1 Introduction

The RT600 is a family of dual-core microcontrollers featuring an Arm Cortex-M33 CPU combined with a Cadence Xtensa HiFi4 advanced Audio Digital Signal Processor. The RT600’s bootloader supports In-System Programming or serial boot via the SPI/I2C peripheral, where the SPI / I2C peripheral serves as the SPI/I2C slave.

For more details on the RT600 MCU, see the documents available here.

The blhost application is used on a host to issue commands to an NXP platform running an implementation of the MCU bootloader.

For more details on the blhost application, download the blhost application blhost_2.6.7 available here.

This application note introduces the implementation of the feature nIRQ pin, which the application processor (namely, the host) can use to improve the communication performance between the host and the RT600’s bootloader via the SPI/I2C peripheral.

2 SPI/I2C transaction protocol

This section explains the general protocol for the packet transfers between the host and the RT600’s bootloader.

2.1 Command with no data phase

The protocol for a command with no data phase contains:

- Command packet (from the host).
- Generic response command packet (to the host).

![Figure 1. Command with no data phase](image)

2.2 Command with incoming data phase

The protocol for a command with incoming data phase contains:

- Command packet (from the host) (the \texttt{kCommandFlag\_HasDataPhase} set).
• Generic response command packet (to the host).
• Incoming data packets (from the host).
• Generic response command packet.

Figure 2. Command with incoming data phase

2.3 Command with outgoing data phase

The protocol for a command with an outgoing data phase contains:
• Command packet (from the host).
• ReadMemory Response command packet (to the host) (the kCommandFlag_HasDataPhase set).
• Outgoing data packets (to the host).
• Generic response command packet (to the host).
2.4 The feature nIRQ notifier pin

Once the feature nIRQ notifier pin being enabled, the host waits until it catches a negative edge on the nIRQ notifier pin before reading any data from the RT600’s bootloader. It must suspend operation until the nIRQ notifier pin is high before sending any commands/data to the RT600’s bootloader. For each packet, the sent timeout time is the packet length (in byte) multiplied to 10 ms and the receive timeout time is the packet length (in byte) multiplied to 20 ms. It means that the host must send the packet to the RT600’s bootloader before the sending packet timeout and receive the packet from to the RT600’s bootloader before the receiving packet timeout.

3 The feature nIRQ notifier pin support of blhost

The blhost application, blhost_2.6.7, has the set-property command implemented to enable the feature nIRQ notifier pin.

```
set-property <tag> <value>[<memoryID>]
```

- **tag:**
  - 0x1c - The pin selected as IRQ notifier pin.
- **value:**
  - bit[31] - Enable nIRQ notifier pin, 0: disable, 1: enable.
  - bit [7:0] pin.
However, the blhost application, blhost_2.6.7, has not implemented the feature nIRQ notifier pin described in section The feature nIRQ notifier pin.

This section provides details on how the feature nIRQ notifier pin described in section The feature nIRQ notifier pin can be implemented.

3.1 Modifications to blhost.cpp

The blhost.cpp is in \blhost_2.6.7\tools\blhost\src\. The modifications are in bold below.

```cpp
/* set-property command execution */
extern char SetProperty_Flag;

int BlHost::run()
{
    try
    {
        if (m_cmdv.size())
        {
            // Check for any passed commands and validate command.
            cmd = Command::create(&m_cmdv);
            if (!cmd)
            {
                std::string msg = format_string("Error: invalid command or arguments '%s",
                                                m_cmdv.at(0).c_str());
                string_vector_t::iterator it = m_cmdv.begin();
                for (++it; it != m_cmdv.end(); ++it)
                {
                    msg.append(format_string(" %s", (*it).c_str()));
                }
                msg.append("'
                                 throw std::runtime_error(msg);
            }
            progress = new Progress(displayProgress, NULL);
            cmd->registerProgress(progress);
        }
        //If the instruction is set-property, the flag is set
        if (cmd->getName() == "set-property")
        {
            SetProperty_Flag = 1;
        }
    }
}
```

3.2 Modifications to Command.cpp

The Command.cpp is in \blhost_2.6.7\src\blfwk\src\. The modifications are in bold below.

```cpp
/* set-property command execution */
extern char SetProperty_Flag;
```
The feature nIRQ notifier pin support of blhost

3.3 Modifications to SerialPacketizer.cpp

The SerialPacketizer.cpp is in \blhost_2.6.7\src\blfwk\src. The modifications are in bold below.

```c
/* set-property command execution */
char SetProperty_Flag = 0;
/* nIRQ notifier pin enabled */
char IrqNotifierPin_Flag = 0;

status_t SerialPacketizer::serial_packet_write(const uint8_t *packet, uint32_t byteCount, packet_type_t packetType)
{
    
    // If nIRQ notifier pin has been enabled, then waits for nIRQ notifier pin high here.
    if (SetProperty_Flag == 0) {
        // Waits for nIRQ notifier pin high.
        if(wait_for_high()!=kStatus_Success)
        {
            return kStatus_Timeout;
        }
    }
    // Send the framing data packet.
    status = m_peripheral->write((uint8_t *)framingPacket, sizeof(framing_data_packet_t) + byteCount);
    if (status != kStatus_Success)
    {
        return status;
    }
    // If current command is set-property to enable nIRQ notifier pin, then waits for nIRQ notifier pin high here.
    if (SetProperty_Flag == 1) {
        SetProperty_Flag = 0;
        // Waits for nIRQ notifier pin high.
        if(wait_for_high()!=kStatus_Success)
        {
            
        }
    }
}```
status_t SerialPacketizer::serial_packet_send_sync(uint8_t framingPacketType)
{
  framing_sync_packet_t sync;
  sync.header.startByte = kFramingPacketStartByte;
  sync.header.packetType = framingPacketType;
  // Indicate last transaction was a write.
  m_serialContext.isBackToBackWrite = true;
  // Waits for nIRQ notifier pin high.
  if(wait_for_high() != kStatus_Success)
  {
    return kStatus_Timeout;
  }

status_t SerialPacketizer::wait_for_ack_packet()
{
  framing_sync_packet_t sync;
  status_t status = kStatus_NoCommandResponse;
  do
  {
    // Waits for nIRQ notifier pin low.
    if(wait_for_low() != kStatus_Success)
    {
      return kStatus_Timeout;
    }
    // Waits for nIRQ notifier pin high.
    if(wait_for_high() != kStatus_Success)
    {
      return kStatus_Timeout;
    }
  } while(1);
  return status;
}

status_t SerialPacketizer::read_data_packet(framing_data_packet_t *packet, uint8_t *data, packet_type_t packetType)
{
  // Waits for nIRQ notifier pin low.
  if(wait_for_low() != kStatus_Success)
  {
    return kStatus_Timeout;
  }

3.4 Implementation of wait_for_high() and wait_for_low()

The implementation of wait_for_high() and wait_for_low() is host-dependent.

This application note shows their implementation with RT600 as the host.

status_t wait_for_high(void)
{
  uint32_t duration = 0;
}
if(IrqNotifierPin_Flag == 1)
{
    uint32_t start = CTIMER_GetTimerCountValue(CTIMER0);
    while (duration < m_packetTimeoutMs)
    {
        if(GPIO_PinRead(GPIO, HOST_PORT, HOST_PIN)==1)
        {
            return kStatus_Success;
        }
        duration = (uint32_t)( CTIMER_GetTimerCountValue(CTIMER0) - start) / CLOCKS_PER_1MS;
    }
    return kStatus_Timeout;
}
return kStatus_Success;
}

status_t wait_for_low(void)
{
    uint32_t duration = 0;
    if(IrqNotifierPin_Flag == 1)
    {
        uint32_t start = CTIMER_GetTimerCountValue(CTIMER0);
        while (duration < m_packetTimeoutMs)
        {
            if(GPIO_PinRead(GPIO, HOST_PORT, HOST_PIN)==0)
            {
                return kStatus_Success;
            }
            duration = (uint32_t)( CTIMER_GetTimerCountValue(CTIMER0) - start) / CLOCKS_PER_1MS;
        }
        return kStatus_Timeout;
    }
    return kStatus_Success;
}

For more details on the SDK_2_11_0_EVK-MIMXRT685, refer to the software available here.

4 Conclusion

The application processor (namely, host) can use the feature nIRQ notifier pin to improve the communication performance between it and the RT600’s bootloader, which can be enabled by the SetProperty <tag> <value> command.

5 Revision history

Table 1. Revision history

<table>
<thead>
<tr>
<th>Revision Number</th>
<th>Date</th>
<th>Substantive Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>22 April 2022</td>
<td>Initial release</td>
</tr>
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</table>
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Application Note

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