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International Roaming - IEEE 802.11d

Overview

The purpose of this document is to provide an overview of IEEE 802.11d – which provides for Extensions to Operate in Additional Regulatory Domains. This standard will allow WLAN vendors to provide additional capabilities to customers who want to have a single radio that will work in every regulatory domain worldwide.

The Intel PRO/Wireless 2011B LAN Access Point and the Intel PRO/Wireless 2011B PC Card provide support for 802.11d International Roaming. Additionally the Intel PRO/Wireless 2011 LAN Access Point and PC Card are to support 802.11d International Roaming via a forthcoming firmware update.

The 802.11d Standard

The PHY layer of a WLAN is subject to regulations that may vary significantly from one geopolitical area to another. The standard provides a mechanism that allows an implementation to be built that is able to meet many different sets of regulations. This allows conforming equipment to be able to operate in more than one regulatory domain over time. The standard describes the mechanism required to implement a capability in 802.11 FH and DS stations that support cross-domain mobility and operation in multiple regulatory domains. (This document focuses on the DS Implementation Only)

The standard provides a framework for WLAN developers to work from, but the actual method for configuring individual stations is outside the scope of the standard. The standard only discusses IBSS (Infrastructure) Mode of WLAN operation. No mention is made of AdHoc mode or backward compatibility between Access Points and Stations that may not support 802.11d. As is typical with IEEE standards, no mention of interoperability between WLAN vendors is made. It is left to WLAN vendors to manufacture systems that are acceptable to regulatory bodies in countries they wish to sell equipment into. International Roaming is not a requirement for Wi-Fi certification but may become a WECA requirement for Wi-Fi at some point in the future.

New WLAN Communication Elements

The standard is relatively straightforward in operation. It adds new elements to AP Beacons and Probe Responses. These new elements may contain the following information elements as shown in this table:

Element ID	Length
Country String (Octets 1,2)	
Country String (Octet 3)	First Channel Number
Number of Channels	Maximum Transmit Power Level

This Element contains the country string; the first channel number, the number of channels allowed and the maximum transmit power level. In this way, the Station (MU) may obtain all of the necessary information required to conform to local regulatory guidelines. The standard also calls for the appropriate changes to the 802.11b MIB to allow for these new elements.

The length of the information element is variable, as the element may contain more than one triplet comprising the First Channel Number, number of Channels, and Maximum Transmit Power Level fields.

The AP sets this value to the value contained in the dot11CountryString attribute before transmission in a Beacon or Probe Response frame. Upon reception of this element, a STA shall set the value of the dot11CountryString to the value contained in this field.

The First Channel Number field contains a positive integer value that indicates the lowest channel number in the sub-band described in this information element. The group of channels described by each pair of the First Channel Number and Number of Channels fields shall not overlap and shall be monotonically increasing in channel numbers.

The Maximum Transmit Power Level field indicates the maximum allowed power to be transmitted in dBm.

802.11d In Operation

A Station (MU) that is enabled for operation across regulatory domains will default to passive scanning when it has lost connectivity with its ESS or when first powered on. Passive scanning is performed using only the receive capabilities of the station and is, thus, compatible with regulatory requirements. The timeout for determining the loss of connectivity is system dependent and beyond the scope of the standard.

When a STA enters a regulatory domain, it shall passively scan to learn at least one valid channel, i.e., a channel upon which it detects 802.11 frames. The Beacon frame contains information on the country code, the maximum allowable transmit power, and the channels to be used for the regulatory domain.

Optionally, the Beacon frame may also include, on a periodic basis, the regulatory information that would be returned in a Probe Response frame. Once the Station has acquired the information so that it is able to meet the transmit requirements of the regulatory domain, it shall transmit a Probe Request to an AP to gain the additional regulatory domain information contained in the Probe Response frame, unless the information was previously received in a Beacon fame. The Station then has sufficient information available to configure its PHY (radio) for operation in the regulatory domain.

A Station shall return only those information elements that it supports. In an improperly formed Request Information Element, a Station may ignore the first information element requested that is not ordered properly and all subsequent information elements requested. In the probe response frame, the Station shall return the requested information elements in the same order requested in the request information element.

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Intel Station Operation

The function is supported in Windows 95/98/2000/ME/NT4 and Pocket PC. In order to enable International Roaming support for the client, the user must make a change to the Windows driver settings. This change does not require a reboot in Windows 2000/ME. Driver changes in Windows 95/98 and NT4 require a reboot. Driver changes in Pocket PC will require an adapter reset.

Once checked, the radio will begin passive scanning (listening) for AP beacons for country configuration information. Since the PC Card radios are factory configured to use all 14 available channels, the card will be able to "hear" beacons from any AP with 802.11d capabilities worldwide. Once it has received a beacon, the driver will configure the card to use the proper channel. At this point the card will send a probe request to the AP and receive the probe response in order to complete the international mode configuration.

The Operational Rules

- An Intel PRO/Wireless 2011B LAN PC Card that is set for International Roaming will associate only to an AP that supports 802.11d

- A Intel PRO/Wireless 2011B LAN PC Card that is set for International Roaming will not associate to an AP that does not support 802.11d. This assures that our card does not violate local regulatory guidelines. Once the International Roaming setting is unchecked in the driver settings, the card will operate in 802.11b mode, which follows the channel the AP passes to it. Intel Access Points must have firmware version 2.50-00 or better in order to support International Roaming.

- The Intel PRO/Wireless 2011B LAN PC Card will operate properly with 3rd Party Wi-Fi compliant Access Points that support 802.11d if International Roaming is enabled in the driver settings. The Intel PRO/Wireless 2011B LAN PC card will not attached to 3rd party Access Points if the AP does not support 802.11d and International Roaming is enabled on the PC Card. In this case, disable International Roaming on the PC Card driver for normal operation.

- A 3rd Party WLAN Card that supports International Roaming will associate to an Intel AP that supports 802.11d. A 3rd party NIC that does not support International Roaming can still associate to an Intel AP that supports International Roaming. The card will merely ignore the extra AP beacon elements.

Ad Hoc Mode

There is no support for International 802.11d operation in the driver. If the Driver is configured for International Roaming the selections for PIBSS and IBSS mode are not available to the user. The user must first deselect International Roaming and then select PIBSS or IBSS (AdHoc) mode as desired. There are no International Roaming specific settings from that point forward. Once the cards have established peer communication they will operate on whatever channel the WLAN card driver is set for**.** Remember that Ad Hoc mode is NOT part of the 802.11d specification. This is acceptable since peer networks are generally very small, use antennas that don't propagate the RF signal very far and are weaker transmitters compared to an Access Point with high gain antennas. Ad Hoc networks also tend not to be used for extended periods of time.