

An Introduction to IEEE 802.11 Concepts & Definitions.

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Motivation:

Wireless networks have become a popular topic. This has increased attendance and participation at our standards meetings. Increased participation is a mixed blessing. New people attending don't have the benefit of having been present at previous meetings.

The various concepts and terminology used at the meetings can be difficult to pick up (without reading the entire document archive). While we encourage active participation, we can not afford to be spending a significant amount of our time bringing people up to speed.

This paper is intended as an introduction to the concepts and terminology used within 802.11. It is hoped that from this paper the reader will gain enough background to at least be able to follow 802.11 discussions. The pictures in this document are not intended to represent any particular physical implementation of an 802.11 conformant LAN. Rather, the figures are intended to illustrate the interrelationships of the key *logical* components.

Definitions in this document were taken from the 802.11 Functional requirements document version 0.3. At the time this paper was written, formal adoption of the Functional Requirements document was expected during the July, 1992, 802.11 meeting.

How wireless LAN systems are different:

Those familiar with conventional networks should realize that wireless networks have fundamental characteristics that make them very different from other LAN architectures.

Destination address does not equal destination location:

In 802.11 the addressable unit is a station (STA). The STA is a destination, but not a fixed location.

The media impacts the design:

The PHY layers used in 802.11 are fundamentally different from wired media. 802.11 PHYs:

- Have limited physical point to point connection ranges.
- Are inherently shared and unprotected from outside signals.
- Are significantly less reliable (in terms of BER) than wired networks.
- Have dynamic topologies.

Because of the limited PHY ranges, wireless LANs intended to cover reasonable geographic distances must be built from basic coverage building blocks.

Impact of handling mobile stations:

One of the requirements of 802.11 is to handle *mobile* as well as *portable* stations. A portable station is one that is moved from location to location, but is only used while at a fixed location. Mobile stations actually access the LAN while in motion.

For technical reasons, it is not sufficient to handle only portable stations. Because of propagation effects there is little difference between portable and mobile stations (stationary stations often appear to be mobile).

Interaction with other 802 layers:

802.11 is also faced with the requirement that it appear to higher layers (LLC) as a current 802 style LAN. This requires that the 802.11 network handle mobile stations transparently to the upper layers.

BSS: The Basic building block of a Wireless LAN:

First some definitions:

MAC Service Data Unit (MSDU): The MAC Service Data Unit is information that is delivered as a unit between MAC service access points.

Wireless Medium (WM): The medium used to implement a wireless LAN.

Station (STA): Any *device* which contains an 802.11 conformant MAC and PHY interface to the wireless medium.

Basic Service Set (BSS): A set of STAs controlled by a single CF.

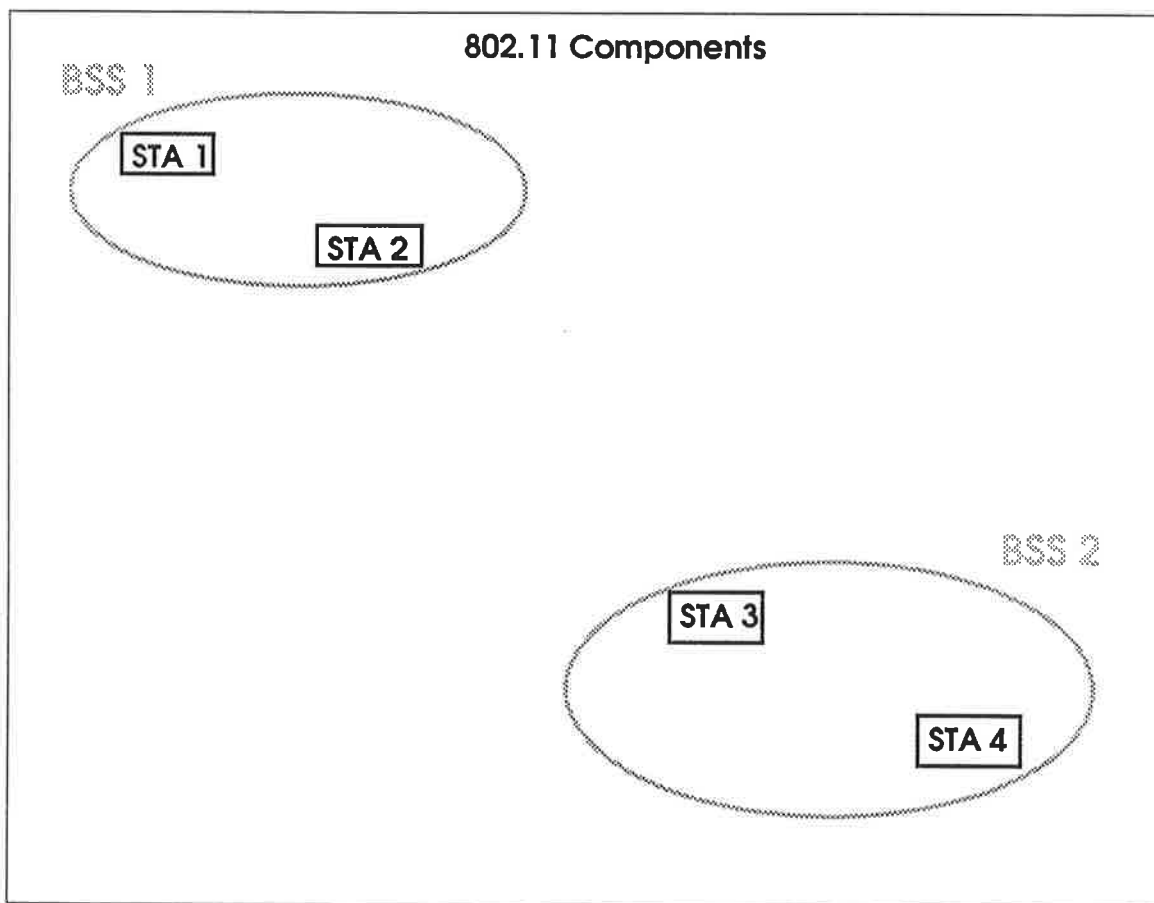


Figure 1

Figure 1 shows two BSSs, each of which has two stations which are members of the BSS. It is probably useful at this point for the reader to think of the ovals used to depict a BSS as the coverage area within which the member stations of the BSS can remain in communication.

This is not precise, and the concept of area can lead one astray, but is good enough for now. If a station moves out of its BSS, it can no longer communicate with other members of the BSS. While Figure 1 shows sharp boundaries for the BSS, this should be considered more an artifact of the drawing than a physical reality. (Signal strength does not tend to be binary in nature).

STA to BSS association is dynamic:

The association between a STA and a BSS must be dynamic (STAs turn on, turn off, come within range and go out of range). 802.11 has recognized that several steps exist as part of this association processes.

The processes defined so far are:

Sign-On:

The process by which one STA identifies (and possibly authenticates) itself, and exchanges operational parameters in order to participate in a BSS.

Registration:

A process by which a STA gets its "identity" (address, signature & certificates, etc.).

Authentication:

A higher layer process by which one STA convinces other STAs of its "identity".

The Coordination Function concept:

One of the important 802.11 concepts is that of the Coordination Function. To properly think about an 802.11 LAN one must realize that the path(s) that data travels between stations is different from the questions surrounding how the LAN determines when station(s) transmit on the media and when they listen.

Coordination function (CF): That logical function which determines *when* a station operating within a BSS transmits and receives via the WM.

In figures 2 and 3, the heavy lines represent the data paths between stations. The dashed lines show which stations are controlled by the CF.

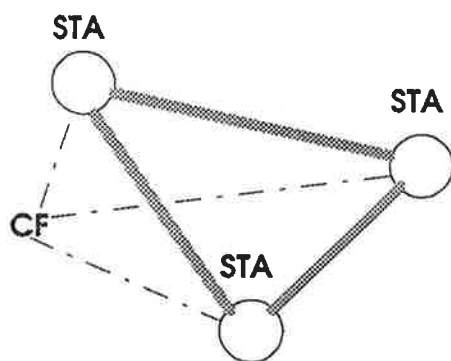


Figure 2

Figure 2 could be a typical peer-to-peer communication case.

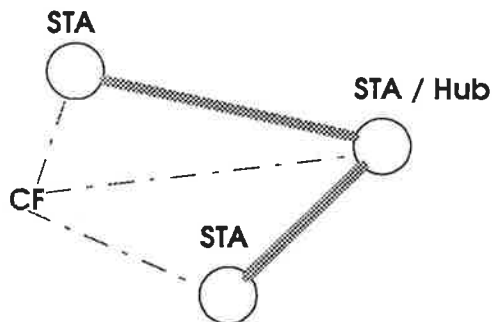


Figure 3

Figure 3 could be a typical hub oriented network where all data must travel through the hub.

(These two cases are meant to be illustrative only. It is believed by 802.11 that the definitions adopted are general enough to include the cases pictured as well as many others not pictured.)

Another important concept is that the logical function performed by the CF is not dependent on the physical object chosen to contain the implementation of the CF. The definitions have been written explicitly to include all the combinations recognized. (This does not mean that all combinations of CF type and implementation are equal in functionality or complexity.)

802.11 has defined two broad classes of CFs. Their definitions are:

Distributed CF (DCF): A class of possible CFs where the same CF logic is active in every STA at any given time.

Point CF (PCF): A class of possible CFs where the CF logic is active in only one STA at any given time.

Distribution System Concepts:

The BSS is the basic building block of the 802.11 LAN. Some networks can be satisfied with a simple BSS type of network. Other networks require greater coverage. Those networks are built with multiple BSSs.

The logical component that is used to interconnect BSSs is called the Distribution System.

Distribution System (DS): A system used to interconnect a set of BSSs to create an ESS.

Distribution System Medium (DSM): The medium used by a DS (for BSS interconnections).

The reader should note that it is important to logically separate the WM from the DSM. Each medium is used for very different purposes. However, the 802.11 definitions neither preclude, nor demand, that the two media be either the same, or different.

Figure 4 adds the DS component to our previous picture.

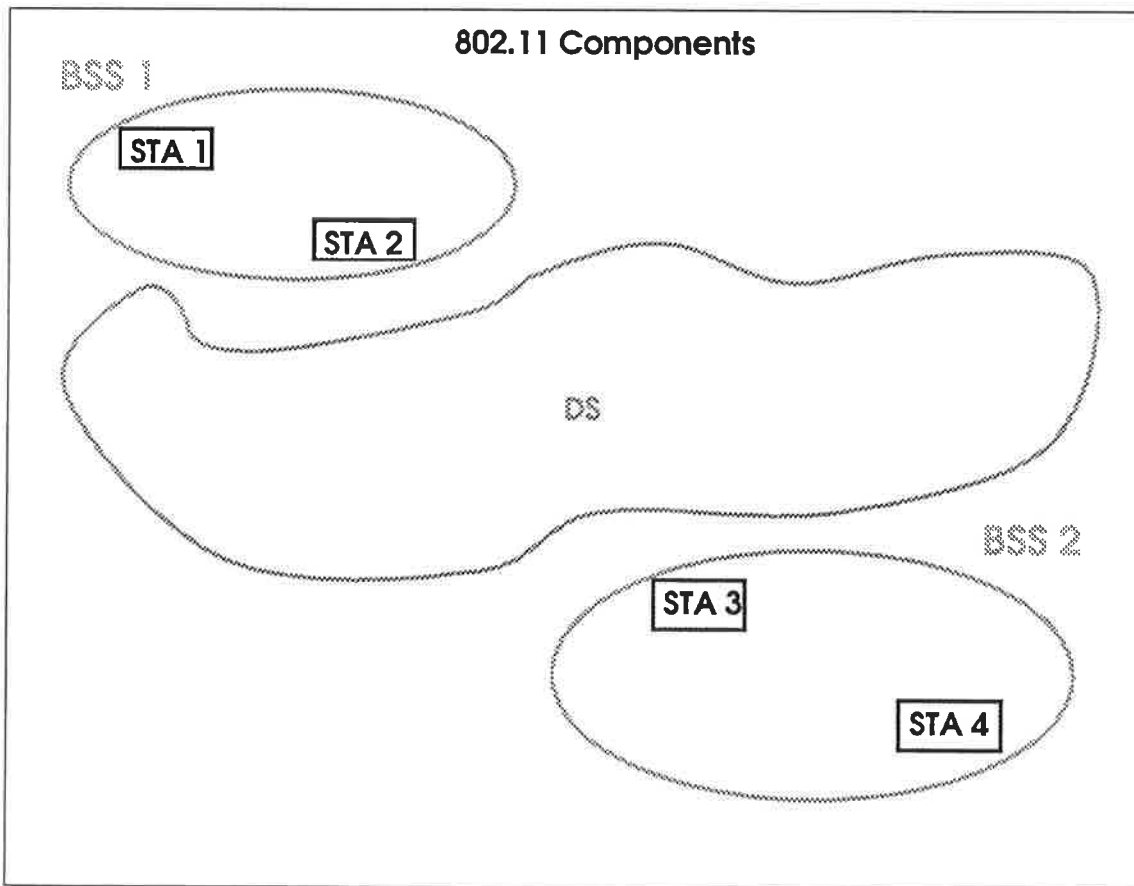


Figure 4

It is the DS that provides the logical services necessary to handle mobile stations and seamless integration of multiple BSSs.

Distribution System Services (DSS): The set of services provided by the DS which enable the MAC to transport MSDUs between BSSs within an ESS.

Access Point (AP): Any entity that has STA functionality and provides access to the DS.

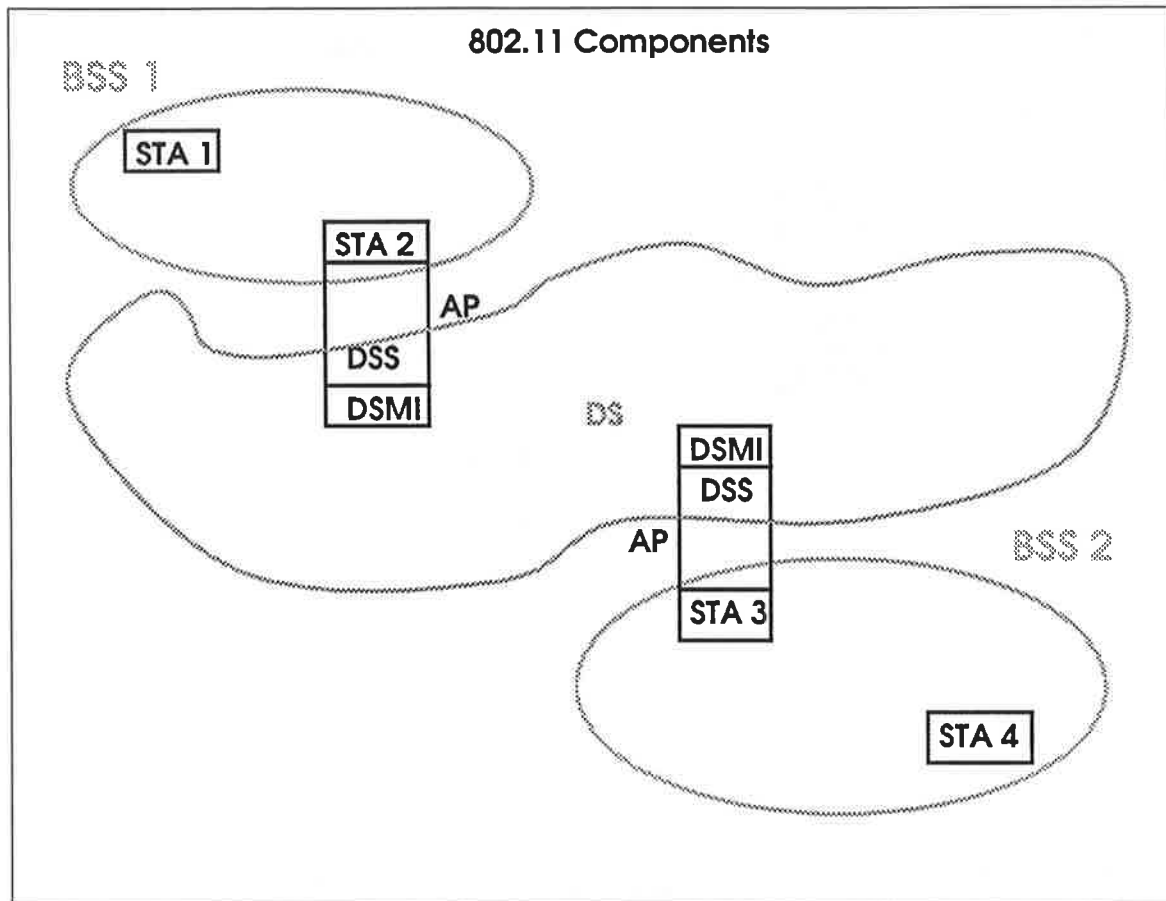


Figure 5

DSMI stands for Distribution Systems Medium Interface.

Data moves between a BSS and the DS via an Access Point (AP). Note that by definition, all APs are also STAs. The reader should also note that while an AP may initially appear to look very similar to a MAC layer bridge, it is in fact significantly different. We will return to this difference later on.

ESS: The large coverage network:

Now we have the primary components needed to create a wireless network of arbitrary size and complexity. 802.11 refers to this type of network as the ESS network.

Extended Service Set (ESS): A set of interconnected BSSs which appear as a single BSS to LLC.

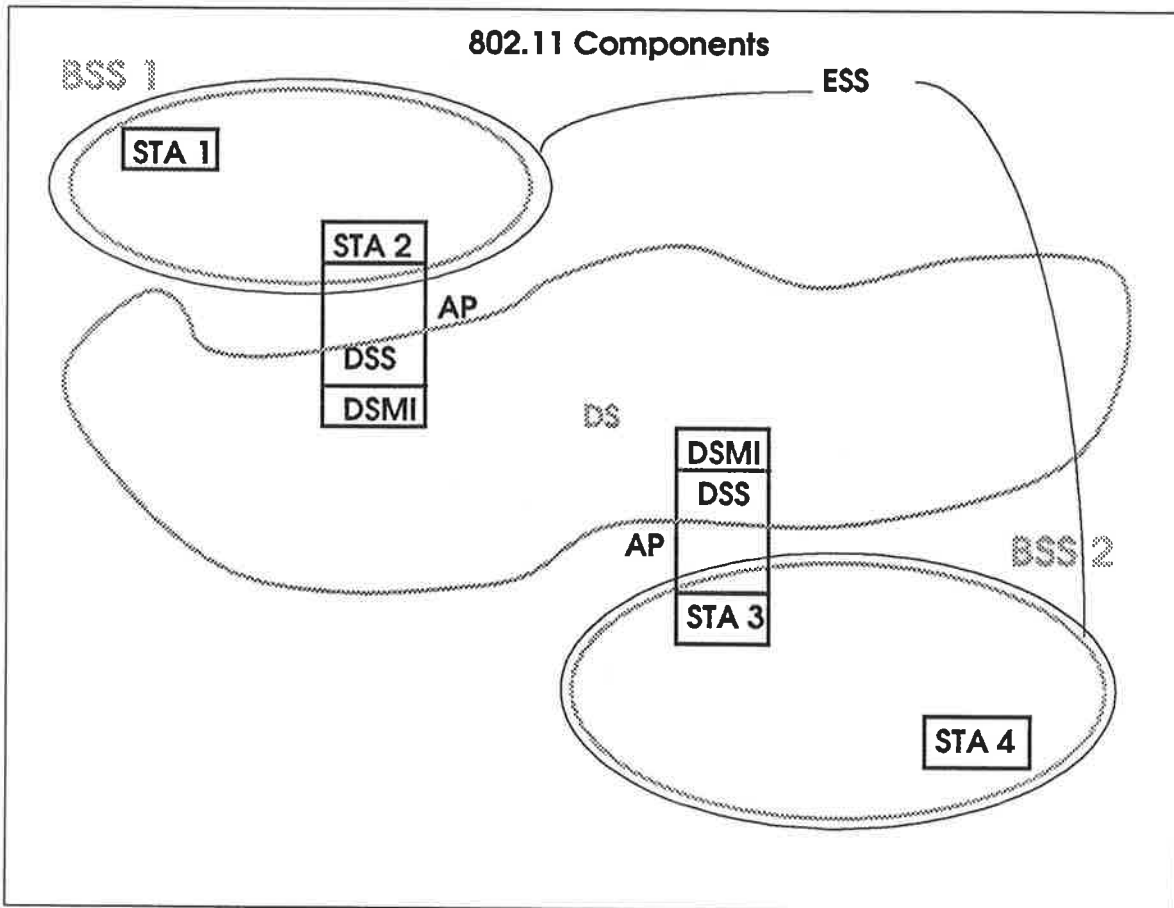


Figure 6

The key concept is that the ESS network appears the same to an LLC layer as a BSS network. Stations within an ESS can communicate and mobile stations may move from one BSS to another (within the same ESS) transparently to LLC.

Note that nothing is assumed about the relative physical locations of the two BSSs in figure 6.

All of the following are possible:

- The BSSs may partially overlap. This could be commonly used to arrange contiguous coverage for some physical volume.

- The BSS could be physically disjoint. Logically there is no limit to the distance between BSSs (all you have to do is build the DS to cover the distance you desire).
- The BSSs may be physically co-located. This might be done to provide redundancy.

The reader should also be aware that one (or more) BSS networks may be physically present in the same space as one (or more) ESS networks. This can arise for a number of reasons. Two of the most common are:

- An Ad-hoc network is operating in a location which also has an ESS network.
- Physically adjacent networks have been set up by different organizations.

Area concepts:

One may wonder why we use the set terminology rather than that of area or volume. Much of the initial difficulty in 802.11 meetings stemmed from the assumptions that are (too) easily made when thinking about areas.

Several contributions have shown that nice, well defined areas simply do exist.

Propagation tends to be fractal in nature and unpredictable. Even small changes in location can result in drastic differences in signal strength. The same effect occurs when the station is stationary; other moving objects (including people) impact propagation.

Additional difficulties arise when one tries to talk about co-located network coverage areas.

Consider figure 7, which network do stations 6 and 7 belong to?

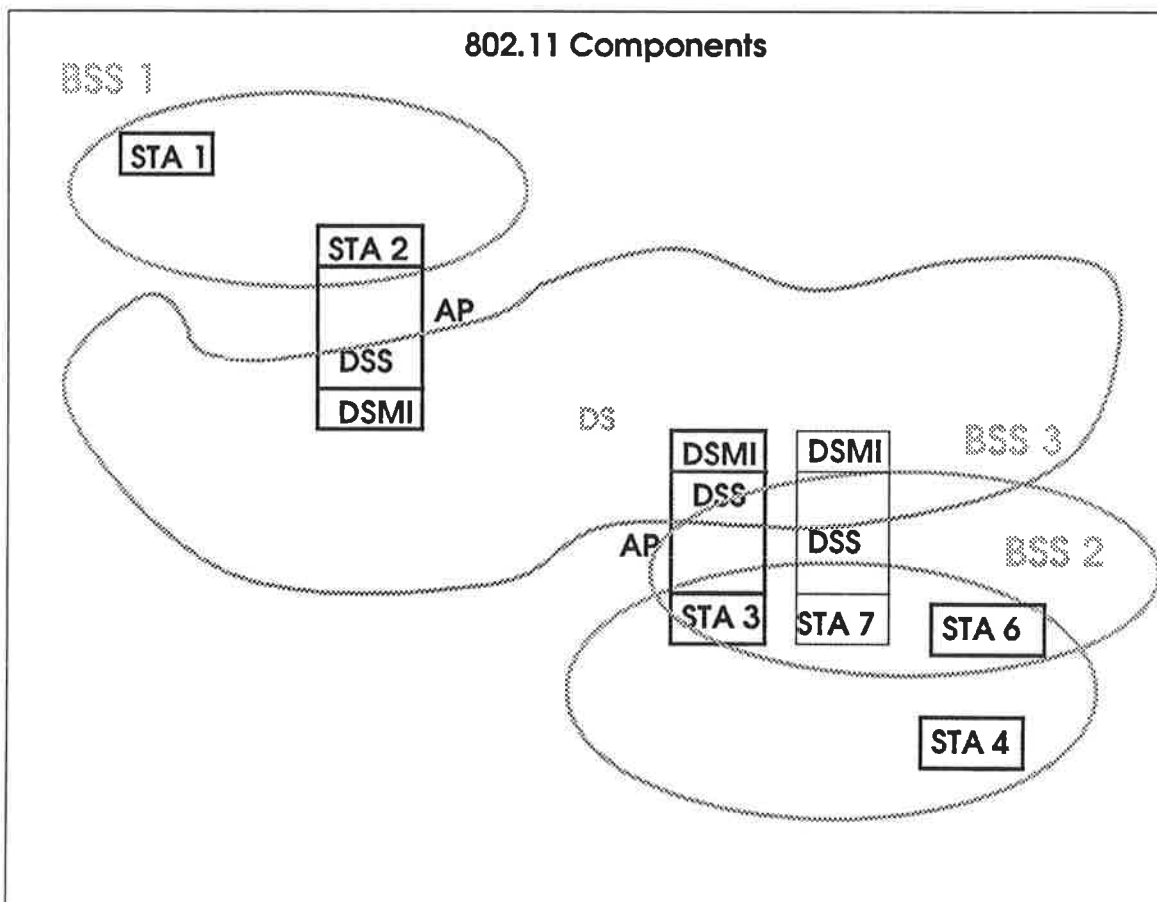


Figure 7

Yet for all this, we often find it easy to talk about areas. For many topics the concept of area is "good enough". The newcomer to 802.11 is cautioned to be wary whenever he

hears a conversation about areas. (Even "volume" is not really good enough, though it is better than area. For historical reasons we opted to continue to use "area" instead of "volume".)

802.11 defines areas in terms of sets:

Basic Service Area (BSA): The area within which members of a BSS can communicate.

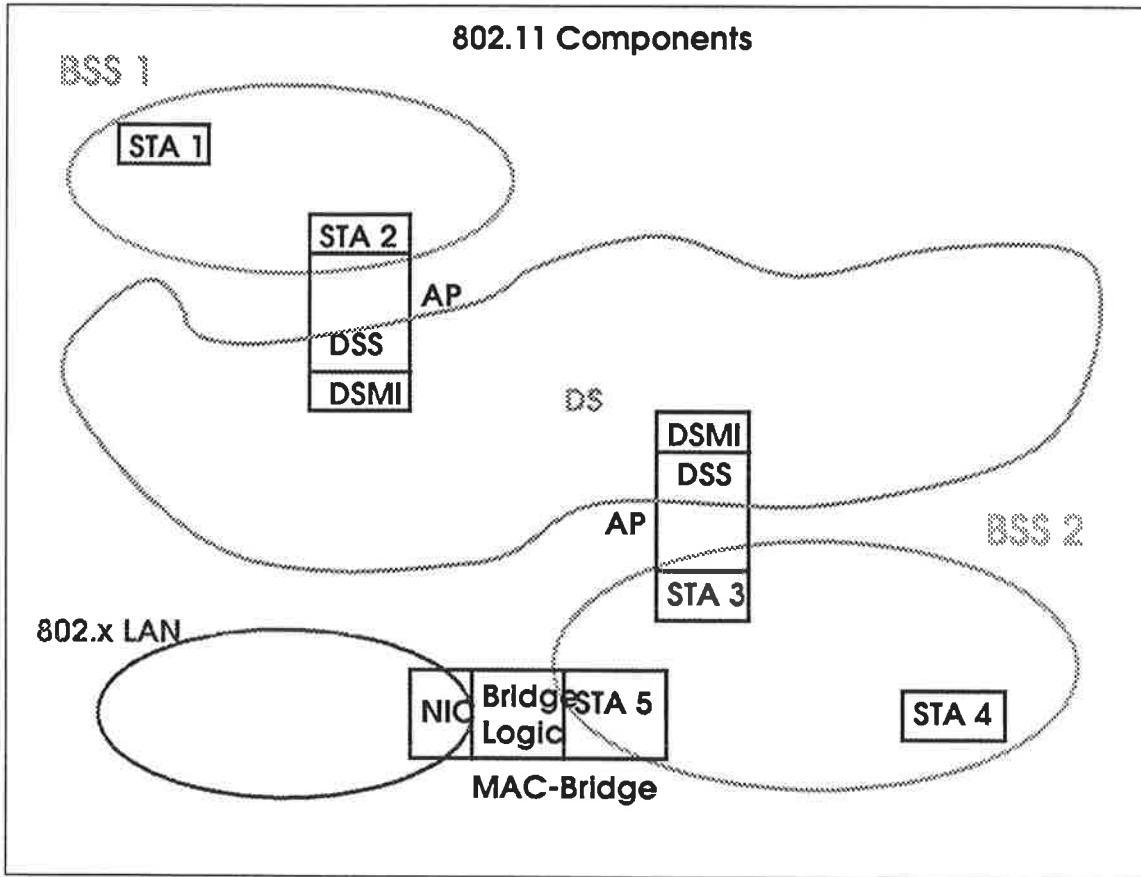
Extended Service Area (ESA): The area within which members of an ESS can communicate. An ESA is larger than or equal to a BSA.

How an AP relates to (but is not) a MAC layer bridge:

It is important to realize that an AP is not the same as a MAC layer bridge. An AP provides access between a BSS and the DS. A MAC bridge provides data access between an 802.x LAN and an 802.11 LAN.

Figure 8 shows how a MAC bridge connects to an 802.11 LAN.

Figure 8



One might be tempted to equate an AP and a MAC bridge simply because they each have similar looking parts - this would be a mistake. What is important is that an AP and a MAC bridge perform very different *logical* functions.

While all the figures have shown the DSS in the middle of an AP, this is for illustration purposes only. The DSS is a set of services provided at an interface - the physical embodiment of those services might or might not be in an AP.

The DSS Portal:

There is one more component that we need to understand. It is called a "DSS Portal".

The MAC layer bridge provides a way to interconnect an 802.11 LAN with other 802.x LANs; data enters the 802.11 LAN via a station in a BSS.

Data may also enter an 802.11 LAN (from an 802.x LAN) via the DS. This is accomplished by a DSS portal and is shown in figure 9.

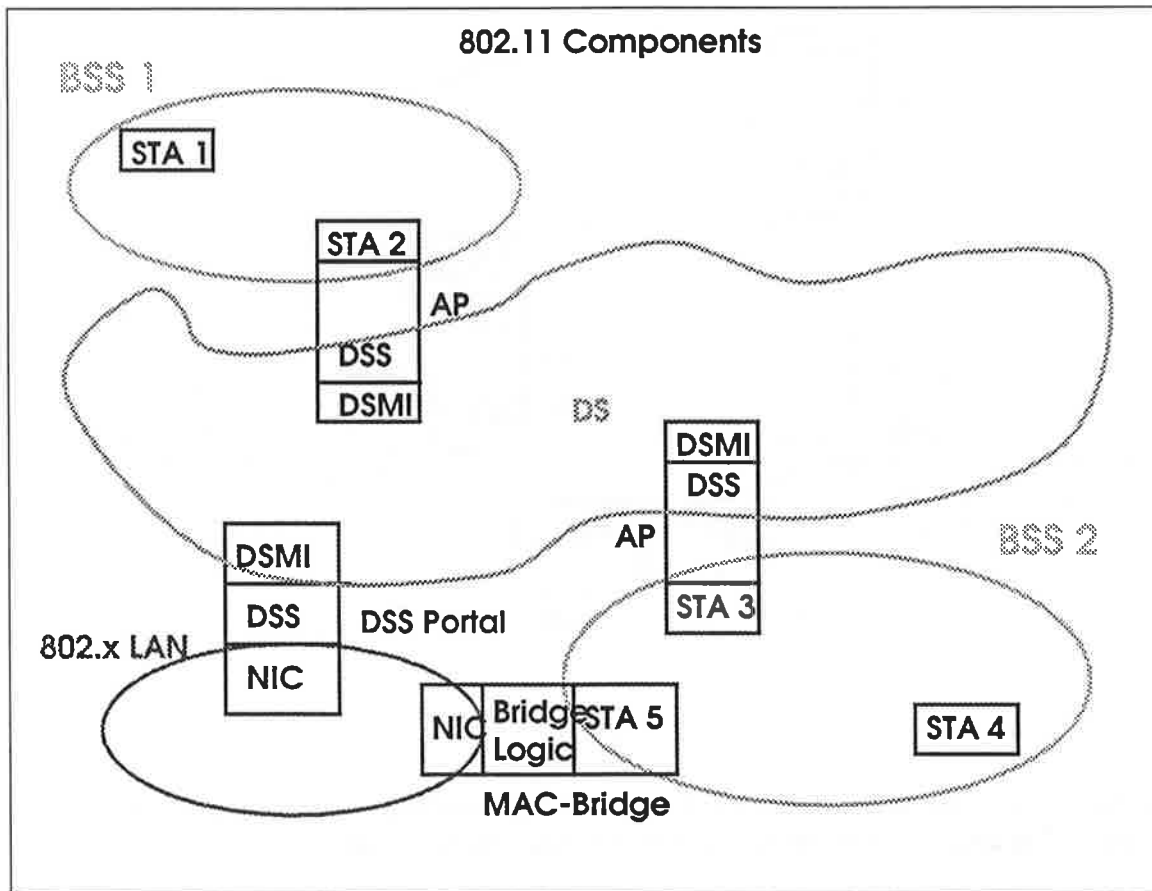


Figure 9

Please do not assume 802.x MAC level interaction for a DSS portal. The exact operation of the DSS portal is very dependent on the DSS services (which are not yet defined by 802.11). The DSS portal is simply a logical entity which provides for the prospect of 802.x LAN data entry into the DS.

The composite picture of an 802.11 LAN:

Figure 10 combines the previous figures together to show all the components of an 802.11 LAN in one picture.

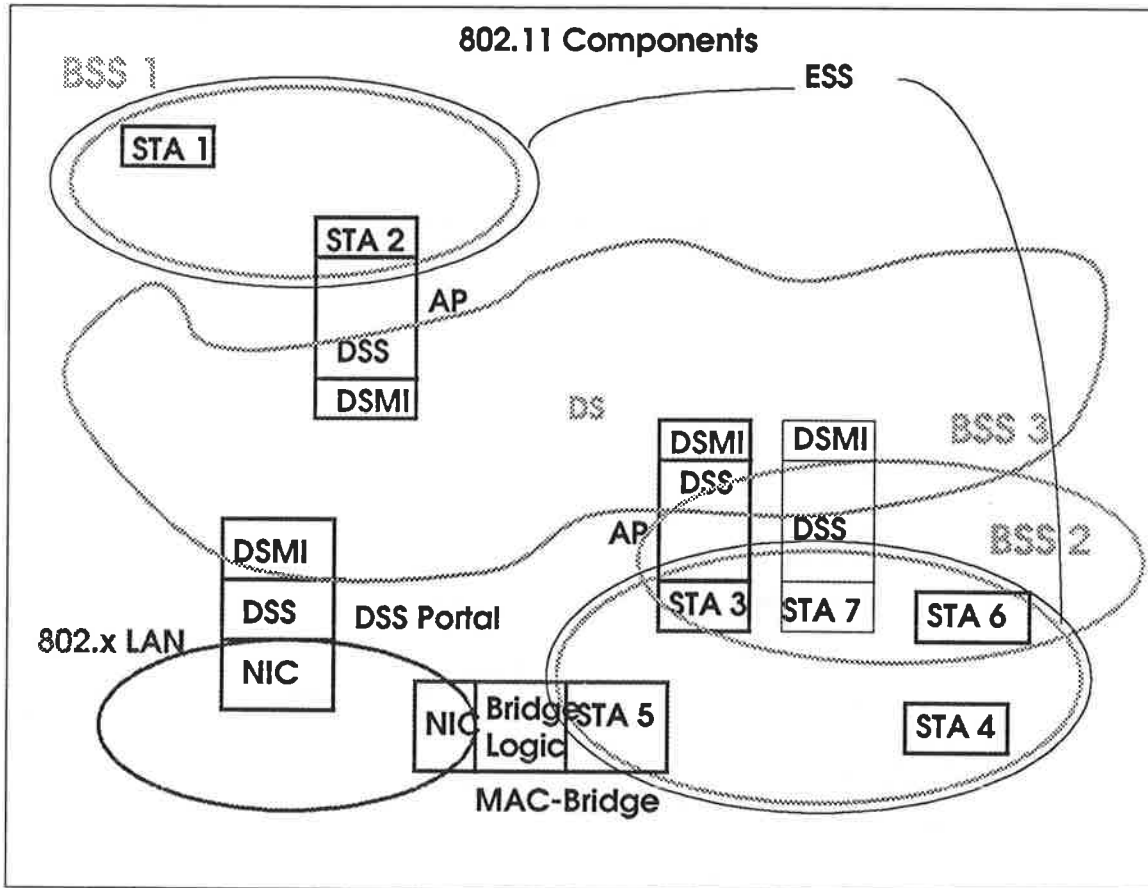


Figure 10

It is hoped that this paper has been of help in understanding some of the major 802.11 concepts. Constructive suggestions for improvement are welcome.