ISO/IEC 14443-3

Initialization and anticollision for Type A and Type B tags

ISO/IEC 14443:

Identification cards - Contactless integrated circuit(s) cards - Proximity cards

1. Physical characteristics
2. Radio frequency power and signal interface
3. Initialization and anticollision
4. Transmission protocol

Terminology

- Anticollision loop
  - Algorithm to prepare the communication with one or more tags in the reader range
  - Bit collision detection protocol
    - A collision occurs when two tags transmit complementary bits
    - Upon detection, the reader initiates a cascaded recognition of all nearby tags
    - Each tag has a unique ID (UID or PUPI) for disambiguation
- Time slot protocol
  - Reader→tag and tag→reader messages are sent on specific time slots
  - Allows a reader to communicate with one or more tags

Terminology

- Frame
  - Series of bits containing
    - Start and end delimiters
    - Data bits
    - [optional] error correcting bits
- Unique IDs
  - Unique binary values that identify tags
  - Type A tags UID
    - 4, 7 or 10 bytes (32, 56 or 80 bits)
    - Single, double or triple size
  - Type B tags UID
    - 4 bytes (32 bits)

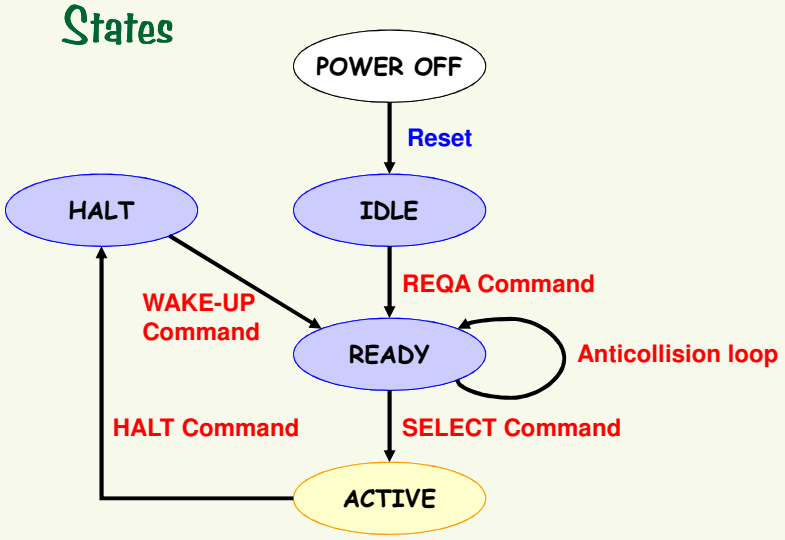
Terminology

- Single size Type A UIDs
  - Fixed
    - First byte = 08H
  - Random
    - First byte = proprietary fixed number
- Double/triple size Type A UIDs
  - Fixed or random, depends on manufacturer
    - First byte = Manufacturer ID

Acronyms

- PICC (Proximity Integrated Chip Card)
  - RFID tag
- PCD (Proximity Coupling Device)
  - RFID reader
- AFI (Application Family Identifier)
  - It helps the reader to select tags suitable for a particular application
- PUPI (Pseudo-Unique PICC Identifier)
  - Permanent UID; or
  - Temporary, random UID after power-on reset

Type A tag: States



Type A tag: Commands

- REQA
  - Read the UID size of a Type A tag
  - All IDLE tags in range send their UID size and become READY
- WAKE-UP
  - All HALTed tags in range become READY
- SELECT
  - Change state of tag from READY to ACTIVE
  - Is used to select a tag for a longer interaction with the reader
- ANTICOLLISION
  - Similar to SELECT but with UID selection bits
  - Cascade Level
    - To identify a UID 40-bit block

CL1	CL2	CL3

- HALT
  - The ACTIVE tag becomes HALTed

Type A tags: REQA command

- All nearby tags respond with ATQA
  - ATQA = UID size + bit frame anticollision bit
  - 0+1 collisions → 1
  - Reader is able to learn the maximum UID size:
    - Single (up to 32 bits): 0 0
    - Double (up to 56 bits): 0 1
    - Triple (up to 80 bits): 1 0

Type A tags: Anticollision loop (initial step)

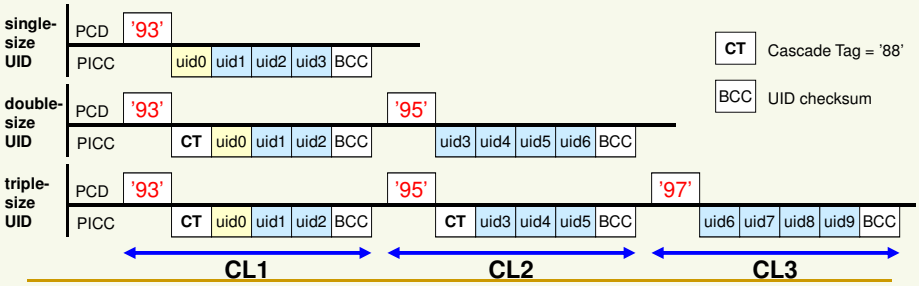
- Reader sends (probing) SELECT
  - NVB = '20'
    - No part of UID transmitted
  - All nearby tags send their UID and remain READY
- No collision
  - Reader gets only one UID
  - Reader sends SELECT + UID
    - NVB = '70'
      - Complete 5-byte portion of UID transmitted
  - Tags sends SACK and becomes ACTIVE
- Collision
  - Reader gets many overlapped UIDs
  - Reader starts anticollision loop to SELECT a single tag

Type A tags:
Anticollision loop (next steps)

- Reader sends (tentative) SELECT
  - NVB = initial identical bits of all UIDs + 1 tentative bit
    - NVB bits of UID transmitted
  - All nearby tags with a UID conforming with NVB bits send their UID and remain READY
- No answer
  - Keep NVB
  - Use the other value for tentative bit
  - Send tentative SELECT again
- Single UID answer
  - Reader sends SELECT + UID
    - NVB = 70
      - Complete UID transmitted
  - Tags sends SACK and becomes ACTIVE
- Multiple UID answers (collision)
  - Increase NVB
  - Use initial value for tentative bit
  - Send tentative SELECT again

Type A tags:
Anticollision loop (using Cascade Level)

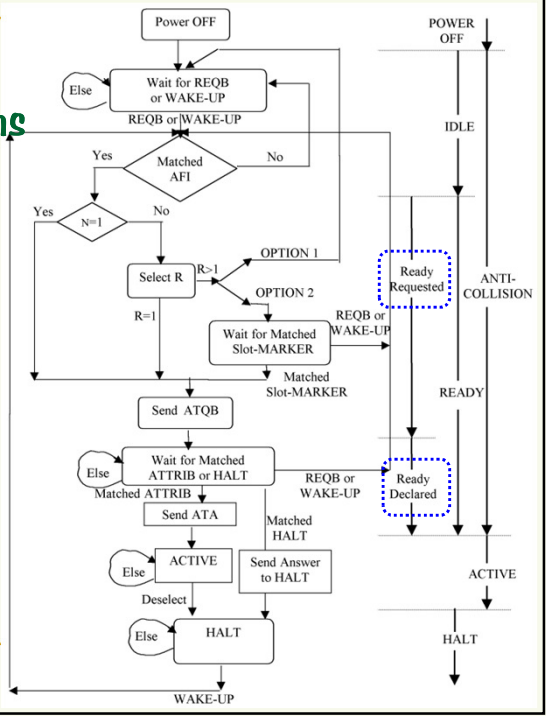
- Tentative SELECT is for a Cascade Level
  - When exhausted, increase it
    - CL1 → CL2 → CL3
  - Start tentative SELECT cycle again



Type B tags: Anticollision sequence

- Strategies
  - Time-slotted responses
    - Tags respond in different time slots
  - Probabilistic answers
    - Tags not always respond to a REQB/WAKE-UP
- Combinations
  - Probabilistic
    - Repetitive single slot prompt with response probability ≤ 1
  - Pseudo-deterministic
    - Multiple slots with scanning of all them
  - Dynamic mixture of both

Type B tag: State transitions



Type B tags: Commands (1/2)

- REQB (AFI, N response slots, tag selector)
  - AFI = 0 → all-apps, AFI ≠ 0 → app-specific
  - Selects all IDLE and READY tags, possibly HALTed tags
  - All selected tags in range may send an ATQB and become Ready-Declared
    - Until sending ATQB remain in the Ready-Requested sub-state
- Slot-MARKER (slot mark)
  - All Ready-Requested tags in range matching the slot-marker send ATQB and become Ready-Declared
    - ATQB = PUPI + App Data + Protocol Info
  - Protocol Info:
    - Bit rate capability
    - Maximum frame size
    - Protocol type (ISO/IEC 14443-4 / other)
    - Frame Waiting time Integer
    - Frame Option (Node ADdress / Card IDentifier support)

Type B tags: Commands (2/2)

- ATTRIB (PUPI, Param[3], CID)
  - Used to select a tag for a longer interaction with the reader
    - Tag replies with ATA
      - ATA = CID + optional higher layer response
    - Tag changes from state Ready-Declared to ACTIVE
  - CID (Card IDentifier)
    - [0,14], unique ID of all ACTIVE cards
- HALT (PUPI)
  - The Ready-Declared or ACTIVE tag with the given PUPI becomes HALTed