The Printer Working Group

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IPP Registration

IPP Wi-Fi Configuration Extensions v1.0 (WIFI)

Status: IPP Workgroup Approved

Abstract: This registration defines IPP attributes and values to query and set the current Wi-Fi network configuration and status.

This registration is available electronically at:

https://ftp.pwg.org/pub/pwg/ipp/registrations/reg-ippwifi10-20240912.docx
https://ftp.pwg.org/pub/pwg/ipp/registrations/reg-ippwifi10-20240912.pdf

Title: *IPP Wi-Fi Configuration Extensions v1.0 (WIFI)*

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1. Introduction

This registration defines IPP attributes and values for the current Wi-Fi network connection to enable network setup over USB and monitoring over all interfaces.

2. Terminology

2.1 Conformance Terminology

Capitalized terms, such as MUST, MUST NOT, RECOMMENDED, REQUIRED, SHOULD, SHOULD NOT, MAY, and OPTIONAL, have special meaning relating to conformance as defined in Key words for use in RFCs to Indicate Requirement Levels [BCP14]. This specification defines the following additional capitalized conformance terms:

CONDITIONALLY REQUIRED: A MUST conformance requirement that applies only when a specified condition is true.

DEPRECATED: A SHOULD NOT conformance requirement for previously defined and approved protocol elements that are planned to be removed from use.

OBSOLETE: A MUST NOT conformance requirement for previously defined and approved protocol elements that have been removed from use.

2.2 Printing Terminology

Normative definitions and semantics of printing terms are imported from the Internet Printing Protocol/1.1 [STD92].

2.3 Protocol Role Terminology

The following protocol roles are defined to specify unambiguous conformance requirements:

Client: Initiator of outgoing connections and sender of outgoing operation requests (Hypertext Transfer Protocol -- HTTP/1.1 [STD99] User Agent).

Printer: Listener for incoming connections and receiver of incoming operation requests (Hypertext Transfer Protocol -- HTTP/1.1 [STD99] Server) that represents one or more Physical Devices or a Logical Device.

2.4 Other Terminology

This specification defines the following term:

Wi-Fi; Wireless networking as defined in the IEEE 802.11 series of standards and certified by the Wi-Fi Alliance.

2.5 Acronyms and Organizations

This specification defines the following acronyms and organizations:

IANA: Internet Assigned Numbers Authority, https://www.iana.org/

IETF: Internet Engineering Task Force, https://www.ietf.org/

ISO: International Organization for Standardization, https://www.iso.org/

PWG: Printer Working Group, https://www.pwg.org/

SSID: Service Set Identifier

Wi-Fi Alliance: https://www.wi-fi.org/

3. Requirements

3.1 Rationale

Given the following existing specifications:

1. Internet Printing Protocol/1.1 [STD92]
2. Internet Printing Protocol (IPP): Job and Printer Set Operations [RFC3380]
3. USB Print Interface Class IPP Protocol Specification [IPP-USB]
4. IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications [IEEE802.11]

And given the need for configuring the Wi-Fi network for a Printer, the IPP Wi-Fi Configuration Extensions should:

1. Provide a method for configuring a Printer's Wi-Fi network over USB,
2. Provide a method for querying a Printer's current Wi-Fi network configuration, and
3. Define attributes and values describing the current Wi-Fi network configuration and status.

3.2 Use Cases

3.2.1 Connect to Wi-Fi Network

Sam wants to connect a new Printer to their Wi-Fi network. They connect their Printer to the USB port on their computer and select the "connect Printer to network" action when presented.

3.2.2 Query Wi-Fi Network Connection Status

Pat wants to query the Wi-Fi network connection status. They run a Printer management utility on their Client device which queries the connection status and displays the results.

3.3 Exceptions

This registration does not define additional exceptions to the Internet Printing Protocol/1.1 [STD92].

3.4 Out of Scope

The following are considered out of scope for this registration:

1. Definition of new file formats; and
2. Definition of new protocol bindings.

3.5 Design Requirements

The design requirements for this registration are:

1. Define attributes and values to describe the current Wi-Fi network name, password, and connection status;
2. Define security requirements necessary to support Wi-Fi configuration; and
3. Define sections to register all attributes and values with IANA.

4. Model

Configuration of a Printer on a Wi-Fi network has historically been more difficult for End Users than on wired networks. This registration documents an IPP extension developed by Apple [APPLE-CUPS] in 2017 for supporting this configuration over an IPP-USB [IPP-USB] connection. The End User will typically:

1. Remove the Printer from its packaging and remove any protective tape, plastic, and/or spacers according to the included documentation,
2. Plug the Printer into a power source,
3. Turn the Printer on,
4. Connect the Printer to the Client device using a USB cable, and
5. Click on a button directing the Client device to send its Wi-Fi network configuration information to the Printer.

Once configured, the USB cable can be disconnected, and the Printer can be accessed over the Wi-Fi network.

Two Printer Description attributes are defined ("printer-wifi-ssid" and "printer-wifi-password") to specify the Wi-Fi network name and its access password in a Set-Printer-Attributes [RFC3380] request, while a single Printer Status attribute ("printer-wifi-state") reports the current Wi-Fi network connection state. A new "printer-state-reasons" [STD92] keyword allows a Client to detect when a Printer's Wi-Fi network has not yet been configured so that it can show the configuration alert for the End User. As with other feature-specific attributes and values, these new attributes and the "printer-state-reasons" value are only present when a Wi-Fi network interface is installed.

Configuration or status reporting of Wi-Fi networks hosted by a Printer, such as those provided by Wi-Fi Direct, are out of scope for this document.

5. New Attributes

5.1 Printer Description Attributes

5.1.1 printer-wifi-password (octetString(MAX))

This REQUIRED write-only attribute provides the Wi-Fi network password for the Printer. An octetString value with a length of 0 is used if the Wi-Fi network is "open" and does not use a password.

5.1.2 printer-wifi-ssid (name(MAX))

This REQUIRED read/write attribute specifies the Wi-Fi network name for the Printer as configured by a Set-Printer-Attributes [RFC3380] request and/or through the Printer's web interface, control panel, or other interfaces. The empty string indicates that the Printer will not connect to a Wi-Fi network.

Note: The Wi-Fi SSID is defined as an octet string [IEEE802.11], but for historical reasons this attribute uses the name syntax. Interoperability with networks that do not use UTF-8 SSIDs could be an issue - when a matching UTF-8 network cannot be found, implementations can try transcoding the name value to common alternate character encodings to join a network but such details are out of scope for this specification.

5.2 Printer Status Attributes

5.2.1 printer-wifi-state (type2 enum)

This REQUIRED attribute specifies a Printer's current Wi-Fi network state. The following values are defined in this registration:

'3' (off): Wi-Fi networking is turned off

'4' (not-configured): Wi-Fi networking is not yet configured

'5' (not-visible): The configured Wi-Fi network is not visible

'6' (cannot-join): The configured Wi-Fi network is visible but cannot be joined due to an incorrect password or some other connection establishment error

'7' (joining): The Printer is currently joining the configured Wi-Fi network

'8' (on): The Printer is joined to the configured Wi-Fi network

6. New Values for Existing Attributes

6.1 printer-settable-attributes-supported (1setOf keyword)

Printers MUST list the values 'printer-wifi-password' and 'printer-wifi-ssid' to indicate that Wi-Fi networking can be configured using the Set-Printer-Attributes [RFC3380] operation.

6.2 printer-state-reasons (1setOf type2 keyword)

This registration defines the 'wifi-not-configured-report' keyword to specify that the "printer-wifi-password" (section 5.1.1) and "printer-wifi-ssid" (section 5.1.2) Printer Description attributes have not been set, regardless of the value of the "printer-wifi-state" (section 5.2.1) Printer Status attribute.

7. Additional Semantics for Existing Operations

7.1 Get-Printer-Attributes: "printer-wifi-password"

Printers MUST NOT return the "printer-wifi-password" value in a Get-Printer-Attributes response.

7.2 Set-Printer-Attributes: "printer-wifi-password" and "printer-wifi-ssid"

If a Client does not supply both the "printer-wifi-password" (section 5.1.1) and "printer-wifi-ssid" (section 5.1.2) Printer Description attributes in a Set-Printer-Attributes request, the Printer MUST reject the request with the 'client-error-bad-request' status code. If either attribute is supplied with an invalid value, the Printer MUST reject the request with the 'client-error-attributes-or-values-not-supported' status code.

Printers MUST support unauthenticated Set-Printer-Attributes requests over IPP-USB when Wi-Fi networking has not yet been configured. This allows a Client to configure the Wi-Fi networking of a Printer over USB.

8. Conformance Requirements

In order for a Printer to claim conformance to this document, a Printer MUST support:

1. The Set-Printer-Attributes [RFC3380] operation;
2. The required attributes and values defined in section 0;
3. The additional values defined in section 6;
4. The additional semantics for existing operations defined in section 7;
5. The internationalization considerations defined in section 9; and
6. The security considerations defined in section 10.

9. Internationalization Considerations

For interoperability and basic support for multiple languages, conforming implementations MUST support:

1. The Universal Character Set (UCS) Transformation Format -- 8 bit (UTF-8) [STD63] encoding of Unicode [UNICODE] [ISO10646]; and
2. The Unicode Format for Network Interchange [RFC5198] which requires transmission of well-formed UTF-8 strings and recommends transmission of normalized UTF-8 strings in Normalization Form C (NFC) [UAX15].

Unicode NFC is defined as the result of performing Canonical Decomposition (into base characters and combining marks) followed by Canonical Composition (into canonical composed characters wherever Unicode has assigned them).

WARNING – Performing normalization on UTF-8 strings received from Clients and subsequently storing the results (e.g., in Job objects) could cause false negatives in Client searches and failed access (e.g., to Printers with percent-encoded UTF-8 URIs now 'hidden').

10. Security and Privacy Considerations

The IPP extensions defined in this document require the same security and privacy considerations as defined in the Internet Printing Protocol/1.1 [STD92].

10.1 Unicode Security Considerations

Implementations of this specification SHOULD conform to the following standard on processing of human-readable Unicode text strings, see:

Unicode Security Mechanisms [UTS39] – detecting and avoiding security attacks

10.2 Access Control Considerations

This registration requires Printers to allow unauthenticated Set-Printer-Attributes requests over the IPP-USB interface for initial setup. While this does open a potential attack vector, such an attack still requires physical access to the Printer before Wi-Fi networking is configured. Printers SHOULD limit unauthenticated Set-Printer-Attributes requests to those attributes that are required for initial configuration such as the "printer-wifi-password" and "printer-wifi-ssid" attributes defined in this registration, and only when such configuration has not already been performed.

If a Printer supports configuration over a network interface, including a self-hosted Wi-Fi network, it MUST require authentication to prevent unauthorized remote Wi-Fi configuration changes.

11. IANA Considerations

11.1 Attribute Registrations

The attributes defined in this registration will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following file:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

Printer Description attributes:	Reference
printer-wifi-password (octetString(MAX))	[IPPWIFI]
printer-wifi-ssid (name(MAX))	[IPPWIFI]

Printer Status attributes:	Reference
printer-wifi-state (type2 enum)	[IPPWIFI]

11.2 Type2 keyword Registrations

The attributes defined in this registration will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following file:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

Attributes (attribute syntax) Keyword Attribute Value	Reference
printer-state-reasons (type2 keyword)	[RFC8011]
wifi-not-configured	[IPPWIFI]

11.3 Type2 enum Registrations

The attributes defined in this registration will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following file:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

Attributes (attribute syntax) Enum Value	Enum Symbolic Name	Reference
printer-wifi-state (type2 enum)		[IPPWIFI]
3	off	[IPPWIFI]

4	not-configured	[IPPWIFI]
5	not-visible	[IPPWIFI]
6	cannot-join	[IPPWIFI]
7	joining	[IPPWIFI]
8	on	[IPPWIFI]

11.4 Operation Registrations

The attributes defined in this registration will be published by IANA according to the procedures in the Internet Printing Protocol/1.1 [STD92] in the following file:

https://www.iana.org/assignments/ipp-registrations

The registry entries will contain the following information:

Operation Name	Reference
Get-Printer-Attributes(extension)	[IPPWIFI]
Set-Printer-Attributes(extension)	[IPPWIFI]

12. References

12.1 Normative References

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[ISO10646] "Information technology -- Universal Coded Character Set (UCS)", ISO/IEC 10646:2011

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[RFC5198] J. Klensin, M. Padlipsky, "Unicode Format for Network Interchange", RFC 5198, March 2008, https://datatracker.ietf.org/doc/html/rfc5198

[STD63] F. Yergeau, "UTF-8, a transformation format of ISO 10646", RFC 3629/STD 63, November 2003, https://datatracker.ietf.org/doc/html/rfc3629

[STD66] T. Berners-Lee, R. Fielding, L. Masinter, "Uniform Resource Identifier (URI): Generic Syntax", RFC 3986/STD 66, January 2005, https://datatracker.ietf.org/doc/html/rfc3986

[STD92] M. Sweet, I. McDonald, "Internet Printing Protocol/1.1", RFC 8010/RFC 8011/STD 92, June 2018, https://datatracker.ietf.org/doc/html/rfc8010, https://datatracker.ietf.org/doc/html/rfc8011

[STD99] R. Fielding, J. Reschke, "Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing", RFC 9112/STD 99, June 2014, https://datatracker.ietf.org/doc/html/rfc9112

[UAX15] M. Davis, M. Duerst, "Unicode Normalization Forms", Unicode Standard Annex 15, August 2021, https://www.unicode.org/reports/tr15

[UNICODE] Unicode Consortium, "Unicode Standard", Version 16.0.0, September 2024, https://www.unicode.org/versions/Unicode16.0.0/

[UTS39] Unicode Consortium, “Unicode Security Mechanisms”, UTS#39, August 2021, https://www.unicode.org/reports/tr39

12.2 Informative References

[APPLE-CUPS] "CUPS Implementation of IPP", https://github.com/apple/cups/blob/master/doc/help/spec-ipp.html

[IEEE802.11] "IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications", IEEE 802.11-2020, February 2021, https://ieeexplore.ieee.org/document/9363693

[IPP-USB] "USB Print Interface Class IPP Protocol Specification", December 2012, https://www.usb.org/document-library/ipp-protocol-10

[UNISECFAQ] Unicode Consortium “Unicode Security FAQ”, November 2016, https://www.unicode.org/faq/security.html

13. Author

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