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(54) **SYSTEMS AND METHODS FOR ENABLING STATIONS TO CONNECT TO WIRELESS HOTSPOTS USING NON-UNICODE SERVICE SET IDENTIFICATION INFORMATION**

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H04W 48/08 (2009.01)
H04W 84/12 (2009.01)

(52) **U.S. Cl.**

CPC **H04W 88/08** (2013.01); **G06F 17/2223** (2013.01); **H04W 48/08** (2013.01); **H04W 48/12** (2013.01); **H04W 84/12** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56)

References Cited

U.S. PATENT DOCUMENTS

7,415,500 B2	8/2008	Morris et al.
7,657,234 B2	2/2010	Qu et al.
2003/0215074 A1	11/2003	Wrobel
2009/0175250 A1*	7/2009	Mathur et al.
2012/0257536 A1*	10/2012	Kholaif et al.
		370/338
		370/254

OTHER PUBLICATIONS

Research in Motion, "Clarifying the requirements for the CJKV language ambiguity with the NITZ feature", C1-102429, 3GPP CT1-65 Meeting, Jun. 28-Jul. 2, 2010.*

(Continued)

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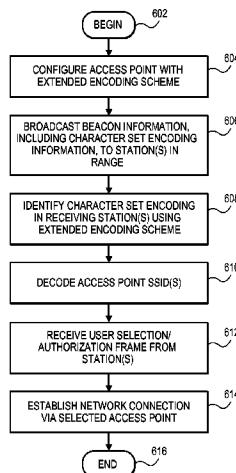
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(57)

ABSTRACT

Embodiments relate to systems and methods for enabling stations to connect to wireless hotspots using non-Unicode service set identification information. A WiFi™ wireless router or other access point can broadcast beacon information to smart phones or other stations within wireless range of that device. In existing access point implementations, the character set in which the access point broadcasts this information, including a service set identification indicating the connection services available from the access point, are assumed to be encoded in Unicode format, specifically, UTF-8 format. While English-language options are properly displayed, character sets and/or languages which are not encoded in Unicode (UTF-8) format are translated into unintelligible characters using this approach. According to embodiments, access point hardware can be configured to broadcast the type of character set encoding in the beacon information itself, for instance, in existing SSID information elements, vendor-specific information elements, and/or other locations in the beacon data.

80 Claims, 7 Drawing Sheets



(56)

References Cited**OTHER PUBLICATIONS**

International Search Report and Written Opinion—PCT/US2013/024833—ISA/EPO—May 31, 2013.

Research in Motion: “Clarifying the requirements for the CJKV language ambiguity with the NITZ feature”, 3GPP Draft; C1-102429, 3rd Generation Partnership Project (3GPP), Mobile Competence Centre; 650, Route Des Lucioles; F-06921 Sophia-Antipolis Cedex; France, vol. CT WGI, no. Dublin; Jul. 2, 2010 , XP050443156, [retrieved on Jul. 5, 2010].

3GPP TS 23.038, “3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Alphabets and Language-specific Information,” (Release 10), V10.0.0, Mar. 2011, 56 Pages.

3GPP TS 23.041, “3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Technical realization of Cell Broadcast Service (CBS),” (Release 10), V10.3.0, Mar. 2012, 51 Pages.

Chromium-OS, “Issue 8563: non-ASCII Wifi SSID is not displayed correctly—the open source project behind google chrome OS”, Google Project Hosting, 2011, [retrieved on Dec. 19, 2012]. Retrieved from the Internet:< URL: <http://code.google.com/p/chromium-os/issues/detailed?id=8563>>, 5 pages.

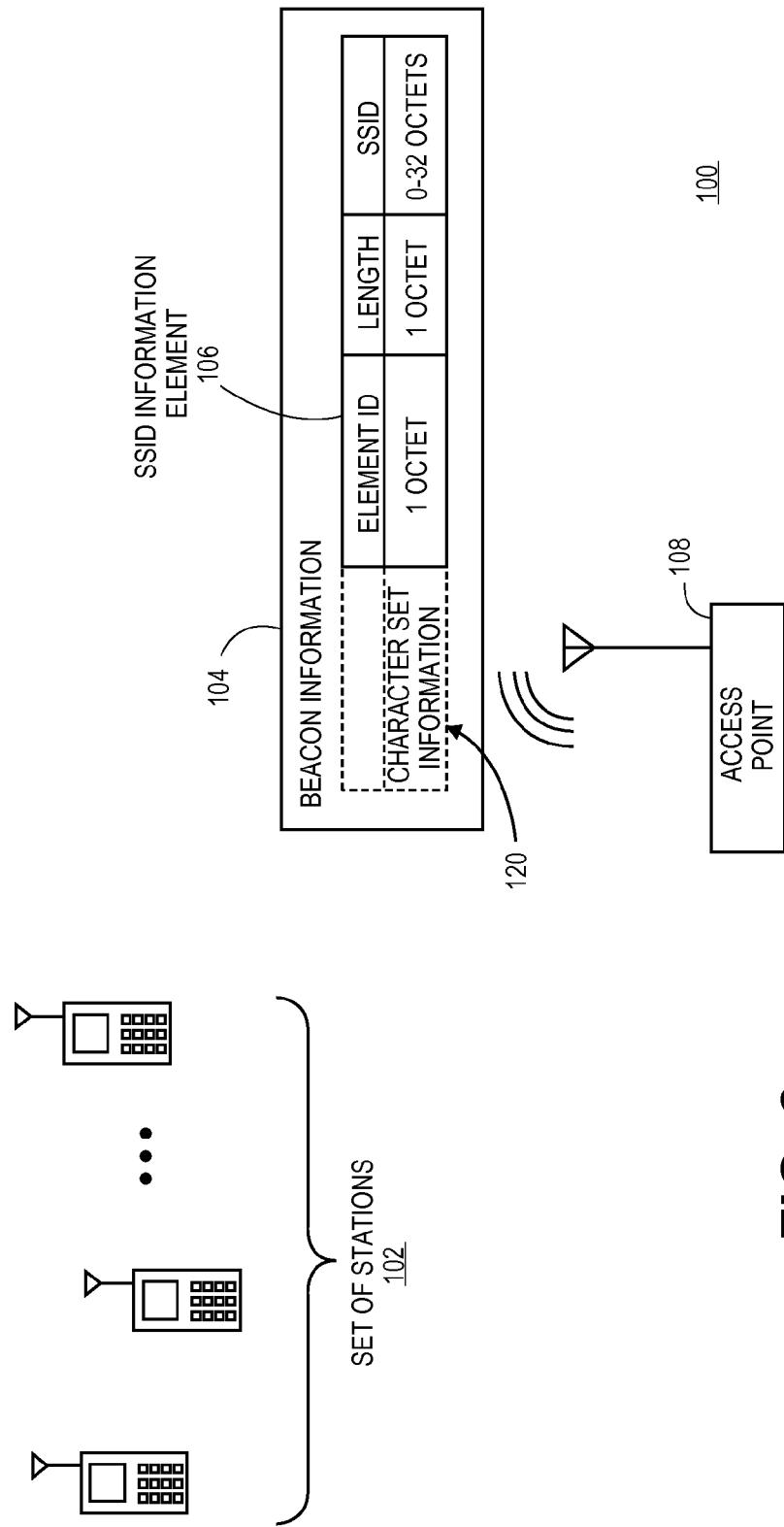
“Android—Issue 8035—WiFi association fails for SSIDs with spaces them”, Apr. 29, 2010, XP055063104, Retrieved from the Internet: URL:<http://code.google.com/p/android/issues/detail?id=8035&can=1&q=ssid%20utf&colspec=ID%20Type%20Status%200wner%20Summary%20Stars> [retrieved on Sep. 3, 2015].

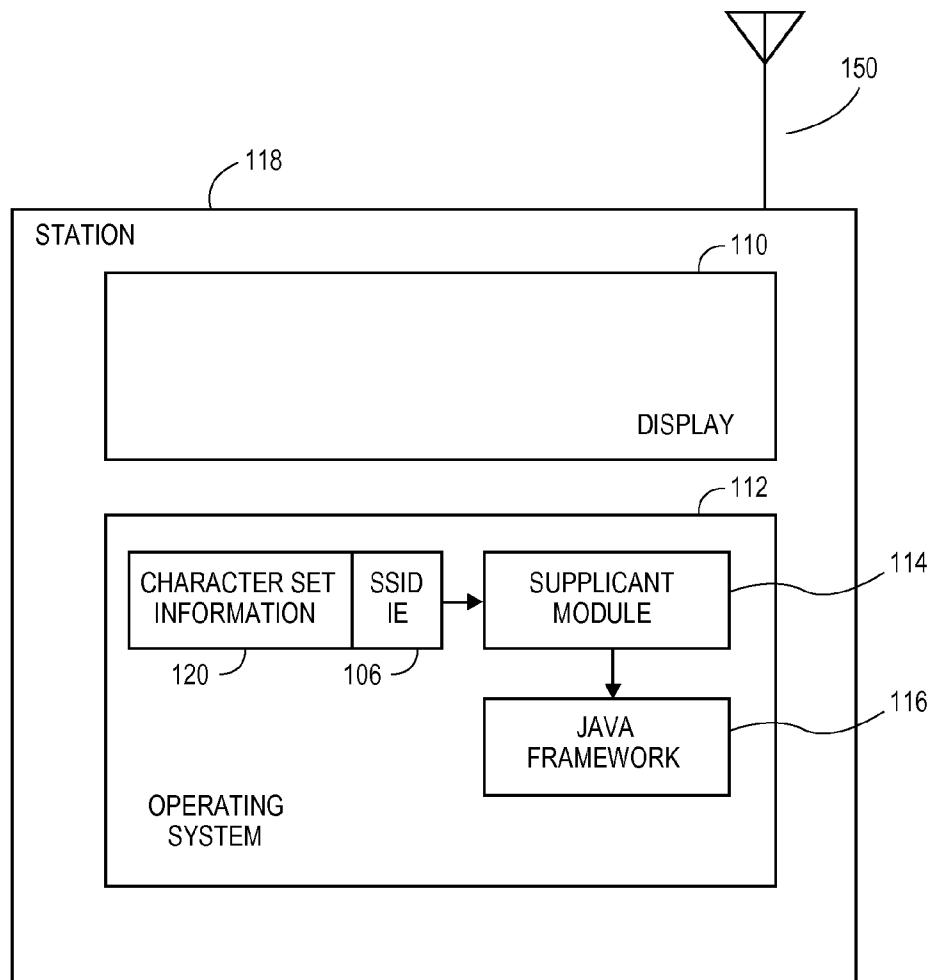
Chromium—Issue 190935—non-ASCII Wifi SSID is not displayed correctly, Nov. 2, 2010, XP055063103, Retrieved from the Internet: URL:<http://code.google.com/p/chromium/issues/detail?id=190935&can=1&q=unicode%20SSID&colspec=ID%20Pri%20M%20Iteration%20ReleaseBlock%20Cr%20Status%200wner%20Summary%200S%20Modified> [retrieved on Sep. 3, 2015].

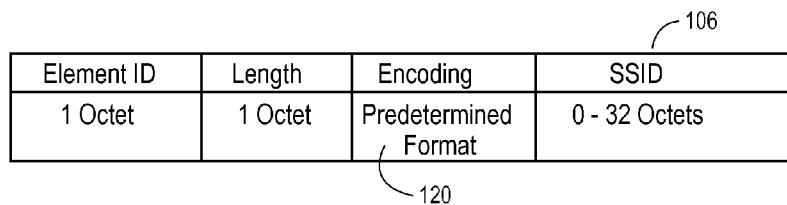
* cited by examiner

ELEMENT ID	LENGTH	SSID
1 OCTET	1 OCTET	0-32 OCTETS

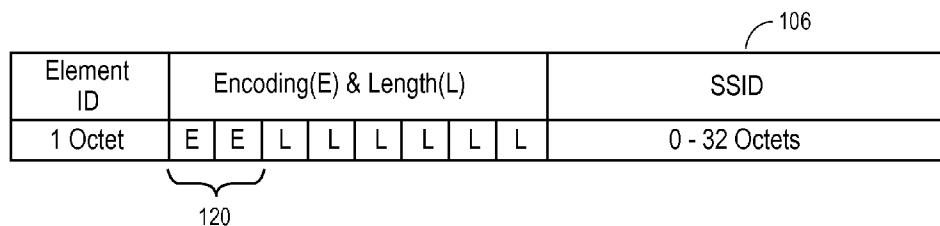
FIG. 1

**FIG. 2**

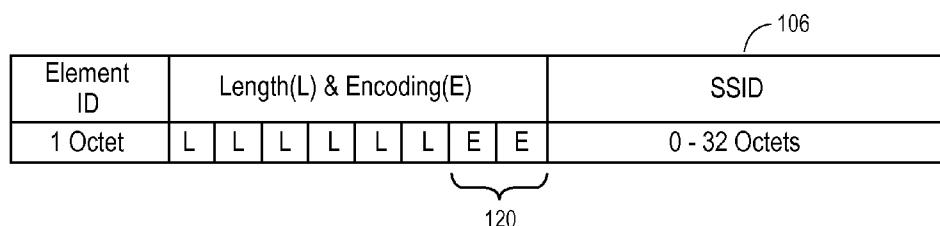
**FIG. 3**



Element ID	Length	Encoding	SSID
1 Octet	1 Octet	Predetermined Format	0 - 32 Octets

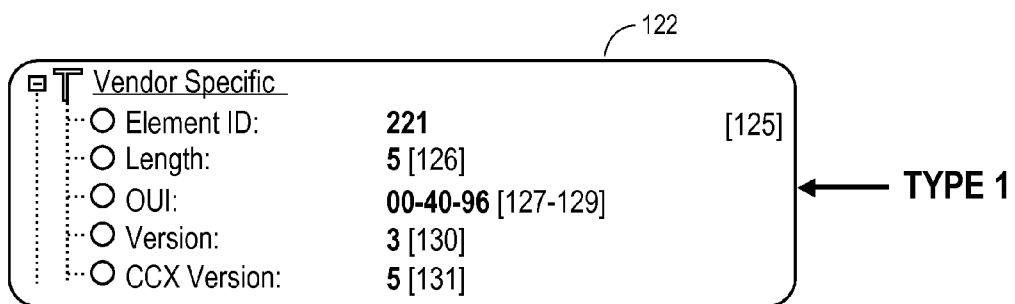
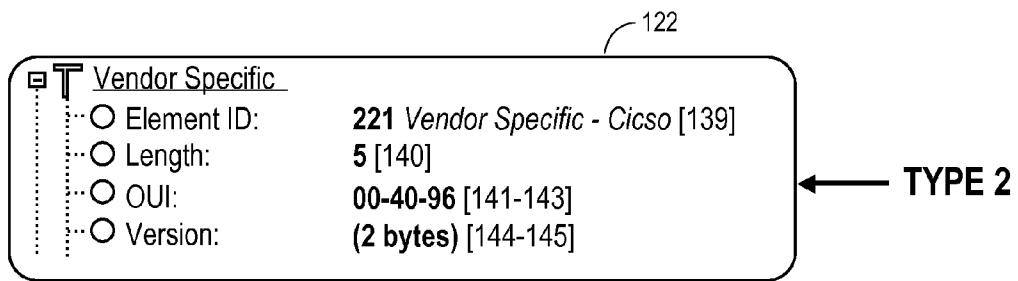
FIG. 4A

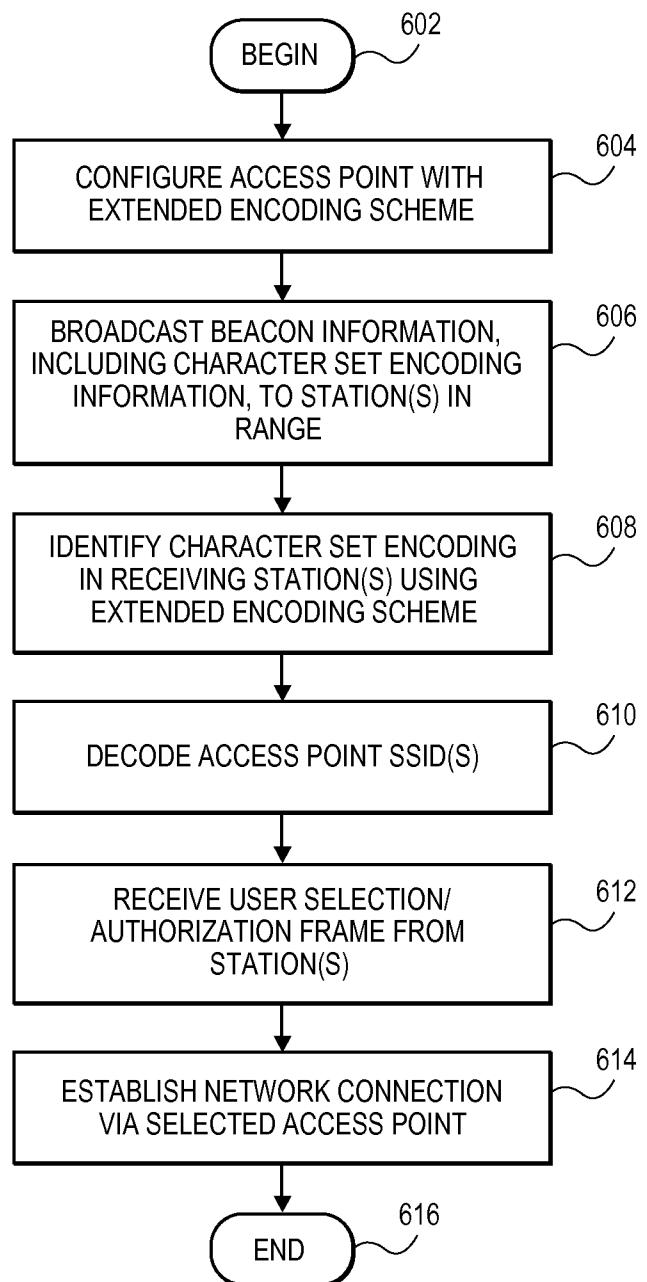
Element ID	Encoding(E) & Length(L)								SSID
1 Octet	E	E	L	L	L	L	L	L	0 - 32 Octets

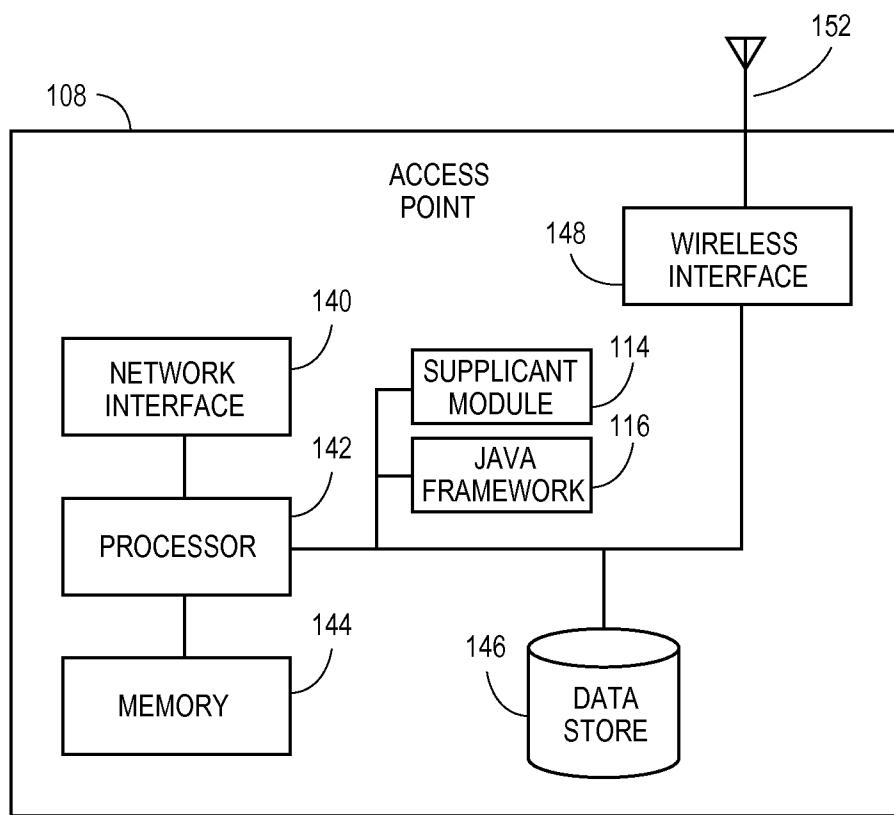
FIG. 4B

Element ID	Length(L) & Encoding(E)								SSID
1 Octet	L	L	L	L	L	L	E	E	0 - 32 Octets

FIG. 4C

**FIG. 5A****FIG. 5B**

**FIG. 6**

**FIG. 7**

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**SYSTEMS AND METHODS FOR ENABLING
STATIONS TO CONNECT TO WIRELESS
HOTSPOTS USING NON-UNICODE SERVICE
SET IDENTIFICATION INFORMATION**

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 61/595,291, filed Feb. 6, 2012, entitled "Systems and Methods for Enabling Stations to Connect to Wireless Hotspots Using Non-Unicode Service Set Identification Information," by the same inventors herein, which application is incorporated herein by reference in its entirety.

FIELD

The present teachings relate to systems and methods for enabling stations to connect to wireless hotspots using non-Unicode service set identification information. The present teachings more particularly relate to platforms and techniques for enabling the specification of a character set which a wireless router or other WiFi™ access point is using to broadcast available service sets to wireless devices in range of that access point

BACKGROUND

It has been observed that there are common potential problems in smart phones based on the Android™ operating system or others, in terms of connectivity to wireless WiFi™ routers, hot spots, or other access points (APs) broadcasting in certain languages. One problem is that Android™-based phones or other devices are unable to show the exact service set identification (SSID) name of the wireless router in the phone's scan window for WiFi™ routers or other access points which are configured with SSID data in languages other than English. Those alternative languages can be or include languages such as Chinese, Indian, Spanish, etc. This, by itself, means that if there are two co-located AP's which are each configured with a unique Chinese SSID, for instance, and the user of the smart phone or other device wants to connect to one of the two, then the user has no basis upon which to choose one to connect to, just by viewing the scan window of the smart phone graphical user interface (GUI).

BACKGROUND

The reason for this difficulty is that existing smart phones or other devices will display unintelligible or junk characters in place of the intended Chinese characters indicating SSID information in that language. To make matters worse, even if the user guesses and selects one of the access points to connect to, the smart phone is typically not able to establish a connection with the selected router or hot spot. Some smart phones are not even capable or recognizing or scanning an access point when the SSID is configured in Chinese, Indian, Spanish, etc. This is a significant limitation of smart phones from the perspective of many users, because a smart phone which is expected to connect with any WiFi™ hot spot in the world can actually paralyze the complete WLAN feature of the smart phone when the phone's user tries to connect to those hot spots which are configured with non-English SSID's, as mentioned above.

In terms of smart phones based on the Android™ operating system, the reason that Android™ phones display "junk" characters for Chinese or other languages is not because the Android™ graphical user interface (GUI), which is powered

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or supported by the Java™ framework, does not support Chinese characters. Instead, a significant part of the difficulty lies in the way processing of SSID information is handled in the existing Android™ operating system and related logic.

5 More particularly, the Android™ framework, including the supplicant module used to establish connections to hotspots, is completely unaware of the encoding format in which the SSID name is encoded in beacon frames broadcast by the access point. Instead, smart phones based on the existing 10 Android™ operating system merely and always assume that SSID information passed to them is in Unicode (UTF-8 code) format. This default processing of character sets results in anomalous behavior if the SSID is encoded in a coding format other than Unicode. As noted, wireless routers or other access 15 point devices may be encoded in non-Unicode formats in many regions of the world, including as noted China, as well as other locations.

To consider the existing SSID format used by smart phones 20 connecting to WiFi™ access points, the SSID information is presented in an SSID Information Element identified by Element Id: 0, in a structure which is illustrated in FIG. 1. The SSID IE shown is mandated by industry standards published by the Institute of Electrical and Electronics Engineers, or 25 "IEEE.". As per this SSID IE which is defined by the IEEE standards, the only significant information conveyed is the SSID name and the length of the SSID. There is no additional information that is available to assist in identifying the character set, associated language, or other extended characteristics of a WiFi™ access point.

30 A scenario can likewise be considered in which there are two access points transmitting and announcing their SSID's, which might be in English and Chinese, respectively, within a local broadcast range. As expected the SSID IE's broadcast 35 the SSID's, but the English SSID is encoded according to ASCII code set, whereas the Chinese SSID might be encoded according to the official Guo Biou (GB) code set promulgated for Chinese character processing.

The smart phone supplicant module, which interfaces 40 between the Java™ framework and the underlying WLAN driver and other transceiver logic, receives these two SSID IE's from the WLAN interface. The supplicant module passes both of them on to the Android™ graphical user interface (GUI) framework. That GUI framework handles the responsibility of appropriately decoding the SSID name and displaying it in the smart phone's WiFi™ scan window or other display. But the Chinese SSID which is encoded in the separate GB code is assumed to be represented UTF-8 compatible code, causing it to be decoded incorrectly by the Android™ 45 Java™ framework, since that framework attempts to decode the GB code assuming the character set information is available in UTF-8 format.

This incompatibility leads to unintelligible or "junk" characters being displayed in the device's scan window. In contrast, since the UTF-8 values for ASCII-based characters are 50 identical, the scan window shows the English SSID correctly on the smart phone.

If an attempt were made to manage the issue for Chinese or other non-English SSIDs outside conventional ASCII set, that 55 approach would cause the supplicant module and Java™ framework module installed on the smart phone to require very complex and possibly unreliable decoding logic to identify whether the SSID name is encoded in ASCII, GB code, or any other encoding scheme that the access point might use. It 60 may be remembered that there is no guideline mandated by the IEEE for access point manufacturers to encode the SSID in any particular coding format. That lack of standardization 65

makes the possible decoding of the access point character set by the smart phone itself that much more difficult at the applicant/framework level.

It may be desirable to provide systems and methods for enabling stations to connect to wireless hotspots using non-Unicode service set identification information, in which the access point can systematically share which coding scheme is used for the character set used for the SSID broadcast by that device. This information can be passed to the Android™ operating system, Java™ framework, and/or other logic which can then accurately and reliably parse the SSID based on a variety of different character coding schemes, providing visibility into WiFi™ networks by users of a variety of languages.

DESCRIPTION OF DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the present teachings and together with the description, serve to explain the principles of the present teachings. In the figures:

FIG. 1 illustrates a service set information element as used in known WiFi™ systems;

FIG. 2 illustrates an overall wireless WiFi™ network in which systems and methods for enabling stations to connect to wireless hotspots using non-Unicode service set identification information can operate, according to various embodiments;

FIG. 3 illustrates features of an individual smart phone or other WiFi™ station, according to various embodiments;

FIGS. 4A-4C illustrate various character set encoding schemes that can be used in stations to connect to wireless hotspots using non-Unicode service set identification information, in which an SSID IE structure is extended according to the present teachings, according to various embodiments;

FIGS. 5A and 5B illustrate possible formats that can be adopted for allowing stations to connect to wireless hotspots using non-Unicode service set identification information, in which a vendor-specific IE is added to the beacon frame that can carry the character set encoding information, according to various embodiments;

FIG. 6 illustrates overall character set encoding operations that can be used in configuring stations to connect to wireless hotspots using non-Unicode service set identification information, according to various embodiments; and

FIG. 7 illustrates exemplary hardware, software, and other resources that can be used in enabling stations to connect to wireless hotspots using non-Unicode service set identification information, according to various embodiments.

DESCRIPTION

Embodiments of the present teachings relate to systems and methods for enabling stations to connect to wireless hotspots using non-Unicode service set identification information. More particularly, embodiments relate to platforms and techniques for generating and embedding native character set information into the beacon information broadcast by wireless routers and/or other access points in a WiFi™ and/or other wireless networks. According to aspects, an identification of the character set, and/or associated language, used by an access point can be inserted into SSID information elements and/or otherwise built into extended encoding schemes transmitted by the access point broadcasting to one or more smart phones and/or other stations within operating range of that wireless device. Each receiving smart phone or other

station can be configured to locate and decode the embedded character set information in the beacon, to allow a user to view and select access points in their intended operating language. That can be accomplished whether that character set and/or language is encoded in the Unicode format, or other formats. Enhanced portability, reliability, and usability of WiFi™ routers and operations can thereby be achieved.

Reference will now be made in detail to exemplary embodiments of the present teachings, which are illustrated in the accompanying drawings. Where possible the same reference numbers will be used throughout the drawings to refer to the same or like parts.

FIG. 2 illustrates an overall network environment 100 in which systems and methods for enabling stations to connect to wireless hotspots using non-Unicode service set identification information can operate, according to aspects. In aspects as shown, an access point 108 can broadcast a wireless network signal to a set of stations 102 within range. In aspects, the access point 108 can be or include a wireless router, hub, extender, and/or other network access point, and can in embodiments be configured to operate using the WiFi™ wireless standard, specified by IEEE specification 802.11b, 802.11g, 802.11n, and/or other existing or future standards. In aspects, when operating as a WiFi™ access point, the access point 108 can for instance operate in the 2.4 GHz frequency band. It will be appreciated however that in implementations, other wireless access standards, channels, protocols, and/or frequencies can be used.

In aspects, each device or station in the set of stations 102 can be or include any wireless-network enabled device, such as a WiFi™-equipped smart phone, touch pad device, media player device, GPS (global positioning system) device, and/or other device or network-enabled platform. In aspects, and as shown in FIG. 3, each individual station 118 in the set of stations 102 can be configured with one or more hardware, software, service, and/or other resources. In aspects as shown, a station 118 can comprise various hardware, software, and other resources, including an operating system 112, a display 110 which can for instance be or include a graphical user interface (GUI) of the operating system 112, and a radio frequency antenna 150 (or multiple antennas). In aspects, the operating system 112 can comprise a mobile device operating system such as the Android™ operating system available from Google Inc., Mountain View, Calif., U.S. or others. In aspects, the operating system 112 as noted can comprise a graphical user interface (GUI), as well as file management, power management, communications, security, and/or other logic, services, and/or resources to operate each station 118. According to aspects, each individual station 118 can likewise host applications, services, logic, and/or modules including a supplicant module 114 used to establish connections to access points and/or other channels. Each individual station 118 can likewise incorporate a Java™ framework 116, used to support the execution of Java™-based services and applications on the station 118.

In aspects, any one or more of the set of stations 102 can in general be connected, or available to be connected, to the access point 108 at one time. In general, and as likewise shown in FIG. 2, the access point 108 can broadcast beacon information 104 to the set of stations 102. The beacon information 104 can in general include a service set identification (SSID) information element (IE) 106 indicating the name, connection type, occupied and/or available channels, and other network information and services provided by the access point 108 to any station within its wireless connection range. According to aspects, in general, the beacon information 104 broadcast by the access point 108 configured accord-

ing to the teachings herein can comprise not just the standard SSID IE **106**, but also character set information **120** indicating or encoding the type of character set formatting or encoding used to broadcast the SSID IE **106**, and/or other information. By incorporating native character set information **120** into the beacon information **104** itself, each smart phone or other station **118** in the set of stations **102** can receive, decode, and display that information about the access point **108**, regardless of whether the SSID IE **106** is stored or encoded in the Unicode format, and/or other proprietary or distinct character set encoding schemes.

According to aspects, the character set information **120** which identifies the character set encoding scheme can be embedded in the beacon information **104** in various ways, according to various embodiments. However, it will be appreciated that all implementations permit the use of non-Unicode or propriety character sets by the access point **108**, and the recognition of those character sets by the set of stations **102**. More specifically and as for instance illustrated in FIGS. **4A-4C**, the character set information **120** can be encoded within the standard SSID IE **106** format by either adding additional fields, or “borrowing” or “stealing” selected bits from the existing fields, of that information element.

More particularly, as for example shown in FIG. **4A**, the character set information **120** and/or portions thereof can be encoded in an additional field labeled “Encoding” added to the SSID IE **106**. The Encoding field can be stored in a variety of formats and/or lengths, such as a one-byte or two-byte value indicating the character set to be used, for instance, via a look-up table and/or other reference. According to aspects, and as for example further shown in FIG. **4B**, the character set information **120** and/or portions thereof can instead be encoded in selected bits of the existing Length (L) field (this legacy 1 byte Length (L) field may also be referred to herein as an encoding (E) and length (L) field, since it carries both encoding and length information) of the standard SSID IE **106**. In aspects as shown in FIG. **4B**, the first two bits of the encoding (E) and length (L) field can be re-assigned or re-interpreted as the specification of the character set used by the access point **108**, thereby allowing four independent character sets to be specified and used.

In additional implementations, and as shown in FIG. **4C**, the character set information **120** and/or portions thereof can alternatively be encoded in last two bits of the encoding (E) and length (L) field. According to aspects, the use of encoding schemes or types as illustrated in FIGS. **4B** and **4C** result in particularly compact encoding formats, since the overall length of the SSID IE **106** is not enlarged to accommodate the character set information **120**. It will be appreciated, however, that other bit combinations and/or positions can be used to encode the character set information **120**, as desired.

According to implementations in further regards, the character set information **120** can also be encoded or embedded in other positions in the SSID IE **106** or related information, such as a vendor-specific information element (IE) **122** which is added to or specified in the beacon information **104**, but which is not incorporated in the base SSID IE **106**. In aspects, and as for example shown in FIG. **5A**, the vendor-specific information element (IE) **122** can be configured as a Cisco-compatible extension (CCX), illustratively labeled “Type 1,” having an illustrative format as shown in that figure, including an Element ID field, a length field, an organizationally unique identifier (OUI) field, a version field, and a separate CCX version field. In aspects, and as for example shown in FIG. **5B**, the vendor-specific information element (IE) **122** can be configured in a non-CCX based format, labeled as “Type 2,” including an Element ID field, a length field, an organization-

ally unique identifier (OUI) field, and a data field (illustratively two bytes). Any one or more of the foregoing fields or combinations of fields, and/or other fields or combinations can be used consistent with implementations shown in FIGS. **5A** and **5B** to encode or specify the character set used by the access point **108** and/or SSID IE **106** being broadcast by that access point, which can again be identified or determined via a look-up table and/or other reference.

It may be noted that, according to aspects, implementations as shown in FIGS. **5A** and **5B** may hold advantages in terms of backward compatibility with existing WiFi™ access point and station hardware. This can be the case because devices configured according to the existing industry standards can continue to operate in the usual or expected manner, even when those devices operate in the presence of platforms equipped with encoding schemes according to the present teachings. More particularly, implementations using a vendor-specific information element (IE) **122** enjoy an advantage compared to other solutions involving the extension of the SSID IE **106**, since backward compatibility is ensured. In implementations using a vendor-specific information element (IE) **122**, various scenarios can be compatibly or transparently handled, from the perspective of a user of a station **118** or other device. Particularly, a station **118** which is not adapted or upgraded according to the present teachings and/or cannot parse or understand the vendor-specific information element (IE) **122** which has encoding information may be referred to as an “old station.” In contrast, a station which is adapted or upgraded to use features of the present teachings and can parse or understand the vendor-specific information element (IE) **122** which has character set encoding information may be referred to as a “new station.” Similarly for access points, an access point which is not adapted or upgraded to support features of sending a vendor-specific information element (IE) **122** with encoded character set information may be referred to as an “old access point,” while an access point which is adapted or upgraded to support features of sending a vendor-specific information element (IE) **122** with encoded character set information can be referred to as a “new access point.” Using those terms or references, according to embodiments illustrated in FIGS. **5A** and **5B**, if there is any old station **118** that receives beacon information **104** from a new access point **108**, then the old station **118** can safely ignore the additional IE since it does not understand that construction.

Conversely, if there is any new station **118** that receives beacon information from a new access point **108**, then the new station **118** can parse the encoding information located in the vendor-specific information element (IE) **122**, as described herein. On the other hand, if there is a new station **118** which receives beacon information **104** from an old access point **108**, then the new station **118** will still be able to ensure that the current behavior (i.e., the way in which an existing or old station **118** behaves with an existing or old access point **108**) remains intact or unaltered.

In terms of overall operation, according to any of the various implementations described herein, the access point **108** therefore transmits the beacon information **104** incorporating character set information **120** including encoding information which serves to identify the encoding logic, character set, language, and/or other formatting or logic used by the access point **108** to pack the SSID IE **106** in the beacon information **104**. The supplicant module **114** of any individual receiving station **118** can then parse the correct data field from the appropriate information element and/or field of the beacon information **104** (e.g., extended or altered fields of the standard SSID IE **106** and/or vendor-specific information element (IE) **122**) which gives the encoding value.

The supplicant module 114 can then pass this encoding value to the Java™ framework 116, along with the SSID data, including the constituent fields and/or IEs that it communicates to the Java™ framework 116 in current implementations not employing platforms and techniques described herein. The Java™ framework 116 can then decode the raw SSID data based on the specified encoding information. According to aspects, once a character set is identified, the Java™ framework 116 can for instance look up and/or otherwise retrieve that character set, for instance, from local memory or storage, and/or from remote sources. The Java™ framework 116 can accordingly display the SSID and/or other information to the user via display 110 of the station 118 in a properly decoded character set and/or language. According to aspects, the Java™ framework 116 may only understand Unicode (UTF-8 or other) encoding, so that any ultimately identified character set encoding has to be eventually decoded and/or translated to equivalent UTF-8 code set. The Java™ framework 116 of the station 118 can then display the appropriate fonts in the display 110 via a graphical user interface (GUI) screen and/or other interface, assuming support for necessary fonts is in place.

According to aspects, when user tries to connect to a particular access point 108, then the Java™ framework 116 can exchange the necessary information with the supplicant module 114 via a “SET_NETWORK” or other command. Based on the information passed to the supplicant module 114, the supplicant module 114 will be able to choose the correct access point 108 from the list of scanned access points available to the station 118 which the supplicant module 114 is aware of. The supplicant module 114 can then for instance transmit an authorization frame, the first frame that gets exchanged between a station and access point when a new connection is initiated according to WiFi™ standards, essentially ensuring the connection of the station 118 to the access point 108. According to aspects, the user of station 118 is thereby enabled to not only see the access point 108 in the scan window in the correct language, but is also ensured to be able to successfully connect to the access point 108, as well. Those abilities represent a significant improvement over the non-standard language scenario in systems not equipped with platforms and techniques described herein.

It may be noted that the systems and methods discussed herein are not limited to the above types or categories of use case scenarios, but can also be implemented in any related or other scenarios where association activities or other operations on a wireless network (WLAN or other) system become paralyzed or are otherwise affected because of the use of a non-Unicode character set. For instance, consider an access point 108 which is configured with a non-English SSID and which is configured or established as having a “Hidden” status. Such an access point 108 cannot transmit beacon information 104. In the absence of beacon information 104, a station in the set of stations 102 desiring access will be forced to send a Unicast Probe Request, with the appropriate SSID information in an encoding format understandable to the access point 108, to be able to attempt to connect to the access point 108. If the station can not send a Probe Request with SSID information encoded in the format expected by the access point 108, then the requesting station may never be able to connect to the access point 108. To ensure that such a scenario is also appropriately addressed, according to systems and methods according to the present teachings, the supplicant module 114, the graphical user interface (GUI) of the smart phone or other station 118, any WiFi™ driver installed on that phone or device, the access point 108, and/or other network resources can be configured to incorporate

character set encoding, platforms, and/or techniques as described herein. Hence in implementations, not just the beacon information 104 itself, but also any Probe Request transmitted by a station 118, resulting Probe Response frames from the access point 118, and/or other frames, fields, data, elements, and/or information can include the character set encoding information 120, the SSID information identifying or employing the correct encoding set, and/or other associated information or data.

As can therefore be understood, by having native provisions in the beacon information 104, probe request, response frame, and/or other frame, field, and/or element which specifies character set encoding, a flexible approach to character set processing is adopted. According to aspects of the present teachings, the burden of decoding character set information is avoided on the supplicant module 114 and/or any other associated logic, service, or module of a smart phone or other WiFi™ platform. This results in a robust decoding scheme that converts any desired character set code to UTF-8, other Unicode standard, and/or other protocol or standard. A less complex design for each station 118 can therefore be achieved, while still providing robust language capabilities to the overall network environment 100. Platforms and techniques according to the present teachings also lead to greater flexibility in character set decoding, and likewise involve fewer necessary dependencies in carrying out character processing operations. These advantages can be observed as WiFi™ hotspots become more common in different regions of the world, and as more users move to smart phones in regions where English is not the native language. Smart phone users and users of other devices can therefore connect to an available access point, regardless of what language the SSID is configured in.

FIG. 6 illustrates a flowchart of character set encoding and other processing that can be performed in systems and methods for enabling stations to connect to wireless hotspots using non-Unicode service set identification information, according to aspects. In 602, processing can begin. In 604, an access point 108 can be configured with one or more extended character set encoding schemes encoded in the beacon information 104, according to various implementations of the present teachings. In 606, the access point 108 can broadcast the beacon information 104, including character set encoding information 120, to a set of stations 102 within range of the access point 108. In 608, the type of character set encoding and/or other information can be identified in a receiving station 118 (or stations), using the identified extended encoding scheme.

For instance, the beacon information 104 can contain fields and/or information elements, including those illustrated herein, indicating an encoding of character sets in the SSID IE 106, and/or in a vendor-specific information element (IE) 122. In 610, the receiving station 118 (or stations) can decode and/or display the SSID IE 106 of the broadcasting access point 108, for instance using the supplicant module 114, Java™ framework 116, operating system 112, and/or other software, logic, module, and/or service. The SSID IE 106 and/or other information can be displayed in the character set and/or language indicated in the character set encoding information 120, for instance in a scan window of station 118. In 612, the access point 108 can receive a user selection, authorization frame from the communicating station 118 (or stations), and/or other “handshake” or transaction between the access point 108 and communicating station 118. In 614, a network connection, for instance, to the Internet and/or other public or private network, can be established via the selected

access point **108**. In **616**, processing can repeat, return to a prior processing point, jump to a further processing point, or end.

FIG. 7 illustrates various hardware, software, and other resources that can be used in implementations of enabling stations to connect to wireless hotspots using non-Unicode service set identification information, according to embodiments. In embodiments as shown, the access point **108** can comprise features of a processor **142** communicating with memory **144**, such as electronic random access memory, as well as with a network interface, such as an Ethernet™ and/or other wired or wireless connection to the Internet and/or other networks. The processor **140** can be programmed or configured to carry out character set encoding operations, network connectivity operations, and other operations according to the present teachings. The processor **140** can also communicate with a local data store **146**, such as a local hard disk and/or other storage, as well as to a wireless interface **148**, such as a WiFi™-compatible chipset, including radio frequency chip set(s) and associated hardware and software, which may be connected to a radio frequency antenna **152** (or multiple antennas).

The foregoing description is illustrative, and variations in configuration and implementation may occur to persons skilled in the art. For example, while embodiments have been described in which encoding into certain languages, such as Chinese, Indian, and Spanish, is performed, it will be appreciated that encoding into any desired character set, language, and/or symbolic scheme can be performed. Similarly, while embodiments have been described in which one access point **108** broadcasts to a set of stations **102**, in embodiments, multiple access points **108** can broadcast to one or to multiple smart phones or other stations **118** and/or sets of stations **102**. Other resources described as singular or integrated can in embodiments be plural or distributed, and resources described as multiple or distributed can in embodiments be combined. The scope of the present teachings is accordingly intended to be limited only by the following claims.

The invention claimed is:

1. A method of encoding character set information, comprising:

retrieving character set information identifying a non-Unicode character set for an access point broadcasting a wireless beacon, the wireless beacon comprising a service set identification information element comprising a service set identification for the access point;
identifying at least one field in the wireless beacon associated with the service set identification in which to encode the character set information;
embedding the character set information in the at least one field of the wireless beacon for decoding by one or more wireless stations receiving the wireless beacon to display the non-Unicode character set in Unicode format for selection of a network connection; and
packing at least a portion of the service set identification information element in the wireless beacon according to the non-Unicode character set.

2. The method of claim **1**, wherein embedding the character set information comprises embedding the character set information in a specified field of the service set identification information element.

3. The method of claim **2**, wherein embedding the character set information comprises embedding the character set information in a dedicated encoding field of the service set identification information element.

4. The method of claim **2**, wherein embedding the character set information comprises embedding the character set infor-

mation in a specified subset of bits of a length field of the service set identification information element.

5. The method of claim **1**, wherein embedding the character set information comprises embedding the character set information in a vendor-specific information element.

6. The method of claim **5**, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, a version field, and a Cisco-compatible type extensions version field.

7. The method of claim **5**, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, and a data field.

8. The method of claim **1**, wherein the access point comprises a wireless router.

9. The method of claim **8**, wherein the wireless router comprises a WiFi™ device.

10. The method of claim **1**, further comprising receiving an authentication frame from the at least one station to establish a connection to the access point.

11. A wireless system, comprising:
a wireless interface to at least one wireless station in wireless range of an access point; and
a processor, communicating with the at least one station via the wireless interface, the processor being configured to: retrieve character set information identifying a non-Unicode character set for the access point, the access point being configured to broadcast a wireless beacon, the wireless beacon comprising a service set identification information element comprising a service set identification for the access point;
identify at least one field in the wireless beacon associated with the service set identification in which to encode the character set information;
embed the character set information in the at least one field of the wireless beacon for decoding by at least one wireless station receiving the wireless beacon to display the non-Unicode character set in Unicode format for selection of a network connection; and
pack at least a portion of the service set identification information element in the wireless beacon according to the non-Unicode character set.

12. The system of claim **11**, wherein embedding the character set information comprises embedding the character set information in a specified field of the service set identification information element.

13. The system of claim **12**, wherein embedding the character set information comprises embedding the character set information in a dedicated encoding field of the service set identification information element.

14. The system of claim **12**, wherein embedding the character set information comprises embedding the character set information in a specified subset of bits of a length field of the service set identification information element.

15. The system of claim **11**, wherein embedding the character set information comprises embedding the character set information in a vendor-specific information element.

16. The system of claim **15**, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, a version field, and a Cisco-compatible type extensions version field.

17. The system of claim **15**, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, and a data field.

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18. The system of claim 11, wherein the access point comprises a wireless router.

19. The system of claim 18, wherein the wireless router comprises a WiFi™ device.

20. The system of claim 11, wherein the processor is further configured to receive an authentication frame from at least one wireless station to establish a connection to the access point.

21. A wireless system, comprising: wireless interface means to at least one wireless station

means in wireless range of access point means; and processor means, communicating with the at least one station via the wireless interface, the processor means being configured to:

retrieve character set information identifying a non-Unicode character set for the access point means, the access point means being configured to broadcast a wireless beacon, the wireless beacon comprising a service set identification information element comprising a service set identification for the access point means;

identify at least one field in the wireless beacon associated with the service set identification in which to encode the character set information;

embed the character set information in the at least one field of the wireless beacon for decoding by at least one wireless station means receiving the wireless beacon to display the non-Unicode character set in Unicode format for selection of a network connection; and

pack at least a portion of the service set identification information element in the wireless beacon according to the non-Unicode character set.

22. The system of claim 21, wherein embedding the character set information comprises embedding the character set information in a specified field of the service set identification information element.

23. The system of claim 22, wherein embedding the character set information comprises embedding the character set information in a dedicated encoding field of the service set identification information element.

24. The system of claim 22, wherein embedding the character set information comprises embedding the character set information in a specified subset of bits of a length field of the service set identification information element.

25. The system of claim 21, wherein embedding the character set information comprises embedding the character set information in a vendor-specific information element.

26. The system of claim 25, wherein vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, a version field, and a Cisco-compatible type extensions version field.

27. The system of claim 25, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, and a data field.

28. The system of claim 21, wherein the access point means comprises a wireless router means.

29. The system of claim 28, wherein the wireless router means comprises a WiFi™ device means.

30. The system of claim 21, wherein the processor means is further configured to receive an authentication frame from the at least one wireless station means to establish a connection to the access point means.

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31. A computer program product, comprising: a non-transitory computer-readable medium comprising: at least one instruction for causing a computer to retrieve character set information identifying a non-Unicode character set for an access point broadcasting a wireless beacon, the wireless beacon comprising a service set identification information element comprising a service set identification for the access point;

at least one instruction for causing the computer to identify at least one field in the wireless beacon associated with the service set identification in which to encode the character set information;

at least one instruction for causing the computer to embed the character set information in the at least one field of the wireless beacon for decoding by one or more wireless stations receiving the wireless beacon to display the non-Unicode character set in Unicode format for selection of a network connection; and

at least one instruction for causing the computer to pack at least a portion of the service set identification information element in the wireless beacon according to the non-Unicode character set.

32. The computer program product of claim 31, wherein embedding the character set information comprises embedding the character set information in a specified field of the service set identification information element.

33. The method of claim 32, wherein embedding the character set information comprises embedding the character set information in a dedicated encoding field of the service set identification information element.

34. The computer program product of claim 32, wherein embedding the character set information comprises embedding the character set information in a specified subset of bits of a length field of the service set identification information element.

35. The computer program product of claim 31, wherein embedding the character set information comprises embedding the character set information in a vendor-specific information element.

36. The computer program product of claim 35, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, a version field, and a Cisco-compatible type extensions version field.

37. The computer program product of claim 35, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, and a data field.

38. The computer program product of claim 31, wherein the access point comprises a wireless router.

39. The computer program product of claim 38, wherein the wireless router comprises a WiFi™ device.

40. The computer program product of claim 31, further comprising at least one instruction for causing a computer to receive an authentication frame from at least one station to establish a connection to the access point.

41. A method of decoding character set information, comprising: locating character set information identifying a non-Unicode character set for an access point in a wireless beacon broadcast by the access point, the wireless beacon comprising a service set identification information element comprising a service set identification for the access point encoded in the character set; decoding the service set identification information element packed in the wireless beacon in accordance with the

non-Unicode character set and broadcast by the access point using the non-Unicode character set; and presenting the service set identification in Unicode format to a user of at least one station receiving the wireless beacon to select a network connection.

42. The method of claim 41, wherein locating the character set information comprises extracting the character set information from a specified field of the service set identification information element.

43. The method of claim 42, wherein locating the character set information comprises extracting the character set information from a dedicated encoding field of the service set identification information element.

44. The method of claim 42, wherein locating the character set information comprises extracting the character set information from a specified subset of bits of a length field of the service set identification information element.

45. The method of claim 41, wherein locating the character set information comprises extracting the character set information from a vendor-specific information element.

46. The method of claim 45, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, a version field, and a Cisco-compatible type extensions version field.

47. The method of claim 45, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, and a data field.

48. The method of claim 41, wherein the access point comprises a wireless router.

49. The method of claim 48, wherein the wireless router comprises a WiFi™ device.

50. The method of claim 41, further comprising transmitting an authentication frame from at least one station to establish a connection to the access point.

51. A wireless station, comprising:

a wireless interface to at least one wireless access point in wireless range of the wireless station; and a processor, communicating with the at least one access point via the wireless interface, the processor being configured to—

40 locate character set information identifying a non-Unicode character set for the access point in a wireless beacon broadcast by the access point, the wireless beacon comprising a service set identification information element comprising a service set identification for the access point encoded in the character set, decode the service set identification information element packed in the wireless beacon in accordance with the non-Unicode character set and broadcast by the access point using the non-Unicode character set, and

45 present the service set identification in Unicode format to a user of the wireless station to select a network connection.

52. The wireless station of claim 51, wherein locating the character set information comprises extracting the character set information from a specified field of the service set identification information element.

53. The wireless station of claim 52, wherein locating the character set information comprises extracting the character set information from a dedicated encoding field of the service set identification information element.

54. The wireless station of claim 52, wherein locating the character set information comprises extracting the character

set information from a specified subset of bits of a length field of the service set identification information element.

55. The wireless station of claim 51, wherein locating the character set information comprises extracting the character set information from a vendor-specific information element.

56. The wireless station of claim 55, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, a version field, and a Cisco-compatible type extensions version field.

10 57. The wireless station of claim 55, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, and a data field.

15 58. The wireless station of claim 51, wherein the access point comprises a wireless router.

59. The wireless station of claim 58, wherein the wireless router comprises a WiFi™ device.

20 60. The wireless station of claim 51, wherein the processor is further configured to transmit an authentication frame from the wireless station to establish a connection to the access point.

61. A wireless station, comprising:

wireless interface means to at least one wireless access point in wireless range of the wireless station means; and processor means, communicating with the at least one access point means via the wireless interface means, the processor means being configured to—

locate character set information identifying a non-Unicode character set for the access point in a wireless beacon broadcast by the access point means, the wireless beacon comprising a service set identification information element comprising a service set identification for the access point means encoded in the character set,

decode the service set identification information element packed in the wireless beacon in accordance with the non-Unicode character set and broadcast by the access point using the non-Unicode character set, and

present the service set identification in Unicode format to a user of the wireless station means to select a network connection.

62. The wireless station of claim 61, wherein locating the character set information comprises extracting the character set information from a specified field of the service set identification information element.

63. The wireless station of claim 62, wherein locating the character set information comprises extracting the character set information from a dedicated encoding field of the service set identification information element.

64. The wireless station of claim 62, wherein locating the character set information comprises extracting the character set information from a specified subset of bits of a length field of the service set identification information element.

65. The wireless station of claim 61, wherein locating the character set information comprises extracting the character set information from a vendor-specific information element.

66. The wireless station of claim 65, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, a version field, and a Cisco-compatible type extensions version field.

67. The wireless station of claim 65, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, and a data field.

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68. The wireless station of claim **61**, wherein the access point means comprises wireless router means.

69. The wireless station of claim **68**, wherein the wireless router means comprises WiFi™ device means.

70. The wireless station of claim **61**, wherein the processor means is further configured to transmit an authentication frame from the wireless station to establish a connection to the access point means.

71. A computer program product, comprising:
a non-transitory computer-readable medium comprising:
at least one instruction for causing a computer to locate character set information identifying a non-Unicode character set for an access point in a wireless beacon broadcast by the access point, the wireless beacon comprising a service set identification information element comprising a service set identification for the access point encoded in the character set,
at least one instruction for causing a computer to decode the service set identification information element packed in the wireless beacon in accordance with the non-Unicode character set and broadcast by the access point using the non-Unicode character set, and at least one instruction for causing a computer to present the service set identification in Unicode format to a user of at least one station receiving the wireless beacon to select a network connection.

72. The computer program product of claim **71**, wherein locating the character set information comprises extracting the character set information from a specified field of the service set identification information element.

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73. The computer program product of claim **72**, wherein locating the character set information comprises extracting the character set information from a dedicated encoding field of the service set identification information element.

74. The computer program product of claim **72**, wherein locating the character set information comprises extracting the character set information from a specified subset of bits of a length field of the service set identification information element.

75. The computer program product of claim **71**, wherein locating the character set information comprises extracting the character set information from a vendor-specific information element.

76. The computer program product of claim **75**, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, a version field, and a Cisco-compatible type extensions version field.

77. The computer program product of claim **75**, wherein the vendor-specific information element comprises at least an element ID field, a length field, an organizationally unique identifier field, and a data field.

78. The computer program product of claim **71**, wherein the access point comprises a wireless router.

79. The computer program product of claim **78**, wherein the wireless router comprises a WiFi™ device.

80. The computer program product of claim **71**, further comprising at least one instruction for causing a computer to transmit an authentication frame from at least one station to establish a connection to the access point.

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