# OSI Model

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# Introduction

- PSTN (Public Switched Telephony Network)
  - Voice
- Computer Networks
  - Data
  - Communication between computer applications
    - Distributed Processing
    - File Transfer
    - Electronic Mail
    - Distributed Games

# History

- At the beginning of the 70s, each manufacturer had developed an architecture to allow communication between his systems
  - IBM (1974)
    - SNA Systems Network Architecture
  - DEC (1975)
    - DNA Distributed Network Architecture (DECNET)
  - Xerox
    - XNS
- Proprietary Architectures
- No communication between different architectures
  - Only with a previous agreement between manufacturers

# Problems

- No communication between heterogeneous systems
  - No data exchange between computer applications running on different systems
- User is dependent on the manufacturer
  - Agreements between manufacturers resolve partially the problem
- Need of an architecture which allows interconnection between different systems

# Standardization

- Two standardization organizations for computer networks
  - ISO (International Standards Organization)
  - ITU-T (International Telecommunications Union Telecommunications Standardization Sector) previously CCITT (Comit Consultatif International pour le Téléphone et le Télégraphe)
- ISO is a UN organization
  - National Standardization Organizations
    - SASO (KSA)
    - ANSI (USA)
    - AFNOR (France)
    - DIN (Germany)
    - BSI (UK)
- ITU-T is founded by Telecom Operators
  - France Telecom
  - AT&T

# OSI Model

- History
  - Work started at the end of the 70s independently inside ISO and CCITT
  - Two working documents were published in 1983 describing a 7 layer reference model for open systems interconnection
    - Different texts
    - Many technical similarities
    - CCITT accepts ISO document with some minor technical changes
  - Start of the collaboration between the two organizations at 1984
  - Maturity at the end of the 80s and the beginning of the 90s

# OSI Model

- Documents produced by the two organizations (ISO and ITU-T) are first published as drafts
  - Copyrighted
  - Comments
- Documents are published later as standards
  - International Standards (ISO)
  - Recommendations (ITU-T)

# OSI Model

- Reference model for open systems Interconnection
  - (Basic Reference Model for Open Systems Interconnection)
- Describes concepts for open systems interconnection
- The model is not a network architecture
  - It does not describe services and protocols used in each layer
    - ISO has described its standards for each layer
- The model contains 7 layers
  - What is the concept of layer?
  - Why 7 layers?

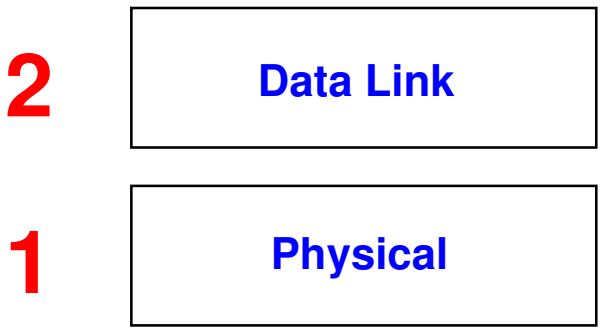
# OSI Model

- Requirements
  - A layer should be created where a different abstraction is needed
  - Each layer should perform well-defined functions
  - Homogenous functions in each layer
  - Borders between layers must be chosen in order to have minimum interactions between them
  - Reasonable number of layers

# OSI Model

1 **Physical**

# OSI Model



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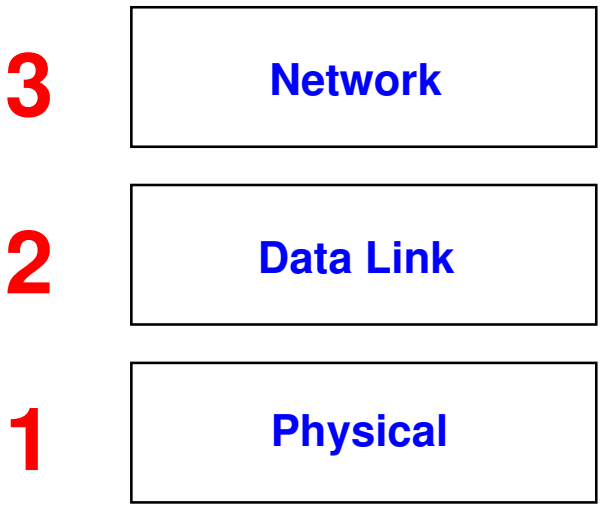

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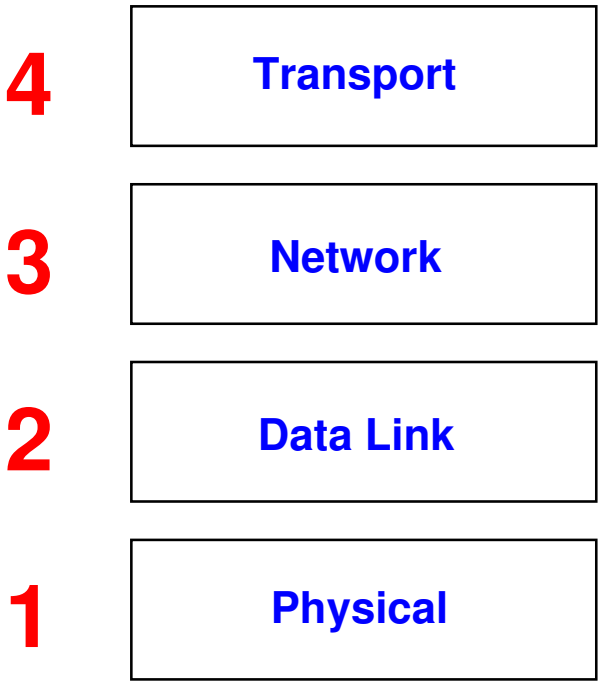

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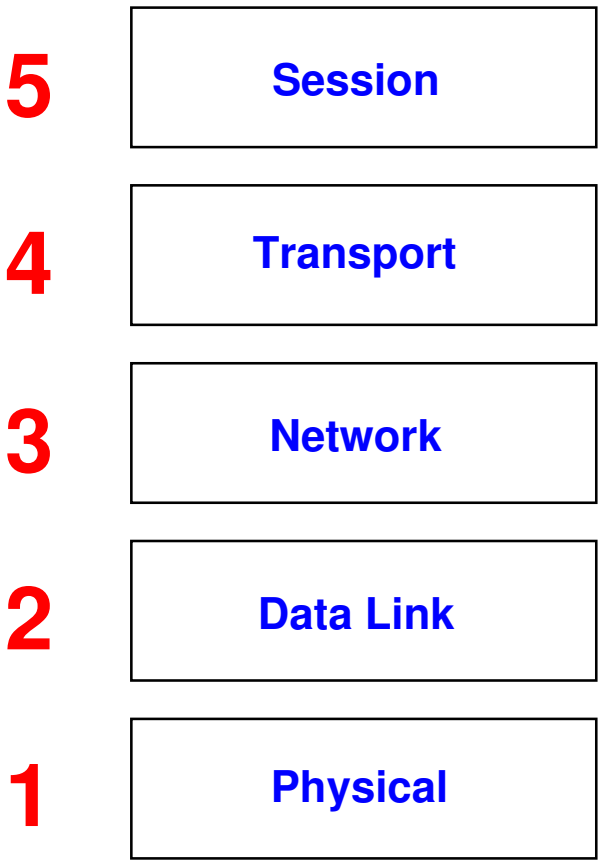

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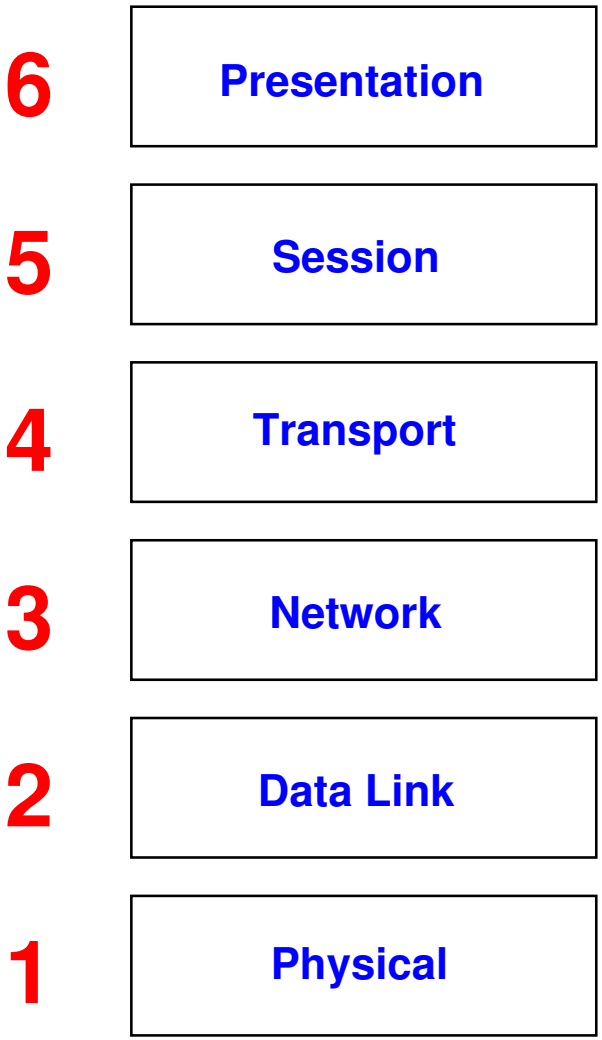
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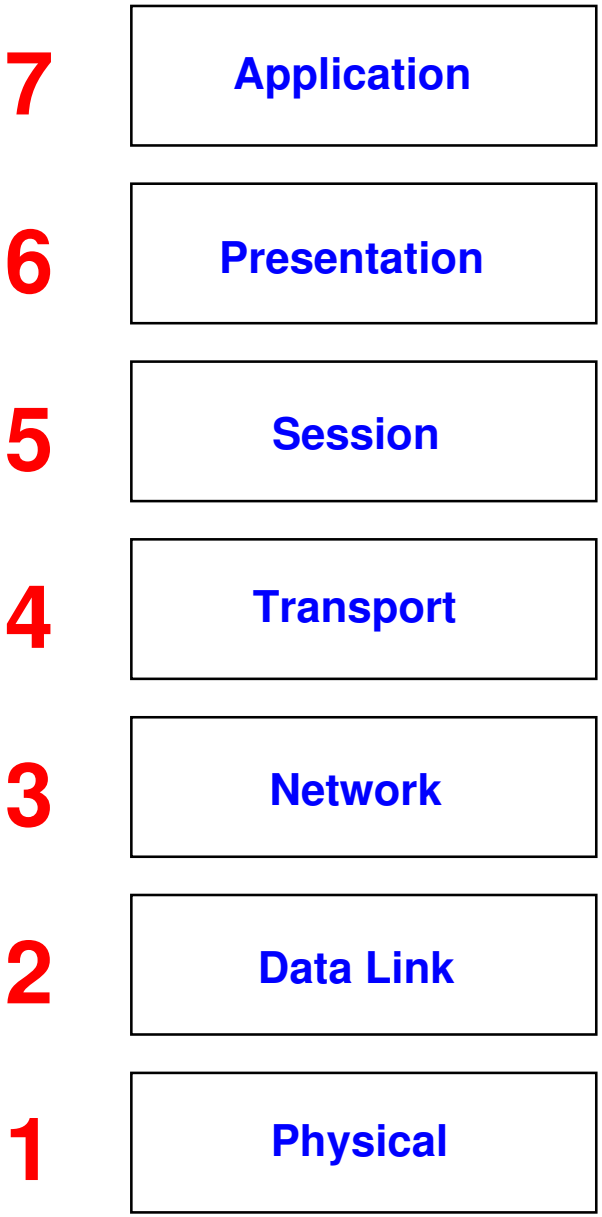
5
Session
4
Transport
3
Network
2
Data Link
1
Physical

# OSI Model


7
Application
6
Presentation
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Session
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Transport
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Network
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Data Link
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Physical

# Physical Layer

- Layer 1 of OSI Model
- It provides services to the Data Link Layer
- Physical Layer Functions
  - Definition of Hardware Specifications
    - Cables, Connectors, Transceivers, Network Interface Cards (NIC),
  - Encoding, Modulation, and Signaling
  - Data Transmission and Reception
- Example of Physical layer standards
  - X.21
    - Defines physical interface between DTE and DCE
    - DTE (Data Terminal Equipment)
    - DCE (Data Circuit Equipment)

# Data Link Layer

- Layer 2 of OSI Model
- It uses services of the Physical layer
- It provides services to the Network Layer
- It performs following functions:
  - Framing
    - Transport of Network layer data using frames
  - Error Control
    - Error Detection and Error Correction
  - Flow Control
    - Traffic regulation between sender and receiver in order to meet the receiver requirements

# Network Layer

- Layer 3 of OSI Model
- It uses Data-Link layer services
- Its provides services to the Transport Layer
- It performs following functions:
  - Addressing
    - Logical Addressing
  - Routing
    - Computation of routes between different nodes
  - Congestion Control
    - Traffic regulation in order to meet the network requirements

# Transport Layer

- Layer 4 of OSI model
- It uses Network Layer services
- It provides services to the Session Layer
- It performs following functions:
  - Multiplexing
  - Segmentation and Reassembly
  - Flow Control (at the process level)

# Session Layer

- Layer 5 of OSI model
- It uses Transport layer services
- It provides services to the Presentation Layer
- It performs following functions:
  - Synchronization
  - Dialogue Management

# Presentation Layer

- Layer 6 of OSI Model
- It uses Session layer services
- It provides services to the Application Layer
- It performs following functions:
  - Information Encoding (Translation)
  - Compression/Decompression
  - Encryption/Decryption

# Application Layer

- Layer 7 of OSI model
- It uses Presentation layer services
- It provides services to the communicating processes
- It allows to application processes to access OSI environment and offers to the user basic services such as file transfer and specific services such as database access
  - FTAM
  - VT

# Protocol

- A protocol is a formal description of rules and conventions to follow in a information exchange in order to forward data to the receiver and that the receiver understands what he had received.
- A protocol may be implemented:
  - Hardware
  - Software
  - Both
- Example
  - IP, TCP
- Protocol Entity p:
  - An active element implementing protocol p
- Peer Entities
  - Entities implementing the same protocol p and so they can communicate using this protocol

# Service Access Point

- Service Access Point
  - SAP (Service Access Point)
  - The point where services are granted by layer N to the layer N+1

# Protocol Data Unit

- PDU : Protocol Data Unit
  - Information exchanged between two peer entities
  - If peer entities belong to the layer X, we use the notation X-PDU
    - DL-PDU : Data unit exchanged between peer entities belonging to the Data-Link layer (Data Link  Protocol Data Unit)
    - N-PDU: Network layer (Network  Protocol Data Unit)
    - T-PDU: Transport layer
    - S-PDU: Session layer
    - P-PDU: Presentation layer
    - A-PDU: Application layer

# Service Data Unit

- SDU : Service Data Unit
  - Information exchanged between entities belonging to adjacent layers (layer X and layer X+1)
  - X-SDU
    - Layer X+1 information transported by layer X
    - DL-SDU: Network Data unit transported by Data-Link layer
    - N-SDU: Network layer (Transport Data)
    - T-SDU: Transport layer (Session Data)
    - S-SDU: Session layer (Presentation Data)
    - P-SDU: Presentation layer (Application Data)
    - A-SDU: Application layer (Process Data)

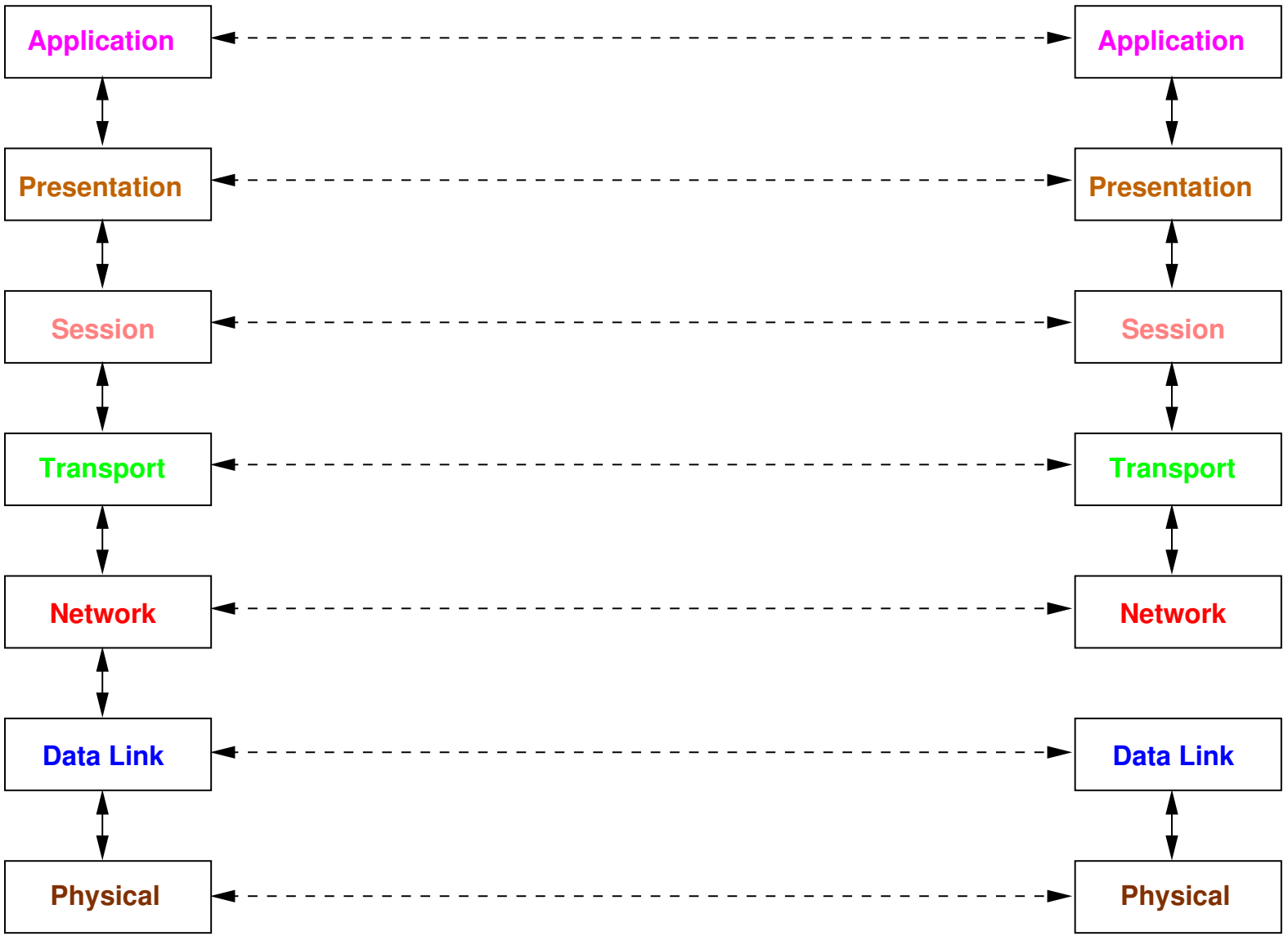
# Protocol Control Information

- PCI : Protocol Control Information
  - Control Information between two peer entities
  - If peer entities belong to the layer X, we use the notation X-PCI
    - DL-PCI: Control Information exchanged between two peer entities belonging to Data-Link layer (Data Link  Protocol Control Information)
    - N-PCI: Network layer (Network  Protocol Control Information)
    - T-PCI: Transport layer
    - S-PCI: Session layer
    - P-PCI: Presentation layer
    - A-PCI: Application layer

# Encapsulation

- X-SDU + X-PCI = X-PDU
- (X+1)-PDU + X-PCI = X-PDU
- X-SDU = (X+1)-PDU
- Example :
  - N-PDU = N-PCI + N-SDU = N-PCI + T-PDU
- PCI may be
  - At the start of the message (Header) (IP)
  - At the end of the message (Trailer) (ATM AAL5)
  - At the start and at the end of the message (Header and Trailer) (Ethernet)

# Encapsulation



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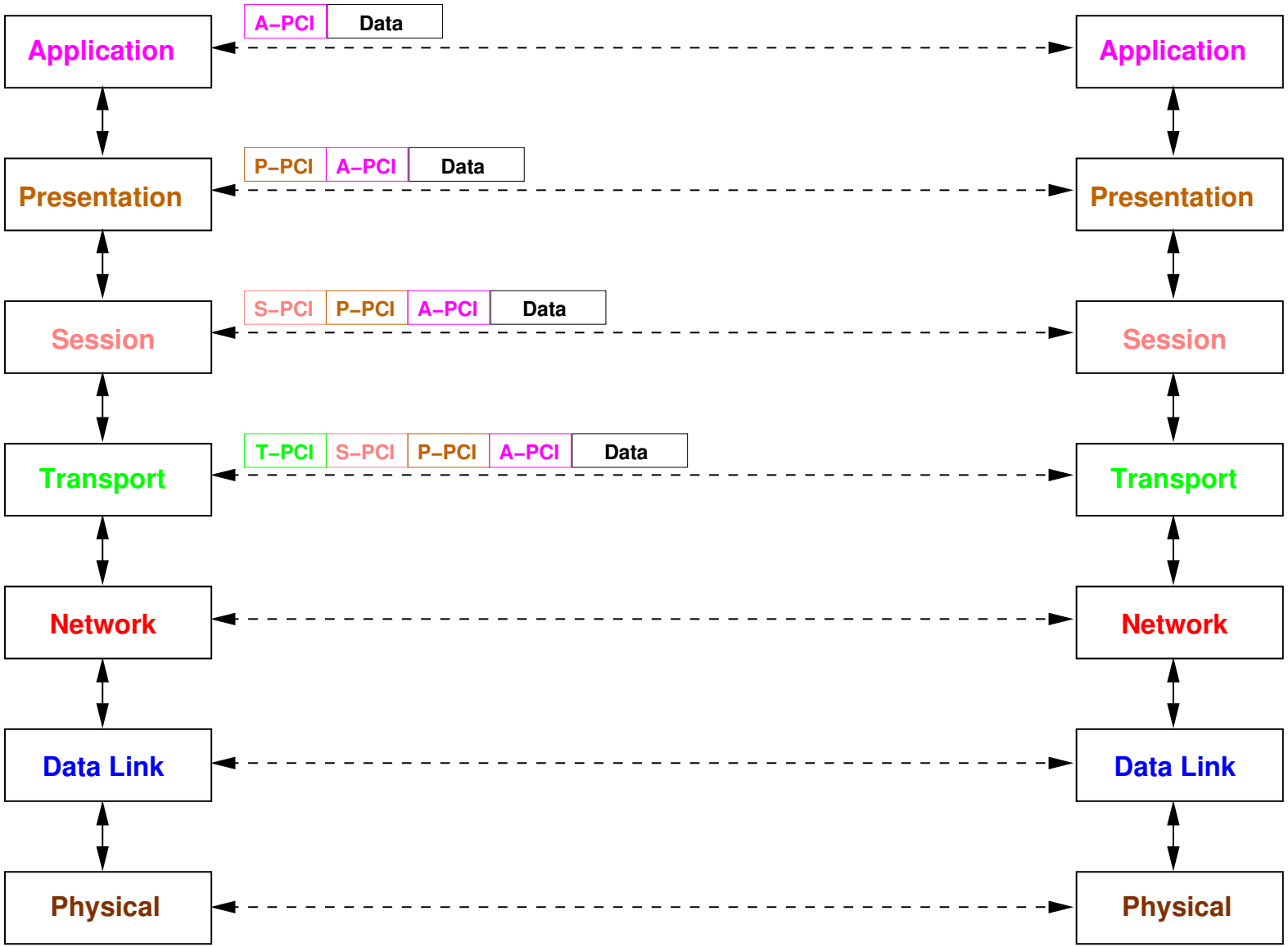

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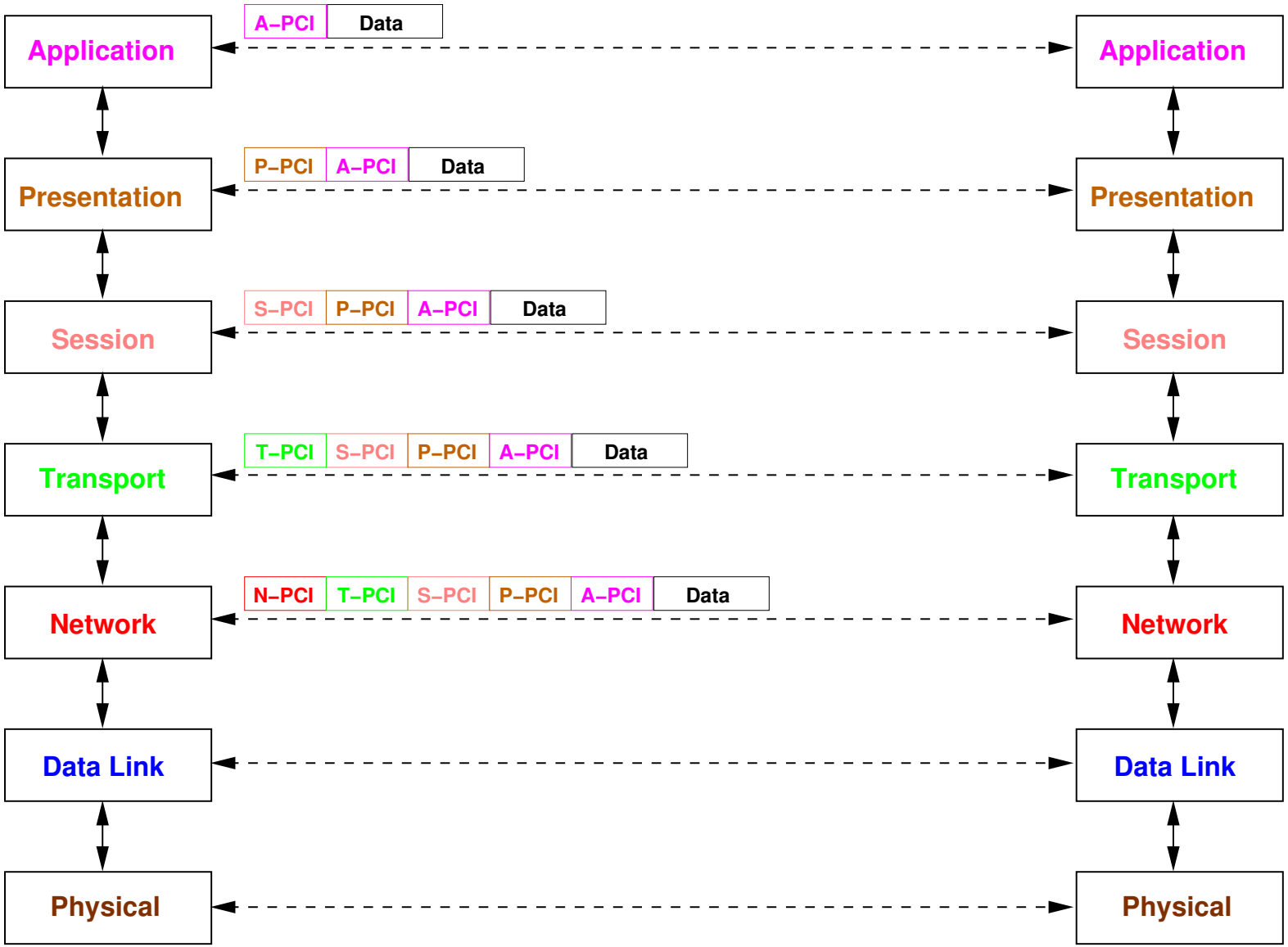

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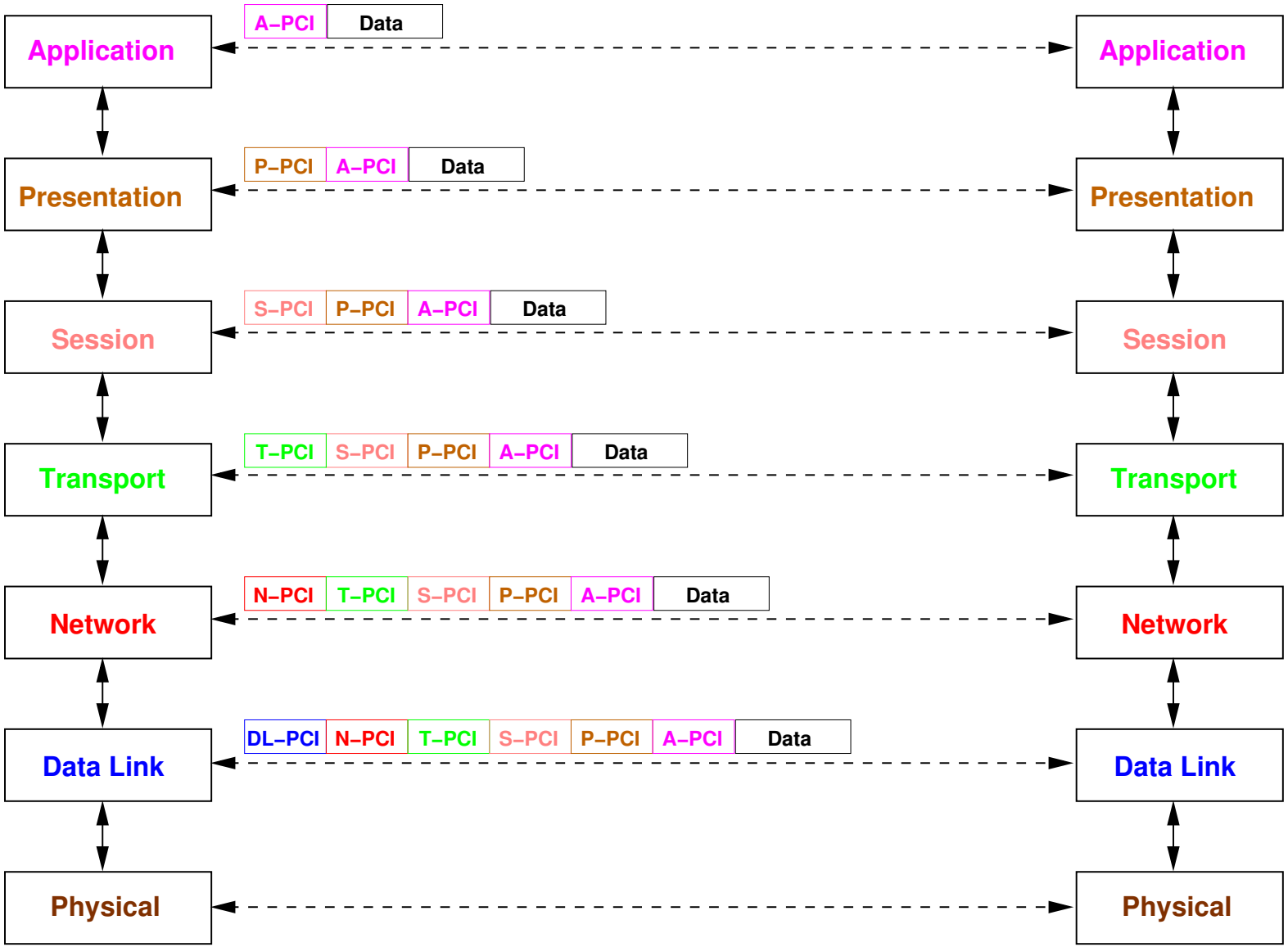

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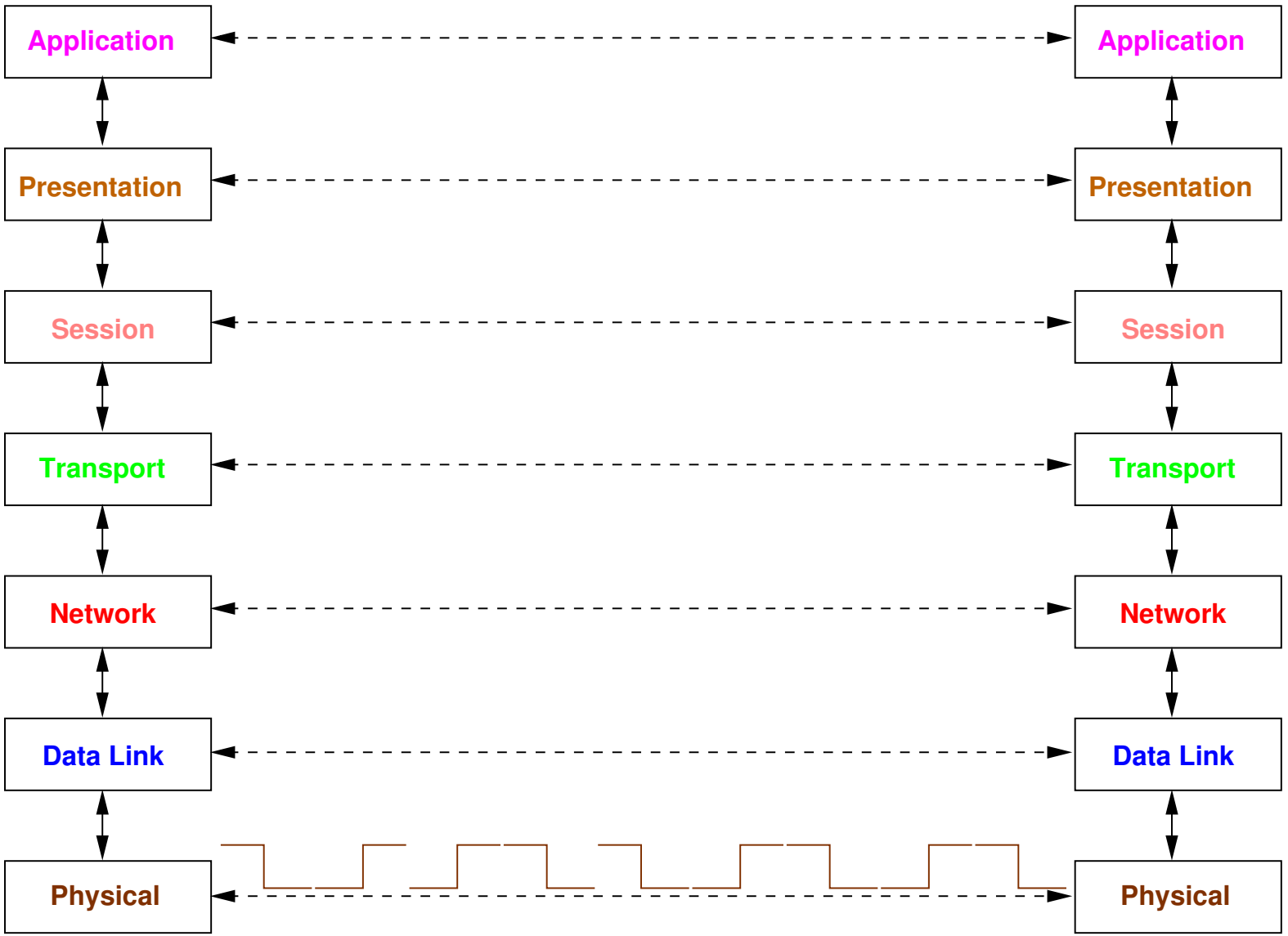

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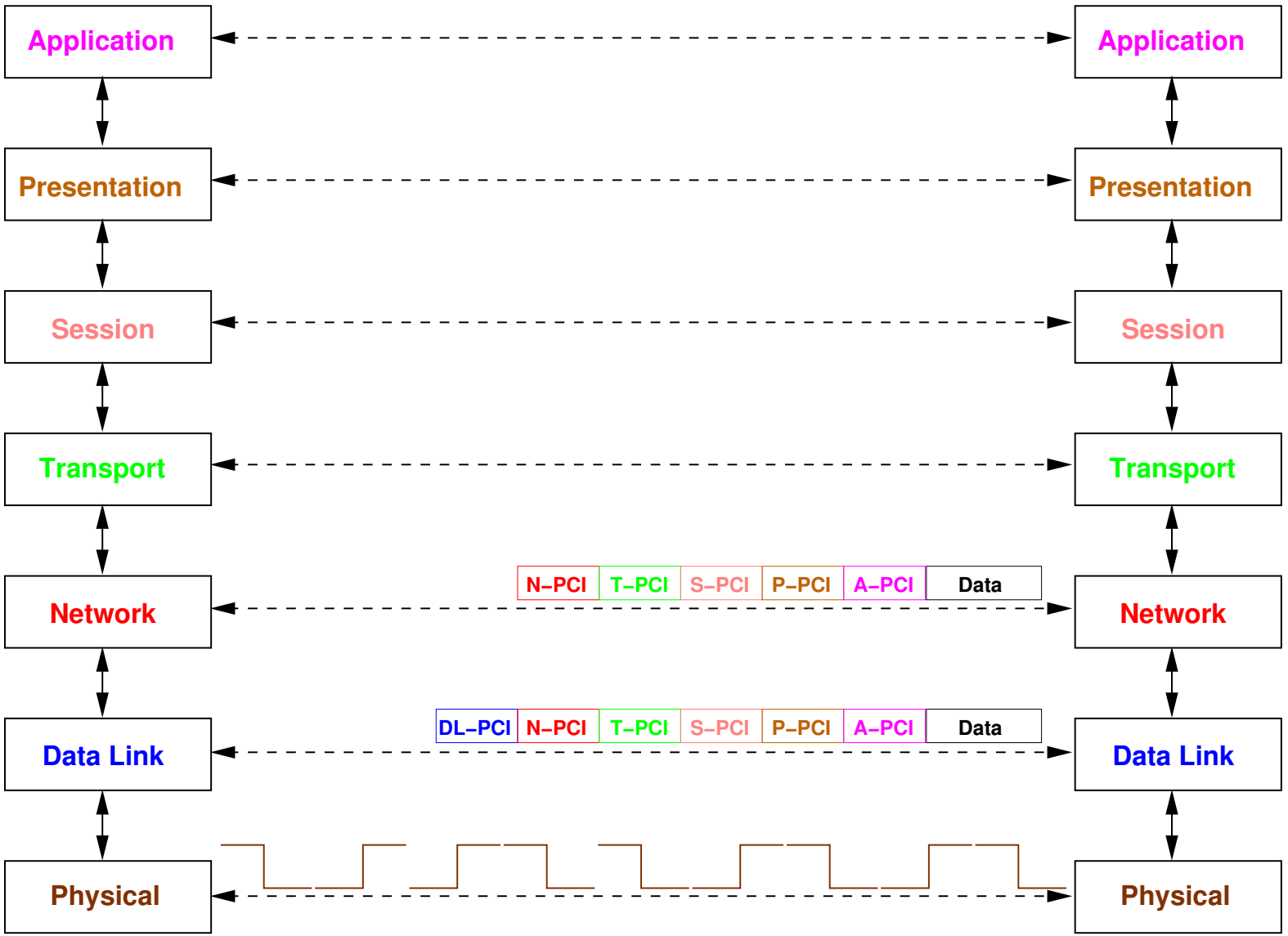

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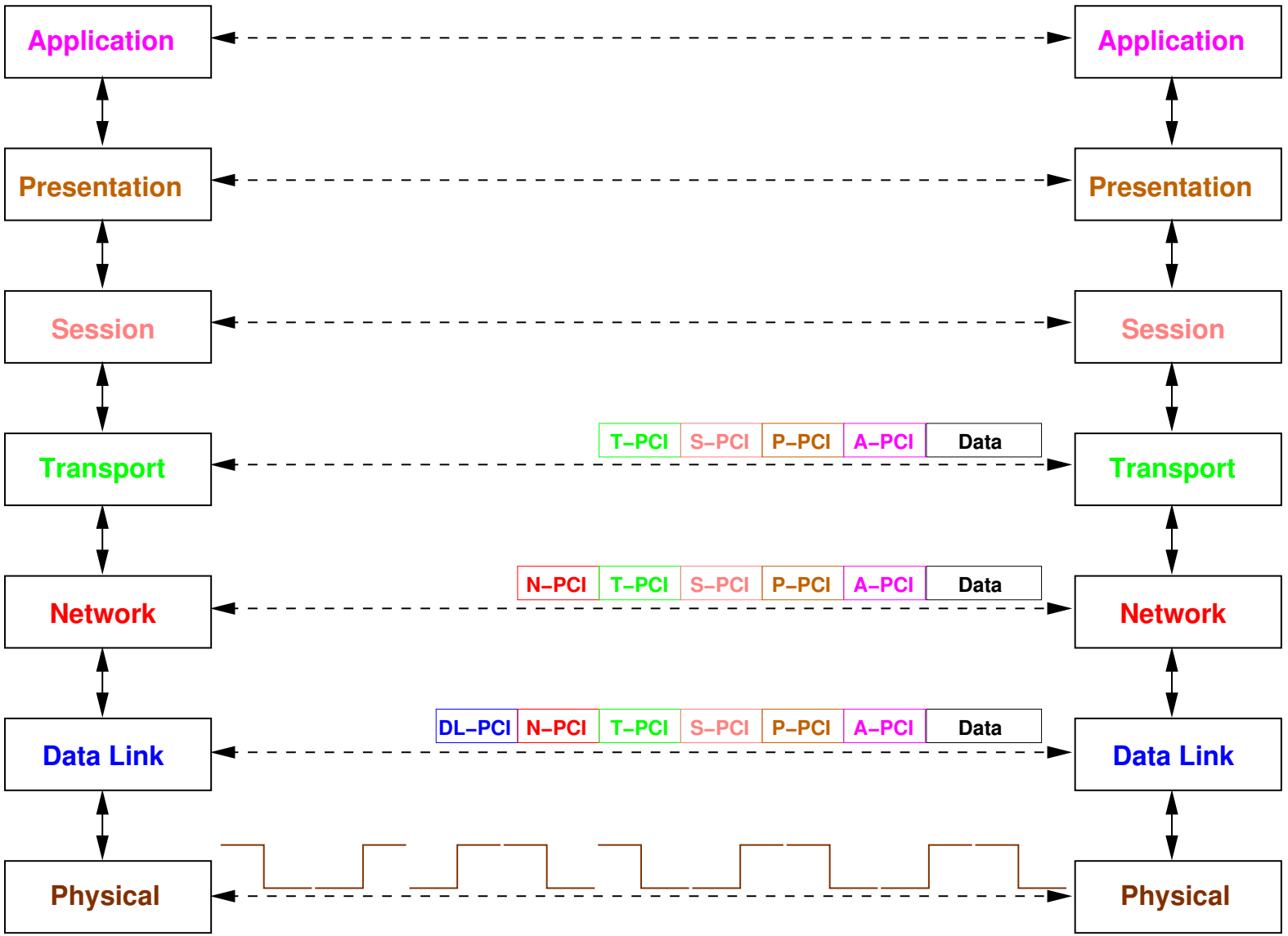

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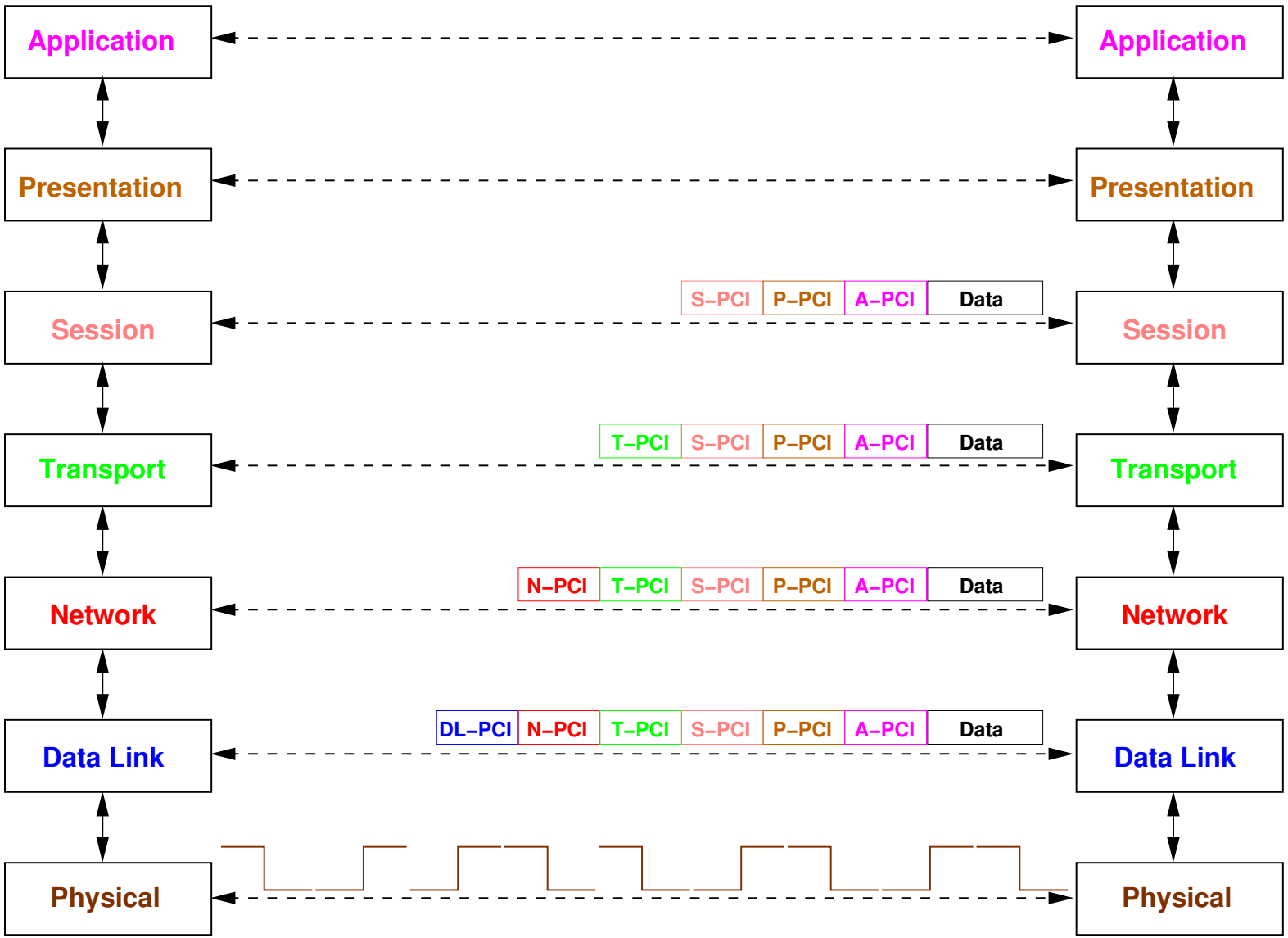

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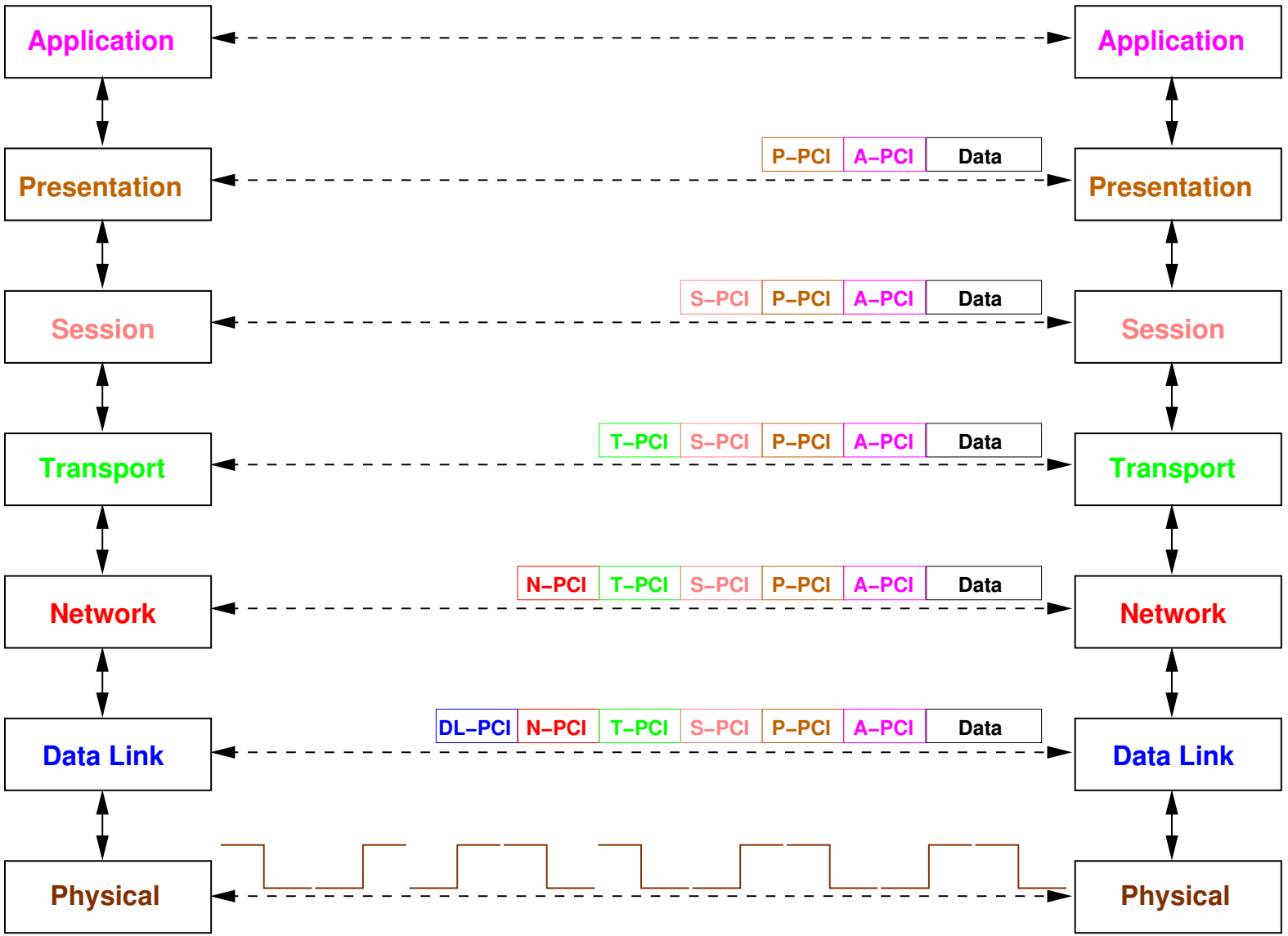

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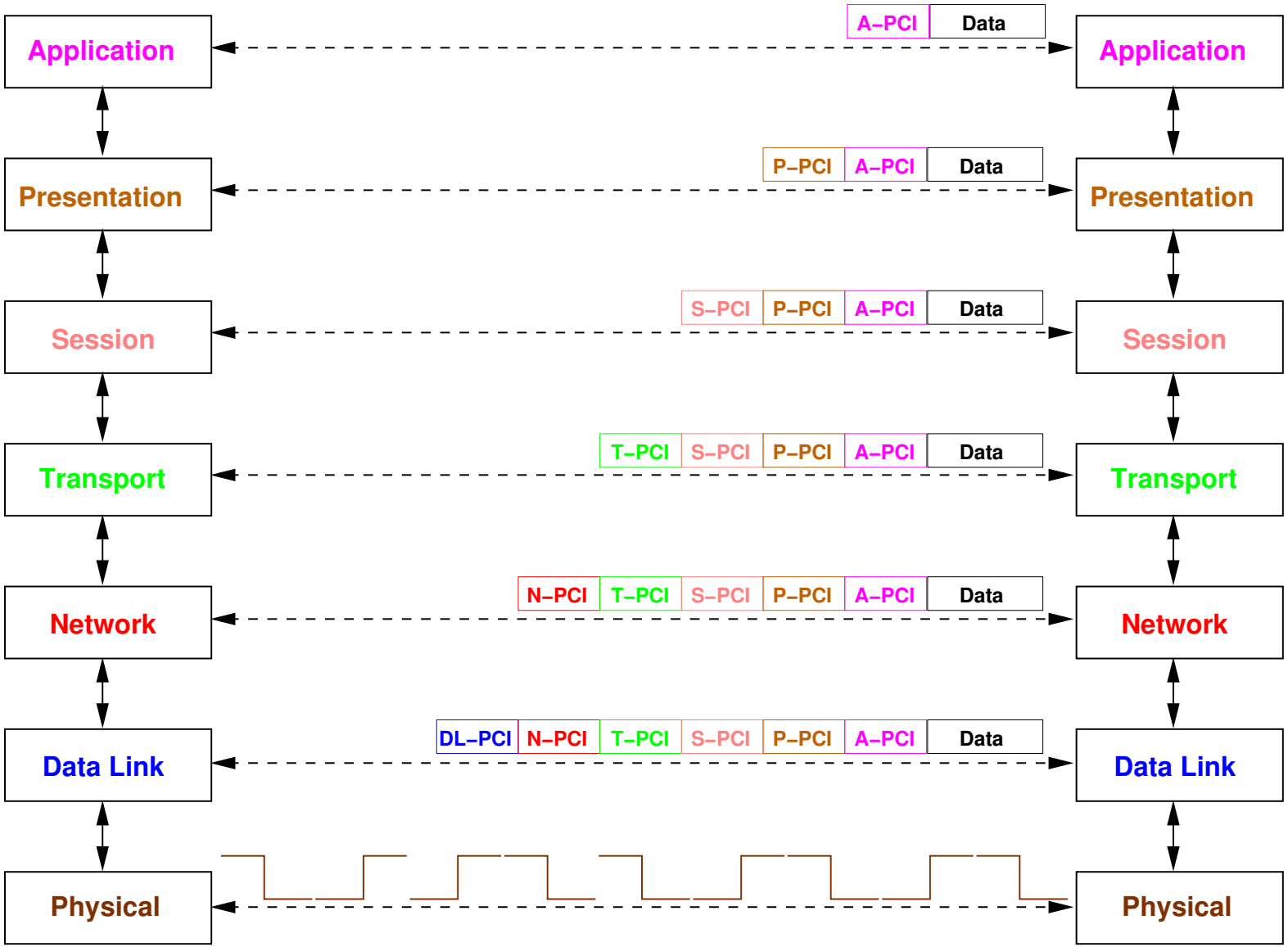

# Architecture

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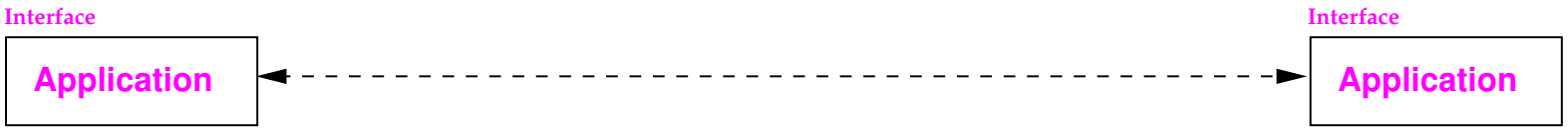


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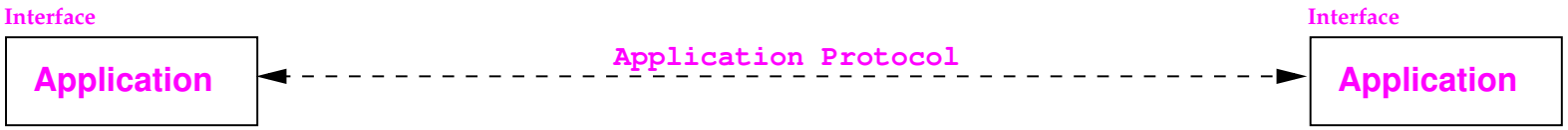


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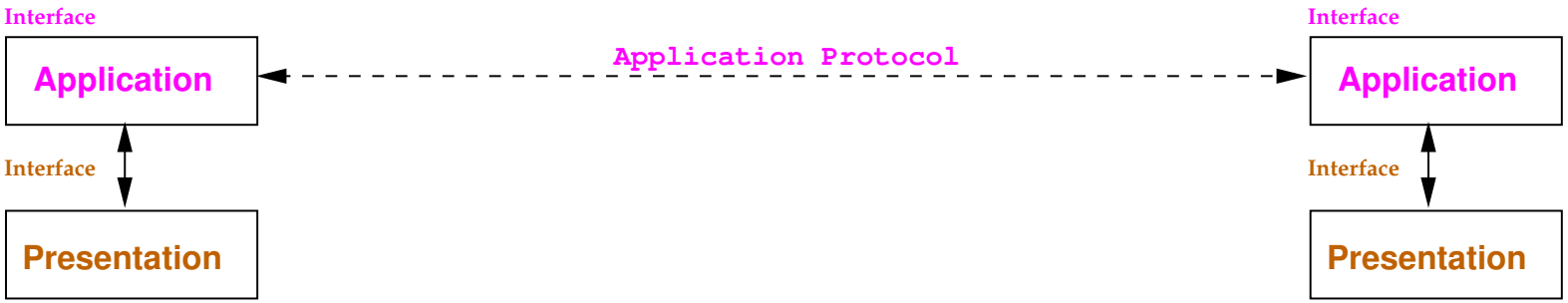


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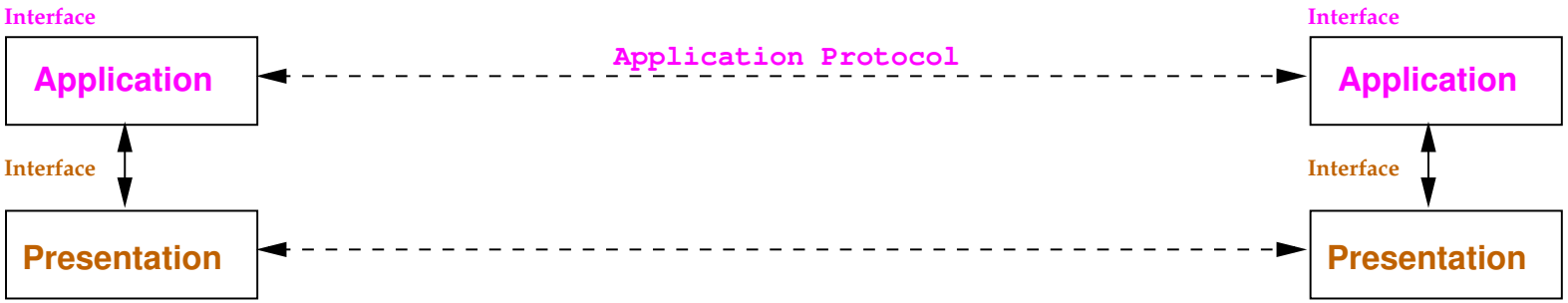


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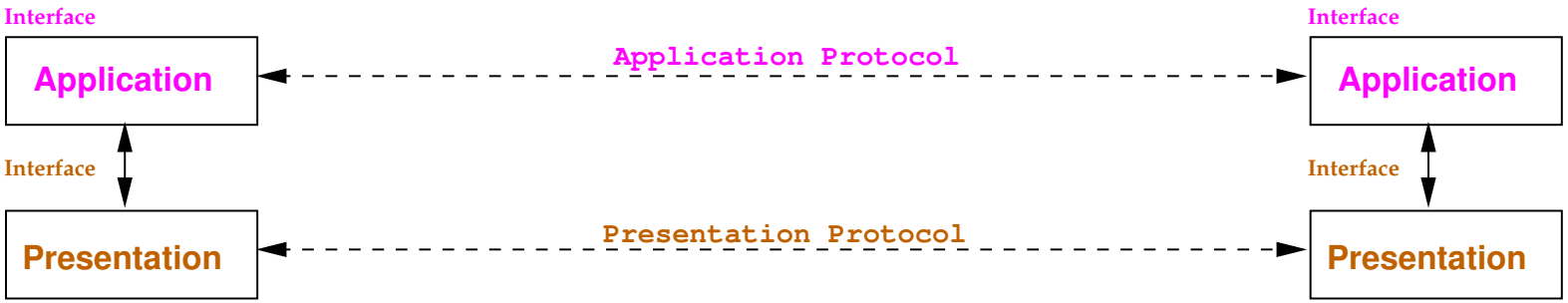


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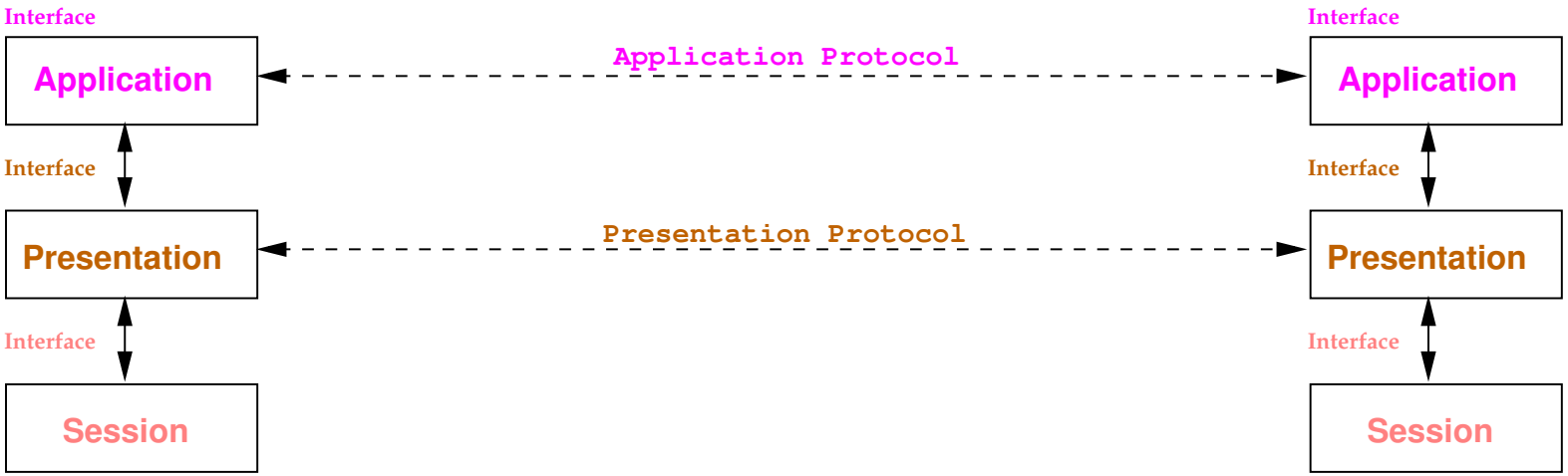


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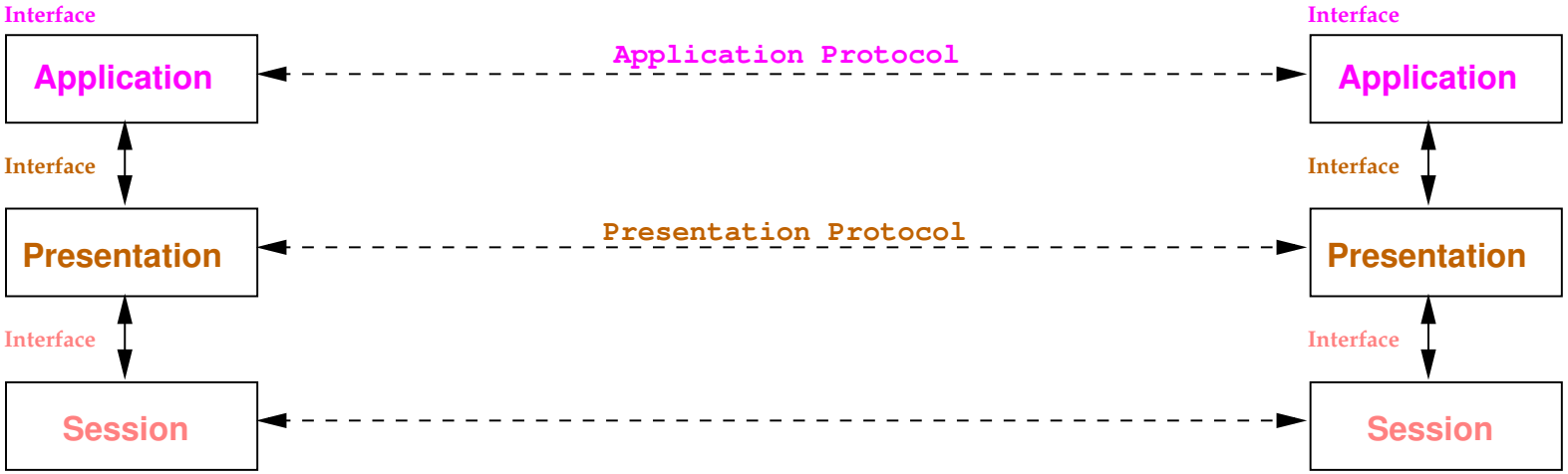


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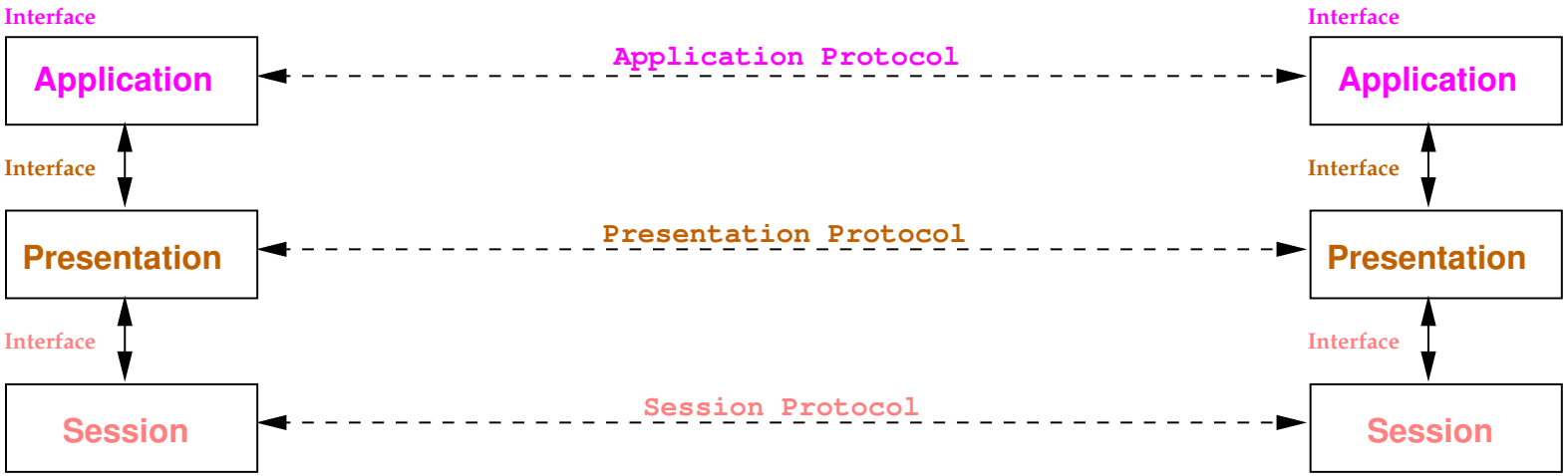


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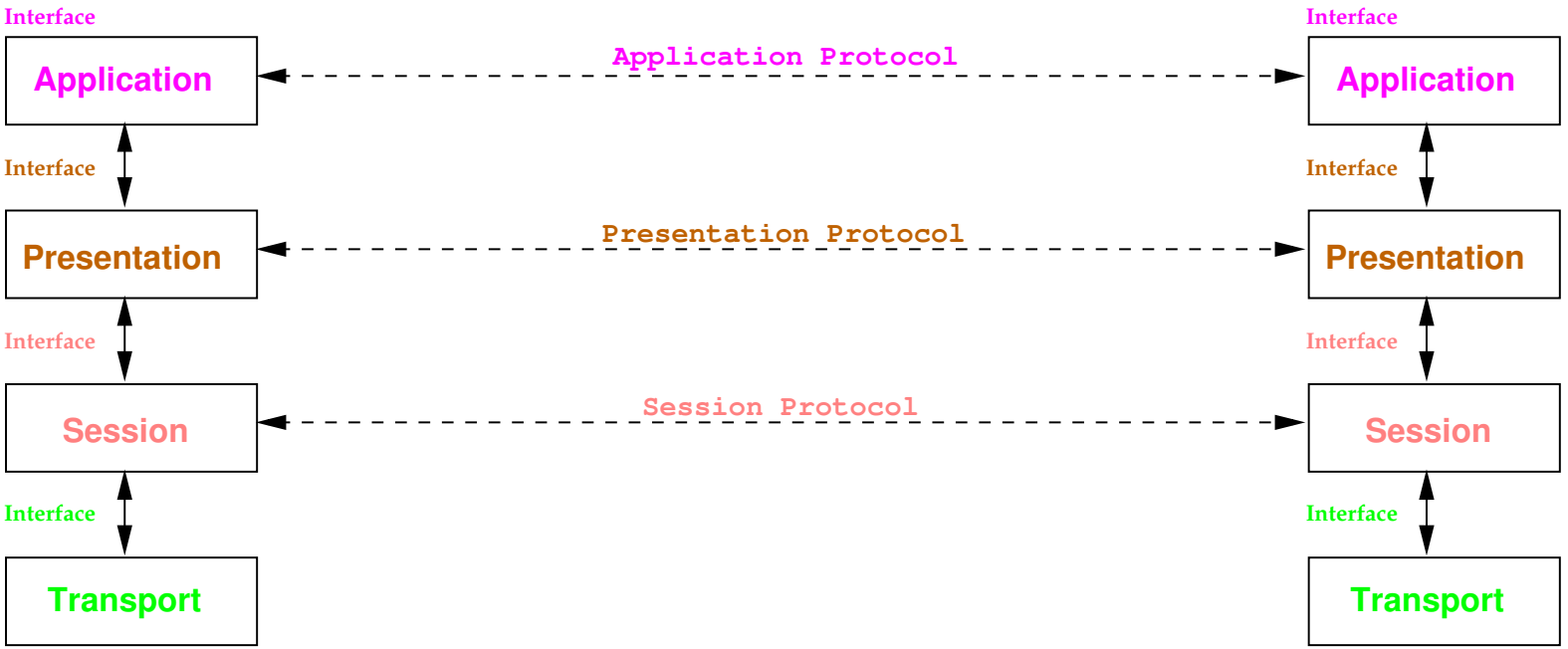


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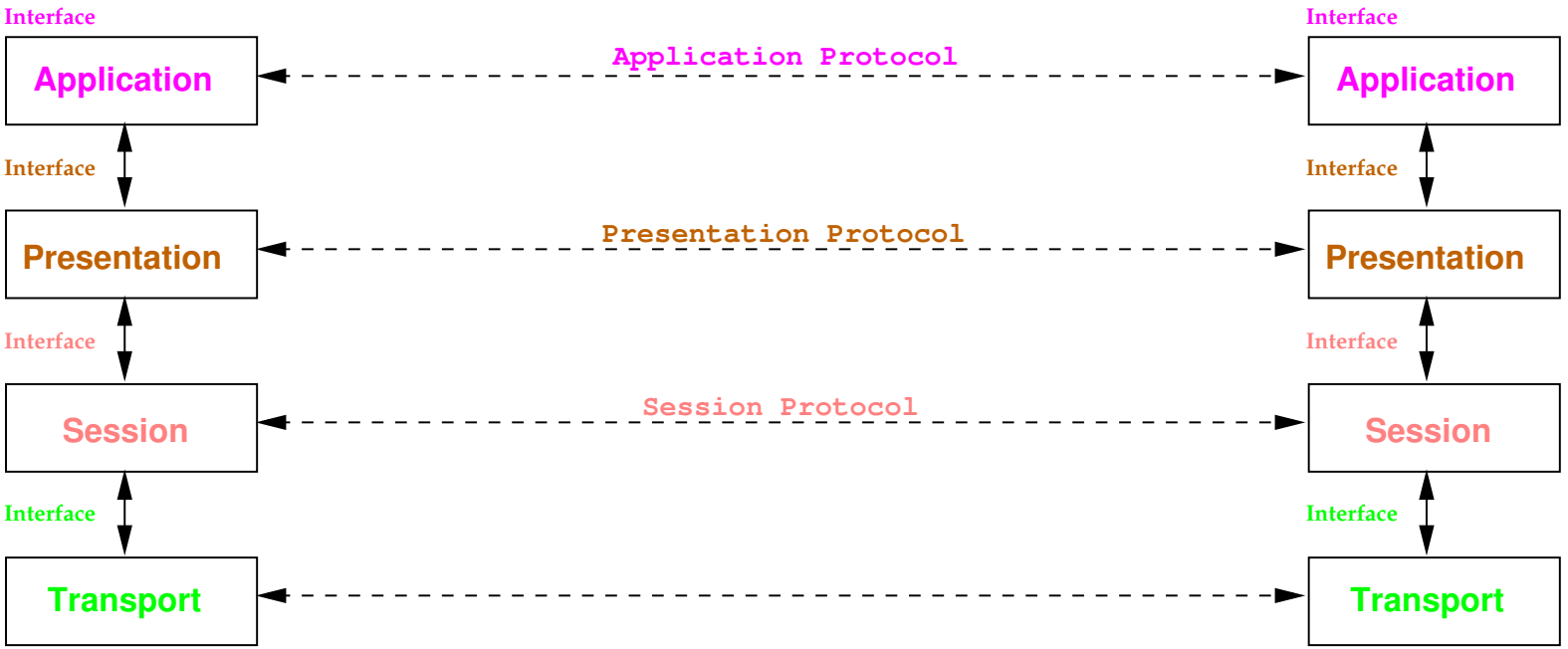


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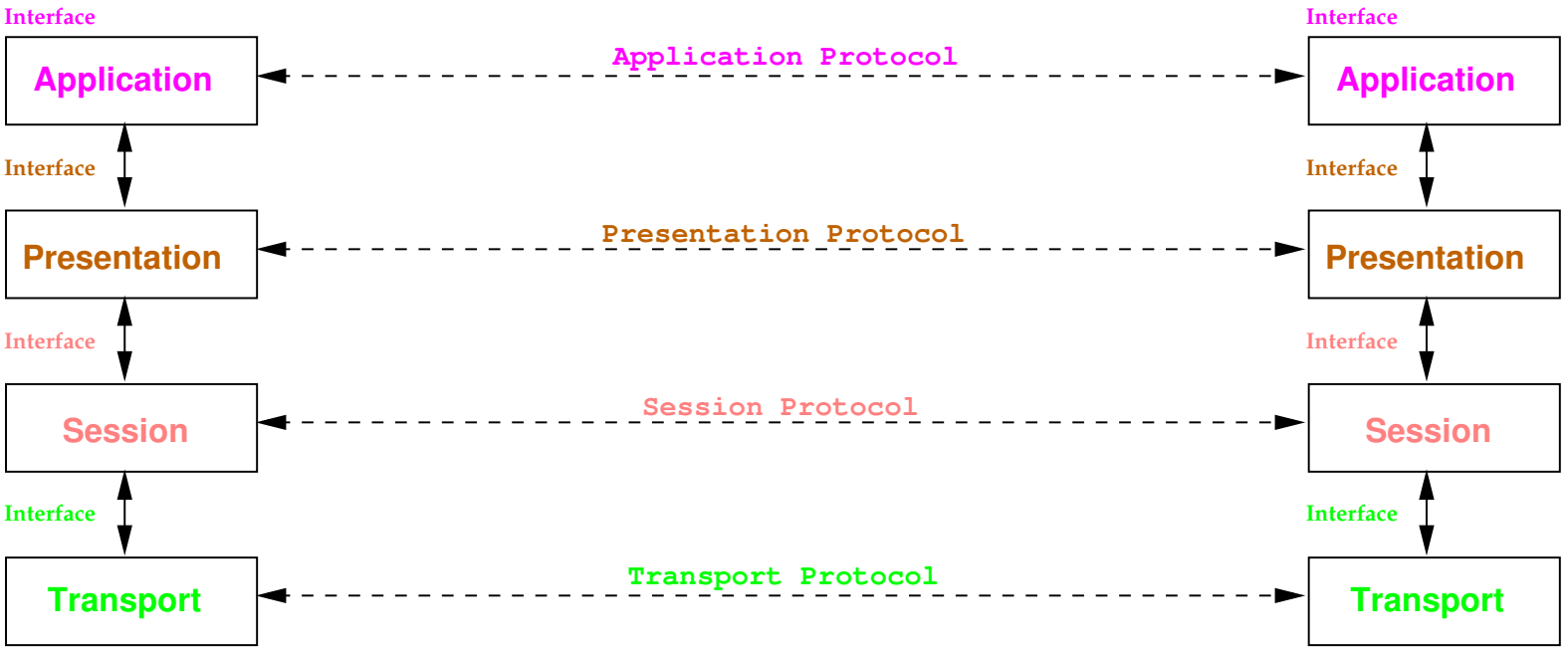


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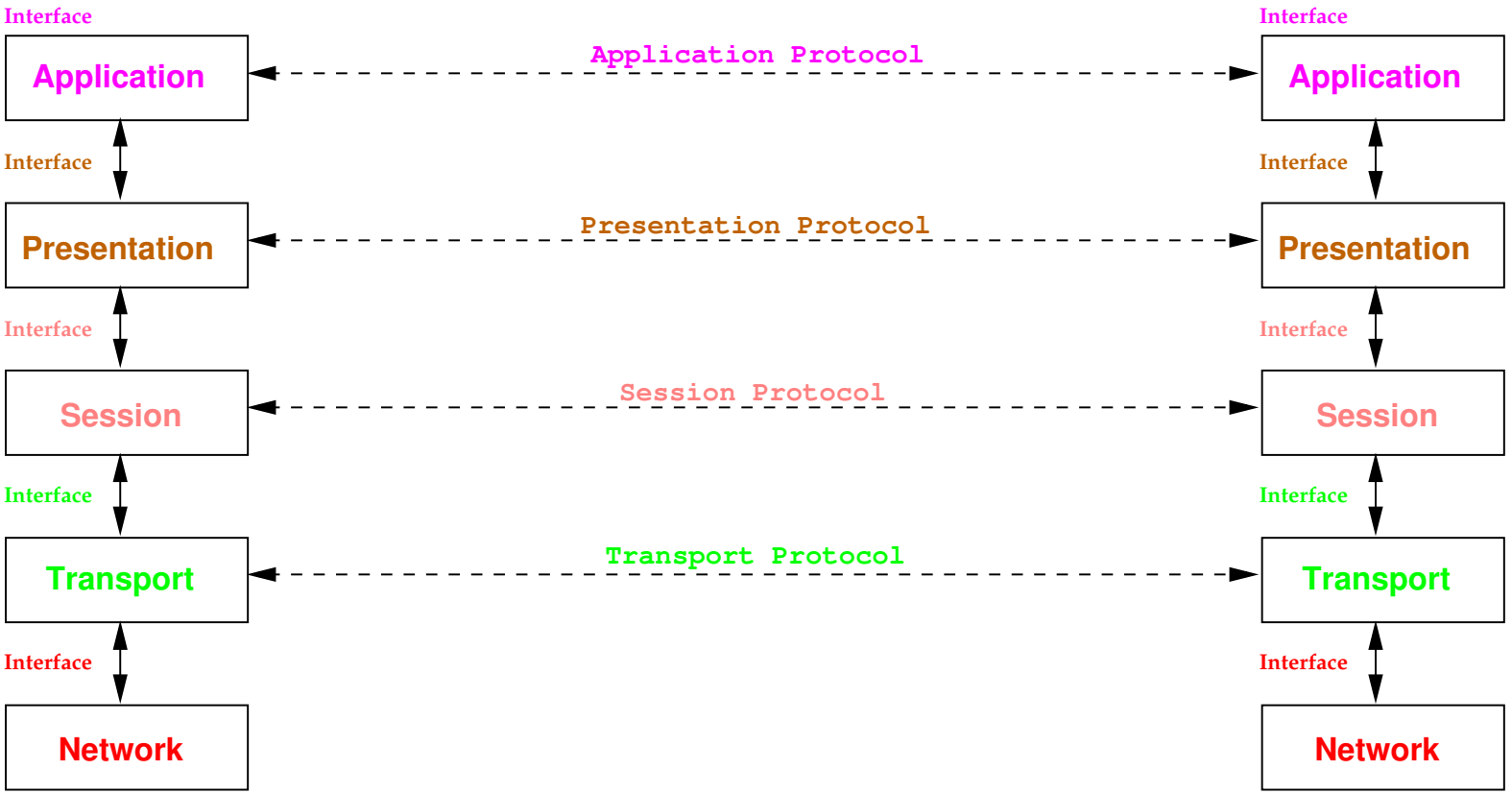


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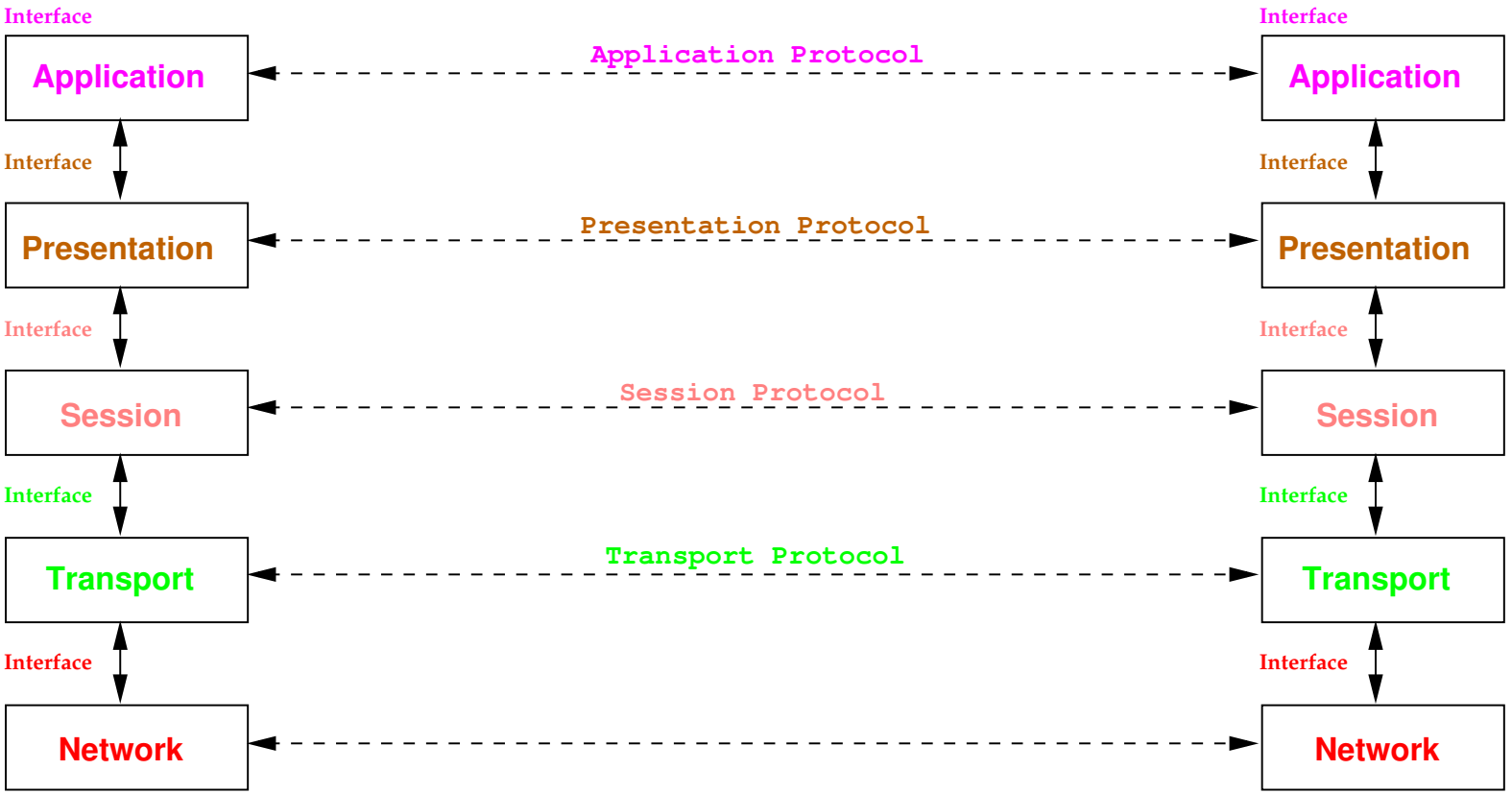


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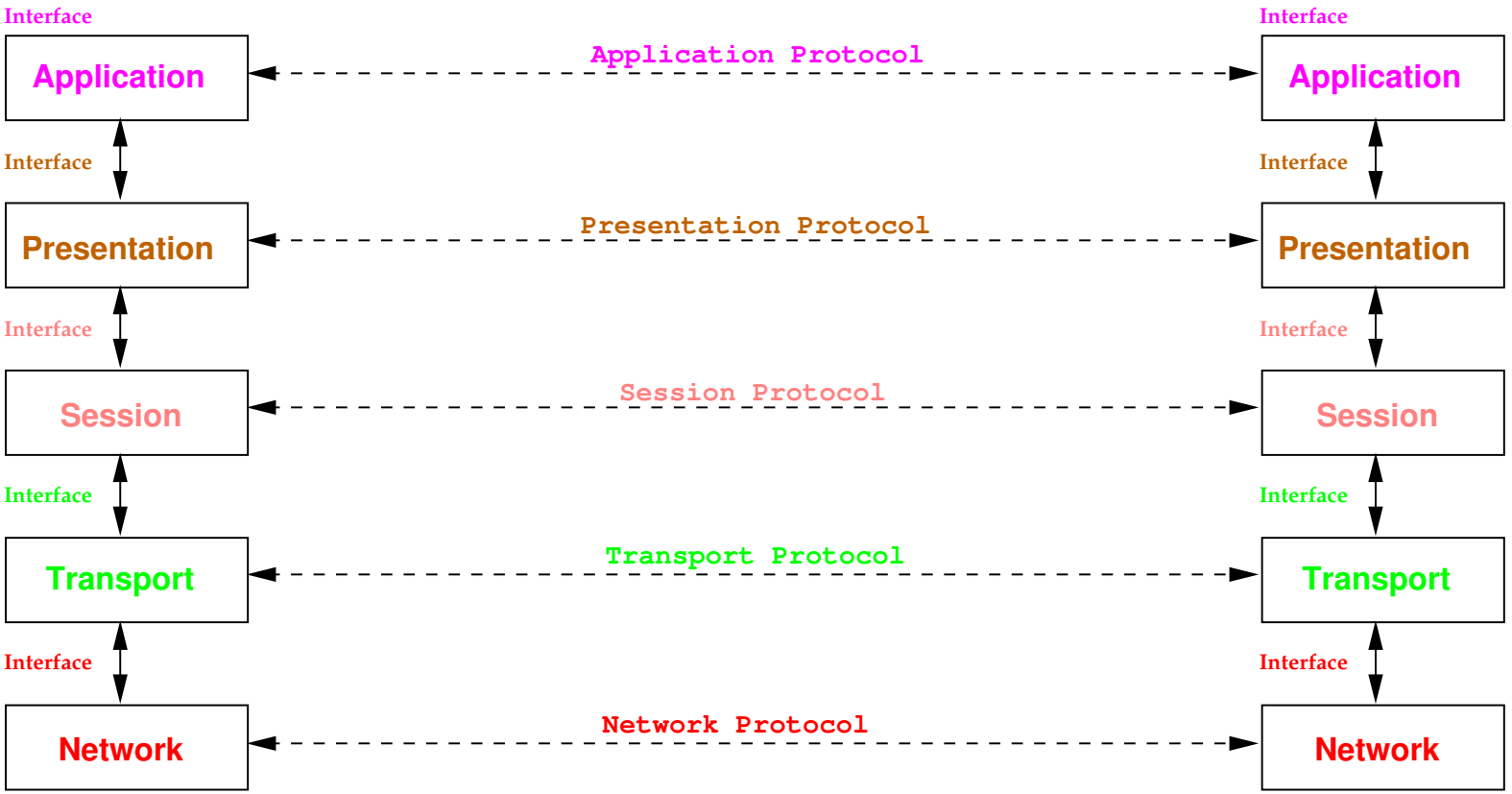


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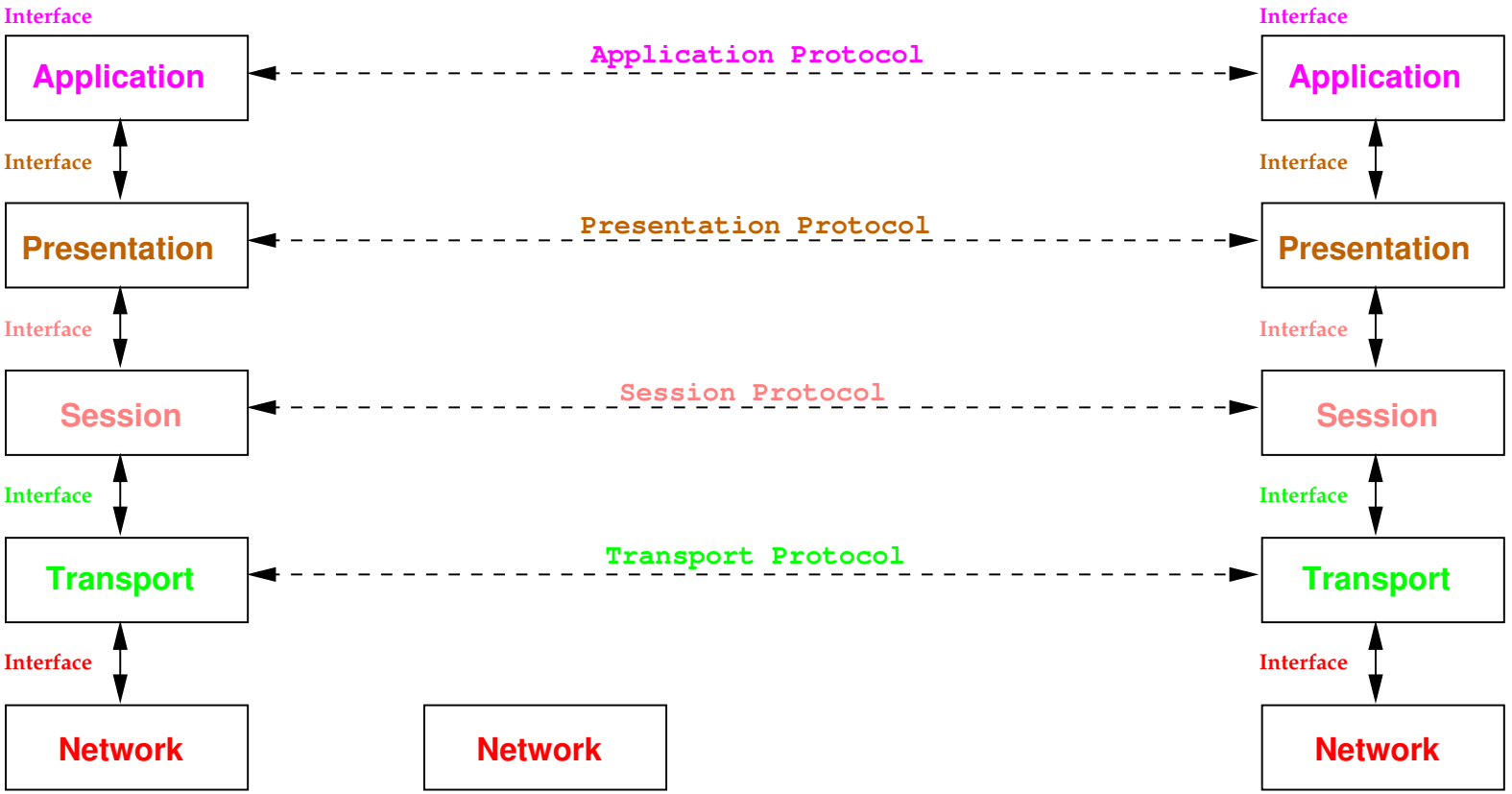


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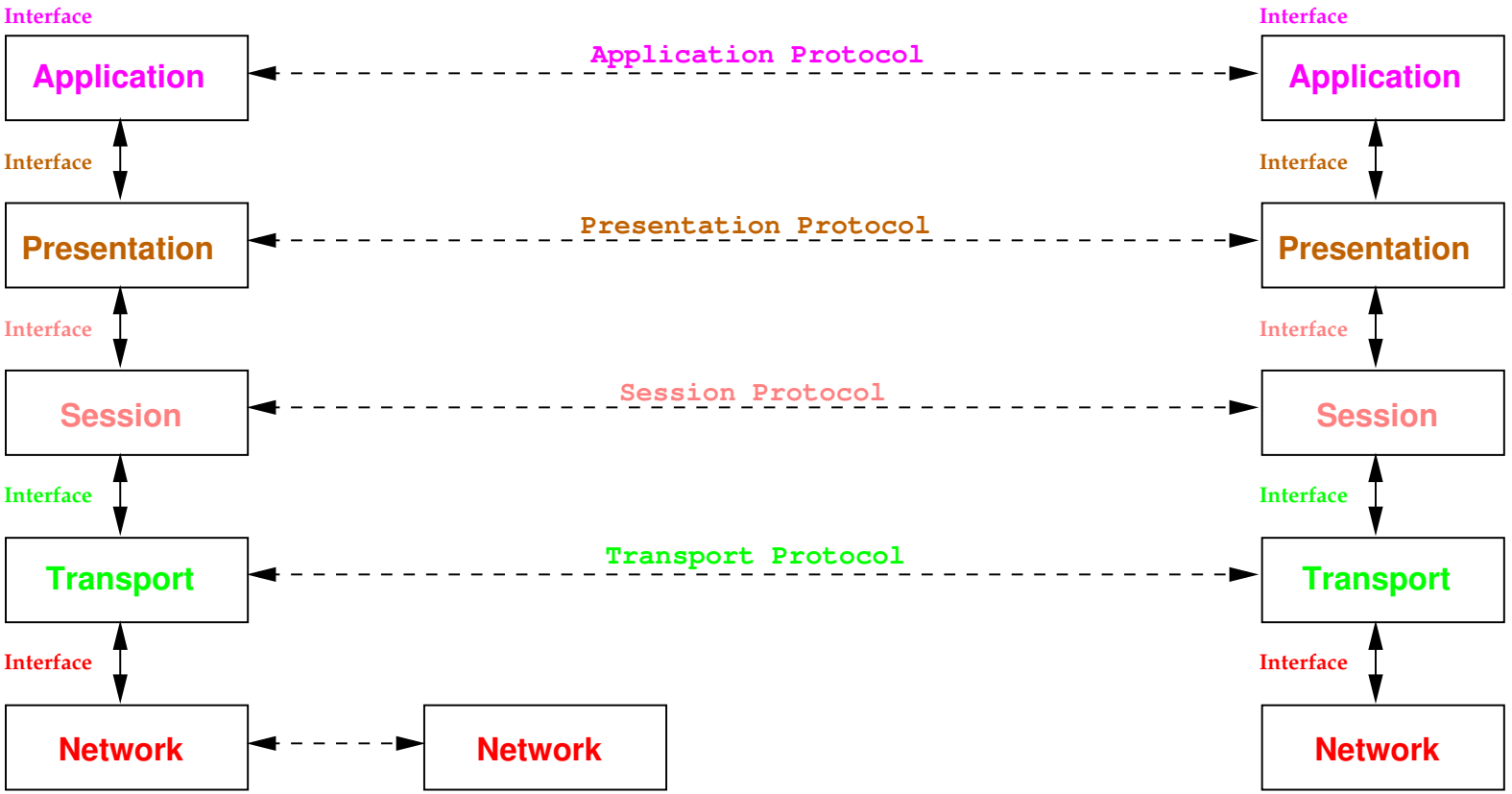


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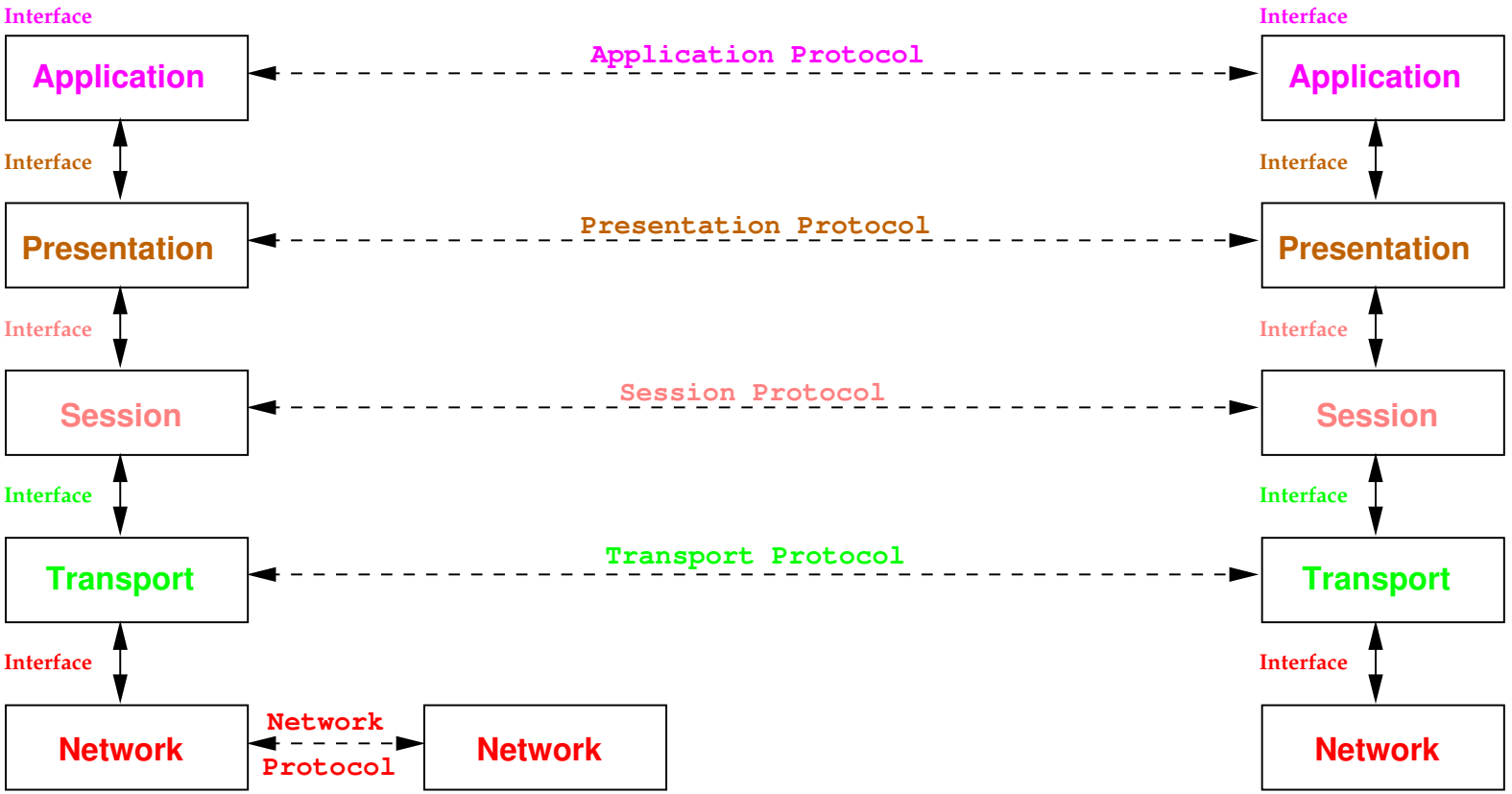


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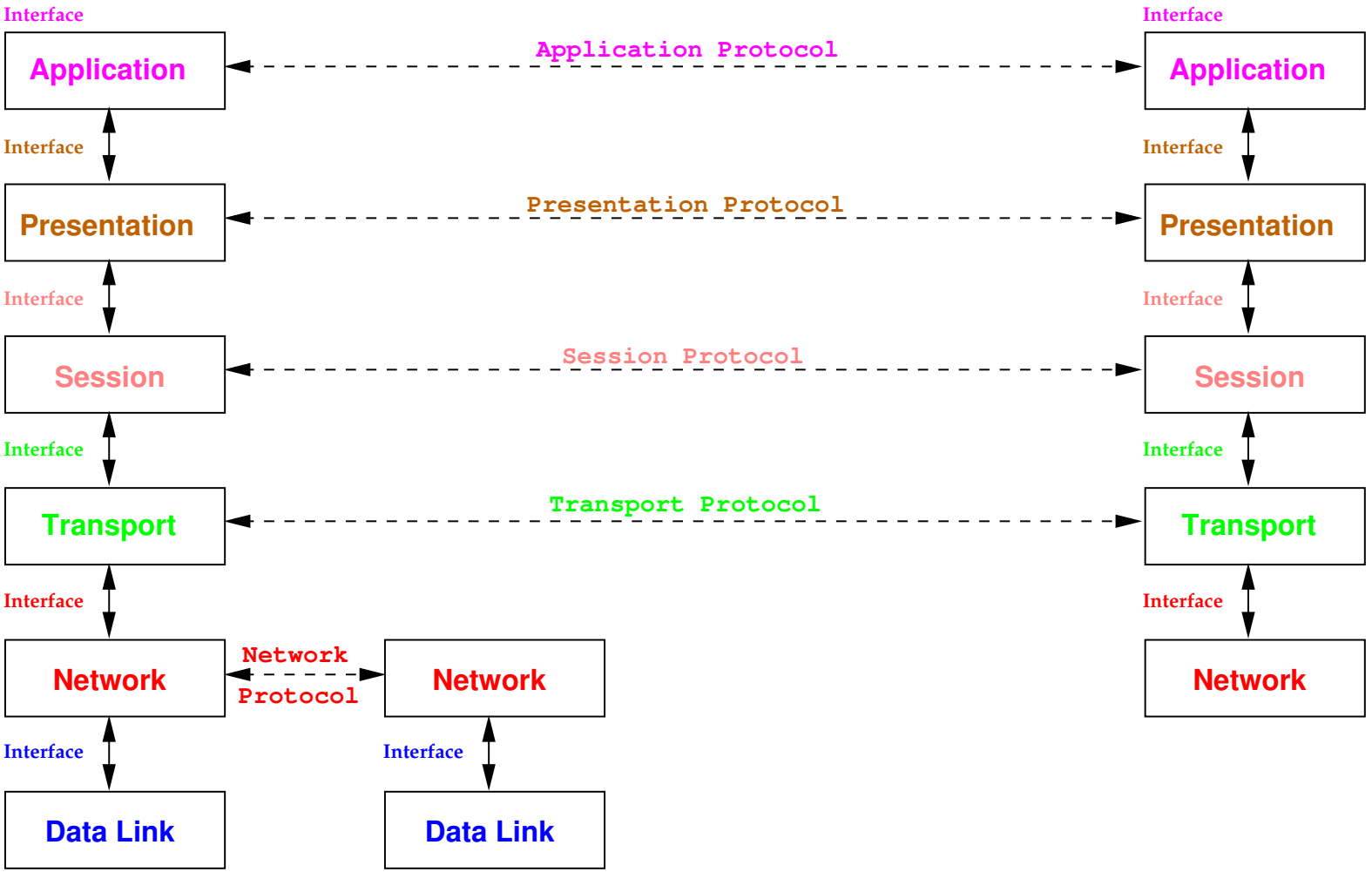

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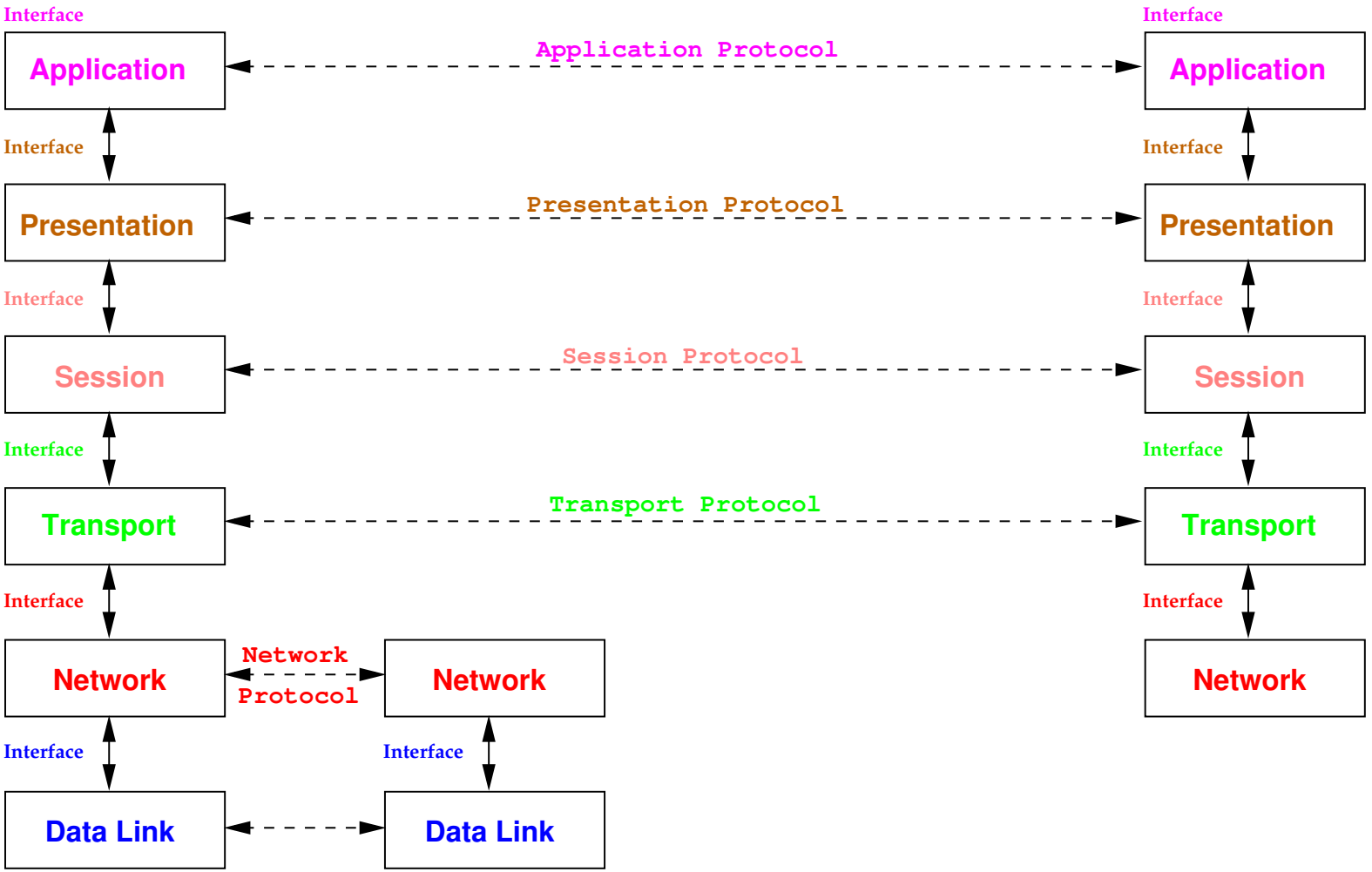

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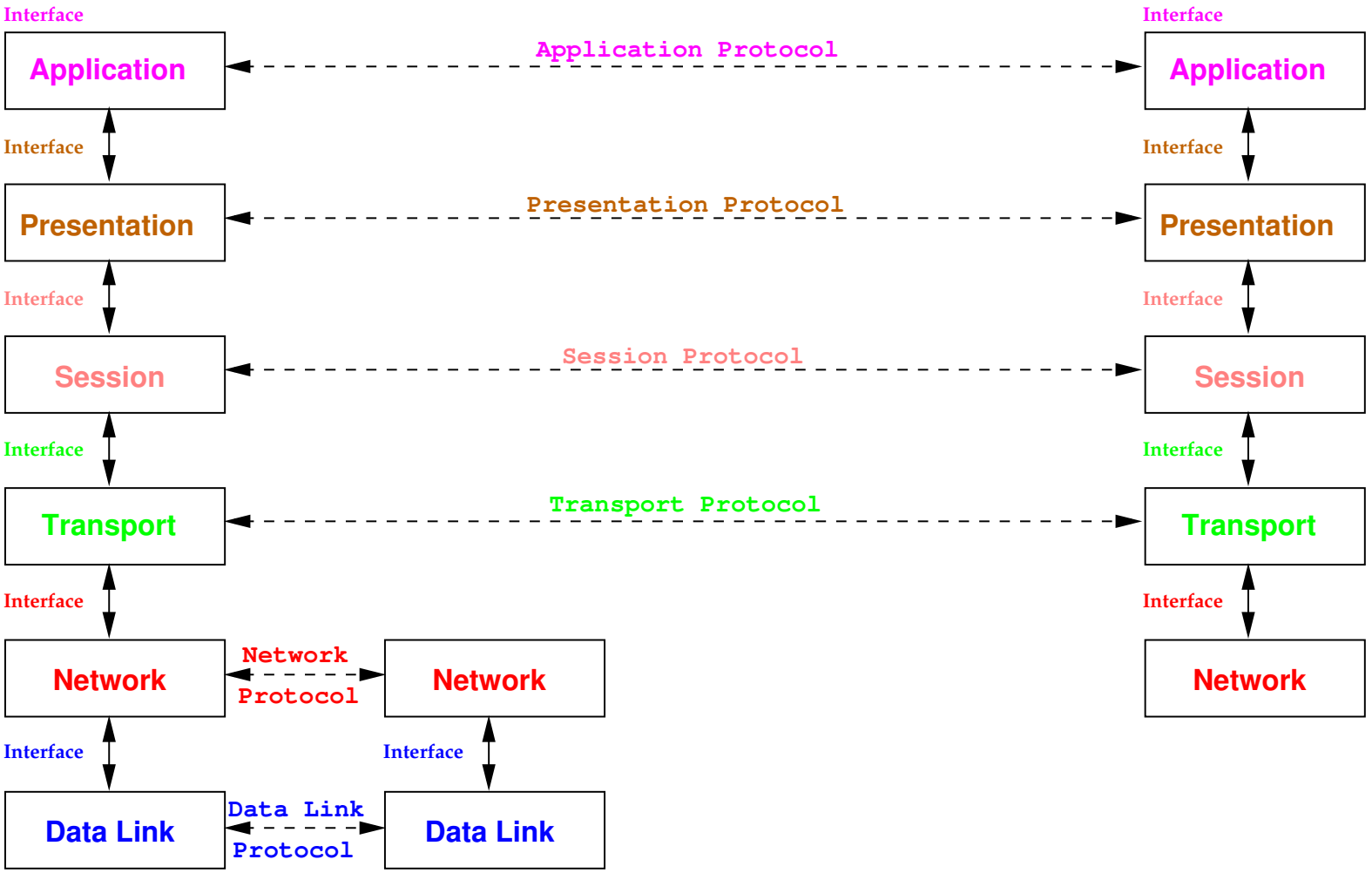

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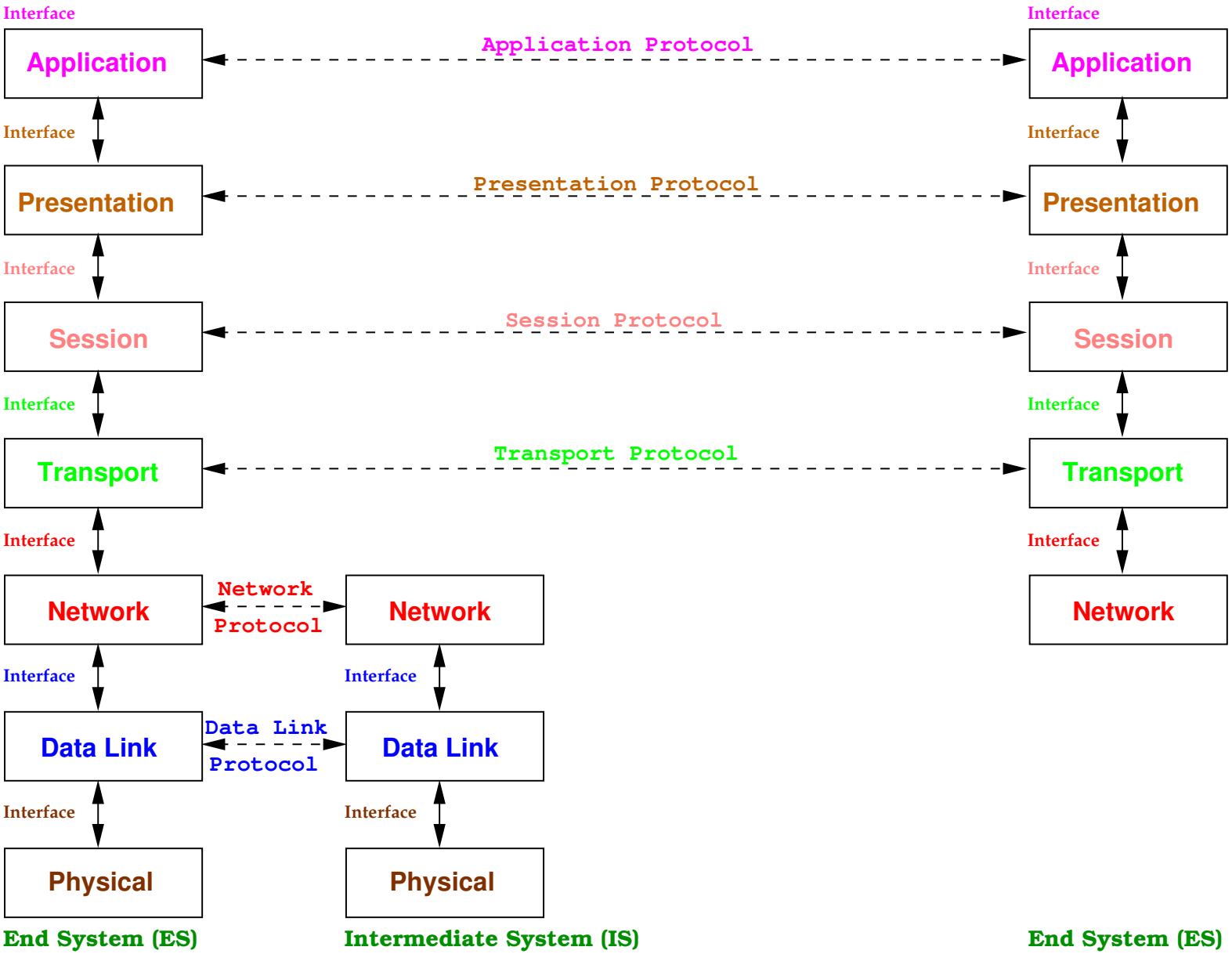

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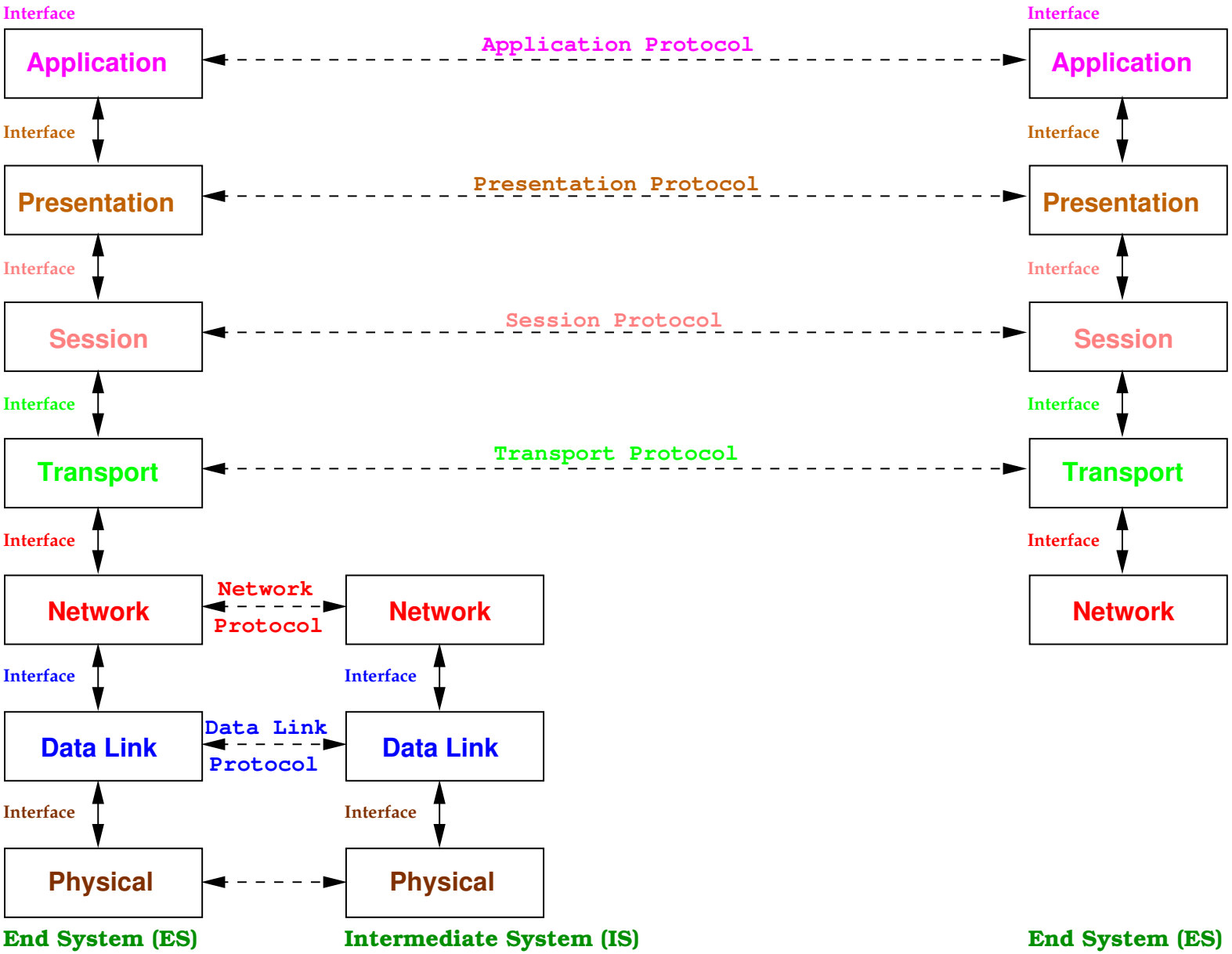

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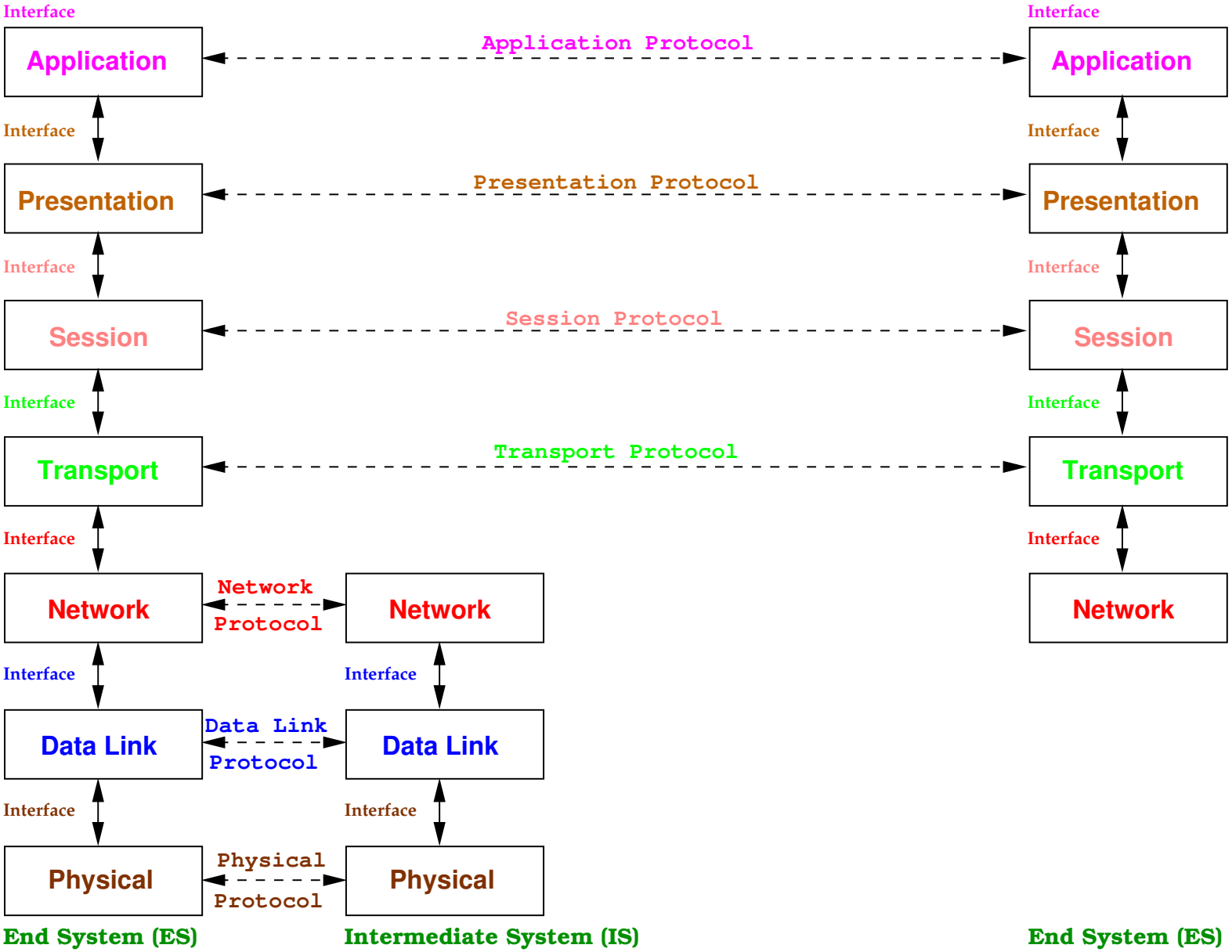

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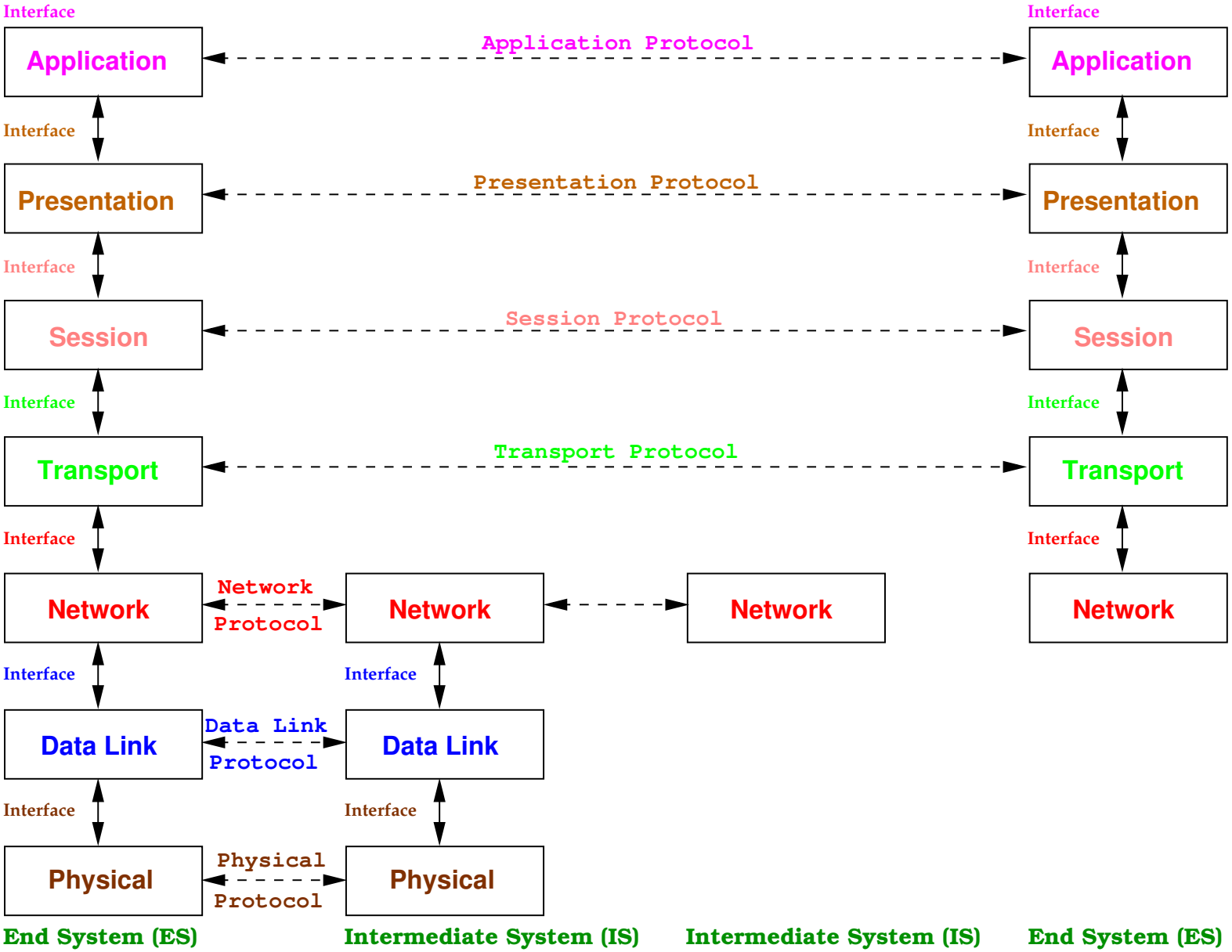

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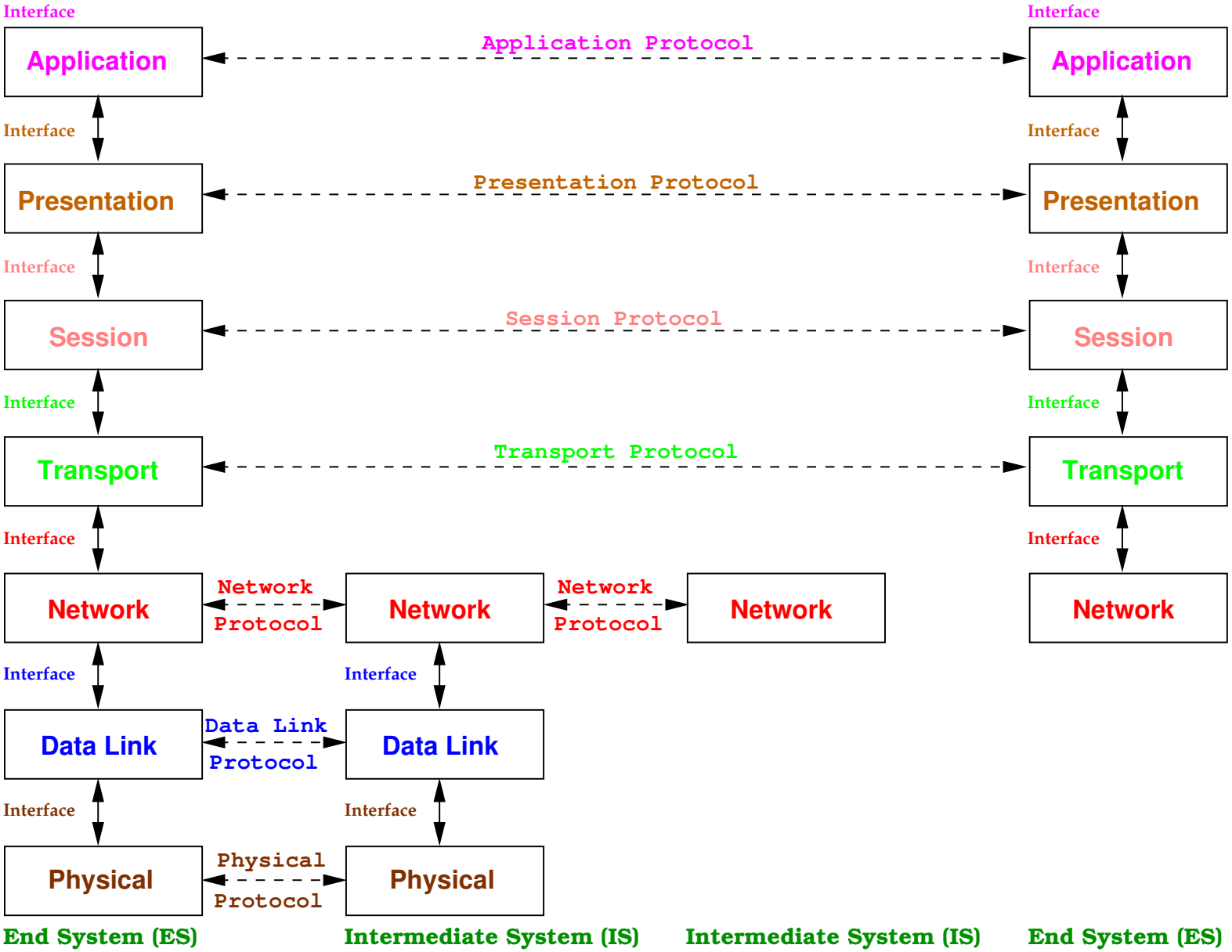

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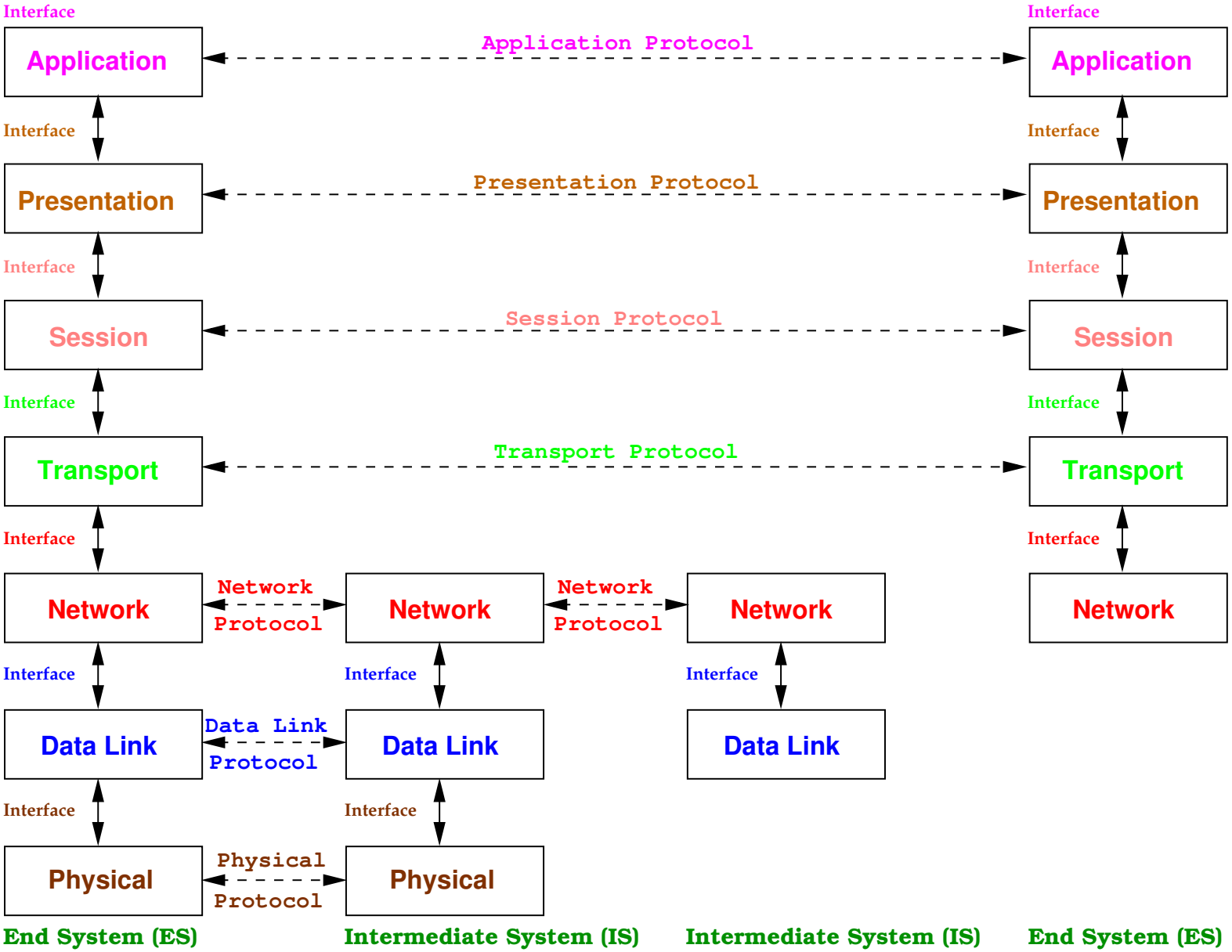
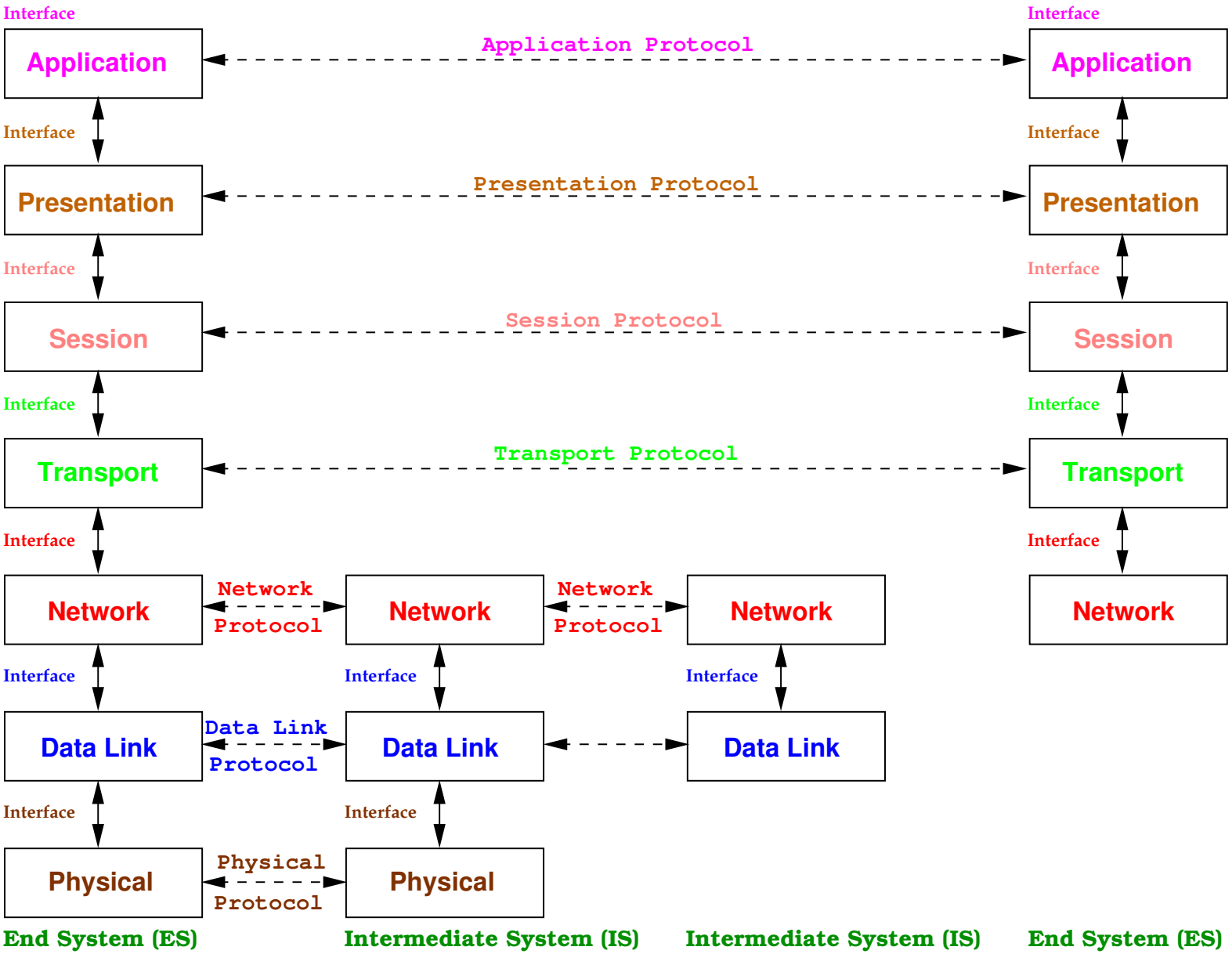


# Architecture



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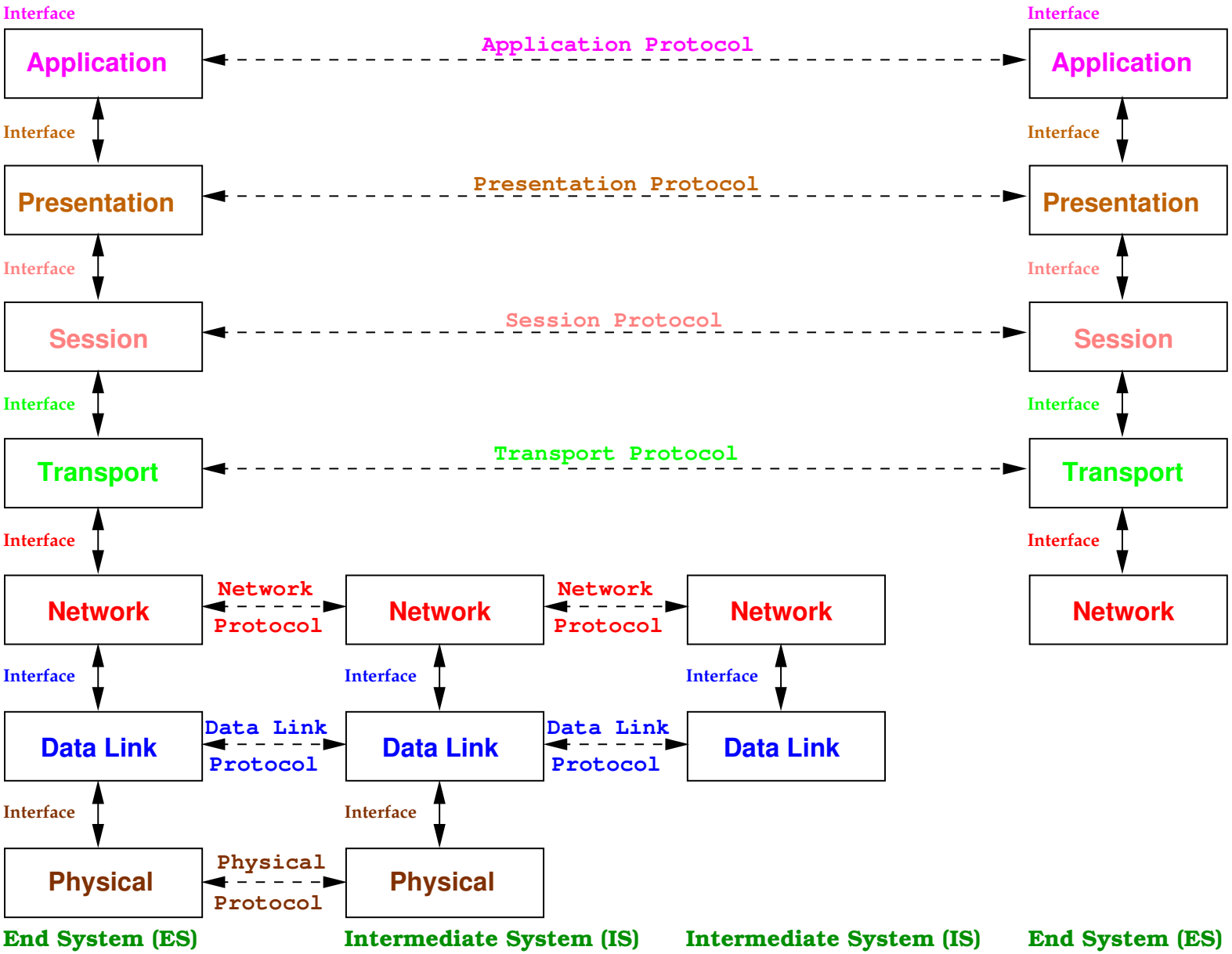

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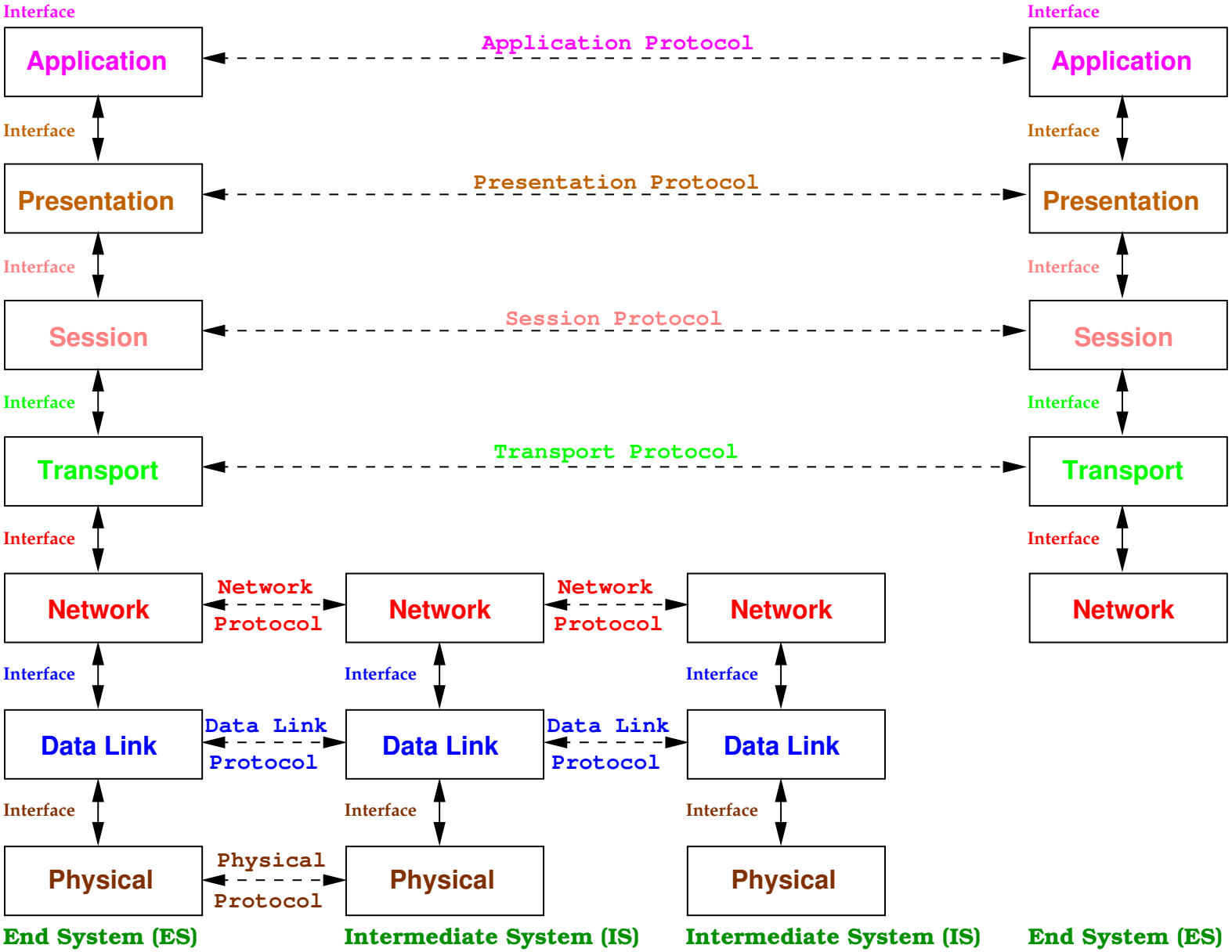

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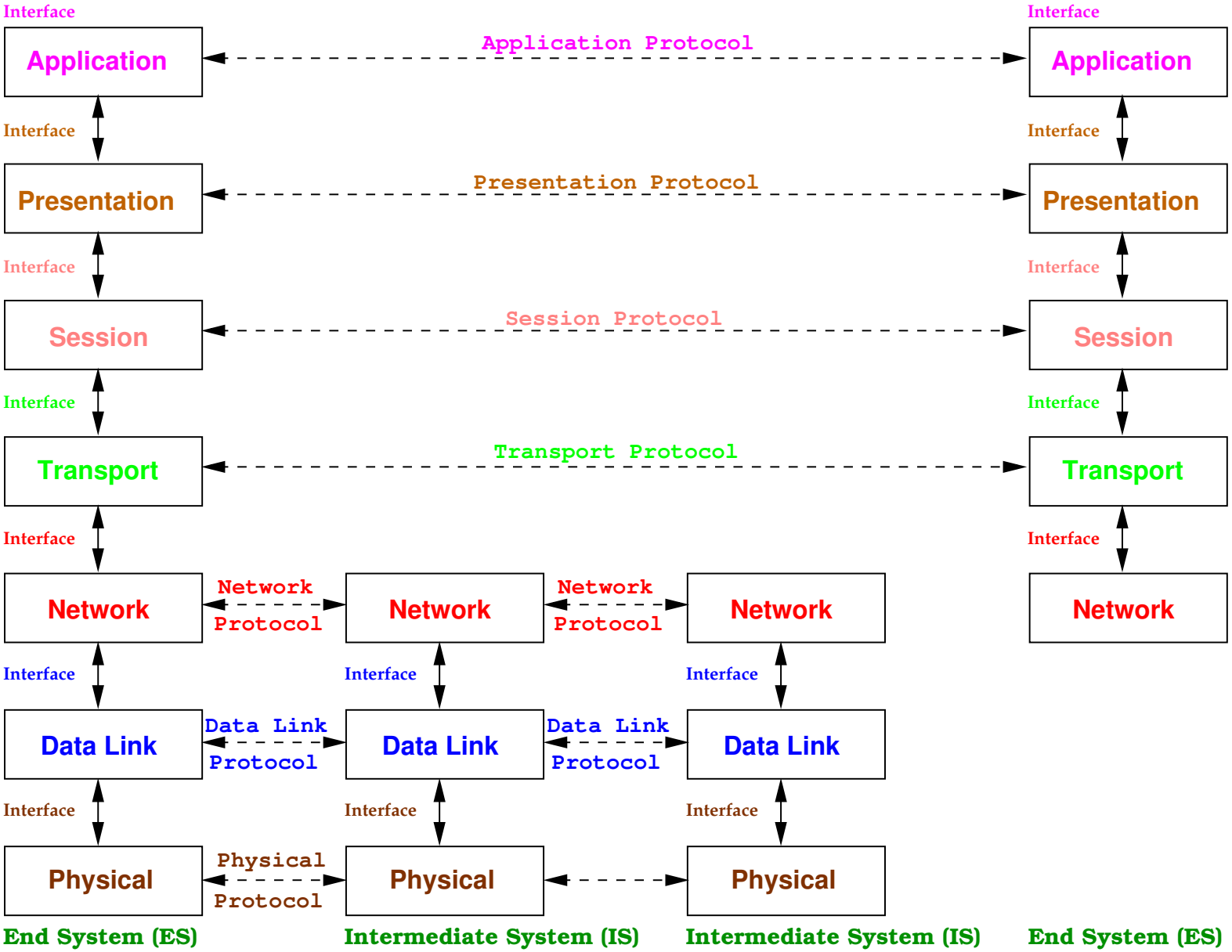

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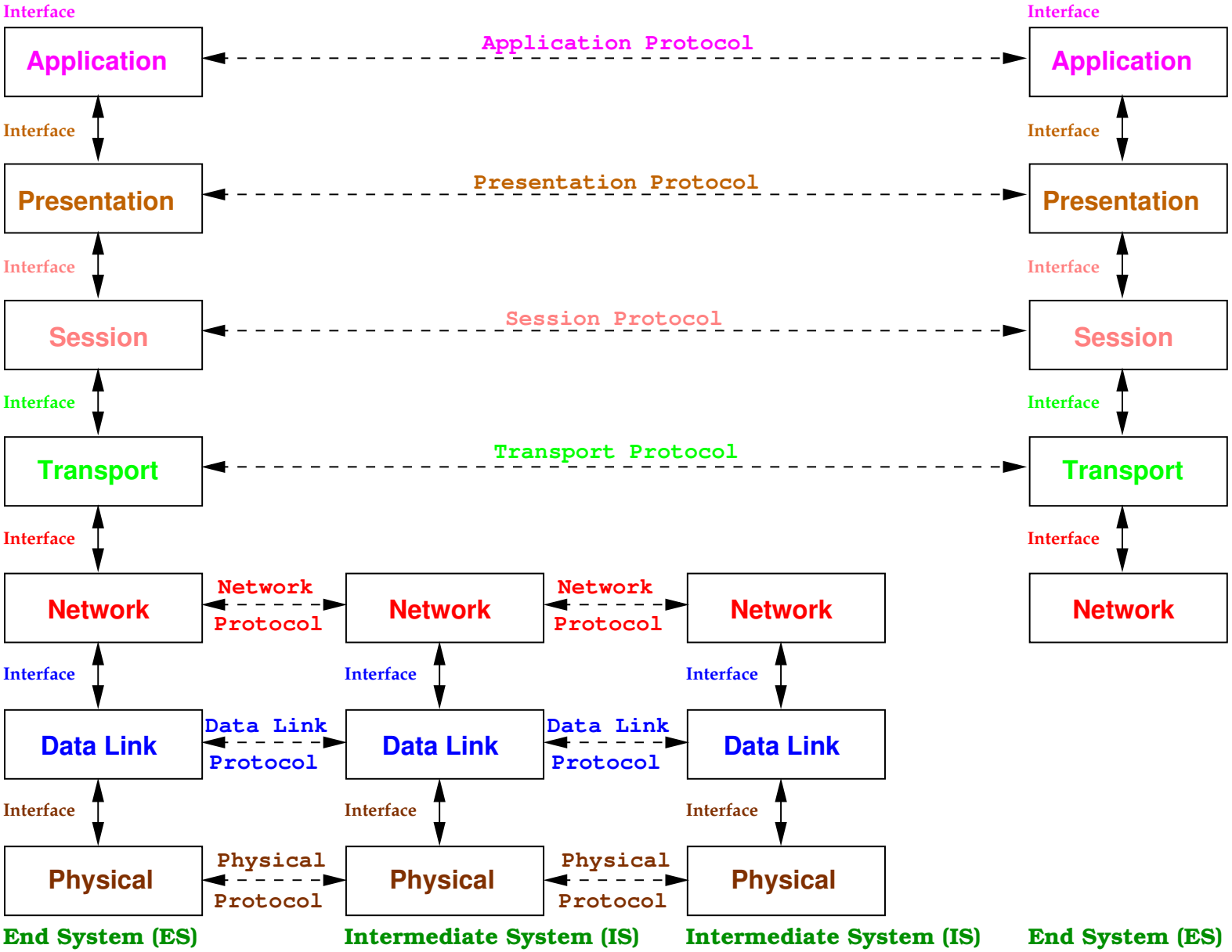

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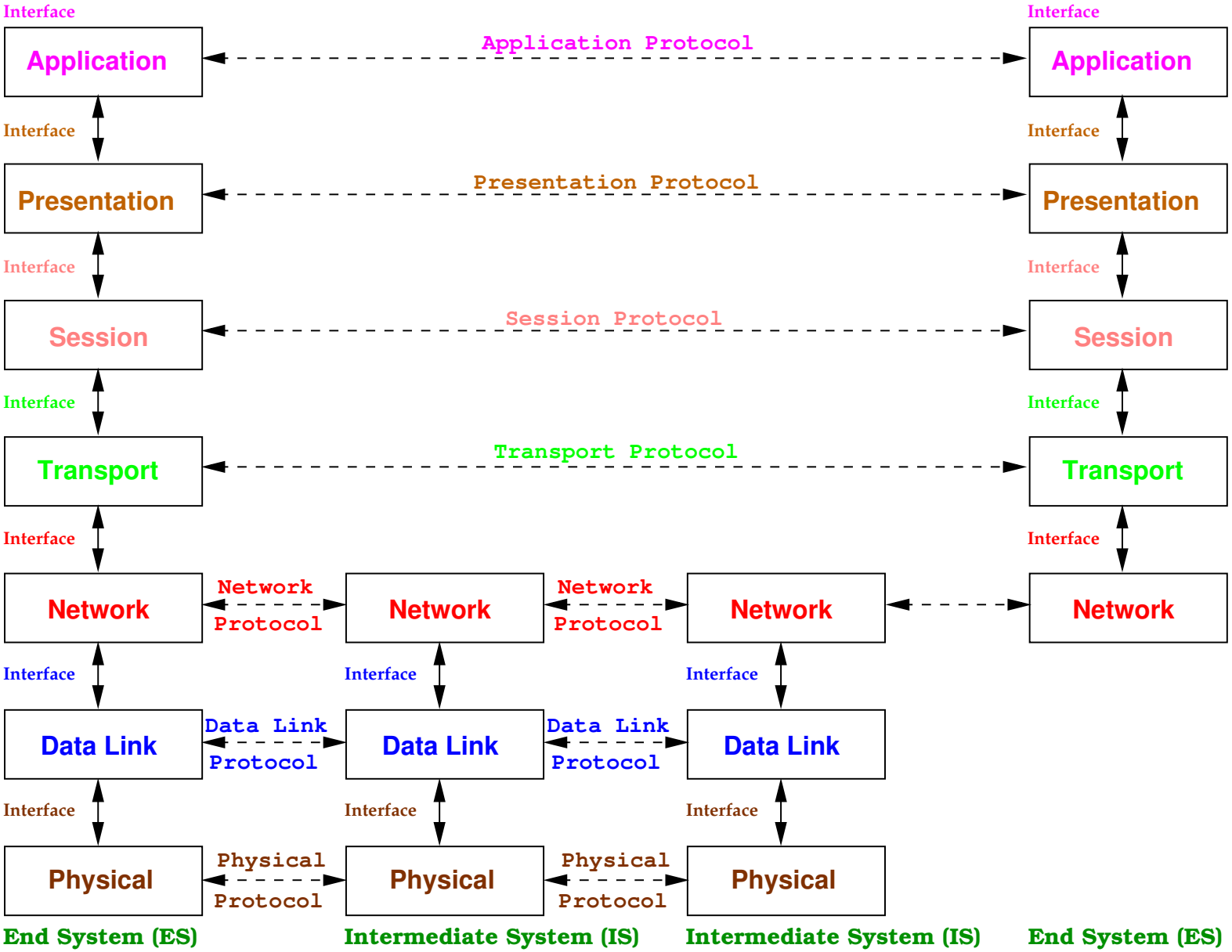

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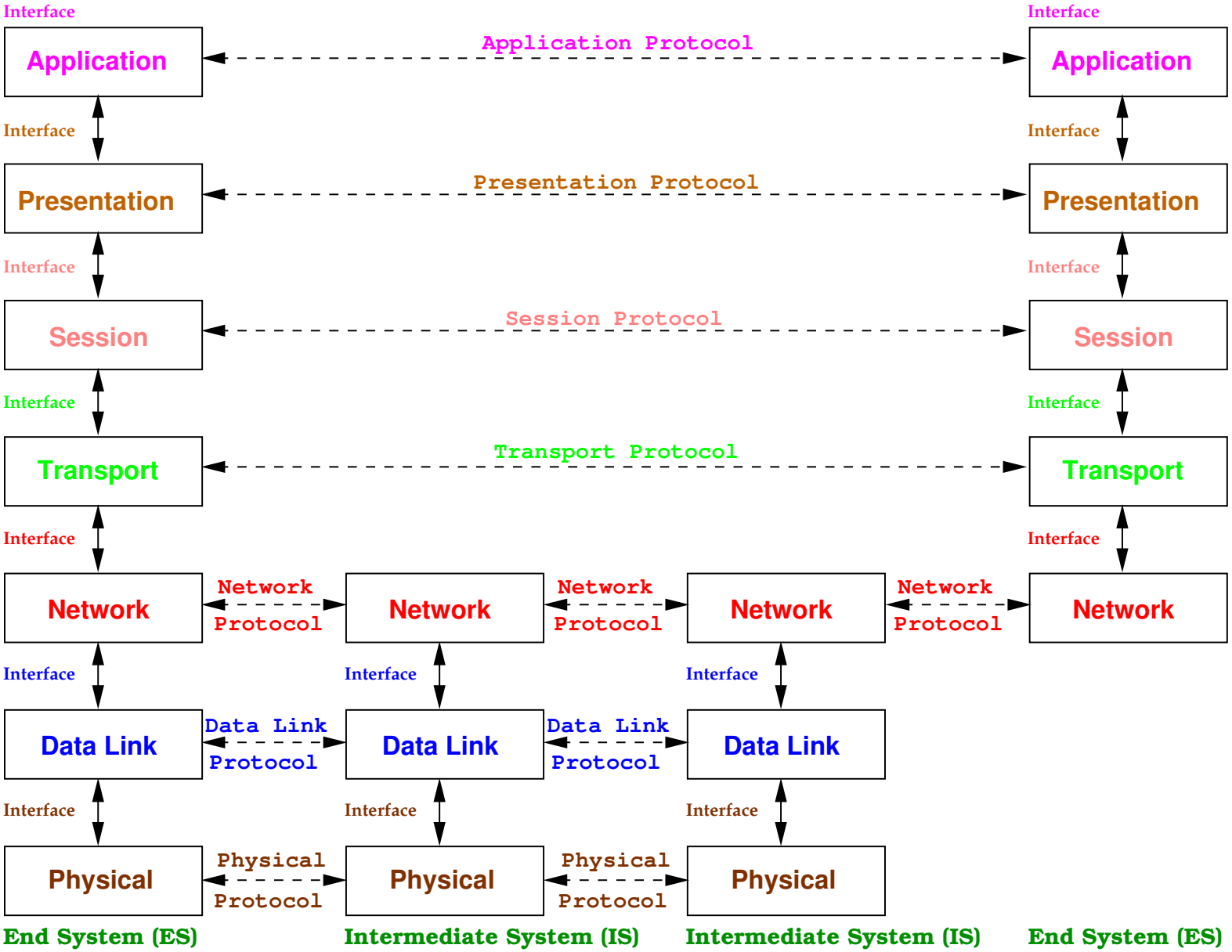

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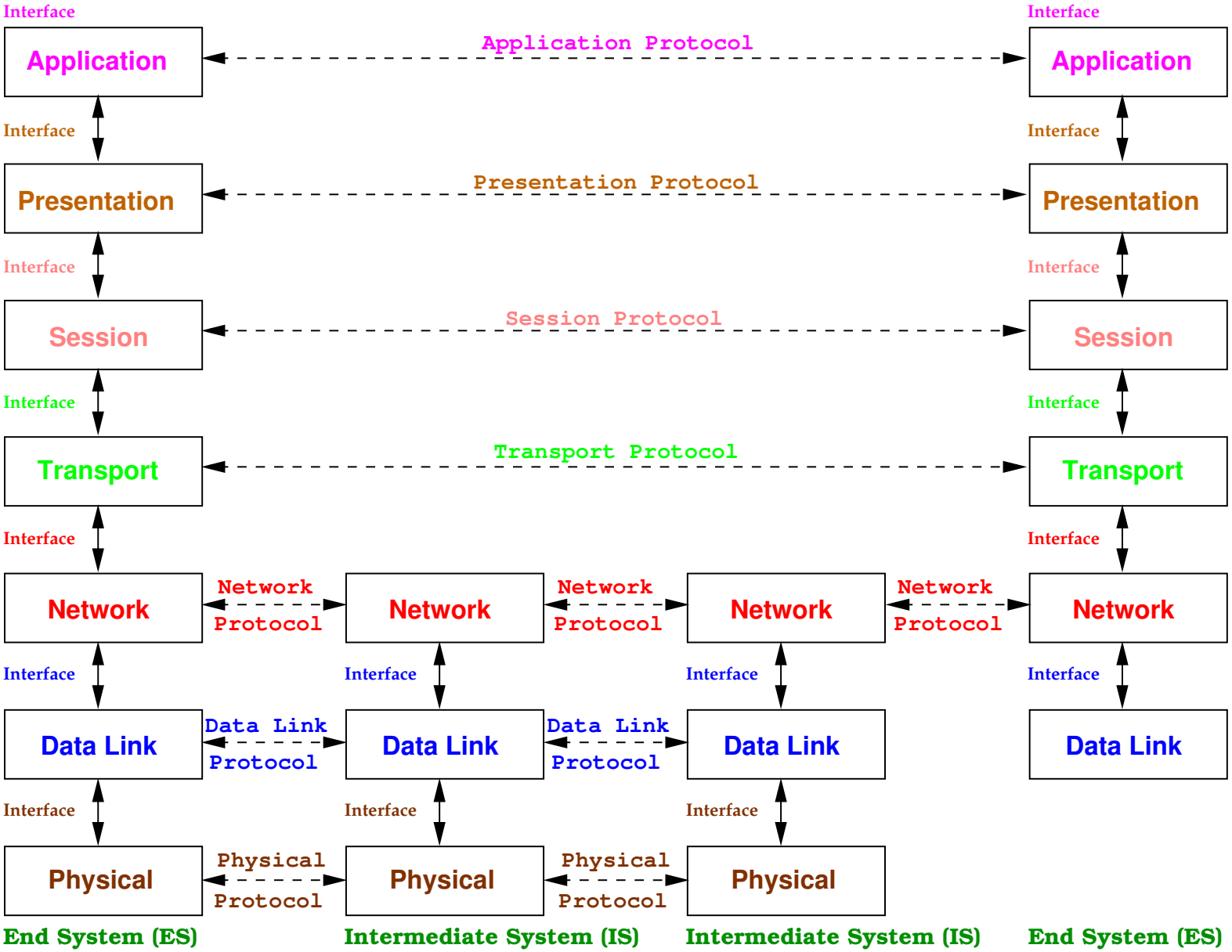

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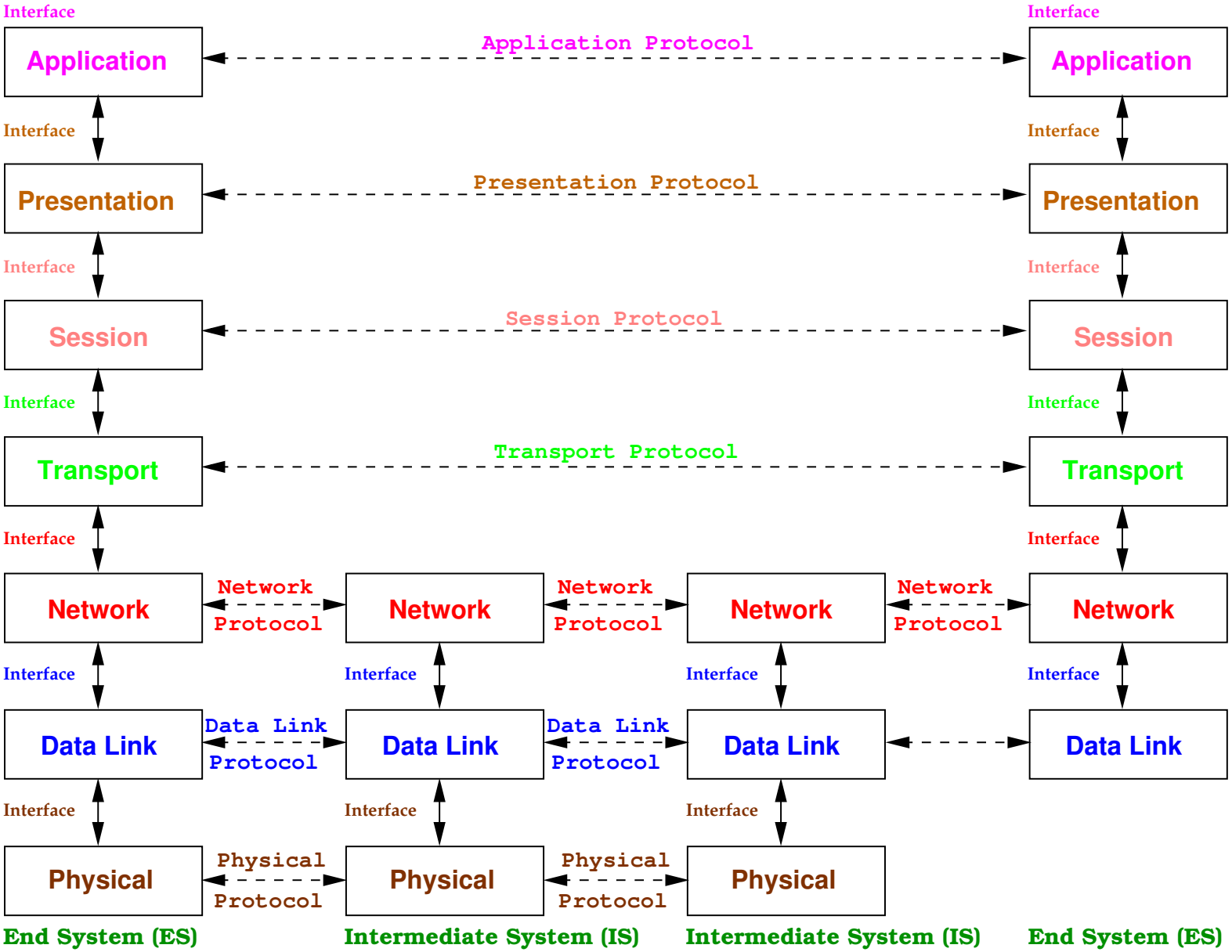

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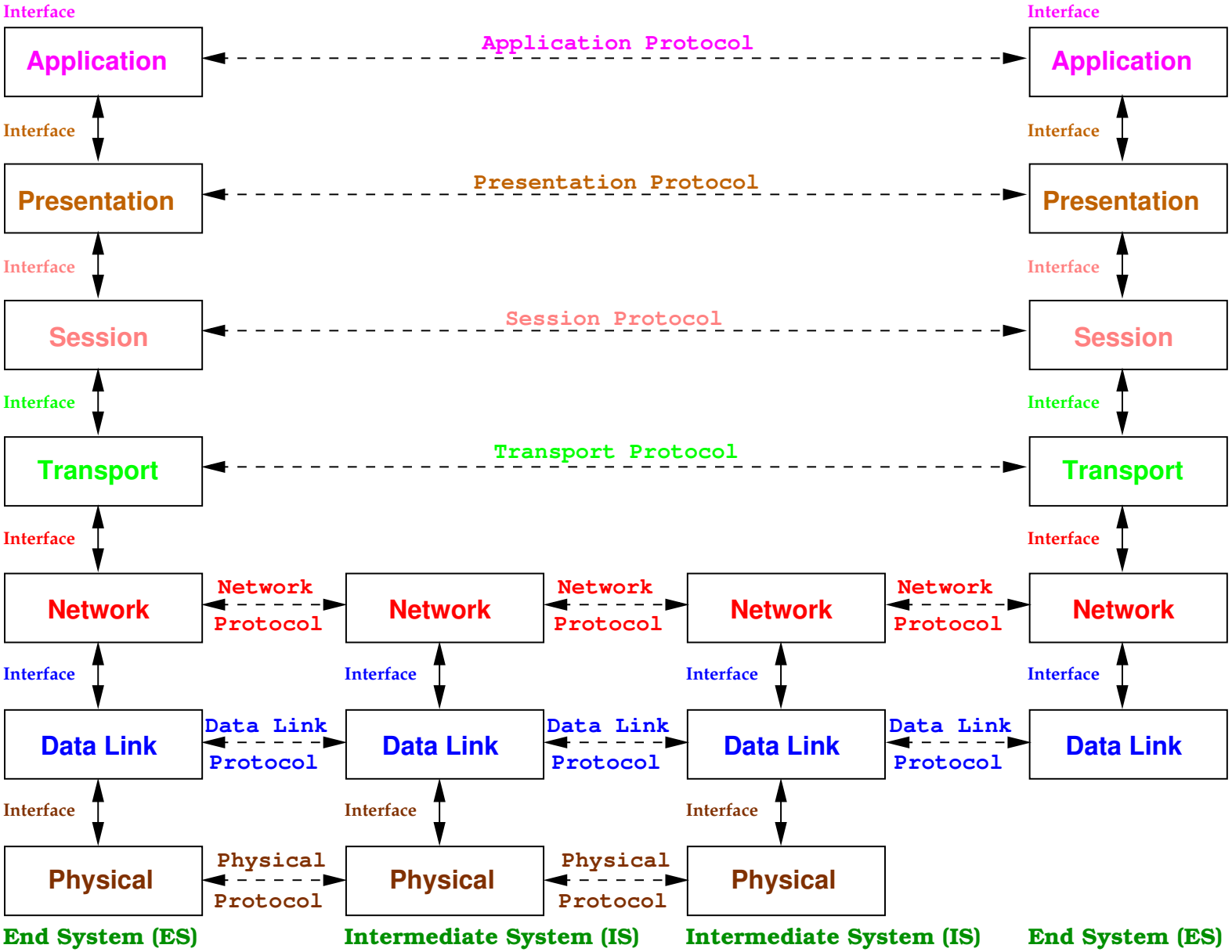

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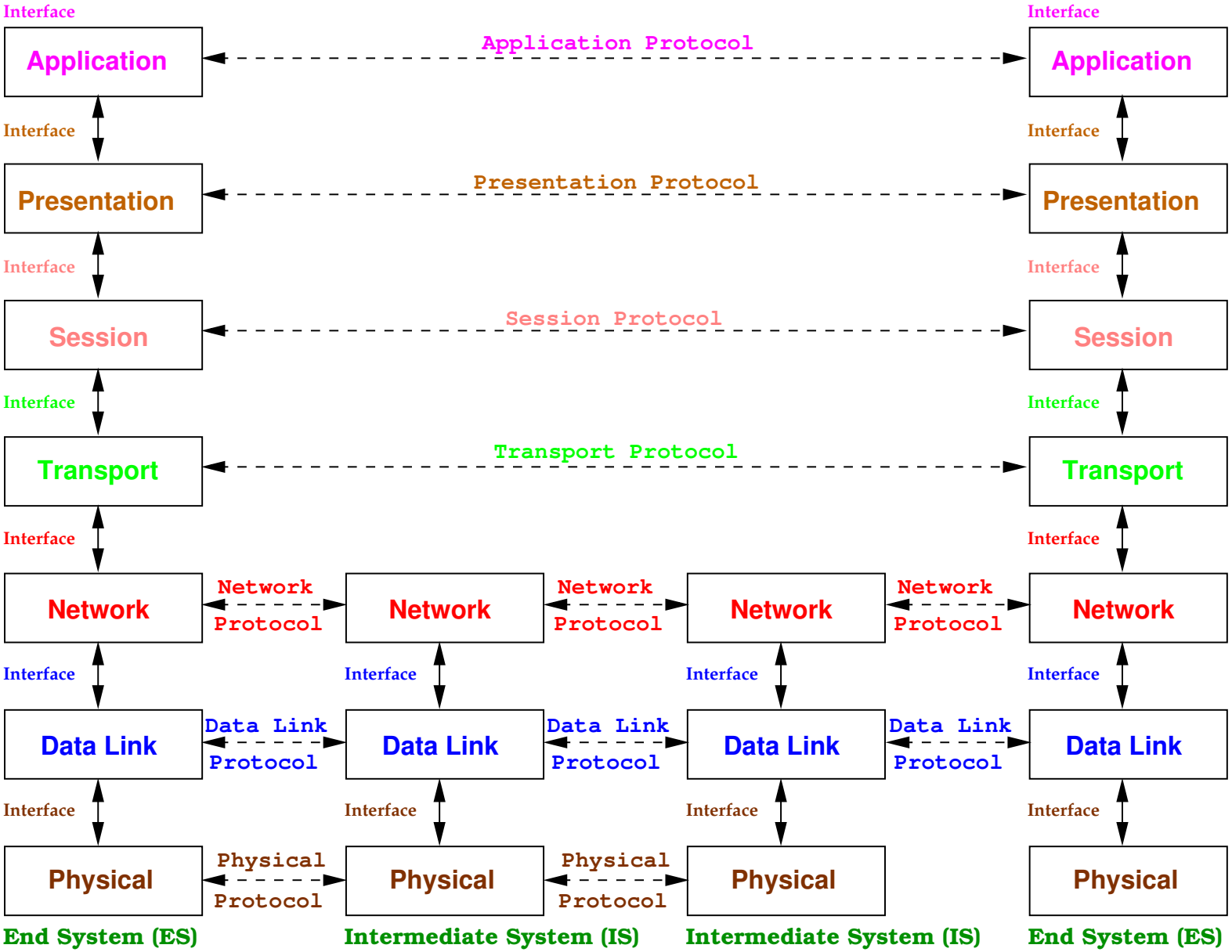

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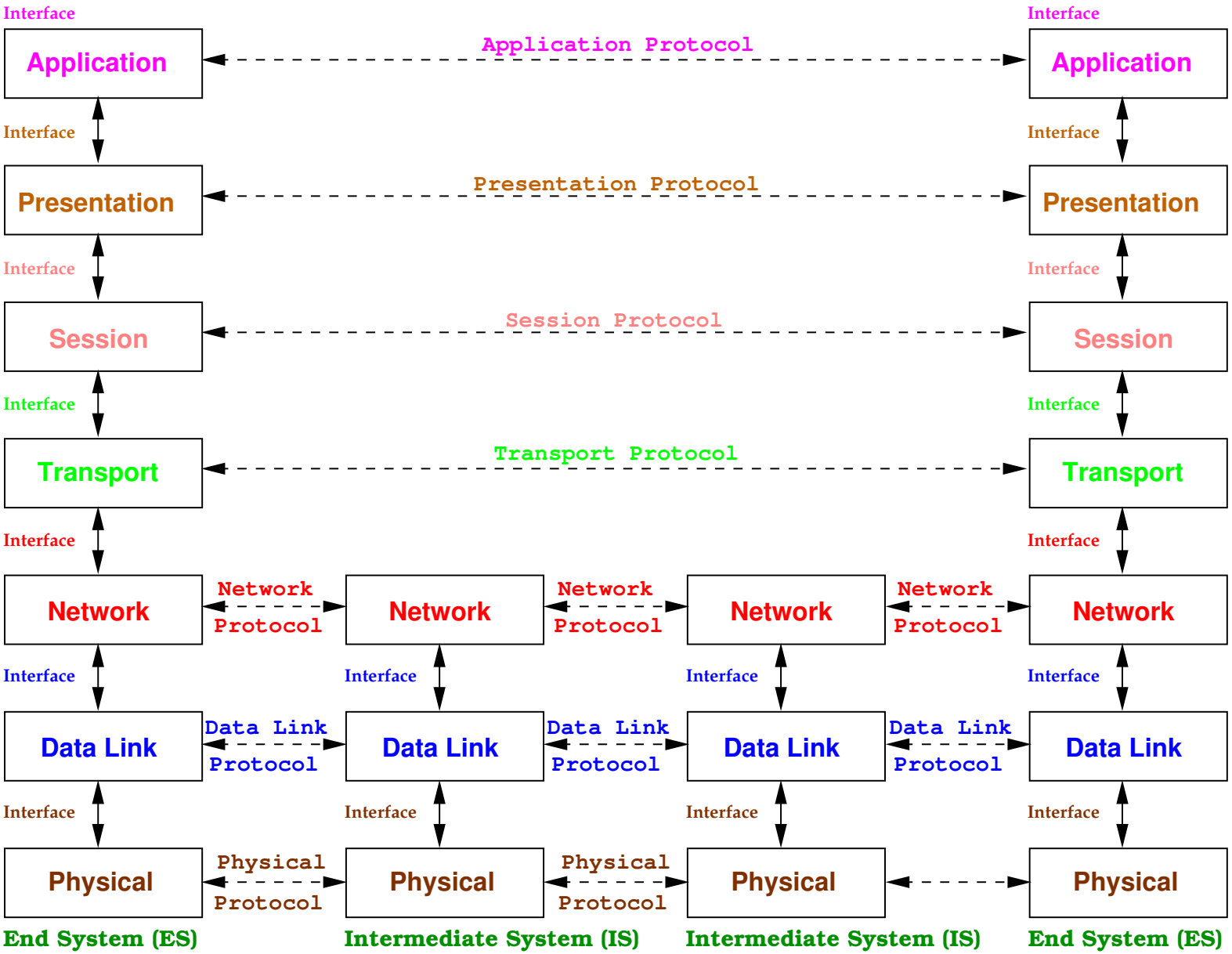

# Architecture