

CS 725/825

Computer Networks

IT 725

Network Technology

Fall 2023

CS 725/825 & IT 725

Lecture 23

Network and Link Layers

November 29, 2023

SDN

► Software Defined Networks

► Motivation:

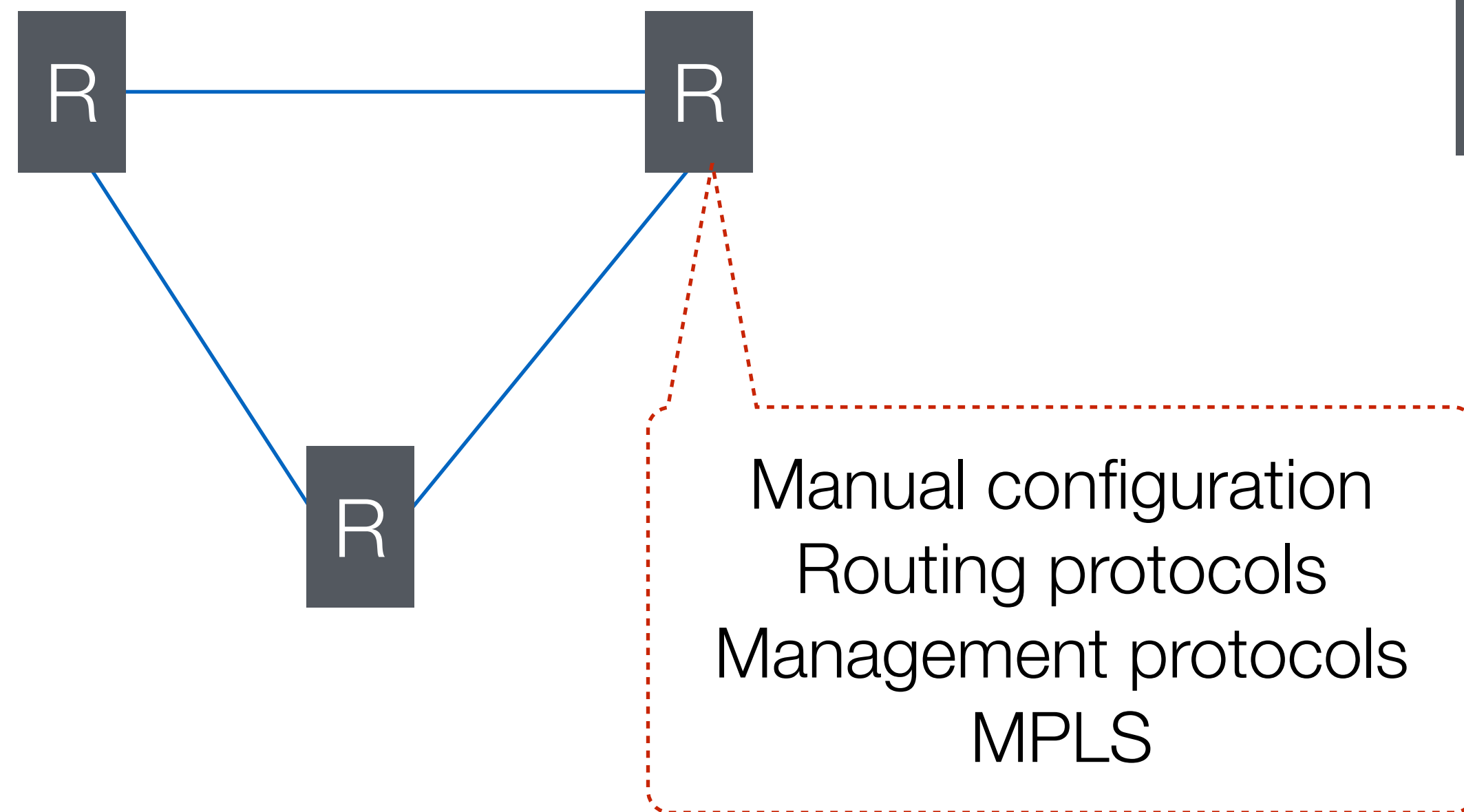
- many protocols, vendors, management platforms
- virtualization, cloud, ... (fill the buzzword of a day)
- scale up in size and bandwidth

► Goals:

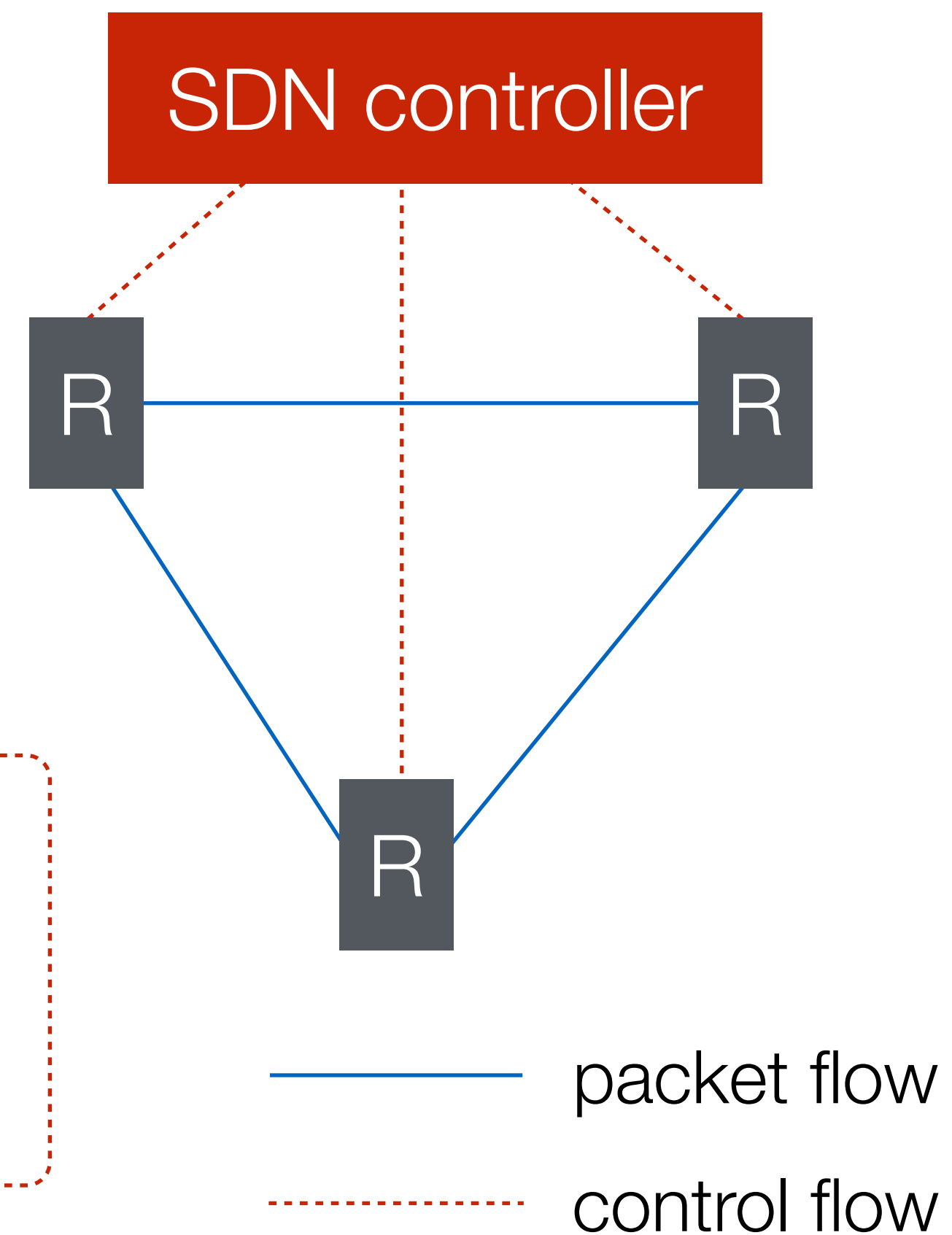
- flexibility, agility, ...
- central management, programmatically configured (API)
- open and vendor-independent

SDN

Traditional approach

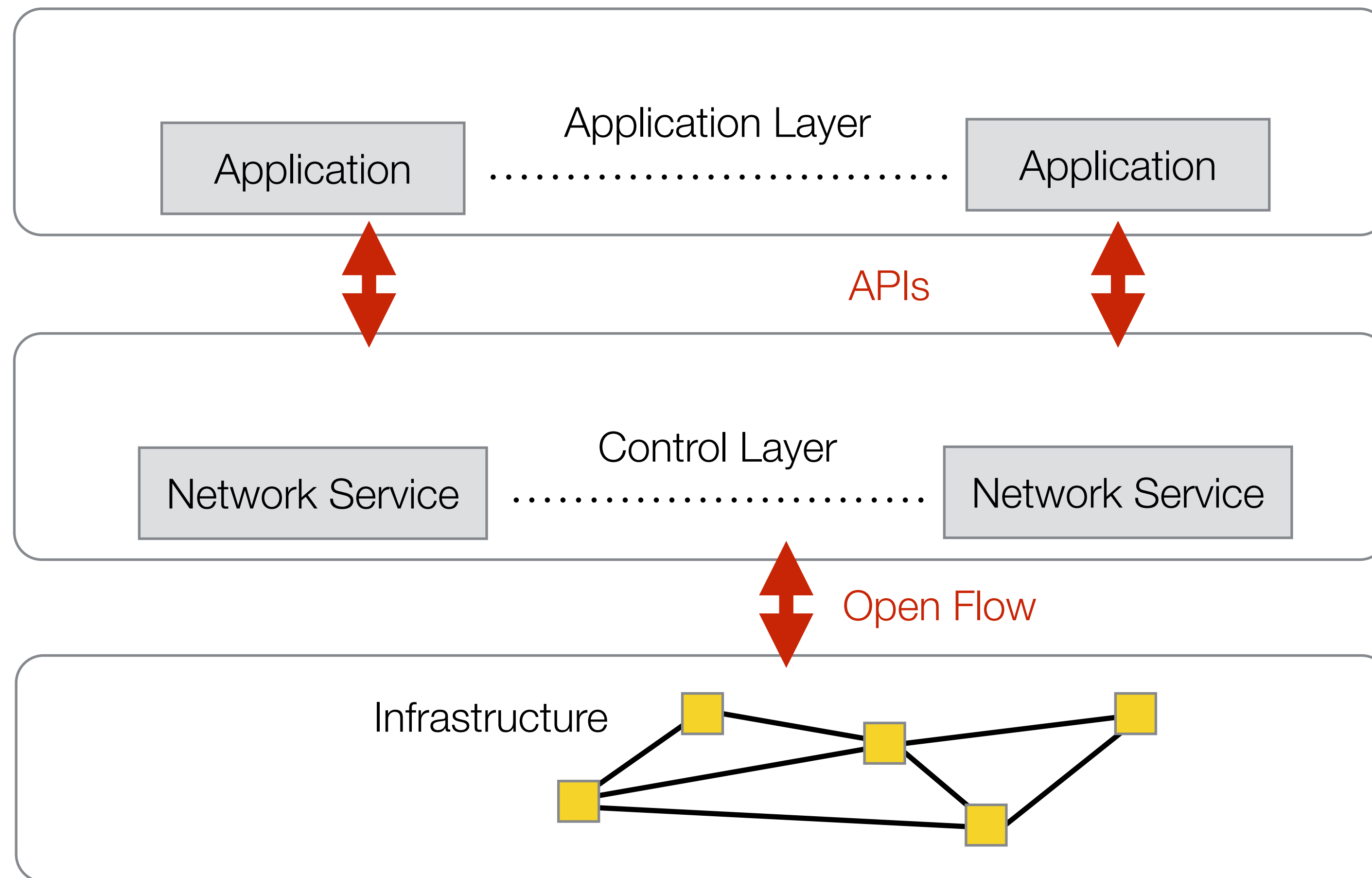


Software Defined Networks (SDN)



SDN Architecture

► Grossly simplified:



Link Layer

Channel Capacity

- Shannon's (noisy-channel coding) Theorem:

$$C = B \cdot \log_2 \left(1 + \frac{S}{N} \right)$$

C - channel capacity

B - channel bandwidth

S/N - signal to noise ratio

Multiplexing

... allowing multiple simultaneous transmissions

- ▶ “Space multiplexing”
- ▶ Time Division Multiplexing (TDM)
- ▶ Frequency/Wavelength Multiplexing (WDM)
- ▶ Code Division Multiplexed Access (CDMA)

Components of Link Layer

► Data Link Control

- addressing
- framing
- error detection and correction
- flow control
- QoS

► Media Access Control (MAC)

- controlling access to the shared medium

Media Access Control

- ▶ **Objective**: Arbitration of access to the shared medium - prevention or avoidance of collisions.
- ▶ **Deterministic** - collisions are prevented
 - centralized
 - distributed
- ▶ **Stochastic** - some collisions are permissible - as long as they are detected and transmissions retried

Stochastic (random) MAC

ALOHA

- ▶ Transmit at will...
- ▶ Detect collisions with transmissions of other nodes
- ▶ Random back-off if collision is detected

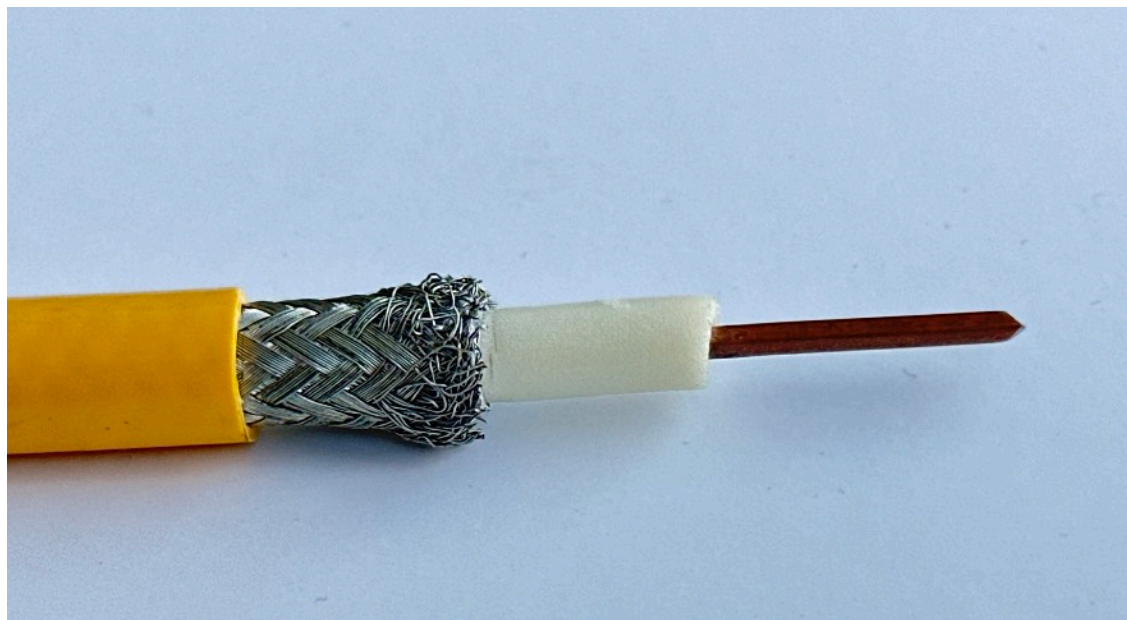
ALOHA Improvements

- ▶ Listen before you talk:
 - Carrier Sense Multiple Access (CSMA)
 - What to do after someone else's transmission is over (Persistency)
- ▶ Stop talking when you detect a collision:
 - Collision Detect (CD)
- ▶ Result: 1-persistent CSMA/CD (a.k.a. Ethernet)

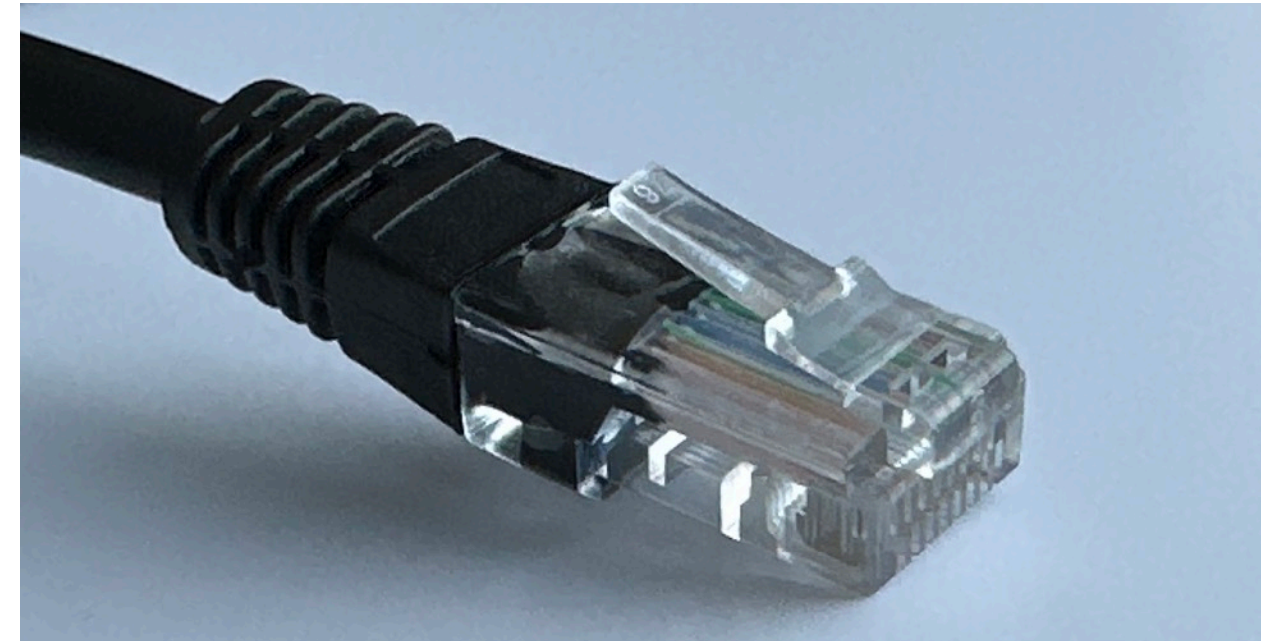
Ethernet Evolution

- ▶ Constant: frame format, 1-persistent CSMA/CD
- ▶ Medium
 - *(historical)* coaxial cable (thick and thin Ethernet)
 - twisted pair, fiber
- ▶ Rate
 - *(historical)* 10M, 100M; currently: 1G, 10G, 40G, 100G, ...
- ▶ Connectivity
 - *(historical)* broadcast and select medium (L1), hub (L1)
 - bridge/switch (L2)

Ethernet



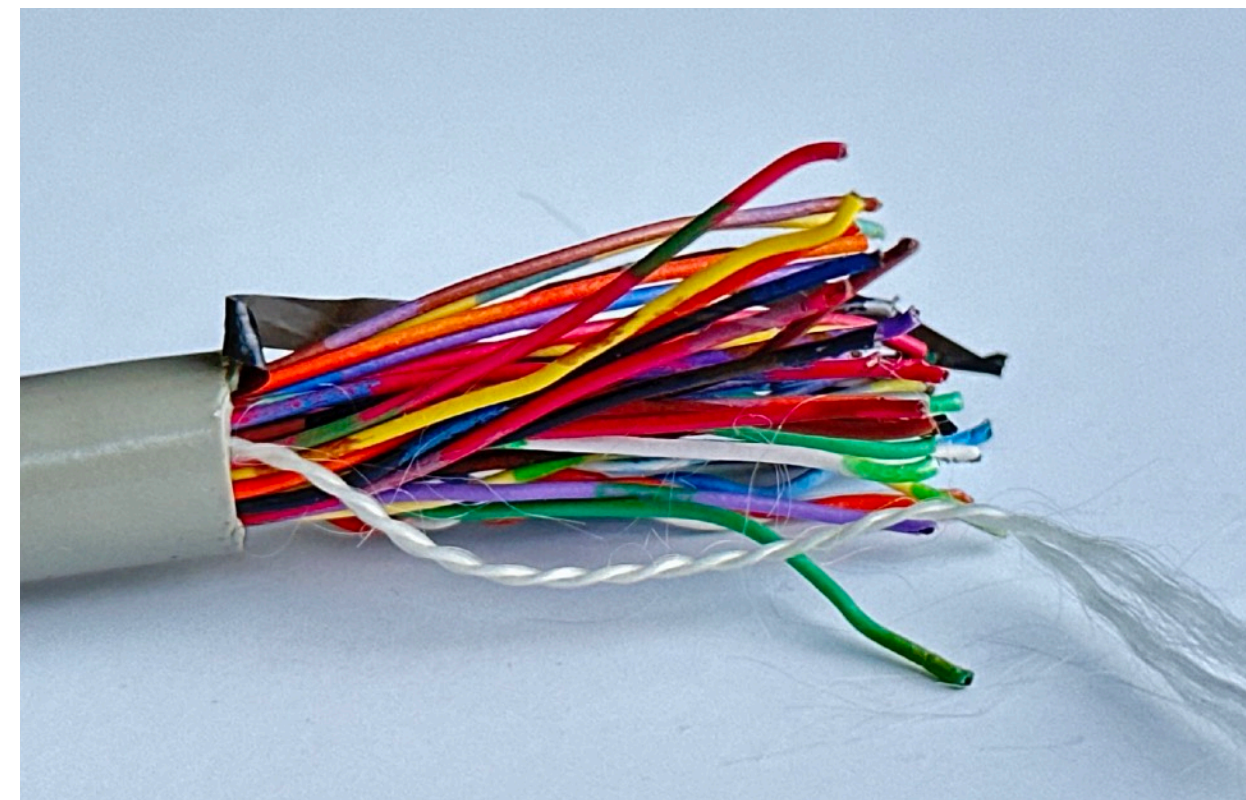
10BASE5 Ethernet



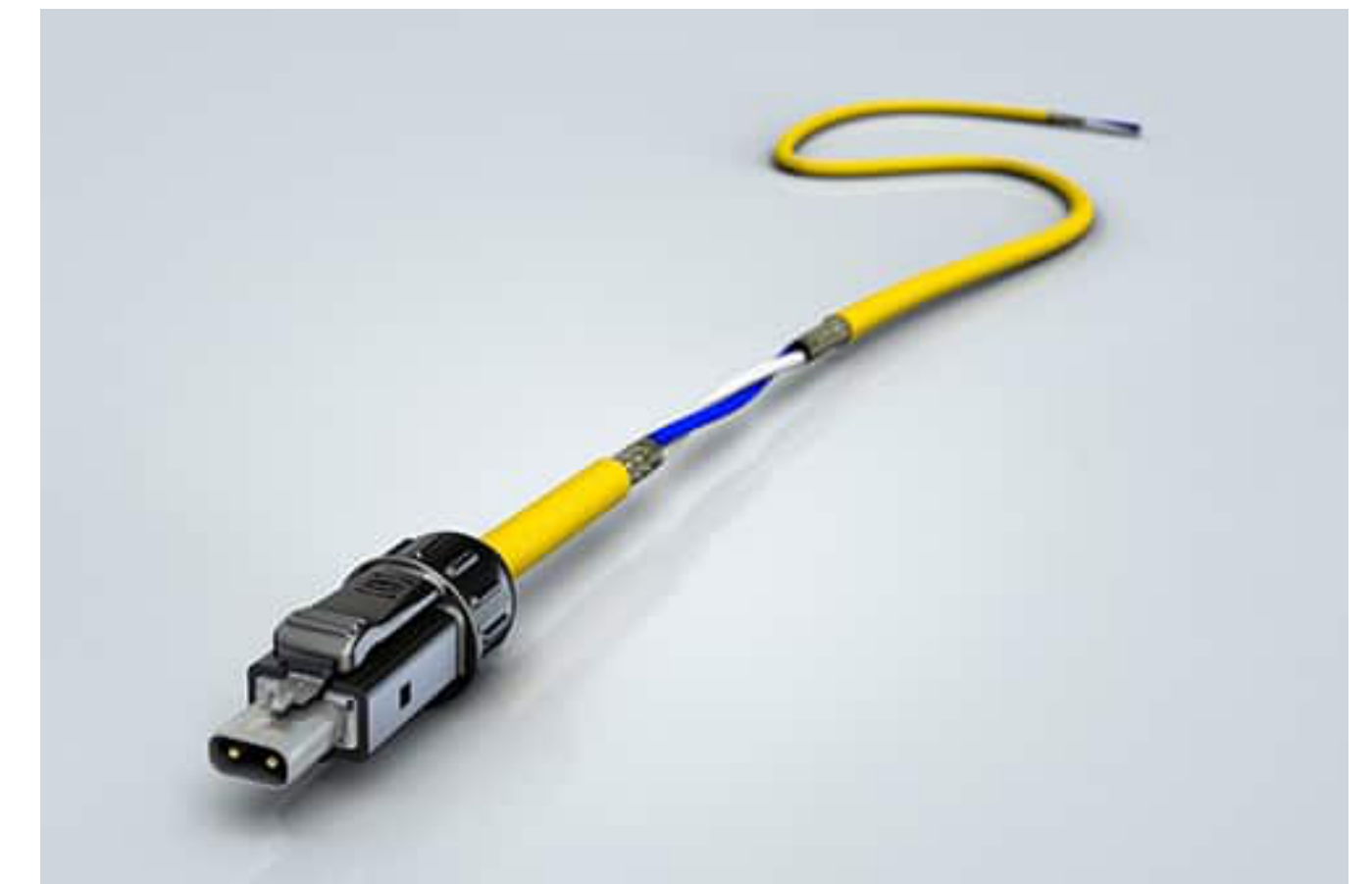
Twisted Pair Ethernet connector



10BASE2 Ethernet connector



25 twisted pairs cable



Single Pair Ethernet
(image source: HARTING)