

What is Ethernet Access Network?

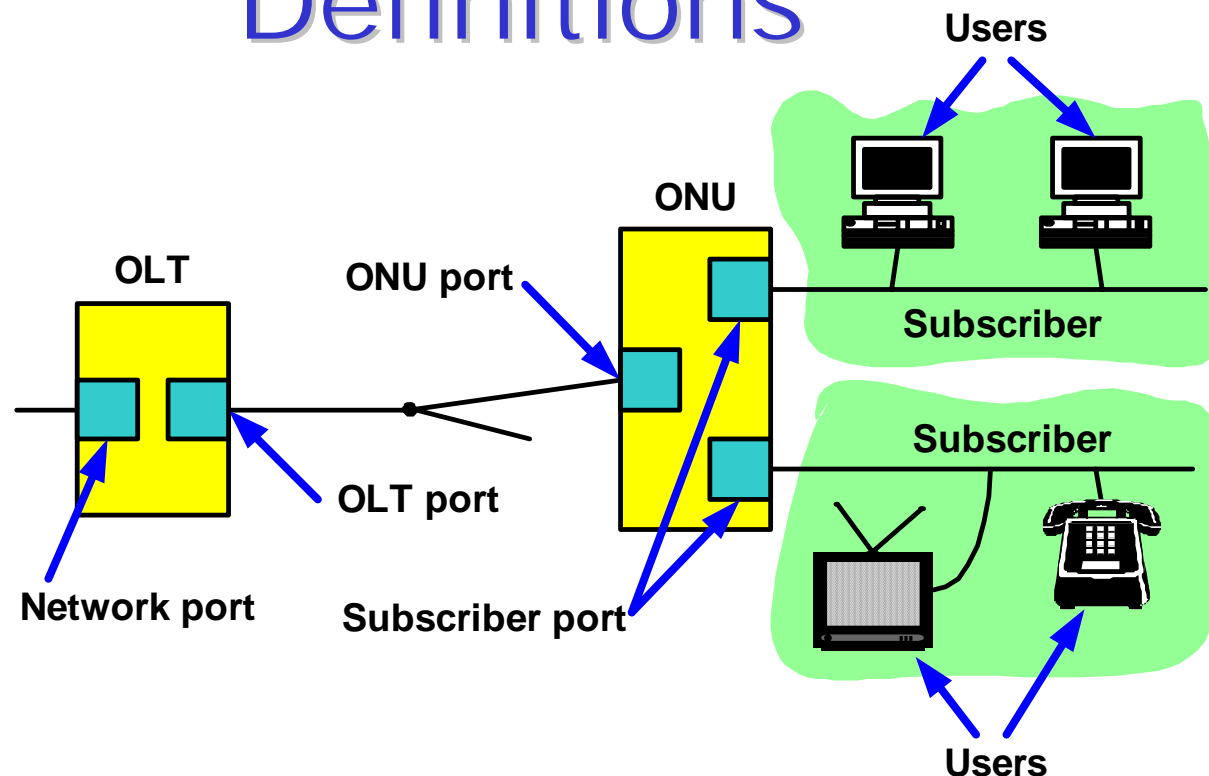
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Foreword

- Ethernet Access Network (EAN) is a complex system.
- 802.3ah only covers a (small) portion of EAN.
Considerable part of EAN is outside 802.3ah scope.
- This presentation investigates several possible architectures of EAN.
- This presentation has nothing to do with 802.3ah scope.
- The aim of this presentation is to refine functional requirements for P2MP architecture.
- Many issues are related to P2P as well.

Definitions



- **Subscriber** – a legal entity with whom network operator has a contract. Each subscriber is associated with one **subscriber port**. SLA/policy/forwarding is configured per subscriber port
- **User** - any device (station) within a subscriber network (LAN) capable of sinking and originating 802.3 frames. User population changes dynamically and is beyond network operator's control

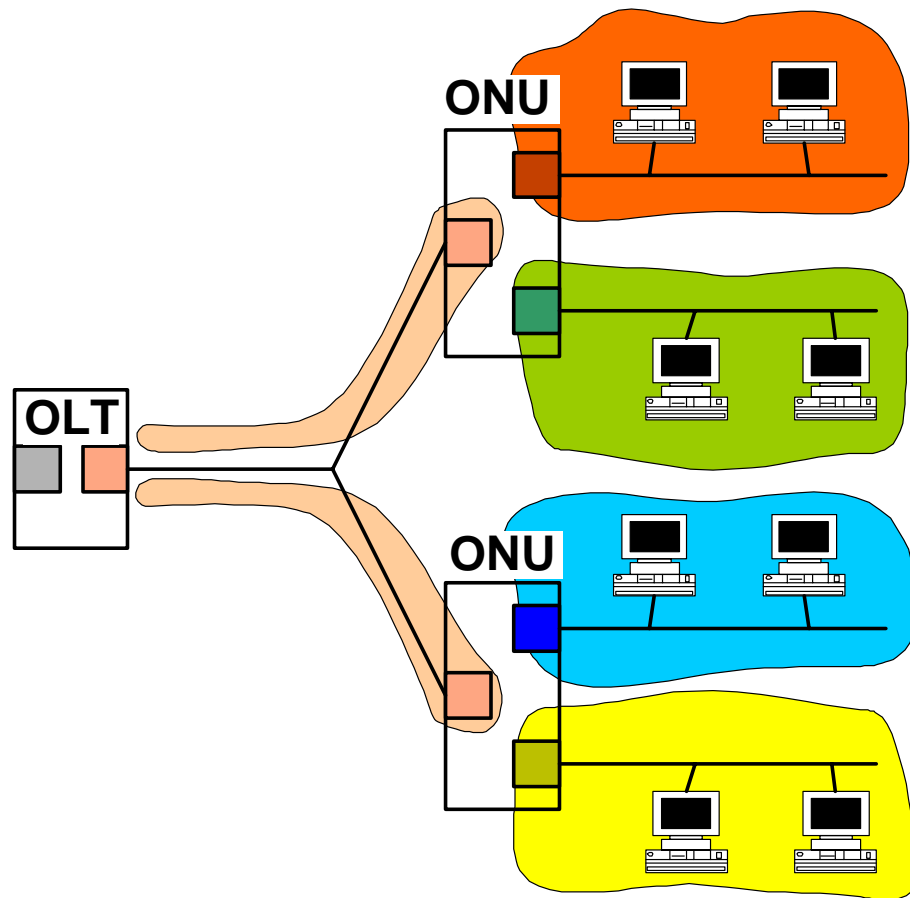
What is “peer-to-peer” network?

1. Peers are all equals, and thus all arbitration is done fairly.
Peers are subjected to the same network policies and (in general) see the same network performance.
 2. Peers can communicate with any other peer, and thus all stations can address all other stations (broadcast and unicast).
- **Can subscribers be peers?**

Can subscribers be peers?

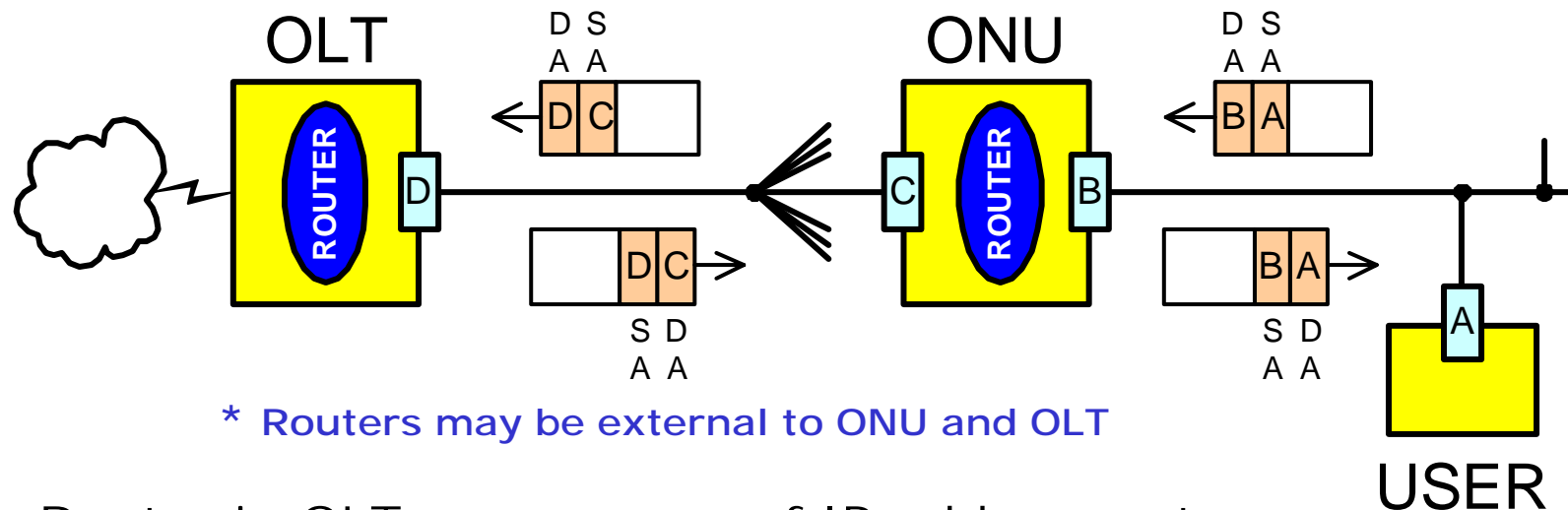
- **No.** Subscribers are private entities with different SLAs, policies, and privacy requirements. Subscribers should not be allowed to communicate to each other or even be aware of each other.
- **Yes.** Under some circumstances several subscribers may wish to join into a common domain – **subscriber group**. All users in in the same subscriber group should be able to communicate to each other (i.e. broadcast to all other users in the group).

Scheme 1: EAN is a set of virtual P2P links independent of subscriber networks



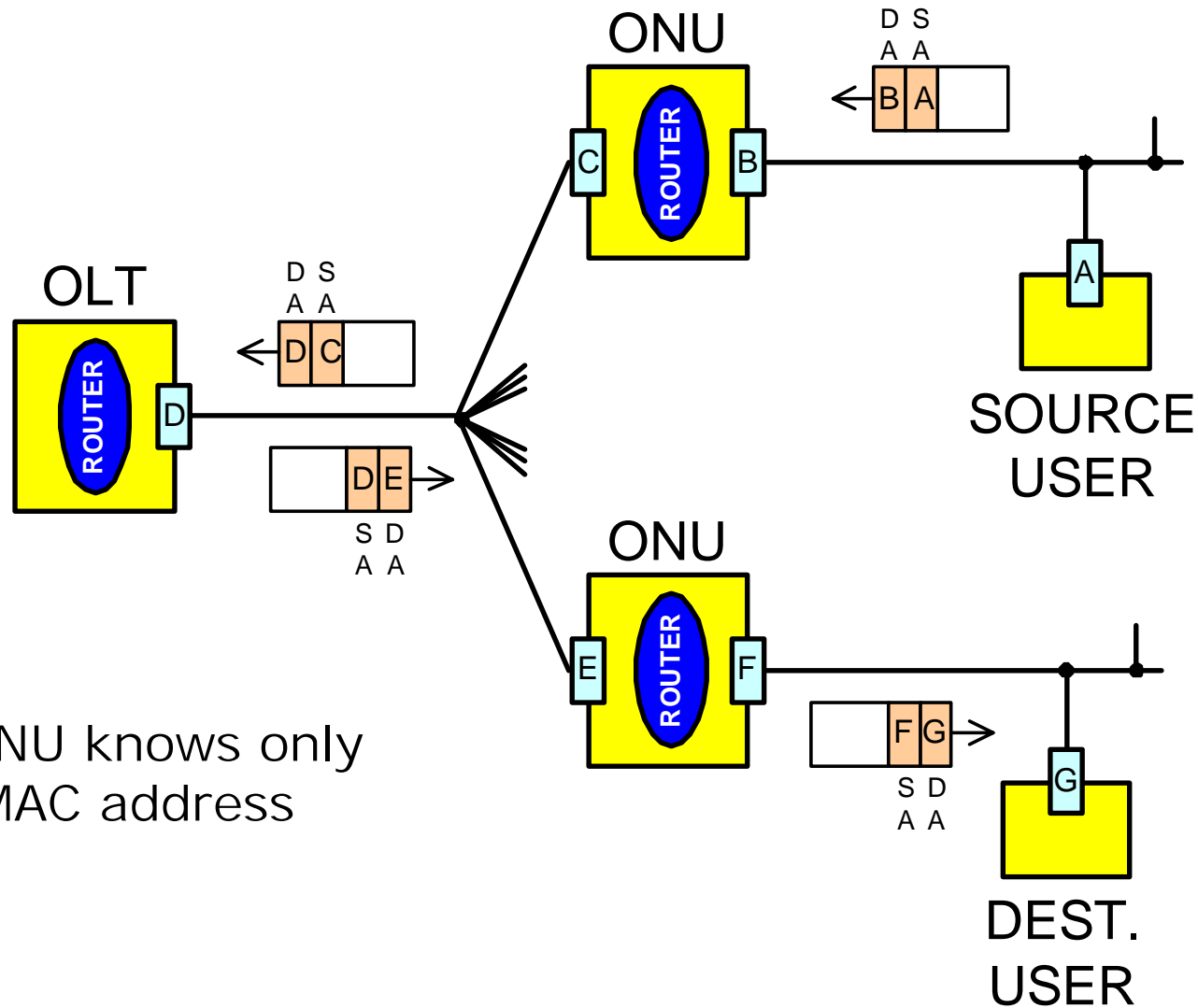
- Networks structure, number of users, and policies within a subscriber network are not known in the EAN
- User's MAC addresses are not exposed to EAN
- MAC frames in EAN only use OLT and ONU port MAC addresses
- ONU-to-ONU communication (within L2) is not possible

Scheme 1: User-to-Network traffic Network-to-User traffic



- Router in OLT maps range of IP addresses to a particular ONU port MAC
- Router in ONU maps IP addresses to user MACs. Since user population is dynamic (users may change their MACs), this mapping should also be dynamic.
- Can we use ARP? (All users behind one ONU may learn IP addresses of other users)

Scheme 1: User-to-User traffic

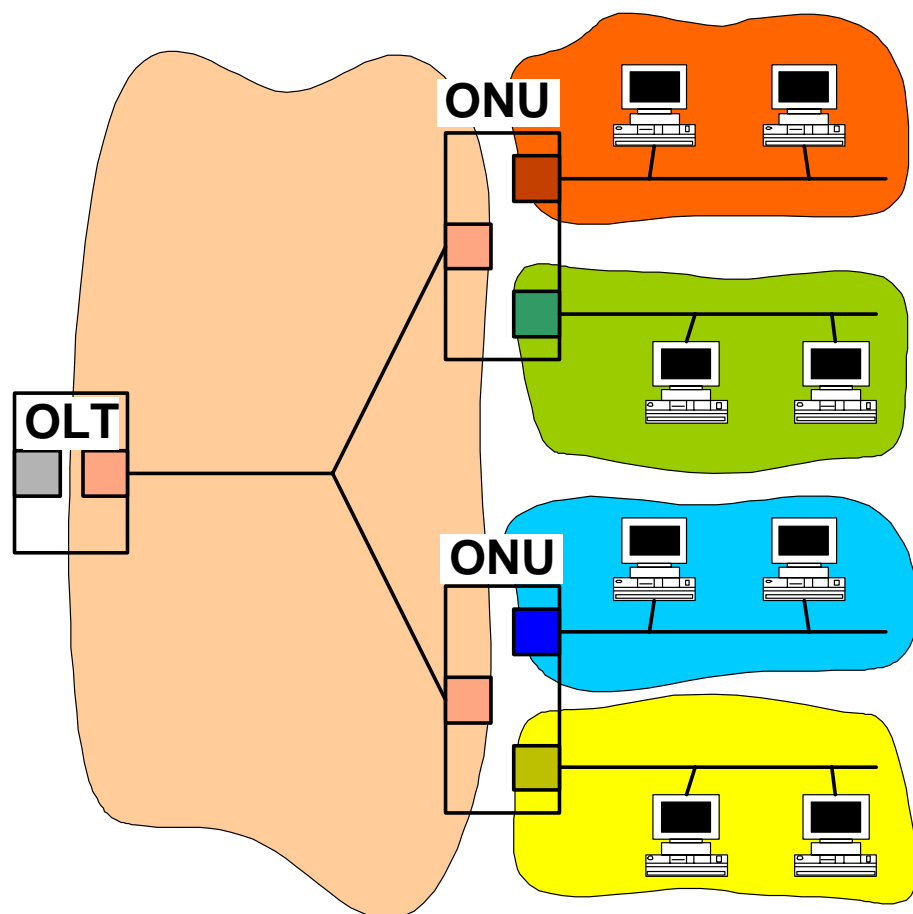


Each ONU knows only OLT's MAC address

Scheme 1: Inter-subscriber communication

- Broadcast messages from users are ignored by ONU
- User-to-user communication is done through higher layers (VPN/IP tunneling). “remote peers” use the same mechanism no matter whether they are on the same PON or not.

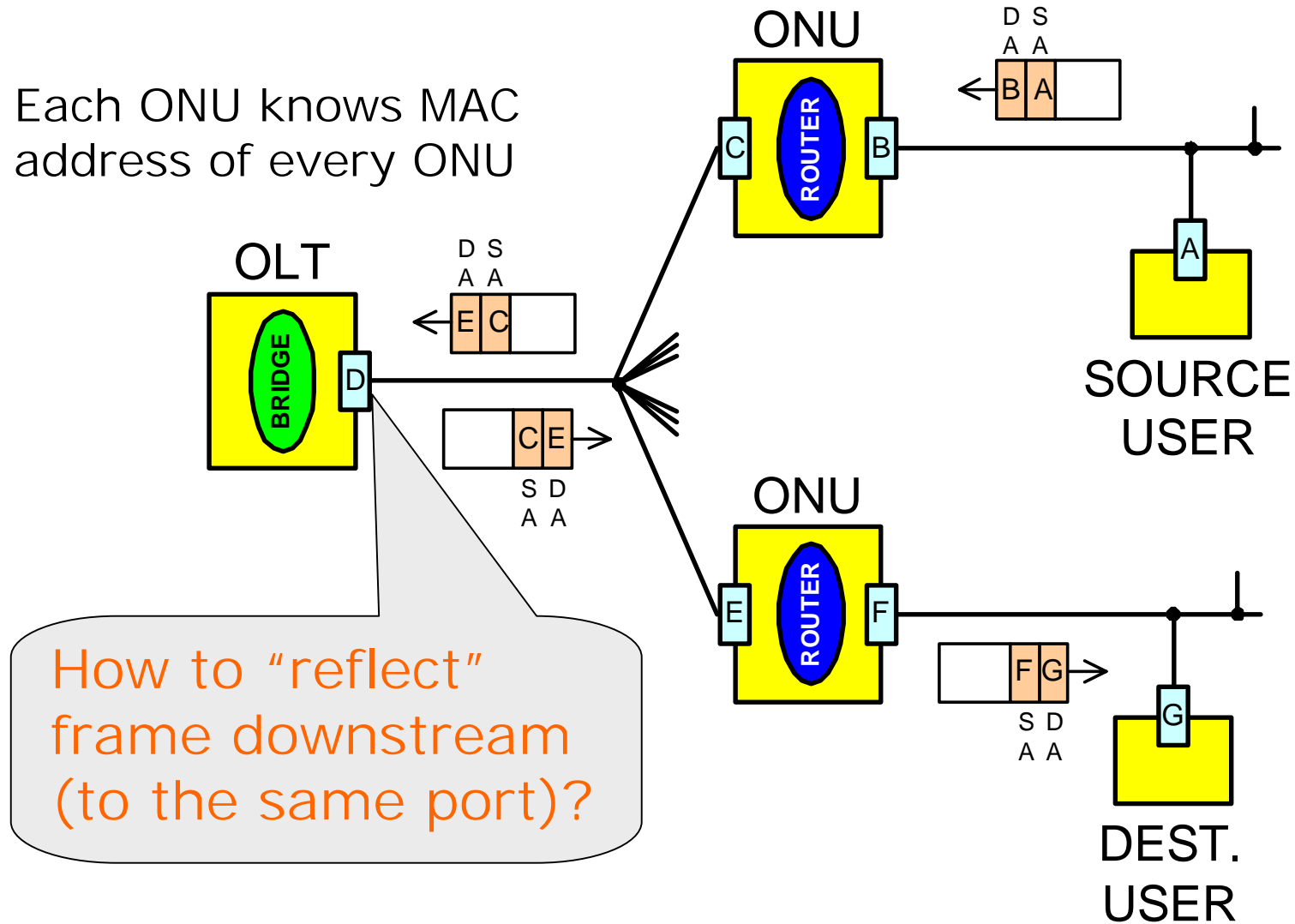
Scheme 2: EAN is a layer-2 network independent from subscriber networks



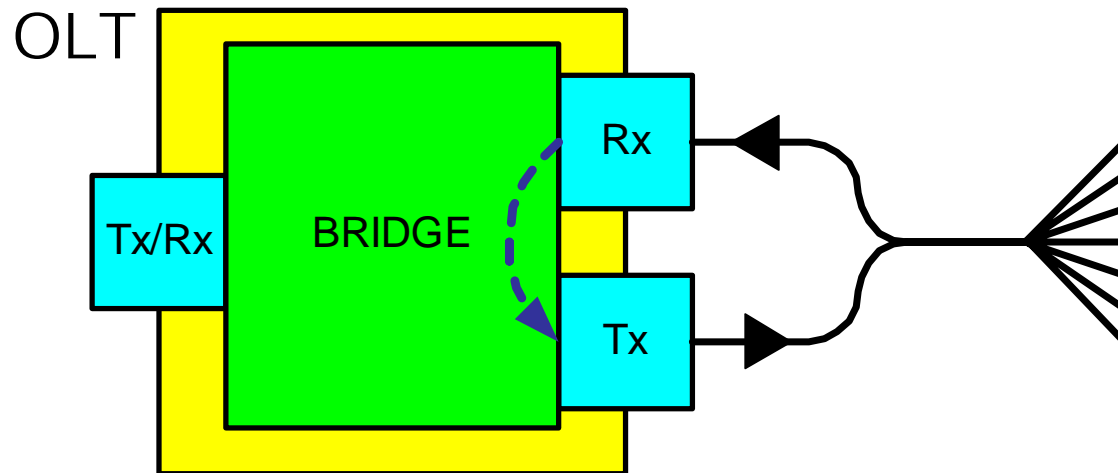
- Networks structure, number of users, and policies within a subscriber network are not known in the EAN
- User's MAC addresses are not exposed to EAN
- MAC frames in EPON only use OLT and ONU port MAC addresses
- ONUs can communicate to each other within layer 2.
- Subscriber-to-subscriber communication (within L2) is not possible

Scheme 2: User-to-User traffic

Each ONU knows MAC address of every ONU

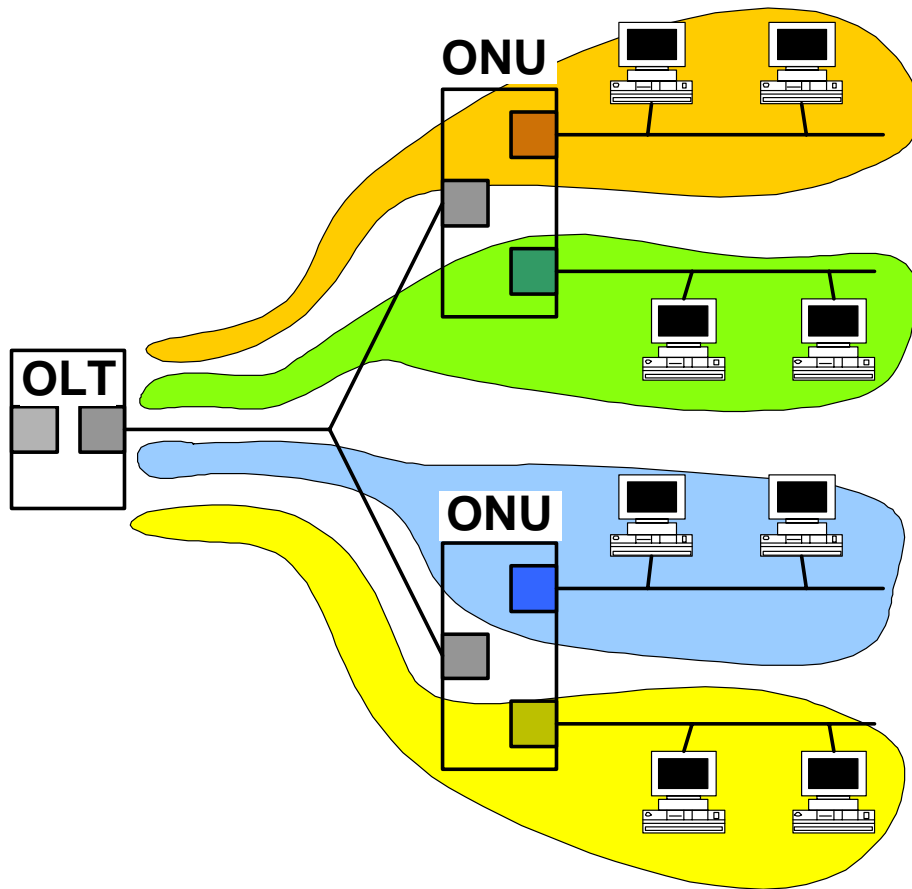


How to “reflect” frame downstream



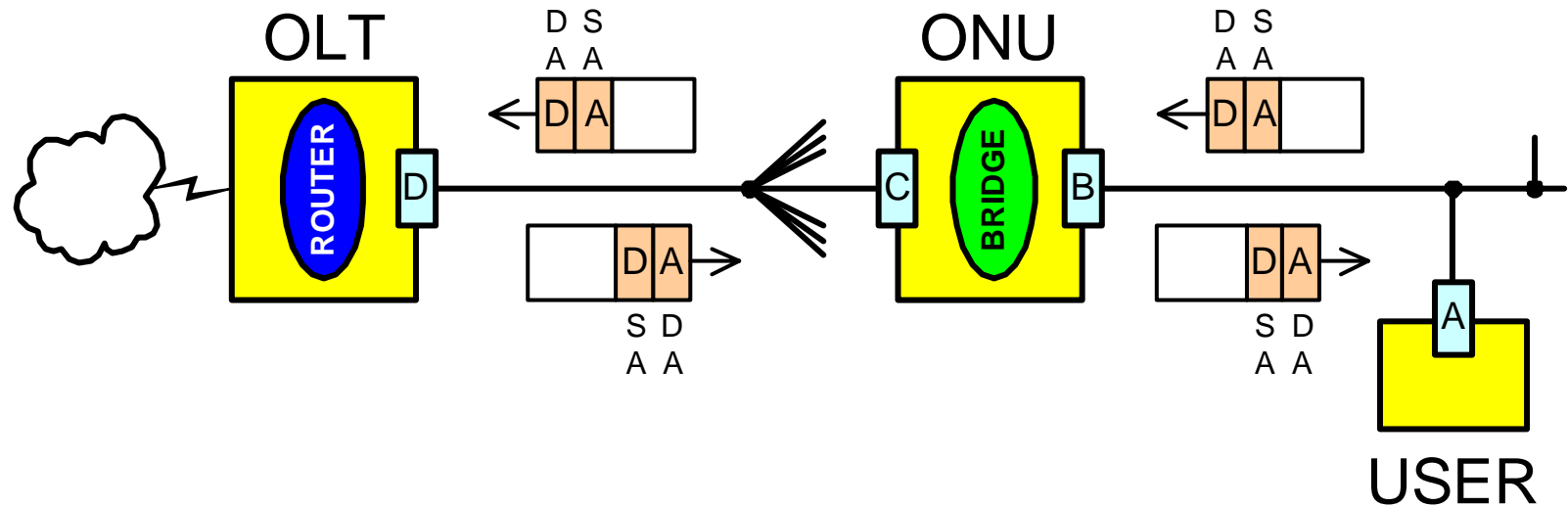
- Use separate ports for Tx and Rx (in OLT)
- Use [Static Filtering Entry](#) (802.1D, clause 7.9.1) for each ONU MAC address.
 - Ignore dynamic address learning
 - ONU MAC addresses are learned during initialization
 - Forward all frames with DA=ONU's MAC to Tx port

Scheme 3: EAN is a set of extension links of subscriber's networks



- EAN is a continuation of subscriber private network
- User's MAC addresses are exposed to EAN (thus, link segregation is important)
- OLT must learn user's MAC addresses

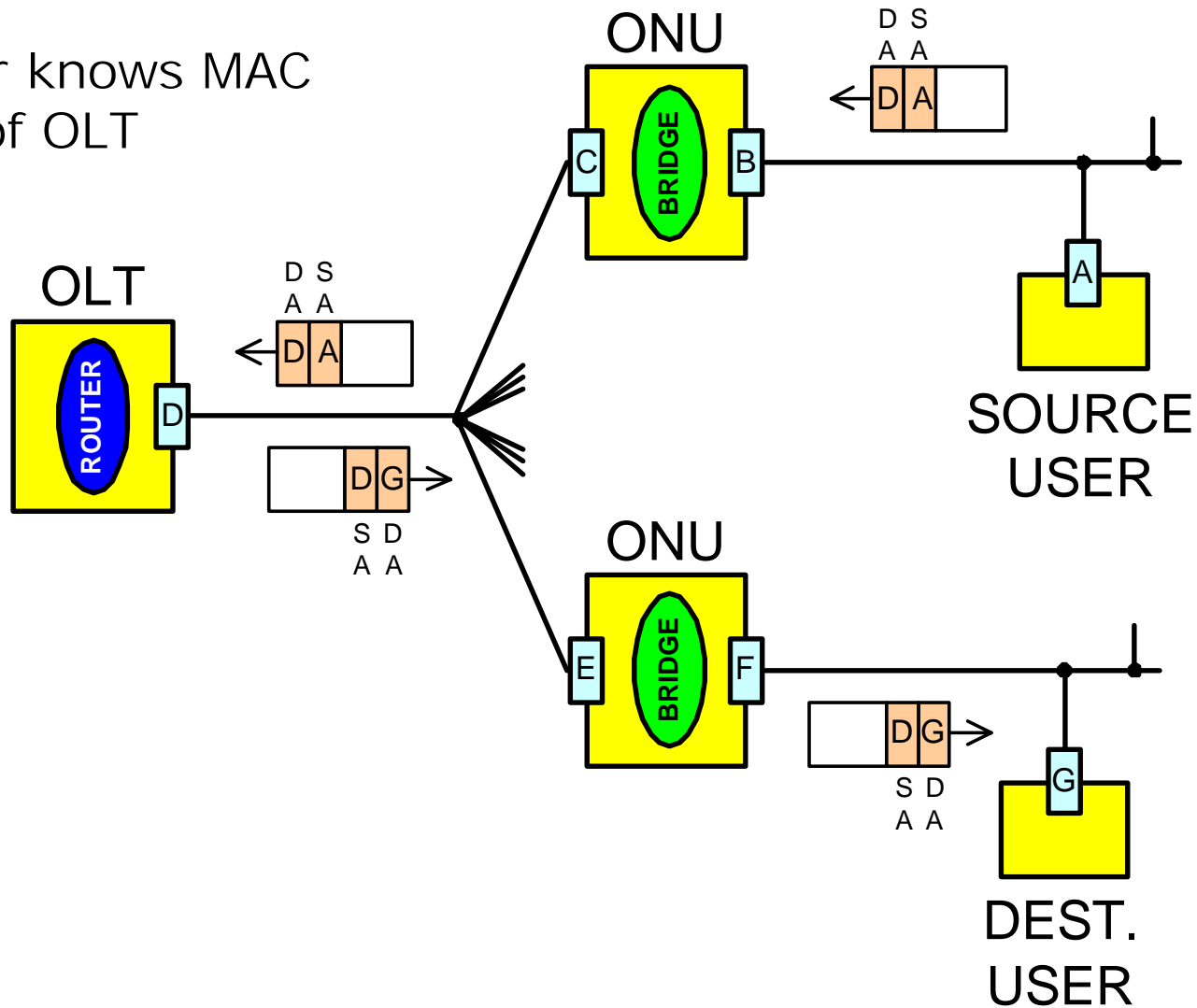
Scheme 3: User-to-Network traffic Network-to-User traffic



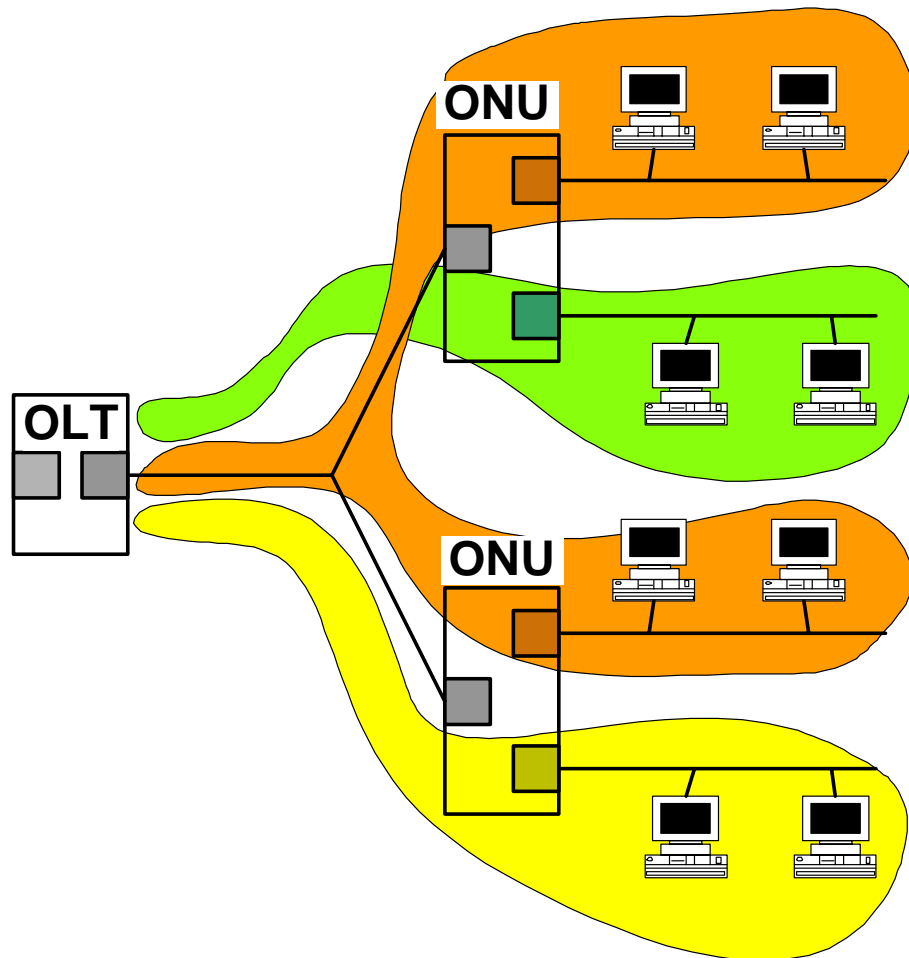
- User network is extended to the OLT (but not to other ONUs)
- L3 routing/switching is required in the OLT
- Users must know OLT's MAC address.
- Bridge in ONU is necessary to separate/stop local traffic from going to the router (and consuming upstream bandwidth).
[In case of single user, it can be just a gated repeater]

Scheme 3: User-to-User traffic

Each user knows MAC address of OLT

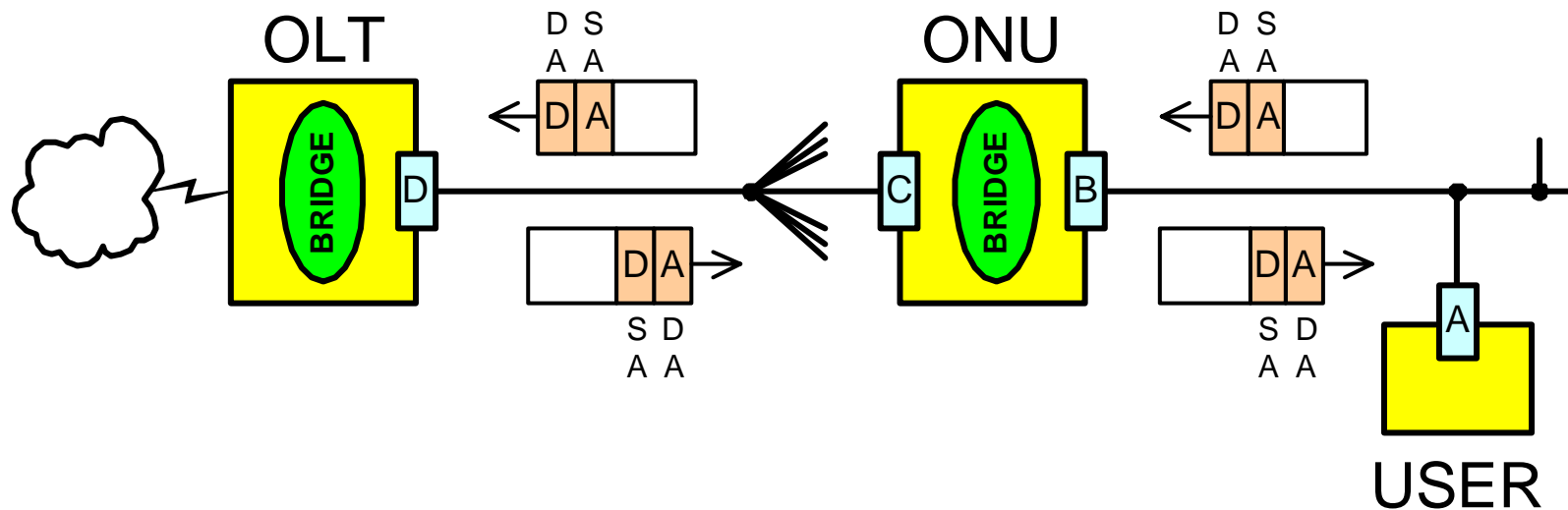


Scheme 4: EAN is a set of layer-2 networks spanning multiple subscribers



- EAN is a continuation of subscriber private network
- Multiple subscribers can form a joint layer-2 network (subscriber group)
- User can send a frame to another user (within a subscriber group)
- OLT must learn user's MAC addresses
- ONU's and OLT must support EPON-specific forwarding [broadcast frame "reflected" downstream should be received by a subset of subscribers (subscriber group)]

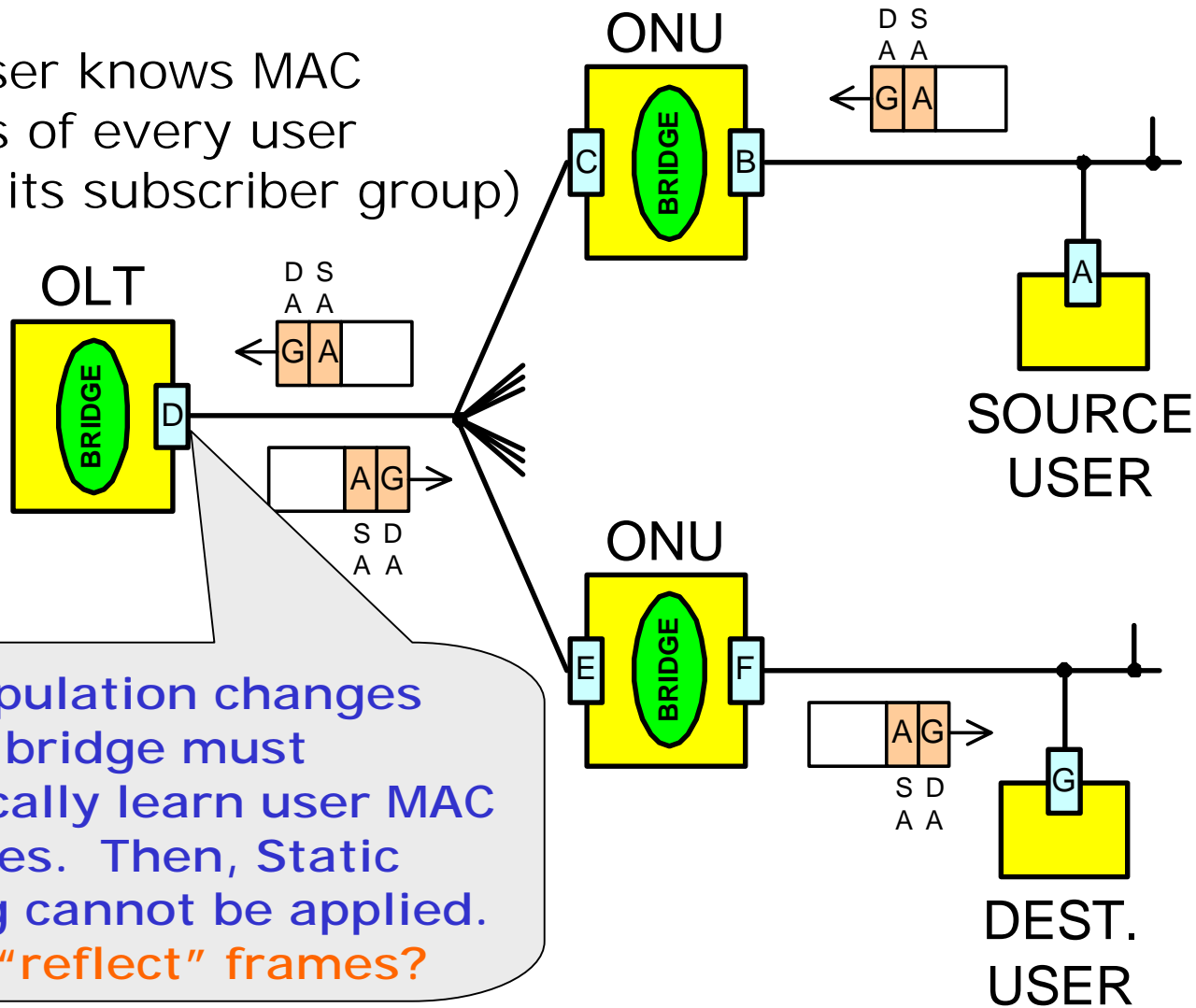
Scheme 4: User-to-Network traffic Network-to-User traffic



- OLT must learn user's MAC addresses
- User network is extended to other ONUs
- Users must know other user's (in subscriber group) MAC addresses.
- Bridge in ONU is necessary to separate/stop local traffic from going to the router (and consuming upstream bandwidth).
[In case of single user, it can be just a gated repeater]

Scheme 4: User-to-User traffic

Each user knows MAC address of every user (within its subscriber group)



User population changes => OLT bridge must dynamically learn user MAC addresses. Then, Static Filtering cannot be applied. How to "reflect" frames?

Scheme 4: Inter-subscriber communication

- User sends a broadcast frame toward OLT.
- OLT identifies subscriber group that the user belongs to.
- If there are more than one subscriber in the subscriber group, OLT sends broadcast frame downstream with a new channel. That new channel is received by all users in subscriber group except the sender.
- Channel can be identified by link ID or encryption key (i.e., ONU tries to receive all data, but only if it has a matching key will the received data make sense).
- Subsets that exclude sender can be preconfigured (link ID preprogrammed) or link ID may consist of two parts: **group ID** and **sender ID**. Thus, a frame is accepted by everyone in the subscriber group except the sender

Summary

	ONU	OLT	
Scheme 1	Router	Router	EAN is a set of (virtual) point-to-point links separate from user's LANs
Scheme 2	Router	Bridge	EAN is a connected network (ONUs are peers) separate from user's LANs
Scheme 3	Bridge	Router	EAN is a set of (virtual) point-to-point extension links joint with user's LANs
Scheme 4	Bridge	Bridge	EAN is a network interconnecting user's LANs at layer 2 (users are peers)

Scheme 1 Summary

- 👍 Clear separation between user LAN and EAN
- 👍 No channel segregation necessary
- 👍 Encryption can be implemented at higher layer (i.e., router to router encryption)
- 👎 Subscriber-to-subscriber (on different ONUs) communication (within L2) is not possible

Scheme 2 Summary

- 👍 Clear separation between user LAN and EAN.
- 👍 No channel segregation necessary.
- 👍 Encryption can be implemented at higher layer (i.e., router to router encryption).
- 👎 Subscriber-to-subscriber (on different ONUs) communication (within L2) is not possible.
- 👎 Each ONU should know MAC addresses of all other ONUs and IP addresses of all users behind those ONUs.

Scheme 3 Summary

- 👍 No router in ONU is needed
- 👍 No user MAC address learning in OLT
- 👎 Subscriber-to-subscriber (on different ONUs) communication (within L2) is not possible
- 👎 Router in OLT must map all user's IP addresses to the MAC addresses. How? If using ARP:
 - **Security:** ARP requests are broadcast to all users – malicious users may learn IP addresses of other users

Scheme 4 Summary



Subscribers can form a group where they can broadcast to each other (L2 peer-to-peer network)



Bridging should be modified to be able to segregate subscriber groups. EAN should appear as multiple independent local loops (one for each subscriber group). This independence is needed in PHY as well as in forwarding engine.



OLT must learn user's MAC addresses.

- **Scalability:** Bridge in OLT must learn MAC addresses for every user (each subscriber has multiple users).
- **Security:** Until an address is learned, frames destined to that address are broadcast to all users.

Questions

1. Other P2MP models possible?
2. Which scheme is most appropriate for Ethernet Access Network?
3. Should 802.3ah standard assume one or multiple models?
4. Should we support subscriber groups in which users can broadcast to each other?
5. Is it acceptable if users learn IP addresses of other users (not in the same subscriber group)?

Need feedback from Carriers and Network Operators