AN12698

MIFARE SAM AV3 for NTAG 5, ICODE DNA and UCODE DNA

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522012 COMPANY PUBLIC

Document information

Information	Content
Keywords	MIFARE SAM AV3, ICODE, UCODE, DNA, TAM Authenticate, MF4SAM3, NTAG 5, MAM Authenticate
Abstract	This application note shows the use of MIFARE SAM AV3 in combination with NTAG 5, ICODE DNA and UCODE DNA

Revision history

Rev	Date	Description
1.2	20200310	Added NTAG 5 link and NTAG 5 boost
1.1	20200108	AN number changed, security status changed into “Company Public”
1.0	20190702	Initial version

1 Introduction

MIFARE SAMs (**S**ecure **A**pplication **M**odule) have been designed to provide the secure storage of cryptographic keys and cryptographic functions for the terminals to access the MIFARE products securely and to enable secure communication between terminals and host (backend).

1.1 Scope

This application note presents examples of using MIFARE SAM AV3 (referred to SAM in this document, if not otherwise mentioned) for NTAG 5 link, NTAG 5 boost (both referred to NTAG 5 in this document), ICODE DNA and UCODE DNA. In this document, the SAM is used in S mode. There is a set of application note for MIFARE SAM AV3; each of them is addressing specific features. The list of application note is given in [1].

This application note is a supplement document for application development using MIFARE SAM AV3. Should there be any confusion please check MIFARE SAM AV3 data sheet [2].

Note: This application note does not replace any of the relevant data sheets, application notes or design guides.

1.2 Abbreviations

Refer to application note “AN5210 MIFARE SAM AV3 – Quick Start up Guide” [1].

1.3 Examples presented in this document

The following symbols have been used to mention the operations in the examples:

= Preparation of data by SAM, PICC or host.

> Data sent by the host to SAM or PICC (if not mentioned, SAM).

< Data Response from SAM or PICC (if not mentioned, SAM).

C-APDU:

CLA	INS	P1	P2	Lc	Data (nc)	Le

R-APDU:

Response data	SW1	SW2

Please note, that the numerical data are used solely as examples. They appear in the text in order to clarify the commands and command data.

Any data, values, cryptograms are expressed as hex string format if not otherwise mentioned, e.g., 0x563412 in hex string format represented as “123456”. Byte [0] = 0x12, Byte [1] = 0x34, Byte [2] = 0x56.

1.4 S interface

The host is managing the communication to SAM AV3 and NTAG 5 / ICODE / UCODE via the RF Controller.

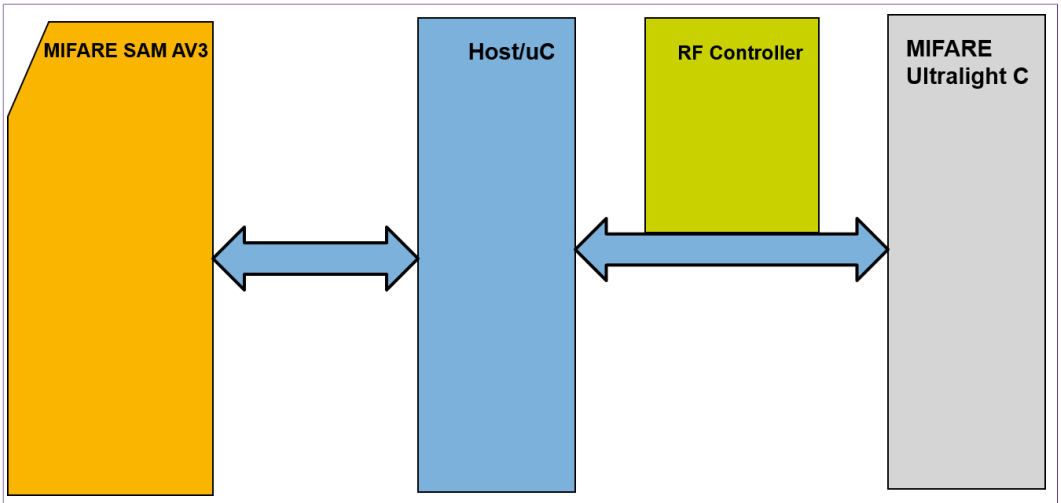


Figure 1. Architecture in non-X interface

2 NTAG 5, ICODE DNA and UCODE DNA

MIFARE SAM AV3 can be used to perform the AES authentication for NTAG 5, ICODE DNA and UCODE DNA. Both, tag authentication and mutual authentication are available. More details about these functionalities can be found in the product datasheets of NTAG 5, ICODE DNA and UCODE DNA [3,4,5].

For NTAG 5, ICODE and UCODE, only **S-mode** support is available.

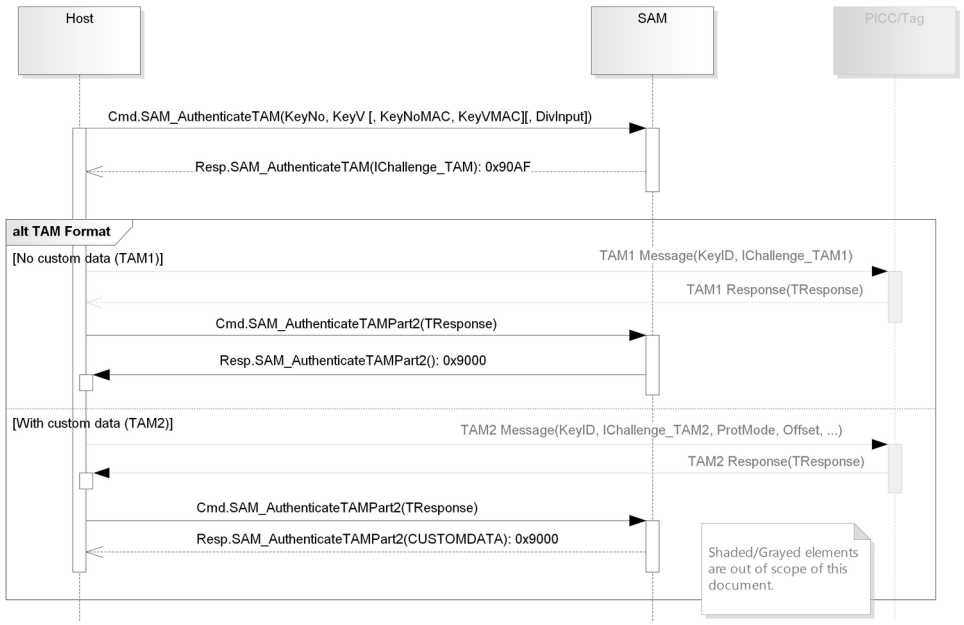
The following example for TAM is valid for NTAG 5, ICODE DNA and UCODE DNA.

The following example for MAM is valid for NTAG 5 and ICODE DNA.

2.1 Authenticate TAM

In this example, a TAM authentication is performed. The TAM sequence looks like the following:

Figure 2. TAM Authenticate sequence



The command uses one AES-128 Key from the Keystore to perform the authentication.

To perform this example, a key with the following attributes needs to be created:

- KeyType = AES128
- KeyClass = PICC
- KeyNoCEK = 0x00 and KeyVCEK = 0x00
- RefNo. KUC = 0xFF (no KUC used)
- KeyNoAEK = 0x00 and KeyVAEK = 0x00
- Diversified use only: This property is not set in this example, however it is strongly recommended to set for real applications. This setting prohibits the use the key in an undiversified form.

- Key Value: 0x00000000000000000000000000000000, Version 0x01
  The KeyID on the tag is 0x00 in this example.

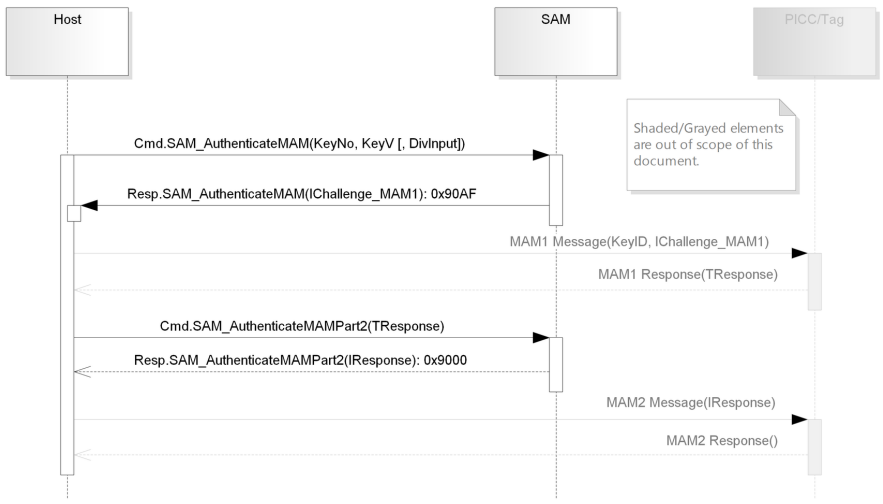
Table 1. Example - SAM_AuthenticateTAM

step	Indication		Data / Message	Comment
1	Request IChallenge_ TAM from SAM	>	80B0000002090100	Use Key 0x09 version 0x01
2	Receive IChallenge_ TAM from SAM	<	A2E61C15CF69D1F3BC 2890AF	The SAM AV3 answers with 10 Byte random challenge and SW1SW2 as 0x90AF
3	Send IChallenge_TAM to NTAG 5/ICODE DNA/UCODE DNA	>	3500000028BCF3D169C F151CE6A2	Pass the received IChallenge along with the Authenticate command to the NTAG 5/ICODE DNA/UCODE DNA. **Attention**: The byte order is reversed!
4	Receive TResponse from NTAG 5/ICODE DNA/UCODE DNA	<	A7C76124B0CAC5B66FF E3BA594D838C2DF	The NTAG 5/ICODE DNA/UCODE DNA answers with A7 and the TResponse
5	Send TResponse to SAM AV3	>	80B0000010DFC238D89 4A53BFE6FB6C5CAB02 461C7	Pass the TResponse without the A7 **Attention**: The byte order is reversed.
6	Return Code	<	9000	Return code from SAM signalizing the TAM is pass.

2.2 Authenticate MAM

In this example, a MAM authentication (mutual authentication) is performed. This example is only valid for NTAG 5 / ICODE DNA. The MAM sequence looks like the following:

Figure 3. TAM Authenticate sequence



The command uses one AES-128 Key from the Keystore to perform the authentication.

To perform this example, a key with the following attributes needs to be created:

- KeyType = AES128
- KeyClass = PICC
- KeyNoCEK = 0x00 and KeyVCEK = 0x00
- RefNo. KUC = 0xFF (no KUC used)
- KeyNoAEK = 0x00 and KeyVAEK = 0x00
- Diversified use only: This property is not set in this example, however it is strongly recommended to set for real applications. This setting prohibits the use the key in an undiversified form.
- Key Value: 0x11111111111111111111111111111111, Version 0x02
  The KeyID on the tag is 0x01 in this example.

Table 2. Example - SAM_AuthenticateMAM

step	Indication		Data / Message	Comment
1	Request IChallenge_ MAM from SAM	>	80B2000002090200	Use Key 0x09 version 0x02
2	Receive IChallenge_ MAM from SAM	<	2AAF36011365224B134A90AF	The SAM AV3 answers with 10 Byte random challenge and SW1SW2 as 0x90AF
3	Send IChallenge_ MAM to NTAG 5/ ICODE DNA	>	3500020 14A134B2265130136AF2A	Pass the received IChallenge along with the Authenticate command to the NTAG 5/ ICODE DNA **Attention**: The byte order is reversed!
4	Receive TResponse from NTAG 5/ ICODE DNA	<	A74C76F7D4458E1C520C30798F7D73B24BC522F47D10C4	The NTAG 5/ ICODE DNA answers with A7 and the TResponse
5	Send TResponse to SAM AV3	>	80B2000016C4107DF422C54BB2737D8F79300C521C8E45D4F7764C00	Pass the TResponse without the A7 **Attention**: The byte order is reversed.
6	Receive IResponse from SAM AV3	<	84D8EF30D3581C2561A26330A6ABFECD9000	The SAM AV3 answers with 16 Byte IResponse and 0x9000
7	Send IResponse to NTAG 5/ ICODE DNA	>	350006CDFEABA63063A261251C58D330EFD884	Pass the IResponse to the NTAG 5/ ICODE DNA. **Attention**: The byte order is reversed.
8	Receive return code from NTAG 5/ ICODE DNA	<	A7	NTAG 5/ ICODE DNA responds with A7 to signalize the authentication is pass

3 References

1. **Application note** – **AN12695 – MIFARE SAM AV3 – Quick Start up Guide**, document number 5210xx, https://www.nxp.com/docs/en/application-note/AN12695.pdf.
2. **Data sheet –** Data sheet of MIFARE SAM AV3, document number 3235xx.
3. **Data sheet –** Data sheet of UCODE DNA, document number 3201xx.
4. **Data sheet –** Data sheet of ICODE DNA, document number 3486xx.
5. **Data sheet –** Data sheet of NTA5332, document number 5447xx.

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