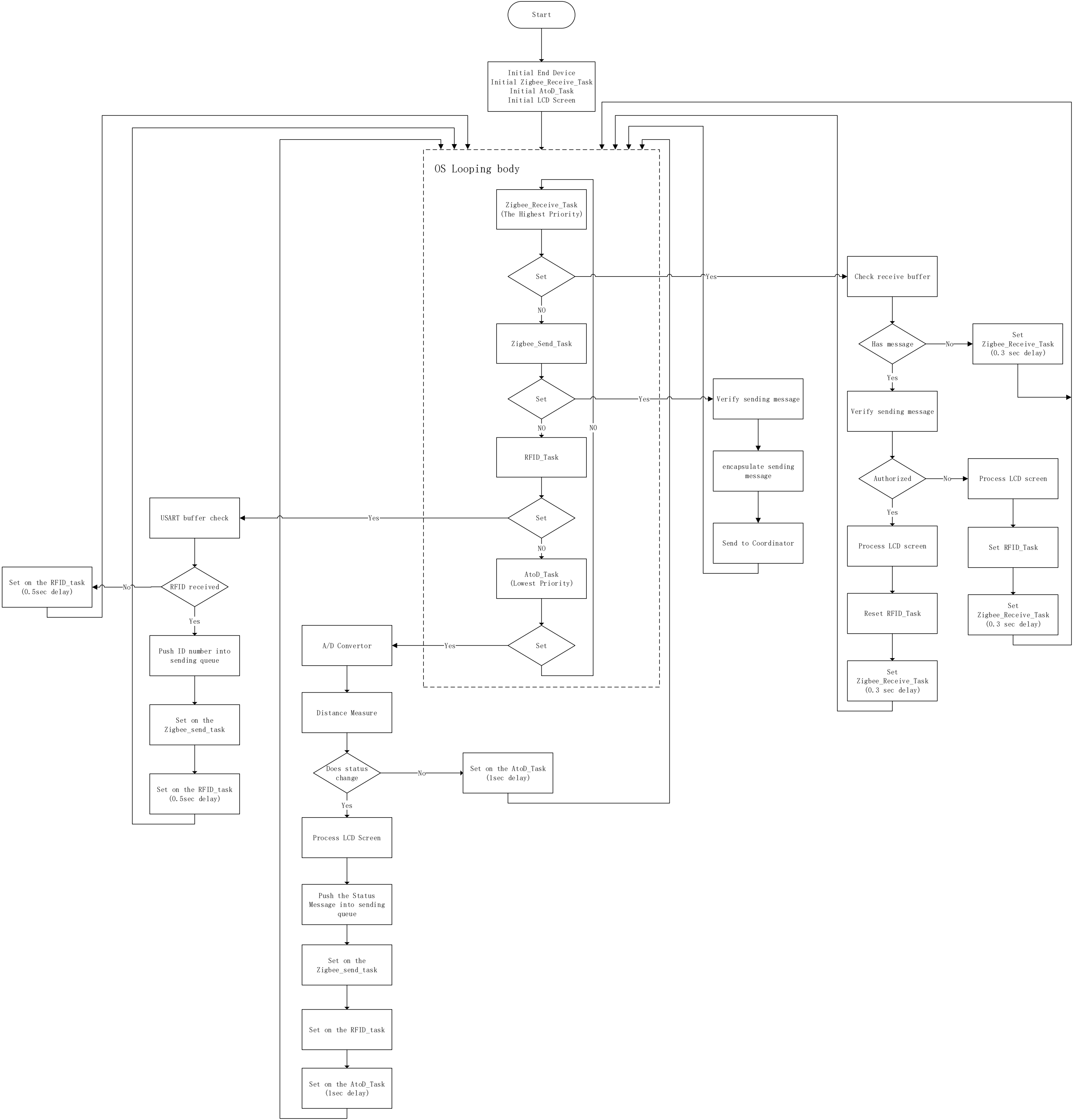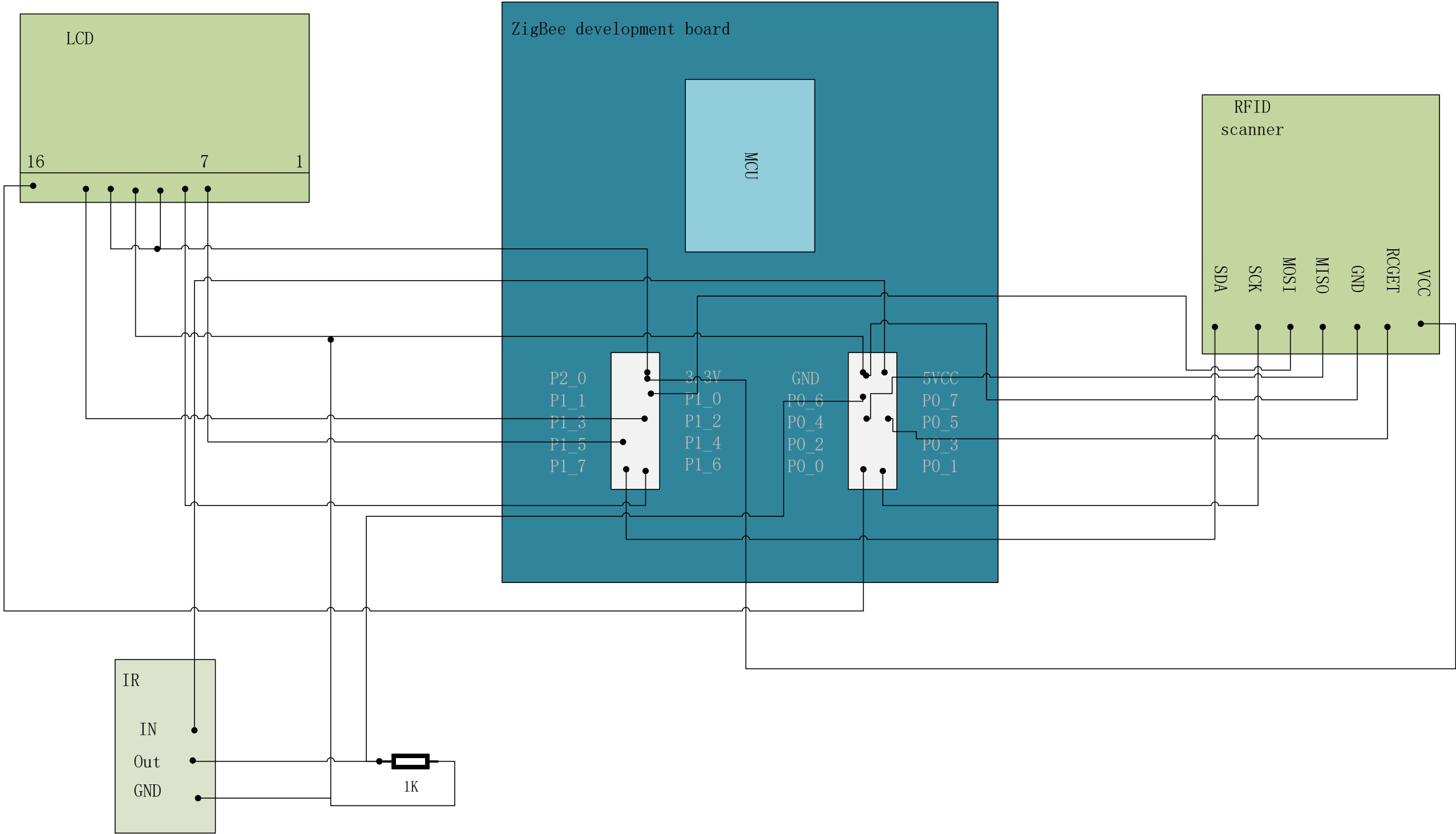8051 architecture MCU
Zstack Operating System
Multi-task embedded system
End-device software diagram

Four Tasks:
AtoD_task: check the presence of vehicle
RFID_task: grab RFID number
ZigBee_send_task: send info to coordinator
ZigBee_receice_task: check receive package
Other sources:
RFID driver
LCD driver
Infrared sensor deiver

Start

Initial End Device
Initial Zigbee_Receive_Task
Initial AtoD_Task
Initial LCD Screen

OS Looping body

Zigbee_Receive_Task
(The Highest Priority)

Set — NO

Zigbee_Send_Task

Set — NO — NO

RFID_Task

Set — NO

AtoD_Task
(Lowest Priority)

Set — Yes

A/D Convertor

Distance Measure

Does status change — No — Set on the AtoD_Task (1sec delay)

Process LCD Screen

Push the Status Message into sending queue

Set on the Zigbee_send_task

Set on the RFID_task

Set on the AtoD_Task (1sec delay)

USART buffer check — Yes

RFID received — No — Set on the RFID_task (0.5sec delay)

Push ID number into sending queue — Yes

Set on the Zigbee_send_task

Set on the RFID_task (0.5sec delay)

Check receive buffer — Yes

Has message — No — Set Zigbee_Receive_Task (0.3 sec delay)

Verify sending message — Yes

Authorized — No — Process LCD screen

Process LCD screen — Yes

Reset RFID_Task

Set Zigbee_Receive_Task (0.3 sec delay)

Set RFID_Task

Set Zigbee_Receive_Task (0.3 sec delay)

Verify sending message — Yes

encapsulate sending message

Send to Coordinator

End device wire diagram

LCD

16 7 1

ZigBee development board

MCU

RFID
scanner

SDA SCK MOSI MISO GND RCGFT VCC

P2_0   3.3V   GND   5VCC
P1_1   P1_0   P0_6   P0_7
P1_3   P1_2   P0_4   P0_5
P1_5   P1_4   P0_2   P0_3
P1_7   P1_6   P0_0   P0_1

IR

IN

Out

GND

1K

8051 architecture MCU
Zstack Operating System
Multi-task embedded system
Coordinator software diagram

Five Tasks:
Push_task: keep same NAT table in the carrier
USART_send_task: send package to WIFI module
USART_receive_task: receive package from WIFI module
ZigBee_receice_task: receive package from end devices
ZigBee_send_task: send package to end devices

```
                                    ┌─────────┐
                                    │  Start  │
                                    └─────────┘
                                         │
                              ┌────────────────────┐
                              │ Initial Coordinator │
                              │ Initial all tasks    │
                              └────────────────────┘
                                         │
    ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
    │ OS Looping body
    │                     ┌────────────────────┐
    │                     │  ZigBee_send_task   │
    │                     │ (The Highest Priority)│
    │                     └────────────────────┘
    │                              │
    │  Retrieve sending            ◇ Set ── Yes
    │  message        ←── Yes ──   ◇
    │     │                        NO
    │  Verify and determine   ┌──────────────┐
    │  end device             │ USART_send_task │
    │     │                   └──────────────┘
    │  Encapsulate message          ◇ Set ── Yes ──  Retrieve data from buffer
    │     │                         NO                       │
    │  Sending process        ┌──────────────────┐    Encapsulate package
    │                         │ Zigbee_received_task │         │
    │  Check received Buffer ← ─ ─ Yes ─ ─ ◇ Set        Usart send
    │     │                              NO
    │  ◇ Has message ── No ── Set            ┌──────────────────┐
    │     │ Yes           Zigbee_received_task│ USART_received_task│
    │  Analyze message    (0.5 sec delay)    └──────────────────┘
    │     │                                         ◇ Set ── Yes ── Check received Buffer
    │  Push into sending queue                      No                    │
    │     │                                  ┌──────────┐         ◇ Has message ── No ── Set USART_received_task
    │  Set USART_send_task                   │ Push_task │            │ Yes                 (0.5 sec delay)
    │     │                                  │(Lowest Priority)│   Analyze message
    │  Set Zigbee_received_task              └──────────┘         │
    │  (0.5 sec delay)                          ◇ Set           Push into sending queue
    │                                            │                │
    │  Push random message ── Yes ──            Set ZigBee_send_task
    │  into sending queue                        │
    │     │                                 Set USART_received_task
    │  Set USART_send_task                  (0.5 sec delay)
    │     │
    │  Set Push_task
    │  (0.5 sec delay)
    └ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
```

Server architecture
block diagram

Programming language: JAVA
Library use:
Java.nio

Start

Retrive datas
Initial Server

Loop body   Main thread

Selector
(Listening for TCP request)

No

Has Key ——Yes—→ Verify Key type

Type

New client   Incoming message

Verify the
client

Decode/decrypt
Message

Adding the
client into list

Analyze message

Message type

command   Update

Dispatch process
method
(new thread)

Dispatch process
method

Process command

Update data

Response to
client

Push back
updates to all
connected
clients

Android APP
Block diagram

Start

Welcome activity

Connect to server

6 sec delay

Retrieve the latest status

Initial TCP Listening thread

Go to status activity

Background thread
Looping

No — Listen incoming package

Has Package

Yes

Analyze message

Dispatch process method

Update Parking meter status

Notify all activity

Status activity

Show status of each Parking Meter

Real-time updates

Payment event Listener

No

Fire event — Yes

Payment activity

User input

Submit Listener

Fire event — Yes — Verify all inputs

No

No

Valid Data

Encapsulate and encrypt date

Send to server