802.11 DS Services Transactions.

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Distribution System Services

- Association:
  - The service which enables the establishment of an initial Association between a STA and an AP.
- Reassociation:
  - The service which enables an established Association (of a Station) to be transferred from one AP to another AP.
- Disassociation:
  - The service which removes an existing Association.
- Distribution:
  - The service which (by using Association information) delivers MSDUs within the DS.

Distribution System Services

- Authentication:
  - The service used to establish the identity of Stations and APs to each other.
- Privacy:
  - The functionality used to prevent the contents of messages from being read by other than the intended recipient.
- Integration:
  - The service which enables delivery of MSDUs between the DS and an existing network.
- Network Management
  - TBD.

The Transaction Concept

- Each DSS requires one or more transfers of information between components of the architecture.
- Within this presentation I have chosen to call such an information exchange a "transaction".
- A transaction is a logical abstraction convenient for discussing DSS functionality.
- A transaction is typically implemented by one or more messages in any particular protocol.
- In any specific protocol proposal, it should be possible for us to identify a set of messages that implement the conceptual transactions (which in turn provide the DS services).

Station States

- Authentication state
- Association state

Authentication States

- Unauthenticated
  - Initial state
- Authenticated
  - Each end of a link now has validated the identity of the other end and can provide appropriate services.

Authentication service Transactions

- Must establish mutually acceptable authentication.
- Transaction model must enable both simple, unsecured networks and more complex, highly secured, authentication schemes.
- We must not mandate any particular authentication scheme.
- A challenge / response based authentication transaction sequence will support these goals.

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Authentication Transaction Sequence

- Inquire list of supported authentication schemes.
- Pick a (mutually acceptable) scheme.
- Assertion of identity (via mutually agreed scheme).
- Challenge of assertion.
- Response to challenge.

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Authentication Transaction Examples

- Initial STA state = Unauthenticated.
- Assume a mutually acceptable authentication scheme exists and was agreed to.

Authentication Transaction Examples

- An open system example:
  - Assertion: I'm station 4
  - Challenge: null
  - Response: null
  - Result: Station becomes Authenticated.
- A password based example:
  - Assertion: I'm station 4
  - Challenge: Prove your identity
  - Response: Here is my password.
  - Result: If password ok, station becomes authenticated.
- A complex, secure network example:
  - Please refer to separate presentation on cryptographic based authentication approaches.

Privacy Service Transactions

- Service must provide negotiation of mutually acceptable privacy level.
- Service must enable both simple, unsecured networks and more complex, highly secured privacy schemes.
- Service must not mandate any particular privacy scheme.
- Service must allow the privacy level to be altered dynamically.
  - So that privacy overhead can be matched to privacy requirements of the data.
  - Via a subsequent invocation of the privacy service.

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Privacy Service Transactions

- Inquire list of supported privacy schemes.
- Pick a (mutually acceptable) privacy scheme.
- The agreed privacy scheme will be applied to all subsequent transactions.

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Association States

- Unassocited state
  - Initial state
  - Can only invoke Association Service or Authentication Service.
- Associated State
  - STA can exchange MSDUs (via the associated AP)
    - » with other stations,
      (via the Distribution Service)
    - » and with existing networks.
      (via the Integration Service)

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Association and Authentication are Independent.

- A STA is Associated with at most one AP.
  - Simple
  - Sufficient to handle required functionality
- A STA can be Authenticated to many APs at once.
  - Necessary due to possible expense of Authentication process and interaction with probable performance requirements for reassociation service.
- An AP can be Associated with many STAs at once.
  - Necessary to handle required functionality.
- An AP can be Authenticated to many STAs at once.

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State Combinations

- Unassociated & Unauthenticated
  - Initial state for all STAs
- Unassociated & Authenticated
  - Station ID is known but the STA is not currently associated.
  - Typical intermediate combination during initial association establishment.
- Associated & Unauthenticated
  - Might chose to make this state illegal.
    - » Depends on if you believe "unauthenticated" == "don't care who you said you are".
  - Possible utility in creating an unsecured network.
- Associated and Authenticated
  - Normal operating state of a STA

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Association Transactions

- Initial state = Unassociated and Unauthenticated.
- Association transaction sequence:
  - Authenticated with desired AP?
    - » yes - go ahead
    - » no - invoke authentication service
  - Mutually acceptable privacy level agreed upon?
    - » yes - go ahead
    - » no - invoke privacy service
  - Association service
    - » Let DS know of the new Association
    - » STA state becomes Associated.
- Associated State
  - STA can now exchange MSDUs with with other STAs and existing networks.

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Issue: Direction of the Association service transaction?

- Alternatives:
  - From STA to AP?
    - » Obvious need when STA first turned on.
  - From AP to STA?
    - » See Reassociation discussion
  - Bidirectional?
    - » implied if AP to STA decided necessary.
- Recommendation:
  - From STA to AP.

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Disassociation Service Transactions

- Simple single transaction
- Bidirectional between STA and AP
  - From STA to AP
    - » Nice for symmetry and system operation
    - » Can not count on this transaction, must still handle error conditions.
  - From AP to STA
    - » Needed to terminate "unauthorized" station.
    - » Needed for orderly shut down of an AP.
- Let DS know the Association is terminated.
- Resets Station State to Unassociated.
- No impact on Authenticated state.
- Might be useful as part of Reassociation Service.

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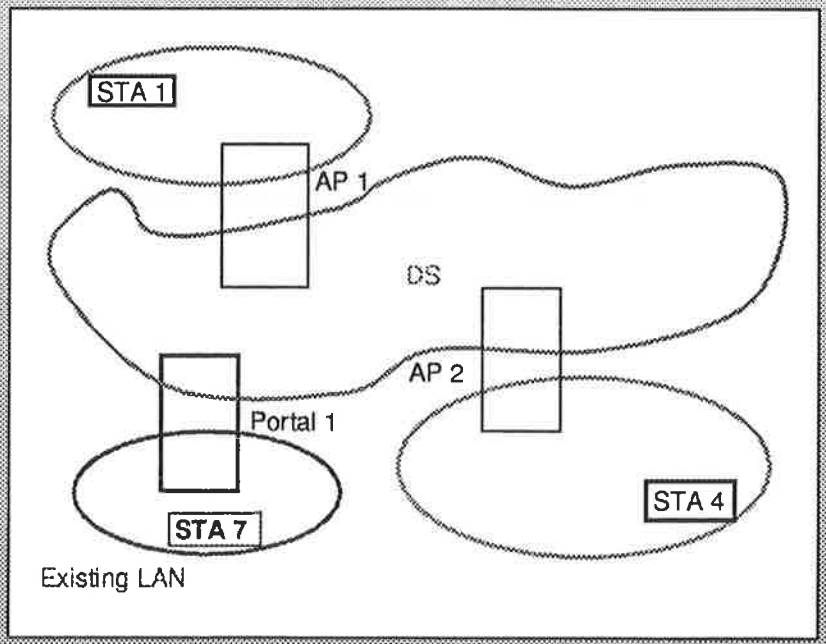
Issue: How to determine what APs are present?

- Alternatives
  - Discover
    - » Listen (APs beacon)
      - hard for ad-hoc nets
    - » Ask (talk then listen)
      - may cause unneeded traffic.
  - Preconfigured knowledge
    - » Disadvantages from installation and configuration viewpoints.
- Recommendation:
  - Discover, first listen a bit, if hear nothing, then ask.

Simplified 802.11 Architecture



Distribution Service Transactions

- AP to AP Distribution
  - Example 1: Msg from STA 1 to STA 4
- AP to Portal Distribution
  - Example 2: Msg from STA 1 to STA 7

AP to AP Distribution Transactions

- STA 1 sends msg addressed to STA 4
- Msg received by AP Associated with STA 1
  - In this example: AP 1
  - If msg not received by associated AP, we have an error condition to recover from.
- Receiving action at APs
  - Receives msg, checks that Sta 1 is a current association.
    - » Yes, AP provides msg to DS.
    - » No, ignores msg.
- Msg provided by AP 1 to DS

AP to AP Distribution Transactions

- DS uses Association Service to determine DS_Destination(STA 4).
  - In this example DS_Destination(STA 4) = AP 2
- DS delivers msg to AP 2
  - Using the Distribution services.
  - Details of this delivery dependent on DS implementation and outside our scope.
- AP 2 checks to see if STA 4 is currently associated.
  - Yes, msg transmitted to STA 4.
  - No, msg given back to DS and the inquiry re DS_Destination(Sta 4) recurses.

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AP to Portal Distribution Transactions

- STA 1 sends msg addressed to STA 7
- Msg received by AP Associated with STA 1
  - In this example: AP 1
  - If msg not received by associated AP, we have an error condition we need to recover from.
- Receiving action at APs
  - Receives msg, checks that Sta 1 is a current association.
    - » Yes, AP provides msg to DS.
    - » No, ignores msg.
- Msg provided by AP 1 to DS

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AP to Portal Distribution Transactions

- DS uses Association Service to determine DS_Destination(STA 7).
  - In this example DS_Destination(STA 7) = Portal 1
- DS delivers msg to Portal 1
  - Using the Distribution services
  - Detail of this delivery dependent on DS implementation and outside our scope.
- Portal 1 checks to see if STA 7 is currently associated.
  - Yes, msg given to integrated network for transmission to STA 7 (via Integration Services).
  - No, msg given back to DS and the inquiry re DS_Destination(Sta 7) recurses.

Distribution Service Restriction

- We can NOT depend on DS_Destination(sta) answer being correct.
  - Could change while msg transiting the DS, so there is always a potential timing window.
  - Since can not count on - don't try, design must account for this and work around it.

Reassociation Service Transactions

- From STAs point of view there is no change of state, it simply remains in the Associated state (only now the association is with a different AP).

Issue: How Does Reassociation Interact with Authentication?

- Alternatives:
  - Each reassociation requires reauthentication.
    - » Potentially very expensive and requires that authentication be done in very little time since we require reassociation to be fast.
    - » Makes for a simpler conceptual system design.
  - Make a DS service which allows an AP to authenticate a STA to another AP.
    - » Based on "if A trusts B, and B trusts C, then A can trust C".
    - » Moves authentication overhead to less time critical path for all but initial association (when the user already expects a bit more overhead).

Issue: How Does Reassociation Interact with Authentication?

- Recommendation:
  - Third party authentication service.
  - We should provide the ability for a STA to ask the DS to establish Authentication for himself to a requested set of APs.

"Pre-Reassociation" Authentication Transactions:

- While running, a station which is concerned about making reassociations quickly, authenticates itself to all APs that it hears by asking the DS to do a third party authentication transaction.
- Those STAs that do not do third party authentications, fall back to the default of doing the authentication process at reassociation time. The overhead for which will vary depending on the mutually acceptable level of authentication required in each system.

Reassociation Transactions:

- Simple single transaction between STA and Current AP.
- Let's DS know that the delivery routing for the STA is now changed.

How does Reassociation Interact With Privacy Level?

- Because the privacy level can change dynamically, you do not gain by trying to pre-determine the privacy level at the same time you do a third party authentication.
- If a reassociation transaction includes the current privacy level, it is very cheap to check that the new AP supports this privacy level.

Issue: Do we need an explicit Reassociation transaction?

- Alternatives:
  - No.
    - » Do this with a Disassociate / Associate transaction pair.
    - » Probably translates into more message traffic in a protocol.
  - Yes.
    - » Conceptually cleaner to do an explicit reassociation as the intent is then known from start to finish.
    - » Nicer for interaction with privacy level.
- Recommendation:
  - Provide an explicit Reassociation transaction.

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Issue: What is the Direction of a Reassociation Transaction?

- Alternatives:
  - From STA to AP.
  - From AP to STA.
  - Bidirectional.
- Arguments:
  - STAs may wish to reassociate to another AP for reasons of signal quality.
  - APs may wish to reassociate STAs for reasons of signal quality, load balancing, or to take an AP out of a network for service.
- Recommendation:
  - Bidirectional, Reassociation can be initiated by either a STA or an AP.

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Transactions Types TBD

- Network Management Transactions
- Integration Service Transactions

Summary

- Base Distribution Systems Services Functionality identified at the Nov '92 meeting were further explored in this presentation and appear to be a good basic functional set.
- A set of logical transactions which would provide many of the identified services has been described.
- New issues have been presented along with arguments and recommendations for closure.
- The logical transactions presented can form a basis from which we can evaluate various MAC protocol proposals to compare how they provide desired functionality.