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DTE Power Detection Algorithm
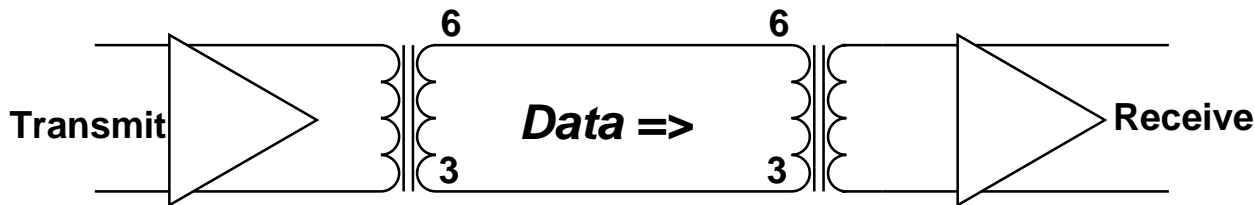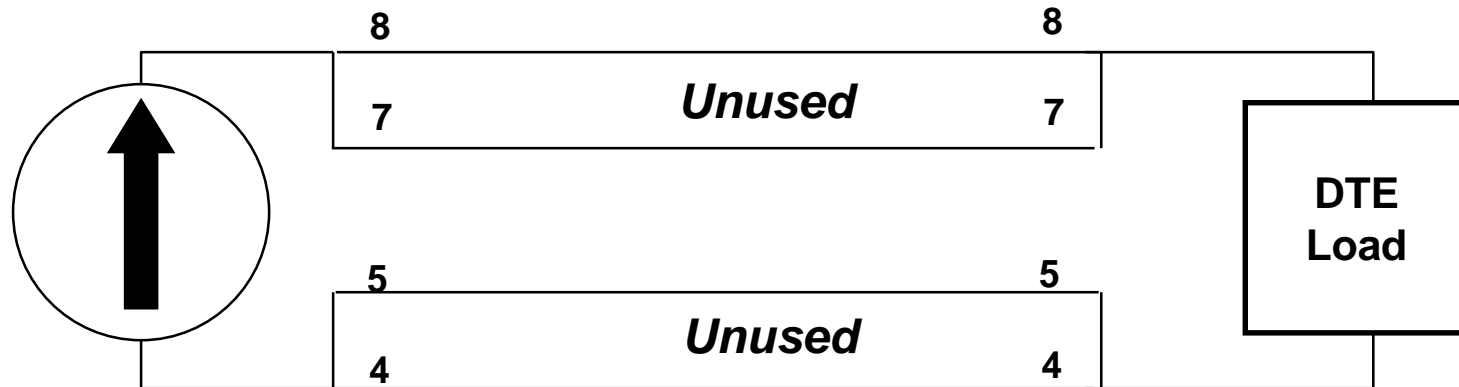
March - 2000

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Switch-to-DTE Wiring with Power over Unused Pairs

Switch /
DTE Detecting Station

End station
DTE Requiring Power
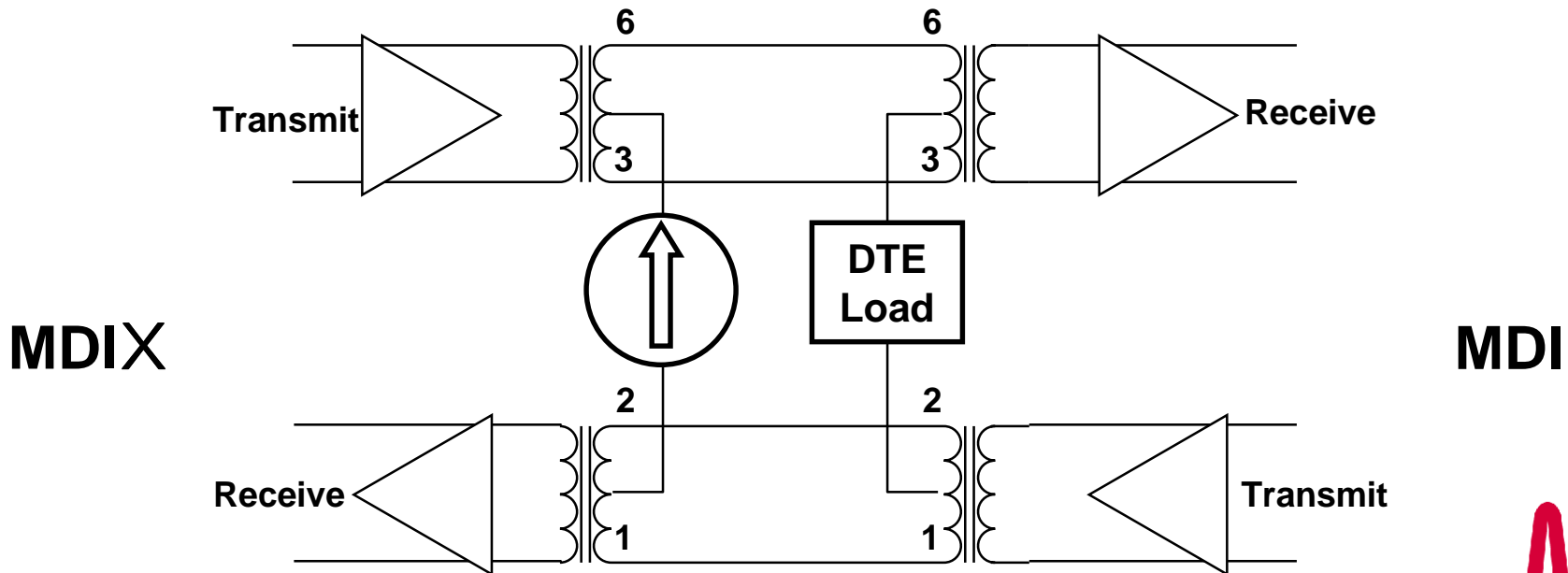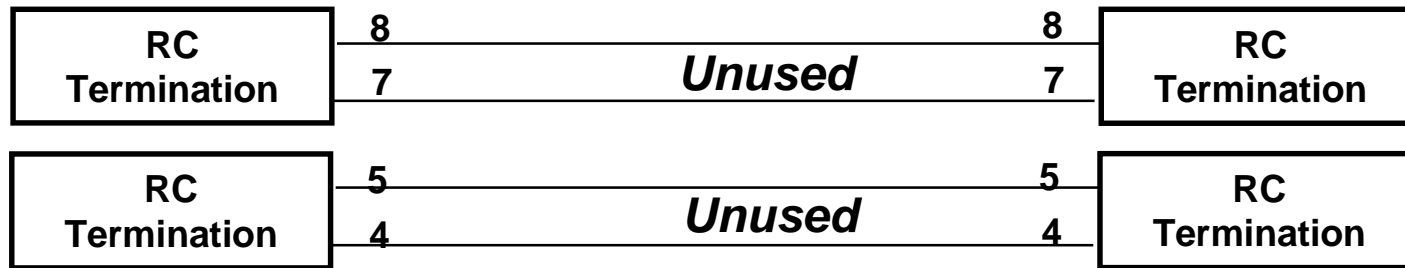

MDIX

MDI

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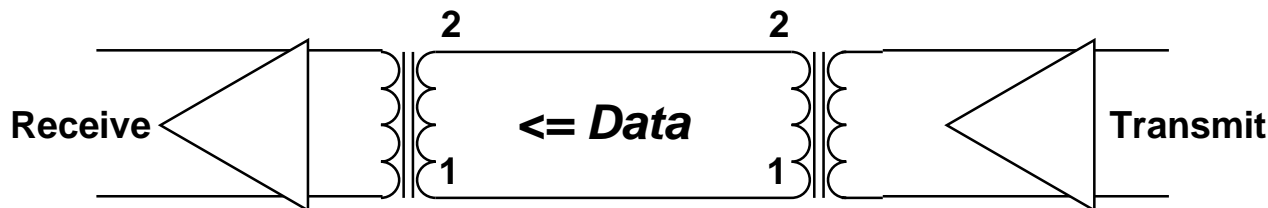
Switch-to-DTE Wiring with Power over Data Pairs

DTE Detecting Station

DTE Requiring Power

Detecting a DTE Requiring Power

- **Must always detect legacy equipment, and not supply power, to avoid damage**
  - ➢Detect legacy equipment which is powered on and transmitting:
    - Normal Link Pulses
    - Fast Link Pulses
    - MLT-3 Idle
  - ➢Detect legacy equipment which is powered down
    - Passive RC network

- **Termination of "data pairs" 1 and 2 bounded by 10BASE-T/100BASE-TX for legacy equipment**
- **Termination of "unused" pairs 3 and 4 in legacy equipment is not defined by 802.3**

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Detecting a DTE Requiring Power

- **Use data pairs to detect unique attributes of a DTE Requiring Power (DTE-RP)**

- **Detection via data pairs can be used for**
  - ➢ **Power supplied via data pairs**
                    OR
  - ➢ **Power supplied via unused pairs**

- **Detection via data pairs uses known attributes of the termination of legacy equipment**
  - ➢No loopback between transmit and receive
  - ➢Recognizable signal when powered on: NLP, FLP, or MLT-3

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Fast Link Pulses

Data

Clock pulse

125us

62.5us

100ns

1   1   0   0   1   0   0   0

Not drawn to scale

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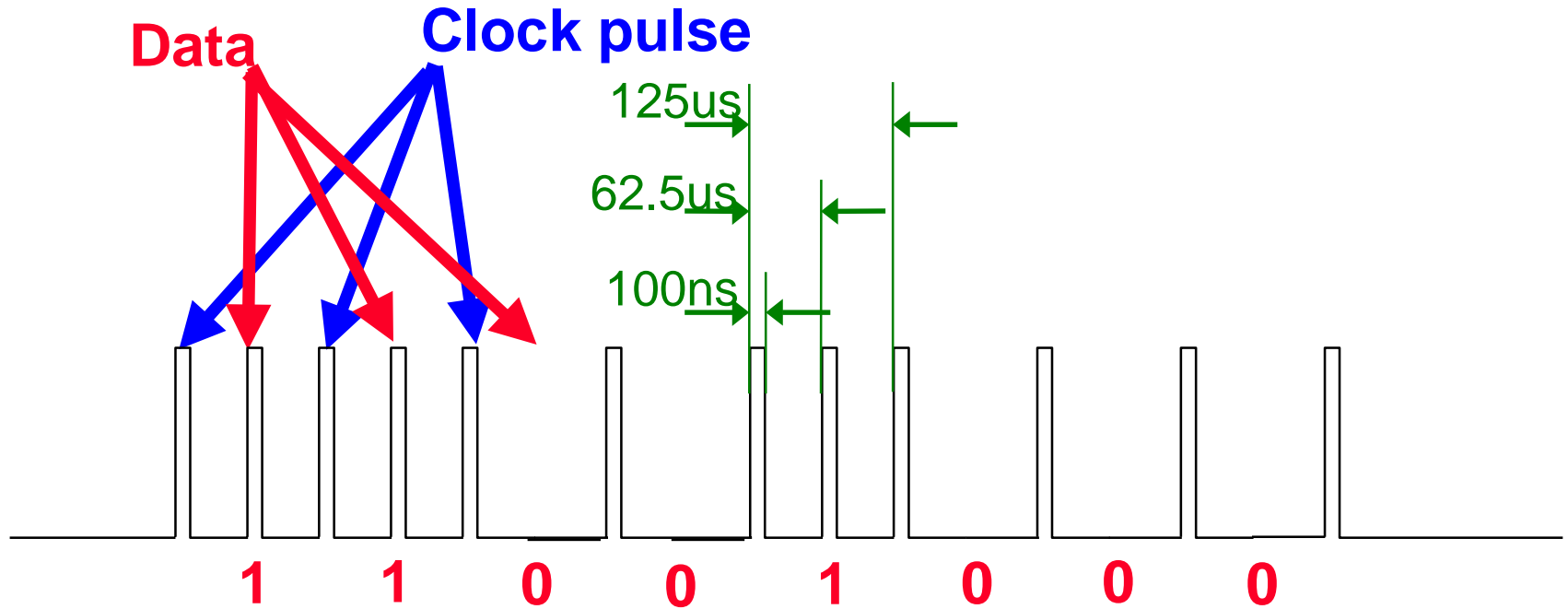
Fast Link Pulses (100BASE-TX) vs Normal Link Pulses (10BASE-T)

2ms

FLP's

16ms

NLP's

Not drawn to scale

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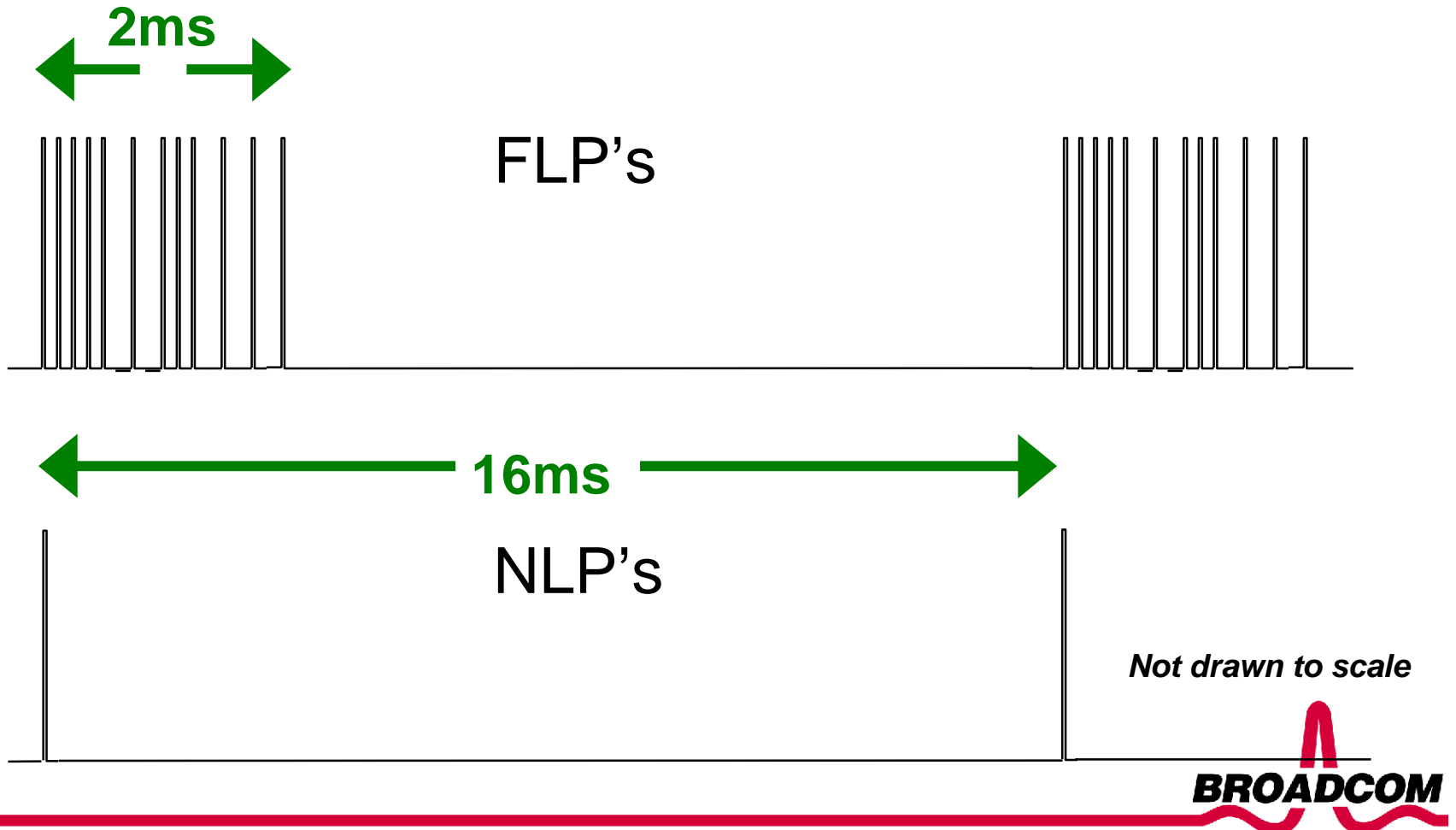
Modified Fast Link Pulses
Width Stretched up to 150ns-1uS

125us

62.5us

100ns

150ns to 1us

Not drawn to scale

1   0   0

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8
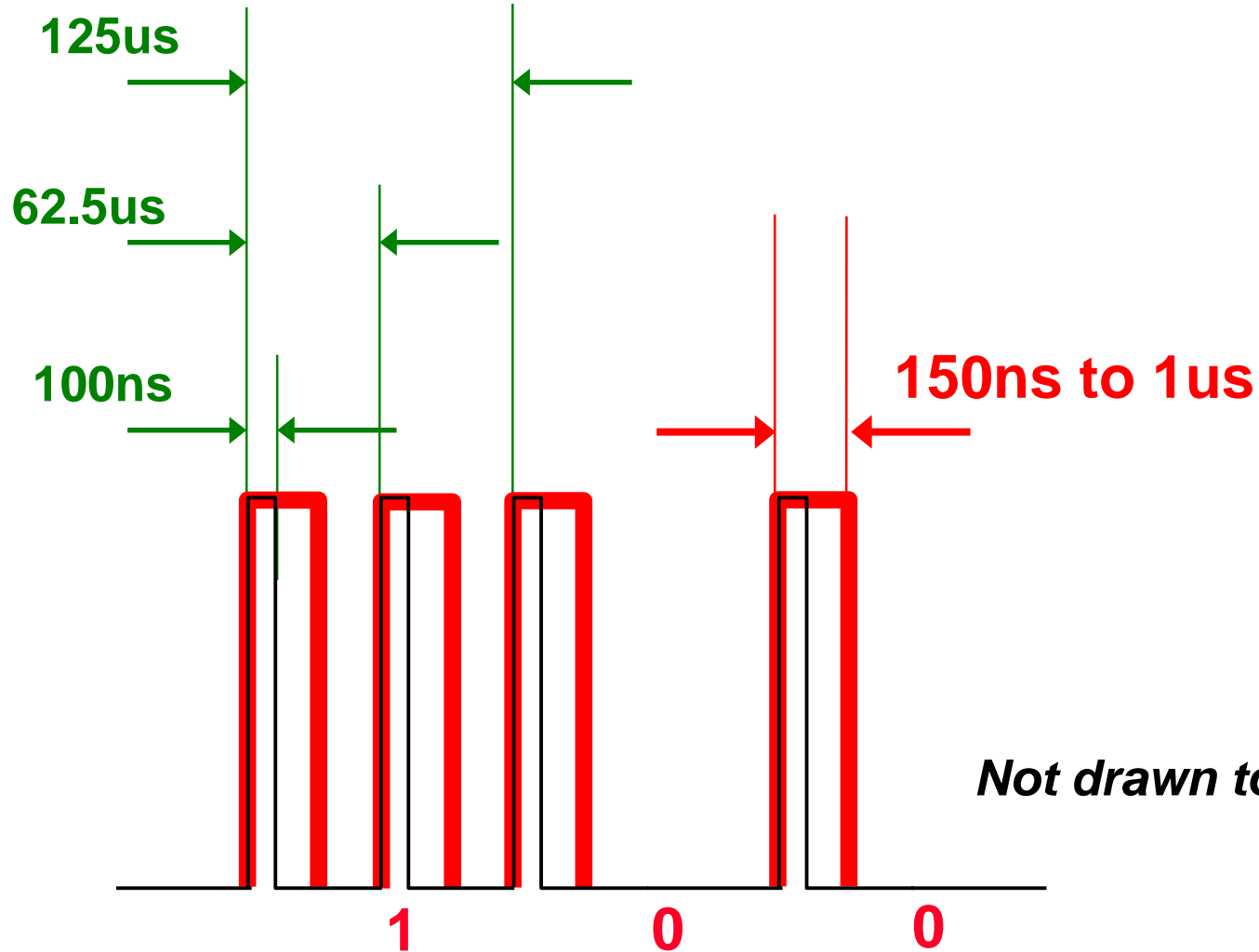
DTE Requiring Power Includes Filtered Loopback on Data Pair

Switch /
DTE Detecting Station

End station
DTE Requiring Power

Transmit

Rx

RC Filter

Receive

Tx

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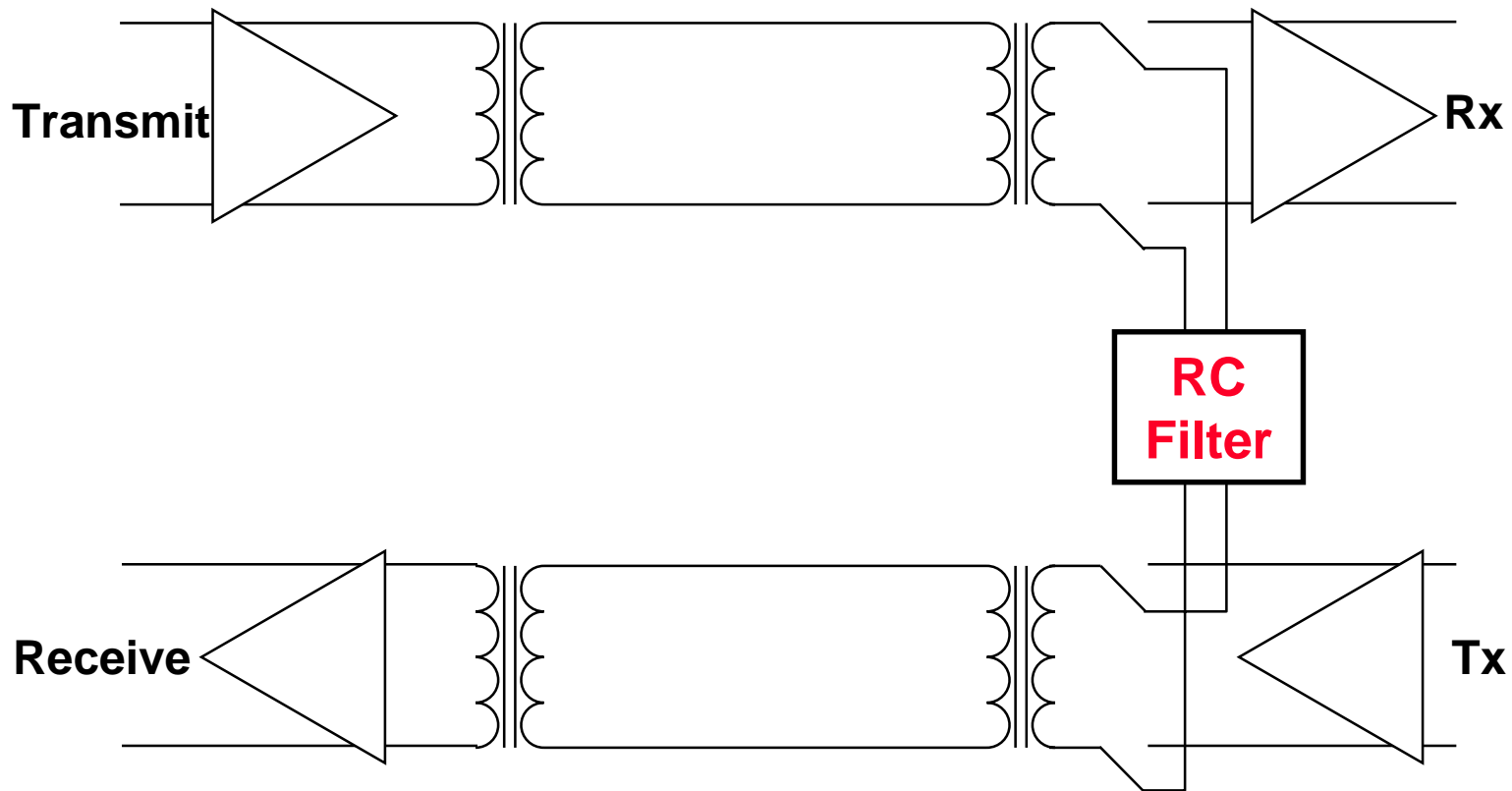
Detecting Stations Transmits Modified FLP's, Looped Back in DTE-RP

Switch /
DTE Detecting Station

End station
DTE Requiring Power

Transmit

Rx

RC Filter

Receive

Tx

BROADCOM
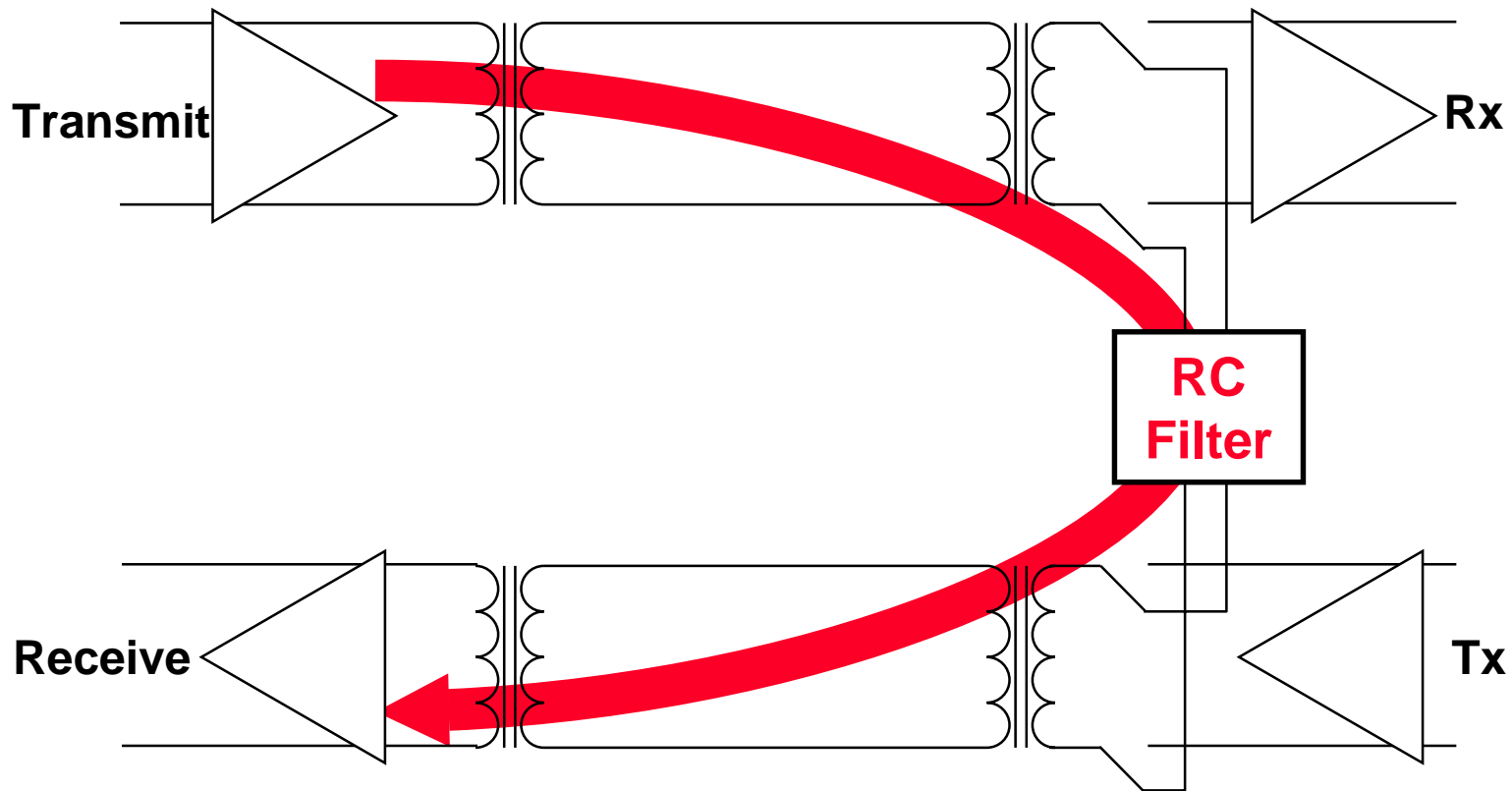
Legacy Equipment Never Loops Back FLP's

**Switch /
DTE Detecting Station**

Legacy Equipment

Transmit

Rx

X

Receive

Tx

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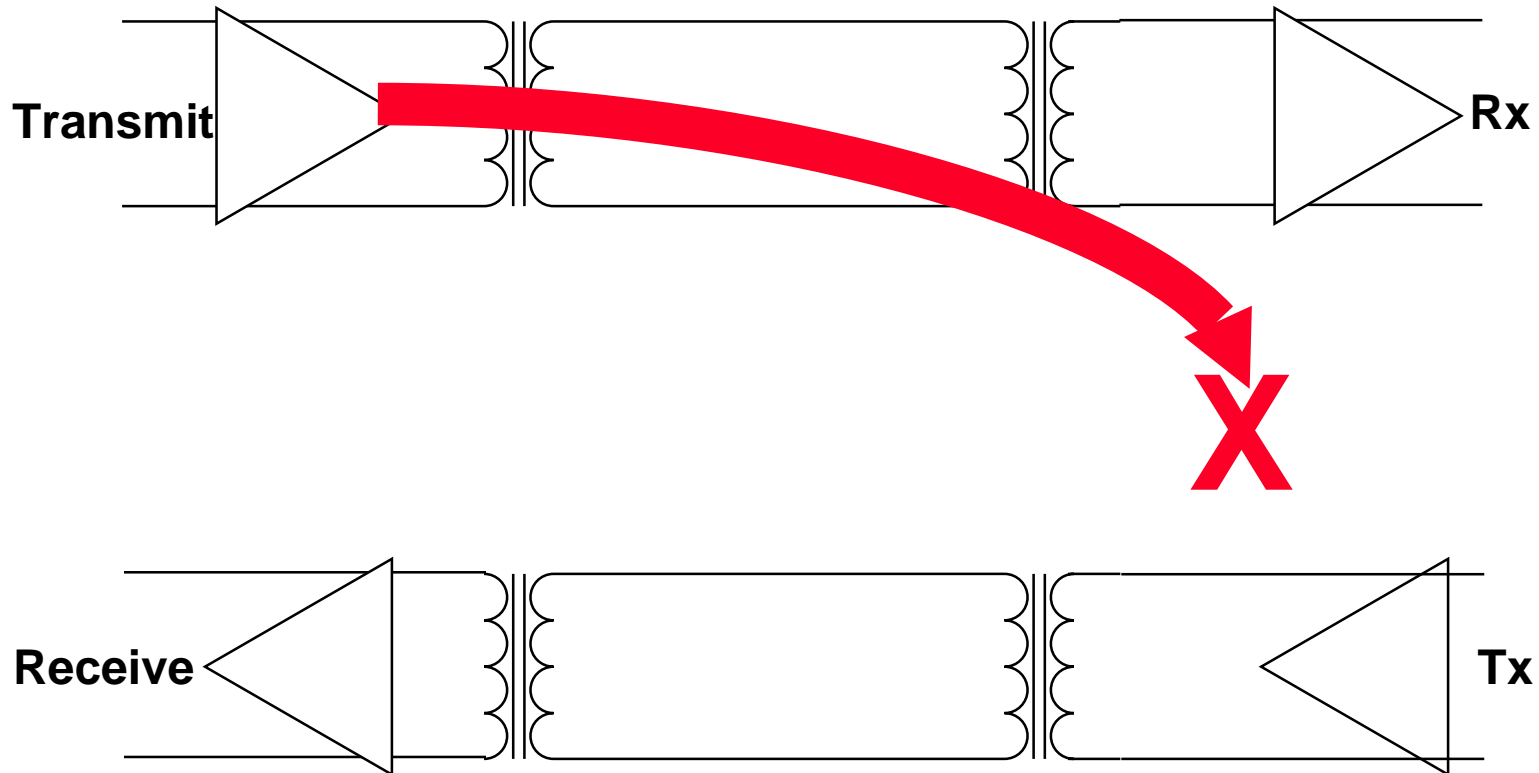
Special Case: Legacy Switch => DTE-RP Filter does not pass FLP's, NLP's or Data

Legacy Switch

End station DTE Requiring Power

FLP's or NLP's

Transmit

Rx

Legacy Switch will not link to itself through the loopback filter

X

RC Filter

Receive

Tx

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Detecting a DTE Requiring Power: Basic Sequence

- **Detecting Station (Switch) continuously listens for standard FLP's, NLP's or MLT-3**
  - ➢Links and begins normal operation if received
- **Detecting Station Transmits Modified FLP's**
- **DTE Requiring Power loops back modified FLP's**
- **Detecting Station matches received FLP word received against the FLP word transmitted**
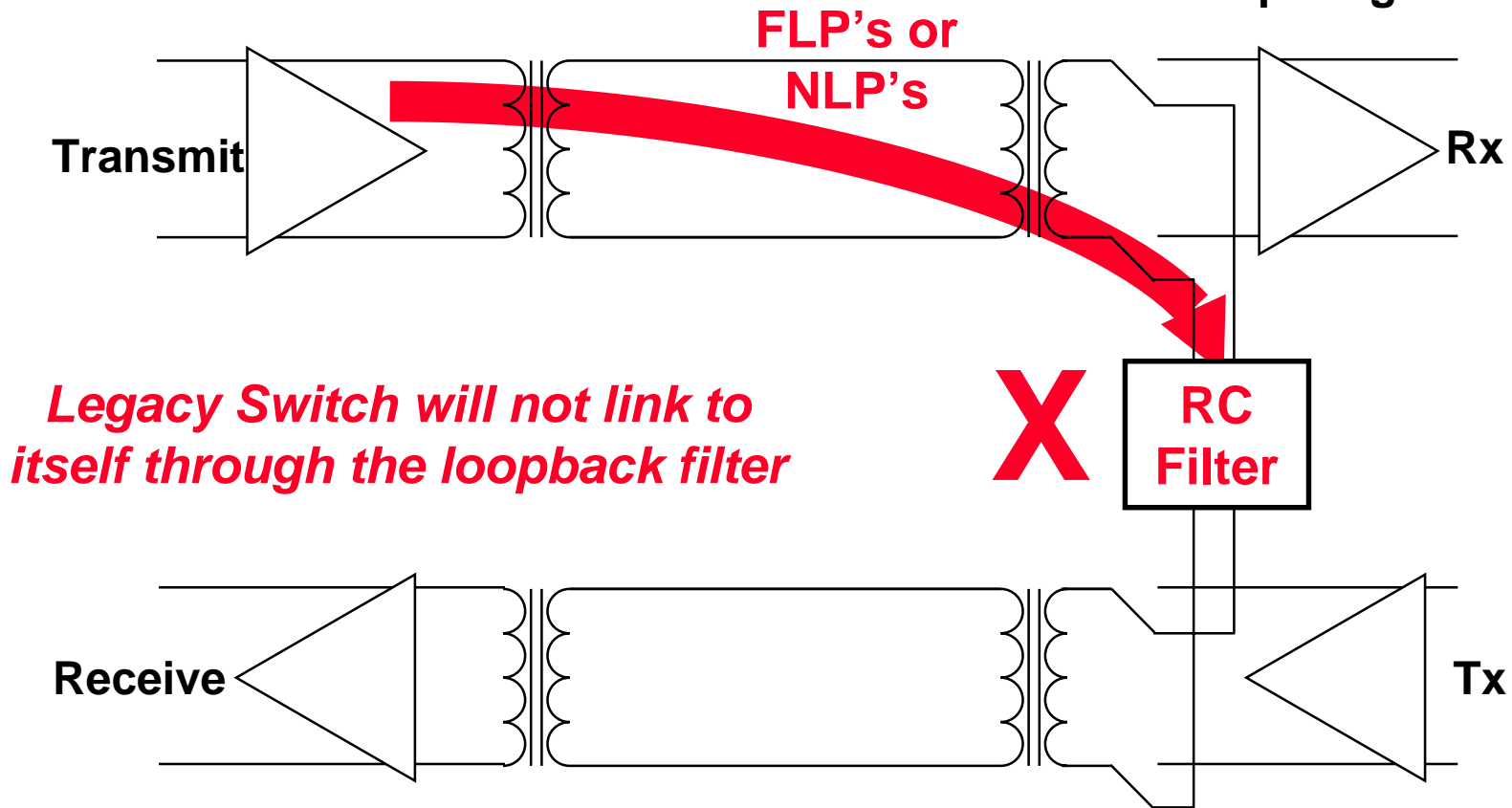- **Detecting Station applies power, if a match exists**
  - ➢Via unused pair, or over the data pair
- **DTE-RP powers up, removes loopback, begins normal operation**
  - ➢Normal operation includes 10BASE-T, 100BASE-TX, or Autonegotiation
- **Detecting station receives DTE-RP signal, links normally**

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Detecting a DTE Requiring Power: Modified Fast Link Pulses

- **Detecting Station (Switch) Transmits Modified FLP's**
  - ➢ Pulse width is stretched
  - ➢ Unique word is transmitted
- **DTE Requiring Power loops back modified FLP's**
  - ➢ Standard FLP's are filtered out by a low pass filter in the loopback path
  - ➢ Modified FLP's with wider pulses pass through the loopback filter
- **Detecting Station matches received unique word received against the word transmitted, to verify loopback condition on far end**
  - ➢ Process may be iterated, changing the unique word each time

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Modified Fast Link Pulses

- **Pulse width is stretched**
  - ➢**Standard FLP is 100ns per 802.3(u)**
  - ➢**FLP may be stretched from 150ns to 1us**
    - Programmable via an MII register
    - Due to transformer characteristics, pulse widths >950ns are not recommended

- **Pulse width chosen to match DTE-RP filter characteristics**
  - ➢Modified FLP's must pass through filter plus 200 meters of UTP
  - ➢DTE-RP filter must always remove 100ns FLP's and NLP's
  - ➢System designer can choose filter and pulse width for development of pre-standard equipment
    - Goal is 802.3 standardization of modified FLP pulse width and DTE-RP filter characteristics

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Modified Fast Link Pulses

- ## Unique FLP word is transmitted
  - ➢ FLP registers are loaded with a pseudo-random word
    - 14 of 16 bits are random: 16,384 possible words
  - ➢ DTE-RP loops back the unique word to the detecting receiver
  - ➢ The detecting station examines incoming FLP and declares a match or mismatch
    - Maximum loopback time is ~1us
    - Matched word must be received within 4us window
  - ➢ Process may be iterated to increase confidence that the end station is a DTE Requiring Power
    - There is a small but finite possibility that 2 detecting stations can choose the same random word and transmit it simultaneously
    - 4us window makes a random match unlikely
    - Iteration effectively makes this possibility infinitesimal
    - PHY can iterate continuously with one FLP word, or process can be restarted via software with a different FLP word loaded

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Detecting a DTE Requiring Power: Modified Sequence

- **Detecting Station (Switch) continuously listens for standard FLP's, NLP's or MLT-3**
- **Detecting Station Transmits Modified FLP's**
- **DTE Requiring Power loops back Modified FLP's**
- **Detecting Station matches received FLP word received against the FLP word transmitted**
- **Detecting Station checks for short circuit: sends FLP with 100ns pulses and verifies no receipt (pulses are filtered out)**
  - ➢ **Confirms that no loopback without filter exists (no short)**
- **Detecting Station applies power, if a match exists**
- **DTE-RP powers up, removes loopback, begins normal operation**
  - ➢ Normal operation includes 10BASE-T, 100BASE-TX, or Autonegotiation
- **Detecting station transmits unique FLP word again and verifies no match**
  - ➢ **Confirms that DTE-RP has removed the loopback condition**
  - ➢ **Confirms that no constant loopback exists (no short)**
- **Detecting station receives DTE-RP signal, links normally** **BROADCOM**

Advantages of DTE Power Detection Algorithm via FLP's

- **Compatible with either power over data pair or power over unused pair**

- **Relies on known characteristics of all legacy 802.3 equipment: DTE's, Repeaters, Switches**

- **Compatible with all legacy 802.3 equipment**
  - ➢ *PHY will never falsely detect any legacy equipment as a DTE Requiring Power*

- **Leverages well-understood and widely implemented AutoNegotiation FLP's**

- **Includes protection against short circuits**

- **Programmable pulse width allows flexibility in design, and in standard-setting**
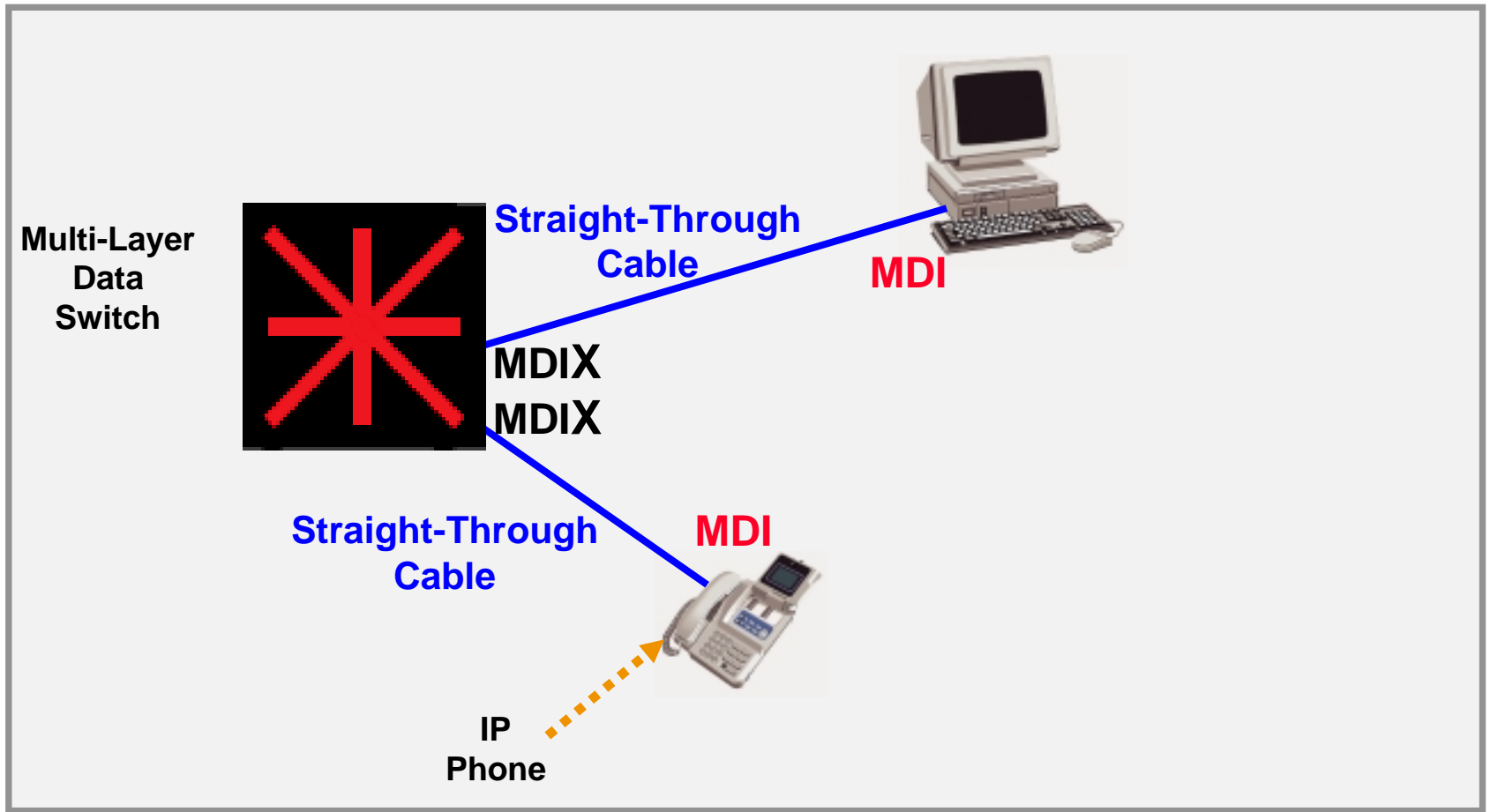
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Cross-Over and Straight-Through Cabling

- **DTE Power via MDI will enable new classes of very small, 2-3 port switches**

  ➢ Example:. IP Phone with an embedded switch

- **Insertion of these new "MDI Powered" switches into the network will blur the traditional distinction between hub/switch versus DTE**

  ➢ A single device can be both a DTE requiring power (e.g., an IP Phone), and a switch connected to another DTE that does not require power (e.g., a desktop PC).

- **Potential for confusion and wiring errors**

- **DTE powering techniques that are insensitive to crossed cables have benefits for new devices**

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Example: IP Telephone

Multi-Layer Data Switch

Straight-Through Cable

MDI

MDIX
MDIX

Straight-Through Cable

MDI

IP Phone

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Example: IP Telephone
One MDI Port, One MDIX Port

Multi-Layer Data Switch

MDI

MDIX

MDIX

MDIX

MDI

Straight-Through Cables

MDI

IP Phone with Switch

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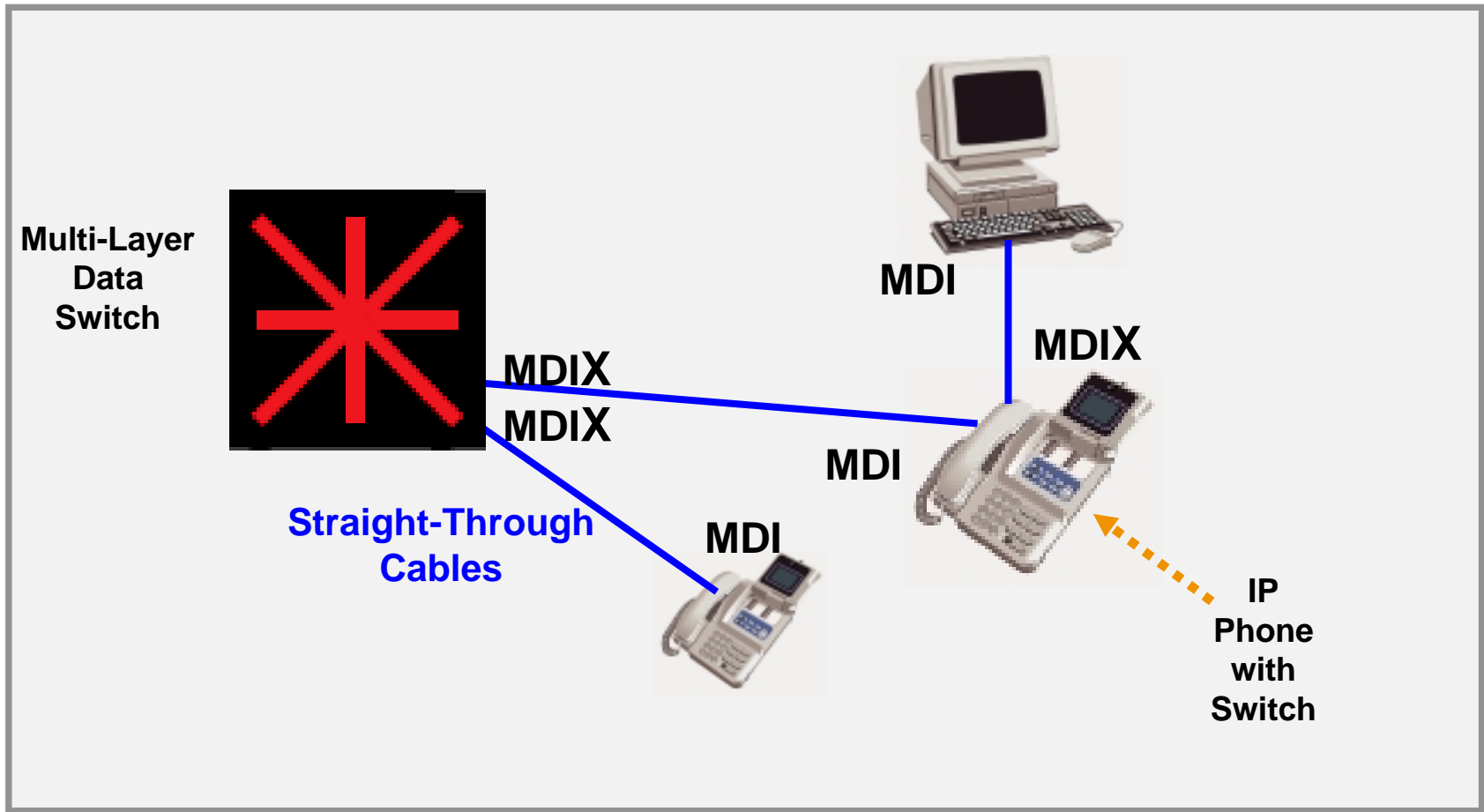
Example: IP Telephone
Two MDIX Ports

Multi-Layer Data Switch

MDI

Cross-Over Cable Required

Straight-Through Cables

MDIX

MDIX

MDIX

MDIX

MDI

IP Phone with 2 Port Switch

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Example: IP Telephone
One MDI Port, Two MDIX Ports

Multi-Layer Data Switch

MDI

MDIX
MDIX

Straight-Through Cables

MDI

MDIX

MDI

MDI

IP Phone with 3 Port Switch

Network Device:
Printer
PDA
Camera
Etc.

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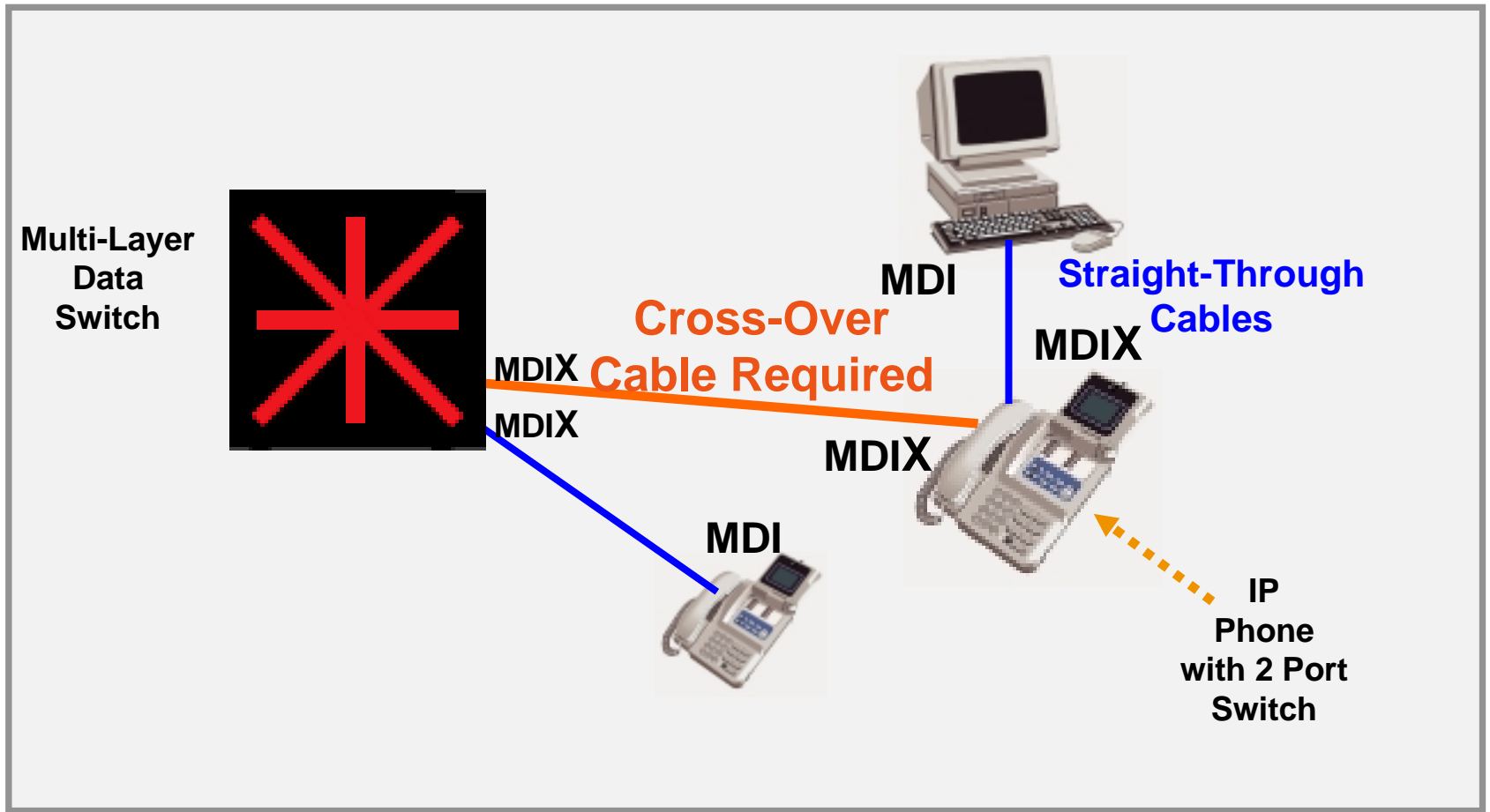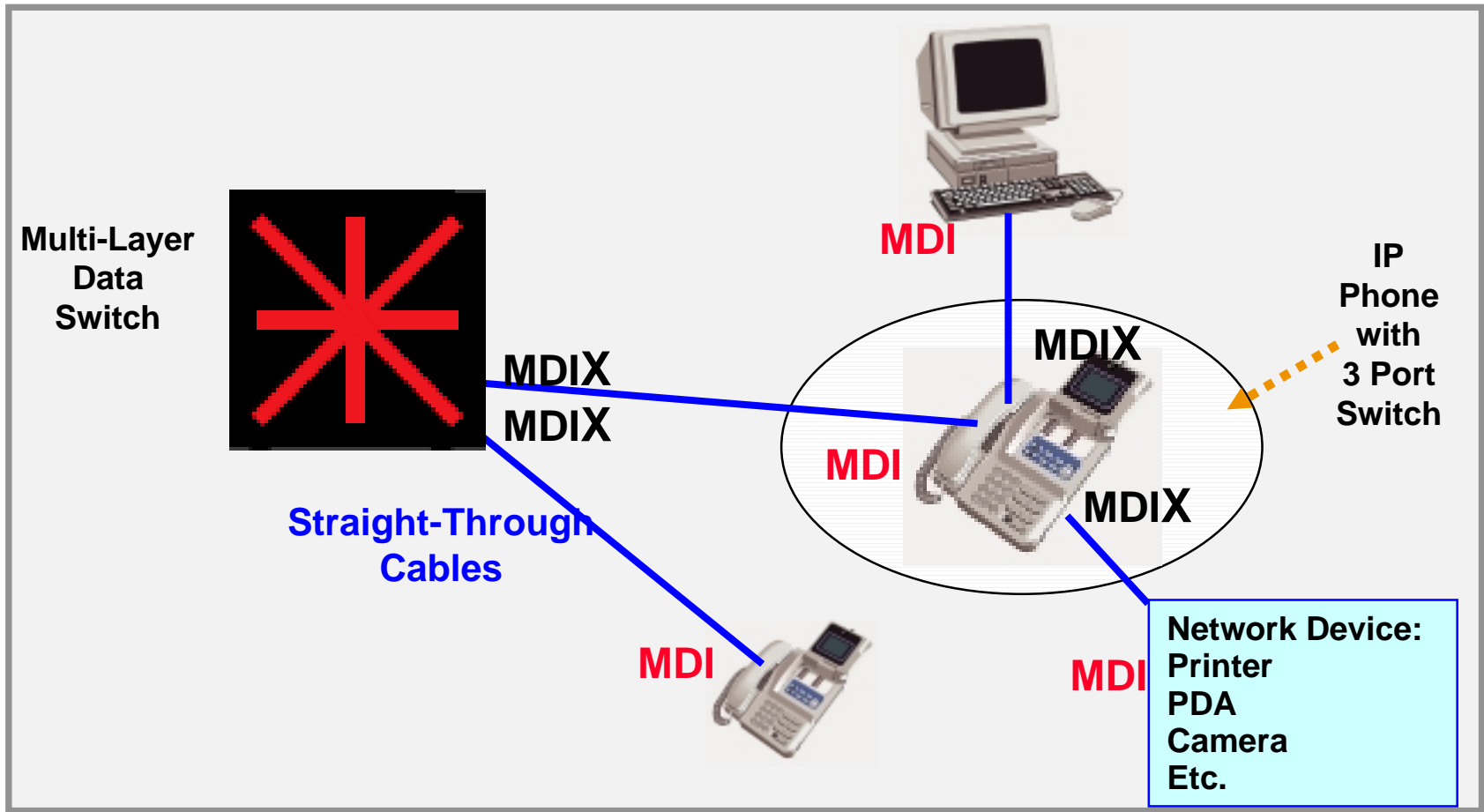
Example: Mini-Switch Power via MDA
One MDI Port, Two MDIX Ports
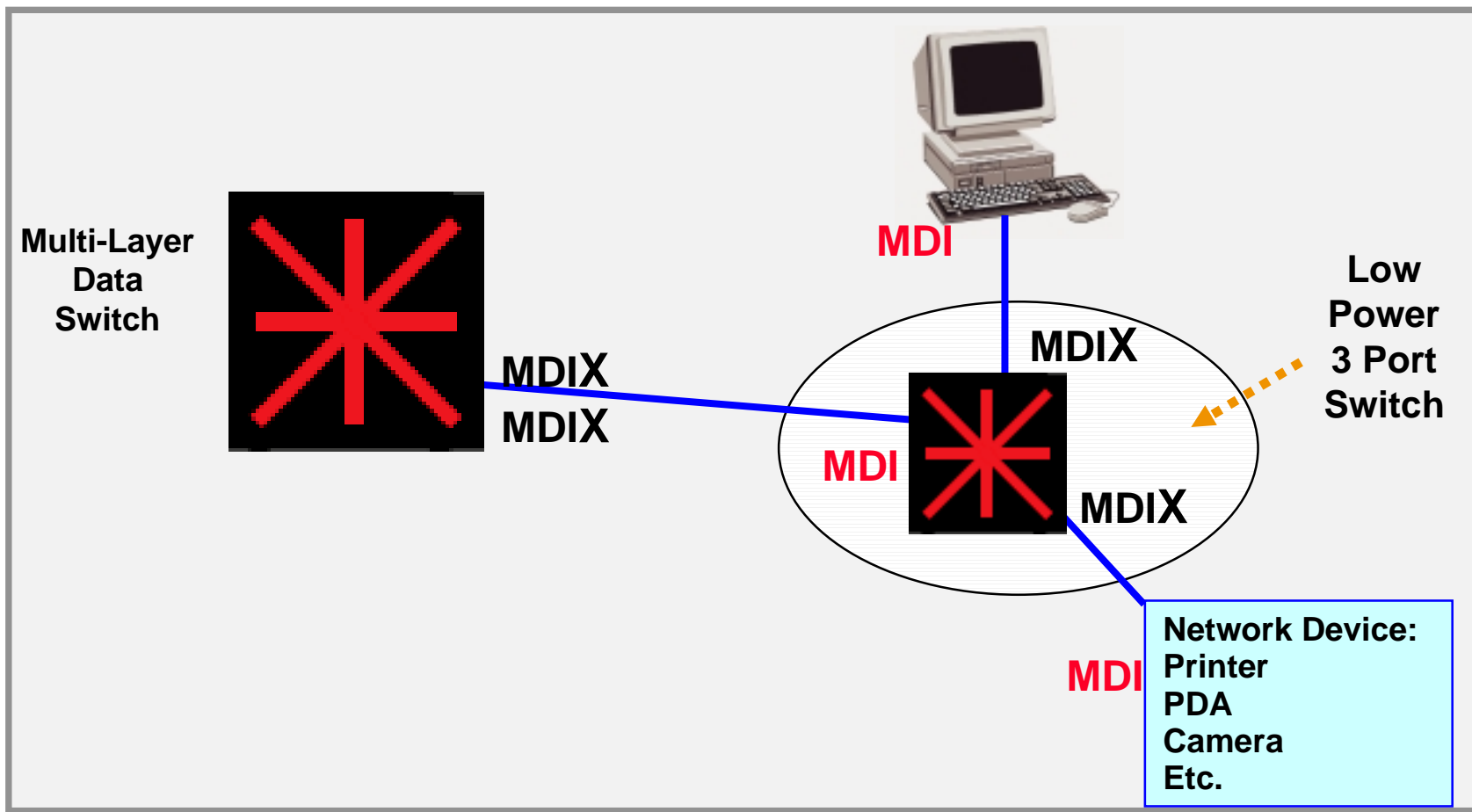
Multi-Layer Data Switch

MDI

MDIX
MDIX

MDIX

MDI

Low Power 3 Port Switch

MDIX

MDI

Network Device:
Printer
PDA
Camera
Etc.

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A DTE Insensitive to Wiring Polarity
Power over Data Pairs

Switch /
DTE Detecting Station

End station
DTE Requiring Power

Tx

Tx / Rx

MDI
OR
MDIX

DTE Load

RC Filter

Transceiver with Automatic MDI / MDIX Detection and Correction

Rx

Tx / Rx

Straight-Through *OR* Crossover Cable

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DTE Insensitive to Wiring Polarity
Power over Data Pairs

Switch /
DTE Detecting Station

End station
DTE Requiring Power

Unused

Unused

DTE Load

MDI
or
MDIX

Transmit

Data =>

Receive

<= Data

RC Filter

Transceiver with Automatic MDI / MDIX Detection and Correction

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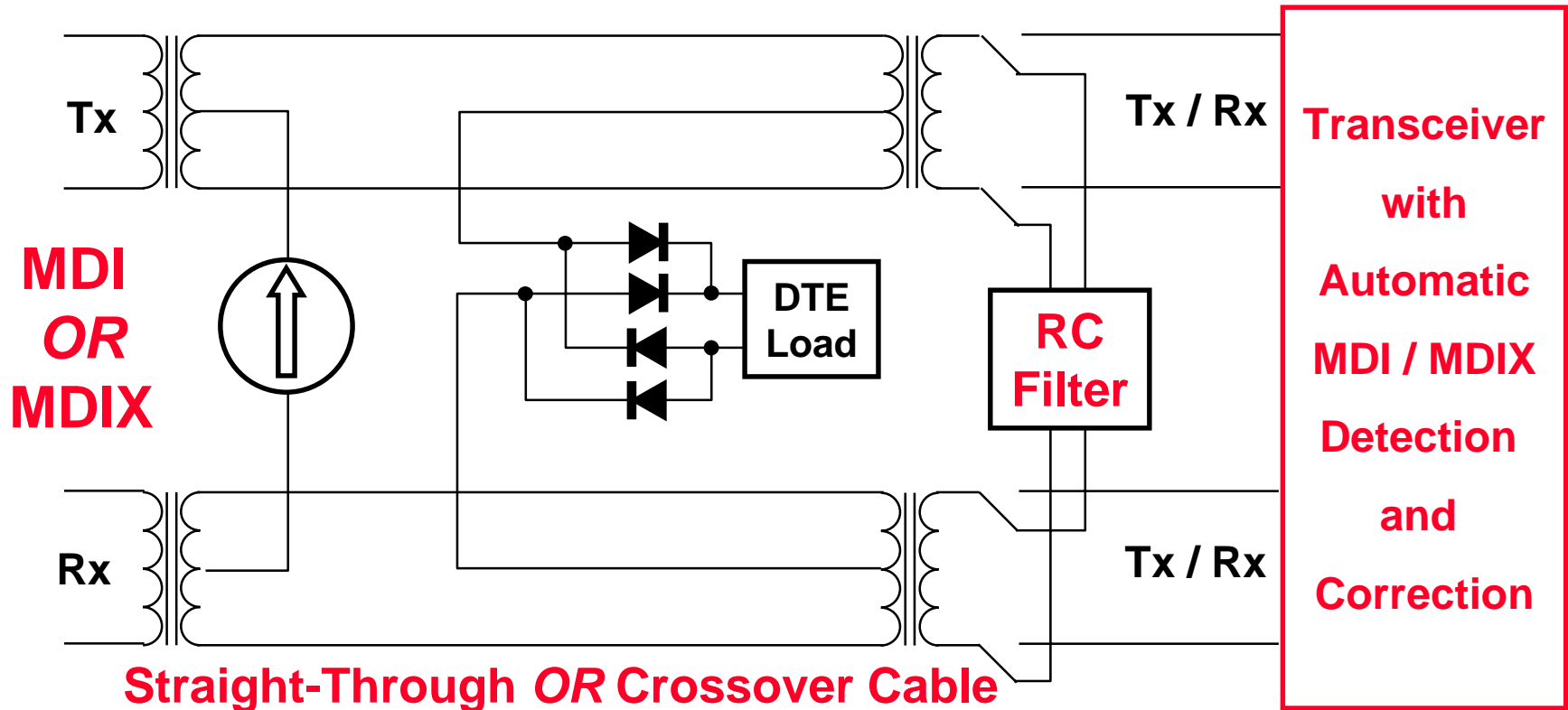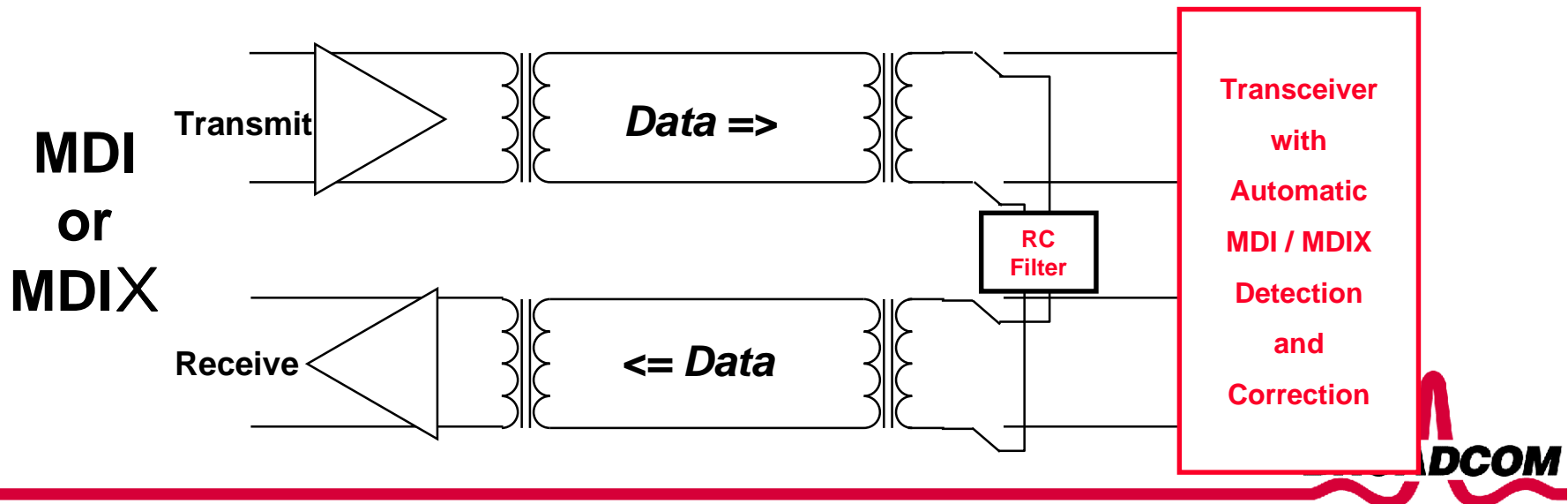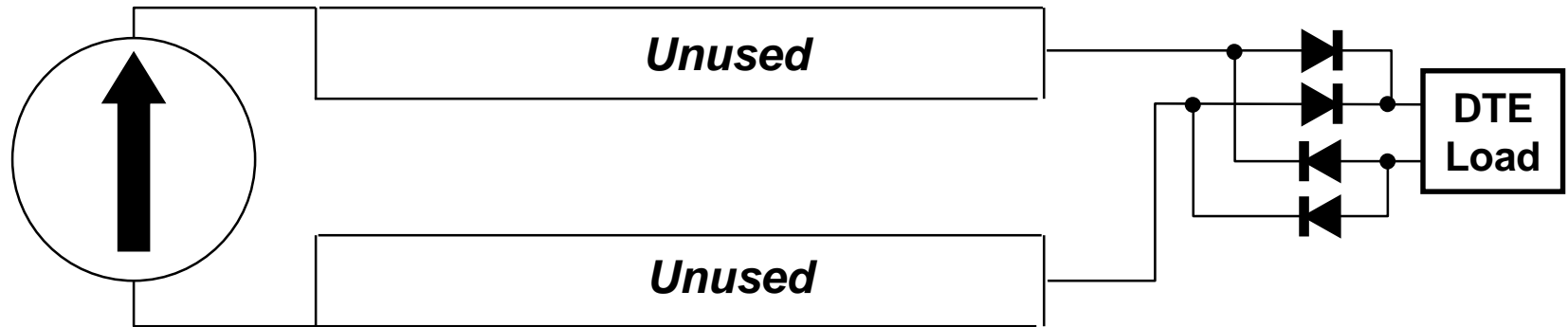
A DTE Requiring Power That is Insensitive to Wiring Installation Errors

- **Loop-back filter is symmetric**
  - ➤ FLP's will pass equally in either direction
- **Rectifying bridge connects transformer center taps to the DTE Load**
  - ➤ DTE will accept power regardless of polarity
  - ➤ Configurable to accept power from data OR unused pairs
- **Automatic detection and correction of crossover provided in the PHY transceiver**
  - ➤ Either in the DTE, the switch, or both
  - ➤ 10BASE-T, 100BASE-TX, 1000BASE-T
- **Polarity on each pair automatically corrected**
  - ➤ Standard feature on legacy 10BASE-T and 10/100 PHY's
- **Allows crossover or straight-through cables to be used interchangeably**

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Advantages of DTE Power Detection Algorithm via FLP's

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- **Includes protection against short circuits**

- **Programmable pulse width allows flexibility in design, and in standard-setting**

- **Compatible with with crossed cables**

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