The Printer Working Group

CWMP Data Models for Printers and MFDs
(CWMPMFD)

Status: White Paper

Abstract: The purpose of this white paper is to propose input for future Broadband Forum Technical Reports that would define new data models for printers, multifunction devices (MFDs), and other imaging devices that are managed as customer premises equipment (CPE) devices:

(a) Guidance for remote management of printers and MFDs via Broadband Forum CPE WAN Management Protocol (CWMP) [TR-069];

(b) Guidance for CWMP Proxy implementations that communicate with printers and MFDs using their native IPP, SNMP, and/or web services, e.g., PWG Print Service;

(c) Data model for PrintService, with an XML schema binding, that follows the BBF Data Model Template for TR-069-Enabled-Devices [TR-106] and is composed of the machine-translated existing objects, element groups, and elements defined in the PWG Semantic Model v2.0 XML schema; and

(d) Data models for Scan, Fax, MFD (i.e., System) and various other PWG SM services, that follow the BBF Data Model Template for TR-069-Enabled-Devices [TR-106] and are each composed of the machine-translated existing objects, element groups, and elements defined in the PWG Semantic Model v2.0 XML schema.

This document is a PWG White Paper. For a definition of a "PWG White Paper", see:

ftp://ftp.pwg.org/pub/pwg/general/pwg-process30.pdf

This document is available electronically at:

ftp://ftp.pwg.org/pub/pwg/BOFs/cwmp/white-cwmpmfdmodel10-20120312.pdf

9   Title: Broadband Forum CWMP Multifunction Device Data Model (CWMPMFD)

37

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About the IEEE-ISTO PWG

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

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

For additional information regarding the Printer Working Group visit:

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139 1. Introduction

140 This document focuses on the evolution of the Managed Print Services (MPS) industry
141 and the broadband Telecommunications (Telecom) industry and has primary goals of
142 supporting automatic, remote, secure configuration of newly installed printers and then
143 securely managing them throughout their lifecycle.

144 Since the mid-1990s, high-quality digital printing technologies have become widespread.
145 This has led to the convergence of traditional copiers and printers and the subsequent
146 development of a new class of multifunction devices (MFDs). Older stand-alone office
147 equipment typically performed a single copy, print, scan, or fax function. Newer MFDs
148 have evolved to support all of these basic functions and also often include email, resource
149 management, document transform, document storage, and other imaging services.

150 In recent years, managed print service (MPS) providers have offered proactive supplies
151 and maintenance service contracts to business, government, and university customers.
152 The key limitation for MPS market growth has been the lack of a single, comprehensive
153 monitoring and management interface across the current generation of MFDs.

154 Currently, device and service information about printers is typically available via SNMP
155 using IETF MIB-II [RFC1213], IETF Host Resources MIB v2 [RFC2790], PWG Imaging
156 System State and Counter MIB v2 [PWG5106.3], PWG Job Monitoring MIB [RFC2707],
157 IETF Printer MIB v2 [RFC3805], IETF Finisher MIB [RFC3806], PWG Printer Port Monitor
158 MIB [PWG5107.1], and PWG Imaging System Power MIB [PWG5106.3].

159 On the other hand, service and job information about printers is typically available via
160 IPP/1.1 [RFC2911] and often via the newer IPP versions 2.0, 2.1, and 2.2 [PWG5100.12].

161 Currently information about other imaging services and MFDs overall is not available via
162 open standard interfaces (i.e., the suite of PWG Semantic Model abstract services and
163 WSDL/SOAP bindings).

164 Meanwhile, the Telecommunications (hereafter, Telecom) service providers have also
165 changed dramatically. High-speed Internet and other data communications customer
166 endpoints have become widespread, affordable, and reliable. Older single-function
167 telecom customer premise equipment [CPE] such as land line telephones, set-top boxes
168 (STBs), and mobile phones have converged and given rise to multifunction high-speed
169 media offerings.

170 In the past, telecom infrastructure devices such as routers, bridges, cable modems, and
171 DSL modems were monitored and managed via SNMP and TELNET/SSH. More recently,
172 the telecom industry has migrated to the use of Broadband Forum CPE WAN
173 Management Protocol (CWMP) [TR-069]. And the current generation of CPE devices are
174 typically also managed using CWMP.

175   Telecom providers have now joined MPS providers as suppliers of printers and MFDs
176   under service contracts in homes and businesses. Note that current telecom CPE device
177   have more complex life-cycles than current printers and MFDs. A telecom CPE device is
178   typically installed with entirely automatic initial configuration and is subsequently
179   frequently updated with new firmware and new services, again via automatic
180   configuration.

181

2. Terminology

2.1 Conformance Terminology

Capitalized terms, such as MUST, MUST NOT, REQUIRED, SHOULD, SHOULD NOT, MAY, and OPTIONAL, have special meaning relating to conformance as defined in RFC 2119 [RFC2119].

2.2 Printing Terminology

Normative definitions and semantics of printing terms are imported from IETF Printer MIB v2 [RFC3805], IETF Finisher MIB [RFC3806], and IETF IPP/1.1 [RFC2911].

This document also defines the following protocol roles in order to specify unambiguous conformance requirements:

IPP Client - Initiator of outgoing IPP session requests and sender of outgoing IPP operation requests (HTTP/1.0 Client [RFC1957] / HTTP/1.1 Client [RFC2616]).

IPP Printer - Listener for incoming IPP session requests and receiver of incoming IPP operation requests (HTTP/1.0 Server [RFC1957] / HTTP/1.1 Server [RFC2616]).

SNMP MIB Agent: Listener for incoming SNMP Get and Set management requests and sender of optional outgoing SNMP notifications for a Printer or MFD (i.e., an SNMP Agent).

SNMP MIB Client: Initiator of outgoing SNMP Get and Set management requests and receiver of optional incoming SNMP notifications for a Printer or MFD (i.e., an SNMP Manager).

2.3 Telecommunications Terminology

Normative definitions and semantics of telecommunications management terms are imported from Broadband Forum CPE WAN Management Protocol [TR-069], including the following:

Applied – A change to the Customer Premise Equipment (CPE) configuration has been applied when the CPE has stopped using the previous configuration and begun using the new Subunits.

Auto-Configuration Server (ACS) – This is a component in the broadband network responsible for auto-configuration of the Customer Premise Equipment (CPE) for advanced services.

214 Committed – A change to the Customer Premise Equipment (CPE) configuration has
215 been committed when the change has been fully validated, the new configuration appears
216 in the configuration data model for subsequent Auto-Configuration Server (ACS)
217 operations to act on, and the change will definitely be applied in the future, as required by
218 the protocol specification.

219 Customer Premises Equipment (CPE) – Refers to any TR-069-compliant device and
220 therefore covers both Internet Gateway Devices (IGDs) and LAN-side end devices.

221 Data Model – A hierarchical set of parameters that define the managed objects accessible
222 via [TR-069] for a particular device or service.

223 Deployment Unit (DU) – An entity that can be individually deployed on the Execution
224 Environment. A Deployment Unit can consist of functional Execution Units and/or
225 configuration files and/or other resources.

226 Device – Used interchangeably with CPE in [TR-069].

227 Execution Environment (EE) – A software platform that enables the dynamic loading and
228 unloading of Software Modules. Typical examples include Linux, OSGi, .NET, and Java
229 ME. Some Execution Environments enable the sharing of resources amongst modules.

230 Execution Unit (EU) – A functional entity that, once started, initiates processes to perform
231 tasks or provide services, until it is stopped. Execution Units are deployed by Deployment
232 Units. The following list of concepts could be considered Execution Units: services,
233 scripts, software components, libraries, etc.

234 Internet Gateway Device (IGD) – A Customer Premise Equipment (CPE) device, typically
235 a broadband router, that acts as a gateway between the WAN and the LAN.

236 Managed Print Service (MPS) – A service model that adds value to MFDs and printers by
237 combining provisioning, maintenance, and supplies into Service Level Agreements
238 (SLAs).

239 Parameter – A name-value pair representing a manageable CPE parameter made
240 accessible to an ACS for reading and/or writing.

241 Residential Gateway (RGW) – A gateway between the end user premise and the
242 broadband service network (i.e., the Telecom network, not the Internet) that is introduced
243 for architectural clarity in [TR-196].

244 Set Top Box (STB) – A television set top box that supports multimedia and Internet
245 access by the end user.

246 Session – A contiguous sequence of CWMP transactions between a Customer Premise
247 Equipment (CPE) and an Auto-Configuration Server (ACS).   Note that a Session may
248 span multiple TCP connections.

249 Software Module – The common term for all software (except firmware) that will be
250 installed on an Execution Environment, including the concepts of Deployment Units and
251 Execution Units.

252 Transaction – A message exchange between a Customer Premise Equipment (CPE) and
253 an Auto-Configuration Server (ACS) consisting of a single request followed by a single
254 response, initiated either by the CPE or ACS.

255

256 # 3. Requirements

257 ## 3.1 Rationale for Printer and MFD Management via CWMP

258 ### 3.1.1 Rationale from IETF and PWG Perspective

259 IETF and PWG standards for the printing industry define:

260 A rationale for an abstract model of printing (to support alternate encodings and protocols)
261 in section 3 of the IETF IPP Rationale [RFC2568];

262 A set of design goals for status monitoring in a printing protocol in section 3.1.3 'Viewing
263 the status and capabilities of a printer' (for End User), section 3.2.1 'Alerting' (for
264 Operator), and section 3.3 'Administrator' (the bullet requirement to 'administrate billing or
265 other charge-back mechanisms') of the IETF IPP Design Goals [RFC2567];

266 An abstract model of a Print Service (i.e., ISO DPA Logical Printer) and a Print Device
267 (i.e., ISO DPA Physical Printer) in section 2.1 of IETF IPP/1.1 [RFC2911];

268 An abstract model of a Print Device and contained Subunits in section 2.2 of the IETF
269 Printer MIB v2 [RFC3805];

270 An abstract model of Finishing Subunits integrated into the Printer Model (from
271 [RFC3805]) in section 3 of the IETF Finisher MIB [RFC3806];

272 A set of Finishing Subunit types in the 'FinDeviceTypeTC' textual convention in IANA
273 Finisher MIB [IANAFIN], originally published in section 7 of the IETF Finisher MIB
274 [RFC3806]; and

275 An abstract model of a Multifunction Device in section 2 of the PWG MFD Model and
276 Common Semantics [PWG5108.01].

277 When deploying printers and MFDs in home and office CPE environments based on
278 telecom service agreements, initial configuration via SNMP and Embedded Web Server is
279 neither feasible nor scalable.

280 Therefore CWMP printer and MFD data models SHOULD:

281 Standardize native CWMP support for secure operations on printers and MFDs;

282 Standardize capabilities to manage, provision, and service these CWMP-based printers
283 and MFDs;

284 Encourage adoption of modern IPP-based printing infrastructures;

285   Encourage adoption of modern PWG Semantic Model-based MFD infrastructures.

286   **3.1.2 Rationale from Broadband Forum Perspective**

287   The Broadband Forum CPE WAN Management Protocol (CWMP) standard [TR-069]
288   defines a set of standard interfaces between the Auto-Configuration Server (ACS) of a
289   service provider and all customer premise equipment (CPE) devices in a customer's
290   network that supports the CWMP device data model.

291   Figure 1 below is excerpted from section 1.2 of Broadband Forum CWMP [TR-069] and
292   depicts the scope of CWMP in an end-to-end WAN network architecture.

293
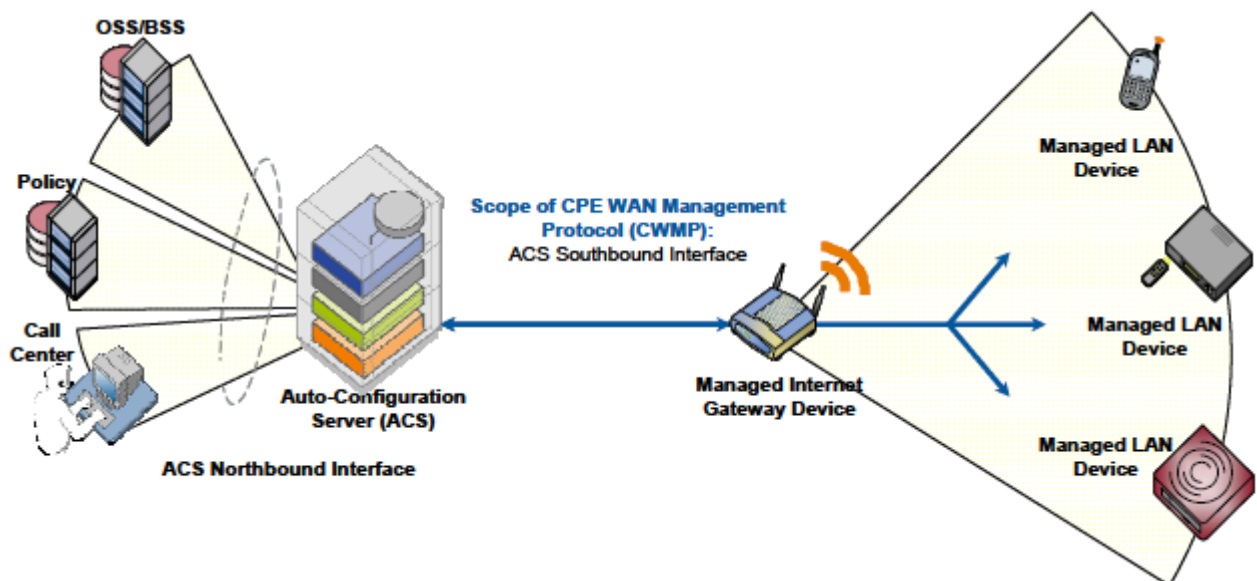
294

295   **Figure 1 – Broadband Forum CWMP End-to-End Architecture**

296   Implementation of CWMP in MFDs would enable a service provider to offer the following
297   advantages throughout the lifecycle of an MFD product:

298   Ease of Deployment: Web-based remote selection, activation, and control of pay-per-use
299   services (e.g. print, copy, scan, fax);

300   Touchless Installation: Automatic discovery, secure configuration, and policy-based
301   setup of MFDs, printers, and their imaging services that is scalable to support many
302   thousands of users according to each user's/group's profile and service contract and the
303   customer's business policies (e.g., access control and monetization of print, fax, scan,
304   copy and other services based on time, volume, user ID, features, payment models, etc.).
305   This is similar to the way mobile phones can be remotely identified, configured, and setup
306   on a broadband network today;

307 Remote Device Management: Provides automatic and secure software/firmware
308 downloads, upgrades, patches, and new value-add services to MFDs, printers, and other
309 imaging devices – provides automatic performance/status monitoring of imaging devices
310 and services; and

311 Remote Diagnostics/Troubleshooting: Provides improved problem resolution capability –
312 eliminates unnecessary and costly device replacement – enhances customer support
313 process.

314 Broadband Forum CWMP standards for the Telecom industry include:

315 A broadband management architecture for CPE devices in CWMP [TR-069];

316 A data model template for all devices that support CWMP in [TR106];

317 A common device data model in [TR-181];

318 An Internet Gateway Device (IGD) data model in [TR-098]; and

319 A series of device-specific CWMP data models based on [TR-106] for DSLHome^{TM} for
320 VoIP [TR-104], Set Top Boxes [TR-135], Storage Service enabled devices [TR-140], and
321 Femto access points [TR-196].

322 There is no currently defined standard TR-069 data model defined for MFDs.

323 By collaborating to propose this MFD data model, the PWG is leading the way for the
324 inclusion of MFDs and printers as part of the managed services offered by Telecom
325 operators by leveraging the PWG Semantic Model [PWG5108.1]. In addition, the PWG is
326 supporting the use of CWMP for MFDs and printers by MPS providers, who will also gain
327 the advantage of managing any TR-069 enabled device – be it a storage device,
328 communications device, or a computing device – this CWMP support would allow MPS
329 providers to evolve into Managed Service Providers (MSPs), in order to compete more
330 effectively with traditional IT and Telecom service providers.
331

3.2 Use Cases

The use cases below are written from the perspective of the End User or local Admin of the MFD or printer being managed as a CPE device.

3.2.1 MFDs managed by Telecom Providers

Customers in home and enterprise environments can use MFDs/Printers that are deployed and maintained by Telecom providers. When the PWG Semantic Model is supported in the proposed Broadband Forum data model for MFDs/Printers, Telecom providers will be able to add these imaging device products into their value added services as part of their managed services portfolios. A user could purchase or lease a TR-069 enabled MDF/Printer, plug it into their network, and have the device automatically securely configured by the Telecom provider's ACS (management server). Based on which services the user has already subscribed to, the device will be appropriately provisioned. Telecom providers could negotiate marketing and support contracts with printer manufacturers for technical support, field service, and toner/supplies replenishment – this would create a whole new revenue stream through a different channel for the printer manufacturers.

3.2.2 MFDs managed by MPS Providers

Customers in enterprise environments can use MFDs/Printers that have been pre-configured and shipped with the domain address of the ACS (management server) used by the MPS provider. When the MFD or Printer is plugged into the enterprise network, the device will automatically contact the ACS, using its pre-configured credentials. Based on the services that have been purchased by the customer, the ACS will automatically securely configure the device (including any firmware updates if necessary). The device will then be under the control of the MPS provider, who can maintain the SLAs, perform toner/supplies replenishment, schedule service calls, and perform metering for control of service levels as well as billing. Through the lifecycle of the product or the service contract, the device will be managed remotely by the MPS provider. If the customer fails to pay or does not renew the service contract, then the device and its services can be disabled remotely by the MPS provider.

3.2.3 MFDs managed by Enterprise IT Staff

Enterprise communications infrastructure devices – routers, bridges, VoIP switches, video telephony servers, etc. – are already typically managed using Broadband Forum CWMP [TR-069]. By adding CWMP clients to MFDs/Printers, manufacturers can ship devices that can all be managed from a single ACS. When devices are physically moved between departments or policies are deployed for usage of these devices – e.g., able to print only black/white but not color or restrictions of usage by page count – or certain departments require stronger security than others, this will necessitate remote configuration and provisioning of these devices. Once a set of policies are created, configuration of these

370 MFD/Printer devices will become automatic instead of based on extensive manual work
371 for IT network operators. This would save time, improve enterprise security and ensure
372 adherence to policy.

373 **3.2.4 Print Kiosks managed by Telecom Providers**

374

375   **Figure 2 – Print Kiosks and Secure Cloud Print Service**

376 In the Cloud Print use cases below, the mobile phones and print kiosks are managed by
377 Telecom providers using CWMP. The mobile phones are managed via Telecom cellular
378 networks, while the print kiosks are managed via Telecom broadband networks. The print
379 kiosks are monitored for status, provisioned with new services, and remote diagnostics
380 are all performed by Telecom providers using CWMP.

381 3.2.4.1 Cloud Print via IPP Everywhere

382 Mobile phone users can access any bundled or 3rd party application (Email, Dropbox,
383 Photoapp, etc.) that shares their desired document (MS Word, PDF, JPEG, etc.) and
384 press the Print button. Using geolocation or other means (default device, last used
385 device, etc.) a list of available Print Kiosks from their Telecom's secure Cloud Print
386 Service is displayed to the user, who then chooses a "nearby" location (same city,
387 neighborhood, building, etc.). The user's print client submits the selected document via
388 PWG IPP Everywhere to their Telecom's secure Cloud Print Service specifying the target
389 Print Kiosk device.

390 3.2.4.2 Cloud Print via Pull Print

391 Mobile phone users can access any bundled or 3rd party application (Email, Dropbox,
392 Photoapp, etc.) that shares their desired document (MS Word, PDF, JPEG, etc.) and
393 press the Print button. The user chooses delayed printing and the user's client submits

394   the selected document via PWG IPP Everywhere to their Telecom's secure Cloud Print
395   Service specifying delayed printing. The user receives a secure job identifier and
396   associated PIN via email, instant messaging, or in-band from their application. At a later
397   time, the user queries for a list of available Print Kiosks from their Telecom's secure Cloud
398   Print Service and then chooses a "nearby" location (same city, neighborhood, building,
399   etc.). The user walks up to their chosen Print Kiosk and enters their job identifier and
400   secure PIN information. The Print Kiosk displays the price for the print job which the user
401   accepts (adding to their monthly bill). The user's job is securely pulled from their
402   Telecom's secure Cloud Print Service via PWG IPP Everywhere and is printed with the
403   requested processing options.

404   ## 3.3 Deployment Scenarios

405
406   Because the architecture of the Broadband Forum CWMP [TR-069] is highly scalable and
407   is designed to provide secure remote services in a firewall-friendly manner, several
408   deployment scenarios can be envisioned. No special ports need to be opened up in
409   corporate firewalls, nor is reverse VPN tunneling required for service management – both
410   of which are nightmares for IT security staff.

411
412   An ACS could be deployed as a service in a public cloud, or in a private cloud for an
413   enterprise network, or as a private self- deployment by IT staff. Telecom providers could
414   manage printers in homes, enterprises, and government agencies. MPS providers could
415   manage multiple enterprises (each of which might have multiple physical sites). Printer
416   manufacturers could manage printers in SOHO networks, production printing facilities, or
417   graphic arts companies. Corporate IT staff could deploy CWMP on an in-house server
418   and then manage devices within their Intranets.

419   ## 3.4 Out of Scope

420   The CWMP printer and MFD data models must not:

421   Define any new content outside the PWG Semantic Model XML schema;

422   Define any semantics for workflow applications;

423   Define any semantics for document repositories; and

424   Define any application-specific semantics for MFD monitoring using CWMP.

425   ## 3.5 Design Requirements

426   The CWMP printer and MFD data models should:

427   Be based on the PWG Semantic Model XML schema definitions;

428   Include all content from the PWG Semantic Model XML schema when possible, e.g.,
429   within the limitations of the BBF data model language;

430   Follow the naming conventions of the PWG Semantic Model XML schema when possible,
431   e.g., within the limitations of BBF data model parameter object and parameter names and
432   name lengths; and

433   Preserve the access control semantics of the PWG Semantic Model XML schema, e.g.,
434   PrintServiceStatus abstract elements are read-only.

435

4. CWMP Data Models

437 This section proposes an outline approach for Broadband Forum [TR-106] data models for
438 Printers, MFDs, and other Imaging Devices that are technically equivalent to the PWG
439 Semantic Model [PWG5108.01]. The top-level PrintService object, named according to
440 the [TR-106] data model conventions, contains the PWG PrintService object.

4.1 Technical Approach

4.1.1 XML Format of BBF CWMP and PWG SM Models

443 Each Broadband Forum CWMP data model is written as a single *XML document instance*
444 (.xml) using data model structural elements (model, object, parameter, etc.) and a small
445 closed set of datatypes that are all pre-defined in a separate external CWMP *XML*
446 *document schema* (.xsd) which does NOT allow complex datatypes (choices, unions,
447 sequences, etc.) to be used in parameter definitions (i.e., elements). Instead such
448 complex datatypes can be translated as: (a) string; (b) list (comma-separated list of
449 strings), or (c) sub-objects (sequence of parameters).

450 The PWG Semantic Model, on the other hand, is written as a set of *XML document*
451 *schema* (.xsd) that each define elements using native XML datatypes (as opposed to the
452 fixed BBF subset) and as well as PWG complex datatypes (e.g., element groups, choices,
453 unions, etc.). Therefore, the existing element dictionary defined in PwgCommon.xsd can't
454 simply be converted to a similar BBF data model (e.g., in sequence clauses), since only a
455 parameter statement can be contained in a BBF object. BBF data models do allow both
456 object reference and parameter reference imports – this is being explored for
457 compactness.

4.1.2 Translation of PWG SM into CWMP Data Models

459 The proposed CWMP PrintService Data Model should be developed as follows:

460 Define translation rules for the PWG complex datatypes and element groups;

461 Machine-translate keyword PWG datatypes in "PwgWellKnownValues.xsd" and
462 "MediaWellKnownValues.xsd" into simple BBF 'string' and save as control files – the
463 authoritative list of standard values remains in the PWG XML Schema and IANA IPP
464 Registry files.

465 Machine-translate other PWG datatypes in "ServiceTypes.xsd", "JobTypes.xsd",
466 "DocumentTypes.xsd", and "WimsType.xsd" into simple BBF types when possible and
467 save as a control file – convert 'choice' and 'union' types into simple BBF 'string' or 'list' or
468 BBF sub-objects (TBD) – convert 'sequence' types into BBF sub-objects.

469 Machine-translate the PWG elements dictionary in PwgCommon.xsd into a BBF
470 parameter dictionary and save as a control file – preserve integer ranges, string lengths,
471 etc.

472 Using the control files output from steps (b) to (d) above, machine-translate the PWG SM
473 PrintService XML schema into an equivalent CWMP Data Model – PWG SM simple
474 elements can be translated one-to-one into BBF parameters – PWG SM element groups
475 can be translated into BBF sub-objects – flatten names whenever possible to shorten fully
476 qualified parameter names – do not translate PrintServiceCapabilitiesReady (too volatile)
477 and JobTable.ActiveJobs (for security);

478 Hand-edit this machine-translated CWMP Data Model in order to fix artifacts and add XML
479 documentation (annotations, comments, etc.).

480 **4.1.3 Simple Parameter Datatypes**

481 Parameters (elements) in BBF data models cannot be defined with syntaxes of sequences
482 or complex types, so such PWG Semantic Model datatypes should be flattened whenever
483 possible, to improve efficiency over limited bandwidth WAN connections to the ACS, for
484 example:

485 PrintServiceCapabilities.PrintDocumentTicketCapabilites.PrintDocumentProcessingCapab
486 ilities.NumberUp (list of integers)
487 → PrintService.Capabilities.DocumentProcessing.NumberUp (string)
488   – comma-separated list of integers

489 PrintServiceStatus.AccessModes (list of keywords)
490 → PrintService.Status.AccessModes (string)
491   – comma-separated list of keywords

492 **4.1.4 Short Parameter Qualified Names**

493 Parameters (elements) in BBF data models are always referred to in CWMP operation
494 requests with fully qualified names (similar to XPath), so redundancy in PWG Semantic
495 Model path names should be eliminated whenever possible, to improve efficiency over
496 limited bandwidth WAN connections to the ACS, for example:

497 PrintService.Configuration.Subunits.InputTrays.InputTray
498 → PrintService.Subunits.InputTray

499 PrintService.Capabilities.PrintJobTicketCapabilities.PrintJobProcessingCapabilities
500 → PrintService.Capabilities.JobProcessing

501 Note: Since each CWMP parameter has explicit access mode (readOnly vs. readWrite),
502 PWG SM MarkerSupplyDescription and MarkerSupplyStatus element groups can be
503 safely folded together into the base CWMP PrintService.Subunits.Marker.MarkerSupply
504 object, while preserving the access control distinctions of the PWG Semantic Model.

505

506   **4.2 PWG SM PrintService Model**

507   The PWG Semantic Model root is the System Object shown in Figure 3 below, which
508   contains the Services group, which in turn contains the PrintServices group. The CWMP
509   PrintService Data Model is derived by a transform of the PWG SM PrintService shown in
510   Figure 4 below.
511
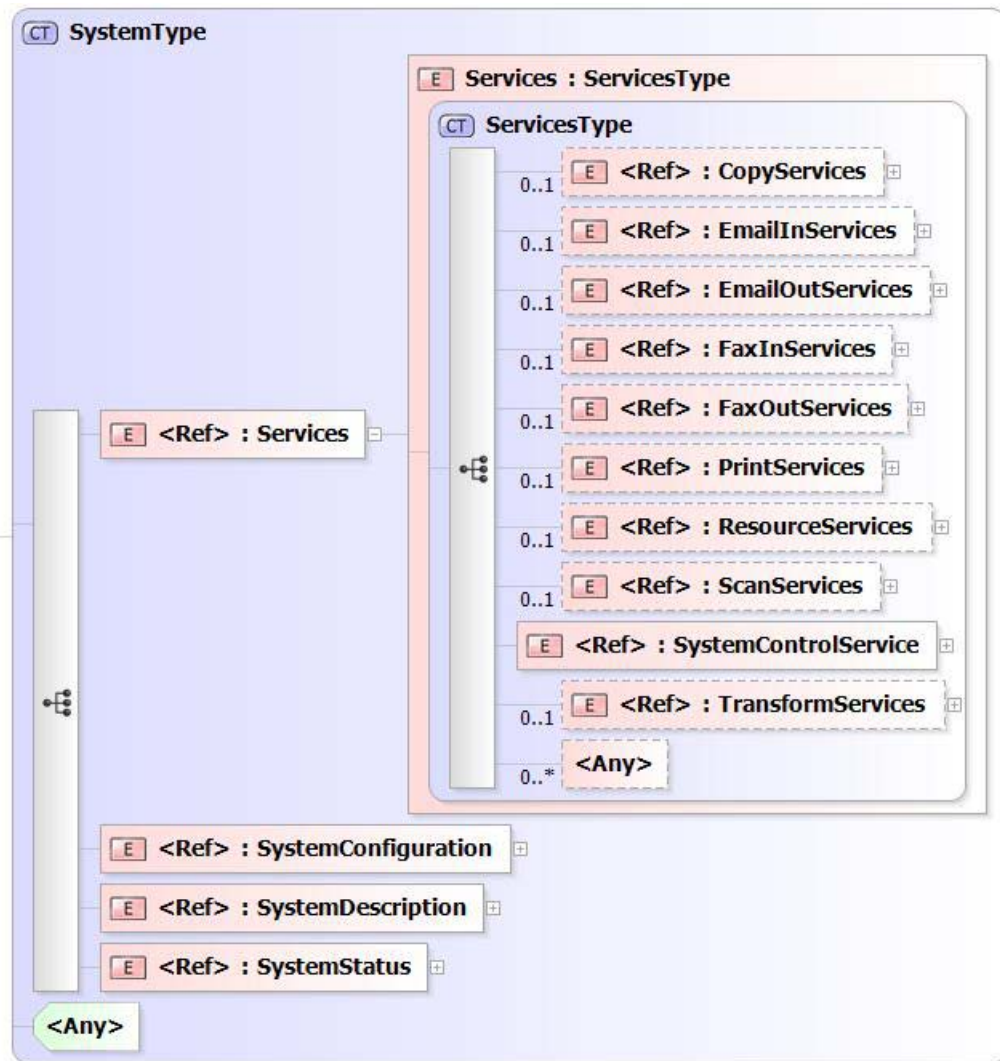
513   **Figure 3 – PWG SM System Object**

514

515
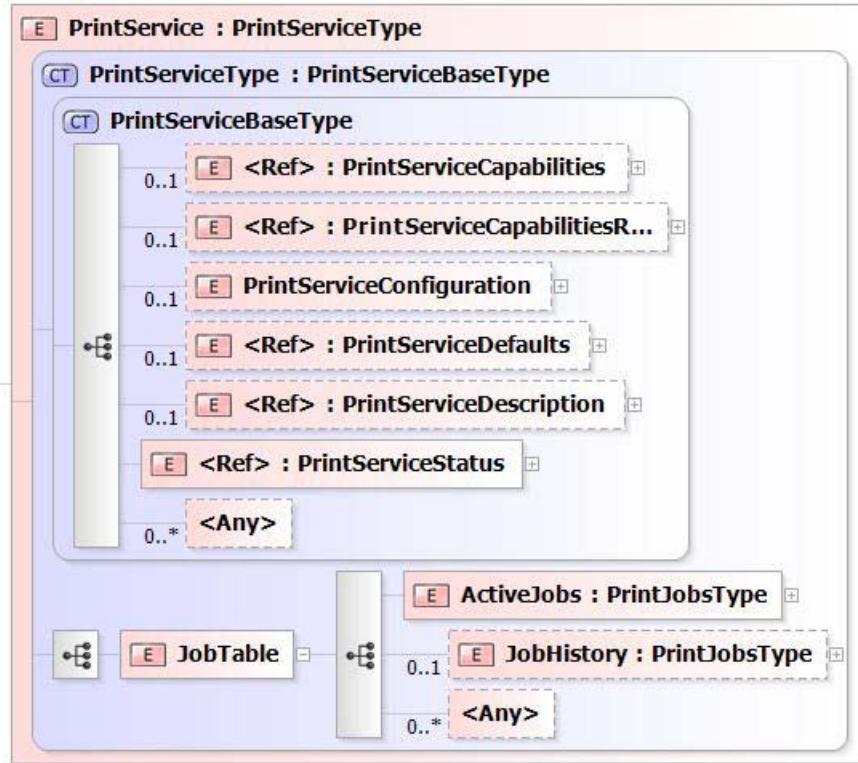
516   **Figure 4 – PWG SM PrintService Object**

517

518
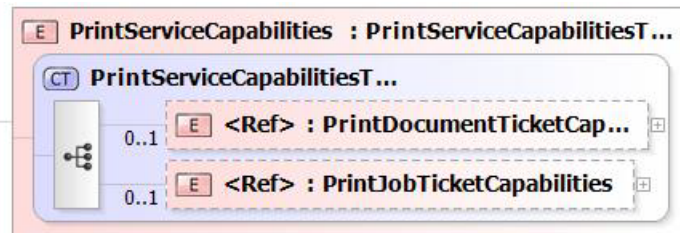
519   **Figure 5 – PWG SM PrintServiceCapabilities Group**

520
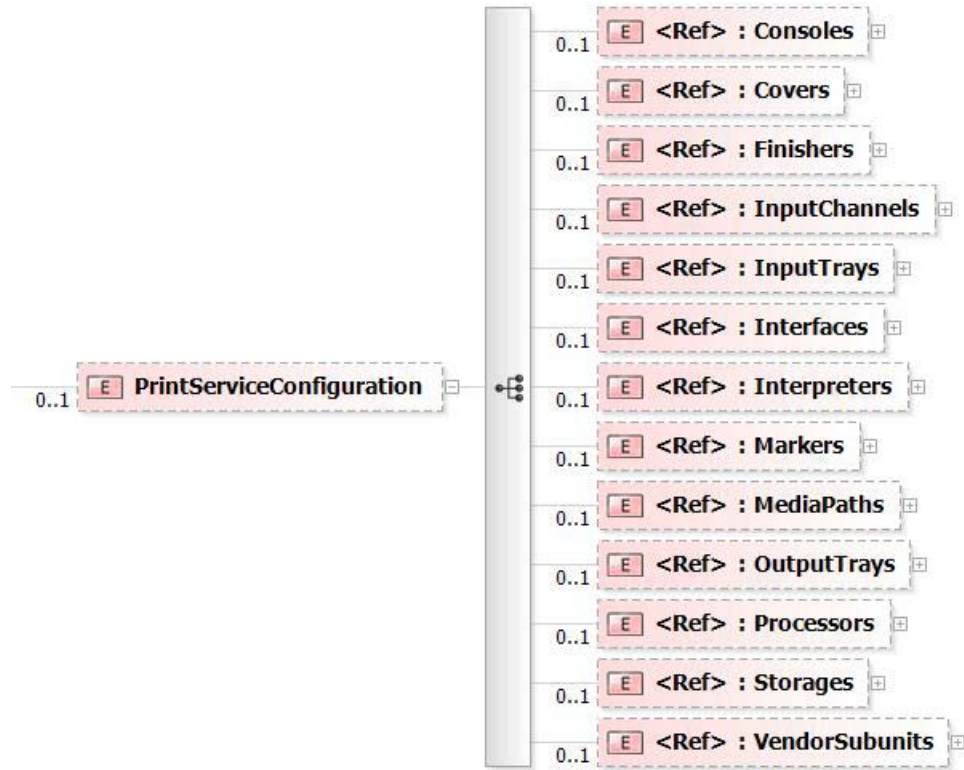
521

522   **Figure 6 – PWG SM PrintServiceConfiguration Group (subunits)**

523
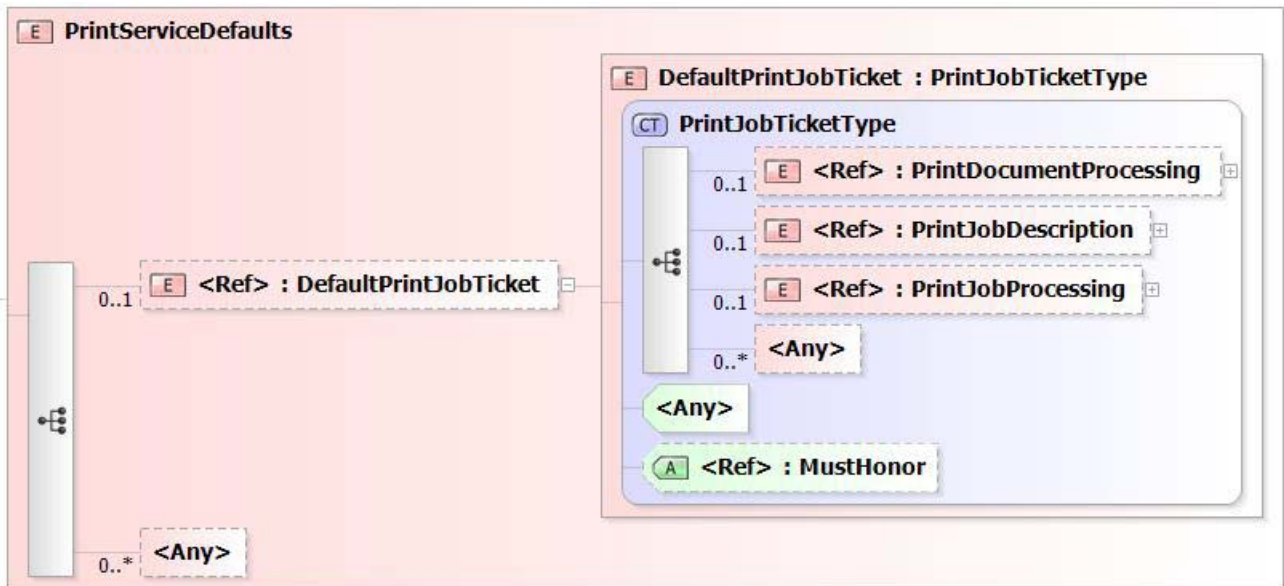
524

525   **Figure 7 – PWG SM PrintServiceDefaults Group**

526
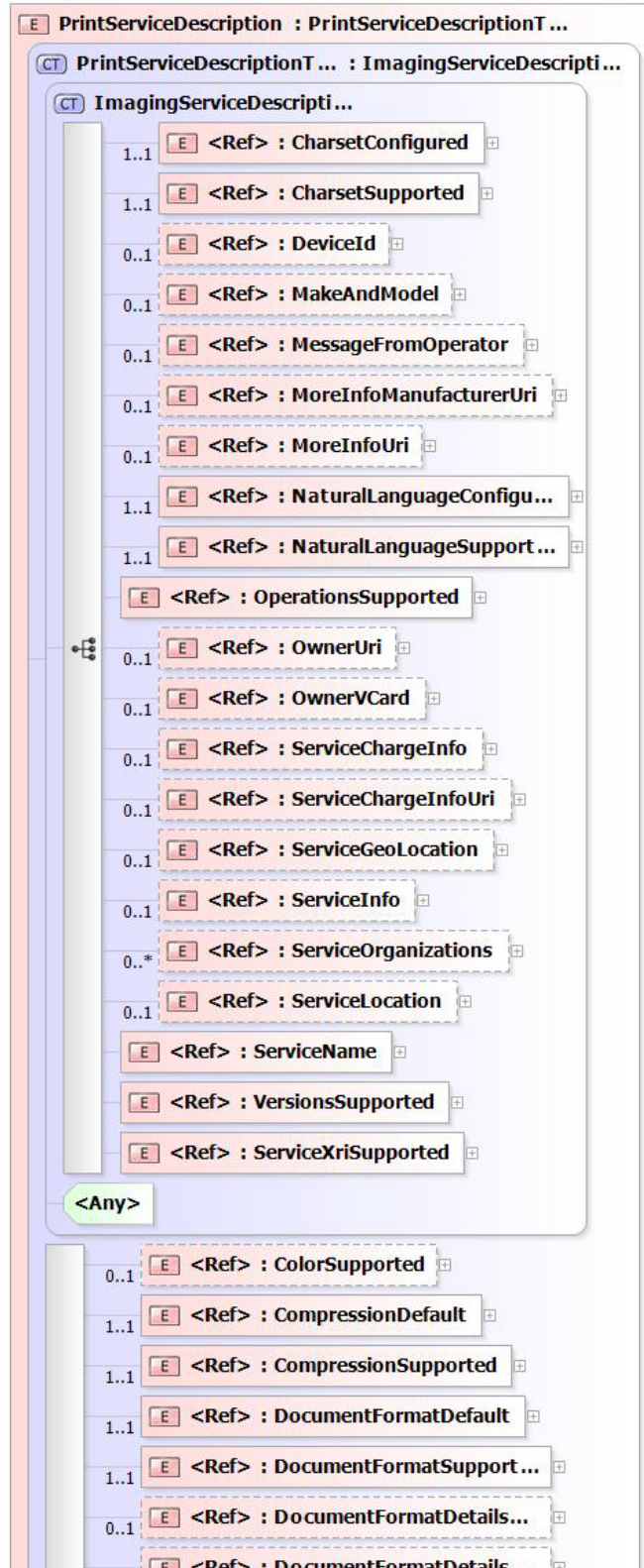
527

528   **Figure 8 – PWG SM PrintServiceDescription Group (excerpt)**

529
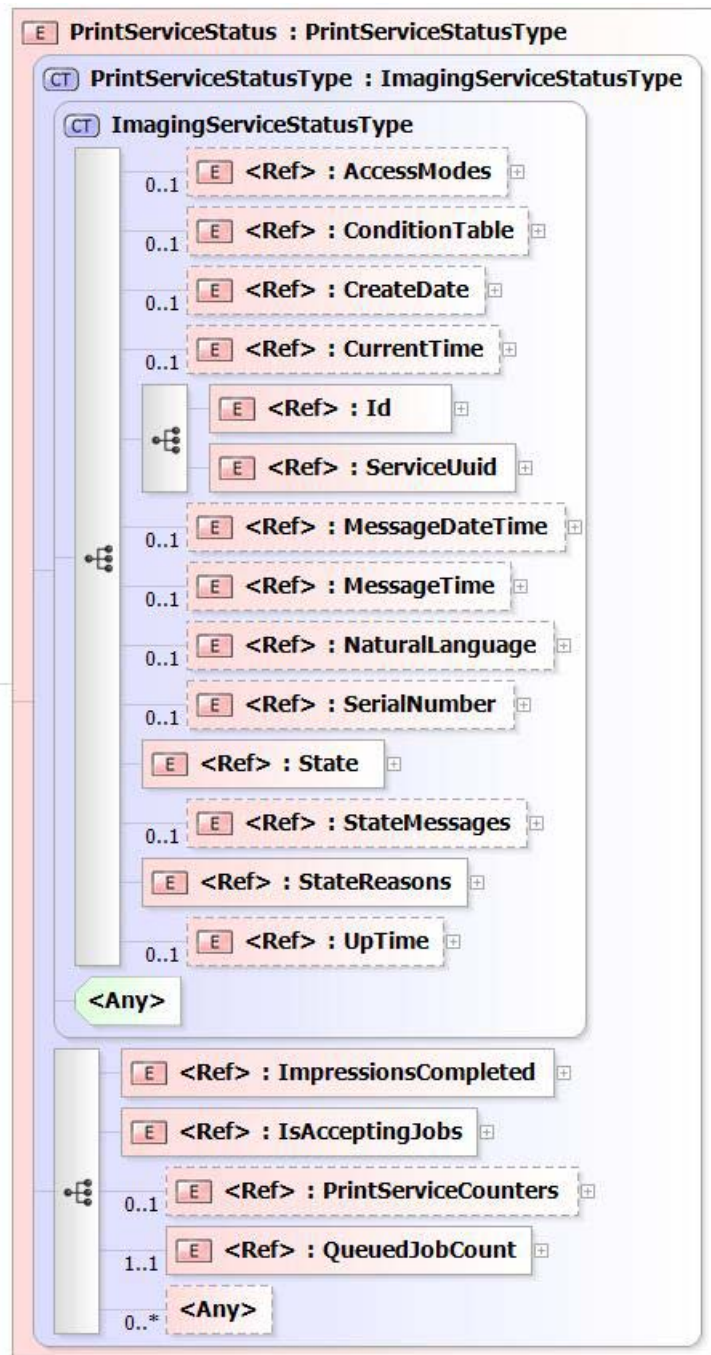
531   **Figure 9 – PWG SM PrintServiceStatus Group**

532
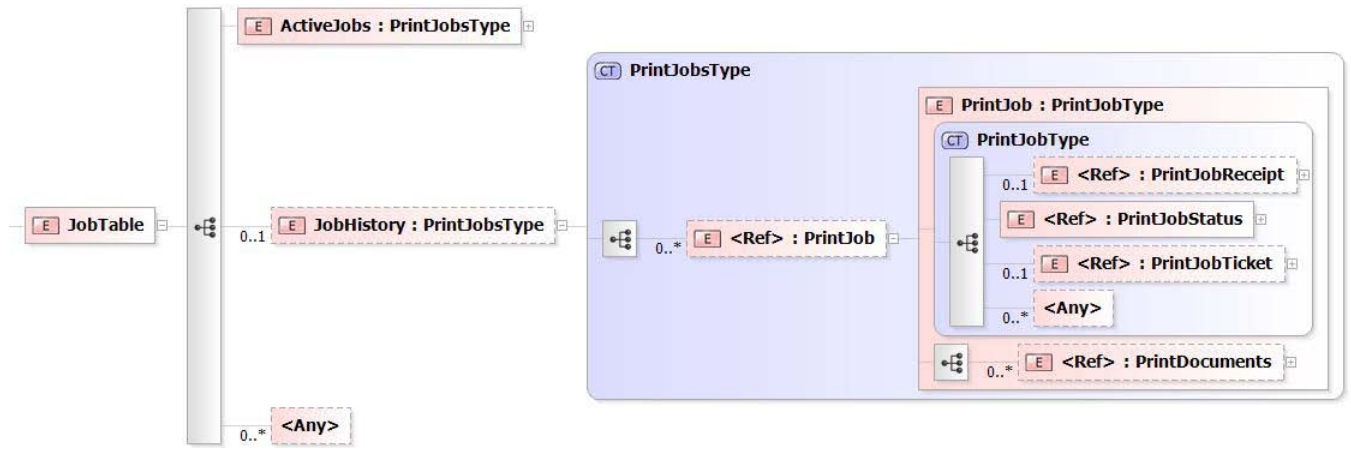
533

534

Figure 10 – PWG SM Print JobTable Group (w/ history)
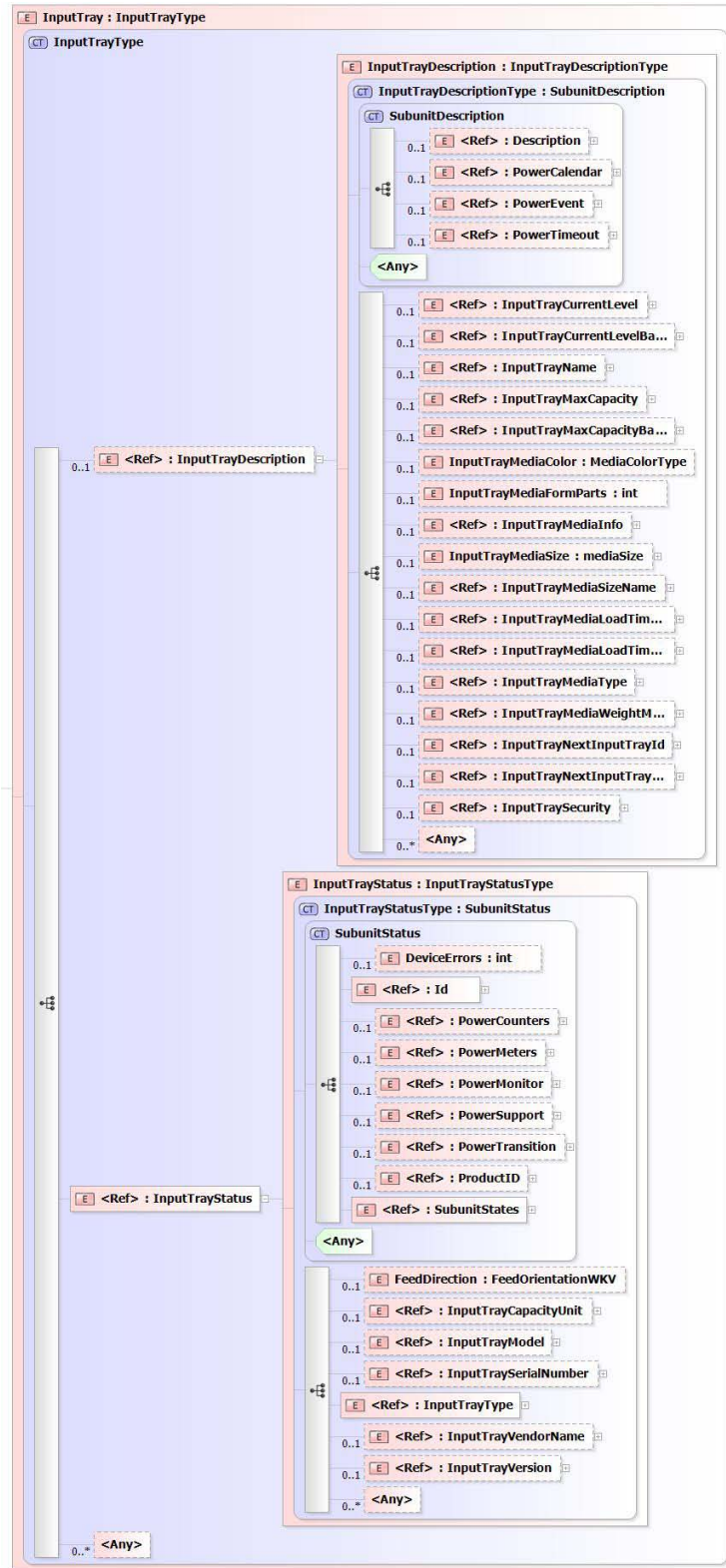
535

536 **Figure 11 – PWG SM InputTray Object**

537
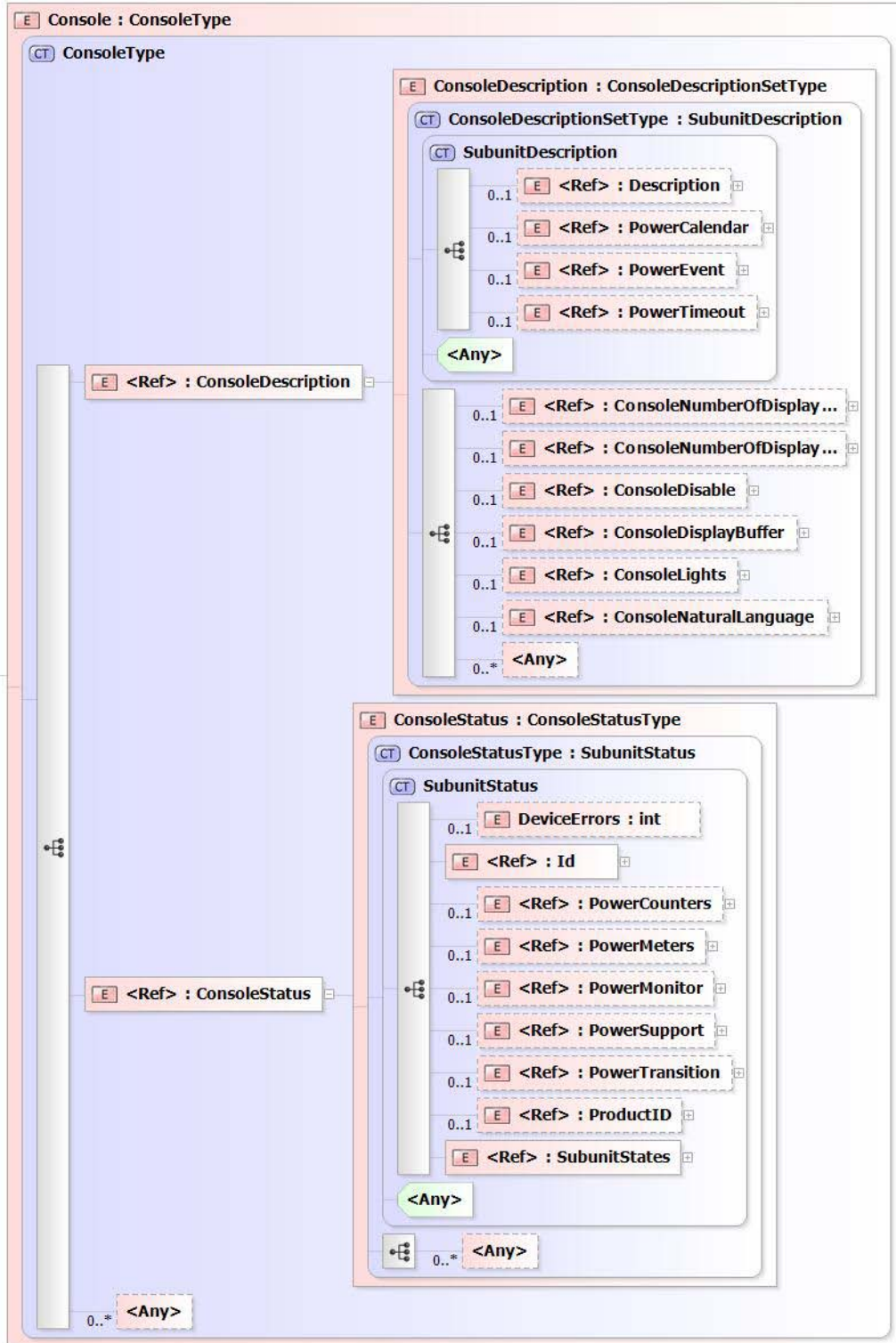
Figure 12 – PWG SM Console Object

538
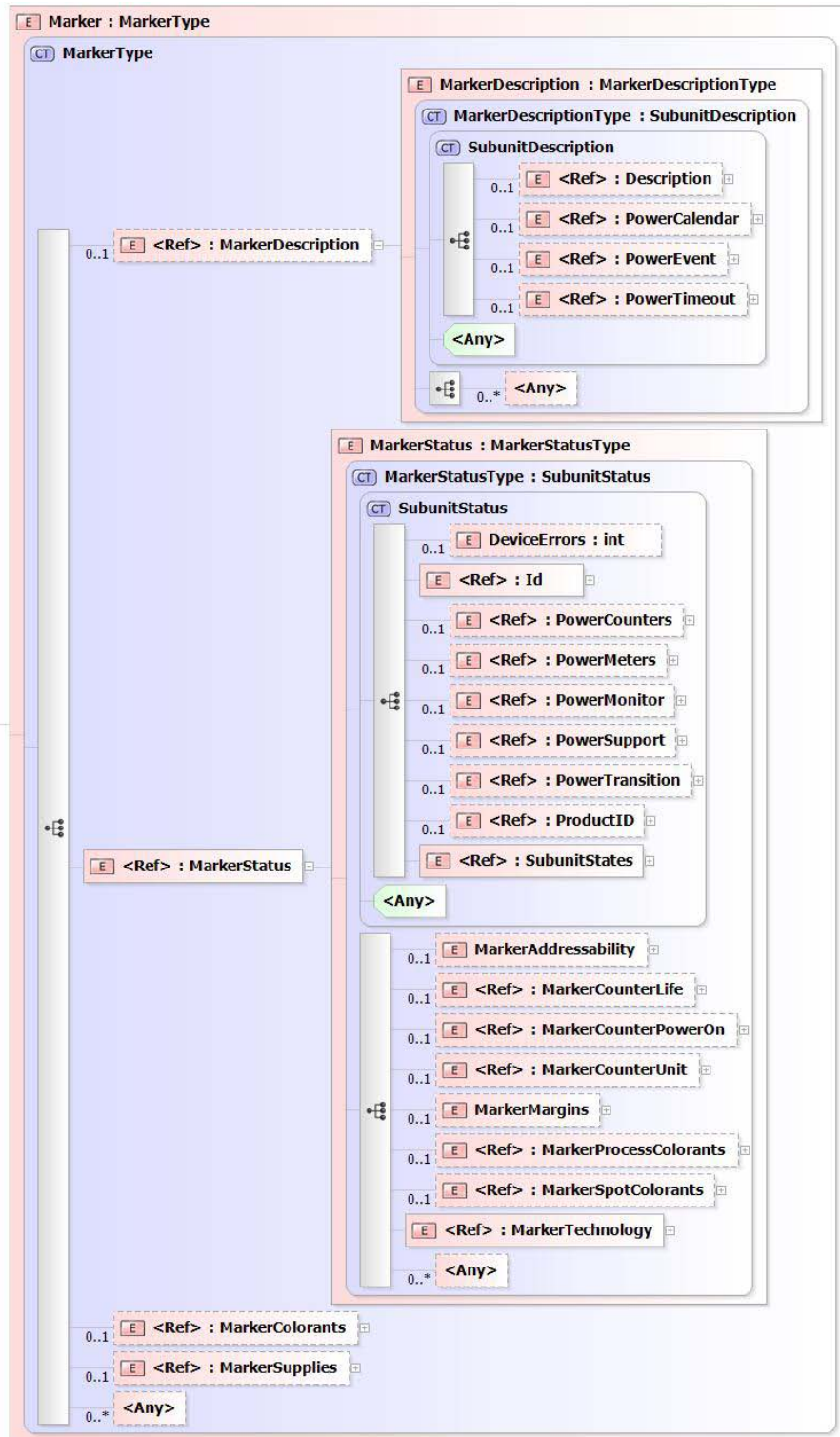
539

540   **Figure 13 – PWG SM Marker Object**
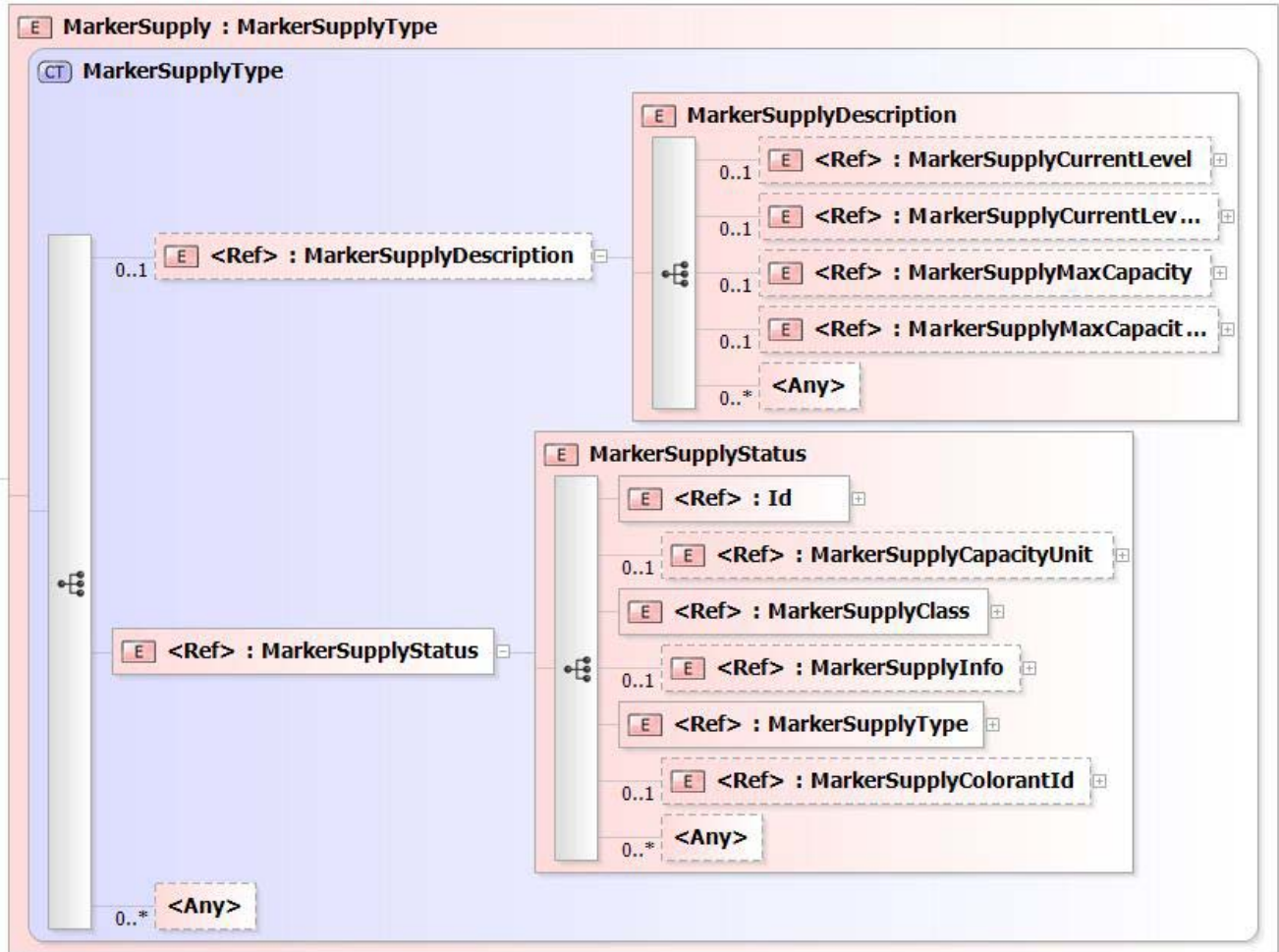
541

542   **Figure 14 – PWG SM MarkerSupply Object**

4.3 CWMP PrintService Data Model

544   The following *XML docment instance* fragment of a CWMP PrintService Data Model
545   illustrates the proposed approach and some of the difficulties in transforming the existing
546   PWG Semantic Model *XML document schema* into a BBF data model [TR-106].

547
```
<?xml version="1.0" encoding="UTF-8"?>
<!-- TR-999 PrintService:1.0 Service Object definition -->
<dm:document xmlns:dm="urn:broadband-forum-org:cwmp:datamodel-1-1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="urn:broadband-forum-org:cwmp:datamodel-1-1 cwmp-datamodel-1-1.xsd"
spec="urn:broadband-forum-org:tr-999-1-0-0">
  <import file="tr-069-biblio.xml" spec="urn:broadband-forum-org:tr-069-biblio"/>
  <import file="tr-106-1-0-types.xml" spec="urn:broadband-forum-org:tr-106-1-0">
    <dataType name="IPAddress"/>
  </import>
  <bibliography>
    <!-- Set of references here -->
```

```
560        <reference id="TR-135">
561          <name>TR-135</name>
562          <title>Data Model for a TR-069 Enabled STB</title>
563          <organization>BBF</organization>
564          <category>TR</category>
565        </reference>
566      </bibliography>
567
568      <!-- CWMP PrintService model with counter of PrintService instances -->
569      <model name="PrintService:1.0" isService="true">
570        <parameter name="PrintServiceNumberOfEntries" access="readOnly">
571          <description>Number of entries in the {{PrintService}} table.
572          </description>
573          <syntax>
574            <unsignedInt/>
575          </syntax>
576        </parameter>
577
578        <!-- CWMP PrintService object with enable/disable -->
579        <object name="PrintService.{i}."
580        access="readOnly" minEntries="0" maxEntries="unbounded"
581        numEntriesParameter="PrintServiceNumberOfEntries">
582          <description>PWG PrintService in Services in the CPE.</description>
583          <parameter name="Enable" access="readWrite">
584            <description>Enables or disables this {{object}} instance.</description>
585            <syntax>
586              <boolean/>
587            </syntax>
588          </parameter>
589        </object>
590
591        <object name="PrintService.{i}.Subunits."
592        access="readOnly" minEntries="1" maxEntries="1">
593          <description>PWG PrintServiceConfiguration in the CPE.</description>
594          <parameter name="InputTrayNumberOfEntries" access="readOnly">
595            <description>Number of entries in the {{InputTray}} table.</description>
596            <syntax>
597              <unsignedInt/>
598            </syntax>
599          </parameter>
600          <parameter name="MarkerNumberOfEntries" access="readOnly">
601            <description>Number of entries in the {{Marker}} table.</description>
602            <syntax>
603              <unsignedInt/>
604            </syntax>
605          </parameter>
606          <parameter name="ProcessorNumberOfEntries" access="readOnly">
607            <description>Number of entries in the {{Processor}} table.</description>
608            <syntax>
609              <unsignedInt/>
610            </syntax>
611          </parameter>
612          <!-- more number of entries parameters for all subunit tables -->
613        </object>
614
615        <object name="PrintService.{i}.Subunits.InputTray.{i}."
616        access="readOnly" minEntries="1" maxEntries="unbounded"
617        numEntriesParameter="InputTrayNumberOfEntries">
618          <description>PWG InputTray in the CPE.</description>
619          <parameter name="Enable" access="readWrite">
620            <description>Enables or disables this {{object}} instance.</description>
621            <syntax>
```

```
622            <boolean/>
623          </syntax>
624        </parameter>
625
626        <!-- PWG InputTrayDescription parameters -->
627        <parameter name="Description" access="readWrite">
628          <syntax>
629            <string/>
630          </syntax>
631        </parameter>
632
633        <!-- PWG InputTrayStatus parameters -->
634        <parameter name="DeviceErrors" access="readOnly">
635          <syntax>
636            <int/>
637          </syntax>
638        </parameter>
639        <parameter name="Id" access="readOnly">
640          <syntax>
641            <int/>
642          </syntax>
643        </parameter>
644        <!-- more parameter definitions that correspond to PWG SM schema elements -->
645      </object>
646
647      <object name="PrintService.{i}.Subunits.Marker.{i}."
648      access="readOnly" minEntries="1" maxEntries="unbounded"
649      numEntriesParameter="MarkerNumberOfEntries">
650        <description>PWG Marker in the CPE.</description>
651        <parameter name="Enable" access="readWrite">
652          <description>Enables or disables this {{object}} instance.</description>
653          <syntax>
654            <boolean/>
655          </syntax>
656        </parameter>
657        <parameter name="ColorantNumberOfEntries" access="readOnly">
658          <description>Number of entries in the {{Colorant}} table.</description>
659          <syntax>
660            <unsignedInt/>
661          </syntax>
662        </parameter>
663        <parameter name="SupplyNumberOfEntries" access="readOnly">
664          <description>Number of entries in the {{Supply}} table.</description>
665          <syntax>
666            <unsignedInt/>
667          </syntax>
668        </parameter>
669
670        <!-- PWG MarkerDescription parameters -->
671        <parameter name="Description" access="readWrite">
672          <syntax>
673            <string/>
674          </syntax>
675        </parameter>
676
677        <!-- PWG MarkerStatus parameters -->
678        <parameter name="DeviceErrors" access="readOnly">
679          <syntax>
680            <int/>
681          </syntax>
682        </parameter>
683        <parameter name="Id" access="readOnly">
```

```
684          <syntax>
685            <int/>
686          </syntax>
687        </parameter>
688      </object>
689
690      <object name="PrintService.{i}.Subunits.Marker.{i}.Supply.{i}."
691      access="readOnly" minEntries="1" maxEntries="unbounded"
692      numEntriesParameter="SupplyNumberOfEntries">
693        <description>PWG MarkerSupplies in the CPE.</description>
694        <parameter name="Enable" access="readWrite">
695          <description>Enables or disables this {{object}} instance.</description>
696          <syntax>
697            <boolean/>
698          </syntax>
699        </parameter>
700
701        <!-- PWG MarkerSupplyDescription parameters -->
702        <parameter name="Description" access="readWrite">
703          <syntax>
704            <string/>
705          </syntax>
706        </parameter>
707
708        <!-- PWG MarkerSupplyStatus parameters -->
709        <parameter name="Id" access="readOnly">
710          <syntax>
711            <int/>
712          </syntax>
713        </parameter>
714        <!-- more parameter definitions that correspond to PWG SM schema elements -->
715      </object>
716
717      <object name="PrintService.{i}.Subunits.Processor.{i}."
718      access="readOnly" minEntries="1" maxEntries="unbounded"
719      numEntriesParameter="ProcessorNumberOfEntries">
720        <description>PWG Processor in the CPE.</description>
721        <parameter name="Enable" access="readWrite">
722          <description>Enables or disables this {{object}} instance.</description>
723          <syntax>
724            <boolean/>
725          </syntax>
726        </parameter>
727        <parameter name="PowerCalendarNumberOfEntries" access="readOnly">
728          <description>Number of entries in the {{PowerCalendar}} table.</description>
729          <syntax>
730            <unsignedInt/>
731          </syntax>
732        </parameter>
733        <parameter name="PowerEventNumberOfEntries" access="readOnly">
734          <description>Number of entries in the {{PowerEvent}} table.</description>
735          <syntax>
736            <unsignedInt/>
737          </syntax>
738        </parameter>
739        <parameter name="PowerTimeoutNumberOfEntries" access="readOnly">
740          <description>Number of entries in the {{PowerTimeout}} table.</description>
741          <syntax>
742            <unsignedInt/>
743          </syntax>
744        </parameter>
745      </object>
```

```
746
747     <object name="PrintService.{i}.Subunits.Processor.{i}.PowerCalendar.{i}."
748     access="readOnly" minEntries="1" maxEntries="unbounded"
749     numEntriesParameter="PowerCalendarNumberOfEntries">
750       <description>PWG ProcessorDescription.PowerCalendar in the CPE.</description>
751       <parameter name="Id" access="readOnly">
752         <syntax>
753           <int/>
754         </syntax>
755       </parameter>
756       <parameter name="RequestPowerState" access="readWrite">
757         <syntax>
758           <string/>
759         </syntax>
760       </parameter>
761       <parameter name="CalendarRunOnce" access="readWrite">
762         <syntax>
763           <boolean/>
764         </syntax>
765       </parameter>
766     </object>
767
768
769     <object name="PrintService.{i}.Capabilities."
770     access="readOnly" minEntries="1" maxEntries="1">
771       <description>PWG PrintServiceCapabilities in the CPE.</description>
772       <parameter name="Enable" access="readWrite">
773         <description>Enables or disables this {{object}} instance.</description>
774         <syntax>
775           <boolean/>
776         </syntax>
777       </parameter>
778     </object>
779
780     <object name="PrintService.{i}.Capabilities.JobDescription."
781     access="readOnly" minEntries="1" maxEntries="1">
782       <description>PWG PrintJobDescriptionCapabilities in the CPE.</description>
783       <parameter name="ElementsNaturalLanguage" access="readWrite">
784         <syntax>
785           <string/>
786         </syntax>
787       </parameter>
788       <!-- more parameter definitions that correspond to PWG SM schema elements -->
789     </object>
790
791     <object name="PrintService.{i}.Capabilities.JobProcessing."
792     access="readOnly" minEntries="1" maxEntries="1">
793       <description>PWG PrintJobProcessingCapabilities in the CPE.</description>
794       <parameter name="JobDelayOutputUntil" access="readWrite">
795         <syntax>
796           <string/>
797         </syntax>
798       </parameter>
799       <!-- more parameter definitions that correspond to PWG SM schema elements -->
800     </object>
801
802     <object name="PrintService.{i}.Capabilities.DocumentDescription."
803     access="readOnly" minEntries="1" maxEntries="1">
804       <description>PWG PrintDocumentDescriptionCapabilities in the CPE.</description>
805       <parameter name="DocumentDigitalSignature" access="readWrite">
806         <syntax>
807           <string/>
```

```
808            </syntax>
809          </parameter>
810          <!-- more parameter definitions that correspond to PWG SM schema elements -->
811        </object>
812
813        <object name="PrintService.{i}.Capabilities.DocumentProcessing." access="readOnly"
814        minEntries="1" maxEntries="1">
815          <description>PWG PrintDocumentProcessingCapabilities in the CPE.</description>
816          <parameter name="NumberUp" access="readWrite">
817            <description>Comma-separated list of allowed integer values</description>
818            <syntax>
819              <list/>
820                  <int/>
821            </syntax>
822          </parameter>
823          <!-- more parameter definitions that correspond to PWG SM schema elements -->
824        </object>
825
826        <!-- skip PWG PrintServiceCapabilitiesReady – not interesting over broadband -->
827
828        <object name="PrintService.{i}.Defaults."
829        access="readOnly" minEntries="1" maxEntries="1">
830          <description>PWG PrintServiceDefaults in the CPE.</description>
831          <parameter name="Enable" access="readWrite">
832            <description>Enables or disables this {{object}} instance.</description>
833            <syntax>
834              <boolean/>
835            </syntax>
836          </parameter>
837        </object>
838
839        <object name="PrintService.{i}.Defaults.JobDescription."
840        access="readOnly" minEntries="1" maxEntries="1">
841          <description>PWG PrintJobDescription in the CPE.</description>
842          <parameter name="ElementsNaturalLanguage" access="readWrite">
843            <syntax>
844              <string/>
845            </syntax>
846          </parameter>
847          <!-- more parameter definitions that correspond to PWG SM schema elements -->
848        </object>
849
850        <object name="PrintService.{i}.Description."
851        access="readOnly" minEntries="1" maxEntries="1">
852          <description>PWG PrintServiceDescription in the CPE.</description>
853          <parameter name="CharsetConfigured" access="readWrite">
854            <syntax>
855              <string/>
856            </syntax>
857          </parameter>
858          <!-- more parameter definitions for all PrintService description -->
859        </object>
860
861        <object name="PrintService.{i}.Status."
862        access="readOnly" minEntries="1" maxEntries="1">
863          <description>PWG PrintServiceStatus in the CPE.</description>
864          <parameter name="AccessModes" access="readOnly">
865            <description>Comma-separated list of access mode keywords</description>
866            <syntax>
867              <list/>
868                  <string/>
869            </syntax>
```

```
870          </parameter>
871          <parameter name="ConditionNumberOfEntries" access="readOnly">
872            <description>Number of entries in the {{Condition}} table.</description>
873            <syntax>
874              <unsignedInt/>
875            </syntax>
876          </parameter>
877          <parameter name="CreateDate" access="readOnly">
878            <syntax>
879              <string/>
880            </syntax>
881          </parameter>
882        <!-- more parameter definitions for PrintService status -->
883        </object>
884
885        <!-- profile statements – i.e., imported profiles start here -->
886      </model>
887    </dm:document>
888
889
```

890 **5. Proxy Implementation Guidance**

891 **5.1 PWG PrintService to IPP Proxy Guidance**

892   **Table 1 – PWG PrintService to IPP Proxy Mapping**

PWG PrintService Group/Element	IPP Printer/Job Attribute	IETF/PWG Reference
PrintServiceCapabilities→	Printer→	RFC 2911
PrintDocumentTicketCapabilities→		
PrintDocumentDescriptionCapabilities→ (ImagingDocumentDescriptionCapabilities)		
DocumentDigitalSignature	document-digital-signature-supported	PWG5100.7
DocumentMessage	(none – 'true' for PWG5100.7)	PWG5100.7
DocumentName	(none – 'true' for PWG5100.7)	PWG5100.7
DocumentNaturalLanguage	document-natural-language-supported	PWG5100.7
(PrintService specific elements)		
CompressionSupplied	compression-supported	RFC 2911
DocumentCharsetSupplied	document-charset-supported	PWG5100.7
DocumentDigitalSignatureSupplied	document-digital-signature-supported	PWG5100.7
DocumentFormatDetailsSupplied	document-format-details-supported	PWG5100.7
DocumentFormatSupplied	document-format-supported	RFC 2911
DocumentFormatVersionSupplied	document-format-version-supported	PWG5100.7
DocumentMessageSupplied	(none – 'true' for PWG5100.7)	PWG5100.7
DocumentMetadata	(none – 'true' for JPS3)	JPS3
DocumentNameSupplied	(none – 'true' for PWG5100.7)	PWG5100.7
DocumentUri	(none – 'true' for PWG5100.5)	PWG5100.5
Impressions	(none – 'true' for PWG5100.5)	PWG5100.5
KOctets	(none – 'true' for PWG5100.5)	PWG5100.5
MediaSheets	(none – 'true' for PWG5100.5)	PWG5100.5
PageOrderReceived	(none – 'true' for PWG5100.5)	PWG5100.5
PrintDocumentProcessingCapabilities→ (ImagingDocumentProcessingCapabilities)		
NumberUp	number-up-supported	RFC 2911

PWG PrintService Group/Element	IPP Printer/Job Attribute	IETF/PWG Reference
PresentationDirectionNumberUp	presentation-direction-number-up	PWG5100.3
(PrintService specific elements)		
Copies	copies-supported	RFC 2911
CoverBack	job-cover-back-supported	PWG5100.5
CoverFront	job-cover-front-supported	PWG5100.5
DocumentPassword	document-password-supported	JPS3
FeedOrientation	feed-orientation-supported	PWG5100.11
Finishings	finishings-supported	RFC 2911
FinishingsCol	finishings-col-supported	PWG5100.3
FontNameRequested	font-name-requested-supported	PWG5100.11
FontSizeRequested	font-size-requested-supported	PWG5100.11
ForceFrontSize	force-front-side-supported	PWG5100.3
ImpositionTemplate	imposition-template-supported	PWG5100.3
InsertSheets	insert-sheet-supported	PWG5100.3
Media	media-supported	RFC 2911
MediaType	media-type-supported	PWG5100.3
MediaColDatabase	(none – not in CWMP model)	PWG5100.11
MediaColSupported	media-col-supported	PWG5100.3
MediaInputTrayCheck	media-input-tray-check-supported	PWG5100.3
OrientationRequested	orientation-requested-supported	RFC 2911
OutputBin	output-bin-supported	PWG5100.2
OutputDevice	output-device-supported	PWG5100.7
PageDelivery	page-delivery-supported	PWG5100.3
PageRanges	page-ranges-supported	RFC 2911
PagesPerSubset	pages-per-subset-supported	JPS3
PrintColorMode	print-color-mode-supported	JPS3
PrintContentOptimize	print-content-optimize-supported	PWG5100.7
PrintRenderingIntent	print-rendering-intent-supported	JPS3
Quality	print-quality-supported	RFC 2911
Resolution	printer-resolution-supported	RFC 2911
SeparatorSheets	separator-sheets-supported	PWG5100.3
SheetCollate	sheet-collate-supported	RFC 3381
Sides	sides-supported	RFC 2911
XImagePosition	x-image-position-supported	PWG5100.3

PWG PrintService Group/Element	IPP Printer/Job Attribute	IETF/PWG Reference
XImageShift	x-image-shift-supported	PWG5100.3
XSide1ImageShift	x-side1-image-shift-supported	PWG5100.3
XSide2ImageShift	x-side2-image-shift-supported	PWG5100.3
YImagePosition	y-image-position-supported	PWG5100.3
YImageShift	y-image-shift-supported	PWG5100.3
YSide1ImageShift	y-side1-image-shift-supported	PWG5100.3
YSide2ImageShift	y-side2-image-shift-supported	PWG5100.3

PWG PrintService Group/Element	IPP Printer/Job Attribute	IETF/PWG Reference

PWG PrintService Group/Element	IPP Printer/Job Attribute	IETF/PWG Reference

PWG PrintService Group/Element	IPP Printer/Job Attribute	IETF/PWG Reference

893

894 **5.2 PWG PrintService to SNMP Proxy Guidance**

895 **6. Conformance Requirements**

896 Provide a list of conformance requirements for the standard.

897 # 7. Internationalization Considerations

898 For interoperability and basic support for multiple languages, conforming implementations
899 MUST support the UTF-8 [RFC3629] encoding of Unicode [UNICODE] [ISO10646].

900 # 8. Security Considerations

901 Provide security considerations for this specification.

902 # 9. IANA Considerations

903 Provide IANA registration information for this specification.

904 Subsections include IANA registration templates using the Example style:

905   `Some IANA registration text.`

906

10. References

10.1 Normative References

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978

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995

996

12. Change History

12.1 March 12, 2012

Sixth draft.

- Revised section 4.2 to update PWG SM figures as needed.
- Added new section 5 Proxy Implementation Guidance.
- Added new section 5.1 PWG PrintService to IPP Proxy Guidance.
- Added new Table 1 PWG PrintService to IPP Proxy Mapping, filling in for PrintServiceCapabilities.

12.2 December 5, 2011

Fifth draft.

- Nancy Chen revised PrintService sketch in section 4.3 to fix XML syntax and editing errors to allow correct display in Altova XML Spy – thanks!

12.3 December 3, 2011

Fourth draft.

- Revised Abstract, Introduction, etc., to reflect phased approach – PrintService first, then other Scan, Fax, MFD, etc., data models per CWMP BOF discussions.
- Added new section 4.1 Approach to Technical Approach, for clarity.
- Added new section 4.2 PWG Semantic Model Print Service, with current PWG SM figures for System, PrintService, all top groups w/in PrintService, and selected Subunits to clarify the mapping.
- Moved former section 4.1 to section 4.3 CWMP PrintService Data Model per CWMP BOF discussions.
- Revised section 4.3 to remove secondary Device.Config and Device.UserInterface objects – changed to service-centric model of STB (TR-135) and Storage (TR-140).

12.4 September 26, 2011

Third draft.

- Corrected various typos per Nancy Chen, Ranga Raj, and Laxman J. Bhat.

1028   -   Revised section 3.2.4 Print Kiosks managed by Telecom Providers to add
1029   introduction to Cloud Print use cases and notion of management/provisioning of the
1030   Print Kiosks by Telecom providers per Laxman J. Bhat.
1031   -   Revised section 4.1 MFDService Model to use correct Secondary Common Objects
1032   of Device.Config and Device.UserInterface per Laxman J. Bhat.

1033

12.5 September 21, 2011

1035   Second draft.
1036
1037   -   Revised section 3.1 Rationale to include content from Nancy Chen.
1038   -   Revised section 3.2 Use Cases to include content from Ranga Raj.
1039   -   Added section 3.3 Deployment Scenarios to include content from Ranga Raj.
1040   -   Revised section 4 MFD Data Model for CWMP to explain machine translation.
1041   -   Revised section 4.1 MFDService Model to add realistic excerpts from PWG SM.

12.6 September 14, 2011

1043   Initial draft.