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# Protocol Layers

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# Protocol “layers” and reference models

Networks are complex,  
with many “pieces”:

- hosts
- routers
- links of various media
- applications
- protocols
- hardware, software

*Question:* is there any  
hope of *organizing*  
structure of network?

- and/or our *discussion*  
of networks?

# Example: organization of air travel



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————— *end-to-end transfer of person plus baggage* —————→

ticket (purchase)

baggage (check)

gates (load)

runway takeoff

airplane routing

ticket (complain)

baggage (claim)

gates (unload)

runway landing

airplane routing

airplane routing

How would you *define/discuss* the *system* of airline travel?

- a series of steps, involving many services



# Example: organization of air travel



*layers:* each layer implements a service

- via its own internal-layer actions
- relying on services provided by layer below



# Why layering?

## Approach to designing/discussing complex systems:

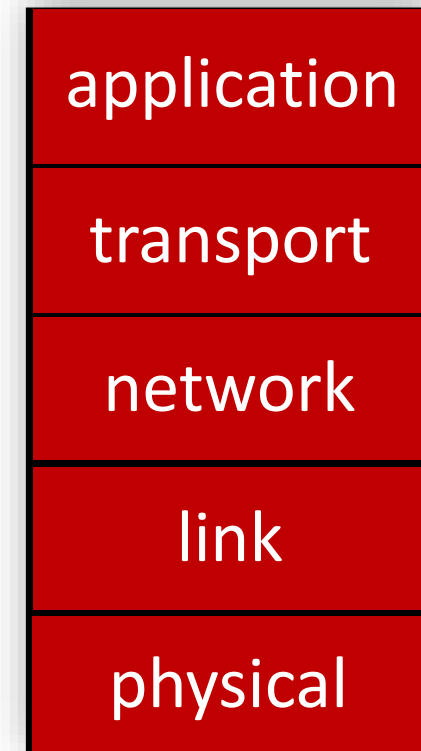
- explicit structure allows identification, relationship of system's pieces
  - layered *reference model* for discussion
- modularization eases maintenance, updating of system
  - change in layer's service *implementation*: transparent to rest of system
  - e.g., change in gate procedure doesn't affect rest of system

# Layered Internet protocol stack



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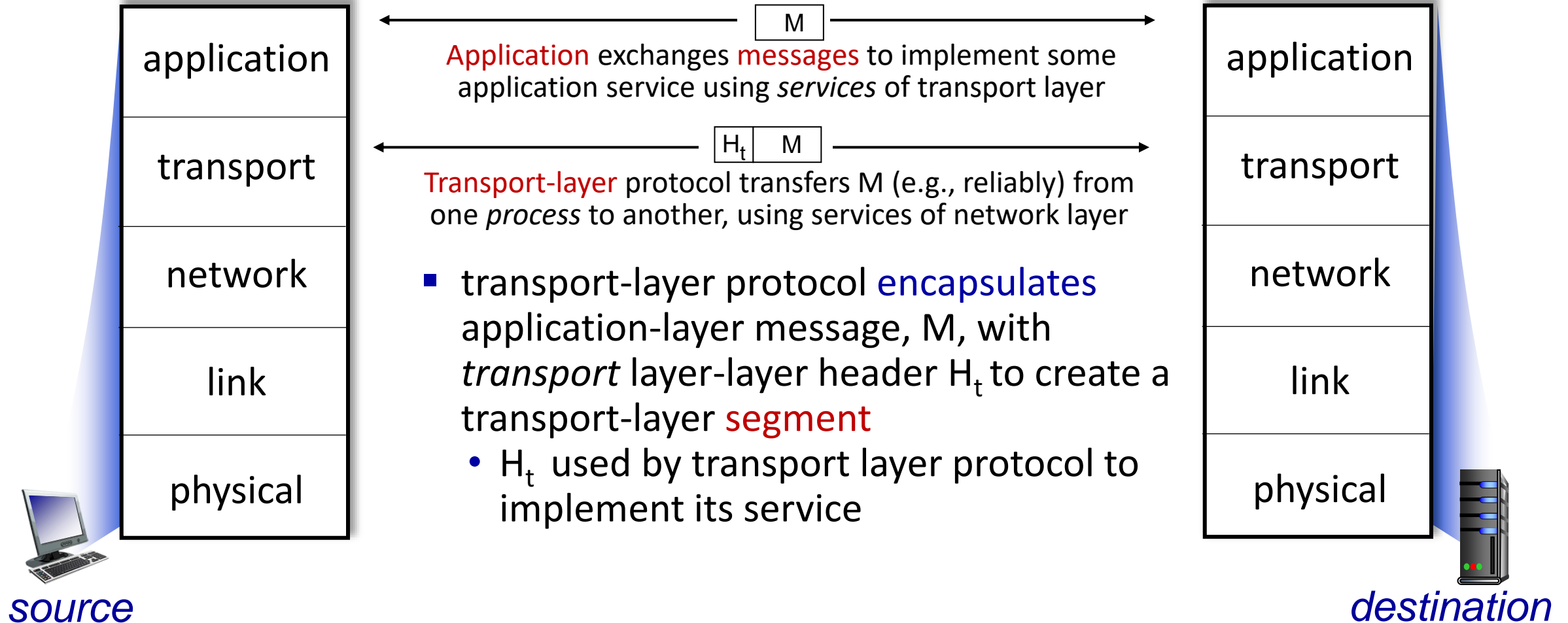
- *application*: supporting network applications
  - HTTP, IMAP, SMTP, DNS
- *transport*: process-process data transfer
  - TCP, UDP
- *network*: routing of datagrams from source to destination
  - IP, routing protocols
- *link*: data transfer between neighboring network elements
  - Ethernet, 802.11 (WiFi), PPP
- *physical*: bits “on the wire”



# Services, Layering and Encapsulation



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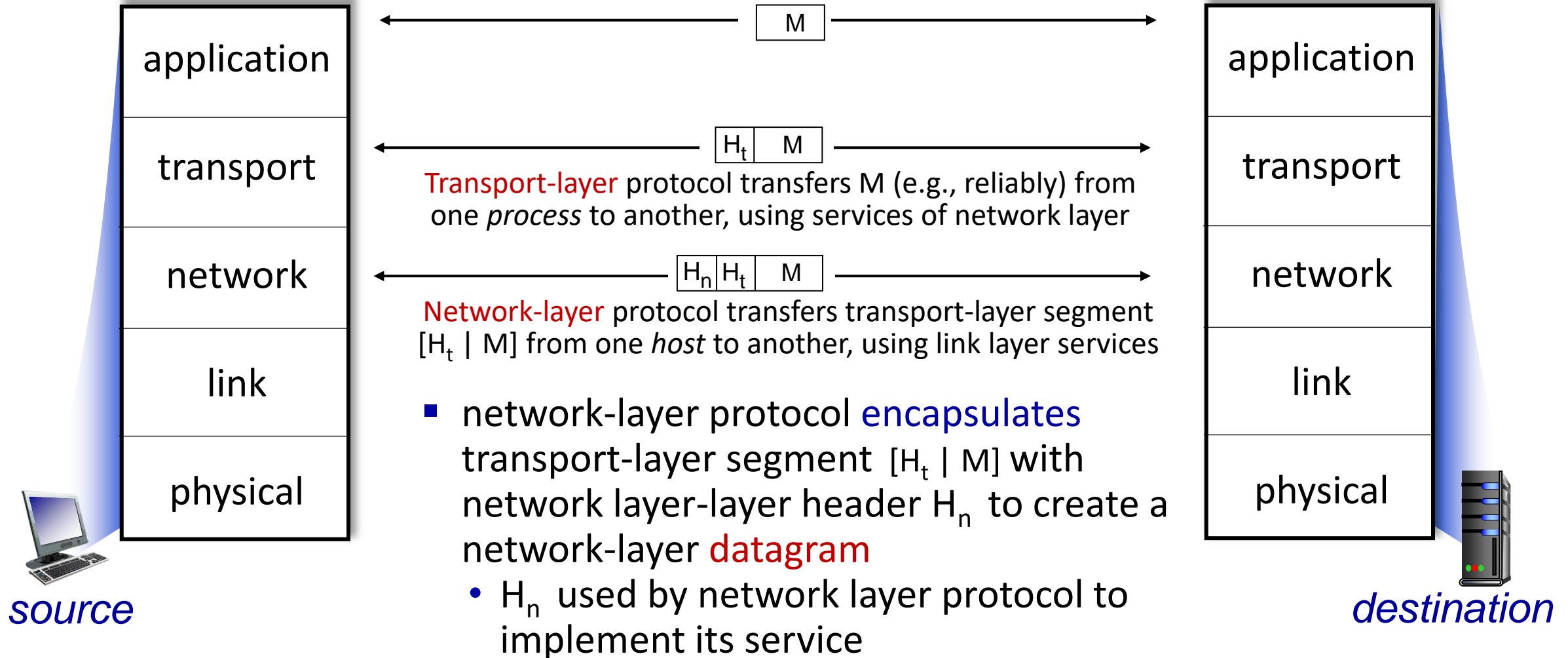




# Services, Layering and Encapsulation



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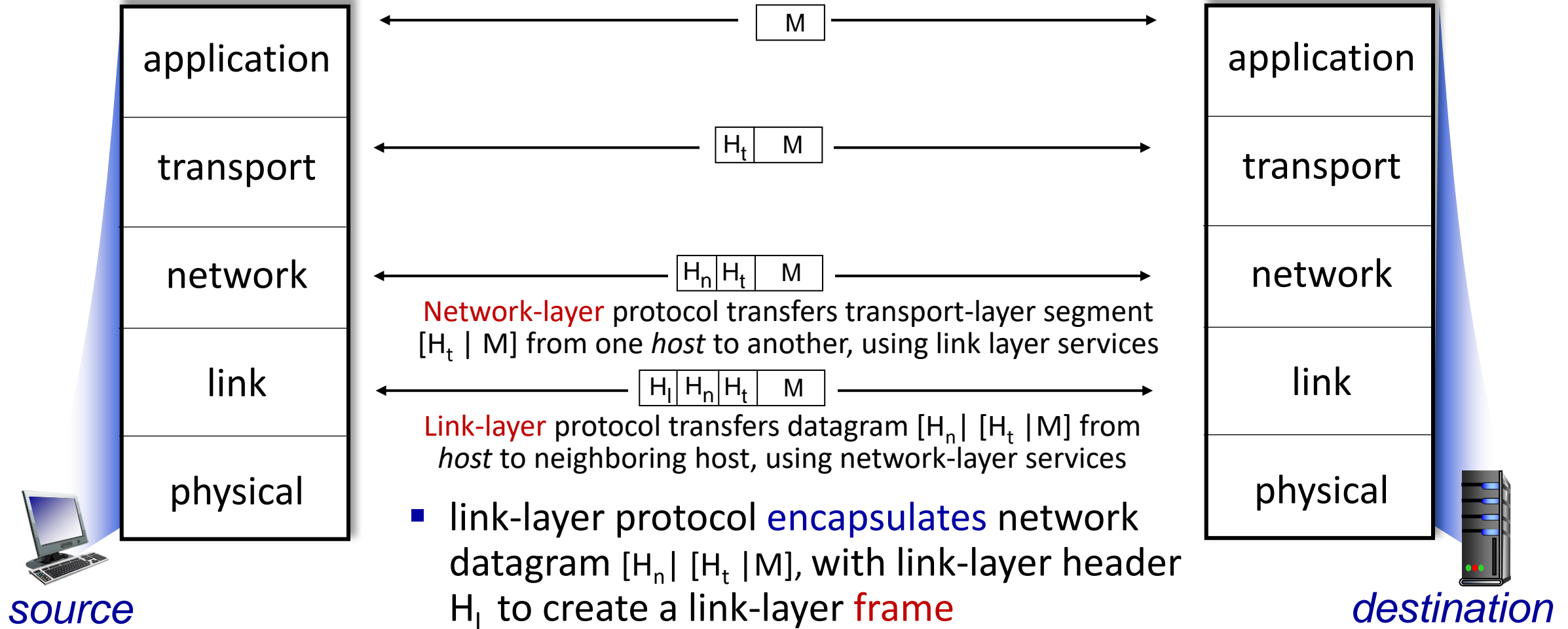




# Services, Layering and Encapsulation

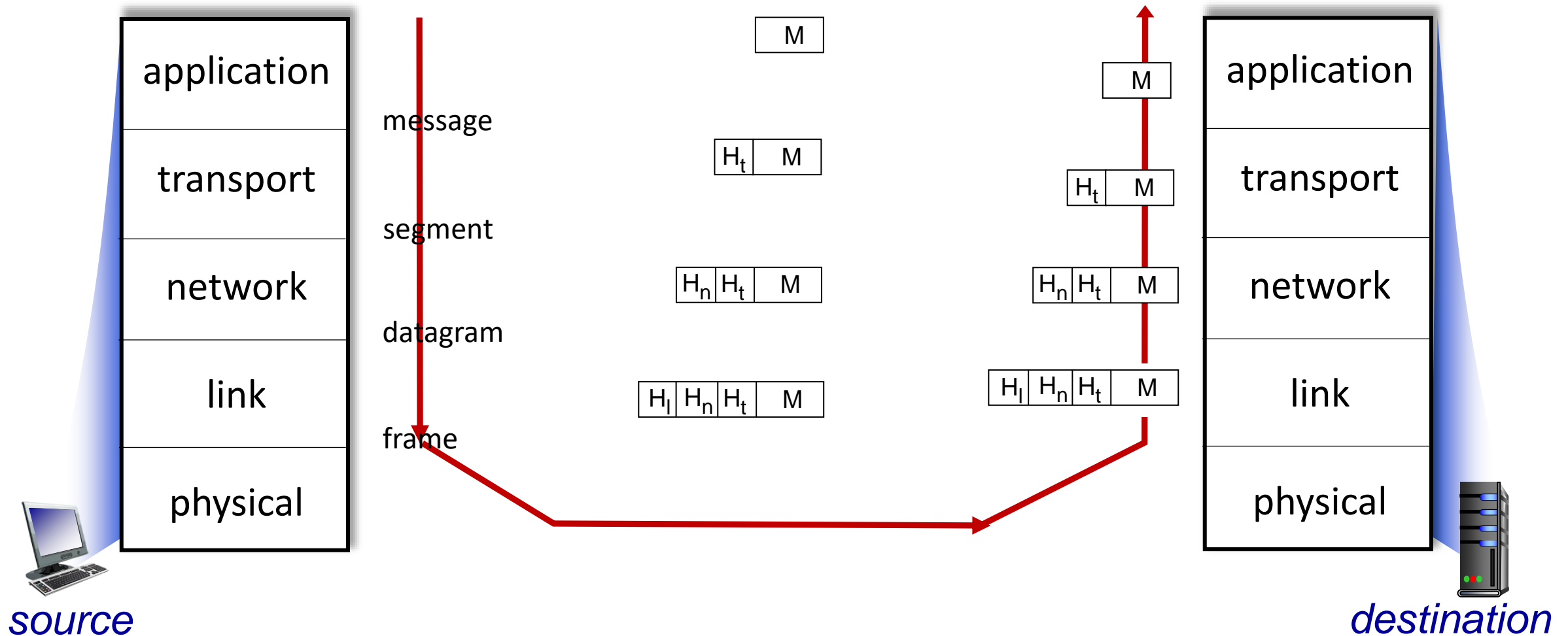


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# Services, Layering and Encapsulation





# Encapsulation: an end-end view

