Job Accounting with IPP v1.0

Status: Interim

Abstract: This document discusses how to perform different kinds of job accounting with IPP and how to address privacy and consent issues associated with accounting information.

This is a PWG Best Practice. For a definition of a "PWG Best Practice", see:


This best practice is available electronically at:


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Title: Job Accounting with IPP v1.0

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1. Introduction

This document discusses how to perform different kinds of job accounting with IPP, including auditing of content and usage, billing, supply and service management, and diagnostics and debugging. In addition, this document provides guidance on the privacy and consent issues associated with the collection, storage, and processing of accounting information.

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]. The term CONDITIONALLY REQUIRED is additionally defined for a conformance requirement that applies when a specified condition is true.

The term DEPRECATED is used for previously defined and approved protocol elements that SHOULD NOT be used or implemented. The term OBSOLETE is used for previously defined and approved protocol elements that MUST NOT be used or implemented.

2.2 Printing Terminology

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

**Administrator**: An End User who is also authorized to manage all aspects of an Output Device or Printer, including creating the printer instances and controlling the authorization of other End Users and Operators [RFC2567].

**Authenticated Guest**: An End User who is authenticated and authorized to perform basic printing functions as a guest on the network. Guests are typically limited to using printers in common areas and granted access for a specific amount of time.

**Client Supplied Metadata**: All Job/Document Template and operation attributes supplied in a Job or Document Creation request.

**Document**: An object created and managed by a Printer that contains the description, processing, and status information. A Document object may have attached data and is bound to a single Job.

**End User**: A person or software process that is authorized to perform basic printing functions, including finding/locating a printer, creating a local instance of a printer, viewing printer status, viewing printer capabilities, submitting a print job, viewing print job status, and altering the attributes of a print job [RFC2567].
Job: An object created and managed by a Printer that contains description, processing, and status information. The Job also contains zero or more Document objects.

Job Accounting: Collection of Metadata to audit, bill, or otherwise report on the origin, processing, and disposition of Jobs and Documents.

Logical Device: a print server, software service, or gateway that processes jobs and either forwards or stores the processed job or uses one or more Physical Devices to render output.

Metadata: Information about a Job or Document such as name, originator, owner, format, state, counters, dates and times, content, and template attributes.

Operator: An End User that also has special rights on the Output Device or Printer. The Operator typically monitors the status of the Printer and manages and controls the Jobs at the Output Device [RFC2567]. The Operator is allowed to query and control the Printer, Jobs, and Documents based on site policy.

Output Device: a single Logical or Physical Device

Personal Data: Information related to a person that can be used to identify the person such as a name, email address, government-issued identification, medical information, and so forth. [IPPPRIVACY]

Physical Device: a hardware implementation of an endpoint device, e.g., a marking engine, a fax modem, etc.

Printer Generated Metadata: All Job and Document Status attributes generated by Printer.

Sensitive Data: Personal Data or other metadata that can be used to correlate or identify a Client or End User.

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 [RFC7230] User Agent).

Printer: Listener for incoming connections and receiver of incoming operation requests (Hypertext Transfer Protocol -- HTTP/1.1 [RFC7230] Server) that represents one or more Physical Devices or a Logical Device.
2.4 Acronyms and Organizations

HTTP: Hypertext Transfer Protocol [RFC7230]
IANA: Internet Assigned Numbers Authority, https://www.iana.org/
NAT: Network Address Translation
PWG: Printer Working Group, https://www.pwg.org/
UI: User Interface

Deleted: http://www.iana.org/
Field Code Changed
Deleted: http://www.ietf.org/
Field Code Changed
Deleted: http://www.iso.org/
Field Code Changed
Deleted: http://www.pwg.org/
Field Code Changed
3. Rationale

3.1 Use Cases

3.1.1 Auditing of Printing Usage

Jane manages a shared office multifunction device and wants to know who prints, what kinds of Jobs are printed, how are those Jobs are submitted, and where are they printed. She configures a Job Accounting service on her network for use with the Printer so that all Jobs are routed through the service and she can then generate reports showing the information she is interested in.

3.1.2 Auditing of Print Content

Bob is concerned that the students in his computer lab are printing inappropriate content on the school's color printer. He configures a server on his network to act as a print server that stores copies of every Job so that he can periodically review what is being printed.

3.1.3 Billing

Kate is the owner of a managed print service company that supplies printers and print servers to businesses. She collects information about each Job that is printed including whether the Job is printed in color, how many sheets are printed on, how many sides are printed on, and what finishing options (if any) are used. She uses the collected information to bill each business for their usage and to plan customer visits to perform maintenance or supply additional media, ink, and/or toner based on their usage.

3.1.4 Diagnostics and Debugging

Joe is a support technician at Kate's managed print service company. He uses the accounting data to reproduce problems specific to a particular Job or Client application.

3.1.5 Supplying Required Information

Some of Kate's larger customers need to be able to track their printing expenses based on their own contract numbers. Kate configures the print server to require the Client to supply a user ID and contract number with every new Job, and then includes the user ID and contract number in the billing reports sent to those customers.

3.1.6 Supplying Optional Information

Some of Kate's customers want to know what applications their End Users are printing from. Kate configures the printer server to request the application name from the Client with every Job, and then includes a separate informational report to her customers showing the amount of printing that has occurred for each application.
3.1.7 Authenticating End Users

Bob uses authentication to both identify and authorize End Users that submit Print Jobs.

3.1.8 Authenticating Print Services

Bob configures his Client computers to require the Print Services they communicate with to have an X.509 certificate using their company root certificate.

3.1.9 Reconfiguring a Print Service

One of Kate's customers wants to change the information that is tracked for printing. After she makes the configuration changes, each Client computer detects the changes and shows the explicit consent UI the next time an End User submits a Print Job.

3.2 Exceptions

In addition to the exceptions in the following sub-sections, the standard Internet Printing Protocol/1.1 [STD92] access control, authorization, and role exceptions apply to the use cases defined in section 3.2.

3.2.1 Opt-Out of Mandatory Data Collection

Mary selects a Printer in her Client application for a report she is printing. Her Client application queries the Printer and presents a dialog showing the mandatory data that is required to submit a Job to this Printer. She decides she does not want to send that data and cancels the print request for that Printer. The Client application does not submit a Job to the Printer.

3.2.2 Opt-Out of Optional Data Collection

John selects a Printer in his Client application for a report he is printing. His Client application queries the Printer and presents a dialog showing the optional data that is requested when submitting a Job to this Printer. He decides he does not want to send that data and indicates his preference using the supplied UI before activating the print action. The Client application submits the Job to the Printer without the requested data.

3.3 Out of Scope

The following are considered out of scope for this document:

1. Definition of authentication methods and requirements;
2. Definition of data collection methods beyond the Printer;
3. Definition of user account configuration and requirements;
4. Definition of new IPP attributes, values, or operations; and
5. Definition of TLS security requirements.
3.4 Design Requirements

The design requirements for this document are:

1. Define requirements for the authentication of the Client, Printer, and/or End User;
2. Define best practices for the collection of (potentially required) metadata from the Client;
3. Define best practices for the generation of metadata by the Printer;
4. Define requirements for explicit privacy and data collection policies that are accessible to/discoverable by Client;
5. Define requirements for explicit consent for all metadata that is sent from the Client to the Printer;
6. Define best practices for audit logging;
7. Define requirements for data protection;
8. Define best practices for the validation of all metadata; and
4. IPP Model for Job Accounting

IPP provides a rich data model that can be used for Job Accounting. Some metadata is supplied by the Client while other metadata is generated by the Printer during Job processing. The following sections describe this metadata, how a Printer requests or requires specific metadata, how a Client is expected to obtain explicit consent from the End User, and how a Printer is expected to describe and follow local privacy and data protection policies.

The IPP Model for Job Accounting is based on the following key principles:

Accuracy: All parties will supply and/or generate accurate metadata that can be validated in various ways;

Confidentiality: All parties make best efforts to preserve the confidentiality of Sensitive Data;

Consent: The Client obtains explicit consent from the End User to send Sensitive Data to the Printer, and the Printer is configured with a consent policy to accept and process Jobs from authorized End Users; and

Trust: All parties establish trust using standards and protocols.

This model works for direct printing from a Client to a Printer representing a Physical Device as well as printing through local or Cloud-based print servers (Printers representing Logical Devices) where the print server is responsible for collecting and managing metadata on behalf of the Output Devices.

4.1 Client Supplied Metadata

Clients supply attributes in Job or Document Creation requests to specify both print intent and associated metadata, including the Job name ("job-name") and Document name ("document-name").

Two additional Job Template attributes, "job-accounting-user-id" and "job-account-id" [PWG5100.7], can be supplied to specify End User and billing identifiers for the Job Accounting system separate from the authenticated user. While these values are not authenticated, they can often be validated against the authenticated user. These attributes are sometimes used together to specify a local user for a given organizational account.

Every Client connection to the Printer also carries the Client's network address which can be used by the Printer for access control, logging, and/or recorded as part of the Job metadata. The validity of the Client network address depends on the network architecture, proximity of the Client to the Printer, and so forth. In particular, the use of HTTP proxies and NAT can disguise the true source address.
4.2 Printer Generated Metadata

Printers generate attributes and values for Job and Document objects based on the processing they perform. Per the Internet Printing Protocol/1.1 [STD92], the "job-originating-user-name" and "job-originating-user-uri" Job Status attributes contain the most authenticated identity of the Job owner.

The "job-impressions", "job-impressions-col", "job-k-octets", "job-media-sheets", "job-media-sheets-col", "job-pages", and "job-pages-col" attributes can be provided by a Client in a Job Creation request but are best generated by the Printer after inspection of the Document data. Similarly, the "impressions", "impressions-col", "k-octets", "media-sheets", "media-sheets-col", "pages", and "pages-col" attributes can be provided by a Client in a Document Creation request but are best generated by the Printer after inspection of the Document data.

Printers provide a receipt of values use for each Job and Document Template attribute in the corresponding "xxx-actual" Job and Document Status attributes. For example, the actual media used for a Job is reported in the "media-col-actual" Job Status attribute.

4.3 Job Creation Requests and Recommended/Required Attributes

The "printer-mandatory-job-attributes (1setOf keyword)" Printer Description attribute [PWG5100.16] is used by a Printer to list the operation and Job Template attributes that a Client needs to supply in a Job Creation Request.

The "printer-requested-job-attributes (1setOf keyword)" Printer Description attribute [PWG5100.16] is used by a Printer to list the operation and Job Template attributes that it would like a Client to supply in a Job Creation Request.

These attributes are typically configured by an Administrator, either using the Set-Printer-Attributes [RFC3380] operation or some out-of-band mechanism.

4.4 Explicit Consent

In any Job Accounting system, certain information is necessary, such as a billing account number, while other information is "nice to have", such as the Client's operating system and name and version. Clients following the guidance in this document provide End Users with the ability to control whether necessary and "nice to have" attributes that are not associated with other UI controls (authenticated user, media settings, etc.) are provided in Job Creation requests. Figure 1 shows one possible UI.

Note: This document does not define a mechanism for the Client to prove to the Printer that the End User has provided explicit consent - if the Client sends the data, the Printer assumes that consent was given. If the End User does not provide explicit consent, a Client following the guidance in this document does not send disallowed metadata to the Printer.
4.5 Privacy and Data Retention Policies

The IPP Privacy Attributes [IPP-PRIVACY] provide a method for a Printer to report its privacy and data retention policies to the Client, which can then be presented to the End User. Printers and Clients following the guidance in this document also conform to the IPP Privacy Attributes.

The IPP Privacy Attributes also enable the Client to discover which Job and Document attributes will be hidden in responses to Get-Jobs and Get-Job-Attributes [STD92] requests.

4.6 Data Validation

One of the key elements of a Job Accounting solution is the validity and accuracy of the accounting data. Typically, Printers can generate accurate metadata (page counts, dates and times, and so forth) but have limited ability to validate Client-supplied metadata. Printers can authenticate Client requests and validate Client-supplied metadata using the most authenticated End User identity. Printers can reject attributes or values in a Job Creation or Document Creation request by returning the client-error-attributes-or-values-not-supported status code in the response or by adding the corresponding "job-state-reasons" keyword during Job processing.

For example, a Printer could validate the "job-account-id" and "job-accounting-user-id" Job Template attributes by looking up the allowed values for the authenticated End User. Other methods of remote validation are being explored [IETF-RATS] [ITU-X.1254].
5. Internationalization Considerations

For interoperability and basic support for multiple languages, conforming implementations 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).

6. Security Considerations

The IPP extensions defined in this document require the same security considerations as defined in the Internet Printing Protocol/1.1 [STD92], including the TLS considerations in the Opportunistic Security: Some Protection Most of the Time [RFC7435] and Recommendations for Secure Use of Transport Layer Security (TLS) and Datagram Transport Layer Security (DTLS) [RFC7525]. The following subsections provide considerations specific to this document.

6.1 Client Considerations

Clients MUST:

1. Allow the End User to examine a Printer's privacy and data handling policies;
2. Allow the End User to opt out of sending requested attributes in Job or Document Creation requests;
3. Allow the End User to cancel a Job submission if the End User does not wish to supply mandatory attributes in Job or Document Creation requests;
4. Provide confidentiality of data in transit using TLS encryption [RFC8446] of Printer connections;
5. Authenticate their connections to Printers, such as by validating the Printer's X.509 certificate or using other in-band mutual authentication protocols; and
6.2 Printer Considerations

Printers MUST:

1. Provide information on configured privacy and data handling policies;
2. Provide lists of optional (requested) and mandatory attributes for Job and Document Creation requests;
3. Validate the HTTP Host request header in order to protect against DNS rebinding attacks;
5. Support authentication of Clients using X.509 certificate validation, HTTP authentication methods, and/or other mechanisms;
6. Support authentication of End Users using HTTP authentication methods [PWG5199.10]; and
7. Provide confidentiality of Document and Job data at rest.

Printers SHOULD support the IPP "-actu als" attributes [PWG5100.8] to provide a Job Receipt for completed Jobs.

6.3 Privacy and Data Collection

Printers SHOULD consider all Job and Document attributes as potentially containing Personal Data. The following attributes explicitly contain Personal Data:

- "document-metadata": Contains author information
- "job-originating-user-name" and "job-originating-user-uri": The most authenticated Job owner

The following attributes/metadata can be used to identify individuals or Client devices:

- Client Network Address: Provides the Client's source network address, which often identifies the Client device uniquely
- "document-format-details": Contains application and operating system information

As a general rule, Personal Data SHOULD be collected and retained only as necessary and discarded when it is no longer needed.

6.4 Data Protection

Printers MUST protect Job and Document data in transit using TLS encryption [RFC8446].

Printers SHOULD protect Job and Document data at rest using encrypted storage and available secure access controls and containment features provided by the Printer's operating system software.
6.5 Data Validation

Printers SHOULD validate all attributes, values, and Document data that are submitted by a Client.

Printers SHOULD also authenticate all Job and Document Creation requests so that the identity of the submitter can be validated.

Printers that do billing and allow guest printing SHOULD implement Authenticated Guest printing to allow for validation of the guest's identity for proper billing.

Deleted:

TPM mechanisms to provide signed information?
Using Client/Printer/User authentication as a source of trust?
Anonymous guest vs. authenticated guest vs. authenticated user.
7. Common Job Accounting Metadata

Table 1 lists the IPP attributes commonly used for Job Accounting. The full list of Job Description, Job Status, and Job Template attributes can be found in the IANA IPP Registry [IANA-IPP].

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>copies (integer(1:MAX))</td>
<td>Number of copies</td>
<td>Client</td>
</tr>
<tr>
<td>date-time-at-completed (dateTime</td>
<td>Date/time when completed</td>
<td>Printer</td>
</tr>
<tr>
<td>date-time-at-creation (dateTime)</td>
<td>Date/time when created</td>
<td>Printer</td>
</tr>
<tr>
<td>date-time-at-processing (dateTime</td>
<td>Date/time when printed</td>
<td>Printer</td>
</tr>
<tr>
<td>document-format (mimeMediaType)</td>
<td>Format of document</td>
<td>Client</td>
</tr>
<tr>
<td>document-format-details (collection)</td>
<td>Application/OS name/version</td>
<td>Client</td>
</tr>
<tr>
<td>document-name (name(MAX))</td>
<td>Document name</td>
<td>Client</td>
</tr>
<tr>
<td>finishings (1setOf type2 enum)</td>
<td>Finisher options (staple, punch, etc.)</td>
<td>Client</td>
</tr>
<tr>
<td>job-account-id (name(MAX))</td>
<td>Accounting identifier</td>
<td>Client</td>
</tr>
<tr>
<td>job-account-type (type2 keyword</td>
<td>Identifier type</td>
<td>Client</td>
</tr>
<tr>
<td>job-accounting-user-id (name(MAX))</td>
<td>Accounting user ID</td>
<td>Client</td>
</tr>
<tr>
<td>job-id (integer(1:MAX))</td>
<td>Job ID</td>
<td>Printer</td>
</tr>
<tr>
<td>job-impressions (integer(0:MAX))</td>
<td>Number of sides</td>
<td>Printer</td>
</tr>
<tr>
<td>job-impressions-col (collection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>job-impressions-completed (integer(0:MAX))</td>
<td>Number of sides printed</td>
<td>Printer</td>
</tr>
<tr>
<td>job-impressions-completed-col (collection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>job-media-sheets (integer(0:MAX))</td>
<td>Number of sheets</td>
<td>Printer</td>
</tr>
<tr>
<td>job-media-sheets-col (collection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>job-media-sheets-completed (integer(0:MAX))</td>
<td>Number of sheets printed</td>
<td>Printer</td>
</tr>
<tr>
<td>job-media-sheets-completed-col (collection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>job-name (name(MAX))</td>
<td>Job name/title</td>
<td>Client</td>
</tr>
<tr>
<td>job-originating-user-name (name(MAX))</td>
<td>End User name</td>
<td>Client</td>
</tr>
<tr>
<td>job-originating-user-uri (uri)</td>
<td>End User URI</td>
<td>Client</td>
</tr>
<tr>
<td>job-pages (integer(0:MAX))</td>
<td>Number of pages</td>
<td>Printer</td>
</tr>
<tr>
<td>job-pages-col (collection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>job-pages-completed (integer(0:MAX))</td>
<td>Number of pages printed</td>
<td>Printer</td>
</tr>
<tr>
<td>job-pages-completed-col (collection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>job-priority (integer(0:100))</td>
<td>Job priority</td>
<td>Client</td>
</tr>
<tr>
<td>job-printer-uri (uri)</td>
<td>Printer</td>
<td>Printer</td>
</tr>
<tr>
<td>job-state (type1 enum)</td>
<td>Job state</td>
<td>Printer</td>
</tr>
<tr>
<td>job-state-reasons (1setOf type2 keyword)</td>
<td>Detailed job state</td>
<td>Printer</td>
</tr>
<tr>
<td>job-uuid (uri)</td>
<td>Job UUID</td>
<td>Printer</td>
</tr>
<tr>
<td>media (type2 keyword</td>
<td>Media to use</td>
<td>Client</td>
</tr>
<tr>
<td>media-col (collection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>print-color-mode (type2 keyword)</td>
<td>Color/B&amp;W print mode</td>
<td>Client</td>
</tr>
<tr>
<td>print-quality (type2 enum)</td>
<td>Print quality (draft/normal/high)</td>
<td>Client</td>
</tr>
<tr>
<td>printer-resolution (resolution)</td>
<td>Print resolution</td>
<td>Client</td>
</tr>
<tr>
<td>sides (type2 keyword)</td>
<td>Duplex mode</td>
<td>Client</td>
</tr>
<tr>
<td>time-at-completed (integer(0:MAX)</td>
<td>Relative time when completed</td>
<td>Printer</td>
</tr>
<tr>
<td>time-at-creation (integer(0:MAX))</td>
<td>Relative time when created</td>
<td>Printer</td>
</tr>
<tr>
<td>time-at-processing (integer(0:MAX)</td>
<td>Relative time when printed</td>
<td>Printer</td>
</tr>
</tbody>
</table>
8. References


9. Author’s Address

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The author would also like to thank the following individuals for their contributions to this best practice:

Cihan Colakoglu - Kyocera  
Smith Kennedy - Hewlett Packard  
Ira McDonald - High North  
Jeremy Reitz - Xerox
10. Change History

10.1 June 8, 2020

- Section 2.2: Added Authenticated Guest and Sensitive Data definitions
- Section 2.4: Updated to https:// URLs, fixed style of "UI"
- Section 3.3: Added out-of-scope for how data is collected outside of the Printer
- Section 4.x: Wordsmithing, elimination of conformance terminology, added references to RATS and X.1254
- Section 6.1: Updated TLS reference, added IPP Authentication reference, added SHOULD for PWG 5100.8
- Section 6.2: Added IPP Authentication reference
- Section 6.3: Wordsmithing
- Section 6.5: Added SHOULDs for validation and recommend implementing Authenticated Guest functionality when billing.
- Section 8: Added IETF-RATS, ITU-X.1254, and PWG 5100.8 references

10.2 April 27, 2020

- Section 4: Added introductory text
- Section 4.1: Added discussion of client addresses
- Expanded discussion of privacy policies
- Dropped printer-requested-job-attributes (now part of IPP TRANS 1.1)
- Expanded security considerations
- Added table of common accounting attributes
- Added missing references to the IANA IPP registry, IPP TRANS 1.1, HTTP/1.1, and TLS 1.3
- Dropped reference to IPP JPS3
10.3 January 29, 2020

- Added discussion of user and printer authentication in use cases
- Added discussion of changing consent requirements in new use case
- Section 3.1.5: Added user ID
- Section 3.3: Added definition of user account configuration/requirements
- Section 4.3: Updated title, added reference to RFC 3380
- Global: Use "explicit consent" throughout
- Section 4.4: Clarify that only information not entered through UI controls needs explicit consent
- Sections 7 and 8: Added references to RFC 7435 and 7525
- Section 8: Add reference to RFC 3380

10.4 October 22, 2019

- Status: Interim
- Section 2: Added some terms and acronyms that were missing.
- Section 3: Cleaned up use cases, out of scope, and design requirements.
- Section 3.2: Added exceptions.
- Section 4: Added discussion of informed consent, notion of required and requested attributes/values for accounting.
- New Section 5: "printer-requested-job-attributes"
- Section 7.1: Added explicit informed consent
- Section 7.2: Added printer-requested-job-attributes
- Updated references.

10.5 April 18, 2019

Initial revision.