Adaptive Distributed and Centralized Coordination

A Review of Some Properties of the Hybrid Protocol

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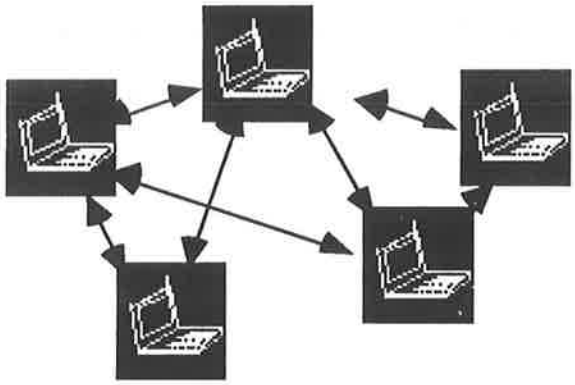
The Hybrid Protocol

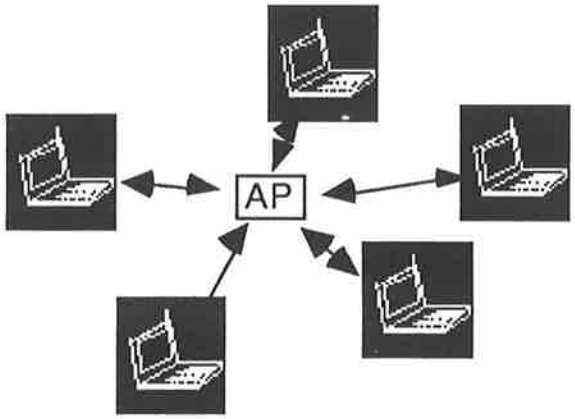
- Provides two data delivery services
  - An asynchronous service: providing stochastic, low delay datagram delivery services
  - A synchronous service: providing time-based, low delay variance stream datagram delivery services
  - The synchronous service is built atop the asynchronous service adding constraints on MSDU delivery timing
  - The asynchronous service always defers to the synchronous service
  - Independent simulation results indicate effectiveness of protocol:
    - Asynchronous service has > 80% maximum throughput
    - Asynchronous service has low delay at normal loads
- Provides two data forwarding BSA configurations
  - A peer configuration: providing direct station-to-station communications with optional MSDU forwarding through access points when stations are not in direct PHY range
  - A hierarchical configuration: providing mandatory indirect station-to-station communications through access points
    - Hierarchical built on peer
    - Hierarchical and peer can interpenetrate and coexist
- Essentially each BSA can have one of four coordination configurations

Hybrid Protocol BSA Configurations

- Peer BSA Configuration
  - Incomplete Station Connectivity
  - Distributed Coordination
  - Both Asynchronous and Synchronous data delivery services supported



- Hierarchical BSA Configuration
  - Incomplete station connectivity
  - Complete station connectivity to Access Point
  - Both Asynchronous and Synchronous data delivery services supported
    - Implicit central coordination for Async services, explicit central coordination for Sync services

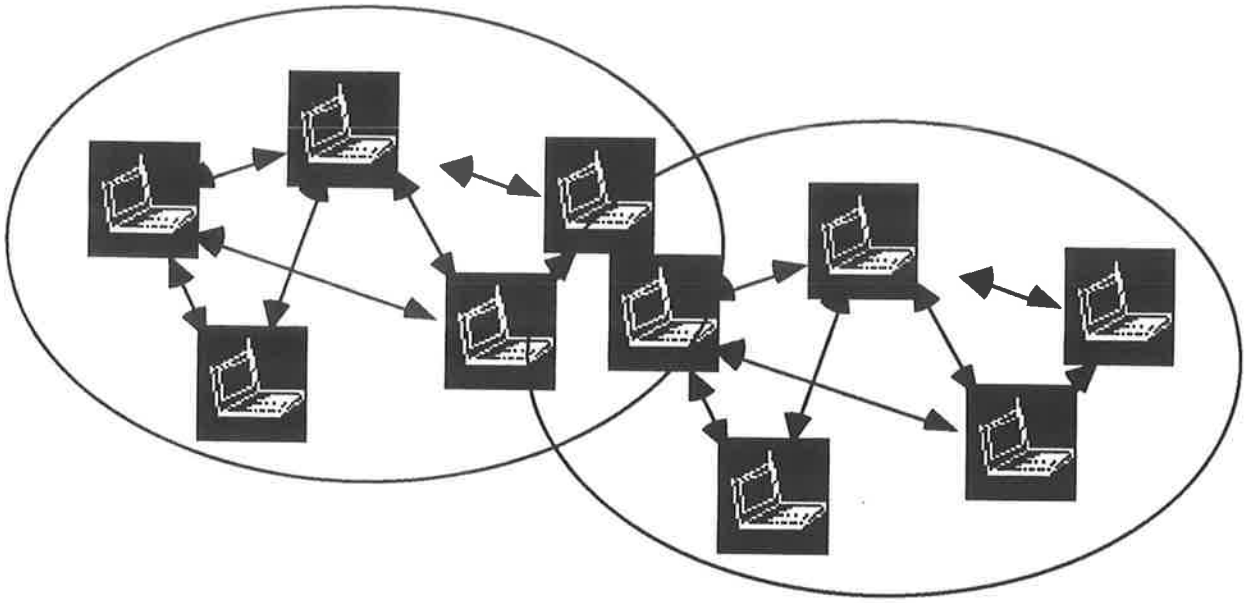


Hybrid Protocol ESA Configurations

- Need to support interaction between overlapping WLANs along a variety of configurations
  - Same or differing administrations
  - Configured data delivery services: Async and/or Sync in either or both WLANs
  - Configured structure: Peer or hierarchical
- Following charts will consider several examples
  - Assume single channel PHY for simplicity

Hybrid Protocol ESA Configuration Example

Overlapping Peer Networks

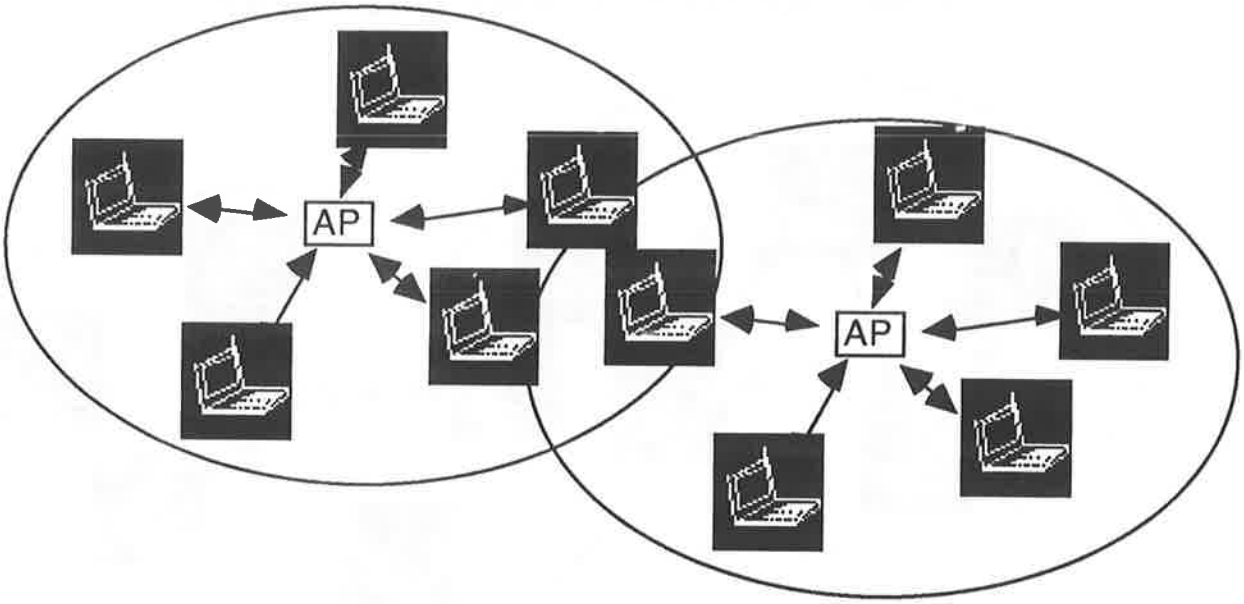


- If <u>differing</u> administrations
  - Networks will cooperatively share bandwidth but will not permit data delivery between stations of differing administrations (registration/access control)
  - Share bandwidth in intersection; space division multiplexing effects outside of intersection
  - Each network can independently offer either or both Asynchronous and Synchronous services
  - Shared bandwidth can be overcommitted for the Synchronous Service and some bandwidth requests in the overlap can be denied; overloaded Asynchronous Service will degrade data delivery performance - increased delay
- If <u>same</u> administration
  - Networks will cooperatively share bandwidth and permit data delivery between all stations that can directly communicatel If networks are each served by an optional access point (in which access points are in turn inteconnected via an infrastructure): a station in range of its destination station or within range of an access point will support data delivery

- Each network can independently offer either or both Asynchronous and Synchronous services

Hybrid Protocol ESA Configuration Example

Overlapping Hierarchical Networks

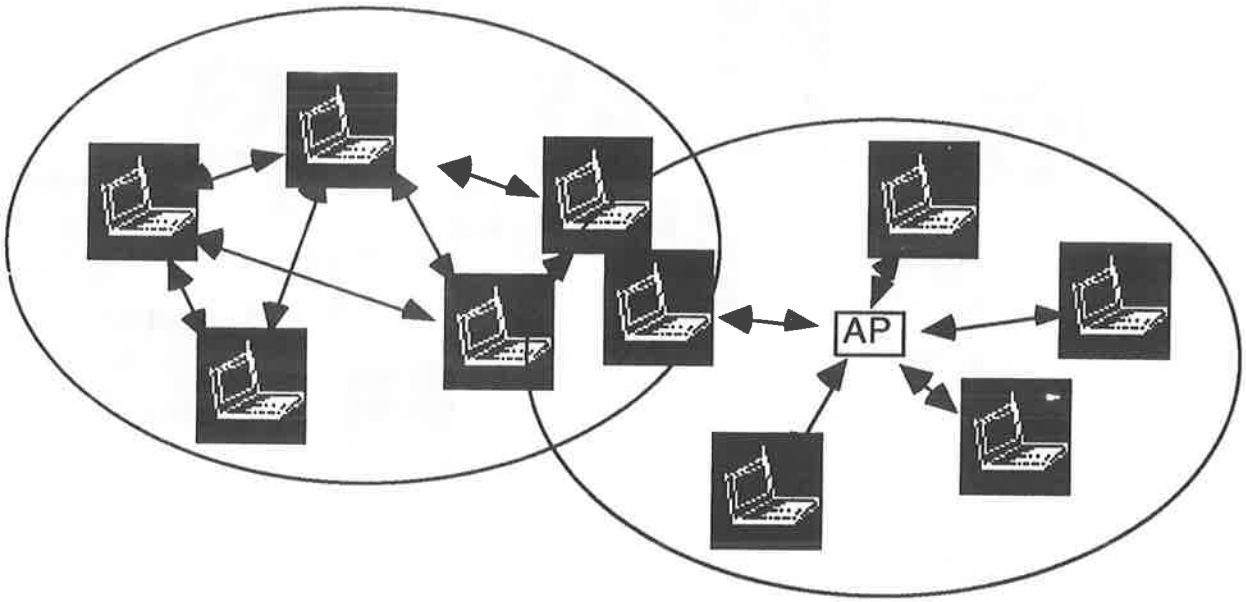


- If <u>differing</u> administrations
  - Networks will cooperatively share bandwidth but will not permit data delivery between stations of differing administrations (registration/access control) nor to stations not in range of an Access Point of its administration
  - Share bandwidth in intersection; space division multiplexing effects outside of intersection
  - Each network can independently offer either or both Asynchronous and Synchronous services
  - Shared bandwidth can be overcommitted for the Synchronous Service and some bandwidth requests in the overlap can be denied; overloaded Asynchronous Service will degrade data delivery performance - increased delay
- If <u>same</u> administration
  - Networks will cooperatively share bandwidth and permit data delivery between all stations that can directly communicate with its Access Point and via infrastructure interconnecting Access Points

- Each network can independently offer either or both Asynchronous and Synchronous services

Hybrid Protocol ESA Configuration Example

Overlapping Mixed Networks

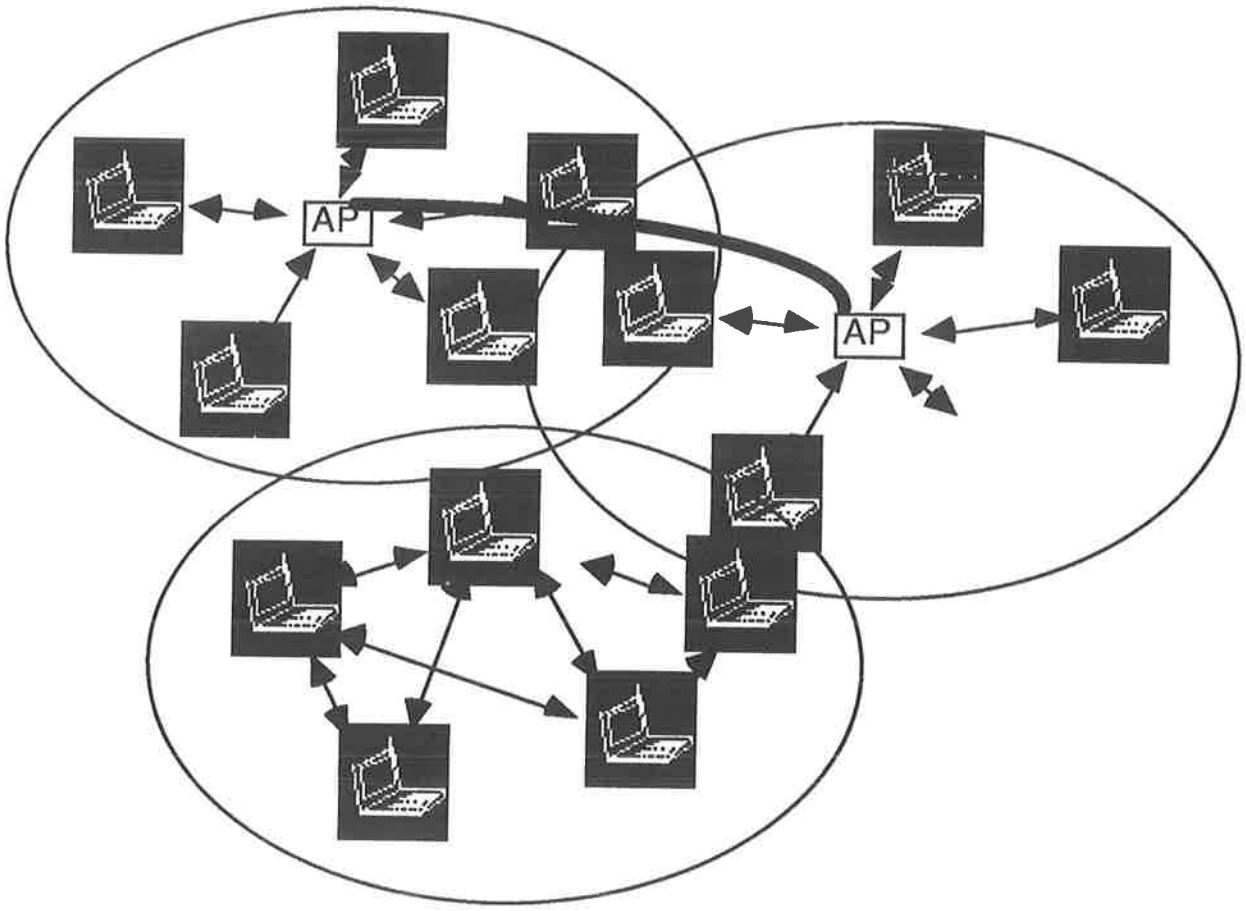


- If <u>differing</u> administrations
  - Networks will cooperatively share bandwidth but will not permit data delivery between stations of differing administrations (registration/access control)
  - Share bandwidth in intersection; space division multiplexing effects outside of intersection
  - Each network can independently offer either or both Asynchronous and Synchronous services
  - Shared bandwidth can be overcommitted for the Synchronous Service and some bandwidth requests in the overlap can be denied; overloaded Asynchronous Service will degrade data delivery performance - increased delay
- If <u>same</u> administration
  - Networks will cooperatively share bandwidth and permit data delivery between all stations that can directly communicate (in the peer BSA) or to an Access Point (in either BSA) - assuming Access Points interconnected through infrastructure

- Each network can independently offer either or both Asynchronous and Synchronous services

Hybrid Protocol ESA Configuration Example

An Overlapping Ad Hoc Network



- Assume differing administrations
- Networks will cooperatively share bandwidth but will not permit data delivery between stations of differing administrations (registration/access control)
- Share bandwidth in intersection; space division multiplexing effects outside of intersection
- Each network can independently offer either or both Asynchronous and Synchronous services
- Shared bandwidth can be overcommitted for the Synchronous Service and some bandwidth requests in the overlap can be denied; Highly committed Synchronous Service allocations can "freeze out"

overlapping Asynchronous Service - Async performance degrades "gracefully"

Summary

- The Hybrid Protocol is a robust architecture supporting a wide variety of WLAN configurations with minimal preconfiguration
- It presents a solution to
  - multiple, overlapping ad hoc networks
  - multiple, overlapping extended WLAN infrastructure systems
  - overlapping ad hoc networks within large WLAN infrastructures

  while
  - Preserving choice of data delivery service
  - Preserving access control
  - Providing graceful degradation of Asynchronous Service; possible impossible allocations between WLANs of differing administrations offering Synchronous Service