Backup registers	X	X
	GPIO configuration locking		
Debug Lock Level	JTAG or SWD	X	X
Privileges Permis-sion Management	Memory Protection Unit (MPU)		
	Firewall		
Memory Protection	Read Protection (RDP)	X	X
	Write protection (WRP)	X	X
	Proprietary Code Protection (PCROP)		
	Mass Erase		
Traceability	Device electronic 96 bit Unique ID	X	X
Secure Firmware Update	Software FSU		

Aurix 1./2. Generation – TC2xx / TC3xx Series

SECURITY Features integrated in MCUs		TC2xx	TC3xx /2.G
Integrity & Safety	CRC calculation unit	X	X
	PowerSupply integrity monitoring	X	X
	Read While Write	(X)[1a]	(X)[1b]
	Clock Security System (CSS)	X	X
	Error Correction Code (ECC)	X	X
	Parity check	X	X
	Temperature Sensor	X	X
	Watchdogs	X	X
Crypto HW	Random Number Generator (RNG)	X	X
	Hashing Functions & HMAC		X SHA[2]
	Symmetric Cryptography	X	X
Cryptro SW	Random Number Generator (RNG)	X	from third party
	Hashing Functions & HMAC		from third party
	Symmetric Cryptography	X	from third party
	Asymmetric Cryptography		from third party
Tamper Protection	Anti Tamper	X	X
	Backup Domain		X[3a]
	RTC (alarm timestamp)		X[3b]
	RTC Register protection		X[4]
	Backup registers		X
	GPIO configuration locking	(X)	(X)[5]
Debug Lock Level	JTAG or SWD	X	X
Privileges Permis-sion Management	Memory Protection Unit (MPU)	X	X
	Firewall	X[6]	X[6]
Memory Protection	Read Protection (RDP) – HSM RAM	X	X
	Write protection (WRP)	X	X
	Proprietary Code Protection (PCROP)	X[7]	X[7]
	Mass Erase	not specified	not specified
Traceability	Device electronic 96 bit Unique ID	X	X
Secure Firmware Update	Software FSU	from third party	from third party

Notes for Aurix

1a) READ PFlash while WRITE DFlash , not for READ while Write inside PFlash

1b) READ PFlash while WRITE DFlash and READ PFlash while WRITE PFlash for SOTA on bank granularity.

2) Feature available in regard to SHA

3a) Standby controller w. 8 bit processor and Standby RAMs available in TC3xx, NOT in TC2xx

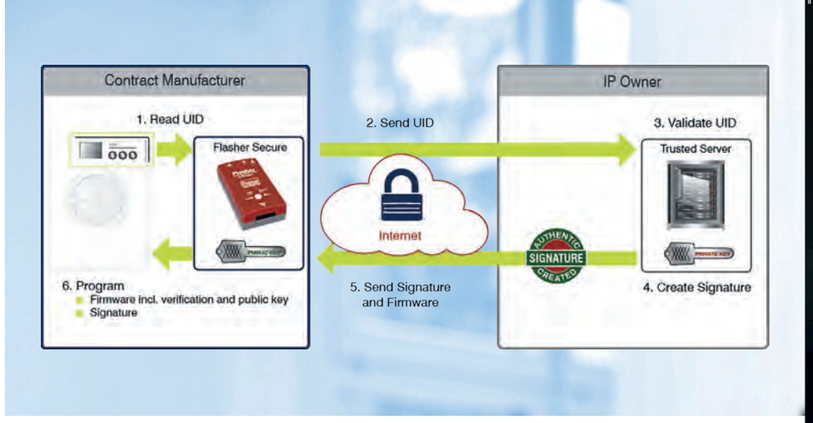
3b) Standby controller contains RTC

4) Standby controller executes its own image

5) GPIO configuration is protected with safety measures (e.g. ACCEN, ENDINIT)

6) Bridge module in HSM can be understood as Firewall functionality

7) Exclusive flag applicable on HSM code and other protection layers – a Proprietary Code protection feature (PCROP)



Security of In-Circuit-Programmer for Off-Site Production

SEGGER

For high volume production it is common to employ a contract manufacturer (CM). This setup introduces a new threat for the intellectual property (IP) of the original owner. To limit the risk of IP theft and overproduction, SEGGER announces the new production programming system Flasher SECURE.

CMs have access to customer IP and large quantities of the components they are contracted to produce. It is essential that the original owner of the IP controls their IP and the production volume. Flasher SECURE does both. To prevent counterfeit devices, the Flasher reads out a unique ID from the system which it is going to program. This ID is sent to a server that is under physical control of the IP owner. This server validates the ID and determines whether a programming run is allowed. In this case, a signature is generated for the device. The signature is sent back to the Flasher which stores the signature inside the target device it programs.

This method of secure programming is also in the best interest of the CM. The CM can now boast that the production floor will protect the customers IP.

Firmware running on the system, or an external application communicating with the system, can now verify that the system is genuine. With an additional signature for the firmware, the bootloader in the system can also verify that the firmware is genuine and unmodified. If any of the above verification fails, the device stops working. As each signature is unique for each device, it is not possible to create a non-approved system by simply copying the firmware.

The signature generation uses a proven asymmetric algorithm where the private key is not accessible by anyone but the IP owner. This prevents attackers from forging a signature for a given ID. All communication between Flasher and server is encrypted and authenticated by a secure SSL/TLS connection to prevent unauthorized access. All actions are logged and accessible through an administration interface to provide as much transparency to the IP owner as possible. Small series and mass production environments benefit from the reliability and performance of SEGGER's in-circuit-programming solution. SEGGER's production programmers are designed with multiple interfaces, making them easy to integrate into any production environment. In mass production environments, ATE or other production control units can easily access the Flasher for programming including serial numbers and patch data.

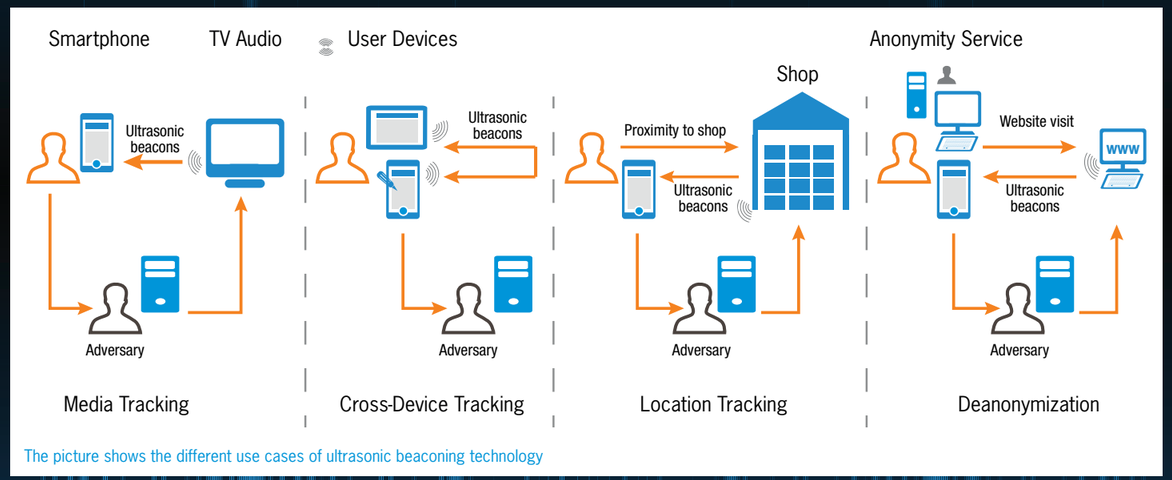
100% transparency & security in manufacturing management enables full control and visibility online about all CM activities:

- Account management
  - Administration
  - User
  - Contract manufacturers
- Firmware management
  - Firmware binary
  - Signature key management
- Project management
  - Manufactured volume
  - Contract manufacturer
- Production recording
  - Logging of programming records
  - Report of failed programming tries

As soon as production reaches a certain volume, contract manufacturing is a serious option. Most companies are hesitant to take that route as it introduces a risk to their intellectual property. Proper application of security systems, such as Flasher SECURE, enable these companies to access the next level with confidence.

IoT Connected Applications with Speakers

Public Loudspeakers



The picture shows the different use cases of ultrasonic beaconing technology

New Trend to Worry About: Ultrasonic Beaconing

There are already some hundred smartphone apps in the stores which contain ultrasonic beaconing software. If the app has the right to use the microphone of the smartphone, than it will listen in the background to audio codes in the range of 18 kHz-20 kHz, which cannot be heard by humans. This audio spy technology can be used to track the consumed media or to identify the people within the same room by cross-device tracking. Even more dangerous is the functionality to de-anonymize users and to detect their position.

Actually the main use case is to send personalized advertisements to public displays if a user is close. This kind of marketing can be discussed in a very controversial way of course. We want to make you aware about another scenario: a manufacturer of vending machines, video walls or other public electronic equipment containing a loudspeaker is a potential victim to become infiltrated by 3rd parties with this kind of software code – similar to the use case of DDoS-Attacks, your devices could also be used to send out ultrasonic audio signals to the purpose of others.

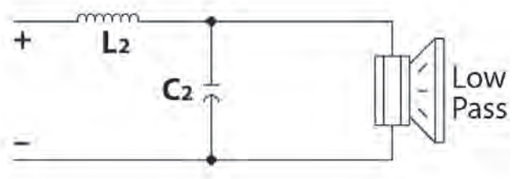
How to prevent this scenario? Of course you should take care that nobody can install such a software on your devices. For this you should use a mainboard with TPM and a supporting operation system, as well as security software to detect malware with a frequent update process. Nevertheless you can only be on the safe side if you prevent the emitting of such 18 kHz-20 kHz audio signals over the loudspeaker. Considering cost and complexity we recommend to start by building at least a 12 dB/Octave 2nd grade Butterworth filter directly connected to the speaker or – in case you use a separate amplifier – before the amplifier. In any case it should not be a digital filter in the same silicon where the beaconing code could be processed:

2nd order Butterworth (12 dB/Octave)

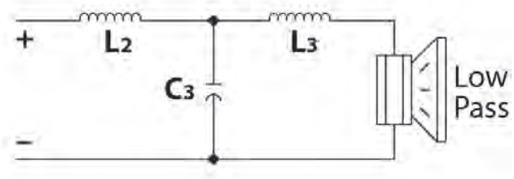
If you are using a 4 Ω speaker and you want a cut-off frequency of 18 kHz, then you should use L2 = 0.05 mH and C2 = 1.56 µF. If you are using a 8 Ω speaker, please choose L2 = 0.1 mH and C2 = 0.78 µF.

To be more on the safe side, you can also try to set up the cut-off frequency to 12 kHz to reach a much lower signal at the critical 18 kHz. Therefore you can try L2 = 0.075 mH and C2 = 2.34 µF at a 4 Ω speaker, or L2 = 0.15 mH and C2 = 1.17 µF at a 8 Ω speaker.

The impedance of speaker chassis is rising at higher frequencies and is not stable or linear, so the fine tuning should be done in your individual design. Nevertheless the suggested values give you a good starting point. Here is another example to get a sharper split of amplified and not amplified frequencies, but it will increase your bill of material:



2nd order Butterworth (12 dB/Octave)



3rd Order Butterworth (18 dB/Octave)

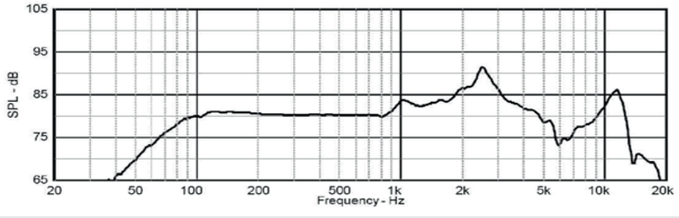
3rd Order Butterworth (18 dB/Octave)

If you are using a 4 Ω speaker and you want a cut-off frequency of 18 kHz, then you should use L2 = 0.05304 mH, L3 = 0.01768 mH, C3 = 2.94722 µF.

For these capacities we recommend the MKP10 series from manufacturer WIMA. They are made for audio requirements up to 250 V. Some examples to order at Rutronik are the order codes KFO9094 for 1 µF, KFO8627 for 1.5 µF, KFO9244 for 2.2 µF, KFO9245 for 3.3 µF. Do not hesitate to ask for the order codes of other specifications.

Parallel to the filtering of playing these frequencies, you can also use a speaker made to avoid playing these ultrasonic beaconing signals. The PUI Audio AS09208AR-R is a wideband speaker with a frequency range of 90 Hz up to 15 kHz. The speaker has an impedance of 8 Ω and can be connected to a 10 W RMS (15 W music) amplifier. The industrial quality ensures an operational temperature range of -20°C up to 60°C, which is good enough for most places of public vending machines or video walls for example.

The picture shows that the speaker is perfect for voice and environmental music, but suppressing the frequencies of critical data protection in the range close to 20 kHz.



Social Engineering

Avoiding Visual and Printed Spying on Displays, Keyboards and Number Pads

All the digital high tech security mechanisms are useless when it comes to social engineering. If somebody wants to spy your pin-code, password or personal data on a screen, all the security on data transmission, data storage and data processing are obsolete.

Avoiding Visual Spy on Displays

Security is also an important topic in the field of visualization. Taking the easy example of an ATM, the person who is in front of the display needs to have the full view and control of his action. The viewing angle of the TFT must be designed in the way that only the user can see the proceedings on the screen. All the other persons next to the user are of course not allowed to see the transactions which are happening at that moment. So therefore the display-designers need to guarantee a restrictive viewing angle for the security of the user.

Displays are made of a front glass and rear glass, backlighting, liquid cristals and polarizers.

The viewing angles of a display are related to the rubbing angle of the LCD masking within the production. The rubbing angle itself is the trace that guides the flow of the liquid crystal inside the display to reveal the expected view.

The polarizer can be produced in a way to influence the viewing angles through his structure on the surface. Another security point in our ATM example is the fact that the user wants to quit the application without leaving any traces of finger prints on the screen. That could make a ”review” of the PIN input possible. Therefore many displays use a touchscreen with an anti-finger-print function.

Most smartphones have the AFP (Anti Finger Print) included. This special coating of the display glass or cover glass avoids traces of dust, scratches and the finger print itself.

Such applications are in the most cases semicustom-made display solutions and are offered by our display suppliers Yeebo, Tianma, URT and Displaytech. The Rutronik Embedded display team can help you building up your display with your specific viewing angel parameters and anti-finger-print cover for a save use in the field.

Avoiding Visual and Printed Spy on Keyboards and Number Pads

If a user has to type in a password on a keyboard or a pin-code on a number pad, the input can be observed by Outsiders. To avoid such lack in security we recommend using a biometrical sensor to ensure the identity of an authorized user.

Fingerprint Solutions from BYD

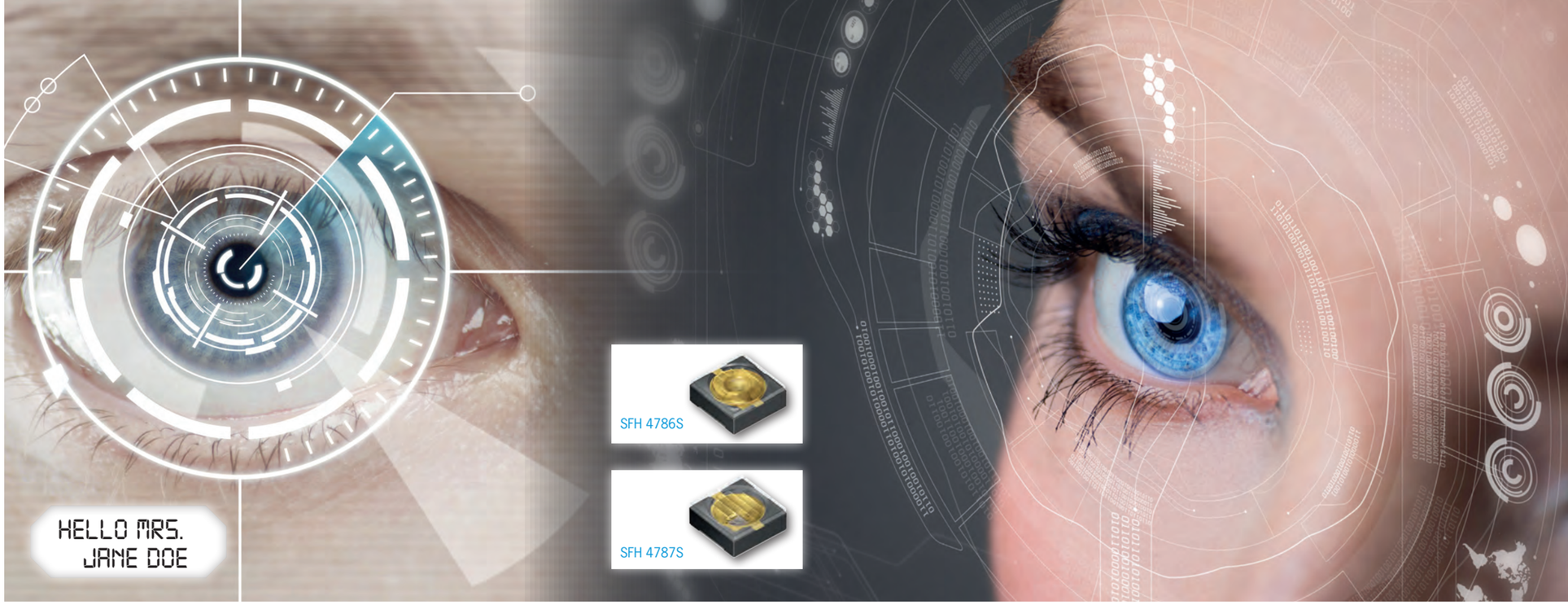
Type	BF6667A	BF6637B	BF6627A	BF6638A	BF6628A	BF6618A
Typical Application	Back or front of phone			Front or side of the phone		
Module Solution	Plastic package + Coating	Plastic package + Coating/Cover	Plastic package + Cover	Plastic package + Coating	Plastic package + Cover	Under-glass
Covering Thickness	50 µm	100 µm	175 µm	100 µm	175 µm	275 µm
Sensor Area	4.8 mm x 4.8 mm			6.4 mm x 3.3 mm		
Sensor Array	96 x 96			128 x 66		
Key	No support			Support		
Ring	Support No ring solution					
V_{CC}	2.8 to 3.3 V					
IOV_{CC}	1.8 V / V_{CC}					
Interface	SPI (Typical 8 MHz)					
Fingerprint Detection	15 mA @ 30 Hz	15 mA @ 15 Hz	15 mA @ 10 Hz	15 mA @ 15 Hz	15 mA @ 10 Hz	15 mA @ 10 Hz
Finger Detection	100 µA @ 20Hz			100 µA @ 20 Hz		
Sleep Mode	20 µA			20 µA		
FRR	<1/100			<1/100		
FAR	<1/200,000			<1/200,000		
Fingerprint Acquisition Time	<50 mS			<50 mS		
System Response Time	<150 mS			<150 mS		

Fingerprint IC Features

- Product line is complete, can be used for mobile phone back, front and side
- Perfect industrial chain layout, has a good capacity to support
- Package support cutting, mobile ID design more flexible
- Support different module structure, such as
  - "Plastic package + Coating"
  - "Plastic package + Cover" and
  - "Under-glass"
- Use unique patented "synchronous excitation" capacitance detection scheme, no need for metal ring, single chip implementation, cost-effective
- Own software algorithm, without authorization fee, with ultra low FAR and FRR, the user experience is better
- For different hardware platforms and software systems , have mature development experience and production experience, technical support efficiency is high

Social Engineering

Avoiding Visual and Printed Spying on Displays, Keyboards and Number Pads



OSRAM
Opto Semiconductors

Reliable Protection of Devices Thanks to Infrared Iris Scanning and Facial Recognition from Osram

Secure data transfer is possible thanks to high tech from Osram. Banking apps on smartphones, business e-mails on your laptop, and online shopping on your tablet – our mobile companions need powerful protection against unauthorized access. Special infrared LEDs from Osram Opto Semiconductors provide the basis for reliable iris and face recognition even on mobile devices. The OSLUX and SYNIOS family are used for any kind of access control.

Iris scans and facial recognition are among the most reliable biometric identification methods and are difficult to fool. Both methods require special infrared LEDs in order to provide reliable protection for mobile devices. Osram Opto Semiconductors is a technology leader in this field. Two years ago, the company was the first to launch an infrared LED that brought iris scanners to smartphones and other mobile devices.

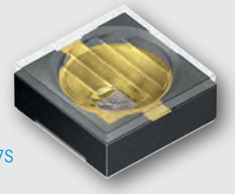
Infrared Iris Scanning

Essentially, iris scanners illuminate the eyes with infrared light and a camera takes a picture. Special software then analyzes the picture to detect the iris pattern, which is unique to each individual. After rolling out its first infrared LED for iris scanners in mobile devices, Osram added a version with a slightly angled direction of emission, which aligns with the camera's field of view.

The latest infrared LED, the Oslux SFH 4787S, is a new version that enables the iris to be illuminated even more uniformly. This third-generation Osram IRED for iris recognition meets another need in this application: the brightness differences in the camera images should ideally only originate from the iris pattern and not be additionally caused by a gradient in the illumination. This would mean that the software needs to correct fewer artefacts when determining the iris pattern. With the SFH 4787S, Osram has thus developed an emitter with a flat light, optimizing the reflector and lens to ensure virtually constant intensity across the emitted light beam.

Apart from this, the SFH 4787S is almost identical to its predecessor, the SFH 4786S. Both are based on the compact 3.5 x 3.5 x 1.6 millimeter large Oslux package. A wavelength of 810 nanometers (nm) delivers high-contrast images for all eye colors. The emission direction is tilted by 8°, while the emission angle is ±18°. The optical output of this highly efficient emitter is 720 milliwatts (mW) at a current of 1 amp, with a radiant intensity of 1,000 milliwatts per steradian (mW/sr).

Products for Secure Iris Recognition
SFH 4787S , SFH 4786S and SFH 4780S


SFH 4787S

Facial Recognition

Sensor systems for facial recognition record the user's face and detect typical features independent of facial expressions. However, to identify these features accurately and reliably, the software requires high-quality images. This means illuminating the face brightly and evenly, without shadows – and for this method to protect laptops and tablets, it also has to work in a wide variety of lighting conditions. The solution is to illuminate the face also with infrared light. Facial recognition is considered a highly secure form of biometric identification. The system records the user's face and detects typical features independent of facial expressions.

However, to identify these features accurately and reliably, the software requires high-quality images. This means illuminating the face brightly and evenly, without shadows – and for this method to safeguard laptops and tablets, it also has to work in a wide variety of lighting conditions. The solution lies in additional illumination of the face with infrared light.

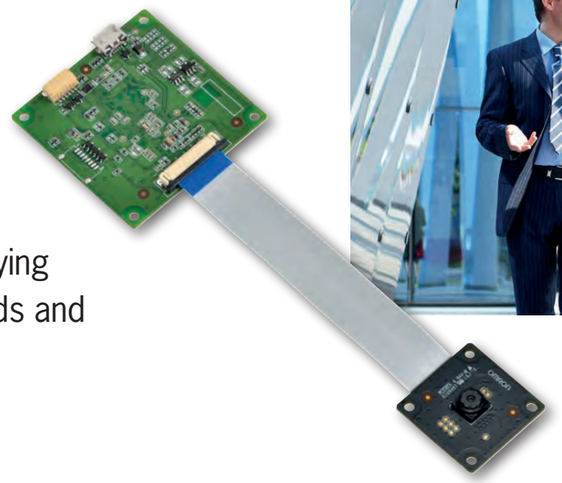
The SFH 4770S is Osram's most compact infrared LED (IRED) in the high-power class. Its low height is of particular benefit in smartphones and tablets. The high optical output of typically 1800 mW @1.5A and broad emission characteristics make this IRED ideal for facial recognition and eye-tracking systems which can activate applications in response to blinking instead of the usual double-click.

The basis for the new record emitter is the SYNIOS package which Osram introduced some time ago for LEDs in the visible spectral range for automotive applications. The package is extremely compact, measuring only 2.7 mm x 2.0 mm x 0.6 mm, and offers optimum light extraction. The SFH 4770S is the first component in which this package has been used for infrared emitters. Installed in the IRED is a 1 mm2 emitter chip with a wavelength of 850 nanometers (nm) in which two emission centers are provided with the aid of nanostack technology. Overall, the component delivers a typical optical output of 1800 mW @ 1.5 A with only one chip.

Products for Facial Recognition
Osram SFH 4770S and SFH 4716AS


SFH 4770S

Social Engineering



Avoiding
Visual and Printed Spying
on Displays, Keyboards and
Number Pads

OMRON

Human Vision Components (HVC-P2)

HVC incorporates different image sensing functions like face recognition in an easy-to-mount and compact format to provide image sensing capability to various devices.

Features

- Camera module angle of view: 2 models (50 deg. and 90 deg.) available
- Multiple Functions (10 functions): Body Detection, Face Detection, Hand Detection, Face Direction Estimation, Gaze Estimation, Blink Estimation, Age Estimation, Gender Estimation, Expression Estimation and Face Recognition
- User friendly: easy implementation through UART or USB

Applicable for:

Outdoors
- Estimate interest and purchase behavior of people to store goods of interest
- Vending machines recommending drinks to people

Home
- Home appliances matching movement of people
- AC units targeting people
- Robots matching people
- Lights targeting only people

Workplace
- AC units targeting people
- Lights targeting only people
- Hands free machine operation
- Doors opening to registered people

Specifications

Function	Dimension
Horizontal detection area (angle of view)	50 deg: 54°±3°; 90 deg: 94°±5°
Vertical detection area (angle of view)	50 deg: 41°±3°, 90 deg: 76°±5°
Detection distance (differs per function)	3.2 –16.7 m (HVC-P2 50 deg), 1.6 – 8.6 m (HVC-P2 90 deg)
Dimensions (W x L x H)	45 x 45 x 8.2 mm (main board for both types) 25 x 25 x 8.7 mm (camera board 50 deg type) 25 x 25 x 15.7 mm (camera board 90 deg type)

Function	Results
Face detection, body detection, hand detection	Result count (max: 35), center coordinates (X & Y), detection size (pixel), degree of confidence
Face direction estimation	Yaw degree, pitch degree, roll degree, degree of confidence
Gaze estimation	Yaw degree, pitch degree
Blink estimation	Blink degree (left-side eye/right-side eye)
Age estimation	Age, degree of confidence
Gender estimation	Gender, degree of confidence
Expression estimation	5 expressions: “neutral”, “happiness”, “surprise”, “anger”, “sadness” and their respective score, expression degree (positive/negative)
Face recognition	Individual recognition result, score
Image output	Choose one: none, 160 × 120 pixels, 320 × 240 pixels Image format: 8 bit Y data

Social Engineering

Secure Entry Systems

A secure access to sensitive areas is the first barrier to prevent damage, theft and unauthorized operatings. An entry system has very often used a pin code terminal, because it was the simplest way to grant access. A pin code is the easiest barrier to hack, so we recommend other solutions:

Secure Entry System Based on RFID Security

Rutronik can offer a wide range of ready to use access control systems including turnstiles. The RFID reader system is already integrated and is being managed via TCP/IP. Our range of RFID identity cards, wristbands and key fobs as well as our servers from Advantech or Fujitsu can complete the whole application of a secure entry system using RFID authentication. It is safer than a pin code, because a RFID transponder cannot be copied or spied out like a pin code. Only the risk of losing the transponder or theft is given. We recommend to discuss the individual compilation of components with our product specialists.

Secure Entry System Based on 3D Face Recognition by Video Technology

Combining a turnstile with biometrical sensor technology is the safest solution. One of our latest high tech sensors is the Intel® RealSense™ Technology. This is a collection of hardware and software capabilities that allows you to interact with a device in a non-traditional manner and enables you to develop highly interactive applications or solutions.

There are three combined cameras that act like one:

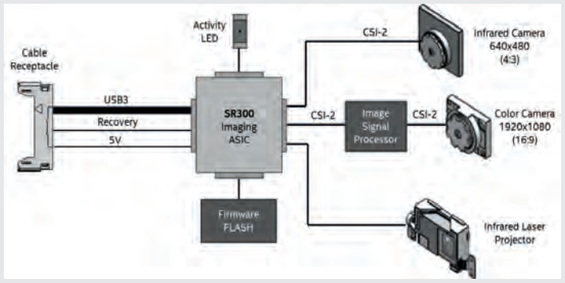
- a 1080p HD camera
- an infrared camera
- an infrared laser projector

allowing them like the human eye to sense depth and track human motion.

Intel® RealSense™ technology redefines how we interact with our devices for a more natural, intuitive and immersive experience, supported by the powerful performance of Intel® processors.

The infrared projector projects an infrared grid onto the scene and the included infrared camera records the reflection on surfaces to compute the depth information and combine it with the recorded 2D camera record. With the integrated microphone array it is possible to localize sound sources in the space and perform background noise cancellation. With Intel® RealSense™ Software Development Kit and RealSense™ modules, you can create compelling, exciting applications in a variety of application areas, or you can just buy needed modules and cables seperatly. Face recognition, which is needed to build a secure entry system, is already available in the SDK to allow a quick time to market.

intel Security



Committed to excellence

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