SAM4S Peripheral DMA Controller (PDC)

Presentation Outline

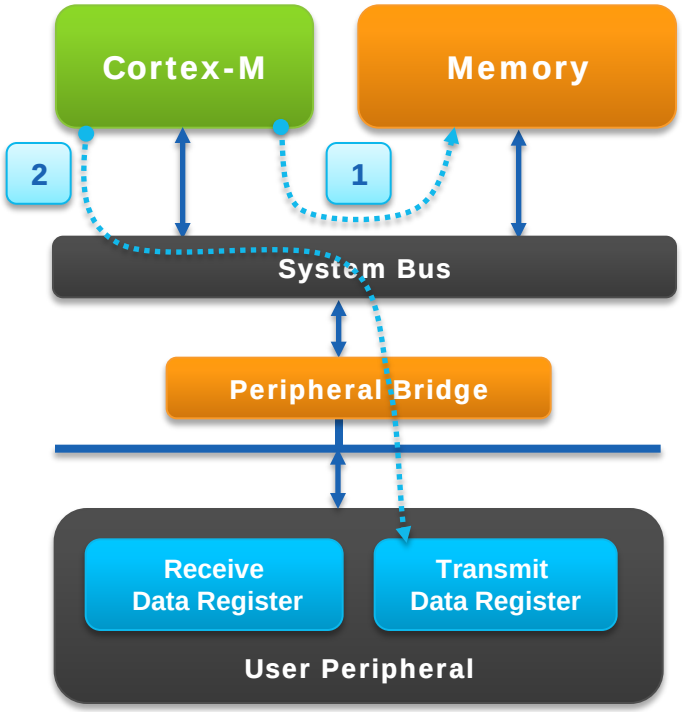
- Introduction
- Functional Description
- Application Examples

Introduction

Introduction

Data Transfer without DMA

- Transmit Transfer Example:

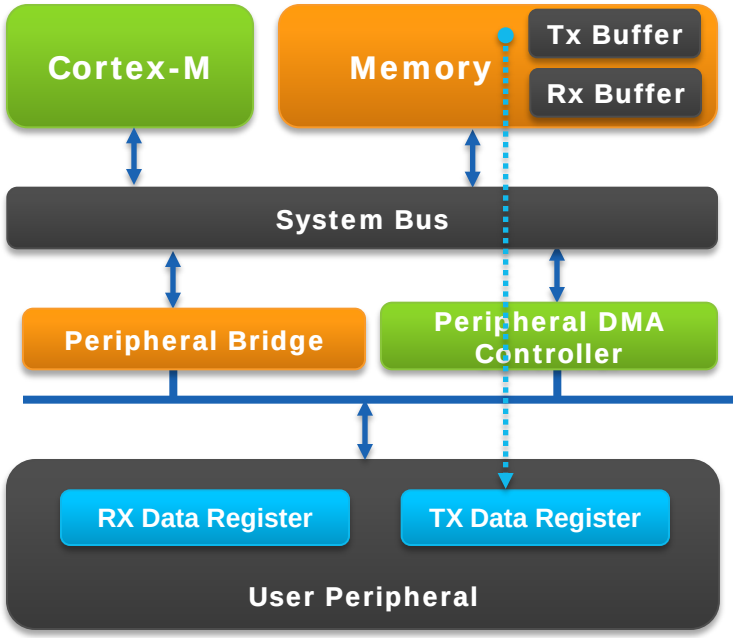


- Each Read or Write accesses to Receive or Transmit Registers must be handled by the core
  1. Data read from Memory
  2. Data write to Transmit Data Register
- CPU spends most of its time transferring large amount of data

Introduction

Data Transfer using Peripheral DMA Controller (PDC)

- Each Read or Write accesses to Receive or Transmit Registers are handled by the PDC
  - 1 clock cycle for a transfer from memory to peripheral
  - 2 clock cycles for a transfer from peripheral to memory
- No need for the CPU to handle data transfer
  - Free for other tasks
  - Can be disabled to reduce power consumption



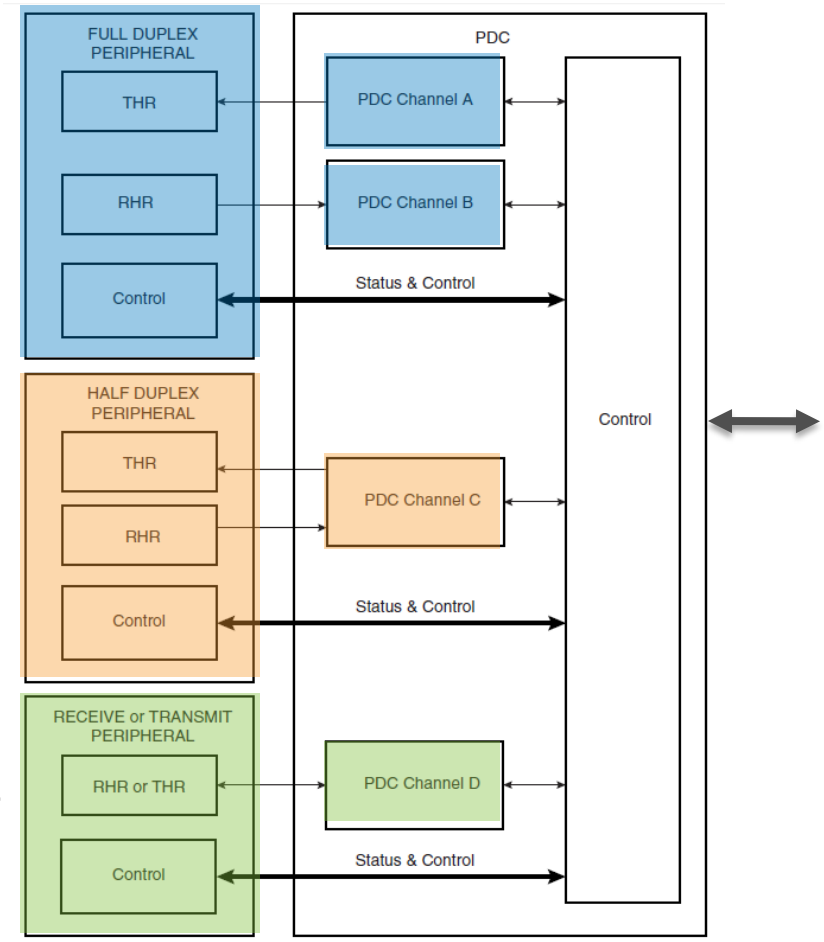
Functional Description

Functional Description

Overview

- The PDC transfers data between:
  - the on-chip peripherals
  - and the on-/off-chip memories

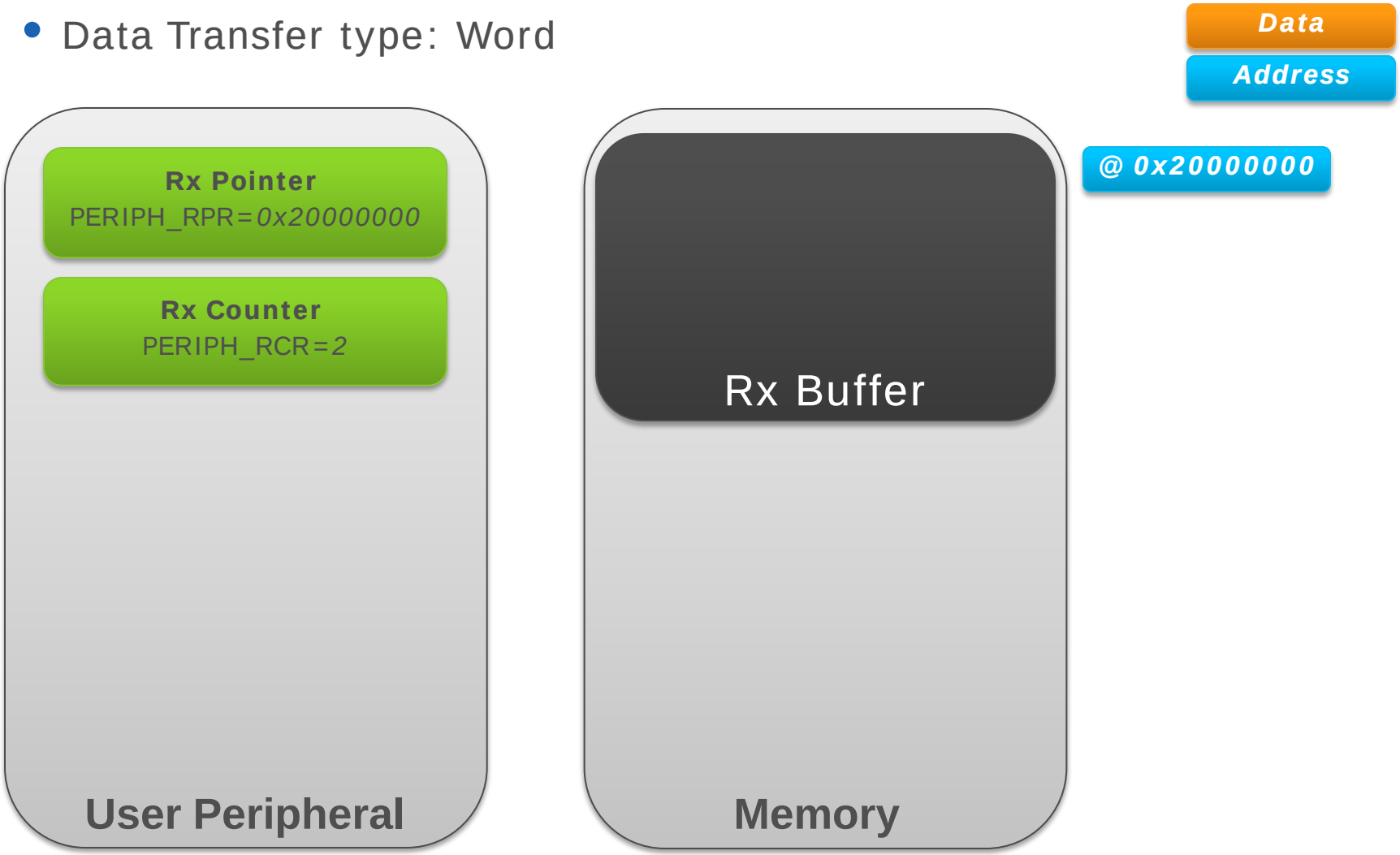
- Features
  - One AHB Master
    - Transfers without CPU intervention
  - Periph to Mem & Mem to Periph transfers
  - Simplex, Half and Full Duplex
  - 8-bit, 16-bit and 32-bit data transfers
  - Buffer chaining for continuous Data transfer
  - Transfers without CPU intervention



Functional Description

Simple PDC Data Transfer

- Data Transfer type: Word



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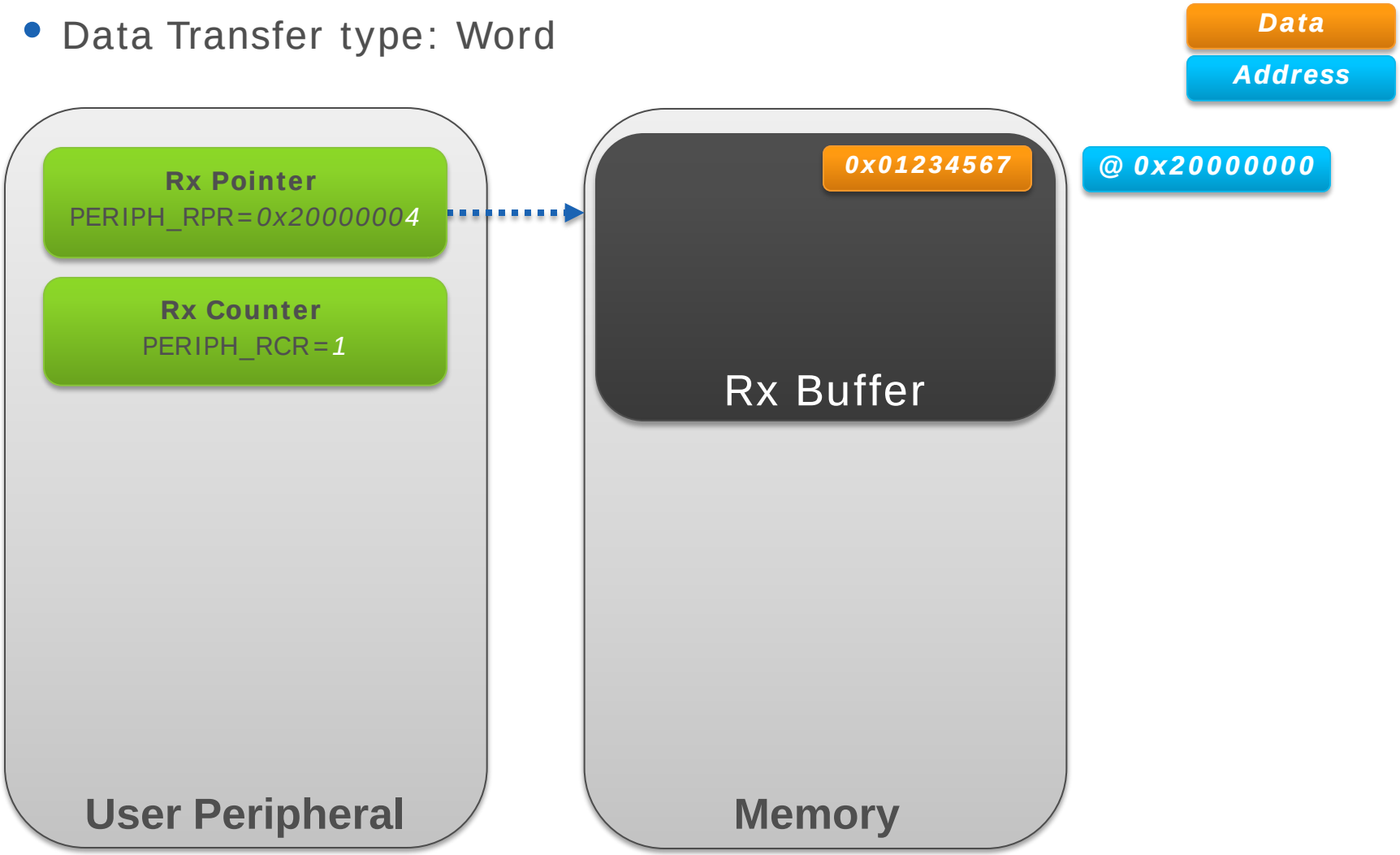

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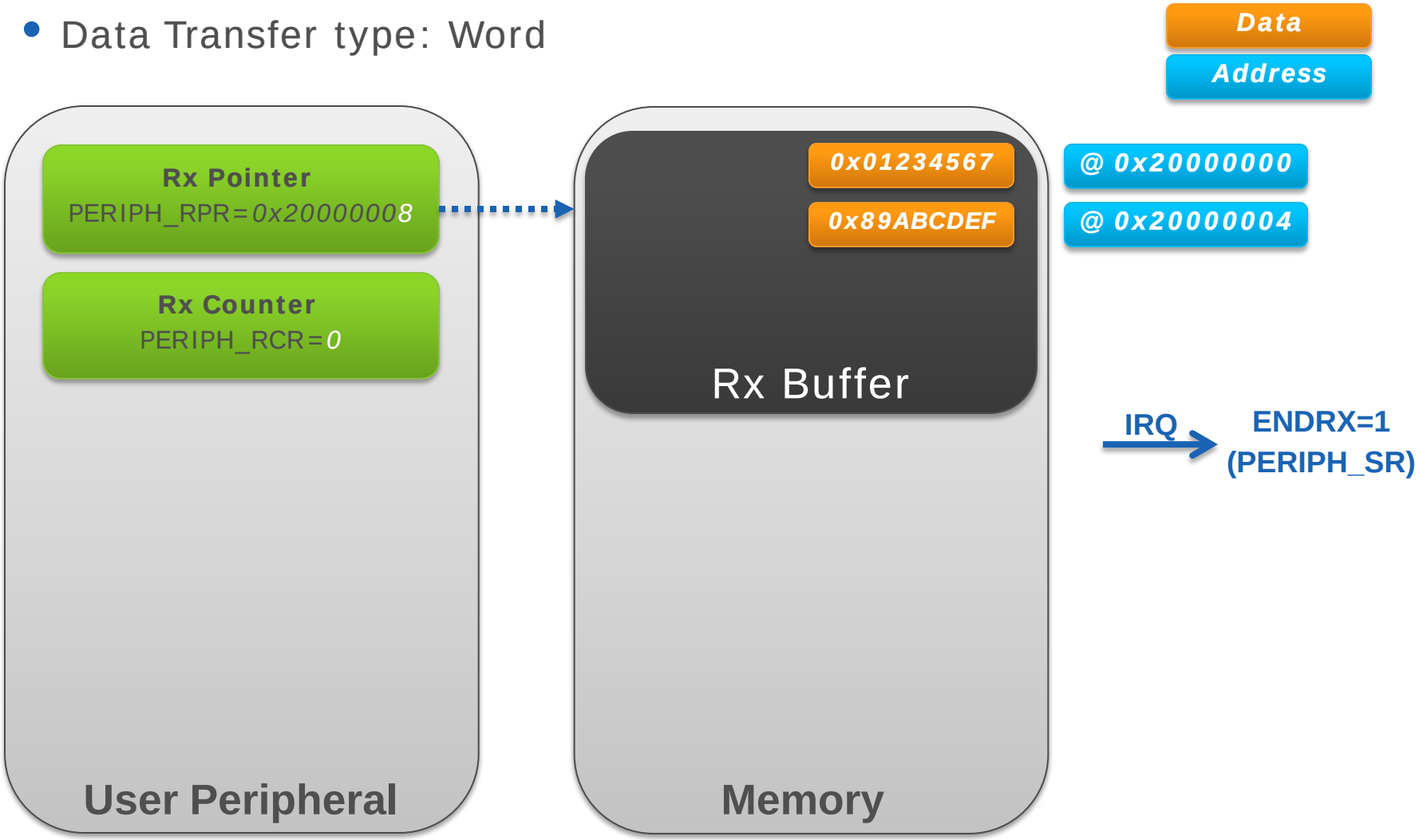


Functional Description

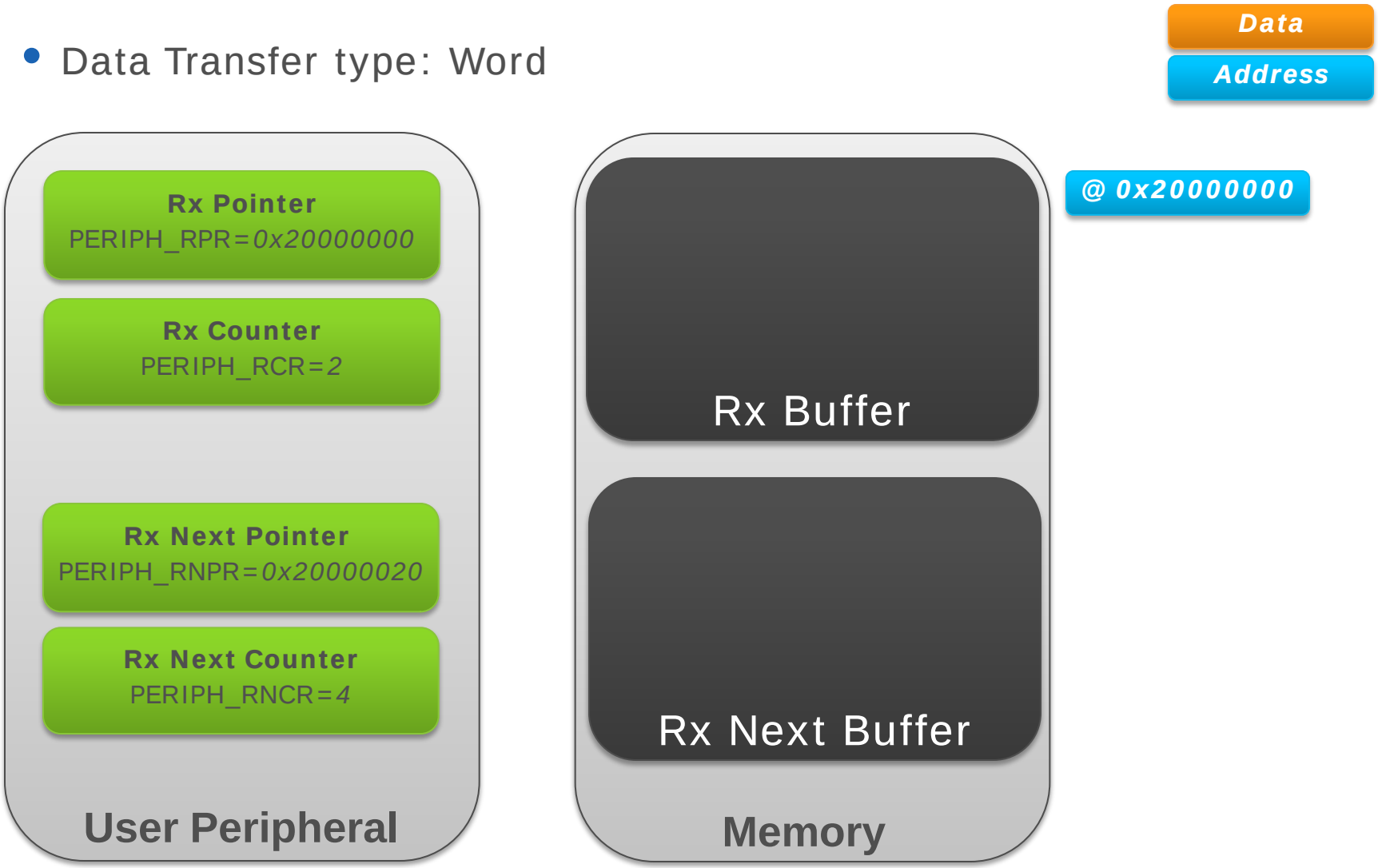
Simple PDC Data Transfer

- How do you program the PDC for 65,535 Tx transfers?
  - Program 0xFFFF in the Transmit Counter Register (TCR)
  - Program Buffer Memory Address in the Transmit Pointer Register (TPR)
  - Enable PDC channel in Transmit (TXTEN)
  - Wait for End Of Transmit Flag (ENDTX=1)
    - Transfer completed

Functional Description

Simple PDC Transfer using Next Pointer/Counter

- Data Transfer type: Word



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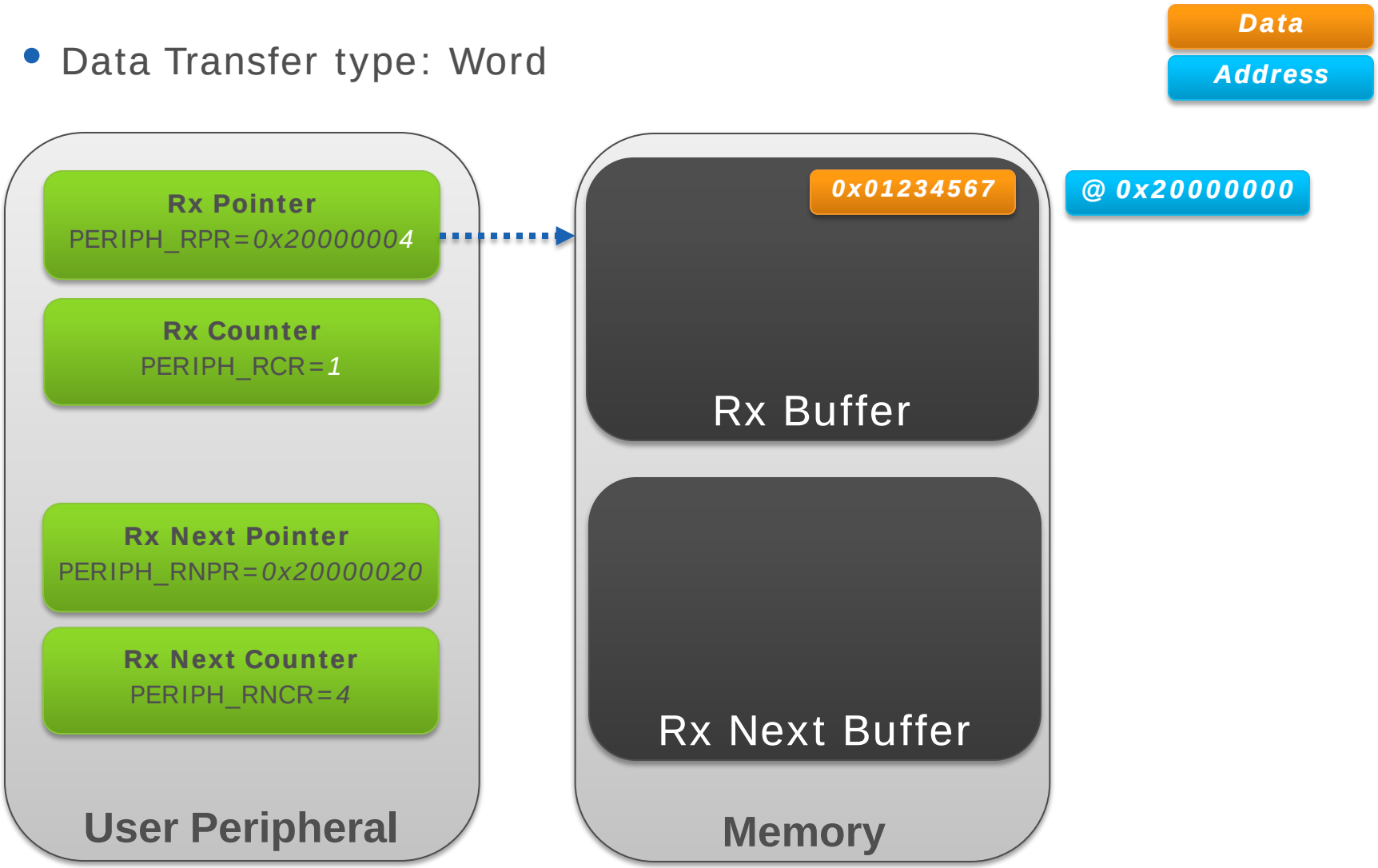

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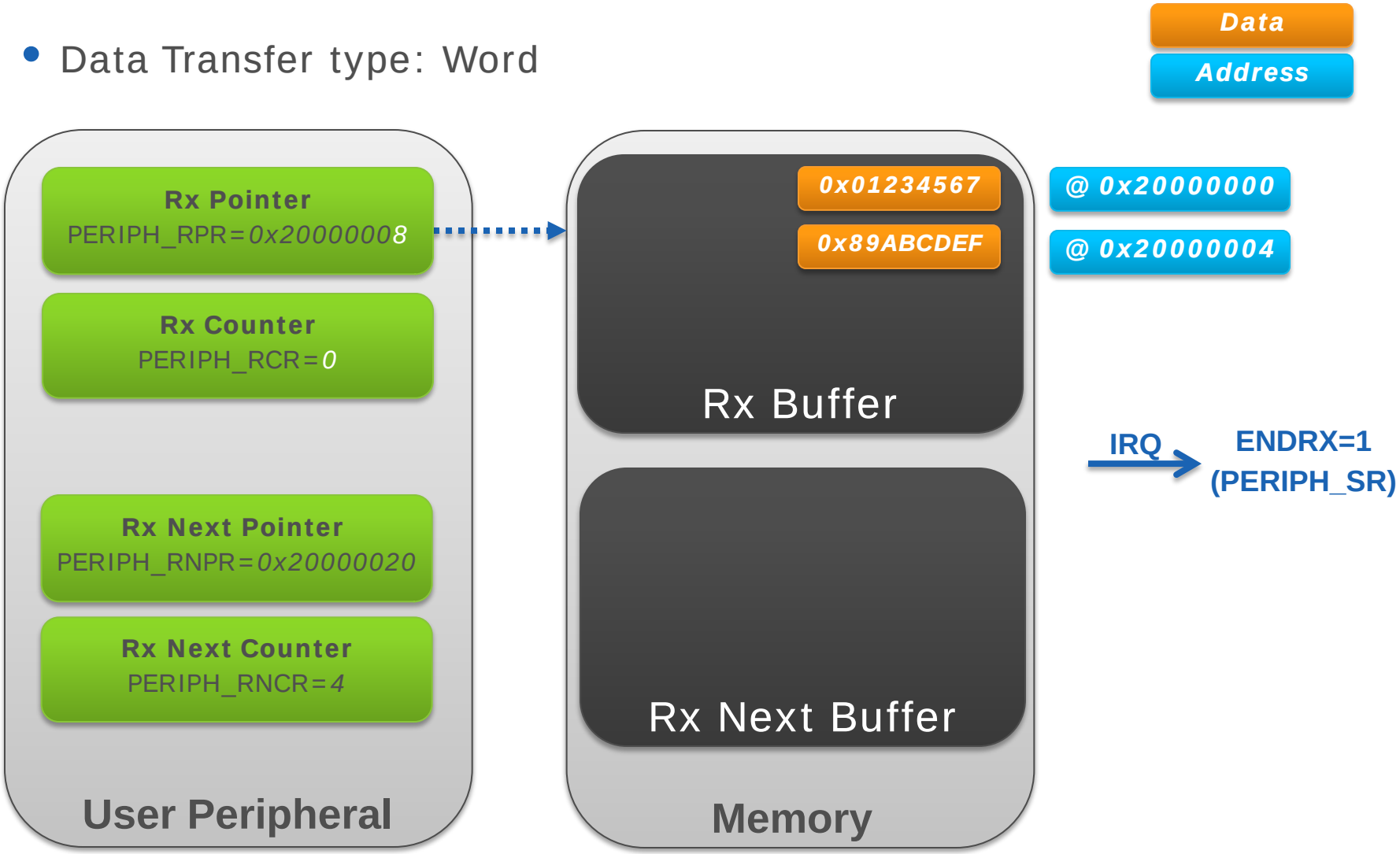

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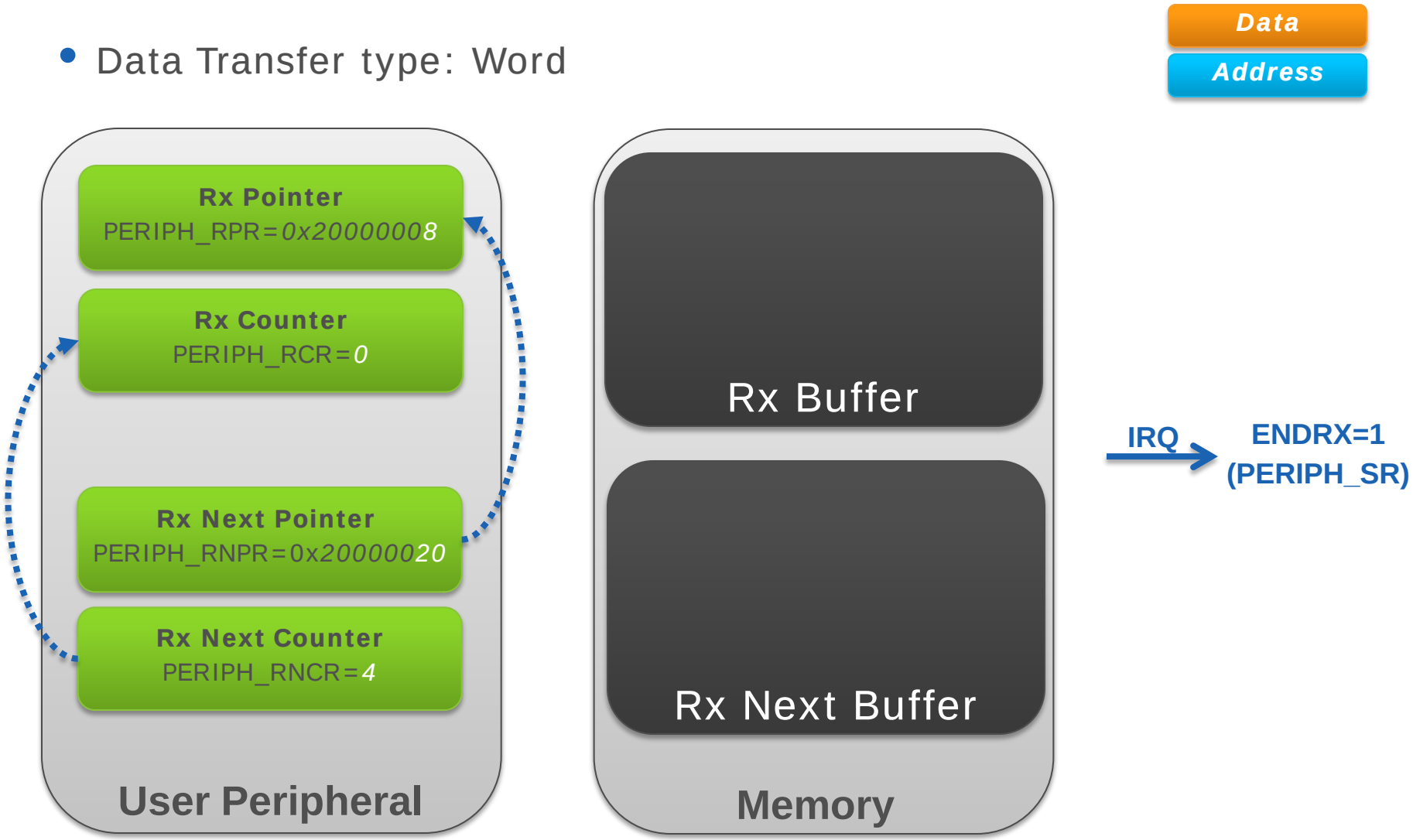

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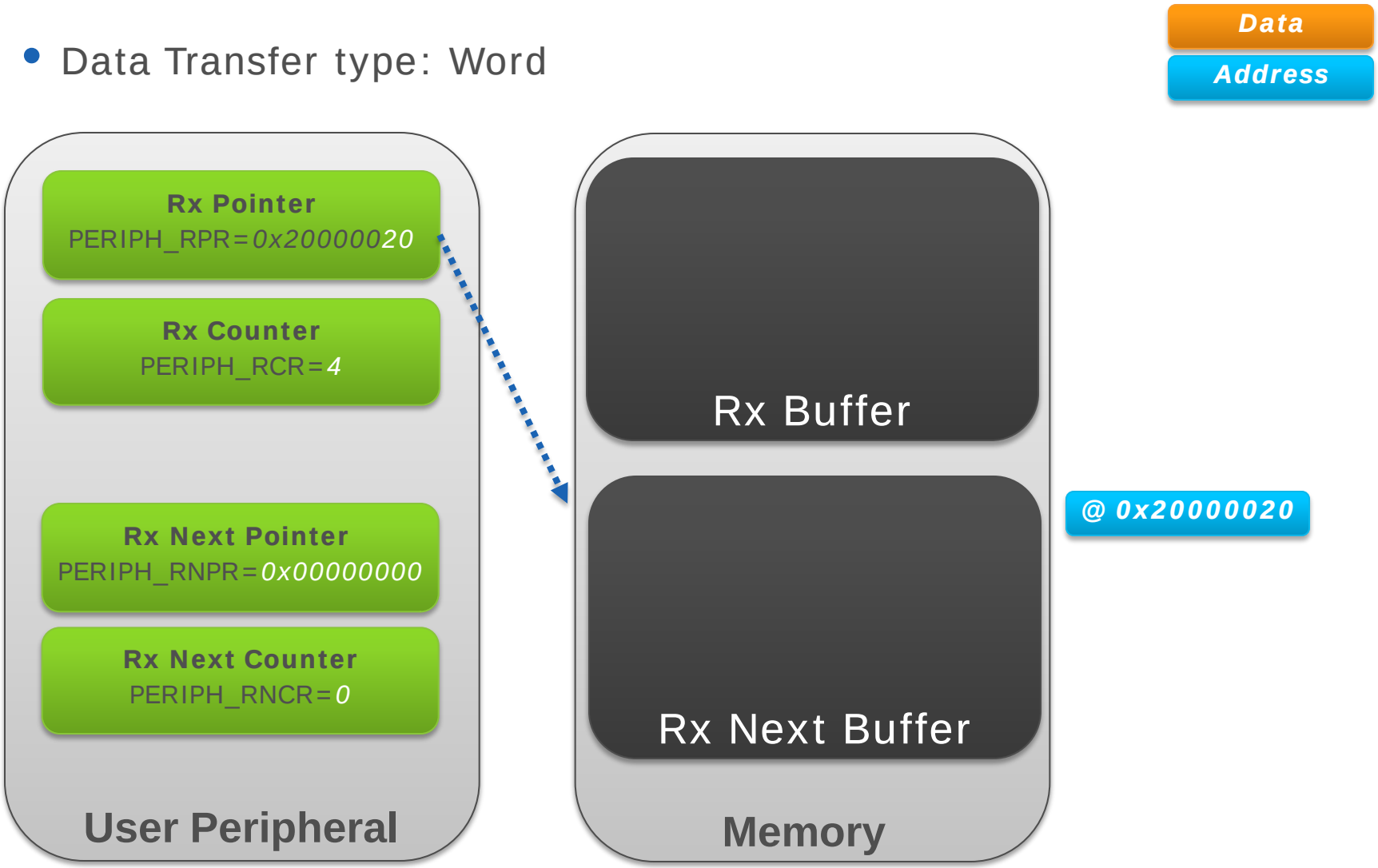

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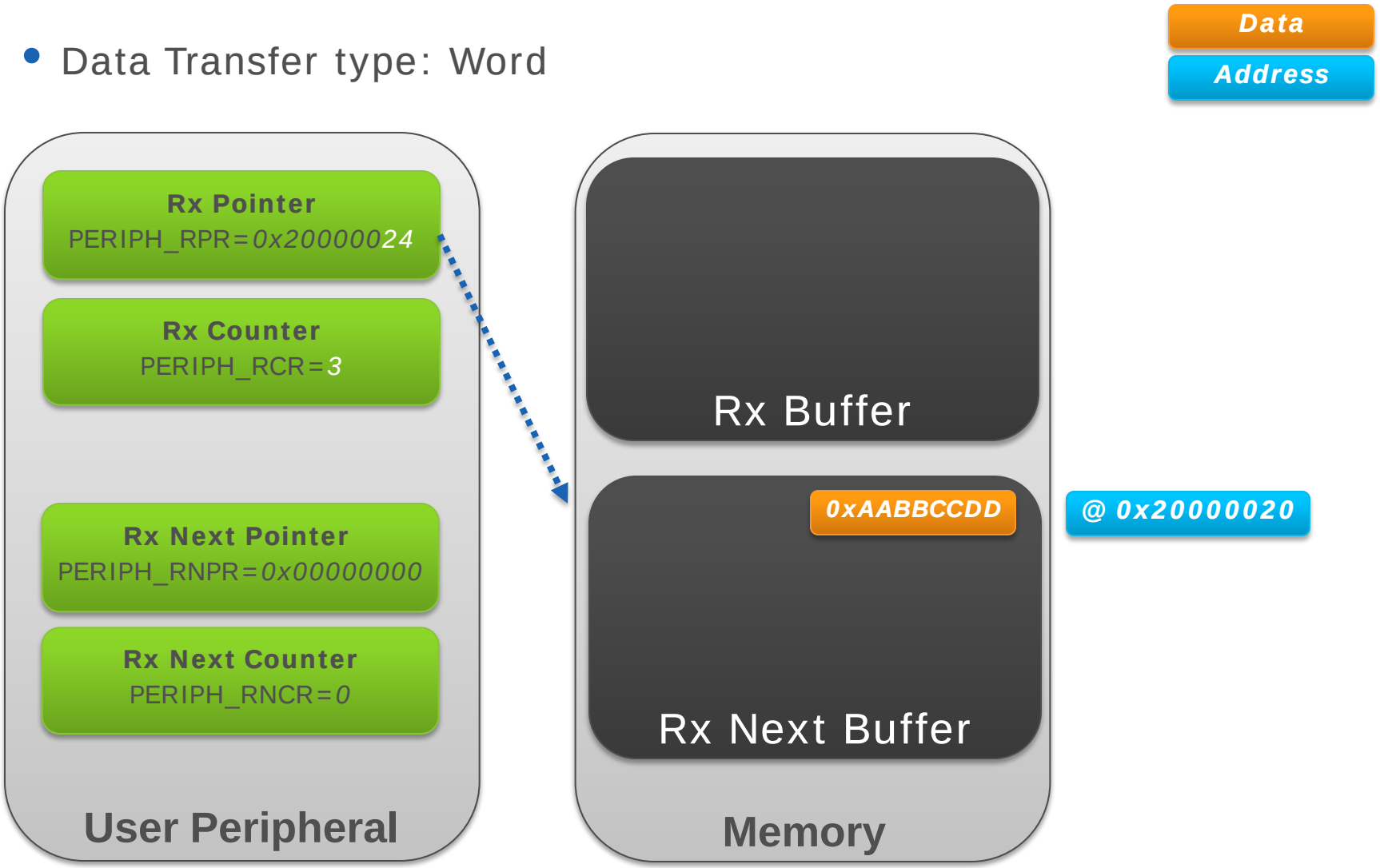

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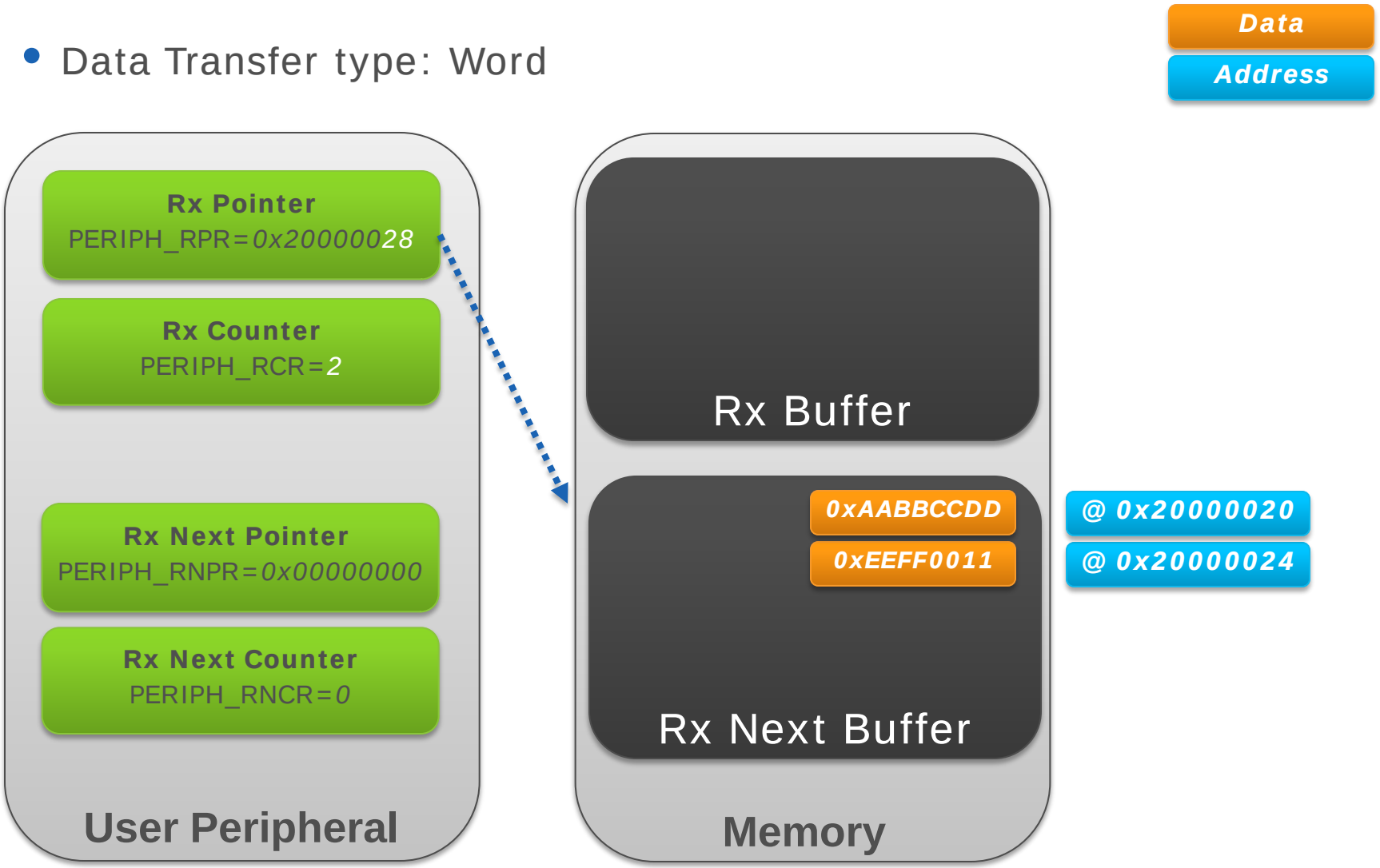

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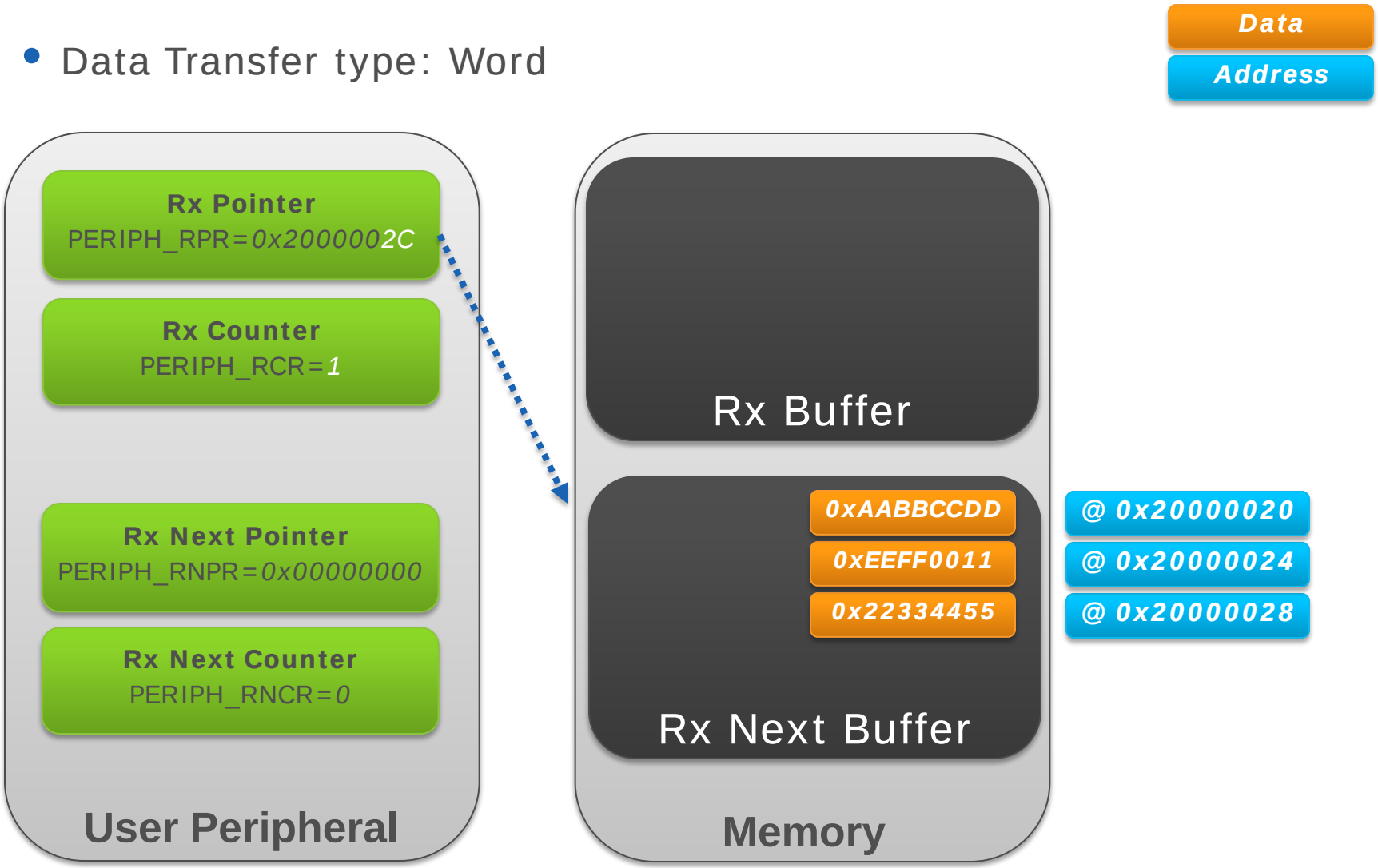

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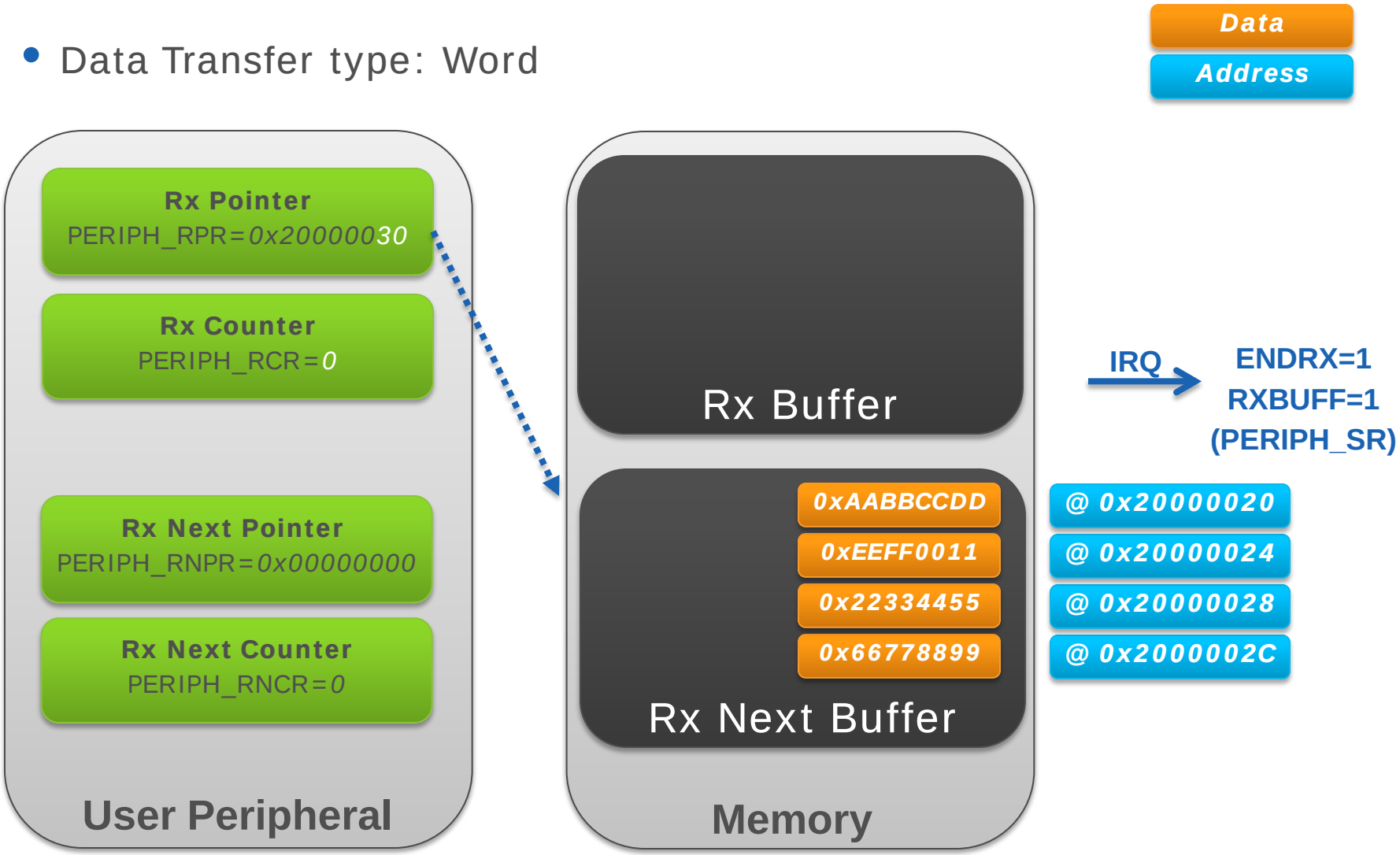


Functional Description

Simple PDC Transfer using Next Pointer/Counter

- How do you program the PDC for 131,070 Tx transfers?
  - Program 0xFFFF in both TCR & TNCR
  - Program Buffer Memory Addresses in both TPR & TNPR
  - Enable PDC channel in Transmit (TXTEN)
  - Wait for Transmit Buffer Empty (TXBUFE=1)
    - Transfer completed

Functional Description

Continuous PDC Transfer (Buffer Chaining)

- How do you program the PDC for continuous Rx transfers?
  - Program both Counter Registers (RCR & RNCR)
  - Program both Buffer Memory Addresses (RPR & RNPR)
  - Enable PDC channel in Receive (RXTEN)
  - Wait for ENDRX = 1
    - Load RNPR with the next address
    - Load RNCR with the next value
  - If RXBUFF = 1 (i.e. RCR = RNCR = 0)
    - Application Overrun
    - System Arbitration Priority to reconsider

Functional Description

PDC Channels and Data Transfer Type

- Depending on Peripheral mode, Data Transfer Type is automatically configured by the PDC

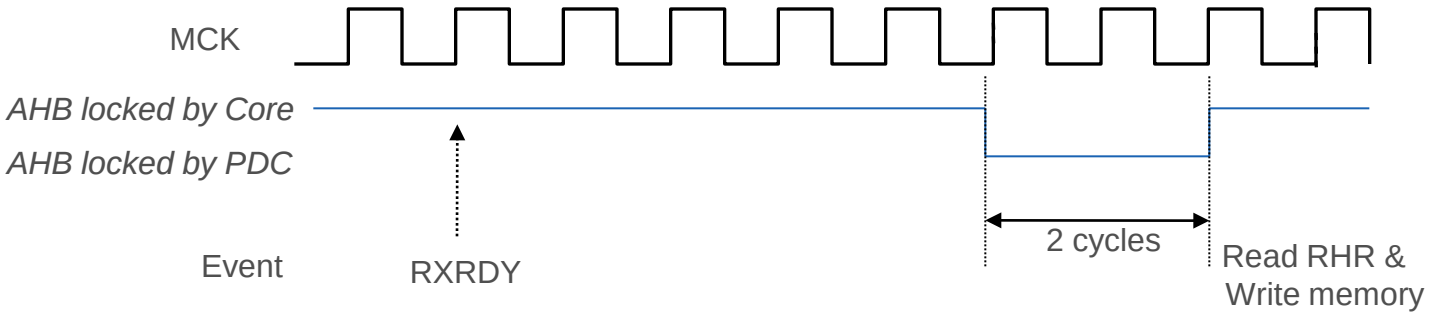
- Example: ADC configured in 10-bit resolution
  - PDC will automatically perform 16-bit data size transfers (MSB filled with '0')

Peripheral	PDC Channels Nb (per Peripheral)	Data Transfer Type	Communication
UART	2	Byte	Full Duplex
USART	2	Byte / Half Word	Full Duplex
SSC	2	Byte / Half Word / Word	Full Duplex
SPI	2	Byte / Half Word / Word	Full Duplex
TWI	2	Byte	Full Duplex
HSMCI	2	Byte / Half Word / Word	Half Duplex
PIOC	1	Byte	Receive Only
ADC	1	Byte / Half Word	Receive Only
DAC	1	Byte / Half Word	Transmit Only
PWM	1	Half Word	Transmit Only

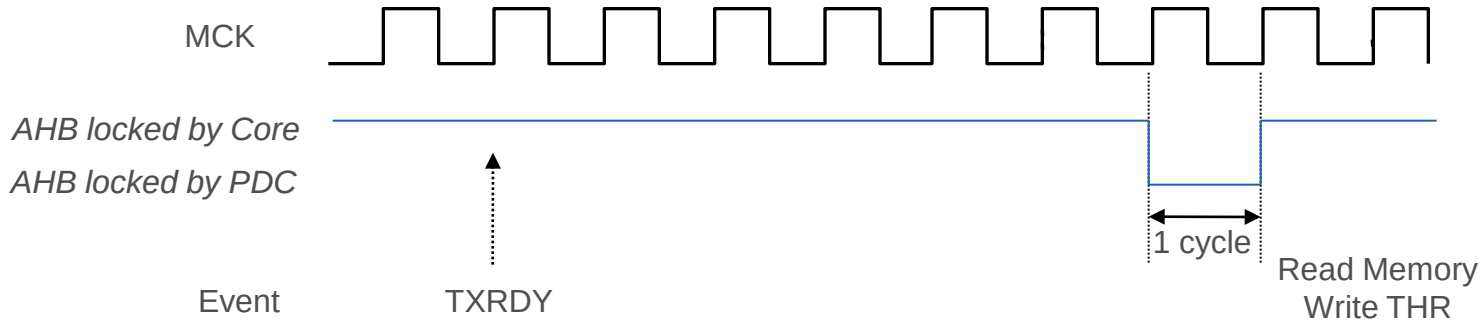
Functional Description

Transfer Delays with AHB bus

- From Peripheral to memory (PDC Receive channel)
  - 2 core cycles



- From Memory to Peripheral (PDC Transmit channel)
  - 1 core cycle

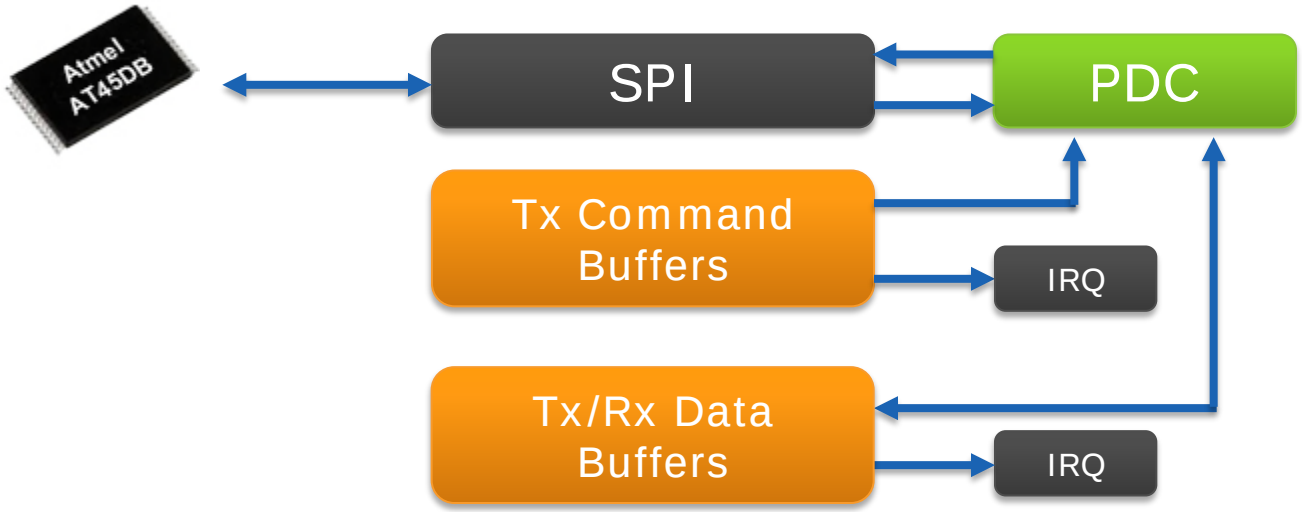


Application Examples

Application Examples

Atmel SPI DataFlash

- Transmit Buffers used for Dataflash commands transfer (Read Status, PageWrite, PageRead,...)
- Next Transmit/Receive Buffers used for Dataflash Data transfer



Application Examples

ADC Data Acquisition

- Both Rx buffers (using Next Pointer/Counter registers) are used for data acquisition and Digital Filtering
- When one is used to get ADC samples…
- … the other one is used by the ARM core to treat the data (Digital Filtering, FFT,…)