802.11 Station Bridges

A path to standardization of 802.11 non-AP stations that are bridge ports

Rev. 1

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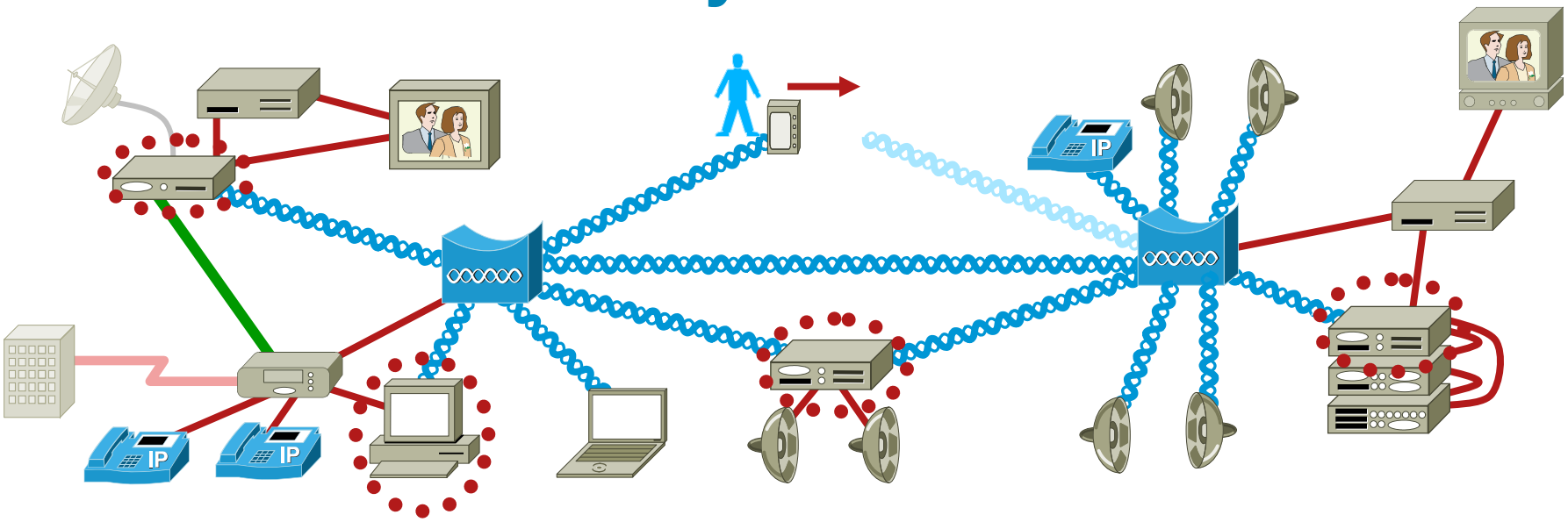
References

- This presentation is available at: http://www.ieee802.org/1/files/public/docs2009/new-nfinn-station-bridge-0309-v01.ppt
- It is mostly a shortened version of: http://www.ieee802.org/1/files/public/docs2008/avb-nfinn-802-11-bridging-0308-v3.pdf
- For a more complete description of the station bridge problem and possible solutions, see: http://www.ieee802.org/1/files/public/docs2007/avb-nfinn-wireless-bridges-0707-v2.pdf
  or: http://www.ieee802.org/1/files/public/docs2008/avb-nfinn-802-11-bridging-0308-v2.pdf

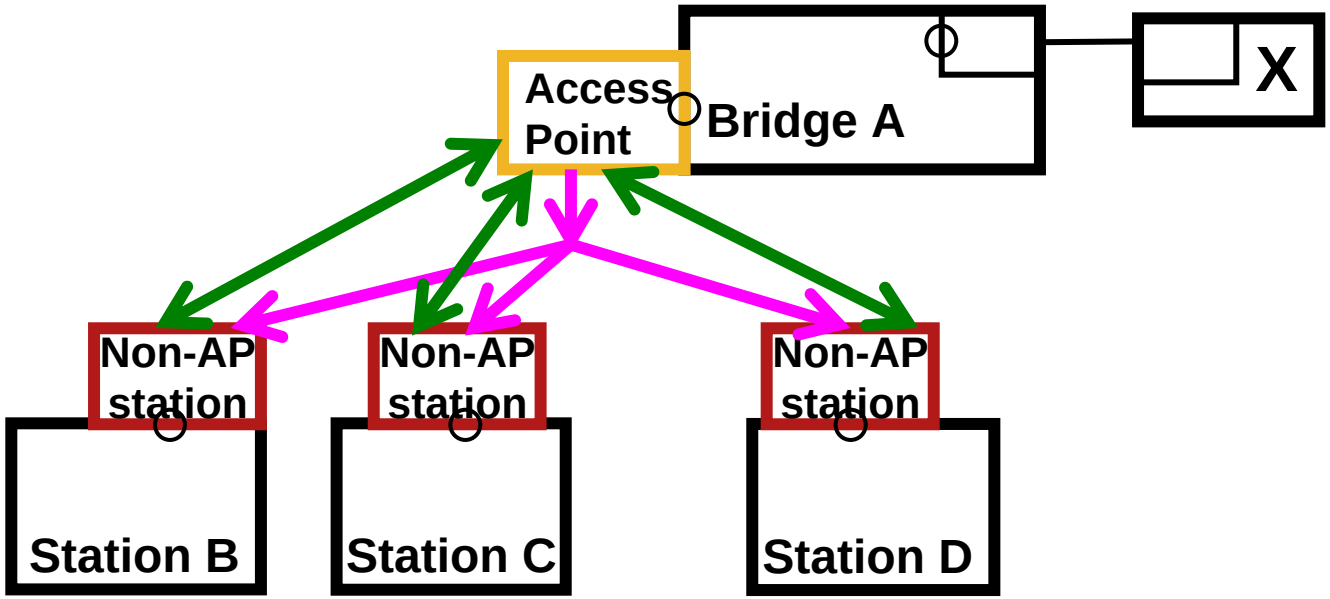
Executive summary



- In a home or small studio, there may be many Ethernet-like links: 802.3, 802.11, MoCA, Ether/DSL, etc.
- Loop-free connectivity is assured if every device with multiple links is an 802.1 bridge (M/RSTP or 802.1aq).
- IEEE 802 standards do not support a "station bridge": an 802.1 bridge with a non-AP station as one of its ports.

Problem statement

Stations and Access Points



- An 802.11 BSS has **Access Point** (AP) stations and **non-AP stations**.
- The non-AP stations have **point-to-point** connectivity with the Access Point.
- There is also an AP-to-non-AP **point-to-multipoint** path.

Four addresses

- IEEE Std. 802.11 provides **four addresses** for every frame:

  Receiver: The AP or station to which the frame is immediately directed.

  Transmitter: The AP or station transmitting the frame.

  Destination: The “ultimate” MAC destination (the MAC address in the IP ARP table).

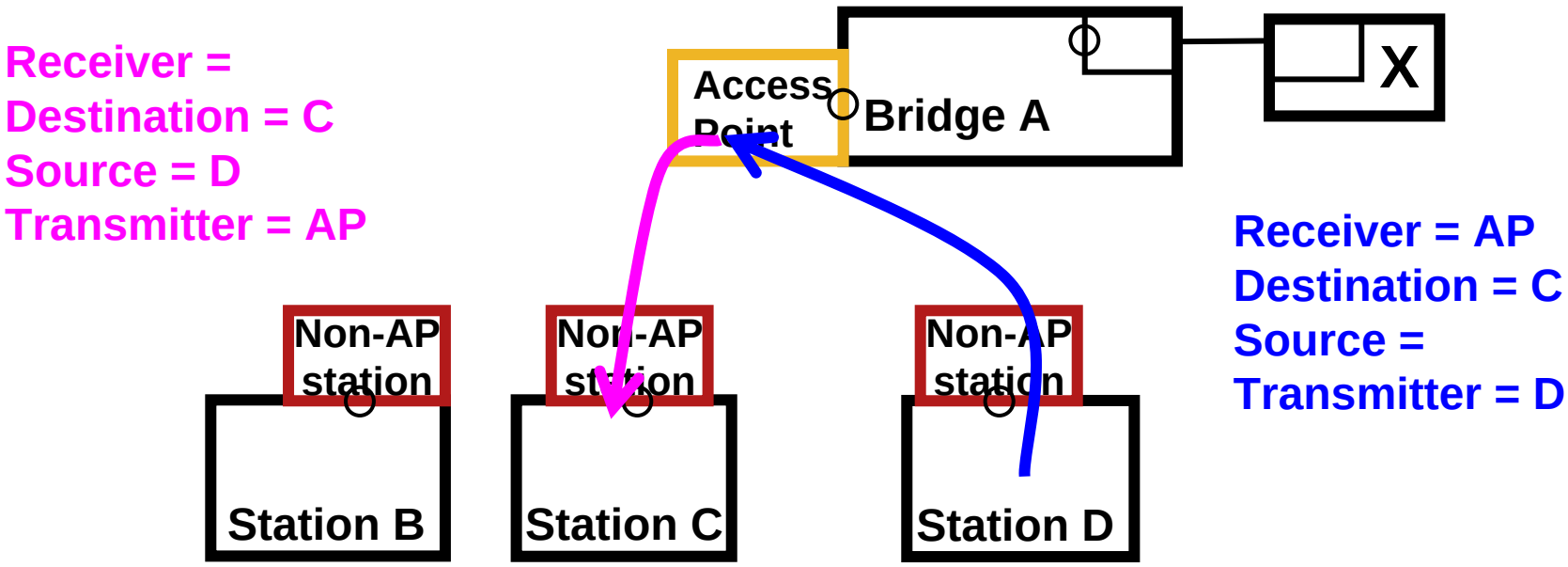
  Source: The “ultimate” MAC source.

- 802.11 defines **frame formats** for carrying 3 or 4 of these addresses.

  2 addresses double up in one field in the 3 address format.

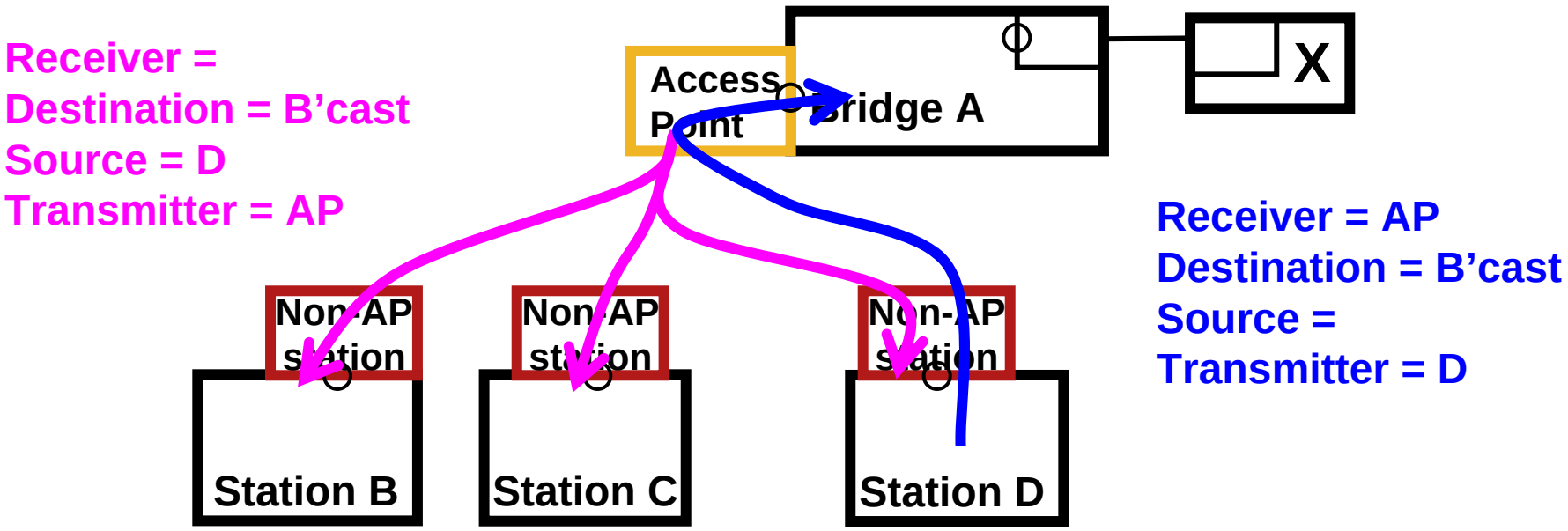
  No use of the 4 address format is defined.

Stations and Access Points



- Station **D** sends a **unicast** to Station **C**.
- Access point relays knows Station **C** is attached, so relays it **back to the wireless medium**, **not** to Bridge A.
- Four addresses, but only three address fields, so two addresses double up in each direction.

Stations and Access Points

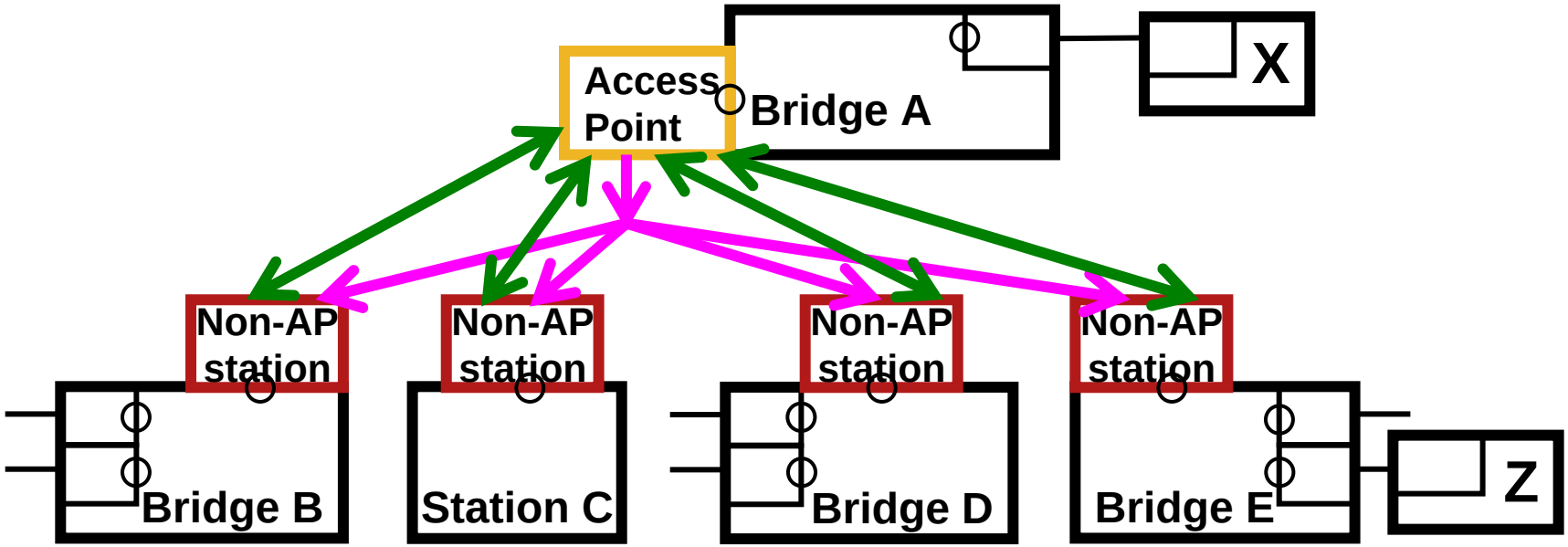


- Station D sends a **broadcast**.
- Access point relays that to Bridge A and **back to the wireless medium**.
- Four addresses, but only three address fields, so two addresses double up in each direction.

What do we mean by, "A station bridge is not supported"?

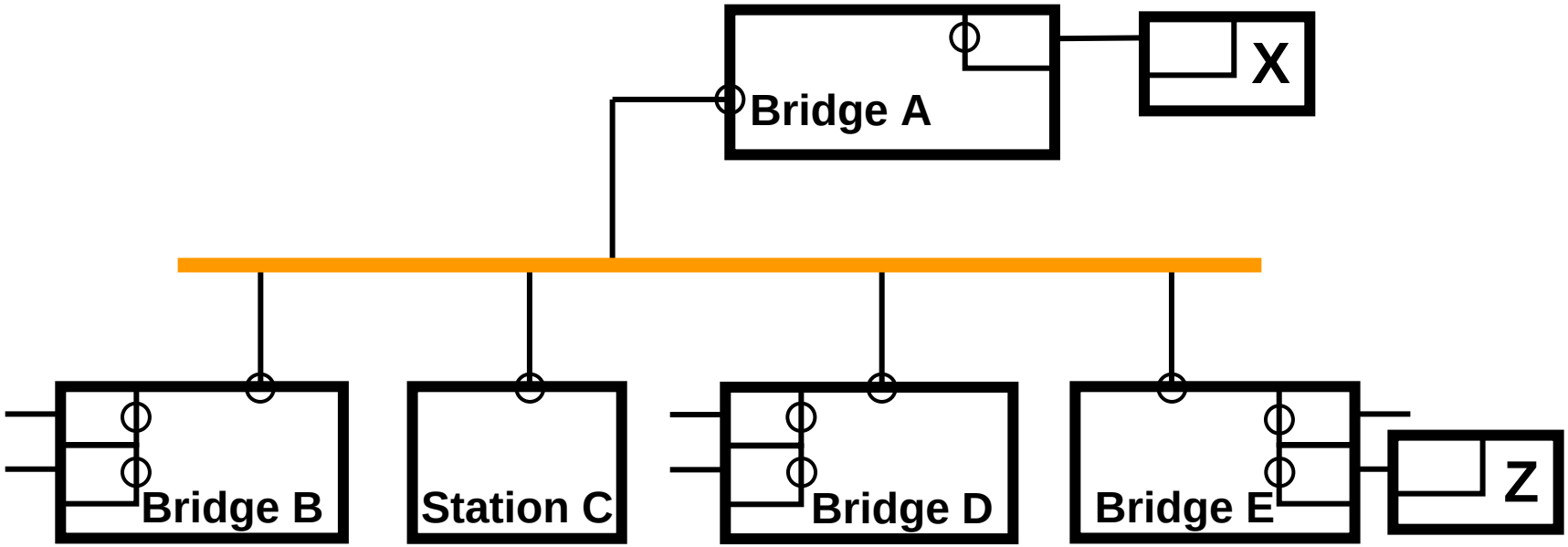
- IEEE Std. 802 leaves it up to each medium whether frames transmitted on that medium are reflected back and received at the source.
- IEEE Std. 802.1D and 802.1Q make it clear that a bridge does not work on any medium that reflects frames back to the source.
- An IEEE 802.11 wireless access point reflects frames (with a time delay!) back to the source non-AP station.
- On this reflecting medium, a station bridge cannot distinguish between frames it should discard as reflections, and frames from which it should learn.

Network with 802.11 wireless medium:



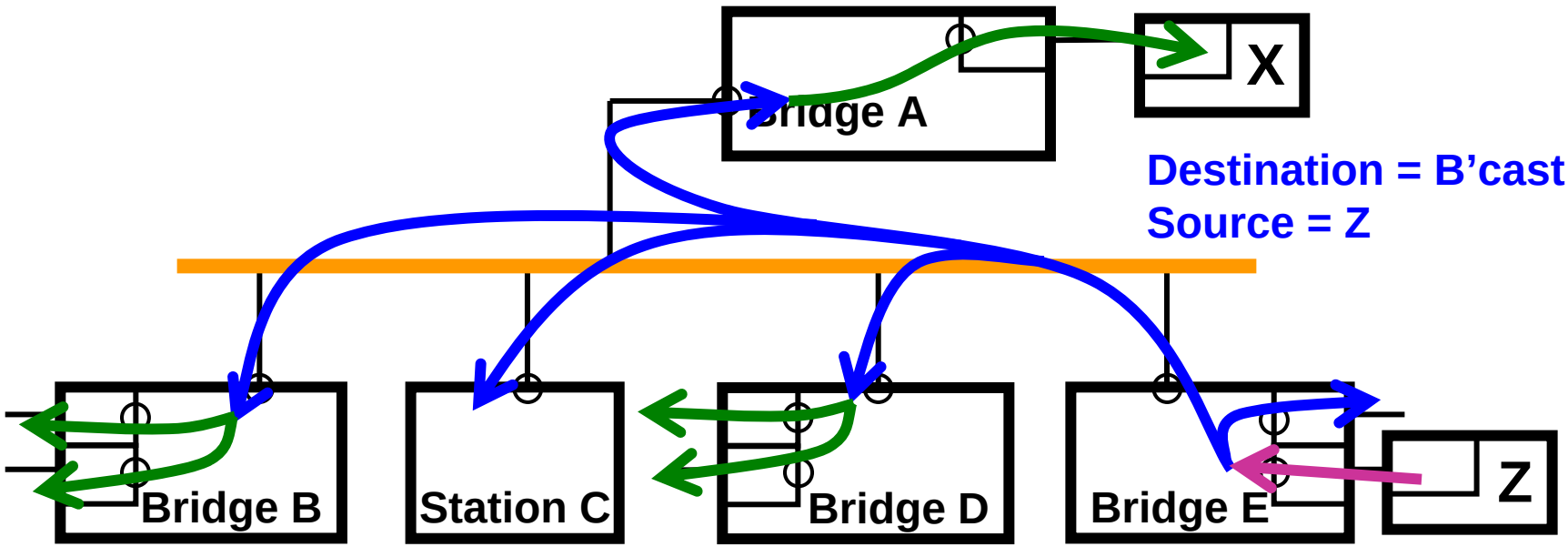
- An 802.11 BSS has **Access Point** (AP) stations and **non-AP stations**.
- The non-AP stations have **point-to-point** connectivity with the Access Point.
- There is also an AP-to-non-AP **point-to-multipoint** path.

Looks to the stations and bridges like:



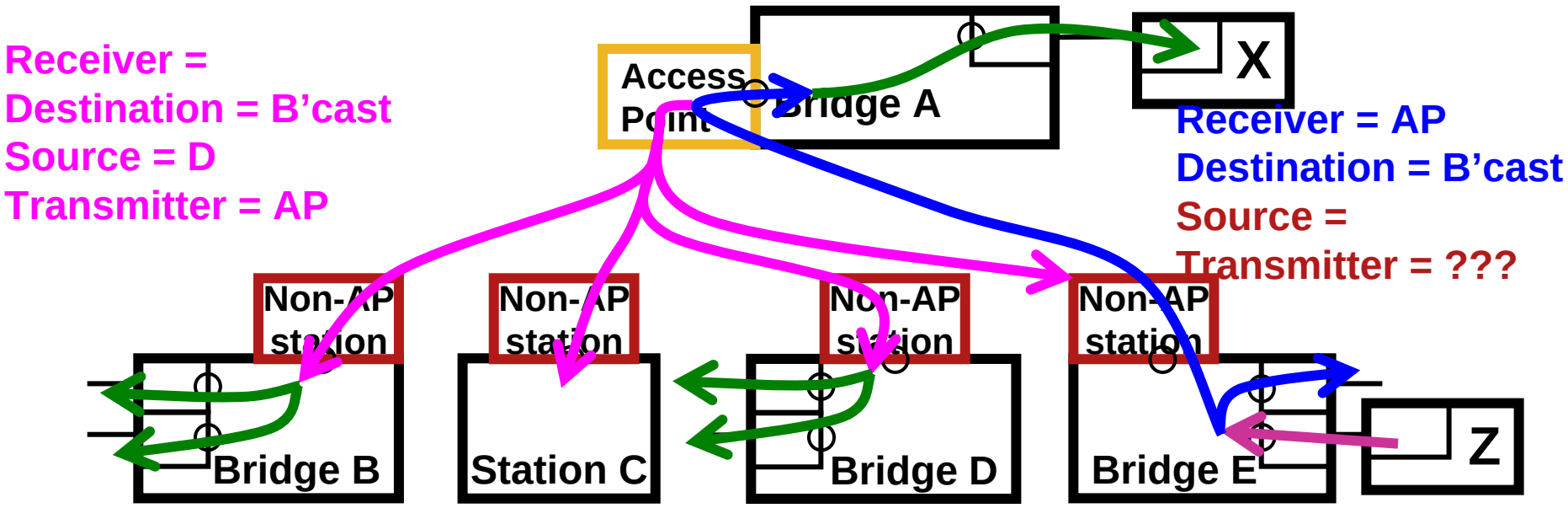
- If this arrangement looks, to the bridges, like an 802.3 10BASE5 **fat yellow coax** with taps. (mostly)

Broadcast from station Z



- Station Z sends a **broadcast**.
- Bridge E **relays** that broadcast to its two other ports.
- The Fat Yellow Coax **distributes** the broadcast, but does not reflect it back to Bridge E.
- The other bridges **relay** that broadcast further.

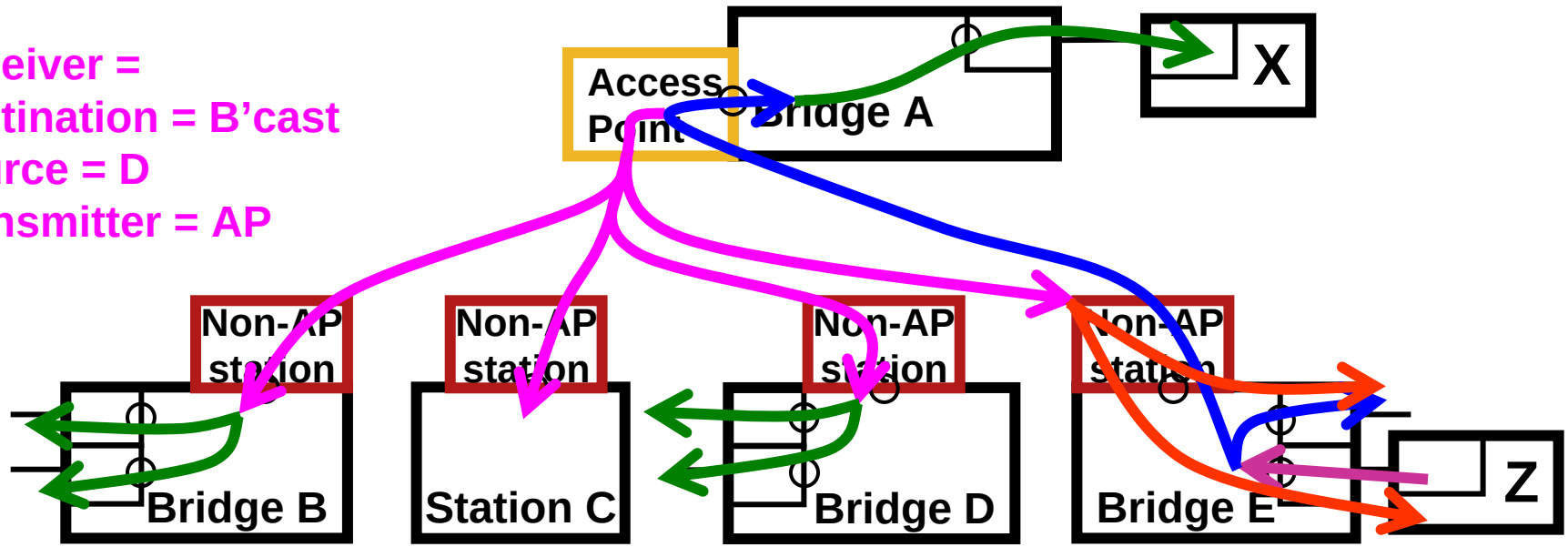
Broadcast with station bridges



- Station Z sends a **broadcast**. Bridge E **relays** that broadcast to its two other ports. (Or would, if it could.)
- The Access Point **distributes** the broadcast, and **does** reflect it back to Bridge E.
- The other bridges **relay** that broadcast further.

Broadcast with station bridges

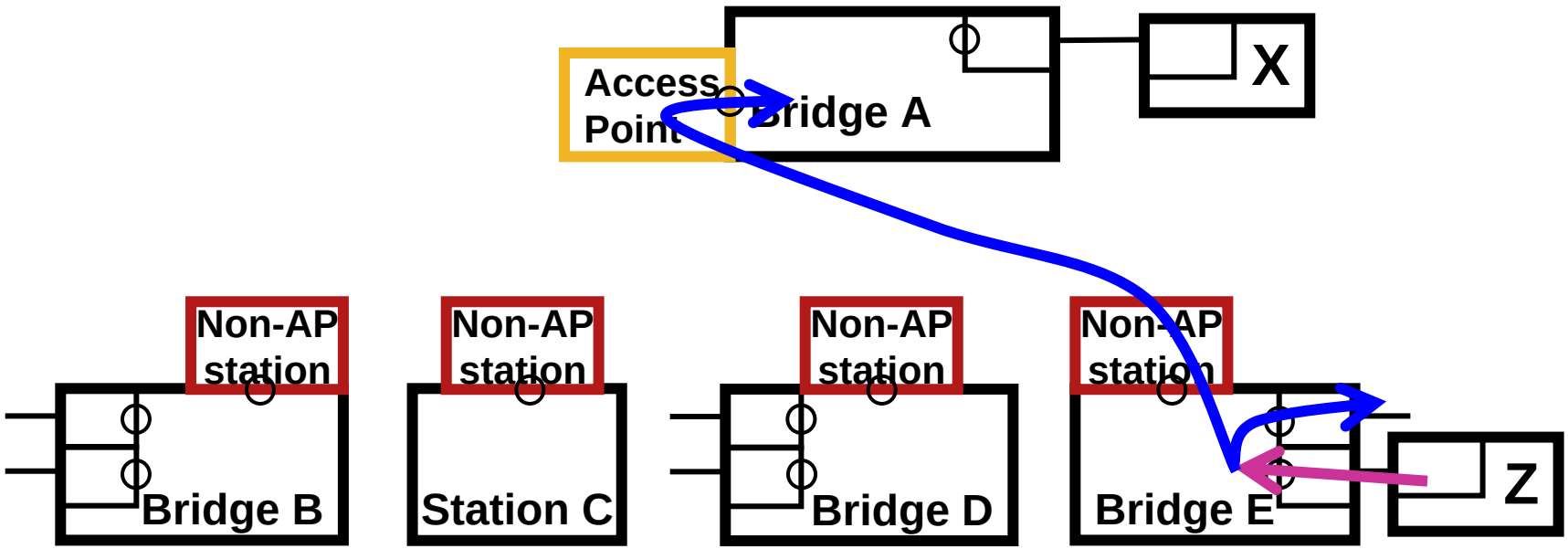
Receiver =
Destination = B'cast
Source = D
Transmitter = AP



- But **what keeps** Bridge E from **relaying** the reflected frame erroneously?
- Today: **Nothing**. That's why station bridges don't work.
- Tomorrow: The reflected frame contains a fourth address, a Receiver Address, that prevents the reflection.

Solution 1 – Four addresses

Four addresses



- On the way up, Bridge **E** needs all four addresses.

  Receiver = AP

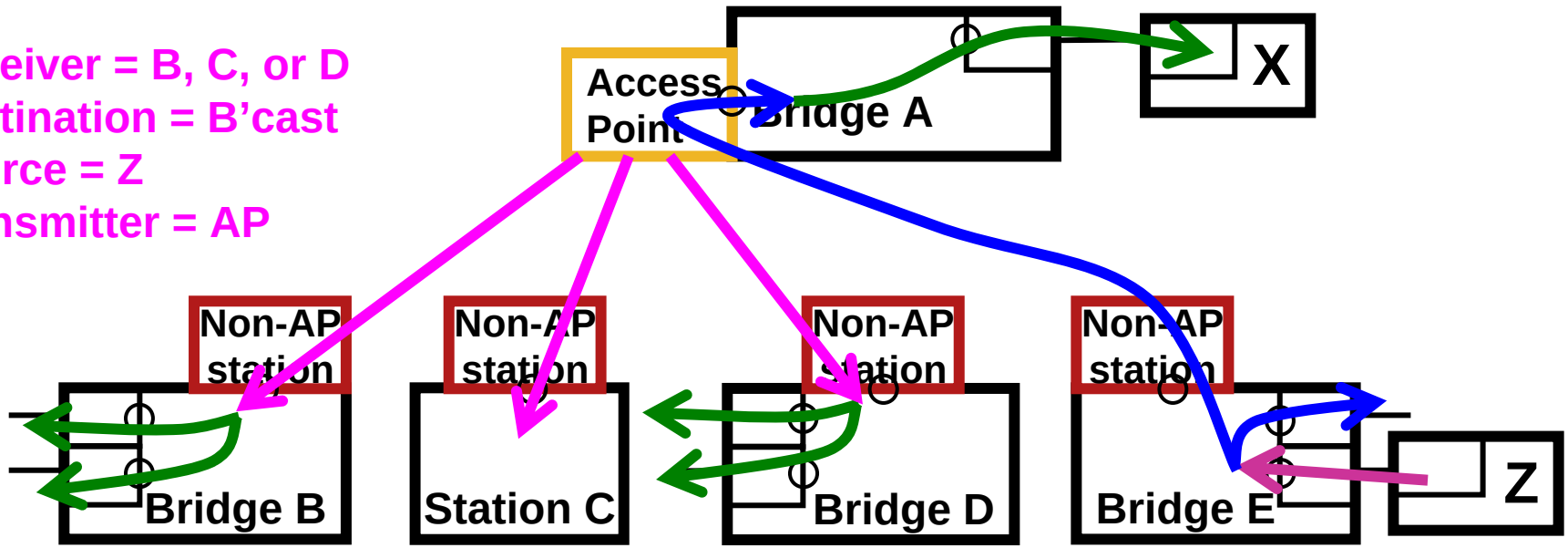
  Destination = Broadcast

  Source = Z

  Transmitter = E

Four addresses, choice 1

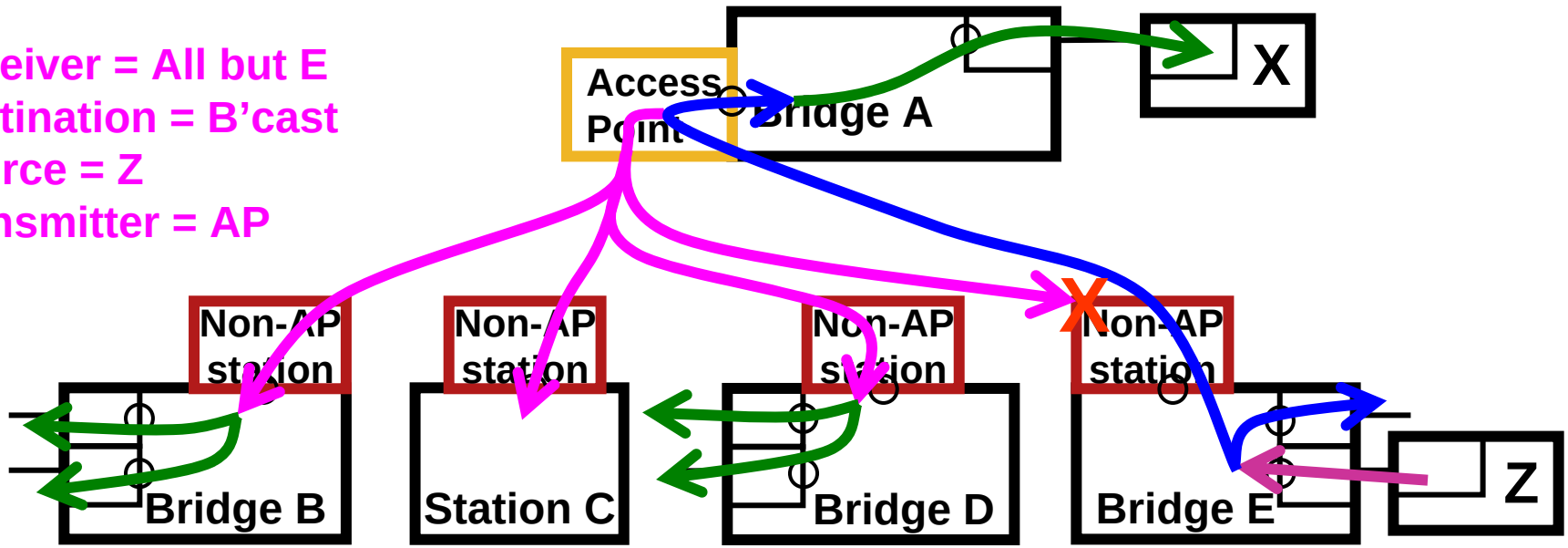
Receiver = B, C, or D
Destination = B'cast
Source = Z
Transmitter = AP



- On the way down, there are at least two choices.
- Choice 1: Send 3 frames. Receiver address = the **unicast address** of each station / bridge (B, C, D) in turn.

Four addresses, choice 2

Receiver = All but E
Destination = B'cast
Source = Z
Transmitter = AP

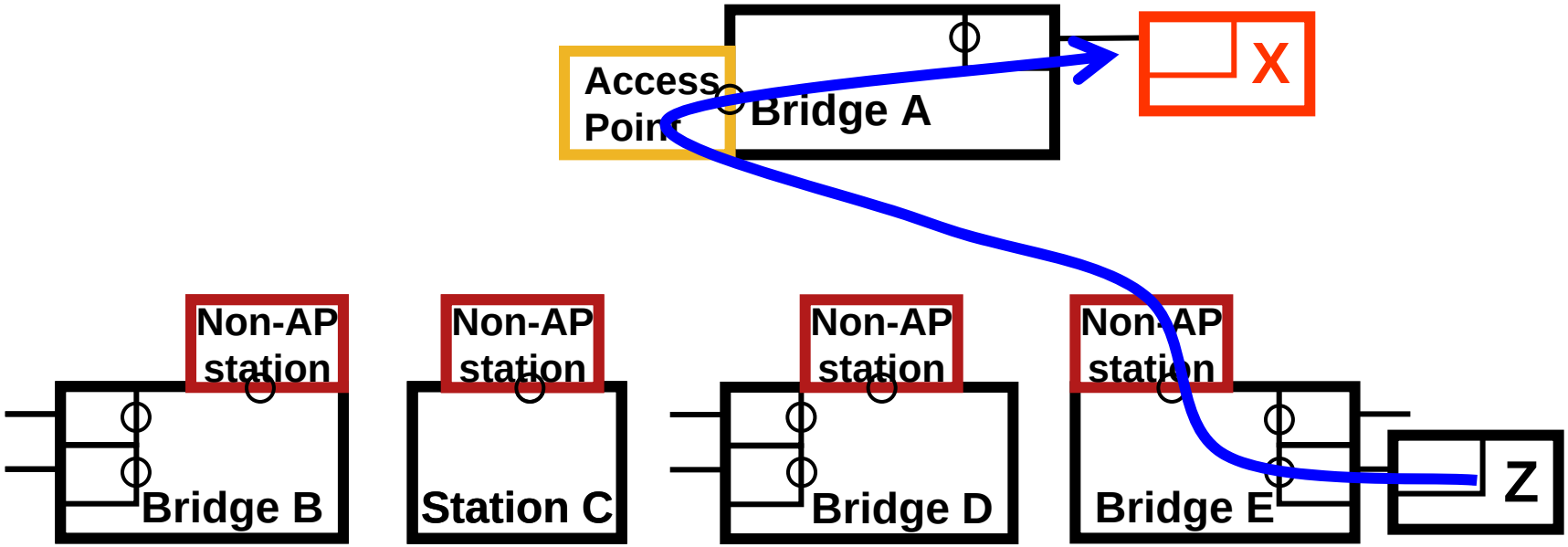


- Several choices of how to use the fourth address.
- Choice 1: Send 3 frames. Receiver address = the **unicast address** of each station / bridge (B, C, D) in turn.
- Choice 2: Receiver address = "**Everybody except E**"

Sending to “Everybody except E”

- We need a Receiver Address in the reflected frame such that the station that transmitted the frame to the access point (Bridge E) will discard it, and the others accept it.
- Using E’s MAC address (Transmitter Address from the original frame) would accomplish this, but that would be a perversion of the meaning of the Receiver Address – “everybody except this address should receive it”.
- So, we use a fixed range of multicast addresses, taken from an 802.1 or 802.11 OUI, and place the Association Identifier of Station E in the low-order bits of the address.
- Every station “**subscribes**” to all multicast addresses in this range **except** the one with its own Association ID.

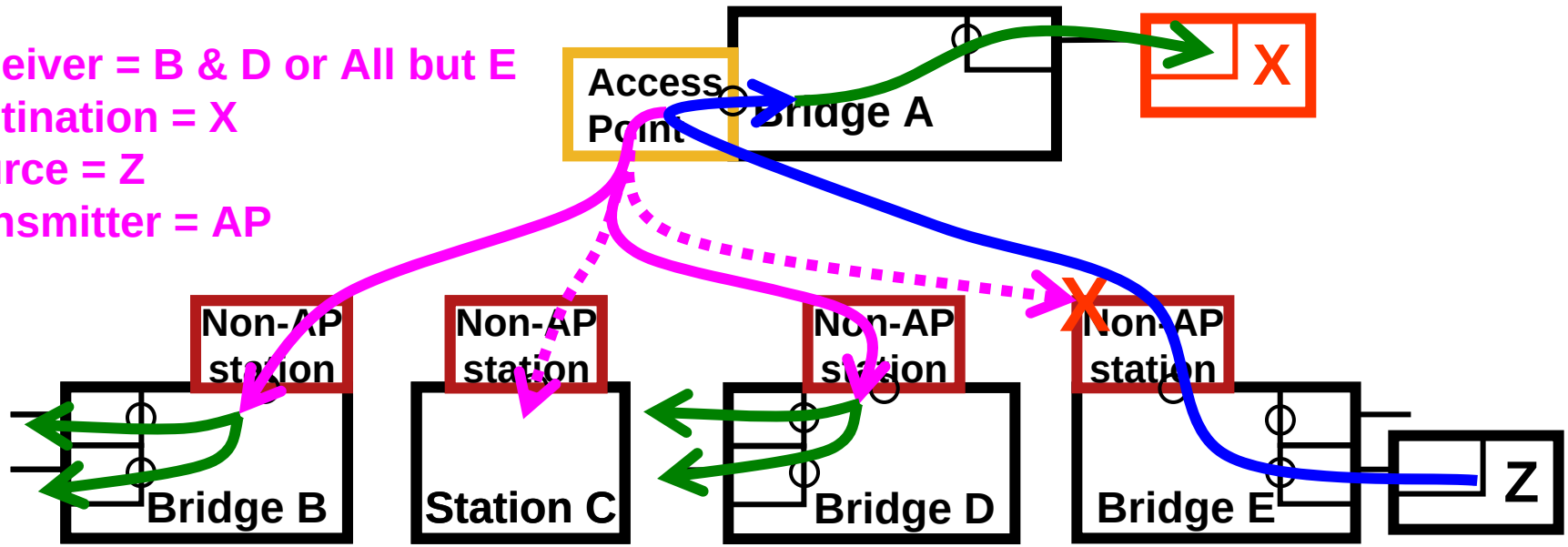
Known unicast with station bridges



- Station **Z** sends a **unicast** to station **X**, behind Bridge **A**.
- **If the AP / Bridge A knows** where **X** is, the AP must pass the frame to Bridge **A** for delivery.

Known unicast with station bridges

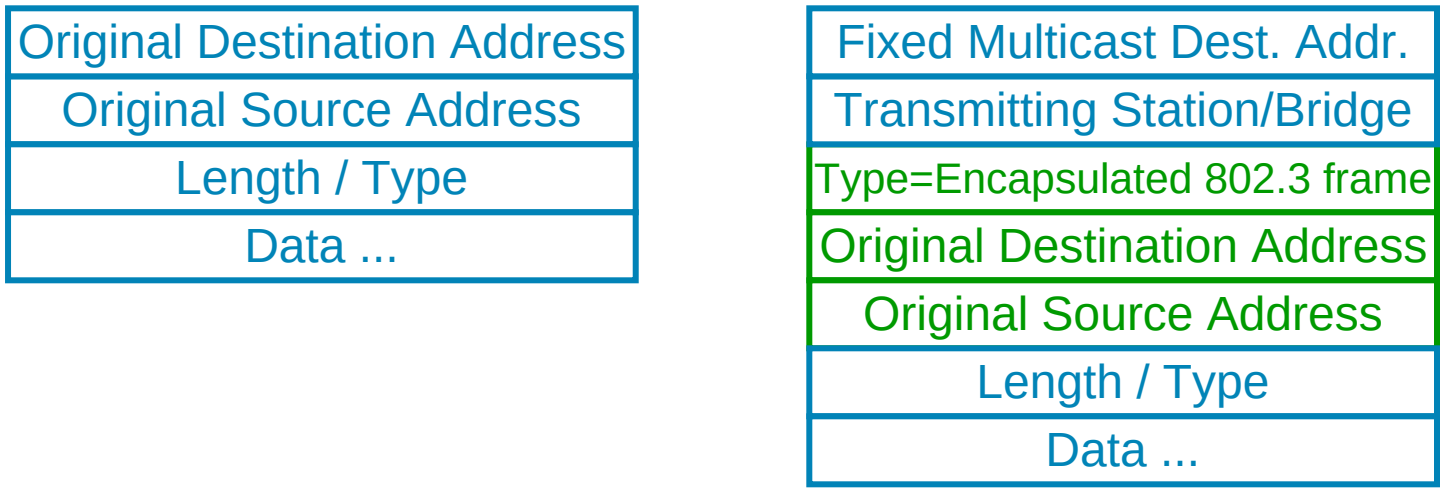
Receiver = B & D or All but E
Destination = X
Source = Z
Transmitter = AP



- Station **Z** sends a **unicast** to station **X**, behind Bridge **A**.
- **If the AP / Bridge A don't know** where **X** is, the AP must **flood** the frame to at least **all bridges**.

Solution 2: Encapsulated 802.3 EtherType

Encapsulated 802.3 EtherType



Original **Encapsulated**

- Extra transmitter/receiver address not shown.
- We define a new EtherType, meaning “An 802.3 frame follows.”
- The extra addresses allow reflection suppression.

Encapsulated 802.3 EtherType

- The access point still has to change, as for the 4-address solution. (These encapsulated frames cannot be passed on to the wired network behind the access point.)
- All of the encapsulated vs. unencapsulated rules apply exactly as for 3-address or 4-address rules for the 4-address solution.
- This solution would be available for other reflective media, should any become common.
- This solution is a valid alternative, if there are large numbers of stations that would cause the 4-address solution to fail.
- This solution applies to 802.1aq, as well as 802.1Q.

Non-solutions

Other solutions

- Know what addresses are “behind” the station/bridge.
  - – You’re fine until something moves.
  - – This only works in very static situations.
- Station bridge remembers its recently-sent source addresses.
  - – Frames may not be reflected for some time, due to higher-priority traffic competing for air time, so a fairly large number of addresses must be maintained.
  - – This list must be learned and examined at wire speed.
  - – This solution cannot be dismissed.
- TRILL
  - – The outer source address solves the reflection problem.

What 802.1 can do to help

Standards work needed

- Any of the described solutions can be standardized by 802.1. For example:

  Describe the use of the 4-address format in 802.1D subclause 6.5.4 “Support by IEEE Std 802.11 (Wireless LANs)”.

  Change to 802.1Q clause 13 to do propose/accept on shared media. (Because the AP knows all attached devices, this is possible.)

  To 6.5.4 or 13, add 3-address vs. 4-address station recognition, and the decision for 4-capable stations of which mode to use.

- Some changes to 802.11 standards would be helpful, but not vital, to achieve interoperability:

  The descriptions of the 4 addresses’ meanings are unchanged.

  The other solutions do not rely on 802.11 at all.