



The Printer Working Group

June 27, 2017
Working Draft

PWG 3D Print Job Ticket and Associated Capabilities v1.0 (PJT3D)

Status: Stable

Abstract: This document describes the PWG Semantic Model Print3D service schema for embedded Job Tickets. The schema is based on the IPP 3D Printing Extensions v1.0 (3D) and suitable for data exchange and embedding within common 3D file formats such as 3MF and 3D PDF documents so that user intent is preserved regardless of the transport or workflow used.

This document is a Working Draft. For a definition of a "Working Draft", see: <http://ftp.pwg.org/pub/pwg/general/pwg-process30.pdf>

This document is available electronically at:

<http://ftp.pwg.org/pub/pwg/ipp/wd/wd-smpjt3d10-20170627.docx>
<http://ftp.pwg.org/pub/pwg/ipp/wd/wd-smpjt3d10-20170627.pdf>

1 Copyright © 2017 The Printer Working Group. All rights reserved.

2 This document may be copied and furnished to others, and derivative works that comment
3 on, or otherwise explain it or assist in its implementation may be prepared, copied,
4 published and distributed, in whole or in part, without restriction of any kind, provided that
5 the above copyright notice, this paragraph and the title of the Document as referenced
6 below are included on all such copies and derivative works. However, this document itself
7 may not be modified in any way, such as by removing the copyright notice or references to
8 the IEEE-ISTO and the Printer Working Group, a program of the IEEE-ISTO.

9 Title: *PWG 3D Print Job Ticket and Associated Capabilities v1.0 (PJT3D)*

10 The IEEE-ISTO and the Printer Working Group DISCLAIM ANY AND ALL WARRANTIES,
11 WHETHER EXPRESS OR IMPLIED INCLUDING (WITHOUT LIMITATION) ANY IMPLIED
12 WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

13 The Printer Working Group, a program of the IEEE-ISTO, reserves the right to make
14 changes to the document without further notice. The document may be updated, replaced
15 or made obsolete by other documents at any time.

16 The IEEE-ISTO takes no position regarding the validity or scope of any intellectual
17 property or other rights that might be claimed to pertain to the implementation or use of the
18 technology described in this document or the extent to which any license under such rights
19 might or might not be available; neither does it represent that it has made any effort to
20 identify any such rights.

21 The IEEE-ISTO invites any interested party to bring to its attention any copyrights, patents,
22 or patent applications, or other proprietary rights which may cover technology that may be
23 required to implement the contents of this document. The IEEE-ISTO and its programs
24 shall not be responsible for identifying patents for which a license may be required by a
25 document and/or IEEE-ISTO Industry Group Standard or for conducting inquiries into the
26 legal validity or scope of those patents that are brought to its attention. Inquiries may be
27 submitted to the IEEE-ISTO by e-mail at: ieee-isto@ieee.org.

28 The Printer Working Group acknowledges that the IEEE-ISTO (acting itself or through its
29 designees) is, and shall at all times, be the sole entity that may authorize the use of
30 certification marks, trademarks, or other special designations to indicate compliance with
31 these materials.

32 Use of this document is wholly voluntary. The existence of this document does not imply
33 that there are no other ways to produce, test, measure, purchase, market, or provide other
34 goods and services related to its scope.

35

36 **About the IEEE-ISTO**

37 The IEEE-ISTO is a not-for-profit corporation offering industry groups an innovative and
38 flexible operational forum and support services. The IEEE-ISTO provides a forum not only
39 to develop standards, but also to facilitate activities that support the implementation and
40 acceptance of standards in the marketplace. The organization is affiliated with the IEEE
41 (<http://www.ieee.org/>) and the IEEE Standards Association (<http://standards.ieee.org/>).

42 For additional information regarding the IEEE-ISTO and its industry programs visit:

43 <http://www.ieee-isto.org>

44 **About the IEEE-ISTO PWG**

45 The Printer Working Group (or PWG) is a Program of the IEEE Industry Standards and
46 Technology Organization (ISTO) with member organizations including printer
47 manufacturers, print server developers, operating system providers, network operating
48 system providers, network connectivity vendors, and print management application
49 developers. The group is chartered to make printers and the applications and operating
50 systems supporting them work together better. All references to the PWG in this
51 document implicitly mean “The Printer Working Group, a Program of the IEEE ISTO.” In
52 order to meet this objective, the PWG will document the results of their work as open
53 standards that define print related protocols, interfaces, procedures and conventions.
54 Printer manufacturers and vendors of printer related software will benefit from the
55 interoperability provided by voluntary conformance to these standards.

56 In general, a PWG standard is a specification that is stable, well understood, and is
57 technically competent, has multiple, independent and interoperable implementations with
58 substantial operational experience, and enjoys significant public support.

59 For additional information regarding the Printer Working Group visit:

60 <http://www.pwg.org>

61 Contact information:

62 The Printer Working Group
63 c/o The IEEE Industry Standards and Technology Organization
64 445 Hoes Lane
65 Piscataway, NJ 08854
66 USA
67

68 About the Internet Printing Protocol Workgroup

69 The Internet Printing Protocol (IPP) workgroup has developed a modern, full-featured
70 network printing protocol, which is now the industry standard. IPP allows a print client to
71 query a printer for its supported capabilities, features, and parameters to allow the
72 selection of an appropriate printer for each print job. IPP also provides job information prior
73 to, during, and at the end of job processing.

74 For additional information regarding IPP visit:

75 <http://www.pwg.org/ipp/>

76 Implementers of this document are encouraged to join the IPP mailing list in order to
77 participate in any discussions of the document. Suggested additions, changes, or
78 clarification to this document, should be sent to the IPP mailing list for consideration.

79

80

Table of Contents

81	Table of Contents		
82	1. Introduction.....		7
83	1.1 Output Intent Versus Device Process and Control		7
84	2. Terminology.....		7
85	2.1 Printing Terminology.....		7
86	2.2 Other Terminology		8
87	2.3 Acronyms and Organizations.....		8
88	3. Rationale for the PWG 3D Print Job Ticket and Associated Capabilities v1.0 (PJT3D)...		9
89	3.1 Use Cases		9
90	3.1.1 Web-Based Submission of 3MF File.....		9
91	3.1.2 Job Accounting using Receipts		10
92	3.2 Out of Scope		10
93	3.3 Design Requirements		10
94	4. The Print3D Schema		11
95	4.1 Print3DServiceType		11
96	4.1.1 Print3DServiceCapabilities.....		12
97	4.1.2 Print3DServiceConfiguration		12
98	4.1.3 Print3DServiceDefaults		12
99	4.1.4 Print3DServiceDescription		12
100	4.1.5 Print3DServiceStatus		12
101	4.1.6 Print3DJob		12
102	4.2 Print3DJobType		12
103	4.2.1 Print3DJobReceipt		12
104	4.2.2 Print3DJobStatus		13
105	4.2.3 Print3DJobTicket.....		13
106	4.2.4 Print3DDocument.....		13
107	4.3 Print3DJobTicketType		13
108	4.3.1 Print3DJobDescription		13
109	4.3.2 Print3DJobProcessing.....		13
110	5. Internationalization Considerations		14
111	6. Security Considerations		14
112	7. References		14
113	8. Author's Address		15
114	9. Sample Print3DJobTicket.....		16
115	10. Sample Print3DServiceCapabilities.....		16
116	11. IPP Mapping.....		19
117	12. Change History.....		20
118	12.1 June 27, 2017		20
119	12.2 May 4, 2017		20
120	12.3 April 20, 2017.....		20
121	12.4 March 27, 2017		20
122	12.5 March 3, 2017		20
123	12.6 February 19, 2017		21

List of Figures

127 Figure 1 - Print3DServiceType Schema 11
128 Figure 2 - Print3DJobType Schema 12
129 Figure 3 - Print3DJobTicketType Schema 13

130
131

132 **1. Introduction**

133 The IPP 3D Printing Extensions v1.0 [PWG5100.21] defines an extension to the Internet
134 Printing Protocol (IPP) that supports printing of physical objects by Additive Manufacturing
135 devices such as three-dimensional (3D) printers. This document defines an XML schema
136 representing the semantic elements and values of the IPP 3D model, allowing conversion
137 of IPP Job Tickets and Printer Capabilities into an XML format suitable for data exchange
138 and embedding within common 3D file formats such as 3MF [3MF] and 3D PDF
139 [ECMA363] [ISO14739] [ISO32000].

140 The Print3D schema [SCHEMA] is automatically generated from the IANA IPP registry by
141 the IPP Registry project's [IPPREGISTRY] "regtasm" tool. This schema is based in part on
142 the PWG Print Job Ticket and Associated Capabilities Version 1.0 (PJT) [PWG5108.07]
143 which defines an XML schema for the IPP 2D model.

144 **1.1 Output Intent Versus Device Process and Control**

145 As with [PWG5108.07], the focus of 3D printing using the Print3DService schema defined
146 in this document is the specification of output intent and not the processes or device
147 control needed to produce a given output. Clients can specify general material selections
148 ("red PLA", "brown wood PLA", "clear ABS", etc.), print preferences and quality, and
149 whether supports and rafts should be printed. Printers then use implementation specific
150 device control and (ordered) processes to satisfy the Client-supplied output intent when
151 processing the Job.

152 Besides enabling simpler, easier to use Client software that is less likely to fail due to
153 minor implementation differences, this model also prevents the Client from providing
154 dangerous device control instructions that exceed safe operating parameters or disable
155 critical safety interlocks.

156 **2. Terminology**

157 **2.1 Printing Terminology**

158 Normative definitions and semantics of printing terms are imported from IETF Printer MIB
159 v2 [RFC3805], IETF Finisher MIB [RFC3806], and IETF Internet Printing Protocol/1.1:
160 Model and Semantics [RFC8011].

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

164 *Intent*: The preferences for the processing and description properties of a Job or
165 Document.

166 *Job*: An object created and managed by a Printer that contains description, processing,
167 and status information. The Job also contains zero or more Document objects.

168 *Job Receipt*: A data object that contains information on the actual values of processing
169 Elements used when a Job was processed.

170 *Job Ticket*: A data object that contains the Job-level Intent (processing and description
171 Elements).

172 *Printer*: A print Service or hardware device that supports 3D printing.

173 *Service*: A program that accepts and processes requests to create, monitor and manage
174 Jobs. The Service accepts and processes requests to monitor and control the status of the
175 Service itself and its associated Resources. A Service may be hosted either locally or
176 remotely from the Printer.

177 **2.2 Other Terminology**

178 *Element*: A term used to convey structure and relationships in XML Document instances.
179 An Element can contain both content and Elements. Complex Elements are composed, at
180 least in part, of other Elements.

181 **2.3 Acronyms and Organizations**

182 *3D PDF Consortium*: <http://www.3dpdfconsortium.org/>

183 *3MF Consortium*: 3D Manufacturing Format Consortium, <http://www.3mf.io/>

184 *ISO*: International Organization for Standardization, <http://www.iso.org/>

185 *ODL*: Object Definition Language

186 *PWG*: Printer Working Group, <http://www.pwg.org/>

187

188 **3. Rationale for the PWG 3D Print Job Ticket and Associated** 189 **Capabilities v1.0 (PJT3D)**

190 Existing specifications define the following:

- 191 1. The IPP 3D Printing Extensions v1.0 (3D) [PWG5100.21] defines an extension
192 to the Internet Printing Protocol (IPP) that supports printing of physical objects
193 by Additive Manufacturing devices such as three-dimensional (3D) printers;
- 194 2. The W3C XML Schema Definition Language (XSD) 1.1 Part 1: Structures
195 [XSD11-1] specifies the XML Schema Definition Language, which offers facilities
196 for describing the structure and constraining the contents of XML documents,
197 including those which exploit the XML Namespace facility;
- 198 3. The W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes
199 [XSD11-2] defines facilities for defining datatypes to be used in XML Schemas
200 as well as other XML specifications;
- 201 4. The 3D Manufacturing Format Core Specification & Reference Guide v1.1 [3MF]
202 defines an XML schema and file format for describing 3D objects with one or
203 more materials;
- 204 5. The Universal 3D File Format [ECMA363] defines a binary format for 3D objects
205 embedded in PDF files;
- 206 6. Document management -- 3D use of Product Representation Compact (PRC)
207 format -- Part 1: PRC 10001 [ISO14739] defines a binary format for 3D objects
208 embedded in PDF files; and
- 209 7. Document management — Portable document format — Part 1: PDF 1.7
210 [ISO32000] defines a binary file format that supports embedded 3D objects with
211 one or more materials.

212 Therefore, this PWG 3D Print Job Ticket and Associated Capabilities document should
213 define an XML schema that represents the IPP attributes and values needed to support
214 embedding of Job Tickets in 3D document files, data exchange of Printer capabilities,
215 Printer status, Job Receipts, Job Status, and Job Tickets, and workflows utilizing XML data
216 models.

217 **3.1 Use Cases**

218 **3.1.1 Web-Based Submission of 3MF File**

219 Jane has a 3D model she wishes to print using a commercial 3D printing provider. The
220 provider supports 3MF files but only allows submission using a HTML form on their web
221 site. Jane uses the software on her Client device to select the materials and required
222 dimensional accuracy, and then exports the 3D model to a 3MF file with an embedded Job
223 Ticket. She then submits the file for printing by the provider.

224 3.1.2 Job Accounting using Receipts

225 A print provider needs to produce machine-readable records of every Job that is printed
226 that are provided to customers to report what work has been performed, the billing
227 department to determine the cost of each Job, and the operations group to track when to
228 order supplies and perform maintenance. The receipts need to record the amount and type
229 of materials used, the total processing time, and any issues that were encountered during
230 printing. The provider generates a standalone file for each Job, providing copies to the
231 customers, billing department, and operations group.

232 3.2 Out of Scope

233 The following are considered out of scope for this document:

- 234 1. Reporting of actual monetary values associated with Jobs.

235 3.3 Design Requirements

236 The design requirements for this document are:

- 237 1. Define PWG Semantic Model elements and values that correspond to their IPP
238 counterparts; and
239 2. Define a named PWG Semantic Model schema incorporating the elements and
240 values so that Job Tickets and their associated capabilities can be exchanged.

241

242 **4. The Print3D Schema**

243 The Print3D schema defines a PWG Semantic Model schema for an abstract 3D printing
 244 Service based on the IPP 3D Printing Extensions v1.0 (3D) [PWG5100.21]. The
 245 "Print3DServiceType" and "Print3DJobType" types define the abstract data models for the
 246 Service and its Jobs. The "Print3DJobTicketType" type defines the abstract data model for
 247 the Job Ticket that is typically embedded in a 3D document file.

248 The schema itself is organized into four schema description ("XSD") files:

249 "Print3DService.xsd": This file defines the Print3D service types and includes all of
 250 the other files.

251 "PwgCommon.xsd": This file defines the elements mapped from IPP attributes.

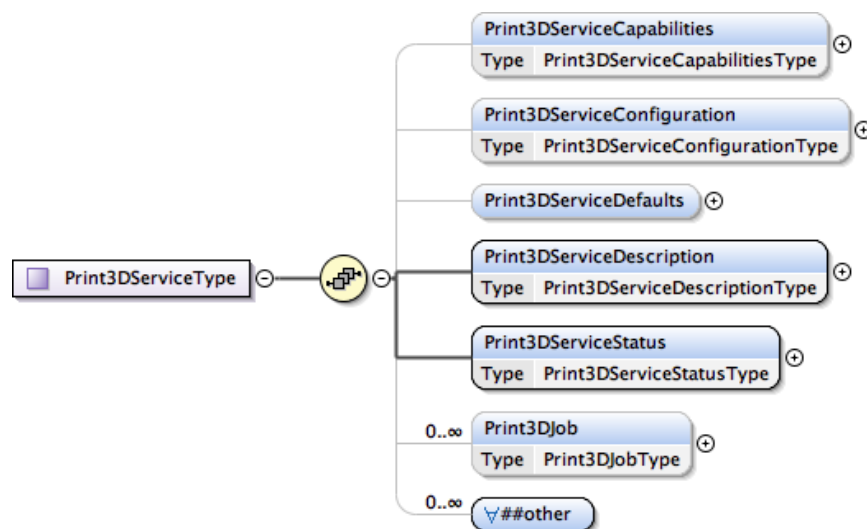
252 "PwgTypes.xsd": This file defines the base IPP types.

253 "PwgWellKnownValues.xsd": This file defines the well-known values of registered
 254 IPP enum and keyword attributes.

255 The schema namespace URL is "http://www.pwg.org/schemas/smpjt3d10".

256 **4.1 Print3DServiceType**

257 Figure 1 shows the "Print3DServiceType" type which describes an instance of the abstract
 258 3D printing service and contains the capabilities, configuration, description, status, and
 259 Jobs list.



260

261

Figure 1 - Print3DServiceType Schema

262 **4.1.1 Print3DServiceCapabilities**

263 This Element contains the supported and "ready" values for each of the Job Ticket
 264 elements. Ready values are those that the Printer can use without operator intervention.

265 **4.1.2 Print3DServiceConfiguration**

266 This Element contains information about the Printer sub-units.

267 **4.1.3 Print3DServiceDefaults**

268 This Element contains the default Job Ticket values for the Printer.

269 **4.1.4 Print3DServiceDescription**

270 This Element contains descriptive values for the Printer, including its name and owner.

271 **4.1.5 Print3DServiceStatus**

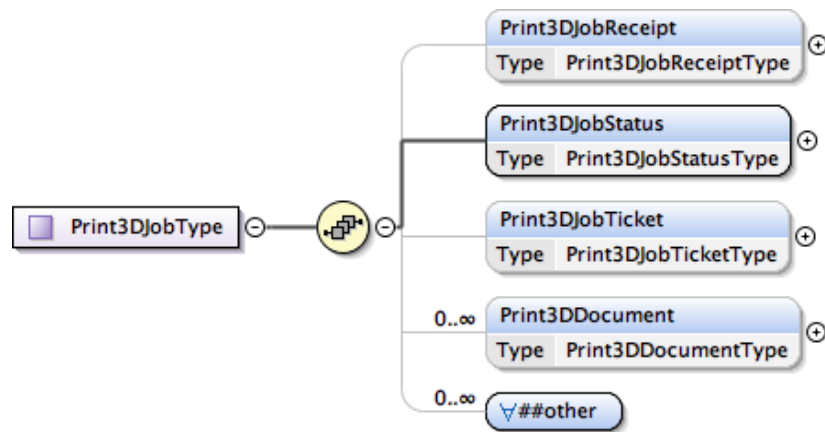
272 This Element contains state values for the Printer.

273 **4.1.6 Print3DJob**

274 This Element contains the list of active and previously completed 3D print Jobs.

275 **4.2 Print3DJobType**

276 Figure 2 shows the "Print3DJobType" type which describes an instance of the abstract 3D
 277 print Job and contains the Job Receipt, Job Ticket, Job status, and Documents list.



278

279

Figure 2 - Print3DJobType Schema

280 **4.2.1 Print3DJobReceipt**

281 This Element contains the Job Receipt for a completed Job.

282 4.2.2 Print3DJobStatus

283 This Element contains the Job status information.

284 4.2.3 Print3DJobTicket

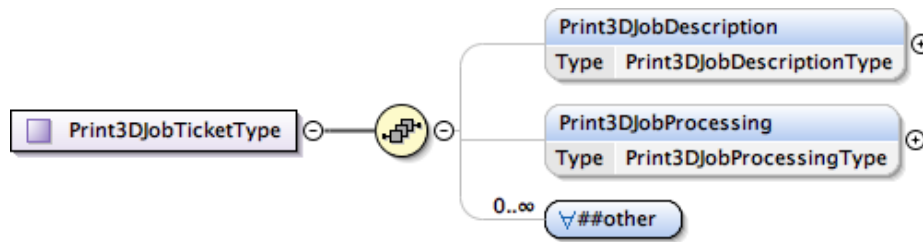
285 This Element contains the Job Ticket for the Job.

286 4.2.4 Print3DDocument

287 This Element contains the list of Documents associated with the Job.

288 4.3 Print3DJobTicketType

289 Figure 3 shows the "Print3DJobTicketType" type which contains the Job name and
290 processing intent.



291

292

Figure 3 - Print3DJobTicketType Schema

293 4.3.1 Print3DJobDescription

294 This Element contains the Job name and any billing information that was supplied.

295 4.3.2 Print3DJobProcessing

296 This Element contains the Job processing intent, including the list of materials to use,
297 required print accuracy, and so forth.

298

299 5. Internationalization Considerations

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

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

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

310 6. Security Considerations

311 The security considerations for this document are the same as those described in the IPP
312 3D Printing Extensions v1.0 (3D) [PWG5100.21].

313 7. References

- 314 [3MF] "3D Manufacturing Format Core Specification & Reference Guide
315 v1.1", <http://www.3mf.io/specification>
- 316 [ECMA363] "Universal 3D File Format", ECMA-363
- 317 [IPPREGISTRY] "ISTO-PWG IPP Registry Repository",
318 <https://github.com/istopwg/ippregistry>
- 319 [ISO10646] "Information technology -- Universal Coded Character Set (UCS)",
320 ISO/IEC 10646:2014
- 321 [ISO14739] "Document management -- 3D use of Product Representation
322 Compact (PRC) format -- Part 1: PRC 10001", ISO 14739-1:2014
- 323 [ISO32000] "Document management — Portable document format — Part 1: PDF
324 1.7", ISO 32000-1:2008
- 325 [PWG5100.21] M. Sweet, "IPP 3D Printing Extensions v1.0 (3D)", PWG 5100.21-
326 2017, [http://ftp.pwg.org/pub/pwg/candidates/cs-ipp3d10-20170210-
327 5100.21.pdf](http://ftp.pwg.org/pub/pwg/candidates/cs-ipp3d10-20170210-5100.21.pdf)
- 328 [PWG5108.07] P. Zehler, "PWG Print Job Ticket and Associated Capabilities Version
329 1.0 (PJT)", PWG 5108.07-2012,

- 330 <http://ftp.pwg.org/pub/pwg/candidates/cs-sm20-pjt10-20120801-5108.07.pdf>
331
- 332 [RFC5198] J. Klensin, M. Padlipsky, "Unicode Format for Network Interchange",
333 RFC 5198, March 2008, <http://tools.ietf.org/html/rfc5198>
- 334 [RFC8011] M. Sweet, I. McDonald, "Internet Printing Protocol/1.1: Model and
335 Semantics", RFC 8011, January 2017, <http://tools.ietf.org/html/rfc8011>
- 336 [SCHEMA] "PWG Print3D Schema",
337 <http://ftp.pwg.org/pub/pwg/sm3/schemas/smpjt3d10-20170420.zip>
- 338 [STD63] F. Yergeau, "UTF-8, a transformation format of ISO 10646", RFC
339 3629/STD 63, November 2003, <http://tools.ietf.org/html/rfc3629>
- 340 [UAX15] Unicode Consortium, "Normalization Forms", UAX#15, June 2014,
341 <http://www.unicode.org/reports/tr15/tr15-41.html>
- 342 [UNICODE] Unicode Consortium, "Unicode Standard", Version 10.0.0, June 2017,
343 <http://www.unicode.org/versions/Unicode10.0.0/>
- 344 [XSD11-1] "W3C XML Schema Definition Language (XSD) 1.1 Part 1:
345 Structures", April 2012, <https://www.w3.org/TR/2012/REC-xmlschema11-1-20120405/>
346
- 347 [XSD11-2] "W3C XML Schema Definition Language (XSD) 1.1 Part 2:
348 Datatypes", April 2012, <https://www.w3.org/TR/2012/REC-xmlschema11-2-20120405/>
349

350 8. Author's Address

351 Primary author:

352 Michael Sweet
353 Apple Inc.
354 1 Infinite Loop
355 MS 111-HOMC
356 Cupertino, CA 95014
357 msweet@apple.com

358 Additional contributors:

359 Ira McDonald (High North)
360 Paul Tykodi (TCS)
361 William Wagner (TIC)
362 Peter Zehler (Xerox)

363 9. Sample Print3DJobTicket

364 The following 3D print job ticket specifies four copies of an object printed with two
365 materials - blue PLA for the object and a dissolvable PLA for the supports - at normal
366 quality with supports and rafts:

```
367 <?xml version="1.0" encoding="UTF-8"?>
368 <pwg:Print3DJobTicket xsi:schemaLocation="Print3DService.xsd"
369   xmlns:pwg="http://www.pwg.org/schemas/smpjt3d10"
370   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
371   <pwg:Print3DJobProcessing>
372     <pwg:Copies>4</pwg:Copies>
373     <pwg:MaterialsCol>
374       <pwg:MaterialColor>blue</pwg:MaterialColor>
375       <pwg:MaterialPurpose>InFill</pwg:MaterialPurpose>
376       <pwg:MaterialPurpose>Shell</pwg:MaterialPurpose>
377       <pwg:MaterialType>pla</pwg:MaterialPurpose>
378     </pwg:MaterialsCol>
379     <pwg:MaterialsCol>
380       <pwg:MaterialPurpose>Base</pwg:MaterialPurpose>
381       <pwg:MaterialPurpose>Support</pwg:MaterialPurpose>
382       <pwg:MaterialType>pva-dissolvable</pwg:MaterialPurpose>
383     </pwg:MaterialsCol>
384     <pwg:PlatformTemperature>60</pwg:PlatformTemperature>
385     <pwg:PrintBase>Raft</pwg:PrintBase>
386     <pwg:PrintSupports>Material</pwg:PrintSupports>
387     <pwg:Quality>Normal</pwg:Quality>
388   </pwg:Print3DJobProcessing>
389   <pwg:Print3DJobDescription>
390     <pwg:DocumentMetadata>creator=Jane Doe</pwg:DocumentMetadata>
391     <pwg:DocumentMetadata>date=2017-03-27T12:34:56Z</pwg:DocumentMetadata>
392     <pwg:JobName>Sample 3D Print Job</pwg:JobName>
393   </pwg:Print3DJobDescription>
394 </pwg:Print3DJobTicket>
```

395 10. Sample Print3DServiceCapabilities

396 The following 3D print service capabilities describe a printer that supports up to two
397 materials simultaneously and has blue PLA and dissolvable PLA loaded:

```
398 <?xml version="1.0" encoding="UTF-8"?>
399 <pwg:Print3DServiceCapabilities xsi:schemaLocation="Print3DService.xsd"
400   xmlns:pwg="http://www.pwg.org/schemas/smpjt3d10"
401   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
402
403   <!-- Support millimeters and nanometers for accuracy -->
404   <pwg:AccuracyUnitsSupported>Mm</pwg:AccuracyUnitsSupported>
405   <pwg:AccuracyUnitsSupported>Nm</pwg:AccuracyUnitsSupported>
406
407   <!-- Support 1 to 999 copies -->
408   <pwg:CopiesSupported>
409     <pwg:LowerBound>1</pwg:LowerBound>
410     <pwg:UpperBound>999</pwg:UpperBound>
```



```
411     </pwg:CopiesSupported>
412
413     <!-- Support 3MF and STL -->
414     <pwg:DocumentFormatSupported>model/3mf</pwg:DocumentFormatSupported>
415     <pwg:DocumentFormatSupported>application/sla</pwg:DocumentFormatSupported>
416
417     <!-- Material amounts in grams -->
418     <pwg:MaterialAmountUnitsSupported>G</pwg:MaterialAmountUnitsSupported>
419
420     <!-- 2.85mm filaments -->
421     <pwg:MaterialDiameterSupported>
422         <pwg:LowerBound>2850000</pwg:LowerBound>
423         <pwg:UpperBound>2850000</pwg:UpperBound>
424     </pwg:MaterialDiameterSupported>
425
426     <!-- Supported purposes -->
427     <pwg:MaterialPurposeSupported>All</pwg:MaterialPurposeSupported>
428     <pwg:MaterialPurposeSupported>Base</pwg:MaterialPurposeSupported>
429     <pwg:MaterialPurposeSupported>InFill</pwg:MaterialPurposeSupported>
430     <pwg:MaterialPurposeSupported>Shell</pwg:MaterialPurposeSupported>
431     <pwg:MaterialPurposeSupported>Support</pwg:MaterialPurposeSupported>
432
433     <!-- Supported rates -->
434     <pwg:MaterialRateSupported>
435         <pwg:LowerBound>1</pwg:LowerBound>
436         <pwg:UpperBound>250</pwg:UpperBound>
437     </pwg:MaterialRateSupported>
438     <pwg:MaterialRateUnitsSupported>Ml_second
439     </pwg:MaterialRateUnitsSupported>
440
441     <!-- Shell thickness -->
442     <pwg:MaterialShellThicknessSupported>
443         <pwg:LowerBound>0</pwg:LowerBound>
444         <pwg:UpperBound>4000000</pwg:UpperBound>
445     </pwg:MaterialShellThicknessSupported>
446
447     <!-- Temperatures -->
448     <pwg:MaterialTemperatureSupported>
449         <pwg:LowerBound>180</pwg:LowerBound>
450         <pwg:UpperBound>260</pwg:UpperBound>
451     </pwg:MaterialTemperatureSupported>
452
453     <!-- Supported types -->
454     <pwg:MaterialTypeSupported>nylon</pwg:MaterialTypeSupported>
455     <pwg:MaterialTypeSupported>pet</pwg:MaterialTypeSupported>
456     <pwg:MaterialTypeSupported>pla</pwg:MaterialTypeSupported>
457     <pwg:MaterialTypeSupported>pla-conductive</pwg:MaterialTypeSupported>
458     <pwg:MaterialTypeSupported>pla-stone</pwg:MaterialTypeSupported>
459     <pwg:MaterialTypeSupported>pla-wood</pwg:MaterialTypeSupported>
460     <pwg:MaterialTypeSupported>pva-dissolvable</pwg:MaterialTypeSupported>
461
462     <!-- Support Blue, Orange, and Red PLA, and Dissolvable PVA -->
463     <pwg:MaterialsColDatabase>
464         <pwg:MaterialColor>blue</pwg:MaterialColor>
465         <pwg:MaterialDiameter>2850000</pwg:MaterialDiameter>
466         <pwg:MaterialKey>pla-blue</pwg:MaterialKey>
```

```
467     <pwg:MaterialName>Blue PLA</pwg:MaterialName>
468     <pwg:MaterialPurpose>All</pwg:MaterialPurpose>
469     <pwg:MaterialTemperature>
470         <pwg:LowerBound>210</pwg:LowerBound>
471         <pwg:UpperBound>235</pwg:UpperBound>
472     </pwg:MaterialTemperature>
473     <pwg:MaterialType>pla</pwg:MaterialPurpose>
474 </pwg:MaterialsColDatabase>
475 <pwg:MaterialsColDatabase>
476     <pwg:MaterialColor>orange</pwg:MaterialColor>
477     <pwg:MaterialDiameter>2850000</pwg:MaterialDiameter>
478     <pwg:MaterialKey>pla-orange</pwg:MaterialKey>
479     <pwg:MaterialName>Orange PLA</pwg:MaterialName>
480     <pwg:MaterialPurpose>All</pwg:MaterialPurpose>
481     <pwg:MaterialTemperature>
482         <pwg:LowerBound>210</pwg:LowerBound>
483         <pwg:UpperBound>235</pwg:UpperBound>
484     </pwg:MaterialTemperature>
485     <pwg:MaterialType>pla</pwg:MaterialPurpose>
486 </pwg:MaterialsColDatabase>
487 <pwg:MaterialsColDatabase>
488     <pwg:MaterialColor>red</pwg:MaterialColor>
489     <pwg:MaterialDiameter>2850000</pwg:MaterialDiameter>
490     <pwg:MaterialKey>pla-red</pwg:MaterialKey>
491     <pwg:MaterialName>Red PLA</pwg:MaterialName>
492     <pwg:MaterialPurpose>All</pwg:MaterialPurpose>
493     <pwg:MaterialTemperature>
494         <pwg:LowerBound>210</pwg:LowerBound>
495         <pwg:UpperBound>235</pwg:UpperBound>
496     </pwg:MaterialTemperature>
497     <pwg:MaterialType>pla</pwg:MaterialPurpose>
498 </pwg:MaterialsColDatabase>
499 <pwg:MaterialsColDatabase>
500     <pwg:MaterialColor>clear-white</pwg:MaterialColor>
501     <pwg:MaterialDiameter>2850000</pwg:MaterialDiameter>
502     <pwg:MaterialKey>pva-dissolvable</pwg:MaterialKey>
503     <pwg:MaterialName>Dissolvable PVA</pwg:MaterialName>
504     <pwg:MaterialPurpose>All</pwg:MaterialPurpose>
505     <pwg:MaterialType>pva-dissolvable</pwg:MaterialPurpose>
506 </pwg:MaterialsColDatabase>
507
508 <!-- Red PLA and Dissolvable PVA are loaded -->
509 <pwg:MaterialsColReady>
510     <pwg:MaterialColor>red</pwg:MaterialColor>
511     <pwg:MaterialDiameter>2850000</pwg:MaterialDiameter>
512     <pwg:MaterialKey>pla-red</pwg:MaterialKey>
513     <pwg:MaterialName>Red PLA</pwg:MaterialName>
514     <pwg:MaterialPurpose>All</pwg:MaterialPurpose>
515     <pwg:MaterialTemperature>
516         <pwg:LowerBound>210</pwg:LowerBound>
517         <pwg:UpperBound>235</pwg:UpperBound>
518     </pwg:MaterialTemperature>
519     <pwg:MaterialType>pla</pwg:MaterialPurpose>
520 </pwg:MaterialsColReady>
521 <pwg:MaterialsColReady>
522     <pwg:MaterialColor>clear-white</pwg:MaterialColor>
```

```
523     <pwg:MaterialDiameter>2850000</pwg:MaterialDiameter>
524     <pwg:MaterialKey>pva-dissolvable</pwg:MaterialKey>
525     <pwg:MaterialName>Dissolvable PVA</pwg:MaterialName>
526     <pwg:MaterialPurpose>All</pwg:MaterialPurpose>
527     <pwg:MaterialType>pva-dissolvable</pwg:MaterialPurpose>
528 </pwg:MaterialsColReady>
529
530 <!-- Maximum number of materials per job -->
531 <pwg:MaxMaterialsColSupported>2</pwg:MaxMaterialsColSupported>
532
533 <!-- Supported platform temperatures -->
534 <pwg:PlatformTemperatureSupported>
535     <pwg:LowerBound>40</pwg:LowerBound>
536     <pwg:UpperBound>100</pwg:UpperBound>
537 </pwg:PlatformTemperatureSupported>
538
539 <!-- Brims, Rafts, and Skirts are supported -->
540 <pwg:PrintBaseSupported>Brim</pwg:PrintBaseSupported>
541 <pwg:PrintBaseSupported>None</pwg:PrintBaseSupported>
542 <pwg:PrintBaseSupported>Raft</pwg:PrintBaseSupported>
543 <pwg:PrintBaseSupported>Skirt</pwg:PrintBaseSupported>
544
545 <!-- Supported supports -->
546 <pwg:PrintSupportsSupported>Material</pwg:PrintSupportsSupported>
547 <pwg:PrintSupportsSupported>None</pwg:PrintSupportsSupported>
548 <pwg:PrintSupportsSupported>Standard</pwg:PrintSupportsSupported>
549
550 <!-- Supported qualities -->
551 <pwg:QualitySupported>Draft</pwg:QualitySupported>
552 <pwg:QualitySupported>High</pwg:QualitySupported>
553 <pwg:QualitySupported>Normal</pwg:QualitySupported>
554 </pwg:Print3DServiceCapabilities>
```

555 11. IPP Mapping

556 The mapping of the IPP 3D Printing Extensions to the PWG 3D Print Job Ticket and
557 Associated Capabilities follows the mapping defined in section 21 of the PWG Print Job
558 Ticket and Associated Capabilities Version 1.0 [PWG5108.07].

559 In addition:

- 560 1. Similar to the handling of "media-color" and "media-type", IPP "material-color"
561 and "material-type" keyword values are preserved (hyphenated lowercase)
562 instead of converting them to TitleCase; and
- 563 2. IPP attributes using the 1setOf syntax are mapped to unbounded elements
564 instead of an element containing an unbounded sequence.
565

566 **12. Change History**

567 **12.1 June 27, 2017**

- 568 1. MS1: Change "pla-dissolvable" to "pva-dissolvable"
- 569 2. Section 7: Unicode 10 has been released.

570 **12.2 May 4, 2017**

- 571 1. Updated references to 3MF and ISO 10646

572 **12.3 April 20, 2017**

- 573 1. Status: Stable
- 574 2. Section 1.1: device control commands
- 575 3. Section 2.1: remote from the printer
- 576 4. Section 9: Fix MaterialColor, MaterialKey, and MaterialType values
- 577 5. Section 10: Fix MaterialColor, MaterialKey, and MaterialType values
- 578 6. Section 11: Drop operations (item 3)

579 **12.4 March 27, 2017**

- 580 1. Section 1: Reference the PJT and talk about output intent
- 581 2. Section 2: Define Service
- 582 3. Section 4: Added a list of the files in the schema ("roadmap") and the
- 583 namespace URL.
- 584 4. Section 8: Added acknowledgements
- 585 5. Added appendices with sample job ticket, capabilities, and the IPP mapping
- 586 strategy.

587 **12.5 March 3, 2017**

- 588 1. Updated acronym to "PJT3D", filename to "smpjt3d10"
- 589 2. Global: Print3d -> Print3D
- 590 3. Global: Element as a defined term.
- 591 4. Global: Updated all schema figures to reflect new service name.
- 592 5. Abstract: "... suitable for data exchange and embedding within common 3D file
- 593 formats such as ..."
- 594 6. Section 1: Made it clear the schema is generated from the IANA IPP registry.
- 595 7. Section 2.1: Added Intent, Job Receipt, and Job Ticket, Printer
- 596 8. Section 2.2: Replaced "Protocol Terminology" with "Other Terminology", define
- 597 Element
- 598 9. Section 3: Dropped "1.1" from "XML 1.1 schema".
- 599 10. Section 3.1.1: Fixed wording.

600 11. Section 7: Added link to IPP 3D spec.

601 **12.6 February 19, 2017**

602 Initial revision.

603