

# iChip WiFi Configuration

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## Introduction

iChip CO2128, iChip CO2144, Secure Socket iWiFi, miniSocket iWiFi and Nano WiReach support 802.11b/g WiFi connectivity using the Marvel 8686 WiFi chipset. The iChip firmware contains built-in drivers that support the WiFi chipset as well as a WPA/WPA2 supplicant allowing for a choice of WEP or WPA/WPA2 PSK or Enterprise mode security over the wireless connection.

iChip contains a variety of parameters associated with WiFi connectivity, which permit configuring the connection profile and its characteristics. iChip may be configured for a WiFi connection in infrastructure mode via an Access Point (AP) or as part of a local WiFi cluster using Ad-Hoc mode.

iChip also supports a Roaming mode, allowing it to seamlessly transfer between Access Points, in support of mobile devices that need to be on the move across geographical distances larger than the AP's supported range.

Several reports are made available to monitor the WiFi environment and quality of connection.

This document details the commands and parameters that are used to configure, control and monitor a WiFi connection when using an iChip based product.

## Initial Connection

Assuming all WiFi related parameters are cleared to their default value, as is the case after a Factory-Defaults setting (AT+iFD), iChip will attempt to associate and connect to the closest available Access Point (AP) that does not have any security configured. When iChip senses several AP's in its vicinity, it determines the closest AP according to the strongest received signal.

If no secure-less AP is detected, iChip will endlessly continue trying to locate one.

## WiFi Related Reports

Several iChip reports are related to information regarding the WiFi environment.

### RP11

The AT+iRP11 report instructs iChip to scan the environment and report all Access Points (AP's) in its vicinity.

For example,

```
AT+iRP11  
Jetta,WPA2,1  
GANG_TEST,NONE,1  
Bora,NONE,1  
Levanto,WEP,1  
Sirocco,WPA,1  
Blue-I The Lab,WEP,1  
Mistral,WEP,1  
3Com,NONE,1  
I/OK
```

Each response line contains one AP details including its SSID, Security setting and signal strength (0-low; 1-good; 2-excellent).

### **!RP11**

The AT+i!RP11 report lists only Ad-Hoc networks that have been detected in the vicinity. The report format is the same as for the AT+iRP11.

### **RP10**

The AT+iRP10 report contains details regarding the current connection.

For example,

```
AT+iRP10  
I/(4,54,63,45)  
I/OK
```

The response contains value fields according to the following syntax:

I(<port stat>, <xfer rate>, <sig level>, <lnk qual>)

Where,

port stat -- Port Status:           0: Wireless LAN adapter not present  
                                  1: Wireless LAN adapter disabled  
                                  2: Searching for initial connection  
                                  4: Connected  
                                  5: Out of range

xfer rate -- Transfer rate in the range 1..54

sig level -- Signal level [%], in the range 0..100

lnk qual -- Link quality [%], in the range 0..100

Note: The *sig\_level* and *lnk\_qual* fields are given in percents relative to estimated values that represent 0% to 100%.

### **!RP10**

The AT+i!RP10 report contains additional details regarding the current connection.

For example,

```
AT+i!RP10  
GANG_TEST,00:17:3F:9F:89:6E,NONE,7,28  
I/OK
```

The response contains value fields according to the following syntax:

<SSID>,<BSSID>,<security type>,<WPA status>,<channel>,<SNR>

Where,

*security type* = NONE | WEP64 | WEP128 | WPA | WPA2 | WPA\_ENT | WPA2\_ENT

*WPA status* = Completed | Not Completed (relevant only for WPA/WPA2 security)

### **RP20**

The AT+iRP20 report is an extension to the AT+iRP11 report. It lists a scan of all AP's and AD-HOC systems in the vicinity.

For example,

```
AT+iRP20  
Jetta,AP,06:14:6C:69:4A:7C,WPA2,1,48  
GANG_TEST,AP,00:17:3F:9F:89:6E,NONE,7,53  
Sirocco,AP,00:18:4D:DE:D7:DF,WPA,7,50  
Mistral,AP,00:11:6B:3B:55:E2,WEP,9,62  
EPSON, Ad-Hoc,02:0E:35:38:6E:92,NONE,11,46
```

```
3Com,AP,00:12:A9:08:79:C8,NONE,11,54
I/OK
```

The response contains value fields according to the following syntax:

```
<SSID>,ADHOC|AP,<BSSID>,<security_type>,<channel>,<RSSI>
```

## Connecting to a Specific Access Point

The primary parameter governing the identity of the AP to which the iChip will associate and connect to is the **Service Set Identifier (SSID)**. Each Access point has its own SSID value. A Wireless-LAN client that needs to connect to a LAN infrastructure via a specific AP needs to specify the SSID of the required AP.

The iChip parameter that is used to configure the required SSID is the WLSI parameter.

The command syntax used is:

```
AT+iWLSI=<ssid>
```

For example,

```
AT+iWLSI=3COM          set required SSID
I/OK
AT+iDOWN              soft reset iChip
I/OK
I/ONLINE
AT+iRP10              connection report
I/(4,54,90,75)
I/OK
AT+i!RP10             connection details
3COM,00:18:4D:DE:D8:35,NONE,5,50
I/OK
```

Note that the 3COM AP does not have security definitions, thereby allowing iChip to connect without configuring security parameters.

The SSID configured in the AP is not necessarily unique. If iChip is in range of more than one AP with the same SSID value configured in its WLSI parameter it will connect to the closest (strongest signal) AP of those with that SSID.

## Multiple Access Points

For cases where it is desired that iChip connect to one of a list of possible AP's, iChip supports a list of up to 10 SSID values. When iChip scans for the AP to connect to, it will scan the environment for an existing AP according to the list until it finds the first match. iChip's SSID list parameters syntax is:

```
AT+iWSIn=<ssid>
```

Where,

*n* can assume values [0..9].

For Example,

```
AT+iWSI2=BORA
```

The default SSID parameter WLSI is equivalent to WSI0. Both refer to the same exact value and are interchangeable.

AP scanning always begins with WLSI (or WST0) and commences to WSI1 only if no AP with WLSI is found. Scanning continues with the next WSI $n$  until a matching AP is found, a WSI $n$  parameter is empty or all 10 SSID's have been scanned.

If a matching AP is found, iChip will attempt to associate and connect to it. Otherwise, it will reiterate scanning the entire list again.

Note that the order of the SSID values in the list defines the connection priority.

Furthermore, note that if a WSI $n$  value is cleared, iChip will not scan past that element even if additional values exist further down the list.

## WiFi Security Configuration

iChip supports several WiFi security standards when connecting to an AP in infrastructure mode. iChip parameters are used to configure the security setting that is to be used for each AP to which iChip will connect. The security standards supported are:

- WEP with 64 bit keys
- WEP with 128 bit keys
- WPA with TKIP encryption in PSK mode
- WPA2 with AES encryption in PSK mode
- WPA-TKIP Enterprise PEAP-MSCHAPv2 with RADIUS server
- WPA2-AES Enterprise PEAP-MSCHAPv2 with RADIUS server

The iChip parameter WST $n$  defines the security method used by the AP.  $n$  is determined according to the matching SSID with which iChip connected to the AP.

The possible values for WST $n$  are:

- 0 = No Security
- 1 = WEP64
- 2 = WEP128
- 3 = WPA PSK
- 4 = WPA2 PSK
- 5 = WPA Enterprise
- 6 = WPA2 Enterprise

### Wired Equivalent Privacy (WEP) Security

When using WEP security the AP and client need to agree on an encryption/decryption key that is either 5 bytes for WEP64 or 13 bytes for WEP128. iChip contains a 4-key repository for WEP keys, However, only one of those keys is active at a time. A fifth parameter contains the index of the WEP key to use. The idea behind this scheme is the ability to change the use of a key with a simple change of index value and without erasing the actual key value, so it is ready for reuse at a later time. This scheme applies only to the default SSID stored in WST0 (also called WLSI). WEP keys for additional AP's who's SSID is defined in WST1 to WST9 are single keys stored for each SSID. The 4-key repository used with WSI0 is stored in the WLK $n$  iChip parameters, where  $n$  is in the range [1..4]. the index of the active key to be used is stored in WLKI.

For example,

AT+iWLK1=12AA4F5C32

AT+iWLK2=A4FF232218

... etc.

AT+iWLKI=2 defines use of the WEP key stored in WLK2 (A4FF232218).



It is not necessary to configure all 4 WEP keys. Setting a value to one key would be enough, provided that the WLKI parameter contains the index to the configured WLK $n$  parameter.

Single WEP keys may also be defined for multi-SSID environments. The iChip parameter list used is WKY $n$ , with  $n$  in the range [1..9] and corresponding to the AP with SSID stored in WSI $n$ .

For example,

```
AT+iWKY1=34FB1C2356
AT+iWKY2=AF4D66EF10
etc.
```

A checklist setting for a WEP environment will entail configuring the following parameters:

1. AT+iWLSI=<ssid>                      *SSID of required AP.*
2. AT+iWST0=<1 or 2>                      *Define WEP64 or WEP128 security.*
3. AT+iWLK1=<WEP key>                      *Define a WEP key using Hex digits.*
4. AT+iWLKi=<WEP key>                      *With WLSI (WSI0) you may define additional WEP keys. 1=2..4*
5. AT+iWLKI=1                              *Define which WEP key to use. Relevant only to WLSI (WSI0).*
  
6. AT+iWSIi=<ssid>                      *Define additional AP's for a multi-SSID environment. i=1..9.*
7. AT+iWKYi=<WEP key>                      *Define single WEP keys for use in a multi-SSID environment. i=1..9*
8. AT+iWSTi=<1 or 2>                      *Define WEP64 or WEP128 security. i=1..9*

WEP security has several vulnerabilities and can be rather easily cracked. It is advised not to use WEP security in security sensitive networks.

### **Wireless Protected Access (WPA/WPA2) Pre-Shared key (PSK) Security**

WPA/WPA2 PSK mode is based on a shared key encryption/decryption scheme using encryption methods that are significantly stronger than those used for WEP. An agreed upon Pass-phrase is configured in both the AP and the client and used together with the SSID to create a symmetric encryption/decryption key, which in turn is used with TKIP (WPA) or AES (WPA2) cipher engines.

When configuring iChip for WPA/WPA2 PSK mode security, the Pass Phrase needs to be configured in the WLPP parameter.

For example,

```
AT+iWLPP=<passphrase>
```

The *passphrase* used is an ASCII string consisting of 8-83 characters.

In multi-SSID environments each SSID setting can have a separate associated passphrase configured in the iChip parameter list WPP $n$ .  $n$  corresponds to the SSID stored in WSI $n$ . WLPP and WPP0 are equivalent and refer to the same exact value.

When setting or updating a *passphrase*, iChip requires about 20 seconds before returning the I/OK, since it needs to calculate a convolution between the *passphrase* and the SSID. Similarly, when a *passphrase* exists, updating the corresponding SSID will acquire the same delay.

A checklist setting for a WPA/WPA2 environment will entail configuring the following parameters:

1. AT+iWLSI=<ssid>                    *SSID of required AP.*
2. AT+iWST0=<3 or 4>                *Define WPA or WPA2 PSK security.*
3. AT+iWLPP=<passphrase>        *Define the passphrase.*
  
4. AT+iWSIi=<ssid>                   *Define additional AP's for a multi-SSID environment. i=1..9.*
5. AT+iWPPi=<passphrase >        *Define passphrases for a multi-SSID environment. i=1..9*
6. AT+iWSTi=<3 or 4>                *Define WPA or WPA2 PSK security. i=1..9*

### **Enterprise Mode Security**

The Enterprise Mode WiFi security approach focuses on a framework for providing centralized authentication and dynamic key distribution for encryption.

Central to this proposal are two main elements:

- IEEE 802.1x: a standard for port-based network access control.
- EAP: Extensible Authentication Protocol that allows wireless client adapters to communicate with different back-end servers such as a Remote Access Dial-In User Service (RADIUS server).

### **iChip supports Enterprise Mode WiFi security from firmware version 8.01 and above.**

Two related parameters have been added in order to support configuration of Enterprise Mode:

- **+iEUSN** – Enterprise User-Name: which contains the Radius Domain and specific client's User-Name.
- **+iEPSW** – Enterprise Password: which contains the Password associated with the User-Name in EUSN.

The EUSN parameter syntax is:

AT+iEUSN=<Domain>\<user-name>

Where,

*Domain* is the RADIUS server domain name

*user-name* is a User-Name defined in the RADIUS server with remote login rights.

For example,

AT+iEUSN=RADIUS\userA

The EPSW parameter syntax is:

AT+iEPSW=<password>

*password* must be the correct password defined in the RADIUS server for the User configured in EUSN.

In addition, the RADIUS server's certificate must be authenticated by iChip as part of the Enterprise Mode negotiation. Therefore, the RADIUS server's CA (Certificate Authority)

must be stored in iChip's CA parameter. The CA parameter accepts a standard PEM coded certificate.

For example,

```
AT+iCA= ----BEGIN CERTIFICATE-----
MIIEizCCA30gAwIBAgIQPcRpw5Ybo6FKV8k5zcDBDTANBgkqhkiG9w0BAQUFADBE
MRUwEwYKczImiZPyLQGGRYFbG9jYWwxFjAUBgoJkiaJk/IsZAEZFgZyYWRpdXMx
EzARBGNVBAMTCKv4YW1wbGUgQ0EwHhcNMdGwNzIxMDYwMDU2WhcNMTMwNzIxMDYx
MDE2WjBEMRUwEwYKczImiZPyLQGGRYFbG9jYWwxFjAUBgoJkiaJk/IsZAEZFgZy
YWRpdXMxEzARBGNVBAMTCKv4YW1wbGUgQ0EwggEiMA0GCSqGSIb3DQEBAQUAA4IB
DwAwggEKAoIBAQcXvtkwCDXMCRLRSsi7zFbAmJyyowyp+16GLJTkGEB6jmmus1
dCeKxi55skw5M+MeIy2TgUzf2iV0a4kSgHUAGuiGqia8kcE3yGQa4kq241JOCb/w
m6bx9p0xVfDcyXSBqTFTRTUFkPq074QDnwLbhGmuhBnt22p3xs3LKI+y3lp3v1Gf
z0EJ2yRXlye/J+skUIZvaFPhrw+85CfPcMLcPvfQ+2t3VJs89NBuak8WZJOn7sM1
zNSmbwA1wIrLt4kkqk6pOKAJ0un9izosWUaP0/qjhG7P2ccVkyAcWWq1ocgIMnZU
AAVSfPM2KUIRQGNm+rDJYF0Yrdw2BrdTL1DnAgMBAAGjggF3MIIBCzATBgkrBgEE
AYI3FAIEBh4EAEMAQTALBGNVHQ8EBAMCAYYwDwYDVR0TAQH/BAUwAwEB/zAdBgNV
HQ4EFggQPBNiHTms/pnCcqlJTEv4hpAqaL0wggELBGNVHR8EggECMIH/MIH8oIH5
oIH2hoG3bGRhcDovLy9DTj1FeGFtcGxlJTlWQ0EsQ049cmFkaXVzLXRzdCxDtj1D
RFAsQ049UHViBGljJTlW5V5JTIwU2VydmljZXMsQ049U2VydmljZXMsQ049Q29u
ZmlndXJhdGlvbixEQz1yYWRpdXMsREM9bG9jYWwvY2VydGlmawNhdGV5ZyY2F0
aW9uTG1zdD9iYXNlP29iamVjdENSYXNzPWNSTERpc3RyaWJldGlvb1BvaW50hypo
dHRwOi8vcmlkLXRzLXRzdC5yYWRpdXMubG9jYWwvY2VydEVucm9sbC9FeGFtcGxl
JTlWQ0EuY3JSMGAGCSsGAQQBbjcVAQDDAgEAMA0GCSqGSIb3DQEBAQUAA4IBAQCK
3GxozfOp6IiSRHNx08zfkKXPYDZrfItsY6FYSk/aLNAUW6y6BdwyCIDSLSDCGawD
ToPiA3reu0rRstrEUWq3D9JnzDoOL3h4MzGL6ddzN6SVigKOCvDxX31bZiq+h73i
8XbfgpSndKpu96itfRLDdBa9mFegfyTIBI5Z472iFKIHosKfdTjCh6Mf5+SGSdF
9G1cRPPTQOrxe7FKzdW+4lShWBanxOOSW3a5q7SbIc4a1dP1xOmzRauwIjkSW00J
pUaHscjALqJLsKqkSwrUNF1WxxvzVsMEfyJE/fEr87XhjeeKRPXV2ex44bvyaJBt
LEk8tY2O5JcAPTIKRMBO
-----END CERTIFICATE-----
I/OK
```

The WSTn parameter receives values 5 or 6 to define Enterprise Mode security:

- If WSTn=5, iChip shall try to associate only to AP's that publish WPA-IE-802.1x (and not PSK) in their beacon.
- If WSTn=6, iChip shall try to associate only to AP's that publish RSN-IE-802.1x (and not PSK) in their beacon.

A checklist setting for Enterprise security environment will entail configuring the following parameters:

1. AT+iCA=<ca> *Certificate Authority that signed the RADIUS server's certificate.*
2. AT+iWLSI=<ssid> *SSID of required AP.*
3. AT+iWST0=<5 or 6> *Define WPA or WPA2 Enterprise security*
4. AT+iEUSN=<dom>\<usr> *Define RADIUS Domain & User-Name*
5. AT+iEPSW=<pass> *Define User's Password*
6. AT+iWSIi=<ssid> *Define additional AP's for a multi-SSID environment. i=1..9.*
7. AT+iWSTi=<5 or 6> *Define WPA or WPA2 Enterprise security. i=1..9*

### Configuring a RADIUS Server

The following link may be consulted in order to configure a RADIUS server on a Windows Server machine:

[http://support.mof.go.th/radius\\_windows.html](http://support.mof.go.th/radius_windows.html)

## AD-HOC Mode

On wireless computer networks, **AD-HOC** mode is a method for wireless devices to directly communicate with each other. Operating in AD-HOC mode allows all wireless devices within range of each other to discover and communicate in peer-to-peer fashion without involving central Access Points. To set up an AD-HOC wireless network, each wireless adapter must be configured for AD-HOC mode as opposed to the alternative **infrastructure mode**. In addition, all wireless adapters on an AD-HOC network must use the same **SSID** and the same **channel number**.

The first system configured for AD-HOC mode is called the **Creator**. It knows that it is first, since it tries to sense if there are other systems in its vicinity in AD-HOC mode (using the same SSID and communicating on the same channel) – and cannot discover any. Additional systems are called **Joiners**, since they sense that other AD-HOC systems with the specified SSID exist on the specified channel and they join in.

The AD-HOC network is self-maintained and will continue to exist even if the Creator goes offline. Note that in an AD-HOC network, **all** members of the network must:

1. Have the same SSID
2. Use the same channel
3. Be in range of **all other** systems

iChip supports AD-HOC mode configuration by setting the WiFi channel and setting an SSID value that is preceded by the ‘!’ character. The ‘!’ is not part of the SSID. For example, to setup an AD-HOC SSID of “MYNET” specify in iChip “!MYNET”.

A checklist setting for AD-HOC will entail configuring the following parameters:

1. AT+iWLCH=<channel>      *Channel number in the range 1 to 11. 12 or 13 may be used in some countries as well.*
2. AT+iWLSI=!<ssid>      *SSID of required AD-HOC Network.*

### Security in AD-HOC mode

Only WEP64 or WEP128 security may be implemented when in AD-HOC mode. See WEP security above for configuration details.

### IP Address Assignment in AD-HOC mode

AD-HOC mode only provides for connectivity at the WiFi level. If an AD-HOC connection needs to support TCP/IP communications each participant system must somehow get an IP address. Furthermore, all IP addresses need to be on the same subnet.

As in other situations, IP addresses can either be pre-assigned in a fixed manner or one of the systems needs to act as a DHCP server. Note however, that when basing a solution on a DHCP server, the DHCP server must be part of the AD-HOC network before the other participants can get IP addresses and start communications.

An iChip can act as a DHCP server, if needed, by setting the DIP and DPSZ parameters. More information on this can be sought in the AT+i Programmers Manual.

### **Ad-Hoc mode Behavior in a MultiSSID environment**

- After power-up or hardware or software reset, iChip starts scanning for APs or Ad-Hoc networks in its vicinity, at intervals set by the WPSI parameter. iChip first refers to the value in the WLSI parameter. If WLSI refers to an Ad-Hoc network, iChip scans for all Ad-Hoc networks in its vicinity. It attempts to join the first Ad-Hoc network whose SSID is listed in the WSI $n$  parameter. If, however, after three consecutive scans, no such network is found – iChip creates its own network according to the WLSI (WSI0) SSID and stops scanning.
- If WLSI is set to (!), iChip scans only for any available Ad-Hoc network (regardless its SSID) and tries to connect to the network with the best signal. (correlates to WLSI="").
- If WLSI is set to (\*), iChip will not scan and remain disconnected.

### **iChip Behavior in the Event of a Lost Link**

If the WiFi connection is lost while no active connection is underway, iChip starts periodic scanning for APs and attempts to connect to the AP having the highest priority. After associating with an AP, iChip starts its DHCP client and monitors the SNR level of the AP it is associated with.

If the WiFi connection is lost during active operation, iChip waits for an IP activity command from the host. When such a command is sent, iChip performs a software reset and starts scanning for APs. iChip responds to the host with **ERROR(074)** to indicate that the current connection has been lost.

## **WiFi related Power Management**

### **Introduction**

The Power Management mechanism in iChip controls both the CO2128/CO2144 power modes as well as the Marvell 8686 power modes.

iChip's power management is enabled by setting the PSE (Power Save Enable) parameter to a value between 1 and 255 (the default value is 0 and means that the power saving mechanism is disabled). The PSE value is given in seconds and defines the number of idle seconds that will cause iChip to go into power save mode.

The Marvell's 8686 power management is enabled by setting the WLPS (Wireless Power Save) parameter to a value between 1 and 5 (the default value is 0 and means that the Wireless power saving mechanism is disabled). The WLPS value is given in number of beacon periods, where the beacon period is determined by the AP.

In Ad-Hoc networks, the value of the ATIM window controls whether the power save operation is permitted in the network or not. If the value of the ATIM window is 0, then the participating stations are not permitted to enter power save mode. The value of the ATIM window is chosen by the Ad-Hoc creator and then the same value is adopted by all the joiners.

When iChip is the creator it sets the ATIM window to a non zero value if WLPS is non zero. With a non-zero ATIM window value, every station participating in the Ad-Hoc network needs to be awake during the ATIM window, which follows a receipt of the

beacon. During this window any participating node may notify a peer that it has information to send. If the peer acknowledges, the sending and receiving node stay awake for the duration of the beacon period and exchange information. Other systems are allowed to doze (enter Sleep mode) for the duration of the Beacon period after the ATIM window is done. The ATIM window value is in units of TU (=1.024mSec).

### **iChip Power Modes :**

The iChip firmware has 3 power modes:

- **Normal mode** – in this mode, the firmware checks if it needs to enter sleep mode every 40 ms.

Several conditions must be fulfilled before entering sleep mode:

- The PSE parameter value is non-zero (i.e. between 1 and 255 seconds).
  - The number of seconds that have elapsed without any activity on the Host serial port is more than the value of the PSE parameter.
  - The number of seconds that have elapsed without incoming data from the WiFi (network) is more than the value of the PSE parameter.
  - There is no ongoing DHCP process (i.e. iChip has a valid IP address).
  - There is no data waiting to be transmitted on one or more of the active sockets.
  - In case of Serial-NET mode, there is no data to send.
- **Sleep mode** – if ALL of the conditions above are fulfilled and if iChip is associated with an AP or connected to an Ad-Hoc network, iChip enters Sleep mode.

In Sleep mode, the firmware shuts down most of its peripherals and if the WLPS parameter is set, it forces the Marvell 8686 chip into Sleep mode as well.

Any activity on the Host serial port or incoming data from the WiFi, restores iChip to Normal mode.

- **Deep Sleep mode** – iChip enters Deep Sleep mode if and only if iChip is **not** connected to an AP or in Ad-Hoc mode.

In this mode, iChip periodically scans for an AP and if fails to associate, it forces the Marvell 8686 chip into Deep Sleep mode and goes to sleep.

The periodic scan for an AP is governed by the WPSI (Wireless Scan Interval) parameter. WPSI contains a value in seconds. When iChip is in Deep-Sleep mode it wakes up every WPSI seconds, forces the Marvel 8686 chip out of Deep Sleep mode and scans again.

If an association succeeds, Deep Sleep mode is no longer used and iChip reverts the Marvell 8686 into Sleep mode.

### **Marvell 8686 chipset Power Modes:**

As mentioned above, the Marvell 8686 chipset has 2 power-save modes:

- Deep Sleep mode –used only when iChip is **not** associated to an AP and not in Ad-Hoc mode.
- Power Save mode –used when iChip is associated to an AP or in Ad-Hoc mode.

#### **Notes**

- The Marvel 8686 chipset goes into Sleep mode only after at least one beacon period of inactivity.

- When associating to an AP, the sleep duration is determined by the WLPS parameter's value multiplied by the beacon period. The beacon period is determined by the AP configuration.
- When in Ad-Hoc network, the sleep duration in milliseconds is determined by the beacon period (regardless of the WLPS parameter). The beacon period is determined by the Ad-Hoc network creator. In Ad-Hoc, the sleep duration **equals** the beacon period. Meaning: each member in the Ad-Hoc network that enters sleep mode, must wake up every beacon period for a period specify in the ATIM window.
- In Ad-Hoc networks, during every beacon period and during the ATIM window, to the WiFi chipset will either stay awake for the entire next beacon period in order to handle incoming or outgoing data, or go back to sleep.

### **Power Management implications:**

- The PSE parameter indicates the number of seconds the iChip must be Idle before entering Sleep mode or Deep Sleep mode.  
Power Save is tightest if the PSE value is set to its minimum value (PSE = 1).
- When the iChip is associated to an AP, the WLPS parameter determines the duration of the WiFi sleep period.  
Power Save is optimized if PSE=1 and WLPS=5.
- When the iChip is NOT associated to an AP, the WPSI parameter determines the duration of the Deep Sleep cycle period.  
In this case, Power Save is optimized as long as the WPSI parameter is set to a large value. Be aware that during WPSI seconds, the iChip does not attempt to scan and connect to any AP.
- While in Power Save, throughput may be reduced.

A checklist setting for a Power-Save environment will entail configuring the following parameters:

- |                      |   |
|----------------------|---|
| 1. AT+iPSE=<idle>    | <i>Enter Power-Save mode after idling for &lt;idle&gt; seconds</i>        |
| 2. AT+iWLPS=<beacs>  | <i>When in Sleep Mode shut down WiFi for &lt;beacs&gt; beacons</i>        |
| 3. AT+iWPSI=<rescan> | <i>When WiFi is shutdown, rescan for APs every &lt;rescan&gt; seconds</i> |

## **Roaming with Wireless-LAN**

### **Introduction**

When set to operate in Roaming mode, iChip can roam seamlessly among Access Points (APs) that share the same SSID and the same security configuration, without interrupting its ongoing IP connectivity. iChip also has a monitoring mechanism that is sensitive to drops in AP signal strength. When iChip detects such a drop, it automatically starts searching for APs in its vicinity that have a stronger signal, while still remaining connected to the current AP.

The following parameters are required to set iChip to Roaming mode:

- WROM — Enables Roaming mode.

- WPSI — Sets the time interval between consecutive scans that iChip performs for APs in its vicinity.
- WSRL — Sets a low SNR threshold for iChip in Roaming mode.
- WSRH — Sets a high SNR threshold for iChip in Roaming mode.

Note that the AT+i!RP10 and AT+iRP20 reports, described above, provide useful information pertaining to Roaming.

### **iChip Behavior when AP Signal Becomes Weak**

When the beacon signal of the AP to which iChip is associated becomes weak (SNR drops below the LOW level set by the WSRL parameter), iChip starts periodic scans for APs having an SNR above the High threshold set by the WSRH parameter.

When in Roaming mode, iChip attempts to connect to the AP that appears first on the list of SSIDs specified by the WSIn parameter, while remaining connected to the current AP. If association with the new AP fails, iChip continues scanning until it succeeds connecting to an AP with a stronger signal. When in Roaming mode, and a new association succeeds, iChip does not restart its DHCP client and the current session remains uninterrupted.

In comparison, when iChip is *not* in Roaming mode, iChip remains connected to an AP as long as it has an open active socket, or until triggered by a Link Loss event. In this case, iChip ignores any decrease in AP signal strength while having open active sockets. However, when iChip is *not* in Roaming mode and *no active sockets are open*, iChip starts periodic scanning for APs having an SNR level above the High (WSRH) threshold. iChip attempts to connect to the AP that has the highest priority (according to the WSIn list). After associating with a new AP, iChip will start its DHCP client.

A checklist setting for a Roaming environment will entail configuring the following parameters:

- |                       |  |
|-----------------------|--|
| 4. AT+iROM=1          | <i>Configure Roaming mode</i>  |
| 5. AT+iWSRL=<low_th>  | <i>LOW SNR threshold, below which scanning commences</i>               |
| 6. AT+iWSRH=<High_th> | <i>High SNR threshold, above which re-association occurs</i>           |
| 7. AT+iWPSI=<rescan>  | <i>When under LOW SNR, rescan for APs every &lt;rescan&gt; seconds</i> |



## Roaming Parameters Description

### +iWROM — Enable Roaming in WiFi

Syntax: AT+iWROM=<*n*>  
Sets iChip to Roaming mode.

Parameters: *n*=0 | 1  
*n*=0 Disable Roaming mode.  
*n*=1 Enable Roaming mode.

Default: *n*=0

Result Code:  
**I/OK** If *n* is a legal value.  
**I/ERROR** Otherwise

AT+iWROM? Returns the current WROM value followed by **I/OK**.  
AT+iWROM=? Returns the message “**0-1**” followed by **I/OK**.

### +iWPSI — Periodic WiFi Scan Interval

Syntax: AT+iWPSI=*n*  
Sets the time interval – *n* – between consecutive scans that iChip performs for APs in its vicinity.

Parameters: *n*=1-3600 seconds  
Default: *n*=5 seconds

Result Code:  
**I/OK** If *n* is a legal value.  
**I/ERROR** Otherwise

AT+iWPSI? Returns the current WPSI value followed by **I/OK**.  
AT+iWPSI=? Returns the message “**1-3600**” followed by **I/OK**.

### +iWSRL — SNR Low Threshold

Syntax: AT+iWSRL=<*n*>  
Sets a low SNR threshold for iChip in Roaming mode. If the SNR value of the signal from the AP that iChip is currently associated with drops below *n*, iChip is triggered by the SNR low event.

Parameters: *n*=0-255 dB  
Default: *n*=10 dB

Result Code:  
**I/OK** If *n* is a legal value.  
**I/ERROR** Otherwise

AT+iWSRL? Returns the current WSRL value followed by **I/OK**.  
AT+iWSRL=? Returns the message “**0-255**” followed by **I/OK**.

### +iWSRH — SNR High Threshold

Syntax: AT+iWSRH=<*n*>  
Sets a high SNR threshold for iChip in Roaming mode. iChip will re-associate only with APs having SNR that is better than *n*.

Parameters: *n*=0-255 dB  
Default: 30 dB

Result Code:

**I/OK** If *n* is a legal value.

**I/ERROR** Otherwise

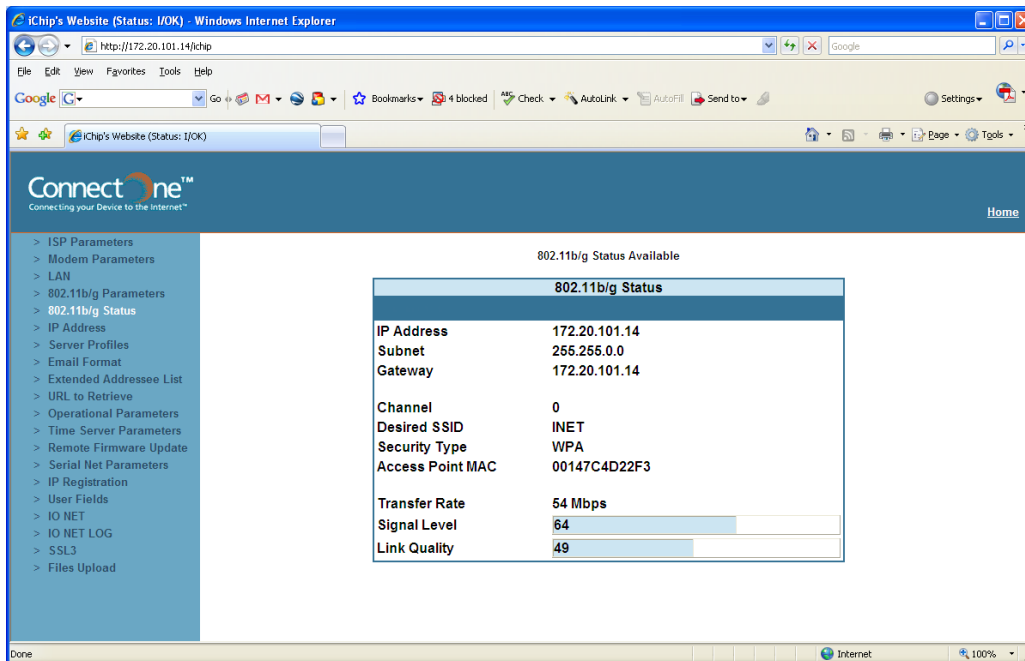
AT+iWSRH? Returns the current WSRH value followed by **I/OK**.

AT+iWSRH=? Returns the message “**0-255**” followed by **I/OK**.

## Monitoring WiFi Performance in iChip’s Configuration Web Site

The iChip configuration Web site includes a page dedicated to WiFi status and performance, The Web page is automatically refreshed every second.

Open iChip’s Configuration Site and select the “*802.11b/g Status*” Menu option:



The screenshot shows a Windows Internet Explorer browser window displaying the iChip configuration website. The browser's address bar shows the URL `http://172.20.101.14/ichip`. The website's header includes the "Connect One" logo and the tagline "Connecting your Device to the Internet". A navigation menu on the left lists various configuration options, with "802.11b/g Status" selected. The main content area displays the "802.11b/g Status" page, which includes a table of network parameters and performance metrics.

802.11b/g Status	
IP Address	172.20.101.14
Subnet	255.255.0.0
Gateway	172.20.101.14
Channel	0
Desired SSID	INET
Security Type	WPA
Access Point MAC	00147C4D22F3
Transfer Rate	54 Mbps
Signal Level	64
Link Quality	49

## Configuring LAN-to-WiFi Bridge Mode

### Introduction and Scope

This section describes the iChip "LAN to WiFi Bridge" mode and its possible uses. The LAN-to-WiFi bridge mode is available from firmware version 8.04 and beyond.

The LAN to WiFi bridge mode enables users to design their application regardless of the network connection. Users can design their system to connect to a LAN infrastructure either by using a standard cable connection, a WiFi to WiFi bridge or a WiFi to AP bridge. The bridge mode enables the user to use these three different connection types without any change to their application or to the LAN infrastructure.

In the LAN to WiFi bridge mode, iChip acts as a layer 2 switch and emulates layer 2 packets from the user application towards the LAN and WiFi infrastructures.

The following section outlines possible uses of the bridge mode and the configuration required to enter this mode.

### General Description

#### **What is LAN to WiFi Bridge:**

LAN to WiFi bridge, is a special iChip mode where iChip acts as a layer 2 bridge between a LAN network on one side and a WiFi network on the other side. iChip FW is responsible for all WiFi connectivity and security. iChip supports two modes of LAN to WiFi bridge:

- Cable replacement Ad-Hoc Mode
- Cable replacement Access-Point (AP) mode

Note that when iChip is configured for Bridge mode, it enters this mode immediately after power-up and automatic Host port and baud rate detection are not supported. Therefore, the +iHIF and +iBDRF parameters **must** be defined.

The following sections describe the behavior of these two modes.

#### **Cable replacement AD-HOC mode**

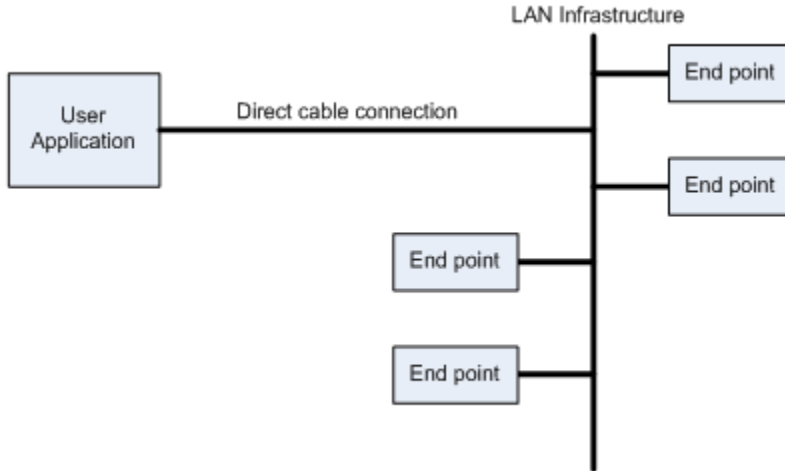
In this mode iChip acts as a cable replacement and placed on both sides. The connection between the two sides is done using WiFi AD-HOC mode. In this mode iChip supports two types of LAN connection:

- RMII/MII connection to iChip
- PHY connection to iChip

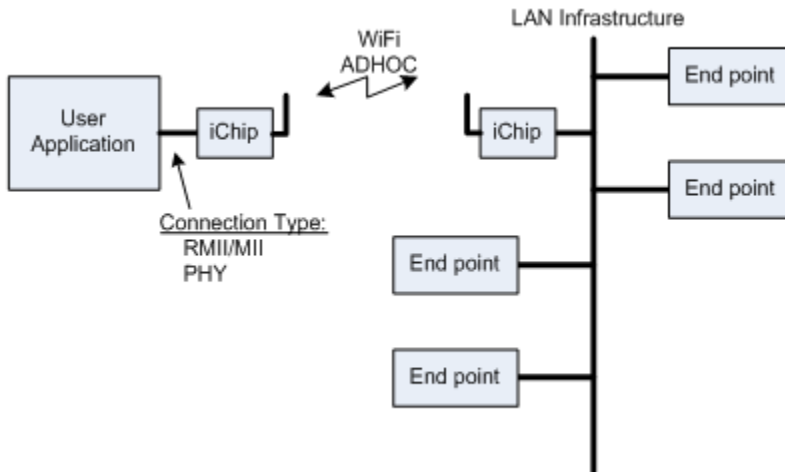
Both sides of the line can be configured differently based on user requirements.

The diagrams below outline the iChip Cable replacement mode:

## Connect One



Drawing 1: Direct Cable connection (Original state)



Drawing 2: Cable replacement AD-HOC mode

In cable replacement AD-HOC mode, iChip supports two security layers. The first layer is the Ad-Hoc WEP security and the second layer is MAC forwarding. When using MAC forwarding the user can configure both iChips to forward packets to a predefined MAC address as define in the MACF parameter. Without MAC forwarding, iChip will need to broadcast outgoing packets. Broadcasting is slower than Unicasting and also has the disadvantage of being received by all systems on a specific AD-Hoc network. In this mode, all traffic from the LAN infrastructure is moved to the user application over the WiFi AD-HOC connection and all traffic sent from the user application is moved back to the LAN infrastructure.

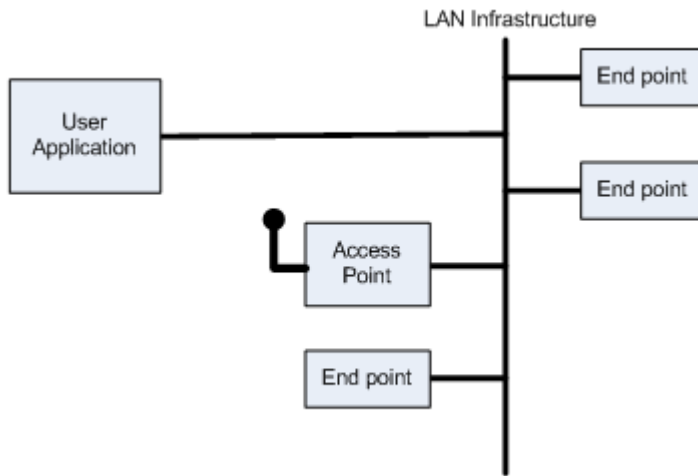
To enter "Cable replacement Ad-Hoc mode" the following parameters should be used:

- +iWLSI - Ad-Hoc network SSID (prefix with !)
- +iWLCH - Ad-Hoc wireless channel
- +iWST0 - WEP security type (64,128)
- +iWKY0 - WEP security Key

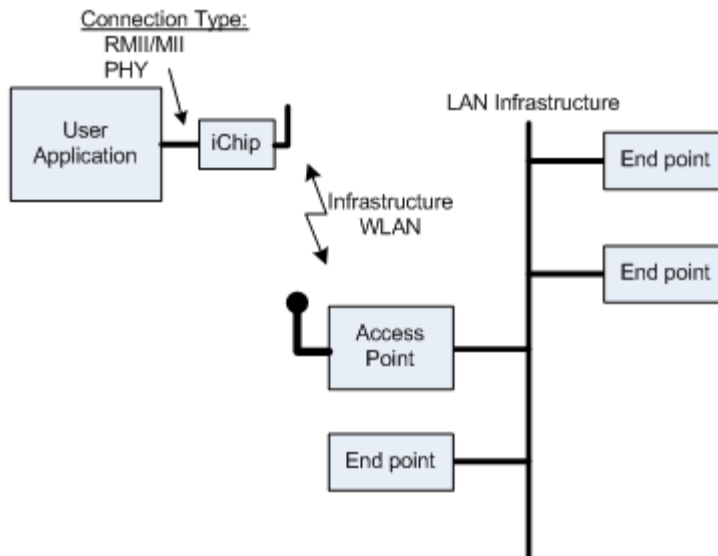
- +iBRM - Bridge mode: LAN interface, MII/RMII or PHY
- +iMACF - MAC Filter on both sides
- +iHIF - Define Host Interface
- +iBDRF - Define Host baud rate

### Cable replacement AP mode

In this mode iChip replaces a direct cable connection of the user application to a LAN infrastructure, by connecting the user application to an Access Point on the LAN infrastructure.



Drawing 3: Direct cable connection to LAN infrastructure



Drawing 4: Cable replacement AP Mode

In Cable replacement AP mode, iChip enables a user application to connect to an existing AP on the LAN infrastructure. iChip connects to the AP using the same MAC address of the user application which enables the LAN infrastructure to maintain that same connection rules for the user application.

The following parameters should be used in order to set "Cable replacement AP mode" (with WPA Security):

- +iWLSI - WiFi network SSID
- +iWST0 - WiFi security type
- +iWLPP - WiFi WPA security Key
- +iBRM - Bridge mode: LAN interface, MII/RMII or PHY
- +iHIF - Define Host Interface
- +iBDRF - Define Host baud rate

## New AT+I Commands to support LAN-to-WiFi Mode

### **AT+iBRM – Bridge Mode**

Syntax: AT+iBRM=<n>                      Sets iChip bridge mode

Parameters: n=0..4

Command Options:

n=0 Bridge mode disable

n=1 Cable replacement PHY to WiFi Ad-Hoc mode

n=2 PHY LAN to WiFi AP mode

n=3 Cable replacement MII/RMII to WiFi Ad-Hoc mode

n=4 MII/RMII LAN to WiFi AP mode

### **AT+iMACF – MAC Forward**

Note - This parameter takes effect only in cable replacement mode (BRM= 1, 3)

Syntax: AT+iMACF= <mac>                      Sets MAC forwarding in Ad-Hoc bridge mode. This MAC will be used as the destination MAC address of the transmitted packets. If left empty Broadcast is used.

Parameters: mac="hhhhhhhhhhhh" 12 HEX digits of MAC address

Command Options:

mac = "" No MAC forwarding. Packets will be Broadcast.

mac = mac\_address

Valid 12 HEX digit representation of MAC destination address.

In case of invalid value – MAC forwarding will not work.

## Micro Access-Point (uAP) Mode

iChip Firmware versions 809 and above contain support for uAP mode. In this mode, iChip's WiFi driver is configured as an Access-Point rather than a station. Changing iChip's WiFi mode of operation requires a Firmware change. iChip's default Firmware version, i.e. 809xxx, is traditionally in WiFi station mode. The parallel Firmware version for uAP mode shall be labeled: 809xxxUAP. Most of iChip's WiFi parameters defined originally for Station mode remain operational in uAP mode as well, possibly with some additional variations. The following describes the parameters and modes relevant for uAP mode.

### Supported AP functionality

- WEP encryption
- Open system authentication
- WEP shared key authentication
- Embedded WPA/WPA2-PSK authenticator
- IEEE power save
- Hidden SSID feature
- Aging of inactive client stations

### Non-Configurable AP Parameter Settings

- Beacon Period = 20 TU (1 TU = 1024 usec)
- DTIM Period = 1 beacon period
- Aging Timer = 0 (station will never be aged out)
- Group ReKey timer = 0 (group key will never be aged out)
- Pairwise key handshake timeout = 650 ms (relevant only if security is WPA or WPA2)
- Pairwise key retries count = 10 (relevant only if security is WPA or WPA2)
- Group key handshake timeout = 650 ms (relevant only if security is WPA or WPA2)
- Group key retries count = 10 (relevant only if security is WPA or WPA2)
- PS (of the uAP unit) is disabled!
- Max TX rate = 54 Mbps      Data rate to use for unicast packets transmission.
- TX power level = 13 dBm      Power level that the AP will use for transmitting packets to client stations in the BSS.
- Broadcast SSID = Enabled      AP responds to probe requests from client stations that contain null SSID. AP Generates beacons that contain its SSID.
- Packet forwarding = 1      AP handles intra-BSS packets
- Max Stations count = 8      Range: 0-8
- Retry Limit = 7      Retry limit to use for packet transmissions. Range: 0-14



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- RSN replay attack protection = Disabled  
If enabled, the frames detected as replay frames will be dropped.

### Configurable iChip Parameters used in AP mode

- +iWLCH – Sets the AP channel. Default value is 6.
- +iWLSI – Sets the AP SSID. Default value is "Connect One uAP"
- +iWST0 – Sets the AP security type, where:
  - n=0 – no security
  - n=100 – WPA-PSK TKIP + WPA2-PSK CCMP (auto mode)
  - n=1 – WEP64 open authentication
  - n=2 – WEP128 open authentication
  - n=101 – WEP64 shared authentication
  - n=102 – WEP128 shared authentication
  - n=3 – WPA-PSK TKIP
  - n=103 – WPA-PSK TKIP + CCMP
  - n=4 – WPA2-PSK CCMP
  - n=104 – WPA2-PSK TKIP + CCMP
- +iWLPP – Sets the AP WPA/WPA2 Pass Phrase
- +iWLK1 – Sets the AP WEP key

### iChip AT+i Commands used in relation to uAP mode

- **AT+iRP30** – displays a list of connected clients. The list contains client MAC address, IP address, Power status (active/power save) and client host name. For example:  
AT+iRP30  
MAC Address Power Status RSSI IP Address Host Name  
001DD934C1EE power save 203 192.168.0.2 PCdesk1  
I/OK
- **AT+iWRFD** – Fully stops the AP. iChip de-authenticates all clients, stops sending beacons and turns the radio OFF.
- **AT+iWRFU** – Restart AP. iChip turns radio ON and resumes sending beacons.
- **AT+iRP10, AT+iRP11 and AT+iRP20**  
These report commands are not relevant in uAP FW, hence, the return value shall be I/ERROR (067).