CS 439: Wireless Networking

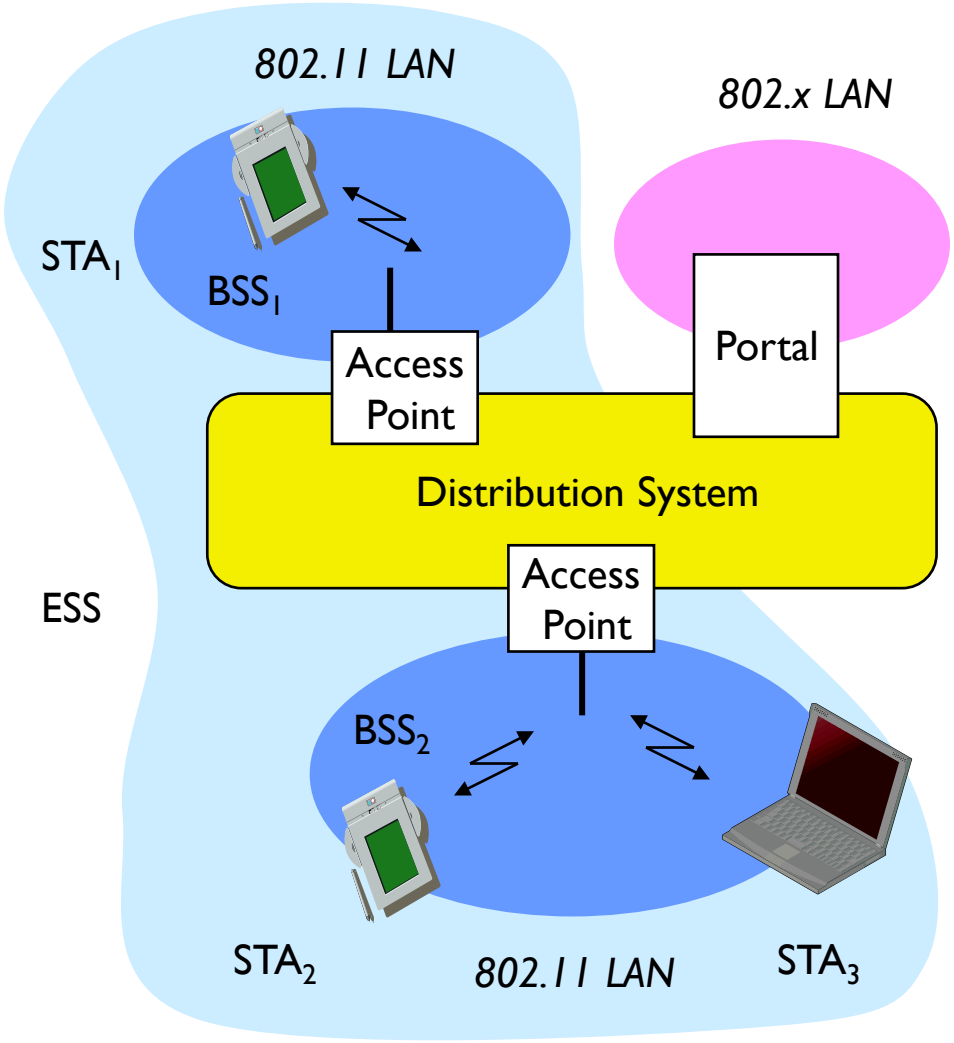
MAC Layer – Management

Management and Control Services

- Association management

- Handoff
- Security: authentication and privacy
- Power management
- QoS

802.11: Infrastructure



- Station (STA)
  - Terminal with access to the wireless medium and radio contact to the access point
- Access Point
  - Station integrated into the wireless LAN and the distribution system
- Basic Service Set (BSS)
  - Group of stations using the same AP
- Portal
  - Bridge to other (wired) networks
- Distribution System
  - Interconnection network to form one logical network (ESS: Extended Service Set) based on several BSS

Service Set Identifier - SSID

- Mechanism used to segment wireless networks
  - Multiple independent wireless networks can coexist in the same location
  - Effectively the name of the wireless network
- Each AP is programmed with a SSID that corresponds to its network
  - Client computer presents correct SSID to access AP
- Security Compromises
  - AP can be configured to "broadcast" its SSID
  - Broadcasting can be disabled to improve security
  - SSID may be shared among users of the wireless segment

Association Management

- Stations must associate with an AP before using network
  - AP must know about them so it can forward packets
  - Often also must authenticate
- Initiated by the wireless host
  - Scanning
    - Finding out what access points are available
  - Selection
    - Deciding what AP (or ESS) to use
  - Association
    - Protocol to "sign up" with AP – involves exchange of parameters
  - Authentication
    - Needed to gain access to secure APs – many options possible
- Disassociation
  - Station or AP can terminate association

Association Management: Scanning

- Stations can detect AP based by scanning
- Passive Scanning
  - Station simply listens for Beacon and gets info of the BSS
    - Beacons are sent roughly 10 times per second
    - Power is saved
- Active Scanning
  - Station transmits Probe Request; elicits Probe Response from AP
    - Saves time + is more thorough
    - Wait for 10-20 msec for response
- Scanning all available channels can become very time consuming!
  - Especially with passive scanning
  - Cannot transmit and receive frames during most of that time – not a big problem during initial association

Association Management: Selecting an AP and Joining

- Selecting a BSS or ESS typically involves the user
  - What networks do you trust? Are you willing to pay?
  - Can be done automatically based on stated user preferences (e.g. the "automatic" list in Windows)
- The wireless host selects the AP it will use in an ESS based on vendor-specific algorithm
  - Uses the information from the scan
  - Typically simply joins the AP with the strongest signal
- Associating with an AP
  - Synchronization in Timestamp Field and frequency
  - Adopt PHY parameters
  - Other parameters: BSSID, WEP, Beacon Period, etc.

Association Management: Roaming

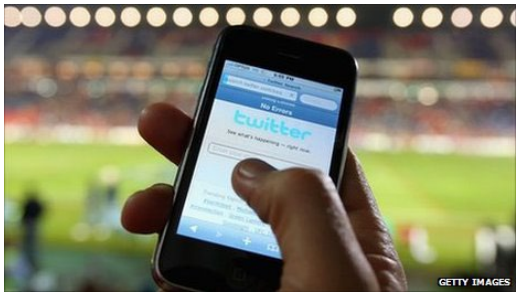
- Reassociation
  - Association is transferred from active AP to a new target AP
    - Supports mobility in the same ESS – layer 2 roaming
  - Initiated by wireless host based on vendor specific algorithms
    - Implemented using an Association Request Frame that is sent to the new AP
    - New AP accepts or rejects the request using an Association Response Frame

Association Management: Reassociation Algorithms

- Failure driven
  - Only try to reassociate after connection to current AP is lost
    - Typically efficient for stationary clients since it not common that the best AP changes during a session
    - Mostly useful for nomadic clients
    - Can be very disruptive for mobile devices
- Proactive reassociation
  - Periodically try to find an AP with a stronger signal
    - Tricky part: cannot communicate while scanning other channels
    - Trick: user power save mode to "hold" messages
    - Throughput during scanning is still affected though
      - Mostly affects latency sensitive applications

Making Dense Networks work for You

High Density WLANs



- **Stadiums, arenas, and ballparks**
- **Concert halls and amphitheaters**
- **Convention center meeting halls**
- **Lecture halls and auditoriums**
- **Press areas at public events**
- **Airport concourses**

High Density Networks

Characteristics of Dense Networks

- More neighbors
- Frequent traffic
- Redundancy

Wireless

- Shared medium
- Limited energy resources

High contention

Dense WLANs

AP provides good connectivity when number of devices < 50

Number of devices > 500

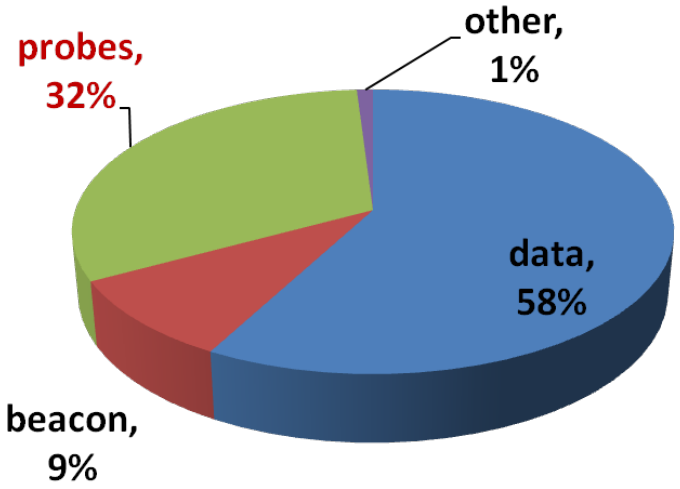
Co-channel interference limits the max. number of APs to 3

All APs are overloaded

User Traces

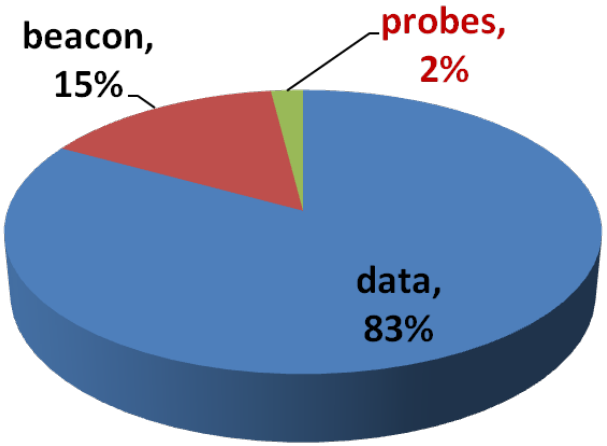
Busy Session

- 824 devices
- 2 APs – channel 6 & 11



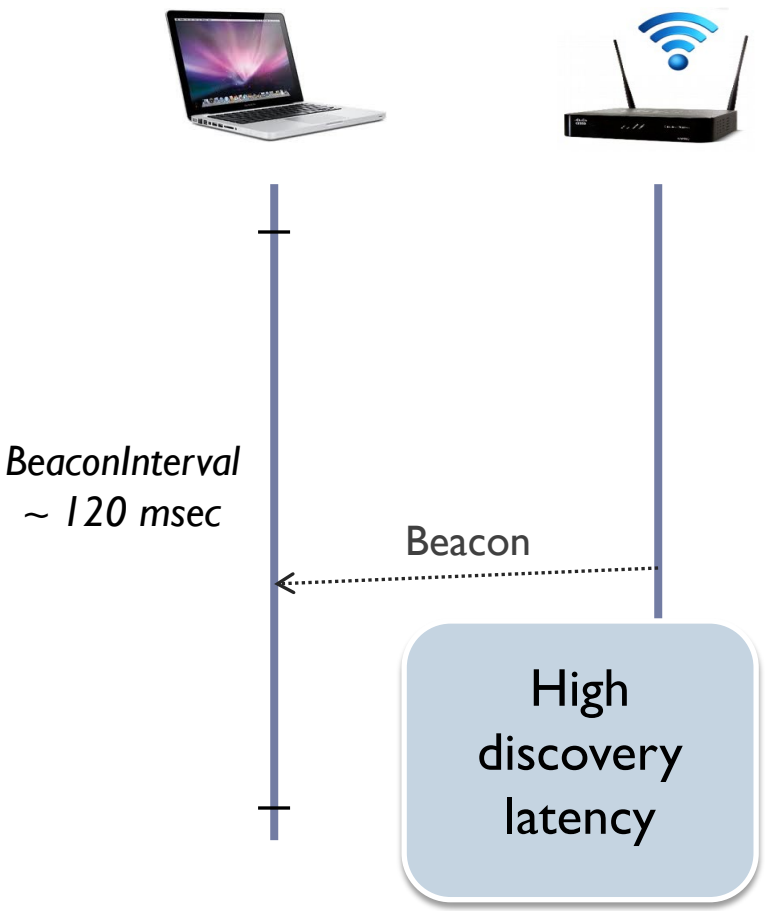
Moderate Session

- 62 devices
- 1 AP – channel 6

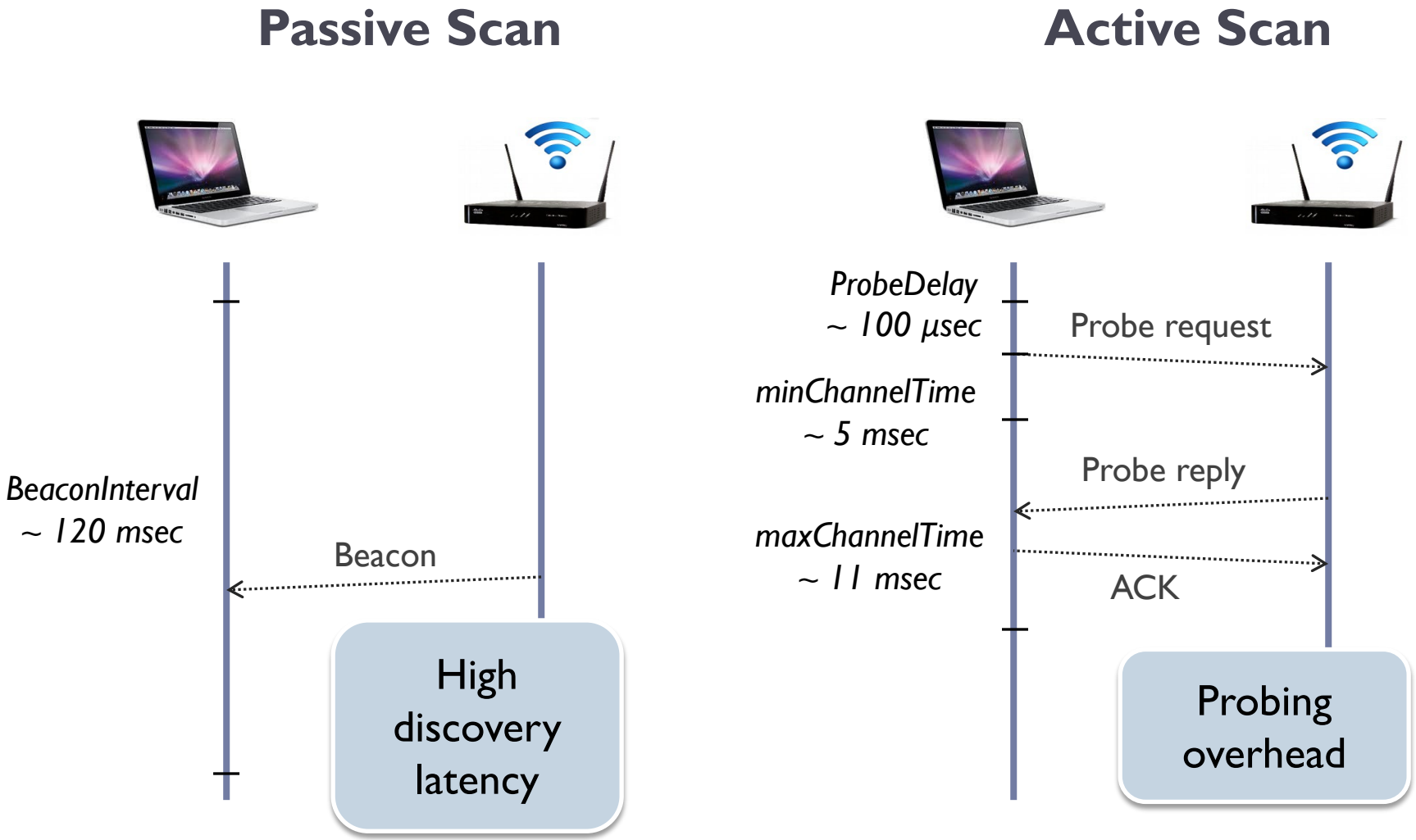


AP Discovery in IEEE standards

Passive Scan



AP Discovery in IEEE standards



AP Discovery in Device Drivers

Hybrid Scan

Passive Scan

Beacon

Targeted Active Scan

Probe request for **IllinoisNet**

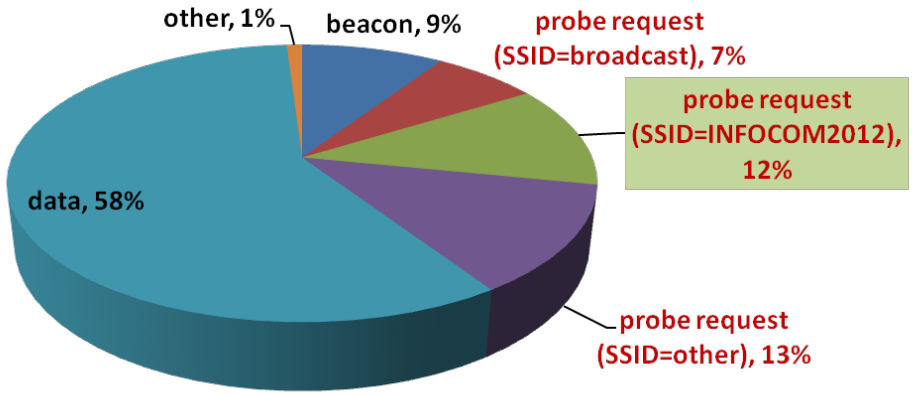
Probe request for **Eduroam**

Broadcast Active Scan

Probe request for **ALL**

Probe reply

ACK



Busy Traces

Even more probing overhead

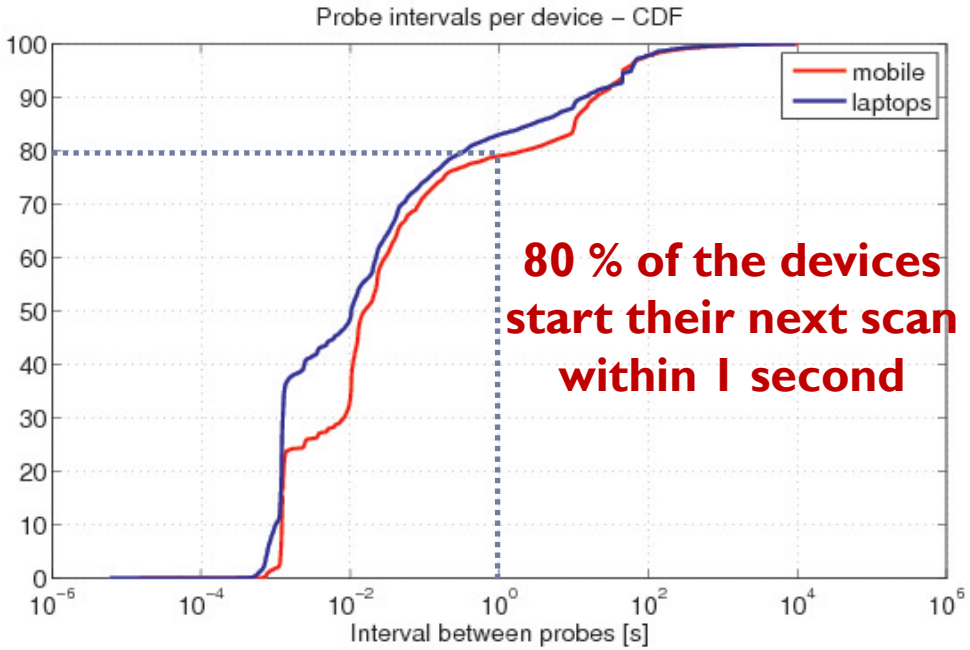
Probe Storms in Busy Traces

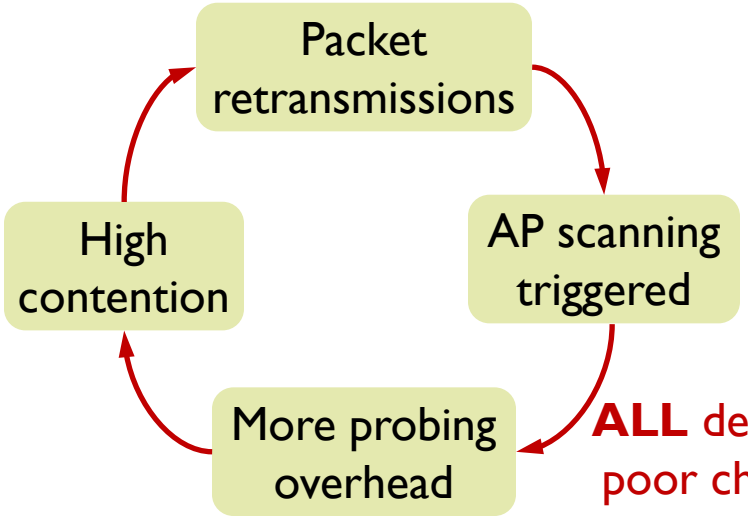
Laptops ~ 569

Avg. Probes ~ 227

Smartphones & tablets ~ 255

Avg. Probes ~ 373



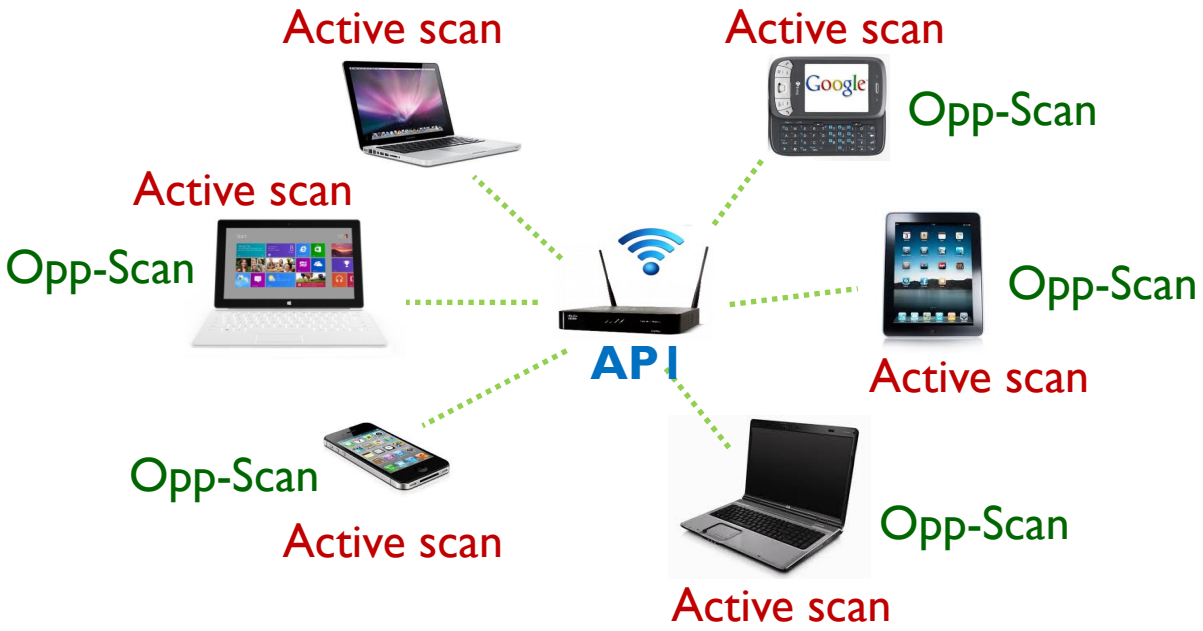


ALL devices experience poor channel conditions

Preventing Probe Storms

- Find a new AP
- Cache AP information
- Broadcast probe responses
- Pre-scan
- Fix timeouts
- Neighbor pruning

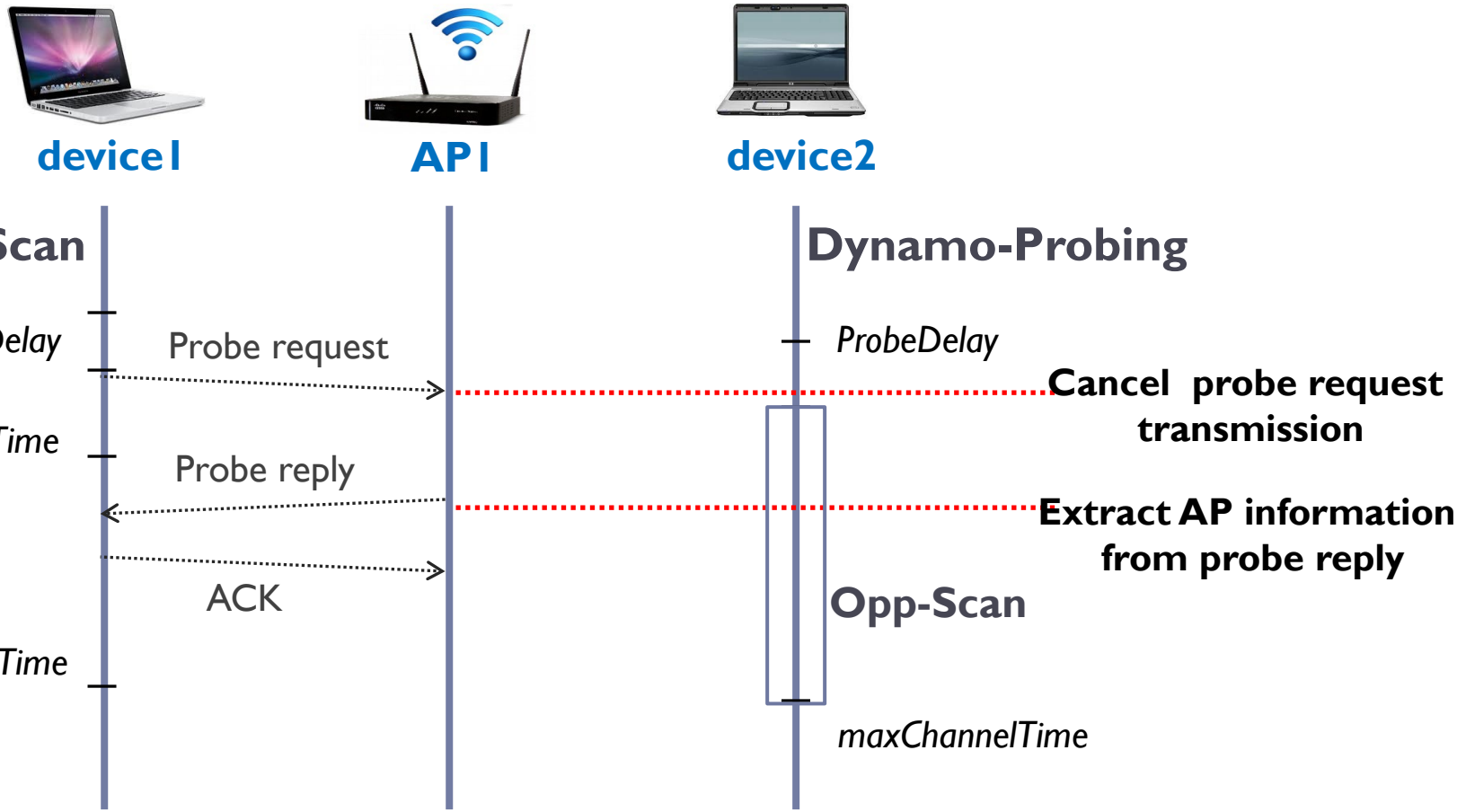
Dynamic Opportunistic Probing



Dynamo-Probing

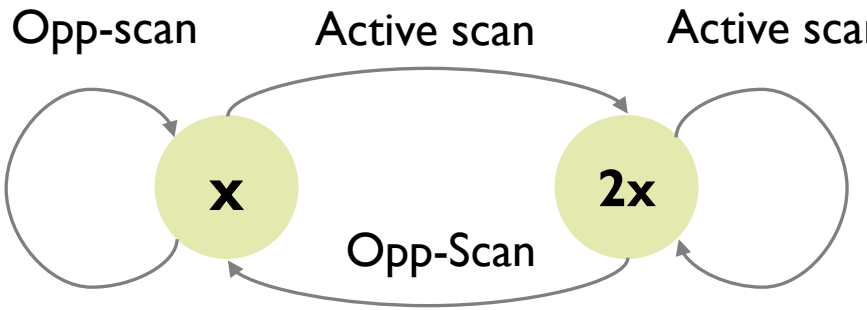
Opportunistic Scan	Active Scan
• No probe overhead • Fast discovery	• High probe overhead • Fast discovery

Dynamo-Probing



Dynamo-Probing: Mode Switch

Priority Based:



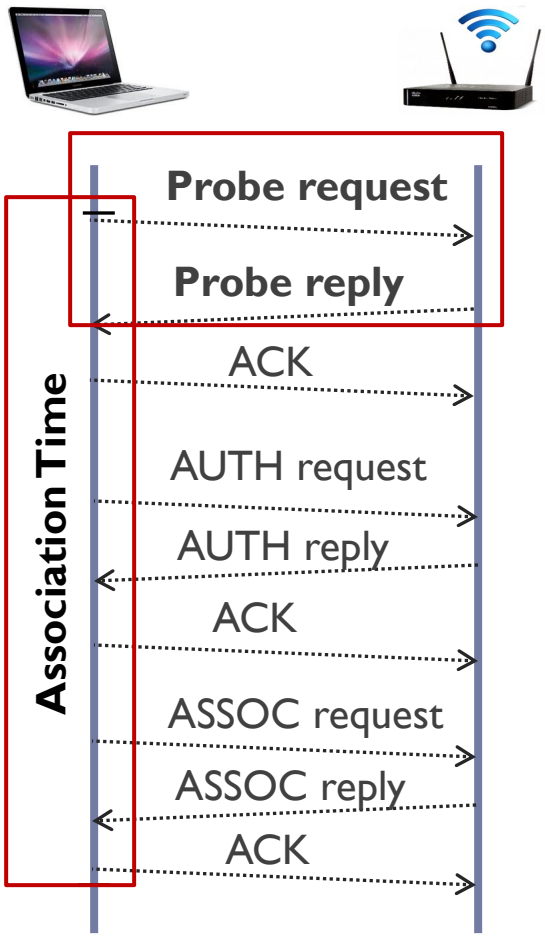
Static:
All devices have the same *ProbeDelay* = x

Evaluation

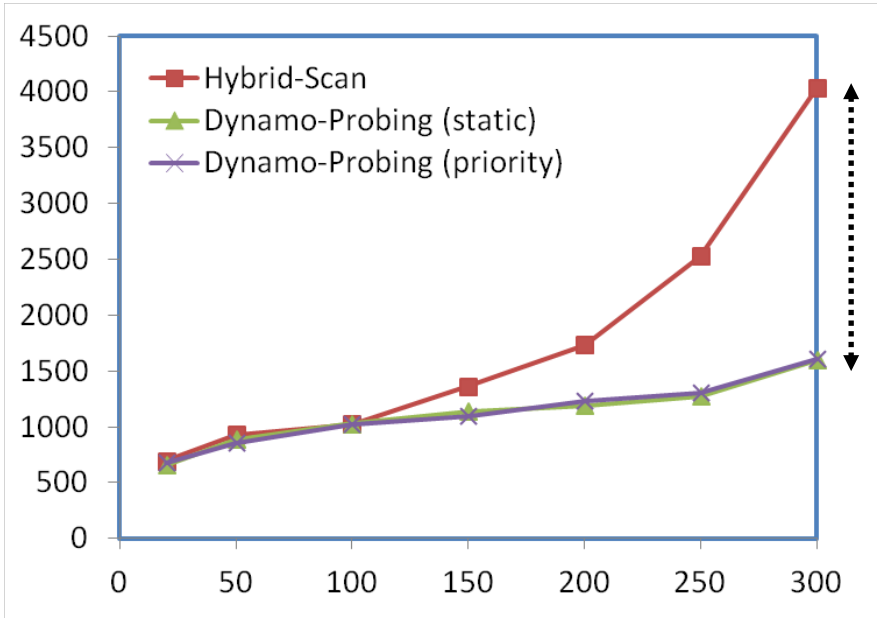
- Dynamo-Probing is an **effective**, **efficient**, **adaptive** and **interoperable** scanning solution

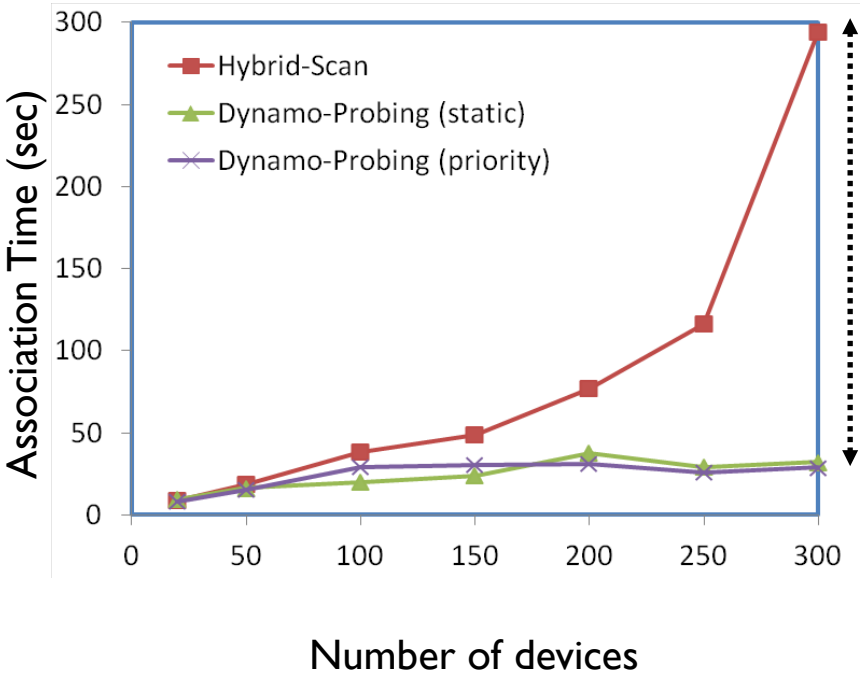
- Metric
  - **Effectiveness:** total probes, association time
  - **Efficiency:** throughput, delay, packet drops

- Network & Traffic
  - Varying density
  - Simulate Internet traffic



Effectiveness

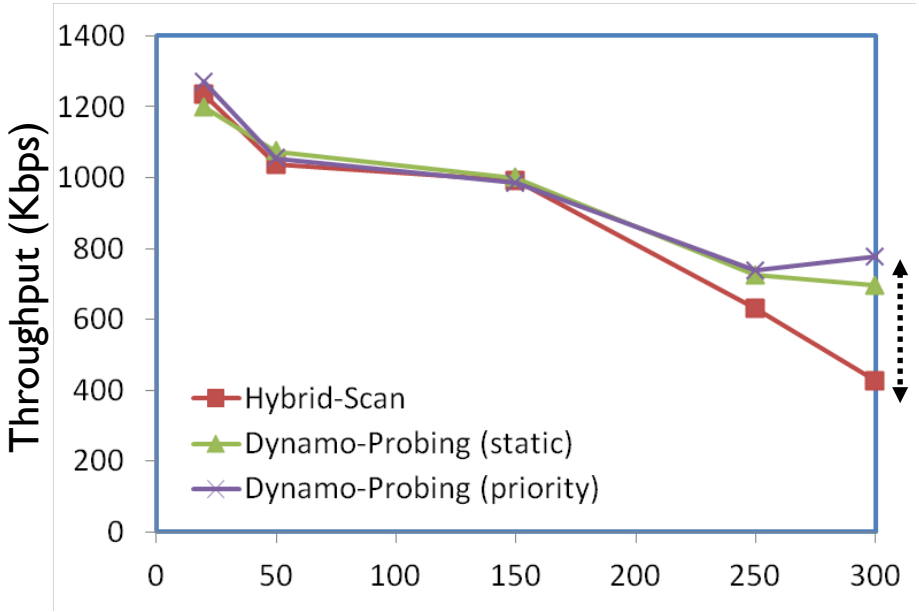




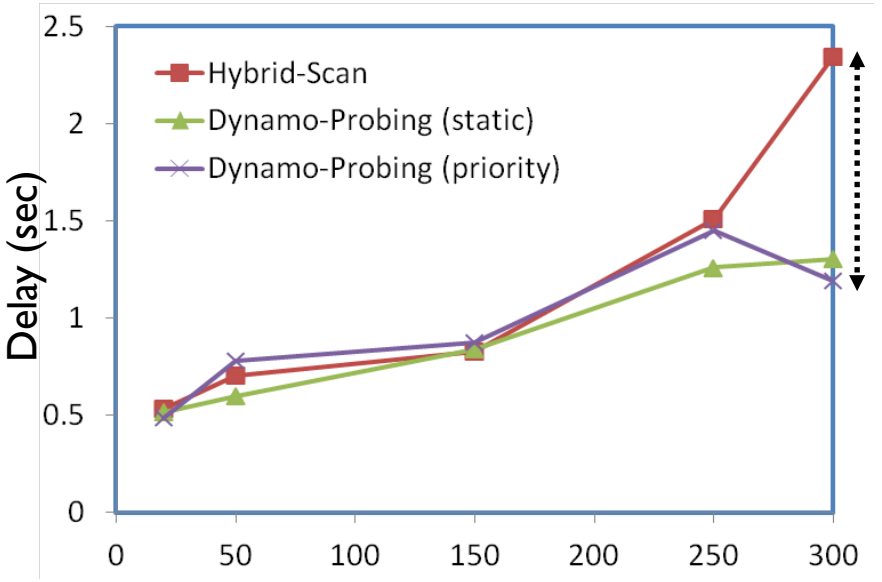
Reduces probing overhead by 59%

Reduces discovery latency by 90%

Efficiency

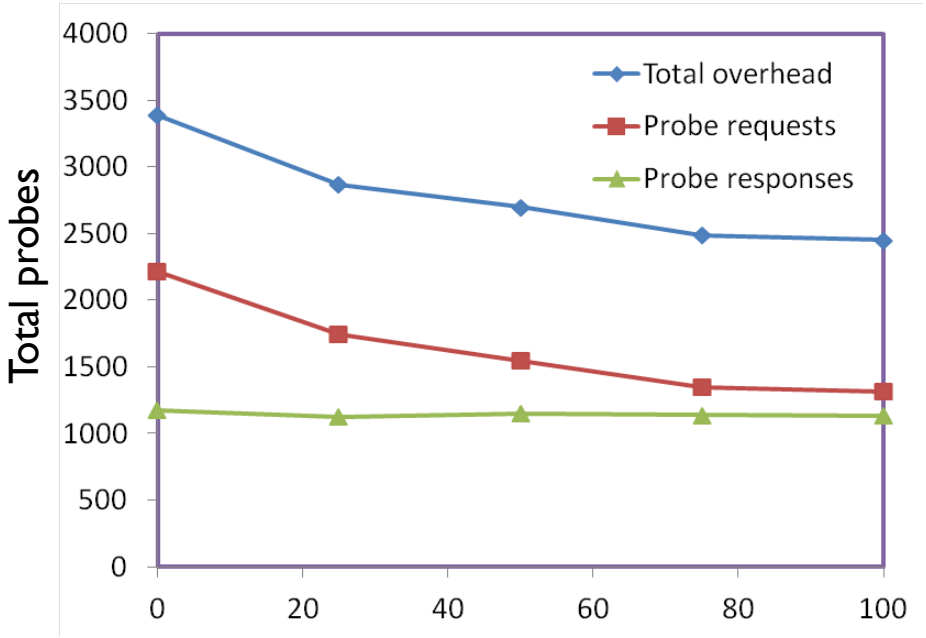


Improves throughput by 82%



Reduces delay by 50%

Incremental Deployment



ALL Hybrid-Scan devices

ALL Dynamo-Probing devices

Probing overhead reduced by 21% with 25% deployment

Achieves maximum benefit with only 75% deployment

(Network density=250 devices)

Summary

- Enables fast AP discovery without overloading the network with streams of probe packets
- Adaptive with density and interoperable with legacy devices
- Leverages the ***close proximity of devices*** and their ***similar AP fingerprints*** to obtain AP information opportunistically