



Final release of the SafeCloud platform

D4.3

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More information

Additional information and public deliverables of SafeCloud can be found at <http://www.safecloud-project.eu>

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Executive summary

This deliverable summarizes the final release of the SafeCloud platform on the SafeCloud website (<https://www.safecloud-project.eu/>). The main updates since the initial platform release are the inclusion of the missing components, the addition of an integration blueprints figure that shows which components can be used together, and a few example architectures that integrate more than one SafeCloud component.

1 Introduction

The framework proposed by SafeCloud consists of three layers: secure communication, secure storage, and secure queries. Secure communication provides schemes for the establishment of channels amongst protocol participants employing technologies for tamper-resistant channels, ensuring confidentiality and availability. Secure storage provides techniques for reliable storage, such as long-term confidentiality, protection against file corruption or data deletion. Finally, secure queries provide cryptographic constructions from the database storage layer to the end-user processing requests. The overarching idea is to allow system developers to use the techniques provided by these three layers to achieve application-specific deployments. These deployments should surpass the state-of-the-art of existing tools with respect to functionality, performance and security. We recall Figure 1, from the general SafeCloud framework description.

Secure communication	State of the art: TLS secure channels	Solution:	SC1 - Vulnerability-tolerant channels	SC2 - Protected channels	SC3 - Route-aware channels
		<i>Gives:</i>	Tolerance to vulnerabilities in components	Decreased risk of fake certificates; resistance to port scans and enumeration of network infrastructure	Improved confidentiality with warnings about route hijacking and making harder access to communication
		<i>API:</i>	Extended secure socket API	Extended secure socket API	Extended secure socket API
		<i>Provided by:</i>	INESC-ID, TUM	INESC-ID, TUM	INESC-ID, TUM
Secure storage	State of the art: Encrypted storage	Solution:	SS1 - Secure block storage	SS2 - Secure data archive	SS3 - Secure file system
		<i>Gives:</i>	Block storage on individual data centers with fine control over data placement	Entangled immutable data storage for protection against tampering and censorship	Distributed secure file storage leveraging the secure block storage
		<i>API:</i>	Key/value	REST (S3 or similar)	POSIX-like
		<i>Provided by:</i>	UniNE, INESC TEC	UniNE, INESC TEC	UniNE, INESC-ID
Secure queries	State of the art: CryptDB	Solution:	SQ1 - Secure database server	SQ2 - Secure multi-cloud database server	SQ3 - Secure multi-cloud application server
		<i>Gives:</i>	Privacy of data against the server	Privacy of data against non-colluding servers	Privacy of data against non-colluding servers and clients
		<i>API:</i>	SQL	SQL	SQL
		<i>Provided by:</i>	INESC TEC	INESC TEC, Cyber	Cyber

Figure 1: Components of the SafeCloud architecture.

The SafeCloud platform is a set of solutions that are being developed in the SafeCloud project.

The components are listed on the SafeCloud public website under the platform menu and are also directly accessible at <http://www.safecloud-project.eu/platform/>. The landing page for SafeCloud platform mimics the SafeCloud architecture as can be seen on Figure 2. For the final release of the platform we updated the landing page with a figure and text about which components can be used together. The new and updated landing page can be seen on Figure 3.

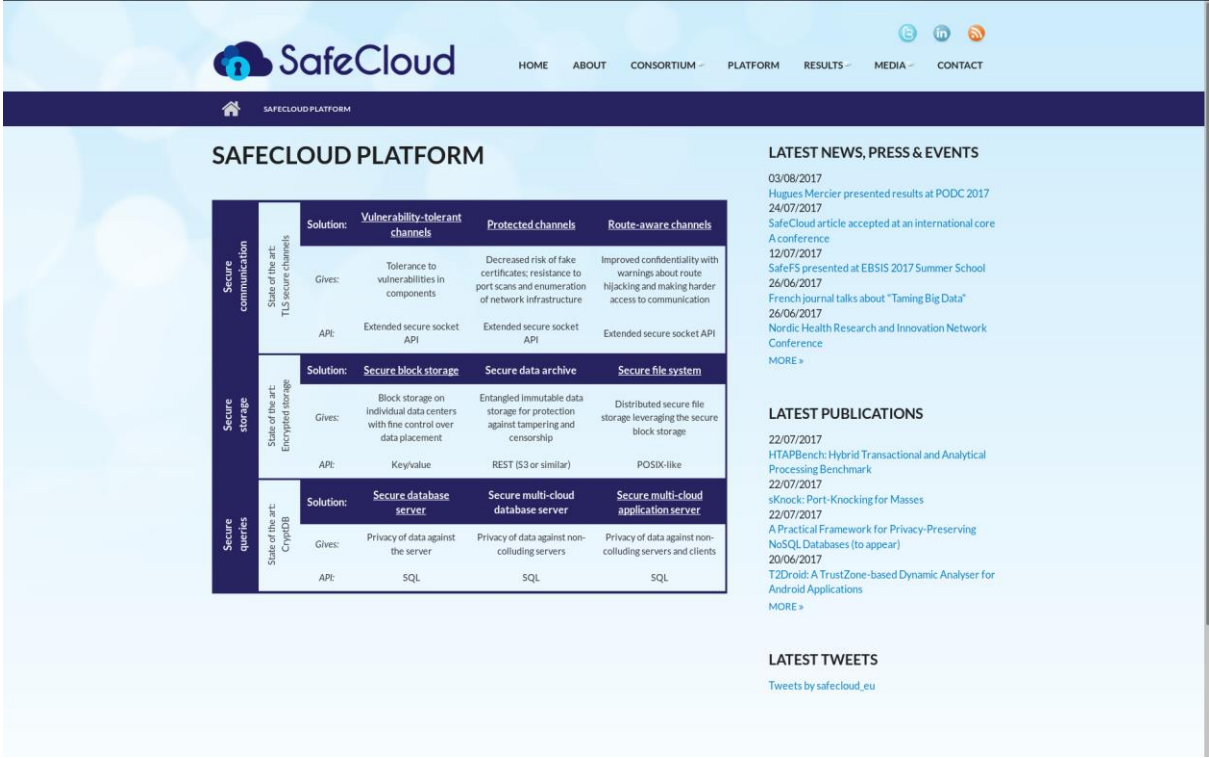


Figure 2: The landing page of SafeCloud platform from the initial release on the SafeCloud website.

The screenshot shows the SafeCloud platform landing page. At the top, there is a navigation bar with links for HOME, ABOUT, CONSORTIUM, PLATFORM, RESULTS, MEDIA, and CONTACT. Below the navigation bar, there is a table with three columns: 'GIVES', 'Privacy of data against the server', 'Privacy of data against non-colluding servers', and 'Privacy of data against non-colluding servers and clients'. The 'API' row shows 'SQL' for each of these categories. To the right of the table, there is a 'LATEST TWEETS' section featuring a tweet from 'SafeCloud Project' (@safecloud_eu) with a photo of a lake and mountains.

INTEGRATION BLUEPRINTS

The diagram illustrates the integration blueprints for SafeCloud technologies. It shows connections between various components: SC1, SC2, and SC3 (Secure Communication); SS1, SS2, and SS3 (Secure Storage); and SQ1, SQ2, and SQ3 (Secure Query). Lines connect SC1 to SS1, SS2, and SS3; SC2 to SS1, SS2, and SS3; SC3 to SS1, SS2, and SS3; SS1 to SQ1, SQ2, and SQ3; SS2 to SQ1, SQ2, and SQ3; and SS3 to SQ1, SQ2, and SQ3. A SafeCloud logo is also present in the diagram.

This figure illustrates how the SafeCloud technologies can be used together to build applications with superior security guarantees. One line on this figure means that it makes sense to build an application that uses these technologies together.

We will now explain the justification behind these lines.

COMMUNICATION

All SafeCloud's secure communication (SC) technologies have similar integration properties. Each of the SC technologies can be used by an application that uses the socket API to connect to other applications. This makes integration easier for both client-server and peer-to-peer applications that need additional assurances about the security of its channels.

SC technologies can be combined with each other, but this should be done after considering the need for each particular set of guarantees. Typically, if an application can use one SC technology, it can use any of them.

STORAGE

The storage technologies are more diverse than the communication technologies. Firstly, SS1 is by itself a backend for SS2 or SS3 that is not intended for use separately. SS2 is a unique storage system that supports its own category of applications with its entangled, censorship-resistant storage. As such, it makes sense to use SS2 in a secure information system with secure transport layers, but doesn't integrate directly with any of the query systems.

SS3 can be a secure storage backend for query systems SQ1 and SQ2 and SQ3 (although it makes less sense for the last of them). While one can imagine a system that uses SS3 and any of the communication platforms, there is no

Figure 3: The updated version of the platform landing page also features integration blueprints.

We also created two example architecture diagrams that show how you can use multiple SafeCloud components together. The examples are linked from the platform landing page and for reference we also include the links here:

- <https://www.safecloud-project.eu/platform/example1>
- <https://www.safecloud-project.eu/platform/example2>

2 Content

The subpage for each solution contains information about where to obtain said solution, and instructions on how to deploy it. Additional information like scientific publications and relevant public SafeCloud deliverables are also linked.

For the final release we updated each solution subpage with the most recent guides, GitHub links and related publications. For an example, the subpage for SafeCloud Secure queries layer solution 1 can be seen on Figure 4.

We favour Docker containers for distributing our software. Docker containers are easy to set up, test and deploy. These properties are paramount for the adoption of the SafeCloud technologies.

The screenshot shows the 'SECURE DATABASE SERVER' subpage on the SafeCloud website. The page features a navigation bar with links for HOME, ABOUT, CONSORTIUM, PLATFORM, RESULTS, MEDIA, and CONTACT. The main content area is divided into several sections:



- SECURE DATABASE SERVER:** A heading followed by a paragraph explaining that any application wanting to integrate SafeCloud secure queries solutions has two distinct APIs (SQL or NoSQL) available. It also mentions full SQL compatibility and a full HBase-like NoSQL interface.
- Diagram:** A flow diagram showing an 'APP' box at the top, connected to a 'SafeCloud' box in the middle. The connection is labeled 'SQL' and 'NoSQL'. Below this, a dashed line separates 'On-premises Infrastructure' from 'Third-party Cloud Infrastructure'. In the 'Third-party Cloud Infrastructure' section, there is another 'SafeCloud' box connected to a database icon.
- LATEST NEWS, PRESS & EVENTS:** A list of recent events with dates and titles, including 'Hugues Mercier presented results at PODC 2017' and 'SafeCloud article accepted at an international core A conference'.
- LATEST PUBLICATIONS:** A list of recent publications with dates and titles, including 'HTAPBench: Hybrid Transactional and Analytical Processing Benchmark' and 'A Practical Framework for Privacy-Preserving NoSQL Databases (to appear)'.
- GET IT HERE:** A section with the text 'Contact Francisco Almeida Maia.'
- RELATED PUBLICATIONS:** A section with the text 'D3.3 - Non-elastic secure Key Value Store.'
- LATEST TWEETS:** A section with the text 'Tweets by safecloud_eu'.

Figure 4: An example of a subpage describing one SafeCloud platform component.

We also updated the Products and solutions page which can be seen on Figure 5. There are descriptions for all the industrial partners. In addition Maxdata and Cloud & Heat, the two industrial partners that had use cases, describe how SafeCloud solutions have helped them.

SAFECLLOUD PRODUCTS AND SOLUTIONS

The components developed by the SafeCloud consortium are integrated in the following solutions and products:

	<p>Since founded as AoTerra back in 2011 the primary focus of Cloud&Heat is to integrate energy efficiency with state of the art safe cloud computing and storage services. Cloud&Heat (C&H) has developed two use cases in the context of the SafeCloud project that represent two product pilots of the company. Both pilots are storage solutions backed by the Ceph distributed storage software. They are described in detail in D5.5. There C&H shows that SafeCloud technology can be fully integrated into C&H products. The SafeCloudBox product relies on the SafeCloud File System (SafeCloudFS, SS3) to provide customers with a secure and fault-tolerant data storage solution. The CloudBlockStorage product extends C&H's block storage cloud offer with inter-datacenter security by using the SafeCloud Private Communication Middleware (SC2).</p>
	<p>Maxdata develops and commercializes the CLINiDATA® healthcare software line of products. These products are used to manage clinical laboratories and store results of clinical tests, among other personal data. Since 1978, this software has been delivered to customers by installing it on their premises. This approach has allowed Maxdata to conquer most of the Portuguese market – currently it is present in more than 80% of national public hospitals – but now the company wants to sell CLINiDATA® abroad and one of the ways is to deploy it on the cloud and sell it as a service (SaaS). However, when moving to the cloud, additional mechanisms are needed to ensure an adequate protection of personal data given that a single breach may destroy company credibility. In the case of CLINiDATA®, as in many other information systems, one component is of paramount importance: the relational database management system (DBMS). SafeCloud provides Maxdata DBMS-like Secure Queries Solutions able to guarantee the classic ACID properties, with an SQL interface, and, at the same time, protect personal data from potential adversaries such as cloud providers, hackers and unauthorized government agencies.</p>
	<p>Cybernetica is a R&D intensive technology company that researches, develops and manufactures software solutions as well as maritime surveillance and radio communications systems. It also investigates and</p>

LATEST NEWS, PRESS & EVENTS

- 30/07/2018
SafeCloud partners gave invited talk at ICSOFT
- 17/07/2018
GDPR Compliant Systems Workshop supported by SafeCloud
- 17/07/2018
SafeCloud co-sponsored the 1st Workshop on Privacy by Design in Distributed Systems
- 17/07/2018
SafeCloud work presented at EBSIS Summer School
- 26/06/2018
RECAST presented at DSN 2018
- [MORE >](#)

LATEST PUBLICATIONS

- 30/07/2018
Storing Critical Data in the Cloud: Challenges and Solutions
- 11/07/2018
Evaluation of Algorithms for Multipath Route Selection over the Internet
- 11/07/2018
S-Audit: Efficient Data Integrity Verification for Cloud Storage
- 07/06/2018
RECAST: Random Entanglement for Censorship-resistant Archival Storage
- [MORE >](#)

LATEST TWEETS

Tweets by safecloud_eu

Figure 5: Updated Products and Solutions page.