

# CS144

## An Introduction to Computer Networks

### Routing

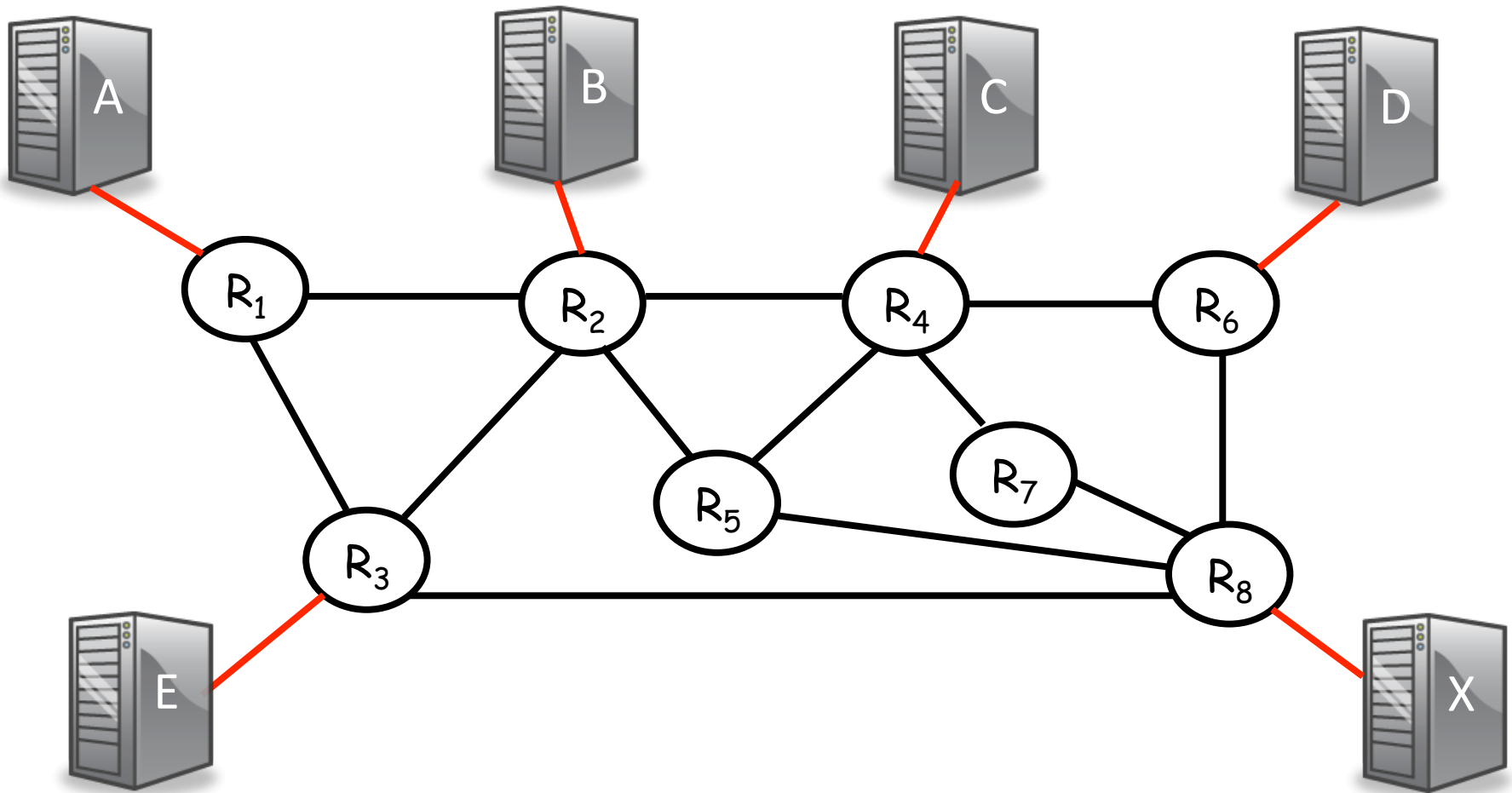
#### *Multicast Routing*



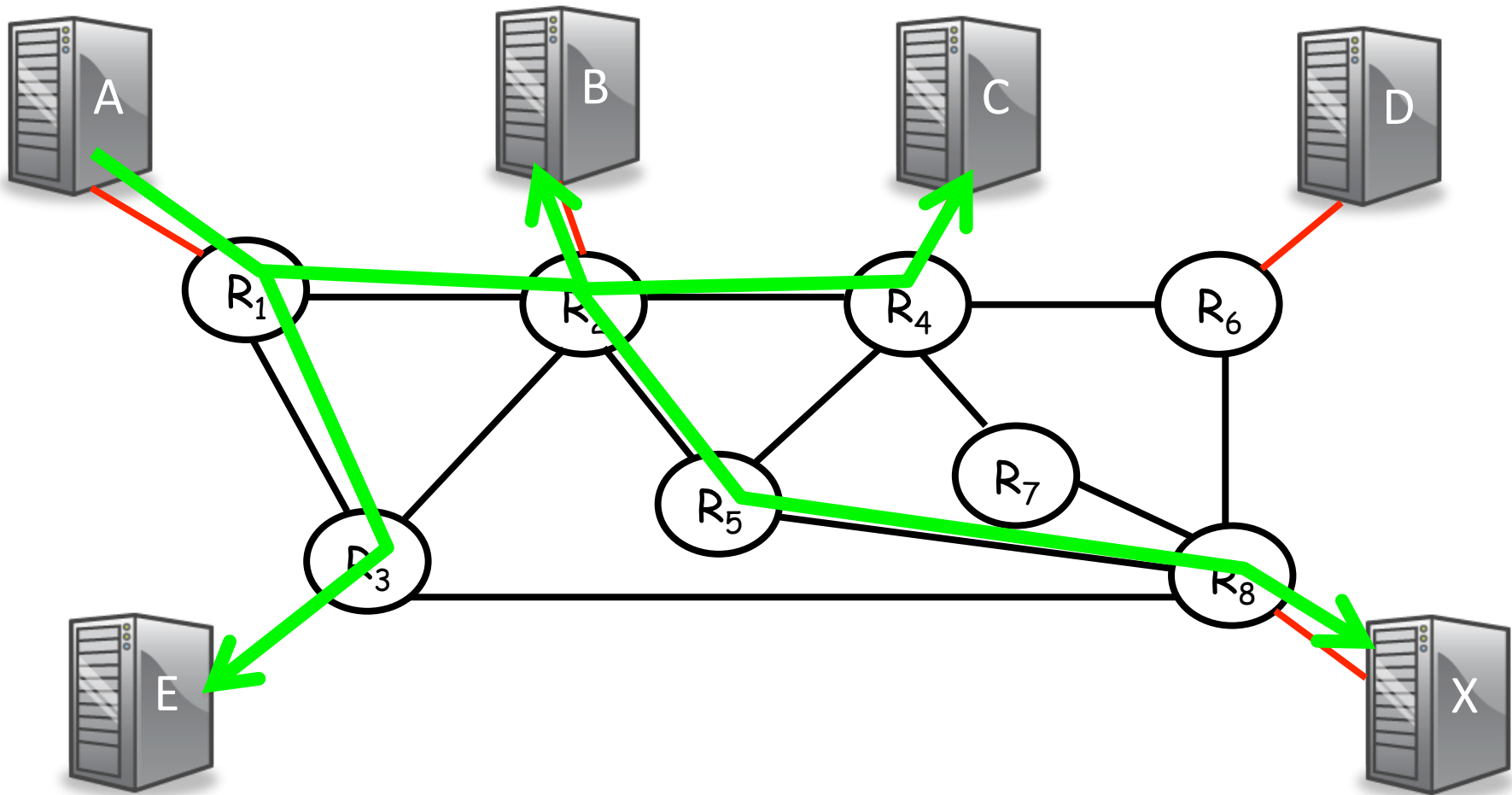
**Nick McKeown**

Professor of Electrical Engineering  
and Computer Science, Stanford University

# Multicast



# Multicast



# Multicast

## Techniques and Principles

- Reverse Path Broadcast (RPB) and Pruning
- One versus multiple trees

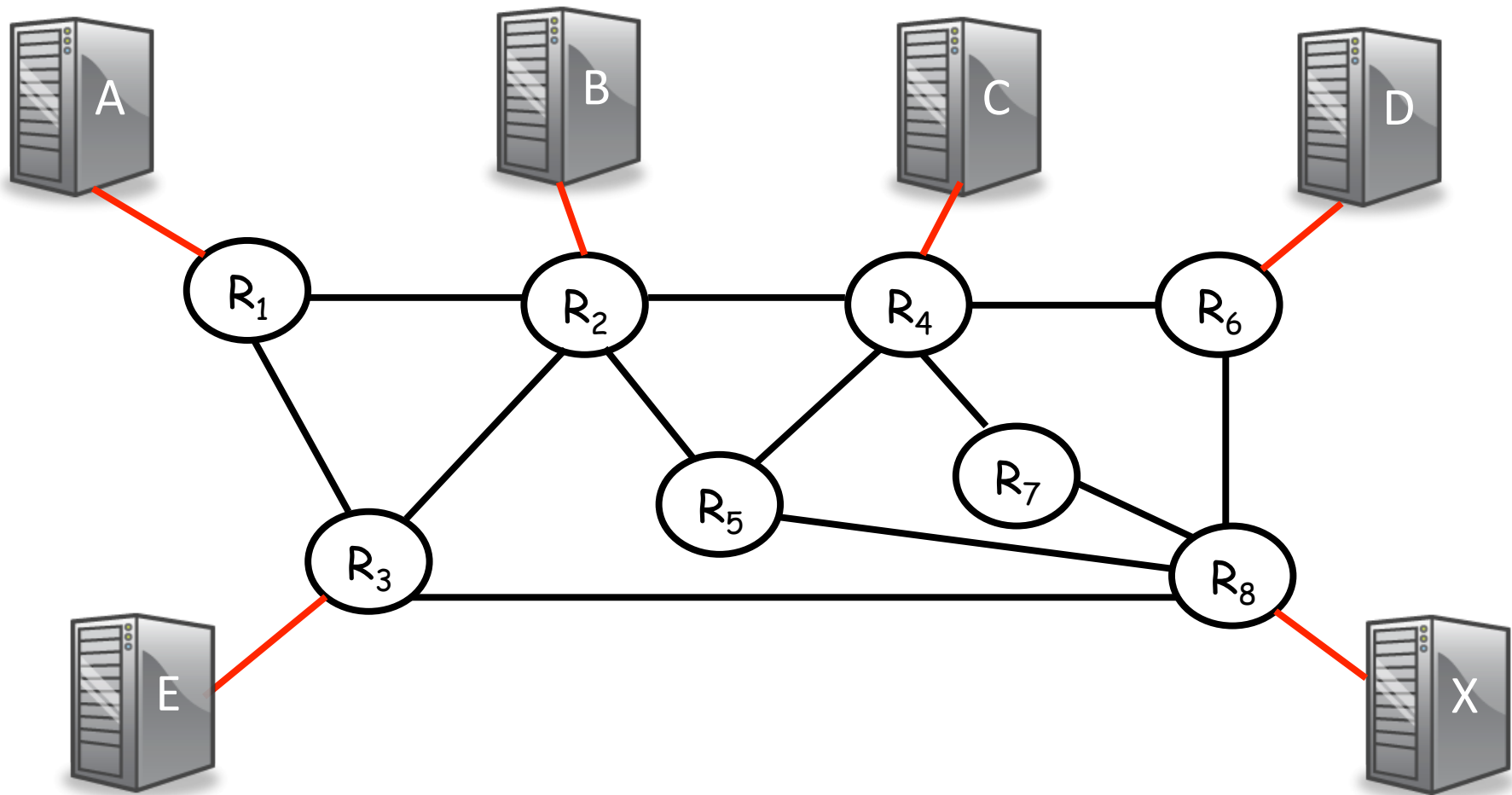
## Practice

- IGMP – group management
- DVMRP – the first multicast routing protocol
- PIM – protocol independent multicast

# Flooding

# Reverse Path Broadcast (RPB)

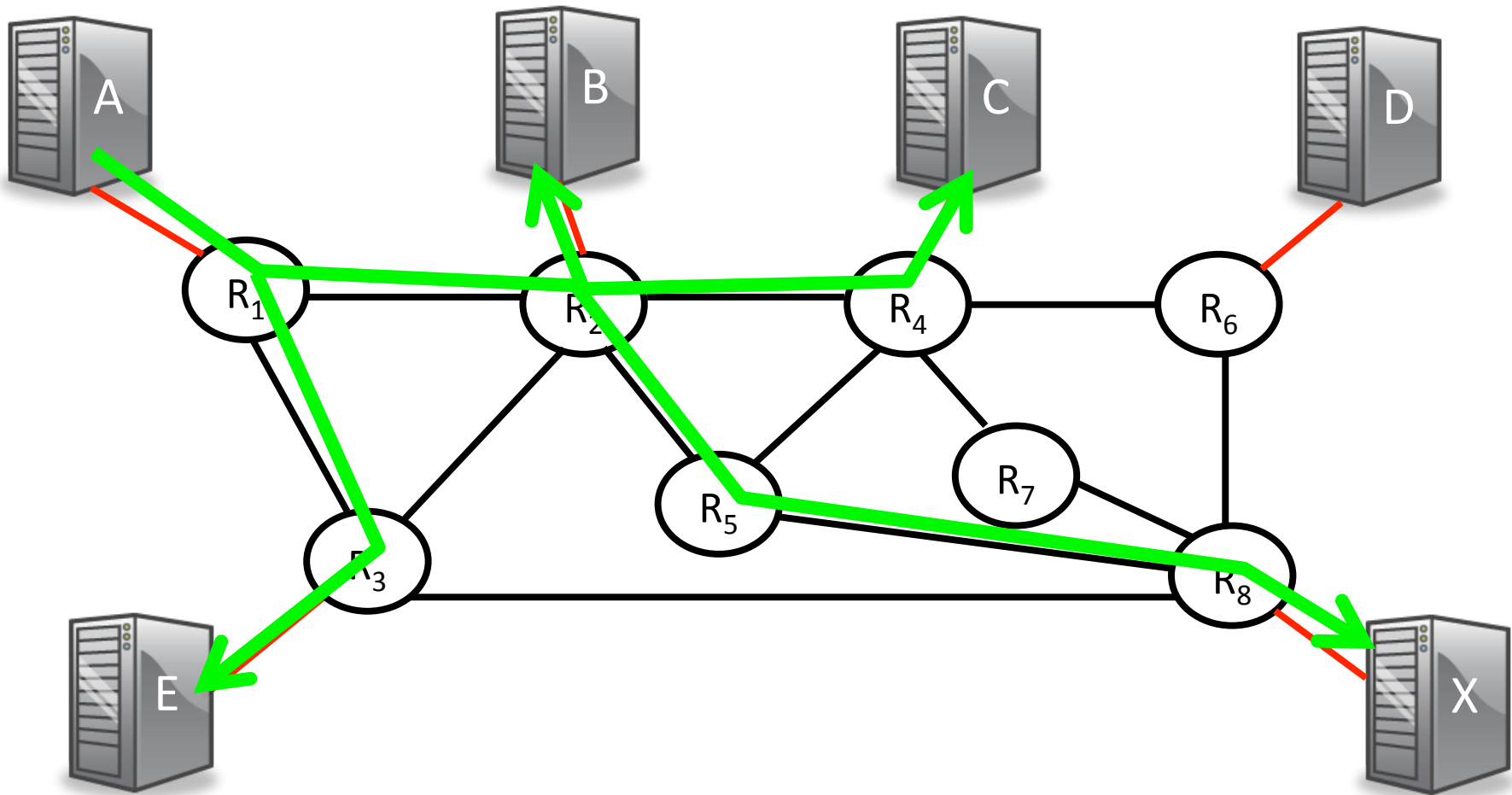
aka Reverse Path Forwarding (RPF)



# RPB + Pruning

1. Packets delivered loop-free to every end host.
2. Routers with no interested hosts send prune messages towards source.
3. Resulting tree is the minimum cost spanning tree from source to the set of interested hosts.

# One tree versus several trees?





# Multicast

## Techniques and Principles

- Reverse Path Broadcast (RPB) and Pruning
- One versus multiple trees

## Practice

- Multicast addresses
- IGMP – group management
- DVMRP – the first multicast routing protocol
- PIM – protocol independent multicast

# Addresses and joining a group

IPv4: Class D addresses are set aside for multicast.

IGMP\* (Internet group management protocol)

- Between host and directly attached router.
- Hosts ask to receive packets belonging to a particular multicast group.
- Routers periodically poll hosts to ask which groups they want.
- If no reply, membership times out (soft-state).

\*RFC 3376

# Multicast routing in the Internet

## DVMRP

- Distance Vector Multicast Routing Protocol (RFC 1075)
- First Internet routing protocol
- Uses RPB + Prune

## PIM

- Protocol Independent Multicast
- Two modes: dense mode, sparse mode
- Dense mode (RFC 3973): Similar to DVMRP
- Sparse mode (RFC 4601): Builds rendezvous points through which packets join small set of spanning trees.

# Multicast in practice

Multicast used less than originally expected

- Most communication is individualized (e.g. time shifting)
- Early implementations were inefficient
- Today, used for some IP TV and fast dissemination
- Some application-layer multicast routing used

Some interesting questions

- How to make multicast reliable?
- How to implement flow-control?
- How to support different rates for different end users?
- How to secure a multicast conversation?