Movilidad...

Ad-hoc

OLSR Concepts (1)

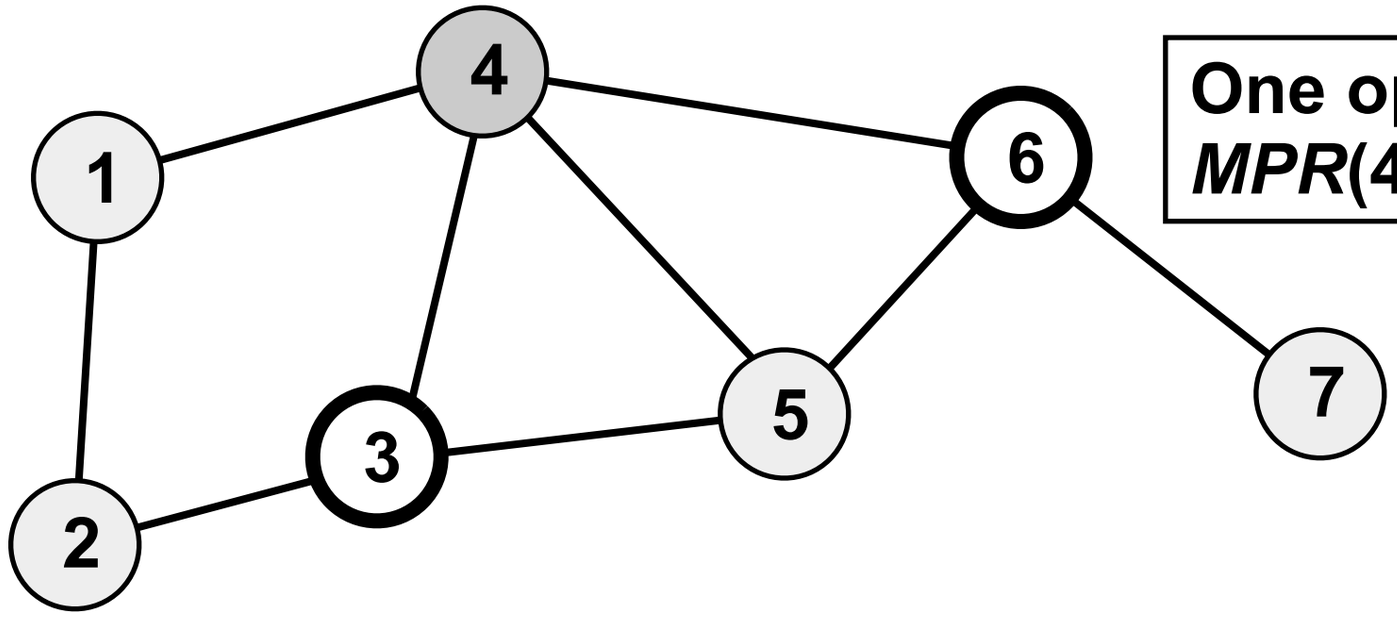
- Proactive (table-driven) routing protocol
  - A route is available immediately when needed
- Based on the link-state algorithm
  - Traditionally, all nodes flood neighbor information in a link-state protocol, but not in OLSR
- Nodes advertise information only about links with neighbors who are in its *multipoint relay selector set*
  - Reduces size of control packets
- Reduces flooding by using only *multipoint relay* nodes to send information in the network
  - Reduces number of control packets by reducing duplicate transmissions

OLSR Concepts (2)

- Does not require reliable transfer, since updates are sent periodically
- Does not need in-order delivery, since sequence numbers are used to prevent out-of-date information from being misinterpreted
- Uses hop-by-hop routing
  - Routes are based on dynamic table entries maintained at intermediate nodes

Multipoint Relays

- Each node *N* in the network selects a set of neighbor nodes as multipoint relays, *MPR*(*N*), that retransmit control packets from *N*
  - Neighbors not in *MPR*(*N*) process control packets from *N*, but they do not forward the packets
- *MPR*(*N*) is selected such that all two-hop neighbors of *N* are covered by (one-hop neighbors) of *MPR*(*N*)

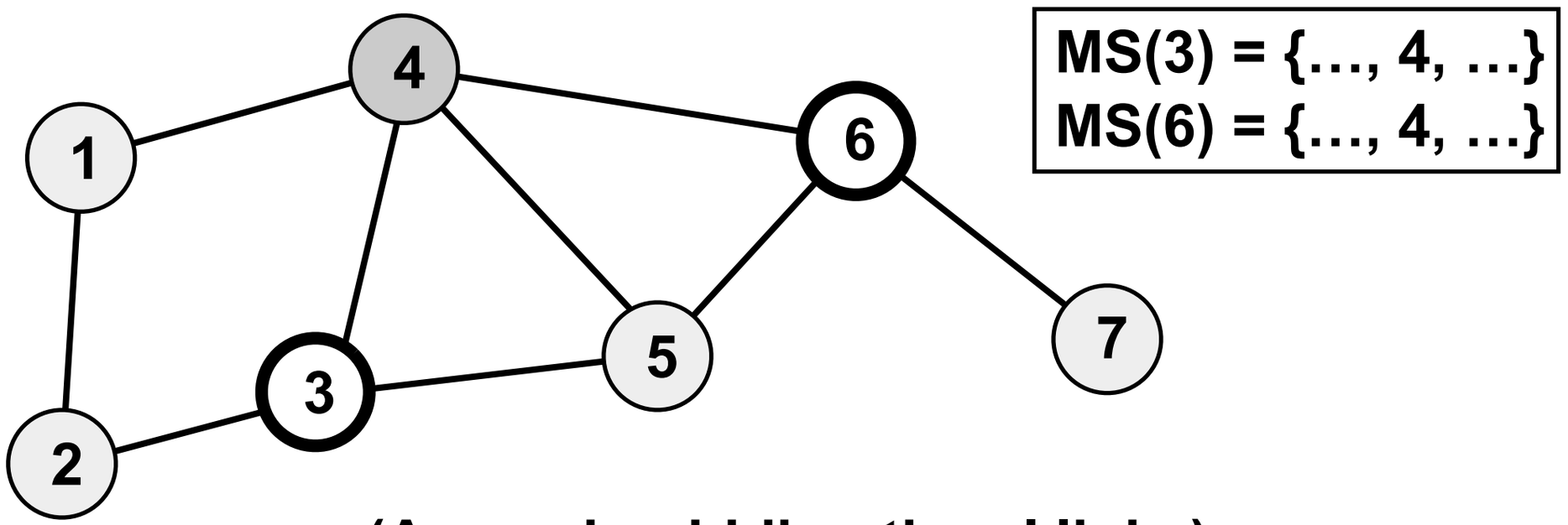


One optimal set for Node 4:
MPR(4) = { 3, 6 }

Is there another optimal *MPR*(4)?

Multipoint Relay Selector Set

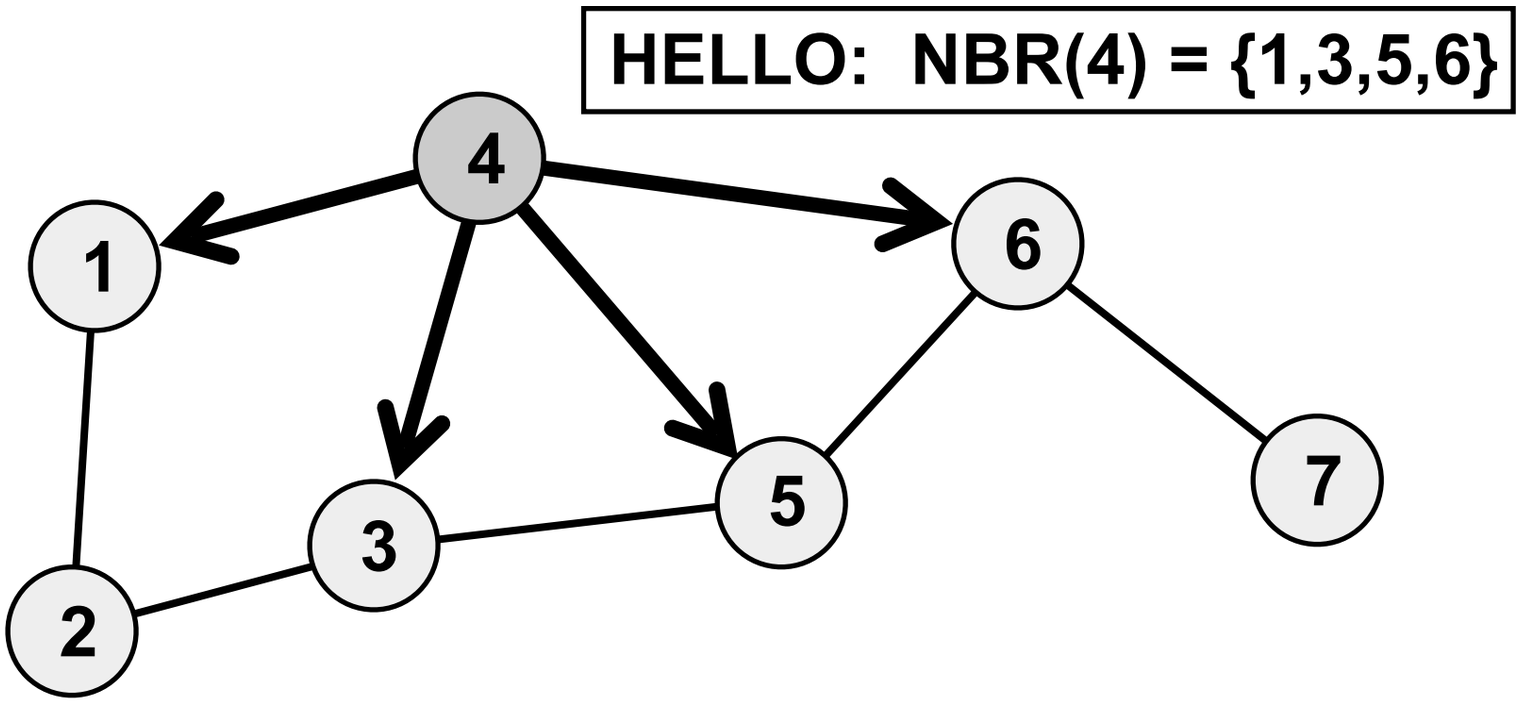
- The multipoint relay selector set for Node *N*, *MS*(*N*), is the set of nodes that choose Node *N* in their multipoint relay set
  - Only links *N-M*, for all *M* such that *N*∈*MS*(*M*) will be advertised in control messages



(Assuming bidirectional links)

HELLO Messages (1)

- Each node uses HELLO messages to determine its MPR set
- All nodes periodically broadcast HELLO messages to their one-hop neighbors (bidirectional links)
- HELLO messages are not forwarded

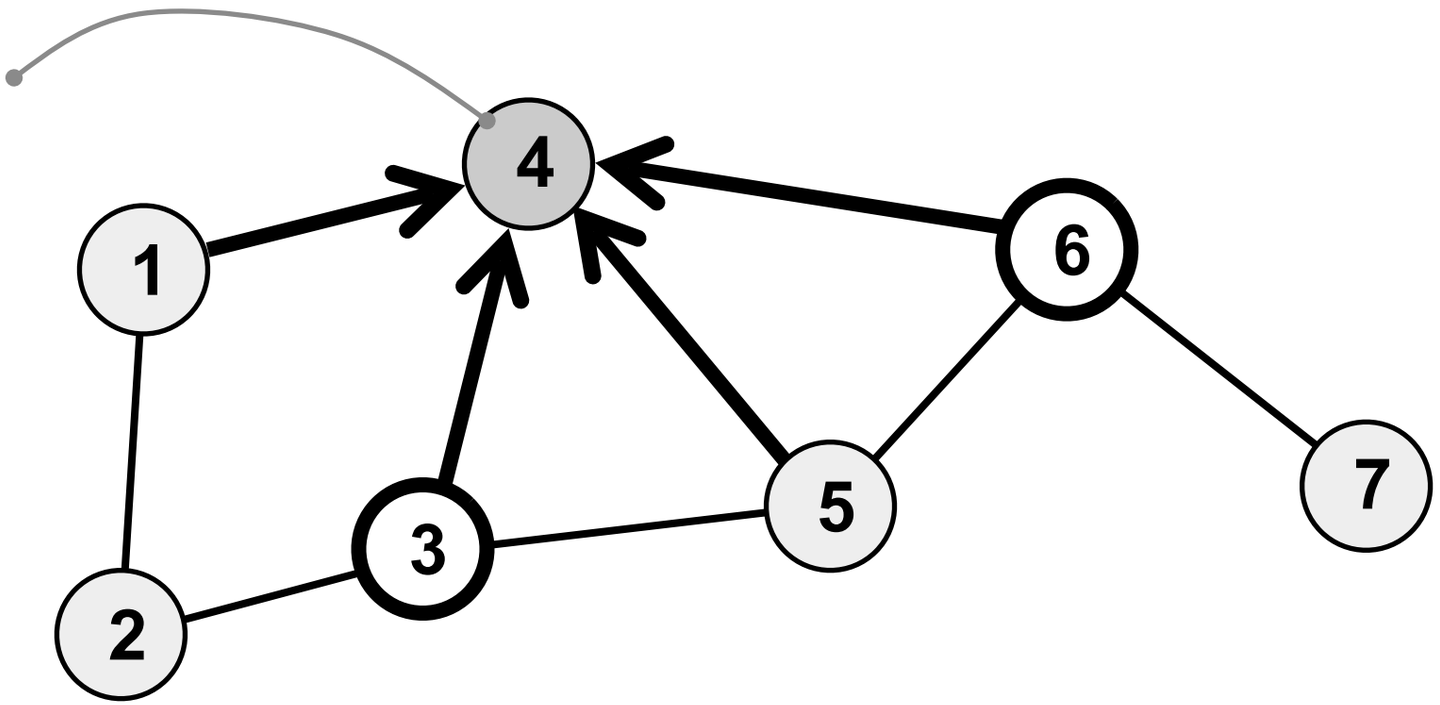


HELLO Messages (2)

- Using the neighbor list in received HELLO messages, nodes can determine their two-hop neighborhood and an optimal (or near-optimal) MPR set
- A sequence number is associated with this MPR set
  - Sequence number is incremented each time a new set is calculated

At Node 4:
NBR(1) = {2}
NBR(3) = {2,5}
NBR(5) = {3,6}
NBR(6) = {5,7}

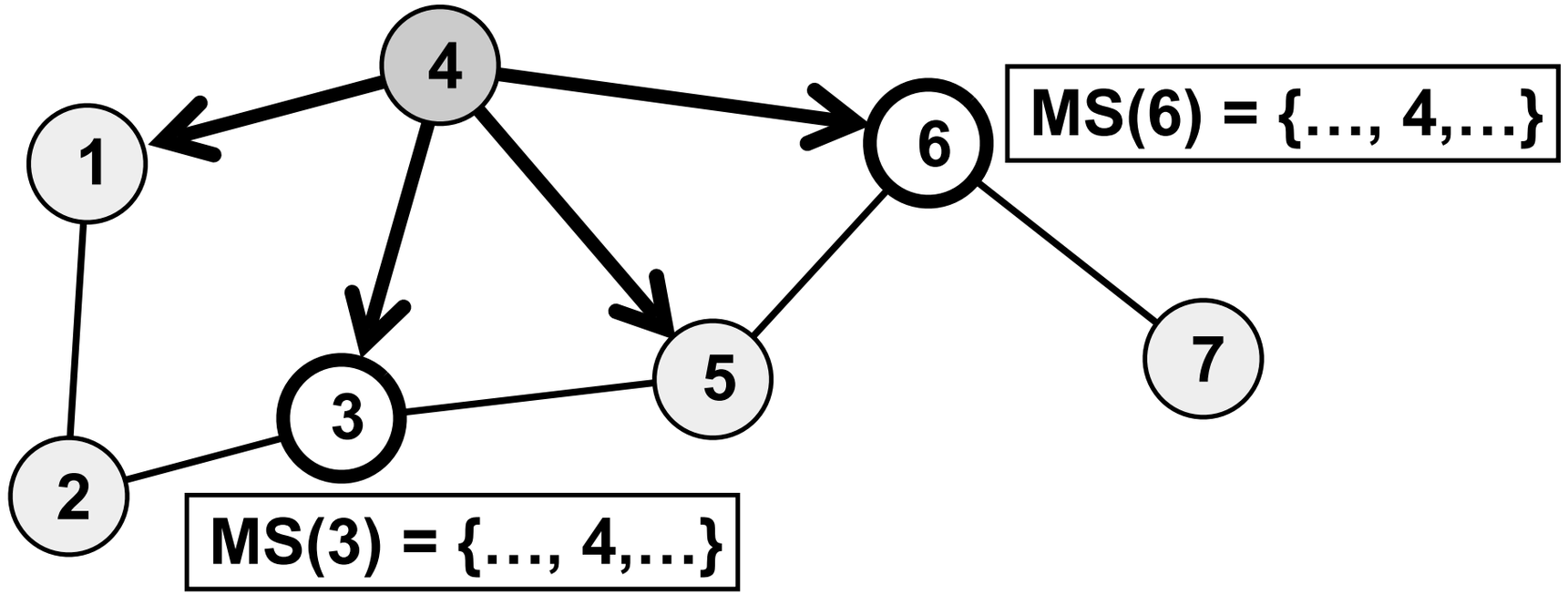
MPR(4) = {3,6}



HELLO Messages (3)

- Subsequent HELLO messages also indicate neighbors that are in the node's MPR set
- MPR set is recalculated when a change in the one-hop or two-hop neighborhood is detected

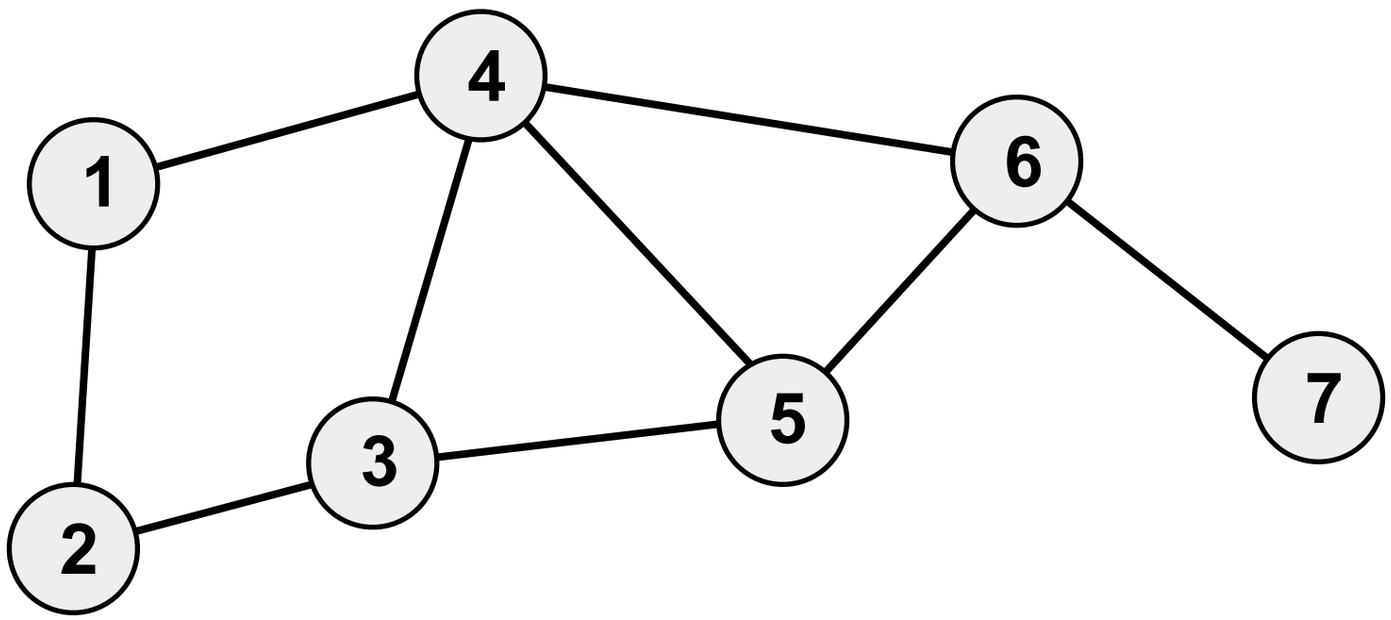
HELLO: NBR(4) = {1,3,5,6}, MPR(4) = {3,6}



TC Messages

- Nodes send topology information in Topology Control (TC) messages
  - List of advertised neighbors (link information)
  - Sequence number (to prevent use of stale information)
- A node generates TC messages only for those neighbors in its MS set
  - Only MPR nodes generate TC messages
  - Not all links are advertised
- A nodes processes all received TC messages, but only forwards TC messages if the sender is in its MS set
  - Only MPR nodes propagate TC messages

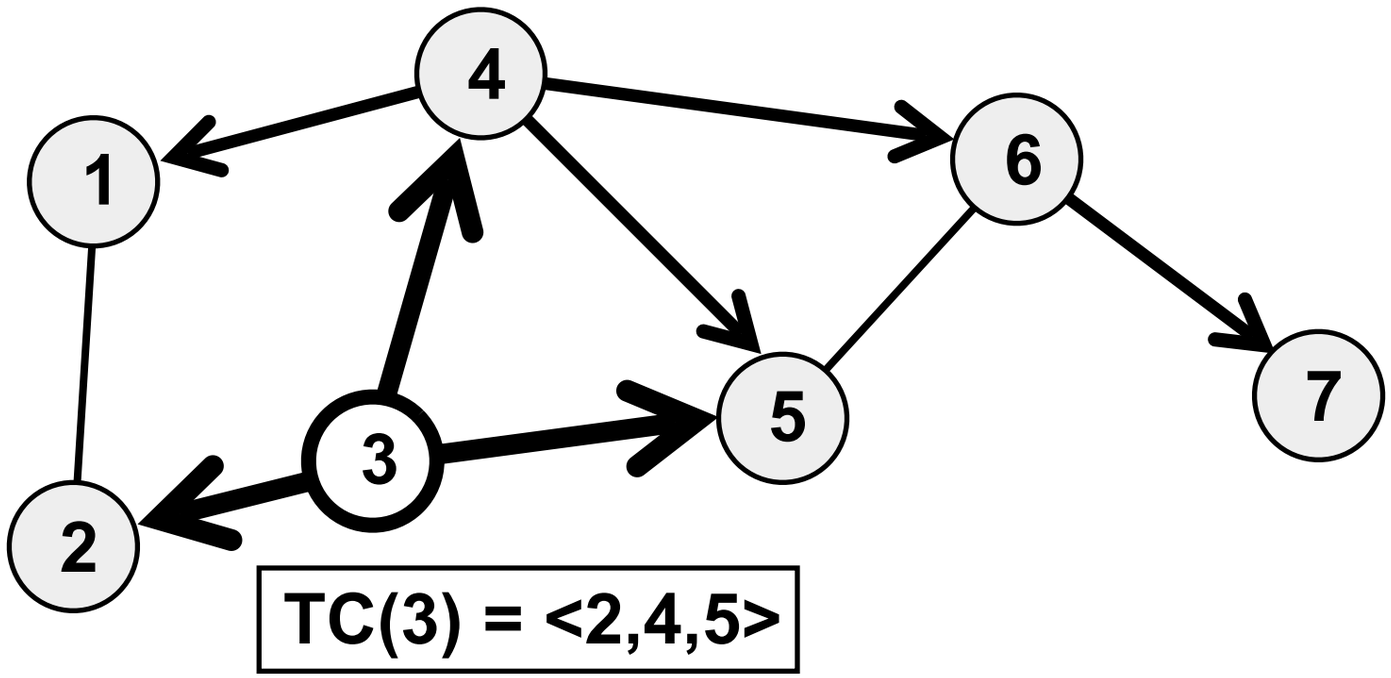
OLSR Example (1)



MPR(1) = { 4 }
MPR(2) = { 3 }
MPR(3) = { 4 }
MPR(4) = { 3, 6 }
MPR(5) = { 3, 4, 6 }
MPR(6) = { 4 }
MPR(7) = { 6 }

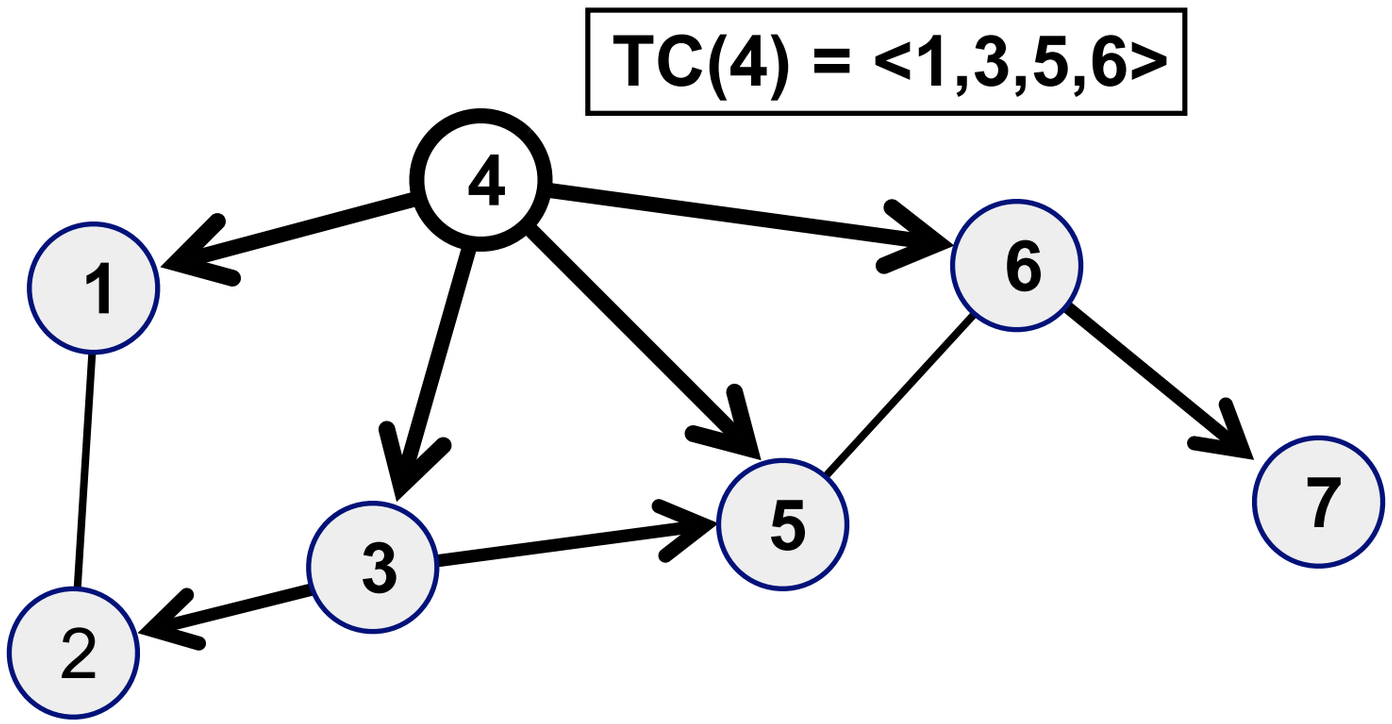
MS(1) = { }
MS(2) = { }
MS(3) = { 2, 4, 5 }
MS(4) = { 1, 3, 5, 6 }
MS(5) = { }
MS(6) = { 4, 5, 7 }
MS(7) = { }

OLSR Example (2)



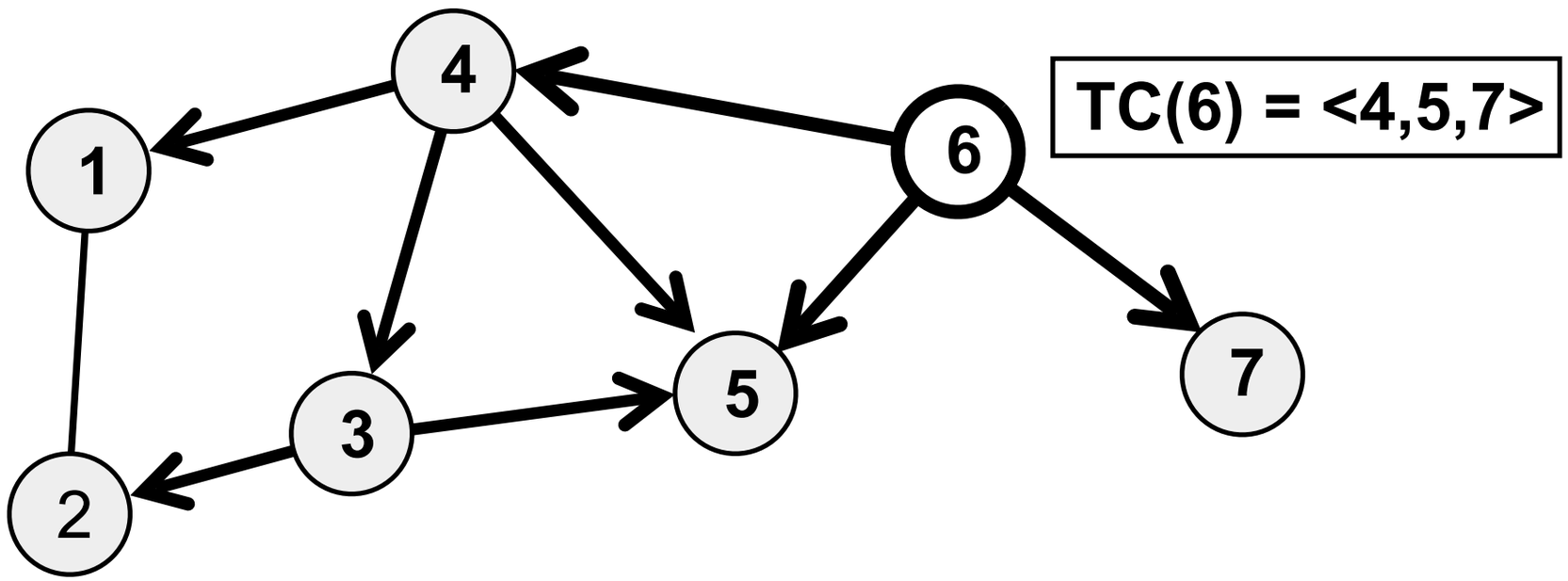
- Node 3 generates a TC message advertising nodes in MS(3) = {2, 4, 5}
- Node 4 forwards Node 3's TC message since Node 3 $\in$ MS(4) = {1, 3, 5, 6}
- Node 6 forwards TC(3) since Node 4 $\in$ MS(6)

OLSR Example (3)



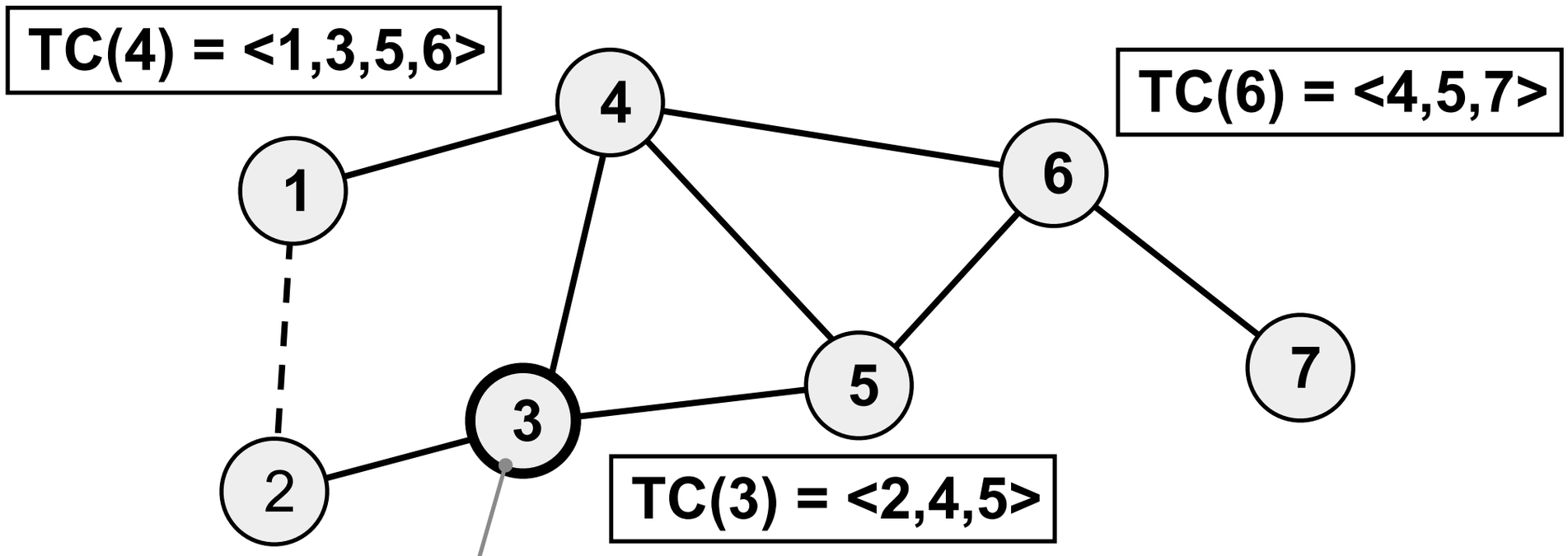
- Node 4 generates a TC message advertising nodes in MS(4) = {1, 3, 5, 6}
- Nodes 3 and 6 forward TC(4) since Node 4 $\in$ MS(3) and Node 4 $\in$ MS(6)

OLSR Example (4)



- Node 6 generates a TC message advertising nodes in MS(6) = {4, 5, 7}
- Node 4 forwards TC(6) from Node 6 and Node 3 forwards TC(6) from Node 4
- After Nodes 3, 4, and 6 have generated TC messages, all nodes have link-state information to route to any node

OLSR Example (5)



Dest	*Next*	*Hops*
1	4	2
2	2	1
4	4	1
5	5	1
6	4 (5)	2
7	4 (5)	3

- Given TC information, each node forms a topology table
- A routing table is calculated from the topology table
- Note that Link 1-2 is not visible except to Nodes 2 and 3

802.11s

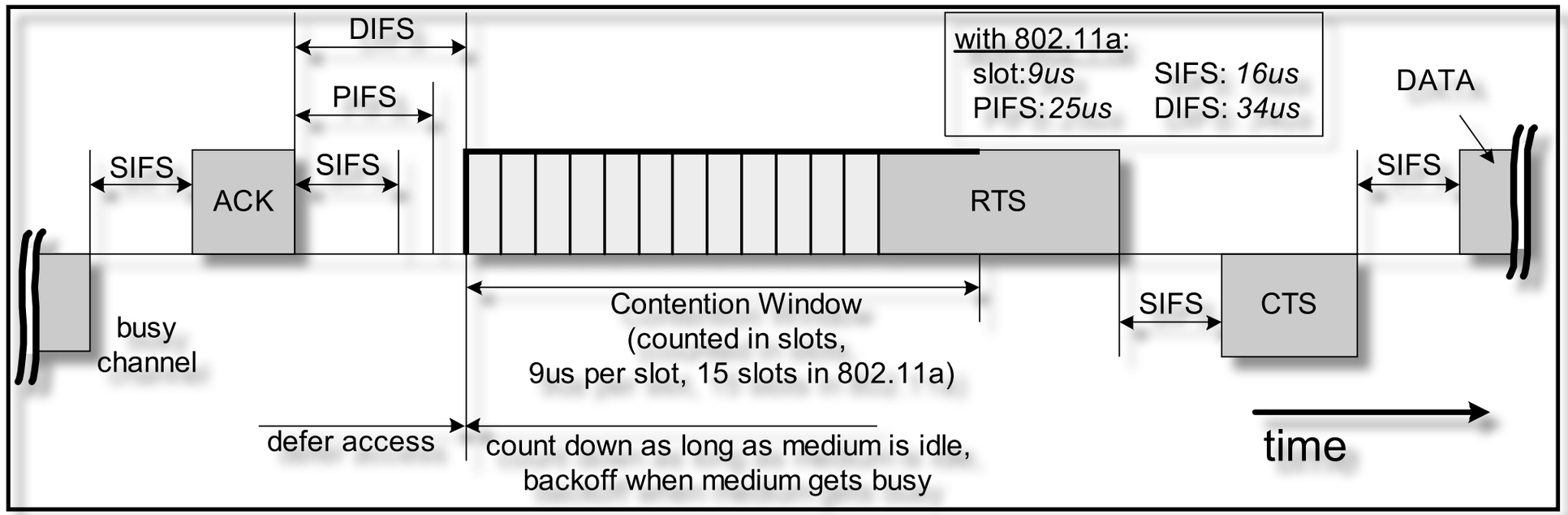
- Extension de 802.11 para definir soporte para redes Ad-hoc en 802.11
  - Aun esta en draft pero podria aprobarse muy pronto
- Dispositivos Mesh Points (MPs)
- Enrutamiento obligatorio por defecto HMMP (Hybrid Wireless Mesh Protocol)
  - Basado en AODV y enrutamiento basado en arboles
- Enrutamiento alternativo OLSR
- Los MPs pueden comunicarse entre si
- Los MPs pueden ser access points que dan acceso a redes 802.11 de tipo infraestructura
- Los MPs pueden ser gateways a la red cableada

- El proyecto OLPC dice soportar 802.11s

802.11e

802.11 sin QoS

- DCF (Distributed Coordination Function)



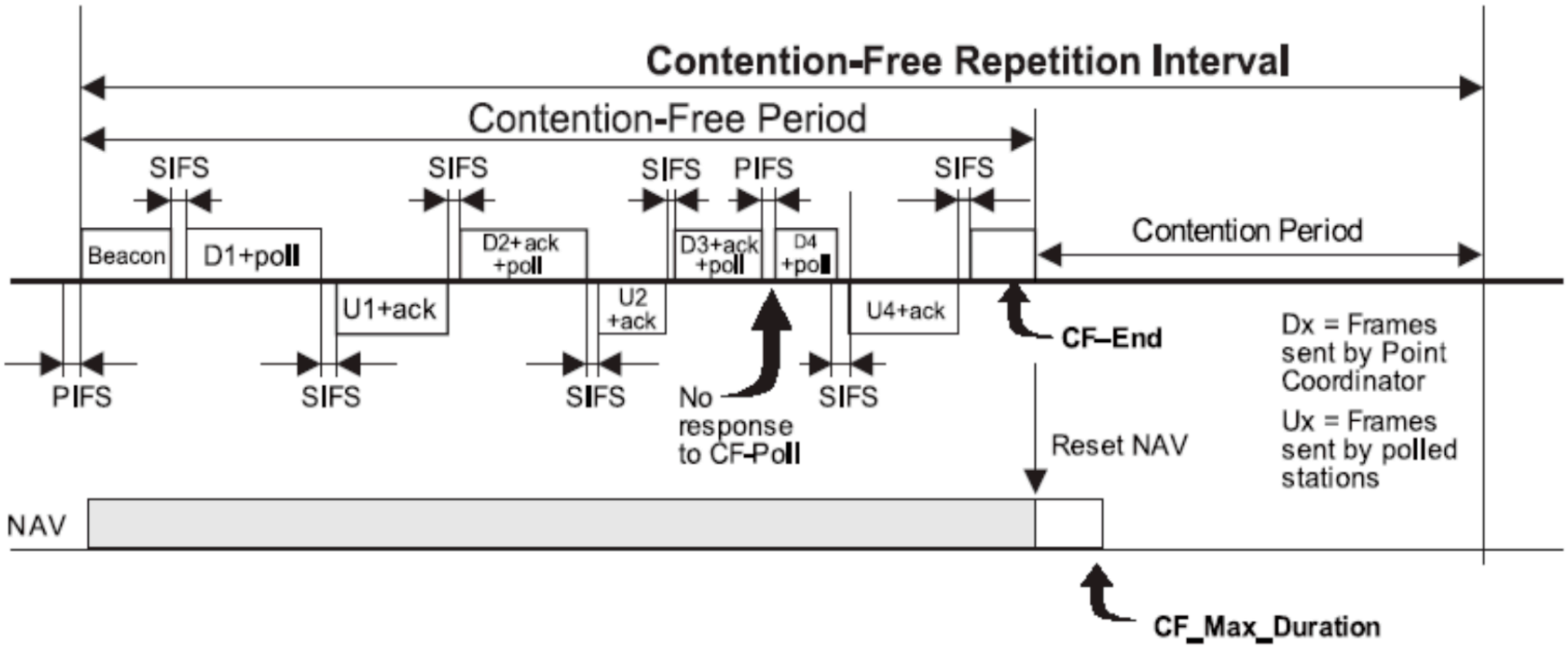
SIFS : small inter frame space

DIFS : DCF inter frame space

PIFS : PCF inter frame space

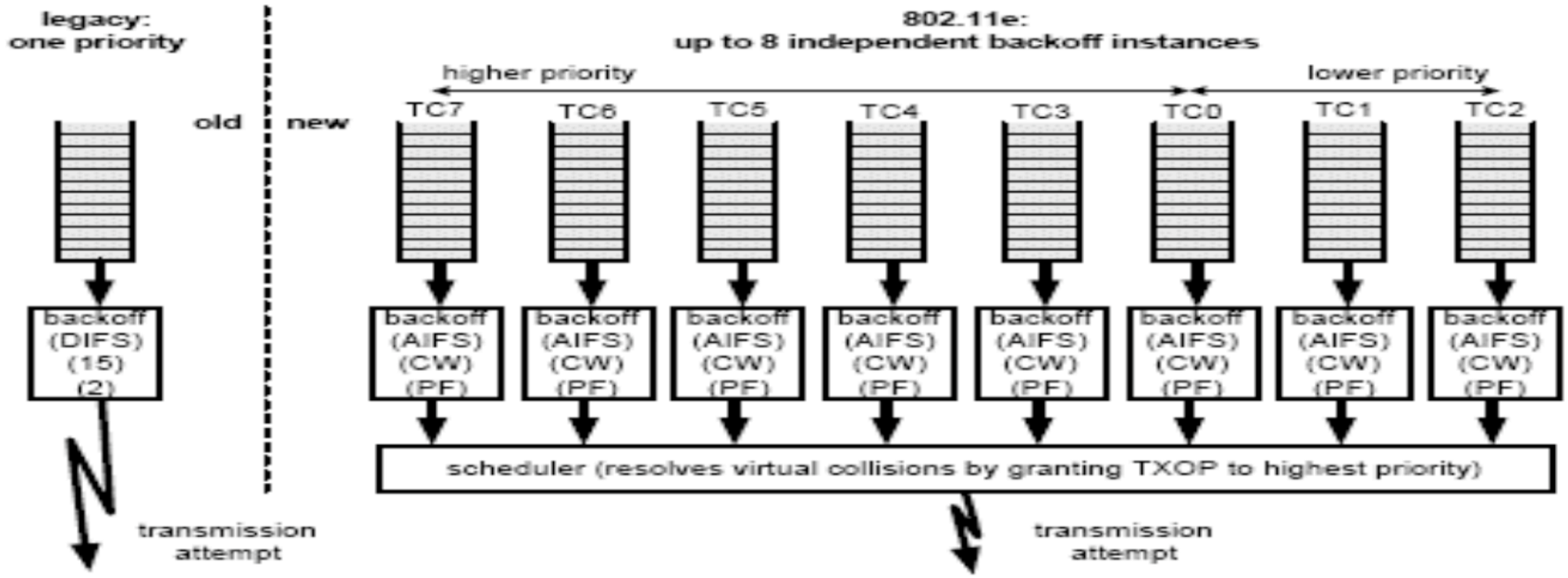
802.11 sin QoS

- PCF (Point Coordination Function)



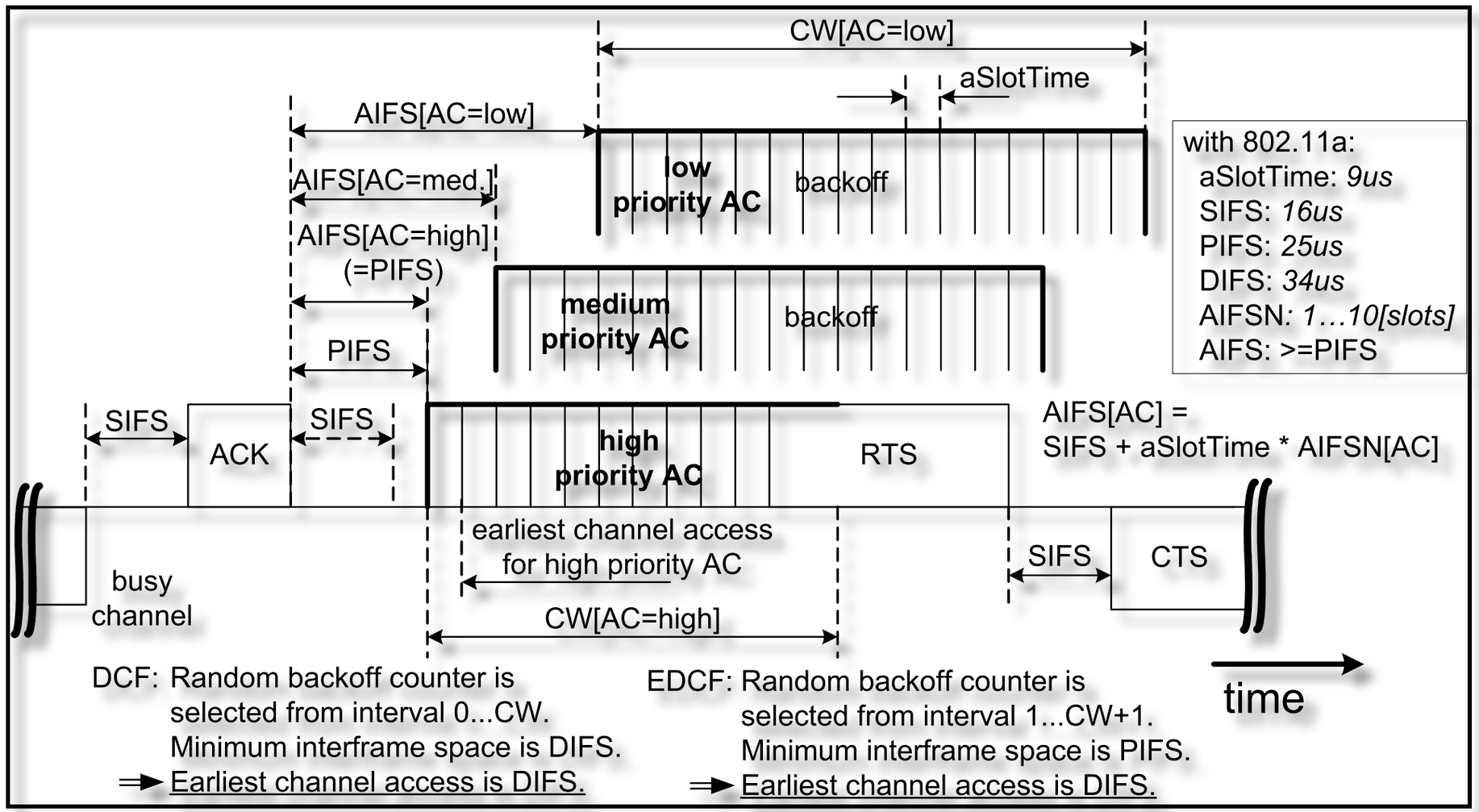
802.11e

- Clases de acceso AC para diferentes traffic categories TC



802.11e Medium Access: HCF

- Contention-based medium access: EDCF (Enhanced DCF)
- Different EDCF parameters per Access Category (AC)
  - DIFS→AIFS[AC]
  - CWmin→CWmin[AC]
  - CWmax→CWmax[AC]
  - (PF=2→PF[AC]*)



EDCF Summary

- EDCF MAC protocol is distributed (as DCF, simple)
- Multiple queues per station (queue = backoff entity)

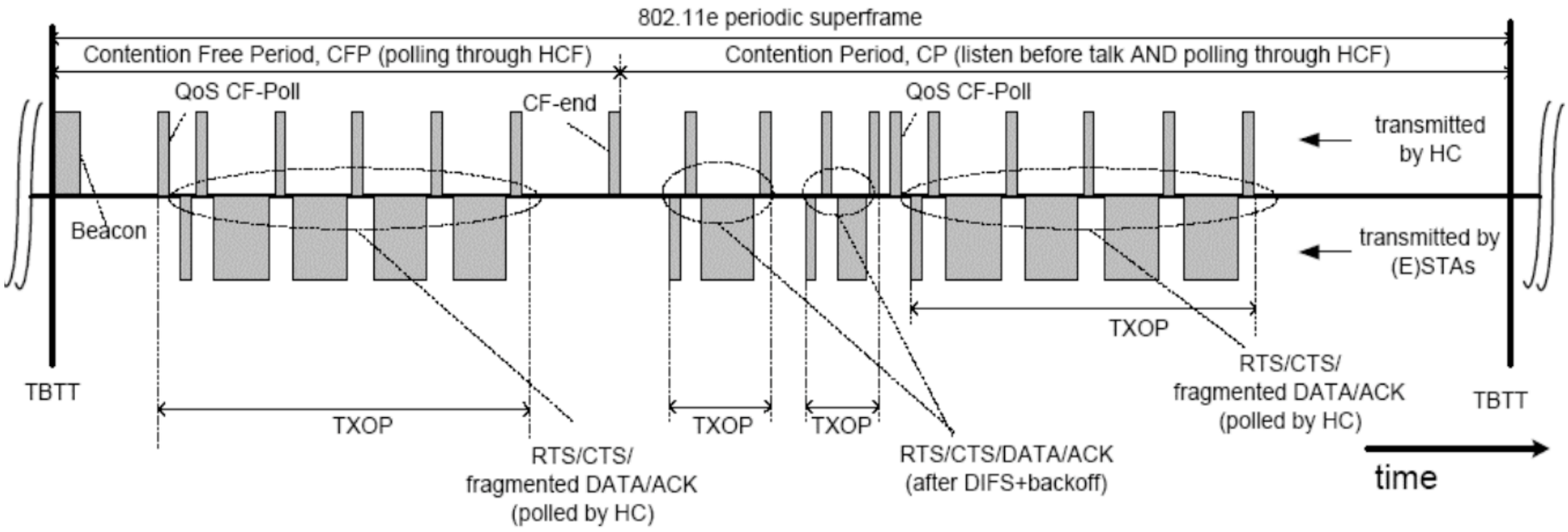
- EDCF supports QoS, but cannot guarantee as resulting share depends on activity of other backoff entities

QoS Support in legacy 802.11? → no!

QoS Support in 802.11e EDCF? → yes, but no guarantee!

HCF Controlled Medium Access

- EDCF cannot guarantee QoS, because of distributed MAC
- For guarantee, controlled medium access allows access right after PIFS, without backoff
- Similar to polling in legacy 802.11 (PCF)



- El HC puede dar el canal a estaciones que tienen reservado BW
- Incluso fuera del periodo de CFP

WiFI Multimedia (WMM)

- Perfil de 802.11e basado en EDCF unicamente
- Priorización de tráfico basado en cuatro clases de acceso
  - WMM Voice
  - WMM Video
  - WMM Best Effort
  - WMM Background
- Implementaciones comerciales