ISO/IEC JTC1/SC17 2009-11-17
Cards and personal identification

ISO/IEC JTC1/SC17 N 3814

DOCUMENT TYPE: National Body Contribution

TITLE: National Body Contribution: 14443/NFC Harmonization Contributions to standardise requirements for interoperability of applications that are to be executed between 14443 (PICC and PCD) and 21481 compliant devices.

BACKWARD POINTER:

SOURCE: Japan Committee SC6 and SC17

STATUS:

ACTION ID: FYI

WORK ITEM:

DUE DATE:

DISTRIBUTION: P and L-Members of ISO/IEC JTC1/SC17
JTC1 Secretariat
ISO/IEC ITTF

MEDIUM: SERVER

NO. OF PAGES: 17

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14443/NFC Harmonization

Contributions to standardise requirements for interoperability of applications that are to be executed between 14443 (PICC and PCD) and 21481 compliant devices

Japan Committee SC6 and SC17

2009-11-13

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14443/NFC Harmonization

1 Introduction

The meeting report of the 2nd SC 6 Study Group for Harmonization between NFC and ISO/IEC 14443, 17-18 September 2009 in Singapore (6N14085) noted the following 8 recommendations and related opinions.

[1] **The SG recommends** submission of further contributions to standardise requirements for interoperability of applications that are to be executed between 14443 (PICC and PCD) and 21481 compliant devices.

[2] **The SG recommends** that the antenna classes specifications in 14443 take into account the requirements of 18092 and 21481 (NFCIP-2).

[3] For emulation of PCD mode, **the SG recommends** that 21481 devices in PCD mode should support at least one of the classes 1, 2, or 3 as specified in 14443-1 amendment 1.

[4] For emulation of the PICC and VICC modes, **the SG recommends** to add the "PICC mode" and "VICC mode" as mandatory modes in 21481.

[5] **The SG recommends** that contributions should be made that analyse the issues regarding "VICC mode".

[6] **The SG recommends** updating the references to 10373-6 in ISO/IEC 22536 and 23917 (NFC test standards for RF and protocol), see 5.1 of the agenda.
Agenda 5.1, RF test methods for NFC-devices/PICC/PCD (10373-6)

[7] The SG added PICC mode (see 14443) support to an initial draft (attached) of 21481 (revision) as a reference for further discussion for the revision; **the SG recommends** to SC 06/WG1 to revise 21481 based on the proposal from the SG that adds the PICC mode (see 14443) support to the initial draft 21481 (revision).

[8] **The SG recommends** that SC 06 starts the revision process on 21481, 18092 and 22536 and 23917.

[9] The electronic appliance should be seen as a device that implements 14443 and/or 18092.

[10] The NFCIP-2 partly solves some (but not all) interoperability problems.

[11] The SG shares Mr. Hegenbarth's opinion that 6N14054 is an excellent survey of the application and their overlaps and it should be used to derive action items for the SG, in response to Mrs. Baronas' question on the potential use for 6N14054.

[12] The user experience should be paramount.

[13] The intention of 6N14054 is to start standardisation on interoperability for overlapping application areas.

[14] The SG clarifies "PCD mode" in 21481.

[15] The addition would follow the same way for "PICC/VICC mode" as "PCD/VCD mode" in 21481 (namely by reference).

[16] SC 06 resolutions the contribution suggest to use references rather than copying text and it also suggests to refer to local/national standards if needed.

[17] Lightweight cryptography for battery powered devices that may consider power saving.

[18] In 6N14054 JISC considers field strength for battery powered devices.

[19] 14443 using an X-block to support interoperability and capabilities exchange of higher layers. It solves the common issue of discovery of options and activation of capabilities or protocols for the contactless systems in addition to providing a bridge between protocols.

[20] Study commonalities and differences between the NFC-SEC and the 7816 security models see considerations and work listed in 5.2.3 on security and battery powered devices.

This contribution provides followings:

a) Clause 2 General contains that replacements of copied text by references to SC17 standards and local/national standards, relates to [1], [8], and [16].

b) Clause 3 Interoperability contains an analysis about the communication capability between tow ISO/IEC 21481 devices, relates to [1], [3], [4], [7], [8], [9], [10], [11], [12], [13], [14], [15], and [19].

c) Clause 4 Test Methods highlights issues that the set of new test methods for revised ISO/IEC 21481 device, relates to [1], [2], [3], [4], [6], [8], [9], [10], [11], [12], [13], [14], [15], and [18].

d) Clause 5 Handheld Devices highlights issues that did not exist on the plastic cards, relates to [1], [2], [3], [4], [5], [9], [10], [11], [12], [13], [14], and [15].

e) Clause 6 Security Framework highlights that the differences between NFC-SEC and 7816 security models, relates to [1] and [20].

2 General

2.1 To use references rather than copying text

6N14085 noted “In response to the WG1 mandate, Takayama-san indicated that SC 06 mirror in Japan is following up on the SC 06/WG1 resolution to replace text copied from 14443 by an appropriate reference to 14443.”

6N14060 states “Clauses in the next edition of ISO/IEC 18092 on the air interface (modulation types and bit coding) shall be replaced by a normative reference to the respective clauses of ISO/IEC 14443 (for type A as well as type B). Care should be given to not bind to a specific edition of this normative reference.”

6N14060 states “If requirements of ISO/IEC 18092 are not specified in 14443, but only in national standards, then informative references to such national standards shall be used in ISO/IEC 18092. An example is the air interface for the bit rate of 212 kbps in ISO/IEC 18092 and parts of the command set defined in JIS X 6319-4, which expands to ISO/IEC 18092.”

6N14085 noted “Mr. Leenders introduced 6N14060 from NL in support of SC 06 resolutions the contribution suggest to use references rather than copying text and it also suggests to refer to local/national standards if needed.”

6N14085 noted “Nakamura-san indicated that the SC 06 mirror in Japan is preparing an English translation of JIS X 6319-4, in response to 6N14060.” Japan National Committee SC 06 will contribute it to the SG Berlin meeting.

2.1.1 How to replace text copied from 14443 by an appropriate reference to 14443

Different mnemonics are used for the same thing; therefore it is possible for us to replace the text copied from 14443 Type A by an appropriate reference to 14443 Type A.

The figure 9 of ISO/IEC 14443-3 and the figure 13 of ISO/IEC 18092 are identical, therefore figure 13 of 18092 can refer figure 9 of 14443-3. This means that the anticollision of 14443-3 Type A and the Single Device Detection (SDD) of 18092 Passive Communication Mode is identical. It is possible for us to replace the text copied from 14443 Type A by an appropriate reference to 14443 Type A.

2.1.1.1 Bit and Byte numbering

The name of bit position is different between 14443 and 18092. 14443 uses the name “bit 1” for the first bit and 18092 uses the name “bit 0” for it. With a simple editorial update this can be synchronized.

2.1.1.2 Terms

Different term is used for the same meaning. The terms are listed by the following contributions.

6N13965 NB of Japan’s contribution to SC 6/WG 1 Tokyo meeting on harmonization between the NFC standards and ISO/IEC 14443 – Terms Proximity

6N13966 NB of Japan’s contribution to SC 6/WG 1 Tokyo meeting on harmonization between the NFC standards and ISO/IEC 14443 – Terms NFC

6N13967 NB of Japan’s contribution to SC 6/WG 1 Tokyo meeting on harmonization between the NFC standards and ISO/IEC 14443 – Terms Vicinity

For instance, table 2.1 indicates comparison of terms in the figure 9 of 14443-3 and figure 13 of 18092. Those are different terms but the same.

Table 2.1 — Example comparison of mnemonics

ISO/IEC 14443 terms	ISO/IEC 18092 terms
Anticollision	Single Device Detection
ATQA	SENS_RES
REQA	SENS_REQ
SAK	SEL_RES
UID	NFCID1

2.1.1.3 Modulation and bit coding

The modulation and bit coding of ISO/IEC 14443-2:2001 type-A is identical with the Passive Communication Mode of 106 kb/s in ISO/IEC 18092:2005.

2.1.1.4 Anticollision (14443-3) and SDD (18092 Passive Mode) flow

There is no essential difference between the type-A of 14443-3 anticollision flow and the 106 kb/s Passive Communication Mode of 18092 Single Device Detection flow. Mnemonics are different but meanings are the same. The figure 9 of ISO/IEC 14443-3 and the figure 13 of ISO/IEC 18092 are identical except the step of “Check SENS_RES”.

The “Check SENS_RES” means an intentional clarification for checking SENS_RES (ATQA) there is no conditional branch at this check point.

For these reason, we can say that the figure 9 of ISO/IEC 14443-3 and the figure 13 of ISO/IEC 18092 are identical, therefore figure 13 of 18092 can refer figure 9 of 14443-3.

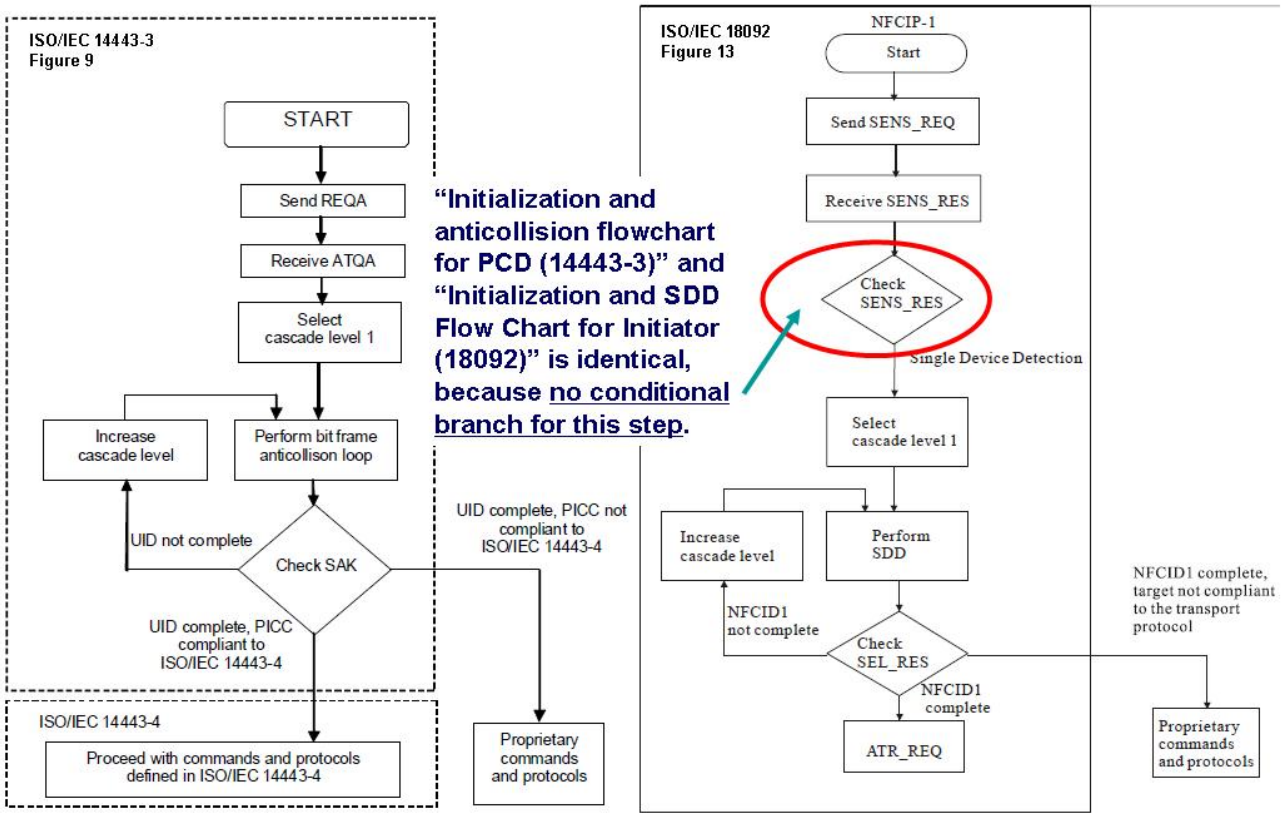

Figure 2.1 — Anticollision (14443-3) and SDD (18092 Passive Mode) flow

2.1.2 Referencing from ISO/IEC 18092

The “RF Signal interface” and the “Initialization and Anticollision” of JIS X 6319-4 is identical with the Passive Communication Mode of 212, 424 kb/s in ISO/IEC 18092 underlying technology is the same. The terms used are slightly different but have the same meaning.

Figure 2.2 is the figure 24 (the title is “Activation protocol in Passive communication mode”) of the ISO/IEC 18092. The ISO/IEC 18092 clause 12.2 clearly specifies the general flow and how it branches to the proprietary protocol box. The “Transmission protocol” and “Organization, security and commands for interchange” of JIS X 6319-4 may be activated in the proprietary protocol box. This mechanism and technology are used in Japan.

From the technical point of view, it is possible to let ISO/IEC 18092 refer JIS X 6319-4 as the Passive Communication Mode 212, 424 kb/s. (424 kb/s have added to the revised version of JIS X 6319-4.)

Table 2.2 — Difference between Passive 212 kb/s ISO/IEC 18092 and JIS X 6319-4

	Passive Communication Mode 212, 424 kb/s ISO/IEC 18092	**JIS X 6319-4**
RF characteristics	identical	
Frame Format	identical	
Initialization	identical	
Anticollision	identical	
Polling Request	“System Code” is always (FFFF)	“System Code” is depends on application family. (FFFF) is wildcard.
Polling Response	identical	
Transmission protocol	Data Exchange Protocol	Read command/response Write command/response
Organization, security and commands for interchange	Not specified	File structure, Authentication command/response

NOTE1: ETSI/SCP is also expecting to have the ISO/IEC 18092 air interface in their UICC solution assuming to work with JIS X 6319-4. See ETSI TS 102 613 (SWP) and ETSI TS 102 622 (HCI).

NOTE: JIS X 6319-4:2005 have finished revising in September 2009 and will be translated into English.

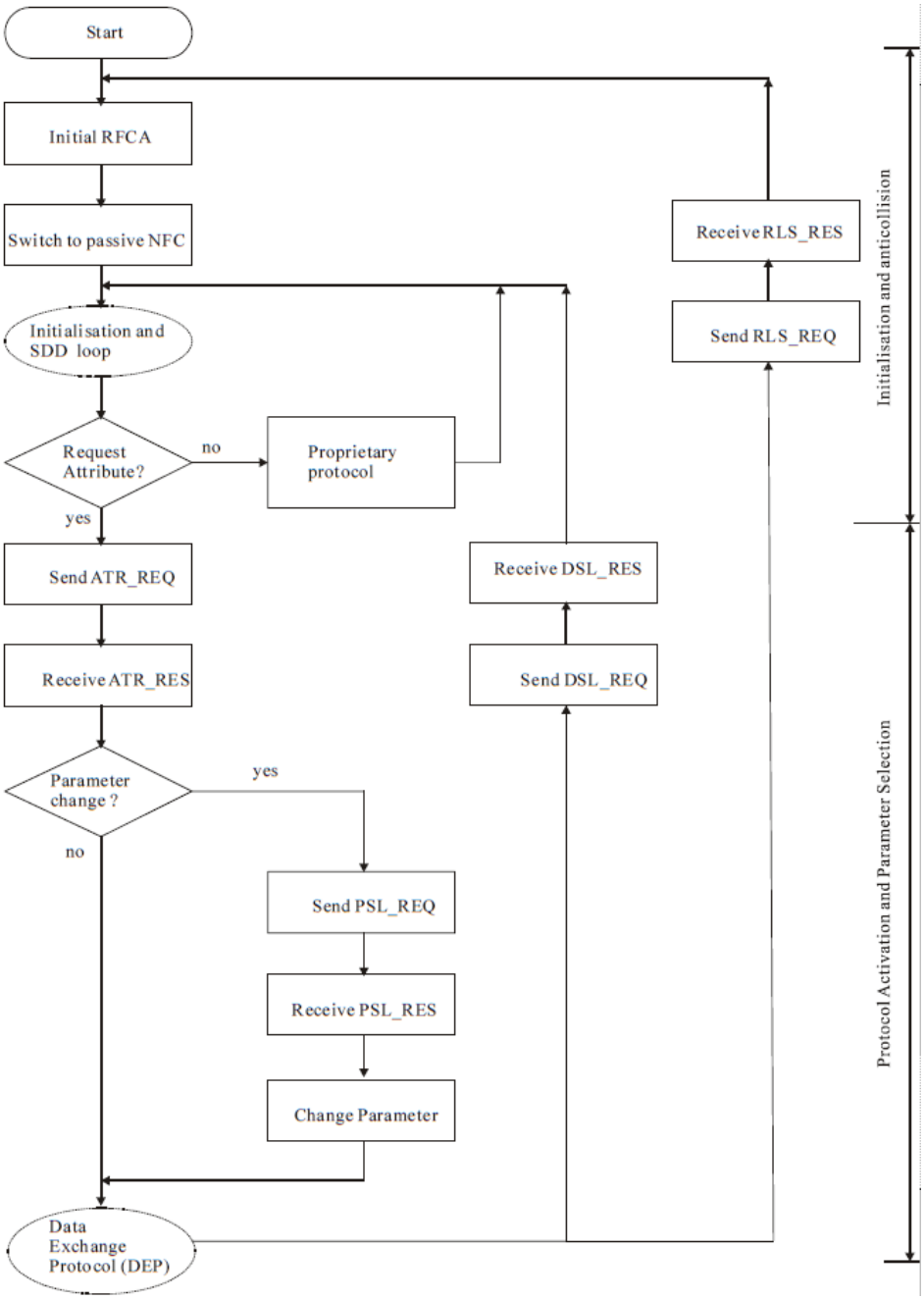

Figure 2.3 — Activation protocol in Passive communication mode (ISO/IEC 18092 Figure 24)

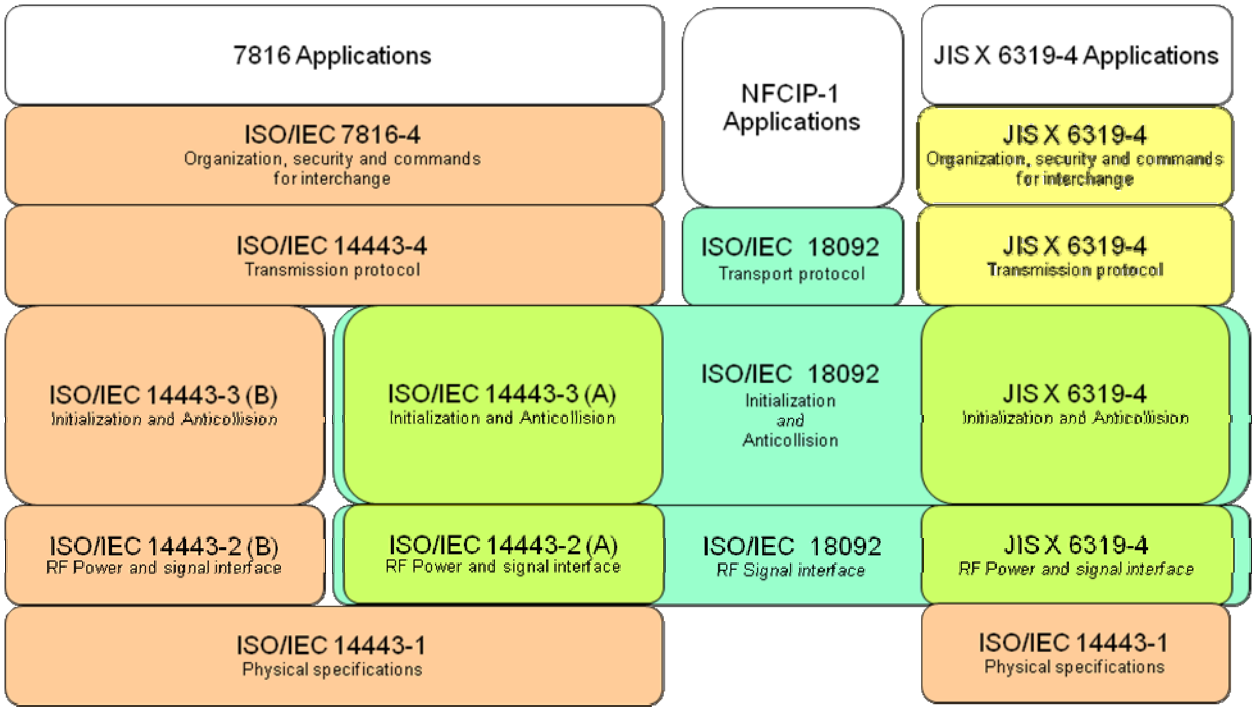

Figure 2.4 — JIS X 6319-4:2005 layer by layer comparisons

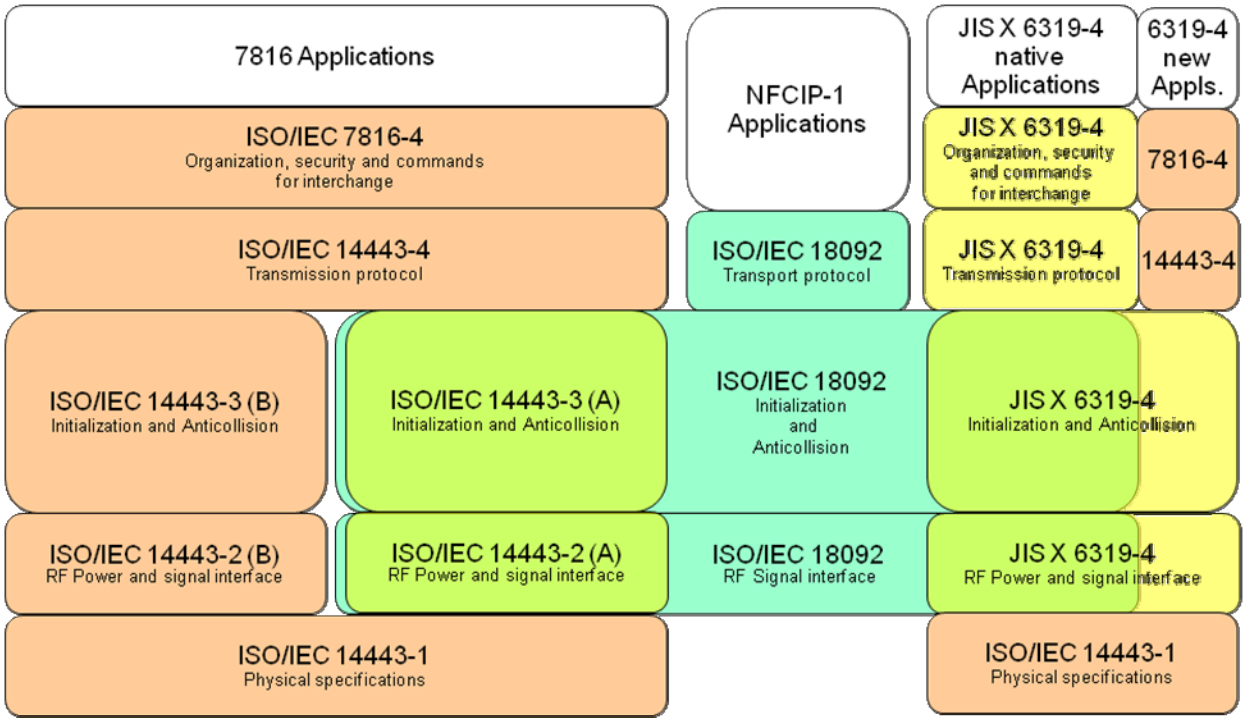

Figure 2.5 — Revised JIS X 6319-4 layer by layer comparisons

3 Interoperability

The 6N14054 indicated three overlapping application areas. Seven different problematic scenarios can be identified between the 18092 and the 14443 devices. The below table 3.1 shows all 28 of combinations under the actual overlapping applications area.

Table 3.1 – All combinations of interoperability

	21481	**18092**	**14443A PICC**	**14443B PICC**	**14443 PCD**	**15693 VICC**	**15693 VCD**
21481	3.1	3.2	3.3	3.4	3.5	3.6	3.7
18092	3.2	3.8	3.9	3.10	3.11	3.12	3.13
14443A PICC	3.3	3.9	3.14	3.15	3.16	3.17	3.18
14443B PICC	3.4	3.10	3.15	3.19	3.20	3.21	3.22
14443 PCD	3.5	3.11	3.16	3.20	3.23	3.24	3.25
15693 VICC	3.6	3.12	3.17	3.21	3.24	3.26	3.27
15693 VCD	3.7	3.13	3.18	3.22	3.25	3.27	3.28

The scope of the ISO/IEC 21481 states: This International Standard specifies the communication mode selection mechanism, designed to not disturb any ongoing communication at 13,56 MHz, for devices implementing ISO/IEC 18092 and the reader functionality for integrated circuit cards compliant to ISO/IEC 14443 or ISO/IEC 15693. This International Standard requires implementations to enter the selected communication mode as specified in the respective standard. The communication mode specifications, however, are outside the scope of this NFCIP-2 Standard.

The ISO/IEC 21481 device shall have its RF field switched off and try to detect external RF field that is 0,1875 A/m at the operating frequency 13,56 MHz. If no external RF field is detected then the RF detection and Initial RF generation is executed according to the clause 9 of ISO/IEC 21481. Then application activates the ISO/IEC 18092, external RF field detection followed by the ISO/IEC 14443 PCD or external RF field detection followed by the ISO/IEC 15693 VCD.

These activated communication modes are independent from the ISO/IEC 21481 and do not have any specification for returning to the ISO/IEC 21481. Therefore, the current version of ISO/IEC 21481 does not provide the interoperability beyond the selected communication mode. The slide number 13 in 6N13898 also mentioned about this point. See figure 3.0.

For this reason, the scope and architecture of the current version of ISO/IEC 21481 is not sufficient for the overlapping applications area. See also 6N14054 that explains about the overlapping applications area.

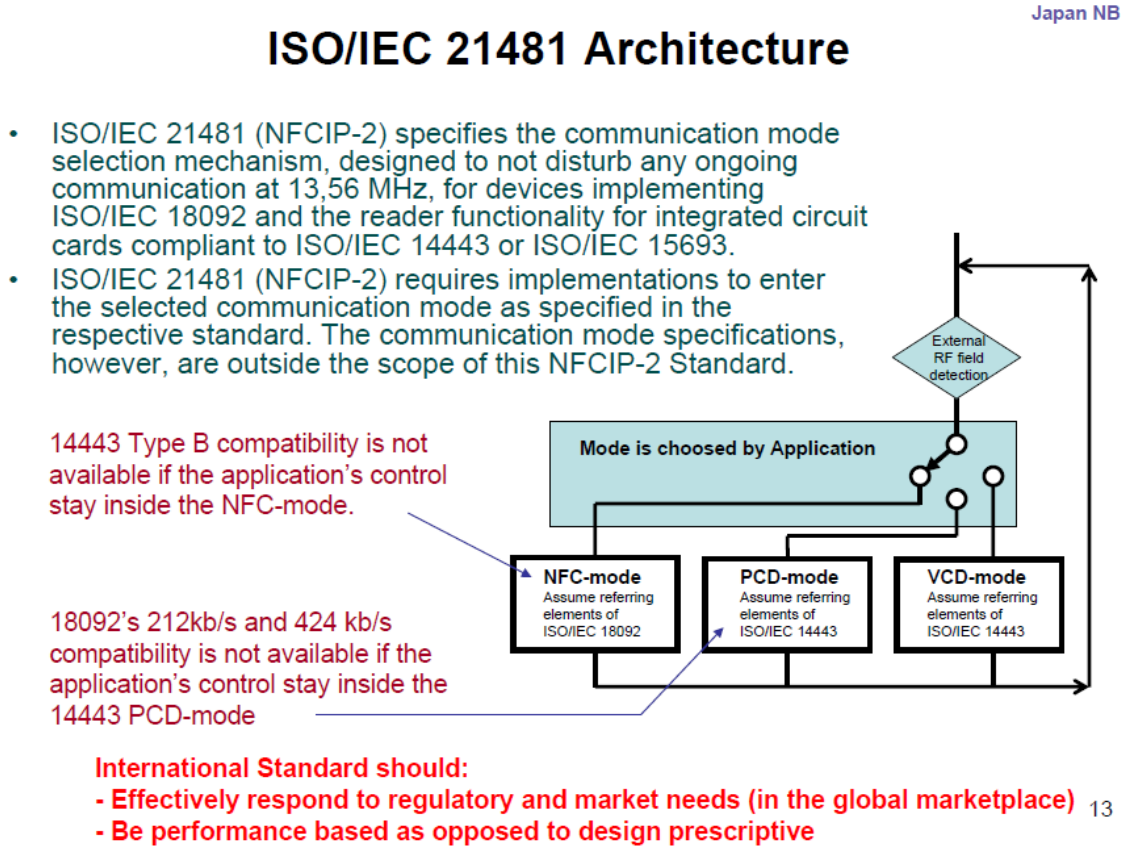

Figure 3.0 — ISO/IEC 21481 architecture

3.1 Interoperability between 21481 devices

There are 21 combinations of the communication modes between two new (it means PICC-mode was added) ISO/IEC 21481 devices, because the selection of the modes depend on the applications. See table 3.2.

From the realistic design point of view, those application providers may use only one mode or some more out of 21 modes for their service and do not care about the other modes. From the users' perspective or experience point of view, there are many other services in their handheld devices like NFC phone. By using the two NFC phones each other for example, a different service does not work. It is natural, but the problem is users cannot distinguish the reason whether device malfunction or different service was activated by the different mode. In this sense, two ISO/IEC 21481 devices have a 4,8 % (1 ÷ 21 = 4,8 %) chance of information exchange, because the application have 21 options of the communication modes in the PICC-mode/VICC-mode added version of ISO/IEC 21481. The value 4,8 % is a kind of index for interoperability, although value itself is not so important. And there are important combinations of modes, and also there are unusual combinations of modes in the table 3.2.

Table 3.2 – Interoperability between 21481 and 21481

New 21481 \ New 21481		NFC-mode		PCD-mode	PICC-mode	VCD-mode	VICC-mode
		Active-mode	Passive-mode				
NFC-mode	Active-mode	3.1.1	3.1.2	3.1.3	3.1.4	3.1.5	3.1.6
	Passive-mode	3.1.2	3.1.7	3.1.8	3.1.9	3.1.10	3.1.11
PCD-mode		3.1.3	3.1.8	3.1.12	3.1.13	3.1.14	3.1.15
PICC-mode		3.1.4	3.1.9	3.1.13	3.1.16	3.1.17	3.1.18
VCD-mode		3.1.5	3.1.10	3.1.14	3.1.17	3.1.19	3.1.20
VICC-mode		3.1.6	3.1.11	3.1.15	3.1.18	3.1.20	3.1.21

In this document, the PICC-mode and the VICC-mode is used as the following definition.

PICC-mode
Receive amplitude modulated signal from sender, but does not expect power transfer. Send own signal by load modulation to sender. Bit oriented or time slot oriented anti-collision management is employed. Assume ISO/IEC 7816 on top of 14443-4 transport protocol.

VICC-mode
Receive amplitude modulated signal from sender, but does not expect power transfer. Send own signal by load modulation to sender. ISO/IEC 15693-3 anti-collision management is employed. Assume ISO/IEC 7816 on top of 15693-3 transport protocol.

3.1.1 NFC-mode.Active-mode ↔ NFC-mode.Active-mode

Two new 21481 (it means PICC-mode was added) devices have a 4,8 % chance of information exchange, because the application have 21 options of the communication modes in the current version of ISO/IEC 21481 (1 ÷ 21 = 4,8 %).

The default condition of the NFC-mode (ISO/IEC 18092; NFCIP-1) is Passive-mode of Target-mode. The NFCIP-1 device may switch to Initiator mode only if required by the application. Either Passive-mode or Active-mode in NFC-mode is decided while the Protocol Activation and Parameter Selection sequence. If the Initiator switches off its RF field after sending ATR_REQ, the device operates in Active-mode, the Target device will behave according to the ISO/IEC 18092 Active Communication Mode. See figure 3.1.1.

If two 21481 devices are already in Active-mode, it is possible to switch to Passive-mode only by terminating the current transaction and fall back to start of the activation sequence. The communication between Active-mode device and Passive-mode device does not work. Therefore, the chance ratio is 4,8 % not 9,5 %.

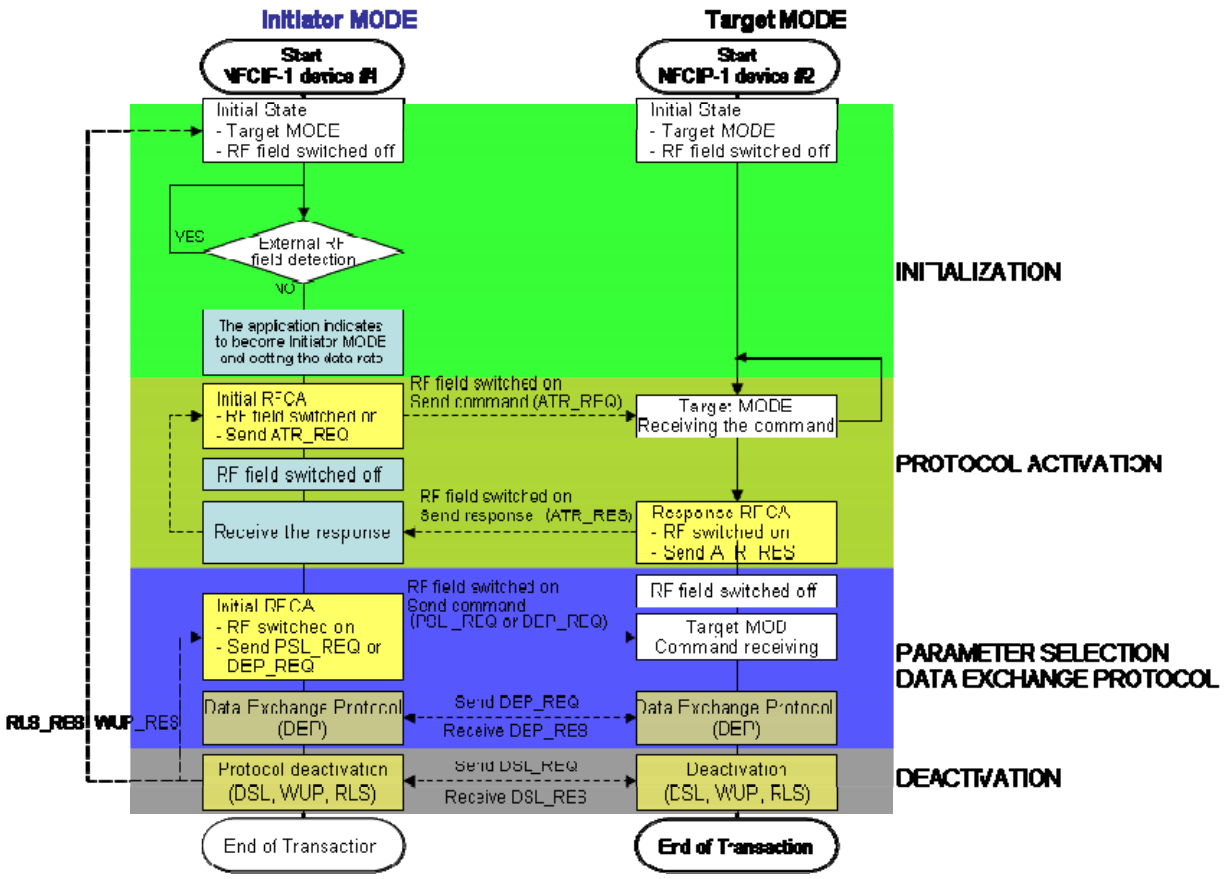

Figure 3.3.1 – General flow of the ISO/IEC 18092 NFC-mode of Active-mode

3.1.2 NFC-mode.Active-mode ↔ NFC-mode.Passive-mode

Two new 21481 devices have a 4,8 % chance of information exchange, because the application have 21 options of the communication modes in the current version of ISO/IEC 21481.

3.1.3 NFC-mode.Active-mode ↔ PCD-mode

It is impossible to communicate. The device in PCD-mode does not allow the other device to switch the RF on. The problem is that this is not obvious to the user.

3.1.4 NFC-mode.Active-mode ↔ PICC-mode

The PICC-mode of handsets is possible to work with battery power and the external RF power transmission is not necessary, although the prerequisite of 14443 PICC is different at this moment.

No common protocol between NFC and PICC, therefore they cannot exchange information.

3.1.5 NFC-mode.Active-mode ↔ VCD-mode

It is impossible to communicate. The device in VCD-mode does not allow the other device to switch the RF on. The problem is that this is not obvious to the user.

3.1.6 NFC-mode.Active-mode ↔ VICC-mode

The VICC-mode of handsets is possible to work with battery power and the external RF power transmission is not necessary, although the prerequisite of 15693 VICC is different at this moment.

No common protocol between NFC and VICC, therefore they cannot exchange information.

3.1.7 NFC-mode.Passive-mode ↔ NFC-mode.Passive-mode

Two new 21481 devices have a 4,8 % chance of information exchange, because the application have 21 option of the communication modes in the current version of ISO/IEC 21481.

The default condition of the NFC-mode (ISO/IEC 18092; NFCIP-1) is Passive-mode of Target-mode. The NFCIP-1 device may switch to Initiator mode only if required by the application. Either Passive-mode or Active-mode in NFC-mode is decided while the Protocol Activation and Parameter Selection sequence. If the Initiator switches off its RF field after sending ATR_REQ, it means Active-mode, the Target device will behave according to the ISO/IEC 18092 Active Communication Mode. See figure 3.1.1.

If two 21481 devices are already in Passive-mode, it is possible to switch to Active-mode only by terminating the current transaction and fall back to start of the activation sequence. The communication between Passive-mode device and Active-mode device does not work. Therefore, the chance ratio is 4,8 % not 9,5 %.

3.1.8 NFC-mode.Passive-mode ↔ PCD-mode

Two 21481 devices have a 0 % chance of information exchange and 4,8 % chance of device detection, because the application have 21 options of the communication modes in the current version of ISO/IEC 21481.

The PCD-mode devices can detect the NFC-mode of Passive-mode devices as 14443A-PICC, although they cannot exchange any information because common data transport protocol between 14443 and NFC-mode (18092) is not available. The word ‘detect’ means anticollision and initialization.

A NFC-mode device is not allowed to enter initiator mode when the PCD’s RF field exists.

3.1.9 NFC-mode.Passive-mode ↔ PICC-mode

Two 21481 devices have a 0 % chance of information exchange and 4,8 % chance of device detection, because the application have 21 options of the communication modes in the current version of ISO/IEC 21481.

If the PICC-mode is a 14443A-PICC emulation device and the NFC-mode.Passive-mode device is Initiator-mode, then NFC-mode.Passive-mode of Initiator device can detect the PICC-mode device as a 14443A-PICC.

But, they cannot exchange any information because common data transport protocol between 14443 and NFC-mode (18092) is not available. In this context, the word 'detect' means anticollision and initialization.

14443-B PICC cannot be detected.

3.1.10 NFC-mode.Passive-mode ↔ VCD-mode

The NFC-mode of Passive-mode of Initiator devices cannot detect RF field comes from ISO/IEC 15693 VCD, because the VCD's Hmin is 150 mA/m and the NFC's RF detection level $H_{threshold}$ is 0,1875 A/m.

3.1.11 NFC-mode.Passive-mode ↔ VICC-mode

The Hmax of NFC-mode of Passive-mode of Initiator device is 7,5 A/m. The Hmax of ISO/IEC 15693 VICC is 5 A/m. If NFC-mode Passive-mode Initiator generates beyond 5 A/m, then VICC may not work appropriately.

3.1.12 PCD-mode ↔ PCD-mode

It is impossible to communicate. The device in PCD-mode does not allow the other device to switch the RF on. The problem is that this is not obvious to the user.

3.1.13 PICC-mode ↔ PCD-mode

Two 21481 devices have a 4,8 % chance of information exchange, because the application have 21 options of the communication modes in the current version of ISO/IEC 21481.

3.1.14 PCD-mode ↔ VCD-mode

It is impossible to communicate. The device in PCD-mode does not allow the other device to switch the RF on. The problem is that this is not obvious to the user.

3.1.15 PCD-mode ↔ VICC-mode

The ISO/IEC 14443 PCD does not support ISO/IEC 15693 VICC.

The revised ISO/IEC 21481 had better support minimum requirements for interoperability of applications that are to be executed between 21481 compliant devices.

3.1.16 PICC-mode ↔ PICC-mode

The ISO/IEC 14443 does not support communication between PICCs.

The revised ISO/IEC 21481 had better support minimum requirements for interoperability of applications that are to be executed between 21481 compliant devices.

3.1.17 PICC-mode ↔ VCD-mode

The ISO/IEC 15693 VCD does not support ISO/IEC 14443 PICC.

The revised ISO/IEC 21481 had better support minimum requirements for interoperability of applications that are to be executed between 21481 compliant devices.

The 14443 PICC expects RF energy at least 1,5 A/m, although the 15693 VCD assumes 150 mA/m as minimum energy.

3.1.18 PICC-mode ↔ VICC-mode

The ISO/IEC 14443 does not support communication with ISO/IEC 15693.

3.1.19 VCD-mode ↔ VCD-mode

It is impossible to communicate. The device in VCD-mode does not allow the other device to switch the RF on. The problem is that this is not obvious to the user.

3.1.20 VCD-mode ↔ VICC-mode

Two 21481 devices have a 4,8 % chance of information exchange, because the application have 21 option of the communication modes in the current version of ISO/IEC 21481.

3.1.21 VICC-mode ↔ VICC-mode

The ISO/IEC 15693 does not support communication between VICCs.

The revised ISO/IEC 21481 had better support minimum requirements for interoperability of applications that are to be executed between 21481 compliant devices.

3.2 to 3.28

See 3.1.

3.29 PICC-mode added to 21481

Combinations of the modes supported by 21481 can lead to scenarios where two NFCIP-2 devices in different modes – device 1 in mode X and device 2 in mode Y – are neither able to detect each other nor to communicate.

Once a 21481 device gets into the PICC mode, it can never switch into the PCD mode or NFC mode or VCD mode.

Once it gets into the NFC mode, it cannot detect Type B (14443 of 106 kb/s). There are two modes in the NFC-mode. Those are Initiator-mode and Target-mode where as the default mode is Target-mode. NFCIP-1 does not execute technology polling alternation.

Once the 21481 device gets into the PCD mode, it cannot detect NFCIP-1's Passive mode of 212 kb/s and 424 kb/s.

See figure 3.29.

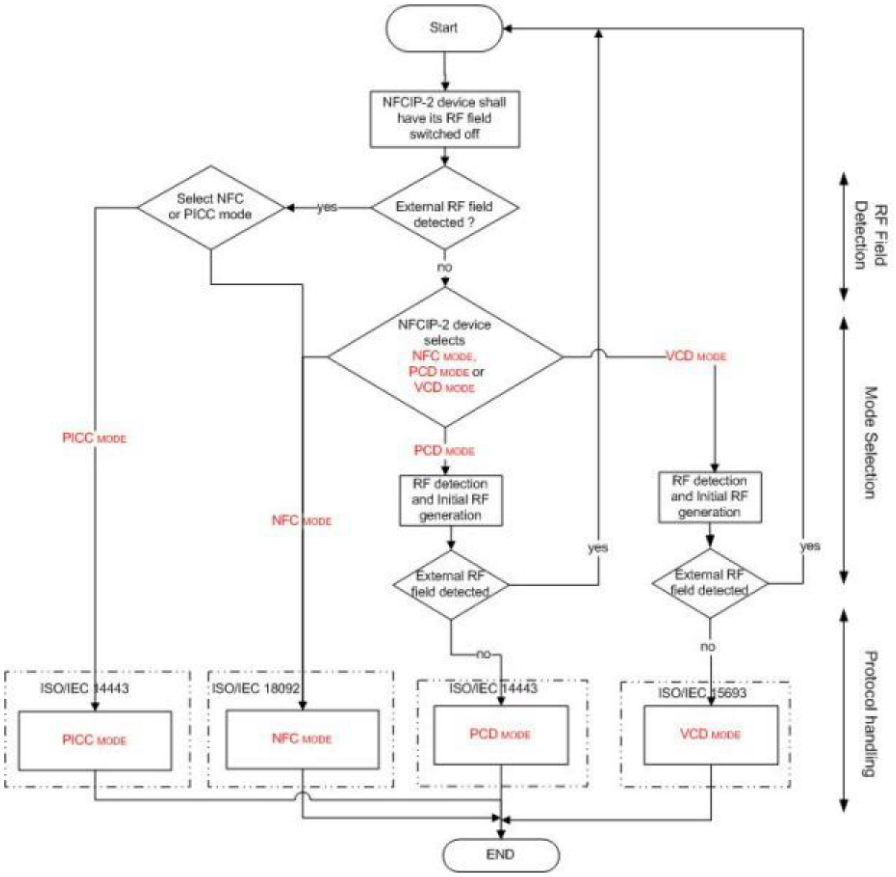

Figure 3.29 – PICC-mode added to 21481

3.30 Suggestion

The 14443/NFC Harmonized specification is for the overlapping applications area. It is proposed to solve the outlined issues by a revision of ISO/IEC 21481, especially taking into account the interoperability problem that occur from the user experience point of view as explained by 6N14054.

Those problems are not resolved if PCD-mode is still PCD, PICC-mode is still PICC, VCD-mode is still VCD, VICC-mode is still VICC, and NFC-mode is still NFCIP-1. Those PCD-mode, PICC-mode, VCD-mode, VICC-mode, and NFC-mode (only passive communication mode) should be integrated as the revised version of ISO/IEC 21481. How it should be integrated is the key to interoperability.

Although the SG added PICC-mode as the corresponding target-mode of 14443, and added VICC-mode as the corresponding target-mode of 15693, the default mode of 21481 is required. The default condition of the revised 21481 should be passive-mode of target-mode. The revised 21481 device may switch to Initiator mode only if required by the application. The revised 21481 device may use 18092 Active Communication Mode only if required by the application.

How should 21481 devices wait for all type of polling and how should a 21481 device respond? The standard reaction for the different technology of polling should be specified.

Common capability information exchange and higher layer protocol activation protocol that are independent from the communication mode and RF technology are required in order to ensure a satisfying user experience.

All the technology polling methods, including 18092 Active Communication Mode, should be accepted by the 21481 target-mode, and should be possible to exchange capability information and activating the communication mode by using the common protocol.

The ISO/IEC 21481 conformance is required for the interoperability between two 21481 devices.

4 Test Methods

To be filled.

5 Handheld Devices

To be filled.

6 Security Framework

To be filled.