Data Communication Issues For Digital Power Management

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Data Communications Issues For Digital Power System Management

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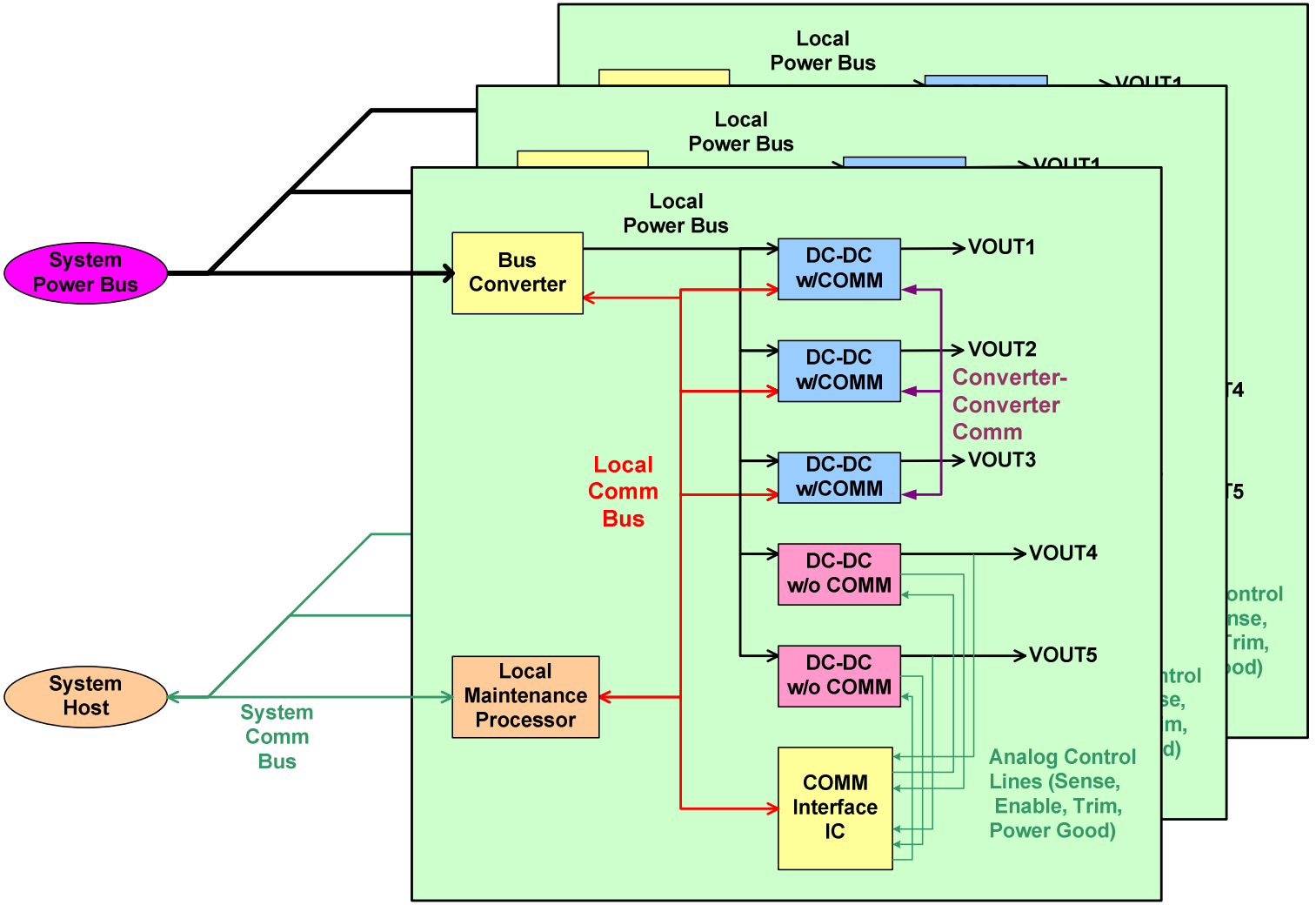
Presentation Overview

- Requirements
  - Physical
  - Fiscal
  - Data Flow
- Data Communication Characteristics
  - Types Of Buses
  - Issues And Constraints
- Recommendations
  - By Data Bus
  - By Application

Fundamental Requirements

- Low Cost, Low Cost & Low Cost
  - Component - Low Cost
  - Development - Low Cost
- Robust
  - Carry Data Without Corruption Or Interruption In The Presence Of Noise
  - Does Not Pass the Burden To The Host
- Must Support Time Critical Communication
  - Address The Need For Alarms And Alerts
  - Address The Need For Fast Host Intervention

Additional Requirements: Who Talks To Whom?



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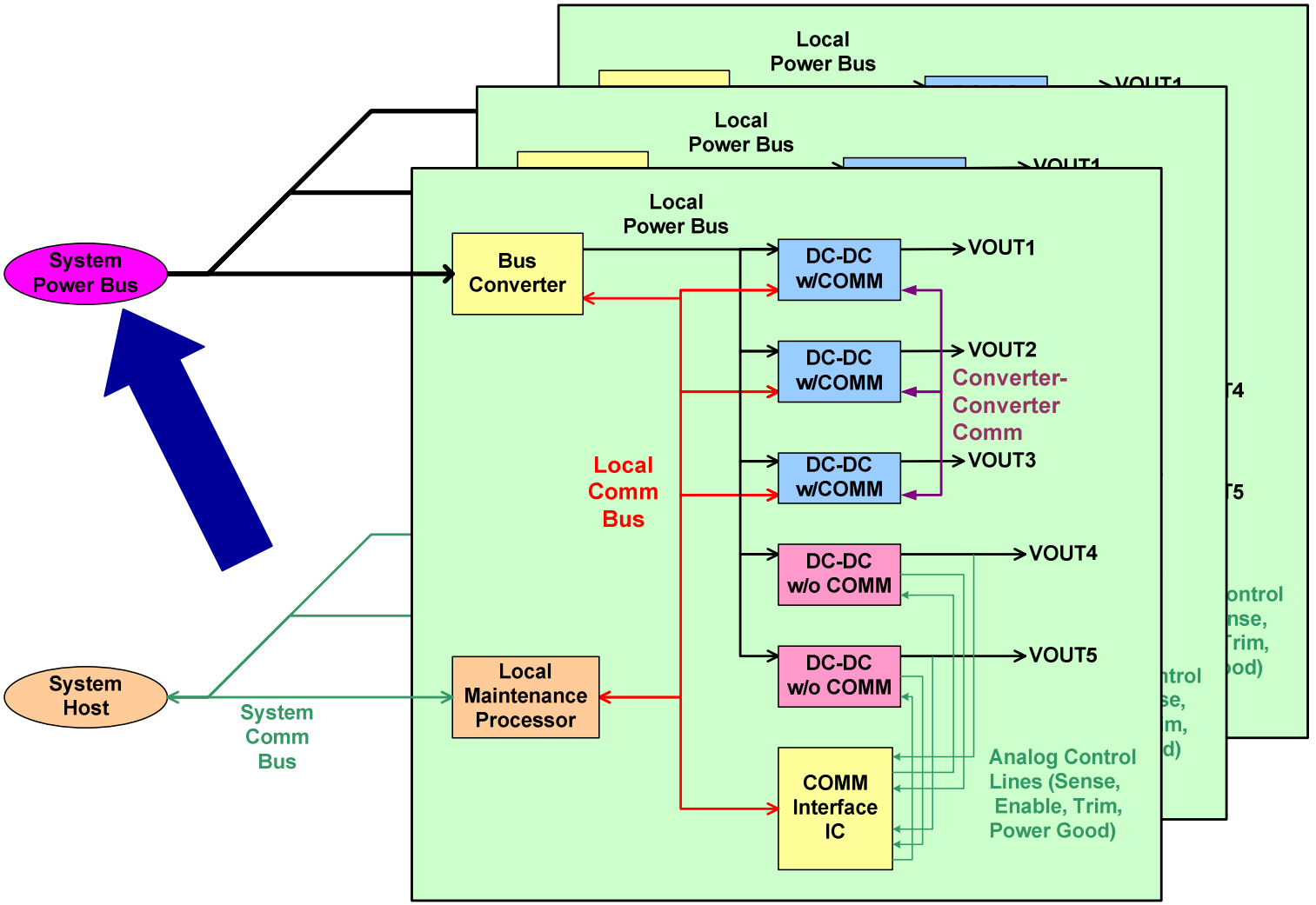

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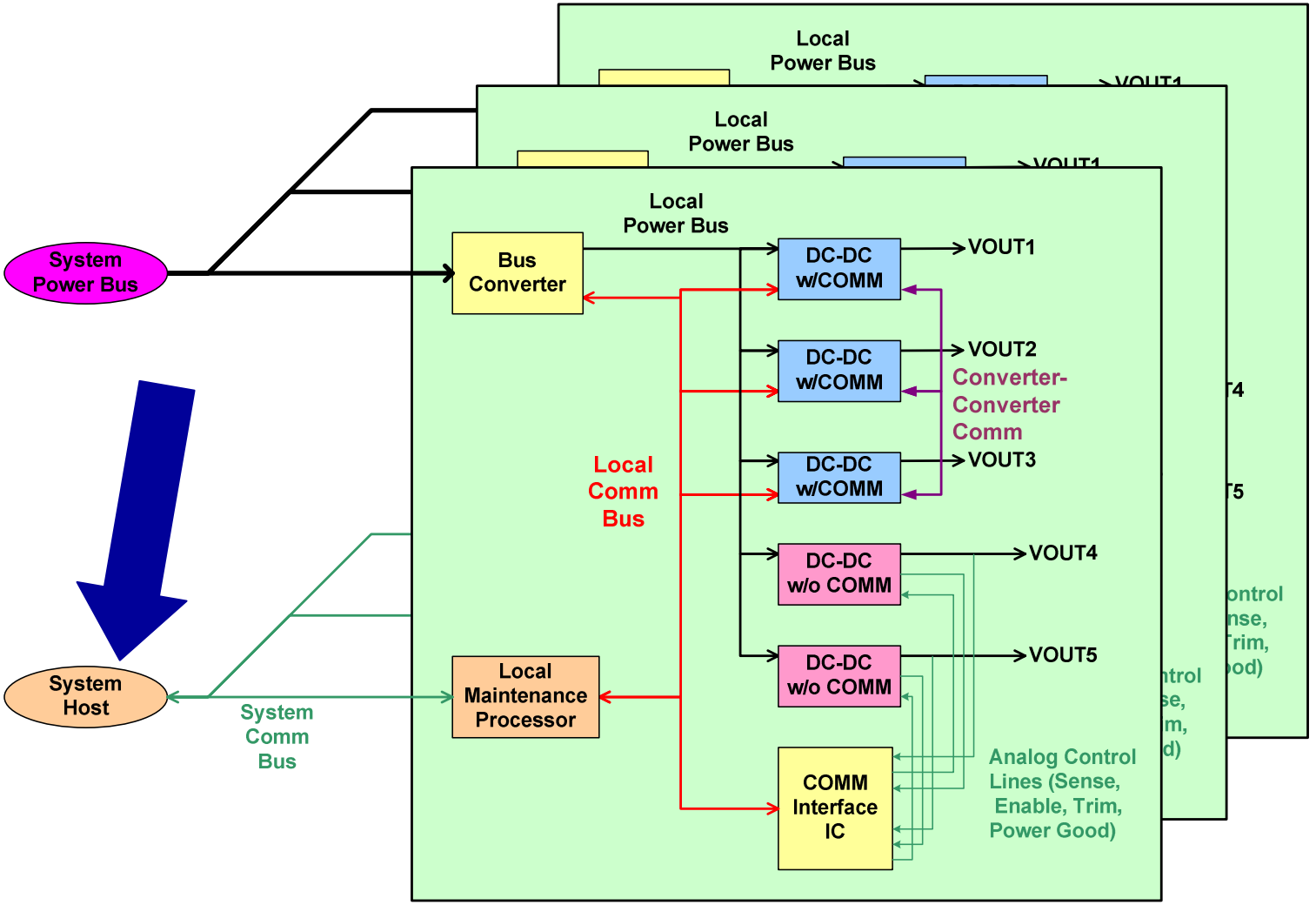

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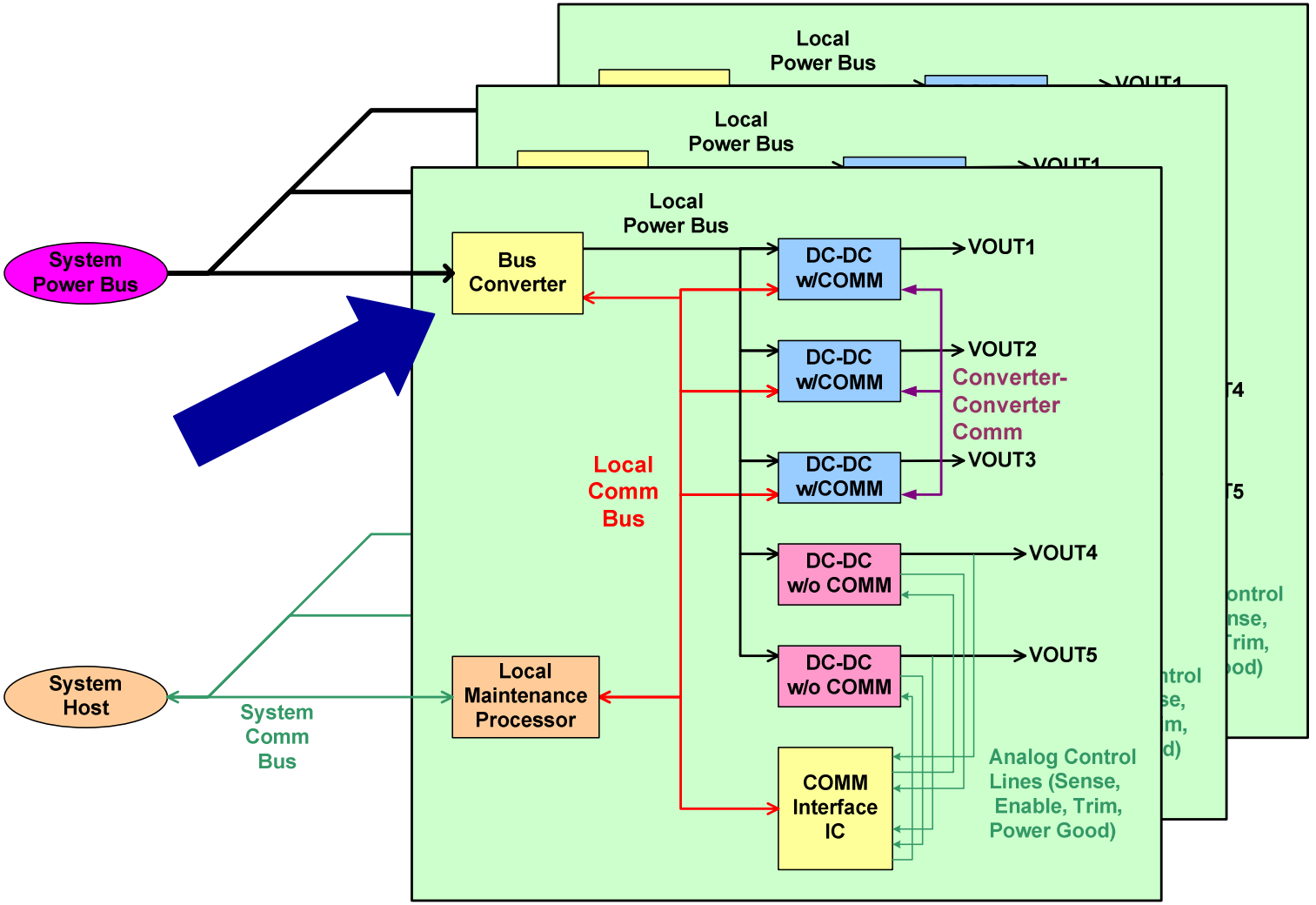

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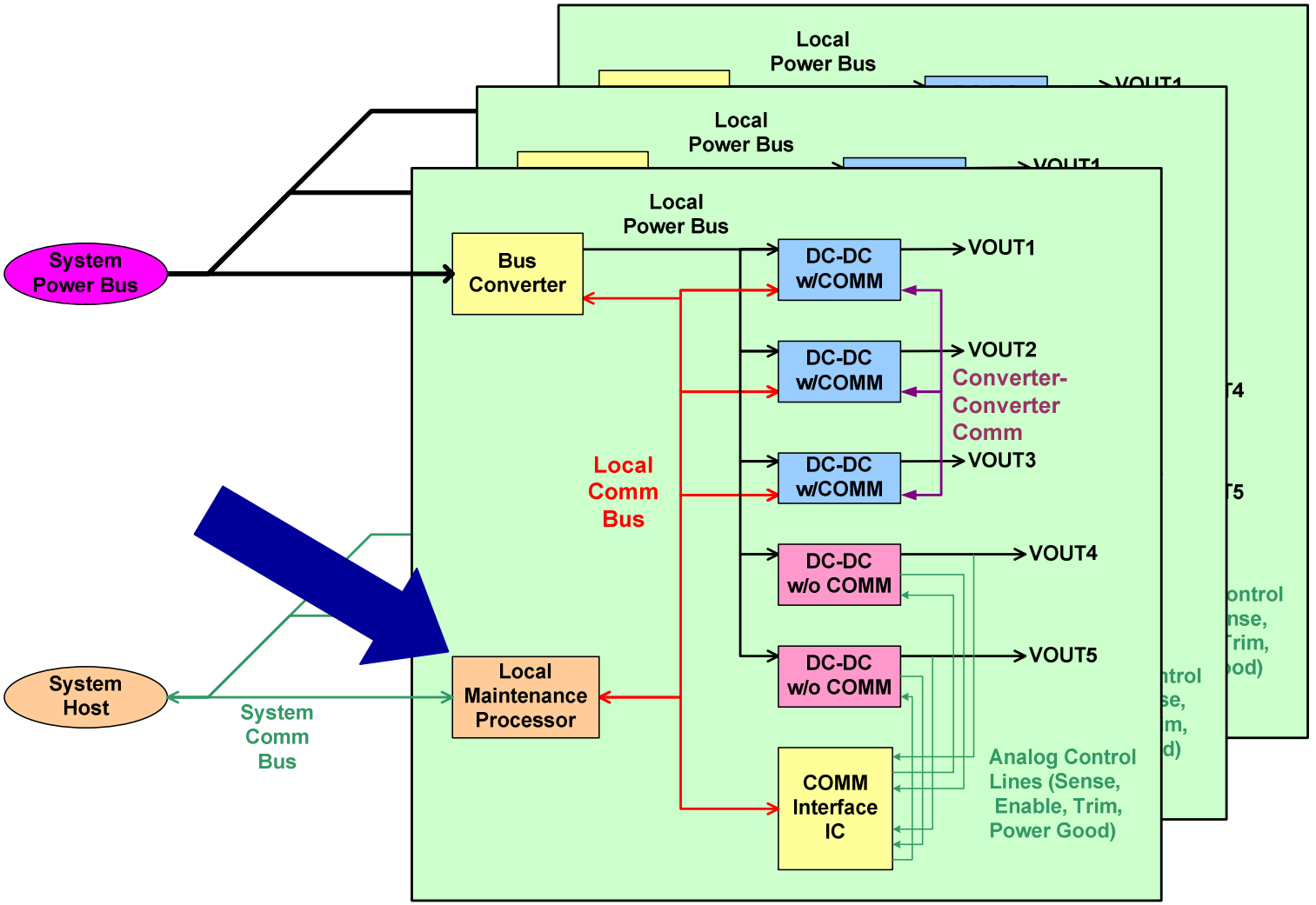

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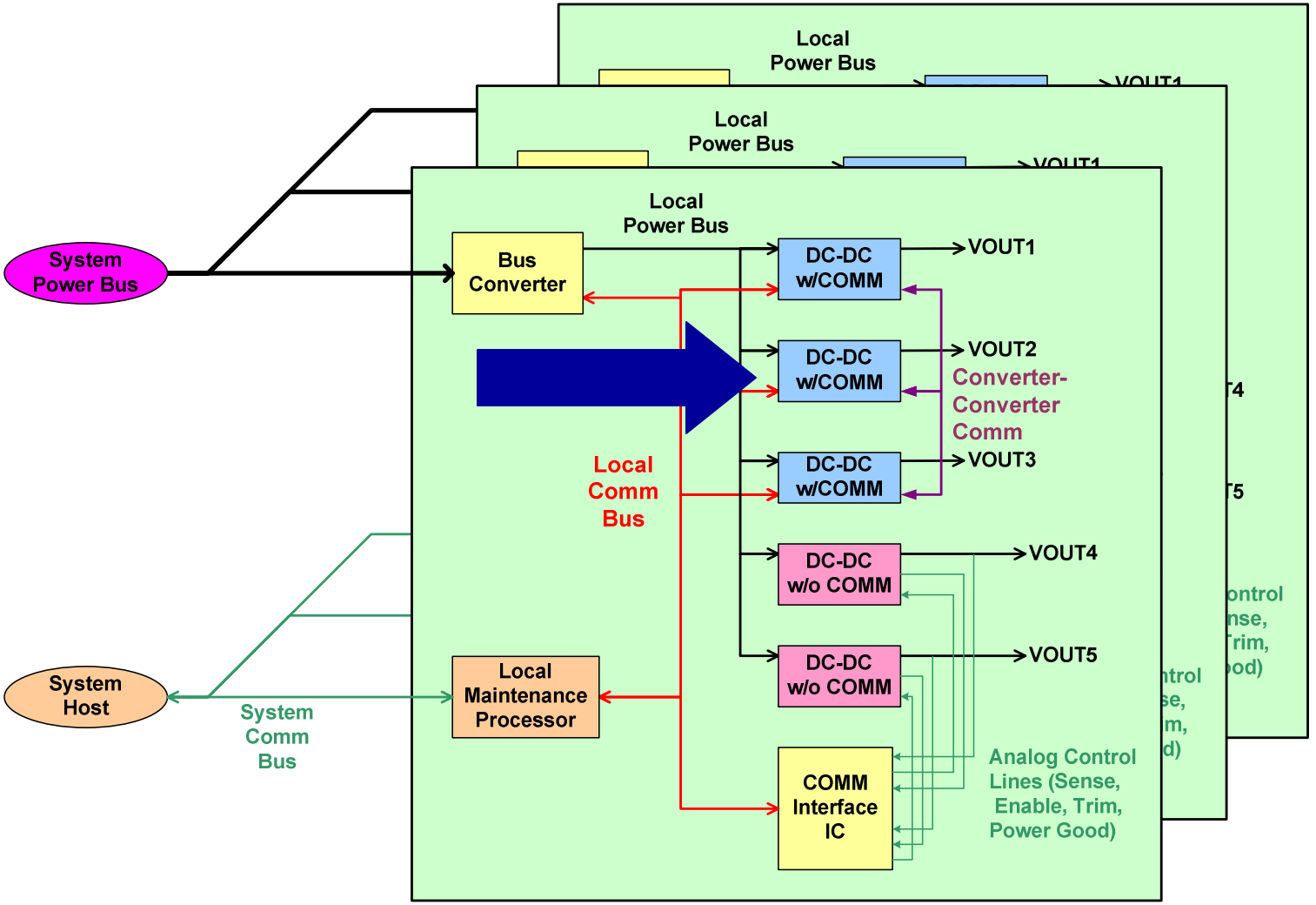

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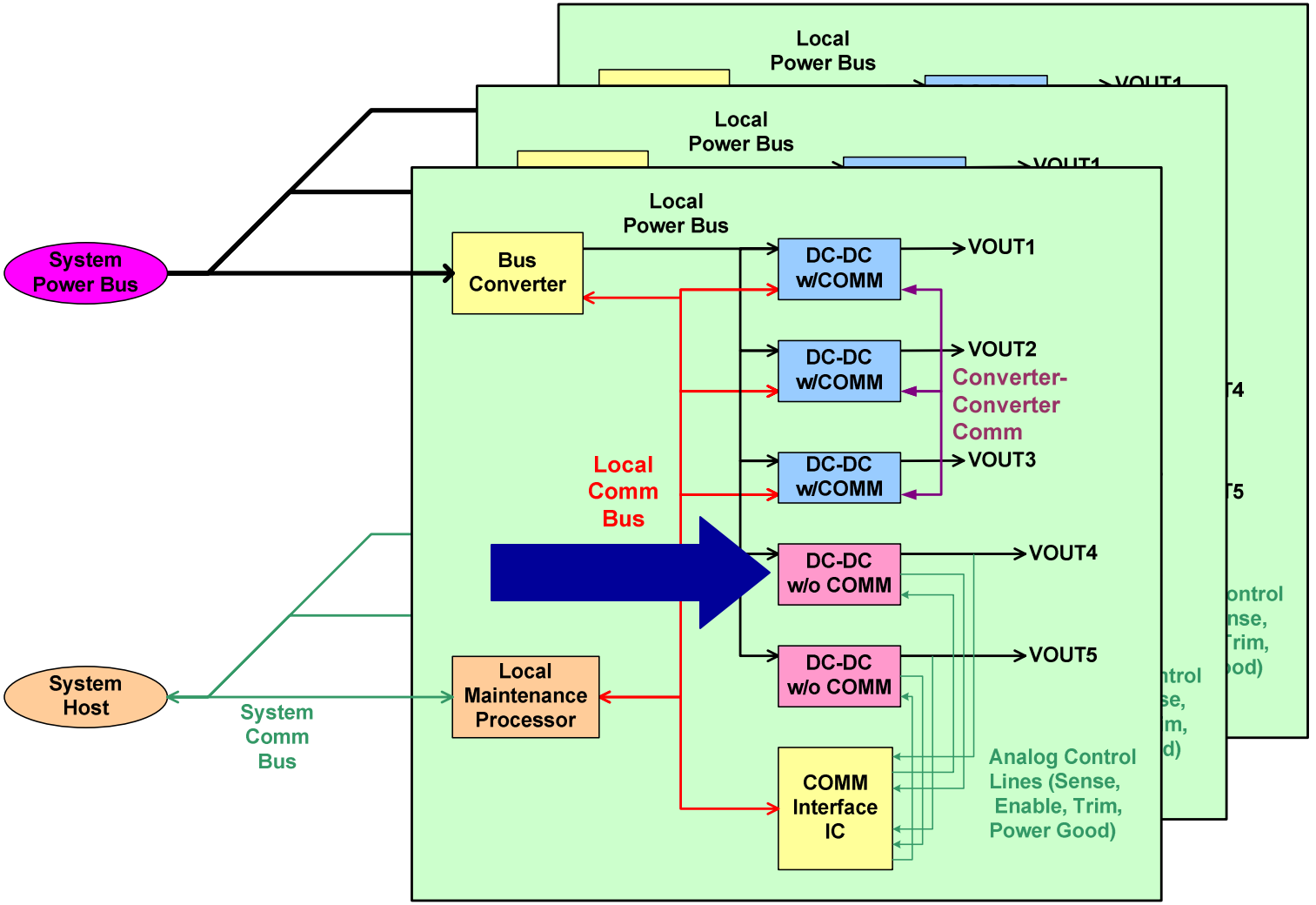

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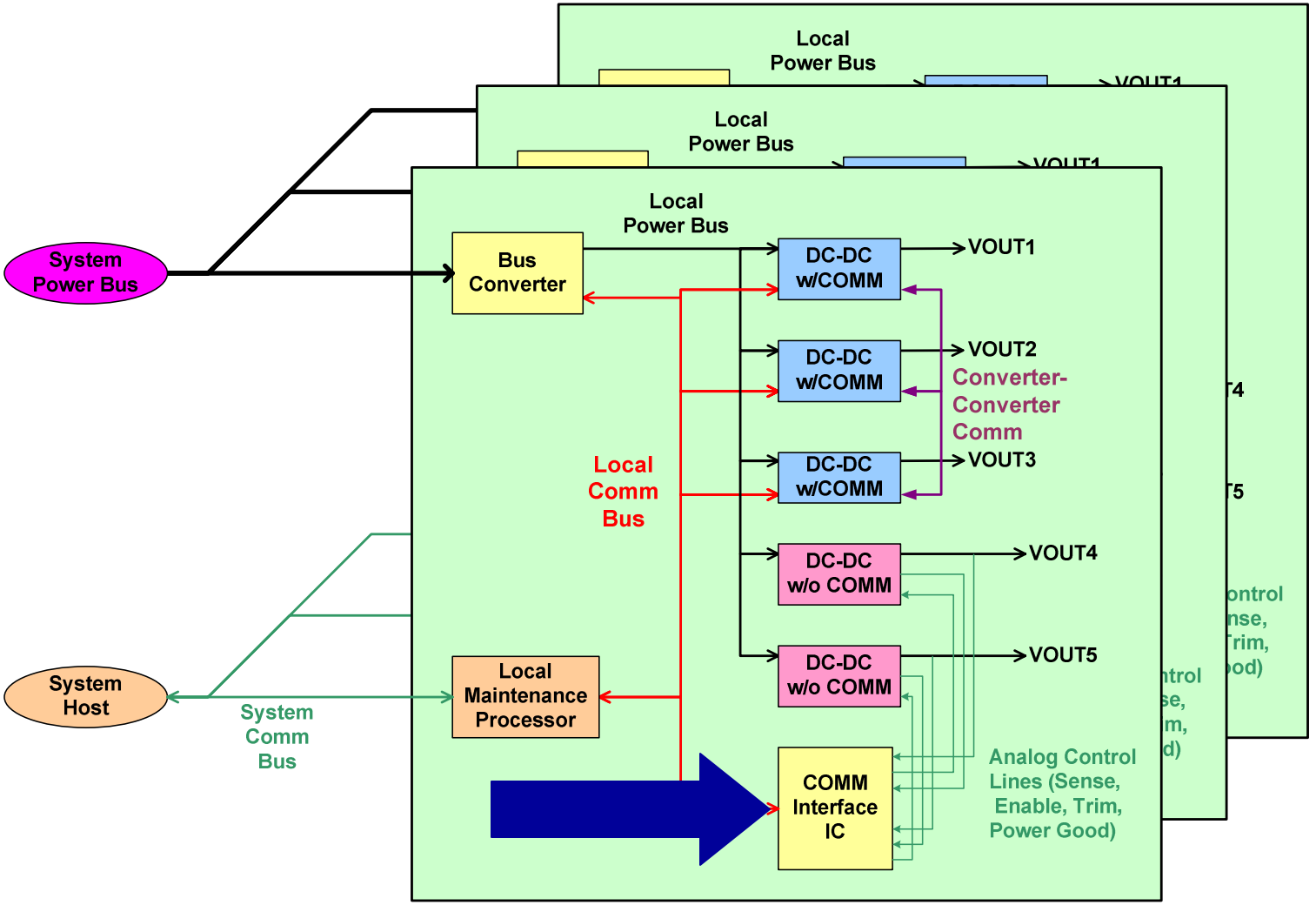

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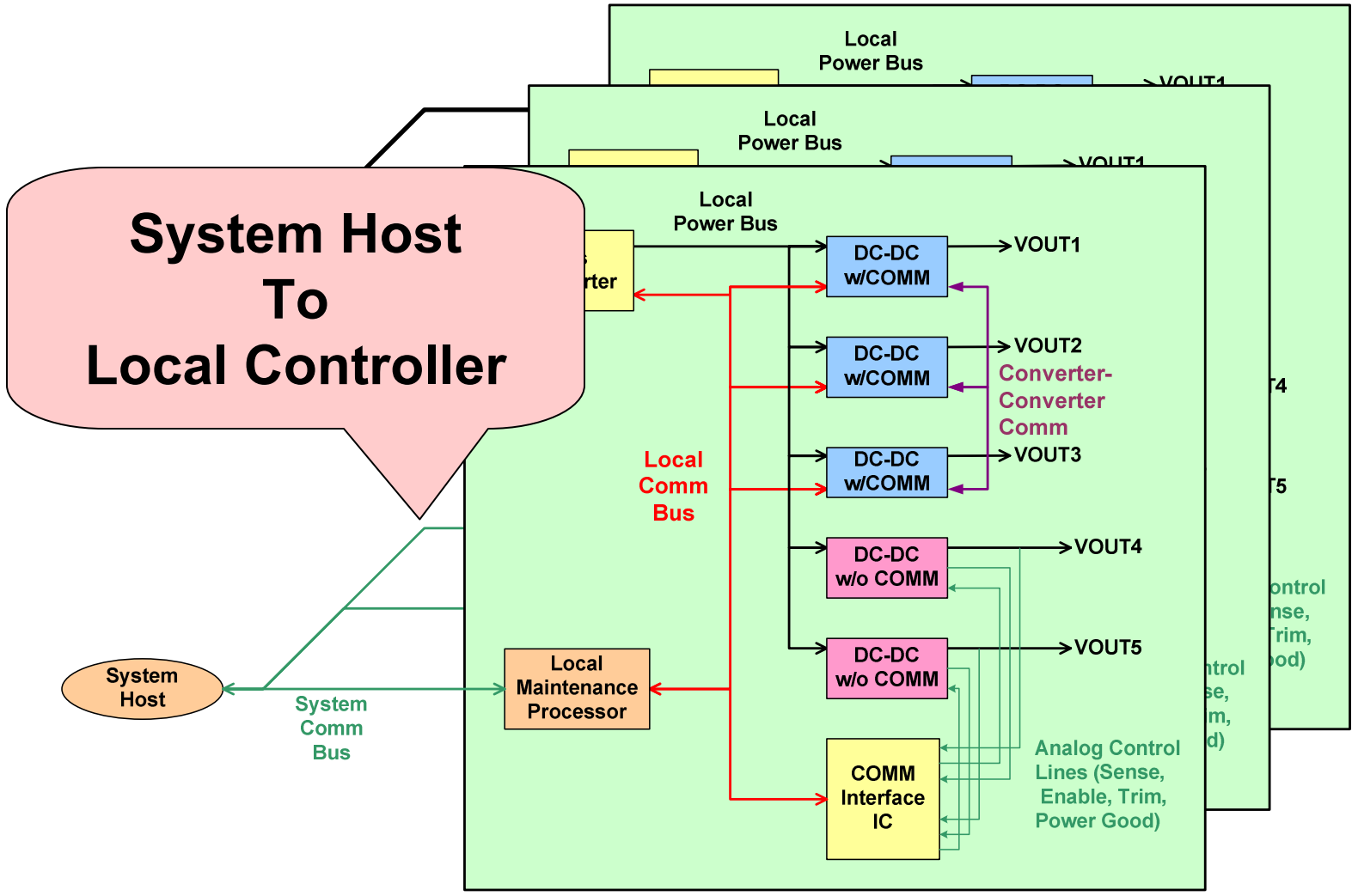

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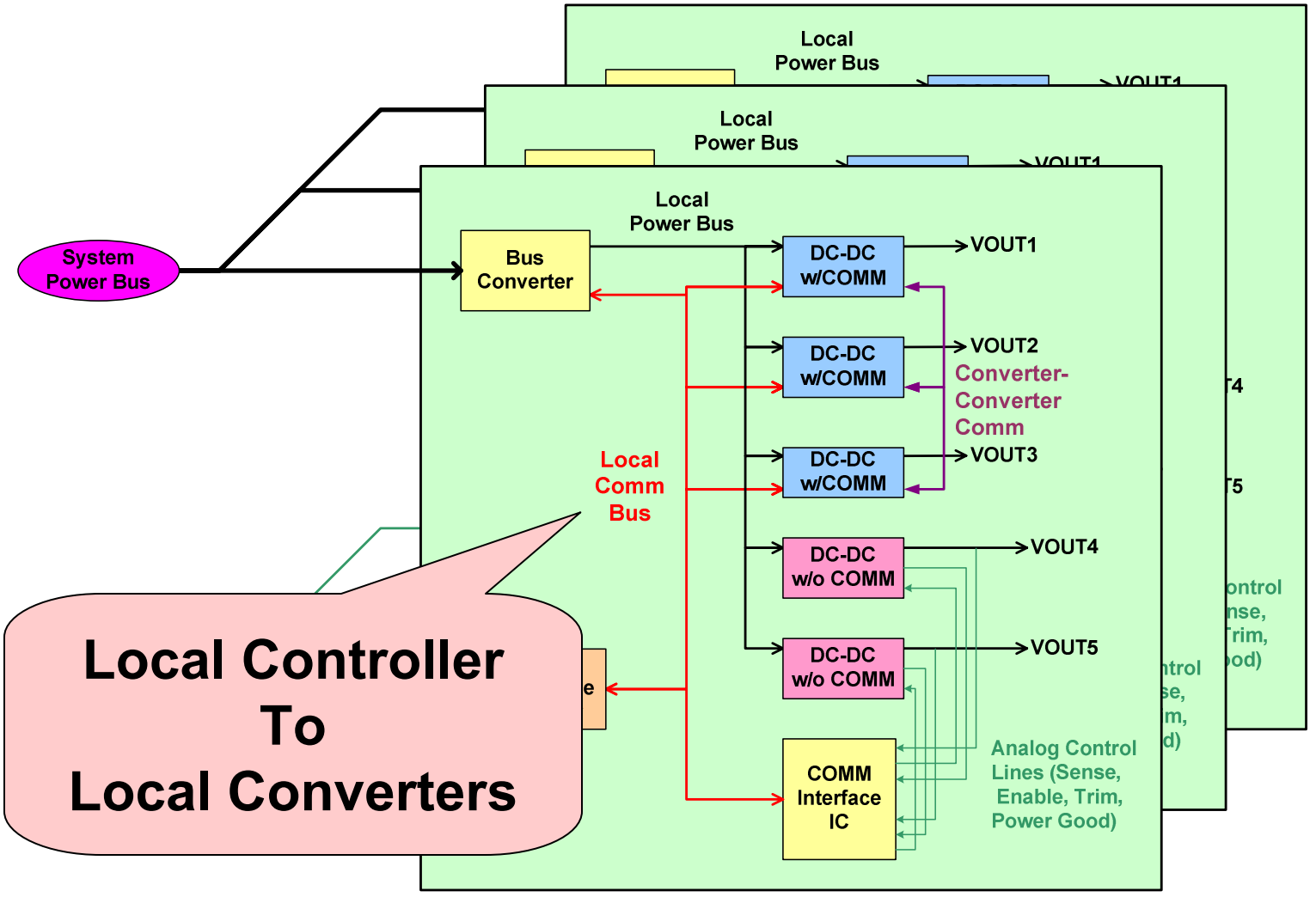

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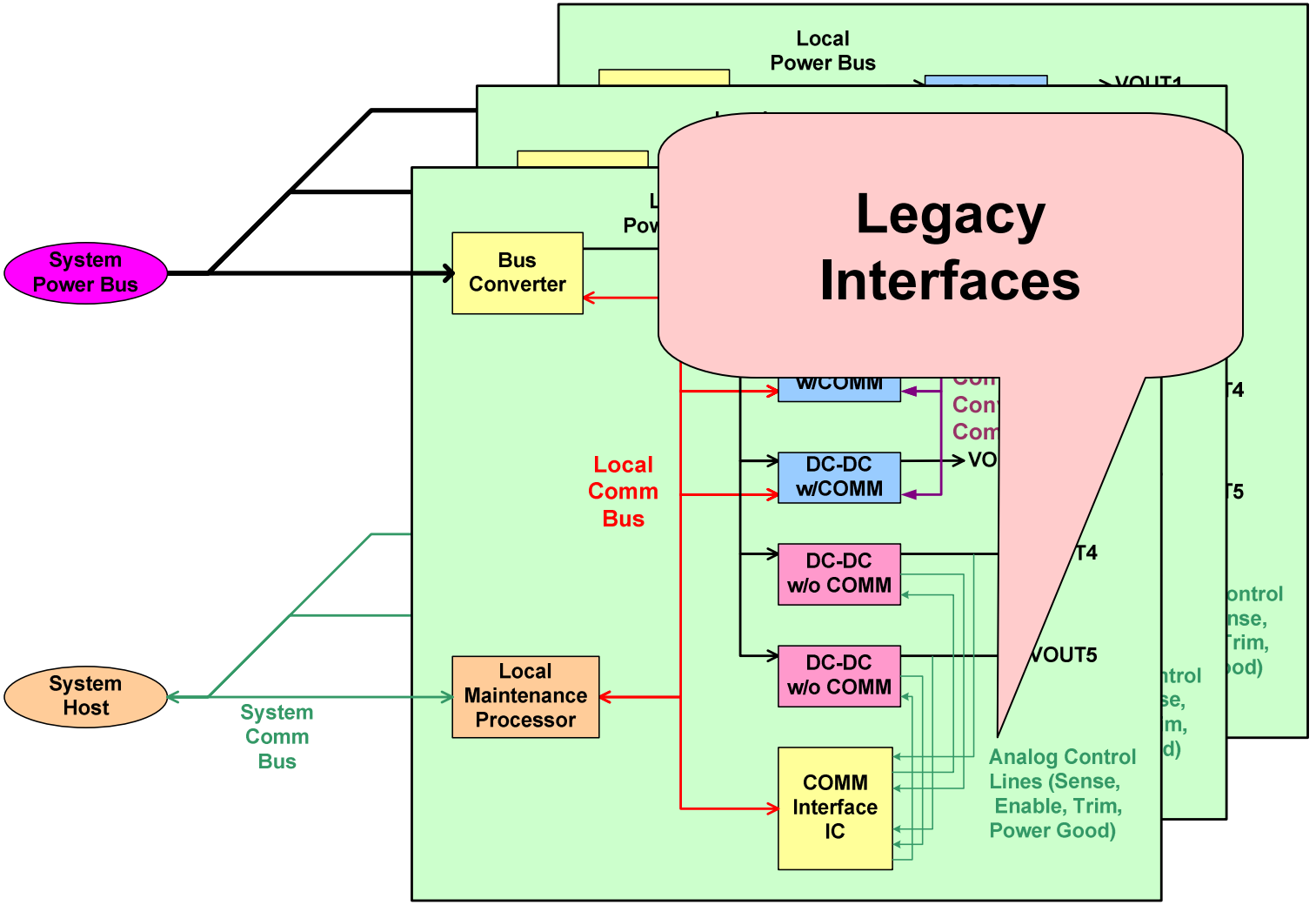

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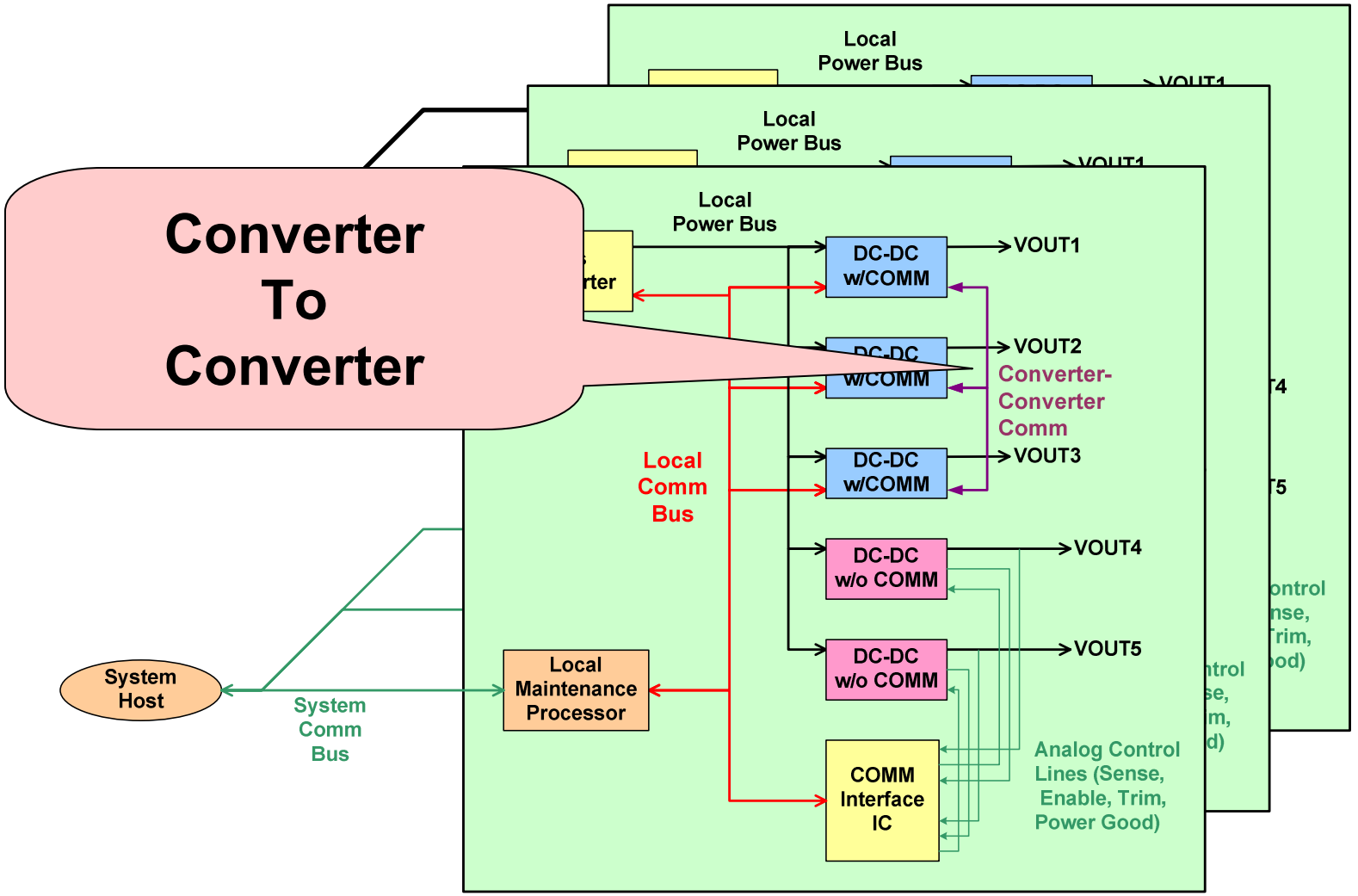


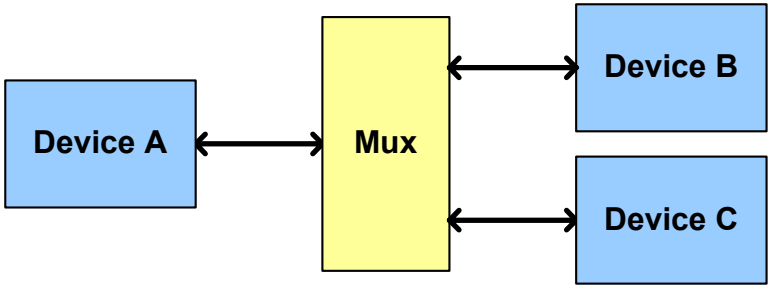
Additional Requirements: Real Time Data

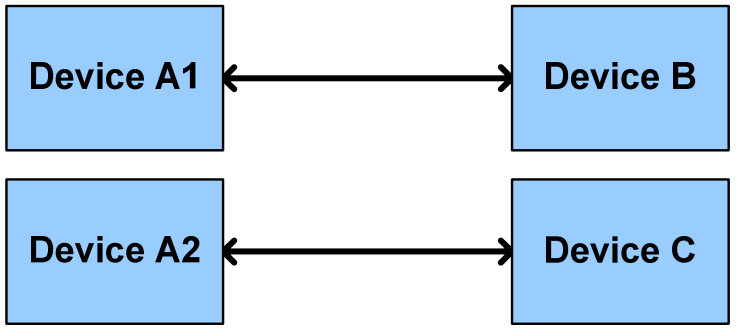
- Time Critical Information Of Two Types
  - Events
  - Parametric
- Fault Events Can Be Catastrophic And Must Be Transmitted With Minimum Delay
- Parametric Data Requires Data Rates Of Tens Of Megabits Per Second
- Recommendation
  - Events: Dedicated Signal Lines
  - Parametric: Dedicated, Customized Buses

Additional Requirements: Hot Swap

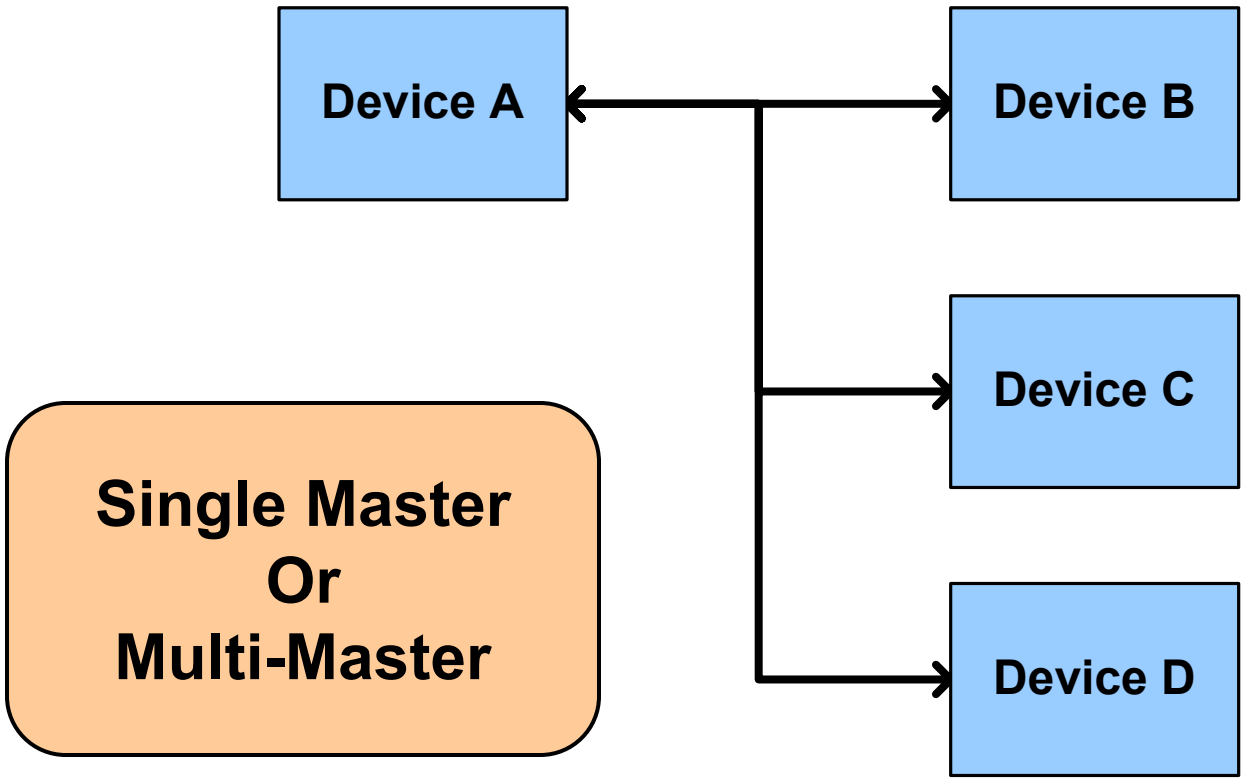
- A Common Requirement
- Hot Insertion Or Removal Must Not:
  - Interrupt Bus Traffic
  - Require Complex System Response
- More On This Later

Data Communication Characteristics: Connectivity: Point-to-Point





Data Communication Characteristics: Connectivity: Multi-Drop



Data Communication Characteristics: Directing Communication On Multi-Drop Bus

- Chip/Device Select Lines
- Addressing
  - Hard Versus Soft Addresses
  - Allowable Addresses
  - Assuring Unique Addresses
  - Address Ties To Physical Location Or Function
- Address Pins – Not Just Binary
  - Tri-State
  - Resistor Programmable

Data Communication Characteristics: Bus Contention

- Bus Contention In Multi-Drop Buses Is Unavoidable For Multi-Master
- Lossless, Bitwise Arbitration Common For Simultaneous Attempts To Transmit
- Adding Priority To Messages (Like CAN Bus) Does Not Prevent Delayed Messages
  - If Bus Is Busy, Even High Priority Messages Have To Wait Until The Bus Is Clear
  - Continuous Stream Of Higher Priority Messages Can Indefinitely Delay A Lower Priority Message

Data Communication Characteristics: Speed And Timing

- Megabits Per Second Is Not The Whole Story
- How Fast Can Data Get From Sender To Receiver?
  - Over Communication Bus, Not Fast Enough For Most Time Critical Events
- Packet Overhead Reduces Effective Bit Rate
- Time Critical Data Should Be Routed Over Dedicated Buses Between Only The Devices Involved
  - Example: Real Time Digital Current Sharing

Data Communication Characteristics: Polling And Interrupts

- Polling
  - Simpler To Implement
  - Detection Of Failed Or Removed Devices
  - Consumes A Lot Of Resources
  - Possible Delay Time = Refresh Rate
- Alert Or Interrupt Driven
  - More Complicated Code
  - Reduces Burden On Host
  - Quick Notification Of Events
- Good Choice: Blend The Two

Data Communication Characteristics: Range And Number Of Devices

- Range
  - Often Capacitance Limited
  - Short Range, Open Drain Drivers = Low Cost

Watch Out For The Edges!

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Obey The Spec – Or Else!

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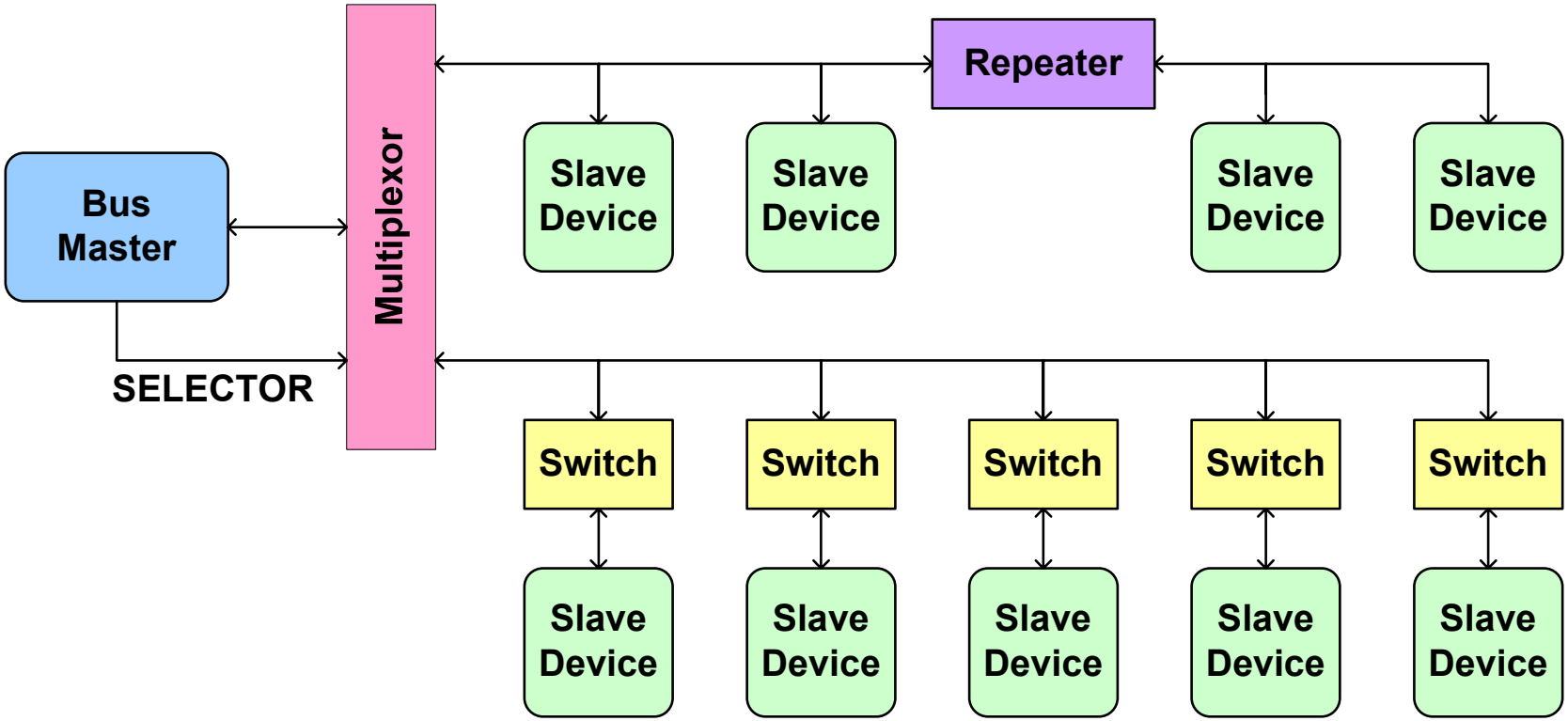
  - Longer Range Requires More Robust Drivers

Data Communication Characteristics: Range And Number Of Devices

- Range
  - Often Capacitance Limited
  - Short Range, Open Drain Drivers = Low Cost
  - Longer Range Requires More Robust Drivers
- Number Of Devices
  - Like Range, Often Load Limited
  - May Be Address Limited
  - Generally Not A Problem

Data Communication Characteristics: Range And Number Of Devices



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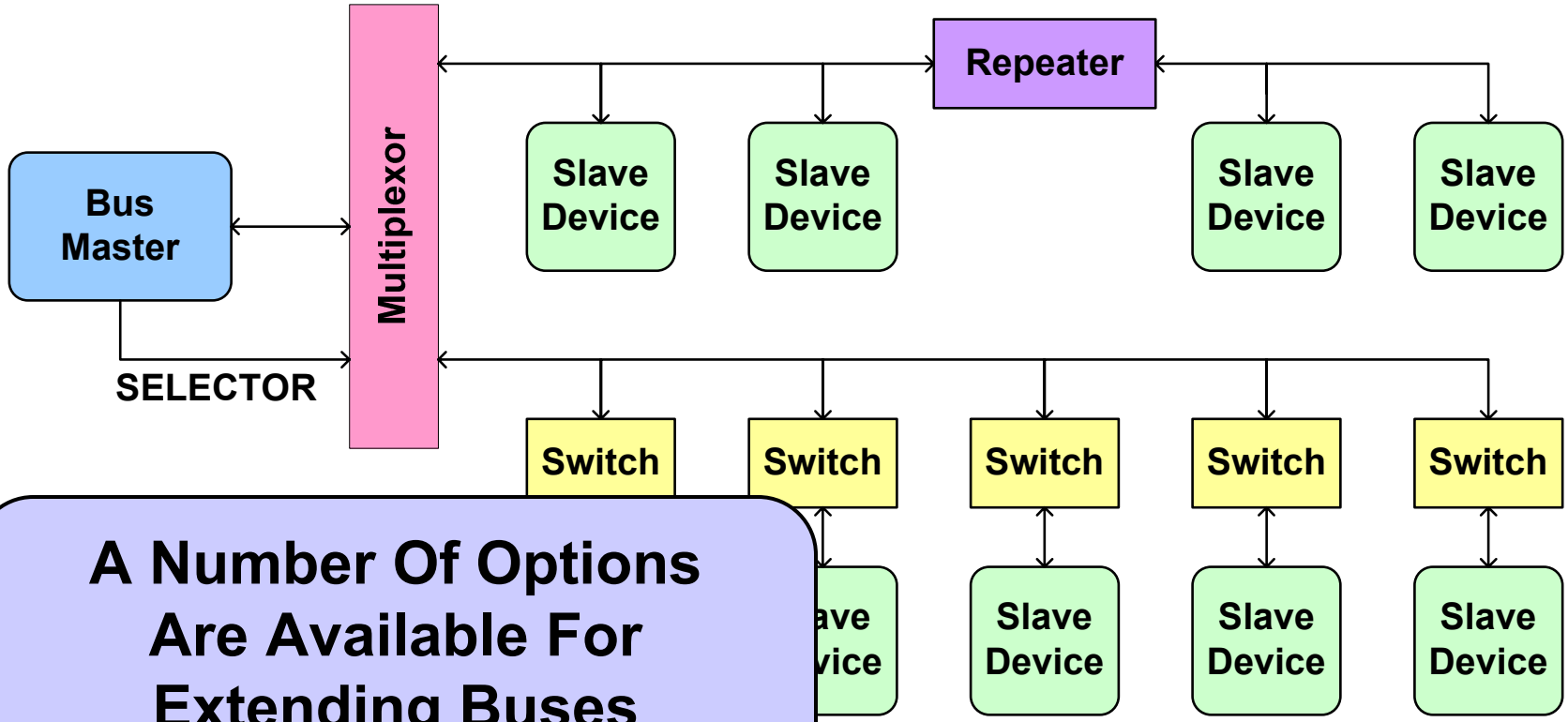
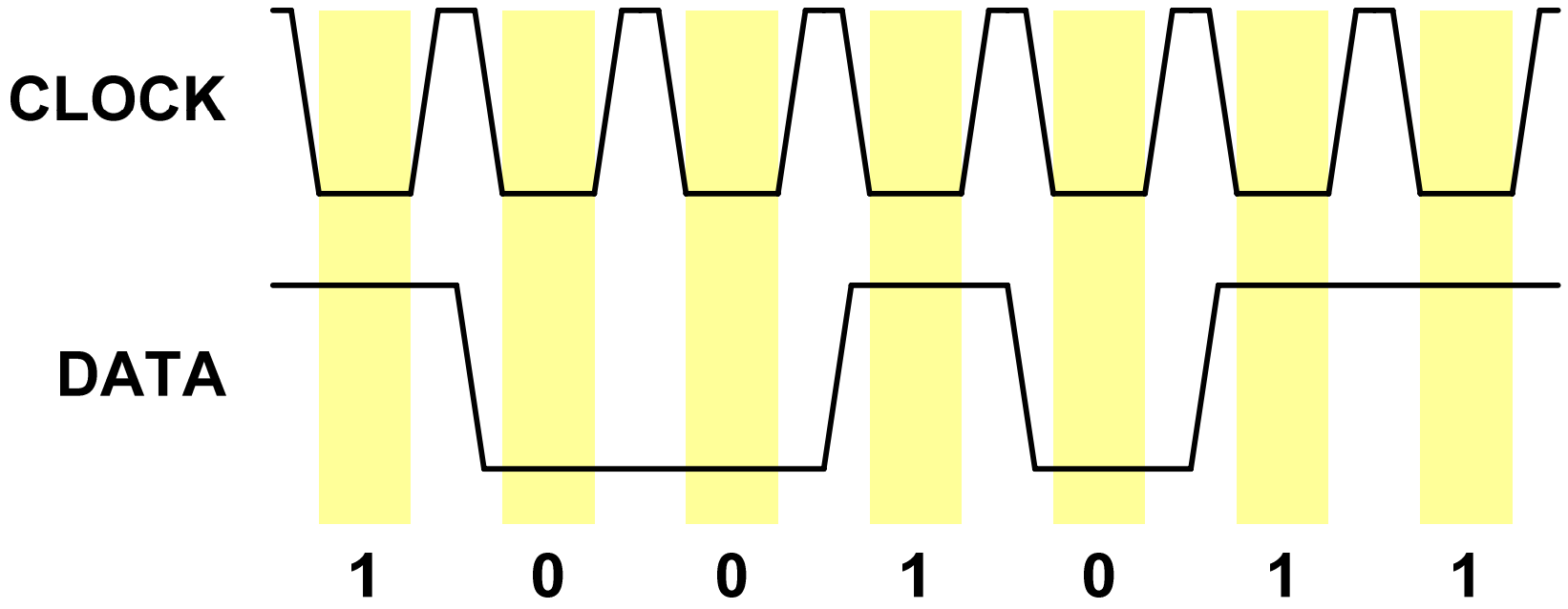


A Number Of Options Are Available For Extending Buses And Number Of Devices

Data Communication Characteristics: Clock

- Synchronous
  - Clock Signal Sent With Data



Data Communication Characteristics: Clock

- Synchronous
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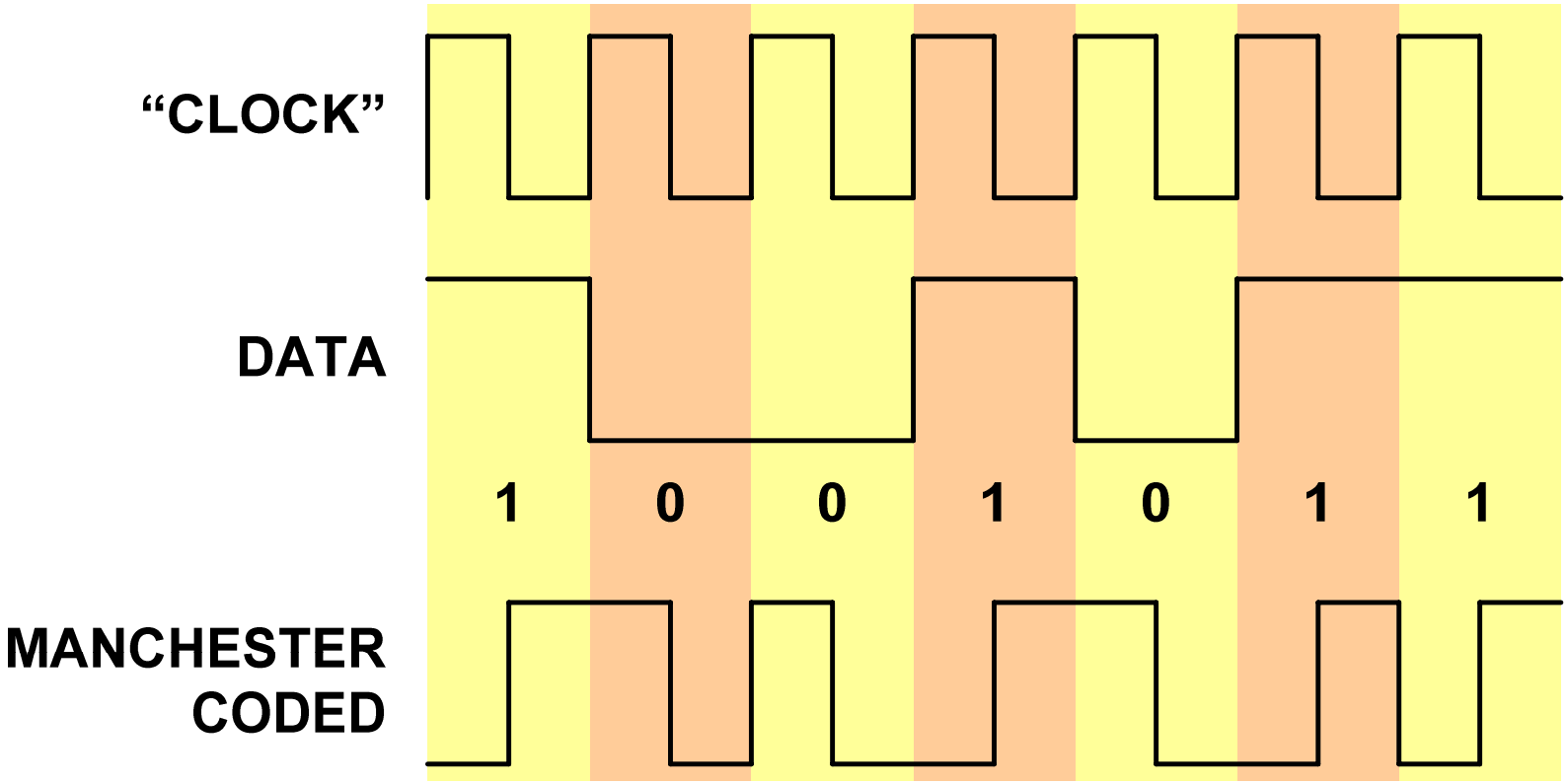
  - Receiving Devices Do Not Need An Oscillator
  - Range Limited

Data Communication Characteristics: Clock

- Synchronous
  - Clock Signal Sent With Data
  - Receiving Devices Do Not Need An Oscillator
  - Range Limited
- Asynchronous
  - No Clock Signal Sent With Data
  - Each Device Needs Its Own Oscillator
  - Can Loose Sync On Long Strings Of Ones Or Zeroes
    - Bit Stuffing
    - Fancy Coding

Manchester Coding (per IEEE 802.3)



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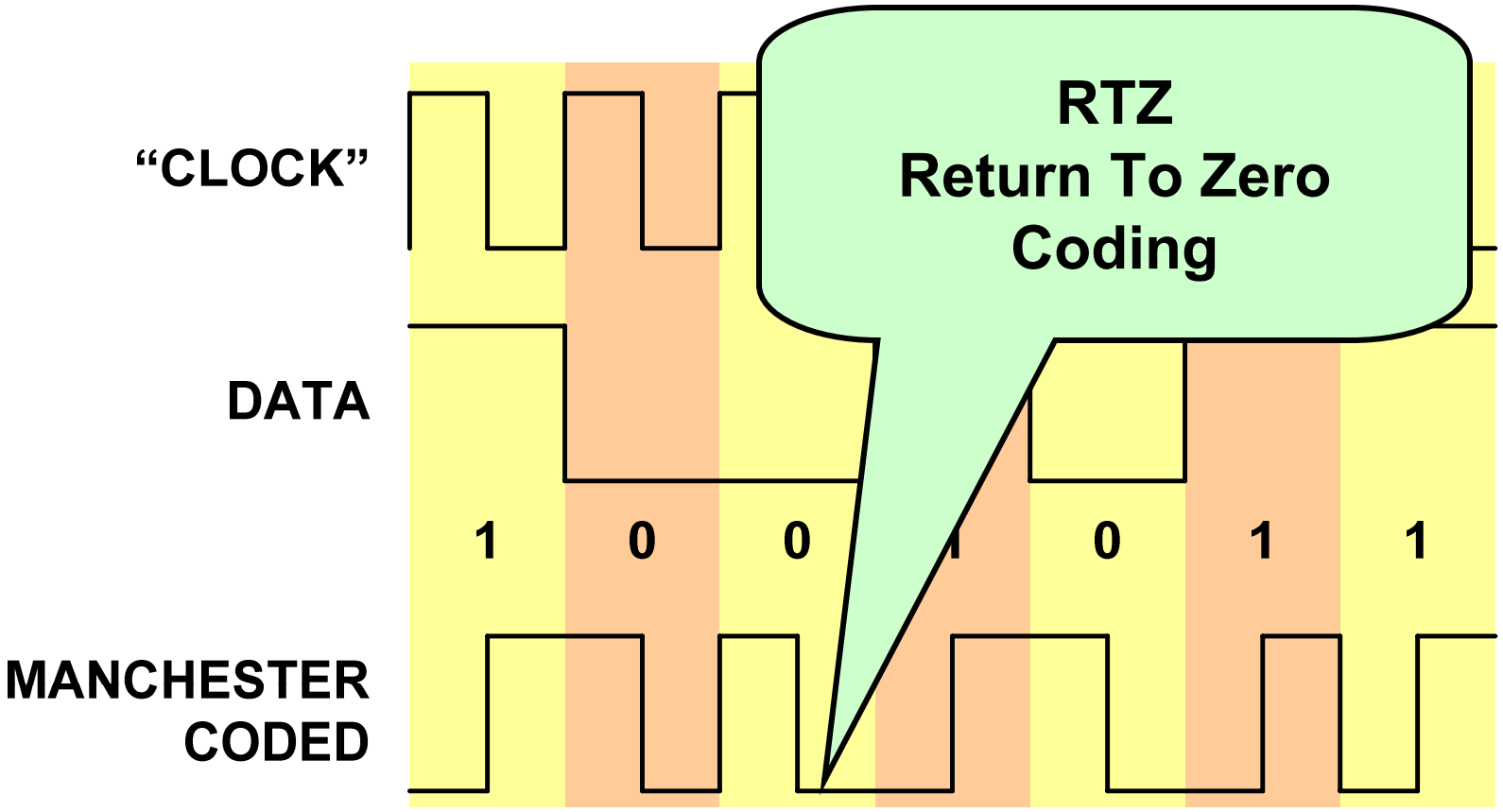

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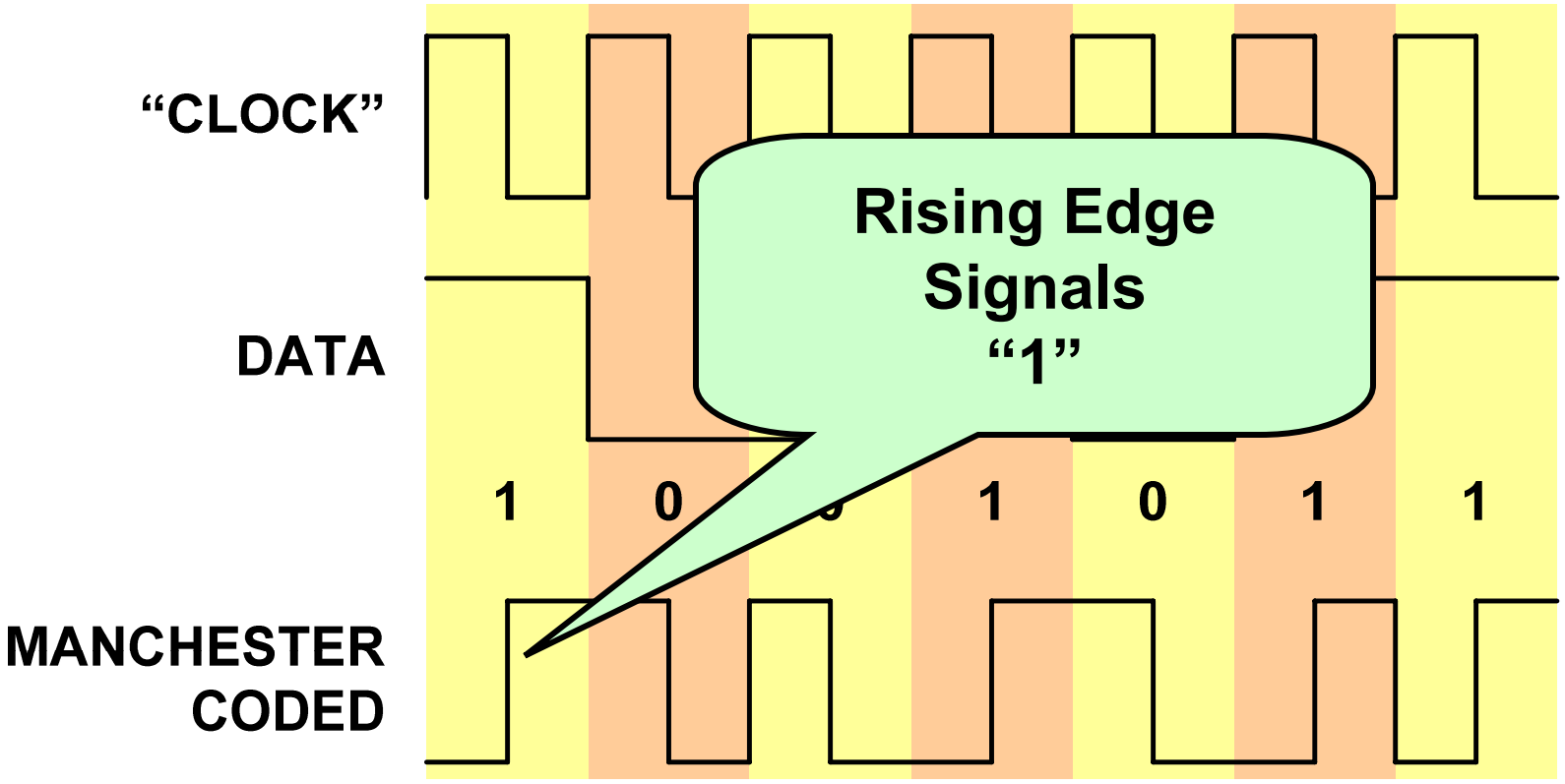

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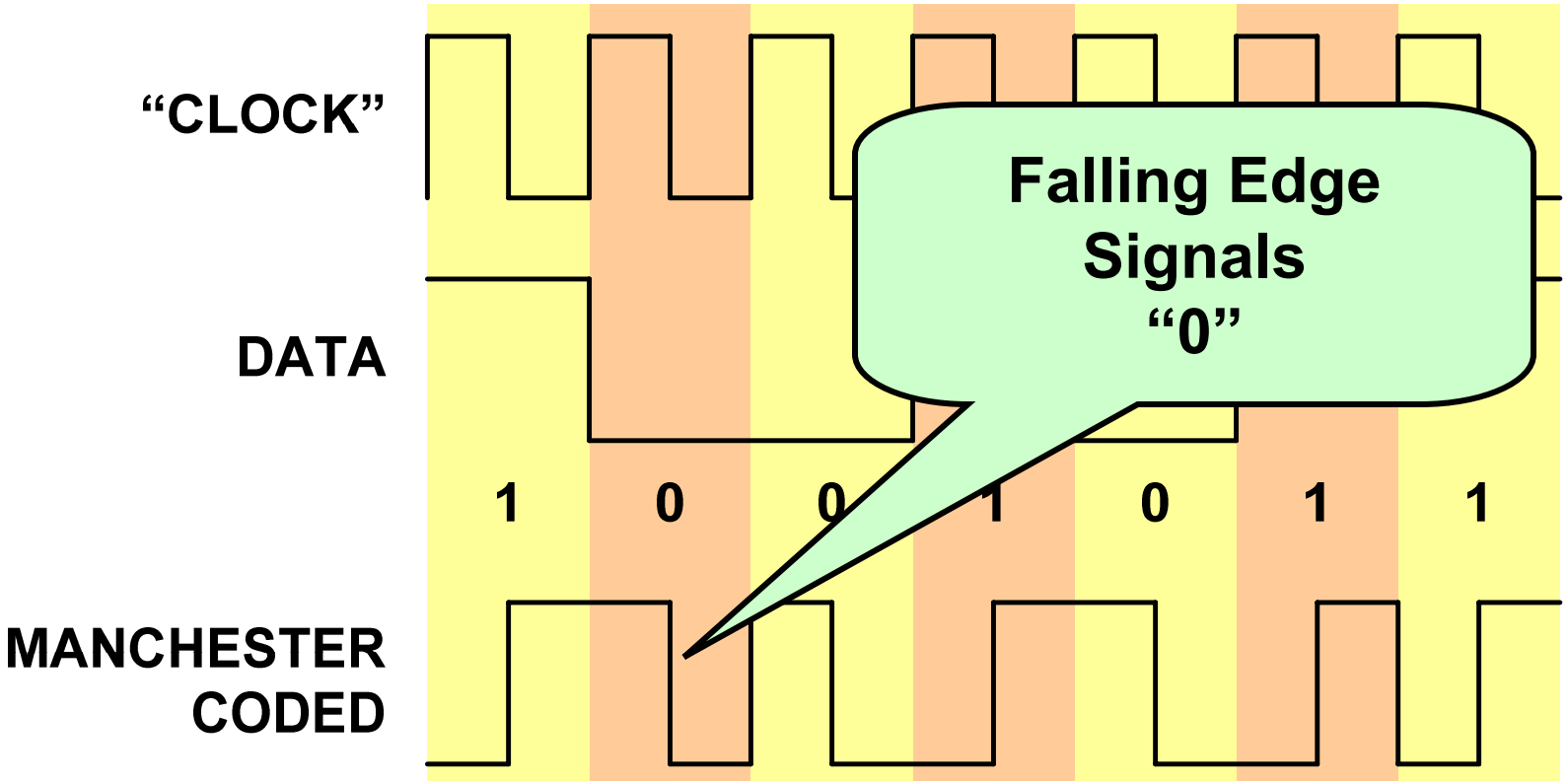

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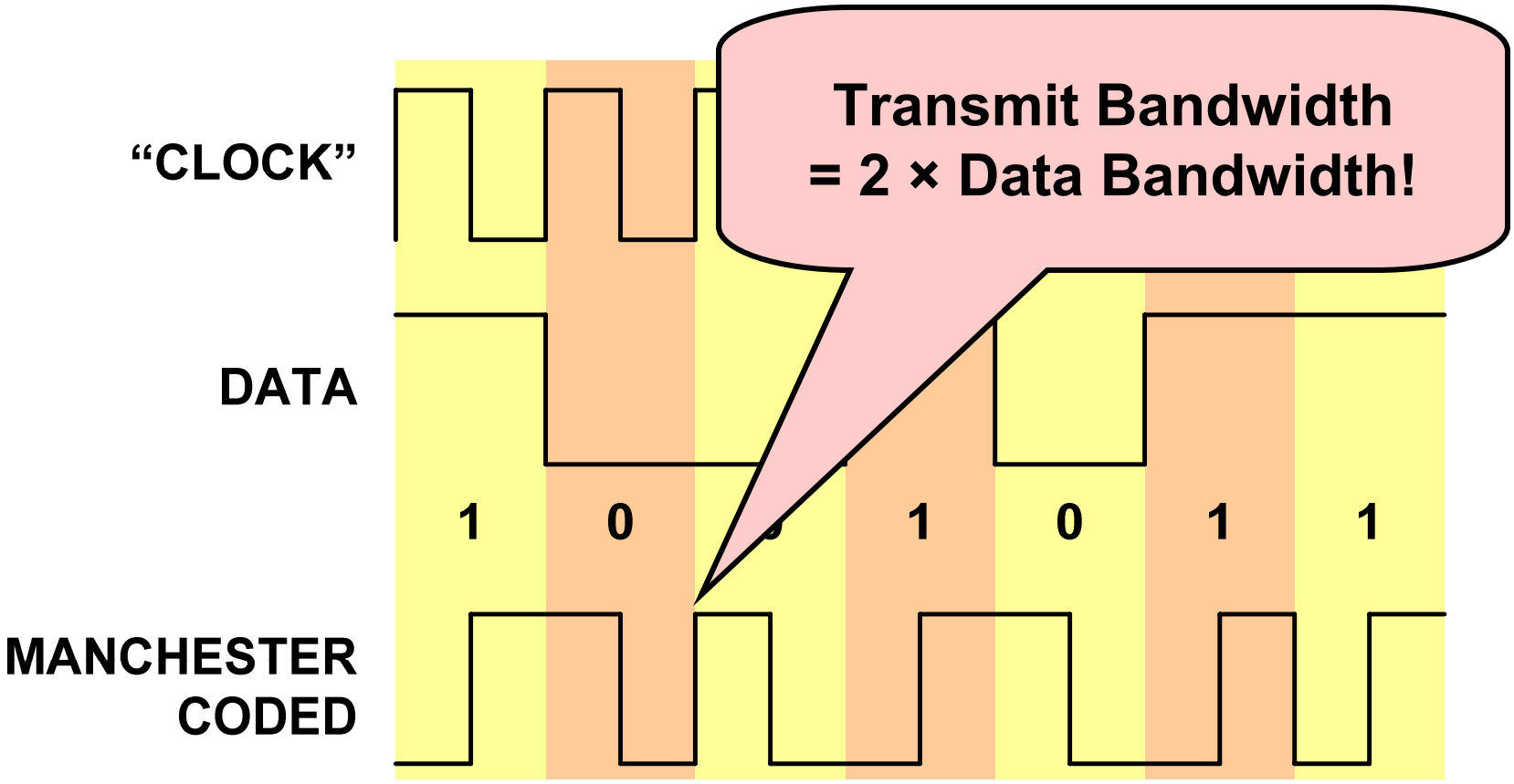

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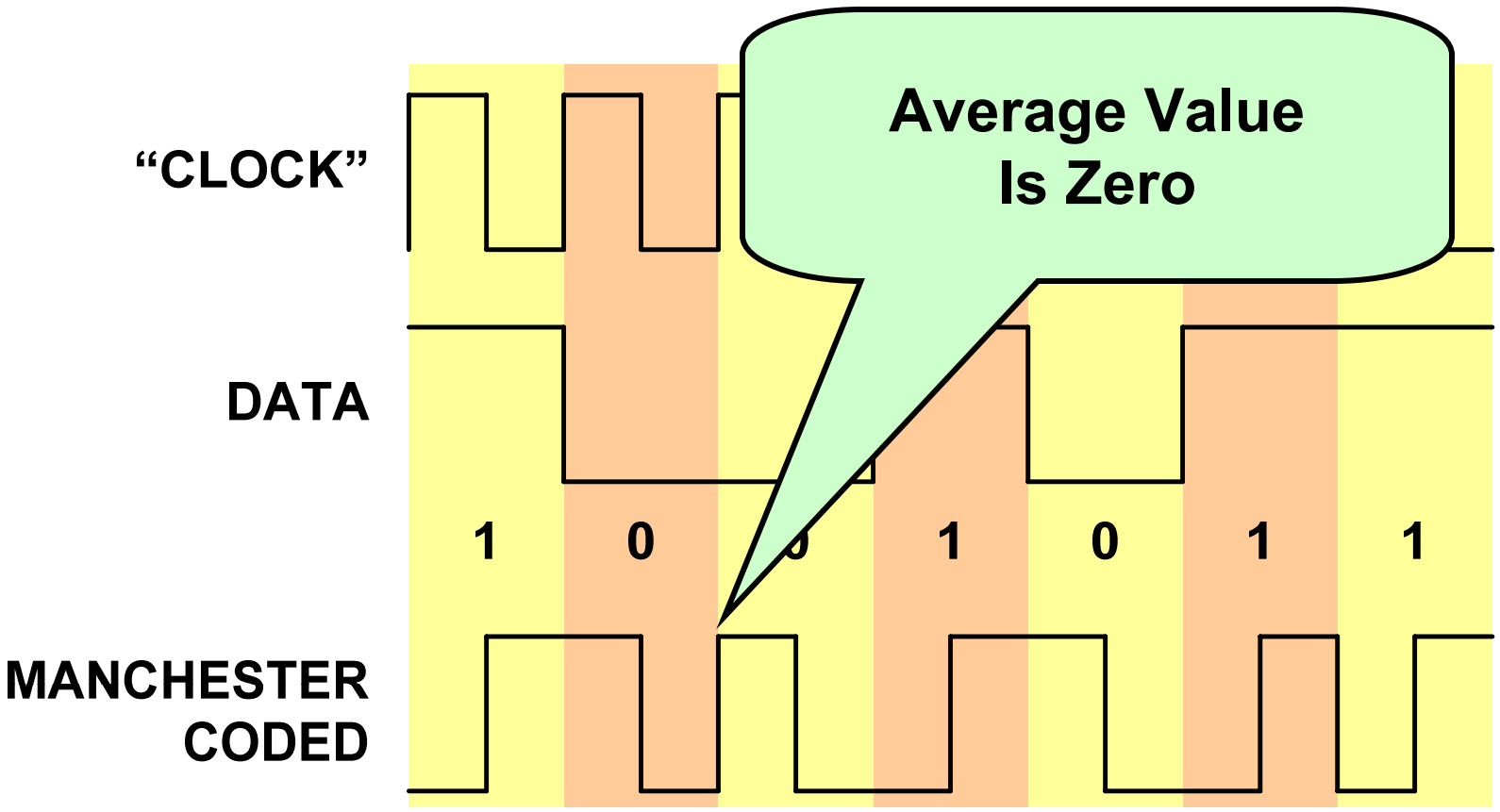

Data Communication Characteristics: Single Ended Or Differential Signaling

- Single Ended Signaling
  - One Wire For Data
  - Lower Cost, Less Complicated
  - More Susceptible To Noise Then Differential
- Differential Signaling
  - Two Wires For Data
    - Opposite Polarity Signals On Each
  - More Immune To Noise
  - More Immune To Ground Voltage Differences
  - Higher Cost

Data Communication Characteristics: Transmission Control Issues

- Device Is Busy And Cannot Be Interrupted To Respond To Another Request
- Device Cannot Accept Data At Current Rate
- Device's Buffer Is Full
- Bus Is Busy And Device Must Wait

Data Communication Characteristics: Transmission Protocols

- Read/Write
  - Complete Transaction In One Uninterrupted Flow
  - Example: Reading/Writing Serial Memory Device
- Message Based
  - Like Sending Email Messages Back And Forth
  - Example: IPMI

Data Communication Characteristics: Transmission Protocols

- Read/Write
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Best For Most Power Conversion Devices

Data Communication Characteristics: Transmission Protocols

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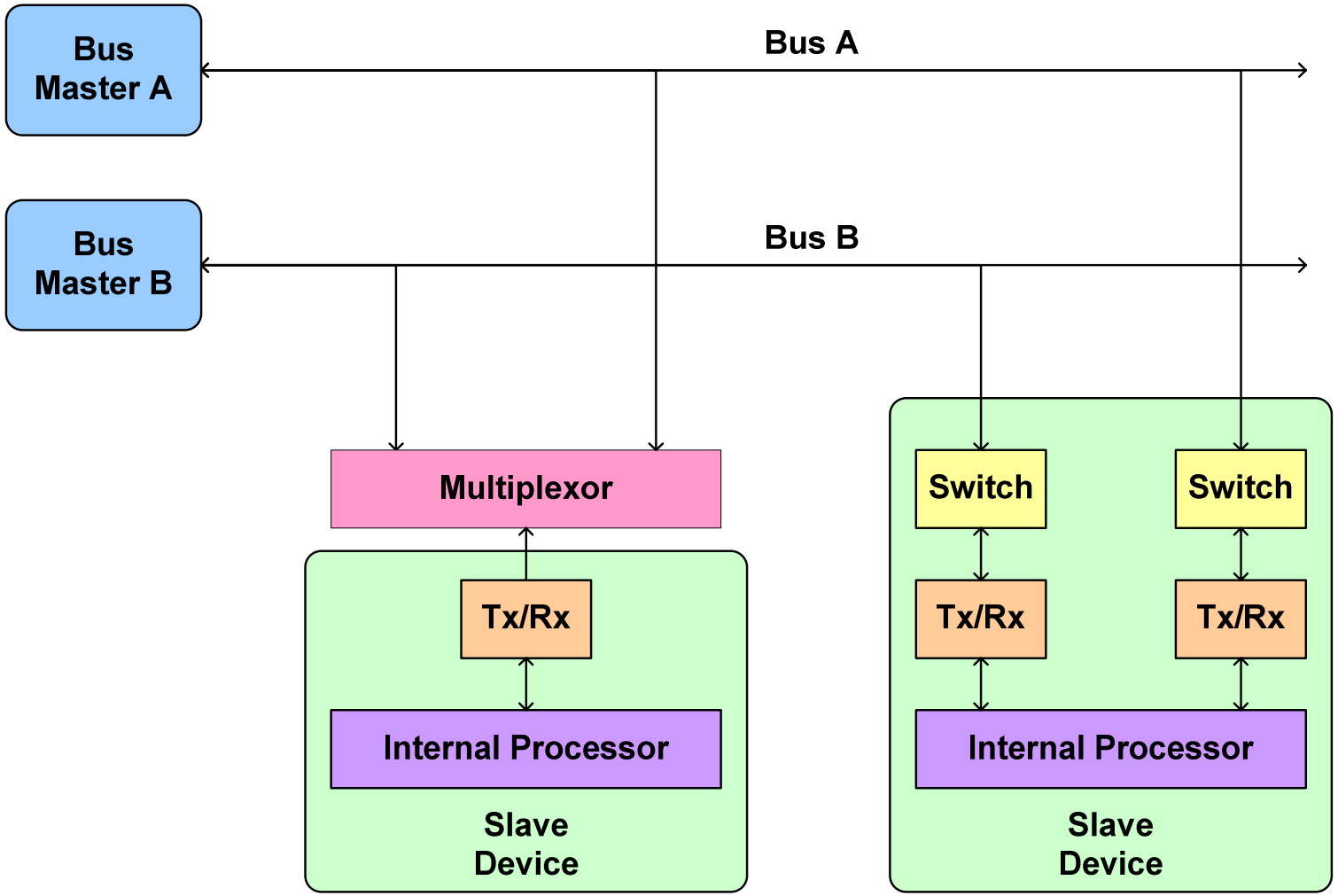
  - Complete Transaction In One Uninterrupted Flow
  - Example: Reading/Writing Serial Memory Device
- Message Based
  - Like Sendi Email Messages Back And Forth
  - Example: I

Better For More Complex Devices Over Longer Distances

Data Communication Characteristics: Error Detection And Correction

- Possible Errors
  - Bit Value Changed
  - Beginning Or End Of A Byte Or Bit Sequence Not Recognized
  - Too Many/Too Few Bits In A Frame Or Packet
  - Start Or End Of A Packet Or Message Not Recognized
- Error Detection: Parity Bit, Checksum, CRC
- Error Correction
  - More Complex
  - Lots More Bits

Data Communication Characteristics: Fault Tolerance



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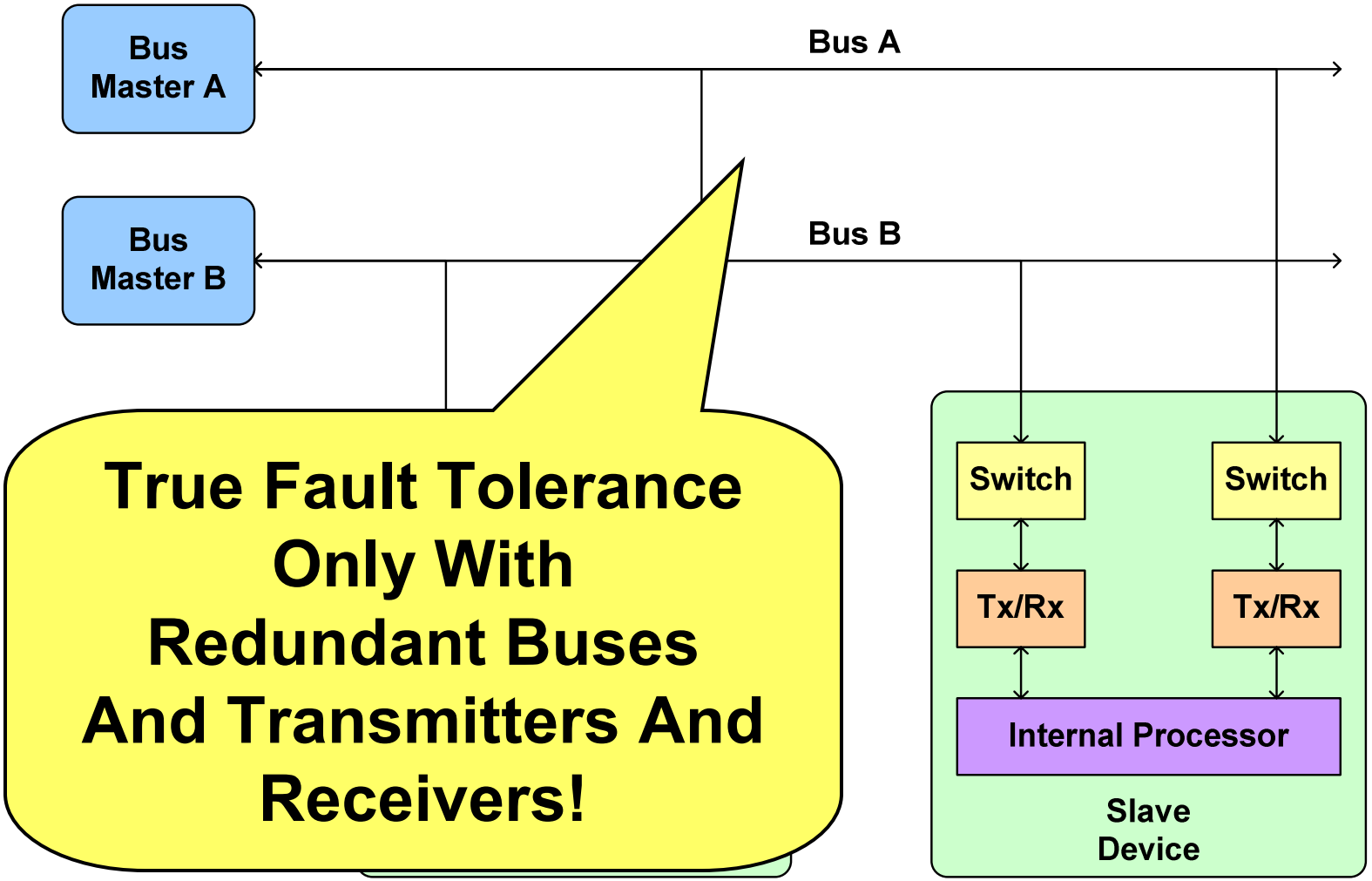

Data Communication Characteristics: Hot Swap

- Hot Swap Issues
  - Removal And Insertion Without Disruption
  - How Does System Know If A Unit Has Been Added Or Removed?
- Most Buses Support Hot Swap Fairly Well
- Implementation Issues
  - Making Ground Connection “Last Break & First Make”
  - Preventing Unpowered Devices From Shorting Bus During Insertion Or Removal
  - MODULE_PRESENT Signal To Assist Detection

Data Communication Characteristics: Hardware Implementation

- Software Emulation Using GPIO
  - Possible To Do
  - A Source Of Many, Many Headaches
  - Timing Is Very Difficult Even For “Slow” Buses
- Integrated Solutions
  - Many Low Cost Microcontrollers Have Bus Interfaces Built In
  - Must Have For Complex Buses Like CAN Bus And Ethernet

Data Communication Characteristics: IP Issues

- Standard: De Facto vs. De Jure
- Who Controls?
  - An Organization
  - Single Company
  - No One
- Organization Ownership Preferred
  - Adopter's Agreements
  - Compliance Assurance
- Royalty Free Or Not?

Recommendation By Bus Type
RS-232

- Advantages
  - Common Peripheral
  - Simple
  - Relatively Low Cost
- Disadvantages
  - Point-To-Point
  - Oscillator
  - Speed
- Recommended
  - Simple Point-To-Point With Logic Level Interface

Recommendation By Bus Type
RS-485

- Advantages
  - Differential Signaling
  - Long Distance Communication
- Disadvantages
  - Additional Cost Of $1.00 to $1.50 In High Volume
  - All Protocol In Software
- Recommended
  - Longer Range Communication Such As Rack-To-Rack

Recommendation By Bus Type
I²C

- Advantages
  - Common Peripheral
  - Simple
  - Very Low Cost
- Disadvantages
  - Noise Sensitivity
  - Bus Capacitance Limitation
- Recommended
  - SMBus Is Better Choice In Almost Any Case

Recommendation By Bus Type
SMBus

- Advantages
  - Low Cost Like I²C
  - More Robust Than I²C
  - Additional Features
- Disadvantages
  - Bus Capacitance Limitation
- Recommended
  - On-Board And Shelf-Level Communication

Recommendation By Bus Type
SPI Bus

- Advantages
  - Simple
  - Chip Select Lines Eliminate Addressing Concerns
  - Good Speed (1 MHz)
- Disadvantages
  - No Standard
  - Chip Select Lines
- Recommended
  - Local Interconnect Of A Couple Of Peripherals

Recommendation By Bus Type
Dallas 1-Wire

- Advantages
  - 1-Wire
  - Unique ID In Every Device
  - Low Power
- Disadvantages
  - Noise Sensitivity
  - Proprietary
  - Cost
- Recommended
  - Only To Accommodate Legacy Situations

Recommendation By Bus Type
CAN Bus

- Advantages
  - Differential Signaling
  - Noise Immunity
  - Fault Tolerance
- Disadvantages
  - Cost
  - Requires Integrated Peripheral
- Recommended
  - Longer Range Communication Such As Rack-To-Rack And Beyond

Recommendation By Bus Type
LIN Bus

- Advantages
  - Single Wire
  - Reasonable Noise Immunity
- Disadvantages
  - Cost
  - Slow Speed
  - Complexity
- Recommended
  - Not Recommended (Use SMBus Or CAN Bus/ RS-485 Instead)

Recommendation By Bus Type
USB

- Advantages
  - Well Supported
  - Hot Swap Friendly
- Disadvantages
  - Requires Hub To Initiate All Communication
  - Relatively Complex Software And Hardware
- Recommended
  - PC To Power System Interface For Service

Recommendation By Bus Type
Ethernet

- Advantages
  - Long Haul Capability
  - Electrical Isolation
  - Internet Friendly
- Disadvantages
  - Cost And Complexity
  - Very Large Packets
  - Software Support
- Recommended
  - Interface To An Embedded Web Server In A Power System Manager

SST: “New Kid On The Block”

- Advantages
  - One Wire
  - Relatively High Speed (~ 1 Mbit/s)
  - Low Gate Count
  - Low Error Rate/High Noise Immunity

Claim Needs Independent Verification

SST: “New Kid On The Block”

- Advantages
  - One Wire
  - Relatively High Speed (~ 1 Mbit/s)
  - Low Gate Count
  - Low Error Rate/High Noise Immunity
- Disadvantages
  - Not Widely Available
  - Not An Open Standard
  - Does Not Have Extensive Field Experience

Appears Promising – Worth Watching

Recommendation By Application

- On-Board/Single Board Power System
  - SMBus
- Shelf-Level/Chassis-Level Power System
  - SMBus If Capacitance Allows
  - RS-485 If Not
- Shelf-To-Shelf Or Rack-To-Rack
  - RS-485
  - CAN Bus

Recommendation By Application

- Facility Level
  - RS-485 Or CAN Bus
  - Ethernet
- Campus Level
  - Ethernet
- PC To Power System Manager
  - USB

Summary

- No One “Right” Bus For All Power Communications
  - The Scope and Benefits Extend Beyond The Local Area
  - Several Well Established Buses To Choose From
- Know Your Application And Its Requirements
- Be Knowledgeable About Your Choices
- Choose The “Right Tool For The Job”
- Be Smart In Your System Design
  - Imitate Successful Designs
  - Understand The Constraints Before You Start Your Design

Summary

- No One “Right” Bus For All Power Communications
  - The Scope and Benefits Extend
- **Follow The Specification!**
  - Understand The Constraints Before You Start Your Design

Thank You For Your Time And Attention